

**CLARKSTOWN SANITARY LANDFILL RI/FS
FINAL REMEDIAL INVESTIGATION REPORT**

**VOLUME 1 OF 2
FINAL RI REPORT
AND APPENDICES A, B, AND C**

April 10, 1995

Prepared For:

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Town of Clarkstown
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Prepared By:

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May 17, 1995

Mr. Guy T. Bobersky, P.E.
NYS Dept. of Environmental Conservation
Bureau of Central Remedial Action
50 Wolf Road
Albany, NY 12233-7010

**Re: Clarkstown Sanitary Landfill
Final Remedial Investigation Report Submittal
WESTON W.O. No. 03228-010-002-0200**

Dear Mr. Bobersky:

On behalf of the Town of Clarkstown, herewith transmitted are six (6) copies of the *Final Remedial Investigation (RI) Report for the Clarkstown Landfill*. This is the final version of the report and reflects comments received from NYSDEC.

In accordance with the Consent Order, the requisite number of copies have been distributed to the other NYSDEC and NYSDOH offices listed at the end of this letter. At your direction, a report copy will be sent to the Tarrytown DEE (Division of Environmental Enforcement) office, and not to the Albany or White Plains DEE offices listed in the Consent Order. Copies will also be provided to the document repositories established for the project. The RI drawings (oversized) will be distributed under separate cover with the Final Feasibility Study Report submittal.





Mr. Guy T. Bobersky, P.E.
NYS Dept. of Environmental Conservation

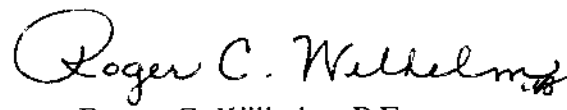
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Please call either of the undersigned should you have any questions.

Very truly yours,

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EXECUTIVE SUMMARY

The Town of Clarkstown is required to conduct a Remedial Investigation/Feasibility Study (RI/FS) of its inactive sanitary landfill facility located in West Nyack, New York, as stipulated in an Order On Consent with the New York State Department of Environmental Conservation (NYSDEC). An RI/FS is required prior to landfill closure due to the landfill's listing by the New York State Department of Environmental Conservation (NYSDEC) as a Class 2 Inactive Hazardous Waste Site. The Class 2 listing is based on an investigation of the landfill completed in 1983 which determined it to be a suspected hazardous waste site, in need of further investigation and possibly remediation (Wehran Engineering, 1983). More recently, in 1994 the U.S. Environmental Protection Agency (USEPA) completed its own hazard ranking scoring for the landfill and concluded that the landfill qualifies for listing on the National Priority List (NPL) as a potential federal Superfund hazardous waste site (Personal communication, USEPA, Region 2).

Two phases (Phase I and Phase II) of remedial investigation (RI) field activities were completed by Roy F. Weston of New York, Inc. (WESTON) on behalf of the Town of Clarkstown. The major objective of the Phase I RI field program was to characterize the nature and extent of contamination that may be emanating from the landfill into the surrounding media through a preliminary round of chemical sampling of site media (surface water, sediment, groundwater, ambient air, leachate, soil gas, and surface and subsurface soil). The RI also included determination of groundwater flow patterns, laboratory strength testing of subsurface soils to evaluate the landfill slopes stability, an ecological investigation of the environment around the landfill, and a qualitative analysis of potential risks to human health and the environment.

The objectives of the Phase II field investigation were to confirm the Phase I sampling results, to address data gaps identified during the Phase I RI activities, and to obtain additional data for the qualitative risk assessment and feasibility study to aid in identifying the need for and scope of final site remedial measures. The scope of the Phase II field investigation was developed based on a thorough review of the Phase I data and subsequent meetings with NYSDEC staff,

as well as input from a public meeting held in the Town of Clarkstown, New York, on January 26, 1994.

Objectives of the Remedial Investigation

The evaluation of the nature and extent of contamination at the Clarkstown Landfill requires an assessment of many complex issues because the landfill is located in an urbanized setting. The landfill is situated at the bottom of a topographic basin in an urbanized area of the Town of Clarkstown, Rockland County, New York. This basin receives storm runoff from surrounding roadways and commercial properties which, at times, might contain high amounts of dissolved and suspended solids. The streams and wetlands located adjacent to two sides of the landfill property represent a "sink" for any contaminants present in this urban runoff. In addition, at least six known or suspected hazardous waste sites exist within the basin and are likely to contribute contaminants to the runoff.

The Clarkstown Landfill RI attempts to distinguish any contamination present in the adjacent streams and wetlands caused by the landfill from contamination originating in urban runoff or other sources besides the landfill. Contamination present at the landfill and in the wetlands was evaluated with respect to potential risks posed to landfill workers and visitors, areas residents, and the ecological community in the wetlands.

Other Known Hazardous Waste Sites in the Vicinity of the Clarkstown Landfill

Two of the known hazardous waste sites in the basin include the Xerox Corporation facility, located approximately 3/4 of a mile south of the Clarkstown Landfill, and the Chromalloy facility, located about 1,000 feet southwest of the landfill on the opposite side of the wetlands. During surface water sampling efforts conducted in 1989 by NYSDEC and in 1992 as part of an RI/FS at the Xerox facility, halogenated volatile organic solvents, including the common industrial solvents tetrachloroethene and trichloroethene (TCE), were found in drainage channels downstream of the Xerox facility. The presence of these compounds was attributed to a volatile

organics plume in groundwater emanating from the Xerox facility and discharging to the drainage channels. Also, in 1992, groundwater at the Chromalloy facility was found to be contaminated with TCE at levels as high as 33,000 parts per billion (ppb) and chromium up to 328 ppb. The presence of these compounds is inferred to be a result of industrial operations at the Chromalloy facility, and a separate RI/FS of this facility is pending. This information suggests that these two facilities may contribute to any contamination present in the groundwater, surface water, and sediment in the wetlands adjacent to the Clarkstown Landfill.

In addition, an undocumented off-site source of volatile organic compounds (VOCs) in groundwater exists to the southeast of the landfill based on a review of private well data obtained from the Rockland County Health Department. The results of the most recent (Phase II) sampling effort indicate that groundwater beneath the southeast corner of the landfill appears to have been impacted by this VOC source.

Physical Characteristics of the Study Area

Potential sources of contamination which may be emanating from the Clarkstown Landfill include landfill leachate, landfill gas, and surface runoff from the landfill side slopes. Potentially impacted media have been identified to include groundwater, soils, surface water, sediments, and ambient air. Numerous exposure pathways and potential human and environmental receptors were also identified to exist under current conditions at the landfill. The results of the RI/FS, in particular the feasibility study (FS), will be used to develop plans to mitigate these exposure pathways during the landfill closure.

Subsurface investigations completed at the landfill have shown that it is underlain by a relatively impermeable and fine-grained "confining unit" of peat, organic silt, and glacial varved clay deposits. Where present, these deposits greatly impede the vertical downwards flow of leachate into the deeper deposits. In addition, the relatively high natural organic carbon content of the soils provide an effective filtering mechanism to remove organic contaminants from any leachate. Potential "windows", or openings, exist within the confining unit in the southwest corner of the

landfill and along the north central property boundary where the deposits are thin, absent, or interlayered with more permeable sand deposits.

Horizontal groundwater flow within the native deposits beneath the landfill is in a westerly to southwesterly direction towards the wetlands. The water table within the landfill mass is slightly mounded with a radial flow pattern from the center towards the outer edges of the landfill. A portion of the groundwater within the landfill is intercepted by a perimeter leachate collection system while the remainder is transported by slow seepage into the confining unit deposits. Strong upwards groundwater flow gradients exist between the bedrock aquifer and permeable glacial sand outwash, and the overlying confining unit deposits. The combination of these upwards flow gradients and the extensive confining unit deposits provides an effective barrier to the downwards flow of leachate into the deeper deposits.

Several streams flow along the boundaries of the Clarkstown Landfill and ultimately discharge into the Hackensack River. The Hackensack River is used as a drinking water source upstream of the landfill by area residents, and approximately 1.5 miles downstream of the landfill by northern New Jersey residents. It has been reported that at times during river flood stage conditions (normally spring thaw and heavy rains) the floodwaters have reached the edge of the landfill. During these events, contaminants present in the runoff from the various tributaries may become mixed in the floodwaters and distributed throughout the basin floor.

Nature and Extent of Contamination

Landfill Leachate

In 1983, the Town completed the installation of the leachate collection system around the landfill perimeter to prevent the lateral movement of leachate into the wetlands. The system consists of approximately 9,000 feet of 6-inch diameter perforated PVC pipe laid in a trench excavated into the top of the peat layer below the wastes and backfilled with crushed gravel. The outer wall of the trench was lined with a fabric barrier to trap silts and impede the flow of leachate beyond the trench towards the wetlands and streams. The leachate collection system

encompasses the entire landfill except for a former ballfield area located in the southeast corner of the property and the two portions of the landfill which lie beyond the northern Town property line.

Recent physical inspection of the leachate collection system indicates portions of the system may not be operational. In addition, the system does not have a waterproof membrane to prevent the leachate from moving from the landfill into adjacent surface waters. The fabric currently in place in the leachate system impedes flow from the landfill and presently appears to be effective. However, inspection of the fabric indicates it is deteriorating. The FS will evaluate the remediation requirements for this system to intercept and remove landfill leachate.

Landfill leachate which is intercepted by the leachate collection system is currently discharged into the Rockland County Sewer District #1 system without pretreatment. Since the start of monthly leachate sampling by the Town, individual leachate constituents regulated by the plant have been within the allowable plant limits. Only infrequent detections of organic compounds were reported in the Phase I and Phase II RI leachate samples collected from the leachate collection chambers, holding basins, leachate monitoring wells, and seeps. The detected organic compounds were primarily either laboratory-induced contaminants from the sample analysis (methylene chloride, acetone and 2-butanone) or compounds present in petroleum products which are likely derived from leakage of truck and automobile fluids on the landfill (benzene, toluene, and xylenes).

The most frequently detected metals in the Phase I and II RI leachate samples were cadmium, chromium, copper, iron, manganese, nickel, and zinc. Only zinc exceeded the County pretreatment standard in one Phase I leachate seep sample. A comparison was made of the leachate analytical results to surface water standards to conservatively evaluate the potential impacts on surface waters of leachate which may escape the leachate collection system and discharge into the wetlands. This comparison demonstrates that should the leachate escape from the leachate system and enter the surface waters that the surface waters would be adversely

impacted. While the remedial investigation did not find leachate directly entering the surface waters at this time, it may occur in the future unless mitigation measures are put in place.

A comparison of the historical data (1985 - 86) and the Phase I RI leachate data shows that the leachate quality has changed over the monitoring period. Iron concentrations have increased significantly since 1985, while copper, lead, zinc, arsenic, and mercury have decreased over the same time period. A comparison of the Phase I (1990) and Phase II (1993) data shows that during the most recent sampling (Phase II) less organic compounds were detected, and concentrations of inorganics, in particular the heavy metals, are significantly less than the Phase I round. The inorganics data indicate that the leachate is becoming weaker over time or is being more diluted by other sources, possibly related to deterioration of the collection trench liner. However, a comparison of the raw leachate quality data and pre-treatment standards indicates that should leachate concentrations increase upon closure (capping), concentrations are not so great that they would be likely to exceed the discharge standards.

Soil Gas and Landfill Gas

A variety of volatile organic compounds were present in the Phase I and Phase II RI soil gas and landfill gas samples. In general, the highest number and concentrations of volatile organics were detected in samples collected from the interior portion of the main landfill mass. Lesser concentrations were noted in the perimeter areas and older landfilled areas. In these areas, the waste is thinner and gas generation is less because the waste is older and in a more advanced stage of decay. The most frequently detected compounds were the refrigerant Freon 12 and petroleum-related compounds benzene, toluene, xylenes, and ethylbenzene. Regulatory standards exist for combustible gas levels in soil gas. Soil gas results also may be correlated to the ambient air results since the landfill gas is a potential source of contamination to ambient air.

A Phase II soil gas screening was completed along the Route 303 boundary of the landfill property to identify the potential for off-site landfill gas migration. A preliminary screening conducted as part of the Phase I soil gas sampling effort indicated that off-site gas migration did

not appear to be a concern at the site. The Phase II screening was designed to confirm these earlier Phase I findings. During the Phase II effort, seven of the thirteen soil gas locations produced combustible gas levels above the regulatory limit of 5% of the lower explosive limit (LEL) of gas in air; all but three of the samples were measured at below 10% of the LEL of gas in air. The data suggest that control of landfill gas migration along Route 303 is warranted. Combustible gas levels in samples collected from around the landfill garage and administration building were below the regulatory limit of 25% of the LEL of gas in air.

The RI determined that landfill gas is currently being generated at the landfill and is being emitted to the atmosphere. In addition, landfill gas at the Clarkstown Landfill was found to contain trace amounts of toxic and hazardous contaminants, as well as NMOCs (Non-Methane Organic Compounds) which contribute to the deterioration of the atmosphere. The quantity of landfill gas emissions is estimated to exceed federal regulations. Since the intended use of the landfill will include use of the site by maintenance workers and other Town employees and limited use by site visitors, control of landfill gas contaminants is warranted.

Test Pits/Landfill Waste Characterization

Eight test pits were excavated to determine the waste thickness in two areas of the landfill (the Northeast Area and former Ballfield Area) and to determine if the wastes in the Northeast Area were hazardous according to the RCRA regulations. The wastes in the Northeast Area extend beyond the Town property line. The waste thickness ranged from 5 feet to greater than 25 feet in the Northeast Area and from 9.5 feet to 15 feet in the Ballfield Area. Waste samples collected from the Northeast Area did not exhibit any RCRA hazardous characteristics above the regulatory standards.

Surface Water

Surface water sampling programs completed by NYSDEC prior to the RI identified volatile organic compounds in surface water at numerous locations in the Hackensack River basin. The highest concentrations of volatile organics, most of which are common industrial solvents, were reported for two locations downstream of the Bradley Industrial Park and the Xerox Corporation facility. These locations are upstream of the Clarkstown Landfill and therefore, the volatile organics detections are not attributable to the landfill. The highest concentrations were reported for tetrachloroethene (PCE), ranging from 1 ug/l to 7 ug/l.

A surface water sampling effort was also conducted in 1992 in the Bradley Industrial Park south of the landfill as part of the RI/FS of the Xerox Corporation facility. Volatile organics including 1,1-dichloroethane, 1,2-dichloroethene, 1,1,1-trichloroethane, trichloroethene, and tetrachloroethene were detected in samples from drainage channels in the industrial park. The data reflect the impact of contaminated groundwater discharge into the drainage channels of an organic solvent plume emanating from the Xerox facility. All of the sampling locations are upstream of the wetlands surrounding the Clarkstown landfill.

In general, relatively low estimated concentrations of organic compounds below the New York State water quality standards were detected in the Clarkstown Landfill Phase I and Phase II RI surface water samples collected from the wetlands, the Hackensack River, and its tributaries. Infrequent detections of organics were reported for locations downstream of the Clarkstown Landfill; however, similar or higher concentrations for the same compounds were reported for the upstream samples. Although some of the detected organic compounds were present in the leachate from the landfill, other upstream sources for these contaminants appear to exist in the basin.

The surface water data were compared to the most stringent NYSDEC surface water standards since the landfill is located upstream of a drinking water supply in-take source (Tappan Reservoir) and adjacent to an extensive state and federal designated wetlands area. The most

frequently detected metals detected in the Phase I RI surface water samples were aluminum, iron, lead, manganese and zinc. Iron exceeded the State water quality standard in all twelve Phase I RI samples while the aluminum standard was exceeded in six of the twelve samples. The aluminum, manganese, cadmium and copper standards exceedances were reported for one upstream and three downstream samples. The lead and zinc standards were exceeded each in two of twelve samples, namely in two upstream and one downstream sample. The iron and aluminum are naturally-occurring compounds in sediment and their presence in the samples is inferred to be predominantly a result of suspended solids in the surface water. The iron concentrations were similarly elevated in both upstream and downstream samples with respect to the landfill.

The highest concentrations of numerous metals detected in surface water during Phase I occurred in an upstream sample from a tributary draining Route 59 and the adjacent businesses. Elevated inorganics were also reported in two Phase I samples of ponded water from the wetlands to the west of the landfill. One of the samples appears to reflect impacts from the upstream waters draining the Route 59 business area. The second sample appears to show impacts from the landfill. However, it is not possible to quantify the landfill's contribution due to the mixing effects of waters draining into the wetlands.

On the south side of the landfill, the levels of aluminum, iron, lead, and zinc were elevated in a downstream sample compared to the upstream sample collected from the same tributary suggesting an influence from the landfill. Based on the Phase I data, the Hackensack River water quality was shown to be relatively unchanged between the samples collected furthest upstream and downstream of the confluence with the tributaries that drain the basin containing the Clarkstown Landfill.

During Phase II, the most frequently detected metals were aluminum, copper, iron, lead, manganese, nickel and zinc. All of these compounds except lead were detected in all samples. Iron exceeded the applicable ambient water quality standard in all samples. The Phase II sample showing the greatest number and the highest concentrations of inorganics detections was

collected from ponded waters in a small stream channel in the wetlands within fifty feet of the landfill. This location is one of the closest to the landfill and would be expected to show the greatest impact due to proximity. However, evaporation of ponded water over time could result in the observed elevated concentrations. The calculated copper and lead standards were exceeded each in only one Phase II downstream sample. The zinc and aluminum standards were each exceeded in three downstream samples.

A comparison of the Phase II upstream sample data with the downstream data suggests that the landfill or the other adjacent properties are contributing to increases in concentrations of some inorganic compounds along the unnamed tributary on the north side of the landfill. Results for two downstream samples collected from adjacent to the landfill are higher for each inorganic detected compared to the upstream sample. Iron, however, was the only compound which exceeded the respective standard. The data indicate that the landfill may contribute to the identified exceedances of criteria for these metals in surface water. However, the actual amounts caused by the landfill cannot be determined due to the presence of other upstream sources and the mixing effects of surface waters in the wetlands.

Sediment

Relatively low estimated concentrations of volatile organic compounds were present in the Phase I and Phase II RI sediment samples collected at the same locations as the surface water samples. Only one volatile organic compound, 1,1-dichloroethene, was present above its State sediment criterion. The 1,1-dichloroethene was found in one upstream sediment sample and one sample from a location downstream of the Xerox Corporation facility and adjacent to the Chromalloy facility. This compound is a typical breakdown product of industrial solvents.

Numerous semivolatile organic compounds classified as polynuclear aromatic hydrocarbons (PAHs), commonly present in road runoff and vehicle exhaust, were consistently elevated in the upstream Phase I and Phase II sediment samples. Only one sample exceeded a State aquatic criterion; namely, the phenanthrene chronic criterion was exceeded for a Phase II sample from

the unnamed tributary on the north side of the landfill. The human health criteria for six PAHs were exceeded in some Phase I samples. The highest exceedances were reported for the upstream samples with no exceedances reported for samples collected directly downstream and in close proximity to the landfill. During Phase II, the human health criteria for the same six PAHs were exceeded in two upstream samples and three downstream samples collected from the tributaries on the north side of the landfill. The data suggest that these PAHs were derived from upstream sources or properties other than the landfill lying adjacent to the tributaries. None of the PAHs were found in any of the RI leachate, groundwater or subsurface soil samples and, therefore, are not attributed to the Clarkstown Landfill.

In general, the metals were present at varying concentrations in both upstream and downstream samples. Lead and zinc were significantly elevated in two upstream Phase I samples compared to the other samples, and both are common constituents of road runoff. The most frequently detected heavy metals in sediment were arsenic, cadmium, chromium, copper, lead, nickel, and zinc. Beside landfill influences, other upstream sources appear to exist which may have contributed to the observed downstream concentrations. Landfilling at the former Ballfield Area in the southeast corner of the landfill property appears to have resulted in elevated levels of arsenic, cadmium, chromium, iron, manganese, and nickel in sediment in Muddy Brook greater than the upstream concentrations. Sediment at the western end of Muddy Brook appears to be similarly impacted by the landfill by these and other metals based on the upstream/downstream comparisons.

Concentrations of cadmium, lead, and mercury found to be higher in downstream sediment on the north side of the landfill than the upstream sediment are believed to be due to the landfill and/or activities at adjacent properties. Although it was not possible to quantify the contribution of the landfill on metals concentrations in sediment in the wetlands west of the landfill, the data suggest that the landfill has influenced sediment quality in the wetlands. Levels of arsenic, chromium, copper, and manganese were higher in wetlands sediment samples than upstream sediment samples.

For both phases of sampling, all of the heavy metals were present in some samples at levels above the State lowest effects criteria. These levels may be tolerated by a majority of benthic (bottom-dwelling) organisms. The more stringent state criteria, the severe effects criteria, were exceeded for copper, lead, zinc, iron, and manganese each in at least one sample for each sampling round. The RI data suggests that the landfill may contribute to the identified exceedances of criteria for these metals in sediment, although the actual amounts caused by the landfill can not be determined due to the presence of other upstream sources and mixing effects of surface waters in the wetlands.

Surficial Soils

Ten organic compounds were detected in the three Phase I RI surficial soil samples collected. Eight of the ten compounds were present in the off-site background sample suggesting that other sources for these compounds exist in the basin. Only one organic compound, namely acetone which is a common laboratory contaminant, was present at a concentration above the respective NYSDEC soil cleanup guidance value. The detected organics consisted primarily of the common laboratory contaminants (acetone, methylene chloride, and 2-butanone) and the PAHs which are typically elevated in urban soils.

Thirteen of the nineteen inorganic compounds detected in the surficial soils were present at their highest concentrations in the off-site background sample. Four inorganics, namely mercury, nickel, zinc, and beryllium, were each present in at least one sample at levels above the typical Eastern USA background ranges. The highest levels for mercury and zinc were reported in the off-site background sample. Beryllium was present in all three samples above the Eastern USA background range and the USEPA guidance value.

Subsurface Soils

Only one site-related organic compound was detected above the State soil cleanup guidance value in any of the eight Phase I RI subsurface soil samples collected. Overall, the inorganics detections fell within the typical Eastern USA background soil concentration ranges, except for cadmium, chromium, nickel, and zinc which exceeded the typical background values in most samples. The concentrations of these four inorganics were uniformly distributed indicating that they may be naturally elevated in site soils. Elevated chromium levels in the upgradient/background groundwater may explain the chromium levels present in the subsurface soils.

Groundwater

The greatest number and highest concentrations of organic compounds found in the historical and Phase I and Phase II RI groundwater samples were reported for leachate monitoring wells screened in the refuse. Most of the organic detections in the leachate wells included the aromatic hydrocarbons, such as benzene, toluene, xylenes, and ethylbenzene, which are commonly found in motor oils and gasoline. Three organic compounds, namely toluene, 1,2-dichloroethene, and chlorobenzene, were present in the leachate well samples above the State groundwater standards.

Four volatile organic compounds were each detected once in a total of three RI groundwater monitoring wells at concentrations slightly greater than the State groundwater standards. Trichloroethene was present in a downgradient well, tetrachloroethene in an upgradient well, and 1,2-dichloroethene and cis-1, 2-dichloroethene both in a cross-gradient well above the State standards. The upgradient and cross-gradient wells monitor the deep glacial sandy outwash or bedrock formations. Eight other volatile organic compounds were present at trace levels in groundwater samples collected from monitoring wells located downgradient of the landfill. The presence of these same compounds or related compounds in both the leachate and groundwater wells indicates that the landfill leachate has impacted groundwater beneath the landfill.

The pesticide Endosulfan I was found in one upgradient well and can be attributed to an off-site source for this contaminant. The presence of the extensive confining unit deposits and upwards hydraulic gradients appear to be effective in preventing the migration of any volatile organic compounds into the deeper glacial outwash, till, and bedrock formations.

The presence of the tetrachloroethene, as well as other chlorinated solvents at levels below the State standards, in the site upgradient well may be attributable to unknown off-site sources located upgradient of this well. Documented detections of similar "fingerprints" of organic compounds were found in private supply wells lying upgradient of the well during sampling by the Rockland County Department of Health.

Highly unusual detections of the pesticide 4,4-DDT and that the polychlorinated biphenyl (PCB) Aroclor-1260 were reported during Phase I for two adjacent downgradient wells monitoring the sandy till and bedrock formations in the southwest corner of the landfill. These compounds were not detected during the Phase II confirmatory sampling of these wells, although another pesticide, heptachlor, was detected at trace levels above the standard. These compounds are not typically found in groundwater due to their low water solubility. Their presence in groundwater suggests that a nearby source exists in the landfill and that the confining unit deposits may be thin or absent in this area. However, these concentrations are not of significant concern since these compounds are relatively immobile in groundwater and they were not detected in the leachate, groundwater, surface water or sediment samples collected directly downstream of the landfill.

Of the detected inorganic compounds in downgradient groundwater monitoring wells, only barium, sodium, chromium, iron, lead, and manganese were present in the Phase I and II RI samples at levels exceeding the State groundwater standards. The highest chromium detection was reported for an upgradient Phase I bedrock well sample suggesting that chromium is naturally elevated in the bedrock aquifer. The lead exceedances were reported in two wells which monitor the confining unit deposits, and one leachate monitoring well. Iron and manganese were elevated in all classes of monitoring wells (upgradient, downgradient, and

leachate wells). These two compounds are naturally-occurring in the subsurface soils and may be released to groundwater under the low oxygen conditions present beneath the landfill. The inorganics data also indicate that the confining unit deposits are effective barriers to any downwards leachate migration.

An RI groundwater monitoring well was constructed in an interlayered sand and peat "window" in the confining unit on the north side of the landfill to evaluate the quality of groundwater which might be leaving the site in this manner. The analytical results suggest that the groundwater is not significantly impacted by volatile organics in this area, although elevated chlorides and BOD were present indicative of landfill leachate. The inorganics TDS, chlorides, barium, iron, and manganese were present above the State groundwater standards in this well. Potential leachate influences were also identified in two shallow wells monitoring the peat and silt beneath the landfill, as indicated by elevated ammonia and BOD.

A second possible path for off-site leachate migration was identified along the northern landfill boundary during the RI. Some landfilled material was noted to have been placed over the area traversed by the leachate collection line, thereby creating a potential pathway for leachate to bypass the collection system. An RI leachate monitoring well was constructed in the fill to monitor the quality of any leachate which might be circumventing the collection system. The leachate sample was relatively free of organic and heavy metal contamination. Only one organic compound, chlorobenzene, was detected in the sample at a concentration equal to the State groundwater standard. Of the detected inorganic compounds, only iron, manganese, and sodium were present above the State standards.

Ambient Air

The Phase I data suggest that landfill gas emissions may be the source of increased concentrations of toluene, acetone, carbon disulfide, and 4-methyl-2-pentanone (MIBK) above the ambient background air. However, no compounds exceeded the State short-term ambient

air guideline concentrations. In addition, acetone and MIBK are typical laboratory contaminants introduced during sample equipment cleaning and sample preparation in the laboratory.

Contaminant Fate and Transport

Contaminant fate and transport can be defined as how potential contamination present at the landfill can move through the environment. The source of contamination from the landfill includes landfill leachate, landfill gas, and surface runoff from the landfill side slopes. the migration of compounds of concern from the Clarkstown Landfill is influenced by environmental factors such as the hydrogeological characteristics of the aquifer, site soil conditions, and the physical/chemical characteristics of the contaminants themselves. Ultimately, the two major factors that affect the fate and transport of a contaminant are the contaminant's mobility and its persistence in the different environmental media that it encounters. Mobility is a measure of the tendency for a chemical to be transported in the environment. Persistence is the amount of time a chemical will remain at measurable concentrations in the environment once introduced.

The compounds of concern identified during the Clarkstown Landfill risk assessment include organic and inorganic compounds. The volatile organic compounds of concern identified at the landfill and other nearby hazardous waste sites in the basin are very leachable, mobile and not very persistent in the environment, principally due to their high volatility, low adsorption to soils, and high water solubility. A representative detected semivolatile organic compound, fluoranthene, is relatively persistent in soil because of its high attraction to organic matter and soil particles, low water solubility, and low volatility. Detected pesticides, including endosulfan I and 4,4-DDT, are highly persistent chemicals in the environment which strongly adsorb to soils and organic matter.

The identified inorganic compounds of concern are typically persistent within all of the sampled media. The inorganic compounds may be derived from the landfill leachate and are commonly present in dissolved form. Inorganic compounds which migrate off-site in leachate are affected

by fate processes such as microbial activity, adsorption to soil particles, precipitation reactions, ion exchange, and the oxidation potential of the groundwater environment.

Site specific contaminant release and transport mechanisms at the Clarkstown Landfill include direct contact, volatilization/wind transport, erosion/runoff, leaching, and landfill gas migration. These mechanisms may result in potential exposures via physical contact, inhalation, or ingestion of humans and terrestrial and aquatic wildlife to exposed refuse, leachate, landfill gas, or windborne dusts.

Risk Assessment

A qualitative risk assessment, was performed for both human health and ecological risks. After reviewing the remedial investigation (RI) data for the Clarkstown Landfill it has become evident that in addition to the impacts of the landfill there are significant impacts from other sources in the area which are upgradient of the landfill. Impacts due to these other sources may represent similar, if not greater, risks than the landfill. These other sources include urban runoff and runoff or groundwater inflow from the numerous other identified hazardous waste sites in the basin. Some of these impacts might pose a greater total risk to human health and the environment in the area. However, remedial measures (landfill closure) at the landfill should significantly reduce the overall risk to the local population by addressing those specific potential impacts and risks caused by the landfill.

This qualitative risk assessment was based on a comparison of the identified compounds of concern and appropriate human health and ecological standards for the site media (surfacewater, sediment, air, etc.). The ecological risk assessment focused on compounds in the surface water and sediment media potentially exposed to aquatic and terrestrial wildlife residing in the streams and wetlands around the landfill. In addition, the impacts of closure of the landfill in accordance with Part 360 closure requirements were evaluated as they relate to reduction in the risk from the landfill.

Human health exposure risks are generated by the presence of a contaminant, a route of exposure, and a receptor, or person, who comes in contact with the contaminant. If any one of these three components do not exist there is no human health risk. The primary receptors at the landfill, those people who spend the most time at the landfill, are the site workers employed by the Town. These individuals would potentially be exposed to most of the media of concern on a routine basis and would represent the population with the highest risk due to their proximity and exposure duration. The media for which a complete exposure pathway exists for these individuals are surface soil, fugitive dust (which results from surface soil becoming airborne through wind action), leachate, ambient air, surface water and sediment. Another receptor group is comprised of those employees who work at the transfer station, who would not be exposed to surface water, leachate or sediment, but who may have a significant exposure to ambient air and fugitive dust. For the general public not considered to be trespassers, a complete exposure pathway exists for fugitive dust, ambient air, surface water, and sediment, but not for surficial soil or leachate.

There were no potential site-related compounds of concern identified for surface water, therefore, on an area wide basis, human health exposure risks do not exist for this media. Sediment is a media of concern with respect to human health due to potential exposure of site workers or trespassers to sediment present in the adjacent stream beds and wetlands. The only route of exposure to the sediments is through dermal contact by people who may wade in the streams and wetlands. The identified potential site-related compounds of concern in sediment are beryllium, copper and carbazole. Of these compounds, no State criteria exist for protection of human health. Therefore, no human health risks were identified for sediment.

The potential site-related compounds of concern for groundwater were confined primarily to metals and nitrogen compounds. Based on the RI hydrogeologic data and information received from the Rockland County and New York State Departments of Health, the human exposure pathway is not believed to be complete for this medium. Most local residents receive public water, and residents that are known to use private wells are located beyond the areas potentially

impacted by the landfill. The nearest public groundwater supply well is over two miles from the landfill. For these reasons, the current groundwater ingestion exposure route is not viable for this medium and, therefore, human health risks for groundwater do not exist.

Similarly, future use of groundwater potentially impacted by the landfill is not a likely scenario. The area is serviced by public water mains, making it unnecessary for new commercial or residential developments to obtain their potable water from wells. An added measure of protection against usage of potentially contaminated groundwater is provided by Rockland County Sanitary Code which prohibits the unpermitted installation and usage of a water supply well for potable purposes. In addition, with the exception of Pine View Road which is serviced by public water, the properties adjacent to the Clarkstown Landfill property are zoned as commercial. The installation and use of private water supply wells in areas potentially impacted by the landfill is therefore not likely.

During the Phase I RI field sampling, a number of volatile organic compounds were detected in ambient air. Most of these compounds appear to be derived from local industries and from petroleum products related to truck and automobile traffic at the landfill and in the Clarkstown basin. Of the potential site-related compounds of concern, listed above, only tetrachloroethene and carbon disulfide were present at concentrations exceeding NYSDEC ambient air guidelines. Of these two compounds, tetrachloroethene, a common industrial solvent, does not appear to be originating at the landfill based upon the comparison of the ambient air results with the soil gas results.

Human exposure to leachate is confined primarily to Town workers who may come in contact with the leachate while performing maintenance activities on the leachate collection system. Human health risks do not exist for this medium so long as the Town workers employ appropriate health and safety techniques to minimize exposure to the leachate. Trespassers could also incur an exposure risk on a limited basis by contacting leachate present in the holding ponds. Placement of a cap on the landfill as a part of the remedy is designed to eliminate

leachate seeps and ponding of leachate on the landfill property. This will eliminate the uncontrolled exposure route for leachate.

While the existing leachate collection system appears to be effective in presently controlling the off-site migration of leachate, it could begin to leak at some time in the future. The FS Report will address the remedial actions to prevent this condition through an upgrade of the system. In the absence of any remediation, the resulting human health and ecological risks could be significant. The landfill is upstream of a public water supply source which uses the water from the Hackensack River. Should leachate leak from the landfill, these contaminants could enter the intake for that public water supply, although in a significantly diluted form, most likely at or below the laboratory analytical detection levels. Equally or more significantly would be the impact of a leak on the adjacent ecology. Heavy metals in particular would most likely affect the aquatic organisms and could enter the food chain for humans.

The surface soil samples collected from the Clarkstown Landfill contained a variety of metals, but only one was identified as a compound of concern, namely beryllium. Since approximately 90 percent of the landfill property has received an interim final clean soil cover layer over the fill material, human health exposure risk to surface soil is not a significant concern.

Human health exposure risks were not identified for subsurface soils because an exposure pathway does not exist for this media since these soils lie below landfilled wastes. A pathway for incidental exposure to subsurface soils may occur if regrading or consolidation of any off-site wastes into the main landfill is considered as part of the remedial alternative of capping. This would be addressed in a health and safety program for the remediation.

Various organic compounds were detected in the soil gas samples collected at the landfill. Exposure to soil gas is not considered a route of exposure under present conditions. The results of sampling of ambient air are considered to be the most representative of airborne contamination emanating from the landfill. However, if an intrusive remedial alternative such

as excavation or capping which may require extensive regrading is chosen, then precautions for exposure to soil gas will be included in the contract plans and specifications.

The purpose of the ecological risk assessment is to evaluate the potential risks to aquatic and terrestrial plant and animal species from contamination emanating from the Clarkstown Landfill. For the ecological assessment, the concentrations of the site-related contaminants were compared to established State ecological criteria. The ecological risk assessment provides the information required to select a remedial alternative which is protective of the environment.

The most significant aspect of the ecological exposure setting is the presence of the wetlands and streams adjacent to the landfill. The streams serve as potential pathways to transport contaminants from the landfill and other adjoining properties to downstream locations, and as a means of transporting contaminants introduced into the food chain to remote locations. Animals living or dependent on the wetlands include the benthic (sediment) community, turtles, fish, birds, and mammals. The animals' exposure to contaminants from the landfill are both direct, in the form of direct ingestion of contaminated soils or water, or indirect through eating other organisms which have had direct contact with contamination.

There were no contaminants of concern identified for surface water. Therefore, on a basin wide basis, ecological risks for this medium do not exist. Locally, ecological risks may exist where concentrations of detected compounds exceed risk-based ecological criteria.

Of the three compounds of concern for sediments, ecological criteria exist for only one compound, copper. According to NYSDEC guidance, if any criteria are exceeded the sediments are considered to be contaminated and a potential risk to the biota and/or human health exists which must be further evaluated. Additional information to be evaluated in this case, as noted in the guidance, include the volumes and location of sediment exceeding the criteria, the type of exceedance (low, severe, acute or chronic), the contaminant persistence, accessibility to the contaminated sediment, the sensitivity of the affected habitat to any such remedial measures, and

the availability of remedial technologies. Even if criteria are exceeded, sediment remediation may not be warranted, nor advisable, with all of the above considerations in mind.

Based on the RI data and NYSDEC guidance, all of the sampled sediment in the streams and wetlands, including locations not potentially affected by the landfill, may be toxic to some benthic species with respect to copper. Sediment copper concentrations in the study area at both upstream and downstream locations relative to the landfill appear to be naturally elevated above the State guidance values. The RI data suggest that sediment copper concentrations in the basin are naturally elevated or are also impacted by sources other than the landfill.

Localized ecological risks due to detected concentrations of compounds other than copper may exist where these concentrations exceed risk-based ecological sediment criteria. Numerous exceedances of the State low and severe effects criteria occurred in both upstream and downstream sediment samples. The percentage of samples exceeding the State criteria versus the total number of samples collected for some of the inorganic compounds indicates that the wetlands and tributary system in the Clarkstown Basin is stressed. The sources of these inorganic inputs to the wetlands system include the landfill and upstream contaminant sources, including urban runoff. Capping of the landfill will eliminate one significant adjacent source of inorganic compounds to the wetland system. The landfill is not currently a source of organic compounds to sediment.

The findings of the risk assessment were that implementation of the NYSDEC Part 360 landfill closure requirements (the primary standards applicable to remedial activities at the landfill site) will either eliminate or greatly reduce those risks which are attributable to the landfill. Some risks, such as those related to ambient air and sediment quality, appear to be primarily a result of off site sources of contamination rather than activities at the landfill. Ambient air exposures to the landfill gas will be eliminated by the Part 360 closure while surface water and sediment quality impacts will be greatly reduced.

1.0 INTRODUCTION

1.1 Overview of Clarkstown Landfill RI/FS

The Town of Clarkstown is required to conduct a Remedial Investigation/Feasibility Study (RI/FS) of its inactive sanitary landfill facility located in West Nyack, New York, as stipulated in an Order On Consent (Index No. W-3-0234-88-07, dated June 30, 1989) with the New York State Department of Environmental Conservation (NYSDEC). The RI/FS activities were conducted on behalf of the Town by its engineering consultant, Roy F. Weston of New York, Inc. (WESTON). An RI/FS is required at the Clarkstown Sanitary Landfill prior to landfill closure due to the landfill's listing by the New York State Department of Environmental Conservation (NYSDEC) as a Class 2 Inactive Hazardous Waste Site (Site No. 344001, Rockland County). The landfill is subject to the requirements of New York State's 6 NYCRR Part 375 Regulations.

Two phases (Phase I and Phase II) of remedial investigation (RI) field activities were completed. The major objective of the Phase I RI field program at the Clarkstown Landfill was to characterize the nature and extent of contamination that may be emanating from the landfill into surrounding media through a preliminary round of chemical sampling of site media (surface water, sediment, groundwater, ambient air, leachate, soil gas, and surface and subsurface soil). The Phase I RI also included a determination of groundwater flow patterns, laboratory strength testing of subsurface soil samples to evaluate the landfill slopes stability, an ecological investigation of the environment around the landfill, and a qualitative analysis of potential risks to human health and the environment.

A Phase II RI was completed subsequent to evaluating the results of the Phase I RI. The objectives of the Phase II field investigation were:

- To confirm the results obtained during the Phase I sampling effort,
- To address data gaps identified during Phase I RI activities, and

- To obtain supplemental data for the qualitative risk assessment and feasibility study to aid in identifying the need for and scope of final site remedial measures.

The scope of the Phase II RI field investigation was developed based on a thorough review of the Phase I RI data and subsequent meetings with NYSDEC staff, as well as input from a public meeting held in the Town of Clarkstown, New York, on January 26, 1994. Confirmatory groundwater, surface water, sediment, and leachate sampling was conducted. Landfill gas samples were collected from various areas of the landfill and from a gas vent installed at the refuse transfer station to evaluate landfill gas management alternatives. Test pits were excavated in two areas off the landfill to evaluate the feasibility of removing the wastes materials. Most recently, in December 1994, an inspection and evaluation of the landfill's perimeter leachate collection system was conducted as part of the landfill closure pre-design activities.

Associated feasibility study (FS) activities completed concurrent with the RI included the development of site remedial action technologies and alternatives, based upon the RI data and qualitative risk assessment, to minimize any risks posed by the landfill. The results of the FS are presented in the Final Feasibility Study Report (WESTON, 1995) which is a companion document to this Final RI Report. Landfill capping has been identified as the most likely remedial action at typical municipal landfill sites such as the Clarkstown Landfill. The primary standards and criteria governing the landfill closure will be the NYSDEC Part 360 landfill closure requirements, effective December 31, 1988, and will include landfill gas, leachate, and stormwater control systems. The landfill closure will also satisfy requirements of the Federal Resource Conservation and Recovery Act (RCRA) Subtitle D regulations for municipal landfills and the anticipated New Source Performance Standards under the revised Federal Clean Air Act.

An evaluation of the nature and extent of contamination at the Clarkstown Landfill requires an assessment of many complex issues because the landfill is located in a urbanized setting. The landfill lies in the central, lowest-lying area of a topographic basin, which receives surface water runoff from the surrounding roadways and industrial and commercial properties. This urban

runoff might contain high amounts of dissolved and suspended solids from auto emissions, fluid leaks from these vehicles, fertilizers and pesticides from home and commercial use, urban refuse, and animal wastes. The streams and wetlands adjacent to three sides of the landfill property represent a potential "sink" for any contaminants present in this urban runoff. In addition, at least six known or suspected hazardous waste sites exist within this topographic basin and are likely to contribute contaminants to the urban runoff. A major focus of the Clarkstown Landfill RI/FS was to attempt to distinguish contamination present in the wetlands caused by the landfill from the contamination originating in urban runoff or other sources besides the landfill. Any contamination from the landfill must be evaluated with respect to potential risks posed to landfill workers and visitors, area residents, and the ecological community in the adjacent wetlands.

This Final RI Report presents the findings of the Phase I and Phase II RI field investigations, a qualitative risk assessment for the landfill, and a discussion of the current environmental conditions at the landfill and the surrounding area. This Final RI Report combines new data as well as information that was formerly presented separately in the Interim RI Report, dated August 1991, and the Draft RI Report, dated October 1993, both prepared by WESTON. This Final RI Report supercedes these two earlier documents.

This report and others prepared previously during the RI will be retained in document repositories within the Town of Clarkstown and at the NYSDEC Albany and New Paltz (Region 3), New York offices for review by interested individuals. Other documents pertinent to the Clarkstown Landfill RI/FS include the following:

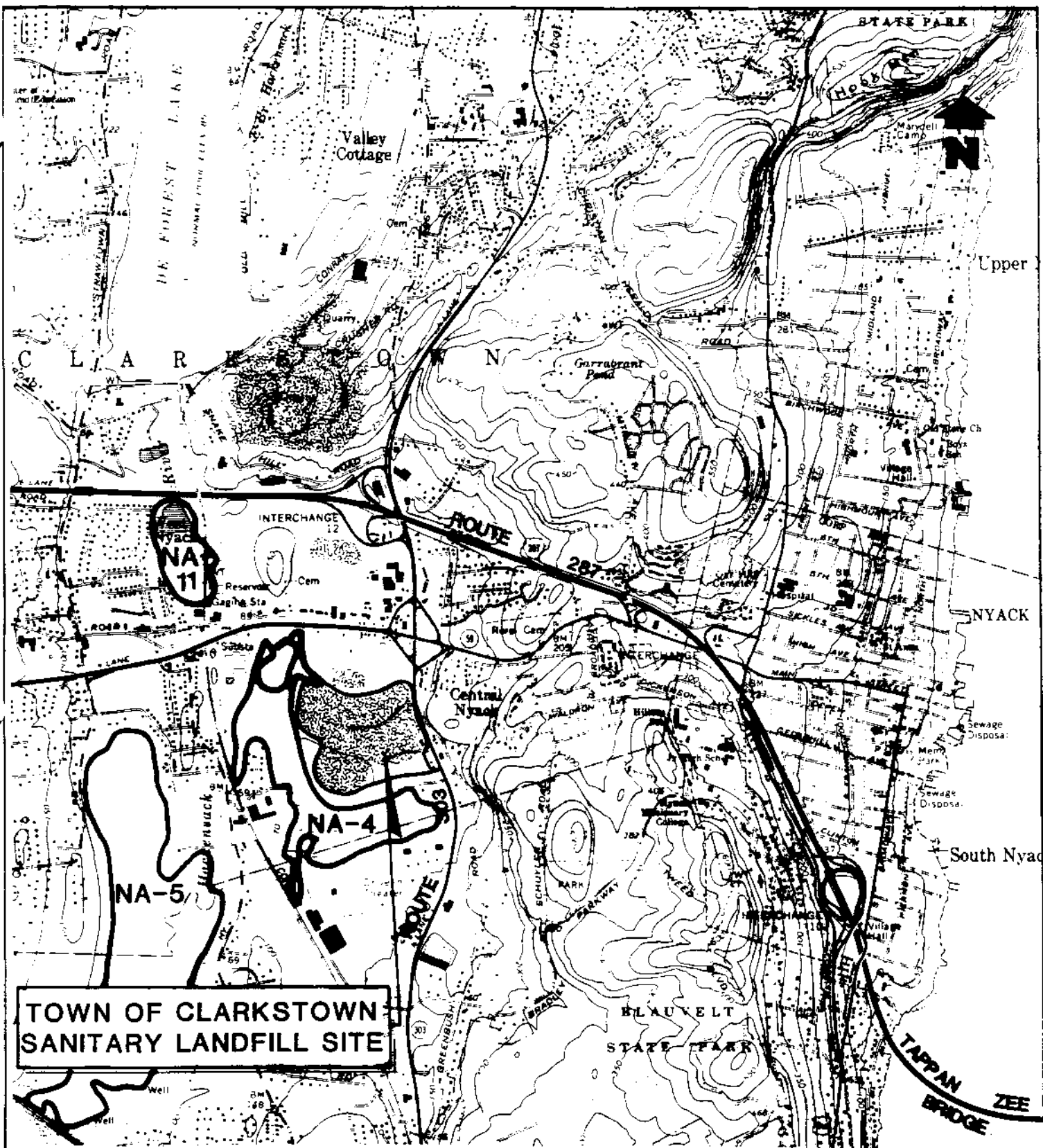
- "Remedial Investigation/Feasibility Study of Clarkstown Sanitary Landfill - Interim Report", Velzy/WESTON, Inc., August 1991, including Phase I Analytical Data Assessments and Appendices.
- "Site Operations Plan for Clarkstown Sanitary Landfill RI/FS", Velzy/WESTON, Inc., April 17, 1990.

- "Work Plan for Clarkstown Sanitary Landfill RI/FS", Velzy/WESTON, Inc., April 17, 1990.
- "Earth Buttress Berm Analysis", Velzy/WESTON, Inc., March 13, 1992.
- "Slope Stability Analysis - Response to Questions Raised by DEC in Review of Interim Report", Velzy/WESTON, Inc., March 13, 1992.
- "Transfer Station Site Study", Charles R Velzy Associates, Inc., November 1989.
- "Transfer Station Site Remediation Report", Velzy/WESTON, Inc., September 1990.
- "Draft Commentary Report - Review of Previous Stability Studies for Clarkstown Landfill," Woodward-Clyde Consultants, June 1993.
- "Phase I Investigation Report, Clarkstown Landfill, Rockland County, New York", Wehran Engineering, P.C., June 1983.

1.2 Site Background

1.2.1 Site Location and Description

The Clarkstown Sanitary Landfill is located approximately 1000 feet south of Route 59, on the west side of New York State Route 303 in the hamlet of West Nyack, in the Town of Clarkstown, New York, as shown on Figure 1-1. The landfill is located immediately north of the Clarkstown-Orangetown municipal border, and is bordered by New York State Department of Environmental Conservation (NYSDEC) classified wetlands on the western and southern sides of the landfill. The landfill lies on property owned by the Town of Clarkstown, consisting of an estimated 100 acres, with the exception of two small portions in the northwest and northeast corners which extend onto adjacent privately-owned properties. The Town property extends beyond the landfill boundary on the west and south sides into the wetlands (see Figure 1-2). Almost the entirety of the landfill property consists of filled former marshland, as does much of the property bordering Route 59. The area of the main landfill covers approximately eighty



Base Map: U.S.G.S. 7 1/2 Minute Quadrangle-Nyack, N.Y.

NA-4, NA-5 and NA-11 are NYSDEC wetlands designations.

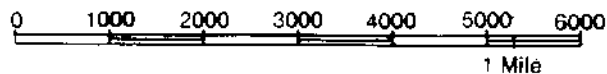
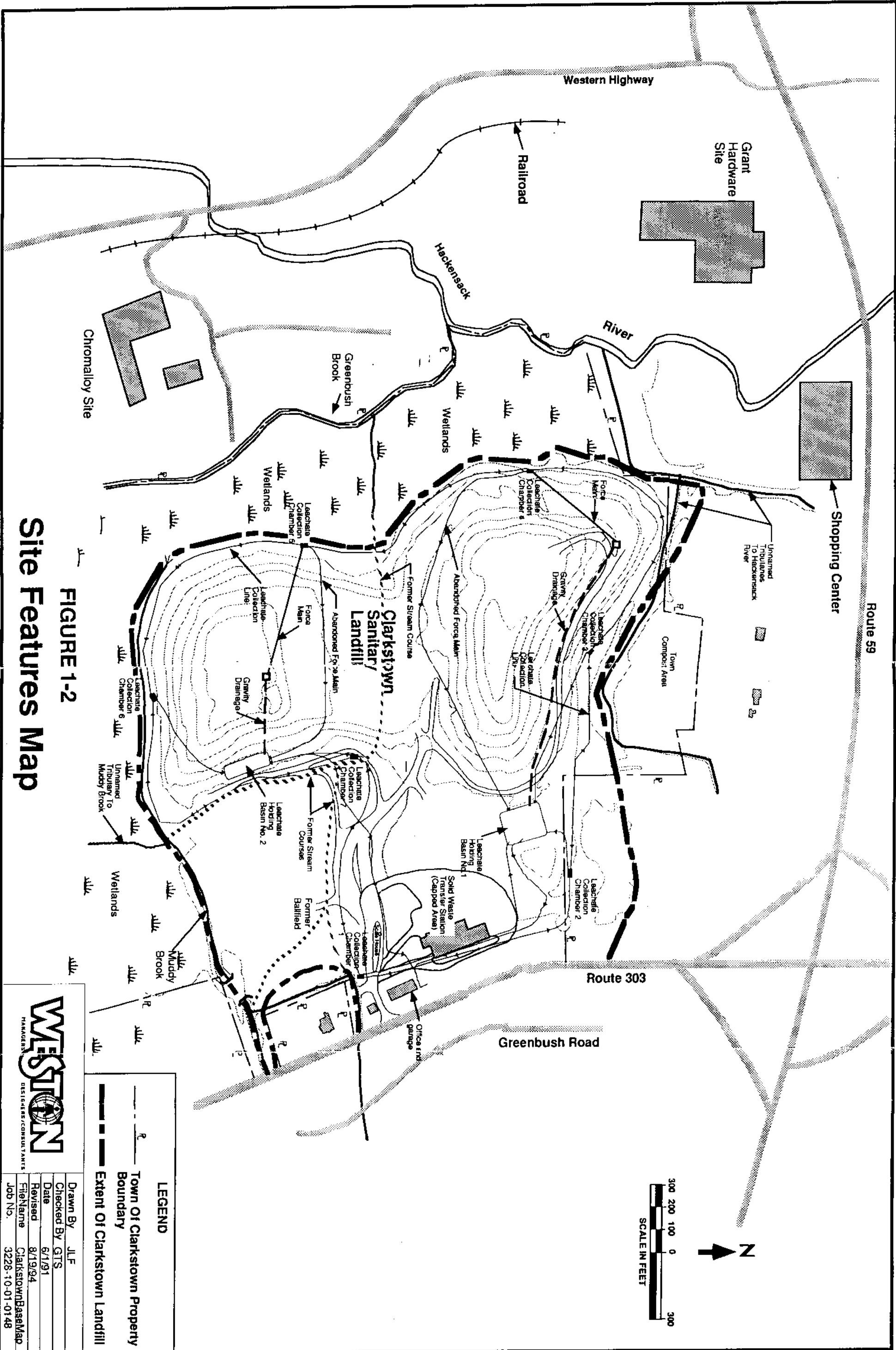


FIGURE 1-1

SITE LOCATION MAP AND LOCATION
OF NYSDEC DESIGNATED WETLANDS

WESTON



(80) acres and rises to a height of approximately 80 feet above the surrounding areas. The landfill is situated in the approximate center of a low-lying, swampy basin which receives urban runoff from the higher surrounding elevations. The basin drains into the Hackensack River approximately 500 feet west of the landfill. Tributaries to the Hackensack River flow along the northern and southern landfill boundaries.

1.2.2 Site Operational and Regulatory History

Landfilling operations began at the site in the 1940s, prior to ownership by the Town of Clarkstown. The Town purchased the property in the 1950s and operated the landfill until December 31, 1990, when it was closed to landfilling as required under a Consent Decree agreement with the NYSDEC. The landfill received primarily municipal refuse at an average rate of 450 to 500 tons per day except during the period of 1982 to 1984 when a greater average disposal rate was received due to the receipt of municipal waste from the Town of Greenburgh, New York. In the latter part of 1987, solid waste from the Town of Ramapo was accepted at the landfill, and continued for approximately fifteen months.

The Clarkstown Landfill is listed on the NYSDEC Registry of Inactive Hazardous Waste Sites (Site No. 344001, Rockland County) as a Class 2 site (a site that poses a "significant threat to the public health or environment - action required"). The Class 2 listing is based on an investigation of the landfill completed in 1983 which determined it to be a suspected hazardous waste site, in need of further investigation and possibly remediation (Wehran Engineering, 1983). More recently, in 1994 the U.S. Environmental Protection Agency (USEPA) completed its own hazard ranking scoring for the landfill and concluded that the landfill qualifies for listing on the National Priority List (NPL) as a potential federal Superfund hazardous waste site (Personal communication, USEPA, Region 2, 1995).

In February, 1978, Clarkstown applied for a permit from the NYSDEC to operate the landfill in response to the enactment of the New York State Part 360 Solid Waste Regulations in 1977. Charles R Velzy Associates, Inc. (Velzy Associates), engineering consultant to the Town of Clarkstown, retained Converse, Ward, Davis and Dixon, Inc. to conduct a hydrogeologic investigation as part of the permitting process. This study included the installation of monitoring wells, soil testing and groundwater sampling and analysis. In September, 1979, the permit application was denied because of noted violations of the Part 360 landfill regulations. In May, 1980, the NYSDEC issued Clarkstown a consent order to close the landfill by December 31, 1983. The consent order was modified in July, 1984, to allow landfilling to continue for an indefinite period of time while Clarkstown acted to rectify the conditions at the landfill which violated the Part 360 regulations. Actions required at the site by NYSDEC included the installation of a leachate collection system implementation of a groundwater monitoring program, and installation of a cap over the landfilled refuse.

The initial hydrogeologic investigation of the landfill was completed in 1979. This study determined the types of soils beneath the landfilled area and established the direction of groundwater flow in a westerly direction beneath the property. Seven sets of shallow and deep monitoring wells were installed around the perimeter of the landfill, from which quarterly groundwater samples and groundwater elevation data were taken. The hydrogeologic investigation identified the existence of an extensive "confining unit" of relatively impermeable layers of peat, organic silt, and clay below the landfill area. These low permeability sediments were considered to be a deterrent to vertical seepage of leachate through the bottom of the landfill into the deeper groundwater system (Converse, Ward, Davis, Dixon, 1979). These types of soils are also known to be highly effective in removing contaminants from groundwater because of their adsorptive capacities.

In 1983, the Town completed the installation of the leachate collection system around the landfill perimeter to prevent the lateral movement of leachate into the wetlands. The system consists

of approximately 9,000 feet of 6-inch diameter perforated PVC pipe laid in a trench excavated into the top of the peat layer below the wastes and backfilled with crushed gravel. The outer wall of the trench was lined with a fabric barrier to trap silts and impede the flow of leachate beyond the trench towards the wetlands and streams. The leachate collection system encompasses the entire landfill except for a former ballfield area located in the southeast corner of the property and the two portions of the landfill which lie beyond the northern Town property line. As part of the leachate collection system contract, Muddy Brook, a stream which flowed east to west through the center of the landfill, was re-routed around the southerly side of the landfill to direct storm water drainage away from the landfill. Leachate intercepted by the perimeter collection system was pumped into two holding ponds located in the interior portion of the property (see Figure 1-2).

During the next several years, testing of groundwater from the existing monitoring wells around the site as well as the seven leachate collection chambers was performed to determine whether there was leachate migration from the landfill. Groundwater and leachate analytical testing results indicated that the leachate quality was comparable to other municipal sanitary landfills. In 1985, the NYSDEC requested that further subsurface analysis be performed which extended down to the deeper groundwater flow system underlying the landfill. The results of the study determined the thickness of the various layers of fine-grained deposits below the landfill, the level of groundwater elevations across the site, and enabled a more precise determination of the direction of groundwater flow across the site (Converse Consultants, 1986).

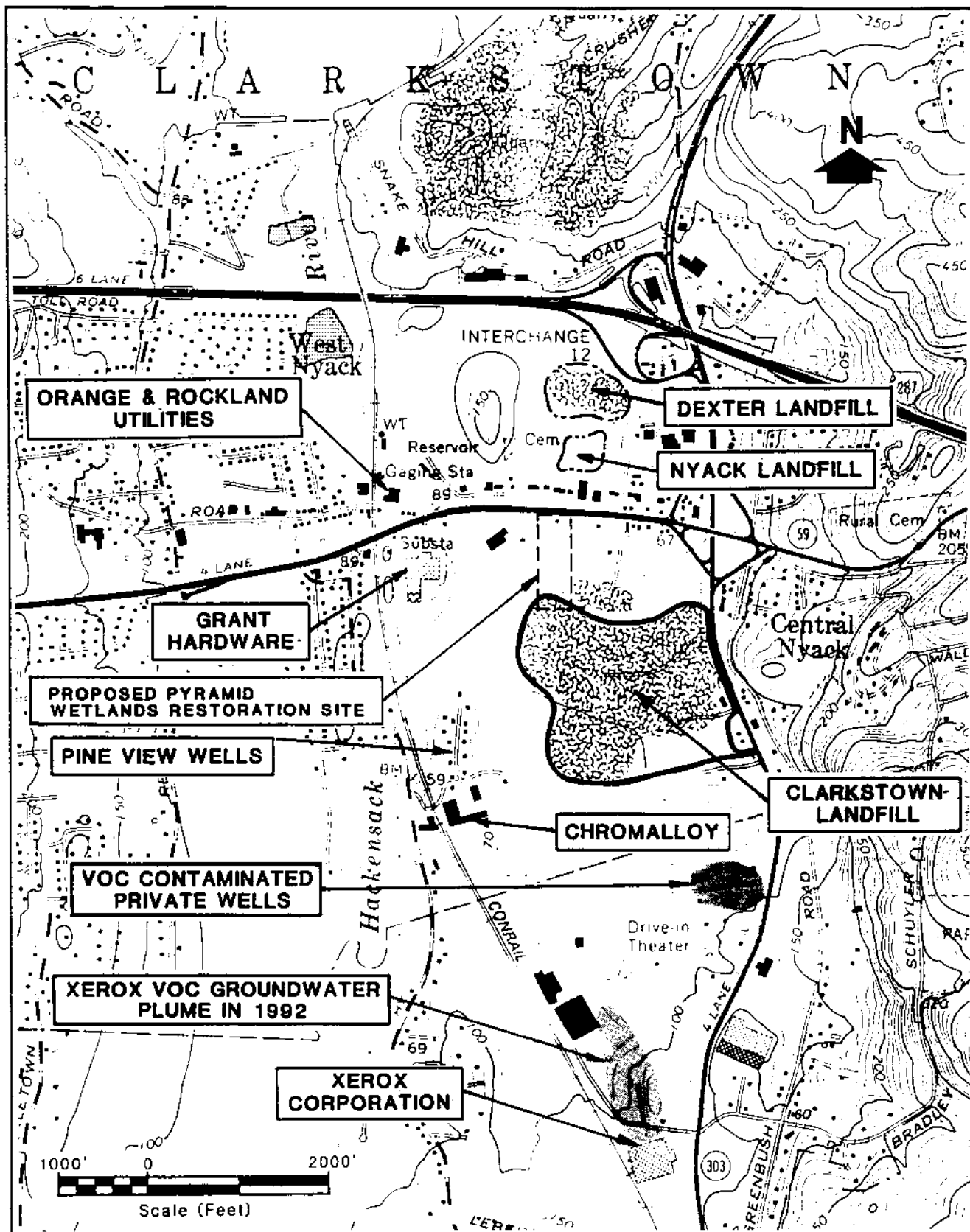
In 1989, the Town obtained and currently holds a permit to discharge leachate from the leachate collection system to the Rockland County Sewer District #1 without pretreatment. Starting in that year, leachate was pumped from the two holding ponds into a pump station wet well located next to the landfill garage, and then into the County sanitary system. Monthly testing of the leachate has shown that the quality of the leachate at the site is within the pretreatment standards for the plant.

Pursuant to a later Consent Decree issued by NYSDEC in August 1989, the landfill was scheduled to close by December 31, 1989. However, the landfill was allowed to remain in operation until a solid waste transfer facility was constructed at the site and placed into operation in January, 1991. The transfer station occupies an approximate six acre portion of Town property adjacent to Route 303 and north of the landfill administrative and maintenance buildings, as shown on Figure 1-2. This six acre parcel was "closed" (capped) in accordance with the 1988 NYSDEC Part 360 solid waste regulations to permit construction of the transfer facility. The closure was initiated as an interim closure activity and will be incorporated into the overall closure design of the entire landfill. The landfill was officially closed December 31, 1990. The August 1989 Consent Decree also called for the implementation of an RI/FS. The Phase I RI field investigation was implemented during the Summer and Fall of 1990, with groundwater sampling conducted in early Spring 1991. An Interim Report for the Phase I RI was submitted in August, 1991, and a Draft RI Report was issued in October 1993.

1.2.3 Previous Investigations/Information on Surrounding Properties Known or Suspected to Contain Hazardous Waste

There are several properties in proximity to the Clarkstown Landfill which have documented groundwater contamination and may be impacting groundwater, surface water, and sediment in the wetlands adjacent to the Clarkstown Landfill. As part of the RI, information related to investigations conducted on these properties was reviewed to evaluate the potential for these sites to impact groundwater beneath the landfill property and storm water runoff entering the wetlands. The following is a summary of pertinent information for these properties with their locations depicted in Figure 1-3 in relation to the landfill.

Chromalloy - This property, located approximately 1000 feet to the southwest of the Clarkstown Landfill, has been listed as a NYSDEC Class 2 inactive hazardous waste site and a Remedial Investigation/Feasibility Study is required. A Phase II Investigation Report was completed by the responsible party in late 1992. This report indicated that the Chromalloy site is the source



Base Map:
U.S.G.S. 7 1/2 Minute Quadrangle-Nyack, N.Y.

Information From:
NYSDEC, Albany and New Paltz, N.Y. Offices

FIGURE 1-3
OFF-SITE LOCATIONS OF ENVIRONMENTAL INVESTIGATION

WESTON
MANAGERS DESIGN & CONSULTANTS

of contamination by trichloroethene (TCE) to several Pine View Road domestic wells located immediately north of the facility. Groundwater at the site is contaminated with TCE, an industrial solvent, at levels as high as 33,000 parts per billion (ppb) and chromium up to 328 ppb. It is inferred that the presence of TCE and chromium are a result of industrial operations at the facility (NYSDEC Inactive Hazardous Waste Disposal Sites in New York State, Volume 3, April 1993). Based upon the above information, this site has the potential to contaminate groundwater, surface water, and sediment in the wetlands and Greenbush Brook. Groundwater beneath the Clarkstown Landfill does not appear to have been impacted by this site. However, given that the Town property extends beyond the landfill and into the wetlands, groundwater contamination emanating from this site may have impacted Town property. An RI/FS is currently being completed at this site.

Xerox Corporation - The Xerox facility is located approximately 3/4 of a mile south of the Clarkstown Landfill. This property is also a NYSDEC Class 2 Inactive Hazardous Waste site. A RI/FS conducted at this property has identified at least two releases of an unknown volume of organic chemicals from underground storage tank overfills during the 1970s. These releases have resulted in a groundwater contaminant plume migrating in a northerly direction towards the Clarkstown Landfill. A majority of the plume lies beneath the Bradley Industrial Park located to the north of the Xerox facility. The northern extent of the groundwater plume was estimated in 1992 to be approximately 1200 feet from the Xerox property boundary and approximately 2,000 feet south of the Clarkstown Landfill (see Figure 1-3). Organic chemicals noted in the groundwater and surface water above NYSDEC standards include primarily industrial solvents such as trichloroethene (TCE), tetrachloroethene (PCE), and several other breakdown products of TCE. The surface waters consist of drainage channels which pass through the industrial park from the Xerox property and discharge into Greenbush Brook and the wetlands located to the southwest of the Clarkstown Landfill. A Record of Decision (ROD) was issued in March 1993 for cleanup of the chemical contamination emanating from this property (Personal Communication, NYSDEC, Albany, New York, 1993). Based upon the above information, this

facility has the potential to contaminate surface water and sediment in the wetlands and Greenbush Brook.

VOC Contaminated Private Wells - Birchwood Drive and Drive-In Theater Property - According to the Rockland County Department of Health (DOH), two private water supply wells located along Birchwood Drive (former entrance road to the Drive-In Theater, see Figure 1-3) have shown contamination by volatile organic compounds (VOCs) from an unknown source. The detected VOCs included 1,1-dichloroethene; cis-1,2-dichloroethene; 1,1,1-trichloroethane; trichloroethene; and tetrachloroethene. Concentrations ranged from non-detected to 29 ppb, based on data obtained from the County DOH, provided in Appendix E. In addition, halogenated volatile organic compounds were also detected in a nearby groundwater monitoring well installed approximately 200 feet west of Route 303 on the Drive-In Theater property (Personal Communication, NYSDEC, Albany, New York office, 1992).

A small intermittent stream flows through the Drive-In Theater property toward the Clarkstown Landfill. The source(s) of the VOC contamination in groundwater and any related impacts to surface water are presently unknown. Based on topography and a review of the RI hydrogeologic data, the Drive-In Theater property appears to lie upgradient of the Clarkstown Landfill. Based on the most recent (Phase II) sampling effort, groundwater beneath the southeast corner of the landfill appears to have been impacted by the VOC contamination. No information was available from the State regarding any completed or planned investigations of groundwater conditions in this area.

Nyack Landfill/Dexter Landfill - These landfill properties are located approximately 1500 feet north of the Clarkstown Landfill and were reported as containing similar waste products as the Clarkstown Landfill, consisting of municipal solid waste, paper, metal, tires and appliances. The Dexter Landfill operated primarily between 1966 and 1976. Solid waste materials also deposited in the Dexter landfill included incinerator residue from a municipal facility in Yonkers,

NY, construction debris, earth and tree stumps. The Nyack Landfill is an approximate 12 acre site which accepted automotive debris, construction materials, yard debris, and municipal/household solid waste. The Nyack Landfill operated for almost 20 years until 1973. Drums containing oils, water, waste lacquers and sludge were found on the property during a site investigation in 1984. Polychlorinated biphenyls (PCBs) were detected in a drum at a level of 50 parts per million (ppm). The site was classified by NYSDEC as a Class 3 site (does not present a significant threat to the public health or environment; response action may be deferred) in 1987 after drum removal. Since that time, the site was de-classified by NYSDEC with no further action required (NYSDEC Inactive Hazardous Waste Disposal Sites in New York State, Volume 3, April 1990).

The Pyramid Development Corporation is the current owner of the Nyack/Dexter landfill properties and has submitted to NYSDEC a landfill closure plan as part of a larger site development plan which includes the two landfill properties. The development plan formerly included removal of fill and restoration of a former wetlands on a plot of land which abuts the northwest corner of the Clarkstown Landfill. A portion of the northwest toe of the Clarkstown Landfill, approximately one acre in size, extends over the Town property boundary onto the proposed wetlands restoration site property. The developer may remove and properly dispose of this Clarkstown Landfill waste as part of the wetlands restoration project (O'Brien & Gere Engineers, Inc., 1992).

Orange & Rockland Utilities - This property is located along the Hackensack River northwest of the landfill. This site has been investigated for petroleum and PCB contamination from leaking electrical transformers and spillage of transformer oils during refilling. PCBs were found in soils on the river banks in 1988. Remediation of soils was performed and surface water samples of the Hackensack River collected in 1990 were determined to be free of PCBs. The site is presently classified by NYSDEC as 2a (inadequate and/or insufficient data for inclusion in any of the other classifications). The most recent Phase II Investigation completed in

February, 1992, sampled groundwater, soils, surface water, and sediments. PCB contamination was detected at concentrations up to 4.9 ppm in sediments, up to 60 ppb in groundwater, and up to 58 ppb in soil. In groundwater, organic chemical industrial solvents such as TCE and 1,1,1-trichloroethane (1,1,1-TCA) were detected at levels above NYSDEC standards, up to 84 ppb and 430 ppb, respectively. Further investigations of the impact of this property on the surrounding environment are anticipated (Personal Communication, NYSDEC, Region 3 New Paltz, New York, 1992).

Grant Pulley/Hardware - The Grant Pulley property is located approximately 1500 feet west of the northwest corner of the Clarkstown landfill. Records research of this property indicates reports of spills of both trichloroethene (TCE) and waste oil in the past. This site was delisted by the NYSDEC in 1992 as a Class 2 Inactive Hazardous Waste Site because there was no evidence of contaminants on-site. The owner of the property performed a preliminary site assessment, which consisted of a record search, and petitioned the NYSDEC for delisting. The site was delisted in 1992 (Personal Communication, NYSDEC Region 3, New Paltz, New York, 1993).

Pine View Wells - These wells provided potable water to fifteen residences in a housing development located west of the landfill. These wells are located 200 feet from the Chromalloy facility and approximately 1000 feet west of the Clarkstown Landfill. Approximately twelve years ago the wells were abandoned due to contamination by an unknown source of trichloroethene (TCE). In response, a water main was installed and municipal water service was brought into the development. The property was subsequently delisted by NYSDEC when a Phase II Investigation of the nearby Chromalloy facility determined it to be the source of TCE contamination to the Pine View wells. (Personal Communication, NYSDEC Region 3, New Paltz, New York, 1993).

1.3 Report Organization

Section 2.0 of this report describes the Phase I and Phase II field investigation activities. Section 3.0 presents the physical characteristics of the landfill site and surrounding environs, including surface features, surface water hydrology, soils types, geology and hydrogeology, and ecology of the study area.

Section 4.0 discusses the nature and extent of contamination in media located within the boundaries of the landfill property (leachate, soil gas, soil, groundwater, and air) and in the surrounding surface waters and sediments as determined during the RI. The Phase I and Phase II RI data are summarized in tabular form in Appendices A and B and are discussed in this section in relation to applicable or relevant and appropriate requirements (ARARs).

Section 5.0 discusses contaminant fate and transport and presents a conceptual site model which discusses the hydrogeologic framework of the landfill and adjoining areas and the relationship with the surface water drainage and hydrology. The site-specific hydrogeology is used to establish the presence of potential contaminant migration pathways and identifies potential receptors (human and wildlife) and exposure pathways for any contamination emanating from the landfill. The characteristics of the compounds of concern identified during the RI are discussed as well as the fate and transport of these compounds in the environment.

Section 6.0 presents a qualitative risk assessment of the potential human health and environmental risks posed by the landfill.

Finally, Section 7.0 presents the summary and conclusions of the remedial investigation, and Section 8.0 includes the references cited in the report.

1.4 Applicable or Relevant and Appropriate Requirements (ARARs)

A brief summary of the State, Federal, and local environmental regulations, standards, and criteria which are applicable to the Clarkstown Landfill RI/FS is presented in Appendix C. A comparison of these applicable or relevant and appropriate requirements (ARARs) with the results of analytical testing of samples from the landfill was used to determine if the landfill has had an impact on the surrounding media (i.e., ambient air, groundwater, surface water, sediment, and soil). A more extensive discussion of ARARs is presented in the companion Final FS Report.

In Section 4.0 of the report, the Phase I and Phase II RI analytical sampling results are compared to the appropriate ARARs. The ARARs are included where appropriate, for reference in the data tables in the Appendix and include the following:

- New York State Ambient Water Quality Standards and Guidance Values (Part 703),
- New York State Department of Health Drinking Water Standards (Parts 5 and 170),
- NYSDEC Sediment Criteria,
- NYSDEC Air Guide-1 and Air Cleanup Levels,
- Rockland County Wastewater Treatment Plant Pretreatment Standards,
- NYSDEC Part 375 Inactive Hazardous Waste Site Regulations,
- NYSDEC Part 360 Solid Waste Regulations,
- NYSDEC Soil Cleanup Objectives,
- Federal Clean Air Act New Source Performance Standards, and
- Federal Resource Conservation and Recovery Act (RCRA) Subtitle D Regulations.

The most stringent of the State, Federal, and local ARARs, predominantly the New York State ARARs, were used for comparison with the RI analytical testing results.

2.0 STUDY AREA INVESTIGATION

2.1 Site Reconnaissance

An initial site reconnaissance was completed in 1990 prior to the Phase I sampling effort at the Clarkstown Landfill to inspect the planned sampling points, to identify any areas of potential contamination or erosion problems, and to record other pertinent surface features. Leachate seeps were observed on the northern landfill face at two locations. An area of potential erosion problems was identified at the western base of the landfill at the juncture of the two landfill mounds. Surface runoff channels were observed leading from the landfill slopes towards the wetlands. A leachate seep was observed emanating from one of the channels.

Ambient air conditions were documented to detect potential on-site contaminants and to ensure the health and safety of workers during the planned site investigations. Various field instruments were used including an HNu and OVA (detect volatile organic compounds), combustible gas indicator (detects combustible gases such as methane), and a radiation detector (detects potential gamma radiation from background sources or waste). The ranges of response for the various instruments were as follows:

HNu	No response above background levels (0.2 units)
OVA	40 - > 1000 parts per million (ppm)
Gastechtor	No response
Ludlum	No response above background levels (0.01 - 0.02 milli-Roentgen/hour)

The elevated OVA response is likely to be a result of methane in the landfill gas emissions. The HNu does not detect methane. The highest OVA response corresponded generally to landfill gas odors.

2.2 Surface Water and Sediment Investigation

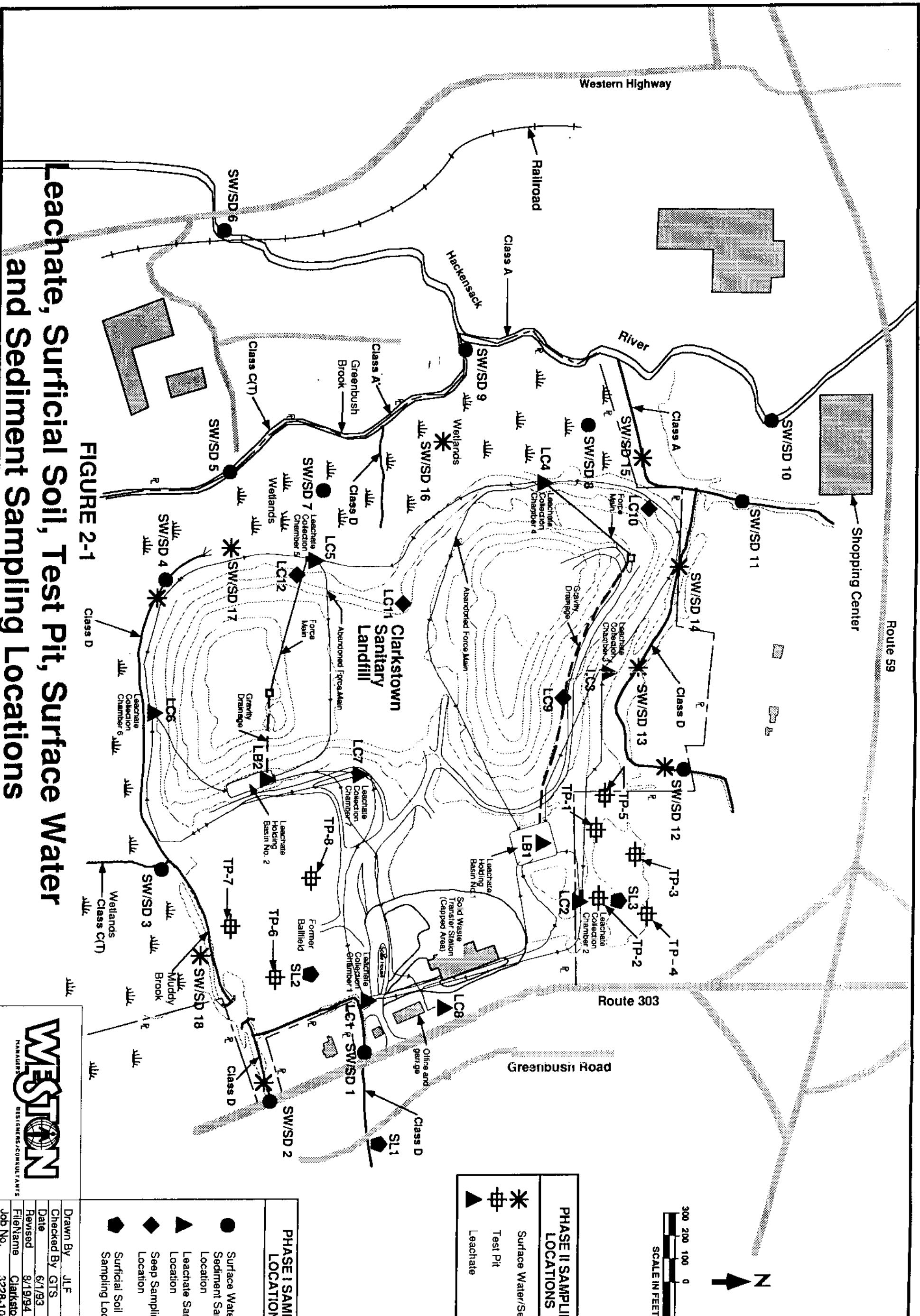
2.2.1 Introduction

The main watercourse that drains the area around the Clarkstown Landfill is the Hackensack River located to the west of the landfill. Numerous streams and tributaries to the Hackensack River flow near and along the boundary of the landfill, as described in Section 3.2. These streams and tributaries originate in off-site areas upstream of the Clarkstown Landfill. Some of these streams receive runoff from roads and other impervious surfaces. Others, such as Muddy Brook, have been rerouted and channelized to direct flow around the landfill.

2.2.2 Sampling Locations and Objectives

Surface water and sediment samples were collected from the streams and tributaries to the Hackensack River around the landfill. Surface water samples were taken to determine the surface water quality of the Hackensack River and its tributaries to determine if these waters are affected by discharges originating from the Clarkstown Landfill or any other upstream locations, such as urban runoff or the other NYSDEC-designated hazardous waste sites. Sediment samples were collected to determine the present sediment quality, which also reflects past historical inputs of contamination to the streams due to the ability of various contaminants to accumulate in the sediment particles.

Figure 2-1 presents the locations of the Phase I and Phase II surface water and sediment sample locations. Sample points were located upstream and downstream of the landfill. Phase I upstream sample points SW/SD-1, SW/SD-2, SW/SD-11 and SW/SD-12 were located in waterways which flow toward the landfill. Phase I sample points SW/SD-10 and SW/SD-6 were located along the Hackensack River upstream and downstream, respectively, of the confluence of the Hackensack River with Greenbush Brook and the northern unnamed tributaries to the Hackensack River. Phase I sample points SW/SD-8 and SW/SD-7 were located in the wetlands which receive runoff from the landfill and surrounding areas, as well as overflow from the Hackensack River. Phase I location SW/SD-4 is located at the end of Muddy Brook where the



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ClarkstownBaseMap

3228-10-01-0148

Table 2-1

Phase I Analytical Parameters and Number of Samples for Each Medium

Analytical Parameters	Ground Water	Surface Water	Sediment	Leachate	Surface Soil	Ambient Air	Soil Gas	Subsurface Soil
TCL Volatile Organics	23	12	12	14	3	15	30	10
TCL Semivolatile Organics	23	12	12	14	3	0	0	10
TCL Pesticide/PCBs	23	12	12	14	3	0	0	10
TAL Metals/Cyanide	23	12	12	14	3	0	0	10
Nitrite/Nitrate	0	12	0	0	0	0	0	0
Ammonia	0	12	0	0	0	0	0	0
Orthophosphate	0	12	0	0	0	0	0	0
Chlorophyll a	0	12	0	0	0	0	0	0
Total Organic Carbon	23	0	12	0	0	0	0	28
Grain Size Analysis	0	0	0	0	0	0	0	18
Vertical Permeability	0	0	0	0	0	0	0	8
Atterberg Limits	0	0	0	0	0	0	0	12
Moisture Content	0	0	0	0	0	0	0	60
CEC	0	0	0	0	0	0	0	8
Specific Gravity	0	0	0	0	0	0	0	15
Duplicates	2	1	1	1	1	0	0	6
Field Blanks	2	1	1	1	1	0	0	3
Trip Blanks	4	2	2	2	1	3	3	5

Table 2-2

Phase II Analytical Parameters and Number of Samples for Each Medium

Analytical Parameters	Groundwater	Surface Water	Sediment	Leachate	Soil	Landfill Gas	Analytical Method
Volatile Organics	—	—	—	—	—	7	EPA Method TO-14 ^c
Part 360 Baseline Organics ^a	22 ^b	7 ^b	7	10 ^c	4 ^c	—	EPA 524.2 ^b NYSDECASP ^c CLP 91
TCL Semivolatiles	—	—	7	—	4	—	NYSDEC ASP CLP 91
TCL Pesticide/PCBs	2	2	2	—	4	—	NYSDEC ASP CLP 91
TAL/Part 360 Baseline Metals ^a	22	7	7	10	4	—	NYSDEC ASP CLP 91
Total Cyanide	22	7	7	10	4	—	NYSDEC ASP CLP 91
RCRA Characteristics	—	—	—	—	2	—	NYSDEC ASP CLP 91
TKN	22	—	—	10	—	—	EPA 351.2
Ammonia	22	7	—	10	—	—	EPA 350.1
Nitrate/Nitrite	22	—	—	10	—	—	EPA 353.2
COD	22	—	—	10	—	—	HACH Method 8000
BOD ₅	22	—	—	10	—	—	EPA 405.1
TOC	22	—	7	10	—	—	EPA 415.2
TDS	22	—	—	10	—	—	EPA 160.1
Sulfate	22	—	—	10	—	—	EPA 375.4
Alkalinity	22	—	—	10	—	—	EPA 310.1
Total Phenols	22	—	—	10	—	—	SW-846 9066/ EPA 420.1
Chlorides	22	—	—	10	—	—	SW-846 9052/ EPA 325.3
Hardness	22	7	—	10	—	—	EPA 130
Turbidity/Color	22	—	—	10	—	—	EPA 180.1/ EPA 110.2
Boron	22	—	—	10	—	—	SW-846 6010
Hexavalent Chromium ^a	22	—	—	10	—	—	SW-846 M7195
Bromide	22	—	—	10	—	—	EPA 320.1

Table 2-2

**Phase II Analytical Parameters and Number of Samples for Each Medium
(concluded)**

Analytical Parameters	Groundwater	Surface Water	Sediment	Leachate	Soil	Landfill Gas	Analytical Method
Equipment Blanks	1	-	1	1	-	—	QA/QC samples shall be analyzed according to appropriate methods, all parameters for each medium.
Field Duplicates	2	1	1	1	1	1	
Matrix Spikes	2	1	1	1	1	—	
Matrix Spike Duplicate	2	1	1	1	1	—	
Trip Blanks	5	1	—	2	—	1	

*See attached NYSDEC Part 360 Baseline Parameters List.

*Low Detection Limit Method; not done for surface water due to lab error, used ASP method instead.

*NYSDEC ASP Method

*Actual method used was T01/T02 as per NYSDEC.

is taken to determine possible sources of contamination from sampling equipment. One field blank was also collected during Phase I. A trip blank is a set of VOA vials which are filled at the laboratory or prepared in the field with analyte-free water and remain unopened during the field sampling efforts for that day. Trip blank analyses provide a measure of possible contamination from airborne contaminants or glassware. Trip blanks were analyzed for the Target Compound List (TCL) volatiles only, and a set of trip blanks were shipped with the samples for each day of sampling. Matrix spikes and matrix spike duplicates were collected at a frequency of one per ten samples at locations SW/SD-2 and SW/SD-9 during Phase I for internal laboratory QA/QC purposes.

Physical parameters measured in the field for surface waters include conductivity, pH, water temperature and dissolved oxygen. Table 2-3 and Table 2-4 present the Phase I and Phase II surface water field parameters. Conductivity is a numerical expression of the ability of a water sample to carry an electrical current. Conductivity depends on the total concentration of the ionized substances dissolved in the water and the temperature at which the measurement is made. The pH of a solution refers to its hydrogen ion activity. The pH scale extends from 0 (very acidic) to 14 (very basic), with 7 corresponding to exact neutrality at 25°C. The pH of most natural waters falls within the range of 4 to 9. All the pH of the surface waters sampled at Clarkstown Landfill fall within this range. Dissolved oxygen (DO) levels in natural waters are dependent on the physical, chemical and biochemical activities prevailing in the water body.

Wide ranges in dissolved oxygen, temperature, and conductivity can be seen in the data in Table 2-3 (Phase I) which reflect the varying stages of flow of the streams during the dry season. The wet season sampling field parameters, shown on Table 2-4 (Phase II), are relatively uniform reflecting a constant base flow to the streams during the wet season. As shown on Table 2-3 in the data for samples SW-6 and SW-10, the Hackensack River does not reflect these extreme variations in temperature or DO because of the continuous volume of water it receives from the Lake DeForest Reservoir.

Table 2-3

Phase I Surface Water Field Parameters

Sample Location	Date Collected	pH	Conductivity (μ mhos)	Water Temperature ($^{\circ}$ C)	Depth of Water	Dissolved Oxygen (mg/l)
SW-1	7/25/90	7.4	252	23	6"	2
SW-2	7/23/90	6.5	450	22	6"-1'	5
SW-3	7/25/90	7.1	270	17	6"	10
SW-4	7/23/90	6.2	230	23	0-2'	7.6
SW-5	7/31/90	7.2	520	17	6"	5.8
SW-6	7/25/90	7.5	310	28	3'	6.3
SW-7	10/16/90	7.5	258	13	NA	NA
SW-8	7/31/90	7.1	1250	17.5	2-3'	2.2
SW-9	7/30/90	7.3	345	16.5	1'	5
SW-10	8/2/90	8.3	300	24	1-3'	6.6
SW-11	8/1/90	7.0	1800	21	1'	2.2
SW-12	8/1/90	8.7	800	26	6-8"	9

NA = Data not available

Table 2-4

Phase II Surface Water Field Parameters

Sample Location	Date Collected	pH	Conductivity (μ mhos)	Depth of Water (in.)	Water temp. ($^{\circ}$ C)	Estimated Discharge ($\text{ft}^3/\text{min.}$)	Stream Width (feet)	Dissolved oxygen (mg/l)
SW-2	4/18/94	6.8	182	9	9	NF	10	11
SW-4	4/18/94	6.8	210	8	15	-	20	11.5
SW-12	4/19/94	7.4	470	8	11	210	6	12.4
SW-13	4/19/94	6.7	480	10	11	230	30	11.8
SW-14	4/19/94	6.8	600	18	12.5	240	9	10.8
SW-15	4/19/94	6.8	750	18	13	21	25	9.0
SW-16	4/18/94	6.7	480	8	18	NF	-	11.6
SW-17	4/18/94	7	390	4	22	NF	3	11.8
SW-18	4/18/94	7	210	18	9.5	48	15	10.8

NOTES:

- (1) NF = Not Flowing
 (2) - = No Data Available

2.3 Geological Investigations

2.3.1 Previous Geological Investigations

Available existing data from previous investigations conducted at the landfill were compiled to supplement the RI data for characterization of the site subsurface conditions. Existing soil boring data from these investigations were used to generate hydrogeologic cross-sections, thickness contour maps, and upper surface topographic maps for the various geologic formations present below the landfill (See Drawings 1 of 11 through 11 of 11 accompanying this report). A data quality review was completed for each set of data to determine the suitability of the data prior to its use. The soil boring logs for the RI and previous investigations are presented in Appendix D.

The soil boring data generated during previous studies at the landfill was generally found to be acceptable for use in the RI. Existing site monitoring wells installed in 1985 were found to be unsuitable for groundwater sampling purposes but were used for water level measurements. However, groundwater sampling results for these wells were also compared to the remedial investigation Phase I and II groundwater results to qualitatively evaluate historic changes in groundwater quality beneath the landfill.

During the RI program, NYSDEC expressed concerns regarding the presence of numerous other sites listed on the State Registry of Inactive Hazardous Waste Sites in the Hackensack River Valley. In response to these concerns, the existing data review was expanded to include collection and review of available subsurface data from studies completed at these sites. In particular, data were used to determine the regional extent of the fine-grained confining unit deposits which are a deterrent to vertical contaminant migration into the deeper glacial and bedrock aquifers. Data from site investigations at the Dexter and Village of Nyack landfills, Town of Clarkstown, New York, and the Xerox Corporation, Hamlet of Blauvelt, New York were reviewed. Other listed sites which are present in the Hackensack River Valley but for which data were not obtained include Orange and Rockland Utilities, the Pine View Wells, Grant Hardware, and the Chromalloy sites. A series of regional geologic formation thickness contour

maps and topographic maps were prepared to provide a better regional perspective of subsurface conditions in the valley (Drawing 11 of 11).

2.3.2 Phase I RI Monitoring Well Installations

2.3.2.1 Introduction

The Phase I monitoring well installation program was initiated in July, 1990, with the drilling of two deep exploratory borings (B-7 and B-9) on the north side of the landfill. Initially, the work was awarded to R&R International, Inc., Akron, Ohio, a minority-owned business enterprise (MBE). A relatively thick, coarse-grained, collapsing glacial outwash deposit was encountered which presented problems with the selected drilling methods. R&R International, Inc. subsequently withdrew from the project after completing the borings because they could not provide the equipment necessary for well installation in the outwash deposit.

Other drilling methods and drilling firms were investigated which were available to complete the work successfully. The TUBEX (formerly ODEX) method of drilling was selected as the most appropriate method for drilling into the outwash formation. Moretrench Environmental Services, Inc., Rockaway, New Jersey, was contracted to complete the remaining work. A total of twenty-five monitoring wells and three piezometers were installed at the landfill over the period from October, 1990, to February, 1991, under the supervision of WESTON field geologists. Subsurface split-spoon and undisturbed soil samples were collected for geotechnical testing for soil strength and physical properties as described in Section 2.3.4.

2.3.2.2 Monitoring Well Locations, Depths, and Rationale

A total of nine (9) well couplets and seven (7) single wells (a total of 25 monitoring wells) were installed. Three (3) additional piezometers were installed. One (1) piezometer was installed in the same borehole as a well and the other two (2) were installed in a single borehole to reduce drilling/installation costs. The procedures used for construction of the wells/piezometers in the same borehole were developed and approved by NYSDEC concurrent with the drilling program.

2.2.3 Sampling Protocols and Analytical Program

In preparation of the sampling effort, sample bottles were shipped pre-cleaned with appropriate preservatives from the Contract Laboratory Program (CLP) laboratory, and were labelled prior to entering the field. Samples were collected by filling the bottle directly or by using a decontaminated stainless steel trowel (sediment sample) or a stainless steel scoop (water sample). Bottles were filled to the shoulder with a small amount of headspace to allow for sample expansion, except for volatile organic analysis (VOAs). After samples were collected, they were placed in a cooler with ice for shipment to the laboratory for analysis. Samples were collected in a downstream to upstream sequence whenever possible to prevent disturbance of downstream water quality.

Sediment samples were collected immediately after collecting surface water samples at the same locations. Samples were collected with a decontaminated stainless steel trowel or scoop and homogenized, after first filling the VOA container, in a stainless steel mixing bowl. Sediment samples were collected to a depth of approximately three inches.

Table 2-1 and Table 2-2, respectively, present the Phase I and Phase II analytical parameters and number of samples per medium. During the Phase I sampling event, field duplicates, field blanks, trip blanks, matrix spikes and matrix spike duplicates (MS/MSD) were also collected. During the Phase II effort, only matrix spikes and matrix spike duplicates, and trip blanks were collected. The NYSDEC project Quality Assurance Officer waived the requirement to collect field duplicates and field blanks for the Phase II investigation since dedicated sampling equipment was planned for use, and the MS/MSD satisfied the duplicate analysis Quality Assurance/Quality Control (QA/QC) requirements.

Field duplicate samples are a replicate set of samples taken at a designated sampling point. A field duplicate sample was taken for Phase I at a frequency of one for every twenty samples. The field duplicate was collected at sampling point SW/SD-12. A field blank is laboratory-supplied analyte-free water poured over the field sampling equipment and collected in the appropriate glassware for analysis for the same parameters as the field samples. The field blank

A majority of the monitoring wells (wells RFW-1S/D, 2, 3S/3D, 4S/4D, 5S/5D, 6S/6D, 7S/7D, 8S/8D, 9S/9D, and 12) were installed around the perimeter of the landfill, as shown on Figure 2-2. The purpose of these wells was to monitor groundwater quality downgradient of the landfill. Wells RFW-14, 15 and 16 were installed in the center of the landfill to establish groundwater quality and elevations within the landfill mass. Wells RFW-10S/D, 11, and 13 were installed as "background" wells to monitor upgradient groundwater quality. The results for these background wells are compared to the perimeter wells to identify any impacts to groundwater quality due to the landfill versus other sources. The piezometers (RFW-11PZ1, 11PZ2, and 13PZ) were installed as additional groundwater level observation points.

The wells and piezometers were generally installed as couplets adjacent to each other and were screened at varying depths to establish the vertical component of groundwater flow direction and to compare water quality in the various subsurface deposits. Wells RFW-2, 12, 14, 15, and 16 were installed as single wells. Originally, the shallow wells at the couplet locations were planned for installation in the peat and organic silt deposits lying directly below the landfill. However, subsequently it was decided that a majority of the wells would be installed in the more permeable deposits at each location (glacial outwash, till and bedrock) since they represent the most likely groundwater flow and potential contaminant migration pathways.

Monitoring well locations are presented in Figure 2-2, and the depths and other construction details are presented in Table 2-5. The locations and depths generally correlate with those presented in the site work plans. Some modifications to the drilling/well installation program were made based on actual field conditions encountered and discussions with the NYSDEC project manager and field hydrogeologists.

Well RFW-9S was installed in shallow fill deposits rather than native soils as proposed. A review of the site topographic map showed that recent soil fill may have been placed on top of

brook disperses into the wetlands, and SW/SD-3 is located upstream of a point of convergence between Muddy Brook and an unnamed stream flowing northwards from the former drive-in theater. Sample point SW/SD-5 was located in Greenbush Brook beyond the southwest corner of the landfill. SW/SD-9 was located where Greenbush Brook converges with the Hackensack River. These latter two locations receive runoff and baseflow from upstream areas around Bradley Industrial Park and the Xerox Corporation facility, and possibly from the Clarkstown Landfill.

The Phase II samples were collected at three downstream locations on the tributaries on the north side of the landfill (SW/SD-13, SW/SD-14 and SW/SD-15), two downstream locations along Muddy Brook (SW/SD-4 and SW/SD-18), two upstream locations (SW/SD-2 and SW/SD-12) and two downstream locations in the wetlands west of the landfill (SW/SD-16 and SW/SD-17). During the Phase I sampling, only ponded water was present in the wetlands at the time of sampling (locations SW/SD-7 and SW/SD-8). The analytical results suggested that evaporation of the ponded waters had resulted in anomalously high detected concentrations of metals (See Section 4.2). Therefore, only flowing water was sampled, if possible, during Phase II in the wetlands, in order to represent average surface water conditions in the wetlands.

The Phase I sampling effort (July - August 1990) constituted a dry season (Summer) sampling round and the Phase II sampling (April 1994) represented a wet season (Spring) sampling round. During Phase I, surface water/sediment sample SW/SD-7 had to be collected at a later date (November 1990) than the other Phase I samples, because of insufficient flows during July and August. During the field investigations, height variations in the Hackensack River were evidenced by water marks on the bridge crossing Western Highway and by the stream gauge data provided by the United States Geological Survey (USGS). The Phase II effort was completed to confirm the Phase I detections and to evaluate any seasonal effects on surface water/sediment quality.

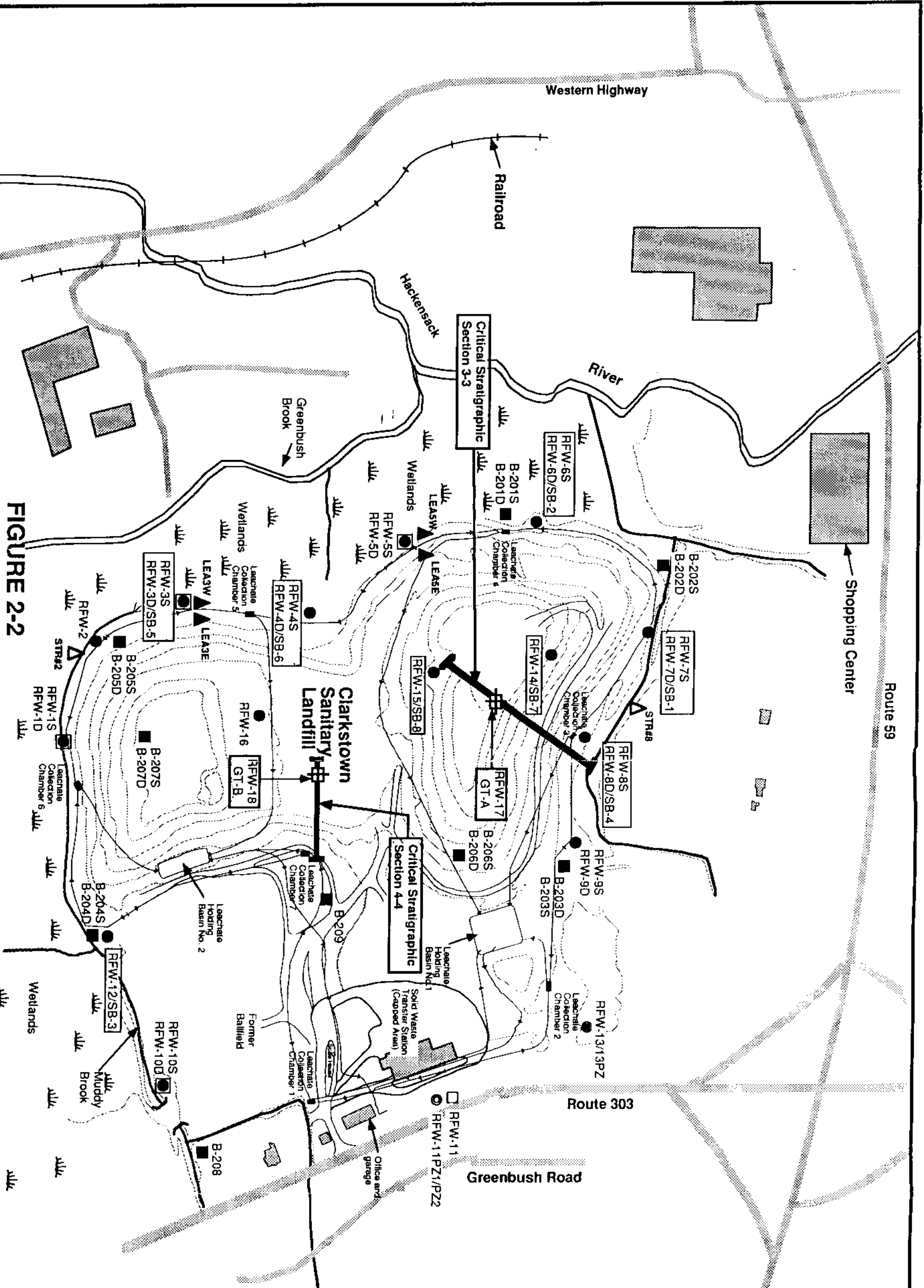
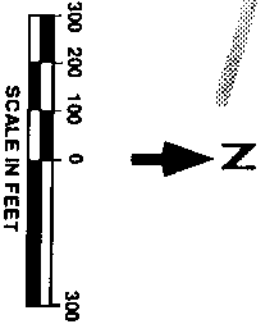


FIGURE 2-2

Subsurface Soil and Ground Water Sampling Locations and Existing Monitor Wells

PHASE II SAMPLING LOCATIONS	
	Geotechnical Soil Sampling
	Groundwater Sampling
	(Except Wells RFW-14, 15, 16)

PHASE I SAMPLING LOCATIONS	
	Existing Monitor Well
	Single overburden Well or Couplet
	Single Bedrock Well
	Well Couplet with Deep Well in Bedrock
	Piezometer Couplet installed in same Borehole
	Well and Piezometer installed in same Borehole
	Leachate Collection System Piezometer
	Stream Gage



Drawn By	JLF
Checked By	GTS
Date	6/1/91
Revised	8/19/94
Filename	ClarkstownBaseMap
Job No.	3228-10-01-0148

Table 2-5

**Summary of Monitoring Well and Piezometer Data
Clarkstown Landfill RI**

Well or Piezometer Number(1)	Elevation of Ground Surface(2)	Elevation of Top of Casing(2)	Diameter of Casing(in.)	Screened or Open Interval		Formation Screened
				Feet Below Grade	Referred to MSL(2)	
RFW-1S	70.0	72.11	2	20-25	52.11-47.11	Sandy Till
RFW-1D	69.6	71.70	2	45-55	26.7-16.7	Rock
RFW-2	63.5	66.20	2	24-29	42.2-37.2	Sandy Till
RFW-3S	63.2	65.28	2	29-34	36.28-31.28	Sandy Till
RFW-3D	63.3	64.89	2	45.5-60.5	19.39-4.39	Rock
RFW-4S	60.6	62.51	2	15-20	47.51-42.51	Peat
RFW-4D	60.6	62.83	2	35-45	27.83-17.83	Outwash
RFW-5S	58.4	60.44	2	33-43	27.44-17.44	Outwash
RFW-5D	58.3	60.06	2	84-94	(23.94-33.94)	Rock
RFW-6S	66.7	69.39	2	22.5-27.5	46.89-41.89	Peat/Silt
RFW-6D	67.4	69.86	2	37-42	32.86-27.86	Outwash
RFW-7S	63.0	65.69	2	53-58	12.69-7.69	Outwash
RFW-7D	63.0	65.99	2	77-87	(11.01-21.01)	Outwash
RFW-8S	62.7	64.77	2	25-30	39.77-34.77	Peaty Sand
RFW-8D	62.5	63.90	2	108-118	(44.1-54.1)	Outwash
RFW-9S	64.9	66.86	2	7-17	59.86-49.86	Fill
RFW-9D	65.1	66.58	2	48-58	18.58-8.58	Outwash
RFW-10S	59.1	60.67	2	30-35	30.67-25.67	Outwash
RFW-10D (B)	59.1	61.09	4	90-125	(28.91-63.91)	Rock
RFW-11 (B)	68.2	70.57	2	31-36	39.57-34.57	Rock
RFW-11 PZ1	68.1	70.30	2 PVC	17-27	53.3-43.3	Sandy Till
RFW-11 PZ2	68.1	70.27	2 PVC	5-10	65.27-60.27	Fill
RFW-12	61.1	63.10	2	20-25	43.1-38.1	Outwash
RFW-13 (B)	68.6	70.84	2	19.5-24.5	51.34-46.34	Outwash
RFW-13 PZ	68.6	70.85	2 PVC	6-11	64.85-59.85	Fill
RFW-14	118.9	121.80	4	77-87	44.8-34.8	Refuse
RFW-15	133.4	136.20	4	87-97	49.2-39.2	Refuse
RFW-16	137.4	140.01	4	77-87	63.01-53.01	Refuse
RFW-17 PZ	136.3	138.3 (3)	4	78.5-98.5	57.8-37.8	Refuse
RFW-18 PZ	134.0	136.0 (3)	4	64.0-84.0	70.0-50.0	Refuse

NOTES

(1) Monitoring wells are constructed of stainless steel; piezometers are PVC except RFW-17PZ and RFW-18PZ which are constructed of PVC screen and carbon steel riser casing.

(2) MSL - Mean Sea Level Datum (Parentheses indicate data below MSL)

(3) Casing elevations are approximate, not surveyed.

(B) = Background wells

PZ = Piezometers

the buried leachate collection system on the northern side of the landfill. This situation may cause leachate to flow over and escape the collection system. Well RFW-9S was placed to characterize quality of groundwater (leachate) that may be leaving the site in this manner.

Background well location RFW-10 was relocated from the northeast to the southeast corner of the property to minimize the potential amount of municipal waste which might be encountered. A single well (rather than a couplet) was installed at background well location RFW-11 because only one suitable water-bearing formation was encountered (bedrock). Bedrock well locations were shifted from RFW-6 and RFW-2 to RFW-5 and RFW-3, respectively, in an attempt to place the well screens at approximately the same relative depths for groundwater flow contouring purposes. The deep well at location RFW-1 was installed into bedrock because the bedrock was found to be highly fractured and at a relatively shallow depth. A piezometer couplet (RFW-11PZ1 and RFW-11PZ2) was installed at location RFW-11 to determine the vertical flow component and to estimate the permeability of the till through the completion of slug tests (See Section 2.8.2).

2.3.2.3 Exploratory Borings Completed by R&R International, Inc.

Two exploratory borings (B-7 and B-9; well locations RFW-7 and RFW-9, respectively) were completed by R & R International, Inc. The borings were advanced with hollow-stem augers through fill using the drive-and-wash method through the peat, organic silt, and varved clay (which together constitute a "confining zone" beneath the landfill; see Section 3.4.4.5), and a combination of a casing advancer method and rock coring through the remaining deposits into bedrock. A thick, highly permeable, cobbly and gravelly, collapsing outwash formation was found beneath the confining zone. Continuous split-spoon sampling was completed until reaching the outwash. Both the split-spoon sampling and the drive-and-wash drilling methods became unsuccessful in the outwash deposit because of high drill fluid loss and the presence of the cobbles and coarse gravels. Instead, samples of the outwash and underlying deposits (dense till and bedrock) were obtained with a rock coring system. The borings were abandoned and sealed with bentonite/cement grout upon completion.

Natural gamma ray geophysical logging was performed for exploratory boring B-7 upon completion of drilling to assist with correlating the stratigraphy across the property (See Section 2.4.2). Geophysical logging was attempted also for boring B-9, but was unsuccessful because the instrument would not pass down through the narrower conductor casing. Geophysical logging was attempted at two other existing monitoring wells, however, the wells contained accumulated silts which prevented the instrument from passing to the bottom.

2.3.2.4 Split-Spoon Soil Sampling

With the exception of select zones at B-7, B-9, and RFW-7, 8, 9, and 10, split-spoon soil sampling was completed at each well couplet or single well location continuously from grade surface to the deepest depth of overburden penetrated. Sampling was conducted generally in accordance with the standard penetration test ASTM D1586-67 with the use of 2-foot long, 1 3/8-inch inside diameter split-spoon samplers and 140 lb. hammers. Four-foot long samplers were used to sample thick sections of the confining zone for borings B-7 and B-9 to expedite the sampling process. During sampling of the dense tills at some locations, 300 lb. hammers were used.

The samples were screened with an HNu photoionization detector (PID) immediately upon opening the sampler and the HNu response noted in the field logbook. Representative samples of each geologic stratum were collected for laboratory chemical analysis, physical testing, or future inspection (See Section 2.3.4 for a description of the laboratory physical testing program and Section 2.5.2 for the chemical analysis program). Each sample was inspected and classified in the field by the field geologist. Split-spoon samplers were cleaned with an Alkonox® detergent wash and a fresh water rinse between uses at a borehole, and by steam cleaning between boreholes.

The dense till layer at location RFW-10 was split-spoon sampled at five (5) foot intervals rather than continuously because existing boring data indicated that the till was unusually homogenous.

Split-spoon samples of the outwash encountered at B-7, B-9, and RFW-7, 8, and 9 could not be successfully collected due to the coarse-grained nature of the deposit.

2.3.2.5 Bedrock Sampling

Bedrock core samples were collected continuously through the drilled thickness of bedrock with NX or HX core barrels at 5-foot or 10-foot run lengths. The core samples were screened with an HNu, inspected and classified by the field geologist, and transferred to core boxes for future inspection.

2.3.2.6 Shelby Tube Sampling

Undisturbed soil samples from the confining zone deposits were collected with the use of brass, thin-wall Shelby Tube samplers. The Shelby Tubes were sealed with paraffin wax on both ends, capped, sealed with tape and sent to the geotechnical laboratory via courier. The samples were submitted for triaxial strength and vertical permeability testing, as described in Section 2.3.4.

2.3.2.7 Drilling Methods For Monitoring Well Installation

Drilling for the monitoring well installations was completed by a variety of methods depending on the subsurface conditions. Because drilling at all locations was expected to first encounter refuse fill, certain precautions were taken to avoid cross contamination of the underlying native deposits. First, drilling for all the perimeter wells was conducted outside of the leachate collection system line to avoid drilling through leachate-saturated refuse. For well installations, permanent oversized steel casings were grouted through the shallow refuse zone and into the top of the confining zone before drilling into the native deposits. The steel casings are also designed to provide structural support to the wells in case of future settling or movement of the refuse. For the exploratory borings B-7 and B-9, augers or steel casing were used as temporary seals through the refuse zone. Finally, prior to drilling into the outwash, till, or bedrock, drilling fluids were replaced with fresh water.

Drill cuttings were disposed of on the landfill property inside the boundaries of the leachate collection system line. Potentially contaminated drilling fluids and well development water were discharged either into the leachate collection chambers, leachate storage ponds, or to the ground near the well, also inside the boundaries of the leachate collection system line. The drill rigs and all downhole equipment were decontaminated by steam cleaning between boreholes at three designated decontamination areas located inside the boundaries of the leachate collection line. Drill cuttings, fluids, and development water were visually inspected and screened with an HNu prior to disposal.

The permanent steel casings were installed with the use of 8-inch inside diameter hollow-stem augers. Upon reaching the required depth, the augers were filled with bentonite/cement grout and removed from the boring. The casing was then lowered into the grout column to depth and allowed to cure for at least 24 hours before further drilling. The casing was fitted with a bottom plug consisting of a plastic bucket to prevent grout from entering the casing. The plug was subsequently drilled out.

Drilling through the overburden beyond the depth of the permanent casing was completed with the 5-inch, 6-inch, and/or 8-inch drive-and-wash method; 6-inch ODEX method (wells RFW-7D, 8D, and 9D only); and 6-inch and/or 8-inch open hole rotary method. Fresh water obtained from the public water supply system was used as a drilling fluid for the drive-and-wash and open hole rotary methods at all locations with the exception of selected bedrock well locations. At these bedrock locations, bentonite muds (sodium variety) were required during drilling through the overburden to lift drill cuttings to the surface, to overcome water loss to the formation, and to stabilize caving formations. The muds were either flushed thoroughly from the borehole or isolated from the drill casing prior to drilling into the bedrock. Borings were advanced into bedrock using the rotary method with a roller bit after sampling the rock with a core barrel system. Samples of the fresh water used for drilling were collected and submitted for full TCL/TAL analysis.

At locations RFW-7, 8, and 9, the ODEX method of drilling was used in place of the specified drive-and-wash/open hole rotary methods to drill through the outwash. Locations RFW-7 and RFW-9 were relocated approximately fifty (50) feet from the respective exploratory boring (B-7 and B-9) locations to avoid encountering drilling fluids and/or bentonite/cement grouts lost to the formation during drilling of the borings. The sequence of drilling was as follows: (1) the permanent casing was installed with hollow-stem augers, (2) 8-inch temporary casing was set to the bottom of the confining unit with the drive-and-wash method, (3) open hole rotary method was used until collapsing/heaving conditions developed, and (4) use of the 6-inch ODEX method to the final depth. The ODEX method operates on an air rotary system while a downhole hammer advances the casing at the same time. An Atlas-Copco "oil-free" air compressor with an Ingersoll-Rand auxiliary air filter was used to prevent introducing contaminated air into the formation during drilling.

Continuous split-spoon and Shelby Tube sampling was completed at location RFW-8 as required to the depth at which the ODEX method was employed. Split-spoon samples were collected at locations RFW-7 and RFW-9 to the depth at which the ODEX method was employed only for intervals where poor recovery was recorded for the respective exploratory boring (B-7 and B-9). Split-spoon sampling was not completed through the interval drilled with the ODEX method due to the nature of the drilling method and formation. Extensive time and effort is required to remove the downhole hammer/bit assembly under normal conditions. Fine sands present in the outwash were also found to clog the air ports in the ODEX bit and heave into the casing when the hammer/bit assembly was removed. In addition, sample recovery with the split-spoon method was poor or nonexistent in the outwash because of cobbles and coarse gravel present. Instead, characterization of the outwash deposits was completed by inspection of cuttings blown to the surface. Split spoons were collected, however, at the final drilled depth to characterize and confirm the presence of the dense till below the outwash.

An exploratory boring was completed at location RFW-13 with hollow stem augers to determine if municipal waste found in this area is in direct contact with the bedrock system. Waste was found above a relatively thin confining zone overlying an outwash deposit. It was decided that

a monitoring well should be installed in the outwash deposit to characterize groundwater quality beneath the waste. Since this location is not near the main landfill mass, it was determined that well installation was acceptable without installation of a permanent casing beforehand. A PVC piezometer (RFW-13PZ) was installed in the same borehole as the monitoring well at a shallower depth. Bentonite pellets were used to seal the annulus between the screen zones of the well and piezometer in place of a bentonite/cement grout. Piezometer couplet RFW-11PZ1/RFW-11PZ2 was installed using the same construction methods as RFW-13/13PZ. Since this location was also near the main landfill mass and the piezometers would not be used for sampling, it was decided that the hollow-stem auger method was acceptable without installation of a permanent casing.

An exploratory boring (B-12) was completed at location RFW-12 to characterize the full thickness of overburden prior to well screen placement. Hollow-stem augers were advanced through the fill and used as temporary casing while drilling into the native deposits with the drive-and-wash method. The boring was terminated in a permeable, collapsing, coarse-grained outwash deposit which presented difficulties for the drive-and-wash method. The boring was abandoned with bentonite/cement grout upon completion. Well RFW-12 was then installed approximately ten feet from the boring location.

During drilling for wells RFW-14, 15, and 16, exploratory borings were completed below the planned well depths through the confining unit beneath the landfill. The purpose of the exploratory borings was to confirm the presence and thickness of the confining unit and to collect samples for physical and chemical laboratory analysis (See Sections 2.3.4 and 2.5.2). The borings were advanced through the landfill mass using 6-inch inside diameter hollow-stem augers. Once native soils were encountered, drilling with augers was terminated and the augers were left in place as temporary casing. Five-inch diameter steel casing was then driven approximately five feet below the augers into the confining unit to seal off and prevent cross contamination of the native deposits. The boring was then advanced to the final depth using the open hole rotary method with fresh water as a drilling fluid. The confining zone was abandoned

with a bentonite/cement grout pumped through tremie pipe, followed by removal of the five-inch steel casing. Well installation in the landfill mass was completed the following day.

The confining unit was sampled continuously with split-spoon and Shelby Tube samplers. For wells RFW-14 and 16, the borings were terminated upon reaching a sandy silt unit below the confining unit. The boring for well RFW-15 was terminated before penetrating the entire thickness of the confining unit because the boring would not remain open despite the use of a thick drilling mud.

2.3.2.8 Monitoring Well Installation

Monitoring well construction diagrams are provided in Appendix E. With the exception of monitoring wells RFW-14, 15, and 16, all overburden monitoring wells and four of the five bedrock wells are constructed of 2-inch diameter, 304 stainless steel, Schedule 5, threaded, flush-joint casing with continuous-wrap, 10 slot well screens manufactured by Howard Smith Screen Company. One bedrock well (RFW-10D) is an open hole construction with 4-inch diameter, 304 stainless steel, Schedule 5 casing grouted ten feet into competent bedrock. With the exception of well RFW-3D, well screens are either 5-foot or 10-foot in length depending on the thickness of the formation. Well RFW-3D is screened in the bedrock system with a 15-foot long screen to maximize the area open to fractures in the bedrock, which were found to be infrequent. Wells RFW-14, 15, and 16 are constructed of 4-inch diameter, 316 stainless steel, Schedule 5 casing and 10-foot long screens. The 316 stainless steel was used for these wells as an added protection against corrosion and chemical attack by the landfill leachate. Wells are fitted with stainless steel caps and bottom plugs. No solvent glues were used to assemble the well casings and screens.

A compatible graded sand filter pack was placed in the annulus of the well around the screen to a depth of approximately two feet to five feet above the top of the screen. Two grades of sand filter pack were used, Morie #0 and Morie #00, depending on the relative grain size distribution of the formation. The finer sand pack, Morie #00, was used for formations with

a significant silt and clay fraction. For a majority of the wells, a two foot or three foot thick bentonite pellet seal was placed above the sand filter pack to isolate the screened interval from the overlying deposits. A bentonite/cement grout was then pumped slowly through tremie pipe into the remaining annulus to the surface. A locking, steel protective casing was set into a concrete pad at the surface to prevent damage to the well.

For some of the deeper wells (RFW-5D, 7D, 8D, 14, 15, and 16), a granular bentonite slurry, pre-hydrated with fresh water, was used in place of the bentonite pellet seal to avoid bridging of the bentonite pellets. An equivalent volume of approximately five linear feet of bentonite slurry was pumped slowly through tremie pipe into the borehole annulus, followed by placement of the bentonite/cement grout seal.

Upon installation, the elevation of the top of the well casing, protective casing, and grade surface were established, relative to mean sea level datum (MSL), by a New York State-licensed surveyor. The outside of each protective casing was identified with the well identification number.

2.3.2.9 Monitoring Well Development

After installation, each well was developed by surging and pumping to remove fines and to establish hydraulic communication between the well and the formation. A majority of the wells were pumped with the use of a centrifugal (surface) pump and either small diameter, dedicated polyvinyl chloride (PVC) pipe or polyethylene hosing fitted with a PVC, one-way bottom check valve. At the start of pumping, the hosing was vigorously moved up and down with the check valve in the screen zone to surge the well and loosen the fines. The well was then pumped continuously, if possible, while field parameters were monitored for stabilization.

Slowly recharging wells were repeatedly either pumped dry, or pumped until the water level dropped below suction lift (approximately 29 feet), and then allowed to recover. Due to extremely slow recharge conditions, wells RFW-4S and RFW-6S were developed by repeatedly

pumping the well dry manually with the polyethylene hosing and check valve assembly. Wells RFW-14, 15, and 16 were developed by pumping and by bailing with a PVC bailer suspended on polyethylene cord.

Prior to development, the target volume of water for removal from each well was determined from the estimated volume of water lost to the formation during drilling and well installation.

During development, field parameters (pH, specific conductivity, and temperature) were monitored until stabilization to demonstrate that the target volume was removed and the well was producing representative groundwater. Stabilization was defined to occur when the difference between the measured values of a parameter for two successive samples was less than ten percent of the first measured value. Turbidity was monitored in the field in an attempt to obtain groundwater with a turbidity less than the NYSDEC goal of 50 Nephelometric Turbidity Units (NTUs). Well development was considered complete after a minimum of the target volume was removed, the field parameters stabilized, and either the turbidity goal was achieved or, if not, the turbidity showed no additional improvement over a reasonable amount of time pumping.

Water levels were measured with a Soil Test electronic water level indicator; pH was measured with Cole-Palmer pocket pH meters; turbidity was measured with an Analytical Instruments turbidity meter; and conductivity and temperature were measured with a YSI Model 33 meter. Development water was discharged to the leachate collection chambers and ponds or to the ground inside the boundaries of the leachate collection line. Development water was screened periodically with an HNu photoionization detector.

During well development, the pH of well RFW-10S was found to be abnormally high (10.9 upon completion of development) which may be due to contamination of the screen zone by drilling muds used to drill adjacent well RFW-10D. Turbidity levels below the NYSDEC goal of 50 Nephelometric Turbidity Units (NTUs) for eight (8) of the perimeter wells were not obtainable due to fines in the formation. Upon installation, wells RFW-14, 15, and 16 were only partially developed. A rigorous development program for these wells was not pursued because they were anticipated to be used only for gross characterization of the landfill leachate.

Existing wells B-201S, B-202S, B-203S, and B-205S were re-developed in preparation for in-situ permeability testing. Development consisted of surging the screen zone to loosen fines in the filter pack, followed by pumping with a centrifugal pump. At least three well volumes were removed while water level recovery was monitored to verify that recharge to the well from the formation was occurring.

2.3.3 Phase II RI Subsurface Soil Sampling and Piezometer Installations

2.3.3.1 Introduction

The Phase II subsurface soil sampling program was completed to obtain split-spoon and undisturbed soil samples from the native fine-grained confining unit soils beneath the landfill for additional geotechnical soil strength and physical properties testing. Two test borings were completed near the two critical stratigraphic sections 3-3 and 4-4, identified from the earlier slope stability evaluation, as shown in Figure 2-2. Upon completion of each boring, the native soils were sealed with a bentonite/cement grout and a 4-inch diameter piezometer constructed of a 20 foot long, continuous slot PVC screen and carbon steel riser casing was installed in the waste mass. The piezometers were used to monitor groundwater elevations within the landfill.

2.3.3.2 Drilling and Soil Sampling Methods

The Phase II drilling program was initiated on March 8, 1994 at borehole GT-A (Piezometer RFW-17) located on transect 3-3. The hollow-stem auger drilling method was used to drill through the landfill mass into the top of the native soils. The wastes observed in the drill cuttings generally consisted of municipal refuse (plastic, paper, cloth, glass and metal). The waste appeared to be more decomposed with depth. Continuous split-spoon sampling was initiated 10 feet above the anticipated waste/native soils boundary and continued until the native soils were encountered at a depth of 100 feet below grade surface (bgs). Once native soils were encountered, drilling with augers was terminated and the augers were left in place as temporary casing. A 5-inch diameter steel casing was then driven approximately one foot below the augers into the confining unit to seal off and prevent cross contamination of the native deposits. The

boring was then advanced to the final depth (152' bgs) using the open hole rotary method with fresh water as a drilling fluid. The confining unit was sampled continuously with split-spoon and Shelby Tube samplers. The boring was terminated upon reaching the sand and gravel outwash deposit. The confining unit was sealed with a bentonite/cement grout pumped through tremie pipe, followed by removal of the five-inch steel casing. Piezometer installation in the landfill mass was completed the following day. Boring logs for these two piezometers are provided in Appendix A of the Final FS Report.

Borehole GT-B (Piezometer RFW-18), located on transect 4-4, was advanced using the same methods discussed above with the exception that split spoon samples were obtained every ten feet through the landfill mass to obtain estimates of the unit weight of the refuse. The split spoon samples were screened with an OVM photoionization detector (PID) immediately upon opening the sampler, and the response noted in the field logbook. Blow counts and a description of the recovered sample were also recorded. Representative samples of each split spoon sample were collected for future inspection. The waste/native soil boundary was encountered at 87 feet bgs at GT-B. The confining unit was sampled continuously with split-spoon and Shelby Tube samplers. The boring was terminated at 119 feet bgs after penetrating 9 feet of a stiff silt layer lying below the varved clay deposit.

2.3.3.3 Piezometer Installation

Both piezometers were constructed of 4-inch carbon steel casing with welded joints and 20 feet long, continuous wrap, PVC, 10-slot well screens. The piezometers were screened in the waste mass. No solvent glues were used to assemble the well casings and screens. After the confining zone was sealed with a bentonite/cement grout, the piezometers were set in the waste mass; piezometer RFW-17 was installed in boring GT-A at a depth of 98.5 ft. bgs and piezometer RFW-18 was installed in boring GT-B at a depth of 84 feet bgs. A compatible graded sand filter pack was placed in the boring annulus around the screen to a depth of approximately two feet above the top of the screen. A five foot thick granular bentonite slurry, pre-hydrated with fresh water, was placed above the sand filter pack to isolate the screened interval. A bentonite/cement

grout was then pumped slowly through a tremie pipe into the remaining annulus to the surface. The bentonite/cement grout was allowed to harden overnight and each piezometer was developed the following day by bailing for approximately one hour. A locking, steel protective casing was set into a concrete pad at the surface to prevent well damage.

2.3.4 Geotechnical Soil Sampling Program

A geotechnical soil sampling program was completed to characterize the strength and physical properties of the site subsurface soils. A Phase I program was completed in 1990 during the Phase I monitoring well installation program, and a Phase II program was completed in March and April 1994, during the Phase II drilling program. Representative samples of the various subsurface soils were submitted for analysis for shear strength, vertical permeability, total organic content (TOC), cation exchange capacity (CEC), grain size analysis, natural moisture content and specific gravity. The majority of the physical testing was completed on samples of the fine-grained soils (peat, organic silt, and clay). Shear strength testing was completed to evaluate the stability of the compressible soils beneath the landfill. Fine-grained soil samples were tested for vertical permeability to evaluate the ability of the soils to impede vertical migration of any contamination from the landfill. Atterberg limits and natural moisture content testing was conducted to estimate the degree of consolidation of the fine-grained soils due to the weight of the landfill. Coarse-grained and fine-grained soil samples were analyzed for TOC to characterize the soil's adsorptive properties.

Samples submitted for analysis for shear strength and vertical permeability were collected with brass, thin-walled Shelby Tube samplers as described in Section 2.3.2.6. Samples submitted for the remaining physical tests were collected with split-spoon samplers, as described in Section 2.3.2.4, transferred to labeled soil sample jars, and sent to the laboratory, following the proper sample shipment and custody procedures.

The testing program was completed in part by WESTON's Geotechnical Laboratory in Lionville, PA., and partly by Huntingdon Geotechnical Laboratory of Middleport, NY (a subsidiary of

Empire Soils Investigations, Inc.). The program included completion of the following physical property tests on selected representative split-spoon soil samples:

1. Natural moisture control (ASTM D-2216)
2. Atterberg limits (ASTM D-4318)
3. Grain size distribution by mechanical sieve and hydrometer analysis (ASTM D-421/422)
4. Specific gravity (ASTM D-854)
5. Organic content (ASTM D-2924)
6. Cation exchange capacity (SW-846, 9080/81).

The laboratory testing program also included the completion of the following engineering property tests on selected representative Shelby Tube soil samples:

1. Vertical permeability using flexible wall permeameter (EPA Method 9100).
2. One Dimensional Consolidation (ASTM D-2435).
3. Unconsolidated-Undrained (UU) Triaxial Compression Testing (ASTM D-2850) and
4. Consolidated-Undrained (CIU) Triaxial Compression Testing with pore pressure measurements (ASTM D-4767).

These tests provide direct measurement of the permeability, compressibility and shear strength parameters used in the engineering analyses completed as part of the soil stability evaluations. The results of the laboratory testing completed for the Phase I and II geotechnical programs are provided in Section 3.4.6.

2.4 Geophysical Investigation

2.4.1 Surface Geophysical Investigation

2.4.1.1 Objectives

A surface geophysical program was completed during Phase I to attempt to locate the actual areal extent of the landfill at the wetlands boundary on the north, west, and south sides of the landfill. Data generated from the surface geophysical program were used in conjunction with the soil boring data, visual inspection of the toe of the landfill, and a review of aerial photos to estimate the extent of the landfill. The results of the surface geophysical program are described in Section 3.4.2.

2.4.1.2 Methodology

A Geonics Model EM 34-3 was utilized for the surface geophysical survey. This instrument detects the emitted electromagnetic radiation which is a measure of the subsurface soil conductivity. Differences in the conductivity infer different types of soil or material. Conductivity data in millimhos per meter were obtained over a series of traverse lines using a 10-meter coil spacing with both horizontal and vertical dipole orientations. The locations of the lines are shown on Sheet 10 of 11 of the drawings. Conductivity measurements along lines 1-5 were read at 10-foot intervals. Measurements along lines 6-8 were read at 20-foot intervals. This type of survey allows for station to station profiling of both horizontal and vertical readings and for dipole comparison of shallow versus deeper conductivity values.

2.4.2 Downhole Geophysical Investigation

2.4.2.1 Objectives

The objective of the downhole geophysical investigation originally was to attempt to verify the presence of a thin, compressed layer of peat beneath the landfill at existing well location B-207D. A previous investigation (Converse Consultants, 1986) hypothesized that a peat layer in this area impeded vertical downwards migration of leachate into the deeper deposits. However,

attempts to collect samples of the peat during the previous drilling work failed. A borehole logging tool capable of detecting gamma-ray radiation emitted from clay minerals present in the peat was planned for use to complete the investigation.

As the work proceeded, it became evident that the existing well and one other existing well, planned for use for calibration purposes (B-202D), were either damaged or had accumulated fines in the screen zone. The logging tool was prevented from passing down through the full depth of either well. A field decision was made to instead conduct gamma logging of the exploratory borings (RFW-B7 and RFW-B9) being completed at the same time to provide additional information on the site stratigraphy. The results of the subsurface geophysical investigation are presented in Section 3.4.2 and Appendix E.

2.4.2.2 Methodology

The borehole logging tool consisted of a Geonics EM-39 system with a gamma radiation detector probe. The probe was suspended on heavy gauge stainless steel cable. The probe was lowered into and extracted from the boring with a variable speed, electric winch and reel assembly.

Logging of exploratory boring RFW-B7 was initiated upon reaching the final drilled depth (fifteen feet into bedrock). Logging was completed through the temporary steel drill casing which was used as a conductor casing for the logging tool. The ability of the logging tool to detect emitted gamma radiation is not significantly affected by the steel casing. Logging of boring RFW-B9 could not be completed because the logging tool would not pass through the narrower conductor casing.

2.5 Soil Investigation

2.5.1 Surficial Soil Investigation

2.5.1.1 Introduction

A surficial soil sampling and analysis program was executed as part of the Clarkstown Sanitary Landfill Phase I RI. This investigation was completed due to the potential for surficial soils to serve as a source of groundwater, surface water, and air contamination on and off property.

2.5.1.2 Sampling Locations and Rationale

Three surficial soil samples plus a matrix spike and matrix spike duplicate (MS/MSD) sample were collected at the Clarkstown Sanitary Landfill during the Phase I RI effort. The on-site soil sampling effort was limited due to the on-going site activities at the time of sampling including active landfilling, construction of the refuse transfer station, and preparation for placement of an interim soil cover layer over the inactive landfill areas.

The three surficial soil samples were collected at the locations shown in Figure 2-1. Two samples, one taken from the former ballfield (SL-2) and one collected north of the refuse transfer station (SL-3), were collected within the physical boundaries of the Clarkstown Landfill in older, currently inactive areas. The third sample (SL-1) was collected upgradient and off-site to provide background soil data.

Sample locations SL-2 and SL-3 fall within the soil classification "Ur", as designated by the Soil Survey of Rockland County, New York (United States Department of Agriculture, Soil Conservation Service, October 1990). The Ur designation represents a soil with a refuse substratum. These sample locations consisted of a loamy and sandy soil covered by various grasses, weeds and shrubs. The background soil sample, location SL-1, is situated in an area which falls under the soil classification "WeC" (Wethersfield gravelly silt loam, 8 - 15% slopes). This soil occurs on ridgetops, sides of ridges and upper parts of foot slopes. Sample SL-1 was

collected from a residential area along Greenbush Road adjacent to a small stream draining towards the landfill.

2.5.1.3 Sampling Protocols

Samples were collected using decontaminated, stainless steel trowels at a depth of 0-3". The samples were screened for volatile organics with an HNu. The following information was logged for each sample: sample identification number, location, depth interval, color, texture, and moisture content. Three samples plus one matrix spike and matrix spike duplicate were collected. The samples for VOA were filled directly with the stainless steel trowel into the VOA vials with minimal headspace. The sample for the remaining analyses were first homogenized in a decontaminated stainless steel bowl before being transferred to the glassware. After samples were collected they were placed on ice in a cooler for shipment to the laboratory.

Table 2-1 presents the number of soil samples collected and analytical parameters. A field duplicate was not collected (waived by the NYSDEC Quality Assurance Division), and a matrix spike and matrix spike duplicate was collected at SL-2. A field/equipment blank was not collected for surficial soils; instead the field blank from the sediment sampling effort was used to determine possible sources of contamination to surficial soils due to equipment decontamination because equipment from the same decontamination batch was used for both efforts. Although no trip blanks are required by NYSDEC for soils, the samples were shipped with other coolers (leachate samples collected the same day) containing trip blanks. Samples were transferred to the Contract Laboratory Program (CLP) analytical laboratory following proper sample shipment and custody procedures.

2.5.2 **Subsurface Soil**

2.5.2.1 Introduction

Subsurface soil samples of the native confining zone deposits beneath the landfill were collected at eight locations as shown on Figure 2-2. The samples were collected during drilling for installation of selected RI monitoring wells. The objective of the sampling was to determine the

nature and extent of contamination in the confining zone deposits. Elevated levels of contaminants, particularly the semi-volatile compounds, were detected in samples collected during the refuse transfer station boring program. These data suggested that the confining zone deposits may act as a "sink", or filter, for a variety of organic compounds. Additional testing was completed during the RI to determine the physical and adsorptive properties of the confining zone deposits. (See Section 2.3.4).

2.5.2.2 Sampling Locations

The subsurface soil sampling locations are shown on Figure 2-2. Samples of the peat deposit were collected during drilling at well locations RFW-3D, 4D, 7D, and 12. Samples of the organic silt deposit were collected at well locations RFW-6S, 8D, 14 and 15. The samples were generally collected within reaching a depth of ten feet below the refuse/native soils interface. All attempts were made to sample the peat deposit because of its relatively high organic content and high potential adsorptive capacity, compared to the other confining zone deposits. Samples were collected from the organic silt deposit where adequate samples from the peat deposit could not be collected.

2.5.2.3 Sampling Protocols and Analytical Program

Samples were collected with decontaminated split-spoon samplers and transferred to sample jars with stainless steel trowels. The split spoon samplers and trowels were cleaned prior to sampling with the approved decontamination procedures. The samples were transferred to the analytical laboratory following the proper sample shipment and custody procedures.

The subsurface soil samples were analyzed for the volatile organics, semi-volatile organics, pesticides/PCBs, and metals and cyanide, as shown on Table 2-1. One field duplicate and one field blank sample were also collected. The sampling program was not completed as a single sampling event, but instead samples were collected over a four month period as the drilling and monitoring well installation program progressed. For this reason, a total of five trip blanks were

collected. The balance of the field duplicates and field blank samples indicated in Table 2-1 were collected as part of the physical properties testing program described in Section 2.3.4.

2.6 Test Pit Investigation

2.6.1 Off-Site Landfill Waste Evaluation

2.6.1.1 Introduction

Two areas containing Clarkstown Landfill wastes extending beyond the present northern property boundary were identified from a review of aerial photographs during the Phase I RI. The larger of the two areas (Northeast Area) was used for landfiling operations sometime between the years 1970 and approximately 1975, while the smaller area located in the extreme northwest corner of the property at the junction of two small unnamed streams was used for landfiling operations in the early 1960s or earlier (See Drawing 10 of 11). The course of the east-west trending stream near the latter property has since been re-routed, resulting in the separation of this portion of the landfill from the main landfill mass.

2.6.1.2 Sampling Locations and Objectives

A test pit program was implemented to evaluate the nature and extent of the landfill wastes in the Northeast Area. The second area in the northwest corner was not investigated because these wastes were planned for removal and proper disposal as part of the Pyramid Corporation development project along Route 59. Five (5) test pits (TP-1 through TP-5) were excavated in the Northeast Area as shown in Figure 2-1. The data collected from the off-site waste evaluation were used in the feasibility study (FS) to evaluate disposal costs and the potential for consolidation of the off-site wastes into the main landfill during capping or the need for condemnation and acquisition of the properties.

Test pit locations were staked prior to the start of excavation activity. Test pits were selected in place of soil borings because drill rig access was not possible due to the soft nature of the waste and cover soils. The test pits were excavated initially on March 9, 1994, to the maximum reach of the backhoe arm (about 11 feet below grade surface). Because at most locations the

bottom of the waste extended below this depth, a larger backhoe was mobilized and the pits were deepened on May 11, 1994, to establish the lower limits of waste.

2.6.1.3 Sampling Protocols and Analytical Program

The waste material was removed and placed next to the pit during excavation and inspected and photographed. Test pit numbers TP-1 and TP-5 were excavated in the Northeast area. Test pit dimensions were approximately 3 - 4 feet wide by 10 - 12 feet long by the depths noted in Table 2-6. Wastes and soil types were logged as well as the depth to groundwater, if encountered, as indicated in Table 2-6. Field monitoring with a PID and a combustible gas indicator was performed for health and safety purposes and to evaluate potential off-gassing of volatile organic vapors, combustible gases, and odors during any future remedial excavation activities.

One sample was collected from each test pit and submitted for laboratory analysis for analysis for the TCLP (Toxic Characteristics Leaching Procedure) and RCRA hazardous waste characteristics (ignitibility, corrosivity, reactivity). Samples were taken from the soil and decomposed waste matrix material between large objects. Samples were collected using stainless steel trowels directly from the excavated waste piles. Typically, the wastes were a mixture of household waste, metal, wood, glass and soil. A matrix spike and matrix spike duplicate was obtained at one of the locations. Upon completion of the excavation the pit was backfilled and clean fill was placed on top of the waste.

2.6.2 Former Ballfield Area Waste Evaluation

2.6.2.1 Introduction

The former Ballfield Area of the landfill is located in the southeast corner of the landfill property and was one of the first areas used for landfilling at the site (prior to 1962). A test pit program was completed to evaluate the vertical extent of the waste and to determine groundwater levels. Three test pits (TP-6, 7 and 8) were excavated in the former Ballfield as shown in Figure 2-1.

TABLE 2-6

**CLARKSTOWN LANDFILL RI TEST PITTING RESULTS
FOR NORTHEAST AREA AND FORMER BALLFIELD
FROM MARCH 9, 1994 AND MAY 11, 1994**

Test Pit No.	Depth Interval Ft.	OVM Reading (Units)	Material Description	Comments
NORTHEAST AREA				
TP-1	0-2'	Bkgd	Household trash in red brown till matrix	Plastic, paper, wood, metal
	2-5'	Bkgd	Green/grey matrix interbedded with black matrix in household trash	Newspaper found with 1974 date
	5-8'	Bkgd	Reddish brown silty sand with gravel	Top of natural material, no groundwater
TP-2	0-1.5'	Bkgd	Reddish brown silty sand with cobbles	Cover material
	2.0'	Bkgd	Water table	
	1.5-10.5'	4	Household trash, with very little matrix, saturated	Tires, wood, plastic, cloth, paper, bottles
	10.5'	Bkgd	Reddish brown sandy silt with green/grey staining, saturated	Possible native soil - till
TP-3	0-1'	Bkgd	Reddish brown sandy silt, frozen	Cover material
	1-8'	5	Household trash with reddish brown matrix	Paper, plastic, glass, magazines dated 1972
	8-9'	-	Green/grey silt/clay layer	Cover material
	9-22'	Bkgd	More household trash	
	10'	-	Water table	
	22'	-	Peat/clay	Native soils

TABLE 2-6

**CLARKSTOWN LANDFILL RI TEST PITTING RESULTS
FOR NORTHEAST AREA AND FORMER BALLFIELD
FROM MARCH 9, 1994 AND MAY 11, 1994**

Test Pit No.	Depth Interval Ft.	OVM Reading (Units)	Material Description	Comments
NORTHEAST AREA (CONTINUED)				
TP-4	0-.5'	Bkgd	Reddish brown silty sand	Cover material
	.5-16'	31	Household trash, wet	Bottles, cans, plastic, paper, tires
	11'	-	Water table	
	16'	-	Clay/peat	Native soils
TP-5	0-1'	Bkgd	Reddish brown silty sand	Cover material
	1-14'	5	Household trash, very wet	Paper, plastic metal, cans, cloth
	14-15'	Bkgd	Green/grey silt/clay layer	Cover material
	≈ 13'	-	Water table	
	15-25'	Bkgd	Household trash, saturated	A 25' maximum reach of backhoe arm
FORMER BALLFIELD				
TP-6	0-5'	Bkgd	Grass & clean fill material	Soils to build up ballfield and cover material
	5-15'	Bkgd	Trash-crushed glass, wood, wire	
	5.5'	-	Water table	
	15'	-	Muck/silt	Native soils
TP-7	0-3'	Bkgd	Grass & clean fill material	Cover material
	3'	-	Water table	

TABLE 2-6**CLARKSTOWN LANDFILL RI TEST PITTING RESULTS
FOR NORTHEAST AREA AND FORMER BALLFIELD
FROM MARCH 9, 1994 AND MAY 11, 1994**

Test Pit No.	Depth Interval Ft.	OVM Reading (Units)	Material Description	Comments
FORMER BALLFIELD (CONTINUED)				
	3-10'	Bkgd	Trash-cans, glass bottles, wood, wire	
	10'	-	Muck/silt	Native soils
TP-8	0-4'	Bkgd	Grass & clean fill material	Cover material
	4.5'	-	Water table	
	4-9.5'	Bkgd	Trash-glass, metal, wood, tires	
	9.5'	-	Muck-silt	Native soils

Notes:

Bkgd = Background concentrations

OVM = Organic vapor analyzer, units in parts per million (ppm) relative to isobutylene calibration gas.

The data were used in the feasibility study (FS) to evaluate disposal costs and the potential for consolidation of the off-site wastes into the main landfill during capping.

2.6.2.2 Field Protocols

Test pits were excavated with a backhoe until native soils were encountered. Wastes and soil types were logged as well as the depth to groundwater. Field monitoring with a PID/FID and a combustible gas indicator was performed for health and safety purposes and to evaluate potential for off-gassing of volatile organic vapors, combustible gases and odors during any future remedial excavation activities. Upon completion of the excavation the hole was backfilled and clean fill was placed on top of the waste.

2.7 Soil Gas Investigation

2.7.1 Introduction

Soil gas consists of air present in the pore spaces of the unsaturated subsurface soil zone. In the case of a landfill site, the soil gas is comprised mostly of landfill gases generated by the decomposing wastes. A soil gas sampling and analysis program was executed as part of the Clarkstown Sanitary Landfill RI. Contaminated soil gas may serve as an exposure pathway to human, plant, and animal populations primarily through the inhalation of contaminated soil gas once it enters the ambient air.

The proposed amendments to the Clean Air Act (40 CFR 52 and 60) indicate that a landfill of the size of the Clarkstown Landfill will require a landfill gas collection and treatment system to eliminate emissions of non-methane organic compounds (NMOCs) to the atmosphere. The proposed regulations cover any facility accepting waste after 1987. The Clarkstown Landfill is estimated to exceed the 110,000 tons of inplace waste (expected to be increased to 300-500,000 tons in the final regulations) and 167 tons of annual NMOC emissions cutoff values.

2.7.2 Sampling Locations, Objectives, and Analytical Program

The soil gas investigation consisted of a Phase I and Phase II sampling effort. The Phase I program, completed in November 1990, included an initial soil gas screening followed by a soil gas sampling program for laboratory analysis to characterize the components of the soil gases. The Phase II program consisted of a limited landfill gas laboratory sampling program and a property boundary soil gas screening program to identify any landfill gas migration.

For Phase I, initially a preliminary screening of shallow (less than 4 feet deep) soil gases for total VOCs and methane was conducted using direct reading field instruments. Screening samples were collected across most of the landfill property in a grid-like manner as shown on Figure 2-3, with data presented in Table 2-7. The ninety-one (91) OVA, HNu, and CGI instrument screening locations were spaced at approximately 75- to 200-foot spacings. Due to the monitoring instrument's sensitivity to moisture and high methane concentrations, screening values varied from day to day, dependent upon field conditions and soil gas concentrations.

Based on the Phase I preliminary screening data presented in Table 2-7, ten soil gas samples and one duplicate sample were collected for laboratory analysis from the locations shown on Figure 2-3. The sampling locations were selected from the soil gas screening locations which registered the highest total VOC and methane concentrations. Samples were analyzed for compounds included in the Target Compound List (TCL) of volatile organics analyzed by Method TO-14.

For Phase II, landfill gas samples were collected on March 17, 1994 from three locations on the landfill property, as shown on Figure 2-3, to characterize the constituents in the gas and to evaluate gas generation. These landfill gas samples were collected from deeper depths (5-10 feet bgs) than the Phase I soil gas samples and were presumably less affected by atmospheric conditions. A total of three gas samples, one duplicate sample and a trip blank were collected. One sample was collected from a passive gas vent installed beneath the capped area around the refuse transfer station to evaluate soil gas conditions beneath the liner. The other two samples

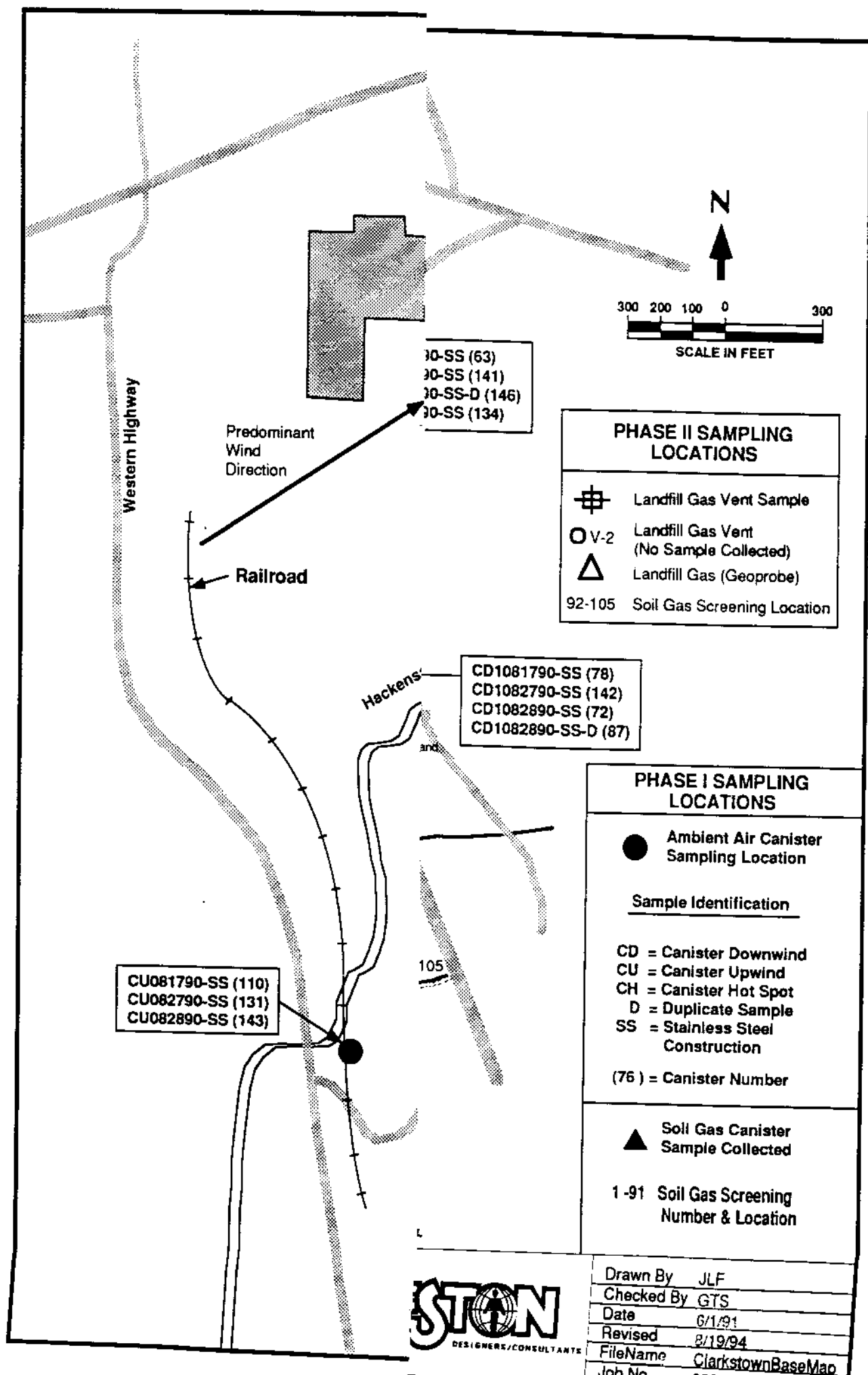


Table 2-7

CLARKSTOWN LANDFILL RI
Phase I Preliminary Soil Gas Screening Data

Sampling Point	HNu (ppm)	OVA (ppm)	CGI (% LEL)	Date, Time (hrs)
1	10-20	100	22	10/17/90, 1020
2	1.6	80	0	10/17/90, 1045
3	1.5	> 1000	5	10/17/90, 1055
4	1.2	0	3	10/17/90, 1105
5	0.2	0.2	29	10/17/90, 1115
6	0.5	0	4	10/17/90, 1155
7	140	> 1000	100	10/22/90, 1135
8	2.5	> 1000	20	10/17/90, 1425
9	12-20	> 1000	17	10/17/90, 1350
10	1.4	> 1000	7	10/17/90, 1335
11	3	> 1000	100	10/17/90, 1310
12	9-11.5	> 1000	55	10/17/90, 1205
13	0.2	> 1000	100	10/18/90, 1640
14	23	> 1000	85	10/22/90, 1200
15	5	> 1000	2	10/17/90, 1433
16	0.2	> 1000	100	10/17/90, 1612
17	1.0	> 1000	3	10/17/90, 1621
18	50	> 1000	100	10/17/90, 1638
19	-	-	-	-
20	-	-	-	-
21	9	> 1000	13	10/18/90, 1100
22	0.5	300	2	10/17/90, 1450
23	11	> 1000	100	10/17/90 1555
24	9.5	> 1000	60	10/18/90, 0920

Table 2-7 (Continued)

CLARKSTOWN LANDFILL RI
Phase I Preliminary Soil Gas Screening Data

Sampling Point	HNu (ppm)	OVA (ppm)	CGI (% LEL)	Date, Time (hrs)
25	8	> 1000	100	10/17/90, 1703
26	-	-	-	-
27	2.2	30-40	0	10/18/90, 1030
28	0.6	> 1000	8	10/17/90, 1458
29	(wet conditions)	> 1000	62	10/18/90, 0915
30	0.6	> 1000	80	10/17/90, 1712
31	3	> 1000	93	10/18/90, 0930
32	2	70	0	10/18/90, 1115
33	4.5	1000	100	10/17/90, 1540
34	20	> 1000	100	10/18/90, 0950
35	1	> 1000	86	10/18/90, 0945
36	3	> 1000	100	10/18/90, 1130
37	0.8	> 1000	5	10/17/90, 1510
38	28	> 1000	73	10/18/90, 1000
39	7	> 1000	95	10/18/90, 1020
40	1.5	> 1000	85	10/17/90, 1440
41	13	40-50	0	10/18/90, 1015
42	1	> 1000	7	10/18/90, 1145
43	1	> 1000	100	10/18/90, 1140
44	9.5	> 1000	65	10/18/90, 1200
45	3	> 1000	2	10/18/90, 1155
46	1.5	> 1000	24	10/22/90, 1415
47	0	> 1000	7	10/18/90, 1215

Table 2-7 (Continued)

**CLARKSTOWN LANDFILL RI
Phase I Preliminary Soil Gas Screening Data**

Sampling Point	HNu (ppm)	OVA (ppm)	CGI (% LEL)	Date, Time (hrs)
48	3	> 1000	9	10/18/90, 1240
49	0.4	42	1	10/22/90, 1445
50	1	> 1000	100	10/18/90, 1225
51	13	> 1000	75	10/18/90, 1300
52	90	> 1000	69	10/18/90, 1315
53	2	> 1000	75	10/18/90, 1325
54	0.6	> 1000	100	10/18/90, 1345
55	1.2	> 1000	100	10/18/90, 1405
56	22	> 1000	60	10/18/90, 1430
57	2	> 1000	65	10/18/90, 1450
58	14	> 1000	59	10/18/90, 1510
59	200	> 1000	42	10/18/90, 1530
60	1	> 1000	73	10/18/90, 1550
61	0.6	> 1000	100	10/18/90, 1610
62	2	> 1000	100	10/18/90, 1630
63	6.5	> 1000	100	10/22/90, 1225
64	0.2	> 1000	100	10/22/90, 1320
65	6.5	> 1000	90	10/22/90, 1345
66	0.8	> 1000	100	10/22/90, 1110
67	2.8	> 1000	88	10/22/90, 1045
68	140	> 1000	65	10/22/90, 0930
69	39	> 1000	60	10/22/90, 0950
70	13.5	> 1000	60	10/22/90, 1005

Table 2-7 (Continued)

CLARKSTOWN LANDFILL RI
Phase I Preliminary Soil Gas Screening Data

Sampling Point	HNu (ppm)	OVA (ppm)	CGI (% LEL)	Date, Time (hrs)
71	4	> 1000	100	10/22/90, 1020
72	4.5	42	2	10/22/90, 1510
73	6	38	0	10/22/90, 1535
74	190	> 1000	30	10/22/90, 1600
75	350	125	4	10/22/90, 1630
76 (BF1)	1.2	820	-	9/26/90, 0920
77 (BF2)	0.8	2.2	-	9/26/90, 0930
78 (BF3)	1.4	60-80	-	9/26/90, 0945
79 (BF4)	0.8	100-180	-	9/26/90, 1000
80 (BF5)	2.8-6.2	340	-	9/26/90, 1005
81 (BF6)	0.6	50	-	9/26/90, 1015
82 (BF7)	0.4	80-320	-	9/26/90, 1025
83 (BF8)	0.4	> 1000	-	9/26/90, 1040
84 (BF9)	0.6	52	-	9/26/90, 1050
85 (BF10)	50-80	200	-	9/26/90, 1100
86 (BF11)	(wet conditions)	(wet conditions)	(wet conditions)	9/26/90
87 (BF12)	0.2	54	-	9/26/90, 1110
88 (BF13)	0.2	> 1000	-	9/26/90, 1120
89 (BF14)	0.4	2	-	9/26/90, 1130
90 (BF14)	0.8	38-62	-	9/26/90, 1140
91 (BF16)	0.2	> 1000	-	9/26/90, 1320

Notes: (-) = No Data Available
 ppm = Parts per Million
 LEL = Lower Explosive Limit (5% gas)

were collected from the main landfill area at Phase I soil gas screening locations that reported amongst the greatest VOC concentrations. One sample (LFG-2B) was located in the most recently filled area where potentially the greatest amount of gas generation is occurring currently.

An additional five (5) Phase II samples were scheduled to be collected from the main landfill area, the former ballfield and the Northeast Area. These samples were not collected due to inaccessibility, excess soil moisture, or refusal of the drive point sampler. The Phase II samples were analyzed for an expanded list of volatile organics using a modified version of USEPA Method T01/T02.

A Phase II property boundary soil gas field screening was also completed in selected areas to evaluate compliance with the landfill gas migration control requirements of the NYSDEC Part 360 regulations and the newly issued Federal Resource Conservation and Recovery Act (RCRA) Subtitle D regulations for municipal landfills. Soil gas screening was conducted around the site maintenance and administrative buildings where gas levels may not exceed 25 percent of the Lower Explosive Limit (LEL) of methane in air (see Figure 2-3). Soil gas screening was also completed along Route 303 to confirm the Phase I soil gas screening results which indicated that off-site gas migration was not occurring in this area. The regulations require that methane in air concentrations may not exceed 5 percent of the LEL at the property boundary. The remaining property boundaries were not surveyed because they are surrounded by water or wet, fine-grained marsh soils through which off-site gas migration is not likely to be significant.

2.7.3 Sampling Protocols

For the Phase I sampling, a conventional slam bar was used to create a 1/2-inch diameter, 4-foot deep hole to install a temporary sampling probe. A decontaminated, rigid stainless steel probe (1/4-inch diameter, 5-feet long) was inserted into the 4-foot deep hole. In the event the probe became obstructed with dirt, a stainless steel cable was inserted to clear the obstruction. The opening around the probe at the ground surface was sealed with modelling clay. Disposable

tygon tubing was slipped over the 1/4-inch diameter probe and connected to each screening instrument (OVA, HNu, and CGI). The probe/tygon assembly was purged of ambient gases for approximately one minute before readings were recorded. The Phase I screening data appear in Table 2-7. Soil gases were screened during the Phase II property boundary survey using the same procedures described above with the resultant field data shown in Table 2-8.

The Phase I soil gas samples were collected using this same sampling probe setup, but, instead of field screening instruments, the probe was connected to an evacuated, certified clean, stainless steel Summa® canister with dedicated teflon tubing. The canister's valve was opened and the soil gas was drawn into the canister until the evacuated pressure reached atmospheric equilibrium, at which time the valve was closed.

For the Phase II landfill gas sampling effort, two of the samples (LFG-2B and LFG-3B) were collected by using a mobile drive point sampling unit (Geoprobe®) mounted in a van. At these locations, a stainless steel drive point was driven to a depth of 5 to 10 feet below grade. Once at depth, teflon tubing was inserted into the sampling rods and attached to the sampling point. Once attached, the point was detached from the sampling rod and landfill gas was allowed to flow through the teflon tubing to the surface. The teflon tubing was then purged of ambient air using the Geoprobe® vacuum pump unit. After purging the teflon tubing, free flow of landfill gas was verified using the PID and a combustible gas indicator (CGI). The PID and CGI were attached to the teflon tubing by inserting the instrument probe into the free end of the tubing. The PID was used to monitor for volatile organic compounds (VOCs) and the CGI was used to monitor percent LEL combustible gases, percent oxygen and hydrogen sulfide. When instrument readings stabilized, they were recorded and landfill gas sampling commenced.

At the third Phase II sampling location (LFG-8B), the sample was collected from a passive gas vent installed beneath the refuse transfer station liner. First, all of the six gas vents which exist

Table 2-8
CLARKSTOWN LANDFILL RI
Phase II Soil Gas and Vent Screening Data

Location	CGI (% LEL)	Oxygen (%)	OVA (ppm)	HNu/OVM (ppm)	H ₂ S (ppm)
PROPERTY BOUNDARY SOIL GAS SCREENING DATA					
92	4	20	150	0.4	-
93	>100	0	>1000	1.0	-
94	8	20.5	560	1.6	-
95	9	19	200	NR	-
96	5	21	NR	NR	-
97	11	20	740	1.2	-
98	18	20	380	NR	-
99	4	17	180	0.2	-
100	6	18	210	0.4	-
101	6	17.5	375	0.6	-
102	0	21.5	NR	NR	-
103	0	20	NR	NR	-
104	(wet conditions)	(wet conditions)	(wet conditions)	(wet conditions)	-
105	3	21	NR	NR	-
LANDFILL GAS AND VENT SCREENING DATA					
LFG-2	>100	0	-	75	4
LFG-3	>100	0	-	70	25
LFG-8 (Vent V-1)	>100	9	-	NR	10
Vent V-2	2	20.7	-	NR	0
Vent V-3	0	20.8	-	NR	0
Vent V-4	1	20.8	-	NR	0
Vent V-5	8	18.5	-	NR	0
Vent V-6	6	20.7	-	NR	0

NOTES:

- (1) NR = No response
- (2) - = No data available
- (3)LEL = Lower Explosive Limit
- (4)ppm = Parts Per Million

at the transfer station were screened with the HNu for VOCs and the CGI for percent LEL combustible gases, percent oxygen, and hydrogen sulfide. The vent which recorded the highest overall concentrations was selected for sampling for laboratory analysis. The gas vent screening data are presented in Table 2-8 and the gas vent locations are shown on Figure 2-3.

The sampling system used for collection of the three Phase II landfill gas samples consisted of a mixed bed sorbent tube connected to a portable sampling pump (Sensidyne Model BDX 530) calibrated to a flow rate between 50 and 55 milliliters per minute. The mixed bed sorbent tubes, supplied by the CLP laboratory, contained 150 milligrams (mg) of Tenax-TA, 30 mg Charcoal and 70 mg Amersorb. Two (2) samples using sorbent tubes were collected at each sampling location. One had a sampling duration of approximately 10-15 seconds and the other had a sampling duration of approximately 1-2 minutes, resulting in a low volume (approximately 0.01 liter) and a high volume (approximately 0.1 liter) sample, respectively. The high volume sample was the primary sample and the low volume was a secondary sample collected as a backup in the event there was breakthrough of the primary sample.

As a backup to the sorbent tube samples, a one (1) liter Tedlar® bag sample was collected at each location. The Tedlar® bag was attached to the teflon tubing by inserting the bag's nipple into the free end of the tubing. The bag was placed in a small vacuum-sealed case. A vacuum line was then attached to the case and activated. As the case was evacuated of air, the Tedlar® bag was filled. Sampling was complete when the bag was fully expanded.

All connections between the sorbent tubes and Tedlar® bags and teflon tubing were sealed with teflon tape during sampling. All sampling pumps were pre- and post-calibrated using a primary soap bubble calibrator (Mini-Buck Model M-5) with a representative sorbent tube installed. Three (3) constant flow calibration readings were obtained before and after sample collection. The average of the pre- and post-calibration rates were used to calculate total sample volume.

Upon completion of sampling, all sorbent tube samples were placed in glass storage tubes, which were sealed with teflon tape and placed inverted into a glass jar containing activated charcoal.

The glass jar was also sealed with teflon tape. This was done as per method requirements to eliminate the potential for cross-contamination of sorbent tubes by other sources. The Tedlar® bags were placed in a cooler with ice to preserve them. It was not necessary to analyze the Tedlar® bag samples.

All samples were then transported to the CLP laboratory via courier service complete with sample numbers and properly executed chain-of-custody records within 24 hours of sample collection.

2.8 Groundwater Investigation

The groundwater investigation consisted of the installation of a total of twenty-five monitoring wells and three piezometers, as described in Section 2.3, a fracture trace analysis, in-situ permeability ("slug") testing of the wells and piezometers, measurement of water levels in the wells and piezometers, and two rounds of groundwater sampling from each of the monitoring wells.

2.8.1 Fracture Trace Analysis

Bedrock fracture traces (linears) were identified from stereoscopic review of available aerial photographs of the landfill and surrounding Hackensack River Valley (Clarkstown Basin) examined at the NYS Department of Transportation offices. Airphoto linears are linear features exposed at grade surface which are correlated to potential bedrock fracture traces. Linears for the Clarkstown Basin are presented in Figure 3-3 in Section 3.0 of the report along with an interpretation of the linears as they relate to preferred groundwater flow pathways at the landfill.

2.8.2 In-situ Permeability Testing

2.8.2.1 Objectives

In-situ permeability tests ("slug tests") were conducted on selected new and existing monitoring wells to obtain order-of-magnitude estimates of the permeability, or hydraulic conductivity, of

the geologic formations beneath the landfill. The resulting permeabilities can be used with measured hydraulic gradients to calculate average groundwater flow velocities across the site. A comparison of the permeability values for the various geologic deposits can also be used to identify the primary groundwater flow pathways beneath the landfill.

2.8.2.2 Methodology

The "slugs" consisted of solid cylinders of PVC suspended on stainless steel or teflon-coated stainless steel cable. Before the start of each test, static water levels were measured with electronic water level indicators. For quickly recovering wells, water levels were measured automatically during the test with the use of an In-situ® SE2000 environmental data logger (HERMIT) equipped with downhole pressure transducers. For slowly recovering wells, water levels were measured manually using the electronic water level indicators. Since water levels change quickly during the beginning of the test, the data logger was programmed to record the early test data more frequently than the later test data.

Initially, "falling head" tests were performed by lowering the slug into the water column, thereby raising the water level, and then monitoring the water level drop to the original static level. "Rising head" tests were subsequently performed by removing the slug from the water column, lowering the water level, and monitoring the water level rise to the original level. Tests were run until water levels recovered to at least 90 percent of the original level. Field data were downloaded from the data logger onto a computer file at the end of each day's activities. The slugs and downhole pressure transducers were decontaminated between wells using the approved procedures. The results of the slug testing are presented in Section 3.0 of the report.

2.8.3 Water Level Measurements

Water levels were measured monthly in the new monitoring wells, selected existing wells and piezometers, and two stream gauges between March and July 1991, and periodically thereafter to establish the full seasonal range in water levels at the landfill. Water levels were measured

with electronic water level indicators which were decontaminated between wells with a deionized water rinse. The results of the water level measurements are presented and discussed in Section 3.0 of the report.

2.8.4 Groundwater Sampling

2.8.4.1 Introduction

Groundwater flow patterns are complex at the Clarkstown Landfill due to the variable composition, thickness, and areal extent of the geologic deposits. At least three separate groundwater flow systems appear to exist at the site: the upper saturated deposits (peat, silt, and fill), the lower coarse-grained deposits (outwash and tills), and the bedrock system. Groundwater mounding within the fill material on the property may represent a fourth system, separate from the underlying upper saturated deposits. The mounding condition is enhanced by the relatively low permeability of the underlying fine-grained deposits. Where present, these deposits tend to create a predominant lateral movement of leachate radially away from the center of the mound.

Due to its low measured permeability, the varved clay layer represents a barrier to vertical flow from the upper saturated deposits into the outwash and tills (see Section 3.0). The absence of the upper saturated deposits, and the varved clay in the southwest landfill area provides a direct pathway for potential preferential flow into the deeper deposits and bedrock. Horizontal groundwater flow in both the upper saturated deposits and the tills was found to be generally in a westerly/southwesterly direction towards the marsh areas. An upwards measured vertical component to groundwater flow (discharge conditions) from the bedrock system into the overlying outwash and tills, and from the outwash and tills into the upper saturated deposits, provides additional protection against the vertical downwards migration of leachate from the landfill.

2.8.4.2 Sampling Locations, Objectives and Analytical Program

Twenty-five (25) monitoring wells were installed at sixteen locations at the landfill, as shown in Figure 2-2. A majority of the monitoring wells (wells RFW-1S/1D, 2, 3S/3D, 4S/4D, 5S/5D, 6S/6D, 7S/7D, 8S/8D, 9S/9D and 12) were installed around the perimeter of the landfill. The purpose of these wells is to monitor groundwater quality downgradient of the landfill. Wells RFW-14, 15 and 16 were installed in the center of the landfill to establish groundwater quality within the landfill mass. Wells RFW-10S/10D, 11 and 13 were installed to monitor upgradient groundwater quality. A majority of the wells were installed in the more permeable deposits at each location (glacial outwash, tills, and bedrock) since they represent the most likely migration pathways.

Phase I (April 1991) and Phase II (December 1993) groundwater sampling efforts were conducted. For the Phase I sampling effort, a total of twenty-two (22) groundwater monitoring wells were sampled for the TCL volatile organics, semivolatile organics, pesticides/PCBs, metals, cyanide, and total organic carbon using a CLP laboratory. Well RFW-10S was not sampled due to unstable field parameters, and wells RFW-15 and RFW-16 were not sampled because of obstructions that had occurred within the wells sometime after installation. A matrix spike and matrix spike duplicate were collected from RFW-12, a field duplicate was collected at RFW-2, and two field blanks and four trip blanks were collected as part of the Phase I sampling effort.

The Phase II groundwater sampling was used to confirm the Phase I round results. Phase II samples were collected from twenty-one (21) of the monitoring wells, the same wells sampled as Phase I except RFW-14 was not sampled because it is a leachate monitoring well and the leachate was characterized during Phase II by other means. The Phase II groundwater samples were analyzed by a CLP laboratory for the NYSDEC Part 360 baseline volatile organics using a low detection limit method (EPA 524.2), the Part 360 baseline metals and leachate indicators, total cyanide, boron, and hexavalent chromium. In this way, the Phase II sampling results can potentially be used for Part 360 landfill closure baseline monitoring requirements. Two wells

(RFW-2 and RFW-3D) were also sampled for the TCL pesticides/PCBs in an attempt to confirm the Phase I concentrations of one pesticide and a PCB compound found in these wells.

A matrix spike and matrix spike duplicate were collected from wells RFW-1S and RFW-2, and five trip blanks were collected. Well RFW-5D was sampled at a later date than the other wells after it was repaired of earlier damage.

2.8.4.3 Sampling Protocols

The groundwater samples were collected in the following manner:

1. Well was checked for any above-ground damage or shifting.
2. Well was unlocked and the cap removed, an OVA or HNu was used to screen the breathing zone and headspace of the well to confirm that there was no imminent danger and that the current safety level was adequate.
3. The depth from the top of the casing to the water surface was measured using a water level indicator to an accuracy of 0.01 inch.
4. At least three well volumes were purged from the well (in the case of slow recharging wells, a minimum of one well volume was removed). See Table 2-9 for actual volumes removed per well.
5. During purging, periodic field screening was done for turbidity, temperature, conductivity and pH. At the end of purging, if turbidity levels were < 50 NTU's, sample collection proceeded within three hours for all of the scheduled analytical parameters. If turbidity levels were > 50 NTU's, metals sample collection was postponed until the end of the day of sampling to allow fines to settle out of the water column. The samples for all other parameters were collected within three hours of well purging. See Table 2-10 and Table 2-11 for Phase I and Phase II groundwater field parameters measured at the time of sample collection.
6. The sample was collected with a polyethylene or teflon disposable bailer, lowered into the bottom of the well with polypropylene line. All samples were dispensed directly from the bailer into the appropriate sample bottle with use of a bottom emptying device to minimize agitation of the sample. See Tables 2-1 and 2-2 for the scheduled laboratory analytical parameters. Bottles were logged into the field book, labelled, and stored on ice in preparation for shipment to the laboratory.
7. Well caps were replaced and the well was locked.

Table 2-9
Well Purge Calculations for Ground Water Sampling
Clarkstown Landfill RI

Well Number	Approx. DTW	Approx. Well Depth	Screen Length	Length of Water Column (ft)	Volume of Water per Number of Columns (gal)					Recovery Rate	Purge Method	Purge Rate
					1	3	5					
RFW-1S	14.00	28.0	5	14.0	2.2	6.7	11.2			30 MIN	M	2.5 GAL
RFW-1D	11.90	58.0	10	46.1	7.4	22.1	36.9			N/A	CP	2 GPM
RFW-2	7.80	32.0	5	24.2	3.9	11.6	19.4			N/A	CP	8 GPM
RFW-3S	7.20	37.0	5	29.8	4.8	14.3	23.8			N/A	CP	0.5 GPM
RFW-3D	4.50	63.5	15	59.0	9.4	28.3	47.2			N/A	CP	4 GPM
RFW-4S	4.40	23.0	5	18.6	3.0	8.9	14.9			2 HR	M	1.5 GAL
RFW-4D	4.40	48.0	10	43.6	7.0	20.9	34.9			N/A	CP	10 GPM
RFW-5S	1.70	46.0	10	44.3	7.1	21.3	35.4			N/A	CP	3 GPM
RFW-5D	0.00	97.0	10	97.0	15.5	46.6	77.6			1 HR	CPM	25 GAL
RFW-6S	9.00	30.0	5	21.0	3.4	10.1	16.8			1 HR	M	1 GAL
RFW-6D	11.10	45.0	5	33.9	5.4	16.3	27.1			30 MIN	CPM	8 GAL
RFW-7S	6.40	61.0	5	54.6	8.7	26.2	43.7			30 MIN	CPM	13 GAL
RFW-7D	6.80	90.0	10	83.2	13.3	39.9	66.6			N/A	CP	7 GPM
RFW-8S	6.50	33.0	5	26.5	4.2	12.7	21.2			N/A	CPM	1 GPM
RFW-8D	4.70	121.0	10	116.3	18.6	55.8	93.0			N/A	CP	3 GPM
RFW-9S	7.70	20.0	5	12.3	2.0	5.9	9.8			2 HR	M	5 GAL
RFW-9D	5.60	61.0	10	55.4	8.9	26.6	44.3			N/A	CP	2 GPM
RFW-10S	1.70	38.0	5	36.3	5.8	17.4	29.0			2 HR	M	1.5 GAL
RFW-10D	0.00	128.0	35	128.0	83.2	249.6	416.0			N/A	CP	6 GPM
RFW-11	10.40	39.0	5	28.6	4.6	13.7	22.9			N/A	CP	9 GPM
RFW-12	4.00	28.0	5	24.0	3.8	11.5	19.2			N/A	CP	5 GPM
RFW-13	10.30	27.0	5	16.7	2.7	8.0	13.4			5 MIN	CP	5 GPM
RFW-14	56.00	80.0	10	24.0	15.6	46.8	78.0			---	S	---
RFW-15	63.00	100.0	10	37.0	24.1	72.2	120.3			---	S	---
RFW-16	77.50	90.0	10	12.5	8.1	24.4	40.6			---	S	---

NOTES

1. Depth to Water (DTW) and Well Depth measured from top of well casing.
2. Recovery rate for slow recharging wells only; approximate time for water level to recover to approximately 75% of original water level.
3. Purge method entries: (cp) centrifugal pump, (cpm) centrifugal pump with manual assistance, (s) submersible pump, (m) manual purge.
4. Purge rates for wells that pumped dry are given in number of gallons per purging event, wells that recharged quick enough for continuous purging are given in gallons per minute (GPM).
5. For 2 inch wells the calculation of 0.16 gallons per lineal foot was used. For 4 inch wells the calculation of 0.65 gallons per lineal foot was used.
6. Wells 5D and 10D are flowing Artesian wells.

Table 2-10
Phase I Groundwater Field Parameters

Sample Ident.	Date Collected	pH	Temp.(°C)	Conductivity (µmhos/cm)	Turb. (NTU)	HNu/OVA Detections (ppm)
GW1D-01	4-15-91	7.8	12	188	1.4	-
GW1S-01	4-15-91	8.0	12.5	252	> 200	NR
GW2-01	4-15-91	8.2	12	192	38.0	30-250
GW3S-01	4-16-91	8.3	24.8	333	82	NR
GW3D-01	4-16-91	8.3	15.2	150	7.5	NR
GW4D-01	4-16-91	7.8	14	330	32	-
GW4S-01	4-16-91	6.8	18	390	> 200	3-6
GW5S-01	4-16-91	9.9	18	168	4.8	NR
GW5D-01	4-16-91	8.8	17	155	16	NR
GW6S-01	4-23-91	7.5	18.5	330	108	NR
GW6D-01	4-22-91	9.8	15	152	9.5	-
GW7S-01	4-22-91	8.8	13	210	> 200	NR
GW7D-01	4-22-91	8.7	13.5	140	2.6	NR
GW8S-01	4-22-91	6.7	13	1080	21	NR
GW8D-01	4-23-91	8.3	13	750	1.4	NR
GW9S-01	4-23-91	6.9	14.2	3000	> 200	NR
GW9D-01	4-23-91	7.5	15	1200	18	NR
GW10D-01	4-17-91	8.1	11.5	195	2.2	-
GW11-01	4-17-91	6.9	12.5	510	26	-
GW12-01	4-17-91	7.4	12.7	362	12	NR
GW13-01	4-23-91	7.1	13	803	2.5	NR
GW14-01	4-24-91	7.1	39.4	1392	120	5-9

Notes:

- (1) NR = No Response
- (2) - = No Data Available
- (3) NTU = Nephelometric Turbidity Units
- (4) PPM = Parts per million response units above background levels
- (5) Monitoring well number is indicated by the number following "GW" in the sample identification.

Table 2-11
Phase II
Groundwater Field Parameters

Sample Location	Date Collected	pH	Temp (°C)	Conductivity (μmhos/cm)	Turbidity (NTU)	Eh
GW1D-02	12-27-93	7.72	12.9	208	1.30	+120
GW1S-02	12-27-93	7.70	12.4	224	151.3	+131
GW2-02	12-27-93	7.95	12.1	170	8.68	+110
GW3S-02	12-28-93	7.63	14.3	208	>200	+109
GW3D-02	12-28-93	7.68	13.7	104	2.89	+100
GW4S-02	12-28-93	7.0	10.9	172	>200	+123
GW4D-02	12-28-93	7.57	11.8	249	23.0	+100
GW5S-02	12-28-93	9.34	14.4	97	6.42	+73
GW5D-02	3-23-94	7.1	19	168	>200	--
GW6S-02	12-29-93	10.2	14.3	120	>200	+25
GW6D-02	12-29-93	8.29	16.7	132	>200	+70
GW7S-02	12-29-93	10.91	13.5	315	>200	+27
GW7D-02	12-29-93	8.94	12.3	113	87.4	+59
GW8S-02	12-22-93	6.3	14.6	825	14	-10
GW8D-02	12-22-93	9.62	12.0	548	79.6	-18
GW9S-02	12-22-93	6.53	12.8	1654	12	+97
GW9D-02	12-22-93	6.98	13.2	790	52	+8
GW10S-02	12-27-93	10.31	11.5	162	90.5	+127
GW10D-02	12-27-93	7.84	9.9	151	1.86	+114
GW11-02	12-28-93	6.41	12.2	457	124.2	+101
GW12-02	12-27-93	7.3	10.4	288	3.04	+120
GW13-02	12-29-93	6.68	10.4	587	168.6	+102

NOTES:

- (1) NTU = Nephelometric Turbidity Units
- (2) Monitoring well number is indicated by the number following "GW" in the sample identification.
- (3) -- = No Data Available

2.9 Leachate Investigation

2.9.1 Introduction

In 1983, the Town completed the installation of the existing landfill leachate collection system. The system consists of approximately 9,000 feet of 6-inch perforated PVC pipe laid in a trench excavated into the top of the peat layer below the wastes and backfilled with crushed gravel. Figure 1-2 shows the lateral distribution of the leachate collection system.

The leachate collection line includes seven (7) leachate collection chambers located approximately 1,200 feet apart. A high point was constructed midway between each chamber which uses a gradual slope to induce gravitational flow into the respective chambers. Leachate is pumped from the chambers to two holding basins located in the north and south section of the landfill, and then from the holding basins to a pump station wet well located next to the landfill garage (See Figure 1-2). The leachate is then combined with effluent from sanitary sewer lines from a small number of properties located along Route 303, and is sent to the Rockland County Sewer District (RCSD) #1 treatment plant.

During the Phase I sampling effort, leachate outbreaks (seeps) were found at four locations on the landfill side slopes and were sampled for laboratory analysis. During the Phase II sampling, no leachate seeps were noted presumably because landfilling had ceased and an interim soil cover layer placed subsequent to the Phase I effort was effective in preventing any outbreaks.

2.9.2 Sampling Locations, Objectives and Analytical Program

Leachate samples were collected for laboratory analysis during both the Phase I (August through October 1990) and Phase II (December 1993) sampling efforts. Fourteen (14) Phase I and ten (10) Phase II leachate samples were collected to characterize the leachate at the site. The leachate sample locations are shown in Figure 2-1. Phase I and Phase II leachate samples LC-1 through LC-7 were collected from each of the seven leachate collection chambers located along the perimeter leachate collection lines. During both phases of sampling, sample LC-8 was taken

from the wet well at the leachate pumping station and one sample was taken from each of the two holding basins, LB-1 and LB-2. During Phase I, four additional leachate seep samples were collected at LC-9, LC-10, LC-11 and LC-12. During Phase II, no leachate seep samples were collected because no active seeps were noted during the field sampling effort.

Tables 2-1 and 2-2 present the analytical program for the two phases of sampling. The Phase I leachate samples were analyzed for the TCL volatile organics, semivolatile organics, metals, and pesticides/PCBs. The Phase II leachate samples were analyzed for the NYSDEC Part 360 baseline volatiles, metals, and leachate indicator parameters. A matrix spike and matrix spike duplicate were collected from LB-1 during both phases and a field duplicate was collected at LC-3 during Phase I. One field blank was collected during Phase I and a total of four trip blanks were submitted for analysis for both phases.

2.9.3 Sampling Protocols

The leachate samples from each of the seven collection chambers, the wet well, and the two holding basins were collected with the use of dedicated stainless steel buckets attached to polypropylene rope. The gate to the chamber or wet well was unlocked and an iron was used to remove the manhole cover. The breathing zone and opening to the collection chamber were screened with an HNu before sampling began for health and safety purposes. The stainless steel bucket was lowered into the chamber, wet well, or holding basin to collect the liquid to be sampled. The first bucket was screened with the HNu and physical parameters of pH, temperature, and conductivity were measured before filling the glassware. The bucket was lowered as many times as were necessary to collect samples for all parameters.

Leachate seep sample locations were staked prior to sampling. Seep samples were collected with the use of dedicated stainless steel bowls and trowels. Due to low seep flow rates, the stainless steel bowls were placed in small basins dug along the seep flow path to allow the leachate to collect over the necessary amount of time. Field parameters were taken from the first full bowl of liquid collected and an HNu was used to screen the leachate.

Sample bottles were logged into the field book, labelled, and stored on ice in preparation for shipment to the laboratory. The leachate chamber manhole cover was replaced and the gate locked upon completion of sampling. Tables 2-12 and Table 2-13 present the Phase I and Phase II leachate field parameters, respectively. An extremely elevated field conductivity was reported for one particularly concentrated leachate seep sample during Phase I (LC-10), as shown on Table 2-12.

2.10 Ecological Investigations

WESTON performed a record search to compile existing background information pertaining to the wetlands surrounding the Clarkstown landfill. This included gathering various maps, accessing databases, and conducting telephone conversations with regulatory agency personnel, civic groups and concerned citizens, as well as reviewing environmental reports which had been performed to date.

WESTON reviewed the Nyack USGS Quadrangle; the National Wetlands Inventory Map; NYSDEC Freshwater Wetlands Map; information provided by the New York State Natural Heritage Database on Significant Habitats; and various vegetative, wildlife and fish species lists compiled by the NYSDEC and other consultants to the Town of Clarkstown.

In addition, WESTON conducted a field investigation to confirm or supplement species lists and to classify ecological communities across the site. A cover type map was created by visual observation and use of the NYSDEC document "Ecological Communities of New York State", March 1990. A summary of results of the ecological investigation are presented in Section 3.6 of this report.

Table 2-12

Phase I Leachate Field Parameters

Sample Ident.	Date Collected	pH	Temperature (° C)	Conductivity (μmhos/cm)	HNu Detections (ppm)
LB-1	8/29/90	6.7	24	---	0.0
LB-2	8/29/90	6.7	24	2000	---
LC-1	9/5/90	6.6	19	2500	---
LC-2	9/5/90	6.2	17	1900	---
LC-3	9/5/90	6.6	20	2400	---
LC-4	9/5/90	6.5	22	2500	---
LC-5	9/10/90	7.0	20	1000	0.0
LC-6	9/10/90	6.7	20	2100	---
LC-7	9/5/90	6.9	24	800	---
LC-8	9/10/90	7.1	21	2700	---
LC-9	8/29/90	6.6	28	3000	---
LC-10	9/5/90	6.7	27	80,000	---
LC-11	10/15/90	6.9	25	7800	2
LC-12	10/15/90	6.5	23	1400	---
LC-3 Dup	9/5/90	6.6	20	2400	---

NOTE:

(1) -- = No data available

Table 2-13
Phase II Leachate Field Parameters

Sample Identification	Date Collected	pH	Temperature (°C)	Conductivity (μmhos/cm)	CGI Detections (% LEL)
LB-1-02	12/20/93	6.0	9	1500	--
LB-2-02	12/20/93	6.2	11	1400	--
LC-1-02	12/20/93	6.2	12.5	1700	NR
LC-2-02	12/20/93	6.4	13	1750	NR
LC-3-02	12/20/93	6.6	15	2350	NR
LC-4-02	12/20/93	6.6	15	2200	NR
LC-5-02	12/20/93	6.4	15	1700	7
LC-6-02	12/20/93	6.6	13	1250	*
LC-7-02	12/20/93	4.6	12.5	1600	*
LC-8-02	12/20/93	5.0	11	1700	*

Notes:

- (1) * = Combustible Gas Indicator (CGI) malfunctioned.
- (2) NR = No response
- (3) -- = No data available
- (4) LEL = Lower Explosive Limit

2.11 Air Investigations

2.11.1 Introduction

A byproduct of a sanitary landfill is the emission of landfill gas generated from the decomposition of the wastes. This landfill gas is largely composed of methane and nitrogen, but can contain various trace volatile contaminants, depending on the composition of the material present in the landfill and the conditions for decay. The gas flow direction will be from regions of high pressure to regions of low pressure, from within the landfill through cavities towards the landfill surface, and ultimately into the ambient air. The concentrations of these uncontrolled landfill gases are most likely the highest directly above the landfill mass, but the gases also move laterally beyond the landfill boundaries as they mix and become dispersed into the atmosphere. Landfill emissions may have an impact on the site safety, as well as the environment and public health.

2.11.2 Sampling Locations, Objectives and Analytical Program

Ambient air sampling was conducted during Phase I to determine the effect of landfill gas emissions on air quality. The release of volatile contaminants from the landfill which result in an ambient concentration greater than the appropriate ambient air quality standard or guideline concentration may necessitate treatment or control.

Figure 2-3 shows the ambient air sampling locations on the landfill. Sample locations were selected to meet two objectives:

- 1) to measure the impact of the landfill on air quality by collecting and analyzing samples at both up and down wind locations, and
- 2) to analyze samples from "hot spot" concentrations along the landfill perimeter, identified by a direct reading field instrument calibrated to detect VOCs. These "hot spot" locations represent worst case scenarios of potential exposures to any contamination present in the landfill gas.

Fifteen samples were collected during the four-day sampling program, as well as 4 trip blanks and 4 field duplicate samples for a total of 23 analyses. Samples were shipped via overnight courier to the CLP laboratory for analysis for volatile organic compounds using EPA Method TO-14.

2.11.3 General Sampling Protocols

Ambient air samples were collected over a four day period in August of 1990. Meteorological conditions (wind speed, wind direction, temperature and barometric pressure) were measured and recorded hourly for the duration of the ambient air sampling operations. A portable, self-contained meteorological station was positioned at the top of the landfill (See Figure 2-3) for collecting wind speed and direction data continuously on a strip chart and averaged over one hour periods. Barometric pressure and temperature were manually recorded. Tables 2-14 through 2-17 contain the meteorological data summarized for the air sampling period.

Seven locations were selected for ambient air sampling, as shown in Figure 2-3. At four locations (three [3] downwind and one [1] upwind), 12-hour ambient air samples were collected daily on three separate days. The actual sampling locations were selected based on the meteorological conditions present during the day. A duplicate sample was taken at an alternating downwind location each day. In addition, over one 12-hour sampling day, samples were also collected from three (3) "hot spot" locations along the perimeter of the landfill, identified by an OVA and HNu. These "hot spot" locations corresponded to odors of landfill gas. A duplicate sample was collected at one of the perimeter "hot spot" locations. Once the sampling locations were selected, the locations were staked and a 12-hour sample was collected using a battery-operated personal sampling pump with stainless steel Summa® canisters.

On August 15, 1990, the landfill perimeter was traversed with OVA and HNu instruments to identify possible "hot spot" locations. Ambient readings were at or close to background levels with the exception of three areas. An area on the north perimeter registered a reading of greater than 1,000 ppm on the OVA and background level HNu readings. A second location on the

TABLE 2-14
METEOROLOGICAL STATION DATA
FOR PHASE I AMBIENT AIR SAMPLING - AUGUST 1990

WIND SPEED MEASUREMENTS (mph)				
Hour	August 15	August 17	August 27	August 28
8	1.7	1.4	0.7	2.1
9	1.5	1.1	0.9	4.6
10	2.2	1.5	1.4	3.9
11	5.8	1.8	2.2	2.6
12	5.8	4.0	2.5	3.5
13	6.3	4.9	4.5	5.7
14	7.1	4.2	4.3	6.5
15	6.4	4.0	6.2	5.5
16	6.4	4.7	2.1	4.6
17	6.8	6.2	2.6	4.4
18	6.7	5.7	6.0	4.6
19	4.2	4.6	2.6	3.1
Average	5.1	3.7	3.0	4.3
Maximum	7.1	6.2	6.2	6.5

Note:

mph = miles per hour

TABLE 2-15
METEOROLOGICAL STATION DATA
FOR PHASE I AMBIENT AIR SAMPLING - AUGUST 1990

WIND DIRECTION MEASUREMENTS (degrees)				
Hour	August 15	August 17	August 27	August 28
8	315	217	198	210
9	189	237	224	234
10	153	240	194	224
11	338	240	119	23
12	321	129	-	226
13	304	104	309	219
14	280	115	285	-
15	280	89	332	262
16	282	141	230	252
17	271	164	219	241
18	273	173	224	255
19	261	179	215	225
Average	272	169	232	237
Maximum	338	240	332	262

Notes:

"0" or "360" are due north; "90" is due east; "180" is due south; and "270" is due west wind directions.

(-) = No Data Available

TABLE 2-16

**METEOROLOGICAL STATION DATA
FOR PHASE I AMBIENT AIR SAMPLING - AUGUST 1990**

TEMPERATURE MEASUREMENTS (°C)				
Hour	August 15	August 17	August 27	August 28
8	18.5	20.6	-	19.8
9	21.2	-	20.2	21.1
10	-	24.8	22.9	-
11	23.7	-	24.3	-
12	25.2	-	-	22.5
13	26.7	28.9	28.5	26.4
14	25.2	-	31.5	27.2
15	26.7	29.7	-	29.6
16	27.0	-	25.5	-
17	26.7	-	24.2	-
18	28.7	29.2	24.0	27.3
19	25.9	25.7	-	26.3
Average	25.0	26.5	25.1	24.2
Maximum	28.7	29.7	31.5	29.6

Note:

(-) No data available

TABLE 2-17
METEOROLOGICAL STATION DATA
FOR PHASE I AMBIENT AIR SAMPLING - AUGUST 1990

BAROMETRIC PRESSURE (inches Hg)				
Hour	August 15	August 17	August 27	August 28
8	30.12	30.13	-	29.88
9	30.13	-	29.98	29.82
10	-	30.13	29.97	-
11	30.13	-	29.95	-
12	30.13	-	-	29.84
13	30.12	30.13	29.92	29.82
14	30.10	-	29.88	29.81
15	30.08	30.10	-	29.80
16	30.07	-	29.85	-
17	30.05	-	29.98	-
18	30.05	30.07	29.86	29.78
19	30.05	30.08	-	29.76
Average	30.09	30.11	29.92	29.81
Maximum	30.13	29.7	29.98	29.88

Note:

(-) = No data available

south perimeter gave an HNu reading of 0.2 ppm and an OVA reading of 50-80 ppm. The third location on the west side at the landfill next to leachate collection chamber No. 5 gave an OVA reading greater than 1,000 ppm and background level HNu readings. The stainless steel Summa® canister with a battery operated pump was used to collect a 12-hour sample at these 3 locations where OVA and/or HNu readings were above background levels. All canisters were monitored hourly for pressure and flow rate. The weather was mostly clear and sunny throughout the sampling period.

On August 17, 1990 the first day of upwind and downwind sampling was performed. The weather was sunny and clear with southwest winds. The sampling was resumed on the next clear days; August 27 and 28, 1990. All canisters were monitored hourly for pressure and flow rate. On August 28, the weather remained mostly mild, with light winds out of the southwest. The meteorological station was checked for alignment at the end of the sampling period.

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3.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

3.1 Site Topography

Various aerial photographs and maps were obtained and reviewed to portray the pattern of landfilling at the Clarkstown Sanitary Landfill, as shown on Figure 3-1. For the RI, aerial photographs were initially taken in February 1991 to create a topographic map, and thereafter in 1993. The 1991 topographic map (scale 1" = 100') is the basis for the accompanying drawings (Sheets 2 of 11 through 10 of 11). Sheet 10 of 11 presents the most current outline of the landfill. This drawing highlights the two areas where filling has occurred beyond the boundaries of the landfill.

3.2 Surface Water Hydrology

Several streams flow along the boundaries of the Clarkstown Sanitary Landfill and ultimately into Greenbush Brook and the Hackensack River, as shown on Figure 3-2. Muddy Brook formerly flowed through the center of the landfill but has been diverted and currently flows along the southern landfill boundary in a westerly direction into the wetlands (See Figure 1-2). Greenbush Brook, which flows in a northwesterly direction and lies to the west of the site, originates south of the landfill near the Xerox facility and Bradley Industrial Park. Two unnamed tributaries flow along the northern boundary of the site and ultimately discharge into the Hackensack River. An unnamed intermittent stream flows in a northerly direction into Muddy Brook on the south side of the landfill. The origin of this stream is the drive-in theater and driving range off Route 303.

Surface drainage occurs generally from the inland sections of the landfill towards the perimeter areas down the landfill slopes. Runoff from the north slope enters the westerly flowing tributary on the north side of the landfill. Drainage from the south slope enters Muddy Brook which drains into the wetlands adjoining Greenbush Brook. Runoff from the west slopes enters the wetlands.



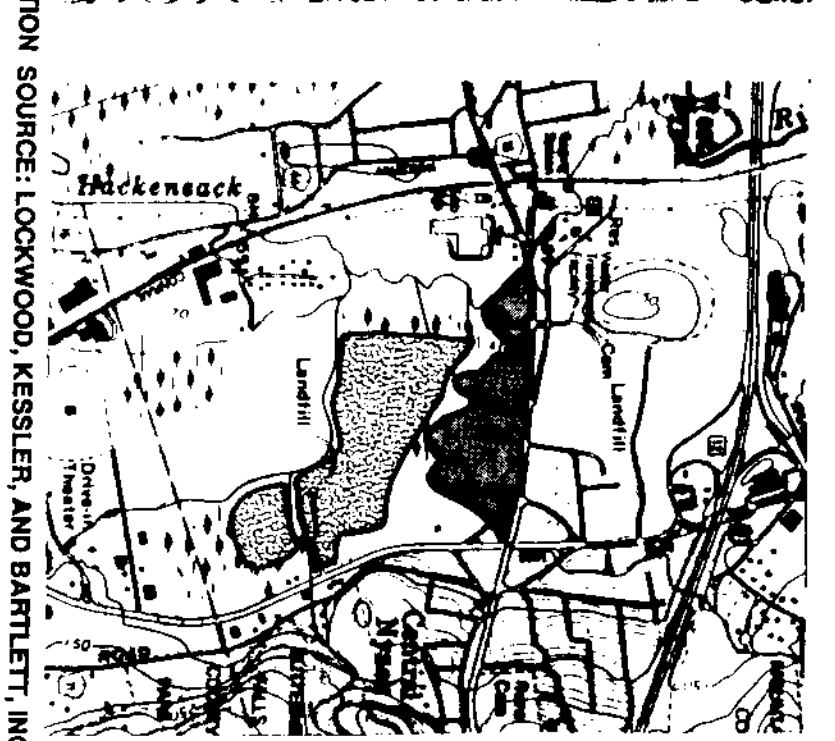
SOURCE: N.Y.S. D.O.T. ORTHOPHOTO MAPS OF THE NYACK QUADRANGLE.

1962



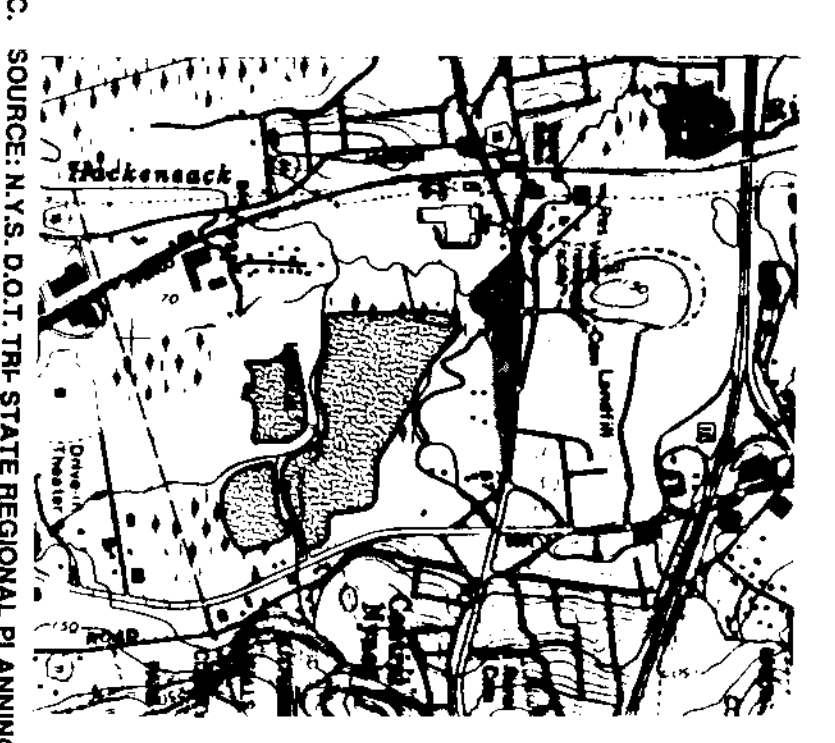
SOURCE: U.S.G.S. NATIONAL CARTOGRAPHIC INFORMATION CENTER.

1964



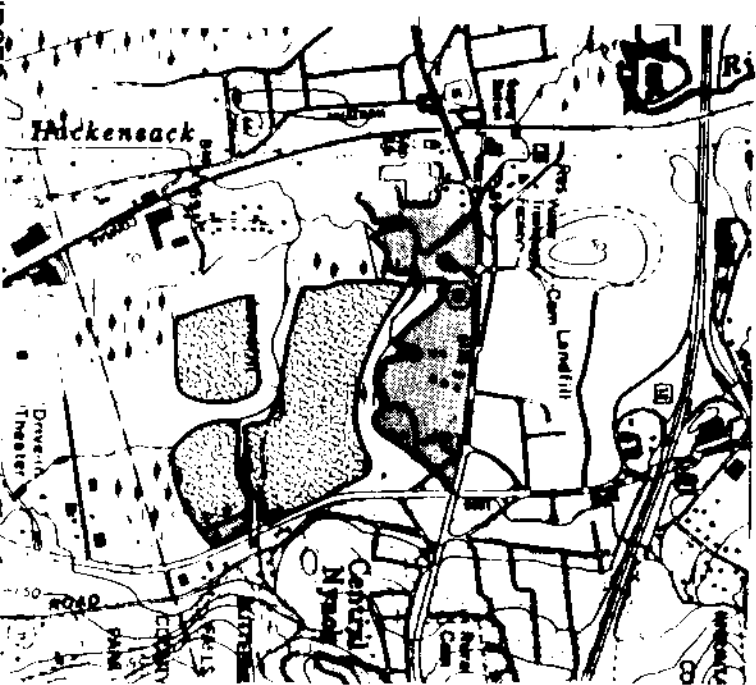
SOURCE: LOCKWOOD, KESSLER, AND BARTLETT, INC.

1968



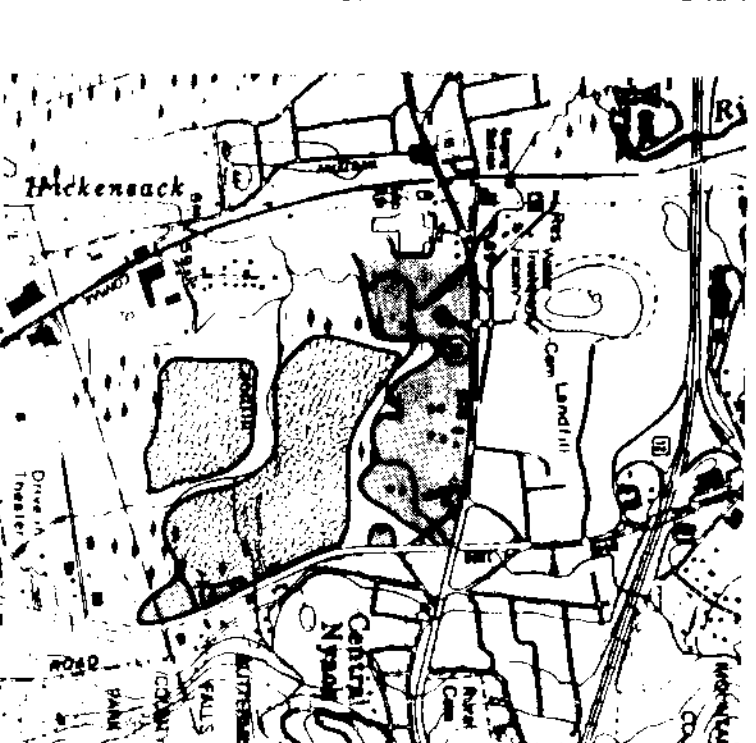
SOURCE: N.Y.S. D.O.T. TRI-STATE REGIONAL PLANNING COMMISSION (FLOWN BY RAYTHEON).

1970



SOURCE: 1974 - U.S.G.S. NATIONAL CARTOGRAPHIC INFORMATION CENTER.

1974 & 1976



SOURCE: KEYSTONE AERIAL SURVEY, FLOWN FOR THE TRI-STATE REGIONAL PLANNING COMMISSION.

1980



SOURCE: N.Y.S. D.O.T. WESTCHESTER & ROCKLAND CO. (FLOWN BY KEYSTONE AERIAL SURVEY).

1989

- LEGEND**
- CLARKSTOWN LANDFILL
 - OTHER FILLED AREAS

- NOTES:**
1. DISTRIBUTION OF FILL WAS BASED ON AERIAL PHOTO INTERPRETATIONS.
 2. BASE MAP: N.Y.S. D.O.T. NYACK QUADRANGLE 7.5 MINUTE SERIES (U.S.G.S. BASE), 1967, REVISED 1989.

SCALE: 1" = 2000'



SOURCES:
1974 - U.S.G.S. NATIONAL CARTOGRAPHIC INFORMATION CENTER.
1976 - N.Y. METROPOLITAN TRANSPORTATION COUNCIL
(FLOWN BY KEYSTONE AERIAL SURVEY).

SOURCE:
KEYSTONE AERIAL SURVEY, FLOWN FOR THE
TRI-STATE REGIONAL PLANNING COMMISSION.

SOURCE: N.Y.S. D.O.T. WESTCHESTER & ROCKLAND CO.
(FLOWN BY KEYSTONE AERIAL SURVEY).

FIGURE 3-1
LANDFILL DEVELOPMENT
1962 THRU 1989

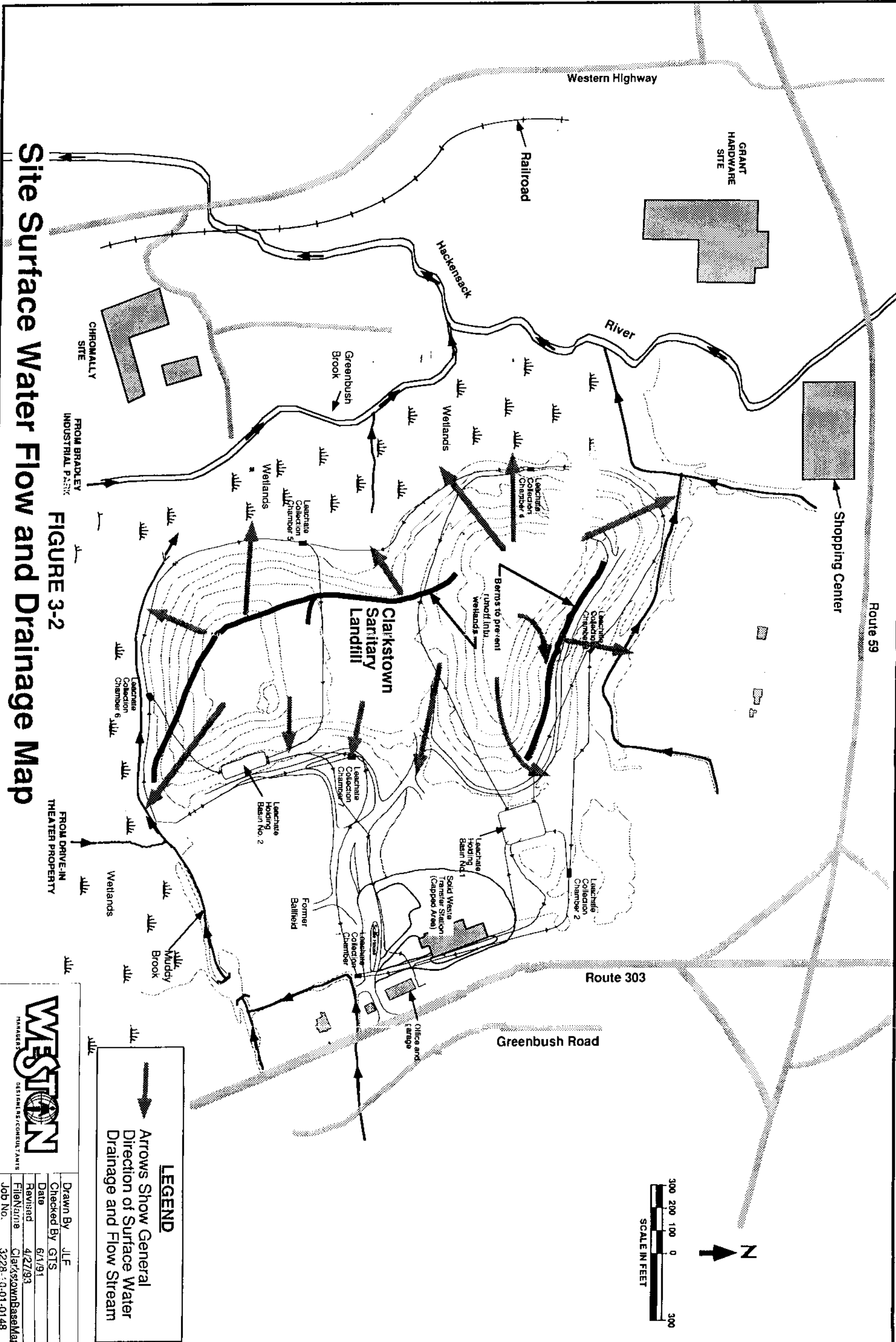


FIGURE 3-2
Site Surface Water Flow and Drainage Map

DESIGNERS/CONSULTANTS

Drawn By	JLF
Checked By	GTS
Date	6/1/91
Revised	4/27/93
File Name	ClarkstownBaseMap
Job No.	3228-0-01-0148

It has been reported that at times during the Hackensack River flood stage conditions (normally spring thaw and heavy rains) the floodwaters have reached the edge of the landfill. During these events, contaminants present in the runoff from the various tributaries may become mixed in the floodwaters and distributed throughout the basin floor.

In the past, leachate seeps were observed on the west and north landfill slopes during the wet seasons and after storm events. Currently, leachate seepage along the side slopes appears to have been eliminated with the placement of the interim soil cover layer.

Placement of more than 12-inches of interim soil cover layer on the slopes of Clarkstown Landfill since landfilling was terminated has resulted in runoff and the accumulation of silt in Muddy Brook and the wetlands along the southwest side of the landfill. The area of siltation measures approximately 1.1 acres and the depth of the material varies from less than one inch to twenty-four (24) inches.

In response, the Town has implemented erosion control measures to prevent further siltation in the wetland area. A silt fence has been installed along the lower perimeter landfill road in the affected areas. The entire top portion of the landfill has been regraded and an earthen berm constructed to prevent surface runoff from the top of the landfill into the wetlands (See Figure 3-2). The landfill side slopes have been seeded and hay bale fences have been constructed within the wetlands to prevent further transport of silt into the wetlands. Excavation of the silt has been initiated for areas containing a depth of 2 inches or more of silt, and silt bars have been removed from Muddy Brook along the south edge of the landfill.

3.3 Soils

3.3.1 Rockland County Soil Survey

Information regarding soils existing on-site at the Clarkstown Sanitary Landfill was obtained from the USDA Soil Conservation Service, Soil Survey of Rockland County, New York, dated October, 1990. Soils that exist on-site include Alden silt loam, Carlisle muck, Riverhead fine

sandy loam, Sloan silt loam, Wethersfield gravelly silt loam, and udorthents. These soils along with their properties are discussed below.

3.3.1.1 Wetland Soils

Alden silt loam is deep, nearly level and very poorly drained soil. It is in broad drainageways or depressional areas of dissected till plains and in depressional areas of bedrock-controlled uplands. The soils formed in glacial till with an 18 to 40 inch thick layer of material washed from adjacent areas. The major limitation of this soil is the prolonged period of wetness and water commonly at or above the surface, thus the potential productivity of this soil for woodlands is moderate. The shallow water table causes high seedling mortality and restricts rooting, making windthrow a severe hazard.

Carlisle muck is a very deep, nearly level and very poorly drained soil formed in decomposed organic material. This soil is found in broad depressional or basin-like swamps and bogs that have water at the surface for extensive periods. Small perennial streams either bisect or run along the edge of this unit. The thickness of the organic material is more than 50 inches and in many areas is 10 to 15 feet. The amount of undecomposed plant remains, some of which are woody, is variable. The potential productivity of this soil for red maple is moderate. The shallow water table causes high seedling mortality and restricts rooting, making windthrow a severe hazard.

Sloan silt loam is a deep, nearly level and very poorly drained soil. It occurs on the floodplains of the larger streams in the County. The potential productivity of this soil for pin oak is moderately high. The flooding and periods of wetness cause seedling mortality and windthrow.

3.3.1.2 Upland Soils

Upland soils found on or around the Clarkstown Sanitary Landfill include Riverhead fine sandy loam, Wethersfield gravelly silt loam and udorthents.

The Riverhead soils consist of very deep, gently sloping well drained soils. The soils formed in glacial outwash derived dominantly from granitic rocks. These soils occur on outwash plains, terraces and river valleys. The potential productivity of the soils for sugar maple is moderate. The soils have few or no limitations for woodland development.

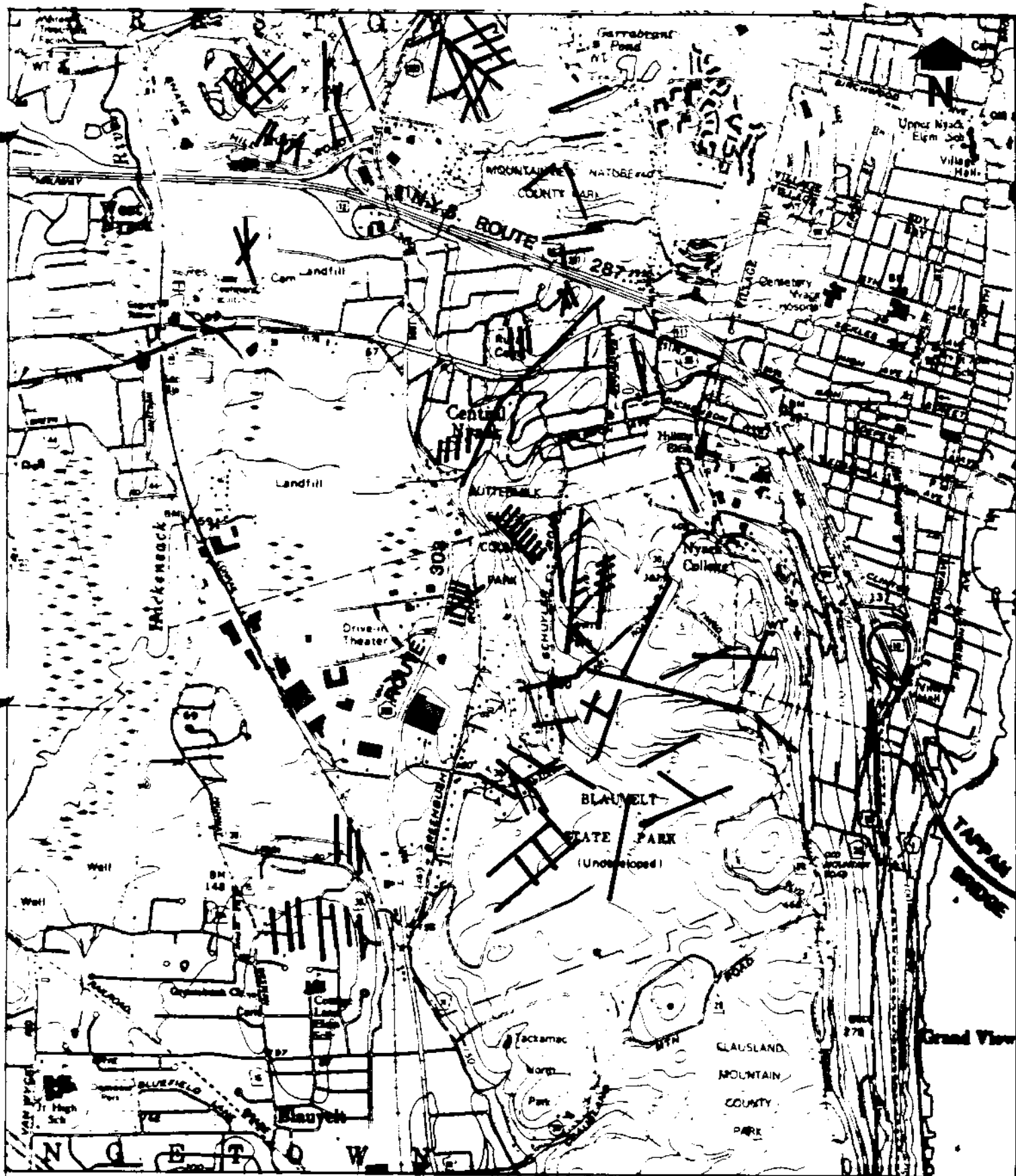
The Wethersfield soils consist of very deep, well-drained soils formed in reddish glacial till derived mainly from Triassic sandstone, Shale and conglomerate. The soils occur on smooth ridges on uplands. The potential productivity of this soil for northern red oak is moderately high. Seasonal wetness restricts rooting, causing a hazard of windthrows.

Udorthents refuse substratum are defined as landfilled materials. This soil consists of nearly level to steep landfills on sandy and loamy soils. The landfills have been reworked by earth moving and grading equipment to cover trash and other refuse. Often the refuse is partly covered or mixed with the fill material. The sides of most areas are steep and the tops are nearly level or gently sloping. Udorthents consist of somewhat excessively drained soils mainly in disturbed areas of urban development. As in the case of the Clarkstown Sanitary Landfill, these soils overlie somewhat poorly drained to very poorly drained soils.

3.4 Geology and Hydrogeology

3.4.1 Fracture Trace Analysis

Bedrock fracture traces (linears) were identified from stereoscopic review of available aerial photographs of the landfill and surrounding Hackensack River Valley (Clarkstown Basin). The fracture trace analysis was completed as part of the basin-wide investigation to evaluate the potential for contaminant migration in groundwater towards the landfill from the surrounding hazardous waste sites. Airphoto linears for the Clarkstown Basin presented in Figure 3-3 show several trends that are probably related to fracturing in the bedrock. The linear orientations include strong northeast (052 degrees; N 52 E), north-northeast (008 degrees; N 8 E), north-northwest (345 degrees; N 15 W), and northwest (308 degrees; N 52 W) trends. The northwest trend is orientated parallel to the depression in the bedrock surface beneath the landfill marked



BASE MAP: U.S.G.S. 7 1/2 MINUTE QUADRANGLE NYACK, NY

FIGURE 3-3
FRACTURE TRACES FROM AIR PHOTO INTERPRETATION

SCALE: 1" = 2000'

FRACTURE TRACE

WESTON

by the "-50" foot elevation contour (see Drawing 8 of 11). The north-northeast trend is orientated parallel to the trend of the narrow valley in the bedrock surface located along the eastern edge of the site.

A rose diagram of airphoto fracture traces (Figure 3-4) is based on 125 fracture traces visible on airphotos examined at the NYS Department of Transportation. A rose diagram is a cumulative plot of fracture traces according to directions of orientation and lengths. The traces can be put into four classes by size: 250 to 500 feet long (36%), 500 to 1,000 feet long (32%), 1,000 to 2,000 feet long (30%), greater than 2,000 feet long (2%).

Fourteen percent of the fracture traces were in sedimentary rocks. None of the traces in the sedimentary rocks were over 1,000 feet long.

The orientations of the fracture traces were plotted in classes of 15 degrees of arc:

<u>Orientation</u> (degrees)	<u># of Traces (Length)</u>				<u>Percent</u>
	0- 500 ft	500- 1,000 ft	1,000- 2,000 ft	> 2,000 ft	
0 to 15	7	5	3	1	13
16 to 30	5	1	1	-	5
31 to 45	1	3	4	-	6
46 to 60	11	-	5	1	14
61 to 75	3	5	3	-	9
76 to 90	7	2	2	-	9
91 to 105	4	-	3	-	8
106 to 120	2	-	-	-	2
121 to 135	-	7	3	-	8
136 to 150	-	1	5	-	5
151 to 165	2	8	5	-	12
166 to 180	4	8	3	-	12

The topographic expression of fractures that are orientated from north-south to N 45 E would have been enhanced by glacial erosion (Averill and others, 1980).

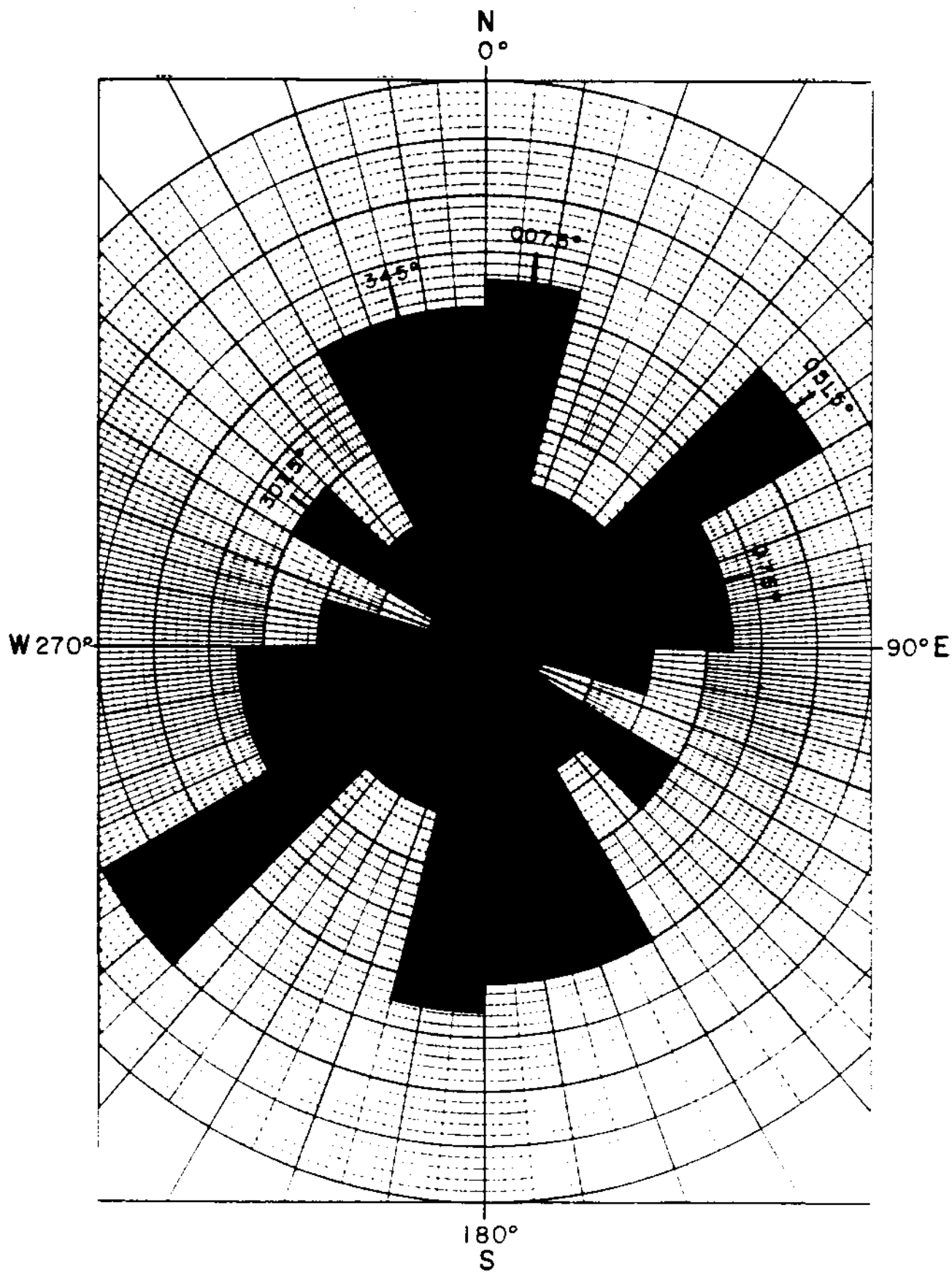


FIGURE 3-4
ROSE DIAGRAM OF FRACTURE TRACES

Five fracture sets dominate the rose diagram. They are, in decreasing order of expression: 052 degrees (N 52 E); 008 degrees (N 08 E); 345 degrees (N 15 W); 075 degrees (N 75 E); and 308 degrees (N 52 W). The sedimentary rocks show six fracture sets. They are, in decreasing order of importance: 052 degrees (N 52 E); 008 degrees (N 08 E); 345 degrees (N 15 W); 022 degrees (N 22 E); 278 degrees (N 82 W); and 292 degrees (N 68 W). The 345 to 008 degree sets are visible on the glacially-streamlined Blauvelt hill south of the landfill.

Bedrock fracture sets were not identified for the landfill property and immediately adjacent areas because of the presence of the thick unconsolidated overburden, although fractures in the bedrock are likely to extend beneath the landfill. The orientation of the identified primary fracture sets infers the potential for preferential groundwater flow in bedrock from the most notable designated hazardous waste sites (Chromalloy and Xerox Corporation sites) and the unidentified source of VOCs near Birchwood Drive towards the landfill. In particular, the N 08 E and N 15 W sets trend along a line connecting the Xerox site and Birchwood Drive area with the landfill, and the N 52 E set trends along a line connecting the Chromalloy site with the landfill.

3.4.2 Geophysical Investigation Results

3.4.2.1 Surface Geophysical Investigation

Subsurface conductivity measurements were plotted for each surface geophysical traverse line. The data plots are presented in Appendix E with the estimated location of the boundary between the landfill and native marsh soils. The traverse lines and estimated landfill boundary location are also shown on Sheet 10 of 11 of the drawings. The estimated landfill boundary location is based on the aerial photo review and field inspection, and was verified by the surface geophysical results.

3.4.2.2 Subsurface Geophysical Investigation

The gamma ray log for boring RFW-B7 is presented in Appendix E. Twelve gamma-ray units were identified from the log using the average intensity, and the pattern and the relative intensity of the jagged excursions around the average intensity. The relative intensities were estimated from the log by dividing the intensity scale into seven-and-a-half "degrees," and estimating intensity to one tenth of a "degree." Some of the units exhibited intensities or "excursion patterns" that contrasted sharply with adjacent units. Often, these sharply contrasting zones coincided with lithologic contacts, as suggested by different materials in the split spoon samples. The contacts between most of the units are more subtle, with gradual changes from one unit to the other. The logs were used to assist with making stratigraphic correlations and preparation of the geologic sections (sheets 3 of 11 through 6 of 11).

3.4.3 In-Situ Permeability Testing Results

Table 3-1 presents the results of the in-situ permeability testing. The graphical plots and parameters used for the calculations are presented in Appendix E. The in-situ permeabilities generally correspond to the horizontal permeability of the formation. Table 3-1 also includes the vertical permeability measured in the laboratory for samples collected during the RI as well as an earlier investigation (Velzy Associates, 1990).

As expected, the permeability of peat and organic silt are generally less than the permeability of the fill, outwash, till, and bedrock. A range in permeabilities for each lithologic unit is noted which reflects the textural variation observed within each unit across the site. The measured permeabilities and their use in evaluating groundwater flow are described in more detail in the following sections for each of the hydrostratigraphic units identified below the landfill.

TABLE 3-1

**PERMEABILITY RESULTS
CLARKSTOWN LANDFILL RI**

Boring or Sample Number	Screened/Sampled Below Grade (ft)	Interval Elevation (ft-msl)	Lithology	Permeability (cm/sec)
FILL				
RFW-95	7-17	59.9-49.9	Fill	6.40 X 10E-4(H)
PEAT				
RFW-4S	15-20	47.5-42.5	Peat	6.70 X 10E-6(H)
RFW-6S	22.5-27.5	46.9-41.9	Peat/Organic Silt	4.00 X 10E-7(H)
RFW-8S	25-30	39.8-34.8	Peaty Sand	1.69 X 10E-3(H)
B-202S	20-35	41.2-26.2	Peat/Organic Silt	5.14 X 10E-4(H)
B-205S	12-17	49.9-44.9	Peat	4.67 X 10E-5(H)
RFW-7A-SH1-1	16-18	50-48	Peat/Organic Silt	1.45 X 10 ⁻⁷ (vert)
RFW-7A-SH1-2	16-18	50-48	Silty Sand Layer in Peat Strata	6.71 X 10 ⁻⁷ (vert)
SB-3*	29.5-30		Peat	6.9 X 10E-8(vert)
ORGANIC SILT				
B-201S	25-35	42.5-32.5	Organic Silt	5.66 X 10E-5(H)
B-203S	33-43	33.5-23.5	Organic Silt	5.30 X 10E-6(H)
RFW-7S-SH3-3	30-32.5	36-33.5	Organic Silt	7.55 X 10E-8(vert)

Notes:

(H) Hvorslev Method (horizontal permeability)

(C) Cooper, Bredehoeft, and Papadopoulos Method (horizontal permeability)

* Sampled for Transfer Station Study, 1989; all others sampled for RI/FS, 1990

(Vert) = Laboratory measured vertical permeability

TABLE 3-1

**PERMEABILITY RESULTS
CLARKSTOWN LANDFILL RI**

Boring or Sample Number	Screened/Sampled Below Grade (ft)	Interval Elevation (ft-msl)	Lithology	Permeability (cm/sec)
ORGANIC SILT CONTINUED				
RFW-15-SH-1	120-122	16-14	Organic Silt	9.78 X 10 ⁻⁸ (vert)
SB-1*	57-59		Organic Silt	8.8 X 10E-8(vert)
OUTWASH				
RFW-4D	35-45	27.8-17.8	Outwash	1.22 X 10E-2(C)
RFW-5S	33-43	27.4-17.4	Fine Sand Outwash	9.24 X 10E-4(C)
RFW-6D	37-42	32.9-27.9	Outwash	2.54 X 10E-3(C)
RFW-7S	53-58	12.7-7.7	Silt Outwash	7.43 X 10E-5(C)
RFW-7D	77-87	-11-(-21)	Outwash	3.40 X 10E-2(C)
RFW-8D	108-118	-44.1-(-54.1)	Outwash	1.61 X 10E-3(C)
RFW-9D	45-58	18.6-8.6	Outwash	4.31 X 10E-3(C)
RFW-13	19.5-24.5	51.3-46.3	Outwash	9.17 X 10E-3(C)
TILL				
RFW-1S	20-25	52.1-47.1	Sandy Till	4.78 X 10E-4(H)
RFW-2	24-29	42.2-37.2	Sandy Till	1.00 X 10E-2(C)

Notes:

(H) Hvorslev Method (horizontal permeability)

(C) Cooper, Bredehoeft, and Papadopoulos Method (horizontal permeability)

* Sampled for Transfer Station Study, 1989; all others sampled for RI/FS, 1990

(Vert) = Laboratory measured vertical permeability.

TABLE 3-1

**PERMEABILITY RESULTS
CLARKSTOWN LANDFILL RI**

Boring or Sample Number	Screened/Sampled Below Grade (ft)	Interval Elevation (ft-msl)	Lithology	Permeability (cm/sec)
TILL (CONTINUED)				
RFW-3S	29-34	36.3-31.3	Sandy Till	4.98 X 10E-4(C)
RFW-PZ1	17-27	53.3-43.3	Sandy Till	6.80 X 10E-5(H)
BEDROCK				
RFW-1D	45-55	26.7-18.7	Bedrock	1.18 X 10E-3(C)
RFW-3D	45.5-60.5	19.4-4.4	Bedrock	8.27 X 10E-4(C)
RFW-5D	84-94	-23.9-(-33.9)	Bedrock	7.82 X 10E-5(C)
RFW-11	31-36	39.6-34.6	Bedrock	4.00 X 10E-2(C)

Notes:

(H) Hvorslev Method (horizontal permeability)

(C) Cooper, Bredehoeft, and Papadopoulos Method (horizontal permeability)

• Sampled for Transfer Station Study, 1989; all others sampled for RI/FS, 1990

(Vert) = Laboratory measured vertical permeability

3.4.4 Hydrogeologic Conditions

Test borings and monitoring wells completed for the RI have been supplemented with data from previous investigations to refine the understanding of the regional hydrogeology of the Clarkstown Landfill site and the "Clarkstown Basin". Hydrogeologic cross-sections developed from the data are presented on Sheets 3 of 11 through 6 of 11 to accompany the following text. The topography of the upper surface of the various geologic formations and thickness contours are shown on Sheets 7 of 11 and 8 of 11. Locations of borings are shown on Sheets 2 of 11 and 11 of 11.

This information was developed to evaluate the potential for flow of leachate from the landfill into the native underlying geologic materials and beyond the landfill boundaries. The thicknesses and areal extent of the deposits determine the physical framework of the groundwater system and what preferential groundwater flow paths exist beneath the site. In hydrogeologic practice, geologic materials or units are evaluated relative to inherent hydraulic properties (i.e., permeability, porosity, isotropy/anisotropy, heterogeneity) to define a more useful framework consisting of hydrostratigraphic units. The terms "aquifer", "aquitard" and "confining unit" refer to types of hydrostratigraphic units. In general, hydrostratigraphic units are characterized in terms of their relative capability for storing, transmitting, or restricting groundwater flow.

The peat, organic silt, and varved clay deposits together form a "confining unit" or "aquitard", which is a hydrostratigraphic unit typically of low permeability that impedes the flow of groundwater or leachate. Where these deposits are thickest, a greater protection against downwards leachate flow is afforded. The sandy deposits, such as glacial outwash and tills, freely transmit groundwater depending on the particle grain size distribution, sorting, packing, and percentage of fines (silt and clay). Again, greater volumes of groundwater can be transmitted where the sandy deposits are thickest and generally of greater particle size.

Another important factor in defining the hydrogeologic conditions relates to the establishment of "boundary conditions". Boundary conditions within the groundwater flow system are

generally described as being source (recharge) or discharge areas for groundwater, and are used to define how groundwater enters and leaves the study area. An example of a hydrologic boundary is a river or stream channel. In most cases, a river marks a boundary across which groundwater flow does not occur.

The Clarkstown Landfill is located in eastern Rockland County, New York, in a low, swampy basin (the "Clarkstown Basin") with diabase ridges to the east and north and sandstone and siltstone ridges to the west and southeast. The ridges lie at higher elevations and act as recharge areas for groundwater, which then flow from the ridges towards the basin to discharge into the wetlands and streams surrounding the Clarkstown Landfill. The Hackensack River represents the regional hydrologic boundary, or divide, within the basin. Bedrock and outwash deposits present in the basin are aquifers which can provide fresh water in adequate volumes for beneficial use. The bedrock and outwash deposits exist under artesian, or pressurized, head conditions, with upwards measured groundwater flow gradients into the overlying deposits. The till and lacustrine (lake) silts and clays act as aquitards that confine the artesian systems (Perlmutter, 1959; Converse Consultants, 1986; Malcolm Pirnie, 1986; Woodward-Clyde Consultants, 1989).

The landfill site itself is underlain by seven hydrostratigraphic units: Fill, Peat, Organic Silt, Varved Silt and Clay, Outwash, Till, and Bedrock. The contact between the peat and organic silt is gradational, while contacts between the remaining formations are generally sharp. With the exception of the organic silt, this sequence was also encountered at the Dexter and Old Nyack Landfills (Malcolm Pirnie, 1986), and at the DeForest Lake dam and the Hackensack River crossing of the Interstate Parkway (Perlmutter, 1959). This section of the report describes the geologic materials and their measured permeabilities. This information was then used in conjunction with the groundwater elevation data to determine groundwater flow velocities and directions (see Section 3.4.5). The areal distribution, thickness, physical description, and permeabilities of the hydrostratigraphic units are described in the following subsections.

3.4.4.1 Fill

The Fill is a heterogenous unit that consists of organic and inorganic municipal and construction wastes and cover material. It ranges in thickness from 106 feet (northern landfill mound) to 2 feet (along the landfill perimeter). It consists of an upper and a lower unit. The lower unit is more compact than the upper unit. Both units are generating "pockets" of methane gas and leachate. The Fill is interbedded with peat along the northwestern section of the site. The Fill was emplaced from 1950 until 1990, when landfilling was terminated. Figure 3-1 presents the changing distribution of Fill during that time period.

Fill permeabilities ranged from $10E-3$ to $10E-5$ cm/sec at the Old Nyack and Dexter Landfills (Malcolm Pirnie, 1986) and was measured at $10E-4$ cm/sec for well RFW-9S at the Clarkstown Landfill (See Table 3-1). Groundwater is mounded under the main landfill mass at the Clarkstown Landfill (See Section B-B, Sheet 4 of 11; Sheet 10 of 11). Perched water tables may exist within the fill at various levels as evidenced by seeps which existed on the landfill slopes in the past.

3.4.4.2 Peat

The Peat ranges from dark gray through brown to black, fibrous vegetation that becomes progressively more decomposed and compact from the surface to its base. The texture of the Peat varies from slightly sandy Peat to Peat and Sand. The sandy Peats lie in the northern (borings RFW-8 and B-7) and eastern (near the transfer station, see Converse Engineering Consultants, 1988; Velzy Associates, 1989 and 1990) sections of the site. Peat and refuse (Fill) are intermixed in the upper section of the Peat bed (borings B-7, RFW-7, RFW-8, and RFW-9). The Peat grades down into the Organic Silt.

The Peat ranges in thickness from one foot (near boring B-206D) to seventeen feet in the southeastern (boring B-208) and northern (boring B-9) sections of the site. It may be absent under the southern landfill mound (borings B-207D and RFW-16) and northwestern section

(boring RFW-14) of the site. The Peat lies below an elevation of 55 feet in the vicinity of the Clarkstown Landfill and at an elevation of 65 feet at the Dexter and Old Nyack Landfills (Malcolm Pirnie, 1986).

The Peat is usually saturated, but has a very low to low permeability, ranging from $10E-4$ to $10E-7$ cm/sec in wells at the Clarkstown Landfill (Table 3-1) and from $10E-3$ to $10E-5$ cm/sec at the Dexter and Old Nyack Landfills (Malcolm Pirnie, 1986). One well screened in a peaty sand at the Clarkstown Landfill had a permeability of $10E-3$. Vertical permeabilities measured in the laboratory for samples of peat collected at the Clarkstown Landfill ranged from $10E-7$ to $10E-8$ cm/sec. Where permeabilities are low, the peat is an aquitard.

3.4.4.3 Organic Silt

The Organic Silt ranges in color from medium gray through dark brown. It is massive, with thin streaks of fine-grained peat, to thinly bedded (laminated) with layers of fine-grained peat alternating with silt. Thin laminae of very fine to fine sand are also present, especially in the eastern section of the site. Locally, the Organic Silt grades downward into the Varved Silt and Clay or upward into Peat. The Organic Silt was not identified at the Old Nyack and Dexter Landfills (Malcolm Pirnie, 1986).

The Organic Silt is twenty feet thick along the northern edge of the site (boring B-202D). The Organic Silt is absent in the southern and western part of the site (borings B-205D, B-207D, B-209D, RFW-1, RFW-2, RFW-3, RFW-5, RFW-10, RFW-12, RFW-16, A-A, and B-B) and the Truck Scale area (Converse Ward Davis Dixon, 1978); however, it thickens to over ten feet thick further to the south between the landfill and the old drive-in theater (boring B-204D). It is discontinuous in the eastern part of the site, near the transfer station (boring SB-1, Converse Engineering Consultants, 1988; Velzy Associates, 1989 and 1990). In some cases, the Organic Silt is indistinguishable from the overlying Peat. It locally grades downward into Varved Silt and Clay. The Organic Silt is quite sandy in the southern area of the landfill (borings RFW-12 and B-204). The Organic Silt is an aquitard, with permeabilities measured in wells ranging from

10E-5 to 10E-6 cm/sec (Table 3-1). Three samples had vertical permeabilities of 10E-8 measured in the laboratory.

3.4.4.4 Varved Silt and Clay

The Varved Silt and Clay is reddish brown to brown, although one small area of gray Varved Silt and Clay was encountered in the northwestern corner of the site. At the Clarkstown Site, the Varved Silt and Clay lies below an elevation of 49 feet, and is draped over the underlying units (Converse Consultants, 1986; Malcolm Pirnie, 1986). The Varved Silt and Clay "highs" are located over Outwash or Till ridges (see the distributions of Outwash and Till, below). The unit is thinly layered silt and clay, with some fine to very fine sand laminae and infrequent gravel layers. It is sandier at its base, and tends to become finer-grained upwards. It locally grades into the underlying Outwash and/or overlying Organic Silt.

The Varved Silt and Clay is thickest north of the Clarkstown Landfill (Perlmutter, 1959) and is very thin to absent in the west-central (boring B-206D) and the south-central (borings B-207D, RFW-1, RFW-12, and RFW-10) portions of the site. It is thin along the southwestern edge of the site (borings RFW-2, RFW-3, B-205D, and B-204D) and thickens to the north and east. The unit is sandier to the west and northwest (borings B-201D, B-205D, B-207D, and B-209D) and to the north (borings B-209, B-9, RFW-9, and B-203).

Varved Silt and Clay is an aquitard, with vertical permeabilities measured in the laboratory of 10E-6 to 10E-7 cm/sec at the Clarkstown Landfill (Converse Consultants, 1986). The unit is probably more permeable in its sandier zones, such as at the Old Nyack and Dexter Landfills, where permeabilities range from 10E-3 to 10E-4 cm/sec (Malcolm Pirnie, 1986).

3.4.4.5 Confining Unit

The Varved Silt and Clay, Organic Silt, plus Peat form a Confining Unit that is widespread across the site. They are draped over the underlying deposits and are thickest over the deepest portion of the bedrock basin. The confining unit forms thick wedges in the northern and southeastern sections of the site. It thins along the edges of the Clarkstown basin. The confining unit also thins or may be absent under the south landfill mound (borings RFW-1, B-207D). The unit is thin where it overlies the esker formed by the outwash (borings RFW-7, B-7, and B-202; see below). Thus, the confining unit is thickest to the north, in the bedrock basin, and is thinnest under the south-central portion of the site. The thickest area of the confining unit coincides with the thickest area of the Outwash.

3.4.4.6 Outwash

The Outwash aquifer, or stratified drift, is reddish brown to brown in color. It is a sand and gravel to a cobbly, bouldery sand and gravel, with trace to little silt and/or clay. Some sandy zones occur in the eastern portion of the site. The unit tends to be coarser (more cobbly or bouldery) to the northwest. Locally, the Outwash grades up into Varved Silt and Clay. It is interbedded with the Till in the northwestern portion of the site (borings B-7, RFW-7, and RFW-8). The unit is yellow-brown, cross-bedded, gravelly, medium to fine sand in exposures along Route 303, southeast of the site.

The Outwash is thickest in the central and northern sections of the landfill (borings B-201D, B202D, B-206D, RFW-4, RFW-5, B-7, RFW-7, and RFW-8). It pinches out along the western, eastern, and northeastern edges and is absent in the south-central section of the site (borings RFW-1, RFW-2, RFW-3, B-204D, and B-205D). A nearly-separate body of the Outwash is present under the southeastern section of the site (borings SB-1, RFW-12, A-A, B-B, and B-208D), with only a limited connection to the northwestern Outwash beds via a narrow neck under the transfer station (boring RFW-11 and Converse Engineering Consultants, 1988; Velzy Associates, 1989 and 1990). The Outwash is quite thin (two feet) under the south landfill

mound (borings RFW-3 and B-207D). It thickens towards the north and dips towards the northwest, forming a thick wedge along the northern edge of the site (borings RFW-7, B-7, and RFW-8). It forms a 40-foot ridge in the northwestern portion of the site (borings RFW-4, RFW-6, B-7, RFW-7, and RFW-15) that is probably a buried esker. Till and Outwash are interbedded along the esker (borings RFW-7, B-7, and RFW-8). The Till is very thin near boring RFW-8, thus the Outwash might be in contact with the bedrock there. The thickness of Till or Outwash are complimentary; where the Till is thick, the Outwash is thin, and vice versa.

The Outwash outcrops on the slopes south of the site, at the old drive-in theater. In the landfill area, the Outwash is overlain by aquitards, such as Peat, Organic Silt, or Varved Silt and Clay, except possibly in an area under the south landfill mound where the Confining Unit may not be present.

The permeability of the Outwash is relatively high, ranging from $10E-1$ to $10E-2$ cm/sec (coarse facies) and $10E-4$ to $10E-5$ cm/sec (fine facies) at the Dexter and Old Nyack Landfills (Malcolm Pirnie, 1986), and from $10E-2$ to $10E-3$ cm/sec (coarse facies) and $10E-4$ to $10E-5$ cm/sec (fine facies) at the Clarkstown Landfill.

3.4.4.7 Till

The Till is loose to compact, reddish brown to dark brown with a clayey-silt to silty-sand matrix and some gravel, cobbles, and boulders. Three Till facies have been mapped, they are: loose reddish-brown sandy till, compact reddish-brown clayey till, and compact yellow brown clayey till. The Till underlies the stratified drift (Varved Silt and Clay and the Outwash), and usually is in sharp contact with the overlying units. The Till is generally massive or unbedded, however interbedded zones of Till and Outwash were noted in the northwestern corner of the site (borings B-7, RFW-7, and RFW-8). The Till also grades into Outwash in the southern section of the site (borings RFW-10, RFW-1, RFW-2, and RFW-3). Locally, the Outwash appears to be deposited in channels cut into the Till. Sandy Till dominates the southern edge of the site (borings RFW-1 and RFW-10). Clayey Till underlies the rest of the landfill.

The Till is thickest in the northwestern (borings B-7, RFW-7, and B-203D), southwestern (boring RFW-3) and southeastern (borings RFW-10 and B-B) parts of the site. It pinches out against the diabase outcrop along Route 303 (borings B-208D and RFW-13, and Converse Engineering Consultants, 1988; Velzy Associates, 1989 and 1990) and is thin-to-absent in the southwest-central (borings B-204D, B-205D, B-207D, and RFW-2) and north-central (boring RFW-8) sections of the site. A Till ridge underlies the northwestern corner of the site (borings RFW-6, B-7, and RFW-7). This ridge is probably a buried drumlin.

The Clayey Till is usually dense and relatively impermeable, although no permeability values were obtained during the RI or earlier investigations. The permeability of the Sandy Till ranges from $10E-2$ to $10E-5$ cm/sec. Although permeability can increase with increasing sand and decreasing silt content, the Till is generally considered an aquitard.

3.4.4.8 Bedrock

The Bedrock is Triassic in age. The bedrock of the lowlands are red to gray siltstone, shale, and sandstone, with localized lava flows, of the Newark Group. They were intruded by a diabase sill (Perlmutter, 1959). The sedimentary rocks have been assigned to either the Brunswick Formation (Perlmutter, 1959) or the Passaic Formation (Olsen, 1980). It is reddish brown to brown, shale, siltstone, sandstone, and conglomeritic sandstone, except for a zone of dark gray diabase along Route 303 and the eastern edge of the site (borings B-208D and B-B, and Converse Engineering Consultants, 1988; Velzy Associates, 1989 and 1990). A thin zone of rotten or highly weathered rock, or Saprolite, has formed in the rock surface.

The topography of the Bedrock surface slopes down to the north and west. The elevation of the Top-of-Bedrock is 60 feet at the diabase exposure on the east side of Route 303. It dips steeply to an elevation of 29 feet below sea level at the western side of the Transfer Station, dropping nearly 90 feet in a distance of 250 feet. The southern mound of the landfill is underlain by Bedrock at an elevation of 28 to 35 feet above sea level (borings RFW-2, RFW-3, RFW-1, and

B-207D). The Bedrock surface dips to 68 feet below sea level at the north-central section of the site (boring RFW-8).

The top-of-Bedrock contours indicate that a structural bench or bedrock platform underlies the southwestern part of the site, while a narrow, deep, northwest-trending valley lies under the site's eastern portion. The valley dips into the "-50" foot depression that was mapped by Perlmutter (1959). The valley appears to be developed along the strike of a sequence of shale and sandstone. Locally, the sandstone appears to be interbedded with diabase (compare borings B-B, RFW-10, and B-208D).

The glacial deposits are draped over the Bedrock topography. They are thickest over the buried valleys and thinnest over the valley walls and bedrock platform. Thus, the overburden thickness increases dramatically from south to northwest. Bedrock outcrops east and southeast of the site, along Route 303. It also outcrops on the Pineview ridge, west of the site (Perlmutter, 1959).

The Rock Quality Designations (RQD's) for the bedrock platform range from 80% (boring RFW-8) to 6% (for the top of boring RFW-3D). The RQD's on the bedrock platform are 74% to 85% at RFW-5, 6% to 98% at RFW-3, 25% to 82% at RFW-1, and 88% to 97% for RFW-10. Boring RFW-3D illustrates the tendency for RQD's to increase with depth in the Bedrock.

RQD's along the eastern valley are fairly high (RQD = 94% for boring 208D and 12% to 82% at boring RFW-11). These high RQD values suggest that the eastern valley is controlled by lithology rather than structure.

Anomalously low RQD's occur along the northwest-trending axis of the "-50" foot depression. They range from 20% to 30% at boring RFW-7, 71% to 77% at boring RFW-8, to 51% at boring RFW-9. The northwest axis is aligned with a cliff (with northwest and northeast airphoto linears) at Central Nyack.

The Bedrock is an aquifer in eastern Rockland County (Perlmutter, 1959). The aquifer consists of Triassic sandstone and shale. In the shale, water flows along bedding plane fractures, while water in sandstones flows in cross-cutting joints. Perlmutter (1959) noted the presence of localized, open joints and faults. The diabase tends to have very low yield with highly permeable zones in joints at the top and base of sills (Perlmutter, 1959; Wood and Fernandez, 1988). Permeabilities measured in wells in the sandstone and shale ranged from $10E-3$ to $10E-5$ cm/sec. Permeability for one well in the diabase was measured at $10E-2$ cm/sec.

The groundwater in the Bedrock flows along discontinuities, such as bedding planes, cleavage, joints, and faults. Airphoto interpretation and field observations suggests that north-, east-northeast-, northeast-, and east-southeast-trending joints are developed in the diabase, while north-, northeast-, and northwest-trending joints are found in the Triassic sedimentary rocks. The bedding planes strike north-south to northeast-southwest and dip down to the west. The Bedrock might be in contact with the Fill in the area where Till or Varved Silt and Clay are absent, in the south-central part of the site.

Perlmutter (1959) mapped an outcrop of sandstone southeast of the Clarkstown Landfill that had a strike to the northeast and a 10 degree dip to the northwest. Field observations were made of jointing and fracturing in the vicinity of the site. The joints were generally vertical and fracturing was prominent along the bedding planes.

3.4.4.9 Bedrock Outcrops

Surface outcrops of the Bedrock were inspected in the vicinity of the Clarkstown Landfill for the RI to supplement the subsurface data. An outcrop of sandstone and shale was mapped in a trench near Route 303, approximately 1100 feet south of the landfill. The sandstone beds were 0.8 to 3 feet thick. East-west and north-south jointsets were 3 to 8 feet apart.

A second outcrop of shale and siltstone was exposed on the east side of Route 303, approximately 2,000 feet south of the landfill. Three joints were noted: 150 degrees (S 30 E),

with a spacing of 1 to 8 feet, 060 degrees (N 60 E), and 140 degrees (S 40 E), in a distinct jointset with fractures that were 0.5 to 1 foot apart (aimed at the landfill). The bedding of the rocks dipped 15 degrees to the west and had a strike of 050 degrees (N 50 E). The bedding showed partings that were 0.1 to 0.3 foot thick. Seeps were visible on some of the joints.

Joints were measured on diabase in the quarry 5,000 feet north of the landfill and north of Route 287. Three jointsets were noted in the quarry. A primary set had a strike of 035 to 040 degrees (N 35 E to N 40 E) and 0.5 to 0.8 foot spacing, a secondary set with a strike of 160 degrees (S 20 E) and a spacing of 5 to 15 feet spacing, and a third, poorly-developed set with a strike of 100 degrees (S 80 E). Horizontal partings were ten feet apart.

Fractures were also measured on a diabase knob that lies 1,500 feet northwest of the landfill. The primary jointset at the knob has a strike of 035 degrees (N 35 E) and a spacing of 1 to 2 feet, a secondary set with a strike of 130 degrees (S 50 E) and a spacing of 1 to 2 feet, and a third set with a strike of 170 degrees (S 10 E).

3.4.5 Groundwater Flow

Groundwater flow patterns in the physical system including the Clarkstown Landfill and the underlying geologic materials are determined by the distribution and thickness of the various hydrostratigraphic units, the permeabilities of these units, and the distribution of hydraulic head. The hydrostratigraphic units and their measured permeabilities (described above) are the independent variables that exist within this system. The general groundwater flow patterns that develop within this physical flow system can be represented by the distribution of hydraulic head, the dependent variable, which can be viewed in both plan and profile. The head data provides the basis for delineating equipotentials (contours of equal head) which in turn can be used to infer groundwater flow directions and to calculate flow rates. The head data obtained from monitoring wells and piezometers are provided in Table 3-2 and resulting plotted equipotentials are presented in plan and profile on Sheets 4,5,6,9, and 10 of 11.

3.4.5.1 Vertical Groundwater Flow

The differences between measured hydraulic heads between two monitoring wells is the hydraulic gradient, which creates the potential for groundwater flow. Actual groundwater flow depends on these hydraulic gradients and the permeability and porosity (pore volume versus total volume) of the intervening geologic materials. Vertical hydraulic gradients at the Clarkstown Landfill were evaluated by a comparison of groundwater elevations measured in the monitoring well couplets (See Table 3-2).

Groundwater contained within the bedrock, outwash, and sandy till deposits at the landfill exists under artesian or pressurized conditions. Consistent upwards flow potential (gradients) have been measured at well locations RFW-1, 3, 4, 5, 8, 9, 10 and 11 throughout the period of measurement. These upwards gradients infer flow to be from the bedrock into the outwash or sandy till, and from the outwash into the overlying confining unit. The upwards gradients are indicative of the groundwater discharge conditions which prevail in river valleys such as the "Clarkstown Basin." A consistent downwards flow (recharge) potential was observed at well location RFW-13 throughout the period of measurement, except for the most recent May, 1994, data where a slight upwards flow gradient was measured.

Hydraulic head distribution and equipotentials for the various formations are presented in profile on the hydrogeologic cross-sections (Sheets 4, 5, and 6 of 11 of drawings). The measured groundwater elevations shown in Table 3-2 decrease from Spring to Summer in response to expected seasonal patterns. The groundwater elevation measured in well RFW-8S has consistently been greater than the adjacent stream (North Stream - Stream #1) elevation indicating that a potential for flow exists from the landfill to the stream. The same relationship was observed between Muddy Brook (Stream #2) and wells RFW-1S and RFW-2 during March and April, 1991.

Table 3-2 Clarkstown Landfill RI - Water Level Elevations in On-Site Monitoring Wells and Piezometers

Well or Piezometer Number	Elevation at Top of Casing	Formation Screened	Date: 3/91		Date: 4/91		Date: 5/91	
			DTW	Elevation	DTW	Elevation	DTW	Elevation
RFW-1S	72.11	Sandy Till	13.66	58.45	14.00	58.11	13.75	58.36
RFW-1D	71.70	Rock	11.66	60.04	11.90	59.80	11.75	59.95
RFW-2	66.20	Sandy Till	7.75	58.45	7.80	58.40	7.92	58.28
RFW-3S	65.28	Sandy Till	7.17	58.11	7.20	58.08	7.08	58.20
RFW-3D	64.89	Rock	4.00	60.89	4.50	60.39	4.50	60.39
RFW-4S	62.51	Peat	4.33	58.18	4.40	58.11	4.42	58.09
RFW-4D	62.83	Outwash	4.25	58.58	4.40	58.43	4.50	58.33
RFW-5S	60.44	Outwash	1.25	59.19	1.70	58.74	1.87	58.57
RFW-5D	60.06	Rock	0.00	60.06	0.00	60.06	0.00	60.06
RFW-6S	69.39	Peat/Silt	11.00	58.39	9.00	60.39	9.42	59.97
RFW-6D	69.86	Outwash	10.58	59.28	11.10	58.76	10.92	58.94
RFW-7S	65.69	Outwash	5.83	59.86	6.40	59.29	6.42	59.27
RFW-7D	65.99	Outwash	6.25	59.74	6.80	59.19	6.75	59.24
RFW-8S	64.77	Peaty Sand	5.92	58.85	6.50	58.27	6.50	58.27
RFW-8D	63.90	Outwash	4.17	59.73	4.70	59.20	5.00	58.90
RFW-9S	66.86	Fill	8.58	58.28	7.70	59.16	9.08	57.78
RFW-9D	66.58	Outwash	6.17	60.41	5.60	60.98	6.58	60.00
RFW-10S	60.67	Outwash	1.08	59.59	1.70	58.97	1.50	59.17
RFW-10D	61.09	Rock	0.00	61.09	0.00	61.09	0.00	61.09
RFW-11	70.57	Rock	9.83	60.74	10.40	60.17	9.83	60.74
RFW-11 PZ1	70.30	Sandy Till	9.83	60.47	10.50	59.80	10.17	60.13
RFW-11 PZ2	70.27	Fill	9.66	60.61	10.30	59.97	10.00	60.27
RFW-12	63.10	Outwash	3.67	59.43	4.00	59.10	3.67	59.43
RFW-13	70.84	Outwash	9.83	61.01	10.30	60.54	10.00	60.84
RFW-13 PZ	70.85	Fill	10.04	60.81	10.30	60.55	9.58	61.27
RFW-14	121.80	Refuse	61.00	60.80	N/M	---	61.80	60.00
RFW-15	136.20	Refuse	63.00	73.20	N/M	---	N/M	---
RFW-16	140.01	Refuse	77.50	62.51	N/M	---	76.50	63.51
RFW-17 PZ	136.26 +	Refuse	---	---	---	---	---	---
RFW-18 PZ	133.98 +	Refuse	---	---	---	---	---	---
B-201S	68.08	Org. Silt	9.92	58.16	10.40	57.68	10.33	57.75
B-201D	66.60 *	Outwash	N/M	---	N/M	---	N/M	---
B-202S	62.59	Peat/Silt	3.00	59.59	3.40	59.19	5.00	57.59
B-202D	62.57	Outwash	5.25	57.32	N/M	---	N/M	---
B-203S	66.96	Org. Silt	4.58	62.38	3.90	63.06	3.67	63.29
B-203D	66.70 *	Outwash	N/M	---	N/M	---	N/M	---
B-205S	63.25	Peat	4.67	58.58	5.00	58.25	5.00	58.25
B-205D	62.30 *	Outwash	N/M	---	N/M	---	N/M	---
LEA3W	62.98	Fill	5.00	57.98	5.25	57.73	5.00	57.98
LEA3E	67.19	Fill	8.33	58.86	9.33	57.86	9.00	58.19
LEA5W	62.21	Fill	5.75	56.46	6.58	55.63	5.75	56.46
LEA5E	69.56	Fill	11.25	58.31	13.25	56.31	11.33	58.23
STR #1(8)	58.95	No. Stream	2.4	56.55	1.7	57.25	1.3	57.65
STR #2(2)	60.51	So. Stream	2.6	57.91	2.8	57.71	1.4	59.11

Table 3-2 Clarkstown Landfill RI - Water Level Elevations in On-Site Monitoring Wells and Piezometers

Well or Piezometer Number	Elevation at Top of Casing	Formation Screened	Date: 6/91		Date: 7/91		Date: 9/91	
			DTW	Elevation	DTW	Elevation	DTW	Elevation
RFW-1S	72.11	Sandy Till	14.39	57.72	14.50	57.61	14.53	57.58
RFW-1D	71.70	Rock	12.70	59.00	13.15	58.55	12.78	58.92
RFW-2	66.20	Sandy Till	8.52	57.68	8.45	57.75	8.55	57.65
RFW-3S	65.28	Sandy Till	7.74	57.54	8.09	57.19	6.82	58.46
RFW-3D	64.89	Rock	5.81	59.08	6.52	58.37	6.1	58.79
RFW-4S	62.51	Peat	4.91	57.60	4.90	57.61	5.25	57.26
RFW-4D	62.83	Outwash	4.78	58.05	5.04	57.79	4.86	57.97
RFW-5S	60.44	Outwash	2.20	58.24	2.53	57.91	2.35	58.09
RFW-5D	60.06	Rock	0.95	59.11	1.35	58.71	1.13	58.93
RFW-6S	69.39	Peat/Silt	10.09	59.30	5.15	64.24	9.23	60.16
RFW-6D	69.86	Outwash	11.53	58.33	11.99	57.87	11.7	58.16
RFW-7S	65.69	Outwash	6.80	58.89	7.45	58.24	7.09	58.60
RFW-7D	65.99	Outwash	6.99	59.00	7.91	58.08	7.42	58.57
RFW-8S	64.77	Peaty Sand	7.02	57.75	6.29	58.48	7.25	57.52
RFW-8D	63.90	Outwash	5.05	58.85	5.53	58.37	5.34	58.56
RFW-9S	66.86	Fill	10.00	56.86	9.75	57.11	12.15	54.71
RFW-9D	66.58	Outwash	7.21	59.37	7.23	59.35	7.48	59.10
RFW-10S	60.67	Outwash	2.09	58.58	2.56	58.11	N/M	---
RFW-10D	61.09	Rock	0.00	61.09	0.00	61.09	0.00	61.09
RFW-11	70.57	Rock	11.23	59.34	11.54	59.03	11.66	58.91
RFW-11 PZ1	70.30	Sandy Till	11.04	59.26	11.10	59.20	11.17	59.13
RFW-11 PZ2	70.27	Fill	11.12	59.15	11.46	58.81	11.34	58.93
RFW-12	63.10	Outwash	4.38	58.72	4.55	58.55	4.45	58.65
RFW-13	70.84	Outwash	11.07	59.77	11.78	59.06	11.53	59.31
RFW-13 PZ	70.85	Fill	11.00	59.85	11.58	59.27	11.34	59.51
RFW-14	121.80	Refuse	N/M	---	N/M	---	N/M	---
RFW-15	136.20	Refuse	N/M	---	N/M	---	N/M	---
RFW-16	140.01	Refuse	N/M	---	N/M	---	N/M	---
RFW-17 PZ	136.26 +	Refuse	---	---	---	---	---	---
RFW-18 PZ	133.98 +	Refuse	---	---	---	---	---	---
B-201S	68.08	Org. Silt	11.56	56.52	11.38	56.70	13.52	54.56
B-201D	66.60 *	Outwash	5.81	60.79	10.97	55.63	10.66	55.94
B-202S	62.59	Peat/Silt	5.62	56.97	6.29	56.30	5.95	56.64
B-202D	62.57	Outwash	8.73	53.84	8.76	53.81	8.55	54.02
B-203S	66.96	Org. Silt	5.00	61.96	5.10	61.86	5.57	61.39
B-203D	66.70 *	Outwash	8.55	58.15	8.90	57.80	8.43	58.27
B-205S	63.25	Peat	8.02	55.23	7.75	55.50	9.53	53.72
B-205D	62.30 *	Outwash	6.70	55.60	6.94	55.36	6.77	55.53
LEA3W	62.98	Fill	6.09	56.89	5.93	57.05	N/M	---
LEA3E	67.19	Fill	10.00	57.19	9.90	57.29	N/M	---
LEA5W	62.21	Fill	6.65	55.56	6.90	55.31	6.69	55.52
LEA5E	69.56	Fill	13.35	56.21	11.85	57.71	12.94	56.62
STR #1(8)	58.95	No. Stream	3.1	55.85	3.2	55.75	3.2	55.75
STR #2(2)	60.51	So. Stream	3.1	57.41	3.2	57.31	3.2	57.31

Table 3-2 Clarkstown Landfill RI - Water Level Elevations in On-Site Monitoring Wells and Piezometers

Well or Piezometer Number	Elevation at Top of Casing	Formation Screened	Date: 10/91		Date: 11/91		Date: 1/92	
			DTW	Elevation	DTW	Elevation	DTW	Elevation
RFW-1S	72.11	Sandy Till	14.41	57.70	14.03	58.08	14.18	57.93
RFW-1D	71.70	Rock	12.34	59.36	12.20	59.50	12.31	59.39
RFW-2	66.20	Sandy Till	8.27	57.93	6.90	59.30	8.18	58.02
RFW-3S	65.28	Sandy Till	7.56	57.72	7.07	58.21	7.40	57.88
RFW-3D	64.89	Rock	5.56	59.33	5.28	59.61	5.17	59.72
RFW-4S	62.51	Peat	5.14	57.37	4.98	57.53	4.85	57.66
RFW-4D	62.83	Outwash	4.55	58.28	4.50	58.33	4.53	58.30
RFW-5S	60.44	Outwash	2.09	58.35	1.95	58.49	1.97	58.47
RFW-5D	60.06	Rock	0.66	59.40	0.56	59.50	0.17	59.89
RFW-6S	69.39	Peat/Silt	8.20	61.19	10.34	59.05	10.48	58.91
RFW-6D	69.86	Outwash	11.44	58.42	11.21	58.65	11.28	58.58
RFW-7S	65.69	Outwash	6.78	58.91	6.56	59.13	6.63	59.06
RFW-7D	65.99	Outwash	7.17	58.82	7.08	58.91	7.05	58.94
RFW-8S	64.77	Peaty Sand	7.92	56.85	8.13	56.64	8.30	56.47
RFW-8D	63.90	Outwash	5.02	58.88	5.00	58.90	5.00	58.90
RFW-9S	66.86	Fill	9.48	57.38	10.55	56.31	10.85	56.01
RFW-9D	66.58	Outwash	7.12	59.46	7.12	59.46	6.98	59.60
RFW-10S	60.67	Outwash	2.05	58.62	1.96	58.71	1.35	59.32
RFW-10D	61.09	Rock	0.00	61.09	0.00	61.09	0.00	61.09
RFW-11	70.57	Rock	11.03	59.54	10.94	59.63	10.98	59.59
RFW-11 PZ1	70.30	Sandy Till	10.71	59.59	11.11	59.19	10.73	59.57
RFW-11 PZ2	70.27	Fill	10.96	59.31	10.82	59.45	10.65	59.62
RFW-12	63.10	Outwash	4.27	58.83	3.90	59.20	4.15	58.95
RFW-13	70.84	Outwash	11.12	59.72	10.77	60.07	10.93	59.91
RFW-13 PZ	70.85	Fill	10.95	59.90	10.89	59.96	10.85	60.00
RFW-14	121.80	Refuse	N/M	---	N/M	---	N/M	---
RFW-15	136.20	Refuse	N/M	---	N/M	---	N/M	---
RFW-16	140.01	Refuse	N/M	---	N/M	---	N/M	---
RFW-17 PZ	136.26 +	Refuse	---	---	---	---	---	---
RFW-18 PZ	133.98 +	Refuse	---	---	---	---	---	---
B-201S	68.08	Org. Silt	13.52	54.56	13.97	54.11	13.58	54.50
B-201D	66.60 *	Outwash	10.30	56.30	5.30	61.30	8.45	58.15
B-202S	62.59	Peat/Silt	5.59	57.00	5.60	56.99	3.28	59.31
B-202D	62.57	Outwash	8.50	54.07	8.27	54.30	6.90	55.67
B-203S	66.96	Org. Silt	5.54	61.42	5.56	61.40	5.00	61.96
B-203D	66.70 *	Outwash	8.04	58.66	7.71	58.99	7.56	59.14
B-205S	63.25	Peat	9.32	53.93	9.93	53.32	7.25	56.00
B-205D	62.30 *	Outwash	6.60	55.70	6.40	55.90	4.80	57.50
LEA3W	62.98	Fill	6.34	56.64	5.26	57.72	5.96	57.02
LEA3E	67.19	Fill	N/M	---	N/M	---	11.25	---
LEA5W	62.21	Fill	6.75	55.46	7.23	54.98	6.87	55.34
LEA5E	69.56	Fill	12.75	56.81	14.41	55.15	14.00	55.56
STR #1(8)	58.95	No. Stream	3.05	55.90	2.98	55.97	2.98	55.97
STR #2(2)	60.51	So. Stream	3.15	57.36	2.90	57.61	2.94	57.57

Table 3-2 Clarkstown Landfill RI - Water Level Elevations in On-Site Monitoring Wells and Piezometers

Well or Piezometer Number	Elevation at Top of Casing	Formation Screened	Date: 4/92		Date: 5/92		Date: 6/92	
			DTW	Elevation	DTW	Elevation	DTW	Elevation
RFW-1S	72.11	Sandy Till	14.28	57.83	14.30	57.81	14.73	57.38
RFW-1D	71.70	Rock	11.80	59.90	12.27	59.43	12.34	59.36
RFW-2	66.20	Sandy Till	7.89	58.31	8.16	58.04	8.62	57.58
RFW-3S	65.28	Sandy Till	6.93	58.35	7.39	57.89	7.39	57.89
RFW-3D	64.89	Rock	4.85	60.04	5.11	59.78	5.00	59.89
RFW-4S	62.51	Peat	5.64	56.87	6.18	56.33	6.11	56.40
RFW-4D	62.83	Outwash	4.10	58.73	4.48	58.35	4.33	58.50
RFW-5S	60.44	Outwash	1.70	58.74	1.83	58.61	1.83	58.61
RFW-5D	60.06	Rock	0.00	60.06	0.18	59.88	0.58	59.48
RFW-6S	69.39	Peat/Silt	10.64	58.75	10.12	59.27	11.62	57.77
RFW-6D	69.86	Outwash	11.01	58.85	11.12	58.74	11.10	58.76
RFW-7S	65.69	Outwash	6.33	59.36	6.40	59.29	6.42	59.27
RFW-7D	65.99	Outwash	6.22	59.77	6.71	59.28	6.71	59.28
RFW-8S	64.77	Peaty Sand	6.82	57.95	7.24	57.53	7.20	57.57
RFW-8D	63.90	Outwash	4.39	59.51	4.55	59.35	4.55	59.35
RFW-9S	66.86	Fill	3.25	63.61	11.41	55.45	5.27	61.59
RFW-9D	66.58	Outwash	6.42	60.16	6.81	59.77	6.60	59.98
RFW-10S	60.67	Outwash	1.15	59.52	2.25	58.42	2.90	57.77
RFW-10D	61.09	Rock	0.00	61.09	0.00	61.09	0.00	61.09
RFW-11	70.57	Rock	10.63	59.94	11.13	59.44	11.25	59.32
RFW-11 PZ1	70.30	Sandy Till	10.52	59.78	11.08	59.22	10.98	59.32
RFW-11 PZ2	70.27	Fill	10.37	59.90	10.90	59.37	11.04	59.23
RFW-12	63.10	Outwash	3.91	59.19	4.12	58.98	4.10	59.00
RFW-13	70.84	Outwash	9.92	60.92	11.06	59.78	10.86	59.98
RFW-13 PZ	70.85	Fill	10.30	60.55	10.84	60.01	10.76	60.09
RFW-14	121.80	Refuse	N/M	---	N/M	---	N/M	---
RFW-15	136.20	Refuse	N/M	---	N/M	---	N/M	---
RFW-16	140.01	Refuse	N/M	---	N/M	---	N/M	---
RFW-17 PZ	136.26 +	Refuse	---	---	---	---	---	---
RFW-18 PZ	133.98 +	Refuse	---	---	---	---	---	---
B-201S	68.08	Org. Silt	15.00	53.08	15.38	52.70	13.10	54.98
B-201D	66.60 *	Outwash	10.00	56.60	9.88	56.72	10.00	56.60
B-202S	62.59	Peat/Silt	5.10	57.49	5.22	57.37	5.34	57.25
B-202D	62.57	Outwash	7.75	54.82	8.48	54.09	8.09	54.48
B-203S	66.96	Org. Silt	5.61	61.35	6.04	60.92	5.00	61.96
B-203D	66.70 *	Outwash	7.34	59.36	7.76	58.94	7.22	59.48
B-205S	63.25	Peat	10.16	53.09	10.26	52.99	10.00	53.25
B-205D	62.30 *	Outwash	6.33	55.97	6.50	55.80	6.50	55.80
LEA3W	62.98	Fill	6.38	56.60	6.81	56.17	N/M	---
LEA3E	67.19	Fill	N/M	---	N/M	---	N/M	---
LEA5W	62.21	Fill	8.37	53.84	7.65	54.56	7.62	54.59
LEA5E	69.56	Fill	16.75	52.81	16.59	52.97	15.00	54.56
STR #1(8)	58.95	No. Stream	2.80	56.15	3.00	55.95	3.00	55.95
STR #2(2)	60.51	So. Stream	2.80	57.71	3.10	57.41	3.15	57.36

Table 3-2 Clarkstown Landfill RI - Water Level Elevations in On-Site Monitoring Wells and Piezometers

Well or Piezometer Number	Elevation at Top of Casing	Formation Screened	Date: 8/92		Date: 11/92		Date: 12/93	
			DTW	Elevation	DTW	Elevation	DTW	Elevation
RFW-1S	72.11	Sandy Till	14.26	57.85	14.00	58.11	13.95	58.16
RFW-1D	71.70	Rock	12.38	59.32	11.54	60.16	11.98	59.72
RFW-2	66.20	Sandy Till	8.16	58.04	7.75	58.45	8.02	58.18
RFW-3S	65.28	Sandy Till	7.67	57.61	7.19	58.09	7.33	57.95
RFW-3D	64.89	Rock	5.45	59.44	5.25	59.64	4.70	60.19
RFW-4S	62.51	Peat	6.53	55.98	5.96	56.55	5.02	57.49
RFW-4D	62.83	Outwash	4.71	58.12	4.31	58.52	4.20	58.63
RFW-5S	60.44	Outwash	1.92	58.52	1.83	58.61	1.56	58.88
RFW-5D	60.06	Rock	0.74	59.32	0.92	59.14	N/M	---
RFW-6S	69.39	Peat/Silt	11.02	58.37	11.75	57.64	11.25	58.14
RFW-6D	69.86	Outwash	11.12	58.74	11.38	58.48	10.80	59.06
RFW-7S	65.69	Outwash	6.50	59.19	6.17	59.52	5.95	59.74
RFW-7D	65.99	Outwash	6.84	59.15	6.46	59.53	6.25	59.74
RFW-8S	64.77	Peaty Sand	7.10	57.67	7.69	57.08	7.41	57.36
RFW-8D	63.90	Outwash	4.78	59.12	4.13	59.77	3.80	60.10
RFW-9S	66.86	Fill	7.82	59.04	6.79	60.07	7.11	59.75
RFW-9D	66.58	Outwash	6.80	59.78	6.38	60.20	5.95	60.63
RFW-10S	60.67	Outwash	2.32	58.35	N/M	---	1.25	59.42
RFW-10D	61.09	Rock	0.00	61.09	0.00	61.09	0.00	61.09
RFW-11	70.57	Rock	11.58	58.99	11.33	59.24	10.47	60.10
RFW-11 PZ1	70.30	Sandy Till	11.00	59.30	10.63	59.67	N/M	---
RFW-11 PZ2	70.27	Fill	11.34	58.93	11.08	59.19	N/M	---
RFW-12	63.10	Outwash	4.38	58.72	4.00	59.10	3.70	59.40
RFW-13	70.84	Outwash	N/M	---	10.92	59.92	10.45	60.39
RFW-13 PZ	70.85	Fill	N/M	---	11.29	59.56	N/M	---
RFW-14	121.80	Refuse	N/M	---	N/M	---	N/M	---
RFW-15	136.20	Refuse	N/M	---	N/M	---	N/M	---
RFW-16	140.01	Refuse	N/M	---	N/M	---	N/M	---
RFW-17 PZ	136.26 +	Refuse	---	---	---	---	---	---
RFW-18 PZ	133.98 +	Refuse	---	---	---	---	---	---
B-201S	68.08	Org. Silt	N/M	---	N/M	---	N/M	---
B-201D	66.60 *	Outwash	N/M	---	10.00	56.60	N/M	---
B-202S	62.59	Peat/Silt	N/M	---	5.00	57.59	N/M	---
B-202D	62.57	Outwash	N/M	---	8.58	53.99	N/M	---
B-203S	66.96	Org. Silt	N/M	---	N/M	---	N/M	---
B-203D	66.70 *	Outwash	N/M	---	N/M	---	N/M	---
B-205S	63.25	Peat	10.17	53.08	9.71	53.54	N/M	---
B-205D	62.30 *	Outwash	6.62	55.68	6.13	56.17	N/M	---
LEA3W	62.98	Fill	N/M	---	5.38	57.60	N/M	---
LEA3E	67.19	Fill	N/M	---	N/M	---	N/M	---
LEA5W	62.21	Fill	8.53	53.68	7.60	54.61	N/M	---
LEA5E	69.56	Fill	11.22	58.34	9.58	59.98	N/M	---
STR #1(8)	58.95	No. Stream	3.00	55.95	2.80	56.15	N/M	---
STR #2(2)	60.51	So. Stream	3.30	57.21	2.90	57.61	N/M	---

Table 3-2 Clarkstown Landfill RI - Water Level Elevations in On-Site Monitoring Wells and Piezometers

Well or Piezometer Number	Elevation at Top of Casing	Formation Screened	Date: 5/94	
			DTW	Elevation
RFW-1S	72.11	Sandy Till	13.94	58.17
RFW-1D	71.70	Rock	11.76	59.94
RFW-2	66.20	Sandy Till	7.91	58.29
RFW-3S	65.28	Sandy Till	7.08	58.20
RFW-3D	64.89	Rock	4.22	60.67
RFW-4S	62.51	Peat	5.86	56.65
RFW-4D	62.83	Outwash	4.09	58.74
RFW-5S	60.44	Outwash	1.46	58.98
RFW-5D	60.06	Rock	0.00	---
RFW-6S	69.39	Peat/Silt	11.20	58.19
RFW-6D	69.86	Outwash	10.62	59.24
RFW-7S	65.69	Outwash	5.83	59.86
RFW-7D	65.99	Outwash	6.06	59.93
RFW-8S	64.77	Peaty Sand	7.24	57.53
RFW-8D	63.90	Outwash	3.95	59.95
RFW-9S	66.86	Fill	8.32	58.54
RFW-9D	66.58	Outwash	6.14	60.44
RFW-10S	60.67	Outwash	1.36	59.31
RFW-10D	61.09	Rock	0.00	61.09
RFW-11	70.57	Rock	10.24	60.33
RFW-11 PZ1	70.30	Sandy Till	10.50	59.80
RFW-11 PZ2	70.27	Fill	10.02	60.25
RFW-12	63.10	Outwash	3.50	59.60
RFW-13	70.84	Outwash	10.40	60.44
RFW-13 PZ	70.85	Fill	10.44	60.41
RFW-14	121.80	Refuse	37.75	84.05
RFW-15	136.20	Refuse	N/M	---
RFW-16	140.01	Refuse	N/M	---
RFW-17 PZ	136.26 +	Refuse	63.00	73.26
RFW-18 PZ	133.98 +	Refuse	52.50	81.48
B-201S	68.08	Org. Silt	N/M	---
B-201D	66.60 *	Outwash	N/M	---
B-202S	62.59	Peat/Silt	N/M	---
B-202D	62.57	Outwash	N/M	---
B-203S	66.96	Org. Silt	N/M	---
B-203D	66.70 *	Outwash	N/M	---
B-205S	63.25	Peat	N/M	---
B-205D	62.30 *	Outwash	N/M	---
LEA3W	62.98	Fill	N/M	---
LEA3E	67.19	Fill	N/M	---
LEA5W	62.21	Fill	N/M	---
LEA5E	69.56	Fill	N/M	---
STR #1(8)	58.95	No. Stream	N/M	---
STR #2(2)	60.51	So. Stream	N/M	---

Notes for Water Level Measurements

1. All Elevations referred to feet above Mean Sea Level(MSL).
2. DTW - Depth to Water from top of casing in feet, N/M - Not Measured.
3. * - Not re-surveyed during RI/FS; estimated elevation based on measured change in elevation of shallow well casing since original survey (1985).
4. LEA = Leachate Collection System Piezometers, LEA3W and LEA5W are on the west side of the collection line, LEA3E and LEA5E are on the east side of the collection line.
5. STR#1(8) is a stream gauge in the North stream near well RFW-8; STR#2(2) is a stream gauge in Muddy Brook near well RFW-2.
6. All wells with "B" prefix were installed by Converse Consultants, Inc.
7. Wells 15&16 are obstructed and can not be measured.
8. + - Wells 17&18 were installed 3/94 and elevations are from ground surface.

3.4.5.2 Horizontal Groundwater Flow

Horizontal groundwater flow patterns observed at the landfill during the RI are inferred from the water table and piezometric surface equipotentials shown in plan on the drawings (Sheets 9 of 11 and 10 of 11). The average groundwater flow direction is inferred to be perpendicular to the contours from areas of greater to lesser hydrostatic head. The groundwater appears to exist in four distinct flow systems: Fill, Peat/Organic Silt aquitard, Outwash/Sandy Till, and Bedrock. The Varved Clay is considered to be part of the Peat/Organic Silt aquitard. The Clayey Till is also considered to be an aquitard lying between the outwash and bedrock.

Based on the drawings, horizontal groundwater flow in the Peat/Silt aquitard and outwash is generally in a westerly to southwesterly direction. Groundwater within the landfill is shown to be mounded with a radial flow pattern leading from the center of the landfill towards the surrounding areas. The groundwater mound height was measured to be approximately five (5) feet higher during the most recent (May 1994) water level measurement round compared to the 1991 data. The calculated average horizontal groundwater flow velocity in the outwash/till based on Darcy's Law is 0.07 feet/day, based on an average permeability of 17.9 feet/day from the slug test results, a measured hydraulic gradient of 0.00125 (June 1991 mapped data, sheet 9 of 11), and an estimated porosity of 0.30. The average horizontal flow velocity in the peat/silt aquitard ranges from 0.02 feet/day to 0.0035 feet/day based on an average permeability of 0.94 feet/day, a porosity of 0.40, and a measured range in hydraulic gradient of 0.0015 to 0.0075 (June 1991 data). Using the most recent data, similar hydraulic gradients and groundwater flow velocities were calculated as those presented in the above analysis.

3.4.5.3 MODFLOW Groundwater Modelling Analysis

Groundwater flow modelling of the leachate mound within the landfill was completed during the FS to evaluate the lowering of the mound height upon landfill capping. The U.S. Geological Survey developed model MODFLOW was utilized for this effort. The modelling results are presented in Appendix B of the Final FS Report.

3.4.6 Geotechnical Soil Sampling Results and Landfill Slopes Stability

3.4.6.1 Geotechnical Soil Sampling Results

The results of the physical testing of subsurface soils are summarized in Table 3-3. The raw data are presented in Appendix E. The results of these tests were used to classify the subsurface soils beneath the landfill according to the Unified Soil Classification System (USCS) and to calculate basic soil properties (such as void ratio, porosity and degree of saturation) from basic weight/volume relationships for use in the various soils stability analyses completed as part of the RI (See Appendix F). The test results were used to help define stratigraphic correlations between the various subsurface geologic deposits shown on the cross-sections on sheets 3 of 11 through 6 of 11. The data were also used as indices and cross checks to soil engineering properties such as permeability, compressibility and shear strength.

As expected, extremely low vertical permeabilities were measured in the laboratory on samples of the peat, organic silt, and varved clay. The vertical permeability ranged from a high of 6.71×10^{-7} cm/sec to a low of 7.55×10^{-8} cm/sec, as shown on Table 3-3. One of the lowest values (9.78×10^{-8} cm/sec) was reported for boring RFW-15 located in the center of the landfill. This datum supports the conclusion that the weight of the landfill mass has the effect of consolidating the underlying fine-grained soils and, thereby, further reducing their permeabilities. The fibrous peat samples reported the highest organic content, ranging from 30.9 to 91.6 percent (dry basis). The organic silt reported the next highest organic content with a more uniform range of 10.8 to 35.6 percent, while the varved clay had the lowest organic content at less than 7.4 percent. Of the fine grained soils, the peat has the greatest capacity to attenuate organic compounds present in the leachate.

When used in conjunction with information on the clay mineral composition in the geologic materials, the cation exchange capacity (CEC) data can be used to determine the ability of the soils under the landfill to naturally attenuate metals content in leachate. Although actual sampling to determine clay mineralogy was not completed, the types of clays present were inferred from the gamma ray log for boring RFW-B7 (See Appendix E). The log suggests the

Table 3-3
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Subsurface Soil Sample Physical Testing Schedule
Clarkstown Landfill RI

SAMPLE #	DESCRIPTION	DEPTH	TOTAL ORG. CONTENT (% dry basis)	MOISTURE CONTENT (% dry basis)	CEC (meq/100g)	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	SPECIFIC GRAVITY	VERT. PERM.	GRAIN SIZE	STRENGTH UU	STRENGTH CIU	CONSOLIDATION TESTING
<u>Phase I Subsurface Soil Sampling Program</u>														
RFW-1S-SS8	Dk. Orange Bn. Sand	20-22		13.4	18.1				2.77		App			
RFW-2-SS11	Red. Bn. vwd. Clay	20-22	0.90	39.0		26.9	32.25	5.35			App			
RFW-2-SS13	Bn. Sand	28-28		8.9										
RFW-3D-SS5	Dk. Bn. Peat	12-14	56.6	317.7					2.75		App			
RFW-3D-SS13	Red. Bn. Sand & Gravel	32-34		8.2							App			
RFW-4D-SS14	Dk. Red. Bn. Gravel	38-40		14.8						4.21E-7	App			
RFW-4S-SH2	Fibrous Peat	15-17.5		472.6		213.1	228.5	15.4						
RFW-4S-SH3	Dk. Bn. Organic silt	17.5-20	37.2											
RFW-4D-SH2	Bn. Clayey Silt	21-23												
RFW-4D-SH3	Bn. Organic Clay	23-26							2.83	2.15E-7				
RFW-4D-SH4	Red. Bn. vwd. Clay & Silt	26-28	1.4	47.6										
RFW-4D-SH5	Red. Bn. vwd. Clay & Silt	28-30												
RFW-5D-SS4	Dk. Bn. Peat	6-8	76.6	538.1										
RFW-5D-SS5	Red. Bn. Clay	18-21		44.1										
RFW-5D-SS7	Red. Bn. Clay	23-25	1.41	47.2		23.74	29.0	5.26						
RFW-5D-SS15	Brown Fine Sand	39-41			10.1									
RFW-5D-SS16	Red. Bn. Fine Sand	41-43		22.1					2.69		App			
RFW-5D-SH3	Bn. & Gry. Silty Clay	13-15.5												
RFW-5D-SH4	Bn. & Gry. Clay	15.5-18	2.15	65.3							App			
RFW-6S-SS11	Bn. Clayey silt	24-26	3.2	39.7										App(w/6D-SH1)
RFW-6S-SH1	Dk. Bn. Organic Silt	20-22		(262.9)										
RFW-6D-SS9	Dk. Red. Brown Till	49-51		12.4							App			App(w/6S-SH1)
RFW-6D-SH1	Dk. Bn. Organic Silt	22-24	23.4	138.1(53-92.5)										

Notes

App = Grain size distribution curve and other raw data provided in Appendix.

Table 3-3
(Page 2 of 3)

Subsurface Soil Sample Physical Testing Schedule
Clarkstown Landfill RI

SAMPLE #	DESCRIPTION	DEPTH	TOTAL ORG. CONTENT (% dry basis)	MOISTURE CONTENT (% dry basis)	CEC (meq/100g)	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	SPECIFIC GRAVITY	VERT. PERM.	GRAIN SIZE	STRENGTH UU	STRENGTH CIU	CONSOLIDATION TESTING
Phase I Subsurface Soil Sampling Program (Cont'd)														
RFW-7A-SH1-1	Fibrous Peat	16-18		387.4					2.11	1.45E-7				
RFW-7A-SH1-2	Gray Silty Sand	16-18		62.6					2.27	6.71E-7				
RFW-7B-SH1	Dk. Bn. Organic silt	24-26		(268.1-328.3)									App	
RFW-7B-SH2	Dk. Bn. Organic Silt	26-28	10.8	96.0(92.9-114.2)								App		
RFW-7S-SS3	Red. Bn. Silt	54-56		23.5					2.76		App			
RFW-7S-SH3	Dk. Bn. Organic Silt	30-32.5		104.6					2.47	7.55E-8				
RFW-7S-SH4	Brown Silt	32.5-35												
RFW-7S-SH5	Red. Bn. vvd. Clay & Silt	46-48.5												
RFW-7D-SS8	Red. Bn. S&G & Clay Silt	80-82		15.1	20.7						App			
RFW-7D-SH4	Dk. Bn. Organic Silt	30-32.5		104.8				14.8	2.47		App			
RFW-7D-SH5	Dk. Bn. Organic Silt	32.5-35		(41.6-54.5)								App		
RFW-7D-SH6	Dk. Bn. Organic Silt	35-37.5												
RFW-B7-SS15	Dk. Bn. Clay	34-38	0.92	40.6					2.74					
RFW-8D-SS9	Dk. Bn. Fibrous Peat	16-18	72.3	354.2	39.3				2.58		App			
RFW-8D-SS16	Dk. Bn. Organic Silt	32-34	17.7	150.4										
RFW-8D-SS17	Dk. Bn. Organic Silt	38-40	20.1	174.6	23.2	108.3	121.8		2.56		App			
RFW-8D-SS20	Gray Silty Clay	44-46	7.4	74.8		51.4	52.1		2.71		App			
RFW-8D-SS21	Brown Silty Clay	54-56	2.1	45.3	9.6	32.8	33.9		2.72		App			
RFW-8D-SS24	Gray & Red. Bn. Clay	60-62	2.7	54.0										
RFW-8D-SS25	Red. Bn. vvd. Clay	62-64				26.0	34.7		2.79		App			
RFW-8D-SS26	Red. Bn. vvd. Clay	84-86			6.8									
RFW-8D-SS27	Red. Bn. vvd. Clay	66-68	1.3	35.8										
RFW-8D-SS41	Red. Bn. Sand & Gravel	94-96		10.3					2.71		App			
RFW-8D-SH1	Dk. Bn. Organic Silt	34-36		(121.7-205.4)									App	
RFW-8D-SH2	Dk. Bn. Organic Silt	36-38												
RFW-8D-SH3	Gray Green Silty Clay	46-48.5		(52.8-67.8)									App(w/8D-SH4)	
RFW-8D-SH4	Gray Green Silty Clay	48.5-51	3.5	56.8(62.5)									App(w/8D-SH3)	

Notes

App = Grain size distribution curve and other raw data provided in Appendix.

Table 3-3
(Page 3 of 3)
Subsurface Soil Sample Physical Testing Schedule
Clarkstown Landfill RI

SAMPLE #	DESCRIPTION	DEPTH	TOTAL ORG. CONTENT (% dry basis)	MOISTURE CONTENT (% dry basis)	CEC (meq/100g)	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	SPECIFIC GRAVITY	VERT. PERM.	GRAIN SIZE	STRENGTH UU	STRENGTH CU	CONSOLIDATION TESTING
<u>Phase I Subsurface Soil Sampling Program (Cont'd)</u>														
RFW-8D-SH5	Brown Silty Clay	51-53.5			14.2									
RFW-9D-SS3	Red Bn. Sand	47-49		9.6					2.76		App			
RFW-9D-SS4	Red Bn. Sand	49-51		6.0							App			
RFW-9D-SS6	Red Bn. Clay, Silt	62-64												
RFW-10S-SS5	Dk. Bn. Fibrous Peat	8-10	91.6	710.5										
RFW-10S-SS8	Lt. Bn. Fibrous Peat	14-16	33.3	493.3										
RFW-10S-SS10	Pale Red Silty Clay	18-20	2.5	52.9										
RFW-10S-SS11	Red Bn. vvd. Clay & Silt	20-22	1.3	51.8										
RFW-10D-SS7	Dk. Bn. Sand & Gravel	60-62		7.7					2.71		App			
RFW-10D-SH2	Lt. Bn. Fibrous Peat	16-18.5												
RFW-14-SH1	Dk. Bn. Organic Silt	92-94.5	35.6	211.3		126.0	136.0	8.0						
RFW-14-SH2	Bn. & Gry. Silty Clay	110-112.5	1.8	37.9										
RFW-15-SH1	Dk. Bn. Organic Silt	120-122	23.9	85.0		139.9	173.0	33.1	2.47	9.78E-8	App			
RFW-15-SH2	Gry. & Bn. Silty Clay	144-146.5												
RFW-16-SH1	Bn. & Gry. Silty Clay	96-98	2.4	47.7		19.0	31.1	12.1	2.71		App			
<u>Phase II Subsurface Soil Sampling Program</u>														
GTB-ST1	Red Bn. vvd. Clay	94-96	1.0	33.1		21	31	10			App	App	App	App
GTB-S11	Fibrous Peat	86-88		254.9										
GTB-S12	Fibrous Peat	88-90	30.9	338.3		187	192	5					App	
GTA-ST3	Dk. Bn. Organic Silt	112-114	19.1	181.8		105	156	51			App			App
GTA-ST8	Red Bn. vvd. Clay	134.5-136.5	1.6	31.4		20	31	11			App	App		

Notes

App = Grain size distribution curve and other raw data provided in Appendix.

presence of predominant potassium-rich clays, such as illite, in the peat, organic silt, and varved clay layers. The CEC data support this conclusion. The measured CECs range from 6.8 to 39.3 milliequivalents sodium per 100 grams (meq/100g). Most of the samples reported CECs of less than 25 meq/100g which are typical of illitic clays.

The only minerals that exhibit high cation exchange capacities are zeolites, manganese oxides, and clay minerals (Carroll, 1959). Of these, only clay minerals are abundant in most natural sedimentary environments. Therefore, it is assumed that the cation exchange capacity of the Clarkstown Landfill samples is a function of the clay minerals present in each sample. These data imply there is little cation exchange in the sediment beneath the landfill. However, the cation exchange that does occur is enhanced by the extensive areal distribution and thickness of the fine-grained deposits which exceeds twenty feet over approximately 75 percent of the site. The fibrous peat reported the highest exchange capacity (39.3 percent) and, therefore, has the greatest capacity to attenuate metals concentrations in the leachate.

3.4.6.2 Landfill Slopes Stability

As part of the RI, landfill slope stability issues have been evaluated in preparation for the planned closure of the Clarkstown Landfill. The landfill is underlain by varying thicknesses of fine-grained, compressible soils which are inherently weak under natural conditions. These soils undergo a gain in strength over time under a landfilled mass, due to compression of soils and reduction of soil pore water pressures. The proposed closure could consist of capping of the landfill with up to five (5) feet of cover materials as required by NYSDEC Part 360 Solid Waste regulations. It has been suggested by the NYSDEC that surcharging the existing waste mass and underlying fine grained soil layers by the weight of this final cover system could affect the short-term stability of these soils and, hence, the landfill side slopes. Numerous reports were prepared by WESTON during the remedial investigation addressing landfill slope stability issues. These reports are presented in Appendix F for reference, and are summarized below.

An evaluation of the existing topography of the landfill and the subsurface stratigraphy identified the presence of four (4) critical cross-sections with respect to slope stability of the landfill mass (WESTON, 1991). The most critical cross-sections were identified as those with potential slope instabilities caused by greater heights and steeper slopes than other areas, in combination with the presence of thicker deposits of the weaker site soils (peat, organic silt and varved clay). Factor of Safety (FS) values were evaluated using the Modified Bishop Method of Slices STABL2 Slope Stability computer program at three critical cross-sections under both undrained (short-term) and drained (long-term) soil and waste shear strength conditions. The fourth cross-section was not evaluated because it was determined to only have an unfavorable slope (2.5 Horizontal:1 Vertical).

The FS values for the undrained soil shear strength conditions indicated acceptable values at only two locations. These values were subsequently reduced to marginally acceptable values once the respective slopes were subjected to loads simulating the final cover system. The FS values for the drained soil shear strength conditions indicated marginally acceptable values. These values subsequently increased once the slopes were subjected to loads simulating the final cover system. The effects of a design earthquake event evaluated for the long-term stability condition on the most critical cross-section indicated acceptable values for the final anticipated configuration of the landfill.

The results of the slope stability analyses indicated that it would be possible to construct the final cover system without initiating slope failure of the landfill mass. However, it was also noted that the FS values for undrained soil shear strength conditions (which govern the stability of the landfill side slopes in the short term following cap construction) indicated marginal to unacceptable conditions. To compensate for the less than desirable FS values, WESTON proposed:

- The use of geosynthetics as a substitute for some of the earthen components of the final cover system. While reducing the thickness and weight of the final cover system, this could minimize the reduction in FS values which typically occur in the short term following cap construction during undrained soil shear strength conditions.

- The flattening of areas of the landfill steeper than 3Horizontal:1Vertical to increase stability values.
- Staging the construction of the final cover system to allow the dissipation of unfavorable excess pore water pressures, and to allow the consolidation of wastes/soils to occur so as to develop increased soil strengths.
- The consideration of a toe-of-slope buttressing berm along the northern edge of the landfill.

The NYSDEC subsequently requested WESTON to:

- Perform additional stability analyses for the case of undrained shear strength conditions in the soils in combination with drained shear strength conditions in the waste mass, and
- Evaluate and recommend measures to increase the FS values on the north and east sides of the landfill.

In a subsequent report (WESTON, 1992) and following a request from the NYSDEC, WESTON determined that while the use of toe-of-slope buttressing berms along the north and east sides of the landfill could be used to increase the FS values to acceptable levels, the economics of these options were unfeasible.

A re-evaluation of the initial slope stability analysis for the two critical cross-sections was subsequently performed to determine if a less conservative approach to this analysis could be utilized (WESTON, 1993). Based upon this re-evaluation, improved minimum FS values for the final capped scenario for the two cross-sections were calculated utilizing the undrained soil shear strength values in combination with drained shear strength values.

The unacceptable minimum FS values increased upon re-analysis to marginally acceptable levels. This was accomplished by accounting for strength gain in the portion of the fine-grained soil layers underlying the landfill and the results from the consolidation of these materials from the weight of the overlying waste. The strength gain was quantified using an empirically derived

relationship between undrained cohesion, effective vertical overburden pressure, and plasticity index. As the FS values were only marginally acceptable, it could not be concluded that the landfill could be safely capped without the need for the toe buttressing berm or other similar stabilizing measures to safeguard against slope instabilities.

NYSDEC requested that a "value engineering" analysis be performed to verify the results obtained by WESTON. The Town of Clarkstown hired Woodward-Clyde Consultants for this task. Although opinions differed slightly between WESTON and Woodward-Clyde on the factors most affecting slope stability, both firms agreed that additional data was required to determine what actions, if any, were necessary. It was determined that data from directly beneath the main landfill mass were required. Up to that point, data were only obtained for samples collected from the toe of the landfill where the benefit of gain in soil strength due to consolidation would not have occurred compared to the center portions of the landfill.

Therefore, WESTON proposed in the Amendment to the Work Plan and SOP (WESTON, November 1993) to conduct laboratory shear strength testing on samples of the peat, organic silt and varved clay soil layers from test borings to be drilled near the two critical cross-sections. If the results from these tests indicated FS values greater than 1.3, the landfill could be safely capped without the need for a toe buttressing berm or other stabilizing measures. The results of these tests are provided in Appendix A of the accompanying Final Feasibility Study Report, as a new report "Stability Analysis for Clarkstown Sanitary Landfill."

3.5 Drinking Water Supplies

A review of groundwater usage near the landfill was completed through telephone discussions with the Rockland County Health Department and local potable water suppliers, and a review of published reports. Area residents receive their potable water supply from the Spring Valley Water Company and the Village of Nyack Water District. Spring Valley Water Company obtains water from Lake DeForest; the Village of Nyack obtains water from the Hackensack River. Water suppliers in New Jersey obtain potable water from the Tappan Reservoir located

about 1.5 miles downstream of the confluence of Greenbush Brook and the Hackensack River. The nearest public water supply well field is operated by Spring Valley Water Company and is located approximately 2.5 miles to the west of the landfill.

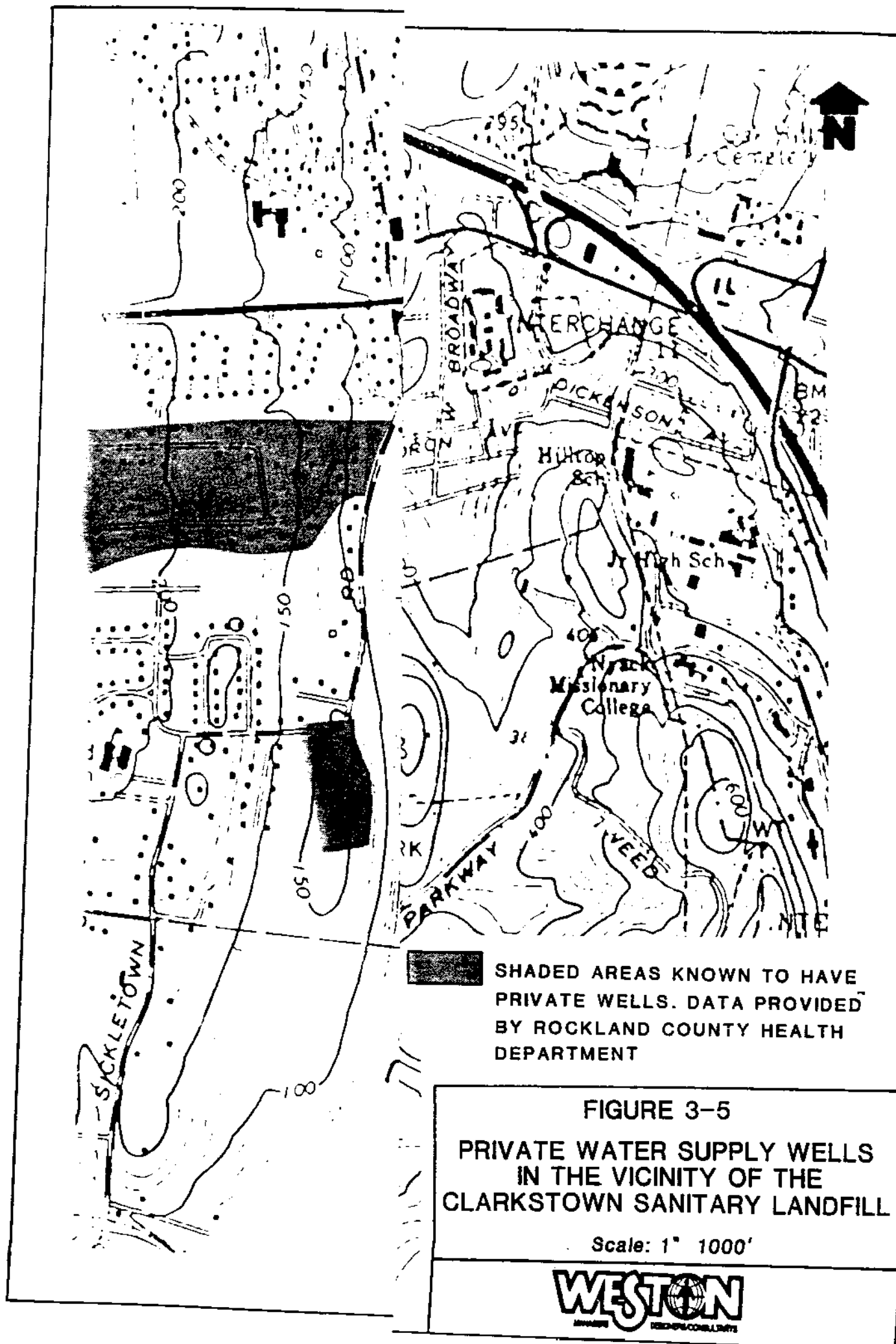
Rockland County Health Department reported that private domestic wells exist along Western Highway and Tompkins Avenue on the western side of the Hackensack River, Pine View Road to the west of the landfill and Greenbush Brook, East Greenbush Road south of the landfill and west of Bradley Parkway. Two commercial non-potable supply wells are known to exist in proximity to the landfill, one at the car wash north of the landfill on Route 59 and one on Birchwood Drive at Douglaston Electric just south of the landfill, as shown on Figure 3-5. The Pine View Road wells are no longer used for potable purposes, for the reasons discussed in Section 1.2.3.

These domestic and commercial wells are not likely to be located in areas which might be impacted by any landfill-derived groundwater. The public supply wellfield and the wells located along Western Highway and Tompkins Avenue are located on the opposite side of the "Clarkstown Basin" and the Hackensack River, the regional hydrologic divide, from the landfill. The wells south of the landfill are located on property lying at higher elevations and are inferred to be upgradient of the landfill.

3.6 Ecology

3.6.1 Record Search

A record search was performed to assess existing background information pertaining to the wetlands surrounding the Clarkstown Sanitary Landfill. This included gathering various maps, accessing databases, conducting phone conversations with regulatory agencies, civic groups, and concerned citizens; as well as reviewing environmental reports regarding this area. The results of this effort are presented below.



3.6.2 National Wetlands Inventory Map

The National Wetlands Inventory map for Nyack, NY (See Figure 3-6) was reviewed for the presence, extent and type of wetlands surrounding the Clarkstown Sanitary Landfill. Wetland inventory maps are prepared primarily by stereoscopic analysis of high altitude aerial photographs. Wetlands are identified on these photographs by vegetation, visible hydrology and geography. Wetlands noted for the area surrounding the Clarkstown Sanitary Landfill are PFO1, palustrine forested, broad-leaved deciduous wetlands, POW, palustrine open water, unknown bottom wetlands and PEM, palustrine emergent wetlands.

3.6.3 New York State Department of Environmental Conservation (NYSDEC) Freshwater Wetlands Map

The NYSDEC has mapped wetland areas in Rockland County near the landfill shown on the New York State Freshwater Wetlands Map, Rockland County, Map 8 of 9, 1987, (identified as wetlands NA-4, NA-5, and NA-11 on Figure 1-1). The wetland surrounding Clarkstown is labelled as NA-4 which is a number used for identification purposes. This wetland is approximately 100 acres in size and borders the Hackensack River between Route 59 and Western Highway, and extends well to the east and south of the river. This wetland system has been classified as Class I by the NYSDEC according to Part 664 of 6 NYCRR. In order to be designated as Class I, a system must be found to have at least one of the following wetland characteristics: 1) classic kettle hole bog, 2) resident habitat of endangered species, 3) supports animal species in diversity or abundance for New York State, 4) prevents significant flooding of a substantially developed area, and 5) has four or more Class II characteristics. Characteristics 4 and 5 most likely apply to the wetland system contiguous with the Clarkstown Sanitary Landfill. The following Class II characteristics apply to this wetland: 1) emergent marsh with less than two-thirds common reed (*Phragmites australis*) disturbance, 2) contains two or more wetland structural groups, 3) associated with permanent open water outside the wetland (Lake DeForest) and 4) adjacent or contiguous to a stream classified as C(t) or higher, according to Environmental Conservation Law (ECL) Article 15. In addition to these

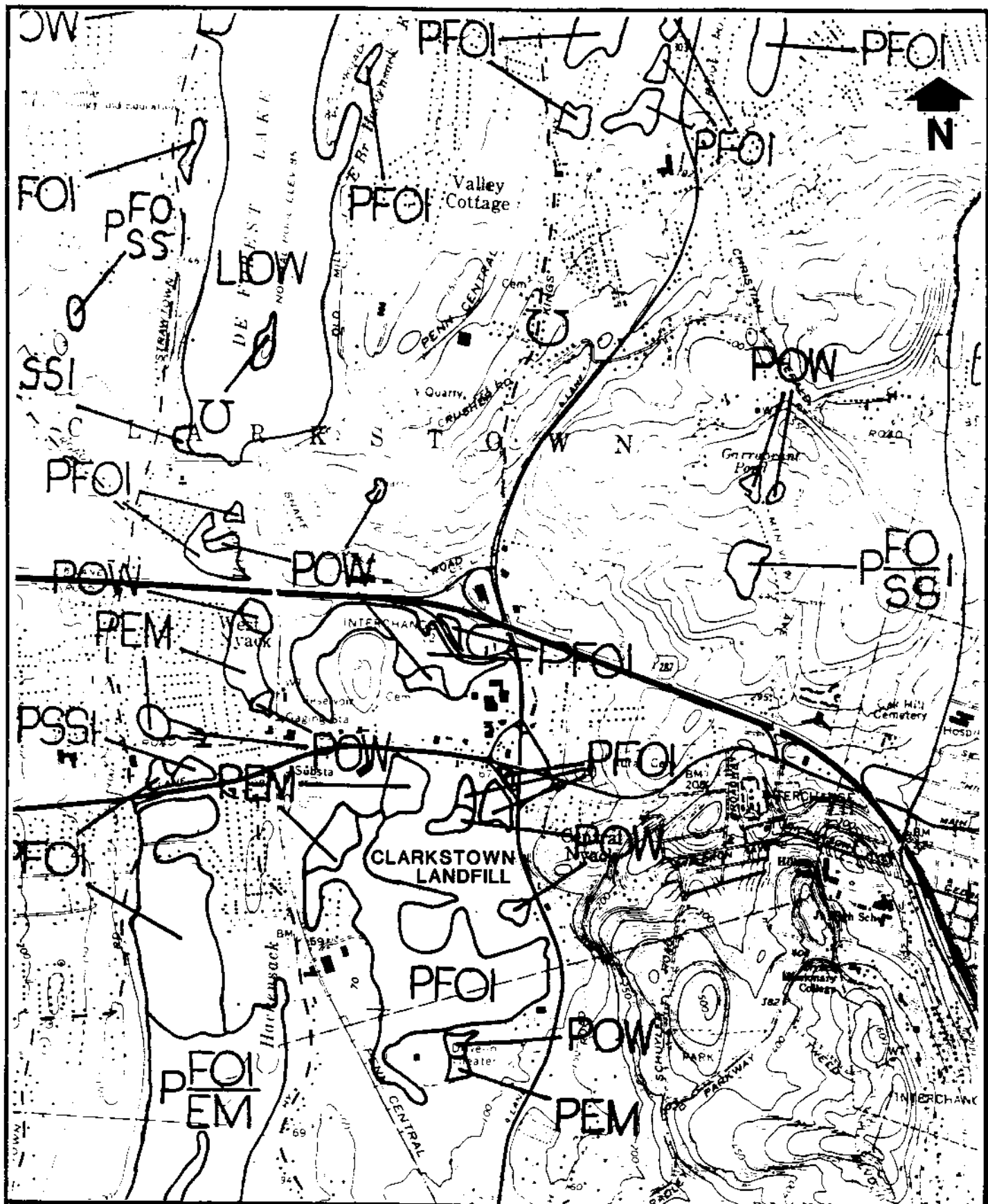


FIGURE 3-6
NATIONAL WETLANDS INVENTORY
MAP FOR NYACK, NY

characteristics, the following wetland benefits under ECL Article 24, may be provided by this wetland system: 1) flood and storm control, 2) wildlife habitat, 3) recreation, 4) pollution treatment, 5) erosion/sedimentation control, 6) open space/ aesthetics, 7) nutrient sources, and 8) fish habitat.

3.6.4 New York Natural Heritage Database Information/Significant Habitats

The NYSDEC defines a significant habitat as follows: "Habitats are significant if they provide some of the key factors required for the survival, variety or abundance of wildlife, and/or human recreation associated with such wildlife." Correspondence with the NYSDEC Information Services in Latham, New York indicates that there are no endangered, rare or species of special concern nor are there any habitats of significance in or around the wetlands surrounding the Clarkstown Landfill. (The record of correspondence is provided in Appendix E).

3.6.5 Vegetative, Wildlife and Fish Species

Vegetative, wildlife and fish species identified by WESTON during field observations in August of 1990 presented as Tables 3-4 and 3-5 located at the end of this section. It should be noted that these lists are in no way conclusive, nor comprehensive of the vegetative and wildlife species occurring in the wetlands surrounding the Clarkstown Landfill. Observations were not made on a continual, daily basis throughout the year. Additional lists (Table 3-6, Table 3-7 and Table 3-8) are included also at the end of this section which were obtained from "Draft Environmental Impact Statement (DEIS) Hackensack River Drainage Improvement Project, Town of Clarkstown, Rockland County, New York "prepared by Kozma Associates and Carpenter Environmental Associates, Inc. These lists were used to supplement WESTON's observations and findings.

3.6.5.1 Vegetative Lists

Three vegetative species identified by WESTON, as shown on Table 3-4, are listed as "exploitly vulnerable" in the publication "Protected Native Plants" dated March, 1990 published by the New York State Department of Environmental Conservation. These plants are Black alder *Ilex verticillata*, Cinnamon fern *Osmunda cinnamomea*, and Royal fern *Osmunda regalis*. Exploitly vulnerable is defined as "native plants likely to become threatened in the near future throughout all or a significant portion of their ranges within the State if causal factors continue unchecked."

3.6.5.2 Wildlife Lists

Wildlife noted by WESTON in the wetlands surrounding the Clarkstown Landfill are listed in Table 3-5. These animals were identified by the presence of tracks, scat, or by visual observations. There were no endangered, threatened or species of special concern identified per the NYSDEC list. Wildlife common to Rockland County is listed in Table 3-7. This list was taken from the report "Draft Environmental Impact Statement (DEIS) Hackensack River Drainage Improvement Project, Town of Clarkstown, Rockland County, New York" prepared by Kozma Associates and Carpenter Environmental Associates, Inc.

3.6.5.3 Fish Species Lists

A fish survey was not part of the scope of the Clarkstown Landfill RI/FS. However, fish species information was made available and is presented here to further document the ecological health of the Hackensack River and its tributaries. This information was obtained from the report "Draft Environmental Impact Statement (DEIS) Hackensack River Drainage Improvement Project, Town of Clarkstown, Rockland County, New York" prepared by Kozma Associates and

Carpenter Environmental Associates, Inc. Conversations with members of the NYSDEC staff and local concerned citizens have led to the formation of a fish species list which is presented in Table 3-8.

There are no fish recently identified as being endangered, threatened or of special concern. Two fish surveys were performed in 1936 and in 1984 by New York State Conservation officials. Four species identified in the Lake Tappan survey in 1984 are identified in the 1936 survey (see Table 3-8). The mud sunfish (*Acantharcus pomotis*), which is currently listed as "threatened", was observed in 1936 but not during the 1984 survey. These species are white sucker (*Catostomus commersoni*), pumpkinseed, (*Lepomis gibbosus*), bluegill (*Lepomis macrochirus*) and golden shiner (*Notemigonus chrysoleucas*). All four of these species prefer standing water and quiet streams with weedy soft bottoms. The white sucker is tolerant of siltation, turbidity and is able to survive in low oxygenated water. The blue-spotted sunfish also lives in waters where the oxygen content is low.

Species that were included in the 1984 survey but not in the 1936 survey are carp (*Cyprinus carpio*), largemouth bass (*Micropterus salmoides*), white perch (*Morone americana*) and yellow perch, (*Perca flavescens*). The most interesting addition is the introduction of the carp. Carp prefer streams, lakes and shallows with an abundance of organic matter. Carp are tolerant of all bottom types and prefer either deep or turbid water. Carp tolerate low oxygen levels and extreme variations in temperature. These fish are large and numerous in the Hackensack River and the tributaries that compose the wetlands. WESTON personnel observed several carp during the Phase I and II surface water/sediment sampling events and while moving through the channels via canoe during the natural resource inventory.

3.6.5.4 Vegetative Communities

There are 16 identified ecological communities present at or around the Clarkstown Sanitary Landfill. These ecological communities were identified by visual observations during site reconnaissance in August of 1990 and are reported per "Ecological Communities of New York State, March 1990" published by the New York Natural Heritage Program, NYSDEC. A description of these communities is discussed below and their locations are depicted on Figure 3-7.

Terrestrial System

The terrestrial system consists of upland habitats including the following Terrestrial Cultural and Open Uplands subsystems. These habitats have well-drained soils that are dry to mesic and vegetative cover that is never predominantly hydrophytic, even if the soil surface is occasionally or seasonally flooded or saturated. This is a broadly defined system that includes everything except aquatic, wetland, and subterranean communities.

Terrestrial Cultural

This subsystem includes communities that are either created and maintained by human activities, or are modified to such a degree that the physical conformation of the substrate, or the biological composition of the resident communities is substantially different from the character of the substrate or community as it existed prior to human influence. This subsystem includes the following Landfill/Dump, Construction/Road Maintenance Spoils, Junkyard, and Unpaved Roads/Paths communities.

Landfill/Dump (13)

The Clarkstown Landfill is classified as a landfill/dump which is a site that has been cleared or excavated and where garbage is disposed. The bulk of the material in the landfill is organic and

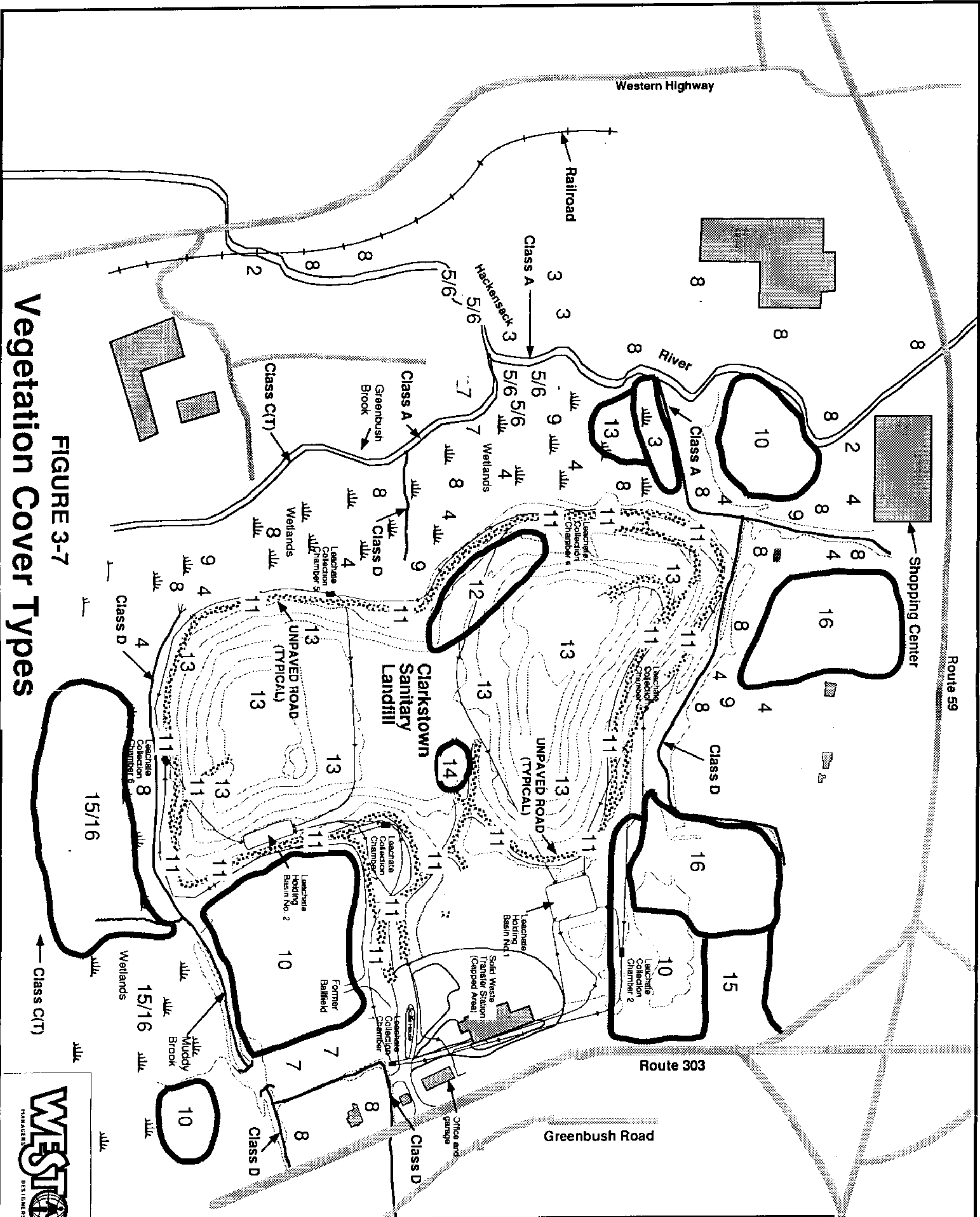
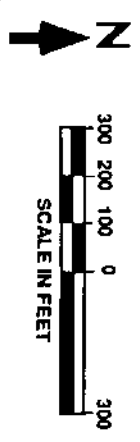


FIGURE 3-7
Vegetation Cover Types



LEGEND	
RIVERINE SYSTEM	
1=Marsh Headwater Stream	
2=Main Channel Stream	
3=Backwater Slough	
4=Intermittent Stream	
PALUSTRINE SYSTEM	
Open Mineral Soil Wetlands	
5=Deep Emergent Marsh	
6=Shallow Emergent Marsh	
7=Shrub Swamp	
Forested Mineral Soil Wetlands	
8=Red Maple-Hardwood Swamp	
9=Silver Maple-Ash Swamp	
PALUSTRINE CULTURAL	
15=Impounded Swamp	
16=Reedgrass/Purple Loosestrife Marsh	
TERRESTRIAL SYSTEM	
Open Uplands	
10=Successional Old Field	
Terrestrial Cultural	
11=Unpaved Road/ Path	
12=Construction/Road Maintenance Spoils	
13=Landfill/ Dump	
14=Junkyard (White Goods)	

MANAGED DESIGNERS/CONSULTANTS

Drawn By	JL.F
Checked By	GTS
Date	6/1/91
Revised	8/19/94
FileName	ClarkstownBasinMap
Job No.	3228-10-01-0148

biodegradable, although some inorganic material is present. The area classified as landfill/dump is designated in Figure 3-7.

Construction/Road Maintenance Spoils (12)

The landfill has, in the western portion, an area where construction/road maintenance spoils are deposited. This is another ecological community where there is little if any vegetation.

Junkyard (14)

At the time of creation of this figure, in the east-central portion of the landfill existed an area where "white goods", such as large appliances and machinery parts, were stored. As of 1991, this area no longer exists.

Unpaved Roads/Paths (11)

Throughout the landfill are unpaved roads/paths which are is classified as an ecological unit by the NYSDEC. This unit consists of sparsely vegetated roads or pathways of gravel, bare soil or bedrock outcrops. These roads or pathways are maintained by regular trampling or scraping of the land surface. The substrate consists of the soil or parent material at the site, which is modified by garbage fill. The areas surrounding the Clarkstown Landfill have diverse ecological communities which are described below.

Open Uplands

This open upland subsystem includes upland communities with less than 25% canopy cover of trees; the dominant species in these communities are shrubs, herbs or cryptogrammatic plants (mosses, lichens, etc.). This subsystem includes the following successional Old Field community.

Successional Old Field (10)

The successional old field community occurs in four distinct areas near the Clarkstown Landfill which are noted on Figure 3-7. Old field #10a occurs behind the abandoned shopping center. This area was dominated by rose and goldenrod. Old field #10b located near Route 303 is dominated by Phragmites, Japanese bamboo, goldenrod, Queen Anne's lace, swamp smartweed, groundsel tree, red ash, purple loosestrife, staghorn sumac, common pliantain, birdsfoot trefoil and tartarian honeysuckle. The former ballfield is old field #10c. This area is dominated by panic grasses, eggs n' butter, nut grass, and fleabane. Old field #10d was surrounded by a border of thick phragmites and purple loosestrife which open up to a field dominated by goldenrod, fleabane, crown vetch, strawberry, Queen Anne's lace and purple loosestrife. Old field communities are relatively short-lived and succeed to a shrubland, woodland or forest community.

Palustrine System

The palustrine system consists of non-tidal perennial wetlands characterized by emergent vegetation. The system includes wetlands permanently saturated by seepage, permanently flooded wetlands, and wetlands that are seasonally or intermittently flooded (these may be seasonally dry) if the vegetative cover is predominantly hydrophytic and soils are hydric. This system includes the following Open Mineral Soil Wetlands, Forested Mineral Soil Wetlands, and Palustrine Cultural Subsystems.

Open Mineral Soil Wetlands

This subsystem consists of wetlands with less than 50% canopy cover of trees including the following Shrub Swamp, Deep Emergent Marsh, and Shallow Emergent Marsh communities. The dominant vegetation may include shrubs or herbs. Substrates range from mineral soils or bedrock to well-decomposed organic soils (muck). Fluctuating water levels allow enough

aeration of the substrate to allow plant litter to decompose, so there is little or no accumulation of peat.

Shrub Swamp (7)

Two areas that occur near the Clarkstown Landfill can be classified as shrub swamp. This ecological community is an inland wetland dominated by shrubs that in this case occur along the shore of the Hackensack River, in wet depressions or as a transition to an upland community. The substrate is usually mineral soil or muck. The shrub swamp communities found at Clarkstown Landfill are dominated by buttonbush. Shrub swamp #7a was found near surface water/sediment sampling point #9 on the Hackensack River. Buttonbush was dominating the shoreline with an herbaceous understory of pickerelweed and pond lily. Shrub swamp #7b occurred on the eastern portion of ecological community #10C (old field). Here, the shrub swamp community was found in a low flow area of a tributary connecting two streams originating from Route 303. These two streams are the locations for surface water/sediment sampling points #1 and #2. In community #7b, buttonbush and red osier dogwood are dominating with an overstory of cottonwood and red maple. Herbaceous plants found here include jewelweed and arrow arum.

Deep Emergent Marsh (5)

From the crossing of Western Highway to past surface water/sediment sampling point #9, the Hackensack River can be classified as a deep emergent marsh. This marsh community occurs on fine-grained organic soils (muck or well-decomposed peat), the substrate is flooded by waters that are not subject to violent wave action. Water levels here fluctuate seasonally and are affected by releases from the Lake Deforest Reservoir located upstream and there is standing water throughout the year. Vegetation noted for this community includes the dominant emergent plant, pickerelweed associated with pond lily and arrow arum. Included in the open water areas are clumps of swamp rose mallow and small patches of purple loosestrife. It should be noted that no canopy exists here. On the banks of the Hackensack River in this area is pin oak, red

maple, weeping willow, black locust, black willow , ash-leaved maple and quaking aspen. Herbaceous plants found on the banks include jewelweed, bog hemp, false nettle, cattails, arrow-leaved tear thumb, wild rye and blueflag.

Shallow Emergent Marsh (6)

The area around where the Greenbush Brook meets the Hackensack River can be classified as Shallow Emergent Marsh. This marsh meadow community occurs on mineral soil or muck soils that are permanently saturated and seasonally flooded. This marsh area is better drained than the deep emergent marsh; water depths may range from 6 inches to 3.3 feet during floor stages, but the water level usually drops by mid to late summer and the substate is exposed. Shallow emergent marshes typically occur along streams.

Deep and shallow emergent marshes often integrate, and they may occur together in a complex mosaic in a large wetland.

Forested Mineral Soil Wetlands

This subsystem includes seasonally flooded forests, and permanently flooded or saturated swamps. These forests and swamps typically have at least 50% canopy cover of trees and include the following Red Maple-Hardwood Swamp and Silver Maple-Ash Swamp communities.

Red Maple-Hardwood Swamp (8)

The most dominant wetland community at the Clarkstown Landfill is the red-maple hardwood swamp, ecological community #8 as can be seen on Figure 3-7. This community is predominant on the western portion of the Clarkstown Landfill. This wetland occurs in poorly drained depressions usually on inorganic soils. This community contains the dominant red maple with codominant hardwood species such as box elder, sugar maple, silver maple, northern catalpa, white ash, red ash, sycamore, cottonwood, quaking aspen, pin oak, northern red oak, black

locust, weeping willow, black willow, basswood and american elm. Shrub understory species include speckled alder, sweet pepperbush, silky dogwood, red osier dogwood, black alder, spicebush and maple-leaved viburnum. Herbaceous plants include jewelweed, sensitive fern, cinnamon fern, royal fern, skunk cabbage and tussock sedge. This community is not only the dominant at Clarkstown Landfill but, throughout southern New England as well.

Silver Maple-Ash Swamp (9)

Integrated among the Red-Maple Hardwood Swamp communities, are Silver Maple-Ash Swamp communities. Silver Maple-Ash is a hardwood swamp that occurs on poorly drained soils along rivers and in poorly drained depressions. These sites are characterized by uniformly wet conditions with minimal seasonal fluctuations in water levels. The dominant trees are silver maple, with as much as 70% cover, mixed with smaller quantities of green ash, black ash and white ash. These swamps have low herb diversity, a characteristic herb is skunk cabbage.

Palustrine Cultural

This subsystem includes communities that are either created and maintained by human activities, or are modified to such a degree that the physical conformation of the substrate, or the biological composition of the resident communities is substantially different from the character of the substrate or community as it existed prior to human influence. This subsystem includes the following Reedgrass/Purple Loosestrife Marsh and Impounded Swamp communities.

Reedgrass/Purple Loosestrife Marsh (16)

Several ecological communities surrounding the Clarkstown landfill have been created and maintained by human activities or have been modified to such a degree that the physical conformation of the substrate, the hydrology, or the biological composition of the resident community is substantially different from the character of the substrate, hydrology, or community as it existed prior to human influence. There are two areas that can be classified as reedgrass/purple loosestrife marshes, #16a and #16b, (see Figure 3-7). Both of these areas contain monotypic stands of *Phragmites*.

Impounded Swamp (15)

An area located northeast of the Clarkstown Landfill is an impounded swamp which has at least 50% canopy cover, the water levels have been artificially manipulated or modified, as in this case for road drainage purposes. There are many standing dead tree trunks with purple loosestrife dominating. Two areas (see Figure 3-7) adjacent to the Clarkstown Landfill can be classified as an impounded swamp, reedgrass/purple loosestrife marsh. In both of these areas there are dead tree clumps with purple loosestrife growing from these stumps. This area includes shrub species of sweet pepperbush, buttonbush, maple-leaved viburnum with an herbaceous understory of cattail, spikerush, royal fern, wooly sedge, water hemlock and groundnut. These areas were very difficult to negotiate with a canoe due to the many fallen trees blocking the way.

Riverine System

The riverine system consists of the aquatic communities of flowing non-tidal waters that lack persistent emergent vegetation, but may include areas with submerged or floating-leaved aquatic vegetation. The riverine communities in this classification are distinguished primarily by position of the stream in the watershed, and water flow characteristics. The riverine communities are also distinguished by size of the stream. Large streams have an average width greater than 100 feet, medium streams are from 10 to 100 feet and small stream have an average width less than 10 feet. This system includes the following Main Channel Streams, Backwater Slough, and Intermittent Streams communities.

Main Channel Streams (2)

Main channel stream ecological community occur in two areas of the Hackensack River and shown on Figure 3-7. These areas are characterized as a large, quiet base level section of stream where there are no distinct riffles. Main channel streams have clearly distinguished meanders and are characterized by considerable deposition with a relatively minor amount of erosion.

Backwater Slough (3)

An area to the north of the Deep Emergent Marsh can be classified as Backwater Slough. This area is an aquatic community of quiet to stagnant waters in sloughs that form in embayments and old meanders that are partially cut off from a main channel stream by deposition of a levee. Aquatic vegetation is usually abundant. Vegetation in this area included waterweed, pickerel weed and arrow arum.

Intermittent Streams (4)

The wetlands surrounding the Clarkstown Sanitary Landfill have many intermittent streams that feed into the Hackensack River. These communities are small, ephemeral streambeds with a moderate gradient where water flows only during the spring or after a heavy rain. Fauna is limited to species that do not require a permanent supply of running water, or that inhabit the streambed only during the rainy season. Intermittent streams surrounding the Clarkstown Landfill were identified by drift lines, water-stained leaves, and wetland drainage patterns.

Drift lines are indicators typically found adjacent to streams or other sources of water flow in wetlands. Evidence consists of sediment, litter and other water-borne materials deposited more or less parallel to the direction of water flow. For example, this occurred in the area to the north of the old drive-in movie theater where drainage originates from the golf driving range and runs in a northwesterly direction toward the Clarkstown Landfill. Debris from the golf driving range (mainly golf balls, tees and tee covers) was noted throughout this area. One stream running through the golf driving range was full in late summer and supplied water to the wetland area south of the landfill. Water-stained leaves occurred in forested wetlands on the forest floor. These leaves are generally grayish or blackish in appearance darkened from being underwater for significant periods. These leaves were found throughout the wetlands of the Clarkstown Landfill. Wetland drainage patterns are observable by meandering or braided drainage patterns that are readily recognizable.

TABLE 3-4

VEGETATIVE SPECIES IDENTIFIED BY WESTON

TREES

Ash-leaved maple/Box elder	<u>Acer negundo</u>
Red maple	<u>Acer rubrum</u>
Sugar maple	<u>Acer saccharum</u>
Silver maple	<u>Acer saccharinum</u>
Northern catalpa	<u>Catalpa bignoniodes</u>
White ash	<u>Fraxinus americana</u>
Red ash	<u>Fraxinus pennsylvanica</u>
Sycamore	<u>Platanus occidentalis</u>
Cottonwood	<u>Populus deltoides</u>
Quaking aspen	<u>Populus tremuloides</u>
Northern Red oak	<u>Quercus borealis</u>
Pin oak	<u>Quercus palustris</u>
Staghorn sumac	<u>Rhus typhina</u>
Black locust	<u>Robinia pseudoaccia</u>
Weeping willow	<u>Salix babylonica</u>
Black willow	<u>Salix nigra</u>
Linden/Basswood	<u>Tilia americana</u>
American elm	<u>Ulmus americana</u>

SHRUBS

Speckled alder	<u>Alnus rugosa</u>
Buttonbush	<u>Cephalanthus occidentalis</u>
Sweet pepperbush	<u>Clethra alnifolia</u>
Silky dogwood	<u>Cornus amomum</u>

TABLE 3-4

VEGETATIVE SPECIES IDENTIFIED BY WESTON

Red osier dogwood	<u>Cornus stolonifera</u>
Black alder	<u>Ilex verticillata</u> (exploitly vulnerable)
Spicebush	<u>Lindera benzoin</u>
Japanese bamboo	<u>Polygonum cuspidatum</u>
Rose	<u>Rosa multiflora</u>
Maple-leaved viburnum	<u>Viburnum acerifolium</u>

TREES

Ash-leaved maple/Box elder	<u>Acer negundo</u>
Red maple	<u>Acer rubram</u>
Sugar maple	<u>Acer saccharum</u>
Silver maple	<u>Acer saccharinum</u>
Northern catalpa	<u>Catalpa bignoniodes</u>
White ash	<u>Fraxinus americana</u>
Red ash	<u>Fraxinus pennsylvanica</u>
Sycamore	<u>Platanus occidentalis</u>
Cottonwood	<u>Populus deltoides</u>
Quaking aspen	<u>Populus tremuloides</u>
Northern Red oak	<u>Quercus borealis</u>
Pin oak	<u>Quercus palustris</u>
Staghorn sumac	<u>Rhus typhina</u>
Black locust	<u>Robinia pseudoaccia</u>
Weeping willow	<u>Salix babylonica</u>
Black willow	<u>Salix nigra</u>
Linden/Basswood	<u>Tilia americana</u>
American elm	<u>Ulmus americana</u>

TABLE 3-4

VEGETATIVE SPECIES IDENTIFIED BY WESTON

SHRUBS

Speckled alder	<u>Alnus rugosa</u>
Buttonbush	<u>Cephalanthus occidentalis</u>
Sweet pepperbush	<u>Clethra alnifolia</u>
Silky dogwood	<u>Cornus amomum</u>
Red osier dogwood	<u>Cornus stolonifera</u>
Black alder	<u>Ilex verticillata</u> (exploitly vulnerable)
Spicebush	<u>Lindera benzoin</u>
Japanese bamboo	<u>Polygonum cuspidatum</u>
Rose	<u>Rosa multiflora</u>
Maple-leaved viburnum	<u>Viburnum acerifolium</u>

HERBACEOUS

Wild garlic mustard	<u>Alliaria officinales</u>
Rue anemone	<u>Anemonella thalictroides</u>
Groundnut	<u>Apios americana</u>
Common burdock	<u>Arctium minus</u>
Milkweed	<u>Asclepias incarnata</u>
Bog hemp	<u>Beohmeria cylindrica</u>
Water hemlock	<u>Cicuta maculata</u>
Bull thistle	<u>Cirsium vulgare</u>
Queen's Anne lace	<u>Daucus carota</u>
Spike rush	<u>Eleocharis obtusa</u>
Wild rye	<u>Elymus riparius</u>
Marsh mallow	<u>Hibiscus palustris</u>

TABLE 3-4

VEGETATIVE SPECIES IDENTIFIED BY WESTON

Jewelweed	<u>Impatiens capensis</u>
Morning Glory	<u>Ipomoea purpurea</u>
Blue flag	<u>Iris versicolor</u>
Butter and eggs	<u>Linaria vulgaris</u>
Birdsfoot trefoil	<u>Lotus corniculatus</u>
Purple loosestrife	<u>Lythrum salicaria</u>
Partridge berry	<u>Mitchella repens</u>
Yellow pond lily	<u>Nuphar variegatum</u>
Evening primrose	<u>Oenothera biennis</u>
Sensitive fern	<u>Onoclea sensibilis</u>
Cinnamon fern	<u>Osmunda cinnamomea</u> (exploitly vulnerable)
Royal fern	<u>Osmunda regalis</u> (exploitly vulnerable)
Arrow arum	<u>Peltandra virginica</u>
Giant reed	<u>Phragmites australis</u>
Pokeweed	<u>Phytolacca americana</u>
Common plaintain	<u>Plantago major</u>
Swamp smartweed	<u>Polygonum coccineum</u>
Arrow-leaved tearthumb	<u>Polygonum sagittarum</u>
Pickernelweed	<u>Pontederia cordata</u>
Poison ivy	<u>Rhus radicans</u>
Swamp dewberry	<u>Rubus hispidus</u>
Common elder	<u>Samubucus canadensis</u>
Lizard's tail	<u>Saururus cernuus</u>
Wooly sedge	<u>Scirpus cyperinus</u>
Great bulrush	<u>Scirpus validus</u>
Common nightshade	<u>Solanum dulcamara</u>
Goldenrod	<u>Solidago sp.</u>

TABLE 3-4

VEGETATIVE SPECIES IDENTIFIED BY WESTON

Burreed	<u>Sparganium eurycarpum</u>
Duckweed	<u>Spirodela polyrhiza</u>
Skunk cabbage	<u>Symlocarpus foetidus</u>
Cattails	<u>Typha latifolia</u>

LIANAS

Bur cucumber	<u>Echinocystis lobata</u>
Tartarian honeysuckle	<u>Lonicera tataria</u>
Virginia creeper	<u>Parthenocissus quinquefolia</u>
Currant	<u>Ribes triste</u>
Cat briar	<u>Smilax rotundifolia</u>
Fox grape	<u>Vitis labrusca</u>
Riverbank grape	<u>Vitis riparia</u>

Table 3-5
WILDLIFE IDENTIFIED BY WESTON

MAMMALS

Virginia opossum	<u>Didelphis virginianus</u>
Striped skunk	<u>Mephitis mephitis</u>
White-tailed deer	<u>Odocoileus virginianus</u>
Raccoon	<u>Procyon lotor</u>
Gray fox	<u>Urocyon cinereoargenteus</u>
Red fox	<u>Vulpes vulpes</u>

BIRDS

Wood duck	<u>Aix sponsa</u>
Mallard	<u>Anas platyrhynchos</u>
Great blue heron	<u>Ardea herodias</u>
Red-tailed hawk	<u>Buteo jamaicensis</u>
Green heron	<u>Butorides striatus</u>
Canada goose	<u>Branta canadensis</u>
Great egret	<u>Casmerodius albus</u>
Killdeer	<u>Charadrius vociferus</u>
Marsh hawk	<u>Circus cyaneus</u>
Herring gull	<u>Larus argentatus</u>
Lesser Black-backed gull	<u>Larus fuscus</u>
Starling	<u>Sturnus vulgaris</u>
Mourning dove	<u>Zenaida macroura</u>

Table 3-5

WILDLIFE IDENTIFIED BY WESTON

AMPHIBIANS

Snapping turtle	<u>Chelydra serpentina</u>
Eastern painted turtle	<u>Chrysemys picta</u>
Spring peeper	<u>Hyla crucifer</u>

FISH

Carp	<u>Cyprinus carpio</u>
Bluegill	<u>Leponis macrochirus</u>
Largemouth bass	<u>Micropterus salmoides</u>
White perch	<u>Morone americana</u>
Yellow perch	<u>Perca flavescens</u>

INVERTEBRATES

Chimney crayfish	<u>Cambarus diogenes</u>

Table 3-6

VEGETATIVE SPECIES FOUND IN THE HACKENSACK RIVER
WETLANDS IN ADDITION TO WESTON'S IDENTIFICATION

TREES

Horse chestnut	<u>Aesculus hippocastanum</u>
Tree-of-heaven	<u>Ailanthus altissima</u>
River birch	<u>Betula nigra</u>
Shagbark Hickory	<u>Carya ovata</u>
Beech	<u>Fagus grandifolia</u>
Black gum	<u>Nyssa sylvatica</u>
Black cherry	<u>Prunus serotina</u>
Smooth sumac	<u>Rhus glabra</u>
Sassafras	<u>Sassafras albidum</u>
Slippery elm	<u>Ulmus rubra</u>

SHRUBS

Gray-stemmed dogwood	<u>Cornus racemosa</u>
Ironwood	<u>Carpinus caroliniana</u>
Witch hazel	<u>Hamamelis virginiana</u>
Mock orange	<u>Philadelphus inodorus</u>
Chokeberry	<u>Pyrus arbutifolia</u>

HERBACEOUS

Onion grass	<u>Allium</u> sp.
Spikenard	<u>Aralia racemosa</u>
Jack-in-the-pulpit	<u>Arisaema atrorubens</u>
Lady fern	<u>Athyrium felix-femina</u>
Tussock sedge	<u>Carex stricta</u>
Enchanter's nightshade	<u>Circaea lutetiana</u>

Table 3-6
VEGETATIVE SPECIES FOUND IN THE HACKENSACK RIVER
WETLANDS IN ADDITION TO WESTON'S IDENTIFICATION

Pink lady's slipper	<u>Cypripedium acaule</u>
Wild geranium	<u>Geranium maculatum</u>
Canada's mayflower	<u>Maianthemum canadense</u>
Solomon's seal	<u>Polygonatum biflorum</u>
False solomon's seal	<u>Smilacina racemosa</u>
Wild rice	<u>Zizania aquatica</u>

Table 3-7

WILDLIFE COMMON TO ROCKLAND COUNTY, NEW YORK***MAMMALS**

Beaver	<u>Castor canadensis</u>
Starnose mole	<u>Condylura cristata</u>
Opossum	<u>Didelphis marsupialis</u>
Big brown bat	<u>Eptesicus fuscus</u>
Flying squirrel	<u>Glaucomys volans</u>
Silver haired bat	<u>Lasionygteris noctivagans</u>
Red bat	<u>Lasiurus borealis</u>
Heary bat	<u>Lasiurus cinereus</u>
Woodchuck	<u>Marmota momax</u>
Striped skunk	<u>Mephitis mephitis</u>
Meadow vole	<u>Microtus pennsylvanicus</u>
House mouse	<u>Mus musculus</u>
Long-tailed weasel	<u>Mustela frenata</u>
Little brown bat	<u>Myotis lucifugus</u>
Muskrat	<u>Ondatra zibethicus</u>
White-footed mouse	<u>Peromyscus leocopus</u>
Raccoon	<u>Procyon lotor</u>
Norway rat	<u>Rattus norvegicus</u>
Eastern mole	<u>Scapopus aquaticus</u>
Gray squirrel	<u>Sciurus carolinensis</u>
Masked shrew	<u>Sorex cinereus</u>
Eastern cottontail	<u>Sylvilagus floridanus</u>
Eastern chipmunk	<u>Tamias striatus</u>
Meadow jumping mouse	<u>Zapus hudsonius</u>

*Taken from: "Draft Environmental Impact Statement, Hackensack River Drainage Improvement Project, Town of Clarkstown, Rockland County, New York."

Prepared by: Kozma Associates and Carpenter Environmental Associates, Inc.

Table 3-7

WILDLIFE COMMON TO ROCKLAND COUNTY, NEW YORK***BIRDS**

Red-winged blackbird	<u>Agelaius phoeniceus</u>
Wood duck	<u>Aix sponsa</u>
Mallard	<u>Anas platyrhynchos</u>
Black duck	<u>Anas rubripes</u>
Gadwall	<u>Anas strepera</u>
Cedar waxwing	<u>Bombycilla cedrorum</u>
American bittern	<u>Botaurus lentiginosus</u>
Canada goose	<u>Branta canadensis</u>
Red-tailed hawk	<u>Buteo jamaicensis</u>
Rough-legged hawk	<u>Buteo lagopus</u>
Common snipe	<u>Capella gallinago</u>
Brown creeper	<u>Certhis familiaris</u>
Killdeer	<u>Charadrius vociferus</u>
Common crow	<u>Corvus brachyrhynchos</u>
Blue jay	<u>Cyanocitta cristata</u>
Downy woodpecker	<u>Picoides pubescens</u>
Catbird	<u>Dumetella carolinensis</u>
Sparrow hawk	<u>Falco sparverius</u>
Evening grosbeak	<u>Hesperiphona vespertina</u>
Hermit thrush	<u>Catharus guttata</u>
Slate-colored junco	<u>Junco hyemalis</u>
Swamp sparrow	<u>Melospiza georgiana</u>
Song sparrow	<u>Melospiza melodia</u>
Brown-headed cowbird	<u>Molothrus ater</u>
Mockingbird	<u>Mionus polyglottos</u>
Screech owl	<u>Otus asio</u>
Black-capped chickadee	<u>Parus atricapillus</u>

Table 3-7

WILDLIFE COMMON TO ROCKLAND COUNTY, NEW YORK*

Tufted titmouse	<u>Parus bicolor</u>
House sparrow	<u>Passer domesticus</u>
Savannah sparrow	<u>Passerculus sandwichensis</u>
Ring-necked pheasant	<u>Phasianus colchicus</u>
Rufous-sided towhee	<u>Pipilo erythrophthalmus</u>
Pied-billed grebe	<u>Podilymbus podiceps</u>
Common grackle	<u>Quiscalus quiscula</u>
Cardinal	<u>Cardinalis</u>
Eastern phoebe	<u>Sayornis phoebe</u>
White-breasted nuthatch	<u>Sitta carolinensis</u>
Pine siskin	<u>Carduelis pinus</u>
American goldfinch	<u>Carduelis tristis</u>
Eastern meadowlark	<u>Sturnella magna</u>
Starling	<u>Sturnus vulgaris</u>
Carolina wren	<u>Thryothorus ludovicianus</u>
American robin	<u>Turdus migratorius</u>
Mourning dove	<u>Zenaidura macroura</u>
White-crowned sparrow	<u>Zonotrichia leucophrys</u>

AMPHIBIANS AND REPTILES

Copperhead	<u>Agkistrodon contortrix</u>
Spotted salamander	<u>Ambystoma maculatum</u>
American toad	<u>Bufo americanus</u>
Worm snake	<u>Carphophis amoenus</u>
Snapping turtle	<u>Chelydra serpentina</u>
Painted turtle	<u>Chrysemys picta</u>
Spotted turtle	<u>Clemmys guttata</u>
Wood turtle	<u>Clemmys insculpta</u>

Table 3-7

WILDLIFE COMMON TO ROCKLAND COUNTY, NEW YORK*

Black racer	<u>Coluber constrictor</u>
Dusky salamander	<u>Desmognathus fuscus</u>
Northern ringnecked snake	<u>Diadophis punctatus edwardsi</u>
Red spotted newt	<u>Diemictylus viridescens</u>
Rat snake	<u>Elaphe obsoleta</u>
Five lined skink	<u>Eumeces fasciatus</u>
Two lined salamander	<u>Eurycea bislineata</u>
Spring peeper	<u>Hyla crucifer</u>
Milk snake	<u>Lampropeltis triangulum</u>
Northern water snake	<u>Nerodia sipedon</u>
Red backed salamander	<u>Plethodon cinereus</u>
Red salamander	<u>Pseudotriton ruber</u>
Bull frog	<u>Rana catesbeiana</u>
Green frog	<u>Rana clamitans</u>
Pickerel frog	<u>Rana paulstris</u>
Wood frog	<u>Rana sylvatica</u>
Stinkpot	<u>Sternotherus odoratus</u>
De Kay's (Brown) snake	<u>Storeria dekayi</u>
Eastern box turtle	<u>Terrapene carolina</u>
Common garter snake	<u>Thamnophis s. sirtalis</u>

Table 3-8

FISH SPECIES FOUND IN AND AROUND THE HACKENSACK RIVER
BY NEW YORK STATE CONSERVATION OFFICIALS

HACKENSACK RIVER, 1936

Mud sunfish	<u>Acantharcus pomotis</u>
	<u>Amiurus nebulosus</u>
Boston eel	<u>Anguilla bostoniensis</u>
White sucker	<u>Catostomus commersoni</u>
Bluespotted sunfish	<u>Enneacanthus gloriosus</u>
Creek chub	<u>Erimyzon oblongus</u>
Redfin pickerel	<u>Esox americanus</u>
Chain pickerel	<u>Esox niger</u>
Johnny darter	<u>Etheostoma nigrum</u>
Redbreast sunfish	<u>Lepomis auritus</u>
Pumpkin seed	<u>Lepomis gibbosus</u>
Bluegill	<u>Lepomis macrochirus</u>
	<u>Leucosomas corporalis</u>
Golden shiner	<u>Notemigonus crysoleucas</u>
Bridled shiner	<u>Notropis bifrenatus</u>
Ironcolor shiner	<u>Notropis chalybasus</u>
Common shiner	<u>Notropis cornutus</u>
Tadpole madtom	<u>Schilbeodes gyrimus</u>

LAKE TAPPAN, 1984

White sucker	<u>Catostomus commersoni</u>
Carp	<u>Cyprinus carpio</u>
Pumpkinseed	<u>Lepomis gibbosus</u>
Bluegill	<u>Lepomis macrochirus</u>
Large mouth bass	<u>Micropterus salmoides</u>
White perch	<u>Morone americana</u>
Golden shiner	<u>Notemigonus chrysoleucas</u>
Yellow perch	<u>Perca flavescens</u>

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4.0 NATURE AND EXTENT OF CONTAMINATION

The Phase I remedial investigation (RI) sampling at the Clarkstown Landfill was conducted from July of 1990 to May of 1991. The Phase II sampling effort was conducted from December, 1993 through April, 1994. The intent of the sampling was to characterize the nature and extent of any contamination emanating from the landfill. Potentially affected environmental media included surface and subsurface soils, groundwater, ambient air, surface water and sediments. Tests were also performed to determine the characteristics of the landfill leachate which represents a source of potential contamination to groundwater, surface water, sediments, and subsurface soils in the vicinity of the landfill. Landfill gases generated from the decomposition of the municipal waste were characterized through soil gas testing. The landfill gas represents a source of potential contamination to ambient air.

The Phase I and Phase II RI results and sampling results from previous investigations are discussed in this section for each media separately in relation to exceedances of the applicable local and State ARARs. Where appropriate, upgradient/downgradient (groundwater), upstream/downstream (surface water and sediment), and upwind/downwind (ambient air) comparisons are made in an attempt to distinguish contaminants originating at the landfill versus other off-site sources of contamination.

For reference, tables presenting the concentrations of all detected compounds at each sampling location, as well as summary detection tables, are included as appendices A and B. The summary tables (Appendix A) present the frequency of detection and the range in concentrations for all detected organic compounds and selected inorganic contaminants of concern, primarily the heavy metals. The data in the summary tables is presented separately for sampling locations that are upgradient/downgradient, upstream/downstream, and upwind/downwind of the landfill for ease of interpretation.

The analytical data generated during the RI were analyzed by NYSDEC approved laboratories and validated in accordance with NYSDEC requirements. The detected compounds data tables

in Appendix B present the results for all detected compounds and provide a complete explanation of the data qualifiers that appear on the tables and in the accompanying text in this section. Briefly, a "J" qualifier indicates a positive detection but an estimated concentration. A "B" qualifier for the inorganics data indicates a value less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL). In addition, "ND" appearing in the text signifies a "non-detected" concentration.

4.1 Contaminant Sources

4.1.1 Leachate

4.1.1.1 Introduction

Landfill leachate is a liquid generated from precipitation which has percolated through the landfill. Leachate contains a large number of organic and inorganic compounds derived from the municipal waste and is typically high in total dissolved solids content. The occurrence of a mounded water table within the landfill is discussed in Section 5.1 of this report. Horizontal leachate flow from the central portions of the landfill may be intercepted by the existing perimeter leachate collection system. From seven leachate collection chambers located along the perimeter collection lines, this intercepted leachate is pumped to two on-site holding basins and then into the Rockland County Sewer District #1 system via an on-site leachate pumping station (See Figure 1-2). Sections 1.2.2 and 2.9.1 of the report present a more detailed discussion of the leachate collection system at the landfill.

Under the current discharge permit with Rockland County Sewer District #1, the leachate is accepted at the plant without pretreatment. At a minimum, sampling of the leachate is conducted on a monthly basis with two (2) sampling rounds completed for the full target compound list (TCL) parameters on an annual basis. Individual leachate constituents regulated by the plant have almost always been within the allowable sewer system pre-treatment discharge limits. Treated wastewaters are ultimately discharged from the plant into the Hudson River.

4.1.1.2 Historical and Remedial Investigation Results

In order to characterize the current leachate quality at the Clarkstown Landfill, leachate samples were collected from fourteen different locations during each of the Phase I and Phase II phases. The Phase I RI data were compared to the County pretreatment standards and to previous leachate sampling data from the landfill to evaluate any changes in leachate quality over time which might impact the leachate treatment options for the site. The Phase II RI leachate data were compared to newly revised County pretreatment standards in place at the time of the Phase II sampling round. The leachate data were also compared to State surface water standards to assess potential impacts of leachate discharges to the surface waters located directly adjacent to the landfill. Analytical detection tables and summary data tables are presented in the appendices A and B for the Phase I and II RI and historical data.

The Phase I and Phase II RI leachate sampling locations are shown on Figure 2-1. Leachate samples LC-1 through LC-7 were collected from the seven leachate collection chambers. Sample LC-8 was taken from the wet well at the leachate pumping station. Samples LB-1 and LB-2 were taken from each of the two holding basins. Phase I samples LC-9 through LC-12 were collected from leachate seeps located on the side slopes of the landfill. Two additional samples (groundwater samples collected from monitoring wells RFW-9S and RFW-14, screened in the landfill mass) can be considered as leachate samples. These samples consist of groundwater in direct contact with the landfilled waste. These sample results were included in this leachate discussion as well as in the groundwater discussion (Section 4.4).

The Phase I RI leachate samples were analyzed for the full Target Compound List (TCL) organic and inorganic compounds and the Phase II samples for the NYSDEC Part 360 baseline volatile organics, metals, and leachate indicators. Tables A-1 (Phase I) and A-2 (Phase II) in the appendix shows the compounds detected, the frequency of detection, and the range of concentrations found at each sampling location. Table B-1 in the appendix presents the complete detected compounds data for leachate for both phases.

During Phase I, as shown in Tables A-1 and B-1, numerous inorganic compounds were detected in all of the leachate samples but only zinc in one sample (LC-10) exceeded the local pretreatment regulations in force at that time. The most frequently detected inorganics were iron, manganese, chromium, nickel and zinc. No exceedances of pretreatment regulations were reported for volatile or semivolatile compounds, although standards existed for only one of the detected organic compounds (methylene chloride). The most frequently detected organic compounds in leachate were benzene, chlorobenzene and carbon disulfide. The two former compounds are related to petroleum products and solvents, respectively. The third, carbon disulfide, is commonly used in the manufacture of rayon and cellophane, as a solvent for various industrial processes, and as a degreasing and drycleaning agent. Acetone and 2-butanone were detected at high levels in three of the four leachate seep samples. The pesticide 4,4-DDT was detected in leachate samples LC-3, LC-3 DUPE, LC-9 and LC-10 with the concentration ranging from 0.13 micrograms per liter (ug/l) to 9.21 ug/l. A common source of pesticides in municipal landfills is grass and shrub clippings from areas where pesticides were applied. No PCBs were detected in the leachate samples. In addition, no exceedances were reported for the two leachate samples from monitoring wells RFW-9S and RFW-14.

During Phase II, as shown in Table A-2 and B-1, several inorganic compounds were detected in all of the leachate samples; none of the detections (including those reported for the leachate samples collected from monitoring wells RFW-9S and RFW-14) exceeded the recently revised County pretreatment standards. The most frequently detected inorganics were cadmium, chromium, copper, iron, manganese, nickel, and zinc. No exceedances of pretreatment standards were reported for volatile and semivolatile compounds or for pesticides. The most frequently detected organic compounds in leachate were chlorobenzene, xylene (total), and 1,4-dichlorobenzene. Chlorobenzene is used as a solvent. The latter two compounds are associated with petroleum products. No pesticides were detected in the Phase II leachate samples.

A comparison was also made of the leachate analytical results to surface water standards to conservatively evaluate the potential impacts on surface waters of leachate which may bypass the leachate collection system and discharge into the wetlands. It is important to note that the

existing leachate collection system was not constructed with an impervious barrier to lateral leachate flow. A fabric barrier which traps silt and which can partly impede the flow of liquids was installed in the collection trench as part of the leachate collection system. Recent investigations of the condition of the system revealed that this fabric barrier was partially effective in impeding liquid flow. It also revealed that the fabric has begun to deteriorate. This deterioration is expected to continue over time. As this occurs, the leachate in the landfill may migrate past this barrier and enter the surface waters surrounding the landfill. Mitigation measures to prevent this from happening, in particular upgrading of the leachate collection system, are discussed in the accompanying Final FS Report.

Table 4-1 presents a comparison of the detected compounds in the Clarkstown Landfill leachate with the NYSDEC most stringent surface water standards for those compounds. This comparison demonstrates that should the leachate escape from the leachate system and enter the surface waters that the surface waters would be adversely impacted. While the remedial investigation did not find leachate directly entering the surface waters at this time, it may occur in the future unless mitigation measures are put in place.

Table 4-2 compares the County pre-treatment discharge standards to the Phase I and II RI leachate data, including data for the two leachate monitoring wells RFW-9S and RFW-14. A comparison of the leachate quality from the collection chambers and basins was made to that from the leachate seeps and wells to evaluate whether the leachate in the collection system is being diluted by other sources of fresh water. During hydraulic modelling completed for the RI, and presented in Section 1.0 of the Final FS Report, it was determined that more leachate was being pumped from the system than was estimated to be generated from precipitation infiltrating into the landfill. Potential sources of the diluting waters are infiltrating surface runoff at the toe of the landfill, inflowing groundwater from upgradient areas, and/or groundwater from the wetlands being drawn into the collection system from through or around the collection trench liner.

TABLE 4-1

COMPARISON OF CLARKSTOWN LANDFILL LEACHATE AND
NEW YORK STATE SURFACE WATER STANDARDS

COMPOUND	RANGE IN DETECTED RI LEACHATE CONCENTRATIONS ^(a)	LOWEST SURFACE WATER STANDARD OR GUIDANCE VALUE
<i>Inorganics (µg/l)</i>		
Arsenic	3-188	50
Cadmium	3-37	1
Chromium	6-264	50
Copper	7-874	10.5
Iron	7.75-58,900	300
Lead	3-2000	2.7
Manganese	1.15J-5230	300
Mercury	0.14-1.23	0.2
Nickel	10-384	86
Zinc	17-6080	30
<i>Organics (µg/l)</i>		
Acetone	34,000J	50
Benzene	1J-5J	0.7
Bis(2-ethylhexyl)phthdate	140	0.6
Chlorobenzene	10-36	5
Chloroethane	45J-410J	5
1,1-Dichloroethane	135J	5
1,2 Dichloroethane (total)	3J-100J	0.8
Ethylbenzene	36J	5
Methylene Chloride	190J	5
Naphthalene	5J-13	10
Phenol	490	1
Toluene	1J-220J	5
Vinyl Chloride	130J	0.3
Xylenes (total)	62J	5

TABLE 4-1

COMPARISON OF CLARKSTOWN LANDFILL LEACHATE AND
NEW YORK STATE SURFACE WATER STANDARDS

COMPOUND	RANGE IN DETECTED RI LEACHATE CONCENTRATIONS ⁽¹⁾	LOWEST SURFACE WATER STANDARD OR GUIDANCE VALUE
<i>Other Compounds (mg/l)</i>		
Ammonia	35-784	2
Chlorides	100-1900	250

Notes:

- (1) Data for Phase I and II RI leachate samples from the leachate collection chambers, basins, wet well, seeps, and leachate monitoring wells RFW-9S and RFW-14. Where only one concentration is presented, compound was detected on only one occasion.
- (2) "J" data qualifier = concentration estimated by laboratory.

TABLE 4-2

**COMPARISON OF CLARKSTOWN LANDFILL LEACHATE⁽¹⁾ AND ROCKLAND COUNTY SEWER DISTRICT NO. 1
PRE-TREATMENT DISCHARGE STANDARDS**

COMPOUND	PRE-TREATMENT STANDARDS	LEACHATE BASINS AND CHAMBERS	LEACHATE SEEPS	LEACHATE WELLS ⁽²⁾
<i>Inorganics (µg/l)</i>				
Arsenic	1000	1.1-5.2	4.4-188	3.3-17.1
Cadmium	100	1.5-5	8-37	2-13
Chromium	3000	5.3-49J	46-264	9.3-113
Copper	1000	2.3-63	13-874	20.9-66
Iron	-	7.75-43,400	15.3-226	12,500-58,000
Lead	3000	3-14.1	3.8-2000	5.3J-633J
Manganese	-	1.15J-1740	2.69J-22.1J	158-5230
Mercury	50	0.14-0.18	1.23	0.14-0.98
Nickel	1000	5.2-30	82-269	10-384J
Silver	5000	7-13	17-31	-
Zinc	3000	17-68	395-6080	107-850
<i>Organics (µg/l)</i>				
Benzene	140	1J-3J	ND	5J
Carbon Disulfide	60	9-90	15J	ND
Chlorobenzene	2130	4J-36	ND	4-14J
Chloroethane	240	2J	45J-410J	ND
1,1-Dichloroethane	2130	ND	135J	ND
1,1,1-Trichloroethane	1360	ND	310J	ND
Ethylbenzene	1590	1J	ND	36J
Methylene Chloride	2060	ND	190J	ND
Vinyl Chloride	710	ND	130J	ND

- Notes: (1) Data for Phase I and II RI leachate samples. Where only one concentration is presented, compound was detected on only one occasion.
 (2) Data for leachate monitoring wells RFW-9S and RFW-14.
 (3) "J" data qualifier = concentration estimated by laboratory.
 (4) ND = Not detected

The leachate well data most closely represents raw, undiluted leachate. The leachate seep data also represents raw leachate, although evaporation may tend to increase compound concentrations. As shown on Table 4-2 for the inorganic compounds, the leachate well concentrations are greater than the basins and chambers generally by a factor of 2 or more, but for some compounds by greater than one order of magnitude. These data suggest that the leachate collected in the perimeter system is diluted compared to leachate from the interior of the landfill. A comparison of the leachate well data and pre-treatment standards from Table 4-2 also indicates that should leachate concentrations increase upon closure (capping), concentrations are not so great that they would be likely to exceed the discharge standards.

Table A-3 compares the frequency of detection and concentration ranges for the Phase I RI data and available historical sampling data for the leachate collection chambers for the years 1985, 1986 and 1987. Historical data for the leachate holding basins, wet well, or leachate seeps was not available for comparison to the Phase I RI data. Table A-3 includes the results for all detected organic compounds and only those inorganic compounds which were sampled for during both the historical and Phase I RI efforts for consistency. Overall, slight differences between the organics data findings are noted which can be expected as the leachate comes into contact with the varied fill within the landfill. In general, the most frequently detected volatile organic compounds historically were the aromatic organic compounds (chlorobenzene, benzene, ethylbenzene, toluene, and xylenes) which is consistent with the Phase I RI data. Historically, relatively few semivolatile organic compounds were present in the leachate. The detected organic compounds are primarily associated with either petroleum products (oils, gasoline), construction debris such as roofing tars or road asphalt, or the breakdown of plastics present in the fill material.

The inorganics data in Table A-3 for the leachate collection chamber shows some significant variability over time. Iron showed a tenfold increase between the 1985 and Phase I RI data,

while manganese increased slightly between the same sampling periods. Copper, lead, and zinc have shown a tenfold decrease in concentration over time. Chromium and silver were not previously detected but were present in the Phase I RI samples. However, concentrations may not have increased appreciably considering that the analytical detection limits were greater for the historical data. Arsenic and mercury were also reported in the past at a greater frequency of detection and higher concentrations than the Phase I RI data.

A comparison of the Phase I (Table A-1) and Phase II (Table A-2) data shows that the most recent (Phase II) maximum concentrations for arsenic, chromium, cadmium, lead, nickel, zinc and the major cations (calcium, magnesium, potassium, and sodium) are significantly less than the Phase I maximum levels, but iron is greater. The inorganics data indicate that the leachate is becoming weaker over time or is being more diluted by other sources, possibly related to deterioration of the collection trench liner discussed previously. The organics data between the two phases differ in that carbon disulfide, benzene, toluene, two phthalate compounds, naphthalene, and the pesticide 4,4-DDT were present in some Phase I samples but not the Phase II samples. In addition, total xylenes and 1,4-dichlorobenzene were present in the Phase II but not the Phase I samples. Chlorobenzene was consistently found at similar concentrations during both sampling phases.

4.1.2 Soil Gas/Landfill Gas Sampling Program

4.1.2.1 Introduction

Soil gas consists of air present in the pore spaces of the unsaturated subsurface soil zone. In the case of a landfill site, the soil gas is comprised mostly of landfill gases generated by the decomposing wastes. The Phase I RI soil gas sampling program, completed in November 1990, was a two phased program. Initially, a preliminary screening of shallow (less than 4 feet deep) soil gases for total VOCs and methane was performed across most of the landfill property in a grid-like manner, as shown on Figure 2-2, using direct reading field instruments. The central portion of the property was not included in the screening program due to ongoing landfilling and construction of the refuse transfer station at the time of sampling. Based on the results of the

field screening, ten soil gas samples were subsequently collected for laboratory analysis for VOCs on 8 and 14 November, 1990. The soil gas sampling locations were selected from the soil gas screening locations which registered the highest total VOC and methane concentrations.

A Phase II landfill gas program was completed in March 1994. The objectives of this program were to characterize deeper landfill gases and to evaluate gas generation for input to the feasibility study. In the following discussion, soil gas differs from landfill gas in that soil gas samples were collected from shallow soils (less than 4 feet deep) that may be affected by ambient air conditions. Landfill gas samples, on the other hand, are samples of deeper landfill gas less affected by atmospheric conditions.

4.1.2.2 Phase I Remedial Investigation Results

Figure 2-2 presents the ten Phase I soil gas sampling locations. Table B-2 presents all detected compounds. Average soil gas concentrations are presented in Table A-4 along with the average ambient air data for comparison. The frequency of detections and range of concentrations for the detected compounds in soil gas are shown in Table A-5. This table breaks the ten soil gas sample locations into three data sets: Off-Property sample (SG44), Western Landfill Perimeter samples (SG1 and SG7-A) and interior property samples (remaining sample locations). Sample SG44 was collected in the area of Clarkstown Landfill waste which extends beyond the Town property.

A summary of the VOC detections is presented below. It should be noted that there are no applicable federal, state or local regulatory standards for VOCs in soil gas, although federal and state regulations exist for combustible gas levels in soil gas, as described in the following Section 4.1.2.4. The federal Occupational Safety and Health Administration (OSHA) issues permissible exposure limits (PELs) for workplace exposures. These PELs may apply at the Clarkstown Landfill during remedial measures if exposures to landfill or soil gases are possible. Soil gas concentrations may impact upon ambient air contaminant levels. This correlation is made in the Ambient Air Section (4.5).

The interior property samples had the greatest number of detected volatile compounds (22) and generally the highest concentration of these compounds. Dichlorodifluoromethane (Freon 12) was detected in every sample at a range of 8 parts per billion (ppb) to 17,000 ppb. Toluene (4-10,000 ppb), m/p xylene (21-5,800 ppb), o-xylene (15-1,000 ppb) and 1,2,4-trimethylbenzene (37-680 ppb) were all detected in seven of the eight interior property sample locations. Benzene (4-330 ppb) and ethylbenzene (85-3,800 ppb) were detected in six of the eight samples, and vinyl chloride (4-2,100 ppb) and 1,3,5-trimethylbenzene (20-80 ppb) were detected in five of the samples. The remaining compounds were detected in 50 percent or less of the interior property sample locations at ranges of 1.4 ppb to 610 ppb.

The western landfill perimeter samples had nine detected volatile compounds. Vinyl chloride (190 and 990 ppb) and toluene (170 and 860 ppb) were detected in both samples. Freon 12 which was detected in all the interior property samples was detected in one of the perimeter samples (SG7-A) at a concentration of 4,300 ppb. Ethylbenzene (1,300 ppb), m/p xylene (1,100 ppb), o-xylene (400 ppb) and trichlorofluoromethane (Freon 11) (220 ppb) were all detected in western perimeter sample SG7-A at concentrations that fell within the concentration ranges of the interior property samples. Ethyl chloride (1,500 ppb) and benzene (450 ppb) were detected in one of the two samples at concentrations higher than the interior property samples.

The off-property sample (SG44) located northeast of the Town of Clarkstown property in landfilled waste had twelve (12) volatile compound detections. This sample was taken at a location where landfilling operations had taken place between the years 1970 and approximately 1975. The compound 1,2,4-trichlorobenzene (4.5 ppb) was only detected at this location at an extremely low level. Freon 12 (202 ppb), toluene (60 ppb), 1,3,5-trimethylbenzene (24 ppb), 1,2,4-trimethylbenzene (50 ppb) and p-dichlorobenzene (67 ppb) were all detected at concentrations that fell within the concentration ranges of the interior property samples. The remaining detected compounds were found at levels less than the interior and western perimeter samples.

4.1.2.3 Phase II Remedial Investigation Landfill Gas Sampling Results

The Phase II soil gas sampling locations are also presented in Figure 2-3. Table B-3 presents all detected compounds, and Table A-6 presents the frequency of detection and range of concentrations for the detected compounds. Table A-6 breaks the soil gas samples into two data sets, namely the vent sample (LFG-8B) and the main landfill samples (LFG-2B, LFG-3B and LFG-3B DUP). The Phase II detections were comparable to or less than the Phase I detections, confirming the general level of detected VOCs in the gas generated by the landfill.

The vent sample was obtained from the northwest corner vent installed beneath the capped area around the refuse transfer station in order to evaluate landfill gas conditions beneath the liner. Seventeen volatile compounds were detected in the vent sample. 1,1,2-trichlorotrifluoroethane (0.19J ppb) was detected only in the vent sample and 1,2-dichlorotetrafluoroethane (11 ppb) was detected at a higher concentration in the vent sample than the Phase II main landfill samples. Both dichlorodifluoromethane (Freon 12) (20 ppb) and Benzene (2.7 ppb) were detected in the vent sample within the concentration ranges for the Phase II main landfill samples. All other detected compounds in the vent sample were found at concentrations lower than those of the Phase II main landfill samples.

The Phase II main landfill samples were obtained from the top of the landfill utilizing a mobile drive point sampling unit (Geoprobe®) mounted in a van. The use of the Geoprobe® allowed for samples to be obtained from a greater depth than the previous sampling effort. Sample LFG-2B was obtained from 10 feet below ground surface (bgs) and sample LFG-3B was obtained from 9 feet bgs.

Twenty-one volatile compounds were detected in the Phase II main landfill samples. Four compounds were detected in all three samples (1,4-dichlorobenzene at 3.1-16 ppb, benzyl chloride at 3.6JN-12JN ppb, isopropylbenzene at 2.3J-3.8 ppb, and 1,2-dichlorotetrafluoroethane at 1.2J-7.8 ppb) and one compound, chloroethane, was detected in one sample at 7.1 ppb. These compounds were not detected in the Phase I soil gas samples. Dichlorodifluoromethane

(8.5-32 ppb), vinyl chloride (6.8-10 ppb), tetrachloroethene (0.92-12 ppb), toluene (63-150 ppb) and o-xylene (14-17 ppb) were detected in all Phase II main landfill samples at ranges that fell within the detected concentration ranges from the Phase I main landfill samples. All other detected compounds were found at concentrations lower than those of the Phase I main landfill samples.

4.1.2.4 Phase II Soil Gas Screening Results

Phase II soil gas screening was completed in selected areas to evaluate compliance with landfill gas migration control requirements of the NYSDEC Part 360 regulations and the newly issued Federal Resource Conservation and Recovery Act (RCRA) Subtitle D regulations for municipal landfills. Soil gas screening was conducted around the maintenance and administrative buildings where gas levels may not exceed 25% of the lower explosive limit (LEL) of methane in air. Figure 2-3 presents the soil gas screening locations and Table 2-8 presents the screening data. The gas levels for these locations (97, 98, 99 and 100) ranged from 4% to 18% of the LEL which is below the regulated levels. Soil gas screening was also conducted along Route 303 to confirm the Phase I soil gas results which indicated that off-site gas migration was not occurring in this area. The regulations require that methane in air concentrations may not exceed 5% of the LEL at the property boundary. The gas levels for seven (7) of thirteen (13) of the soil gas screening locations exceeded the 5% LEL level. Soil gas screening location 104 was too saturated to obtain a reading and soil gas screening location 93 located in the northeast corner of the landfill had a reading of greater than 100% of the LEL.

4.1.2.5 Summary of Soil Gas/Landfill Gas Sampling Results

Based upon the results of the RI sampling the following can be concluded regarding landfill gas:

- 1) Landfill gas is currently being generated at the landfill and is being emitted to the atmosphere.

- 2) Landfill gas when mixed with air is explosive at certain levels. These explosive levels have been found at one location, but most locations are below the explosive limit.
- 3) Landfill gas at the Clarkstown Landfill was found to contain trace amounts of toxic and hazardous contaminants.
- 4) Landfill gas at the Clarkstown Landfill contains NMOCs (Non-Methane Organic Compounds) which contribute to the deterioration of the atmosphere. The estimated quantity of emissions is expected to exceed federal regulations.

Landfill gas measurements at the landfill were taken either from vents or probes placed below the landfill surface. These measurements represent concentrated levels of the landfill gas before being diluted by the atmosphere. Once the landfill gas is released from the vents or escapes through the landfill surface there is a dilution of the gases by mixing with air. However, since the intended use of the landfill will include use of the site by maintenance workers and other Town employees and limited use by site visitors, landfill gas contaminants are a concern.

Table 4-3 shows the ranges of selected undiluted landfill gas contaminants detected during the RI. Some contaminants are listed on the table as carcinogenic (cancer causing) at or above the listed PELs (permissible exposure levels). The Table 4-3 comparison shows that concentrated contaminant levels found in the gas samples are well below the PELs. However, the fact that these emissions will continue for many decades is a concern. The remedial measures for these landfill gas issues are addressed in the Final FS Report.

4.1.3 Test Pits

A test pit program was completed in two areas of the landfill, the former Ballfield Area and the Northeast Area to evaluate the nature and extent of the waste. The Northeast Area extends beyond the present site property boundary. Three test pits were excavated in the former Ballfield Area and five were excavated in the Northeast Area. Figure 2-1 presents the test pit

TABLE 4-3 SELECTED COMPOUNDS PRESENT IN LANDFILL GAS AND SOIL GAS AT THE CLARKSTOWN LANDFILL			
COMPOUND	RANGES IN DETECTED CONCENTRATIONS (ppb)	CARCINOGENIC	PEL⁽¹⁾ (ppb)
Toluene	4-10,000	Yes	100,000
Benzene	2.5-450	Yes	1000
Ethylbenzene	1.2-3800	No	100,000
m/p-Xylene	0.64-5800	No	100,000
o-Xylene	0.68-1000	No	100,000
Freon 113	1.4-11	No	1,000,000
1,1-Dichloroethane	7-94	No	100,000
Vinyl Chloride	0.64-990	Yes	1000
Trichloroethene	0.31-48	Yes	25,000
p-Dichlorobenzene	18-140	Yes	75,000

Notes:

- (1) Permissible exposure levels for continuous exposure during any 8 hour workday of a 40 hour work week.
- (2) ppb = Parts Per Billion

locations. Test pits were excavated with a backhoe to the maximum reach of the backhoe arm or until native soils were encountered, wastes and soil types were logged as well as the depth to groundwater. Field monitoring with an OVA and a combustible gas indicator was performed to evaluate the potential off-gassing of volatile vapors, combustible gases and odors during any future remedial excavation activities.

In addition to field logging the excavations, composite samples of the excavated landfill wastes were collected for testing for Toxic Characteristics Leaching Procedure (TCLP) and RCRA characteristics from the test pits located in the northeast area. Table B-4 presents the analytical results for the TCLP and RCRA hazardous waste characteristics. While no samples exceeded the regulatory limits, some compounds were detected at levels well below the limits in the TCLP extract. Barium (480B ug/l to 1,150B ug/l), cadmium (1.6B ug/l to 4.1 ug/l) and lead (28B ug/l to 384B ug/l) were detected in all five samples. Selenium (37.9B ug/l to 60.1B ug/l) was found in three samples and chromium (7.3B ug/l) was found in one sample. The volatile chlorobenzene (1J ug/l to 12 ug/l) was detected in all samples, while 2-butanone (1J ug/l) was detected in one sample.

The RCRA characteristics results showed that two of the five samples, while below the regulatory limit of 500 mg/kg, were reactive to sulfide (RFWTP3 at 308 mg/kg and RFWTP5 at 74.6 mg/kg). These results indicate that the waste found was not hazardous under the RCRA regulations.

4.2 Surface Water and Sediment

4.2.1 Surface Water

4.2.1.1 Previous Investigations

Recognizing the importance of the Hackensack River as a public drinking water source and its susceptibility to contamination by urban runoff and other sources, two water quality stream surveys were performed on the river and its tributaries by the NYSDEC, Division of Water, on January 18, 1989 and March 2, 1989. Figure 4-1 presents sampling locations for both surveys.

The samples were analyzed for the following selected compounds: Priority Pollutant metals (antimony, arsenic, beryllium, cadmium, chromium, copper, zinc, mercury, lead, nickel, selenium, silver, and thallium), acid/base/neutral extractable organic compounds, (pyrene, nitrobenzene, hexachloroethane, 2-nitrophenol), pesticides/PCBs (aldrin, endrin, chlordane, aroclor 1221), volatile halogenated organic compounds (trichloroethene, vinyl chloride, bromomethane, chloromethane) and volatile aromatic organic compounds (benzene, toluene, styrene, naphthalene).

The results from the January sampling round showed that the Priority Pollutant metals were not of concern because their levels were either less than the analytical detection limits or were below the New York State Water Quality Standards. All of the pesticides/PCBs and volatile aromatic compounds analytical results were less than detection limits.

Table A-7 in the appendix summarizes the halogenated volatile organics data from these two sampling efforts. The data are presented separately in the table for locations that are both upstream and downstream of the Clarkstown Landfill for comparison. Compounds detected in upstream surface water samples are not likely to be derived from the Clarkstown Landfill, while compounds found in downstream samples may be derived from the landfill or other upstream sources such as hazardous waste sites or urban runoff. A majority of the results for the halogenated volatile organic compounds, most of which are common industrial solvents, were less than detection limits. However, detected concentrations not attributable to the Clarkstown Landfill were noted at the January upstream locations 4, 7, and 8, and the March upstream locations 5A and 6A. Detected concentrations were also noted for January downstream location 3 and March downstream locations 1A through 4A (see Figure 4-1).

The highest concentrations of volatile halogenated organics were reported for two locations that are upstream of the Clarkstown Landfill and downstream of the Bradley Industrial Park and the Xerox Corporation facility. The highest concentrations reported at these two locations (location 4 of the January sampling round and location 5A of the March round) were for tetrachlorethene

(PCE), ranging from 1 ug/l to 7 ug/l. Downstream location 1A of the March round of sampling showed the highest concentrations of trichloroethene (TCE), 1,1-dichloroethane and methylene chloride. Location 1A is one of the furthest downstream sampling points. Surface waters at this location reflect the quality of water draining from the entirety of the topographic basin containing the Clarkstown Landfill and the numerous other potential sources of contamination.

A surface water sampling effort was conducted in 1992 in the Bradley Industrial Park south of the landfill as part of the RI/FS of the Xerox Corporation facility. Nine samples were collected from drainage channels in the industrial park which were shown to be impacted by contaminated groundwater discharge of an organic solvent plume emanating from the Xerox facility. The following halogenated volatile organic compounds were detected in the surface water samples at the concentrations indicated in parentheses: 1,1-dichloroethane (ND - 2.55 ug/l), 1,2-dichloroethene (ND - 8.24 ug/l), 1,1,1-trichloroethane (ND - 17.3 ug/l), trichloroethene (ND - 26.1 ug/l) and tetrachloroethane (ND - 53.9 ug/l) (Personal Communication, NYSDEC, Albany, New York office, 1992). All sampling locations are upstream of the wetlands surrounding the Clarkstown landfill.

Halogenated volatile organic compounds were also detected in groundwater from private supply wells south of the landfill and from a monitoring well installed approximately 200 feet west of Route 303 on the drive-in theater property. A small intermittent stream flows through this property toward the Clarkstown landfill and feeds into Muddy Brook along the south side of the landfill. (Personal Communication, NYSDEC, Albany, New York office, 1992). The source of the VOCs in groundwater in this area and any potential impacts to surface water are presently unknown.

4.2.1.2 Phase I and Phase II Remedial Investigation Results

Figure 2-1 presents the twelve Phase I and the nine Phase II RI surface water sampling locations. Tables A-8 and A-9 in the appendix summarize the Phase I and II RI surface water sampling data, respectively, and Table B-5 presents all detected compounds. The data are

presented as upstream or downstream with respect to the Clarkstown Sanitary Landfill in Tables A-8 and Table A-9 for comparison.

Compounds detected in upstream samples (SW-1, SW-2, SW-3, SW-10, SW-11, and SW-12) are not likely to be derived from the landfill, while compounds detected in downstream samples (SW-4 through SW-9, and SW-13 through SW-18) may be derived from more than one source including the landfill, urban runoff, and other upstream sources such as hazardous waste sites. Downstream sample locations SW-4, SW-13, SW-14, SW-17 and SW-18 are located directly adjacent closest to the landfill and therefore should be the samples most likely to reflect landfill impacts.

To determine the significance of compounds detected in the surface water, a comparison of the surface water upstream/downstream sample results was made to the New York State Ambient Water Quality Standards and Guidance Values for the protection of human health and aquatic life. In addition, upstream/downstream comparisons of the data were made to evaluate contributions of constituents in surface water from the landfill versus upstream contaminant sources. Based on a review of the surface water data and sampling locations with respect to one another, upstream/downstream comparisons were made for the following sample pairs or groups, as discussed below:

<u>Upstream Samples</u>	versus	<u>Downstream Samples</u>
SW-02-02		SW-18-02
SW-1 and SW-2		SW-4
SW-2-02		SW-4-02
SW-12-02		SW-13-02 and SW-14-02
SW-11		SW-8
SW-4		SW-7
SW-4-02		SW-17-02
SW-14-02		SW-15-02
SW-15-02		SW-16-02

The sampling data were only compared to other data collected during the same sampling phase (Phase I and Phase II) because surface water quality varies seasonally, annually, and possibly daily reflecting antecedent conditions (rainfall, snowmelt, flooding). Phase I represented a dry season sampling round and Phase II represented a wet season sampling round.

The standards for cadmium, chromium, copper, lead, nickel, silver and zinc were calculated using the sample hardness data (calcium plus magnesium) and formulas provided in the regulations. The calculated standards are presented in the complete surface water detection table (Table B-5) located in Appendix B. The Hackensack River and its tributaries are used for drinking water purposes approximately 1.5 miles downstream from the landfill in the Tappan reservoir but not in close proximity to the landfill. Therefore data were compared to the strictest NYSDEC water quality standards whether for human health or for aquatic organisms. These standards are provided in Tables A-8, A-9 and B-5 for reference. This conservative comparative approach has been used since:

- 1) The landfill is upstream of a drinking water supply in-take source. While this water intake is over one mile downstream, the federal Safe Drinking Water Act requires water suppliers to evaluate potential upstream contaminant sources contributing to a surface water supply source within a 60 day stream travel time. The Clarkstown Landfill is within this travel time from the Tappan reservoir and therefore contaminants from the landfill could have an impact.
- 2) Drinking water standards represent levels of metals and other compounds which are permissible for human consumption without adverse human health impacts. However, the levels of metals and other compounds which affect aquatic organisms in many cases are lower than those allowed for humans in drinking water. Some compounds at very low (single digit part per billion) levels have been found to have detrimental adverse effects on the aquatic ecology. In addition, some compounds such as certain heavy metals can accumulate in the food chain in other animals or humans who use these aquatic organisms as a food source.

Organic Compounds

During the Phase I sampling effort, as shown on Table A-8, nine volatile organic compounds and two semivolatile organic compounds were present in the surface water samples, although no pesticides or PCB's were found in the samples. Tetrachloroethene, a common industrial solvent, was detected at upstream location SW-3 at a concentration of 7.0 ug/l, and at downstream location SW-4 at 2.0J ug/l, both above the strictest guidance value for the protection of human health for this compound (0.7 ug/l). No standards for the protection of aquatic life exist for this compound. Bis(2-ethylhexyl)phthalate exceeded the applicable standard of 0.6 ug/l in sample SW-12 at 4J ug/l. No other organic compounds were detected at concentrations exceeding regulatory levels.

A review of Figure 2-1 and Tables A-8 and B-5 in the appendix indicates that generally lower concentrations and frequencies of detection of volatile organic compounds were reported for the Phase I downstream samples than the upstream samples. Four of the nine volatile organic compounds listed in Table A-8 were not detected at any of the downstream locations (methylene chloride, chloroform, 1,1,1-trichloroethane, and bromodichloromethane). The greatest number of detections and highest concentrations of volatile organic compounds occurred at upstream location SW-11, located in a southerly-flowing tributary at the northwest corner of the landfill. This stream drains stormwater runoff from Route 59 and the bordering properties.

Sample SW-3 reported the highest concentration of tetrachloroethene. This location is downstream of the former drive-in theater property which has recently been identified to be impacted by halogenated volatile organic compounds. A comparison of the results for SW-3 and SW-4 suggests that the tetrachloroethene detected at SW-4 at 2J ug/l may not be due to the landfill but rather a source located upstream of SW-3. Trichloroethene was present in the Hackensack River at SW-10 (3J ug/l) located upstream of the basin draining the landfill and surrounding properties. Although some of these volatile organic compounds were present in the leachate at the Clarkstown Landfill, numerous other upstream sources for these contaminants appear to exist in the area.

Two semivolatile organic compounds were detected only in upstream samples, namely di-n-butylphthalate and bis(2-Ethylhexyl)phthalate. The carbon disulfide detections are questionable due to its presence in the field equipment blank sample.

During Phase II surface water sampling, as presented in Tables A-9 and B-5, there was only one volatile organic detection at downstream location SW-16-02 in the wetlands. Trichloroethene was detected at 2 ug/l at this location below the NYSDEC guidance value of 3ug/l. During Phase II, surface water samples were not analyzed for semivolatile organics. Two locations, SW-4-02 and SW-17-02 were analyzed for pesticides and PCB's due to Phase I detections in groundwater monitoring wells near those sampling stations. There were no detections of either type of compound in these two samples.

Inorganic Compounds

Overall, for both phases of sampling, the inorganic compounds were detected at a greater frequency than the organic compounds, as indicated in Tables A-8, A-9 and B-5. The most significant inorganic compounds for evaluating impacts of the landfill on surface water are the heavy metals (cadmium, arsenic, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc) and aluminum. These compounds were detected in the leachate and are typically not naturally occurring or occur only at trace levels in unpolluted surface waters.

The most frequently detected metals during the Phase I round of sampling were aluminum, iron, lead, manganese and zinc. Aluminum and iron were detected in all the samples. Iron exceeded the ambient water quality standard in all but one sample while aluminum exceeded the standard in six of the twelve samples. The aluminum exceedances were similarly elevated for both the upstream and downstream samples. With the exception of one sample (SW-7), similar ranges in iron concentrations were also reported in both the upstream (135.0J - 6560.0J ug/l) and downstream (562.0J - 4450.0J ug/l) samples. Iron and aluminum are naturally-occurring compounds in sediment and are likely derived from suspended solids in the surface water.

The zinc and lead standards were exceeded in two upstream and one downstream Phase I sample, namely in upstream samples SW-11 (zinc at 49.0 ug/l) and SW-10 (lead at 3.7BJ ug/l) and downstream wetlands sample SW-7 (zinc at 485J ug/l and lead at 94.8J ug/l). In addition, the lead concentration was reported at the calculated standard value of 3.8BJ ug/l at downstream location SW-9. Of the remaining metals listed above, aluminum, manganese, cadmium and copper exceeded their respective standard in at least one sample. Cadmium was reported slightly above the calculated standard of 2.4 ug/l in one sample (downstream sample SW-5 at 4.0B ug/l). Copper exceeded the calculated standard in one upstream (SW-10) and two downstream samples (SW-6 and SW-7). The aluminum and manganese standards were exceeded in SW-7. There were no reported exceedances of standards for arsenic, chromium, nickel, and silver, although the mercury analytical data were rejected during data validation.

During Phase II, the most frequently detected metals were aluminum, copper, iron, lead, manganese, nickel and zinc. All of these compounds except lead were detected in all samples. Iron exceeded the applicable ambient water quality standard in all samples. Phase II sample SW-17-02 showed the greatest number of inorganics detections and the highest concentrations for seven of the nine inorganics tabulated. This sample was collected from ponded waters in a small stream channel in the wetlands beyond SW-4-02 and the diffusion point of Muddy Brook, within fifty feet of the landfill. Most other Phase II samples were collected from waters flowing at various rates. This location is one of the closest to the landfill and would be expected to show the greatest impact due to proximity. However, evaporation of ponded water over time could result in the observed elevated concentrations.

During Phase II, calculated copper and lead standards were exceeded each in only one sample, namely in downstream samples SW-15-02 (copper at 12.3 B ug/l) and SW-17-02 (lead at 15.1 ug/l). Three of the nine samples exceeded the zinc standard of 30 ug/l (downstream samples SW-15-02 at 35.6 ug/l, SW-16-02 at 65.8 ug/l, and SW-17-02 at 82.6 ug/l). The aluminum standard of 100 ug/l was also exceeded at these three locations.

A comparison of the upstream and downstream surface water data was made to identify potential impacts on surface water from the landfill versus upstream contaminant sources, primarily road runoff. In general, the Phase I upstream samples SW-1, SW-2, SW-3 and SW-12 and Phase II upstream sample SW-12 reported the least number of standards exceedances and lower metals concentrations than the downgradient samples. These samples were located along small tributaries draining towards the landfill property and appear to be the most representative site background samples. However, for Phase I the highest concentrations for numerous inorganics, including barium, calcium, chromium, iron, lead, magnesium, manganese, potassium, sodium, and zinc, were reported in upstream sample SW-11 and downstream sample SW-8. Sample SW-11 was collected from a small tributary which appears to be impacted by runoff from the Route 59 business area and passes through the wetlands near SW-8. The elevated concentrations at SW-8 may be the result of this impacted runoff from the Route 59 area. Similarly to Phase I upstream sample SW-11, during Phase II upstream sample location SW-2 reported amongst the highest inorganic concentrations for aluminum, copper, iron, lead, manganese, nickel and zinc.

The surface water sampling on the south side of the landfill in Muddy Brook produced conflicting results with respect to potential landfill impacts on surface water. Downstream sample SW-4 reported higher concentrations than the corresponding Phase I upstream samples SW-1 and SW-2 for aluminum, iron, lead, and zinc, suggesting an impact from the landfill on surface water in this area. However, during the Phase II sampling at two of these same locations (SW-2-02 and SW-4-02), overall concentrations were greater in the upstream sample (SW-2-02), in particular for aluminum, copper, iron, manganese, nickel, and zinc. One other downstream Phase II sample, SW-18-02, located adjacent to the former Ballfield Area, reported no standards exceedances and only potassium at higher concentrations than other metals detected in the corresponding upstream sample, SW-2-02. Copper and lead were present at similar levels in the two samples. However, surface waters flowing from SW-2-02 towards SW-18-02 may undergo dilution by waters from the tributary entering Muddy Brook between the two sampling points, thereby possibly reducing the metals concentrations. This process is supported by the Phase I data which showed that metals concentrations were less in sample SW-1 from the tributary entering Muddy Brook compared to those in SW-2 collected from Muddy Brook itself.

In the westerly flowing tributary on the north side of the landfill, an increase in metals concentrations was reported from the Phase II upstream sample SW-12-02 to downstream samples SW-13-02, then SW-14-02. Levels of aluminum, copper, iron, lead, manganese, nickel, and zinc were observed to increase in the direction of streamflow past the landfill. Iron, however, was the only compound which exceeded the iron standard. The data suggest that impacts from the landfill and/or the properties on the north side of this tributary have resulted in increases in these metals in the surface water. Metals concentrations in downstream Phase II sample SW-15-02 were generally less than the closest upstream sample SW-14-02, although the waters at SW-15-02 may undergo dilution from the southerly-flowing tributary from Route 59.

The wetlands surface water samples (SW-7, SW-8, and SW-16-02) were not collected from defined stream channels, but from standing or slow moving ponded water. Surface water quality from these sampling locations represents the combined effects of the landfill as well as upstream contaminant sources due to mixing of waters draining into the wetlands. From the Phase I sampling, metals concentrations in the wetlands sample SW-8 were generally similar to or less than those measured in the nearest upstream sample, SW-11. During Phase II, concentrations of some heavy metals (iron, lead, and zinc) were higher in the wetlands sample SW-16-02 than the nearest upstream sample SW-15-02 but less than the upstream sample for others (aluminum and copper).

The Phase I data suggest that an evaporative effect has resulted in increased concentrations of dissolved compounds in the ponded wetland waters collected at Phase I sample location SW-7. Sample SW-7 was collected in November 1990, a few months after the other samples were collected during the July 1990 sampling effort. Insufficient flow was available for sampling near SW-7 during the July sampling round and only small volumes were present in November. As a result, sample SW-7 reported extremely elevated concentrations of aluminum, chromium, copper, iron, lead, nickel, and zinc compared to the other samples. Based on a comparison of the metals concentrations found at SW-7 and the nearest upstream sample, SW-4, an evaporative effect cannot account for all of the elevated metals detections. Although it is not possible to

quantify the contribution of the landfill on metals in surface in the wetlands, the data suggest that the landfill has influenced surface water quality.

A review of the Phase I data for SW-4 and SW-5 indicates that the water quality adjacent to the landfill (SW-4) was found to be similar to that of Greenbush Brook (SW-5) which originates at the Bradley Industrial Park to the south and traverses past the Chromalloy facility. The naturally-occurring metals iron, aluminum, and manganese were greater in SW-4 than SW-5, although the heavy metals zinc and chromium were slightly more elevated in SW-5.

A comparison of the Phase I results for samples SW-10, SW-9 and SW-6 was made to identify any measurable changes in the Hackensack River water quality due to inflow from Greenbush Brook and the other tributaries draining the basin. Sample SW-10 represents upstream Hackensack River water quality, SW-6 represents downstream river water quality, and SW-9 represents water quality at the confluence of the Hackensack River and the tributaries draining the Clarkstown Landfill and surrounding properties. The overall water quality was unchanged between the upstream (SW-10) and downstream (SW-9) sample locations based on similar measured concentrations of the major naturally-occurring compounds calcium, magnesium, potassium, and sodium. The heavy metals barium, copper, and manganese were also comparable in the two samples.

Other heavy metals showed some slight variations between SW-6 and SW-10. Aluminum, chromium, lead, and zinc levels were higher in upstream sample SW-10 while only iron and nickel were more elevated in downstream sample SW-6. Iron was shown earlier to be consistently elevated in upstream and downstream samples collected from around the landfill. Nickel does not appear to be a metal of concern because it was found only in SW-6 and one other sample (SW-7). Sample SW-9 reported higher levels of most detected metals than the downstream sample SW-6, suggesting local impacts on surface water quality from the tributaries entering the Hackensack River. However, based on the SW-10 and SW-6 data comparison, the overall Hackensack River water quality does not appear to be impacted.

Upstream sampling stations SW-2 and SW-12 and downstream station SW-4 are the only locations which were sampled for both phases of the remedial investigation. A comparison of Phase I and II inorganics results for SW-2 shows that during Phase II aluminum, copper, iron, lead, nickel and zinc detections were higher. Phase II results for SW-4 inorganics were all significantly lower than the Phase I results with the exception of sodium. For SW-12, Phase II aluminum, barium, iron, manganese, sodium, and zinc detections were higher than Phase I.

4.2.2 Sediments

4.2.2.1 Phase I and Phase II Remedial Investigation Results

Figure 2-1 presents the twelve Phase I and the nine Phase II RI sediment sampling locations. The sediment samples were collected at the same locations as the surface water samples. Tables A-10 and A-11 in the appendix summarize the Phase I and II RI sediment sampling data, respectively, and Table B-6 presents the complete sediment data for all detected compounds. The data in Tables A-10 and A-11 are presented as upstream or downstream with respect to the Clarkstown Sanitary Landfill for comparison.

Compounds detected in upstream samples (SD-1, SD-2, SD-3, SD-10, SD-11 and SD-12) are not likely to be derived from the landfill, while compounds detected in downstream samples (SD-4 through SW-9 and SD-13 through SD-18) may be derived from more than one source including the landfill, urban runoff, and other upstream sources such as hazardous waste sites. Downstream sample locations SD-4, SD-13, SD-14, SD-17 and SD-18 are located directly adjacent to the landfill and therefore should be the samples most likely to reflect landfill impacts.

During Phase I, the samples were analyzed for the full Target Compound List (TCL) parameters and total organic carbon content (TOC). During Phase II, samples were analyzed for TCL metals, semivolatile organic compounds, volatile organics, hexavalent chromium, TOC, as well as pesticides/PCBs at two locations (SD-4 and SD-17) due to Phase I detections of these compounds in nearby monitoring wells.

To determine the significance of compounds detected in the sediment, a comparison of the sediment sample results was made to the New York State Sediment Criteria listed in the data tables. In addition, upstream/downstream comparisons of the data were made to evaluate contributions of constituents in sediment from the landfill versus upstream contaminant sources.

The sediment criteria for the organic compounds are based on predicted toxicity to either aquatic organisms or humans. The aquatic toxicity values pertain to benthic organisms (burrowing into the sediments) or epibenthic organisms (crawling or floating on top of the sediment surface) and are provided for both acute and chronic effects. The human health criteria for the organics are the predicted concentrations above which accumulation of the compound in aquatic animals, such as fish or shellfish, would occur such that ingestion would exceed a human health tolerance, action level, or cancer risk dose. The criteria also account for wildlife bioaccumulation for selected compounds but are not included as a separate column in Table B-6. Instead, these criteria appear in the footnotes because values exist for only two of the compounds detected in the RI samples, namely 4,4-DDT and heptachlor epoxide.

For the inorganic compounds, two separate criteria apply. The first value appearing in the tables, the lowest of the "Lowest Effect Level" or "Effect Range-Low" (LEL), is the concentration which will impair sediment use by some benthic organisms, but that can be tolerated by the majority. The second value, the lowest of the "Severe Effect Level" or "Effect Range-Moderate (SEL)", is the concentration which will significantly impair use of the sediment by benthic organisms. Sediment criteria are not available for all compounds; therefore, a comparison to the criteria was made for only those compounds for which criteria were available.

The Phase I sediment data herein were compared to the 1989 Sediment Criteria which were revised effective November 1993. The Phase II data were compared to the revised criteria appearing in Tables A-11 and B-6. Based on a review of the sediment data and the sediment sample locations with respect to one another, upstream/downstream comparisons were made for the following sample pairs or groups, as discussed below:

<u>Upstream Samples</u>	versus	<u>Downstream Samples</u>
SD-1 and 2		SD-18
SD-1 and 2		SD-4
SD-12		SD-13 and 14
SD-11 and 14		SD-15
SD-10		SD- 6
SD- 9		SD- 6

Compared to surface water data that represent a single point in time, sediment data relate a longer term 'picture.' Sediments contribute to stream beds over many decades and therefore provide a history of changes in levels of contamination over a period of time. These changes could be a result of contamination from deposition of floodwater sediments, soil erosion, spills, or discharges from other upstream or adjacent sources, as well as impacts from the landfill.

Organic Compounds

Overall, the Phase I sediment sample locations upstream of the Clarkstown Landfill reported higher concentrations and frequencies of detection of the organic compounds indicating the presence of upstream sources of organic contamination (See Table A-10). The following eight volatile organic compounds were detected: acetone, methylene chloride, 1,1-dichloroethene, 1,1-dichloroethane, chloroform, 2-butanone, benzene, and chlorobenzene. Several semivolatile organic compounds, primarily those classified as polycyclic aromatic hydrocarbons (PAHs), and one pesticide, 4,4-DDT, were also detected in the samples. The PAHs are found in road tars and vehicle exhaust, and are commonly present in storm runoff from urban areas.

Of the eight volatile organic compounds detected during Phase I, only one, 1,1-dichloroethene, was present above its human health criterion of 0.02 ug/gOC (micrograms per gram of organic carbon). Upstream location SD-2 reported a value of 0.05 ug/gOC, slightly above the criterion, and downstream location SD-5 reported a value of 0.25 ug/gOC. SD-2 is located along a

tributary which drains Route 303 and adjoining businesses. Location SD-5 is in Greenbush Brook which receives inflow from Bradley Industrial Park and the Xerox Corporation facility area. 1,1-dichloroethene is a typical breakdown product of the industrial solvents, such as trichloroethene and tetrachloroethene, that were previously found in samples collected from the drainage channels in Bradley Industrial Park and were attributed to the Xerox facility.

The Phase I detected semivolatile organics are almost exclusively limited to the PAHs. The PAHs were primarily found in all upstream samples, and only one downstream sample, SD-6. Fluoranthene was the most frequently detected PAH and was found in all upstream samples. The PAH detections are probably a result of road runoff and do not appear to be caused by activities at the landfill. None of the PAHs detected in the sediment samples were present in any of the Phase I RI leachate, groundwater, surface water, or subsurface soil samples. The PAHs are strongly attracted to the natural organic matter present in the sediments.

During Phase I, six of the PAHs exceeded their respective human health sediment criteria. Aquatic sediment criteria do not exist for these six compounds. The highest exceedances were reported for upstream samples SD-1, SD-11, and SD-12, ranging from 9.17 ug/gOC (indeno(1,2,3-cd)pyrene in SD-1) to 28 ug/gOC (benzo(a)anthracene, chrysene, and benzo(a)pyrene in SD-12), above the human health criteria of 1.3 ug/gOC. No semivolatile organics were present above the sediment criteria in samples collected downstream and in close proximity to the landfill (i.e. - sample locations SD-4, SD-5, SD-7, SD-8, and SD-9). The only downstream location with reported exceedances, SD-6 located along the Hackensack River, is the furthest downstream sampling location. In contrast to the SD-6 results, no semivolatiles, including PAHs, were present in the upstream Hackensack River sediment sample, SD-10. This data suggests that the PAHs detected in SD-6 have entered the river from the tributaries draining the basin or in runoff from properties located along the river.

During the Phase II sampling, the following five volatile organic compounds were detected: methylene chloride, acetone, carbon disulfide, 2-butanone, and 2-hexanone. With the exception

of carbon disulfide, these volatiles are common laboratory chemicals. There are no sediment criteria for these compounds.

Similarly to the Phase I results, with the exception of samples SD-13 and SD-14, the Phase II upstream sample locations reported higher ranges of concentrations and frequencies of detection of the organic compounds in sediment than downstream locations. On the south side of the landfill, background sample SD-2 reported the greatest number and highest concentrations of organics, in particular the semivolatiles. On the north side of the landfill, upstream location SD-12 reported lower concentrations of organic compounds than downstream samples SD-13 and SD-14 located on the unnamed tributary to the north of the landfill. Samples SD-13 and SD-14 were collected from a section of the tributary not characterized previously during the Phase I sampling effort. Sample SD-14 reported the greatest number of detections and highest concentrations of organics for all samples, including the greatest number of detections above the human health sediment criteria. Semivolatile organic concentrations in SD-14 ranged from 10.62 ug/gOC (acenaphthene) to 461.54 ug/gOC (fluoranthene). Sample SD-14 was the only Phase I or Phase II sample to exceed a semivolatile aquatic criterion; the chronic criterion for the PAH phenanthrene (120 ug/gOC) was exceeded at a concentration of 353.85 ug/gOC. The data suggest that the PAHs exceeding the sediment criteria were derived from upstream sources or properties other than the landfill lying adjacent to the tributary. None of these PAHs were detected in the Phase I or Phase II leachate, groundwater, or subsurface soil samples collected from the landfill property.

The Phase II detected semivolatile organics are almost exclusively limited to the PAHs. The most commonly detected semivolatiles include the PAHs fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, and indeno(1,2,3-cd)perylene. As with the Phase I PAH detections, these compounds are typically associated with storm runoff from urbanized areas. During Phase II, seven of the PAHs exceeded their respective sediment criteria. Upstream sample SD-2 reported six PAH detections above the human health based criterion (1.3 ug/gOC) for benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, and indeno(1,2,3-cd)pyrene with

concentrations ranging from 5.75 ug/gOC (indeno(1,2,3-cd) pyrene) to 19.54 ug/gOC (benzo(b)fluoranthene). No other upstream locations reported values exceeding criteria. Phase II downstream samples SD-13, SD-14, and SD-15 all reported PAH detections above the 1.3 ug/gOC criterion for the same six PAHs mentioned above. Sample location SD-15 is downstream of the unnamed tributary on the north side of the landfill and the tributary draining Route 59 where PAHs above the criteria were detected during Phase I in upstream Sample SD-11.

Individual concentrations of PAHs above the human health criteria of 1.3 ug/gOC ranged from 6.34 - 13.62 ug/gOC at SD-13; 56.92 - 146.15 ug/gOC at SD-14; and 2.38 - 5.15 ug/gOC at SD-15.

One pesticide compound was found in one Phase I RI sediment sample. 4,4-DDT was present in downstream Hackensack River sediment sample SD-6 at 0.34 ug/gOC, above the human health criterion of 0.01 ug/gOC but below the aquatic acute and chronic toxicity criteria. Although 4,4-DDT was also found in the Phase I RI leachate and groundwater samples, the detection in SD-6 does not appear to be related to the landfill. Location SD-6 is the furthest downstream sampling location from the landfill and 4,4-DDT was not detected at any other sediment sampling locations.

During Phase II, samples SD-4 and SD-17 were sampled for pesticides and PCBs, as well as the semivolatiles, to evaluate the presence of the pesticide 4,4-DDT and a PCB compound (Aroclor-1260) in two nearby Phase I groundwater monitoring well samples (RFW-2 and RFW-3D; see Figure 2-2). There were no pesticide detections reported in SD-17. The pesticide heptachlor epoxide was detected at SD-4 with a concentration of 0.03 ug/gOC, exceeding the human health based criterion (0.0008 ug/gOC) but not the aquatic toxicity criteria. No other pesticide or PCB detections were reported for either sample.

Inorganic Compounds

Overall, for both sampling phases of the RI, the inorganic compounds were detected at a greater frequency than the organic compounds, as indicated in Tables A-10, A-11 and B-6. The most significant inorganic compounds for evaluating impacts of the landfill on sediment are the heavy metals including cadmium, arsenic, chromium, copper, lead, mercury, nickel and zinc. These compounds were detected in the leachate and are typically not naturally occurring or occur only at trace levels in unpolluted sediments. Iron, aluminum, calcium, magnesium, potassium, sodium and manganese are typically of secondary importance, since they are the primary naturally-occurring elements in sediment, unless their concentrations exceed background levels or sediment criteria.

During Phase I, the most frequently detected of the above heavy metals were arsenic, chromium, copper, lead, nickel and zinc. In general, the metals were present at varying concentrations in both upstream and downstream samples. The lowest concentrations were reported for two upstream samples, SD-1 and SD-10, and two downstream samples, SD-4 and SD-5. Lead was present at high concentrations in upstream sample SD-11 at 421.0 milligrams per kilogram (mg/kg) and downstream Hackensack River sample SD-6 at 462.0J mg/kg, compared to the other samples which ranged from 5.2J mg/kg (SD-4) to 189 mg/kg (SD-12). Zinc was significantly elevated in upstream samples SD-2 (1730.0J mg/kg) and SD-11 (930.0 mg/kg) compared to the other samples. Although these metals were present in leachate at the landfill, other upstream sources appear to exist which may have contributed to the observed downstream concentrations.

During Phase II, the most frequently detected heavy metals were arsenic, cadmium, chromium, copper, lead, nickel and zinc. Similar to the Phase I results, the metals were present at varying concentrations in both upstream and downstream samples. Overall, SD-17 reported the lowest concentrations of heavy metals while SD-16 in the wetlands reported the highest heavy metals concentrations.

A comparison of the upstream and downstream sediment data was made to identify potential impacts on sediment from the landfill versus upstream contaminant sources, primarily road runoff. In the southeast corner of the landfill, concentrations of arsenic, cadmium, chromium, iron, manganese and nickel were greater in downstream sample SD-18 (located on the re-routed portion of Muddy Brook) compared to upstream samples SD-1 and SD-2. These data suggest that this portion of the landfill (formerly the Ballfield area) has impacted sediment at this location. (Sample SD-1 was collected during Phase I while SD-18 was collected during Phase II. For the sediment results, data for separate sampling events were compared although the sampling was done at different times and seasons. Sediment data provide a historical record of past inputs to the system and do not generally vary significantly seasonally or over a few years time.) Also in Muddy Brook on the south side of the landfill, concentrations of all of the TCL metals detected, except cadmium, zinc, and the major naturally-occurring elements calcium, magnesium, and sodium, were higher in downstream sediment sample SD-4 compared to upstream samples SD-1 and SD-2, reflecting impacts on sediment from the south portion of the landfill.

In the westerly flowing unnamed tributary on the north side of the landfill, concentrations of some heavy metals (cadmium, lead, and mercury) were higher in downstream samples SD-13 and SD-14 than upstream sample SD-12. The data suggest that impacts from the landfill and/or the properties on the north side of this tributary have resulted in increases in these metals in the sediments. Arsenic, manganese, and nickel were higher in the upstream sample.

Sediment data for sampling locations SD-11, SD-14, and SD-15 were compared to determine the relative impacts on downstream sediment at SD-15 from the two unnamed tributaries on the north side of the landfill, both of which drain Route 59 and the adjoining businesses. Impacts on sediment at SD-15 appear to be due primarily to the southerly flowing tributary from the area where sample SD-11 was collected. Concentrations of all TCL metals detected were higher in SD-11 than SD-15, and all detected metals except magnesium were higher in SD-15 compared to SD-14. The southerly flowing tributary would not be expected to be impacted by the landfill along its course from Route 59 to the confluence with the westerly flowing tributary. From this

point to its discharge point into the Hackensack River, it may be influenced by the northwest corner of the landfill and the westerly flowing tributary.

The wetlands samples (SD-7, SD-8, and SD-16) were not collected from defined stream channels, but from standing or slow moving ponded water. Sediment quality from these sampling locations represents the combined effects of the landfill as well as upstream contaminant sources due to mixing of waters draining into the wetlands. In the northern half of the wetlands west of the landfill, concentrations of aluminum, arsenic, and potassium are greater in both samples SD-8 and SD-16 than the nearest upstream sample SD-11. Additionally, chromium, copper, and manganese were higher in SD-8 than SD-11. In the southern half of the wetlands, all detected metals except calcium, lead, magnesium, and zinc were higher in SD-7 than the two upstream samples SD-1 and SD-2. Although it is not possible to quantify the contribution of the landfill on metals levels in sediment in the wetlands, the data suggest that the landfill has influenced sediment quality.

A comparison of the data for SD-10, SD-9, and SD-6 suggests that Greenbush Brook and the other tributaries draining into the Hackensack River have had a measurable impact on sediment in the river. All detected metals were present at higher concentrations in downstream samples SD-6 and SD-9 than upstream sample SD-10. However, these impacts are observed to decrease downstream based on a comparison of sediment data for SD-6 and SD-9. Only aluminum and lead were found at higher concentrations in SD-6 than SD-9.

For both phases of sampling, iron, manganese, and all of the heavy metals were present in some of the samples at levels above the New York State LEL sediment criteria. Concentrations above the LELs are not expected to significantly affect aquatic life in the streams and wetlands around the landfill. These levels in sediment may generally be tolerated by a majority of benthic organisms with no severe effects expected. Some sensitive species may be affected. The LELs were exceeded at the same frequency in both upstream and downstream samples.

During Phase I, the heavy metals copper, lead, and zinc, and the naturally-occurring metals iron and manganese each exceeded the State SEL in at least one sample. The zinc SEL (270 mg/kg) was exceeded in four upstream samples (SD-2, SD-3, SD-11 and SD-12) from 354 to 1730J mg/kg and four downstream samples (SD-6 through SD-9) from 306 to 692 mg/kg. The manganese SEL (1100 mg/kg) was slightly exceeded in only one sample, SD-9, collected at the confluence of Greenbush Brook and the Hackensack River at 1140 mg/kg. The SELs for copper, lead, and iron were exceeded in three upstream (SD-3, SD-11, SD-12) and three downstream (SD-6, SD-8, SD-9) samples.

During Phase II, the heavy metals copper, iron, lead, manganese and zinc each exceeded the SEL in at least one sample. The copper SEL (110 mg/kg) was slightly exceeded in one downstream sample (SD-16) with a concentration of 125 mg/kg. The lead SEL (110 mg/kg) was exceeded in three downstream samples (SD-13, SD-15 and SD-16) with concentrations ranging from 194 J mg/kg (SD-15) to 310J mg/kg (SD-16). The zinc SEL (270 mg/kg) was exceeded in three downstream samples (SD-13, SD-15 and SD-16) with concentrations ranging from 320 mg/kg (SD-13) to 899 mg/kg (SD-16). The data indicate that the landfill may contribute to the identified exceedances of criteria for these metals in sediment, although the actual amounts caused by the landfill cannot be determined due to the presence of other upstream sources and the mixing effects of surface waters and sediment in the wetlands.

4.3 SOILS

4.3.1 Surficial Soils

4.3.1.1 Phase I Remedial Investigation Results

Three surficial soil samples (SL-1, SL-2 and SL-3) were collected during the Phase I RI at the locations shown on Figure 2-1. Sample SL-1 was collected off-site from the landfill to provide background soil data. Samples SL-2 and SL-3 were collected within the physical boundaries of the Clarkstown Landfill in older, currently inactive areas of the landfill. Sample SL-2 was collected from the former ballfield and sample SL-3 was collected from a portion of the landfill which extends beyond the northern Town property boundary. The remainder of the site soils

at the time of the sampling had been recently disturbed (transfer station area) or were being prepared for placement of the interim soil cover layer. Therefore, no samples were collected from these areas. Sample SL-1 was collected from a residential area along Greenbush Road adjacent to a small stream draining towards the landfill.

Table A-12 in the Appendix summarizes the surficial soil data for the heavy metals and detected organic compounds. The complete data tables for all detected compounds in surficial soil is also presented in the appendix as Table B-7. The surficial soil samples were analyzed for the full Target Compound List (TCL) parameters. To determine the significance of the detected concentrations, the data were compared to the USEPA Health Effects Assessment Summary Tables (HEASTS) contained within the NYSDEC draft Cleanup Policy and Guidelines, October 1991; the Eastern USA soil background data for inorganic compounds provided in the NYSDEC Technical and Administrative Guidance Memorandum (TAGM) HWR-92-4046, November 1992; and the soil cleanup objectives to protect groundwater quality contained within the same NYSDEC TAGM. The HEASTS values are based on ingestion of soils by humans. The NYSDEC TAGM soil cleanup objectives are estimated values for organic compounds which will not result in an exceedance of the State groundwater standards through leaching of contaminants from the soil.

Organic Compounds

Ten organic compounds were present in the surficial soil samples. Eight of the ten compounds were found in the background sample SL-1. Three of the organic compounds (phenanthrene, pyrene, and benzo(a)pyrene) were found only in the background sample. These three compounds, and a fourth (fluoranthene) that was found in SL-1 and SL-3, are polycyclic aromatic hydrocarbons (PAHs) which are typically elevated in soils in urban areas. PAHs can be derived from vehicle exhaust and transferred to soils by dry deposition or in precipitation.

As shown on Table A-12, only one organic compound, namely acetone at 123J $\mu\text{g}/\text{kg}$ in sample SL-2, was present at a level above the respective NYSDEC soil cleanup objective of 110 $\mu\text{g}/\text{kg}$. A possible source of the acetone is laboratory interference. Acetone is also a volatile compound which makes its presence in surficial soils unlikely. No organic compounds exceeded the respective HEASTS values.

Inorganic Compounds

All of the inorganic compounds of concern were present in the surficial soil samples. Many of the inorganics are naturally occurring compounds in soils. Of the nineteen inorganic compounds, thirteen were present at their highest concentrations in the site background sample SL-1. Mercury, nickel, and zinc were each present in at least one sample at concentrations above the typical Eastern USA background ranges presented in the NYSDEC TAGM. The highest levels for both the mercury and zinc were reported in the site background sample SL-1. Beryllium was also present in all three samples at levels above the HEASTS value and the Eastern USA background level. All other inorganic compound results did not exceed either the HEASTS values or the Eastern USA background levels.

4.3.2 Subsurface Soils

4.3.2.1 Transfer Station Study Results

A previous investigation of the chemical quality of subsurface soils was completed in 1989 in the area occupied currently by the refuse transfer station (Charles R Velzy Associates, Inc, November 1989). Samples of native peat, organic silt, and clay soils underlying the fill were collected at four soil boring locations. Samples were analyzed for the full Target Compound List parameters. The objective of the investigation was to evaluate the nature and extent of any subsurface soil contamination and to confirm that construction of the transfer station could proceed without interfering with future site remedial actions.

Four volatile organic compounds, namely carbon disulfide, tetrachloroethene, toluene, and 2-hexanone were found at low concentrations in the native soils ranging from 0.007 mg/kg to 0.057 mg/kg. Twenty-one semivolatile organic compounds were detected at concentrations ranging from undetected to 7.6 mg/kg. No State soil guidance values were in existence at the time of the transfer station study, although, a comparison of the transfer station study data with the current State soil guidance values contained within NYSDEC TAGM HWR-92-4046, effective November 1992, indicates that only one organic detection (1400 μ g/kg of chrysene) exceeded the respective soil cleanup objective of 400 μ g/kg.

The semivolatile compounds consisted mainly of the polycyclic aromatic hydrocarbons (PAHs) such as anthracene, phenanthrene, pyrene, benzo(a) pyrene, and naphthalene. This suite of organic compounds is consistent with the type of fill deposited in this portion of the landfill which was determined to consist of household rubbish and construction debris. In particular, the PAHs are typically associated with road asphalt, creosotes used in wood preservatives, and roofing tars present in construction debris. The PAHs are relatively immobile in groundwater and readily adsorb to the soil matrix.

Infrequent detections of inorganic compounds (in particular, the heavy metals copper, nickel, selenium, and zinc) were noted in excess of the typical Eastern USA background ranges. Similar to the surface soil data, beryllium was consistently elevated above the background soil range.

Construction of the transfer station was approved by NYSDEC considering that remediation of the soils was unnecessary because of the low permeability of the soils and low mobility of the compounds found. It was determined that the transfer station construction would not interfere with any remedial actions selected for this portion of the site. An approximate six acre parcel around the transfer station was closed (capped) in accordance with the 1988 NYSDEC Part 360 regulations (Velzy/WESTON, 1990).

4.3.2.2 Phase I Remedial Investigation Results

Subsurface soil samples of the native confining zone deposits beneath the landfill were collected at eight locations during drilling for installation for the RI monitoring wells, as indicated on Figure 2-2. The objective of the sampling was to further evaluate the extent of contamination in the confining zone deposits based on the transfer station study data which suggested that the confining zone deposits may act as a "sink", or filter, for a variety of organic compounds. Additional testing was completed to determine the physical and adsorptive properties of the confining zone deposits. Samples of the peat deposit were collected during drilling at well locations RFW-3D, 4D, 7D, and 12. Samples of the organic silt deposit were collected at well locations RFW-6S, 8D, 14 and 15. The samples were generally collected within reaching a depth of ten feet below the fill/native soils interface.

Table A-13 in the appendix summarizes the subsurface soils data for selected heavy metals and the organic compounds detected. The complete data table presenting all detected compounds is also presented in the appendix as Table B-8. To determine the significance of the detected concentrations, the data were compared to the NYSDEC TAGM, HWR-92-4046, November 1992, soil cleanup guidance values (for organics) and Eastern USA background soil concentration ranges (for inorganics). The soil cleanup objectives are concentrations in soil which will not result in an exceedance of the groundwater standards through leaching of contaminants from the soil. The State guidance values for inorganic compounds are based on Eastern USA or New York State background concentrations unless site background levels can be established. Site-specific background samples could not be obtained during the Phase I RI because the property consists entirely of filled land.

Organic Compounds

Of the organic detections only one compound, namely benzoic acid, was found at a level above the State soil cleanup objective. Methylene chloride and acetone were also reported at levels above the guidance. However, both compounds were found in blank samples which suggest

their source to be laboratory interference. The other organic detections were mainly reported for samples from below the north landfill mound (SB-7 and SB-8) and the southwest corner of the site (SB-5 and SB-6). An occurrence of 4,4-DDT found in boring samples SB-5 and SB-5D (duplicate sample), but rejected during data validation, correlates to the detection of the same compound in groundwater in the associated well (RFW-3D) installed at that boring location (See Section 3.4).

Inorganic Compounds

Almost all of the inorganics detections of cadmium, chromium, nickel, and zinc exceeded the typical Eastern USA background values. The concentrations of each of these compounds are relatively uniformly distributed indicating that they may be naturally elevated in site soils. Chromium was noted to be greatly elevated in upgradient/background groundwater (See Section 3.4) and, therefore, would be expected to also be elevated in subsurface soils which receive this groundwater inflow. A total of one or two samples exceeded the background values for arsenic, copper, and mercury. Overall, the inorganics detections fell within the typical Eastern USA background soil concentration ranges listed in Table A-13.

In contrast to the refuse transfer station study results, no PAHs were found in the Phase I RI soil samples except for the naphthalene found in sample SB-8. The absence of PAHs may be due to the lack of construction debris, noted to be the likely source of the PAHs, in the area of the RI borings.

4.4 GROUNDWATER

4.4.1 Groundwater Monitoring Well Locations

A total of 25 monitoring wells and three piezometers were installed at the landfill during the RI field investigation, at the locations shown on Figure 2-2. A majority of the monitoring wells (wells RFW-1S/D, 2, 3S/3D, 4S/4D, 5S/5D, 6S/6D, 7S/7D, 8S/8D, 9S/9D, and 12) were installed around the perimeter of the landfill. All but three wells (RFW-14, 15, and 16) were

installed outside of the leachate collection system line. The purpose of the wells was to monitor groundwater quality downgradient of the landfill. Wells RFW-9S, 14, 15, and 16 are screened in the waste mass. Wells RFW-14, 15, and 16 were installed in the center of the landfill to establish the height of the leachate mound and leachate quality. In the vicinity of well RFW-9S, some landfilled material was placed over the area traversed by the leachate collection line since its installation, thereby creating a potential pathway for leachate to bypass the leachate collection system. Well RFW-9S was screened within this fill material overlying the leachate collection line to monitor the quality of any leachate moving in this manner. Wells RFW-10S/D, 11, and 13 were installed to monitor upgradient groundwater quality.

The piezometers (RFW-11PZ1, 11PZ2, and 13PZ) were installed as additional groundwater level observation points. The wells and piezometers were generally installed as couplets to establish the vertical groundwater flow direction and variations in water quality with depth. Figure 2-2 also presents the locations of existing monitoring wells installed prior to the RI as part of the operational landfill groundwater monitoring program (Wells B-201S/D, B-202S/D, B-203S/D, B-204I/D, B-205S/D, B-206S/D, B-207S/D, and B-208D). Groundwater samples could not be collected from the RI leachate wells RFW-15 and RFW-16 due to well damage.

4.4.2 Groundwater Conditions

Table A-14 in the appendix summarizes historical groundwater data for the existing monitoring wells, and Tables A-15 and A-16, respectively, summarize the Phase I and Phase II RI groundwater data. Upgradient, downgradient, and leachate monitoring well data are presented separately in Tables A-14, A-15 and A-16 for comparison purposes. Detected organic compounds and selected heavy metals are presented in these tables. Tables presenting the analytical results for all detected compounds for each RI well are presented in the appendix (B-9).

The Phase I RI samples were analyzed for the full Target Compound List (TCL) parameters and selected miscellaneous inorganic leachate indicator parameters. The historical data represent one

round of sampling for the TCL parameters and additional sampling rounds for miscellaneous heavy metals. The Phase II samples were analyzed for the NYSDEC Part 360 baseline volatile organics using a low detection limit method of analysis (EPA Method 524.1), and the Part 360 baseline metals, cyanide, and leachate indicators. Two wells (RFW-2 and RFW-3D) were also analyzed for the TCL pesticides and PCBs to confirm Phase I detections of two of these compounds in the wells. The inorganics and organic data are discussed separately below with respect to upgradient/downgradient comparisons, comparison to the New York State groundwater standards, frequency of occurrence, and comparison to the historical data.

4.4.2.1 Organic Compounds

Phase I Results

The greatest number and highest concentrations of organic compounds in groundwater were reported for leachate samples obtained from monitoring wells screened in the refuse. The leachate well data represent the quality of raw leachate within the saturated refuse which may potentially migrate off-site. The source of the organic compounds is primarily the lesser amounts of hazardous materials disposed of with the municipal and commercial wastes.

A majority of the detections in the leachate wells include the aromatic hydrocarbons, such as benzene, toluene, xylenes, and ethylbenzene, which are found in motor oils and gasoline. These compounds were found at comparable levels during both the Phase I RI and historical sampling events. The highest detections above groundwater standards occurred for toluene (180 $\mu\text{g/l}$) and the chlorinated hydrocarbon 1,2-dichloroethene (100 $\mu\text{g/l}$) in well RFW-14 during the RI. Only one organic compound (chlorobenzene) was present in the RI leachate well RFW-9S at a concentration equal to the groundwater standard (5 $\mu\text{g/l}$). These data indicate that leachate potentially escaping capture by the collection system in this area is not significantly impacted by organic contamination. The volatile organic compounds chloroform and methylene chloride were reported for the historical groundwater sampling, but not during the RI. A greater number of organic compounds were detected during the historical sampling rounds than the Phase I RI sampling round; however, all were detected on only one occasion.

The upgradient groundwater was found to be relatively free of organic contamination. With the exception of one detection of the pesticide Endosulfan I, no organic compounds were found in upgradient monitoring wells. Because this compound was not detected in any other landfill monitoring wells, it can be attributed to some other off-site source such as commercial or residential application of pesticides.

Excluding the two leachate wells (RFW-9S and RFW-14), five organic compounds were present in the Phase I RI downgradient groundwater samples. All but one of these compounds were present at levels above the State groundwater standards. A review of the data indicates that the downgradient groundwater has not been significantly impacted by organic compounds present in the leachate. The presence of the extensive confining unit deposits and upwards hydraulic gradients appear to be effective in preventing the migration of constituents in the leachate into the deeper glacial outwash, till, and bedrock formations. Only two volatile organic compounds, 1,2-dichloroethene (total) and trichloroethene, were detected each in one RI well at concentrations slightly greater than the standards. Trichloroethene was present in RFW-3S, monitoring the glacial till in the area of a potential "window" in the confining unit, at 13 ug/l during Round 1. The 1,2-dichloroethene detection was reported at 13 ug/l for well RFW-9D which monitors the deep glacial outwash and is not located directly downgradient of the landfill, but more cross-gradient of the landfill. This detection may rather be the result of an off-site source.

The occurrence of the pesticide 4,4-DDT and the polychlorinated biphenyl (PCB) Aroclor-1260 at extremely low concentrations in two adjacent downgradient RI wells (RFW-2 and RFW-3D) is highly unusual. These compounds are not typically found in groundwater due to their low water solubility. Their presence in groundwater suggests that a nearby source exists in the landfill and that the confining unit deposits may be thin or absent in this area. However, these compounds are relatively immobile in groundwater and they were not detected in the surface water or sediment samples collected directly downstream of the landfill. Again, the occurrence of the organics chloroform, methylene chloride, and bis(2-ethylhexyl)phthalate may be due to laboratory interference.

Phase II Results

Volatile organic compounds were detected in nine of the Phase II groundwater samples, and in two of the samples above the respective State groundwater standards. The detections above State standards occurred for the chlorinated solvents cis-1,2-dichloroethene at 12 ug/l in well RFW-9D and tetrachloroethane at 7 ug/l in RFW-10D, both above the respective standards of 5 ug/l. The RFW-10D detection can not be attributed to the landfill because this well is upgradient of the landfill. As mentioned above, well RFW-9D is located cross-gradient of the landfill.

No volatile organic compounds were present above the State standards in samples from any of the other monitoring wells sampled during the Phase II effort. Trace concentrations of volatile organics at or less than 5 ug/l were reported for wells RFW-3S (Phase 2 round, trichloroethene at 2 ug/l), RFW-4S (2-butanone at 5 ug/l), RFW-5D (toluene at 4J ug/l and total xylenes at 2J ug/l), RFW-8D (vinyl chloride at 1J ug/l, 2-butanone and carbon tetrachloride at 1 ug/l, and trichlorofluoromethane at 2 ug/l), RFW-9S (chlorobenzene at 4 ug/l), RFW-12 (trichloroethene at 2 ug/l and tetrachloroethene at 4 ug/l), and RFW-13 (chlorobenzene at 1 ug/l).

The greater number of detections of volatile organics in the Phase II samples compared to the Phase I samples is likely due to the lower analytical detection limits achieved during Phase II. Detections were reported for the upgradient wells (RFW-10D and RFW-13), the leachate well RFW-9S, and six downgradient wells (RFW-3S, 5D, 8D, 9D and 12 in the outwash/till; and RFW-4S in the peat). The presence of the same or related volatile organics in both the leachate wells and downgradient groundwater wells indicates that the landfill leachate has impacted groundwater beneath the landfill. The presence of the tetrachloroethene as well as other chlorinated solvents at levels below the standards in site upgradient well RFW-10D, may be attributable to unknown off-site sources considering the documented detections of similar "fingerprints" of organic compounds in residential wells located upgradient of this well (See Section 1.0 and Rockland County Health Department data in Appendix E).

The pesticide heptachlor was detected at extremely low concentrations in downgradient wells RFW-2 and RFW-3D. These wells were sampled for pesticides to confirm the Phase I detections of 4,4-DDT at trace levels. This compound was not detected in any other groundwater, surface water, sediment, subsurface soil, or leachate samples collected at the landfill. In addition, heptachlor is not typically found in groundwater due to its low water solubility. Therefore, it is likely that the occurrence of this pesticide is anomalous or due to a localized source in the landfill.

4.4.2.2 Inorganic Compounds

Phase I Results

The inorganic compounds were found at a greater frequency of detection than the organics, as indicated in Tables A-14 and A-15, because most inorganics are naturally occurring in groundwater. The most significant inorganic compounds for evaluating impacts of the landfill on groundwater are the heavy metals (arsenic, cadmium, chromium, copper, iron, manganese, mercury, lead, nickel, and zinc) because they were detected in the leachate and are either not normally detectable in groundwater or are detectable only at trace levels. Cyanide was not detected at concentrations exceeding the standards during either the historical or Phase I RI sampling rounds.

Of the heavy metals, only chromium, iron, lead, and manganese were found at levels exceeding the State groundwater standards in any downgradient Phase I RI well samples. The highest chromium detection was reported for an upgradient/background bedrock monitoring well (RFW-11D) suggesting that chromium is naturally elevated in the bedrock aquifer. Lead was detected above the standard in a leachate monitoring well (RFW-14) and in two shallow downgradient wells monitoring the silt/peat and outwash deposits (RFW-6S and RFW-7, respectively). Zinc and cadmium concentrations exceeded the respective standard in only one Phase I RI well sample, namely the leachate monitoring well RFW-14. The iron and manganese concentrations are particularly high in all classes of monitoring wells (upgradient, downgradient, and leachate

wells). Iron and manganese are naturally occurring compounds in the subsurface soils and may be released to groundwater under the reducing conditions present beneath the landfill.

A comparison of Table A-14 with Table A-15 shows that the maximum concentrations of the metals reported for the Phase I RI downgradient samples were less than the historical downgradient well data, often by one order of magnitude. Although these differences may be partly due to improved well construction and sampling procedures used during the RI to reduce groundwater turbidities, the data does indicate that groundwater quality has not degraded since the previous sampling rounds.

Phase II Results

Similarly, as Phase I, the inorganic compounds were found at a greater frequency of detection than the organics, as indicated in Table A-16, since most inorganics are naturally occurring in groundwater. Heavy metals (arsenic, cadmium, chromium, copper, iron, manganese, mercury, lead, nickel, and zinc) are the most significant compounds for evaluating impacts of the landfill on groundwater since they were detected in the leachate and are either not normally detectable in groundwater or are detectable only at trace levels. Cyanide was not detected at concentrations exceeding the State standard during the Phase II RI sampling round.

Of the heavy metals, only chromium, iron, lead, and manganese were detected at levels exceeding the State standards. Chromium was detected above the standard at upgradient and downgradient monitoring wells screened in the bedrock aquifer, as well as in the outwash deposits. The highest chromium level was present RFW-8D, a downgradient well screened in the outwash. The data indicate that chromium is naturally elevated in the bedrock aquifer as discussed above in the Phase I results section. Lead was detected slightly above the standard in leachate monitoring well RFW-9S. The elevated concentrations of iron and manganese can be attributed to the same factors as discussed above in the Phase I inorganics results.

Besides the heavy metals, other inorganics exceeding the groundwater standards were barium at 3700J ug/l in RFW-8S, above the standard of 1000 ug/l, and sodium above the 20,000 ug/l standard in wells RFW-7D, 7S, 8D, 9D, 9S, 10S, 11, 12 and 13, ranging from 20,600 ug/l (RFW-12) to 216,000 ug/l (RFW-9S). Besides the leachate well RFW-9S, the two highest sodium levels were reported for cross-gradient well RFW-9D and upgradient well RFW-11, indicating that sodium is naturally elevated in groundwater and that the elevated detections in downgradient wells are not due to the landfill.

4.4.2.3 Phase I and II Additional Parameters

The following discussion presents the notable Phase I and II detections of the potential leachate indicator parameters total dissolved solids (TDS), biological oxygen demand (BOD-5 day), ammonia, total phenols, and chlorides. In general, a majority of the significant detections occurred in the two leachate wells (RFW-9S and RFW-14), the upgradient wells RFW-11 and RFW-13, and in the cross-gradient and downgradient wells on the north side of the landfill.

The TDS standard was exceeded in wells RFW-8D, 8S, 9D, 9S, 11, 13 and 14 during Phase I and/or II. The TDS exceedances generally correlated to exceedances of chlorides for these same wells. These wells include the leachate monitoring wells RFW-9S and RFW-14, upgradient wells RFW-11 and RFW-13, and cross- or downgradient wells RFW-8S, 8D and 9D. The exceedances in wells RFW-9S and RFW-14 reflect leachate impacts while those for wells RFW-8D and RFW-9D appear to reflect upgradient sources. A likely source of the chlorides in the upgradient wells is road salt runoff from Routes 59 and 303. These wells are directly adjacent to or downgradient of these roadways.

Well RFW-8S monitors a shallow sand interbed in the peat deposit below the landfill. This sand layer represents one of the two identified "windows" in the confining unit. The elevated chlorides in RFW-8S may reflect leachate influence. This is substantiated by the elevated BOD concentrations of 13 mg/l and 21 mg/l, respectively, detected in this well during Phase I and II, compared to concentrations generally less than 4 mg/l in the other downgradient wells.

However, significant detections of the TCL organics and metals were not reported for this well, as described in Sections 4.4.2.1 and 4.4.2.2. Slightly elevated BOD levels ranging from 7 to 14 mg/l were noted in wells RFW-4S and RFW-6S which also monitor the shallow peat/organic silt deposits, indicative of landfill leachate impacts. For comparison, the leachate monitor wells BOD levels ranged from 17 to 191 mg/l.

Total phenols were found sporadically above the standard of 1 ug/l in six wells during Phase I and II, although not in either leachate monitoring well. Ammonia was present in eight wells above the standard of 2 ug/l, including the two leachate wells and three wells which monitor the peat/organic silt deposit. The presence of ammonia is likely due to the combined effects of leachate migration and natural degradation of the marsh deposits beneath the landfill.

4.5 AMBIENT AIR

4.5.1 Ambient Air Sampling Program

The Phase I RI ambient air sampling program at the Clarkstown Landfill consisted of two phases of ambient air sampling for laboratory analysis. The samples were collected with stainless steel canisters and analyzed for volatile organic compounds (VOCs) using USEPA Method TO-14. Figure 2-3 presents the ambient air sampling locations. An initial one day sampling event was conducted to sample ambient air at "hot spots" to evaluate the maximum (worst case) concentrations of VOCs in the ambient air on the landfill. Samples were collected at three locations downwind of hot spots on the landfill perimeter for laboratory analysis. The samples were collected from locations which exhibited the highest ambient total VOCs concentrations based on results from direct reading field screening instruments.

The second phase of the air program was designed to characterize the overall site-wide impact of VOC emissions from the landfill on ambient air quality. This sampling effort involved collecting one sample upwind and three samples downwind of the landfill on three separate days, and submitting the samples for laboratory analysis for VOCs. Meteorological data collected during this phase assisted with locating the sample canisters and in the interpretation of the final

results. To determine which of the detected VOCs were possibly originating in the landfill gas and not other sources in the basin, samples of soil gas from the landfill were collected in conjunction with the ambient air data, as discussed in a following section.

The "hot spot" ambient air samples were taken on 15 August, 1990, and the remaining samples on 17, 27, and 28 August, 1990, over a period of 12 hours during each day. The "hot spot" air samples were collected in the three areas of highest total VOCs measured using the direct reading instruments. The ambient air samples taken on 17, 27, and 28 August, 1990, were located based on the wind direction (predominantly a southwest wind) for each sampling day.

4.5.2 Phase I Remedial Investigation Results

The results of the ambient air sampling program have been tabulated as several basic statistical summaries including the minimum, maximum, and average for each relevant data set by sample location and sampling period, and are presented in Tables A-17, A-18 and A-4 in the appendix. This comparison assisted with identifying possible origins of the detected VOCs and their relative concentrations. Average concentrations for each compound detected are presented along with the applicable NYSDEC short term ambient air guideline concentrations (SGC) on each summary table for reference. The short term guideline concentrations are based on a 1-hour sampling period and have been factored by 0.7 (according to USEPA guidelines for an 8-hour sample) to more accurately compare them to the actual 12-hour sampling period.

In addition to the ambient air data, Tables A-5 and A-6 show the frequency of detections and range of concentrations for the detected compounds in the Phase I and Phase II soil gas, and landfill gas samples, respectively. The average Phase I soil gas concentrations are presented on Table A-4 with the average ambient air data for comparison. VOCs detected in the soil gas and landfill gas samples represent potential indicators of landfill gas constituents detected in the ambient air samples. The soil gas samples are presumably unaffected by the ambient air. Therefore, compounds detected in the ambient air samples but not in the soil gas samples are most likely derived from sources other than the landfill.

A comparison of the data on Tables A-4 and A-6 shows that methylene chloride, methyl chloride and chloroform are found only in the Phase I ambient air samples but were not detected in the soil gas. In addition, any compounds detected in the ambient air that are believed to be derived from the landfill would be present at significantly lower concentrations in the ambient air than in the soil gas samples due to the dilution of the soil gas in the ambient air. With this in mind, it appears that the presence of the two halogenated volatile compounds, 1,1,1-trichloroethane (1,1,1-TCA) and tetrachloroethene (TCA), in the Phase I ambient air was not due to the landfill because their average ambient air concentrations were not significantly lower than the Phase I soil gas concentrations.

Table A-17 compares the hot spot ambient air results with the upwind sample results. Since there were no defined upwind samples taken during the hot spot sampling event, the average upwind data from the other sampling events were used for comparison. The hot spot locations would be expected to reflect the worst case ambient air concentrations caused by any landfill gas emissions. The upwind locations would be expected to reflect ambient air concentrations not affected or minimally affected by any landfill emissions.

A comparison of the data in Table A-17 shows that methylene chloride, freon 113, benzene, and m/p-xylene have ranges and average concentrations significantly higher at the upwind locations than the hot spot locations. This indicates that upwind sources of these compounds exist which contribute a greater percentage of the observed downwind concentrations than the landfill. Since methylene chloride was not detected in soil gas, upwind sources were the likely sole source(s) of its presence in ambient air. Benzene and m/p-xylene are commonly present in vehicle exhaust fumes. Freon 113 is commonly used as a refrigerant, an industrial solvent, and in the production of styrofoam for the packaging industry. Tetrachloroethene, acetone, carbon disulfide, and 4-methyl-2-pentanone (MIBK) were found in ranges and average concentrations substantially higher at the hot spot locations than at the upwind locations. This data indicates that a greater percentage of the observed downwind concentrations of these compounds may be originating from the landfill. However, as discussed above, the tetrachloroethene concentration in soil gas is relatively low compared to the ambient air, suggesting that the landfill is not a

significant source for this compound in ambient air. Acetone and MIBK are typical laboratory contaminants introduced during sample equipment cleaning and sample preparation in the laboratory.

Table A-18 compares the ambient air results for the upwind locations with the three downwind locations for each of the three sampling days. Each upwind location is assumed to reflect VOC concentrations minimally or not affected by the landfill relative to the downwind locations. A comparison of the data shows that freon 12, freon 113, 1,1,1-trichloroethane, ethylbenzene, o-xylene, and 1,2,4-trimethylbenzene were present at higher or similar concentrations at the upwind locations than at the downwind locations on at least one of the sampling days. This suggests that, while these compounds are present in the landfill gas, landfill gas emissions have not resulted in an increase of their concentrations above the ambient background air around the landfill. Tetrachloroethene, toluene, and carbon disulfide were present at consistently higher ranges and average concentrations at the downwind locations than at the upwind locations. This data suggests that a greater percentage of the observed downwind concentrations of toluene and carbon disulfide may be originating from the landfill. Again, the tetrachloroethene does not appear to be a result of landfill gas emissions. A much greater than 10:1 dilution rate would be expected than is inferred from the measured soil gas and ambient air concentrations for tetrachloroethene. The results for the remaining compounds are inconclusive; these compounds were found at higher concentrations in both upwind and downwind samples on different sampling days.

In summary, these simple statistical summaries suggest that landfill gas emissions from the Clarkstown Landfill may result in increased concentrations of toluene, acetone, carbon disulfide, and 4-methyl-2-pentanone (MIBK) above the ambient background air around the landfill. However, no compounds exceeded the NYSDEC short-term ambient air guideline concentrations (SGC) during the sampling program at any of the ambient air sampling locations. In addition, acetone and MIBK are typical laboratory contaminants. The NYSDEC annual ambient Air Guideline Concentrations (AGC) are presented in Table A-4 for reference. Benzene, tetrachloroethene and carbon disulfide were found to have average concentrations at the

downwind locations above the AGC. However, a comparison of the data to the AGC is based on the unlikely assumption that the landfill gas emissions and the meteorological conditions present during the air sampling program represented the average conditions for the year.

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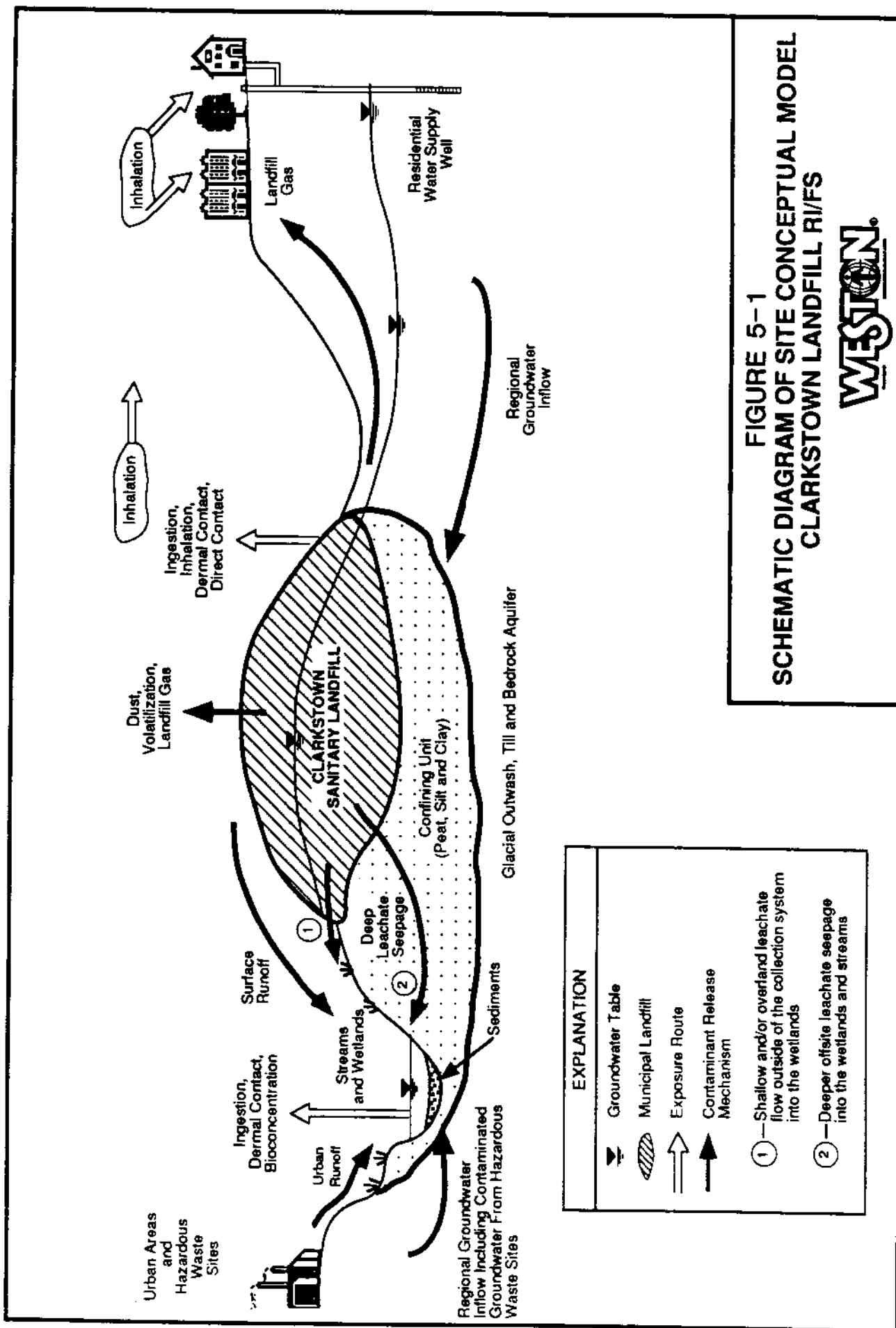
5.0 CONTAMINANT FATE AND TRANSPORT

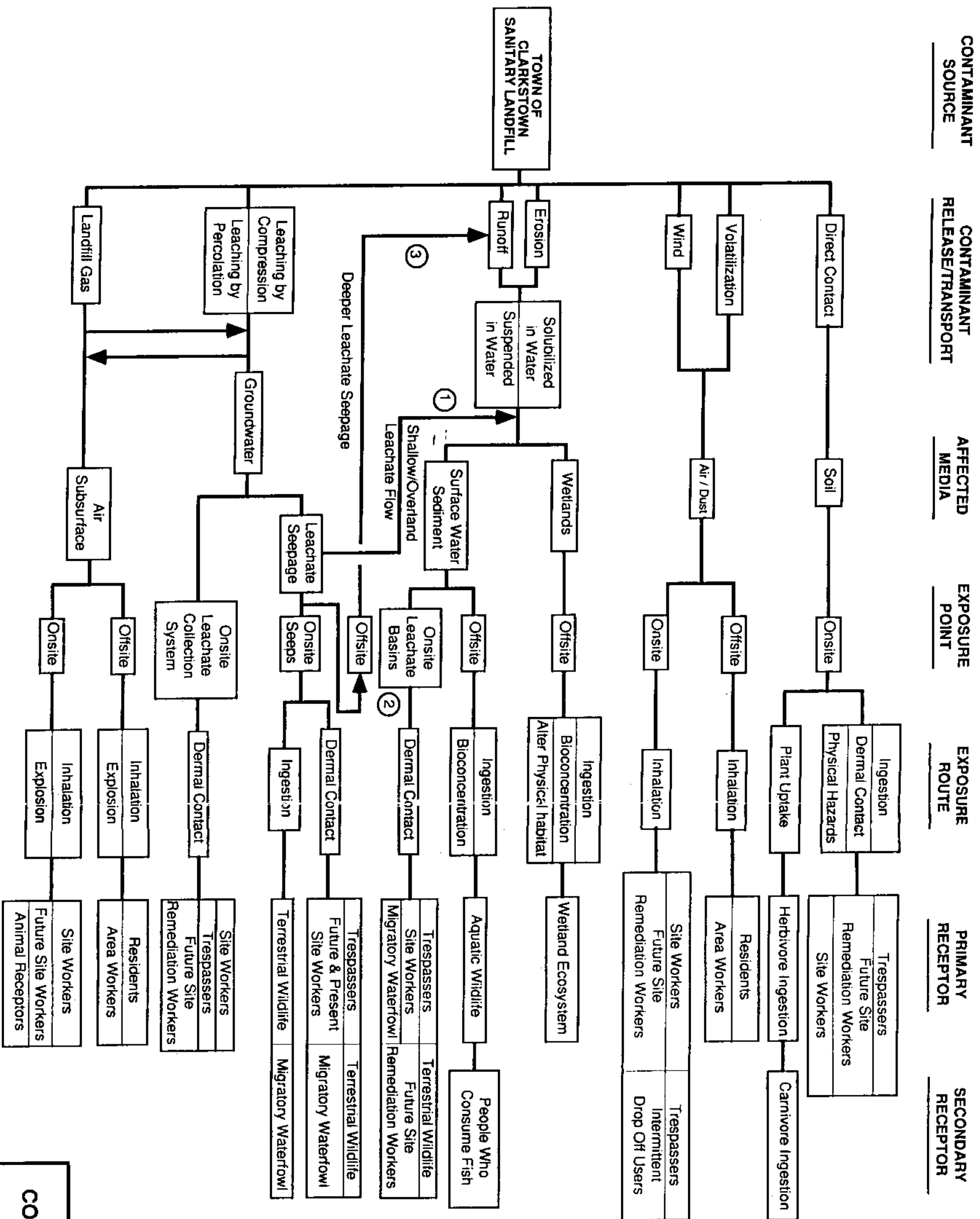
This section presents a qualitative evaluation of the contaminant fate and transport, or how potential contamination present at the landfill can move through the environment. The source of contamination emanating from the landfill includes landfill leachate, landfill gas, and surface runoff from the landfill side slopes which has carried leachate or contacted exposed waste in the past. Specifically, this section describes the occurrence of leachate and landfill gas, the types of contaminants found in the leachate and gas, the potential routes of contaminant migration, exposure pathways, and the potential human and environmental receptors. A schematic diagram of the generalized contaminant transport for the Clarkstown Sanitary Landfill is illustrated in Figure 5-1. The site specific contaminant release and transport mechanisms are presented in a flow chart format as shown in Figure 5-2. The information presented in this section should be viewed as an overall guide to the potential interaction of contaminated media (i.e. soil, surface water, air, etc.) with receptors including humans and aquatic and terrestrial wildlife. This information was used in conjunction with the data presented in Section 4.0 in preparation of the qualitative risk assessment (Section 6.0).

First, the following sections 5.1 and 5.2 provide a discussion of the subsurface conditions, site surface water drainage patterns, and the area hydrology which will influence contaminant transport. Section 5.3 presents a brief discussion of the site contaminants of concern identified during the RI with regards to their chemical and physical properties and the fate and transport of these compounds in the environment. Finally, the potential site specific contaminant release/transport mechanisms are discussed individually in Section 5.4.

5.1 Subsurface Conditions and Hydrogeology

Test borings and monitoring wells were completed for the RI investigation and were supplemented with data from previous investigations to refine the understanding of the regional hydrogeology of the Clarkstown Landfill Site. Groundwater elevation measurements were collected from the RI wells and other existing wells to determine groundwater flow directions





- EXPLANATION**
- Onsite = Within Landfill Property
- Offsite = Adjacent / Adjoining Properties
- ① - Shallow and/or overland leachate flow outside of the collection system into the wetlands
 - ② - Deeper offsite leachate seepage into the wetlands and streams
 - ③ - Offsite leachate seepage subsequently carried into wetlands and streams in storm runoff

FIGURE 5-2
CONCEPTUAL SITE MODEL FLOW CHART
CLARKSTOWN LANDFILL RI/FS



and velocities. Physical testing of subsurface soil samples was also conducted to evaluate the soil stability and permeability, and its ability to remove contaminants from groundwater. The following is a brief summary of the significant findings of the related Phase I RI data. A more detailed presentation of the data and findings is presented in Sections 3.0 and 4.0 of this report.

The Clarkstown Landfill is located in eastern Rockland County, New York, in a low, swampy basin (the "Clarkstown Basin") with diabase bedrock ridges to the east and north, and sandstone and siltstone ridges to the west and southeast. The site is underlain by seven hydrogeologic units. From the surface downwards, these units include: Fill, Peat, Organic Silt, Varved Silt and Clay, Glacial Outwash, Glacial Till, and Bedrock. This sequence of deposits extends regionally throughout the basin. All of the deposits but the Bedrock formation consist of unconsolidated sediments. The Till and Outwash were deposited during a period of active glaciation. The Peat, Silt, and Clay deposits were the result of the slow infilling of a post-glacial lake which previously occupied the basin.

The Fill material at the Clarkstown Landfill consists of organic and inorganic municipal and construction wastes and cover material. The Fill was emplaced from the 1940's to 1990 prior to and during ownership of the property by the Town of Clarkstown. The Peat, Organic Silt, and Varved Silt and Clay deposits together form a low permeability "confining unit" that is present everywhere across the site except possibly a portion of the southwest corner beneath the south landfill mound. The confining unit is thickest in the north central part of the site. The Peat and Organic Silt deposits have been compressed by the weight of the overlying Fill. The greatest degree of compression has occurred below the center of the main landfill mound where the Fill/Peat boundary lies as much as 25 feet below the surrounding elevation of the marsh. The stability of the soft compressible soils was evaluated for the RI and is discussed in Appendix F to this report, in the previous reports referenced in Section 1.2, and in Appendix A of the Final FS Report.

Four separate groundwater flow systems appear to exist beneath the landfill and include the saturated Fill, the Peat and Organic Silt, the Outwash, and the Bedrock. Groundwater flow in

the Peat, Organic Silt, and Outwash deposits is in a horizontal westerly to southwesterly direction across the landfill property towards the wetlands. The water table lies within the main landfill mass (Fill) and is slightly mounded with a radial flow pattern from the center of the landfill towards the surrounding areas. A portion of the groundwater within the landfill is intercepted by the perimeter leachate collection system with the remainder transported primarily by slow seepage into the underlying confining unit deposits. A more detailed discussion of the leachate collection system and leachate generation at the landfill is presented in Sections 2.9.1 and 4.1.1.

Where present, the confining unit deposits greatly impede the vertical downwards flow of leachate from the landfill into the deeper deposits due to their low measured vertical permeabilities, ranging from 10^{-7} to 10^{-8} centimeters per second. The low permeability of these deposits also contributes to the mounding of the water table within the landfill. The Peat and Organic Silt have a relatively high measured total organic carbon (TOC) content (10.8 to 91.6 percent) compared to the other geologic materials and, therefore, are estimated to have a high capacity for filtering out organic compounds. The possible absence of the confining deposits in the southwest corner of the property provides a direct pathway for potential leachate flow into the Outwash, Till and Bedrock. A 10 foot thick interval of the Peat deposit on the north side of the landfill was found to be interlayered with sand deposits. This area also represents a potential pathway for leachate migration.

A greater proportion of groundwater flow beneath the Clarkstown Landfill occurs within the permeable glacial Outwash deposits and fractured Bedrock. Similar to the confining unit, the Outwash is thickest in the north central part of the site and thins in the southwest corner of the site beneath the south landfill mound where a Bedrock "high" exists. A glacial Till layer, consisting of an unsorted mixture of gravel, sand, silt, clay, and cobbles, exists between the Outwash and Bedrock. The Till is relatively impermeable compared to the Outwash and Bedrock. Two distinct types of Till were found beneath the landfill, a Clay Till and a Sandy Till. The Sandy Till was found in the south and west portions of the site and was almost indistinguishable from the Outwash. The Clay Till forms a barrier to groundwater flow between

the Outwash and Bedrock. The Bedrock surface slopes down steeply to the north and west from the outcrop visible on the east side of Route 303 adjacent to the landfill. The bedrock platform, or "high", underlying the southwest part of the site, corresponds to the area where the confining unit is thin or absent.

Due to topography, the Clarkstown basin receives groundwater inflow from the surrounding high ridges. Groundwater discharges into the central low-lying area occupied by the landfill and adjacent wetlands. Beneath the landfill, groundwater exists under artesian, or pressurized, conditions in the Bedrock and Outwash. Groundwater flows upwards from these deposits into the confining unit deposits and ultimately discharges into the streams and wetlands.

The combination of upwards flow gradients and the extensive confining unit deposits provides an effective barrier to the downwards flow of leachate into the Outwash deposits and Bedrock. Where the confining unit deposits are thin or absent, the upwards flow gradients measured in the Outwash and Till offer some protection against the downwards flow of leachate from the landfill. With the planned capping of the landfill and the resultant lowering of the leachate mound, the artesian pressures should become more effective in preventing the downward migration of leachate.

The Bedrock aquifer is used as a source of drinking water in eastern Rockland County. The nearest public supply well field, operated by Spring Valley Water Company, is located approximately 2.5 miles to the west of the landfill well beyond the influence of the site. Most area residents receive their potable water supply from surface water sources including Lake DeForest and the Hackensack River. Areas with domestic drinking water supply wells in use exist east of the landfill along Greenbush Road, southeast of the landfill along Birchwood Drive (former entrance road to the Drive-In Theater), and west of the landfill along Western Highway (See Figure 3-5). These areas are estimated to lie upgradient and outside of the influence of the landfill. Two known commercial non-potable supply wells also exist to the north and south, within 1,000 feet from the landfill. These wells are also estimated to lie upgradient of the landfill.

5.2 Surface Water Drainage and Hydrology

Several streams flow along the boundaries of the Clarkstown Sanitary Landfill and ultimately into Greenbush Brook and the Hackensack River, as shown on Figure 1-2 and described in Section 3.2. Surface drainage occurs generally from the inland sections of the landfill towards the perimeter areas down the landfill slopes. Runoff from the north slope enters a westerly flowing tributary on the north side of the landfill. Drainage from the south slope enters Muddy Brook which drains into the wetlands adjoining Greenbush Brook. Runoff from the west slopes enters the wetlands.

It has been reported that at times during the Hackensack River flood stage conditions (normally spring thaw and heavy rains) the floodwaters have reached the edge of the landfill. During these events, contaminants present in the runoff from the various tributaries may become mixed in the floodwaters and distributed throughout the basin floor.

In the past, leachate seeps were observed on the west and north landfill slopes during the wet seasons and after storm events. Currently, leachate seepage along the side slopes appears to have been eliminated with the placement of the interim soil cover layer.

Placement of more than 12-inches of interim soil cover layer on the slopes of Clarkstown Landfill has resulted in runoff and the accumulation of silt in Muddy Brook and the wetlands along the southwest side of the landfill. In response, the Town has implemented erosion control measures to prevent further siltation in the wetland area. The entire top portion of the landfill has been regraded and an earthen berm constructed to prevent surface runoff from the top of the landfill into the wetlands (see Figure 3-2). The landfill side slopes have been seeded and hay bale fences have been constructed within the wetlands to prevent further transport of silt into the wetlands. Excavation of the silt has been initiated for areas containing a depth of 2 inches or more of silt, and silt bars have been removed from Muddy Brook along the south edge of the landfill.

5.3 Contaminants of Concern Fate and Transport

This section describes the fate and transport processes which affect the movement of chemicals through the environment. The specific chemicals discussed include those that were detected at the landfill.

5.3.1 Fate and Transport Processes

An understanding of the specific fate and transport processes at work at the Clarkstown Landfill is essential to evaluate contaminant migration and the potential for exposure at concentrations that pose human health or environmental risks. The physical characteristics of the Clarkstown Landfill and adjoining areas which are pertinent to the fate and transport of contaminants from the site have been summarized in the preceding Sections 5.1 and 5.2. The migration of compounds detected at the Clarkstown Landfill is influenced by environmental factors such as the hydrogeological characteristics of the aquifer, site soil conditions, and the physical/chemical characteristics of the contaminants themselves. Ultimately, the two major factors that affect the fate and transport of a contaminant are the contaminant's mobility and its persistence in the different environmental media that it encounters.

Mobility is a measure of the tendency for a chemical compound to be transported in the environment. Mobility is predominantly affected by the physical and chemical characteristics of the media and the contaminant. Some of the more important physical and chemical characteristics include solubility in water, volatilization, sorption, precipitation, and cation exchange. Compounds with high water solubilities, as indicated in Table 5-1, readily dissolve in water, can rapidly leach from wastes and soils, and are generally mobile. Volatilization is the physical process whereby a chemical goes from the surface of a liquid or solid to a gas or vapor phase. Sorption is a process whereby a chemical binds to or releases from a solid surface under electrostatic forces. Precipitation occurs when compounds which are dissolved in water combine to form a solid substance and, in the case of groundwater are removed from the flowing

TABLE 5-1

**PHYSICAL CHARACTERISTICS AFFECTING THE
ENVIRONMENTAL FATE AND TRANSPORT OF DETECTED ORGANIC COMPOUNDS**

	Water Solubility ⁽¹⁾ (mg/l)	Specific Gravity	Volatility	Sorption	Susceptible to Photolysis ⁽²⁾	Susceptible to Hydrolysis ⁽²⁾	Mobility
1. VOLATILES							
CHLORINATED VOLATILE ORGANIC COMPOUNDS							
Chlorobenzene	4.66×10^2	1.11	High	Moderate	Negligible	No	Moderate
1,2-Dichlorobenzene	1.00×10^2	1.31	High	Moderate to Strong	Negligible	Negligible	Moderate
Methyl Chloride	6.5×10^3		High	Moderate	Negligible	-	-
Chloroform	8.2×10^3	1.48	High	Moderate	Yes	Yes	Moderate
Tetrachloroethene	1.50×10^2	1.62	High	Moderate to Strong	Negligible	Negligible	Moderate
Acetone	1.0×10^6	1.27	Moderate	Moderate	Negligible	Negligible	Moderate
Carbon Disulfide	$2.9^4 \times 10^3$	1.25	High	Moderate to Strong	-	-	Low
2-Butanone	2.68×10^3	0.81	High	Very Weakly Sorbed	Negligible	Slight	Moderate
Vinyl Chloride	2.67×10^3	0.91	Very High	-	Yes	Yes	-
1,3,5-Trimethylbenzene	-	-	-	-	-	-	-
NON-CHLORINATED VOLATILE ORGANIC COMPOUNDS							
Benzene	1.75×10^3	0.87	High	Moderate	Negligible	No	High
Toluene	5.35×10^2	0.87	High	Moderate	Negligible	No	Moderate
Ethylbenzene	1.52×10^2	0.86	High	Moderate to Strong	Negligible	No	Moderate
Xylenes	1.98×10^2	0.86	High	Moderate to Strong	-	-	Low
2. SEMIVOLATILES							
Fluoranthene	2.06×10^{-1}	1.25	High	Very Strong	-	No	Slight

TABLE 5-1

**PHYSICAL CHARACTERISTICS AFFECTING THE
ENVIRONMENTAL FATE AND TRANSPORT OF DETECTED ORGANIC COMPOUNDS**

	Water Solubility ⁽¹⁾ (mg/l)	Specific Gravity	Volatility	Sorption	Susceptible to Photolysis ⁽²⁾	Susceptible to Hydrolysis ⁽²⁾	Mobility
3. PESTICIDES							
Dichlorodiphenyltri- chloroethane (DDT)	4.00 x 10 ⁻²	-	High	Very Strong	Yes	Negligible	Moderate

(1) - USEPA, 1986

(2) - Clement Associates, 1985

groundwater in the process. Cation exchange occurs primarily for the inorganic compounds only and is the process whereby ions in water are exchanged for ions on soil surfaces.

Persistence, or the amount of time a chemical will remain at measurable concentrations in the environment once introduced, is influenced by many of the same chemical and physical characteristics listed above. However, persistence is also a function of other processes in the environment such as biodegradation which is the natural breakdown of a contaminant into simpler chemical compounds by bacteria. Factors and processes that control the mobility and persistence of contaminants, in addition to the above factors, are the composition of site soils and aquifer properties including advection and hydrodynamic dispersion. Contaminants may exist in the gas phase, aqueous phase, or solid phase. The ultimate fate of these contaminants is controlled by a combination of the aforementioned factors.

The migration of contaminants is controlled by the various fate and transport processes. Processes that tend to disperse, or spread out, contamination include advection (bulk surface water and groundwater flow), surface water runoff, and leaching by dissolution or desorption from soils. Contaminants can be transported in the dissolved phase in groundwater by advection or hydrodynamic dispersion. Advection involves the transport of the contaminant at the same velocity as that of the flowing groundwater. Hydrodynamic dispersion has two components: molecular diffusion and mechanical dispersion. Molecular diffusion is the process by which ionic or molecular constituents move under the influence of concentration gradients. Dispersion is related to the varying pore fluid velocities and path lengths of the intergranular flow paths of the aquifer.

5.3.2 Fate and Transport of the Contaminants of Concern

The compounds detected at the landfill are generally grouped into two types: organic and inorganic compounds. The organic constituents consist of three different groups of contaminants

which include volatile organic compounds (chlorinated and non-chlorinated), semivolatile organic compounds, and pesticides. A summary of the major fate and transport processes for organic and inorganic compounds is given below.

5.3.2.1 Organic Compounds

A summary of the most important fate and transport processes such as water solubility, volatility, and sorption are given in Table 5-1 for the organic contaminants of concern. In general, the volatile organic compounds identified at the Clarkstown Landfill and the other nearby hazardous waste sites in the basin are very leachable, mobile and not very persistent in the environment, principally due to their high volatility, low adsorption to soils and high water solubility. Due to the high mobility of volatile organic compounds, their concentrations will tend to decrease with time, as long as there are no ongoing sources of organic contamination.

A representative semivolatile organic contaminant, fluoranthene, identified during the RI is relatively persistent in soil matrices because of its high attraction to organic matter and soil particles; low aqueous solubility; and low volatilization rate. However, if desorbed from soil, this compound may not persist because of its susceptibility to microbial degradation.

A pesticide compound detected during the remedial investigation, DDT, is a highly persistent chemical in the environment which strongly adsorbs to soils and organic matter. Adsorption appears to be the dominant environmental process affecting the fate of pesticides. Volatilization can occur but is not a significant transport mechanism, and bioaccumulation can be a significant fate process.

5.3.2.2 Inorganic Compounds

The inorganic compounds detected during the remedial investigation were reported in the majority of the investigated media including the leachate, surface and subsurface soil, groundwater, and surface water/sediments. Most inorganic compounds are naturally occurring

in soil/sediment and are common constituents in aqueous media because of leaching from soil/sediment. In general, the concentrations of inorganics in water, in particular the metals, depends upon the relative stability of individual oxidation states, oxygen content, pH and Eh (measure of the electrical potential of a system) conditions, and the availability of complexing agents.

The identified inorganic compounds are typically persistent within the full range of media tested. The inorganic compounds may be derived from the landfill leachate which is generated from precipitation infiltrating through the waste. These compounds are primarily in the dissolved form in the leachate. Many of the chemical processes determining their concentrations in the leachate are controlled by microbial activity. The concentrations of any inorganic compounds which migrate off-site in leachate are also affected by other fate processes such as adsorption to soil particles, precipitation reactions, and ion exchange.

Most of the major inorganics such as calcium, magnesium, sodium, potassium, and chlorides either pass freely through the groundwater system or change in concentration by exchange with the soil particles. Iron, manganese, and some of the heavy metals such as cadmium, chromium, lead, and beryllium, are typically more soluble directly beneath or adjacent to a landfill under the reducing (lack of oxygen) groundwater conditions. Further from the landfill where groundwaters contain greater concentrations of oxygen, the heavy metals typically adsorb strongly to soils or precipitate out of the solution with iron, manganese, and aluminum compounds. During transport in surface waters, the heavy metals bind to suspended matter, such as clay particles or organic matter, and may be deposited further downstream as sediment.

5.4 Contaminant Release/Transport Mechanisms

Figure 5-2 presents the site specific contaminant release and transport mechanisms in a flow chart format. These diagrams were adapted from a generic conceptual site model format presented in the USEPA OSWER Directive 9355.3-11 document, February, 1991, entitled "Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites".

The contaminant release/transport mechanisms listed in the column on the left side of the flow chart are discussed separately below in relation to potential exposure points (on-site and off-site) and identified receptors.

Direct Contact - This transport mechanism represents the potential for direct contact with exposed refuse or contaminated soil within the landfilled portion of the property under present conditions (i.e. - uncapped landfill). Humans (consisting of site workers, future site remediation workers, and trespassers) and terrestrial wildlife (consisting of herbivores and, indirectly, carnivores) are potentially exposed to contaminated materials primarily through ingestion. Humans may also be exposed via skin (dermal) contact. The steep slopes, exposed refuse and debris also may present physical hazards to humans and wildlife. The Direct Contact mechanism and associated potential exposures can be eliminated by the planned capping of the landfill. The Town of Clarkstown has placed an interim cover on the entire landfilled area which has effectively minimized the potential exposure to contaminated refuse.

Volatilization/Wind - This contaminant release/transport mechanism represents contaminants potentially present in surface soils which volatilize/vaporize or are carried as particulate matter in the air by wind, resulting in potential exposures to humans present on-site and off-site. Humans are potentially exposed via inhalation of the contaminants. This exposure pathway will be eliminated by the planned landfill capping and landfill gas control measures.

Erosion/Runoff - Under the Erosion/Runoff transport mechanism, contaminants may be transported in surface water runoff from the landfill slopes and then enter the surrounding wetlands, streams, and sediments. Suspended particles are deposited in the wetlands and streambeds at varying distances from the landfill depending on the particle size and velocity of the carrying waters. Dissolved contaminants which are carried greater distances from the landfill may ultimately enter the Hackensack River. Some of the dissolved fraction infiltrates into the marsh soils and through the streambeds, particularly during periods of high water such as storms and spring flooding. Aquatic wildlife and the wetland ecosystem may be exposed under this mechanism via ingestion and bioconcentration of contaminants. These transport

mechanisms have been noted to also alter the physical habitat by siltation with potential impacts to the wetlands ecosystem and aquatic wildlife. Humans may also be exposed through the consumption of fish. The Erosion/Runoff transport mechanism from the landfill sideslopes will be eliminated with the planned landfill capping.

The Erosion/Runoff on-site exposure point scenario for surface water/sediment in Figure 5-2 represents the potential exposure from contaminants present in the leachate holding basins. Potential human exposure would be from dermal contact to trespassers or present and future site workers. Migratory waterfowl could also incur an exposure to leachate through ingestion and dermal contact. The future need for the leachate holding basins will be addressed in the site feasibility study.

Leaching - This release/transport mechanism represents the leaching of contaminants from material in the landfill into the groundwater system, followed by off-site migration or on-site discharge as leachate seepage. The off-site migration has been categorized into shallow/overland leachate flow and deeper leachate seepage. A portion of the leachate generated is captured by the perimeter leachate collection system where it is transported for off-site treatment, thereby eliminating exposure.

Shallow/overland off-site leachate seepage may bypass the perimeter leachate collection system and enter the surrounding wetlands, surface waters, and sediments. This scenario is indicated in the flow chart (Figure 5-2) as Arrow 1. Arrow 2 on Figure 5-2 represents the deeper off-site leachate seepage which discharges as subflow with groundwater into the wetland soils and surface water bodies in the wetlands. Contaminants present in the leachate are subsequently carried into streams in runoff during storms or flooding conditions (Arrow 3). The off-site leachate seepage scenarios result in the same potential exposures to site workers and trespassers through dermal contact as discussed in the above Erosion/Runoff contaminant transport mechanism section. In addition, an exposure potential exists for migratory waterfowl and terrestrial wildlife through dermal contact and ingestion.

The on-site leachate seepage exposure scenario represents potential exposure to humans and wildlife by leachate seeps on or at the base of the landfill slopes. Site workers, and future site remediation workers may also incur a dermal exposure potential when completing maintenance on the on-site leachate collection system. Trespassers may be exposed to leachate seeps or leachate present in the holding ponds. The leachate seepage mechanism can be effectively eliminated with the proper capping of the landfill and overall leachate collection and management. This on-site leachate seepage exposure reflects current conditions at the landfill prior to capping/closure and additional leachate collection. Both on-site and off-site leachate seepage will decrease after landfill capping due to the anticipated reduction of the groundwater mound within the landfill. Additional information on the operation of the leachate collection system is presented in Sections 2.9 and 4.1.1 of the report.

Landfill Gas - Migration of landfill gas through the air and through the subsurface soils as soil gas poses potential risks to residents, site workers, area workers, future site users, and burrowing animals (on-site and off-site) via the inhalation exposure route as well as explosion hazards. Landfill gas management alternatives, such as an active gas collection network or a peripheral gas migration control system, will be examined during the feasibility study.



6.0 BASELINE RISK ASSESSMENT

6.1 Introduction

The purpose of a risk assessment is to:

- 1) Evaluate the potential threat to human health and the environment in the absence of any remedial action (baseline risk assessment), and
- 2) Demonstrate that the final remedy at the site is protective of human health and the environment. (USEPA, 1991)

The primary objective of the risk assessment for the Clarkstown Landfill is to identify which routes of exposure and potential site-related compounds of concern represent the greatest threat to human health and the environment as a result of the landfill site. Remedial measures can then be selected which most effectively reduce the risk to human health and the environment.

After reviewing the remedial investigation (RI) data for the Clarkstown Landfill (See Section 4.0) it has become evident that in addition to the impacts of the landfill there are significant impacts from other sources in the area which are upgradient of the landfill. Impacts due to these other sources may represent similar, if not greater, risks than the landfill. These other sources include urban runoff and runoff or groundwater inflow from the numerous other identified hazardous waste sites in the basin. Some of these impacts might pose a greater total However, risk to human health and the environment in the area. Remedial measures (landfill closure) at the landfill should significantly reduce the overall risk to the local population by addressing those specific potential impacts and risks caused by the landfill.

For the purposes of this risk assessment, a qualitative analysis of the potential human health and ecological risks identified by the Phase I and II RI data has been completed. This qualitative

risk assessment was based on a comparison of the identified compounds of concern and appropriate human health and ecological standards for the site media (surface water, sediment, air, etc.). The ecological risk assessment focused on compounds in the surface water and sediment media potentially exposed to aquatic and terrestrial wildlife residing in the streams and wetlands around the landfill. In addition, the impacts of closure of the landfill in accordance with Part 360 closure requirements are discussed as they relate to reduction in the risk from the landfill.

The findings of this qualitative risk assessment were that implementation of Part 360 closure requirements at the landfill site will either eliminate or greatly reduce those risks which are attributable to the landfill. Some risks, such as those related to ambient air, surface water and sediment quality, appear to be driven by off site sources of contamination rather than activities at the landfill. Ambient air exposures from the landfill will be eliminated by Part 360 closure while surface water and sediment quality impacts will be greatly reduced.

Information and data presented in the preceding Sections 4.0 (Nature and Extent of Contamination) and 5.0 (Contaminant Fate and Transport) of the Final RI Report were the basis for this qualitative risk assessment. Section 5.0 presents the identified potential exposure pathways, receptor populations, and contaminant transport mechanisms. The selection of compounds of concern is described in the following Section 6.1. The human health and ecological risk assessments are presented in Sections 6.2 and 6.3, respectively.

6.2 Selection of Compounds of Concern

The first step in the risk assessment process is to evaluate the sampling data results and to identify compounds of concern for the landfill site. For example, although numerous chemicals may be detected in surface water, they may be unrelated to site activities, i.e., they may be naturally occurring at the levels observed, or they may be of little concern toxicologically. For the selection of compounds of concern, a screening process was used to eliminate non-significant

data and to account for the effect of upgradient sources of contamination. The screening process consisted of three steps:

- 1) The elimination of compounds which are naturally occurring and considered essential nutrients to human health and ecology.
- 2) The elimination of compounds which were not detected or were detected only sporadically in the environment of the site.
- 3) The elimination of compounds which are statistically demonstrated to be found in either greater than or the same concentration in upgradient samples as downgradient samples. This indicates that the compounds found are resulting from upgradient sources and minimally from the landfill.

The drawback of the third step, the statistical analysis (like any statistical analysis), is that localized impacts may not be accounted for in the analysis. The statistical approach will tend to present the effect of the landfill on the surrounding area in general and not on one specific location. The resulting identified compounds of concern are those that the landfill is introducing into the environment on an area wide basis (in this case, the Clarkstown Basin in general). The screening process in the risk assessment does not consider the exceedance or non-exceedance of environmental standards or guidelines (this is considered and discussed in Section 4). The purpose of the risk assessment is to evaluate risks independent of established standards. Generally the standards are risk based, but based upon highly conservative exposure scenarios and represent conservative values, which may not be suitable for the site in question.

Tables 6-1 and 6-2 provided at the end of this section of the report present the compounds of concern identified from a screening of the Phase I and II RI data. Table 6-1 presents the media and compounds of concern that are directly related to the landfill (source) itself. The media include leachate, surficial soil, and soil gas; the subsurface soil medium was also included in this category because these soils lie directly underneath the landfill (within a few feet), and for all intents and purposes can be considered to be part of the landfill mass. Table 6-2 presents the

media of concern that are only potentially impacted by the landfill materials. Impacts to these media (including surface water, sediment, groundwater, and ambient air) would only occur due to off-site migration of the landfill source materials (leachate, landfill gas and surficial soils). The compounds listed in Table 6-2 may be derived from the landfill or from sources other than the landfill such as urban runoff.

The screening criteria used to develop the two lists of compounds of concern differed for the various media depending upon the number of background (or upgradient) samples obtained, and whether background sampling was appropriate for the media. For those media with a large number of background samples collected, such as surface water and sediment, the statistical comparison of the upgradient and downgradient data was performed to determine if the two data sets were statistically different. A large number of background samples were obtained from the surface water and sediment media because of concerns with upstream contamination from a number of nearby hazardous waste sites and urban runoff entering the streams and wetlands adjacent to the landfill. If the measured concentrations for a particular compound detected in the surface water or sediment were determined to be statistically similar for the upgradient and downgradient samples, it was concluded that the landfill did not have a measurable effect, on a basin wide basis, for that particular compound. The compound was, therefore, eliminated as a compound of concern. This procedure can be done with a relatively high degree of confidence in this instance for the surface water and sediment because of the large number of background samples collected.

Only validated data were used in the risk assessment. The first criterion used is that of toxicological significance, and the second criterion relates to the percentage of positive detections in the downgradient samples for each media. The first and second criteria were applied to all media.

The third criterion used to select compounds of concern for surface water, sediment, groundwater, and ambient air involved statistical methods to compare the upgradient and

downgradient data. A third criterion used to screen compounds of concern for soil gas, surficial soil, and subsurface soil included a comparison to standards and criteria since background (upgradient) data are either not relevant or were not available for these media. The surficial and subsurface soils results were compared to the NYSDEC soil guidance values (TAGM HWR-92-4046, effective November 16, 1992). Although standards or criteria do not exist for soil gas, the soil gas results were compared to the OSHA/NIOSH permissible or recommended exposure limits. For the soils and soil gas, compounds remaining after applying the first two criteria which did not exceed the standards or criteria were eliminated as compounds of concern.

Regarding the first criterion, the following compounds are commonly found, are either not toxicologically significant or are essential nutrients to flora and fauna, and have been eliminated from the risk assessment for all media:

Calcium	Magnesium
Aluminum	Potassium
Iron	Sodium

The second criterion is the percentage of positive detections per media. Where appropriate, the data were separated into upgradient and downgradient groups for ease of analysis (hot spot sample locations were included in the downgradient group). If there were less than ten percent of positive identifications (including sample concentrations with "J" and "B" qualifiers) in the downgradient samples of a given compound, the compound was eliminated from the list of compounds of concern. Those analyses with "R" qualifiers (rejected) were eliminated and not counted as a sample in this evaluation. The remaining compounds were considered to be positively identified in the media (potentially site-related) and were carried forth into the next part of the analysis. All compounds were treated in the same manner regardless of whether they are particularly toxic or human carcinogens or not, since the selection of compounds of concern must realistically represent site conditions for the risk analysis (Section 6.2 and 6.3). Those compounds which were eliminated for each media using this criterion and the percentage of

positive identifications are presented in Tables 6-3 through 6-10, provided at the end of this section of the report.

For the surface water, sediment, groundwater, and ambient air, the next step involved applying the third criterion, the statistical analysis, initiated by first removing the non-essential data qualifiers and adjusting the data for the non-detects. Any value which was flagged with a "U" was considered a non-detect and was adjusted to one half of the indicated detection limit. Although arguments can be made that the actual concentration can range from zero to the detection limit value, the U.S. Environmental Protection Agency (EPA) has consistently accepted and recommends the use of one half of the detection limit. Data with only "J" qualifiers (estimated) are left at the value shown. Data with only "B" qualifiers were left at the value shown, as were data with "BJ" qualifiers (although the "B" qualifier has different meanings depending on whether the analysis is organic or inorganic, they were both treated in the same manner).

After the qualifiers were removed and the non-detect data were adjusted, the data were statistically analyzed. For each remaining potential site-related compound of concern, both the upgradient and downgradient maximum value, arithmetic average and standard deviation (small sample) were calculated. The final potential site-related compounds of concern for groundwater and ambient air were identified using a simple comparison of the upgradient and downgradient means. If the mean of the upgradient data was greater than the downgradient mean, the compound was eliminated. If the upgradient mean was lower than the downgradient mean, the compound was retained as a potential site-related compound.

For the surface water and sediment which had ample upstream data, a statistical analysis using the "Z" test was performed to determine whether there was a statistically significant difference between the upstream and downstream data (i.e., the samples do not come from the same population). Since most risk assessments do not have the luxury of a large number of upstream samples, this is not a common procedure. In this instance, this approach is reasonable because

the large number of upstream samples provides a high degree of confidence in the analysis and there are known significant upstream sources of contamination. Using this approach, upstream detected compounds unrelated to the landfill are removed from consideration. A remedial program can thereby be selected at the landfill which addresses those compounds whose concentrations can be effectively reduced and not those driven by upstream sources.

The test statistic "Z" used in this analysis relates to the differences in means:

$$Z = \bar{X}_1 - \bar{X}_2 / \sqrt{(S_1^2 / N_1 + S_2^2 / N_2)}$$

where: $\bar{X}_1$ - mean of sample set one
 S_1 - standard deviation of sample set one
 N_1 - number of samples in sample set one

The "Z" value is then compared to the critical value for a level of significance of 0.1 for a one tailed test or -1.28. If "Z" is between the values of -1.28 and 1.28 it is concluded that the samples come from the same population. A one tailed test is used since it is more stringent than the two tailed test and we are only concerned if the downstream sample mean is higher than the upstream sample mean.

The lumping of all data as either upgradient or downgradient of the landfill for all of the surface water and sediment data does lose location specific impacts that may be occurring in the various tributaries. On the other hand, separation of the data by tributary eliminates the ability to statistically evaluate the northern tributaries. The statistical approach is appropriate when evaluating the overall area wide risks of the landfill. Localized impacts due to the landfill on surface water and sediment are discussed in Section 4.

As can be seen from the list on Tables 6-1 and 6-2, the most significant compounds of concern found in the site media, with the exception of ambient air, were inorganic compounds, specifically the heavy metals. Many of the compounds of concern are naturally-occurring compounds that exist in media such as soil and sediment. These compounds contribute to human health or environmental toxicity when their concentrations exceed certain established limits or standards that are specific to the particular media.

6.3 Public Health Evaluation

6.3.1 Introduction

The overall intent of the site characterization tasks of the remedial investigation process is to gather information to determine potential health risks posed by the Clarkstown Landfill. The remediation process requires that any remedial alternative chosen for the Clarkstown Landfill is protective of human health and the environment. Human health exposure risks are generated by the presence of a contaminant, a route of exposure, and a receptor, or person, who comes in contact with the contaminant. If any one of these three components do not exist there is no human health risk. The requirements for landfill closure under Part 360 generally focus on the elimination of the routes of exposure. The human health exposure setting and human health exposure risk analysis are presented in this section. The specific landfill-related and potential site-related compounds of concern discussed were identified from a review of the Phase I and II RI data presented in section 4.0 of the report.

6.3.2 Human Health Exposure Setting

The Clarkstown Sanitary Landfill is currently not accessible to the general public. Legal access is controlled by a guarded gate entrance from Route 303. A solid waste transfer station operates on the property, which employs approximately thirteen people. Three of these workers are located primarily indoors. A commercially developed area exists approximately 500 feet to the

north of the landfill boundary along Route 59. A residential area exists approximately 500 to 1,000 feet to the east, across Route 303, atop an adjacent hill. Wetlands exist adjacent to the landfill boundary to the south and west, making access from these directions difficult. A composting area operated by the Town exists on Town property to the north of the landfill.

Previously, the southeast portion of the site was used for recreational purposes, including a ballfield, starting in the mid-1960's, with continued use until the early 1980's. Most recently, a model airplane club used the recreational area until 1987. Currently, no recreational activity takes place at the landfill. Currently, individuals who access the landfill on a regular basis are primarily refuse haulers and Town of Clarkstown employees who perform routine maintenance or operational tasks for the transfer station and composting area. Commercial tippers, such as landscaping companies and developers, access the composting area by a landfill haul road which runs from the scale house to the composting area. Individual local residents (hereafter referred to as homeowners) access the composting area from a separate entrance from Route 59. The only homeowners who access the landfill proper are those who deposit old tires at the tire drop-off area located along the perimeter road. Illegal access to the site is possible; those individuals who may access the site in this manner are considered trespassers.

Based upon the information above, the main user, or receptor, groups at the landfill were defined as discussed below. The primary receptors, those people who spend the most time at the landfill, are the site workers employed by the Town. These individuals would potentially be exposed to most of the media of concern on a routine basis and would represent the population with the highest risk due to their proximity and exposure duration. The media for which a complete exposure pathway exists for these individuals are surface soil, fugitive dust (which results from surface soil becoming airborne through wind action), leachate, ambient air, surface water and sediment.

Another receptor group is comprised of those employees who work at the transfer station, who would not be exposed to surface water, leachate or sediment, but who may have a significant

exposure to ambient air and fugitive dust. Intermittent exposures to these same media would be experienced by truck drivers who drop off landscaping waste at the composting facility. Homeowners dropping off tires at the tire drop-off area may experience a very infrequent exposure to the air and fugitive dust.

For the general public not considered to be trespassers, a complete exposure pathway exists for fugitive dust, ambient air, surface water, and sediment, but not for surficial soil or leachate. Humans may be exposed to contaminants through the consumption of fish or other wildlife. Some fishing may occur along the Hackensack River at locations west of the landfill. Hunting in the wetlands is not allowed, although hunting does occur. Fish and wildlife in these areas may be exposed to compounds derived from the landfill as well as from other sources located both up and downstream, making a meaningful evaluation of the incremental risk from the landfill from this route of exposure difficult.

6.3.3 Compounds of Concern and Human Health Exposure Risk Analysis by Media

Included in this section is an overall evaluation of the human health exposure risks for the Clarkstown Landfill site. The exposure risk analysis was performed by comparing measured concentrations of the landfill-derived and potential site-related compounds in downgradient samples with the appropriate State standards, guidance values, or criteria. The relationship of each media to the planned Part 360 landfill closure and the anticipated mitigation of the identified exposure risks are also discussed. The landfill-related impacts on the environment are discussed in Section 4.0 of the report, as opposed to the landfill-related risks which are discussed in the following sections.

Surface Water

There were no potential site-related compounds of concern identified for surface water. Although surface water samples may exceed Class A (drinking water source) stream standards,

as discussed in Section 4.2.1, surface water is not used as a drinking water source in proximity to and downstream of the landfill. Therefore, human health exposure risks do not exist for this media. The capping of the landfill and upgrade of the leachate collection system will reduce the quantity of leachate generation and off-site leachate migration to the surface waters around the landfill.

Sediment

Sediment is a media of concern with respect to human health due to potential exposure of site workers or trespassers to sediment present in the adjacent stream beds and wetlands. The only route of exposure to the sediments is through dermal contact by people who may wade in the streams and wetlands. The identified potential site-related compounds of concern in sediment are beryllium, copper and carbazole. Of these compounds, State criteria exist for only copper. Since the criteria apply only to benthic organisms, as discussed in the ecological exposure risk analysis (Section 6.3), no human health risks were identified for sediment. The identified potential site-related compounds of concern are not known for being toxic or carcinogenic via dermal exposure at the levels noted. Capping of the landfill will control the runoff of silts and sediments and will reduce leachate discharge from the landfill into the streams and wetlands.

Groundwater

The potential site-related compounds of concern for groundwater were identified by a comparison of the upgradient and downgradient arithmetic means. They include:

Arsenic	Vanadium
Barium	Zinc
Beryllium	Trichloroethene
Cadmium	Arochlor 1260 (PCB)
Copper	Total Kjeldahl Nitrogen

Lead	Ammonia
Mercury	Nitrite

As reported in Section 4.4, numerous organic compounds and heavy metals were detected in samples collected from the leachate monitoring wells which reflect the quality of groundwater in direct contact with the landfill refuse. A comparison of downgradient and upgradient groundwater quality for samples collected from monitoring wells constructed in the native deposits identified in some areas impacts on groundwater quality from the landfill. However, these impacts have resulted in relatively few exceedances of groundwater standards. The RI data suggests that the natural confining unit beneath the site, the upwards groundwater flow gradients, and the operation of the leachate collection system, are serving to contain downwards vertical and off-site migration of the compounds reported in the leachate wells.

The potential site-related compounds of concern were confined primarily to metals and nitrogen compounds. Of the fourteen identified compound of concern, six, or less than half, were present in downgradient wells monitoring the native deposits at levels above groundwater standards, namely barium, beryllium, trichloroethene, Arochlor 1260, lead, and ammonia. Of these six compounds, all but ammonia were present above the standards in only one or two of the eighteen downgradient wells sampled. The occurrence of the Arochlor 1260 in the Phase I sampling of two wells would be of the greatest concern, although these results were not confirmed during the Phase II sampling round.

Based on the RI hydrogeologic data and information received from the Rockland County and New York State Departments of Health, the human exposure pathway is not believed to be complete for this medium. Most local residents receive public water, and residents that are known to use private wells are located beyond the areas potentially impacted by the landfill. For this reason, the current groundwater ingestion exposure route is not viable for this medium and, therefore, human health risks for groundwater do not exist.

Similarly, future use of groundwater potentially impacted by the landfill is not a likely scenario. Since the area is serviced by public water mains, new commercial or residential developments could conveniently hook up to these systems. An added measure of protection against usage of contaminated groundwater is provided by the Rockland County Sanitary Code, Article 2, enforced by the Rockland County Health Department, which prohibits the unpermitted installation and usage of a water supply well for potable purposes. In addition, with the exception of Pine View Road which is serviced by public water, the properties adjacent to the Clarkstown Landfill property are zoned as commercial. Therefore, assuming zoning categories remain the same, it is not likely that any new residential supply wells could be brought into use which might result in human health risks due to ingestion of contaminated groundwater.

Ambient Air

The potential site-related compounds of concern identified by a comparison of the means for ambient air were:

Freon 12	Tetrachloroethylene
Methyl Chloride	Styrene
Chloroform	Acetone
Toluene	Carbon Disulfide

During the Phase I RI field sampling, a number of volatile organic compounds were detected in ambient air. Most of these compounds appear to be derived from local industries and from petroleum products related to truck and automobile traffic at the landfill and in the Clarkstown basin. Of the potential site-related compounds of concern listed above, only tetrachloroethene and carbon disulfide were present at concentrations exceeding NYSDEC ambient air guidelines.

Of these two compounds, tetrachloroethene, a common industrial solvent, does not appear to be originating at the landfill based upon the comparison of the ambient air results with the soil gas results.

Sampling for inorganics that may be present in fugitive dust was not performed for ambient air. However, exposure to fugitive dusts is not considered a significant exposure pathway since most of the site has received an interim or final clean soil cover layer over the fill material, as discussed in detail in the following "Surface Soil" section. The areas without an interim soil cover layer lie on the eastern portion of the site between the landfill and Route 303. This area is low-lying and is not exposed to winds due to its position between the higher elevations of the landfill to the west and the topographic ridge to the east.

The capping of the landfill under Part 360 and the anticipated Clean Air Act requirements will necessitate a final landfill cover system and a landfill gas collection and treatment system. These systems will eliminate the landfill gas emissions and fugitive dust from the landfill and effectively reduce the resulting ambient air risk.

Leachate

Numerous inorganic compounds, as well as organic compounds to a lesser extent, were identified as landfill-related compounds of concern in leachate. This list in Table 6-1 is rather extensive because a comparison of the data to standards, criteria, or background concentrations, which would allow eliminating some compounds of concern, is not appropriate for this media. The compounds of concern are:

Antimony	Benzene
Arsenic	Toluene
Barium	Chlorobenzene
Beryllium	Xylene

Cadmium	1,4-Dichlorobenzene
Chromium	1,2-Dichlorobenzene
Cobalt	Phenol
Copper	4-Methylphenol
Lead	Naphthalene
Manganese	Di-n-Butylphthalate
Mercury	Bis(2-Ethylhexyl)phthalate
Nickel	4,4 DDT
Silver	Nitrate-Nitrite
Vanadium	Tot. Kjeldahl Nitrogen
Zinc	Ammonia
Chloromethane	Sulfate
Carbon Disulfide	Boron
2-Butanone	Bromide

Human exposure to this media is confined primarily to Town workers who may come in contact with the leachate while performing maintenance activities on the leachate collection system. Human health risks do not exist for this medium so long as the Town workers employ appropriate health and safety techniques to minimize exposure to the leachate. Trespassers could also incur an exposure risk on a limited basis by contacting leachate present in the holding ponds. Placement of a cap on the landfill as a part of the remedy is designed to eliminate leachate seeps and ponding of leachate on the landfill property. In addition, the use of open leachate holding ponds will be eliminated. These measures will eliminate the uncontrolled exposure route for leachate.

While the existing leachate collection system appears to be effective in presently controlling the off-site migration of leachate, it could begin to leak at some time in the future, as discussed in Section 4.1.1 of the report. The FS Report will address the remedial actions to prevent this condition through an upgrade of the system. In the absence of any remediation, the resulting

human health and ecological risks could be significant. The landfill is upstream of a public water supply source which uses the water from the Hackensack River. Should leachate leak from the landfill, these contaminants could enter the intake for that public water supply, although in a significantly diluted form most likely at or below the laboratory analytical detection levels. Equally or more significantly would be the impact of a leak on the adjacent ecology. Heavy metals in particular would most likely affect the aquatic organisms and could enter the food chain for humans.

Surface Soil

The surface soil samples collected from the Clarkstown Landfill contained a variety of metals, but only one was identified as a compound of concern, namely beryllium. Beryllium exceeded the State soil guidance value in both on-site samples, at levels slightly above the off-site background sample. Elevated concentrations of other inorganics and organics (primarily polycyclic aromatic hydrocarbons) were present in the background samples at levels above the on-site samples for this medium.

Since approximately 90 percent of the landfill property has received an interim final clean soil cover layer over the fill material, human health exposure risk to surface soil is not a significant concern. The landfill and the area between the landfill and the transfer station area has received up to 18 inches of interim soil cover. The soils were supplied by bid contract to the Town from acceptable inspected sources and included primarily virgin excavated soil from new building developments. A five acre area surrounding the transfer station received a final Part 360 cap during construction of the transfer station in 1990. The old, inactive landfill areas to the northeast and southeast received up to 12 inches of final cover when the Town terminated landfilling in these areas in the 1960s. In addition, the former ballfield received additional soil fill and topsoil cover during construction. The remaining areas (approximately 10 percent of the site) comprise soil storage areas, site roads, and miscellaneous concrete and construction debris fill used for grading and as a sub-base for the site roads. For the above reasons, the

surface soil ingestion exposure pathway is not considered as viable. The planned capping of the landfill property will eliminate future exposures to surface soils.

Subsurface Soils

Subsurface soils were also reported to contain numerous heavy metals, although the compounds of concern identified were beryllium, chromium, nickel and zinc. Of these four metals, chromium exceeded the State soil guidance value in one of nine samples, while no samples exceeded the guidance value for nickel. Beryllium and zinc exceeded the respective guidance value in at least 50 percent of the samples. However, human health exposure risks were not identified for subsurface soils because an exposure pathway does not exist for this media since these soils lie below landfilled wastes. A pathway for incidental exposure to subsurface soils may occur if regrading or consolidation of any off-site wastes into the main landfill is considered as part of the remedial alternative of capping. This would be addressed in a health and safety program for the remediation.

Soil Gas

Various organic compounds were detected in the soil gas samples collected at the landfill. Benzene and vinyl chloride in soil gas exceeded the NIOSH and OSHA industrial exposure limits. Exposure to soil gas is not considered a route of exposure under present conditions. The results of sampling of ambient air are considered to be the most representative of airborne contamination emanating from the landfill. However, if an intrusive remedial alternative such as excavation or capping which may require extensive regrading is chosen, then precautions for exposure to soil gas will be included in the contract plans and specifications.

6.4 Ecological Assessment

6.4.1 Introduction

Surface waters in the streams and wetlands adjacent to the Clarkstown Landfill provide habitat to fish, amphibians, and other aquatic animals. Birds and some mammals also depend upon the presence of surface water directly for their existence. Sediments provide habitat to a wide variety of benthic (sediment dwelling) organisms. Since some of these organisms live directly in the surface water or sediment, they may also be in constant contact with any contaminants in the water or adsorbed onto the sediment particles.

Potential impacts to these communities include acute (short term) and chronic (long term) toxicity, bio-accumulation, and the potential to pass contaminants upwards through the food chain. New York State has established surface water and sediment criteria as levels of protection against the adverse effects of contaminants on the biota themselves, as well as impacts on human health through the ingestion of bio-accumulated contaminants.

The purpose of the ecological risk assessment is to evaluate the potential risks to aquatic and terrestrial plant and animal species from contamination emanating from the Clarkstown Landfill. The NYSDEC guidance document, "Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites," prepared by the Division of Fish and Wildlife, dated June 18, 1991, provided the basis for the ecological risk assessment. For the ecological assessment, the concentrations of the site-related contaminants were compared to established State ecological criteria. The ecological risk assessment provides the information required to select a remedial alternative which is protective of the environment. In general, the technical approach for the ecological risk assessment parallels the approach used in the human health risk assessment, except the ecological risk assessment specifically evaluated the ecological media, namely surface water and sediment.

6.4.2 Ecological Exposure Setting

The general landfill exposure scenario has been summarized in the preceding human health risk section but there are aspects which are of particular concern to the ecological setting. The site can best be characterized as a landfill which was built in the transitional zone between wetlands and upland areas. Much of the site is adjacent to wetlands or swamps with permanent or intermittent streams. The general character of the area is that of a developing rural area with commercial/industrial buildings, shopping centers and pockets of residential development. There are adequate residual woodlands and old fields in the area to support a number of larger terrestrial animals such as white tailed deer and fox.

The most significant aspect of the exposure setting is the presence of the wetlands and streams adjacent to the landfill. The locations of the NYSDEC-designated wetlands and streams around the landfill are shown on Figures 1-1 and 1-2. The wetlands are also Federal-designated wetlands, as shown on Figure 3-6. Muddy Brook flows westerly along the southern landfill boundary, Greenbush Brook flows northwesterly to the west of the landfill and wetlands, and two unnamed tributaries flow along the northern landfill boundary.

All of these streams ultimately discharge into the Hackensack River. During flood stage conditions, normally spring thaw and after heavy rains, the floodwaters can back-up in the wetlands, causing any contaminants present in the runoff to become mixed in the floodwaters throughout the wetlands. Surface water chemistry data collected during the remedial investigation (including temperature, DO, pH, conductivity, and discharge) are presented in Tables 2-3 (Phase I) and 2-4 (Phase II).

The streams serve as potential pathways to transport contaminants from the landfill and other adjoining properties to downstream locations, and as a means of transporting contaminants introduced into the food chain to remote locations. Animals living or dependent on the wetlands include the benthic (sediment) community, turtles, fish (such as carp, largemouth bass, white perch and yellow perch), birds (such as ducks, great blue herons, marsh hawks and gulls) and mammals (such as opossums and raccoons). The animals' exposure to contaminants from the landfill are both direct, in the form of direct ingestion of contaminated soils or water, or indirect through eating other organisms which have had direct contact with contamination.

A more detailed summary of the fish and wildlife surveys conducted at the landfill and in the wetlands for the Phase I RI was presented in Section 3.6. There were no identified endangered, rare, or species of special concern nor habitats of significance in or around the wetlands surrounding the landfill. Three vegetative species (namely Black alder, Cinnamon fern, and Royal fern,) were identified to exist in the wetlands which are considered by NYSDEC to be "exploitly vulnerable," or may become threatened in the near future.

6.4.3 Compounds of Concern and Ecological Exposure Risk Analysis

Table 6-2 presents the compounds of concern which were found to be significant in the ecological media (surface water and sediment). The compounds of concern identified for surface water and sediment for the ecological assessment are the same as those for the human health risk assessment.

Surface Water

There were no compounds of concern identified for surface water. Therefore, on a basin wide basis, ecological risks for this medium do not exist. Locally, ecological risks may exist where concentrations of detected compounds exceed risk-based ecological criteria, as discussed in

Section 4.2.1. The capping of the landfill and upgrade of the leachate collection system will reduce the quantity of leachate which may migrate to the surface waters around the landfill.

Sediment

Of the three compounds of concern for sediments, ecological criteria exist for only one compound, copper. The NYSDEC "Technical Guidance for Screening Contaminated Sediments," effective November 1993, specifies a low effect level (LEL) and a severe effect level (SEL) of 16 ppm and 110 ppm, respectively, for copper. Copper concentrations above the LEL but below the SEL can be tolerated by the majority of benthic organisms, but may cause toxicity to a few species. Concentrations above the SEL would result in a more likely disturbance to the benthic community.

According to the NYSDEC guidance, if any criteria are exceeded the sediments are considered to be contaminated and a potential risk to the biota and/or human health exists which must be further evaluated. Additional information to be evaluated in this case, as noted in the guidance, include the volumes and location of sediment exceeding the criteria, the type of exceedance (low, severe, acute or chronic), the contaminant persistence (See Section 5.0 for a discussion of persistence and other contaminant characteristics), and uncertainty regarding the criteria. Other information needed to determine the need for and feasibility of sediment remediation include the accessibility of removing any contaminated sediment, the sensitivity of the affected habitat to any such remedial measures, and the availability of remedial technologies. Even if criteria are exceeded, sediment remediation may not be warranted, nor advisable, with all of the above considerations in mind.

The average copper concentration in the downstream sediments was 103.6 ppm and the maximum value was 328 ppm. The detected RI sediment copper concentrations fall generally between the low and severe impact level for benthic organisms. Of a total of 21 Phase I and II RI samples, all of the eight upstream samples and all but one of the thirteen downstream

samples exceeded the low effect level of 16 ppm. These data infer that basically all of the sampled sediment in the streams and wetlands, including locations not potentially affected by the landfill, may be toxic to some benthic species with respect to copper. A total of five samples, one upstream and four downstream, exceeded the severe effect level of 110 ppm.

Sediment copper concentrations in the study area at both upstream and downstream locations relative to the landfill appear to be naturally elevated above the State guidance values. Besides the one downstream sediment sample from the wetlands (SD-8, 328 ppm) and the furthest downstream Hackensack River sediment sample (SD-6, 180 ppm), the next highest copper detection above the severe effect level was reported in an upstream sample, SD-11, at 173 ppm. The average downstream copper concentrations were found to be statistically higher than the upstream average concentrations (from the compound of concern selection process). However, upstream sediment samples also exceeded the low and severe criteria for copper. The data suggest that sediment copper concentrations in the basin are naturally elevated or are also impacted by sources other than the landfill. Five of the eight upstream copper levels fell within the relatively narrow range from 26.2 ppm to 37.6 ppm, suggesting that these concentrations may approximate natural background levels. These background levels exceed the low effects criteria of 16 ppm.

In addition, localized ecological risks due to detected concentrations of compounds other than copper may exist where these concentrations exceed risk-based ecological sediment criteria. As discussed in Section 4.2.2, numerous exceedances of the LEL and SEL criteria were reported in both upstream and downstream samples. An exceedance of the LEL criteria was reported for at least one compound at each sampling location. Table 6-11 presents ratios of the sediment criteria exceedances to the total number of samples collected for upstream and downstream sediment. A comparison of the upstream and downstream ratios was made to assess the relative contaminant concentrations in upstream sediment, not impacted by the landfill, versus downstream sediment impacted by the landfill and other contaminant sources (urban runoff).

For the inorganics, in most cases, the downstream ratios are higher which suggests that the landfill and other upstream locations have influenced sediment contaminant concentrations in the downstream tributaries and wetlands. The differences between the upstream/downstream ratios for the LEL exceedances were greatest for arsenic, chromium, iron, lead, manganese, mercury, and nickel. The only significant differences for the SEL exceedances were for copper and iron. For the organics, in all but a few isolated instances, the ratios were greater in the upstream samples indicating that upstream sources (urban runoff) are the greatest contributor to the observed concentrations.

The large number of LEL and SEL exceedances in both upstream and downstream samples is indicative of a stressed wetlands and tributary system. Capping and remedial measures at the Clarkstown Landfill will eliminate one significant adjacent source of inorganic compounds to the wetlands system. The data suggest that the landfill is not a source of organic compounds to sediment. Potential future ecological risks should decrease upon completion of landfill capping and reduction in potential leachate discharge to the wetlands. Any such decreases in future potential ecological risks in the basin resulting from landfill capping might be offset due to land development activities on other properties which increase contaminant discharges to surface water or involve major stream diversions in areas containing contaminated sediment.

TABLE 6-1

**LANDFILL-RELATED COMPOUNDS OF CONCERN AND
GENERAL PUBLIC EXPOSURE PATHWAY EVALUATION**

Media	Compound of Concern	General Public Exposure Pathway Complete Under Baseline (Present) Condition (yes/no)	Exposure Mitigation Anticipated as a Result of Part 360 Landfill Capping/Leachate Collection	Background Data Status
Leachate	Antimony Arsenic Barium Beryllium Cadmium Chromium Cobalt Copper Lead Manganese Mercury Nickel Silver Vanadium Zinc Benzene Toluene Chlorobenzene Xylene 1,4-Dichlorobenzene 1,2-Dichlorobenzene	No	Not Applicable	Not Applicable

TABLE 6-1

**LANDFILL-RELATED COMPOUNDS OF CONCERN AND
GENERAL PUBLIC EXPOSURE PATHWAY EVALUATION**

Media	Compound of Concern	General Public Exposure Pathway Complete Under Baseline (Present) Condition (yes/no)	Exposure Mitigation Anticipated as a Result of Part 360 Landfill Capping/Leachate Collection	Background Data Status
Leachate	Chloromethane Carbon Disulfide 2 - Butanone Phenol 4-Methylphenol Naphthalene Di-n-Butylphthalate Bis(2-ethylhexyl)phthalate 4,4-DDT Nitrate-nitrite Tot. Kjeldahl Nitrogen Ammonia Sulfate Boron Bromide	No	Not Applicable	Not Applicable
Surface Soil	Beryllium	Yes	Yes. Fugitive dust exposure pathway is insignificant due to predominant interim clean cover soils on most of site.	Background data sufficient.
Subsurface Soil	Beryllium Chromium Nickel Zinc	No. Subsurface soils are not now exposed and will not be exposed in the future at the surface.	Not Applicable	Not Applicable.
Soil Gas	Vinyl Chloride Benzene	No	Not Applicable	Not Applicable

TABLE 6-2

**POTENTIAL SITE-RELATED COMPOUNDS OF CONCERN AND ENVIRONMENTAL
EXPOSURE PATHWAY EVALUATION**

Media	Compound of Concern	General Public Exposure Pathway Complete Under Baseline (Present) Condition (yes/no)	Exposure Mitigation Anticipated as a Result of Part 360 Landfill Capping/Leachate Collection	Background Data Status
Surface Water	None identified	Yes	Yes, through lowering of leachate mound and preventing potential discharge into surface water.	Background data sufficient
Sediment	Copper Beryllium Carbazole	Yes	Yes	Background data sufficient
Ground-water	Arsenic Barium Beryllium Cadmium Copper Lead Mercury Vanadium Zinc Trichloroethane Arochlor 1260 (PCB) Total Kjeldahl Nitrogen Ammonia Nitrite	No. No known private wells in use in area potentially impacted by landfill.	Not Applicable	Not Applicable

TABLE 6-2

**POTENTIAL SITE-RELATED COMPOUNDS OF CONCERN AND ENVIRONMENTAL
EXPOSURE PATHWAY EVALUATION**

Media	Compound of Concern	General Public Exposure Pathway Complete Under Baseline (Present) Condition (yes/no)	Exposure Mitigation Anticipated as a Result of Part 360 Landfill Capping/Leachate Collection	Background Data Status
Ambient Air	Freon 12 Tetrachloroethane Styrene Chloroform Toluene Acetone Methyl Chloride Carbon Disulfide	Yes	Yes, through collection and management of landfill gas as part of capping alternative.	Background data for VOCs sufficient. Exposure to inorganics in fugitive dust is insignificant due to predominant interim clean cover soils on most of site.

TABLE 6-3

CONTAMINANTS ELIMINATED IN SEDIMENT
BY THE PERCENT POSITIVE CRITERION

<u>Contaminant</u>	<u>Percent Pos.</u>
Selenium	0
Chloroform	6
Benzene	9
2-Hexanone	8
Carbon Disulfide	8
1,1-Dichloroethene	8
1,1-Dichloroethane	0
Chlorobenzene	8
Naphthalene	8
Acenaphthene	8
Dibenzofuran	8
Butylbenzylphthalate	0
Carbazole	8
Heptachlor epoxide	8
DDT	8
Hex Chrome	0

TABLE 6-4

CONTAMINANTS ELIMINATED IN SURFACE WATER
BY THE PERCENT POSITIVE CRITERION

<u>Contaminant</u>	<u>Percent Pos.</u>
Antimony	5
Silver	5
Methylene Chloride	5
Chloroform	5
Bromodichloromethane	5
Tetrachloroethane	9
Toluene	5
Di-n Butylthalate	8
Bis(2-ethylhexyl)phthalate	8

TABLE 6-5

CONTAMINANTS ELIMINATED IN GROUNDWATER
BY THE PERCENT POSITIVE CRITERION

<u>Contaminant</u>	<u>Percent Pos.</u>
Antimony	9
Silver	3
Thallium	0
Cyanide	3
Vinyl Chloride	3
Chloroethene	0
Methylene Chloride	0
Acetone	3
1,1-Dichloroethene	0
1,2-Dichloroethene	6
Chloroform	0
2-Butanone	7
1,1,1-Trichloroethane	0
Carbon Tetrachloride	3
Benzene	0
Tetrachloroethane	3
Toluene	3
Chlorobenzene	0
Ethylbenzene	0
Styrene	0
Xylene	3
Trichlorofluoromethane	6
cis-1,2-Dichloroethene	6
1,4-Dichlorobenzene	0
2-Methylphenol	0
Naphthalene	0
Heptachlor	10
Endosulfanol	0
Arochlor 1254	0
Hexavalent Chrome	0

TABLE 6-6

CONTAMINANTS ELIMINATED IN AMBIENT AIR
BY THE PERCENT POSITIVE CRITERION

<u>Contaminant</u>	<u>Percent Pos.</u>
Freon 114	0
Vinyl Chloride	0
Methyl Bromide	0
Ethyl Chloride	0
1,1 Dichloroethene	0
Freon 113	6
1,1 Dichloroethane	0
1,2 Dichloroethylene	0
1,2 Dichloroethane	0
Carbon Tetrachloride	0
1,2 Dichloropropane	0
Trichloroethylene	0
cis-1,3-Dichloropropene	0
trans-1,3-Dichloropropene	0
1,1,2-Trichloroethane	0
1,2-Dibromoethane	0
Chlorobenzene	0
Styrene	0
1,1,2,2-Tetrachloroethane	0
1,3,5-Trimethylbenzene	0
m-Dichlorobenzene	0
Benzyl Chloride	0
o-Dichlorobenzene	0
p-Dichlorobenzene	0
1,2,4-Trichlorobenzene	0
Hexachlorobutadiene	0
Bromodichloromethane	0
2-Butanone	0
2-Chloroethylvinyl Ether	0
Dibromochloromethane	0
2-Hexanone	0
Vinyl Acetate	0

TABLE 6-7

CONTAMINANTS ELIMINATED IN LEACHATE
BY THE PERCENT POSITIVE CRITERION

<u>Contaminant</u>	<u>Percent Pos.</u>
Selenium	4
Thallium	8
Bromomethane	4
Vinyl Chloride	4
Methylene Chloride	8
Acetone	8
1,1-Dichloroethane	4
1,2-Dichloroethylene	7
1,1,1-Trichloroethane	4
4-Methyl-2-Pentanone	8
2-Hexanone	4
Ethylbenzene	4

TABLE 6-8

SURFACE SOIL
CONTAMINANTS ELIMINATED IN SURFACE SOIL
BY THE PERCENT POSITIVE CRITERIA

<u>Contaminant</u>	<u>Percent Pos.</u>
Selenium	0
Silver	0
Thallium	0
Cyanide	0
Chloromethane	0
Bromomethane	0
Vinyl Chloride	0
Chloroethane	0
Carbon DiSulfide	0
1,1 - Dichloroethene	0
1,1 - Dichloroethane	0
1,2 - Dichloroethene	0
Chloroform	0
1,2 - Dichloroethane	0
1,1,1 - Trichloroethane	0
Carbon Tetrachloride	0
Vinyl Acetate	0
Bromodichloromethane	0
1,2 - Dichloropropane	0
cis - 1,3 - Dichloropropene	0
Trichloroethene	0
Dibromochloromethane	0
1,1,2 - Trichloroethane	0
Benzene	0
Trans - 1,3 - Dichloropropane	0
Bromoform	0
4- Methyl -2 - Pentanone	0
2 - Hexanone	0
Tetrachloroethene	0
1,1,2,2 - Tetrachloroethane	0
Toluene	0
Chorobenzene	0
Ethylbenzene	0
Styrene	0
Xylene	0
Phenol	0

TABLE 6-8 cont.
SURFACE SOIL

<u>Contaminant</u>	<u>Percent Pos.</u>
bis (2-chloroethyl) ether	0
2 - Chlorophenol	0
1,3 - Dichlorobenzene	0
1,4 - Dichlorobenzene	0
Benzyl alcohol	0
1,2 - Dichlorobenzene	0
2 - Methylphenol	0
bis (2-Chloroisopropyl) ether	0
4 - Methylphenol	0
N- Nitroso - Di-n-propylamine	0
Hexachloroethane	0
Nitrobenzene	0
Isophorone	0
2-Nitrophenol	0
2,4 - Dimethylphenol	0
bis (2-Chloroethoxy) methane	0
2,4 - Dichlorophenol	0
1,2,4 - Trichlorobenzene	0
4-Chloroaniline	0
Hexachlorobutadiene	0
4-Chloro-3-methylphenol	0
2-Methylnaphthalene	0
Hexachlorocyclopentadiene	0
2,4,6 - Trichlorophenol	0
2,4,5 - Trichlorophenol	0
2 - Chloronaphthalene	0
2 - Nitroaniline	0
Dimethylphthalate	0
Acenaphthylene	0
2,6 - Dinitrotoluene	0
3-Nitroaniline	0
Acenaphthene	0
2,4 - Dinitrophenol	0
4 - Nitrophenol	0
Dibenzofuran	0
2,4-Dinitrotoluene	0
4-Chlorophenyl-phenyl ether	0
Fluorene	0

TABLE 6-8 cont.
SURFACE SOIL

<u>Contaminant</u>	<u>Percent Pos.</u>
4-Nitroaniline	0
4,6-Dinitro-2-methylphenol	0
N-Nitrosodiphenylamine (1)	0
4-Bromophenyl-phenylether	0
Hexachlorobenzene	0
Pentachlorophenol	0
Phenanthrene	0
Anthracene	0
Di-n-Butylphthalate	0
Fluoranthene	0
Pyrene	0
Butylbenzylphthalate	0
3,3-Dichlorobenzidine	0
Benzo (a) anthracene	0
Chrysene	0
bis (2-Ethylhexyl) phthalate	0
Di-n-Octyl phthalate	0
Benzo (b) fluoranthene	0
Benzo (k) fluoranthene	0
Benzo(a)pyrene	0
Indeno (1,2,3-cd) pyrene	0
Dibenzo (a,h) anthracene	0
Benzo (g,h,i) perylene	0
Alpha-BHC	0
Beta-BHC	0
Delta-BHC	0
Gamma-BHC (Lindane)	0
Heptachlor	0
Aldrin	0
Heptachlor epoxide	0
Dieldrin	0
4,4-DDE	0
Endrin	0
Endosulfan II	0
4,4-DDD	0
Endosulfan sulfate	0
4,4 DDT	0
Endrin Ketone	0
Alpha-Chlordane	0
Gamma-Chlordane	0
Toxaphene	0

TABLE 6-8 cont.
SURFACE SOIL

Arochlor-1016	0
Arochlor-1221	0
Arochlor-1232	0
Arochlor-1242	0
Arochlor-1248	0
Arochlor-1254	0
Arochlor-1260	0

TABLE 6-9

SUB-SURFACE SOIL
CONTAMINANTS ELIMINATED IN SUB-SURFACE SOIL
BY THE PERCENT POSITIVE CRITERIA

<u>Contaminant</u>	<u>Percent Pos.</u>
Thallium	0
Cyanide	0
Chloromethane	0
Bromomethane	0
Vinyl Chloride	0
Chloroethane	0
1,1 - Dichloroethene	0
1,1 - Dichloroethane	0
1,2 - Dichloroethene	0
1,2 - Dichloroethane	0
1,1,1 - Trichloroethane	0
Carbon Tetrachloride	0
Vinyl Acetate	0
Bromodichloromethane	0
1,2 - Dichloropropane	0
cis - 1,3 - Dichloropropene	0
Trichloroethene	0
Dibromochloromethane	0
1,1,2 - Trichloroethane	0
Benzene	0
Trans - 1,3 - Dichloropropane	0
Bromoform	0
4- Methyl -2 - Pentanone	0
2 - Hexanone	0
Tetrachloroethene	0
1,1,2,2 - Tetrachloroethane	0
Chorobenzene	0
Ethylbenzene	0
Phenol	0

TABLE 6-9 cont.
SUB-SURFACE SOIL

<u>Contaminant</u>	<u>Percent Pos.</u>
bis (2-chloroethyl) ether	0
2 - Chlorophenol	0
1,3 - Dichlorobenzene	0
1,4 - Dichlorobenzene	0
Benzyl alcohol	0
1,2 - Dichlorobenzene	0
2 - Methylphenol	0
bis (2-Chloroisopropyl) ether	0
4 - Methylphenol	0
N- Nitroso - Di-n-propylamine	0
Hexachloroethane	0
Nitrobenzene	0
Isophorone	0
Z-Nitrophenol	0
2,4 - Dimethylphenol	0
Benzoic Acid	0
bis (2-Chloroethoxy) methane	0
2,4 - Dichlorophenol	0
1,2,4 - Trichlorobenzene	0
Naphthalene	0
4-Chloroaniline	0
Hexachlorobutadiene	0
4-Chloro-3-methylphenol	0
2-Methylnaphthalene	0
Hexachlorocyclopentadiene	0
2,4,6 - Trichlorophenol	0
2,4,5 - Trichlorophenol	0
2 - Chloronaphthalene	0
2 - Nitroaniline	0
Dimethylphthalate	0
Acenaphthylene	0
2,6 - Dinitrotoluene	0
3-Nitroaniline	0
Acenaphthene	0
2,4 - Dinitrophenol	0
4 - Nitrophenol	0
Dibenzofuran	0
2,4-Dinitrotoluene	0
Diethylphthalate	0
4-Chlorophenyl-phenyl ether	0
Fluorene	0

TABLE 6-9 cont.
SUB-SURFACE SOIL

<u>Contaminant</u>	<u>Percent Pos.</u>
4-Nitroaniline	0
4,6-Dinitro-2-methylphenol	0
N-Nitrosodiphenylamine (1)	0
4-Bromophenyl-phenylether	0
Hexachlorobenzene	0
Pentachlorophenol	0
Anthracene	0
Butylbenzylphthalate	0
3,3-Dichlorobenzidine	0
Benzo (a) anthracene	0
Chrysene	0
bis (2-Ethylhexyl) phthalate	0
Di-n-Octyl phthalate	0
Benzo (b) fluoranthene	0
Benzo (k) fluoranthene	0
Indeno (1,2,3-cd) pyrene	0
Dibenzo (a,h) anthracene	0
Benzo (g,h,i) perylene	0
Alpha-BHC	0
Beta-BHC	0
Delta-BHC	0
Gamma-BHC (Lindane)	0
Heptachlor	0
Aldrin	0
Heptachlor epoxide	0
Eudosulfan I	0
Dieldrin	0
4,4-DDE	0
Endrin	0
Endosulfan II	0
4,4-DDD	0
Endosulfan sulfate	0
Methoxychlor	0
Endrin Ketone	0
Alpha-Chlordane	0
Gamma-Chlordane	0
Toxaphene	0
Arochlor-1016	0
Arochlor-1221	0
Arochlor-1232	0
Arochlor-1242	0

TABLE 6-9 cont.
SUB-SURFACE SOIL

Arochlor-1248	0
Arochlor-1254	0
Arochlor-1260	0

TABLE 6-10

SOIL GAS
CONTAMINANTS ELIMINATED IN SOIL GAS
BY THE PERCENT POSITIVE CRITERION

<u>Contaminant</u>	<u>Percent Pos.</u>
Methyl Chloride	0
Methyl bromide	0
Methylene Chloride	0
Freon 113	9
1,1 Dichloroethene	0
Chloroform	0
1,2 Dichloroethane	0
Carbon Tetrachloride	0
1,2 Dichloropropane	0
cis - 1,3 - Dichloropropene	0
trans - 1,3 - Dichloropropene	0
1,1,2 Trichloroethane	0
1,2 - Dibromomethane	0
1,1,2,2 - Tetrachloroethane	0
m - Dichlorobenzene	0
o - Dichlorobenzene	9
1,2,4 - Trichlorobenzene	9
Hexachlorobutadiene	0

TABLE 6-11

**RATIO OF NUMBER OF SEDIMENT CRITERIA EXCEEDANCES TO TOTAL NUMBER OF SAMPLES
COLLECTED FOR UPSTREAM AND DOWNSTREAM SEDIMENT**

Compound	Upstream Samples (6 total samples)	Downstream Samples (11 total samples)	Upstream Samples (6 total samples)	Downstream Samples (11 total samples)
INORGANICS	LEL EXCEEDANCES		SEL EXCEEDANCES	
Arsenic	0.33	0.46	0.0	0.0
Cadmium	0.83	0.91	0.0	0.0
Chromium	0.5	0.73	0.0	0.0
Copper	1.0	1.0	0.17	0.36
Iron	0.5	0.82	0.33	0.46
Lead	0.67	1.0	0.5	0.36
Manganese	0.17	0.36	0.17	0.1
Mercury	0.17	0.46	0.0	0.0
Nickel	0.5	0.91	0.17	0.1
Silver	0.5	0.18	0.33	0.1
Zinc	0.67	0.73	0.67	0.64
ORGANICS	AQUATIC TOXICITY		HUMAN HEALTH TOXICITY	
1,1-dichloroethene	0.0	0.0	0.33	0.46
Phenanthrene	0.0	0.1	0.0	0.0
Benzo(a)anthracene	0.0	0.0	0.83	0.36
Chrysene	0.0	0.0	0.83	0.36
Benzo(b)fluoranthene	0.0	0.0	0.83	0.36
Benzo(k)fluoranthene	0.0	0.0	0.67	0.36
Benzo(a)pyrene	0.0	0.0	0.83	0.36
Indeno(1,2,3-cd)pyrene	0.0	0.0	0.50	0.36
Heptachlor Epoxide	0.0	0.0	0.0	0.1
4-D,D,T	0.0	0.0	0.0	0.1

1

2

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7.0 SUMMARY AND CONCLUSIONS

7.1 Introduction

The Town of Clarkstown is required to conduct a Remedial Investigation/Feasibility Study (RI/FS) of its inactive sanitary landfill facility located in West Nyack, New York, as stipulated in an Order On Consent with the New York State Department of Environmental Conservation (NYSDEC). An RI/FS is required prior to landfill closure due to the landfill's listing by the New York State Department of Environmental Conservation (NYSDEC) as a Class 2 Inactive Hazardous Waste Site. The Class 2 listing is based on an investigation of the landfill completed in 1983 which determined it to be a suspected hazardous waste site, in need of further investigation and possibly remediation (Wehran Engineering, 1983). More recently, in 1994 the U.S. Environmental Protection Agency (USEPA) completed its own hazard ranking scoring for the landfill and concluded that the landfill qualifies for listing on the National Priority List (NPL) as a potential federal Superfund hazardous waste site (Personal communication, USEPA, Region 2).

Two phases (Phase I and Phase II) of remedial investigation (RI) field activities were completed by Roy F. Weston of New York, Inc. (WESTON) on behalf of the Town of Clarkstown. The major objective of the Phase I RI field program was to characterize the nature and extent of contamination that may be emanating from the landfill into the surrounding media through a preliminary round of chemical sampling of site media (surface water, sediment, groundwater, ambient air, leachate, soil gas, and surface and subsurface soil). The RI also included determination of groundwater flow patterns, laboratory strength testing of subsurface soils to evaluate the landfill slopes stability, an ecological investigation of the environment around the landfill, and a qualitative analysis of potential risks to human health and the environment.

The objectives of the Phase II field investigation were to confirm the Phase I sampling results, to address data gaps identified during the Phase I RI activities, and to obtain additional data for the qualitative risk assessment and feasibility study to aid in identifying the need for and scope of final site remedial measures. The scope of the Phase II field investigation was developed

based on a thorough review of the Phase I data and subsequent meetings with NYSDEC staff, as well as input from a public meeting held in the Town of Clarkstown, New York, on January 26, 1994.

7.2 Objectives of the Remedial Investigation

The evaluation of the nature and extent of contamination at the Clarkstown Landfill requires an assessment of many complex issues because the landfill is located in an urbanized setting. The landfill is situated at the bottom of a topographic basin in an urbanized area of the Town of Clarkstown, Rockland County, New York. This basin receives storm runoff from surrounding roadways and commercial properties which, at times, might contain high amounts of dissolved and suspended solids. The streams and wetlands located adjacent to two sides of the landfill property represent a "sink" for any contaminants present in this urban runoff. In addition, at least six known or suspected hazardous waste sites exist within the basin and are likely to contribute contaminants to the runoff.

The Clarkstown Landfill RI attempts to distinguish any contamination present in the adjacent streams and wetlands caused by the landfill from contamination originating in urban runoff or other sources besides the landfill. Contamination present at the landfill and in the wetlands was evaluated with respect to potential risks posed to landfill workers and visitors, areas residents, and the ecological community in the wetlands.

7.3 Other Known Hazardous Waste Sites in the Vicinity of the Clarkstown Landfill

Two of the known hazardous waste sites in the basin include the Xerox Corporation facility, located approximately 3/4 of a mile south of the Clarkstown Landfill, and the Chromalloy facility, located about 1,000 feet southwest of the landfill on the opposite side of the wetlands. During surface water sampling efforts conducted in 1989 by NYSDEC and in 1992 as part of an RI/FS at the Xerox facility, halogenated volatile organic solvents, including the common industrial solvents tetrachloroethene and trichloroethene (TCE), were found in drainage channels

downstream of the Xerox facility. The presence of these compounds was attributed to a volatile organics plume in groundwater emanating from the Xerox facility and discharging to the drainage channels. Also, in 1992, groundwater at the Chromalloy facility was found to be contaminated with TCE at levels as high as 33,000 parts per billion (ppb) and chromium up to 328 ppb. The presence of these compounds is inferred to be a result of industrial operations at the Chromalloy facility, and a separate RI/FS of this facility is pending. This information suggests that these two facilities may contribute to any contamination present in the groundwater, surface water, and sediment in the wetlands adjacent to the Clarkstown Landfill.

In addition, an undocumented off-site source of volatile organic compounds (VOCs) in groundwater exists to the southeast of the landfill based on a review of private well data obtained from the Rockland County Health Department. The results of the most recent (Phase II) sampling effort indicate that groundwater beneath the southeast corner of the landfill appears to have been impacted by this VOC source.

7.4 Physical Characteristics of the Study Area

Potential sources of contamination which may be emanating from the Clarkstown Landfill include landfill leachate, landfill gas, and surface runoff from the landfill side slopes. Potentially impacted media have been identified to include groundwater, soils, surface water, sediments, and ambient air. Numerous exposure pathways and potential human and environmental receptors were also identified to exist under current conditions at the landfill. The results of the RI/FS, in particular the feasibility study (FS), will be used to develop plans to mitigate these exposure pathways during the landfill closure.

Subsurface investigations completed at the landfill have shown that it is underlain by a relatively impermeable and fine-grained "confining unit" of peat, organic silt, and glacial varved clay deposits. Where present, these deposits greatly impede the vertical downwards flow of leachate into the deeper deposits. In addition, the relatively high natural organic carbon content of the soils provide an effective filtering mechanism to remove organic contaminants from any leachate.

Potential "windows", or openings, exist within the confining unit in the southwest corner of the landfill and along the north central property boundary where the deposits are thin, absent, or interlayered with more permeable sand deposits.

Horizontal groundwater flow within the native deposits beneath the landfill is in a westerly to southwesterly direction towards the wetlands. The water table within the landfill mass is slightly mounded with a radial flow pattern from the center towards the outer edges of the landfill. A portion of the groundwater within the landfill is intercepted by a perimeter leachate collection system while the remainder is transported by slow seepage into the confining unit deposits. Strong upwards groundwater flow gradients exist between the bedrock aquifer and permeable glacial sand outwash, and the overlying confining unit deposits. The combination of these upwards flow gradients and the extensive confining unit deposits provides an effective barrier to the downwards flow of leachate into the deeper deposits.

Several streams flow along the boundaries of the Clarkstown Landfill and ultimately discharge into the Hackensack River. The Hackensack River is used as a drinking water source upstream of the landfill by area residents, and approximately 1.5 miles downstream of the landfill by northern New Jersey residents. It has been reported that at times during river flood stage conditions (normally spring thaw and heavy rains) the floodwaters have reached the edge of the landfill. During these events, contaminants present in the runoff from the various tributaries may become mixed in the floodwaters and distributed throughout the basin floor.

7.5 Nature and Extent of Contamination

7.5.1 Landfill Leachate

In 1983, the Town completed the installation of the leachate collection system around the landfill perimeter to prevent the lateral movement of leachate into the wetlands. The system consists of approximately 9,000 feet of 6-inch diameter perforated PVC pipe laid in a trench excavated into the top of the peat layer below the wastes and backfilled with crushed gravel. The outer wall of the trench was lined with a fabric barrier to trap silts and impede the flow of leachate

beyond the trench towards the wetlands and streams. The leachate collection system encompasses the entire landfill except for a former ballfield area located in the southeast corner of the property and the two portions of the landfill which lie beyond the northern Town property line.

Recent physical inspection of the leachate collection system indicates portions of the system may not be operational. In addition, the system does not have a waterproof membrane to prevent the leachate from moving from the landfill into adjacent surface waters. The fabric currently in place in the leachate system impedes flow from the landfill and presently appears to be effective. However, inspection of the fabric indicates it is deteriorating. The FS will evaluate the remediation requirements for this system to intercept and remove landfill leachate.

Landfill leachate which is intercepted by the leachate collection system is currently discharged into the Rockland County Sewer District #1 system without pretreatment. Since the start of monthly leachate sampling by the Town, individual leachate constituents regulated by the plant have been within the allowable plant limits. Only infrequent detections of organic compounds were reported in the Phase I and Phase II RI leachate samples collected from the leachate collection chambers, holding basins, leachate monitoring wells, and seeps. The detected organic compounds were primarily either laboratory-induced contaminants from the sample analysis (methylene chloride, acetone and 2-butanone) or compounds present in petroleum products which are likely derived from leakage of automobile fluids on the landfill (benzene, toluene, and xylenes).

The most frequently detected metals in the Phase I and II RI leachate samples were cadmium, chromium, copper, iron, manganese, nickel, and zinc. Only zinc exceeded the County pretreatment standard in one Phase I leachate seep sample. A comparison was made of the leachate analytical results to surface water standards to conservatively evaluate the potential impacts on surface waters of leachate which may escape the leachate collection system and discharge into the wetlands. This comparison demonstrates that should the leachate escape from the leachate system and enter the surface waters that the surface waters would be adversely

impacted. While the remedial investigation did not find leachate directly entering the surface waters at this time, it may occur in the future unless mitigation measures are put in place.

A comparison of the historical data (1985 - 86) and the Phase I RI leachate data shows that the leachate quality has changed over the monitoring period. Iron concentrations have increased significantly since 1985, while copper, lead, zinc, arsenic, and mercury have decreased over the same time period. A comparison of the Phase I (1990) and Phase II (1993) data shows that during the most recent sampling (Phase II) less organic compounds were detected, and concentrations of inorganics, in particular the heavy metals, are significantly less than the Phase I round. The inorganics data indicate that the leachate is becoming weaker over time or is being more diluted by other sources, possibly related to deterioration of the collection trench liner. However, a comparison of the raw leachate quality data and pre-treatment standards indicates that should leachate concentrations increase upon closure (capping), concentrations are not so great that they would be likely to exceed the discharge standards.

7.5.2 Soil Gas and Landfill Gas

A variety of volatile organic compounds were present in the Phase I and Phase II RI soil gas and landfill gas samples. In general, the highest number and concentrations of volatile organics were detected in samples collected from the interior portion of the main landfill mass. Lesser concentrations were noted in the perimeter areas and older landfilled areas. In these areas, the waste is thinner and gas generation is less because the waste is older and in a more advanced stage of decay. The most frequently detected compounds were the refrigerant Freon 12 and petroleum-related compounds benzene, toluene, xylenes, and ethylbenzene. Regulatory standards exist for combustible gas levels in soil gas. Soil gas results also may be correlated to the ambient air results since the landfill gas is a potential source of contamination to ambient air.

A Phase II soil gas screening was completed along the Route 303 boundary of the landfill property to identify the potential for off-site landfill gas migration. A preliminary screening

conducted as part of the Phase I soil gas sampling effort indicated that off-site gas migration did not appear to be a concern at the site. The Phase II screening was designed to confirm these earlier Phase I findings. During the Phase II effort, seven of the thirteen soil gas locations produced combustible gas levels above the regulatory limit of 5% of the lower explosive limit (LEL) of gas in air; all but three of the samples were measured at below 10% of the LEL of gas in air. The data suggest that control of landfill gas migration along Route 303 is warranted. Combustible gas levels in samples collected from around the landfill garage and administration building were below the regulatory limit of 25% of the LEL of gas in air.

The RI determined that landfill gas is currently being generated at the landfill and is being emitted to the atmosphere. In addition, landfill gas at the Clarkstown Landfill was found to contain trace amounts of toxic and hazardous contaminants, as well as NMOCs (Non-Methane Organic Compounds) which contribute to the deterioration of the atmosphere. The quantity of landfill gas emissions is estimated to exceed federal regulations. Since the intended use of the landfill will include use of the site by maintenance workers and other Town employees and limited use by site visitors, control of landfill gas contaminants is warranted.

7.5.3 Test Pits/Landfill Waste Characterization

Eight test pits were excavated to determine the waste thickness in two areas of the landfill (the Northeast Area and former Ballfield Area) and to determine if the wastes in the Northeast Area were hazardous according to the RCRA regulations. The wastes in the Northeast Area extend beyond the Town property line. The waste thickness ranged from 5 feet to greater than 25 feet in the Northeast Area and from 9.5 feet to 15 feet in the Ballfield Area. Waste samples collected from the Northeast Area did not exhibit any RCRA hazardous characteristics above the regulatory standards.

7.5.4 Surface Water

Surface water sampling programs completed by NYSDEC prior to the RI identified volatile organic compounds in surface water at numerous locations in the Hackensack River basin. The highest concentrations of volatile organics, most of which are common industrial solvents, were reported for two locations downstream of the Bradley Industrial Park and the Xerox Corporation facility. These locations are upstream of the Clarkstown Landfill and therefore, the volatile organics detections are attributable to the landfill. The highest concentrations were reported for tetrachloroethene (PCE), ranging from 1 ug/l to 7 ug/l.

A surface water sampling effort was also conducted in 1992 in the Bradley Industrial Park south of the landfill as part of the RI/FS of the Xerox Corporation facility. Volatile organics including 1,1-dichloroethane, 1,2-dichloroethene, 1,1,1-trichloroethane, trichloroethene, and tetrachloroethene were detected in samples from drainage channels in the industrial park. The data reflect the impact of contaminated groundwater discharge into the drainage channels of an organic solvent plume emanating from the Xerox facility. All of the sampling locations are upstream of the wetlands surrounding the Clarkstown landfill.

In general, relatively low estimated concentrations of organic compounds below the New York State water quality standards were detected in the Clarkstown Landfill Phase I and Phase II RI surface water samples collected from the wetlands, the Hackensack River, and its tributaries. Infrequent detections of organics were reported for locations downstream of the Clarkstown Landfill; however, similar or higher concentrations for the same compounds were reported for the upstream samples. Although some of the detected organic compounds were present in the leachate from the landfill, other upstream sources for these contaminants appear to exist in the basin.

The surface water data were compared to the most stringent NYSDEC surface water standards since the landfill is located upstream of a drinking water supply in-take source (Tappan Reservoir) and adjacent to an extensive state and federal designated wetlands area. The most

frequently detected metals detected in the Phase I RI surface water samples were aluminum, iron, lead, manganese and zinc. Iron exceeded the State water quality standard in all twelve Phase I RI samples while the aluminum standard was exceeded in six of the twelve samples. The aluminum, manganese, cadmium and copper standards exceedances were reported for one upstream and three downstream samples. The lead and zinc standards were exceeded each in two of twelve samples, namely in two upstream and one downstream sample. The iron and aluminum are naturally-occurring compounds in sediment and their presence in the samples is inferred to be predominantly a result of suspended solids in the surface water. The iron concentrations were similarly elevated in both upstream and downstream samples with respect to the landfill.

The highest concentrations of numerous metals detected in surface water during Phase I occurred in an upstream sample from a tributary draining Route 59 and the adjacent businesses. Elevated inorganics were also reported in two Phase I samples of ponded water from the wetlands to the west of the landfill. One of the samples appears to reflect impacts from the upstream waters draining the Route 59 business area. The second sample appears to show impacts from the landfill. However, it is not possible to quantify the landfill's contribution due to the mixing effects of waters draining into the wetlands.

On the south side of the landfill, the levels of aluminum, iron, lead, and zinc were elevated in a downstream sample compared to the upstream sample collected from the same tributary suggesting an influence from the landfill. Based on the Phase I data, the Hackensack River water quality was shown to be relatively unchanged between the samples collected furthest upstream and downstream of the confluence with the tributaries that drain the basin containing the Clarkstown Landfill.

During Phase II, the most frequently detected metals were aluminum, copper, iron, lead, manganese, nickel and zinc. All of these compounds except lead were detected in all samples. Iron exceeded the applicable ambient water quality standard in all samples. The Phase II sample showing the greatest number and the highest concentrations of inorganics detections was

collected from ponded waters in a small stream channel in the wetlands within fifty feet of the landfill. This location is one of the closest to the landfill and would be expected to show the greatest impact due to proximity. However, evaporation of ponded water over time could result in the observed elevated concentrations. The calculated copper and lead standards were exceeded each in only one Phase II downstream sample. The zinc and aluminum standards were each exceeded in three downstream samples.

A comparison of the Phase II upstream sample data with the downstream data suggests that the landfill or the other adjacent properties are contributing to increases in concentrations of some inorganic compounds along the unnamed tributary on the north side of the landfill. Results for two downstream samples collected from adjacent to the landfill are higher for each inorganic detected compared to the upstream sample. Iron, however, was the only compound which exceeded the respective standard. The data indicate that the landfill may contribute to the identified exceedances of criteria for these metals in surface water. However, the actual amounts caused by the landfill cannot be determined due to the presence of other upstream sources and the mixing effects of surface waters in the wetlands.

7.5.5 Sediment

Relatively low estimated concentrations of volatile organic compounds were present in the Phase I and Phase II RI sediment samples collected at the same locations as the surface water samples. Only one volatile organic compound, 1,1-dichloroethene, was present above its State sediment criterion. The 1,1-dichloroethene was found in one upstream sediment sample and one sample from a location downstream of the Xerox Corporation facility and adjacent to the Chromalloy facility. This compound is a typical breakdown product of industrial solvents.

Numerous semivolatile organic compounds classified as polynuclear aromatic hydrocarbons (PAHs), commonly present in road runoff and vehicle exhaust, were consistently elevated in the upstream Phase I and Phase II sediment samples. Only one sample exceeded a State aquatic criterion; namely, the phenanthrene chronic criterion was exceeded for a Phase II sample from

the unnamed tributary on the north side of the landfill. The human health criteria for six PAHs were exceeded in some Phase I samples. The highest exceedances were reported for the upstream samples with no exceedances reported for samples collected directly downstream and in close proximity to the landfill. During Phase II, the human health criteria for the same six PAHs were exceeded in two upstream samples and three downstream samples collected from the tributaries on the north side of the landfill. The data suggest that these PAHs were derived from upstream sources or properties other than the landfill lying adjacent to the tributaries. None of the PAHs were found in any of the RI leachate, groundwater or subsurface soil samples and, therefore, are not attributed to the Clarkstown Landfill.

In general, the metals were present at varying concentrations in both upstream and downstream samples. Lead and zinc were significantly elevated in two upstream Phase I samples compared to the other samples, and both are common constituents of road runoff. The most frequently detected heavy metals in sediment were arsenic, cadmium, chromium, copper, lead, nickel, and zinc. Beside landfill influences, other upstream sources appear to exist which may have contributed to the observed downstream concentrations. Landfilling at the former Ballfield Area in the southeast corner of the landfill property appears to have resulted in elevated levels of arsenic, cadmium, chromium, iron, manganese, and nickel in sediment in Muddy Brook greater than the upstream concentrations. Sediment at the western end of Muddy Brook appears to be similarly impacted by the landfill by these and other metals based on the upstream/downstream comparisons.

Concentrations of cadmium, lead, and mercury found to be higher in downstream sediment on the north side of the landfill than the upstream sediment are believed to be due to the landfill and/or activities at adjacent properties. Although it was not possible to quantify the contribution of the landfill on metals concentrations in sediment in the wetlands west of the landfill, the data suggest that the landfill has influenced sediment quality in the wetlands. Levels of arsenic, chromium, copper, and manganese were higher in wetlands sediment samples than upstream sediment samples.

For both phases of sampling, all of the heavy metals were present in some samples at levels above the State lowest effects criteria. These levels may be tolerated by a majority of benthic (bottom-dwelling) organisms. The more stringent state criteria, the severe effects criteria, were exceeded for copper, lead, zinc, iron, and manganese each in at least one sample for each sampling round. The RI data suggests that the landfill may contribute to the identified exceedances of criteria for these metals in sediment, although the actual amounts caused by the landfill can not be determined due to the presence of other upstream sources and mixing effects of surface waters in the wetlands.

7.5.6 Surficial Soils

Ten organic compounds were detected in the three Phase I RI surficial soil samples collected. Eight of the ten compounds were present in the off-site background sample suggesting that other sources for these compounds exist in the basin. Only one organic compound, namely acetone which is a common laboratory contaminant, was present at a concentration above the respective NYSDEC soil cleanup guidance value. The detected organics consisted primarily of the common laboratory contaminants (acetone, methylene chloride, and 2-butanone) and the PAHs which are typically elevated in urban soils.

Thirteen of the nineteen inorganic compounds detected in the surficial soils were present at their highest concentrations in the off-site background sample. Four inorganics, namely mercury, nickel, zinc, and beryllium, were each present in at least one sample at levels above the typical Eastern USA background ranges. The highest levels for mercury and zinc were reported in the off-site background sample. Beryllium was present in all three samples above the Eastern USA background range and the USEPA guidance value.

7.5.7 Subsurface Soils

Only one site-related organic compound was detected above the State soil cleanup guidance value in any of the eight Phase I RI subsurface soil samples collected. Overall, the inorganics detections fell within the typical Eastern USA background soil concentration ranges, except for cadmium, chromium, nickel, and zinc which exceeded the typical background values in most samples. The concentrations of these four inorganics were uniformly distributed indicating that they may be naturally elevated in site soils. Elevated chromium levels in the upgradient/background groundwater may explain the chromium levels present in the subsurface soils.

7.5.8 Groundwater

The greatest number and highest concentrations of organic compounds found in the historical and Phase I and Phase II RI groundwater samples were reported for leachate monitoring wells screened in the refuse. Most of the organic detections in the leachate wells included the aromatic hydrocarbons, such as benzene, toluene, xylenes, and ethylbenzene, which are commonly found in motor oils and gasoline. Three organic compounds, namely toluene, 1,2-dichloroethene, and chlorobenzene, were present in the leachate well samples above the State groundwater standards.

Four volatile organic compounds were each detected once in a total of three RI groundwater monitoring wells at concentrations slightly greater than the State groundwater standards. Trichloroethene was present in a downgradient well, tetrachloroethene in an upgradient well, and 1,2-dichloroethene and cis-1,2-dichloroethene both in a cross-gradient well above the State standards. The upgradient and cross-gradient wells monitor the deep glacial sandy outwash or bedrock formations. Eight other volatile organic compounds were present at trace levels in groundwater samples collected from monitoring wells located downgradient of the landfill. The presence of these same compounds or related compounds in both the leachate and groundwater wells indicates that the landfill leachate has impacted groundwater beneath the landfill.

The pesticide Endosulfan I was found in one upgradient well and can be attributed to an off-site source for this contaminant. The presence of the extensive confining unit deposits and upwards hydraulic gradients appear to be effective in preventing the migration of any volatile organic compounds into the deeper glacial outwash, till, and bedrock formations.

The presence of the tetrachloroethene, as well as other chlorinated solvents at levels below the State standards, in the site upgradient well may be attributable to unknown off-site sources located upgradient of this well. Documented detections of similar "fingerprints" of organic compounds were found in private supply wells lying upgradient of the well during sampling by the Rockland County Department of Health.

Highly unusual detections of the pesticide 4,4-DDT and that the polychlorinated biphenyl (PCB) Aroclor-1260 were reported during Phase I for two adjacent downgradient wells monitoring the sandy till and bedrock formations in the southwest corner of the landfill. These compounds were not detected during the Phase II confirmatory sampling of these wells, although another pesticide, heptachlor, was detected at trace levels above the standard. These compounds are not typically found in groundwater due to their low water solubility. Their presence in groundwater suggests that a nearby source exists in the landfill and that the confining unit deposits may be thin or absent in this area. However, these concentrations are not of significant concern since these compounds are relatively immobile in groundwater and they were not detected in the leachate, groundwater, surface water or sediment samples collected directly downstream of the landfill.

Of the detected inorganic compounds in downgradient groundwater monitoring wells, only barium, sodium, chromium, iron, lead, and manganese were present in the Phase I and II RI samples at levels exceeding the State groundwater standards. The highest chromium detection was reported for an upgradient Phase I bedrock well sample suggesting that chromium is naturally elevated in the bedrock aquifer. The lead exceedances were reported in two wells which monitor the confining unit deposits, and one leachate monitoring well. Iron and manganese were elevated in all classes of monitoring wells (upgradient, downgradient, and

leachate wells). These two compounds are naturally-occurring in the subsurface soils and may be released to groundwater under the low oxygen conditions present beneath the landfill. The inorganics data also indicate that the confining unit deposits are effective barriers to any downwards leachate migration.

An RI groundwater monitoring well was constructed in an interlayered sand and peat "window" in the confining unit on the north side of the landfill to evaluate the quality of groundwater which might be leaving the site in this manner. The analytical results suggest that the groundwater is not significantly impacted by volatile organics in this area, although elevated chlorides and BOD were present indicative of landfill leachate. The inorganics TDS, chlorides, barium, iron, and manganese were present above the State groundwater standards in this well. Potential leachate influences were also identified in two shallow wells monitoring the peat and silt beneath the landfill, as indicated by elevated ammonia and BOD.

A second possible path for off-site leachate migration was identified along the northern landfill boundary during the RI. Some landfilled material was noted to have been placed over the area traversed by the leachate collection line, thereby creating a potential pathway for leachate to bypass the collection system. An RI leachate monitoring well was constructed in the fill to monitor the quality of any leachate which might be circumventing the collection system. The leachate sample was relatively free of organic and heavy metal contamination. Only one organic compound, chlorobenzene, was detected in the sample at a concentration equal to the State groundwater standard. Of the detected inorganic compounds, only iron, manganese, and sodium were present above the State standards.

7.5.9 Ambient Air

The Phase I data suggest that landfill gas emissions may be the source of increased concentrations of toluene, acetone, carbon disulfide, and 4-methyl-2-pentanone (MIBK) above the ambient background air. However, no compounds exceeded the State short-term ambient

air guideline concentrations. In addition, acetone and MIBK are typical laboratory contaminants introduced during sample equipment cleaning and sample preparation in the laboratory.

7.6 Contaminant Fate and Transport

Contaminant fate and transport can be defined as how potential contamination present at the landfill can move through the environment. The source of contamination from the landfill includes landfill leachate, landfill gas, and surface runoff from the landfill side slopes. the migration of contaminants of concern from the Clarkstown Landfill is influenced by environmental factors such as the hydrogeological characteristics of the aquifer, site soil conditions, and the physical/chemical characteristics of the contaminants themselves. Ultimately, the two major factors that affect the fate and transport of a contaminant are the contaminant's mobility and its persistence in the different environmental media that it encounters. Mobility is a measure of the tendency for a chemical to be transported in the environment. Persistence is the amount of time a chemical will remain at measurable concentrations in the environment once introduced.

The compounds of concern identified during the Clarkstown Landfill risk assessment include organic and inorganic compounds. The volatile organic compounds of concern identified at the landfill and other nearby hazardous waste sites in the basin are very leachable, mobile and not very persistent in the environment, principally due to their high volatility, low adsorption to soils, and high water solubility. A representative detected semivolatile organic compound, fluoranthene, is relatively persistent in soil because of its high attraction to organic matter and soil particles, low water solubility, and low volatility. Two detected pesticides, endosulfan I and 4,4-DDT, are highly persistent chemicals in the environment which strongly adsorb to soils and organic matter.

The identified inorganic compounds of concern are typically persistent within all of the sampled media. The inorganic compounds may be derived from the landfill leachate and are commonly present in dissolved form. Inorganic compounds which migrate off-site in leachate are affected

by fate processes such as microbial activity, adsorption to soil particles, precipitation reactions, ion exchange, and the oxidation potential of the groundwater environment.

Site specific contaminant release and transport mechanisms at the Clarkstown Landfill include direct contact, volatilization/wind transport, erosion/runoff, leaching, and landfill gas migration. These mechanisms may result in potential exposures via physical contact, inhalation, or ingestion of humans and terrestrial and aquatic wildlife to exposed refuse, leachate, landfill gas, or windborne dusts.

7.7 Risk Assessment

A qualitative risk assessment, was performed for both human health and ecological risks. After reviewing the remedial investigation (RI) data for the Clarkstown Landfill it has become evident that in addition to the impacts of the landfill there are significant impacts from other sources in the area which are upgradient of the landfill. Impacts due to these other sources may represent similar, if not greater, risks than the landfill. These other sources include urban runoff and runoff or groundwater inflow from the numerous other identified hazardous waste sites in the basin. Some of these impacts might pose a greater total risk to human health and the environment in the area. However, remedial measures (landfill closure) at the landfill should significantly reduce the overall risk to the local population by addressing those specific potential impacts and risks caused by the landfill.

This qualitative risk assessment was based on a comparison of the identified compounds of concern and appropriate human health and ecological standards for the site media (surface water, sediment, air, etc.). The ecological risk assessment focused on compounds in the surface water and sediment media potentially exposed to aquatic and terrestrial wildlife residing in the streams and wetlands around the landfill. In addition, the impacts of closure of the landfill in accordance with Part 360 closure requirements were evaluated as they relate to reduction in the risk from the landfill.

Human health exposure risks are generated by the presence of a contaminant, a route of exposure, and a receptor, or person, who comes in contact with the contaminant. If any one of these three components do not exist there is no human health risk. The primary receptors at the landfill, those people who spend the most time at the landfill, are the site workers employed by the Town. These individuals would potentially be exposed to most of the media of concern on a routine basis and would represent the population with the highest risk due to their proximity and exposure duration. The media for which a complete exposure pathway exists for these individuals are surface soil, fugitive dust (which results from surface soil becoming airborne through wind action), leachate, ambient air, surface water and sediment. Another receptor group is comprised of those employees who work at the transfer station, who would not be exposed to surface water, leachate or sediment, but who may have a significant exposure to ambient air and fugitive dust. For the general public not considered to be trespassers, a complete exposure pathway exists for fugitive dust, ambient air, surface water, and sediment, but not for surficial soil or leachate.

There were no potential site-related compounds of concern identified for surface water, therefore, on an area wide basis, human health exposure risks do not exist for this media. Sediment is a media of concern with respect to human health due to potential exposure of site workers or trespassers to sediment present in the adjacent stream beds and wetlands. The only route of exposure to the sediments is through dermal contact by people who may wade in the streams and wetlands. The identified potential site-related compounds of concern in sediment are beryllium, copper and carbazole. Of these compounds, no State criteria exist for protection of human health. Therefore, no human health risks were identified for sediment.

The potential site-related compounds of concern for groundwater were confined primarily to metals and nitrogen compounds. Based on the RI hydrogeologic data and information received from the Rockland County and New York State Departments of Health, the human exposure pathway is not believed to be complete for this medium. Most local residents receive public water, and residents that are known to use private wells are located beyond the areas potentially

impacted by the landfill. For this reason, the current groundwater ingestion exposure route is not viable for this medium and, therefore, human health risks for groundwater do not exist.

Similarly, future use of groundwater potentially impacted by the landfill is not a likely scenario. Since the area is serviced by public water mains, new commercial or residential developments could conveniently hook up to these systems. An added measure of protection against usage of contaminated groundwater is provided by the Rockland County Sanitary Code, Article 2, enforced by the Rockland County Health Department, which prohibits the unpermitted installation and usage of a water supply well for potable purposes. In addition, with the exception of Pine View Road which is serviced by public water, the properties adjacent to the Clarkstown Landfill property are zoned as commercial. Therefore, assuming zoning categories remain the same, it is not likely that any new residential supply wells could be brought into use which might result in human health risks due to ingestion of contaminated groundwater.

During the Phase I RI field sampling, a number of volatile organic compounds were detected in ambient air. Most of these compounds appear to be derived from local industries and from petroleum products related to truck and automobile traffic at the landfill and in the Clarkstown basin. Of the potential site-related compounds of concern, listed above, only tetrachloroethene and carbon disulfide were present at concentrations exceeding NYSDEC ambient air guidelines. Of these two compounds, tetrachloroethene, a common industrial solvent, does not appear to be originating at the landfill based upon the comparison of the ambient air results with the soil gas results.

Human exposure to leachate is confined primarily to Town workers who may come in contact with the leachate while performing maintenance activities on the leachate collection system. Human health risks do not exist for this medium so long as the Town workers employ appropriate health and safety techniques to minimize exposure to the leachate. Trespassers could also incur an exposure risk on a limited basis by contacting leachate present in the holding ponds. Placement of a cap on the landfill as a part of the remedy is designed to eliminate

leachate seeps and ponding of leachate on the landfill property. This will eliminate the uncontrolled exposure route for leachate.

While the existing leachate collection system appears to be effective in presently controlling the off-site migration of leachate, it could begin to leak at some time in the future as discussed in Section 4.1.1 of the report. The FS Report will address the remedial actions to prevent this condition through an upgrade of the system. In the absence of any remediation, the resulting human health and ecological risks could be significant. The landfill is upstream of a public water supply source which uses the water from the Hackensack River. Should leachate leak from the landfill, these contaminants could enter the intake for that public water supply, although in a significantly diluted form, most likely at or below the laboratory analytical detection levels. Equally or more significantly would be the impact of a leak on the adjacent ecology. Heavy metals in particular would most likely affect the aquatic organisms and could enter the food chain for humans.

The surface soil samples collected from the Clarkstown Landfill contained a variety of metals, but only one was identified as a compound of concern, namely beryllium. Since approximately 90 percent of the landfill property has received an interim final clean soil cover layer over the fill material, human health exposure risk to surface soil is not a significant concern.

Human health exposure risks were not identified for subsurface soils because an exposure pathway does not exist for this media since these soils lie below landfilled wastes. A pathway for incidental exposure to subsurface soils may occur if regrading or consolidation of any off-site wastes into the main landfill is considered as part of the remedial alternative of capping. This would be addressed in a health and safety program for the remediation.

Various organic compounds were detected in the soil gas samples collected at the landfill. Exposure to soil gas is not considered a route of exposure under present conditions. The results of sampling of ambient air are considered to be the most representative of airborne contamination emanating from the landfill. However, if an intrusive remedial alternative such

as excavation or capping which may require extensive regrading is chosen, then precautions for exposure to soil gas will be included in the contract plans and specifications.

The purpose of the ecological risk assessment is to evaluate the potential risks to aquatic and terrestrial plant and animal species from contamination emanating from the Clarkstown Landfill. For the ecological assessment, the concentrations of the site-related contaminants were compared to established State ecological criteria. The ecological risk assessment provides the information required to select a remedial alternative which is protective of the environment.

The most significant aspect of the ecological exposure setting is the presence of the wetlands and streams adjacent to the landfill. The streams serve as potential pathways to transport contaminants from the landfill and other adjoining properties to downstream locations, and as a means of transporting contaminants introduced into the food chain to remote locations. Animals living or dependent on the wetlands include the benthic (sediment) community, turtles, fish, birds, and mammals. The animals' exposure to contaminants from the landfill are both direct, in the form of direct ingestion of contaminated soils or water, or indirect through eating other organisms which have had direct contact with contamination.

There were no compounds of concern identified for surface water. Therefore, on a basin wide basis, ecological risks for this medium do not exist. Locally, ecological risks may exist where concentrations of detected compounds exceed risk-based ecological criteria.

Of the three compounds of concern for sediments, ecological criteria exist for only one compound, copper. According to NYSDEC guidance, if any criteria are exceeded the sediments are considered to be contaminated and a potential risk to the biota and/or human health exists which must be further evaluated. Additional information to be evaluated in this case, as noted in the guidance, include the volumes and location of sediment exceeding the criteria, the type of exceedance (low, severe, acute or chronic), the contaminant persistence, accessibility to the contaminated sediment, the sensitivity of the affected habitat to any such remedial measures, and

the availability of remedial technologies. Even if criteria are exceeded, sediment remediation may not be warranted, nor advisable, with all of the above considerations in mind.

Based on the RI data and NYSDEC guidance, all of the sampled sediment in the streams and wetlands, including locations not potentially affected by the landfill, may be toxic to some benthic species with respect to copper. Sediment copper concentrations in the study area at both upstream and downstream locations relative to the landfill appear to be naturally elevated above the State guidance values. The RI data suggest that sediment copper concentrations in the basin are naturally elevated or are also impacted by sources other than the landfill.

Localized ecological risks due to detected concentrations of compounds other than copper may exist where these concentrations exceed risk-based ecological sediment criteria. Numerous exceedances of the State low and severe effects criteria occurred in both upstream and downstream sediment samples. The percentage of samples exceeding the State criteria versus the total number of samples collected for some of the inorganic compounds indicates that the wetlands and tributary system in the Clarkstown Basin is stressed. The sources of these inorganic inputs to the wetlands system include the landfill and upstream contaminant sources, including urban runoff. Capping of the landfill will eliminate one significant adjacent source of inorganic compounds to the wetland system. The landfill is not currently a source of organic compounds to sediment.

The findings of the risk assessment were that implementation of the NYSDEC Part 360 landfill closure requirements (the primary standards applicable to remedial activities at the landfill site) will either eliminate or greatly reduce those risks which are attributable to the landfill. Some risks, such as those related to ambient air and sediment quality, appear to be primarily a result of off site sources of contamination rather than activities at the landfill. Ambient air exposures to the landfill gas will be eliminated by the Part 360 closure while surface water and sediment quality impacts will be greatly reduced.

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8.0 REFERENCES

- Averill, S. P., Pardi, R. R., Newman, W. S., Dineen, R. J., 1980, Late Wisconsinan-early Holocene History of the Lower Hudson Valley, New Evidence from the Hackensack and Hudson River Valleys: in Manspeizer, W. (editor) Field Studies of New Jersey Geology: 52nd Annual Meeting, New York State Geological Association, Rutgers University, Newark, NJ, pp 160-186.
- Charles R Velzy Associates, Inc., November 1989. Transfer Station Site Study.
- Clement Associates, 1985. Chemical, Physical, and Biological Properties of Compounds Present at Hazardous Waste Sites.
- Converse, Ward, Davis, Dixon, 1978. Report of Soils and Foundation Investigation, Proposed Truck Scale, Clarkstown, NY.
- Converse, Ward, Davis, Dixon, 1979. Report of Geotechnical Investigation and Groundwater Monitoring Program, Existing Landfill, Clarkstown, New York.
- Converse Consultants, 1986. Report of Geotechnical and Hydrogeologic Investigation, Existing Landfill, Clarkstown, New York.
- Converse Engineering Consultants, 1988. Report of Soils and Foundation Investigation, Proposed Transfer Station, Clarkstown Landfill, Clarkstown, NY.
- Dineen, R. J. and Hanson, E. L., 1985. Bedrock Topography and Glacial Deposits of the Colonie Channel between Saratoga Lake and Coeymans, New York: New York State Museum map and Chart 37.
- Kozma Associates/Carpenter Environmental Associates, Inc. Draft Environmental Impact Statement for the Hackensack River Drainage Improvement Project, Town of Clarkstown, Rockland County, New York.
- Malcolm Pirnie, 1986. Report of Site Investigations, Dexter and Old Nyack Landfills, Clarkstown, New York.
- Metcalf and Eddy, 1981. Sludge Compost Study, Boring Logs and Plans.
- NYSDEC, 1990. "Protected Native Plants."
- NYSDEC, 1990. "Ecological Communities of New York." New York Natural Heritage Program.
- NYSDEC, 1990. Inactive Hazardous Waste Disposal Sites in New York State, Volume 3.
- NYSDEC, 1992 and 1993. Personal Communication, Albany and New Paltz offices, New York.

NYSDEC, March 1993. Record of Decision, Xerox-Blauvelt Site, I.D. Number 344021.

NYSDEC, 1993. Inactive Hazardous Waste Disposal Sites in New York State, Volume 3.

New York State Department of Transportation, aerial photographs.

New York State and Rockland County Departments of Health, water quality data.

New York State Freshwater Wetlands Map, Rockland County, Map 8 of 9, 1987.

O'Brien & Gere Engineers, Inc., 1992.

Olsen, P.E., 1980, Triassic and Jurassic Formations of the Newark Basin: in Manspeizer, W. (editor) Field Studies of New Jersey Geology: 52nd Annual Meeting, New York State Geological Association, Rutgers University, Newark, NJ, pp 2-41.

Perlmutter, N.M., 1959. Geology and Groundwater Resources of Rockland County, New York. New York State Department of Conservation, Bulletin GW-42.

U.S. Department of Agriculture, Soil Conservation Service, 1990. Soil Survey of Rockland County, New York.

USEPA, 1986. Superfund Public Health Evaluation Manual, EPA 540/1-86/060.

USEPA, 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, EPA/540/004.

USEPA, 1991. Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites, EPA/540/P-91/001, OSWER Directive 9355.3-11.

USEPA, Region 2, 1995. Personal Communication.

Velzy/WESTON, September 1990. Transfer Station Site Remediation Report.

Velzy/WESTON, April 17, 1990. Site Operations Plan for Clarkstown Sanitary Landfill RI/FS.

Velzy/WESTON, April 17, 1990. Work Plan for Clarkstown Sanitary Landfill RI/FS.

Velzy/WESTON, August 1991. Remedial Investigation/Feasibility Study of Clarkstown Sanitary Landfill - Interim Report, including Analytical Data Assessments and Appendices.

Velzy/WESTON, March 13, 1992. Earth Buttress Berm Analysis, RI/FS, Clarkstown Sanitary Landfill, Rockland County, New York.

Velzy/WESTON, March 13, 1992. Slope Stability Analysis - Response to Questions Raised by DEC in Review of Interim Report, RI/FS, Clarkstown Sanitary Landfill, Rockland County, New York.

Wehran Engineering, P.C., June 1983. Phase I Investigation Report, Clarkstown Landfill, Rockland County, New York.

WESTON, 1993. Re-evaluation of Slope Stability Analysis, RI/FS, Clarkstown Sanitary Landfill, Rockland County, New York.

WESTON, October 1993. Draft Remedial Investigation Report, Clarkstown Sanitary Landfill.

WESTON, November 1993. Amendment to Work Plan and Site Operations Plan.

WESTON, March 1995. Final Feasibility Study Report, Clarkstown Sanitary Landfill, Rockland County, New York.

Wood, W. W. and Fernandez, L. A., 1988, Volcanic Rocks: in Back, W., Rosenshein, J. S., and Seaber, P. R. (editors) Hydrogeology: The Geology of North America, Volume O-2, Geological Society of America, pp 353-366.

Woodward-Clyde Consultants, 1989. Site Investigations, Xerox Corporation, Blauvelt, NY.

Woodward-Clyde Consultants, June 1993. Draft Commentary Report - Review of Previous Stability Studies for Clarkstown Landfill.

APPENDIX A
ANALYTICAL DATA SUMMARY TABLES

CLARKSTOWN SANITARY LANDFILL RI/FS
FINAL REMEDIAL INVESTIGATION REPORT

TABLE

TABLE

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TABLE A-1

PHASE I RI LEACHATE DATA SUMMARY

CLARKSTOWN LANDFILL RI/FS

COMPOUND	County of Rockland Local Law No. 2 Sewer Use Law (µg/l)	Leachate Collection Chambers LC-1 → LC-7		Wet Well (LC-8) and Holding Basins (LB-1 and LB-2)		Leachate Seeps LC-9, LC-10, LC-11 and LC-12	
		Frequency of Detection	Range of Detected Concentrations	Frequency of Detection	Range of Detected Concentrations	Frequency of Detection	Range of Detected Concentrations
Heavy Metals (µg/l)							
Arsenic	1000	3/7	3.0(B) - 5.6(B)	1/3	5.2	4/4	4.4 - 188.0
Cadmium	100	1/7	3.0(BJ)	2/3	5.0	3/4	8.0 - 37.0
Chromium	3000	7/7	6.0(BJ) - 49.0(J)	3/3	12.0 - 18.0	3/4	46.0 - 264.0
Copper	1000	6/7	7.0(BJ) - 63.0	3/3	7.0 - 14.0	4/4	13.0 - 874.0
Iron	-	7/7	7.75 - 32.5	3/3	10.6(J) - 34.6	4/4	15.3 - 226.0
Lead	3000	3/7	3.0 - 14.1	2/3	5.0 - 10.1	4/4	3.8 - 2000.0
Manganese	-	7/7	1.53(J) - 3.09(J)	3/3	1.15(J) - 1.89(J)	4/4	2.69(J) - 22.1(J)
Mercury	50	1/7	0.14	1/3	0.18	1/4	1.23
Nickel	1000	7/7	10.0 - 30.0	3/3	20.0 - 25.0	3/4	82.0 - 269.0
Silver	5000	3/7	7.0 - 13.0	2/3	10.0	2/4	17.0 - 31.0
Zinc	3000	7/7	17.0 - 68.0	3/3	49.0 - 67.0	3/4	395.0 - 6080.0
Major Cations (mg/l)							
Calcium	-	7/7	49.6(J) - 234.0	3/3	165.0 - 187.8(J)	4/4	138.0(J) - 1050.0(J)
Magnesium	-	7/7	17.9 - 76.4	3/3	5.16(J) - 52.2	4/4	16.3(J) - 179.0
Potassium	-	7/7	17.9 - 166.0	3/3	75.4(J) - 111.0(J)	4/4	39.1(J) - 421.0(J)
Sodium	-	7/7	61.1 - 343.5(J)	3/3	173.0(J) - 284.5(J)	4/4	58.8(J) - 753.0(J)

NOTES:

J = Estimated Value

B = Value is less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL).

TABLE A-1

**PHASE I RI LEACHATE DATA SUMMARY
CLARKSTOWN LANDFILL RI/FS**

COMPOUND	County of Rockland Local Law No. 2 Sewer Use Law (µg/l)	Leachate Collection Chambers LC-1 → LC-7		Wet Well (LC-8) and Holding Basins (LB-1 and LB-2)		Leachate Seeps LC-9, LC-10, LC-11 and LC-12	
		Frequency of Detection	Range of Detected Concentrations	Frequency of Detection	Range of Detected Concentrations	Frequency of Detection	Range of Detected Concentrations
Volatile Organics (µg/l)							
Vinyl Chloride	-	0/7	ND	0/3	ND	1/4	130(J)
Chloroethane	-	0/7	ND	0/3	ND	2/4	45(J) - 410(J)
Methylene Chloride	6000	0/7	ND	0/3	ND	1/4	190(J)
Acetone	-	0/7	ND	0/3	ND	2/4	13,000(BJ) - 34,000(J)
Carbon Disulfide	-	5/7	18 - 90	1/3	9	1/4	15(J)
1,1-Dichloroethane	-	0/7	ND	0/3	ND	1/4	135(J)
1,2-Dichloroethane (TOTAL)	-	1/7	3(J)	0/3	ND	0/4	ND
2-Butanone	-	0/7	ND	0/3	ND	3/4	40(J) - 17,000(J)
1,1,1-Trichloroethane	-	0/7	ND	0/3	ND	1/4	310(J)
Benzene	-	4/7	1(J) - 3(J)	0/3	ND	0/4	ND
4-methyl-2-pentanone	-	0/7	ND	0/3	ND	1/4	400(J)
Toluene	-	0/7	ND	2/3	1(J)	2/4	215(J) - 220(J)
Chlorobenzene	-	4/7	9 - 26(J)	3/3	4(J) - 12	0/4	ND
Semivolatile Organics (µg/l)							
Phenol	-	0/7	ND	0/3	ND	1/4	490
4-methylphenol	-	0/7	ND	0/3	ND	1/4	4,000(J)
Napthalene	-	1/7	5(J)	0/3	ND	1/4	8(J)
Di-n-Butylphthalate	-	2/7	4(J) - 6(J)	1/3	6(J)	0/4	ND
Bis(2-ethylhexyl)phthalate	-	0/7	ND	1/3	100(BJ)	0/4	ND
Pesticides (µg/l)							
4,4-DDT	-	1/7	9.2(J)	0/3	ND	2/4	0.13 - 0.24

NOTES: J = Estimated Value B = Compound Found in Blank ND = Compound Not Detected

TABLE A-2

**PHASE II RI LEACHATE DATA SUMMARY
CLARKSTOWN LANDFILL RI/FS**

Compound	County of Rockland Local Law No. 2 Sewers Use Law (ug/l)	Leachate Collection Chambers LC-1 thru LC-7		Wet Well (LC-8) and Holding Basins (LB-1 and LB-2)	
		Frequency of Detection	Range of Detected Concentrations	Frequency of Detection	Range of Detected Concentrations
Inorganics: (ug/l)					
Arsenic	1000	4/7	1.1(B)-2.2(B)	3/3	1.5(B)-2.8(B)
Cadmium	100	7/7	1.5(B)-4.0(B)	3/3	2.0(B)-4.3(B)
Chromium	3000	5/7	5.3(B)-6.8(B)	3/3	6.9(B)-11.0
Copper	1000	7/7	2.3(B)-5.0(B)	3/3	10.7(B)-13.4(B)
Iron	-	7/7	20700-43400	3/3	23500-46700
Lead	3000	1/7	4.6	3/3	5.1-11.8
Manganese	-	7/7	836-1740	3/3	1100-1730
Mercury	50	7/7	ND	0/3	ND
Nickel	1000	0/7	5.2(B)-11.4(B)	3/3	14.6(B)-16.6(B)
Silver	5000	0/7	ND	0/3	ND
Zinc	3000	7/7	19.4(B)-31.0	3/3	37.6-52.3
Major Cations					
Calcium	-	7/7	129000-176000	3/3	146000-150000
Magnesium	-	7/7	31900-53400	3/3	37600-48300
Potassium	-	7/7	31900-74300	3/3	49500-57200
Sodium	-	7/7	86600-202000	3/3	119000-168000

J - Estimated Value

B - Value is less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL)

ND - Not Detected

TABLE A-2

**PHASE II RI LEACHATE DATA SUMMARY
CLARKSTOWN LANDFILL RI/FS**

Compound	County of Rockland Local Law No. 2 Sewers Use Law (ug/l)	Leachate Collection Chambers LC-1 thru LC-7		Wet Well (LC-8) and Holding Basins (LB-1 and LB-2)	
		Frequency of Detection	Range of Detected Concentrations	Frequency of Detection	Range of Detected Concentrations
Volatile Organics					
Bromomethane	-	1/7	2J	0/3	ND
Vinyl Chloride	710	0/7	ND	0/3	ND
Chloroethane	240	1/7	2JN	0/3	ND
Methylene Chloride	2060	0/7	ND	0/3	ND
Carbon Disulfide	60	0/7	ND	0/3	ND
1,1-Dichloroethane	2130	0/7	ND	0/3	ND
2-Butanone	-	0/7	ND	0/3	2J
1,1,1-Trichloroethane	1360	0/7	ND	0/3	ND
Benzene	140	0/7	ND	1/3	ND
Chlorobenzene	2130	7/7	10-36	3/3	9J-18
Ethylbenzene	1590	0/7	ND	1/3	1J
Xylene (Total)	-	2/7	2J	2/3	1J-3J
1,4-Dichlorobenzene	2130	6/7	4J-8J	2/3	4J-7J
1,2-Dichlorobenzene	2130	0/7	ND	0/3	1J

J - Estimated Value
 B - Compound Found in Blank
 ND - Compound Not Detected
 N - Presumptive Evidence for Presence of Compound

TABLE A-3

COMPARISON OF HISTORICAL AND PHASE I RI LEACHATE DATA FOR LEACHATE COLLECTION CHAMBERS
CLARKSTOWN LANDFILL RI/FS

	1985 Sampling ($\mu\text{g/l}$) ⁽¹⁾		1986/1987 Sampling ($\mu\text{g/l}$)		Phase I RI Sampling ($\mu\text{g/l}$)	
	Frequency	Range	Frequency	Range	Frequency	Range
Inorganics						
Arsenic	4/7	<1.0 - 25	1/14 ⁽⁴⁾	60	3/7	3.0(B) - 5.6(B)
Cadmium	0/7	ND	0/7 ⁽²⁾	ND	1/7	3.0(BJ)
Chromium	0/7	ND	0/7 ⁽²⁾	ND	7/7	6.0(BJ) - 49.0(J)
Copper	7/7	43 - 121	10/14 ⁽⁴⁾	50 - 440	6/7	7.0(BJ) - 63.0
Iron	7/7	1830 - 23,200	21/21 ⁽³⁾	260 - 203,000 ⁽³⁾	7/7	7750.0 - 234,000.0
Lead	0/7	ND	5/14 ⁽⁴⁾	50 - 630	3/7	3.0 - 14.1(J)
Manganese	7/7	641 - 2,010	21/21 ⁽³⁾	240 - 3,560 ⁽³⁾	7/7	1530.0(J) - 3090.0(J)
Mercury	7/7	0.7 - 0.9	0/7 ⁽²⁾	ND	1/7	0.14(B)
Nickel	3/7	48 - 78	0/7 ⁽²⁾	ND	7/7	10.0(B) - 30.0(B)
Silver	0/7	ND	0/7 ⁽²⁾	ND	3/7	7.0(BJ) - 13.0(J)
Zinc	7/7	32 - 241	12/14 ⁽⁴⁾	60 - 530	7/7	17.0(BJ) - 68.0

Notes:⁽¹⁾ 1985 Sampling of leachate at Clarkstown Sanitary Landfill for discharge permit purposes; sampling conducted by Consolidated Technology, Inc.⁽²⁾ 1986 Sampling of leachate at Clarkstown Sanitary Landfill for discharge permit purposes; sampling conducted by Consolidated Technology, Inc.⁽³⁾ 1987 Sampling of leachate at Clarkstown Sanitary Landfill for discharge permit purposes (3 quarterly rounds); sampling conducted by Laboratory Resources, Inc.⁽⁴⁾ Combined 1986 and 1987 data.

ND = Compound Not Detected.

J = Estimated Value

B = Value is less than the Contract Required Detection Limit but greater than the Instrument Detection Unit.

TABLE A-3
COMPARISON OF HISTORICAL AND PHASE I RI LEACHATE DATA FOR LEACHATE COLLECTION CHAMBERS
CLARKSTOWN LANDFILL RI/FS

COMPOUND	1985 Sampling ⁽¹⁾		1986 Sampling ⁽²⁾		Phase I RI Sampling (1990)	
	Frequency	Range	Frequency	Range	Frequency	Range
Volatile Organics (ug/l)						
Chlorobenzene	1/7	<10	6/7	<10 - 14	4/7	9 - 26(J)
Carbon Disulfide	NA	NA	NA	NA	5/7	18 - 90
1,2-Dichloroethane (TOTAL)	NA	NA	NA	NA	1/7	3(J)
Trans-1,2-Dichloroethylene	0/7	ND	1/7	12	NA	NA
Methylene Chloride	1/7	<10	NA	NA	0/7	ND
Benzene	0/7	ND	1/7	<10	4/7	1(J) - 3(J)
Ethylbenzene	0/7	ND	1/7	<10	0/7	ND
Toluene	0/7	ND	2/7	<10	0/7	ND
2-Butanone	0/7	ND	1/7	<10	0/7	ND
Acetone	0/7	ND	2/7	<10	0/7	ND
Xylene	1/7	3.0	2/7	<10 - 30	1/7	3(J)
Semivolatile Organics (ug/l)						
Acenaphthene	NA	NA	3/7	<10	0/7	ND
Bis (2-ethylhexyl)phthalate	1/7	38	3/7	<10 - 22	0/7	ND
n-Nitrosodiphenylamine	0/7	ND	2/7	<10 - 24	0/7	ND
Dibenzofuran	NA	NA	1/7	<10	0/7	ND
Napthalene	NA	NA	NA	NA	1/7	5(J)
Di-n-Butylphthalate	NA	NA	NA	NA	2/7	4(J) - 6(J)
Pesticides (ug/l)						
4,4-DDT	NA	NA	NA	NA	1/7	8.8(J) - 9.2(J)

NOTES: ⁽¹⁾ 1985 Sampling of leachate at Clarkstown Sanitary Landfill for discharge permit purposes; sampling conducted by Consolidated Technology, Inc.

⁽²⁾ 1986 Sampling of leachate at Clarkstown Sanitary Landfill for discharge permit purposes; sampling conducted by Consolidated Technology, Inc.

J = Estimated Value. ND = Compound Not Detected. NA = Not Analyzed or Data Not Available.

< = Compound was detected at an estimated concentration below the indicated value.

TABLE A-4
AMBIENT AIR AND SOIL GAS SAMPLES - STATISTICAL SUMMARY

COMPOUNDS DETECTED All Units in Parts Per Billion by Volume (PPBV)	NYSDEC Ambient AGC* Guideline Concentration	NYSDEC Ambient SGC** Guideline Concentration	AMBIENT AIR HOT SPOT LOCATIONS 15 AUG 1990		AMBIENT AIR DOWNWIND LOCATIONS 17, 27 & 28 AUG 1990		AMBIENT AIR UPWIND LOCATIONS 17, 27 & 28 AUG 1990		SOIL GAS ALL LOCATIONS 8 & 14 NOV 1990	
			AVG		AVG		AVG		AVG	
Dichlorodifluoromethane (Ereon 12)	---	---	9.33		3.11		4.17		2,307.27	
Methyl Chloride	342.37	7,463.62	4.13		1.71		1.67		ND	
Trichlorofluoromethane (Ereon 11)	---	69,827.76	0.97		1.40		1.67		122.36	
Methylene Chloride	7.14	8,268.06	0.33		1.29		1.40		ND	
1,1,2-Trichloro-1,2,2-trifluoroethane (Ereon 113)	19,342.33	164,543.71	0.00		0.00		0.30		0.13	
Chloroform	4.37	140.61	0.00		0.13		0.00		ND	
1,1,1-Trichloromethane	168.27	57,777.15	1.13		0.74		1.27		3.45	
Benzene	0.03	6.58	1.00		1.90		1.77		142.41	
Toluene	487.35	16,545.27	3.63		4.48		3.40		1,805.11	
Tetrachloroethene	0.01	8,366.69	1.30		1.00		0.30		10.48	
Chlorobenzene	3.99	1,673.94	0.00		0.07		0.00		31.54	
Ethylbenzene	211.47	16,135.08	1.00		0.13		0.47		802.00	
m/p-Xylene	63.44	16,133.56	2.47		1.23		3.13		890.27	
o-Xylene	148.03	16,133.56	0.77		0.11		0.50		220.45	
1,3,5-Trimethylbenzene	54.16	4,132.96	0.50		0.00		0.00		51.09	
1,2,4-Trimethylbenzene	---	4,132.96	1.90		0.16		1.10		123.27	
Acetone	5,411.50	41,288.91	500.00		54.72		73.93		399.91	
Carbon Disulfide	2.06	159.73	20.00		8.78		0.00		277.91	
4-Methyl-2-Pentanone (MIBK)	0.52	8,205.51	2.33		0.22		0.00		9.18	
1,2-Dichloroethane (Total)	NA	NA	ND		ND		ND		14.64	
Trichloroethene	NA	NA	ND		ND		ND		5.36	
Styrene	NA	NA	ND		ND		ND		4.45	
o-Dichlorobenzene	NA	NA	ND		ND		ND		0.55	
p-Dichlorobenzene	NA	NA	ND		ND		ND		27.00	
1,2,4-Trichlorobenzene	NA	NA	ND		ND		ND		0.41	

NA - Ambient Air Guidelines not applicable to soil gas concentrations.

* - Annual Guideline Concentrations presented for informational purposes only - Not used for comparison with the Phase I RI data.

** - Short Term Guideline Concentrations for a 1-hour sampling period have been corrected to reflect an 8-hour sampling period.

ND - Not detected

TABLE A-5 PHASE I RI SOIL GAS DATA SUMMARY						
COMPOUND All Units in Parts Per Billion by Volume (PPbv)	Off-property Sample (SG44)	Western Landfill Perimeter Samples (SG1, SG7-A)		Interior Property Samples (SG9-A, SG34-C, SG38-A, SG52-A, SG52-A-FD, SG68-C, SG69-A, SG70)		Range of Detected Concentrations
		Frequency of Detection	Range of Detected Concentrations	Frequency of Detection	Range of Detected Concentrations	
Dichlorodifluoromethane (FREON 12)	202	1/2	4,300	8/8	8-17,000	
Vinyl Chloride	ND	2/2	190-990	5/8	4-2,100	
Ethyl Chloride	ND	1/2	1,500	3/8	27-860	
Trichlorofluoromethane (FREON 11)	4	1/2	220	4/8	36-610	
1,1,2-Trichloro-1,2,2 trifluoroethane (FREON 113)	ND	0/2	ND	1/8	1.4	
1,1-Dichloroethane	ND	0/2	ND	2/8	7-94	
1,2-Dichloroethane (TOTAL)	ND	0/2	ND	3/8	11-130	
1,1,1-Trichloroethane	ND	0/2	ND	1/8	38	
Benzene	2.5	1/2	450	6/8	4-330	
Trichloroethane	ND	0/2	ND	2/8	11-48	
Toluene	60	2/2	170-860	7/8	4-10,000	
Tetrachloroethane	4	0/2	ND	4/8	4-12	
Chlorobenzene	ND	0.2	ND	3/8	6-310	
Ethylbenzene	17	1/2	1,300	6/8	100-3,800	
m/p Xylene	22	1/2	1,100	7/8	600-5,800	
Styrene	ND	0/2	ND	1/8	49	
o-Xylene	13	1/2	400	7/8	15-1,000	
1,3,5-Trimethylbenzene	24	0/2	ND	5/8	20-80	
1,2,4-Trimethylbenzene	50	0/2	ND	7/8	37-680	
o-Dichlorobenzene	ND	0/2	ND	1/8	6	
p-Dichlorobenzene	67	0/2	ND	4/8	40-140	
1,2,4-Trichlorobenzene	4.5	0/2	ND	0/8	ND	

ND = Compound Not Detected

TABLE A-6

PHASE II RI SOIL GAS DATA SUMMARY

COMPOUND All Units in Parts Per Billion by Volume (PPBv)	Transfer Station Gas Vent (LFG-8B)	Interior Property Samples (LFG-2B, LFG-3B, LFG-3B DUP)	
		Frequency of Detection	Range of Detected Concentrations
Dichlorodifluoromethane (Freon 12)	20	3/3	8.5 - 32
Vinyl Chloride	0.64	3/3	6.8 - 10
Chloroethane	1.6	1/3	7.1
Trichlorofluoromethane (Freon 11)	0.5	1/3	4.9
1,2 Dichlorotetrafluoroethane	11	3/3	1.2J - 7.8
112-Trichlorotrifluoroethane	0.19J	0/3	ND
1,1-Dichloroethane	ND	1/3	4.2
cis-1,2-Dichloroethane	ND	2/3	1.8J
1,1,1-Trichloroethane	ND	1/3	4.3
Trichloroethene	0.31J	3/3	0.64J - 4.1
Benzene	2.7	3/3	0.83J - 2.9
Tetrachloroethene	ND	3/3	0.92J - 12
Toluene	0.65	3/3	63 - 150
Chlorobenzene	3	0/3	ND
Ethylbenzene	1.2	3/3	24 - 33
M/P-Xylene	0.64	3/3	20 - 35
O-Xylene	0.68	3/3	14 - 17
Isopropylbenzene	1.5	3/3	2.3J - 3.8
Benzyl Chloride	ND	3/3	3.6JN - 12JN
1,3,5-Trimethylbenzene	0.25J	3/3	4.6 - 9.6
1,2,4-Trimethylbenzene	1.7	3/3	13 - 27
1,4-Dichlorobenzene	0.29J	3/3	3.1 - 16
Styrene	ND	1/3	8.4

TABLE A-7

**SUMMARY OF DETECTED VOLATILE ORGANIC COMPOUNDS FROM NYSDEC
HACKENSACK RIVER BASIN STREAM SURVEY (JANUARY, 1989 and MARCH, 1989)
CLARKSTOWN LANDFILL RI/FS**

Compound	Upstream Sampling Locations (3/89-5A, 6A; 1/89-4, 5, 6, 7, 8, 9)		Downstream Sampling Locations Locations (3/89-1A, 2A, 3A, 4A; 1/89-3)	
	Frequency of Detection	Range of Detected Concentrations with Location and Date of Highest Detection	Frequency of Detection	Range of Detected Concentrations with Location and Date of Highest Detection
1,1-Dichloroethane	1/8	1 µg/l (4-1/89)	ND	ND
Cis-1,2-Dichloroethene	4/8	1 µg/l-4 µg/l (4-1/89)	5/5	1 µg/l-4 µg/l (3A, 1A-3/89)
Trichloroethene	3/8	2 µg/l-3 µg/l (4, 8-1/89)	4/5	2 µg/l-4 µg/l (1A-3/89)
Tetrachloroethene	2/8	3 µg/l-7 µg/l (4-1/89)	2/5	1 µg/l (2A, 4A-3/89)
1,1,1-Trichloroethane	1/8	3 µg/l (4-1/89)	ND	ND
Methylene Chloride	ND	ND	3/5	1 µg/l-2 µg/l (1A-3/89)

Note:

ND = Compound Not Detected

PHASE I RI SURFACE WATER DATA SUMMARY
CLARKSTOWN LANDFILL RI/FS

Compound/ Analyte	New York State Water Quality Standards and Guidance Values (µg/l)		Upstream Surface Water Sampling Locations (SW-1, SW-2, SW-3, SW-10, SW-11 SW-12)		Downstream Surface Water Sampling Locations (SW-4, SW-5, SW-6, SW-7, SW-8, SW-9)	
			Frequency of Detection	Range of Detected Concentrations and Location of Highest Detection (µg/l)	Frequency of Detection	Range of Detected Concentrations and Location of Highest Detection (µg/l)
	Surface Water Classification					
Inorganics (µg/l):	A(H)	A, B, C(A)	D(A)			
Aluminum	-	100	-	6/6	34.0B - 383.0 (SW-10)	162.0B - 41,500 (SW-7)
Arsenic	50	190	360	ND	ND	3.4J - 5.9B (SW-7)
Cadmium	10	(1)	(1)	1/6	3.0B (SW-12)	3.0B - 4.0B (SW-5)
Chromium	50	(1)	(1)	4/6	3.0BJ - 7.0B (SW-11)	3.0B - 51.0 (SW-7)
Copper	200	(1)	(1)	5/6	6.0B - 12.0B (SW-10)	5.0B - 124 (SW-7)
Iron	300	300	300	6/6	135.0J - 6560J (SW-11)	562.0J - 64,300 (SW-7)
Lead	50	(1)	(1)	4/6	2.4BJ - 9.8J (SW-11)	2.2J - 94.8J (SW-7)
Manganese	300	-	-	6/6	3.0BJ - 1150J (SW-2)	116.0J - 1290J (SW-8)
Mercury	2	0.2*	0.2*	R	R	R
Nickel	--	(1)	(1)	ND	ND	8.0B - 53.0 (SW-7)
Silver	50	0.1	(1)	1/6	7.0B (SW-12)	ND
Zinc	300	30	(1)	5/6	3.0B - 49.0 (SW-11)	6.0B - 485.0J (SW-7)

NOTES:

*Guidance Value

(H) = Standards based on protection of human health.

(A) = Standards based on protection of aquatic life.

(I) = See complete data tables in Appendix for calculation of standards for protection of aquatic life based on hardness (calcium and magnesium) data.

ND = Compound Not Detected.

J = Estimated value.

B = Reported value is less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL).

R = Data rejected during validation.

TABLE A-8

**PHASE I SURFACE WATER DATA SUMMARY
CLARKSTOWN LANDFILL RI/FS**

Compound/ Analyte	New York State Surface Water Quality Standards and Guidance Values (µg/l)			Upstream Surface Water Sampling Locations (SW-1, SW-2, SW-3, SW-10, SW-11 SW-12)		Downstream Surface Water Sampling Locations (SW-4, SW-5, SW-6, SW-7, SW- 8, SW-9)	
	Surface Water Classification			Frequency of Detection	Range of Detected Concentrations and Location of Highest Detection (µg/l)	Frequency of Detection	Range of Detected Concentrations and Location of Highest Detection (µg/l)
	A(H)	A, B, C(A)	D(A)				
Organics: (µg/l)							
Methylene Chloride	5*	-	-	1/6	2J (SW-11)	ND	ND
Acetone	-	-	-	2/6	5J - 6J (SW-11)	1/6	6J (SW-8)
Carbon disulfide	-	-	-	2/6	4J - 100 (SW-11)	1/6	11 (SW-4)
Chloroform	7.0	-	-	1/6	26 (SW-2)	ND	ND
1,1,1-Trichloroethane	5*	-	-	2/6	2J - 26 (SW-2)	ND	ND
Bromodichloromethane	50*	-	-	1/6	4J (SW-2)	ND	ND
Trichloroethene	3*	11.0*	11.0*	2/6	2J - 3J (SW-10)	1/6	3J (SW-9)
Tetrachloroethene	1.0			1/6	7 (SW-3)	1/6	2J (SW-4)
Toluene	5*	-	-	ND	ND	1/6	3BJ (SW-7)
Semivolatiles: (µg/l)							
Di-n-Butylphthalate	50*	-	-	1/6	2J (SW-11)	ND	ND
Bis(2-Ethylhexyl)phthalate	4*	0.6	-	1/6	4J (SW-12)	ND	ND

TABLE A-9

**PHASE II SURFACE WATER DATA SUMMARY
CLARKSTOWN LANDFILL RI/FS**

Compound/ Analyte	New York State Notes Quality Standards and Guidance Values (µg/l)	Upstream Surface Water Sampling Locations (SW-2, SW-12)		Frequency of Detection	Downstream Surface Water Sampling Locations (SW-4, SW-13, SW-14, SW-15, SW-16, SW-17, SW-18)			
		Frequency of Detection	Range of Detected Concentrations and Location of Highest Detection (µg/l)		Frequency of Detection	Range of Detected Concentrations and Location of Highest Detection (µg/l)		
Inorganics: (µg/l)		Surface Water Classification						
		A(H)	A, B, C(A)	D(A)				
Aluminum		-	100	-	3/3	51.6(B)-526 (SW-2)	6/6	72.8(B)-3950 (SW-17)
Beryllium		3	11/1100	-	1/3	0.50(B) (SW-12)	1/6	0.70(B) (SW-17)
Cadmium		10	(1)	(1)	0/3	ND	1/6	1.3(B) (SW-13)
Copper		200	(1)	(1)	3/3	3.5(B)-14.7(B) (SW-2)	6/6	3.0 (B)-21.6(B) (SW-17)
Iron		300	300	300	3/3	382-4290 (SW-2)	6/6	827-8370 (SW-17)
Lead		50	(1)	(1)	2/3	3.7 (SW-2)	5/6	1.2(B) -15.1 (SW-17)
Manganese		300	-	-	3/3	241J-474 (SW-2)	6/6	119-2140 (SW-17)
Nickel		-	(1)	(1)	3/3	7.6(B)-27.7(B) (SW-2)	6/6	6.7(B)-15.2(B) (SW-14)
Zinc		300	30	(1)	3/3	12.5B-167 (SW-2)	6/6	13.5(B)-82.6 (SW-17)
Organics: (µg/l)		Surface Water Classification						
		A(H)	A, B, C(A)	D(A)				
Trichloroethene		3*	11.0*	11.0*	0/3	ND	1/6	2J (SW-16)

TABLE A-10

**PHASE I RI SEDIMENT DATA SUMMARY
CLARKSTOWN LANDFILL RI/FS**

Compound	New York State Sediment Criteria (mg/kg) ⁽¹⁾	Upstream Sediment Sampling Locations (SD-1, SD-2, SD-3,SD-10, SD-11 SD-12)		Downstream Sediment Sampling Locations (SD-4, SD-5, SD-6, SD-7, SD-8, SD-9)	
		Frequency of Detection	Range of Detected Concentrations (mg/kg)	Frequency of Detection	Range of Detected Concentrations (mg/kg)
Inorganics (mg/kg):					
Arsenic	6#/33##	5/6	0.98BJ - 7.5J (SD-12)	6/6	1.60BJ-12.1J (SD-6)
Cadmium	0.6#/9##	3/6	3.2J - 6.2B (SD-11)	3/6	2.6J - 5.5 (SD-9)
Chromium	26#/110##	6/6	10.3J - 78.9J (SD-3)	6/6	13.1J - 103.0J (SD-9)
Copper	16#/110##	6/6	26.2 - 173.0 (SD-11)	6/6	11.6 - 328.0 (SD-8)
Iron	2 %#/4%##	6/6	9270J - 68,600J (SD-12)	6/6	10,500 - 58,200J (SD-9)
Lead	31#/110##	6/6	10.1 BJ - 421.0 (SD-11)	6/6	5.2J - 462J (SD-6)
Manganese	460#/1100##	6/6	264.0J - 959.0J (SD-12)	6/6	256.0J - 1140.0J (SD-9)
Mercury	0.15#/1.3##	1/6	0.18B (SD-12)	1/6	1.0 (SD-7)
Nickel	16#/50##	6/6	9.5B - 43.2B (SD-11)	6/6	11.6 - 56.2 (SD-9)
Silver	1#/2.2##	3/6	1.7B - 16.5B (SD-11)	1/6	11.0B (SD-8)
Zinc	120#/270##	6/6	41.0 - 173.0J (SD-3)	6/6	21.8J - 692 (SD-9)

TABLE A-10
PHASE I RI SEDIMENT DATA SUMMARY
CLARKSTOWN LANDFILL RI/FS

Compound/ Analyte	New York State Sediment Criteria µg/gOC ⁽¹⁾	Upstream Sediment Sampling Locations (SD-1, SD-2, SD-3,SD-10, SD-11, SD-12)		Downstream Sediment Sampling Locations (SD-4, SD-5, SD-6, SD-7, SD-8, SD-9)	
		Frequency of Detection	Range of Detected Concentrations µg/gOC	Frequency of Detection	Range of Detected Concentrations µg/gOC
Volatile Organics (µg/gOC):					
Methylene Chloride	-	1/6	0.84B (SD-3)	1/6	0.05J (SD-7)
1,1-Dichloroethene	0.02 (H)	1/6	0.05J (SD-2)	1/6	0.25J (SD-5)
1,1-Dichloroethane	-	1/6	0.07J (SD-11)	ND	ND
Chloroform	-	1/6	0.72J (SD-12)	ND	ND
2-Butanone	-	3/6	0.07J - 0.26J (SD-12)	1/6	0.26J (SD-9)
Benzene	0.6 (H)	1/6	0.06J (SD-2)	1/6	0.25J (SD-5)
Chlorobenzene	3.5 (A)	1/6	0.10J (SD-11)	1/6	0.25J (SD-5)
Semivolatiles (µg/gOC):					
Acenaphthylene	-	ND	ND	1/6	1.19J (SD-6)
Phenanthrene	139 (A)	2/6	3.33 - 34.0J (SD-12)	1/6	1.69J (SD-6)
Anthracene	-	2/6	3.33J - 9.6J (SD-12)	1/6	1.69 (SD-6)
Di-n-butylphthalate	-	3/6	0.93J - 5.42J (SD-1)	2/6	1.20J - 14.17J (SD-4)
Fluoranthene	-	6/6	2.13J - 68.0 (SD-12)	4/6	1.03J - 16.95 (SD-6)
Pyrene	-	4/6	5.07J - 50.0 (SD-12)	1/6	10.17 (SD-6)
Butylbenzylphthalate	-	2/6	2.89J - 8.07J (SD-11)	ND	ND
Benzo(a)anthracene	1.3 (H)	4/6	2.51J - 28.0 (SD-12)	1/6	6.21 (SD-6)
Chrysene	1.3 (H)	4/6	2.99J - 28.00 (SD-12)	1/6	7.91 (SD-6)
Bis(2-ethylhexyl)phthalate	119.7 (A)	3/6	2.63J - 80.70 (SD-11)	ND	ND
Benzo(b)fluoranthene	1.3 (H)	4/6	2.54J - 24.0 (SD-12)	1/6	6.21 (SD-6)
Benzo(k)fluoranthene	1.3 (H)	3/6	2.89J - 22.0 (SD-12)	1/6	6.21 (SD-6)
Benzo(a)pyrene	1.3 (H)	4/6	2.51J - 28.0 (SD-12)	1/6	6.21 (SD-6)

TABLE A-10
PHASE I RI SEDIMENT DATA SUMMARY
CLARKSTOWN LANDFILL RI/FS

Compound/ Analyte	New York State Sediment Criteria $\mu\text{g/gOC}^{(1)}$	Upstream Sediment Sampling Locations (SD-1, SD-2, SD-3, SD-10, SD-11, SD-12)		Downstream Sediment Sampling Locations (SD-4, SD-5, SD-6, SD-7, SD-8, SD-9)	
		Frequency of Detection	Range of Detected Concentrations $\mu\text{g/gOC}$	Frequency of Detection	Range of Detected Concentrations $\mu\text{g/gOC}$
Indeno(1,2,3-cd)pyrene	1.3 (H)	2/6	2.53J - 16.4 (SD-12)	1/6	3.22J (SD-6)
Benzo(g,h,i)perylene	-	2/6	2.41J-14.0 (SD-12)	ND	ND
Pesticides:					
4,4-DDT	<50 (A) / 0.01 (H)	ND	ND	1/6	0.34J (SD-6)

NOTES:

- J - Estimated Value
- B - Inorganics: Reported Value is less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL);
Organic: Compound was detected in blank sample.
- ND - Compound Not Detected.
- # - The "lowest effect" level, the concentration which will impair sediment use by some benthic organisms, but that can be tolerated by the majority (Persaud, 1992).
- ## - The "severe effect" level, the concentration which will significantly impair use of sediment by some benthic organisms (Persaud, 1992).

⁽¹⁾NYSDEC Sediment Criteria - December 1989, Used as Guidance by the NYSDEC Bureau of Environmental Protection, (Note: This document is used as guidance by the Division of Fish and Wildlife. It is neither a standard nor a policy of the Department). The sediment criteria are normalized to organic carbon (OC) content as $\mu\text{g/gOC}$; to obtain criteria for bulk sediments in $\mu\text{g/kg}$ multiply by fraction OC. The data for SD-1 through SD-12 were converted into $\mu\text{g/gOC}$ (using TOC values) from $\mu\text{g/kg}$ for comparison to standards presented in the data table. The following formula was used to perform the conversion from $\mu\text{g/kg}$ to $\mu\text{g/gOC}$:

$$(\mu\text{g/Kg}) \times (100 \text{ Kg/\% TOC}) \times (1 \text{ KgOC/1000 gOC}) = \mu\text{g/gOC Inorganic Analytical Parameters}$$

Sediment Criteria for inorganics were derived from estimated toxicity to benthic (bottom) organisms. There are no human health based sediment criteria for inorganics.

For the organics, the criterion shown is the aquatic toxicity (A) or human health (H) based value. Exceedance of the aquatic toxicity based criterion would be predicted to cause toxicity to benthic or epibenthic organisms. Exceedance of the human health based criterion would be predicted to cause accumulation of the chemicals in aquatic animals to levels that would exceed a human health tolerance, action level, or cancer risk dose.

TABLE A-11

**PHASE II SEDIMENT DATA SUMMARY
CLARKSTOWN LANDFILL RI/FS**

Compound/ Analyte	New York State Sediment Criteria (mg/kg)	Upstream Sediment Sampling Locations (SD-2, SD-12)		Downstream Sediment Sampling Locations (SD-4, SD-13, SD-14, SD-15, SD-16, SD-17, SD-18)	
		Frequency of Detection	Range of Detected Concentrations and Location of Highest Detection (mg/kg)	Frequency of Detection	Range of Detected Concentrations and Location of Highest Detection (mg/kg)
Inorganics (mg/kg)	Aq. Tox. Acute/Chronic				
Aluminum	-	2/2	6,030 - 8,750 (SD-2)	7/7	7,220 - 24,200 (SD-13)
Arsenic	6#/33##	2/2	2.2B - 13.4 (SD-12)	7/7	1.6B - 8.7 (SD-16)
Beryllium	-	2/2	.33B - .69B (SD-2)	7/7	0.33B - 1.6B (SD-16)
Cadmium	0.6#/9##	2/2	1.3B - 1.8 (SD-12)	7/7	1.1B - 7.9 (SD-16)
Chromium	26#/110#	2/2	14.0 - 15.9 (SD-2)	7/7	9.1 - 37.0 (SD-13)
Copper	16#/110#	2/2	31.9 - 33.0 (SD-12)	7/7	26.0 - 125 (SD-16)
Iron	2 %#/4%##	2/2	14,700 - 18,500 (SD-12)	7/7	14,400 - 50,000 (SD-18)
Lead	31#/110##	2/2	52.5 - 107 (SD-12)	7/7	34.7 - 310 (SD-16)
Manganese	460#/1100##	2/2	168 - 1,340 (SD-12)	7/7	162 - 472 (SD-4)
Mercury	0.15#/1.3##	2/2	0.09B - 0.1B (SD-2)	5/7	0.15 - 0.37 (SD-16)
Nickel	16#/50##	2/2	10.6 - 11.8B (SD-2)	7/7	12.4 - 35.6 (SD-16)
Silver	1#/2.2##	0/2	ND	1/7	2.2BJ (SD-18)
Zinc	120#/270##	2/2	89.2 - 201 (SD-2)	7/7	42.2-899 (SD-16)

NOTES: See Appendix B data table footnotes for explanation of sediment criteria

B = Value is less than the CRDL but greater than the IDL; ND = Not Detected; J = Estimated value

TABLE A-11

**PHASE II SEDIMENT DATA SUMMARY
CLARKSTOWN LANDFILL RI/FS**

Compound/ Analyte	New York State Sediment Criteria ($\mu\text{g/gOC}$)		Upstream Surface Water Sampling Locations (SD-2, SD-12)		Downstream Surface Water Sampling Locations (SD-4, SD-13, SD-14, SD-15, SD-16, SD-17, SD-18)	
			Frequency of Detection	Range of Detected Concentrations and Location of Highest Detection ($\mu\text{g/gOC}$)	Frequency of Detection	Range of Detected Concentrations and Location of Highest Detection ($\mu\text{g/gOC}$)
<u>Volatiles</u> <u>Organics</u> ($\mu\text{g/gOC}$)	Aq. Tox. Acute/Chronic	Human				
Methylene Chloride	-	-	0/2	ND	1/7	0.15J (SD-18)
Acetone	-	-	0/2	ND	6/7	6.18B (SD-18)
2-Butanone	-	-	1/2	0.76 (SD-2)	3/7	1.06 - 1.84 (SD-18)
2-Hexanone	-	-	1/2	0.12 (SD-12)	0/7	ND
<u>Semi-Volatiles</u> ($\mu\text{g/gOC}$):						
Naphthalene	-		0/2	ND	1/7	13.54 (SD-14)
Acenaphthylene	-		0/2	ND	1/7	13.85 (SD-14)
Acenaphthene	140(c)	-	1/2	2.30J (SD-2)	1/7	10.62 (SD-14)
Dibenzofuran	-	-	0/2	ND	1/7	16.92 (SD-14)
Fluorene	-	-	1/2	2.53J (SD-2)	2/7	1.81 - 56.92 (SD-14)
Phenanthrene	120(c)	-	2/2	6.71J - 22.07 (SD-2)	2/7	13.43 - 353.85 (SD-14)
Anthracene	-	-	1/2	4.60J (SD-2)	2/7	3.36 - 75.38 (SD-14)
Fluoranthene	1,020(c)	-	2/2	14.02J - 39.08 (SD-2)	4/7	1.27 - 461.54 (SD-14)

NOTES: See Appendix B data table footnotes for explanation of sediment criteria.

B = Compound detected in blank sample; J = Estimated value; ND = Not Detected.

TABLE A-11

**PHASE II SEDIMENT DATA SUMMARY
CLARKSTOWN LANDFILL RI/FS**

Compound/ Analyte	New York State Sediment Criteria ($\mu\text{g/gOC}$)		Upstream Surface Water Sampling Locations (SD-2, SD-12)		Downstream Surface Water Sampling Locations (SD-4, SD-13, SD-14, SD-15, SD-16, SD-17, SD-18)	
	Aq. Tox. Acute/Chronic	Human	Frequency of Detection	Range of Detected Concentrations and Location of Highest Detection ($\mu\text{g/gOC}$)	Frequency of Detection	Range of Detected Concentrations and Location of Highest Detection ($\mu\text{g/gOC}$)
Semi-Volatiles ($\mu\text{g/gOC}$):						
Pyrene	-	-	2/2	12.80J - 22.99 (SD-2)	4/7	1.05J - 307.69 (SD-14)
Benzo(a)anthracene	-	1.3	2/2	6.10J - 15.17 (SD-2)	3/7	3.96J - 146.15 (SD-14)
Chrysene	-	1.3	2/2	9.15J - 15.86 (SD-2)	3/7	5.15J - 143.08 (SD-14)
bis(2-Ethylhexyl)phthalate	199.5(c)		2/2	ND	0/7	ND
Benzo(b)fluoranthene	-	1.3	2/2	8.54J - 19.54 (SD-2)	3/7	4.06-113.85 (SD-14)
Benzo(k)fluoranthene	-	1.3	2/2	6.71J - 7.36J (SD-2)	3/7	5.05J - 118.46 (SD-14)
Benzo(a)pyrene	-	1.3	2/2	8.54J - 14.02J (SD-2)	3/7	4.65J - 143.08 (SD-14)
Indeno(1,2,3-cd)pyrene	-	1.3	2/2	4.88J - 5.75J (SD-2)	3/7	2.38J - 56.92J (SD-14)
Dibenzo(a,h)anthracene	-	-	1/2	2.62J (SD-12)	2/7	1.79J - 16.92J (SD-14)
Benzo(g,h,i)perylene	-	-	2/2	4.27J - 5.29J (SD-2)	3/7	2.38J - 55.38J (SD-14)
Carbazole	-	-	1/2	2.76J (SD-2)	1/7	107.69 (SD-14)
Pesticides						
Heptachlor epoxide**	13.1/0.1	0.0008	0/2	ND	1/7	0.03J (SD-4)
4,4-DDT*	1100/1.0	0.01	0/2	ND	0/7	ND

Wildlife bioaccumulation criteria = 1.0 $\mu\text{g/goc}$ AND 0.03 $\mu\text{g/goc}$ (**)

TABLE A-12
PHASE I RI SURFICIAL SOIL DATA SUMMARY
CLARKSTOWN LANDFILL RI/FS

COMPOUND	NYSDEC Draft Cleanup Policy & Guidelines October 1991 ⁽¹⁾	NYSDEC TAGM Soil Cleanup Objectives and Background Levels, November 1992 ⁽²⁾	Frequency of Detection	Maximum Concentration and Location of Maximum Detected Level	Other Detected Locations
Inorganics (mg/kg)					
Arsenic	80	3 - 12	3/3	3.2 SL-1	SL-2 SL-3
Beryllium	0.16	0 - 1.75	3/3	3.6 SL-1	SL-2 SL-3
Cadmium	80	0.1 - 1	3/3	0.90(BJ) SL-3	SL-1 SL-2
Chromium	NA	1.5 - 40	3/3	21.6(J) SL-1	SL-2 SL-3
Copper	NA	1 - 50	3/3	23.8 SL-1	SL-2 SL-3
Lead	250	4 - 61	3/3	54.2(J) SL-1	SL-2 SL-3
Mercury	20	0.001 - 0.2	3/3	0.50 SL-1	SL-2 SL-3
Nickel	2,000	0.5 - 25	3/3	56.2 SL-3	SL-1 SL-2
Zinc	20,000	9 - 50	3/3	78.4(J) SL-1	SL-2 SL-3
Volatile Organics (µg/kg)					
Methylene Chloride	93,000	100	3/3	32(J) SL-2	SL-1 SL-3
Acetone	8,000,000	110	3/3	123(J) SL-2	SL-1 SL-3
2-Butanone	4,000,000	300	2/3	12(J) SL-3	SL-2
Toluene	20,000,000	1500	1/3	1.6(J) SL-1	None
Semivolatile Organics (µg/kg)					
Phenanthrene	NA	220,000	1/3	220(J) SL-1	None
Di-n-Butylphthalate	8,000,000	8100	3/3	230(J) SL-3	SL-1 SL-2
Fluoranthene	3,000,000	1,900,000	2/3	400(J) SL-1	SL-3
Pyrene	2,000,000	665,000	1/3	310(J) SL-1	None
Benzo(a)pyrene	61	11,000	1/3	160(J) SL-1	None
Pesticides (µg/kg)					
4,4-DDT	2,100	2,500	1/3	20.07(J) SL-3	None

⁽¹⁾NYSDEC Draft Cleanup Policy and Guidelines, Vol. II, Subappendix 1A of Appendix C (HEAST Tables); Current through April 1991.

⁽²⁾NYSDEC TAGM HWR-92-4046; Inorganics values are range of Eastern USA background concentrations; organics values are soil cleanup objectives to protect groundwater quality.

J = Estimated value; B = Value is less than CRDL but greater than IDL

NA = No Standard Available

TABLE A-13 PHASE I RI SUBSURFACE SOIL DATA SUMMARY CLARKSTOWN LANDFILL RI/FS				
Compound	NYSDEC TAGM Soil Guidance Values (mg/kg) ⁽¹⁾	Frequency of Detection	Max. Concentration(mg/kg) and Location of Detected Level	Other Detected Locations
Inorganics (mg/kg)				
Arsenic	3.0 - 12 ⁽²⁾	9/9	SB-5D - 9.18(J)	Detected at all locations
Cadmium	0.1 - 1	4/9	SB-1 - 4.6(J)	SB-2, SB-7, SB-8
Chromium	1.5 - 40 ⁽²⁾	9/9	SB-3 - 56.7(J)	Detected at all locations
Copper	1.0 - 50	7/9	SB-8 - 29.5(J)	SB-2, SB-3, SB-4, SB-6, SB-7
Lead	4.0 - 61	9/9	SB-8 - 10.03(J)	Detected at all locations
Mercury	0.001 - 0.2	1/9	SB-1 - 0.99	Only detected at SB-1
Nickel	0.5 - 25	8/9	SB-5 - 24.6(B)	SB-2 through SB-8
Zinc	9.0 - 50	9/9	SB-5, SB-6 - 77.2(J)	Detected at all locations, SB-2 rejected
Volatile Organics (mg/kg)				
Methylene Chloride	0.1	4/9	SB-1 - 0.55(BJ)	SB-6, SB-7, SB-8
Acetone	0.11	8/9	SB-1 - 1.9(BJ)	SB-3 through SB-8
Carbon Disulfide	2.7	3/9	SB-5 - 1.0(J)	SB-5D, SB-7
Chloroform	0.3	2/9	SB-5D - 0.15(J)	SB-6
2-Butanone	0.3	6/9	SB-7 - 0.26(BJ)	SB-1, SB-4, SB-5, SB-5D, SB-8
Toluene	1.5	2/9	SB-8 - 0.018(J)	SB-7
Styrene	NA	1/9	SB-7 - 0.007(J)	-
Xylene (total)	1.2	1/9	SB-2 - 0.0001(J)	-

TABLE A-13 PHASE I RI SUBSURFACE SOIL DATA SUMMARY CLARKSTOWN LANDFILL RI/FS				
Compound	NYSDEC TAGM Soil Guidance Values (mg/kg) ⁽¹⁾	Frequency of Detection	Max. Concentration(mg/kg) and Location of Detected Level	Other Detected Locations
Semivolatile Organics (mg/kg)				
Benzoic Acid	2.7	3/9	SB-3 - 2.8(J)	SB-4, SB-7
Naphthalene	13	1/9	SB-8 - 0.24(J)	-
Diethylphthalate	7.1	1/9	SB-6 - 0.47(J)	-
Pesticides (mg/lg)				
Endosulfan I	0.9	2/9	SB-5 - 0.028	SB-5D
Methoxychlor	900	1/9	SB-2 - 0.12(J)	-

Notes: ⁽¹⁾ From NYSDEC Division of Technical and Administrative Guidance Memorandum (TAGM): Determination of Soil Cleanup Objectives and Cleanup Levels, HWR-92-4046, November 16, 1992. Inorganics values are range of Eastern USA background concentrations; Organics values are soil cleanup objectives to protect groundwater quality.

⁽²⁾ From NYSDEC TAGM - New York State background values.

J - Estimated value

B - Inorganics: Reported value is less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL); Organic: Compound was detected in blank sample

NA - No Guidance Value Available.

TABLE A-14

HISTORICAL GROUNDWATER DATA SUMMARY⁽¹⁾ CLARKSTOWN LANDFILL RI/FS

Compound	New York State Groundwater Standard (µg/l) ⁽²⁾	Upgradient Monitoring Well (B-208D)		Downgradient Monitoring Wells (B-201 S/D, B-202S/D, B-203 S/D B-204 I/D, B-205 S/D, B-206D, B-207D)		Leachate Monitoring Wells (B-206S, B-207S)	
		Frequency of Detection	Range of Detection Concentrations (ug/l)	Frequency of Detection	Range of Detection Concentrations (ug/l)	Frequency of Detection	Range of Detection Concentrations (µg/l)
Inorganics							
Arsenic	25	ND	ND	8/22	3 - 135	2/3	140 - 231
Cadmium	10	0/1	ND	0/12	ND	0/2	ND
Chromium	50	0/1	ND	0/12	ND	0/2	ND
Copper	200	1/1	27	15/22	18 - 304	2/3	58 - 124
Iron	300	1/1	89	40/43	12 - 42,400	5/6	1510 - 24,400
Lead	25	ND	ND	9/22	90 - 300	1/3	180
Manganese	300	1/1	74	41/43	50 - 5340	5/6	240 - 1270
Mercury	2	1/1	5.6	12/12	0.2 - 2.4	2/2	0.6 - 1.5
Zinc	300	1/1	28	16/22	23 - 241	3/3	64 - 210
Volatile Organics							
Bromodichloromethane	50(3)	ND	ND	ND	ND	1/2	66
Chloroethane	5	ND	ND	1/2	24	1/2	77
Chloroform	7	ND	ND	4/12	11 - 141	1/2	1022
Methylene Chloride	5	ND	ND	1/12	19	ND	ND
Chlorobenzene	5	ND	ND	1/12	13	1/2	10
Ethylbenzene	5	ND	ND	ND	ND	1/2	28
Toluene	5	ND	ND	ND	ND	1/2	13
Trans-1,2-Dichloroethene	5	ND	ND	1/12	11	ND	ND
Semivolatile Organics							

TABLE A-14

**HISTORICAL GROUNDWATER DATA SUMMARY⁽¹⁾
CLARKSTOWN LANDFILL RI/FS**

Compound	New York State Groundwater Standard ($\mu\text{g/l}$) ⁽²⁾	Upgradient Monitoring Well (B-208D)		Downgradient Monitoring Wells (B-201 S/D, B-202S/D, B-203 S/D B-204 I/D, B-205 S/D, B-206D, B-207D)		Leachate Monitoring Wells (B-206S, B-207S)	
		Frequency of Detection	Range of Detection Concentrations ($\mu\text{g/l}$)	Frequency of Detection	Range of Detection Concentrations ($\mu\text{g/l}$)	Frequency of Detection	Range of Detection Concentrations ($\mu\text{g/l}$)
Bis(2-ethylhexyl)phthalate	50	ND	ND	1/12	12	1/2	47
Diethylphthalate	50(3)	ND	ND	ND	ND	1/2	10
Naphthalene	10(3)	ND	ND	1/12	18	ND	ND
Phenanthrene	50(3)	ND	ND	1/12	10	ND	ND

Notes:⁽¹⁾Summary of groundwater sampling rounds completed 6/85, 6/87, 9/87, and 12/87.⁽²⁾Current New York State Groundwater Standards shown for reference only, may not have been in effect at the time of sampling.⁽³⁾Guidance Value

ND = Compound Not Detected

TABLE A-15

**PHASE I RI GROUNDWATER DATA SUMMARY
CLARKSTOWN LANDFILL RI/FS**

Compound	New York State Groundwater Standard (ug/l)	Upgradient Monitoring Wells (RFW-10D, 11, and 13)		Downgradient Monitoring Wells (RFW- 1S, 1D, 2, 3S, 3D, 4S, 4D, 5S, 5D, 6S, 6D, 7S, 7D, 8S, 8D, 9D, and 12)		Leachate Monitoring Wells (RFW-9S and RFW-14)	
		Frequency of Detection	Range of Detected Concentrations (ug/l)	Frequency of Detection	Range of Detected Concentrations (ug/l)	Frequency of Detection	Range of Detected Concentrations (ug/l)
Inorganics							
Arsenic	25	ND	ND	8/18	1.5(B) - 10.2	2/2	9.2(B) - 17.1
Cadmium	10	ND	ND	8/18	2.0(B) - 8.0	2/2	8.0 - 13.0
Chromium	50	1/3	1250(J)	12/18	11(J)-300(J)	2/2	37-113
Copper	200	ND	ND	6/18	6.0(B) - 96.0	2/2	55.0 - 66.0
Iron	300	3/3	719-4970	18/18	406-66,300	2/2	12,500-58,800
Lead	25	2/3	2.1(BJ)-5(J)	17/18	1.1(BJ)-35.6(J)	2/2	5.3(J)-633(J)
Manganese	300	3/3	23-1690	18/18	18-3040	2/2	158-5230
Mercury	2	3/3	0.64 - 0.92	14/18	0.58 - 1.1	2/2	0.92 - 0.98
Nickel	-	2/3	11.0(BJ) - 173.0(J)	15/18	7.0(BJ) - 90.0(J)	2/2	36.0(BJ) - 384.0(J)
Zinc	300	2/3	16(BJ)-25(J)	17/18	4(B)-174	2/2	161-850
Volatile Organics							
1,2-Dichloroethene (total)	5(a)	ND	ND	1/18	13	1/2	100(J)
Trichloroethene	5	ND	ND	1/18	12	ND	ND
Benzene	0.7	ND	ND	ND	ND	1/2	5(J)
Toluene	5	ND	ND	ND	ND	1/2	180(J)
Chlorobenzene	5	ND	ND	ND	ND	2/2	5-14(J)
Ethylbenzene	5	ND	ND	ND	ND	1/2	36(J)
Styrene	5	ND	ND	ND	ND	1/2	4(J)
Xylene (total)	5(b)	ND	ND	ND	ND	1/2	62(J)

TABLE A-15

**PHASE I RI GROUNDWATER DATA SUMMARY
CLARKSTOWN LANDFILL RI/FS**

Compound	New York State Groundwater Standard (ug/l)	Upgradient Monitoring Wells (RfW-10D, 11, and 13)		Downgradient Monitoring Wells (RfW- 1S, 1D, 2, 3S, 3D, 4S, 4D, 5S, 5D, 6S, 6D, 7S, 7D, 8S, 8D, 9D, and 12)		Leachate Monitoring Wells (RfW-9S and RfW-14)	
		Frequency of Detection	Range of Detected Concentrations (ug/l)	Frequency of Detection	Range of Detected Concentrations (ug/l)	Frequency of Detection	Range of Detected Concentrations (ug/l)
Semivolatile Organics							
1,4-Dichlorobenzene	4.7(c)	ND	ND	ND	ND	1/2	9(J)
2-Methylphenol	1	ND	ND	ND	ND	1/2	5(J)
Naphthalene	10(d)	ND	ND	ND	ND	1/2	13
bis(2-Ethylhexyl)phthalate	50	ND	ND	5/18	4(J)-10	1/2	140
Pesticides/PCBs							
Endosulfan I	-	1/3	0.06	ND	ND	ND	ND
4,4-DDT	ND(e)	ND	ND	3/18	0.09(J)0.13	1/2	0.22
Aroclor-1254	0.1(f)	ND	ND	ND	ND	1/2	3.1
Aroclor-1260	0.1(f)	ND	ND	3/18	0.60(J)-1.3	ND	ND

Notes:

- J - Estimated value
 B - Reported value is less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL)
 ND - Compound Not Detected
 (a) - Standard applies to cis- and trans-isomers individually
 (b) - Standard applies to 1,2-; 1, 3-; and 1,4-isomers individually
 (c) - Standard applies to sum of 1,2- and 1,4-isomers
 (d) - Guidance value
 (e) - Standard applies to sum of DDD, DDE, and DDT
 (f) - Standard applies to sum of Aroclors (PCBs)

TABLE A-16

**PHASE II RI GROUNDWATER DATA SUMMARY
CLARKSTOWN LANDFILL R/FS**

Compound	New York State Groundwater Standard (ug/l)	Upgradient Monitoring Wells RFW-10D, 11 and 13)		Downgradient Monitoring Wells (RFW-1S, 1D, 2, 3S, 3D, 4S, 4D, 5S, 5D, 6S, 6D, 7S, 7D, 8S, 8D, 9D and 12)		Leachate Monitoring Well (RFW-9S)	
		Frequency of Detection	Range of Detected Concentrations (ug/l)	Frequency of Detection	Range of Detected Concentrations (ug/l)	Frequency of Detection	Range of Detected Concentrations (ug/l)
Inorganics, Total: ug/l (H)							
Arsenic	25	1/3	2.2(B)	10/17	1.5(B)-19.6	1/1	3.3(B)
Cadmium	10	1/3	1.4(B)	3/17	1.4(B)-4.3(B)	1/1	2.0(B)
Chromium	50	2/3	18.9-79.7	17/17	10.5-160	1/1	9.3(B)
Copper	200	3/3	1.6(B)-11.1(B)	4/17	2.9(B)-95.6	1/1	20.9(B)
Iron	300	3/3	91.9(B)-8690	17/17	199-111000	1/1	35500
Lead	25	2/3	1.4(B)-2.8(B)	17/17	1.5(B)-19.1	1/1	26.7
Manganese	500	3/3	2.2(B)-1000	17/17	1.9(B)-3690	1/1	3000
Mercury	2	0/3	ND	2/17	0.10(B)-0.11(B)	1/1	0.14(B)
Nickel	-	2/3	15.5(B)-236	17/17	8.2(B)-166	1/1	10.0(B)
Silver	50	0/3	ND	1/17	3.5(B)	1/1	ND
Zinc	300	3/3	4.1(B)-32.8	17/17	10(B)-183	1/1	107
Cyanide	100	3/3	ND	0/17	ND	0/1	ND
Pesticides: ug/l							
Heptachlor	ND	0/3	NA	2/17	0.15-0.031J	0/1	NA

J - Estimated Value

B - For inorganics, reported value is less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL); for organics, compound was detected in a laboratory or field blank sample

ND - Not Detected

TABLE A-16

**PHASE II RI GROUNDWATER DATA SUMMARY
CLARKSTOWN LANDFILL RI/FS**

Compound	New York State Groundwater Standard (ug/l)	Upgradient Monitoring Wells RFW-10D, 11 and 13		Downgradient Monitoring Wells (RFW-1S, 1D, 2, 3S, 3D, 4S, 4D, 5S, 5D, 6S, 6D, 7S, 7D, 8S, 8D, 9D and 12)		Leachate Monitoring Well (RFW-9S)	
		Frequency of Detection	Range of Detected Concentrations (ug/l)	Frequency of Detection	Range of Detected Concentrations (ug/l)	Frequency of Detection	Range of Detected Concentrations (ug/l)
Volatile Organics							
Vinyl Chloride	2	0/3	ND	1/17	1J	0/1	ND
Acetone	-	0/3	ND	1/17	8B	0/1	ND
1,1-Dichloroethene	5	1/3	1J	0/17	ND	0/1	ND
2-Butanone	-	0/3	ND	2/17	1-5	0/1	ND
1,1,1-Trichloroethane	5	1/3	3	0/17	ND	0/1	ND
Carbon Tetrachloride	5	0/3	ND	1/17	1	0/1	ND
Trichloroethene	5	1/3	4	3/17	2-3	0/1	ND
Tetrachloroethene	5	1/3	7	1/17	4	0/1	ND
Toluene	5	1/3	ND	1/17	4J	0/1	4
Chlorobenzene	5	1/3	1	0/17	ND	1/1	ND
Xylene (Total)	5 ^(a)	0/3	ND	1/17	2J	0/1	ND
Trichlorofluoromethane	5	0/3	ND	1/17	2	0/1	ND
cis-1,2-Dichloroethene	5	0/3	ND	1/17	12	0/1	ND

J - Estimated Value

B - For inorganics, reported value is less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL); for organics, compound was detected in a laboratory or field blank sample

ND - Not Detected

TABLE A-17
PHASE I RI AMBIENT AIR HOT SPOT VS. UPWIND SAMPLE CONCENTRATIONS
STATISTICAL SUMMARY
ALL UNITS IN PARTS PER BILLION BY VOLUME (PPBV)

COMPOUNDS DETECTED	NYSDEC Ambient SOC* Guideline Concentration	AMBIENT AIR HOT SPOT LOCATIONS 15 AUGUST 1990			AMBIENT AIR UPWIND LOCATIONS 17, 27 & 28 AUGUST 1990		
		MIN	MAX	AVG	MIN	MAX	AVG
Dichlorodifluoromethane, (Freon 12)	---	5.00	13.00	9.33	0.00	11.00	4.17
Methyl Chloride	7,463.62	3.40	5.00	4.13	0.00	5.00	1.67
Trichlorofluoromethane, (Freon 11)	69,827.76	0.80	1.10	0.97	0.00	5.00	1.67
Methylene Chloride	8,268.06	0.00	1.00	0.33	1.20	1.70	1.40
1,1,2-Trichloro-1,2,2-trifluoroethane, (Freon 113)	164,543.71	0.00	0.00	0.00	0.00	0.90	0.30
Chloroform	140.61	0.00	0.00	0.00	0.00	0.00	0.00
1,1,1-Trichloroethane	57,777.15	0.90	1.40	1.13	0.90	2.00	1.27
Benzene	6.58	0.00	1.60	1.00	1.10	2.50	1.77
Toluene	16,545.27	2.00	4.60	3.63	2.20	5.40	3.40
Tetrachloroethene	8,366.69	0.00	2.90	1.30	0.00	0.90	0.30
Chlorobenzene	1,673.94	0.00	0.00	0.00	0.00	0.00	0.00
Ethylbenzene	16,135.08	0.00	3.00	1.00	0.00	1.40	0.47
m/p-Xylene	16,133.56	0.60	4.90	2.47	0.00	6.00	3.13
o-Xylene	16,133.56	0.00	2.30	0.77	0.00	1.50	0.50
1,3,5-Trimethylbenzene	4,132.96	0.00	1.50	0.50	0.00	0.00	0.00
1,2,4-Trimethylbenzene	4,132.96	0.00	4.70	1.90	0.00	3.30	1.10
Acetone	41,288.91	200.00	700.00	500.00	0.00	111.90	73.93
Carbon Disulfide	159.73	0.00	60.00	20.00	0.00	0.00	0.00
4-Methyl-2-Pentanone (MIBK)	8,205.51	0.00	7.00	2.33	0.00	0.00	0.00

* Short Term Guidelines for a 1-hour sampling period have been corrected to reflect an 8-hour sampling period.

TABLE A-18

**PHASE I RI AMBIENT AIR UPWIND VS. DOWNWIND SAMPLE CONCENTRATIONS
STATISTICAL SUMMARY - AUGUST 17, 1990, SAMPLING
ALL UNITS IN PARTS PER BILLION BY VOLUME [PPBv]**

COMPOUNDS DETECTED	NYSDEC Ambient SOC* Guideline Concentration	Ambient Air UPWIND LOCATION 17 AUGUST 1990	Ambient Air DOWNWIND LOCATION 17 AUGUST 1990		
		SAMPLE VALUE	MIN	MAX	AVG
Dichlorodifluoromethane, (Freon 12)	—	11.00	5.50	11.00	8.83
Methyl Chloride	7,463.62	5.00	0.00	5.30	1.77
Trichlorofluoromethane, (Freon 11)	69,827.76	5.00	0.00	2.00	1.33
Methylene Chloride	8,268.06	1.30	0.00	1.60	0.53
1,1,2-Trichloro-1,2,2-trifluoroethane, (Freon 113)	164,543.71	0.90	0.00	0.00	0.00
Chloroform	140.61	0.00	0.00	0.00	0.00
1,1,1-Trichloroethane	57,777.15	2.00	0.00	1.10	0.37
Benzene	6.58	2.50	1.80	2.30	2.10
Toluene	16,545.27	5.40	5.10	7.00	6.13
Tetrachloroethene	8,366.69	0.90	0.70	2.80	1.70
Chlorobenzene	1,673.94	0.00	0.00	0.00	0.00
Ethylbenzene	16,135.08	1.40	0.00	1.20	0.40
m/p-Xylene	16,133.56	6.00	2.00	3.00	2.40
o-Xylene	16,133.56	1.50	0.00	1.00	0.33
1,3,5-Trimethylbenzene	4,132.96	0.00	0.00	0.00	0.00
1,2,4-Trimethylbenzene	4,132.96	3.30	0.00	1.40	0.47
Acetone	41,288.91	0.00	0.00	0.00	0.00
Carbon Disulfide	159.73	0.00	0.00	0.00	0.00
4-Methyl-2-Pentanone (MIBK)	8,205.51	0.00	0.00	0.00	0.00

* Short Term Guidelines for a 1-hour sampling period have been corrected to reflect an 8-hour sampling period.

TABLE A-18

PHASE I RI AMBIENT AIR UPWIND VS. DOWNWIND SAMPLE CONCENTRATIONS
STATISTICAL SUMMARY - AUGUST 27, 1990, SAMPLING
ALL UNITS IN PARTS PER BILLION BY VOLUME [PPBV]

COMPOUNDS DETECTED	NYSDEC Ambient SGC* Guideline Concentration	Ambient Air UPWIND LOCATION 27 AUGUST 1990	Ambient Air DOWNWIND LOCATION 27 AUGUST 1990		
		SAMPLE VALUE	MIN	MAX	AVG
Dichlorodifluoromethane, (Freon 12)	---	0.00	0.00	0.00	0.00
Methyl Chloride	7,463.62	0.00	0.00	4.50	1.50
Trichlorofluoromethane, (Freon 11)	69,827.76	0.00	0.00	8.60	2.87
Methylene Chloride	8,268.06	1.20	0.80	1.50	1.07
1,1,2-Trichloro-1,2,2-trifluoroethane, (Freon 113)	164,543.71	0.00	0.00	0.00	0.00
Chloroform	140.61	0.00	0.00	1.20	0.40
1,1,1-Trichloroethane	57,777.15	0.90	0.00	1.00	0.60
Benzene	6.58	1.70	1.40	2.20	1.90
Toluene	16,545.27	2.60	2.90	4.00	3.50
Tetrachloroethene	8,366.69	0.00	0.00	1.10	0.67
Chlorobenzene	1,673.94	0.00	0.00	0.60	0.20
Ethylbenzene	16,135.08	0.00	0.00	0.00	0.00
m/p-Xylene	16,133.56	3.40	0.00	1.10	0.63
o-Xylene	16,133.56	0.00	0.00	0.00	0.00
1,3,5-Trimethylbenzene	4,132.96	0.00	0.00	0.00	0.00
1,2,4-Trimethylbenzene	4,132.96	0.00	0.00	0.00	0.00
Acetone	41,288.91	109.90	0.00	97.70	50.20
Carbon Disulfide	159.73	0.00	1.00	40.00	14.00
4-Methyl-2-Pentanone (MIBK)	8,205.51	0.00	0.00	0.00	0.00

* Short Term Guidelines for a 1-hour sampling period have been corrected to reflect an 8-hour sampling period.

TABLE A-18

**PHASE 1 RI AMBIENT AIR UPWIND VS. DOWNWIND SAMPLE CONCENTRATIONS
STATISTICAL SUMMARY - AUGUST 28, 1990, SAMPLING
ALL UNITS IN PARTS PER BILLION BY VOLUME (PPBV)**

COMPOUNDS DETECTED	NYSDEC Ambient SGC* Guideline Concentration	Ambient Air UPWIND LOCATION 28 AUGUST 1990	Ambient Air DOWNWIND LOCATION 28 AUGUST 1990		
		SAMPLE VALUE	MIN	MAX	AVG
Dichlorodifluoromethane, (Freon 12)	---	1.50	0.00	1.50	0.50
Methyl Chloride	7,463.62	0.00	0.00	5.60	1.87
Trichlorofluoromethane, (Freon 11)	69,827.76	0.00	0.00	0.00	0.00
Methylene Chloride	8,268.06	1.70	1.90	2.50	2.27
1,1,2-Trichloro-1,2,2-trifluoroethane, (Freon 113)	164,543.71	0.00	0.00	0.00	0.00
Chloroform	140.61	0.00	0.00	0.00	0.00
1,1,1-Trichloroethane	57,777.15	0.90	1.00	1.60	1.27
Benzene	6.58	1.10	1.10	2.20	1.70
Toluene	16,545.27	2.20	3.30	4.40	3.80
Tetrachloroethene	8,366.69	0.00	0.60	0.70	0.65
Chlorobenzene	1,673.94	0.00	0.00	0.00	0.00
Ethylbenzene	16,135.08	0.00	0.00	0.00	0.00
m/p-Xylene	16,133.56	0.00	0.00	1.30	0.67
o-Xylene	16,133.56	0.00	0.00	0.00	0.00
1,3,5-Trimethylbenzene	4,132.96	0.00	0.00	0.00	0.00
1,2,4-Trimethylbenzene	4,132.96	0.00	0.00	0.00	0.00
Acetone	41,288.91	111.90	97.70	142.40	113.97
Carbon Disulfide	159.73	0.00	1.00	35.00	12.33
4-Methyl-2-Pentanone (MIBK)	8,205.51	0.00	0.00	2.00	0.67

* Short Term Guidelines for a 1-hour sampling period have been corrected to reflect an 8-hour sampling period.

APPENDIX B

PHASE I AND II RI ANALYTICAL DATA DETECTED COMPOUNDS TABLES, PHASE II DATA USABILITY AND DATA VALIDATION REPORTS

CLARKSTOWN SANITARY LANDFILL RI/FS FINAL REMEDIAL INVESTIGATION REPORT

APPENDIX

CONTENTS

B-1	Phase I and II RI Analytical Data Detected Compounds Tables
B-2	Phase II Data Usability Report and Data Validation Reports

APPENDIX B-1

PHASE I AND II RI DETECTED COMPOUNDS TABLES

<u>TABLE</u>	<u>TITLE</u>
B-1	Phase I and II Leachate
B-2	Phase I Soil Gas
B-3	Phase II Soil Gas
B-4	Test Pits
B-5	Phase I and II Surface Water
B-6	Phase I and II Sediment
B-7	Phase I Surficial Soil
B-8	Phase I Subsurface Soil
B-9	Phase I and II Groundwater
B-10	Phase I Ambient Air

TABLE B-1 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - LEACHATE SAMPLES

WESTON ID#	County of Rockland Local Law No. 2 Sewer Use Law	LB-1 08/29/90 3649	LB-1-02 12/20/93 WES025	LB-2 08/29/90 3649	LB-2-02 12/20/93 WES025	LC-1 09/05/90 3737	LC-1-02 12/20/93 WES025
Inorganics, Total: ug/l							
Aluminum	-	1520 J	3130 J	1950 J	2690 J	464 J	71.3 BJ
Antimony	-	29 B	8.2 U	26 U	8.2 U	30 BJ	8.2 U
Arsenic	1000	5.2 BJ	2.8 B	2.4 UJ	1.7 B	5.6 B	2.2 B
Barium	-	598	423	435	518	545	361
Beryllium	-	2.0 B	0.43 B	1.0 B	0.43 B	2.0 BJ	0.30 U
Cadmium	100	5.0	4.3 B	5.0	4.1 B	3.0 U	1.5 B
Calcium	-	171000 J	150000	187800 J	146000	229000 J	159000
Chromium	3000	18.0	6.9 B	12.0	11.0	19.0 J	5.7 B
Cobalt	-	13.0 B	5.8 B	10.0 B	8.7 B	11.0 BJ	5.3 B
Copper	1000	14.0 BJ	13.4 B	11.0 BJ	13.3 B	14.0 BJ	2.9 B
Iron	-	22300 J	40200	10600 J	46700	20700	20700
Lead	3000	10.1 J	10.7	2.0 UJ	5.1	14.1 J	2.3 U
Magnesium	-	51800 J	48300	5160 J	37600	59400	44600
Manganese	-	1310 J	1100	1890 J	1730	1530 J	1310
Mercury	50	0.18 B	0.10 U	0.12 U	0.10 U	0.14 B	0.10 U
Nickel	1000	23 B	14.6 B	20 B	16.4 B	15 B	9.8 B
Potassium	-	80800 J	57200	75400 J	49800	84400	44200
Selenium	-	1.6 UJ	9.0 UJ	1.6 UJ	1.8 UJ	1.8 B	1.8 UJ
Silver	5000	10	1.8 U	10	1.8 U	7.0 U	1.8 U
Sodium	-	215000 J	168000	173000 J	119000	231000 J*	140000
Thallium	-	7.6 UJ	4.5 BJ	7.6 UJ	1.2 UJ	7.6 UJ	1.2 UJ
Vanadium	-	30.0 BJ	9.9 B	51.0 J	12.0 B	32.0 BJ	1.8 U
Zinc	3000	49.0	52.3	56.0	37.6	41.0 J	31.0

TABLE B-1 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - LEACHATE SAMPLES

WESTON ID# Sample Date Case #	County of Rockland Local Law No. 2 Sewer Use Law	LC-2 09/05/90 3737	LC-2-02 12/20/93 WES025	LC-3 09/05/90 3737	LC-3DUPE 09/05/90 3737	LC-3-02 12/20/93 WES025	LC-4 09/05/90 3737
<u>Inorganics, Total: ug/l</u>							
Aluminum	-	621 J	101 BJ	492 J	4290	66.1 BJ	196 BJ
Antimony	-	26 UJ	8.2 U	26 UJ	26 UJ	8.2 U	26 UJ
Arsenic	1000	3.0 B	1.6 B	2.4 U	2.4 U	1.8 B	2.4 U
Barium	-	542	351	399	422	492	775
Beryllium	-	2.0 BJ	0.30 U	1.0 BJ	2.0 BJ	0.30 U	1.0 BJ
Cadmium	100	3.0 U	4.0 B	3.0 U	3.0 U	2.6 B	3.0 U
Calcium	-	224000 J	129000	161000 J	164000 J	169000	224500 J*
Chromium	3000	15.0 J	6.6 B	14.0 J	18.0 J	6.8 B	27.0 J
Cobalt	-	7.0 BJ	4.6 B	7.0 U	13.0 BJ	8.7 B	20.0 BJ
Copper	1000	7.0 BJ	4.0 B	7.0 BJ	11.0 BJ	2.3 B	11.0 BJ
Iron	-	29900	43400	19000	20700	23400	18200
Lead	3000	103.5 R	2.3 U	12.3 R	2.0 UJ	2.3 U	2.0 UJ
Magnesium	-	57500	42200	46200	48000	53400	76400
Manganese	-	1890 J	836	1560 J	1550 J	1370	1810 J
Mercury	50	0.12 U	0.10 U	0.12 U	0.12 U	0.10 U	0.12 U
Nickel	1000	12 B	5.5 B	10 B	12 B	11.4 B	30 B
Potassium	-	75400	43300	91000	88700	75300	166000
Selenium	-	1.6 U	1.8 UJ	1.6 U	1.6 U	1.8 UJ	1.6 U
Silver	5000	7.0 U	1.8 U	7.0 U	7.0 U	1.8 U	10.0
Sodium	-	203000 J*	141000	225500 J*	225500 J*	202000	343500 J*
Thallium	-	7.6 UJ	1.2 UJ	7.6 U	7.6 U	1.2 UJ	7.6 UJ
Vanadium	-	46.0 BJ	5.8 B	39.0 BJ	41.0 BJ	1.8 U	52.0 J
Zinc	3000	27.0 J	30.8	33.0 J	31.0 J	19.4 B	68.0

TABLE B-1 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - LEACHATE SAMPLES

WESTON ID# Sample Date Case #	County of Rockland Local Law No. 2 Sewer Use Law	LC-4-02 12/20/93 WES025	LC-5 09/10/90 3827	LC-5-02 12/20/93 WES025	LC-6 09/10/90 3827	LC-6-02 12/20/93 WES025	LC-7 09/06/90 3737
Inorganics, Total: ug/l							
Aluminum	-	51.1 BJ	286	60.6 BJ	28800	110 BJ	2300 J
Antimony	-	8.2 U	26 UJ	8.2 U	68.0 J	8.2 U	26 UJ
Arsenic	1000	1.1 B	2.4 U	0.80 U	2.4 U	0.80 U	5.4 B
Barium	-	492	339	395	619	369	94 B
Beryllium	-	0.30 U	1.0 BJ	0.30 U	3.0 BJ	0.60 B	1.0 UJ
Cadmium	100	1.5 B	2.0 UJ	2.5 B	3.0 BJ	2.7 B	3.0 U
Calcium	-	171000	174000	154000	234000	153000	49600 J
Chromium	3000	6.3 B	11.0 J	4.3 U	49.0 J	4.3 U	6.0 BJ
Cobalt	-	6.8 B	9.0 U	3.8 B	19.0 B	5.2 B	7.0 U
Copper	1000	2.6 B	6.0 U	2.7 B	63.0	4.1 B	21.0 BJ
Iron	-	26000	7750	28500	32500	29400	5040
Lead	3000	2.3 U	2.00 U	4.6	3.0	2.3 U	12.8 J
Magnesium	-	51900	23500	40200	52000	31900	17900
Manganese	-	1600	3090	1740	1910 J	1510	1900 J
Mercury	50	0.10 U	0.12 U	0.10 U	0.12 U	0.10 U	0.12 U
Nickel	1000	5.3 B	17 B	7.0 B	28 B	5.2 B	11 B
Potassium	-	71900	33300 J	53500	102000 J	31900	17900
Selenium	-	9.0 UJ	1.6 U	9.0 UJ	1.6 U	1.8 UJ	1.6 U
Silver	5000	1.8 U	7.0 BJ	1.8 U	13.0 J	1.8 U	7.0 U
Sodium	-	176000	61100	130000	236000 ***	86600	95600 J
Thallium	-	1.2 UJ	7.6 U	2.4 BJ	7.6 U	1.2 UJ	7.6 UJ
Vanadium	-	1.8 U	23.0 BJ	1.8 U	42.0 BJ	3.0 B	17.0 BJ
Zinc	3000	22.8	17.0 BJ	31.0	50.0 J	21.4	59.0

TABLE B-1 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - LEACHATE SAMPLES

WESTON ID# Sample Date Case #	County of Rockland Local Law No. 2 Sewer Use Law	LC-7-02 12/20/93 WES025	LC-8 09/10/90 3827	LC-8-02 12/20/93 WES025	LC-9 09/06/90 3737	LC-10 09/06/90 3737	LC-11 10/15/90 4322
Inorganics, Total: ug/l							
Aluminum	-	102 BJ	342	992 J	7690 J	96400 J	1700
Antimony	-	8.2 U	26 UJ	8.2 U	39 BJ	188 J	124 J
Arsenic	1000	0.80 U	2.4 U	1.5 BJ	13.7	188	25.6
Barium	-	395	613	351	328	1620	439
Beryllium	-	0.30 U	4.0 BJ	0.43 B	1.0 BJ	18.0 J	8.0
Cadmium	100	2.0 B	2.0 UJ	2.0 B	8.0	37.0	11.0
Calcium	-	176000	165000	149000	545000 J*	1050000 J**	749000 J**
Chromium	3000	5.3 B	18.0 J	8.2 B	46.0	264	72.0
Cobalt	-	6.2 B	19.0 B	8.3 B	28.0 BJ	106	54.0
Copper	1000	5.0 B	7.0 B	10.7 B	35.0 J	874	28.0 J
Iron	-	25800	34600	23500	15300	226000 **	56200 J
Lead	3000	2.3 U	5.0	11.8	16.3 J	2000 J	22.1 J
Magnesium	-	41100	52200	44700	99800	179000	144000 J
Manganese	-	1530	1150	1160	2690 J	22100 J**	12300 **
Mercury	50	0.10 U	0.12 U	0.10 U	0.12 U	1.23	0.1 U
Nickel	1000	7.7 B	25 B	16.6 B	82	269	208
Potassium	-	45300	111000	49500	239000 *	342000 **	421000 J**
Selenium	-	1.8 UJ	1.6 U	9.0 UJ	1.6 U	1.6 U	1.6 U
Silver	5000	1.8 U	6.0 UJ	1.8 U	17.0	31.0	26.0 U
Sodium	-	135000	284500	152000	540000 J*	753000 J**	1410000 J**
Thallium	-	1.2 UJ	7.6 U	1.2 UJ	7.6 UJ	7.6 UJ	7.6 UJ
Vanadium	-	1.8 U	32.0 BJ	3.6 B	80.0 J	322	127.0
Zinc	3000	23.7	67.0 J	38.0	395	6080	1580.0

TABLE B-1 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - LEACHATE SAMPLES

WESTON ID# Sample Date Case #	County of Rockland Local Law No. 2 Sewer Use Law	LC-12 10/15/90 4322	EB(FB) 09/10/90 3827
<u>Inorganics, Total: ug/l</u>			
Aluminum	-	243 U	57.0 U
Antimony	-	26 J	26.0 UJ
Arsenic	1000	4.4 B	2.4 U
Barium	-	408	36.0 U
Beryllium	-	15.0	1.0 UJ
Cadmium	100	2.0 U	2.0 UJ
Calcium	-	138000 J	289 U
Chromium	3000	19.0 U	4.0 B
Cobalt	-	41.0 B	9.0 U
Copper	1000	13.0 BJ	6.0 U
Iron	-	61500 J	80 B
Lead	3000	3.8 J	2.0 U
Magnesium	-	16300 J	354 U
Manganese	-	3160	5.0 BJ
Mercury	50	0.1 U	0.31
Nickel	1000	27 UB	7.0 U
Potassium	-	39100 J	1910 BJ
Selenium	-	1.6 U	1.60 U
Silver	5000	13.0 U	6.0 UJ
Sodium	-	58800 J	481 B
Thallium	-	7.6 UJ	7.6 U
Vanadium	-	18.0 UB	27.0 B
Zinc	3000	50.0 U	4.0 BJ

TABLE B-1 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - LEACHATE SAMPLES

WESTON ID# Sample Date Case #	County of Rockland Local Law No. 2 Sewer Use Law(ug/l)	LB-1 08/29/90 3649	LB-1-02 12/20/93 WES025	LB-2 08/29/90 3649	LB-2-02 12/20/93 WES025	LC-1 09/05/90 3737	LC-1-02 12/20/93 WES025
<u>Volatiles: ug/l</u>							
Bromomethane	-	10 U	10 U	10 U	10 U	10 U	10 U
Vinyl Chloride	710	10 U	10 U	10 U	10 U	10 U	10 U
Chloroethane	240	10 U	10 U	10 U	10 U	10 U	10 U
Methylene Chloride	2060	5 U	10 U	5 U	10 U	5 U	10 U
Acetone	-	6 UB	10 U	8 UB	10 U	10 UJ	10 U
Carbon Disulfide	60	5 U	10 U	5 U	10 U	90	10 U
1,1-Dichloroethane	2130	5 U	10 U	5 U	10 U	5 U	10 U
1,2-Dichloroethene (total)	-	5 U	NA	5 U	NA	5 U	NA
2-Butanone	-	10 U	2 J	10 U	10 U	10 U	10 U
1,1,1-Trichloroethane	1360	5 U	10 U	5 U	10 U	5 U	10 U
Benzene	140	1 J	10 U	5 U	10 U	2 J	10 U
4-Methyl-2-pentanone	-	10 U	10 U	10 U	10 U	10 U	10 U
2-Hexanone	-	10 U	10 U	10 U	10 U	10 UJ	10 U
Toluene	-	1 J	10 U	1 J	10 U	5 U	10 U
Chlorobenzene	2130	5 J	18	4 J	9 J	9	10
Ethylbenzene	1590	5 U	10 U	5 U	1 J	5 U	10 U
Xylene (total)	-	5 U	1 J	5 U	3 J	5 U	10 U
1,4-Dichlorobenzene	2130	10 UJ	7 J	10 UJ	10 U	10 UR	4 J
1,2-Dichlorobenzene	2130	10 UJ	1 J	10 UJ	10 U	10 UR	10 U
<u>Semi-volatiles: ug/l</u>							
Phenol	-	10 UJ	NA	10 UJ	NA	10 UR	NA
4-Methylphenol	-	10 UJ	NA	10 UJ	NA	10 UR	NA
Naphthalene	2130	10 UJ	NA	10 UJ	NA	10 UR	NA
Di-n-Butylphthalate	-	14 UB	NA	12 UB	NA	10 UR	NA
bis(2-Ethylhexyl)phthalate	-	100 BJ	NA	10 UB	NA	5 R	NA
<u>Pesticides: ug/l</u>							
4,4-DDT	-	0.10 UJ	NA	0.10 UJ	NA	0.10 UJ	NA

TABLE B-1 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - LEACHATE SAMPLES

WESTON ID# Sample Date Case #	County of Rockland Local Law No. 2 Sewer Use Law(ug/l)	LC-2 09/05/90 3737	LC-2-02 12/20/93 WES025	LC-3 09/05/90 3737	LC-3DUPE 09/05/90 3737	LC-3-02 12/20/93 WES025	LC-4 09/05/90 3737
<u>Volatiles: ug/l</u>							
Bromomethane	-	10 U	10 U	10 UJ	10 UJ	10 U	10 U
Vinyl Chloride	710	10 U	10 U	10 UJ	10 UJ	10 U	10 U
Chloroethane	240	10 U	10 U	10 UJ	10 UJ	10 U	10 U
Methylene Chloride	2060	5 UB	10 U	5 UJ	5 UB	10 U	9 UB
Acetone	-	10 UB	10 U	10 UJ	10 UB	10 U	10 UB
Carbon Disulfide	60	68	10 U	5 UJ	41 J	10 U	18
1,1-Dichloroethane	2130	5 U	10 U	5 UJ	5 UJ	10 U	5 U
1,2-Dichloroethene (total)	-	3 J	NA	5 UJ	5 UJ	NA	5 U
2-Butanone	-	10 U	10 U	10 UJ	10 UJ	10 U	10 U
1,1,1-Trichloroethane	1360	5 U	10 U	5 UJ	5 UJ	10 U	5 U
Benzene	140	3 J	10 U	5 UJ	2 J	10 U	2 J
4-Methyl-2-pentanone	-	10 U	10 U	10 UJ	10 UJ	10 U	10 U
2-Hexanone	-	10 UJ	10 U	10 UJ	10 UJ	10 U	10 UB
Toluene	-	5 U	10 U	5 UJ	5 UJ	10 U	5 U
Chlorobenzene	2130	13	36	23 J	26 J	19	5 U
Ethylbenzene	1590	5 U	10 U	5 UJ	5 UJ	10 U	5 U
Xylene (total)	-	5 U	2 J	5 UJ	5 UJ	10 U	5 U
1,4-Dichlorobenzene	2130	10 UR	8 J	6 JR	5 JR	5 J	10 UR
1,2-Dichlorobenzene	2130	10 UR	1 J	10 UR	10 UR	10 U	10 UR
<u>Semi-volatiles: ug/l</u>							
Phenol	-	10 UR	NA	10 UR	10 UR	NA	10 UR
4-Methylphenol	-	10 UR	NA	10 UR	10 UR	NA	10 UR
Naphthalene	2130	5 JR	NA	10 UR	10 UR	NA	10 UR
Di-n-Butylphthalate	-	10 UR	NA	10 UR	10 UR	NA	10 UR
bis(2-Ethylhexyl)phthalate	-	5 UR	NA	10 UR	10 UR	NA	10 UR
<u>Pesticides: ug/l</u>							
4,4-DDT	-	0.10 U	NA	8.80 J	9.20 J	NA	0.10 R

TABLE B-1 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - LEACHATE SAMPLES

WESTON ID# Sample Date Case #	County of Rockland Local Law No. 2 Sewer Use Law(ug/l)	LC-4-02 12/20/93 WES025	LC-5 09/10/90 3827	LC-5-02 12/20/93 WES025	LC-6 09/10/90 3827	LC-6-02 12/20/93 WES025	LC-7 09/06/90 3737
<u>Volatiles: ug/l</u>							
Bromomethane	-	10 U	10 U	2 J	10 U	10 U	10 UJ
Vinyl Chloride	710	10 U	10 U	10 U	10 U	10 U	10 UJ
Chloroethane	240	10 U	10 U	10 U	10 U	10 U	10 UJ
Methylene Chloride	2060	10 U	5 U	10 U	5 U	10 U	5 UB
Acetone	-	10 U	10 U	10 U	10 UB	10 U	10 UB
Carbon Disulfide	60	10 U	27	10 U	23	10 U	5 UJ
1,1-Dichloroethane	2130	10 U	5 U	10 U	5 U	10 U	5 UJ
1,2-Dichloroethene (total)	-	NA	5 U	NA	5 U	NA	5 UJ
2-Butanone	-	10 U	10 U	10 U	10 U	10 U	10 UJ
1,1,1-Trichloroethane	1360	10 U	5 U	10 U	5 U	10 U	5 UJ
Benzene	140	10 U	5 U	10 U	3 J	10 U	5 UJ
4-Methyl-2-pentanone	-	10 U	10 U	10 U	10 U	10 U	10 UJ
2-Hexanone	-	10 U	10 UJ	10 U	10 UJ	10 U	10 UJ
Toluene	-	10 U	5 U	10 U	5 U	10 U	5 UJ
Chlorobenzene	2130	12	5 U	11	18	19	5 UJ
Ethylbenzene	1590	10 U	5 U	10 U	5 U	10 U	5 UJ
Xylene (total)	-	10 U	5 U	10 U	3 J	10 U	5 UJ
1,4-Dichlorobenzene	2130	5 J	10 U	5 J	10 U	10	10 UR
1,2-Dichlorobenzene	2130	10 U	10 U	10 U	10 U	1 J	10 UR
<u>Semi-volatiles: ug/l</u>							
Phenol	-	NA	10 U	NA	10 U	NA	10 UR
4-Methylphenol	-	NA	10 U	NA	10 U	NA	10 UR
Naphthalene	2130	NA	10 U	NA	5 J	NA	10 UR
Di-n-Butylphthalate	-	NA	4 J	NA	6 J	NA	10 UR
bis(2-Ethylhexyl)phthalate	-	NA	10 U	NA	10 U	NA	10 UR
<u>Pesticides: ug/l</u>							
4,4-DDT	-	NA	0.10 UJ	NA	0.10 UJ	NA	0.10 UR

TABLE B-1 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - LEACHATE SAMPLES

WESTON ID#	County of Rockland Local Law No. 2 Sewer Use Law(ug/l)	LC-7-02 12/20/93 WES025	LC-8 09/10/90 3827	LC-8-02 12/20/93 WES025	LC-9 09/06/90 3737	LC-10 09/06/90 3737	LC-11 10/15/90 4322
Sample Date							
Case #							
<u>Volatiles: ug/l</u>							
Bromomethane	-	10 U	10 U	10 U	50 UJ	100 UJ	10 U
Vinyl Chloride	710	10 U	10 U	10 U	50 UJ	130 J	10 U
Chloroethane	240	2 JN	10 U	10 U	45 J	410 J	10 U
Methylene Chloride	2060	10 U	5 U	10 U	190 J	50 UJ	3 J
Acetone	-	10 U	10 UB	10 U	170 U	34000 J*	13000 BJ
Carbon Disulfide	60	10 U	9	10 U	15 J	50 UJ	5 U
1,1-Dichloroethane	2130	10 U	5 U	10 U	135 J	50 UJ	5 U
1,2-Dichloroethene (total)	-	NA	5 U	NA	25 UJ	50 UJ	5 U
2-Butanone	-	10 U	10 U	10 U	40 J	17000 J*	14000
1,1,1-Trichloroethane	1360	10 U	5 U	10 U	310 J	50 UJ	5 U
Benzene	140	10 U	5 U	10 U	25 UJ	50 UJ	5 U
4-Methyl-2-pentanone	-	10 U	10 U	10 U	50 UJ	400 J	200 J
2-Hexanone	-	10 U	10 UJ	10 U	50 UJ	100 UJ	110 J
Toluene	-	10 U	5 U	10 U	215 J	220 J	110 J
Chlorobenzene	2130	13	12	11	25 UJ	50 UJ	5 U
Ethylbenzene	1590	10 U	5 U	10 U	25 UJ	50 UJ	8 J
Xylene (total)	-	2 J	5 U	10 U	25 UJ	50 UJ	12 J
1,4-Dichlorobenzene	2130	4 J	10 U	4 J	10 UR	200 UR	100 U
1,2-Dichlorobenzene	2130	10 U	10 U	10 U	10 UR	200 UR	100 U
<u>Semi-volatiles: ug/l</u>							
Phenol	-	NA	10 U	NA	10 UR	780 R	490
4-Methylphenol	-	NA	10 U	NA	16 R	9200 R	4000 EJ
Naphthalene	2130	NA	10 U	NA	6 R	85 R	100 U
Di-n-Butylphthalate	-	NA	6 J	NA	10 UR	200 UR	100 U
bis(2-Ethylhexyl)phthalate	-	NA	10 U	NA	4 R	200 UR	100 U
<u>Pesticides: ug/l</u>							
4,4-DDT	-	NA	0.10 UJ	NA	0.13 J	0.24 J	0.10 UJ

TABLE B-1 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - LEACHATE SAMPLES

WESTON ID# Sample Date Case #	County of Rockland Local Law No. 2 Sewer Use Law(ug/l)	LC-12 10/15/90 4322	EB(FB) 09/10/90 3827	TBLC-122093 12/20/93 WES025
<u>Volatiles: ug/l</u>				
Bromomethane	-	10 U	10 UJ	10 U
Vinyl Chloride	710	10 U	10 UJ	10 U
Chloroethane	240	10 U	10 UJ	10 U
Methylene Chloride	2060	5 U	5 UJ	10 U
Acetone	-	10 UB	10 UJ	3 J
Carbon Disulfide	60	5 U	5 UJ	10 U
1,1-Dichloroethane	2130	5 U	5 UJ	10 U
1,2-Dichloroethene (total)	-	5 U	5 UJ	10 U
2-Butanone	-	10 UB	10 UJ	10 U
1,1,1-Trichloroethane	1360	5 U	5 UJ	10 U
Benzene	140	5 U	5 UJ	10 U
4-Methyl-2-pentanone	-	10 U	10 UJ	10 U
2-Hexanone	-	10 U	10 UJ	10 U
Toluene	-	5 U	5 UJ	10 U
Chlorobenzene	2130	5 U	5 UJ	10 U
Ethylbenzene	1590	5 U	5 UJ	10 U
Xylene (total)	-	5 U	5 UJ	10 U
1,4-Dichlorobenzene	2130	10 U	10 U	10 U
1,2-Dichlorobenzene	2130	10 U	10 U	10 U
<u>Semi-volatiles: ug/l</u>				
Phenol	-	10 U	10 U	NA
4-Methylphenol	-	10 U	10 U	NA
Naphthalene	2130	8 J	10 U	NA
Di-n-Butylphthalate	-	10 U	3 J	NA
bis(2-Ethylhexyl)phthalate	-	10 UJ	10 U	NA
<u>Pesticides: ug/l</u>				
4,4-DDT	-	0.10 UJ	0.10 UJ	NA

TABLE B-1 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - LEACHATE SAMPLES

WESTON ID#	County of Rockland Local Law No. 2 Sewer Use Law(ug/l)	LB-1 08/29/90 3649	LB-1-02 12/20/93 WES025	LB-2 08/29/90 3649	LB-2-02 12/20/93 WES025	LC-1 09/05/90 3737	LC-1-02 12/20/93 WES025
Sample Date							
Case #							
<u>Additional Parameters: (ug/L unless noted otherwise)</u>							
Total Dissolved Solids (TDS)	-	NA	1190	NA	1000	NA	1110
Biological Oxygen Demand (BOD)	-	NA	33	NA	21	NA	11
Turbidity (NTU)	-	NA	NA	NA	NA	NA	NA
Nitrate-Nitrite (as N)	-	NA	0.3	NA	0.3	NA	0.1
Total Kjeldahl Nitrogen (TKN)	-	NA	78.0	NA	62.0	NA	51.0
Ammonia	-	NA	78.0	NA	57.0	NA	50.0
Total Organic Carbon (TOC)	-	NA	65.5	NA	73.7	NA	64.9
Chemical Oxygen Demand (COD)	-	NA	320	NA	170	NA	130
Total Phenols	-	NA	<1	NA	<1	NA	<1
Sulfate	-	NA	13.0	NA	17.6	NA	31.6
Chlorides	-	NA	204	NA	140	NA	178
Alkalinity (as CaCO ₃)	-	NA	1020	NA	928	NA	930
Hardness (as CaCO ₃)	-	NA	572	NA	519	NA	581
Boron	-	NA	1840	NA	1400	NA	1180
Bromide	-	NA	<0.5	NA	2.0	NA	2.3
Hex. Chrome	-	NA	<0.02	NA	<0.02	NA	<0.02

TABLE B-1 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - LEACHATE SAMPLES

WESTON ID# Sample Date Case #	County of Rockland Local Law No. 2 Sewer Use Law (ug/l)	LC-2 09/05/90 3737	LC-2-02 12/20/93 WES025	LC-3 09/05/90 3737	LC-3DUPE 09/05/90 3737	LC-3-02 12/20/93 WES025	LC-4 09/05/90 3737
<u>Additional Parameters: (mg/L unless noted otherwise)</u>							
Total Dissolved Solids (TDS)	-	NA	1030	NA	NA	1450	NA
Biological Oxygen Demand (BOD)	-	NA	15	NA	NA	15	NA
Turbidity (NTU)	-	NA	NA	NA	NA	NA	NA
Nitrate-Nitrite (as N)	-	NA	0.1	NA	NA	<0.1	NA
Total Kjeldahl Nitrogen (TKN)	-	NA	76.0	NA	NA	95.0	NA
Ammonia	-	NA	69.0	NA	NA	87.0	NA
Total Organic Carbon (TOC)	-	NA	54.0	NA	NA	90.7	NA
Chemical Oxygen Demand (COD)	-	NA	145	NA	NA	245	NA
Total Phenols	-	NA	<1	NA	NA	2.8	NA
Sulfate	-	NA	34.6	NA	NA	30.5	NA
Chlorides	-	NA	190	NA	NA	224	NA
Alkalinity (as CaCO ₃)	-	NA	889	NA	NA	1250	NA
Hardness (as CaCO ₃)	-	NA	494	NA	NA	641	NA
Boron	-	NA	1690	NA	NA	2170	NA
Bromide	-	NA	3.0	NA	NA	2.7	NA
Hex. Chrome	-	NA	<0.02	NA	NA	<0.02	NA

TABLE B-1 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - LEACHATE SAMPLES

WESTON ID# Sample Date Case #	County of Rockland Local Law No. 2 Sewer Use Law (ug/l)	LC-4-02 12/20/93 WES025	LC-5 09/10/90 3827	LC-5-02 12/20/93 WES025	LC-6 09/10/90 3827	LC-6-02 12/20/93 WES025	LC-7 09/06/90 3737
<u>Additional Parameters: (mg/L unless noted otherwise)</u>							
Total Dissolved Solids (TDS)	-	1340	NA	1080	NA	879	NA
Biological Oxygen Demand (BOD)	-	17	NA	13	NA	14	NA
Turbidity (NTU)	-	NA	NA	NA	NA	NA	NA
Nitrate-Nitrite (as N)	-	0.1	NA	0.1	NA	0.1	NA
Total Kjeldahl Nitrogen (TKN)	-	85.0	NA	66.0	NA	41.0	NA
Ammonia	-	80.0	NA	59.0	NA	35.0	NA
Total Organic Carbon (TOC)	-	95.8	NA	66.4	NA	59.4	NA
Chemical Oxygen Demand (COD)	-	210	NA	155	NA	115	NA
Total Phenols	-	5.8	NA	2.6	NA	<1	NA
Sulfate	-	<5.0	NA	<5.0	NA	<5.0	NA
Chlorides	-	188	NA	145	NA	100	NA
Alkalinity (as CaCO ₃)	-	1220	NA	965	NA	805	NA
Hardness (as CaCO ₃)	-	641	NA	551	NA	514	NA
Boron	-	2240	NA	1570	NA	875 J	NA
Bromide	-	3.0	NA	5.0	NA	1.7	NA
Hex. Chrome	-	<0.02	NA	<0.02	NA	<0.02	NA

TABLE B-1 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - LEACHATE SAMPLES

WESTON ID# Sample Date Case #	County of Rockland Local Law No. 2 Sewer Use Law (ug/l)	LC-7-02 12/20/93 WES025	LC-8 09/10/90 3827	LC-8-02 12/20/93 WES025	LC-9 09/06/90 3737	LC-10 09/06/90 3737	LC-11 10/15/90 4322
<u>Additional Parameters: (mg/L unless noted otherwise)</u>							
Total Dissolved Solids (TDS)	-	1130	NA	1170	NA	NA	NA
Biological Oxygen Demand (BOD)	-	14	NA	10	NA	NA	NA
Turbidity (NTU)	-	NA	NA	NA	NA	NA	NA
Nitrate-Nitrite (as N)	-	1.0	NA	0.2	NA	NA	NA
Total Kjeldahl Nitrogen (TKN)	-	53.0	NA	75.0	NA	NA	NA
Ammonia	-	49.0	NA	68.0	NA	NA	NA
Total Organic Carbon (TOC)	-	65.0	NA	57.5	NA	NA	NA
Chemical Oxygen Demand (COD)	-	150	NA	185	NA	NA	NA
Total Phenols	-	<1	NA	<1	NA	NA	NA
Sulfate	-	6.6	NA	<5.0	NA	NA	NA
Chlorides	-	162	NA	193	NA	NA	NA
Alkalinity (as CaCO ₃)	-	930	NA	973	NA	NA	NA
Hardness (as CaCO ₃)	-	609	NA	556	NA	NA	NA
Boron	-	1430	NA	1540	NA	NA	NA
Bromide	-	2.3	NA	2.0	NA	NA	NA
Hex. Chrome	-	<0.02	NA	<0.02	NA	NA	NA

TABLE B-1 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - LEACHATE SAMPLES

WESTON ID# Sample Date Case #	County of Rockland Local Law No. 2 Sewer Use Law(ug/l)	LC-12 10/15/90 4322	EB(FB) 09/10/90 3627
<u>Additional Parameters: (mg/L unless noted otherwise)</u>			
Total Dissolved Solids (TDS)	-	NA	NA
Biological Oxygen Demand (BOD)	-	NA	NA
Turbidity (NTU)	-	NA	NA
Nitrate-Nitrite (as N)	-	NA	NA
Total Kjeldahl Nitrogen (TKN)	-	NA	NA
Ammonia	-	NA	NA
Total Organic Carbon (TOC)	-	NA	NA
Chemical Oxygen Demand (COD)	-	NA	NA
Total Phenols	-	NA	NA
Sulfate	-	NA	NA
Chlorides	-	NA	NA
Alkalinity (as CaCO ₃)	-	NA	NA
Hardness (as CaCO ₃)	-	NA	NA
Boron	-	NA	NA
Bromide	-	NA	NA
Hex. Chrome	-	NA	NA

NOTES

CLARKSTOWN LANDFILL RI

Detected Compounds: Phase I and II Leachate

NA = Not Analyzed.

Organic Data Reporting and Validation Qualifiers:

- U - Compound undetected at the instrument detection limit given.
- J - Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1-1 response is assumed or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the specified detection limit but greater than zero. It is also used to qualify data obtained when analytical protocol deviates slightly from criteria set forth by the 1989 (Phase I) and 1991 (Phase II) New York State Analytical Services Protocol (ASP).
- B - This flag is used when the compound is found in the associated blank as well as in the sample, at a sufficient concentration to rule out blank contamination (e.g., sample concentration is greater than 5x the blank level, or 10x the blank level for common laboratory contaminants).
- E - This flag identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for that specific analysis.

Inorganic Data Reporting and Validation Qualifiers:

- U - Compound undetected at the instrument detection limit given.
- B - Reported value is less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL).
- J - Indicates an estimated value. Data are qualified estimated because analytical protocol deviate slightly from 1989 (Phase I) and 1991 (Phase II) ASP criteria.
- * - Sample run at a dilution factor of 5 to obtain reported result.
- ** - Sample run at a dilution factor of 10 to obtain reported result.

Notes Pertaining to Regulatory Information:

- (1) Local Law No. 2 of 1984, County of Rockland, State of New York, Article V, Federal Categorical Pretreatment Standards and Toxic Substances Prohibited or Accepted, as presented in Rockland County Sewer District No. 1, Wastewater Discharge Permit for the Clarkstown Sanitary Landfill - January 1, 1993

TABLE B-2 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - PHASE I SOIL GAS SAMPLES

WESTON ID# Canister # Sample Date	SG38-A 44 11/08/90	SG9-A 23 11/08/90	SG34-C 24 11/08/90	SG69-A 37 11/09/90	SG68-C 57 11/09/90	SG70 52 11/09/90	SG52-A 19 11/09/90
Volatiles: ppm (v/v)							
Dichlorodifluoromethane, Freon 12	0.68	0.070	0.78	0.15 E	0.79 E	0.008	1.4 E
Vinyl Chloride	0.86	0.003 U	2.1	0.085	0.03 U	0.004	0.17 E
Ethyl chloride	0.2 U	0.003 U	0.86	0.67 E	0.03 U	0.003 U	0.027
Trichlorofluoromethane, Freon 11	0.61	0.036	0.036 J	0.001 U	0.44	0.001 U	0.001 U
1,1,2-Trichloro-1,2,2-trifluoroethane, Freon 113	0.05 U	0.0009 U	0.05 U	0.0014	0.009 U	0.0009 U	0.0009 U
1,1-Dichloroethane	0.1 U	0.007	0.094 J	0.002 U	0.02 U	0.002 U	0.002 U
1,2-Dichloroethylene, Total	0.1 U	0.002 U	0.13	0.011	0.02 U	0.002 U	0.02
1,1,1-Trichloroethane	0.07 U	0.038	0.07 U	0.001 U	0.01 U	0.001 U	0.001 U
Benzene	0.33	0.002 U	0.16	0.3 E	0.02 U	0.004	0.17 E
Trichloroethylene	0.08 U	0.001 U	0.048 J	0.001 U	0.01 U	0.001 U	0.011
Toluene	7.3 E	0.002 U	10.0 E	0.094 E	0.048	0.004	0.65 E
Tetrachloroethylene	0.06 U	0.012	0.083	0.001 U	0.01 U	0.004	0.012
Chlorobenzene	0.09 U	0.002 U	0.09 U	0.31 E	0.02 U	0.006	0.031
Ethylbenzene	3.8	0.002 U	0.52	0.10 E	0.085	0.002 U	1.5 E
m/p-Xylene	5.8 E	0.002 U	1.0	0.25 E	0.06	0.021	0.87 E
Styrene	0.10 U	0.002 U	0.09 U	0.002 U	0.049	0.002 U	0.002 U
o-Xylene	1.0	0.002 U	0.22	0.092 E	0.035	0.015	0.37 E
1,3,5-Trimethylbenzene	0.33	0.001 U	0.08 U	0.075 E	0.031	0.02	0.082 E
1,2,4-Trimethylbenzene	0.68	0.001 U	0.090	0.069	0.037	0.05	0.22 E
o-Dichlorobenzene	0.07 U	0.001 U	0.07 U	0.006	0.01 U	0.001 U	0.001 U
p-Dichlorobenzene	0.04 J	0.001 U	0.07 U	0.14 E	0.01 U	0.018	0.032
1,2,4-Trichlorobenzene	0.05 U	0.0010 U	0.05 U	0.0009 U	0.010 U	0.0010 U	0.0010 U

TABLE B-2 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - PHASE I SOIL GAS SAMPLES

WESTON ID#	SG52-AFD	SG44	SG7-A	SG1	SGTB1	SGTB2	SGTB3
Canister #	58	49	2	45	35	34	32
Sample Date	11/09/90	11/08/90	11/14/90	11/14/90	11/08/90	11/09/90	11/14/90
Volatiles: ppm (v/v)	17 E	0.202 E	4.3	0.08 U	0.0005 U	0.0005 U	0.0005 U
Dichlorodifluoromethane, Freon 12	0.2 U	0.003 U	0.99	0.19	0.001 U	0.001 U	0.001 U
Vinyl Chloride	0.2 U	0.003 U	1.5	0.2 U	0.001 U	0.001 U	0.001 U
Ethyl chloride	0.07 U	0.004	0.22	0.07 U	0.0005 U	0.0005 U	0.0005 U
Trichlorofluoromethane, Freon 11	0.05 U	0.0009 U	0.1 U	0.05 U	0.0003 U	0.0003 U	0.0003 U
1,1,2-Trichloro-1,2,2-trifluoroethane, Freon 113	0.1 U	0.002 U	0.3 U	0.1 U	0.0007 U	0.0007 U	0.0006 U
1,1-Dichloroethane	0.1 U	0.002 U	0.3 U	0.1 U	0.0007 U	0.0007 U	0.0007 U
1,2-Dichloroethylene, Total	0.07 U	0.001 U	0.2 U	0.07 U	0.0005 U	0.0005 U	0.0005 U
1,1,1-Trichloroethane	0.15	0.0025	0.45	0.1 U	0.0008 U	0.0008 U	0.0008 U
Benzene	0.08 U	0.001 U	0.2 U	0.08 U	0.0005 U	0.0005 U	0.0005 U
Trichloroethylene	0.67	0.06	0.86	0.17	0.0008	0.0008	0.0007 U
Toluene	0.06 U	0.004	0.1 U	0.06 U	0.0004 U	0.0004 U	0.0004 U
Tetrachloroethylene	0.09 U	0.002 U	0.2 U	0.09 U	0.0006 U	0.0006 U	0.0006 U
Chlorobenzene	1.5	0.017	1.3	0.09 U	0.0006 U	0.0006 U	0.0006 U
Ethylbenzene	0.67	0.022	1.1	0.09 U	0.0006 U	0.0006 U	0.0006 U
m/p-Xylene	0.10 U	0.002 U	0.2 U	0.10 U	0.0006 U	0.0006 U	0.0006 U
Styrene	0.28	0.013	0.4	0.09 U	0.0006 U	0.0006 U	0.0006 U
o-Xylene	0.08 U	0.024	0.2 U	0.08 U	0.0005 U	0.0005 U	0.0005 U
1,3,5-Trimethylbenzene	0.16	0.05	0.2 U	0.08 U	0.0005 U	0.0005 U	0.0005 U
1,2,4-Trimethylbenzene	0.07 U	0.001 U	0.2 U	0.07 U	0.0004 U	0.0004 U	0.0004 U
o-Dichlorobenzene	0.07 U	0.067 E	0.2 U	0.07 U	0.0004 U	0.0004 U	0.0004 U
p-Dichlorobenzene	0.05 U	0.0045	0.1 U	0.05 U	0.0004 U	0.0004 U	0.0004 U
1,2,4-Trichlorobenzene							

TABLE B-3 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - PHASE II SOIL GAS SAMPLES

WESTON ID#	LFG-2B	LFG-3B	LFG-3B DUP	LFG-8B	LFG-FB
Sample Date	03/17/94	03/17/94	03/17/94	03/17/94	03/17/94
Validation Date					
Volatiles: (NG/L)					
Sample Volume	10ML	9ML	8ML	53ML	NA
Dichlorodifluoromethane	32000	9800	8500	20000	25 U
Vinyl Chloride	7800	10000	6800	640	25 U
Chloroethane	7100	2800 U	3100 U	1600	25 U
Trichlorofluoromethane	4900	2800 U	3100 U	500	25 U
1,2-Dichlorotetrafluoroethane	7800	1500 J	1200 J	11000	25 U
1,1,2-Trichlorotrifluoroethane	2500 U	2800 U	3100 U	190 J	25 U
Methylene Chloride	5400 U	2800 U	3100 U	470 U	107
1,1-Dichloroethane	4200	2800 U	3100 U	470 U	25 U
cis-1,2-Dichloroethane	2500 U	1800 J	1800 J	470 U	25 U
1,1,1-Trichloroethane	4300	2800 U	3100 U	470 U	25 U
Trichloroethene	4100	680 J	640 J	310 J	25 U
Benzene	2900	890 J	830 J	2700	25 U
Tetrachloroethene	12000	1100 J	920 J	470 UJ	25 UJ
Toluene	150000	68000	63000	650	25 U
Chlorobenzene	2500 U	2800 U	3100 U	3000	25 U
Ethylbenzene	33000	25000	24000	1200	25 U
m/p-Xylene	35000	21000	20000	640	25 U
o-Xylene	17000	15000	14000	680	25 U
Isopropylbenzene	2300 J	3800	3500	1500	25 U
Benzyl chloride	3600 JN	6700 JN	12000 JN	470 U	25 U
1,3,5-Trimethylbenzene	4600	9200	9600	250 J	25 U
1,2,4-Trimethylbenzene	13000	29000	27000	1700	25 U
1,4-Dichlorobenzene	3100	16000	16000	290 J	25 U
Styrene	8400	2800 U	3100 U	470 U	25 U

NOTES

CLARKSTOWN LANDFILL RI

Detected Compounds: Phase I and II Soil Gas

Organic Data Reporting and Validation Qualifiers:

- U - Compound not detected at the instrument detection limit given.
- J - Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1-1 response is assumed or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the specified detection limit but greater than zero. It is also used to qualify data obtained when analytical protocol deviates slightly from criteria set forth by the 1989 (Phase I) and 1991 (Phase II) New York State Analytical Services Protocol.
- E - This flag identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for that specific analysis.
- N - Indicates presumptive evidence of a compound.

Notes Pertaining to Regulatory Information:

There are no applicable Federal, State or local regulatory standards for soil gas data. Soil gas concentrations impact upon ambient air contaminant levels but are not regulated specifically or independently.

TABLE B-4 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - TEST PIT SAMPLES

WESTON ID# Sample Date	Regulatory Limit (ug/l)	RFWTP1 03/09/94	RFWTP2 03/09/94	RFWTP3 03/09/94	RFWTP4 03/09/94	RFWTP5 03/09/94
<u>Inorganics (ug/l)</u>						
Barium	100000	697 B	548 B	480 B	1150 B	543 B
Cadmium	1000	4.1 B	1.9 B	1.6 B	4.1 B	2.0 B
Chromium	5000	6.4 U	6.4 U	6.4 U	7.3 B	6.4 U
Lead	5000	42.4 B	28.0 B	185 B	384 B	36.0 B
Selenium	1000	60.1 B	24.0 U	53.1 B	37.9 B	24.0 U
<u>Volatile (ug/l)</u>						
2-Butanone	200000	10 U	10 U	10 U	10 U	1 J
Chlorobenzene	100000	1 J	2 J	2 J	9 J	12
<u>Herbicides (ug/l)</u>						
2,4-D	10000	<20	<20	<20	<20 J	<20
2,4,5-TP (SILVEX)	1000	<5	<5	<5	<5 J	<5
<u>RCRA Characteristics</u>						
Flash pt (C)	<60 degree C	>60	>60	>60	>60	>60
pH (corros)	2>pH>12.5	7.2	7.5	6.3	7.0	7.5
Releases Cyanide	250 mg/kg	No <1.3	No <1.3	No <1.2	No <1.9	No <1.3
Releases Sulfide	500 mg/kg	No <24.7	No <23.8	Yes 308	No <38.0	Yes 74.6

NOTES

CLARKSTOWN LANDFILL RI

Detected Compounds: Phase II Test Pit Samples

Organic Data Reporting and Validation Qualifiers:

- U - Compound was not detected at the instrument detection limit given.
- J - Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed or when the mass spectral data indicates the presence of a compound that meets the identification criteria but the result is less than the specified quantification limit but greater than zero. It is also used to qualify data obtained when analytical protocol deviates slightly from criteria set forth by the 1991 New York State Analytical Services Protocol (ASP).

Inorganic Data Reporting and Validation Qualifiers:

- U - Indicates compound was not detected at the instrument level given.
- B - Reported value is less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL).

Notes Pertaining to Regulatory Information:

- (1) NYSDEC - 6 NYCRR Part 371 Identification and Listing of Hazardous Wastes December, 25, 1988. These are the Federal Resource Conservation and Recovery Act (RCRA) regulations pertaining to the RCRA characteristics analysis as adopted by New York State.

TABLE B-5 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SURFACE WATER SAMPLES

SAMPLE LOCATION	NYSDEC(1)		SW1		SW2		SW2-02		SW3		SW4		SW4-02	
SAMPLE DATE	Surface Water Qual.		7/25/90		7/23/90		4/18/94		7/25/90		7/23/90		4/18/94	
CASE #	Sids & Guid. Values		3151		3109		WES031		3151		3109		WES031	
WATER CLASS	A	A,B,C	D	D	D	D	D	D	D	D	D	D	D	D
Inorganics, Total: ug/l	(H)	(A)	(A)	(A)										
Aluminum	-	100	-	130 B	72.0 BJ	526	258	710	258	710	72.8 B			
Antimony	3*	-	-	6.0 U	6.0 U	7.9 U	6.0 U	6.0 U	6.0 U	6.0 U	7.9 U			
Arsenic	50	190	360	3.4 UR	3.4 UR	1.5 U	3.4 UR	3.4 UR	3.4 UR	3.4 UR	1.5 U			
Barium	1000	-	-	27.0 B	74.0 BJ	47.9 B	139 B	123 B	139 B	123 B	45.9 B			
Beryllium	3*	11/1100++	-	1.0 U	1.0 BJ	0.50 U	1.0 U	1.0 U	1.0 U	1.0 U	0.50 U			
Cadmium	10	++	++	3.0 U	3.0 UJ	1.3 U	3.0 U	3.0 B	3.0 U	3.0 B	1.3 U			
Calcium	-	-	-	27300	54600 J	23900	45700	40800	45700	40800	24900			
Chromium	50	++	++	3.0 U	3.0 BJ	6.4 U	3.0 U	3.0 B	3.0 U	3.0 B	6.4 U			
Cobalt	-	5	110*	7.0 U	7.0 UJ	3.2 U	7.0 U	7.0 U	7.0 U	7.0 U	3.2 U			
Copper	200	++	++	6.0 B	6.0 J	14.7 B	5.0 U	5.0 B	5.0 U	5.0 B	3.0 B			
Iron	300	300	300	659 J	1890 J	4290	3190 J	3140 J	3190 J	3140 J	1170			
Lead	50	++	++	1.7 UR	2.4 BJ	3.7 J	4.6 J	6.6 J	4.6 J	6.6 J	1.0 UJ			
Magnesium	35000	-	-	6720	10000 J	6680	8480	7780	8480	7780	6460			
Manganese	300	-	-	262 J	1150 J	474 J	242 J	357 J	242 J	357 J	119 J			
Nickel	-	++	++	8.0 U	8.0 UJ	27.7 B	8.0 U	8.0 U	8.0 U	8.0 U	6.9 B			
Potassium	-	-	-	1260 B	2750 BJ	1090 B	2030 B	2050 B	2030 B	2050 B	1520 B			
Silver	50	0.1	++	7.0 U	7.0 UJ	2.1 U	7.0 U	7.0 U	7.0 U	7.0 U	2.1 U			
Sodium	-	-	-	20300 J	41200 J	30700	17900 J	17000 J	17900 J	17000 J	24300			
Vanadium	-	14	190	35.0 B	28.0 BJ	2.0 U	46.0 B	29.0 B	46.0 B	29.0 B	2.0 U			
Zinc	300	30	++	3.0 B	9.0 BJ	167	3.0 U	18.0 B	3.0 U	18.0 B	13.5 B			

TABLE B-5 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SURFACE WATER SAMPLES

SAMPLE LOCATION	NYSDEC(1)		SW5	SW6	SW7	SW8	SW9	SW10
SAMPLE DATE	Surface Water Qual.		7/31/90	7/25/90	10/17/90	7/31/90	7/30/90	08/02/90
CASE #	Sids & Guid. Values		3216	3151	4342	3216	3203	3256
WATER CLASS	A	A,B,C	D	A	A	A	A	A
Inorganics, Total: ug/l	(H)	(A)	(A)					
Aluminum	-	100	-	553	41500	162 B	403	383
Antimony	3*	-	-	6.0 U	46.0 B	6.0 U	6.0 U	6.0 U
Arsenic	50	190	360	3.4 UR	5.9 B	3.4 J	3.4 UR	3.4 UR
Barium	1000	-	-	218	577	336	97.0 B	63.0 B
Beryllium	3*	11/1100++	-	1.0 U	9.0	1.0 U	1.0 U	1.0 U
Cadmium	10	++	++	4.0 B	8.0 U	3.0 B	3.0 U	3.0 U
Calcium	-	-	-	69000	50500	108000	34800	27500
Chromium	50	++	++	8.0 B	51.0	6.0 B	3.0 B	3.0 B
Cobalt	-	5	110*	7.0 B	47.0 UB	7.0 U	12.0 B	8.0 B
Copper	200	++	++	5.0 B	124	5.0 U	10.0 B	12.0 B
Iron	300	300	300	1070 J	64300	4450 J	1520 J	355 J
Lead	50	++	++	4.1 BJ	94.8 J	1.9 BJ	3.8 BJ	3.7 BJ
Magnesium	35000	-	-	8900	19600	20400	6470	5270
Manganese	300	-	-	116 J	970	1290 J	354 J	191 J
Nickel	-	++	++	8.0 U	53.0	8.0 U	8.0 U	8.0 U
Potassium	-	-	-	1340 B	9240 U	7940	1990 B	1360 B
Silver	50	0.1	++	7.0 U	9.0 UB	7.0 U	7.0 U	7.0 U
Sodium	-	-	-	38800 J	10600	136000 J	31600 J	23400 J
Vanadium	-	14	190	18.0 B	101 U	23.0 B	28.0 B	8.0 B
Zinc	300	30	++	22.0	485 J	14.0 B	26.0	21.0

TABLE B-5 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SURFACE WATER SAMPLES

SAMPLE LOCATION	NYSDEC(1)		SW11	SW12	SW12FD	SW12-02	SW13-02	SW14-02
SAMPLE DATE	Surface Water Qual.		08/01/90	08/01/90	08/01/90	4/19/93	4/19/93	4/19/93
CASE #	Sids & Guid. Values		3238	3238	3238	WES031	WES031	WES031
WATER CLASS	A	A,B,C	D	D	D	D	D	D
Inorganics, Total: ug/l	(H)	(A)	(A)					
Aluminum	-	100	-	71.0 B	34.0 B	51.6 B	102 B	487
Antimony	3*	-	-	6.0 U	6.0 U	7.9 U	7.9 U	7.9 U
Arsenic	50	190	360	3.4 UR	3.4 UR	1.5 U	1.5 U	1.5 U
Barium	1000	-	-	34.0 B	34.7 B	39.7 B	51.6 B	102 B
Beryllium	3*	11/1100++	-	1.0 U	1.0 U	0.50 B	0.50 U	0.50 U
Cadmium	10	++	++	3.0 B	3.0 U	1.3 U	1.3 U	1.3 U
Calcium	-	-	-	44000	44200	42300	46900	54500
Chromium	50	++	++	4.0 B	3.0 B	6.4 U	6.4 U	6.4 U
Cobalt	-	5	110*	11.0 B	7.0 B	3.2 U	3.2 U	3.2 U
Copper	200	++	++	8.0 B	6.0 B	3.5 B	3.1 B	9.0 B
Iron	300	300	300	174 J	135 J	382	827	3790
Lead	50	++	++	9.8 J	1.7 UR	1.0 UJ	1.2 BJ	2.9 BJ
Magnesium	35000	-	-	8250	8370	8160	9490	10600
Manganese	300	-	-	878 J	3.0 BJ	241 J	338 J	447 J
Nickel	-	++	++	8.0 U	8.0 U	7.6 B	6.7 B	15.2 B
Potassium	-	-	-	6070	2160 B	1250 B	2660 B	3550 B
Silver	50	0.1	++	7.0 U	7.0 U	2.1 U	2.1 U	2.1 U
Sodium	-	-	-	262000 J	94600 J	104000	107000	105000
Vanadium	-	14	190	29.0 B	35.0 B	2.0 U	2.0 U	2.0 U
Zinc	300	30	++	49.0	5.0 B	12.5 B	28.4	74.0

TABLE B-5 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SURFACE WATER SAMPLES

SAMPLE LOCATION	NYSDEC(1)		SW15-02	SW16-02	SW17-02	SW18-02	FBSW
SAMPLE DATE	Surface Water Qual.		4/19/93	4/18/93	4/18/93	4/18/93	08/01/90
CASE #	Sids & Guid. Values		WES031	WES031	WES031	WES031	3238
WATER CLASS	A	A,B,C	A	A	C(T)	D	
Inorganics, Total: ug/l	(H)	(A)	(A)	(A)			
Aluminum	-	100	-	463	3950	299	31.0 U
Antimony	3*	-	-	7.9 U	7.9 U	7.9 U	6.0 U
Arsenic	50	190	360	1.5 U	2.4 BJ	1.5 U	3.4 UR
Barium	1000	-	-	88.3 B	153 B	36.8 B	4.0 U
Beryllium	3*	11/1100**	-	0.50 U	0.70 B	0.50 U	1.0 U
Cadmium	10	++	++	1.3 U	1.3 U	1.3 U	3.0 B
Calcium	-	-	-	47200	64000	23500	178 B
Chromium	50	++	++	6.4 U	6.4 U	6.4 U	3.0 U
Cobalt	-	5	110*	3.2 U	3.9 B	3.2 U	7.0 U
Copper	200	++	++	12.3 B	21.6 B	12.3 B	5.0 U
Iron	300	300	300	2190	8370	1620	32.0 BJ
Lead	50	++	++	2.6 BJ	15.1 J	4.1 J	1.7 UR
Magnesium	35000	-	-	5390	12300	6200	39.0 U
Manganese	300	-	-	249 J	2140 J	182 J	2.0 UJ
Nickel	-	++	++	11.4 B	13.2 B	8.3 B	8.0 U
Potassium	-	-	-	1280 B	6160	1550 B	443 U
Silver	50	0.1	++	2.1 U	2.1 U	2.1 U	7.0 U
Sodium	-	-	-	40200	28300	27500	359 BJ
Vanadium	-	14	190	2.0 U	10.0 B	2.0 U	31.0 B
Zinc	300	30	++	35.6	82.6	36.2	3.0 B

TABLE B-5 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SURFACE WATER SAMPLES

SAMPLE LOCATION	NYSDEC(1)	SW1	SW2	SW2-02	SW3	SW4	SW4-02
SAMPLE DATE	Surface Water Qual.	7/25/90	7/23/90	4/18/94	7/25/90	7/23/90	4/18/94
CASE #	Stds & Guid. Values	3151	3109	WES031	3151	3109	WES031
WATER CLASS	A	D	D	D	D	D	D
Volatiles: ug/l	(H)	(A)	(A)	(A)	(A)	(A)	(A)
Methylene Chloride	5*	-	5 U	4 UB	5 U	2 UB	5 U
Acetone	-	-	10 U	10 U	10 U	10 U	5 U
Carbon Disulfide	-	-	5 U	4 J	5 U	11	5 U
Chloroform	7.0	-	5 U	26	5 U	5 U	5 U
Bromodichloromethane	50*	-	5 U	4 J	5 U	5 U	5 U
Trichloroethene	3*	11.0*	5 U	5 U	2 J	5 U	5 U
Tetrachloroethene	1.0	-	5 U	5 U	7	2 J	5 U
Toluene	5*	-	5 UB	4 UB	5 U	4 UB	5 U
Semi-volatiles: ug/l	(H)	(A)	(A)	(A)	(A)	(A)	(A)
Di-n-Butylphthalate	50*	-	10 UB	10 U	10 UJ	10 U	NA
bis(2-Ethylhexyl)phthalate	4*	0.6	10 U	10 U	10 U	10 U	NA
Additional Parameters							
Nitrate (mg/l)	10	-	0.30	0.13	NA	0.54	NA
Nitrite (mg/l)	-	-	<0.02	<0.02	NA	<0.02	NA
Ammonia (mg/l)	2.0	++	<0.03	0.13	0.21	<0.03	0.61
Ortho Phosphate (mg/l)	-	-	0.07	<0.05	NA	0.05	NA
Chlorophyll A (mg/m ³)	-	-	1.54	3.61	NA	12.9	NA
Hexavalent Chromium (mg/l)	-	0.011	NA	NA	NA	NA	<0.02
Total Hardness (mg/l)	-	-	NA	NA	87.1	NA	88.7

TABLE B-5 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SURFACE WATER SAMPLES

SAMPLE LOCATION	NYSDEC(1)	SW5	SW6	SW7	SW8	SW9	SW10
SAMPLE DATE	Surface Water Qual.	7/31/90	7/25/90	10/17/90	7/31/90	7/30/90	08/02/90
CASE #	Sids & Guid. Values	3216	3151	4342	3216	3203	3256
WATER CLASS	A A,B,C D	C(T)	A	A	A	A	A
<u>Volatiles: ug/l</u>	(H)	(A)	(A)	(A)			
Methylene Chloride	5*	-	-	-	5 U	5 U	5 U
Acetone	-	-	-	-	10 UJ	10 U	10 UJ
Carbon Disulfide	-	-	-	-	5 U	5 U	5 U
Chloroform	7.0	-	-	-	5 U	5 U	5 U
Bromodichloromethane	50*	-	-	-	5 UJ	5 UJ	5 UJ
Trichloroethene	3*	11.0*	-	-	5 U	5 U	3 J
Tetrachloroethene	1.0	-	-	-	5 U	5 U	5 U
Toluene	5*	-	-	-	5 UB	5 UB	5 UB
<u>Semi-volatiles: ug/l</u>	(H)	(A)	(A)	(A)			
Di-n-Butylphthalate	50*	-	-	-	10 U	10 UJ	10 UJ
bis(2-Ethylhexyl)phthalate	4*	0.6	-	-	10 U	10 U	10 U
<u>Additional Parameters</u>							
Nitrate (mg/l)	10	-	-	-	0.42	<0.02	0.09
Nitrite (mg/l)	-	-	-	-	<0.02	<0.02	<0.02
Ammonia (mg/l)	2.0	++	++	++	<0.03	0.34	0.11
Ortho Phosphate (mg/l)	-	-	-	-	<0.05	<0.05	<0.05
Chlorophyll A (mg/m ³)	-	-	-	-	2.70	NR	18.2
Hexavalent Chromium (mg/l)	-	0.011	0.016	-	NA	NA	NA
Total Hardness (mg/l)	-	-	-	-	NA	NA	NA

TABLE B-5 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SURFACE WATER SAMPLES

SAMPLE LOCATION	NYSDEC(1)	SW11	SW12	SW12FD	SW12-02	SW13-02	SW14-02
SAMPLE DATE	Surface Water Qual.	08/01/90	08/01/90	08/01/90	4/18/93	4/18/93	4/19/93
CASE #	Sids & Guid. Values	3238	3238	3238	WES031	WES031	WES031
WATER CLASS	A	A	D	D	D	D	D
Volatiles: ug/l	(H)	(A)	(A)	(A)	(A)	(A)	(A)
Methylene Chloride	5*	-	-	-	5 U	5 U	5 U
Acetone	-	-	-	-	5 J	5 U	5 U
Carbon Disulfide	-	-	-	-	5 U	5 U	5 U
Chloroform	7.0	-	-	-	5 U	5 U	5 U
Bromodichloromethane	50*	-	-	-	5 UJ	5 U	5 U
Trichloroethene	3*	11.0*	-	-	5 U	5 U	5 U
Tetrachloroethene	1.0	-	-	-	5 U	5 U	5 U
Toluene	5*	-	-	-	5 UB	5 U	5 U
Semi-volatiles: ug/l	(H)	(A)	(A)	(A)	(A)	(A)	(A)
Di-n-Butylphthalate	50*	-	-	-	10 UJ	NA	NA
bis(2-Ethylhexyl)phthalate	4*	0.6	-	-	10 U	NA	NA
<u>Additional Parameters</u>							
Nitrate (mg/l)	10	-	-	-	0.40	NA	NA
Nitrite (mg/l)	-	-	-	-	<0.02	NA	NA
Ammonia (mg/l)	2.0	++	++	++	<0.03	0.11	1.3
Ortho Phosphate (mg/l)	-	-	-	-	<0.05	NA	NA
Chlorophyll A (mg/m ³)	-	-	-	-	8.62	NA	NA
Hexavalent Chromium (mg/l)	-	0.011	0.016	-	NA	<0.02	<0.02
Total Hardness (mg/l)	-	-	-	-	NA	139	180

TABLE B--5 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SURFACE WATER SAMPLES

SAMPLE LOCATION	NYSDEC(1)		SW15-02	SW16-02	SW17-02	SW18-02	FBSW	TB
SAMPLE DATE	Surface Water Qual.		4/19/93	4/18/93	4/18/93	4/18/93	08/01/90	07/23/90
CASE #	Stds & Guid. Values		WES031	WES031	WES031	WES031	3238	3109
WATER CLASS	A	A,B,C	A	A	C(T)	D		
<u>Volatiles: ug/l</u>	(H)	(A)	(A)					
Methylene Chloride	5*	-	5 U	5 U	5 U	5 U	3 J	5 U
Acetone	-	-	5 U	5 U	5 U	5 U	10 UJ	10 U
Carbon Disulfide	-	-	5 U	5 U	5 U	5 U	7	5 U
Chloroform	7.0	-	5 U	5 U	5 U	5 U	5 U	5 U
Bromodichloromethane	50*	-	5 U	5 U	5 U	5 U	5 UJ	5 U
Trichloroethene	3*	11.0*	5 U	2 J	5 U	5 U	5 U	5 U
Tetrachloroethene	1.0	-	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	5*	-	5 U	5 U	5 U	5 U	5 UB	4 UB
<u>Semi-volatiles: ug/l</u>	(H)	(A)						
Di-n-Butylphthalate	50*	-	NA	NA	NA	NA	10 UJ	
bis(2-Ethylhexyl)phthalate	4*	0.6	NA	NA	NA	NA	10 U	
<u>Additional Parameters</u>								
Nitrate (mg/l)	10	-	NA	NA	NA	NA	<0.02	
Nitrite (mg/l)	-	-	NA	NA	NA	NA	<0.02	
Ammonia (mg/l)	2.0	++	0.10	0.56	0.78	0.76	<0.03	
Ortho Phosphate (mg/l)	-	-	NA	NA	NA	NA	<0.05	
Chlorophyll A (mg/m ³)	-	-	NA	NA	NA	NA	1.26	
Hexavalent Chromium (mg/l)	-	0.011	<0.02	<0.02	<0.02	<0.02	NA	
Total Hardness (mg/l)	-	-	96.8	154	210	84.1	NA	

TABLE B-5 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SURFACE WATER SAMPLES

SAMPLE LOCATION	NYSDEC(1)	TBSW	TBSW	TBSW	TBSW	TBSW	TBSW
SAMPLE DATE	Surface Water Qual.	07/25/90	07/30/90	07/31/90	08/01/90	08/02/90	10/17/90
CASE #	Stds & Guid. Values	3151	3203	3216	3238	3256	4342
WATER CLASS	A A,B,C D						
<u>Volatiles: ug/l</u>	(H) (A) (A)	(A)					
Methylene Chloride	5*	5 U	5 UB	5 U	5 U	5 U	5 U
Acetone	-	10 U	10 UJ	10 UJ	10 UJ	10 UJ	10 U
Carbon Disulfide	-	5 U	5 U	5 U	5 U	5 U	5 U
Chloroform	7.0	5 U	5 U	5 U	5 U	5 U	5 U
Bromodichloromethane	50*	5 U	5 U	5 UJ	5 UJ	5 UJ	5 U
Trichloroethene	3*	11.0*	5 U	5 U	5 U	5 U	5 U
Tetrachloroethene	1.0	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	5*	5 UB	5 UB	5 UB	5 UB	5 UB	5 U
<u>Semi-volatiles: ug/l</u>	(H) (A) (A)	(A)					
Di-n-Butylphthalate	50*	-	-	-	-	-	-
bis(2-Ethylhexyl)phthalate	4*	0.6	-	-	-	-	-
<u>Additional Parameters</u>							
Nitrate (mg/l)	10	-	-	-	-	-	-
Nitrite (mg/l)	-	-	-	-	-	-	-
Ammonia (mg/l)	2.0	++	++	++	++	++	++
Ortho Phosphate (mg/l)	-	-	-	-	-	-	-
Chlorophyll A (mg/m ³)	-	-	-	-	-	-	-
Hexavalent Chromium (mg/l)	-	0.011	0.016	0.016	0.016	0.016	0.016
Total Hardness (mg/l)	-	-	-	-	-	-	-

TABLE B-5 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SURFACE WATER SAMPLES

SAMPLE LOCATION	NYSDEC(1)	TBSW-041894	TBSW-041994
SAMPLE DATE	Surface Water Qual.	4/18/93	4/19/93
CASE #	Sids & Guid. Values	WES031	WES031
WATER CLASS	A A,B,C D		
<u>Volatiles: ug/l</u>	(H) (A) (A)		
Methylene Chloride	5* -	10 U	10 U
Acetone	- -	10 U	10 U
Carbon Disulfide	- -	10 U	10 U
Chloroform	7.0 -	10 U	10 U
Bromodichloromethane	50* -	10 U	10 U
Trichloroethene	3* 11.0*	10 U	10 U
Tetrachloroethene	1.0 -	10 U	10 U
Toluene	5* -	10 U	10 U
<u>Semi-volatiles: ug/l</u>	(H) (A) (A)		
Di-n-Butylphthalate	50* -		
bis(2-Ethylhexyl)phthalate	4* 0.6		
<u>Additional Parameters</u>			
Nitrate (mg/l)	10 -		
Nitrite (mg/l)	- -		
Ammonia (mg/l)	2.0 ++		
Ortho Phosphate (mg/l)	- -		
Chlorophyll A (mg/m ³)	- -		
Hexavalent Chromium (mg/l)	- 0.011		0.016
Total Hardness (mg/l)	- -		-

NOTES

CLARKSTOWN LANDFILL RI

Detected Compounds: Phase I and II Surface Water Samples

NA - Not Analyzed

Organic Data Reporting and Validation Qualifiers:

U - Compound was not detected at the instrument detection limit given.

J - Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1-1 response is assumed or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the specified detection limit but greater than zero. It is also used to qualify data obtained when analytical protocol deviates slightly from criteria set forth by the 1989 (Phase I) and 1991 (Phase II) New York State Analytical Services Protocol.

B - Reported result is qualified estimated because of a possible blank interference. Sample concentration is sufficient to treat as a detect (e.g., greater than 5x the blank concentration).

Inorganic Data Reporting and Validation Qualifiers:

U - Compound was not detected at the instrument detection limit given.

B - Reported value is less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL).

J - Indicates an estimated value. Data are qualified estimated because analytical protocol deviate slightly from 1989 (Phase I) and 1991 (Phase II) ASP criteria.

R - Rejected during data validation.

Notes Pertaining to Regulatory Information:

(1) = Water Quality Regulations for Surface Waters and Groundwater, 6 NYCRR PARTS 700 - 705, Effective September 1, 1991.

NYSDEC - Technical & Operational Guidance Series (1.1.1), Ambient Water Quality Standards & Guidance Values, Effective November 15, 1991.

* = Guidance Value

(H) = Value designated for protection of human health

(A) = Value designated for protection of aquatic life

++ = Calculated Standards based upon hardness values appear in the tables below:

PHASE I

ANALYTE Hardness (mg/l):	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10	SW11	SW12
	95.8	177.5	149.0	133.9	253.0	87.1	206.8	353.7	113.5	90.4	352.4	143.8
Cadmium	3.8	7.6	1.6	5.5	2.4	1.0	9.0	16.4	1.3	1.0	3.0	6.0
Chromium	1677.8	2778.5	287.0	2205.7	442.7	184.8	3148.7	4886.4	229.7	190.5	580.7	2338.8
Copper	17.0	30.4	16.6	23.3	26.1	10.5	35.2	58.3	13.8	10.8	34.7	25.0
Lead	78.3	170.8	5.3	119.6	10.4	2.7	207.3	408.9	3.8	2.8	15.9	130.9
Nickel	1785.8	2852.9	129.4	2302.8	193.5	86.0	3204.1	4817.4	105.3	88.5	248.9	2431.4
Silver	3.8	10.9	0.1	6.7	0.1	0.1	14.2	35.6	0.1	0.1	0.1	7.6
Zinc	310.1	517.3	30.0	409.4	30.0	30.0	587.2	916.7	30.0	30.0	30.0	434.4

PHASE II

ANALYTE Hardness (mg/l):	SW2-02 87.1	SW4-02 88.7	SW12-02 139	SW13-02 156	SW14-02 180	SW15-02 96.8	SW16-02 154	SW17-02 210	SW18-02 84.1
Ammonia	0.028	0.042	0.082	0.030	0.038	0.003	0.004	0.0059	0.046
Cadmium	3.4	3.4	5.7	6.5	7.6	1.1	1.6	2.0	3.2
Chromium	1550.8	1574.1	2274.1	2499.5	2810.3	201.5	294.8	380.0	1506.9
Copper	15.6	15.8	24.2	26.9	30.8	11.5	17.1	22.3	15.01
Lead	69.4	71.0	125.3	145.1	173.8	3.1	5.6	8.2	66.3
Nickel	1660.6	1683.8	2368.9	2586.1	2883.2	93.2	132.7	168.0	1617
Zinc	286.5	290.8	422.3	464.7	523.3	30.0	30.0	30.0	278.3

EQUATIONS TO CALCULATE STANDARDS

Analyte:	Surface Water Class A, B, C:	Surface Water Class D:
Ammonia	Standard depends on pH and temperature	Standard depends on pH and temperature.
Beryllium	11 ug/l if hardness is less than or equal to 75 ppm and 1100 ug/l if hardness is greater than 75 ppm.	No standard or formula given for this water class.
Cadmium	$\exp(0.7852[\ln(\text{ppm hardness})] - 3.490)$	$\exp(1.128[\ln(\text{ppm hardness})] - 3.820)$
Copper	$\exp(0.8545[\ln(\text{ppm hardness})] - 1.465)$	$\exp(0.9422[\ln(\text{ppm hardness})] - 1.464)$
Chromium	$\exp(0.819[\ln(\text{ppm hardness})] + 1.561)$	$\exp(0.819[\ln(\text{ppm hardness})] + 3.688)$
Lead	$\exp(1.266[\ln(\text{ppm hardness})] - 4.661)$	$\exp(1.266[\ln(\text{ppm hardness})] - 1.416)$
Nickel	$\exp(0.76[\ln(\text{ppm hardness})] + 1.06)$	$\exp(0.76[\ln(\text{ppm hardness})] + 4.02)$
Silver	0.1 (Applies to ionic silver)	$\exp(1.72[\ln(\text{ppm hardness})] - 6.52)$
Zinc	30 ug/l	$\exp(0.83[\ln(\text{ppm hardness})] + 1.95)$; aquatic standards apply to acid-soluble form.

The standards which appear in the top two tables were calculated from the formulas in the lower table. These formulas were compiled directly from Table 1, Water Quality Regulations for Surface Waters and Groundwaters, 6 NYCRR PARTS 700 - 705, Effective September 1, 1991. The standards for the analytes were calculated based on hardness of the sample collected at each location. Since hardness was not a Phase I parameter, it had to be calculated from the calcium and magnesium concentrations detected in each sample. The following formula was used:

$$\text{mg/l Ca} \times .0499 = \text{millieq/l Ca} + \text{mg/l Mg} \times .08220 = \text{millieq/l Mg/Total} \times 50 = \text{CaCO}_3$$

TABLE B-6 DETECTED COMPOUNDS CLARKSTOWN LANDFILL R1 - SEDIMENT SAMPLES

WESTON ID# Sample Date Case #	NYSDEC SEDIMENT CRITERIA (mg/kg)	SD1 07/25/90 3151	SD2 07/23/90 3109	SD2-02 04/18/91 WES031	SD3 07/25/90 3151
% Solids		83	82	54.4	15
Inorganics, Total: mg/kg					
Aluminum	Aq. Tox Human	mg/kg 7720	mg/kg 7750	mg/kg 8750	mg/kg 25500
Arsenic	-	1.3 BJ	1.7 J	2.2 B	4.47 UR
Barium	6#/33##	36.5 B	41.2 B	65.3 B	337
Beryllium	-	0.24 B	0.49 B	0.69 B	1.3 B
Cadmium	0.6#/9##	0.72 UJ	3.2 J	1.3 B	3.9 BJ
Calcium	-	18400	35900	4060	14900
Chromium	26#/110##	19.5 J	17.3 J	15.9	78.9 J
Cobalt	-	7.9 B	6.5 B	5.8 B	21.1 B
Copper	16#/110##	26.2	27.6	31.9	108
Iron	2%/4%##	15600	18500	14700	39700
Lead	31#/110##	29.0 J	69.9 J	85.5 J	162 J
Magnesium	-	10500 J	20800 J	2940	6670 J
Manganese	60#/1100#	267 J	308 J	168	288 J
Mercury	.15#/1.3#	0.14 U	0.15 U	0.10 B	0.79 U
Nickel	16#/50##	11.8	12.5	11.8 B	36.7 B
Potassium	-	683 BJ	802 BJ	519 B	1890 BJ
Selenium	-	0.41 UR	0.42 UR	0.81 U	3.2 BJ
Silver	1#/2.2##	1.7 U	1.7 B	0.77 UJ	9.1 U
Sodium	-	1190 BJ	1080 BJ	290 B	1590 BJ
Vanadium	-	61.5	33.0	30.9	107
Zinc	120#/270#	80.3 J	1730 J	201	457 J
Volatiles:	Acute/Chronic	ug/kg ug/goc	ug/kg ug/goc	ug/kg ug/goc	ug/kg ug/goc
Methylene Chloride	-	10 UB 0.42	12 UB 0.14	16 U 0.37	280 B 0.84
Acetone	-	39 J 1.63	93 UB 1.12	110 BU 2.53	230 UJ 0.69
1,1-Dichloroethene	-	6 U 0.25	4 J 0.05	16 U 0.37	31 U 0.09
1,1-Dichloroethane	-	6 U 0.25	6 U 0.07	16 U 0.37	31 U 0.09
Chloroform	-	6 U 0.25	6 U 0.07	16 U 0.37	31 U 0.08
2-Butanone	-	12 UJ 0.50	6 J 0.07	33	36 J 0.11
Benzene	-	6 U 0.25	5 J 0.06	16 U 0.37	31 U 0.09
Chlorobenzene	34.6/3.5	6 U 0.25	3 R 0.04	16 U 0.37	31 U 0.09

TABLE B-6 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SEDIMENT SAMPLES

WESTON ID#	NYSDEC	SD7	SD8	SD9	SD10
Sample Date	SEDIMENT CRITERIA	10/16/90	07/31/90	07/30/90	08/02/90
Case #	(mg/kg)	4342	3216	3203	3256
% Solids		16	18	15	74
Inorganics, Total: mg/kg	Aq. Tox	mg/kg	mg/kg	mg/kg	mg/kg
Aluminum	-	21000	58300	36600	4840
Arsenic	6#/33##	7.0 B	10.51 BJ	8.70 BJ	0.98 BJ
Barium	-	229	423	456	35.6 B
Beryllium	-	6.0	1.4 B	1.4	0.27 U
Cadmium	0.6#/9##	4.0 BJ	4.0 U	5.5	0.82 U
Calcium	-	9680 J	16300 J	12000 J	11600 J
Chromium	26#/110##	39.6 J	81.4 J	103 J	10.3 J
Cobalt	-	18.3 B	9.6 U	103	2.7 B
Copper	16#/110##	73.2	328	160	63.2
Iron	2%#/4%##	32300	43900 J	58200 J	9270 J
Lead	31#/110##	85.0	61.7 J	82.9	10.1 BJ
Magnesium	-	5440	6110 BJ	8490 J	2180 J
Manganese	60#/1100#	332	530 J	1140 J	264 J
Mercury	.15#/1.3#	1.0	0.69 U	0.96 U	0.16 U
Nickel	16#/50##	35.6 B	40.0 B	56.2	9.5 B
Potassium	-	3040 UB	2300 BJ	3440 J	554 BJ
Selenium	-	1.6 U	2.5 BJ	2.33 UJ	0.46 UR
Silver	1#/2.2##	8.1 UB	11.0 B	9.3 U	1.9 U
Sodium	-	1260 B	2390 BJ	1710 J	503 BJ
Vanadium	-	76.2	97.9	126	18.5
Zinc	120#/270#	543	352	692	41.0
Volatiles:	Acute/Chronic	ug/goc	ug/goc	ug/goc	ug/goc
Methylene Chloride	-	15 J	36 UB	33 UB	14 UB
Acetone	-	160 J	470 JB	410 JB	14 UJ
1,1-Dichloroethene	0.02	31 UJ	28 UJ	33 UJ	7 U
1,1-Dichloroethane	-	31 UJ	28 UJ	33 UJ	7 U
Chloroform	-	31 UJ	28 UJ	33 UJ	7 U
2-Butanone	-	38 J	56 UJ	97 J	14 UJ
Benzene	-	31 UJ	28 UJ	33 UJ	7 U
Chlorobenzene	34.6/3.5	31 UJ	28 UJ	33 UJ	7 U

TABLE B-6 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SEDIMENT SAMPLES

WESTON ID#	NYSDEC SEDIMENT CRITERIA (mg/kg)	SD4 07/23/90	SD4-02 04/18/94 WES031	SD5 07/31/90	SD6 07/23/90
Sample Date		3109	33.6	3216	3151
Case #		85		67	38
% Solids					
Inorganics, Total: mg/kg	Aq. Tox Human	mg/kg	mg/kg	mg/kg	mg/kg
Aluminum	-	8920	21100	13300	21100
Arsenic	6#/33##	2.1 J	4.3 B	1.60 BJ	12.1 J
Barium	-	44.4 B	198	135	202
Beryllium	-	0.23 B	1.3 B	0.30 B	0.53 B
Cadmium	0.6#/9##	0.70 UJ	3.2	0.90 U	2.6 J
Calcium	-	1450	7120	1950 J	5870
Chromium	26#/110##	13.1 J	28.7	22.0 J	39.7 J
Cobalt	-	6.0 B	15.8 B	7.2 B	21.7 B
Copper	16#/110##	11.6	92.4	12.4	180
Iron	2%/4%##	10500	37500	16100 J	31300
Lead	31#/110##	5.2 J	109 J	10.7 J	462 J
Magnesium	-	2270 J	7550	4010 J	4080 J
Manganese	60#/1100#	296 J	472	256 J	630 J
Mercury	.15#/1.3#	0.14 U	0.17 B	0.18 U	0.32 U
Nickel	16#/50##	11.6	26.7	17.2	27.5
Potassium	-	1060 BJ	1900 B	2110 J	1360 BJ
Selenium	-	0.40 UR	1.3 U	0.51 UR	0.90 UR
Silver	1#/2.2##	1.6 U	1.2 UJ	2.1 U	3.7 U
Sodium	-	246 BJ	799 B	350 BJ	720 BJ
Vanadium	-	23.8	72.1	30.2	64.0
Zinc	120#/270#	21.8 J	230	42.2	306 J
Volatiles:	Acute/Chronic	ug/goc	ug/goc	ug/goc	ug/goc
Methylene Chloride	-	12 UB	23 U	11 UB	16 UB
Acetone	-	21 UB	39 BU	76 JB	21 J
1,1-Dichloroethene	-	6 U	23 U	4 J	13 U
1,1-Dichloroethane	-	6 U	23 U	7 U	13 U
Chloroform	-	6 U	23 U	7 U	13 U
2-Butanone	-	12 U	23 U	15 U	26 UJ
Benzene	-	6 U	23 U	4 J	13 U
Chlorobenzene	34.6/3.5	6 U	23 U	4 J	13 U

TABLE B-6 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SEDIMENT SAMPLES

WESTON ID# Sample Date Case #	NYSDEC SEDIMENT CRITERIA (mg/kg)	SD13-02 04/19/94 WES031 36.6	SD14-02 04/19/94 WES031 80.4	SD15-02 04/19/94 WES031 34.3	SD16-02 04/18/94 WES031 27.0
% Solids	Aq. Tox Human				
Inorganics, Total: mg/kg					
Aluminum	-	24200	7640	13600	19900
Arsenic	6#/33##	4.0 B	1.6 B	4.1 B	8.7
Barium	-	172	36.0 B	188	315
Beryllium	-	1.4 B	0.55 B	0.99 B	1.6 B
Cadmium	0.6#/9##	3.7	1.3	4.9	7.9
Calcium	-	14800	1880	5930	8340
Chromium	26#/110##	37.0	9.1	24.3	36.5
Cobalt	-	13.0 B	6.1 B	9.6 B	14.3 B
Copper	16#/110##	88.1	26.0	95.2	125
Iron	2%/4%##	32400	17000	40200	49700
Lead	31#/110##	219 J	39.0 J	194 J	310 J
Magnesium	-	6540	3280	3500	5340
Manganese	60#/1100#	448	162	335	273
Mercury	.15#/1.3#	0.27	0.06 U	0.20 B	0.37
Nickel	16#/50##	30.9	12.5	18.1 B	35.6
Potassium	-	1870 B	794 B	986 B	2180 B
Selenium	-	1.2 U	0.55 U	1.3 U	1.6 UJ
Silver	1#/2.2##	1.1 UJ	0.52 UJ	1.2 UJ	1.6 UJ
Sodium	-	1220 B	249 B	553 B	730 B
Vanadium	-	68.9	27.1	49.2	74.7
Zinc	120#/270#	320	88.2	343	899
Volatiles:	Acute/Chronic	ug/Kg ug/goc	ug/Kg ug/goc	ug/Kg ug/goc	ug/Kg ug/goc
Methylene Chloride	-	22 U 0.41	12 U 1.85	43 JBU 0.43	35 U 0.16
Acetone	-	210 BU 3.92	23 BU 3.54	140 BU 1.39	64 BU 0.29
1,1-Dichloroethene	-	22 U 0.41	12 U 1.85	43 U 0.43	35 U 0.16
1,1-Dichloroethane	-	22 U 0.41	12 U 1.85	43 U 0.43	35 U 0.16
Chloroform	-	22 U 0.41	12 U 1.85	43 U 0.43	35 U 0.16
2-Butanone	-	57 1.06	12 U 1.85	43 U 0.43	35 JU 0.16
Benzene	-	22 U 0.41	12 U 1.85	43 U 0.43	35 U 0.16
Chlorobenzene	34.6/3.5	22 U 0.41	12 U 1.85	43 U 0.43	35 U 0.16

TABLE B-6 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SEDIMENT SAMPLES

WESTON ID# Sample Date Case #	NYSDEC SEDIMENT CRITERIA (mg/kg)	SD17-02 04/18/94 WES031 73.5	SD18-02 04/18/94 WES031 77.9	FBSD 08/01/90 3238 0
% Solids	Aq. Tox			ug/L
Inorganics, Total: mg/kg	Human			
Aluminum	-	10300	7220	31.0 U
Arsenic	6#/33##	2.1 B	2.9	3.4 UR
Barium	-	62.9	54.6	4.0 U
Beryllium	-	0.51 B	0.33 B	1.0 U
Cadmium	0.6#/9##	1.1 B	3.8	3.0 U
Calcium	-	4560	1380	173 B
Chromium	26#/110##	10.6	30.9	3.0 U
Cobalt	-	8.8 B	8.2 B	7.0 U
Copper	16#/110##	51.3	32.3	5.0 U
Iron	2%/4%##	14400	50000	7.0 BJ
Lead	31#/110##	34.7 J	52.5 J	1.7 UR
Magnesium	-	3870	1530	39.0 U
Manganese	60#/1100#	269	402	2.0 UJ
Mercury	.15#/1.3#	0.05 U	0.15	0.12 U
Nickel	16#/50##	15.1	29.3	8.0 U
Potassium	-	1090 B	507 B	443 U
Selenium	-	0.60 U	0.56 U	1.7 UR
Silver	1#/2.2##	0.57 UJ	2.2 BJ	7.0 U
Sodium	-	441 B	74.1 B	373 BJ
Vanadium	-	35.5	22.4	32.0 B
Zinc	120#/270#	42.2	89.2	10.0 B
Volatiles:	Acute/Chronic	ug/Kg	ug/Kg	ug/L
Methylene Chloride	-	13 U	2 J	5 U
Acetone	-	45 BU	84 B	10 UJ
1,1-Dichloroethene	-	13 U	13 U	5 U
1,1-Dichloroethane	-	13 U	13 U	5 U
Chloroform	-	13 U	13 U	5 U
2-Butanone	-	8 J	25	10 UJ
Benzene	-	13 U	13 U	5 U
Chlorobenzene	34.6/3.5	13 U	13 U	5 U

TABLE B-6 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SEDIMENT SAMPLES

WESTON ID# Sample Date Case # % Solids	NYSDEC SEDIMENT CRITERIA (ug/goc) Aq.Tox Human	SD1 07/25/90 3151 83	SD2 07/23/90 3109 82	SD2-02 04/18/91 WES031 54.4	SD3 07/25/90 3151 15
<u>Semi-volatiles:</u>	Acute/Chronic				
Naphthalene	-	370 U 15.42	380 U 4.58	640 U 14.71	2000 U 5.97
Acenaphthylene	-	370 U 15.42	380 U 4.58	640 U 14.71	2000 U 5.97
Acenaphthene	140(c)	370 U 15.42	380 U 4.58	100 J 2.30	2000 U 5.97
Dibenzofuran	-	370 U 15.42	380 U 4.58	640 U 14.71	2000 U 5.97
Fluorene	-	370 U 15.42	380 U 4.58	110 J 2.53	2000 U 5.97
Phenanthrene	120(c)	80 J 3.33	380 J 4.58	960 22.07	2000 U 5.97
Anthracene	-	80 J 3.33	380 U 4.58	200 J 4.60	2000 U 5.97
Di-n-Butylphthalate	-	130 J 5.42	77 J 0.93	640 U 14.71	500 J 1.49
Fluoranthene	1020(c)	780 32.50	700 8.43	1700 39.08	1700 J 5.07
Pyrene	-	760 31.67	650 7.83	1000 22.99	1700 J 5.07
Butylbenzylphthalate	-	370 U 15.42	240 J 2.89	640 U 14.71	2000 U 5.97
Benzo(a)anthracene	-	420 17.50	330 J 3.98	660 15.17	840 J 2.51
Chrysene	-	480 J 20.00	330 J 3.98	690 15.86	1000 J 2.99
bis(2-Ethylhexyl)phthalate	199.5(c)	370 U 15.42	320 J 3.86	1600 BU 36.78	880 J 2.63
Benzo(b)fluoranthene	-	320 J 13.33	290 J 3.49	850 19.54	850 J 2.54
Benzo(k)fluoranthene	-	360 J 15.00	240 J 2.89	320 J 7.36	2000 U 5.97
Benzo(a)pyrene	-	420 17.50	300 J 3.61	610 J 14.02	840 J 2.51
Indeno(1,2,3-cd)pyrene	-	220 J 9.17	210 J 2.53	250 J 5.75	2000 U 5.97
Dibenzo(a,h)anthracene	-	370 U 15.42	380 U 4.58	640 U 14.71	2000 U 5.97
Benzo(g,h,i)perylene	-	210 J 8.75	200 J 2.41	230 J 5.29	2000 U 5.97
Carbazole	-	NA NA	NA NA	120 J 2.76	NA NA
<u>Pesticides:</u>					
Heptachlor epoxide**	13.1/0.1	9.62 U 0.40	48.78 U 0.59	NA	52.74 U 0.16
4,4-DDT*	1100/1.0	19.23 U 0.80	97.56 U 1.18	NA	105.47 U 0.31
<u>Additional Parameters</u>					
TOC - Organic Matter (%)	-	2.4	8.3	4.35	33.5
TOC (mg/kg)	-	NA	NA	43500	NA
Total Solids (%)	-	NA	NA	51.9	NA
Hexavalent Chromium (mg/kg)	-	NA	NA	<1.9	NA

TABLE B-6 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SEDIMENT SAMPLES

WESTON ID# Sample Date Case # % Solids	NYSDEC SEDIMENT CRITERIA (ug/goc) Aq.Tox Human	SD4 07/23/90 3109 85	SD4-02 04/18/94 WES031 33.6	SD5 07/31/90 3216 67	SD6 07/23/90 3151 38
<u>Semi-volatiles:</u>	Acute/Chronic				
Naphthalene	-	360 U	980 U	470 U	820 U
Acenaphthylene	-	360 U	980 U	470 U	210 J
Acenaphthene	140(c)	360 U	980 U	470 U	820 U
Dibenzofuran	-	360 U	980 U	470 U	820 U
Fluorene	-	360 U	980 U	470 U	820 U
Phenanthrene	120(c)	360 U	980 U	470 U	300 J
Anthracene	-	360 U	980 U	470 U	300 J
Di-n-Butylphthalate	-	170 J	980 U	470 UB	820 U
Fluoranthene	1020(c)	360 U	980 U	140 J	3000
Pyrene	-	360 U	980 U	470 U	1800
Butylbenzylphthalate	-	360 U	980 U	470 U	820 U
Benzo(a)anthracene	-	360 UJ	980 U	470 U	1100
Chrysene	-	360 UJ	980 U	470 U	1400
bis(2-Ethylhexyl)phthalate	199.5(c)	360 U	1300 BU	470 U	820 U
Benzo(b)fluoranthene	-	360 U	980 U	470 U	1100
Benzo(k)fluoranthene	-	360 U	980 U	470 U	1100
Benzo(a)pyrene	-	360 U	980 U	470 U	1100
Indeno(1,2,3-cd)pyrene	-	360 UJ	980 U	470 U	570 J
Dibenzo(a,h)anthracene	-	360 U	980 U	470 U	820 U
Benzo(g,h,i)perylene	-	360 U	980 U	470 U	820 U
Carbazole	-	NA	980 U	NA	NA
<u>Pesticides:</u>					
Heptachlor epoxide**	13.1/0.1	47.06 U	2.9 J	11.94 U	21.16 U
4,4-DDT*	1100/1.0	94.12 U	9.7 UJ	23.88 U	60.85 J
<u>Additional Parameters</u>					
TOC - Organic Matter (%)	-	1.2	10	1.6	17.7
TOC (mg/kg)	-	NA	100000	NA	NA
Total Solids (%)	-	NA	33.9	NA	NA
Hexavalent Chromium (mg/kg)	-	NA	<2.9	NA	NA

TABLE B-6 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SEDIMENT SAMPLES

WESTON ID#	NYSED SEDIMENT CRITERIA (ug/goc)	SD17-02 04/18/94 WES031 73.5	SD18-02 04/18/94 WES031 77.9	FBSD 08/01/90 3238 0
Sample Date				
Case #				
% Solids				
<u>Semi-volatiles:</u>				
Naphthalene	-	450 U	430 U	10 U
Acenaphthylene	-	450 U	430 U	10 U
Acenaphthene	140(c)	450 U	430 U	10 U
Dibenzofuran	-	450 U	430 U	10 U
Fluorene	-	450 U	430 U	10 U
Phenanthrene	120(c)	450 U	430 U	10 U
Anthracene	-	450 U	430 U	10 U
Di-n-Butylphthalate	-	450 U	430 U	10 U
Fluoranthene	1020(c)	450 U	430 U	10 U
Pyrene	-	450 U	430 U	10 U
Butylbenzylphthalate	-	450 U	430 U	10 U
Benzo(a)anthracene	-	450 U	430 U	10 U
Chrysene	-	450 U	430 U	10 U
ble(2-Ethylhexyl)phthalate	199.5(c)	910 BU	660 BU	10 U
Benzo(b)fluoranthene	-	450 U	430 U	10 U
Benzo(k)fluoranthene	-	450 U	430 U	10 U
Benzo(a)pyrene	-	450 U	430 U	10 U
Indeno(1,2,3-cd)pyrene	-	450 U	430 U	10 U
Dibenzo(a,h)anthracene	-	450 U	430 U	10 U
Benzo(g,h,i)perylene	-	450 U	430 U	10 U
Carbazole	-	450 U	430 U	NA
<u>Pesticides:</u>				
Heptachlor epoxide**	13.1/0.1	2.3 U	NA	0.05 U
4,4-DDT*	1100/1.0	4.5 U	NA	0.10 U
<u>Additional Parameters</u>				
TOC - Organic Matter (%)	-	0.51	1.36	<1
TOC (mg/kg)	-	5050	13600	NA
Total Solids (%)	-	73.5	77.9	NA
Hexavalent Chromium (mg/kg)	-	<1.4	<1.3	NA

TABLE B-6 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SEDIMENT SAMPLES

WESTON ID# Sample Date Case # % Solids	NYSDEC SEDIMENT CRITERIA (ug/goc) Aq. Tox Human	SD7 10/16/90 4342 16	SD8 07/31/90 3216 18	SD9 07/30/90 3203 15	SD10 08/02/90 3256 74
<u>Semi-volatiles:</u>	Acute/Chronic				
Naphthalene	-	21000 UJ 63.06	1700 U 3.89	2100 U 5.60	420 U 51.22
Acenaphthylene	-	21000 UJ 63.06	1700 U 3.89	2100 U 5.60	420 U 51.22
Acenaphthene	140(c)	21000 UJ 63.06	1700 U 3.89	2100 U 5.60	420 U 51.22
Dibenzofuran	-	21000 UJ 63.06	1700 U 3.89	2100 U 5.60	420 U 51.22
Fluorene	-	21000 UJ 63.06	1700 U 3.89	2100 U 5.60	420 U 51.22
Phenanthrene	120(c)	21000 UJ 63.06	1700 U 3.89	2100 U 5.60	420 U 51.22
Anthracene	-	21000 UJ 63.06	1700 U 3.89	2100 U 5.60	420 U 51.22
Di-n-Butylphthalate	-	21000 UJ 63.06	1700 UB 3.89	450 J 1.20	420 U 51.22
Fluoranthene	1020(c)	21000 UJ 63.06	450 J 1.03	1200 J 3.20	130 J 15.85
Pyrene	-	21000 UJ 63.06	1700 U 3.89	2100 U 5.60	420 U 51.22
Butylbenzylphthalate	-	21000 UJ 63.06	1700 U 3.89	2100 U 5.60	420 U 51.22
Benzo(a)anthracene	-	21000 UJ 63.06	1700 U 3.89	2100 U 5.60	420 U 51.22
Chrysene	1.3	21000 UJ 63.06	1700 U 3.89	2100 U 5.60	420 U 51.22
bis(2-Ethylhexyl)phthalate	1.3	21000 UJ 63.06	1700 U 3.89	2100 U 5.60	420 U 51.22
Benzo(b)fluoranthene	1.3	21000 UJ 63.06	1700 U 3.89	2100 U 5.60	420 U 51.22
Benzo(k)fluoranthene	1.3	21000 UJ 63.06	1700 U 3.89	2100 U 5.60	420 U 51.22
Benzo(a)pyrene	1.3	21000 UJ 63.06	1700 U 3.89	2100 U 5.60	420 U 51.22
Indeno(1,2,3-cd)pyrene	1.3	21000 UJ 63.06	1700 U 3.89	2100 U 5.60	420 U 51.22
Dibenzo(a,h)anthracene	-	21000 UJ 63.06	1700 U 3.89	2100 U 5.60	420 U 51.22
Benzo(g,h,i)perylene	-	21000 UJ 63.06	1700 U 3.89	2100 U 5.60	420 U 51.22
Carbazole	-	NA	NA	NA	NA
<u>Pesticides:</u>					
Heptachlor epoxide**	13.1/0.1	50.00 U 0.15	44.44 U 0.10	54.83 U 0.15	10.81 U 1.32
4,4-DDT*	1100/1.0	100.00 U 0.30	88.89 U 0.20	109.66 U 0.29	21.62 U 2.64
<u>Additional Parameters</u>					
TOC - Organic Matter (%)	-	33.3	43.7	37.5	0.82
TOC (mg/kg)	-	NA	NA	NA	NA
Total Solids (%)	-	NA	NA	NA	NA
Hexavalent Chromium (mg/kg)	-	NA	NA	NA	NA

TABLE B-6 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SEDIMENT SAMPLES

WESTON ID# Sample Date Case #	NYSDEC SEDIMENT CRITERIA (ug/goc) Aq. Tox Human	SD11 08/01/90 3238 10	SD12 08/01/90 3238 68	SD12FD 08/01/90 3238 65	SD12-02 04/19/94 WES031 82.7
% Solids					
<u>Semi-volatiles:</u>	Acute/Chronic				
Naphthalene	-	3100 U	460 U	480 U	400 U
Acenaphthylene	-	3100 U	460 U	480 U	400 U
Acenaphthene	140(c)	3100 U	460 U	480 U	400 U
Dibenzofuran	-	3100 U	460 U	480 U	400 U
Fluorene	-	3100 U	460 U	160 J	400 U
Phenanthrene	120(c)	3100 U	460 U	1700 J	110 J
Anthracene	-	3100 U	460 U	480 J	400 U
Di-n-Butylphthalate	-	3100 U	170 UB	480 U	400 U
Fluoranthene	1020(c)	10000	98 J	3400	230 J
Pyrene	-	4900	460 U	2500	210 J
Butylbenzylphthalate	-	2300 J	460 U	390 J	400 U
Benzo(a)anthracene	-	4500	460 U	1400	100 J
Chrysene	-	4800	460 U	1400	150 J
bis(2-Ethylhexyl)phthalate	199.5(c)	23000	460 U	480 U	290 BUJ
Benzo(b)fluoranthene	-	5000	460 U	1200	140 J
Benzo(k)fluoranthene	-	3400	460 U	1100	110 J
Benzo(a)pyrene	-	3600	460 U	1400	140 J
Indeno(1,2,3-cd)pyrene	-	3100 U	460 U	820	80 J
Dibenzo(a,h)anthracene	-	3100 U	460 U	480 U	43 J
Benzo(g,h,i)perylene	-	3100 U	460 U	700	70 J
Carbazole	-	NA	NA	NA	400 U
<u>Pesticides:</u>					
Heptachlor epoxide**	13.1/0.1	80.00 U	11.76 U	12.31 U	NA
4,4-DDT*	1100/1.0	160.00 U	23.53 U	24.62 U	NA
<u>Additional Parameters</u>					
TOC - Organic Matter (%)	-	28.5	4.6	5.0	1.64
TOC (mg/kg)	-	NA	NA	NA	16400
Total Solids (%)	-	NA	NA	NA	82.7
Hexavalent Chromium (mg/kg)	-	NA	NA	NA	<1.2

TABLE B-6 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SEDIMENT SAMPLES

WESTON ID# Sample Date Case #	NYSDEC SEDIMENT CRITERIA (ug/goc)	SD13-02 04/19/94 WES031 36.6	SD14-02 04/19/94 WES031 80.4	SD15-02 04/19/94 WES031 34.3	SD16-02 04/18/94 WES031 27.0
% Solids	Aq. Tox Human				
<u>Semi-volatiles:</u>	Acute/Chronic				
Naphthalene	-	740 U	88 J	1400 U	1400 U
Acenaphthylene	-	740 U	90 J	1400 U	1400 U
Acenaphthene	140(c)	740 U	69 J	1400 U	1400 U
Dibenzofuran	-	740 U	110 J	1400 U	1400 U
Fluorene	-	97 J	370 J	1400 U	1400 U
Phenanthrene	120(c)	720 J	2300	1400 U	1400 U
Anthracene	-	180 J	490	1400 U	1400 U
Di-n-Butylphthalate	-	740 U	420 U	1400 U	1400 U
Fluoranthene	1020(c)	1600	3000	1000 J	1400 U
Pyrene	-	1100	2000	730 J	280 J
Butylbenzylphthalate	-	740 U	420 U	1400 U	230 J
Benzo(a)anthracene	-	660 J	950	400 J	1400 U
Chrysene	-	680 J	930	520 J	1400 U
bis(2-Ethylhexyl)phthalate	199.5(c)	900 BU	550 BU	5000 BU	2300 BU
Benzo(b)fluoranthene	-	410 J	740	410 J	1400 U
Benzo(k)fluoranthene	-	730 J	770	510 J	1400 U
Benzo(a)pyrene	-	680 J	930	470 J	1400 U
Indeno(1,2,3-cd)pyrene	-	340 J	370 J	240 J	1400 U
Dibenzo(a,h)anthracene	-	96 J	110 J	1400 U	1400 U
Benzo(g,h,i)perylene	-	360 J	360 J	240 J	1400 U
Carbazole	-	740 U	700	1400 U	1400 U
<u>Pesticides:</u>					
Heptachlor epoxide**	13.1/0.1	NA	NA	NA	NA
4,4-DDT*	1100/1.0	NA	NA	NA	NA
<u>Additional Parameters</u>					
TOC - Organic Matter (%)	-	5.36	0.65	10.1	22
TOC (mg/kg)	-	53600	6450	101000	220000
Total Solids (%)	-	45.3	80.4	23.0	24.1
Hexavalent Chromium (mg/kg)	-	<2.2	<1.2	<4.3	<4.1

NOTES

CLARKSTOWN LANDFILL RI

Detected Compounds: Phase I and II Sediment Samples

NA - Not Analyzed

Organic Data Reporting and Validation Qualifiers:

U - Compound not detected at the instrument detection limit given.

J - Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1-1 response is assumed or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the specified detection limit but greater than zero. It is also used to qualify data obtained when analytical protocol deviates slightly from criteria set forth by the 1989 (Phase I) and 1991 (Phase II) New York State Analytical Services Protocol (ASP).

B - Reported result is qualified estimated because of a possible blank interference. Sample concentration is sufficient to treat as a detect (e.g., greater than 5x the blank concentration).

Inorganic Data Reporting and Validation Qualifiers:

U - Compound not detected at the instrument detection limit given.

B - Reported value is less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL).

J - Indicates an estimated value. Data are qualified estimated because analytical protocol deviate slightly from 1989 (Phase I) and 1991 (Phase II) ASP criteria.

R - Rejected during data validation.

Notes Pertaining to Regulatory Information:

- (1) - Technical Guidance for Screening Contaminated Sediment, 22 November 1993, used as Guidance by the Bureau of Environmental Protection, Division of Fish and Wildlife, and Division of Marine Resources, New York State Department of Environmental Conservation.

Inorganics:

- The lowest of the "Lowest Effect Level", the concentration which will impair sediment use by some benthic organisms but that can be tolerated by the majority (Persaud, 1992), or the "Effect Range-Low" (Long and Morgan, 1990).

- The lowest of the "Severe Effect Level", the concentration which will significantly impair use of sediment by some benthic organisms (Persaud, 1992), or the "Effect Range-Moderate" (Long and Morgan, 1990).

Organics:

(c) - Chronic Toxicity to Benthic Aquatic Life.

* - Wildlife bioaccumulation criteria = 1.0 ug/gOC

** - Wildlife bioaccumulation criteria = 0.03 ug/gOC

TABLE B-7 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SURFICIAL SOIL

WESTON ID# Sample Date Case # % Solids	NYSDEC(2) Soil Cleanup Guidance	NYSDEC(1) Draft Cleanup Policy and Guidelines October 1991	SL-1 10/15/90 4322 74	SL-2 10/15/90 4322 81	SL-3 10/15/90 4322 85
<u>Inorganics, Total: mg/kg</u>					
Aluminum	33,000	-	15100 J	13700 J	8090 J
Antimony	-	30	19.1 J	7.0 BJ	6.5 BJ
Arsenic	3-12	80	3.2	2.3 B	1.7 B
Barium	15-600	4000	77.4	78.3	53.7
Beryllium	0-1.75	0.16	3.6	3.2	2.9
Cadmium	0.1-1	80	0.68 BJ	0.73 BJ	0.90 BJ
Calcium	130-35,000	-	1490 J	3550 J	4570 J
Chromium	1.5-40	-	21.6 J	17.3 J	14.6 J
Cobalt	2.5-60	-	10 B	7.8 B	6.0 B
Copper	1-50	-	23.8	11.6	13.4
Iron	2,000-550,000	-	16900 J	14400 J	12100 J
Lead	4-61	250	54.2 J	20.76 J	12.4 J
Magnesium	100-5,000	-	2820	2890	2330
Manganese	50-5,000	20000	484 J	567 J	300 J
Mercury	0.001-0.2	20	0.5	0.17	0.22
Nickel	0.5-25	2000	18.3	16.3	56.2
Sodium	6,000-8,000	-	273 B	270 B	249 B
Vanadium	1-300	600	36.7	25.8	24.6
Zinc	9-50	20000	78.4 J	65.0 J	43.9 J
<u>Volatiles: ug/kg</u>					
Methylene Chloride	100	93000	13	32 J	11 J
Acetone	110	6000000	12 J	123 J	91 J
2-Butanone	-	-	14 UJ	5.7 J	12 J
Toluene	1500	20000000	1.6 J	6.1 UJ	6 UJ
<u>Semi-volatiles: ug/kg</u>					
Phenanthrene	220,000	-	220 J	400 U	390 U
Di-n-Butylphthalate	8,100	8000000	150 J	130 J	230 J
Fluoranthene	1,900,000	3000000	400 J	400 U	96 J
Pyrene	665,000	2000000	310 J	400 U	390 U
Benzo(a)pyrene	11,000	61	160 J	400 U	390 U
<u>Pesticides: ug/kg</u>					
4,4-DDT	2,500	2100	22 UJ	19.66 UJ	20.07 J

NOTES

CLARKSTOWN LANDFILL RI

Detected Compounds: Phase I Surface Soil

Organic Data Reporting and Validation Qualifiers:

- U - Compound not detected at the instrument detection limit given.
- J - Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1-1 response is assumed or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the specified detection limit but greater than zero. It is also used to qualify data obtained when analytical protocol deviates slightly from criteria set forth by the 1989 New York State Analytical Services Protocol (1989 ASP).

Inorganic Data Reporting and Validation Qualifiers:

- U - Compound not detected at the instrument detection limit given.
- B - Reported value is less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL).
- J - Indicates an estimated value. Data are qualified estimated because analytical protocol deviate slightly from 1989 ASP criteria.

Notes Pertaining to Regulatory Information:

- (1) - NYSDEC Draft Cleanup Policy and Guidelines, Vol. II, October 1991, Subappendix 1A of Appendix C (HEAST Tables); current through April 1991.
- (2) - NYSDEC Division of Technical and Administrative Guidelines Memorandum (TAGM) HWR-92-4046: Determination of Soil Cleanup Objectives and cleanup levels; November 16, 1992. Inorganics values are range of eastern USA background concentrations; organics values are soil cleanup objectives to protect groundwater quality.

TABLE B-8 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SUBSURFACE SOIL SAMPLES

WESTON ID#	NYSDEC (1)	SB-1	SB-2	SB-3	SB-4	SB-5	SB-5D	SB-6	SB-7	SB-8	Field Blank
Sample Date	Soil Cleanup	10/30/90	11/05/90	11/12/90	11/12/90	12/17/90	12/17/90	01/03/91	01/24/91	02/07/91	02/07/91
Case #	Guidance	4533	4637	4734	4734	5278	5279	0054	0387	0585	0585
Sample Location		RFW-7D	RFW-6S	RFW-12	RFW-8D	RFW-3D	RFW-3D	RFW-4D	RFW-14	RFW-15	
Sample Depth (ft)		24.5-26.5	24-26	12-14	32-34	14-16	14-16	15-19	89-92	114-116	
Soil Type		peat	organic silt	peat	organic silt	peat	peat	peat	organic silt	organic silt	
% Solids		24	72	24	44	29	43	29	39	36	
Inorganics, Total: mg/kg											(ug/L)
Aluminum	33,000	6540	10200 J	11400 J	6700 J	10300	10500	12500	7210	9390	132.0 BJ
Antimony	-	20.1 UJ	16.8 R	21.2 J	15.9 J	18.3 BJ	14.3 BJ	16.5 UJ	12.6 UJ	15.6 BJ	26.0 UJ
Arsenic	3-12	3.77 B	2.29	3.39 B	1.28 B	4.6 BJ	9.18 J	3.7 B	2.8 B	2.38 B	2.40 U
Barium	15-600	184 R	82.9	221	179	154	134	235	204	247	36.0 U
Beryllium	0-1.75	3.9 R	4.7	2.9 B	2.7	4.8	5.3	1.9 BJ	1.9 BJ	2.0 BJ	1.0 UJ
Cadmium	0.1-1	4.6 J	1.2 J	1.5 U	0.81 U	1.4 U	0.82 UB	1.3 U	1.5 B	1.6 BJ	2.0 U
Calcium	130-35,000	5000	2660	10700 J	4550 J	5260	3940	5940	6430	7370	316 B
Chromium	1.5-40	21.6	21.8	56.7 J	15.4 J	24.6	24.5	27.2	20.3	26.1 J	3.0 U
Cobalt	2.5-60	6.9 U	11.9	6.5 U	6.9 B	14.3	14.3 B	12.6 B	13.5 BJ	16.2 BJ	9.0 U
Copper	1-50	33.2 R	16.6	23.6 J	6.9 BJ	35.5 U	32.6 U	29.1 J	27.1 J	29.5 J	6.0 U
Iron	2,000-550,000	11700 R	14500 J	9220 J	8480 J	14100 J	17700 J	12500 J	11500	12400	231.0
Lead	4-61	4.54	5.48	4.58	4.48	8.6 J	5.79 J	6.4	4.23 J	10.03	2.00 U
Magnesium	100-5,000	1780 B	4390	3130 B	2030	2710 B	3100	3290	2510	3360	354.0 U
Manganese	50-5,000	200	157 J	144 J	222 J	125	117	122	228 J	235 J	8.0 BJ
Mercury	0.001-0.2	0.99	0.10 U	0.29 U	0.22 U	0.05 U	0.14 U	0.2 U	0.15 U	0.17 U	0.12 U
Nickel	0.5-25	10.0 UB	22.6	17.0 B	10.1 B	24.6 B	24.5	17.7 B	16.8 B	16.7 B	7.0 UJ
Potassium	8,500-43,000	1010 BR	1690 R	2610 B	1800 B	1460 UB	1600 UB	1890 BJ	1060 BJ	375 UJ	4610 BJ
Selenium	0.1-3.9	2.14 BJ	0.32 U	7.28 J	1.08 BJ	3.23 J	2.03 J	3.3	2.8 J	1.67 B	1.60 U
Silver	-	4.5 UR	1.4 U	4.4 UJ	2.4 UJ	4.0 U	2.9 UB	15.8 J	7.7 J	2.9 U	6.0 BJ
Sodium	6,000-8,000	307 BR	275 BJ	630 BJ	364 BJ	339 B	173 B	217 B	157 UB	169 B	489 B
Vanadium	1-300	53.2 R	25.6 R	44.1	17.6 B	36.2	31.3	55.7	42.1	39.2	18.0 BJ
Zinc	9-50	47.1	63.7 R	50.7	35.6	77.2 J	53.4 J	77.2 J	46.4	65.2 J	4.0 UJ

TABLE B-8 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - SUBSURFACE SOIL SAMPLES

WESTON ID#	NYSDEC (1)	SB-1	SB-2	SB-3	SB-4	SB-5	SB-5D	SB-6	SB-7	SB-8	Field Blank
Sample Date	Soil Cleanup	10/30/80	11/05/90	11/12/90	11/12/90	12/17/90	12/17/90	01/03/91	01/24/91	02/07/91	02/07/91
Case #	Guidance	4533	4637	4734	4734	5279	5279	0054	0387	0585	0585
Sample Location		RFW-7D	RFW-6S	RFW-12	RFW-8D	RFW-3D	RFW-3D	RFW-4D	RFW-14	RFW-15	
Sample Depth (ft)		24.5-26.5	24-26	12-14	32-34	14-16	14-16	15-19	89-92	114-116	
Soil Type		peat	organic silt	peat	organic silt	peat	peat	peat	organic silt	organic silt	
% Solids		24	72	24	44	29	43	29	39	36	
Volatiles: ug/kg											(ug/L)
Methylene Chloride	100	550 BJ	7 U	21 U	11 U	108 UB	72 UB	25 J	8 J	19 J	5 U
Acetone	110	1900 EJB	42 U	570 BJ	300 BJ	980 JBD	490 JBD	260 J	1000 EJB	420 J	10 U
Carbon Disulfide	2,700	21 UJ	7 U	21 UJ	11 UJ	1000 DJ	960 DJ	17 UJ	16 J	14 UJ	5 U
Chloroform	300	21 UJ	7 UJ	21 UJ	11 UJ	43 UJ	150 DJ	10 J	13 UB	14 UJ	5
2-Butanone	-	230 BJ	14 U	42 UJ	80 BJ	64 DJ	69 DJ	34 UJ	260 BJ	130 J	10 U
Toluene	1,500	21 UJ	7 U	21 UJ	11 UJ	43 UJ	29 UJ	10 UJB	9 J	18 J	5 U
Styrene	-	21 UJ	7 U	21 UJ	11 UJ	43 UJ	29 UJ	17 UJ	7 J	14 UJ	5 U
Xylene (total)	1,200	21 UJ	0.1 J	21 UJ	11 UJ	43 UJ	29 UJ	17 UJ	13 UJ	14 UJ	5 U
Semi-volatiles: ug/kg											
Benzole acid	2,700	6700 UJ	2200 UJ	2800 J	940 J	5500 U	3700 U	5500 U	870 J	4400 U	50 U
Naphthalene	13,000	1400 UJ	460 UJ	1400 U	750 U	1100 U	770 U	1100 U	850 U	240 J	10 U
Diethylphthalate	7,100	1400 UJ	460 UJ	1400 U	750 U	1100 U	770 U	470 J	850 U	920 U	10 U
Pesticides: ug/kg											
Endosulfan t	900	33 U	11 U	33 U	18 U	28	19	11 U	21 U	22 U	0.05 U
Methoxychlor	900,000	330 U	120 J	330 U	180 U	280 U	190 U	110 U	210 U	220 U	0.50 U

NOTES

CLARKSTOWN LANDFILL RI

Detected Compounds: Phase I Subsurface Soil

Organic Data Reporting and Validation Qualifiers:

- U - Compound not detected at the instrument detection limit given.
- J - Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1-1 response is assumed or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the specified detection limit but greater than zero. It is also used to qualify data obtained when analytical protocol deviates slightly from criteria set forth by the 1989 New York State Analytical Services Protocol (1989 ASP).
- B - This flag is used when the compound is found in the associated blank as well as in the sample. It indicates possible/probable blank contamination and, although data are considered usable, the user is warned to take appropriate action regarding qualification.
- BJ - This flag is used when the compound is found in the associated blank as well as in the sample, at a sufficient concentration to rule out blank contamination (e.g., sample concentration is greater than 5x the blank level, or 10x the blank level for common laboratory contaminants). The J qualifier indicates that the reported concentration is estimated.
- EJB - This flag identifies compounds which exceed the instrument calibration range, in addition to being present in the blank (as in BJ, above). The J qualifier indicates that the reported concentration is estimated.

Inorganic Data Reporting and Validation Qualifiers:

- U - Compound not detected at the instrument detection limit given.
- B - Reported value is less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL).
- J - Indicates an estimated value. Data are qualified estimated because analytical protocol deviate slightly from 1989 ASP criteria.

Notes Pertaining to Regulatory Information:

- (1) - NYSDEC Division of Technical and Administrative Guidance Memorandum (TAGM) HWR-92-4046; Determination of Soil Cleanup Objectives and Cleanup Levels, November 16, 1992.

Inorganics values are range of Eastern USA background concentrations; organics values are soil cleanup objectives to protect groundwater quality.

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well # Sample Date Case #	NYSDEC(1) Groundwater Quality Stds & Guid. Value(*)	Origin of Standard	GW1D-01 04/15/91 1800	GW1D-02 12/27/93 WES027	GW1S-01 04/15/91 1800	GW1S-02 12/27/93 WES027	GW2-01 04/15/91 1800	GW2-01-FD 04/15/91 1800
<u>Inorganics, Total: ug/l</u>								
Aluminum	-	-	325	86.6 B	1320	3890	189 UB	205 U
Antimony	3*	TOGS 1.1.1	1010 J	7.9 U	26.0 UJ	7.9 U	26.0 UJ	26.0 UJ
Arsenic	25	-	3.0 UB	3.4 BJ	2.0 UB	1.5 BJ	2.0 UB	2.0 UB
Barium	1000	-	282	310	226	338	203	210
Beryllium	3*	TOGS 1.1.1	1.0 U	0.50 B	1.0 U	0.50 B	1.0 U	1.0 U
Cadmium	10	-	2.0 BJ	1.3 U	2.0 U	1.3 U	2.0 U	2.0 U
Calcium	-	-	37500	42700	52800	67000	31000	33300
Chromium	50	MCL	24.0 U	23.2	72.0 J	48.8	27.0 J	39.0 J
Cobalt	-	-	9.0 BJ	3.2 U	9.0 BJ	3.2 U	9.0 U	9.0 BJ
Copper	200	Part 170	6.0 UJ	7.9 B	16.0 BJ	28.4	6.0 UJ	6.0 UJ
Iron	300	-	408	199	2690	5800	466	554
Lead	25	-	3.9	9.3	4.0	4.6	2.5 B	2.6 B
Magnesium	35000*	TOGS 1.1.1	3810 B	4800 B	6740	8930	4730 B	5060
Manganese	300	-	18.0	1.9 B	166	282	44.0	46.0
Mercury	2	-	0.17 U	0.10 B	0.17 U	0.10 U	0.17 U	0.17 U
Nickel	-	-	7.0 U	14.2 B	41.0	29.6 B	13.0 B	18.0 B
Potassium	-	-	763 U	1870 B	2220 UB	2040 B	1840 UB	2120 UB
Selenium	10	MCL	3.0 BJ	2.2 UJ	2.6 BJ	2.2 UJ	2.0 BJ	2.0 UJ
Silver	50	-	6.0 UR	2.1 U	9.0 R	2.1 U	9.0 R	9.0 R
Sodium	20000	Part 170	5280	6500	8300	9710	5040	5400
Thallium	4*	TOGS 1.1.1	4.7 U	1.2 U	4.7 U	1.2 U	4.7 U	4.7 U
Vanadium	-	-	16.0 U	2.0 U	16.0 U	8.3 B	16.0 U	16.0 UB
Zinc	300	Part 170	42.0 J	31.8	64.0 J	38.0	18.0 BJ	19.0 BJ
Cyanide	100	Part 170	20.0 U	10.0 U	20.0 U	10.0 U	20.0 U	20.0 U

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well # Sample Date Case #	NYSDEC(1) Groundwater Quality Stds & Guid. Vals(*)	Origin of Standard	GW2-02 12/27/93 WES027	GW3D-01 04/16/91 1820	GW3D-02 12/28/93 WES027	GW3S-01 04/16/91 1820	GW3S-02 12/28/93 WES027	GW4D-01 04/16/91 1820
Inorganics, Total: ug/l								
Aluminum	-	-	232	949	215	1080	2190	916
Antimony	3*	TOGS 1.1.1	7.9 U	26.0 UJ	7.9 U	26.0 UJ	7.9 U	26.0 UJ
Arsenic	25	-	1.5 UJ	1.0 UB	1.5 UJ	3.0 UB	3.2 BJ	1.0 UB
Barium	1000	-	262	129 B	112 B	411	483	328
Beryllium	3*	TOGS 1.1.1	0.50 U	1.0 U	0.50 U	1.0 U	0.50 B	1.0 U
Cadmium	10	-	1.3 U	2.0 U	1.3 U	2.0 U	1.3 U	2.0 U
Calcium	-	-	41700	24600	24600	41100	51100	54400
Chromium	50	MCL	15.4	49.0 J	30.2	23.0 U	94.2	51.0 J
Cobalt	-	-	3.2 U	12.0 BJ	3.2 U	9.0 BJ	3.2 U	9.0 U
Copper	200	Part 170	4.7 B	10.0 UB	5.4 B	7.0 UB	6.5 B	6.0 UB
Iron	300	-	409	1660	497	1230	3150	1490
Lead	25	-	2.0 B	2.2 B	2.0 B	1.8 BJ	2.3 B	1.4 B
Magnesium	35000*	TOGS 1.1.1	6410	3450 B	3250 B	5510	7120	6980
Manganese	300	-	13.6 B	121	14.9 B	63.0	63.6	67.0
Mercury	2	-	0.10 U	0.75	0.10 U	0.70	0.10 U	0.58
Nickel	-	-	12.5 B	28.0 BJ	27.4 B	7.0 BJ	166	22.0 BJ
Potassium	-	-	959 B	2460 UB	731 B	2780 UB	1810 B	1430 UB
Selenium	10	MCL	2.2 UJ	2.0 UJ	2.2 UJ	2.0 UJ	2.2 UJ	2.2 BJ
Silver	50	-	2.1 U	11.0 R	2.1 U	15.0 R	2.1 U	16.0 R
Sodium	20000	Part 170	6050	4630 B	4710 B	7840	10400	12600
Thallium	4*	TOGS 1.1.1	1.2 U	5.0 UJ	1.2 U	5.0 U	1.2 U	5.0 U
Vanadium	-	-	2.0 U	16.0 U	2.0 U	21.0 UB	5.1 B	24.0 UB
Zinc	300	Part 170	10.0 B	19.0 BJ	16.4 B	17.0 BJ	16.0 B	27.0 J
Cyanide	100	Part 170	10.0 U	20.0 U	10.0 U	20.0 U	10.0 U	20.0 U

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well # Sample Date Case #	NYSDEC(1) Groundwater Quality Stds & Guid. Value(s)	Origin of Standard	GW4D-02 12/28/93 WES027	GW4S-01 04/16/91 1820	GW4S-02 12/29/93 WES027	GW5D-01 04/16/91 1820	GW5D-02 03/23/94 WES029	GW5S-01 04/16/91 1820
Inorganics, Total: ug/l								
Aluminum	-	-	509	4640	731	3360	13700	1480
Antimony	3*	TOGS 1.1.1	7.9 U	26.0 UJ	7.9 U	26.0 UJ	7.9 U	26.0 UJ
Arsenic	25	-	1.5 U	3.0 UB	7.6 B	5.0 UB	7.7 B	8.0 B
Barium	1000	-	353	311	180 B	118 B	212	125 B
Beryllium	3*	TOGS 1.1.1	0.50 U	1.0 B	0.50 B	1.0 B	1.6 B	1.0 U
Cadmium	10	-	1.3 U	2.0 U	1.3 U	2.0 U	1.3 U	2.0 U
Calcium	-	-	59500	46200	32800	40600	52300	37300
Chromium	50	MCL	45.4	26.0 U	13.2	63.0 J	156	37.0 U
Cobalt	-	-	3.2 U	15.0 BJ	3.2 U	12.0 BJ	7.1 B	10.0 BJ
Copper	200	Part 170	4.0 B	12.0 UB	4.9 B	96.0 J	95.6	6.0 UJ
Iron	300	-	1070	9250	1940	5340	16900	1840
Lead	25	-	2.2 B	2.4 B	2.4 B	18.3	15.7 J	3.6
Magnesium	35000*	TOGS 1.1.1	7470	8440	4790 B	4370 B	12400	1860 B
Manganese	300	-	52.5	556	135	235	364	87.0
Mercury	2	-	0.10 U	0.81	0.10 U	0.75	0.10 U	0.81
Nickel	-	-	96.0	16.0 BJ	13.1 B	32.0 BJ	85.4	28.0 BJ
Potassium	-	-	1260 B	4160 UB	2050 B	4790 UB	5250	5700 U
Selenium	10	MCL	2.2 UJ	2.0 UJ	2.2 UJ	2.0 UJ	2.2 UJ	2.0 UJ
Silver	50	-	2.1 U	15.0 R	2.1 U	14.0 R	2.1 U	14.0 R
Sodium	20000	Part 170	12300	21900	15700	7850	8650	7400
Thallium	4*	TOGS 1.1.1	1.2 U	5.0 U	1.2 U	5.0 UJ	1.4 U	5.0 U
Vanadium	-	-	2.0 U	32.0 UB	9.2 B	29.0 UB	25.9 B	32.0 UB
Zinc	300	Part 170	19.7 B	79.0 J	27.7	49.0 J	92.5	32.0 J
Cyanide	100	Part 170	10.0 U	20.0 J	10.0 U	20.0 U	10.0 U	20.0 U

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well # Sample Date Case #	NYSDEC(1) Groundwater Quality Stds & Guid. Vals(*)	Origin of Standard	GW5S-02 12/28/93 WES027	GW6D-01 04/22/91 1892	GW6D-02 12/29/93 WES027	GW6S-01 04/23/91 1911	GW6S-02 12/29/93 WES027	GW7D-01 04/22/91 1892
Inorganics, Total: ug/l								
Aluminum	-	-	504	1270	2200	19100	5700	590
Antimony	3*	TOGS 1.1.1	7.9 U	33.0 U	7.9 U	33.0 U	7.9 U	33.0 U
Arsenic	25	-	5.6 BJ	2.0 B	1.5 U	10.2	6.4 B	2.6 B
Barium	1000	-	156 B	185 B	328	405	160 B	227
Beryllium	3*	TOGS 1.1.1	0.50 B	1.0 U	0.50 B	4.0 B	0.50 B	1.0 U
Cadmium	10	-	1.3 U	2.0 B	1.3 U	6.0	1.3 U	2.0 B
Calcium	-	-	36600	44900	29800	53400	39500	35700
Chromium	50	MCL	14.2	19.0 J	10.5	52.0	13.3	11.0 J
Cobalt	-	-	3.2 U	10.0 U	3.2 U	21.0 B	3.2 U	10.0 U
Copper	200	Part 170	10.3 B	8.0 B	5.4 B	50.0	12.0 B	6.0 B
Iron	300	-	600	1150	2980	36700	8570	580
Lead	25	-	2.9 B	2.1 BJ	3.2	35.6 J	6.0	1.0 UJ
Magnesium	35000*	TOGS 1.1.1	2280 B	3510 B	10100	13000	4480 B	8280
Manganese	300	-	16.2	37.0	77.7	819	156	45.0
Mercury	2	-	0.10 U	1.0	0.10 U	0.98	0.10 U	1.1
Nickel	-	-	15.5 B	8.0 UJ	8.3 B	47.0 J	14.2 B	8.0 UJ
Potassium	-	-	2270 B	2760 B	2440 B	12200	5750	3990 B
Selenium	10	MCL	2.2 UJ	2.0 UJ	2.2 UJ	2.0 UJ	2.2 UJ	2.0 UJ
Silver	50	-	2.1 U	8.0 UR	2.1 U	8.0 UR	2.1 U	8.0 UR
Sodium	20000	Part 170	5580	11900 J	7810	22000 J	9780	12000 J
Thallium	4*	TOGS 1.1.1	1.2 U	5.0 U	1.2 U	5.0 U	1.2 U	5.0 U
Vanadium	-	-	3.1 B	6.0 UJ	4.7 B	55.0 J	19.3 B	6.0 UJ
Zinc	300	Part 170	20.8	8.0 B	15.6 B	104	81.0	4.0 B
Cyanide	100	Part 170	10.0 U	20.0 U	10.0 U	20.0 U	NA	20.0 U

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well # Sample Date Case #	NYSDEC(1) Groundwater Quality Stds & Guid. Vals(*)	Origin of Standard	GW7D-02 12/29/93 WES027	GW7S-01 04/22/91 1892	GW7S-02 12/29/93 WES027	GW8D-01 04/23/91 1911	GW8D-02 12/22/93 WES026	GW8S-01 04/22/91 1892
<u>Inorganics, Total: ug/l</u>								
Aluminum	-	-	327	47800	49100	232 U	612	4680
Antimony	3*	TOGS 1.1.1	7.9 U	70.0	8.8 B	33.0 U	7.9 U	33.0 U
Arsenic	25	-	1.5 J	8.3 B	19.6	1.5 B	2.4 B	3.7 B
Barium	1000	-	105 B	807	449	228	208 J	1630
Beryllium	3*	TOGS 1.1.1	0.50 U	17.0	3.2 B	1.0 U	0.50 U	3.0 B
Cadmium	10	-	1.3 U	8.0	2.2 B	3.0 B	1.3 U	5.0
Calcium	-	-	9950	107000	113000	106000	117000	123000
Chromium	50	MCL	12.3	102	105	30.0 U	160	36.0
Cobalt	-	-	3.2 U	32.0 B	31.2 B	10.0 U	3.2 U	11.0 B
Copper	200	Part 170	7.5 B	96.0	63.1	8.0 UB	8.4 B	22.0 B
Iron	300	-	415	68300	68500	587	1930	33200
Lead	25	-	2.0 BJ	34.4 J	19.1	20.5 J	3.5	12.6 J
Magnesium	35000*	TOGS 1.1.1	4450 B	34300	30200	23800	34200	21300
Manganese	300	-	15.4	1860	1730	55.0	190	3040
Mercury	2	-	0.10 U	1.1	0.10 U	0.92	0.10 U	0.92
Nickel	-	-	8.2 B	85.0 J	88.8	19.0 BJ	83.6	20.0 BJ
Potassium	-	-	22000	23300	25400	6400	6450	1860 B
Selenium	10	MCL	2.2 UJ	2.0 UJ	11.0 UJ	5.7 J	1.8 UJ	2.0 UJ
Silver	50	-	2.1 U	9.0 R	10.5 U	8.0 UJ	2.1 U	8.0 UR
Sodium	20000	Part 170	21200	18700 J	25500	34300 J	52900	17100 J
Thallium	4*	TOGS 1.1.1	1.2 U	5.0 U	1.2 U	5.0 U	1.2 U	5.0 U
Vanadium	-	-	2.0 U	111 J	115	21.0 BJ	2.0 U	28.0 BJ
Zinc	300	Part 170	23.0	174	183	8.0 UB	61.3	87.0
Cyanide	100	Part 170	10.0 U	20.0 U	10.0 U	20.0 U	10.0 U	20.0 U

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well # Sample Date Case #	NYSDEC(1) Groundwater Quality Stds & Guid. Value(*)	Origin of Standard	GW8S-02 12/22/93 WES026	GW9D-01 04/23/91 1911	GW9D-02 12/22/93 WES026	GW9S-01 04/23/91 1911	GW9S-02 12/22/93 WES026
<u>Inorganics, Total: ug/l</u>							
Aluminum	-	-	304	2600	1280	2090	1060
Antimony	3*	TOGS 1.1.1	7.9 U	33.0 U	7.9 U	55.0 B	8.8 B
Arsenic	25	-	1.5 U	1.5 B	1.5 U	9.2 B	3.3 B
Barium	1000	-	3700 J	522	466	496	432
Beryllium	3*	TOGS 1.1.1	0.50 U	1.0 B	0.50 U	6.0	0.50 U
Cadmium	10	-	4.3 B	3.0 B	1.5 B	8.0	2.0 B
Calcium	-	-	133000	151000	133000	372000 *	266000
Chromium	50	MCL	16.8	22.0 U	41.4	37.0	9.3 B
Cobalt	-	-	5.2 B	10.0 U	3.9 B	31.0 B	4.4 B
Copper	200	Part 170	8.6 B	14.0 UB	5.8 B	66.0	20.9 B
Iron	300	-	111000	3380	2070	58800	35500
Lead	25	-	6.6 J	1.1 BJ	9.1	5.3 J	26.7
Magnesium	35000*	TOGS 1.1.1	22700	31400	29100	82800	70300
Manganese	300	-	3690	344	179	5230	3000
Mercury	2	-	0.11 B	0.92	0.10 U	0.92	0.14 B
Nickel	-	-	9.5 B	14.0 BJ	87.3	36.0 BJ	10.0 B
Potassium	-	-	2490 B	2750 B	2770 B	67300	48600
Selenium	10	MCL	9.0 UJ	2.0 UJ	1.8 UJ	2.0 UJ	1.8 UJ
Silver	50	-	3.5 B	8.0 UR	2.1 U	15.0 R	2.1 U
Sodium	20000	Part 170	15500	98200 J	94900	342000 J*	216000
Thallium	4*	TOGS 1.1.1	1.2 U	5.0 U	1.2 U	5.0 UJ	1.2 UJ
Vanadium	-	-	11.3 B	27.0 BJ	2.0 U	31.0 BJ	2.0 U
Zinc	300	Part 170	21.5	24.0	18.1 B	161.0	107
Cyanide	100	Part 170	10.0 U	20.0 U	10.0 U	20.0 U	10.0 U

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well # Sample Date Case #	NYSDEC(1) Groundwater Quality Stds & Guid. Vals(*)	Origin of Standard	GW10D-01 04/17/91 1837	GW10D-02 12/27/93 WES027	GW10S-02 12/28/93 WES027	GW11D-01 04/17/91 1837	GW11-02 12/28/93 WES027
Inorganics, Total: ug/l							
Aluminum	-	-	472	88.8 B	613	1610	102 B
Antimony	3*	TOGS 1.1.1	26.0 UJ	7.9 U	7.9 U	26.0 UJ	7.9 U
Arsenic	25	-	3.0 UB	2.2 BJ	9.0 B	1.0 UB	1.5 U
Barium	1000	-	274	281	97.9 B	338	275
Beryllium	3*	TOGS 1.1.1	1.0 U	0.50 U	0.50 U	1.0 B	0.50 B
Cadmium	10	-	2.0 U	1.3 U	1.3 U	2.0 U	1.4 B
Calcium	-	-	39900	41000	22200	54100	61100
Chromium	50	MCL	15.0 U	6.4 U	6.4 U	1250 J	79.7
Cobalt	-	-	40.0 BJ	3.2 U	3.2 U	16.0 BJ	3.2 U
Copper	200	Part 170	14.0 UB	1.6 B	4.0 B	24.0 UB	4.5 B
Iron	300	-	719	91.9 B	546	6150	339
Lead	25	-	1.0 U	1.4 B	1.0 UJ	5 J	1.0 UJ
Magnesium	35000*	TOGS 1.1.1	6360	6500	1300 B	9950	10700
Manganese	300	-	23.0	2.2 B	10.9 B	707	99.0
Mercury	2	-	0.81	0.10 U	0.10 U	0.64	0.10 U
Nickel	-	-	7.0 UJ	4.8 U	4.8 U	173 J	236
Potassium	-	-	2380 UB	905 B	5180	2920 UB	1830 B
Selenium	10	MCL	2.7 BJ	2.2 UJ	2.2 UJ	2.0 UJ	2.2 UJ
Silver	50	-	15.0 R	2.1 U	2.1 U	17.0 R	2.1 U
Sodium	20000	Part 170	11600	11200	36500	64700	79900
Thallium	4*	TOGS 1.1.1	5.0 UJ	1.2 U	1.2 U	5.0 UJ	1.2 U
Vanadium	-	-	31.0 UB	6.9 B	29.7 B	36.0 UB	2.0 U
Zinc	300	Part 170	16.0 BJ	4.1 B	19.8 B	25.0 J	12.4 B
Cyanide	100	Part 170	20.0 U	10.0 U	10.0 U	20.0 J	10.0 U

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well # Sample Date Case #	NYSDEC(1) Groundwater Quality Sids & Guid. Value(*)	Origin of Standard	GW12D-01 04/17/91 1837	GW12-02 12/27/93 WES027	GW13-01 04/23/91 1911	GW13-02 12/29/93 WES027	GW14-01 04/23/91 1931	GWFB-01 04/15/91 1800
<u>Inorganics, Total: ug/l</u>								
Aluminum	-	-	782	127 B	509 U	1600	3450	87.0 UB
Antimony	3*	TOGS 1.1.1	26.0 UJ	7.9 U	33.0 U	7.9 U	33.0 U	26.0 UJ
Arsenic	25	-	1.0 UB	1.5 U	1.0 U	1.5 U	17.1	2.0 UB
Barium	1000	-	233	176 B	274	269	487	36.0 U
Beryllium	3*	TOGS 1.1.1	1.0 B	0.50 U	1.0 U	0.50 B	1.0 B	1.0 U
Cadmium	10	-	2.0 U	1.3 U	2.0 U	1.3 U	13.0	2.0 U
Calcium	-	-	52300	61000	111000	101000	48400	32700
Chromium	50	MCL	300 J	25.1	19.0 U	18.9	113	10.0 U
Cobalt	-	-	15.0 BJ	3.2 U	10.0 U	3.2 U	113	9.0 U
Copper	200	Part 170	15.0 UB	2.9 B	11.0 UB	11.1 B	55.0	6.0 UJ
Iron	300	-	3280	354	4970	8690	12500	16.0 U
Lead	25	-	4.7 J	1.5 B	2.1 BJ	2.8 B	633 J	1.00 U
Magnesium	35000*	TOGS 1.1.1	11000	11600	21900	22500	71600	4990 B
Manganese	300	-	845	43.0	1690	1000	158	3.0 U
Mercury	2	-	0.75	0.10 U	0.92	0.10 U	0.98	0.17 U
Nickel	-	-	90.0 J	35.7 B	11.0 BJ	15.5 B	384 J	7.0 U
Potassium	-	-	2780 UB	905 B	1380 B	1930 B	489000	2660 UB
Selenium	10	MCL	2.0 UJ	2.2 UJ	4.8 BJ	2.2 UJ	2.0 UJ	2.0 UJ
Silver	50	-	10.0 R	2.1 U	8.0 UR	2.1 U	8.0 R	8.0 R
Sodium	20000	Part 170	18100	20600	51100 J	58500	1510000 J	14100
Thallium	4*	TOGS 1.1.1	5.0 UJ	1.2 U	5.0 UJ	1.2 B	5.0 UJ	4.7 U
Vanadium	-	-	29.0 UB	2.0 U	6.0 UJ	4.3 B	11.0 BJ	16.0 UB
Zinc	300	Part 170	35.0 J	13.5 B	11.0 UB	32.8	850	28.0 J
Cyanide	100	Part 170	20.0 U	10.0 U	20.0 U	10.0 U	20.0 U	20.0 J

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well #	NYSDEC(1)	Origin of Standard	GW1D-01	GW1D-02	GW1S-01	GW1S-02	GW2-01	GW2-01-FD
Sample Date	Groundwater Quality Sids		04/15/91	12/27/93	04/15/91	12/27/93	04/15/91	04/15/91
Case #	& Guid. Vals		1800	WES027	1800	WES027	1800	1800
Water Class			GA	GA	GA	GA	GA	GA
Volatiles: ug/L	(H)							
Vinyl Chloride	2	MCL	10 U	1.0 UJ	10 U	1.0 UJ	10 U	10 U
Chloroethane	5	POC	10 UJ	1.0 U	10 UJ	1.0 U	10 UJ	10 UJ
Methylene Chloride	5	Subpart 5-1	5 U	1.0 U	5 U	1.0 U	5 U	5 U
1,1-Dichloroethane	5	Subpart 5-1	5 U	1.0 U	5 U	1.0 U	5 U	5 U
1,2-Dichloroethane (total)	-	-	5 U	NA	5 U	NA	5 U	5 U
Chloroform	7	-	5 U	1.0 U	5 U	1.0 U	5 U	5 U
2-Butanone	-	-	10 UJ	1.0 U	10 UJ	1.0 U	10 UJ	10 UJ
1,1,1-Trichloroethane	5	Subpart 5-1	5 U	1.0 U	5 U	1.0 U	5 U	5 U
Carbon Tetrachloride	5	-	5 U	1.0 U	5 U	1.0 U	5 U	5 U
Trichloroethene	5	Subpart 5-1	5 U	1.0 U	5 U	1.0 U	5 U	5 U
Benzene	0.7	-	5 U	1.0 U	5 U	1.0 U	5 U	5 U
Tetrachloroethane	5	Subpart 5-1	5 U	1.0 U	5 U	1.0 U	5 U	5 U
Toluene	5	POC	5 U	1.0 U	5 U	1.0 U	5 U	5 U
Chlorobenzene	5	POC	5 U	1.0 U	5 U	1.0 U	5 U	5 U
Ethylbenzene	5	POC	5 U	1.0 U	5 U	1.0 U	5 U	5 U
Styrene	5	-	5 U	1.0 U	5 U	1.0 U	5 U	5 U
Xylene (total)	5(B)	POC	5 U	1.0 U	5 U	1.0 U	5 U	5 U
Trichlorofluoromethane	5	Subpart 5-1	NA	1.0 U	NA	1.0 U	NA	NA
cis-1,2-Dichloroethene	5(A)	POC	NA	1.0 U	NA	1.0 U	NA	NA
1,4-Dichlorobenzene	4.7(C)	-	10 U	1.0 U	10 U	1.0 U	10 U	10 U

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well # Sample Date Case # Water Class	NYSDEC(1) Groundwater Quality Stds & Guid. Vals	Origin of Standard	GW2-02 12/27/93 WES027 GA	GW3D-01 04/16/91 1820 GA	GW3D-02 12/28/93 WES027 GA	GW3S-01 04/16/91 1820 GA	GW3S-02 12/28/93 WES027 GA	GW4D-01 04/16/91 1820 GA
<u>Volatiles: ug/L</u>	(H)							
Vinyl Chloride	2	MCL	1.0 UJ	10 U	1.0 UJ	10 U	1.0 UJ	10 U
Chloroethane	5	POC	1.0 U	10 UJ	1.0 U	10 UJ	1.0 U	10 UJ
Methylene Chloride	5	Subpart 5-1	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
1,1-Dichloroethene	5	Subpart 5-1	1.0 UJ	5 U	1.0 UJ	5 U	1.0 UJ	5 U
1,2-Dichloroethene (total)	-	-	NA	5 U	NA	5 U	NA	5 U
Chloroform	7	-	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
2-Butanone	-	-	1.0 U	10 UJ	1.0 U	10 UJ	1.0 U	10 UJ
1,1,1-Trichloroethane	5	Subpart 5-1	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Carbon Tetrachloride	5	-	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Trichloroethene	5	Subpart 5-1	1.0 U	5 U	1.0 U	12	2	5 U
Benzene	0.7	-	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Tetrachloroethene	5	Subpart 5-1	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Toluene	5	POC	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Chlorobenzene	5	POC	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Ethylbenzene	5	POC	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Styrene	5	-	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Xylene (total)	5(B)	POC	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Trichlorofluoromethane	5	Subpart 5-1	1.0 U	NA	1.0 U	NA	1.0 U	NA
cis-1,2-Dichloroethene	5(A)	POC	1.0 U	NA	1.0 U	NA	1.0 U	NA
1,4-Dichlorobenzene	4.7(C)	-	1.0 U	10 U	1.0 U	10 U	1.0 U	10 U

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well #	NYSDEC(1) Groundwater Quality Stds & Guid. Vals	Origin of Standard	GW4D-02 12/28/93 WES027 GA	GW4S-01 04/16/91 1820 GA	GW4S-02 12/28/93 WES027 GA	GW5D-01 04/16/91 1820 GA	GW5D-02 03/23/94 WES029 GA	GW5S-01 04/16/91 1820 GA
<u>Volatiles: ug/L</u>	(H)							
Vinyl Chloride	2	MCL	1.0 UJ	10 U	1.0 UJ	10 U	1.0 U	10 U
Chloroethane	5	POC	1.0 U	10 UJ	1.0 U	10 UJ	1.0 U	10 UJ
Methylene Chloride	5	Subpart 5-1	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
1,1-Dichloroethane	5	Subpart 5-1	1.0 UJ	5 U	1.0 UJ	5 U	1.0 U	5 U
1,2-Dichloroethane (total)	-	-	NA	5 U	NA	5 U	NA	5 U
Chloroform	7	-	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
2-Butanone	-	-	1.0 U	10 UJ	5	10 UJ	1.0 U	10 UJ
1,1,1-Trichloroethane	5	Subpart 5-1	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Carbon Tetrachloride	5	-	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Trichloroethene	5	Subpart 5-1	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Benzene	0.7	-	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Tetrachloroethene	5	Subpart 5-1	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Toluene	5	POC	1.0 U	5 U	1.0 U	5 U	4 J	5 U
Chlorobenzene	5	POC	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Ethylbenzene	5	POC	1.0 U	5 U	1.0 U	5 U	1.0 UJ	5 U
Styrene	5	-	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Xylene (total)	5(B)	POC	1.0 U	5 U	1.0 U	5 U	2 J	5 U
Trichlorofluoromethane	5	Subpart 5-1	1.0 U	NA	1.0 U	NA	1.0 U	NA
cis-1,2-Dichloroethene	5(A)	POC	1.0 U	NA	1.0 U	NA	1.0 U	NA
1,4-Dichlorobenzene	4.7(C)	-	1.0 U	10 U	1.0 U	10 U	1.0 U	10 U

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well # Sample Date Case # Water Class	NYSDEC(1) Groundwater Quality Stds & Guid. Vals	Origin of Standard	GW5S-02 12/28/93 WES027 GA	GW6D-01 04/22/91 1892 GA	GW6D-02 12/29/93 WES027 GA	GW6S-01 04/23/91 1911 GA	GW6S-02 12/29/93 WES027 GA	GW7D-01 04/22/91 1892 GA
<u>Volatiles: ug/L</u>	(H)							
Vinyl Chloride	2	MCL	1.0 UJ	10 U	1.0 UJ	10 U	1.0 UJ	10 U
Chloroethane	5	POC	1.0 U	10 U	1.0 U	10 U	1.0 U	10 U
Methylene Chloride	5	Subpart 5-1	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
1,1-Dichloroethane	5	Subpart 5-1	1.0 UJ	5 U	1.0 UJ	5 U	1.0 UJ	5 U
1,2-Dichloroethane (total)	-	-	NA	5 U	NA	5 U	NA	5 U
Chloroform	7	-	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
2-Butanone	-	-	1.0 U	10 R	1.0 U	10 R	1.0 U	10 R
1,1,1-Trichloroethane	5	Subpart 5-1	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Carbon Tetrachloride	5	-	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Trichloroethane	5	Subpart 5-1	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Benzene	0.7	-	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Tetrachloroethane	5	Subpart 5-1	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Toluene	5	POC	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Chlorobenzene	5	POC	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Ethylbenzene	5	POC	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Styrene	5	-	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Xylene (total)	5(B)	POC	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Trichlorofluoromethane	5	Subpart 5-1	1.0 U	NA	1.0 U	NA	1.0 U	NA
cis-1,2-Dichloroethane	5(A)	POC	1.0 U	NA	1.0 U	NA	1.0 U	NA
1,4-Dichlorobenzene	4.7(C)	-	1.0 U	10 U	1.0 U	10 U	1.0 U	10 U

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well # Sample Date Case # Water Class	NYSDEC(1) Groundwater Quality Stds & Guid. Vals	Origin of Standard	GW7D-02 12/29/93 WES027 GA	GW7S-01 04/22/91 1892 GA	GW7S-02 12/29/93 WES027 GA	GW8D-01 04/23/91 1911 GA	GW8D-02 12/22/93 WES026 GA	GW8S-01 04/22/91 1892 GA
<u>Volatiles: ug/L</u>	(H)							
Vinyl Chloride	2	MCL	1.0 UJ	10 U	1.0 UJ	10 U	1 J	10 U
Chloroethane	5	POC	1.0 U	10 U	1.0 U	10 U	1.0 U	10 U
Methylene Chloride	5	Subpart 5-1	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
1,1-Dichloroethene	5	Subpart 5-1	1.0 UJ	5 U	1.0 UJ	5 U	1.0 U	5 U
1,2-Dichloroethene (total)	-	-	NA	5 U	NA	5 U	NA	5 U
Chloroform	7	-	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
2-Butanone	-	-	1.0 U	10 R	1.0 U	10 R	1	10 R
1,1,1-Trichloroethane	5	Subpart 5-1	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Carbon Tetrachloride	5	-	1.0 U	5 U	1.0 U	5 U	1	5 U
Trichloroethene	5	Subpart 5-1	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Benzene	0.7	-	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Tetrachloroethene	5	Subpart 5-1	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Toluene	5	POC	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Chlorobenzene	5	POC	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Ethylbenzene	5	POC	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Styrene	5	-	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Xylene (total)	5(B)	POC	1.0 U	5 U	1.0 U	5 U	1.0 U	5 U
Trichlorofluoromethane	5	Subpart 5-1	1.0 U	NA	1.0 U	NA	2	NA
cis-1,2-Dichloroethene	5(A)	POC	1.0 U	NA	1.0 U	NA	1.0 U	NA
1,4-Dichlorobenzene	4.7(C)	-	1.0 U	10 U	1.0 U	10 U	1.0 U	10 U

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well # Sample Date Case # Water Class	NYSDEC(1) Groundwater Quality Stds & Guld. Vals	Origin of Standard	GW8S-02 12/22/93 WES026 GA	GW9D-01 04/23/91 1911 GA	GW9D-02 12/22/93 WES026 GA	GW9S-01 04/23/91 1911 GA	GW9S-02 12/22/93 WES026 GA
<u>Volatiles: ug/L</u>	(H)						
Vinyl Chloride	2	MCL	1.0 UJ	10 U	1.0 UJ	10 UJ	1.0 UJ
Chloroethane	5	POC	1.0 U	10 U	1.0 U	10 UJ	1.0 U
Methylene Chloride	5	Subpart 5-1	1.0 U	5 U	1.0 U	5 UJ	1.0 U
1,1-Dichloroethene	5	Subpart 5-1	1.0 U	5 U	1.0 U	5 UJ	1.0 U
1,2-Dichloroethene (total)	-	-	NA	13	NA	5 UJ	NA
Chloroform	7	-	1.0 U	5 U	1.0 U	5 U	1.0 U
2-Butanone	-	-	1.0 U	10 R	1.0 U	10 R	1.0 U
1,1,1-Trichloroethane	5	Subpart 5-1	1.0 U	5 U	1.0 U	5 U	1.0 U
Carbon Tetrachloride	5	-	1.0 U	5 U	1.0 U	5 U	1.0 U
Trichloroethene	5	Subpart 5-1	1.0 U	5 U	3	5 U	1.0 U
Benzene	0.7	-	1.0 U	5 U	1.0 U	5 U	1.0 U
Tetrachloroethene	5	Subpart 5-1	1.0 U	5 U	1.0 U	5 U	1.0 U
Toluene	5	POC	1.0 U	5 U	1.0 U	5 U	1.0 U
Chlorobenzene	5	POC	1.0 U	5 U	1.0 U	5	4
Ethylbenzene	5	POC	1.0 U	5 U	1.0 U	5 U	1.0 U
Styrene	5	-	1.0 U	5 U	1.0 U	5 U	1.0 U
Xylene (total)	5(B)	POC	1.0 U	5 U	1.0 U	5 U	1.0 U
Trichlorofluoromethane	5	Subpart 5-1	1.0 U	NA	1.0 U	NA	1.0 U
cis-1,2-Dichloroethene	5(A)	POC	1.0 U	NA	12	NA	1.0 U
1,4-Dichlorobenzene	4.7(C)	-	1.0 U	10 U	1.0 U	10 U	1.0 U

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well # Sample Date Case # Water Class	NYSDEC(1) Groundwater Quality Sids & Guld. Vals	Origin of Standard	GW10D-01 04/17/91 1837 GA	GW10D-02 12/27/93 WES027 GA	GW10S-02 12/28/93 WES027 GA	GW11D-01 04/17/91 1837 GA	GW11-02 12/29/93 WES027 GA
<u>Volatiles: ug/L</u>	(H)						
Vinyl Chloride	2	MCL	10 U	1.0 UJ	1.0 UJ	10 U	1.0 UJ
Chloroethane	5	POC	10 U	1.0 U	1.0 U	10 U	1.0 U
Methylene Chloride	5	Subpart 5-1	5 U	1.0 U	1.0 U	5 U	1.0 U
1,1-Dichloroethene	5	Subpart 5-1	5 U	1 J	1.0 UJ	5 U	1.0 UJ
1,2-Dichloroethene (total)	-	-	5 U	NA	NA	5 U	NA
Chloroform	7	-	5 U	1.0 U	1.0 U	5 U	1.0 U
2-Butanone	-	-	10 R	1.0 U	1.0 U	10 R	1.0 U
1,1,1-Trichloroethane	5	Subpart 5-1	5 UJ	3	1.0 U	5 UJ	1.0 U
Carbon Tetrachloride	5	-	5 UJ	1.0 U	1.0 U	5 UJ	1.0 U
Trichloroethene	5	Subpart 5-1	5 U	4	1.0 U	5 U	1.0 U
Benzene	0.7	-	5 U	1.0 U	1.0 U	5 U	1.0 U
Tetrachloroethene	5	Subpart 5-1	5 UJ	7	1.0 U	5 U	1.0 U
Toluene	5	POC	5 UJ	1.0 U	1.0 U	5 U	1.0 U
Chlorobenzene	5	POC	5 UJ	1.0 U	1.0 U	5 U	1.0 U
Ethylbenzene	5	POC	5 UJ	1.0 U	1.0 U	5 U	1.0 U
Styrene	5	-	5 UJ	1.0 U	1.0 U	5 U	1.0 U
Xylene (total)	5(B)	POC	5 UJ	1.0 U	1.0 U	5 U	1.0 U
Trichlorofluoromethane	5	Subpart 5-1	NA	1.0 U	1.0 U	NA	1.0 U
cis-1,2-Dichloroethene	5(A)	POC	NA	1.0 U	1.0 U	NA	1.0 U
1,4-Dichlorobenzene	4.7(C)	-	10 U	1.0 U	1.0 U	10 U	1.0 U

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well #	NYSDEC(1) Groundwater Quality Sids & Guid. Vals	Origin of Standard	GW12D-01 04/17/91 1897 GA	GW12-02 12/27/93 WES027 GA	GW13-01 04/23/91 1911 GA	GW13-02 12/29/93 WES027 GA	GW14-01 04/23/91 1931 GA	GWFB-01 04/15/91 1800 GA
Water Class								
Volatiles: ug/L	(H)							
Vinyl Chloride	2	MCL	10 U	1.0 UJ	10 U	1.0 UJ	10 UJ	10 U
Chloroethane	5	POC	10 U	1.0 U	10 U	1.0 U	10 UJ	10 UJ
Methylene Chloride	5	Subpart 5-1	5 U	1.0 U	5 U	1.0 U	5 UJ	5 U
1,1-Dichloroethene	5	Subpart 5-1	5 U	1.0 UJ	5 U	1.0 UJ	5 UJ	5 U
1,2-Dichloroethene (total)	-	-	5 U	NA	5 U	NA	100 J	5 U
Chloroform	7	-	5 U	1.0 U	5 U	1.0 U	5 UJ	5 U
2-Butanone	-	-	10 R	1.0 U	10 R	1.0 U	10 R	10 UJ
1,1,1-Trichloroethane	5	Subpart 5-1	5 UJ	1.0 U	5 U	1.0 U	5 UJ	5 U
Carbon Tetrachloride	5	-	5 UJ	1.0 U	5 U	1.0 U	5 UJ	5 U
Trichloroethene	5	Subpart 5-1	5 U	2	5 U	1.0 U	5 UJ	5 U
Benzene	0.7	-	5 U	1.0 U	5 U	1.0 U	5 J	5 U
Tetrachloroethene	5	Subpart 5-1	5 U	4	5 U	1.0 U	5 UJ	5 U
Toluene	5	POC	5 U	1.0 U	5 U	1.0 U	180 J	5 U
Chlorobenzene	5	POC	5 U	1.0 U	5 U	1	14 J	5 U
Ethylbenzene	5	POC	5 U	1.0 U	5 U	1.0 U	36 J	5 U
Styrene	5	-	5 U	1.0 U	5 U	1.0 U	4 J	5 U
Xylene (total)	5(B)	POC	5 U	1.0 U	5 U	1.0 U	62 J	5 U
Trichlorofluoromethane	5	Subpart 5-1	NA	1.0 U	NA	1.0 U	NA	NA
cis-1,2-Dichloroethene	5(A)	POC	NA	1.0 U	NA	1.0 U	NA	NA
1,4-Dichlorobenzene	4.7(C)	-	10 U	1.0 U	10 U	1.0 U	9 J	10 U

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well #	NYSDEC(1) Groundwater Quality Sids & Guid. Vals	Origin of Standard	GWTB1-01 04/15/91 1800 GA	GWTB2-01 04/16/91 1820 GA	GWTB3-01 04/17/91 1837 GA	GWTB4-01 04/22/91 1892 GA	GWTB5-01 04/23/91 1911 GA	GWTB6-01 04/24/91 1931 GA
<u>Volatiles: ug/L</u>	(H)							
Vinyl Chloride	2	MCL	10 U	10 U	10 U	10 U	10 U	10 UJ
Chloroethane	5	POC	10 UJ	10 UJ	10 U	10 U	10 U	10 UJ
Methylene Chloride	5	Subpart 5-1	5 U	5 U	5 U	5 U	5 U	5 UJ
1,1-Dichloroethene	5	Subpart 5-1	5 U	5 U	5 U	5 U	5 U	5 UJ
1,2-Dichloroethene (total)	-	-	5 U	5 U	5 U	5 U	5 U	5 UJ
Chloroform	7	-	5 U	5 U	5 U	5 U	5 U	5 UJ
2-Butanone	-	-	10 UJ	10 UJ	10 R	10 R	10 R	10 R
1,1,1-Trichloroethane	5	Subpart 5-1	5 U	5 U	5 UJ	5 U	5 U	5 UJ
Carbon Tetrachloride	5	-	5 U	5 U	5 UJ	5 U	5 U	5 UJ
Trichloroethane	5	Subpart 5-1	5 U	5 U	5 U	5 U	5 U	5 UJ
Benzene	0.7	-	5 U	5 U	5 U	5 U	5 U	5 UJ
Tetrachloroethene	5	Subpart 5-1	5 U	5 U	5 U	5 U	5 U	5 UJ
Toluene	5	POC	5 U	5 U	5 U	5 U	5 U	5 UJ
Chlorobenzene	5	POC	5 U	5 U	5 U	5 U	5 U	5 UJ
Ethylbenzene	5	POC	5 U	5 U	5 U	5 U	5 U	5 UJ
Styrene	5	-	5 U	5 U	5 U	5 U	5 U	5 UJ
Xylene (total)	5(B)	POC	5 U	5 U	5 U	5 U	5 U	5 UJ
Trichlorofluoromethane	5	Subpart 5-1	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	5(A)	POC	NA	NA	NA	NA	NA	NA
1,4-Dichlorobenzene	4.7(C)	-	NA	NA	NA	NA	NA	NA

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well #	NYSDEC(1) Groundwater Quality Stds & Guid. Vals	Origin of Standard	TBGW-122293 12/22/93 WES026	TBGW-032394 03/23/94 WES029
Sample Date				
Case #				
Water Class				
Volatiles: ug/L	(H)			
Vinyl Chloride	2	MCL	1.0 UJ	1.0 U
Chloroethane	5	POC	1.0 U	1.0 U
Methylene Chloride	5	Subpart 5-1	1	1.0 U
1,1-Dichloroethene	5	Subpart 5-1	1.0 U	1.0 U
1,2-Dichloroethene (total)	-	-	NA	1.0 U
Chloroform	7	-	1.0 U	4
2-Butanone	-	-	1.0 U	1.0 U
1,1,1-Trichloroethane	5	Subpart 5-1	1.0 U	1.0 U
Carbon Tetrachloride	5	-	1.0 U	1.0 U
Trichloroethene	5	Subpart 5-1	1.0 U	1.0 U
Benzene	0.7	-	1.0 U	1.0 U
Tetrachloroethene	5	Subpart 5-1	1.0 U	1.0 U
Toluene	5	POC	1.0 U	1.0 U
Chlorobenzene	5	POC	1.0 U	1.0 U
Ethylbenzene	5	POC	1.0 U	1.0 U
Styrene	5	-	1.0 U	1.0 U
Xylene (total)	5(B)	POC	1.0 U	1.0 U
Trichlorofluoromethane	5	Subpart 5-1	1.0 U	1.0 U
cis-1,2-Dichloroethene	5(A)	POC	1.0 U	1.0 U
1,4-Dichlorobenzene	4.7(C)	-	1.0 U	1.0 U

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well #	NYSDEC(1)	Origin of Standard	GW1D-01	GW1D-02	GW1S-01	GW1S-02	GW2-01	GW2-01-FD
Sample Date	Groundwater		04/15/91	12/27/93	04/15/91	12/27/93	04/15/91	04/15/91
Case #	Quality Stds & Guid. Vals		1800	WES027	1800	WES027	1800	1800
Water Class		Standard	GA	GA	GA	GA	GA	GA
<u>Semi-Volatiles: ug/L</u>								
2-Methylphenol	-	-	10 U	NA	10 U	NA	10 U	10 U
Naphthalene	10*	TOGS 1.1.1	10 U	NA	10 U	NA	10 U	10 U
bis(2-Ethylhexyl)phthalate	50	Subpart 5.1	4 J	NA	5 J	NA	10 U	10 U
<u>Pesticides: ug/L</u>	(H)							
Heptachlor	ND(G)	-	0.05 U	NA	0.05 U	NA	0.05 U	0.06 U
Endosulfan I	-	-	0.05 U	NA	0.05 U	NA	0.05 U	0.06 U
4,4-DDT	ND(E)	-	0.10 U	NA	0.10 U	NA	0.13	0.12
<u>PCB's: ug/L</u>								
Aroclor - 1254	0.1(F)	-	1.00 U	NA	1.00 U	NA	1.00 U	1.11 U
Aroclor - 1260	0.1(F)	-	1.00 U	NA	1.00 U	NA	0.60 J	1.10
<u>Additional Parameters: (mg/L unless noted otherwise)</u>								
Total Dissolved Solids (TDS)	500	-	88	204	88	267	138	154
Biological Oxygen Demand (BOD)	-	-	<2	<4	<2	<4	<2	<2
Color (Pt/Co Units)	15	-	10	NA	35	NA	5	10
Turbidity (NTU)	50	NYSDEC Goal	26	NA	98	NA	15.2	18.5
Nitrate	10	Part 170	1.5	NA	1.2	NA	1.6	1.6
Total Kjeldahl Nitrogen (TKN)	-	-	0.44	0.9	0.19	0.9	0.10	0.14
Ammonia	2	Part 170	<0.03	0.09 U	<0.03	0.07	<0.03	<0.03
Total Organic Carbon (TOC)	-	-	2.0	7.2	1.2	7.0	1.4	1.4
Chemical Oxygen Demand (COD)	-	-	23	<15.0	31	60	19	13
Nitrite	10	Part 170	<0.02	NA	<0.02	NA	<0.02	<0.02
Total Phenols (Phase II ug/l)	1 ug/(KD)	-	<0.01	3.2	<0.01	1.5	<0.01	<0.01
Sulfate	250	-	13	14.0	14	17.2	21	20
Chlorides	250	-	10	18	24	30	9	9
Alkalinity (as CaCO3(l))	-	-	9	98.6	105	147	84	85
Total Hardness	-	-	NA	126	NA	204	NA	NA
Boron (ug/l)	1000	Part 170	NA	47.8 B	NA	55.3 B	NA	NA
Bromide	2*	-	NA	2.3	NA	2.7	NA	NA
Hexavalent Chromium	0.05	-	NA	<0.02	NA	<0.02	NA	NA
Nitrate-Nitrite (as N)	10	Part 170	NA	1.9	NA	1.7	NA	NA

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well #	NYSDEC(1) Groundwater Quality Sids & Guid. Vals	Origin of Standard	GW2-02 12/27/93 WES027 GA	GW3D-01 04/16/91 1820 GA	GW3D-02 12/28/93 WES027 GA	GW3S-01 04/16/91 1820 GA	GW3S-02 12/28/93 WES027 GA	GW4D-01 04/16/91 1820 GA
<u>Semi-Volatiles: ug/L</u>								
2-Methylphenol	-	-	NA	10 U	NA	10 U	NA	10 U
Naphthalene	10*	TOGS 1.1.1	NA	10 U	NA	10 U	NA	10 U
bis(2-Ethylhexyl)phthalate	50	Subpart 5.1	NA	10 U	NA	4 J	NA	10 U
<u>Pesticides: ug/L</u>	(H)							
Heptachlor	ND(G)	-	0.031 J	0.05 U	0.15	0.05 U	NA	0.05 U
Endosulfan I	-	-	0.050 U	0.05 U	0.050 U	0.05 U	NA	0.05 U
4,4-DDT	ND(E)	-	0.10 U	0.09 J	0.10 U	0.10 U	NA	0.10 U
<u>PCB's: ug/L</u>								
Aroclor-1254	0.1(F)	-	1.0 U	1.00 U	1.0 U	1.00 U	NA	1.00 U
Aroclor-1260	0.1(F)	-	1.0 U	1.30	1.0 U	1.00 U	NA	1.00 U
<u>Additional Parameters: (mg/L unless noted otherwise)</u>								
Total Dissolved Solids (TDS)	500	-	198	94	133	204	269	332
Biological Oxygen Demand (BOD)	-	-	<4	<2	<4	<2	<4	3 J
Color (Pt/Co Units)	15	-	NA	20	NA	30	NA	30
Turbidity (NTU)	50	NYSDEC Goal	NA	7.5	NA	82	NA	32
Nitrate	10	Part 170	NA	2.68	NA	1.78	NA	0.63
Total Kjeldahl Nitrogen (TKN)	-	-	0.6	0.22	<0.2	0.10	1.9	0.36
Ammonia	2	Part 170	0.07	<0.03	<0.02	<0.03	<0.02	<0.03
Total Organic Carbon (TOC)	-	-	6.4	8.2	22.6	1.2	2.7	1.6
Chemical Oxygen Demand (COD)	-	-	<15.0	35	60	18	30	30
Nitrite	10	Part 170	NA	<0.02	NA	<0.02	NA	<0.02
Total Phenols (Phase II ug/l)	1 ug/l(D)	-	<1	<0.01	<1	<0.01	<1	<0.01
Sulfate	250	-	22.7	15	21.2	14	16.4	4
Chlorides	250	-	13	1	5	32	45	62
Alkalinity (as CaCO ₃)	-	-	105	54	54.0	85	95.0	120
Total Hardness	-	-	131	NA	74.9	NA	157	NA
Boron (ug/l)	1000	Part 170	33.2 B	NA	19.1 B	NA	38.8 B	NA
Bromide	2*	-	4.0	NA	7.3	NA	6.7	NA
Hexavalent Chromium	0.05	-	<0.02	NA	<0.02	NA	<0.02	NA
Nitrate-Nitrite (as N)	10	Part 170	1.9	NA	3.1	NA	2.0	NA

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well #	NYSDEC(1)	GW4D-02	GW4S-01	GW4S-02	GW5D-01	GW5D-02	GW5S-01
Sample Date	Groundwater	12/28/93	04/16/91	12/28/93	04/16/91	03/23/94	04/16/91
Case #	Quality Sds	WES027	1820	WES027	1820	WES029	1820
Water Class	& Guild. Vals	GA	GA	GA	GA	GA	GA
<u>Semi-Volatiles: ug/L</u>							
2-Methylphenol	-	NA	10 U	NA	10 U	NA	10 U
Naphthalene	10*	NA	10 U	NA	10 U	NA	10 U
bis(2-Ethylhexyl)phthalate	50	NA	10 U	NA	4 J	NA	10 U
<u>Pesticides: ug/L</u>	(H)						
Heptachlor	ND(G)	NA	0.05 U	NA	0.05 U	NA	0.05 U
Endosulfan I	-	NA	0.05 U	NA	0.05 U	NA	0.05 U
4,4-DDT	ND(E)	NA	0.10 U	NA	0.10 U	NA	0.10 U
<u>PCB's: ug/L</u>							
Aroclor-1254	0.1(F)	NA	1.00 U	NA	1.00 U	NA	1.00 U
Aroclor-1260	0.1(F)	NA	1.00 U	NA	1.00 U	NA	1.00 U
<u>Additional Parameters: (mg/L unless noted otherwise)</u>							
Total Dissolved Solids (TDS)	500	330	290	151	144	48 R	100
Biological Oxygen Demand (BOD)	-	<4	14	7	<2	<4	<2
Color (PCU Units)	15	NA	70	NA	60	NA	20
Turbidity (NTU)	50	NA	>200	NA	16	NA	4.8
Nitrate	10	NA	<0.02	NA	<0.02	NA	0.03
Total Kjeldahl Nitrogen (TKN)	-	<0.2	11	8.6	0.24	0.5	0.17
Ammonia	2	<0.02	7.30	6.6	<0.03	0.09	<0.03
Total Organic Carbon (TOC)	-	3.1	4.2	9.7	5.3	7.2	2.3
Chemical Oxygen Demand (COD)	-	<15.0	109	20	44	70	15
Nitrite	10	NA	<0.02	NA	<0.02	NA	<0.03
Total Phenols (Phase II ug/l)	1 ug/(D)	<1	<0.01	<1	<0.01	<1	<0.01
Sulfate	250	14.1	<10 UJ	<5.0	<5 UJ	<5.0	<2 UJ
Chlorides	250	54	5	3	<1	4	<1
Alkalinity (as CaCO3)	-	119	203	162	120	146	70
Total Hardness	-	179	NA	102	NA	181	NA
Boron (ug/l)	1000	47.7 B	NA	35.7 B	NA	42.0 B	NA
Bromide	2*	7.3	NA	2.3	NA	1.3 J	NA
Hexavalent Chromium	0.05	<0.02	NA	<0.02	NA	<0.02	NA
Nitrate-Nitrite (as N)	10	0.7	NA	<0.1	NA	0.1	NA

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well #	NYSDEC(1) Groundwater Quality Stds & Guid. Vals	Origin of Standard	GW5S-02 12/28/93 WES027 GA	GW6D-01 04/22/91 1892 GA	GW6D-02 12/29/93 WES027 GA	GW6S-01 04/23/91 1911 GA	GW6S-02 12/29/93 WES027 GA	GW7D-01 04/22/91 1892 GA
<u>Semi-Volatiles: ug/L</u>								
2-Methylphenol	-	-	NA	10 U	NA	10 U	NA	10 U
Naphthalene	10*	TOGS 1.1.1	NA	10 U	NA	10 U	NA	10 U
bis(2-Ethylhexyl)phthalate	50	Subpart 5.1	NA	10 U	NA	10 U	NA	10 U
<u>Pesticides: ug/L</u>	(H)							
Heptachlor	ND(G)	-	NA	0.05 U	NA	0.05 U	NA	0.05 U
Endosulfan I	-	-	NA	0.05 U	NA	0.05 U	NA	0.05 U
4,4-DDT	ND(E)	-	NA	0.10 U	NA	0.10 U	NA	0.10 U
<u>PCB's: ug/L</u>								
Aroclor-1254	0.1(F)	-	NA	1.00 U	NA	1.00 U	NA	1.00 U
Aroclor-1260	0.1(F)	-	NA	1.00 U	NA	1.00 U	NA	1.00 U
<u>Additional Parameters: (mg/L unless noted otherwise)</u>								
Total Dissolved Solids (TDS)	500	-	72	96	108	250	NA	142
Biological Oxygen Demand (BOD)	-	-	<4	2	<4	8	NA	2
Color (Pt/Co Units)	15	-	NA	30	NA	90	NA	10
Turbidity (NTU)	50	NYSDEC Goal	NA	9.5	NA	>200	NA	2.6
Nitrate	10	Part 170	NA	<0.02	NA	<0.02	NA	<0.02
Total Kjeldahl Nitrogen (TKN)	-	-	<0.2	0.79	2.2	9.0	NA	0.60
Ammonia	2	Part 170	<0.02	0.73	1.2	5.6	NA	0.51
Total Organic Carbon (TOC)	-	-	1.1	3	2.6	5	NA	6
Chemical Oxygen Demand (COD)	-	-	<15.0	21	<15.0	112	NA	34
Nitrite	10	Part 170	NA	<0.02	NA	<0.02	NA	<0.02
Total Phenols (Phase II ug/l)	1 ug/l(D)	-	<1	<0.01	4.7	<0.01	NA	<0.01
Sulfate	250	-	<5.0	6	<5.0	<10 UJ	NA	9
Chlorides	250	-	2	2 J	3	12 J	NA	<1 UJ
Alkalinity (as CaCO ₃)	-	-	64.9	43	135	220	NA	84
Total Hardness	-	-	101	NA	116	NA	117	NA
Boron (ug/l)	1000	Part 170	19.8 B	NA	111	NA	86.7 B	NA
Bromide	2*	-	4.3	NA	3.3	NA	NA	NA
Hexavalent Chromium	0.05	-	<0.02	NA	<0.02	NA	NA	NA
Nitrate Nitrite (as N)	10	Part 170	<0.1	NA	<0.1	NA	NA	NA

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well #	NYSDEC(1) Groundwater Quality Sids & Guid. Vals	Origin of Standard	GW7D-02 12/29/93 WES027 GA	GW7S-01 04/22/91 1892 GA	GW7S-02 12/29/93 WES027 GA	GW8D-01 04/23/91 1911 GA	GW8D-02 12/22/93 WES026 GA	GW8S-01 04/22/91 1892 GA
<u>Semi-Volatiles: ug/L</u>								
2-Methylphenol	-	-	NA	10 U	NA	10 U	NA	10 U
Naphthalene	10*	TOGS 1.1.1	NA	10 U	NA	10 U	NA	10 U
bis(2-Ethylhexyl)phthalate	50	Subpart 5.1	NA	10	NA	10 U	NA	10 U
<u>Pesticides: ug/L</u>	(H)							
Heptachlor	ND(G)	-	NA	0.05 U	NA	0.05 U	NA	0.05 U
Endosulfan I	-	-	NA	0.05 U	NA	0.05 U	NA	0.05 U
4,4-DDT	ND(E)	-	NA	0.10 U	NA	0.10 U	NA	0.10 U
<u>PCB's: ug/L</u>								
Aroclor-1254	0.1(F)	-	NA	1.00 U	NA	1.00 U	NA	1.00 U
Aroclor-1260	0.1(F)	-	NA	1.00 U	NA	1.00 U	NA	1.00 U
<u>Additional Parameters: (mg/L unless noted otherwise)</u>								
Total Dissolved Solids (TDS)	500	-	142	206	135	688	558	612
Biological Oxygen Demand (BOD)	-	-	4	1	<4	2	4	13
Color (Pt/Co Units)	15	-	NA	800	NA	5	NA	180
Turbidity (NTU)	50	NYSDEC Goal	NA	>200	NA	1.4	NA	21
Nitrate	10	Part 170	NA	0.75	NA	0.49	NA	<0.02
Total Kjeldahl Nitrogen (TKN)	-	-	6.2	6.3	16.6	1.0	11.4	124 J
Ammonia	2	Part 170	3.6	6.4	13.4	0.61	10.8	99
Total Organic Carbon (TOC)	-	-	3.9	2	4.1	7	8.2	44
Chemical Oxygen Demand (COD)	-	-	<15.0	28	50	25	50	262
Nitrite	10	Part 170	NA	0.05	NA	0.14	NA	<0.02
Total Phenols (Phase II ug/l)	1 ug/(D)	-	<1	<0.01	22.8	<0.01	49.5	<0.01
Sulfate	250	-	11.8	<50 UJ	<5.0	46	24.3	<5 UJ
Chlorides	250	-	2	13 J	4	280 J	265	2 J
Alkalinity (as CaCO3)	-	-	113	220	170	42	230	564
Total Hardness	-	-	43.1	NA	406	NA	432	NA
Boron (ug/l)	1000	Part 170	83.1 B	NA	123	NA	71.9 B	NA
Bromide	2*	-	3.3	NA	5.7	NA	3.3	NA
Hexavalent Chromium	0.05	-	<0.02	NA	<0.02	NA	<0.02	NA
Nitrate-Nitrite (as N)	10	Part 170	<0.1	NA	<0.1	NA	0.1	NA

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well #	NYSDEC(1)	GW8S-02	GW9D-01	GW9D-02	GW9S-01	GW9S-02
Sample Date	Groundwater	12/22/93	04/23/91	12/22/93	04/23/91	12/22/93
Case #	Quality Sids	WES026	1911	WES026	1911	WES026
Water Class	& Guid. Vals	GA	GA	GA	GA	GA
<u>Semi-Volatiles: ug/L</u>						
2-Methylphenol	-	NA	10 U	NA	10 U	NA
Naphthalene	10*	NA	10 U	NA	10 U	NA
bis(2-Ethylhexyl)phthalate	50	NA	10 U	NA	10 U	NA
<u>Pesticides: ug/L</u>	(H)					
Heptachlor	ND(G)	NA	0.05 U	NA	0.05 U	NA
Endosulfan I	-	NA	0.05 U	NA	0.05 U	NA
4,4-DDT	ND(E)	NA	0.10 U	NA	0.10 U	NA
<u>PCB's: ug/L</u>						
Aroclor-1254	0.1(F)	NA	1.00 U	NA	1.00 U	NA
Aroclor-1260	0.1(F)	NA	1.00 U	NA	1.00 U	NA
<u>Additional Parameters: (mg/L unless noted otherwise)</u>						
Total Dissolved Solids (TDS)	500	545	107	873	236	1740
Biological Oxygen Demand (BOD)	-	21	1	<4	17	21
Color (Pt/Co Units)	15	NA	60	NA	200	NA
Turbidity (NTU)	50	NA	18	NA	>200	NA
Nitrate	10	NA	0.26	NA	<0.02	NA
Total Kjeldahl Nitrogen (TKN)	-	114	0.48	0.8	90	52.0
Ammonia	2	108	0.03	0.08	56	48.0
Total Organic Carbon (TOC)	-	73.2	5	2.8	44	57.5
Chemical Oxygen Demand (COD)	-	255	26	40	201	170
Nitrite	10	NA	<0.02	NA	<0.02	NA
Total Phenols (Phase II ug/l)	1 ug/(D)	4.2	<0.01	<1	<0.01	<1
Sulfate	250	<5.0	24	30.1	80	226
Chlorides	250	5	370 J	300	540 J	245
Alkalinity (as CaCO ₃)	-	730	231	212	1600	1080
Total Hardness	-	426	NA	453	NA	954
Boron (ug/l)	1000	107	NA	107	NA	897
Bromide	2*	6.7	NA	2.0	NA	4.7
Hexavalent Chromium	0.05	<0.02	NA	<0.02	NA	<0.02
Nitrate-Nitrite (as N)	10	<0.1	NA	0.8	NA	<0.1

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well #	NYSDEC(1) Groundwater Quality Sids & Guid. Vals	Origin of Standard	GW10D-01 04/17/91 1837 GA	GW10D-02 12/27/93 WES027 GA	GW10S-02 12/28/93 WES027 GA	GW11D-01 04/17/91 1837 GA	GW11-02 12/29/93 WES027 GA
<u>Semi-Volatiles: ug/L</u>							
2-Methylphenol	-	-	10 U	NA	NA	10 U	NA
Naphthalene	10*	TOGS 1.1.1	10 U	NA	NA	10 U	NA
bis(2-Ethylhexyl)phthalate	50	Subpart 5.1	10 U	NA	NA	10 U	NA
<u>Pesticides: ug/L</u>	(H)						
Heptachlor	ND(G)	-	0.05 U	NA	NA	0.05 U	NA
Endosulfan I	-	-	0.05 U	NA	NA	0.05 U	NA
4,4-DDT	ND(E)	-	0.10 U	NA	NA	0.10 U	NA
<u>PCB's: ug/L</u>							
Aroclor-1254	0.1(F)	-	1.00 U	NA	NA	1.00 U	NA
Aroclor-1260	0.1(F)	-	1.00 U	NA	NA	1.00 U	NA
<u>Additional Parameters: (mg/L unless noted otherwise)</u>							
Total Dissolved Solids (TDS)	500	-	186	203	217	474	537
Biological Oxygen Demand (BOD)	-	-	<2	<4	<4	<2	<4
Color (Pt/Co Units)	15	-	10	NA	NA	30	NA
Turbidity (NTU)	50	NYSDEC Goal	2.2	NA	NA	26	NA
Nitrate	10	Part 170	2.03	NA	NA	0.14	NA
Total Kjeldahl Nitrogen (TKN)	-	-	0.02	<0.2	1.0	0.22	<0.2
Ammonia	2	Part 170	<0.03	<0.02	0.27	<0.03	0.02
Total Organic Carbon (TOC)	-	-	<1	2.9	1.8	1	4.3
Chemical Oxygen Demand (COD)	-	-	<5	65	25	30	25
Nitrite	10	Part 170	<0.02	NA	NA	<0.02	NA
Total Phenols (Phase II ug/l)	1 ug/l(D)	-	<0.01	<1	<1	<0.01	<1
Sulfate	250	-	20	20.9	40.0	22	27.2
Chlorides	250	-	7	12	28	183	173
Alkalinity (as CaCO3)	-	-	100	111	127	129	128
Total Hardness	-	-	NA	129	60.9	NA	197
Boron (ug/l)	1000	Part 170	NA	44.6 B	36.6 B	NA	60.6 B
Bromide	2*	-	NA	23.0	4.7	NA	7.7
Hexavalent Chromium	0.05	-	NA	<0.02	<0.02	NA	0.07
Nitrate-Nitrite (as N)	10	Part 170	NA	2.8	2.1	NA	0.2

TABLE B-9 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - GROUNDWATER SAMPLES

Sample Location/Well # Sample Date Case # Water Class	NYSDEC(1) Groundwater Quality Stds & Guid. Vals	Origin of Standard	GW12D-01 04/17/91 1837 GA	GW12-02 12/27/93 WES027 GA	GW13-01 04/23/91 1911 GA	GW13-02 12/28/93 WES027 GA	GW14-01 04/23/91 1931 GA	GWFB-01 04/15/91 1800 GA
<u>Semi-Volatiles: ug/L</u> 2-Methylphenol Naphthalene bis(2-Ethylhexyl)phthalate <u>Pesticides: ug/L</u> Heptachlor Endosulfan I 4,4-DDT <u>PCB's: ug/L</u> Aroclor - 1254 Aroclor - 1260	- 10* 50 (H) ND(G) - - ND(E) 0.1(F) 0.1(F)	- TOGS 1.1.1 Subpart 5.1 - - - - - - -	10 U 10 U 10 U 0.05 U 0.05 U 0.10 U 1.00 U 1.00 U	NA NA NA NA NA NA NA NA	10 UR 10 U 10 U 0.05 U 0.08 0.10 U 1.00 U 1.00 U	NA NA NA NA NA NA NA NA	5 J 13 140 0.05 U 0.05 U 0.22 3.10 1.00 U	10 U 10 U 10 U 0.05 U 0.05 U 0.10 U 1.00 U 1.00 U
<u>Additional Parameters: (mg/L unless noted otherwise)</u>								
Total Dissolved Solids (TDS)	500	-	312	303	820	575	6768	20
Biological Oxygen Demand (BOD)	-	-	<2	<4	3	<4	191	<2
Color (Pt/Co Units)	15	-	15	NA	10	NA	200	5
Turbidity (NTU)	50	NYSDEC Goal Part 170	12	NA	2.5	NA	>200	0.36
Nitrate	10	-	0.88	NA	0.14	NA	0.15	0.55
Total Kjeldahl Nitrogen (TKN)	-	-	0.17	0.2	0.54	2.4	5200 J	0.02
Ammonia	2	Part 170	<0.03	<0.02	0.12	0.60	784 J	<0.03
Total Organic Carbon (TOC)	-	-	3	3.9	3	5.0	38 R	<0.5
Chemical Oxygen Demand (COD)	-	-	22	<15.0	22	35	2482	11
Nitrite	10	Part 170	<0.02	NA	<0.02	NA	0.09	<0.02
Total Phenols (Phase II ug/l)	1 ug/(D)	-	<0.01	<1	<0.01	<1	<0.01	<0.01
Sulfate	250	-	18	19.6	22	30.7	<5 UJ	30
Chlorides	250	-	58	57	260 J	197	1900 J	25
Alkalinity (as CaCO3(l))	-	-	128	151	187	182	5210	NA
Total Hardness	-	-	NA	200	NA	345	NA	NA
Boron (ug/l)	1000	Part 170	NA	66.9 B	NA	384	NA	NA
Bromide	2*	-	NA	22.6	NA	4.0	NA	NA
Hexavalent Chromium	0.05	-	NA	<0.02	NA	<0.02	NA	NA
Nitrate-Nitrite (as N)	10	Part 170	NA	1.2	NA	0.5	NA	NA

NOTES

CLARKSTOWN LANDFILL RI

Detected Compounds: Phase I and II Groundwater

NA - Not Analyzed

Organic Data Reporting and Validation Qualifiers:

- U - Compound not detected at the instrument detection limit given.
- J - Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1-1 response is assumed or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the specified detection limit but greater than zero. It is also used to qualify data obtained when analytical protocol deviates slightly from criteria set forth by the 1989 (Phase I) and 1991 (Phase II) New York State Analytical Services Protocol (ASP).
- B - Reported result is qualified estimated because of a possible blank interference. Sample concentration is sufficient to treat as a detect (e.g., greater than 5x the blank concentration).
- R - Rejected during data validation.

Inorganic Data Reporting and Validation Qualifiers:

- U - Compound not detected at the instrument detection limit given.
- B - Reported value is less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL).
- J - Indicates an estimated value. Data are qualified estimated because analytical protocol deviate slightly from 1989 (Phase I) and 1991 (Phase II) ASP criteria.
- R - Rejected during data validation.

Notes Pertaining to Regulatory Information:

- (1) = NYSDEC - Technical & Operational Guidance Series (1.1.1), Ambient Water Quality Standards & Guidance Values, November 15, 1991
- (a) - Standard applies to cis- and trans-isomers individually
- (b) - Standard applies to 1,2-; 1,3-; and 1,4-isomers individually
- (c) - Standard applies to sum of 1,2- and 1,4-isomers
- (d) - Standard applies to sum of phenolic compounds
- (e) - Standard applies to sum of DDD, DDE, and DDT
- (f) - Standard applies to sum of Aroclors (PCBs)
- (g) - Standard applies to sum of heptachlor and heptachlor epoxide

TABLE B-10 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - AMBIENT AIR SAMPLES

WESTON ID#	NYSDC(1)	CH1081590-SS	CH1081590-SSD	CH2081590-SS	CH3081590-SS	CD1081790-SS	CD1082790-SS
Canister #	Ambient	77	9	76	88	78	142
Sample Date	Guideline	8/15/90	8/15/90	8/15/90	8/15/90	8/17/90	8/27/90
Validation Date	Concentration	05/07/91	05/07/91	05/07/91	05/07/91	05/07/91	05/07/91
Volatiles: ppm (v/v)							
Dichlorodifluoromethane, Freon 12	---	0.0100	0.0040	0.0050	0.0130	0.0055	0.0005 U
Methyl Chloride	0.34237	0.0050	0.0039	0.0040	0.0034	0.0030 U	0.0045
Trichlorofluoromethane, Freon 11	---	0.0008	0.0009 U	0.0010	0.0011	0.0010 U	0.0086 J
Methylene Chloride	0.00714	0.0010	0.0020 U	0.0007 U	0.0010 U	0.0020 U	0.0008
1,1,2-Trichloro-1,2,2-trifluoroethane, Freon 113	19.34233	0.0009 U	0.0007 U	0.0003 U	0.0005 U	0.0009 U	0.0003 U
Chloroform	0.00432	0.0010 U	0.0010 U	0.0005 U	0.0008 U	0.0010 U	0.0005 U
1,1,1-Trichloroethane	0.16827	0.0014	0.0010 U	0.0009	0.0011	0.0010 U	0.0010
Benzene	0.00003	0.0014	0.0020 U	0.0008 U	0.0016	0.0022	0.0022
Toluene	0.48735	0.0046	0.0020	0.0020	0.0043	0.0051	0.0040
Tetrachloroethylene	0.00001	0.0029	0.0015	0.0010	0.0006 U	0.0016	0.0011
Chlorobenzene	0.00399	0.0020 U	0.0010 U	0.0005 U	0.0008 U	0.0020 U	0.0005 U
Ethylbenzene	0.21147	0.0020 U	0.0010 U	0.0006 U	0.0030	0.0020 U	0.0006 U
m/p-Xylene	0.06344	0.0019	0.0007	0.0006	0.0049	0.0020	0.0011
o-Xylene	0.14803	0.0020 U	0.0010 U	0.0006 U	0.0023	0.0020 U	***
1,3,5-Trimethylbenzene	0.05416	0.0010 U	0.0010 U	0.0005 U	0.0015	0.0010 U	0.0005 U
1,2,4-Trimethylbenzene	---	0.0010	0.0010 U	0.0005 U	0.0047	0.0010 U	0.0005 U
Acetone	5.41150	0.6000	0.3000	0.2000	0.7000	0.0380 UJ	0.0250 U
Carbon Disulfide	0.00206	0.0430 U	0.0430 U	0.0190 U	0.0600	0.0290 UJ	0.0010 J
4-Methyl-2-Pentanone(MIBK)	0.00052	0.0330 U	0.0330 U	0.0150 U	0.0070 J	0.0220 UJ	0.0150 U

***For some samples, results for ortho, meta, and para isomers of xylene were combined to yield Total Xylene Concentration, reported under "m/p xylene".

TABLE B-10 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - AMBIENT AIR SAMPLES

WESTON ID#	NYSED(1)	CD1082890-SS	CD1082890-SSD	CD2081790-SS	CD2082790-SS	CD2082790-SSD	CD2082890-SS
Canister #	Ambient	72	87	63	141	146	134
Sample Date	Guideline	8/28/90	8/28/90	8/17/90	8/27/90	8/27/90	8/28/90
Validation Date	Concentration	05/07/91	05/07/91	05/07/91	05/07/91	05/07/91	05/07/91
Volatiles: ppm (v/v)							
Dichlorodifluoromethane, Freon 12	---	0.0015 J	0.0005 U	0.0100	0.0005 U	0.0005 U	0.0005 U
Methyl Chloride	0.34237	0.0010 U	0.0010 U	0.0053	0.0010 U	0.0010 U	0.0056
Trichlorofluoromethane, Freon 11	---	0.0004 U	0.0004 U	0.0020	0.0004 U	0.0004 U	0.0004 U
Methylene Chloride	0.00714	0.0024	0.0016	0.0010 U	0.0009	0.0011	0.0025
1,1,2-Trichloro-1,2,2-trifluoroethane, Freon 113	19.34233	0.0003 U	0.0003 U	0.0007 U	0.0003 U	0.0003 U	0.0003 U
Chloroform	0.00432	0.0005 U	0.0005 U	0.0010 U	0.0012	0.0006	0.0005 U
1,1,1-Trichloroethane	0.16627	0.0012	0.0009	0.0009 U	0.0004 U	0.0004 U	0.0016
Benzene	0.00003	0.0016	0.0017	0.0023	0.0021	0.0008	0.0022
Toluene	0.48735	0.0037	0.0033	0.0070	0.0029	0.0017	0.0044
Tetrachloroethylene	0.00001	0.0007	0.0005	0.0028	0.0004 U	0.0005	0.0006
Chlorobenzene	0.00399	0.0005 U	0.0005 U	0.0010 U	0.0006	0.0005 U	0.0005 U
Ethylbenzene	0.21147	0.0006 U	0.0006 U	0.0010 U	0.0006 U	0.0006 U	0.0006 U
m/p-Xylene	0.06344	0.0007	0.0008	0.0022	0.0008	0.0006 U	0.0013
o-Xylene	0.14803	---	---	0.0010 U	---	0.0006 U	---
1,3,5-Trimethylbenzene	0.05416	0.0005 U	0.0005 U	0.0010 U	0.0005 U	0.0005 U	0.0005 U
1,2,4-Trimethylbenzene	---	0.0005 U	0.0005 U	0.0010 U	0.0005 U	0.0005 U	0.0005 U
Acetone	5.41150	0.1018	0.4273	0.0320 UJ	0.0529	0.0016 J	0.1424
Carbon Disulfide	0.00206	0.0010 J	0.0010 J	0.0250 UJ	0.0400	0.0190 U	0.0350
4-Methyl-2-Pentanone(MIBK)	0.00052	0.0020 J	0.0150 U	0.0190 UJ	0.0150 U	0.0150 U	0.0150 U

***For some samples, results for ortho, meta, and para isomers of xylene were combined to yield Total Xylene Concentration, reported under "m/p xylene".

TABLE B-10 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - AMBIENT AIR SAMPLES

WESTON ID#	NYSDEC(1)	CD3081790-SS	CD3081790-SSD	CD3082790-SS	CD3082890-SS	CU081790-SS	CU082790-SS
Canister #	Ambient	66	46	133	119	110	131
Sample Date	Guideline	8/17/90	8/17/90	8/27/90	8/28/90	8/17/90	8/27/90
Validation Date	Concentration	05/07/91	05/07/91	05/07/91	05/07/91	05/07/91	05/07/91
Volatiles: ppm (v/v)							
Dichlorodifluoromethane, Freon 12	---	0.0110	0.0081	0.0005 U	0.0005 U	0.0110	0.0010 U
Methyl Chloride	0.34237	0.0020 U	0.0021	0.0010 U	0.0010 U	0.0050	0.0020 U
Trichlorofluoromethane, Freon 11	---	0.0020	0.0013	0.0004 U	0.0004 U	0.0050	0.0009 U
Methylene Chloride	0.00714	0.0016	0.0012	0.0015	0.0019	0.0013	0.0012 J
1,1,2-Trichloro-1,2,2-trifluoroethane, Freon 113	19.34233	0.0006 U	0.0004	0.0003 U	0.0003 U	0.0009	0.0006 U
Chloroform	0.00432	0.0009 U	0.0006 U	0.0005 U	0.0005 U	0.0009 U	0.0010 U
1,1,1-Trichloroethane	0.16827	0.0011	0.0006 U	0.0008	0.0010	0.0020	0.0009 J
Benzene	0.00003	0.0018	0.0015	0.0014	0.0011	0.0025	0.0017
Toluene	0.48735	0.0063	0.0050	0.0036	0.0033	0.0054	0.0026
Tetrachloroethylene	0.00001	0.0007	0.0016	0.0009	0.0006	0.0009	0.0007 U
Chlorobenzene	0.00399	0.0009 U	0.0007 U	0.0005 U	0.0005 U	0.0010 U	0.0010 U
Ethylbenzene	0.21147	0.0012	0.0007 U	0.0006 U	0.0006 U	0.0014	0.0010 U
m/p-Xylene	0.06344	0.0030	0.0016	0.0006 U	0.0006 U	0.0060	0.0034
o-Xylene	0.14803	0.0010	0.0007 U	0.0006 U	0.0006 U	0.0015	***
1,3,5-Trimethylbenzene	0.05416	0.0009 U	0.0006 U	0.0005 U	0.0005 U	0.0009 U	0.0010 U
1,2,4-Trimethylbenzene	---	0.0014	0.0006	0.0005 U	0.0005 U	0.0033	0.0010 U
Acetone	5.41150	0.0320 UJ	0.0330 UJ	0.0977	0.0977	0.0310 UJ	0.1099
Carbon Disulfide	0.00206	0.0250 UJ	0.0250 UJ	0.0010 J	0.0010 J	0.0240 UJ	0.0020 U
4-Methyl-2-Pentanone(MIBK)	0.00052	0.0190 UJ	0.0190 UJ	0.0150 U	0.0150 U	0.0180 UJ	0.0300 U

***For some samples, results for ortho, meta, and para isomers of xylene were combined to yield Total Xylene Concentration, reported under "m/p xylene".

TABLE B-10 DETECTED COMPOUNDS CLARKSTOWN LANDFILL RI - AMBIENT AIR SAMPLES

WESTON ID#	NYSDEC(1)	CU082890-SS	1ST DAY TPBLK	2ND DAY TPBLK	3RD DAY TPBLK	4TH DAY TPBLK
Canister #	Ambient	143	56	79	50	50
Sample Date	Guideline	8/28/90	8/15/90	8/17/90	8/27/90	8/28/90
Validation Date	Concentration	05/07/91	05/07/91	05/07/91	05/07/91	05/07/91
Volatiles: ppm (v/v)						
Dichlorodifluoromethane, Freon 12	---	0.0015 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U
Methyl Chloride	0.34237	0.0010 U	0.0010 U	0.0010 U	0.0010 U	0.0010 U
Trichlorofluoromethane, Freon 11	---	0.0004 U	0.0004 U	0.0004 U	0.0004 U	0.0004 U
Methylene Chloride	0.00714	0.0017	0.0007 U	0.0007 U	0.0007 U	0.0007 U
1,1,2-Trichloro-1,2,2-trifluoroethane, Freon 113	19.34233	0.0003 U	0.0003 U	0.0003 U	0.0003 U	0.0003 U
Chloroform	0.00432	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U
1,1,1-Trichloroethane	0.16827	0.0009	0.0004 U	0.0004 U	0.0004 U	0.0004 U
Benzene	0.00003	0.0011	0.0008 U	0.0008 U	0.0008 U	0.0008 U
Toluene	0.48735	0.0022	0.0006 U	0.0006 U	0.0006 U	0.0006 U
Tetrachloroethylene	0.00001	0.0004 U	0.0004 U	0.0004 U	0.0004 U	0.0004 U
Chlorobenzene	0.00399	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U
Ethylbenzene	0.21147	0.0006 U	0.0006 U	0.0006 U	0.0006 U	0.0006 U
m/p-Xylene	0.06344	0.0006 U	0.0006 U	0.0006 U	0.0006 U	0.0006 U
o-Xylene	0.14803	0.0006 U	0.0006 U	0.0006 U	0.0006 U	0.0006 U
1,3,5-Trimethylbenzene	0.05416	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U
1,2,4-Trimethylbenzene	---	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U
Acetone	5.41150	0.1119	0.0260 UJ	0.0260 UJ	0.0250 U	0.0005 U
Carbon Disulfide	0.00206	0.0190 U	0.0200 UJ	0.0190 UJ	0.0250 U	0.0250 U
4-Methyl-2-Pentanone(MIBK)	0.00052	0.0150 U	0.0150 UJ	0.0150 UJ	0.0190 U	0.0190 U

***For some samples, results for ortho, meta, and para isomers of xylene were combined to yield Total Xylene Concentration, reported under "m/p xylene".

NOTES

CLARKSTOWN LANDFILL RI

Detected Compounds: Phase I and II Ambient Air

Organic Data Reporting and Validation Qualifiers:

- U - Compound undetected at the instrument detection limit given.
- J - Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1-1 response is assumed or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the specified detection limit but greater than zero. It is also used to qualify data obtained when analytical protocol deviates slightly from criteria set forth by the 1989 New York State Analytical Services Protocol (ASP).

Notes Pertaining to Regulatory Information

- (1) New York State Air Guide - 1, Guidelines For the Control of Toxic Ambient Air Contaminants, Division of Air Resources, New York State Department of Environmental Conservation, Sept. 1989 Printing.

DRAFT
DATA USABILITY REPORT
CLARKSTOWN SANITARY LANDFILL
PHASE II SAMPLING DATA

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ATTACHMENTS

Data Validation Reports, Data Validation Services, Inc.

APPENDIX B-2

CLARKSTOWN SANITARY LANDFILL RI/FS FINAL REMEDIAL INVESTIGATION REPORT

**DATA USABILITY REPORT
CLARKSTOWN SANITARY LANDFILL
PHASE II SAMPLING PROGRAM**

OVERVIEW

The data generated during this investigation were generally within acceptable quality control (QC) specifications. Both quantitative and qualitative analyses were acceptable. All critical data are usable. Data are complete (over 90 percent usable) and satisfactorily meet the data quality objectives for this project. The completeness, accuracy, and precision of the data indicate that no additional sampling was required for this specific site. The data validation reports for the Phase II analyses are attached. Data validation was completed by Data Validation Services, Inc. Tabulated data are included in Appendix B of the RI Report. Laboratory analyses were completed by H2M Laboratories, Melville, New York.

This report addresses the following critical items used in determining the overall quality of the data:

- I. Data Quality Objectives.
- II. Data Comparability.
- III. Data Completeness.
- IV. Data Representativeness.
- V. Precision and Accuracy.
- VI. Overview of Data Quality.
- VII. Recommendation for Additional Sampling.

BACKGROUND

A total of 5 soil, 9 sediment, 10 leachate, 21 groundwater, 3 landfill gas, and 9 surface water samples (exclusive of QC samples) were collected during the Phase II field investigation at the Clarkstown Landfill.

The data validation packages for this sampling effort were comprised of seven Sample Delivery Groups (SDGs). Each SDG corresponds to a specific set of samples, as previously designated in the amendment to the Clarkstown Sanitary Landfill Site Operations Plan/Quality Assurance Project Plan, dated November 1993. Table 1 presents a summary of the Phase II sample numbers, sampling locations, and corresponding SDGs.

Table 1
Sample Collection Summary

SDG No.	Sample Nos.	No. of Samples	Site Location/Description
WES025	LB-1, LB-2 LC-1, → LC-8 <u>QC</u> 1 duplicate 1 spike	10	Leachate Holding Basin No. 1 Leachate Holding Basin No. 2 Leachate System Wet Well (LC-8) Leachate Collection Chambers No. 1 → No. 7
WES026	GW-8D, 8S, 9D, 9S <u>QC</u> 1 duplicate 1 spike	4	Groundwater wells located on the northern portion of the landfill
WES027	GW-2, 1S, 1D, 3D, 3S, 4D, 4S, 5S, 6D, 6S, 7D, 7S, 10S, 11, 12, 13 <u>QC</u> 1 duplicate 1 spike	17	Groundwater wells located around the periphery of the landfill
WES028	TP1, TP2, TP3, TP4, TP5 1 duplicate 1 spike	5	Test pits in North East area
WES029	GW-5D	1	Groundwater well RFW-5D
WES030	LFG-3B, LFG-2B, LFG-8B Field Blank Duplicate	4	Selected "Hot Spots" from Phase I - transfer station vent, center and south mound
WES031	SD2, 4, 12, 13, 14, 15, 16, 17, 18 SW2, 4, 12, 13, 14, 15, 16, 17, 18 <u>QC</u> 2 duplicates 2 spikes	18	Five downstream, two upstream and two locations in the wetlands west of the landfill

These samples were analyzed in compliance with previously designated protocol requirements (Table 2), with the exception of the surface water samples for volatiles analysis. An ASP method was used instead of the specified low detection limits (LDL) method (524.2) due to laboratory error. It was mutually agreed by WESTON and NYSDEC that re-sampling and re-analysis of the surface waters for the LDL volatiles was not critical to the project, therefore, was not completed.

Tables following the description of each matrix in Section VI provide a summary of data validation findings in accordance with the U.S. Environmental Protection Agency (EPA) Region II Organic and Inorganic Data Validation Checklist/Guidelines (January 1992) and the Contract Laboratory Program (CLP) portion of the New York State Department of Environmental Conservation (NYSDEC) Analytical Services Protocol (ASP) (December 1991).

I. DATA QUALITY OBJECTIVES

The objectives of the Phase II Clarkstown Landfill field investigation were: to confirm the results obtained during the Phase I sampling effort, to address data gaps and complete the remedial investigation (RI) data base, and to obtain data for the feasibility study to aid in identifying final remedial measures. These data quality objectives were met by the Phase II sampling program.

The Phase II field investigation included:

- Leachate sampling from leachate chambers, basins, and wet well.
- Sampling of surface water and sediment in the streams bordering the landfill.
- Sampling of the landfill gas from the transfer station area, the center of the landfill, and the southern landfill mound.
- Groundwater sampling from the groundwater monitoring wells.
- Test pit and waste sampling program to characterize fill material.

II. DATA COMPARABILITY

This section provides a comparison of the compounds detected in the earlier (Phase I) samples with the results obtained from this Phase II investigation.

Leachate

During Phase I, numerous inorganic compounds were detected in all of the leachate samples, but only zinc in one sample (LC-10) exceeded the local pretreatment regulations

Table 2

Analytical Parameters and Number of Samples for Each Medium

Analytical Parameters	Groundwater	Surface Water	Sediment	Leachate	Soil	Landfill Gas	Analytical Method
Volatile Organics	---	---	---	---	---	3	EPA Method TO-14 ^d
Part 360 Baseline Organics ^a	21 ^b	9 ^b	9 ^c	10 ^c	---	--	EPA 524.2 ^b NYSDECASP ^c CLP 91
TCL Semivolatiles	---	---	9	---	---	--	NYSDEC ASP CLP 91
TCL Pesticide/PCBs	2	2	2	---	---	--	NYSDEC ASP CLP 91
TAL/Part 360 Baseline Metals ^a	21	9	9	10	---	--	NYSDEC ASP CLP 91
Total Cyanide	21	9	9	10	---	--	NYSDEC ASP CLP 91
RCRA Characteristics	---	---	---	---	5	--	NYSDEC ASP CLP 91
TKN	21	---	---	10	---	--	EPA 351.2
Ammonia	21	9	---	10	---	--	EPA 350.1
Nitrate/Nitrite	21	---	---	10	---	--	EPA 353.2
COD	21	---	---	10	---	--	HACH Method 8000
BOD ₅	21	---	---	10	---	--	EPA 405.1
TOC	21	---	9	10	---	--	EPA 415.2
TDS	21	---	---	10	---	--	EPA 160.1
Sulfate	21	---	---	10	---	--	EPA 375.4
Alkalinity	21	---	---	10	---	--	EPA 310.1
Total Phenols	21	---	---	10	---	--	SW-846 9066/ EPA 420.1
Chlorides	21	---	---	10	---	--	SW-846 9052/ EPA 325.3
Hardness	21	9	---	10	---	--	EPA 130
Turbidity/Color	21	---	---	10	---	--	EPA 180.1/ EPA 110.2
Boron	21	---	---	10	---	--	SW-846 6010
Hexavalent Chromium ^a	21	9	9	10	---	--	SW-846 M7195
Bromide	21	---	---	10	---	--	EPA 320.1

Table 2

Analytical Parameters and Number of Samples for Each Medium
(concluded)

Analytical Parameters	Groundwater	Surface Water	Sediment	Leachate	Soil	Landfill Gas	Analytical Method
Equipment Blanks	---	-	---	---	---	1	QA/QC samples shall be analyzed according to appropriate methods, all parameters for each medium.
Field Duplicates	2	2	2	1	1	1	
Matrix Spikes	2	2	2	1	1	---	
Matrix Spike Duplicate	2	2	2	1	1	---	
Trip Blanks	5	2	---	2	---	1	

^aSee attached NYSDEC Part 360 Baseline Parameters List.

^bLow Detection Limit Method; not done for surface water due to lab error, used ASP method instead.

^cNYSDEC ASP Method

^dActual method used was T01/T02 as per NYSDEC.

in force at that time. The most frequently detected inorganics were iron, manganese, chromium, nickel, and zinc. No exceedances of pretreatment regulations were reported for volatile or semivolatile compounds, although standards existed for only one of the detected organic compounds (methylene chloride). The most frequently detected organic compounds in leachate were benzene, chlorobenzene, and carbon disulfide. Acetone and 2-butanone were detected at high levels in three of the four leachate seep samples. The pesticide 4,4-DDT was detected in leachate samples LC-3, LC-3 DUPE, LC-9, and LC-10 with the concentration ranging from 0.13 micrograms per liter ($\mu\text{g/l}$) to 9.2 $\mu\text{g/l}$.

During Phase II, several inorganic compounds were detected in all of the leachate samples; none of the detections exceeded the recently revised County pretreatment standards. The most frequently detected inorganics were cadmium, chromium, copper, iron, manganese, nickel, and zinc. No excess of pretreatment standards were reported for volatile or semivolatile compounds. The most frequently detected organic compounds in leachate were chlorobenzene, xylene (total), and 1,4-dichlorobenzene.

A comparison of the Phase I and Phase II data shows that the most recent (Phase II) maximum concentrations for arsenic, chromium, cadmium, lead, nickel, zinc, cadmium, magnesium, potassium, and sodium are significantly less than the Phase I maximum levels. The organics data between the two phases differ in that carbon disulfide, benzene, toluene, two phthalate compounds, and naphthalene were present in some Phase I samples but not the Phase II samples. The pesticide 4,4-DDT was detected in some Phase I samples; however, leachate samples were not analyzed for pesticides during Phase II. In addition, total xylenes and 1,4-dichlorobenzene were present in the Phase II, but not the Phase I samples. Chlorobenzene, typically associated with petroleum products, was consistently found at similar concentrations during both sampling phases.

Landfill Gas

The soil gas data from Phase I was obtained from shallow depths (<4 feet) and was reported in three separate data sets, namely off-property sample (SG44), western landfill perimeter samples (SG1 and SG7-A) and interior property samples (remaining sample locations). The interior property samples had the greatest number of detected volatile compounds (22) and generally the highest concentration of these compounds: dichlorodifluoromethane (Freon 12) (8 to 17,000 ppb), toluene (4 to 10,000 ppb), m/p xylene (21 to 5,800 ppb), o-xylene (15 to 1,000 ppb), 1,2,4-trimethylbenzene (37 to 680 ppb), benzene (4 to 330 ppb), ethylbenzene (85 to 3,800 ppb), vinyl chloride (4 to 2,100 ppb), and 1,3,5-trimethylbenzene (20 to 80 ppb). The remaining compounds were detected in 50 percent or less of the interior property sample locations at ranges of 1.4 ppb to 610 ppb.

The western landfill perimeter samples had nine detected volatile compounds: vinyl chloride, toluene, Freon 12, ethylbenzene, m/p xylene, o-xylene, and Freon 11 at concentrations that fell within the ranges of the interior property samples, and ethyl chloride (1,500 ppb) and benzene (450 ppb) at concentrations higher than the interior property samples.

The off-property sample (SG44) located northeast of the Town of Clarkstown property in landfilled waste had 12 volatile compounds detected at concentrations that fell within or below

the concentration ranges of the interior property samples. The compound 1,2,4-trichlorobenzene (4.5 ppb) was detected at this location only.

The Phase II soil gas samples were collected from depths of approximately 10 feet, and the results reported in two data sets, namely the transfer station passive vent sample (LFG-8B) and the main landfill samples (LFG-2B, LFG-3B, and LFB-3B DUP). The Phase II detections were comparable to or less than the Phase I detections, confirming the general level of detected VOCs in the gas generated by the landfill.

Twenty-one volatile compounds were detected in the Phase II main landfill samples. Compounds detected during Phase II, which were not detected during Phase I were 1,4-dichlorobenzene (3.1 to 16 ppb), benzyl chloride (3.6 JN to 12 JN ppb), isopropylbenzene (2.3 J to 3.8 ppb), 1,2-dichlorotetrafluoroethane (1.2 J to 7.8 ppb), and chloroethane (7.1 ppb). In addition, dichlorodifluoromethane (8.5 to 32 ppb), vinyl chloride (6.8 to 10 ppb), tetrachloroethene (0.92 J to 12 ppb), toluene (63 to 150 ppb), and o-xylene (14 to 17 ppb) were detected in all Phase II main landfill samples at ranges that fell within the detected concentration ranges from the Phase I main landfill samples. All other detected compounds were found at concentrations lower than those of the Phase I main landfill samples.

Seventeen volatile compounds were detected in the vent sample. 1,1,2-Trichlorotrifluoroethane (0.18 J ppb) was detected only in the vent sample and 1,2-dichlorotetrafluoroethane (11 ppb) was detected at a higher concentration in the vent sample than the Phase II main landfill samples. Both dichlorodifluoromethane (Freon 12) (20 ppb) and benzene (2.7 ppb) were detected in the vent sample within the concentration ranges for the Phase II main landfill samples. All other detected compounds in the vent sample were found at concentrations lower than those of the Phase II main landfill samples.

A Phase II soil gas screening was also completed along the Route 303 boundary of the landfill property to identify the potential for off-site landfill gas migration. A preliminary screening conducted as part of the Phase I soil gas sampling effort indicated that off-site gas migration did not appear to be a concern at the site. The Phase II screening was designed to confirm these earlier Phase I findings. During the Phase II effort, 7 of the 13 soil gas locations produced combustible gas levels above the regulatory limit of 5 percent gas in air. The data suggest that control of landfill gas migration along Route 303 is warranted. Combustible gas levels in samples collected from around the landfill garage and administration building were below the regulatory limit of 25 percent of the lower explosive limit (LEL) of gas in air.

Groundwater

During Phase I, the greatest number and highest concentrations of organic compounds in groundwater were reported for leachate samples obtained from monitoring wells screened in the refuse.

A majority of the detections in the leachate wells included the aromatic hydrocarbons; such as benzene, toluene, xylenes, and ethylbenzene. The highest detections above groundwater standards occurred for toluene (180 µg/l) and the chlorinated hydrocarbon 1,2-dichloroethene (100 µg/l) in leachate monitoring well RFW-14 during the Phase I RI. Only one organic

compound (chlorobenzene) was present in the RI leachate well RFW-9S at a concentration equal to the groundwater standard (5 µg/l).

The upgradient groundwater was found to be relatively free of organic contamination. With the exception of one detection of the pesticide, Endosulfan I, no organic compounds were found in upgradient monitoring wells.

Excluding the two leachate wells (RFW-9S and RFW-14), five organic compounds were present in the Phase I RI downgradient groundwater samples. All but one of these compounds were present at levels above the state groundwater standards.

Only two volatile organic compounds, 1,2-dichloroethene (total) and trichloroethene, were detected each in one RI well at concentrations slightly greater than the standards. Trichloroethene was present in RFW-3S at 13 µg/l during Round 1. The 1,2-dichloroethene detection was reported at 13 µg/l for well RFW-9D.

The pesticide 4,4-DDT and the polychlorinated biphenyl (PCB) Aroclor-1260 were detected at extremely low concentrations in two adjacent downgradient RI wells (RFW-2 and RFW-3D).

Chromium, iron, lead, and manganese were found at levels exceeding the state groundwater standards in downgradient Phase I RI well samples. The highest chromium detection was reported for an upgradient/background bedrock monitoring well (RFW-11D). Lead was detected above the standard in a leachate monitoring well (RFW-14) and in two shallow downgradient wells (RFW-6S and RFW-7, respectively). Zinc and cadmium concentrations exceeded the respective standard in one Phase I RI well (RFW-14). The iron and manganese concentrations were particularly high in all classes of monitoring wells (upgradient, downgradient, and leachate wells).

Volatile organic compounds were detected in nine of the Phase II groundwater samples, and in two of the samples above the respective state groundwater standards. The detections above state standards occurred for the chlorinated solvents cis-1,2-dichloroethene at 12 µg/l in well RFW-9D and tetrachloroethane at 7 µg/l in RFW-10D, both above the respective standards of 5 µg/l.

No volatile organic compounds were present above the state standards in samples from any of the other monitoring wells sampled during the Phase II effort. Trace concentrations of volatile organics at or less than 5 µg/l were reported for wells RFW-3S (Phase II round, trichloroethene at 2 µg/l, RFW-4S (2-butanone at 5 µg/l), RFW-5D (toluene at 4 J µg/l and total xylenes at 2 J µg/l), RFW-8D (vinyl chloride at 1 J µg/l, 2-butanone and carbon tetrachloride at 1 µg/l, and trichlorofluoromethane at 2 µg/l, RFW-9S (chlorobenzene at 4 µg/l), RFW-12 (trichloroethene at 2 µg/l and tetrachloroethene at 4 µg/l, and RFW-13 (chlorobenzene at 1 µg/l).

The greater number of detections for volatile organics in the Phase II samples compared to the Phase I samples is likely due to the lower analytical detection limits achieved during Phase II. Detections were reported for the upgradient wells (RFW-10D and RFW-13), the leachate well RFW-9S, and six downgradient wells (RFW-3S, 5D, 8D, 9D, and 12 in the outwash/till; and RFW-4S in the peat).

The pesticide heptachlor was detected at extremely low concentrations in downgradient wells RFW-2 and RFW-3D. These wells were sampled for pesticides to confirm the Phase I detections of 4,4-DDT at trace levels. This compound was not detected in any other samples collected at the landfill.

During Phase II, chromium, iron, lead, and manganese were detected at levels exceeding the state standards. Chromium was detected above the standard at upgradient and downgradient monitoring wells screened in the bedrock aquifer, as well as, in the outwash deposits. The highest chromium level was present at RFW-8D, a downgradient well screened in the outwash. Lead was detected slightly above the standard in leachate monitoring well RFW-9S. Elevated concentrations of iron and manganese were detected during Phase II, similar to the Phase I results.

Other inorganics exceeding the groundwater standards were barium at 3,700 $\mu\text{g/l}$ in RFW-8S, above the standard of 1,000 $\mu\text{g/l}$, and sodium above the 20,000 $\mu\text{g/l}$ standard in wells RFW-7D, 7S, 8D, 9D, 9S, 10S, 11, 12, and 13, ranging from 20,600 $\mu\text{g/l}$ (RFW-12) to 216,000 $\mu\text{g/l}$ (RFW-9S).

Test Pit Soils

During the Phase II investigation, eight test pits were excavated to determine the waste thickness in two areas of the landfill (the Northeast Area and former Ballfield Area). Five samples were collected from the Northeast Area to determine if the wastes in the Northeast Area were hazardous according to the Resource Conservation and Recovery Act (RCRA) regulations. The wastes in the Northeast Area extend beyond the town property line. The waste thickness ranged from 5 feet to over 25 feet in the Northeast Area and from 9.5 feet to 15 feet in the former Ballfield Area.

While no samples exceeded the regulatory limits, the following compounds were detected at levels below the limits in the TCLP extract: barium (480B $\mu\text{g/l}$ to 1,150B $\mu\text{g/l}$), cadmium (1.6B $\mu\text{g/l}$ to 4.1 $\mu\text{g/l}$), lead (28B $\mu\text{g/l}$ to 384B $\mu\text{g/l}$), selenium (37.9B $\mu\text{g/l}$ to 60.0B $\mu\text{g/l}$), chromium (7.3B $\mu\text{g/l}$), chlorobenzene (1 J $\mu\text{g/l}$ to 12 $\mu\text{g/l}$), and 2-butanone (1 J $\mu\text{g/l}$). The RCRA characteristics results showed that two samples, while below the regulatory limit of 500 mg/kg, were reactive to sulfide (RFW TP3 at 308 mg/kg and RFW TP5 at 74.6 mg/kg).

Surface Water

During the Phase I sampling effort, nine volatile organic compounds and two semivolatile organic compounds were present in the surface water samples, although no pesticides or PCBs were found in the samples. Tetrachloroethane was detected at upstream location SW-3 (7.0 $\mu\text{g/l}$) and at downstream location SW-4 (2.0 J $\mu\text{g/l}$). Bis(2-ethylhexyl)phthalate exceeded the applicable standard of 0.6 $\mu\text{g/l}$ in sample SW-12 at 4 J $\mu\text{g/l}$. No other organic compounds were detected at concentrations exceeding regulatory levels.

Generally lower concentrations and frequencies of detection of volatile organic compounds were reported for the Phase I downstream samples than the upstream samples. Four of the nine volatile organic compound detected were not reported in any of the downstream locations

(methylene chloride, chloroform, 1,1,1-trichloroethane, and bromodichloromethane). The greatest number of detections and highest concentrations of volatile organic compounds occurred at upstream location SW-11, located in a southerly-flowing tributary at the northwest corner of the landfill.

Two semivolatile organic compounds were detected only in upstream samples, namely di-n-butylphthalate and bis(2-ethylhexyl)phthalate.

The most frequently detected metals during the Phase I round of sampling were aluminum, iron, lead, manganese, and zinc. Aluminum and iron were detected in all of the samples. Iron exceeded the ambient water quality standard in all but one sample, while aluminum exceeded the standard in 6 of the 12 samples.

The zinc and lead standards were exceeded in two upstream and one downstream Phase I sample, namely in upstream samples SW-11 (zinc at 49.0 $\mu\text{g/l}$) and SW-10 (lead at 3.7 BJ $\mu\text{g/l}$) and downstream wetlands sample SW-7 (zinc at 485 J $\mu\text{g/l}$ and lead at 94.8 J $\mu\text{g/l}$). In addition, the lead concentration was reported at the calculated standard value of 3.8 BJ $\mu\text{g/l}$ at downstream location SW-9. Of the remaining metals detected, aluminum, manganese, cadmium, and copper exceeded the respective standard in at least one sample. Cadmium was reported slightly above the calculated standard of 2.4 $\mu\text{g/l}$ in one sample (downstream sample SW-5 at 4.0 B $\mu\text{g/l}$). Copper exceeded the calculated standard in one upstream (SW-10) and two downstream samples (SW-6 and SW-7). The aluminum and manganese standards were exceeded in SW-7. There were no reported excess of standards for arsenic, chromium, nickel, and silver, although the mercury analytical data were rejected during data validation.

During Phase II surface water sampling, there was only one volatile organic detection at downstream location SW-16-02 in the wetlands. Trichloroethene was detected at 2 $\mu\text{g/l}$ at this location below the NYSDEC guidance value of 3 $\mu\text{g/l}$. During Phase II, surface water samples were not analyzed for semivolatile organics. Two locations, SW-4-02 and SW-17-02 were analyzed for pesticides and PCBs due to Phase I detections in groundwater monitoring wells near those sampling stations. There were no detections of either type of compound in these two samples.

During Phase II, the most frequently detected metals were aluminum, copper, iron, lead, manganese, nickel, and zinc. All of these compounds except lead were detected in all samples. Iron exceeded the applicable ambient water quality standard in all samples. Phase II sample SW-17-02 showed the greatest number of inorganics detected and the highest concentrations for seven of the nine inorganics tabulated.

During Phase II, calculated copper and lead standards were exceeded each in only one sample, namely in downstream samples SW-15-02 (copper at 12.3 B $\mu\text{g/l}$) and SW-17-02 (lead at 15.1 $\mu\text{g/l}$). Three of the nine samples exceeded the zinc standard of 30 $\mu\text{g/l}$ (downstream samples SW-15-02 at 35.6 $\mu\text{g/l}$, SW-16-02 at 65.8 $\mu\text{g/l}$, and SW-17-02 at 82.6 Pb/l). The aluminum standard of 100 $\mu\text{g/l}$ was also exceeded at these three locations.

Sediment

Overall, the Phase I sediment sample locations upstream of the Clarkstown Landfill reported higher concentrations and frequencies of detection of the organic compounds indicating the presence of upstream sources of organic contamination. The following eight volatile organic compounds were detected: acetone, methylene chloride, 1,1-dichloroethene, 1,1-dichloroethane, chloroform, 2-butanone, benzene, and chlorobenzene. Several semivolatile organic compounds, primarily those classified as polycyclic aromatic hydrocarbons (PAHs), and one pesticide, 4,4-DDT, were also detected in the samples.

Of the eight volatile organic compounds detected during Phase I, only one, 1,1-dichloroethene, was present above its human health criterion of $0.02 \mu\text{g/gOC}$ (micrograms per gram of organic carbon). Upstream location SD-2 reported a value of $0.05 \mu\text{g/gOC}$, slightly above the criterion, and downstream location SD-5 reported a value of $0.25 \mu\text{g/gOC}$.

During Phase I, six of the PAHs exceeded their respective human health sediment criteria. Aquatic sediment criteria do not exist for these six compounds. The highest excess were reported for upstream samples SD-1, SD-11, and SD-12, ranging from $9.17 \mu\text{g/gOC}$ [(indeno(1,2,3-cd)pyrene in SD-1)] to $28 \mu\text{g/gOC}$ [benzo(a)anthracene, chrysene, and benzo(a)pyrene in SD-12], above the human health criteria of $1.3 \mu\text{g/gOC}$. The only downstream location with reported exceedances, SD-6 located along the Hackensack River, is the furthest downstream sampling location. No semivolatiles, including PAHs, were present in the upstream Hackensack River sediment sample, SD-10.

One pesticide compound was found in one Phase I RI sediment sample. 4-4-DDT was present in downstream Hackensack River sediment sample SD-06 at $0.34 \mu\text{g/gOC}$, above the human health criterion of $0.01 \mu\text{g/gOC}$, but below the aquatic acute and chronic toxicity criteria.

During Phase I, the most frequently detected of the above heavy metals were arsenic, chromium, copper, lead, nickel, and zinc. In general, the metals were present at varying concentrations in both upstream and downstream samples. The lowest concentrations were reported for two upstream samples, SD-1 and SD-10, and two downstream samples, SD-4 and SD-5. Lead was present at high concentrations in upstream sample SD-11 at 421.0 milligrams per kilogram (mg/kg) and downstream Hackensack River sample SD-06 at 462.0 J mg/kg, compared to the other samples, which ranged from 5.2 J mg/kg (SD-4) to 189 mg/kg (SD-12). Zinc was significantly elevated in upstream samples SD-2 (1730.0 J mg/kg) and SD-11 (930.0 mg/kg) compared to the other samples.

During Phase I, the heavy metals copper, lead, and zinc, and the naturally-occurring metals iron and manganese each exceeded the state SEL in at least one sample. The zinc SEL (270 mg/kg) was exceeded in four upstream samples (SD-2, SD-3, SD-11, and SD-12) from 354 to 1730 J mg/kg and four downstream samples (SD-6 through SD-9) from 306 to 692 mg/kg. The manganese SEL (1100 mg/kg) was slightly exceeded in only one sample, SD-9, collected at the confluence of Greenbush Brook and the Hackensack River at 1140 mg/kg. The SELs for copper, lead, and iron were exceeded in three upstream samples (SD-3, SD-11, and SD-12) and three downstream samples (SD-6, SD-8, and SD-9).

During the Phase II sampling, the following five volatile organic compounds were detected: methylene chloride, acetone, carbon disulfide, 2-butanone, and 2-hexanone. With the exception of carbon disulfide, these volatiles are common laboratory artifacts. There are no sediment criteria for these compounds.

Similarly to the Phase I results, with the exception of samples SD-13 and SD-14, the Phase II upstream sample locations reported higher ranges of concentrations and frequencies of detection of the organic compounds in sediment than downstream locations. Sample SD-14 reported the greatest number of detections and highest concentrations of organics for all samples, including the greatest number of detections above the human health sediment criteria. Semivolatile organic compounds in SD-14 ranged from 10.62 $\mu\text{g/gOC}$ (acenaphthene) to 461.54 $\mu\text{g/gOC}$ (fluoranthene). Sample SD-14 was the only Phase I or Phase II sample to exceed a semivolatile aquatic criterion; the chronic criterion for the PAH phenanthrene (120 $\mu\text{g/gOC}$) was exceeded at a concentration of 353.85 $\mu\text{g/gOC}$.

The Phase II detected semivolatile organics are almost exclusively limited to the PAHs. The most commonly detected semivolatiles include the PAHs fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, and indeno(1,2,3-cd)pyrene. During Phase II, seven of the PAHs exceeded their respective sediment criteria. Upstream sample SD-2 reported six PAH detections above the human health based criterion (1.3 $\mu\text{g/gOC}$) for benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, and indeno(1,2,3-cd)pyrene with concentrations ranging from 5.75 $\mu\text{g/gOC}$ [indeno(1,2,3-cd)pyrene] to 19.54 $\mu\text{g/gOC}$ [benzo(b)fluoranthene]. No other upstream locations reported values exceeding criteria. Phase II downstream samples SD-13, SD-14, and SD-15 all reported PAH detections above the 1.3 $\mu\text{g/gOC}$ criterion for the same six PAHs mentioned above.

During Phase II, samples SD-4 and SD-17 were sampled for pesticides and PCBs, as well as, the semivolatiles to evaluate the presence of 4,4-DDT and Aroclor-1260 in Phase I samples from two nearby groundwater monitoring wells. There were no pesticide detections reported in SD-17. The pesticide heptachlor epoxide was detected at SD-4 with a concentration of 0.03 $\mu\text{g/gOC}$, exceeding the human health based criterion (0.0008 $\mu\text{g/gOC}$), but not the aquatic toxicity criteria. No other pesticide or PCB detections were reported for either sample.

During Phase II, the most frequently detected heavy metals were arsenic, cadmium, chromium, copper, lead, nickel, and zinc. Similar to the Phase I results, the metals were present at varying concentrations in both upstream and downstream samples. Overall, SD-17 reported the lowest concentrations of heavy metals, while SD-16 in the wetlands reported the highest metals concentrations.

During Phase II, the heavy metals copper, iron, lead, manganese, and zinc each exceeded the SEL in at least one sample. The copper SEL (110 $\mu\text{g/gOC}$) was slightly exceeded in one downstream sample (SD-16) with a concentration of 125 $\mu\text{g/gOC}$. The lead SEL (110 $\mu\text{g/gOC}$) was exceeded in three downstream samples (SD-13, SD-15, and SD-16) with concentrations ranging from 194 J $\mu\text{g/gOC}$ (SD-15) to 310 J $\mu\text{g/gOC}$ (SD-16). The zinc SEL (270 mg/kg) was exceeded in three downstream samples (SD-13, SD-15, and SD-16) with concentrations ranging from 320 mg/kg (SD-13) to 899 mg/kg gOC (SD-16).

III. DATA COMPLETENESS

As stated in the Site Operations Plan for Clarkstown Landfill, a goal of 90 percent valid data was established. This goal was exceeded and all critical data were valid.

IV. REPRESENTATIVENESS

Samples were collected in accordance with the sampling protocol detailed in the Final Standard Operating Procedure/Quality Assurance Project Plan (SOP/QAPP) with the exception of the landfill gas samples which were collected in accordance with procedures specific to EPA Method TO-1/TO-2, instead of Method TO-14. The change in sampling methods were reviewed with NYSDEC beforehand and are documented in Section 2.0 of the RI Report. Deviations from the sampling protocol should have no effect on sample representativeness.

V. ACCURACY AND PRECISION

Accuracy as measured by method blank spike and matrix spike recoveries (MS/MSD) were within ASP established control limits, except as qualified in the text.

Precision as measured by relative percent difference between results for laboratory or field duplicate and MS/MSD samples were within ASP established control limits, except as qualified in the text.

VI. OVERVIEW OF DATA QUALITY

The data generated during this investigation were generally within acceptable QC specifications. Both quantitative and qualitative analyses were acceptable, except for semivolatile acid fractions for five samples in SDG No. WES28, which were rejected due to poor recovery of acid surrogates.

Data are valid and usable with appropriate qualifiers. No additional sampling was recommended for this specific site.

The following discussion summarizes areas of deviation for each analytical fraction in each matrix.

LEACHATE BASIN/CHAMBER SAMPLES

A summary of the data quality for the leachate basin/chamber samples is provided in Table 3.

Volatile Organic Compounds

Method Blanks: Results for 2-hexanone in the leachate samples were qualified as non-detected since it was detected in the samples at a value less than 5 times the associated method blank value. It was also noted that the spectrum of the compound identified as 2-hexanone shows the presence of uncharacteristic mass fragments which do not respond to background subtraction, indicating the possibility of incorrect identification or the presence of a coeluting contaminant.

The positive results reported for acetone, a common laboratory contaminant, were qualified as non-detected since it was detected in the leachate samples at less than 10 times the associated trip blank value.

Compound Identification and Quantitation: The spectrum of the compound identified as chloroethane in sample LC7-02 shows mass fragments which did not respond to background subtraction, indicating a possibility for incorrect identification or the presence of a coeluting contaminant. This result was flagged with an "N," indicating presumptive evidence or tentative identification.

Metals + Boron and Cyanide

Calibration: Due to elevated recovery (181 percent) of boron standard at 200 µg/l, the reported boron value for sample LC6-02 was qualified as estimated.

Matrix Spike: Matrix spike, duplicate and serial dilution evaluations were performed on sample LB1-02. The elements aluminum, selenium, and thallium produced matrix spike recoveries below the recommended limit of 75 percent. The reported results for these elements in all associated leachate samples were qualified as estimated.

The following elements produced post digest spike recoveries outside the recommended range of 85 to 115 percent. Due to the implied matrix effect, all reported values listed below were qualified as estimated:

LB1-02	Thallium
LB2-02	Selenium, Thallium
LC1-02	Selenium, Thallium
LC2-02	Selenium, Thallium
LC3-02	Selenium, Thallium
LC4-02	Thallium
LC5-02	Thallium
LC6-02	Selenium, Thallium
LC7-02	Selenium
LC8-02	Arsenic, Thallium

Table 3
Leachate Basin/Chamber Analytical Data Assessment

Sample No.	VOA	Notes	Metals	Notes	CN	Notes	Wet Chem	Notes
LB1-02	A	b	A, Q	a	A		A	
LB2-02	A	b	A, Q	a	A		A	
LC1-02	A	b	A, Q	a	A		A	
LC2-02	A	b	A, Q	a	A		A	
LC3-02	A	b	A, Q	a	A		A	
LC4-02	A	b	A, Q	a	A		A	
LC5-02	A	b	A, Q	a	A		A	
LC6-02	A	b	A, Q	a	A		A	
LC7-02	A	b, c	A, Q	a	A		A	
LC8-02	A	b	A, Q	a	A		A	

Estimated results for selected metals due to low matrix spike recovery.

Blank corrections for acetone, 2-hexanone in some samples.

The identity of chlorothene in this sample was not established.

A = Usable and Defensible.

Q = Usable with Qualification.

Wet Chemistry/Conventionals

Data were acceptable without qualification.

GROUNDWATER SAMPLES

A summary of the data quality of the groundwater samples is provided in Table 4.

Volatile Organic Compounds

Method Blank: The positive results reported for acetone, a common laboratory contaminant, were qualified as non-detected since it was detected in the groundwater samples at less than 10 times the associated trip blank value.

Calibration: Initial and continuing calibration standards recovered well with several exceptions. Due to erratic responses (32 percent RSD) in associated initial calibration standards, reported detection limit for vinyl chloride was qualified as estimated. The response of 1,1-dichloroethene in the volatile continuing calibration standard of 12/30/93 produced low response relative to the curve (36 percent difference). The reported detection limit for this compound in samples GW2-02, GW3S-02, GW3D-02, GW4D-02, GW4S-02, GW5S-02, GW10D-02, GW10S-02, GW11-02, GW12-02, GW6D-02, GW6S-02, GW7D-02, GW7S-02, and GW13-02 was qualified as estimated, possibly biased low.

Matrix Spike/Matrix Spike Duplicate: Matrix spike/matrix spike duplicate analyses were performed on samples GW1S-02 and GW9S-02 at levels of 5 µg/l. Recoveries of four out of ten spike analytes were below QC limits for each of the set of MS/MSD analysis. Recoveries of all spike compounds except 1,1-dichloroethene were greater than or equal to 60 percent. 1,1-Dichloroethene recovered at 40 percent and 60 percent in GW1S-02MS and GW1S-02MSD and 18 percent and 40 percent in GW9S-02MS and GW9S-02MSD respectively. However, its recovery was 80 percent in the associated Laboratory Fortified Blank (LFB). Internal standard area responses in GW9S-02MS were suppressed and those of the GW9S-02MSD were below QC limits while the sample itself had normal area responses. The method blank spike analysis had to be performed three times before satisfactory recoveries were obtained for 1,1-dichloroethene. These low recoveries may be due to low response factor in the continuing calibration or the result of procedural anomalies (such as leak at purge vessel or spike variance). Since 1,1-dichloroethene results were already qualified as estimated due to calibration, no further qualification was necessary.

Table 4
Groundwater Analytical Data Assessment

Sample No.	VOA	Notes	Pest/PCB	Notes	Metals	Notes	CN	Notes	Wet Chem	Notes
GW1D-02	A		NR		A		A		A	
GW1S-02	A		NR		A		A		A	
GW2-02	A, Q	*	A		A		A		A	
GW3D-02	A, Q	*	A		A		A		A	
GW-3S-02	A		NR		A		A		A	
GW4D-02	A, Q	*	NR		A		A		A	
GW4S-02	A, Q	*	NR		NR		NR		NR	
GW4S-02	NR		NR		A		A		A	
GW5S-02	A, Q	*	NR		A		A		A	
GW6D-02	A, Q	*	NR		A		A		A	
GW6S-02	A, Q	*	NR		A		A		A	
GW7D-02	A, Q	*	NR		A		A		A	
GW7S-02	A, Q	*	NR		A		A		A	
GW8D-02	A		NR		A		A		A	
GW8S-02	A		NR		A		A		A	
GW9D-02	A		NR		A		A		A	
GW9S-02	A		NR		A		A		A	
GW10D-02	A	*	NR		A		A		A	

Table 4
Groundwater Analytical Data Assessment
(concluded)

Sample No.	VOA	Notes	Pest/PCB	Notes	Metals	Notes	CN	Notes	Wet Chem	Notes
GW10S-02	A	*	NR		NR		A		A	
GW10S-02	NR		NR		A		NR		NR	
GW11-02	A	*	NR		NR		A		A	
GW11-02	NR		NR		A		NR		NR	
GW12-02	A		NR		A		A		A	
GW13-02	A	*	NR		A		A		A	

*Detection limit for 1,1-dichloroethene was estimated due to large difference in calibration response.

A = Usable and Defensible.

NR = Analysis not Required.

Q = Usable with Qualification.

Due to low recoveries of the following target compounds in the associated Laboratory Fortified Blanks run at the reported CRDL (5 µg/l), the following detection limits for the samples should be qualified as estimated:

<u>Compound</u>	<u>Associated Samples</u>
<i>trans</i> 1,4-Dichloro-2-butene	All WES026, GW1D-02, GW1S-02
1,2-Dibromo-3-chloropropane	All remaining groundwaters
Chloromethane	
Bromomethane	

Pesticide/PCB Analyses

Although the RTX-35 column shows significant noise response, the reported results for these project samples are not affected, reported results are supported by the raw data and data were acceptable without qualification.

Metals + Boron and Cyanide

Matrix Spike: Matrix spike, duplicate, and serial dilution evaluations were performed on samples GW1S-02 and GW9S-02. Matrix spike recoveries for selenium in both samples GW9S-02 (58 percent) and GW1S-02 (66 percent) were below the recommended limit of 75 percent. Therefore, selenium results for groundwater samples were qualified as estimated.

In addition, the matrix spike recovery of thallium (74.2 percent) in sample GW9S-02 was just below the recommended limit (75 percent). The lead spike of sample GW9S-02MS produced a very low recovery of 13 percent, but the sample itself required a Method of Standard Analysis (MSA) determination due to matrix effect. MSA is not required for matrix spikes, and was not performed on the spike. Consequently, the comparison of spike result to sample result is not valid. No other sample in the SDG showed the same matrix effect as GW9S-02; and therefore, qualification of lead results is not recommended.

The following elements produced post digest spike recoveries outside the recommended range of 85 to 115 percent. Due to the implied matrix effect, the following reported values should be considered estimated.

GW1D-02	Arsenic
GW1S-02	Arsenic, Selenium
GW3D-02	Arsenic
GW3S-02	Arsenic, Selenium
GW4S-02	Selenium
GW5S-02	Arsenic
GW6S-02	Selenium
GW7D-02	Arsenic, Lead
GW8D-02	Arsenic, Selenium
GW8S-02	Arsenic, Lead, Selenium

GW9D-02	Selenium
GW9S-02	Selenium, Thallium
GW10D-02	Arsenic
GW10S-02	Lead, Selenium
GW11-02	Lead, Selenium
GW13-02	Selenium

Laboratory Duplicate Precision: The cyanide analysis of GW9S-02 initially produced a value of 32.4 µg/l, but its duplicate was repeated to be below CRDL. The initial, elevated result was noted as possibly being a result of carryover from a previous run, but the value of the previous sample was only 18 µg/l, and no other samples in the sequence prior to this duplicate produced a value over CRDL. Therefore, the original cyanide result for GW9S-02 was considered as an anomaly and the non-detected value was accepted.

WET Chemistry/Conventionals

Data were acceptable without qualification.

LANDFILL GAS

A summary of the data quality of the landfill gas samples is provided in Table 5.

Table 5
Landfill Gas Analytical Data Assessment

Sample No.	VOA	Notes
LFG-FB	A, Q	*
LFG-3B	A	*
LFG-3B DUP	A	*
LFG-2B	A	*
LFG-8B	A, Q	*

* Reported detection limits for tetrachloroethene 1,2,4-trichlorobenzene and hexachlorobutadiene in all air samples should be considered estimated due to low level calibration standards.

A = Usable and Defensible.

Q = Usable with Qualification.

Volatile Organic Compounds

Method Blanks: The methylene chloride detected in the air samples was qualified as non-detected since it was detected at levels less than five times the value in the associated field blank.

Compound Identification and Quantitation: The benzyl chloride reported for air samples LFG-2B, LFB-3B, and LFG-3B-DUP were flagged as "N" for tentative identification, and "J" for estimated value. The spectra associated with the responses identified as benzyl chloride are inconclusive for identification (common quantitation ion, no parent ion, and numerous interferences) and reflect contribution to the quantitation ion ($n/z=91$) from other, coeluting aromatic compounds.

The reported detection limits for tetrachloroethene in LFG-8B and LFG-FB, and those of 1,2,4-trichlorobenzene and hexachlorobutadiene in each air sample should be considered estimated. This is due to the fact that the lowest level calibration standard concentration is 20 times the reported detection limits for these compounds, and linearity at the low levels has not been established.

SOIL SAMPLES

A summary of the data quality of the test pit soil samples is provided in Table 6.

TCLP Analysis Volatile Organic Compounds

Surrogate Recoveries: Surrogate recoveries were within required ranges, with the exceptions of BFB in sample RFW TP-1. Repeat analyses show recoveries of 82 percent and 58 percent, below the limit of 86 percent.

Matrix Spike/Matrix Spike Duplicate Analyses: Matrix spike analyte recoveries of sample RFW TP-3 produced acceptable values, with the exception of those of 2-butanone, which recovered at 54 percent and 58 percent, below the recommended limit of 97 percent. Recoveries of the associated matrix spike blank (MSB) were acceptable. The duplicate correlation of the matrix spikes was good.

The chloroform value reported for the volatile MSB was not supported by the raw data (no entry on quantitation report, and no spectrum), and should be rejected.

Semivolatile Compounds

Initial and Continuing Calibration: Initial and continuing calibration standards met required criteria, with the exception that the same area response was reported for 4-methylphenol and 3-methylphenol. The two compounds coelute (and therefore individual linearity has not been determined). The issue is not critical to this delivery group's samples, as acid compound results are rejected due to matrix effect.

Table 6

Test Pit Soil Sample Analytical Data Assessment

Sample No.	VOA	Notes	SV	Notes	Pest/PCB	Notes	Metals/CN	Notes	Other	Notes
TP-1	A		A, R	a	A		A, Q	b	A	
TP-2	A		A, R	a	A		A, Q	b	A	
TP-3	A		A, R	a	A		A, Q	b	A	
TP-4	A		A, R	a	A		A, Q	b	A	
TP-5	A		A, R	a	A		A, Q	b	A	

a Reported results for all acid components in TCLP semivolatile fractions must be rejected, due to lack of recovery of acid surrogates for repeated TCLP extractions of all samples.

b Reported results for silver were estimated due to low silver recovery in the laboratory control sample.

A = Usable and Defensible.

Q = Usable with Qualification.

R = Rejected due to various deviations from ASP Protocol.

Surrogates: Due to the lack of recovery of acid surrogates for repeated TCLP extractions of each sample, the reported results for acid components in the TCLP semivolatile fractions must be rejected. These poor recoveries were not reflected in the TCLP extraction fluid method blank, indicating sample matrix effect. The same effect was evident by similarly poor acid spike recoveries in the sample matrix spikes. The initial extraction results for the base/neutral compounds of the samples can be used without qualification. The re-extractions, which verified the poor acid recoveries, were performed beyond a usable holding time.

Internal Standard Response: Sample RFW TP-4 had one internal standard response just below the 50 percent limit, but the value was greater than 49.9 percent; therefore, qualification is not recommended.

Herbicides

Surrogates: Surrogate recoveries were acceptable (R=49-79 percent) with the exception of sample RFW TP-4 (26 percent).

Compound Identification and Quantitation: The reported detection limits for the herbicides (2,4-D and 2,4,5-TP) in sample RFW TP-4 should be considered estimated, possibly biased low, due to chromatographic interferences which may prohibit detection at low levels. This is supported by the relatively low surrogate recovery for the sample (26 percent).

Pesticides

QC limit requirements were met for each parameter except that the response for beta-BHC in the PEM on RTX-5 was 30 percent RFD, exceeding the limit of 25 percent RPD. Reported sample results are not affected.

Metals

Laboratory Control Sample: Due to the poor recovery (4 percent) exhibited by silver in the Laboratory Control Sample (LCS), reported silver results for the samples were qualified as estimated and should be considered significantly biased low. The laboratory was not required to take corrective action, but the depressed recovery does reflect on sample results, as well.

Matrix Spike: Matrix spike recoveries of sample RFW TP-3 were within the recommended range, except for that of barium, which was 1 percentage point high (126 percent).

SURFACE WATER

A summary of the data quality of the surface water samples is provided in Table 7.

Table 7

Surface Water Analytical Data Assessment

Sample No.	VOA	Notes	Pest/PCB	Notes	Metals	Notes	Inorganics	Notes
SW2-02	A		NR		A, Q	b	A	
SW4-02	A		A		A, Q	b	A	
SW12-02	A		NR		A, Q	b	A	
SW13-02	A		NR		A, Q	b	A	
SW14-02	A		NR		A, Q	b	A	
SW15-02	A		NR		A, Q	b	A	
SW16-02	A		NR		A, Q	b	A	
SW17-02	A		A		A, Q	b	A	
SW18-02	A		NR		A, Q	b	A	
GW5D-02	A, Q	a	NR		A, Q	b	A, Q	c
TBGW-032394	A		NR		NR		A	
TBSW-041894	A		NR		NR		NR	
TBSW-041994	A		NR		NR		NR	

a Positive results for toluene and xylene in sample GW5D-02 were estimated due to high recovery of surrogate BFB and non-detected results for acrylonitrile and 1,4-dichloro-2-butene were estimated due to low recovery in the MBS sample.

b Results were estimated due to spike recoveries outside QC limit.

c TDS result for sample GW5D should be qualified as non-detected due to blank contamination.

A = Usable and Defensible.

NR = Analysis not Required.

Q = Usable with Qualification.

Volatile Organic Compounds

Detection limits: The surface water samples were not analyzed for Part 360 baseline volatile organic parameters according to the EPA Method 524.2 procedure due to laboratory error. NYSDEC did not recommend resampling the surface water for VOAs as volatiles were not a concern based upon the results of the Phase I sampling. Additionally, very few standards/guidance values for surface water have been established for comparison purposes. Only 5 mL of each sample were analyzed, rather than the protocol volume of 25 mL. Therefore, the desired low detection limits were not readily achieved. Groundwater sample GW5D-02 was collected and analyzed with the surface water samples. The remaining groundwater samples were collected and analyzed previously. The samples were processed in two different ways:

A. SDG WES029

Method Blank: Acetone, a common laboratory contaminant and the two Tentatively Identified Compounds results in GW5D-02 should be qualified as non-detected since their values were less than 10 times the value reported in the associated blank.

Method Blank Spikes: Sample GW5D (and its trip blank) were run in sequences which included 5 mL method blanks (MBS) spiked with 1 $\mu\text{g/l}$ of all target compounds, and were reported with detection limits of 1 ppb. Review of the recoveries of these MBS compounds was performed during validation for justification of the 1 $\mu\text{g/l}$ sample reported detection limits. Elevated recoveries were present, but are not of concern, as none of those target compounds were detected in the samples.

Depressed recoveries were obtained for acrylonitrile (35 percent) and 1,4-dichloro-2-butene (66 percent). Therefore, non-detected results for these compounds were qualified as estimated in sample GW5D-02 and its associated trip blank.

Holding Time: Holding times were met for initial sample analyses of GW5D1; the trip blank associated with GW5D was run 2 hours after the end of the seventh day. The reanalyses of sample GW5D and its trip blank were performed on the eighth day from receipt, and are not recommended for qualification of results.

Surrogate Recoveries: Surrogate recoveries for BFB were not compliant for the sample GW5D-02 (118 percent) and associated trip blank (134 percent) which indicates system problems affecting detected values.

These samples were reanalyzed one day beyond the holding time limit, and the surrogate recovery was still high. Therefore, the analytes associated with BFB; i.e., toluene and xylene positive results were estimated.

Matrix Spike/Matrix Spike Duplicate Analysis: MS/MSD samples were neither requested nor provided.

Duplicate Analysis: Ethylbenzene was detected at 1 $\mu\text{g/l}$ in the original analysis of GW5D-02, but was non-detected in the duplicate analysis. Therefore, the detection limit for ethylbenzene in GW5D-02 should be qualified as estimated.

B. SDG WES031

Detection Limits: The surface water samples were processed under an initial calibration which included levels of greater than or equal to 10 parts per billion (ppb). The sample reported detection limits were also 10 ppb. Following each day's sample processing, standards at a concentration of 5 ppb were processed and reported. Because the project goals were to have been 1 ppb detection limits for the samples, these 5 ppb standards were incorporated into the initial calibration. Linearity to 5 ppb was then verified.

Detection limits for bromoform and trichloromethane are recommended for qualification as estimated due to depressed non-linear response at the lower concentrations. Certain reporting Forms 1 for the 5 ppb and MSB standards contained transcriptions errors. Actual values were reviewed for acceptable recoveries.

Holding time: Sample SW12-02 was analyzed within seven days of receipt, but was processed outside the 12-hour allowable time frame from BFB instrumental tune verification. Evaluation of the subsequent tune and standard, processed within two hours after the sample, showed consistency with the previous tune and standard. Because instrument sensitivity was comparable, and no target compounds were detected in SW12-02, no qualification to sample reported results is recommended as a result of this non-compliance.

Matrix Spike/Matrix Spike Duplicate Analysis: The MS/MSD analysis of surface water sample SW13-02 were processed at 50 ppb, and produced one outlying recovery, for trichloroethene (68 percent; limit of 71 percent). Duplicate precision criteria was met.

Pesticides/PCBs

Surrogate Recovery: Certain surrogate recoveries fell below the recommended limit of 60 percent, but most were just below.

Matrix Spike/Matrix Spike Duplicate Analysis: Matrix spike recoveries of SW4-02 were within limits. The duplicate precision of gamma-BHC was high, at 27 percent RPD (above 15 percent RPD limit).

Metals

Calibration: The lead values should be considered estimated due to outlying recoveries of the standard at CRDL (CRA/CRI). The CRI/CRA recoveries associated with GW5D were elevated (160 percent, 142 percent, and 148 percent); recoveries associated with surface water samples were depressed at 37 percent.

Matrix Spike: The selenium recovery of the matrix spike of aqueous sample SW13-02 was slightly low, at 71 percent, and reported values for surface waters were qualified as estimated.

The selenium result for sample GW5D-02 should be considered estimated due to low recovery in the associated matrix spike (66 percent).

The following elemental post-digest spike recoveries fell outside the recommended range of 85 to 115 percent, with values indicating consideration for qualification as estimated:

SW2-02	Lead
SW12-02	Selenium
SW13-02	Selenium
SW14-02	Selenium, Lead
SW16-02	Selenium, Lead
SW17-02	Selenium, Arsenic
SW18-02	Selenium, Lead

Serial Dilution: The manganese values for the surface water was qualified as estimated, since the percent difference (13 percent) for serial dilution was greater than QC limit of 10 percent D.

Additional Parameters (Inorganics)

The total dissolved solids (TDS) value reported for GW5D-02 should be rejected due to the similar value detected in the blank.

The bromide value for GW5D-02 should be considered estimated due to the low recovery (40 percent) of the associated matrix spike.

SEDIMENTS

A summary of the data quality of the sediment samples is provided in Table 8.

Volatile Organic Compounds

These samples were processed using Method 91-1.

Method Blank: The positive results for acetone and methylene chloride, common laboratory contaminants, were qualified as non-detected in the soil samples since they were detected in the method blank or trip blank.

Matrix Spike/Matrix Spike Duplicate Analysis: Matrix spikes of sample SD13-02 produced elevated recoveries of benzene, at 145 percent and 155 percent, greater than the recommended limit of 142 percent. Matrix spike blank recoveries were acceptable.

Compound Identification and Quantitation: Due to poor spectral quality, the identification and reported values of the following compounds should be edited to reflect non-detection at the CRDL:

- 2-Hexanone in sample SD12-02.
- Carbon disulfide in samples SD13-02 and SD18-02.
- 2-Butanone in sample SD16-02.

Semivolatiles

Method Blanks: Bis-2(Ethylhexyl)phthalate results were qualified as non-detected in soil samples since it was detected at similar levels in associated blanks. Sample reported results should be qualified either non-detected at the CRDL or non-detected at the originally reported value, whichever is greater.

Matrix Spike/Matrix Spike Duplicate Analysis: MS/MSD analysis of SD13-02 and the MSB produced acceptable recoveries for each component except 4-nitrophenol, which recovered between 100 percent and 142 percent, above the limits of 80 percent/114 percent.

Recovery for hexachlorocyclopentadiene in the MSB was 5 percent. This value was within the laboratory acceptance range, but still indicates a possible low bias to reported detection limits, and non-detected results for hexachlorocyclopentadiene were estimated..

Calibration: Initial and continuing calibration standards produced values within protocol criteria. Certain compounds produced responses greater than 30 percent D, but sample reported results are not impacted.

The reported detection limits of hexachlorocyclopentadiene sediments SD2-02, SD4-02, SD17-02, SD18-02, and SD19-02 should be considered estimated due to outlying recovery of the associated spiked blank (5 percent recovery).

Pesticides/PCBs

Surrogate Recoveries: Certain surrogate recoveries fell below the recommended limit of 60 percent, but most were just below. The exception is sample SD4-02, which was recommended for qualification of detection limits due to low surrogate recoveries.

Matrix Spike/Matrix Spike Duplicate Analysis: The matrix spike recoveries of sample SD4-02 were within range, with the exception of those of gamma-BHC, which recovered at 30 percent and 32 percent, below the limit of 46 percent. Duplicate precision was good for the sediment spikes. MSB recoveries were within range.

Compound Identification and Quantitation: The 4,4'-DDE value for this sample should also be qualified as estimated because of the poor correlation between reported values in the sample and its matrix spikes (undetected in the sample, detected at 48 $\mu\text{g/Kg}$ and 24 $\mu\text{g/Kg}$ in the matrix spikes of the sample).

Table 8

Sediment Analytical Data Assessment

Sample No.	VOA	Notes	SV	Notes	Pest/PCB	Notes	Metals	Notes	Inorganics	Notes
SD2-02	A		A, Q	a	NR		A, Q	c	A	
SD4-02	A		A, Q	a	A, Q	b	A, Q	c	A	
SD12-02	A		A, Q	a	NR		A, Q	c	A	
SD13-02	A		A, Q	a	NR		A, Q	c	A	
SD14-02	A		A, Q	a	NR		A, Q	c	A	
SD15-02	A		A, Q	a	NR		A, Q	c	A	
SD16-02	A		A, Q	a	NR		A, Q	c	A	
SD17-02	A		A, Q	a	A		A, Q	c	A	
SD18-02	A		A, Q	a	NR		A, Q	c	A	

^a Matrix spike for 4-nitrophenol recovered between 100 and 142 percent, above the limits of 80 percent/114 percent, indicates a possible low bias to reported detection limits.
Hexachlorocyclobutadiene results were estimated due to low recovery in the method blank spike sample.

^b The detection limits for sample SD4-02 were estimated due to low surrogate recovery.

^c Sample results for Pb, Sb, and Ag qualified as estimated due to low spike recovery.

A = Usable and Defensible.

NR = Analysis not Required.

Q = Usable with Qualification.

Metals

Calibration: The lead values of each sample should be qualified as estimated due to outlying recoveries of the standard at CRDL (CRA/CRI). The CRI/CRA recoveries associated with soil samples were elevated (160 percent, 142 percent, and 148 percent).

Matrix Spike Recoveries: The antimony and silver matrix spike recoveries for soil sample SD13-02 were low, at 21 percent and 63 percent, respectively, and reported soil values should be considered estimated.

The following elemental post-digest spike recoveries fell outside the recommended range of 85 to 115 percent with values indicating consideration for qualification as estimated: SD18-02-thallium.

Inorganics

Data were acceptable without qualification.

DATA VALIDATION REPORTS

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Data Validation Services

Cobble Creek Road P. O. Box 208

North Creek, N. Y. 12853

Phone 518-251-4429

TO: Roy F. Weston of New York, Inc.

FROM: Judy Harry, Data Validation Services *J. Harry*

DATE: 04-01-94

RE: Validation of Clarkstown Landfill Site data packages
H2M SDG Nos. WES025, WES026, and WES027
Work Order No. 03228-010-002-0180-02
Validation Report of 04-01-94

Review has been completed for the data packages generated by H2M Labs, pertaining to samples collected at the Clarkstown Landfill Site. Thirty one groundwater and leachate samples were processed for baseline organics, metals, and leachate indicators. Two of the samples were also analysed for TCL pesticide/PCBs. Trip blanks and matrix spikes/duplicates were also processed. Methodologies utilized were those of the NYSDEC ASP 91-1 (leachates), 91-3, CLP-M, EPA-524.2 (groundwaters), and applicable wet chemistry indicator methodologies.

In summary, the samples were processed in compliance with the protocol methodologies, with any exceptions noted below and on the attached compliancy chart. Data packages were complete as submitted; no resubmissions were requested. Certain edits/qualifications to sample reported results are noted specifically in the numbered items below. Other issues relating to quality concerns are discussed in the specific analytical sections which follow.

Recommended qualifications and/or edits to reported results are as follows:

1. The reported detection of acetone in all groundwater and leachate samples should not be considered as a component of the samples, as it was detected in associated trip blanks at similar levels. The reported results for acetone in the samples should be edited to reflect nondetection at either the CRDL, or at the originally reported value, whichever is greater.
2. The reported detection of 2-hexanone in the leachate samples should be similarly disregarded as a sample component. In addition to the presence in the associated method blank, it is observed that the spectrum of the compound identified as 2-hexanone in the samples shows presence of uncharacteristic mass fragments which do not respond to background subtraction, indicating the possibility for incorrect identification. Reported results for 2-hexanone should be edited to reflect nondetection at either the CRDL, or at the originally reported value, whichever is greater.

3. Due to low recoveries of certain target compounds in the associated Laboratory Fortified Blanks run at the reported CRDL, the following detection limits for the samples should be qualified as estimated:

Compound	Recovery	Associated Samples
Trans 1,4-dichloro-2-butene	0.2 ug/L	All WES026, GW1D-02, GW1S-02
1,2-dibromo-3-chloropropane	0.3	All remaining groundwaters
Chloromethane	0.4	"
Bromomethane	0.5	"

4. Due to erratic responses (32%RSD) in associated initial calibration standards, reported detection limits for vinyl chloride in the groundwater samples should be considered estimated.
5. The response of 1,1-dichloroethene in the volatile continuing calibration standard of 12/30/93 produced low response relative to the curve (36% difference). The reported detection limit for this compound in the samples processed that day should be considered estimated, possibly biased low. Those affected are:
- GW2-02, GW2S-02, GW3D-02, GW4D-02, GW4S-02, GW5S-02, GW10D-02, GW10S-02, GW11-02, GW12-02, GW6D-02, GW6S-02, GW7D-02, GW7S-02, GW13-02,
6. The spectrum of the compound identified as chloroethane in sample LC7-02 shows mass fragments which did not respond to background subtraction, indicating a possibility for incorrect identification. Therefore the result for that compound in the sample should be flagged as "F" to indicate presumptive evidence, or tentative identification.
7. The result for the volatile Tentatively Identified Compound (TIC) LC4-02 should be 14 ug/L, not 10 ug/L.
8. The arsenic result for sample GW7D02 should be "1.5 W", not "1.5 U W", as the element was detected at a level equal to the IDL.
9. The following elements produced matrix spike recoveries below the recommended limit of 75%, indicating a consideration for reported results of these elements in associated samples as estimated:

Sample Matrix Spike	Element	% Recovery	Associated Samples
LB1-02	Aluminum	40 %	All of SDG WES025
	Selenium	71	
	Thallium	50	
GW9S-02	Selenium	58	All of SDG WES026
GW1S-02	Selenium	66	All of SDG WES027

10. The following elements produced post-digest spike recoveries outside the recommended range of 85% to 115% (as indicated by the "W" flag). Due to the implied matrix effect, all reported values as listed below should be considered estimated:

Sample	Element	% Recovery
LC5-02	Thallium	81 %
LC6-02	Selenium	48
	Thallium	81
LC7-02	Selenium	50
LC8-02	Arsenic	118
	Thallium	79
LC3-02	Selenium	42
	Thallium	81
LC4-02	Thallium	82
LC1-02	Selenium	60
	Thallium	80
LC2-02	Selenium	54
	Thallium	83
LB1-02	Thallium	61
LB2-02	Selenium	45
	Thallium	78
GW8D-02	Arsenic	117
	Selenium	81
GW8S-02	Arsenic	64
	Lead	83
	Selenium	78
GW9D-02	Selenium	68
GW9S-02	Selenium	76
	Thallium	75
GW10S-02	Lead	80
	Selenium	80
GW11-02	Lead	78
	Selenium	79
GW13-02	Selenium	58
GW1D-02	Arsenic	122
GW1S-02	Arsenic	120
	Selenium	81
GW3D-02	Arsenic	128
GW3S-02	Arsenic	120
	Selenium	82
GW4S-02	Selenium	76
GW5S-02	Arsenic	124
GW6S-02	Selenium	72
GW7D-02	Arsenic	119
	Lead	81
GW10D-02	Arsenic	126

11. Due to elevated recovery (181%) of the boron standard at 200 ug/L, the reported value for sample LC6-02 should be considered estimated.
12. Due to an apparent calculation error, the TDS result for sample GW11-02 was misreported as 530 mg/L. It should be 537 mg/L.

13. Due to an apparent calculation error, the TOC result for sample LC2-02 was misreported as 50 mg/L. It should be 54 mg/L.
14. The ammonia analysis of GW1D-02, which was reported with a result of 0.09 mg/L, followed that of a sample with a result over the calibration. In the section of this analysis sequence immediately preceding the analysis of GW1D-02, two calibration blanks also followed high level samples, and produced responses for ammonia which were indicative of carryover (0.06 and 0.07 mg/L). Although the two samples preceding the blanks were of higher ammonia levels than that preceding GW1D-02, GW1D-02 should have been reanalysed to determine what, if any, carryover contribution may have been included in the sample reading. The ammonia result for this sample should be edited to reflect nondetection at an elevated detection limit of 0.09 mg/L.

VOLATILE ANALYSES by 91-1

Holding times were met for sample processing. All surrogate recoveries were within required limits. Method blanks and instrumental tunes met protocol requirements. Internal standard areas and retention times criteria were met for all samples.

Matrix spikes were performed on sample LB1-02, and all recoveries and duplicate correlation values were within recommended limits. Matrix spike blank recoveries were acceptable. Initial and continuing calibration standards met protocol requirements. Sample reported results are substantiated by the raw data, except as noted in the qualification section.

VOLATILE ANALYSES by 524.2

Holding times were met for sample processing. All surrogate recoveries were within required limits. Method blanks and instrumental tunes met protocol requirements. Internal standard area and retention time criteria were met for all samples.

Matrix spikes were performed on samples GW1S-02 and GW9S-02 at levels of 5 ug/L. Recoveries were not good, with four out of ten values below limits for each of the sets of spikes. Recoveries of all spike compounds except 1,1-dichloroethene were greater than or equal to 60%. 1,1-dichloroethene recovered at 40% and 60% in the spikes of GW1S-02. It recovered at only 18% and 40% in those of GW9S-02. However, it recovered at 80% in the associated Laboratory Fortified Blank (LFB). The matrix spikes of GW9S-02 showed suppressed internal standard responses (those of the MSD are below limits) that are not shown by the sample itself. Consequently, it is deduced that the poor 1,1-dichloroethene recoveries shown in GW9S-02 spikes are a result of procedural anomalies (ex. leak at purge vessel, or spike variances), and do not reflect upon sample reported results. Duplicate correlation values are elevated, but that results in part from limited significant figures, as the relative difference of a 1 ng variance is proportionally high. Although the associated matrix spike blank (MSB) recoveries were within required limits (and in the range of 88% to 123%), three MSBs were run before one was acceptable. The nature of the rejection of the other two is not known.

Please see the above discussion regarding qualification due to low responses of target compounds in the 1 ng LFBs and/or calibration standards.

Initial and daily calibration standards recovered well, with exceptions as noted earlier in this text.

Instrument Detection Limits (IDLs) reported for certain of the compounds were generated in January 1994, after the project samples were analysed. IDLs were also provided for these certain compounds from October 1993 determinations, but they were not generated on the same analytical column (RTX-5 vs. RTX-502.2). No IDLs were reported for

some compounds (i.e. trans 1,4-dichloro-2-butene). In addition, some of the IDLs for the target compounds were elevated above the reporting CRDL. However, review of standard responses, spectra, and LFB recoveries was performed to promote confidence in the reported detection limits. Unless noted specifically in this report, qualification as a result of the reported IDLs has not been recommended.

PESTICIDE/PCB ANALYSES

Holding times were met for sample processing. All surrogate recoveries were within required limits; method and instrument blanks met protocol requirements.

Matrix spikes were performed on sample GV2-02, with all recoveries and duplicate correlation values within recommended ranges. Recoveries of the matrix spike blank were also good.

Protocol requirements pertaining to sample processing, including system linearity, breakdown, sequencing, retention times, resolution, calibration standard responses, and cleanup recoveries were reviewed, and found to be acceptable. Chromatographic response and integration accuracy were also reviewed. Although the RTX-35 column shows significant noise response, the reported results for these project samples are not affected, and reported results are supported by the raw data.

METALS + BORON and CYANIDE ANALYSES

Holding times were met for sample processing. All requirements of the ASP protocol were reviewed for compliance and acceptability, and found to be so unless specifically noted elsewhere within this text.

Matrix spike, duplicate, and serial dilution evaluations were performed on samples GV1S-02, GV9S-02, and LB1-02. Outlying spike recoveries warranting qualification of reported results are noted in the numbered section of this report. In addition, the matrix spike of thallium in sample GV9S-02 was just below the recommended limit, at 74.2%. The lead recovery of the spike of GV9S-02 produced a very low recovery of 13%, but the sample itself required a Method of Standard Analysis (MSA) determination due to matrix effect. MSA is not required for matrix spikes, and was not performed on the spike. Consequently, the comparison of spike result to sample result is not valid. No other sample in the SDG showed the same matrix effect as GV9S-02, and therefore qualification of lead results is not recommended. All duplicate correlation of serial dilution values were acceptable.

The analysis of the cyanide duplicate of GV9S-02 initially produced a value of 32.4 ug/L, but was repeated to be below CRDL. The initial, elevated result was noted as possibly being a result of carryover from previous run, but the value of the previous sample was only 18 ug/L, and no other samples in the sequence prior to this duplicate produced a value over CRDL.

WET CHEMISTRY/CONVENTIONALS

Review was performed to verify holding times; method compliancy; calculation algorithms and accuracy; acceptability of system linearity, sequencing, standards, controls, and blanks (as applicable); LCS values (as applicable); spike and duplicate results; and all sample results. For those analyses with automated instrument output, verification of reported results to the output was performed. For those analyses with only technician record notations, verification of results from curve (where applicable), application of dilution factors, and transcriptions to report forms was performed.

As noted in the case narrative, the drying step in the analysis for TDS of samples GW4S-02, GW6D-02, GW7S-02, GW7D-02, and GW13-02 was performed one day beyond the five day allowable holding time. The samples were filtered within the required time, and no qualification of reported results is recommended.

Unless noted elsewhere within this report, results of quality criteria were acceptable, and reported results are substantiated by the raw data.

COMPLIANCY CHART

Project: Clarkstown Landfill

SDG Nos: H2M SDG Nos. VES025, VES026, and VES027

Protocol: 1991 NYSDEC ASP

RecDate	Sample ID	Matrix	VOA	PCB	Metals	CN	Wet Chem	Noncompl
12-28-93	GW1D-02	Aqueous	OK	NR	OK	OK	OK	
12-28-93	GW1S-02	Aqueous	OK	NR	OK	OK	OK	
12-28-93	GW2-02	Aqueous	OK	OK	OK	OK	OK	
12-28-93	GW10D-02	Aqueous	OK	NR	OK	OK	OK	
12-28-93	GW12-02	Aqueous	OK	NR	OK	OK	OK	
12-29-93	GW3D-02	Aqueous	OK	OK	OK	OK	OK	
12-29-93	GW3S-02	Aqueous	OK	NR	OK	OK	OK	
12-29-93	GW4D-02	Aqueous	OK	NR	OK	OK	OK	
12-29-93	GW4S-02	Aqueous	OK	NR	NR	NR	NR	
12-30-93	GW4S-02	Aqueous	NR	NR	OK	OK	NO	1
12-29-93	GW10S-02	Aqueous	OK	NR	NR	OK	OK	
12-30-93	GW10S-02	Aqueous	NR	NR	OK	NR	NR	
12-29-93	GW11-02	Aqueous	OK	NR	NR	OK	OK	
12-30-93	GW11-02	Aqueous	NR	NR	OK	NR	NR	
12-29-93	GW5S-02	Aqueous	OK	NR	OK	OK	OK	
12-30-93	GW6D-02	Aqueous	OK	NR	OK	OK	NO	1
12-30-93	GW6S-02	Aqueous	OK	NR	OK	OK	OK	
12-30-93	GW7D-02	Aqueous	OK	NR	OK	OK	NO	1

RecDate	Sample ID	Matrix	VOA	PCB	Metals	CN	Vet Chem	Noncompl
12-30-93	GW7S-02	Aqueous	OK	NR	OK	OK	NO	1
12-30-93	GW13-02	Aqueous	OK	NR	OK	OK	NO	1
12-23-93	GW8D-02	Aqueous	OK	NR	OK	OK	OK	
12-23-93	GW8S-02	Aqueous	OK	NR	OK	OK	OK	
12-23-93	GW9D-02	Aqueous	OK	NR	OK	OK	OK	
12-23-93	GW9S-02	Aqueous	OK	NR	OK	OK	OK	
12-23-93	LB1-02	Aqueous	OK	NR	OK	OK	OK	
12-21-93	LB2-02	Aqueous	OK	NR	OK	OK	OK	
12-21-93	LC1-02	Aqueous	OK	NR	OK	OK	OK	
12-21-93	LC2-02	Aqueous	OK	NR	OK	OK	OK	
12-21-93	LC3-02	Aqueous	OK	NR	OK	OK	OK	
12-21-93	LC4-02	Aqueous	OK	NR	OK	OK	OK	
12-21-93	LC5-02	Aqueous	OK	NR	OK	OK	OK	
12-21-93	LC6-02	Aqueous	OK	NR	OK	OK	OK	
12-21-93	LC7-02	Aqueous	OK	NR	OK	OK	OK	
12-21-93	LC8-02	Aqueous	OK	NR	OK	OK	OK	
12-21-93	TBLC122093	Aqueous	OK	NR	NR	NR	NR	
12-23-93	TBGW122293	Aqueous	OK	NR	NR	NR	NR	

1. Holding time for drying step of Total Dissolved Solids exceeded.

H2M LABS, INC.

SDG NARRATIVE FOR VOLATILE ANALYSIS
SAMPLES RECEIVED: 12/21/93
WES025

For Samples:

LB1-02 MS/MSD	LC5-02
LB2-02	LC6-02
LC1-02	LC7-02
LC2-02	LC8-02
LC3-02	TBLC122093
LC4-02	

The above samples were analyzed for the Part 360 list of volatile organic compounds. The QC and calibration requirements of 91-1 were followed. Method detection limits for all the required Part 360 compounds are submitted.

Bromochloromethane could not be used as an internal standard, as it is a targeted compound. Pentafluorobenzene and d5-chlorobenzene were added as internal standard. The tertiary ion of d5-chlorobenzene was used for quantification, as other ions showed interferences.

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Date Reported: January 31, 1994

Joann M. Slavin

Joann M. Slavin
Quality Assurance Manager

S 0018

H2M LABS, INC.

SDG NARRATIVE FOR METALS ANALYSIS

SAMPLES RECEIVED: 12/21/93

WES025

For Samples:

LB1-02 MS/MSD	LC4-02
LB2-02	LC5-02
LC1-02	LC6-02
LC2-02	LC7-02
LC3-02	LC8-02

ICP analysis was performed using a TJA61. A Perkin-Elmer 5100 and a Varian Spectra 400 were used for furnace AA analysis. A Varian Spectra 400 AA was used for mercury analysis. Cyanides were performed via the manual spectrophotometric method and read on a Sequoia-Turner model 340 spectrophotometer.

The aluminum, selenium and thallium matrix spike recoveries for sample LB1-02 are not within 75-125%. Results for the analytes above are flagged with an "N" on Forms I and V(a).

The post digestion spike recoveries for the following furnace AA analyses are not within 85-115%:

<u>Arsenic:</u>	LC5-02, LC6-02, LC7-02 and LC8-02.
<u>Selenium:</u>	LB2-02, LC1-02, LC2-02, LC3-02, LC5-02, LC6-02 and LC7-02.
<u>Thallium:</u>	LB1-02, LB1-02D, LB2-02, LC1-02, LC2-02, LC3-02, LC4-02, LC5-02, LC6-02, LC7-02 and LC8-02.

Results for the analyses above are flagged with a "W" on the corresponding data sheets.

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Date Reported: January 31, 1994

** Salvatore Badalamenti **

Salvatore Badalamenti
Inorganic Supervisor

S 0019

H2M LABS, INC.

SDG NARRATIVE FOR VOLATILE ANALYSES
SAMPLES RECEIVED: 12/23/93
(WES026)

FOR SAMPLES: GW8D02
GW8S02
GW9D02
GW9S02
TBGW122293

The above samples were analyzed for the Part 360 Volatile Organics. Bromomethane could not be used as an internal standard as it is a targeted compound. Pentafluorobenzene and d-5 dichlorobenzene were added as internal standards.

The tertiary ion of the initial standard d-5 chlorobenzene was used for quantification due to interference with the other ions.

The internal standard areas of the matrix spike duplicate of sample GW9S02 were low. This sample and the matrix spike had acceptable internal standard areas.

Sample GW9S02 was spiked at 5 ug/L for the matrix spike and matrix spike duplicate. Several percent recoveries and RPD's were outside the limits. All matrix spike blank percent recoveries were within QC limits.

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Date Reported: February 2, 1994

*

*

Joann Slavin
Quality Assurance Manager

H2M LABS, INC.

SDG NARRATIVE FOR METALS ANALYSIS

SAMPLES RECEIVED: 12/23/93

WES026

For Samples:

GW8D-02
GW8S-02
GW9D-02
GW9S-02 MS/MSD

ICP analysis was performed using a TJA61 and an ARL3410. Furnace analysis was performed on a Perkin-Elmer 5100 and a Varian Spectra 400. Mercury was analyzed on a Varian Spectra 400 AA using cold vapor techniques. Cyanides were performed via the manual spectrophotometric method and read on a Sequoia-Turner model 340 spectrophotometer.

The lead, selenium and thallium matrix spike recoveries for sample GW9S-02 were not within 75-125%. All lead, selenium and thallium results are reported flagged with an "N".

Lead samples GW9S-02 and GW9S-02D required analysis by MSA procedures. The correlation coefficients were greater than 0.995. These results are reported flagged with an "S".

The post digestion spike recovery for selenium sample GW8S-02 was less than 40%. A 1:5 dilution was performed. Selenium sample GW8S-02 is reported with a raised detection limit.

The post digestion spike recoveries for the following furnace AA analyses are not within 85-115%:

<u>Arsenic:</u>	GW8D-02 and GW8S-02
<u>Lead:</u>	GW8S-02
<u>Selenium:</u>	GW8D-02, GW8S-02, GW9D-02 and GW9S-02
<u>Thallium:</u>	GW9S-02

The above results are reported flagged with a "W".

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Date Reported: February 4, 1994

Maureen Wineberger

Maureen Wineberger
Metals Supervisor

S 0015

H2M LABS, INC.

SDG NARRATIVE FOR VOLATILE ANALYSES
SAMPLES RECEIVED: 12/28, 12/29, & 12/30/93
(WES027)

FOR SAMPLES:	GW1D02	GW6S02
	GW1S02 MS/MSD	GW7D02
	GW202	GW7S02
	GW3D02	GW10D02
	GW3S02	GW10S02
	GW4D02	GW1102
	GW4S02	GW1202
	GW5S02	GW1302
	GW6D02	

The above samples were analyzed for the Part 360 Volatile Organics.

Bromomethane could not be used as an internal standard as it is a targeted compound. Pentafluorobenzene and d-5 chlorobenzene were added as internal standards.

The tertiary ion of the internal standard d-5 chlorobenzene was used for quantification due to interferences with the other ions.

Sample GW1S02 was spiked at 5 ug/L for the matrix spike and matrix spike duplicate. Several percent recoveries and RPD's were outside the limits. All matrix spike blank percent recoveries were within QC limits.

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Date Reported: February 10, 1994

*
*
*

Joann Slavin
Quality Assurance Manager

S C037

H2M LABS, INC.

SDG NARRATIVE FOR PESTICIDE/PCB ANALYSIS
SAMPLES RECEIVED: 12/28/93 - 12/30/93
WES027

For Samples:

GW2-02 MS/MSD
GW3D-02

Analysis was performed by method 91-3 of the NYSDEC ASP 12/91.

QC DATA

Even though all surrogate recoveries met the advisory limits for the protocol, DCB recoveries were barely above the limit, whereas TCX showed good recoveries.

The TCX recoveries reflect the accuracy data for the spiked sample and matrix spiked blank. In addition to the mandatory MS/MSD, data are submitted for a QC sample, which was spiked with all targeted analytes

CALIBRATION/SYSTEM PERFORMANCE/SAMPLE ANALYSIS

No problems were encountered.

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Date Reported: February 14, 1994

* *Ursula Middel* *
*

Ursula Middel
Technical Manager

S 0035

H2M LABS, INC.

SDG NARRATIVE FOR METALS ANALYSES
SAMPLES RECEIVED: 11/28, 11/29, & 11/30/93
(WES027)

FOR SAMPLES:	GW1D02	GW6S02
	GW1S02 MS/MSD	GW7D02
	GW202	GW7S02
	GW3D02	GW10D02
	GW3S02	GW10S02
	GW4D02	GW1102
	GW4S02	GW1202
	GW5S02	GW1302
	GW6D02	

ICP analysis was performed using a TJA61 and an ARL3410. Furnace analysis was performed on a PE5100, a Varian Spectra 30/GTA-96 and a Varian Spectra 400. Mercury was analyzed on a Varian Spectra 400 using cold vapor techniques. Cyanides were performed via the manual spectrophotometric method and read on a Sequoia-Turner model 340 spectrophotometer.

The selenium matrix spike recovery for sample GW1S02 was not within 75-125%. All selenium results are reported flagged with an "N".

All duplicate results for sample GW1S02 were within the required control limits.

All ICP serial dilution results met the required 10% difference control limit.

Arsenic samples GW10S02, GW4S02, GW6S02 and GW7S02 required analysis by MSA procedures. The correlation coefficients were greater than 0.995. These results are reported flagged with an "S".

The post spike recovery for selenium sample GW7S02 was less than 40%. A 1:5 dilution was performed. Selenium sample GW7S02 is reported with a raised detection limit.

The following post spike recoveries were not with 85-115%:

As - GW1102, GW1202, GW1302, GW1D02, GW1S02, GW3D02, GW3S02, GW4D02, GW5S02, GW6D02, GW7D02, GW10D and GW202
Pb - GW10S02, GW1102, and GW7D02
Se - GW10S02, GW1102, GW1202, GW1302, GW1S02, GW3S02, GW4S02, GW6D02, GW6S02

The above results are reported flagged with an "W".

H2M LABS, INC.

SDG NARRATIVE FOR METALS ANALYSES
SAMPLES RECEIVED: 11/28, 11/29, & 11/30/93
(WES027)

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Date Reported: February 10, 1994

*
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*

Maureen Wineberger
Metals Supervisor

S CC40

H2M LABS, INC.

SDG NARRATIVE FOR WET CHEMISTRY ANALYSES
SAMPLES RECEIVED: 11/28, 11/29, & 11/30/93
(WES027)

FOR SAMPLES:	GW1D02	GW6S02
	GW1S02 MS/MSD	GW7D02
	GW202	GW7S02
	GW3D02	GW10D02
	GW3S02	GW10S02
	GW4D02	GW1102
	GW4S02	GW1202
	GW5S02	GW1302
	GW6D02	

The following samples were received on 12/30/93: GW6D-02, GW7D002, GW7S-02, GW13-02 and GW4S-02. On 12/31/93 it was noticed that the analytical balance was malfunctioning. The samples were filtered for total dissolved solids analysis because of holding time considerations. The sample filtrates were retained in sealed containers at 4°C. On 1/5/94 the balance was repaired and recertified, and the analysis was continued. Earlier repair was not possible due to the holiday.

All quality control criteria were met. No other problems were encountered.

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Date Reported: February 10, 1994

* *Salvatore Badalamenti* *

Salvatore Badalamenti
Inorganic Supervisor

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE IDENTIFICATION AND
ANALYTICAL REQUIREMENT SUMMARY
SAMPLES RECEIVED 06/30/93 and 07/02/93
R.P. WESTON
CLARKSTOWN LANDFILL
(WES025)

Customer Sample Code	Laboratory Sample Code	Analytical Requirements *					
		*VOA GC/MS	*BNA GC/MS	*VOA GC	*PEST PCB	*METALS	*OTHER
LB1-02 MS/MSD	9339380	X				X	X
LB2-02	9339381	X				X	X
LC1-02	9339382	X				X	X
LC2-02	9339383	X				X	X
LC3-02	9339384	X				X	X
LC4-02	9339385	X				X	X
LC5-02	9339386	X				X	X
LC6-02	9339387	X				X	X
LC7-02	9339388	X				X	X
LC8-02	9339389	X				X	X
TBLC122093	9339390	X					

* Check Appropriate Boxes

- * CLP Non-CLP (Please indicate year of protocol) 12/91
* TCL/TAL, HSL, Priority Pollutant + Part 360 volatile compounds.

PAGE 1

S 0003

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS SUMMARY

VOA ANALYSES

SAMPLES RECEIVED 12/21/93

R.F. WESTON

CLARKSTOWN LANDFILL

WES025

LABORATORY SAMPLE ID	MATRIX	DATE COLLECTED	DATE REC'D AT LAB	LOW LEVEL MED. LEVEL	DATE ANALYZED
LB1-01	WATER	12/20/93	12/21/93	LOW	12/23/93
LB2-01 MS	"	"	"	"	"
LB2-01 MSD	"	"	"	"	"
LB2-02	"	"	"	"	"
LC1-02	"	"	"	"	"
LC2-02	"	"	"	"	"
LC3-02	"	"	"	"	"
LC4-02	"	"	"	"	"
LC5-02	"	"	"	"	"
LC6-02	"	"	"	"	"
LC7-02	"	"	"	"	"
LC8-02	"	"	"	"	"
TBLC122093	"	"	"	"	"

PAGE 4 OF 6

S C00-1

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS SUMMARY
INORGANIC ANALYSES

SAMPLES RECEIVED 12/21/93

R.F.WESTON

CLARKSTOWN LANDFILL

(WES025)

SAMPLE ID	MATRIX	METALS REQUESTED	DATE RECEIVED	DATE * ANALYZED
LB1-02 MS/MSD	WATER	TCL METALS + B	12/21/93	12/93-1/94
LB2-02	"	"	"	"
LC1-02	"	"	"	"
LC2-02	"	"	"	"
LC3-02	"	"	"	"
LC4-02	"	"	"	"
LC5-02	"	"	"	"
LC6-02	"	"	"	"
LC7-02	"	"	"	"
LC8-02	"	"	"	"

* SEE INDIVIDUAL RUN SHEETS FOR EXACT DATES.

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S 0005

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS SUMMARY

WET CHEMISTRY ANALYSES

SAMPLES RECEIVED 12/21/93

R.F.WESTON

CLARKSTOWN LANDFILL

(WES025)

SAMPLE ID	MATRIX	PARAMETERS REQUESTED	DATE RECEIVED	DATE * ANALYZED
LB1-02 MS/MSD	WATER	SEE LIST BELOW @	12/21/93	12/93-1/94
LB2-02	"	"	"	"
LC1-02	"	"	"	"
LC2-02	"	"	"	"
LC3-02	"	"	"	"
LC4-02	"	"	"	"
LC5-02	"	"	"	"
LC6-02	"	"	"	"
LC7-02	"	"	"	"
LC8-02	"	"	"	"

@ ANALYSES = BOD₅, BR, CL, COD, CR+⁶, HARD, NH₃, NO₂₃, PHENOL, SO₄,
TALK, TDS, TKN AND TOC.

* SEE INDIVIDUAL RUN SHEETS FOR EXACT DATES.

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE IDENTIFICATION AND ANALYTICAL REQUIREMENT SUMMARY

SAMPLES RECEIVED 12/23/93

R.F. WESTON

CLARKSTOWN LANDFILL

(WES026)

[illegible]

* Check Appropriate Boxes

* CLP, Non-CLP (Please indicate year of protocol) 12/91
* TCL/TAL: HSL, Priority Pollutant Part 360 compounds for volatile organics

PAGE 1

S 0003

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS SUMMARY

VOA ANALYSES

SAMPLES RECEIVED 12/23/93

R. F. WESTON

CLARKSTOWN LANDFILL

WES026

[illegible]

5000

SAMPLES RECEIVED 12/23/93

R. F. WESTON

CLARKSTOWN LANDFILL
(WES026)

* SEE INDIVIDUAL RUN SHEETS FOR EXACT DATES.



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H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE IDENTIFICATION AND
ANALYTICAL REQUIREMENT SUMMARY
SAMPLES RECEIVED 12/28/93 - 12/30/93
R.F. WESTON
CLARKSTOWN LANDFILL
(WES027)

Customer Sample Code	Laboratory Sample Code	Analytical Requirements *					
		*VOA GC/MS	*BNA GC/MS	*VOA GC	*PEST PCB	*METALS	*OTHER
GW1D-02	9339823	X				X	X
GW1S-02 MS/MSD	9339824	X				X	X
GW2-02	9339825	X			X	X	X
GW3D-02	9340041	X			X	X	X
GW3S-02	9340042	X				X	X
GW4D-02	9340043	X				X	X
GW4S-02	9340036	X					
GW4S-02	9340250					X	X
GW5S-02	9340044	X				X	X
GW6D-02	9340243	X				X	X
GW6S-02	9340244	X				X	X
GW7D-02	9340244	X				X	X
GW7S-02	9340245	X				X	X
GW10D-02	9339826	X				X	X
GW10S-02	9340038	X				+	X
GW10S-02	9340248					@	
GW11-02	9340039	X				+	X
GW11-02	9340249					@	
GW12-02	9339827	X				X	X
GW13-02	9340246	X				X	X

* Check Appropriate Boxes

- * CLP, Non-CLP (Please indicate year of protocol) 12/91
- * TCL/TAL, HSL, Priority Pollutant VOA = Part 360 compounds
- + Cyanide only.
- @ TCL Metals (minus cyanide) plus boron.

PAGE 1

S 0003

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS SUMMARY VOA ANALYSES

SAMPLES RECEIVED: 12/28, 12/29 & 12/30/93
R.F. WESTON
(WES027)

SAMPLE ID	MATRIX	DATE COLLECTED	DATE REC'D AT LAB	LOW LEVEL MED LEVEL	DATE ANALYZED
GW1D02	WATER	12/27/93	12/28/93	LOW	12/28/93
GW1S02	"	"	"	"	"
GW1S02 MS	"	"	"	"	"
GW1S02 MSD	"	"	"	"	"
GW202	"	"	"	"	12/30/93
GW3D02	"	12/28/93	12/29/93	"	"
GW3S02	"	"	"	"	"
GW4D02	"	"	"	"	"
GW4S02	"	"	"	"	"
GW5S02	"	"	"	"	"
GW6D02	"	12/29/93	12/30/93	"	"
GW6S02	"	"	"	"	"
GW7D02	"	"	"	"	"
GW7S02	"	"	"	"	"
GW10D02	"	12/27/93	12/28/93	"	"
GW10S02	"	12/28/93	12/29/93	"	"
GW1102	"	"	"	"	"
GW1202	"	12/27/93	12/28/93	"	"
GW1302	"	12/29/93	12/30/93	"	"

PAGE 4 OF 6

S 0006

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS SUMMARY
INORGANIC ANALYSES

SAMPLES RECEIVED 12/28/93 - 12/30/93

R.F.WESTON
CLARKSTOWN LANDFILL
(WES027)

SAMPLE ID	MATRIX	METALS REQUESTED	DATE RECEIVED	DATE * ANALYZED
GW1D-02	WATER	TCL METALS + B	12/28/93	12/93-1/94
GW1S-02 MS/MSD	"	"	"	"
GW2-02	"	"	"	"
GW3D-02	"	"	12/29/93	"
GW3S-02	"	"	"	"
GW4D-02	"	"	"	"
GW4S-02	"	"	12/30/93	"
GW5S-02	"	"	12/29/93	"
GW6D-02	"	"	12/30/93	"
GW6S-02	"	"	"	"
GW7D-02	"	"	"	"
GW7S-02	"	"	"	"
GW10D-02	"	"	12/28/93	"
GW10S-02	"	"	12/29&30/93	"
GW11-02	"	"	"	"
GW12-02	"	"	12/28/93	"
GW13-02	"	"	12/30/93	"

* SEE INDIVIDUAL RUN SHEETS FOR EXACT DATES.

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S 0007

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS SUMMARY
WET CHEMISTRY ANALYSES

SAMPLES RECEIVED 12/28/93 - 12/30/93

R.F.WESTON
CLARKSTOWN LANDFILL
(WES027)

SAMPLE ID	MATRIX	ANALYSIS REQUESTED	DATE RECEIVED	DATE * ANALYZED
GW1D-02	WATER	SEE LIST BELOW @	12/28/93	12/93-1/94
GW1S-02 MS/MSD	"	"	"	"
GW2-02	"	"	"	"
GW3D-02	"	"	12/29/93	"
GW3S-02	"	"	"	"
GW4D-02	"	"	"	"
GW4S-02	"	"	12/30/93	"
GW5S-02	"	"	12/29/93	"
GW6D-02	"	"	12/30/93	"
GW6S-02	"	"	"	"
GW7D-02	"	"	"	"
GW7S-02	"	"	"	"
GW10D-02	"	"	12/28/93	"
GW10S-02	"	"	12/29/93	"
GW11-02	"	"	"	"
GW12-02	"	"	12/28/93	"
GW13-02	"	"	12/30/93	"

@ ANALYSES = BOD₅, BR, CL, COD, CR+⁶, HARD, NH₃, NO₂₃, PHENOL, SO₄,
TALK, TDS, TKN AND TOC.

* SEE INDIVIDUAL RUN SHEETS FOR EXACT DATES.

PAGE 6

S 0008

Data Validation Services

Cobble Creek Road P. O. Box 208

North Creek, N. Y. 12853

Phone 518-251-4429

TO: Roy F. Weston of N.Y

FROM: Judy Harry, Data Validation Services *J. Harry*

DATE: 5-12-94

RE: Validation of Clarkstown Landfill Air and TCLP data packages
H2M SDGs VES 028 and VES030
Work Order No. 03228-010-002-0180-02

Review is complete for data packages generated by H2M Labs, pertaining to samples collected at the Clarkstown Landfill Site. Five sorbent tube samples, including a field blank and field duplicate, were submitted for air analysis by EPA TO-1/TO-2. Five sediments were submitted for full TCLP analyses by 12/91 NYSDEC ASP.

In summary, the samples were processed in compliance with protocol requirements. Any exceptions are noted in the text below, and on the attached compliancy chart. Communications relating to resubmission requests are included with this report, as are copies of the laboratory case narratives and NYSDEC Sample Prep/Analysis Summary Forms.

Review of the quality issues indicates that certain qualifications to sample reported results be recommended; these are outlined immediately below. All quality concerns are discussed in the subsequent analysis sections of this text.

1. The methylene chloride detected in the air samples should be rejected from consideration as a sample component, as it was detected at similar relative levels in the associated field blank. The reported results should be edited to reflect nondetection at the sample CRDL, or at the originally reported value, whichever is greater.
2. The benzyl chloride reported for air samples LFG-2B, LFB-3B, and LFG-3B-DUP should be flagged as "N" for tentative identification, and "J" for estimated value. The spectra associated with the responses identified as benzyl chloride are inconclusive for identification (common quant ion, no parent ion, and numerous interferences), and reflect contribution to the quantitation ion ($m/z = 91$) from other, coeluting aromatic compounds.
3. The reported detection limits for tetrachloroethene in LFG-8B and LFG-FB, and those of 1,2,4-trichlorobenzene and hexachlorobutadiene in all air samples should be considered estimated. This is due to the fact that the lowest level calibration standard concentration is twenty times the reported detection limits for these compounds, and linearity at the low levels has not been determined.

- Due to the lack of recovery of acid surrogates for repeated TCLP extractions of all samples, the reported results for all acid components in the TCLP semivolatile fractions must be rejected. These poor recoveries were not reflected in the TCLP method blank for the extraction, indicating sample matrix effect. The same effect was evident by similarly poor acid spike recoveries in the sample matrix spikes. The initial extraction results for the base/neutral compounds of the samples can be used without qualification. The reextractions, which verified the poor acid recoveries, were performed beyond a usable holding time (as relates to quantitative values).
5. The reported detection limits for the herbicides (2,4-D and 2,4,5-TP) in sample RFWTP-4 should be considered estimated, possibly biased low due to chromatographic interferences which may prohibit detection at low levels. This is supported by the relatively low surrogate recovery for the sample (26%).
 6. The chloroform value reported for the volatile matrix spike blank (MSB) was not supported by the raw data (no entry on quant report, and no spectrum), and should be rejected.
 7. Due to the poor recovery (4%) exhibited by silver in the Laboratory Control Sample (LCS), all silver reported results for the samples should be considered significantly biased low. The laboratory was not required to take corrective action, but the depressed recovery does reflect on sample results, as well.

AIR ANALYSES

Holding times were met for sample processing. Surrogate recoveries were reasonable for the methodology, with values of 117% to 131% for the samples. Matrix spike analyses are not applicable to these methodologies.

Instrumental tunes and method blanks were acceptable. Internal standard areas and retention times were also within required ranges. Multipoint calibrations were performed for all target compounds, with good resultant linearity. Please see the earlier discussion regarding qualification due to inappropriate, elevated calibration ranges for three compounds. With the exception of any items noted specifically within this text, sample reported results are substantiated by the raw data.

TCLP VOLATILES

Holding times were met for sample processing. Surrogate recoveries were within required ranges, with the exception of BFB in sample RFWTP-1. Repeat analyses show recoveries of 82% and 58%, below the limit of 86%. Recoveries of the matrix spikes of sample RFWTP-3 produced acceptable values, with the exception of those of 2-butanone, which recovered at 54% and 58%, below the recommended limit of 97%. Recoveries of the associated MSB were acceptable. The duplicate correlation of the matrix spikes was good.

Method blanks and instrumental tunes met protocol requirements. Internal standard areas and retention times were acceptable. Initial and continuing calibration standards met required criteria.

TCLP SEMIVOLATILES

Holding times were met for sample processing. Please see the above discussions regarding acid surrogate recoveries, which were below 8% for 19 out of 20 initial extraction values. Surrogate recoveries on two of the samples improved somewhat upon reextraction, but the leaching was performed 21 days from VTSR, and the data is not usable

(sample reactivity may have dropped significantly during the extended time). Recoveries of the acidic matrix spikes of sample RFWTP-3 produced all but one value below required limits. Recoveries and duplicate correlation values for the base/neutrals in the sample matrix spikes was good. Recoveries of the laboratory fortified blank were within required limits for all compounds.

Method blanks and instrumental tunes met protocol requirements. Internal standard areas and retention times were acceptable. Sample RFWTP-4 had one internal standard response just below the 50% limit, but the value was greater than 49.9%, and qualification is not therefore recommended.

Initial and continuing calibration standards met required criteria, with the exception that the same area response was reported for 4-methylphenol and 3-methylphenol. Either the two compounds coelute (and therefore individual linearity has not been determined), or a mis-identification was made. The issue is not critical to this delivery group's samples, as all acid compound results are rejected due to matrix effect.

TCLP HERBICIDES

Holding times were met for sample processing. With the exception of sample RFWTP-4, noted earlier, surrogate recoveries were acceptable, with values of 49% to 79%. Accuracy and precision values for the spikes of RFWTP-3 were acceptable. MSB recoveries were also good.

Method blanks met protocol requirements. Calibration standards produced good linearity and consistency of response. Calculation algorithms were correct, and, with exception of RFWTP-4, sample reported results are substantiated by the raw data.

LP PESTICIDES

Holding times were met, and method blanks were acceptable. Surrogate, matrix spike, and MSB recoveries were within recommended limits. Duplicate correlation was good.

All requirements for analysis were reviewed, including linearity, breakdown, resolution, sequencing, retention times, florisil recoveries, etc. All met required limits except that the response for b-BHC in the PEM on RTX-5 was 30%RPD, exceeding the limit of 25%RPD. Sample reported results are not affected.

TCLP METALS

All requirements of the protocol were reviewed for compliance and technical validity, and were found to be acceptable, unless noted specifically within this text (i.e. silver recovery in the LCS, noted earlier).

Matrix spike recoveries of sample RFWTP-3 were within recommended range, except for that of barium, which was 1 percentage point high (126%). Duplicate and serial dilution correlations of RFWTP-3 were also good. Sample reported results are supported by the raw data provided.

COMPLIANCY CHART

Project: Clarkstown Landfill
 SDG Nos: H2M SDG Nos. WES028 and WES030
 Protocol: TO-1/TO-2, 1991 NYSDEC ASP

RecDate	Sample ID	Matrix	VOA	BNA	Pest/PCB	Metals/CN	Other	Noncompl
03-18-04	LFG-FB	Air	OK	NR	NR	NR	NR	
03-18-04	LFG-3B	Air	OK	NR	NR	NR	NR	
03-18-04	LFG-3B DUP	Air	OK	NR	NR	NR	NR	
03-18-04	LFG-2B	Air	OK	NR	NR	NR	NR	
3-18-04	LFG-8B	Air	OK	NR	NR	NR	NR	
03-11-04	RFWTP-1	TCLP	OK	NO	NO	OK	OK	1,2
03-11-04	RFWTP-2	TCLP	OK	NO	NO	OK	OK	1,2
03-11-04	RFWTP-3	TCLP	OK	NO	NO	OK	OK	1,2
03-11-04	RFWTP-4	TCLP	OK	NO	NO	OK	OK	1,2
03-11-04	RFWTP-5	TCLP	OK	NO	NO	OK	OK	1,2

1. BNA re-leaching/reextraction performed beyond allowable holding times (1991 NYSDEC ASP pgs. I-38 and D-III-8).
2. Response of b-BHC in PEM on RTX-5 exceeds allowable 25% RPD limit (pg. E-¹⁰¹~~219~~).
94 512-44

Data Validation Services

Cobble Creek Road P. O. Box 208

North Creek, N. Y. 12853

Phone 518-251-4429

FACSIMILE TRANSMISSION

Date: 4-27-94
To: Joann Slawn
Company: H2M Labs
From: Judy Hany
Number of pages including cover: 1

Comments: RE: Roy F. Weston - Clarkstown Landfill Site
H2M SDG WES 028 TCLP Pesticides
Although the raw data for the pesticides
standards is present, none of the standard
summary forms are in the package. Could
you please forward them to me when they
are available? Thanks,
Judy

JETSET Reply

H2M LABS, INC.
575 Broad Hollow Road
MELVILLE, NEW YORK 11747-5076

(516) 694-3040

Data Validation Services

DATE *5/4/94*

☐ URGENT
☐ SOON AS POSSIBLE
☒ NO REPLY NEEDED

FILE NO.

ATTENTION

SUBJECT

Judy Henry

WES 028 TCP REST.

MESSAGE

Enclosed please find the standard summary forms for this package.

Copy forwarded to Weston.

SIGNED

Joanne Deignan

DATE OF REPLY

SIGNED

RECIPIENT: WRITE REPLY RETURN WHITE TO SENDER. KEEP THIS PINK COPY.

Data Validation Services

Cobble Creek Road P. O. Box 208

North Creek, N. Y. 12858

Phone 518-251-4429

FACSIMILE TRANSMISSION

Date: 5-4-94

To: Joann Slavin

Company: Hm Labs

From: Judy Harry

Number of pages including cover: 1

Comments: RE: Weston - Clarkstown Landfill
Air Volatile Data - SDG WES030 Re'd 3/18/94
As noted in the case narrative, methylene chloride
standard response factors were manually edited.
Please provide the actual ng of Mecl₂
used in the standards, if different than that
of the other compounds. The software had
correctly calculated RF's for the ng indicated
in the standard raw data, and a "corrected"
ng value of Mecl₂ is not shown.

Thanks,
Judy

H2M LABS, INC.

RESPONSE TO DATA VALIDATION
ON R.P. WESTON CLARKSTOWN LANDFILL PROJECT
SDG NO.: WES030
AIR SAMPLING
SAMPLES RECEIVED: 3/18/94

In response to your fax of 5/4/94, please find the following information you requested:

1.) The calibration was performed with a mix of two solutions, an analyte mix, and a benzyl chloride solution. The response factors, calculated by the computer, are based on the concentration of the standard mix alone. Since the individual solution of benzyl chloride also contained methylene chloride, the response factors were manually calculated for the concentrations resulting from this contribution, and analytical results were corrected accordingly.

The following are the standard concentrations that the computations are based on:

109.9 ng (50 ng from mix)
1099 ng (500 ng from mix)
2198 ng (1000 ng from mix)
4396 ng (2000 ng from mix)

H2M LABS, INC.

SDG NARRATIVE FOR TCLP BASE NEUTRAL/ACID EXTRACTABLES
SAMPLES RECEIVED: 3/11/94
(WES028)

FOR SAMPLES: RFW-TP-1
RFW-TP-2
RFW-TP-3
RFW-TP-3 MS
RFW-TP-3 MSD
RFW-TP-4
RFW-TP-5

The samples were extracted by EPA Method 1311, and analyzed according to the protocol 91-2 in the NYS DEC ASP 12/91.

QC DATA

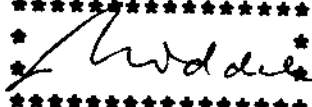
Poor recoveries were obtained for the acid surrogates and part of the spiked analytes in the MS/MSD analyses. Reextractions were still low, but sample 2 and 4 were in the acceptable range.

The recoveries for sample RFWTP-1 RE, RFWTP-2 RE and RFWTP-5 RE are still unacceptable.

Apparently the low recoveries are caused by matrix interference. It should be noted that some low bias (but in the acceptable range) is also caused by the leaching fluids. This can be observed in the lowered recoveries of the TCLP blank, compared to the method blank.

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Date Reported: April 14, 1994

*  *

Ursula Middel
Technical Manager

H2M LABS, INC.

SDG NARRATIVE FOR TCLP VOLATILE ANALYSIS
SAMPLES RECEIVED: 3/11/94
(WES028)

FOR SAMPLES: RFW-TP-1 RFW-TP-4
 RFW-TP-2 RFW-TP-5
 RFW-TP-3 MS/MSD

Samples were leached according to the EPA Method 1311 and analyzed by procedure 91-2 of the NYSDEC ASP 12/91.

QC DATA/CALIBRATION

The surrogate recovery for sample RFWTP-1 was outside the QC limits for bromofluorobenzene. As the results of the re-analysis indicates, this is due to matrix interference. Both analyses are reported.

Acceptance criteria were met for accuracy and precision data, as well as the initial and continuous calibration. Good agreement were obtained for the MSB spikes and the QC standard spike for which a different spiking solution was used.

A low contamination under reporting limit for trichloroethene was found in the TCLP (blank, which, however) was not present in any sample leachate.

SAMPLE ANALYSES

Some peaks were observed in the sample runs, that appear to originate from the leaching fluid, but do not interfere with the analysis of the targeted analytes.

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Date Reported: April 15, 1994

* *Ursula R. Middel* *

Ursula R. Middel
Technical Manager

H2M LABS, INC.

SDG NARRATIVE FOR PESTICIDE/PCB ANALYSIS
SAMPLES RECEIVED: 3/11/94
(WES028)

- L2 smaller than 1/2 contract required reporting limit on column 2
- W1 outside the actual retention time window established on column 1
- W2 outside the actual retention time window on column 2
- I PCB isomer interfering with pesticide
(Pesticides are reported, but with qualifier)

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Date Reported: April 5, 1994

* *Ursula Middel* *

Ursula Middel
Technical Manager

H2M LABS, INC.

SDG NARRATIVE FOR PESTICIDE/PCB ANALYSIS

SAMPLES RECEIVED: 3/11/94

(WES028)

FOR SAMPLES: RFW-TP-1
RFW-TP-2
RFW-TP-3
RFW-TP-3 MS
RFW-TP-3 MSD
RFW-TP-4
RFW-TP-5

The samples were extracted by EPA Method 1311, and analyzed according to the protocol 91-3 in the NYS DEC ASP 12/91.

QC DATA

All surrogate recoveries, precision and accuracy data, as well as TCLP blank and method blank results met acceptance criteria.

Note that the retention times of the spiked heptachlor epoxide are outside the RT windows as determined from the calibration standard. This was caused by the fact that the solution used for spiking contained a different isomer of this analyte than that in the calibration solution.

CALIBRATION/SYSTEM PERFORMANCE

The limits for calibration standards and system checks were met. Two deviations from the protocol have to be noted:

A technical chlordane standard was added to the ASP sequence and the time difference between the instrument blanks in the sequence exceeded the time interval of 12 hours, plus one run, by 10 min.

DCB in the first PEM analysis was outside the RT window on column RTX-35. This did not have any effect on the data of the samples.

SAMPLE ANALYSIS

No problems were encountered.

CODES USED IN RAW DATA

Identification printed by the data system are tentative. The data are reviewed by the analyst and the following codes are used to indicate reasons for rejection of identifications:

L1 smaller than 1/2 contract required reporting limit
(CRQL) on column 1

(Peaks smaller than 1/2 CRDL are not reported as positives due to interference/noise levels)

Data Validation Services

Cobble Creek Road P. O. Box 208

North Creek, N. Y. 12853

Phone 518-251-4429

FACSIMILE TRANSMISSION

Date: 4-27-94

To: Joann Slawn

Company: H2M Labs

From: Judy Hany

Number of pages including cover: 1

Comments: RE: Roy E. Weston - Clarkstown Landfill Site

H2M SDG WES 028 TCLP Pesticides

Although the raw data for the pesticides
standards is present, none of the standard
summary forms are in the package. Could
you please forward them to me when they
are available? Thanks,

Judy

H2M LABS, INC.

SDG NARRATIVE FOR TCLP HERBICIDE ANALYSIS
SAMPLES RECEIVED: 3/11/94
(WES028)

FOR SAMPLES: RFW-TP-1 RFW-TP-4
 RFW-TP-2 RFW-TP-5
 RFW-TP-3 MS/MSD

The leachates of the samples, prepared by EPA Method 1311, were analyzed for the targeted compounds by EPA Method 8150. The reporting format of the data package follows the requirements of ASP B of the NYSDEC ASP 12/91.

QC DATA/CALIBRATION

QC limits were met for surrogate recoveries and accuracy and precision data. The acceptance criteria were met for the initial and continuous calibration.

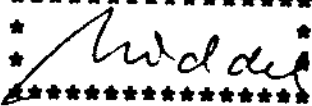
A low contamination was found in the method blank that was eluting just before 2,4-D, but in the targeted retention time window. The concentration found was under the reported quantification limit.

SAMPLE ANALYSES

The same secondary contamination as in the blank was found in the samples, but was under the reporting limits in all extracts.

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Date Reported: April 14, 1994

*  *

Ursula R. Middel
Technical Manager

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE IDENTIFICATION AND ANALYTICAL REQUIREMENT SUMMARY

SAMPLE RECEIVED: 3/18/94
R.F. WESTON
(WES030)

Customer Sample Code	Laboratory Sample Code	Analytical Requirements *					
		*VOA GC/MS	*BNA GC/MS	*VOA GC	*PEST PCB	*METALS +	*OTHER
FG-FB	9409385	X					
FG-3B	9409375	X					
FG-3B DUP	9409376	X					
FG-2B	9409377	X					
FG-8B	9409378	X					

Check Appropriate Boxes

CLP, Non-CLP (Please indicate year of protocol) ASP B 12/91
TCL, HSL, Priority Pollutant, other VOC in air (TO1 - TO2)

Comments: Only low volume samples were analyzed.

Page 1 of 6

S 0003

H2M LABS, INC.

SDG NARRATIVE FOR METALS ANALYSES
SAMPLES RECEIVED: 3/11/94
(WES028)

FOR SAMPLES:

RFWTP1
RFWTP2
RFWTP3 MS/MSD
RFWTP4
RFWTP5

ICP analysis was performed using a Thermo Jarrell Ash TJA61. A Varian Spectra 400 AA was used for mercury and flame AA analysis.

The barium matrix spike recovery for sample RFWTP3 is not within 75-125%. All barium results are reported flagged with an "N" on Forms I and V(a).

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Date Reported: April 4, 1994

* *Sal Badalamenti* *
*

Sal Badalamenti
Inorganic Supervisor

H2M LAES, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE IDENTIFICATION AND ANALYTICAL REQUIREMENT SUMMARY

SAMPLES RECEIVED: 3/11/94
R.F. WESTON
CLARKSTOWN LANDFILL
(WES028)

[illegible]

* Check Appropriate Boxes

* CLP, Non-CLP (Please indicate year of protocol) 1201

- * CLP, Non-CLP (Please indicate year)
- * TCL, HSL, Priority Pollutant TCLP
- * ~~Dissolved TCL Metals analyzed as well~~

* ~~Dissolved TCL Metals analyzed as well~~

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS FORM

TCLP HERBICIDE ANALYSES

SAMPLES RECEIVED: 3/11/94

R. F. WESTON

(WES028)

[illegible]

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS SUMMARY TCLP B/N-A ANALYSES

SAMPLES RECEIVED: 3/11/94
R.F. WESTON
(WES028)

SAMPLE ID	MATRIX	DATE COLLECTED	DATE REC'D AT LAB	DATE EXTRACTED	DATE ANALYZED
RFWTP-1	WATER	3/09/94	3/11/94	3/17/94	3/30/94
RFWTP-1 RE	"	"	"	4/04/94	4/04/94
RFWTP-2	"	"	"	3/17/94	3/30/94
RFWTP-2 RE	"	"	"	4/04/94	4/04/94
RFWTP-3	"	"	"	3/17/94	3/30/94
RFWTP-3 RE	"	"	"	4/04/94	4/04/94
RFWTP-3 MS	"	"	"	3/17/94	3/30/94
RFWTP-3 MS RE	"	"	"	4/04/94	4/04/94
RFWTP-3 MSD	"	"	"	3/17/94	3/30/94
RFWTP-3 MSD RE	"	"	"	4/04/94	4/04/94
RFWTP-4	"	"	"	3/17/94	3/30/94
RFWTP-4 RE	"	"	"	4/04/94	4/04/94
RFWTP-5	"	"	"	3/17/94	3/30/94
RFWTP-5 RE	"	"	"	4/04/94	4/04/94

PAGE 2 OF 6

S 0004

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS FORM

TCLP B/N-A ANALYSES

SAMPLES RECEIVED: 3/11/94

R. F. WESTON

(WES028)

[illegible]

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS FORM

TCLP HERBICIDE ANALYSES

SAMPLES RECEIVED: 3/11/94

R. F. WESTON

(WES028)

[illegible]

F2M LAES, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
SAMPLE PREPARATION AND ANALYSIS SUMMARY

TCLP HERBICIDE ANALYSES

SAMPLES RECEIVED: 3/11/94
(WES028)

[illegible]

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS SUMMARY

TCLP INORGANIC ANALYSES

SAMPLES RECEIVED: 3/11/94
R.F. WESTON
CLARKSTOWN LANDFILL
(WES028)

[illegible]

* SEE RUN SHEETS FOR EXACT DATES.

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
SAMPLE PREPARATION AND ANALYSIS SUMMARY

TCLP HERBICIDE ANALYSES

SAMPLES RECEIVED: 3/11/94
(WES028)

[illegible]

Data Validation Services

Cobble Creek Road P. O. Box 208

North Creek, N. Y. 12853

Phone 518-251-4429

TO: Roy F. Weston

FROM: Judy Harry, Data Validation Services *J. Harry*

DATE: July 1, 1994

RE: Validation of Clarkstown Landfill data packages
Surface water and sediment samples
H2M SDG Nos. VES029 and VES031

Review is complete for the data packages generated by H2M Labs, pertaining to samples collected at the Clarkstown Landfill Site. One groundwater, nine surface waters, and nine sediments were processed for various parameters. Three trip blanks and sample matrix spikes were also analysed. Methodologies utilized were those of the 12/91 NYSDEC ASP.

In summary, most sample processing was performed in compliance with protocol requirements. The aqueous volatile samples were to have been processed for Part 360 parameters, according to EPA-524.2 (under the ASP), but were not analysed in accordance with that protocol. Consequently, the low level detection limits associated with 524.2 were not achieved. See discussions later in this text.

Attached to this narrative, please find a compliance chart and copies of the laboratory case narratives and NYSDEC sample tracking forms. Also included in this report are copies of resubmission communications with the laboratory.

Although the pesticide/PCB report Form 1 for sample SW17-02 was edited to this correct sample ID in the Data Summary Package, all summary forms and raw data in the Sample Data Package contain the incorrect ID of SW7-02. No sample with the ID of SW7-02 was processed for this phase of this project. Laboratory ID numbers were correct, and provided for sufficient verification of SW17-02 reported results.

Certain sample reported values are recommended for qualification due to results of quality control evaluations, and are outlined below. Other issues of concern are discussed in the subsequent analysis sections.

Edits, and recommended qualifications are as follows:

1. The volatile analysis of sample GW5D produced elevated surrogate recoveries (118% to 134%) for BFB in the sample, the trip blank, and the method blank, which indicate an instrumental effect. The reanalyses occurred one day beyond allowable holding time, and also produced outlying surrogate values. The initial sample results, run within the required holding time, should be used, but the reported toluene and xylene values should be considered estimated (indicated by surrogate recoveries). The detection of ethylbenzene in GW5D was inconsistent between the initial and reanalyses of this sample (undetected in the initial analysis, and detected at 1 ug/L in the reanalysis), and therefore the reported results/detection limit for this compound in GW5D should be considered estimated.
2. Due to poor recovery in the associated 1 ppb Matrix Spike Blank (MSB), the reported detection limits for acrylonitrile (35%), and trans-1,4-dichloro-2-butane (66% recovery) should be considered estimated for sample GW5D and its associated trip blank. The detection limits for 1,2-dibromopropane (40%) and vinyl acetate (22%) in the trip blank should also be considered estimated.

10. Please see the attached resubmitted volatile Form 1E reporting the TICs for sample SD15-02.
11. The volatile TIC in sample SW2-02 should be rejected due to copresence in the associated trip blank and another project method blank.
12. The volatile TIC #3 of SD13-02 should be omitted from the report Form 1E. Please see resubmitted report form attached to this narrative. In addition, the reported values for volatile TICs #6 and 7 for this sample should be edited to reflect 13 ug/kg and 12 ug/kg, respectively.
13. The detection limits for the pesticide/PCB target compounds of sample SD4-02 should be considered estimated, possibly biased low, as indicated by the low surrogate recoveries (26% to 34%). The 4,4'-DDE value for this sample should also be considered estimated because of the poor correlation between reported values in the sample and its matrix spikes (undetected in the sample, detected at 48 ug/Kg and 24 ug/Kg in the matrix spikes of the sample).
14. The cadmium result for sample SW13-02 should be "1.3 U", not "1.3 B".
15. The lead values of all project samples should be considered estimated due to outlying recoveries of the standard at CRDL (CRA/CRI). The CRI/CRA recoveries associated with soil samples and sample GW5D were elevated (160%, 142%, and 148%); that associated with the surface water samples was depressed, at 37%.
16. The selenium recovery of the matrix spike of aqueous sample SW13-02 was slightly low, at 71%, and reported values for surface waters should be considered estimated.
17. The selenium result for sample GW5D should be considered estimated due to low recovery in the associated matrix spike (66%).
18. The antimony and silver matrix spike recoveries for soil sample SD13-02 were low, at 21% and 63%, respectively, and reported soil values should be considered estimated.
19. The following elemental post-digest spike recoveries fell outside the recommended range of 85 to 115%, with values indicating consideration for qualification as estimated:

<u>Sample ID</u>	<u>Element</u>	<u>Post-Digest Spike Recovery</u>
SD18-02	Thallium	78
SW2-02	Lead	120
SW12-02	Selenium	81
SW13-02	Selenium	79
SW14-02	Selenium	76
	Lead	118
SW16-02	Selenium	80
	Lead	126
SW17-02	Selenium	72
	Arsenic	124
SW18-02	Selenium	80
	Lead	113

3. The detection limit of the surface water samples can be lowered from the originally reported values of 10 ug/L, to 5 ug/L (see later discussion). Due to poor linearity of trichlorofluoromethane (31%RSD) and bromoform (40%RSD) in the (revised) initial calibration associated with the surface water samples, the modified detection limit of 5 ppb should be qualified as estimated.
4. The acetone detected in the soil samples should not be considered as a sample component. This compound was detected in the associated blanks at levels similar to those of the samples. Therefore sample reported results should be edited to reflect either nondetection at the CRDL, or nondetection at the originally reported value, whichever is greater.

Additionally, the methylene chloride in the soil samples should be disregarded due to the copresence in the associated matrix spike blank. Reported values should be edited to reflect nondetection at the CRDL.

5. The acetone, and the two Tentatively Identified Compounds (TICs) reported for sample GW5D should be rejected due to copresence in the associated method and/or trip blank. The reported value for acetone should be edited to reflect nondetection at 8 ug/L.
6. Due to poor spectral quality, the identification and reported values of the following compounds should be rejected, and results edited to reflect nondetection at the CRDL:
 - 2-hexanone in sample SD12-02
 - carbon disulfide in samples SD13-02 and SD18-02
 - 2-butanone in sample SD16-02
7. The reported detection limits for hexachlorocyclopentadiene sediments SD2-02, SD4-02, SD17-02, SD18-02, and SD19-02 should be considered estimated or rejected due to outlying recovery of the associated spiked blank (5% recovery).
8. Bis-2(ethylhexyl)phthalate should not be considered a sample component for this project, as it was detected at similar levels in associated blanks. Sample reported results should be edited to reflect either nondetection at the CRDL or nondetection at the originally reported value, whichever is greater.
9. The "B" flags, which indicate the presence of the compound in the associated blank were omitted from certain of the volatile sample TICs, including the following.:

<u>Sample ID</u>	<u>TIC Numbers</u>
GW5D-02	#2
SD2-02	#2,3,4,5
SD4-02	#1,2,3
SD12-02	#1,2,3,4
SD13-02	#1,2,4,5 -after revision (see below)
SD14-02	#1,2,3,5,6
SD15-02	#1,2,3 -after revision (see below)
SD16-02	#1,2,3,4
SD17-02	#1,2,3,4
SD18-02	#1,2,3,4
SW13-02	#1
TBSV041994	#1

All TICs with the "B" flag should be disregarded as sample components.

All semivolatile TICs flagged as "A" should also be disregarded as sample components (extraction byproducts).

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
SAMPLE PREPARATION AND ANALYSIS SUMMARY
PESTICIDE/PCB
ANALYSES

SAMPLES RECEIVED: 4/19/94
(WES031)

SAMPLE ID	MATRIX	DATE COLLECTED	DATE REC'D AT LAB	DATE EXTRACTED	DATE ANALYZED
SW4-02	WATER	4/18/94	4/19/94	4/21/94	4/28/94
SW4-01 MS	"	"	"	"	"
SW4-01 MSD	"	"	"	"	"
SD4-02	SOIL	"	"	4/19/94	"
SD4-02 MS	"	"	"	"	"
SD4-02 MSD	"	"	"	"	"
SD17-02	"	"	"	"	"
SW4-02 CONF	WATER	4/18/94	4/19/94	4/21/94	4/28/94
SW4-01 MS CONF	"	"	"	"	"
SW4-01 MSD CONF	"	"	"	"	"
SD4-02 CONF	SOIL	"	"	4/19/94	"
SD4-02 MS CONF	"	"	"	"	"
SD4-02 MSD CONF	"	"	"	"	"
SD17-02 CONF	"	"	"	"	"

are recommended for edit to that level (see above). The amended initial calibration verification summary form is attached to this narrative. Detection limits for bromoform and trichloromethane are recommended for qualification due to depressed nonlinear response at the lower concentrations. Certain of the reporting Forms 1 for the 5 ppb and MSB standards contained transcription errors. All actual values were reviewed for acceptable recoveries.

Sample SW12-02 was processed within seven days of receipt, but was processed outside the twelve hour allowable timeframe from instrumental tune verification. Evaluation of the subsequent tune and standard, processed within two hours after the sample, showed consistency with the previous tune and standard. Because instrument sensitivity was comparable, and no target compounds were detected in SW12-02, no qualification to sample reported results is recommended as a result of this noncompliance.

The surface water matrix spikes of sample SW13-02 were processed at 50 ppb, and produced one outlying recovery, for trichloroethene (68%; limit of 71%). Duplicate correlation was good. Method blanks, instrumental tunes, and internal standard areas/retention times met protocol criteria.

VOLATILES 91-1

Sediment samples were processed under 91-1. Holding times, surrogate recoveries, and instrumental tunes were acceptable. Matrix spikes of sample SD13-02 produced elevated recoveries of benzene, at 145% and 155%, greater than the recommended limit of 142%. Matrix spike blank recoveries were acceptable.

Initial and continuing calibration standards were compliant, and acceptable. Internal standard areas and retention times were within compliant ranges.

The soil method blanks showed TICs which are resultant of instrumental column bleed. The analyses of most samples also showed these components, which should have been flagged as "B" (see earlier discussion), and which should be disregarded as sample constituents.

SEMIVOLATILES

Holding times were met for sample processing. Surrogate recoveries fell within required ranges. Sample matrix spikes of SD13-02 and the MSB produced acceptable recoveries for all components except 4-nitrophenol, which recovered between 100% and 142%, above the limits of 80%/114%. The spiked blank produced depressed recovery of 5% for cyclopentadiene. This value was within the lab acceptance range, but still indicates a possible low bias to reported detection limits.

Initial and continuing calibration standards produced values within protocol criteria. Certain compounds produced responses greater than 30% D, but sample reported results are not impacted. Method blanks and instrumental tunes met the requirements, and internal standard areas/retention times were compliant.

PESTICIDES/PCB

Holding times were met for sample processing. Certain surrogate recoveries fell below the recommended limit of 60%, but most were just below. The exception is sample SD4-02, which was recommended for qualification of detection limits due to low surrogate recoveries. Method blanks met protocol requirements.

Matrix spike recoveries of SW4-02 were within limits. The duplicate precision of gamma-BHC was high, at 27%RPD (above 15%RPD limit). The matrix spike recoveries of sample SD4-02 were within range, with the exception of those of gamma-BHC, which recovered at 30% and 32%, below the limit of 46%. Duplicate precision was good for the sediment spikes. MSB recoveries were within ranges for both matrices.

20. The "N" flag was misapplied by the laboratory to the surface water sample cyanide values, and should be removed. The matrix spike recovery for cyanide was acceptable, at 89%.
21. The manganese values for the surface waters should be considered estimated, as indicated by the serial dilution outlying value of 13%D (limit of 10%D).
22. The "N" flag was misapplied to the selenium result for sample SD16-02, and should be removed.
23. The total dissolved solids (TDS) value reported for GW5D should be rejected due to the similar value detected in the blank.
24. The bromide value for GW5D should be considered estimated due to the low recovery (40%) of the associated matrix spike.

EPA 524.2 VOLATILES

The aqueous samples for this project were to have been processed for Part 360 parameters according to the EPA-524.2 procedure. Due to laboratory communication lapses, they were not. Only 5 mLs of each sample were analysed, rather than the protocol volume of 25 mLs. Therefore, the desired low detection limits were not readily achieved. The samples were processed in two different ways:

A. SDG WES029

Sample GW5D (and its trip blank) were run in sequences which included 5 mL blanks (MSBs) spiked with 1 ug/L of all target compounds, and were reported with detection limits of 1 ppb. Review of the recoveries of these MSB compounds was performed during validation for justification of the 1 ug/L sample reported detection limits. Elevated recoveries were present, but are not of concern, as none of those target compounds were detected in the samples. Those compounds with depressed recoveries are noted for qualification in the earlier section.

Holding times were met for initial sample analyses of GW5D; the trip blank associated with GW5D was run 2 hours after the end of the seventh day. The reanalyses of sample GW5D and its trip blank were performed on the eighth day from receipt, and are not recommended for use of results (see earlier discussion).

Surrogate recoveries were not compliant for the sample and blank processing, as noted earlier, which indicates system problems affecting detected values. Sample matrix spikes were not requested/provided. Method blanks and instrumental tunes produced acceptable values.

Initial calibration standards were processed at levels of 5 to 80 ppb; continuing calibration standards were analysed at levels of 10 ppb. The linearity and correlation values for the standards were compliant. Internal standards retention times and areas were acceptable.

B. SDG WES031

The surface water samples were processed under an initial calibration which included levels greater than or equal to 10 ppb. The sample reported detection limits were also 10 ppb. Following each day's sample processing, standards at a concentration of 5 ppb were processed and reported. Because the project goals were to have been 1 ppb detection limits for the samples, these 5 ppb standards were incorporated into the initial calibration. Linearity to 5 ppb was then verified, and sample reported detection limits

COMPLIANCY CHART

Project: Roy F. Weston- Clarkstown Landfill

SDG Nos: H2M SDG Nos. WES029 and WES031

Protocol: 1991 NYSDEC ASP

RecDate	Sample ID	Matrix	VOA	BNA	Pest/PCB	Metals/CW	Other	Noncompl
03-24-94	GW5D-02	Aqueous	NO	NR	NR	OK	OK	1
03-24-94	TBGW-032394	Aqueous	NO	NR	NR	NR	OK	1
04-19-94	SW2-02	Aqueous	NO	NR	NR	OK	OK	1
04-19-94	SW4-02	Aqueous	NO	NR	OK	OK	OK	1
04-20-94	SW12-02	Aqueous	NO	NR	NR	OK	OK	1,2
04-20-94	SW13-02	Aqueous	NO	NR	NR	OK	OK	1
04-20-94	SW14-02	Aqueous	NO	NR	NR	OK	OK	1
04-20-94	SW15-02	Aqueous	NO	NR	NR	OK	OK	1
04-19-94	SW16-02	Aqueous	NO	NR	NR	OK	OK	1
04-19-94	SW17-02	Aqueous	NO	NR	OK	OK	OK	1
04-19-94	SW18-02	Aqueous	NO	NR	NR	OK	OK	1
04-19-94	SD2-02	Soil	OK	NO	NR	OK	OK	3
04-19-94	SD4-02	Soil	OK	NO	OK	OK	OK	3
04-20-94	SD12-02	Soil	OK	NO	NR	OK	OK	3
04-20-94	SD13-02	Soil	OK	NO	NR	OK	OK	3
04-20-94	SD14-02	Soil	OK	NO	NR	OK	OK	3
04-20-94	SD15-02	Soil	OK	NO	NR	OK	OK	3
04-19-94	SD16-02	Soil	OK	NO	NR	OK	OK	3
04-19-94	SD17-02	Soil	OK	NO	OK	OK	OK	3
04-19-94	SD18-02	Soil	OK	NO	NR	OK	OK	3
04-19-94	TBSW-041894	Aqueous	NO	NR	NR	NR	NR	1
04-20-94	TBSW-041994	Aqueous	NO	NR	NR	NR	NR	1

1. Aqueous volatiles not processed by EPA-524.2
2. Volatile sample analysis performed in excess of twelve hours from verification of instrument tune (NYSDEC ASP pg. E-40).
3. BNA matrix spike blank with outlying recovery (pg. E-85).

All protocol requirements for standard/system processing were met. Sample reported results are substantiated by the raw data.

METALS

Holding times were met for sample processing. All results of protocol quality criteria requirements were reviewed for compliancy, and found to be acceptable unless noted specifically within this text.

Sample GW5D was evaluated for accuracy and precision using the results from the other groundwater matrix spike analyses for this project. The outlying matrix spike recoveries of samples SW13-02 and SD13-02 which warranted qualification were discussed earlier in this text. In addition to those noted, the silver recovery in the spike of SW13-02 produced a recovery of 74.8%, just below the recommended limit of 75%. Duplicate correlation was good for both matrices. Outlying lead CRDL standard recoveries and serial dilution values were noted above.

The Form 14 analysis logs contain incorrect recovery values for furnace post-digest spikes. Raw data contain the correct values.

INORGANICS

Holding times were met. Sample results were reviewed for compliance with protocol, standard and blank acceptability, accuracy and precision (resulting from project and/or batch QC), calculation algorithms, transcriptions, and dilution factors, all as applicable. Unless discussed specifically, all were acceptable, and reported values were substantiated by raw data.

The bromide matrix spike recovery associated with GW5D was 40%; other recoveries were within recommended limits.

The blank TDS value associated with sample GW5D was 19 mg/L. As discussed earlier, the sample result of 48 mg/L is therefore unusable.

The value for the duplicate hexavalent chromium on the SDG WES029 QC summary form should be "<0.02 mg/L", not "<0.2 mg/L". The wrong total hardness summary for WES029 was provided. The reported value for GW5D was verified using raw metals results. The ammonia raw data indicate the wrong sample ID for the matrix spikes. The correct laboratory number ID was present.

Data Validation Services

Cobble Creek Road P. O. Box 208

North Creek, N. Y. 12853

Phone 518-251-4429

FACSIMILE TRANSMISSION

Date: 6-17-94
To: Joanne Dignan (516) 420-8434
Company: Vern Labs
From: Judy Hany
Number of pages including cover: 1

Comments: Re: Weston Clarkstown Landfill Site.

As we discussed today, the aqueous samples
(WES031) were to have been processed by EPA 524.2
low level VOA. The lowest calibration standard
used to determine linearity was 10ppb. Would
it be possible for the analysts to regenerate
the water standard form 6 using the 5 ppb
standard from May 4/27 and the 4 lowest
concentration standards from the curve of 4/26?

The resultant RSD values can then be used
to determine possible linearity to lower
detection limits than those originally
reported. Please let me know the feasibility
of this as soon as possible. And please fax
the Form 6 as soon as available.

Thanks,

Judy

Data Validation Services

Cobble Creek Road P. O. Box 208

North Creek, N. Y. 12853

Phone 518-251-4429

June 9, 1994

Joann Slavin
H2M Labs
575 Broad Hollow Rd.
Melville, NY 11747

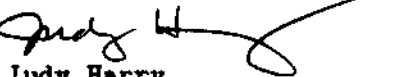
Dear Joann:

Review of Roy F. Weston Clarkstown Landfill Site data packages is in progress. The following items will be needed prior to completion of the validation report. They all pertain to SDG WES031:

1. The Inorganics report form for lab ID number 9412922 (pg. 011) shows a sample ID of SD-1-02. This should be SD13-02. In that this is a result report form, it is preferable that this form be regenerated with the correct sample ID, so that the end users of the data use the information correctly.
2. No spectrum was provided for the volatile TIC #3 (13.06') for sample SD13-02. This compound was also not on the TIC raw data summary form. Please provide.
3. The volatile TIC compounds for sample SD15-02 were reported with the % solids value for % moisture (see moisture value on Form 1E), and therefore all TIC values are incorrect. In addition, a TIC was present (with all required raw data) for this sample at a retention time of 9.94', which was not reported as TIC on the Form 1E.
4. All semivolatile samples processed on 4/28/94 were quantitated against the calibration standard for 4/27/94. Therefore many reported values for these samples are incorrect. Please regenerate report Forms 1B, 1C, and 1F with corrected values for these samples and spikes. Also please regenerate associated Forms 3 for the matrix spikes processed this day.
No Forms 3 were provided for the semivolatile MSBs. Please provide.

Please also forward copies of all communications to LuAnn Pasciak at the Valhalla office of Roy F. Weston. Please do not hesitate to contact me with any questions or comments. Thank you for your attention to this matter.

Very truly yours,


Judy Harry

H2M LABS, INC.

Response to Data Validation
of Roy F. Weston
Clarkstown Landfill Site
SDG: WES031

1. Corrected copy enclosed.

2. Sample SD13-02 (VOA)

The TIC at RT 13.06 was less than 10% of the closest internal standard. A revised TIC form IE is submitted.

3. Sample SD15-02 (VOA)

The TIC form IE is corrected for the % moisture and the TIC at RT 9.94 has been added.

4. All corrected forms are enclosed. (SVOA)

H2M LABS, INC.

Environmental and Industrial Analytical Laboratory

575 Broad Hollow Road, Melville, NY 11747-5076
(516) 694-3040 • FAX: 516-694-4122

June 17, 1994

Ms. Judy Harry
Data Validation Services
Cobble Creek Road
P.O. Box 208
North Creek, NY 12853

Re: Response to Data Validation comments on
R.F. Weston - Clarkstown Landfill
SDG No.: WES031

Dear Ms. Harry:

Enclosed please find a response to your fax of June 9, 1994.
Each item has been addressed and resubmittals should be in
order of your comments.

An additional copy of all has been transmitted to Luann
Pasciak of R.F.Weston of Valhalla.

If there are any further questions or comments, please call
Joann Slavin or myself at anytime.

Very truly yours,

Joanne Duignan
Joanne Duignan
QA/QC Section Supervisor

Enclosure
letter/response wes31



1E
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.

SD13-02

Lab Name: H2M LABS. INC

Contract: NYSDEC

Lab Code: H2M

Case No.: WES

SAS No.: _____

SDG No.: WES031

Matrix: (soil/water) SOIL

Lab Sample ID: 94129228 *SL 61044*

Sample wt/vol: 5.0 (g/mL) G

Lab File ID: A01487.D

Level: (low/med) LOW

Date Received: 4/20/94

% Moisture: not dec. 54.7

Date Analyzed: 4/26/94

GC Column: RTX502.2

ID: 0.53 (mm)

Dilution Factor: 1.0

Soil Extract Volume: 1 (uL)

Soil Aliquot Volume: 1 (uL)

Concentration Units:

Number TICs found: 8

(ug/L or ug/Kg) ug/Kg

CAS Number	Compound Name	RT	Est. Conc.	Q
1	Column Bleed	9.92	98	J
2	Column Bleed	11.89	140	J
3	Unknown Hydrocarbon	13.72	16	J
4	Column Bleed	13.93	190	J
5	Unknown	14.61	18	J
6	Unknown Hydrocarbon	15.36	11	J
7	Unknown Hydrocarbon	16.06	14	J
8				
9				
10.				
11.				
12.				
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30.				

VOU75A

H2M LABS, INC.

575 Broad Hollow Road, Melville, N.Y. 11747
(516)694-3040 FAX:(516)694-4122

LAB NO: 9412922

R.F. WESTON
1 OLD COUNTRY RD./SUITE 430
CARLE PLACE, NY 11514

TYPE..... SOIL
ROUTINE
METHOD.... GRAB

DATE COLLECTED. 04/19/94
DATE RECEIVED.. 04/20/94
COLLECTED BY... CL99
PROJECT NO..... 3228-10-02

POINT NO:
LOCATION: SD13-02
MS/MSD ALSO
REMARKS: CLARKSTOWN LANDFILL

<u>PARAMETER (S)</u>	<u>RESULTS</u>	<u>UNITS</u>
HEXAVALENT CHROMIUM	<2.2	mg/kg
TOTAL ORGANIC CARBON(TOC)	53600	mg/kg
TOTAL SOLIDS	45.3	%

COPIES TO:

DATE ISSUED 05/23/94

ORIGINAL

JM
LABORATORY DIRECTOR

VOLATILE ORGANICS INITIAL CALIBRATION DATA

Lab Name: H2M LABS, INCContract: NYSDECLab Code: H2MCase No.: WES

SAS No.: _____

SDG No.: WES031Instrument ID: H5971Calibration Date(s): 4/26/94 4/27/94Heated Purge: (Y/N) NCalibration Times: 1143 1628GC Column RTX502.2ID: 0.53 (mm)

Lab File ID:		RRF05 = A01524.D		RRF10 = A01498.D			
RRF20 = A01499.D		RRF50 = A01494.D		RRF100 = A01500.D			
COMPOUND		RRF 05	RRF10	RRF20	RRF50	RRF100	% RSD
chloromethane		0.388	0.233	0.278	0.230	0.193	28.5
vinyl chloride	*	0.408	0.247	0.317	0.289	0.349	18.9
bromomethane	*	0.383	0.247	0.303	0.285	0.318	16.3
chloroethane		0.261	0.171	0.214	0.211	0.233	15.1
acetone		0.042	0.040	0.031	0.053	0.031	23.1
acrylonitrile		0.157	0.126	0.168	0.190	0.201	17.3
iodomethane		0.879	0.615	0.766	0.815	0.846	13.2
vinylacetate		0.168	0.244	0.231	0.254	0.258	15.9
2-butanone		0.142	0.086	0.087	0.130	0.090	25.1
carbendisulfide		0.490	0.320	0.497	0.479	0.572	19.6
trichlorofluoromethane		0.198	0.379	0.465	0.504	0.377	30.7
1,1-dichloroethene	*	0.454	0.271	0.341	0.352	0.369	18.3
methylene chloride		0.446	0.293	0.352	0.367	0.373	15.0
trans-1,2-dichloroethene		0.473	0.304	0.374	0.389	0.404	15.6
1,1-dichloroethane	*	0.911	0.587	0.704	0.735	0.754	15.8
cis-1,2-dichloroethene		0.422	0.338	0.376	0.361	0.427	10.0
bromochloromethane		0.296	0.231	0.242	0.276	0.536	39.7
chloroform	*	0.925	0.578	0.684	0.725	0.744	17.2
1,2-dichloroethane	*	0.478	0.336	0.392	0.405	0.421	12.6
1,1,1-trichloroethane	*	0.701	0.468	0.574	0.607	0.622	14.3
carbon tetrachloride	*	0.327	0.343	0.423	0.456	0.497	17.8
benzene	*	0.925	0.693	0.779	0.743	0.889	12.2
trichloroethene	*	0.591	0.367	0.441	0.443	0.485	17.6
1,2-dichloropropane		0.498	0.319	0.393	0.395	0.429	16.0
dibromomethane		0.400	0.285	0.349	0.348	0.392	12.9
bromodichloromethane	*	0.500	0.445	0.541	0.570	0.626	12.8
cis-1,3-dichloropropene	*	0.566	0.425	0.518	0.536	0.576	11.4
toluene	*	0.652	0.494	0.566	0.552	0.651	11.7
trans-1,3-dichloropropene	*	0.469	0.373	0.453	0.463	0.507	10.9
1,1,2-trichloroethane	*	0.328	0.242	0.294	0.294	0.325	11.6
1,2-dibromoethane		0.610	0.473	0.579	0.574	0.648	11.3
4-methyl-2-pentanone		0.381	0.389	0.432	0.323	0.465	13.6
chlorobenzene	*	2.413	1.559	1.920	1.887	2.056	15.7
tetrachloroethene	*	0.919	0.610	0.768	0.780	0.839	14.5
dibromochloromethane	*	0.801	0.983	1.231	1.246	1.401	21.0
2-hexanone		0.464	0.291	0.331	0.407	0.358	18.2

* Compounds with required minimum RRF and maximum %RSD values.

All other compounds must meet a minimum RRF of 0.010.

SDG No.: WES031

Calibration Times: 1143 1628

ID: 0.53 (mm)

* Compounds with required minimum RRF and maximum %RSD values.
All other compounds must meet a minimum RRF of 0.010.

BASE/NEUTRAL/ACID EXTRACTABLE
INSTRUMENT DETECTION LIMITS

Instrument ID: H59706

Analysis Date: 1/17/94

Column ID: Quadrex DB.5

Method: DEC CLP

Amount Analyzed: 20 ng

File ID No.	A0996	A0997	A0998	A0999	A1000	A1001	A1002		ng
	IDL 1	IDL 2	IDL 3	IDL 4	IDL 5	IDL 6	IDL 7	S	IDL
Acenaphthene	23.94	21.52	23.41	23.70	23.10	23.27	22.91	.73	2.19
2,4-Dinitrophenol	16.71	14.70	15.26	15.51	15.96	14.71	14.90	.68	2.05
4-Nitrophenol	23.23	21.26	21.39	20.82	20.29	18.72	19.52	1.34	4.01
Dibenzofuran	24.53	22.53	24.02	23.22	23.62	22.52	22.93	.70	2.11
2,4-Dinitrotoluene	21.04	20.17	20.15	21.24	21.27	18.73	20.22	.83	2.49
2,6-Dinitrotoluene	20.05	20.04	19.82	19.61	19.47	18.16	18.81	.70	2.11
Diethylphthalate	24.40	23.11	24.07	23.42	24.50	22.04	23.90	.80	2.39
4-Chlorophenyl-phenyle	29.29	27.69	28.63	29.01	28.39	27.17	27.64	.72	2.17
Fluorene	25.03	23.02	23.60	23.82	25.11	22.47	23.60	.90	2.70
4-Nitroaniline	24.34	21.56	24.00	24.08	23.94	21.84	26.23	1.47	4.41
4,6-Dinitro-2-methylph	18.06	18.45	19.23	18.89	19.52	18.38	19.74	.59	1.75
N-Nitrosodiphenylamine	21.07	22.11	22.57	23.47	23.24	21.64	23.69	.91	2.74
4-Bromophenyl-phenylet	24.26	24.18	26.12	25.20	24.65	25.55	26.05	.75	2.24
Hexachlorobenzene	25.14	25.14	26.19	26.49	23.82	25.73	24.70	.84	2.53
Pentachlorophenol	22.05	22.51	23.30	21.97	22.80	22.37	20.78	.73	2.20
Phenanthrene	23.81	23.69	23.70	23.36	23.19	22.89	23.27	.34	1.01
Anthracene	22.08	23.24	22.21	23.90	23.94	21.87	23.81	.86	2.57
Carbazole	25.60	25.58	25.09	26.27	26.24	24.42	26.69	.81	2.43
Di-n-Butylphthalate	20.99	20.88	22.05	23.22	20.83	21.56	22.55	.85	2.56
Fluoranthene	24.84	24.87	25.52	25.17	24.31	25.89	26.04	.57	1.72
Pyrene	20.70	20.98	21.06	20.34	19.25	19.97	20.80	.60	1.80
Butylbenzylphthalate	17.50	18.26	18.77	18.03	16.33	16.76	18.04	.80	2.40
3,3'-Dichlorobenzidine	23.17	23.17	23.67	22.60	20.94	21.67	22.58	.88	2.63
Benzo(a)Anthracene	21.70	22.18	21.88	20.61	19.88	20.29	21.85	.85	2.54
bis(2-ethylhexyl)Phtha	19.48	18.99	18.85	18.51	18.67	18.166	19.10	.30	.91
Chrysene	21.28	22.20	22.43	21.57	20.33	21.73	21.56	.63	1.89
Di-n-octylphthalate	21.09	21.06	21.29	21.66	21.07	20.666	20.01	.48	1.45
Benzo(b)Fluoranthene	25.23	25.02	27.29	25.08	24.80	21.52	25.85	1.61	4.83
Benzo(k)Fluoranthene	20.17	22.66	23.79	20.93	20.31	23.75	19.44	1.66	4.99
Benzo(a)Pyrene	23.38	21.95	23.28	22.12	22.83	21.13	22.41	.74	2.21
Indeno(1,2,3-cd)Pyrene	22.03	20.99	21.86	20.67	20.71	20.25	20.80	.61	1.82
Dibenzo(a,h)anthracene	22.47	22.26	23.14	22.29	22.70	21.56	20.99	.66	1.99
Benzo(g,h,i)Perylene	21.07	20.75	22.27	20.89	22.40	20.93	21.40	.63	1.89

BASE/NEUTRAL/ACID EXTRACTABLE

INSTRUMENT DETECTION LIMITS

Instrument ID: H5970B

Analysis Date: 11/17/94

Column ID: Quadrex AB.5

Method: AECCLP

Amount Analyzed: 20 ng

File ID No.	A0996	A0997	A0998	A0999	A1000	A1001	A1002	S	IDL
	IDL 1	IDL 2	IDL 3	IDL 4	IDL 5	IDL 6	IDL 7		
Phenol	23.17	23.14	21.99	20.74	23.23	21.95	23.22	.89	2.68
bis(2-Chloroethyl)Ethe	23.21	23.53	21.16	20.28	23.07	22.29	22.65	1.18	3.55
2-Chlorophenol	20.43	21.44	19.59	19.35	20.42	21.16	21.01	.73	2.19
1,3-Dichlorobenzene	21.44	21.09	20.67	21.01	21.61	21.59	21.33	.32	.95
1,4-Dichlorobenzene	22.13	22.35	21.67	22.16	21.70	21.45	22.87	.45	1.35
1,2-Dichlorobenzene	23.91	25.41	23.45	22.57	24.62	23.73	22.62	.95	2.85
2-Methylphenol	22.65	23.62	21.67	20.44	23.13	24.20	21.51	1.22	3.67
2,2,-oxybis(1-chloropr	31.22	29.84	27.81	26.43	28.24	27.41	23.92	2.18	6.53
4-Methylphenol	26.41	23.90	22.66	21.23	24.11	25.50	22.81	1.63	4.90
N-Nitroso-Di-n-propyla	27.37	27.25	25.15	24.44	26.16	25.84	22.56	1.56	4.67
Hexachloroethane	24.40	22.75	20.65	19.92	22.01	23.50	21.58	1.45	4.36
Nitrobenzene	30.18	27.97	27.16	25.16	27.02	26.11	22.96	2.10	6.29
ophorone	29.30	29.71	28.35	26.18	29.94	27.04	24.11	1.99	5.96
Nitrophenol	23.43	23.68	23.41	22.07	25.33	23.56	21.16	1.22	3.66
2,4-Dimethylphenol	24.57	24.63	24.22	23.16	26.38	24.84	22.51	1.15	3.46
bis(2-Chloroethoxy)met	27.33	27.94	27.49	25.32	26.37	26.55	24.92	1.04	3.13
2,4-Dichlorophenol	25.99	27.21	25.96	24.60	27.30	26.41	24.91	.96	2.88
1,2,4-Trichlorobenzene	27.37	28.28	28.23	27.02	28.27	27.56	25.31	.98	2.95
Naphthalene	24.25	25.01	24.49	25.48	23.74	25.15	24.61	.54	1.63
4-Chloroaniline	25.24	25.31	26.62	24.52	25.91	25.80	23.54	.93	2.79
Hexachlorobutadiene	28.21	32.01	31.32	27.52	29.38	28.98	24.04	2.44	7.31
4-Chloro-3-methylpheno	30.17	27.66	26.48	25.06	26.99	26.04	23.57	1.92	5.77
2-Methylnaphthalene	29.49	28.43	27.46	26.69	28.27	27.23	25.51	1.26	3.79
Hexachlorocyclopentadi	20.44	19.03	19.16	19.25	20.72	18.82	19.29	.68	2.05
2,4,6-Trichlorophenol	21.89	21.72	23.00	22.71	23.77	21.66	22.69	.72	2.16
2,4,5-Trichlorophenol	23.60	22.92	23.22	23.52	25.30	21.60	23.64	1.02	3.05
2-Chloronaphthalene	22.47	21.10	22.91	23.57	22.38	20.28	23.63	1.01	3.03
2-Nitroaniline	23.82	21.22	21.26	20.90	21.30	19.17	20.48	1.29	3.86
Dimethylphthalate	24.94	24.38	24.80	23.89	23.54	22.55	23.85	.76	2.27
Acenaphthylene	24.10	25.01	25.46	24.44	23.81	23.22	24.40	.69	2.06
3-Nitroaniline	25.57	24.77	24.93	25.30	23.48	24.05	24.91	.73	2.19

Sheet1

VOA INSTRUMENT DETECTION LIMIT											
DATE: 4/2/8/94	INST.ID		HP5971		COLUMN.ID		RTX502.2				
	METHOD NO.		360S								
RUNS A01538-A01544	ng	ng	ng	ng	ng	ng	ng				
COMPOUND NAME	IDL1	IDL2	IDL3	IDL4	IDL5	IDL6	IDL7	AVE	SD	IDL	CRQL (%)
chloromethane	24	25	24	20	28	26	25	24	3	8	50
vinyl chloride	19	20	19	16	23	21	20	20	2	6	50
bromomethane	23	24	23	22	27	14	23	22	4	12	50
acetone	84	97	90	81	86	97	72	87	9	27	50
acrylonitrile	72	80	85	70	89	89	60	75	10	31	50
iodomethane	21	22	22	20	25	23	22	22	1	4	50
vinylacetate	16	33	22	27	44	37	35	30	10	29	50
2-butanone	38	34	39	27	45	43	33	37	6	18	50
carbendisulfide	25	20	22	20	29	25	24	24	3	10	50
trichlorofluoromethane	3	20	20	16	25	23	20	18	7	21	50
1,1-dichloroethene	22	22	22	20	28	24	12	21	4	13	50
methylene chloride	29	29	30	29	32	29	27	29	2	5	50
trans-1,2-dichloroethene	23	23	23	21	27	25	23	24	2	5	50
1,1-dichloroethane	25	25	25	24	28	27	25	26	1	4	50
cis-1,2-dichloroethene	27	22	24	26	31	26	25	26	3	8	50
chloroform	26	26	26	26	29	27	26	26	1	4	50
1,2-dichloroethane	29	30	30	28	31	30	28	29	1	4	50
1,1,1-trichloroethane	24	24	23	21	27	25	26	24	2	6	50
carbon tetrachloride	19	19	19	17	23	21	20	20	2	5	50
benzene	28	22	24	25	31	27	26	26	3	9	50
trichloroethene	25	24	24	22	28	25	25	25	2	5	50
1,2-dichloropropane	26	26	26	25	29	27	26	26	1	4	50
dibromomethane	30	29	30	27	31	29	25	29	2	6	50
bromodichloromethane	25	24	25	22	28	25	24	24	2	6	50
cis-1,3-dichloropropene	34	32	32	55	37	45	50	41	9	28	50
toluene	27	21	23	25	31	27	27	26	3	10	50
trans-1,3-dichloropropene	27	27	26	23	30	27	23	26	2	7	50
1,1,2-trichloroethane	31	30	32	27	33	30	27	30	2	7	50
1,2-dibromoethane	31	30	2	27	32	30	27	26	11	32	50
4-methyl-2-pentanone	41	38	39	38	46	41	34	40	4	11	50
chlorobenzene	26	24	24	23	28	26	23	25	2	6	50
tetrachloroethene	23	21	21	19	26	23	21	22	2	6	50
dibromochloromethane	29	25	25	21	27	25	21	24	2	7	50
2-hexanone	37	33	39	26	45	37	26	35	7	20	50
1,1,1,2-tetrachloroethane	25	24	23	22	27	25	22	24	2	6	50
ethylbenzene	29	20	25	25	34	27	25	26	4	13	50
o-xylene (total)	28	22	23	24	31	26	22	25	3	10	50
styrene	27	21	22	24	30	25	21	24	3	10	50
bromoform	26	24	26	21	28	26	21	24	3	8	50
trans-1,4-dichloro-2-butene	32	32	35	26	38	35	32	33	4	11	50
1,1,2,2-tetrachloroethane	33	31	33	30	36	33	33	33	2	6	50
1,2,3-trichloropropane	35	33	35	32	36	18	35	32	6	19	50
1,4-dichlorobenzene	26	23	22	22	29	26	23	24	3	8	50
1,2-dichlorobenzene	26	26	25	25	30	28	22	26	3	8	50
1,2-dibromo-3-chloropropane	41	34	39	32	41	36	32	36	4	12	50

Time: 10:37
 Fax Note 7671
 Judy HARRY
 Data Val. Servs
 518 251 4429

Date 6/17/94
 From JONNE KALGAM
 Co. H2M LABS
 Phone 516 644 3406

VOA INSTRUMENT SELECTION LIMIT												
	INST.ID				HP5971				COLUMN.ID			
	METHOD NO.				360				RTX502.2			
RUNS A01531-A01536												
	ng	ng	ng	ng	ng	ng	ng					
COMPOUND NAME	IDL1	IDL2	IDL3	IDL4	IDL5	IDL6	IDL7	AVE	SD	IDL	CRQL	
chloromethane	37	38	38	34	37	36	38	37	1	4	50	
vinyl chloride	25	25	25	21	21	21	22	23	2	6	50	
bromomethane	24	24	27	23	24	24	25	24	1	3	50	
chloroethane	22	24	25	22	22	21	23	23	1	4	50	
acetone	27	25	27	63	33	23	28	32	14	41	50	
acrylonitrile	44	44	45	42	43	44	44	44	1	3	50	
iodomethane	23	24	25	23	22	22	23	23	1	3	50	
vinylacetate	34	23	21	17	21	32	19	24	7	20	50	
2-butanone	22	27	24	35	26	22	25	26	4	13	50	
carbonylsulfide	20	27	26	26	24	19	22	23	3	10	50	
trichlorofluoromethane	24	27	28	24	25	24	22	25	2	6	50	
1,1-dichloroethene	23	23	24	21	21	21	22	22	1	4	50	
methylene chloride	25	24	26	24	24	24	24	24	1	2	50	
trans-1,2-dichloroethene	24	24	26	22	22	22	23	23	1	4	50	
1,1-dichloroethane	25	25	26	24	23	23	25	24	1	3	50	
cis-1,2-dichloroethene	21	25	25	26	24	20	23	23	2	7	50	
bromochloromethane	20	25	24	27	25	20	24	24	2	7	50	
chloroform	24	25	26	24	23	23	25	24	1	3	50	
1,2-dichloroethane	24	25	26	24	24	24	25	25	1	2	50	
1,1,1-trichloroethane	24	24	25	22	22	22	23	23	1	4	50	
carbon tetrachloride	22	22	24	20	20	19	20	21	2	5	50	
benzene	22	26	25	27	24	20	24	24	2	7	50	
trichloroethene	23	23	24	22	22	22	23	22	1	2	50	
1,2-dichloropropane	24	24	25	24	23	23	25	24	1	2	50	
dibromomethane	23	24	24	24	23	23	24	24	1	2	50	
bromodichloromethane	23	23	24	23	23	22	23	23	1	2	50	
cis-1,3-dichloropropene	24	24	25	24	22	21	23	23	1	3	50	
toluene	20	25	24	26	23	19	23	23	3	8	50	
trans-1,3-dichloropropene	23	23	24	23	22	22	23	23	1	2	50	
1,1,2-trichloroethane	24	24	25	25	23	24	24	24	1	2	50	
1,2-dibromoethane	23	23	2	24	22	23	24	20	8	24	50	
4-methyl-2-pentanone	24	27	27	29	27	23	27	28	2	6	50	
chlorobenzene	24	26	26	25	23	23	24	24	1	4	50	
tetrachloroethene	24	25	25	22	22	21	22	23	2	5	50	
dibromochloromethane	22	23	23	23	21	21	21	22	1	3	50	
2-hexanone	24	27	27	29	27	21	28	28	2	7	50	
1,1,1,2-tetrachloroethane	23	24	24	24	21	21	23	23	1	4	50	
ethylbenzene	22	26	25	26	25	19	21	23	3	8	50	
o-xylene(total)	21	26	25	26	24	19	23	23	3	8	50	
styrene	21	25	24	25	23	19	21	23	2	7	50	
bromoform	20	21	22	24	20	19	19	21	2	5	50	
trans-1,4-dichloro-2-butene	23	22	23	23	22	20	23	22	1	3	50	
1,1,2,2-tetrachloroethane	26	26	28	27	24	24	24	25	2	5	50	
1,2,3-trichloropropane	23	24	24	25	23	23	23	23	1	3	50	
1,4-dichlorobenzene	23	24	25	25	22	22	24	24	1	4	50	
1,2-dichlorobenzene	23	24	25	25	22	22	24	24	1	3	50	
1,2-dibromo-3-chloropropane	25	25	26	26	24	26	22	26	2	6	50	

H2M LABS, INC.

SDG NARRATIVE FOR VOLATILE ANALYSES
METHOD 524.2
SAMPLES RECEIVED: 3/24/94
(WES029)

FOR SAMPLES: GW5D-02
TBGW-032394

The surrogate recovery of bromofluorobenzene was outside the QC limits (high) for both samples as well as the method blank. The samples were reanalyzed however outside the 7 day holding time. The re-analysis surrogate recoveries were also outside the QC limits (low) as was the method blank associated with these samples.

Method 524.2 calls for the use of bromochloromethane as an internal standard for the method but since this was a targeted compound the internal standard and surrogates from method 8260 were utilized. 5 ml of sample were analyzed.

No matrix spike/matrix spike duplicate was submitted for these samples.

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Date Reported: May 3, 1994

*
* *Joann M. Slavin* *
*

Joann M. Slavin
Quality Assurance Manager

S00017

H2M LABS, INC.

SDG Narrative
For Metals Analysis
Samples Received: 3/24/94
(WES029)

Page 1 of 1

For Sample: GW5D02

One sample was received on March 24, 1994 to be analyzed for TAL metals, cyanide and boron.

Karen Kavanagh, of our laboratory, spoke to John Rhyner of Weston regarding the matrix spike and duplicate for this sample. The client requested that we use the MS/MSD flags from the last groundwater package to qualify this data. The last groundwater package was WES027. The matrix spike sample for WES027 had a poor recovery for selenium of 66.0%. The duplicate sample reproduced within the required control limits for all elements. Selenium was flagged with an "N" on all Form I's in this package.

Selenium's post spike recovery for sample GW5D02 was not within 85-115%. Selenium is flagged with a "W" on Form I.

All other quality control criteria were met.

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Date Reported: April 13, 1994

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Stanley Isaacson
Laboratory Manager

S00018

2M LABS, INC.

SDG NARRATIVE FOR VOLATILE ANALYSES
SAMPLES RECEIVED: 4/19/94 - 4/20/94
(WES031)

FOR SAMPLES:	<u>SOIL</u>	<u>WATER</u>
	SD2-02	SW2-02
	SD4-02	SW4-02
	SD12-02	SW12-02
	SD13-02 MS/MSD	SW13-02 MS/MSD
	SD14-02	SW14-02
	SD15-02	SW15-02
	SD16-02	SW16-02
	SD17-02	SW17-02
	SD18-02	SW18-02
		TBSW-041894
		TBSW-041994

The above samples were analyzed for the Part 360 list of volatile organics. The QC requirements of NYSDEC CLP 91-1 were followed for the soil and water samples.

A standard at a concentration level of 5 ug/L was analyzed during the continuing calibration analytical sequence as a low level check.

Although the lowest calibration standard analyzed was at a concentration level of 10 ug/L, all targeted analytes were quantified to the method detection limit study which was performed for this project.

These analytes were flagged with a "J" as estimated if detected.

The original scope of work called for a low level method for the waters. The only difference in comparing the original scope of work to that reported, is that for the surface waters, the 5 ug/L standard was analyzed as a check during the continuing calibration and not as part of the initial calibration.

No targeted analytes were detected in the surface water samples except for 2 ug/L J trichloroethene which was detected in sample SW16-02.

Bromochloromethane is a targeted compound in the Part 360 list, so the internal standard was replaced with pentafluorobenzene. Many samples contained TIC's which were identified by the analyst as column bleed.

Sample SD 13-02 was analyzed as the soil matrix spike/matrix spike duplicate (MS/MSD). All percent recoveries and RPD's were met except for the percent recovery of benzene in both the MS and MSD sample at 145% and 155%.

Sample SW-13-02 was analyzed as the surface water matrix spike/matrix spike duplicate. All percent recovery and RPD criteria were met except for the percent recovery of trichloroethene for the MSD at 68%. The lower limit is 71%.

2M LABS, INC.

SDG NARRATIVE FOR VOLATILE ANALYSES
SAMPLES RECEIVED: 4/19/94 - 4/20/94
(WES031)

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Date Reported: May 31, 1994

J. M. Slavin

Joann Slavin
Quality Assurance Manager

H2M LABS, INC.

SDG NARRATIVE FOR BASE NEUTRAL/ACID EXTRACTABLES
SAMPLES RECEIVED: 4/19/94 - 4/20/94
(WES031)

FOR SAMPLES:	SD2-02	SD15-02
	SD4-02	SD16-02
	SD12-02	SD17-02
	SD13-02 MS/MSD	SD18-02
	SD14-02	

NYSDEC CLP Method 91-2 was performed for these samples. All quality control and calibration requirements are met except for the following:

The percent recovery of 4-nitrophenol was 100% in MSB22S. The upper limit is 80%. This analyte was also high in the MS/MSD sample SD13-02. This does not appear to be matrix related.

Benzo(b)fluoranthene and benzo(k)fluoranthene required manual integration since they elute close to each other and have the same ions.

Aldol condensation products were detected in most samples and qualified with an "A".

Samples SD4-02 and SD18-02 were cleaned up on GPC column #2. In review of U.V. trace of this GPC column the resolution of perylene to sulfur is under 90%.

All quality control requirements for surrogate recoveries of these samples were met and are consistent with the recoveries found in other samples.

The sample results reported do not appear to be effected by this deviation.

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Date Reported: May 19, 1994

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*  *

Joann Slavin
Quality Assurance Manager

H2M LABS, INC.

SDG NARRATIVE FOR PESTICIDE/PCB ANALYSIS SAMPLES RECEIVED: 4/19/94 (WES031)

FOR SAMPLES: SW4-02 MS/MSD
SW7-02
SD4-02 MS/MSD
SD17-02

The SDG contained water and soil samples for analysis by Method 91-3 of the NYSDEC ASP 9/93.

QC DATA

Even though not required by the protocol, a QC spike containing all targeted analytes was included in the soil and water extraction batches.

Surrogates for the water blank and blank spikes show good recoveries, whereas all samples are biased low indicating possible matrix interference. (All sample TCX spikes are under the acceptance limit and DCBs range from 56% to 72%.)

Surrogate recoveries for the soil extracts are overall acceptable or just under the QC limit (TCX in PBLK1, MSB-04-19, SD4-02 MSD and DCB in PBLK1 and SD4-02 MSD) with the exception of SD4-02, which has approximately half the recovery of the other extracts. The data were calculated correctly and the low data are therefore due to the preparation process. The data are regarded estimated, but no positives were found. No corrective action was necessary according to the protocol.

Spike recoveries for the QC spikes indicate good method efficiency, and accuracy and precision data were all within acceptance limits, with the exception of lindane, which showed 27% RPD in the MS/MSD extracts.

CALIBRATION/SYSTEM PERFORMANCE

Acceptance criteria were met for all check parameters with these exceptions:

The continuous calibration for beta-BHC on column RTX-5 exceeded the RSD limit of 20% with a percent difference of 20.3%. Since none of the samples contained beta-BHC, no further action was taken.

DBC in SW4-02 MS, at retention time 27.82, on the RTX-35 column was outside the RT window of 27.61 - 27.81. Only DBC was affected; all targeted spike compounds were well within the retention time windows.

H2M LABS, INC.

SDG NARRATIVE FOR PESTICIDE/PCB ANALYSIS SAMPLES RECEIVED: 4/19/94 (WES031)

SAMPLE ANALYSIS

A large phthalate peak and other smaller secondary contaminations were introduced during sample preparation of the soils, as indicated by the method blank. None of the peaks in the blank chromatogram interfered with the analysis of the targeted analytes, i.e. identified as positive. The same peaks occurred in the sample, but again none of the peaks coeluted with analytes on both columns.

The GPC chromatogram for column 2 did not meet the 90% resolution requirement for perylene-sulfur. Due to pump problems, which necessitated the use of a loaner pump, the cleanups were performed nevertheless. To avoid potential slight loss, the collection fraction was slightly extended, which would include some sulfur, if present. Subsequently, the extracts were subjected to thorough sulfur cleanup.

CODES USED IN RAW DATA

Identification printed by the data system are tentative. The data are reviewed by the analyst, and the following codes are used to indicate reasons for rejection of identifications:

L1 smaller than 1/2 contract required reporting limit
(CRQL) on column 1

(Peaks smaller than 1/2 CRDL are not reported as
positives due to interference/noise levels)

L2 smaller than 1/2 contract required reporting limit on
column 2

W1 outside the actual retention time window established on
column 1

W2 outside the actual retention time window on column 2

I PCB isomer interfering with pesticide
(Pesticides are reported, but with qualifier)

H2M LABS, INC.

SDG NARRATIVE FOR PESTICIDE/PCB ANALYSIS
SAMPLES RECEIVED: 4/19/94
(WES031)

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Date Reported: May 18, 1994

* *Ursula Middel* *
* *Ursula Middel* *

Ursula Middel
Technical Manager

H2M LABS, INC.

SDG NARRATIVE FOR METALS
R. F. WESTON
CLARKSTOWN LANDFILL
SAMPLES RECEIVED: 04/19 AND 04/20/94
SURFACE WATER AND SOIL SAMPLES
WES031

Page 1 of 2

FOR SAMPLES:	SW2-02	SW16-02	SD13-02 MS/MSD
	SW4-02	SW17-02	SD14-02
	SW12-02	SW18-02	SD15-02
	SW13-02 MS/MSD	SD2-02	SD16-02
	SW14-02	SD4-02	SD17-02
	SW15-02	SD12-02	SD18-02
	TBSW-041894	TBSW-041994	

ICP analysis was performed using a TJA61. Furnace analysis was performed on a Perkin Elmer 5100, a Varian Spectra 4400 and a Varian Spectra30/GTA96. Mercury was analyzed on a Varian Spectra 400 AA using cold vapor techniques. Cyanides were performed via the manual spectrophotometric method and read on a Sequoia-Turner model 340 spectrophotometer.

The selenium and silver matrix spike recoveries for sample SW1302 were not within 75-125% recovery. All selenium and silver water samples were reported flagged with an "N".

The antimony and silver matrix spike recoveries for sample SD1302 were not within 75-125%. All antimony and silver soil samples were reported flagged with an "N".

The manganese serial dilution result for sample SW1302 was not within the required control limit (10% difference). All associated manganese results are reported flagged with an "E".

Arsenic sample SD1302 required analysis by MSA procedures. The correlation coefficient was greater than 0.995. Arsenic sample SD1202 was reported flagged with an "S".

The post digestion spike recoveries for the following furnace AA analyses are not within 85-115%.

S 0038

H2M LABS, INC.

SDG Narrative
For Metals Analysis
Samples Received: 4/19 and 4/20/94
R.F WESTON
CLARKSTOWN LANDFILL
SURFACE WATER AND SOIL SAMPLES
(WES031)

Page 2 of 2

The post digestion spike recoveries for the following furnace AA analyses are not within 85-115%.

As - SW1202, SW1402, SW1502, SW1602, SW1702, SW1802, XSW202, XSW402

Pb - SW1402, SW1602, SW1802, XSW202, XSW402

Se - SW1202, SW1302, SW1402, SW1602, SW1702, SW1802

Tl - SD1802, SW1602, SW1702, SW1802, XSW202

The above results are reported flagged with an "W".

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Date Reported: May 27, 1994

*
*
*

Stanley Isaacson
Laboratory Manager

S 0039

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE IDENTIFICATION AND ANALYTICAL REQUIREMENT SUMMARY

SAMPLES RECEIVED: 3/11/94
R.F. WESTON
CLARKSTOWN LANDFILL
(WES029)

[illegible]

*** Check Appropriate Boxes**

* CLP Non-CLP (Please indicate year of protocol) 12/91

* TCL, HSL, Priority Pollutant

+ Dissolved TCL Metals analyzed as well

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS SUMMARY

INORGANIC ANALYSES

SAMPLES RECEIVED: 3/24/94
R.F. WESTON
CLARKSTOWN LANDFILL
(WES029)

[illegible]

* SEE RUN SHEETS FOR EXACT DATES.

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE IDENTIFICATION AND ANALYTICAL REQUIREMENT SUMMARY

R.F. WESTON

CLARKSTOWN LANDFILL RI/FS

WORK ORDER NO.: 003228010002

SAMPLES RECEIVED 04/19 and 04/20/94

WES031

Customer Sample Code	Laboratory Sample Code	Analytical Requirements *					
		*VOA GC/MS	*BNA GC/MS	*VOA GC	PEST PCB	*METALS	*OTHER
SW2-02	9412733	X				X	X
SW4-02	9412734	X			X**	X	X
SW12-02	9412917	X				X	X
SW13-02 MS/MSD	9412918	X				X	X
SW14-02	9412919	X				X	X
SW15-02	9412920	X				X	X
SW16-02	9412735	X				X	X
SW17-02	9412736	X			X	X	X
SW18-02	9412737	X				X	X
SD2-02	9412738	X	X			X	X
SD4-02	9412739	X	X		X**	X	X
SD12-02	9412921	X	X		X	X	X
SD13-02 MS/MSD	9412922	X	X			X	X
SD14-02	9412923	X	X			X	X
SD15-02	9412924	X	X			X	X
SD16-02	9412740	X	X			X	X
SD17-02	9412741	X	X		X	X	X
SD18-02	9412742	X	X			X	X
TBSW-041894	9412743	X					
TBSW-041994	9412925	X					
** MS/MSD FOR PEST/PCB ONLY							

Check Appropriate Boxes

* CLP, Non-CLP (Please indicate year of protocol) 12/91

* TCL/TAL, HSL, Priority Pollutant

PAGE 1 OF 6

S C003

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS SUMMARY

B/N-A
ANALYSES

SAMPLES RECEIVED: 4/19/94 - 4/20/94
(WES031)

SAMPLE ID	MATRIX	DATE COLLECTED	DATE REC'D AT LAB	DATE EXTRACTED	DATE ANALYZED
SD2-02	SOIL	04/18/94	04/19/94	04/19/94	04/26/94
SD4-02	"	"	"	"	"
SD16-02	"	"	"	"	"
SD17-02	"	"	"	"	"
SD18-02	"	"	"	"	"
SD12-02	"	04/19/94	04/20/94	04/22/94	04/28/94
SD13-02	"	"	"	"	"
SD13-02 MS	"	"	"	"	"
SD13-02 MSD	"	"	"	"	"
SD14-02	"	"	"	"	"
SD15-02	"	"	"	"	"

PAGE 2 of 6

S 0004

H2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS FORM

PESTICIDE/PCB ANALYSES

SAMPLES RECEIVED: 4/19/94

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
(WES031)

SAMPLE ID	MATRIX	ANALYTICAL PROTOCOL	EXTRACTION METHOD	AUXILARY CLEAN UP	DIL/CONC FACTOR
SW4-02	WATER	NYSDEC ASP 9/93	SEPF	* NONE	1
SW4-02 MS	"	"	"	"	"
SW4-02 MSD	"	"	"	"	"
SD4-02	SOIL	"	SONC	GPC	"
SD4-02 MS	"	"	"	"	"
SD4-02 MSD	"	"	"	"	"
SD17-02	"	"	"	"	"

ALL SAMPLES SULFUR CLEANED

AGE 3P of 6

S 0005

2M LABS, INC.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS FORM

B-N/A ANALYSES

SAMPLES RECEIVED: 4/19/94 - 4/20/94
(WES031)

SAMPLE ID	MATRIX	ANALYTICAL PROTOCOL	EXTRACTION METHOD	AUXILARY CLEAN UP	DIL/CONC FACTOR
D2-02	SOIL	NYSDEC CLP 12/91	SONC	GPC	1
D4-02	"	"	"	"	"
D12-02	"	"	"	"	"
D13-02	"	"	"	"	"
D13-02 MS	"	"	"	"	"
D13-02 MSD	"	"	"	"	"
D14-02	"	"	"	"	"
D15-02	"	"	"	"	"
D16-02	"	"	"	"	"
D17-02	"	"	"	"	"
D18-02	"	"	"	"	"

AGE 3S of 6

S C006

APPENDIX C

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

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APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

This section summarizes the primary State, Federal, and local environmental regulations, standards, and criteria (ARARs) which are applicable to the Clarkstown Landfill RI/FS.

AMBIENT AIR

Draft New York State Air Guide-1 - Guidelines for the Control of Toxic Ambient Air Contaminants-(NYSDEC), 1991 Edition

This document presents Ambient Guideline Concentrations (ACGs) for toxic pollutants. The ACGs are contaminant specific and are set by NYSDEC and New York State Department of Health (NYSDOH) toxicologists. These standards are included in the Clarkstown Landfill RI/FS ambient air data tables as a basis for comparison to the air data. Screening models are provided which can be used to predict on-site and off-site emission impacts using landfill gas production rates and soil gas data. An inventory of contaminant and emission rates from the landfill can be derived to aid in developing remediation strategies.

Air Cleanup Criteria-(NYSDEC - Division of Air Resources), January 8, 1990

This document addresses the evaluation of air impacts from contaminated sites. It describes the requirements and procedures for addressing emissions and impacts associated with pre-remediation, remediation and post-remediation activities. In addition, it includes the Air Guide-1 ACGs.

6 New York Code of Rules and Regulations (NYCRR) Part 212 - General Process Emission Sources

Under this regulation, when an application is made for a permit to operate a process emission source, the NYSDEC Commissioner will issue an environmental rating for each air contaminant from each emission point. The degree of emission control required is based on the ratings designated. The NYSDEC has interpreted this regulation to include vents on capped landfills as process emission sources. Therefore, compliance with this ARAR may be required in the future during remediation if a landfill gas collection system is installed.

GROUNDWATER

Ambient Water Quality Standards and Guidance Values, Division of Water Technical and Operational Guidance Series (TOGS)-(1.1.1)-(NYSDEC-Division of Water), 1991

This document consolidates all NYSDEC groundwater standards and guidance values from 6 NYCRR Part 703.5, NYSDOH 10NYCRR Part 5 maximum contaminant levels (MCLs) and Part 170 standards for sources of water supply. These standards include the general standards of principal organic contaminants (POCs) and unspecified organic contaminants (UOCs). By including the relevant Part 5 MCLs and Part 170 standards in this document, it is no longer necessary for the user to review these NYSDOH regulations independently to determine applicable NYSDEC standards. These standards are contaminant specific and will be used as a basis for comparison to the groundwater data. Such comparisons will provide guidance for the Phase II sampling effort, risk assessment activities and site remediation to determine potential impacts on public health and the environment.

6 NYCRR Part 703 - Surface Water and Groundwater Quality and Groundwater Effluent Standards, 1991

These regulations are contaminant specific and present surface water and groundwater classifications, water quality standards and effluent standards or limitations to prevent contamination of groundwater and to protect groundwater as a public drinking water supply. New York State has designated all groundwater as Class GA with best usage as a source of potable water. For this reason, the groundwater at the Clarkstown Landfill has been classified GA for data evaluation purposes.

10 NYCRR Part 170 - Sources of Water Supply (Stat. Auth., Pub. Health Law, Sec. 1100)

This regulation applies to Class GA sources of water in the state of New York and has been incorporated into NYSDEC TOGS(1.1.1). It applies to any groundwater, surface water body, aquifer or water course from which water is regularly taken for drinking or which has been classified for present or future public beneficial use.

Safe Drinking Water Act, 42 U.S.C.A. 300F to 300J-11

This is a chemical-specific regulation. The Maximum Contaminant Levels (MCLs) from this regulation are the standards upon which NYSDOH MCLs have been based and incorporated into TOGS 1.1.1 as referenced above. These standards have not been included in the Clarkstown RI/FS data tables for groundwater as such but as the equivalent or more stringent State MCLs.

New York State Sanitary Code, Part 5 - Drinking Water Supply

This regulation was promulgated to protect present or future sources of water supply. It applies to all existing and proposed sources and addresses planning, citing, treatment and approval as

well as MCLs, monitoring and quality control. As mentioned above, the standards from this regulation have been incorporated into TOGS 1.1.1 and will be used for data analysis purposes.

SURFACE WATER

Ambient Water Quality Standards and Guidance Values. Division of Water Technical and Operational Guidance Series (TOGS)-(1.1.1). (NYSDEC-Division of Water). 1991

This document consolidates all NYSDEC surface water standards from 6 NYCRR Part 703.5 and revised guidance values based on NYSDOH 10NYCRR Part 5 principal organic contaminant (POC) standards. These standards will be used as a basis of comparison for detected compounds in the surface water samples. Such a comparison will provide guidance for the Phase II sampling effort, risk assessment and evaluation of site remediation alternatives.

6 NYCRR Part 703 - Surface Water and Groundwater Quality and Groundwater Effluent Standards. 1991

The goal of this regulation is to present classifications for surface water bodies and standards to maintain their best usage based upon human health, protection of aquatic life, aesthetics, bioaccumulation, etc. Data from the Clarkstown Landfill RI/FS will be compared to these standards and guidance values as referenced in the TOGS 1.1.1. Surface waters surrounding the landfill from which samples were collected have been classified A, B, C, C(T) and D. Therefore, the data tables include the standards for all classifications.

SEDIMENT

Sediment Criteria - (NYSDEC) December 1989: Used as Guidance by the Bureau of Environmental Protection, Division of Fish and Wildlife

This document is used as guidance by NYSDEC, Division of Fish and Wildlife; it is neither a standard nor a policy of the Department. The criteria are based upon the theory that toxins in sediments will exert their effect, either toxicity or bioaccumulation, to the extent that the chemical becomes freely bioavailable in the sediment water. Such criteria reflect a variety of environmental protection objectives. The criteria provide human health-based and aquatic toxicity-based values. For purposes of the Clarkstown RI/FS, the sediment criteria (normalized to organic carbon content) will be used as the basis for comparison to the sediment data.

SOIL GAS

Draft New York State Air Guide -1 - Guidelines for the Control of Toxic Ambient Air Contaminants-(NYSDEC), 1991 Edition

This document presents Ambient Guideline concentrations (ACGs) for toxic pollutants. The ACGs are contaminant specific and are set by NYSDEC and NYSDOH toxicologists. These standards will not be compared directly to the Clarkstown RI/FS soil gas data but will only be evaluated with regard to soil gas contributions to ambient air concentrations of toxins. Screening models can be used to predict on-site and off-site emission impacts using landfill gas production and soil gas data. An inventory for contaminant and emission rates from the landfill can be derived to aid in remediation strategies.

LEACHATE

Local Law No. 2 of 1984, County of Rockland, State of New York - Sewer Use Law, Federal Categorical Pretreatment Standards and Toxic Substances Prohibited or Accepted Conditionally

This regulation includes Federal categorical pre-treatment standards, limits on toxic substances and pathogenic bacteria, industrial effluent limitations, and special concentration limits. The relevant section includes concentration limits for discharges into sewers. The Standards list includes 16 toxic substances which have been included in the leachate data tables for the Clarkstown Landfill RI/FS. They are also referenced in the landfill's most recent permit for discharge to the county sewage treatment plant from the leachate collection system.

SURFICIAL AND SUBSURFACE SOIL

Technical and Administrative Guidance Memorandum (TAGM): Determination of Soil Cleanup Objectives and Cleanup Levels. HWR-92-4046 - (NYSDEC-Division of Hazardous Waste Remediation). November 16, 1992

This TAGM provides the basis for determination of soil cleanup levels at state Superfund and Federal Superfund sites. The Technology Section develops soil cleanup objectives and the levels calculated by this division were used for comparison to remedial investigation surface and subsurface soil data. These cleanup objectives were derived to eliminate all significant threats to human health and/or the environment posed by inactive hazardous waste sites. They are based upon a combination of human health cancer risks (excess lifetime exposure) presented in EPA's HEAST report, daily exposure reference doses and environmental concentrations which are protective of groundwater/drinking water quality standards.