FOURTH FIVE-YEAR REVIEW REPORT

WARWICK LANDFILL SUPERFUND SITE

TOWN OF WARWICK, ORANGE COUNTY, NEW YORK

Prepared by:
U.S. Environmental Protection Agency
Region II
New York, New York

May 2016

Approved by: **Date:**

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Walter E. Mugdan, Director
Emergency and Remedial Response Division

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EXECUTIVE SUMMARY

This is the fourth five-year review for the Warwick Landfill Superfund site (Site), located in the Village of Greenwood Lake, Town of Warwick, Orange County, New York. The purpose of this five-year review is to review information to determine if the remedy is and will continue to be protective of human health and the environment. The triggering action for this statutory five-year review is the completion date of the previous FYR.

Based upon a review of the Site documents, sampling data and the Site inspection, the U.S. Environmental Protection Agency concludes that the remedy implemented at the Site currently protects human health and the environment; because, the landfill cap reduces leachate generation, and groundwater monitoring does not indicate contaminated groundwater is migrating from the landfill.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Warwick Landfill		
EPA ID: NYD980506679		
Region: 2	**State:** NY	**City/County:** Town of Warwick/Orange

SITE STATUS	
NPL Status: Deleted	
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes

REVIEW STATUS
Lead agency: EPA ***[If "Other Federal Agency", enter Agency name]*:** Click here to enter text.
Author name (Federal or State Project Manager): Damian Duda
Author affiliation: Remedial Project Manager
Review period: 8/31/2011 - 2/29/2016
Date of site inspection: 10/22/2015
Type of review: Statutory
Review number: 4
Triggering action date: 8/31/2011
Due date *(five years after triggering action date)*: 8/31/2016

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
01

Protectiveness Statement(s)		
Operable Unit: 01	*Protectiveness Determination:* Protective	*Addendum Due Date (if applicable):* Click here to enter a date.
Protectiveness Statement: The remedy implemented at the Site currently protects human health and the environment.		

Sitewide Protectiveness Statement	
Protectiveness Determination: Protective	*Addendum Due Date (if applicable):* Click here to enter a date.
Protectiveness Statement: The remedy implemented at the Site currently protects human health and the environment.	

INTRODUCTION

The purpose of a five-year review is to evaluate the implementation and performance of a remedy in order to determine if the remedy is and will continue to be protective of human health and the environment and is functioning as intended by the decision documents. The methods, findings and conclusions of reviews are documented in the five-year review. In addition, five-year review reports identify issues found during the review, if any, and document recommendations to address them.

This is the fourth five-year review (FYR) for the Warwick Landfill Superfund site (Site), located in the Village of Greenwood Lake, Town of Warwick, Orange County, New York (see Figure 1). This FYR was conducted by the Environmental Protection Agency (EPA) Remedial Project Manager Damian Duda. The review was conducted pursuant to Section 121(c) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, 42 U.S.C. §9601 *et seq.* and 40 CFR(f)(4)(ii) and in accordance with the Comprehensive Five-Year Review Guidance, OSWER Directives 9355.7-02B-P (June 2001). This report will become part of the Site file.

The triggering action for this statutory review is the completion date of the previous FYR. A five-year review is required at this Site due to the fact that hazardous substances, pollutants or contaminants remain at the Site above levels that allow for unlimited use and unrestricted exposure. The Site consists of two operable units. Operable Unit One (OU-1) addresses the landfill property. The remedy has been constructed and is operating. Operable Unit Two (OU-2) Record of Decision selected No Further Action for groundwater. OU1 will be evaluated in this FYR.

SITE CHRONOLOGY

See Table 1 for the Site chronology.

SITE BACKGROUND

Physical Characteristics

The Site is located approximately one and one-half miles northeast of the Village of Greenwood Lake in the Town of Warwick, Orange County, New York and is approximately three-quarters of a mile north of State Route #17A and fronts Penaluna Road on its western boundary between Old Tuxedo Road and Old Dutch Hollow Road. The landfill mound transects a small valley and occupies approximately 19 acres of a former 26-acre area. Contiguous to the landfill mound are two wetland areas: an emergent marsh/scrub-shrub wetland, approximately nine acres in size, in the southeast, and a smaller, palustrine, forested scrub-shrub, deciduous wetland, approximately three to four acres in size, to the northwest. Upland habitats surround both wetlands. The 26-acre area is a portion of a 64-acre parcel of property.

Site Geology and Hydrogeology

Two aquifers exist beneath the Site. The overburden aquifer is an unstratified drift deposit consisting of a mixture of clay, silt, sand, gravel and boulders which widely range in size, shape, and permeability. The bedrock aquifer generally consists of moderately fractured quartz-plagioclase gneiss, hornblende-feldspar gneiss and amphibolite.

The landfill is situated in a groundwater discharge environment, *i.e.*, perched leachate and lower leachate primarily flows to North Brook and South Brook and their associated wetlands. Shallow bedrock groundwater moves from the residential area, located northeast of the landfill, towards the landfill (southwest). The hydraulic properties, *i.e.*, hydraulic heads and lower hydraulic conductivity, of the shallow bedrock minimize the movement of leachate to the north and northeast. Northeast of the landfill, the natural hydrogeologic conditions show potential for downgradient groundwater flow in the shallow bedrock aquifer; and, combined with the construction techniques of deep residential wells in that area (typically 300 feet or more), conditions may exist for some downward vertical migration of shallow groundwater.

Land and Resource Use

The Village of Greenwood Lake is a semi-rural residential community located approximately fifty miles northwest of New York City. Total population of the Village of Greenwood Lake is estimated to be 3,500. The Town of Warwick has a population of approximately 33,000.

The area surrounding the Site is generally wooded with clusters of residential homes, all of which utilize private wells as their source of drinking water. One residential property is located adjacent to the Site on the western side, and additional residential properties are located directly across Penaluna Road from the landfill.

History of Contamination

The Site was owned and farmed by the Penaluna family from 1898 to the mid-1950s, when the Town of Warwick leased the property from the Penaluna family and utilized it as a refuse disposal area. The facility accepted waste from the Town of Warwick, which includes the Villages of Florida, Warwick and Greenwood Lake, and other surrounding towns in Orange County. Some industrial wastes containing hazardous substances were disposed of during this time. The Town of Warwick operated the landfill until 1977.

From 1977-1980, the landfill was operated by Grace Disposal, Inc.; evidence indicated that the majority of the disposal of materials containing hazardous substances occurred during this time. In 1979, in response to concerns of local citizens who had reported observations of suspicious dumping activities at the landfill, the EPA and the New York Department of Environmental Conservation (NYSDEC) collected and analyzed two leachate samples from the Site. The results indicated the presence of heavy metals, phenols and various volatile organic compounds (VOCs), some of which exceeded the Federal and state drinking water standards. After transfer of the property from the Penalunas to Orange County, as a result of non-payment of taxes, the property was ultimately transferred in 1987 to the current owner, L & B Developers, Inc.

Initial Response

In March 1985, a preliminary assessment/site inspection, including a field investigation, was performed by NYSDEC. The information generated was utilized to prepare a Hazard Ranking System (HRS) assessment of the Site. Based upon the HRS score, the Site was proposed for inclusion on EPA's National Priorities List (NPL) of uncontrolled hazardous waste sites in 1985 and was added to the NPL in March 1989.

From September 1989 until November 1990 during the initial Remedial Investigation (RI) phase of the project, residential well sampling was conducted by EPA and the New York State Department of Health (NYSDOH). The data results indicated levels of VOC-contamination above Federal and state drinking water standards. As a result, NYSDOH and NYSDEC fitted those affected households with granular activated carbon units. These units were subsequently turned over to the homeowners for their continued use. The RI and Feasibility Study (FS) were completed in February 1991.

Basis for Taking Action

In June 1991, EPA issued a Record of Decision (ROD) which called for the construction of a landfill cap.

On February 28, 1992 and April 9, 1993, EPA issued Unilateral Administrative Orders (UAOs) to a select group of the potentially responsible parties (PRPs), *i.e.*, Ford, Georgia Pacific, Reichold Chemicals, IBM, Town of Warwick and Union Carbide, which organized into the Warwick Administrative Group (WAG) to perform the remedial design (RD) and remedial action (RA) work for OU-1.

On September 28, 1992, EPA entered into an Administrative Order on Consent (AOC) with certain members of the WAG to perform the supplemental groundwater investigation for OU-2. The WAG also retained Arcadis to conduct this effort.

In December 1993 and August/September 1994, groundwater sampling (upgradient and downgradient) was conducted at on-site and off-site monitoring wells. Various VOCs were detected above the Federal and state standards in seven monitoring wells during the two rounds of sampling. With the exception of a few isolated, low-level detections of benzene and chloromethane, VOC-contamination was not found in downgradient wells above federal and state drinking water standards. Some inorganic compounds, including chromium, nickel and lead, were detected at or above Federal and state drinking water standards in both upgradient and downgradient monitoring wells. Chromium and nickel were found to be naturally occurring in the formations.

In September 1994, 11 residential septic systems northeast of the landfill were sampled. The maximum concentrations of VOCs detected in the residential septic tank systems included substantial levels of 1,1-dichloroethane (DCA), toluene and chlorobenzene. In some cases, the same VOCs were also found in the nearby residential wells, indicating that the septic systems presented a potential source of contamination to the domestic drinking water wells in this area.

Also, during September 1994, as required by the OU-1 ROD, a separate residential well sampling program was initiated. Most residences within a quarter-mile radius of the Site were sampled for VOCs and inorganics. Three sampling events were undertaken: September 1994, May and November 1995. Some low-level VOC-contamination, present in some upgradient residential wells, was determined to be related to privately-owned septic systems in the area and not landfill-related. Lead was also detected above the federal action level in some upgradient residential wells; the presence of lead here was determined to be attributable to household plumbing sources.

Based on the RI for OU-1, the potential for direct human exposure, as well as the potential for further contaminant migration to groundwater or surface water existed at the Site. At the time of the RI, there were no permanent controls in place to prevent contaminant migration. In addition, the environmental assessment evaluated potential exposure routes of the Site contamination to terrestrial wildlife and aquatic life. However, because of the low concentrations of contaminants detected, lack of potential bioaccumulation, absence of fishing or other recreational activity, the assessment was not quantified.

The RI for OU-2 concluded that, since most of the contaminants detected above federal and/or state standards were isolated occurrences, no groundwater plumes could be delineated for organic or inorganic contaminants and, as a result, there was no unacceptable risk.

REMEDIAL ACTIONS

Remedy Selection

The June 1991 ROD addressed the primary threats posed by the Site by controlling the source of contamination and provided an interim measure to ensure that area residents have a potable water supply. The Remedial Action Objectives (RAOs) were:

- Minimize the infiltration of rainfall and snow melt into the landfill, which will reduce the quantity of water percolating through the landfill materials and leaching out contaminants;
- Eliminate the risk to area resident associated with contaminated groundwater ingestion and exposure;
- Minimize any further contamination of the wetlands and drainage channels which feed into Greenwood Lake; and,
- Reduce the movement and toxicity of the contaminated landfill leachate, thereby reducing the downward migration of contaminants.

The major components of the selected remedy included:

- Construction of an approximate 22-acre multi-layer cap consistent with New York Part 360 Solid Waste Landfill closure requirements;
- Regrading and compaction of the landfill mound to provide a stable foundation for the placement of the cap prior to its construction;

- Construction of a gas venting system following the testing and characterization of landfill gas emissions;
- Performance of air monitoring prior to, during, and following construction at the Site, to ensure that air emissions resulting from the cap construction meet applicable or relevant and appropriate requirements;
- Installation of groundwater monitoring wells within the landfill mound to observe effect of groundwater flow patterns through the saturated portion of the landfill and to monitor the movement of contaminants beneath the landfill;
- Quarterly groundwater monitoring program using existing groundwater monitoring wells and newly installed wells within the mound;
- Construction of fencing around the perimeter of the 25-acre leasehold;
- Recommendations that ordinances be established or restrictions imposed on the deed to ensure that future use of the Site property will maintain the integrity of the cap;
- Implementation of a residential well sampling program of area residential wells;
- As an interim measure, fitting and maintenance of granular activated carbon units on residential wells where contaminant levels found exceed either Federal or state maximum contaminant levels (MCLs) or on those residential wells which are threatened by potential contamination in exceedance of MCLs based on the results of the residential well sampling program and the OU2 investigation. The units will be maintained until the decision on a final groundwater remedy is evaluated under OU2; and,
- Evaluate and delineation of the northwestern and southeastern wetlands and the drainage channels flowing through the wetlands adjacent to the landfill.

In addition to the landfill closure activities selected for OU-1, the selected response action in the ROD ensured that, until a decision on a final groundwater remedy was made in OU-2, the area residents were protected from drinking contaminated groundwater by the installation of point-of-use treatment systems on the residential wells. In addition, a full evaluation of the two adjacent wetlands would be performed prior to remediation activities to determine any measures which would be necessary to mitigate potential negative impacts to the wetlands.

Based on the findings of the OU-2 RI performed at the Site, EPA and NYSDEC determined that Site-related groundwater contamination is very limited in extent, was not found to be the probable source of contamination in wells located northeast of the Site and did not pose any significant risk to human health and the environment. The implementation of an environmental monitoring program to include sampling of the groundwater, ambient air, surface water, sediments and landfill gas would further ensure that the Site remedies remained protective of human health and the environment.

Remedy Implementation

The Town of Warwick performed the remedial action, pursuant to the February 28, 1992 UAO, as discussed above. The landfill system, *i.e.*, the landfill cap, was designed to prevent surface water infiltration into the landfill, thereby, reducing leachate production and the subsequent migration of contaminants in the groundwater.

The elements of the cap construction include the following:

- Relocation of waste from outside the landfill footprint;
- Regrading and relocation of waste within the footprint of the landfill;
- Covering the waste with a minimum of one-foot cover material;
- Construction of a gas venting layer, consisting of geotextile, gas venting piping, passive gas venting wells and a layer of gas venting sand;
- Construction of a cap, consisting of placement of 60-mil textured membrane, a geo-composite layer, two feet of protective and vegetative material, six inches of topsoil and the establishment of a vegetative cover on the topsoil; and,
- Construction of permanent surface water controls.

The remedy was constructed in accordance with the 1991 OU-1 ROD and the approved Final Design Report plans and specifications, with modifications as shown in the as-built documentation. The landfill cap and appurtenances were constructed between June 1996 and August 1998. The Remedial Action Report was approved on May 11, 1999.

Operations, Maintenance and Monitoring

The operation and maintenance (O&M) at the Site include 1) performing general Site maintenance to maintain the vegetative layer, including reseeding, fertilizing and/or grass cutting (depending on Site conditions, one third of the landfill's vegetative cover should be mowed on annual basis), as necessary; 2) evaluating the integrity of the remedial measures that have been implemented, namely the landfill cover system and its various components, *i.e.*, vegetative and synthetic barrier layers, surface water control systems (drainage swales), the passive gas venting systems (gas vents) and, Site security (fence, gate and locks); 3) evaluating the monitoring program components, including the monitoring wells and piezometers and the surface water and sediment sampling locations; and, 4) performing any repair and/or maintenance work, associated with all of the above-discussed components of the landfill cover system and monitoring network. When identified, any repair and/or maintenance work deemed necessary is completed by the WAG inspection personnel. In addition to the annual inspections, supplemental inspections may be conducted at other times.

When necessary, a maintenance/repair form is completed to identify any necessary actions to be taken; this form includes the dates when the problem was identified and when the repair/maintenance was made. Grass-mowing, reseeding and/or fertilizing activities are identified as maintenance activities. The O&M Inspection Reports also include photographs taken during the time of the O&M Site inspections.

The monitoring program at the Site includes investigation of 1) the current hydrogeology, including taking water level measurements at piezometers within the landfill mound, 2) the current groundwater by sampling the select monitoring wells at upgradient and downgradient locations, 3) the current surface water at two locations adjacent to the landfill and two downstream of the landfill and 4) the current sediments at two locations adjacent to the landfill and two downstream of the landfill.

The regular O&M monitoring of the groundwater, surface water and sediment conditions began shortly after the Site's final inspection on September 1998. Sampling for these parameters has been performed from October 2012 and December 2015. These events have been documented in the associated O&M Sampling, Analysis and Monitoring Plan (SAMP) reports. Since the last FYR, two O&M SAMPs were prepared (October 2012 and December 2015) and formal Site inspections were conducted in October 2012, November 2014 and September 2015 with follow-up inspections conducted for any necessary maintenance activities. The O&M SAMP chronicles the associated Site Inspection reports, as well as any maintenance activities and repairs that were conducted as a result of the inspections.

The most recent maintenance tasks were completed in October 2015 that included (1) removal of overgrowth vegetation in the perimeter drainage swale, (2) the cutting and removal of fallen tree limbs in the west drainage swale, (3) the removal of excessive weed growth at the Site entrance gates and (4) mowing of approximately one third (1/3) of the landfill cover.

Potential Site impacts from climate change have been assessed, and the performance of the remedy is currently not at risk from any expected effects of climate change in the region and/or near the Site.

PROGRESS SINCE LAST FIVE-YEAR REVIEW

Protectiveness Statement from previous FYR:

The remedy implemented at the Site currently protects human health and the environment; because, the landfill cap reduces leachate generation and groundwater monitoring does not indicate contaminated groundwater is migrating from the landfill. However, in order for the remedy to be protective in the long-term, the downgradient residential wells screened in the bedrock aquifer should be sampled in order to ensure residents are not being exposed to Site contaminants.

Recommendation from previous FYR:

During the next five-quarter O&M monitoring event, sample the residential wells downgradient of the landfill for Site constituents to ensure that the drinking water from these wells remains potable.

Progress on Recommendation from previous FYR:

The residential wells downgradient of the landfill were sampled during the previous FYR and were shown to be potable and that Site-related contaminants were not found. Arcadis contacted the Town of Warwick during this FYR period to survey residential wells downgradient of the Site and found that only one new residential well had been installed during the past five years. The well was completed by the NYSDEC and was sampled for bacterial parameters and, like the other wells, was shown to be potable. The Town of Warwick has indicated that there have been no issues reported with respect to residential wells located downgradient of the landfill in the last five years.

The residential wells downgradient of the landfill were sampled during the previous FYR and were shown to be potable. No further sampling was conducted during the current five-year period. Arcadis contacted the Town of Warwick during this FYR period and found that only one new residential well had been installed during the past five years and was sampled for bacterial parameters. This well was sampled and shown to be potable. The Town of Warwick has indicated that there have been no issues reported with respect to residential wells downgradient of the landfill.

During the period when the various residential wells were installed and sampled, all residential wells showed non-detect for VOCs with the exception of 1) toluene detected at 0.297 and 0.5 µg/L, respectively, 2) chloroform detected at 5.1 µg/L and 3) carbon disulfide detected at 0.9 ppb. Toluene has been historically non-detect in the bedrock monitoring wells located down-gradient of the landfill, including monitoring wells WL-4D, WL-6D, MW-13 and MW-14.

The Town of Warwick Planning Board implements a number of protocols related to the installation of new private residential wells. These protocols include requiring certain construction techniques, reports and well testing for subdivision lots within approximately 2000 feet of the limits of the former landfill, as discussed above. EPA will continue to review the results of the Town of Warwick's activities with respect to the monitoring of existing and new residential drinking water wells downgradient of the Site.

THE FIVE-YEAR REVIEW PROCESS

Administrative Components

The FYR team consists of Damian Duda (EPA-RPM), Ed Modica (EPA-Hydrogeologist), Julie McPherson (EPA-Human Health Risk Assessor), Mindy Pensak (EPA-Ecological Risk Assessor), Cecilia Echols (EPA-Community Involvement Coordinator), Sal Badalamenti (EPA-Supervisor) and (Lelani Davis (EPA-Site Attorney).

Community Notification and Involvement

On November 19, 2015, EPA Region 2 posted a notice on its website indicating that it would be reviewing site cleanups and remedies at 32 Superfund sites and four federal facilities in New York and New Jersey, including the Warwick Landfill site. The announcement can be found at the following web address: http://www2.epa.gov/sites/production/files/2015-11/documents/fy_16_fyr_public_website_summary.pdf.

In addition to this notification, in March 2016, EPA Region 2 posted a notice on its website indicating that it would be reviewing site cleanup at the Site. The announcement can be found at this web address: https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0201695.

To date, there have been no inquiries from the public about this FYR.

Once the FYR is completed, the results will be made available at the local Site repository:

Warwick Town Hall
132 Kings Highway
Warwick, New York 10990

In addition, efforts will be made to reach out to local public officials to inform them of the results.

Document Review

The relevant documents and reports which were reviewed during the FYR process are identified in Table 3.

Institutional Controls Verification

With respect to institutional controls, an environmental protection easement and declaration of restrictive covenants (Easement) by the property owner is filed with the Orange County Clerk's office. The Easement restricts residential development and groundwater extraction on the landfill and requires EPA review and approval of any and all future development plans for the landfill cap area. In addition, around 2003, the Town of Warwick Planning Board instituted protocols requiring specific construction techniques, reports and well testing (pump test and analytical testing) for subdivision lots (residential) within 2000 feet of the landfill.

Data Review

The O&M SAMP reports, including the Site inspection reports, evaluate the effectiveness of the landfill cap through the monitoring of groundwater, surface water and sediments. If the O&M data indicate that either groundwater quality in the overburden and/or bedrock aquifers or surface water quality in the adjacent wetlands is not being restored to acceptable levels by reduced leachate generation, further actions would be taken. Since the construction of the landfill cap in 1998, on-site and off-site groundwater, surface water and sediment data have been collected on a regular basis.

Since the completion of the remedial action activities and the final inspection, the Site conditions have remained relatively stable. The landfill cap remains in good repair while O&M activities continue at the Site. The fence which surrounds the majority of the Site is intact and in good condition. The monitoring wells installed within and around the Site are functional; and, the passive gas vents are operational.

<u>Groundwater Quality</u>

Groundwater elevation monitoring results for the October 2012 and September 2015 sampling events, indicate negligible variation from previous sampling events. Overall, the general direction of groundwater flow in both the overburden and bedrock aquifers has not changed.

Therefore, the monitoring well network and surface water and sediment locations identified in the original O&M Manual remain suitable for the current O&M SAMP.

The October 2012 and September 2015 SAMP reports show groundwater-elevation maps of the overburden and bedrock aquifers. In the overburden, groundwater flows radially towards North Brook and South Brook. In the bedrock aquifer, over an area that encompasses the footprint of the landfill and the area west of Penaluna Road, the map shows a groundwater flow direction from the northeast to the west; an indication that the residential wells along Penaluna Road that are installed in the deep bedrock aquifer to the southwest of the landfill are directly down-gradient from the landfill.

In general, for all sampling events, groundwater quality has remained consistent over the years with some moderate improvement for some VOCs and some metals. Based on sampling activities carried out in 2012 and 2015, VOC concentrations in the monitoring wells were observed only sporadically and at low levels in samples from two monitoring wells. A summary of the 2012 and 2015 groundwater sampling results from upgradient versus downgradient wells are presented in Tables 2 and 3. A detailed discussion is provided below.

Monitoring well MW-l0S is located up-gradient of the Site and down-gradient of a residential neighborhood in the overburden. Historically, some VOCs (1,1-DCE, 1,1-DCA, and 1,1,1-TCA) detected in MW-10S, were above state standards; however, the VOC trend is now downward with 1,1-DCE, 1, 1-DCA, and 1,1,1-TCA concentrations currently below their respective MCLs (of 5 µg/L) during the 2015 sampling event.

In MW-10S, 1,1,1-TCA was detected at 5.7 µg/L for the 2015 sampling event, slightly above the NYS standard of 5 µg/L. For the prior sampling event in 2012, the concentration was observed at 3.2 µg/L. In upgradient monitoring well MW-11S, located about 300 feet west of MW-10S, benzene was detected at a concentration of 1.2 µg/L in the 2015 sampling event, slightly above the NYS standard of 1 µg/L and was not detected in the 2012 sampling event.

Historically, antimony, chromium and nickel were detected in samples from background monitoring wells that are not part of the O&M SAMP monitoring well network and were determined to be naturally occurring in the formations. The groundwater conditions have been relatively stable since monitoring began during the OU-2 RI. Over the past five-year period, chromium and nickel were detected at concentrations above NYS standards in both up-gradient and down-gradient wells. An analysis was also made for antimony but was reported as non-detect in down-gradient wells WL-8D, MW-13, and MW-14 and in up-gradient well MW-10S.

Chromium was detected in the down-gradient well WL-6D at a concentration of 65.2 µg/L in 2012, above the 50 µg/L standard, but was not detected in the same well in 2015. At well MW-14 (located nearWL-6D), chromium was detected at 1,490 µg/L in 2012 but was detected at 39.9 µg/L in the same well in 2015. At well WL-8D (located about 1,600 feet upgradient of WL-6D), chromium was detected at 148 µg/L in 2012 and detected at below-standard-concentrations of 35.4 µg/L in 2015. In 2012, at the up-gradient well MW-10S, chromium was detected at 732 µg/L in 2012. In 2015, chromium was detected at 170 µg/L.

In 2012, in WL-4D, nickel was detected at 215 µg/L above the NYS 100 µg/L standard. For the 2015 sampling event, nickel was detected at 108 µg/L, a reduction from the previous sampling event. In 2012, at well MW-10S, nickel was detected at 196 µg/L and not detected in any sample during the 2015 sampling event.

In May of 2011, Arcadis (PRPs/WAG) contacted the Township of Warwick to obtain information regarding any installation of new residential potable wells located within a quarter-mile of the landfill and for any additional updated well construction logs and water-testing results which may have been taken at properties located close to the landfill. Twelve potable well locations were found within a quarter-mile of the perimeter of the landfill. Five of these residences are located southwest of the landfill (along Penaluna Road) and have domestic wells installed downgradient of the landfill. All wells were tested for total coliform and E. Coli and successfully met drinking water standards. Furthermore, a domestic well search yielded five additional residential wells (four of which are down-gradient of the landfill) which were sampled for additional parameters, including VOCs, SVOCs and metals.

Surface Water and Sediments

Surface water and sediment samples were taken at two sampling locations (SW/SD-B and SW/SD-H) in the wetland adjacent to the landfill (northeast of) and at two locations (SW/SD-G and SW/SD-E) in the wetland down-stream of the landfill (south-southwest of). The most recent sampling indicates low levels of poly--aromatic hydrocarbons (PAHs) and pesticides. Historically, pesticides were reported infrequently and at very low concentrations from 0.51 to 11 parts per trillion.

For the 2012 sampling event, at the SD-G location, PAHs were detected in the sediments at low levels: benzo(a)pyrene was detected at 41 µg/kg, phenanthrene at 55 µg/kg, pyrene at 66 µg/kg, benzo(b)flouranthene at 46 µg/kg, flouranthene at 83 µg/kg, benzo(k)flouranthene at 43 µg/kg, and chrysene at 40 µg/kg. In 2012, at location SD-H, benzo(b)flouranthene was reported at 22 µg/kg and flouranthene at 21 µg/kg.

In 2012, at the downstream surface water SD-E locations, PAHs were detected in the sediments at very low levels: benzo(a)pyrene was detected at 26 µg/kg, phenanthrene at 23 µg/kg, pyrene at 39 µg/kg, benzo(b)flouranthene at 52 µg/kg, flouranthene at 51 µg/kg, benzo(k)flouranthene at 20 µg/kg and chrysene at 24 µg/kg. In the SD-B location, benzo(a)pyrene was detected at 34 µg/kg, phenanthrene at 49 µg/kg, pyrene at 54 µg/kg, benzo(b)flouranthene at 46 µg/kg, flouranthene at 77 µg/kg, benzo(k)flouranthene at 29 µg/kg and chrysene at 37 µg/kg. For the 2015 sampling event, flouranthene was the only PAH detected in sediments at locations SD-B and SD-E, at concentrations of 23 µg/kg and 27 µg/kg, respectively.

For the 2012 sampling event, low levels of pesticides were reported in sediments adjacent to and down-stream of the landfill: At the adjacent SD-G location, 4,4'-DDT was detected at 6.5 µg/kg, Dieldrin at 2.8 µg/kg, Endrin at 1.9 µg/kg and 4,4'-DDE at 3.2 µg/kg. 4,4'-DDE was the only pesticide detected at location SD-H at 82 µg/kg. Similarly, at the down-stream SD-B location, 4,4'-DDT was detected at 6.2 µg/kg, Dieldrin at 2.4 µg/kg, 4,4'-DDD at 9.5 µg/kg, and

4,4'-DDE at 27 µg/kg. At SD-E location, 4,4'-DDT, Dieldrin, Endrin, and 4,4'-DDE were detected at 9.3, 4.8, 2.1, and 5 µg/kg, respectively. Gamma-chlordane was also reported at a concentration of 26 µg/kg. For the 2015 sampling event, no pesticide results were reported.

O&M Site Inspections

General O&M Site inspections were conducted in the spring, summer, and fall of 2012, 2013, 2014 and 2015. Formal Site inspection reports were submitted in the O&M SAMP for 2012, 2104 and 2015. Some maintenance and repair activities were performed, including removal of various dead tree trunks and branches from the landfill cover and from the west drainage swale, the replacement of well locks and various repairs and maintenance needs for monitoring wells as noted on inspection forms. In recent months, fallen trees have damaged sections of the fence near the main entranceway; these sections have been repaired.

Site Inspection and Interviews

EPA conducted a Site inspection on October 22, 2014. In attendance were Damian Duda, Ed Modica and Laura Fishman from EPA, Scott Deyette from NYSDEC, Mike Klechkowski from Arcadis and Glen Schultz from Waste Management, Inc.

During the Site inspection, the team performed a walk around the landfill cap in and around the drainage swales, no problems or irregularities were identified with respect to the ongoing O&M of the landfill cap remedy. Arcadis had performed some major cleanup of brush, etc., prior to the Site inspection. The group also assessed any new residential development near the Site. One property was identified.

At the Site inspection, a brief, informal interview was conducted of a local resident (Mark Gray) who was in the area while the inspection team was inspecting the landfill cap. Mr Gray installs and evaluates septic tanks. He indicated that he had no issues regarding the landfill cap and saw that it appeared to be in good condition. He also was not aware of anyone in the area having any concerns.

Institutional Controls Implementation

The June 1991 ROD called for recommendations that ordinances be established or restrictions imposed on the deed to ensure that future use of the Site property will maintain the integrity of the cap. In January 2003, restrictions on the deed of the landfill were obtained through the filing of an environmental protection easement and declaration of restrictive covenants (Easement) by the property owner with the Orange County Clerk's office. The Easement was granted by the property owner to members of the WAG and requires, inter alia, that the cap area not be developed residentially, that groundwater not be extracted from the property and that any plans for future development of the cap area be provided to EPA for review and approval. The Easement is now part of the property record and runs with the land, ensuring compliance by any future owners of the property.

As discussed above, the Town of Warwick Planning Board has instituted protocols requiring certain construction techniques, reports and well testing for subdivision lots within 2000 feet of the landfill. The Town of Warwick now requires that prospective purchasers are placed on notice that the potential subdivision is located within the immediate vicinity of the landfill. In addition, a residential site plan application requires the following: 1) installation of a vapor intrusion protection system; 2) the installation of a deep bedrock well, grouted to a minimum of 20 feet into the bedrock; 3) potable well sampling analysis for metals, VOCs and SVOCs by the Orange County Department of Health; and, 4) a recommendation for the installation of a point-of-entry treatment system if contaminants exceed the NYSDOH Part 5, Subpart 5-1 maximum contaminant levels (MCLs) for drinking water. In addition, the Town of Warwick well testing procedures outline pump test and analytical testing requirements, including general water quality and other parameters on a case-by-case basis, if the property is located near areas of potential concern, including landfills, gas stations, hazardous waste sites or other areas of potential concern. These requirements are in place and functioning for all future residential development around the Site.

TECHNICAL ASSESSMENT

Question A: Is the remedy functioning as intended by the decision documents?

The 1991 ROD selected remedy consisted of the following components: construction of a landfill cap and associated gas venting, in compliance with NYS 360 closure requirements for solid waste landfills; implementation of groundwater, residential well, surface water and sediments monitoring programs; an ongoing maintenance program; installation of perimeter fencing; and, securing ICs. The landfill continues to eliminate the exposure pathway to Site-related contaminants via the soil exposure pathway. The media sampling data indicate that the landfill cap is working to reduce contamination migrating from the landfill.

Arcadis inspects and assesses the integrity of the cap, as well as the fence, on an annual basis. At the present time, the landfill cap and fencing are in good shape, the vegetative cover is intact and flourishing, and Site maintenance and security is sufficient. Numerous types of wildlife cross through or reside in the vegetative cover, such as deer, quail, migrating birds, various rodents, even bear. In addition, a select group of monitoring wells and surface water and sediment locations are monitored to assess the migration of any Site-related contaminants.

The groundwater monitoring and landfill cap maintenance programs were implemented as part of the O&M phase of the remedial action, and the final O&M Manual was issued by Arcadis in August 2000. O&M sampling and monitoring has continued at the Site. As discussed previously, the sampling frequency was reduced over the past five years as reflected in NYSDEC's 2006 modification.

During the 2012 and 2015 sampling events, VOCs were detected below the federal MCL with the exception of benzene, which was detected at the MCL in one monitoring well. The concentrations of the majority of VOCs were non-detect during the two most recent sampling events. Historic residential well data, paired information about the extent of groundwater,

indicate that the private wells would not be impacted by Site-related contaminants. This will be evaluated in future FYRs.

Sediment samples were collected twice within the past five years. The samples were only analyzed for pesticides and PAHs. The only PAH compound that was detected was fluoranthene. The concentration of this compound was compared to the RSL for soils. The concentration did not exceed its respective risk-based screening criteria. Pesticides detected were methoxychlor, 4,4' DDD and 4,4 DDE. The concentrations did not exceed their respective risk-based screening criteria.

Homes downgradient of the landfill have private wells screened in the deep bedrock aquifer. At the present time, a review of the limited residential groundwater data secured from the Town of Warwick does not show any Site-related contaminant impacts to these downgradient residential wells which have been installed through 2014. In addition, as discussed above, historical groundwater sampling downgradient does not show Site-related contamination in the bedrock aquifer.

With respect to ICs, an environmental protection easement and declaration of restrictive covenants (Easement) by the property owner is filed with the Orange County Clerk's office. The Easement restricts residential development and groundwater extraction on the landfill and requires EPA review and approval of any and all future development plans for the landfill cap area.

The Town of Warwick Planning Board instituted protocols requiring specific construction techniques, reports and well testing (pump test and analytical testing) for subdivision lots (residential) within 2000 feet of the landfill.

Question B: Are the exposure assumptions, toxicity data, cleanup levels and remedial action objectives (RAOs) used at the time of the remedy still valid?

The exposure pathways and the receptor populations identified in the 1995 Baseline Human Health Risk Assessment (BHHRA) are still valid. Although some exposure assumptions have changed and several exposure pathways were not evaluated, it is not expected to affect the overall protectiveness of the remedy.

Soil vapor intrusion was evaluated in the last FYR as a potential future exposure pathway based on the conservative (health protective) assumption that buildings are located above the maximum detected concentration of the contaminants of concern in the groundwater. Based on the results of the groundwater sampling events within the five years, vapor intrusion does not appear to be an issue at the Site.

With respect to the ecological assessment, the exposure pathways and receptor populations identified in both the OU-1 and OU-2 ROD are appropriate although the study conducted was qualitative. The results of the sediment and surface water sample data indicate that concentrations identified are not associated with unacceptable risk to ecological receptors.

The wetlands and streams draining the Site area do not support fishing or other recreational activities. However, they are a suitable habitat for small aquatic wildlife, such as frogs and turtles. The Site inspections reveal no signs of distressed conditions in the wetlands.

Question C: Has any new information come to light that could call into question the protectiveness of the remedy?

No.

ISSUES, RECOMMENDATIONS AND FOLLOW-UP ACTIONS

There were no issues or recommendations identified in this FYR.

The following suggestions are provided here to improve the accuracy of the data and reporting for all sampling events and investigatory activities.

1) Ensure that the method detection limit for metals is set below the screening criteria.
2) Ensure that filtered and unfiltered metals' data are correctly identified in the SAMP data tables.
3) Review the frequency of all sampling events (groundwater, surface water and sediments) in order to ensure at least two rounds of data for each media are collected during each five-year review period.
4) Continue to review residential development in the Site area.

PROTECTIVENESS STATEMENT

OU-1

The remedy implemented at the Site is protective of human health and the environment.

Sitewide

The remedy implemented at the Site is protective of human health and the environment.

NEXT FIVE-YEAR REVIEW

The next FYR for the Warwick Landfill site should be completed within five years of the signature date.

TABLES

TABLE 1 - Chronology of Site Events

Event	Date
NYSDEC denies Grace Disposal permit to continue operation of the Warwick Landfill	September 1979
Phase I and II Preliminary Investigation Warwick Landfill	1983 and 1985
Warwick Landfill added to the National Priorities List (NPL)	March 1989
Remedial Investigation/Feasibility Study (RI/FS) Report (Operable Unit One (OU-1))	February 1991
EPA issued first Record of Decision (Operable Unit - One (OU-1))	June 1991
Unilateral Administrative Order No. II CERCLA-20203 For Remedial Design/Remedial Action, USEPA, Warwick Landfill Superfund Site.	February 1992
EPA Administrative Order on Consent No. II CERCLA-20214 for RI/FS for Groundwater, USEPA, Warwick Landfill Superfund Site	September 1992
RI/FS Report issued (Operable Unit - Two (OU-2))	April 1995
Final Design Report issued (OU-1)	May 1995
Amendment to Administrative Order No. II CERCLA-20214 for the Risk Assessment, USEPA, Warwick Landfill Superfund Site	May 1995
EPA issued second Record of Decision (OU-2)	September 1995
Landfill Cap Construction Began (bid award)	June 1996
Substantial Completion of Warwick Landfill Cap	August 1998
Final Inspection of Warwick Landfill Cap and Demobilization	September 1998
Preliminary Close Out Report (EPA Construction Completion)	September 1998
Final Close Out Report	July 2000
Operations and Maintenance (O&M) Manual issued	August 2000
Initial O&M Sampling, Analysis and Monitoring Plan Report	December 2000
First Five-Year Review Report Issued by EPA	August 2001
Deletion from NPL	July 6, 2001
Filing of Easement with Orange County Clerk's Office	January 6, 2003
Second Five-Year Review Site Inspection	April 27, 2006
Second Five-Year Report Issued by EPA	August 2006
Third Five-Year Review Site Inspection	May 2011
Fourth Five-Year Review Site Inspection	October 2015

Table 2 Summary of Constituents in Groundwater at Concentrations Greater Than NYSDEC Water Quality Standards, Warwick Landfill Site, Warwick, New York. (2012)

Constituent and Standard	Detection Frequency Detects/Total Rounds		Concentration Range				Number of Samples that Exceed Standard in Tenth Round (9/15)	
			Upgradient		Downgradient			
	Upgradient	Downgradient	Minimum (ug/L)	Maximum (ug/L)	Minimum (ug/L)	Maximum (ug/L)	Upgradient	Downgradient
VOCs								
Acetone [--]	19/10	30/10	ND	<12	ND	<12	0	0
Benzene [1 ug/L]	19/10	26/10	ND	1.8	ND	1.8	1	0
Tetrachloroethene [5 ug/L]	21/10	33/10	ND	<1	ND	0.96	0	0
Toluene [5 ug/L]	23/10	31/10	ND	1	ND	1.4	0	0
m,p-Xylenes [5 ug/L]	16/10	25/10	ND	<0.5	ND	1.1	0	0
Metals: Total *(Filtered)*								
Antimony [3 ug/L]	5/10	10/10	ND	6.6	ND	17.4	0	0
Arsenic [25 ug/L]	1/10	7/10	ND	5.7	ND	8.8	0	0
Barium [1000 ug/L]	32/10	51/10	ND	20.1	ND	132	0	0
Cadmium [5 ug/L]	4/10	4/10	ND	11.7	ND	1.2	0	0
Chromium [50 ug/L]	30/10	41/10	ND	2070	ND	1300	1	0
Lead [25 ug/L]	2/10	5/10	ND	2.5	ND	10	0	0
Nickel [100 ug/L]	30/10	49/10	ND	266	ND	715	0	1
Selenium [10 ug/L]	2/10	3/10	ND	6.1	ND	9	0	0

ug/L Micrograms per liter.
NYSDEC New York State Department of Environmental Conservation.
VOCs Volatile organic compounds.

[ ] NYSDEC Standards are shown in brackets.
ND Not Detected
-- No standard available
J Estimated Value
B Concentration is between the instrument detection limit and the contract required detection limit
E Indicates a value estimated or not reported due to precense of interference
BN Spike failed for the compound and also found in blank
NA Not Analyzed

Standards and guidance values are for NYSDEC Class GA Groundwater.

Table 3 **Summary of Constituents in Groundwater at Concentrations Greater Than NYSDEC Water Quality Standards, Warwick Landfill Site, Warwick, New York.** (2015)

Constituent and Standard	Detection Frequency Detects/Total Rounds		Concentration Range				Number of Samples that Exceed Standard in Tenth Round (9/15)	
			Upgradient		Downgradient			
	Upgradient	Downgradient	Minimum (ug/L)	Maximum (ug/L)	Minimum (ug/L)	Maximum (ug/L)	Upgradient	Downgradient
VOCs								
Acetone [--]	19/10	30/10	ND	<12	ND	<12	0	0
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Tetrachloroethene [5 ug/L]	21/10	33/10	ND	<1	ND	0.96	0	0
Toluene [5 ug/L]	23/10	31/10	ND	1	ND	1.4	0	0
m,p-Xylenes [5 ug/L]	16/10	25/10	ND	<0.5	ND	1.1	0	0
Metals: Total								
Antimony [3 ug/L]	5/10	10/10	ND	6.6	ND	17.4	0	0
Arsenic [25 ug/L]	1/10	7/10	ND	5.7	ND	8.8	0	0
Barium [1000 ug/L]	32/10	51/10	ND	20.1	ND	132	0	0
Cadmium [5 ug/L]	4/10	4/10	ND	11.7	ND	1.2	0	0
Chromium [50 ug/L]	30/10	41/10	ND	2070	ND	1300	1	0
Lead [25 ug/L]	2/10	5/10	ND	2.5	ND	10	0	0
Nickel [100 ug/L]	30/10	49/10	ND	266	ND	715	0	1
Selenium [10 ug/L]	2/10	3/10	ND	6.1	ND	9	0	0

ug/L Micrograms per liter.
NYSDEC New York State Department of Environmental Conservation.
VOCs Volatile organic compounds.

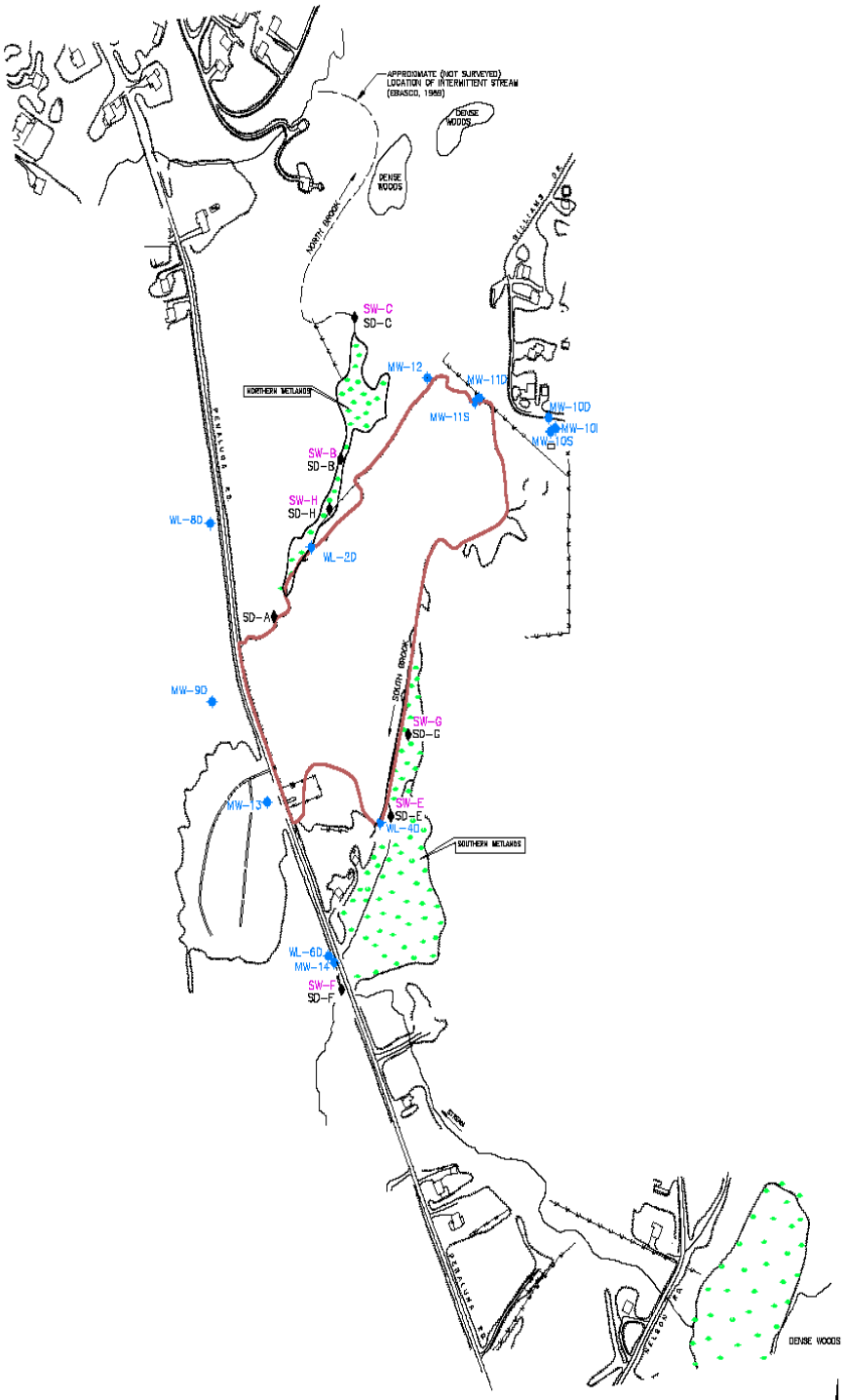
[ ] NYSDEC standards are shown in brackets.
ND Not Detected
-- No standard available
J Estimated Value
B Concentration is between the instrument detection limit and the contract required detection limit
E Indicates a value estimated or not reported due to precense of interference
BN Spike failed for the compound and also found in blank
NA Not Analyzed

Standards and guidance values are for NYSDEC Class GA Groundwater.

TABLE 4 **Documents, Data and Information Reviewed in Completing the Five-Year Review**	
Document Title, Author	**Date**
Comprehensive Five-Year Review Guidance, EPA	June 2001
Remedial Investigation/Feasibility Study Report, Ebasco Services, Inc. (EPA)	February 1991
Record of Decision for Operable Unit One, EPA,	June 27, 1991
Remedial Investigation Report, Operable Unit Two, Geraghty & Miller, Inc.	April 1995
Record of Decision for Operable Unit Two, EPA	September 29, 1995
Superfund Preliminary Close-Out Report, EPA	September 28, 1998
Operations and Maintenance Manual, Arcadis Geraghty & Miller	February 2000
O&M SAMP Five-Quarter Report (December 2000), Arcadis	January 2001
O&M SAMP Five-Quarter Report (April 2002), Arcadis	January 2003
O&M Inspection Report (May 2001; July and October 2002; June 2003), Arcadis	November 2003
O&M SAMP Five-Quarter Report (November 2003), Arcadis	May 2004
O&M SAMP Five-Quarter Report (April 2004), Arcadis	October 2004
O&M Inspection Report (May 2004; October 2004), Arcadis	December 2004
O&M Inspection Report (October, November 2005 and April 2006), Arcadis	August 2006
O&M SAMP Five-Quarter Report (July 2006) and Site Inspections (April, July and October 2006), Arcadis	December 2006
O&M SAMP Five-Quarter Report (October 2007) and Site Inspections (April, July and October 2007), Arcadis	May 2008
O&M Inspection Report (May, July, September and November 2008)	December 2008
O&M SAMP Five-Quarter Report (November 2008), Arcadis	June 2009
O&M Inspection Report (May, July and October 2009), Arcadis	December 2009
O&M SAMP Five-Quarter Report (May 2010), Arcadis	December 2010
O&M SAMP Five-Quarter Report (October 2012), Arcadis	January 2015
O&M SAMP Five-Quarter Report (September 2015), Arcadis	December 2015
O&M Inspection Reports (Spring, Summer and Fall of 2012, 2013, 2014 and September, October and December of 2015	December 2015

ATTACHMENT

FIGURE #1



LEGEND

- SD-B — SEDIMENT SAMPLING LOCATION (APPROXIMATE)
- SW-B — SURFACE-WATER SAMPLING LOCATION (APPROXIMATE)
- MW-13 — MONITORING WELL (GERAGHTY & MILLER, 1993)
- WL-8D — MONITORING WELL (EBASCO, 1989)
- STONE WALL
- TREE LINE
- FENCE
- APPROXIMATE LIMITS OF WASTE (PRE-CLOSURE)

NOTE:
BASE MAP PRODUCED BY EBASCO UNDER USEPA CONTRACT 68-W9-0110 FOR THE OU-1 RI/FS.

WARWICK LANDFILL SITE
WARWICK, NEW YORK

SITE PLAN WITH GROUNDWATER SURFACE-WATER, AND SEDIMENT SAMPLING LOCATIONS

ARCADIS

FIGURE 1