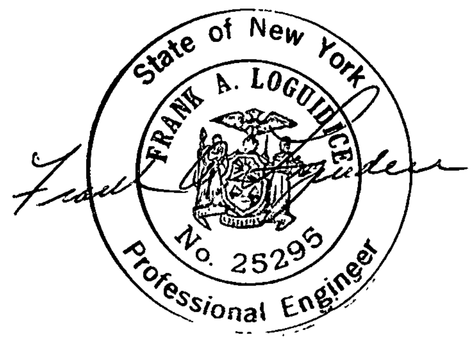
CORTLAND COUNTY LANDFILL
WEST SIDE EXTENSION

PHASE I DEVELOPMENT

HYDROGEOLOGIC REPORT

CORTLAND COUNTY
DEPARTMENT OF SOLID WASTE

March, 1989



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Barton & Loguidice, P.C.

HYDROGEOLOGIC REPORT

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EXECUTIVE SUMMARY

The Hydrogeologic Report defines the site geology and hydrology and relates these features to regional and local hydrogeologic patterns. Stratigraphic sections are presented based on regional and site specific data. Utilizing the wells installed on the site, the groundwater flow patterns were determined and the baseline water quality established. Evaluation of water level data from the wells provided sufficient data to establish an environmental monitoring plan capable of detecting a contaminant release and determining whether the release could affect surface or subsurface waters.

Field investigations included boring/well installations, test pit excavations, rising head hydraulic conductivity tests, water quality sampling, water level measurements and visual reconnaissance of the site. From samples collected during field investigations, laboratory analyses were performed on selected soil samples to determine the classification and engineering properties of the soils present. The engineering properties were determined for use in the design of the landfill which is presented under separate cover entitled, "Engineering Design Report".

Based on the results of the literature search, review of previous studies and supplemental field work performed, the site was determined to be suitable for development. However, due to shallow bedrock on the west side of the site, the original footprint area proposed in 1987 had to be reduced.

Both the soils and bedrock have low permeabilities. The till has a geometric mean of 4.1×10^{-6} cm/sec and the bedrock 5.3×10^{-6} cm/sec as determined by field rising head hydraulic conductivity tests. In addition, due to a seasonal high groundwater level in the low permeability till, a waiver for clearance above groundwater will be required. An underdrain system will be included in the design to prevent head buildup under the liner.

Vertical hydraulic gradients vary from downward or recharge conditions (.085 feet/foot in MW-7) on the west of the site to upward or discharge conditions (.007 feet/foot in MW-5 to .093 feet/foot in MW-12) on the east of the site. The horizontal gradients vary across the site but average around 0.1 feet/foot, being somewhat higher in the southeast corner and much lower in the extreme northwest corner. The resultant groundwater flow is principally toward the east side and southeast corner of the proposed site. A contaminant release on the west side would slowly migrate downward and eastward under the slight recharge condition as observed in MW-7. The downward migration would be reversed as the lateral migration encountered the discharge condition on the eastern part of the site. A contaminant release on the east side would be contained in the secondary leachate containment system or the underdrain system due to the upward (discharge) gradient in the underlying soils. Any contaminant would therefore intercept the underdrain as lateral and upward migration continued.

The water quality analyses indicate the proposed landfill area has not been influenced by contaminants (if any) from the existing landfills. Some parameters were noted to exceed standard or guidance values, but these may be attributed to natural conditions and not outside contamination.

Based on the investigations and analyses, the proposed site is suitable for construction and is monitorable for any contaminant release. The site provides an isolated area with little impact on the surrounding area. The nearest downgradient well in the same drainage basin is 9,000 feet (1.7 miles) away. The nearest well, which is across the drainage divide, is 2,300 feet away from the nearest point of the proposed site. The site area has reportedly been used for dumping or disposal purposes since 1940, so a landfill extension within the same drainage basin as the previous landfill activities will have minimal impact on the surrounding area.

SECTION 1

1.0 GENERAL INFORMATION

1.1 Introduction

The Hydrogeology Report for the proposed Cortland County Landfill-West Side Extension forms a portion of the Engineering Design Report that was prepared for permitting of the Phase I landfill extension. Engineering Plan Drawings which accompany the Engineering Design Report are referenced in the Hydrogeology Report by the sheet number. All figures specific to the Hydrogeologic Report are presented at the end of the appropriate section. General site information is presented in Section 2 of the Engineering Design Report. The drawings include development of the entire site, but only Phase I is being submitted for permitting (Sheet 10).

In May, 1988, B&L was authorized to proceed with preparation of the necessary hydrogeologic and engineering design for permitting of the proposed long term landfill facility to the west of the existing landfill. The previous investigations were reviewed and supplemental studies performed during the summer and fall of 1988. This report presents the results and conclusions derived from the hydrogeologic investigations and literature review.

1.2 Purpose and Scope

The Hydrogeology Report was prepared to meet the requirements as specified in 6 NYCRR Part 360-2.11 Solid Waste Management Facilities. The site investigations by B&L were intended to supplement the previous studies performed by others. The objectives of the hydrogeologic investigations were to:

a) establish the geologic setting at the site including lithology, structure and glacial geology;

b) characterize groundwater levels and flow patterns within the geologic setting, especially noting the ability to transmit contaminants; and

c) derive and present data for use in the engineering design of the facility.

1.3 Environmental Setting

1.3.1 Location

The proposed landfill is located approximately 5 miles northeast of the City of Cortland in the northeast corner of the Town of Cortlandville on the west side of abandoned Town Line Road (Sheets 2 and 3). The proposed landfill is located on the USGS Truxton Quadrangle, 7.5 minute series topographic map. The center of the proposed site is located at approximately 42° 38' north latitude and 76° 4' west longitude. The proposed site is located in an isolated rural area of the County.

The 231.1 acre parcel for the west side extension is owned by Cortland County and was purchased for a long term landfill facility in 1986 and 1987. It is located immediately west and is contiguous to the existing 308.8 acre landfill site that contains: the operational "Pine Tree" landfill site; the closed Cortland County Landfill; the abandoned City of Cortland dump; and the Buckbee-Mears inactive hazardous waste landfill site (Sheet 5). The 308.8 acre site may have been used for dumping as early as the 1940's (NYSDEC Phase I RI/FS Report, 1984). The proposed west side extension will include a portion of the contiguous 308.8 acre parcel for access roads and perimeter berm construction. Limits of refuse approximate the eastern property line between the two land tracts (Sheets 4 and 5).

1.3.2 Surface Water and Drainage

The streams in the site area are part of the Susquehanna River basin (Sheet 3). The Tioughnioga River is the primary stream in the drainage of Cortland County (Sheet 2). The Tioughnioga is formed in the City of Cortland where seven valleys converge. Factory Brook and the West Branch of the Tioughnioga flow from the north, the East Branch Tioughnioga and Trout Brook flow from the east, Dry Creek and Otter Creek flow from the west and the Tioughnioga River flows southward away from Cortland after converging in the Cortland area.

The Cortland County Landfill, both existing and proposed, sites are located south of the drainage divide between the East Branch Tioughnioga, to the north of the site, and Trout Brook to the south (Sheet 3). All of the surface water drainage from the landfill property flows into tributaries of Trout Brook. Mosquito Creek flows on the west and north and Maybury Brook on the east side of the landfill property and form adjacent drainage basins. An unnamed stream has its headwaters on the east and south side of the landfill property and collects drainage for surface waters in the existing landfilled areas and for the proposed landfill area. From the southern landfill property line, the unnamed stream flows approximately 9,500 feet, through undeveloped woodlands and fields, to Trout Brook. The unnamed stream enters Trout Brook approximately 3,700 feet east of the McGraw village limits. Trout Brook joins the Tioughnioga River about 1-3/4 miles south of the Cortland City limits.

The proposed landfill site lies entirely within the same drainage area as the existing landfill (Sheet 3). No new streams will be impacted by location of the landfill extension on the west side of the Town Line Road.

1.3.3 Sensitive or Significant Habitats

A review of the data at the NYSDEC offices in Delmar, NY, indicates no sensitive or significant habitats are present on the proposed landfill site and are not contiguous to the property.

NYSDEC designated wetlands are not present within the proposed Phase I landfill footprint area.

1.3.4 Climatology and Meteorology

1.3.4.1 Climate

The climate in Cortland County is cool, humid, continental type representative of the Northeastern United States (Pack, 1972). Summers are warm with occasional short periods of high temperature. Winters are typically long and cold.

Lengthy periods of either abnormally cold or warm weather result from the movement of great high pressure (anticyclonic) systems into and through the Eastern United States. Cold winter temperatures prevail over New York whenever Arctic air masses, under high barometric pressure, flow southward from central Canada or from Hudson Bay. High pressure systems often move just off the Atlantic coast, become more or less stagnant for several days, and then a persistent air flow from the southwest or south affects the State. This circulation brings the very warm, often humid weather of the summer season and the mild, more pleasant temperatures during the fall, winter, and spring seasons (Pack, 1972).

The prevailing wind direction for February through July is west-northwest; west-southwest for August and October through January; and southerly for September. The primary prevailing wind direction is west-northwest (NOAA, 1982). Windroses for both the Tompkins County Airport in Ithaca and for Hancock Airport in Syracuse, New York are presented on Sheet 3.

The mean annual temperature from 1951 to 1980 for Cortland was 45.7°F with a mean maximum temperature of 80.5°F during July and mean minimum of 13.5°F during January and February (NOAA, 1982). For the Cortland Station the highest recorded temperature was 102°F and the lowest was -30°F.

1.3.4.2 Precipitation

The average annual precipitation from 1951 to 1980 for Cortland was 41.21 inches (NOAA, 1982). The mean average precipitation is highest in June with 3.95 inches and lowest in February with 2.86 inches. Syracuse has a slightly lower annual average with 39.11 inches and Ithaca with 35.27 inches (NOAA, 1982). The HELP model, Version 2.0 standard precipitation tables indicate Ithaca to have a slightly higher annual precipitation than Cortland with 47.97 inches. The higher precipitation data is recommended for use in designing the facility.

1.4 Previous Investigations

The Cortland County Landfill has had geologic investigations performed at least seven times since 1972. In 1972, the County looked at the site as a possible landfill site. A summary of the investigations from 1972 to the present are presented on Table A-1 in Appendix A. A total of 46 soil borings have been drilled and 38 monitoring wells installed on the two contiguous properties owned by Cortland County. In addition, at least 80 test pits have been excavated. The 308.8 acre site with the existing and abandoned landfills has 13 monitoring wells in boreholes and two additional wells in test pit excavations.

The proposed 231.1 acre site, of which 30.6 are considered for a total Phase I and II footprint, has 27 wells installed in or adjacent to the proposed landfill area (Sheet 5). All but four of the original 23 wells installed by others will be destroyed by construction of the landfill or the borrow area. The four most recent wells are located adjacent to the proposed landfill area and will require protection during construction. In addition to the borings, 38 test pits were excavated and backfilled to determine the limits of shallow depth to rock areas.

The boring logs and monitoring well installation records are presented in Appendix A. Drillers logs are presented with the 1987 MacNeill final logs since the field logs give an uninterpreted description that can be correlated with the other field logs. The driller's log clearly indicates the soil to be "similar as above" with embedded sand and gravel fragments indicating a till, but the final log changes classification to clayey gravel (MW-4A). A review of the soil samples indicates the clayey gravel is a till with gravel fragments.

All of the bedrock wells screened the bedrock at or below the soil-bedrock interface. Typically, these wells were sealed below the interface. The overburden wells were screened in till at various depths.

Laboratory analyses from the various investigations are presented in Appendix B.

2.0 METHOD OF INVESTIGATION

This section presents the types and methods of investigations conducted by Barton & Loguidice, P.C., during the summer and fall of 1988. These field investigations were intended to supplement the significant work efforts already performed by previous investigations. These previous investigations have been documented in Section 1.4 and summarized on Table A-1.

In addition to the field work, literature review has been performed to obtain background information on the site characteristics. A list of references reviewed for this report are presented and follow the text portion of the report.

2.1 Borings/Monitoring Wells

2.1.1 Borings

Four additional monitoring wells were installed in September, 1988, to establish permanent downgradient monitoring points outside the limits of the landfill. Two borings with continuous soil sampling to the top of bedrock and 10 to 15 feet of rock drilling to verify bedrock were advanced to install the deeper wells in the couplet. The two shallower wells were drilled within 20 feet of the deep well without sampling to the screened interval and sampled continuously through the screened interval. Boring logs for Monitoring Wells MW-11A and B and MW12A and B are presented in Appendix A.

The borings were completed using either 4-1/4" I.D. hollow stem augers or conventional rotary wash method with 4-inch casing to maintain hole integrity. Sampling of the soil was by the Standard Penetration Test method following ASTM D 1586 for split barrel sampling, except that the sampler was driven 2 feet instead of the 18 inches specified. Rock coring was performed utilizing an NX size double tube core barrel.

Soil samples from the standard penetration test were removed from the sampler upon retrieval, the sample was classified, special features, if any, were noted and the sample placed in a glass jar. The jar was sealed by securely closing the lid and labelled to identify the project location, depth, standard penetration resistance and date of sampling. In addition to the jar samples, a bulk sample of soil from the auger cuttings was collected from Monitoring Well MW11B.

Rock core was placed in wooden boxes labeled with the project, location, depth, recovery and rock quality designation (RQD). A geological engineer from B&L classified the soil and rock samples.

2.1.2 Monitoring Wells

The two downgradient monitoring well couplets were installed to replace previously installed wells that will be destroyed during construction of the landfill. The new wells in conjunction with the 23 previously installed wells will be used to:

a. monitor groundwater elevations in the vicinity of the landfill;

b. evaluate the impact of landfill construction on the hydrologic system;

c. determine vertical and horizontal groundwater flow direction;

d. determine hydraulic conductivity of soil and bedrock units; and

e. provide sampling points to establish a groundwater quality monitoring system.

The four monitoring wells installed in September, 1988, were constructed of 2-inch diameter, Schedule 40 PVC, flush joint threaded well screen and casing. A 10-foot long, 0.010-inch slot size well screen and compatible sand pack were used. PVC casing and screen came individually wrapped and sealed in plastic from the manufacturer. A 2-foot length of PVC casing was attached to the bottom of each well screen to act as a sediment trap. After placement of the sand pack, a bentonite seal was placed and the remainder of the bore hole filled with a Portland cement-bentonite grout mixture. A locking protective steel casing with keyed alike locks was installed at the surface. The boring logs presented in Appendix A provide details of the well construction for each well. Also presented in Appendix A are the boring logs, well details and installation procedures, where available, for the previously installed monitoring wells.

The well installation method for the wells installed August, 1988, involved:

a. assembling the PVC screen and casing as it was lowered into the hollow stem augers or casing;

b. installing washed silica sand by slowly pouring into the annulus between the steel casing and PVC pipe. Sand was installed through the screened interval to a minimum of 2 feet above the top of the screen;

c. installing bentonite pellets by slowly dropping to form a minimum of a 3-foot thick seal on top of the sand pack;

d. installing a bentonite-cement grout to fill the remainder of the annulus to the ground surface; and

e. a vented PVC cap was placed on the PVC casing and a steel protective casing was placed over the PVC casing. Typically the casing extended 2 to 3 feet above the ground surface. the steel casing was secured by a Portland cement grout seal extending radially about 1 foot from the protective casing.

Monitoring Well MW12A required a modification of this installation procedure due to problems getting the bentonite pellets to the proper elevation. These modifications are documented in the notes on the boring log in Appendix A.

The depth for placement of the screened interval was determined by the supervising geological engineer for each installation. A B&L representative recorded the well design details and measurements for each well. Development of the wells was not initiated until a minimum of 24 hours after installation. The monitoring wells were developed by pumping and/or bailing. The bedrock wells developed to a near sediment free condition. The wells in the clayey silt overburden soil, however, could not be developed to as clean a condition. The water generally becomes cloudy with fine near colloidal sediment as bailing progresses.

2.2 Test Pits

In July, 1988, 38 test pits were excavated with a CAT 215 track mounted backhoe to identify shallow depth to bedrock areas. The test pit information was correlated to data from previous investigations. Typically, the test pits were excavated to refusal on bedrock or the maximum depth of reach for the equipment which was about 17.5 to 18 feet. Test Pit TP-1 was terminated on nested boulders at 14.5 feet in depth. Sheet 5 illustrates the location of the test pit excavations. Logs of the test pits are presented in Appendix A.

Bulk samples were collected from various depths in selected test pits. In addition, selected samples of intact soil were collected and sealed in plastic bags for in-situ density and moisture determination. The bulk samples were analyzed for moisture-density determination (compaction tests), permeability, particle size including hydrometer and specific gravity. Laboratory test data are summarized on Tables B-1 and B-2 in Appendix B.

Test pits were backfilled with the excavated soils and tamped into place using the bucket of the backhoe.

A temporary monitoring well was installed in selected test pits where water seeps were encountered. The temporary wells consisted of 1-1/2-inch PVC pipe capped on both ends and perforated in the bottom 3 feet using a hack saw to cut slots at approximately 2-inch increments. These wells were installed for temporary use only and are to be grouted closed prior to start of construction. No sand pack or bentonite seal was utilized.

2.3 Hydraulic Conductivity Tests

Hydraulic conductivity tests were performed on selected wells in the proposed landfill area to assess the horizontal hydraulic conductivity of the soils intersected by the screened interval. The test was performed utilizing an SE1000B Hermit logger with a 10 psi transducer and the data reduced using a Hermit-DM software package.

The test procedure involved:

a. immerse transducer and cable approximately 10 to 15 feet below the water surface;

b. monitor the water level until equilibrium is established from the transducer and cable displacing water in the well;

c. using a small 1-inch diameter bailer quickly remove one bailer volume of water from the well; and

d. initiate measurement of the rate at which the water level returns to equilibrium as soon as the bailer is withdrawn from the water.

The tables and curves printed out using the Hermit program for the variable head hydraulic conductivity tests are presented in Appendix C. Table C-1 summarizes the data obtained from the field hydraulic conductivity tests. The recorder generated data at specified intervals ranging from tenths of a second to 10 minute intervals. The raw field data were reviewed and selected values utilized in the analyses to establish the curves presented in the appendix. A sample of the raw data is presented at the end of Appendix C, that represents the voluminous data recorded for each well.

The initial steeper portion of the curve shown for many of the wells may be attributed to the equalization of water pressure within the sand pack. The initial readings are also affected by water dripping from the sides of the bailer and inside diameter of the pipe when the bailer is withdrawn. Since the soils are relatively impermeable, this quantity of water has a noticeable effect on the very early data. In sands or gravels with more rapid recovery rates this data would not be significant.

2.4 Groundwater Elevation Monitoring

Groundwater elevation monitoring was initiated in May, 1988, by B&L for the proposed landfill area for the purpose of evaluating seasonal fluctuations in the groundwater level. In August, 1988, the monitoring was expanded to include the wells in the vicinity of the "Pine Tree" site and Buckbee-Mears disposal area. A total of 38 permanent wells was monitored. The 8 temporary wells installed in the test pits were also monitored; however, the accuracy of the readings beyond the initial reading may be in doubt after the fall rains when surface water collected around some of the wells. Tables in Appendix E provide a list of the groundwater elevation data collected at the site and selected previous data that was available. Well hydrographs are also included in Appendix E. Wells are grouped for couplets and triplets where appropriate.

The information obtained was utilized in determining the horizontal direction of groundwater flow in both the overburden and bedrock. For the multiple well installations the vertical gradient between the overburden and bedrock was determined. The elevation data for each unit were plotted on separate site maps and contours of equal head were drawn to establish the piezometric level of each unit. Groundwater flow will, in general, be perpendicular to the contour lines representing equal head. The vertical component may somewhat alter this, but, in general, considering the relatively minor differences in piezometric head across the proposed landfill site, this will have a minimal impact on the direction of groundwater flow. Piezometric maps of the overburden and bedrock are presented on Sheets 8, 8A, 9 and 9A of the Engineering Design Drawings. Vertical components of flow are presented on the profiles on Sheets 15, 16 and 19.

2.5 Laboratory Soils Analyses

During the course of the 1988 field investigations, samples of the overburden soils and bedrock were collected. Bulk samples were collected from the test pits and monitoring well installations. The intact soil samples that were collected from the test pit excavation were analyzed to determine the natural moisture and in-situ density of the soil for various depths. The bulk samples were initially used for moisture-density (compaction), grain size, including hydrometer analyses, and specific gravity tests. Once the maximum density and optimum moisture content were determined using the Modified Proctor method (ASTM D1557), laboratory permeability tests were performed on samples remolded to various moisture and density limits.

Results of the laboratory tests for the investigations by B&L and the previous investigations are presented in Appendix B. Table B-1 summarizes the index properties and various other properties for the 1988 B&L investigations. Laboratory tests were performed in accordance with the ASTM standards referenced on the laboratory data sheets. Falling head tests were performed in accordance with procedures set forth in Appendix VII of the Department of the Army-Engineers Manual EM-1110-2-1906.

Previous investigations performed the moisture-density determinations utilizing the Standard Proctor method (ASTM D698). The optimum moisture for the Standard Proctor tests ranged from 9.4% to 11.1%. The natural moisture content of the soils ranged from 7.7% to 12.3% with an average moisture of about 10%. Since the previous permeability tests performed on remolded samples indicates the moisture content has to be wet of optimum to achieve a permeability of at least 1×10^{-7} cm/sec, the Modified Proctor test (ASTM D1557) would place more of the in-situ soil in the moisture range to obtain the desired maximum permeability. The Modified Proctor test was therefore used for the 1988 samples.

2.6 Water Sampling and Analyses

The water quality sampling and analyses were performed to establish background water chemistry parameters and to evaluate the similarities between overburden and bedrock wells. Groundwater samples were collected and analyzed from two downgradient couplets (MW-11A, B and MW-12A, B) and one upgradient couplet (MW-1A, B). Two rounds of sampling were performed, one on October 7 and another on November 28, to verify the consistency of the results. Baseline water quality analyses in accordance with the August, 1988 Part 360 Draft were performed by Upstate Laboratories of Syracuse, New York, for both monitoring periods. Dedicated bailers and polypropylene ropes were installed in the six wells. Sampling was performed by B&L personnel. Summaries of the analyses are presented on Tables D-1, 2, 3, 4 and 5 and laboratory data in Appendix D. Table D-6 summarizes parameters exceeding the standards or guidance values.

In addition to the sampling performed by B&L, the County has quarterly sampling performed for the interim "Pine Tree" landfill site currently in operation. That sampling program includes a downgradient surface water monitoring point. This data was reviewed but not tabulated. Results of this sampling have been submitted to NYSDEC by the County and representative data are presented in Appendix D.

2.7 Surveying

Surveying was performed by Bruce Davison Surveying of Cortland, New York, using standard survey procedures to establish the location and elevation of monitoring wells, test pits and pertinent features. Three permanent bench marks were established at various locations around the perimeter of the proposed facility. Coordinates and elevations for the bench marks are shown on Sheet 5 in the Engineering Design Drawings. Horizontal locations were established to the nearest 0.1 feet using full station survey equipment. Vertical elevations were established to the nearest 0.01 foot using a standard level survey. Horizontal control is based on the New York State Coordinate System and vertical control on the National Geodetic Vertical Datum - 1929. Survey data for monitoring wells are presented on Sheets 8 and 9.

Topographic maps were generated based on the 1987 aerial survey by Erdman Anthony Associates. The topographic map was expanded in 1988 by B&L to include additional area to the east. Erdman Anthony Associates provided the revised base maps.

2.8 Water Well Survey

Part 360 requires that a water well survey be performed to identify the owners of water supply wells 1/4 mile upgradient and 1 mile downgradient of the proposed site (Sheet 3). The survey was performed utilizing NYSDOT 7-1/2 minute topographic maps published in 1974 and reconnaissance of the area to establish locations of residences. Department of Health files and tax maps were utilized to identify the landowners.

SECTION 3

3.0 GEOLOGY AND HYDROGEOLOGY

3.1 Regional Characteristics

3.1.1 Physiography

The site area is located in the northern extreme of the Appalachian Plateaus physiographic province known as the Appalachian Uplands (Broughton, 1967). The Appalachian Plateaus form the western flank of the Appalachian Highlands Division (Hunt, 1967). The Uplands were formed as the peneplained surface of the eroded Appalachian mountains was uplifted and tilted towards the sea (Broughton, 1967). Erosion of this uplifted plain resulted in the formation of flat-topped divides separated by incised valleys. This topography was further modified during the Pleistocene Epoch in which the continental ice sheets advanced and covered the Uplands. The glaciation changed the topography by rounding off flat-topped divides, scouring valleys into U-shaped troughs and redirecting drainage patterns. The overall effect of the approximately 180 million years of erosion is the topography of Central New York today (Broughton, 1967).

3.1.2 Bedrock Geology

3.1.2.1 Stratigraphy

The rock units within the Appalachian Uplands area of Central New York were deposited in shallow seas that covered portions of the State during the Paleozoic Era, some 350 to 600 million years ago (Figure 3-1). Total thickness of the Paleozoic age strata in New York is approximately 9,000 feet (Broughton, 1981). The Paleozoic strata is underlain by the Pre-Cambrian basement rock complex which lies some 7,000 to 9,000 feet below sea level in the Cortland County area (Broughton, 1967). Deposition during the Paleozoic Era included:

Genesee Group

Approx. Years Before Present	Geologic Time Period	Primary Type of Deposition
(YOUNGEST) 225-350M	Missippian and Permian	No deposition in site area — In Allegany Parks Area
350-390M	Middle and Late Devonian 345	Clastics (sands, (shales) silts and clays)
390-405M	Early Devonian 345	Carbonates (limestones and dolostones) — Top Sil
405-420M	Middle and Late Silurian	shales, cong ← Carbonates and Evaporites (gypsum, halite) Lockport,
420-440M	Late Ordovician and Early Silurian	Clastics — Clinton shales + S.S. — Oswego S.S.
440-500M	Early and Middle Ordovician	Carbonates + Shales — Trenton / Black River
500-600M (OLDEST)	Cambrian	Clastics — Potsdam; Sim. L.S. Beekmantown Little Falls Dolo

M = Million Years

The uppermost bedrock units in the Cortland County area are Upper (Late) Devonian Age shale and siltstones of the West Falls, Sonyea and Genesee Groups and Middle Devonian Age Tully Limestone and Hamilton Group. Sediments for these rock units were deposited about (360) 350 million years ago. The majority of the County, including the proposed landfill site, has the Genesee Group as the uppermost bedrock unit (Figure 3-1). The Genesee sediments are part of the Catskill deltaic wedge that appended the rising land mass to the east. The Genesee Group is composed of intertonguing cyclically recurring facies resulting from fluctuating sea levels and variable depositional energy (deWitt, 1978). — Very General!

Pred. Shales w/ Intbd L.S.

Septarian Concretions — Genesee Shale Weathered

The geologic column on Figure 3-2 indicates the stratigraphic relation of the Genesee Group and other Devonian Age rock units in Cortland County. As shown on the geologic cross section on Figure 3-2, there is approximately 1,100 feet of the Upper Devonian Age Genesee Group siltstone and shales overlying the Middle Devonian Age Tully Limestone. The Genesee Group consists of the Ithaca, Renwick Shale, Sherburne Flagstone and Geneseo Shale members within Cortland County. To the west, the formation, through facies changes, is divided into additional members. These, however, are not present or not distinguishable from other units in the Cortland area. The Ithaca member forms the uppermost unit and the Geneseo Shale member the basal unit.

Landfill site

The Geneseo Shale is composed predominantly of grayish-black, brownish-black and olive-black fissile shale. The rock is laminated and massive on fresh exposure and becomes fissile on weathering. Within central Cortland County the unit ranges from 75 to 100 feet in thickness (deWitt, 1978).

Due to metamorphism (pressure)

The Sherburne Flagstone Member overlies the Geneseo Shale and is composed of thin-bedded to massive light gray siltstone and some silty shale, shaley siltstone and a few beds of very fine grained sandstone. Bedding commonly ranges from an inch to 1 foot but locally may exceed 15 feet. The Sherburne can be identified with certainty only where the overlying Renwick Shale is present, otherwise it cannot be separated from the overlying Ithaca Member. In Cortland County, where subsurface data are scant, the Sherburne is believed to be in excess of 250 feet in thickness (deWitt, 1978).

The Renwick Shale is composed of grayish-black, brownish-black to very dark olive-gray iron stained shale which contains abundant siltstone filled scour channels. This unit is less than 10 feet thick in the general site area and may be absent entirely in central Cortland County (deWitt, 1978).

The Ithaca Member forms the uppermost bedrock unit in the central Cortland County area. The unit is composed primarily of gray, weathered to tan, slightly argillaceous medium to coarse-grained quartzose siltstone with subordinate amounts of gray shaley siltstone, silty shale and silty mudrock. Local beds of fine grained sandstone, gray to black shale and scattered beds of coquinoidal (Shelly) limestone are found within the unit. The Ithaca Member forms an eastward thickening wedge that is in excess of 450 feet thick in central Cortland County (deWitt, 1978).

Nearshore Tidal Flat & Alluvial

3.1.2.2 Structural

The main structural feature of the bedrock in the region is an east-west trending monoclinal structure with a gentle dip to the south of about one-half degree as shown on the Geologic Cross Section (Figure 3-2). Superimposed on this monocline are a series of broad, open folds (anticlines and synclines) that trend east-west. These broad low undulations die out northward and south of the line of outcrop of the lower Devonian Age Onondaga Limestone which outcrops to the north of the study area (Newland, 1933; United Engineers, 1978).

Secondary structures such as joints and faults are generally developed when the strata are moved by tectonic activity. Mapping of regional lineations (suspected

No, FAULTING IS EVIDENT ACROSS GLACIAL VALLEY FLOOR ALONG Rt 81 CORRIDOR RUN N-S

faults) and known faults indicates an absence of these features in the Cortland County area (Woodward-Clyde, 1979). Other features such as joints are common in the bedrock. Literature indicates the joint patterns in adjacent Tompkins County are (O'Brien & Gere, 1988):

<u>Dip Joints</u>	<u>Strike Joints</u>	<u>Tension Joints</u>
N15° to 30°E N40° to 50°W	N60° to 70°E	N84°W

Field measurements of outcrops in the borrow area indicate dominant trends N23°W and N14°E and a minor trend E-W. Other patterns may have been present, but the ripping by the equipment had disturbed the area such that measurements were not consistent.

A study of the drainage patterns on the McGraw and Truxton USGS 7-1/2 minute topographic maps suggest several general trends exist. Assuming the lineations from the drainge patterns are a reflection of the bedrock, a regional joint pattern can be inferred (Figure 3-3). Analyses of the lineations indicate the following trends.

<u>Dominant</u>	<u>Minor</u>
N10 to 40°E N10 to 30°W N5°W to N5°E	N30 to 50°W N80°W to N80°E

YES!

The lineations study may be influenced by the masking of bedrock by the till and by direction of glacial movement. The results, however, suggest a reasonable correlation with literature and field data (Isachsen and McKendree, 1977). TRUE

3.1.3 Seismicity

The proposed landfill is located in a seismically stable region. The epicenter and intensity map indicates there are few earthquakes in the near vicinity of the site, and those that occur are generally of low intensity (Figure 3-4). The seismic risk map, as presented in the 1988 Uniform Building Code, indicates the site is in a Seismic Zone 1 which is a relatively stable region not susceptible to major ground accelerations. The horizontal acceleration in rock, typically expressed as a percent of gravity (g = 32 ft./sec.^{2}), for a 50 year recurrence interval is less than .04 g and 250 year recurrence interval of less than .1 g (Algermisson, 1982). The horizontal velocity in rock for a 50 year recurrence interval will be approximately 0.066 ft/sec and for 250 year recurrence interval 0.2 ft/sec (Algermisson, 1982). Data for the 50 year recurrence interval should be used for design since decomposition should be accomplished within a 50 year time span.

All of the data suggests the site area is stable, and ground motion will not be sufficient to cause detrimental effects to the liner, piping or structures.

3.1.4 Glacial Geology

During Pleistocene time, continental ice sheets covered the region. Movement of tongues of ice down the valleys preceded the ice sheets. As the lobes of ice moved, they deepened and broadened the valleys. Eventually the ice sheet associated with the lobes of ice completely covered the uplands as well as the valleys. Because the ice was thicker and moved faster in the valleys, it caused greater erosion of the bedrock valleys than on the uplands.

The materials eroded by the moving ice were transported and redeposited as an unsorted mixture of clay, silt, sand and gravel termed glacial till. Since the glacial activity was much less on the uplands due to thinner ice and slower movement, the character of the till is largely determined by the underlying bedrock. When the ice retreated, the uplands were left covered with a mantle of glacial till. In the major valleys these materials were frequently reworked by the flowing melt water resulting in sorting and stratification. In the valleys where glaciation was more active, the materials deposited may be from more distant locations and thus have slightly different composition from the upland tills. Distribution of surficial geologic deposits are presented on Figure 3-5.

(6000 - 20,000)

Prior to the last advance of ~~ice~~ over the Cortland County area in Wisconsinan time (10,000 to 12,000 years ago), drainage was to the southwest through the Fall Creek Valley (SUNY, undated). As a result of an ice dam or morainal sediments in the vicinity of south Cortland, the preglacial westward flow down the Fall Creek Valley was cut off. With the original westward flow in the Tioughnioga Valley blocked, water ponded forming a lake. As the ponded water rose, it eventually flowed across the upland into the adjacent south flowing valley near Messingerville to the south of Marathon. The erosion of the upland was of such extent that when the ice retreated, the flow continued to the south through the present Tioughnioga River Valley.

Valley Heads moraine

Kettle Lake

— 105 ?

During the periods when water was ponded, lacustrine sands, silts and clays were deposited in the valleys. As the glaciers and lake waters receded, glacial streams carried outwash sands and gravels into the valleys. In the Cortland area, the glacial deposits in the major valleys are reported to range from 200 to 260 feet in thickness (Waller, 1982).

The upland areas are characterized by shallow glacial till soils on the hill crests and northern slopes with till shadows of varying thickness on the southern slopes. Bedrock is not frequently exposed but may be near the surface especially on the hillcrests. Upland soils are typically lodgement till with varying amounts of cobbles and boulders. The till is generally very dense compacted with depth, while the near surface materials reflect oxidation due to surface water percolation.

The smaller tributary valleys are typically underlain by till or bedrock with recent alluvial sands and gravels of limited extent. This type of deposition would be similar to that formed in Mosquito Creek, Maybury Brook and the unnamed creek in the site area.

3.1.5 Groundwater

3.1.5.1 Flow Direction

Groundwater movement within the Cortland County area generally follows the topographic relief. No karst features have been reported in the literature or were observed in the field and none should be encountered based on the general bedrock geology (shales and siltstones).

Typically, flow is from the till and bedrock of the uplands to the more productive aquifers in the major stream valleys. The groundwater typically is recharged through infiltration on the uplands and valley bottoms. A general downward (vertical) movement of groundwater occurs in the more level upland areas. The uplands also generally have a thinner soil cover permitting more rapid percolation into the bedrock where the water disseminates through the fractures and altered bedding planes in the upper bedrock surface. The bedrock typically becomes less fractured and weathered with depth, thereby limiting the vertical movement and promoting horizontal flow. Horizontal flow is also promoted by the thin bedded nature of the bedrock. Horizontal flow is especially pronounced on the slopes where runoff predominates over infiltration due to the low permeability glacial till soils.

The groundwater typically recharges the streams in the valleys and may appear as springs on the lower slopes depending on the hydraulic gradient and local geologic conditions. The till may tend to locally confine groundwater in the bedrock, but, in general, both till and bedrock should reflect a similar potentiometric surface due to the similar permeability.

Within the major valleys, till lenses and lacustrine deposits may confine the permeable sand and gravel aquifers or separate them into an upper, unconfined layer, and a lower confined layer (Figure 3-6). This reportedly occurs in the McGraw area (Miller, 1988).

The Tioughnioga River forms the regional discharge point for Cortland County. Local discharge points would be the streams between the uplands which are recharged by shallow groundwater regimes. In general, the groundwater flow is relatively limited in extent since recharge to surface waters generally occurs in the vicinity of initial infiltration. Consequently, the local streams form hydrologic barriers to groundwater flow. Therefore, the unnamed creek forms a hydrologic barrier to groundwater flow in the landfill area. The topography and stratigraphy is such that the proposed landfill area will recharge the unnamed creek. Maybury Brook and Mosquito Creek are in adjacent drainage basins and should not be influenced by construction of the landfill (Sheet 3).

3.1.5.2 Water Supply

The glacial tills which mantle most of the uplands are, in general, not used for domestic water wells. Instead, the upland wells penetrate through the overburden into the underlying bedrock (siltstones and shales) from which a nominal quantity of water can be drawn to supply domestic needs. The USGS map showing the Unconsolidated Aquifers in Upstate New York - Finger Lakes Sheet by T. Miller, 1988, indicates Maybury Brook, Mosquito Creek and the unnamed creek are underlain by till, clay, silt or silty sand that may contain only local sand and gravel aquifers. Dug wells in till and drilled wells in bedrock are generally capable of yielding 1 to 5 gallons per minute (Miller, 1988).

The only large water yielding formation in the area would be the unconsolidated valley fill deposits consisting of sands and gravels within the major stream valleys. These deposits form the primary aquifer shown on Figure 5 known as the Cortland-Homer-Preble Primary Water Supply Aquifer. As previously discussed, the valley fill deposits including the lacustrine clays and silts and tills may reach depths of 260 feet in the Cortland area. Within the

Trout Brook area, the saturated thickness of the aquifer may be limited to 20 to 40 feet (Waller, 1982).

The operating municipal water wells for the Village of McGraw are located in the valley fill deposits on the south side of Trout Brook. Two wells were drilled 140 feet in depth with the third and newest, 200 feet deep. All have artesian flow to the surface with well yields of 65, 80 and 130 gpm (Pers. Comm. J. Campbell, 1989). The aquifer is reportedly confined beneath a less permeable layer in the vicinity of the wells (Miller, 1988). Potential yields suggest 10 to 100 gpm in areas where the aquifer is unconfined to more than 500 gpm possible where it is confined (Miller, 1988).

USGS data indicates a steady rise in the concentrations of nitrate and chlorides in the Cortland-Homer-Preble aquifer (Waller, 1982). These were attributed to fertilizers, residential septic systems and road salts. Similar trends would be expected in the McGraw area.

3.2 Site Characteristics

3.2.1 General

3.2.1.1 Topography

The proposed landfill site is situated on a gentle to moderate sloping east facing hillside. The slopes vary from 3% in the northwest corner to 14% in the southeast corner in Phase I and from 3% to 7% in Phase II. Local areas of steeper slopes exist in both phases. Elevation varies from 1644 on the southeast to 1779 on the northwest corner of Phase I for a total elevation difference of 135 feet. From the northwest corner of Phase II to the southeast corner of Phase I there is 156 feet of elevation difference (Sheet 5).

The area within the proposed landfill and borrow area slopes to the east-southeast. The proposed borrow area forms the ridge between Mosquito Creek and the unnamed creek drainage basins. The borrow area slopes gently to the east in what was once a cultivated field. On the center portion of the proposed Phase I and II development area, the slope flattens to a near level (approximately 3% slope) area just to the east of the proposed landfill. This near level area is characterized by wet soil conditions during spring and periods of extended rainfall. In the summer, the area is dry and trafficable with a 2-wheel drive vehicle. To the south and north end of the proposed development area, there is a continuous slope from the upland ridge to Town Line Road. In the southeast corner, the slope steepens about half way across the proposed Phase I landfill area.

3.2.1.2 Vegetation and Surface Features

The borrow area and proposed landfill area have relatively minimal clearing. The borrow area has several fence rows to clear out which have some mature trees, but the majority is abandoned cultivated fields or pasture land. Brambles, scrub brush and part of an abandoned orchard exist along the east side.

The proposed Phase I landfill area has secondary growth and brush to remove on the northern end and a strip of about 75 feet of more mature woodlands to remove on the southern limit. Several hollowed out large diameter maple trees will be removed from the southwestern corner. The remainder of the area is open abandoned pasture with scrub brush.

The near level area and proposed development area appear to have been pasture land and not cultivated. The near level area also has the appearance of being logged off as there are numerous low mounds of earth that are not related to soil depth over bedrock.

Within the perimeter berm area and just south of the proposed landfill there are nine abandoned vehicles from 1940's to 1960's vintage. These should be removed and the top couple feet of soil excavated and removed to the existing or abandoned landfill area. The soils most likely have petroleum product or chemical (antifreeze) contamination. Soils in this area should not be used in landfill construction.

The leachate tank and detention ponds are located in more heavily wooded areas and require clearing of most of the site area. Growth ranges from scrub brush to mature trees.

The area on the east side of the proposed landfill along the abandoned Town Line Road also requires some extensive clearing. Mature trees line the road for most of the Phase I area and part of Phase II.

3.2.1.3 Drainage

All of the proposed landfill and borrow areas lie within the unnamed creek drainage basin. Construction of the landfill will not impact any new drainage basins or surface waters.

The proposed landfill slopes to the east and southeast towards abandoned Town Line Road. Surface water flows toward a shallow swale on the north end of the site and into a ditch on the west side of the road. This ditch flows the entire length of Town Line Road and empties into the unnamed drainage where the 48-inch culvert carries the stream under the road. This drainage ditch collects most of the runoff water from the proposed landfill site. Drainage on the extreme southern end flows directly to the unnamed stream.

Drainage from the existing closed Cortland County landfill flows southward and through a series of ponds before discharging to a ditch leading to the unnamed creek. The Buckbee-Mears area drains south and east and into the ponds. All of the existing, closed or abandoned landfills east of Town Line Road direct surface drainage to the streams. This runoff enters the stream upgradient of the proposeed landfill.

Surface drainage from the abandoned cars area enters the stream downgradient of 48-inch culvert. Surface water from this area will most likely enter the detention pond for the borrow area runoff.

The current total flow volume for the unnamed stream transmitted through the 84-inch culvert under Heath Road will be maintained so as not to increase flooding downgradient. Controlled outlets will be designed for the detention ponds. Calculations for determining runoff and sizing of the detention ponds is presented in the Engineering Report.

3.2.2 Bedrock Geology

3.2.2.1 Site Stratigraphy

As discussed in the regional geology section of this report, the majority of the County has the Upper Devonian Age Genesee Group as the uppermost bedrock unit. The proposed landfill site is underlain by the Ithaca Member of the Genesee Group which may exceed 450 feet in thickness at the site area. Based on the north-south regional geologic section shown on Figure 2, there is approximately 900 feet of primarily interbedded siltstone and shale underlying the proposed landfill site. Since the total thickness of the Genesee in the Cortland County area is estimated to be about 1,100 feet, all of the borings taken at the Cortland County Landfill have terminated in the Ithaca Member.

Previous investigations on the County Landfill property indicate the depth to bedrock varies from about 2 feet west of the proposed west side extension to 157 feet east of the proposed site. The logs for the deeper borings to the east (Dunn Geoscience, 1985) generally describe the bedrock as gray siltstone with interbedded shale and limestone and occasional sandstone beds; while the borings in the site area and to the west describe the bedrock as interbedded shale and siltstone (MacNeill, 1987). Since the borings span about 200 feet of the Ithaca Member, this variation in rock descriptions could reflect a change in depositional environment and depositional energy which is common both horizontally and vertically in the Genesee Group.

— Thus 200' not enough distance to envo changes in depo ENV.

West deeper Ithaca

moderate currents lot of breaks

Below wave base depo

East shallow

The boring logs indicate the upper part of the bedrock generally to be fractured and slightly weathered. However, within a few feet the bedrock improves in quality. RQD values for core runs in the proposed site area varied from 0% to 56%. The Dunn Geoscience borings penetrated in excess of 20 feet of bedrock and reported 100% RQD in at least one well and all showed steady improvement with depth. B&L noted in the two borings (MW-11A and 12A) drilled in 1988, that there was less weathering and fractures with depth. Low RQD was generally the result of inherent breaking along bedding planes in the thin bedded strata. Occasional, near vertical to 70°, tight fractures were noted. The bedrock encountered in Borings MW-11A and 12A were primarily siltstone with thin shale seams and occasional fossiliferous limestone stringers or thin fine to medium grained sandstone layers. The rock units were generally medium hard although occasionally highly weathered. Thin black shale seams were also noted.

3.2.2.2 Bedrock Surface

A bedrock surface elevation contour map was prepared by assimilating data from the various field investigations performed at the site (Sheet 6). This drawing indicates localized rapid changes in the elevation of the bedrock surface across the general site area. Maximum relief in the bedrock surface within the Phase I and II boundary is approximately 180 feet from a high of about 1790 in the northwest corner to a low of 1570 in the southeast corner. To the east of the proposed site and beneath the Pine Tree site a deep bedrock valley exists with steep side slopes and an abrupt, very steep valley head which could have formed an approximately 70 to 100 foot high waterfall. The deep valley is believed to abruptly end near the Buckbee-Mears area and the retention ponds (Sheets 5 and 6). A second, more shallow, valley presumably connects with the deep valley near Monitoring Well D6. This valley trends roughly parallel to the eastern side of the proposed site and then apparently ends abruptly in a 40 to 50 foot high steep rock slope under Phase II. Depth to bedrock in MW-4A was reported at 61 feet. Between MW-4A and MW-3A, 250 feet to the northwest, there is 53 feet of relief. Both of these valleys may end in a near vertical valley head where a waterfall and plunge pool may have developed. This phenomenon is unique to the Phase II area.

It is important to note that bedrock was not encountered in LT-7 and TP-34 and was not verified in LT-6 where sampling refusal was noted and less than .1 foot of weathered shale fragments were recovered. The bedrock contours in the vicinity of these exploration points (LT-6, LT-7 and TP-34) are based on the conservative assumption that the bottom of the excavation encountered bedrock (Sheet 6). The bedrock contours, therefore, are based on a conservative estimate of the depth to bedrock in this area. The minimum 10 foot depth to rock may be several feet thicker in these areas than indicated by the contours.

The slope of the bedrock in the Phase I area varies from 10% in the northwest portion of Phase IB to about 40% at the extreme southeast corner of Phase IA and along the eastern portion of Phase IB where it slopes into the smaller bedrock valley. The remainder of the Phase IA area has a fairly uniform 13% to 17% slope. Bedrock in Phase IA slopes to the southeast but Phase IB slopes to the east due to the presence of the smaller buried valley. The phase line between IA and IB roughly reflects this change in flow direction. The Phase II area has similar slope directions with Phase II sloping east and Phase IIB southeast. Both Phase IIA and IIB slope towards the smaller bedrock valley. The degree of slope varies from about 5% on the northwest half to roughly 25% to 30% near the head of the small buried valley. The remainder of Phase II has slopes similar to the 13% to 17% in Phase I.

The deep valley trends roughly N30°E and the shallow valley roughly N10°W. From the lineations study described in the regional geology section of this report, the bedrock valleys appear to follow two of the more dominant joint trends.

The development of the buried valleys is most likely the result of ice dams or morainal drift blocking drainage, resulting in ponding and eventual overland flow from one drainage basin to another. The rushing melt waters seek the path of least resistance to develop a channel, and exploit the inherent rock weaknesses provided by the joints. These valleys were subsequently overridden by the glacial ice and filled with debris as the glaciers retreated.

3.2.3 Soils

The unconsolidated materials that mantle the proposed landfill construction area consist of glacial till deposited during the last glacial advance (Figure 3-5). Samples were collected from test pits and borings and analyses performed to determine their classification and engineering properties. During the post glacial erosional period, modern soils have developed in the upper part of the till.

3.2.3.1 Stratigraphy

The till consists of a clayey silt and fine sand matrix with fine to coarse gravel and medium to coarse sand embedded in the fine grained matrix. Four soil units were identified in the test pits below the topsoil. Although all the soil units have similar classification based on standard engineering laboratory analyses (grain size, Atterberg Limits, unit weight, etc.), differentiation of the soils was based on color, density and secondary features (Appendices A and B).

The upper 2 to 5.5 feet consist of brown mottled gray soil. The mottling is due to water percolation through root channels and secondary features. The mottled gray areas indicated the clayey portion of the soil had been removed (illuviation) leaving a silt and fine sand. Water movement would be primarily vertical through this zone. The soil is moist but generally below the plastic limit. Gravel fragments are predominantly angular. The soil has a characteristic blocky structure and will crumble easily into small blocks and individual particles under slight pressure. The effects of frost were noted in the form of occasional horizontal planes in the upper 2 to 3 feet of the soil profile.

The light gray mottling diminishes with depth, and the soil grades into a uniform strong brown color. The uniform brown soil extends from approximately 3.5 feet to a maximum of 12 feet, although typically only to about 8 or 9 feet in depth. The blocky structure remains evident especially near the upper portion of the soil strata. The soil is slightly more moist than above and most likely retards the vertical, downward, migration of water and promotes horizontal, lateral movement. The blocky structure decreases (i.e., block fragments become larger) with depth as the soil makes a gradual change to a brown-gray color.

The brown-gray soil was encountered between 5 and 15 feet in depth in the test pits. The soil is moist to very moist and more dense than the soils above. The soil remains below the plastic limit and breaks into cobble size and larger blocks when excavated. Slight discoloration was occasionally noted along the surface of the block structures indicating percolation of water. These were not frequent and did not appear to be continuous either horizontally or vertically. The surfaces were tight and did not easily break along the plane. The soil was dense and required effort to break the blocks of soil. The soil did not crumble when broken but remained intact. The soil appeared to break through the soil matrix as easily as through a block surface. The surfaces of the planes forming the blocks were generally moist as were the surfaces of stones removed from the till matrix. The collection of free moisture along these features indicates the soils are saturated.

The brown-gray soil graded into a uniform gray color with depth. The gray soil was encountered below 11 feet in depth and was continuous to the bedrock surface or bottom of the test pit. The soil is slightly more dense than the brown-gray soil and exhibits little if any blocky texture. The soil is moist and below the plastic limit. Great hand pressure is required to break chunks of soil, and the excavation progress was slowed. There also appears to be more rounded gravel fragments than in the soils above. Cobbles and boulders are noted throughout the soil strata in both the test pits and soil borings. Most of these were of local origin (siltstones) but occasional non-native material was noted, especially in the gray till.

The various changes in soil color appear to be the result of oxidation due to water movement through the vadose and upper saturated zone and not related to deposition. The gray uniform color soil most likely indicates a zone of permanent saturation. The brown and brown-gray strata indicate a zone of soil moisture migration and gradual depletion of oxygen due to the oxidation of minerals in the soil.

Borings MW-11A, MW-12A, LT-8, LT-7, LT-6, MW-7A and MW-5A extend below the depth of the test pit excavation and confirm the dense gray till extends to bedrock. All of these except MW-5A attempted continuous sampling for the full depth of the boring. All of the borings indicated a similar soil, although varying in color, below the modern soil profile. Boring MW-5A noted a very cobbly zone between 14 and 18.5 feet which had a higher moisture content making drilling easier according to the driller's note on the field log.

The final log for Boring MW-4A as presented in the MacNeill report indicates the presence of a gray clayey gravel below a depth of 43 feet. Free water was also noted between 40 and 43 feet in depth which was unusual since other borings did not note free water in the till section. The driller's field log conflicts with the final log in that the soils are logged as "similar" to the above (i.e., till soils) but brown in color. No sample was recovered between 50 and 61 feet except for air rotary cutting, and no water was noted between the interval with the augers set at 50 feet. Since this boring is located at the head of the bedrock valley, it is possible a reworked till or basal type of material with more gravel may have been locally deposited at the base of the steep bedrock slope. None of the borings (LT-6, 7, 8, MW-5A, 7A, 11A and 12A) in the Phase I area, however, indicate a similar type of material. This area may warrant some additional investigation for Phase II development. This portion of the Phase II development will also have limited excavation below existing grade due to the shallow depth to rock area to the north.

It is important to remember that isolated or confined areas of more permeable zones may exist in the till. The borings and test pits indicate the soils to be relatively uniform both horizontally and vertically throughout the site. In the 38 test pits and two borings supervised by B&L, only one thin (less than 1/16") fine sand lense was noted (MW-12A). The soils in the test pits and B&L borings appear to be very uniform which is confirmed by laboratory analyses. A review of the logs from previous investigations confirms the soils to be similar within the Phase I area. Boring MW-7A indicates the presence of a clayey sand seam from 15.8 to 16.8 feet, but this was not noted in Test Pit TP-7 which is about 65 feet to the north.

X (section)

It was noted that the gray till is present only where the soils are in excess of about 11 feet to bedrock. On the shallow to rock areas, only the brown mottled gray or brown soils are present. As the soil profile thickens, the brown-gray and gray soils are encountered, and the dense gray till thickens as the depth to bedrock increases.

3.2.3.2 Modern Soils

A thin modern soil profile has developed in the surface of the glacial till. The more loamy portion of the soil is limited to less than 2 feet in depth with the organics predominantly in the top 6 to 9 inches. The previously cultivated areas have a deeper loamy soil than the pasture areas, but the pasture areas have more of a sod like upper root zone. Removal of the upper 12 inches for use in revegetation of disturbed areas and landfill slopes should remove the bulk of the organic material.

The USDA Soil Conservation Service has mapped the Lordstown Silt Loam on the ridges in the shale borrow area, west of the landfill, where the depth to rock is shallow. The proposed landfill site is located within the area mapped as Volusia Silt Loam which is formed in the deeper deposits of till. The Volusia has a hard pan within the soil profile which restricts the vertical movement of water as it infiltrates resulting in a horizontal component of flow. Some areas of Chippewa soils are located on the northeast corner of Phase II. These soils are typically wet indicating low percolation rate and elevated groundwater conditions.

The modern soils will be removed during the site development process in the landfill and borrow areas. Where the soils remain undisturbed, the influence on infiltration and runoff should be considered in the hydrology review of the facility.

3.2.3.3 Soil Depth

A total of 46 borings have been drilled, 80 test pits have been excavated and 38 wells installed in the solid waste disposal area during the 17 years since the County took over the landfill property. With this information the bedrock contour map (Sheet 6) was produced. Using this map and the existing topography, the depth of soil can be predicted for any portion of the site (Sheet 7).

The glacial till varies from 2 feet to 157 feet in thickness from west to east across the general site area as encountered in the borings. The thinnest soils occur on the ridge to the west of the landfill and the level area just west of the proposed landfill in the vicinity of MW-8A and TP-11. These areas will be incorporated in the shale borrow area. The soil thickness varies from about 3 to 7 feet in the shale borrow area and thickens to the south toward the soil borrow area where greater than 10 feet of soil is present.

In the proposed future Phase II landfill area, the soil depth varies from 8 feet (TP-32) at the far north end to 61 feet (MW-4A) about 400 feet south of TP-32. The maximum depth of soil occurs predominantly in Phase II in a strip that parallels the eastern side of the proposed landfill in the buried bedrock valley. The deep soils extend south to MW-12A in Phase I. South of MW-12A, in the proposed Phase I landfill area, the thickness varies from 10 feet on the west side of the landfill to about 50 feet at the southeast corner. In general, for Phase I, the soil thickness varies from 10 to 20 feet on the west and thickens very rapidly toward abandoned Town Line Road on the east (Sheet 7).

The western and northern limits of refuse were established by the 10 foot depth to bedrock contour. The landfill will be constructed at grade or above grade where required for shallow depth to bedrock. Subgrade preparation by addition of compacted soil may be required in the local shallow to bedrock areas to maintain 10 foot of clearance above bedrock.

3.2.4 Soil Properties

3.2.4.1 Classification

Laboratory test results of previous investigations have been reviewed and are presented in Appendix B. The composite plot of the 23 gradation analyses indicates the soils are essentially uniform across the proposed site. The site soils are borderline between ML-CL and GM-GC according to the Unified Soil Classification System. The percent passing the #200 sieve, which separates coarse grained from fine grained soils (silts and clays), ranges from 45 to 55%. The soil has 15 to 22% sand and 23 to 40% gravel content excluding cobbles. The Atterberg Limits indicate low plasticity soils with plasticity indexes ranging from 4 to 10 and an average index of 6. The average plastic limit is about 17 and average liquid limit is 23. The moisture profiles from ground surface to bedrock are presented on the MacNeill boring logs (Appendix A). Moisture data and other soil classification properties for test pit samples are shown on Table B-1. Both sets of data indicate the soils are below the plastic limit in an in-situ state. The composite grain size curve in Appendix B indicates the uniformity in particle size distribution within the entire proposed landfill area.

3.2.4.2 Compaction and Laboratory Permeability

Compaction tests and permeability tests were performed for the MacNeill Report using the Standard Proctor Method, ASTM D698, and for B&L's report using the Modified Proctor Method, ASTM D1557. The Modified Proctor Method indicates optimum moisture contents of 6.8 to 8.5%, whereas the Standard Proctor indicates a range from 9 to 11%. The natural moisture content of the soils ranges from roughly 8 to 12%. In order to obtain the required 1 x 10^{-7} cm/sec maximum permeability, the soils need to be compacted wet of optimum. The degree of moisture above optimum varies with the compaction effort. (Preliminary tests indicate about 0.5% above optimum at 95% density and 1.5% above optimum of 90% for the Modified Proctor test.) There was insufficient testing using the Standard Proctor Method to determine a moisture range. Additional testing using prepared liner soil should be performed to establish the moisture requirements. Considering the natural moisture content of the soils, the Modified Proctor Method appears to include more of the soils at their natural moisture content than the Standard Proctor Method. Either method will consistently yield soils capable of meeting the 1 x 10^{-7} cm/sec permeability criterion. Compaction and permeability data are presented in Appendix B and summarized on Table B-2.

Due to the numerous cobbles and occasional boulders, a separation or screening system will be required to remove the stone over 3 inches for soils to be used as liner material.

It is also important to note that the moisture content after the permeability test (saturated condition) was only slightly above the natural moisture content of several samples. This indicates the soils are in a saturated condition in the field but do not yield water easily upon excavation. The saturated condition apparently also occurs below the plastic limit of the soil (average approximately 17%).

3.2.4.3 Hydraulic Conductivity

Field hydraulic conductivity tests to determine horizontal permeability were performed in selected wells in the proposed landfill area. The tests were performed in the overburden soils from 3 to 43 feet in depth and in the upper ~~15 feet of the~~ bedrock surface. This upper portion of the bedrock typically had an RQD value increasing with depth indicating more broken or fractured rock in the soil/bedrock interface area where lower RQD values were recorded. Field hydraulic conductivity tests are summarized on Table C-1 in Appendix C. The borings indicate that the low RQD is frequently due to separation along horizontal bedding planes.

In the proposed Phase I area, the hydraulic conductivity of the overburden soils ranged from 4.21×10^{-6} to 1.61×10^{-7} cm/sec and in the bedrock from 7.24×10^{-6} to 1.81×10^{-7} cm/sec. The overburden interval tested represented soils between 11 and 33 feet in depth. Only Well MW-4C in the Phase II area was tested for the shallower soil depths. The hydraulic conductivity in the 3 to 13 foot interval tested in MW-4C was 2.05×10^{-6} cm/sec. The test pits indicated similar soils were present throughout the area; therefore, it a valid extrapolation of data to include MW-4C in the Phase I data base. The range of soils from 3 to 33 feet covers the depths of soil to be encountered in the Phase I development. The average values of hydraulic conductivity for the soil and bedrock in Phase I as determined using a geometric mean are:

Overburden Soil: 9.1×10^{-7} cm/sec

Bedrock: 1.3×10^{-6} cm/sec or higher/5

Monitoring Wells MW-4B and 5B, both in Phase II, indicated permeabilities on the order of 1×10^{-4} cm/sec. Monitoring Well MW-4B encountered free water in the testing interval which is not representative of any other overburden well. Monitoring Well MW-5B indicates a "very cobbly" zone was encountered in the testing interval. If all of the hydraulic conductivity data is included in the data base as a worst case scenario, the geometric mean for overburden soil would be 4.1×10^{-6} cm/sec and 5.3×10^{-6} cm/sec for the bedrock. The geometric mean for the soils still satisfies the requirements for a waiver.

Localized more permeable zones may exist in the till as evidenced by the minor seeps noted in some test pits, but the continuity is lacking as evidenced by the uniformity encountered in the overburden soils in the test pits and borings. Utilizing the geometric mean from representative soil and bedrock areas should be considered as an average horizontal permeability for the geologic strata evaluated.

UDBC not in rock

3.2.4.4 Consolidation

The in-situ till soils have been subjected to previous loading as a result of glacial ice. Based on the liquidity index (average 17) and natural moisture (7-12%), the in-situ brown-gray and gray soil is estimated to have a preconsolidation pressure in excess of 10 TSF (NAVFAC DM 7.1, 1982). Since landfill loading is typically significantly less than the preconsolidation pressure, the coefficient of consolidation for the recompression curve (Cr) should be used instead of the virgin curve (Cc). Using empirical relations to calculate the Cc value and assuming Cr equal to 5% to 20% of Cc a Cr value of .006 to .02 should be used. Use of the Cr = .02 will provide a conservative estimate of settlement.

3.2.4.5 Compressive Strength

An unconfined compression test was performed on a sample remolded to 90% of the maximum density (ASTM D1557) and about 2% above optimum (Appendix B). This test indicates an ultimate strength of 3122 psf at 2.7% strain. A shear strength of 1,500 psf should be used for design unless strain requirements dictating a reduction is required.

3.2.5 Groundwater

Groundwater in the proposed site area was evaluated based on the 38 wells installed during the various investigations performed at the Cortland County Landfill site. Previous laboratory testing of water quality and various reports by consultants were also reviewed.

3.2.5.1 Water Well Survey

Part 360 requires that a water well survey be performed to identify the owners of water supply wells 1/4 mile upgradient and 1 mile downgradient of the proposed site (Sheet 3). As shown on Sheet 3, the downgradient boundary was modified by hydrologic barriers. Within the immediate drainage basin affected by the proposed landfill, there are no downgradient water supply wells within 9,000 feet of the proposed site. The only well in the drainage basin in the vicinity of the landfill is the county well at the landfill office upgradient of the proposed site. To be conservative, the survey was expanded to the next drainage basin east and west of the site, with the streams, Mosquito Creek and Maybury Brook, used as hydrologic boundaries.

Use of the streams as barriers for the well survey are based on the elevation differential between the landfill and closest point of the streams and the local hydrogeologic regime. The lowest elevation of refuse in the landfill is about elevation 1658. The closest point of the streams to the downgradient end of the landfill have elevations of 1,390 feet (Mosquito Creek 4,200 feet to the west) and elevation 1,460 feet (Maybury Brook 3,900 to the east).

Using this conservative expanded area, sixteen existing and abandoned residences are included in the survey, including two camps with no electric service which are seasonal for recreational use. There are no private wells within 1/4 mile upgradient of the proposed landfill footprint. The results of the survey are presented in Table 1. All sixteen wells are located in adjacent drainage basins and would not be considered downgradient of the landfill. The closest well is about 2,300 feet from the footprint area of the proposed landfill.

3.2.5.2 Water Quality

Baseline sampling has been performed by B&L on three well couplets (Tables D-1 to 5). Upstate Laboratories of Syracuse, New York, performed the analyses. The upgradient monitoring wells are MW-1A (bedrock) and 1B (overburden). The two recently installed wells MW-11A, 11B, 12A and 12B were analyzed as the downgradient wells. The wells installed by previous investigations were not selected due to poor location for downgradient monitoring or location such that they would be destroyed by landfill construction at some time in the future.

The bedrock wells designated by "A" are set at the bedrock-soil interface or just below the bedrock surface. The overburden wells designated by "B" and "C", where triplets were installed, are set in the glacial till soils. The "C" wells indicate the shallowest well. Details of well construction are shown either on the boring log or on a separate sheet following the boring log. Since there have been several investigations, there is no uniformity in the method of presentation. The boring logs are presented in Appendix A.

The baseline water quality analyses results are summarized on Tables D-1, 2, 3, 4 and 5 with the laboratory analyses presented in Appendix D. Results of the analyses performed in 1988 indicate groundwater standards or guidance values were exceeded for: total phenols, total boron, total iron, total manganese and dissolved lead.

Toluene was noted in small quantities in the bedrock wells. Table D-6 summarizes the parameters that exceeded the standards or guidance values.

Phenols, boron, iron and manganese are all typical parameters found in groundwater as confirmed by the presence in both upgradient and downgradient wells. The metal values do not exceed regulatory limits in the filtered samples. The total iron content for MW-12B is elevated, yet the dissolved iron analyses shows compliance with the groundwater standards; thus, indicating particulate contamination or leaching from sediment in the non-filtered sample.

The presence of toluene in low levels in both the upgradient and downgradient bedrock wells indicates the parameter is either native to the rock strata or has been introduced upgradient of the proposed landfill. The area upgradient of all the wells has been cultivated at one time and may have been introduced through weed control or fertilizer application. As noted previously, the ridge areas which were cultivated had the thinner soils thereby allowing more rapid infiltration. Results of groundwater sampling in the Pine Tree Landfill area, however, do not indicate the presence of toluene. The presence of this parameter in the low concentrations that were found are not a hindrance to development of the site area but should be monitored on a routine basis.

The presence of the elevated dissolved lead in MW-1A for the second round of sampling is possible laboratory or sampling bias. The metal (lead) is not present in the total lead sample. This well is upgradient of existing landfill activity. Routine sampling will confirm or discard the presence of the lead. The lack of lead in the total metals sample is incompatible with its apparent presence in the dissolved metals sample, indicating a possible non-environmental source.

The lack of elevated leachate indicator parameters, including chloride and low specific conductance, in the wells also suggests that the existing landfills are not influencing the proposed landfill wells. The upgradient and downgradient wells presently have similar concentrations of parameters. Monitoring using conventional frequency and parameters will determine if the proposed landfill impacts the environment. The existing landfill areas are not anticipated to have an effect on monitoring the new facility. Additional monitoring points are discussed in the environmental monitoring plan presented in Section 4 of this report.

The groundwater contour map also supports monitorability of the site since flow will essentially be perpendicular to the contours. The flow direction indicates the proposed site can be monitored independently of the existing landfill.

In 1985, the Health Department sampled the unnamed stream to verify if the waters of the unnamed stream and of Trout Brook were being degraded. A sample was taken of the unnamed stream and two of Trout Brook, one upgradient and one downgradient of the unnamed streams confluence with Trout Brook. Results of the analyses indicated no significant impact on Trout Brook by the unnamed creek. The analyses indicate that the pH in Trout Brook above the confluence with the creek is much more alkaline (basic) than waters in the creek. The mixing of the two streams lowers the pH of Trout Brook water thereby improving the quality of Trout Brook (CCHD, 1985).

3.2.5.3 Groundwater Levels

Since May, 1988, B&L has measured the water levels in the 38 existing monitoring wells and 8 temporary wells located in test pits, Tables E-1, 2, 3 and 4. The database generated, combined with water level measurements from historic data, were used to generate Drawings 8, 8A, 9 and 9A. Drawings 8 and 8A represent the groundwater table surface within the glacial till, and Drawings 9 and 9A represent the piezometric (or potentiometric) surface of the bedrock. Drawings 8A and 9A represent a contoured water level surface of the highest recorded water levels at a given location during the period of record for the respective screened geologic unit. These contoured surfaces do not represent actual or potential field conditions, rather they illustrate the most extreme condition at each measurement location and may not reflect a true groundwater surface condition at any point in time.

The groundwater table and piezometric surfaces as mapped are sensitive to changes in recharge (from precipitation) as evidenced by the drop in water levels during the low precipitation months. Therefore, the proposed landfill development is likely to alter these surfaces since the recharge through incident rainfall to the glacial till and bedrock will be virtually eliminated over the landfill footprint area by the liner system. In addition, where site drainage and grading improvements reduce surface water percolation, a corresponding reduction in net recharge should be observed in subsequent water level measurements. Noteworthy is the construction of a drainage ditch excavated to the top of rock and eventually below it (the ditch deepens with the development of the shale borrow area) between the borrow areas and the western limit of the landfill. This ditch will intercept surface water runoff and any lateral groundwater flow to the depth of the ditch and convey this flow to a detention pond.

Based on the geometric mean of in-situ variable head permeability tests conducted for Phase I on both the glacial till (9.1×10^{-7} cm/sec) and top of bedrock (1.3×10^{-6} cm/sec), it can be concluded that a marginal permeability contrast exists between the two geologic units. Therefore, the glacial till confinement of the bedrock is limited, and the bedrock piezometric surface is essentially a representation of head loss (recharge condition) or gain (discharge condition) across the thickness of the glacial till. By superimposing the glacial till groundwater table surface over the bedrock piezometric surface, a recharge/discharge boundary may be defined. Such a boundary marks the limit where the glacial till recharges the bedrock and the bedrock begins discharging through the till.

Monitoring well couplet locations MW-11A & B and MW-5A & B are contiguous to the proposed landfill development area and below the discharge boundary. The wells have a head differential of about .5 feet between the bedrock and overburden. Monitoring Well MW-12A has showed a continuous increase in water level to the extent that the bedrock water elevation reflects an artesian condition. The bedrock water level is 3.5 to 4.5 feet above the overburden water level. These gradients indicate that the recharge/ discharge boundary transects a portion of the proposed landfill (Phase I) on the eastern side. Stronger upward vertical gradients can be observed closer to the center line of the valley (adjacent to the Pine Tree site). These gradients result in flowing artesian conditions in Monitoring Wells D2, D3 and sometimes D6. Upward discharging gradients would be expected within the lower portions of the valley as flow lines originating from opposing slopes converge and are forced to the surface by less pervious bedrock beneath the top of bedrock zone.

3.2.5.4 Flow Direction

The horizontal flow direction across the proposed site is primarily from west to east and northwest to southeast (Sheets 8 and 9). The horizontal flow direction would, in general, be perpendicular to the groundwater contours (Sheets 8, 8A, 9 and 9A). The vertical flow component associated with the horizontal flow varies with the magnitude of the vertical gradient. Vertical gradients vary from near unity in the recharge areas (top of ridges) to negative or upward gradients of approximately 0.15 feet/foot in discharge areas (valley floor). Beneath the proposed landfill development area vertical gradients range from slightly greater than zero (recharge) to slightly below zero (discharge). Monitoring Well couplets MW-12, MW-11 and MW-5 have measured vertical discharge gradients of 0.093 feet/foot (January and March); 0.023 and 0.007 feet/foot, respectively. Monitoring Well triplet MW-7 has a vertical recharge (downward) gradient of 0.072 feet/foot for the bedrock and deep overburden well and 0.085 feet/foot between the bedrock and shallow overburden well. Horizontal gradients within the landfill development area average approximately 0.1 feet/foot; therefore, horizontal flow will dominate the flow direction beneath the proposed landfill. Furthermore, any contaminants released from the west side of the landfill (upgradient side) are likely to follow a flow path (perpendicular to the groundwater contours) that will initially take a downward trend (under slight recharge conditions) until the recharge/discharge limit is passed. Upon reaching the recharge/discharge limit, the contaminant will begin moving upward and horizontally, in response to the increasing upward vertical gradient, to the point of discharge along the unnamed stream. Noteworthy is that the critical sections (i.e., leachate pipe liner penetrations) of the liner system will be within the southeast corner of the proposed landfill development area which is also the area where discharge conditions are strongest. Therefore, any leakage will be collected along with the seepage entering the underdrain system. The underdrain system, as well as designated wells and surface water locations, will be routinely monitored according to the environmental monitoring plan.

It can be concluded that the groundwater flow conditions as described above are favorable to the landfill development since these conditions establish a shallow critical hydrogeologic section which will:

- promote monitorability given horizontal flow predominates directly beneath the proposed facility;

- restrict the majority of groundwater flow to the top-of-rock fractured zone which discharges a relatively short distance (1,000 feet) downgradient through the glacial till;

- effectively forms a hydraulic barrier at the unnamed stream thereby limiting the potential groundwater contamination to a relatively small area west of the stream in the vicinity of the landfill; and

- limit potential contaminant flow, originating from the proposed landfill, to the local groundwater flow regime, thereby limiting potential contaminant flow from entering a regional groundwater flow regime.

To Be Sampled Annually

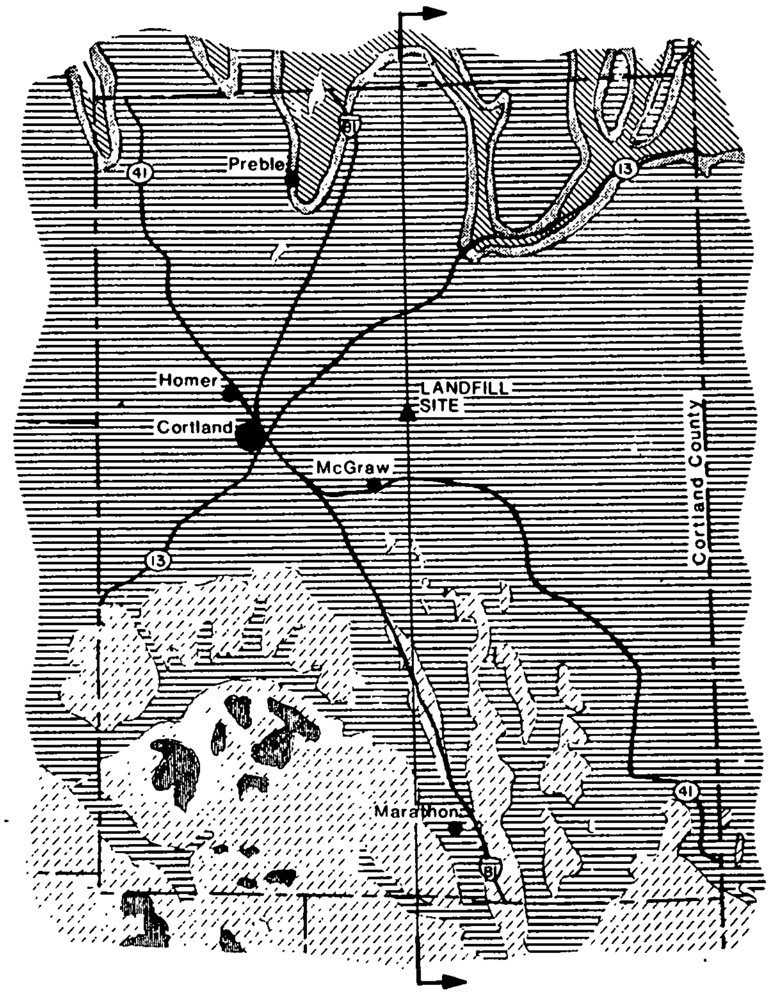
TABLE 3-1
WATER WELL SURVEY

LOCATION NO.	OWNER/ADDRESS	PARCEL	TOWN	REMARKS
1	William MacClean 2446 E. River Road Cortland, New York 13045	69.00-01-17	Solon	Upgradient (Demolished)
2	James McGuinness 2911 Heath Road McGraw, New York 13101	78.00-01-40	Cortlandville	– Sample
3	William MacClean 2446 E. River Road Cortland, New York 13045	79.00-01-02.1	Cortlandville	(Abandoned)
4	Robert Doran R.D. #1 McGraw, New York 13101	79.00-01-5.1	Cortlandville	Seasonal (No Well)
5	William MacClean R.D. #1 McGraw, New York 13101	79.00-01-2.1	Cortlandville	Seasonal (No Well)
6	Donald Henry McGraw, New York 13101	79.00-01-22.1	Solon	(Demolished)
7	Howard Henry 4411 Soshinsky Road McGraw, New York 13101	79.00-01-23.0	Solon	
8	Kevin Seaman Soshinsky Road McGraw, New York 13101	79.00-01-24.2	Solon	~~(Demolished)~~
9	Joan Furlin R.D. #1, Box 123 Bloomingburg, New York	79.00-01-36.0	Solon	(House Demolished)
10	Soshinsky Farms R.D. #1, Soshinsky Road McGraw, New York 13101	89.00-01-01	Solon	
11	Soshinsky Farms R.D. #1, Soshinsky Road McGraw, New York 13101	89.00-01-01	Solon	
12	William Rogers R.D. #1, Box 493 4340 McGraw North Road McGraw, New York 13101	78.00-01-38	Cortlandville	
13	John R. Soshinsky R.D. #1 Soshinsky Road McGraw, New York 13101	89.00-01-01	Solon	

TABLE 3-1 (continued)
WATER WELL SURVEY

LOCATION NO.	OWNER/ADDRESS	PARCEL	TOWN	REMARKS
14	John R. Soshinsky R.D. #1 Soshinsky Road McGraw, New York 13101	89.00-01-01	Solon	
15	Louis Cranson R.D. #1, Maybury Road McGraw, New York 13101	79.00-01-01	Solon	
16	Donald Henry McGraw, New York 13101	79.00-01-22.1	Solon	

NOTE: Water well survey performed for the area within the hydrologic boundaries shown on Sheet 3 of the Engineering Design drawings.



LEGEND

PALEOZOIC

Upper Devonian

WEST FALLS GROUP

Dwm — Beers Hill Shale, Grimes Siltstone, Dunn Hill, Millport and Moreland Shales.

SONYEA GROUP

Ds — Middlesex Shale

GENESEE GROUP AND TULLY LIMESTONE

Dg — Ithaca, Renwick Shale and Sherburne Flagstone, and Geneseo Shale Members – shale and siltstone

Middle Devonian

Dt — Tully Limestone.

HAMILTON GROUP

Dhmo — Moscow Formation – Cooperstown Shale Member, Portland Point Limestone Member.

NOTE:
1. See Figure 2 for Regional Geologic Section.

NORTH

0 1 2 3 4 5 Miles

Scale 1:250,000

Source:

Geologic Map of New York - 1970 Finger Lakes sheet, New York State Museum and Science Service, Map and Chart Series No. 15.

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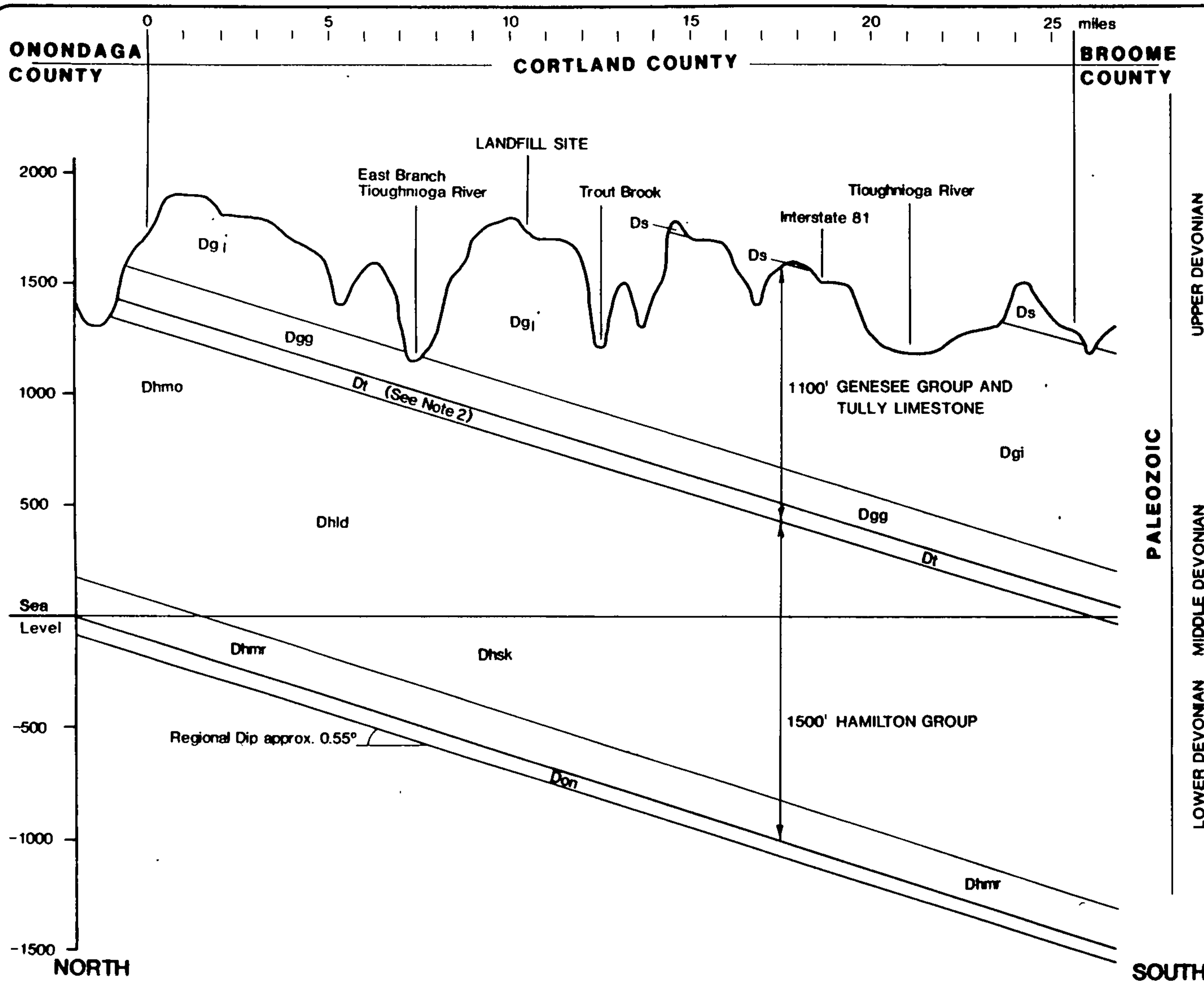
CORTLAND COUNTY LANDFILL
WEST SIDE EXTENSION

BEDROCK GEOLOGY

Figure 3-1

Project No. 331.02



NOTES:
1. See Figure 1 for location of section.
2. Thickness of formations enlarged for visual presentation. Unit is approximately 20 ft. thick in Tully area (deWitt & Cotton, 1978).

PALEOZOIC

GEOLOGIC COLUMN

UPPER DEVONIAN

WEST FALLS GROUP

Dwm — Beers Hill Shale, Grimes Siltstone, Dunn Hill, Millport and Moreland Shales

SONYEA GROUP

Ds — Middlesex Shale

GENESEE GROUP AND TULLY LIMESTONE DG

Dgi — Ithaca, Renwick Shale, Sherburne Flagstone Members

Dgg — Geneseo Shale Member

MIDDLE DEVONIAN

Dt — Tully Limestone

HAMILTON GROUP

Dhmo — Moscow Formation – Shale, limestone

Dhld — Ludlowville Formation – Shale, limestone

Dhsk — Skaneateles Formation – Shale, limestone

Dhmr — Marcellus Formation – Shale

LOWER DEVONIAN

ONONDAGA LIMESTONE

Don — Onondaga Limestone

HELDERBERG GROUP

Dhg — Coeymans and Manlius Limestone, Roundout Dolostone

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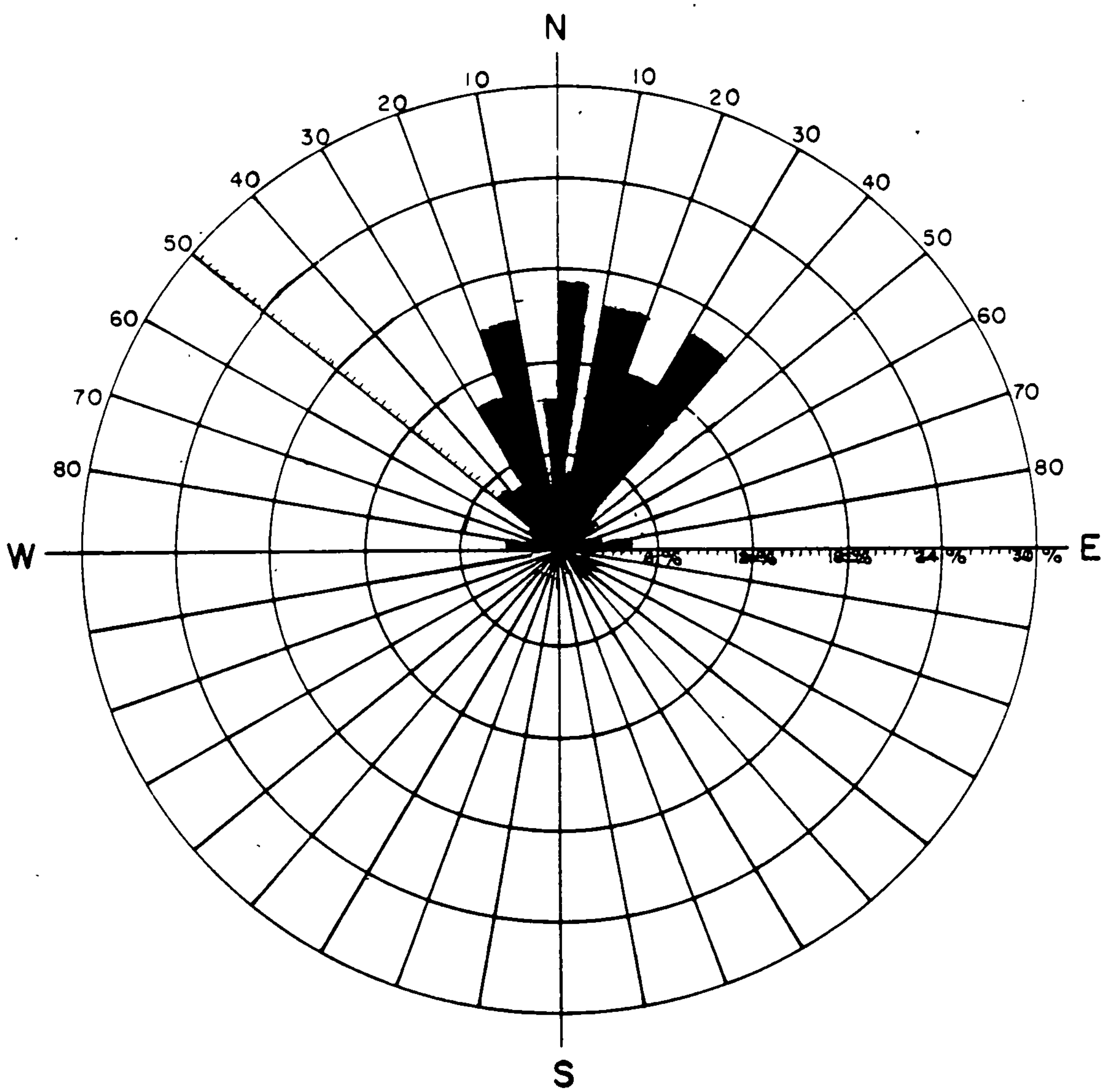
CORTLAND COUNTY LANDFILL
WEST SIDE EXTENSION

REGIONAL GEOLOGIC CROSS SECTION

Figure 3-2

Project No. 331.02



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CORTLAND COUNTY LANDFILL
WEST SIDE EXTENSION

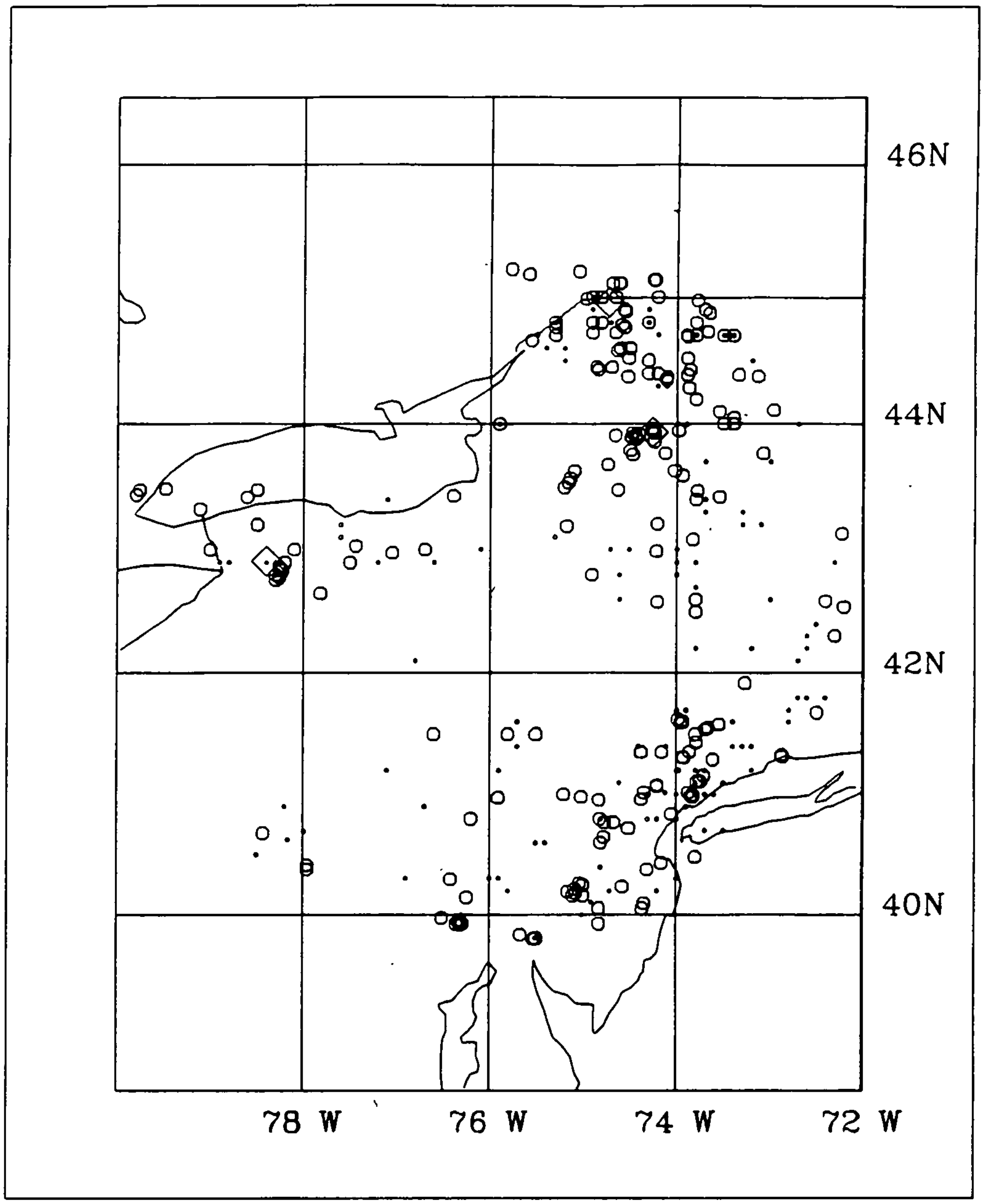
LINEATION STUDY

Figure

3-3

Project No.

331.02



Computer graphics by Roger N. Hunter, Geophysicist

MAGNITUDES:

0 . 1 o 2 o 3 o 4 o 5 ◇

U. S. Geological Survey, National Earthquake information center
Data taken from the Earthquake Data Base System

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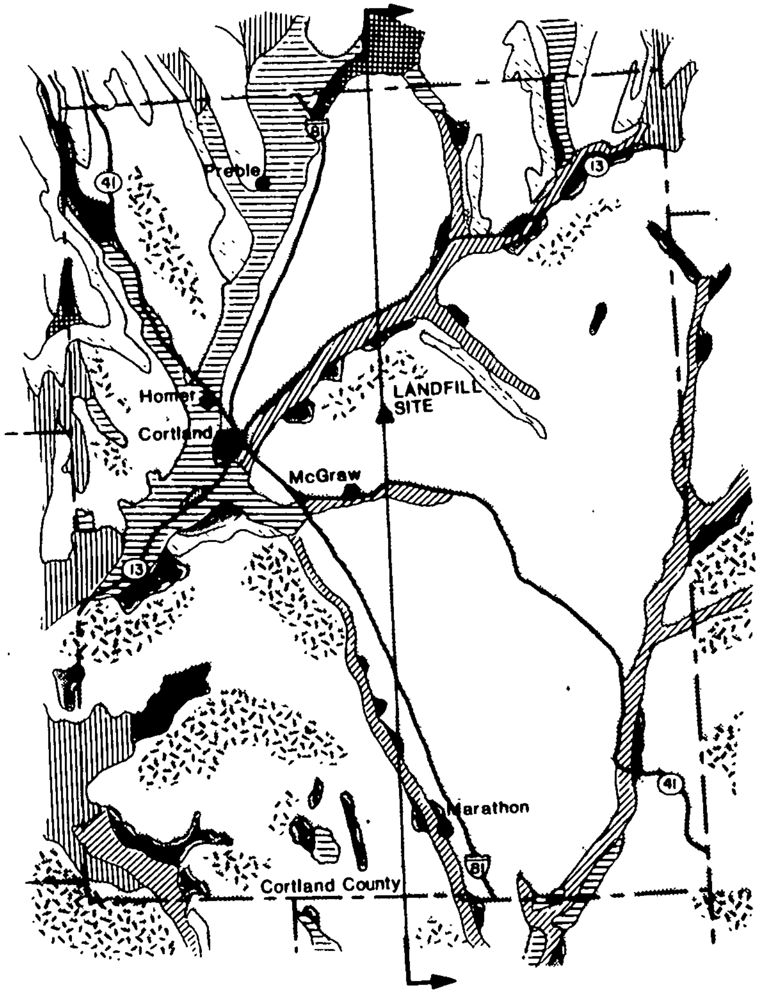
CORTLAND COUNTY LANDFILL
WEST SIDE EXTENSION

EARTHQUAKE MAGNITUDES

Figure 3-4

Project No. 331.02



LEGEND

al – Recent deposits – Generally confined to floodplains within a valley, oxidized, non-calcareous, fine sand to gravel, in larger valleys may be overlain by silt, subject to frequent flooding, thickness 1-10 meters.

lsc – Lacustrine silt and clay – Generally laminated clay and silt deposits in proglacial lakes, generally calcareous, potential land instability, thickness variable (up to 50 meters).

og – Outwash sand and gravel – Coarse to fine gravel with sand, proglacial fluvial deposition, well-rounded and stratified, generally finer texture away from ice border, thickness variable (2-20 meters).

k – Kame deposits – Includes kames, eskers, kame terraces, kame deltas, coarse to fine gravel and/or sand, deposition adjacent to ice, lateral variability in sorting, coarseness and thickness, locally firmly cemented with calcareous cement, thickness variable (10-30 meters).

km – Kame moraine – Variable texture (size and sorting) from boulders to sand, deposition at a ice margin during deglaciation, locally cemented with calcareous cement, thickness variable (10-30 meters).

tm – Till moraine – Much like till, but more variable in sorting, generally more permeable than till, deposition adjacent to ice, more variably drained, may be ablation till, thickness variable (10-30 meters).

t – Till – Variable texture (e.g. clay, silt-clay, boulder clay), usually poorly sorted diamict, deposition beneath glacier ice. Within the site area, till varies from brown to gray in color, clayey silt and fine sand matrix with embedded fine to coarse gravel and sand. Boulders and cobbles frequently encountered. Thickness variable (1-50 meters).

r – Bedrock – Exposed or within 1 meter of surface, the following types of rock are typically exposed: Paleozoic shale and siltstone.

Bedrock stipple overprint – bedrock may be within 1-3 meters of surface, may sporadically crop out, variable mantle of rock debris and glacial till.

NORTH

0 1 2 3 4 5 Miles

Scale 1:250,000

Source:

Surficial Geology Map of New York - 1986, Finger Lakes sheet, E. Miller and D. Cadwell, New York State Museum and Science Service, Map and Chart Series No. 40.

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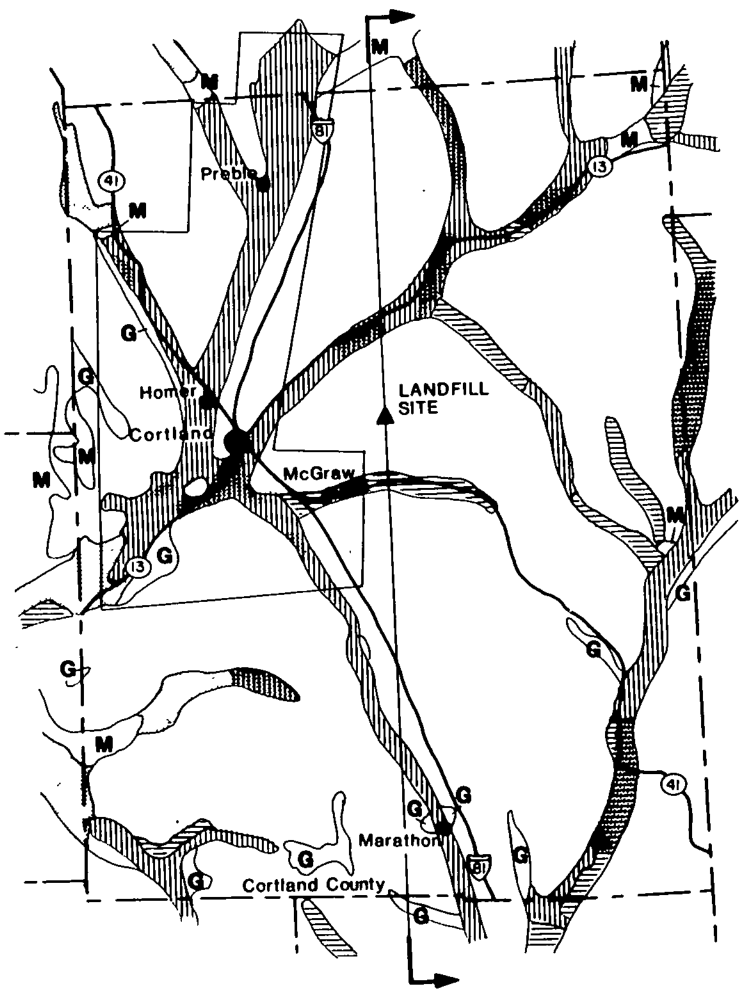
CORTLAND COUNTY LANDFILL
WEST SIDE EXTENSION

SURFICIAL GEOLOGY

Figure 3-5

Project No. 331.02



LEGEND

POTENTIAL YIELD OF WATER FROM WELLS THAT TAP UNCONSOLIDATED AQUIFERS

UNCONFINED AQUIFER, 10 TO 100 GALLONS PER MINUTE--Sand and gravel with saturated zone generally less than 10 ft. thick, or thicker but with less permeable silty sand and gravel. Yields in areas adjacent to streams may exceed 100 gal/min through pumping-induced infiltration, but these areas are too small to show at this scale.

UNCONFINED AQUIFER, MORE THAN 100 GALLONS PER MINUTE—Sand and gravel of high transmissivity and with saturated thickness greater than 10 ft. Many such areas area associated with a surface-water source that can provide pumping-induced recharge.

CONFINED AQUIFER, 5 TO MORE THAN 500 GALLONS PER MINUTE--Areas where a relatively impermeable till, very fine sand, silt, or clay layer seperates the buried sand and gravel aquifer from an overlying surficial aquifer.

CONFINED AQUIFER, 5 TO MORE THAN 500 GALLONS PER MINUTE--Sand and gravel overlain by till, very fine sand, silt, or clay, but without a surficial aquifer.

G Kame, kame terrace, outwash, or alluvium.--Sand and gravel of unknown thickness or saturation. Yield potential is greater where streams are present.

M Moraine.--Mostly till and lacustrine deposits (fine sand, silt, and clay) capped in some places with unsaturated sand and gravel. Thin, scattered confined aquifers of sand and gravel in some places.

CORTLAND - HOMER - PREBLE Primary Water Supply Aquifer--A highly productive aquifer that is being used as a source of water supply by major public water supply systems.

NORTH

0 1 2 3 4 5 Miles

Scale 1:250,000

Source:

Unconsolidated Aquifers in Upstate New York - Finger Lakes sheets - 1988, Finger Lakes sheet, T. S. Miller, United States Department of the Interior - Geological Survey, Water-Resources Investigations Report 87-4122.

BARTON & LOGUIDICE, P.C.

CORTLAND COUNTY LANDFILL
WEST SIDE EXTENSION

UNCONSOLIDATED AQUIFERS

Figure 3-6

Project No. 331.02

SECTION 4

4.0 ENVIRONMENTAL MONITORING PROGRAM

4.1 Introduction

The environmental monitoring plan describes the proposed on-site monitoring for all environmental and facility monitoring points. The monitoring plan includes the sampling schedule, method of sample collection and preservation, chain-of-custody documentation, list of analyses to be performed, analytical and statistical methods, and reporting requirements. Baseline groundwater analyses were performed during the field investigations and are discussed in Section 3.2.4 of this report. This plan was prepared for Phase I development and will be modified for Phase II development.

4.2 Monitoring Points

4.2.1 Groundwater

There are 27 existing monitoring wells that presently provide data for the proposed site. Four of these, D5, D6, RE-7 and RE-8 are also related to monitoring the existing Pine Tree site, 14 will be destroyed by construction activities and two are too distant. Monitoring Wells MW-1A, 1B, 11A, 11B, 12A and 12B were selected for permanent monitoring points based on their locations. Monitoring Well MW-1A and 1B are designated as upgradient bedrock (A) and overburden (B) wells. Monitoring Wells MW-11A, 11B, 12A and 12B are designated as downgradient wells.

After construction and prior to operation, an additional three downgradient well couplets (MW-13A, 13B, 14A, 14B, 15A and 15B) should be installed at the locations shown on Sheet 37. During Phase I operation, Monitoring Well MW-8A and the landfill water well should be used as additional upgradient bedrock monitoring points. Monitoring Well MW-8A will be destroyed by borrow activities during Phase II operation but will provide data during Phase I operation.

Installation of the new monitoring wells should provide for monitoring of the bedrock from 3 to 15 feet below the soil/rock interface and the overburden soil from the liner subgrade to 10 feet below the subgrade.

perhaps deeper & [illegible] closer

A total of fourteen wells will be monitored during Phase I development of the landfill, but only ten will be sampled during Phase IA operation. Monitoring Wells MW-12A & 12B and MW-1A and 1B will not be sampled until Phase IB construction is initiated. During the Phase I operation period, monitoring of the existing "Pine Tree" site will also continue, and additional data from the four wells (RE-7, RE-8, D-5 and D-6) can be entered in the data base for the analyses. Table 4-1 summarizes the sampling methodology.

Tighter To site control

4.2.2 Surface Water

Five surface water sampling points (SW-1, 2, 3, 4 and 5) are proposed in the vicinity of the site (Sheet 37). All monitoring points are within the property owned by the County. The open channel monitoring points will be monumented such that replication of sampling locations are possible. Table 4-1 summarizes the sampling methodology.

Samples SW-1, 2 and 3 will sample surface water stream flow from upgradient (SW-1 and 2) and downgradient (SW-3) of the proposed facility. Two upgradient samples are proposed to provide one background sample upgradient of possible influence of the existing Pine Tree site and existing closed landfill and the other immediately upgradient of the proposed facility to determine possible influence of the existing landfills. / good

Sample SW-4 will be taken from the underdrain collection pipe in the manhole south of the landfill limits. Sample SW-5 will be taken from the 6-inch discharge line from the leachate tank underdrain.

4.2.3 Leachate

Two leachate sampling points (LT-1 and LT-2) are proposed. Sampling of the primary collection pipe (LT-1) and secondary collection pipe (LT-2) will be performed in the dry manhole south of the landfill limits. Samples will be drawn through sampling ports provided in the collection pipes. Locations of the sampling points are shown on Sheet 37, and Table 4-1 summarizes the sampling methodology.

4.2.4 Methane Gas

A series of 17 air monitoring points (AA-1 to 17) are proposed around the perimeter of the landfill and selected points within the property boundary. These air monitoring points will be monumented such that replication of the sampling locations are possible. Location of the monitoring points are shown on Sheet 37. Table 4-2 summarizes the sampling methodology. Monitoring of methane gas will commence when portions of the landfill are put into final closure but not exceeding 2 years from initial waste placement. Monitoring will be on a quarterly basis.

Monitoring Points AA-2, 6 and 7 have two monitoring points at each location. Monitoring Point AA-2 has one test at ground level (AA-2) and one test from the gas well (GW-1). Monitoring Points AA-6 and 7 are sampling manholes. One test is taken upwind from the manhole at ground level and the second at the base of the manhole. Monitoring inside the manhole is also for personal protection prior to sampling the water or leachate.

If a monitoring point exceeds the 25% lower explosive limit (LEL) stipulated in Part 360-2.15 additional sampling will be performed on a 50 foot grid to determine the source of the gas. Additional gas vents may be installed as needed to effectively dissipate gas at an acceptable level (see Contingency Plan Section 3.4). Exceedance of 25% LEL for the manhole samples does not require additional air quality sampling.

Since methane gas may move in any direction, all sampling points are considered downgradient.

Only one gas monitoring well is proposed since the proposed landfill will have permeable layers above and below the refuse and gas vents in the cap. The movement of gas is also restricted by the saturated soil conditions below the liner system. Gas wells may be installed later at locations identified from the gas monitoring program.

4.3 Sampling Schedule

4.3.1 Water Quality

4.3.1.1 Existing Water Quality

Sampling for existing water quality was performed on October 7, 1988, with a second round of sampling on

November 28, 1988. Both sampling events were analyzed for baseline parameters. Results of the laboratory analyses are presented in Section 3.2.5.2 and Appendix D of the Hydrogeologic Report. Quarterly monitoring of the wells will be performed through construction at which time operational water quality monitoring will be initiated.

BTX

Due to the presence of toluene in the bedrock wells, the existing water quality sampling events will include EPA Method 602 as part of the routine sampling for Monitoring Wells MW-1A, 11A and 12A. Pre-operational testing for all other wells will be according to Table 4-3.

4.3.1.2 Operational Water Quality

Sampling will be performed quarterly for the designated water quality sampling points during operation and closure of the facility. Baseline water quality analyses will be performed on an annual basis with routine water quality analyses performed for the remaining three quarters. The baseline analyses will be rotated to a different quarter each year. Table 4-3 presents the proposed schedule of water quality sampling through Phase I development and five years of closure. The requirements for subsequent analyses will be determined at the end of each five year period after closure by the NYSDEC. The environmental monitoring points must be maintained and sampled during the post closure period for a minimum of 30 years.

If contamination is found, the contingency monitoring program should be followed.

4.3.1.3 Contingency Water Quality

The contingency water quality monitoring plan is conducted when landfill derived contamination is found. The contingency plan may be modified by the NYSDEC at any time. The contingency monitoring plan will modify the operational or closure monitoring plans to include additional parameters or more frequent analyses or both. Once initiated, the contingency water quality monitoring must be continued until the elevated parameter(s) is shown not to be landfill-derived, the release by the landfill has been remediated, NYSDEC approves that the monitoring is no longer needed to protect the public health or the environment.

If contamination for one or more routine parameters is found:

a. Baseline analyses will be performed for those monitoring points at the next quarterly sampling. If the contamination detected by the baseline poses an immediate threat to public health or the environment as determined by the NYSDEC, additional and/or more frequent sampling may be required as part of a corrective action plan approved by the NYSDEC.

b. Subsequent sampling and analysis for baseline parameters will be conducted at least semi-annually until the previously stated conditions are met to stop the contingency plan.

If during analysis for baseline parameters, contamination by any toxic metal, cyanide, volatile organic compound or other substance identified in Appendix 33 of 6 NYCRR part 373-2 is found:

a. Affected monitoring points will be analyzed for the expanded parameters excluding dioxin and furans in the next quarterly sampling event.

b. Subsequent annual analyses will be for the expanded parameters and quarterly analyses for routine parameters plus those baseline and expanded parameters that were elevated or implicated in the expected pattern of contamination. More frequent sampling to evaluate potential or adverse environmental impact or perceived health risk may be requested by the NYSDEC. Revised sampling and analyses schedule will remain in effect until the conditions are met to stop the contingency plan.

NYSDEC may require initiation of specific contingency water quality monitoring based on landfill containment failure.

4.3.2 Methane Gas

The ambient air quality monitoring will be performed on a quarterly basis at the same time the water quality monitoring is performed. Should more frequent water quality monitoring be required, methane gas sampling will remain at quarterly intervals except for those areas where personal safety to perform water quality sampling or maintenance requires air quality monitoring.

4.4 Sampling Procedures

4.4.1 Groundwater Sample Collection

Each monitoring well is equipped with a dedicated bailer. This is used both for well purging and for sampling. The following general procedure should be used:

- Sampling will be conducted in sequence from upgradient background wells to the downgradient wells, or from least contaminated to most contaminated in order to minimize any potential cross contamination.

- Inspect each well for any visible damage to the well casing or seal.

- Measure and record the static water level in each well. The volume of water required to purge three well volumes from the well can be determined using Table 4-4.

- Purge each well of at least three volumes of water or evacuate completely at least once, depending on the well hydraulics. Periodic measurements of Specific Conductance, Temperature and pH during purging can, on the attainment of stabilized readings, indicate that all stagnant water has been removed and replaced by fresh formation water.

- Measure and record the field determined parameters: Oxidation-Reduction Potential (Eh), Temperature, Specific Conductance, pH. Also note the general sample appearance: turbidity, color, sediment, immiscible components, odor.

- Volatile organics analyses samples must be free of air bubbles. Bottles must be gently filled to overflowing, tightly capped, inverted and inspected. If any bubbles can be seen in the sample, the bottle must be emptied and refilled. When a bubble-free sample has been obtained, it must be immediately chilled.

- Samples for metals analysis should be taken in duplicate. One sample should be filtered in the field through a 0.45 micron membrane filter prior to preservation; the metals results for this sample would be expressed as "dissolved". The other sample ("total") should be whole and unfiltered. No other samples should be filtered.

- Fill the necessary number of prepared, pre-labelled sample bottles with groundwater samples. Pack the filled sample bottles in a cooler chest for transportation to the laboratory using ice if ambient air temperatures are above 40°F.

- Complete the field sampling data sheet, chain-of-custody form, and any other notes in the field sampling logbook.

4.4.2 Surface Water Sample Collection

The surface water monitoring points are located in small streams. Grab samples should be collected near the mid-stream point, just below the water's surface, where the flow is most rapid and the stream is well mixed. The samples should be collected directly into the sample bottle if possible, or an intermediate sampling container such as a pre-cleaned wide mouth glass jar should be used. The following general procedure should be used:

- Sampling will be conducted in sequence from the most downstream monitoring point to the most upstream monitoring point, in order to minimize any potential cross contamination.

- Before collecting the actual sample, the sampler shall rinse his gloves and the intermediate sampling container three times in the stream before moving a couple feet upstream to collect the sample.

- Measure and record the field determined parameters: Oxidation-Reduction Potential (Eh), Temperature, Specific Conductance, pH, Dissolved Oxygen. Also note the general sample appearance: turbidity, color, sediment, immiscible components, odor.

- Duplicate samples for metals analysis should be collected as noted above, one filtered and the other unfiltered.

- Fill the necessary number of prepared, pre-labelled sample bottles with surface water samples. Wipe dry and pack the filled sample bottles in a cooler chest for transportation to the laboratory using ice if the temperature is above 40°F.

- Complete the field sampling data sheet, chain-of-custody form, and any other notes in the field sampling logbook.

4.4.3 Leachate Sample Collection

Samples from the leachate collection system should be obtained with dedicated intermediate containers into which the leachate can be drained from the sampling port in the primary and secondary collection pipes. Low flows in the secondary line may necessitate leaving the container for a period of time in order to obtain sufficient sample. Care should be exercised in handling leachate samples; all samplers, filter equipment and field measurement probes should be thoroughly cleaned after use at each monitoring point. The following general procedure should be used:

- Leachate sampling should follow all other sampling at the facility.

- Record the rate at which the intermediate container is filled. Do not overfill the container.

- Measure and record the field determined parameters: Oxidation-Reduction Potential (Eh), Temperature, Specific Conductance, pH. Also note the general sample appearance: turbidity, color, sediment, immiscible components, foaming, odor.

- Duplicate samples for metals analysis should be collected as noted above, one filtered and the other unfiltered.

- Carefully fill the necessary number of prepared, pre-labelled sample bottles with leachate samples. Clean, wipe dry and pack the filled sample bottles on ice in a cooler chest for transportation to the laboratory.

- Complete the field sampling data sheet, chain-of-custody form, and any other notes in the field sampling logbook.

4.4.4 Gas Sample Collection

Samples for gas monitoring should be collected in accordance with the directions given in the operators manual supplied with the particular equipment selected to perform the sampling.

4.4.5 Water Supply Well Sample Collection

Water supply wells are those wells that supply water for household or other domestic, agricultural or industrial purposes. These will typically have pumps installed, but for abandoned dwellings, the pump may have been removed and a portable generator and submersible pump may be required.

To sample the well, the pump should be allowed to run continuously for 15 minutes or until three times the well volume has been withdrawn. Sampling should be done from an outside valve or other suitable sampling point being sure that water is directly from pump and does not flow through water heaters, softeners or other filtration devices.

Sampling should follow typical procedures for collection, preservation, documentation, reporting, etc., as established in Sections 4.4.1, 4.5 and 4.7.

4.5 Sample Preservation

To insure the integrity of the water quality samples during transportation from the field to the laboratory, the U.S. EPA and NYSDEC guidelines for sample containers, preservatives and maximum holding times should be observed (Table 4-5).

No samples are retained from the air monitoring program.

4.6 Laboratory Analyses

The field and laboratory determined parameters for expanded, baseline and routine water quality analyses are listed in Table 4-6. Due to the presence of toluene in the existing baseline analyses, an EPA Method 601 test will be performed as part of the routine analyses for bedrock wells MW-1A, 11A and 12A until the toluene is not detected for two consecutive sampling events.

4.7 Documentation and Reporting

4.7.1 Field Sampling Data

The following information should be recorded for each monitoring point:

- General:
  - project ID
  - personnel ID
  - sample location ID
  - weather conditions
  - date and time

- Well Data:	- casing diameter - static water level - reference datum - well depth (reference data) - volume of water in well - condition of well
- Purging Data:	- method - dedicated equipment? - volume purged, duration - well evacuated (bailed dry)? - well volumes purged
- Sampling Data:	- method - dedicated equipment? - sample filtration - number and type of containers - preservatives used
- ~~Field Determinations~~:	- ~~general appearance~~ color, odor ~~- chemical parameters measured~~
- Sample Handling:	- sample distribution - transportation method - date and time of delivery

These data should be recorded in the field on a field data sheet or in a sampling logbook. If a logbook is used, a separate data sheet containing the same information should be prepared to accompany the laboratory analysis results.

4.7.2 Chain-of-Custody

The following information should, at a minimum, be included on the chain-of-custody record:

- Project ID
- Sample Location
- Containers: number, type and condition
- Signature of person(s) maintaining custody
- Inclusive dates of possession

4.7.3 Quality Control

All field equipment used for field determination of chemical or physical parameters must be calibrated immediately prior to use. After use at each monitoring point, the probes and apparatus must be thoroughly rinsed with distilled water, cleaned using appropriate chemicals, rinsed with distilled water and rinsed again with water from the next sampling point prior to contacting any water that will be bottled and submitted for analyses.

Good

At least one field (trip) blank must be included on each scheduled sampling event. In addition, a duplicate sample from a selected monitoring point should be submitted with every sampling event. This sample should be submitted to an independent laboratory for analyses for verification results.

The analytical laboratories must be NYSDEC approved, and must maintain and utilize proper internal QA/QC procedures.

4.7.4 Reporting of Data

The monitoring results consist of the field sampling data sheet, the chain-of-custody form, and the laboratory analysis report. The latter should include:

- Sample location designation
- Sample collection date
- Analytical results
- Method Detection Limits (MDL)
- Applicable NYSDEC water quality standards or guidance values
- Annotation if compounds detected (even if below MDL)
- Chemical Abstracts Service (CAS) numbers of all compounds

The results of analyses for each round of sampling will be forwarded to NYSDEC within ~~30 days of~~ receipt.

An annual summary report will be prepared, including additional tables, diagrams or graphs indicating temporal or spatial trends in water quality, comparisons of background and existing water quality, and a discussion of contraventions of water quality standards or statistically significant elevations of parameters above background concentrations.

TABLE 4-1
SAMPLING METHODOLOGY
WATER QUALITY

SAMPLE ID	SAMPLE POINT	SAMPLE TYPE	METHOD OF SAMPLING	REASON FOR SAMPLING
Phase IB MW-1A	Bedrock Well	Groundwater	Dedicated Bailer	Upgradient Water Quality
MW-1B	Overburden Well	Groundwater	Dedicated Bailer	
MW-8A	Bedrock Well	Groundwater	Dedicated Bailer	
MW-11A	Bedrock Well	Groundwater	Dedicated Bailer	Downgradient Water Quality
MW-11B	Overburden Well	Groundwater	Dedicated Bailer	
Phase IB MW-12A	Bedrock Well	Groundwater	Dedicated Bailer	
MW-12B	Overburden Well	Groundwater	Dedicated Bailer	
MW-13A	Bedrock Well	Groundwater	Dedicated Bailer	
MW-13B	Overburden Well	Groundwater	Dedicated Bailer	
MW-14A	Bedrock Well	Groundwater	Dedicated Bailer	
MW-14B	Overburden Well	Groundwater	Dedicated Bailer	
MW-15A	Bedrock Well	Groundwater	Dedicated Bailer	
MW-15B	Bedrock Well	Groundwater	Dedicated Bailer	
SW-1	Open Channel	Surface Water	Grab	Upgradient Water Quality
SW-2	Open Channel	Surface Water	Grab	
SW-3	Open Channel	Surface Water	Grab	
SW-4	Manhole-Underdrain Collection Pipe	Seepage Water	Grab	Downgradient Water Quality
SW-5	Leachate Tank Underdrain Pipe	Seepage Water	Grab	
LT-1	Manhole Primary Collection Pipe	Leachate	Grab	Leachate Characterization
LT-2	Manhole Secondary Collection Pipe	Leachate	Grab	
WW-1	Bedrock Well	Groundwater	Submersible Pump	Upgradient Water Supply Well

TABLE 4-2

SAMPLING METHODOLOGY
METHANE GAS

SAMPLE ID	SAMPLE POINT	SAMPLE TYPE	METHOD OF SAMPLING	REASON FOR SAMPLING
AA-1	Office Trailer	Ambient Air	PGM+	Downgradient
AA-2	Maintenance Bldg.	Ambient Air	PGM	Downgradient
AA-3	Monitoring Well	Ambient Air	PGM	Downgradient
AA-4	Monitoring Well	Ambient Air	PGM	Downgradient
AA-5	Monitoring Well	Ambient Air*	PGM	Downgradient
AA-6A	Leachate Manhole	Ambient Air*	PGM	Downgradient
AA-6B	Leachate Manhole	Manhole Airspace	PGM	Downgradient
AA-7A	Underdrain Manhole	Ambient Air*	PGM	Downgradient
AA-7B	Underdrain Manhole	Manhole Airspace	PGM	Downgradient
AA-8	Leachate Underdrain	Ambient Air	PGM	Downgradient
AA-9	Surface	Ambient Air		
AA-10	Monitoring Well	Ambient Air	PGM	Downgradient
AA-11	Surface	Ambient Air	PGM	Downgradient
AA-12	Monitoring Well	Ambient Air	PGM	Downgradient
AA-13	Surface Water Monitoring Point	Ambient Air	PGM	Downgradient
AA-14	Surface Water Monitoring Point	Ambient Air	PGM	Downgradient
AA-15	Surface Water Monitoring Point	Ambient Air	PGM	Downgradient
AA-16	Access Gate	Ambient Air	PGM	Downgradient
AA-17	Monitoring Well	Ambient Air	PGM	Downgradient
GW-1	Gas Well	Airspace in Well	PGM	Downgradient

*Sampling to be performed upwind of manhole.

+Portable Gas Monitor (i.e., Bacharach Sniffer 503 or Model RA-SSP or Equivalent)

TABLE 4-3

WATER QUALITY SAMPLING SCHEDULE - PHASE I

YEAR		MARCH	JUNE	SEPTEMBER	DECEMBER
1989	Start Operation Dec.	R	R	R	B
1990		R	B	R	R
1991		R	R	B	R
1992		R	R	R	B
1993		B	R	R	R
1994		R	B	R	R
1995		R	R	B	R
1996		R	R	R	B
1997	Phase IA Closed	B	R	R	R
1998		R	B	R	R
1999		R	R	B	R
2000		R	R	R	B
2001		B	R	R	R
2002		R	B	R	R
2003		R	R	B	R
2004		R	R	R	B
2005	Phase IB Closed	B	R	R	R
2006		R	B	R	R
2007		R	R	B	R
2008		R	R	R	B
2009		B	R	R	R
2010		R	B	R	R
2011		NYSDEC REVIEW OF SAMPLING			

E = Expanded Parameters
B = Baseline Parameters
R = Routine Parameters Method 602*

*EPA Method 602 included on Bedrock Wells MW-1A, MW-11A and MW-12A.

+Expanded parameters will be performed as directed by the NYSDEC or contingency plan.

TABLE 4-4

VOLUME OF WATER (IN GALLONS) NEEDED TO PURGE THREE WELL VOLUMES FROM 2-INCH CASED WELLS

Water Column Height (ft)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0	0	0	0	0	0	0	0	0	0
1	0	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1
3	1	2	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2	2	2
5	2	2	3	3	3	3	3	3	3	3
6	3	3	3	3	3	3	3	3	3	3
7	3	3	4	4	4	4	4	4	4	4
8	4	4	4	4	4	4	4	4	4	4
9	4	4	5	5	5	5	5	5	5	5
10	5	5	5	5	5	5	5	5	5	5
11	5	5	5	6	6	6	6	6	6	6
12	6	6	6	6	6	6	6	6	6	6
13	6	6	6	7	7	7	7	7	7	7
14	7	7	7	7	7	7	7	7	7	7
15	7	7	7	7	8	8	8	8	8	8
16	8	8	8	8	8	8	8	8	8	8
17	8	8	8	8	9	9	9	9	9	9
18	9	9	9	9	9	9	9	9	9	9
19	9	9	9	9	9	10	10	10	10	10
20	10	10	10	10	10	10	10	10	10	10
21	10	10	10	10	10	11	11	11	11	11
22	11	11	11	11	11	11	11	11	11	11
23	11	11	11	11	11	12	12	12	12	12
24	12	12	12	12	12	12	12	12	12	12
25	12	12	12	12	12	12	13	13	13	13
26	13	13	13	13	13	13	13	13	13	13
27	13	13	13	13	13	13	14	14	14	14
28	14	14	14	14	14	14	14	14	14	14
29	14	14	14	14	14	14	14	15	15	15
30	15	15	15	15	15	15	15	15	15	15
31	15	15	15	15	15	15	15	16	16	16
32	16	16	16	16	16	16	16	16	16	16
33	16	16	16	16	16	16	16	16	17	17
34	17	17	17	17	17	17	17	17	17	17
35	17	17	17	17	17	17	17	17	18	18
36	18	18	18	18	18	18	18	18	18	18
37	18	18	18	18	18	18	18	18	19	19
38	19	19	19	19	19	19	19	19	19	19
39	19	19	19	19	19	19	19	19	19	20
40	20	20	20	20	20	20	20	20	20	20
41	20	20	20	20	20	20	20	20	20	21
42	21	21	21	21	21	21	21	21	21	21
43	21	21	21	21	21	21	21	21	21	21
44	22	22	22	22	22	22	22	22	22	22
45	22	22	22	22	22	22	22	22	22	22
46	23	23	23	23	23	23	23	23	23	23
47	23	23	23	23	23	23	23	23	23	23
48	24	24	24	24	24	24	24	24	24	24
49	24	24	24	24	24	24	24	24	24	24
50	25	25	25	25	25	25	25	25	25	25

TABLE 4-5

Sampling and
Preservation of Samples[1]

Parameter[2]	Container[3]	Preservative	Holding Time[4]
Alkalinity	P,G	Cool, 4°C	14 days
BOD_5	P,G	Cool, 4°C	48 hrs.
COD	P,G	Cool, 4°C, H_2SO_4 to pH<2	28 days
Chloride	P,G	None Required	28 days
Color	P,G	Cool, 4°C	48 hrs.
Cyanide	P,G	Cool, 4°C, NaOH to pH>12	14 days
Hardness	P,G	HNO_3 or H_2SO_4 to pH<2	6 mos.
Metals	P,G	HNO_3,pH<2	6 mos.
Chromium-Hex.	P,G	Cool, 4°C	24 hrs.
Mercury	P,G	HNO_3, pH<2	28 days
Nitrogen			
Ammonia	P,G	Cool, 4°C, H_2SO_4 to pH<2	28 days
Nitrate	P,G	Cool, 4°C	48 hrs.
TKN	P,G	Cool, 4°C, H_2SO_4 to pH<2	28 days
Odor	G only	Cool, 4°C	24 hrs.
Phenols	G only	Cool, 4°C, H_2SO_4 to pH<2	28 days
Sulfate	P,G	Cool, 4°C	28 days
TDS	P,G	Cool, 4°C	48 hrs.
TOC	P,G	Cool, 4°C, HCl or H_2SO_4 to pH<2	28 days
Turbidity	P,G	Cool, 4°C	48 hrs.
Volatile Organics			
Method 601	G, Teflon-lined septum[5]	Cool, 4°C	14 days
Method 602	G, Teflon-lined septum[5]	Cool, 4°C	7 days
		Cool, 4°C, HCl to pH 2	14 days

NOTES (Table 4-5):

[1]Based on "RCRA Ground-Water Monitoring Technical Enforcement Guidance Document", U.S. EPA, 1986; "Approved Tests and Analytical Determinations - Water Quality Standards", NYSDEC Organization and Delegation Memorandum No. 85-49, December 5, 1985; and "Required Containers, Preservation Techniques, and Holding Times (40 CFR 136)" 3 in "Analytical Laboratory Guidebook for Environmental Professionals", NUS Corp., 1987.

[2]Laboratory determinations only; field determinations to be made immediately during sampling.

[3]P = Plastic (polyethylene), G = Glass

[4]Holding Time is defined as the length of time from collection of the sample until initiation of analysis.

[5]Do not allow any head space in the container.

TABLE 4-6

Water Quality Analysis Table

	Routine	Baseline	Expanded
FIELD PARAMETERS			
Static water level (in wells and sumps)	X	X	X
Specific Conductance	X	X	X
Temperature	X	X	X
Floaters or Sinkers[1]		X	X
pH	X	X	X
Eh (Oxidation-Reduction Potential)	X	X	X
Dissolved Oxygen[2]	X	X	X
Field Observations[3]	X	X	X
INORGANIC PARAMETERS (Leachate Indicators)			
Total Kjeldahl Nitrogen (TKN)		X	X
Ammonia	X	X	X
Nitrate	X	X	X
Chemical Oxygen Demand (COD)	X	X	X
Biochemical Oxygen Demand (BOD_5)		X	X
Total Organic Carbon (TOC)	X	X	X
Total Dissolved Solids (TDS)	X	X	X
Sulfate	X	X	X
Alkalinity	X	X	X
Total Phenols	X	X	X
Chloride	X	X	X
Total Hardness as $CaCO_3$	X	X	X
Turbidity	X	X	X
Color	X	X	X
Bicarbonate	X	X	X
Carbonate	X	X	X
METALS[4]			
Boron		X	X
Potassium	X	X	X
Sodium	X	X	X
Iron	X	X	X
Manganese	X	X	X
Magnesium	X	X	X
Aluminum		X	X
Calcium	X	X	X
Lead	X	X	X
Cadmium	X	X	X

TABLE 4-6 (continued)

Water Quality Analysis Table

	Routine	Baseline	Expanded
METALS[4] (Continued)			
Cyanide		X	X
Toxic Metals			
Antimony		X	X
Arsenic		X	X
Beryllium		X	X
Barium		X	X
Chromium (Total and Hexavalent)		X	X
Copper		X	X
Mercury		X	X
Nickel		X	X
Selenium		X	X
Silver		X	X
Thallium		X	X
Zinc		X	X
ORGANIC PARAMETERS			
EPA Method 601 (Purgeable Halocarbons)		X	X
EPA Method 602 (Purgeable Aromatics)		X	X
All constituents listed in 6 NYCRR Part 373-2, Appendix 33[5]			X

NOTES:

[1]Any floaters or sinkers found will be analyzed separately for baseline parameters.

[2]Surface water only.

[3]Any unusual conditions (colors, odors, surface sheens, etc.) noticed during well development, purging or sampling will be reported.

[4]All samples for metals will be taken in duplicate, one analysis should be filtered in the field prior to preservation; the other should be whole and unfiltered. No other samples (organics or inorganics) should be filtered.

[5]Upon request of the applicant, the department may waive the requirement to analyze for dioxins and furans (suggested method 8280), where appropriate.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The results of the hydrogeologic investigation indicate that the area selected for the proposed landfill is suitable for development as a solid waste management facility. The site suitability was established by accomplishing the objectives of the hydrogeology report.

5.1 Geologic Setting

5.1.1 Site Location

The proposed site is located in an isolated valley with no downgradient water supply wells within 9,000 feet of the landfill property. The downgradient area is defined by the unnamed stream drainage basin (Sheet 3). The proposed landfill is adjacent to the existing landfill. Additional surface waters will not be impacted since the proposed site is located within the same drainage basin as the existing facilities.

The proposed landfill is to be constructed on the side of a hill. The groundwater flow direction would naturally have a tendency toward horizontal flow, and the sloping subgrade provides for rapid drainage of leachate in the collection system. This would, therefore, reduce potential head build-up on the liner.

5.1.2 Depth to Bedrock

~~The proposed landfill is located with a minimum ten feet of low-permeability glacial till over rock, provided by either in-situ glacial till or a combination of in-situ plus remolded glacial till (Sheet 14A).~~ The shallow depth to rock areas occur primarily at the northern end (Phase IIB) and west side of the proposed site (Phase IIB). Some fill areas, as along the western and southwestern portions of Phase I, occur to maintain a uniform subgrade for the liner.

5.1.3 Structure in Till

The test pit investigation noted a blocky structure in the upper 5 to 12 feet of the glacial till soils. The structure is not jointing that transcends vertically with soil filling, etc., as would be derived from desiccation or ice polygons. It is an intrinsic property of the till soils possibly related to stress relief. The blocky structure decreases with depth, being most pronounced in the upper 3 feet in the frost zone. The soil structure is medium dense to very dense in an in-situ condition.

? not a sentence

The soils in the upper 3 to 7 feet may require excavation and recompaction to disturb the blocky structure and effects of frost. In most cases, these soils will be removed by the excavation to subgrade. Where this 3 to 7 feet of soil forms a part of the 10 feet of soil immediately below the liner subgrade, reworking will be required. Care should be taken to evaluate the subgrade for the extent that reworking is required. In general, the excavation should not extend below the brown uniform till soils.

Not a sentence

This depth of excavation is based on the field hydraulic tests performed by B&L for Monitoring Well MW-4C. The field hydraulic conductivity test conducted in MW-4C indicates the soil from 3 to 11 feet to have permeability less than 5 x 10^{-6} cm/sec (Table C-1). This also suggests that the blocky structure is relatively tight with depth and does not easily transmit water. The excavation for remolding of till subgrade in general should not extend below the brown uniform till soils. Visual field inspection will be required.

5.1.4 Bedrock Geology

The thick (900 foot) sequence of siltstone and shales underlying the site have relatively low permeabilities as evidenced by the low yields for residential wells (Miller, 1982). The water quality also leaves something to be desired as evidenced by the Village of McGraw sealing their bedrock well to use the sand and gravel aquifer in the valley. The well was sealed due to its inadequacy to produce sufficient water and "objectionable taste and odor qualities" (Corps, 1983).

5.2 Groundwater

5.2.1 Groundwater Level

The hydrogeologic investigation demonstrated that the seasonal high groundwater table in the glacial till is typically above the bottom of the proposed liner subgrade. Consequently, a waiver from 6 NYCRR Part 360-2.13d requirement for a minimum five foot separation distance to the seasonal high water table will be required. As outlined in Part 360-2.13d, the waiver can be granted based on the homogeneity of the subgrade soils and the overall geometric mean permeability of 4.1×10^{-6} cm/sec based on field hydraulic conductivity testing.

In addition, an underdrain system is required to be constructed immediately beneath the liner system to prevent hydrostatic pressure from developing on the liner system. This underdrain should have free draining capabilities. The underdrain will also act as a third collection system and can be monitored independently.

5.2.2 Flow Direction

The water level measurements in the wells from the proposed site area indicate a vertical (downward) gradient to the west of the proposed landfill shifting to a near horizontal flow beneath the site and an upward gradient (reflected in artesian flow) east of the site. This shallow groundwater flow pattern and the local recharge to the unnamed stream southeast of the site indicates a monitorable condition and also facilitate implementation of groundwater based contingency plans. The low permeability of the soil and bedrock indicates quantities of groundwater flow through the units are relatively low. Correspondingly, flow velocities are lower, and movement of contaminants, if any, are slowed allowing more time for implementation of corrective action should it be necessary.

Installation of the free draining underdrain below the liner system and the upward groundwater gradient on the east side of the proposed landfill result in the monitoring wells essentially being monitors of background water quality. The configuration of the landfill bottom and upward gradient will intercept any seeps from the side hill portion of the landfill. Monitoring of the underdrain system will be the primary leak detection system with the wells and surface water sampling as a secondary system. The collection layers in the trough of the landfill where the bottom grade is 5% will be more permeable granular fill to promote rapid drainage and minimize head build-up on the liner systems.

Location of the leachate tank with an underdrain system to prevent uplift and the detention ponds at the southeast downgradient portion of the landfill provide additional points for intercepting plumes of potential contamination.

5.3 Soil Properties

The glacial till encountered in the proposed landfill area exhibits favorable textural and permeability characteristics for use as a subgrade for the landfill liner system and for use as liner material. The vertical hydraulic conductivity of the till was determined to be less than 1×10^{-7} cm/sec based upon laboratory testing. The horizontal hydraulic conductivity for Phase I was determined to be 9.1×10^{-7} cm/sec with the overall (Phase I and II) permeability of 4.1×10^{-6} cm/sec in the till and 5.3×10^{-6} cm/sec in the upper part of the bedrock. Permeabilities of this magnitude significantly restrict the rate and volume of groundwater flow.

The narrow range exhibited by the grain size curves indicates similar soils across the site including those in the existing Pine Tree site area (Dunn Geoscience data). The lack of noticeable sandy seams or lenses in the test pits also indicates a uniform soil. With all of the test pits and borings, if there were significant sandy seams or the tills were prone to have pockets or channels, these features should have been encountered in the 27 wells, 7 soil borings and 38 test pits in the proposed landfill area that were logged by three different engineering firms.

5.4 General Construction Considerations

The depth of excavation was determined by four factors: 1) minimize the quantity of borrow from outside the footprint area, 2) provide aggressive slopes and as uniform slopes as feasible for the liner subgrade and leachate collection pipe, 3) maximize the quantity of refuse and 4) provide adequate embedment at the down slope toe of the side hill landfill for stability. Soil removed from the excavation of the landfill area was planned for reuse in site development and constructing the landfill in a sequential method. Changing grades to reduce excavation will result in additional use of borrow sources (Sheet 11).

The landfill is designed as a side hill fill and requires extensive excavation in some areas to provide a degree of uniformity in the subgrade. However, some areas will actually have fill added to provide a uniform slope rather than breaking slope. This fill occurs primarily in the areas of naturally occurring shallow depth to bedrock. In general, the maximum excavation areas do not correspond to minimum depth over bedrock. The landfill design in some areas may have a minimum 10 foot of clearance over bedrock but not necessarily in maximum cut areas.

In addition to the design providing an optimized capacity by the excavation, a leachate collection system with aggressive slopes has been integrated into the design to minimize head build-up on the liner (Drawings 11 and 19).

5.5 Migration Pathways and Plume Detection

The migration of leachate will follow the flow direction of groundwater which was previously discussed in Section 5.2.2. Movement of a contaminant, if any, that is released through the liner system will be intercepted by the underdrain. Should, by some remote possibility, leachate not be collected by the underdrain, movement would be to the southeast towards the monitoring well couplets installed along the downgradient perimeter of the landfill, the detention ponds and the leachate tank. The wells including the proposed new wells on the east side are spaced about 250 feet apart in Phase IA and 500 feet in Phase IB with MW-11 about midway on the short south side (Sheet 37). Should a leak develop, the wells would detect the plume developed by the release. Due to the direction of groundwater movement and low permeability of the soils, it is unlikely a plume could pass between the wells without being detected.

Construction of the detention ponds and leachate tank requires excavation below the bottom of the landfill liner system (Sheet 27). Monitoring of the underdrain below the leak detection system for the tank and visual observations for seeps in the detention pond will provide additional interception and detection points for plume migration. Sampling of the surface water drainage provides the fourth and final detection area for any leachate not intercepted by the underdrain.

Both the surface water stream and the detention ponds/ leachate tank excavations form interception lines for possible plumes from the landfill. The proposed landfill is monitorable for any possible leak.

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