FINAL REPORT

Town of Carroll Landfill Site Hamlet of Frewsburg, New York Feasibility Study

New York State Department of Environmental Conservation
Albany, New York

April 2006

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1. Introduction

1.1. Purpose

The purpose of this report is to present the Feasibility Study (FS) for the Town of Carroll Landfill Site (Site), New York State Superfund Site No. 9-07-017, located in Frewsburg, New York. A site location map is provided as Figure 1.

This FS was conducted on behalf of the New York State Department of Environmental Conservation (NYSDEC) in accordance with:

- the provisions of CERCLA as amended by SARA
- the National Oil and Hazardous Substances Pollution Contingency Plan (NCP; Federal Register 1990)
- the NYSDEC Division of Environmental Remediation *Technical Guidance for Site Investigation and Remediation* (DER-10; NYSDEC 2002)
- the USEPA *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA 1988)
- the NYSDEC revised *Technical Administrative Guidance Memorandum (TAGM) on Selection of Remedial Actions at Inactive Hazardous Waste Sites* (NYSDEC 1990)
- the USEPA *Presumptive Remedy for CERCLA Municipal Landfill Sites* (USEPA 1993)
- the Remedial Investigation/Feasibility Study – Final Project Management Work Plan (PMWP; O'Brien & Gere 2004).

1.2. Site Background

The Town of Carroll Landfill is a former municipal and construction and demolition (C&D) debris landfill and solid waste transfer station. The landfill is located at the end of an unnamed gravel road, approximately 1,700 feet north of NYS Route 62 (also known as Ivory Road) in the Village of Frewsburg, Town of Carroll, Chautauqua County, New York (Figure 1). The landfill is located on a 305-acre lot, although the landfill Site occupies only approximately 25 acres of the property. The surrounding area includes active and inactive farmland, wooded areas, wetlands, and private homes. Conewango Creek lies to the north, northwest, and west of the Site within a broad floodplain (NYSDEC, 2003).

The Site is located on a northwest-facing, gently sloping hillside and is composed of two roughly rectangular landfill cells, each surrounded by drainage ditches and swales. Based on the field activities conducted at the Site, the western landfill cell is approximately 900 ft from north to south and 450 ft from east to west. The eastern landfill cell is approximately 750 ft from north to south and 300 ft from east to west. The ground surface of the eastern cell is estimated to range from 1 to 4 feet above surrounding ditches on the east, north and west. The topography of the western cell is more uneven, ranging from approximately 1 to 10 feet above the surrounding ditches with several flat areas. A narrow drainage area, approximately 70 ft wide, separates the two landfill cells and eventually drains to the northwest into a wetland area before reaching Conewango Creek (NYSDEC, 2003).

Approximately 700 feet west of the Site is the Town of Carroll Public Works Garage area and the Frewsburg Water District including a water supply well and pump station. The Public Works Garage and Water District are located on the same lot, but are accessed from Wahlgren Road off NYS Route 62. The nearest homes are approximately 1200 feet to the west and south and uphill from the Site (NYSDEC, 2003).

1.3. Geology and Hydrogeology

1.3.1. Geology

The Site is located in the Allegany Plateau physiographic province of New York State near the Village of Frewsburg. The following hydrogeologic units can be differentiated at the Site: fill, lacustrine sandy silt and silty clay, glacial outwash sand and gravel, till, and bedrock.

Fill. The uppermost unit within the boundaries of the landfill cells is fill. Fill materials around the edges of the western cell were observed to be mainly composed of wood pieces, metal debris, metal turnings, plastic and glass bottles, plastic sheeting, paper, tires, and drum carcasses. Fill materials around the edges of the southern portion of the eastern cell were observed to be mainly composed of municipal waste such as plastics, miscellaneous metallic debris, paper and plastic toys. Fill materials around the edges of the northern portion of the eastern cell were observed to be mainly composed of brush and log materials. Test pits completed around the edges of the landfill cells indicate that the total depth of fill ranged from approximately 2-ft at TP-01, TP-11, and TP-18 to approximately 10-ft at TP-12. The top of the fill materials was encountered between approximately 1 and 5-ft within each test pit.

A soil cover exists over the fill material, however, this cover was noted to be eroded in places with partially buried drums observed. The cover, did not appear to be suitable for preventing infiltration of precipitation through the underlying fill materials. No consistent cover thickness was noted during field investigations, with several drums observed partially exposed at the surface.

Lacustrine sandy silt and silty clay. The uppermost naturally occurring material outside of the boundaries of the landfill cells, and underlying the fill consists of a yellowish brown, stiff, fine sandy silt with some clay. This sandy silt unit varies in thickness from 5 ft (southwest) to 10 ft (northeast). Underlying this unit is a medium gray, stiff, silty clay unit. This silty clay unit varies in thickness from about 3 ft to 10 ft. The total depth of these units ranges from 7 ft to 20 ft below ground surface.

Glacial outwash sand and gravel. An outwash sand and gravel was encountered underlying the lacustrine sandy silt and silty clay units. The sand and gravel unit consists of yellowish brown, medium dense, fine to coarse sand and gravel with some silt. The total depth of this unit is approximately 45 ft below ground surface.

Till. Till was encountered at the MW-109D location underlying the outwash sand and gravel unit. The glacial till consists of olive gray, very dense gravel and medium to coarse sand with few cobbles. This unit has a thickness of about 15 ft.

Bedrock. Bedrock was not encountered at the Site during the Remedial Investigation (RI; O'Brien & Gere 2005). The uppermost bedrock formations consist of upper Devonian age shale and siltstone of the Conneaut Group. The formations may also include limited beds of sandstone and conglomerate. Previous activities completed for the investigation for the Frewsburg Water District encountered weathered shale bedrock at 76 to 81 ft below ground surface (O'Brien & Gere 2005)

1.3.2. Hydrogeology

Ground water was observed between 3 ft and 9 ft below grade. Shallow ground water is defined as the ground water present to approximately 20 ft below grade. Intermediate ground water is defined as the ground water present between 20 and 45 ft below grade. Deep ground water is defined as ground water present between 45 and 70 ft below grade. Nine wells are installed such that the screen is situated within the shallow ground water zone, eight wells are installed such that the screen is situated within the intermediate zone, and one ground water well is installed within the deep ground water zone.

Flow components of ground water observed during the RI, in combination with historical information, suggest that the natural flow of ground water is generally northerly toward Conewango Creek. The Frewsburg Water District Supply Well #5 is located about 700-ft southwest of the landfill Site. Shallow ground water was observed during various monitoring events to have a flow component to the west-northwest or to the west-southwest. Ground water in the intermediate zone flows to the southwest. It is likely that ground water flow direction is being influenced and redirected by initiation of pumping activities of the Frewsburg Water District Supply Well #5 in January 1995.

Shallow ground water hydraulic gradients ranged from 0.002 to 0.009 ft/ft and were noted to generally be higher in the southern portions of the landfill than in the northern portion. Intermediate ground water had a uniform hydraulic gradient of about 0.004 ft/ft. Vertical hydraulic gradients were observed to be both upward and downward depending on the sampling date.

Results indicate that hydraulic conductivity of the shallow hydrogeologic unit ranges from 0.05 ft/day to 0.5 ft/day. Hydraulic conductivity values from the intermediate wells range from 0.16 ft/day to 9.72 ft/day. The hydraulic conductivity of the deep sand and gravel is approximately 2.85 ft/day.

The geometric mean hydraulic conductivity of the intermediate sand and gravel is approximately one order of magnitude higher than the hydraulic conductivity of the silts and clay of the shallow hydrogeologic unit. The low hydraulic conductivity values from the shallow wells are representative of the finer grained surficial sandy silt and silty clay units at the Site. Conductivity values from the intermediate wells are representative of the coarser grained sand and gravel unit.

1.4. Summary of Remedial Investigation

A RI was conducted at the Site by O'Brien & Gere Engineers, Inc. on behalf of NYSDEC from August 16, 2004 through November 10, 2004. The RI is summarized in the Remedial Investigation Report (O'Brien & Gere 2005).

Environmental samples were collected from the following media: soil vapor, surface soil, surface water, sediment, landfill material, leachate seep liquid, and ground water. Ground water wells were installed to three general depths: "shallow" screened within the 10 to 20 ft interval, "intermediate" screened within the 35 to 45 ft interval, and "deep" screened within the 60 to 70 ft interval. Surface soils were sampled, generally, from within 2 inches of the surface. Landfill material was sampled from test pits dug by an excavator at locations along the edges of the western cell. Surface water and sediment samples were co-located. Two surface water/sediment samples were collected from a drainage swale (intermittent stream) north of the landfill cells, one surface water/sediment sample was collected from the wetland area west of the western landfill cell, and two surface water/sediment samples were collected in the drainage swale between the eastern and western landfill cells. Test wells (those with the designation "TW") were installed in test pit locations that contained visibly impacted water. Sampling locations are shown on Figure 2.

Solid and liquid samples were analyzed by O'Brien and Gere Laboratories in Syracuse New York, while soil vapor samples were screened in the field by a photoionization detector (PID) and subsequently analyzed by Lancaster Laboratories.

The following media were analyzed for volatile organic compounds (VOCs) by USEPA Method OLM04.2 (soil vapor by USEPA Method TO-15):

- Soil Vapor (4 samples)
- Sediment (5 samples)
- Landfill material (8 samples)
- Leachate seeps (3 samples)
- Ground water (25 samples).

VOC compounds were detected in each of the media sampled; however, concentrations within the sediment, landfill material, and leachate seeps were below associated screening criteria.

VOCs were detected in soil vapor within the boundaries of the landfill cells at concentrations that exceeded the generic screening levels for target shallow soil gas concentrations (O'Brien & Gere 2005). Since occupied structures are not currently present in the immediate vicinity of the landfill, potential for vapor impacts are considered minimal. VOCs detected in soil vapor consist mainly of aromatic hydrocarbons, chlorinated aliphatic hydrocarbons, and refrigerant compounds. Detected concentrations in the soil vapor are relatively low and do not indicate the presence of a significant VOC source.

VOCs were detected in shallow and intermediate ground water at concentrations above New York State (NYS) Class GA drinking water standards; however, based on ground water data collected from upgradient, cross gradient, and downgradient monitoring wells, concentrations above NYS Class GA standards in shallow and intermediate ground water appear to be localized at or near monitoring wells MW-107S and MW-102I, respectively. VOCs in deep ground water samples did not exceed the NYS Class GA drinking water standards.

The detection of VOCs in the shallow, intermediate, and deep monitoring wells suggest that VOCs have migrated from the landfill; however, overall VOC concentrations decrease with depth. This may suggest that the limited detection and low concentration of VOCs in the intermediate and deep sand and gravel unit are the result of attenuation of VOCs along the migration pathways.

The following media were analyzed for semivolatile organic compounds (SVOCs) by USEPA Method OLM04.2:

- Surface water (5 samples)
- Sediment (5 samples)
- Landfill material (6 samples)
- Leachate seeps (1 sample)
- Ground water (5 samples).

SVOCs were detected in each medium sampled except for the leachate seeps. SVOCs were detected at concentrations above associated screening levels in surface water, landfill material, and perched ground water. SVOCs detected in sediment were below the associated sediment criteria. While SVOCs were detected in the perched ground water collected from TW-TP-02, they were not detected in ground water samples collected from the monitoring wells, which suggests that the migration of SVOCs from landfill materials is limited.

The following media were analyzed for pesticides and polychlorinated biphenyls (PCBs) by USEPA Method OLM04.2:

- Surface soil (5 samples)
- Surface water (1 sample)
- Landfill material (3 samples)
- Leachate seeps (1 sample)
- Ground water (5 samples).

Neither pesticides nor PCBs were detected above associated screening criteria in any of the environmental media sampled.

The following media were analyzed for inorganic constituents including cyanide by USEPA Method ILM04.0:

- Surface soil (5 samples)
- Surface water (5 samples)
- Sediments (5 samples)
- Landfill material (8 samples)
- Leachate seeps (3 samples)
- Ground water (5 samples).

Within surface soil, the concentrations of inorganic constituents that appear to be related to the landfill due to their elevated concentrations compared to other surface soil sample concentrations are barium, cadmium, lead, and zinc at the SS-09 location, and lead and zinc at the SS-10 location. As shown on Figure 10, these surface soil samples were collected within the eastern landfill cell. Although barium and lead concentrations at SS-09 appear as though they could be related to landfill operations, their respective concentrations are within the range for Eastern United States background soils (NYSDEC 1990). Review of the analytical results for cadmium, lead, and zinc indicates that concentrations are within an order of magnitude of either the TAGM 4046 criteria and/or Eastern United States background concentrations ranges, indicating the overall inorganic impacts to surface soil are low.

Within surface water, inorganic constituents that were detected at concentrations exceeding NYS Class C water quality criteria included aluminum, cobalt, iron, lead, vanadium, and zinc. The inorganic constituents detected in the surface water samples are likely attributable to the migration of leachate from the landfill to drainage swales between the two landfill cells, which ultimately drain to the drainage swale to the north of the cells. Similar inorganic constituents were detected in the surface water samples as in the leachate samples. Whether the elevated concentrations of inorganics are adversely impacting Conewango Creek which is located approximately 4,000 feet to the west of the Site is not known. However, given the relatively large distance to Conewango Creek, potential for impacts is considered to be low.

Sediment samples were co-located with the surface water samples. In general, similar inorganic constituents were detected in the sediment samples as in the surface water samples. However, in almost all cases, constituent concentrations in the sediment were higher than those detected in surface water. Inorganic sediment concentrations were compared to the Lowest Effect Level and the Severe Effect Level. This comparison indicated that arsenic, cadmium, copper, iron, lead, manganese, nickel, and zinc exceeded the Lowest Effect Level, whereas iron in the SED-03 and SED-04 samples, and manganese in the SED-03 sample exceeded the Severe Effect Level. The highest concentrations of arsenic, copper, iron, manganese, and nickel were detected in the SED-03 sample. SED-03 is located within a drainage swale located west of the western landfill cell.

Within leachate, concentrations of aluminum, cadmium, cobalt, copper, iron, lead, mercury, nickel, selenium, thallium, vanadium, and zinc were detected at concentrations that exceeded NYS Class C water quality criteria. The highest concentrations of these constituents were detected at the LT-03 location to the northwest of the western landfill cell. Concentrations of inorganics were generally one order of magnitude greater at the LT-03 location than the other leachate sampling locations. The LT-03 location was observed to have a sheen during sampling.

Within subsurface soil, the concentrations of inorganic constituents that appear to be related to the landfill due to their elevated concentrations compared to other subsurface soil sample concentrations were cadmium, chromium, cobalt, copper, mercury, nickel, and zinc. As shown on Figure 11, these subsurface soil samples were from test pits installed at the northern, eastern and southern limits of the western landfill cell. The highest concentrations of these inorganic constituents were detected in the subsurface soil sample collected from the TP-07/SS-2 location.

Within ground water, arsenic, barium, beryllium, cadmium, chromium, iron, lead, magnesium, manganese, sodium, and thallium were detected at concentrations exceeding ground water standards. Of these constituents, iron was the only constituent that was detected consistently (30 of 31 samples) above ground water standards in the ground water samples. The frequency of detections of the other inorganic constituents that exceeded ground water standards are as follows:

- barium (MW-108S – one of two sampling rounds)
- beryllium (MW-110I – one of two sampling rounds)
- cadmium (MW-102 – one of two sampling rounds)
- sodium (MW-104 – one of two sampling rounds)
- chromium (MW-108S and MW-110I – one of two sampling rounds)
- thallium (MW-109I and MW-110I – one of two sampling rounds)
- manganese (MW-108S, MW-109I, and MW-110I – one of two sampling rounds)
- lead (MW-109I – both sampling rounds; MW-110S and MW-110I – one of two sampling rounds)
- magnesium (MW-107S – both sampling rounds, MW-104 and MW-110I – one of two sampling rounds)
- arsenic (MW-101, MW-104, MW-105S, MW-108S, MW-109I, MW-110S MW-110I, MW-111S – one of two sampling rounds)

As shown above, inorganic concentrations above the ground water standards were detected sporadically, both spatially and temporally, with the exception of iron. Review of the iron concentrations, combined with the frequency of detection suggests that the detected concentrations are likely representative of background ground water quality conditions.

1.5. Chautauqua County Department of Health Ground Water Sampling

As described in the RI Report (O'Brien & Gere 2005), The Chautauqua County Department of Health (CCDOH) has been conducting ground water sampling of the Frewsburg Water District Supply Well # 5 and sentinel well MW-13 on a periodic basis. Based on available data from the CCDOH, vinyl chloride and cis-1,2-DCE have been detected in the Frewsburg Water District Supply Well # 5 since 2003. These detections range from 0.5 ug/L to 0.9 ug/L for vinyl chloride and 0.9 ug/L to 2.7 ug/L for cis-1,2- DCE. These detected concentrations were below drinking water standards. The analytical results for the Frewsburg Water District Supply Well # 5 are summarized in a table included in the RI Report (O'Brien & Gere 2005).

Concentrations of Freon-12, vinyl chloride, chloroethane, and cis-1,2 DCE have been consistently detected in sentinel well MW-13 since July 2003. Vinyl chloride has been consistently detected above the NYS Class GA ground water standard of 2 ug/L since October 2002. Review of data indicate that concentrations of vinyl chloride have been slowly increasing between 2002 and 2005. Concentrations of cis-1,2-DCE have also been detected above the NYS Class GA ground water standard of 5 ug/L in samples collected during August and October 2004, and June 2005. Review of data indicate that concentrations of cis-1,2-DCE have been slowly increasing between 2003 and 2005. The analytical results for the sentinel well are summarized in a table included in the RI Report (O'Brien & Gere 2005).

1.6. Summary of Risk Assessment

1.6.1. Human Health Risk Assessment

A qualitative exposure pathway analysis was performed to evaluate the potential for human contact with site constituents and is documented in the exposure pathway analysis report (EPAR) (O'Brien and Gere, 2005a) The qualitative exposure pathway analysis consisted of identification of potentially complete exposure pathways.

Potentially complete exposure pathways identified in the EPAR for the Site were:

Current on-site exposure pathways

- Ingestion and dermal contact of surface soil by adult, adolescent, and child trespasser; and adult site worker
- Inhalation of ambient air by adult site worker
- Ingestion and dermal contact of subsurface soil by adult site worker
- Inhalation of outdoor air (trenches/excavations) by adult site worker.
- Ingestion and dermal contact with site ground water by adult site worker
- Ingestion of potable ground water by adult, adolescent, and child town residents

Future on-site exposure pathways

- Ingestion and dermal contact of surface soil by adult, adolescent, and child residents; adult site worker; adult commercial worker; adult, adolescent, and child trespasser
- Inhalation of ambient air by adult site worker
- Ingestion and dermal contact of subsurface soil by adult site worker
- Inhalation of outdoor air (trenches/excavations) by adult site worker
- Inhalation of indoor air (vapor intrusion) by adult commercial worker; adult office worker; and adult, adolescent, and child residents
- Ingestion and dermal contact with potable ground water by adult commercial worker; adult office worker; and adult, adolescent, and child residents.

Current/future off-site exposure pathways

- Inhalation of indoor air (vapor intrusion) by adult, adolescent, and child residents
- Ingestion and dermal contact with potable ground water by adult, adolescent, and child residents

- Ingestion and dermal contact with ground water by adult construction worker
- Ingestion and dermal contact with sediment by adult, adolescent, and child trespasser.

1.6.2. Fish and Wildlife Impact Analysis

A Fish and Wildlife Impact Analysis (FWIA) through Step IIA was completed for the Site (O'Brien & Gere 2005b). The FWIA was conducted according to the NYSDEC document entitled *Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites* (NYSDEC 1994; Guidance). Step I - *Site Description* and Step IIA - *Contaminant-Specific Impact Assessment – Pathway Analysis* of the NYSDEC Guidance were addressed.

The FWIA evaluated the physical and biological characteristics and potential ecological receptors. The results and conclusions of the assessment are summarized below:

- The terrestrial portion of the Site consists of the landfill cells, dirt access roads, maintained fields/mowed areas, an old concrete loading bay area, and a small block structure. These features limit the use by resident and transient wildlife species.

- Aquatic areas existing on-site include a portion of the unnamed tributary of Conewango Creek, emergent and scrub-shrub wetlands and several drainage ways. The wetlands provide habitat for a variety of terrestrial and aquatic receptors. The unnamed tributary likely provides some habitat for a variety of fish and other wildlife species that frequent aquatic habitats. However, the relatively small size of the tributary limits the value of this habitat to some wildlife, particularly fish.

- The terrestrial areas surrounding the Site and within the study area consist of a mixture of natural communities and areas exhibiting rural (predominantly agricultural and residential) land use. Approximately 45 percent of the areal extent of the study area consists of agricultural and residential land uses that may somewhat limit use by transient or residential wildlife species.

- Approximately 55 percent of the areal extent of the study area consists of natural covertypes such as coniferous and hardwood forest; freshwater wooded, scrub-shrub and emergent wetlands; and streams that provide appropriate habitat for a variety of fish and wildlife species.

- The United States Fish & Wildlife Service (USFWS) has records of an endangered species, the clubshell, and a candidate species, the rayed bean, within a 2-mile radius of the Site. The New York Natural

Heritage Program (NYNHP) had no records of rare, threatened or endangered flora and fauna or significant natural communities within a two-mile radius of the Site.

- Based on a review of the applicable state and federal mapping, several freshwater wetlands were identified in within 2 miles of the Site. Although a wetland boundary delineation was not performed as part of this assessment, it appears that regulated wetland habitats exist on and adjacent to the Site.

- Due to the presence of chemical constituents in surface soil, surface water and sediment associated with the Site, complete exposure pathways to terrestrial and aquatic receptors likely exist at and down gradient of the Site.

1.7. Conceptual Site Model

Based on a review of the results of the RI, the following represent the conceptual site model:

- The landfill consists of two distinct and irregularly shaped landfill cells. The fill material of these cells is generally municipal in nature (brush and wood pieces, plastics and glass, miscellaneous metallic debris, paper, plastic toys, tires, etc.) with industrial materials (metal turnings, drum carcasses, metal debris) observed primarily in the northern portions of the western cell.
- The fill material was observed to range from 2 ft to 10 ft in thickness and overlays silty clay and clay layers to a total depth below grade of 7 ft to 10 ft. The fill material is overlain by soil that varies in thickness from 1 to 5 ft from top of fill with several drums partially buried at the surface.
- The soil cover did not appear to prevent or minimize infiltration to fill materials below, and some drums were observed to be only partially buried.
- Observations from test pits around the western landfill cell suggest that shallow ground water within the limits of the landfill cell is "perched". Comparison of the approximate bottom elevations of the test pits to shallow ground water elevations further suggests that this is perched water within the fill with no direct hydraulic connection to the water table during water elevation monitoring events conducted as part of the RI.
- A municipal drinking water well (Frewsburg Water District Supply Well # 5) serving the Frewsburg Water District is located approximately 700 feet southwest of the landfill Site.
- The nearest discharge for shallow and intermediate ground water is likely Conewango Creek to the north; however, ground water flow was observed to be to the southwest toward the municipal drinking water well.

- VOCs were detected in each of the media sampled (sediment, landfill material, leachate seeps, soil vapor, and ground water). VOC concentrations within the sediment, landfill material, and leachate seep samples were below associated screening levels, which may indicate that VOC concentrations in the fill material are low, or are naturally attenuating. Soil vapor and ground water were the only environmental media sampled that contained VOCs at concentrations above associated screening levels. Given the historical placement of fill at the site, the landfill material is likely the source of ground water and soil vapor VOC contamination.
- Regarding soil vapor, the magnitudes of detected concentrations in the soil vapor samples are relatively low and do not appear indicative of the presence of a significant source of VOCs at the sample locations. Exposure to indoor or ambient air is considered to be minimal as occupied structures are not currently present in the immediate vicinity of the landfill.
- Vinyl chloride and cis-1,2-dichloroethene were the predominant VOCs exhibiting concentrations above NYS Class GA ground water standards that are contaminants of concern. These constituents are common degradation products of trichloroethene (TCE).
- Methane, ethane, and ethene were monitored to evaluate degradation. Ethene was detected indicating that geochemical conditions are serving to allow degradation of vinyl chloride. Ethane was also detected in shallow and intermediate wells, indicating that ethene is degrading to ethane.
- Based on data collected by NYSDOH, it is apparent that VOCs have migrated from the landfill to the municipal drinking water well. A review of NYSDOH sample data also indicate that concentrations of vinyl chloride and cis-1,2-dichloroethene have increased over time but constituent concentrations remain below NYS Class GA ground water standards. The detection of these constituents in the municipal drinking well approximately eight years after the initiation of pumping suggests that these constituents were drawn to the municipal drinking water well and were not present in the area prior to installation of the well.
- The highest concentration of an organic constituent was vinyl chloride detected in the shallow ground water sample collected at MW-107S; however, organic concentrations at this location appear to be limited in horizontal and vertical extent.
- Inorganics were detected in each of the environmental media sampled (surface soil, surface water, sediment, landfill material, leachate seeps, ground water). Several inorganics were detected at concentrations exceeding associated screening criteria.
- Review of the ground water data suggests that the inorganic detections may be indicative of background conditions for certain constituents. Concentrations of inorganic constituents were generally within one order of magnitude upstream and downstream of the Site.
- Ground water inorganic data indicates that there is a general decrease in concentrations with depth.

- Within leachate, inorganics were detected at concentrations that exceeded NYS Class GA ground water standards. The highest concentrations of inorganics in leachate were detected to the northwest of the western landfill cell. Leachate from this area ultimately drains to Conewango Creek.
- The inorganic constituents detected in surface water are likely attributable to the migration of leachate from the landfill to the drainage swale between the two landfill cells, which ultimately drain to the drainage swale/intermittent creek north of the landfill. Similar inorganic constituents were detected in the surface water samples as in the leachate samples. Impacts to the Conewango Creek, which is located approximately 4,000 ft to the west of the Site, are not known. However, given the distance to Conewango Creek, and the common low flow conditions in the drainage swales, potential for impacts is considered to be minimal.
- Exposure to impacted surface water and sediments is considered to be minimal based on the limited extent of impacted sediment. The presence of elevated concentrations of inorganic constituents in sediment may be due to direct run-off and deposition of sediment material from the landfill to the drainage swales, or due to potentially more dense landfill leachate flowing to surface water areas that may subsequently settle into the sediment. The drainage swales from which sediment samples were collected are believed to be low flow systems for much of the time. It is also possible that during certain times of the year the surface water in the drainage swales evaporates potentially concentrating inorganic constituents in the underlying sediment.

2. Development of Remedial Alternatives

The objective of this phase of the FS was to develop a range of remedial alternatives for the Site. The development of alternatives process included the development of remedial action objectives; development of general response actions; identification of volumes or areas of media; identification and screening of remedial technologies and process options; evaluation of remedial technologies and process options; and the assembly of remedial alternatives.

2.1. Development of Remedial Action Objectives

Remedial action objectives are goals set for environmental media such as soil, ground water, sediment and surface water (medium-specific objectives) that are intended to provide protection for human health and the environment. These remedial action objectives form the basis for the FS by providing overall goals for site remediation. The remedial action objectives are considered during the identification of appropriate remedial technologies and formulation of alternatives for the Site, and later during the evaluation of remedial alternatives.

Remedial action objectives (RAOs) are based on engineering judgement, risk-based information established in the risk assessment, and potentially applicable or relevant and appropriate standards, criteria and guidance (SCGs). Based on the consideration of potentially complete exposure pathways identified in Sections 1.5.1. and 1.5.2., the conceptual site model described in Section 1.6 and potentially applicable or relevant and appropriate SCGs, the following remedial action objectives (RAOs) have been established:

- Minimize or eliminate unacceptable human health and ecological risks associated with dermal contact or ingestion of landfill materials.
- Minimize or eliminate unacceptable human health risks associated with ingestion of ground water via the Frewsburg Water District drinking water well located adjacent to the Site.
- Minimize, to the extent practicable, discharge and/or migration of leachate from the landfill material to surface water or ground water.

- Meet ground water standards or guidance values to the extent practicable.

2.2. Identification of General Response Actions

General response actions are remedial actions for environmental media such as soil, ground water, sediment and surface water ("medium-specific actions") that may be combined into alternatives to satisfy the RAOs. Based on RAOs identified in Section 2.1, ground water, landfill material and leachate are the media of concern. General response actions that address the RAOs related to the landfill material include institutional controls, containment, removal, disposal, and treatment. General response actions that address the RAOs related to ground water and leachate are institutional controls, containment, collection, treatment, and discharge actions.

2.3. Identification of Areas and Volumes of Media

Site conditions, the nature and extent of contamination, and RAOs were taken into consideration to estimate the volumes and areas of media to be addressed by the general response actions.

This Site is composed of two "cells" of landfilled materials running generally north-south. These cells are adjacent to one another and generally rectangular in shape, although the width of the western cell varies. A swale separates the two cells. The eastern cell measures approximately 9.3 acres, while the western cell measures approximately 5.2 acres. The areal extent of both landfill cells and contiguous swale measures approximately 20 acres. Fill material was observed to range from approximately 2 ft to 10 ft in thickness based on test pits completed along the perimeter of the cells during the RI. Assuming the depth of fill averages 4 ft over this area, the estimated volume of landfill material is approximately 90,000 cubic yards, with approximately 60,000 cubic yards contained in the western cell, and approximately 30,000 cubic yards contained in the eastern cell.

Contaminated ground water was not observed within the limits of the eastern cell. The areal extent of contaminated ground water, therefore, generally occurs between MW-104 and MW-106S to the northeast and MW-13 to the southwest. This area is approximately 12 acres in area.

2.4. Estimates of Ground Water Remedial Timeframes

In an effort to estimate timeframes for different ground water remedial approaches, a two-dimensional ground water flow model was used. The modeling effort is described in Appendix A.

The estimated remedial timeframe for vinyl chloride in Site ground water using a ground water extraction well system is within approximately 40 years. The remedial timeframe for vinyl chloride currently present in off-site ground water if a site ground water extraction system is implemented is estimated to be within approximately 32 years.

The estimated remedial timeframe for vinyl chloride in Site and off-site ground water using an *in situ* ground water treatment wall is approximately 40 years. If the source of VOCs is removed and no active ground water remediation is implemented, ground water remediation of site ground water is estimated to be within approximately 72 years.

Each of these estimates assumes that the source of VOC concentrations in ground water is removed and the municipal drinking water well continues to be pumped. A range of retardation factors for vinyl chloride was considered and applied to advective ground water flow rates for these estimates; however, natural attenuation was not considered, since there is currently insufficient information to evaluate the rate of natural attenuation.

2.5. Identification and Screening of Remedial Technologies and Process Options

Potentially applicable remedial technology types and process options for each general response action were identified during this step. Process options were screened on the basis of technical implementability. The technical implementability of each identified process option was evaluated with respect to site contaminant information, site physical characteristics, and areas and volumes of affected media.

Descriptions and screening comments for technologies and process options identified for the Site are presented in Table 1. Process options that were viewed as not implementable for the Site were not considered further in the FS. Following are descriptions of technologies that were considered potentially implementable for the Site.

2.5.1. No Action

The no action general response action must be considered in the FS, as specified in the NCP (40 CFR Part 300.430) and DER-10.

2.5.2 Institutional Actions

The institutional actions identified for the landfill material were deed restrictions and access restrictions. Deed restrictions would involve limiting the future uses of the Site, while access restrictions would limit access to the Site.

The institutional actions identified for ground water were monitoring and deed restrictions. Deed restrictions identified consist of ground water use restrictions that would preclude the use of contaminated ground water at the Site as a potable source of water without prior treatment. In addition, deed restrictions would preclude the use of untreated contaminated ground water at the Site for sources other than potable use without prior review and approval by NYSDEC.

Ground water monitoring would involve periodic sampling and analysis of ground water at the Site. Ground water monitoring would provide a means to detect changes in VOC, SVOC and inorganics concentrations in the ground water. Data gathered by ongoing monitoring would provide the opportunity to gauge the effectiveness of the implemented alternative. While VOCs are the primary contaminants of concern, monitoring of SVOCs and inorganic constituents would continue allowing for future assessment of these constituents in ground water.

2.5.3. Containment Actions

Presumptive remedy. USEPA has developed presumptive remedies for certain categories of sites that have similar characteristics, such as types of contamination present, types of disposal practices, or how environmental media are affected. The objective of presumptive remedies is to make use of past experience to streamline the FS process. If a presumptive remedy is applicable for the Site, a focused FS can be prepared. The study can then be limited to the “no action” alternative and the presumptive remedy technologies. This is possible because USEPA has conducted an analysis of potentially available technologies for the presumptive remedy site categories and has determined that certain technologies are routinely and appropriately screened out. This detailed analysis serves to substitute for the development and screening of alternatives phases of the FS (and will allow the remaining alternatives to be limited to variations of the presumptive remedy)(USEPA 1993).

The presumptive remedy guidance that is relevant and appropriate for the Site is the *Presumptive Remedy for CERCLA Municipal Landfill Sites* (USEPA 1993). As stated in the Presumptive Remedy guidance, USEPA expects that “engineering controls such as containment will be used for waste that poses a relatively low long-term threat or where treatment is impracticable.” For sites such as municipal landfills where wastes are present as large volumes of heterogeneous materials, USEPA generally considers treatment impracticable. Thus, USEPA regards containment as the presumptive remedy for municipal landfill sites (USEPA 1993). The landfill material is considered to be heterogeneous and constitute a considerable volume to warrant the application of the presumptive remedy for municipal landfills.

USEPA presumptive remedy guidance specifies that a soil cover be built to Federal Subtitle D requirements except where State closure requirements are more stringent. The prevailing closure requirement for this Site, therefore, is 6 NYCRR Part 360 requiring the installation of a low permeability landfill cap which must be "constructed to minimize precipitation migration into an inactive area of the landfill" (NYSDEC, 1999). However, minimizing infiltration of precipitation at this Site may not prevent the production of leachate at the Site, given that fill material may be in contact with ground water, based on the RI. The possible incidence of ground water to landfill material was considered in the development of RAOs resulting in the objective to minimize discharge and/or migration of leachate from the landfill to the surface water or ground water to the extent practicable. A soil cover, as defined by presumptive remedy guidance, would be substantively equivalent to the Part 360 cover by meeting this RAO and the containment requirement of the presumptive remedy.

The following containment actions have been identified in accordance with the presumptive remedy:

- **Vegetated soil cover.** A soil cover for containment of landfill material would incorporate layers of backfill soil material and topsoil to encapsulate the landfill material preventing direct contact when properly maintained. The soil cover would be vegetated to provide stability and resistance to erosion. These layers would be such that surface run off and evapotranspiration are favored over infiltration. The cover would incorporate toe drains at the edges for the management of leachate present or produced as is required by the presumptive remedy. To reduce the overall footprint of the cover, consolidation of the fill could be performed. This would consist of excavation of the western cell and consolidation over the eastern cell prior to installation of the cover.

- **Low-permeability cover.** A low permeability cover for containment of landfill materials would have the components of a soil cover, however additional layers of low permeability material (*i.e.*, low permeable soils or geocomposites) would be incorporated minimizing infiltration with proper maintenance. The cover would incorporate toe drains at the edges for the management of leachate present or produced as is required by the presumptive remedy. To reduce the overall footprint of the cover, consolidation of the fill could be performed. This would consist of excavation of the western cell and consolidation over the eastern cell prior to installation of the cover.

2.5.4 Removal Actions

The following removal action has been identified for landfill material:

- **Excavation.** Physical removal of the landfill material was considered for this Site to evaluate returning the Site to "pre-disposal conditions" in accordance with NYSDEC DER-10 guidance.

- **Partial excavation.** Physical removal of only a portion of the landfill material, such as the western cell, for options including fill consolidation. Partial excavation is not fundamentally different than Excavation described previously and will not be considered as a distinct removal action. Partial excavation will not return the site to a "pre-disposal" condition, but is applicable as part of other containment and disposal actions for the landfill material.

The following removal action has been identified for ground water:

- **Recovery wells.** Recovery wells are placed such that they intercept and remove contaminated ground water. A pumping test performed on the Site would be required to identify the number and locations to place the recovery wells and evaluate appropriate pumping rates. Recovery wells would require a discharge action, and possibly a treatment action, be implemented.

2.5.5 Treatment Actions

In accordance with the presumptive remedy, treatment actions were not evaluated for landfill material.

The following *in situ* treatment actions have been identified for ground water:

- **Natural Attenuation.** Natural attenuation relies on the biotic and abiotic processes naturally occurring *in situ* to degrade organic constituents in the saturated zone.

- **Air sparging.** Air sparging is an *in situ* technology used primarily to remove VOCs from the subsurface. Air sparging, when used in conjunction with an *in situ* air stripping system, enables ground water to be stripped of VOCs. Contaminant-free air is introduced into the affected aquifer system in the form of minute bubbles utilizing microporous bubblers (or sparge points). VOCs below the water table are removed by volatilization, and often biodegradation, as the air percolates through the water column and into the unsaturated zone. The movement of the air bubbles tends to facilitate the transfer of VOCs into soil pore spaces in the unsaturated zone where they can be removed by an *in situ* air stripping system.

- **In-well stripping.** In-well stripping is similar in function to the *ex situ* treatment action of air stripping and involves the contact of ground water with air. However, ground water is not drawn up to an above ground treatment system; instead a blower and diffuser release air bubbles into the well itself. Ground water is taken in through either a top or bottom screen and released through the opposite screen contacting the air as it moves through the well. These wells may be driven by the convection induced solely by the air, or they may be a pumped system. Depending on the resulting characteristics of the discharging air stream, air treatment may be required. In-well stripping would be effective to treat site-related VOCs.

- **Bioremediation/Biobarrier.** A biobarrier is a zone of enhanced natural attenuation established to degrade contaminants by exploiting desired metabolic processes of the natural microorganisms. Electron donors and/or nutrients are added to facilitate the desired process. This process may also include bioaugmentation of the existing microbial fauna. Electron donors and/or nutrients are injected by wells to the required depth. Wells are spaced such that a continuous zone is established perpendicular to flow of ground water to provide treatment as the affected water flows through the zone. Typically, proprietary systems are used that are proven to provide treatment of the desired contaminant.

- **Treatment wall (iron wall).** An iron wall is a subsurface treatment wall constructed of iron granules or other iron bearing material for treatment of chlorinated VOCs within ground water. Chlorinated VOCs are dechlorinated by oxidizing the iron material as ground water flows through the wall area. Physical treatment walls are typically suitable for long term treatment and control of contaminated ground waters, but are limited to depths achievable by conventional trenching equipment unless injection techniques are utilized.

The following *ex situ* treatment actions have been identified for ground water:

- **Air stripping**. Air stripping involves the contact of ground water with air in a countercurrent packed or tray column or bulk reactor to transfer volatile contaminants from the ground water to the air. Air stripping would be effective to treat site-related VOCs. Depending on the resulting characteristics of the discharging air stream, air treatment may be required.

- **Carbon adsorption.** Activated carbon can adsorb organic contaminants from ground water onto its surfaces during contact. Carbon adsorption would likely be an effective treatment for site-related VOCs, although only minimally effective for vinyl chloride. The carbon must be periodically replaced, regenerated, treated and/or disposed. Regeneration may be accomplished at the Site or off-site at a permitted facility. Carbon disposal would be off-site at a permitted facility.

- **Adsorptive resins.** Commercial resins are available which can adsorb organic contaminants from the ground water during contact. Adsorptive resins would likely be an effective treatment for site-related organic compounds. Such resins are typically regenerated on the Site on a periodic basis.

- **Chemical oxidation.** Chemical oxidation involves the addition of oxidation agents such as hydrogen peroxide or ozone to the ground water in the presence of ultraviolet light to oxidize organic contaminants to non-toxic byproducts. Chemical oxidation would likely be an effective treatment for site-related VOCs. Chemical oxidation is typically performed in a closed reactor system.

- **Biological reactor.** A biological reactor could be used to enhance conditions for co-metabolic degradation of chlorinated organics. Nutrients, co-metabolites, and aeration would be provided as necessary to optimize degradation. Sludge management would be required.

2.5.6 Disposal/Discharge Actions

The following disposal action has been identified for landfill material:

- **Off-site commercial landfill disposal.** Excavated material would be transported off-site for disposal at a permitted facility. Non-hazardous material would be appropriately landfilled. If hazardous material is encountered, it will be appropriately managed to meet land disposal restrictions (LDRs) prior to disposal.

- **On-site relocation (fill consolidation).** Material excavated for the purpose of fill consolidation. Material removed from the western cell would be consolidated to the eastern cell to reduce the footprint of waste on-site.

The following discharge action has been identified for ground water:

- **Surface water discharge.** Ground water removed and treated *ex situ* would be discharged to the unnamed tributary of Conewango Creek adjacent to the Site. Discharge to surface water would be contingent upon the *ex situ* treatment technology producing effluent meeting Class C surface water limits.

2.6. Evaluation of Remedial Technologies

The process options remaining after the initial screening were evaluated further according to the criteria of effectiveness, implementability, and cost. The effectiveness criterion included the evaluation of: potential effectiveness of the process options in meeting remedial objectives and handling the estimated volumes or areas of media; potential effects on human health and the environment during construction and implementation; and experience and reliability of the process options for site contaminants and conditions. Technical and institutional aspects of implementing the process options were assessed for the implementability criterion. The capital and operation and maintenance (O&M) costs of each process option were evaluated as to whether they were high, medium, or low relative to the other process options of the same technology type. The evaluation of the process options is shown in Table 2.

Based on the evaluation, the more favorable process options of each technology type were chosen as representative process options. The selection of representative process options simplifies the assembly and evaluation of alternatives, but does not eliminate other process options. The process option actually used to implement remediation may not be selected until the remedial design phase.

2.7. Assembly of Remedial Alternatives

Remedial alternatives were developed by assembling general response actions and the process options chosen to represent the various technology types into combinations that address the Site.

Five alternatives were developed for the Site. These alternatives are described in the following subsections, and are summarized in Table 3. Descriptions of each alternative have been developed according to the parameters set forth in DER-10 Section 4.2.5. as follows:

1. Size and configuration of process options
2. Time for remediation
3. Spatial requirements
4. Options for disposal
5. Substantive technical permit requirements
6. Limitations or other factors necessary to evaluate the alternatives, and
7. Beneficial and/or adverse impacts on fish and wildlife resources.

2.7.1. Alternative 1

Alternative 1 is the no further action alternative. The no further action alternative is required by the NCP and serves as a benchmark for the evaluation of action alternatives. This alternative involves the following process options:

Ground water monitoring. Ground water monitoring would be implemented to track VOC and SVOC compounds and inorganic constituent concentrations in ground water. For estimating purposes, it is assumed that the 18 existing monitoring wells will be sampled quarterly for VOCs, SVOCs and inorganics (including cyanide) for a period of 30 years.

Five-year reviews. Five-year reviews are required by the NCP (Federal Register 1990) when contaminated material remains at a site. The five-year review would focus on evaluating the Site with regard to the continuing protection of human health and the environment as evidenced by information such as ground water monitoring and documentation of field inspections.

This alternative is further defined, consistent with Section 2.6, as follows:

1. No process options requiring sizing are included under this alternative.

2. Some natural attenuation is evident by the presence of TCE breakdown products observed during the RI. The results of the RI do not provide enough information to determine the rate at which natural attenuation is occurring. Because source material (western cell landfill material) likely remains at the Site in this alternative, natural attenuation is not anticipated to achieve the NYS Class GA standards for Site ground water for the foreseeable future. For cost estimation purposes, a period of 30 years was assumed for O&M activities.

3. This alternative maintains the existing conditions (surface, subsurface and ground water conditions) of the Site.

4. No options for disposal are associated with this alternative.

5. This option would not allow for the re-permitting of this Site as a landfill or transfer station, as is currently in place.

6. The analysis of this alternative is limited by the lack of information regarding natural attenuation mechanisms. In particular, it is not known if natural attenuation of ground water will continue to be protective for the nearby municipal drinking water well. Ongoing monitoring of the sentinel well (MW-13) shows increasing concentrations of vinyl chloride and cis-1,2-dichloroethene in the sentinel well with recent detections in June 2005 of both compounds at concentrations greater than the respective NYS Class GA standards. Neither of these compounds were detected at concentrations greater than the respective NYS Class GA standards in the municipal drinking water well, and the increasing trend observed in the sentinel well is not clearly evident in this well.

7. The Site currently has a minimal and variable depth of soil covering landfill material that provides some encapsulation of waste. Contamination of surface and ground waters and sediments appear, by the RI, to be relatively limited in extent. Notwithstanding, this alternative does not remove identified potential exposure pathways, nor does it eliminate additional or increased migration of contaminant off-site by means of ground water or surface water. The “no further action” alternative, however, does consist of ground water monitoring, and five year reviews as described in Section 2.6.1, to provide continued assessment of affects to off-site areas.

2.7.2. Alternative 2

The "Pre-Disposal" alternative is required by the NYSDEC DER-10 to establish the cost and feasibility of returning the Site to "pre-disposal condition". This alternative involves the following process options:

Excavation and off site disposal of landfill material. Landfill material would be removed by excavators and appropriately managed. Clean backfill and topsoil would be deposited on-site, graded and seeded for restoration.

Ground water recovery and treatment. Ground water would be pumped from the aquifer by means of approximately one recovery well located downgradient of the western landfill cell to minimize potential future impacts to the Frewsburg Water District Supply Well # 5. As described in Section 2.4, if the source of ground water VOC impacts is removed, it is estimated that remediation of Site ground water to NYS Class GA standards could be accomplished within approximately 40 years. It is estimated that off-site ground water could be remediated to NYS Class GA standards within approximately 32 years. Leachate present would also be recovered and treated incidental to ground water recovery and treatment. Recovered ground water would be treated by an on-site air stripper system for the mass removal of VOCs. Treated water would be discharged to the unnamed tributary of Conewango Creek adjacent to the landfill site. The system would operate until NYS Class GA ground water standards are achieved in the monitoring wells. It has been assumed that air controls would not be required for the treatment system, however, a pretreatment system to handle naturally occurring inorganics and solids may be required.

Institutional controls. Institutional controls would include "use restrictions" as follows:

- *Ground water use restrictions* would preclude the use of untreated ground water with concentrations in excess of NYS Class GA ground water standards as a potable water source, or as a non-potable water source without prior notification and approval from NYSDEC. The property deed would be revised to reflect this restriction. This restriction could be lifted upon attainment of NYS Class GA ground water standards by the recovery and treatment system.

Ground water monitoring. The 18 existing monitoring wells would be employed for continued sampling. It is assumed that the monitoring wells would be sampled quarterly for VOCs, SVOCs and inorganics (including cyanide) for the duration of recovery and treatment activities.

Five-year reviews. Five-year reviews are required by the NCP (Federal Register 1990) when impacted soil remains at a site; however, this program would be applicable to this alternative for the ground water medium. The five-year review would focus on evaluating the Site with regard to the continuing protection of human health and the environment as evidenced by information such as ground water monitoring and documentation of field inspections conducted for the five-year review.

This alternative is further defined, consistent with Section 2.6, as follows:

1. Both landfill cells, 14.5 acres, would be excavated to an average depth of approximately 4-ft yielding an estimated total excavated volume of 90,000 cubic yards. The recovery well would be installed to capture ground water. Treated ground water would ultimately discharge to surface water.

2. It is estimated that excavation and management of landfill material and restoration of the Site will require 1 to 2 years. It is estimated that ground water remediation to attain NYS Class GA ground water standards at the Site would occur within approximately 40 years. For cost estimation purposes, a period of 30 years was assumed for O&M activities.

3. Implementation of Alternative 2 would disturb approximately 20 acres of site area with a nominal amount of additional space required for the installation of treatment equipment.

4. No options exist for the disposal of landfill material off-site other than handling or treatment and disposal by a permitted facility. Other technologies for the treatment of extracted ground water are available, as is an option to utilize ground water injection as a means of treated water discharge. These options not withstanding, the aspects incorporated into this alternative have been chosen to be representative of the time and costs expected of applicable options.

5. Compliance with substantive requirements for wetland permitting would likely be required for construction of the remedy. Compliance with the substantive requirements of a NYSDEC SPDES discharge permit would be required for surface water disposal of treated ground water. This would likely require flow monitoring as well as periodic sampling to verify that discharge criteria established by the NYSDEC permit are met. The air stripping system may require compliance with substantive requirements of an air permit.

6. The analysis of this alternative is limited by the data available to accurately determine the fill depth, and by extension, the volume of waste material to be removed. The actual volume of waste removed would directly affect remediation time and disposal and remediation costs.

7. This alternative would remove the potential exposure sources, thereby removing the associated potential risks.

2.7.3. Alternative 3

Alternative 3 is the landfill cover and natural attenuation alternative. This alternative incorporates the presumptive remedy of containment as identified by the Superfund Accelerated Cleanup Model (SACM) for landfills composed primarily of municipal waste. Because ground water is a potential exposure pathway at this Site, process options are included for this medium. This alternative would involve the following process options:

Landfill cover. A soil cover would consist of the following minimum components (listed from the finished grade down): 6 inches topsoil and 18 inches soil material as a vegetative support layer. The cover would function to encapsulate the waste, would be vegetated to maximize evapotranspiration, and would be graded to promote surface water runoff. Vegetation and grading would reduce infiltration to the wastes below. A low permeability layer may be installed to further decrease infiltration and consolidation of fill material from the western cell to the eastern cell may be performed to reduce the footprint of the waste and decrease the volume of waste potentially in contact with ground water. To achieve a low permeability cover per 6 NYCRR Part 360, the soil material layer would be expanded to 24 inches to serve as a barrier protection layer and the following additional layers would be installed (listed in order from the barrier protection material down): tri-planar geonet, 40 mil linear low density polyethylene, 6 inches soil bedding layer. Consolidation of fill material would consist of partial excavation and subsequent placement on-site. Results of the RI do not suggest that landfill gas (methane) management is required at this Site. Leachate would be conveyed to a holding tank by toe drains incorporated at the cover edges and hauled off-site for treatment and disposal.

Monitored natural attenuation. This alternative would utilize the natural attenuation mechanisms currently observed at this site. RI results identified the breakdown products of TCE, vinyl chloride and cis-1,2-DCE, as the primary VOCs present suggesting that natural attenuation is active at this Site.

Institutional controls. Institutional controls would generally include "use restrictions" and "access restrictions". The various components are more specifically described as follows:

- *Access/Use restrictions* would preclude the conduct of activities that would potentially disturb or expose contaminated materials or impair the integrity of a cover over contaminated materials without prior notification and approval from NYSDEC.

  A program would be established to educate and authorize users about the past uses, remedial technologies in place, potential hazards, and proper conduct while on-site. Persons wishing to engage in an approved use upon the property must receive this education and authorization. This program would be developed by the NYSDEC in conjunction with the Town and implemented by the Town.

- *Ground water use restrictions* would preclude the use of untreated ground water with concentrations in excess of NYS Class GA ground water standards as a potable water source, or as a non-potable water source without prior notification and approval from NYSDEC. The property deed would be revised to reflect this restriction. This restriction could be lifted upon attainment of NYS Class GA ground water standards.

Ground water monitoring. The 18 existing monitoring wells would be employed for continued sampling. It is assumed that the monitoring wells would be sampled quarterly for VOCs, SVOCs and inorganics (including cyanide) for a period of 30 years.

Five-year reviews. Five-year reviews are required by the NCP (Federal Register 1990) when impacted material remains at a site. The five-year review would focus on evaluating the Site with regard to the continuing protection of human health and the environment as evidenced by information such as ground water monitoring and documentation of field inspections conducted for the five year review.

This alternative is further defined, consistent with Section 2.6, as follows:

1. It is assumed that a single cover would be installed over fill material.. Based on the area of both cells and contiguous swale area presented in Section 2.3, the largest cover area required would be approximately 20 acres if no consolidation of fill material is incorporated into the designed alternative. If consolidation of the western cell to the eastern cell is performed, the cover area would be approximately 10 acres.

2. It is estimated that either landfill cover option would require approximately 1 to 2 years to install. The rate of attenuation of VOCs in ground water is not known. For cover options other than consolidation, where source material (western cell landfill material) would likely remain in place, natural attenuation is not anticipated to achieve the NYS Class GA standards for Site ground water for the foreseeable future. Under the consolidation cover option, where source material would be removed, it is estimated that Site ground water would exhibit VOC concentrations at or below NYS Class GA standards within 72 years. For cost estimation purposes, a period of 30 years was assumed for O&M activities.

3. Implementation of this alternative would disturb approximately 10 to 20 acres of site area for the installation of the landfill cover plus a nominal surrounding work area during construction activities.

4. If partial excavation of the landfill material is performed, placement on site would be used for disposal of material.

*5.*Compliance with substantive requirements for wetland permitting would likely be required for construction of the remedy.

6. The analysis of this alternative is limited by the lack of information regarding natural attenuation mechanisms. In particular, it is not known if natural attenuation of ground water will continue to be protective for the nearby municipal drinking water well. Ongoing monitoring of the sentinel well (MW-13) shows increasing concentrations of vinyl chloride and cis-1,2-dichloroethene in the sentinel well with recent detections in June 2005 of both compounds at concentrations greater than the respective NYS Class GA standards. Neither of these compounds were detected at concentrations greater than the respective NYS Class GA standards in the municipal drinking water well, and the increasing trend observed in the sentinel well is not clearly evident in this well. In addition, the analysis of this alternative is limited by the data available to accurately determine the fill depth, and by extension, the volume of waste material to be removed and consolidated.

7. Impacted soil remains on this site, but is encapsulated by the landfill cover minimizing direct contact. The ground water pathway to nearby surface waters is monitored but not removed.

2.7.4. Alternative 4

Alternative 4 is the landfill cover and ground water extraction alternative. This alternative also incorporates the presumptive remedy process option to address the landfill media. However, an engineered process option for the treatment of ground water is utilized. This alternative would involve the following process options:

Landfill cover. As described in Section 2.6.3.

Ground water recovery and treatment. This alternative incorporates ground water recovery wells to pump and treat ground water in place of monitored natural attenuation. As described in Section 2.4, if the source of ground water VOC impacts is removed (*i.e.*, the consolidation cover is implemented), it is estimated that remediation of Site ground water to NYS Class GA standards could be accomplished within approximately 40 years. It is estimated that off-site ground water could be remediated to NYS Class GA standards within approximately 32 years. For cover options other than consolidation where source material (western cell landfill material) would likely remain in place, ground water extraction is not anticipated to achieve the NYS Class GA standards for Site ground water for the foreseeable future. Approximately two, 70-foot deep ground water recovery wells would be installed downgradient of the landfill between the landfill and the municipal drinking water well. Ground water pumped from this system would be treated by an on-site air stripper system for the mass removal of VOC compounds. Treated water would be discharged to the unnamed tributary of Conewango Creek adjacent to the landfill site. It has been assumed that air controls would not be required for the treatment system, however, a pretreatment system to handle naturally occurring inorganics and solids may be required.

Institutional controls. Institutional controls would include "use restrictions" and "access restrictions". The various components are more specifically described as follows:

- *Access/Use restrictions* would preclude the conduct of activities that would potentially disturb or expose contaminated materials or impair the integrity of a cover over contaminated materials without prior notification and approval from NYSDEC.

  A program would be established to educate and authorize users about the past uses, remedial technologies in place, potential hazards, and proper conduct while on-site. Persons wishing to engage in an approved use upon the property must receive this education and authorization. This program would be developed by the NYSDEC in conjunction with the Town and implemented by the Town.

- *Ground water use restrictions* would preclude the use of untreated ground water with concentrations in excess of NYS Class GA ground water standards as a potable water source, or as a non-potable water source without prior notification and approval from NYSDEC. The property deed would be revised to reflect this restriction. This restriction could be lifted upon attainment of NYS Class GA ground water standards.

Ground water monitoring. The 18 existing monitoring wells would be employed for continued sampling. It is assumed that the monitoring wells would be sampled quarterly for VOCs, SVOCs and inorganics (including cyanide) for a period of 30 years.

Five-year reviews. Five-year reviews are required by the NCP (Federal Register 1990) when impacted material remains at a site. The five-year review would focus on evaluating the Site with regard to the continuing protection of human health and the environment as evidenced by information such as ground water monitoring and documentation of field inspections conducted for the five-year review.

This alternative is further defined, consistent with Section 2.6, as follows:

1. It is assumed that a single cover would be installed over the fill material. Based on the area of both cells and contiguous swale area presented in Section 2.3, the largest cover area required would be approximately 20 acres if no consolidation of fill material is incorporated into the designed alternative. If consolidation of the western cell to the eastern cell is performed, the cover area would be approximately 10 acres. Nominal additional space may be required along the extents of the cover for the installation of ground water handling piping.

2. It is estimated that either landfill cover option would require approximately 1 to 2 years to install. For cover options other than consolidation where source material (western cell landfill material) remains in place, ground water treatment is not anticipated to achieve the NYS Class GA standards for Site ground water for the foreseeable future. If the source material is removed (e.g. through consolidation of the western cell to the eastern cell), it is estimated that ground water remediation to attain NYS Class GA ground water standards at the Site would be achieved within approximately 40 years. For cost estimation purposes, a period of 30 years was assumed for O&M activities.

3. Spatial requirements would be similar to those for Alternative 3.

4. Other technologies for the treatment of recovered ground water are available, as is an option to utilize ground water injection as a means of treated water discharge. These options not withstanding, the aspects incorporated into this alternative have been chosen to be representative of the time and costs expected from applicable options. If partial excavation of the landfill material is performed, placement on site would be used for disposal of material.

5. Compliance with substantive requirements for wetland permitting would likely be required for construction of the remedy. Compliance with the substantive requirements of a NYSDEC SPDES discharge permit would be required for surface water disposal of treated ground water. This permit would likely require flow monitoring as well as periodic sampling to verify that discharge criteria established by the NYSDEC permit are met. The air stripping system may require compliance with substantive requirements of an air permit.

6. The analysis of this alternative is limited by the data available to accurately determine the fill depth, and by extension, the volume of waste material to be removed and consolidated.

7. Impacted soil remains on this site, but is encapsulated by the landfill cover minimizing direct contact. The movement of impacted ground water to nearby surface waters and associated ecological receptors is greatly reduced by recovery and treatment activities.

2.7.5. Alternative 5

Alternative 5 is the landfill cover and enhanced natural attenuation (biobarrier) of ground water treatment alternative. This alternative also incorporates the presumptive remedy process option to address the landfill media. However, an engineered biological process option for the treatment of ground water is utilized. This alternative would involve the following process options:

Landfill cover. As described in Section 2.6.3.

In situ enhanced natural attenuation (biobarrier). A biobarrier would be constructed between the existing landfill site and the municipal drinking water well (MW-5). Wells would be installed to inject materials that would favor the establishment of a zone within the ground water aquifer where microbial activity is enhanced. The zone would be established such that affected ground water would pass through the "treatment zone" of engineered microbial activity. Based on data collected to date, an approximate treatment zone comprising a 500-foot width and a 75-foot depth has been assumed. As described in Section 2.4, if the source of ground water VOC impacts is removed (*i.e.*, the consolidation cover option is chosen), it is estimated that remediation of impacted ground water to NYS Class GA standards would be achieved within approximately 40 years. For cover options other than consolidation, where source material (western cell landfill material) would likely remain in place, treatment of the ground water is not anticipated to achieve the NYS Class GA standards for Site ground water for the foreseeable future.

Institutional controls. Institutional controls would include "use restrictions" and "access restrictions". The various components are more specifically described as follows:

- *Access/Use restrictions* would preclude the conduct of activities that would potentially disturb or expose contaminated materials or impair the integrity of a cover over contaminated materials without prior notification and approval from NYSDEC.

  A program would be established to educate and authorize users about the past uses, remedial technologies in place, potential hazards, and proper conduct while on-site. Persons wishing to engage in an approved use upon the property must receive this education and authorization. This program would be developed by the NYSDEC in conjunction with the Town and implemented by the Town.

- *Ground water use restrictions* would preclude the use of untreated, ground water with concentrations in excess of NYS Class GA ground water standards as a potable water source, or as a non-potable water source without prior notification and approval from NYSDEC. The property deed would be revised to reflect this restriction. This restriction could be lifted upon attainment of NYS Class GA ground water standards.

Ground water monitoring. The 18 existing monitoring wells would be employed for continued sampling. It is assumed that the monitoring wells would be sampled quarterly for VOCs, SVOCs and inorganics (including cyanide) for a period of 30 years.

Five-year reviews. Five-year reviews are required by the NCP (Federal Register 1990) when impacted material remains at a site. The five-year review would focus on evaluating the Site with regard to the continuing protection of human health and the environment as evidenced by information such as ground water monitoring and documentation of field inspections conducted for the five-year review.

This alternative is further defined, consistent with Section 2.6, as follows:

1. It is assumed that a single cover would be installed over the fill material. Based on the area of both cells and contiguous swale area presented in Section 2.3, the largest cover area required would be approximately 20 acres if no consolidation of fill material is incorporated into the designed alternative. If consolidation of the western cell to the eastern cell is performed, the cover area would be approximately 10 acres. Nominal additional area may be disturbed downgradient of the fill for the installation of ground water treatment injection wells.

2. It is estimated that either landfill cover option would require approximately 1 to 2 years to install. For cover options other than consolidation where source material (western cell landfill material) remains in place, ground water treatment is not anticipated to achieve the NYS Class GA standards for Site ground water for the foreseeable future. If the source material is removed (eg. through consolidation of the western cell to the eastern cell), it is estimated that ground water remediation to attain NYS Class GA ground water standards would be achieved within approximately 40 years. For cost estimation purposes, a period of 30 years was assumed for O&M activities.

3. Spatial requirements would be similar to those for Alternative 3.

4. If partial excavation of the landfill material is performed, placement on site would be used for disposal of material. This option requires no options for ground water disposal to be developed.

5. Compliance with substantive requirements for wetland permitting would likely be required for construction of the remedy.

6. Site investigations to date do not provide adequate detail to determine the dimensions of the *in situ* zone. Pre-design investigations related to ground water treatment would be necessary to identify the biological treatment option, to estimate the number of injection wells necessary, and to estimate the frequency of reagent injection required. In addition, the analysis of this alternative is limited by the data available to accurately determine the fill depth, and by extension, the volume of waste material to be removed and consolidated.

7. Impacted soil remains on this site, but is encapsulated by the landfill cover thereby minimizing direct contact. The movement of impacted ground water to nearby surface waters and associated ecological receptors would be reduced by recovery drains.

2.7.6. Alternative 6

Alternative 6 is the landfill cover and *in situ* ground water treatment (iron wall) alternative. This alternative would involve the following process options:

Landfill cover. As described in Section 2.6.3.

In situ ground water treatment (iron wall). This alternative incorporates a reactive barrier wall designed to intercept contaminated ground water. Treatment would be provided as ground water flows through the wall material. A wall would be installed to a depth of approximately 75 feet below grade, extending approximately 500 feet in length perpendicular to the predominant direction of ground water flow (assumed will be installed between the existing landfill site and the municipal drinking water well, MW-5). Conventional excavation techniques are not expected to achieve sufficient depth of treatment due to the depth of the affected aquifer. Installation of an iron wall to the depths required would require employing a trenched slurry wall or hydrofracturing/injection well techniques. As described in Section 2.4, if the source of ground water VOC impacts is removed (*i.e.*, the consolidation cover option is chosen), it is estimated that ground water remediation to NYS Class GA standards could be achieved within 40 years. For cover options other than consolidation where source material (western cell landfill material) would likely remain in place, treatment of the ground water is not anticipated to achieve the NYS Class GA standards for Site ground water for the foreseeable future.

Institutional controls. Institutional controls would include "use restrictions" and "access restrictions". The various components are more specifically described as follows:

- *Access/Use restrictions* would preclude the conduct of activities that would potentially disturb or expose contaminated materials or impair the integrity of a cover over contaminated materials without prior notification and approval from NYSDEC.

  A program would be established to educate and authorize users about the past uses, remedial technologies in place, potential hazards, and proper conduct while on-site. Persons wishing to engage in an approved use upon the property must receive this education and authorization. This program would be developed by the NYSDEC in conjunction with the Town and implemented by the Town.

- *Ground water use restrictions* would preclude the use of untreated, ground water with concentrations in excess of NYS Class GA ground water standards as a potable water source, or as a non-potable water source without prior notification and approval from NYSDEC. The property deed would be revised to reflect this restriction. This restriction could be lifted upon attainment of NYS Class GA ground water standards.

Ground water monitoring. The 18 existing monitoring wells would be employed for continued sampling. It is assumed that the monitoring wells would be sampled quarterly for VOCs, SVOCs and inorganics (including cyanide) for a period of 30 years.

Five-year reviews. Five-year reviews are required by the NCP (Federal Register 1990) when impacted material remains at a site. The five-year review would focus on evaluating the Site with regard to the continuing protection of human health and the environment as evidenced by information such as ground water monitoring and documentation of field inspections conducted for the five-year review.

This alternative is further defined, consistent with Section 2.6, as follows:

1. It is assumed that a single cover would be installed over fill material. Based on the area of both cells and contiguous swale area presented in Section 2.3, the largest cover area required would be approximately 20 acres if no consolidation of fill material is incorporated into the designed alternative. If consolidation of the western cell to the eastern cell is performed, the cover area would be approximately 10 acres. Nominal additional area may be disturbed downgradient of the fill for the installation of an iron wall.

2. It is estimated that either landfill cover option would require approximately 1 to 2 years to install. For cover options other than consolidation where source material (western cell landfill material) remains in place, ground water treatment is not anticipated to achieve the NYS Class GA standards for Site ground water for the foreseeable future. If the source material is removed (eg. through consolidation of the western cell to the eastern cell), it is estimated that ground water remediation to attain NYS Class GA ground water standards could be achieved within approximately 40 years. For cost estimation purposes, a period of 30 years was assumed for O&M activities. Because the life of the iron reactive wall is anticipated to be approximately 15 years, a one-time replacement at year 15 has been included in the O&M costs.

3. Spatial requirements would be similar to those for Alternative 3 with the additional space for the installation of the iron wall.

4. If partial excavation of the landfill material is performed, placement on site would be used for disposal of material. This option requires no options for ground water disposal to be developed.

5. Compliance with substantive requirements for wetland permitting would likely be required for construction of the remedy.

6. Site investigations to date do not provide adequate detail to determine the dimension or location of the iron wall. Pre-design investigations related to ground water treatment would be necessary to estimate the

service life of the wall. In addition, the analysis of this alternative is limited by the data available to accurately determine the fill depth, and by extension, the volume of waste material to be removed and consolidated.

7. Impacted soil remains on this site, but is encapsulated by the landfill cover minimizing direct contact. The movement of impacted ground water to nearby surface waters and associated ecological receptors would be reduced by recovery drains.

2.7.7. Alternative 7

Alternate 7 is the wellhead protection alternative. The adjacent municipal drinking water well is specifically addressed. This alternative would involve the following process options:

Air stripping. An air stripper system would be installed on the existing municipal drinking water well system to treat volatile compounds in the well water. The air stripper system would be constructed adjacent to the well and treat pumped ground water prior to release into the potable water distribution system. The system would begin operation only if the concentration of VOCs in the well exceed NYS Class GA ground water standards. It would operate until such time as NYS Class GA ground water standards are attained within the municipal drinking water well or the well is abandoned. For purposes of cost estimation it is assumed that the system would operate for a period of 30 years. It has been assumed that air controls would not be required for the treatment system, however, a pretreatment system to handle naturally occurring inorganics and solids may be required.

Five-year reviews. Five-year reviews are required by the NCP (Federal Register 1990) when impacted material remains at a site. The five-year review would focus on evaluating the Site with regard to the continuing protection of human health and the environment as evidenced by information such as ground water monitoring and documentation of field inspections conducted for the five-year review.

This alternative is further defined, consistent with Section 2.6, as follows:

1. Air stripping equipment would be located adjacent to the existing production water well and would treat water following extraction, but prior to discharge to the distribution system.

2. Installation of the well head air stripper system would require approximately 6 months. It was assumed that the wellhead stripping system would be necessary for the useful life of the production drinking water well. For cost estimation purposes, a period of 30 years was assumed for O&M activities. Because source material (western cell landfill material) remains at the Site in this alternative, natural attenuation is not anticipated to achieve the NYS Class GA standards for ground water for the foreseeable future.

3. This alternative would require nominal space for air stripping equipment.

4. This alternative requires no options for disposal to be developed.

5. This option may require the modification of the permit in place governing the drinking water well. The wellhead air stripper system may be required to meet the substantive requirements of an air permit.

6. The concentration of VOCs observed at the production well and the pumping rate and volume over the useful life of the production well are not known. These gaps in data may limit precision when estimating flow rates and contaminant concentrations for design purposes.

7. This alternative would not address potential impacts to fish or wildlife resources posed by landfill material.

3. Detailed Analysis of Alternatives

The following section documents the detailed evaluation of the alternatives developed for the site. The objective of the detailed analysis of alternatives was to analyze and present sufficient information to allow the alternatives to be compared and a remedy selected. The analysis consisted of an individual assessment of each alternative with respect to nine evaluation criteria that encompass statutory requirements and overall feasibility and acceptability. The detailed evaluation of alternatives also included a comparative evaluation designed to consider the relative performance of the alternatives and identify major trade-offs among them. The nine evaluation criteria are:

- Overall protectiveness of human health and the environment
- Compliance with SCGs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance

The preamble to the NCP (Federal Register 1990) indicates that, during remedy selection, these nine criteria should be categorized into three groups: threshold criteria, primary balancing criteria, and modifying criteria. The two threshold criteria, overall protection of human health and the environment, and compliance with SCGs, must be satisfied in order for an alternative to be eligible for selection. Long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost are primary balancing criteria that are used to balance the trade-offs between alternatives. The modifying criteria are state and community acceptance, which are formally considered after public comment is received on the Proposed Remedial Action Plan. The New York State TAGM entitled *Selection of Remedial Actions at Inactive Hazardous Waste Sites*, (NYSDEC 1990) and NYSDEC's Department of Environmental Restoration (DER)-10 draft guidance entitled *Technical Guidance or Site Investigation and Remediation* were also considered during this evaluation (NYSDEC 2002).

3.1. Individual Analysis of Alternatives

In the individual analysis of alternatives, each of the remedial alternatives was evaluated with respect to the evaluation criteria. A summary of the individual analysis of alternatives is presented in Table 4.

3.1.1. Overall Protection of Human Health and the Environment

The analysis of each alternative with respect to this criterion provides an evaluation of whether the alternative achieves and maintains adequate protection and a description of how site risks are eliminated, reduced, or controlled through treatment, engineering, or institutional controls. The individual analysis of each remedial alternative with respect to this criterion is presented in Table 4.

3.1.2. Compliance with SCGs

Identification of potential standards, criteria and guidance (SCGs). Section 121(d) of CERCLA, as amended by the Superfund Amendment and Reauthorization Act (SARA), requires that remedial actions comply with ARARs under federal and state environmental law. USEPA also requires consideration of TBCs (USEPA 1988). NYSDEC evaluates compliance with SCGs, as such, SCGs will be evaluated for this Site.

There are three types of SCGs: chemical-, location-, and action-specific SCGs. Chemical-specific SCGs are health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to the ambient environment. Location-specific SCGs set restrictions on activities based on the characteristics of the site or immediate environs. Action-specific SCGs set controls or restrictions on particular types of remedial actions once the remedial actions have been identified as part of a remedial alternative

Compliance. Potential SCGs for the Site are presented in Table 5. The alternatives meeting the individual SCGs are noted in Table 5.

3.1.3. Long-Term Effectiveness and Permanence

This criterion assesses the magnitude of residual risk remaining from untreated material or treatment residuals at the site. The adequacy and reliability of controls used to manage untreated material or treatment residuals are also evaluated. The individual analysis of each remedial alternative with respect to this criterion is presented in Table 4.

3.1.4. Reduction of Toxicity, Mobility, or Volume through Treatment

The evaluation of this criterion addressed the expected performance of treatment technologies in each alternative. The individual analysis of each remedial alternative with respect to this criterion is presented in Table 4.

3.1.5. Short-Term Effectiveness

The evaluation of short-term effectiveness addressed the protection of workers and the community during construction and implementation of each alternative, and the potential environmental effects resulting from implementation of each alternative. The time required to achieve remedial objectives was also evaluated under this criterion. The individual analysis of each remedial alternative with respect to this criterion is presented in Table 4.

3.1.6. Implementability

The analysis of implementability involved an assessment of the ability to construct and operate the technologies, the reliability of the technologies, the ease of undertaking additional remedial action, the ability to monitor the effectiveness of each remedy, and the ability to obtain necessary approvals from other agencies. Additionally, the availability of services, capacities, equipment, materials, and specialists necessary for implementation of the alternative was also assessed. The individual analysis of each remedial alternative with respect to this criterion is presented in Table 4.

3.1.7. Cost

For the cost analysis, cost estimates were prepared for each alternative based on vendor information and quotations, cost estimating guides, and experience. Cost estimates were prepared for the purpose of alternative comparison and were based on information currently known about the study area. The cost estimates include capital costs, annual operation and maintenance costs, and present worth cost. The present worth cost for these alternatives was calculated for the expected duration of the remedy at a 7% discount rate.

The individual cost estimates for the remedial alternatives are included in Tables 6 through 12.

3.1.8. Support Agency Acceptance

Support agency acceptance will be addressed during development of the preferred alternative.

3.1.9. Community Acceptance

Community acceptance will be addressed during the preferred alternative public comment period prior to the ROD.

3.2. Comparative Analysis of Alternatives

In the comparative analysis of alternatives, the performance of each alternative relative to the others was evaluated for each criterion.

As discussed in the following subsections, with the exception of Alternative 1, each alternative satisfies the threshold criteria by providing protection to human health and the environment and by complying with the identified SCGs; therefore, each active alternative is eligible for selection as the final remedy. The primary balancing criteria (long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost) were used for balance in the comparative evaluation of alternatives.

3.2.1. Overall Protection of Human Health and the Environment

Concentrations of site-related constituents in the municipal drinking water well are currently below NYS Class GA standards, thus each alternative is protective of human health exposure to VOCs in ground water through the municipal drinking water well. In the event that the municipal drinking water well were to become impacted, Alternative 7 would provide the greatest level of protection for human health exposure to VOCs in the ground water from the municipal drinking water well through the active treatment at the well head. The remaining alternatives would rely on natural attenuation of currently impacted ground water that has reached the vicinity of the municipal drinking water well, as is evidenced by the sentinel well concentrations detected in June 2005. Alternative 2, through source removal and treatment of site ground water, provides the next greatest level of protection, followed by Alternatives 4, 5 and 6 that would provide treatment of on-site ground water. Alternatives 1 and 3 would provide the least level of protection to the municipal drinking water well as these would rely on natural attenuation to address VOCs in on-site ground water that may reach the municipal drinking water well.

Exclusive of wellhead concerns, each alternative, with the exception of Alternatives 1 and 7, would be protective of human health and the environment through institutional controls, removal of fill material, and/or containment of fill material. Alternative 2, by removal of the fill material and the treatment of ground water would provide the greatest overall level of protection to human health and the environment. Alternatives 4, 5, and 6 would provide adequate protection to human health and the environment. Alternative 3, because it relies on natural attenuation, would provide a lesser degree of protection to human health and the environment from a protection of ground water impacts standpoint, however, it would be just as protective as Alternatives 4, 5 and 6 from fill material/soil impacts.

Although Alternative 7 would be most protective of impacts, should they occur at the municipal drinking water well, it would provide no protection of impacts to human health through exposure to site ground water nor would it be protective of the environment. Alternative 7 would need to be implemented in conjunction with another alternative to be protective of human health through pathways not directly related to the municipal drinking water well and be protective of the environment.

Alternatives 1 and 7 would provide no protection of human health or the environment from the soil medium.

3.2.2. Compliance with SCGs

Attainment of ground water SCGs for inorganics is technically impracticable due to background concentrations. With the exception of inorganics, Alternative 2 would achieve the soil and ground water SCGs through fill material removal and ground water treatment. Alternative 4, 5 and 6 are anticipated to meet ground water SCGs through active ground water treatment. Alternatives 1 and 3 rely on natural attenuation to meet ground water SCGs. Though soil SCGs are not met for Alternatives 3, 4, 5 and 6, soil SCGs are addressed through containment. Action and location specific SCGs can be met for each alternative.

3.2.3. Long-term Effectiveness and Permanence

With the exception of Alternative 1, each active alternative would provide for long-term effectiveness and permanence. With the exception of Alternative 1, each alternative would effectively discourage contact with fill material and provide for management of risks at the site, through deed restrictions, landfill material removal or containment.

Deed restrictions, included in Alternatives 3 through 6, would provide adequate long-term effectiveness for the control of ground water use. Treatment at the well head included in Alternative 7 provides the greatest reduction in the magnitude of potential residual risk to human health relative to the municipal drinking water well, if the municipal drinking water well were to become impacted by site-related constituents.

3.2.4. Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives 2, 4, 5, 6 and 7 include active treatment of ground water. The treatment processes included in Alternatives 2 4, 5, and 6 would provide a reduction of toxicity of Site ground water to both human and environmental receptors. Treatment of ground water included in Alternative 7 would result in a reduction of toxicity to human receptors. Reduction of ground water toxicity by these alternatives would be an irreversible process.

Containment of the fill material by a cover in Alternatives 3, 4, 5, and 6 would also reduce the volume of impacted ground water potentially produced by increasing runoff and evapotranspiration of surface waters. The option to consolidate fill, as part of Alternative 3, 4, 5, and 6, would provide a reduction of the footprint of the fill material possibly decreasing the amount of fill in contact with ground water, further reducing mobility of contaminant from the soil to the ground water media.

Alternative 2 would reduce the toxicity, mobility and volume of the fill material itself by excavation and removal. Alternatives 3, 4, 5 and 6 provide a reduction in mobility of the fill material. Containment of fill material in this manner is considered an acceptable and relevant action for municipal landfills (USEPA, 1993).

3.2.5. Short-Term Effectiveness

Implementation of Alternatives 1, 3, 4, 5, 6 and 7 would not be anticipated to result in the need for protection of the community during implementation aside from standard construction protections (*e.g.* air and surface water quality). During implementation of Alternative 2, protection of workers and the community would be required with respect to dust, volatile emissions, landfill gas and surface runoff. Engineering controls would be implemented during construction of the alternatives that would be adequately protective of the community and the environment.

Alternative 1 could be implemented immediately. It is assumed that the cover component (either cover configuration) included in Alternatives 3, 4, 5 and 6 would require approximately 1 to 2 years to construct. It is assumed that the landfill material removal component included in Alternative 2 would require approximately 1 to 2 years to construct. It is estimated that in the absence of ground water treatment, ground water would achieve NYS Class GA standards within approximately 72 years of landfill material removal (*i.e.*, Alternative 2 or the consolidation cover in Alternatives 3).

Installation of the ground water treatment system components of Alternatives 2 and 4 though 7 was assumed to require approximately 1 year to construct. When combined with the source removal (*i.e.*, Alternative 2 or the consolidation cover in Alternatives 4 through 6), it was assumed that operation of the ground water extraction and treatment system or installation of an *in situ* treatment wall would result in NYS Class GA standards being achieved in Site ground water within approximately 40 years. In the absence of source removal, active treatment or natural attenuation of Site ground water is not anticipated to meet NYS Class GA standards in the foreseeable future.

3.2.6. Implementability

Each alternative is implementable. The technologies being used are reliable technologies. Each alternative allows for additional remedial actions to be implemented if necessary, and is readily monitored for effectiveness of the remedy.

3.2.7. Cost

Detailed cost estimates for Alternatives 1 through 7 are included as Tables 6 through 12. Assumptions employed for the development of the costs for each alternative are included as Table 13.

Alternative 7, if implemented as a stand alone alternative, represents the least cost with a present worth value of $467,000. The cost of Alternate 7 can also be applied as an "adder" to other alternatives to represent the present worth value of incorporating well head treatment. Alternative 1, the no further action alternative, is the second least cost alternative at an estimated present worth value of $983,000 (due primarily to the ongoing ground water monitoring).

Alternative 3, with soil cover and monitored natural attenuation, is the least cost of the active cover alternatives at estimated present worth values of $4,620,000 (soil), $6,842,000 (low permeability with consolidation), and $9,163,000 (low permeability).

Alternatives 4 and 5, which incorporate active ground water treatment and a cover, are the next least cost alternatives. Alternative 4 with ground water extraction and *ex situ* treatment is the next least cost at an estimated present worth value of $5,246,000 (soil), $7,465,000 (low permeability with consolidation), and $9,788,000 (low permeability). Alternative 5 with *in situ* ground water treatment by biobarrier has an estimated present worth of $13,768,000 (soil), $15,988,000 (low permeability with consolidation), and $18, 309,000 (low permeability).

Alternatives 2 and 6 are the most expensive alternatives. Alternative 6 with *in situ* ground water treatment by iron reactive wall has an estimated present worth value of $28,224,000 (soil), $30,765,000 (low permeability with consolidation), and $32,765,000 (low permeability), and $24,674,000. Alternative 2, the excavation and disposal and ground water treatment alternative has an estimated total present worth of approximately $28,492,000.

3.2.8. Support Agency Acceptance

Support agency acceptance will be addressed during development of the preferred alternative.

3.2.9. Community Acceptance

Community acceptance will be addressed during the preferred alternative public comment period prior to the ROD.

References

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Table 1. *Screening of remedial technologies and process options*

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Landfill material				
NO ACTION	None	None	No remedial action.	Required for consideration by NCP.
INSTITUTIONAL ACTIONS	Access restrictions	Deed restrictions	Land use restrictions for site.	Potentially applicable.
		Fencing	Installation of fencing surrounding area(s) of contamination.	Potentially applicable.
CONTAINMENT ACTIONS (Presumptive Remedy)	Capping	Vegetated soil cover	Vegetated soil layer covering landfill	Potentially applicable
		Low-permeability cover	Vegetated soil layer used in conjunction with low permeability and protective layers.	Potentially applicable.
REMOVAL ACTIONS	Excavation	Excavation	Use of construction equipment, such as backhoes, bulldozers, clamshells, draglines, or conveyors to remove site soils.	Required for consideration by DER-10 (in conjunction with disposal) to restore site to “Pre-Disposal Conditions”.
DISPOSAL ACTIONS	Land disposal	Off-site commercial landfill	Off-site disposal of soil.	Required for consideration by DER-10 (in conjunction with removal) to restore site to “Pre-Disposal Conditions”.
		On-site relocation (fill consolidation)	On-site placement of excavated soils to reduce the footprint of impacted material.	Potentially applicable.
Ground water				
NO ACTION	None	Natural attenuation	In-place reduction of VOCs, SVOCs in ground water over the long-term by biotic and abiotic attenuation processes.	Required for consideration by NCP. Potentially applicable.

Table 1. *Screening of remedial technologies and process options*

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
INSTITUTIONAL ACTIONS	Monitoring	Ground water monitoring	Periodic sampling and analysis of ground water to observe and document the effectiveness of natural attenuation or other treatment technology.	Potentially applicable.
INSTITUTIONAL ACTIONS	Use restrictions	Ground water use restriction	Restriction of ground water use at the site.	Potentially applicable.
CONTAINMENT ACTIONS	Vertical barrier	Slurry wall	Soil- or cement-bentonite slurry wall placed around the area of contamination to contain ground water.	Potentially applicable for shallow ground water only.
		Sheet piles	Sheet piles installed around the area of contamination to contain ground water.	Potentially applicable for shallow ground water only.
	Ground water control	Groundwater extraction wells	Removal of ground water by pumping for hydraulic containment to site.	Potentially applicable.
		Recovery trench	Removal of ground water by pumping from recovery trenches for hydraulic containment or mass removal.	Potentially applicable for shallow ground water only.
COLLECTION ACTIONS	Ground water control	Recovery wells	Removal of ground water by pumping from recovery wells for mass removal.	Potentially applicable.
IN SITU TREATMENT ACTIONS	Physical	Air sparging	Injection of air into the saturated soil zone to volatilize constituents from the liquid medium.	Potentially applicable.
		In-well stripping	Injection of air into the water column within a well to volatilize constituents. Ground water circulation is performed i*n situ*; entering the well at one screen and discharged through a second screen. Air is collected and treated if necessary.	Potentially applicable.

Table 1. *Screening of remedial technologies and process options*

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
	Biological	Bioremediation/ Biobarrier	Injection of oxygen and/or nutrient (as required) to the aquifer to enhance biological degradation of organics by indigenous microbes. Either in a large spatial area, or as a targeted "treatment zone".	Potentially applicable.
IN SITU TREATMENT ACTIONS	Chemical	Treatment wall	Construction of an iron wall or carbon wall to treat ground water as it flows through the treatment zone.	Potentially applicable.
EX SITU TREATMENT ACTIONS	Physical	Air stripping	Contact of air with water in countercurrent column or bulk reactor to transfer VOCs from water to air.	Potentially applicable.
		Carbon adsorption	Adsorption of organic constituents from water to activated carbon.	Potentially applicable.
		Adsorptive resin	Adsorption of organic constituents from water to commercial adsorptive resin.	Potentially applicable.
		Settling	Retention of aqueous stream in tank to settle/separate light or heavy components.	Not applicable for dissolved constituents.
		Filtration	Separation of solids from water phase using semipermeable filter medium.	Not applicable for dissolved constituents.
	Chemical	Chemical oxidation	Addition of oxidation agents such as hydrogen peroxide and ultraviolet light to water to oxidize/destroy organic contaminants.	Potentially applicable.
		Precipitation	pH adjustment of ground water to separate out dissolved metal contaminants.	Not applicable for dissolved organic constituents.

Table 1. *Screening of remedial technologies and process options*

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
		Ion exchange	Chemical alternation of a hazardous constituent to a non-hazardous constituent.	Not applicable for dissolved organic constituents.
EX SITU TREATMENT ACTIONS	Biological	Biological reactor	Addition of oxygen, nutrients, and cometabolites to ground water in reactor to enhance co-metabolic degradation of organic constituents.	Potentially applicable.
DISCHARGE ACTIONS	Treated water discharge	Discharge to Surface water	Discharge of extracted and treated ground water to surface water features such as streams, ponds, culverts, *etc*.	Potentially applicable.
		Discharge to ground water	Re-injection of extracted and treated ground water back to the sub-surface.	Potentially applicable.
		Discharge to engineered system	Discharge of extracted and treated ground water to sanitary or storm sewers.	Not applicable because these facilities are not available.

Table 2. *Evaluation of process options*

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
Landfill material					
NO ACTION	None	Natural attenuation *	Relies on long-term biotic and abiotic degradation. Effectiveness is not certain.	Readily implementable.	No capital No O&M
INSTITUTIONAL ACTIONS	Access restrictions	Deed restrictions *	Effectively minimizes access to the Site.	Readily implementable.	Low capital No O&M
		Fencing	Effectively minimizes access to the Site.	Readily implementable.	Low capital Low O&M
CONTAINMENT ACTIONS	Capping	Vegetated soil cover *	Effectively minimizes human and ecological contact with impacted soil.	Readily implementable.	Low capital Low O&M
		Low-permeability cover*	Effectively minimizes human and ecological contact with impacted soil.	Readily implementable.	High capital Low O&M
REMOVAL ACTIONS	Excavation	Excavation *	Effectively removes impacted soil and fill material.	Readily implementable for unsaturated soil. Difficult to implement for soil below ground water table due to dewatering needs in highly permeable soil.	High capital No O&M
DISPOSAL ACTIONS	Land disposal	Off-site commercial landfill or handling facility*	Effective method of disposal. Minimizes constituent migration.	Readily implementable.	High capital No O&M
		On-site relocation (fill consolidation)*	Effectively reduces area of cover required for containment and reduces the volume of impacted soil in contact with ground water.	Readily implementable.	Medium capital No O&M

Table 2. *Evaluation of process options*

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
Ground water					
NO ACTION	None	Natural attenuation *	Relies on long-term biological and abiotic degradation. Effectiveness is not certain.	Readily implementable.	No capital No O&M
INSTITUTIONAL ACTIONS	Monitoring	Ground water monitoring*	Effective for monitoring changes in organics and metals over time. Useful for evaluating remedy effectiveness.	Readily implementable.	Low capital Low O&M
	Deed restrictions	Ground water use restriction*	Effectively minimizes potable water use of ground water.	Readily implementable.	Low capital No O&M
CONTAINMENT ACTIONS	Vertical barrier	Slurry wall	Effectively minimizes movement of ground water into or out of a containment area.	Readily implementable to limited depths.	Medium capital No O&M
		Sheet Piles	Effectively minimizes movement of ground water into or out of a containment area.	Readily implementable to limited depths.	Medium capital No O&M
	Groundwater Control	Groundwater extraction wells	Effectively controls migration of contaminated groundwater from site.	Readily implementable.	Low capital Medium O&M
		Recovery trench	Effectively removes contaminated ground water.	Readily implementable to limited depths.	Medium capital Medium O&M
COLLECTION ACTIONS	Groundwater removal	Recovery wells*	Effectively removes contaminated ground water.	Readily implementable.	Low capital Medium O&M
IN SITU TREATMENT ACTIONS	Physical	Air sparging	Effective for removal of chlorinated VOCs.	Readily implementable.	High capital Medium O&M

Table 2. *Evaluation of process options*

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
		In well air stripping	Effective for removal of chlorinated VOCs.	Readily implementable.	High capital Medium O&M
	Biological	Bioremediation/ Biobarrier*	Effective for removal of chlorinated VOCs	Readily implementable.	Low capital Medium O&M
IN SITU TREATMENT ACTIONS	Chemical	Treatment wall (iron wall)*	Effective for removal of chlorinated VOCs	Readily implementable.	High capital High O&M
EX SITU TREATMENT ACTIONS	Physical	Air stripping*	Effective for removal of chlorinated VOCs.	Readily implementable.	Low capital Medium O&M
		Carbon adsorption	Effective for removal of some chlorinated VOCs.	Readily implementable.	Low capital High O&M
		Adsorptive resin	Effective for removal of some chlorinated VOCs.	Readily implementable.	Medium capital Medium O&M
	Chemical	Chemical oxidation	Effective for destruction of chlorinated VOCs.	Difficult to implement due excessive quantities of extracted water as a result of the underlying sand and gravel.	Medium capital Medium O&M
EX SITU TREATMENT ACTIONS	Biological	Biological reactor	Likely effective for destruction of chlorinated VOCs.	Difficult to implement due excessive quantities of extracted water as a result of the underlying sand and gravel.	Medium capital Medium O&M

Table 3. *Components of remedial alternatives*

General Response Actions	Remedial technology - process option	1	2	3	4	5	6	7
Institutional actions	Access/Use restrictions		x	x	x	x	x	
	Ground water monitoring	x	x	x	x	x	x	
	Five-year reviews	x	x	x	x	x	x	x
Containment actions	Landfill cover - vegetated soil cover			x	x	x	x	
	Landfill cover - low permeability cover			x	x	x	x	
Removal actions	Fill excavation (complete)		x					
	Fill excavation (partial relocation)			x	x	x	x	
	Ground water recovery well		x		X			
Disposal actions	Off-site land disposal of fill (permitted facility)		x					
	On-site land disposal of fill (consolidation of fill)			x	x	x	x	
	Discharge of treated ground water to site surface water				x			
Treatment actions	*Ex situ* air stripping		x		x			x
	In situ enhanced attenuation (biobarrier)					x		
	In situ groundwater treatment (iron wall)						x	
	Monitored natural attenuation (MNA)			x				

Alternative 1 No Action
Alternative 2 Excavation and disposal with ground water recovery and treatment and institutional controls
Alternative 3 Landfill cover with monitored natural attenuation and institutional controls
Alternative 4 Landfill cover with ground water extraction and treatment and institutional controls
Alternative 5 Landfill cover with *in situ* ground water enhanced natural attentuation (biobarrior) and institutional controls
Alternative 6 Landfill cover with *in situ* ground water treatment (iron wall) and institutional controls
Alternative 7 Wellhead protection by *ex situ* air stripping of municipal drinking water well and five-year reviews.

Table 4. Detailed analysis of alternatives

Criterion	**Alternative 1:** **No further action**	**Alternative 2:** **Excavation and off-site disposal with GW recovery and treatment**	**Alternative 3:** **Landfill cover with MNA of GW**	**Alternative 4:** **Landfill cover with GW extraction and *ex situ* treatment**	**Alternative 5:** **Landfill cover with *in situ* GW treatment by biobarrier**	**Alternative 6:** **Landfill cover with *in situ* GW treatment by iron wall**	**Alternative 7** **Wellhead Protection by *ex situ* water treatment**
	• **Ground water monitoring** • **Five year reviews**	• **Ground water monitoring** • **Five year reviews** • **Access/Use restrictions** • **Excavation of fill material** • **Offsite fill material disposal** • **Ground water recovery** • ***Ex situ* air stripping** • **Surface water disposal**	• **Ground water monitoring** • **Five year reviews** • **Access/Use restrictions** • **Soil or low-permeability landfill cover** • **Natural attenuation of ground water (with monitoring)**	• **Ground water monitoring** • **Five year reviews** • **Access/Use restrictions** • **Soil or low-permeability landfill cover** • **Ground water recovery** • ***Ex situ* air stripping** • **Surface water disposal**	• **Ground water monitoring** • **Five year reviews** • **Access/Use restrictions** • **Soil or low-permeability landfill cover** • ***In situ* ground water treatment (biobarrier)**	• **Ground water monitoring** • **Five year reviews** • **Access/Use restrictions** • **Soil or low-permeability landfill cover** • ***In situ* ground water treatment (iron wall)**	• **Five year reviews** • ***Ex situ* air stripping (of drinking water well)** • **Discharge to distribution system**
Overall protection of human health and the environment							
Overall protection of human health	Ground water monitoring provides minimal protection of adjacent municipal water supply well. Does not eliminate any identified exposure pathway. Existing soil cover provides minimal protection of potential exposure pathways to landfill material. Relies on natural attenuation for protection of potental and existing pathways to ground water.	Protection of human health is provided through the removal of fill material from the site. Ground water treatment and onsite disposal would address existing impacts to ground water and protect the adjacent municipal water supply well.	Protection of human health is provided through the isolation of the fill and surface water exposure pathways. Relies on natural attenuation for continued protection of potential and existing pathways for ground water offsite. Future use of onsite ground water would be further restricted through deed restrictions. Impacted ground water already at the vicinity of the drinking water well would be addressed by natural attenuation.	Protection of human health is provided through the isolation of the fill and surface water exposure pathways. Ground water treatment and onsite disposal would provide protection of the exposure pathway of the adjacent municipal drinking water well. Future use of onsite ground water would be further restricted through deed restrictions. Impacted ground water already at the vicinity of the drinking water well would be addressed by natural attenuation.	Protection of human health is provided through the isolation of the fill and surface water exposure pathways. Ground water treatment and onsite disposal would provide protection of the exposure pathway of the adjacent municipal drinking water well. Future use of onsite ground water would be further restricted through deed restrictions. Impacted ground water already at the vicinity of the drinking water well would be addressed by natural attenuation.	Protection of human health is provided through the isolation of the fill and surface water exposure pathways. Ground water treatment and onsite disposal would provide protection of the exposure pathway of the adjacent municipal drinking water well. Future use of onsite ground water would be further restricted through deed restrictions. Impacted ground water already at the vicinity of the drinking water well would be addressed by natural attenuation.	Direct treatment of municipal water flow would provide protection for ground water pathway of the adjacent municipal drinking water well. No protection from exposure to fill material or affected surface water is provided by this alternative.
Overall protection of the environment	Relies on natural attenuation for protection of the environment.	Protection of the environment is provided through treatment or removal of contaminated media of concern.	Protection of the environment is provided through isolation of the fill and surface water exposure pathways. Consolidation of fill is more protective of ground water media than capping material in place. Relies on natural attenuation of ground water for to provide protection from impacted ground water.	Protection of the environment is provided through isolation of the fill and surface water exposure pathways. Consolidation of fill is more protective of ground water media than capping material in place. Protection of environment is provided through ground water treatment.	Protection of the environment is provided through isolation of the fill and surface water exposure pathways. Consolidation of fill is more protective of ground water media than capping material in place. Protection of environment is provided through ground water treatment.	Protection of the environment is provided through isolation of the fill and surface water exposure pathways. Consolidation of fill is more protective of ground water media than capping material in place. Protection of environment is provided through ground water treatment.	No protection to the environment is provided by this alternative. Relies on natural attenuation for protection of the environment.
Compliance with standards, criteria, and guidance (SCGs)							
Compliance with chemical-specific SCGs	Does not attain surface water or soil chemical specific SCGs. Relies on natural attenuation to achieve ground water SCGs. Attainment of NYS Class GA ground water standards for inorganics is technically impracticable due to background concentrations.	Attainment of NYS Class GA ground water (for VOCs only) and TAGM soil guidance values is provided through source removal and removal of landfill material and ground water. Attainment of NYS Class GA ground water standards for inorganics is technically impracticable due to background concentrations.	Relies on natural attenuation to achieve ground water SCGs for VOCs. Soil SCGs would be addressed through risk management (containment). Attainment of NYS Class GA ground water standards for inorganics is technically impracticable due to background concentrations.	Attainment of NYS Class GA ground water standards (for VOCs only) is provided through isolation of source material and removal/treatment of ground water. Soil SCGs would be addressed through risk management (containment). Attainment of NYS Class GA ground water standards for inorganics is technically impracticable due to background concentrations.	Attainment of NYS Class GA ground water standard (for VOCs only) is provided through isolation of source media and treatment of ground water. Soil SCGs would be addressed through risk management (containment). Attainment of NYS Class GA ground water standards for inorganics is technically impracticable due to background concentrations.	Attainment of NYS Class GA ground water standard (for VOCs only) is provided through isolation of source media and treatment of ground water. Soil SCGs would be addressed through risk management (containment). Attainment of NYS Class GA ground water standards for inorganics is technically impracticable due to background concentrations.	Does not attain surface water or soil chemical specific SCGs. Relies on natural attenuation to achieve ground water SCGs. Attainment of NYS Class GA ground water standards for inorganics is technically impracticable due to background concentrations.
Compliance with location-specific SCGs	No potential location specific SCGs were identified.	Landfill excavation and treated water discharge would need to be conducted in a manner consistent with NYS and Federal requirements for the protection of wetlands. Cultural resource assessments should be conducted prior to sitework, and depending on outcome, construction activities may need to be conducted such that archeological and historical resources are not damaged.	Landfill cover installation would need to be conducted in a manner consistent with NYS and Federal requirements for the protection of wetlands. Cultural resource assessments should be conducted prior to sitework, and depending on outcome, construction activities may need to be conducted such that archeological and historical resources are not damaged. Landfill cover design would need to consider NYS and Federal requirements concerning construction within a 100-year flood plain.	Landfill cover installation and treated water discharge would need to be conducted in a manner consistent with NYS and Federal requirements for the protection of wetlands. Cultural resource assessments should be conducted prior to sitework, and depending on outcome, construction activities may need to be conducted such that archeological and historical resources are not damaged. Landfill cover design would need to consider NYS and Federal requirements concerning construction within a 100-year flood plain.	Landfill cover and *in situ* technologies would need to be conducted in a manner consistent with NYS and Federal requirements for the protection of wetlands. Cultural resource assessments should be conducted prior to sitework, and depending on outcome, construction activities may need to be conducted such that archeological and historical resources are not damaged. Landfill cover design would need to consider NYS and Federal requirements concerning construction within a 100-year flood plain.	Landfill cover and *in situ* technologies would need to be conducted in a manner consistent with NYS and Federal requirements for the protection of wetlands. Cultural resource assessments should be conducted prior to sitework, and depending on outcome, construction activities may need to be conducted such that archeological and historical resources are not damaged. Landfill cover design would need to consider NYS and Federal requirements concerning construction within a 100-year flood plain.	No potential location specific SCGs were identified.

Table 4. Detailed analysis of alternatives

Criterion	**Alternative 1: No further action**	**Alternative 2: Excavation and off-site disposal with GW recovery and treatment**	**Alternative 3: Landfill cover with MNA of GW**	**Alternative 4: Landfill cover with GW extraction and *ex situ* treatment**	**Alternative 5: Landfill cover with *in situ* GW treatment by biobarrier**	**Alternative 6: Landfill cover with *in situ* GW treatment by iron wall**	**Alternative 7 Wellhead Protection by *ex situ* water treatment**
	• **Ground water monitoring** • **Five year reviews**	• **Ground water monitoring** • **Five year reviews** • **Access/Use restrictions** • **Excavation of fill material** • **Offsite fill material disposal** • **Ground water recovery** • ***Ex situ* air stripping** • **Surface water disposal**	• **Ground water monitoring** • **Five year reviews** • **Access/Use restrictions** • **Soil or low-permeability landfill cover** • **Natural attenuation of ground water (with monitoring)**	• **Ground water monitoring** • **Five year reviews** • **Access/Use restrictions** • **Soil or low-permeability landfill cover** • **Ground water recovery** • ***Ex situ* air stripping** • **Surface water disposal**	• **Ground water monitoring** • **Five year reviews** • **Access/Use restrictions** • **Soil or low-permeability landfill cover** • ***In situ* ground water treatment (biobarrier)**	• **Ground water monitoring** • **Five year reviews** • **Access/Use restrictions** • **Soil or low-permeability landfill cover** • ***In situ* ground water treatment (iron wall)**	• **Five year reviews** • ***Ex situ* air stripping (of drinking water well)** • **Discharge to distribution system**
Compliance with action-specific SCGs	No actions are part of this alternative.	Excavation activities would be conducted consistent with air quality standards and requirements for construction within a flood plain. Offsite disposal of landfill material would be conducted in accordance with transportation and disposal requirements. Construction activities would be conducted in accordance with OSHA safety requirements. The air stripper would be operated according to applicable air discharge regulations.	Construction activities would be conducted consistent with air quality standards and requirements for construction within a flood plain. Site construction activities would be conducted in accordance with OSHA safety requirements.	Construction activities would be conducted consistent with air quality standards and requirements for construction within a flood plain. Site construction activities would be conducted in accordance with OSHA safety requirements. The air stripper would be operated according to applicable air discharge regulations.	Construction activities would be conducted consistent with air quality standards and requirements for construction within a flood plain. Site construction activities would be conducted in accordance with OSHA safety requirements.	Construction activities would be conducted consistent with air quality standards and requirements for construction within a flood plain. Site construction activities would be conducted in accordance with OSHA safety requirements.	Site construction activities would be conducted in accordance with OSHA safety requirements. The air stripper would be operated according to applicable air discharge requirements.
Long-term effectiveness and permanence							
Magnitude of residual risk	Impacted media would remain onsite. No reduction of risk associated with landfill material. Minimal potential residual risk to end users of municipal drinking water source from adjacent well due to ground water monitoring.	Removal of fill material removes risk of exposure to fill material. Minimal potential residual risk of exposure to ground water by treatment and use controls.	Minimal residual risk to end users of municipal drinking water source from adjacent well due to ground water monitoring. Minimal risk of exposure to on-site ground water through use controls. Minimal potential residual risk of exposure to fill material despite being left onsite.	Minimal residual risk of exposure to covered fill material. Minimal potential residual risk of exposure to ground water by treatment and use controls.	Minimal residual risk of exposure to covered fill material. Minimal potential residual risk of exposure to ground water by treatment and use controls.	Minimal residual risk of exposure to covered fill material. Minimal potential residual risk of exposure to ground water by treatment and use controls.	Negligible potential residual risk of exposure via the municipal drinking water well. No reduction of risk for other identified pathways.
Adequacy and reliability of controls	Natural attenuation is adequte protection to control direct exposure via the municipal drinking well, however long-term reliability is not known. Ground water monitoring is an adequate and reliable method for detecting increasing concentrations approaching the municipal water supply well.	Removal of landfill material and ground water treatment and use restrictions provide adequate and reliable control of exposures.	Covering landfill material provides adequate and reliable control over exposures to contaminated soil and fill media. Ground water use restrictions provides adequate control of onsite ground water exposure. Natural attenuation is adequate protection to control direct exposure via the municipal drinking water well, however long-term reliability is not known. Ground water monitoring is an adequate and reliable method of detecting increasing concentrations approaching the municipal water supply well.	Covering landfill material and ground water treatment and use restrictions provide adequate and reliable control of exposures.	Covering landfill material and ground water treatment and use restrictions provide adequate and reliable control of exposures.	Covering landfill material and ground water treatment and use restrictions provide adequate and reliable control of exposures.	Treatment of ground water would provide reliable removal of potential risk of exposure to affected ground waters via the municipal drinking water well.
Reduction of toxicity, mobility, or volume through treatment							
Treatment process used and materials treated	No active treatment processes are used in this alternative. Natural attenuation will be used for ground water.	Excavation and offsite disposal will address contaminats in fill material. Ex situ air stripping will be used to treat VOCs in ground water.	No active treatment processes are used in this alternative. Natural attenuation will be used for ground water.	*Ex situ* air stripping will be used to treat VOCs in ground water.	*In situ* treatment zone of increased metabolic activity of site microorganisms established by introduction of nutrients will be used to address VOCs in ground water.	*In situ* treatment zone established to oxidize VOCs in groundwater by interaction with iron.	*Ex situ* air stripping and natural attentuation will be used to treat VOCs in ground water.
Amount of hazardous material destroyed or treated	No active treatment processes or removal are used in this alternative. Natural attenuation will be used for ground water.	Approximately 90,000 cubic yards of fill material will be removed. Approximately 2,000,000 gallons per year of ground water will be treated.	Approximately 90,000 cubic yards of fill material will be isolated by installation of a landfill cover.	Approximately 90,000 cubic yards of fill material will be isolated by installation of a landfill cover. Approximately 2,000,000 gallons per year of ground water will be treated.	Approximately 90,000 cubic yards of fill material will be isolated by installation of a landfill cover. Approximately 2,000,000 gallons per year of ground water will be treated.	Approximately 90,000 cubic yards of fill material will be isolated by installation of a landfill cover. Approximately 2,000,000 gallons per year of ground water will be treated.	The volume of ground water treated will vary based on water system demands.
Degree of expected reduction in toxicity, mobility, or volume	No active treatment processes or removal are used in this alternative. Natural attenuation provide a sufficient reduction in concentration of organic compounds in ground water. Long term reduction of compounds is not known.	Approximately 90,000 cubic yards of fill material will be removed. Approximately 2,000,000 gallons per year of ground water will be treated. Air strippers can be up to 99% efficient in VOC removal from water.	Consolidation of fill material would reduce potential for mobility of contaminants in fill to ground water (degree based on amount of fill excavated from contact with ground water).	Extraction and treatment of ground water would capture ground water migration toward the municipal well. Consolidation of fill would yield reductions similar to Alt. 3. Air strippers can be up to 99% efficient in VOC removal from water.	Treatment zone would provide reduction of VOC concentration to below Class GA ground water standards.	Treatment zone would provide reduction of VOC concentration to below Class GA ground water standards.	Attainment of drinking water standards for VOC compounds of interest is expected.

Criterion	Alternative 1: No further action	Alternative 2: Excavation and off-site disposal with GW recovery and treatment	Alternative 3: Landfill cover with MNA of GW	Alternative 4: Landfill cover with GW extraction and *ex situ* treatment	Alternative 5: Landfill cover with *in situ* GW treatment by biobarrier	Alternative 6: Landfill cover with *in situ* GW treatment by iron wall	Alternative 7 Wellhead Protection by *ex situ* water treatment
	• **Ground water monitoring** • **Five year reviews**	• **Ground water monitoring** • **Five year reviews** • **Access/Use restrictions** • **Excavation of fill material** • **Offsite fill material disposal** • **Ground water recovery** • ***Ex situ* air stripping** • **Surface water disposal**	• **Ground water monitoring** • **Five year reviews** • **Access/Use restrictions** • **Soil or low-permeability landfill cover** • **Natural attenuation of ground water (with monitoring)**	• **Ground water monitoring** • **Five year reviews** • **Access/Use restrictions** • **Soil or low-permeability landfill cover** • **Ground water recovery** • ***Ex situ* air stripping** • **Surface water disposal**	• **Ground water monitoring** • **Five year reviews** • **Access/Use restrictions** • **Soil or low-permeability landfill cover** • ***In situ* ground water treatment (biobarrier)**	• **Ground water monitoring** • **Five year reviews** • **Access/Use restrictions** • **Soil or low-permeability landfill cover** • ***In situ* ground water treatment (iron wall)**	• **Five year reviews** • ***Ex situ* air stripping (of drinking water well)** • **Discharge to distribution system**
Degree to which treatment is irreversible	Natural attenuation of ground water is irreversible.	Removal of landfill material is irreversible. Treatment of ground water is irreversible.	Natural attenuation of ground water is irreversible.	Treatment of ground water is irreversible.	Treatment of ground water is irreversible.	Treatment of ground water is irreversible.	Treatment of ground water is irreversible.
Type and quantity of residuals remaining after treatment	No active treatment processes or removal are used in this alternative.	No residuals would remain after treatment.	90,000 cubic yards of fill material will remain onsite. VOCs will remain in ground water.	90,000 cubic yards of fill material will remain onsite.VOCs will remain in ground water downgradient of treatment zone.	90,000 cubic yards of fill material will remain onsite. VOCs will remain in ground water downgradient of treatment zone.	90,000 cubic yards of fill material will remain onsite. VOCs will remain in ground water downgradient of treatment zone.	90,000 cubic yards of fill material will remain onsite. VOCs will remain in ground water.
Short-term effectiveness							
Protection of community during remedial actions	No remedial actions are considered under this alternative.	Dust and volatile emissions, if any, will be controlled during excavation and removal of fill material. Air stripper would be designed such that emissions will be protective of the community.	Dust and volatile emissions, if any, will be controlled during installation of landfill cover.	Dust and volatile emissions, if any, will be controlled during installation of landfill cover. Air stripper would be designed such that emissions will be protective of the community.	Dust and volatile emissions, if any, will be controlled during installation of landfill cover.	Dust and volatile emissions, if any, will be controlled during installation of landfill cover.	Air stripper would be designed such that emissions will be protective of the community.
Protection of workers during remedial actions	No remedial actions are considered under this alternative.	Proper health and safety measures will be established and implemented during remedial activities.	Proper health and safety measures will be established and implemented during remedial activities.	Proper health and safety measures will be established and implemented during remedial activities.	Proper health and safety measures will be established and implemented during remedial activities.	Proper health and safety measures will be established and implemented during remedial activities.	Proper health and safety measures will be established and implemented during remedial activities.
Environmental impacts	There are no environmental impacts expected as a result of implementation of this alternative.	Dust, volatile emissions, and surface runoff controls will be instituted to minimize impacts to the environment during implementation of this alternative. This action will require the discharge of approximately 6,000 gallons per day of treated ground water to surface waters.	Dust, volatile emissions, and surface runoff controls will be instituted to minimize impacts to the environment during implementation of this alternative.	Dust, volatile emissions, and surface runoff controls will be instituted to minimize impacts to the environment during implementation of this alternative. This action will require the discharge of approximately 6,000 gallons per day of treated ground water to surface waters.	Dust, volatile emissions, and surface runoff controls will be instituted to minimize impacts to the environment during implementation of this alternative.	Dust, volatile emissions, and surface runoff controls will be instituted to minimize impacts to the environment during implementation of this alternative.	Air stripper would be designed such that emissions will be protective of the environment.
Time until remedial action objectives (RAOs) are achieved	RAOs related to human health and to ecological receptors will not be met upon completion of the remedy. Natural attenuation under this alternative is not anticipated to achieve NYS Class GA standards in ground water in the foreseeable future, due to the presence of a continuing source of VOCs.	RAOs associated with direct contant of fill and leachate generation would be met upon completion of excavation. RAOs associated with Site ground water contact and criteria are estimated to be met within approximately 40 years. RAOs associated with off-site ground water contact and criteria are estimted to be met within approximately 32 years.	RAOs associated with direct contant of fill and leachate generation would be met upon completion of a cover. Under the consolidation cover alternative, RAOs associated with Site ground water contact and criteria are estimated to be met within approximately 72 years. For cover options other than consolidation, it is not anticipated that natural attenuation will achieve Site ground water RAOs in the foreseeable future, due to the presence of a continuing source of VOCs.	RAOs associated with direct contant of fill and leachate generation would be met upon completion of a cover. Under the consolidation cover alternative, RAOs associated with Site ground water contact and criteria are estimated to be met within approximately 40 years. RAOs associated with off-site ground water contact and criteria are estimted to be met within approximately 32 years. For cover options other than consolidation, it is not anticipated that natural attenuation will achieve Site ground water RAOs in the foreseeable future, due to the presence of a continuing source of VOCs.	RAOs associated with direct contant of fill and leachate generation would be met upon completion of a cover. Under the consolidation cover alternative, RAOs associated with Site ground water contact and criteria are estimated to be met within approximately 40 years. For cover options other than consolidation, it is not anticipated that natural attenuation will achieve Site ground water RAOs in the foreseeable future, due to the presence of a continuing source of VOCs.	RAOs associated with direct contant of fill and leachate generation would be met upon completion of a cover. RAOs associated with ground water contact and criteria are estimated to be met within approximately 40 years. For cover options other than consolidation, it is not anticipated that natural attenuation will achieve Site ground water RAOs in the foreseeable future, due to the presence of a continuing source of VOCs.	This alternative would achieve the RAO addressing exposure to affected ground water via the municipal drinking water well upon installation. Natural attenuation is not anticipated to achieve NYS Class GA standards in Site ground water in the foreseeable future, due to the presence of a continuing source of VOCs.

Criterion	Alternative 1: No further action	Alternative 2: Excavation and off-site disposal with GW recovery and treatment	Alternative 3: Landfill cover with MNA of GW	Alternative 4: Landfill cover with GW extraction and *ex situ* treatment	Alternative 5: Landfill cover with *in situ* GW treatment by biobarrier	Alternative 6: Landfill cover with *in situ* GW treatment by iron wall	Alternative 7 Wellhead Protection by *ex situ* water treatment
	• Ground water monitoring • Five year reviews	• Ground water monitoring • Five year reviews • Access/Use restrictions • Excavation of fill material • Offsite fill material disposal • Ground water recovery • *Ex situ* air stripping • Surface water disposal	• Ground water monitoring • Five year reviews • Access/Use restrictions • Soil or low-permeability landfill cover • Natural attenuation of ground water (with monitoring)	• Ground water monitoring • Five year reviews • Access/Use restrictions • Soil or low-permeability landfill cover • Ground water recovery • *Ex situ* air stripping • Surface water disposal	• Ground water monitoring • Five year reviews • Access/Use restrictions • Soil or low-permeability landfill cover • *In situ* ground water treatment (biobarrier)	• Ground water monitoring • Five year reviews • Access/Use restrictions • Soil or low-permeability landfill cover • *In situ* ground water treatment (iron wall)	• Five year reviews • *Ex situ* air stripping (of drinking water well) • Discharge to distribution system
Implementability							
Ability to construct and operate the technology	There are no technologies to be constructed in this alternative.	Removal of fill material is readily constructable. Installation and operation of ground water recovery wells and air stripping equipment is readily constructable and operable.	Installation of any landfill cover option is readily constructable.	Installation of any landfill cover option is readily constructable. Installation and operation of ground water extraction wells and air stripping equipment is readily constructable and operable.	Installation of any landfill cover option is readily constructable. Installation of material or equipment of develop treatment zones are readily constructable.	Installation of any landfill cover option is readily constructable. Installation of material or equipment of develop treatment zones are readily constructable.	Addition of air stripping equipment to municipal well system is readily constructable and operable.
Reliability of technology	Ground water sampling and analysis is a reliable means to continue to monitor on- and off-site ground water concentrations.	Removal of soil and fill materials is a reliable technology. Air stripping is a reliable technology to remove VOCs in ground water.	A landfill cover is a reliable technology for isolation of impacted soils and for reduction of surface water infiltration. A low-permeability cover provides reliablility for minimizing infiltration and subsequent potential for contaminant migration.	A landfill cover is a reliable technology for isolation of impacted soils and for reduction of surface water infiltration. A low-permeability cover provides the reliablility for minimizing infiltration and subsequent potential for contaminant migration. Air stripping is a reliable technology to remove VOC concentrations in ground water.	A landfill cover is a reliable technology for isolation of impacted soils and for reduction of surface water infiltration. A low-permeability cover provides the reliablility for minimizing infiltration and subsequent potential for contaminant migration. Biobarriers are a reliable technology to reduce VOC concentrations in ground water.	A landfill cover is a reliable technology for isolation of impacted soils and for reduction of surface water infiltration. A low-permeability cover provides the reliablility for minimizing infiltration and subsequent potential for contaminant migration. Iron walls are a reliable technology to reduce VOC concentrations in ground water.	Air stripping is a reliable technology to remove VOC concentrations in ground water.
Ease of undertaking additional remedial actions, if necessary	Additional remedial actions, if necessary, would be readily implementable.	Additional remedial actions, if necessary, would be readily implementable.	Additional remedial actions, if necessary, would be readily implementable.	Additional remedial actions, if necessary, would be readily implementable.	Additional remedial actions, if necessary, would be readily implementable.	Additional remedial actions, if necessary, would be readily implementable.	Additional remedial actions, if necessary, would be readily implementable.
Ability to monitor effectiveness of remedy	Ground water monitoring allows the ability to monitor the effectiveness of natural attenuation.	Effectiveness of remedy could be monitored through confirmation sampling and ground water monitoring.	Effectiveness of remedy could be monitored by ground water monitoring and cover inspection.	Effectiveness of remedy could be monitored by ground water monitoring and cover inspection.	Effectiveness of remedy could be monitored by ground water monitoring and cover inspection.	Effectiveness of remedy could be monitored by ground water monitoring and cover inspection.	Effectiveness of remedy components would be monitored through analysis of stripper emissions and treated water discharge.
Coordination with other agencies and property owners	None required.	Coordination with local authorities would be necessary to implement use and access restrictions.	Coordination with local authorities would be necessary to implement use and access restrictions.	Coordination with local authorities would be necessary to implement use and access restrictions.	Coordination with local authorities would be necessary to implement use and access restrictions.	Coordination with local authorities would be necessary to implement use and access restrictions.	Coordination with authorities, including the local water department and state and local departments of health, would be necessary to implement modifications to the municipal ground water well.
Availability of off-site treatment storage and disposal services and capacities	None required.	Offsite disposal facilities for material generated by removal of landfill material are available.	None required.	None required.	None required.	None required.	None required.
Availability of necessary equipment, specialists, and materials	Readily available.	Readily available.	Readily available.	Readily available.	Readily available.	Readily available.	Readily available.
Costs							
Capital cost (1)	$0	$21,800,000	$2,720,000 $6,360,000 $4,500,000	$3,032,000 $6,671,000 $4,810,000	$3,845,000 $7,483,000 $5,623,000	$6,024,000 $9,662,000 $7,801,000	$290,000
Present worth of operation and maintenance cost (1)(2)	$983,000	$6,692,000	$1,900,000 $2,803,000 $2,342,000	$2,214,000 $3,117,000 $2,655,000	$9,923,000 $10,826,000 $10,365,000	$22,200,000 $23,103,000 $22,641,000	$177,000
Approximate total net present worth cost (1)	$983,000	$28,492,000	$4,620,000 $9,163,000 $6,842,000	$5,246,000 $9,788,000 $7,465,000	$13,768,000 $18,309,000 $15,988,000	$28,224,000 $32,765,000 $30,442,000	$467,000

(1) Where applicable, top figure represents cost for soil cover; middle figure represents cost of low-permeability cover, bottom figure represents of cost of fill consolidation with low-permeability cover.

(2) Operation and Maintenance costs for Alternative 6 include a one time cost to reinstall the iron wall after an anticipated 15-year service life. The present worth value of $19,464,000 has been added to O&M. See Table 11.

Table 5. *Evaluation of potential SCGs*

Medium/Location/ Action	Citation	Requirements	Comments	PotentialSCG	Alternative
Potential chemical-specific SCGs					
Ground water	6 NYCRR 703 - Class GA ground water quality standards	Fresh ground waters of the state must attain Class GA standards if intended for potable use. There are no specific standards for other ground water classifications.	Potentially applicable to site ground water given proximity to existing municipal water production well.	Yes	1, 2, 3, 4, 5, 6 & 7
Surface water	6 NYCRR 703 - Class C surface water standards	Outlines surface water quality standards and guidance values for Class C surface waters.	Potentially applicable to site surface wa ter.	Yes	1, 2, 3, 4, 5, 6 & 7
Soil	NYSDEC TAGM HWR-94-4046 - Recommended soil cleanup objectives	Guidance that provides recommended soil cleanup objectives.	Potentially applicable to site soil.	Yes	1, 2, 3, 4, 5, 6 & 7
Potential location-specific SCGs					
Wetlands	6 NYCRR 663 - Freshwater wetland permit requirements	Actions occurring in a designated freshwater wetland (within 100 ft) must be approved by NYSDEC or its designee. Activities occurring adjacent to freshwater wetlands must: be compatible with preservation, protection, and conservation of wetlands and benefits; result in no more than insubstantial degradation to or loss of any part of the wetland; and be compatible with public health and welfare.	Potentially applicable since the Site is within 100 ft of one or more NYS designated freshwater wetlands, as shown on available mapping provided in the FWIA for the Site (O'Brien & Gere 2005).	Yes	2, 3, 4, 5, & 6
	Executive Order 11990 - Protection of Wetlands	Activities occurring in wetlands must avoid, to the extent possible, the long- and short-term adverse impacts associated with the destruction or modification of wetlands. The procedures also require USEPA to avoid direct or indirect support of new construction in wetlands wherever there are practicable alternatives or minimize potential harm to wetlands when there are no practicable alternatives.	Potentially applicable based on available mapping which shows NWI habitat within 100 ft of the Site (O'Brien & Gere 2005). However, delineation of Federal Wetlands has not been conducted at this site.	Yes	2, 3, 4, 5, & 6
100-year flood plain	6 NYCRR 373-2.2 - Location standards for hazardous waste treatment, storage, and disposal facilities -100-yr floodplain	Hazardous waste treatment, storage, or disposal facilities located in a 100-yr floodplain must be designed, constructed, operated and maintained to prevent washout of hazardous waste during a 100-yr flood.	Potentially applicable if hazardous waste is capped on-site and if the Site is in the 100-year floodplain.	Yes	3, 4, 5, & 6
	Executive Order 11988 - Floodplain Management	EPA is required to conduct activities to avoid, to the extent possible, the long- and short- term adverse impacts associated with the occupation or modification of floodplains. The procedures also require EPA to avoid direct or indirect support of floodplain development wherever there are practicable alternatives and minimize potential harm to floodplains when there are no practicable alternatives.	Potentally applicable for alternatives that involve excavation/grading activities if the Site is located in the 100-year floodplain.	Yes	2, 3, 4, 5, & 6
Within 61 meters (200 ft) of a fault displaced in Holocene time	40 CFR Part 264.18	New treatment, storage, or disposal of hazardous waste is not allowed.	Not applicable or relevant and appropriate. Site is not located within 200 ft of a fault displaced in Holocene time, as listed in 40 CFR 264 Appendix VI.	No	None
River or stream	16 USC 661 - Fish and Wildlife Coordination Act	Requires protection of fish and wildlife in a stream when performing activities that modify a stream or river.	Potentially applicable for actions that may impact the unnamed tributary located adjacent to the site to the north by discharge of treated ground water.	Yes	2, 3, 4, 5, & 6
Habitat of an endangered or threatened species	6 NYCRR 182	Provides requirements to minimize damage to habitat of an endangered species.	Potentially applicable for actions that may impact the habitat of identified endangered species.	Yes	2, 3, 4, 5, & 6
	Endangered Species Act	Provides a means for conserving various species of fish, wildlife, and plants that are threatened with extinction.	Potentially applicable because of the existance of one listed and one recommended endangered species w/in 2 mi. radius of site.	Yes	2, 3, 4, 5, & 6

Table 5. *Evaluation of potential SCGs*

Medium/Location/ Action	Citation	Requirements	Comments	PotentialSCG	Alternative
Potential location-specific SCGs (cont.)					
Historical property or district	National Historic Preservation Act	Remedial actions are required to account for the effects of remedial activities on any historic properties included on or eligible for inclusion on the National Register of Historic Places.	Potentially applicable or relevant and appropriate, if Site found to be a historical property.	Yes	2, 3, 4, 5, & 6
Potential action-specific SCGs					
Construction in a floodplain	6 NYCRR 500 - Floodplain management regulations development permits	Development in a 100-year floodplain must be approved by NYSDEC. Construction must not result in increased flood elevations in the community.	Potentially applicable for alternatives that involve excavation, grading, and/or capping if the Site is located in a 100-year floodplain.	Yes	2, 3, 4, 5, & 6
General excavation	6 NYCRR 257-3 - Air Quality Standards	Provide limitations for generation of constituents including particulate matter.	Not applicable or relevant and appropriate because dust emissions would not be from a point source. May be useful for consideration during dust generating activities such as earth moving, grading and excavation of soil.	Yes	2, 3, 4, 5, & 6
	40 CFR 50.1 through 50.12 - National Ambient Air Quality Standards.	Provides air quality standards for pollutants considered harmful to public health and the environment. The six principle pollutants include carbon monoxide, lead, nitrogen dioxide, particulates, ozone, and sulfur oxides.	Potentially applicable during dust generating activities such as earth moving, grading, and excavation of soil.	Yes	2, 3, 4, 5, & 6
Removal & treatment actions	6 NYCRR 373 - Hazardous waste management facilities	Provides requirements for managing hazardous wastes.	Potentially applicable if hazardous waste is present in/removed from the landfill. May also be applicable for treatment of ground water.	Yes	2 & 4
Landfill cover	6 NYCRR 360 - Solid Waste Management Facilities	Provides requirements for construction of the final cover of a solid waste landfill.	Potentially applicable for alternatives that include capping material on-site.	Yes	3, 4, 5, & 6
Land disposal	6 NYCRR 376 - Land disposal restrictions	Provides treatment standards to be met prior to land disposal of hazardous wastes.	Potentially applicable for alternatives that include capping material on-site.	Yes	3, 4, 5, & 6
Discharge to surface water	6 NYCRR Parts 750 - 758 - SPDES	Provides concentration limits and monitoring requirements for discharges to waters of the State.	Potentially applicable for surface discharge of treated ground water	Yes	2 & 4
Construction	29 CFR Part 1910 - Occupational Safety and Health Standards - Hazardous Waste Operations and Emergency Response	Remedial activities must be in accordance with applicable OSHA requirements.	Applicable for construction and monitoring phase of remediation.	Yes	1, 2, 3, 4, 5, 6 & 7
	29 CFR Part 1926 - Safety and Health Regulations for Construction	Remedial construction activities must be in accordance with applicable OSHA requirements.	Applicable for construction phase of remediation.	Yes	2, 3, 4, 5, 6 & 7
Transportation	6 NYCRR 364 - Waste Transporter Permits	Hazardous waste transport must be conducted by a hauler permitted under 6 NYCRR 364.	Potentially applicable.	Yes	2
	6 NYCRR Part 372 - Hazardous Waste Manifest System and Related Standards for Generators, Transporters, and Facilities	Substantive hazardous waste generator and transportation requirements must be met when hazardous waste is generated for disposal. Generator requirements include obtaining an EPA Identification Number and manifesting hazardous waste for disposal.	Potentially applicable.	Yes	2
	49 CFR 172-174 and 177-179 - Department of Transportation Regulations	Hazardous waste transport to offsite disposal facilities must be conducted in accordance with applicable DOT requirements	Potentially applicable.	Yes	2
Generation of air emissions	NYS Air Guide 1	Provides annual guideline concentrations (AGLs) and short-term guideline concentrations (SGCs) for specific chemicals. These are property boundary limitations that would result in no adverse health effects.	Potentially applicable.	Yes	2, 3, 4, 5 & 6
	NYS TAGM 4031 - Dust Suppressing and Particle Monitoring at Inactive Hazardous Waste Disposal Sites	Provides limitations on dust emissions.	Potentially applicable.	Yes	2, 3, 4, 5 & 6

Table 5. *Evaluation of potential SCGs*

Medium/Location/ Action	Citation	Requirements	Comments	PotentialSCG	Alternative
Construction storm water management	NYSDEC General permit for storm water discharges associated with construction activities. Pursuant to Article 17 Titles 7 and 8 and Article 70 of the Environmental Conservation Law.	The regulation prohibits discharge of materials other than storm water and all discharges that contain a hazardous substance in excess of reportable quantities established by 40 CFR 117.3 or 40 CFR 302.4, unless a separate NPDES permit has been issued to regulate those discharges. A permit must be acquired if activities involve the disturbance of 5 acres or more. If the project is covered under the general permit, the following are required: development and implementation of a storm water pollution prevention plan; development and implementation of a monitoring program; all records must be retained for a period of at least 3 years after construction is complete.	Potentially applicable for construction activities.	Yes	2, 3, 4, 5, & 6

Town of Carroll Landfill
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Table 6: Alternative #1
No Action
COST ESTIMATE

ITEM	UNIT	ESTIMATED QUANTITY	ESTIMATED UNIT COST	ESTIMATED COST	
Direct Capital Costs; *No Direct Capital Costs are associated with Alternative No. 1*					
				SUBTOTAL:	**None**
			TOTAL DIRECT CAPITAL COST:		
Indirect Capital Costs; *No Indirect Capital Costs are associated with Alternative No. 1*					
Contingency (25% Direct Capital Costs)	LS	1	$0	$0	
Engineering (15% of Direct Capital Costs)	LS	1	$0	$0	
Legal Fees (5% Direct Capital Costs)	LS	1	$0	$0	
			TOTAL INDIRECT CAPITOL COSTS:		**None**
			TOTAL CAPITAL COSTS ROUNDED:		
Annual Operation & Maintenance Costs					
Site Inspection	DAYS	4	$800	$3,200	
Site Maintenance	LS	1	$2,000	$2,000	
Ground Water Monitoring	LS	1	$70,000	$70,000	
5 year Review (Annual Cost)	LS	1	$1,000	$1,000	
Insurance (1% Direct Capital Cost; $1,500 minimum)	LS	1	$0	$1,500	
Reserve Fund (1% Direct Capital Cost; $1,500 minimum)	LS	1	$0	$1,500	
			SUBTOTAL:	**$79,200**	
			PRESENT WORTH OF ANNUAL O&M: *30 yr, I=7%		**$983,000**
			APPROXIMATE TOTAL PRESENT WORTH COST:		**$983,000**

Town of Carroll Landfill
Carroll, NY

Table 7: Alternative #2
Excavation and Offsite Disposal
COST ESTIMATE

ITEM	UNIT	ESTIMATED QUANTITY	ESTIMATED UNIT COST	ESTIMATED COST	
Direct Capital Costs					
1) Mobilization					
Contractor Bond (1%)	LS	1	$155,567	$155,567	
Equipment and Site Facilities	LS	1	$259,000	$259,000	
				SUBTOTAL:	**$414,567**
2) Site Preparation					
Site Survey and Topography	ACRE	16	$1,000	$16,000	
Clearing and Grubbing	ACRE	6.4	$15,300	$97,920	
Erosion and Sediment Control					
Silt Fence	LF	3,800	$1	$3,800	
				SUBTOTAL:	**$117,720**
3) Soil Excavation, Offsite Disposal and Surface Restoration					
Dewatering Pad	LS	1	$85,000	$85,000	
Excavation of Landfill Material	CY	90,000	$15	$1,350,000	
Soil Management and Staging	LS	1	$50,000	$50,000	
Confirmatory Sampling	LS	1	$150,000	$150,000	
Offsite Disposal - Hazardous	TON	33,750	$150	$5,062,500	
Offsite Disposal - Nonhazardous	TON	101,250	$75	$7,593,750	
Backfill Material	CY	15,000	$12	$180,000	
Topsoil	CY	12,000	$22	$264,000	
Seeding/Mulch	SF	864,000	$0.50	$432,000	
				SUBTOTAL:	**$15,167,250**
4) Groundwater Recovery and Treatment					
Install 8-inch wells	VLF	140	$75	$10,500	
Submersible Well Pump	EA	2	$2,500	$5,000	
Level Transducer	EA	2	$1,000	$2,000	
Air Stripper Equipment	LS	1	$12,000	$12,000	
Air Stripper Enclosure	LS	1	$85,000	$85,000	
Controls and Integration	LS	1	$15,000	$15,000	
Electrical Conduit and Service	LS	1	$25,000	$25,000	
Treatment system discharge piping (8-inch PVC)	LF	250	$45	$11,250	
				SUBTOTAL:	**$165,750**
5) Other Costs					
Winter Shutdown	LS	1	$30,000	$30,000	
Deed Restrictions	LS	1	$20,000	$20,000	
Air monitoring	LS	1	$20,000	$20,000	
Dust Control Plan	LS	1	$5,000	$5,000	
Stormwater Pollution Prevention Plan	LS	1	$5,000	$5,000	
SPDES Discharge Permit	LS	1	$10,000	$10,000	
Final Site Survey	LS	1	$16,000	$16,000	
				SUBTOTAL:	**$106,000**
				TOTAL DIRECT CAPITAL COST:	**$15,971,287**
Indirect Capital Costs					
Contingency (30% Direct Capital Costs)		1	$4,791,386	$4,791,386	$4,791,386
Engineering (15% of Direct Capitol Costs)		1	$239,569	$239,569	$239,569
Legal Fees (5% Direct Capital Costs)		1	$798,564	$798,564	$798,564
				TOTAL INDIRECT CAPITOL COSTS:	**$5,829,520**
				TOTAL CAPITAL COSTS ROUNDED:	**$21,800,000**
Annual Operation & Maintenance Costs					
Site Inspection	DAYS	4	$800	$3,200	
Site Maintenance	LS	1	$10,000	$10,000	
5 year Review (Annual Cost)	LS	1	$1,000	$1,000	
Ground Water Monitoring	LS	1	$70,000	$70,000	
SDPES Discharge Monitoring	LS	1	$18,000	$18,000	
Electrical Usage	LS	1	$1,050	$1,050	
Insurance (1% Direct Capital Cost)	LS	1	$218,000	$218,000	
Reserve Fund (1% Direct Capital Cost)	LS	1	$218,000	$218,000	
			SUBTOTAL:	**$539,250**	
			PRESENT WORTH* OF ANNUAL O&M: *30 yr, I=7%		**$6,692,000**
				APPROXIMATE TOTAL PRESENT WORTH COST:	**$28,492,000**

Town of Carroll Landfill
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Table 8: Alternative #3
Landfill Cover
COST ESTIMATE

ITEM	UNIT	ESTIMATED QUANTITY	ESTIMATED UNIT COST	ESTIMATED COST	
Direct Capital Costs					
1) Mobilization					
Contractor Bond (1%) (Soil cover)	LS	1	$17,986	$17,986	
Contractor Bond (1%) (Low perm cover)	LS	1	$42,002	$42,002	
Contractor Bond (1%) (Fill consolidation with low perm cover)	LS	1	$29,720	$29,720	
Equipment and Site Facilities	LS	1	$66,000	$66,000	
				SUBTOTAL (soil cover):	**$83,986**
				SUBTOTAL (low-perm cover):	**$108,002**
				SUBTOTAL (Fill consolidation and low-perm cover):	**$95,720**
2) Site Preparation					
Site Survey and Topography	ACRE	16	$1,000	$16,000	
Clearing and Grubbing	ACRE	6.4	$15,300	$97,920	
Swale/Site Fill Material	CY	10,000	$12	$120,000	
Erosion and Sediment Control					
Silt Fence	LF	3,800	$1	$3,800	
				SUBTOTAL:	**$237,720**
3A) Soil Cover					
Topsoil	CY	16,000	$22	$352,000	
Seeding/Mulch	SF	864,000	$0.50	$432,000	
Backfill Soil Material (18-inch depth)	CY	48,000	$12	$576,000	
Perimeter Drainage Stone	CY	320	$6	$1,920	
Toe Drain	LF	1,800	$15	$27,000	
Holding Tank	EA	1	$10,000	$10,000	
3B) Low Permeability Cover (additional components)					
Backfill Soil Material (additional 6-inch depth)	CY	16,000	$12	$192,000	
Tri-Planar Geonet	SF	864,000	$1.40	$1,209,600	
40 mil LLDPE (Impermeable layer)	SF	864,000	$0.75	$648,000	
Soil Bedding Material (6-inch depth)	SF	16,000	$22	$352,000	
3C) Fill Consolidation and Low-Permeability Cover					
Dewatering Pad	LS	1	$85,000	$85,000	
Excavation of Landfill Material (western cell)	CY	60,000	$15	$900,000	
Topsoil	CY	16,000	$22	$352,000	
Seeding/Mulch	SF	864,000	$0.50	$432,000	
Backfill Soil Material (24-inch depth)	CY	17,000	$12	$204,000	
Tri-Planar Geonet	SF	225,000	$1.40	$315,000	
40 mil LLDPE (Impermeable layer)	SF	225,000	$0.75	$168,750	
Soil Bedding Material (6-inch depth)	SF	4,000	$22	$88,000	
Perimeter Drainage Stone	CY	170	$6	$1,020	
Toe Drain	LF	1,100	$15	$16,500	
Holding Tank	EA	1	$10,000	$10,000	
				SUBTOTAL (soil cover):	**$1,398,920**
				SUBTOTAL (low-perm cover):	**$3,800,520**
				SUBTOTAL (Fill consolidation and low-perm cover):	**$2,572,270**
4) Other Costs					
Winter Shutdown	LS	1	$30,000	$30,000	
Deed Restrictions	LS	1	$20,000	$20,000	
Air monitoring	LS	1	$20,000	$20,000	
Dust Control Plan	LS	1	$5,000	$5,000	
Stormwater Pollution Prevention Plan	LS	1	$5,000	$5,000	
Final Site Survey	LS	1	$16,000	$16,000	
				SUBTOTAL:	**$96,000**
				TOTAL DIRECT CAPITAL COST (SOIL COVER):	**$1,816,626**
				TOTAL DIRECT CAPITAL COST (LOW PERM COVER):	**$4,242,242**
				TOTAL DIRECT CAPITAL COST (FILL CONSOLIDATION WITH LOW PERM COVER):	**$3,001,710**
Indirect Capital Costs					
Soil Cover					
Contingency (30% Direct Capital Costs)		1	$544,988	$544,988	$544,988
Engineering (15% of Direct Capitol Costs)		1	$272,494	$272,494	$272,494
Legal Fees (5% Direct Capital Costs)		1	$90,831	$90,831	$90,831
Low perm cover					
Contingency (30% Direct Capital Costs)		1	$1,272,673	$1,272,673	$1,272,673
Engineering (15% of Direct Capitol Costs)		1	$636,336	$636,336	$636,336
Legal Fees (5% Direct Capital Costs)		1	$212,112	$212,112	$212,112
Soil Cover with Fill consolidation and low perm cover					
Contingency (30% Direct Capital Costs)		1	$900,513	$900,513	$900,513
Engineering (15% of Direct Capitol Costs)		1	$450,256	$450,256	$450,256
Legal Fees (5% Direct Capital Costs)		1	$150,085	$150,085	$150,085
				TOTAL INDIRECT CAPITAL COST (SOIL COVER):	**$908,313**
				TOTAL INDIRECT CAPITAL COST (LOW PERM COVER):	**$2,121,121**
				TOTAL INDIRECT CAPITAL COST (FILL CONSOLIDATION WITH LOW PERM COVER):	**$1,500,855**
				TOTAL CAPITAL COST (SOIL COVER):	**$2,720,000**
				TOTAL CAPITAL COST (LOW PERM COVER):	**$6,360,000**

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Table 8: Alternative #3
Landfill Cover
COST ESTIMATE

ITEM	UNIT	ESTIMATED QUANTITY	ESTIMATED UNIT COST	ESTIMATED COST	
	TOTAL CAPITAL COST (FILL CONSOLIDATION WITH LOW PERM COVER):				$4,500,000

Town of Carroll Landfill
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Table 8: Alternative #3
Landfill Cover
COST ESTIMATE

ITEM	UNIT	ESTIMATED QUANTITY	ESTIMATED UNIT COST	ESTIMATED COST
Annual Operation & Maintenance Costs				
Insurance (1% Direct Capital Cost of Soil cover)	LS	1	$27,200	$27,200
Reserve Fund (1% Direct Capital Cost of Soil cover)	LS	1	$27,200	$27,200
Insurance (1% Direct Capital Cost of Low perm cover)	LS	1	$63,600	$63,600
Reserve Fund (1% Direct Capital Cost of Low perm cover)	LS	1	$63,600	$63,600
Insurance (1% Direct Capital Cost of fill consolidation with low perm cover)	LS	1	$45,000	$45,000
Reserve Fund (1% Direct Capital Cost of fill consolidation with low perm cover)	LS	1	$45,000	$45,000
Site Inspection	DAYS	4	$800	$3,200
Site Maintenance	LS	1	$12,000	$12,000
Off-site Leachate removal and disposal	Gal.	10000	$1.25	$12,500
5 year Review (Annual Cost)	LS	1	$1,000	$1,000
Ground Water Monitoring	LS	1	$70,000	$70,000
			SUBTOTAL (soil cover):	**$153,100**
			SUBTOTAL (low-perm cover):	**$225,900**
			SUBTOTAL (Fill consolidation and low-perm cover):	**$188,700**

APPROX. PRESENT WORTH* OF ANNUAL O&M (SOIL COVER):	**$1,900,000**
APPROX. PRESENT WORTH* OF ANNUAL O&M (LOW PERM COVER):	**$2,803,000**
APPROX. PRESENT WORTH* OF ANNUAL O&M (FILL CONSOLIDATION WITH LOW PERM COVER):	**$2,342,000**
*30 yr, I=7%	
APPROXIMATE TOTAL PRESENT WORTH COST (SOIL COVER):	**$4,620,000**
APPROXIMATE TOTAL PRESENT WORTH COST (LOW PERM COVER):	**$9,163,000**
APPROXIMATE TOTAL PRESENT WORTH COST (FILL CONSOLIDATION WITH LOW PERM COVER):	**$6,842,000**

Town of Carroll Landfill
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Table 9: Alternative #4
Cover with Ground water Extraction/Treatment
COST ESTIMATE

ITEM	UNIT	ESTIMATED QUANTITY	ESTIMATED UNIT COST	ESTIMATED COST	
Direct Capital Costs					
1) Mobilization					
Contractor Bond (1%) - Soil cover	LS	1	$20,014	$20,014	
Contractor Bond (1%) - Low-permeability cover	LS	1	$44,030	$44,030	
Contractor Bond (1%) - Fill consolidation with low-perm cover	LS	1	$31,747	$31,747	
Equipment and Site Facilities	LS	1	$58,000	$58,000	
				SUBTOTAL (soil cover):	**$78,014**
				SUBTOTAL: (low-perm cover):	**$102,030**
				SUBTOTAL: (fill consolidation and low-perm cover):	**$89,747**
2) Site Preparation					
Site Survey and Topography	ACRE	16	$1,000	$16,000	
Clearing and Grubbing	ACRE	6.4	$15,300	$97,920	
Swale/Site Fill Material	CY	10,000	$12	$120,000	
Erosion and Sediment Control					
Silt Fence	LF	3,800	$1	$3,800	
				SUBTOTAL:	**$237,720**
3) Landfill Cover*					
**See Table 8 (Alternative 3) for detailed estimate of each option*					
				SUBTOTAL (soil cover):	**$1,398,920**
				SUBTOTAL: (low-perm cover):	**$3,800,520**
				SUBTOTAL: (fill consolidation and low-perm cover):	**$2,572,270**
4) Groundwater Recovery and Treatment					
Pre-design study	EA	1	$40,000	$40,000	
Install 8-inch wells	VLF	140	$75	$10,500	
Submersible Well Pump	EA	2	$2,500	$5,000	
Level Transducer	EA	2	$1,000	$2,000	
Air Stripper Equipment	LS	1	$12,000	$12,000	
Air Stripper Enclosure	LS	1	$85,000	$85,000	
Controls and Integration	LS	1	$15,000	$15,000	
Electrical Conduit and Service	LS	1	$25,000	$25,000	
Treatment system discharge piping (8-inch PVC)	LF	250	$45	$11,250	
				SUBTOTAL:	**$205,750**
5) Other Costs					
Winter Shutdown	LS	1	$30,000	$30,000	
Deed Restrictions	LS	1	$20,000	$20,000	
Air monitoring	LS	1	$20,000	$20,000	
Dust Control Plan	LS	1	$5,000	$5,000	
Stormwater Pollution Prevention Plan	LS	1	$5,000	$5,000	
Modification of Drinking Water Permit	LS	1	$5,000	$5,000	
Final Site Survey	LS	1	$16,000	$16,000	
				SUBTOTAL:	**$101,000**
				TOTAL DIRECT CAPITOL COSTS (soil cover):	**$2,021,404**
				TOTAL DIRECT CAPITOL COSTS (low-perm cover):	**$4,447,020**
				TOTAL DIRECT CAPITOL COSTS (fill consolidation and low-perm cover):	**$3,206,487**
Indirect Capital Costs					
Soil Cover					
Contingency (30% Direct Capital Costs)		1	$606,421	$606,421	$606,421
Engineering (15% of Direct Capitol Costs)		1	$303,211	$303,211	$303,211
Legal Fees (5% Direct Capital Costs)		1	$101,070	$101,070	$101,070
Low-permeability cover					
Contingency (30% Direct Capital Costs)		1	$1,334,106	$1,334,106	$1,334,106
Engineering (15% of Direct Capitol Costs)		1	$667,053	$667,053	$667,053
Legal Fees (5% Direct Capital Costs)		1	$222,351	$222,351	$222,351
Fill consolidation and low-permeability cover					
Contingency (30% Direct Capital Costs)		1	$961,946	$961,946	$961,946
Engineering (15% of Direct Capitol Costs)		1	$480,973	$480,973	$480,973
Legal Fees (5% Direct Capital Costs)		1	$160,324	$160,324	$160,324
				TOTAL INDIRECT CAPITOL COSTS (soil cover):	**$1,010,702**
				TOTAL INDIRECT CAPITOL COSTS low-perm cover):	**$2,223,510**
				TOTAL INDIRECT CAPITOL COSTS (fill consolidation and low-perm cover):	**$1,603,244**
				TOTAL CAPITOL COSTS (soil cover):	**$3,032,000**
				TOTAL CAPITOL COSTS (low-perm cover):	**$6,671,000**
				TOTAL CAPITOL COSTS (fill consolidation and low-perm cover):	**$4,810,000**

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Table 9: Alternative #4
Cover with Ground water Extraction/Treatment
COST ESTIMATE

ITEM	UNIT	ESTIMATED QUANTITY	ESTIMATED UNIT COST	ESTIMATED COST	
Annual Operation & Maintenance Costs					
Insurance (1% Direct Capital Cost of Soil Cover)	LS	1	$30,320	$30,320	
Reserve Fund (1% Direct Capital Cost of Soil Cover)	LS	1	$30,320	$30,320	
Insurance (1% Direct Capital Cost of Low-Perm Cover)	LS	1	$66,710	$66,710	
Reserve Fund (1% Direct Capital Cost of Low-Perm Cover)	LS	1	$66,710	$66,710	
Insurance (1% Direct Capital Cost of Fill Consolidation and Low-Perm Cover)	LS	1	$48,100	$48,100	
Reserve Fund (1% Direct Capital Cost of Fill Consol. and Low-Perm Cover)	LS	1	$48,100	$48,100	
Site Inspection	DAYS	4	$800	$3,200	
Site Maintenance	LS	1	$12,000	$12,000	
Off-site Leachate removal and disposal	Gal.	10000	$1.25	$12,500	
SPDES Discharge Monitoring	LS	1	$18,000	$18,000	
5 year Review (Annual Cost)	LS	1	$1,000	$1,000	
Electrical Usage	LS	1	$1,050	$1,050	
Ground Water Monitoring	LS	1	$70,000	$70,000	
			SUBTOTAL ANNUAL O&M (soil cover):	**$178,390**	
			SUBTOTAL ANNUAL O&M (low-perm cover):	**$251,170**	
			SUBTOTAL ANNUAL O&M (fill consolidation and low-perm cover):	**$213,950**	
				APPROX. PRESENT WORTH* OF ANNUAL O&M (soil cover):	**$2,214,000**
				APPROX. PRESENT WORTH* OF ANNUAL O&M (low-perm cover):	**$3,117,000**
				APPROX. PRESENT WORTH* OF ANNUAL O&M (fill consolidation and low-perm cover):	**$2,655,000**
				*30 yr, I=7%	
				APPROXIMATE TOTAL PRESENT WORTH COST (soil cover):	**$5,246,000**
				APPROXIMATE TOTAL PRESENT WORTH COST (low-perm cover):	**$9,788,000**
				APPROXIMATE TOTAL PRESENT WORTH COST (fill consolidation and low perm cover):	**$7,465,000**

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Table 10: Alternative #5
Cover with *In Situ* Enhanced Attenuation
COST ESTIMATE

ITEM	UNIT	ESTIMATED QUANTITY	ESTIMATED UNIT COST	ESTIMATED COST	
Direct Capital Costs					
1) Mobilization					
Contractor Bond (1%) - Soil cover	LS	1	$25,379	$25,379	
Contractor Bond (1%) - Low-permeability cover	LS	1	$49,395	$49,395	
Contractor Bond (1%) - Fill consolidation with low-perm cover	LS	1	$37,113	$37,113	
Equipment and Site Facilities	LS	1	$58,000	$58,000	
				SUBTOTAL (soil cover):	**$83,379**
				SUBTOTAL: (low-perm cover):	**$107,395**
				SUBTOTAL: (fill consolidation and low-perm cover):	**$95,113**
2) Site Preparation					
Site Survey and Topography	ACRE	16	$1,000	$16,000	
Clearing and Grubbing	ACRE	6.4	$15,300	$97,920	
Swale/Site Fill Material	CY	10,000	$12	$120,000	
Erosion and Sediment Control					
Silt Fence	LF	3,800	$1	$3,800	
				SUBTOTAL:	**$237,720**
3) Landfill Cover*					
**See Table 8 (Alternative 3) for detailed estimate of each option*					
				SUBTOTAL (soil cover):	**$1,398,920**
				SUBTOTAL: (low-perm cover):	**$3,800,520**
				SUBTOTAL: (fill consolidation and low-perm cover):	**$2,572,270**
4) In Situ groundwater treatment - Biobarrier					
Predesign Investigation	LS	1	$32,400	$32,400	
Injection Wells (7 wells)	VLF	525	$75	$39,400	
Initial injection	LS	1	$99,600	$99,600	
Regular injection round (1 per mo.)	LS	11	$49,800	$547,800	
Ground water sampling (for injection confirmation)	LS	11	$2,100	$23,100	
				SUBTOTAL:	**$742,300**
5) Other Costs					
Winter Shutdown	LS	1	$30,000	$30,000	
Deed Restrictions	LS	1	$20,000	$20,000	
Air monitoring	LS	1	$20,000	$20,000	
Dust Control Plan	LS	1	$5,000	$5,000	
Stormwater Pollution Prevention Plan	LS	1	$5,000	$5,000	
Modification of Drinking Water Permit	LS	1	$5,000	$5,000	
Final Site Survey	LS	1	$16,000	$16,000	
				SUBTOTAL:	**$101,000**
				TOTAL DIRECT CAPITOL COSTS (soil cover):	**$2,563,319**
				TOTAL DIRECT CAPITOL COSTS (low-perm cover):	**$4,988,935**
				TOTAL DIRECT CAPITOL COSTS (fill consolidation and low-perm cover):	**$3,748,403**
Indirect Capital Costs					
Soil Cover					
Contingency (30% Direct Capital Costs)		1	$768,996	$768,996	$768,996
Engineering (15% of Direct Capitol Costs)		1	$384,498	$384,498	$384,498
Legal Fees (5% Direct Capital Costs)		1	$128,166	$128,166	$128,166
Low-permeability cover					
Contingency (30% Direct Capital Costs)		1	$1,496,681	$1,496,681	$1,496,681
Engineering (15% of Direct Capitol Costs)		1	$748,340	$748,340	$748,340
Legal Fees (5% Direct Capital Costs)		1	$249,447	$249,447	$249,447
Fill consolidation and low-permeability cover					
Contingency (30% Direct Capital Costs)		1	$1,124,521	$1,124,521	$1,124,521
Engineering (15% of Direct Capitol Costs)		1	$562,260	$562,260	$562,260
Legal Fees (5% Direct Capital Costs)		1	$187,420	$187,420	$187,420
				TOTAL INDIRECT CAPITOL COSTS (soil cover):	**$1,281,660**
				TOTAL INDIRECT CAPITOL COSTS low-perm cover):	**$2,494,468**
				TOTAL INDIRECT CAPITOL COSTS (fill consolidation and low-perm cover):	**$1,874,201**
				TOTAL CAPITOL COSTS (soil cover):	**$3,845,000**
				TOTAL CAPITOL COSTS low-perm cover):	**$7,483,000**
				TOTAL CAPITOL COSTS (fill consolidation and low-perm cover):	**$5,623,000**

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Table 10: Alternative #5
Cover with *In Situ* Enhanced Attenuation
COST ESTIMATE

ITEM	UNIT	ESTIMATED QUANTITY	ESTIMATED UNIT COST	ESTIMATED COST	
Annual Operation & Maintenance Costs					
Insurance (1% Direct Capital Cost of Soil Cover)	LS	1	$38,450	$38,450	
Reserve Fund (1% Direct Capital Cost of Soil Cover)	LS	1	$38,450	$38,450	
Insurance (1% Direct Capital Cost of Low-Perm Cover)	LS	1	$74,830	$74,830	
Reserve Fund (1% Direct Capital Cost of Low-Perm Cover)	LS	1	$74,830	$74,830	
Insurance (1% Direct Capital Cost of Fill Consolidation and Low-Perm Cover)	LS	1	$56,230	$56,230	
Reserve Fund (1% Direct Capital Cost of Fill Consol. and Low-Perm Cover)	LS	1	$56,230	$56,230	
Site Inspection	DAYS	4	$800	$3,200	
Site Maintenance	LS	1	$12,000	$12,000	
Off-site Leachate removal and disposal	Gal.	10000	$1.25	$12,500	
Regular injection round (1 per mo.)	LS	12	$49,800	$597,600	
Ground water sampling (for injection confirmation)	LS	12	$2,100	$25,200	
5 year Review (Annual Cost)	LS	1	$1,000	$1,000	
Electrical Usage	LS	1	$1,280	$1,280	
Ground Water Monitoring	LS	1	$70,000	$70,000	
SUBTOTAL ANNUAL O&M (soil cover):				**$799,680**	
SUBTOTAL ANNUAL O&M (low-perm cover):				**$872,440**	
SUBTOTAL ANNUAL O&M (fill consolidation and low-perm cover):				**$835,240**	
APPROX. PRESENT WORTH* OF ANNUAL O&M (soil cover):					**$9,923,000**
APPROX. PRESENT WORTH* OF ANNUAL O&M (low-perm cover):					**$10,826,000**
APPROX. PRESENT WORTH* OF ANNUAL O&M (fill consolidation and low-perm cover):					**$10,365,000**
				*30 yr, I=7%	
APPROXIMATE TOTAL PRESENT WORTH COST (soil cover):					**$13,768,000**
APPROXIMATE TOTAL PRESENT WORTH COST (low-perm cover):					**$18,309,000**
APPROXIMATE TOTAL PRESENT WORTH COST (fill consolidation and low perm cover):					**$15,988,000**

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Table 11: Alternative #6
Cover with *In Situ* Ground water Treatment
COST ESTIMATE

ITEM	UNIT	ESTIMATED QUANTITY	ESTIMATED UNIT COST	ESTIMATED COST	
Direct Capital Costs					
1) Mobilization					
Contractor Bond (1%) - Soil cover	LS	1	$39,760	$39,760	
Contractor Bond (1%) - Low-permeability cover	LS	1	$63,776	$63,776	
Contractor Bond (1%) - Fill consolidation with low-perm cover	LS	1	$51,494	$51,494	
Equipment and Site Facilities	LS	1	$58,000	$58,000	
				SUBTOTAL (soil cover):	**$97,760**
				SUBTOTAL: (low-perm cover):	**$121,776**
				SUBTOTAL: (fill consolidation and low-perm cover):	**$109,494**
2) Site Preparation					
Site Survey and Topography	ACRE	16	$1,000	$16,000	
Clearing and Grubbing	ACRE	6.4	$15,300	$97,920	
Swale/Site Fill Material	CY	10,000	$12	$120,000	
Erosion and Sediment Control					
Silt Fence	LF	3,800	$1	$3,800	
				SUBTOTAL:	**$237,720**
3) Landfill Cover*					
**See Table 8 (Alternative 3) for detailed estimate of each option*					
				SUBTOTAL (soil cover):	**$1,398,920**
				SUBTOTAL: (low-perm cover):	**$3,800,520**
				SUBTOTAL: (fill consolidation and low-perm cover):	**$2,572,270**
4) In Situ groundwater treatment - iron wall					
Pre-design Study	LS	1	$28,400	$28,400	
Bench Scale Testing	LS	1	$15,000	$15,000	
Zero Valent Iron (including delivery)	LS	1	$683,000	$683,000	
Installation (by slurry wall construction technique)	LS	1	$1,454,000	$1,454,000	
				SUBTOTAL:	**$2,180,400**
5) Other Costs					
Predesign Investigation	LS	1	$28,390	$28,390	
Winter Shutdown	LS	1	$30,000	$30,000	
Deed Restrictions	LS	1	$20,000	$20,000	
Air monitoring	LS	1	$20,000	$20,000	
Dust Control Plan	LS	1	$5,000	$5,000	
Stormwater Pollution Prevention Plan	LS	1	$5,000	$5,000	
Modification of Drinking Water Permit	LS	1	$5,000	$5,000	
Final Site Survey	LS	1	$16,000	$16,000	
				SUBTOTAL:	**$101,000**
				TOTAL DIRECT CAPITOL COSTS (soil cover):	**$4,015,800**
				TOTAL DIRECT CAPITOL COSTS (low-perm cover):	**$6,441,416**
				TOTAL DIRECT CAPITOL COSTS (fill consolidation and low-perm cover):	**$5,200,884**
Indirect Capital Costs					
Soil Cover					
Contingency (30% Direct Capital Costs)		1	$1,204,740	$1,204,740	$1,204,740
Engineering (15% of Direct Capitol Costs)		1	$602,370	$602,370	$602,370
Legal Fees (5% Direct Capital Costs)		1	$200,790	$200,790	$200,790
Low-permeability cover					
Contingency (30% Direct Capital Costs)		1	$1,932,425	$1,932,425	$1,932,425
Engineering (15% of Direct Capitol Costs)		1	$966,212	$966,212	$966,212
Legal Fees (5% Direct Capital Costs)		1	$322,071	$322,071	$322,071
Fill consolidation and low-permeability cover					
Contingency (30% Direct Capital Costs)		1	$1,560,265	$1,560,265	$1,560,265
Engineering (15% of Direct Capitol Costs)		1	$780,133	$780,133	$780,133
Legal Fees (5% Direct Capital Costs)		1	$260,044	$260,044	$260,044
				TOTAL INDIRECT CAPITOL COSTS (soil cover):	**$2,007,900**
				TOTAL INDIRECT CAPITOL COSTS low-perm cover):	**$3,220,708**
				TOTAL INDIRECT CAPITOL COSTS (fill consolidation and low-perm cover):	**$2,600,442**
				TOTAL CAPITOL COSTS (soil cover):	**$6,024,000**
				TOTAL CAPITOL COSTS low-perm cover):	**$9,662,000**
				TOTAL CAPITOL COSTS (fill consolidation and low-perm cover):	**$7,801,000**

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Table 11: Alternative #6
Cover with *In Situ* Ground water Treatment
COST ESTIMATE

ITEM	UNIT	ESTIMATED QUANTITY	ESTIMATED UNIT COST	ESTIMATED COST	
Annual Operation & Maintenance Costs					
Insurance (1% Direct Capital Cost of Soil Cover)	LS	1	$60,240	$60,240	
Reserve Fund (1% Direct Capital Cost of Soil Cover)	LS	1	$60,240	$60,240	
Insurance (1% Direct Capital Cost of Low-Perm Cover)	LS	1	$96,620	$96,620	
Reserve Fund (1% Direct Capital Cost of Low-Perm Cover)	LS	1	$96,620	$96,620	
Insurance (1% Direct Capital Cost of Fill Consolidation and Low-Perm Cover)	LS	1	$78,010	$78,010	
Reserve Fund (1% Direct Capital Cost of Fill Consol. and Low-Perm Cover)	LS	1	$78,010	$78,010	
Site Inspection	DAYS	4	$800	$3,200	
Site Maintenance	LS	1	$12,000	$12,000	
Off-site Leachate removal and disposal	Gal.	10000	$1.25	$12,500	
5 year Review (Annual Cost)	LS	1	$1,000	$1,000	
Electrical Usage	LS	1	$1,280	$1,280	
Ground Water Monitoring	LS	1	$70,000	$70,000	
			SUBTOTAL ANNUAL O&M (soil cover):	**$220,460**	
			SUBTOTAL ANNUAL O&M (low-perm cover):	**$293,220**	
			SUBTOTAL ANNUAL O&M (fill consolidation and low-perm cover):	**$256,000**	
				APPROX. PRESENT WORTH* OF ANNUAL O&M (soil cover):	**$2,736,000**
				APPROX. PRESENT WORTH* OF ANNUAL O&M (low-perm cover):	**$3,639,000**
				APPROX. PRESENT WORTH* OF ANNUAL O&M (fill consolidation and low-perm cover):	**$3,177,000**
				*30 yr, I=7%	
Reinstallation of Iron Wall Costs					
Zero Valent Iron (including delivery)	LS	1	$683,000	$683,000	
Installation (by slurry wall construction technique)	LS	1	$1,454,000	$1,454,000	
			SUBTOTAL (iron wall reinstallation):	**$2,137,000**	
				APPROX. PRESENT WORTH* OF REINSTALLATION:	**$19,464,000**
				15 yr, I=7%	
				APPROXIMATE TOTAL PRESENT WORTH COST (soil cover):	**$28,224,000**
				APPROXIMATE TOTAL PRESENT WORTH COST (low-perm cover):	**$32,765,000**
				APPROXIMATE TOTAL PRESENT WORTH COST (fill consolidation and low perm cover):	**$30,442,000**

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Table 12: Alternative #7
Wellhead Ground water Treatment
COST ESTIMATE

ITEM	UNIT	ESTIMATED QUANTITY	ESTIMATED UNIT COST	ESTIMATED COST	
Direct Capital Costs					
1) Mobilization					
Contractor Bond (1%)	LS	1	$1,890	$1,890	
Equipment and Site Facilities	LS	1	$5,000	$5,000	
				SUBTOTAL:	**$6,890**
2) Wellhead Air Stripping					
Air Stripper with carbon polishing	LS	1	$49,000	$49,000	
Air Stripper Enclosure	LS	1	$85,000	$85,000	
Miscellaneous Piping Modifications	LS	1	$5,000	$5,000	
Controls, Integration and Electrical Modifications	LS	1	$20,000	$20,000	
				SUBTOTAL:	**$159,000**
3) Other Costs					
Air monitoring	LS	1	$20,000	$20,000	
Modification of Drinking Water Permit	LS	1	$5,000	$5,000	
				SUBTOTAL:	**$25,000**
				TOTAL DIRECT CAPITAL COST:	**$190,890**
Indirect Capital Costs					
Air Stripper					
Contingency (30% Direct Capital Costs)		1	$57,267	$57,267	$57,267
Engineering (15% of Direct Capitol Costs)		1	$28,634	$28,634	$28,634
Legal Fees (5% Direct Capital Costs)		1	$9,545	$9,545	$9,545
				TOTAL INDIRECT CAPITOL COSTS:	**$95,445**
				TOTAL CAPITAL COST:	**$290,000**
Annual Operation & Maintenance Costs					
Insurance (1% Direct Capital Cost of Soil Cover)	LS	1	$2,900	$2,900	
Reserve Fund (1% Direct Capital Cost of Soil Cover)	LS	1	$2,900	$2,900	
Site Inspection	DAYS	4	$800	$3,200	
Site Maintenance	LS	1	$3,000	$3,000	
5 year Review (Annual Cost)	LS	1	$1,000	$1,000	
Electrical Usage	LS	1	$1,280	$1,280	
			SUBTOTAL ANNUAL O&M:	**$14,280**	
				APPROX. PRESENT WORTH* OF ANNUAL O&M (SOIL COVER):	**$177,000**
				*30 yr, I=7%	
				APPROXIMATE TOTAL PRESENT WORTH COST:	**$467,000**

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Table 13: Assumptions and Calculations

DIMENSIONS

Area (* As scaled from Site Plan Feb. 2005)	Dimensions (approx)	Area (sf) (approx)	Area (ac.) (approx)	Average Depth (approx)	Volume (cf) (approx)	Volume (cy) (approx)
Western Cell	900 x 450	405,000	9.3	4	1,620,000	60,000
Eastern Cell	750 x 300	225,000	5.2	4	900,000	33,333
Total of Both Cells:		630,000	14		2,500,000	90,000
Saturated Waste if GW at 3-feet:				*2*	1,300,000	50,000
Assume 25% Hazardous Waste:	**22500 cy**		**33750 TON**			
Assume 75% Non-Haz Waste:	**67500 cy**		**101250 TON**			
Combined Cells	960' x 900'	864,000	19.8			
Swale Only (estimate)	70' x 900'	63,000	1.4	4	252,000	10,000

GLOBAL COST ESTIMATES

Item	Cost	Unit
Site Survey and Topography	$1,000	acre
Clearing and Grubbing	$5,000	acre
Excavation	$15	CY
Offsite Disposal - Hazardous	$150	TON
Offsite Disposal - Nonhazardous	$75	TON
Backfill Material	$12	CY
Topsoil	$22	CY
Seeding/Mulch	$0.50	SF
Mirafi 140N Indicator Layer	$0.08	SF
Silt Fence	$1.00	LF
Soil Management and Staging	$50,000	LS
40 mil LLDPE (Impermeable layer)	$0.75	SF
Tri-Planar Geonet	$1.40	SF
Barrier Protection Material	$12	CY
Soil Bedding Layer	$22	CY
Crushed Stone	$6.00	CY
Leachate Disposal and Treatment	$1.25	Gal.

ASSUMPTIONS

1. Site is approximately 40% heavily vegetated requiring clearing and grubbing.
2. Waste material to be removed averages 4-foot deep over both cells.
3. Wastes are generally covered by 1-foot of clean material.
4. A weight to volume ratio of 1.5 has been applied to all excavated material disposed of off-site.
5. Excavated waste will be predominantly municipal in nature and non-hazardous; assume only 25% of all waste excavated disposed of as haz. material.
6. Assume installed topsoil depth to be 6-inches
7. Assume depth to GW at uniformly worst case: 3-feet.
8. No GW monitoring wells will be installed; existing wells assumed to provide adequate monitoring points.
9. Assume 250 LF of discharge piping will be required between Air Stripping equipment and the point of discharge.
10. Final Grade for Alt. 2 is assumed to generally be that of the surrounding swale elevations. An allowance of 15,000 cy of clean fill is assumed to reach final grade.
11. A site inspection will be performed during quarterly groundwater monitoring site visits.
12. "Site Maintenance" for Alt. 3A and 4 includes an allowance for pumping and disposal of holding tank of leachate collected from shallow soils.
13. Leachate collected in holding tank (Alt. 3A and 4) will be minimal following installation of cover. An allowance of 10,000 gal/ yr has been assumed.

CALCULATED ESTIMATES

Confirmatory Sampling

Alternative	Volume Removed (cf)	No. of Samples	Cost of Sampling
Alt 2	2,500,000	500	$150,000

Assume
- 1 sample / 5000 cf excavated material
- Analysis to be VOC and SVOC by OLM04.2 on Soil
- $300 per sample.

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Table 13: Assumptions and Calculations

CALCULATED ESTIMATES (continued)

Dewatering Pad

F&I Components	Cost	Unit	Area of pad (sf)	Extended Total
40 mil LLDPE	$0.75	sf		
Tri-Planar Geonet	$1.40	sf		
12" Crushed Stone	$0.65	cf		
Mirafi Layer	$0.15	sf		
Subtotal:	$2.95	sf	22500	$66,375.00
6-Inch Pump	$1,500.00	ea		$1,500.00
Maintenance Contingency (25%):				$16,968.75
Pad Total:				**$85,000**

Groundwater Monitoring				**SPDES Discharge Monitoring**	
Assume one sample analyzed for VOC/SVOC/Inorg.					
No. Sampling Events per year:	4			12	
No. Wells Sampled per event:	18			1	Assume outfall only sampled
No. Samples per well	1			1	
Annual No. Samples Taken:	72	annually		12	per event
Labor Hours per sampling event:	16	per event		8	per event
Total Sampling hours per year:	64	annually		96	annually
No. Analite types per sample	3			3	
Cost per Analysis	$300			$300	
Labor Rate:	$80	per hour		$80	per hour
Annual Analysis Cost:	$64,800	annually		$10,800	annually
Annual Labor Cost:	$5,120	annually		$7,680	annually
Total Annual GW Monitoring Cost:	**$70,000**	(rounded)	Tot. Annual SPDES cost:	**$18,000**	(rounded)

Site Fill, Restoration and Low Perm Layers

Alternative	Backfill (cy)	Topsoil (cy)	Seeding/mulch (sf)	Backfill Soil Mat.(cy)	Backfill Soil Mat.(cy)	Soil Bedding (cy)
	D = Varies	D = 0.5 ft		D = 18in	D = 6in	D = 0.5 ft
Alt. 2	15,000	12,000	0			
Low permeability cover (both cells)	10,000	16,000	864,000	48,000	16,000	16,000
	Tri-Planar Geonet=	864,000	40 mil LLDPE (Impermeable layer)=		864,000	
Low permeability cover (consolidation)	17,000	16,000	864,000			4,000
	Tri-Planar Geonet=	225,000	40 mil LLDPE (Impermeable layer)=		225,000	

Perimeter Drainage Stone

Assume stone "wedge" at edge of cover. 18-inches deep at edge of cover, 3-foot wide to end of stone.
- (1.5' x 3' x 1') / 2 = CF stone per LF of perimeter length = 2.25 CF

(960LF + 900LF)*2 = 3,800LF (approx) x 2.25 CF/LF =	8600 CF (approx)	320 CY (approx)	Alt 3A/B
(750LF + 300LF)*2 = 2100 LF (approx) x 2.25 CF/LF=	4700 CF (approx)	170 CY (approx)	Alt 3C

Toe Drain

Assume toe drain to be 5' deep by 3' wide with 6-inch CPP integral.

- (5' x 3' x 1') = 15 CF stone per LF of perimeter length	$6 / CY x (15 CF / 27)=	$3
- 6-inch CPP	$12 / LF	$12
		$15 / LF

Power Usage (Assume 80% efficiency to pumps/blowers; Assume cost / kWh = $0.065)

	Effective HP	kW equivalent	Operating Hours / YR	Annual KWH	Annual Cost	(rounded)
Alt 2/4 (2 HP) GW Extraction Pump	1.6	1.1936	8760	10456	$680	$700
Alt 2/4 (1 HP) Blower	0.8	0.5968	8760	5228	$340	$350
Alt 7 (7.5 HP) Blower	6	4.476	4380	19605	$1,274	$1,280

Air Stripper

	Pump Rate	Cost	Discharge	Carbon polishing	Total
Alt 2/4	4 gpm	$12,000	by gravity		
Alt 7	200 gpm	$37,000	to water system	$12,000	$49,000

Notes
Costs per quote from North East Environmental Products, Inc.; 5-05
Vendor quote does not indicate a need for pretreatment based on an initial screening of groundwater constituents.
Each alternative includes cost of the basic system with controls, alarms and enclosure. Alt. 7 includes the cost of a discharge pump to match water system pressures.

Town of Carroll Landfill
Carroll, NY

Table 13: Assumptions and Calculations

General In Situ treatment assumptions

In Situ treatment "zone" has been assumed to extend the full depth of the aquifer (to approx. 75-ft below grade); Assumed 500-ft wide.
A predesign study will be required for any in situ treatment technology to further assess plume extents and chemistry.

Predesign Ground Water Study

	No. wells	Depth	Cost / VLF	Cost per well	Total cost
Installation of monitoring wells (2-in OD)	10	75	$25	$1,875	$18,750
	Samples per well	Analysis Cost/samp	Labor hours	Labor Rate	
Sampling/Analysis for VOCs	3	$300	8	$80	$9,640
Bench-scale microbiological assay	$4,000	(addnl cost for biobarrier technology only)			

Total Predesign Cost

Alt 6 (Iron Wall).	$28,390
Alt 5 (biobarrier).	$32,390

In Situ Bio Barrier Assumptions

7 injection wells (on 25-foot centers) D=75 foot Assume $75 / LF installation costs
Assume one round of injections per month for a period of 15 years
Sampling: assume 7 GW samples for VOCs collected monthly. (7 * $300 per analysis = $2,100)
Assumed that bench scale treatability results indicate that the proposed technology is applicable for the site conditions/constituents.

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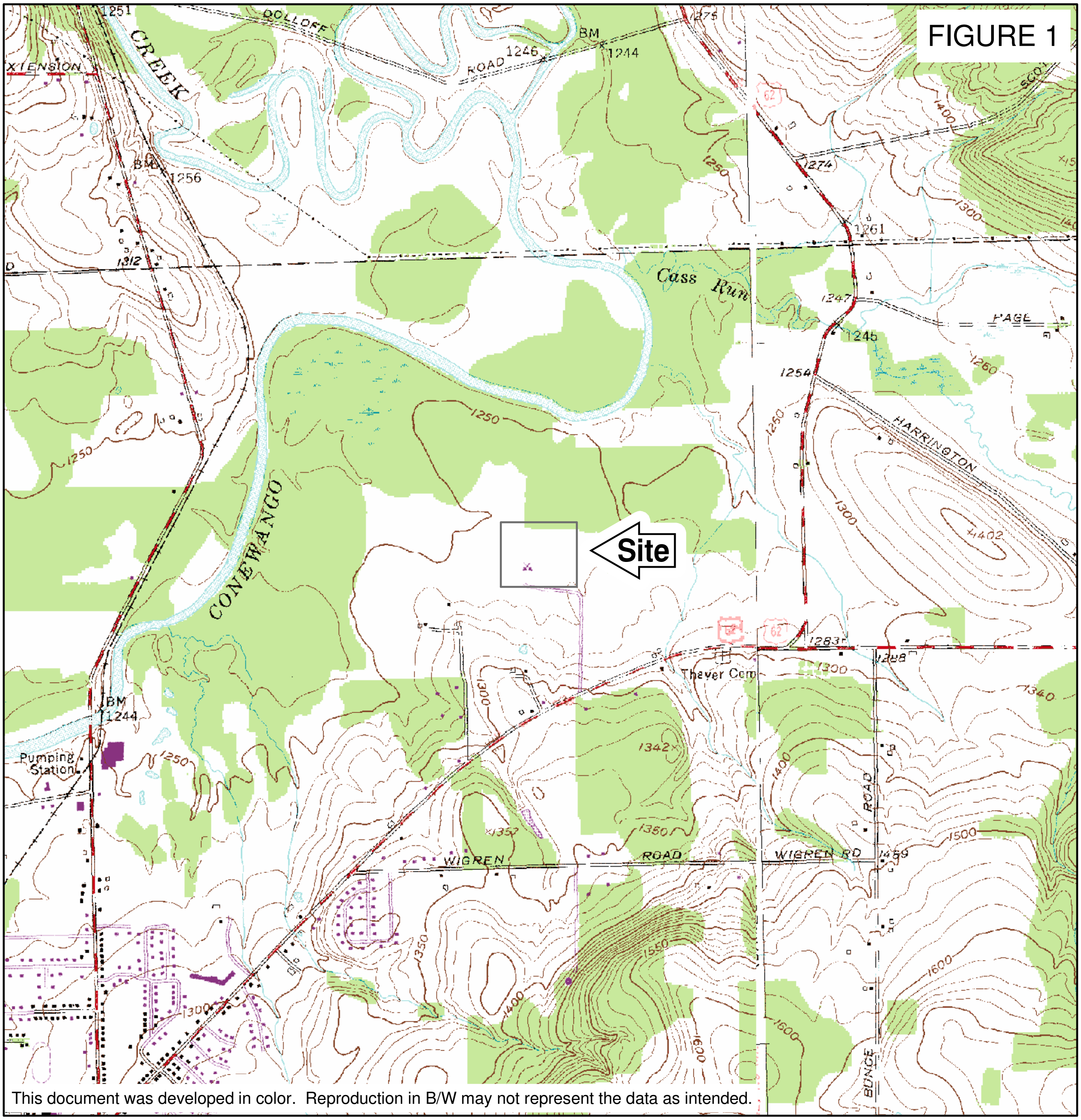
PLOT DATE: 03/03/05 DIV. 84 JPS



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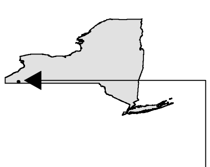

QUADRANGLE LOCATION

TOWN OF CARROLL
LANDFILL SITE
FREWSBURG, NEW YORK

SITE LOCATION

0 1,000 2,000 4,000 6,000 8,000

Feet

10653.34241
MARCH 2005

1:24,000

O'BRIEN & GERE ENGINEERS, INC.

Dec 14, 2005 - 2:56pm

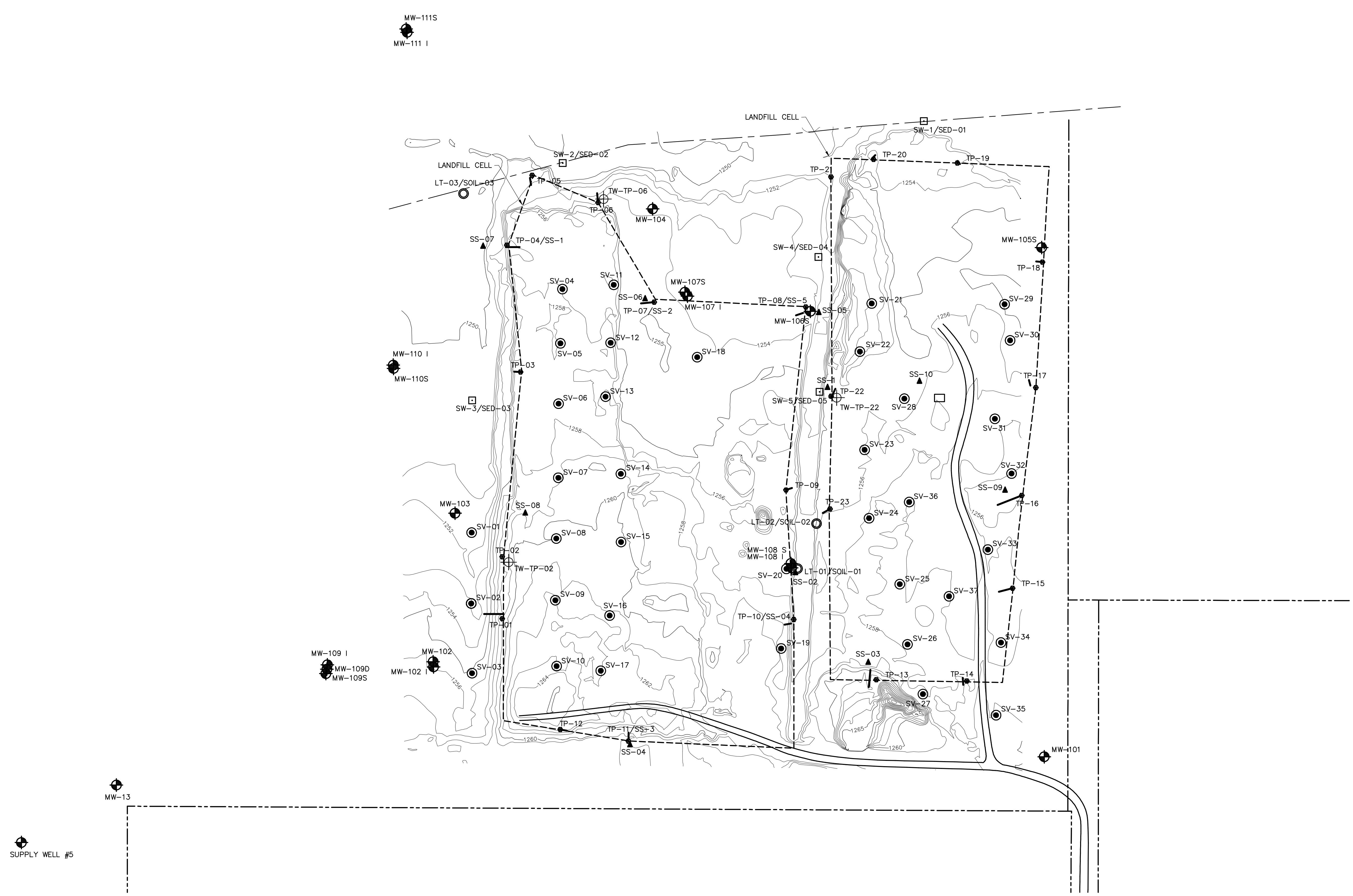

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FIGURE 2

LEGEND

- PROPERTY LINE
- EDGE OF CREEK
- ACCESS ROAD
- SV-30 SOIL VAPOR LOCATIONS
- SW-1/SED-01 SURFACE WATER AND SEDIMENT LOCATIONS
- SS-07 SURFACE SOIL LOCATIONS
- LT-01 LEACHATE SEEP LOCATIONS
- TP-18 TEST PIT LOCATIONS
- MW-105S MONITORING WELL LOCATIONS
- TW-TP-02 TEMPORARY WELL

TOWN OF CARROLL
LANDFILL SITE
FREWSBURG, NEW YORK
NYSDEC SITE #9-07-017

SITE MAP

0 80 160
SCALE IN FEET

FILE NO.10653.34241.027
MAY 2005

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Appendix A
Estimated Remedial Timeframes for Ground Water
Town of Carroll Landfill Site
Feasibility Study

A two-dimensional ground water flow model (WinTran by Environmental Simulations, Inc.) was used to evaluate ground water travel times based on estimated aquifer parameters obtained during the Remedial Investigation. The flow modeling was restricted to the intermediate/deep aquifer. The shallow water-bearing formation was not modeled due to the low hydraulic conductivity and resulting slow ground water velocity within this formation (~2.5 ft/year) and limited impacts at the landfill.

The travel times for an *in-situ* treatment wall remedial scenario (Alternatives 5 and 6), a ground water extraction remedial scenario (Alternatives 2 and 4), and a waste consolidation and capping remedial scenario were evaluated using the ground water flow model. The locations of the different treatment components for these remedies are shown on Figure A1. A key assumption in this evaluation is that the source of ground water contaminants has been effectively controlled such that continued contaminant loading to ground water does not occur. Also, this evaluation estimates remedial timeframes based on March 2005 ground water flow conditions and pumping from the Frewsburg Water District Supply Well # 5. If the supply well is shutdown or pumping rates significantly altered, ground water flow directions and velocities may change the remedial timeframes presented herein.

Aquifer parameter inputs to the ground water flow model for the intermediate/deep aquifer were as follows:

- hydraulic conductivity — 9.7 feet per day (based on site-specific hydraulic conductivity testing and testing within the flow model)
- aquifer thickness — 60 feet (based on site-specific monitoring well installations)
- hydraulic gradient — 0.002 feet per foot (based on ground water elevations across the southern portion of the western landfill cell during March 2005)
- aquifer porosity — 0.25 (estimate based on mixed sand and gravel (Fetter, 1980))

The travel time results from the model are representative of advective ground water flow. The ground water modeling provided the following travel times for the two remedial scenarios:

	Estimated Travel Time of Ground Water (Years)	
Remedial Scenario	**Upgradient of Remedy**	**Downgradient of Remedy**
In-situ treatment wall (Alt. 5 & 6)	25	25
Ground water extraction (Alt. 2 & 4)	25	20
Consolidation/Capping	---	45

Note: The ground water extraction scenario included one extraction well pumping at a rate of 10 gallons per minute

To better represent contaminant travel time, a retardation factor should be applied. For the purposes of this evaluation, sorption was assumed to be the primary process influencing retardation of contaminant transport. The retardation factor is dependent on the amount of organic carbon present in an aquifer. In addition to the amount of organic carbon present in an aquifer, contaminant retardation is also dependent on the specific contaminant. Some organic contaminants sorb more readily than others depending on their chemical structure.

For the purposes of estimating contaminant travel time, vinyl chloride was selected as the contaminant of concern as it was detected at the highest concentration within site ground water, and also detected in the sentinel well (MW-13) near the Town of Carroll Supply Well #5. Retardation factors for vinyl chloride have been calculated to range from 1 to 1.6 depending on the fraction of organic carbon present in an aquifer (0.0001 to 0.1) and assuming a porosity and bulk soil density of 0.35 and 1.72, respectively

(Wiedemeier, 1999). If the retardation factor for vinyl chloride is estimated to be 1, then the travel time for vinyl chloride is equal to advective ground water flow and would equal the travel times provided in the table above. If the retardation factor of vinyl chloride is estimated to be 1.6, then the travel time of vinyl chloride is 1.6 times slower than the advective ground water flow and the values presented in the table above would be multiplied by 1.6. Using the retardation factor for vinyl chloride of 1.6, the following travel times are estimated:

	Estimated Travel Time of Vinyl Chloride (Years)	
Remedial Scenario	**Upgradient of Remedy**	**Downgradient of Remedy**
In-situ treatment wall (Alt. 5 & 6)	40	40
Ground water extraction (Alt. 2 & 4)	40	32
Consolidation/Capping	---	72

REFERENCES

Fetter, C.W., 1980. Applied Hydrogeology. Bell & Howell Company. ISBN 0-675-08126-2.

Wiedemeier, T.H., 1999. Natural Attenuation of Fuels and Chlorinated Solvents in the Subsurface. John Wiley & Sons, Inc. ISBN 0-471-19749-1.

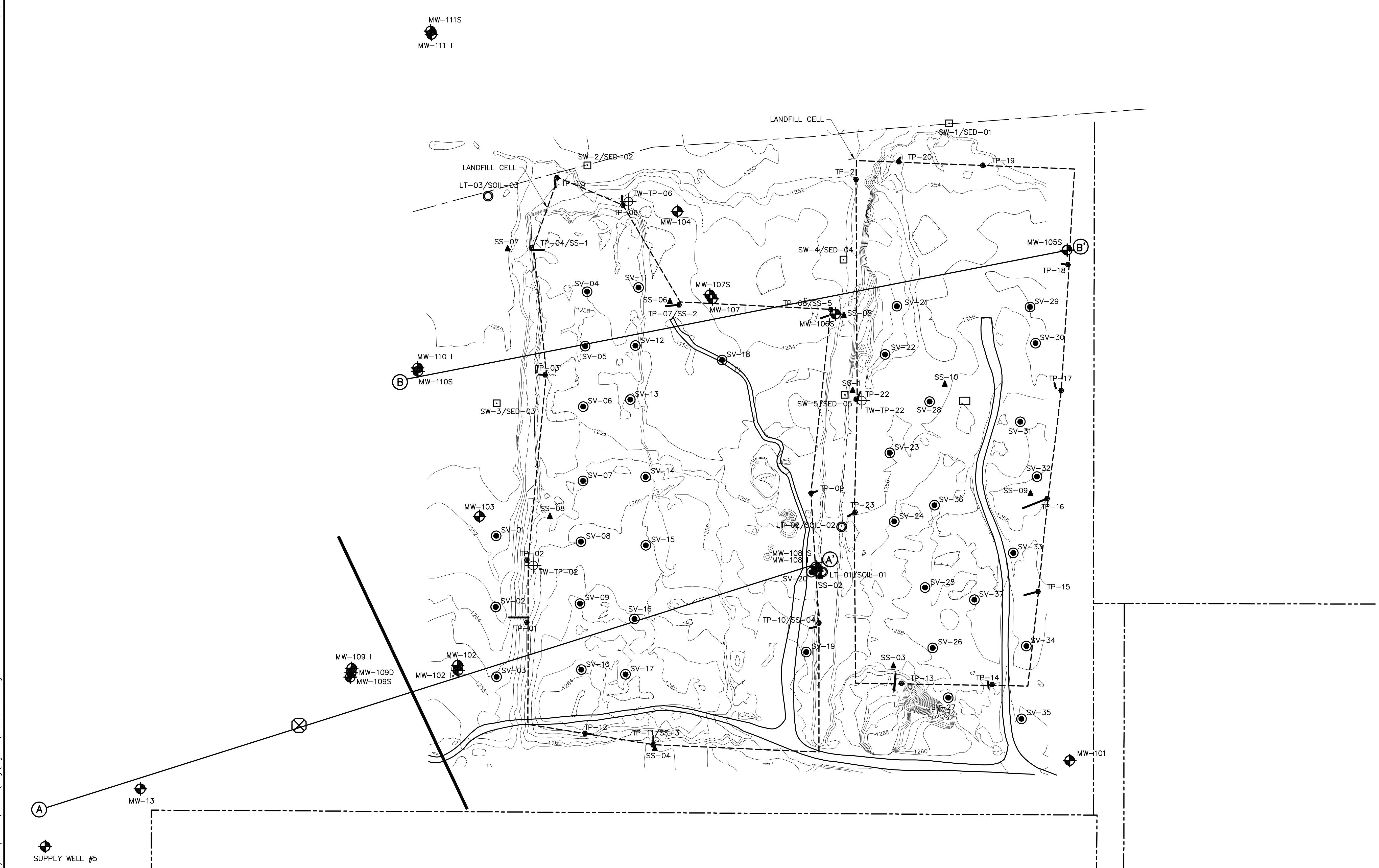

FIGURE A1

LEGEND

PROPERTY LINE
EDGE OF CREEK
ACCESS ROAD
SV-30 SOIL VAPOR LOCATIONS
SW-1/SED-01 SURFACE WATER AND SEDIMENT LOCATIONS
SS-07 SURFACE SOIL LOCATIONS
LT-01 LEACHATE SEEP LOCATIONS
TP-18 TEST PIT LOCATIONS
MW-105S MONITORING WELL LOCATIONS
A CROSS SECTION LINES
TW-TP-02 TEMPORARY WELL
SIMULATED EXTRACTION WELL
IN-SITU TREATMENT WALL

TOWN OF CARROLL
LANDFILL SITE
FREWSBURG, NEW YORK
NYSDEC SITE #9-07-017

LOCATION OF POTENTIAL REMEDIES

0 80 160
SCALE IN FEET

FILE NO.10653.34241.029
DECEMBER 2005

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Dec 14, 2005 - 2:50pm

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