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WATER PROTECTION AND LAND REUSE

NOV 01 2013

REMEDIATION DIVISION

November 1, 2013

Ms. Amanda Killeen
Remediation Division
Bureau of Water Protection & Land Reuse
Connecticut Department of Energy and Environmental Protection
79 Elm Street
Hartford CT 06106

Re: Off-site Environmental Impact Evaluation Report
Scofieldtown Park
Stamford CT
TRC Project No. 191277

Dear Amanda:

Enclosed please find one copy of the Off-site Environmental Impact Evaluation Report for the Scofieldtown Park. Also included is a CD-ROM that contains an electronic file of the complete document. Should you have any questions or require any additional information or copies of the report, please contact me at 860-298-6219 or strombetta@trcsolutions.com .

Yours truly,
TRC ENVIRONMENTAL CORPORATION

Sarah J. Trombetta

Sarah J. Trombetta, LEP, CPG
Senior Project Manager

Encl.

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OFFSITE ENVIRONMENTAL IMPACT EVALUATION REPORT

SCOFIELDTOWN PARK, STAMFORD, CT

Submitted to:

City of Stamford
Stamford, Connecticut

Submitted by:

TRC Environmental Corporation
Windsor, Connecticut

October 2013

OFF-SITE IMPACT EVALUATION REPORT

For

SCOFIELDTOWN PARK
STAMFORD, CONNECTICUT

Prepared for

City of Stamford
Stamford, Connecticut

Prepared by

TRC
Windsor, Connecticut

October 2013

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TRC
Windsor, Connecticut

Carl N. Stopper, PE
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October 2013

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1.0 **INTRODUCTION**

On September 10, 2010, the Connecticut Department of Environmental Protection (CTDEP) (now referred to as the Connecticut Department of Energy and Environmental Protection (CTDEEP)) and the City of Stamford (City) entered into a Consent Order (SRD-205) (Appendix A) that stipulated the requirements of immediate actions to be taken by the City with respect to a former landfill (site) located between Scofieldtown Road and Rock Rimmon Road in the northern part of the City (see Figure 1). The site currently contains City Public Works operations that will continue until closure construction commences. TRC Environmental Corporation (TRC) was retained to provide a Professional Engineer (PE), licensed to practice in the state of Connecticut, to oversee the development and submittal of all required documents pursuant to this order as prescribed in Section B, Number 1a of the Consent Order, as well as a Licensed Environmental Professional (LEP) to assess existing leachate quality and propose a long-term water quality monitoring program and implement the requirements of the approved plan as prescribed in Section B, Number 1b.

This document presents the actions taken to date necessary to complete the closure and meets the requirements of Section B, Number 2 of the Consent Order. This Off-site Impact Evaluation Report (OIER) has been prepared in accordance the Closure Plan (CP) dated March 2011 (approved by CTDEEP on and addresses the following items:

- An evaluation of the potential impact of the landfill to off-site areas, including leachate seeps and impacts to surface water and groundwater; and
- An evaluation of leachate quality;

1.1 Objective

This OIER describes the investigation procedures and methodologies that were used to obtain data and information necessary to complete the above tasks at and near the site. The accumulated information gained from this evaluation of the site and the surrounding area were used in conjunction with previous investigations to determine the geology and hydrogeology of the site area as it affects soil and groundwater contaminant concentrations and leachate fate and transport. The final landfill closure planning will incorporate current site conditions, surrounding site conditions and land use, final end use of the capped landfill site and impacts to off-site areas as defined by this investigation.

The approach used for each task was to provide as much information as possible to meet the requirements of the landfill closure regulations and achieve compliance with the remediation standards regulations (RCSA §22a-133k 1 through 3). This plan will present the recommended actions to meet those requirements and satisfy the stipulations of the Consent Order.

This OIER provides introductory information in Section 1.0, including the overall project objective and schedule. Section 2.0 describes relevant background information, including site location and description, as well as information regarding the previous investigations. Section 3.0 provides the evaluation, approach, and procedures employed to complete the off-site impact evaluation. Section 4.0 describes the leachate seep investigation. Section 5.0 discusses the Quality Assurance/ Quality Controls implemented as part of this evaluation. Lastly, Section 6.0 describes the proposed future use of the site.

1.2 Project Organization

The Project Director for the landfill closure is Lou Casolo (City Engineer). The Project Manager for the landfill closure activities is Jeff Brown. Investigation and closure design services have been completed under the supervision of Carl Stopper, PE and Sarah Trombetta, LEP under contract to the City. All work activities have been closely coordinated with representatives of the City.

1.3 Project Schedule

The closure activities to date have been completed in the following stages;

- Mobilization Activities,
- Field Activities, including area of concern review, groundwater monitoring well installation, surface water and leachate seep sampling and groundwater sampling;
- Corrective Action Evaluation
- Impact Evaluation/Leachate Seep Data Analysis/Report Preparation

To be completed;

- Post-Closure Use Evaluation
- Landfill Closure Design
- Permitting
- Construction
- Post-closure monitoring

The projected schedule for each of the above stages has been presented under separate cover.

2.0 **BACKGROUND INFORMATION**

2.1 Site Location and Description

The site is located in the City of Stamford, Connecticut in an area of land between the intersection of Scofieldtown and Rock Rimmon Roads in the northern portion of the City. A general view of the area is presented in Figure 1 and site layout is shown on Figure 2. The now-closed Scofieldtown Park, the City of Stamford's Recycling/Composting Center and Public Works Department salt shed comprise the top surface area that was a former municipal landfill (See Figure 2). The top of the landfill has soil cover and grass vegetation except in the active recycling, compost and salt shed areas where asphalt is present at some locations on the surface. In all, the former landfill area, which reportedly ceased operation in the early 1970s, covers approximately 17 acres in a roughly triangular shape. The landfill property is bounded by Rock Rimmon Road to the west, Scofieldtown Road to the south and east, the Diocese of Bridgeport-owned cemetery property to the north and the Connecticut Light and Power Property (CL&P) to the northeast.

A portion of the site covering approximately four acres directly north of the intersection was used as a public park. The park was closed to the public in May 2009 after the discovery of drums along the northerly slope requiring removal and disposal. The park, which slopes up from the south to north, was primarily grass covered with a small maintenance building, a picnic shelter/pavilion, a paved tennis court and a former play scape. In anticipation of the construction of the engineered landfill cap, the City of Stamford has been stockpiling soil from off-site sources in the area of the former park as well as the western portion of the composting area for use in the construction of the cap. A locked gate at the far southern portion of the park area accessed from Rock Rimmon Road controls access to this portion of the site.

The park portion of the site is located at the lowest elevation over the site. The composting area and public works area are situated approximately 10 feet higher than the park. Both the composting and recycling facilities are paved or milling-covered surfaces and extend to the top of the heavily vegetated slopes on the north and east side of the site.

The Public Works composting operation, recycling facility and salt shed are accessed by two separate driveway access points located along Rock Rimmon Road. The recycling facility is located on a paved area on the far western portion of the site and consists of segregated bins and

dumpsters as well as a small attendant structure. There is also a mobile site office trailer located in this area which is used by Public Works employees staffing both the recycling facility and compost operation. The composting operation is located on the northern portion of the site and encompasses approximately 5 ½ acres. The composting operation utilizes several pieces of heavy equipment including a large shredder/chipper, a loader and bulldozer. The composting area consists of multiple rows of compost materials generally oriented north to south though there are several piles which exist along the top of the northern slope.

From the top of the slope to the landfill toe of slope adjacent to the stream/wetlands the grade drops approximately 30 feet with some terracing and varying degrees of steepness. The landfill slope along Scofieldtown Road varies in height and is generally lees steep than the north and east slopes. The vegetation on all of the slopes is moderately dense trees and understory brush.

A small unnamed perennial brook and some adjacent wetlands are present between the northerly property edge and the cemetery. A 24-inch concrete storm drainage pipe crossing Rock Rimmon Road at the northwest corner of the property discharges in a steep drainage swale leading to the unnamed perennial stream. There is also a manmade narrow soil berm that is off the landfill property that crosses the unnamed stream/wetland connecting the cemetery to the toe of the landfill. On the upstream side of the berm is a concrete weir structure that creates a shallow pool of water in the stream/wetland on the upstream side. The weir structure has a concrete pipe that passes through the soil berm and discharges on the opposite side. Along the easterly CL&P property boundary the northerly perennial stream converges with another larger perennial stream/wetland system that becomes Poorhouse Brook as it crosses Scofieldtown Road through a double culvert.

A stream that flows from the Scofield Manor property to the south enters the site in the southwest corner via a pipe beneath Rock Rimmon Road and empties into a small half-acre man-made pond on the property. The pond has an overflow weir concrete structure that discharges via a concrete pipe which runs beneath the landfill to the northeast. The pipe discharges to the unnamed stream on the east side of the landfill approximately 350 feet upstream from the Scofieldtown Road twin culverts. The City-run recycling/composting center, along with a salt

storage shed located in the extreme northwest portion of the site, encompasses the remaining top area of the site.

The immediate area surrounding the site consists of residential neighborhoods to the south and east of Poorhouse Brook, the cemetery directly to the north across the unnamed stream to the east of the cemetery, and woodlands to the west across Rock Rimmon Road. In addition to the residential developments, the Scofield Magnet School is located to the east of Scofieldtown Park between Scofieldtown Road and Poorhouse Brook as the brook flows to the south in this area. There are also two residential facilities, Scofield Manor, an assisted-living retirement facility, and Smith House, a municipal nursing home, located along the western sides of Scofieldtown and Rock Rimmon Roads, respectively, south and west of the site.

2.2 Geologic and Hydrogeologic Setting

According to the information presented on the Bedrock Map of Connecticut (Rogers, 1985), the site and surrounding area are underlain by the Trap Falls Formation and Ordovician granitic gneiss undivided which consists of a gray to silvery, partly rusty-weathering, medium grained schist and light colored, foliated granitic gneiss. Although information regarding the bedrock surface is limited, based on measurements made during the TRC well installation program, the bedrock surface appears to be relatively consistent across the site with a slight depression located in the north central portion of the site.

According to the Quaternary Geologic Map of Connecticut and Long Island Sound Basin (Stone, et al, 2005), the unconsolidated materials at the site are identified as thin till deposits over bedrock. The till is generally non-stratified with variable amounts of sand, silt, clay and larger-grained materials. Subsurface investigation completed previously by TRC encountered till thickness ranging from approximately 10 to 15 feet around the property of the site along Rock Rimmon Road to Scofieldtown Road and approximately 20 to 30 feet along the central portion of the site. The residential area to the east of site was identified as a drumlin or till hill. While drumlins typically contain thicker deposits of till, a monitoring well installed during TRC's prior investigation (well MW-7R) encountered bedrock at approximately ten feet below grade indicating that the drumlin is supported by bedrock.

2.3 Landfill History Summary

The Scofieldtown Park Landfill began operating in the 1930's and was shut down between 1968 and 1970. During the years that the landfill was in operation, it was mainly utilized for the disposal of household waste as well as a disposal facility for the City of Stamford. To date, there have been several environmental investigations performed by federal, state, city and private organizations in order to determine the nature and extent of contaminants contained within the soils, groundwater and surface water at the site. A summary of the historic use of the landfill as well as a brief summary of the previous site investigations are discussed below.

In 2008, the United States Environmental Protection Agency (USEPA) released a report entitled "Final Site Reassessment Report (FSRR) for Scofieldtown Road Park" (2008 FSRR). In this report the EPA indicates that the landfill began operations in the 1930's as a disposal site for household waste and in 1949 began to accept wastes generated by the City of Stamford as well. The landfill was reportedly closed in 1968, however, due to operational problems with an incinerator at another local landfill facility, there was sporadic use of the Scofieldtown Park Landfill up until 1970. According to the FSRR, the landfill encompassed between 10 and 18 acres of land and the waste materials are estimated to be between 10 and 40 feet thick across the site. Once the landfill was permanently closed for waste disposal, it is reported to have been covered with clean fill.

In order to supplement the information provided by the USEPA and to better understand the historical site use and footprint, TRC reviewed historical aerial photographs dated 1934, 1951, 1979, 1985 and 2006. The photographs indicate that in 1934, the area in which the site is located is vacant vegetated land. There are what appear to be several roads/pathways present on the property, however, nothing to indicate that a landfill is in operation on the property. By the 1950's it is apparent that the property has been cleared of vegetation and the roads/pathways appear to be more defined. In addition, there are several areas on the property where soils seem to have been disturbed, indicating that landfill activities are in operation. Between the 1970's and the present, the photographs show the landfill property as being generally in its current state. There are some vegetation changes from one photograph to the next; however, the footprint of the site remains generally consistent. The areas surrounding the site changed from being an

agricultural/undeveloped area to a more residential area after the 1970's and a park appears on the property in the 1985 photograph.

2.4 Previous Site Investigations and Regulatory History

There have been several environmental investigations conducted at the site. These investigations were initiated in the 1980's when a local resident filed a complaint to the CTDEEP claiming that there were transformers located on the property. The following is a brief summary of environmental assessments and investigations that have taken place at the property.

- In May 1986, the CTDEEP was on-site to further investigate a complaint of drums being located on the property. At this time, the CTDEEP discovered an unspecified amount of rusted, half-buried drums on the property adjacent to Poorhouse Brook. Some of the drums were reported to be empty while others were reported to contain a white granular powder and epoxy residue. The CTDEEP collected several samples of the white powder as well as surface water samples. The analytical results of the sampling of the drum contents indicated the presence of several petroleum-related contaminants and several metals above the laboratory detection limits. City of Stamford personnel removed the drums and their contents to a staging area near the salt-shed from where they were subsequently shipped off-site in November 1987. The analytical results of the surface water samples indicated the presence of two metals (lead and barium) as well as two petroleum-related contaminants above the laboratory detection limits.
- In May 1986, the site was listed in the Comprehensive Environmental Response Compensation Liability Information System (CERCLIS) database. This triggered the USEPA to begin a series of assessments to determine if the site should be placed on the National Priority List (Superfund sites).
- In August 1986 a Preliminary Assessment (PA) was performed by NUS Corporation Field Investigation Team (NUS/FIT) on behalf of the US EPA. The PA recommended that a Site Investigation be performed.
- In March 1988, NUS/FIT submitted a Final Site Investigation Form 2070-13 as well as a Draft Preliminary Hazardous Ranking System Package. These reports indicated that 17 drums had been sampled and removed from the site. In addition, the reports documented the potential for a release to the ground and surface water at the site and recommended that groundwater and surface water sampling be conducted.
- Between March 1988 and June 1989, several additional site walks were conducted by agencies including the CTDEEP, the CT DHS, the Stamford Environmental Protection Board and the City of Stamford. During these site walks, additional drums were identified at the site along with old tires, refuse, etc. Also during this time, several surface water and soil samples were collected at the site. These

samples indicated that VOCs were present in soils and metals were present in both soil and surface water.

- In the summer of 1989, the CTDEEP collected drinking water samples from several private homes in the area of the landfill. The sample results indicated that both hydrocarbons and metals were present in drinking water. Due to the inconsistencies of the contaminants found in the drinking water, the CTDEEP concluded that while some homes did have water quality issues, there was no evidence that they were a product of contaminant migration from the landfill. Drinking water samples were also collected in September 1992 and it was determined that none of the wells contained water that was unsafe for consumption.
- In February 1996, Weston Solutions, Inc., on behalf of the USEPA, completed a Removal Program Preliminary Assessment/Site Investigation PA/SI. As part of the investigation, soil and drum samples were collected. The samples did not exhibit any elevated contaminant concentrations and therefore it was concluded that it was not urgent to remove the drums or soil.
- In March 1996, CDM Federal (CDM) completed a Site Inspection Prioritization (SIP) on behalf of the US EPA. As part of the SIP, CDM collected surface soil, sediment and drinking water samples. The results indicated that both the surface soil and sediment samples contained concentrations of VOCs, SVOCs, pesticides and metals. The drinking water samples also exhibited concentrations of pesticides and metals.
- In June and November 2007, the Superfund Technical Assessment and Response Team (START) performed a Removal PA/SI. As part of this investigation START collected drum samples which indicated the presence of VOCs, SVOCs, pesticides, PCBs and metals.
- In March and April 2008, the START, on behalf of the EPA, was on-site at the landfill to further investigate the soils and sediments at the site and drinking water wells in the area of the landfill. The results of the sampling indicated that there were VOCs, SVOCs, pesticides, PCBs and metals present in the soils and sediments located on the property. In addition, pesticides and metals were reported to be present in samples collected from private drinking water wells. The results of this sampling event are further discussed in Section 2.4.1.
- In the fall of 2009, TRC was commissioned by the City of Stamford to perform a limited environmental investigation in the site and the surrounding area to determine if the landfill was impacting the groundwater in the area used by private residences for potable water supply (TRC, 2010). The investigation included a ground penetrating radar survey of the landfill area, surface water sampling along the unnamed stream, and groundwater sampling of monitoring wells. TRC issued a report entitled ‘Environmental Investigation Report” in April 2010. The results of TRC’s environmental investigation are further discussed in Section 2.4.2.

2.4.1 Discussion of USEPA Reassessment Results

Between March and April 2008, START, on behalf of the USEPA conducted and environmental investigation at the Scofieldtown Park Landfill. As part of the investigation, START collected surface soil samples from both on and off-site locations, sediment samples from both on and off-site locations and potable well samples. A summary of activities and results of this investigation are discussed below:

- A total of 18 surface soil samples were collected at the site while 2 additional soil samples were collected from a background area across Rock Rimmon Road. The samples were analyzed for VOCs, SVOCs, pesticides, PCBs and metals. The analytical results for the samples collected at the site indicated that there were concentrations of SVOCs (specifically PAHs), PCBs, chlorodane and lead present in several of the samples at levels which exceeded the Connecticut Remediation Standard Regulations (RSRs), specifically the Residential Direct Exposure Criteria (RDEC). The majority of the samples which exhibited CT RSR exceedences were collected from locations along the northern slope of the landfill or within the park area. In addition, VOCS, additional SVOCs and cyanide were also detected in surface soil samples; however, none of the concentrations exceeded the applicable RSR criteria.

- A total of 18 sediment samples were collected from various locations along the unnamed stream, the wetland to the north of the unnamed stream, Poorhouse Brook and the on-site pond. In addition, background sediment samples were collected from wetland areas across Rock Rimmon Road. The samples were sent to the laboratory for analysis of VOCs, SVOCs, pesticides, PCBs and metals. The USEPA compared the results of their sediment sampling to the National Oceanic and Atmospheric Administration's (NOAA) Screening Quick Reference Tables (SQuiRTs) Threshold Effects Levels (TEL) and Probable Effects Level (PEL) values in freshwater sediment. These values represent the levels at which adverse effects to benthic organisms are expected and are generally used only for screening purposes (note that the results of this screening process are considered to be conservative values). As such, many reported concentrations of analytes were identified as exceeding SQuiRTs TELs and PELs. TRC reviewed the sediment results and also compared them to RDEC and Industrial/Commercial Direct Exposure Criteria (I/CDEC) standards. This review identified several PAHs and arsenic at reported concentrations which exceeded the RDEC along the unnamed stream.

- 13 private drinking water wells were sampled along Hannah's and Brookdale Roads and tested for VOCs, SVOCs, pesticides, PCBs, TAL metals and cyanide. Dieldrin was found exceeding CTDPH drinking water standards in several of the

wells sampled while chlordane was reported to be present in one well, but below the CTDPH drinking water standards. These findings resulted in the City of Stamford initiating a potable well testing program of the area in August of 2009 to determine the extent of the chlordane and dieldrin.

2.4.2 Discussion of TRC's Environmental Investigation 2009-2010

TRC was retained by the City of Stamford in the fall of 2009 to conduct a limited environmental investigation of the Scofieldtown Park Landfill. This investigation was initiated in response to the report that concentrations of pesticides, specifically chlorodane and dieldrin, were detected in private drinking water well samples that were collected during the EPA investigation conducted in 2008 from several residential wells along Hannahs Road which is located to the east of the site across Poorhouse Brook. The purpose of TRC's environmental investigation was to obtain information regarding the quality of the surface water and groundwater in the area of the landfill that would augment the information already collected by the USEPA regarding surface soil and sediment. The investigation was also designed to assess groundwater hydrogeology and evaluate groundwater flow patterns in order to assess if landfill leachate might impact groundwater and surface water surrounding the site. As part of this investigation, TRC conducted a ground penetrating radar (GPR) survey in order to identify any additional drums or unknown tanks that could be buried in the landfill, collected additional surface water samples along Poorhouse Brook, installed and sampled overburden and bedrock wells located both on-site and surrounding properties, collected soil samples from within the landfill and evaluated groundwater table elevations and determined the groundwater flow direction. A summary of the results of this investigation are discussed below:

- The GPR survey, which covered the relatively flat areas of the site surface, concluded that there were "no clustering of metallic anomalies characteristic of buried drums, parabolic features common to underground storage tanks, or any unusual anomalies not characteristic of the surrounding geological conditions."
- TRC collected a total of five surface water samples in October 2009. The samples were collected from the unnamed stream, the unnamed pond located in Socfieldtown Park and an unnamed pond located to the south of Alma Rock Road. The surface water samples exhibited concentrations of certain VOCs and metals. One of the surface water samples collected from the unnamed stream located along the northern portion of the site downstream of the confluence with the overflow from the on-site pond exhibited a concentration of benzene which

slightly exceeded the Human Health Criteria for consumption of water and organisms as defined in the CT Water Quality Standards.

- A total of thirteen on and off-site groundwater monitoring wells were installed and sampled as a part of TRC's environmental investigation. The locations of the monitoring wells include on-site, Scofield Magnet School (located to the east of the site), Rock Rimmon Road (west of the site), Verry Merry Road (east of the site) and Alma Rock Road (east of the site). All groundwater samples were analyzed for VOCs, SVOCs, ETPH, total Target Analyte List (TAL) metals, PCBs, pesticides, herbicides, cyanide, alkalinity, gross alpha and gross beta. The results of the groundwater sampling were compared to CTDEEP RSR groundwater remediation criteria including: the Ground Water Protection Criteria (GWPC), the Surface Water Protection Criteria (SWPC) and the Residential Volatilization Criteria (RVC).
    - Samples collected from the wells located within the landfill exhibited concentrations of VOCs, SVOCs, ETPH and metals. There were several VOCs (benzene and vinyl chloride) which were detected at concentrations which exceeded the applicable RSR critera. In addition, ETPH, arsenic and barium were also detected in the on-site monitoring wells at concentrations which exceeded the applicable RSR criteria. None of the additional compounds detected in the on-site wells exhibited concentrations which exceeded the RSR criteria.
    - The samples collected from the monitoring wells located on the properties to the east of the site at the Scofield Magnet School contained concentrations of several metals and one VOC, toluene, however, none of the concentrations of the analytes was reported to be over regulatory criteria.
    - The samples collected from wells east of Poorhouse Brook and within the residential neighborhoods contained concentrations of VOCs (1,1,1,2 tetrachloroethane) and pesticides (chlordane and dieldrin) which exceeded one or more of the applicable criteria.
    - There were no concentrations of PCBs or cyanide reported in any of the well samples. Several metals had reported concentrations which exceeded Secondary Maximum Contaminant Levels set by the USEPA, based on aesthetic considerations only and constituents that exceed these levels are not considered to present a risk to human health.
- Three soil samples were collected during the well installations on the former footprint of the landfill. The results indicated varying concentrations of VOCs, SVOCs (generally PAHs), ETPH, and metals with some exceedances of both the RDEC and the Pollutant Mobility Criteria (GA PMC) Concentrations of PCBs were also reported to be present in one of the three soil samples collected and a concentration of 4,4-DDD was reported to be present in another. None of these reported concentrations exceeded any of the applicable criteria.

2.4.3 Summary of All Results

Results of a review of the previous site investigations conducted by the CTDEEP and the USEPA as well as soil, surface water and groundwater testing conducted by TRC in 2009 in the landfill area indicate the following:

- A review of the topography of the areas to the north, west and south indicate that the ground elevation increases to the north within and beyond the cemetery. The topography to the west remains generally the same as the site. To the south there is also a gradual increase in elevation along Scofieldtown Road. As identified on the Natural Drainage Basins Map of Stamford, Connecticut (CTDEEP January 2010), the drainage basin in which the landfill is located (7405-05) extends from an area just north of Ingleside pond to the general location of the Northeast School to the south. To the east, the drainage basin extends to the topographic high (Very Merry Road) to Hunting Ridge wetland area to the west. In the vicinity of the site, the drainage basin western boundary is close to the northwest corner of the landfill area.

- The surveyed elevations of all the wells indicated that the groundwater flow for both the overburden and bedrock aquifers in the vicinity of the landfill is toward the east/northeast with some surface discharge occurring along the unnamed stream and Poorhouse Brook. The well pairs present in the general area show good correlation between the overburden and bedrock aquifer systems associated with the site. Both overburden and bedrock pieziometric are similar in both elevation and flow direction. The presence of the man-made pond in the southern section of the landfill area appears to be creating a groundwater mounding effect in this area.

- Contaminants found in the soil and sediment across the site and wetland areas are consistent with the use of the site as a former municipal solid waste landfill and its current use as an asphalt-covered leaf composting/recycling facility. The results of the sampling indicated low levels of regulated contaminants.

- Groundwater quality within the footprint of the landfill is consistent with the soil data in the prior investigations. Low levels of dissolved contaminants were reported to be present. However, petroleum compounds were reported to be present in the overburden and bedrock groundwater samples collected from the monitoring wells near the salt shed. In addition, elevated concentrations of sodium were also reported in the same wells nearest the salt shed.

- The cessation of landfill operations nearly 40 years ago suggests that groundwater conditions associated with the site have likely reached equilibrium with respect to contaminant concentration.

3.0 **OFF-SITE IMPACT EVALUATION**

The impact evaluation consisted of investigation of the groundwater, surface water and sediment as pathways that may have resulted in the migration or deposition of contaminants emanating from the landfill in off-site areas. In order to meet the stipulations of the Consent Order, the following tasks were completed in the off-site impact evaluation. These tasks were designed to meet the requirements of the Consent Order and CP, and provide information that may be part of the landfill cap construction.

3.1 Off-Site Impact Evaluation Tasks

- Additional overburden and bedrock monitoring wells were used to better delineate groundwater migration associated with the site and document surface discharge locations for the groundwater.
- Hydrogeologic investigation of overburden soil and bedrock was completed to estimate hydraulic conductivity of the landfill materials, overburden soil and bedrock for use in evaluating contaminant flow and transport.
- Evaluation of the groundwater and surface water quality with respect to seasonal trends was conducted.
- Areas where leachate seeps or outbreaks are occurring along the edges of the landfill were delineated and leachate quality was evaluated.

The impact evaluation, as described in the following sections, focused on developing and validating a conceptual site model of the site and surrounding area in relation to the hydrogeology to determine migration pathways in the both the overburden and the bedrock aquifers. An investigation of the surface water flow, the discharge of groundwater into the surface water and the interaction of leachate seeps with the surface water was also conducted. An evaluation of contaminant concentrations was completed for groundwater, surface water and sediment to focus on the potential of off-site migration and impact.

The objectives of the impact evaluation were to:

- Determine the nature and extent of migration of contaminants from the landfill primarily through groundwater and surface water flow using a conceptual site model to identify the hydraulic relationships between the landfill and the receptors at potential risk;
- Determine if any off-site impacts require the need for immediate corrective action and recommend such actions; and

- Provide data to allow for the optimum design of a post-closure groundwater monitoring system.

The data collected during this investigation were also used to determine the hydrologic system of the landfill and the immediate surrounding area using rainfall, drainage areas, stormwater drainage infrastructure, proposed end use needs, leachate composition, groundwater and surface water quality to support the modeling of leachate flow both pre- and post-closure. Leachate production is a function of the current uncapped surface of the landfill mound allowing rainfall to infiltrate through the landfill material and enter the groundwater system. Once capping is completed, infiltration and leachate generation will be negligible.

3.2 Groundwater Monitoring Well Network Installation

To evaluate off-site groundwater quality and to aid in better defining groundwater flow conditions across the site and the adjacent areas, thirty-four groundwater monitoring wells were installed both on and around the periphery of the site (see Figure 2). These wells augmented nine wells previously installed in 2009 as part of TRC's initial assessment of the landfill. As stated above, the monitoring wells were generally installed in nested pairs with a shallow unconsolidated overburden well and a cased bedrock well comprising each pair where groundwater was present in both aquifers. Groundwater was not present in the unconsolidated overburden in two of the clustered pair locations precluding the installation of overburden wells in these locations. In addition, two overburden wells were installed adjacent to bedrock wells previously drilled within the landfill (MW-6(R) and MW-9(R)) to complete the nested pairs. Wells with the (R) designation denotes a bedrock aquifer well while wells with the (OB) denotes an overburden aquifer well. The following are descriptions of each well cluster installed:

Within the Landfill

MW-10 (R) - Located on the western perimeter of the landfill (Rock Rimmon Road) near the current office trailer to determine groundwater conditions at a potentially upgradient position. No groundwater was observed in overburden.

MW-11 (OB and R) – Also located along the western perimeter to the south in the current recycling area to monitor groundwater in this area.

MW-12 (OB and R) – Located on the southeastern perimeter of the landfill near the man-made pond and the intersection of Scofieldtown and Rock Rimmon Roads to determine the groundwater quality at a down or cross-gradient location.

MW-13 (OB and R) - Located in the southeastern portion of the landfill in the former park area east of wells MW-3(OB) and MW-3(R) and the man-made pond. This well pair was used to evaluate groundwater quality at this location and assist with determining the effect that the man- made pond currently has on mounding the groundwater table elevation.

MW-14 (OB and R) – Located in the central portion of the site in the leaf composting area to evaluate groundwater conditions with this area of the site.

MW-15 (OB and R) – Located along the eastern perimeter of the landfill (Scofieldtown Road) toward the north in a downgradient location.

MW-16 (OB and R) – Located in the northwest corner of the landfill between the toe of the landfill slope and the drainage swale/stream. This well was used to evaluate the extent of groundwater flow and quality in this location near the salt shed.

MW-17 (OB and R) – Located along the northern perimeter of the landfill between the toe of the landfill slope and the unnamed stream near the western edge of the known leachate seepage area.

MW-18 (OB and R) – Also located along the northern perimeter of the landfill between the toe of the slope and the stream near the present outfall location of the drainage culvert that is present under the landfill.

MW-19 (R only) Proposed Location J) – Located at the northeastern corner of the landfill near the location where the unnamed stream passes into the double culvert at Scofieldtown Road at a downgradient position.

Outside the Landfill

MW-21 (OB and R) - Located on the grounds of the Smith House assisted living facility to the west/northwest of the site in an upgradient position.

MW-22 (OB and R - Located on the grounds of the Scofield Manor assisted living facility to the south of the site in an up-gradient position.

MW-23 (OB and R) – Also located on the grounds of Scofield Manor near the community garden and close to the southern side of Rock Rimmon Road in a cross-gradient position.

MW-24 (OB and R) - Located on the grounds of the Scofield Magnet School further downgradient from the locations of wells MW-4(OB) and MW-4(R).

MW-25 (OB and R) – Also located on the grounds of the Magnet School to the north of the MW-24 cluster and to the west of Poorhouse Brook in a downgradient position.

MW-26 (OB and R) – Located on the property owned by Connecticut Light and Power to the northeast of the site. This well pair was located to assess if a plume may be migrating beneath the unnamed stream.

MW-27 (OB and R) – Located on the undeveloped grounds of the cemetery to the north of the site and was also used to evaluate for plume migration beyond the unnamed stream.

The locations of the wells are presented on the map entitled Figure 2; Site Layout and Monitoring Well and Sample Location Map. It should be noted that variations between proposed monitoring well, surface water and sediment sample locations were based on field observations, field screening and access conditions encountered during well installation and sampling activities.

The following sections describe the procedures followed during the investigation. The basic procedures associated with the completion of a sensitive receptor survey are also outlined below.

3.2.1 Shallow Overburden and Bedrock Monitoring Well Installation

TRC provided oversight for the installation of the additional wells to the existing monitoring well network between March 6, 2012 and April 5, 2012. Thirty-four wells were installed at nineteen locations within the study area by Glacier Drilling, LLC. of Durham, CT. Wells were installed as clustered pairs consisting of a shallow overburden monitoring well and a deeper, cased and sealed bedrock monitoring well at seventeen locations, except for two locations where groundwater was not observed within the overburden soils (MW-10 (OB) and MW-19 (OB)). Shallow overburden wells (MW-6 (OB) and MW-9 (OB)) were also installed at two locations where bedrock monitoring wells had previously been installed in December 2009, to provide the clustered pairs at these locations. Of the 34 wells installed, 20 were installed within the limits of the historical landfill area. The remaining 14 wells were installed adjacent to and surrounding the landfill. The map entitled Figure 2, Site Layout and Monitoring Well and Sample Location Map shows the surveyed locations of all monitoring wells.

These wells were installed using hollow-stem auger drilling rigs. Two rigs, a truck-mounted CME-75 and a track-mounted CME-55 LC were utilized for the drilling and construction of all thirty-six wells completed during this phase of the project. In addition, seven

of the bedrock wells installed during the 2009 investigation and left as open rock wells were completed as permanent monitoring wells per the specifications outlined below. The completed monitoring well network was used to assess shallow overburden and bedrock groundwater flow conditions and groundwater quality.

Overburden monitoring wells were construction per the following specifications:

- Nine-inch diameter borehole ;
- Two-inch, inside diameter PVC riser and screen (.01-inch slotted screen);
- Threaded joints only on PVC pipe (no glued joints);
- Clean silica (quartz) #1 sand filter pack to two feet above the screened interval;
- Two-foot–thick bentonite seal above the sand pack; Portland cement/bentonite slurry (about 6:1 ratio) in the well annulus from the top of the bentonite seal to approximately 40" below the ground surface;
- Concrete surface seal;
- Casing sealant and drilling fluids mixed only with potable water;
- Vented well cap; and
- Stick-up, steel protective casings with lock, or flush-mounted enclosures as noted below.

The 0.01-inch well screen slot size (10-slot) was selected to retain at least 90% of the filter pack and the filter pack size of #1 sand was selected so that the approximately 70% retained grain size of the gravel pack was approximately four times that of the surrounding formation (The landfill site and surrounding area are predominantly underlain by a fine to medium grained sand matrix with varying amounts of silt and gravel). A bottom cap was installed on all wells. The ground surface seal extended at least 40 inches below the land surface and flared such that the diameter at the top was greater than the diameter at the bottom. All constructed wells with the exception of MW-10 (R), the MW-14 couplet, the MW-11 couplet, the MW-21 couplet and the MW-25 couplet were completed as steel-encased stick-ups with locking caps labeled with the respective well designations. The excepted wells were completed as flush to grade road-boxed wells with locking gripper caps within bolted capped enclosures.

The screen lengths for wells intercepting the water table were selected to be 10 feet and were installed so that no more than 8 feet extending below the water table at the time of drilling. The length of screen above the water table was intended to maintain the water table within the screened interval during seasonal and/or diurnal groundwater fluctuations. Well Construction Logs are provided in Appendix D.

Upon completion, each well was developed using a surge block and pump. Fine-grained material around the well screen was drawn into the well and removed by agitating the well water with a surge block and simultaneously pumping water from the well using a submersible pump with a low discharge rate. The pump was outfitted with new, clean polyethylene tubing which was replaced between each well. The dedicated tubing was rinsed with deionized water prior to its use. The progress of development was determined by monitoring turbidity periodically. Well development was determined to be complete when a sufficient volume of water was evacuated from each well and successive turbidity readings were below 30 NTUs. In cases where the goal of less than 30 NTUs was not met, then well development was determined to be complete when successive well volumes had turbidity readings within 10% of each other.

Bedrock Monitoring Wells

Bedrock coring and monitoring well installation was completed with a combination of drilling methods. Hollow-stem augers were utilized to drill to the bedrock surface. Split-spoon soil samples were collected continuously from the ground surface to the observed water table to allow for the identification of fill layers, soil characterization and description for the development of well construction/boring logs.

Once the bedrock surface was reached, based on auger refusal, the driller switched to the air-hammer method of drilling to advance the drill string several feet into the bedrock surface to ensure that competent bedrock was reached and an adequate seal was achieved between the overburden and bedrock aquifers. Once this was achieved, steel casing was inserted into the borehole down to the bedrock surface and grouted in place with a cement and bentonite mixture. At each bedrock well location the grout was allowed to cure for at least 24-hours prior to the completion of the borehole. Once this period was complete, the grout was “cleaned” from the inside of the steel casing with a roller-bit and a potable water wash to the bedrock surface. The boring was then advanced into the bedrock utilizing a 3-inch diameter diamond bit and core barrel.

With the aid of the minimum drill fluids needed to bring cuttings to the surface, the bedrock was cored in continuous 5-foot length intervals (runs) to at least fifteen feet below the bedrock surface to allow for the construction of the well. Drilling was conducted with minimal

vertical pressure (downhole pressure) and rotation. Downhole pressure ranged from 250 pounds per square inch (psi) to 550 psi across the site.

Upon completion of each 5-foot run, the core barrel was removed and the core was labeled and stored in a wood core box.

Each core was geologically logged for physical factors including mineralogy, color, grain size, alterations, cementation, hardness and weathered state. In addition, features and structures (e.g., clay seams, bedding, fissility, etc.) were noted. Core run lengths and recovery (as a percent) was noted, as well as any loss zones. Discontinuity information was recorded in the field notebook including tightness, smoothness, number of fractures per foot, any filling and/or weathering of fractures, fracture orientation, and staining. The rock quality designation (RQD) was recorded (as a percent). The RQD is the sum of inches of all naturally fractured rock core pieces larger than four inches over the total number of inches in the run, with the length of the piece determined by the distance between naturally occurring fractures. The lower the RQD percentage the lower the rock mass quality.

Generally the RQDs for the upper cores of the bedrock surface were of lower percentage than those of the deeper cores. The average of the RQDs of the upper cores across the site footprint was 59% while the middle and lower cores averaged 62% and 72%, respectively. With respect to the hydrogeologic characteristics of the bedrock, generally lower RQDs and therefore higher numbers of fractures, generally equates to higher groundwater transmissivity.

Upon completion of the bedrock core, a monitoring well was installed in each of the bedrock core holes. Screens for the bedrock wells are 10 feet in length (10-slot) and consist of 2-inch diameter Schedule 40 PVC. A filter pack of #1 Morie sand was placed in the annular space to a depth of 2 feet above the top of the well screen. A 2-foot layer of cement/bentonite grout mixture was placed above the filter pack to ensure a proper seal. Sand was used to fill the remaining annular space to the surface. Each bedrock well was completed with a locking protective outer casing with the exception of the well locations noted above which were completed as flush to grade road-boxed wells with locking gripper caps within bolted capped enclosures.

Upon completion, each well was developed using a surge block and pump. Fine-grained material around the well screen was drawn into the well and removed by agitating the well water with a surge block and simultaneously pumping water from the well using a submersible pump

with a low discharge rate. The pump was outfitted with new, clean polyethylene tubing which was replaced between each well. The dedicated tubing was rinsed with deionized water prior to its use. The volume of groundwater extracted during development was recorded at each location to ensure that at least five well volumes of water were evacuated from each well to account for the water loss during the bedrock coring process. The progress of development was determined by monitoring turbidity periodically. Well development was determined to be complete when a sufficient volume of water was evacuated from each well and successive turbidity readings were below 30 NTUs. In cases where the goal of less than 30 NTUs was not met, then well development was determined to be complete when successive well volumes had turbidity readings within 10% of each other. Water produced during well development will be handled in accordance with the guidelines outlined in Appendix F of the Landfill Closure Plan.

3.2.2 Groundwater Sampling

The completed monitoring well network was allowed to equilibrate for at least two weeks after development. Quarterly groundwater sampling of the well network was initiated on May 7th through 15th, 2012 with successive events occurring approximately three months apart as follows:

- Second Quarterly Event; August 28th to September 5th, 2012,
- Third Quarterly Event; November 5th to 19th, 2012,
- Fourth Quarterly Event; February 26th to March 4th, 2013.

The results of each of the first three groundwater sampling events were reported in quarterly status reports submitted to the City of Stamford. These results inclusive of the fourth quarter results will be discussed in Section 3.1.3 below.

Prior to the initiation of each quarterly sampling activities and immediately upon opening each well, the vapor headspace in the casing was screened with a PID and FID to evaluate for the presence of methane and volatile organic vapors. This screening did not occur in the second quarterly event due to an equipment malfunction. Subsequent to the headspace screening, a complete round of groundwater level measurements were collected at the beginning of each quarterly event for the development of groundwater contour maps as well as to determine the depth at which the pump, or pump tubing would be placed. The water level of each monitoring well was measured to the nearest 0.01 ft. with an electronic water sensing device and recorded in

a field notebook. Groundwater contour maps for each quarter for both the shallow, overburden aquifer and the deeper, bedrock aquifer are provided with this report.

The wells were purged using either a bladder pump outfitted with new tubing and bladder for each well or a peristaltic pump outfitted with dedicated tubing for each well, as determined by the depth to groundwater at each location. In accordance with low-flow sampling protocols, indicator geochemical parameters, including pH, specific conductivity, turbidity, dissolved oxygen, temperature and oxidation-reduction potential, were monitored and recorded throughout the purging process to determine when the groundwater chemistry had stabilized. Summary tables of the final geochemical parameter readings prior to sample collection at each well have been included as Tables 25 through 27 Wells where purged at a purge rate ranging between 100 and 500 milliliters per minute in order to prevent the effects of well water drawdown. Groundwater samples were collected once the indicator geochemical parameters stabilized to within the prescribed tolerances for three consecutive readings recorded at three to five minute intervals. All samples were collected directly from the dedicated pump tubing into the appropriate laboratory provided sample containers and delivered to the laboratory at the end of each day of sampling under proper chain-of-custody procedures. At the laboratory, an unpreserved aliquot from each groundwater sample was filtered utilizing 0.45 micron filters to be used for dissolved metals analysis. Dissolved metals analysis was conducted for comparison to the total metals results to determine the effects of turbidity and suspended solids on the reported metals concentrations. Dissolved metals concentrations were not compared to applicable regulatory criteria.

The following sections provide a summary of the analytical results from each of the four quarterly sampling events.

3.3 Groundwater Sampling Analytical Results Summary

Each groundwater sample was analyzed according to the parameters shown in Table 1.

The CT RSR Criteria to which the groundwater samples were compared are the GWPC, SWPC, the Residential Volatilization Criteria (RVC) and the Industrial/Commercial Volatilization Criteria (I/CVC). The GWPC are applicable to areas with a “GA” groundwater designation under certain circumstances. The SWPC are based on the State’s Ambient Water Quality Criteria and apply to groundwater that discharges, or potentially may discharge to a

surface water body. The RVC and I/CVC are based on impacts to groundwater by contaminants that are volatile and can affect indoor air quality and apply to groundwater within 15 feet of the ground surface or the lowest level of a building.

Table 1: Groundwater Analytical Parameter Summary

Analytical Parameter (Analytical Method)	Ground Water
Volatile Organic Compounds (EPA Method 8260)	√
Semivolatile Organic Compounds (EPA Method 8270)	√
Extractable Total Petroleum Hydrocarbons (CTDEEP-Approved Method)	√
Polychlorinated Biphenyls (EPA Method 8082)	√
Pesticides (EPA Method 8081)	√
Herbicides (EPA Method 8151)	√
Priority Pollutant Metals (EPA Methods 6020/7471)	√
Total Organic Carbon (EPA Method 9060)	
Hardness (EPA Method 200.7)	√
Total Dissolved Solids (Standard Method 2540C)	√
Total Suspended Solids (Standard Method 2540D)	√
Alkalinity (Standard Method 2320B)	√
Total Dissolved Iron (EPA Method 200.7)	√
Total Dissolved Manganese (EPA Method 200.7)	√
Ammonia (as Nitrogen) (Standard Method 4500-NH3D)	√
Nitrate (as Nitrogen) (EPA Method 300.0)	√
Sodium (EPA Method 200.7)	√
Potassium (EPA Method 200.7)	√
Chlorides (EPA Method 300.0)	√
Sulfates (EPA Method 300.0)	√
Biological Oxygen Demand (5-day)	√
pH (Standard Method 4500 H+B for Soils/Field Measurement for water)	√
Oxidation Reduction Potential (Field Measurement)	√

For discussion purposes, the monitoring well network has been grouped into three categories: background wells (Background), landfill footprint wells (Footprint) and hydraulically downgradient wells (Downgradient) as per the following table:

Table 2: Well Category Designations

Well Category	Well Designations:
Background (7 Wells)	MW-5 (R), MW-21 (OB), MW-21 (R), MW-22 (OB), MW-22 (R), MW-23 (OB) and MW-23 (R).
Site (28 Wells)	MW-1 (OB), MW-1 (R), MW-2 (OB), MW-2 (R), MW-3 (OB), MW-3 (R), MW-6 (OB), MW-6 (R), MW-9 (OB), MW-9 (R), MW-10 (R), MW-11, MW-11 (R), MW-12 (OB), MW-12 (R), MW-13 (OB), MW-13 (R), MW-14 (OB) MW-14 (R), MW-15 (OB), MW-15 (R), MW-16 (OB) MW-16 (R), MW-17 (OB) MW-17 (R), MW-18 (OB), MW-18 (R) and MW-19 (R).
Downgradient (10 Wells)	MW-4 (OB), MW-4 (R), MW-24 (OB), MW-24 (R), MW-25 (OB), MW-25 (R), MW-26 (OB), MW-26 (R), MW-27 (OB) and MW-27 (R).

The groundwater analytical results for all four quarters are provided in Tables 17 through 19 and are organized in accordance with the above well categories.

3.3.1 Background Wells

3.3.1.1 VOC

VOCs by United States Environmental Protection Agency (EPA) Method 8260 were not detected in any of the groundwater samples collected from the seven background wells located hydraulically upgradient of the landfill footprint during any of the four quarterly sampling events.

3.3.1.2 SVOCs

SVOCs by EPA Method 8270 were detected in one of the samples collected from the seven background wells located upgradient of the landfill footprint during one of the four quarterly sampling events. The reported concentration of the SVOC benzo(b)fluoranthene in the sample collected from well MW-5 (R) during the first quarterly event was slightly above GWPC. Bezo(b)fluoranthene was not reported to be present in the samples collected from this well during the remaining three sampling events.

No other SVOCs were reported to be present in any of the other samples collected from any of the remaining background wells.

3.3.1.3 Extractable Total Petroleum Hydrocarbons (ETPH)

ETPH by the CT ETPH Method was reported to be present in two of the samples collected from the seven background wells located upgradient of the landfill footprint during two of the four quarterly sampling events. A concentration of ETPH was reported to be present slightly above GWPC in the sample collected from well MW-23 (R) during the first quarterly sampling event. In addition, a concentration of ETPH was reported to present below GWPC in the sample collected from well MW-21 (OB) during the third quarterly sampling event. No other concentrations of ETPH were reported for any other samples collected from the background wells during any of the four quarterly sampling events.

3.3.1.4 Polychlorinated Biphenyls (PCBs), Herbicides and Pesticides

PCBs by EPA Method 8082, herbicides by EPA Method 8151A and pesticides by EPA Method 8081B were not reported to be present in any of the samples collected from the seven background wells located upgradient of the landfill footprint during any of the four quarterly sampling events.

3.3.1.5 Metals

Two of the 15 total metals analyzed, potassium and sodium were reported to be present in all samples collected from the seven background wells located hydraulically upgradient of the landfill footprint during all four of the quarterly sampling events. In addition, iron and manganese were reported to be present in various combinations in over half the samples collected from the background wells. Finally, zinc was reported to be present in samples collected from two of the background wells. Of the five total metals reported to be present in the samples collected from the background wells, RSR criteria have been established for zinc only. Neither of the reported concentrations of zinc exceeded either SWPC or GWPC.

Dissolved metal analysis was conducted to assess the effects of turbidity and suspended solids on the reported total metals concentrations. Concentrations of dissolved iron and manganese were reported to be present in approximately half the samples collected from the background wells. In addition, dissolved zinc was reported to be present in in two samples collected from the background wells. Finally, dissolved mercury was reported to be present in a

sample collected from one of the background wells. The following table summarizes all metals reported to be present in samples collected from the background wells:

Table 3: Background Wells Metals Summary

Total Metals	# of Samples	# of Detections	% of Detections	# of GWPC Exceedances	# of SWPC Exceedances	Min (µg/L)	Max (µg/L)	Average (µg/L)	Mean (µg/L)
Iron	26	15	57.7%	NE	NE	140	26,000	7,273	1,600
Manganese	26	17	65.4%	NE	NE	21	1,700	505	370
Potassium	26	26	100.0%	NE	NE	1,500	9,600	3,715	2,900
Sodium	26	26	100.0%	NE	NE	3,500	290,000	41,046	17,000
Zinc	26	2	7.7%	0	0	25	27	26	26
Dissolved Metals									
Iron	26	11	42.3%	NA	NA	130	17,000	6,928	5,000
Manganese	26	18	69.2%	NA	NA	29	1,400	423	305
Mercury	26	1	3.8%	NA	NA	1.4	1.4	1.4	1.4
Zinc	26	2	7.7%	NA	NA	21	28	24.5	24.5

Notes:
NE: No criteria established for constituent
NA: Not applicable

3.3.2 Site Wells

3.3.2.1 VOCs

VOCs by EPA Method 8260 were reported to be present in the groundwater samples collected from 16 of the 28 wells located within the site during the four quarterly sampling events. The number of wells with reported VOC concentrations each quarter ranged from 11 wells during the second, third and fourth quarterly events to 14 wells during the first quarterly event. Eight wells had reported VOC concentrations in all four quarters. In all, 30 different VOCs were reported to be present in samples collected in one or more of the 28 footprint wells. In general, the reported VOC concentrations were related to either petroleum constituents or chlorinated solvents and were concentrated in two distinct areas of the footprint.

Well MW-1 (OB) located to the north of salt shed in the northwest corner of the site had consistent reported concentrations of 13 to 15 petroleum-related VOCs in all four quarters. Of these reported concentrations, only benzene exceeded GWPC. The reported concentrations of the remaining VOCs reported to be present in the samples from this well were typically well below the applicable criteria. No VOCs were reported to be present in the samples collected from the bedrock well MW-1 (R) during any of the four quarterly sampling events. The MW-16

well couplet which is located to the north and hydraulically downgradient from the MW-1 couplet also had no reported concentrations of any VOCs during any of the four quarterly sampling events.

Well MW-18 (OB) located along the toe of the landfill slope near the discharge culvert of the pipe from the landfill pond had consistent reported concentrations of 10 to 12 petroleum related VOCs in all four quarters. As with MW-1 (OB), only the reported concentrations of benzene in three of four samples collected from this well exceeded GWPC. Well MW-17 (OB) which is located to the west of the MW-18 couplet along the toe of the landfill slope had significantly fewer detections of petroleum-related VOCs with a single concentration of benzene exceeding GWPC in the sample from one quarterly sampling event. To the southeast of the MW-18 couplet, well MW-2 (OB) had only several petroleum related VOC concentrations reported above method detection limits in the four quarterly sample events. None of these concentrations approached the applicable criteria.

MW-18 (OB), MW-17 (OB) and MW-2 (OB) are all located in the northeast portion of the site and based on the reported concentrations of petroleum-related VOCs identified in these wells appear to define the east-west and northern extent of a low-level dissolved petroleum hydrocarbon plume in the shallow groundwater in this area of the site. Three other well couplets, MW-6, MW-14 and MW-9, are located southwest of the other wells. Only the MW-14 couplet had any reported concentration of petroleum-related VOCs during the four quarterly sampling events, all below regulatory criteria.

The bedrock aquifer in this same northeast portion of the site has reported concentrations of chlorinated VOCs. The highest reported concentrations of the chlorinated VOCs were in the samples collected from MW-18 (R). A total of ten different VOCs were reported to be present in the samples collected from well MW-18 (R) during the four quarterly sampling events with seven of these compounds identified in three or four of the four quarters. Most of these VOCs belong to the chlorinated VOC group. Elevated concentrations with respect to the applicable criteria of the following were reported to be present in the samples collected from MW-18 (R) during the four sampling events: 1,1-dichloroethene (1,1-DCE), 1,2-dichloroethane, benzene, cis-1,2-dichloroethene, tetrachloroethylene (PCE), trichloroethylene (TCE), and vinyl chloride (VC). Of these compounds, 1,1-DCE exceeded RVC and VC exceeded RVC, I/CVC and GWPC. The remaining compounds exceeded only GWPC.

Well MW-17 (R) had reported concentrations of four different VOCs from samples collected during the four sampling events. Of these compounds, the reported concentrations of TCE exceeded GWPC in three of the four quarters, while 1,2-dichloroethane and VC exceeded GWPC in only one quarter. Well MW-2 (R) had low level concentrations of cis-1,2-dichloroethene and TCE reported to be present in the samples collected in all four quarters and a low level concentration of VC reported to be present in the sample from one quarter. The hydraulically downgradient well MW-19 (R) located at the northeast corner of the site had reported concentrations of TCE exceeding GWPC in samples collected from all four quarters as well as reported concentrations of 1,1-DCE which exceeded either the RVC, GWPC or both from samples collected during two of the four quarters. The upgradient bedrock wells from this area, MW-6 (R), MW-14 (R) and MW-9 (R) had reported low level VOC concentrations during the four quarterly sampling events. Only low level concentrations of chlorobenzene were consistently reported to be present in the samples collected from wells MW-6 (R) and MW-14 (R).

Well MW-19 (R) near the northeast corner of the site had consistent reported concentrations of two chlorinated VOCs in all four quarters. In addition, a third chlorinated VOC was reported to be present in this well in samples collected from two of the four quarters. Of these reported concentrations, 1,1-DCE (one quarter) and TCE (all four quarters) exceeded GWPC. The two reported concentrations of 1,1-DCE also exceeded the RVC one quarter and both the RVC and I/CVC the other. The reported concentrations of the remaining VOCs reported to be present in the samples from this well were typically well below the applicable criteria.

Two VOCs associated with the breakdown of chlorine drinking water disinfectant, bromodichloromethane and chloroform, were detected in the first quarter sampling event in the well MW-15 (R). MW-15 (R) is located near the western edge of the site on Scofieldtown Road. The reported concentration of chloroform in MW-15 (R) exceeded GWPC.

3.3.2.2 SVOCs

SVOCs by EPA Method 8270 were reported to be present in one or more samples collected from several of the wells located within the site. The majority of these reported concentrations were well below the applicable standards. The sample collected from well MW-6 (OB) from the second quarterly sampling event had reported concentrations of several polycyclic

aromatic hydrocarbons (PAHs) which exceeded either GWPC, SWPC or both. PAHs were not reported to be present in any of the other samples collected from this well. Two of the PAHs reported to be present in the sample collected from overburden well were also reported to be present in the sample collected from the bedrock well, MW-6 (R) during the same sampling event at concentrations exceeding GWPC.

3.3.2.3 ETPH

ETPH by the CT ETPH Method was reported to be present consistently in the samples collected from wells MW-1 (OB), MW-2 (OB), MW-6 (OB), MW-17 (OB) and MW-18 (OB). The samples collected from well MW-1 (OB) reported concentrations of ETPH exceeding GWPC for all four quarterly sampling events. The reported concentration for the sample collected from the well MW-6 (OB) during the third quarterly sampling event also exceeded GWPC.

Wells MW-2 (R), MW-3 (OB), MW-6 (R), MW-14 (R) MW-17 (R) and MW-18 (R) had reported concentrations of ETPH which were isolated to single samples collected from one of the quarters. In general these isolated concentrations were below GWPC with the exception of the samples collected from wells MW-3 (OB), third quarter sample and MW-10 (R), fourth quarter sample which both exceeded GWPC. The reported concentration of 20,000 parts per billion (ppb) from the third quarter MW-3 (OB) sample was confirmed with the lab and appears to be a valid result although it is anomalous in that ETPH has not been reported to be present in samples collected from MW-3 (OB) during any of the other quarters from this investigation, nor was it reported to be present in the sample collected from MW-3 (OB) from the 2009 TRC preliminary investigation. Field observations made during each of the sampling events for MW-3 (OB) have noted moderate to slight petroleum odors associated with the purge water from this well, but no sheen has been noted.

3.3.2.4 PCBs, Herbicides and Pesticides

PCBs by EPA Method 8082, herbicides by EPA Method 8151A and pesticides by EPA Method 8081B were not detected in any of the samples collected from the 28 wells located within the site during any of the four quarterly sampling events.

3.3.2.5 Metals

Four of the 15 total metals analyzed were reported to be present in various combinations in nearly all samples collected from the 28 wells located within the site during all four of the quarterly sampling events. Similar to the samples collected from the background wells, iron, manganese, potassium and sodium were reported to present in nearly all the samples collected from the wells located within the site although the reported concentrations of these metals were typically higher than in the samples collected from the background wells. There are no RSR criteria established for these four metals.

Total concentrations of seven other metals for which RSR criteria have been established were reported to be present in samples collected from wells located within the site. Total concentrations of arsenic, cadmium, lead, mercury, nickel, selenium and zinc were reported to be present either singularly or in various combinations in samples collected from 14 of the 28 wells within the site in at least one of the four quarterly sampling events. Dissolved concentrations for these seven metals were reported to be present in samples from ten of the 28 wells at concentrations above the method detection limits. The reported total concentrations of these seven metals for 12 wells within the site were above applicable criteria. A summary of all elevated metal concentrations by constituent metal is as follows.

Total arsenic was reported to be present at concentrations above SWPC in samples collected from four wells in at least one of the four quarterly sampling events. Three of these four wells, MW-1 (OB), MW-2 (OB) and MW-17 (OB) are located along the northern edge of the site while MW-14 (R) is located in the central portion of the footprint. None of the reported arsenic concentrations exceeded GWPC.

Total cadmium was reported to be present at concentrations above both SWPC and GWPC in samples collected in all four quarters from the well MW-16 (OB). In addition, cadmium was reported to be present at a concentration exceeding both SWPC and GWPC in the sample collected from well MW-16 (R) during the third quarter sampling event. Dissolved cadmium was also reported to be present in the samples collected from well MW-16 (OB) for all four quarters and from a sample collected from the well MW-16 (R) during one of the quarters. The MW-16 well cluster is located in the northwest corner of the landfill footprint.

Total lead was reported to be present at a concentration above SWPC in the sample collected in the fourth quarter from well MW-3 (OB). In addition, total lead was reported to be

present at concentrations exceeding both SWPC and GWPC in samples collected during at least one of the four quarters from wells, MW-9 (OB) (1st Quarter), MW-12 (R) (1st Quarter), MW-13 (OB) (1st Quarter) and MW-14 (OB) (1st and 3rd Quarter). Dissolved lead was also reported to be present in the sample collected in the first quarter from well MW-9 (OB) while it was not reported to be present in the samples collected from wells MW-13 (OB) and MW-14 (OB).

Total mercury was reported to be present at concentration above SWPC in the sample collected in the second quarter from well MW-9 (R). Total or dissolved mercury was not reported to be present in any of the remaining samples collected from the wells within the site above the method detection limits during any of the four quarters.

Total nickel was reported to be present at concentrations above GWPC in the sample collected in the third quarter from wells MW-16 (OB). Concentrations of total and dissolved nickel were reported to be present in the samples collected in all four quarters from well MW-16 (R). The reported concentration for total nickel from the first quarter sample exceeded GWPC. Total nickel was reported to be present in samples collected in three of the four quarters and dissolved nickel was reported to be present in the samples collected in all four quarters from well MW-17 (OB). The reported concentrations for total nickel from the fourth quarter sample exceeded GWPC.

Total selenium was reported to be present in samples collected in three of the four quarters from well MW-16 (R) at concentrations below both the GWPC and the SWPC. Selenium was not reported to be present in any of the remaining samples collected from wells within the site above the method detection limits during any of the four quarters.

Total zinc was reported to be present in samples collected in at least one of the four quarters in wells, MW-1 (OB), MW-3 (OB), MW-13 (OB), MW-14 (OB), MW-16 (OB), MW-16 (R) and MW-17 (OB). The reported concentrations from one of the four quarters from wells, MW-13 (OB), MW-14 (OB) and MW-17 (OB) exceed SWPC. The reported concentrations of total zinc from three of the four quarters from well MW-16 (OB) exceeded SWPC. Dissolved zinc was reported to be present in samples collected in at least one of the four quarters from wells, MW-1 (R), MW-13 (OB), MW-14 (OB), MW-16 (OB), MW-16 (R) and MW-17 (OB). The reported concentrations of dissolved zinc from samples collected in one of the four quarters from wells MW-13 (OB), MW-16 (OB) and MW-17 (OB) were of similar concentrations as

those observed in the total analysis. The following table summarizes all metals reported to be present in samples collected from the footprint wells during the four quarterly sample events:

Table 4: Site Wells Metals Summary

Total Metals	# of Samples	# of Detections	% of Detections	# of GWPC Exceedances	# of SWPC Exceedances	Min (µg/L)	Max (µg/L)	Average (µg/L)	Mean (µg/L)
Arsenic	99	8	8.08%	0	8	4.3	20	10	9
Cadmium	99	4	4.04%	1	4	6.8	150	44	9
Total Metals	**# of Samples**	**# of Detections**	**% of Detections**	**# of GWPC Exceedances**	**# of SWPC Exceedances**	**Min (µg/L)**	**Max (µg/L)**	**Average (µg/L)**	**Mean (µg/L)**
Iron	99	87	87.88%	NE	NE	110	56,000	10,542	6,700
Lead	99	6	6.06%	5	6	14	330	86	36
Manganese	99	96	96.97%	NE	NE	42	22,000	2,883	955
Mercury	99	1	1.01%	0	1	0.58	0.58	0.58	0.58
Nickel	99	9	9.09%	3	0	52	160	98	91
Potassium	99	98	98.99%	NE	NE	2,100	190,000	25,889	11,000
Selenium	99	3	3.03%	0	0	11	11	11	11
Sodium	99	99	100.00%	NE	NE	23,000	9,000,000	484,313	82,000
Zinc	99	17	17.17%	0	6	20	1,100	169	69
Dissolved Metals									
Arsenic	99	4	4.04%	NA	NA	4.3	11	6	5
Cadmium	99	5	5.05%	NA	NA	6.3	130	32	7
Copper	99	1	1.01%	NA	NA	42	42	42	42
Iron	99	52	52.53%	NA	NA	100	16,000	3,432	2,150
Lead	99	1	1.01%	NA	NA	17	17	17	17
Manganese	99	95	95.96%	NA	NA	55	27,000	3,036	860
Mercury	99	1	1.01%	NA	NA	0.69	0.69	0.69	0.69
Nickel	99	8	8.08%	NA	NA	65	140	95	88
Zinc	99	15	15.15%	NA	NA	21	910	145	64

Notes:
NE: No criteria established for constituent
NA: Not applicable

3.3.3 Downgradient Wells

3.3.3.1 VOCs

VOCs by EPA Method 8260 were reported to be present in the groundwater samples collected from four of the ten wells located hydraulically downgradient from the site during the four quarterly sampling events. The number of wells with reported VOC concentrations each quarter ranged from two wells during the second and third quarterly events to three wells during

the first and fourth quarterly event. Two wells had reported VOC concentrations in all four quarters. In all, four different VOCs were reported to be present in samples collected in one or more of the ten downgradient wells.

Two VOCs associated with the breakdown of chlorine drinking water disinfectant, bromodichloromethane and chloroform, were detected in the first quarter sampling event in the well MW-24 (R). Well MW-24 (R) is located in between the middle school and Poorhouse Brook to the west of the site.

Samples collected from the MW-25 well couplet had consistent reported concentrations of TCE in all four quarters from both the overburden and bedrock well. None of these reported concentrations exceeded the applicable criteria. The MW-25 well couplet is located directly to the east of the landfill footprint at the edge of the middle school's athletic fields.

3.3.3.2 SVOCs

SVOCs by EPA Method 8270 were reported to be present in two samples collected from the MW-24 well couplet. Benzo(b)fluoranthene was reported to be present in the sample collected only during the first quarterly sampling event at a concentration exceeding GWPC. Four PAHs were reported to be present in the sample collected from well MW-24 (R) during the third quarter sampling event. Of these four, the reported concentrations of benzo(a)anthracene and benzo(b)fluoranthene exceeded GWPC. No other SVOCs were reported to be present in any samples collected from the remaining wells downgradient of the site.

3.3.3.3 ETPH

ETPH by the CT ETPH Method was reported to be present in one sample collected from well MW-24 (R) during the fourth quarter. The reported concentration from this sample was below GWPC. ETPH was not reported to be present in any other samples collected from the remaining wells downgradient of the site.

3.3.3.4 PCBs, Herbicides and Pesticides

PCBs by EPA Method 8082, herbicides by EPA Method 8151A and pesticides by EPA Method 8081B were not detected in any of the samples collected from the ten wells located downgradient of the site during any of the four quarterly sampling events.

3.3.3.5 Metals

Four of the 15 total metals analyzed were reported to be present in various combinations in nearly all samples collected from the ten wells located downgradient of the site during all four of the quarterly sampling events. Similar to the samples collected from the background and site wells, iron, manganese, potassium and sodium were reported to present in nearly all the samples collected from the wells located downgradient from the site. The reported concentrations of these four metals in the samples collected from the downgradient wells were typically lower than the reported concentrations samples from the site wells and more comparable to the concentrations reported in the samples collected from the background wells. There are no RSR criteria established for these four metals.

Total concentrations of two other metals for which criteria have been established were reported to be present in wells located downgradient of the site.

Of these reported concentrations, two exceeded the applicable criteria. The reported concentration of arsenic in the sample collected from well MW-24 (OB) during the third quarter sampling event exceeded SWPC and the reported concentration of mercury in the sample collected from well MW-27 (OB) during the second quarter sampling event also exceeded SWPC. Well MW-27 (OB) is located north of the site on the property occupied by the cemetery.

Dissolved concentrations of four metals were reported to be present in the samples collected from the downgradient wells. Dissolved concentrations of manganese were reported to be present in nearly all samples collected from the downgradient wells while concentrations of dissolved iron were reported to be present in only 12.5% percent of the samples collected. The remaining two dissolved metals which had reported concentrations, mercury and zinc were only reported to be present in several samples. Dissolved mercury was reported in present in samples collected from wells MW-24 (R) (1st Quarter) and MW-25 (R) (1st and 2nd Quarter). Total mercury was not reported to be present in the corresponding samples collected from either of these wells. Finally, dissolved zinc was reported to be present in samples collected from wells MW-4 (R) (2nd Quarter), MW-24 (OB) (2nd Quarter), MW-24 (R) (3rd Quarter) and MW-25 (OB) (1st Quarter). Again, total zinc was not reported to be present in the corresponding samples collected from any of these wells. As part of the DQA/DUE process all lab results were assessed for any issues which may impact the accuracy of the analytical results. No issues were noted for the relevant samples above which would explain these contradictory results.

The following table summarizes all metals reported to be present in samples collected from the downgradient wells:

Table 5: Downgradient Wells Metals Summary

Total Metals	# of Samples	# of Detections	% of Detections	# of GWPC Exceedances	# of SWPC Exceedances	Min (µg/L)	Max (µg/L)	Average (µg/L)	Mean (µg/L)
Arsenic	40	1	2.5%	0	1	4.8	5	5	5
Iron	40	19	47.5%	NE	NE	100	1,500	460	300
Manganese	40	34	85%	NE	NE	21	620	187	99
Mercury	40	1	2.5%	0	1	0.76	0.76	0.76	0.76
Potassium	40	36	90%	NE	NE	1,000	11,000	4,364	3,650
Sodium	40	40	100%	NE	NE	8,200	310,000	80,030	67,500
Dissolved Metals									
Iron	40	5	12.5%	NA	NA	110	490	228	180
Manganese	40	32	80%	NA	NA	21	570	173	98
Mercury	40	3	7.5%	NA	NA	0.4	1.1	0.64	0.43
Zinc	40	4	10%	NA	NA	21	38	27	24

Notes:
NA: Not applicable
NE: No criteria established for constituent

3.3.4 Groundwater General Chemistry Summary

Groundwater samples from bedrock and overburden monitoring wells from the background area, the site, and downgradient area were obtained over the course of four quarters and analyzed for the general chemistry parameters total alkalinity (as calcium carbonate), ammonia as nitrogen, 5-day biochemical oxygen demand (BOD), chloride, hardness, nitrate as nitrogen, sulfate, total dissolved solids (TDS), and total suspended solids (TSS). The results of each parameter are presented below, grouped by the area from which the samples were collected. There were a total of 26, 88, and 57 groundwater samples obtained from the background, footprint, and downgradient areas, respectively, over the course of the four quarters of sampling

3.3.4.1 Total Alkalinity

The concentrations of total alkalinity reported for the background area samples ranged from 11,000 µg/L to 180,000 µg/L. The average concentration of total alkalinity was 60,115 µg/L.

The concentrations of total alkalinity reported for the site samples ranged from 30,000 µg/L to 1,300,000 µg/L. The average concentration of total alkalinity was 396,534 µg/L.

The concentrations of total alkalinity reported for the downgradient area samples ranged from 6,300 µg/L to 260,000 µg/L. The average concentration of total alkalinity was 91,966 µg/L.

3.3.4.2 Ammonia

Ammonia was detected in eight of the 26 background area samples analyzed. The concentrations of ammonia ranged from 120 µg/L to 2,600 µg/L. The average concentration of ammonia was 925 µg/L.

Ammonia was detected in 64 of the 88 site samples analyzed. The concentrations of ammonia ranged from 100 µg/L to 48,000 µg/L. The average concentration of ammonia was 4,513 µg/L.

Ammonia was detected in two of the 57 downgradient area samples analyzed. The concentrations of ammonia ranged from non-detect to 200 µg/L. The average concentration of ammonia was 200 µg/L.

3.3.4.3 BOD

BOD was detected in one background area monitoring well (MW-21OB) at a concentration of 4,000 µg/L.

BOD was detected in 37 of the 88 site samples analyzed. The concentrations of BOD ranged from 3,000 µg/L to 720,000 µg/L. The average concentration of BOD was 67,316 µg/L.

BOD was detected in five of the 57 downgradient area samples analyzed. The concentrations of BOD ranged from non-detect to 26,000 µg/L. The average concentration of BOD was 16,200 µg/L.

3.3.4.4 Chloride

Chloride was detected in all of the background area samples analyzed. The concentrations of chloride ranged from 3,600 µg/L to 620,000 µg/L. The average concentration of chloride was 60,935 µg/L.

Chloride was detected in all of the site samples analyzed. The concentrations of chloride ranged from 35,000 µg/L to 15,000,000 µg/L. The average concentration of chloride was 1,501,375 µg/L.

Chloride was detected in all of the downgradient area samples analyzed. The concentrations of chloride ranged from 6,100 µg/L to 590,000 µg/L. The average concentration of chloride was 141,791 µg/L.

3.3.4.5 Hardness

The concentrations of hardness reported for the background area samples ranged from 18,000 µg/L to 250,000 µg/L. The average concentration of hardness was 48,423 µg/L.

The concentrations of hardness reported for the site samples ranged from 41,000 µg/L to 1,400,000 µg/L. The average concentration of hardness was 366,000 µg/L.

The concentrations of hardness reported for the downgradient area samples ranged from 14,000 µg/L to 700,000 µg/L. The average concentration of hardness was 327,936 µg/L.

3.3.4.6 Nitrate

Nitrate was detected in 15 of the background area samples analyzed. The concentrations of nitrate ranged from 440 µg/L to 2,200 µg/L. The average concentration of nitrate was 1,205 µg/L.

Nitrate was detected in 16 of the site samples analyzed. The concentrations of nitrate ranged from 100 µg/L to 1,800 µg/L. The average concentration of nitrate was 641 µg/L.

Nitrate was detected in 41 of the downgradient area samples analyzed. The concentrations of nitrate ranged from 110 µg/L to 8,100 µg/L. The average concentration of nitrate was 2,546 µg/L.

3.3.4.7 Sulfate

Sulfate was detected in 25 of the background area samples analyzed. The concentrations of sulfate ranged from 8,200 µg/L to 33,000 µg/L. The average concentration of sulfate was 16,828 µg/L.

Sulfate was detected in 72 of the site samples analyzed. The concentrations of sulfate ranged from 1,000 µg/L to 120,000 µg/L. The average concentration of sulfate was 24,425 µg/L.

Sulfate was detected in all of the downgradient area samples analyzed. The concentrations of sulfate ranged from 1,900 µg/L to 59,000 µg/L. The average concentration of sulfate was 25,498 µg/L.

3.3.4.8 TDS

The concentrations of TDS reported for the background area samples ranged from 14,000 µg/L to 1,300,000 µg/L. The average concentration of TDS was 173,154 µg/L.

The concentrations of TDS reported for the site samples ranged from 100,000 µg/L to 23,000,000 µg/L. The average concentration of TDS was 2,178,977 µg/L.

The concentrations of TDS reported for the downgradient area samples ranged from 42,000 µg/L to 2,100,000 µg/L. The average concentration of TDS was 352,281 µg/L.

3.3.4.9 TSS

TSS were detected in 11 of the background area samples analyzed. The concentrations of TSS ranged from 5,000 µg/L to 200,000 µg/L. The average concentration of TSS was 36,273 µg/L.

TSS were detected in 72 of the site samples analyzed. The concentrations of TSS ranged from 5,000 µg/L to 300,000 µg/L. The average concentration of TSS was 46,389 µg/L.

TSS were detected in 24 of the downgradient area samples analyzed. The concentrations of TSS ranged from 5,000 µg/L to 90,000 µg/L. The average concentration of TSS was 17,417 µg/L.

3.3.5 General Groundwater Chemistry Interpretation

The table below summarizes the average (mean) values of each general chemistry parameter for the background area, site and the downgradient area. A short discussion follows.

Table 6: General Groundwater Chemistry, Background, Site and Downgradient Comparison

Parameter	Background Area Mean (µg/L)	Site Mean (µg/L)	Downgradient Area Mean (µg/L)
Total Alkalinity	60,115	396,534	91,966
Ammonia	925	4,513	200
BOD	4,000	67,316	16,200
Chloride	60,395	1,501,375	141,791
Hardness	48,423	366,000	155,719
Nitrate	1,205	641	2,546
Sulfate	16,828	24,425	25,498
TDS	173,154	2,178,977	352,281
TSS	36,273	46,389	17,417

It should be noted that lateral groundwater flow is generally from the background area, towards the site , and then towards the downgradient area. It is apparent by reviewing the above

table that there is a significant difference in the general chemistry parameters when comparing the average groundwater sample result values of the background area and the site. In all cases, with the exception of nitrate, the average concentration detected in the site groundwater samples is greater than the average concentration detected in the background area. Because the general chemistry parameters provide an indication of overall groundwater quality, and higher concentrations of the general chemistry parameters indicate decreasing water quality, in comparing the overall water quality of the two areas, it appears that the site groundwater is of a lower overall quality than that of the background area. Based on this statement, and accounting for the direction of lateral groundwater flow, activities at the landfill have had a negative impact on overall groundwater quality within the site. For example, the average chloride concentration reported for the footprint monitoring wells is approximately 25 times that of the average chloride concentration reported for the background monitoring wells. The potential source for the chloride detected in site groundwater is the salt stockpile area in the northwest area of the landfill.

In comparing the general chemistry parameters in the above table for the site area versus the downgradient area, significant differences are apparent for all parameters, with the exception of sulfate. Furthermore, all average values for the site parameters are higher than the average values for the downgradient area, with the exception of nitrate. Generally speaking, this observation would be expected as activities that have degraded water quality occurred within the site. In contrast to most of the average footprint area general chemistry parameter values being higher than the average downgradient area general chemistry parameter values, the average nitrate value for the downgradient area is actually higher than the average nitrate value for the site. Furthermore, as mentioned above, there appears to be no significant difference between the average site sulfate concentration versus the average downgradient area sulfate concentration.

However, while the overall average general chemistry parameters of the downgradient area indicate a generally better groundwater quality of the downgradient area compared to the site, the downgradient still appears somewhat degraded in quality when compared to the background area general chemistry parameters.

3.4 Sediment and Surface Water Sampling and Stream Gauge Installation

The locations of the sediment and surface water sampling locations are shown on Figure 2. Sediment sampling was completed during the first quarterly sampling event and was conducted after the initial round of surface water samples were collected to avoid the potential of cross contamination between sites. The sediment/surface water sample locations were identified as follows:

Sample ID	Location
SW/SED-1:	Located at the northwest corner of the site where the culverted drainage enters the site.
SW/SED-2:	Located further downstream where the unnamed stream becomes permanent.
SW/SED-3:	Located on the upstream side of the bermed area to the north of the site.
SW/SED-4:	Located at the southerly jog of the unnamed stream but upstream of the outfall of the discharge pipe that extends from beneath the site.
SW/SED-5:	Located at the intersection of the leachate drainage outfall and the unnamed stream.
SW/SED-6:	Located immediately upstream of the double culvert that brings the unnamed stream under Scofieldtown Road.
SW/SED-7:	Located further downstream within Poorhouse Brook directly west of the MW-25 well couplet.
SW/SED-8:	Located at the outfall of the drainage pipe that enters the site man-made pond from beneath Rock Rimmon Road.
SW/SED-9:	Located on the northern end of the site man-made pond.

During the sediment sampling four graduated stream gauges were installed by driving pressure treated 2x4s with the gauges attached into the bottom sediments of unnamed stream or Poorhouse Brook on May 17, 2012. The four stream gauge designations correspond to the following SW/SED sampling locations:

- SG-1: SW/SED-7

- SG-2: SW/SED-6
- SG-3: SW/SED-4
- SG-4: SW/SED-2

Sediment samples were collected at the locations described above on May 16th and 17th, 2013 in the following manner. Measurements of the stream gauges were obtained during each quarter of sampling and were used in the hydrologic evaluation

3.4.1 Sediment Sampling

The technique used to collect the sediment samples depended on the conditions at each location. A bucket auger alone was utilized to collect both sediment intervals from locations SED-1, SED-2, SED-4, SED-5 and SED-7. At location SED-2, minimal standing water allowed for collection of the samples without sample wash or loss. At the remaining locations where a bucket auger was used alone, the rockiness of the stream bottom prevented driving the PVC pipe into the sediment. In these cases, care was taken to minimize sample wash and sloughing of the upper interval sediments into the lower interval. At locations SED-3, SED-6, SED-8, and SED-9, a 4-inch diameter PVC pipe was driven into the sediment to at least 1.5 feet. This allowed for the collection of multi-level sediment samples to depths of six inches and one foot with minimal collapse of the borehole, as the PVC pipe impeded the influx of water. The sediment sample were then collected from within the pipe using a decontaminated stainless steel auger.

The contents of the auger were placed carefully (with minimal disturbance) into a dedicated, stainless steel mixing bowl to allow for the collection of an aliquot for the analysis of VOCs. After the aliquot has been collected for VOC analysis, the contents of the bowl was then homogenized with a decontaminated stainless steel spoon and placed directly into the appropriate sample containers for the remaining analyses. All sediment samples were geologically logged for grain size, color, texture, consistency, and other physical parameters (e.g., staining, odors, etc.). These observations were recorded in the field notebook.

3.4.2 Sediment Sampling Analytical Results

Although excluded from the definition of soil in the RSRs, the sediment sample results were compared to the RDEC and the I/C DEC to provide general information related to direct exposure criteria. In addition, the sediment sample results were also compared to the National

Oceanic and Atmospheric Administration (NOAA) screening level concentrations for inorganic and organic contaminants in sediments. In particular, the sediment sample results were compared to the Threshold Effects Level (TEL) and the Probable Effects Level (PEL) as provided by NOAA's Screening Quick Reference Table (SQuiRTs) for Inorganics in Sediment.

The TEL is the concentration of a particular contaminant that, when ingested by an organism, above which some type of effect (or response) will be produced and below which, will not. The PEL is the concentration of a particular contaminant that, when ingested by an organism, above which an adverse effect is likely to be caused. The provided TEL and PEL concentrations are for screening purposes only and should not be interpreted as action level concentrations. In the absence of a more comprehensive ecological risk assessment, it is not possible at this time to more thoroughly assess the results of the sampling of the sediments of the unnamed stream, Poorhouse Brook and the site man-made pond.

Each sediment sample was analyzed according to the parameters shown in Table 7.

Table 7: Sediment Analytical Parameter Summary

Analytical Parameter (Analytical Method)	Sediment
Volatile Organic Compounds (EPA Method 8260)	√
Semi-volatile Organic Compounds (EPA Method 8270)	√
Extractable Total Petroleum Hydrocarbons (CTDEEP-Approved Method)	√
Polychlorinated Biphenyls (EPA Method 8082)	√
Pesticides (EPA Method 8081)	√
Herbicides (EPA Method 8151)	√
Priority Pollutant Metals (EPA Methods 6020/7471)	√
Total Organic Carbon (EPA Method 9060)	√

The sediment sample analytical results are provided in Table 20 and are summarized below by analytical category.

3.4.2.1 VOCs

Four VOCs by EPA Method 8260 were reported to be present either singularly or in combination in samples collected from three of the nine locations at concentrations significantly below either the RDEC or the I/C DEC for the three of the four compounds for which criteria have been established. There are no NOAA TELs or PELs for the identified compounds.

3.4.2.2 SVOCs

Thirteen SVOCs by EPA Method 8270 were reported to be present either singularly or in various combinations in samples collected from five of the nine sediment locations. With respect to the RSR criteria, benzo(a)anthracene, benzo(a)pyrene and benzo(b)fluoranthene were reported to be present in the sample collected from the 0-6 inch interval at the SED-7 location at concentrations exceeding the RDEC. The reported concentration of benzo(a)pyrene also exceeded the I/C DEC. SED-7 is located within Poorhouse Brook downstream from Scofieldtown Road.

The reported concentrations of seven of the 11 SVOCs present in the 0-6 inch interval of sediment sample location SED-7 also exceeded the NOAA TEL and PEL. The NOAA criteria were also exceeded for at least one SVOC in samples collected from either the shallow interval, the deeper interval or both in sediment sample locations SED-2, SED-5 and SED-8

3.4.2.3 ETPH

ETPH by the CT Method was reported to be present in samples collected from the 0-6 inch intervals at sediment sample location SED-5 and sediment sample location SED-8. Both of these reported concentrations were less than the RDEC. There are NOAA criteria for ETPH.

3.4.2.4 PCBs, Herbicides and Pesticides

PCBs by EPA Method 8082, herbicides by EPA Method 8151A and pesticides by EPA Method 8081B were not reported to be present in any of the samples collected from the nine sediment sample locations.

3.4.2.5 Metals

Eight of the 13 metals analyzed for were reported to be present in various combinations in all samples collected from the nine sediment sample locations. Chromium, copper, lead, nickel and zinc were reported to be present in all 18 sediment sample intervals collected while arsenic was reported present in 12 of 18 sample intervals and finally, cadmium was reported to be present in five of 18 sample intervals and selenium was reported to be present in two of 18 sample intervals.

The reported concentrations of arsenic in the samples collected from the 6-12 inch interval from sediment sample location SED-1 and the 0-6 inch interval from sediment sample location SED-6 exceeded both RDEC and I/C DEC. In addition, the reported lead concentration

in the sample collected from the 0-6 inch interval from sediment sample location SED-2 exceeded RDEC. No other reported concentrations of metals from the remaining sediment samples collected exceeded the RSR criteria.

Of the seven of eight metals reported to be present in 14 of the 18 sediment samples for which NOAA criteria have been established there were multiple reported concentrations that exceeded TEL or both TEL and PEL. There were no NOAA exceedances of metals for the four sediment samples collected from sediment sample locations SED-7 and SED-8. SED-7 is located in Poorhouse Brook downstream of Scofieldtown Road, while SED-8 is located at the south end of the unnamed pond located on-site.

For the sediment samples collected from the remaining seven locations, the number of metals with reported concentrations exceeding TEL or both TEL and PEL ranged from two to seven in each sample. Correspondingly, the percentage of metals exceeding NOAA criteria in a given sample ranged from 33% to 100%. Six of the seven remaining locations were within the unnamed stream which flows west to east along the northern toe of the landfill while the seventh location was at the north end of the site pond.

In general the number of metals with reported concentrations exceeding the NOAA criteria decreased from the 0-6 inch interval to the 6-12 inch interval.

The following table summarizes the reported metals concentrations exceeding criteria:

Table 8: Sediment Metals Summary

Total Metals	# of Samples	# of Detections	% of Detections	# of RSR Criteria Exceedances	# of NOAA Criteria Exceedances	Min (mg/kg)	Max (mg/kg)	Average (mg/kg)	Mean (mg/kg)
0-6 inch Interval									
Arsenic	9	6	67%	2	5	3.1	22	8.7	7.1
Cadmium	9	2	22%	0	4	11	14	12.5	12.5
Chromium	9	9	100%	NE	3	6.6	50	27.1	25
Copper	9	9	100%	0	8	5.9	510	127.3	40
Lead	9	9	100%	1	9	8	410	108.6	73
Nickel	9	9	100%	0	7	4.5	95	31.8	18
Selenium	9	1	11%	0	NE	6.2	6.2	6.2	6.2
Zinc	9	9	100%	0	7	45	1,500	428	160
6-12 inch Interval									
Arsenic	9	6	67%	2	3	1.8	13	5.8	4.9
Cadmium	9	3	33%	0	5	1.3	12	5.9	4.4

Total Metals	# of Samples	# of Detections	% of Detections	# of RSR Criteria Exceedances	# of NOAA Criteria Exceedances	Min (mg/kg)	Max (mg/kg)	Average (mg/kg)	Mean (mg/kg)
6-12 inch Interval (continued)									
Chromium	9	9	100%	NE	3	6.2	69	28.5	14
Copper	9	9	100%	0	2	4.8	400	60.3	20
Lead	9	9	100%	0	4	9.7	260	55.4	33
Nickel	9	8	89%	0	4	3.7	73.0	19.7	12.5
Selenium	9	1	11%	0	NE	3.4	3.4	3.4	3.4
Zinc	9	9	100%	0	4	23	1,100	203.6	85

Notes:
NE: No criteria established for constituent

3.4.2.6 Total Organic Carbon (TOC)

TOC by EPA Method 9060A was reported to be present as a percentage in all sediment samples collected with the exception of the sample collected from the 6-12 inch interval at sediment sample location SED-7. The remaining samples had reported TOC ranging from 0.75% to 21.5%. The percentage of TOC seems to inversely correlate with low flow conditions which allows for more settling of organic matter along the bottom of the stream or pond. Typically the deeper intervals had a lower percentage of TOC as well.

3.4.3 Surface Water Sampling

Surface water sampling was conducted on a quarterly bases and was typically done sequentially with the groundwater sampling events. In all cases the surface water sampling was accomplished in a single day. Surface water sampling was conducted in a downstream to upstream manner to prevent any disturbance of the surface water sampling conditions (i.e., the potential for introducing sediment into the water column). Surface water samples were collected directly into the appropriate sample containers by facing upstream and partially submerging the containers within the stream current. All surface water samples were collected from the surface of the water and care was taken to minimize turbulence during sampling.

At each of the sample locations, the physical characteristics of the stream was noted (e.g. depth, width, and approximate flow velocity) and recorded in a field notebook. Field chemistry measurements, including pH, temperature, specific conductance, dissolved oxygen, turbidity, and oxidation-reduction potential were collected in-situ within the stream channel or pond at each location.

3.4.4 Surface Water Sampling Analytical Results

The surface water analytical results were compared to the CT Water Quality Standards (WQS) Chronic and Acute Aquatic Life Criteria (ALC), and the Human Health Criteria (HHC), for the Consumption of Fish and the Consumption of Fish and Water.

Each surface water sample was analyzed according to the parameters shown in Table 9.

Table 9: Surface Water Analytical Parameter Summary

Analytical Parameter (Analytical Method)	Surface Water
Volatile Organic Compounds (EPA Method 8260)	√
Semivolatile Organic Compounds (EPA Method 8270)	√
Extractable Total Petroleum Hydrocarbons (CTDEEP-Approved Method)	√
Polychlorinated Biphenyls (EPA Method 8082)	√
Pesticides (EPA Method 8081)	√
Herbicides (EPA Method 8151)	√
Priority Pollutant Metals (EPA Methods 6020/7471)	√
Total Organic Carbon (EPA Method 9060)	
Hardness (EPA Method 200.7)	√
Total Dissolved Solids (Standard Method 2540C)	√
Total Suspended Solids (Standard Method 2540D)	√
Alkalinity (Standard Method 2320B)	√
Total Dissolved Iron (EPA Method 200.7)	√
Total Dissolved Manganese (EPA Method 200.7)	√
Ammonia (as Nitrogen) (Standard Method 4500-NH3D)	√
Nitrate (as Nitrogen) (EPA Method 300.0)	√
Sodium (EPA Method 200.7)	√
Potassium (EPA Method 200.7)	√
Chlorides (EPA Method 300.0)	√
Sulfates (EPA Method 300.0)	√
Biological Oxygen Demand (5-day)	√
pH (Standard Method 4500 H+B for Soils/Field Measurement for water)	√
Oxidation Reduction Potential (Field Measurement)	√

The surface water sample analytical results summary for all four quarters are provided in Table 21 and are summarized below by analytical category.

3.4.4.1 VOCs

VOCs by EPA Method 8260 were reported to be present in samples collected from at least one of the quarterly sampling events from three of the nine surface water sample locations. Concentrations of chlorobenzene were reported to be present in samples collected from surface

water sample locations SW-2 in one quarter and from SW-5 in two quarters. None of the reported concentrations of chlorobenzene exceeded any of the applicable criteria. Chloroform was reported to be present in the fourth quarter sample collected from the surface water sample location SW-1 at a concentration below the applicable criteria. No concentrations of any other VOCs were reported to be present in any of the remaining surface water samples collected from each of the four quarterly sample events.

3.4.4.2 SVOCs

SVOCs by EPA Method 8270 were not reported to be present in any of the surface water samples collected during the four quarterly events.

3.4.4.3 ETPH

ETPH by the CT ETPH Method was reported to be present in the samples collected from four of the nine surface water sample locations during two of the four quarterly sampling events. ETPH was reported to be present in the sample collected from surface water sample location SW-3 during the first quarter sample event. There were no additional reported concentrations of ETPH from any of the other surface water samples collected during the first quarter.

ETPH was reported to be present in surface water samples collected from three locations, SW-1, SW-2 and SW-9 during the second quarter sample event concentrations above the method detection limits. There are no CT WQS established for ETPH. No concentrations of ETPH were reported for any other surface water samples collected during third or fourth quarterly sampling events.

3.4.4.4 PCBs, Herbicides and Pesticides

PCBs by EPA Method 8082, herbicides by EPA Method 8151A and pesticides by EPA Method 8081B were not detected in any of the surface water samples collected during any of the four quarterly sampling events.

3.4.4.5 Metals

Four of the 15 total metals analyzed were reported to be present in various combinations in nearly all surface water samples collected from the unnamed stream, Poorhouse Brook and the site pond during all four of the quarterly sampling events. Iron, manganese, potassium and sodium were reported to be present in nearly all the samples collected from the surface water sample locations. There are no criteria established for these four metals.

Total concentrations of three other metals for which criteria have been established were reported to be present in samples collected from the surface water sample locations. Total concentrations of copper, lead, and zinc were reported to be present either singularly or in various combinations in samples collected from six of the nine surface water locations during at least one of the four quarterly sampling events. Of these reported concentrations several exceeded the applicable CT WQS in samples collected from two of the surface water sample locations. The reported concentrations of total copper and zinc in the sample collected from location SW-1 (off-site drainage pipe outfall) during the second quarter sampling event exceeded both the chronic and acute ALC. Also, during the second quarter sampling event, the reported concentrations of total copper, lead and zinc in the sample collected from location SW-2 exceeded both the chronic and acute ALC as well. Finally, the reported total concentration of zinc in the sample collected from the surface water sample location, SW-2 during the third quarter sampling event also exceeded both the chronic and acute ALC. No other reported concentrations of total metals exceeded any of the established criteria during any of the four quarterly sample events.

For the dissolved metal analysis, significantly fewer metals were reported to be present above the method detection limits in the samples collected from the nine surface water sample locations during four quarterly sample events. Concentrations of dissolved iron and manganese were reported to be present in nearly all the samples collected from the surface water sample locations. As stated, above there are no CT WQS criteria established for these metals.

Only the reported concentrations of dissolved copper and zinc in the sample collected from the locations SW-1 during the second quarter sampling event exceeded the chronic and acute ALC. No other reported concentrations of dissolved metals exceeded any of the established criteria during any of the four quarterly sample events.

3.4.5 General Surface Water Chemistry

Surface water samples from the unnamed stream, Poorhouse Brook and the site pond were obtained over the course of four quarters and analyzed for the general chemistry parameters total alkalinity (as calcium carbonate), ammonia as nitrogen, 5-day BOD, chloride, hardness, nitrate as nitrogen, sulfate, TDS, and TSS. The results of each parameter are presented below, grouped by the water body from which the samples were collected. There were a total of 22, 4,

and 8 surface water samples obtained from the unnamed stream, Poorhouse Brook, and the site pond, respectively, over the course of the four quarters of sampling

3.4.5.1 Total Alkalinity

The concentrations of total alkalinity reported for the unnamed stream samples ranged from 14,000 µg/L to 410,000 µg/L. The average concentration of total alkalinity was 95,273 µg/L.

The concentrations of total alkalinity reported for the Poorhouse Brook samples ranged from 60,000 µg/L to 130,000 µg/L. The average concentration of total alkalinity was 89,750 µg/L.

The concentrations of total alkalinity reported for the site pond samples ranged from 25,000 µg/L to 48,000 µg/L. The average concentration of total alkalinity was 35,000 µg/L.

3.4.5.2 Ammonia

Ammonia was detected in 14 of the 22 unnamed stream samples analyzed. The concentrations of ammonia ranged from 100 µg/L to 1,600 µg/L. The average concentration of ammonia was 398 µg/L.

Ammonia was detected in two of the four Poorhouse Brook samples analyzed. The concentrations of ammonia ranged from 160 µg/L to 210 µg/L. The average concentration of ammonia was 185 µg/L.

Ammonia was detected in three of the eight site pond samples analyzed. The concentrations of ammonia ranged from 110 µg/L to 240 µg/L. The average concentration of ammonia was 157 µg/L.

3.4.5.3 BOD

BOD was detected in two of the 22 unnamed stream samples analyzed. The concentrations of BOD ranged from 9,400 µg/L to 15,000 µg/L. The average concentration of ammonia was 12,200 µg/L.

BOD was not detected in any of the samples collected from Poorhouse Brook.

BOD was detected in two of the eight site pond samples analyzed. The concentrations of BOD ranged from 16,000 to 28,000 µg/L. The average concentration of BOD was 22,000 µg/L.

3.4.5.4 Chloride

Chloride was detected in all of the unnamed stream samples analyzed. The concentrations of chloride ranged from 4,200 µg/L to 1,300,000 µg/L. The average concentration of chloride was 261,827 µg/L.

Chloride was detected in all of the Poorhouse Brook samples analyzed. The concentrations of chloride ranged from 75,000 µg/L to 110,000 µg/L. The average concentration of chloride was 92,000 µg/L.

Chloride was detected in all of the site pond samples analyzed. The concentrations of chloride ranged from 35,000 µg/L to 78,000 µg/L. The average concentration of chloride was 54,125 µg/L.

3.4.5.5 Hardness

The concentrations of hardness reported for the unnamed stream samples ranged from 15,000 µg/L to 290,000 µg/L. The average concentration of hardness was 94,455 µg/L.

The concentrations of hardness reported for the Poorhouse Brook samples ranged from 65,000 µg/L to 110,000 µg/L. The average concentration of hardness was 78,750 µg/L.

The concentrations of hardness reported for the site pond samples ranged from 45,000 µg/L to 69,000 µg/L. The average concentration of hardness was 54,625 µg/L.

3.4.5.6 Nitrate

Nitrate was detected in 20 of the 22 unnamed stream samples analyzed. The concentrations of nitrate ranged from 100 µg/L to 2,100 µg/L. The average concentration of nitrate was 470 µg/L.

Nitrate was detected in all of the Poorhouse Brook samples analyzed. The concentrations of nitrate ranged from 310 µg/L to 850 µg/L. The average concentration of nitrate was 545 µg/L.

Nitrate was detected in seven of the eight site pond samples analyzed. The concentrations of nitrate ranged from 350 µg/L to 3,300 µg/L. The average concentration of nitrate was 1,503 µg/L.

3.4.5.7 Sulfate

Sulfate was detected in all of the unnamed stream samples analyzed. The concentrations of sulfate ranged from 3,400 µg/L to 22,000 µg/L. The average concentration of sulfate was 11,627 µg/L.

Sulfate was detected in all of the Poorhouse Brook samples analyzed. The concentrations of sulfate ranged from 6,400 µg/L to 15,000 µg/L. The average concentration of sulfate was 10,575 µg/L.

Sulfate was detected in all of the site pond samples analyzed. The concentrations of sulfate ranged from 9,800 µg/L to 16,000 µg/L. The average concentration of sulfate was 13,225 µg/L.

3.4.5.8 TDS

The concentrations of TDS reported for the unnamed stream samples ranged from 28,000 µg/L to 2,300,000 µg/L. The average concentration of TDS was 497,727 µg/L.

The concentrations of TDS reported for the Poorhouse Brook samples ranged from 180,000 µg/L to 300,000 µg/L. The average concentration of TDS was 235,000 µg/L.

The concentrations of TDS reported for the site pond samples ranged from 100,000 µg/L to 260,000 µg/L. The average concentration of TDS was 162,500 µg/L.

3.4.5.9 TSS

TSS were detected in 14 of the unnamed stream samples analyzed. The concentrations of TSS ranged from 5,000 µg/L to 180,000 µg/L. The average concentration of TSS was 34,071 µg/L.

TSS were detected in one of the Poorhouse Brook samples analyzed. The reported concentration of TSS in this sample was 12,000 µg/L.

TSS were detected in three of the site pond samples analyzed. The concentrations of TSS ranged from 10,000 µg/L to 290,000 µg/L. The average concentration of TSS was 105,667 µg/L.

3.4.6 General Surface Water Chemistry Interpretation

It is apparent by reviewing the above summarized surface water general chemistry results and the complete surface water general chemistry results as provided in Table 21: Surface Water Analytical Results Summary Table that there is a fairly significant difference in the general

chemistry parameters when comparing the average surface water sample result values of the unnamed stream, Poorhouse Brook and the site pond. In all cases, with the exception of nitrate, the average concentration detected in the unnamed stream surface water samples is greater than the average concentration reported in the Poorhouse Brook samples. Additionally, when comparing the average surface water sample results from the site pond with those of the unnamed stream and Poorhouse Brook, with the exception of nitrate, sulfate and TSS, the unnamed stream and Poorhouse Brook average sample results were greater than the site pond. Because the general chemistry parameters provide an indication of overall surface water quality, and higher concentrations of the general chemistry parameters indicate decreasing water quality, in comparing the overall water quality of the three areas, it appears that the unnamed stream is of a lower overall quality than that of the Poorhouse Brook and the site pond. It also appears that Poorhouse Brook at the point that surface water samples are collected is of lower overall water quality than the site pond. It must be remembered that the unnamed stream turns into Poorhouse Brook at Scofieldtown Road and therefore is a contributor to water quality along the upper portion of Poorhouse Brook where the surface water samples are collected. The site pond receives surface runoff from the former park area, groundwater discharge and the majority of the flow from the discharge of a small culverted stream which flows under Rock Rimmon Road from the Smith House property to the southwest.

When the average results from each surface water sample location along the unnamed stream, Poorhouse Brook and the site pond are compared it is apparent that the most degraded surface water quality is at the upstream locations SW-2 and SW-3 on the unnamed stream as indicated in the following summary table of average sample results from the four quarterly sample events for each surface water sample location.

Table 10: Average Surface Water General Chemistry Results

Sample ID:	SW-01	SW-02	SW-03	SW-04	SW-05	SW-06	SW-07	SW-08	SW-09
Analysis/ Analytes	Unnamed Stream	Unnamed Stream	Unnamed Stream	Unnamed Stream	Unnamed Stream	Unnamed Stream	Poorhouse Brook	Site Pond	Site Pond
General Chemistry (µg/l)									
Alkalinity, Tot(CaCO3)	19,667	186,250	156,667	51,000	71,750	82,750	89,750	33,750	36,250
Ammonia as N	130	910	285	150	308	253	185	120	175
BOD, 5 Day	9,400	15,000							22,000
Chloride	101,400	727,500	490,000	86,250	91,000	91,750	92,000	52,750	55,500
Hardness	44,000	166,750	123,667	66,750	80,500	79,750	78,750	54,000	55,250

Sample ID: / Analysis/ Analytes	SW-01 Unnamed Stream	SW-02 Unnamed Stream	SW-03 Unnamed Stream	SW-04 Unnamed Stream	SW-05 Unnamed Stream	SW-06 Unnamed Stream	SW-07 Poorhouse Brook	SW-08 Site Pond	SW-09 Site Pond
Nitrate as N	343	305	1,007	385	398	400	545	1,238	1,857
Sulfate	10,033	13,950	12,767	11,700	10,400	10,800	10,575	13,500	12,950
TDS	227,333	1,272,500	870,000	207,500	245,000	189,500	235,000	185,000	140,000
TSS	7,000	100,000	36,000	7,000	9,500	9,667	12,000	10,000	153,500

Both SW-2 and SW-3 sample locations are typically characterized by low flow conditions with ponded more stagnant water. These conditions would contribute to higher concentrations of the general chemistry parameters identified above. The surface water sample location SW-4 is located at the confluence of two branches of the unnamed stream with a significantly higher volumetric flow and predictably the average concentrations at this location are significantly lower then at SW-2 and SW-3. The average of all the general chemistry parameters increase again at the next downstream location, SW-5 which is located just downstream of the confluence point of the unnamed stream and the discharge flow from the site pond culvert pipe which runs beneath the landfill and likely intercepts landfill leachate. Downstream from this locations the reported average concentrations are fairly consistent with those observed at SW-5.

4.0 LEACHATE SEEP INVESTIGATION

A leachate seep investigation was conducted in conjunction with the other investigations completed at the site. The objectives of the seep investigation were to:

- Complete a leachate seep inspection to identify the location, extent and characteristics of seeps observed along landfill slopes and in other on-site or off-site areas; and
- Characterize seeps observed along landfill slopes and in other areas seasonally.

4.1 Visual Leachate Seep Inspection

An initial visual leachate seep inspection was conducted on June 4, 2012 of the following areas:

- The slope along the northern boundary of the landfill along the unnamed stream;
- Slopes along the eastern boundary of the landfill along Scofieldtown Road;
- The sloping hillside that separates the composting area from the park; and

Specific items investigated included erosion rills, areas of surface staining and/or stressed vegetation and wet or saturated areas resulting from seeping liquid. A total of nine seep areas were identified during the initial inspection. All nine locations identified were located along the toe of the northern landfill slope where the slope meets the unnamed brook. Each location was marked in the field using a stake driven into the ground and flagged sufficiently in order to be identified during future inspections. A photographic log of each location is included in Appendix C

Based on the distribution of the nine seep areas, five locations were selected for sample collection. These five locations are identified on the map entitled Figure 2; Site Layout and Monitoring Well and Sample Location Map. Leachate seep samples were collected from all five locations on June 11, 2012 and analyzed for the parameters summarized in Table 16 below. The five locations were described and characterized in the field as follows:

UNB-SP-1: An approximate 300 ft^2 fan shaped area located 50 yards nothwest of Scofieldtown Road at the toe of the landfill slope. This area was characterized by heavy ferrous staining of the seep discharge and surrounding sediments. There was no measurable flow from the seep as it was spread across a fairly large area. The sample in this area was collected by digging a small trench and allowing the seep discharge to collect in the depression. The seep

discharge had an odor described as organic decay. The PID screening did not identify any detectable volatile readings.

UNB-SP-2: An approximate 450-500 ft^2 area located on the east side of the discharge from the culvert pipe which runs beneath the landfill from the pond located in the southern portion of the site. This area was characterized by heavy ferrous staining of the seep discharge and surrounding sediments. Several seeps emanate from the toe of the landfill slope in this area and combine to create a larger seep area. The total flow from this area was approximately 4-5 gallons/minute (gpm). The sample in this area was collected directly from the seep discharge. The seep discharge had an odor described as organic decay. The PID screening did not identify any detectable volatile readings.

UNB-SP-3: A small seep emanating from a depression beneath a boulder at the toe of the landfill slope directly north and down-gradient from the MW-17 well couplet. This area was characterized by ferrous staining in the area of the seep, but not within the seep discharge itself. The flow from the seep was very low but distinct. The estimated flow was approximately 100 milliliters/minute (mL/min). The sample in this area was collected by digging a small trench and allowing the seep discharge to collect in the depression. The PID screening did not identify any detectable volatile readings.

UNB-SP-4: A small seep located at the east, downstream side, of the juncture of the toe of the landfill slope and the earthen berm which bisects the wetland between the landfill and the cemetery located to the north. There was no flow or standing water at this seep location, but the ground was saturated indicating the presence of the seep. The sample in this area was collected by digging a small trench and allowing the seep discharge to collect in the depression. The PID screening did not identify any detectable volatile readings.

UNB-SP-5: A small seep located adjacent to the location of stream gauge, SG-4 and surface water sample location SW-2. There was no flow or standing water at this seep location, but the ground was saturated indicating the presence of the seep. The sample in this area was collected by digging a small trench and allowing the seep discharge to collect in the depression. The PID screening did not identify any detectable volatile readings.

4.2 Additional Inspections

After the initial leachate inspection and sample collection, three additional inspections took place over the course of the off-site impact evaluation. The observance of seeps and the

ability to collect samples is highly dependent on seasonal variations in rainfall infiltration. The three additional inspections and seep sampling events were conducted concurrent with the quarterly surface water sampling on the following dates:

- Second Quarterly Event; September 4, 2012,
- Third Quarterly Event; November 11, 2012,
- Fourth Quarterly Event; March 11, 2013.

The inspection conducted on September 4, 2012 (Second Quarterly Event) and November 11, 2012 (Third Quarterly Event) did not identify any active seep locations at the previously identified areas or from any additional areas observed during a visual inspection of the landfill slopes conducted on these dates. Consequently, no leachate seep samples were collected on these two dates.

The leachate seep inspection conducted on March 11, 2013 (Fourth Quarterly Event) identified four active seeps from which samples were collected.

4.3 Leachate Seep Sample Analytical Results

The leachate seep sample results were compared to the CT WQS both the ALC and HHC. Each leachate seep sample was analyzed according to the parameters shown in Table 11.

Table 11: Leachate Seep Analytical Parameter Summary

Analytical Parameter (Analytical Method)	Leachate Seep Samples
Volatile Organic Compounds (EPA Method 8260)	√
Semivolatile Organic Compounds (EPA Method 8270)	√
Extractable Total Petroleum Hydrocarbons (CTDEEP-Approved Method)	√
Polychlorinated Biphenyls (EPA Method 8082)	√
Pesticides (EPA Method 8081)	√
Herbicides (EPA Method 8151)	√
Priority Pollutant Metals (EPA Methods 6020/7471)	√
Total Organic Carbon (EPA Method 9060)	
Hardness (EPA Method 200.7)	√
Total Dissolved Solids (Standard Method 2540C)	√
Total Suspended Solids (Standard Method 2540D)	√
Alkalinity (Standard Method 2320B)	√
Total Dissolved Iron (EPA Method 200.7)	√
Total Dissolved Manganese (EPA Method 200.7)	√
Ammonia (as Nitrogen) (Standard Method 4500-NH3D)	√
Nitrate (as Nitrogen) (EPA Method 300.0)	√

Analytical Parameter (Analytical Method)	Leachate Seep Samples
Sodium (EPA Method 200.7)	√
Potassium (EPA Method 200.7)	√
Chlorides (EPA Method 300.0)	√
Sulfates (EPA Method 300.0)	√
Biological Oxygen Demand (5-day)	√
pH (Standard Method 4500 H+B for Soils/Field Measurement for water)	√
Oxidation Reduction Potential (Field Measurement)	√

The leachate seep sample analytical results for the two quarters during which seep samples were collected are provided in Table 22 and are summarized below by analytical category.

4.3.1 VOCs

VOCs by EPA Method 8260 were reported to be present in the leachate seep samples collected from four of the five leachate seep sample locations during the two quarterly sampling events from which leachate seepage was present. In all, eight different VOCs were reported to be present in samples collected in one or more of the four leachate seep sample locations. In general, the reported VOC concentrations were related to either petroleum-related or chlorinated VOCs.

Three of the eight VOCs reported to be present in leachate seep samples have established CT WQS criteria. Two of these three VOCs were reported to be present in concentrations exceeded applicable criteria. The reported concentration of benzene in the sample collected from the leachate seep sample location UNB-SP-2 during the fourth quarterly sampling event exceeded HHC CF&W. In addition, the reported concentration of benzene in the sample collected from the leachate seep sample location UNB-SP-4 during the fourth quarterly sample event also exceeded the CF&W. Finally, the reported concentration of TCE in the sample collected from the leachate seep sample location UNB-SP-1 during the fourth quarterly sample event exceeded the CF&W.

4.3.2 SVOCs

SVOCs by EPA Method 8270 were reported to be present in samples collected from three of the five leachate seep sample locations during the two quarterly sampling events. Five and

seven SVOCs of the PAH subgroup, respectively were reported to be present in the samples collected from the leachate seep sample location UNB-SP-1 during the first and fourth quarterly sampling events.

Of the five PAHs reported to be present in the sample collected from the first quarter sample from UNB-SP-1, the reported concentrations of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene and indeno(1,2,3-cd)pyrene exceeded both the HHC CF and CF&W. In addition to these four compounds, the reported concentrations of benzo(k)fluoranthene and fluoranthene also exceeded both the HHC CF and CF&W in the sample collected from UNB-SP-1 during the fourth quarter event.

Finally, the reported concentrations of three PAHs, benzo(a)pyrene, benzo(b)fluoranthene and indeno(1,2,3-cd)pyrene from the sample collected from the leachate seep sample location UNB-SP-5 during the fourth quarter event exceeded both the HHC CF and CF&W.

No other reported SVOC concentrations from any other of the collected samples exceeded any of the applicable criteria. It should be noted that no ALC have been established for any of the SVOCs reported to be present in any of the samples collected from the leachate seep sample locations.

4.3.3 ETPH

ETPH by the CT ETPH Method was reported to be present in the samples collected from three of the five leachate seep sample locations during two of the four quarterly sampling events.

ETPH was reported to be present in the both samples collected from the leachate seep sample locations UNB-SP-3 and UNB-SP-5 during the first and fourth quarter sample events. In addition, ETPH was reported to be present in the sample collected from leachate seep sample location UNB-SP-4 during the first quarter event.

There are no CT WQS established for ETPH. No concentrations of ETPH were reported for any other leachate seep samples collected during the first or fourth quarterly sampling events.

4.3.4 PCBs, Herbicides and Pesticides

PCBs by EPA Method 8082, and herbicides by EPA Method 8151A were not detected in any of the leachate seep samples collected during the first and fourth quarter sample events.

Two pesticides by EPA Method 8081B were reported to be present in the sample collected from the leachate seep sample location UNB-SP-1 during the first quarter sample event. The reported concentrations of 4,4-DDD and 4,4-DDE exceeded both the HHC CF and CF&W.

There are no CT WQS ALC established for 4,4-DDD or 4,4-DDE. No concentrations of any other pesticides were reported for any other leachate seep samples collected during the first or fourth quarterly sampling events.

4.3.5 Metals

Five to twelve of the 15 total metals analyzed were reported to be present in various combinations in all leachate seep samples collected during the two quarterly sampling events. Iron, manganese, potassium, sodium and zinc were reported to be present in all the samples collected from the leachate seep sample locations. With the exception zinc, there are no CT WQS criteria established for these metals.

Total concentrations of seven other metals for which criteria have been established were reported to be present in various combinations in samples collected from the leachate seep sample locations. Total concentrations of arsenic, cadmium, chromium, copper, lead, nickel, and silver were reported to be present either singularly or in various combinations in samples collected from all five leachate seep sample locations during both quarterly sampling events. Of these reported concentrations multiple exceeded the applicable CT WQS in samples collected from two of the leachate seep sample locations. The reported concentrations of six metals exceeded at least one of the CT WQS criteria in the sample collected from leachate seep sample location UNB-SP-1 during the first quarterly event. In addition, the reported concentrations of seven metals exceeded at least one of the CT WQS criteria in the sample collected from leachate seep sample location UNB-SP-1 during the first and fourth quarterly events. A summary of exceedances of the applicable CT WQS criteria by metal is provided in the table below:

Table 12: Leachate Seep Metal Summary

Metal	Number of Detections	Number of ALC Acute Exceedances	Number of ALC Chronic Exceedances	Number of HHC CF Exceedances	Number of HHC CF&W Exceedances
Arsenic	9	0	0	9	9
Cadmium	3	3	3	0	3
Copper	6	6	6	NA	2
Lead	9	7	9	NA	9
Nickel	3	1	3	0	1
Silver	1	1	NA	0	0
Zinc	11	9	9	0	1

For the dissolved metal analysis, significantly fewer metals were reported to be present above the method detection limits in the samples collected from the five leachate seep sample locations during the two quarterly sample events. Concentrations of dissolved iron and manganese were reported to be present in nearly all the samples collected from the leachate seep sample locations although at significantly lower concentrations. This relationship between total and dissolved metals concentrations within leachate seep samples is to be expected given the highly turbid conditions created during leachate seep collection.

Concentrations of dissolved zinc were reported to be present in samples collected from two of the leachate seep sample locations also at concentrations well below the reported total concentrations. No other dissolved metals were reported to be present in any of the collected leachate seep samples during either of the two quarterly sample events.

5.0 HYDROLOGIC AND HYDROGEOLOGIC ASSESSMENT

As part of the off-site impact evaluation, the hydrology and hydrogeology of the site and surrounding area were assessed to determine the direction and nature of the groundwater flow through the site as well as to evaluate the interrelationship of the associated surface water bodies with the groundwater system.

Quarterly measurements of the groundwater piezometric surfaces were conducted of both the shallow overburden and bedrock aquifers to identify groundwater flow directions and gradients. Flow monitoring of the unnamed stream and Poorhouse Brook was also conducted in order to determine the approximate volumetric flow of these two interconnected water bodies. In addition, hydraulic conductivity testing was performed to determine the approximate rate at which groundwater flows beneath the site. Finally, landfill leachate modeling was conducted in order to determine approximate leachate volumes as a result of precipitation infiltrating through the fill based on the current configuration and surface materials associated with the site and to predict the effects of the proposed engineered cap on leachate volume. The following subsections discuss the methods and findings of this evaluation.

5.1 Groundwater Flow

5.1.1 Overall Groundwater Flow

To determine the direction and gradient of the groundwater flow beneath the site and surrounding area, each shallow overburden and bedrock monitoring well was gauged as a preliminary step to each of the four quarterly sampling events. These readings were utilized to determine the piezometric surface of both the shallow overburden and bedrock aquifers by determining the groundwater elevation in each well and then utilizing triangulation to establish groundwater gradients and flow directions.

In general, there was a strong correlation of groundwater flow direction and gradient with each of the four quarters in both the shallow overburden and bedrock aquifers. In addition, the average measured groundwater elevation for the shallow overburden aquifer wells was between 1 to 2 feet greater than the average measured groundwater elevation for the bedrock aquifer wells, indicating a downward gradient from the shallow overburden to the bedrock aquifer. The measured flow directions of each of the aquifers is as follows.

5.1.1.1 Shallow Overburden Aquifer Flow

Shallow overburden aquifer groundwater elevation contour maps are provided for each of the four quarters as Figures 7 through 10. For each of the four quarters, groundwater flow within the shallow overburden aquifer was from the southwest to the northeast across the site with a fairly consistent gradient although a slightly steeper hydraulic gradient was observed in the north-northeastern portion of the landfill footprint. In addition, there was a mounding of the groundwater table in the vicinity of the pond located in the southern portion of the site observed during all four quarters. The indicated flow direction for the site wide groundwater flow is towards the unnamed stream and Poorhouse Brook.

5.1.1.2 Bedrock Aquifer Flow

Bedrock aquifer groundwater elevation contour maps are provided for each of the four quarters as Figures 3 through 6. For each of the four quarters groundwater flow within the bedrock aquifer was from the southwest to the northeast across the northwestern portion of the site. The bedrock aquifer groundwater direction in the eastern portion of the site appears to flow somewhat radially from the mounded area related to the pond and overflow pipe feature located on the former park area. Though the predominant flow direction in this area is to the north towards the unnamed stream, there is also groundwater flow to the east and south.

5.1.2 Seasonal Gradients and Trends

While there were seasonal fluctuations in the measured groundwater contour elevations for both the shallow overburden and bedrock aquifers, the overall groundwater system was fairly consistent from one season to the next. The first and fourth quarterly sampling events, which corresponded to the spring and winter seasons, respectively, had measured groundwater elevations in the shallow overburden aquifer which were on average between 1 ½ to 2 feet greater than the second and third quarterly sampling events which corresponded to the summer and fall seasons. This effect was somewhat more pronounced in the bedrock aquifer where the average difference in the measured groundwater surface between the spring and winter and the summer and fall was nearly 2 ½ feet. While elevations between the seasons varied, these changes in elevations did not result in notable changes in the groundwater flow direction.

5.1.3 Relationship to Surface Water and Leachate Seeps

In general, there was a strong correlation between the measured groundwater surface as determined by the measurements made each quarter from each of the shallow overburden and bedrock aquifer wells across the site and the measured and observed surface water levels and leachate seep activity. Based on the stream gauge readings from each quarter, it appears that there is a hydraulic connection between the surface water and overburden groundwater system at the unnamed stream and Poorhouse Brook

Table 13: Stream Gauge Readings for the Unnamed Stream and Poorhouse Brook

Stream Gauge Location	First Quarter		Second Quarter		Third Quarter		Fourth Quarter	
	Gauge Reading (ft)	Elevation (ft)	Gauge Reading (ft)	Elevation (ft)	Gauge Reading (ft)	Elevation (ft)	Gauge Reading (ft)	Elevation (ft)
SG-1	1.46	263.76	0.92	263.22	1.52	263.82	1.67	263.97
SG-2	1.16	264.26	0.88	263.98	1.14	264.24	1.46	264.56
SG-3	1.5	267	1.98	267.48	1.55	267.05	1.6	267.1
SG-4	0.7	271.1	0.88	271.28	0.82	271.22	0.68	271.08

While leachate flow was observed at the five sampled locations as discussed above during the first quarterly event (spring) and at four of the five locations during the fourth quarterly event (winter), no flow was observed at any of the leachate seep sample locations during either the second or third quarterly events (summer and fall). As discussed above, the average groundwater elevations were approximately 1 ½ to 2 ½ feet lower during the summer and fall compared to the spring and winter. All five of the seep locations are located in close proximity to each stream but at slightly higher elevations. Based on the groundwater measurements from each quarter and the observations made of the leachate seep flow it is apparent that the slightly depressed groundwater table and reduced rainfall infiltration during the summer and fall limited the presence of leachate seeps at the ground surface at these locations. Similarly, it is likely that groundwater contribution to the stream and brook is greater at times of higher groundwater elevations and less during the summer and fall when the water table is lower in elevation.

5.2 Flow Monitoring

The flow of the unnamed stream and Poorhouse Brook was measured by establishing cross-sections at stream gauge locations SG-1, SG-2 and SG-3 as well as from the discharge pipe from the culvert which runs beneath Rock Rimmon Road. At the SG-1 and SG-3 stream gauge locations the stream channel geometry was measured with a tape measure to establish the cross-sectional area. At each of these two locations the steam channel was divided into two segments based on the flow characteristics at each location. At the SG-2 stream gauge location which is located directly upstream of the culvert which conveys the stream beneath Scofieldtown Road, the flow was measured within the two concrete pipes running beneath the road. Similarly, flow was measured within the pipe at the Rock Rimmon Road culvert which is the point at which the unnamed stream enters the boundary of the site. In general, stream flows measured within culvert pipes tend to be more accurate than open channel measurements due to the inherent inaccuracies caused by the irregular shape of the stream channel and flow irregularities caused by rocks, logs and other flow disturbances within the channel itself.

To estimate the average stream velocity at each location, a portable flow meter was used. The flow for each segment was calculated by multiplying the velocity for the segment by the average depth and width. The total flow at a given location was obtained by adding the flow for each segment. The following equation applies to this method for the two open channel locations SG-1 and SG-3:

$$Q = \sum_{i=0}^{n} V_i * w_i * d_i$$

Where
Q = Stream flow in cubic feet per second (cfs),
V_i = Average segment velocity in feet per second (ft/s,)
w_i = the width of the stream segment in feet (ft),
d_i = the average stream segment depth in ft and
n = the number of segments in the stream cross section.

For the two locations where flow was measured within the concrete culvert pipes, the following formula was used:

$$Q = V_i * \frac{R^2}{2}\left(\frac{\Pi}{180}\theta - \sin\theta\right)$$

Where: θ = The central angle of the pipe as determined by the depth of water in the pipe and the resulting chord length

R = The radius of the pipe.

The calculated flows at each of the four locations are listed in the following table:

Table 14: Volumetric Flow Volumes for the Unnamed Stream and Poorhouse Brook

Flow Location	Cross-Sectional Area (ft^2)	Average Flow Velocity (ft/sec)	Volumetric Flow	
			Ft^3/sec	Gallons/min
24" Ø Concrete Pipe SW-01	0.62	2.81	0.18	78.69
Stream Channel SW-04 (SG-3)	17.24	0.41	7.15	3,207.20
Twin 36" Ø Concrete Pipes SW-06 (SG-2)	3.89	1.21	4.69	2,104.09
Stream Channel SW-07 (SG-1)	19.58	0.49	9.50	4,262.67

Based on these calculated values, there is a significant increase in flow along the unnamed stream as it traverses the northern boundary of the landfill from the SW-01 location where it enters the site to location SW-06 where the unnamed stream becomes Poorhouse Brook. While the large wetland network to the north likely makes a significant contribution to the stream flow in this area, the overflow of the site pond, surface runoff and groundwater discharge from the site also likely contribute to this increased flow. However, based on flow calculations and stream gauge readings it would be difficult to quantify this contribution. The apparent contradiction between the calculated flow volumes at locations SW-04 and SW-06 are likely the result of the inherent inaccuracies of measuring flow in a small stream with irregular shape, shallow depth and turbulent flow conditions. Overall, stream flow increases in the downstream direction are likely the result of increased contributions from surface runoff and groundwater discharge.

5.3 Unnamed Stream 7Q10 Flow Analysis

Due to the proximity of the site to the unnamed stream and Poorhouse Brook, one of the primary considerations regarding contaminant migration from the site is the potential for groundwater to discharge to surface water. As the site is located in an area classified as GA by the CTDEEP area, and is located adjacent to a surface water body classified as A, comparisons of the groundwater quality have been made to both GWPC and SWPC. The surface water flow is important to understanding the potential for the dilution of contaminants discharged to a stream.

The 7Q10 is a parameter that is used to estimate the worst case conditions for flow within a given river or stream. It is defined as the "seven-day, consecutive low-flow within a ten year return frequency" or "the lowest stream flow for seven consecutive days that would be expected to occur once in ten years" (EPA, 1997). The 7Q10 statistic is often used as a representative low stream flow value for regulatory and modeling purposes, particularly with respect to point-source pollution.

A number of methods are available for the calculation of 7Q10 statistics for rivers in the State of Connecticut. Several such methods are presented in the CTDEEP Connecticut Water Resources Bulletin No. 34, entitled *A Method for Estimating the 7-Day, 10-Year Low Flow of Streams in Connecticut*, dated 1982. 7Q10 values may be calculated from river gage data or by using a regression calculation based on the surface area of the individual watershed underlain by coarse-grained stratified drift, with that underlain by till-mantled bedrock.

As the site is located in an area without any river gauging data, the 7Q10 adjacent to the site was estimated using the methodology described in *A Method for Estimating the 7-Day, 10-Year Low Flow of Streams in Connecticut.* In general, the evaluation involves the delineation of the area enclosed by the upstream drainage basin that contributes runoff and streamflow to the portion of the unnamed stream adjacent to the site. Areas (in square miles) of both coarse-grained stratified drift (sd) and till-mantled bedrock (till) are then delineated. The 7Q10 is then estimated using the following equation: $7Q10 = 0.67\ A_{sd} + 0.01\ A_{till}$

As shown in Figure 23; 7Q10 Aquifer Classification Map & Calculation, the area that comprises the upstream drainage basin is primarily defined as till by the *Surficial Materials Map of Connecticut* 1992. There is a very small area in the extreme northeast portion of the basin which is identified to be sand and gravel which, for the purposes of the 7Q10 evaluation, can be

considered a stratified drift deposit. The total upstream drainage basin comprises an area of 1.25 square miles of which 1.24 square miles is underlain by till materials and 0.01 square miles is underlain by stratified drift.

For the unnamed stream adjacent to the site at the point that the watercourse becomes Poorhouse Brook, the estimated 7Q10 is 0.0149 ft^3/sec. While this number appears to be extremely low, it should be noted that it is an estimate based on the regression analysis of data collected from streams and rivers around the state over a period of many years and, as such, has a potential estimate error which must be taken into account. Furthermore, during extreme low stream flow conditions, leachate production from rainwater infiltration through the fill materials would also be extremely low to non-existent.

5.4 Hydraulic Conductivity Testing

Rising head slug tests were performed on three monitoring wells, MW-12(OB), MW-16(OB) and MW-18(OB), on April 17, 2013. These three wells were selected based on their downgradient proximity of groundwater flow from the landfill footprint. Following the collection of a water level measurement, a miniTROLL® pressure transducer was installed into each well. For monitoring wells MW-12(OB), MW-16(OB) and MW-18(OB), a 1.6-inch by 36-inch bailer was lowered into the well and the water level was allowed to equilibrate. The bailer was then removed from the well and the water level recovery was logged by the miniTROLL®. The volume of water removed by bailer was measured in a large graduated cylinder to verify the volume of water displaced, taking into account the volume displaced by the empty bailer. Following recovery, this procedure was repeated in each of these monitoring wells utilizing a 1.6-inch by 48-inch bailer.

Following each of the slug tests, the data was downloaded from the miniTROLLs ® onto a RuggedReader® for subsequent uploading for computer-based slug test analysis software, as discussed further in Section 5.4.1.

5.4.1 Calculation of the Hydraulic Conductivity

As described above, instantaneous “slug” withdrawal tests were performed on four monitoring wells to calculate the hydraulic conductivity (K) using the Bouwer and Rice (1989) equation. A bailer or slug placed in the well was removed and the water level recovery measured over time with a pressure transducer. Slug test summary tables and graphs are presented in

Appendix E. The slug test was repeated in each well to evaluate the potential for a "skin" effect. The graphs showed a "double straight line", where the initial recovery curve represents drainage from the sand pack, followed by the middle portion that represents drainage from geologic materials. Data from the middle portion of the curve were used along with the initial head displacement at the start of the test and well construction geometry to calculate K using the Bouwer and Rice equation.

The slug test analysis results indicate that K values measured at the three monitoring well locations range from approximately 0.9 to 18 feet/day, which is consistent with fine sand and silt and fine to medium sand noted in the boring logs for those wells. The calculated K values from the initial and repeated slug tests at each well were similar, indicating the lack of a skin effect. As a conservative approach, the maximum K value, 18 feet/day (0.0064 cm/sec) was used in evaluating the groundwater discharge from the property.

5.5 Leachate Modeling

Using information obtained from the off-site impact evaluation as well as other information gathered specifically for this task, the Hydrologic Evaluation of Landfill Performance (HELP) model developed by the USEPA was used to estimate water balances for the site both pre- and post-closure. The HELP model used weather, soil, groundwater and design data to confirm the behavior of leachate generation in the landfill in its current state and to predict leachate generation once the landfill has been capped. Understanding the generation of leachate of the closed landfill will assist in the comparison of potential design alternatives and predict if leachate capture may be needed to reduce or eliminate impact to the surface waters of the unnamed stream or Poorhouse Brook. Ultimately, the recommended approach will involve evaluation of the actual groundwater and surface water quality post-closure monitoring results over a three year period before possible decisions can be made regarding the need for additional remedial measures. The trends developed over a three year monitoring period should be sufficient to predict if the landfill cap alone is sufficient to meet groundwater quality that is protective of surface water quality standards.

5.5.1 Hydrologic Evaluation of Landfill Performance Computer Model

The HELP program is a quasi-two-dimensional hydrologic model for conducting water balance analysis of landfills, cover systems, and other solid waste containment facilities. The model accepts weather, soil and design data, and uses solution techniques that account for the effects of surface storage, snowmelt, runoff, infiltration, evapotranspiration, vegetative growth, soil moisture storage, lateral subsurface drainage, leachate recirculation, unsaturated vertical drainage, and leakage through soil, geomembrane or composite liners. Landfill systems including various combinations of vegetation, cover soils, waste cells, lateral drain layers, low permeability barrier soils, and synthetic geomembrane liners may be modeled. The model facilitates rapid estimation of the amounts of runoff, evapotranspiration, drainage, leachate collection and liner leakage that may be expected to result from the operation of a wide variety of landfill designs. The primary purpose of the model is to assist in the comparison of design alternatives. The model is a tool for both designers and permit writers.

Practical application of the HELP program requires that a landfill be sub-divided into a reasonable number of areas that have approximately the same surface cover, surface/subsurface drainage and soil/barrier layer/waste characteristics. The infiltration for the subarea is then determined for a unit area (acre). The total cover infiltration (leachate) is the sum of the subareas.

The hydrogeologic properties of the soils and barrier layers are either taken as the default values provided in the computer program or from published or estimated values for soils or barrier layers not in the program database.

Climatological input for the site is usually derived from the program climate database of selected locations around the United States. For the Scofieldtown Landfill, data for New Haven, CT was used. The program creates a synthetic day-by-day set of climate parameters (rainfall, solar radiations, temperature) for use in the water balance calculations. The simulation is run for a long period of time, typically 50 years, to assure quasi-steady state soil moisture conditions.

Output from the program includes day-by-day, monthly, and annual listing of a number of significant data for each year. The program also provides average annual values for the entire period. The out files are approximately 300 pages for each subarea. To limit the bulk of this report, only the input/average annual out data for two subareas – the landfill top subarea for the existing and closed landfill have been provided in Appendix D.

5.5.1.1 Existing Landfill

Modeling the existing landfill using HELP required a number of approximations due to the unusual, from the perspective of a typical "HELP" landfill, conditions of the site. The most significant of these unusual conditions are discussed below.

1. Changing landfill surface shape – the composting operations on the landfill results in large windrows of organic material that change in size and location over time. These changes alter runoff/infiltration relationship. The HELP model simulates a static site only. Therefore, the condition of the landfill, as presented by Figure C in the 2011 Closure Plan was selected as the "design" existing conditions.

2. The paved surfaces in the transfer station/storage yard/entrance area and on compost area on top of the landfill are clearly acting as a barrier layer preventing, to some degree, infiltration of rainfall. This is due, in part, to a high rainfall/runoff coefficient of pavement. The HELP model does not have default barrier layer properties for bituminous pavement. To model the layer, it was assumed the pavement was a soil barrier layer similar to a clay barrier layer with a coefficient of permeability, k, related to the quality (age, cracks, pot holes, etc.).

   The pavement is exposed over much of the landfill area. The HELP model does not permit a barrier layer to be the upper most layer of a landfill cover. The work around for this condition is to assume a very thin soil layer (vertical percolation layer in HELP terminology) above the pavement.

3. The landfill lacks defined drainage swales or ditches over a large portion of the top and grass- covered southern area. Therefore, reasonable approximations of flow channels were made to facilitate rainfall/runoff calculations. This approximation results in an under-estimating of leachate as it ignores the infiltration of runoff water in the drainage ways.

4. The topography and surface conditions along the eastern side of the landfill including the paved areas and berm and banks next to the road is complex. To limit subareas to

a reasonable number, this section of the landfill was subdivided into two areas for modeling. Adjustments were made to slope/runoff coefficient and soil/waste depth on an average area basis to account for the differences in the paved and steep grass covered slopes included in subareas.

5. The pond in the southern part of the landfill cannot be modeled by HELP. The infiltration rate of the pond was estimated using Darcy's Law assuming flow from the perimeter of the pond (reference "Drainage Seepage and Flow Nets", Cedergren, 1989 Section 11.2 – Infiltration Ponds). This is a reasonable approximation as the pond surface is controlled and the pond is in contact with the groundwater table. The permeability of the bottom sediment liner of the pond was also assumed at a reasonably low value.

The existing landfill was subdivided into 8 subareas as shown on the plan included as Figure 9. Also shown on the plan are impervious areas within the subareas and units of differing conditions. These were used to modify runoff parameters. The existing HELP input matrix table (Table 25-1) provides the data used by the HELP model for each subarea. The existing HELP soil and barrier layers properties table (Table 26-1) shows the various properties assigned to each layer of the cover soil and waste. The waste thickness shown is the unsaturated thickness. The calculation for the pond infiltration rate is also included in the Attachment.

Each subarea was run as a separate model to determine average annual percolation at the base of the waste layer (leachate) using a 50 year time period. Soil moisture changes over time was checked and steady -state moisture content was achieved well before 50 years. Therefore, the average annual values were judged to represent steady state conditions.

The results of the modeling exercise are presented in the following table:

Table 15: Existing Conditions HELP Results Average Annual Leachate

Land Fill Area	Area (acres)	Leachate		Leachate Volume
		inches/ac/year	% precipitation	cubic feet/year
Concrete Apron	0.3	15.07	42.8%	14,726
Pond	0.6	NA	NA	8,205
Lower Paved Area	1.8	22.02	62.5%	141,552
Park	2.6	15.14	43.0%	142,505
Upper Paved Area	1.1	22.69	64.4%	94,527
Top	5.3	9.01	25.6%	173,474
North Side Slope	3.1	14.67	41.6%	167,256
East Side Slope	1.9	14.96	42.5%	100,772
Total Area	**16.7**	**14.4**	**40.9%**	**843,017**

Notes:
1. Total inches/acres and % precipitation do not include the pond
2. Average Annual Precipitation=35.24 inches

5.5.1.2 Closed Landfill

With the exception of the paved transfer station which will still be at the site after closure and the lined detention pond, modeling the closed Scofieldtown landfill using HELP was straight forward.

The pavement transfer station subarea was handled in the same manner as in the existing conditions analysis. The bituminous pavement was treated as a soil barrier layer. Therefore, the paved transfer area had, in effect, two barrier layers.

The lined detention pond, like the pond in existing conditions, cannot be modeled by HELP. The steady state infiltration rate was estimated using the Bernoulli equation using the method outlined in "Leakage through Liners Constructed with Geomembranes, Part 1: Geomembrane Liners", Giroud and Bonaparte, *Geotextiles and Geomembranes*, 1989. Giroud et al. suggest that a liner, installed under strict quality control, might have one to two 2 mm defects per acre. Four 2 mm defects per acre were conservatively selected for the detention pond. It was assumed the pond full conditions would occur 5% of the time to account for fluctuations in head in the pond due to storm flow.

Figure 10 is provide to show a closed landfill plan based on Figure E in the 2011 Landfill Closure Plan, showing the subareas used in the HELP model. The Post-Closure input matrix tables presenting input data for the HELP model for each subarea and the soil and barrier layer properties are provided in Table 25-2 and Table 26-2, respectively. The configuration of closed landfill was based on the description and drawings in the Closure Plan.

Each subarea was run as a separate HELP model to determine average annual percolation at the base of the waste layer (leachate) using a 50 year time period. Soil moisture changes over time were checked and "steady state" moisture content was achieved well before 50 years. Therefore, the average annual output was judged to equate to "steady state" conditions.

The results of the Post-Closure model are presented in the following table:

Table 16: Capped Landfill HELP Results Average Annual Leachate

Land Fill Area	**Area** (acres)	**Leachate**		**Leachate Volume**
		inches/ac/year	% precipitation	cubic feet/year
Paved Area	2.9	0.046	0.1%	488
Pond	0.8	NA	NA	0
Top	6.1	0.00103	0.0%	23
Park	2.6	15.14	43.0%	142,505
North Side Slope	4.4	0.127	0.4%	2,009
East Side Slope	2.1	0.0716	0.2%	539
Total Area	**16.3**	**0.1**	**0.1%**	**3,060**

Notes:
1. Total inches/acres and % precipitation do not include the pond
2. Average Annual Precipitation=35.24 inches

5.5.2 Model Summary

Estimates of the leachate generated by infiltration of precipitation through the existing cover of the landfill and after closure were completed using the HELP computer model. The landfill configuration used for the existing condition was based on Figure C – Landfill Cap Existing Conditions Plan topographic survey in the March 2011 TRC Landfill Closure Plan.

The unconventional nature of the existing cover conditions of the landfill required considerable approximating of soil and barrier properties, surface drainage and subareas to permit a reasonable model to be created. The existing pond and proposed detention pond

infiltration rates, which cannot be determined by HELP, were calculated using conventional seepage/flow equations.

Combining the HELP model average annual output for a 50 year analysis period and the pond/detention pond average annual infiltration, the average annual leachate volumes were determined to be:

- Existing – 843,017 cubic feet per year or 40.9 percent of average annual precipitation.
- Post-Closure – 3,060 cubic feet per year or 0.17 percent of average annual precipitation.

Based on the modeling, the result of capping the landfill represents a reduction in infiltration generated leachate of 99.6 percent.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

6.1 Laboratory Quality Assurance/Quality Control

The overall quality assurance objective for laboratory analysis of environmental samples is to provide a laboratory quality assurance/quality control (QA/QC) program that is sufficient to ensure that data quality methods are achieved. The quality control limits for precision and accuracy of laboratory analyses are governed by the methods, equipment used, and so that analytical detection limits are below applicable regulatory criteria. The analytical data have been evaluated by TRC in the context of the RCPs and data quality assessment and data usability evaluation (DQA/DUE) in accordance with the CTDEEP's *Laboratory Quality Assurance and Quality Control Data Quality Assessment and Data Usability Evaluation* (May 2009, Revised December 2010). The DQA/DUE evaluation of these data concluded that the non-conformances identified within the data would not prevent it from evaluation relative to the RSR criteria. More specific information on the DQA/DUE is provided below in Section 6.7.1 and in Table 25.

6.2 Field Quality Control Samples and Field Screening Data

6.2.1 Field Quality Control Samples

A number of field QC samples were collected as part of the investigation: trip blanks, field blanks, solvent blanks, and blind duplicate samples.

Trip blanks were prepared by the laboratory and originated as analyte-free water which was placed in 40-ml Teflon-lined septum volatile organic vials, preserved with 1:1 hydrochloric acid (HCl) in the laboratory and transported to the property in the sample cooler with sample containers. These vials were subsequently returned to the laboratory with the aqueous environmental samples for VOCs. The analyses evaluated the effect of ambient site conditions and sample shipment on sample integrity, and evaluated proper sample container preparation and handling techniques. The results of trip blank analyses, if detects were reported, are presented below in Section 5.7.1.

Field blanks were collected to determine the effectiveness of the decontamination of sample collection equipment. The field blanks were collected by pouring laboratory-supplied, HPLC-grade, ASTM Type II water over the decontaminated sample collection equipment (i.e., stainless steel spoon, stainless steel bowls, etc.) and into the appropriate sample containers. Field

blanks were collected at the beginning of a day's sampling events and accompanied the samples collected that day. Field blanks were analyzed for the same analytical parameters as the sample matrix. Field blanks were labeled and managed according to the proper chain-of-custody procedures, and stored and shipped or delivered with the collected samples. The results of field blank analyses, if detects were reported, are presented below in Section 5.7.1.

Solvent blanks prepared by the laboratory were used to assess whether the extraction solvents provided by the laboratory for the field preservation of soil samples to be analyzed for VOCs had been contaminated. The solvent blanks also served to assess the possible effects of ambient field conditions on the samples. The results of solvent blank analyses, if detects were reported, are presented below in Section 5.7.1.

Blind duplicate samples consist of two separate samples taken from the same source. Blind duplicate samples were collected, homogenized (where appropriate) and divided. The procedure for collecting duplicate samples consisted of alternating the collection of the sample between the sample collection bottle and the duplicate sample collection bottle. Field duplicates were collected generally at a frequency of one duplicate sample per twenty samples per field event. The blind duplicate sample is labeled with a fictitious location/ sample ID so that the laboratory does not know the true identity of the sample (hence, "blind" duplicate sample). In general, in comparing the analytical results for blind duplicate pairs, there is a high correlation observed for the groundwater and surface water samples, and a generally low correlation for the sediment and groundwater seep samples. In the case of sediment samples, even though homogenization of the samples was conducted before containerization, sufficient heterogeneity likely still existed in the matrix to produce the disparate results. In the case of the groundwater seep samples, either “pulses” of seep discharge and/or fluctuations in suspended solids (i.e., turbidity) could have produced the disparate results.

6.2.2 Field Screening Samples

Monitoring well headspace and sediment samples were screened using FIDs or PIDs. The data derived from the use of field screening efforts were not used to determine compliance. Rather, the data were used to provide “real time” *guidance* to the personnel in the field. This guidance was used to determine the relative magnitude of impacts.

6.3 Sample Custody, Shipping and Handling

Sample custody procedures were observed to ensure the validity of the data generated during each investigation. Appropriate sample containers were used so that no chemical alteration could occur between the collection of samples in the field, and the receipt of samples at the laboratory. The sample bottles were prepared and shipped to TRC by the subcontracted analytical laboratory. Sample containers were selected to ensure compatibility with the potential contaminants and to minimize breakage during transportation. Requirements for sample bottles, analytical methods, preservation and holding times were adhered to for all samples. Sample labels were filled out at the time of sampling and were affixed to each container to identify the project name and/or sample location, sample number, sampler's initials, date and time of collection, number of containers per analyte (i.e., 1 of 2, etc.), preservatives added and analyses requested for the sample.

After the bottles for a given sample location were filled, they were placed in a shipping cooler. Samples were stored in such a way as to protect them from temperature extremes, light, breakage, and water damage. Field personnel added bags of crushed ice or ice packs to the shipping coolers as the samples were collected.

A chain-of-custody record was prepared and accompanied all samples to provide documentation of all samples collected and to track sample possession. Samples were shipped to the laboratory for analysis as soon as practical after the sampling, usually the same day the samples were collected.

6.4 Field Equipment Decontamination Procedures

Sampling equipment which was used during the field activities, such as stainless steel spoons or spatulas, stainless steel mixing bowls, and Teflon bailers were decontaminated in a laboratory using the following procedures.

1. Wash and scrub with low phosphate detergent in tap water;
2. Rinse with tap water;
3. Rinse with distilled and deionized (ASTM Type II) water;
4. Rinse with 10% ultra pure nitric acid;
5. Rinse with distilled and deionized (ASTM Type II) water rinse;
6. Rinse with acetone - pesticide grade solvents or better;
7. Air dry - on clean polyethylene sheeting;
8. Distilled and deionized (HPLC-grade, ASTM Type II) water rinse;

9. Wrap in aluminum foil, shiny side out for transport (if not being used immediately).

6.5 Analytical Procedures

EPA-approved methods were used for all analyses. The analyses slated for each of the sediment, seep, and groundwater samples collected as part of the investigation were described in the investigation work plan.

6.6 Data Validation and Reporting

Data validation is the process of reviewing data and associated quality control criteria, and accepting, qualifying, or rejecting it on the basis of sound criteria.

6.6.1 Field Data Validation

Field sampling data was validated by the TRC Project Manager after each sampling event, based on a judgment of the representativeness of the sample, the maintenance and cleanliness of sampling equipment, and adherence to the approved, written sample collection procedure.

The following criteria were used to evaluate the field sampling data:

- Use of approved sampling procedures, and
- Proper chain-of-custody maintained and documented.

6.6.2 Analytical Data Validation

Analytical data validation included procedures within the laboratory and internal TRC evaluation. Data from laboratory analyses was reviewed by the laboratory prior to its release. Complete Environmental Testing, Inc. (CET) performed all analytical testing for the investigation. TRC is aware that the CET Laboratory QC Coordinator validated the data prior to release to TRC. The data derived from the investigation was validated by CET by using the criteria outlined below:

- Use of approved analytical procedures;
- Use of properly operating and calibrated instrumentation; and
- Acceptable results from analyses of laboratory control samples;

6.7 QA/QC Data Assessment Process

Over the time span of the multiple phases of the project, TRC conducted reviews of QA/QC parameters and laboratory information. This review was conducted to evaluate the

effect of variances from these parameters on the overall quality of the project and data usability. The following summarizes these parameters that have been applied to the field phases of the overall project and any applicable relevant concerns.

- Sampling Design – In all phases of the project, soil and groundwater samples were collected at the locations as defined in the work plans.

- Field Equipment (Preventative Maintenance, Calibration and Corrective Action) – The soil and groundwater parameter monitoring equipment were calibrated as specified in TRC's Standard Operating Procedures (SOPs) and/or according to the manufacturer's instructions.

- Decontamination – Decontamination of all equipment was completed as specified in TRC's SOPs.

- Sample Handling and Custody – Information in the field files indicated that environmental samples were handled in accordance with the procedures outlined in the proposals. Holding times were adhered to as well as shipping and preservation procedures.

- Field Quality Control – All blank and duplicate samples were collected for analysis as specified in the work plans (with the exception of where samples needed to be moved to account for the potential of interference with utilities).

- Data Management and Documentation – The field log books were maintained as specified in the plans.

- Analytical Methods – All samples were subjected to the proposed analyses by the analytical methods outlined in the work plans.

- Laboratory Equipment (Preventative Maintenance, Calibration and Corrective Action) - The laboratories did not identify any noteworthy issues in relation to the operation of the laboratory equipment. The laboratories did identify instances when the laboratory control spikes were either too high or too low for particular compounds.

6.7.1 RCP Data Quality Assessment/Data Usability Evaluation

TRC conducted an internal review of the analytical data acquired during the investigation using the DQA/DUE procedures specified in the CTDEEP *Laboratory Data Quality Assessment and Data Usability Evaluation for Environmental Investigation and Remediation Projects*,

released in May 2009. The results of the evaluation are provided below, arranged by sample matrix, and are also summarized in Table 25.

Sediment Sampling

In reviewing the sediment data (CET laboratory reports 12050419a, 12050480a, and 12050480b), non-conformances were identified for each report. In a majority of the cases where a non-conformance was identified, there was a high or low bias associated with a compound recovery in the initial and continuing calibration, laboratory control sample (LCS), the matrix spike (MS) or matrix spike duplicate (MSD), and/or surrogate recovery. These non-conformances were determined to have not affected the validity of the data, as the reporting limits provided by CET were well below the respective RSR criteria, and the non-conformance constituents were not detected in the associated sediment samples.

Another non-conformance was noted for the sample results reported in CET laboratory report 12050419a: total dissolved solids (which do not apply to sediment samples), dissolved manganese (which also do not apply to sediment samples), phenanthrene, and benzo(a)anthracene were detected in field blank FB051612. The phenanthrene and benzo(a)anthracene results do not affect the validity of the sediment data because these compounds were not detected in the associated sediment samples.

Surface Water Sampling

In reviewing the surface water data (CET laboratory reports 12050419a, 1050419b, 12050480a, 12050480b, 12090028, 12110414, 12110417, and 13030171), non-conformances were identified in each report. As with the DQA/DUE evaluation of the sediment results, in a majority of the cases where a non-conformance was identified, there was a high or low bias associated with a compound recovery in the initial and continuing calibration, LCS, MS or MSD, and/or surrogate recovery. These non-conformances were determined to have not affected the validity of the data, as the reporting limits provided by CET were well below the respective RSR criteria, and the non-conformance constituents were not detected in the associated surface water samples.

For the surface water samples presented in CET laboratory report 12050419a, a holding time non-conformance was identified for biological oxygen demand (BOD) for four samples: field blank FB051612, SW-07-20120516, SW-08-20120516, and SW-09-20120516. As such, the

BOD results for these samples are considered biased low. Furthermore, TDS, dissolved manganese, phenanthrene, and benzo(a)anthracene were detected in field blank FB051612. TDS and dissolved manganese were detected in surface water samples collected on May 15, 2012, and therefore, in accordance with EPA guidance, a "B" qualifier has been added to the surface water sample results where the surface water sample result was less than five times the concentration detected in the field blank. Neither phenanthrene nor benzo(a)anthracene were detected in any associated surface water samples.

For the surface water samples presented in CET laboratory report 12050419b, a holding time non-conformance for BOD was identified for SW06_20120516. However, because the holding time exceedance was three minutes, the non-conformance is not considered to have affected the validity of the data.

For the surface water samples presented in CET laboratory report 12110414 (3rd quarter of sampling), a holding time non-conformance for SVOCs was identified for SW02. The non-conformance does not affect the validity of the data, as the results would be considered biased low, and SVOCs were not detected in this sample. Furthermore, SVOCs were not detected during any quarter of sampling for any surface water sample at the site.

For the surface water samples presented in CET laboratory report 12110417, a holding time non-conformance was identified for BOD for all of the samples: SW-2, SW-3, SW-4, SW-5, SW-6 and its blind duplicate SW-10, SW-7, SW-7, and SW-9. As such, the BOD results for these samples are considered biased low.

Leachate Seep Sampling

Two reports detailing the leachate seep analytical results were evaluated: CET laboratory reports 12060256 and 13030170.

For the leachate seep samples presented in CET laboratory report 12060256, two general types of non-conformances were identified: 1) BOD hold time was exceeded by 1 hr 28 min for UNB-SP1_20120611; and, 2) A number of high and low recoveries associated with the LCS's, MS/MSDs, initial and continuing calibration, and surrogate recoveries were identified. For sample UNB-SP1_20120611, the BOD result is considered biased low. Regarding the non-conformances for indeno(1,2,3-c,d)pyrene in UNB-SP1_20120611, naphthalene on the VOC list in UNB-SP4_20120611, and 4,4-DDE in UNB-SP1_20120611 and UNB-SP6_20120611, the

validity of the results are not affected for the following reasons: The concentration of indeno(1,2,3-c,d)pyrene reported for UNB-SP1-20120611 is biased high, however, the result exceeds the CT WQS HHC, CF by one order of magnitude, and exceeds the CT WQS HHC, CF&W by 2 orders of magnitude. Naphthalene is included on both the VOC and SVOC lists, and was therefore also reported for the SVOC list at a concentration of 2.4 ug/L. From a conservative viewpoint, this concentration is 2 orders of magnitude below the CT WQS HHC, CF&W. Finally, the concentrations of 4,4-DDE reported for UNB-SP1_20120611 and UNB-SP6_20120611 (0.13 ug/L and 0.11 ug/L, respectively), are considered biased low, but both concentrations exceed the CT WQS HHC, CF and CF&W by three orders of magnitude.

For the groundwater seep samples presented in CET laboratory report 13030170, non-conformances consisting of high or low bias associated with a compound recovery in the initial and continuing calibration, LCS, and the MS or MSD were identified. These non-conformances were determined to have not affected the validity of the data, as the reporting limits provided by CET were well below the respective RSR criteria, and the non-conformance constituents were not detected in the associated groundwater seep samples.

Monitoring Well Groundwater Sampling

In reviewing the monitoring well groundwater data (CET laboratory reports 12050178, 12050186, 12050225, 12050226, 12050273, 12050307, 12050332, 12050360, 12080697, 12080721, 12080741, 12090027, 12090028, 12090046, 12110126, 12110155, 12110209, 12110231, 12110253, 12110416, 13020452, 13020486, 13030024, and 13030053), non-conformances were identified for each report. As with the DQA/DUE evaluation of the sediment and surface water results, in a majority of the cases where a non-conformance was identified, there was a high or low bias associated with a compound recovery in the initial and continuing calibration, LCS, MS or MSD, and/or surrogate recovery. These non-conformances were determined to have not affected the validity of the data, as the reporting limits provided by CET were well below the respective RSR criteria, and the non-conformance constituents were not detected in the associated groundwater samples.

For the groundwater samples presented in CET laboratory report 12050225, the LCS for total potassium was reported to have low bias for two batches. This does not affect the validity of the data as the recovery for both batches was 82%, the lower limit of the control limit is 85%,

and potassium was either not detected in the samples or it was detected at relatively low concentrations. Another non-conformance that was identified was that dissolved sodium was flagged as having a high bias for two LCS batches. Because the recovery was so far above the control limit (137% and 120%, respectively), this may have resulted in a high bias for sodium for the associated results.

For the groundwater samples presented in CET laboratory report 12050226, the initial calibration percentage for naphthalene was high for one batch. This does not affect the validity of the data as naphthalene was not detected in the sample associated with the affected batch.

For the groundwater samples presented in CET laboratory report 12050307, two field blank detects were identified as non-conformances: total sodium was detected in field blank FB051112 at a concentration of 1.4 mg/L and dissolved manganese was detected at a concentration of 0.067 mg/L. This affected the validity of a few associated samples, and as such, the affected total sodium and dissolved manganese results have been qualified with a "B" qualifier if the concentrations detected in the samples were less than five times the field blank concentration.

For the groundwater samples presented in CET laboratory report 12050360, the naphthalene initial calibration was high for one batch. This does not affect the validity of the data as naphthalene was not detected in any samples associated with the non-conforming batch.

For the groundwater samples presented in CET laboratory report 12080697, the naphthalene initial calibration was high for one batch. This does not affect the validity of the data as naphthalene was not detected in any samples associated with the non-conforming batch.

For the groundwater samples presented in CET laboratory report 12080721, the naphthalene initial calibration was high for one batch. This does not affect the validity of the data since the laboratory reported that naphthalene was not detected in nine of the twelve samples associated with the affected batch. The three samples that exhibited detects of naphthalene were below the applicable RSR criteria, and furthermore, would be considered biased high. Also for this report, sodium was detected in field blank FB083012 at a concentration of 1.0 mg/L. This does not affect the validity of the data, because all of the sodium detects in associated samples were greater than five times the amount detected in the field blank.

For the groundwater samples presented in CET laboratory report 12080741, sodium was detected in field blank FB083112 at a concentration of 1.1 mg/L. This does not affect the validity of the data, because all of the sodium detects in associated samples were greater than five times the amount detected in the field blank.

For the groundwater samples presented in CET laboratory report 13030024, the sulfate MSD had a low recovery for sample MW-16R. This does not affect the validity of the data as the other sulfate QA parameters were within control limits, and also the MSD recovery amount was only 2% lower than the lower control limit (80% and 82%, respectively).

7.0 **SUMMARY AND CONCLUSIONS**

In accordance with the requirements of Section B Number 2 of the Consent Order this document has presented the actions taken to complete the off-site impact evaluation of the Scofieldtown Landfill Site. This OIER has addressed the objectives as outlined in Section 1.1 which were to evaluate the impacts of the former landfill to off-site areas, including leachate seep and impacts to surface water and groundwater as well as leachate quality. The following subsections summarize the findings discussed above.

7.1 Groundwater Quality Summary

Based on the analytical results summarized in Section 3.2, it is apparent that the landfill has had an impact on the groundwater beneath the former landfill footprint. It is also apparent that, while these impacts have migrated in the downgradient direction from the site, the contaminant concentrations attenuate with distance from the landfill. Evaluation of the data after each quarter of sampling indicates there are no imminent risks to any off-site receptors. Based on the contaminant concentrations and their distribution reported for each of the four quarterly events, there are no indications that any free-phase petroleum-related product or chlorinated VOCs are present in the groundwater. Therefore, once the landfill has been capped, the fill material itself will not pose a continuing source of contamination to groundwater. Given the age of the former landfill, it is anticipated that dissolved contaminant concentrations would follow a long-term downward trend if the current site conditions continued.

Based on the results of the four quarterly sampling events it appears that there are three distinct impacted groundwater areas within the landfill footprint. These areas are as follows:

- Two concentrated areas of petroleum-related contamination are located in the northwest portion of the site centered in the area of the current salt shed (MW-1 cluster) and in the north-central/ northeast portion of the site in the area of the MW-17 and MW-18 well clusters. These two areas are characterized as follows:

  Petroleum-related contaminants were consistently reported to be present in the samples collected from the shallow overburden aquifer well MW-1 (OB), but not in the samples collected from the bedrock monitoring well at this location. In addition, petroleum-related contaminants were not reported to be present in any of the samples collected from the MW-16 well cluster which is located in close proximity and downgradient from the MW-1 well cluster. However, concentrations of ETPH were reported to be present in leachate seep samples collected from the leachate seep location SP-5 which is located further

downgradient from both the MW-1 and MW-16 well clusters, suggesting that the petroleum contamination in this area may be following a preferential pathway within the fill material. Further to the east, several petroleum related VOCs and ETPH concentrations were consistently reported to be present in the samples collected from the overburden wells from the MW-17 and MW-18 well clusters. Concentrations of petroleum-related VOCs and/or ETPH were also reported to be present from leachate seep samples collected from leachate seep locations, SP-3 and SP-4 which are both located along the toe of the landfill in the north central portion of the site. Other areas where petroleum-related contaminants were reported to be present include the MW-6 and MW-14 well clusters where ETPH was present in samples. These wells are located in the central portion of the site. Also, lower concentrations of ETPH and intermittent concentrations of a few petroleum related VOCs were reported to be present in the samples collected from the overburden well from the MW-2 well cluster which is located in the northwest corner of the site. Figure 20; Summary of Groundwater Contaminant Areas – Shallow Overburden Aquifer provides an approximate composite extent of the petroleum-contaminant area based on the analytical results from all four quarterly events.

- An area of dissolved chlorinated VOC contamination is located in the northeast portion of the site centered in the area of the MW-18 well couplet. The dissolved VOCs extend to the west and east as defined by reported concentrations of chlorinated VOCs in the samples collected from the bedrock well from the MW-17 well cluster, the bedrock well from the MW-2 well cluster, the bedrock well MW-19 (R) and both the bedrock and overburden wells from the MW-25 well cluster. Well MW-19 (R) and the MW-25 well cluster are located downgradient from the site. This area is delineated by the well clusters MW-6 to the west, MW-14 to the southwest, MW-15 to the southeast and MW-27 to the north. TCE was also reported to be present in a leachate seep sample collected from the leachate seep location SP-1 which on the toe of the landfill in the northeast corner. Figure 19; Summary of Groundwater Contaminant Areas – Bedrock Aquifer provides an approximate composite extent of the dissolved chlorinated VOC area based on the analytical results from all four quarterly events.

- Intermittent reported concentrations of several metals which exceeded the RSR criteria are present across the footprint of the site. As discussed above, the reported average concentrations of metals reported to be present in all three areas were higher in samples collected from site wells as compared to both background wells and downgradient wells. Also, several metals were reported to be present within samples collected from the site wells which were either reported present in significantly fewer samples or not at all in the samples collected from background and/or downgradient wells. Arsenic, cadmium, lead, mercury, nickel and zinc were all reported to be present in samples from one or more of the site wells at concentrations exceeding SWPC or GWPC or both. In general, these reported concentrations were intermittent in that they were not consistently present from one quarterly event to the next in samples collected from a given well. This may

be a result of the nature and distribution of the fill materials within the landfill. In any case, it is indicative of metals impacts to the groundwater beneath the site in both the shallow overburden and bedrock aquifers. However, with the exception of intermittent reported concentrations of mercury in the downgradient wells MW-24 (R) and MW-25 (R) and the background well MW-23 (R), these impacts are limited to the landfill footprint. Since mercury was not reported present in any of the samples collected from the MW-4 well cluster which is located in between the landfill footprint and wells MW-24 (R) and MW-25 (R), there is no reason to conclude that the mercury contamination is migrating off-site. Wells which have had reported concentrations of metals exceeding RSR criteria during at least one of the four quarterly events are identified with summary callouts on both Figure 19; Summary of Groundwater Contaminant Areas – Bedrock Aquifer and Figure 20; Summary of Groundwater Contaminant Areas – Shallow Overburden Aquifer.

7.2 Sediment and Surface Water Quality Summary

7.2.1 Sediment Quality Summary

Based on the results of the sediment sampling conducted as part of this evaluation and discussed in Section 3.3.1 above, there appear to be only minor impacts to the sediments of the unnamed steam, Poorhouse Brook or the unnamed pond located on-site as a result of runoff from the site. Low level concentrations with respect to the RSR criteria of several VOCs and SVOCs were reported to be present in sediment samples collected from the unnamed stream and the pond, while elevated levels of several SVOCs were reported to be present in the sediment sample collected from the shallow interval of the sediment sample location in Poorhouse Brook downstream of Scofieldtown Road. There were no reported concentrations of SVOCs in the samples collected from the next upstream sediment sample location.

The reported concentrations of eight of the thirteen metals analyzed were on average higher in the samples collected from the unnamed stream and the unnamed pond when compared to the sediment samples collected from Poorhouse Brook. Typically, these concentrations increased further upstream on the unnamed stream. This also correlates with lower flow velocities and increased settling of sediment with exception of the furthest upstream location, which is in an area with a steeper grade than the other sample locations. The unnamed stream enters onto the site in this area through a culvert which runs beneath Rock Rimmon Road and also receives runoff from the road in this area which is a likely contributor to sediment and surface water quality of the stream.

The reported concentrations of two metals, arsenic and lead, exceeded RSR criteria in samples collected from three locations along the unnamed stream. Elevated concentrations of arsenic were reported to be present in the sample collected from the deeper interval at the most upstream location in a pooled area below the culvert under Rock Rimmon Road (SD-1). An elevated concentration of arsenic was also reported to be present in the sample collected from the shallow interval at the sediment sample location located directly upstream of the culvert beneath Scofieldtown Road (SD-6) where the unnamed stream becomes Poorhouse Brook. Finally, an elevated concentration of lead was reported to be present in the sample collected from the shallow interval at the sediment sample location SD-2 which is located in area of very low flow with direct exposure to runoff from the slope of the landfill. In addition, the leachate seep sample location SP-5 is located in close proximity to this location.

While significantly more of the reported concentrations of the eight metals exceeded the NOAA screening criteria, as summarized in the tables above, these results are indicative of the current and former uses of the site and are consistent with the previous studies conducted on the site as discussed above in Section 2.4.1. As with these previous investigations, no indications of a significant environmental risk to on-site or off-site receptors were noted to exist. It should be noted that significantly fewer contaminants of concern were reported to be present in the sediment samples collected as part of this off-site impact evaluation than were reported to be present from sediment samples collected as part of the 2008 EPA investigation.

7.2.2 Surface Water Quality Summary

Based on the four quarterly surface water sampling events conducted as part of this evaluation, it appears that there are low level impacts to the waters of the unnamed stream, Poorhouse Brook and the pond located onsite as a result of surface runoff from the landfill or from groundwater or leachate infiltration to the surface water bodies.

The most significant contaminant levels reported were from the surface water samples collected from the upstream locations, SW-1 and SW-2, located within the unnamed stream. In particular, ETPH was reported to be present in the samples collected from these two locations during the second quarterly event. Several metals were also reported to be present in samples collected from these two locations during the second sampling event at elevated concentrations with respect to the CT WQS ALC. Elevated concentrations of copper and zinc were reported to

be present in both samples collected from these two locations while an elevated concentration of lead was also reported to be present in the sample collected from surface water sample location SW-2. It should be noted that concentrations of lead were reported to be present in sediment and leachate seep samples collected in close proximity of this sample location. Surface water sample location SW-1 is located at the outfall of the culvert under Rock Rimmon Road where the unnamed stream enters the site. Because of the steeper grade in this area, the flow of the unnamed stream in this area was variable with either low volume flow (first and fourth quarters) or not flowing with residue standing water (second quarter) or dry (third quarter). Location SW-2 is located further downstream where stream flow is more consistent. However, location SW-2 is immediately upstream of a large ponded area created by the manmade berm which bisects the stream channel and connects the landfill slope with the adjacent property to the north. Consequently, flow conditions at the SW-2 location were typically very low to no flow, though standing water was present. Overflow from this bermed area flows through a concrete weir structure in the manmade berm. The surface water sample location SW-3 is located on the upstream side of this weir structure. Elevated concentrations of chloride with respect to the CT WQS ALC were consistently reported to be present in the samples collected from the surface water sample locations SW-2 and SW-3. This contamination has likely resulted from the current and historical storage of salt on the northwest portion of the site.

Low level concentrations with respect to the CT WQS criteria of chlorobenzene were reported to be present in samples collected from surface water location SW-5 which is located downstream of the confluence of the unnamed stream and the discharge of the culverted overflow pipe from the on-site pond during two of the four quarterly events. In addition, ETPH was reported to be present in a sample collected from the north end of the on-site pond during one of the four quarterly events.

No additional contaminants of concern were reported to be present in any of the remaining surface water sample locations.

Overall, while the surface runoff and leachate and groundwater discharge from the landfill have had an impact on the surface water quality of the unnamed pond and Poorhouse Brook, it does not appear that either of these water bodies are significantly degraded.

7.3 Leachate Seep Quality Summary

Based on the results of the leachate seep sampling conducted as part of this evaluation and discussed above in Section 4.3, the quality of the leachate identified at the groundwater/ground surface interface at the five locations along the length of the unnamed stream that traverses the northern edge of the toe of the landfill is impacted. In general, the contaminants reported to be present in the collected leachate seep samples are consistent with groundwater samples collected from wells located in close proximity to the seep locations.

Several petroleum-related VOCs and chlorinated VOCs were reported to be present in leachate seep samples collected from leachate seep sample locations UNB-SP-1, UNB-SP-2, UNB-SP-3 and UNB-SP-4. The reported concentrations of TCE and benzene exceeded the CT WQS CF&W criteria in the samples collected from UNB-SP-1 and UNB-SP-2, respectively. These four leachate seep locations are located along the unnamed stream from the west central portion of the site extending to the northeastern corner of the site. Similar suites of VOCs were reported to be present in groundwater samples collected from well clusters MW-1, MW-17 and MW-18 which are all located upgradient of the these leachate seep locations.

Concentrations of ETPH were reported to be present in leachate seep samples collected from locations UNB-SP-3, UNB-SP-4 and UNB-SP-5 during both of the sampling events conducted. ETPH was also reported to be present in groundwater samples collected from well clusters MW-1, MW-17 and MW-18. Although there are no established CT WQS criteria for ETPH these results are consistent with what has been determined to be the groundwater quality in this area of the site.

Concentrations of two chlorinated pesticides, 4,4-DDD and 4,4-DDE were reported to be present in the leachate seep sample collected from the location UNB-SP-1 during the first quarterly sampling event. These two pesticides were not reported to be present in any other of the leachate seep samples, nor in any of the groundwater samples collected as part of this evaluation.

Concentrations of arsenic, cadmium, chromium, copper, lead, nickel, and zinc were reported to be present in samples collected from two to five of leachate seep locations at elevated concentrations with respect to the CT WQS criteria. With the exception of zinc, none of these metals were reported to be present in the analysis of the dissolved aliquot for their respective

samples. This is likely due to the high turbidity which results during sample collection caused by the inherent nature of leachate seeps.

Based on the results of the two rounds of leachate seep samples, there appears to be some fluctuations between the two events at some leachate seep sample locations while there appears to be consistency between the two events at others. In the case of locations UNB-SP-2 and UNB-SP-3, the results from the two events are very similar in both the constituents reported to be present and the reported concentrations, but in the case of locations UNB-SP-1 and UNB-SP-5, there are variations in both the constituents and reported concentrations.

7.4 Groundwater and Surface Water Flow Summary

An evaluation of the shallow and bedrock flow regime over the four quarters indicates the flow direction and gradient do not vary significantly seasonally. This data, in conjunction with the groundwater quality results, documents the presence of two primary areas of dissolved contaminant impacts with petroleum-related and chlorinated VOCs without significant off-site downgradient migration. Also, while vertical gradients tended to be downward into the bedrock, in most locations, the bedrock aquifer is not significantly degraded.

In addition, the surface water quality, while more impacted at locations close to the site, improves further downstream.

7.5 HELP Model Summary

While the leachate estimates for the two landfill conditions are approximate, it is clear that the existing landfill has a very “leaky” cover system. The 40% infiltration of precipitation is not, however, an uncommon percentage for an unclosed landfill with a soil cover only. This infiltration over the many years that the landfill has been in its current condition, has resulted in the groundwater/leachate seep quality that have been documented in this report. Using the preliminary proposed landfill capping plan outlined in the, TRC March 2011 Landfill Closure Plan, the HELP model has estimated a low infiltration percentage post-closure. This very low infiltration percentage for an engineered landfill cover with a geomembrane barrier is a very reasonable value for an engineered landfill cover with a single geomembrane barrier.

The model concludes, therefore that, based on the evaluation of the two estimates of leachate volume, capping the Scofieldtown landfill, as outlined in the TRC 2011 Closure Plan Report, will reduce greatly leachate generated by infiltration by 99.6 percent.

7.6 Conclusions

Based on the findings of this OIER, it is apparent that the history of landfilling at the site from the 1930s to the 1970s has had an overall environmental impact on the site and the areas immediately downgradient. Impacts to environmental receptors include degraded groundwater beneath the site with lesser impacts to groundwater in the downgradient direction extending from the northeast quadrant of the site towards Poorhouse Brook. In addition, surface water runoff and groundwater discharge from the site has had an impact on the surface water and sediment quality of the unnamed stream which traverses the northern property boundary of the site footprint and, to a lesser extent, to Poorhouse Brook. At this time, it TRC's opinion that there no immediate threats to public health and safety or to sensitive environmental receptors as a result of the identified impacts discussed above.

The completion of the HELP model indicates that capping of the landfill using a geomembrane will significantly reduce infiltration and subsequent leachate generation. The reduction of leachate generation will then result in an improvement of both groundwater and surface water quality on-site and off-site. Due to the nature of leaching and dissolved contaminant migration, the improvements will be gradual over several years following landfill closure. However, the complete elimination of leachate seeps will be immediate following capping. Furthermore, the rerouting of the stream entering the site pond and elimination of the culvert beneath the site will also significantly reduce leachate generation.

The results of this off-site impact evaluation have been used to determine that no immediate corrective action was necessary and will be used during the final landfill capping design process to insure that the cap is sufficient to achieve the water quality improvement goals. Long-term monitoring will continue post-closure to document the effects of the cap on the groundwater and surface water quality.

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