Site Investigation Plan
Carroll Landfill Expansion
Town of Carroll, Chautauqua County, New York

Prepared for

J. A. Daigler & Associates
12 Leland Drive
Seneca Falls, New York 13148

Prepared by

Environmental Solutions
28 Dock Street
Shelburne, Nova Scotia B0T 1W0

October 2010

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1.0 INTRODUCTION

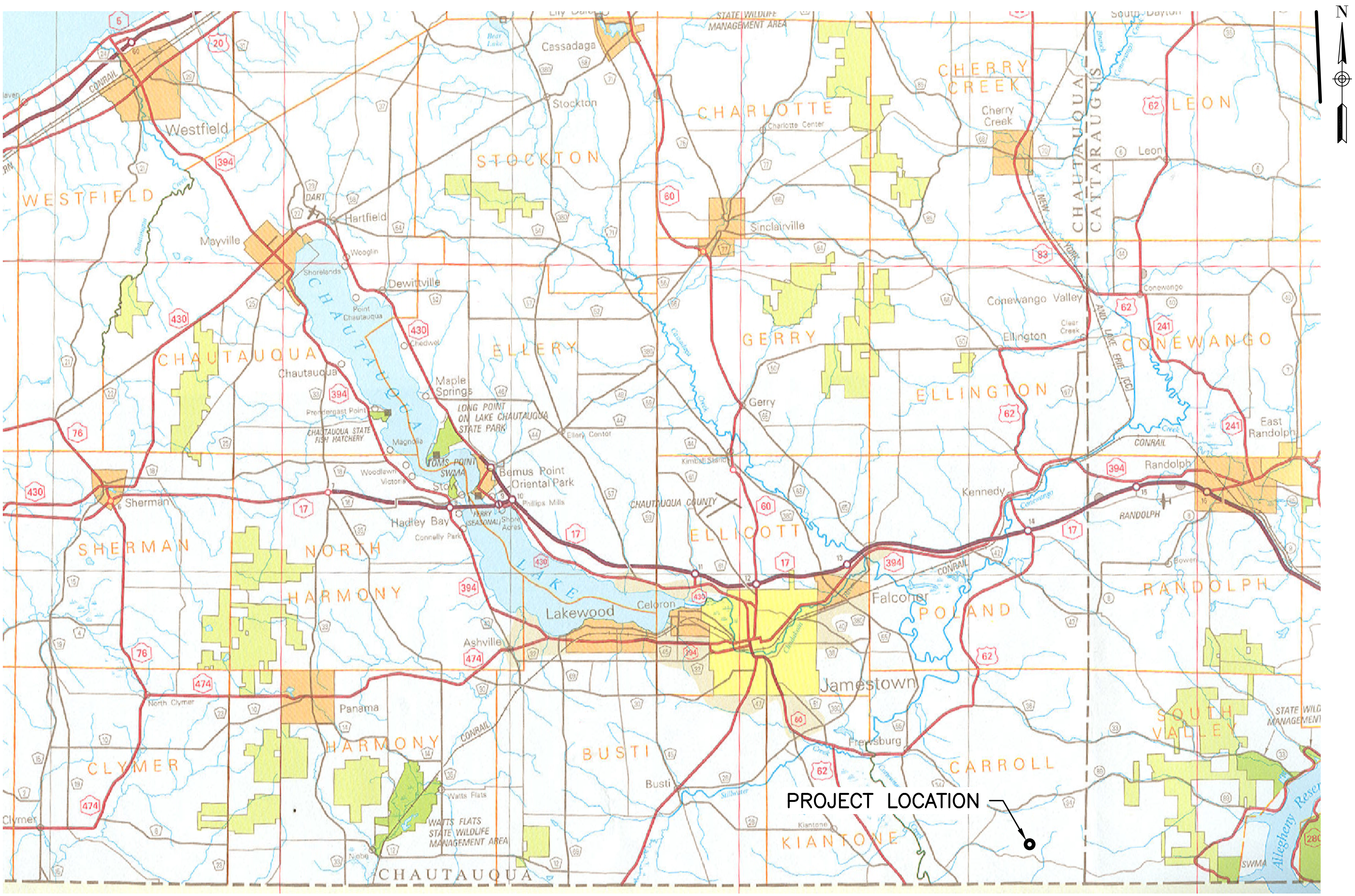
The following document presents the proposed Site Investigation Plan (SIP) for a 6NYCRR Part 360 hydrogeologic investigation at the Carroll Landfill site in the Town of Carroll, Chautauqua County, New York. Figure 1 and Figure 2 show the location of the site on Dodge Road near Sandberg Road. Sealand Waste, L. L. C. (Sealand) is completing a Part 360 Permit Application to develop an engineered C & D landfill on the site. The property consists of approximately 54 acres (Figure 1), 49.5 acres of which are proposed for this development. Since March of 1990, no more than three acres of the site has been used for the disposal of C & D waste. As part of their development of the site, Sealand proposes to remove the existing waste from the three-acre footprint, and place the material inside the proposed single composite lined landfill development in accordance with the applicable local, state and federal requirements.

The field work associated with this investigation, and described in Section 3.0, is focussed on the collection of data from the entire property including the existing landfill area. These data will be used in conjunction with any other available site information to provide a complete hydrogeological report and associated environmental monitoring plan for the site.

1.1 PREVIOUS INVESTIGATIONS

Based on the review of files at the New York State Department of Environmental Conservation (NYSDEC) Region 9 office, there has been very little site specific work conducted to date. There is correspondence between Mr. Ralph W. Wilson, P.E. and Mr. Dennis Weiss of the NYSDEC which discusses bedrock separation; however, no reports of any detailed investigations were found in the file.

Q:\Sealand\02-0104 Carroll Landfill\Site Investigation\acad\FIG 1-REGIONAL MAP.dwg 9/24/2010 8:34 AM



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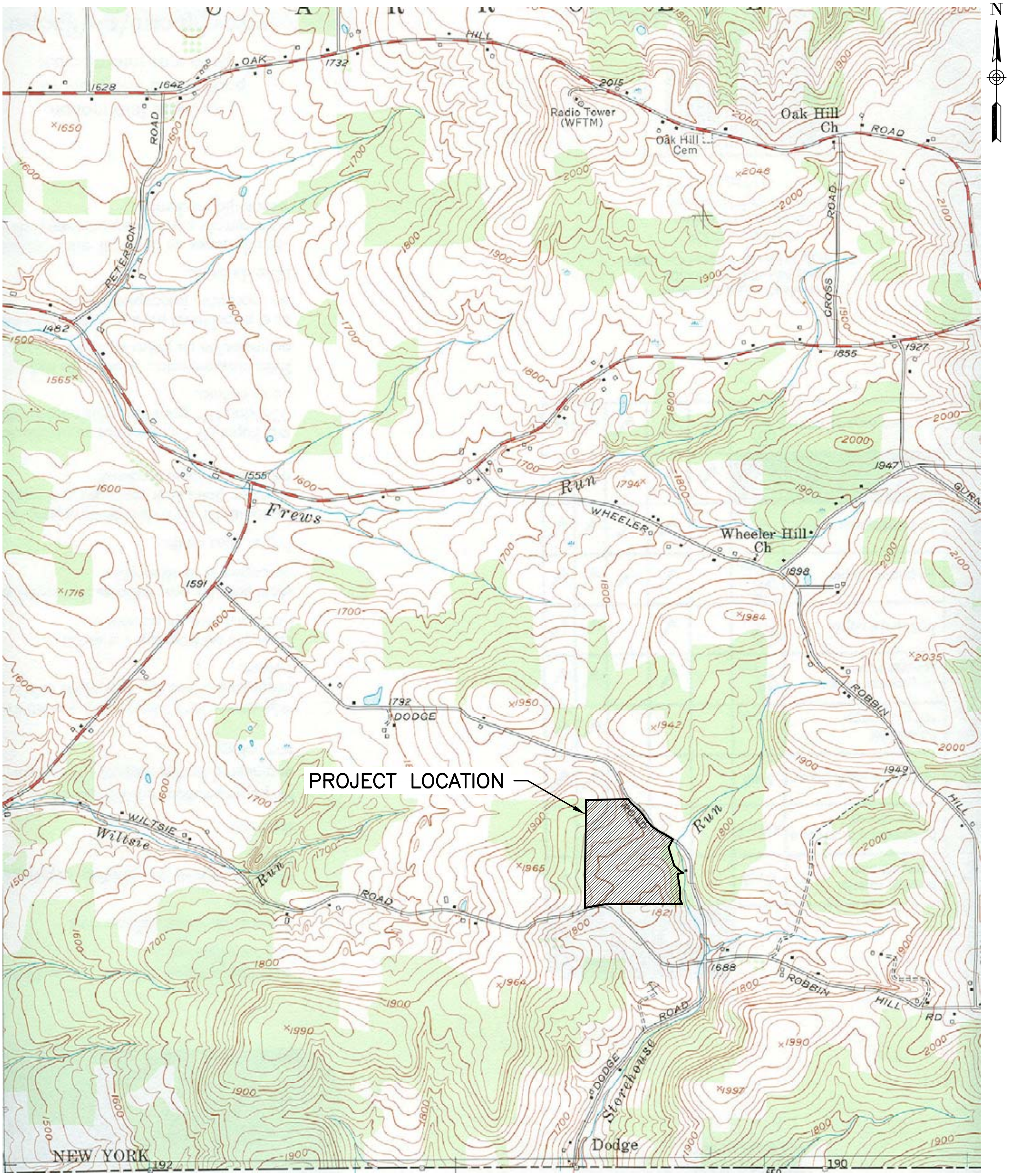
SEALAND WASTE, L.L.C.			REGIONAL MAP CARROLL LANDFILL EXPANSION PROJECT			FIGURE 1
DES. BY:	DRW. BY:	CHK. BY:				
SEPTEMBER 2010			TOWN OF CARROLL	CHAUTAUQUA COUNTY	NEW YORK	

Q:\Sealand\02-0104 Carroll Landfill\Site Investigation\acad\FIG 2-CARROLL LANDFILL VICINITY MAP.dwg 9/24/2010 8:35 AM



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PROJECT NO:

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SCALE: N.T.S.

DES. BY: DRW. BY: CHK. BY:

DATE: September 2010

TITLE:

CARROLL LANDFILL VICINITY MAP

PROJECT: CARROLL LANDFILL EXPANSION PROJECT

PREPARED FOR: SEALAND WASTE, L.L.C.

TOWN OF CARROLL | CHAUTAUQUA COUNTY | STATE OF NEW YORK

FIGURE 2

1.2 INVESTIGATION OBJECTIVES

The objectives of the investigation are to provide sufficient hydrogeological data for the engineering design and environmental monitoring in support of a Part 360 Permit Application; more specifically, the objectives may be summarized as follows:

- collect the geologic (i.e. soil types and thickness) data necessary to describe the site geology and to identify the site's critical stratigraphic section;

- collect the necessary hydrogeological data (depth to water, groundwater flow directions, hydraulic conductivity, hydraulic gradients, recharge and discharge areas, *et cetera* (etc.)) to describe the site hydrogeology;

- collect the necessary data relative to hydrogeological siting requirements, including proximity to primary or principal aquifers, depth to bedrock, overburden hydraulic conductivity, the velocity and predictability of groundwater flow in bedrock, the ability to monitor the on-site groundwater flow system, etc.;

- collect the surface water/hydrologic data necessary to define the existing surface water quality and flow characteristics;

- verify the horizontal extent of waste present in the existing landfill;

- investigate the potential for soil and/or groundwater quality impacts associated with the existing landfill; and

- collect the necessary groundwater quality data in accordance with a site analytical plan (SAP) which can used in conjunction with the site hydrogeological data to prepare an effective Environmental Monitoring Plan (EMP).

2.0 ENVIRONMENTAL SETTING AND REGIONAL CHARACTERISTICS

A preliminary file review, which has included several authoritative references regarding the environmental setting and regional geologic conditions associated with this area of Chautauqua County, provides the basis of the overview presented below.

2.1 CLIMATE

Chautauqua County has a humid, continental climate, which is modified by the proximity of Lake Erie. Atmospheric air flow is predominantly from west to east Temperatures range between approximately 55 to 80 degrees Fahrenheit during the summer and 15 to 38 degrees Fahrenheit in the winter. The mean annual air temperature in the Jamestown, New York area is 47 degrees Fahrenheit. (National Oceanic and Atmospheric Administration, 2002)

The average annual precipitation at Jamestown is 44.17 inches [1]. In general, precipitation in the region is moderate and fairly evenly distributed throughout the year. Snow patterns generally follow the patterns of total precipitation. Despite the even distribution of precipitation throughout the year, groundwater recharge is expected to greatest in the spring and late fall seasons when evapotranspiration rates are low and during snow melt when the ground is not frozen.

2.2 TOPOGRAPHY, PHYSIOGRAPHY AND DRAINAGE

Muller (1963) divided Chautauqua County into three northeast-southwest-trending physiographic “sections”. These sections are 1) the Eastern Lake Section of the

[1] This number is an average of that presented by Crain (1966) for data up to 1960 and the data from 1971-2000 presented by NOAA (2002).

Central Lowlands Physiographic Province; 2) the Southern New York Section of the Appalachian Plateau; and 3) the Kanawha Section of the Appalachian Plateau .

The Carroll Landfill site is located in the glaciated, uplands area of southeastern Chautauqua County (Figure 1) which is in the Southern New York Section of the Appalachian Plateau physiographic province. This region is a maturely dissected upland developed on gently dipping, predominantly fine-grained clastic rocks of Late Devonian age (Muller, 1963; Tesmer, 1963). This portion of Chautauqua County was glaciated several times during the Pleistocene Epoch. Glaciers sculpted the top of bedrock surface in the uplands to produce several deep northwest- and northeast-trending troughs that are in-filled with thick glacial and post-glacial sediments (Muller, 1963).

The topography of the uplands is typified by rolling, irregular hills that rise approximately 700 feet above the valley floors. The highest elevations in the county occur southeast of the site where erosionally resistant conglomerate bedrock appears to have provided a local boundary to further southeastward advance of glacial ice (Muller, 1963). The maximum elevation in the unglaciated, extreme southeastern corner of the county is approximately 2,100 feet above mean sea level (amsl). The uplands are dissected by many narrow, relatively steep-sided valleys which contain swift flowing streams.

Parts of the Ohio and St. Lawrence drainage basins cross Chautauqua County. The Town of Carroll resides within the Ohio Drainage Basin. The town is dissected by several northwest-trending, high elevation streams that discharge into Conewango Creek. Chautauqua Lake is located approximately twelve miles to the northwest of the site. Lake Erie is approximately 30 miles to the northwest and the Conewango Creek is located approximately four miles to the west of the landfill site.

Drainage from the Carroll Landfill site discharges into Storehouse Run which, in turn, discharges into Conewango Creek. Conewango Creek drains into the Allegheny River at Warren, Pennsylvania (Muller, 1963) which ultimately discharges into the Ohio River at Pittsburgh, Pennsylvania.

2.3 REGIONAL GEOLOGY

2.3.1 Bedrock Geology

The bedrock unit that subcrops beneath the Carroll Landfill is a 650 foot sequence of red and gray shales and siltstones with subordinate conglomerates assigned to the Upper Devonian Cattaraugus Formation (Tesmer, 1963). The rock strata are generally flat lying and dip gently to the south-southeast, away from Lake Erie (Muller, 1963) and toward the erosionally resistant, conglomerate-mantled, Salamanca Re-entrant region of southern Cattaraugus County and southeastern Chautauqua County. All of the bedrock units younger than the Late Devonian have been eroded except in this southeastern corner of the county where the Mississippian Knapp Conglomerate outcrops at the crests of hills.

The Devonian rock strata of Chautauqua County are underlain by a sequence of older sedimentary rocks more than 8,000 feet thick below which is crystalline rock. For the most part, shallow subsurface strata are relatively undeformed. Deeper geologic structure in the county is related to the Late Paleozoic Alleghenian Orogeny.

In the uplands, the bedrock surface is typically found at a depth of less than 25 feet; however, in the valleys the depth to rock is considerably deeper. Consequently, the relief of the surface of the bedrock is much greater than the current land surface.

Near the landfill site, a bedrock exposure was observed in a bank adjacent to Dodge Road. As well, bedrock was observed in the bottom of Storehouse Run, the creek located immediately to the east of the site.

Based on the review of the regional geologic information and discussions with NYSDEC staff, the determination of the top of bedrock may be difficult using the traditional split-spoon refusal method. As noted below in the discussion of the surficial geology, Crain (1966) has identified a unit above the top of bedrock which he calls the “rubble zone”. This zone is composed predominantly of fragments of the bedrock in a till matrix. Test pits excavated at the Carroll Landfill site in February 2004 and correspondence by Mr. Ralph Wilson, P. E. demonstrate the likely existence of this rubble zone at the site. Consequently, it is proposed in the test pit program to excavate several large test pits to confirm the existence of the rubble zone and to observe the contact with the top of bedrock. Once these test pits have been excavated, the NYSDEC hydrogeologist will be contacted and invited to inspect them. It is proposed that the method to be used to determine top of bedrock during the rest of the field program be agreed upon in consultation with the NYSDEC hydrogeologist after the inspection of these large test pits.

2.3.2 Surficial Geology

With the exception of the extreme southeast corner, all of the county has been affected by glaciation and the resultant deposits have been studied for many years. A review of the regional glaciation perspective can be found in textbooks on the subject but more specific information is contained in Muller (1963) and Crain (1966). The following is a general summary of the glacial geology of the region, which is intended to provide an overview of the types of deposits and materials expected at the site.

Chautauqua County was subjected to several glaciation events during the Wisconsin period of the Pleistocene Epoch. Continental ice sheets expanded several times spreading over Chautauqua County and preserved groove, striation and drumlin axis trend evidence indicates the movement of ice was southeastward from the present Lake Erie Basin (Muller, 1963). End moraine, ground moraine and stratified drift resulting from these ice fields comprise the majority of the overburden materials in the county and occur in belts which are progressively younger from the southeast corner moving northwest.

A major glacial feature in the Carroll area is the Kent Moraine which is the southernmost end moraine marking the terminus of the ice sheet in the late Wisconsin time. This end moraine enters Chautauqua County due east of Ivory and trends slightly west of south to pass into Warren County, Pennsylvania near Dodge. This end moraine consists of a belt of irregular knolls and depressions covering the pre-existing rugged bedrock topography. The knolls are commonly 15 to 25 feet high and a few kames are considerably higher (Muller, 1963).

In this upland area of the county the only widespread glacial deposit found is till and it is typically found at ground surface. The thickness of this till is typically less than 25 feet. Crain (1966) describes this till as consisting of a heterogeneous mixture of clay, silt, sand, gravel and boulders and as being very compact. According to Crain, the composition of the till may vary widely even in the same locality. In the upland areas where the till is exposed at the surface, weathering and erosion have often resulted in winnowing and downslope transport of some of the finer grained (clay and silt) materials from the upper two or three feet resulting in the altered surficial till horizon being sandier than it is several feet below the surface.

Crain (1966) also noted another unconsolidated unit in the uplands which he refers to as a "rubble zone". He states that, *" In many areas of the uplands, the contact between the till and the bedrock is indistinct and consists of a zone where the lower few feet of the till is composed predominantly of fragments of the underlying bedrock, and the upper surface of the bedrock is highly fractured. This zone was formed by the crushing action of the glacial ice which broke thin-bedded rocks, such as those underlying the Jamestown area, into small irregular-shaped fragments. This zone of broken rock has a higher permeability than either the overlying till or the underlying bedrock."*.

2.4 REGIONAL HYDROGEOLOGY

Based on the preliminary literature review (Crain, 1966; NYSDOH, 1981; Frimpter, 1986 and Miller, 1988), there are at least two significant aquifers located in southern Chautauqua County. These aquifers are located in the unconsolidated deposits in the valleys and are composed of glacial outwash sand and gravels or deltaic deposits of sand and gravel. The outwash deposits either overlie or are confined by silt and clay and the deltaic deposits typically interfinger with the silt and clay.

The Jamestown aquifer is the most important water-bearing deposit in the area and it's southeastern edge is located approximately four miles northwest of the Carroll Landfill site. The Jamestown aquifer underlies much of the Cassadaga Creek valley and extends eastward into part of the Conewango Creek valley. The Jamestown aquifer has an average thickness of approximately 20 feet and is confined in most areas by a silt and clay layer that is up to 140 feet thick. According to Crain (1966), the maximum perennial yield is approximately 10 million gallons per day which is controlled by the amount of water in storage in the deltaic deposits associated with the aquifer.

Another important aquifer is located in the Conewango Creek valley near Poland Center. This aquifer has been mapped as consisting of a sand and gravel deposit of five to 36 feet in thickness which is overlain by ten to 80 feet of silt and clay (Crain, 1966).

Based on mapping by Frimpter (1986), other valleys in the area are not believed to contain large aquifers. The Carroll Landfill site, which is in the uplands, is not located on a primary or principal aquifer. Groundwater in the uplands is found in the till, the rubble zone and the shallow bedrock and is very limited in availability. Most wells in the uplands have yields of only a few gallons per minute and are used for domestic or farm purposes. According to Crain (1966), wells located in the till generally have a yield of less than a half a gallon per minute while wells screened in the upper bedrock have a very variable yield with none exceeding six gallons per minute. Crain noted that *"The existence of a moderately permeable zone, the rubble zone referred to earlier, along the contact of the till and the bedrock surface is an important factor in the yield of bedrock wells in the upland areas. This zone, where it exists, will usually contribute more water to wells than either the till or the bedrock. In fact, the rubble zone appears to contribute most of the water in many bedrock wells."*

Crain (1966) provides an extensive discussion of groundwater quality in the region; however, the majority of the wells sampled in his study are screened in the outwash or deltaic sands and gravels. There were no wells sampled that were screened in the till, and eighteen bedrock wells were sampled.

Bedrock water quality, based on the available data published by Crain (1966), is variable. Chloride concentrations ranged from 3.3 to 2,420 parts per million (ppm) with an average concentration of 244 ppm and a geometric mean concentration of 59 ppm. Dissolved solids ranged from 103 to 4,440 ppm with an average concentration of 653 ppm and a geometric mean concentration of 340 ppm. More than 50% of the bedrock wells tested had water of objectionable quality because of high chloride, dissolved solids or iron. Many of the bedrock wells also had water which contained hydrogen sulphide (H_2S), oil and/or natural gas. In general, shallow bedrock water quality in the uplands areas is of acceptable quality for direct household use. The deeper the bedrock well, the more likely the well will encounter water with high concentrations of chloride, dissolved solids, iron, hydrogen sulphide and/or natural gas.

The reason for this relatively rapid deterioration of water quality with depth into bedrock is that the Cattaraugus Formation strata of southeastern Chautauqua County and adjacent Cattaraugus County are the up-dip extensions of the gas-producing “Venango Sands” of northern Pennsylvania (Donaldson and others, 1996). Thus, diluted oil field brine signatures are likely to be reflected in the groundwater geochemical facies at relatively shallow depths within the bedrock, particularly below the floors of valleys within the uplands region.

3.0 SITE INVESTIGATION METHODS

The following section presents the scope of work and the site investigation methods to be employed during the Part 360 hydrogeological investigation of the Carroll Landfill site.

3.1 LITERATURE REVIEW

A literature review will be conducted to obtain the available pertinent information on the regional and site geology and hydrogeology. This literature review will include, as available, records, reports and publications of the NYS Department of Health (NYSDOH), Chautauqua County DOH, NYS Department of Transportation (NYSDOT), NYS Geological Survey (NYSGS), NYS soil surveys, U.S. Geological Survey (USGS), and the U.S. Environmental Protection Agency (USEPA). As well, pertinent literature published by professional organizations, universities and colleges, aerial photographs and other imagery will be reviewed as available.

3.2 WATER WELL SURVEY

A water well survey of public and private wells within one mile down-gradient and one-quarter mile up-gradient of the site will be conducted. This survey will obtain, if available, the location of the well and the name of the owner. The location of the well will be shown on a field sketch. As well, the following information on the well will be obtained, if available: the approximate elevation of the well; the depth of the well; the age of the well; the usage of the well; the stratigraphic unit screened; the well construction; static water levels; well yield information; drillers log; perceived water quality; water quality data and any other available relevant information. A sample of the form being used for the water well survey is include in Appendix A.

3.3 SURFICIAL GEOLOGICAL MAPPING AND TEST PITS

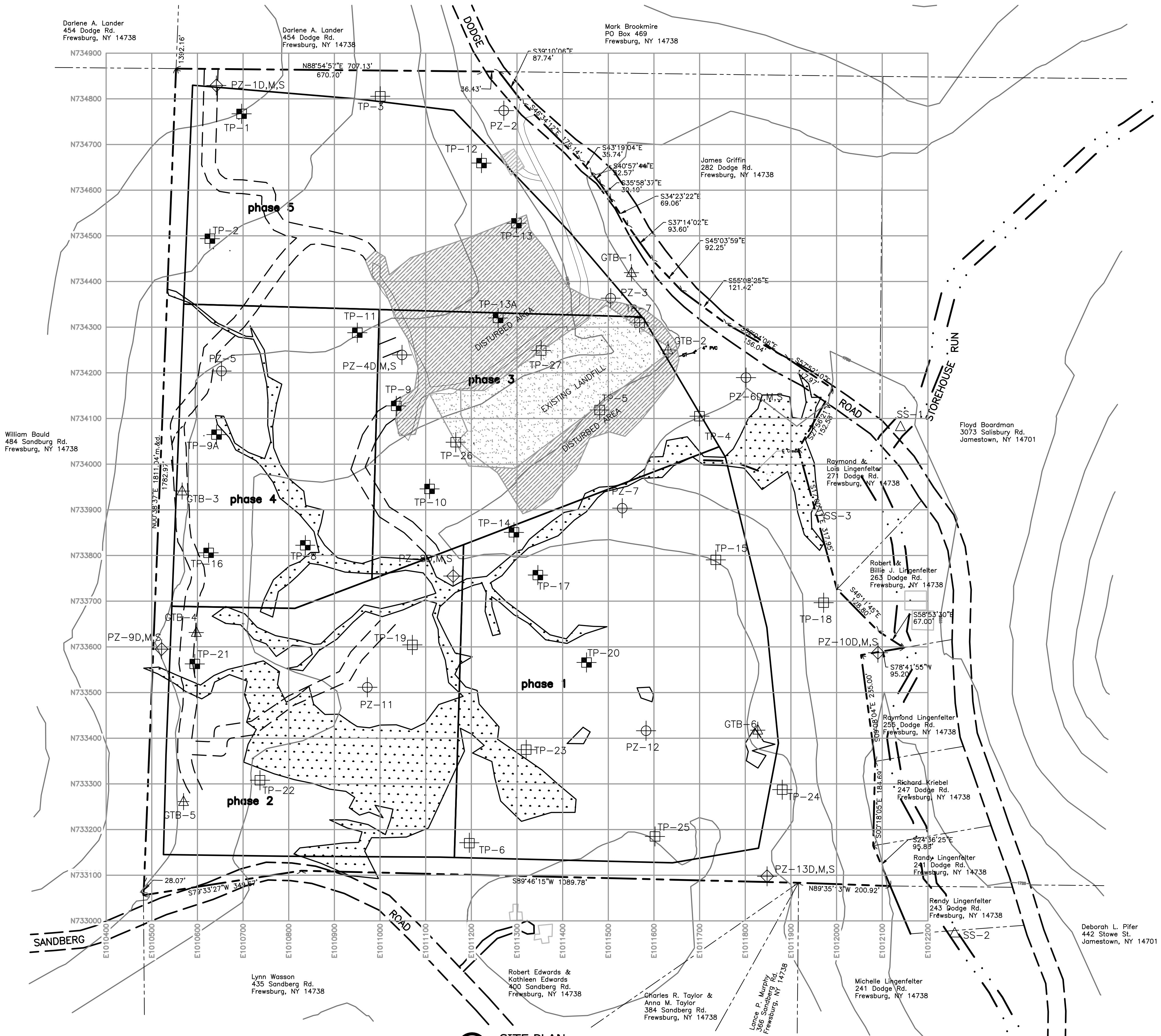
The investigation will include review and analysis of soil maps for the site and surrounding areas. Soil survey data will be analyzed to generate a map of parent surficial geologic deposits on which the myriad of soil types developed. This type of analysis has been demonstrated to yield surficial geologic maps that are more detailed than those that are typically published through the state geological survey.

A test pit program will be used as one of the methods to identify the shallow stratigraphy. Figure 3 presents the proposed test pit locations. Some of these test pits have already been completed. Figure 3 also identifies which test pits are complete and which remain to be excavated. Some of the test pits are being used, as noted above, to assist in determining the best method for identifying the top of bedrock.

Based on the preliminary literature review and site work conducted to date, the depth to bedrock in this area is expected be less than 25 feet. During the preliminary evaluation of the site in 2004, test pits were excavated at several locations on the site. Some of these were excavated to a sufficient size to observe the contact with the bedrock and identify whether the "rubble zone", as described by Crain (1966) is present on the property. Mr. Vince Fay of the NYSDEC met with project team members, Mr. Jim Daigler, Mr. Peter Carey, Mr. Brian Bartron and Mr. Ernie Kaleny on the 9th of September 2004 to inspect some of the test pits and come to an agreement on how the top of bedrock will be determined. Based on the findings of these test pits, it was agreed that the shallow subsurface consists of till soils underlain by residuum derived from shale. The residual soil gradually becomes harder and retains more structure with depth, including larger pieces of a harder sandstone bed. The residual soil transitions into competent, albeit soft and highly weathered, fractured shale bedrock.

In order to establish the top of bedrock on a consistent basis, the following soil characterizations will be used to distinguish soil from bedrock:

- the soil exhibits sufficient fracturing and weathering to allow for the fracture space to be filled with deposits;
- when handled, the aggregated soil pieces break down to a material containing mostly soil size particles that exhibit soil behavior, such as plasticity;
- bedrock does not have the above characteristics and extends to depth. Isolated layers of rock particles, which may be underlain by the above shale soil, are not considered bedrock.



1 SITE PLAN
Scale: 1"=120'

CARROLL LANDFILL EXPANSION PROJECT

TEST PIT LOCATIONS

NO.	NORTHING	EASTING
TP-1	734767.236	1010696.761
TP-2	734805.657	1011000.511
TP-3	734493.803	1010627.293
TP-5	734068.757	1011482.526
TP-13	734527.648	1011298.652
TP-12	734659.344	1011222.215
TP-7	734259.881	1011569.971
TP-13A	734320.148	1011258.595
TP-9A	734064.825	1010641.834
TP-4	734105.123	1011699.668
TP-11	734287.871	1010950.183
TP-27	734248.04	1011352.82
TP-10	733945.905	1011108.453
TP-14	733850.653	1011293.214
TP-15	733790.501	1011735.48
TP-16	733805.93	1010624.484
TP-17	733757.161	1011345.704
TP-18	733696.74	1011971.58
TP-19	733604.334	1011070.814
TP-20	733565.769	1011452.228
TP-21	733562.581	1010594.224
TP-22	733307.889	1010736.985
TP-23	733374.844	1011320.056
TP-24	733287.213	1011880.921
TP-25	733184.863	1011602.19
TP-6	733170.999	1011195.529
TP-26	733998.204	1011167.331
TP-9	734127.60	1011035.467
TP-8	733822.508	1010836.263

NOTES:

1. THE TOPOGRAPHY SHOWN HEREON IS TAKEN FROM THE USGS IVORY QUADRANGLE MAP, PHOTOREVISED 1978.
2. PROPERTY BOUNDARY SHOWN IS AS DEPICTED IN THE DRAWING ENTITLED: CARROLL LANDFILL PROPERTY, PREPARED BY MICHAEL J. RODGERS (MJR) LAND SURVEYORS OF JAMESTOWN, NEW YORK, DATED JUNE 21, 2004.
3. WETLAND AREA IS BASED ON A FIELD DELINEATION COMPLETED ON JULY 22 and 23, 2004 BY ENVIRONMENTAL DESIGN AND RESEARCH, P.C. OF SYRACUSE, NEW YORK.
4. THE WETLAND BOUNDARY SHOWN HEREON WAS LOCATED IN THE FIELD BY INSTRUMENT SURVEY COMPLETED BY MICHAEL J. RODGERS LAND SURVEYORS OF JAMESTOWN, NEW YORK, AND PRESENTED IN DIGITAL FORMAT IN THE DRAWING FILE ENTITLED CARROLL_WETLAND.dwg DATED JUNE 21, 2004.(MJR), AS DEPICTED IN THE DRAWING ENTITLED: CARROLL LANDFILL PROPERTY, PREPARED BY MICHAEL J. RODGERS (MJR).
5. THE LOCATION OF THE TEST PITS, PIEZOMETERS AND BORINGS ARE APPROXIMATE. THE FINAL POSITION OF ANY EXPLORATION WILL BE DETERMINED IN THE FIELD BASED ON ACCESS RESTRICTIONS AND INFORMATION REQUIREMENTS AS DESCRIBED IN THE SITE INVESTIGATION PLAN.
6. SURVEY RELOCATED TO NEW YORK STATE PLANE USING NATIONAL GEODETIC SURVEY CONVERSION SOFTWARE BY DAIGLER ENGINEERING, P.C.

LEGEND:

- WETLAND AREA
- TEST PIT–2004
- PROPOSED TEST PIT
- TRIPLET PIEZOMETER
- PIEZOMETER
- SURFACE WATER SAMPLE
- GEOTECHNICAL TEST BORING

ALTERATION OF ANY SURVEY, DRAWING, DESIGN, SPECIFICATION OR REPORT MUST BE COMPLETED IN ACCORDANCE WITH SECTION 7209 PROVISION 2 OF THE NEW YORK STATE EDUCATION LAW.

NO.	REVISION	BY	DATE

JAMES A. DAIGLER, P.E.
NYSPE NO. 061689

Environmental Solutions
28 Dock Street Shelburne, Nova Scotia

DATE: September 2010

SCALE: 1"=120'

PREPARED FOR: SEALAND WASTE, L.L.C.			SITE INVESTIGATION PLAN			FIGURE 3
DES. BY:	DRW. BY:	CHK. BY:	CARROLL LANDFILL EXPANSION PROJECT			
DWG.	SITE INVESTIGATION PLAN.dwg		TOWN OF CARROLL	CHAUTAUQUA COUNTY	STATE OF NEW YORK	

Each test pit will be logged to describe the soils and/or waste materials at each location, the presence of water seeps, wall stability, odours, or other notable characteristics. If bedrock is encountered, joint orientation and spacing data will be collected if the measurements can be taken safely. The visual observations, as well as, other pertinent information will be provided on the Test Pit Logs. Photographs will be taken at each test pit and representative examples will be presented in the Hydrogeological Report. Representative soil samples of each stratigraphic unit will be collected from the test pits and stored in labelled glass jars. Upon completion, each test pit will be backfilled with the excavated material and marked with a numbered stake pending the collection of survey data for horizontal and vertical control.

3.4 SOIL BORINGS AND PIEZOMETER/WELL INSTALLATION

A soil boring program will be used to identify the site stratigraphy including the upper bedrock, and collect soil and bedrock samples. This soil boring program in conjunction with the installation of piezometers and monitoring wells in some of the boreholes will be used to determine the site's three dimension groundwater flow regime and the critical stratigraphic section. The piezometers will be used to determine the horizontal and vertical hydraulic gradients, the hydraulic conductivity of the screened units and the general groundwater flow directions. Packer tests on select deeper bedrock borings will provide additional hydraulic conductivity data on the bedrock unit(s). Groundwater samples collected from the monitoring wells will be analyzed for NYSDEC Expanded and Baseline parameter lists for use in establishing the existing water quality.

Based on the currently available site mapping, the highest topographic elevation at the site is approximately 1850 feet at the northwest corner of the property and the lowest is approximately 1720 feet near the eastern edge of the property adjacent to Storehouse Run. If bedrock at the top of the hill is found at a depth of approximately 25 feet or less as indicated in the literature and since bedrock was observed in Storehouse Run, then the difference in elevation of the bedrock across the site could be approximately 105 feet. Consequently, at drilling locations proposed for the higher elevations, some of the boreholes will be drilled 75 to 100 feet deep in order characterize the bedrock flow regime.

Based on the regional hydrogeologic information reviewed to date, the “rubble zone” identified by Crain (1966) as the most permeable zone in the uplands may be present on the site; consequently, clusters of three piezometers or monitoring wells are proposed at several locations on the site. These clusters will monitor the hydraulic heads in the till, the rubble zone and the upper bedrock. If the rubble zone does not exist, then only two piezometers or monitoring wells will be installed. One to monitor the uppermost water bearing zone and the other to monitor the upper fractured bedrock zone.

Figure 3 presents the proposed soil borings, piezometer/ monitoring well locations. At five of these locations, PZ-1, PZ-8, PZ-9, PZ-10, and PZ-13, the deep borings will be extended into the bedrock, as discussed above, to extract core to the depth correlative to the bedrock elevation on the eastern edge of the site. At the other proposed locations, the deep boring will be extended twenty feet or less into the upper bedrock. At all boring locations, the deepest boring will be sampled continuously. At the adjacent boreholes in locations where clusters are proposed, samples will be collected at changes in lithology and from the interval where the piezometer or monitoring well screen will be installed.

The possibility exists that contamination from the existing landfill may be encountered during the drilling program.. Contamination would be identified initially based on field observations, I e. staining of the soils, discoloured water or odours. If indications of potential contamination are encountered, the soil/water will be field screened with a photoionization detector (PID) and a combustible gas meter. If these field observations indicate contamination, then samples of the soil and/or water will be collected for analysis. These samples will be analyzed for the NYSDEC Baseline Parameter list. Any affected soil or water will be drummed, labelled and retained until the analytical results are received and proper disposal can be determined.

Overburden sampling will be accomplished in accordance with the Standard Penetration Test Method (ASTM D-1586-84 (1992)) and representative portions of each sample will be stored in moisture tight jars for future reference. Samples will be labelled to include boring or piezometer or monitoring well number, sample number and interval, and date. In bedrock borings, core samples will be collected, logged and stored in labelled wooden core boxes for future reference.

If cohesive soils are encountered, “undisturbed” samples will be collected with the use of a Piston Sampler, which uses water pressure to retract a piston inside the sampling tube while pushing the tube into the soil. The piston creates a vacuum that helps retain the sample within the tube until it can be brought to the surface. Once at the surface, the sample recovery will be measured and each end of the tube will be sealed with wax. The tube will be stored in a vertical position until delivered to the laboratory for analysis, as described in Section 3.4.1, below. A representative number of samples will be submitted for geotechnical analyses.

Soil boring logs will be prepared describing the soils, stratigraphic changes, sampling intervals, and other information observed in the field, such as moisture content, location of the water table, loss of water during drilling, depth to significant changes in lithology, sample recovery measured in tenths of a foot, blow counts and any other pertinent information or comments. As well, the boring logs will include a description of the rock lithology, mineralogy, degree of cementation, percent recovery, rock quality designation (RQD) and any other pertinent information. As well, a photograph of all labelled cores will be taken and submitted with the logs.

3.4.1 Geotechnical Testing

Representative samples of each unconsolidated stratigraphic unit and each screened interval will be submitted for analysis. The geotechnical testing will be conducted to confirm the physical properties of the various soil materials found at the site.

Specifically, the geotechnical testing program will include the following:

- moisture content testing will be performed on select samples from representative boreholes to help establish a moisture content profile;

- at least three samples representative of each stratigraphic unit, as well as, the screened interval will be analyzed for grain size using sieve and/or hydrometer, as appropriate; and

- if cohesive soil units are encountered, the following testing will be performed on undisturbed soil samples: grain size distribution, Atterberg Limits, moisture content and constant head permeability.

3.4.2 Piezometer Installation

Piezometers will be installed at select borehole locations (as shown in Figure 3) in order to help define the site hydrogeology and determine the most appropriate locations for monitoring wells. As shown on Figure 3, piezometer clusters will be installed at locations PZ-1, PZ-4, PZ-6, PZ-8, PZ-9, PZ-10 and PZ-13. As noted above, it is proposed that the clusters will include one piezometer screened in the upper fractured bedrock, one screened in the "rubble zone", if present, and a shallow piezometer screened across the water table. Table 1, below, summaries the proposed piezometer/monitoring well installations. If other highly transmissive zones are encountered during the soil boring program, this proposed piezometer installation program may be modified, in consultation with the NYSDEC hydrogeologist, to monitor those intervals as appropriate. If, for any reason, the proposed piezometers need to be moved, the NYSDEC hydrogeologist will be notified and an explanation for the move will be provided.

Table 1
Proposed Piezometers/Monitoring Wells
Carroll Landfill

Location	Proposed Unit Monitored	Comments
PZ-1D	Upper Bedrock	
PZ-1M	Rubble Zone	If present
PZ-1S	Overburden	Water table
PZ-2	Overburden	Water table
PZ-3	Overburden	Water table
PZ-4D	Upper Bedrock	
PZ-4M	Rubble Zone	If present
PZ-4S	Overburden	Water table
PZ-5	Overburden	Water table

Location	Proposed Unit Monitored	Comments
PZ-6D	Upper Bedrock	
PZ-6M	Rubble Zone	If present
PZ-6S	Overburden	Water table
PZ-7	Overburden	Water table
PZ-8D	Upper Bedrock	
PZ-8M	Rubble Zone	If present
PZ-8S	Overburden	Water table
PZ-9D	Upper Bedrock	
PZ-9M	Rubble Zone	If present
PZ-9S	Overburden	Water table
PZ-10D	Upper Bedrock	
PZ-10M	Rubble Zone	If present
PZ-10S	Overburden	Water table
PZ-11	Overburden	Water table
PZ-12	Overburden	Water table
PZ-13D	Upper Bedrock	
PZ-13M	Rubble Zone	If present
PZ-13S	Overburden	Water table

Drilling, sampling, and development equipment will be steam cleaned prior to use at the site and between boring/piezometer/monitoring well locations. Potable water will be obtained for the drilling program.

At the deepest boring in each location, soil samples will be collected continuously from ground surface to spoon refusal as discussed above. The overburden and bedrock piezometers will be installed directly through the 4.25-inch ID hollow-stem augers or well casing. Each piezometer will be constructed of two-inch diameter PVC riser pipe and a five (overburden) or ten (bedrock) foot long PVC factory constructed, continuous slot wire wrap screen. Piezometer and monitoring well construction will be in accordance with the Part 360 regulations and include a primary sand pack, bentonite seal, secondary sand pack above and below the bentonite seal, and cement/bentonite grout to a concrete or grout seal at the ground surface. For the piezometers, a more modest surface seal will be used rather than that required for monitoring wells under Part 360. Each piezometer or monitoring well will be completed with a locking protective casing at the surface. Figure 4 illustrates a typical monitoring well installation.

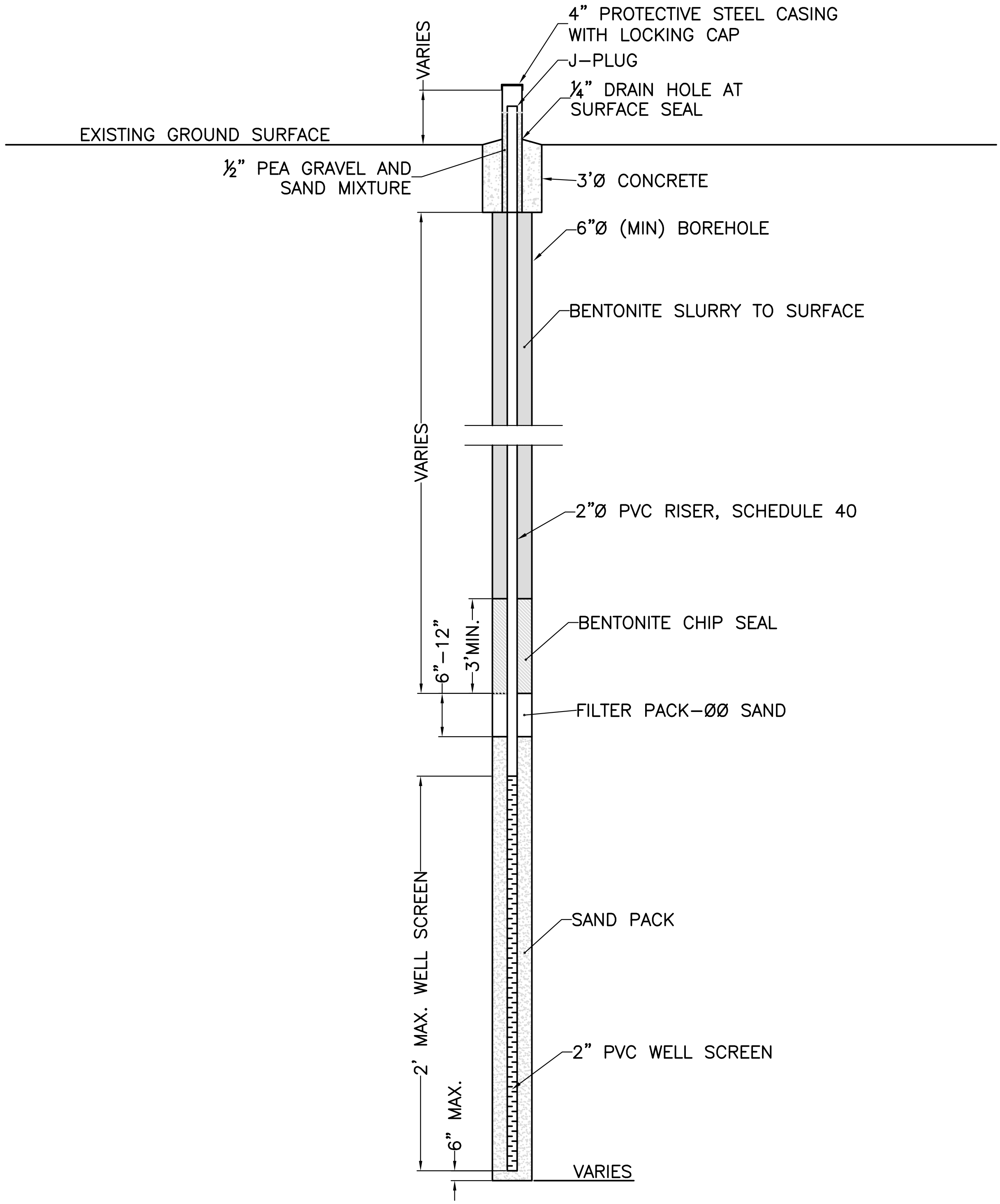
Following completion, each of the piezometers will be developed to remove fine grained material introduced during the drilling process and to promote hydraulic connection with the surrounding geologic material. The piezometers will be developed using a bailer and/or Waterra pump until the purge water is clear or the well was repeatedly pumped dry and there was no noticeable improvement in clarity. Appendix B contains the standard operating procedure (SOP) for piezometer and well development.

3.4.3 Hydraulic Conductivity Testing

In situ hydraulic conductivity testing (K-testing) using packer tests will be conducted on select deep boreholes drilled into the bedrock. *In situ* hydraulic conductivity testing using slug tests will be conducted on each of the newly installed piezometers or monitoring wells. The slug tests will be conducted following ASTM method D-4044-96. Each test will be initiated by recording the static water level in the piezometer. A mechanical means will be used to "instantaneously" change the head of water in the piezometer and the change in water level back to static conditions will be recorded with time using a water level meter. The resulting data from both forms of K-testing will be analyzed following ASTM method D-4104 or other appropriate methods (solutions) which will be chosen based which is most appropriate for existing site conditions.

3.5 EXISTING LANDFILL ASSESSMENT

As noted above, less than three acres of the site has been utilized as a C & D



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Environmental Solutions
28 Dock Street Shelburne, Nova Scotia

TYPICAL WELL INSTALLATION DETAIL

PROJECT: CARROLL LANDFILL EXPANSION PROJECT

PREPARED FOR: SEALAND WASTE, L.L.C.

TOWN OF CARROLL | CHAUTAUQUA COUNTY | STATE OF NEW YORK

FIGURE 4

landfill for approximately the past 14 years. To facilitate an environmentally sound expansion at the site, it is planned that the existing disposal site will be excavated and disposed in the lined expansion area. Consequently, an assessment will be made to confirm the horizontal extent and depth of waste at the site, as well as it characteristics. A work plan, which includes a site specific health and safety plan (HASP), designed to satisfy the data requirements of a landfill reclamation feasibility study and field investigation will be provided under separate cover.

3.5.1 Test Pits

As part of this investigation, test pits, TP-5, TP-7, TP-26 and TP-27, as shown of Figure 3, will be used to confirm the horizontal extent of the existing landfill area and the depth to water in this area. Prior to the initiation of this work a site specific health and safety plan (HASP) will be prepared. Additional test pits will be excavated, as necessary, based on the findings in the field. During the excavation, air monitoring will be conducted with a Photoionization Detector (PID) and combustible gas meter at each test pit to evaluate potential health and safety concerns associated with excavating the waste.

As discussed above, each test pit will be logged by an experienced geologist, photographs will be taken and representative samples will be collected. If any leachate is encountered in the test pits, samples will be collected and analyzed as discussed below in Section 3.5.2.

3.5.2 Waste and Leachate Sampling and Analysis

The excavation of the test pits referenced in Section 3.5.1, above, provides a potential opportunity to collect samples of both soil and waste material in the existing landfill area for laboratory analysis. Waste samples collected from the test pits will be collected from the test pit walls or from the mass within the centre of the backhoe bucket, and placed directly into the sample container. This procedure will be followed so that the collected sample will not directly contact the excavator bucket or groundwater within the test pit. Efforts will be made to collect at least three representative soil samples from beneath the waste area. The collected samples will be stored on ice pending shipment to the laboratory.

The selection of waste and soil samples and the type of analysis will be determined at each individual location based on what is found in the field. In general, it is anticipated that waste and soils adjacent to waste or greater than approximately 10 feet above bedrock will be collected for TCL volatile organic and semi-volatile organic analyses as they will likely be excavated and deposited in the expansion lined landfill area. Soils within approximately 10 feet of bedrock, which would likely remain in place, will be collected for the analysis of TCL volatile organic and semi-volatile organic analyses and TAL metals to evaluate potential future sources of contamination. These samples may also be analyzed for pesticides, and/or PCBs depending on what types of waste are found. Prior to sending these waste and soil samples for analysis, the NYSDEC hydrogeologist will be consulted on the proposed analyses.

During a site visit in May 2004, leachate was noted flowing from the toe of the existing landfill, since then the landfill has been closed and received final cover; consequently, it is not anticipated that leachate seeps will be encountered. If, during the excavation of the test pits, leachate is encountered, based on the waste observed in the test pits, if it is appropriate, leachate sample(s) will be collected and analyzed for the Part 360 Expanded Parameter list.

3.6 SURVEY

All test pit, soil boring, piezometer and monitoring well locations and ground elevations will be surveyed upon completion by a licensed New York State surveyor. These locations, as well as the top of the piezometer/monitoring well casing and top of the protective casing will be surveyed for horizontal position referenced to the site grid and the NAD83 horizontal datum and for elevation referenced to NGVD 29 vertical datum.

3.7 GROUNDWATER MONITORING WELLS

Once the piezometers have been installed, developed, and hydraulic conductivity testing completed, two additional rounds of water level measurements will be collected at least two weeks a part. These hydraulic head data will be used to determine groundwater flow directions as well as horizontal and vertical gradients. Based on all the hydrogeological data collected during this assessment, the critical stratigraphic section will be determined and appropriate groundwater monitoring well locations and screen locations will be confirmed so that an effective environmental monitoring plan for the groundwater flow system can be established. A letter will be submitted to the NYSDEC hydrogeologist with the proposed monitoring well locations and the rationale for their locations. These wells will be used to establish a preliminary evaluation of the existing groundwater quality. A representative number of monitoring wells, screened in each water bearing hydrogeologic unit within the critical stratigraphic section and located both upgradient and downgradient of the proposed landfill will be sampled. In the first round, two samples will be collected from each well and analyzed for the NYSDEC Part 360 Expanded Parameter list. The second round samples will be analyzed for the Part 360 Baseline Parameter list. These two rounds of samples will be collected at the groundwater nominal low and the groundwater nominal high.

Sampling will be completed in accordance with the requirements of Part 360. Briefly, this includes the evacuation of the well while monitoring specific conductance, pH and temperature. The collected samples will be stored on ice and transported to laboratory for analysis at a New York approved laboratory. Appendix C provides the groundwater sampling standard operating procedure.

3.8 EXISTING SURFACE WATER QUALITY

Surface water run off from the site flows to the east into Storehouse Run which is located just to the east of the site property boundary. Based on the initial information available, Storehouse Run is a perennial stream which flows south and discharges into Conewango Creek approximately four miles southwest of the property.

Three surface water sampling stations are proposed to provide preliminary existing surface water quality data. These locations are shown on Figure 3. SW-1 and SW-2 will monitor the upgradient and downgradient water quality, respectively, on Storehouse Run. SW-3 will monitor the water quality exiting the site.

Samples will be collected following the standard operating procedure presented in Appendix D. These samples will be collected when the groundwater quality samples are collected and will be analyzed for the NYSDEC Baseline Parameter list in the first round and the Routine Parameter list in the second round. Note, field parameters will include dissolved oxygen in all surface water sampling.

4.0 REPORTING

All the data collected during this site investigation will be collated and analyzed to prepare the *Site Investigation Report*. This report will include a final version of the *Site Investigation Plan*, raw field data, analytical calculations, maps, cross-sections, photographs, interpretations and conclusions to comprehensively describe the site geology and hydrogeology. All maps will have a minimum scale of 1:24,000. The following is the proposed table of contents for the *Site Investigation Report*:

1.0 INTRODUCTION
- 1.1 Previous Investigations
- 1.2 Investigation Objectives
- 1.3 Limitations

2.0 SITE INVESTIGATION PLAN
- 2.1 Literature Review
- 2.2 Water Well Survey
- 2.3 Test Pits
- 2.4 Soil Borings and Piezometer Installation
  - 2.4.1 Geotechnical Testing
  - 2.4.2 Piezometer Installation
  - 2.4.3 Hydraulic Conductivity Testing
- 2.5 Old C&D Landfill Assessment
  - 2.5.1 Test Pits
  - 2.5.2 Soil and Waste Analytical Sampling
- 2.6 Survey
- 2.7 Groundwater Monitoring Wells

3.0 ENVIRONMENTAL SETTING AND REGIONAL CHARACTERISTICS
- 3.1 Climate
- 3.2 Topography and Physiography
- 3.3 Regional Geology
  - 3.3.1 Bedrock Geology
  - 2.3.2 Surficial Geology
- 2.4 Regional Hydrogeology

2.5 Surface Water

4.0 SITE GEOLOGY
4.1 Surficial Geology
4.2 Bedrock Geology

5.0 SITE HYDROGEOLOGY
5.1 Hydrostratigraphic units
5.2 Groundwater Flow
5.3 Critical Stratigraphic Section
5.4 Groundwater Quality

6.0 SITE HYDROLOGY

7.0 REFERENCES

Specifically, the *Site Investigation Report* will identify the specific glacial features found at the site and discuss how these features affected the investigation and the interpretation of the site geology and hydrogeology. Maps of the tops of the hydrostratigraphic units and their thicknesses will be prepared based on the borehole logs from the drilling programme. The top of bedrock map will note any locations where bedrock is exposed at the ground surface. Based on the evaluation of the site geology and hydrogeology and groundwater flow, the Critical Stratigraphic Section will be identified. Section 5.3 of the *Site Investigation Report* will identify the Critical Stratigraphic Section and discuss the rationale for its determination.

As noted in Section 2.4, there are at least two significant aquifers located in southern Chautauqua County. These aquifers are located in the unconsolidated deposits in the valleys. The *Site Investigation Report* will include a map showing the location of these aquifers relative to the Carroll Landfill site.

In addition to the *Site Investigation Report*, an *Environmental Monitoring Plan* will be prepared and submitted under separate cover with the *Site Investigation Report*. The *Environmental Monitoring Plan*, which will include the site analytical plan, will describe all proposed monitoring, including the location of all environmental, facility and other monitoring points, sampling schedule, sampling methods, analyses to be performed, statistical methods and reporting requirements.

5.0 REFERENCES

Crain, Leslie J. 1966. *Ground-water Resources of the Jamestown Area, New York with Emphasis on the Hydrology of the Major Stream Valleys*, State of New York Conservation Department Water Resources Commission, Bulletin 58.

Donaldson, Alan, Ray Boswell, Xiandong Zou, Larry Cavallo, L. Robert Heim, and Michael Canich . 1996, *Upper Devonian Elk Sandstones and Siltstones*. In Roen, J.B. and Walker, B.J., eds., The Atlas of Major Appalachian Basin Gas Plays. West Virginia Geological and Economic Survey, Publication V-25, p. 77-85.

Frimpter, Michael H. 1986. *Surficial Geology and Groundwater Availability in the Allegheny River basin and Part of Lake Erie, New York,* Water-Resources Investigation Report 86-4041, Ithaca, NY

Muller, Ernest H. 1963. *Geology of Chautauqua County, New York Part II*, New York State Museum and Science Service Bulletin Number 392, University of the State of New York, Albany, NY

National Oceanic and Atmospheric Administration. 2002. *Monthly Station Normals of Temperature, Precipitation and Heating and Cooling degree Days 1071-2000,* National Climate Data Center, Asheville, NC

Tesmer, Irving H. 1963. *Geology of Chautauqua County, New York Part I.* New York State Museum and Science Service Bulletin Number 391, University of the State of New York, Albany, NY.

Van Tyne, Arthur M. 1996, *Upper Silurian Bass Islands Trend*. In Roen, J.B. and Walker, B.J., eds., The Atlas of Major Appalachian Basin Gas Plays. West Virginia Geological and Economic Survey, Publication V-25, p. 130-132.

APPENDIX A

Water Well Survey Form

Environmental Solutions

WATER WELL SURVEY FORM

Client: ______________________________ **Project No.:** ___________________

Property ID: ________________________ **Date:** __________________

Owner: _____________________________ **Telephone Number:** _______________

Civic Address: ____

____

Item	Condition		Comments
Location of Well	**Show on sketch**		
Type of Well (construction)	**Dug**	**Drilled**	
Take picture of well.	**Yes**	**No**	
Copy of original log available?	**Yes**	**No**	
Map showing well(s) available	**Yes**	**No**	
Age or dated drilled			
Elevation (feet) of top of casing	**Yes**	**No**	
Depth of well (feet)	**Yes**	**No**	
Depth to water /static water levels	**Yes**	**No**	
Well yield data	**Yes**	**No**	
General condition of well?	**Good**	**Poor**	
Perceived water quality	**Good**	**Poor**	If poor, describe concerns
Water quality data available?	**Yes**	**No**	

Item	Condition		Comments
Other available information	**Yes**	**No**	

Field Sketch (not to scale)

APPENDIX B

Well Development SOP

1.0 MONITORING WELL DEVELOPMENT PROCEDURE

All equipment will be constructed of inert materials designed to minimize agitation and contact with the atmosphere. The equipment will be cleaned and protected during transport to avoid contamination and checked before use. Dedicated equipment will be constructed of appropriate inert materials. The specific equipment which will be used will be supplied in the SAP.

Development of monitoring wells screened in fine grained materials will be conducted in a manner to minimize the amount of fines entering the well; therefore, these wells will never be surged.

Monitor Well Development Procedure

Monitoring well development techniques will be consistently performed each time a well is sampled, and will comply with the following:

- Ambient air in the well will be checked for the presence of explosive or organic vapours before each well is evacuated and a water level measurement will be taken;

- Standing water in each well will be checked for immiscible layers or other contaminants that are lighter or heavier than water (floaters or sinkers). If present, floaters or sinkers or other indications of contamination are present, all development waters will be contained analyzed and properly disposed. If there is no indication of contamination, then water withdrawn during the development of new wells or the purging of existing wells will be discharged to the ground surface downgradient and away from the immediate vicinity of the well (minimum 20 feet).

- The well borehole volume will be calculated using the radius of the **<u>borehole</u>** and the height of the standing water column.

- Wells will be evacuated to remove sediment in the well and stagnant water in the well and the sand pack to ensure the water sampled is fresh water representative of the formation. Evacuation methods, including pumping rate, depth of pump intake, and method of determining sufficiency of evacuation will be consistently applied each time the well is sampled. Evacuation methods which will create the least possible turbidity in the well and will not lower the water in the well below the top of the sand pack will be used whenever feasible. In general, bailing or gentle pumping with a Waterra pump will be used to develop wells.

- During the development of each well, turbidity, specific conductance, temperature and pH will be monitored with time in order to determine when development is complete. Development will be considered complete when the water from the well is clear, the other parameters monitored have stabilized. In some fine grained materials achieving clear water is not possible. In those cases, development will be continued until the other parameters monitored have stabilized and a minimum of three borehole volumes have been removed.

APPENDIX C

Groundwater Sampling SOP

GROUNDWATER MONITORING WELL SAMPLING PROCEDURE

The field sampling procedures for this project will strictly adhere to those presented in Section 360-2.11(d)(I) of the Title 6 NYCRR Part 360 and are summarized below. Field sampling will be conducted by the designated laboratory. Once the laboratory has been chosen, a copy of the company's quality assurance procedures will be provided as part of the sampling and analytical plan.

Sampling and Handling

The upgradient monitoring wells will be sampled first during each monitoring event. All samples will be collected and stored in the order of the parameter's volatilization sensitivity using methods, consistently applied, which ensure sample integrity. Specifically, samples will be collected in the following order:

1. Volatile Organics
2. Semi-Volatile Organics
3. Field Parameters
4. Remaining Organic Parameters
5. Metals (Whole and Filtered)
6. Phenols and Cyanides
7. Remaining Parameters

All sampling equipment will be constructed of inert materials designed to obtain samples with minimal agitation and contact with the atmosphere. The equipment will be cleaned and protected during transport to avoid contamination and checked before use. Dedicated equipment will be constructed of appropriate inert materials.

The laboratory will provide clean sterilized sample bottles of a suitable material which contain the correct chemical preservatives, for the analytical tests required. Samples will be properly labelled and delivered to the laboratory with proper chain of custody within all appropriate holding times for the parameters to be analyzed.

Monitor Well Sampling Techniques

Monitoring well sampling techniques will be consistently performed each time a well is sampled, and will comply with the following:

- Ambient air in the well will be checked for the presence of explosive or organic vapours before each well is evacuated;

- Standing water in each well will be checked for immiscible layers or other contaminants that are lighter or heavier than water (floaters or sinkers). If present, floaters or sinkers will be sampled and analyzed separately;

- Prior to purging, the volume of water in the well will be determined by measuring the total depth of the well and the depth to the water in the well. The depth to water will be recorded. These data will be used to calculate one well volume.

- Wells will be purged to replace stagnant water in the well and the sand pack to ensure that the water sampled is fresh water, representative of the formation. Evacuation methods, including pumping rate, depth of pump intake, and method of determining sufficiency of evacuation will be consistently applied each time the well is sampled. Evacuation methods which will create the least possible turbidity in the well and will not lower the water in the well below the top of the sand pack will be used whenever feasible. In general, bailing will be used to purge and sample wells.

  Evacuated water will be disposed appropriately. Currently the groundwater at the site is not anticipated to be contaminated; therefore, water withdrawn during the development of new wells or the purging of existing wells will be discharged to the ground surface downgradient and away from the immediate vicinity of the well (minimum 20 feet). Should at anytime contamination be found, evacuated water from affected wells will be contained and properly disposed.

- During the purging of each well the sampler will monitor specific conductance, temperature and pH with time in order to ensure fresh formation water. Typically, a minimum of three well volumes will be removed or the well will be purged until it goes dry.

  Groundwater samples will be obtained no more than 24 hours after well evacuation. The maximum 24 hour delay between purging and sampling the monitoring wells will only be utilized when there is insufficient recharge to allow the collection of an adequate volume of sample for analysis immediately after purging. Where possible wells will be sampled immediately after purging.

- Field analysis will be performed after volatile organic samples have been collected, either within the borehole using a probe or from the next sample collected. All field test equipment will be calibrated at the beginning of each sampling day and checked and recalibrated according to the manufacturer's specifications. Calibration data will be reported with analytical results.

- Groundwater samples will not be filtered, unless otherwise approved by the department. If, due to site-specific conditions, sample turbidity cannot be reduced to 50 nephelometric turbidity units (NTUs) or less by good sampling technique or well redevelopment, it may be necessary to request approval to collect both filtered and unfiltered samples for analyses of the inorganic parameters. All other analyses required will be on the unfiltered samples.

APPENDIX D

Surface Water and Sediment Sampling SOP

SURFACE WATER AND SEDIMENT SAMPLING PROCEDURE

Surface water and sediment sampling methods will be consistently applied to all samples, and will comply with the following:

- Surface water samples collected from shallow water will not include bottom sediment. In shallow moving water, downstream samples will be collected first to avoid disturbances from the bottom sediments.

- Each water body over three feet deep that is sampled will be checked for stratification, and each stratum will be checked for contamination using field parameters. Each stratum showing evidence of contamination will be separately analyzed. If no stratum shows such evidence, a composite sample having equal parts of water from each stratum will be analyzed.

- Depending on the type of surface water body, different types of water sampling tools will be utilized. These include, but are not limited to, filling sample bottles by hand, the Van Dorn or Kemmerer sampler and the APHA BOD sampler.

- In flowing water bodies discharge measurements will be made during spring and fall sampling events.

- In areas where less than four inches of water covers the sediment to be sampled, a trowel or stainless steel spoon will be used. Care will be taken not to disturb the sample or cause any sample washing.

- If the depth of water is greater than four inches, or washing of the sample is a problem, a revolving bucket sampler will be used to obtain a three-inch deep sediment sample. This sampler minimizes washing and contact of sediment with water. This device is good for softer sediments, but is difficult to use when the sediment is composed of dense clay or gravel. In this case, a hand corer will be utilized to obtain a sample.

- The sediment will be transferred directly to a sample container if a grab sample is requested. When composite samples are necessary, the sediment will be transferred to a stainless steel bowl or bucket. Additional samples will be added until all locations or sufficient volumes have been sampled. A representative sample will then be obtained and transferred to the sample bottles using a small spoon or spatula.

- Surface water and sediment samples will not be collected if the water body is frozen or if there is less than 2 inches of water.