Estimate for the volume of the Port Jefferson outwash fan deposited by a Wisconsian subglacial stream using well log data

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Abstract

Using publicly available municipal supply well data, the boundary of the Pleistocene and Upper Cretaceous beneath the Port Jefferson tunnel valley's outwash fan was identified. Outwash fan thickness estimates were interpreted from the well data by assuming that the sand, gravel and boulder deposits present at the surface represented the outwash fan outflow event. In cases where the outwash fan boundary was not distinct or could not be determined from the well data the first significant change in lithology or the Upper Cretaceous boundary was used. Underlying the outwash fan deposits are sands, gravels, clays and boulders representing a complex series of earlier glacial advances and retreats typified by moraine and till deposits reworked by glacio-fluvial/glacio-lacustrine and/or glacio-tectonic activity. Lithologic descriptions from Jensen and Soren (1974) and Smolensky et al. (1989), were used as guides in interpreting the well logs. The well data was used to construct three cross-sections using AutoCAD 2008. One cross-section is north of the outwash fan, the second is through it and the third is south of it. Upper Cretaceous sediments interpreted as the base of the former tunnel valley were identified approximately 300 feet below the deposition point of the fan deposits, confirming the initial hypothesis of Mulch and Hanson (2004) that the outwash fan was deposited by pressurized, sediment-rich, melt-water emerging from a sub-glacial resevoir. Placement of the Pleistocene/Upper Cretaceous boundary at two locations differed from the interpretations of Smolensky et al. (1989), who indicated a glacially excavated trench associated with the Ronkonkoma advance present beneath a portion of the outwash fan. I derived an estimated outwash fan sediment volume estimate of 675 million cubic meters, 6% larger than the 640 million cubic meters originally calculated from digital elevation models by Hanson (2000). Possible glacial-tectonic deformation is indicated in the well logs. Results of the research strongly support and corroborate the hypothesis of Mulch and Hanson (2004) that the outwash fan was deposited following a catastrophic draining of sub-glacial water stored in a glacial-tectonically excavated trench located off the current North Shore of Long Island, as noted by Lewis and Stone (1990). The outwash fan was deposited at some point during the Late Wisconsinan, although it cannot be determined if it was a single event or multiple events.

Table of Contents

FIGURES

TABLES

APPENDICES

Introduction

During the last glacial maximum, the termination of the continental ice sheet at what became the North Shore of Long Island resulted in the creation of multiple tunnel valleys. Of these tunnel valleys, the Port Jefferson tunnel valley is unique due to presence of an extensive outwash fan located at its terminus. In their analysis of the Port Jefferson Harbor area using corroborating evidence and Digital Elevation Models ("DEMs"), Mulch and Hanson, 2004 hypothesized that the tunnel valley and resulting outwash fan were the result of a catastrophic glacial outflow event. They hypothesized that melt-water from the glacier was stored sub-glacially to the north of present day Port Jefferson Harbor in a glacial-tectonically excavated trench where it accumulated until the outflow event. This current study utilizes sub-surface data to corroborate and further investigate the area beneath the outwash fan in order to gain more insight into its formation and the nature of the catastrophic outflow event.

Methodology

Detailed geologic cross-sections of the area surrounding Port Jefferson Harbor were compiled from publicly available well log data obtained from the Suffolk County Water Authority ("SCWA") and New York State Department of Environmental Conservation ("NYSDEC"). Supplemental sub-surface data was taken from the Port Jefferson Public Library's public copy of the United States Environmental Protection Agency's Remediation Investigation Report for the Lawrence Aviation Superfund site authored by Camp, Dresser and McKee ("CDM") and dated May, 2000. Well locations, elevation data and geomorphology were researched using data from three sources, 1:24,000 scale United States Geological Survey ("USGS") topographic maps, digital elevation models ("DEMs")(Hanson 2000) and Google Earth®.

A total of 3 cross-sections, designated A, B and C were completed for this paper, see Figure 1 and Figure 2. Cross-section A, consisting of six well locations (S4372, S24663, S31734, S23255, S32325 and S42504) transects the center of Port Jefferson Harbor and Port Jefferson outwash fan from north to south. Cross-section B, consisting of five well

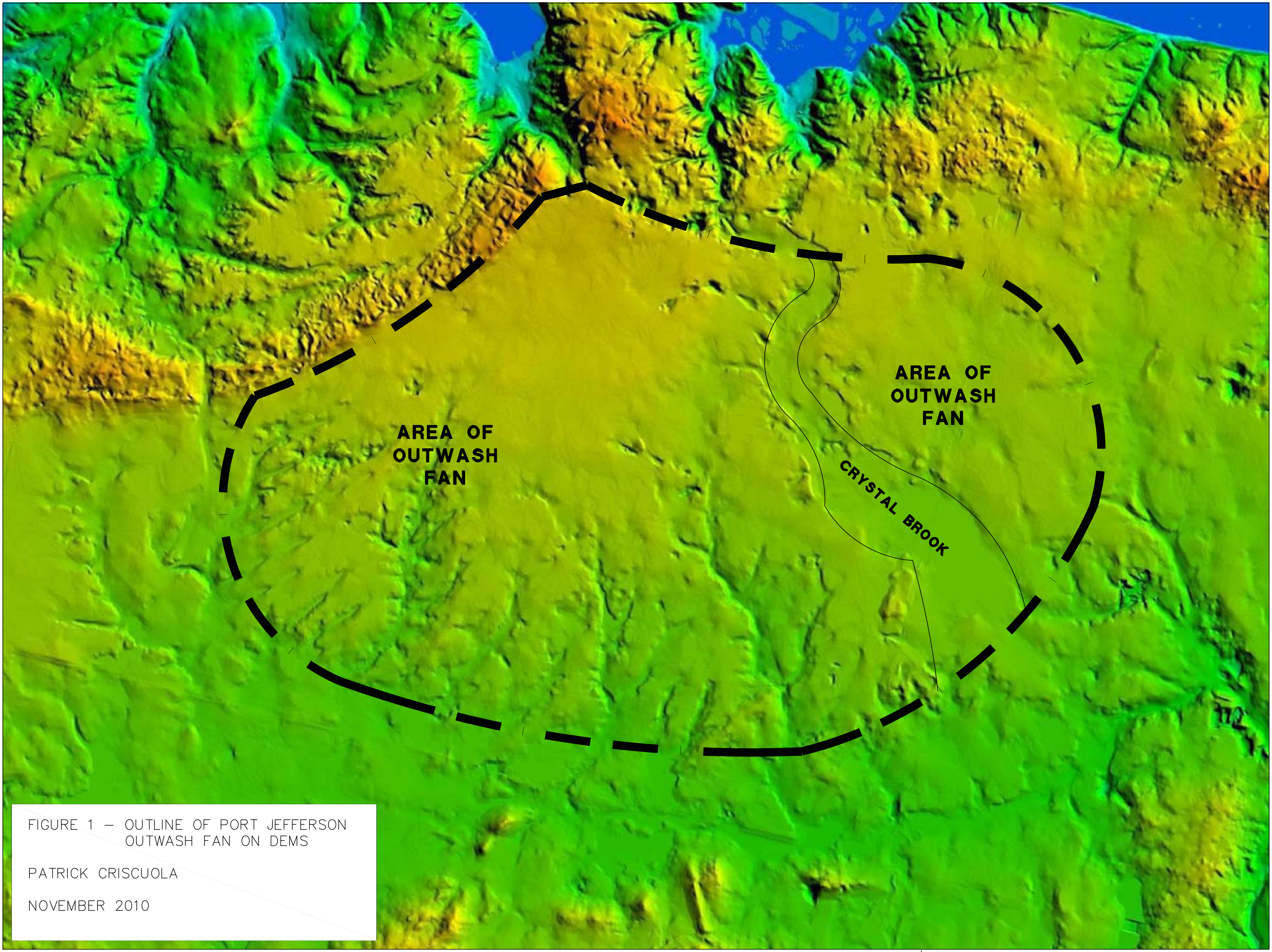

FIGURE 1 – OUTLINE OF PORT JEFFERSON OUTWASH FAN ON DEMS

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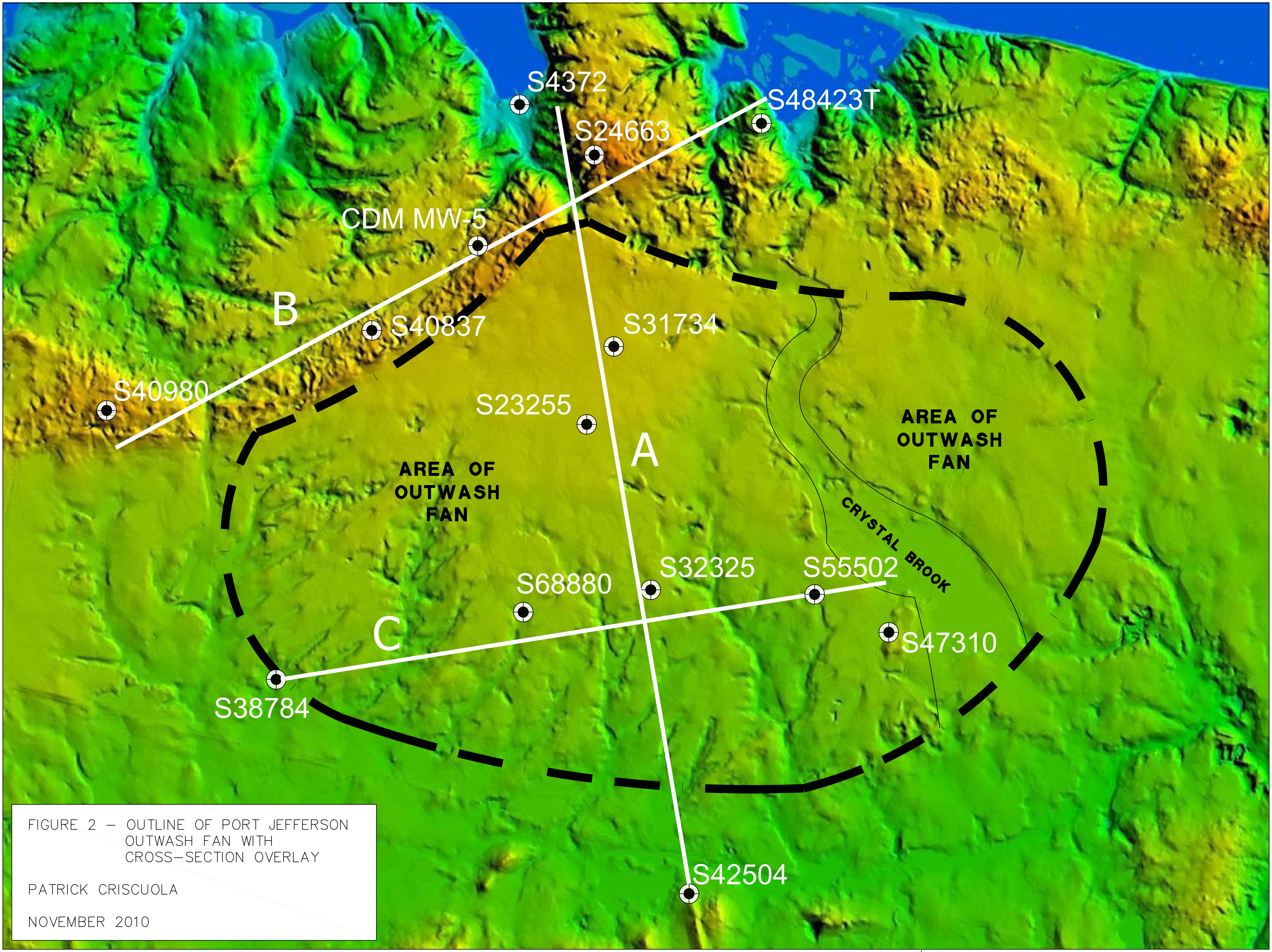

FIGURE 2 – OUTLINE OF PORT JEFFERSON OUTWASH FAN WITH CROSS–SECTION OVERLAY

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NOVEMBER 2010

locations (S38784, S68880, S32325, S55502 and S47310) transects the southern portion of the Port Jefferson outwash fan from west to east. Cross-section C, transects the Harbor Hill moraine from west to east and is comprised of six well locations (S40980, S37301, S48037, CDM MW-5, S24663 and S48423T). At each well location, the well log data was reviewed to determine the boundary between the Pleistocene glacial deposits and the underlying Upper Cretaceous deposits. Descriptions of the Pleistocene and Upper Cretaceous sediments in Jensen and Soren (1974) and Smolensky et al. (1989), were used as guides in interpreting the well logs. For the purposes of this research, only the Pleistocene glacial deposits were considered. Copies of the well logs are provided in Appendix X. The complete well log information, transcribed exactly as it appears in the NYSDEC/SCWA/CDM archives, is included for future reference by others.

Following review and interpretation of the well data, graphical cross-sections were drawn in AutoCAD 2008 that show the outwash fan, depth of the Pleistocene glacial deposits and their contact with the Upper Cretaceous deposits. Using this data set, the previous estimate of sediment volume in the Port Jefferson outwash fan proposed by Hanson (2000) was refined and a more accurate analysis of the catastrophic discharge of a large volume of sub-glacially stored meltwater proposed by Mulch and Hanson (2004) was prepared. This data set was also used to investigate the sub-surface glacial history of the Port Jefferson Harbor area in more detail.

Results

Sub-surface information in the well installation logs available for 14 well locations was sufficient to identify the boundary of the Pleistocene and Upper Cretaceous deposits with varying degrees of certainty. Sources of uncertainty within the data were several incomplete well log lithologic descriptions that omitted critical pieces of information such as sediment color or grain size. Another source of uncertainty in the data is that, with the exception of CDM MW-5, the available sub-surface data in the study area were collected from a hydrogeologic perspective during the installation of municipal supply wells. For this reason, the lithologic data were characterized by grain size (i.e. sand, gravel or clay) and less attention was paid to stratigraphy or glacial history.

Had the available data not been collected from a hydrogeologic perspective, other useful pieces of information important to this study would have been radiological analyses of core samples from boulders and ‘large stones’ encountered at depth (similar to Pacholik and Hanson 2001), radiological dating of mica grains at depth (similar to Pacholik and Hanson (2002)) and Pb isotope dating of pebbles or gravels at depth (similar to Guryn et al. 2010). This data would have been useful in determining origin and age of the sediments. In addition, an interesting source of data would have been palynological (study of fossilized pollen grains) assessments of clays encountered at depth that could provide definite temporal relationships between deposits and would compliment the biostratigraphic zonation research done by Sirkin (1986) on SCWA water wells further to the east and south. Data collected using this technique would be useful in conclusively placing sediments in the glaciers of the Pleistocene or the river-deltas of the Upper Cretaceous and could be an important method in resolving uncertainties resulting from the similarity of these deposits in well logs. Nevertheless, the available data yielded valuable information regarding the Pleistocene/Upper Cretaceous boundary in the area beneath the outwash fan and was suitable for the calculation of the outwash fan volume.

Summary of Well Log Data

Using the well log data, interpretations of the Pleistocene/Upper Cretaceous boundary and the estimated thickness of the Port Jefferson Harbor outwash fan, where present, are summarized. Uncertainties within the data are explained and expounded upon. Interpretations of the descriptions of Pleistocene and Upper Cretaceous sediments used in Jensen and Soren (1974) and Smolensky et al. (1989), were used to place the sediments.

Well Log Data

S4372: This well is located geographically north of the outwash fan, at the mouth of Port Jefferson Harbor. Upper Cretaceous sediments are encountered in the form of red sand and gravel at 100 feet below grade. Whether the overlying gravel and sand from 37 to 92 feet is glacial or Cretaceous is difficult to tell because as detailed below, in S24633, medium sands and gravels with white clay, strongly suggesting the Upper Cretaceous, overly red sand deposits. The proximity of the well to the harbor means that the deposits at 37 feet and above are likely of recent marine origin. The deposits are clearly of Upper Cretaceous origin at 92 feet below grade. Due to the lack of more detailed lithologic information, 92 feet below grade is an upper bound estimate for the Pleistocene boundary at this location. Since the well is located north of the outwash fan, no estimate of the fan's thickness can be made at this location.

S24663: At a depth of 80 feet below grade, a lithology change from large gravel, brown sand and boulders, characteristic of glacial deposits, to the finer sand, gravel and white clays indicates the boundary of the Upper Cretaceous deposits. Since S24663 is located north of the outwash fan on a portion of the Harbor Hill moraine, no estimate of the outwash fan's thickness can be made at this location.

S31734: Pleistocene sediments are present at a depth of 130 feet below grade. The underlying fine to coarse gray sand and streaks of gray sandy clay indicate the Upper Cretaceous. This boundary is in agreement with Smolensky et al. (1989) who included this well in their report. Since the 115 foot thick interval of glacial sediments is logged as 'sand, gravel and stones' and the well is located at the relative up-gradient portion of the outwash fan, the total thickness of the glacial sediments is used as the estimated fan thickness.

S23255: Pyrite was identified at approximately 159 feet below grade, placing these sediments in the Upper Cretaceous. At least two glacial advances and retreats, indicated by the sequences of sand/gravel/stones and brown clays, overly the Upper Cretaceous deposits. Due to the lack of more detailed information, the 122 foot thick interval of overlying glacial sediments, above the first clay interval at 126 feet below grade, is considered as representative of the outwash fan thickness.

S32325: Lignite was identified at a depth of 157 feet below grade, indicating the Upper Cretaceous. From 85 to 137 feet, there is uncertainty if the 'fine to medium to coarse brown sand and gravels with clay strips are of glacial or Upper Cretaceous origin. As such, the boundary was placed at 85 feet below grade. Within the Pleistocene deposits, the change in lithology above 39 feet below grade, is taken to be the thickness of the outwash fan.

S68880 / S58761:

S68880: At a depth of 168 feet below grade, a lithology change from medium to coarse gray and brown sand with stones to fine to medium brown sand overlying sandy white clay and multi-color sandy clay indicates the Upper Cretaceous. Medium to coarse gray sand, gravel and rocks overlying coarse brown sand, gravel and stones in the Pleistocene deposits are considered to be representative of the outwash fan, thus, a thickness of 65 feet is inferred from this location.

S58761: Pleistocene deposits are present to a depth of 180 feet below grade at which point, the multicolored clay and layers of hardpan indicate Upper Cretaceous deposits.

S55502: Deposits from 252 to approximately 325 feet below grade strongly indicate the Upper Cretaceous, however, from 384 to approximately 493 feet below grade, the lithologies strongly indicate Pleistocene glacial deposits. This data indicates possible faulting of the sediments due to glacial-tectonic action, resulting in Pleistocene deposits overlying Upper Cretaceous deposits, which in turn overly relatively intact Pleistocene deposits. At this location, the thickness of the outwash fan is taken to be 67 feet, due to the presence of brown clays at 68 feet. This thickness estimate is consistent with wells S68880/S58761, located horizontally within the outwash fan, with respect to gradient.

S42504: To a depth of 105 feet below grade, the sediments appear to be of glacial origin. Beneath 105 feet, the fine to coarse brown sand, small stones and gravels can not be confidently confirmed as of glacial origin, and may be within the Upper Cretaceous deposits. This well is located geographically south of the outwash fan and was provided to frame the study area.

S40980: At 220 feet below grade, the coarse brown sand, gravel and boulder deposits indicative of glacial origin change to fine to medium gray sands and gravels, beneath which the characteristic clays and finer sediments of the Upper Cretaceous begin. This well is not located within the area of the outwash fan, thus no estimate of the outwash fan thickness can be made at this location.

S40837: At approximately 180 feet below grade, the deposits transition to a hardpan, cemented formation, giving a strong indication of the Upper Cretaceous. Other hardpan formations are seen at depths of 438, 446, and 590 feet below grade, are clearly within the Cretaceous sediments. However, there is much uncertainty between 160 and 180 feet below grade, as no colors were recorded for the sediments. The 'lumps of brown clay' indicated in the 160 to 180 foot interval are assumed to be of glacial origin because brown is the typical color of clays originating in the Pleistocene. This well is not located within the hypothesized area of the outwash fan, thus no estimate of the outwash fan thickness can be made at this location.

CDM MW-5: Cobbles identified at 65 feet below grade indicate that the boring is within the Pleistocene deposits. Varve deposits were identified at approximately 90 feet below grade. Depth of the Upper Cretaceous sediments appears to begin at or around 100 feet, due to the underlying well-sorted white sands and very fine-grained brown sands and silt. This well is not located within the hypothesized area of the outwash fan, thus no estimate of the outwash fan thickness can be made at this location.

S48423T: The glacial deposits appear to end at approximately 71 feet below grade. Alternating intervals of medium to fine brown sand and gray clay are indicative of Upper Cretaceous deposits. This well is not located within the hypothesized area of the outwash fan, thus no estimate of the outwash fan thickness can be made at this location.

S38784: From the information supplied in the drill log, the 'large stones and fine gray sand' interval at approximately 154 feet below grade, is assumed to represent glacial till deposits (large stones) contacting the underlying fine gray sands of Upper Cretaceous age. This erosional contact may have been excavated at a prior advance and recession during the Pleistocene, as indicated by the approximately 53 feet of outwash coarse brown sand and gravels and overlying gray sands and clays. This well is located on the margin of the hypothesized outwash fan area. Thus, for the purposes of calculating the outwash fan, the thickness is taken as 0.

S47310: At 231 feet below grade, the fine gray sand with white clay and iron oxide strongly indicates the Upper Cretaceous. Pleistocene glacial deposits can be placed confidently at 135 feet below ground due to the presence of 'large stones' in the well log. However, there is uncertainty from 135 to 201 feet below grade as to whether the deposits are of glacial origin or were deposited in the Upper Cretaceous. The thickness estimate of the outwash fan is 65 feet below grade due to the change in lithology at that depth.

Table 1 provides a summary of the Pleistocene/Upper Cretaceous boundaries and outwash fan thickness estimates.

Well Id.	Upper Cretaceous Depth (ft)	Outwash Fan Thickness (ft)
S4372	92	None
S24663	80	None
S31734	130	115
S23255	159	122
S32325	85	39
S68880 / S58761	168 / 180	65
S55502	?? - Faulting	67
S42504	105	None
S40980	220	None
S40837	180	None
CDM MW-5	100	None
S48423T	71	None
S38784	154	0
S47310	135	65

Table 1 – Summary of Well Log Data

The boundary of the Port Jefferson Fan, is presented on Figure 1. As indicated in the DEM, Crystal Brook has eroded the eastern margin of the outwash fan. Using the topographic geometry visible on the western margin, the extent of the eastern margin, prior to being obscured by subsequent erosional or depositional events, is inferred. Data for seven wells (S31374, S23255, S32325, S68880, S55502, S38784 and S47310) were utilized to provide thickness estimates of the Port Jefferson Fan, as summarized on Table 2. Figure 2 shows the three cross-sections superimposed on the DEM. Due to the vertical exaggeration of 20:1 chosen for the cross-sections, there is significant distortion of the topography.

Well Id.	Cross-Section	Outwash Fan Thickness (ft)
S31734	A	115
S23255	A	122
S32325	A & C	39
S68880 / S58761	C	65
S55502	C	67
S38784	C	0
S47310	C	65

Table 2 – Summary of Well Log Data within Outwash Fan

Results of Cross-Sections

Please see Figure 3 – Cross-Section A: Cross-Section A is north to south from the mouth of Port Jefferson Harbor to the Ronkonkoma moraine and bisects the outwash fan. The northern portion of the cross-section includes the mouth of Port Jefferson Harbor (well S4372) and the Harbor Hill moraine (well S24663). In the cross-section, the surface of the outwash fan slopes gently to the south at wells S31734, S23255 and S52490/S32325. The fan ends about 1.25 miles south of S52490/S32325, at which point the Ronkonkoma moraine becomes visible at S42504. Based on the location of well S4372, at the mouth of the tunnel valley, Cretaceous sediments at 92 feet below sea are considered to represent the former floor of the tunnel valley. In cross-section, the elevation of the top of the outwash fan is approximately 190 feet above sea level. The difference in elevation

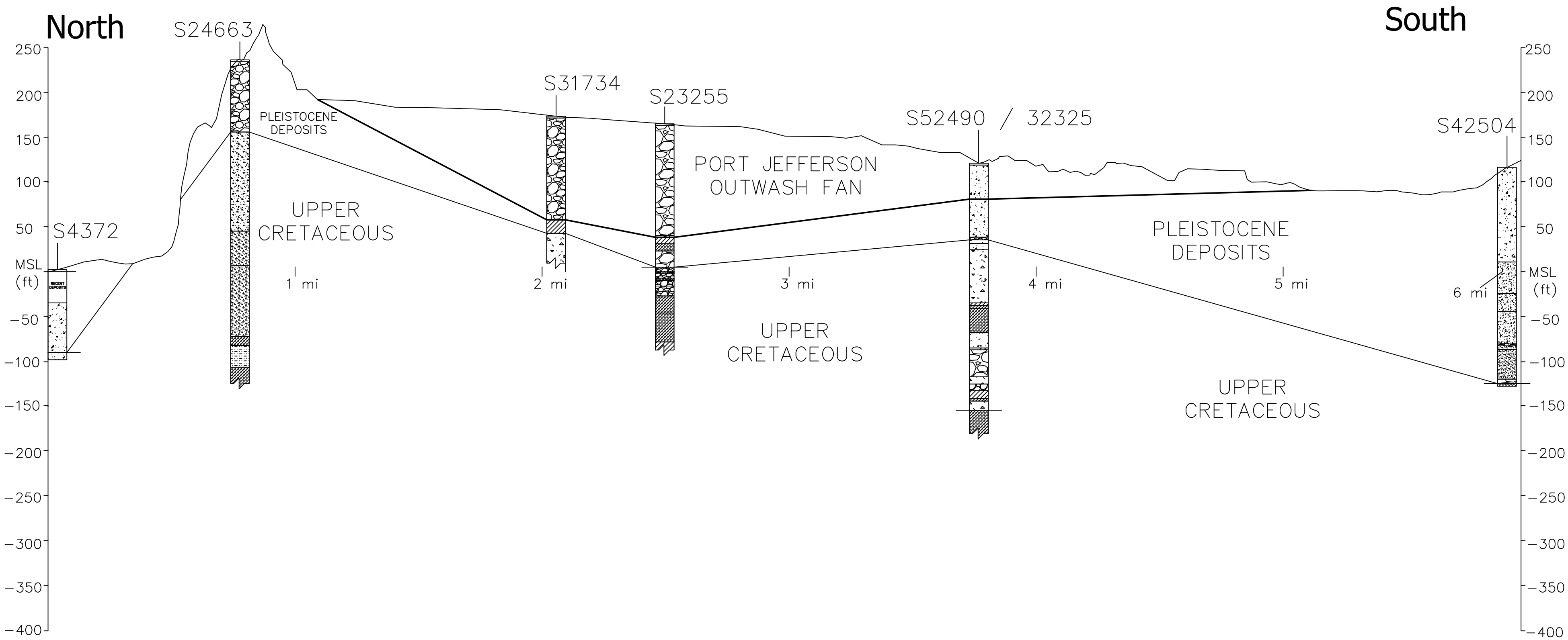

FIGURE 3 – CROSS-SECTION A PORT JEFFERSON OUTWASH FAN
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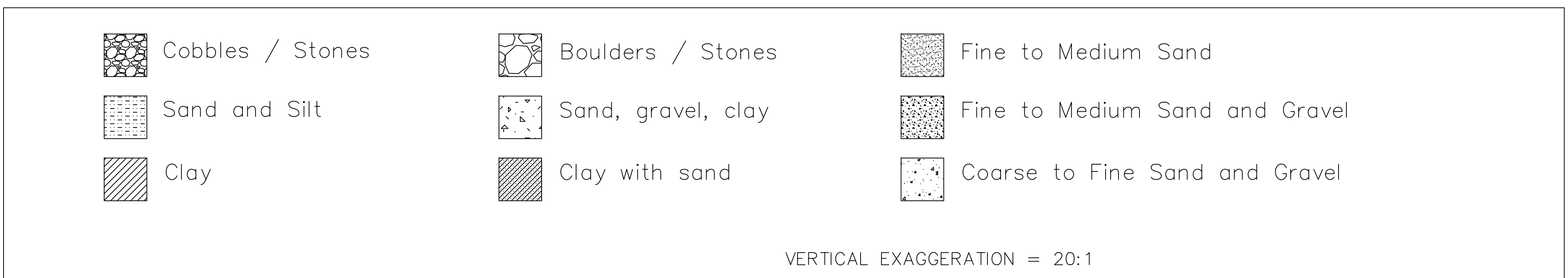

between the infilled base of the tunnel valley and the top of the outwash fan is approximately 282 feet.

Please see Figure 4 – Cross-Section B: Cross-Section B includes a profile view of Port Jefferson valley. Wells S40980, S40837 and CDM MW-5 are located west of Port Jefferson Valley and sit on the arcuate Stony Hill Moraine portion of the Harbor Hill Moraine. Wells S24633 and S48423T sit on the interlobate moraine portion of the Harbor Hill Moraine. Varve deposits identified in the CDM MW-5 soil boring at an approximate depth of 100 feet above sea level were the only ones identified in the soil borings. None of the five wells used in this cross-section are located on the outwash fan. This is supported by the fact that Upper Cretaceous deposits were confirmed to be visible at the surface between CDM MW-5 and S24663 (Hanson 2010). From the cross-section, the area in the vicinity of the tunnel valley appears to have been deformed by glacial tectonic action, because it is higher in the sub-surface as compared to the same deposits to the west and east.

Please see Figure 5 – Cross-Section C: Cross-Section C transects the southern portion of the outwash fan. Several sub-aerial streams at the margin of the outwash fan, visible in the DEM, can be seen in the cross-section. Well S38784 is located on the margin of the fan, with S58761/S68880, S32325, S55502 and S47310 being located across the south portion. Based on the well data, the thickness of the outwash fan deposits appears to be consistent from west to east. Possible glacial-tectonic faulting indicated in well log S55502 likely occurred prior to deposition of the outwash fan. Wells S68880 and S58761 are located at the SCWA Boyle Road facility. Smolensky et al. (1989), includes S58761 in their report, but place the Pleistocene and Upper Cretaceous boundary at a depth of approximately 800 feet below grade. However, based on a review of the well log data from both S58761 and S68880, a more accurate placement of the boundary is at 168 to 180 feet below grade surface.

Estimate of Outwash Fan Volume

To calculate the volume of the outwash fan, numerical integration was used.

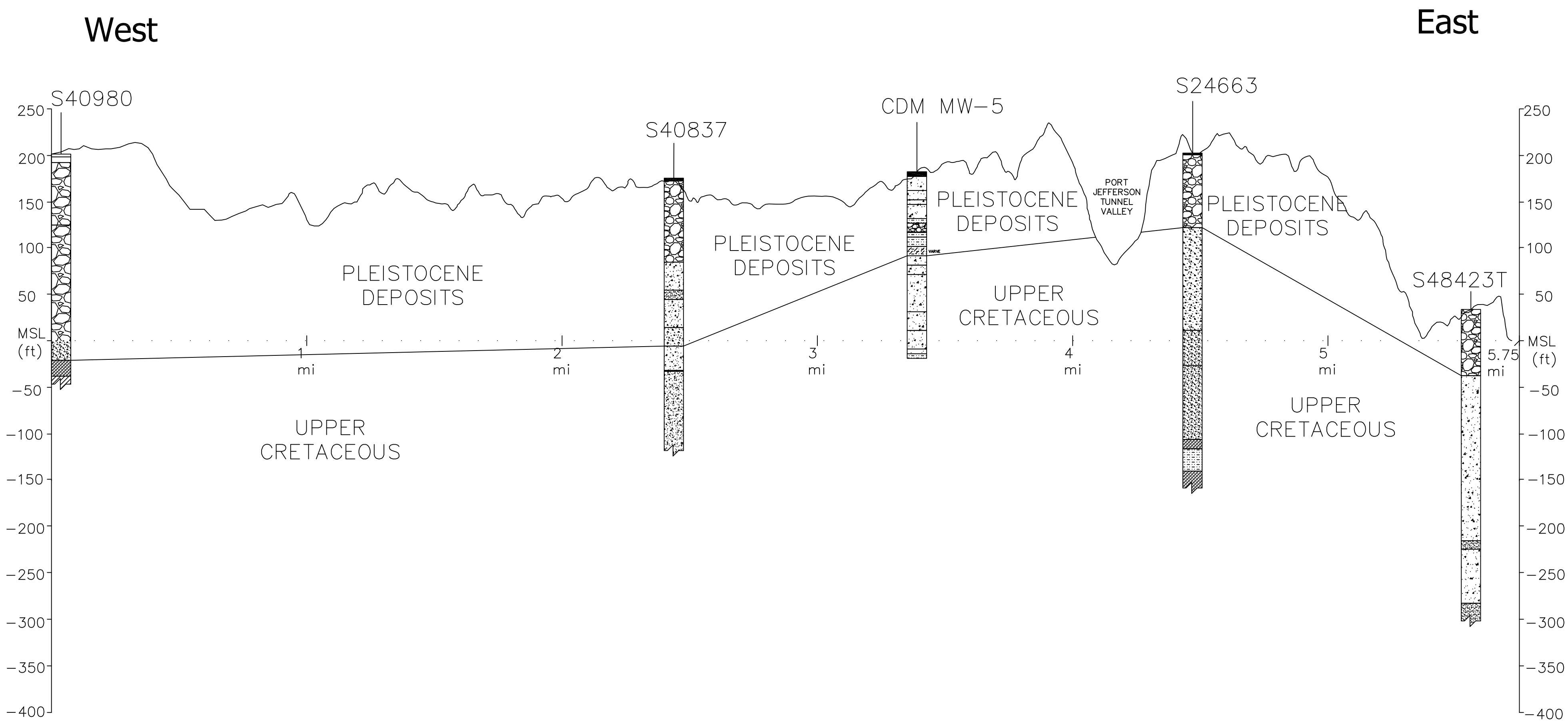

FIGURE 4 – CROSS-SECTION B PORT JEFFERSON OUTWASH FAN
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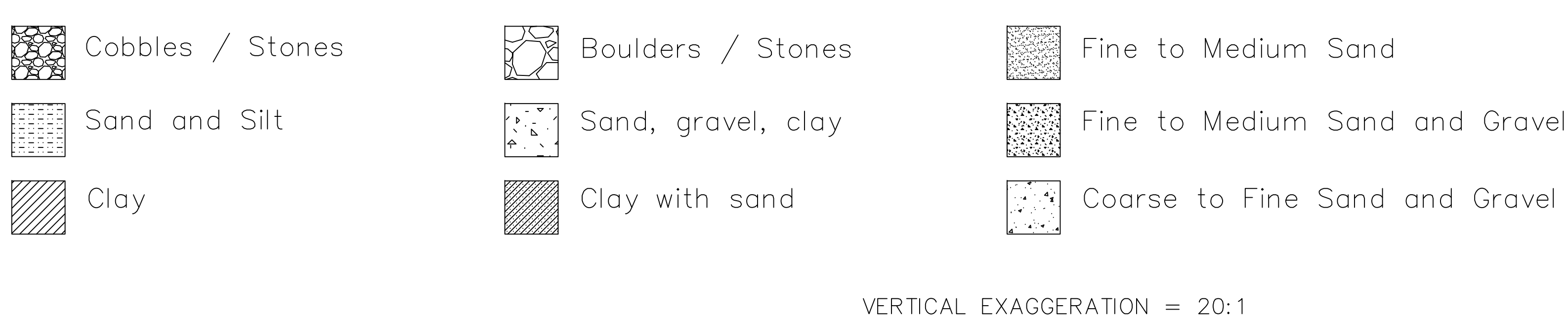

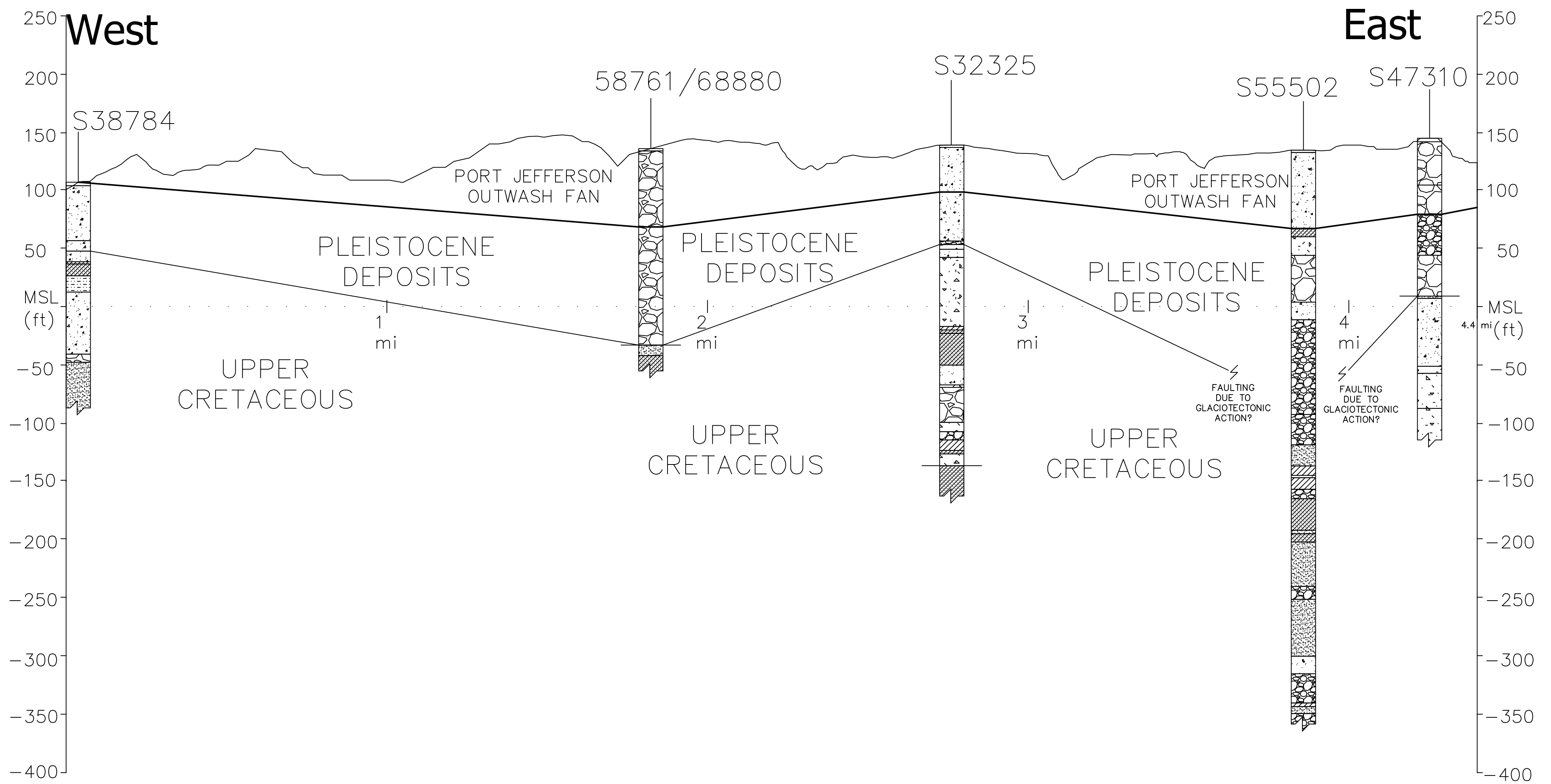

FIGURE 5 – CROSS–SECTION C PORT JEFFERSON OUTWASH FAN
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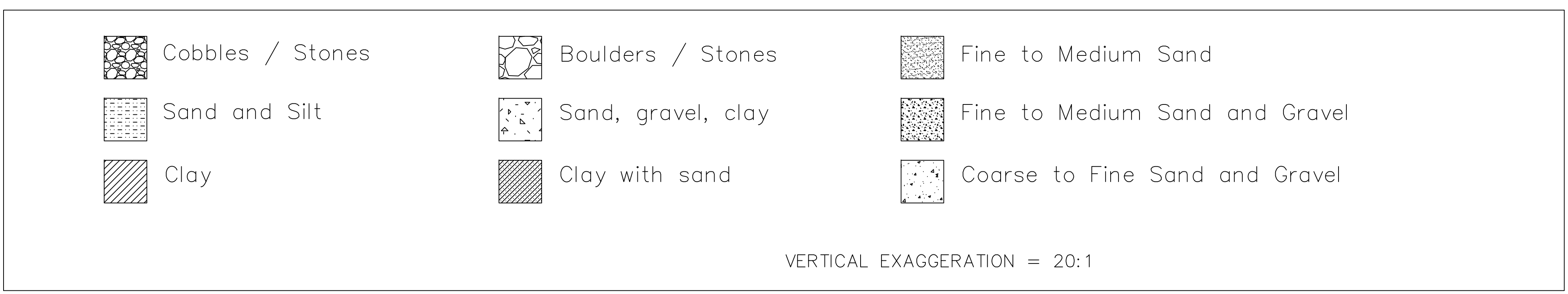

Using the built-in features of AutoCAD, the cross-sectional area of the outwash fan in Cross-Section A was divided up into a rectangle and five right triangles. The sum area and each individual polygon area was measured with AutoCAD. Using this data, the percentage area of the individual polygon to the total polygon was calculated in a spreadsheet. AutoCAD was then used to measure the pertinent height segment of each polygon. Heights measured from each triangle were then divided by two to get the average height of the polygon. Average heights from all polygons were then divided by their respective percentage of the total area. These average heights per percentage of total area values were added together and divided by the vertical exaggeration. An average height (thickness) of 55.14 ft across the entire outwash fan was thus obtained.

Using the Global Mapper software, the surface area of the outwash fan was measured several times and determined to be approximately 15.5 square miles (432,115,200 square feet). The volume estimate of the outwash fan was calculated by multiplying the surface area by the calculated average height. Volume of the outwash fan was calculated to be 23,826,832,128 square feet or 674,700,750 (675 million) cubic meters.

Hanson (2000) estimated the volume of the outwash fan to be 640 million cubic meters, as inferred from DEMs. The current estimate was obtained by taking into account sub-surface data from well logs, which likely represents the additional ~35 million cubic meters of material.

Well information from S4372 places the approximate depth of the tunnel valley at approximately 92 feet below sea level at the mouth of the harbor. Continuing from Hanson (2000), if Port Jefferson Harbor is a trapezohedron of 1,000,000 square meters with an above sea level depth of 50 meters and a below sea level depth of 30.7 meters (depth of Cretaceous sediments at S4372), the volume equals 80.7 meters multiplied by 1,000,000 square meters, for a total of 80.7 million cubic meters of deposited sediment. This estimated volume does not account for the subsequent sub-aerial or fluvial erosion, and thus the actual amount of sediment originally deposited in the outwash fan was likely greater.

Discussion

Smolensky et al (1989), in their north to south Cross-Section G-G', place a trench at the location of well S58761 that appears similar in depth and width to the current Long Island Sound. Cross-Section A, completed for this report, includes two of the same well locations (S31734 and S58761), and closely mirrors the Cross-Section G-G'. Information from well S40381 was not obtained, as this location is too far south to be pertinent to the outwash fan. Smolensky et al's interpretation of the well logs indicates well locations S58761/S68880 as having Pleistocene deposits down to a depth of approximately 800 feet below grade. Current interpretations from both wells at the SCWA Boyle Road property strongly indicate that the multi-colored clays at approximately 190 feet below grade are of Upper Cretaceous origin, and there is no indication of deposition by the Pleistocene glaciers in the deposits below this depth. The current interpretation of the well data available places the Pleistocene/Upper Cretaceous boundary at well location S68761/S68880 at a depth of 168 to 180 feet below grade.

Given the size and depth of the trench indicated by Smolensky et al., it would be expected to appear in well S38784 to the west or S55502 to the east in Cross-Section C. No evidence of the existence of the structure is present in the wells logs or cross-section of Cross-Section A. There appears to be a deepening from well S52490 to S42504, but, as indicated, the maximum depth is approximately 125 feet below grade.

In reviewing the well log data from S55502, there is a strong indication of glacial-tectonic faulting that results in Pleistocene deposits overlying Upper Cretaceous deposits that in turn overly relatively intact Pleistocene deposits. This well log indicates that glacial-tectonic action was responsible for altering a portion of the Upper Cretaceous sediments. Glacial-tectonic deformation of sediments have been recorded in various locales throughout the area (Hanson 2010) and thus their occurrence in the deeper deposits is plausible.

The results of the well log data analysis and cross-sections place the Pleistocene/Upper Cretaceous boundary at the SCWA Boyle Road Facility (wells S58761 and S68880), at a depth significantly different than Smolensky et al (1989). Smolensky et al.'s report is an important source of information regarding the glacial advance represented by the Ronkonkoma terminal moraine. Smolensky et al.'s interpretation of the well log data, implies that the Ronkonkoma moraine sits adjacent to a glacially excavated trench that is identical in outline to the current north shore of Long Island. The figure provided in Smolensky et al. indicates that the Harbor Hill and Ronkonkoma advances are successive, identical, events that are expected to have identical trench/former shoreline/terminal moraine complexes. Study of the Ronkonkoma glacial advance is difficult because the major source of available information is well log analysis, and the moraine is covered by later glacial advances. If Smolensky et al.'s hypothetical sub-glacial trench in fact does not exist, then re-examination of the current hypotheses concerning the Ronkonkoma glacial advance should be evaluated, and additional sub-surface investigation using SCWA well log data appears warranted.

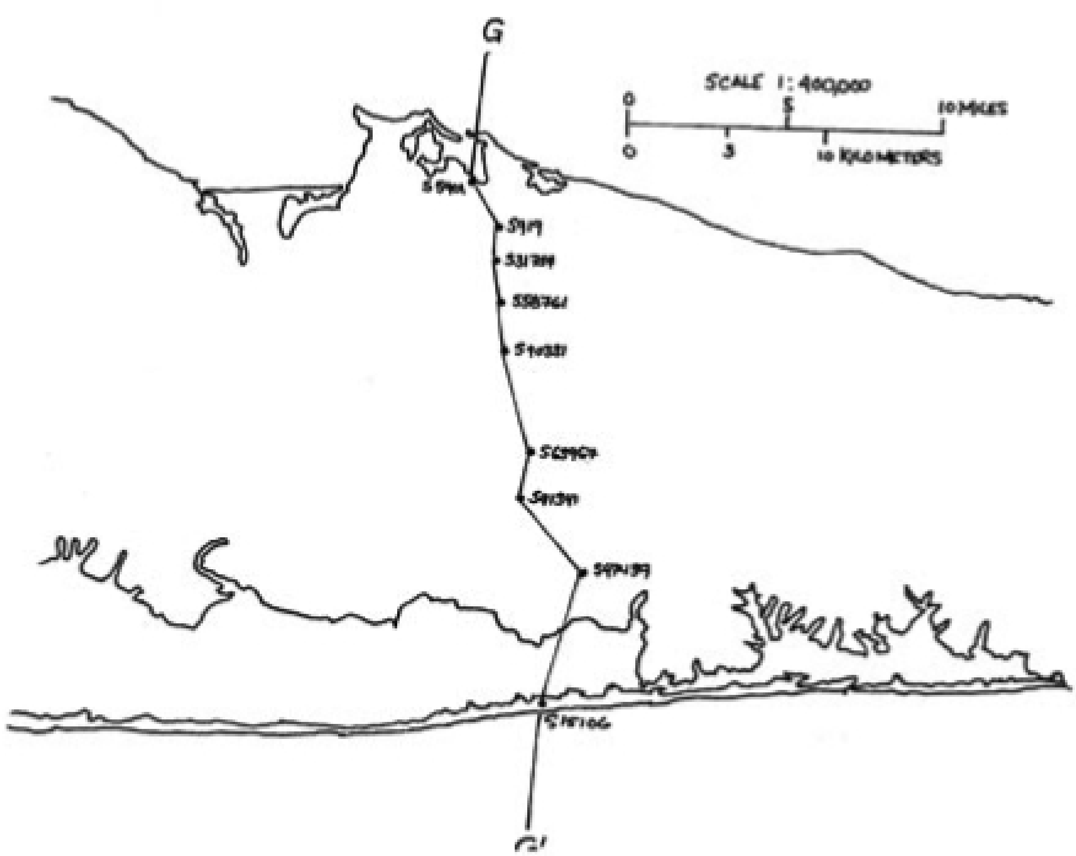

Figure taken from Smolensky et al. (1989), showing Cross-Section G to G'. Wells S31734 and S58761 are the third and fourth wells respectively, from the north.

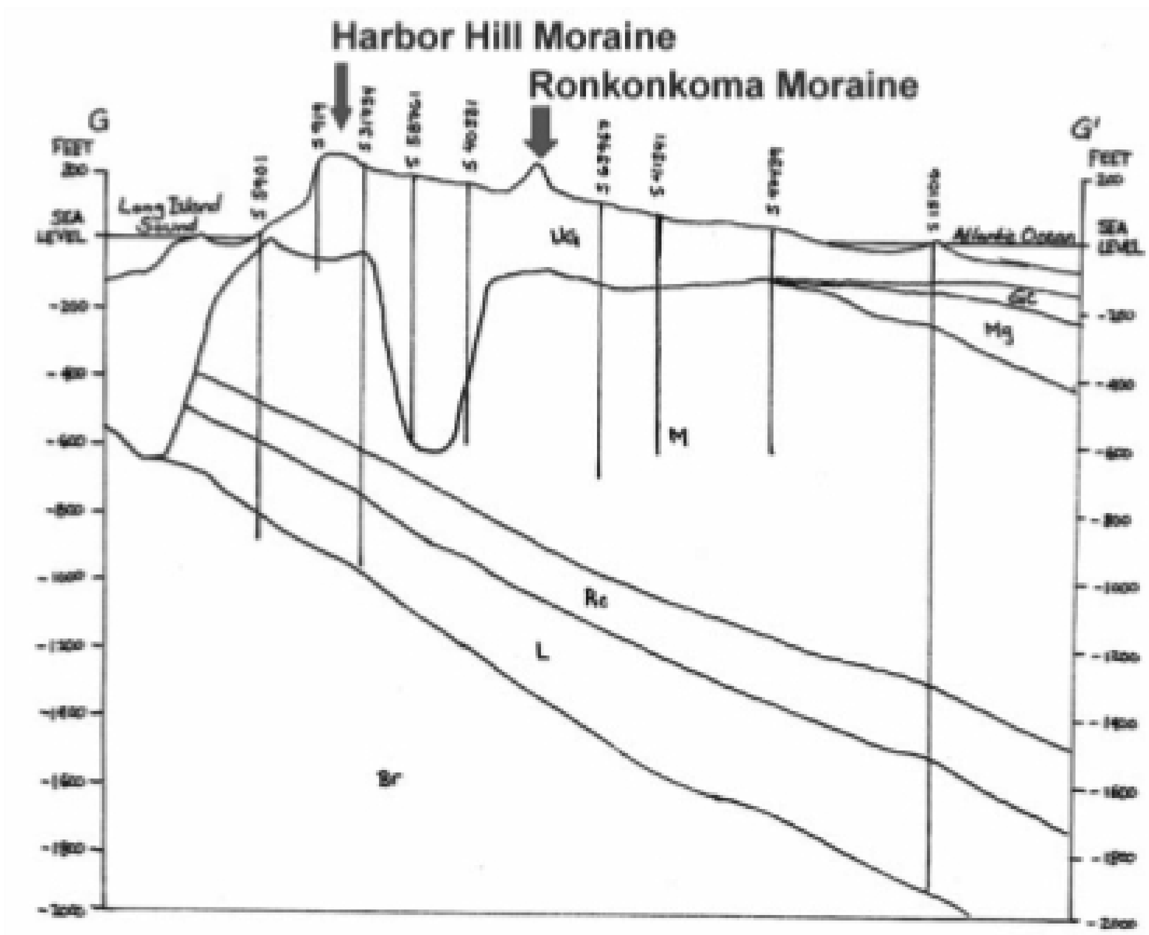

Figure taken from Smolensky et al. (1989) showing interpretations of well log data along Cross-Section G to G'. The current interpretation does not indicate the trench structure shown at well S58761.

Mulch and Hanson (2004) conducted a detailed geomorphologic analysis of the Port Jefferson area using DEMs. The tunnel valley responsible for depositing the outwash fan cuts through the Harbor Hill Moraine, indicating that the outwash event occurred during the last glacial maximum and constrains it to the late Wisconsinan. Deposits from the outwash fan lap onto the edge of the Stony Brook Moraine, indicating that the moraine existed prior to the event. Based on the geomorphologic evidence, the outwash fan would have been deposited at a time after the continental ice sheets had reached their maximum and were beginning to recede (melt). The authors conclude that the Port Jefferson valley, including the harbor, is the remnant of a tunnel valley fed by a sub-glacial lake and the resulting outwash fan is from a catastrophic sub-glacial discharge.

Mulch and Hanson (2004) further hypothesized that the bulk of the water originated from a hypothesized glacially excavated trench, known as Grim's Trench, suspected to be located north of the harbor and concluded that if water entered Grim's trench and exited through the Port Jefferson valley, it should have easily cut through the Cretaceous sediments and left a noticeable incision.

Lewis and Stone (1991) reached a similar conclusion, as detailed in the results of their detailed seismic study that included the area north of Long Island Sound. The study showed a valley filled with glacial sediments deepening to the north, and extending out of Port Jefferson Harbor, cutting the Cretaceous sediments (Figure 6 in Lewis and Stone). Although Lewis and Stone, 1991, did not provide more than a note on the location of the incisement in the Cretaceous sediments, information from well S4372, located at the mouth of Port Jefferson Harbor, constrains the maximum depth that the tunnel valley could have incised during its formation. West Broadway Wells #2 and #3, included in Mulch and Hanson (2004) are located to the west of the mouth of the harbor; the depths of the Cretaceous sediments are similar to S4372. As indicated in personal correspondence with Dr. Hanson (2010), Cretaceous sediments are present at the surface in and around the base of the Port Jefferson Valley, and appear to have undergone glacial tectonic actions, as indicated in Cross-Section B.

In the previous study by Mulch and Hanson, the volume of sediment contained within the outwash fan was compared to the volume of sediment removed during the formation of Port Jefferson Harbor, in order to test the hypothesis of a catastrophic origin. Hanson (2000) calculated that there is about 10 times as much sediment in the outwash fan, as compared to the volume of Port Jefferson Harbor. Mulch and Hanson (2004) concluded that this ratio indicates that the sediment-rich water responsible for these formations originated from a sub-glacial reservoir, and the outwash fan contains more than reworked morainal deposits or tunnel valley erosion. The refinement of the estimate in Hanson (2000) through sub-surface data indicates that the ratio of outwash fan sediments to tunnel valley volume is closer to a 8.36 to 1 difference. This more accurate estimate corroborates Mulch and Hanson's conclusion for the catastrophic deposition of the fan.

Benn and Evans, 1998 (pg. 333), in further defining tunnel valleys state that: “The surfaces of these [large subaerial ice-contact fans] may lie up to 100m (300 feet) above the tunnel valley bottom, reflecting deposition from pressurized meltwater emerging from beneath the ice.” As indicated in the data, the top of the outwash fan (i.e. point of deposition) is approximately 282 feet above the base of the tunnel valley indicated in well S4372. Figure 10 provided by Mulch and Hanson (2004) and Cross-Section A of this report includes a hypothesized potentiometric surface of the glacial hydrology. Using this hypothesis, the point of sediment deposition is almost 300 feet above the base of the tunnel valley, but is below the hypothesized potentiometric surface of the glacier, indicating that a high pressure outflow of water and sediment is a plausible scenario.

Large amounts of glacial melt-water have been stored on the north shore of Long Island, as indicated by multiple, successive, pro-glacial lacustrine environments, the largest being former Lake Connecticut, which occupied the current Long Island Sound (Lewis and Stone, 1991). A known second major pro-glacial lacustrine environment in the study area is the extensive clay deposit informally known as the “Smithtown Clay” (Krulikas et al., 1983). Varve deposits identified in CDM MW-5 at a depth of 90 feet below grade (128 feet below sea level) are located within the Harbor Hill terminal moraine. Based on Figure 3 in Krulikas et al. (1983), the estimated depth of Smithtown Clay in the area of Port Jefferson Harbor would be approximately 25 feet above NGVD. The depths of the varve deposits idenified in CDM MW-5 indicates that these deposits would represent the northern most existence of the clay unit in the area of Port Jefferson Harbor, if in fact they are a part of it. Other varved deposits, not related to the Smithtown Clay, are expected to be present in this area, as indicated in Lewis and Stone, 1991. Further investigation of this area is required to determine the stratigraphic position of these varve deposits.

In reconstructing the chronology of the outwash event, it would be expected that large amounts of water from the terminally melting glaciers could be stored subglacially and subsequently be constrained by the recently formed Harbor Hill Moraine and/or a complex of ice dams. Based on the research by other authors and this current data set, it is hypothesized that this terminally melting glacier's sediment-rich water was stored to the north of Port Jefferson Harbor in a previously glaciotectonically excavated trench, as indicated by Grim et al. 1970 and noted by Lewis et al. (1997). This volume of water, more than had been present in this area prior to the recession of the ice sheet, was stored until the capacity of the probable ice-dams and recently formed Harbor Hill terminal moraine were exceeded, at the point that came to be known as the Port Jefferson Tunnel Valley. This mass of sediment-rich water was then spectacularly and catastrophically released with enough force to lift gravels, cobbles and boulders almost 300 feet in the air to be deposited as the Port Jefferson outwash fan. Recent examples of catastrophic glacial outburst floods similar to the hypothesized event in question have been documented in the modern era and are known by the Icelandic term Jökulhlaup. An eyewitness account of such an event that occurred in 1934 is included in Benn and Evans, 1998 (pg. 117):

"….On the morning of March 31st, the glacier burst reached its climax. 40-50,000 cubic meters of muddy grey water plunged forth every second from under the glacier border bringing with it icebergs as big as three storyed houses. Almost the whole of the sandur, some 1,000 km^2 in area was flooded. At 17.30 hr the same day, the burst suddenly started to abate, and by the following morning the discharge of the Skeidera was normal."

As indicated by this account, it is likely that the entire sub-glacial reservoir of water was released in a matter of hours in a brief but incredibly destructive outpouring. Given that the resulting outwash fan is relatively intact and that incised through the Harbor Hill terminal moraine, the event was likely a spectacular finale of the Later Wisconsinan continental ice sheet on Long Island.

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Appendix X
Well Log Data

SCWA Test Well
NYSDEC Well No. S23255, 46928 and 121599

Location: Jayne Boulevard, Terryville
Elevation: 165.78 above MSL
Depth: 659

S-Number	Thickness	Total Depth	Description
S-23255	0	2	Loam
	122	124	Fine to medium brown sand, gravel, large stones
	2	126	Brown clay, large stones, streaks of fine sand
	7	133	Solid brown clay
	8	141	Brown clay, streaks of fine sand
	18	159	Coarse brown sand and gravel, large stones, hardpan
	21	180	Coarse sand and gravel, stones, gray clay strips, hardpan, pyrite
	11	191	Coarse to medium sand, heavy gravel and stones
	19	210	Fine gray sand with sandy gray clay
	32	242	Fine to coarse sand, multicolored clay, hardpan
	9	251	Solid multicolored clay
	30	281	Fine to coarse sand, gravel, stones, multicolored clay, hardpan
	9	290	Solid multicolored clay
	5	295	Multicolored clay, streaks of fine sand
	10	305	Fine to coarse sand, gray and multicolored clay
	5	310	Solid multicolored clay
	15	325	Gray clay with some fine sand
	4	329	Multicolored clay
	60	389	Fine to coarse pink sand and gravel, multicolored clay, hardpan
	5	394	Solid multicolored clay
	19	413	Coarse sand and gravel with multicolored clay streaks
	2	415	Solid white clay
	3	418	Fine to coarse white sand with white clay
	22	440	Fine to coarse sand with streaks of pink and multicolored clay
	61	501	Fine to coarse pink and white sand
	6	507	Brown and white clay
	2	509	Solid white clay
	9	518	Fine to coarse sand with streaks of white clay
	29	547	Coarse sand with gray and black clay
	15	562	Sandy white multicolored clay
	5	567	Solid white clay
	7	574	Medium to coarse gravel with white clay
	5	579	Grits, white clay, hard pan and stones
	1	580	Sandy gray clay
	3	583	Multicolored clay
	5	588	Fine to coarse sand, gravel and stones, bits of pink clay
	13	601	Fine to coarse sand, gravel with stones, chunks of white clay
	33	634	Fine to coarse sand, streaks of gray clay
	6	640	Fine to coarse sand and gravel, stones, chunks of white clay
	8	648	Fine to coarse gray sand, streaks of gray and white clay
	11	659	Gray clayey sand

Notes:
________ Start of Magothy

Patrick Criscuola
July 2010

NY Water Well
NYSDEC Well No. S4372

Location: Adjacent to south of mouth of harbor
Elevation: 5 feet MSL
Depth: 100 feet

S-Number	Thickness	Total Depth	Description
S-04372	6	6	Dirty Sand and Gravel
S-04372	1	7	Meadow Bog
S-04372	14	21	Gravel and Sand
S-04372	0.5	21.5	Clay
S-04372	9	30.5	Sand and Gravel
S-04372	0.25	30.75	Gray Clay
S-04372	2.25	33	Brown Sand and Gravel
S-04372	3.5	36.5	Light Brown Sand
S-04372	0.5	37	Gray Clay
S-04372	55	92	Gravel and Sand
S-04372	8	100	Red Sand and Gravel

Notes:
________Start of Magothy

SCWA Test Well
NYSDEC Well No. 24663

Location: Belle Terre Road, Well No. 1 Test Hole
Elevation: 225.27 MSL
Depth: 650 feet below grade
Geophysical Data

S-Number	Thickness	Total Depth	Description
S24663	2	2	Topsoil
	78	80	Large Gravel, Brown Sand and Boulders
	110	190	Medium to Coarse sand, medium gravel and streaks of white clay
	38	228	Fine sand, streaks of red clay and medium gravel
	79	307	Fine, silty red sand and streaks of clay and coarse sand
	10	317	Soft gray clay and streaks of fine sand
	24	341	Gray silty sand
	18	359	Hard streaks of gray sand and streaks of brown clay
	2	361	Fine brown sand and streaks of brown clay
	45	406	Coarse white sand (hard packed), red clay streaks (hard packed)
	3	409	Gray clay
	10	419	White clay and fine sand streaks
	7	426	Brown clay, silty white sand and white clay
	31	457	Variagated soft clay and silty sand
	2	459	Hard white clay
	6	465	White clay and silty white sand
			Well continues to 650 feet below grade

Notes:
__________ Start of Magothy

SCWA Test Well
NYSDEC Well No. S52490

Location: Bicycle Path, Port Jefferson Station, Town of Brookhaven
Elevation: 141 feet MSL
Depth: 560 feet

S-Number	Thickness	Total Depth	Description
S-52490	2	2	Loam
	80	82	Fine-Medium to Coarse Brown Sand and Gravel
	3	85	Medium to Coarse Brown Sand, Stones and Gravel
	4	89	Brown Sandy Clay, Streaks of Coarse Brown Sand
	7	96	Medium to Coarse Brown Sand and Gravel
	59	155	Fine, Medium and Coarse Brown Sand and Gravel, Streaks of Brown Clay
	3	158	Solid Brown Clay
	3	161	Medium to Coarse Brown Sand, Streaks of Brown Clay
	27	188	Brown Sandy Clay
	17	205	Coarse Gravel, Brown Sand
	2	207	Black and Brown Clay mixed with Gravel
	30	237	Medium to Coarse Brown Sand, Large Stones and Gravel
	8	245	Medium to Corase Brown Sand grits and Streaks of Brown Clay
	7	252	Coarse Brown Sand, Stones, Streaks of Brown Clay
	9	261	Solid Brown Clay
	3	264	Multi-colored clay, hardpan, Sand layers
	10	274	Coarse Brown Sand, Grits, Gravel, Brown Clay and Hardpan
	26	300	Multi-colored Sand, Hardpan and Clay Streaks
	3	303	White Solid Clay
	4	307	Fine to Medium Brown Sand, Streaks of White Clay
	6	313	Multi-colored Clay, Hardpan, Streaks of Fine Brown Sand
	8	321	Fine to Medium Brown Sand, Streaks of Gray and White Clay
	37	358	Medium to Fine Brown Sand, Hardpan, Streaks of Multi-colored Clay
	28	386	Fine, clayey, Lavender Sand and Streaks of Multi-colored Clay
	12	398	Black Clay, layers of lignite
	7	405	Sandy Gray Clay, Clayey Sand Streaks
	53	458	Medium to Fine Gray Clayey Sand, mixed with Multi-colored Clay
	10	468	Solid Gray Clay
	20	488	Multi-colored Clayey Sand and Streaks of Solid Clay
	72	560	Fine to Medium Brown Sand and Clayey Hardpan

Notes:
________ Start of Magothy

Patrick Criscuola
July 2010

SCWA Test Well
NYSDEC Well No. S42504

Location: Flint Lane No. 2, Selden
Elevation: 115 feet MSL
Depth: 243 feet below ground surface

S-Number	Thickness	Total Depth	Description
S-42504	105	105	Coarse brown sand and gravel
	35	140	Fine brown sand, gravel and small stones
	20	160	Fine to coarse brown sand and gravel
	35	195	Fine to coarse brown sand and gravel
	3	198	Gray sand and gravel
	4	202	Small stones, sand and gravel
	33	235	Coarse to medium sand
	5	240	Coarse to medium sand, heavy gravel and stones
	3	243	Fine gray sand with sandy gray clay

Notes:
_________ Start of Magothy

Patrick Criscuola
July 2010

SCWA Test Well
NYSDEC Well No. S31734T

Location: Jayne Boulevard, Terryville
Elevation: 175 feet MSL
Depth: 1121 feet below grade surface (bedrock)

S-Number	Thickness	Total Depth	Description
S-31734T	2	2	Loam and topsoil
	113	115	Sand, gravel, stones
	15	130	Brown clay
	33	163	Fine and coarse gray sand, streaks of gray sandy clay
	7	170	Sand, heavy gravel, streaks of clay
	15	185	Brown sand and gravel
	27	212	Sand, gravel and clay
	8	220	Hard clay, sandy clay
	81	301	Fine to coarse sand, streaks of gravel and clay
	10	311	Soft clay streaks of sand, gravel and iron oxide
	30	341	Sandy clay. Streaks of sand and clay.
	11	352	Hard black clay
	54	406	Coarse sand streaks, gravel and clay
	5	411	Hard clay
	63	474	Fine packed sand
	43	517	Fine and coarse sand, streaks of clay and sandy clay
	7	524	Hard gray and black clay
	23	547	Sand, gravel and streaks of clay
	13	560	Hard gray and black clay, hard streaks
	52	612	Sand, heavy gravel, streaks of clay and sandy clay
	16	628	Hard clay, sandy clay and sand
	18	646	Sand, gravel and streaks of clay
	13	659	Sand and clay
	4	663	Hard clay
	53	716	Sand, gravel, streaks of hard clay
	22	738	Sandy clay. Hard clay, streaks of sand
	46	784	Fine sand streaks, clay, sandy clay
	29	813	Hard black and gray clay (very hard), hard streaks
	50	863	Silty clay, multi-colored clay, hard clay, gravel and lignite
	16	879	Hard clay
	16	895	Fine sand, sandy clay, clay, gravel, lignite
	44	939	Fine to coarse sand, streaks of clay, lignite and pyrite
	4	943	Hard clay
	53	996	Fine to coarse sand, streaks of clay, lignite and pyrite
	40	1036	Fine and coarse sand, sandy clay, streaks of hard clay, gravel
	65	1101	Fine to coarse sand, gravel
	20	1121	Weathered bedrock, clay
		1121+	Rock

Notes:
_________ Start of Magothy

Patrick Criscuola
July 2010

SCWA Test Well
NYSDEC Well No. S32325

Location: Belle Terre Road, Well No. 3 (Test Hole)
Elevation: 281.7 MSL
Depth: 693 feet below grade

S-Number	Thickness	Total Depth	Description
S-32325	3	3	Loam
	7	10	Fine to Medium Sand
	29	39	Coarse Brown Sand & Gravel
	46	85	Med. To Coarse Brown Sand Grits & Gravel
	52	137	Fine to Med. To Coarse Brown Sand & Gravel Clay Strips
	20	157	Med. Brown Sand Grits & Lignite
	10	167	Fine Med. To Coarse Brown Sand, Streaks of Brown Clay
	27	194	Solid Gray Clay
	4	198	Med. Coarse Sand & Gravel
	5	203	Heavy Gravel & Coarse Sand
	2	205	Solid Black Clay
	4	209	Medium to Coarse Sand
	3	212	Coarse Sand & Gravel
	31	243	Heavy Sand & Gravel
	7	250	Solid Gray Clay
	9	259	Multi-color Clay and some stones, pyrite
	5	264	Fine to Medium Brown Sand
	12	276	White Clay, Stones, Streaks of Sand
	8	282	Med. Brown Sand, Streaks of White Clay, Hard Pan
	17	299	Med. Brown Sand, Stones, Streaks of White Clay
	20	319	Finre to Med. Sand, Streaks of White Clay
	39	358	Fine Sand, Streaks of Multi-color Clay, Hard Pan
	9	367	Fine Sand, Streaks of White Clay

Notes:
__________ Start of Magothy

SCWA Test Well
NYSDEC Well No. 24663

Location: Belle Terre Road, Well No. 1 Test Hole
Elevation: 225.27 MSL
Depth: 650 feet below grade
Geophysical Data

S-Number	Thickness	Total Depth	Description
S24663	2	2	Topsoil
	78	80	Large Gravel, Brown Sand and Boulders
	110	190	Medium to Coarse sand, medium gravel and streaks of white cl
	38	228	Fine sand, streaks of red clay and medium gravel
	79	307	Fine, silty red sand and streaks of clay and coarse sand
	10	317	Soft gray clay and streaks of fine sand
	24	341	Gray silty sand
	18	359	Hard streaks of gray sand and streaks of brown clay
	2	361	Fine brown sand and streaks of brown clay
	45	406	Coarse white sand (hard packed), red clay streaks (hard packe
	3	409	Gray clay
	10	419	White clay and fine sand streaks
	7	426	Brown clay, silty white sand and white clay
	31	457	Variagated soft clay and silty sand
	2	459	Hard white clay
	6	465	White clay and silty white sand
			Well continues to 650 feet below grade

Notes:
__________ Start of Magothy

Monitoring Well installed as part of LAI Superfund Investigation
Installed by CDM on November 5, 1997

Location: Dead End of Park Avenue
Elevation: 218 feet MSL
Depth: 200 feet

S-Number	Thickness	Total Depth	Description
MW-5	5	5	No Data - "Top Soil"
	15	20	Tan-Brown, Medium Sand, some gravel, loose, dry
	10	30	Brown-tan, medium to coarse sand with gravel, loose, dry
	5	35	Tan-medium, coarse sand and little gravel, moist, loose
	15	50	Tan-white medium sand (well sorted), trace gravel, loose, moist
	5	55	Brown, medium to fine sand, little silt, slightly cohesive, moist
	10	65	Cobbles. No split spoon sample.
	5	70	Brown, fine sand with silt and some gravel, slightly cohesive, moist
	10	80	Brown, fine sand with silt and some gravel, slightly cohesive, moist
	10	90	Brown-tan, med to coarse sands, interlayered with silty sands (varve 0.5 to 1.0 cm), cohesive, moist
	10	100	Brown, very fine sand and silt, coarse white sands, loose, little gravel, moist
	10	110	White medium sand, some gravel, loose and moist
	40	150	Sand, well sorted medium to coarse, little gravel, loose, moist
	20	170	Sand, well sorted medium to coarse, loose, moist
	20	190	Tan and white coarse sands, trace gravel, loose, saturated
	5	195	Tan sand, medium to coarse, trace gravel, loose saturated
	5	200	Brown fine sand and silt, slightly cohesive, wet

Notes:
________ Start of Magothy

SCWA Test Well
NYSDEC Well No. S40837T

Location: West End of Oak Street, Approx. 95 feet west of Black Locust Ave, South Setauket
Elevation: 194.84 MSL
Depth: 812 feet below grade

S-Number	Thickness	Total Depth	Description
S-40837T	3	3	Loam and clay
	87	90	Fine to Coarse Sand, Grits, Gravel, Boulders
	30	120	Fine to Coarse Sand, Grits, Gravel
	10	130	Medium Brown Sand
	30	160	Fine to Coarse Sand, Grits, Gravel
	20	180	Coarse Sand, Grits, Gravel, Lumps of Brown Clay
	26	206	Medium to Coarse Sand, Grits, Gravel, Hardpan (cemented formation)
	1	207	Multi-colored clay
	85	292	Fine to Coarse Sand, Grits, Gravel
	8	300	Medium Sandy Brown Clay
	97	397	Fine to Medium Gray Clayey Sand
	41	438	Fine to Medium Gray Clayey Sand and Hardpan
	8	446	Solid Gray Clay-Sandy Gray Clay and Hardpan
	16	462	Solid Gray Clay
	20	482	Layers of Solid White Clay-Clayey Medium Gray Sand
	24	506	Layers of White Clay-Fine Gray Sand
	36	542	Fine Gray Sand, Sandy Clay, Layers of Solid Clay
	10	552	Fine to Coarse Sand-Grits, Lumps of White Clay
	6	558	Solid Gray Clay
	19	577	Fine Gray Sandy Clay - Layers of Solid Gray Clay
	13	590	Fine Gray Sandy Clay - Lumps of Clay-Hardpan
	10	600	Medium Gray Sand
	40	640	Solid Multi-Colored Clay
	34	674	Fine to Coarse Brown Sand, Grits and Gravel, Lumps of Clay
	13	687	Fine Gray Sandy-Clay, Layers of Gray Clay
	15	702	Fine to Coarse Brown Sand, Grits, Lumps of Multi-colored Clay
	8	710	Fine White Clayey Sand
	6	716	Coarse Gray Sand, Grits, Streaks of Gray Clay
	15	731	Coarse Gray Sand, Grits, Small Gravel
	3	734	Very Fine Sandy White Clay
	7	741	Coarse Gray Sand, Grits, Streaks of White Clay
	1	742	Coarse Gray Sand, Grits, Gravel and Streaks of White Clay
	5	747	Fine Gray Sand, Streaks of Sandy White Clay
	6	753	Fine to Coarse Gray Sand, Grits, Gravel, White Clay
	9	762	Coarse Gray Sand, Grits, Gravel, Lumps of Multi-colored Clay
	48	810	Fine to Coarse Gray Sand, Streaks of Sandy White Clay
		--	Medium to Coarse Gray Sand, Solid Gray Clay, Sandy White Clay

Notes:
________ Start of Magothy

SCWA Test Well
NYSDEC Well No. S48423T

Location: Crystal Brook Hollow Road, Mount Sinai, New York
Elevation: 133.10 MSL
Depth: 666 feet below grade

S-Number	Thickness	Total Depth	Description
S48423T	71	71	Coarse Brown Sand, Gravel and Stones
	177	248	Medium to Fine Brown Sand with Streaks of Gra
	9	257	Fine Brown Sand
	58	315	Coarse Sand, Gray Gravel
	15	330	Coarse to Fine Brown Sand
	19	349	Multicolored layers of Sandy Clay
	40	389	Sand
	66	455	Sand with Clay Streaks
	52	507	Gray Sandy Clay with Gravel Streaks
	82	589	Coarse Sand with Stripes of Gray Gravel
	49	638	Coarse to Medium Brown Sand with Clay Streak
	24	662	Gray Clay
	4	666	Brown Clay

Notes:
____________ Start of Magothy

SCWA Supply Well
NYSDEC Well No. S40980

Location: SCWA Hills Lane and Henry Clay Drive, Well No. 2, Setauket
Elevation: 227 feet MSL
Depth: 584 feet below grade

S-Number	Thickness	Total Depth	Description
S-040980	3	2	Top soil, Loam
	6	8	Sandy brown clay and stones
	67	75	Coarse brown sand, gravels, boulders with brown clay binders
	145	220	Coarse brown sand, gravel and large stones
	17	237	Fine to medium gray sand, some gravel
	2	239	Sandy gray clay and streaks of iron oxide
	3	242	Light gray clay
	18	260	Fine to medium gray sand
	30	290	Fine to medium brown sand
	1	291	Silty multicolored clay
	42	333	Fine gray sand, streaks of clay, mica
	35	368	Medium gray sand, mica, bits of iron oxide
	4	372	White and brown clay with straks of gray sand, iron
	11	383	Medium clayey gray sand with bits of iron oxide
	2	385	Light gray clay with streaks of fine gray sand
	5	390	Multicolored clay, streaks of sand and iron oxide
	65	455	Fine gray sand, streaks of gray clay
	32	487	Multicolored clay and fine sand
	6	493	Light and dark gray clay, light sandy clay
	85	578	Fine gray sand with bits of clay
	6	584	Gray clay

Notes:
________ Start of Magothy

SCWA Test Well
NYSDEC Well No. S32325

Location: Belle Terre Road, Well No. 3 (Test Hole)
Elevation: 281.7 MSL
Depth: 693 feet below grade

S-Number	Thickness	Total Depth	Description
S-32325	3	3	Loam
	7	10	Fine to Medium Sand
	29	39	Coarse Brown Sand & Gravel
	46	85	Med. To Coarse Brown Sand Grits & Gravel
	52	137	Fine to Med. To Coarse Brown Sand & Gravel Clay Strips
	20	157	Med. Brown Sand Grits & Lignite
	10	167	Fine Med. To Coarse Brown Sand, Streaks of Brown Clay
	27	194	Solid Gray Clay
	4	198	Med. Coarse Sand & Gravel
	5	203	Heavy Gravel & Coarse Sand
	2	205	Solid Black Clay
	4	209	Medium to Coarse Sand
	3	212	Coarse Sand & Gravel
	31	243	Heavy Sand & Gravel
	7	250	Solid Gray Clay
	9	259	Multi-color Clay and some stones, pyrite
	5	264	Fine to Medium Brown Sand
	12	276	White Clay, Stones, Streaks of Sand
	8	282	Med. Brown Sand, Streaks of White Clay, Hard Pan
	17	299	Med. Brown Sand, Stones, Streaks of White Clay
	20	319	Fine to Med. Sand, Streaks of White Clay
	39	358	Fine Sand, Streaks of Multi-color Clay, Hard Pan
	9	367	Fine Sand, Streaks of White Clay

Notes:
__________ Start of Magothy

SCWA Test Well
NYSDEC Well No. 38784

Location: Hawkins Avenue, Centereach
Elevation: 108 feet MSL
Depth: 604 feet below grade

S-Number	Thickness	Total Depth	Description
S-38784	3	3	Top soil and loam
	47	50	Fine to Coarse Brown sand with some fine gravel
	9	59	Coarse Brown sand and gravel
	9	68	Coarse Brown sand and fine gravel
	2	70	Brown silty clay
	10	80	Gray silty Clay
	14	94	Gray silty clay with streaks of gray sand
	53	147	Coarse brown sand and gravel
	7	154	Fine gray sand and some large stones
	39	193	Fine gray sand
	5	198	Multi-color clay
	17	215	Fine to medium gray sand
	15	230	Coarse rusty brown sand, streaks of multicolor clay
	4	234	Coarse gray sand with streaks of gray clay
	35	269	Light and dark gray clay
	6	275	Multicolor sand clay and brown sand
	74	349	Fine to coarse gray sand with bits of gray clay
	13	362	Sandy brown and gray clay streaks of sand
	16	378	Fine gray sand, streaks of gray clay
	17	395	Light gray silty clay
	19	414	Clayey gray sand
	4	418	White and gray clay
	3	421	Coarse gray sand with layers of gray clay
	16	437	Medium gray clayey sand
	2	439	Coarse gray sand and white silty clay
	30	469	Fine gray sand
	6	475	Clayey gray sand
	26	501	Medium gray sand
	4	505	Sandy gray clay
	10	515	Medium gray sand
	15	530	Fine gray sand
	45	575	Medium gray sand with bits of gray clay
	1	576	White clay with streaks of coarse gray sand
	38	614	Coarse brown and gray sand with bits of clay

Notes:
________ Terminal depth of outwash plain deposits if present

________ Start of Magothy

SCWA Test Well
NYSDEC Well No. S55502

Location: Chestnut Street, Coram
Elevation: 121 feet MSL
Depth: 623 feet below grade

S-Number	Thickness	Total Depth	Description
S-55502	2	2	Top soil and loam
	65	67	Clean, coarse sand, gravel
	7	74	Brown clay, streaks of sand
	16	90	Coarse brown sand, gravel, streaks of clay
	40	130	Coarse brown sand with large stones, boulders
	15	145	Coarse to very coarse brown sand with heavy gravel
	81	226	Coarse brown sand, gravel, stones
	26	252	Solid gray sandy clay, stones and sand streaks
	18	270	Medium to very coarse brown sand
	8	278	Multi-colored clay
	2	280	Medium to coarse brown sand, gravel
	10	290	Solid brown clay
	8	298	Medium to coarse brown sand, heavy gravel, stones
	27	325	Sand streaks, multi-colored clay, layers of sand and gravel
	3	328	Medium brown sand
	7	335	Very fine, dirty brown sand, streaks of brown clay
	38	373	Medium brown sand
	11	384	Coarse brown sand with large gravel and stones
	51	435	Fine to medium brown sand
	15	450	Coarse brown sand and gravel
	25	475	Coarse brown sand, gravel and large stones
	3	478	Solid brown clay
	6	484	Very fine brown sand, mica and occasional stone
	9	493	Medium brown sand, streaks of brown clay and stones
	28	521	Clayey coarse white sand and small gravel
	1	522	Large stones, streaks of blue clay
	1	523	Fine to medium brown sand, some gravel
	20	543	Coarse brown sand and gravel
	7	550	Coarse to medium gray sand with streaks of white clay
	14	564	Sandy white clay with streaks of coarse gray sand
	10	574	Fine to medium gray sand, streaks of white clay
			Send to Professor

Notes:
Terminal depth of outwash plain deposits if present

Start of Magothy

SCWA Test Well
NYSDEC Well No. S68880

Location: Boyle Road, Well No. 2 - Centereach
Elevation: 135 feet MSL
Depth: 753 feet below grade

S-Number	Thickness	Total Depth	Description
S-68880	2	2	Loam / topsoil
	65	67	Medium to coarse, gray sand, gravel, stones
	101	168	Coarse brown sand, gravel, stones, rocks
	9	177	Fine to Medium Brown Sand
	13	190	Sandy white clay
	3	193	Multi-color sandy clay and hardpan
	5	198	Solid dark clay
	23	221	Fine gray sand, streaks of multi-color clay and mica
	3	224	Multi-color clayey sand, hardpan and mica
	15	239	Fine to coarse gray sand with layers of clayey sand, mica, hardpan
	25	264	Fine to coarse brown sand with thin layers of clayey sand, mica, hardpan
	26	290	Fine to coarse tan sand, mica, hardpan and some clay
	18	308	Fine to coarse gray sand, mica and bits of clay and hardpan
	37	345	Fine to coarse gray sand, grits, mica and traces of clay and hardpan
	15	360	Coarse gray sand, gravel, streaks of clay
	2	362	Fine to coarse gray sand, mica, grits, streaks of clay and hardpan
	5	367	Solid multi-color clay, hardpan and pyrite
	6	373	Fine to medium gray sand, mica, hardpan and some clay
	7	380	Fine to coarse gray sand, grits, gravel, hardpan and lumps of clay
	11	391	Multi-color clay with layers of gray sand and hardpan
	27	418	Solid multi-color clay
	17	435	Fine gray sand, streaks of clay and hardpan
	18	453	Layers of multi-color clay and sand, and hardpan
	17	470	Layers of solid and multi-color sandy clay
	10	480	Fine to medium to coarse gray sand, mica with layers of sandy clay
	2	482	Multi-color clayey sand and layers of sand and hardpan
	9	491	Layers of solid and sandy multi-color clay and sand, hardpan
	32	523	Fine to medium gray sand, mica, hardpan and bits of clay
	40	563	Clayey gray and brown sand
	13	576	Fine to coarse brown sand, grits, mica, hardpan and pink and white clay
	49	625	Fine to coarse brown, pink sand, mica, hardpan and pink and white clay
	35	660	Coarse gray sand, gravel, stones, streaks of clay
	40	700	Coarse gray sand and streaks of white clay
	28	728	Fine to coarse gray sand and streaks of clay
	12	740	Fine to coarse gray clayey sand

Notes:
________ Terminal depth of outwash plain deposits if present

________ Start of Magothy

SCWA Test Well
NYSDEC Well No. 47310

Location: Viking Place Well Number 2, Coram
Elevation: 145 MSL
Depth: 713 feet below grade surface

S-Number	Thickness	Total Depth	Description
S-47310	3	3	Top soil and loam
	37	40	Coarse brown sand, gravel with large stones and rocks
	25	65	Coarse brown sand, gravel with large stones and rocks
	35	100	Fine to medium brown sand (some stones)
	35	135	Coarse to very coarse brown sand gravel with large stones
	2	137	Fine brown sand
	58	195	Medium to coarse brown sand with small stones
	6	201	Clay, stones and streaks of coarse gray sand
	30	231	Fine gray sand
	27	258	Fine gray sand with mica and streaks of white sandy clay
	12	270	Fine gray sand with iron oxide
	35	305	Fine gray sand
	3	308	Multicolor clay with streaks of light brown sand and iron oxide
	17	325	Medium to coarse brown sand with bits of white and gray clay
	3	328	Multicolored sandy clay
	16	344	Gray sand with bits of clay and small pebbles
	11	355	Medium to coarse brown sand (dirty)
	40	395	Fine gray sand with layers of clay and iron oxide
	6	401	Fine brown sand
	17	418	Sandy gray clay
	7	425	Fine brown sand with streaks of iron oxide
	70	495	Sandy gray clay
	18	513	Fine gray sand with streaks of sandy gray clay
	5	518	Light gray clay with streaks of iron oxide
	16	534	Fine to coarse gray sand with layers of sandy gray clay
	14	548	Gray clay, streaks of iron oxide
	12	560	Gray sand and clay
	31	591	Fine gray sand
	22	613	Multicolor clayey sand (very dirty)
	7	620	Medium to very coarse gray sand and streaks of gray clay and iron oxide
	5	625	Fine gray clayey sand
	7	632	Coarse brown sand
	3	635	Coarse clay, gray sand, small stones, iron oxide
	23	658	Fine gray sand
	17	675	Fine to medium light brown sand

Notes:
_________ Start of Magothy