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Mr. Eugene W. Melnyk, P.E.
Division of Environmental Remediation
New York State Department of Environmental Conservation
270 Michigan Avenue
Buffalo, New York 14203

Subject: **Basis of Design Report – 30 Percent Design**
Area A Vertical Hydraulic Barrier
Buffalo Color Corporation Site – Area A
Buffalo, New York
NYSDEC Site # C915230

Dear Mr. Melnyk:

As requested, enclosed please find a finalized Basis of Design Report – 30 Percent Design for the former Buffalo Color Corporation Site Area A vertical hydraulic barrier (VHB). A hard copy and a copy on compact disc are being provided. After reviewing the draft submittal of the referenced report, NYSDEC did not have comments; therefore, this submittal removes the draft designation and has been signed and sealed by a professional engineer licensed in the State of New York.

Should you have any questions, please do not hesitate to contact me at 412.279.6661 or dan.forlastro@amec.com.

Very truly yours,

AMEC Environment & Infrastructure, Inc.

Daniel Forlastro

Daniel Forlastro, P.E.

DF:anw

Enclosure

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BASIS OF DESIGN REPORT – 30 PERCENT DESIGN

AREA A VERTICAL HYDRAULIC BARRIER

NYSDEC Site Number C915230

BUFFALO COLOR CORPORATION
BUFFALO, NEW YORK

Prepared for:

SOUTH BUFFALO DEVELOPMENT LLC
Buffalo, New York

Prepared by:

Mactec Engineering and Consulting, Inc.
Mactec Project Number: 3410-09-0701

JUNE 1, 2012

BASIS OF DESIGN REPORT – 30 PERCENT DESIGN

AREA A VERTICAL HYDRAULIC BARRIER

NYSDEC Site Number C915230

BUFFALO COLOR CORPORATION
BUFFALO, NEW YORK

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JUNE 1, 2012

STATE OF NEW YORK ★ STUART C. PEARSON ★ LICENSED PROFESSIONAL ENGINEER 088066

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Principal Geotechnical Engineer

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Principal Engineer

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1.0 INTRODUCTION

Mactec Engineering and Consulting Inc. (Mactec) has prepared this Basis of Design Report (Report) on behalf of South Buffalo Development, LLC (SBD). In April 2009, SBD entered into a Brownfield Cleanup Agreement (BCA) with the New York State Department of Environmental Conservation (NYSDEC) to remediate Areas A and B of the former Buffalo Color Corporation (BCC) property.

SBD has teamed with Honeywell to facilitate the demolition of the former BCC dye plant and remediate the property. The remediation and redevelopment approach for the BCC site utilizes the Track 4 cleanup category in accordance with the New York Brownfield Cleanup Program.

This Report presents the design basis (i.e., 30 Percent Design) for a vertical hydraulic barrier (vertical barrier) that will be constructed on Area A.

1.1 PURPOSE OF THE BASIS OF DESIGN REPORT

This Basis of Design Report summarizes the preliminary and status design decisions for the Area A vertical barrier. The purpose of this report is to present the results of pre-design investigations, groundwater modeling, portions of the geotechnical laboratory testing conducted in support of remedial design, and to provide the conceptual description and design basis for the proposed remedial action.

1.2 BACKGROUND

The design concepts presented in this report are based in part on the final Alternatives Analysis Report (AAR) for the BCC site (Mactec, 2009). SBD is the current owner of the

BCC site and, as noted above, has entered into a BCA with the NYSDEC to complete the remediation of the BCC site to facilitate redevelopment of the property.

The AAR identified construction of a down gradient vertical barrier with groundwater extraction as the preferred alternative for Area A groundwater, which was identified as Alternative GW-A-2: Continued Operation of Interim Corrective Measure (ICM) with Hydraulic Barrier Wall. The selected remedial alternative consists of:

- Construction of a vertical barrier along the eastern boundary of the site along the Buffalo River and along portions of the northern and southern boundaries of Area A. The vertical barrier would be keyed into an underlying glaciolacustrine clay layer that underlies the Area A between approximately 25 feet and 35 feet below ground surface (bgs), and which acts as an aquitard separating the upper aquifer from a deeper aquifer (see **Subsection 2.3** for geology details).
- Continued operation of the groundwater extraction wells and groundwater treatment system installed in 2006 as part of the ICM, which consists of groundwater extraction with treatment and discharge to the Buffalo Sewer Authority (BSA) wastewater treatment plant.

The intent of the remedial alternative is to prevent migration of contaminated groundwater from Area A and to reduce the volume of river water that is extracted by the groundwater extraction and treatment ICM.

The following potential vertical barrier options have been considered, both as stand-alone options, or in combination:

- soil bentonite (SB) slurry wall
- cement bentonite (CB) slurry wall
- grouted steel sheet pile wall
- jet grouted wall

INTRODUCTION

Area A subsurface investigations were performed in 2009 and 2010 to better characterize the underlying soils and glaciolacustrine clay, as well as, to provide a better understanding of the extent of rubble fill, utilities, and abandoned foundations at the site. Results of those investigations are provided in **Section 4.0**.

2.0 EXISTING CONDITIONS

A summary of existing conditions is provided in the following subsections.

2.1 DESCRIPTION OF AREA A

The BCC property is partitioned into Areas A, B, C and E (**Figure 1**); Area A is shown on Drawing C-101 in **Appendix A**. Area A is a 10.2 acre site located along the north/northwest bank of the Buffalo River. The property is enclosed by fencing and is accessible by vehicle via gates located along South Park Avenue on the northern side of the site. SBD has recently completed the demolition of former plant production buildings, above ground storage tanks (ASTs), aboveground piping, and other ancillary structures. Several structures, including Building No. 75, and a groundwater treatment facility (GWTF), remain and will continue to be used in the future. The locations and limits of known former and existing structure limits are provided on Drawing C-101.

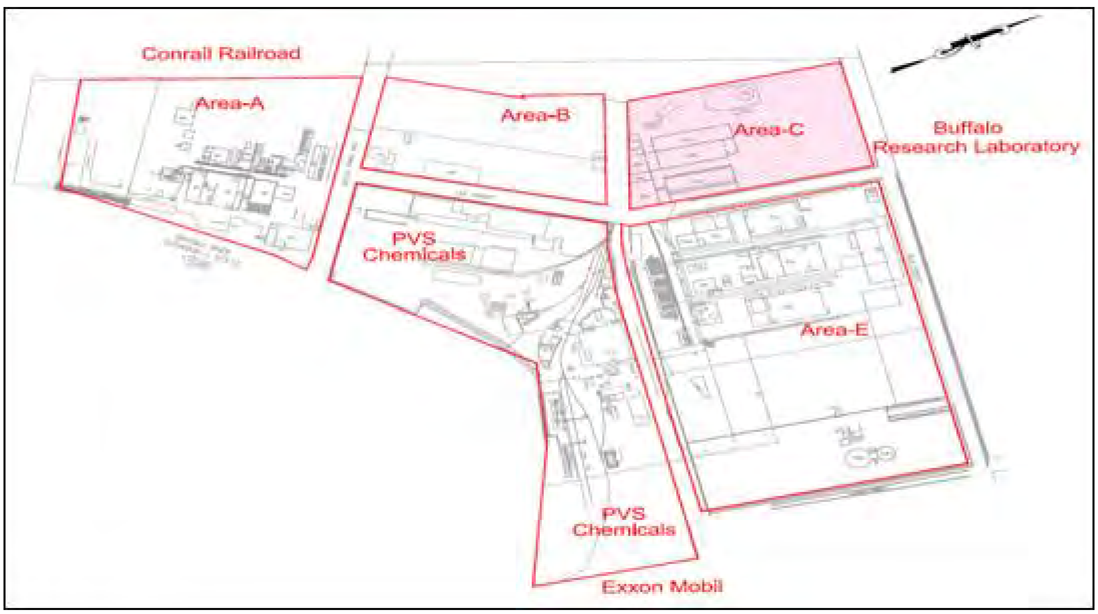

Figure 1. Buffalo Color Corporation Site Plan

The Area A site is bounded by South Park Avenue to the north, the Buffalo River to the east, former/abandoned rail road tracks on an elevated embankment to the south, and active rail road lines to the west. The northeast corner of the Area A site is adjacent to a bridge abutment for the South Park Avenue bridge that extends over the Buffalo River.

The east side of the site contains a combination of several reinforced concrete retaining structures that line the bank of the Buffalo River (Drawing C-101). The majority of the concrete retaining walls shows some deterioration at the base, but visually appear to be in overall good condition. Some or all of the retaining walls are supported on wood pilings, the lengths of which are unknown. A former intake structure (former Building No. 45) is located approximately 400 feet southwest of the northeast property line along the river front, and is believed to have provided water for the former dye plant or power plant operations. The Area A site is also populated by several abandoned concrete foundations and slabs at former building and structure locations. The dimensions and depths of these foundations and slabs are variable across the Area A site. More detail on the abandoned foundations/slabs and intake structure is provided in **Section 4.0**.

At three locations along the river, the bank slopes downward at approximately 2 horizontal to 1 vertical (2H:1V) from existing grade (two locations) or from retaining wall faces (one location) located approximately 20 feet northwest of the river bank. The southern-most slope is lined with an engineered, 170-foot long, marine mattress that was designed by Mactec and constructed in 2006 as part of the ICM program (Drawing C-101). The remaining two slopes are lined with riprap or stone.

The site contains five active extraction wells (EW-1 through EW-5) that were installed in 2006 for extraction of site groundwater. Extracted groundwater from two of these wells (EW-1 and EW-2) is currently pumped and treated via carbon units at the GWTF located at the southern limit of the site. The effluent from the other three wells is also pumped to the GWTF but does not undergo carbon filtration. The treated and untreated effluent is conveyed via separate underground pipes (installed in 2010 to replace aboveground piping) to a BSA manhole located on the northern side of Area B. Presently, the Area A groundwater extraction system pumps an average of approximately ten gallons per minute (gpm) to the BSA. The record locations for the underground piping installed in 2010 for the extraction wells and GWTF effluent are provided on Drawing C-101 (**Appendix A**).

The ground surface topography at the site is relatively flat, and ranges from approximately elevation 583 feet to 585 feet, North American Vertical Datum 1988. A localized high point of elevation 588 feet exists at the northeast corner of Area A to the east of Building No. 75. The former railroad track bed to the south of the Area A site, along the border with Area D, is constructed on an and elevated embankment with a crest that is estimated at approximately elevation 605 feet; the sideslopes of the railroad embankment are graded at slopes estimated at approximately 2H:1V. The toe of the former railroad slope meets existing site grade at approximately elevation 585 feet.

Most of the Area A site has been reworked from the original native topography through the construction and demolition of various structures throughout the life of the plant. Historical records also indicate that the riverbank area, specifically along the southern end of Area A, was filled to reroute the river to the southeast and increase the surface area of Area A.

The Area A site ground surface is presently covered by a combination of sand/gravel aggregate, vegetated topsoil, asphalt pavement, reinforced concrete slabs, and several structures associated with the former BCC operations. As noted above, demolition of the majority of former BCC structures, including production buildings, tank farms, and aboveground piping was recently completed by SBD. The GWTF, Building No. 75 (single-story concrete block structure), and several metal-clad buildings will remain.

Area A is underlain by numerous buried active and abandoned utilities, the majority of which are shown on Drawing C-101 (**Appendix A**).

2.2 REGIONAL GEOLOGY AND HYDROGEOLOGY

The regional geology and hydrogeology has been summarized in prior reports prepared for the BCC site (Engineering Science, Inc., 1989; Remcor, Inc. 1995; Golder Associates 1997) and most recently in the Remedial Investigation Report (Mactec, 2008) and AAR (Mactec, 2009). A brief summary of the regional geology, as discussed in these referenced documents, is presented in the following paragraphs.

The BCC site is located within the Erie-Ontario Lowland physiographic province of New York State. The Erie-Ontario Lowland is underlain by layers of sedimentary bedrock which are largely covered with unconsolidated deposits. The bedrock consists mainly of bedded or layered shale, limestone, and dolomite, and is comprised of fine-grained sediments deposited in seas during the Silurian and Devonian Periods.

The Onondaga Limestone is the uppermost bedrock unit at the BCC site. The upper portion of the Onondaga Limestone was subjected to glacial scouring and weathering and is characterized as a hard, gray, finely crystalline, massively bedded, stylolitic and cherty limestone. The limestone is typically heavily jointed and exhibits a high degree of secondary porosity. The regional dip of the bedrock is gently south-southwest at approximately 1 percent (40 feet per mile).

Unconsolidated deposits overlying bedrock in the vicinity of the BCC site are mostly glacial deposits formed during Pleistocene time (about 10,000 to 15,000 years ago), when a continental ice sheet covered the region, resulting in deposition of glacial till, which is an unsorted mixture of clay, silt, sand and stones deposited directly from the ice sheet. Upon retreat of the ice sheet, glacial lake (or glaciolacustrine) deposits formed, which consisted of bedded clay, silt, and sand that settled out in lakes fed by the melting ice. Further retreat and melting of the ice sheets resulted in sand and gravel deposits associated with glacial streams from the meltwater. The glacial sand and gravel deposits have been interpreted to be ice-contact, outwash, orlude alluvium, which consists of sand and gravel laid down by rivers and streams during recent geologic time. The overburden deposits generally are less than 50 feet thick in the vicinity of the BCC site, excluding fill materials.

Groundwater can be found locally in both the unconsolidated deposits and the limestone bedrock of the region. The unconsolidated deposits exhibit a wide range of hydraulic conductivity and can yield varying quantities of water, or none at all. Groundwater within the bedrock is transmitted through fractures such as horizontal and vertical joints, which are widened by dissolution processes. The availability of groundwater in the bedrock can vary widely based on the occurrence of fractures and the size of the solution openings.

2.3 BCC SITE-SPECIFIC GEOLOGY AND HYDROGEOLOGY

The geology at the site is summarized in the following subsections.

2.3.1 Geology

Approximately 36 monitoring wells, 13 piezometers, and 24 soil borings were installed during previous investigations during the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) (Golder 1997) across Areas A, B, C, and E. Other wells, piezometers, and test borings were installed during investigations that pre-dated the RFI. More recently, numerous wells and piezometers were installed on Area A in 2005-2006 to support the ICM design and test borings were advanced across Area A during the 2007-2008 Remedial Investigation (RI). Drawing C-101, provided in **Appendix A**, shows the current locations of monitoring wells and piezometers on Area A. These previous investigations identified the following subsurface strata across the BCC site in order of increasing depth:

- Fill: Unconsolidated material was found over the majority of the surface of the BCC site and consisted of clay, silt, crushed stone gravel, bricks, and miscellaneous building demolition debris. The fill generally ranges in thickness from less than 1 foot to about 20 feet, with the maximum thickness occurring near the Buffalo River.

- Alluvium: Unconsolidated materials, mostly fine to very coarse sands and likely representative of historical deposits from the Buffalo River have exhibited a moderately high hydraulic conductivity. The alluvium was encountered across the BCC site, but was more prominent along the eastern half of the BCC site, along the existing and former river bed. The thickness of this unit was observed to be up to about 21 feet, with the maximum thickness located near the Buffalo River.
- Clay and Silt Tills (Upper Tills): Unconsolidated fine-grained clay and silt tills. The thickness was historically identified as 0 to 10 feet in thickness, and was previously observed to underlie a portion of Area A.
- Glaciolacustrine Clay: Primarily clay, with occasional fine sand, and was encountered below the entire BCC site. Thickness ranged from 24 to 36 feet. Grain size analyses show that this unit was comprised almost entirely of clay-sized particles, and laboratory testing had shown that it has exhibited a relatively low hydraulic conductivity. This stratum was considered an aquitard between Shallow and Confined Aquifers (see **Section 2.3.1**).
- Basal Till: Unsorted mixture of sand, silt, gravel and minor amount of clay. The basal till was found in all deep borings, was encountered immediately above the bedrock, and was reported as less than 5 feet thick.
- Onondaga Limestone: Bedrock unit described as fractured and weathered, dark gray limestone. Only the upper few feet of this unit were penetrated during prior drilling activities.

Mactec has reviewed and considered the overall historically reported site geology (fill over alluvium, upper till, glaciolacustrine clay, basal till, and limestone). It is our opinion that the previously reported “upper till” is actually part of the alluvium, with the layers containing increased gravel content related to increased depositional energy. The existence of relatively unconsolidated underlying glaciolactustrine deposit further reinforces that the upper tills, which would have consolidated the glaciolacustrine clay, do not exist as a separate stratum.

2.3.2 Hydrogeology

Previous investigations have identified two aquifers at the BCC site. The first aquifer encountered, designated the Shallow Aquifer, consists of a saturated unconfined system within the fill and sediments above the glaciolacustrine clay unit. The Area A groundwater chlorobenzene plumes identified in the RI are located in the unconfined Shallow Aquifer. Typical groundwater elevations for the Shallow Aquifer are between

12 and 14 feet bgs. The second aquifer, designated the Confined Aquifer, occurs within the basal till and weathered upper surface of the bedrock. Golder concluded in the RFI report that the thick, low conductivity glaciolacustrine clay unit acts as an aquitard, separating these aquifers and providing a confining layer for the deeper aquifer.

In general, groundwater in the Shallow Aquifer flows toward the Buffalo River and discharges to the river under normal conditions. However, operation of the Area A groundwater extraction system and the presence of subsurface utilities and other manmade features at the BCC site influence local flow conditions within the Shallow Aquifer. Portions of the sewer lines (and surrounding backfill materials) that are present below the phreatic surface often act as groundwater collection points.

Groundwater in the Confined Aquifer exists under apparent confined conditions within the Basal Till stratum and upper portion of the Onondoga Limestone below the glaciolacustrine clay. In general, groundwater flow within the confined aquifer has been observed to occur to the west/southwest along the Buffalo River valley, with the ultimate discharge point expected to be Lake Erie.

3.0 PRE-DESIGN INVESTIGATION

Pre-design investigations (PDIs) were conducted in support of the design of the Area A vertical barrier as described in the Area A Geotechnical Pre-Design Investigation Work Plan (Mactec, October 2009) and subsequent correspondence with the NYSDEC.

The intent of the PDI, which consisted primarily of a geotechnical investigation, was to explore the subsurface conditions along the proposed alignment of the vertical barrier. The assumed alignment at the time of the investigation included the southern, eastern, and northern boundaries of Area A; the results of the investigation and supplemental evaluation were used to identify the extent of the barrier along the north and south Area A site boundaries. The pre-design investigation was comprised of the following:

- visual site inspections;
- subsurface geophysical survey;
- geotechnical soil boring investigation;
- test pit explorations;
- local borrow source search (for application of SB slurry wall backfill, if appropriate); and
- geotechnical laboratory testing.

3.1 GEOPHYSICAL SURVEY

A subsurface geophysical survey, which utilized ground penetrating radar (GPR), metal detector, and radio detection cable and utility locator, was conducted between November 3 and 5, 2009 and on December 8, 2009 by Northeast Geophysical Services (NGS) of Bangor, Maine. The primary intent of the survey was to:

1) Identify shallow subsurface utilities and obstructions in the immediate vicinity of any geotechnical subsurface investigation (i.e., soil boring or test pit) to mitigate penetration of and damage to a utility (i.e., utility clearance);
2) provide a geophysical survey along the proposed alignment of the vertical barrier to identify shallow subsurface utilities and obstructions that might impact design or construction of the barrier; and
3) provide a subsurface survey of the foundation of the former Building 45 (Intake Structure), located on Drawings C-101 and C-102, that is believed to have been a river water intake structure and crosses the proposed barrier alignment.

NGS also performed, as a supplemental task, a GPR survey along the alignment of a proposed groundwater discharge pipeline for the Area A groundwater extraction system along the western limit of Area A.

As a result of the geophysical survey, several boring locations were adjusted in the field to avoid the potential of disturbing utility lines. A copy of the complete geophysical survey report is presented in **Appendix B**.

3.2 GEOTECHNICAL SOIL BORINGS

Subsurface conditions along the alignment of the proposed vertical barrier were explored by drilling 17 soil borings at the locations shown on Drawing C-102. The borings were assigned identification numbers SB-A1 through SB-A17. The intent of the geotechnical soil borings was to investigate the subsurface stratigraphy and verify the presence and depth of the glaciolacustrine clay stratum at each location. The borings were drilled by SJB Services, Inc., of Buffalo, New York between October 26, 2009 and November 13, 2009. Several of the borings encountered construction debris and abandoned foundations, and were redrilled as necessary to achieve the planned depths. The geotechnical soil borings were advanced a minimum of 5 to 10 feet into the glaciolacustrine clay using 3.25-inch inside diameter hollow stem augers. Even numbered borings were extended a minimum of 5 feet below any observed sand seam or parting within the clay stratum, while odd numbered borings were advanced a minimum of 10 feet below the deepest observed sand seam or parting. Standard

Penetration Test (SPT) sampling was conducted at 5-foot intervals within the fill and alluvium deposits and continuously within the glaciolacustrine clay stratum at each boring. In addition to the SPT sampling, undisturbed thin-walled Shelby tube samples were collected and field vane shear tests were conducted within the clay stratum. A summary of the encountered conditions is provided in **Section 4.0**. Logs of the borings, which present detailed descriptions of the conditions encountered and the drilling methods used, are presented in **Appendix C**.

3.3 TEST PITS

Shallow test pits were excavated at selected locations at Area A along the general alignment of the proposed vertical barrier. The locations of the test pits are presented in Drawing C-102. The intent of the test pits was to investigate:

- Abandoned subsurface (or buried) concrete foundations and floor slabs;
- the composition of demolition debris within the fill; and
- the river-water intake structure at former Building No. 45.

Nine test pits, numbered TP-03 through TP-10 (including TP-05A and TP-05B) were excavated on January 6, 2010 by SBD under the direction of a Mactec engineer. A John Deere 450 track-mounted excavator was used to excavate the test pits. A supplemental test pit investigation, which included a tenth test pit (TP-101), was conducted on March 1, 2010 to further investigate the west side of the Intake Structure (former Building No. 45). Test pit locations were selected based on the review of available drawings that showed the locations of former buildings and assumed abandoned foundations. Excavation depths varied but did not exceed 12 feet bgs. Test pits were backfilled with the excavation cuttings. Logs of the test pits, which present detailed descriptions of the conditions encountered, are presented in **Appendix D**.

3.4 BORROW SOURCE SEARCH

Bulk samples from local soil and aggregate borrow suppliers were obtained and delivered to a selected geotechnical testing laboratory (GeoTesting Express of Boxborough, Massachusetts) for initial index testing. The bulk samples were retained for potential SB slurry wall backfill mix design testing; use of that material was dependent upon whether an SB slurry wall was selected as a preferred vertical barrier alternative. Three local borrow suppliers (Gernatt Asphalt Products, Inc. of Collins and Springville, New York, and Buffalo Crushed Stone Inc. of Williamsville, New York) were visited on January 7, 2010, and each supplier provided bulk samples of sand and gravel with lesser quantity of fines. Each supplier provided bulk representative samples of bank run sand and gravel for index testing. Results of grain size analysis are presented in **Table E1** of **Appendix E**. Individual laboratory data results are also presented in **Appendix E**.

3.5 GEOTECHNICAL LABORATORY TESTING

Laboratory testing focused on characterizing the glaciolacustrine clay aquitard that the vertical barrier would be keyed into to provide bottom/side containment along the barrier alignment. Testing included lab vane shear (American Society for Testing Materials [ASTM] D-2973), Atterberg limit determinations (ASTM D-4318), grain size distribution analyses (ASTM D-422), moisture content determinations (ASTM D-2216), and hydraulic conductivity testing (ASTM D-5084). In addition, grain size distribution analyses (ASTM D-422) were conducted on representative samples from granular borrow of each borrow source discussed in **Subsection 3.4**. A complete summary of laboratory results is presented in **Table E2** of **Appendix E**. Individual laboratory data results are also presented in **Appendix E**.

4.0 PRE-DESIGN INVESTIGATION RESULTS

A summary of the predesign investigation results is presented in the followings subsections.

4.1 SUBSURFACE CONDITIONS

Subsurface conditions from the ground surface downward along the vertical barrier alignment at Area A generally consisted of sand and debris fill, sand, silt and clay alluvium, and glaciolacustrine clay. The borings were terminated approximately 5 to 10 feet into the glaciolacustrine clay. Each stratum appeared to be continuous across the site. An interpretive subsurface profile, developed from the available subsurface information, and located along the vertical barrier alignment, is presented on Drawing C-201 in **Appendix A**. The profile was developed based on widely spaced explorations, and actual conditions may vary from those shown. A description of each soil stratum encountered is summarized in the following subsections. In addition, discussions on encountered abandoned foundations and debris are provided.

4.1.1 Fill (sand, gravel and debris)

A surficial layer of brown to black fine to coarse sand with lesser amounts of silt, gravel and cobbles, interpreted as fill, was encountered at the ground surface in each exploration. The fill contained considerable quantities of construction debris (brick, concrete, steel, wood) at numerous locations. The fill appeared to be a combination of site fill that had been imported for construction of the plant, as well as, debris fill that had been placed in the footprint of the basements and below grade levels of the former structures. In this case, the debris fill was likely the actual demolition debris that resulted from demolition of the various structures. Fill thickness along the vertical barrier alignment ranged between 10 and 21 feet. SPT N-values in the fill ranged from 2 to 24 blows per foot (bpf), which indicated that the fill was very loose to medium dense. The fill contained occasional black staining that exhibited petroleum odor.

4.1.2 Alluvium (sand, silt and clay)

A stratified gray to black fine and fine to coarse sand with lesser amounts of silt and gravel, with occasional wood fragments, was encountered below the fill in each boring at depths ranging from 10 to 21 feet bgs along the barrier alignment. These strata also contained occasional gray silt and clay layers. This stratified unit was interpreted to be alluvium, and ranged between 12 and 23 feet in thickness. SPT N-values in the sand and gravel alluvium ranged from weight of hammer (WOH) to over 50 bpf, and indicated that this stratum was very loose to very dense; the higher N-values were observed to have high gravel content, and the elevated N-values may have been influenced by encountering oversize particles. SPT N-values in the silt and clay alluvium generally ranged from WOH to 7 bpf, and indicated that this stratum was very soft to firm. The alluvium contained occasional black staining that exhibited petroleum odor.

4.1.3 Glaciolacustrine (clay)

A dark gray clay layer, with occasional thin fine sand partings (varved), was encountered below the alluvium in each PDI boring advanced on Area A at depths ranging from 28 to 35 feet bgs. The varved structure was most prominent in the upper part of this stratum, and the fine sand partings became less prominent with increased depth. This stratum was interpreted to be glaciolacustrine in origin. The clay was not fully penetrated during the PDI and therefore the thickness of the unit was not determined at the 2009 boring locations. SPT N-values in the glaciolacustrine clay ranged from WOH to 4 bpf (localized high of 12 bpf at the top of the stratum), and indicated that this stratum was very soft to soft. Laboratory vane shear tests performed on undisturbed thin-walled (Shelby tube) samples ranged between 620 and 920 pounds per square foot (psf), and field vane shear test results ranged between 600 and 1,360 psf; the vane shear tests indicated the consistency of the clay was firm to stiff. Atterberg limit determinations performed on representative samples of the clay indicated a plastic limit ranging between 17 to 23 percent, and liquid limit between 32 and 58 percent. The clay’s plasticity index ranged from 13 to

35 percent. The natural moisture contents of tested samples ranged between 32 and 49 percent, and were generally at or slightly above the liquid limit. Grain size distribution analyses performed on representative samples indicated that the material contained about 65 to 75 percent clay size particles. Hydraulic conductivity tests performed on undisturbed Shelby tube samples under confining pressures similar to those anticipated in the field yielded vertical hydraulic conductivities ranging between 1.1 x 10^{-7} and 2.3 x 10^{-8} centimeters per second (cm/sec). The upper limits of the clay contained occasional black staining that exhibited petroleum odor.

4.1.4 Groundwater

Groundwater levels were observed in open boreholes and test pits, where possible. Water levels measured during this investigation are presented on the boring and test pit logs in Appendices C and D, and are representative of the Shallow Aquifer. The observed levels ranged between 10 and 14 feet bgs, and were found to be generally consistent with levels observed in Area A monitoring wells and piezometers. Groundwater levels are subject to variation due to seasonal weather patterns and snow melt, and may vary from those observed during the investigation. On the eastern portion of the Area A site, shallow groundwater levels are influenced by the Buffalo River and by the continuous pumping of the five Area A groundwater extraction wells (EW-1 through EW-5).

4.2 ABANDONED FOUNDATIONS AND UTILITIES

Significant demolition of former building and other structures has occurred at Area A over the history of the BCC operations. The footprints of numerous former structures, based on historic BCC records, are shown on Drawings C-101 and C-102 in **Appendix A**. Site observations and explorations revealed that the majority of the foundations and below grade slabs (i.e., basement and or floor slabs) were abandoned in place. Construction debris (typically concrete, brick, steel and wood) from the former buildings appeared to be used to backfill former building foundations. The PDI did not investigate all former foundation walls or structures, but did characterize the general type and quantity of foundations and slabs that might be encountered during construction of the vertical barrier.

The most significant of the abandoned foundations appears to be related former Building No. 45 located 400 feet south of the northeast corner of Area A along the Buffalo River. Available information indicates that this structure was utilized as an intake structure to obtain water from the Buffalo River for plant operations and/or a former power plant. Site observations combined with test pit excavations revealed that this structure is approximately 50 feet wide and is supported by 3-foot wide by approximately 14-foot high reinforced concrete retaining structure/foundation walls on three sides. The walls/foundations appear to be supported by wood pilings of unknown length, which are likely supported in the basal till or underlying bedrock; evidence of wood pilings exist at low water where the bottom of the concrete and top of pilings become exposed. This intake structure extends in a northwest direction (away from the river) a distance of approximately 60 feet. The structure appears to contain a 4-foot high by 50-foot wide open slot/aqueduct that appeared to allow water flow from the river into the former plant. The intake slot appears to terminate at a 3-foot thick concrete wall about 20 feet east of existing Building No. 54. It is believed that water was extracted from the slot/aqueduct via a pump system that was mounted on a concrete slab 9 feet below grade (now abandoned and buried); the water was likely conveyed through a 24-inch diameter pipe, towards the west through the 3-foot thick concrete foundation wall, and downward into a 24-inch diameter buried distribution pipe (approximately 8 feet below grade and oriented in a north-south direction). Details are provided on logs for test pits TP-05A, TP-06 and TP-101 (**Appendix D**).

Several abandoned foundations and/or floor slabs from former Building Nos. 1, 40, 42, 43, 44, 45, 46, and 58 were encountered during the test pit and drilling investigation. Abandoned concrete foundations from former buildings that had been demolished were prevalent along the river. It appeared that the backfill used to fill in the foundations and basements was in large part brick and concrete from the demolished buildings themselves.

Two significant deep foundation walls (estimated to be 14 feet deep based on observations of similar walls for former Building No. 45) were abandoned in place at former Building No. 46. These walls, both approximately 3 feet thick, consist of a waterfront retaining wall (with riprap covered slope at its base) and a second wall located 25 to 30 feet northwest of the waterfront retaining wall. Test pit TP-04 encountered and sheared a steel rod that was interpreted to be a tie-back rod connecting the two walls, likely used to stabilize the waterfront retaining wall (i.e., the western-most wall likely acts in part as a deadman for the waterfront wall); observations of the waterfront retaining wall shows that six steel tieback rods may exist. No evidence of tiebacks exists on the waterfront retaining walls at former building No. 45 and near building 75.

Site storm water is presently collected via a series of catch basins and underground pipes that convey the water to the Buffalo River via a concrete outfall pipe (BCC Outfall 006). The locations of the known storm sewer pipes and the river outfall are depicted on Drawings C-101 and C-102 in **Appendix A**. Depending on SBD's requirements for future management of site storm water, it is our understanding that the existing storm sewer system and outfall will either be rehabilitated and reused or replaced with a new system and outfall. The final vertical barrier design will specify the outfall and method of sealing the vertical barrier around the outside of the pipe to maintain the vertical barrier integrity.

Numerous other active and abandoned utilities exist near the proposed vertical barrier across Area A. These include City of Buffalo water lines, lake water lines associated with the Buffalo River Improvement Corporation system, fire water lines, and other utilities. All known utilities are shown on Drawings C-101 and C-102 in **Appendix A**. Consideration of these utilities must be made in the design and construction of the vertical barrier.

4.3 BUILDING NO. 75

Area A contains an existing one-story block building, designated Building No. 75, near the northeast corner of the site. At the time of development of the PDI Work Plan, it was assumed that this building would be demolished prior to design and construction of the vertical barrier. It was, at that time, assumed the barrier could be constructed within the footprint of the northern portion of that building. Subsequent to performance of the PDI, SBD has advised Mactec that Building No. 75 would not be demolished, and that it would be maintained in its current condition until, and after completion of, remedial measures at Area A. Accordingly, the evaluation and final design of the vertical barrier, including alignment and barrier type, must consider the existence and maintenance of Building No. 75.

5.0 GROUNDWATER MODELING

Mactec performed steady-state groundwater modeling to assist with the evaluation of the type and characteristics of the vertical barrier. This modeling was also used to provide an indication of the flow rates required to maintain control of the Area A groundwater within the influence of the proposed vertical barrier wall. The draft results of the groundwater modeling effort are summarized in the following subsections; the draft model summary is presented in its entirety in **Appendix F**.

5.1 GROUNDWATER MODEL PARAMETERS

Using data from previous modeling reports (Parsons, 1999; Golder, 2000; and Mactec, 2005), along with subsurface soil information developed from the PDI, an updated hydraulic model of the Shallow (alluvial) Aquifer was developed. This model included application of conservative hydraulic conductivity values for the alluvial and fill strata and used the glaciolacustrine clay as a lower impermeable boundary layer. The model was developed using the USGS code MODFLOW and was run under the groundwater modeling pre- and post-processor platform Groundwater Vistas. Uncertainty in aquifer hydraulic parameters was accounted for by conducting a sensitivity analysis on these parameters.

The model was run utilizing the following conditions and parameter variations:

- Increase and decrease the estimated alluvial aquifer hydraulic conductivity, K, by 50 percent;
- Vary recharge by minus 20 percent and plus 60 percent;
- Varying the effective vertical barrier K to between 1 x 10^{-4} cm/sec and 1 x 10^{-6} cm/sec; and
- Increase and decrease the river stage from its normal elevation by 2.5 feet.

GROUNDWATER MODEL PARAMETERS

The model was run to allow selection of vertical barrier characteristics (i.e., hydraulic conductivity) and extent of alignment length along the north and south Area A site boundaries. The general goal of the model, from a barrier design perspective, was to estimate required groundwater extraction rates to maintain a minimum of 6 inches of inward head differential across the barrier, as well as maintain inward flow at the north and south boundary limits toward the extraction wells. The model was run simulating conditions where some or all of the extraction wells were in operation.

5.2 GROUNDWATER MODELING RESULTS/CONCLUSIONS

The results of the steady-state groundwater modeling at Area A suggest the following features should be considered in design of the vertical barrier:

- An equivalent of 3-foot thick vertical barrier with a hydraulic conductivity of 1 x 10^{-6} cm/sec or less.
- Extensions (wings) of the vertical barrier, 100 feet in the westerly direction on the north and south site boundaries, appear sufficient to prevent flow around the end of the barrier to the river.
- Adequate capture of the contaminated groundwater could be achieved with a small (0.5-foot or less) inward head differential across the barrier by pumping extraction wells EW-2 and EW-4 using a pumping rate of 9 gpm.
- To maintain an average 0.5- to 1-foot head across the barrier, pumping may be required by all extraction wells at a combined rate of from 14 to 19 gpm.
- Observed and interpreted water level measurements in Area A during future operations with the barrier wall in place will be used to refine and adjust pumping rates to maintain capture under varying hydraulic conditions.

6.0 VERTICAL BARRIER ASSESSMENT AND 30 PERCENT VERTICAL BARRIER DESIGN CRITERIA

The objective of the proposed vertical barrier, as discussed in **Subsection 1.2**, is to prevent migration of contaminated groundwater from Area A to the Buffalo River. The evaluation of vertical barrier alternatives and identification of the preferred approach are summarized in the following subsections.

6.1 VERTICAL HYDRAULIC BARRIER ALTERNATIVES

A summary of vertical hydraulic barrier alternatives are discussed in the following subsections.

6.1.1 General

Four potential vertical barrier options have been considered, both as stand-alone options, or in combination:

- SB slurry wall
- CB slurry wall
- grouted steel sheet pile wall
- jet grouted wall

The barrier would be keyed into the glaciolacustrine clay layer, which acts as an aquitard separating the Shallow Aquifer from the Confined Aquifer below the glaciolacustrine clay layer.

Selection of the type and horizontal extent/alignment of the vertical barrier considered:

- required engineering characteristics of the completed barrier;
- compatibility of the completed barrier with the design requirements of the groundwater extraction system;
- constructability; and
- relative cost of each vertical barrier alternative (detailed cost estimates were not performed at this stage of the project).

Area A contains five active extraction wells, EW-1 through EW-5, for extraction of groundwater. Extracted groundwater from these wells is pumped to the GWTF, a portion of the influent is treated via carbon filtration as necessary to meet BSA discharge limits, and the total effluent from the system is discharged to the BSA sewer system; an average total of approximately 10 gpm is pumped from the five extraction wells without a vertical barrier in place. The results of the groundwater modeling were used to establish vertical barrier design criteria and maintain a pumping rate similar the current rate, provide a minimum of 6 inches of inward head differential across the barrier from the Buffalo River, and to maintain inward flow at the north and south Area A site boundary limits toward the extraction wells. Based on these criteria (as noted in **Subsection 5.2**), assuming a 3-foot thick barrier, the model identified the following barrier design characteristics:

- Hydraulic conductivity of the completed barrier of 1×10^{-6} cm/sec; and
- Extend the barrier alignment 100 feet west of the northeast and southeast corners of the Area A site along the north and south limits of the site.

In addition, the following additional design criteria have been established:

- 3-foot deep (minimum) key of the barrier into the glaciolacustrine clay to provide hydraulic containment at the bottom of the barrier.
- Minimum design life of 30 years (design life will be established and evaluated in greater detail in subsequent design submissions).

The type and alignment of the selected vertical barrier depend considerably upon constructability of the barrier. Significant numbers of abandoned foundations and building footprints filled with demolition debris exist on site. Most significantly, large and deep (estimated to extend to 14 feet bgs) abandoned foundations exist at former Buildings No. 44, 45, 46, and possibly at former Buildings No. 42 and 43. In addition, tieback anchors supporting the waterfront retaining wall at former Building No. 46 and the intake structure at former Building No. 45 must be considered. Further, the site contains many shallow abandoned foundation walls and buried basement slabs at numerous other locations, and many of the former building basement footprints contain building demolition debris. Each of these items complicates the alignment and construction of the barrier. Pre-trenching along the entire alignment of the vertical barrier would require excavating and removing all obstructions to a depth of up to approximately 14 to 15 feet bgs.

6.1.2 Soil Bentonite and Cement Bentonite Slurry Walls

In general, the simplest, cheapest, and fastest installation of the barrier types considered consists of a SB slurry wall and CB slurry wall. Both types of slurry walls are relatively straightforward to construct when significant obstructions do not exist. As discussed previously, however, obstructions and debris exist.

A SB slurry wall would be excavated using bentonite-water slurry exhibiting an initial unit weight of approximately 63 pounds per cubic foot (pcf) to provide a stable trench; the slurry unit weight generally increases with increased suspension of excavated material (up to 90 pcf or greater). The final backfill (typically a mixture of sand, silt, clay and bentonite) placed after excavation of the trench, with the slurry being displaced by the backfill. In this case, because a significant portion of the overburden soils are either debris laden or may be contaminated, the backfill for a SB slurry wall would likely consist of imported materials mixed remotely. SB slurry wall backfill can be designed and constructed to provide a barrier with a hydraulic conductivity as low as 1×10^{-7} cm/sec, which exceeds the modeling requirements.

A CB slurry wall would be excavated using cement-bentonite-water slurry (cement-bentontite slurry) exhibiting an initial unit weight of approximately 70 pcf or more to provide a stable trench; in this case the CB slurry hardens/sets and becomes the final backfill. A typical CB backfill would have a hydraulic conductivity on the order of 1 x 10^{-6} cm/sec, which is consistent with the modeling requirements.

Both slurry wall options would require disposal of slurry trench cuttings. Installation of either barrier would require pre-trenching and removal of obstructions along the alignment. The cost of a SB or CB slurry wall, not including removal and disposal of debris or obstructions, backfill of the pre-trench, or disposal of slurry wall cuttings would be approximately $13 per square foot of vertical barrier. The final typical thickness for SB or CB slurry walls range between 2.5 and 3 feet.

6.1.3 Sheet Pile Wall

A sheet pile, or grouted sheet pile wall, is also generally straightforward to install provided significant obstructions do not exist. As with the slurry walls, installation of this barrier type would require pre-trenching and removal of obstructions along its alignment, as the sheet would not easily penetrate debris and would not penetrate abandoned foundations. Further, wood pilings below the more massive foundations would significantly complicate installation. This type of barrier can require more time to install, and is much more expensive as compared to slurry walls (up to approximately $45 per square foot of vertical barrier, not including removal of debris or obstructions and backfilling of the pre-trench). The width would be the thickness of the sheet, which is typically on the order of 3/8-inch. Hydraulic conductivities of 1 x 10^{-6} to 1 x 10^{-7} cm/sec can be achieved when the sheet joints are sealed to mitigate water leakage.

6.1.4 Jet Grout Wall

Jet grouting consists of high pressure injection of a cementicious grout or slurry into a soil stratum to hydraulically mix the in situ material with grout. The resulting amended soil material is often called "soil-crete". Three primary types of jet grout barriers: single panel, double panel, and column. The most common technique used in jet grouting involves the insertion of the jet grout pipe to the design depth for the bottom of the soil-crete column. The jetting pipe is pressurized with grout slurry made typically of Portland cement and water, although the grout can often contain bentonite and occasionally slag. The high pressure (4,000 to 6,000 psi typically) forces the grout out laterally through ports located in the sides of the pipe, near the bottom. The slurry exits the jet port at very high velocity, impinges on the soil, penetrating it several inches to feet away from the jets.

Depending upon the type of barrier and design needs (single panel, double panel, or column), the means of formation of the barrier vary. For single and double panel barriers, the jets destroy soft soil formations, and intimately and uniformly mix the native soil with cement grout. The pipe is drawn slowly upward at a carefully controlled rate so that the jets create a continuous 4 to 12 inch panel of treated soil. By drilling and grouting a panel at an adjacent borehole, the panels of the adjacent hole overlap/intersect, creating a continuous barrier. For a column barrier arrangement, the jet pipes are slowly rotated as the grout is injected and the pipe is drawn slowly upward to create a nearly cylindrical column of treated soil (the size of the column that can be achieved is dependent upon the soil type and density/consistency)

Aggregate hydraulic conductivities of the backfill of 1 x 10^{-6} to 1 x 10^{-7} cm/sec can be achieved, and the thickness of the barrier would be adjusted, along with the design grout hydraulic conductivity to meet design needs. This type of barrier can require more time to install, and can be similar in cost to sheeting (approximately $25 to $30 per square foot of vertical barrier, not including removal of debris and pre-trenching). However, this methodology has greater ability to deal with the abandoned foundations, as the foundations would not require removal. Pre-trenching in the upper 14 to 15 feet to remove construction debris would be considered to provide a better matrix of soil to mix with the grout (as compared with mass concrete debris).

6.2 PREFERRED VERTICAL HYDRAULIC BARRIER ALTERNATIVE AND ALIGNMENT

Based on the findings of the groundwater modeling, given the existence of the abandoned foundations and debris, and former railroad embankment (south end) it is proposed that the vertical barrier consist of a combination of CB slurry wall and jet grout barrier. In areas where the foundations can be reasonably removed by pre-trenching a CB slurry wall is proposed, as this type of barrier better matches the design hydraulic conductivity of the barrier (1 x 10^{-6} cm/sec) and provides an increase in slurry density to provide more stable trench sideslopes in areas with increased surcharge loads (former railroad embankment). Further, it is a simpler process as compared to an SB slurry wall because the slurry that is used to stabilize the trench under excavation is the final backfill (no backfill replacement is needed). The jet grout barrier is proposed because it can provide a low permeability barrier around existing massive foundations that cannot be reasonably demolished and removed (the other three alternatives cannot).

The proposed vertical barrier alignment is presented in Drawing C-102 in **Appendix A**. The barrier would extend the entire length of the east boundary of Area A along the Buffalo River, and extend 100 feet towards the west along the north and south boundaries. The barrier would extend through the fill and alluvium, and key a minimum of 3 feet into the underlying glaciolacustrine clay. The effective width of the barrier would be 3 feet minimum, with a hydraulic conductivity of 1 x 10^{-6} cm/sec. The resulting barrier would be 972 feet long and be approximately 32 to 36 feet deep. An interpretive subsurface profile along the vertical barrier alignment is presented on Drawing C-201 in **Appendix A**. The top of the barrier for the CB slurry wall section would be ground surface. The top of the jet grout portion of the barrier would be slightly below ground surface to ensure containment and maintenance of the jet grout pressures during installation, and would likely be 4 to 5 feet below grade; the actual top of the jet grout barrier will be established during the 60 percent design phase.

The anticipated alignment of the vertical hydraulic barrier is shown on Drawing C-102; locations for the discrete CB slurry wall and jet grout barrier are shown on Drawing C-201. The CB slurry wall portion of the barrier would extend from Station 100+00 to approximately 104+00 and Stations 107+37 to 109+00 (total length of approximately 563 feet) as foundations in this area of the site appear manageable from a demolition and pre-trenching standpoint. The jet grout wall would extend from approximately Station 104+00 to 107+37 and Station 109+00 to 109+72 (total length of approximately 409 feet); the geometry (columns or single/double panels) of the jet grout barrier will be established during the 60 percent design. Abandoned foundations, debris and abandoned utilities would be removed by pre-trenching along the CB slurry wall alignment, and construction debris and abandoned utilities would be removed by pre-trenching along the jet grout wall alignment. The more massive and deep foundations would remain in place, and the jet grout barrier would be constructed around those foundations. In order to provide better seals around existing foundations, tighter spacings or other modifications to the barrier (column versus panels) may be performed. Soil and debris removed during pre-trenching would require testing and management in accordance with the Interim Site Management Plan (Mactec, 2009), and the trench would be backfilled and compacted with clean suitable borrow soil. Pre-trenching would not extend below the groundwater table, if possible. If perched groundwater is encountered within the pre-trenching depth, it will be pre-treated on site and discharged to the BSA system in accordance with a BSA temporary discharge permit (similar to the approach used for the remedial excavation work completed on Areas C and E).

The preferred alignment was developed to allow the wall to be located west of the tie-back anchor bolts that appear to stabilize the former Building No. 46 waterfront retaining wall. Construction between the two walls at the structure would likely require stabilization of that retaining wall. The selected alignment also avoids penetrating the water intake structure at former building No. 45. Construction of the vertical barrier through this structure (south of its shown location/alignment) would require the task of drilling and grouting through a buried slab and slot/aqueduct that is open to the river. In addition, an increased risk of grout migration to the river would exist. The alignment of the vertical barrier is proposed to extend between Building No. 75 and the abutment of the South Park Avenue bridge. Foundations for these two structures are under investigation, and because the foundation systems have not been fully defined at this point in time, and because space is limited as it relates to excavation equipment that would be used for a slurry wall, a jet grout barrier is planned in this area.

The alignment as shown also indicates that extraction well EW-3 will require replacement to the west side of the vertical barrier. Further, a 100-foot long section of the groundwater extraction pipeline located immediately west of former Building Nos. 45 and 46 may require removal and replacement. As the design process continues, Mactec will evaluate whether an adjustment of the vertical barrier alignment to preserve extraction well EW-3 and associated piping is feasible. Further, adjustments in the barrier type (CB slurry wall or jet grout) along the alignment may be made as design progresses to account for subsurface obstructions and available working space.

6.3 BACKFILL MIX DESIGN

A two phase laboratory program has been implemented to establish CB and jet grout backfill design. The CB backfill generally consists of bentonite, cement and water, while the jet grout consists of cement and water (and possibly bentonite) with small percentages of site soils. The phased laboratory program is in progress and is being performed concurrent with the barrier design. Phase 1 consists of laboratory index and hydraulic conductivity testing of CB backfill and jet grout and bentonite water slurry using bentonite (supplied by several suppliers) and Type I Portland cement. The testing will establish potential mix designs for CB backfill and jet grout.

A Phase 2 laboratory program follows the Phase 1 program, and includes testing to evaluate the long-term compatibility of the backfill with the contaminated site groundwater. This testing program includes laboratory hydraulic conductivity testing of selected backfill CB specimens by permeating them with the site groundwater (up to three samples) to determine the affect of the groundwater chemistry on the hydraulic conductivity of the barrier, and permeation of one sample with deionized water for control purposes. The testing will simulate the performance of the backfill over the intended design life of the barrier. The results of the laboratory testing will be used to confirm selection of the vertical barrier materials, and will be documented in subsequent design submittals.

6.4 AREA A RIVER BANK

In accordance with **Subsection 9.2.1.2** of the AAR, SBD evaluated the feasibility of "restoration of the river bank to a natural vegetative state". An evaluation of alternatives for "softening" of the Area A river bank is currently ongoing. Existing conditions of the river bank include: a marine mattress system located along the downstream end of the bank (constructed as an interim corrective measure in 2006); two segments that consist of vertical concrete walls; a concrete intake structure that was previously used by BCC to obtain river water for plant operations; an earthen sloped section with surficial stone erosion protection and a concrete retaining wall near the top of the slope; and an earthen sloped segment with stone slab erosion protection. These segments of river bank have been evaluated independently to identify softening alternatives. As part of this evaluation, two other consultants with expertise in river bank softening (ENVIRON and Anchor QEA) provided input on feasible softening alternatives. The evaluation process considered the beneficial reuse plans for the site currently proposed by SBD and the Western New York Railway Historical Society (a possible future tenant/occupant of the property) and the potential impact on the vertical hydraulic barrier and groundwater extraction system.

VERTICAL BARRIER ASSESSMENT

The results of the evaluation and design information for the preferred river bank softening approach will be included as part of future design submittals. Elements of the evaluated alternatives include:

- removal of existing concrete, steel, riprap, and nuisance/invasive vegetation
- planting of riparian shrubs and trees
- use of earth stabilization and erosion protection materials, as necessary, such as rock, concrete lunkers, geocells, or other materials

The design basis presented herein for the Area A vertical barrier is based on the assumption that the current shoreline conditions will remain. The selected alternative for riverbank softening may require slight modification of the vertical barrier alignment and will be addressed in future design submittals.

7.0 IMPLEMENTATION

This section of the Report provides a brief description of key design and construction tasks/issues. The current schedule has the remediation of Area A being completed and the issuance of a Certificate of Completion by the NYSDEC by the end of 2011. To meet this schedule, frequent communications between Mactec, SBD, Honeywell, and the NYSDEC will be required. Design and construction activities will need to be sequenced and coordinated. The following lists provide the starting point for this effort. These lists can serve as guidelines and action item lists for the project team.

7.1 DESIGN TASKS

Design Tasks as design progresses:

1. Evaluate, modify, and finalize the alignment and profile for the vertical barrier.
2. Evaluate, modify, and finalize the barrier type along the alignment.
3. Survey or measure the crest elevation and side slopes of the former railroad slope at the south side of the Area A site.
4. Evaluate, modify, and finalize the type of vertical barrier along the alignment by station.
5. Finalize potential backfill mix designs, and evaluate chemical compatibility of groundwater and backfill.
6. Evaluate the foundation conditions of Building No. 75 and the South Avenue bridge abutment to allow finalization of the barrier type and details on the north side of Building No. 75.
7. Design phase investigative test pitting between Building No. 75 and the South Avenue bridge abutment in an effort to confirm foundation conditions for those structures.
8. Provide pre-trenching and foundation/slab demolition details.
9. Identify construction phase site improvements for installation of the barrier.
10. Evaluate the need for increased stabilization measures for the retaining wall along the river front (former Building No. 46) due to the rupture of one tie rod during test pitting.

11. Identify abandoned utilities that require removal prior to installation of the vertical barrier.
12. Identify active utilities that require protection prior to and during installation of the vertical barrier.
13. Provide slurry trench and jet grout barrier details.
14. Identify the need and location of groundwater observation wells to confirm the performance of the vertical barrier.
15. Specify Quality Assurance/Quality Control testing requirements and construction monitoring requirements.
16. Evaluate whether the existence of the vertical barrier impacts the groundwater plume shape and locations, and whether chemistry changes and resulting GWTF modification are required.
17. Evaluate and finalize the necessity of replacement of extraction well EW-3 and a section of the groundwater extraction pipeline located immediately west of former Building Nos. 45 and 46.
18. Evaluate design and construction of the vertical barrier and storm drain discharge line contact at the crossing with the vertical barrier near Station 102+75.
19. Prepare a construction cost estimate.
20. Conduct Construction Project Management Review.
21. Prepare record drawings.
22. Coordinate the peer review of the vertical barrier design submittals by an independent, third-party consultant (Mueser Rutledge Consulting Engineers of New York, New York).

7.2 CONSTRUCTION TASKS

Construction Tasks:

1. Develop and implement a site-specific Health and Safety Plan that addresses applicable safety and health requirements for the vertical barrier construction work.
2. Retain underground utility location firm before construction and obtain utility clearance.
3. Further investigation during pre-trenching portion of construction around former Building No. 45 to better characterize the intake structure.
4. Pre-trench and remove/demolish foundations/slabs along the barrier alignment.
5. Construct site improvements for installation of the barrier.

6. Adjust specific location and alignment of CB slurry wall and jet grout based on pre-trenching operations.
7. Furnish and install new extraction well EW-3 and transition piping to merge with groundwater extraction piping, if necessary.
8. Remove existing, and furnish and install new groundwater extraction piping west of former Building Nos. 45 and 46, if necessary.
9. Temporarily shut-down the storm drain discharge line at the crossing with the vertical barrier near Station 102+75 to allow barrier installation.
10. Construct 535-foot long CB slurry wall portion of the barrier from Stations 100+00 to 104+00 and Stations 107+37 to 109+00.
11. Construct 437-foot long jet grout wall from Station 104+00 to 107+37 and Station 109+00 to 109+72.
12. Manage, test, and dispose of excavated materials, excavation water, and project-related wastes in accordance with the requirements of the Interim Site Management Plan and applicable regulations.
13. Restore site and construct site improvements as required.

8.0 PRELIMINARY LIST OF PLANS AND SPECIFICATIONS

The following is a preliminary list of anticipated design drawings and specifications:

Design Drawings

G-001	Cover Sheet (United States Geological Survey Map for the Location Plan and Drawing Index)
G-002	General Notes, Abbreviations, and Legend
C-101	Existing Conditions Plan
C-102	Vertical Hydraulic Barrier Site Plan
C-103	Extraction Well and Piping Modifications (if needed)
C-201	Vertical Hydraulic Barrier Profile
C-301	Civil Sections and Details – Vertical Hydraulic Barrier
C-302	Civil Sections and Details – Vertical Hydraulic Barrier
C-303	Civil Sections and Details – Vertical Hydraulic Barrier
C-304	Sections and Details – Extraction Well and Piping Details (if needed)
C-305	Sections and Details – Extraction Well and Piping Details (if needed)

Specifications

Section 1 – General Requirements

Section 01100	Summary of Work
Section 01320	Construction Progress Documentation
Section 01322	Photographic Documentation
Section 01330	Submittal Procedures

PRELIMINARY LIST OF PLANS AND SPECIFICATIONS

Section 01420	References
Section 01500	Temporary Facilities and Controls
Section 01524	Construction Waste Management
Section 01700	Execution Requirements
Section 01770	Closeout Procedures
Section 01781	Project Record Documents

<u>Section 2 – Site Construction</u>

Section 02221	Demolition
Section 02230	Site Clearing
Section 02240	Dewatering
Section 02260	Excavation Support and Protection
Section 02300	Earthwork
Section 02350	Cement Bentonite Slurry Wall
Section 02260	Jet Grouting
Section 02375	Erosion and Sedimentation Control
Section 02630	Storm Drainage
Section 02650	Extraction Wells (if needed)
Section 02660	Extraction Well Piping (if needed)

9.0 SCHEDULE AND FUTURE DESIGN SUBMITTALS

A detailed schedule for design and construction of the Area A vertical barrier has been included in the project schedule for remediation of Areas A and B provided separately. As noted above, SBD intends to complete the design and construction of the vertical barrier during the 2011 calendar year, with the goal being to obtain a Certificate of Completion from the NYSDEC by the end of 2011.

The current schedule for submittal of future vertical barrier design documents is as follows:

- June 24, 2011 - 60 Percent Design, to include necessary progress specifications and design drawings;
- July 15, 2011 - 90 Percent Design, to include proposed final versions of specifications and design drawings for the NYSDEC review ; and
- August 5, 2011 - 100 Percent Design, which will be the NYSDEC-approved final design document and will include specification and drawings issued for construction.

Any changes to the above schedule will be communicated to the NYSDEC as the design process continues.

10.0 PEER REVIEW

A peer review has been provided by Mueser Rutledge Consulting Engineers (MRCE) on this Design Basis Report. The results of that peer review were presented by letter dated March 11, 2011. MCRE conclusions and recommendations concurred that a vertical hydraulic barrier (CB slurry wall and jet grout wall) used in conjunction with the existing extraction wells was a viable means of meeting the remedial design objectives, but several design and construction challenges existed. MCRE provided several comments and recommendations, and this input was applied to this Basis of Design Report or will be addressed in the 60 percent or 90 percent design submissions.

11.0 LIST OF ACRONYMS

2H:1V	2 horizontal to 1 vertical
AAR	Alternatives Analysis Report
ASTM	American Society for Testing Materials
AST	above ground storage tank
BCA	Brownfield Cleanup Agreement
BCC	Buffalo Color Corporation
BCP	New York Brownfield Cleanup Program
bgs	below ground surface
bpf	blows per foot
BSA	Buffalo Sewer Authority
CB	cement-bentonite
cm/sec	centimeters per second
EW	extraction well
GPR	ground penetrating radar
GWTF	groundwater treatment facility
gpm	gallons per minute
ICM	Interim Corrective Measure
Mactec	Mactec Engineering and Consulting Inc.
MRCE	Mueser Rutledge Consulting Engineers
NGS	Northeast Geophysical Services
NYSDEC	New York State Department of Environmental Conservation
PDI	Pre-Design Investigation
psf	pounds per square foot
RCRA	the Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RI	remedial investigation
SB	soil-bentonite
SBD	South Buffalo Development, LLC
SPT	Standard Penetration Test
WOH	weight of hammer

12.0 REFERENCES

Golder Associates, November 1997, “Final Report on RCRA Facility Investigation, Buffalo Color Corporation, Buffalo, New York”.

Mactec Engineering and Consulting, Inc., October 2008, “Final Engineering Report, Buffalo
Color Site – Area ABCE, Interim Corrective Measure”.

Mactec Engineering and Consulting, Inc., February 2009, “Alternatives Analysis Report, Former Buffalo Color Corporation”.

Mactec Engineering and Consulting, Inc., August 2008, “Remedial Investigation Report, Buffalo Color Corporation Area ABCE Site, Buffalo, New York.”.

Mactec Engineering and Consulting, Inc., October 2009, “Geotechnical Pre-Design Investigation Work Plan – Buffalo Color Area A”.

New York State Department of Environmental Conservation, April 2009, Brownfield Site Cleanup Agreement (#C915230).

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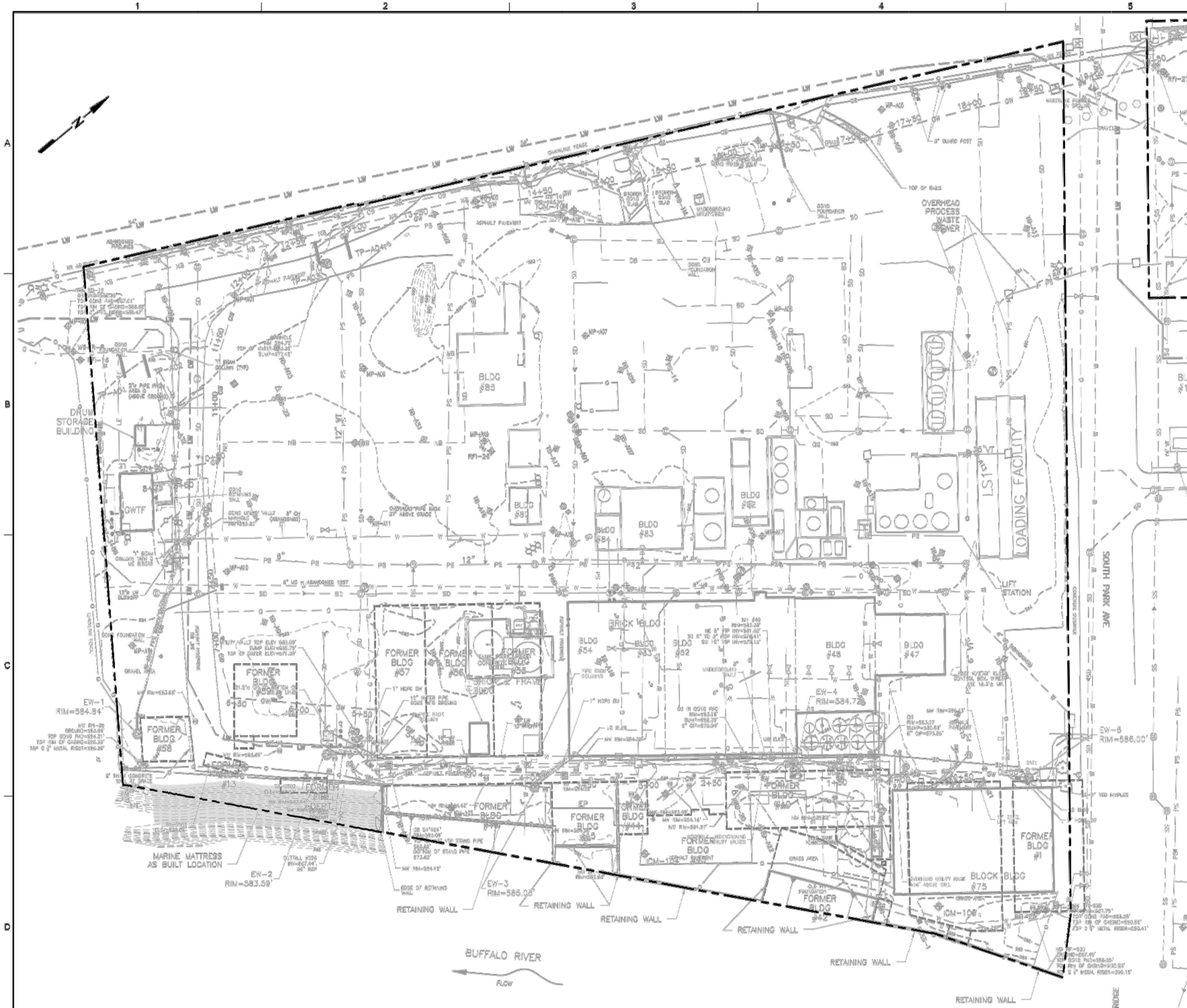
APPENDIX A

SITE DRAWINGS



LEGEND

- PROPERTY BOUNDARY
- EASEMENT BOUNDARY
- MAJOR CONTOUR
- MINOR CONTOUR
- EDGE OF PAVEMENT
- OVERHEAD ELECTRIC
- UNDERGROUND ELECTRIC
- OVERHEAD WATER LINE
- UNDERGROUND WATER LINE
- WATER MANHOLE
- WATER VALVE
- LAKE WATER
- GROUNDWATER EXTRACTION WELL
- GAS LINE
- GAS MANHOLE
- STORM DRAIN
- STORM DRAIN MANHOLE
- SANITARY SEWER
- SANITARY SEWER MANHOLE
- PROCESS SEWER
- PROCESS SEWER MANHOLE
- CHAIN LINK FENCE
- BOLLARD
- UTILITY POLE
- HYDRANT
- CATCH BASIN
- SINGLE TREE
- MW-03-97 MONITORING WELL
- PZ-0206-4 PIEZOMETER
- ELECTRICAL HANDHOLE
- LEAK DETECTION MANHOLE
- FLOW PANEL
- GWTF GROUNDWATER TREATMENT FACILITY
- FORMER BUILDING LIMITS AND ABANDONED FOUNDATIONS
- LIMIT OF MARINE MATRESS
- 11+00 2010 GROUNDWATER EXTRACTION WELL PIPING AND STATIONING

NOTES:

1. FORMER STRUCTURES SHOWN ARE ONLY THOSE IDENTIFIED ON HISTORIC PLANS DATED 1940, 1950, AND 1977, LOCATED NEAR THE PROPOSED VERTICAL HYDRAULIC BARRIER WALL. LOCATIONS OF FORMER STRUCTURES SOUTH OF FORMER BUILDINGS 46 AND 57 ARE APPROXIMATE.
2. BASE PLAN INFORMATION SHOWN HEREON WAS PROVIDED BY "ONTARIO SPECIALTY CONTRACTING, INC" DATED JULY 28, 2010.

0 20 40 80
SCALE IN FEET

NO.	DATE	REVISION	BY	APVD
C	06/01/12	30% DESIGN	JVM	LNT
B	03/25/11	30% DESIGN SUBMITTAL FOR CLIENT REVIEW	RJR	LNT
A	02/16/11	30% DESIGN INTERNAL REVIEW	RJR	LNT

DSGN RSE | DR RJR | CHK RSE | APVD LNT

SBD South Buffalo Development, LLC
335 Seneca Street
Buffalo, New York

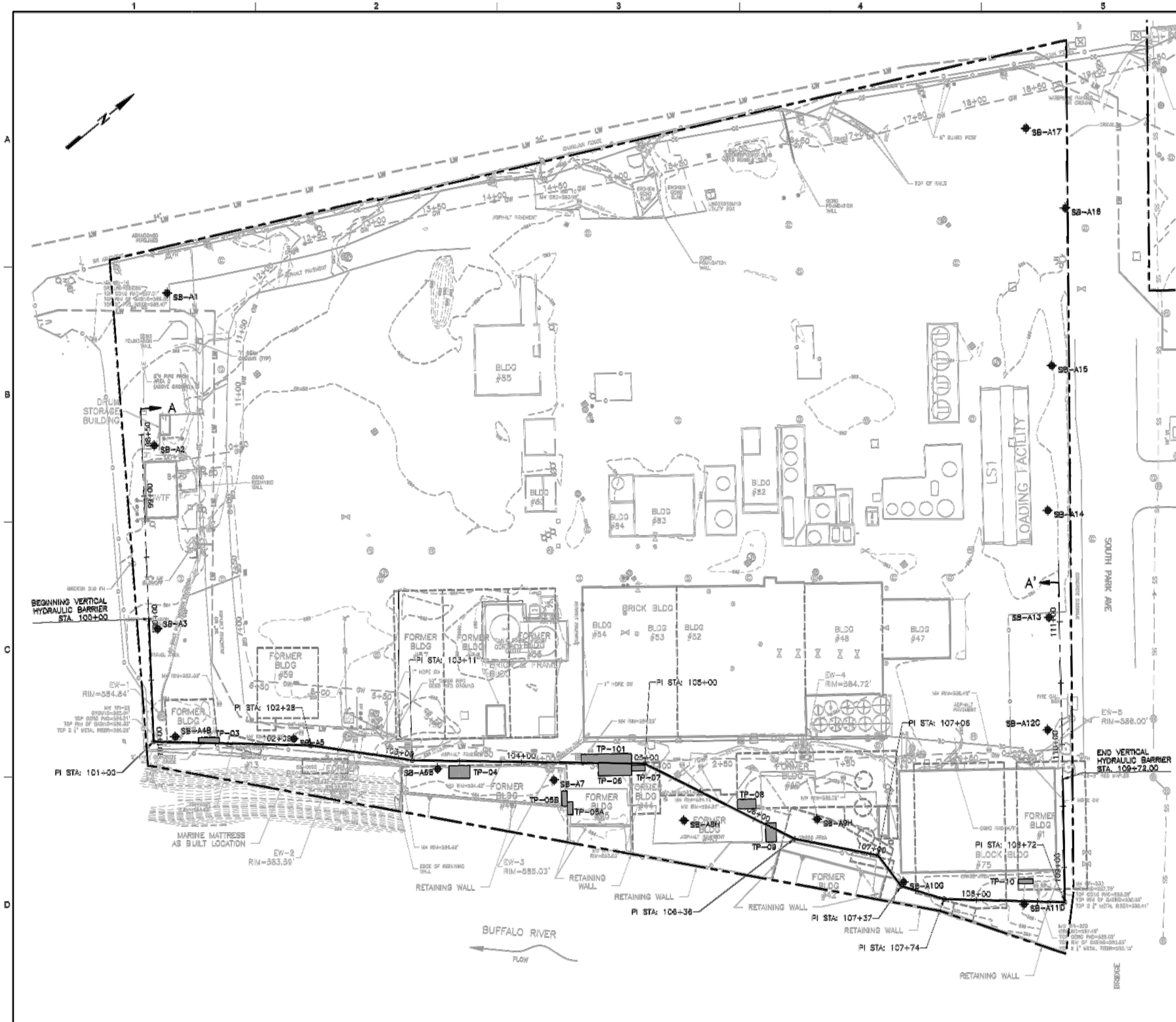
AREA A
VERTICAL HYDRAULIC BARRIER DESIGN
FORMER BUFFALO COLOR CORPORATION SITE
BUFFALO, NY
NYSDEC SITE NO. C915230

MACTEC
MACTEC Engineering and Consulting, Inc.
P.O. Box 7050, 511 Congress Street
Portland, Maine 04112-7050
(207) 775-5401

CIVIL
AREA A
EXISTING CONDITIONS PLAN

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	3410090701
DWG	C-101
SHEET	1 OF 3



LEGEND

- PROPERTY BOUNDARY
- EASEMENT BOUNDARY
- MAJOR CONTOUR
- MINOR CONTOUR
- EDGE OF PAVEMENT
- OVERHEAD ELECTRIC
- UNDERGROUND ELECTRIC
- OVERHEAD WATER LINE
- UNDERGROUND WATER LINE
- WATER MANHOLE
- WATER VALVE
- LAKE WATER
- 2010 GROUNDWATER EXTRACTION WELL PIPING AND STATIONING
- GROUNDWATER EXTRACTION WELL
- GAS LINE
- GAS MANHOLE
- STORM DRAIN
- STORM DRAIN MANHOLE
- SANITARY SEWER
- SANITARY SEWER MANHOLE
- PROCESS SEWER
- PROCESS SEWER MANHOLE
- CHAIN LINK FENCE
- BOLLARD
- UTILITY POLE
- HYDRANT
- CATCH BASIN
- SINGLE TREE
- MW-03-97 MONITORING WELL
- PZ-0208-4 PIEZOMETER
- SB-A3 2009 SOIL BORING
- ELECTRICAL HANDHOLE
- CLEAN OUT
- LEAK DETECTION MANHOLE
- FLOW PANEL
- GWTF GROUNDWATER TREATMENT FACILITY
- TP-03 2010 TEST PIT
- A A' LOCATION AND ORIENTATION OF SUBSURFACE PROFILE
- 11+00 PROPOSED VERTICAL HYDRAULIC BARRIER ALIGNMENT WITH STATIONING
- FORMER BUILDING LIMITS AND ABANDONED FOUNDATIONS

0 20 40 80
SCALE IN FEET

NO.	DATE	REVISION	BY	APVD
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B	03/25/11	30% DESIGN SUBMITTAL FOR CLIENT REVIEW	RJR	LNT
A	02/15/11	30% DESIGN INTERNAL REVIEW	RJR	LNT

DSGN	DR	CHK	APVD
RSE	RSE	RJR	LNT

SBD South Buffalo Development, LLC

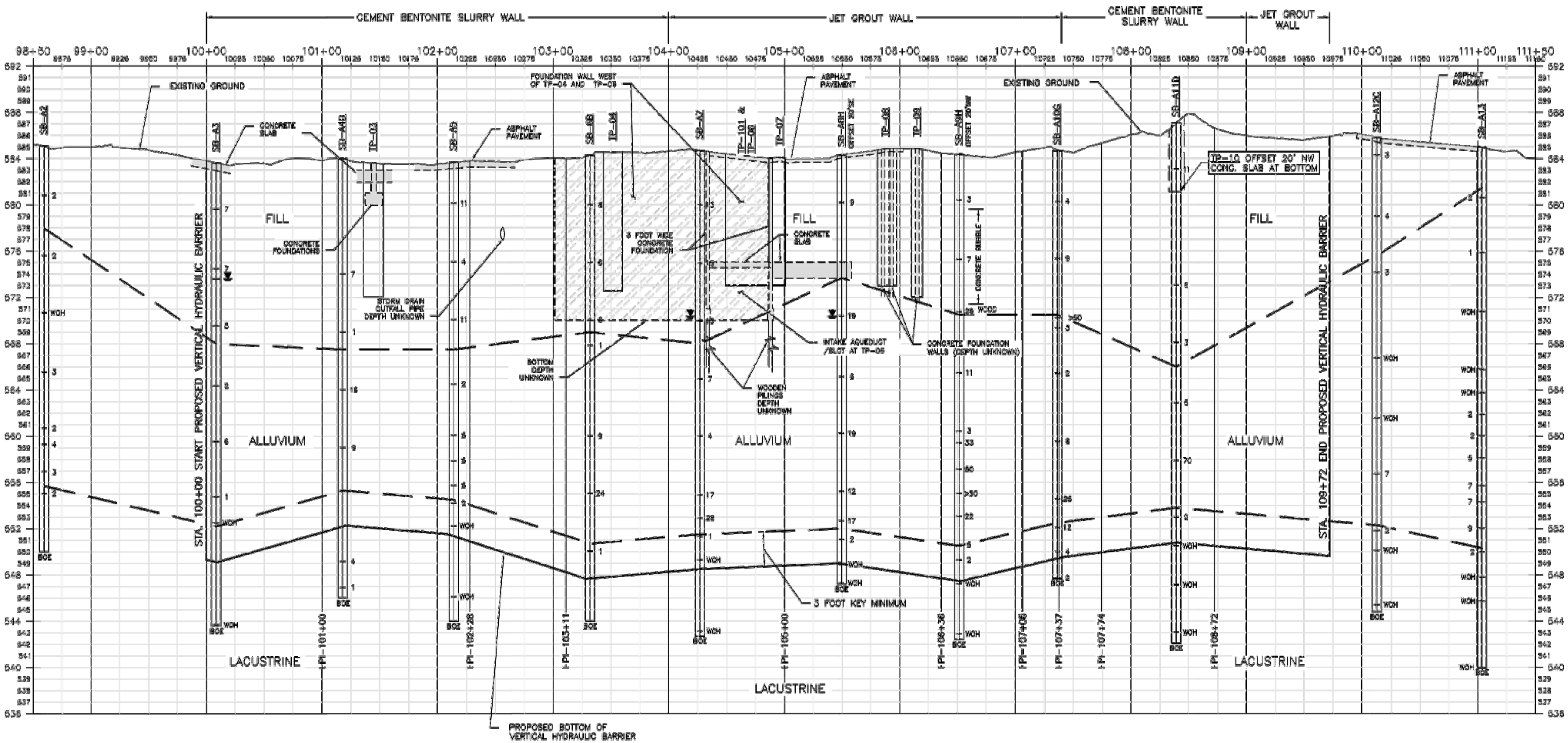
AREA A
VERTICAL HYDRAULIC BARRIER DESIGN
FORMER BUFFALO COLOR CORPORATION SITE
BUFFALO, NY
NYSDEC SITE NO. C915280

MACTEC

CIVIL
AREA A
SITE PLAN

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	3410090701
DWG	C-102
SHEET	2 OF 3



INTERPRETIVE SUBSURFACE PROFILE A–A'

0 25 50 100
SCALE IN FEET
HORIZONTAL SCALE: 1" = 50'

0 2.5 5 10
SCALE IN FEET
VERTICAL SCALE: 1" = 5'

LEGEND

FILL	SAND & GRAVEL WITH CONCRETE BRICK AND WOOD DEBRIS
ALLUVIUM	STRATIFIED SAND, SILT, CLAY, AND GRAVEL
LACUSTRINE	CLAY WITH OCCASIONAL FINE SAND PARTINGS
▼	WATER ELEVATION
5	SPT N VALUE
SB-A3	BORING LOCATION
TP-01	TEST PIT LOCATION
BOE	BOTTOM OF EXPLORATION
PI-101+00	BARRIER TURNING POINT
WOH	WEIGHT OF HAMMER

NO.	DATE	REVISION	BY	APVD
C	06/01/12	30% DESIGN	JVM	LNT
B	03/25/11	30% DESIGN SUBMITTAL FOR CLIENT REVIEW	RJR	LNT
A	02/16/11	30% DESIGN INTERNAL REVIEW	RJR	LNT

DSGN	DR	CHK	APVD
RSE	RSE	RJR	LNT

SBD South Buffalo Development, LLC

AREA A
VERTICAL HYDRAULIC BARRIER DESIGN
FORMER BUFFALO COLOR CORPORATION SITE
BUFFALO, NY
NYSDEC SITE NO. C915230

MACTEC

CIVIL
AREA A
VERTICAL HYDRAULIC BARRIER
INTERPRETIVE SUBSURFACE PROFILE

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	3410090701
DWG	C-201
SHEET	3 OF 3

APPENDIX B

GEOPHYSICAL SURVEY REPORT

Northeast Geophysical Services
4 Union Street, Suite 3, Bangor, ME 04401
Phone: 207-942-2700 Fax: 207-942-8798

GEOPHYSICAL SURVEYS AT THE FORMER BUFFALO COLOR CORP. SITE BUFFALO, NEW YORK

For:

MACTEC Engineering and Consulting, Inc.

December, 2009

Northeast Geophysical Services
4 Union Street, Suite 3, Bangor, ME 04401

February, 2010

GEOPHYSICAL SURVEYS AT THE FORMER BUFFALO COLOR CORP. SITE, BUFFALO, NEW YORK

INTRODUCTION

At the request of MACTEC Engineering and Consulting, Inc. (MACTEC) geophysical surveys were conducted at the former Buffalo Color Corp. site in Buffalo, New York. The geophysical work was primarily focused on site investigation and planning for an underground environmental barrier structure that is to be built around three sides of Area A at the site. The original geophysical tasks included: utility clearance for several soil borings that were being drilled along the planned location of the structure, ground penetrating radar (GPR) surveys along the planned route of the structure, and investigation of a large concrete river water intake structure on the east side of the site. Additional tasks were subsequently added to the geophysical work including: GPR surveying of a planned trench route for a groundwater pipeline along the western side of the site, utility clearance of two additional boring locations and several test pit locations, and EM61 metal detection surveying of the original GPR survey lines and river water intake structure. The surveys were conducted on November 3-5, and December 8, 2009 by Mike Scully of Northeast Geophysical Services (NGS). This report summarizes site conditions, methods used, and the results of the geophysical surveys. Several digital photographs of the survey areas will also be included with the digital submission of this report.

SITE LOCATION AND CONDITIONS

The former Buffalo Color Corp. site is part of a large inactive industrial complex that is situated between the Buffalo River and the Conrail Railroad line on the south side of Buffalo, New York. The plant site was first developed in 1879 and became a major producer of dyes for the textile industry. The company specialized for many years in the production of synthetic indigo for use in blue jeans. Originally established as Schoellkopf Aniline Chemical Co. it merged into National Aniline in 1917, became part of Allied Chemical Corp. in 1921 and was spun off as Buffalo Color Corp. in 1976. The plant eventually ceased production in 2003 due to foreign competition.

South Park Avenue passes through the site from southeast to northwest as a ramp and overpass over the adjacent rail lines. The primary focus of the geophysical investigation was the perimeter of the portion of the site that is located southwest of South Park Avenue. This part of the site is designated as Area A. An underground environmental barrier structure is planned to be built around three sides of the perimeter of Area A to prevent impacted groundwater from leaving the site. Some geophysical work was also conducted in Areas B, C and E, which are on the opposite side of South Park Avenue.

Surface cover in the area of investigation was a mix of asphalt pavement, concrete, gravel and grass-covered soil. According to site plans portions of the areas surveyed are underlain by a variety of underground utilities including water, sewer and surface drainage pipes, electric lines, natural gas pipes and industrial chemical supply lines including chlorobenzene and nitrobenzene lines. Old reinforced concrete floor slabs and foundation walls occur along portions of the perimeter survey lines and many of these are covered by asphalt pavement. Portions of the site are also reportedly underlain by fill that is made up primarily of broken concrete and other debris derived from the previous demolition of old site buildings.

The surface and underground conditions described above resulted in significant limitations for the geophysical surveys at this site. In particular the abundance of old underground concrete structures and concrete rubble fill reduced penetration of the GPR energy and caused EM anomalies that may have masked any underlying metallic utilities, objects or structures. It is also apparent that there are many unmapped underground utilities and remnants of former structures that make it difficult to interpret the exact cause of many of the geophysical anomalies seen.

METHODS AND INSTRUMENTATION

Ground Penetrating Radar (GPR)

Ground penetrating radar utilizes high frequency radio waves to probe the subsurface. Radar waves are transmitted into the ground from an antenna that is pulled across the ground surface. In the subsurface, radar waves are reflected at interfaces of materials with contrasting dielectric properties. The returning signal is intercepted by a receiver and converted to a digital graphic image. The horizontal axis of the image is distance along the traverse. The vertical axis is two-way travel time of the radar pulses, in nanoseconds (ns) which can be converted to depth given an understanding of the material that the radar energy is passing through.

Tanks, pipelines and other objects with rounded tops (boulders, tree roots, or segments of old foundations, for example) may show up on the profiles as hyperbola-shaped reflections. Tanks and pipelines usually appear on more than one survey line as hyperbolic reflectors on lines perpendicular to the tank or pipe axis and as horizontal reflectors on lines along the axis. The GPR instrument used was a GSSI, SIR-3000. 400 MHz and/or 100 MHz antennas were used for the surveys at this site. The GPR time range was set so that the depth of investigation was about 10 feet for the 400 MHz antenna and 20 feet for the 100 MHz antenna. The GPR surveys were conducted at a slow walking pace along the lines. The beginning and end points of the GPR survey lines were marked with wooden stakes.

EM-61 Metal Detector

A Geonics EM61-MK2 high resolution metal detector was used for the metal detection surveys. The EM61-MK2 is a portable time-domain instrument with a coincident transmitter/receiver coil and second parallel receiver coil for depth to target estimation and rejection of surface metal response. The instrument measures the secondary electromagnetic field response in milli-volts (mV). The EM61-MK2 is designed specifically to locate small to large buried metal objects such as UXO, drums and tanks while being relatively insensitive to above-surface metallic objects such as fences, buildings and power lines. The technique is sensitive to conductive metal up to a depth of approximately 12 feet. The size and burial depth of the metal determine the strength of the response. The EM61-MK2 transmitter/receiver coils can either be carried by the operator using a harness, or pulled on wheels. EM data is digitally recorded on an Allegro Cx field computer. Readings can be recorded manually, at regular time intervals or, if the wheel mode is used, at regular distance intervals controlled by the rotation of the wheels. At this site the wheel (distance) mode was used with readings recorded every 0.65 feet along the survey lines.

Utility Cable and Pipe Locator

A Radiodetection RD7000 Utility Cable and Pipe Locator was used to screen for live buried electric lines at each of the proposed soil boring and test pit locations. This instrument uses passive and transmitted electromagnetic frequencies to locate and trace buried pipes and utilities. The passive frequencies include power and radio while the transmitted frequencies include 8, 33, 65 and 83 kHz. This instrument is generally used in a sweeping fashion in multiple directions across an area of interest and any signal detections are marked on the ground. The instrument does not record data. At this site the RD7000 was used only in the passive mode to check for live electric lines at the proposed boring and test pit locations.

Field Survey Procedures

<u>Drill site and test pit clearance:</u> The general procedure for clearance of the soil boring and test pit locations was to conduct a minimum of two, 20 to 30 foot GPR profiles at right angles over each location using the 400 MHz antenna. The locations were also screened for the presence of live electric lines using a utility cable and pipe locator as described above. If any possible obstructions or utilities were detected during this procedure then the location was moved to a nearby spot where no obstructions were observed. Several of the locations had to be adjusted according to this procedure. All but two of the boring locations were cleared in this manner during the first mobilization to the site in November. Two additional boring locations and several test pit locations were cleared during the second mobilization to the site in December.

<u>Barrier Structure Perimeter Lines 1 through 3:</u> The three perimeter lines where the proposed underground barrier structure is to be located were surveyed using GPR and EM61. The results of this work are shown on the attached profiles with interpretive annotations. During the first site mobilization the survey lines were marked on the ground using tape measures and spray paint and then were surveyed using both the 100 MHz and 400 MHz GPR antennas. The surveys using the 400 MHz antenna provided the best results and these are shown on the attached profiles. During the second site mobilization the three lines were surveyed using the EM61-MK2 metal detector. These results are also shown on the attached profiles as color-filled line plots above each of the GPR line segments.

<u>Groundwater Pipeline Route (Line 4):</u> The planned groundwater extraction pipeline route along the western perimeter of Areas A and B was surveyed using the 100 MHz GPR antenna. This line was also marked on the ground using tape measures and spray paint. The results of this survey are shown on the attached profile with interpretive annotations. The smaller 400 MHz antenna was not used on this line because a significant portion of the line had very rough surface conditions including broken, uneven concrete slabs, piles of concrete rubble and railroad tracks. Under these conditions the smaller antenna is very unstable and will bounce around a lot resulting in poor records.

River Water Intake Structure Grid Survey: A 60 foot by 70 foot survey grid was established over the water intake structure using tape measures and spray paint. During the first mobilization to the site in November the grid area was surveyed with GPR using the 400 MHz antenna. GPR profiles were produced every 5 feet in the north-south direction and every 10 feet in the east-west direction. During the second site mobilization in December the grid area was surveyed using the EM61-MK2 metal detector. EM61 readings were recorded every 0.65 feet along 5 foot-spaced lines in the east-west direction. The configuration of the grid and the results of the metal detection survey are shown on Figure 6. Representative GPR profiles with interpretive annotations are also included as Figures 7 and 8.

SURVEY RESULTS

Drill site and test pit clearance: Fifteen proposed drilling sites and nine proposed test pit locations were surveyed in Areas A, C and E using GPR and a utility line locator as described above. Several of the pre-marked locations were adjusted in the field to avoid possible obstructions detected by the surveys. These adjustments were made with the knowledge and approval of a MACTEC onsite representative. The effective depth of investigation for the GPR surveys was generally in the range of 4 to 8 feet in these areas.

Barrier Structure Perimeter Lines 1 through 3: The results of the GPR and EM61 surveys along perimeter lines 1 through 3 are attached as Figures 2 through 4. The 400 MHz GPR profiles are plotted in two to three segments for each line and the EM metal detection results are represented as color-filled line plots above each of the GPR line segments. Interpretive annotations are also shown on the figures. Although the detailed observations and interpretive comments are given on each of the figures, a summary of results for each line are as follows:

Line 1 starts about 6 feet from the chain link fence at the northwest corner of Area A and runs 700 feet to the southeast, ending on the east side of Block Building #75. Wooden stakes mark the beginning and end of the line.

Several metallic and non-metallic GPR reflectors occur along Line 1. The metallic reflectors appear to include metal pipes, pieces of sheet metal or plate steel and hidden concrete slabs or concrete structures such as manholes or old foundation walls. Reinforced concrete slabs are often easy to distinguish with radar because the reinforcing steel causes a regular pattern of multiple small hyperbolic reflectors over the steel bars or mesh. The non-metallic GPR reflectors seen generally appear to be hyperbolic shaped anomalies which could be caused by non-metallic pipes crossing the line or by other rounded objects such as large rocks or logs. The highest concentrations of anomalies along the line occur at 110 to 180 feet, 210 to 240 feet, 270 to 300 feet, 335 to 350 feet, and 370 to 400 feet.

The portion of the line from 440 feet to 650 feet was not surveyed with the EM61 metal detector because that part of the line is within a fenced area that was locked at the time of the EM61 survey. A strong GPR reflector at about 550 feet appears to be caused by a flat metal object – perhaps a piece of sheet metal or steel plate. The portion of the line from 650 to 700 feet shows a few strong metallic anomalies that are caused by proximity to a chain link fence and a monitoring well casing as noted on the figure. A pair of water mains that enter the site from South Park Avenue should cross Line 1 between about 670 and 690 feet. The pipes were not detected by either survey instrument, likely because they are too deep. One of the water lines was punctured during the first attempt to drill soil boring SB-A11 prior to the geophysical field work.

Line 2 starts near the 690-foot mark of Line 1 just east of Block Building #75 and runs 750 feet to the south-southwest along the Buffalo River side of Area A. Wooden stakes mark the beginning and end of the line as well as two points at 106' and 200' where there are sharp bends in the line.

A large portion of the first half of Line 2 shows an irregular pattern of moderate to very strongly anomalous metal response with few distinct GPR reflectors. It was reported that previous test pitting in this area revealed abundant reinforced concrete rubble and other demolition debris in the fill material. The geophysical results are consistent with what would be expected for that type of fill material. A trench-like GPR feature noted on the profile at about 115 to 145 feet appears to be where the water mains mentioned above pass through this part of the site. There is also a large bright GPR reflector at about 280 feet that could be caused by a large metal pipe, concrete or some other type of metal object.

The portion of Line 2 from about 350 to 550 feet shows numerous metal and GPR anomalies which are noted on the profile. Many of these features appear to be caused by paved-over reinforced concrete slabs and foundation walls that are remnants of demolished former site buildings. A few of the GPR reflectors are hyperbole-shaped and may be caused by buried pipes. The anomalies at 367 feet and 403 feet are caused by the concrete side wall and back wall of the river water intake structure. The low level metal response from about 555 to 680 feet is caused by proximity of the line to a chain link fence.

Line 3 starts about 2 feet from the end of Line 2 and runs 380 feet to the northwest ending a few feet from the fence at the southwest corner of Area A. Wooden stakes mark the beginning and end of the line as well as the 200' mark behind the water treatment building.

The GPR profile along Line 3 does not show many distinct reflectors in the subsurface. However there are several strong metal anomalies along the line, some of which can be explained by visible features such as a manhole, monitoring well casing, a broken old fire hydrant and an above-ground pipe rack. Several of the metal anomalies are unexplained however, and the GPR is not very helpful in determining what they might be caused by. The section of the line from about 270 to 345 feet has a fairly rough surface with a lot of broken concrete rubble and what appears to be the remnants of old concrete slabs. It is possible that there was formerly an old building or buildings in this area.

Site utility maps show several underground utility lines that should cross Line 3 but were not clearly detected by the geophysical surveys. There are a few weak reflectors on the GPR profile that may be caused by buried pipes and these are noted on the figure.

Groundwater Pipeline Route (Line 4): Line 4 starts at the face of the Groundwater Treatment Facility building (GWTF), runs northerly to the north side of the paved road (40') where it bends to the west running along the edge of the road and crosses the pavement into the grass near the perimeter fence (208'). There it bends to the north and runs roughly parallel to the perimeter fence, under the S. Park Ave. overpass, to about 1,610' where it turns to the east, passes near the site security office, and ends at the so-called Terminal Manhole. This line is the planned route of an extracted groundwater pipeline that will be installed to replace portions of the existing aboveground system which will be dismantled along with most of the old site structures.

Figure 5 shows the GPR profile for survey Line 4 with surface observations and interpretive annotations. The effective depth of investigation for the radar was limited to a range of about 4 to 8 feet likely due to relatively high soil conductivity. Similar to Line 3, site utility maps show some underground utility lines that should cross or run under Line 4 but many of these were not clearly detected by the GPR survey. The approximate mapped locations of these utilities as well as any possible GPR reflectors associated with them are noted on the figure.

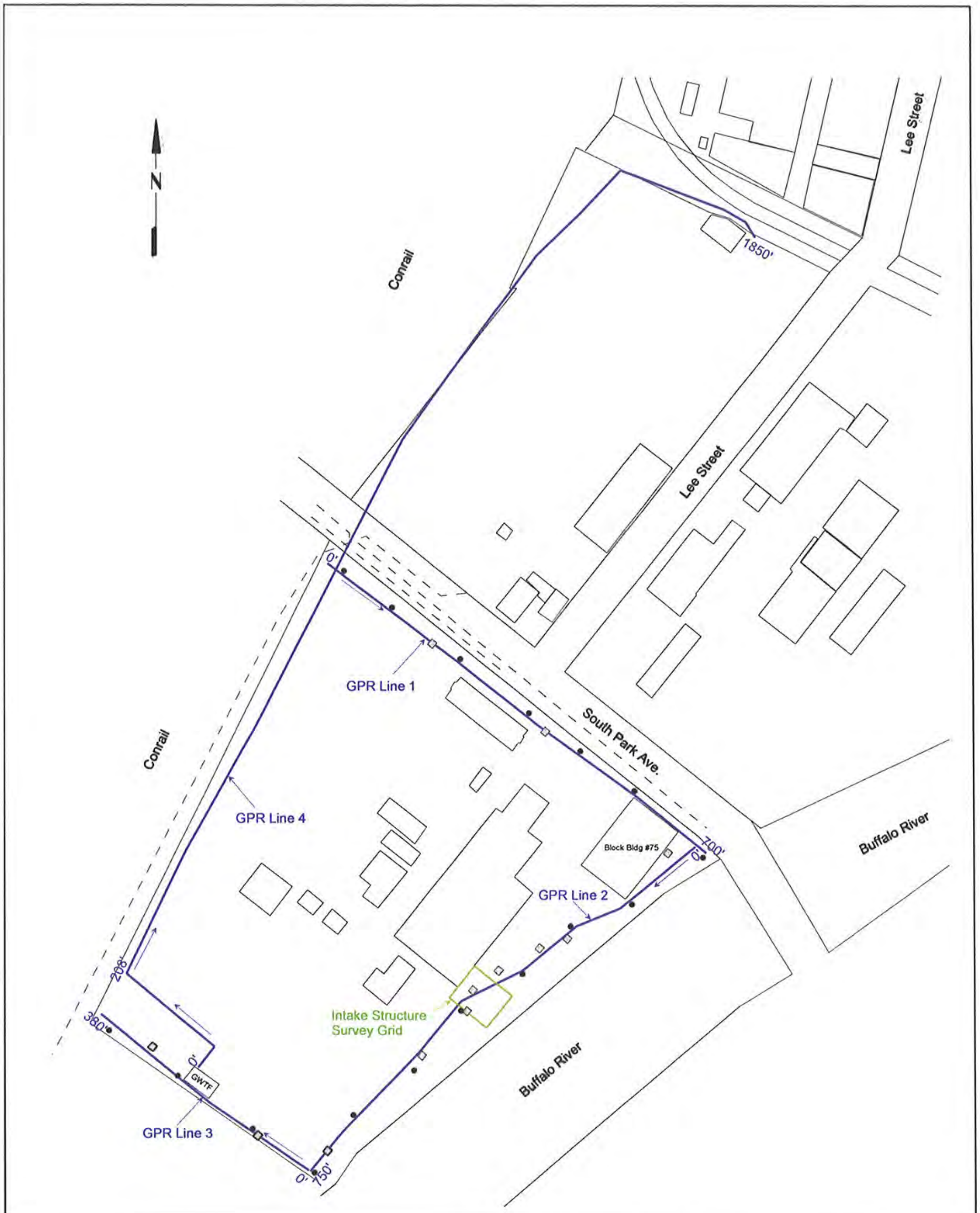
Gas, Lake Water, and Surface Drainage lines are shown running under the paved road within the first 40 feet of Line 4. Another gas line should cross the line at about 85 feet and there is a sharp GPR reflector there. Abandoned Nitrobenzene and Chlorobenzene lines are shown running parallel to Line 4 just inside the perimeter fence from 208 feet to about 520 feet along the line. A 54" lake water pipe, 10" gas main, and 18" water main are also shown crossing the line in the vicinity of the S. Park Ave. overpass. These locations and possible GPR reflectors are also noted on the figure.

River Water Intake Structure Grid Survey: The configuration and results of the Intake Structure grid survey are shown on Figure 6. The EM61 metal detection survey results are shown on the figure as colored blocks. Zero or very low metal responses are indicated by gray plus marks. Increasing metallic responses are indicated by colored blocks progressing from yellow to gold to red to black as shown in the explanation of the figure. Representative GPR profiles with interpretive annotations are also included as Figures 7 and 8. As indicated on the Figures the GPR and EM61 results show strong responses from the reinforcing steel in the side and back walls of the intake structure as well as from steel in a hidden concrete slab or slabs between the back wall of the structure and Building 54. Also, a roughly horizontal reflector at about 6 feet deep under the grassy area within the structure may be caused by the buried roof of the structure.

Mapped utility lines that run under the pavement between the intake structure and Building 54 were not detected by the survey mainly because of the presence of reinforced concrete at the surface. The approximate mapped locations of these lines are shown on Figure 6.

LIMITATIONS OF THE SURVEYS

The EM-61 metal detection survey provides an indication of where buried metal exists at the site surveyed. The Ground Penetrating Radar survey produces reflectors at interfaces of materials with contrasting dielectric properties. Both of these instruments provide indirect measurements of subsurface conditions. The actual cause of the features depicted on the figures can only be conclusively determined by direct observation.



EXPLANATION

- ● Approximate Location of Soil Boring
- ◇ Approximate Location of Test Pit
- —— Location of GPR Survey Line

Scale in Feet

0 100 200 300 400

Figure 1

Geophysical Survey Line Location Map

Buffalo Color Corp. Site
Buffalo, NY

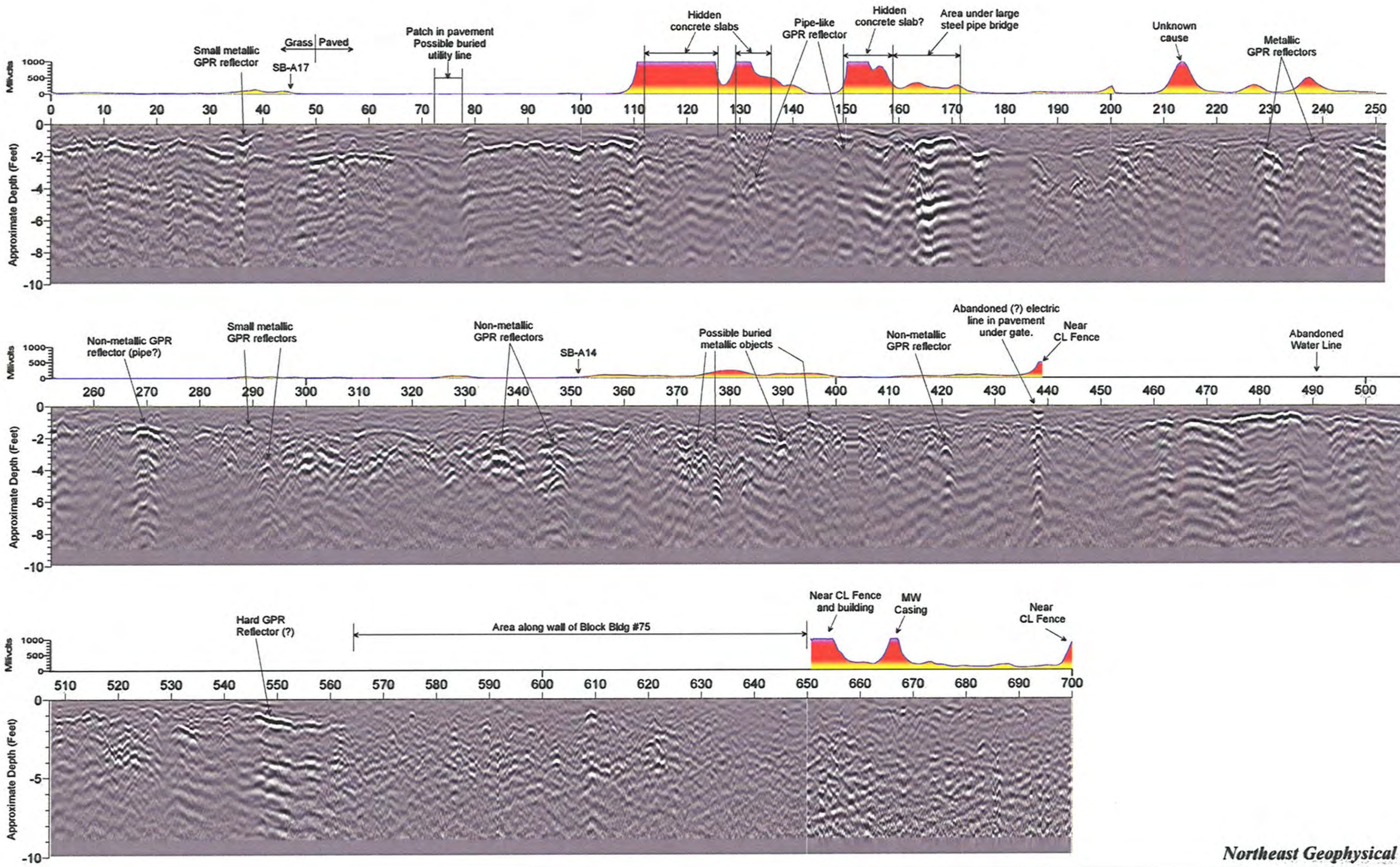
For:

MACTEC Engineering and Consulting, Inc.

Surveyed 11/3 & 12/8/2009 by:

Northeast Geophysical Services

Figure 2: Former Buffalo Color Corp Site, Buffalo, NY
Line 1 - EM61 Metal Detector / 400 MHz GPR Profiles



Northeast Geophysical Services

Figure 3: Former Buffalo Color Corp Site, Buffalo, NY
Line 2 - EM61 Metal Detector / 400 MHz GPR Profiles

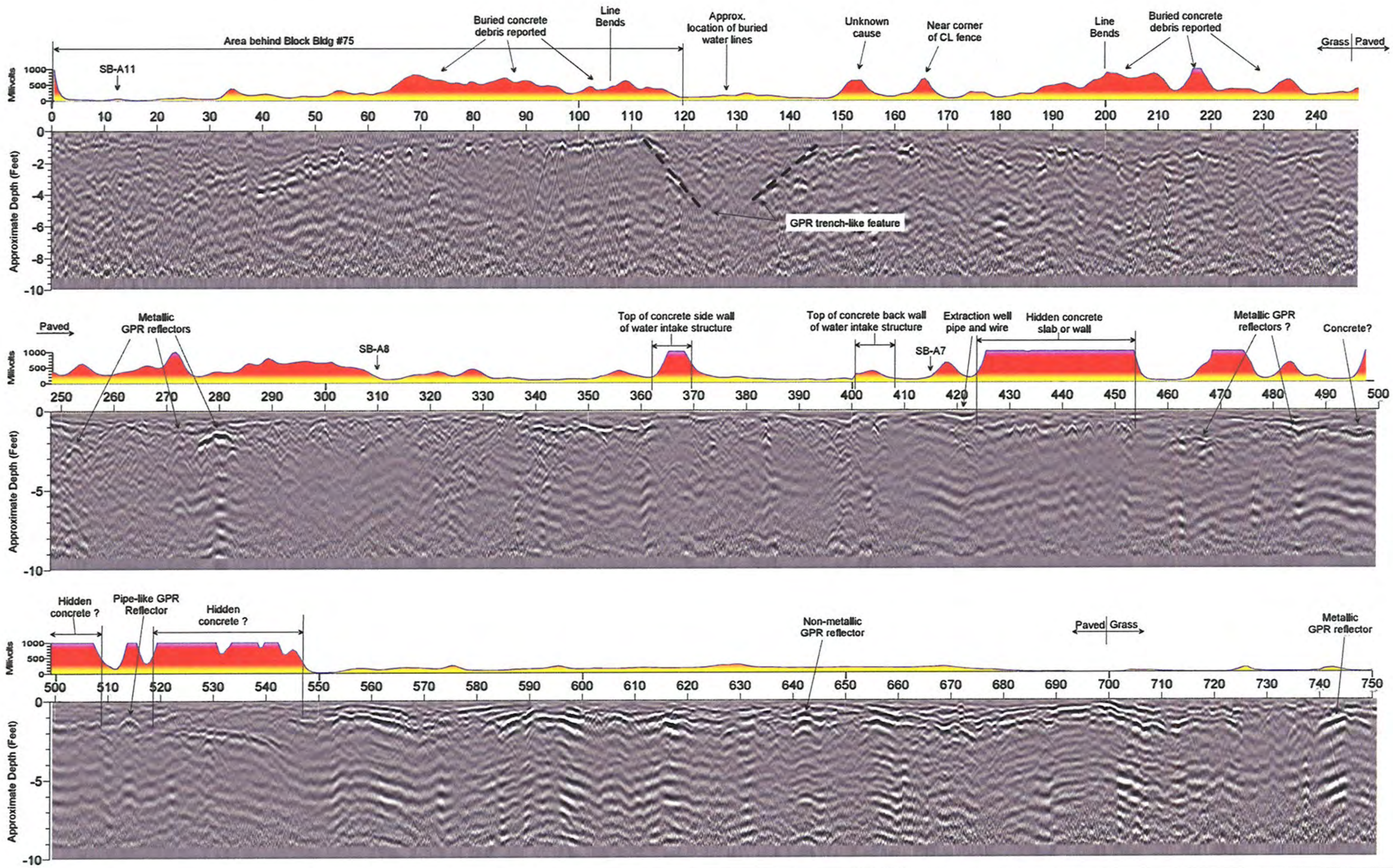
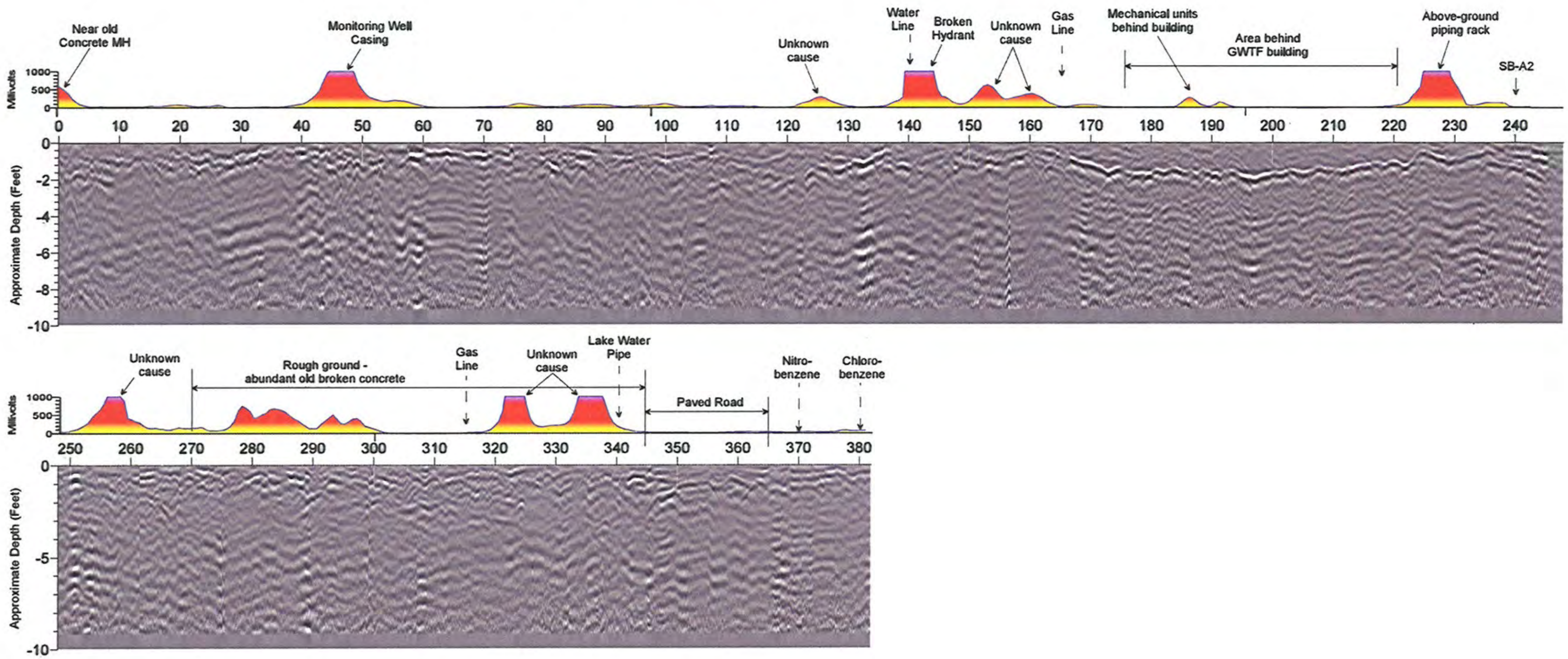
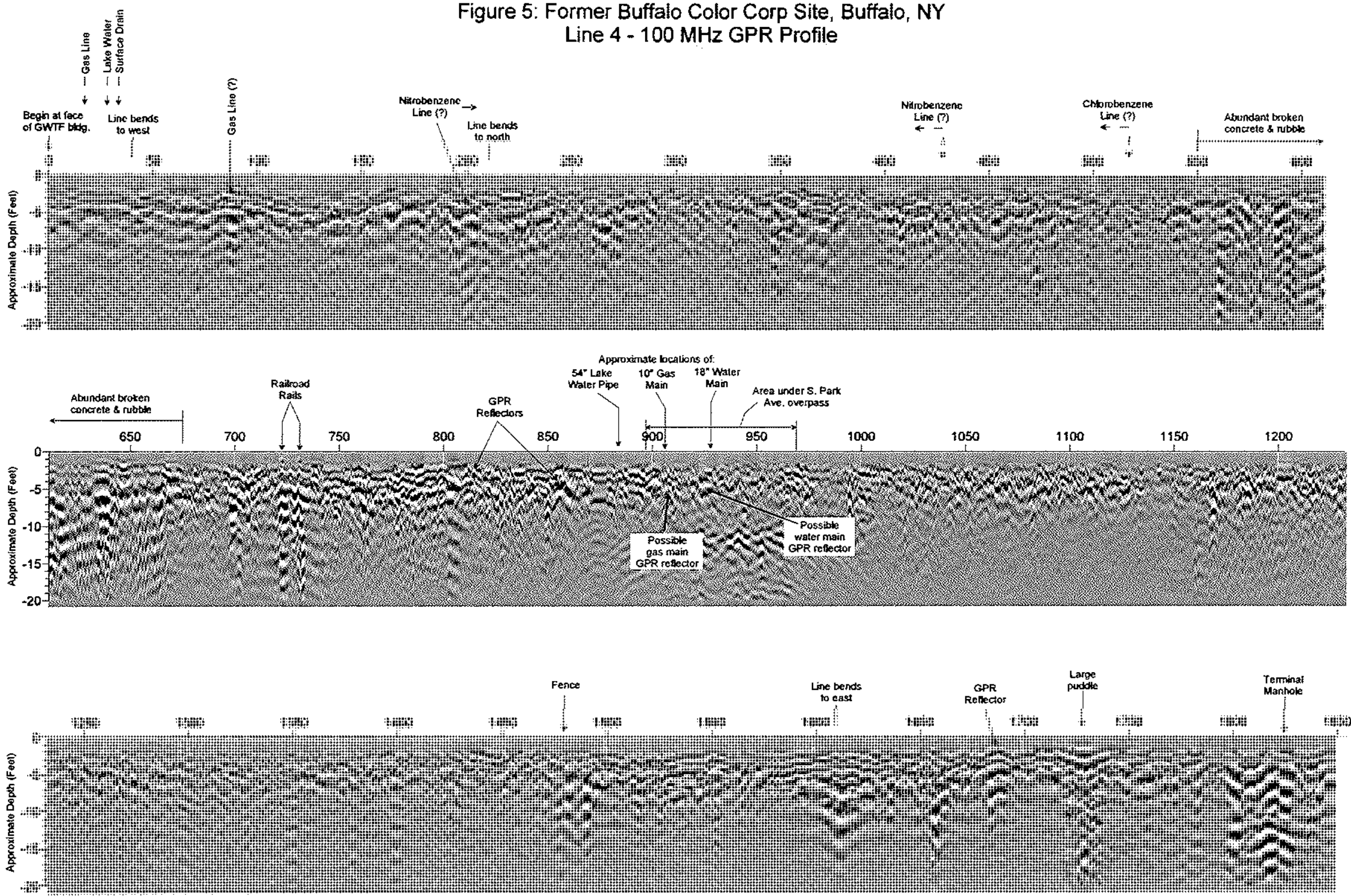


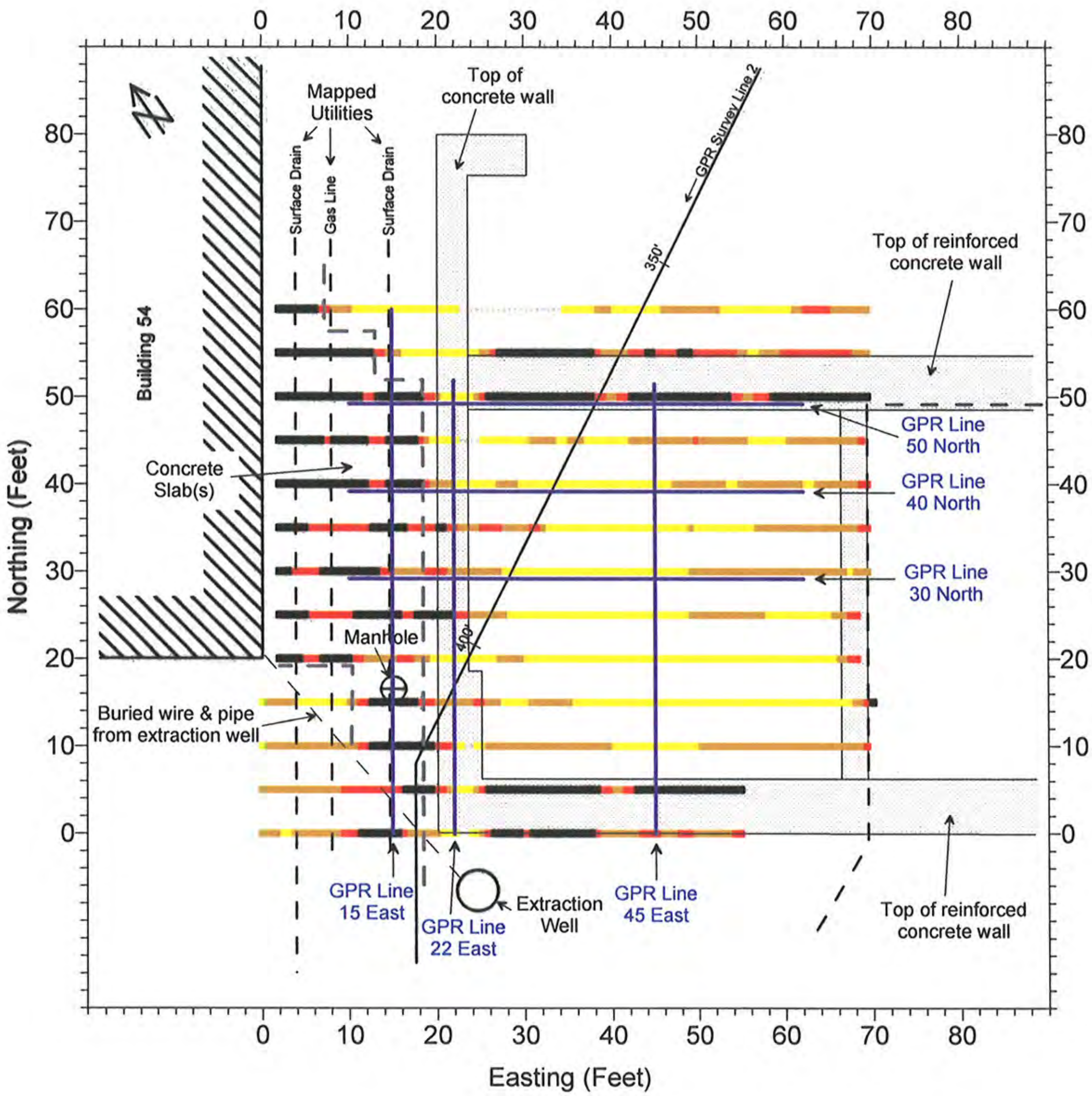
Figure 4: Former Buffalo Color Corp Site, Buffalo, NY
Line 3 - EM61 Metal Detector / 400 MHz GPR Profiles



Northeast Geophysical Services

Figure 5: Former Buffalo Color Corp Site, Buffalo, NY
Line 4 - 100 MHz GPR Profile





EXPLANATION

EM-61 Metal Detector Survey Results
Metallic Response in millivolts

- 0 mV to 100 mV
- 100 mV to 200 mV
- 200 mV to 400 mV
- 400 mV to 1000 mV
- 1000 mV to 15000 mV

Scale in Feet

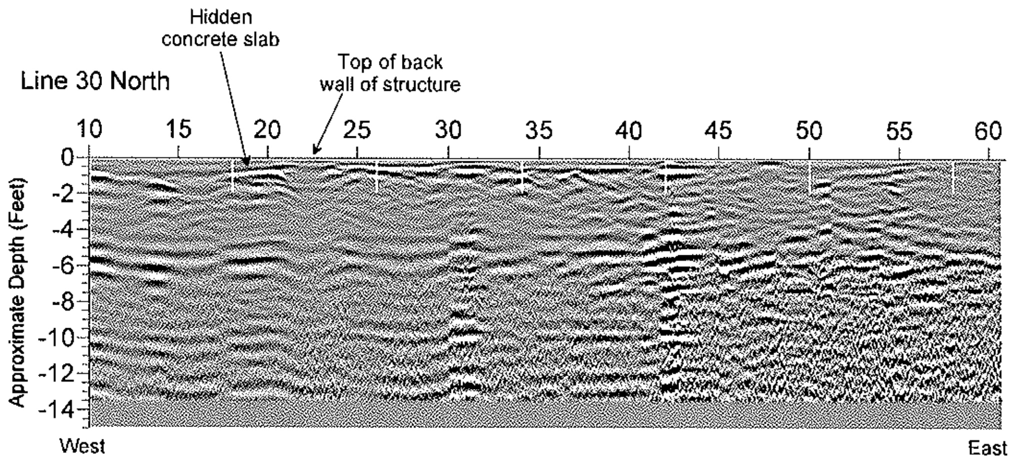
0 10 20 30 40

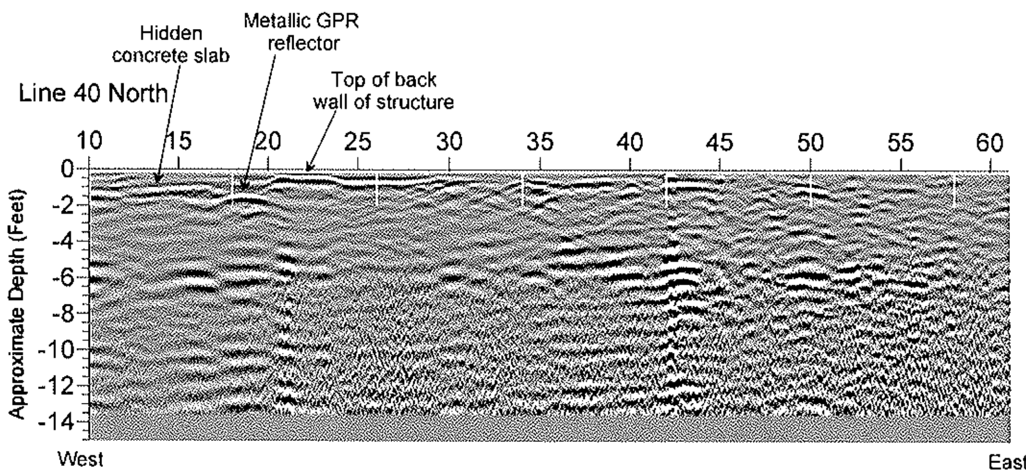
Figure 6
EM61 Metal Detection Survey Results
River Water Intake Structure
Buffalo Color Corp. Site
Buffalo, NY.

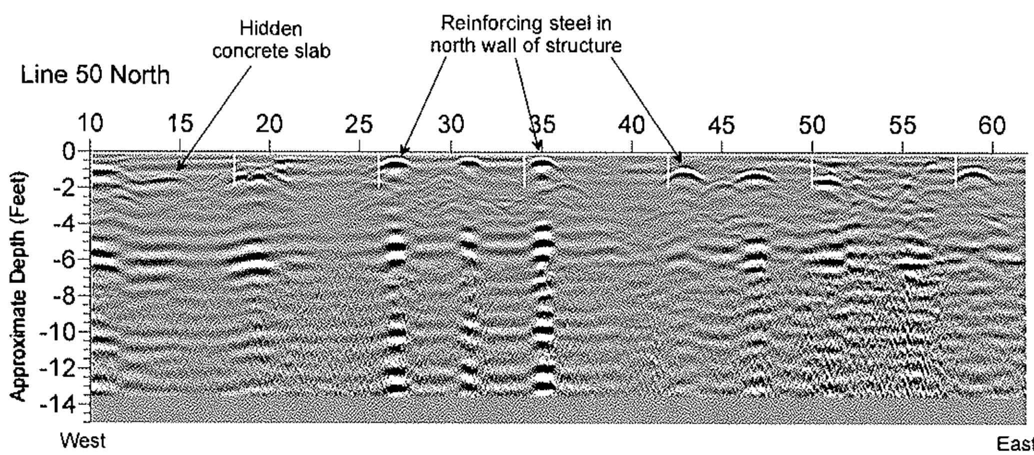
Surveyed 11/3 & 12/8/2009 by:

Northeast Geophysical Services

Figure 7: Former Buffalo Color Corp Site, Buffalo, NY
Intake Structure Grid West to East GPR Profiles

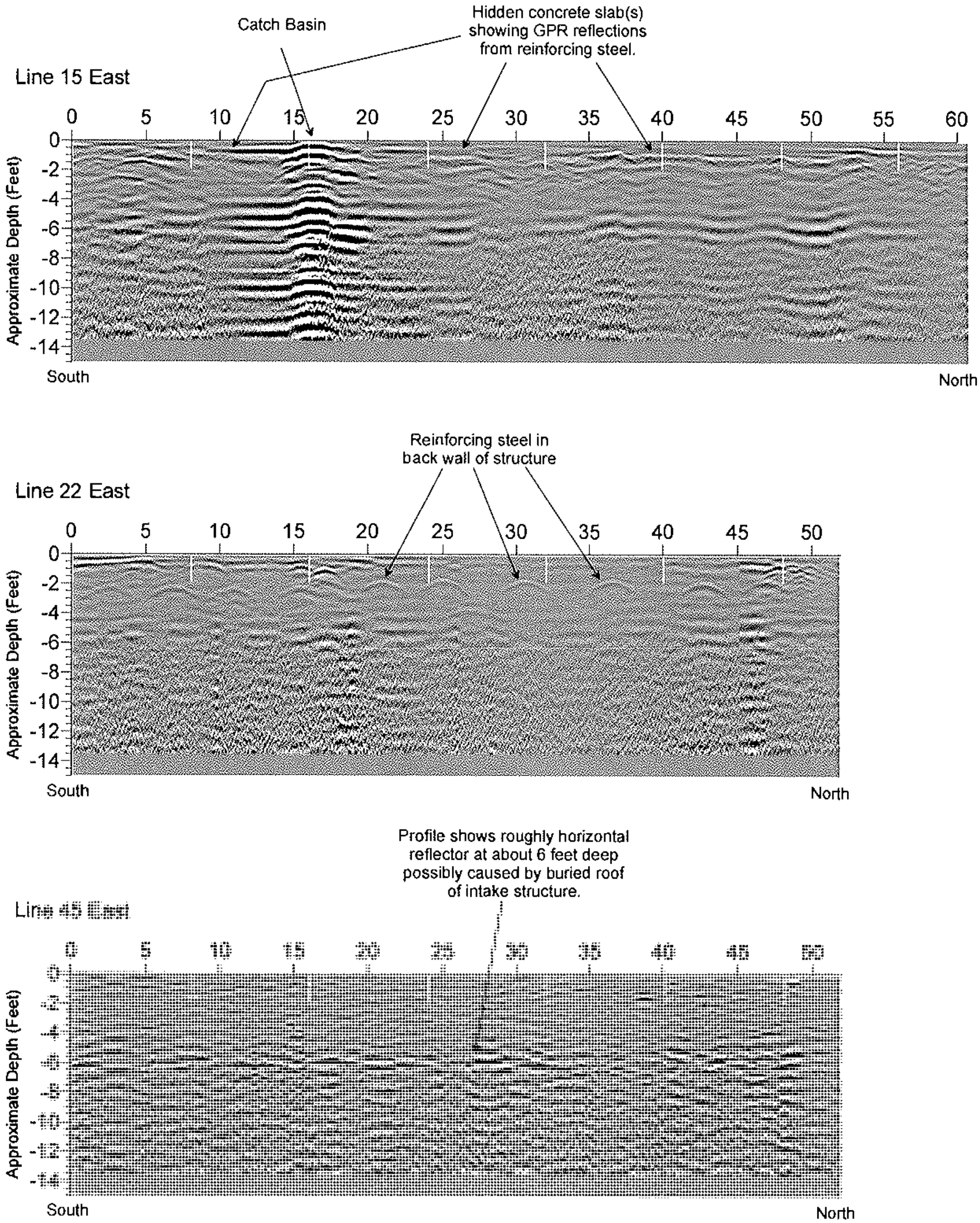






Northeast Geophysical Services

Figure 8: Former Buffalo Color Corp Site, Buffalo, NY
Intake Structure Grid South to North GPR Profiles



Northeast Geophysical Services

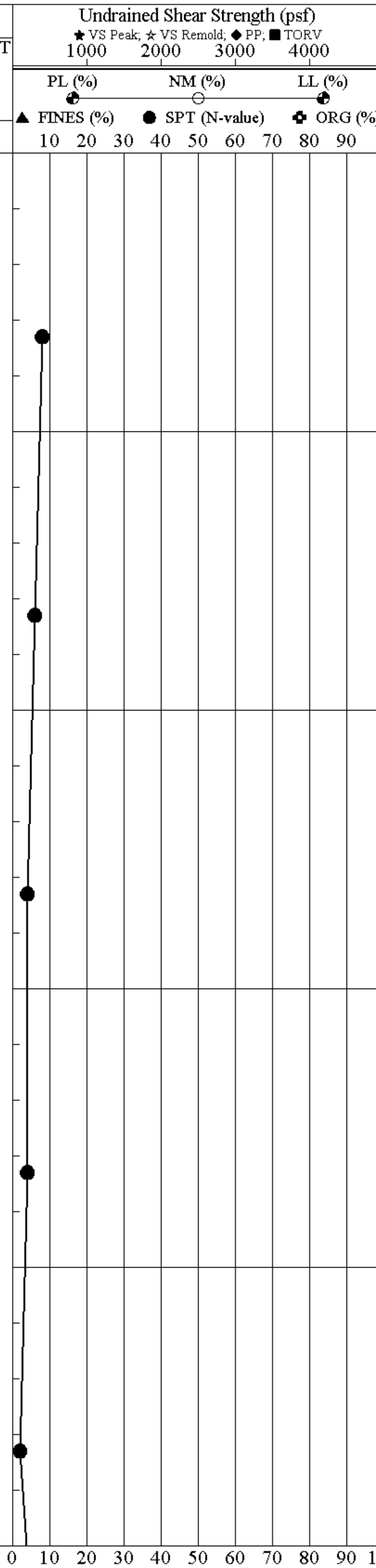
APPENDIX C

2009 GEOTECHNICAL SOIL BORING LOGS

SOIL BORING RECORD

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)	SAMPLE IDENT	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD / % REC
0	Brown, fine to medium SAND, loose, moist (FILL)	586.6		
4			S-1	11-4-4-4 (N = 8)
5		581.6		
7	Brownish gray, SILT with fine sand, wet, slightly plastic, ML (ALLUVIUM) - some staining, possibly petroleum; petroleum-like odor			
9			S-2	3-4-2-2 (N = 6)
10		576.6		
13.7	Brown, very fine Sand with silt, wet, non-plastic, SM (ALLUVIUM)			
14			S-3	1-2-2-2 (N = 4)
14.5	Gray, SILT with clay, soft, wet, plastic, ML (ALLUVIUM) - occasional rust colored very fine sand partings			
15		571.6		
17	Gray, fine SAND, loose, wet, SP (ALLUVIUM)			
18.4	Gray, SILT with fine sand, soft, wet, plastic, ML (ALLUVIUM) - wood fibers			
19			S-4	2-2-2-4 (N = 4)
19.5	Gray, fine SAND, loose, wet, SP (ALLUVIUM) - wood fiber bands			
20		566.6		
21	Dark gray, fine to coarse SAND, very loose, wet, SW (ALLUVIUM)			
24			S-5	1-1-1-1 (N = 2)
25		561.6		

SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS



DRILLER: SJB
RIG TYPE: CME-550 (Auto-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

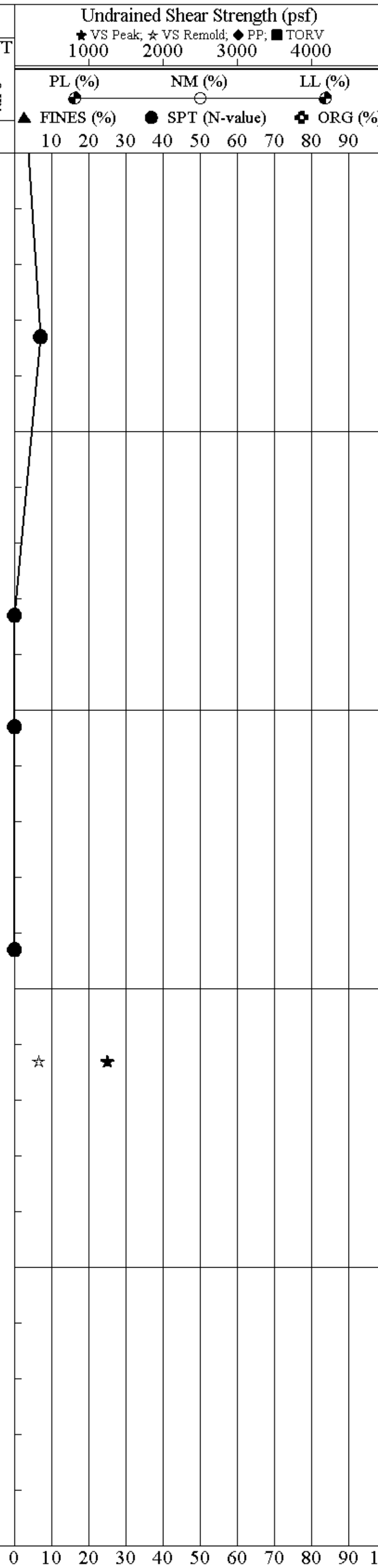
SOIL BORING RECORD

BOREHOLE NO.: SB-A1
DRILLED: 11/4/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)	SAMPLE IDENT	BLOW COUNT
25	Dark gray, fine to coarse SAND, very loose, wet, SW (ALLUVIUM)	561.6		
	- 28.6' bgs: subrounded gravel, becomes loose		S-6	2-3-4-4 (N = 7)
30	- 29.7' bgs: angular gravel	556.6		
	Gray, CLAY, very soft, wet, plastic, CL (LACUSTRINE)		S-7	WOH-24"
35		551.6	S-8	WOH-24"
			ST-9	
40		546.6	S-10	WOH-24"
			VS-11	
	Bottom of boring @ 43' bgs			
45		541.6		
50		536.6		

SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS



BOREHOLE: STANDARD (0-5000 PSF) 3410090707-04.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: SJB
RIG TYPE: CME-550 (Auto-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: SB-A1
DRILLED: 11/4/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

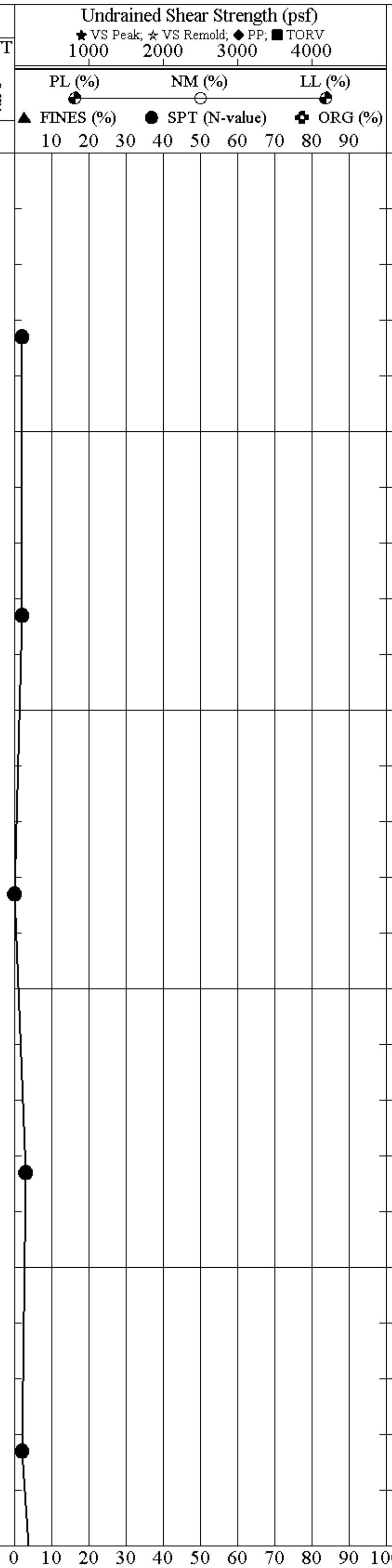
MACTEC

SOIL BORING RECORD

BOREHOLE NO.: SB-A2
DRILLED: 11/06/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)	SAMPLE IDENT	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD / % REC
0	Dark brown, fine to medium SAND with gravel, moist, loose (FILL)	585.0		
	- 1.0' bgs: concrete obstruction at 1' bgs			
	- brick debris			
			S-1	3-1-1-1 (N = 2)
5		580.0		
	Dark brown to black, SILT, wet, very soft, slightly plastic, ML (ALLUVIUM)			
			S-2	2-1-1-1 (N = 2)
10		575.0		
	Brownish gray, SILT with very fine sand, very loose, wet, ML (ALLUVIUM)			
	Black, fine SAND with silt, very loose to loose, wet, SM (ALLUVIUM)		S-3	WOH-12"1
15		570.0		
	Wood			
	Black, fine SAND with silt, very loose to loose, wet, SM (ALLUVIUM)		S-4	2-1-2-1 (N = 3)
20		565.0		
	Gray, fine to coarse SAND with gravel, very loose to loose, wet, SP (ALLUVIUM)			
			S-5	1-1-1-2 (N = 2)
25		560.0		



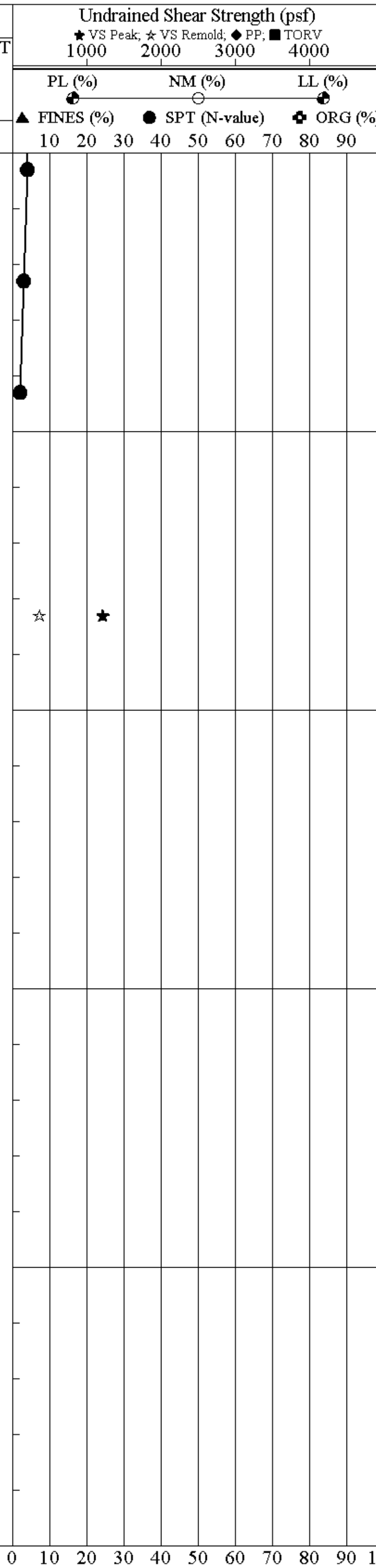
DRILLER: SJB
RIG TYPE: CME-550 (Auto-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (See key to symbols and descriptions for explanation of symbols, terminology, and abbreviations)	ELEV (ft)	SAMPLE IDENT	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD / % REC
25	Gray, fine to coarse SAND with gravel, very loose to loose, wet, SP (ALLUVIUM)	560.0	S-6	4-1-3-3 (N = 4)
	Gray, fine to medium SAND with silt and gravel, loose, SM (ALLUVIUM)		S-7	WOH-1-2-3 (N = 3)
30	Brownish gray, CLAY, wet, very soft, plastic, CL (LACUSTRINE)	555.0	S-8	WOH-1-1-1 (N = 2)
			ST-9	
			VS-10	
35	Bottom of boring at 35' bgs	550.0		
40		545.0		
45		540.0		
50		535.0		



DRILLER: SJB
RIG TYPE: CME-550 (Auto-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: SB-A2
DRILLED: 11/06/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

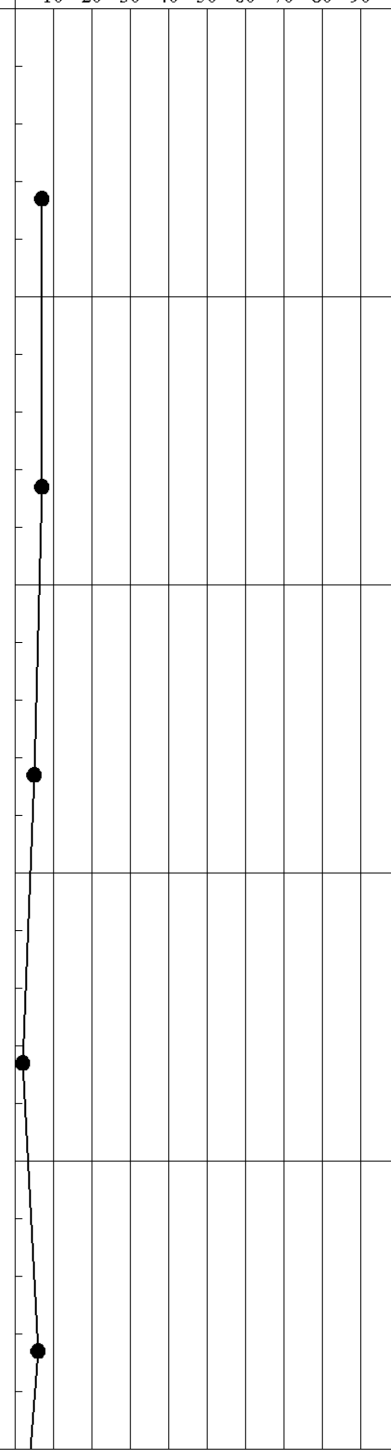
MACTEC

SOIL BORING RECORD

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)	SAMPLE IDENT	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6")
0	Concrete	583.5		
	Brown, fine to coarse SAND with gravel, moist, loose (FILL)			
4			S-1	5-4-3-3 (N = 7)
5		578.5		
8	- petroleum-like odor and staining on sample			
9			S-2	3-3-4-7 (N = 7)
10	Water table at 10' bgs	573.5		
13	- brick debris, heavy petroleum-like staining and odor			
14			S-3	3-3-2-7 (N = 5)
15		568.5		
15.5	Gray, fine to coarse SAND with silt and gravel, loose, SW (ALLUVIUM)			
19			S-4	2-1-1-2 (N = 2)
20		563.5		
23	Gray, fine to coarse SAND with silt, wet, loose, SW (ALLUVIUM)			
24			S-5	4-3-3-8 (N = 6)
25		558.5		

SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS

Undrained Shear Strength (psf): ★ VS Peak; ☆ VS Remold; ◆ PP; ■ TORV — 1000 2000 3000 4000
PL (%) NM (%) LL (%)
▲ FINES (%) ● SPT (N-value) ✪ ORG (%) — 10 20 30 40 50 60 70 80 90



DRILLER: SJB
RIG TYPE: CME-550 (Auto-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: SB-A3
DRILLED: 11/02/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	ELEV (ft)	IDENT	BLOW COUNT (1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD/% REC)
25	Gray, fine to coarse SAND with silt, wet, loose, SW (ALLUVIUM)	558.5		
	Gray, fine to coarse SAND with gravel, wet, loose, SW (ALLUVIUM) - some petroleum-like staining			
	Brownish gray, CLAY, very soft, wet, plastic, CL (LACUSTRINE)		S-6	2-1-WOH-12"
30		553.5	S-7	1-WOH-18"
			VS-8	
	Permeability = 1.1x10-7 cm/sec Laboratory vane shear = 0.37 tsf			
35		548.5	ST-9	
			S-10	WOH-18"1
			S-11	WOH-18"1
40	Bottom of boring at 40' bgs	543.5		
45		538.5		
50		533.5		

Undrained Shear Strength (psf): ★ VS Peak; ☆ VS Remold; ◆ PP; ■ TORV — 1000 2000 3000 4000

PL (%) NM (%) LL (%)

▲ FINES (%) ● SPT (N-value) ✚ ORG (%) — 10 20 30 40 50 60 70 80 90

0 10 20 30 40 50 60 70 80 90 100

DRILLER: SJB
RIG TYPE: CME-550 (Auto-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

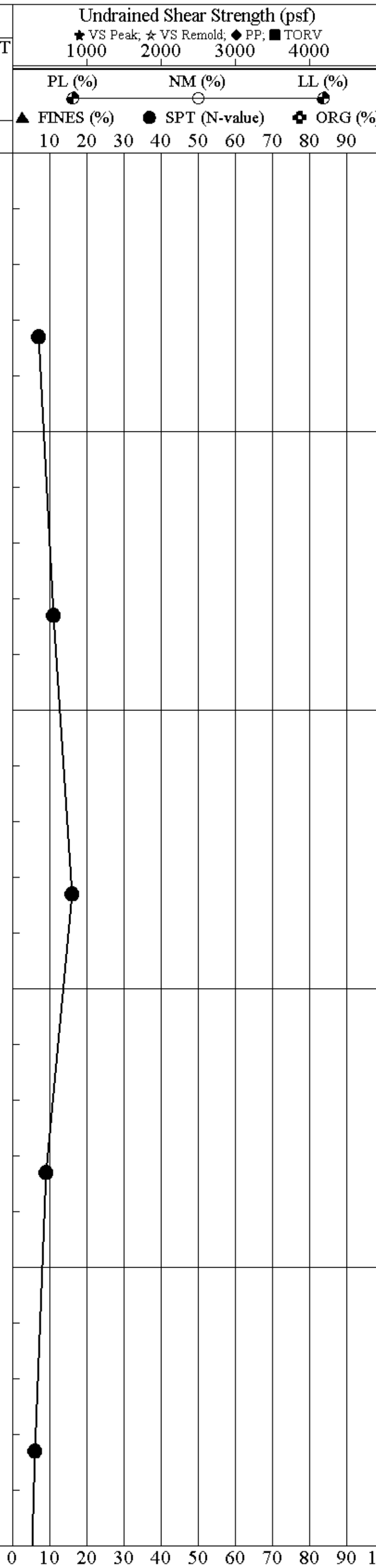
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: SB-A3
DRILLED: 11/02/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT (1st 6" 2nd 6" 3rd 6" 4th 6") Or RQD / % REC
0	Fine to coarse SAND with gravel, loose, moist (FILL) - concrete rubble		584.0			
				S-1		9-3-4-3 (N = 7)
5			579.0			
				S-2		7-7-4-3 (N = 11)
10			574.0			
	Black, coarse SAND with gravel, loose, wet (FILL) - brick and concrete debris - petroleum-like staining on sample			S-3		6-5-11-5 (N = 16)
15			569.0			
	Fine to coarse SAND with gravel, loose, wet, SW (ALLUVIUM)					
	- sample coated in petroleum-like substance; heavy petroleum-like odor			S-4		4-5-4-5 (N = 9)
20			564.0			
	- sample coated in petroleum-like substance; heavy petroleum-like odor			S-5		4-3-3-4 (N = 6)
25			559.0			



BOREHOLE: STANDARD (0-5000 PSF) 3410090707-04.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: SJB
RIG TYPE: CME-550 (Auto-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: SB-A4B
DRILLED: 11/03/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	ELEV (ft)	SAMPLES IDENT	BLOW COUNT (1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD/% REC)
25	Fine to coarse SAND with gravel, loose, wet, SW (ALLUVIUM)	559.0		
	Brownish gray, CLAY, very soft, wet, CL (LACUSTRINE)		S-6	5-3-1-2 (N = 4)
30		554.0	S-7	1-0-1-0 (N = 1)
			VS-8	
	- sample is high plasticity fat CLAY, CH Laboratory vane shear = 0.41 tsf			
35		549.0	ST-9	
	Bottom of Boring at 36' bgs			
	NOTES: 1. Boring SB-A4A terminated at 3.5' bgs (concrete)			
40		544.0		
45		539.0		
50		534.0		

Undrained Shear Strength (psf): ★ VS Peak; ☆ VS Remold; ◆ PP; ■ TORV — 1000 2000 3000 4000

PL (%) NM (%) LL (%)

▲ FINES (%) ● SPT (N-value) ✿ ORG (%) — 10 20 30 40 50 60 70 80 90

0 10 20 30 40 50 60 70 80 90 100

BOREHOLE: STANDARD (0-5000 PSF) 3410090707-04.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: SJB
RIG TYPE: CME-550 (Auto-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

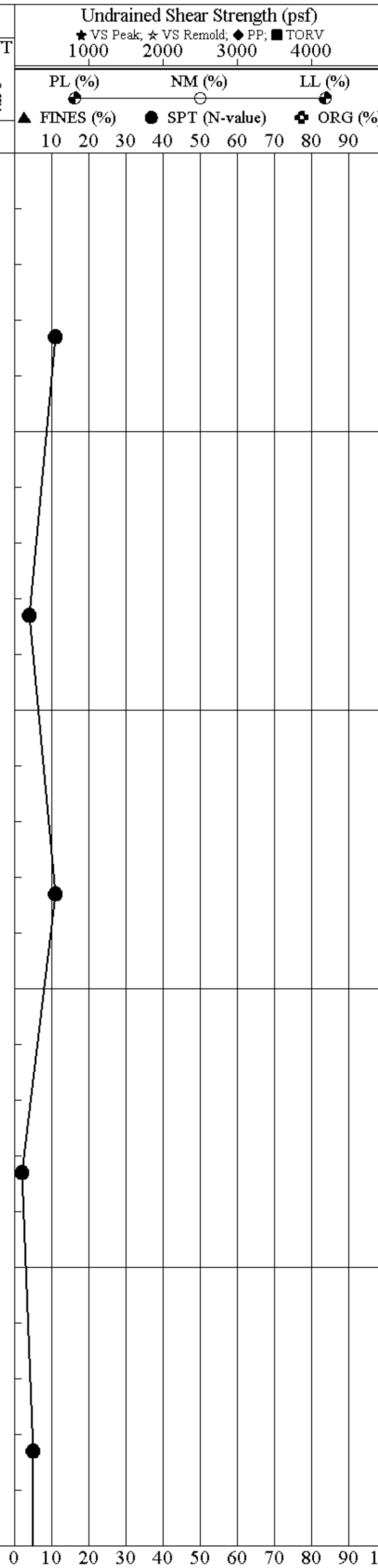
SOIL BORING RECORD

BOREHOLE NO.: SB-A4B
DRILLED: 11/03/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)	SAMPLE IDENT	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD / % REC
0	3 inches of ashpalt pavement (FILL)	584.0		
	Gravel subbabse (FILL)			
	Dark brown to black, fine to medium SAND with some gravel, moist (FILL)		AU-1	
			S-1	6-5-6-1 (N = 11)
5		579.0		
	Brown, fine to coarse SAND with gravel, trace brick, trace fine sand, loose, moist (FILL)		S-2	2-2-2-2 (N = 4)
10		574.0		
	Fine to coarse SAND with gravel, coated in petroleum-like viscous substance, medium dense, wet (FILL) - sample coated in viscous petroleum-like substance		S-3	5-2-9-3 (N = 11)
	Wood, coated in black viscous petroleum-like substance (FILL)			
15	Fine to coarse SAND with gravel, medium dense, wet (FILL)	569.0		
	Dark gray to black, SILT with fine sand, very soft, slightly plastic, wet, ML (ALLUVIUM)			
	Dark gray to black, fine SAND with silt, very loose, non-plastic, wet, SP-SM (ALLUVIUM)		S-4	1-1-1-1 (N = 2)
20		564.0		
	Gray, fine to coarse SAND with gravel, loose, wet, SW (ALLUVIUM)			
	Dark gray, CLAY with angular gravel, soft, wet, plastic, CL (ALLUVIUM) - sample coated in viscous petroleum-like substance		S-5	1-2-3-6 (N = 5)
25		559.0		

SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS



BOREHOLE: STANDARD (0-5000 PSF) 3410090707-04.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: SJB
RIG TYPE: CME-550 (Auto-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

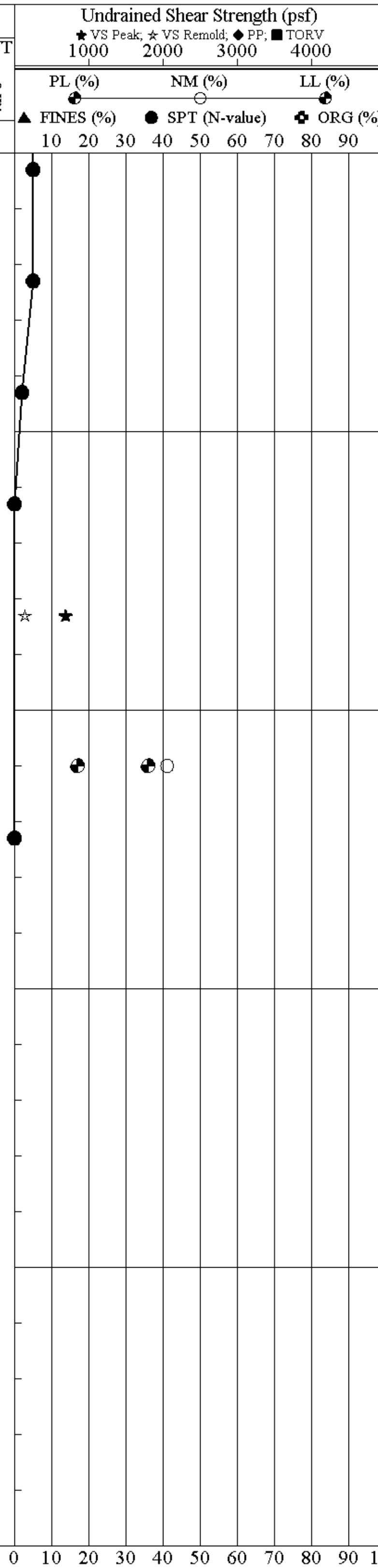
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: SB-A5
DRILLED: 11/09/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	ELEV (ft)	SAMPLES IDENT	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6" Or RQD / % REC)
25	Coarse SAND with gravel, loose, wet, SP-GP (ALLUVIUM) - sample coated in viscous petroleum-like substance	559.0	S-6	1-1-4-6 (N = 5)
	Fine to medium SAND, loose, wet, SP (ALLUVIUM) - sample coated in viscous petroleum-like substance		S-7	3-3-2-1 (N = 5)
	Medium to coarse SAND with gravel, loose, wet, SP (ALLUVIUM) - sample coated in viscous petroleum-like substance			
30	Gray to brownish gray, CLAY, very soft, wet, plastic, CL (LACUSTRINE) - 30.3' bgs: petroleum-like staining	554.0	S-8	1-1-1-1 (N = 2)
			S-9	WOH-24"
			VS-10	
35		549.0		
	Laboratory vane shear = 0.46 tsf		ST-11	
			S-12	WOH-24"
	Bottom of boring at 39' bgs			
40		544.0		
45		539.0		
50		534.0		



BOREHOLE: STANDARD (0-5000 PSF) 3410090707-04.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: SJB
RIG TYPE: CME-550 (Auto-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

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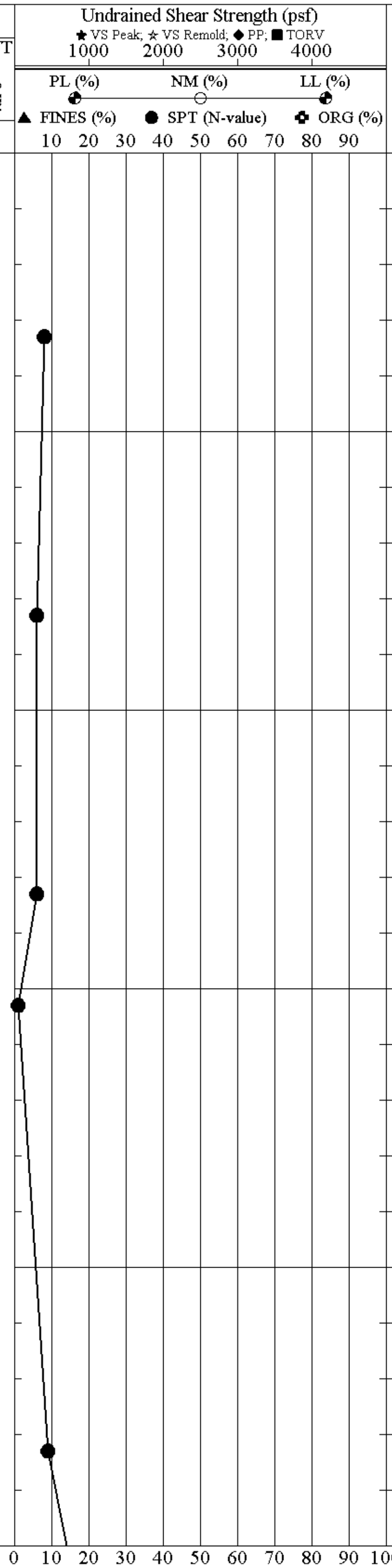
SOIL BORING RECORD

BOREHOLE NO.: SB-A5
DRILLED: 11/09/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

BOREHOLE: STANDARD (0-5000 PSF) 3410090707-04.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	ELEV (ft)	SAMPLES IDENT	BLOW COUNT (1st 6" 2nd 6" 3rd 6" 4th 6") Or RQD / % REC
0	Fine to coarse, SAND with gravel and bricks, loose (FILL)	584.0		
			S-1	4-4-4-1 (N = 8)
5		579.0		
			S-2	3-2-4-1 (N = 6)
10		574.0		
	Coarse sand with angular gravel (FILL)			
			S-3	1-2-4-3 (N = 6)
15	Black, fine to coarse SAND, wet, loose, SW (ALLUVIUM) - black petroleum-like coating on samples, petroleum-like odor is present	569.0		
			S-4	1-1-0-0 (N = 1)
20		564.0		
			S-5	3-4-5-3 (N = 9)
25		559.0		



DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

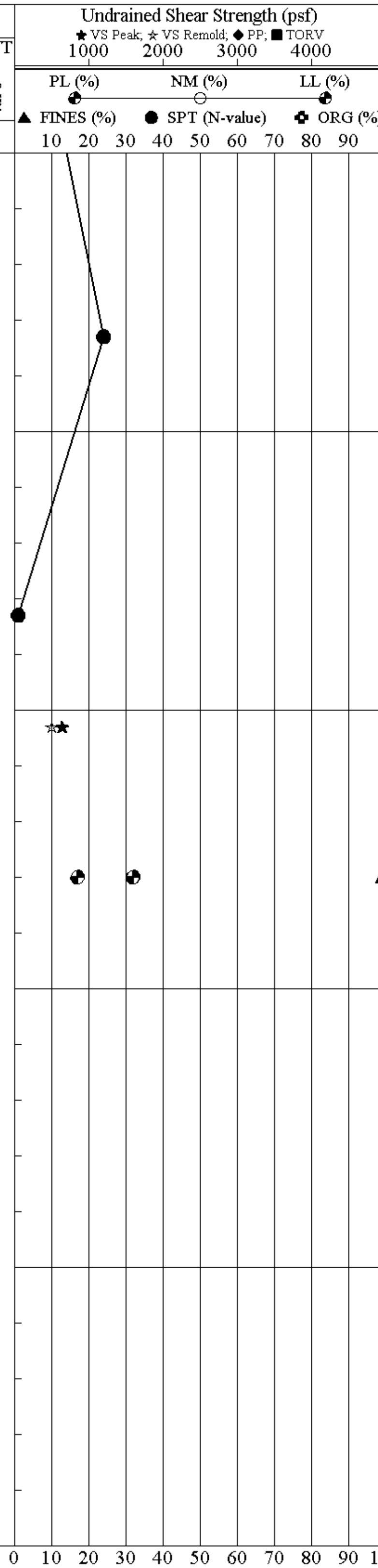
SOIL BORING RECORD

BOREHOLE NO.: SB-A6B
DRILLED: 11/03/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701 **PAGE** 1 **OF** 2

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)	SAMPLES IDENT	BLOW COUNT (1st 6" 2nd 6" 3rd 6" 4th 6") Or RQD / % REC
25	Black, fine to coarse SAND, wet, loose, SW (ALLUVIUM)	559.0		
	Fine to coarse SAND, wet, medium dense, SW (ALLUVIUM)		S-6	10-12-12-14 (N = 24)
30		554.0		
	Brownish gray, CLAY, very soft, wet, plastic, CL (LACUSTRINE)		S-7	2-1-0-0 (N = 1)
35		549.0	VS-8	
	Permeability = 2.5 x 10-8 cm/sec Laboratory vane shear = 0.31 tsf		ST-9	
	Bottom of boring at 39' bgs NOTES: 1. Boring SB-A6A terminated at 2.5' bgs (concrete)			
40		544.0		
45		539.0		
50		534.0		

SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS



DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

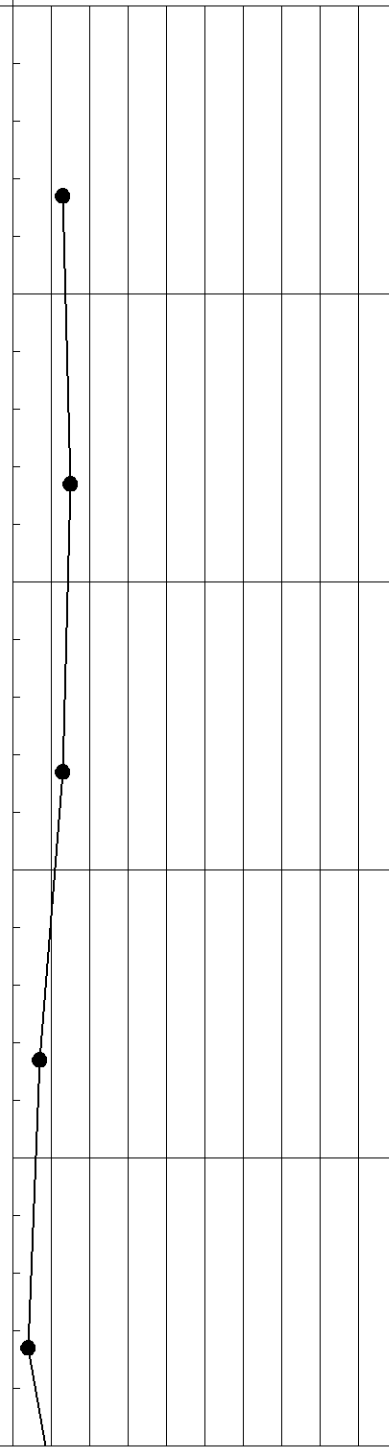
SOIL BORING RECORD

BOREHOLE NO.: SB-A6B
DRILLED: 11/03/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)	SAMPLE IDENT	BLOW COUNT
0	Brown, fine to coarse sand with brick and concrete, medium dense, moist (FILL)	584.0		
	Broken concrete debris (FILL)			
	Brown, fine to medium sand with brick and concrete, medium dense, moist (FILL)		S-1	15-8-5-5 (N = 13)
5		579.0		
			S-2	19-8-7-11 (N = 15)
10		574.0		
	Water table @ 14' bgs		S-3	12-6-7-7 (N = 13)
15		569.0		
	Gray to black, CLAY, soft, wet, CL (ALLUVIUM)			
	7-inches of wood, intact, possible timber pile			
	Brownish gray, CLAY with silt, soft, wet, plastic, CL (ALLUVIUM) - sample coated in black viscous petroleum-like substance		S-4	2-4-3-2 (N = 7)
20		564.0		
	GRAVEL with coarse sand, loose, GP (ALLUVIUM) - sample coated in black viscous petroleum-like substance		S-5	6-2-2-7 (N = 4)
25		559.0		

SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS



BOREHOLE: STANDARD (0-5000 PSF) 3410090707-04.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

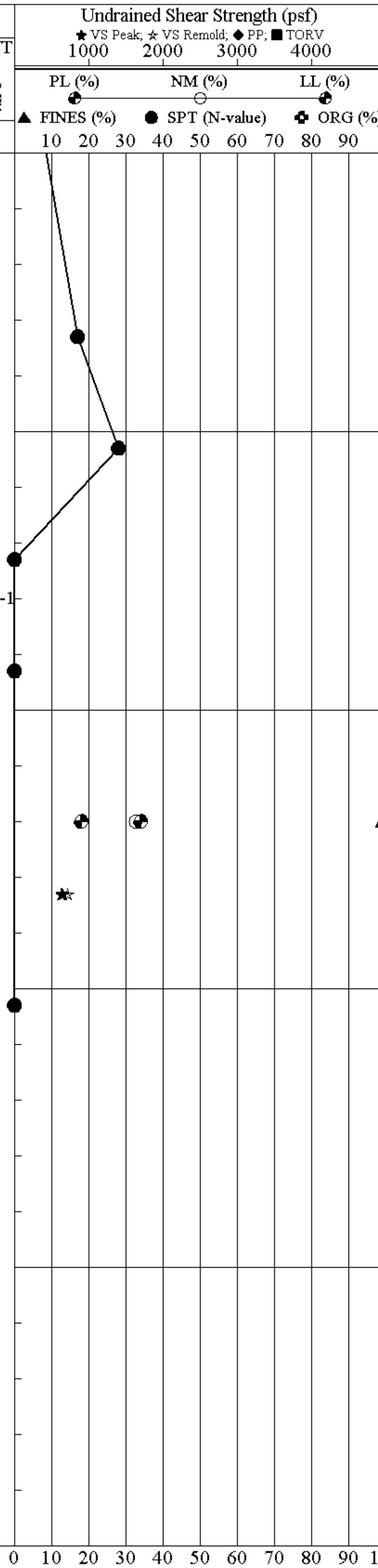
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: SB-A7
DRILLED: 11/11/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	ELEV (ft)	SAMPLES IDENT	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD / % REC
25	GRAVEL with coarse sand, loose, GP (ALLUVIUM)	559.0		
	Coarse SAND with gravel, dense, SP-GP (ALLUVIUM) - samples coated in black viscous petroleum-like substance		S-6	10-8-9-12 (N = 17)
30		554.0	S-7	4-13-15-10 (N = 28)
	Brownish gray, CLAY, very soft, wet, plasctic, CL (LACUSTRINE)		S-8	WOH-1-WOH-1
35		549.0	S-9	WOH-24"
	Permeability = 2.3x10-8 cm/sec Laboratory vane shear = 0.3 tsf		ST-10	
			VS-11	
40		544.0	S-12	WOH-24"
	Bottom of boring at 42' bgs			
45		539.0		
50		534.0		



DRILLER:	SJB
RIG TYPE:	CME-550 (Safety-Hammer)
METHOD:	Hollow-Stem Augers
HOLE DIAM.:	3.25" ID
SPTs:	
REMARKS:	

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

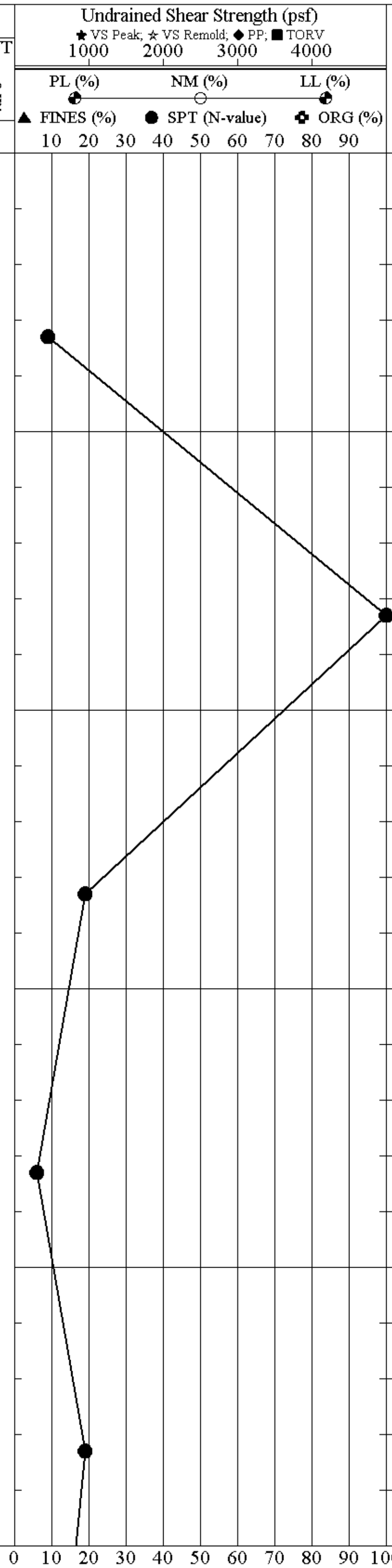
SOIL BORING RECORD

BOREHOLE NO.: SB-A7
DRILLED: 11/11/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)	SAMPLE IDENT	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD / % REC
0	4-inches of asphalt pavement (FILL)	584.2		
	Gravel subbase (FILL)			
	Brown, fine to coarse SAND with gravel, loose, dry (FILL) - brick debris			
			S-1	7-4-5-8 (N = 9)
5		579.2		
	Concrete floor slab		S-2	2-3-50-3"
10		574.2		
	Gray, fine to coarse, SAND with gravel, loose, wet, SW (ALLUVIUM)			
	Gray, fine to coarse SAND with blueish green coarse gravel, medium dense, wet, SW (ALLUVIUM)		S-3	5-9-10-8 (N = 19)
	Gray, fine to coarse SAND with gravel, loose, wet, SW (ALLUVIUM) Water table at 14' bgs			
15		569.2		
	Black, coarse SAND with gravel, trace plastic fines, loose, SP (ALLUVIUM)		S-4	5-3-3-6 (N = 6)
20		564.2		
	Gray to dark gray, coarse GRAVEL, medium dense, GP (ALLUVIUM)			
	Gray to dark gray, fine SAND with gravel, medium dense, SP (ALLUVIUM)		S-5	8-12-7-8 (N = 19)
25		559.2		

SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS



BOREHOLE: STANDARD (0-5000 PSF) 3410090707-04.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

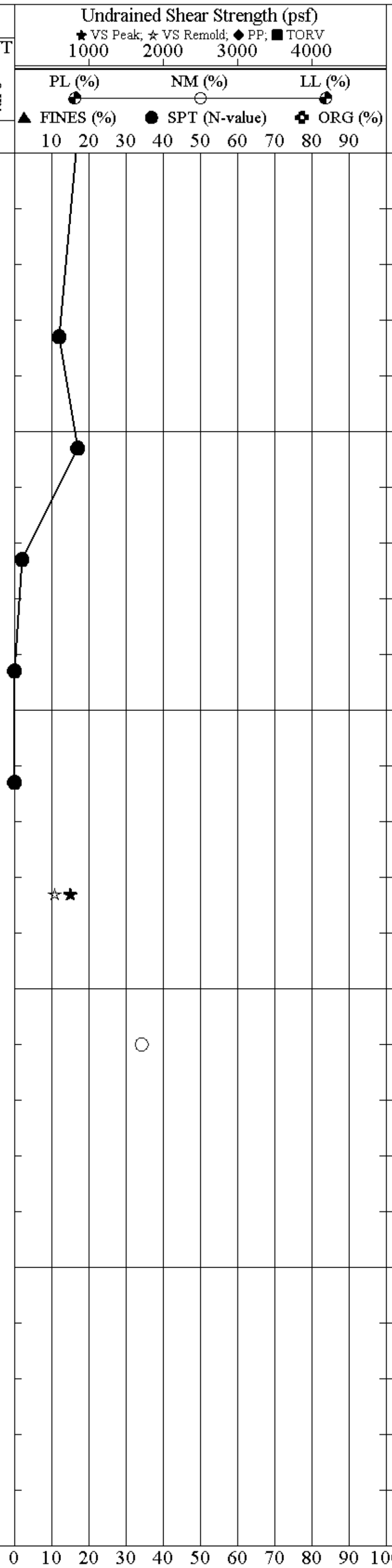
SOIL BORING RECORD

BOREHOLE NO.: SB-A8H
DRILLED: 11/11/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	ELEV (ft)	SAMPLES IDENT	BLOW COUNT (1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD / % REC)
25	Fine to coarse SAND with gravel, medium dense, wet, SW (ALLUVIUM)	559.2		
	- slight petroleum-like odor		S-6	7-7-5-6 (N = 12)
30		554.2	S-7	7-7-10-7 (N = 17)
	Gray to brownish gray CLAY, very soft, wet, plastic, CL (LACUSTRINE)		S-8	1-1-1-1 (N = 2)
35		549.2	S-9	WOH-18"1
			S-10	WOH-24"
			VS-11	
40	Laboratory vane shear = 0.4 tsf	544.2	ST-12	
	Bottom of Boring at 42' bgs			
45		539.2		
50		534.2		

NOTES:
1. Attempted boring seven times before SB-A8H
2. Each was terminated due to obstructions, as follows:
- SB-A8A: 2.5' bgs (debris)
- SB-A8B: 3.0' bgs (debris)
- SB-A8C: 9.5' bgs (concrete slab)
- SB-A8D: 9.0' bgs (concrete slab)
- SB-A8E: 2.0' bgs (debris)
- SB-A8F: 9.5' bgs (concrete slab)
- SB-A8G: 6.5' bgs (steel debris)



DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: SB-A8H
DRILLED: 11/11/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

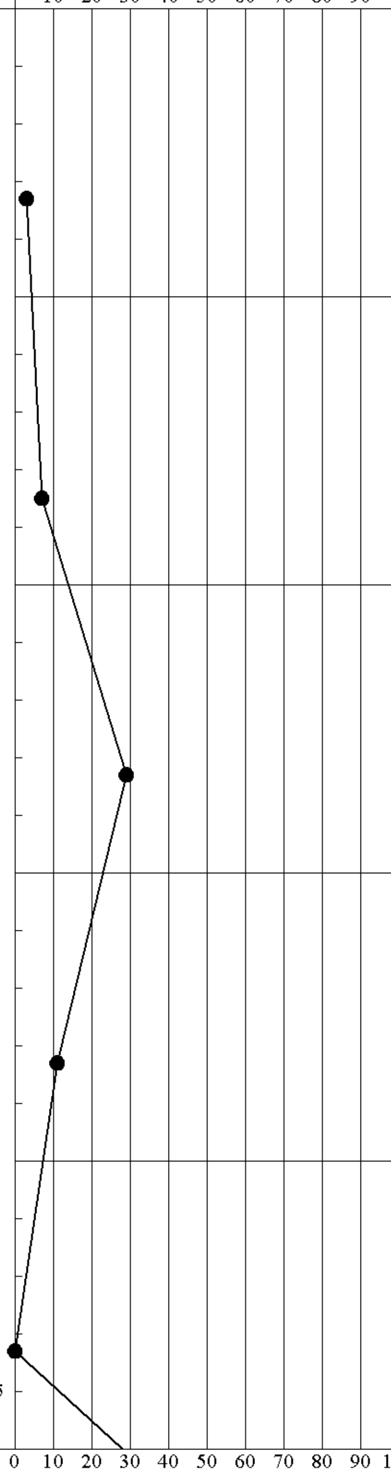
SOIL BORING RECORD

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)	SAMPLE IDENT	BLOW COUNT
0	Brown, fine to medium SAND with some gravel and some fines, loose, moist (FILL)	585.0		
			S-1	1-1-2-1 (N = 3)
5		580.0		
	Obstruction from 6.5' to 8.0' bgs (FILL)			
	Concrete rubble (FILL)			
			S-2	15-4-3-6 (N = 7)
10		575.0		
	Wood, petroleum odor		S-3	10-20-9-6 (N = 29)
	Gray, fine SAND with silt, very loose, wet, non-plastic, SP (ALLUVIUM)			
15		570.0		
	- wood in tip, black petroleum-like staining on wood, slight petroleum-like odor		S-4	4-7-4-1 (N = 11)
20		565.0		
	Gray, very fine SAND with silt, very loose, wet, non-plastic, SP (ALLUVIUM)			
	Gray, SILT with gravel, medium dense, wet, slightly plastic, GM (ALLUVIUM)		S-5	WOH-12"3-5
25		560.0		

SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS

Undrained Shear Strength (psf): ★ VS Peak; ☆ VS Remold; ◆ PP; ■ TORV — 1000 2000 3000 4000

PL (%) NM (%) LL (%); ▲ FINES (%) ● SPT (N-value) ✪ ORG (%)



DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

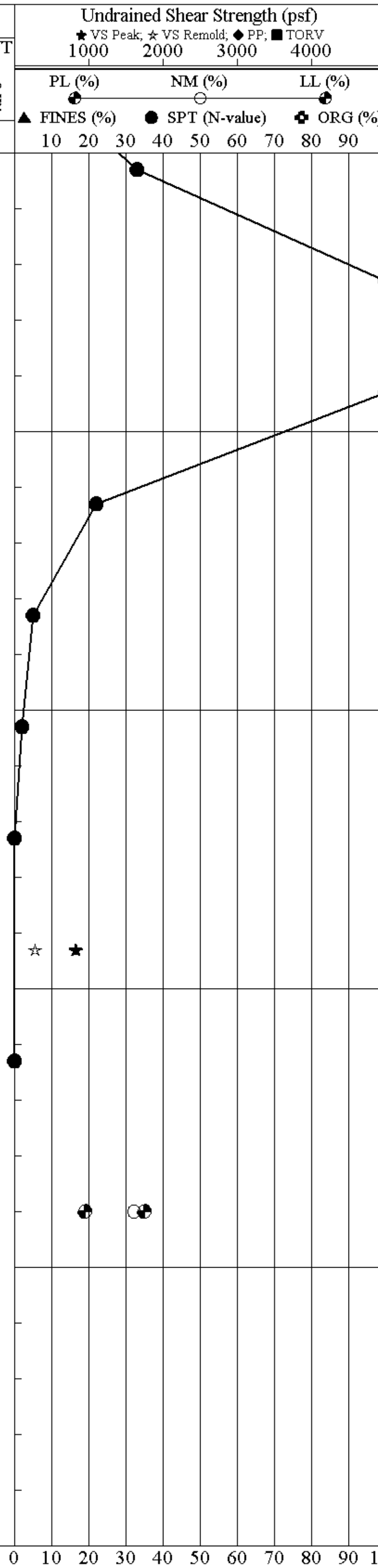
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: SB-A9H
DRILLED: 11/09/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	ELEV (ft)	SAMPLES IDENT	BLOW COUNT (1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD / % REC)
25	Gray, SILT with gravel, medium dense, wet, slightly plastic, GM (ALLUVIUM) - brown to black oil-like sheen in spoon, slight odor	560.0	S-6	2-12-21-14 (N = 33)
	Gray, SILT with angular gravel, dense, non-plastic to slightly plastic, ML (ALLUVIUM)			
	Gray, medium to coarse SAND with gravel, wet, very dense, SP (ALLUVIUM)		S-7	15-46-50-3"
	Gray, SILT, hard, wet, non-plastic, ML (ALLUVIUM)			
	Dark gray, coarse SAND with gravel, wet, very dense, SP-GP (ALLUVIUM)			
30		555.0	S-8	26-50-4"
	Gray, coarse SAND with gravel, dense, wet, SP-GP (ALLUVIUM) - slight petroleum-like odor		S-9	18-10-12-7 (N = 22)
			S-10	3-2-3-5 (N = 5)
35	Gray to brownish gray , CLAY, very soft, wet, plastic, CL (LACUSTRINE)	550.0		
			S-11	1-1-1-1 (N = 2)
			S-12	WOH-24"
40		545.0	VS-13	
			S-14	WOH-24"
	Permeability = 4.8x10-8 cm/sec Laboratory vane shear = 0.39 tsf		ST-15	
45	Bottom of Boring at 45' bgs	540.0		
50		535.0		



NOTES:
1. Attempted boring seven times before SB-A9H
2. Each was terminated due to obstructions, as follows:
- SB-A9A: 1.5' bgs (debris)
- SB-A9B: 14.5' bgs (foundation)
- SB-A9C: 6.5' bgs (debris or foundation)
- SB-A9D: 3.5' bgs (debris)
- SB-A9E: 1.5' bgs (debris)
- SB-A9F: 6.5' bgs (debris)
- SB-A9G: 14.0' bgs (wood)

BOREHOLE: STANDARD (0-5000 PSF) 3410090707-04.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

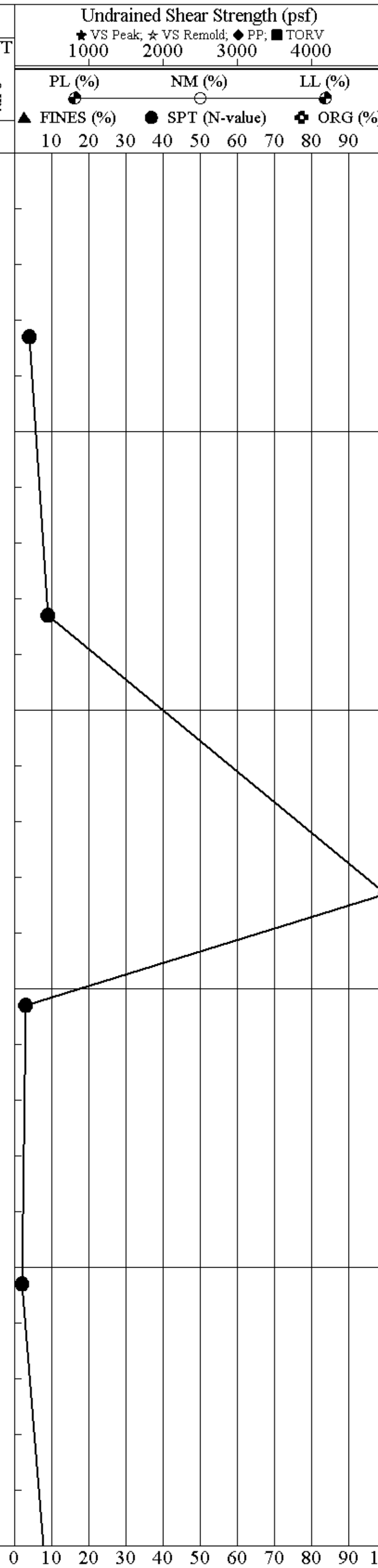
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: SB-A9H
DRILLED: 11/09/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	ELEV (ft)	SAMPLE IDENT	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD / % REC
0	Dark brown, fine to medium sand with gravel, loose, moist (FILL)	585.0		
			S-1	2-2-2-2 (N = 4)
5		580.0		
	Gray, SILT with fine sand, trace roots, soft, wet (FILL)			
	Gray to brown, GRAVEL with fines, loose, wet (FILL)			
	Gray, fine to medium SAND with gravel, loose, wet (FILL)			
	Brown, fine to medium sand with gravel, loose, moist (FILL)		S-2	1-1-8-6 (N = 9)
10		575.0		
	Obstruction from 13.0' to 14.5' bgs (FILL)		S-3	50-5"
	Grayish brown, angular GRAVEL, loose, wet, GP (ALLUVIUM) - 15.0' bgs: sample is coated in viscous petroleum-like substance, below the water table			
15		570.0	S-4	1-2-1-1 (N = 3)
20		565.0	S-5	1-1-1-1 (N = 2)
	Gray, fine to medium SAND with gravel, loose, wet, SP (ALLUVIUM)			
25		560.0		



DRILLER: SJB
RIG TYPE: CME-550 (Auto-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

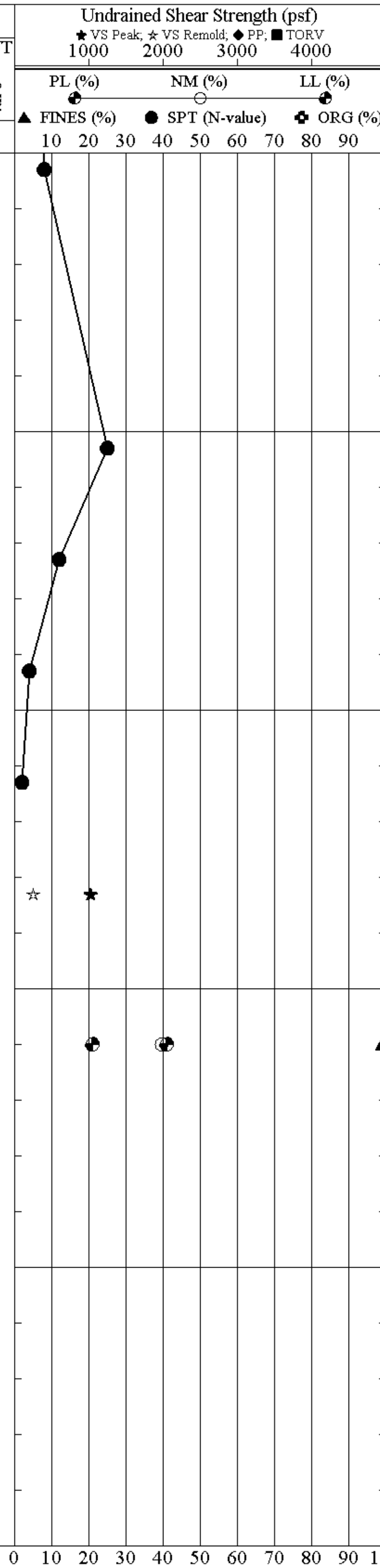
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: SB-A10G
DRILLED: 11/10/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	ELEV (ft)	SAMPLES IDENT	BLOW COUNT (1st 6" 2nd 6" 3rd 6" 4th 6") Or RQD / % REC
25	Gray, fine to medium SAND with gravel, loose, wet, SP (ALLUVIUM)	560.0		
	Gray, coarse sand with gravel to gravel with coarse sand, loose to dense, wet, SP-GP (ALLUVIUM)		S-6	1-5-3-4 (N = 8)
30		555.0	S-7	6-10-15-12 (N = 25)
	Brownish gray, CLAY, soft to medium stiff, wet, plastic, CL (LACUSTRINE)		S-8	7-6-6-6 (N = 12)
35		550.0	S-9	6-2-2-2 (N = 4)
			S-10	2-1-1-1 (N = 2)
			VS-11	
40	Permeability = 2.5x10-8 cm/sec Laboratory vane = 0.37 tsf	545.0	ST-12	
	Bottom of Boring at 42' bgs			
45		540.0		
50		535.0		



NOTES:
1. Attempted boring six times before SB-A10G
2. Each was terminated due to obstruction, as follows:
- SB-A10A: 0.5' to 1.0' bgs (debris)
- SB-A10B: 0.5' to 1.0' bgs (debris)
- SB-A10C: 0.5' to 1.0' bgs (debris)
- SB-A10D: 0.5' to 1.0' bgs (debris)
- SB-A10E: 0.5' to 1.0' bgs (debris)
- SB-A10F: 6.0' bgs (debris)

BOREHOLE: STANDARD (0-5000 PSF) 3410090707-04.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: SJB
RIG TYPE: CME-550 (Auto-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

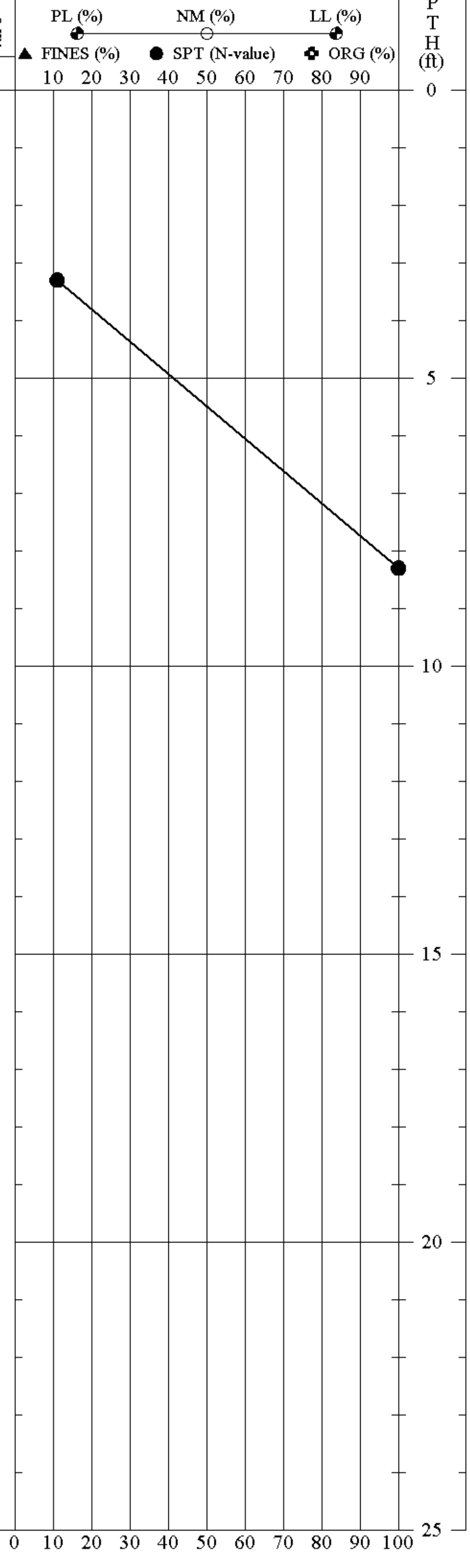
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: SB-A10G
DRILLED: 11/10/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD / % REC
0	Topsoil (FILL)	587.0			
	Dark brown to black, fine to coarse sand with gravel, some brick, loose to medium dense, moist (FILL)				
			S-1		5-5-6-7 (N = 11)
5		582.0			
			S-2		4-4-50-2"
	Bottom of boring at 9.2' - obstruction at 9.2' ; possibly concrete slab				
10		577.0			
15		572.0			
20		567.0			
25		562.0			



BOREHOLE: STANDARD (0-5000 PSF) 3410090707-04.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

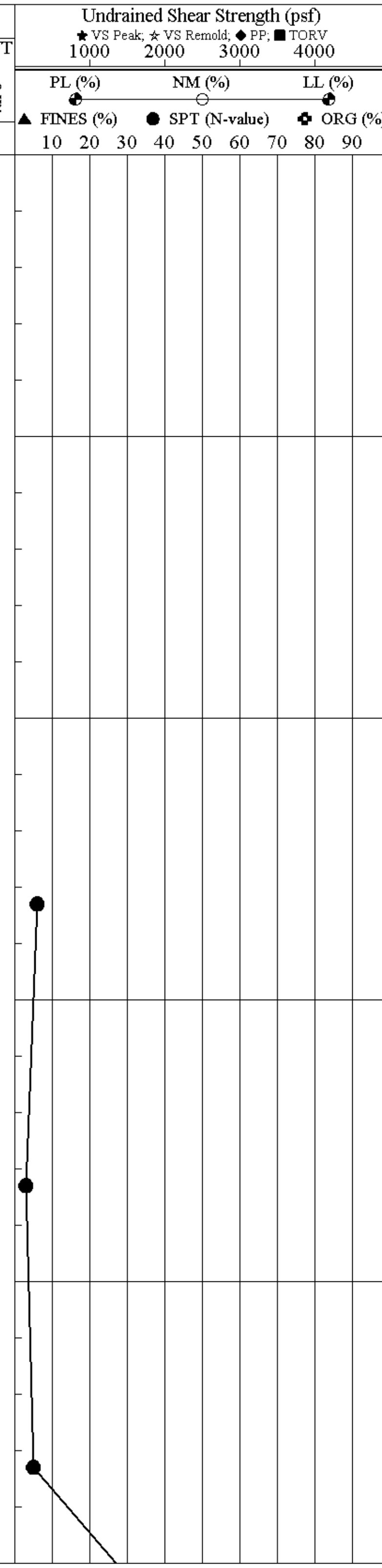
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: SB-A11A
DRILLED: 10/28/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	ELEV (ft)	SAMPLES IDENT	BLOW COUNT (1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD / % REC)
0	Topsoil, roots (FILL)	587.0		
	Dark brown to black, fine to coarse SAND with gravel, loose to medium dense, moist (FILL) - brick debris			
5		582.0		
10		577.0		
			S-4	2-2-4-4 (N = 6)
15		572.0		
			S-5	3-1-2-1 (N = 3)
20		567.0		
	Dark gray, fine to coarse SAND with gravel, loose, wet, SW (ALLUVIUM)			
			S-6	1-1-4-4 (N = 5)
25		562.0		



DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

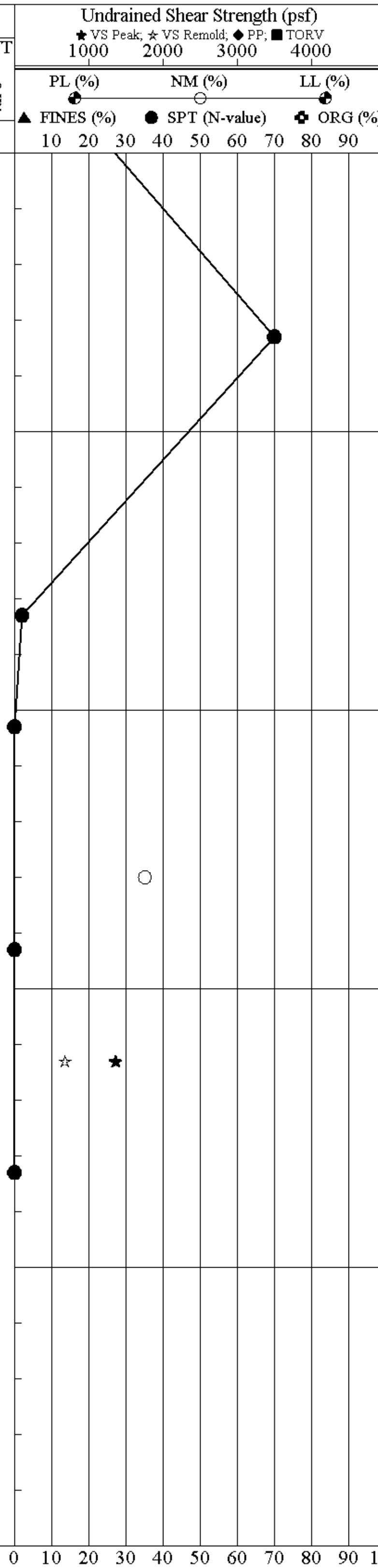
SOIL BORING RECORD

BOREHOLE NO.: SB-A11D
DRILLED: 10/28/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

BOREHOLE: STANDARD (0-5000 PSF) 3410090707-04.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	ELEV (ft)	SAMPLES IDENT	BLOW COUNT (1st 6" 2nd 6" 3rd 6" 4th 6") Or RQD / % REC
25	Dark gray, fine to coarse SAND with gravel, loose, wet, SW (ALLUVIUM)	562.0		
	Fine to coarse SAND with clay and gravel, loose, wet, SP (ALLUVIUM) - petroleum-like staining on sample		S-7	3-36-34-38 (N = 70)
30	Fine to coarse SAND with clay and gravel, loose, wet, SP (ALLUVIUM)	557.0		
	Brownish gray, CLAY, very soft, wet, plastic, CL (LACUSTRINE) - parting of orange, very fine sand, <1/16" thick		S-8	2-1-1-2 (N = 2)
35		552.0	S-9	WOH-24"
			ST-10	
40		547.0	S-11	WOH-18"1
			VS-12	
			S-13	WOH-18"1
45	Bottom of boring at 45' bgs NOTES: 1. Attempted boring three times before SB-A11D 2. Each was terminated due to obstruction, as follows: - SB-A11B: water line at 9.0' bgs - SB-A11C: 13.0' bgs (debris or foundation)	542.0		
50		537.0		



DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: SB-A11D
DRILLED: 10/28/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)	SAMPLE IDENT	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6" Or RQD / % REC)
0	3-inches of asphalt (FILL)	585.6		
	Gravel subbase (FILL)			
	Dark brown, fine to medium SAND with gravel, moist (FILL)			
	Gray, angular GRAVEL, loose, dry (FILL)			
	Reddish brown, coarse SAND with gravel, loose, moist (FILL)		S-1	5-2-1-1 (N = 3)
5	Light to dark brown, fine to medium SAND with silt and some gravel, loose, moist (FILL)	580.6		
			S-2	3-2-2-2 (N = 4)
10	Brownish gray to olive gray, SILT with clay, some fine sand, soft, wet, plastic, ML (ALLUVIUM)	575.6		
			S-3	3-2-1-1 (N = 3)
15		570.6		
	Gray, CLAY with silt, very soft, moist, plastic, CL (ALLUVIUM)		S-4	1-WOH-12"1
20		565.6		
			S-5	WOH-18"1
25		560.6		

SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS

Undrained Shear Strength (psf): ★ VS Peak; ☆ VS Remold; ◆ PP; ■ TORV — 1000 2000 3000 4000

PL (%) — NM (%) — LL (%)

▲ FINES (%) ● SPT (N-value) ✪ ORG (%) — 0 10 20 30 40 50 60 70 80 90 100

BOREHOLE: STANDARD (0-5000 PSF) 3410090707-04.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

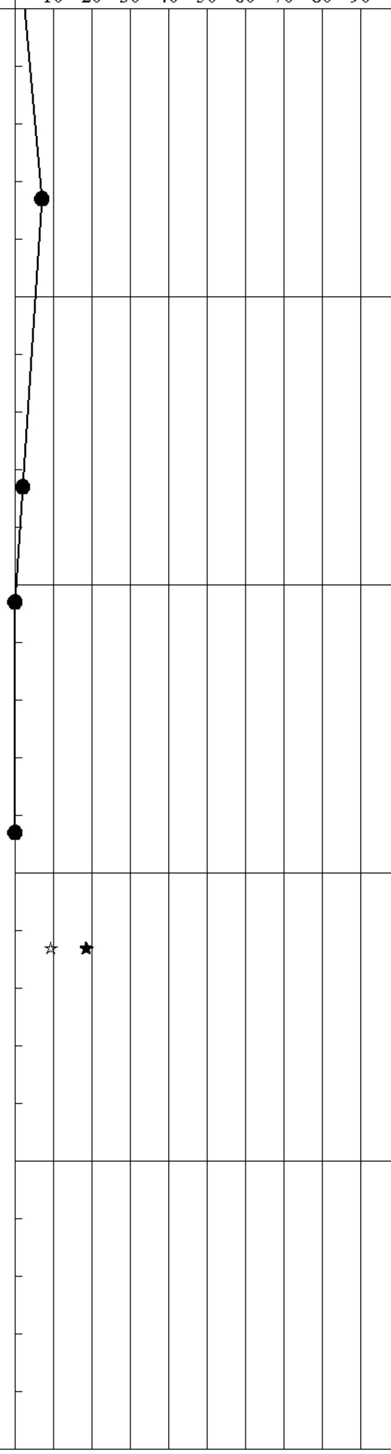
SOIL BORING RECORD

BOREHOLE NO.: SB-A12C
DRILLED: 11/05/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)	SAMPLES IDENT	BLOW COUNT (1st 6" 2nd 6" 3rd 6" 4th 6") Or RQD/% REC
25	Gray, SILT with fine sand, loose, wet, nonplastic, ML (ALLUVIUM)	560.6		
	Gray, medium to coarse SAND with gravel and trace silt, wet, loose, SP (ALLUVIUM)			
			S-6	2-3-4-3 (N = 7)
30		555.6		
	Brownish gray, CLAY, very soft, wet, plastic, CL (LACUSTRINE)		S-7	1-1-1-1 (N = 2)
35		550.6	S-8	WOH-24"
			ST-9	
40		545.6	S-10	WOH-18"2
			VS-11	
	Bottom of boring at 43' bgs			
45		540.6		
50		535.6		

SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS



NOTES:
1. Attempted boring two times before SB-A12C
2. Each was terminated due to obstruction, as follows:
- SB-A12A: 2.5' bgs (concrete)
- SB-A12B: 3.5' bgs (concrete)

DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

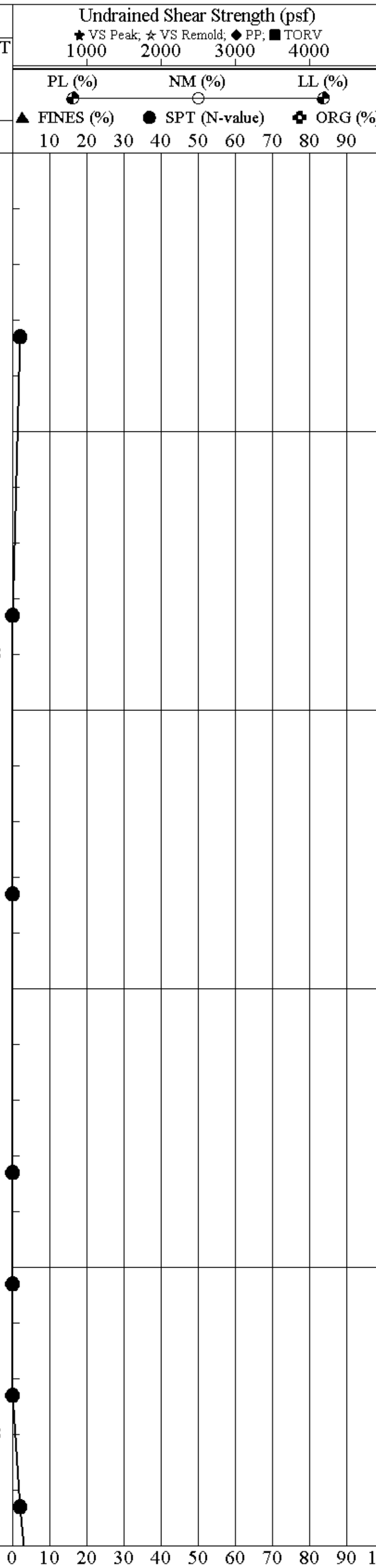
SOIL BORING RECORD

BOREHOLE NO.: SB-A12C
DRILLED: 11/05/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

BOREHOLE: STANDARD (0-5000 PSF) 3410090707-04.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)	SAMPLE IDENT	BLOW COUNT
0	4-inches of pavement (FILL)	585.0		
	Gravel subbase (FILL)			
	Brown, fine to coarse SAND with gravel, loose, dry (FILL)			
	Brownish gray to gray, SILT with clay, very soft, moist, plastic, ML (ALLUVIUM)		S-1	1-1-1-1 (N = 2)
5		580.0		
	Olive gray, SILT with very fine rust colored sand, soft, slightly plastic, ML (ALLUVIUM)		S-2	WOH-12"1-3
10		575.0		
	- becomes wet, increased plasticity		S-3	WOH-24"
15		570.0		
	Olive gray, CLAY with silt, trace fine sand, very soft, wet, plastic, CL (ALLUVIUM)			
	Gray, CLAY, very soft, wet, plastic, CL (ALLUVIUM)		S-4	WOH-24"
20	Dark gray, CLAY with silt, very soft, wet, slightly plastic, CL (ALLUVIUM)	565.0	S-5	WOH-24"
	Olive gray, CLAY with silt, very soft, wet, plastic, CL (ALLUVIUM)		S-6	WOH-12"2-3
	Dark gray, foliated wood			
	Gray, fine to coarse SAND, very loose, wet, SW (ALLUVIUM)			
25	Gray, fine to medium sand with silt, very loose, wet, SP-SM	560.0		



SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS

DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

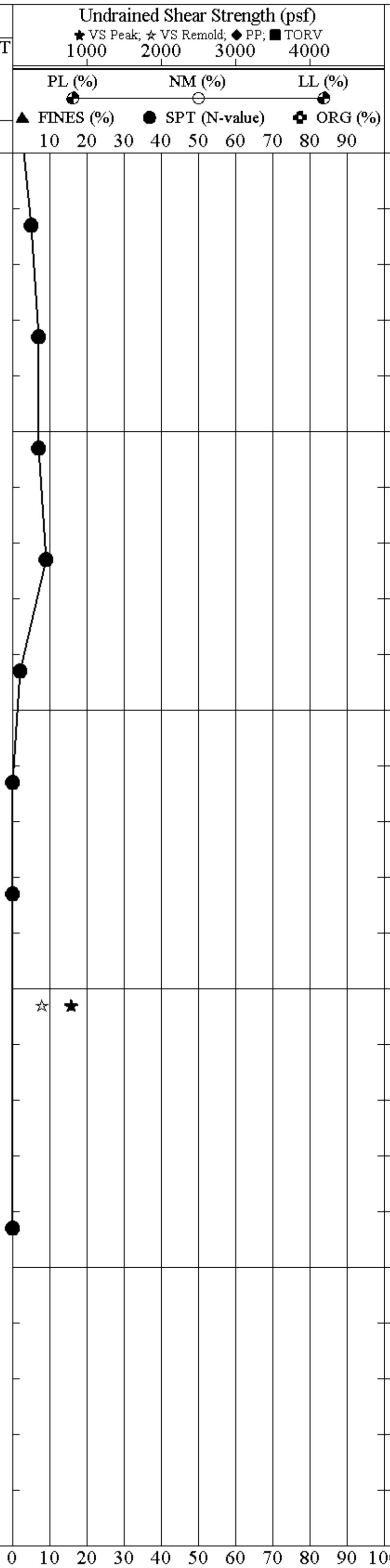
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: SB-A13
DRILLED: 11/09/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (See key to symbols and descriptions for explanation of symbols, terminology, and abbreviations)	ELEV (ft)	SAMPLE IDENT	BLOW COUNT (1st 6" - 2nd 6" - 3rd 6" - 4th 6") Or RQD / % REC
25	(ALLUVIUM)	560.0	S-7	1-1-1-1 (N = 2)
	Dark gray, foliated wood			
	Gray, fine to medium sand with silt, very loose, wet, SP-SM (ALLUVIUM)			
	Dark gray, foliated wood		S-8	1-2-3-3 (N = 5)
	Gray, medium to coarse SAND, loose, wet, SP (ALLUVIUM)			
	Gray, coarse SAND with gravel, loose, wet, SP-GP (ALLUVIUM)		S-9	1-2-5-5 (N = 7)
30	Gray, coarse SAND with gravel, loose, wet, SP (ALLUVIUM)	555.0	S-10	3-5-2-3 (N = 7)
			S-11	1-3-6-8 (N = 9)
35	Gray to brownish gray, CLAY, very soft, wet, plastic, CL (LACUSTRINE) - occasional rust colored partings of sand	550.0	S-12	2-1-1-1 (N = 2)
	Brownish gray, CLAY, very soft, wet, plastic, CL (LACUSTRINE)		S-13	WOH-18"1
			S-14	WOH-18"1
40		545.0	VS-15	
			ST-16	
45		540.0	S-17	WOH-18"1
	Bottom of boring at 46' bgs			
50		535.0		



BOREHOLE: STANDARD (0-5000 PSF) 3410090707-04.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

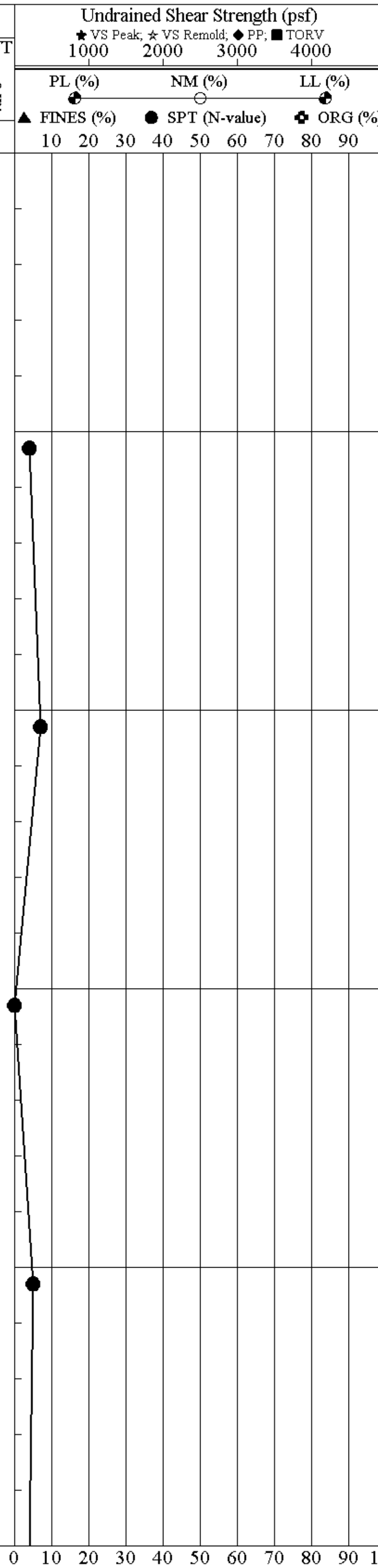
SOIL BORING RECORD

BOREHOLE NO.: SB-A13
DRILLED: 11/09/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)	SAMPLES IDENT	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD / % REC
0	5-inches of pavement (FILL)	584.0		
	Brown, fine to coarse SAND with gravel, very dense, moist (FILL)			
	Gray, CLAY, medium stiff, moist, CL (ALLUVIUM)			
5	- some petroluem-like staining on samples and auger cuttings, slight odor	579.0	S-1	4-2-2-4 (N = 4)
10	Gray, CLAY with silt, medium stiff, moist, slightly plastic, CL (ALLUVIUM) - occasional rust colored partings of very fine sand	574.0	S-2	5-3-4-6 (N = 7)
	Gray, very fine SAND with silt, very loose, wet, SP (ALLUVIUM)			
15		569.0		
	Gray, fine SAND with SILT, very loose, wet, SM (ALLUVIUM)		S-3	1-WOH-18"
20	Dark gray to brown, fine to coarse SAND, SP (ALLUVIUM) - frequent brown, rust colored seams of fine to medium sand	564.0		
	Wood		S-4	5-2-3-2 (N = 5)
	Dark gray to brown, fine to coarse SAND, SP (ALLUVIUM) - frequent brown, rust colored seams of fine to medium sand			
	Brown, fine to medium SAND with silt, loose to medium dense, wet, SM (ALLUVIUM)			
25		559.0		

SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS



DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: SB-A14
DRILLED: 10/29/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	ELEV (ft)	SAMPLES IDENT	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD / % REC
25	Brownish gray, CLAY, soft, wet, plastic, CL (ALLUVIUM) - occasional rust colored partings of fine sand	559.0	S-5	6-3-1-2 (N = 4)
	Brown, fine to coarse SAND, very loose, wet, SW (ALLUVIUM)			
30	Grayish brown, CLAY, very soft, wet, plastic, Lacustrine, CL (LACUSTRINE) - frequent rust colored partings of very fine sand	554.0	S-6	WOH-12"1-1
	Brownish gray, CLAY, soft, wet, plastic, CL (LACUSTRINE)		S-7	WOH-1-1-1 (N = 2)
35		549.0	S-8	WOH-24"
			ST-9	
			VS-10	
40	Bottom of boring at 40' bgs	544.0		
45		539.0		
50		534.0		

Undrained Shear Strength (psf): ★ VS Peak; ☆ VS Remold; ◆ PP; ■ TORV — 1000 2000 3000 4000

PL (%) NM (%) LL (%)

▲ FINES (%) ● SPT (N-value) ✪ ORG (%) — 0 10 20 30 40 50 60 70 80 90 100

BOREHOLE: STANDARD (0-5000 PSF) 3410090707-04.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: SB-A14
DRILLED: 10/29/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

SOIL BORING RECORD

SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)
0	2-inches of asphalt (FILL)	584.0
0	Brown, fine to coarse SAND with gravel, dense, dry (FILL)	
	- 4.0' bgs: pulled augers, encountered several 3" diameter rocks in hole and between auger teeth	
5	Brown to dark gray, CLAY with silt and trace gravel, soft, moist, plastic, CL (ALLUVIUM)	579.0
	- staining on sample, possible petroleum, slight petroleum-like odor	
10		574.0
	Gray, SILT with fine sand, very soft, wet, plastic, ML (ALLUVIUM)	
	- 12.3' bgs: some staining on sample	
15		569.0
20		564.0
	Gray, fine to coarse SAND with trace silt, loose, wet, SW (ALLUVIUM)	
25		559.0

SAMPLES

IDENT	BLOW COUNT (1st 6" - 2nd 6" - 3rd 6" - 4th 6") Or RQD / % REC
S-1	1-1-2-2 (N = 3)
S-2	1-1-2-2 (N = 3)
S-3	WOR-1-1-1 (N = 2)
S-4	1-1-1-1 (N = 2)
S-5	1-2-2-3 (N = 4)

Undrained Shear Strength (psf): ★ VS Peak; ☆ VS Remold; ◆ PP; ■ TORV — 1000 2000 3000 4000

PL (%) NM (%) LL (%)

▲ FINES (%) ● SPT (N-value) ✪ ORG (%) — 10 20 30 40 50 60 70 80 90

0 10 20 30 40 50 60 70 80 90 100

DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

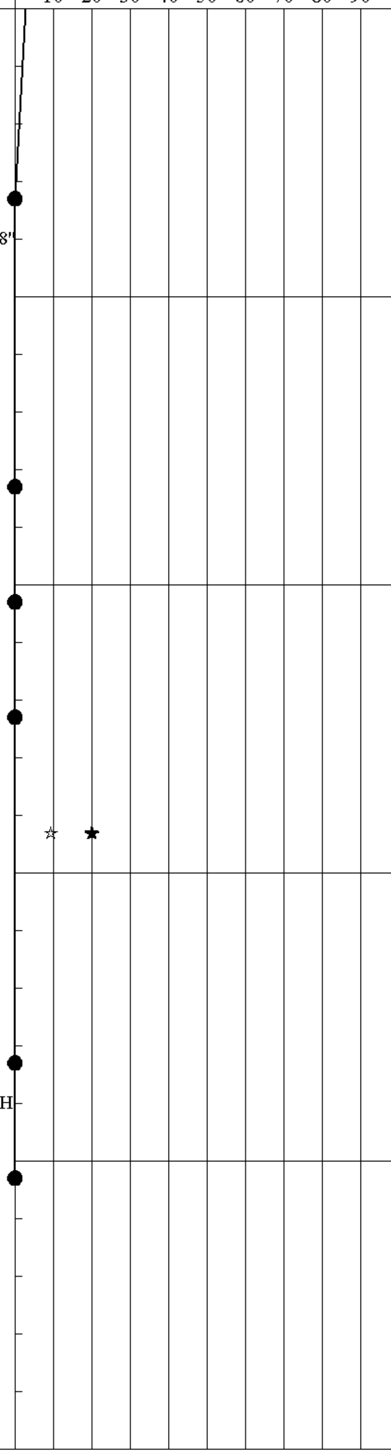
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

BOREHOLE NO.: SB-A15
DRILLED: 10/27/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	ELEV (ft)	SAMPLES IDENT	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD / % REC
25	Gray, fine to coarse SAND with trace silt, loose, wet, SW (ALLUVIUM)	559.0		
	Brownish gray, CLAY, very soft, wet, plastic, CL (ALLUVIUM)		S-6	WOR-WOH-18"
30		554.0		
	Gray, SILT with fine sand, very soft, wet, plastic, ML (ALLUVIUM)			
	Brownish gray, CLAY, very soft, wet, plastic, CL (LACUSTRINE)		S-7	WOH-18"1
35		549.0	S-8	WOH-24"
			S-9	WOH-24"
40		544.0	VS-10	
			ST-11	
			S-12	WOR-18"WOH
45		539.0	S-13	WOH-24"
	Bottom of Boring at 47' bgs			
50		534.0		

Undrained Shear Strength (psf): ★ VS Peak; ☆ VS Remold; ◆ PP; ■ TORV — 1000 2000 3000 4000
PL (%) NM (%) LL (%)
▲ FINES (%) ● SPT (N-value) ✿ ORG (%)



DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

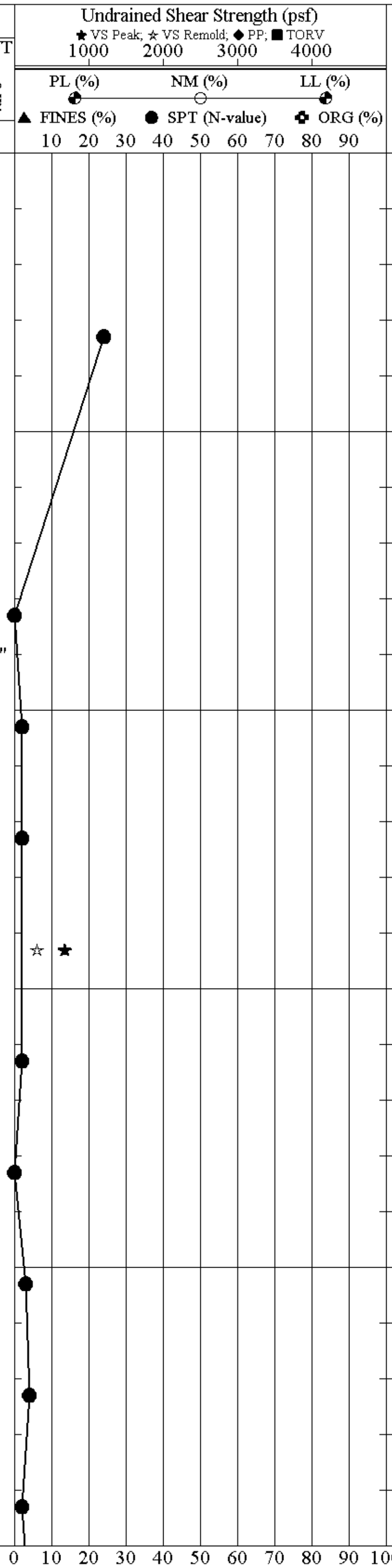
SOIL BORING RECORD

BOREHOLE NO.: SB-A15
DRILLED: 10/27/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD / % REC
0	Brown to reddish brown, fine to coarse SAND with gravel, moist (FILL)		583.5			
	Dark brown to black, SAND with gravel, dense, wet (FILL) - slight petroleum-like odor on sample			S-1		7-12-12-9 (N = 24)
5			578.5			
	Light gray, CLAY, very soft, wet, plastic, CL (ALLUVIUM) - staining on top 2-inches of clay, possibly petroleum			S-2		3-1-WOH-12"
10			573.5	S-3		1-1-1-1 (N = 2)
	- staining on clay, possibly petroleum			S-4		2-1-1-1 (N = 2)
	Light gray, CLAY with silt, very soft wet, plastic, CL (ALLUVIUM)					
	Gray to dark gray, SILT, soft, wet, slightly plastic, ML (ALLUVIUM)					
15	Dark gray, SILT with some clay, soft, wet, plastic, ML (ALLUVIUM)		568.5	VS-5		
				S-6		1-1-1-2 (N = 2)
	Dark gray, fine to medium SAND, very loose, wet, SP (ALLUVIUM)					
	Dark gray, fine SAND with silt, very loose, wet, SM (ALLUVIUM)			S-7		WOH-18"2
20			563.5	S-8		WOH-1-2-1 (N = 3)
				S-9		WOH-2-2-4 (N = 4)
	Dark gray, fine to medium SAND with silt, very loose, wet, SM (ALLUVIUM)					
	Dark gray, SILT with fine sand, very loose, wet, non-plastic, ML-SM (ALLUVIUM)					
25			558.5			

SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS



BOREHOLE: STANDARD (0-5000 PSF) 3410090707-04.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: SB-A16
DRILLED: 10/26/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)	SAMPLE IDENT	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD / % REC
25	Dark gray, SILT with fine sand, very loose, wet, non-plastic, ML-SM (ALLUVIUM)	558.5	S-10	WOH-1-1-2 (N = 2)
	Dark gray, medium to coarse SAND with silt, very loose, wet, non-plastic, SM (ALLUVIUM)		S-11	WOH-2-2-2 (N = 4)
	Dark gray, very fine SAND with silt, very loose, wet, SM (ALLUVIUM)		S-12	1-2-1-3 (N = 3)
30	Dark gray, CLAY with silt, very soft, wet, plastic, CL (ALLUVIUM)	553.5	S-13	WOH-1-1-2 (N = 2)
	Brown to brownish gray, CLAY, soft, plastic, CL (ALLUVIUM) - occasional rust colored partings of very fine sand		S-14	1-1-2-3 (N = 3)
	Dark gray, fine to medium SAND, very loose, wet, SP (ALLUVIUM)			
35	Brown to brownish gray, CLAY, soft, plastic, CL (LACUSTRINE) - 35.3' to 37.2' bgs: occasional rust colored partings of very fine sand	548.5	S-15	1-1-1-1 (N = 2)
			S-16	1-1-1-1 (N = 2)
			S-17	WOH-24"
40		543.5	S-18	WOOR-12"WOH-12"
			ST-19	
	Bottom of boring at 44' bgs			
45		538.5		
50		533.5		

Undrained Shear Strength (psf): ★ VS Peak; ☆ VS Remold; ◆ PP; ■ TORV — 1000 2000 3000 4000
PL (%) NM (%) LL (%)
▲ FINES (%) ● SPT (N-value) ✪ ORG (%) — 0 10 20 30 40 50 60 70 80 90 100

SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS

BOREHOLE: STANDARD (0-5000 PSF) 3410090707-04.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: SB-A16
DRILLED: 10/26/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)	SAMPLE IDENT	BLOW COUNT (1st 6"-2nd 6"-3rd 6"-4th 6")
0	Dark brown, fine to coarse SAND with gravel, loose, moist (FILL) - possible petroleum-like staining on soils, slight odor	583.8		
5		578.8		
	Dark gray, CLAY with silt, soft, wet plastic, CL (ALLUVIUM)		S-1	3-2-1-2 (N = 3)
	- 8.0' to 10.0' bgs: possible petroleum-like staining on soils, slight odor			
10	- trace fine sand - occasional rust colored partings of very fine sand	573.8	S-2	1-1-1-1 (N = 2)
	Dark gray, fine to coarse SAND with gravel, wet, SW (ALLUVIUM)			
15	Gray, SILT with fine sand, very soft, wet, slightly plastic, ML-SM (ALLUVIUM)	568.8	S-3	1-1-1-1 (N = 2)
20	Gray, SILT with very fine to fine sand, very loose, wet, non-plastic, ML-SM (ALLUVIUM)	563.8	S-4	1-1-2-2 (N = 3)
	Gray, SILT with clay, soft, wet, plastic, ML (ALLUVIUM) - occasional rust colored partings of very fine sand			
25		558.8		

SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS

Undrained Shear Strength (psf): ★ VS Peak; ☆ VS Remold; ◆ PP; ■ TORV — 1000 2000 3000 4000
PL (%) NM (%) LL (%)
▲ FINES (%) ● SPT (N-value) ✪ ORG (%) — 10 20 30 40 50 60 70 80 90
Or RQD / % REC

0 10 20 30 40 50 60 70 80 90 100

BOREHOLE: STANDARD (0-5000 PSF) 3410090707-04.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: SB-A17
DRILLED: 11/02/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	ELEV (ft)	SAMPLE IDENT	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD / % REC
25	Gray, SILT with clay, soft, wet, plastic, ML (ALLUVIUM)	558.8	S-5	WOH-18"1
	Gray to brownish gray, CLAY, very soft, wet, plastic, CL (LACUSTRINE)			
30		553.8	S-6	WOH-24"
			S-7	WOH-24"
35		548.8	VS-8	
			ST-9	
	Bottom of boring at 38' bgs			
40		543.8		
45		538.8		
50		533.8		

Undrained Shear Strength (psf): ★ VS Peak; ☆ VS Remold; ◆ PP; ■ TORV — 1000 2000 3000 4000

PL (%) NM (%) LL (%)

▲ FINES (%) ● SPT (N-value) ✿ ORG (%) — 10 20 30 40 50 60 70 80 90

0 10 20 30 40 50 60 70 80 90 100

BOREHOLE: STANDARD (0-5000 PSF) 3410090707-04.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: SJB
RIG TYPE: CME-550 (Safety-Hammer)
METHOD: Hollow-Stem Augers
HOLE DIAM.: 3.25" ID
SPTs:
REMARKS:

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: SB-A17
DRILLED: 11/02/09
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701

MACTEC

APPENDIX D

2010 TEST PIT LOGS

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT (1st 6" 2nd 6" 3rd 6" 4th 6") Or RQD / % REC	PL (%) NM (%) LL (%) ▲ FINES (%) ● SPT (N-value) ✿ ORG (%) 10 20 30 40 50 60 70 80 90	DEPTH (ft)
0	Black, coarse SAND with boulders and bricks, loose, FILL							0
	An 8-inch thick concrete slab was encountered 6-inches bgs adjacent to the north wall on the west side of the pit.							
5	Concrete footings encountered to depths of 3 to 3.5 feet along the north east and south sides of the pit. The north footing was visible at the surface, and the top of the east and south footings were 6-inches below grade.							5
10								10
	Bottom of excavation at 11' bgs							
15							0 10 20 30 40 50 60 70 80 90 100	15

BOREHOLE: STANDARD (0-5000 PSF) 3410090701-04TP.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: OSC
RIG TYPE: JD 450
METHOD:
HOLE DIAM.: 17' x 4.5'
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: TP-3
DRILLED: 01/05/10
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701-04

PAGE 1 **OF** 1

MACTEC

Test Pit 3

Test Pit 3 looking south, concrete footing on east side of pit, 3.5' thick

Test Pit 3, concrete slab at north west corner of pit, approximately 8" thick

Test Pit 3

Test Pit 3 looking west standing at northeast corner, 8" thick concrete slab is shown

Looking south, concrete footings on east and south edges of pit.

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD / % REC	PL (%) NM (%) LL (%) ▲ FINES (%) ● SPT (N-value) ✿ ORG (%) 10 20 30 40 50 60 70 80 90	DEPTH (ft)
0	Brown to black, SAND with brick and boulders, loose, FILL A rebar rod that may have been a tie back from the exterior retaining wall to the foundation was encountered 1.5 feet bgs Excavating was not difficult due to loose fill.	FILL						0
5								5
10								10
	Bottom of excavation at 11' bgs NOTES: 1. Concrete foundation wall is located along western edge of excavation and extends beyond the depth of pit.							
15							0 10 20 30 40 50 60 70 80 90 100	15

DRILLER: OSC
RIG TYPE: JD 450
METHOD:
HOLE DIAM.: 17' x 10'
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

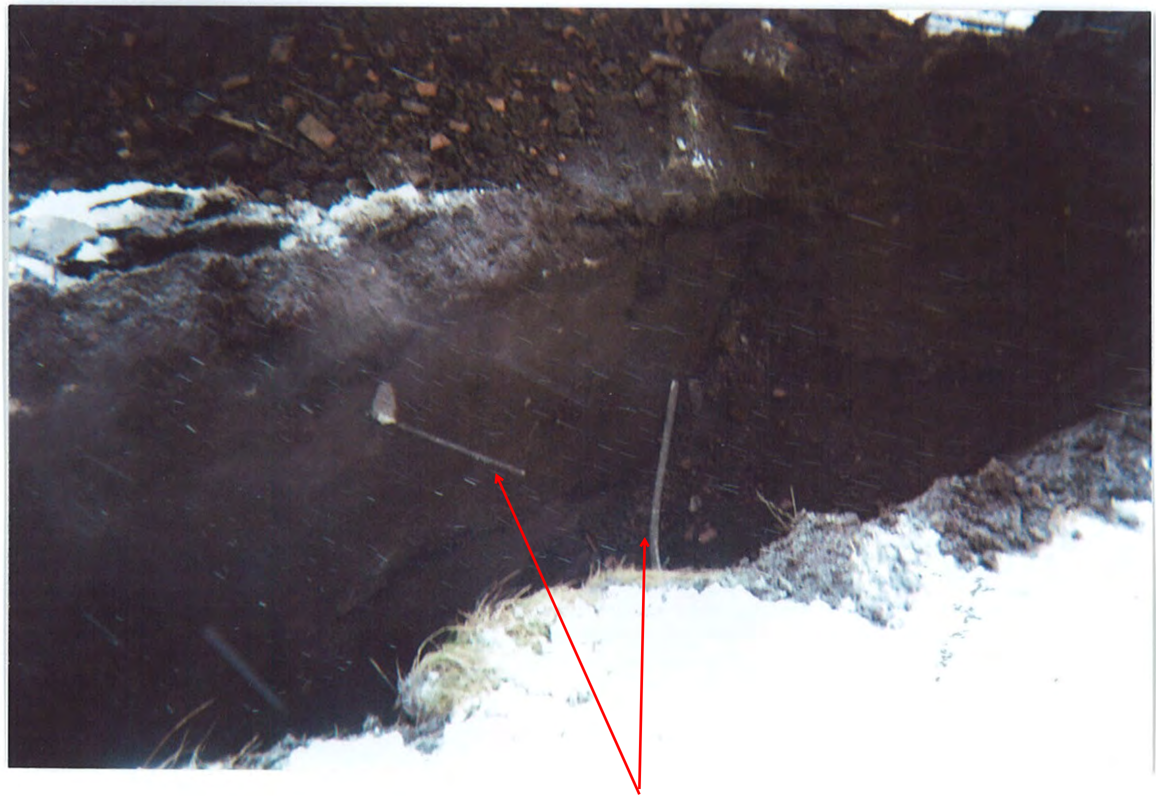
BOREHOLE NO.: TP-4
DRILLED: 01/05/10
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701-04

MACTEC

BOREHOLE: STANDARD (0-5000 PSF) 3410090701-04TP.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

Test Pit 4

Looking north, ICM-103 on east side of pit



Looking west, possible retaining wall tie back to foundation wall

Test Pit 4

Looking west, concrete foundation wall along western edge of pit. Potential retaining wall tie back in center of picture.

Looking north

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD / % REC	PL (%) NM (%) LL (%) ▲ FINES (%) ● SPT (N-value) ✪ ORG (%) 10 20 30 40 50 60 70 80 90	DEPTH (ft)
0	Brown, SAND with gravel, loose, FILL							0
	Cobbles with sand, FILL							
	SAND and boulders, FILL							
5	SAND and gravel with boulders and concrete rubble up to 1' in diameter, FILL							5
	Conrete floor slab at 9' bgs Bottom of excavation at 9' bgs							
10								10
15							0 10 20 30 40 50 60 70 80 90 100	15

BOREHOLE: STANDARD (0-5000 PSF) 3410090701-04TP.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: OSC
RIG TYPE: JD 450
METHOD:
HOLE DIAM.: 10' x 4.5'
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: TP-5A
DRILLED: 01/05/10
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701-04

MACTEC

Test Pit 5a

Looking south at southern wall of in-take structure, directly to the right of photo is the eastern bulkhead wall of the in-take structure.

Looking south at southern wall of the in-take structure.

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	LEGEND	ELEV (ft)	SAMPLES: IDENT	TYPE	BLOW COUNT (1st 6" 2nd 6" 3rd 6" 4th 6") Or RQD / % REC	PL (%) NM (%) LL (%) ▲ FINES (%) ● SPT (N-value) ✪ ORG (%) 10 20 30 40 50 60 70 80 90	DEPTH (ft)
0	Dark brown, SAND with gravel and bricks, loose to medium dense, FILL							0
	Light brown, SAND with gravel, medium dense, FILL							
	Dark brown, SAND with gravel and brick, medium dense, FILL							
5								5
	Construction and Demolition debris, wood, steel I-Beam, barbed wire, FILL							
10	Bottom of excavation at 10' bgs							10
15							0 10 20 30 40 50 60 70 80 90 100	15

DRILLER: OSC
RIG TYPE: JD 450
METHOD:
HOLE DIAM.: 12' x 4.5'
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: TP-5B
DRILLED: 01/05/10
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701-04

MACTEC

Test Pit 5b

Looking south. Pit is located just south of southern wall of the in-take structure.

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	LEGEND	ELEV (ft)	SAMPLES: IDENT	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD / % REC	PL (%) NM (%) LL (%) ▲ FINES (%) ● SPT (N-value) ORG (%) 10 20 30 40 50 60 70 80 90	DEPTH (ft)
0	3-inches of asphalt pavement							0
	Gravel subbase, FILL							
	Brown, SAND with gravel and brick, loose, FILL							
	Fill consists mostly of bricks with rust colored sand, loose, FILL							
	A 24-inch cast iron, capped utility line was exposed on and penetrates the western wall of excavation at 4' bgs							
5								5
	Concrete floor slab at 9' bgs Bottom of excavation at 9' bgs							
10	NOTES: 1. An 18-inch diameter vertical riser pipe penetrates the floor slab and extends to just below ground surface. Foundation walls were encountered at the west and north sides of the excavation.							10
15							0 10 20 30 40 50 60 70 80 90 100	15

BOREHOLE: STANDARD (0-5000 PSF) 3410090701-04TP.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: OSC
RIG TYPE: JD 450
METHOD:
HOLE DIAM.: 22.5' x 10'
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: TP-6
DRILLED: 01/05/10
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701-04

MACTEC

Test Pit 6

Both photos are looking west at 24" capped line penetrating western foundation wall. This line appears to be located in the center (N-S) of the in-take structure.

Test Pit 6

Looking north. Brick backfill.

Looking north. Concrete foundation walls at north and west sides of pit.

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	LEGEND	ELEV (ft)	SAMPLES: IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD / % REC	PL (%) NM (%) LL (%); ▲ FINES (%) ● SPT (N-value) ✪ ORG (%) 10 20 30 40 50 60 70 80 90
0	Asphalt pavement						
	3-inch minus gravel subbase, FILL						
	Brown, SAND with gravel, loose, FILL						
	Gray, Ash-like material, with gravel and cobbles, loose, FILL						
5							
	Concrete floor slab at 9' bgs Bottom of excavation at 9' bgs						
10	NOTES: 1. Concrete foundation walls encountered on the south and west sides of the excavation 2. Foundations extended below bottom of test pit						
15							0 10 20 30 40 50 60 70 80 90 100

BOREHOLE: STANDARD (0-5000 PSF) 3410090701-04TP.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: OSC
RIG TYPE: JD 450
METHOD:
HOLE DIAM.: 11' x 4.5'
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: TP-7
DRILLED: 01/05/10
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701-04

MACTEC

Test Pit 7

Excavated ash-like material

Looking south, concrete foundation wall at southern end of pit

Test Pit 7

Looking south

Looking west

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)
0	Asphalt pavement
	Gravel subbase, FILL
	Loose SAND and gravel with construction debris (steel beams, concrete rubble), FILL
11.5	Bottom of excavation at 11.5 feet bgs

Column headings: LEGEND; ELEV (ft); SAMPLES: IDENT, TYPE, BLOW COUNT (1st 6", 2nd 6", 3rd 6", 4th 6") Or RQD / % REC; PL (%), NM (%), LL (%); ▲ FINES (%) ● SPT (N-value) ✪ ORG (%); 10 20 30 40 50 60 70 80 90

Depth scale: 0, 5, 10, 15

NOTES:
1. Three reinforced concrete footings were encountered from 1' bgs to bottom of pit. Footings are 1-foot wide and are spaced 5-feet on center. Excavator was able to remove the footings with some difficulty.
2. Foundations extended below the bottom of test pit

0 10 20 30 40 50 60 70 80 90 100

DRILLER: OSC
RIG TYPE: JD 450
METHOD:
HOLE DIAM.: 15' x 7.5'
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: TP-8
DRILLED: 01/05/10
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701-04

MACTEC

Test Pit 8

Looking North, concrete slab at surface under pavement in foreground, concrete foundation wall in center of pit running east-west. Three walls were found at 5' on center. Each wall was reinforced and 1' wide.

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	LEGEND	ELEV (ft)	SAMPLES: IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD / % REC	PL (%) / NM (%) / LL (%); ▲ FINES (%) ● SPT (N-value) ✿ ORG (%) 10 20 30 40 50 60 70 80 90	DEPTH (ft)
0	Dark brown, SAND with roots, gravel and some brick, loose, FILL							0
	Dark brown, SAND with gravel and boulders up to 1' in diameter, loose, FILL							
	Dark brown, SAND with gravel and boulders up to 2' in diameter, loose, FILL							
	Dark brown, SAND with gravel and boulders and bricks, and steel members, FILL							
5								5
10								10
	Bottom of excavation at 13.2' bgs							
	NOTES: 1. Concrete walls were encountered at eastern and northern edges of pit 1' bgs. The walls extend the depth of pit. 2. Foundation wall extended below bottom of test pit							
15							0 10 20 30 40 50 60 70 80 90 100	15

DRILLER: OSC
RIG TYPE: JD 450
METHOD:
HOLE DIAM.: 15.2' x 8.5'
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: TP-9
DRILLED: 01/05/10
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701-04

MACTEC

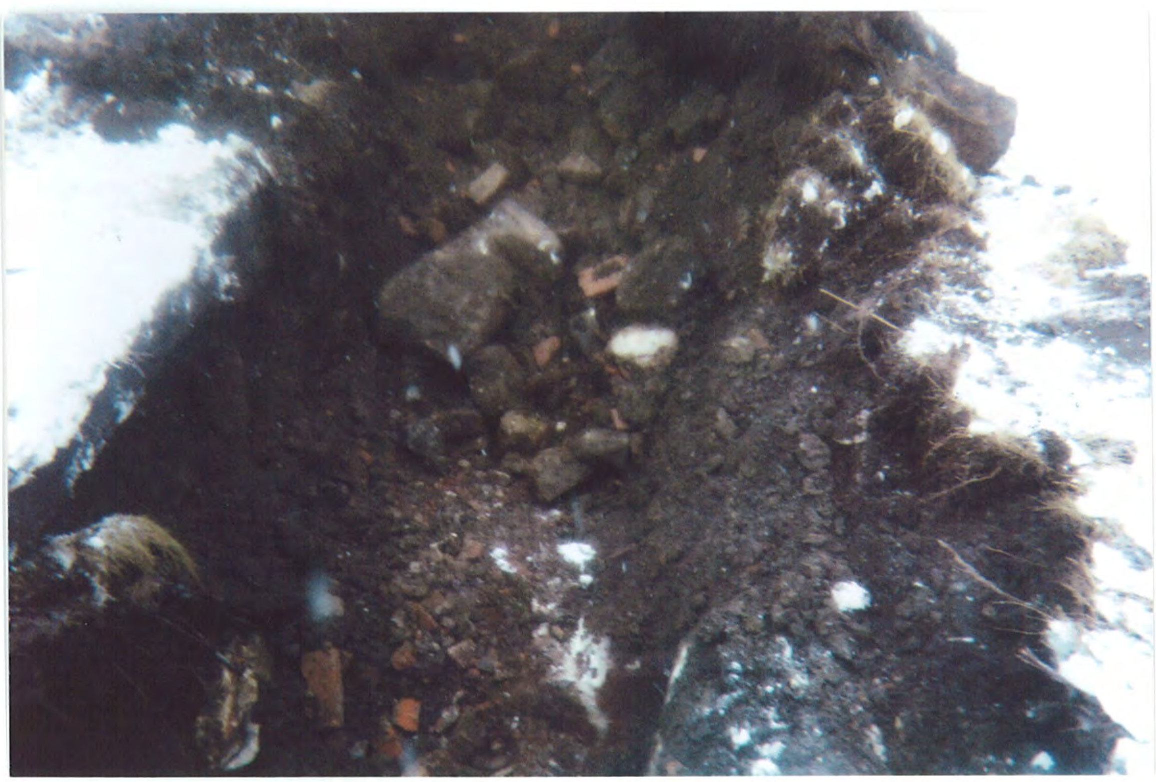
Test Pit 9

Looking north. Concrete wall 1.5' below surface running north-south.

Looking south. Wood timbers at surface along edge of pavement.

Test Pit 9

Looking south. Timbers at edge of pavement.



Looking west, Boulders and bricks in pit.

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD / % REC	PL (%) NM (%) LL (%) ▲ FINES (%) ● SPT (N-value) ✿ ORG (%) 10 20 30 40 50 60 70 80 90	DEPTH (ft)
0	Grass, roots, TOPSOIL							0
	Dark brown, SAND, with brick and boulders up to 2 feet in diameter, loose, FILL							
5								5
	Concrete floor slab encountered at 5.9' bgs Bottom of excavation at 5.9' bgs							
10								10
15							0 10 20 30 40 50 60 70 80 90 100	15

BOREHOLE: STANDARD (0-5000 PSF) 3410090701-04TP.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: OSC
RIG TYPE: JD 450
METHOD:
HOLE DIAM.: 12' x 3.5'
SPTs:
REMARKS:

LOGGED BY: RSE CHECKED BY/DATE: LT

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: TP-10
DRILLED: 01/05/10
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701-04

MACTEC

Test Pit 10

Looking south. Building 75 is to the west of pit.

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS)	LEGEND	ELEV (ft)	SAMPLES: IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD / % REC	PL (%) NM (%) LL (%) ▲ FINES (%) ● SPT (N-value) ✿ ORG (%) 10 20 30 40 50 60 70 80 90	DEPTH (ft)
0	3-inches of asphalt pavement							0
	Tan to brown, SAND with gravel, moist, FILL							
	An 18-inch clay pipe was encountered at 1.5' bgs along western edge of test pit							
	Dark brown to black, SAND with coarse gravel, some cobbles, moist, FILL							
	A 24-inch pipe was encountered at 3.0' bgs running east to west from intake structure. The pipe angled downward and connected to a 90 degree bend. From the bend the pipe extended northward into concrete at bottom of excavation.							
5								5
	A concrete footing was encountered extending 3.5' to 4.0' wide from the intake structure							
10								10
	Bottom of excavation at 12' bgs							
15							0 10 20 30 40 50 60 70 80 90 100	15

BOREHOLE: STANDARD (0-5000 PSF) 3410090701-04TP.GPJ 2007_12-12_PORT_DTMPLT.GDT 02/16/11

DRILLER: OSC
RIG TYPE: KOM 200
METHOD:
HOLE DIAM.:
SPTs:
REMARKS:

LOGGED BY: EW CHECKED BY/DATE:

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING RECORD

BOREHOLE NO.: TP-101
DRILLED: 03/01/10
PROJECT: South Buffalo Development
LOCATION: Buffalo, New York
PROJECT NO.: 3410090701-04 **PAGE** 1 **OF** 1

MACTEC

Test Pit 101

Test Pit 101 looking southeast, 24-inch pipe in foreground

Looking east

Test Pit 101 looking north

APPENDIX E

2009-2010 GEOTECHNICAL LABORATORY RESULTS

Table E1
South Buffalo Development - Geotechnical Pre-Design Investigation
Summary of Geotechnical Laboratory Testing Data

Sample Source	Sample Information				Laboratory Testing Data		
	No.	Type	USCS D 2487 / D 2488				
			Description	Symbol	Sieve and Hydrometer		
					Gravel %	Sand %	Silt and Clay %
BCS	1	bucket	Sandy Gravel with trace silt	GW	57.6	40.9	1.5
BCS	2	bucket	Sandy Gravel with few silt	GW-GM	50.5	42.0	7.5
GC	1	bag	Silty Sand with few gravel	SW-SM	1.7	87.9	10.4
GC	2	bag	Silty Sand with few gravel	SP-SM	3.8	88.6	7.6
GC	3	bag	Silty Sand with few gravel	SP-SM	3.9	88.7	7.4
GC	4	bag	Silty Sand with trace gravel	SP-SM	1.2	91.4	7.4
GSV	1	bag	Gravelly Sand with little silt	SP-SM	39.7	49.0	11.3
GSV	2	bag	Gravelly Sand with little silt	SP-SM	39.5	49.2	11.3
GSV	3	bag	Sandy Gravel with little silt	GP-GM	51.7	38.3	10.0
GSV	4	bag	Sandy Gravel with little silt	GP-GM	46.4	42.9	10.7

BCS - Buffalo Crsuhed Stone Inc., Willamsville, NY
GC - Garnett Asphalt Products - Collins, NY Plant
GSV - Garnett Asphalt Products - Springville, NY Plant

Table E2
South Buffalo Development - Geotechnical Pre-Design Investigation
Summary of Geotechnical Laboratory Testing Data

Soil Boring No.	Sample Information						Laboratory Testing Data								
	No.	Type	Depth Interval (ft bgs)	Primary Stratum	USCS D 2487 / D 2488		Water Content D 2216 (%)	Permeability D 5084 (cm/sec)	Sieve and Hydrometer				Atterberg Limits D 4318		
					Description	Symbol			Gravel %	Sand %	Silt %	Clay %	Liquid Limits LL	Plastic Limit Plastic	Plasticity Index PI
SB-A3	ST-9	tube	34-36	Lacustrine Clay	clay	CL	38.1	1.1E-07	0.0	0.5	35.6	63.9	36	17	19
SB-A4B	ST-9	tube	34-36	Lacustrine Clay	clay	CL	48.9		0.0	0.4	23.5	76.1	58	23	35
SB-A5	ST-11	tube	35-37	Lacustrine Clay	clay	CL	41.1		0.0	0.4	31.0	68.6	39	17	22
SB-A7	ST-10	tube	36-38	Lacustrine Clay	clay	CL	32.6	2.3E-08	0.0	0.9	32.9	66.2	34	18	16
SB-A6B	ST-9	tube	37-39	Lacustrine Clay	clay	CL	31.8	2.5E-08	0.0	1.2	38.8	65.0	32	17	15
SB-A8H	ST-12	tube	40-42	Lacustrine Clay	clay	CL	34.2								
SB-A9H	ST-15	tube	43-45	Lacustrine Clay	clay	CL	32.2	4.8E-08	0.0	1.1	32.6	66.3	35	19	16
SB-A10G	ST-12	tube	40-42	Lacustrine Clay	clay	CL	39.6	2.5E-08	0.0	0.6	26.9	72.5	41	21	20
SB-A11D	ST-10	tube	37-39	Lacustrine Clay	clay	CL	35.1								

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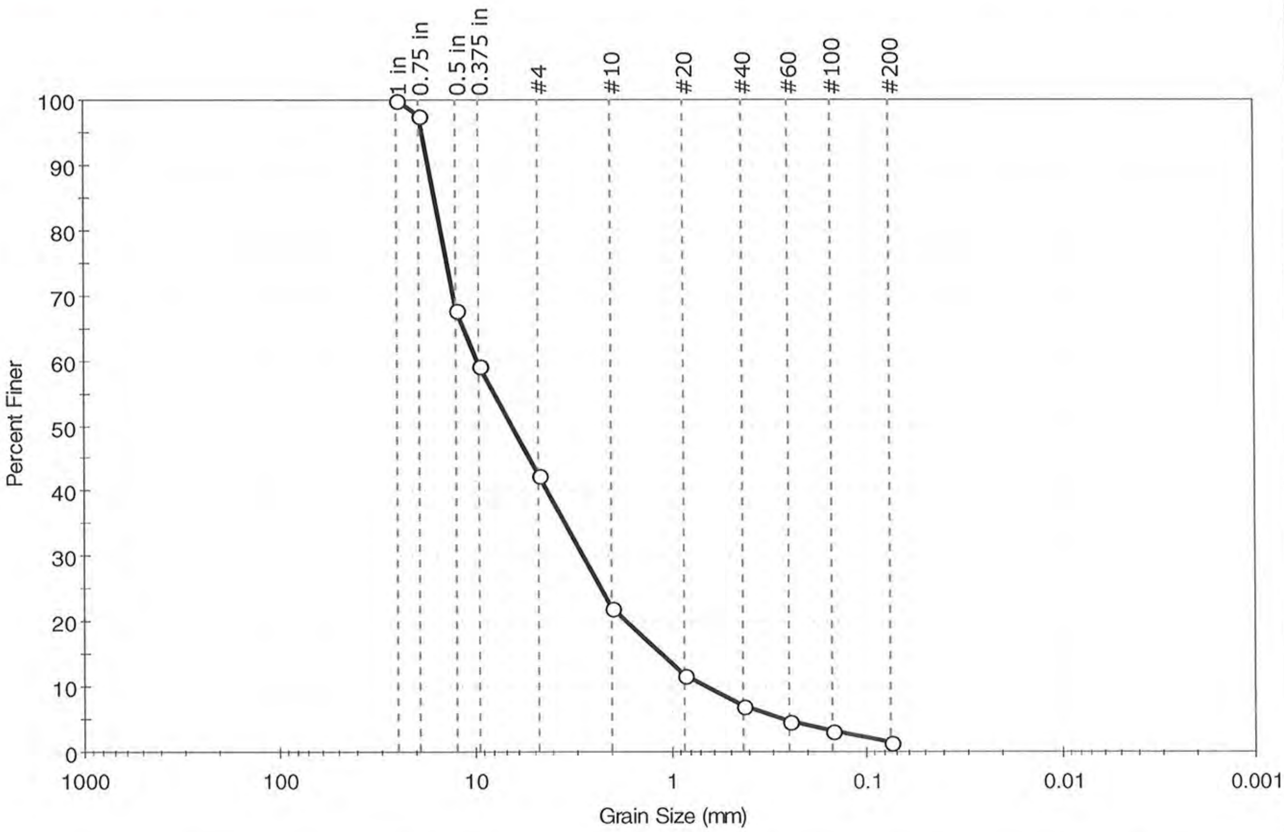
Client:	MACTEC, Inc.				
Project:	South Buffalo Development				
Location:	Buffalo, NY			Project No:	GTX-9611
Boring ID:	---	Sample Type:	bucket	Tested By:	jbr
Sample ID:	BCS-1	Test Date:	01/26/10	Checked By:	jdt
Depth :	---	Test Id:	172621		

Test Comment: ---
Sample Description: Moist, light gray gravel with sand
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	57.6	40.9	1.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	98		
0.5 in	12.50	68		
0.375 in	9.50	59		
#4	4.75	42		
#10	2.00	22		
#20	0.85	12		
#40	0.42	7		
#60	0.25	5		
#100	0.15	3		
#200	0.075	1		

Coefficients

D_{85} = 15.9359 mm	D_{30} = 2.7910 mm
D_{60} = 9.7116 mm	D_{15} = 1.1115 mm
D_{50} = 6.4889 mm	D_{10} = 0.6619 mm
C_u = 14.672	C_c = 1.212

Classification

ASTM Well-graded gravel with sand (GW)

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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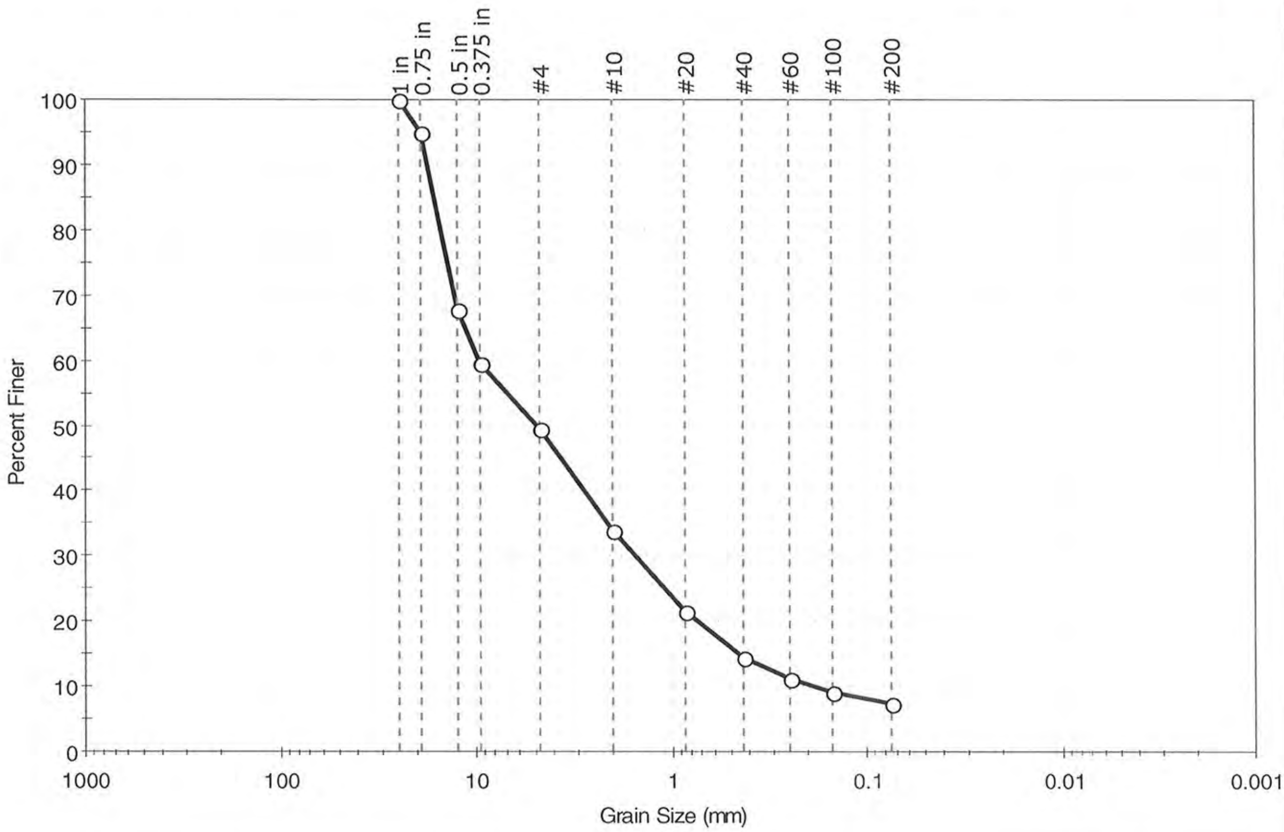
Client: MACTEC, Inc.			
Project: South Buffalo Development			
Location: Buffalo, NY		Project No:	GTX-9611
Boring ID: ---	Sample Type: bucket	Tested By:	jbr
Sample ID:BCS-2	Test Date: 01/26/10	Checked By:	jdt
Depth : ---	Test Id: 172622		
Test Comment: ---			
Sample Description: Moist, light gray gravel with silt and sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	50.5	42.0	7.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	95		
0.5 in	12.50	68		
0.375 in	9.50	59		
#4	4.75	49		
#10	2.00	34		
#20	0.85	22		
#40	0.42	14		
#60	0.25	11		
#100	0.15	9		
#200	0.075	8		

Coefficients

D_{85} = 16.2829 mm	D_{30} = 1.5102 mm
D_{60} = 9.6720 mm	D_{15} = 0.4518 mm
D_{50} = 4.9267 mm	D_{10} = 0.1869 mm
C_u = 51.750	C_c = 1.262

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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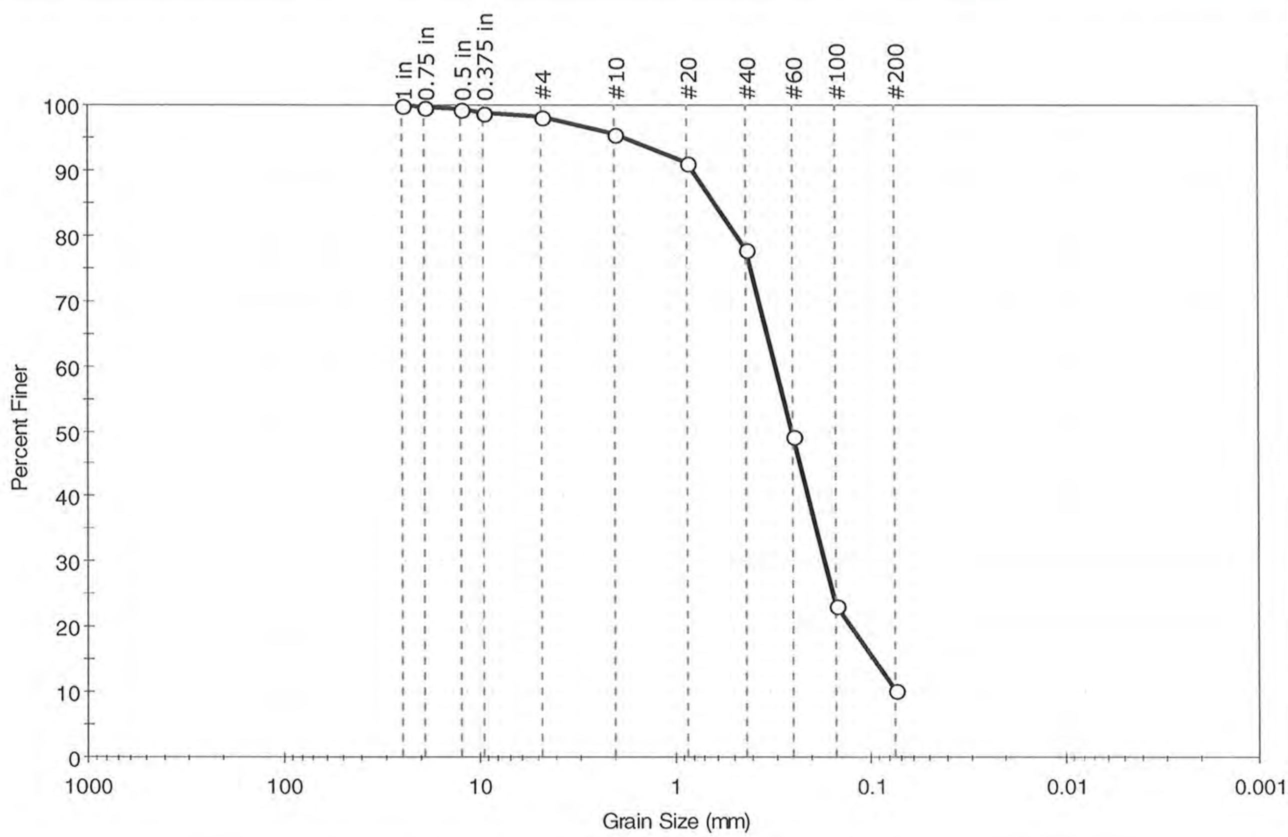
Client:	MACTEC, Inc.				
Project:	South Buffalo Development				
Location:	Buffalo, NY			Project No:	GTX-9611
Boring ID:	---	Sample Type:	bag	Tested By:	jbr
Sample ID:	GC-1	Test Date:	01/26/10	Checked By:	jdt
Depth :	---	Test Id:	172627		
Test Comment:	---				
Sample Description:	Moist, dark yellowish brown sand with silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	1.7	87.9	10.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	100		
0.5 in	12.50	100		
0.375 in	9.50	99		
#4	4.75	98		
#10	2.00	96		
#20	0.85	91		
#40	0.42	78		
#60	0.25	49		
#100	0.15	23		
#200	0.075	10		

Coefficients

D_{85} = 0.6149 mm D_{30} = 0.1710 mm
D_{60} = 0.3054 mm D_{15} = 0.0958 mm
D_{50} = 0.2541 mm D_{10} = 0.0733 mm
C_u = 4.166 C_c = 1.306

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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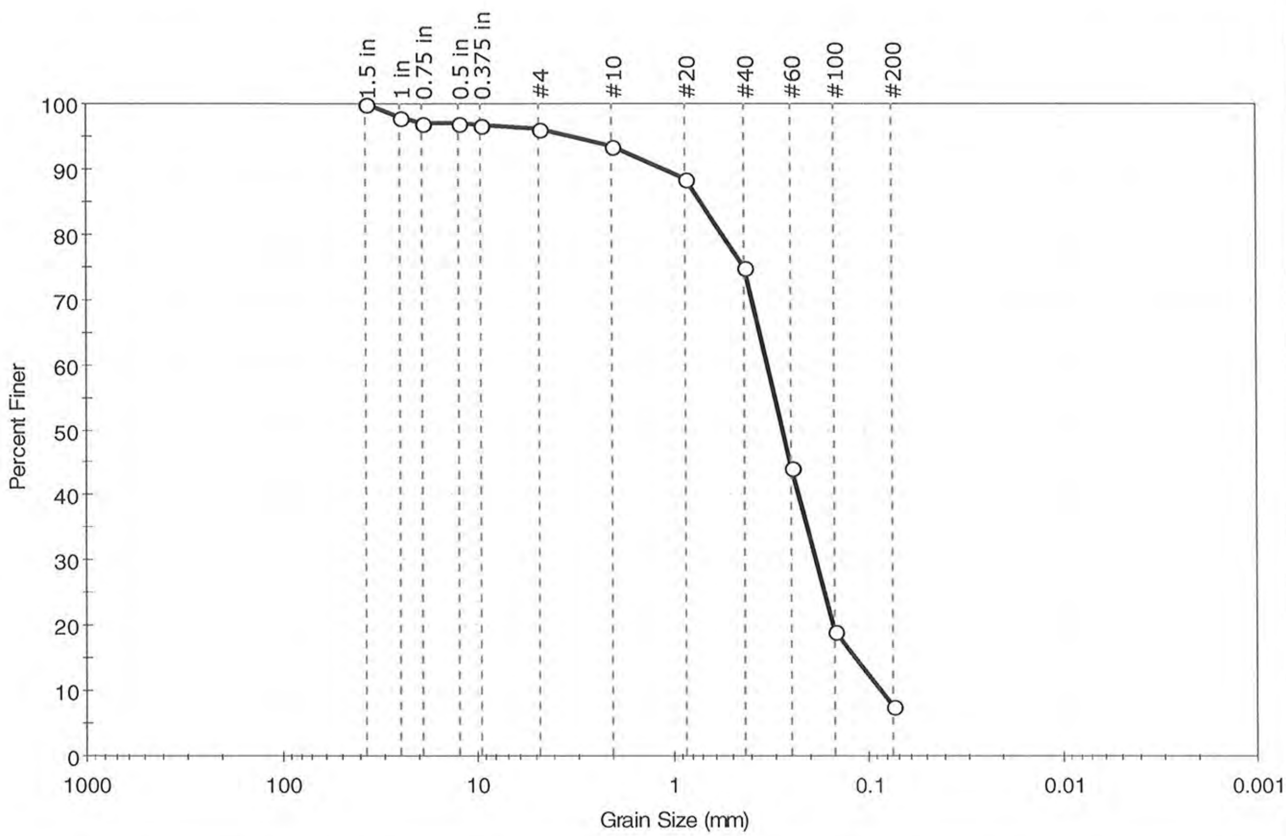
Client: MACTEC, Inc.			
Project: South Buffalo Development			
Location: Buffalo, NY		Project No:	GTX-9611
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GC-2	Test Date: 01/26/10	Checked By:	jdt
Depth : ---	Test Id: 172628		

Test Comment: ---
Sample Description: Moist, dark yellowish brown sand with silt
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	3.8	88.6	7.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	98		
0.75 in	19.00	97		
0.5 in	12.50	97		
0.375 in	9.50	97		
#4	4.75	96		
#10	2.00	93		
#20	0.85	89		
#40	0.42	75		
#60	0.25	44		
#100	0.15	19		
#200	0.075	8		

Coefficients

D_{85} =0.7102 mm	D_{30} =0.1868 mm
D_{60} =0.3283 mm	D_{15} =0.1167 mm
D_{50} =0.2758 mm	D_{10} =0.0865 mm
C_u =3.795	C_c =1.229

Classification

ASTM N/A

AASHTO Fine Sand (A-3 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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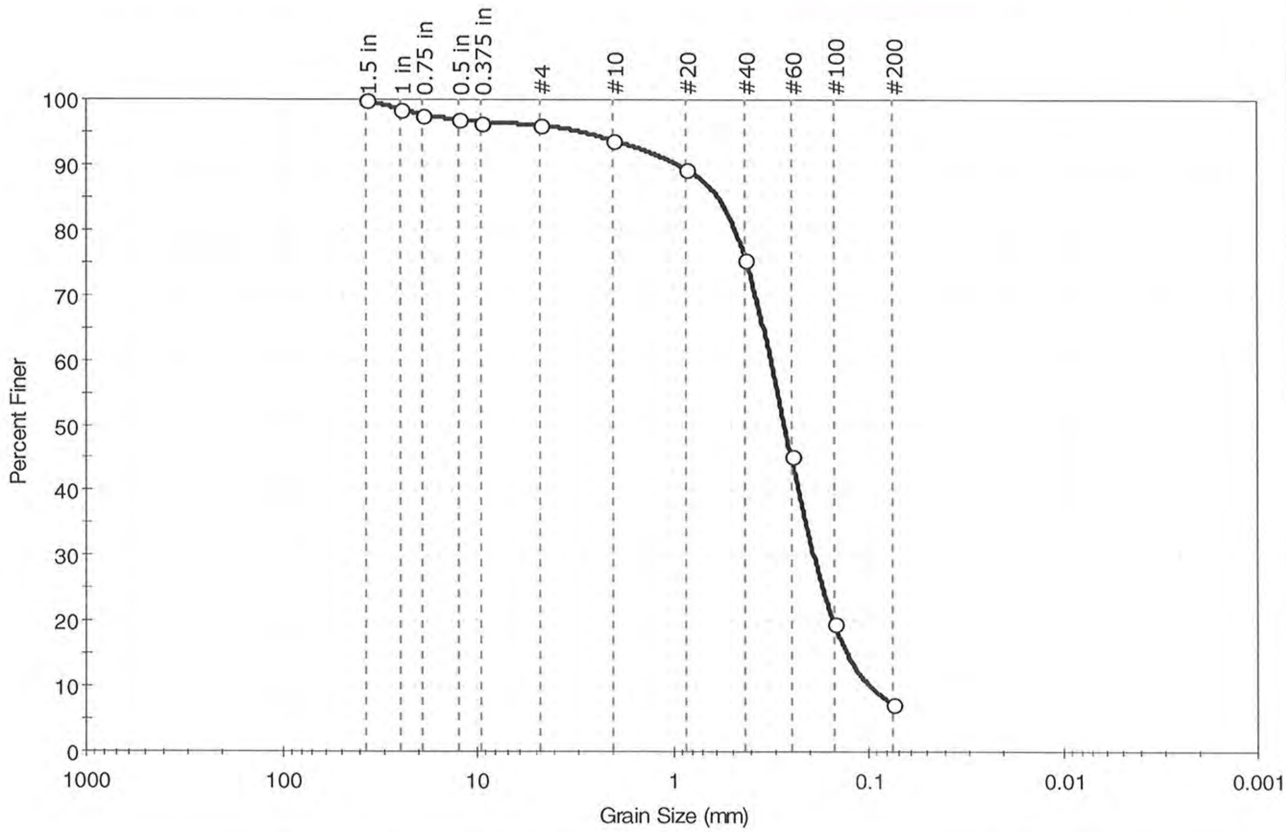
Client:	MACTEC, Inc.				
Project:	South Buffalo Development				
Location:	Buffalo, NY			Project No:	GTX-9611
Boring ID:	---	Sample Type:	bag	Tested By:	jbr
Sample ID:	GC-3	Test Date:	01/26/10	Checked By:	jdt
Depth :	---	Test Id:	172629		
Test Comment:	---				
Sample Description:	Moist, dark yellowish brown sand with silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	3.9	88.7	7.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	99		
0.75 in	19.00	98		
0.5 in	12.50	97		
0.375 in	9.50	97		
#4	4.75	96		
#10	2.00	94		
#20	0.85	89		
#40	0.42	76		
#60	0.25	45		
#100	0.15	20		
#200	0.075	7		

Coefficients

D_{85} =0.6840 mm　　D_{30} =0.1842 mm

D_{60} =0.3235 mm　　D_{15} =0.1151 mm

D_{50} =0.2714 mm　　D_{10} =0.0869 mm

C_u =3.723　　C_c =1.207

Classification

ASTM　N/A

AASHTO　Fine Sand (A-3 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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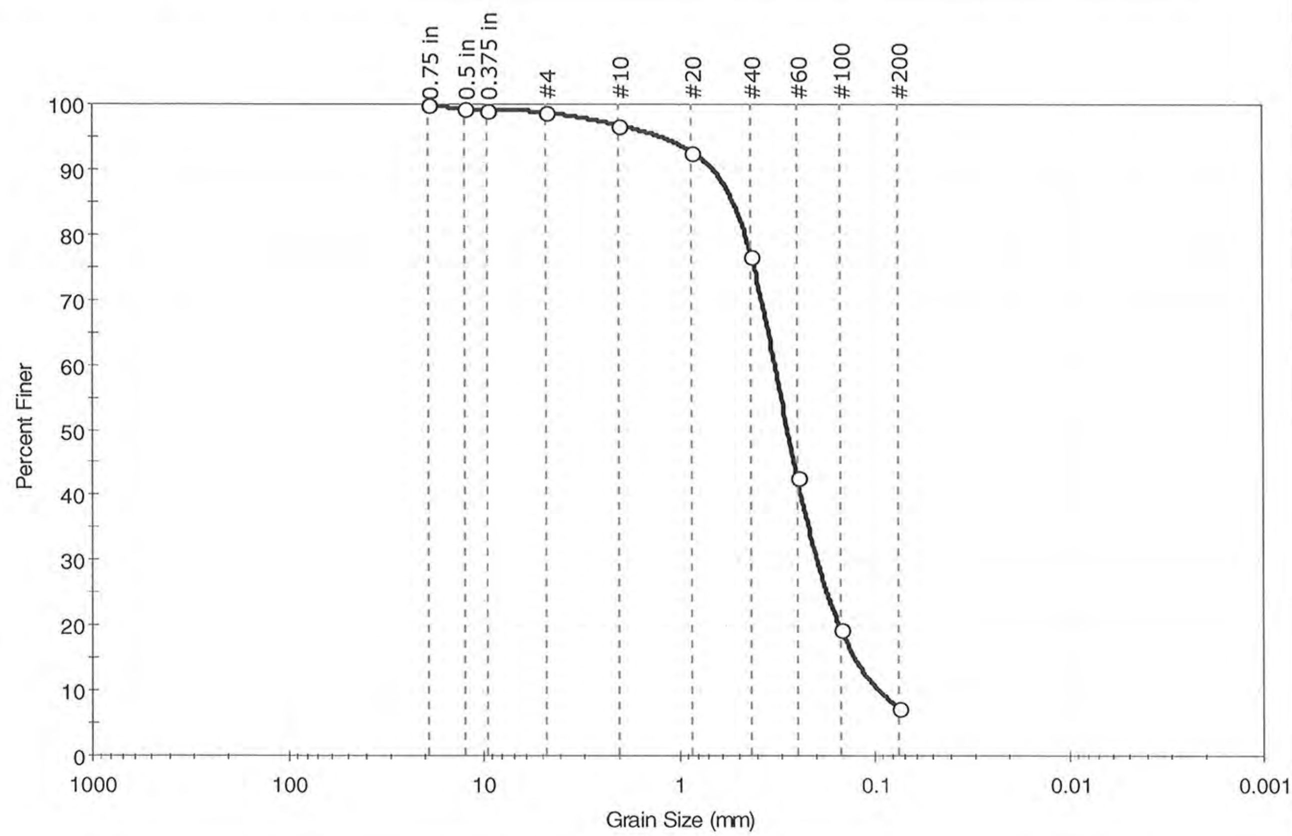
Client:	MACTEC, Inc.				
Project:	South Buffalo Development				
Location:	Buffalo, NY			Project No:	GTX-9611
Boring ID:	---	Sample Type:	bag	Tested By:	jbr
Sample ID:	GC-4	Test Date:	01/26/10	Checked By:	jdt
Depth :	---	Test Id:	172630		
Test Comment:	---				
Sample Description:	Moist, dark yellowish brown sand with silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	1.2	91.4	7.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	99		
0.375 in	9.50	99		
#4	4.75	99		
#10	2.00	97		
#20	0.85	93		
#40	0.42	77		
#60	0.25	43		
#100	0.15	20		
#200	0.075	7		

Coefficients

D_{85} =0.6090 mm D_{30} =0.1889 mm

D_{60} =0.3275 mm D_{15} =0.1159 mm

D_{50} =0.2801 mm D_{10} =0.0871 mm

C_u =3.760 C_c =1.251

Classification

ASTM N/A

AASHTO Fine Sand (A-3 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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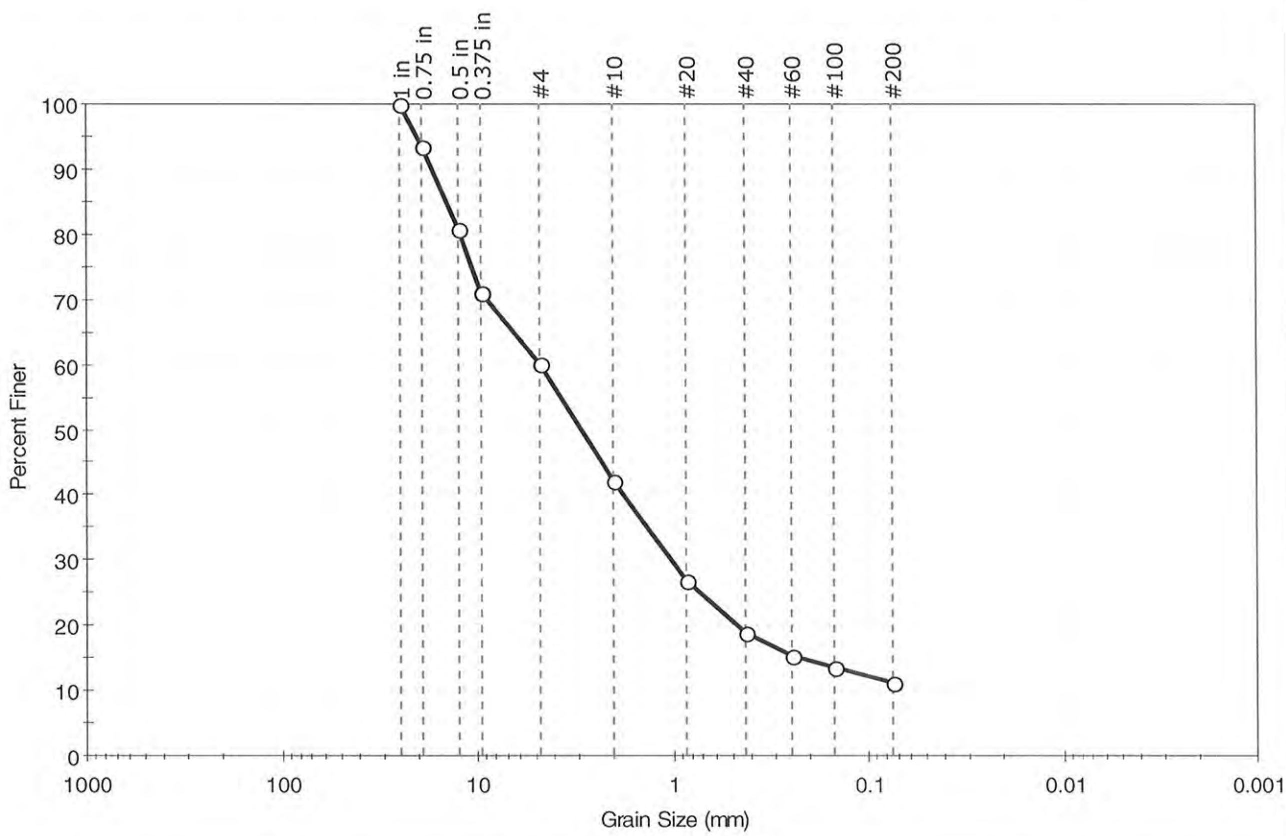
Client: MACTEC, Inc.
Project: South Buffalo Development
Location: Buffalo, NY
Project No: GTX-9611

Boring ID: ---
Sample ID: GSV-1
Depth : ---
Sample Type: bag
Test Date: 01/26/10
Test Id: 172623
Tested By: jbr
Checked By: jdt

Test Comment: ---
Sample Description: Moist, dark brown sand with silt and gravel
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	39.7	49.0	11.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	94		
0.5 in	12.50	81		
0.375 in	9.50	71		
#4	4.75	60		
#10	2.00	42		
#20	0.85	27		
#40	0.42	19		
#60	0.25	15		
#100	0.15	13		
#200	0.075	11		

Coefficients

D_{85} = 14.3066 mm | D_{30} = 1.0116 mm
D_{60} = 4.6848 mm | D_{15} = 0.2242 mm
D_{50} = 2.9129 mm | D_{10} = 0.0486 mm
C_u = 96.395 | C_c = 4.495

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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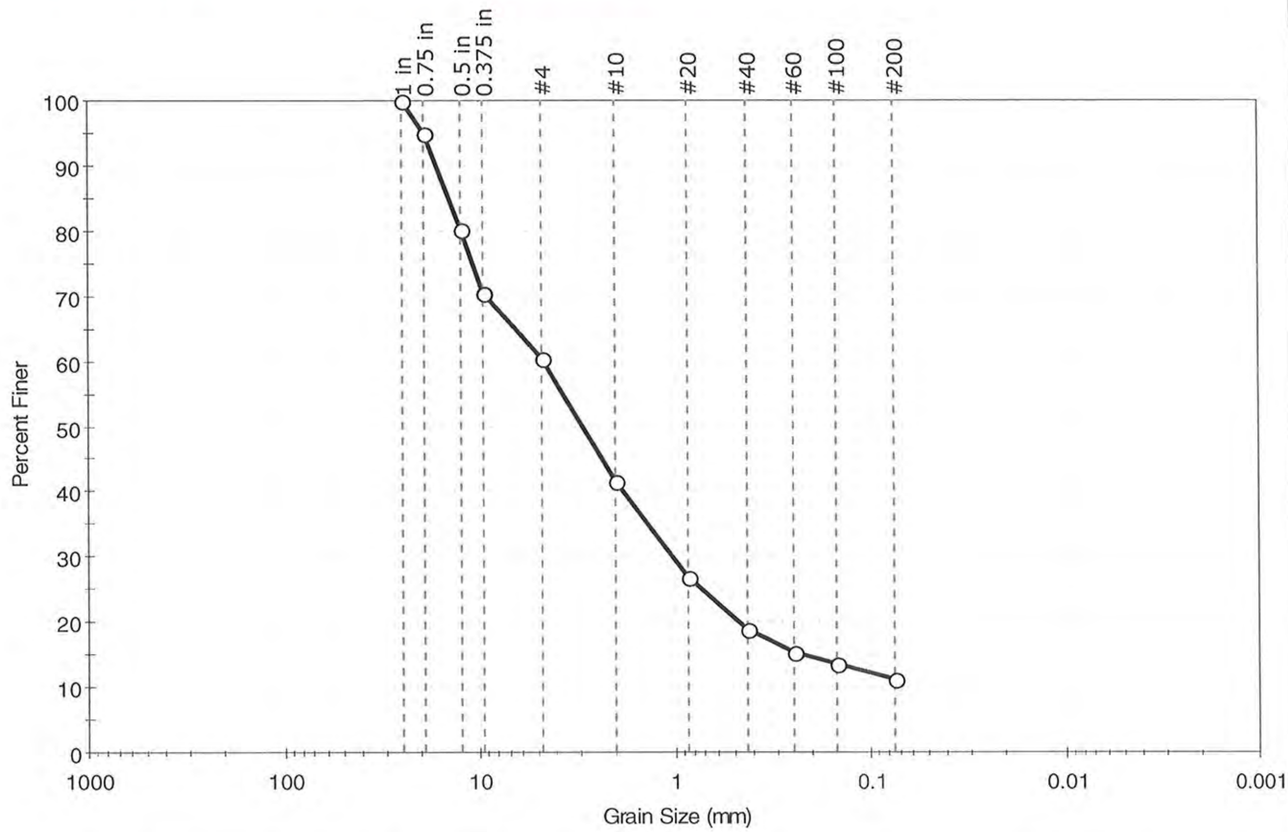
Client:	MACTEC, Inc.				
Project:	South Buffalo Development				
Location:	Buffalo, NY			Project No:	GTX-9611
Boring ID:	---	Sample Type:	bag	Tested By:	jbr
Sample ID:	GSV-2	Test Date:	01/26/10	Checked By:	jdt
Depth :	---	Test Id:	172624		
Test Comment:	---				
Sample Description:	Moist, dark brown sand with silt and gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	39.5	49.2	11.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	95		
0.5 in	12.50	80		
0.375 in	9.50	70		
#4	4.75	61		
#10	2.00	41		
#20	0.85	27		
#40	0.42	19		
#60	0.25	15		
#100	0.15	14		
#200	0.075	11		

Coefficients

D_{85} =14.3198 mm　　D_{30} =1.0164 mm

D_{60} =4.6427 mm　　D_{15} =0.2266 mm

D_{50} =2.9469 mm　　D_{10} =0.0498 mm

C_u =93.227　　C_c =4.468

Classification

ASTM　N/A

AASHTO　Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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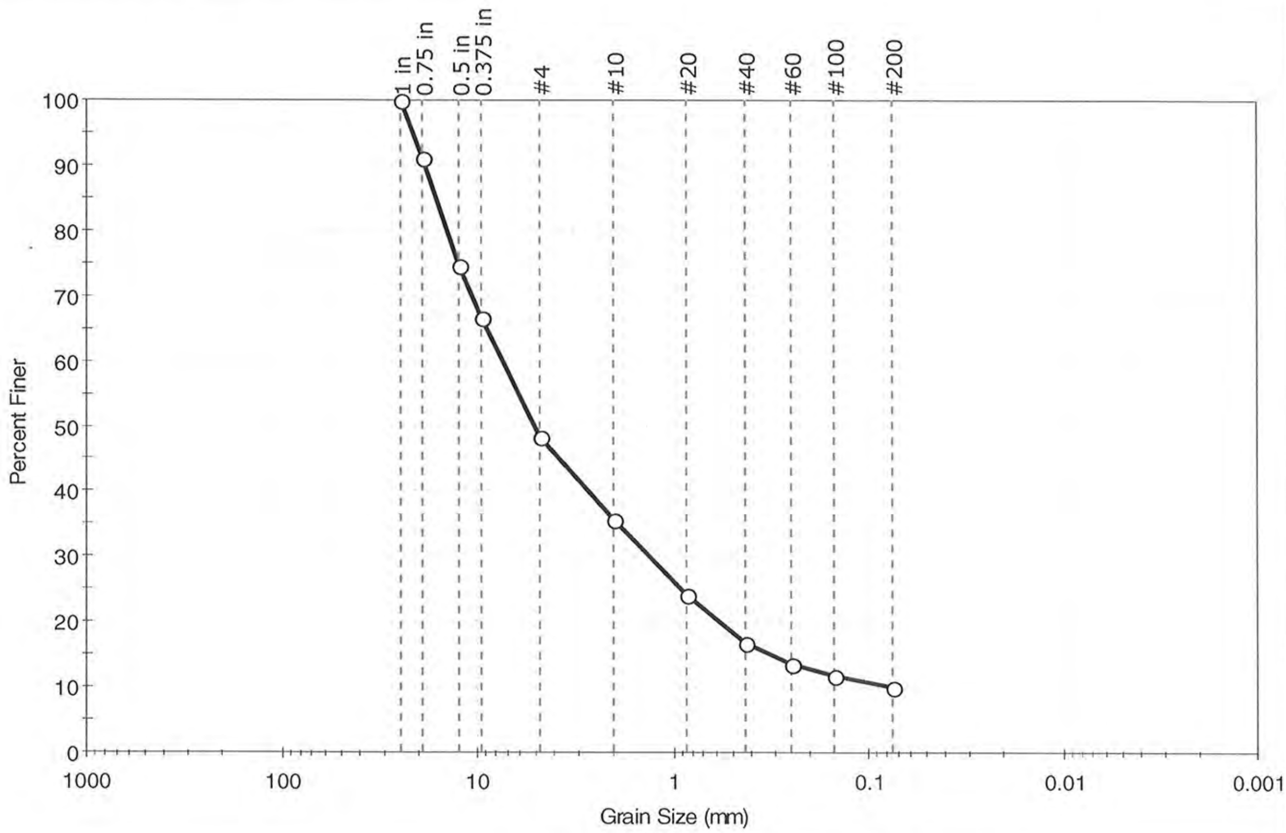
Client:	MACTEC, Inc.				
Project:	South Buffalo Development				
Location:	Buffalo, NY			Project No:	GTX-9611
Boring ID:	---	Sample Type:	bag	Tested By:	jbr
Sample ID:	GSV-3	Test Date:	01/26/10	Checked By:	jdt
Depth :	---	Test Id:	172625		
Test Comment:	---				
Sample Description:	Moist, dark brown gravel with silt and sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	51.7	38.3	10.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	91		
0.5 in	12.50	75		
0.375 in	9.50	67		
#4	4.75	48		
#10	2.00	36		
#20	0.85	24		
#40	0.42	17		
#60	0.25	14		
#100	0.15	12		
#200	0.075	10		

Coefficients

D_{85} =16.2527 mm D_{30} =1.3141 mm

D_{60} =7.3782 mm D_{15} =0.3168 mm

D_{50} =5.0568 mm D_{10} =0.0741 mm

C_u =99.571 C_c =3.159

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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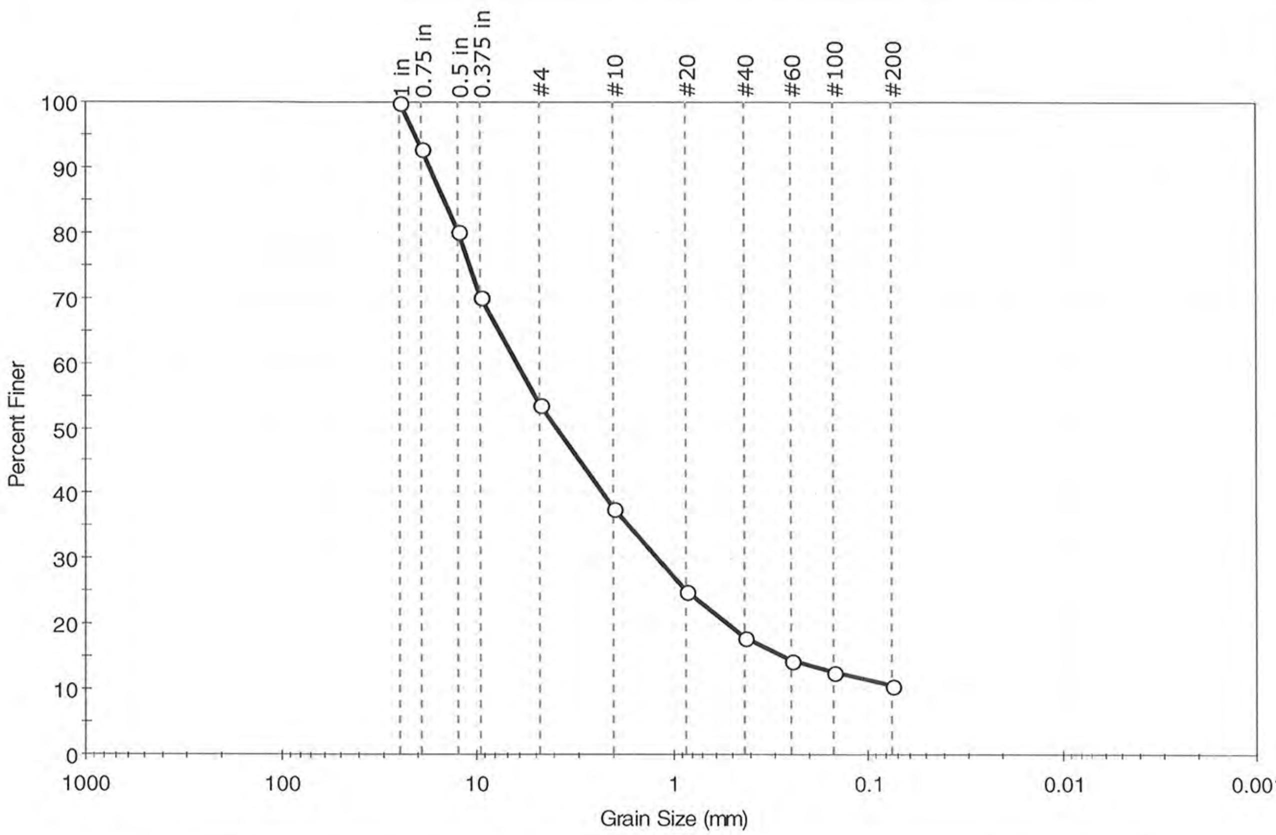
Client: MACTEC, Inc.			
Project: South Buffalo Development			
Location: Buffalo, NY		Project No:	GTX-9611
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GSV-4	Test Date: 01/26/10	Checked By:	jdt
Depth : ---	Test Id: 172626		

Test Comment: ---
Sample Description: Moist, dark yellowish brown gravel with silt and sand
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	46.4	42.9	10.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	93		
0.5 in	12.50	80		
0.375 in	9.50	70		
#4	4.75	54		
#10	2.00	38		
#20	0.85	25		
#40	0.42	18		
#60	0.25	15		
#100	0.15	13		
#200	0.075	11		

Coefficients

D_{85} =14.5732 mm D_{30} =1.1812 mm
D_{60} =6.2067 mm D_{15} =0.2683 mm
D_{50} =3.9050 mm D_{10} =0.0600 mm
C_u =103.445 C_c =3.747

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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GeoTesting express
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Client: MACTEC, Inc.			
Project: South Buffalo Development			
Location: Buffalo, NY		Project No:	GTX-9611
Boring ID: ---	Sample Type: ---	Tested By:	mmd
Sample ID:---	Test Date: 02/10/10	Checked By:	jdt
Depth : ---	Sample Id: ---		

Moisture Content of Soil - ASTM D 2216-05

Boring ID	Sample ID	Depth	Description	Moisture Content,%
SAB-A6B	ST-9	37.0-39.0 ft	Moist, brown clay	31.8
SB-A3	ST-9	34.0-36.0 ft	Moist, brown clay	38.1
SB-A4B	ST-9	34.0-36.0 ft	Moist, gray clay	48.9
SB-A5	ST-11	35.0-37.0 ft	Moist, gray clay	41.1
SB-A7	ST-10	36.0-38.0 ft	Moist, reddish brown clay	32.6
SB-A9H	ST-15	43.0-45.0 ft	Moist, brown clay	32.2
SB-A10G	ST-12	40.0-42.0 ft	Moist, brown clay	39.6
SB-A11D	ST-10	37.0-39.0 ft	Moist, reddish brown clay	35.1
SB-A18H	ST-12	40.0-42.0 ft	Moist, reddish brown clay	34.2

Notes: Temperature of Drying : 110º Celsius

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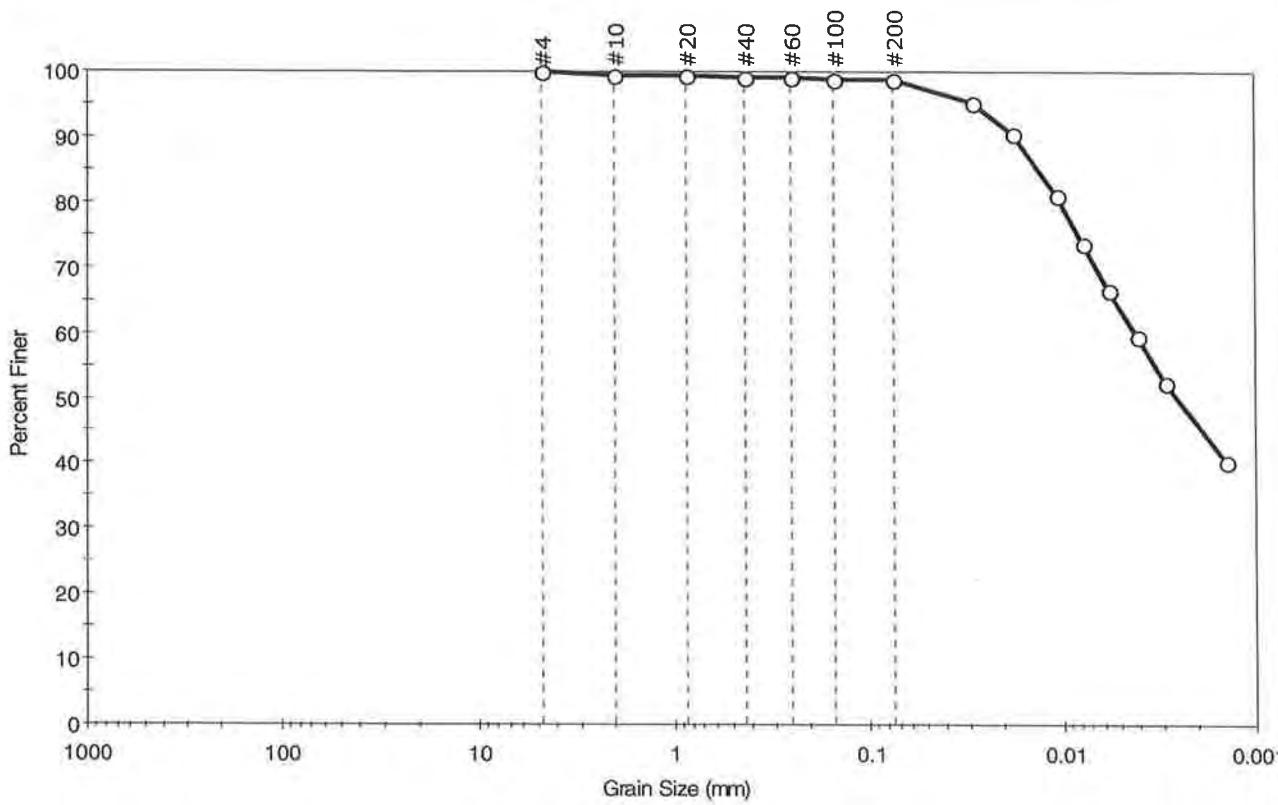
Client: MACTEC, Inc.			
Project: South Buffalo Development			
Location: Buffalo, NY		Project No:	GTX-9611
Boring ID: ~~SB-A6B~~ SB-A6B RSE	Sample Type: tube	Tested By:	jbr
Sample ID: ST-9	Test Date: 02/02/10	Checked By:	jdt
Depth : 37.0-39.0 ft	Test Id: 172652		
Test Comment: ---			
Sample Description: Moist, brown clay			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	1.2	98.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	99		
#60	0.25	99		
#100	0.15	99		
#200	0.075	99		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0292	95		
---	0.0178	91		
---	0.0106	81		
---	0.0078	74		
---	0.0057	67		
---	0.0041	60		
---	0.0029	52		
---	0.0014	41		

Coefficients

D_{85} = 0.0132 mm D_{30} = N/A
D_{60} = 0.0042 mm D_{15} = N/A
D_{50} = 0.0025 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM   lean clay (CL)

AASHTO   Clayey Soils (A-6 (15))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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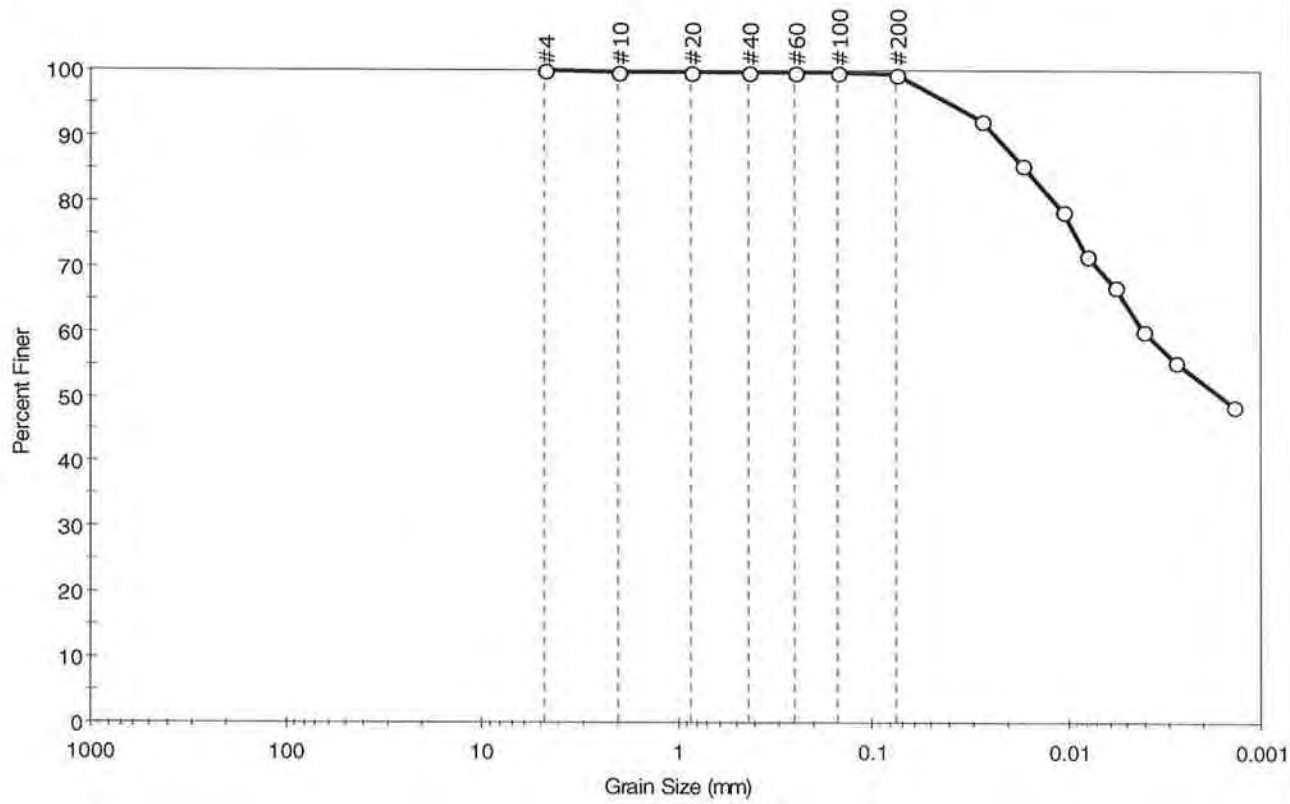
Client:	MACTEC, Inc.				
Project:	South Buffalo Development				
Location:	Buffalo, NY			Project No:	GTX-9611
Boring ID:	SB-A3	Sample Type:	tube	Tested By:	jbr
Sample ID:	ST-9	Test Date:	02/02/10	Checked By:	jdt
Depth :	34.0-36.0 ft	Test Id:	172649		
Test Comment:	---				
Sample Description:	Moist, brown clay				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	0.5	99.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	100		
#100	0.15	100		
#200	0.075	99		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0276	92		
---	0.0171	86		
---	0.0105	79		
---	0.0079	72		
---	0.0057	67		
---	0.0041	60		
---	0.0028	55		
---	0.0014	49		

Coefficients

D_{85} =0.0165 mm D_{30} =N/A

D_{60} =0.0040 mm D_{15} =N/A

D_{50} =0.0016 mm D_{10} =N/A

C_u =N/A C_c =N/A

Classification

ASTM lean clay (CL)

AASHTO Clayey Soils (A-6 (21))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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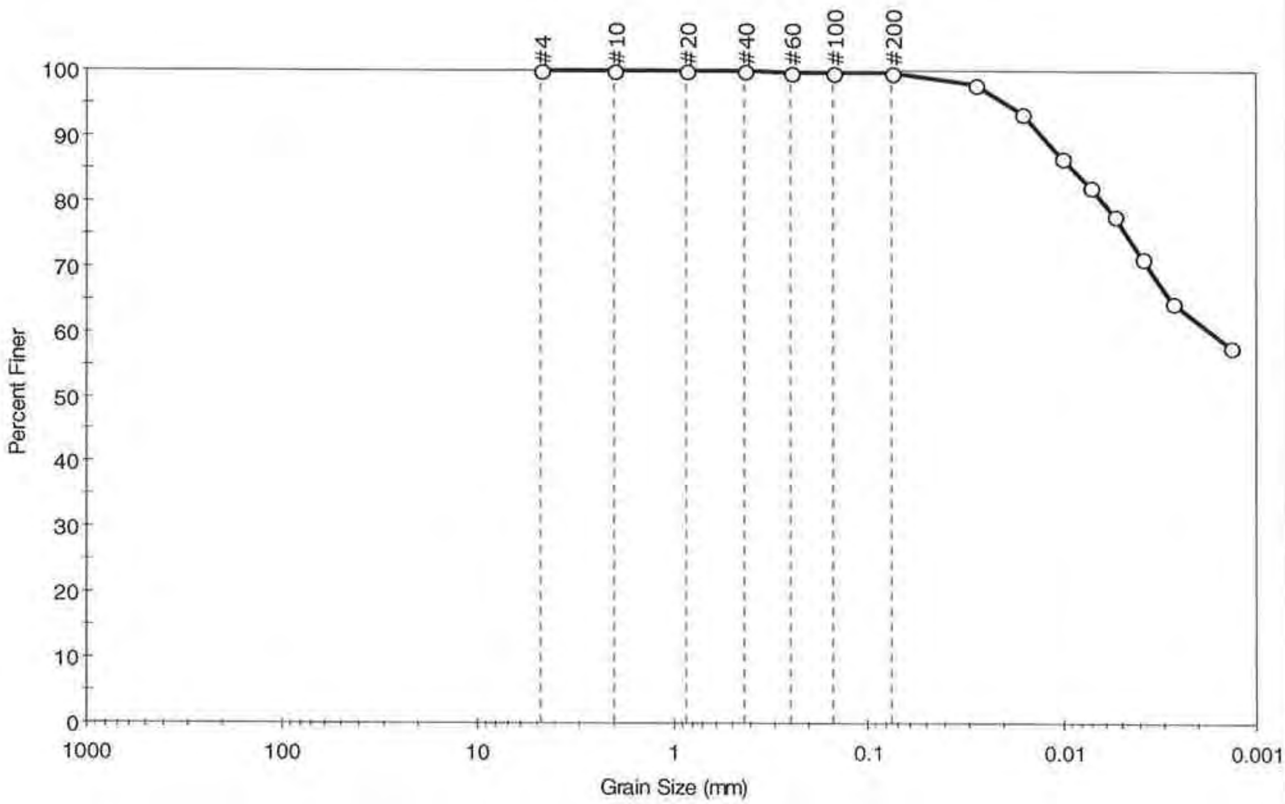
Client: MACTEC, Inc.			
Project: South Buffalo Development			
Location: Buffalo, NY		Project No:	GTX-9611
Boring ID: SB-A4B	Sample Type: tube	Tested By:	jbr
Sample ID: ST-9	Test Date: 02/02/10	Checked By:	jdt
Depth : 34.0-36.0 ft	Test Id: 172650		
Test Comment: ---			
Sample Description: Moist, gray clay			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	0.4	99.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	100		
#100	0.15	100		
#200	0.075	100		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0282	98		
---	0.0161	94		
---	0.0100	87		
---	0.0073	82		
---	0.0054	78		
---	0.0039	71		
---	0.0027	65		
---	0.0014	58		

Coefficients

D_{85} = 0.0088 mm	D_{30} = N/A
D_{60} = 0.0017 mm	D_{15} = N/A
D_{50} = N/A	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM fat clay (CH)

AASHTO Clayey Soils (A-7-6 (43))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
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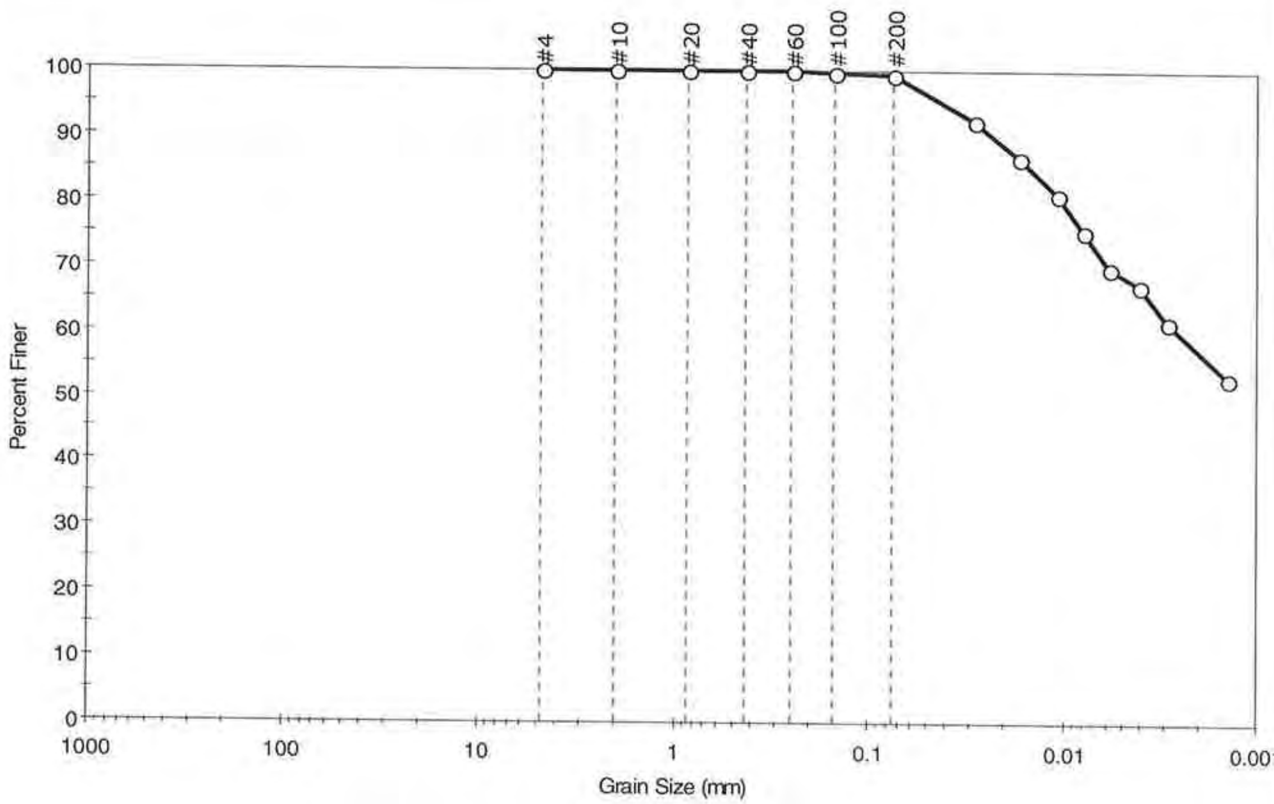
Client: MACTEC, Inc.			
Project: South Buffalo Development			
Location: Buffalo, NY		Project No:	GTX-9611
Boring ID: SB-A5	Sample Type: tube	Tested By:	jbr
Sample ID:ST-11	Test Date: 02/02/10	Checked By:	jdt
Depth : 35.0-37.0 ft	Test Id: 172651		
Test Comment: ---			
Sample Description: Moist, gray clay			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	0.4	99.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	100		
#100	0.15	100		
#200	0.075	100		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0288	92		
---	0.0171	87		
---	0.0109	81		
---	0.0079	76		
---	0.0058	70		
---	0.0041	67		
---	0.0029	62		
---	0.0014	53		

Coefficients

D_{85} =0.0149 mm	D_{30} =N/A
D_{60} =0.0026 mm	D_{15} =N/A
D_{50} =N/A	D_{10} =N/A
C_u =N/A	C_c =N/A

Classification

ASTM lean clay (CL)

AASHTO Clayey Soils (A-6 (25))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
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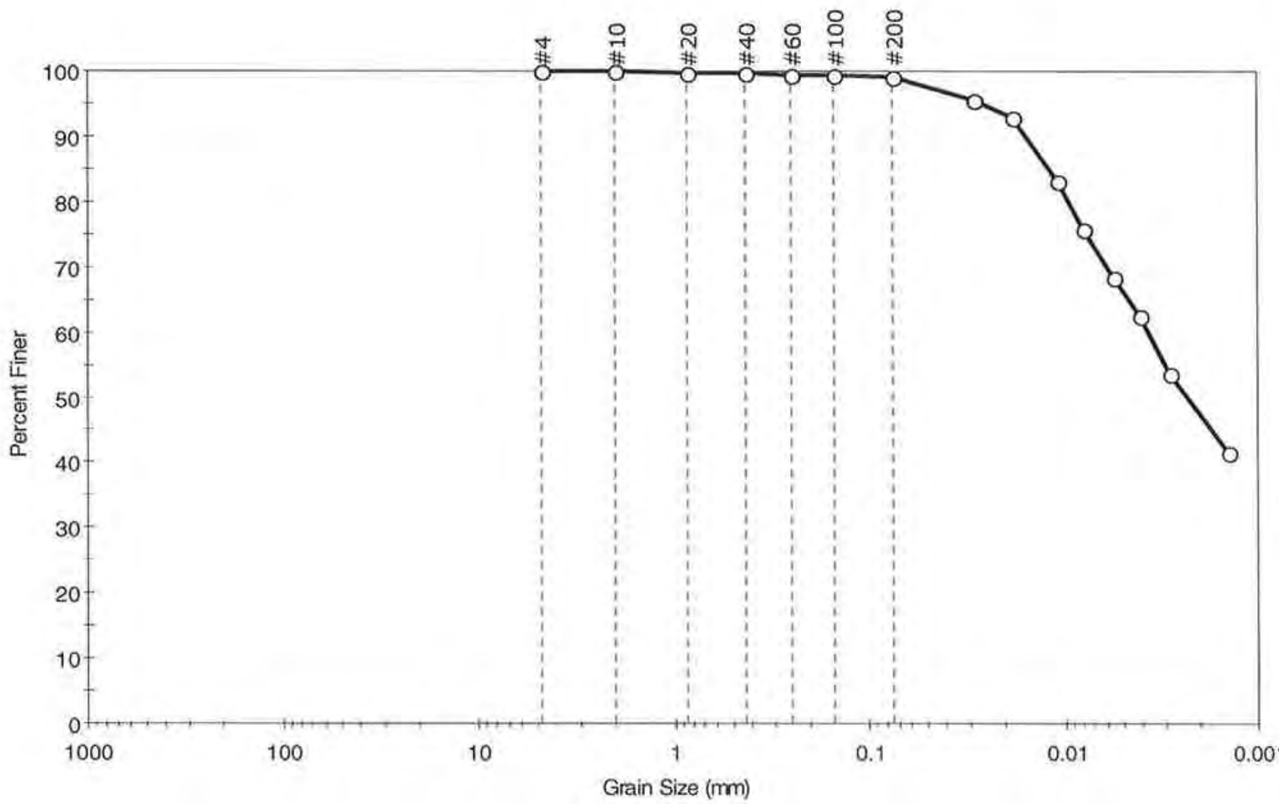
Client: MACTEC, Inc.			
Project: South Buffalo Development			
Location: Buffalo, NY		Project No:	GTX-9611
Boring ID: SB-A7	Sample Type: tube	Tested By:	jbr
Sample ID: ST-10	Test Date: 02/02/10	Checked By:	jdt
Depth : 36.0-38.0 ft	Test Id: 172653		

Test Comment: ---
Sample Description: Moist, reddish brown clay
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	0.9	99.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	100		
#100	0.15	99		
#200	0.075	99		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0290	95		
---	0.0184	93		
---	0.0108	83		
---	0.0079	76		
---	0.0056	69		
---	0.0041	62		
---	0.0029	54		
---	0.0014	42		

Coefficients

D_{85} = 0.0120 mm D_{30} = N/A
D_{60} = 0.0037 mm D_{15} = N/A
D_{50} = 0.0023 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM lean clay (CL)

AASHTO Clayey Soils (A-6 (18))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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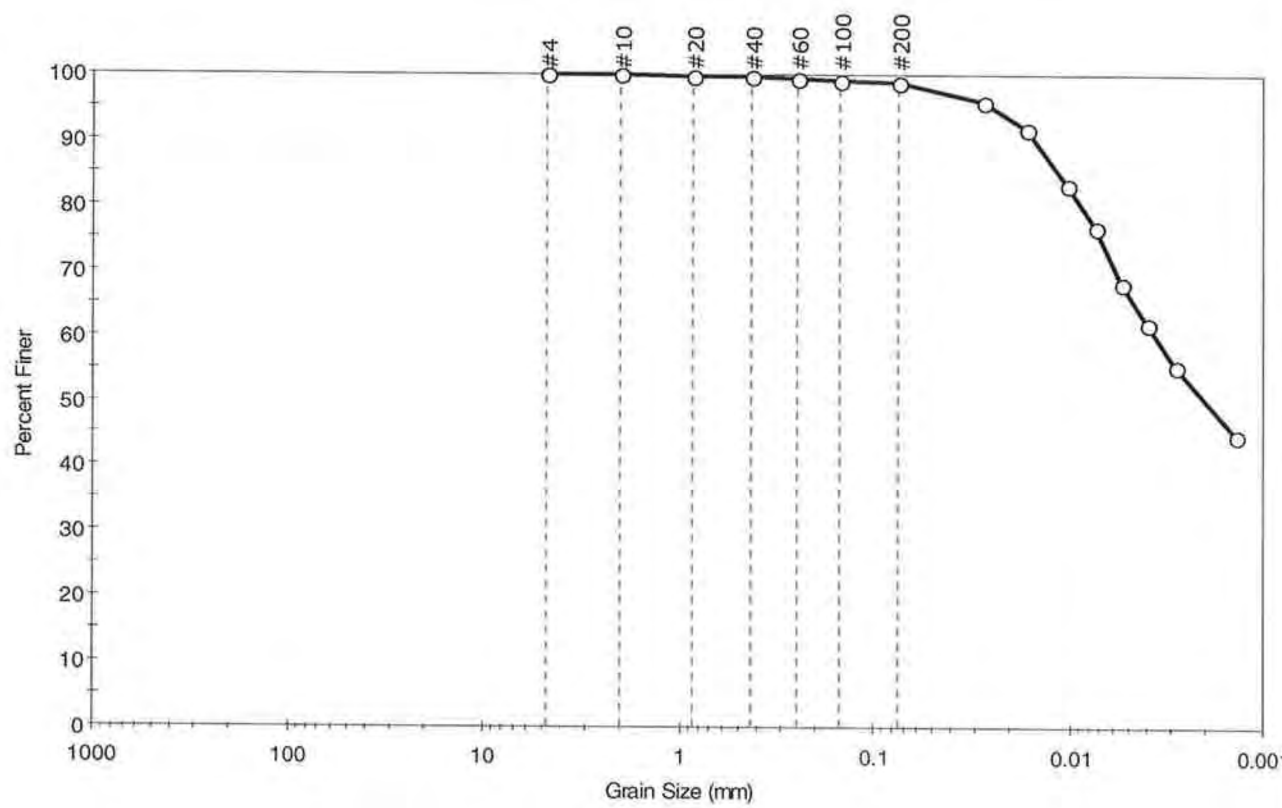
Client: MACTEC, Inc.			
Project: South Buffalo Development			
Location: Buffalo, NY		Project No:	GTX-9611
Boring ID: SB-A9H	Sample Type: tube	Tested By:	jbr
Sample ID:ST-15	Test Date: 02/02/10	Checked By:	jdt
Depth : 43.0-45.0 ft	Test Id: 172654		
Test Comment: ---			
Sample Description: Moist, brown clay			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	1.1	98.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	99		
#100	0.15	99		
#200	0.075	99		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0276	96		
---	0.0166	92		
---	0.0104	83		
---	0.0075	77		
---	0.0054	68		
---	0.0040	62		
---	0.0028	55		
---	0.0014	45		

Coefficients

D_{85} = 0.0114 mm D_{30} = N/A

D_{60} = 0.0036 mm D_{15} = N/A

D_{50} = 0.0020 mm D_{10} = N/A

C_u = N/A C_c = N/A

Classification

ASTM   lean clay (CL)

AASHTO   Clayey Soils (A-6 (17))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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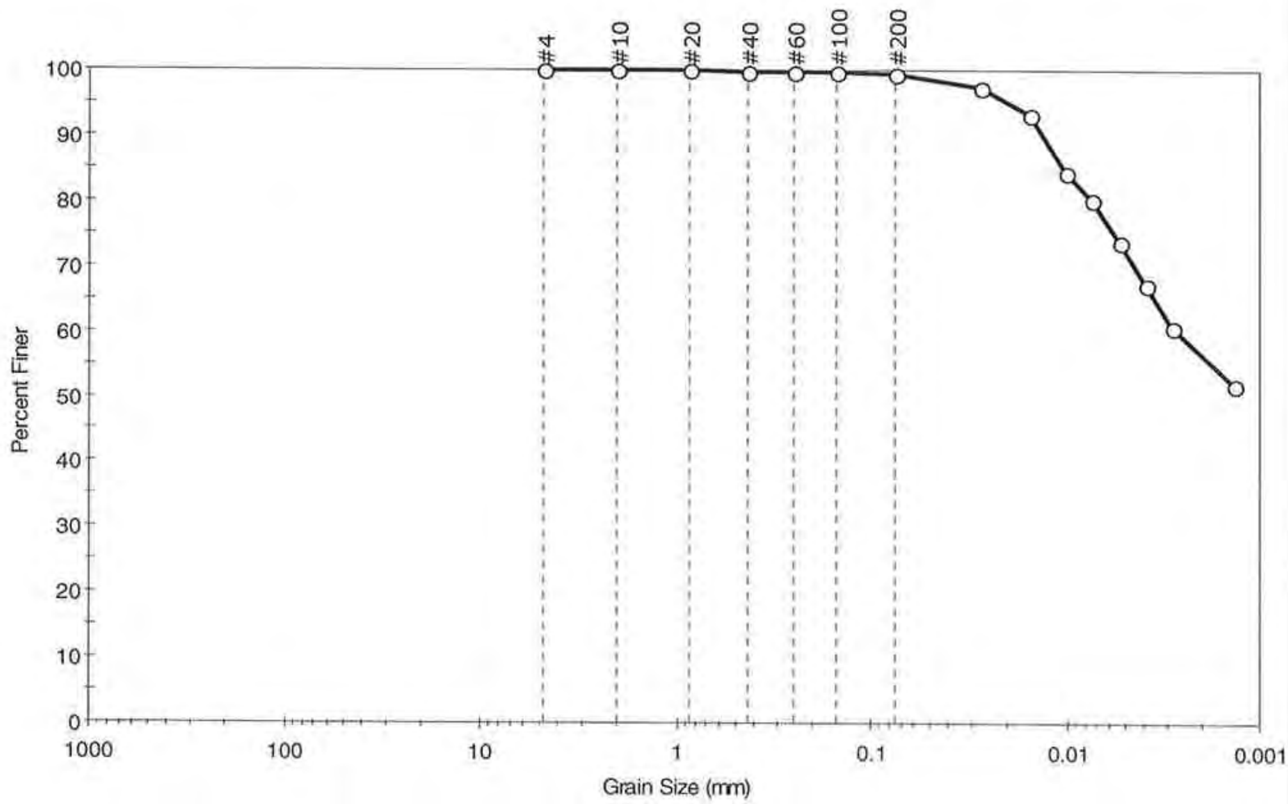
Client:	MACTEC, Inc.		
Project:	South Buffalo Development		
Location:	Buffalo, NY	Project No:	GTX-9611
Boring ID: SB-A10G	Sample Type: tube	Tested By:	jbr
Sample ID:ST-12	Test Date: 02/02/10	Checked By:	jdt
Depth : 40.0-42.0 ft	Test Id: 172655		
Test Comment:	---		
Sample Description:	Moist, brown clay		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	0.6	99.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	100		
#100	0.15	100		
#200	0.075	99		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0278	97		
---	0.0155	93		
---	0.0102	84		
---	0.0075	80		
---	0.0053	74		
---	0.0039	67		
---	0.0028	61		
---	0.0014	52		

Coefficients

D_{85} =0.0105 mm	D_{30} =N/A
D_{60} =0.0027 mm	D_{15} =N/A
D_{50} =N/A	D_{10} =N/A
C_u =N/A	C_c =N/A

Classification

ASTM lean clay (CL)

AASHTO Clayey Soils (A-7-6 (23))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
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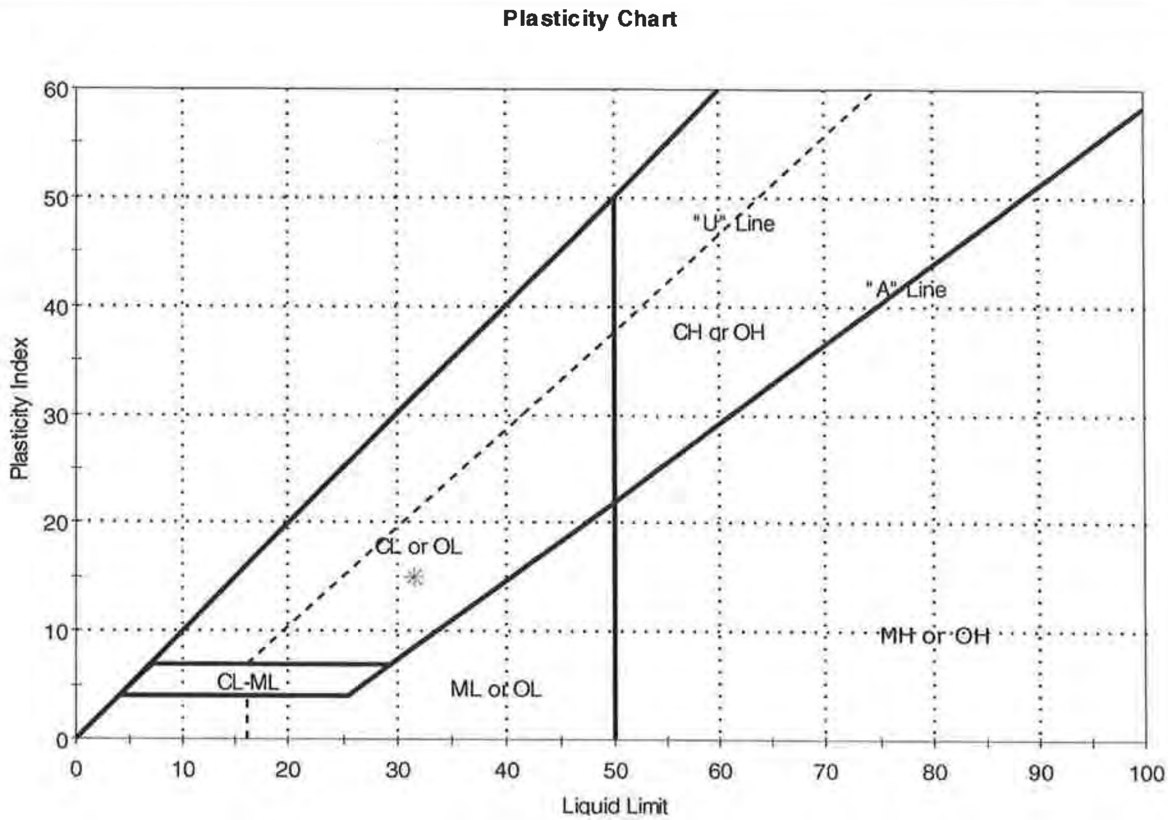
Client: MACTEC, Inc.			
Project: South Buffalo Development			
Location: Buffalo, NY		Project No:	GTX-9611
Boring ID: ~~AB-A6B~~ SB-A6B	Sample Type: tube	Tested By:	cam
Sample ID:ST-9 RSC	Test Date: 02/03/10	Checked By:	jdt
Depth : 37.0-39.0 ft	Test Id: 172659		
Test Comment: ---			
Sample Description: Moist, brown clay			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	ST-9	AB-A6B	37.0-39.0 ft	32	32	17	15	1	lean clay (CL)

Sample Prepared using the WET method

1% Retained on #40 Sieve

Dry Strength: VERY HIGH

Dilentancy: SLOW

Toughness: LOW

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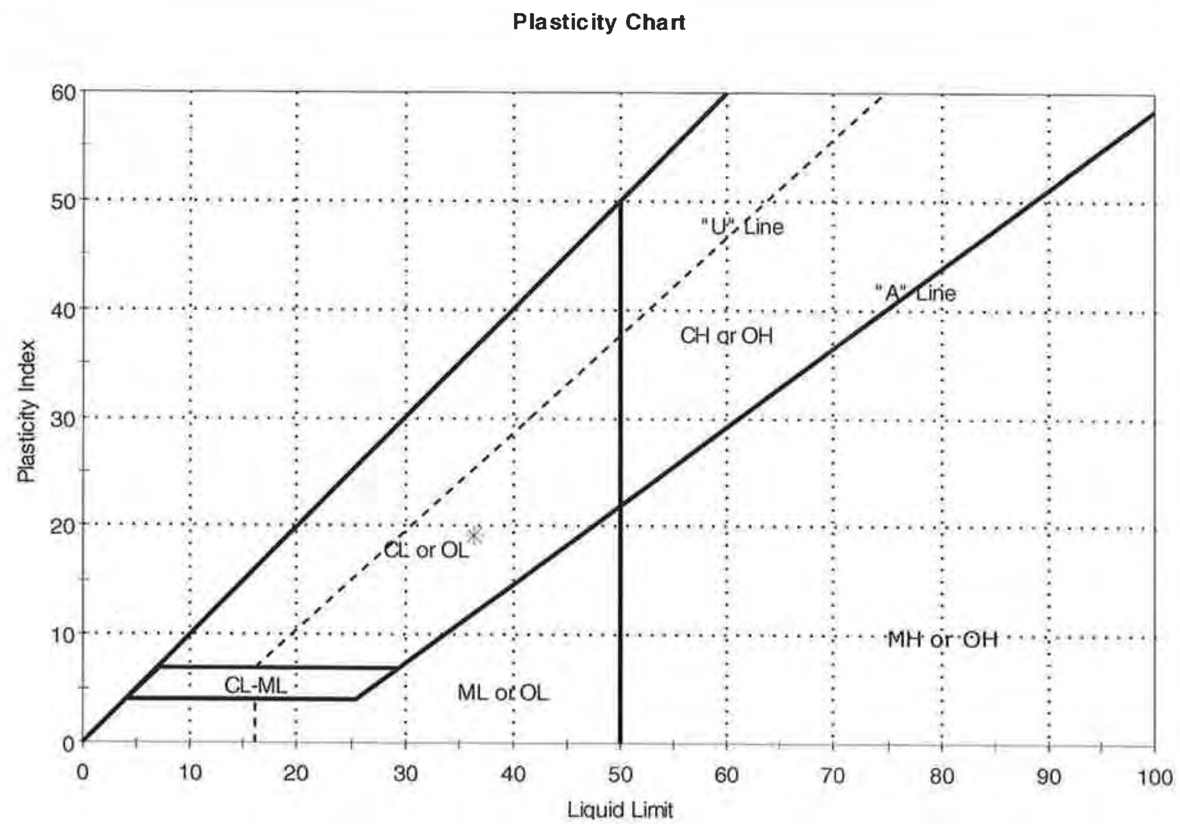
Client: MACTEC, Inc.			
Project: South Buffalo Development			
Location: Buffalo, NY		Project No:	GTX-9611
Boring ID: SB-A3	Sample Type: tube	Tested By:	cam
Sample ID:ST-9	Test Date: 02/03/10	Checked By:	jdt
Depth : 34.0-36.0 ft	Test Id: 172656		
Test Comment: ---			
Sample Description: Moist, brown clay			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	ST-9	SB-A3	34.0-36.0 ft	38	36	17	19	1	lean clay (CL)

Sample Prepared using the WET method
0% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilentancy: SLOW
Toughness: LOW

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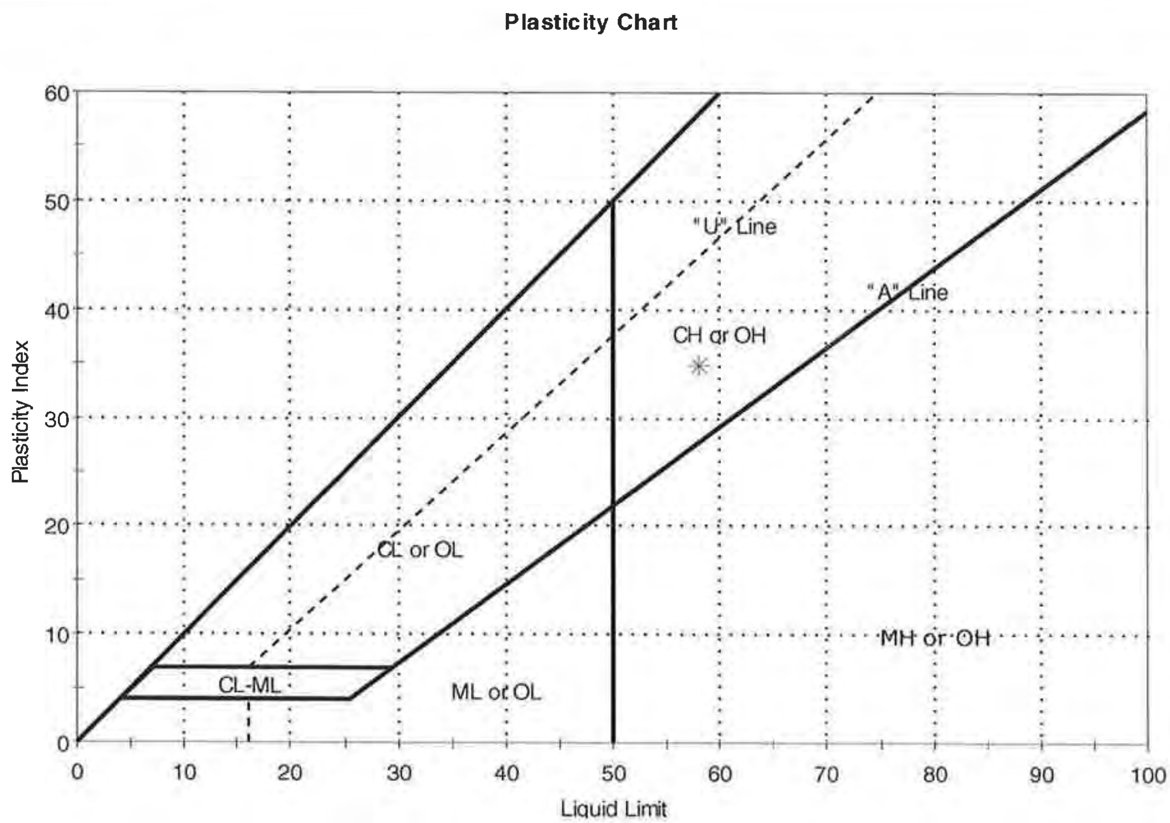
Client: MACTEC, Inc.			
Project: South Buffalo Development			
Location: Buffalo, NY		Project No:	GTX-9611
Boring ID: SB-A4B	Sample Type: tube	Tested By:	cam
Sample ID:ST-9	Test Date: 02/02/10	Checked By:	jdt
Depth : 34.0-36.0 ft	Test Id: 172657		
Test Comment: ---			
Sample Description: Moist, gray clay			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	ST-9	SB-A4B	34.0-36.0 ft	49	58	23	35	1	fat clay (CH)

Sample Prepared using the WET method

0% Retained on #40 Sieve

Dry Strength: VERY HIGH

Dilentancy: SLOW

Toughness: MEDIUM

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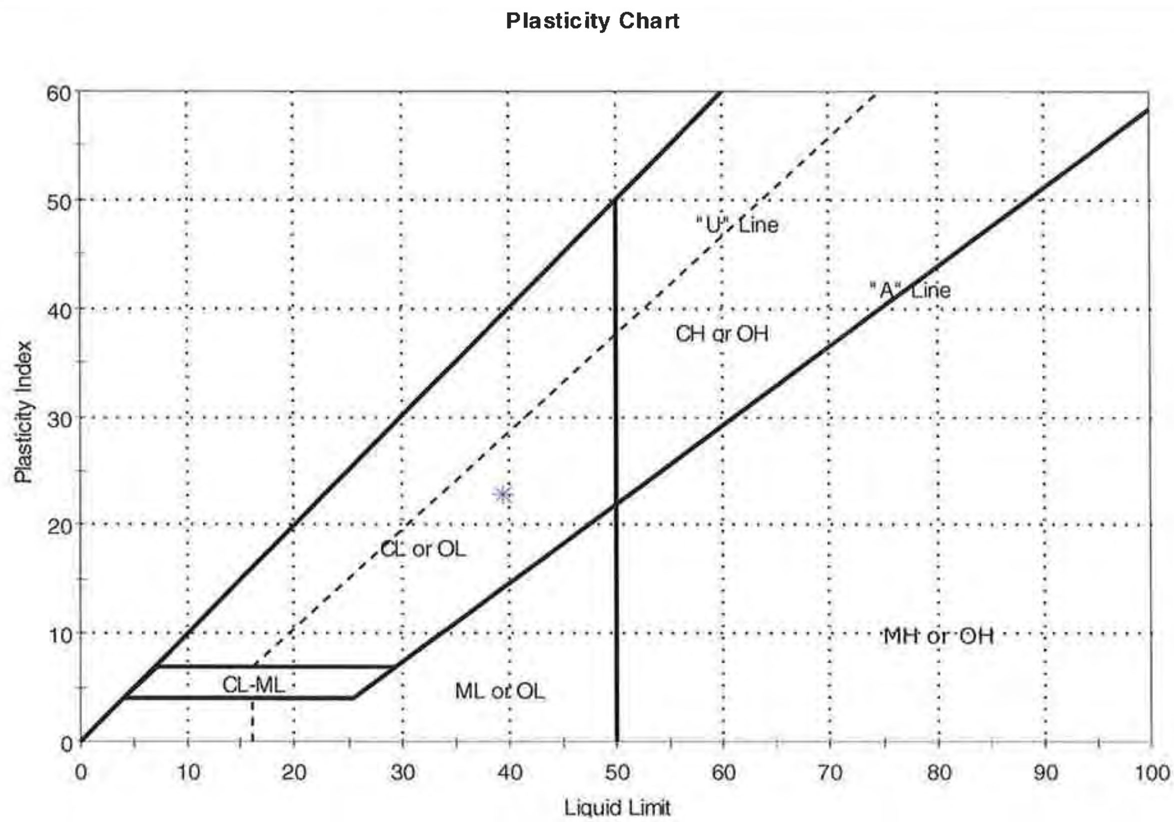
Client: MACTEC, Inc.			
Project: South Buffalo Development			
Location: Buffalo, NY		Project No:	GTX-9611
Boring ID: SB-A5	Sample Type: tube	Tested By:	cam
Sample ID:ST-11	Test Date: 02/03/10	Checked By:	jdt
Depth : 35.0-37.0 ft	Test Id: 172658		
Test Comment: ---			
Sample Description: Moist, gray clay			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	ST-11	SB-A5	35.0-37.0 ft	41	39	17	22	1	lean clay (CL)

Sample Prepared using the WET method

0% Retained on #40 Sieve

Dry Strength: VERY HIGH

Dilentancy: SLOW

Toughness: LOW

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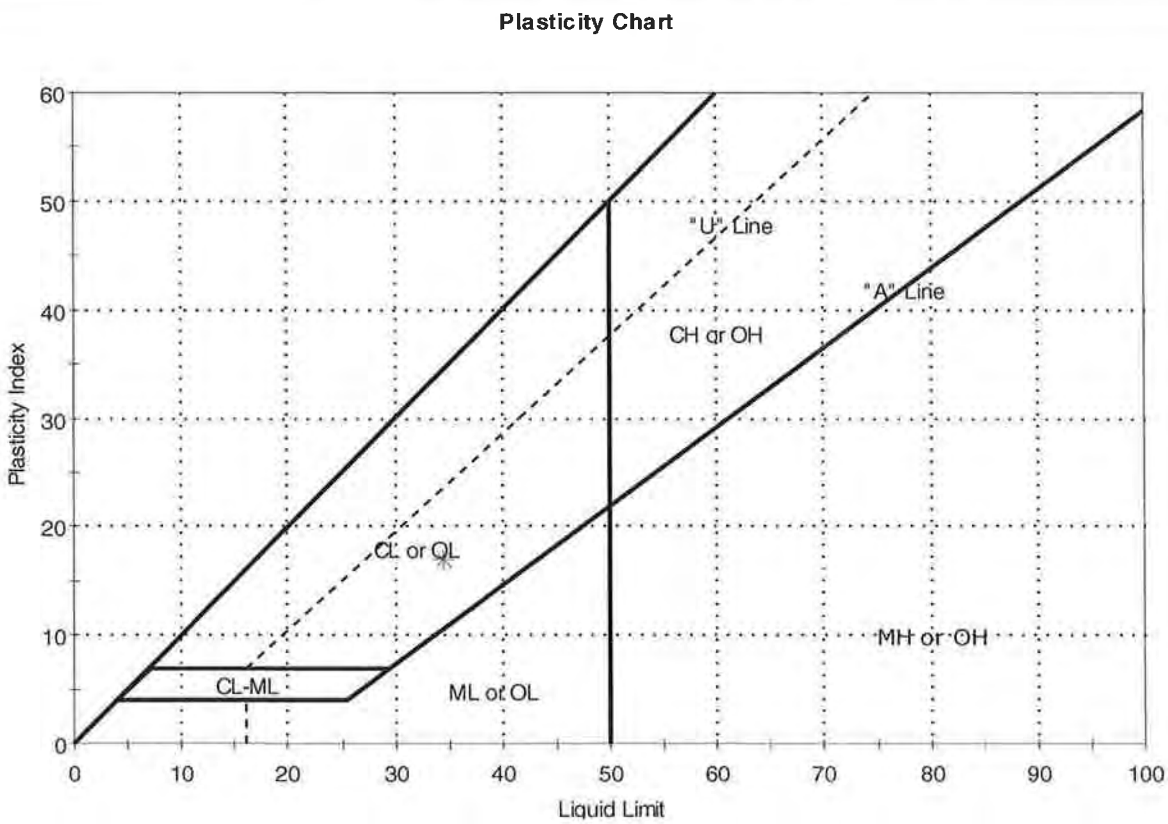
GeoTesting express
a subsidiary of Geocomp Corporation

Client:	MACTEC, Inc.				
Project:	South Buffalo Development				
Location:	Buffalo, NY			Project No:	GTX-9611
Boring ID:	SB-A7	Sample Type:	tube	Tested By:	cam
Sample ID:	ST-10	Test Date:	02/03/10	Checked By:	jdt
Depth :	36.0-38.0 ft	Test Id:	172660		

Test Comment: ---
Sample Description: Moist, reddish brown clay
Sample Comment: ---

Atterberg Limits - ASTM D 4318-05



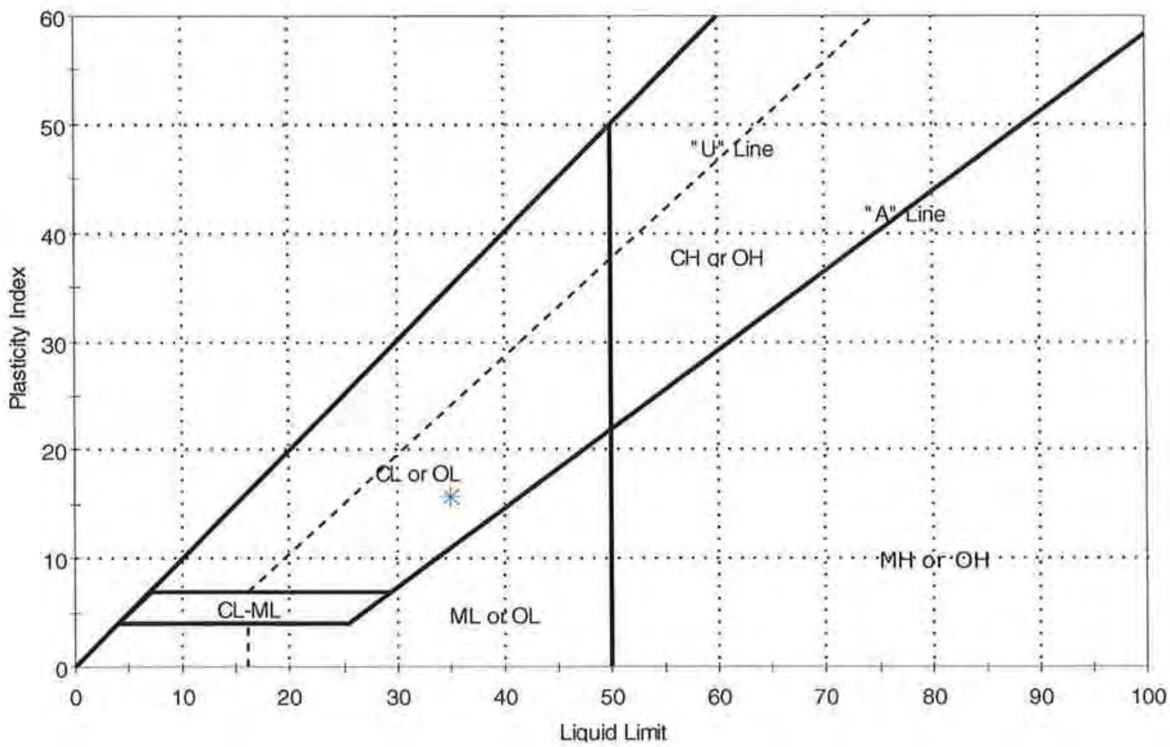
Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	ST-10	SB-A7	36.0-38.0 ft	33	34	18	16	1	lean clay (CL)

Sample Prepared using the WET method
0% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilentancy: SLOW
Toughness: LOW

GeoTesting express
a subsidiary of Geocomp Corporation

Client: MACTEC, Inc.			
Project: South Buffalo Development			
Location: Buffalo, NY		Project No:	GTX-9611
Boring ID: SB-A9H	Sample Type: tube	Tested By:	cam
Sample ID:ST-15	Test Date: 02/04/10	Checked By:	jdt
Depth : 43.0-45.0 ft	Test Id: 172661		
Test Comment: ---			
Sample Description: Moist, brown clay			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	ST-15	SB-A9H	43.0-45.0 ft	32	35	19	16	1	lean clay (CL)

Sample Prepared using the WET method

0% Retained on #40 Sieve

Dry Strength: VERY HIGH

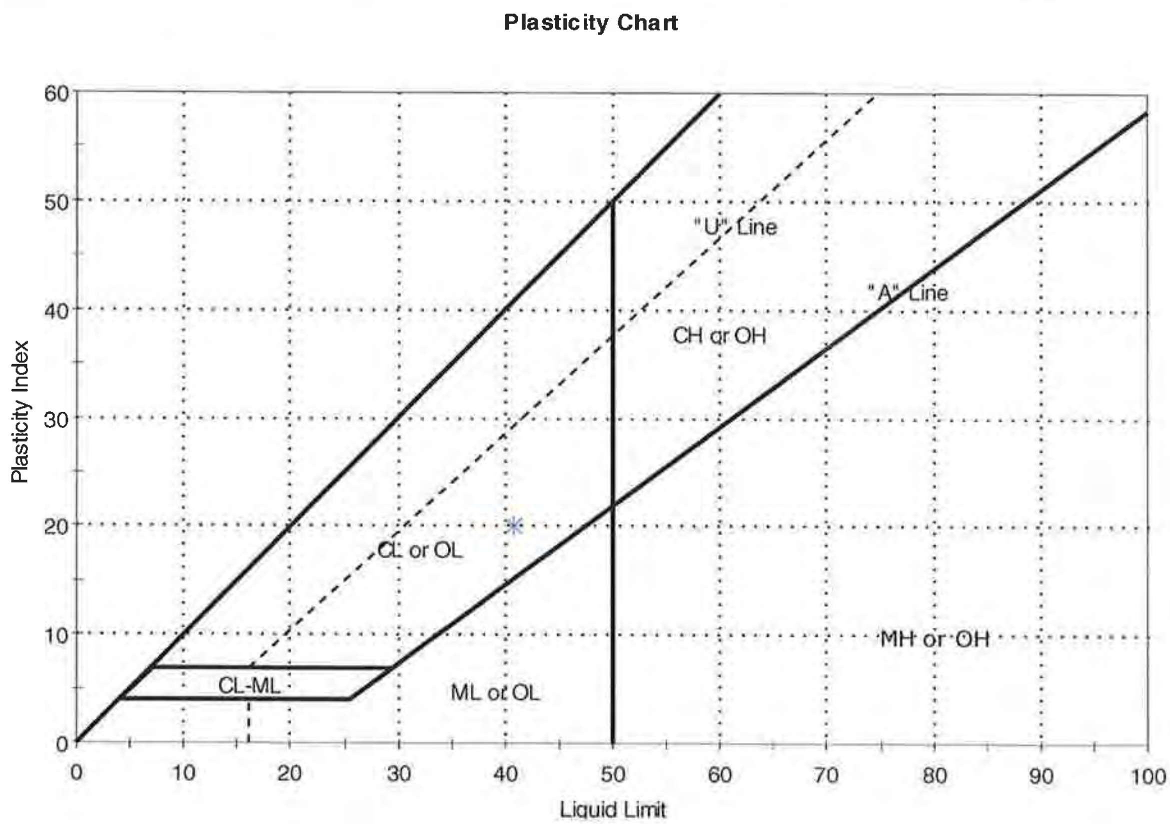
Dilentancy: SLOW

Toughness: LOW

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	MACTEC, Inc.				
Project:	South Buffalo Development				
Location:	Buffalo, NY			Project No:	GTX-9611
Boring ID:	SB-A10G	Sample Type:	tube	Tested By:	cam
Sample ID:	ST-12	Test Date:	02/04/10	Checked By:	jdt
Depth :	40.0-42.0 ft	Test Id:	172662		
Test Comment:	---				
Sample Description:	Moist, brown clay				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	ST-12	SB-A10G	40.0-42.0 ft	40	41	21	20	1	lean clay (CL)

Sample Prepared using the WET method

0% Retained on #40 Sieve

Dry Strength: VERY HIGH

Dilentancy: SLOW

Toughness: LOW

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	MACTEC, Inc.		
Project Name:	South Buffalo Development		
Project Location:	Buffalo, NY		
GTX #:	9611	Tested By:	md
Test Date:	01/29/10	Checked By:	jdt

TUBE LOG using
Density of Soil In Place by the Drive Cylinder Method by ASTM D 2937 and Moisture Content by ASTM D 2216

RSE

Boring ID	Sample ID	Depth, ft	Section	Visual Description	Bulk Density, lb/ft^3	Moisture Content, %	Dry Density, lb/ft^3
S~~A~~B-A6B	ST-9	37-39	Top	Moist, dark gray silty sand and moist very dark brown clay	117	37.8	84.8
S~~A~~B-A6B	ST-9	37-39	Middle-Top	Moist, dark brown clay	120	34.1	89.7
S~~A~~B-A6B	ST-9	37-39	Middle-Bottom	Moist, brown clay	117	31.5	89.2
S~~A~~B-A6B	ST-9	37-39	Bottom	Moist, brown clay	119	33.4	89.0
SB-A3	ST-9	34-36	Top	Moist, brown clay	108	50.4	71.8
SB-A3	ST-9	34-36	Middle-Top	Moist, brown clay	112	41.3	79.1
SB-A3	ST-9	34-36	Middle-Bottom	Moist, brown clay	111	39.6	79.3
SB-A3	ST-9	34-36	Bottom	Moist, brown clay	113	38.1	81.8
SB-A4B	ST-9	34-36	Top	Moist, reddish gray clay and dark gray silt	106	36.9	77.5
SB-A4B	ST-9	34-36	Middle-Top	Moist, gray silty clay	107	44.1	74.3
SB-A4B	ST-9	34-36	Middle-Bottom	Moist, gray clay	109	48.8	73.5
SB-A4B	ST-9	34-36	Bottom	Moist, gray clay	111	43.4	77.4

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	MACTEC, Inc.		
Project Name:	South Buffalo Development		
Project Location:	Buffalo, NY		
GTX #:	9611	Tested By:	md
Test Date:	01/29/10	Checked By:	jdt

TUBE LOG using Density of Soil In Place by the Drive Cylinder Method by ASTM D 2937 and Moisture Content by ASTM D 2216

Boring ID	Sample ID	Depth, ft	Section	Visual Description	Bulk Density, lb/ft^3	Moisture Content, %	Dry Density, lb/ft^3
SB-A5	ST-11	35-37	Top	Moist, gray silty clay	110	49.1	73.5
SB-A5	ST-11	35-37	Middle-Top	Moist, gray clay	111	49.8	73.9
SB-A5	ST-11	35-37	Middle-Bottom	Moist, gray clay	73.5	42.7	51.5
SB-A5	ST-11	35-37	Bottom	Moist, gray clay	110	43.4	76.4
SB-A7	ST-10	36-38	Top	Moist, brown sandy clay	117	34.3	87.2
SB-A7	ST-10	36-38	Middle-Top	Moist, brown clay	116	35.1	85.8
SB-A7	ST-10	36-38	Middle-Bottom	Moist, brown clay	117	38.1	84.5
SB-A7	ST-10	36-38	Bottom	Moist, reddish brown clay	115	33.8	86.3
SB-A9H	ST-15	43-45	Top	Moist, grayish brown clay	114	30.3	87.3
SB-A9H	ST-15	43-45	Middle-Top	Moist, grayish brown clay	117	39.2	83.8
SB-A9H	ST-15	43-45	Middle-Bottom	Moist, brown clay	120	33.6	89.6
SB-A9H	ST-15	43-45	Bottom	Moist, brown clay	117	32.2	88.4

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	MACTEC, Inc.		
Project Name:	South Buffalo Development		
Project Location:	Buffalo, NY		
GTX #:	9611	Tested By:	md
Test Date:	01/29/10	Checked By:	jdt

TUBE LOG using Density of Soil In Place by the Drive Cylinder Method by ASTM D 2937 and Moisture Content by ASTM D 2216

Boring ID	Sample ID	Depth, ft	Section	Visual Description	Bulk Density, lb/ft^3	Moisture Content, %	Dry Density, lb/ft^3
SB-A10G	ST-12	40-42	Top	Moist, brown clay	123	32.4	92.7
SB-A10G	ST-12	40-42	Middle-Top	Moist, brown clay	120	29.9	92.1
SB-A10G	ST-12	40-42	Middle-Bottom	Moist, brown clay	123	30.2	94.1
SB-A10G	ST-12	40-42	Bottom	Moist, brown clay	111	38.8	80.2
SB-A11D	ST-10	37-39	Top	Moist, grayish brown clay	117	34.7	87.0
SB-A11D	ST-10	37-39	Middle-Top	Moist, grayish brown clay	116	34.9	86.1
SB-A11D	ST-10	37-39	Middle-Bottom	Moist, grayish brown clay	115	38.3	83.0
SB-A11D	ST-10	37-39	Bottom	Moist, grayish brown clay	115	35.1	84.7
SB-AA8H	ST-12	40-42	Top	Moist, reddish brown clay	119	31.5	90.2
SB-AA8H	ST-12	40-42	Middle-Top	Moist, reddish brown clay with silt	118	34.9	87.3
SB-AA8H	ST-12	40-42	Middle-Bottom	Moist, reddish brown clay with silt	116	34.4	86.1
SB-AA8H	ST-12	40-42	Bottom	Moist, reddish brown clay	120	34.2	89.4

Notes: Density determined on undisturbed tube sample provided to GeoTesting Express in a Shelby tube
Moisture content determined by ASTM D 2216 at 110° C

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Client:	MACTEC, Inc.
Project Name:	South Buffalo Development
Project Location:	Buffalo, NY
GTX #:	9611
Date:	01/29/10
Tested by:	md
Checked by:	jdt

Laboratory Vane Shear by ASTM D 4648

Boring ID	Sample ID	Depth, ft	Visual Description	Vane Shear Strength, kN/m^2	Vane Shear Strength, tsf
SAB-A6B RSE	ST-9	37-39	Moist, brown clay	31.7	0.33
				27.9	0.29
				28.9	0.30
			Average	29.5	0.31
SB-A3	ST-9	34-36	Moist, brown clay	37.2	0.39
				35.4	0.37
				35.0	0.37
			Average	35.9	0.37
SB-A4B	ST-9	34-36	Moist, gray clay	40.4	0.42
				41.3	0.43
				36.8	0.38
			Average	39.5	0.41
SB-A5	ST-11	35-37	Moist, gray clay	44.0	0.46
				44.4	0.46
				44.4	0.46
			Average	44.3	0.46
SB-A7	ST-10	36-38	Moist, brown clay	28.9	0.30
				28.4	0.30
				28.2	0.29
			Average	28.5	0.30

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Client:	MACTEC, Inc.
Project Name:	South Buffalo Development
Project Location:	Buffalo, NY
GTX #:	9611
Date:	01/29/10
Tested by:	md
Checked by:	jdt

Laboratory Vane Shear by ASTM D 4648

Boring ID	Sample ID	Depth, ft	Visual Description	Vane Shear Strength, kN/m^2	Vane Shear Strength, tsf
SB-A9H	ST-15	43-45	Moist, reddish brown clay	37.2	0.39
				37.2	0.39
				38.1	0.40
			Average	37.5	0.39
SB-A10G	ST-12	40-42	Moist, brown clay	35.9	0.37
				35.0	0.37
				35.4	0.37
			Average	35.4	0.37
SB-A~~1~~8H RSE	ST-12	40-42	Moist, reddish brown clay	39.5	0.41
				38.1	0.40
				38.6	0.40
			Average	38.7	0.40

Comments:

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Client:	MACTEC, Inc.		
Project Name:	South Buffalo Development		
Project Location:	Buffalo, NY		
GTX #:	9611		
Start Date:	1/25/2010	Tested By:	ema
End Date:	1/29/2010	Checked By:	jdt
Boring #:	AB-A6B		
Sample #:	ST-9		
Depth:	37-39 ft.		
Visual Description:	Moist, brown clay		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D 5084
Constant Volume

Sample Type:	tube	Permeant Fluid:	de-aired tap water
Orientation:	Vertical	Cell #:	11/11/11

Sample Preparation: Extruded from tube, cut, trimmed and placed into permeameter at as-received density and moisture content. Trimmings moisture content = 33.9%.

Parameter	Initial	Final
Height, in	2.27	2.21
Diameter, in	2.83	2.79
Area, in^2	6.29	6.11
Volume, in^3	14.3	13.5
Mass, g	455	439
Bulk Density, pcf	121	124
Moisture Content, %	33.5	28.8
Dry Density, pcf	90.7	95.9
Degree of Saturation, %	---	99

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	95.1	Pressure Increment, psi:	4.93
Sample Pressure, psi:	80.4	B Coefficient:	0.88

*B value did not increase with increase in pressure. Final degree of saturation value listed above indicates adequate saturation of test specimen.

FLOW DATA

Date	Trial #	Pressure, psi		Manometer Readings			Elapsed Time, sec	Gradient	Permeability K, cm/sec	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
		Cell	Sample	Z_1	Z_2	Z_1-Z_2						
01/28	2	90.0	75.7	11.0	10.8	0.2	224	24.7	2.9E-08	20	1.000	2.9E-08
01/28	3	90.0	75.7	11.0	10.8	0.2	254	24.7	2.6E-08	20	1.000	2.6E-08
01/28	4	90.0	75.7	11.0	10.8	0.2	278	24.7	2.3E-08	20	1.000	2.3E-08
01/28	5	90.0	75.7	11.0	10.8	0.2	282	24.7	2.3E-08	20	1.000	2.3E-08

PERMEABILITY AT 20° C: 2.5×10^{-8} cm/sec (@ 14.3 psi effective stress)

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	MACTEC, Inc.		
Project Name:	South Buffalo Development		
Project Location:	Buffalo, NY		
GTX #:	9611		
Start Date:	1/25/2010	Tested By:	ema
End Date:	2/1/2010	Checked By:	jdt
Boring #:	SB-A3		
Sample #:	ST-9		
Depth:	34-36 ft.		
Visual Description:	Moist, brown clay		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D 5084
Constant Volume

Sample Type:	tube	Permeant Fluid:	de-aired tap water
Orientation:	Vertical	Cell #:	16

Sample Preparation: Extruded from tube, cut, trimmed and placed into permeameter at as-received density and moisture content. Trimmings moisture content = 53.8%.

Parameter	Initial	Final
Height, in	2.41	2.36
Diameter, in	2.83	2.83
Area, in^2	6.29	6.29
Volume, in^3	15.2	14.8
Mass, g	460	445
Bulk Density, pcf	115	114
Moisture Content, %	45.0	40.3
Dry Density, pcf	79.6	81.2
Degree of Saturation, %	---	99

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	95.1	Pressure Increment, psi:	5.04
Sample Pressure, psi:	83.1	B Coefficient:	0.99

FLOW DATA

Date	Trial #	Pressure, psi		Manometer Readings			Elapsed Time, sec	Gradient	Permeability K, cm/sec	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
		Cell	Sample	Z_1	Z_2	Z_1-Z_2						
01/29	2	90.0	77.3	12.0	11.5	0.5	141	25.2	1.1E-07	20	1.000	1.1E-07
01/29	3	90.0	77.3	12.0	11.5	0.5	148	25.2	1.1E-07	20	1.000	1.1E-07
01/29	4	90.0	77.3	12.0	11.5	0.5	149	25.2	1.1E-07	20	1.000	1.1E-07
01/29	5	90.0	77.3	12.0	11.5	0.5	150	25.2	1.0E-07	20	1.000	1.0E-07

PERMEABILITY AT 20° C: 1.1 x 10^{-7} cm/sec (@ 12.7 psi effective stress)

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	MACTEC, Inc.		
Project Name:	South Buffalo Development		
Project Location:	Buffalo, NY		
GTX #:	9611		
Start Date:	1/25/2010	Tested By:	ema
End Date:	1/29/2010	Checked By:	jdt
Boring #:	SB-A7		
Sample #:	ST-10		
Depth:	37-38 ft.		
Visual Description:	Moist, reddish brown clay		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D 5084
Constant Volume

Sample Type:	tube	Permeant Fluid:	de-aired tap water
Orientation:	Vertical	Cell #:	13/13/12

Sample Preparation: Extruded from tube, cut, trimmed and placed into permeameter at as-received density and moisture content. Trimmings moisture content = 41.3%.

Parameter	Initial	Final
Height, in	2.22	2.19
Diameter, in	2.82	2.82
Area, in^2	6.25	6.25
Volume, in^3	13.9	13.7
Mass, g	439	427
Bulk Density, pcf	120	119
Moisture Content, %	37.6	33.8
Dry Density, pcf	87.5	88.7
Degree of Saturation, %	---	99

B COEFFICIENT DETERMINATION

Cell Pressure, psi:	94.9	Pressure Increment, psi:	5.00
Sample Pressure, psi:	80.7	B Coefficient:	0.87

*B value did not increase with increase in pressure. Final degree of saturation value listed above indicates adequate saturation of test specimen.

FLOW DATA

Date	Trial #	Pressure, psi		Manometer Readings			Elapsed Time, sec	Gradient	Permeability K, cm/sec	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
		Cell	Sample	Z_1	Z_2	Z_1-Z_2						
01/28	1	90.0	75.7	11.0	10.8	0.2	242	24.9	2.6E-08	20	1.000	2.6E-08
01/28	2	90.0	75.7	11.0	10.8	0.2	282	24.9	2.2E-08	20	1.000	2.2E-08
01/28	3	90.0	75.7	11.0	10.8	0.2	297	24.9	2.1E-08	20	1.000	2.1E-08
01/28	4	90.0	75.7	11.0	10.8	0.2	300	24.9	2.1E-08	20	1.000	2.1E-08

PERMEABILITY AT 20° C: 2.3×10^{-8} cm/sec (@ 14.3 psi effective stress)

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	MACTEC, Inc.		
Project Name:	South Buffalo Development		
Project Location:	Buffalo, NY		
GTX #:	9611		
Start Date:	1/25/2010	Tested By:	ema
End Date:	1/29/2010	Checked By:	jdt
Boring #:	SB-A94	Test #:	k
Sample #:	ST-15		
Depth:	43-45 ft.		
Visual Description:	Moist, brown clay		

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D 5084

Constant Volume

Sample Type: tube
Permeant Fluid: de-aired tap water
Orientation: Vertical
Cell #: 12/12/13

Sample Preparation: Extruded from tube, cut, trimmed and placed into permeameter at as-received density and moisture content. Trimmings moisture content = 32.1%.

Parameter	Initial	Final
Height, in	2.25	2.23
Diameter, in	2.84	2.83
Area, in^2	6.33	6.29
Volume, in^3	14.3	14.0
Mass, g	464	450
Bulk Density, pcf	124	122
Moisture Content, %	33.2	29.2
Dry Density, pcf	92.9	94.4
Degree of Saturation, %	---	98

B COEFFICIENT DETERMINATION

Cell Pressure, psi: 95.1
Sample Pressure, psi: 79.5
Pressure Increment, psi: 5.04
B Coefficient: 0.93

*B value did not increase with increase in pressure. Final degree of saturation value listed above indicates adequate saturation of test specimen.

FLOW DATA

Date	Trial #	Pressure, psi		Manometer Readings			Elapsed Time, sec	Gradient	Permeability K, cm/sec	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
		Cell	Sample	Z_1	Z_2	Z_1-Z_2						
01/28	2	90.0	74.1	11.0	10.8	0.2	116	24.5	5.5E-08	20	1.000	5.5E-08
01/28	3	90.0	74.1	11.0	10.8	0.2	132	24.5	4.8E-08	20	1.000	4.8E-08
01/28	4	90.0	74.1	11.0	10.8	0.2	140	24.5	4.6E-08	20	1.000	4.6E-08
01/28	5	90.0	74.1	11.0	10.8	0.2	147	24.5	4.3E-08	20	1.000	4.3E-08

PERMEABILITY AT 20° C: 4.8×10^{-8} cm/sec (@ 15.9 psi effective stress)

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	MACTEC, Inc.
Project Name:	South Buffalo Development
Project Location:	Buffalo, NY
GTX #:	9611
Start Date:	1/25/2010	Tested By:	ema
End Date:	1/29/2010	Checked By:	jdt
Boring #:	SB-A10G
Sample #:	ST-12
Depth:	40-42 ft.
Visual Description:	Moist, brown clay

Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter by ASTM D 5084
Constant Volume

Sample Type: tube
Orientation: Vertical
Permeant Fluid: de-aired tap water
Cell #: 3/9

Sample Preparation: Extruded from tube, cut, trimmed and placed into permeameter at as-received density and moisture content. Trimmings moisture content = 39.7%.

Parameter	Initial	Final
Height, in	2.29	2.22
Diameter, in	2.80	2.76
Area, in^2	6.16	5.98
Volume, in^3	14.1	13.3
Mass, g	455	428
Bulk Density, pcf	123	123
Moisture Content, %	37.3	29.2
Dry Density, pcf	89.3	94.8
Degree of Saturation, %	---	99

B COEFFICIENT DETERMINATION

Cell Pressure, psi: 95.2
Sample Pressure, psi: 80.3
Pressure Increment, psi: 5.03
B Coefficient: 0.91
*B value did not increase with increase in pressure. Final degree of saturation value listed above indicates adequate saturation of test specimen.

FLOW DATA

Date	Trial #	Pressure, psi Cell	Pressure, psi Sample	Manometer Readings Z_1	Manometer Readings Z_2	Manometer Readings Z_1-Z_2	Elapsed Time, sec	Gradient	Permeability K, cm/sec	Temp, °C	R_t	Permeability K @ 20 °C, cm/sec
01/28	2	90.0	74.8	11.0	10.8	0.2	248	24.6	2.7E-08	20	1.000	2.7E-08
01/28	3	90.0	74.8	11.0	10.8	0.2	273	24.6	2.4E-08	20	1.000	2.4E-08
01/28	4	90.0	74.8	11.0	10.8	0.2	273	24.6	2.4E-08	20	1.000	2.4E-08
01/28	5	90.0	74.8	11.0	10.8	0.2	285	24.6	2.3E-08	20	1.000	2.3E-08

PERMEABILITY AT 20° C: 2.5×10^{-8} cm/sec (@ 15.2 psi effective stress)

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	MACTEC, Inc.
Project Name:	South Buffalo Development
Project Location:	Buffalo, NY
GTX #:	9611
Boring ID:	AB-A6B
Sample ID:	ST-9
Depth, ft:	37.0-39.0

Top of Tube

Top-Middle of Tube

Bottom-Middle of Tube

Bottom of Tube

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	MACTEC, Inc.
Project Name:	South Buffalo Development
Project Location:	Buffalo, NY
GTX #:	9611
Boring ID:	SB-A3
Sample ID:	ST-9
Depth, ft:	34.0-36.0

Top of Tube

Middle of Tube

Bottom of Tube

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	MACTEC, Inc.
Project Name:	South Buffalo Development
Project Location:	Buffalo, NY
GTX #:	9611
Boring ID:	SB-A4B
Sample ID:	ST-9
Depth, ft:	34.0-36.0

Top of Tube

Top-Middle of Tube

Middle of Tube

Bottom-Middle of Tube

Bottom of Tube

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	MACTEC, Inc.
Project Name:	South Buffalo Development
Project Location:	Buffalo, NY
GTX #:	9611
Boring ID:	SB-A5
Sample ID:	ST-11
Depth, ft:	35.0-37.0

Top of Tube

Top-Middle of Tube

Middle of Tube

Bottom-Middle of Tube

Bottom of Tube

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	MACTEC, Inc.
Project Name:	South Buffalo Development
Project Location:	Buffalo, NY
GTX #:	9611
Boring ID:	SB-A7
Sample ID:	ST-10
Depth, ft:	36.0-38.0

Top of Tube

Top-Middle of Tube


Middle of Tube

Bottom-Middle of Tube

Bottom of Tube

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	MACTEC, Inc.
Project Name:	South Buffalo Development
Project Location:	Buffalo, NY
GTX #:	9611
Boring ID:	SB-A9H
Sample ID:	ST-15
Depth, ft:	43.0-45.0

Top of Tube

Top-Middle of Tube

Middle of Tube

Bottom-Middle of Tube

Bottom of Tube

Client:	MACTEC, Inc.
Project Name:	South Buffalo Development
Project Location:	Buffalo, NY
GTX #:	9611
Boring ID:	SB-A10G
Sample ID:	ST-12
Depth, ft:	40.0-42.0

Top of Tube

Top-Middle of Tube

Middle of Tube

Bottom-Middle of Tube

Bottom of Tube

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	MACTEC, Inc.
Project Name:	South Buffalo Development
Project Location:	Buffalo, NY
GTX #:	9611
Boring ID:	SB-A11D
Sample ID:	ST-10
Depth, ft:	37.0-39.0

Top of Tube

Top-Middle of Tube

Middle of Tube

Bottom-Middle of Tube

Bottom of Tube

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	MACTEC, Inc.
Project Name:	South Buffalo Development
Project Location:	Buffalo, NY
GTX #:	9611
Boring ID:	SB-AA8H
Sample ID:	ST-12
Depth, ft:	40.0-42.0

Top of Tube

Top-Middle of Tube

Middle of Tube

Bottom-Middle of Tube

Bottom of Tube

APPENDIX F

DRAFT GROUNDWATER MODELING REPORT

To: Lyle Tracy, John Scrabis
From: Ron Lewis
Date: March 24, 2011
Subject: Preliminary modeling to support design of a barrier wall at Area A of the Buffalo Color Site, Buffalo, NY

1.0 Introduction

A barrier wall is to be designed and installed to supplement the current groundwater extraction system at Area A of the former Buffalo Color Corporation Site (Site) in Buffalo, New York. This former chemicals and dye-stuffs manufacturing facility, situated adjacent to the Buffalo River, incurred accidental releases of chemicals to soils and groundwater at the Site. Groundwater and dissolved constituents migrated toward and discharged to the river. An interim remedial action consisting of five extraction wells (EW-1 through EW-5) was installed beginning in May 2006 and went on line in October 2006. Shortly after start-up, geochemical conditions from differing wells resulted in precipitation within and plugging of transfer lines. The problem was analyzed over time and piping eventually replaced. EW-1, with no significant precipitation problems, has operated since April 2007, while the remainder of the system came back on line in December 2007. Although Site water balances and groundwater modeling indicated that plume capture was complete, thus preventing release of Area A groundwater to the river, the relatively high hydraulic conductivity of the alluvial aquifer prevented accurate enough determinations of groundwater flow directions to verify this capture using actual monitoring well and piezometer water level data. In addition, it appeared that the extraction wells could be drawing back flow from the river, unnecessarily increasing flow rates and power and treatment costs. An alternative and supplemental solution is the installation of a barrier wall that will aid in preventing any discharge to the river as well as decreasing the superfluous flow induced from the river, especially during periods of elevated river stage. Monitoring of the system would then be simplified as only piezometers paired on up- and down-gradient sides of the wall should allow the determination of inward hydraulic gradients along the wall and contaminated groundwater capture.

In preparation for barrier wall design, a series of borings and test pits was completed along the south (bordering Area E), east (bordering the river), and north, along South Park Avenue, limits of Area A. These explorations provided additional information on the depth to the glaciolacustrine clay into which the wall would be keyed, and of potential subsurface obstructions that would have to be accounted for in the design and wall alignment.

2.0 Purpose

The purpose of this modeling is to assist in the design of the barrier wall and provide estimate of needed extraction well flow rates to maintain control of Area A groundwater. The model, with reasonable but conservative input parameter values, is used to investigate potential differing alignments of the barrier wall, lengths of potential wing walls at either end of the barrier along the river's edge, effects of changing environmental conditions on necessary flow rates to maintain capture (e.g., river stage elevation or net recharge to the aquifer), and specifications for the wall thickness and effective hydraulic conductivity.

3.0 Model Description

The groundwater flow model for Area A was originally prepared by Parsons Engineering in 1999. The model has a single layer, and focuses mainly on the alluvial aquifer through which nearly all Site groundwater flow occurs. The base of the model is the top of the glaciolacustrine clay which has extremely low hydraulic conductivity. The alluvial aquifer extends back varying distances from the river and transitions into a native clayey, silty upper till of very low hydraulic conductivity. Fill of relatively low hydraulic conductivity overlies the alluvium and the upper till over the entire site. The domain of the model, which includes Area A, and portions of the PVS Chemical facility to the north and of Area E to the south, is shown on Figure 1.

In 2005, MACTEC slightly modified the Parsons model based on review of similar area modeling performed by Golder Associates in 2000 and in response to suggestions by NYSDEC. As a result, upgradient contributions of flow through Area A are modeled as a general head boundary (see Figure 1), recharge is uniformly distributed over the area as a conservative measure (no reduced recharge due to prior buildings or pavement), and two zones of hydraulic conductivity (K) were included in the model (see Figure 2). All flow into the model is assumed to discharge to the Buffalo River (represented as a constant head boundary, see Figure 1) unless intercepted by a remedial measure. The existing extraction well system is shown as the five red squares along the river in Figure 1.

The base of the model (top of glaciolacustrine clay) was slightly revised using the information provided by the series of borings along the proposed potential alignment of the barrier wall (see Figure 3). The model was then recalibrated to available water level data using the parameter estimation software PEST (Doherty, 2004) and to within ranges of hydrogeologic parameters determined in investigations conducted at the site. The resultant recharge distribution is shown on Figure 4. The results of the model calibration residuals analysis are presented on Table 1. Model computed heads and posted residuals are shown on Figure 5. Key model input parameter values for the base calibrated model are shown as Run 101 on Table 2.

The model is steady-state, so the model should capture potential extreme (long-term) effects of what may be only temporary variations in recharge rate or river stage elevation examined through sensitivity analysis. The flow model is constructed using MODFLOW running under the groundwater modeling pre- and post-processor platform Groundwater Vistas. Particle tracking to illustrate groundwater flow patterns and capture zones was conducted with MODPATH using forward tracking and the conservative option for particles passing through cells with weak sinks. Model boundary conditions and calibrated model input parameter values and distributions are shown on Figures 1 through 4.

4.0 Model Use

The model provides estimated responses of the hydrogeologic system as a function of varying environmental conditions and the barrier wall design (length, width, effective K, and lengths of wing walls). The intent is to demonstrate complete containment of contaminated groundwater within the extent of the barrier wall and to determine what flow rates of the extraction well system might be needed to establish this control over a variety of conditions. The modeling thereby supports the barrier wall design decisions.

The base simulation model then considers: placement of the wall along the river with 50- and 100-foot wing wall lengths, with a 3-foot wide wall having an effective K of 1xe-6 centimeters per second (cm/sec) (0.00283 feet per day [ft/d]), and some subset of the existing extraction wells in operation. The model then takes this base run with barrier and wing walls and investigates what extraction wells and flow rates would be necessary to maintain control under the following conditions for sensitivity runs:

- Increase and decrease aquifer K by 50 percent.
- Increase and decrease recharge by minus 20 percent and plus 60 percent.
- Increase the effective barrier wall K to 1xe-5 cm/sec and then again to 1xe-4 cm/sec
- Increase and decrease river stage elevation by 2.5 feet (a total range of 5 feet)

Note that at a reasonably achievable effective barrier wall K of 1xe-6 cm/sec, the estimated flow through the entire wall with a one-half foot head differential is on the order of only 0.05 gallons per minute (gpm) (see calculation in Attachment 2). Sensitivity to lower effective barrier wall K is not necessary.

A secondary simulation considers an alternate alignment of the barrier wall in the vicinity of Building 75 in the northeast corner of Area A. Here, final disposition of the building and its surroundings have yet to be determined. Hence the modeling investigates an alternate alignment that would jog around the building rather than include it. In this alignment, EW-5 may be lost, but also may not be needed to maintain Area A groundwater control.

5.0 Model Run Outputs

Summary base model and simulation run identifications are summarized in Attachment 1. Selected outputs are included as figures and referenced in the following discussions.

5.1 Base Calibrated Flow Model

The base calibrated flow model with no barrier wall with particle tracks is shown on Figure 6, with each extraction well pumping at 2.25 gpm each (total of 11.25 gpm). At these rates, the model suggests complete capture of all upgradient (to the line of extraction wells) groundwater, and minimal (about 0.5 gpm) drawback from the river. These rates could vary slightly from well to well, and would vary depending on seasonal variations in recharge rate and stage of the river. These conditions are examined in the simulations below, but under conditions of a slurry wall added to the extraction well remedial measure.

5.2 Simulations

Simulations were performed with an approximately 750-foot length of 3-foot wide 1e-6 cm/sec (0.00283 ft/d) barrier wall adjacent to the river. Figure 7 shows the effect of the barrier wall with no wing walls and no pumping on groundwater flow. Successive figures show pumping added with 0 (Figure 8), 50 (Figure 9), and 100-foot (Figure 10) long wing walls at the north and south ends of the barrier (perpendicular to the river). In these simulations, the barrier wall enclosed Building 75. In another simulation, the barrier wall alignment jogged around Building 75 leaving it on the downgradient side of the barrier (Figure 11). Such an alignment may be necessary due to access and subsurface obstructions and the final disposition of the building. Simulations were also made with the two wall alignments to estimate required pumping rates needed to establish 0.5 (Figure 12) and 1.0 foot inward head differentials across the barrier wall. Simulation conditions are summarized on Table 2 and discussed in the following paragraphs.

In simulations with the base barrier wall alignment (enclosing Building 75) and 100-foot wing walls, capture could be maintained with 9 gpm and pumping at existing extraction wells EW-2 and EW-4 (see Figure 10). No significant seepage could occur under normal (average) operating conditions. Adjustments to pumping rates might be necessary under more extreme conditions, e.g, unusually wet weather and groundwater recharge. Head differentials across the wall were generally inward, but quite minor at the 9 gpm combined rate. Increased pumping of about 13 to 14 gpm and distributed across all five extraction wells produced an inward head differential of 0.5 feet along the barrier wall. This could be increased to about 1 foot with an increase in pumping rate to about 19 gpm.

The alternate alignment scenario, excluding Building 75, also included a wing wall of about 100 feet up South Park Avenue, which, due to the jog in the wall, extended further from the river than the southern wing wall (see Figure 11). Under a combined pumping rate of 9 gpm at EW-2 and EW-4, all particles upgradient of the extraction well line were captured, but with relatively minor inward head differentials. Upping the extraction well rate to about 14 gpm over wells EW-1 through EW-4 provided an inward head differential of 0.5 feet or better along the wall. Since the capture area is less than with the wall on the river side of Building 75, and the north wing wall further in land, the capture efficiency of this alignment is slightly better than with the base alignment. Increasing combined pumping rates to about 16 gpm across EW-1 through EW-4 created an inward head differential of about 1 foot or better along the re-aligned wall.

5.3 Sensitivity Analyses

Sensitivity runs were made to evaluate potential effects of varying boundary and hydrogeological conditions. The needed variation in pumping rate or wall specification to maintain capture of contaminated groundwater upgradient of the proposed barrier wall under these alternate conditions was determined in a series of model runs. The principal sensitivity parameters considered were the aquifer hydraulic conductivity, hydraulic conductivity of the barrier wall, recharge rate, and stage elevation of the Buffalo River. Sensitivity conditions are summarized on Table 2 and discussed in the following paragraphs. The base model with barrier wall and 100-foot wing walls and an estimated 9 gpm pumping rate to maintain capture is taken as the reference scenario for sensitivity run comparisons. Similar results would be expected for the alternate barrier wall alignment. Except for a few instances, the final depictions of capture under the varying conditions were nearly identical, only the pumping rates changed. Figures for these similar runs are not included, but effects on pumping rates are summarized on Table 2.

Aquifer Hydraulic Conductivity: The model was only slightly sensitive to variation (plus/minus 50 percent) in the aquifer hydraulic conductivity with respect to pumping rate. The effects of variations in hydraulic conductivity are mainly manifest in the drawdown at wells and heads achievable along the interior side of the barrier wall. In each extreme of hydraulic conductivity examined, capture was achieved with no significant loss through the wall, even if a slight outward gradient was present at some locations along the wall.

Barrier wall Hydraulic Conductivity: The model estimated pumping rate was relatively insensitive to hydraulic conductivity of the barrier wall when lower than 1e-5 cm/sec. Even at a 1:3 gradient everywhere across the barrier wall, leakage through the wall would be on the order of 0.09 gpm at 1e-6 cm/sec, 0.9 gpm at 1e-5 cm/sec, and 9 gpm at 1e-4 cm/sec. Varying pumping rates and the distribution of pumping centers along the wall would reduce this further.

Recharge Rates: Recharge rates were varied plus 60 percent and minus 20 percent across the model. These changes in recharge rate were also reflected in changes in GHB reference head in order to approximate the recharge into the model over the estimated entire recharge area contributing flow to groundwater moving through Area A to the river. The total estimated recharge area is believed to extend roughly to the railroad tracks adjacent to the northwest boundary of Area A. Required pumping to maintain capture ranged from about 8 to 15.4 gpm relative to the 9 gpm estimate of the base barrier wall model.

Buffalo River Stage Elevation: When the constant head representing the Buffalo River was decreased by 2.5 feet in the model, pumping rates at EW-2 and EW-4 needed to be increased to 7 and 6 gpm, respectively, thus increasing the total expected pumping by 4 gpm over base model rates. Increasing the constant head value by 2.5 feet had little effect over the base model and still required a total of 9 gpm to maintain capture.

Figure 13 shows a worst-case scenario with high wall hydraulic conductivity, high recharge and low river stage elevation (model Run 116, see Attachment 1).

6.0 Conclusions

- An equivalent barrier wall thickness of 3 feet and an effective hydraulic conductivity of 1e-6 cm/sec would appear to provide an effective barrier to groundwater flow an provide for minimal seepage rates under most anticipated environmental conditions.
- Adequate capture of contaminated groundwater may be achieved with small inward head differentials and pumping at existing extraction wells EW-2 and EW-4 at a combined rate of about 9 gpm under average expected conditions.
- If increased inward head differentials are desired, e.g., 0.5 or 1.0 feet, higher pumping rates on the order of 14 to 19 gpm may be required, and all five existing wells pumped to distribute the drawdown more evenly along the barrier wall.
- Wing wall lengths of 100 feet would appear to be adequate at the north and south ends of the length along the river to aid in preventing flow around the ends of the wall and shielding against extreme environmental conditions that might weaken capture efficiency.
- An alternate wall alignment around Building 75 at the north end of the wall changes needed operating conditions very little over the base alignment. The alternate alignment encloses a smaller area and, with a wing wall that extends further away from the river than in the base case, may be slightly more effective.

- Required pumping rates with a tight wall are largely determined by the recharge to the shallow aquifer on Area A. Since the Buffalo River snakes sharply around Area E, the recharge area to Area A is interpreted as relatively small, extending only slightly west of Area A onto the Conrail property.

- The alternate barrier wall alignment may require decommissioning of EW-5. This well may not be needed in maintaining capture within the smaller containment area.

7.0 Recommendations

The results of the modeling suggest the following design features:

- An equivalent to a 3-foot thick barrier wall with an effective hydraulic conductivity of 1e-6 cm/sec or less.

- Wingwalls of approximate 100-foot length at both ends.

- Operation under normal conditions of EW-2 and EW-4 of about 9-10 gpm combined pumping.

- Retention of other extraction wells to be used in emergency or extreme environmental conditions, or to maintain a more uniform gradient across the wall along its length.

- Maintenance of an inward head differential. A minimal head differential is sufficient, but a 0.5-foot head differential is a reasonable target.

- The system may be monitored by pairs of piezometers placed opposite each other on opposing sides of the barrier.

- As the wall alignment has little significant effect on pumping rates, access and installation cost considerations may dictate a choice of alignment in the vicinity of Building 75.

8.0 Limitations of the Modeling

The model assumes relatively homogeneous conditions within the aquifer and that the proposed barrier wall system can be installed with no hydraulic gaps or windows. Subsurface conditions at such a developed site with multiple utilities running through it may provide some preferential pathways for groundwater flow including flow back from the river. The model incorporates conservative input parameter values and boundary conditions. With these and the sensitivity analysis, it is believed that the model should adequately represent expected groundwater behavior barring the presence of unknown preferential pathways. The barrier wall should cut off these pathways if installed in a continuous manner.

TABLES

TABLE 1
Point-Wise Statistics
For Calibrated Model

Name	Layer	Observed	Computed	Residual
RFI-22	1	573.33	573.39	-0.06
RFI-24	1	573.63	573.43	0.20
RFI-25	1	573.44	573.43	0.01
RFI-26	1	573.48	573.88	-0.40
RFI-34	1	573.68	573.65	0.03
W6-R-R	1	574.35	574.25	0.10
RFI-38	1	573.54	573.43	0.11

Residual Mean	0.00
Res. Std. Dev.	0.18
Sum of Squares	0.22
Abs. Res. Mean	0.13
Min. Residual	-0.40
Max. Residual	0.20
Range in Target Values	1.02
Std. Dev./Range	0.174

TABLE 2
Summary of Simulation Run
Input Parameters

Model Run	K1 ft/d	K2 ft/d	Rech 1 in/yr	Rech 2 in/yr	River stage ft msl	K wall cm/sec	Wing wall ft	Pumping gpm	Wells	Comment
101	70	43.4	10	7.25	573.32	1.00E-06	0	0	None	Calibration mode, no wall
102	70	43.4	10	7.25	573.32	1.00E-06	0	0	None	Wall, no wings, no pumping
103	70	43.4	10	7.25	573.32	1.00E-06	0	11	EW-2, EW-4	
104	70	43.4	10	7.25	573.32	1.00E-06	50	9	EW-2, EW-4	
105	70	43.4	10	7.25	573.32	1.00E-06	100	9	EW-2, EW-4	
106	70	43.4	16	11.4	573.32	1.00E-06	100	15.4	EW-2, EW-4	
107	105	65.1	10	7.25	573.32	1.00E-06	100	9	EW-2, EW-4	
108	70	43.4	10	7.25	573.32	1.00E-05	100	12	All	
109	70	43.4	10	7.25	573.32	1.00E-04	100	15	All	
110	70	43.4	10	7.25	570.82	1.00E-06	100	13	EW-2, EW-4	
111	70	43.4	10	7.25	575.82	1.00E-06	100	9	EW-2, EW-4	
112	35	21.7	10	7.25	573.32	1.00E-06	100	9	EW-2, EW-4	
113	70	43.4	8	5.8	573.32	1.00E-06	100	8	EW-2, EW-4	
114	70	43.4	10	7.25	573.32	1.00E-06	100	15	All	To obtain 0.5-ft head differential
115	70	43.4	10	7.25	573.32	1.00E-05	100	16.25	All	To obtain 0.5-ft head differential
116	105	65.1	16	11.4	570.82	1.00E-04	100	27.5	All	To obtain inward gradient (0.1 to 0.2 ft)
117	70	43.4	10	7.25	573.32	1.00E-06	0	11.25	All	No wall, all wells on to obtain capture
118	70	43.4	10	7.25	573.32	1.00E-06	100	19	All	To obtain 1.0-ft head differential
119	70	43.4	10	7.25	573.32	1.00E-06	100	9	EW-2, EW-4	Alternate wall alignment
120a	70	43.4	10	7.25	573.32	1.00E-06	100	14	EW-1 -> EW-4	Alternate wall; 0.5 head differential
120b	70	43.4	10	7.25	573.32	1.00E-06	100	16	EW-1 -> EW-4	Alternate wall;1.0 head differential

FIGURES

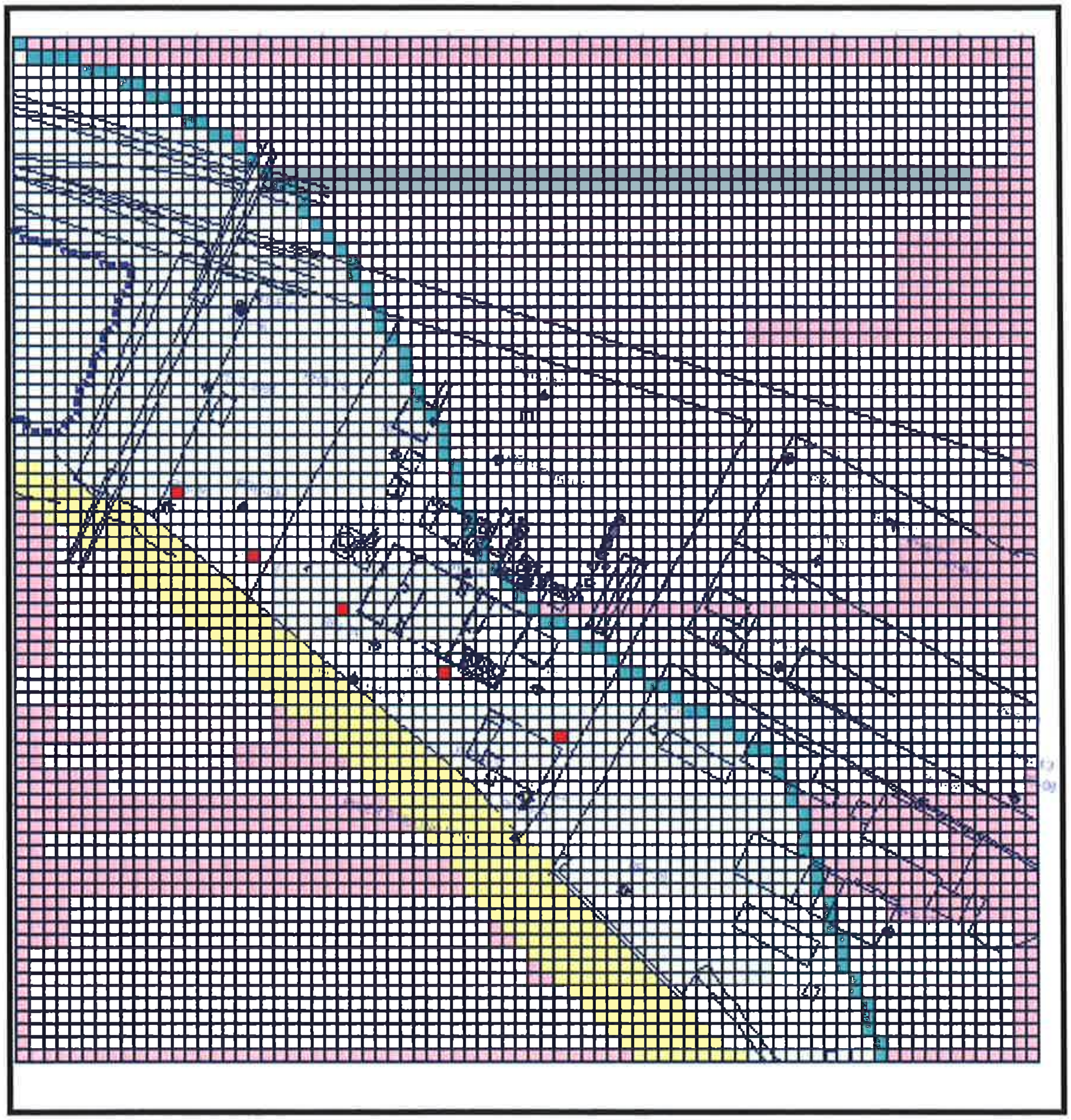

Figure 1: Area A groundwater model domain and features. The model domain is overlain with a regular grid of 20-foot square nodes. Pink areas are inactive in the model. The yellow blocks are constant heads representing the Buffalo River. The light blue nodes are general head boundaries and contribute flow into the model from upgradient recharge areas. The purple line to the upper left simulates the slurry wall around the landfill at Area E. The five red nodes represent the current extraction wells, EW-1 through EW-5 (left to right). Active portions of the model represent the alluvial aquifer.

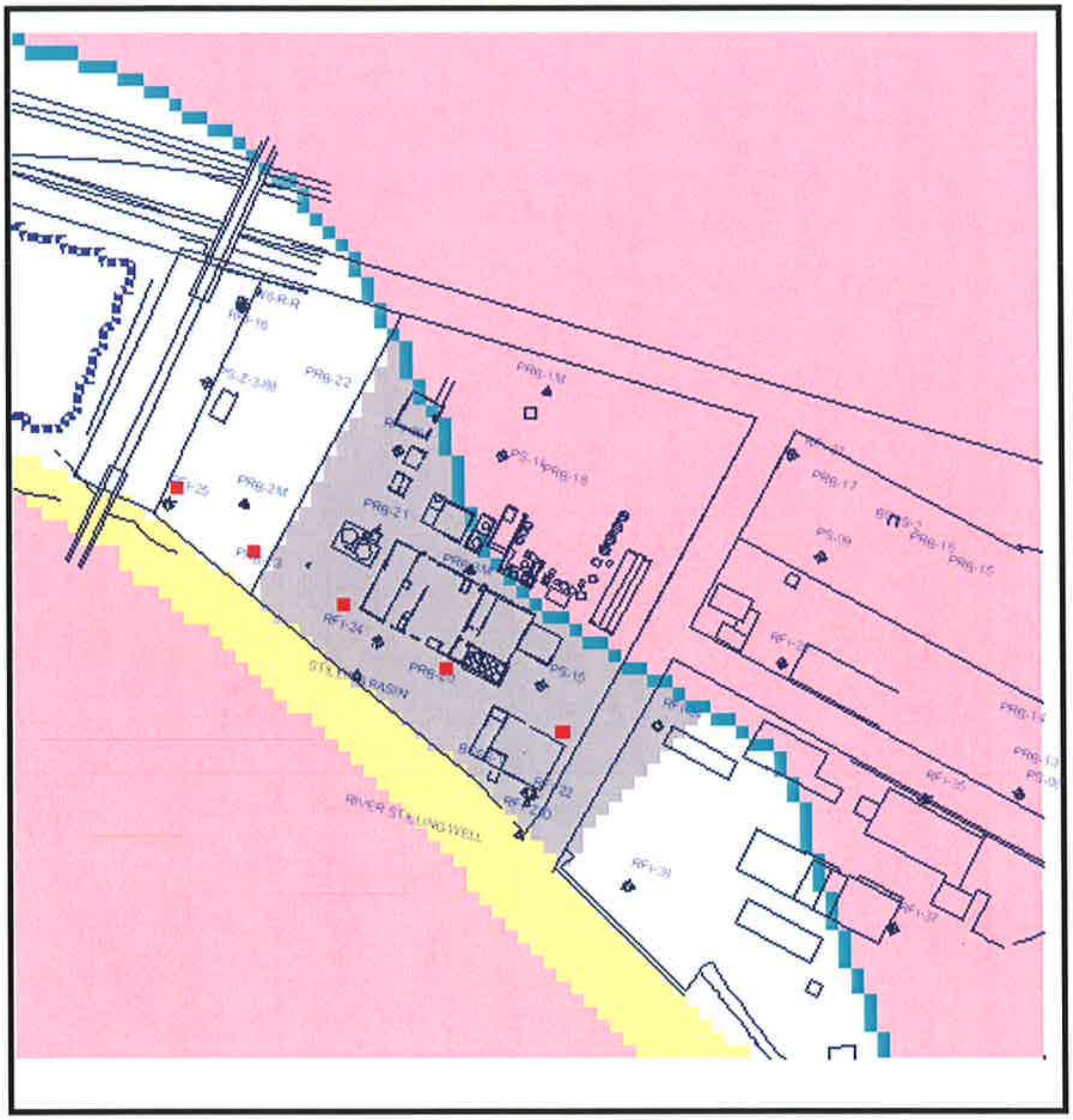

Figure 2: Zones of hydraulic conductivity. The center shaded area is at 70 ft/d, and the areas north and south are at 43.4 ft/d.

Figure 3: Bottom elevations in the model (top of glaciolacustrine clay), two-foot contours.

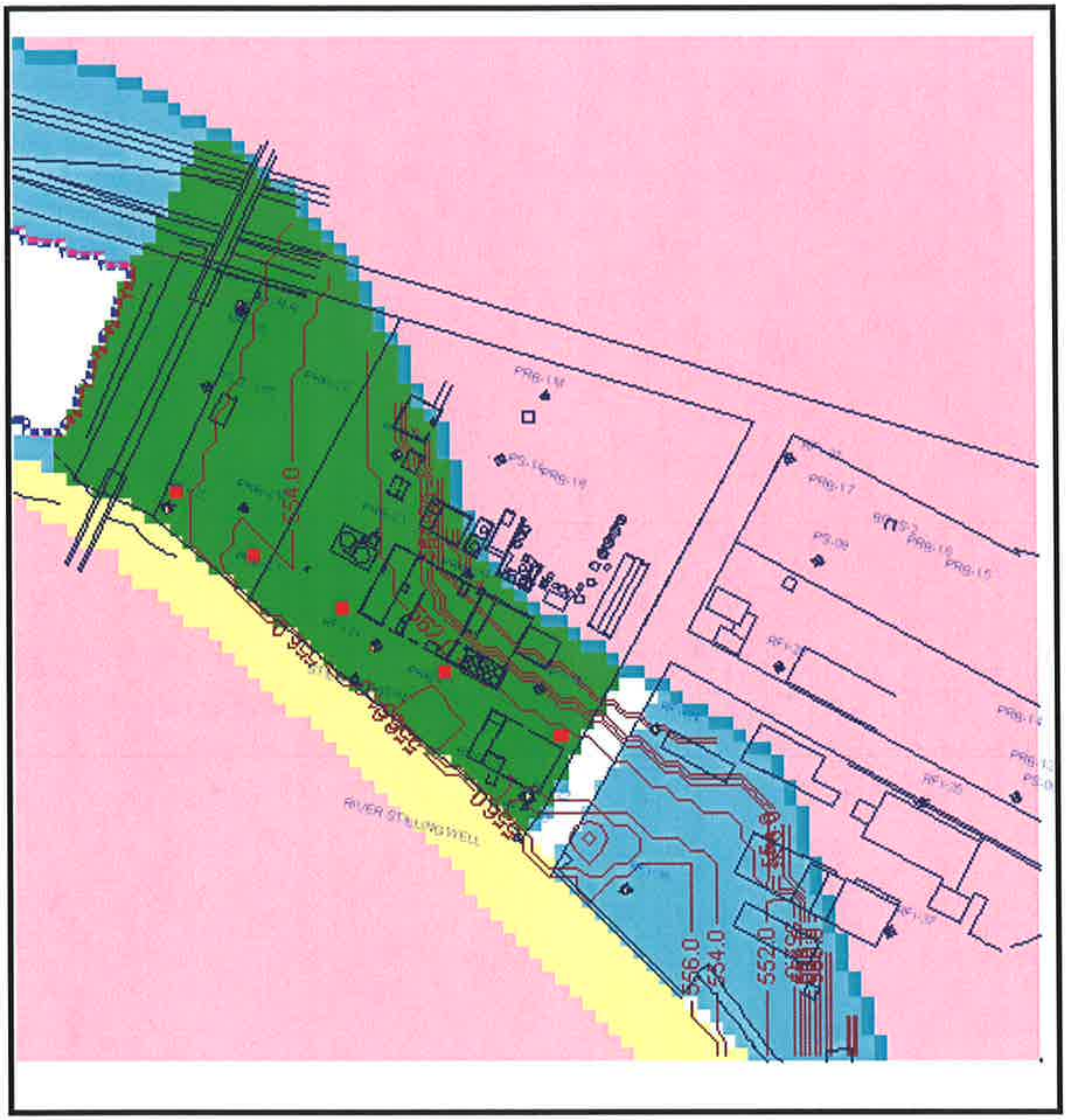

Figure 4: Recharge distribution. Green at a conservatively high 10 inches per year over Area A. Light blue at 7.25 inches per year; and white at zero inches per year.

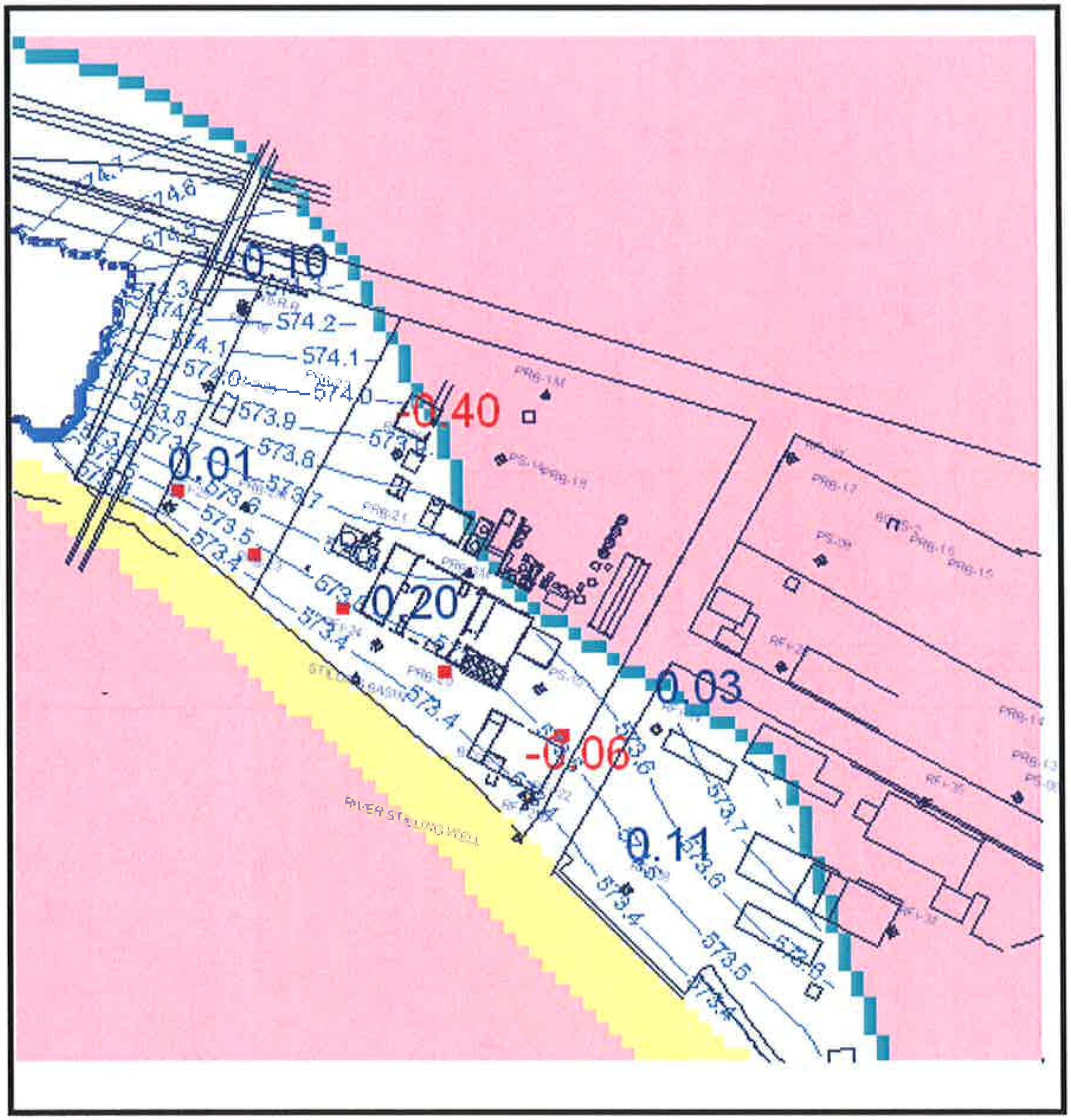

Figure 5: Calibrated model water level head contours and plotted residuals. Residuals in red indicate the model computed head is greater than observed, and residuals in blue the opposite. Extraction wells are not on as the water level data preceded well installation.

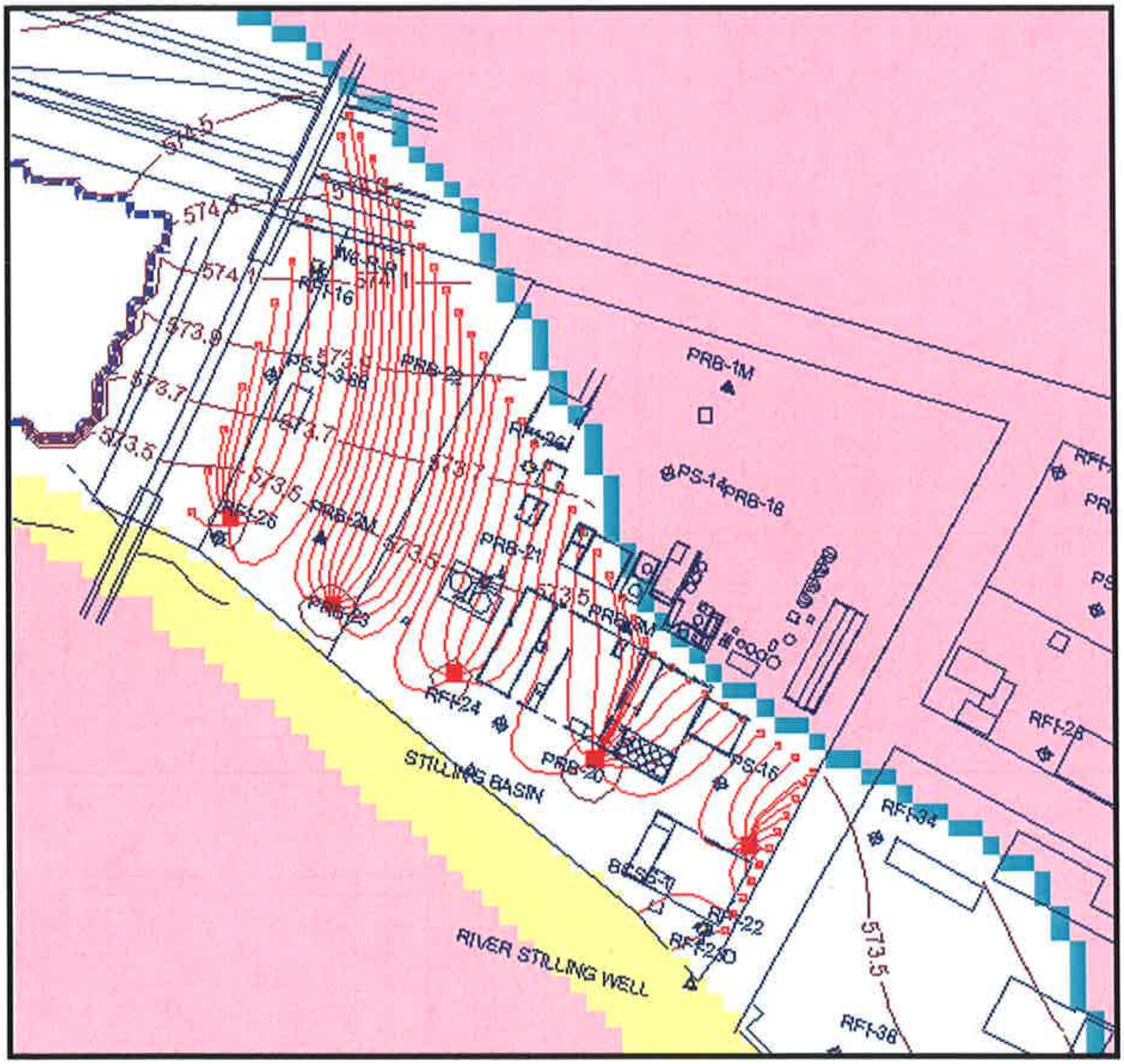

Figure 6: Base model with all extraction wells pumping at 2.25 gpm each (total 11.25 gpm). Particle tracks indicate all groundwater upgradient of extraction wells is captured. Mass balance suggests some slight flow (about 0.5 gpm) back from the river.

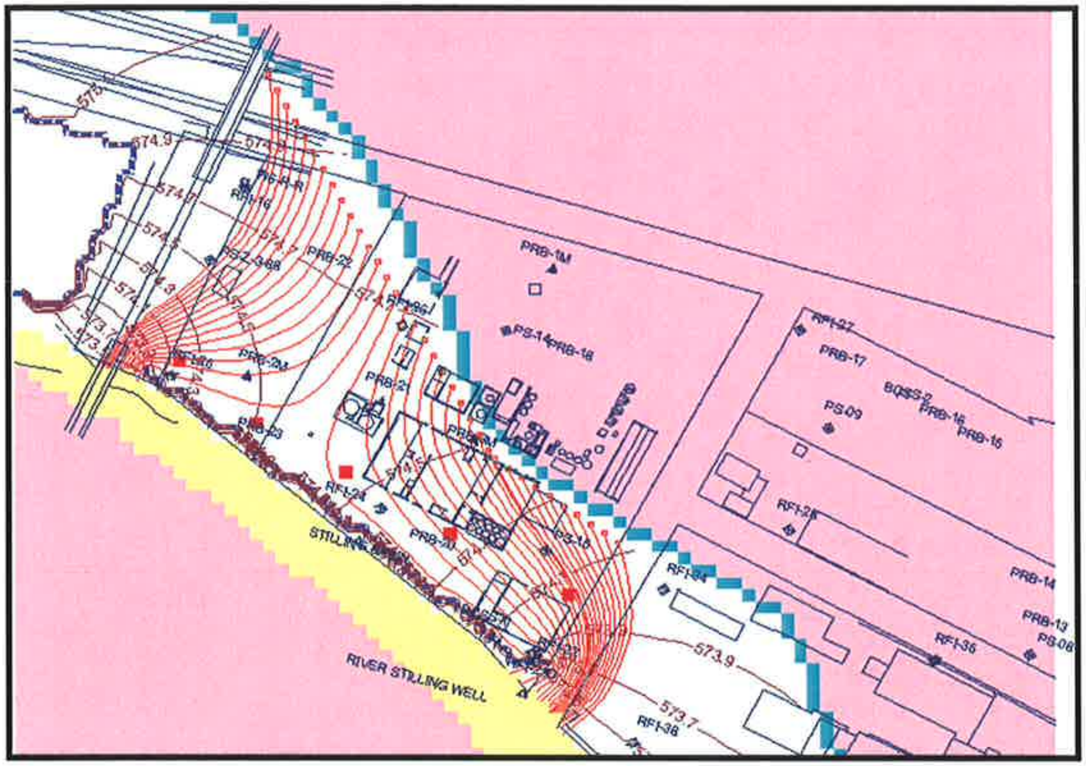

Figure 7: Simulation of a slurry wall (3-feet thick, 1e-6 cm/sec K) along the river, no wing walls. Extraction wells not on, particles tracks from upgradient location. No significant leakage through the wall, and all particles migrate around the ends of the wall to the river.

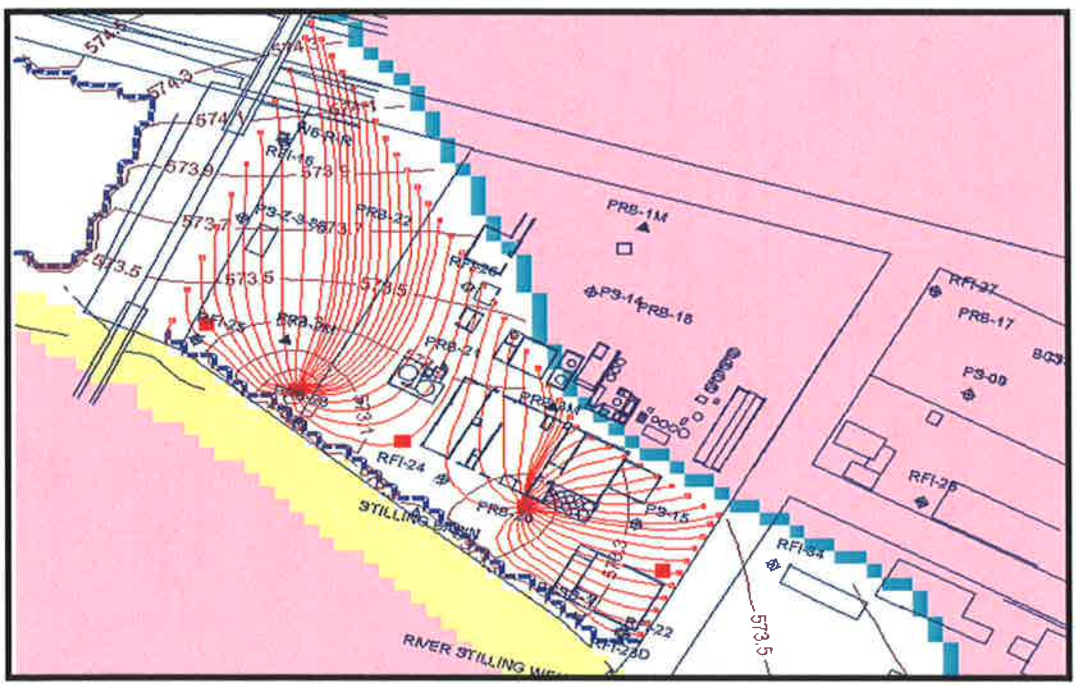

Figure 8: Extraction wells EW-2 and EW-4 on at a total of 11 gpm. All particles captured.

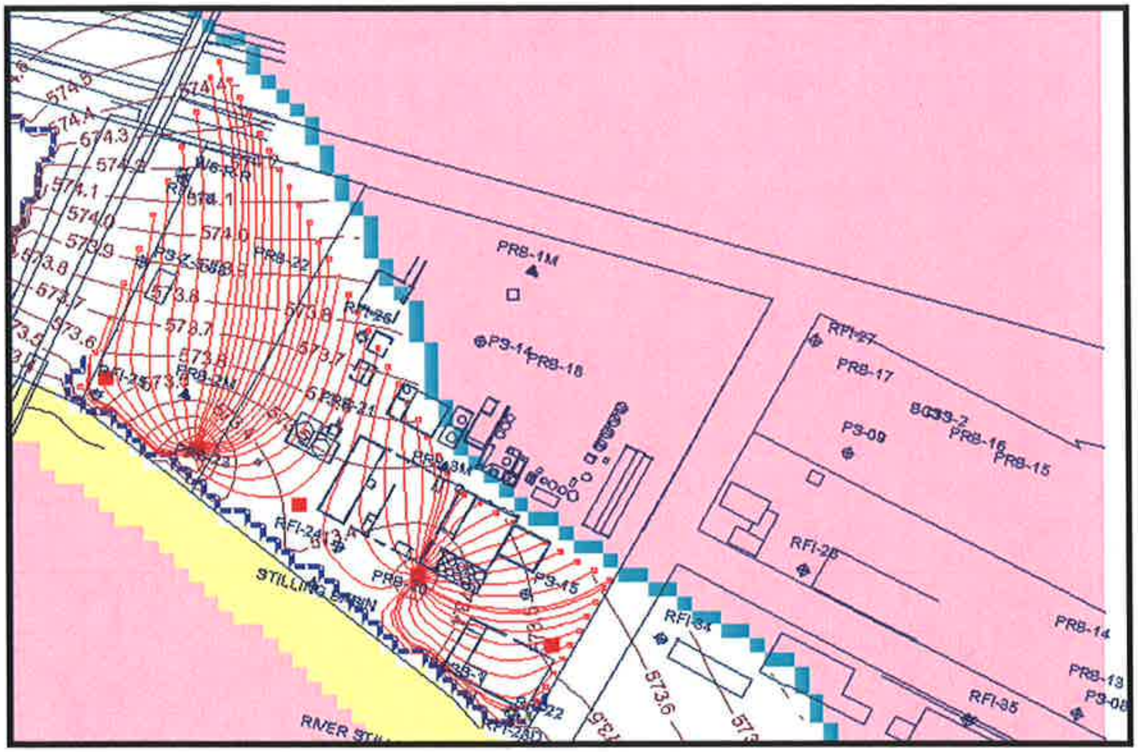

Figure 9: 50-foot wing walls added to the north and south ends of the slurry wall. Total pumping reduced to 9 gpm to maintain capture of particles.

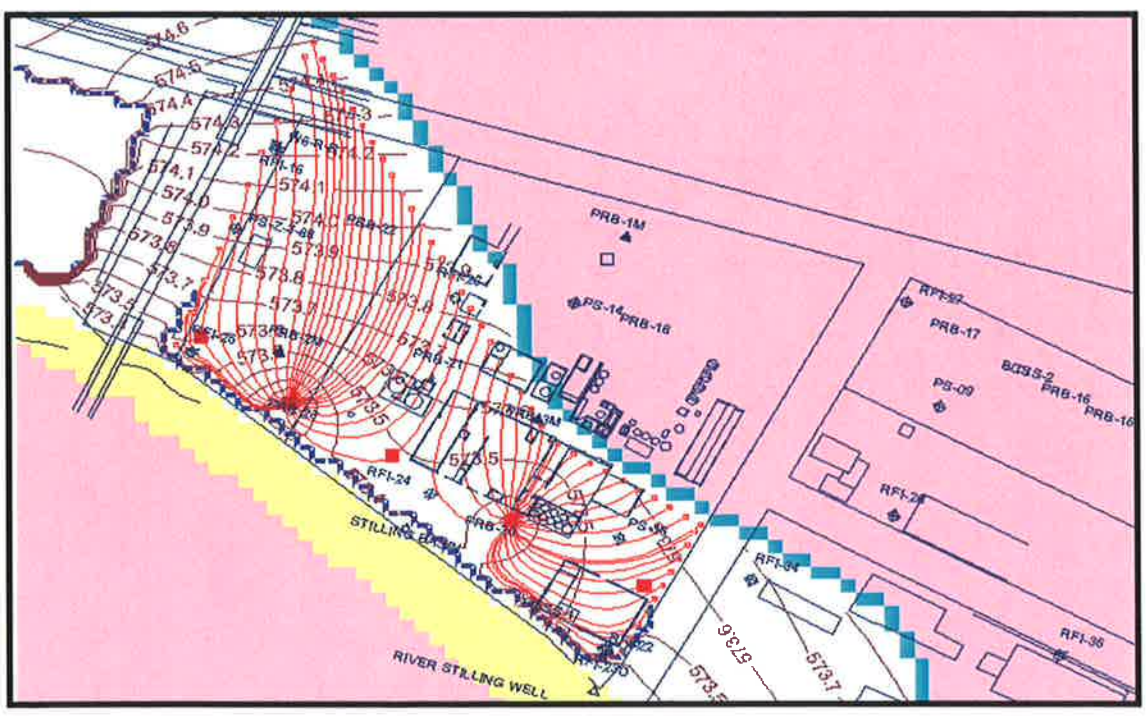

Figure 10: 100-foot wing walls added to the north and south ends of the slurry wall. Total pumping at 9 gpm to maintain capture of all particles.

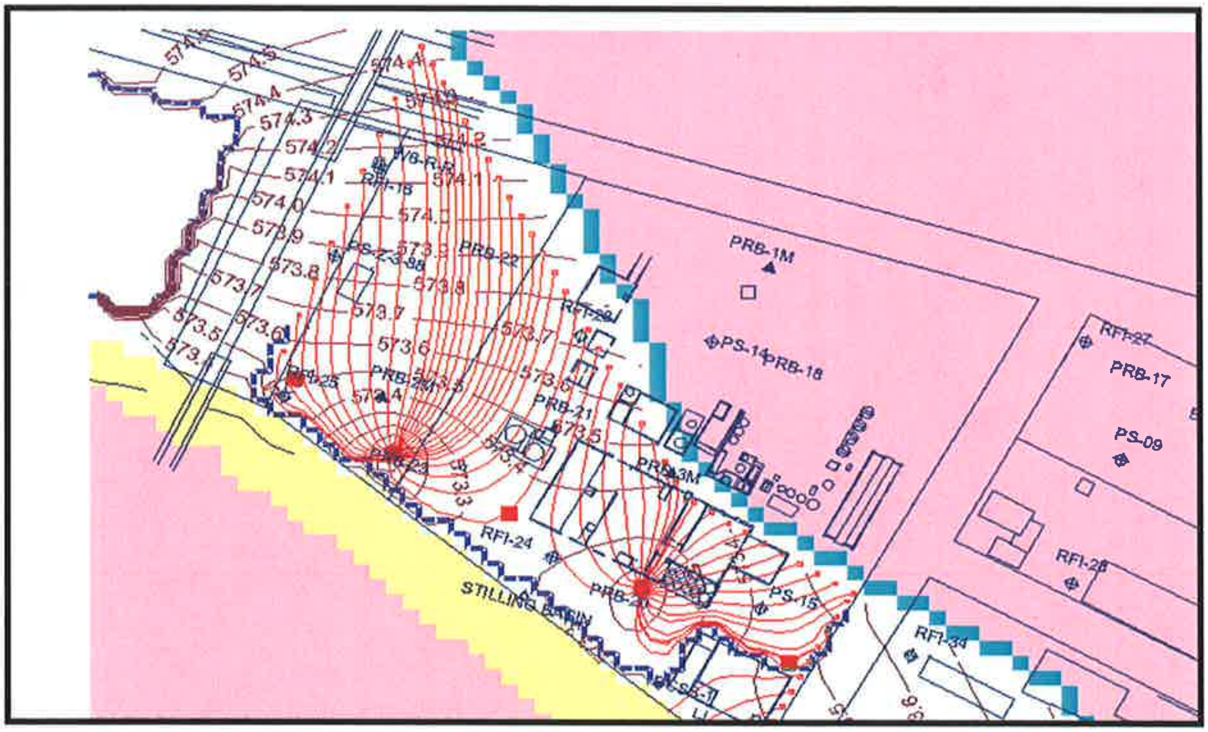

Figure 11: Alternate barrier wall alignment with a jog around Building 75 in the lower right portion of Area A. The northern wing wall (to the right) extends further from the river in this alignment. Pumping at 9 gpm maintains capture of Area A groundwater.

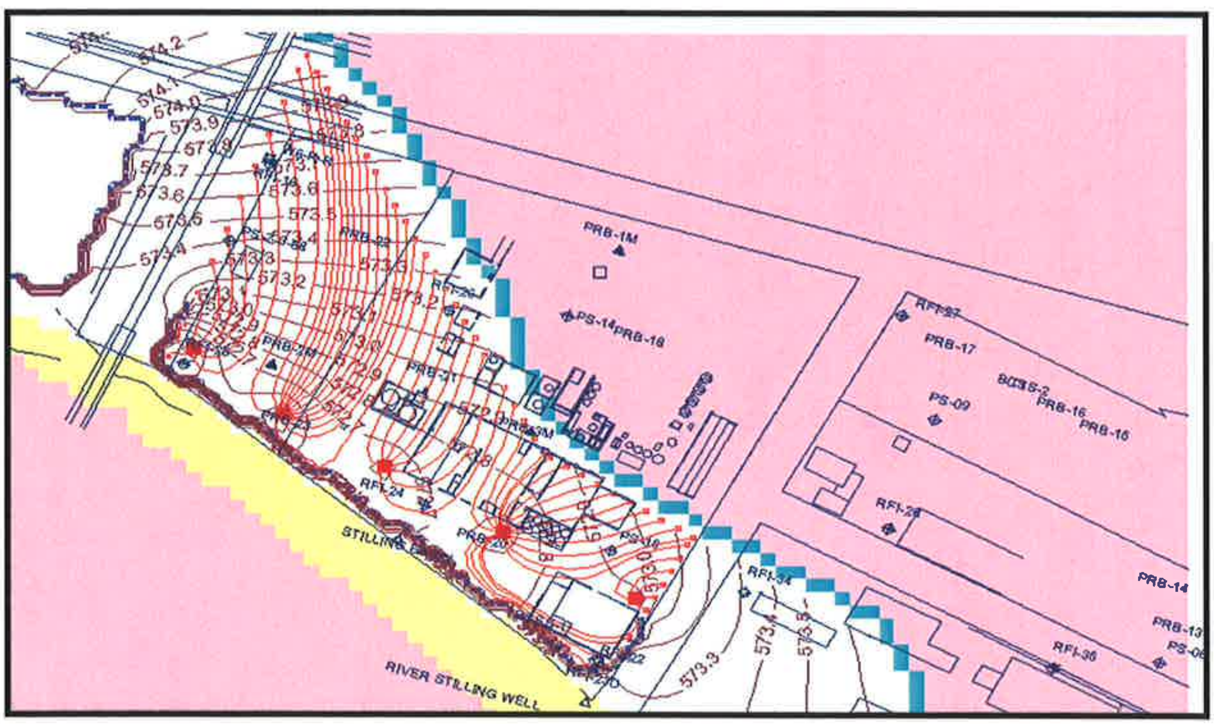

Figure 12: Pumping hard enough with the base model to create an approximate 0.5-foot head inward head differential across the wall. Each well at 3 gpm for a 15 gpm total.

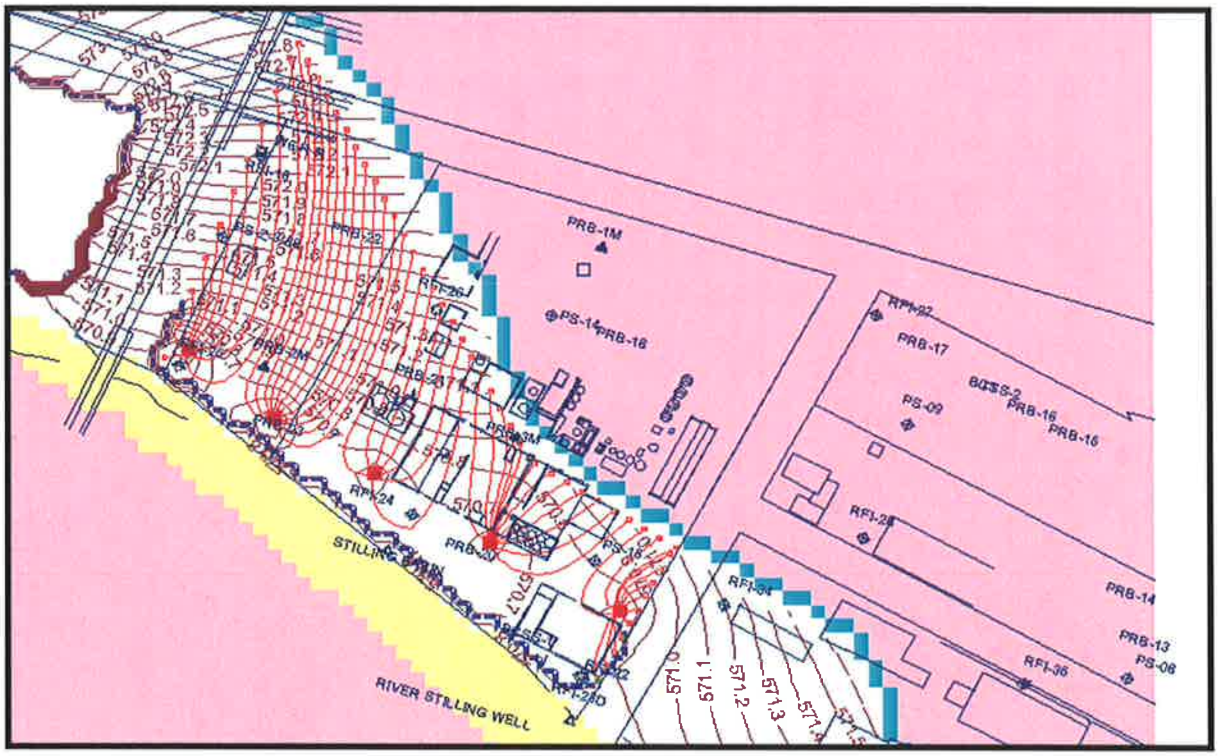

Figure 13: Worst case condition, high recharge, wall K 1e-4 cm/sec, low river. Total pumping to maintain an inward gradient across the wall is 27.5 gpm, with about 1.25 gpm from the river.

ATTACHMENT 1

LIST OF MODEL RUNS

Run 101 – Used to recalibrate model which includes changes to the top of the glaciolacustrine clay base of the model to more closely match what the recent borings conducted along the perimeter wall alignment showed. Changes were relatively small.

Run 102 – Places a 3-ft thick, 1xe-6 cm/sec wall along the river (does not bend around the existing building at the north end). Head buildup is not great behind the wall due to the relatively high K of the alluvium, and all particles placed along the uppgradient boundary bend either north or south around the ends of the wall. In all of these wall simulations, the wall would be considered to be to ground surface or at least to the top of the water table.

Run 103 – Operates EW-2 and EW-4 behind the wall in Run 102. Additional particles were seeded along the north and south property boundaries to visualize flow at the ends of the wall. A total flow of 11 gpm collects all particles (6 gpm at EW-2 and 5 gpm at EW-4). Head differential across the wall is not very substantial and might not be inward at all locations along the wall (still flow is essentially to the EWs, not through the wall).

Run 104 – Add approximate 50-ft long wing walls along north and south ends. This cuts total flow to 9 gpm. Pumping just at EW-2 and EW-4.

Run 105 – Lengthen wings to 100 ft each. No appreciable change in flow rate needed, but this length is likely to perform better under the more extreme environmental conditions (increased recharge, higher river stage). See figure attached.

The following runs keep the 100-ft long wing walls. In each run only a single parameter is varied from the base case (which for the wall in place would be Run 105).

Run 106 – Sensitivity to increased recharge (to 16 in/yr) as proposed in the model WP (GHB specifications adjusted to account for recharge area not in the active model). Flow rates need to be increased to a total of 15.4 gpm to capture all particles. This is about 25 percent above the theoretical flow through Area A. A slightly lower rate might allow some slight flow around or through the wall.

Run 107 - Sensitivity to increased K of the alluvium. Does not affect estimated pumping rates – driven by the recharge and upgradient inflow which remain the same.

Run 108 - Increase K of barrier to 1xe-5 cm/sec. Required flow to capture all particles is 12 gpm (6.5 at EW-2 and 5.5 at EW-4). Drawdowns increasing at these two locations and there may be some flow out through the wall between well locations. Look at spreading out the load by using all five EWs. Eventually get to 2.25 gpm for EW-1 and EW-2 and 2.5 gpm for EW-3, -4 and -5, for total of 12 gpm. Total is the same, but the distribution of head behind the wall is more uniform.

Run 109 - Increase K of barrier again to 1xe-4 cm/sec. All five wells needed and pumping at 3 gpm each for total of 15 gpm.

Run 110 – Decrease river stage by 2.5 feet. Need about 13 gpm to maintain capture, still some outward gradient, but flow inconsequential due to low wall K.

Run 111 – Increase river stage by 2.5 feet. Not much change, 9 gpm at two wells appears adequate.

Run 112 – Decrease aquifer K by 50 percent. No change in the flow requirements (9 gpm) and pumping at just 2 wells.

Run 113 – Decrease recharge to 8 in/yr (adjust GHB head as well). Capture of all particles at 8 gpm total.

Run 114 – Take base run (Run 105) and pump hard enough to create a 0.5-ft inward head differential. Use all five wells at 3 gpm each(total 15 gpm) appears to achieve this.

Run 115 – Repeat Run 114 with the K of the wall increased to 1xe-5 cm/sec. Estimated flow rate required increases slightly to about 16.5 gpm.

Run 116 – A worst-worst case. Aquifer K increased by 50%, recharge at 16 in/yr, river stage decreased by 2.5 ft, and K of wall increased to 1xe-4 cm/sec. Pumping at 5.5 gpm each (total of 27.5 gpm) captures particles and generates head differential across the wall of about 0.1 to 0.2 ft.

Run 117 – Base flow model with no wall and EW-1 through EW-5 pumping (total of 11.25 gpm) to obtain capture and to provide a figure showing approximate existing conditions.

Run 118 – Using the base simulation primary wall alignment, pump harder (total 19 gpm) to obtain minimum 1.0 head differential along the wall.

Run 119 – Set up alternate barrier wall alignment around Building 75 and 100-foot wing wall from the intersection with South Park Ave. Pump EW-2 and EW-4 for total of 9 gpm to achieve capture.

Run 120 – a) Pump harder (total of 14 gpm on EW-1 through EW-4) to achieve 0.5-foot head differential. b) Pump harder yet (total of 16 gpm on EW-1 through EW-4) to achieve 1.0-foot head differential.

ATTACHMENT 2

CALCULATION OF SEEPAGE THROUGH THE WALL

MACTEC

MACTEC Engineering and Consulting, Inc.
511 Congress Street, P.O. Box 7050
Portland, ME 04112-7050

JOB NO. 3410090701 SHEET 1 OF ____

PHASE ____ TASK 04

JOB NAME Buffalo Color

BY RAL DATE 5/5/10

CHECKED BY ____ DATE ____

Purpose: Estimate seepage through proposed barrier wall

Assumptions:

- Total wall length = length along river plus two wing walls
  = 750 ft + 2(100 ft) = 950 ft
- Saturated thickness of aquifer at wall ≈ 20 ft
- Effective hydraulic conductivity of wall = K_{wall} = 1e-6 cm/sec
  = 0.00283 ft/d
- Thickness of wall = 3 ft = Δl
- Head differential across the wall = 0.5 ft of water = Δh

Seepage through wall by Darcy's Law:

$$Q = KiA$$

where Q = flow rate
$K = K_{wall}$
i = hydraulic gradient = $\Delta h / \Delta l$
A = area through which flow occurs

$$Q = (0.00283\ ft/d)(0.5/3)[(950\ ft)(20\ ft)]$$

$$= 8.96\ ft^3/d \Rightarrow \div 192.5\ ft^3/d/gpm = 0.05\ gpm$$

At higher wall effective K, seepage rates would be proportionally greater:

at K_{wall} = 1e-5 cm/sec Q = 0.5 gpm

at K_{wall} = 1e-4 cm/sec Q = 5 gpm