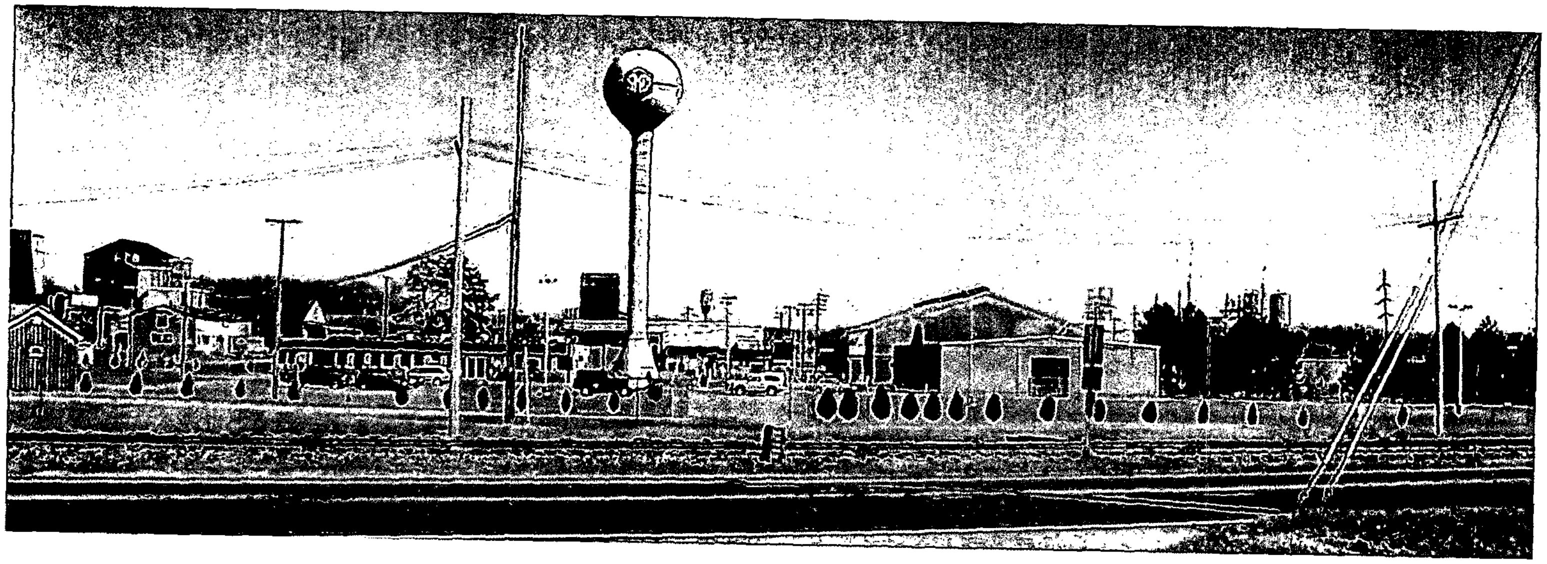

DECOMMISSIONING PLAN

SHIELDALLOY METALLURGICAL CORPORATION
NEWFIELD, NEW JERSEY

REVISION 1b: AUGUST 2009

Appendix 19.6 ENGINEERING SPECIFICATIONS
Appendix 19.7 ENGINEERING EVALUATIONS
Attachments A-J

Prepared by

Integrated Environmental Management, Inc. *and* **TRC Environmental Corporation**

Appendix 19.6 - Engineering Specifications

SECTION 02220

EARTHWORK AND SMC MATERIAL GRADING

PART 1 – GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
AASHTO T 224	Correction for Coarse Particles in the Soil Compaction Test

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
ASTM D 1140	Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75-m) Sieve.
ASTM D 1556	Density of Soil in Place by the Sand-Cone Method.
ASTM D 1557	Moisture-Density Relations of Soils, using 10.0 lb (4.5 kg) Rammer and 18-in. (457 mm) Drop.
ASTM D 2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
ASTM D 2922	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods.
ASTM D 422	Particle-Size Analysis of Soils.
ASTM D 4318	Liquid Limit, Plastic Limit and Plasticity Index for Soils.
ASTM D 5084	Measurement of Hydraulic Conductivity of Saturated Porous Material using a Flexible Wall Permeameter.
ASTM D 6938	Density and Water Content of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).

ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA Method 8270	Priority Pollutant Semivolatile Compounds
EPA Method 8260	Priority Pollutant Volatile Organic Compounds
EPA Method 6010	Priority Pollutant Metals (HG Method).
EPA Method 8081	Pesticides
EPA Method 8151	Herbicides
EPA Method 8082	PCBs
EPA Method 901.1	Radionuclides, Gamma Emitting

Note: EPA Methods referenced above will be referred to as "environmental testing" throughout these Specifications.

1.2 EXTENT OF WORK

1.2.1 Scope:

A. CONTRACTOR shall provide all labor, materials, tools, equipment tests and incidentals required to perform all excavating, filling, backfilling, compaction, and disposing of earth materials as shown, specified, and required for the purpose of constructing the engineered controlled barrier, pipes, drainage structures, drainage swales, embankments, roads, grading, and other facilities required to complete the Work in every respect.

B. All of the necessary excavation, filling, grading and compaction of SMC Materials, including but not limited to slag, baghouse dust, soil, rock concrete and other mixed debris to achieve the engineered control barrier subgrade contours as shown on the Contract Drawings.

C. All temporary means needed to maintain the work in a continuously dewatered condition.

D. All necessary testing of materials as required in the Contract Documents.

E. All necessary preparation required to repair displaced and eroded materials on subgrade, drainage layer, barrier protection layer, general fill layers, and erosion protection layer prior to final acceptance is included.

F. All temporary means needed to prevent discharge of SMC Material, soil and sediment to water courses due to dewatering systems or erosion during construction are included.

G. No classification of excavated and SMC Materials will be made. Excavation and grading includes all materials regardless of type, character, composition, moisture, or condition.

H. All necessary earthwork required to load and transport off-site soil material (borrow); unload, place, compact and grade embankment fill, structural fill, drainage systems and topsoil is included.

I. All necessary earthwork required to cut, fill, backfill and grade existing grade to within 1-inch of specified grade and subgrade.

J. All necessary earthwork required to excavate, load and temporarily stockpile existing on-site soil material; unload, place, compact and grade the SMC Material, embankment fill, structural fill, drainage systems and topsoil is included.

1.2.2 Related Sections:

1. Section 02225, Clay Barrier Layer
2. Section 02227, Engineered Barrier Cover Soil Layer
3. Section 02228, Angular Stone Erosion Protection and Aggregate
4. Section 02935, Turf

1.2.3 General:

A. The CONTRACTOR shall be required to excavate SMC Material from the facility as directed by the ENGINEER and as shown on the Contract Drawings and use the same as compacted backfill to achieve the subgrade contours for the SMC Material pile to be covered by the engineered control barrier as shown on the Contract Drawings.

B. CONTRACTOR is required to use approved clean material from off-site sources as shown on the Contract Drawings to achieve final facility grades.

C. Fill materials and their respective applications include, but are not limited to the following:

Fill Material	Application
1) Common Fill & Borrow	General Facility Grading
2) Topsoil	Vegetative Layer
3) SMC Material	Clay Barrier Subgrade

D. Prior to mobilization to the facility, the CONTRACTOR shall perform a topographic survey of the Work Area to determine areas that will require cut or fill to achieve the final surface grades. The CONTRACTOR will be responsible for grading the surface of the Work Area to achieve this final grade.

E. The CONTRACTOR shall provide a topographic survey of the SMC Material pile prior to constructing the engineered control barrier and final as-built survey of lines and grades showing topography and spot elevations prepared and sealed by a New Jersey licensed surveyor. Copies of all field notes shall accompany the as-built surveys and shall be submitted prior to the request for payment.

F. CONTRACTOR'S test field data shall indicate compliance with the Contract Documents in order to be accepted. The data shall be presented to and accepted by the ENGINEER and Quality Assurance Office (QAO) prior to placement of the next lift. CONTRACTOR shall assist the ENGINEER and QAO in doing periodic conformance testing while the work is in progress. The field data shall be certified and sealed by a New Jersey licensed Professional Engineer.

1.2.4 CONTRACTOR shall provide ENGINEER and QAO with access to the borrow pit or material source upon request for the purposes of observing material source operations and obtaining samples.

1.2.5 CONTRACTOR shall not block the existing roads at any time. If access needs to be temporarily blocked during construction, the CONTRACTOR shall provide written notice to the OWNER at least one week prior to needing to block this access.

1.3 QUALITY ASSURANCE

1.3.1 Tests:

A. The services of a qualified testing laboratory shall be engaged by the CONTRACTOR to make tests and determine acceptability of the fill or material as listed below. The laboratory shall be acceptable to the ENGINEER and QAO.

B. Required Tests:

1. Topsoil and common fill material samples from Off-Site: Gradation, ASTM D 422, ASTM D4318, Priority Pollutant Semivolatile Organic Compounds (SVOCs), EPA Method 8270, Priority Pollutant Volatile Organic Compounds (VOCs), EPA Method 8260, Priority Pollutant Metals, EPA Method 6010 (HG Method), PCBs/Pesticides, EPA Method 8081, Herbicides, EPA Method 8151 and EPA Method 901.1. All environmental test results shall be in conformance with the New Jersey Non-Residential Soil Remediation Standards (NJAC 7:26D) and Table B.1 of NUREG-1757 (63 FR 64132).

2. Compacted in place common fill material: Compaction ASTM D 1557, ASTM D 1556, and ASTM D6938.

3. No materials testing is required for SMC Materials..

1.3.2 Permits and Regulations:

1. CONTRACTOR shall obtain all necessary permits for work.

2. CONTRACTOR shall perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction and any other permits required for this project.

3. CONTRACTOR shall perform work in accordance with the Decommissioning Plan.

1.4 SUBMITTALS

1.4.1 Test Reports:

A. Submit six (6) copies of the following reports directly to ENGINEER from the testing service, with copy to the CONTRACTOR:

1. All tests for common fill material and topsoil.
2. Compliance testing during construction.
3. Field density tests.
4. Optimum moisture - maximum density curve for each soil.

B. Testing shall conform to the requirements as indicated in the specific material specification sections.

1.4.2 Submit six (6) samples of all gravel, backfill and base materials required.

1.5 JOB CONDITIONS

1.5.1 Existing Structures: Shown on the Contract Drawings are certain surface and underground structures adjacent to the Work. This information has been obtained from existing records. It is not guaranteed to be correct or complete and is shown for the convenience of the CONTRACTOR. CONTRACTOR shall explore ahead of the required excavation to determine the exact location of all structures. They shall be supported and protected from injury by the CONTRACTOR. If they are damaged, broken or injured, they shall be restored immediately by the CONTRACTOR at his expense.

1.5.2 Existing Utilities: Locate existing underground utilities in the areas of Work. If utilities are to remain in place, provide adequate means of protection during earthwork operations.

A. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult the ENGINEER immediately for directions as to procedure. Cooperate with OWNER and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

B. Do not interrupt existing utilities serving facilities occupied and used by OWNER or others, except when permitted in writing by ENGINEER and then only after acceptable temporary utility services have been provided.

1.5.3 Use of Explosives:

A. The use of explosives will not be permitted.

1.5.4 Protection of Persons and Property: Barricade open excavations occurring as part of this Work and post with warning lights. Operate warning lights during hours from dusk to dawn each day and as otherwise required.

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

1.5.5 Dust Control: CONTRACTOR shall conduct all of his operations and maintain the area of his activities, including sweeping and sprinkling of roadways, so as to minimize creation and dispersion of dust. Calcium chloride shall be used to control serious or prolonged dust problems, subject to approval of ENGINEER.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

2.1.1 Not Applicable.

2.2 SOIL MATERIALS

2.2.1 Satisfactory Materials

Satisfactory materials for common fill and borrow comprise any materials classified by ASTM D 2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP and SM. Satisfactory materials for grading comprise stones less than 4 inches, except for fill material for pavements which comprise stones less than 3 inches in any dimension. Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic. Perform testing, required for classifying materials, in accordance with ASTM D 4318, ASTM C 136, ASTM D 422, and ASTM D 1140. Satisfactory common fill and borrow shall comply with the New Jersey Non-Residential Soil Remediation Standards (NJAC 7:26D) and radiological constituents in common fill/borrow shall not exceed five (5) picocuries per gram of any isotope excluding uranium and thorium. Source material (uranium and thorium) shall not exceed 50 ppm.

2.2.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; and material classified as satisfactory which contains root and other organic matter or frozen material. Notify the ENGINEER when encountering any contaminated materials.

2.2.3 Topsoil

Material suitable for topsoils obtained from offsite areas and excavations is defined as natural, friable soil representative of productive, well-drained soils in the area, free of subsoil, stumps, rocks larger than one inch diameter, brush, weeds, toxic substances, and other material detrimental to plant growth. Amend topsoil pH range to obtain a pH of 5.5 to 7. See Section 02935 "Turf" for full specifications.

PART 3 - EXECUTION

3.1 INSPECTION

3.1.1 ENGINEER and QAO will examine the areas and conditions under which excavating, filling, and grading are to be performed and notify the CONTRACTOR of conditions he may find that are detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3.1.2 CONTRACTOR shall provide the ENGINEER with clean, unused, scalable 5 gallon pails with handles and lids to obtain samples. CONTRACTOR shall assist ENGINEER while taking samples.

3.2 FACILITY PREPARATION

3.2.1 The SMC materials are sitting in piles as shown on the Contract Drawings. The materials are comprised of a wide range of gradations. The sequence of the consolidation of these materials is to place the coarsest material at the bottom of the pile and the finest material in a uniform layer on top of the coarser material.

Drawing D-1 of the Contract Drawings illustrates the order in which the materials will be consolidated within the final stockpile. Materials from stockpile areas 4, 5, 6, and 7 (see Drawing C-3) represent the coarse slag components of the stockpiled material. These materials, which total approximately 38,000 cubic yards in volume, will form the base of the final stockpile. Within each of these individual stock piles, different sizes of materials are present, some being several feet in diameter. Much of the remaining material is one to two feet in diameter, and smaller. At the completion of the placement of the materials from stockpile areas 4, 5, 6 and 7 (into the final stockpile), the contractor shall ensure that all material is covered by a continuous layer of the one to two foot diameter, and smaller, material.

Materials from stockpile areas 3 and 9 represent medium-sized materials and will be placed and compacted above the lower, coarse slag materials. These medium-sized materials represent approximately 7,000 cubic yards of the total volume. The material from stockpile area 9 is larger in size and will be placed first, followed by the material from stockpile area 3, which is predominantly one to two inches in diameter. The contractor shall spread the material from stockpile area 3 as evenly as practicable across the previously placed materials, including those from stockpile area 9. If insufficient material from stockpile area 3 is available to completely cover the final stockpile to a depth of four finches, one to two inch diameter (d_{50}=1.5-inch) crushed stone material shall be brought to the facility and utilized to complete the covering.

Prior to placing the remaining fine stockpile material, $^1/_8$ to ½-inch (d_{50}=¼-inch) stone (or processed crushed concrete, see Table 2-4 in Specification Section 02228) will be placed over the medium-sized materials. The $^1/_8$ to ½-inch stone will be placed, graded and compacted. *The purpose of the $^1/_8$ to ½-inch stone is to fill voids within the medium-sized material. By filling the voids in the medium-sized material, the movement of fines from the remaining fine material (see below) downward through the underlying coarser materials will be mitigated.* If any voids in the medium-sized material are observed following placement of the $^1/_8$ to ½-inch stone, additional stone will be added at the observed void areas, graded and compacted. This process will continue until a continuous surface of $^1/_8$ to ½-inch stone exists above the medium-sized material. While no specific thickness shall be specified, a continuous layer of the 1/8 to ½-inch must be in place prior to placement of the fine material described below.

Finally, following placement of the 1/8 to ½-inch stone, the fine materials, consisting of approximately 30,000 cubic yards of materials from Areas 1, 2 and 8 and excavated soils from other areas of the facility, will be placed. This fine material will be placed, graded, and compacted.

Some small amounts of wood debris is intermixed with the stockpiled slag material. When this wood material is encountered, the contractor shall uniformly spread through the coarse material, within the largest of the final stockpile materials where possible.

3.3 EXCAVATION

3.3.1 CONTRACTOR shall perform all excavation required to complete the Work as directed by the ENGINEER. Excavations shall include ash only and shall not require drilling and blasting to remove.

3.3.2 Material Storage: Stockpile satisfactory excavated materials in approved areas, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.

1. Locate and retain soil materials at locations indicated on Contract Drawings.
2. Dispose of excess soil material and waste materials as specified hereinafter.
3. CONTRACTOR shall ensure temporary erosion & sediment control measures are taken in accordance with the Stormwater Management Plan.

3.4 UNAUTHORIZED EXCAVATION

3.4.1 All excavation outside the lines and grades shown, and which is not approved by the ENGINEER, together with the removal and disposal of the associated material shall be at the CONTRACTOR'S expense. The unauthorized excavation shall be filled and compacted with select backfill by the CONTRACTOR at his expense.

3.4.2 Any damage, disturbance, or settlement that occurs as a result of the CONTRACTOR'S stockpiling of material or equipment at the facility shall be the responsibility of the CONTRACTOR to repair and/or supply additional materials to compensate for settlement caused by the CONTRACTOR'S actions.

3.4.3 SMC materials shall not be removed from the work areas shown on the Contract Drawings.

3.5 GRADING

3.5.1 General: Uniformly grade areas within limits of grading under this Section, including adjacent transition areas. Smooth subgrade surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

3.5.2 Compaction - SMC Material.

A. Compaction of SMC materials will be addressed as a performance requirement based upon minimum requirements for the vibratory roller, number of passes and visual inspection during and following compaction. Due to the expected high degree of gradation variability of the materials, the CONTRACTOR shall perform in-place density testing of the compacted material to determine the number of roller passes required to reach a degree of compaction that does not increase by more than 3% above the previous reading.

The CONTRACTOR shall be required to use a smooth down vibratory roller having a minimum gross weight of 20,000 pounds for compacting all material having a maximum diameter of six (6) inches. Larger material shall not require compaction, but shall be graded in a manner to fill the larger voids with pieces of smaller material. The CONTRACTOR shall be required to place material having a maximum six (6) inch diameter in loose lifts not to exceed 8 inches. Water shall be applied to the material if it is a relatively dry state and dust is observed. The material shall be compacted with a minimum of three (3) passes of the specified vibratory roller and the in-place density and moisture content checked with a nuclear density gauge after each roller pass. If compaction does not increase by more than 3% when compared to the previous reading, then compaction can stop. This will determine the number of roller passes required and this process shall be repeated for each materials placed. The CONTRACTOR will be required to test each material placed in ten (10) separate locations in the manner described above, in order to establish the number of roller passes required.

Prior to the first use of the nuclear density gauge for each stockpile area material, standard radiation counts shall be taken of the material and compared to off-site counts. The gauge manufacturer shall be consulted and, if necessary, the gauge shall be calibrated to account for the radiation emission from the material.

3.5.3 Compaction - Borrow Material:

A. After grading, compact subgrade surfaces to the depth and 95% percent of maximum density. Degree of compaction required, except as noted in the third sentence, is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557 abbreviated as a percent of laboratory maximum density. Since ASTM D 1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, express the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve as a percentage of the maximum density in accordance with AASHTO T 180 and corrected with AASHTO T 224. To maintain the same percentage of coarse material, use the "remove and replace" procedure as described in NOTE 8 of Paragraph 7.2 in AASHTO T 180.

3.6 FIELD QUALITY CONTROL

3.6.1. Quality Control Testing During Construction:

A. Quality control compaction testing of SMC material shall be as described in Section 3.5.2 of this specification.

B. CONTRACTOR shall establish and maintain a 50 foot grid for control of field density testing of borrow material.

B. Compaction testing of borrow material shall be performed by CONTRACTOR on a 50 foot grid in the presence of the ENGINEER and QAO.

C. Compaction testing shall be performed according to ASTM D 2922, Density of Soil in Place by Nuclear Methods.

D. Compaction testing shall be presented and accepted by the ENGINEER and QAO prior to placement of the next lift.

E. Field compaction testing shall be included in each of the bid items. Field compaction testing for additional compacted backfill and structural fill shall be included in the respective bid items.

PART 4 – MEASUREMENT AND PAYMENT

4.1 SMC Material Method of Measurement

A. The CONTRACTOR will retain the services of a licensed New Jersey Land Surveyor to survey the pre-construction grades and the grades of the top of the finished SMC Material surface upon which the engineered control barrier will be constructed. At a minimum, the survey shall consist of cross-sections spaced every 50 feet and oriented north-south. Spot elevations shall be taken every 25 feet and at grade changes for every section. The survey limits shall coincide with the cap limits plus 50 feet.

B. Measurement for payment shall only be within the limits of grading shown for the on the Contract Drawings. The volume of excavation and filling shall be calculated using the average end area method based upon the pre-construction survey and finished SMC Material pile sections.

4.2 SMC Material Basis for Payment

A. The CONTRACTOR will be paid at the contract unit price for SMC Material relocation and grading" on a cubic yard basis for the combined volume of excavation and fill as defined in the method of measurement above. The price shall include all labor, equipment, materials and tools incidental to the relocation and grading of ash and temporary cover soil to achiever the landfill cap subgrade shown on the Contract Drawings.

B. Common Excavation and Borrow Method of Measurement. The unit of measurement for all excavation and borrow will be the cubic yard, computed by the average end area method from cross sections taken before and after the excavation and borrow operations. Only excavation work below the elevation of the subgrade as defined on the Contract Drawings that depict the finished grade will be measured for payment.

C. Common Excavation and Borrow Basis for Payment. Payment will constitute full compensation for all labor, equipment, tools, supplies, and incidentals necessary to complete the work. Only excavation defined above to be measured will be paid for at the contract unit prices per cubic yard for common excavation. Borrow will be paid for at the contract unit price per cubic yard for common borrow.

END OF SECTION

SECTION 02225

CLAY BARRIER LAYER

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 1140	(2000; R 2006) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
ASTM D 1556	(2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2007) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D 1587	(2000el; R 2007) Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
ASTM D 2167	(1994; R 2001) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2216	(2005) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 2488	(2006) Description and Identification of Soils (Visual-Manual Procedure)
ASTM D 3740	(2004a; el 2007) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D 422	(1963; R 2007) Particle-Size Analysis of Soils
ASTM D 4220	(1995; R 2007) Preserving and Transporting Soil Samples
ASTM D 4318	(2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 5084	(2003) Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

ASTM D 6938	(2007a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D 698	(2007e1) Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft-lbf/cu. ft.

ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA Method 8270	Priority Pollutant Semivolatile Compounds
EPA Method 8260	Priority Pollutant Volatile Organic Compounds
EPA Method 6010	Priority Pollutant Metals (HG Method).
EPA Method 8081	Pesticides
EPA Method 8151	Herbicides
EPA Method 8082	PCBs
EPA Method 901.1	Radionuclides, Gamma Emitting

1.2 UNIT PRICES

Measurement and payment for the clay barrier layer shall be based on the unit price schedule for each cubic yard of clay in place. This unit price shall include the cost for development of the clay borrow source, cost of clay, excavation, hauling, equipment, placement, testing, and other incidental work required to construct the clay barrier layer.

1.3 SUBMITTALS

ENGINEER approval is required for submittals with a "E" designation; submittals not having a "E" designation are for CONTRACTOR Quality Control approval. The following shall be submitted in accordance with the Section entitled SUBMITTAL PROCEDURES:

SD-03 Product Data

Protection Equipment

Materials Handling Plan describing the following: processing and placement of the clay; type, model number, weight and critical dimensions of equipment to be used for soil processing, compaction, scarification, and smooth rolling; method of protecting clay from changes in moisture content and freezing after placement.

Commercial Testing Laboratory; E

Name and qualifications of the proposed commercial testing laboratory.

SD-04 Samples

Clay

Quality Assurance Samples

A minimum of 100 pounds of each principal type of material or combination of materials to the Customer's designated laboratory at least 45 days prior to placement.

SD-06 Test Reports

Borrow Source Assessment; E

Assessment Tests; E

Moisture Content and Density Tests of In-Place Clay; E

Hydraulic Conductivity Tests of In-Place Clay; E

Borrow Source Assessment Report at least 30 days prior to clay placement. No clay shall be placed until the Borrow Source Assessment Report is approved. The report shall include the following: location of each borrow source; plan view and estimated available quantity of clay; locations and logs of subsurface explorations; laboratory test results; moisture-density curves showing the "Acceptable Zone" of moisture contents and densities which achieve the required hydraulic conductivity for each principal type of material or combination of materials.

1.4 EQUIPMENT

Equipment used to place the clay barrier layer shall not brake suddenly, turn sharply, or be operated at speeds exceeding 5.0 miles per hour.

1.4.1 Compaction Equipment

Compaction equipment shall consist of tamping foot rollers which have a minimum weight of 40,000 pounds. At least one tamping foot shall be provided for each 110 square inches of drum surface. The length of each tamping foot, from the outside surface of the drum, shall be equal to or greater than the loose lift thickness. During compaction operations, the spaces between the tamping feet shall be maintained clear of materials which would impair the effectiveness of the tamping foot rollers.

1.4.2 Scarification Equipment

Disks, rotor tillers, or other approved means shall be provided to scarify the surface of each lift of clay prior to placement of the next lift. The scarification equipment shall be capable of uniformly disturbing the upper 1 inch of the clay surface to provide good bonding between lifts.

1.4.3 Steel Wheeled Rollers

A smooth, non-vibratory steel wheeled roller shall be used to produce a smooth compacted surface on the clay barrier layer. Steel wheeled rollers shall weigh a minimum of 20,000 pounds.

1.4.4 Hand Operated Tampers

Hand operated tampers shall consist of rammers or other impact type equipment. Vibratory type equipment will not be allowed.

PART 2 PRODUCTS

2.1 CLAY

Clay shall be free of roots, debris, organic or frozen material, and shall have a maximum clod size of 2 inches at the time of compaction. Clay material shall comply with the criteria listed in Table 1.

TABLE 1 - REQUIRED PHYSICAL PROPERTIES OF CLAY

Property	Test Value	Test Method
Max. particle size (inches)	1	ASTM D 422
Min. percent passing No. 4 sieve	80	ASTM D 422
Min. percent passing No. 200 sieve	50	ASTM D 1140
Min. liquid limit	35	ASTM D 4318
Min. plasticity index	10	ASTM D 4318
Max. plasticity index	40	ASTM D 4318

PART 3 EXECUTION

3.1 BORROW SOURCE ASSESSMENT

Borrow source assessment tests shall be performed on each principal type or combination of materials proposed for use in the clay barrier layer to' assure compliance with specified requirements and to develop compaction requirements for placement. A minimum of one set of borrow assessment tests shall be performed for each borrow source proposed. A set of borrow source assessment tests shall consist of classification testing, moisture-density (compaction) testing, hydraulic conductivity testing and chemical contamination testing.

3.1.1 Classification Testing

Test pits or borings placed in a grid pattern shall be used to characterize each proposed borrow source. The test pits or borings shall extend to the full depth of the proposed borrow source. Visual classification as described in ASTM D 2488 shall be performed over the full depth of each test pit or boring by a registered geologist or geotechnical engineer. Soils shall be grouped into "principal types" based on visual classification. Classification testing shall be performed on representative samples of each principal type or combination of materials. At a minimum, one set of classification tests outlined in Table 1 shall be performed per 6500 cubic yards of proposed borrow. Classification testing shall consist of liquid and plastic limits in accordance with ASTM D 4318 and particle size analysis in accordance with ASTM D 422 and ASTM D 1140. Moisture content testing of proposed borrow shall be performed at a frequency of once per 2600 cubic yards in accordance with ASTM D 2216.

3.1.2 Compaction Testing

A representative sample from each principal type or combination of borrow materials shall be tested to establish compaction curves using ASTM D 698 and ASTM D 1557. A minimum of one set of compaction curves shall be developed per 6,500 cubic yards of each proposed borrow material. A minimum of 5 points shall be used to develop each compaction curve. The compaction curves for each principal type or combination of borrow materials shall be plotted on a single graph of dry density versus moisture content.

3.1.3 Hydraulic Conductivity Testing

A set of hydraulic conductivity tests shall be performed on representative samples of each principal type or combination of borrow materials. A minimum of one set of tests shall be performed per 6,500 cubic yards of proposed borrow material. A set of tests shall consist of one hydraulic conductivity test run on a representative sample corresponding to each point from each compaction curve at or above ASTM D 1557 optimum moisture content. Hydraulic conductivity testing referenced in this section shall be conducted in accordance with ASTM D 5084. In addition, the following procedures shall be adhered to when performing the hydraulic conductivity testing:

a. Saturation of test specimens shall be verified by determination of the B coefficient. The B coefficient must be at least 0.95. The B coefficient is defined as the change in pore water pressure divided by the change in confining pressure.

b. During consolidation of the test specimens, outflow volumes versus time shall be recorded on a semi-log graph to confirm primary consolidation has been completed prior to permeation of the specimens.

c. The permeant used for back pressure saturation and permeation shall be 0.01 molar calcium chloride solution created from deaired, distilled water as specified in ASTM D 5084.

d. The average effective confining pressure shall be 5 psi.

3.1.4 Acceptable Zone Development

An "Acceptable Zone" of moisture contents and densities shall be developed and displayed with the compaction curve graphs for each principal type of borrow material or combination of borrow materials. The "Acceptable Zone" shall consist of moisture-density values that meet the following requirements:

a. Maximum Allowable Hydraulic Conductivity = 1 x 10 to the -7 cm per second.

b. The minimum allowable moisture content shall be no less than optimum moisture content based on ASTM D 1557.

c. The minimum allowable density shall be no less than 95 percent of maximum dry density based on ASTM D 698.

3.1.5 Chemical Contamination and Radiological Testing

Borrow used for the clay barrier layer shall be free of radiological and chemical contamination. Each proposed borrow source shall be sampled and analyzed for chemical contamination in accordance with New Jersey Non-Residential Soil Remediation Standards (NJAC 7.26D) and the test methods referenced in Section 1.1. Radiological constituents in the clay shall not exceed five (5) picocuries per gram of any isotope excluding Potassium-40, uranium and thorium. Radiological constituents shall not exceed 2.5 picocuries per gram for uranium and shall not exceed 11.9 picocuries per gram for thorium.

3.1.6 Commercial Testing Laboratory

Tests for the clay barrier layer shall be performed by an approved testing laboratory furnished by the CONTRACTOR. No testing will be permitted until the facilities have been inspected and approved. The inspection will be performed to determine if the laboratory has a quality system in place for personnel, equipment, reporting procedures, record keeping, and equipment calibration that ensures the laboratory is capable of accurately performing the specified testing. The quality system shall be in accordance with ASTM D 3740 or as approved by the ENGINEER or Quality Assurance Officer (QAO). The radiological laboratory shall maintain appropriate licensing and NELAC Certification (New Jersey). The first inspection will be at the Customer's expense. Cost incurred for subsequent inspections required because of deficiencies found during the first inspection will be charged to the CONTRACTOR.

3.2 INSTALLATION

3.2.1 Clay Placement

Clay shall be placed to the lines and grades shown on the drawings. The clay shall be placed in loose lifts not to exceed 8 inches in thickness. In areas where hand operated tampers must be used, the loose lift thickness shall not exceed 4 inches. Grade stakes shall not be driven into the clay layer.

3.2.2 Moisture Control

Clay shall be placed and compacted within the "Acceptable Zone" moisture content range in the approved Borrow Source Assessment Report. The moisture content shall be maintained uniform throughout each lift. Water added shall be thoroughly incorporated into the clay to ensure uniformity of moisture content prior to compaction.

Once the clay barrier soil has been placed and compacted, the CONTRACTOR shall ensure that it retains a moisture content within its specified range prior to placement of additional lifts of soil. A period of not more than 36 hours shall pass before an additional soil layer or temporary moisture barrier is installed to cover the exposed clay barrier layer. Even short term exposure of barrier soil layers to the environment can cause desiccation (drying out), excessive wetting, or possibly freezing.

A scarified or rough surface is most susceptible to variations in moisture content. The increased surface area of the uneven surface allows a larger portion of the lift to dry out and break into discreet particles. On the other hand, a rainfall event will cause ponding over the uneven surface. To alleviate the potential for gross variations in the moisture content, the CONTRACTOR shall smooth roll the exposed soil lift at the end of each day. The smooth surface will act as a protective skin that will help retain the existing moisture content of the soil and at the same time seal the surface so that excess water from rainfall is prevented from entering the material. A smooth-rolled surface will also shrink and crack, but if left exposed for a short period, the damage will be only surficial, leaving the majority of the lift intact. Application of water sprayed lightly and evenly over the surface of the barrier soil shall be performed by the CONTRACTOR to help prevent desiccation.

The CONTRACTOR shall place and secure a temporary moisture barrier consisting of 6-mil polyethylene sheeting if the surface will be exposed for greater than 36 hours.

3.2.3 Compaction

Clay shall be compacted to meet the density requirements in the approved Borrow Source Assessment Report and by at least 5 passes of the approved compaction equipment over all areas of each lift. For self-propelled compactors, one pass is defined as one pass of the entire vehicle. For towed rollers, one pass of the drum constitutes a pass. Hand operated tampers shall be used in areas where standard compaction equipment cannot be operated.

3.2.4 Scarification

Scarification shall be performed on all areas of the upper surface of each clay lift prior to placement of the next lift. Scarification shall be accomplished with approved equipment. The final lift of clay shall not be scarified. The final lift shall be smooth rolled with at least 3 passes of the approved smooth steel wheeled roller to provide a smooth surface with no ridges or depressions.

3.2.5 Repair of Voids

Voids created in the clay barrier layer during construction (including, but not limited to, penetrations for test samples, grade stakes, and other penetrations necessary for construction) shall be repaired by removing sand or other non-clay material, placing clay backfill in lifts no thicker than 3 inches and tamping each lift with a steel rod. Each lift shall be tamped a minimum of 25 times altering the location of the rod within the void for each blow. Other ruts and depressions in the surface of the lifts shall be scarified, filled, and then compacted to grade.

3.3 CONSTRUCTION TOLERANCES

The top surface of the clay barrier layer shall be no greater than 3 inches above the lines and grades shown on the drawings. No minus tolerance will be permitted.

3.4 CONSTRUCTION TESTS

3.4.1 Clay Material Tests

During construction of the clay barrier layer, representative samples shall be taken for testing at the frequencies listed in Table 2 after a loose lift of clay has been placed. Test results shall meet the requirements listed in Table 1.

TABLE 2 - CLAY MATERIAL PROPERTIES

Property	Frequency	Test Method
Particle size analysis (Note 1)	1,000 cubic yards	ASTM D 422 and ASTM D 1140
Atterberg limits (Note 1)	1,000 cubic yards	ASTM D 4318
Compaction (Note 2)	6,500 cubic yards	ASTM D 698

Note 1: At least one test shall be performed each day that soil is placed.
Note 2: Compaction test results shall be compared to previous results on the same material type to verify the compaction characteristics have remained the same.

3.4.2 Moisture Content and Density Tests of In-Place Clay

Moisture content and density tests shall be performed in a grid pattern. The grid pattern shall be staggered for successive lifts so that sampling points are not at the same location in each lift. Moisture content and density tests shall be performed in accordance with Table 3.

TABLE 3 MOISTURE CONTENT AND DENSITY TESTS OF IN-PLACE CLAY

Property	Frequency Per Lift	Test Method
Rapid Moisture Content	8,500 square feet	ASTM D 6938
Standard Moisture Content	1 for every 10 rapid tests	ASTM D 2216
Rapid Density	8,500 square feet	ASTM D 6938
Standard Density	1 for every 20 rapid tests	ASTM D 1556 or ASTM D 2167

3.4.2.1 Rapid Tests

Each day that clay is compacted, a minimum of one set of moisture content and density tests shall be performed using standard procedures. Rapid tests shall be checked at the frequencies shown in Table 3. Standard tests shall be performed at locations which are as close as possible to the location of the rapid tests being checked.

3.4.2.2 Nuclear Density and Moisture Content Tests

Nuclear density readings shall be taken in the direct transmission mode. When ASTM D 6938 is used, the calibration curves shall be checked and adjusted using only the sand cone method as described in ASTM D 1556. ASTM D 6938 results in a wet unit weight of soil and when using this method, ASTM D 6938 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 6938; the calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed by the ENGINEER or QAO.

3.4.2.3 Test Results

The field moisture content and density test results shall be plotted on the "Acceptable Zone" plot that corresponds to the appropriate material type being tested. If test results are not within the "Acceptable Zone" for moisture content or density, 3 additional tests shall be performed near the location of the failed parameter. If all retests pass, no additional action shall be taken. If any of the retests fail, the lift of soil shall be repaired out to the limits defined by passing tests for that parameter. The area shall then be retested as directed. Repairs to the clay layer shall be documented including location and volume of soil affected, corrective action taken, and results of retests.

3.4.3 Hydraulic Conductivity Tests of In-Place Clay

Undisturbed samples shall be taken for hydraulic conductivity testing at a frequency of once per 40,000 square feet for each lift of clay placed. Samples shall be cut from the lift in accordance with ASTM D 1587 and transported in the vertical position in accordance with ASTM D 4220, Group C. Each undisturbed sample shall be tested for hydraulic conductivity in accordance with ASTM D 5084, moisture content in accordance with ASTM D 2216, particle size analysis in accordance with ASTM D 422, and liquid and plastic limits in accordance with ASTM D 4318. Hydraulic conductivity testing shall be conducted in accordance with the requirements in paragraph Hydraulic Conductivity Testing. If any test result is greater than the "Maximum Allowable Hydraulic Conductivity", modifications shall be proposed and approved for future placement of clay of that type. If the hydraulic conductivity of any test is more than one-half of one order of magnitude greater than the "Maximum Allowable Hydraulic Conductivity", 3 additional tests shall be performed near the location of the original failed test. If all retests pass, no additional action shall be taken. If any of the retests fail, the area shall be repaired out to the limits defined by passing hydraulic conductivity tests. The area shall then be retested as directed. Repairs to the clay layer shall be documented including location and volume of soil affected, corrective action taken, and results of retests.

3.4.4 Quality Assurance Samples

Quality assurance samples shall be taken at locations as directed. Samples shall be taken at a frequency of once per 60,000 square feet for each lift of clay placed. Samples shall be cut from the lift in accordance with ASTM D 1587 and shipped in the vertical position in accordance with ASTM D 4220, Group C.

3.5 PROTECTION

3.5.1 Moisture Content

After placement, moisture content shall be maintained or adjusted to meet the acceptable zone criteria. Refer to Section 3.2.2 of this specification for additional requirements.

3.5.2 Erosion

Erosion that occurs in the clay layer shall be repaired and grades re-established.

3.5.3 Freezing and Desiccation

Freezing and desiccation of the clay layer shall be prevented. If freezing or desiccation occurs, the affected soil shall be removed or reconditioned as directed.

3.5.4 Retests

Areas that have been repaired shall be retested as directed. Repairs to the clay layer shall be documented including location and volume of soil affected, corrective action taken, and results of retests.

END OF SECTION

SECTION 02227

ENGINEERED BARRIER COVER SOIL LAYER MATERIAL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1556	Density of Soil in Place by the Sand-Cone Method.
ASTM D 1557	Moisture-Density Relations of Soils, using 10.0 lb (4.5 kg) Rammer and 18-in. (457 mm) Drop.
ASTM D 422	Particle-Size Analysis of Soils.
ASTM D 4318	Liquid Limit, Plastic Limit and Plasticity Index for Soils.
ASTM D 5084	Measurement of Hydraulic Conductivity of Saturated Porous Material using a Flexible Wall Permeameter.
ASTM D 5321	Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
ASTM D 6938	Density and Water Content of Soil and Soil Aggregate in Place by Nuclear Methods.(Shallow Depth)

ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA Method 8270	Priority Pollutant Semivolatile Compounds
EPA Method 8260	Priority Pollutant Volatile Organic Compounds
EPA Method 6010	Priority Pollutant Metals (HG Method).
EPA Method 8081	Pesticides
EPA Method 8151	Herbicides
EPA Method 8082	PCBs
EPA Method 901.1	Radionuclides, Gamma Emitters

Note: EPA Methods referenced above will be referred to as "environmental testing" throughout these Specifications.

1.2 EXTENT OF WORK

1.2.1 Scope

A. The work to be performed under this Section shall include materials, all labor, tools, equipment, and testing for furnishing, placing, grading, and compacting the Engineered Barrier Cover Soil Layer as shown on the Drawings or as otherwise directed by the ENGINEER.

B. All necessary testing of materials as required in the Contract Documents.

C. CONTRACTOR field test data shall indicate compliance with the Contract Documents in order to be accepted. The field data shall be certified by the ENGINEER.

D. CONTRACTOR shall provide the ENGINEER with access to the borrow pits or material sources upon request for the purposes of observing material source operations and obtaining samples. The CONTRACTOR shall be responsible for supplying all required samples for testing.

E. All soil layer thicknesses referenced in this Section represent the installed compacted thickness.

F. Items listed in Section 02220, Part 1 - General, 1.1 Description also apply.

G. A suitable geotextile shall separate the soil layer from underlying and overlying material. Section 06645 provides geotextile specifications.

1.2.2 Related Sections

Section 02220, Earthwork and SMC Material Grading
Section 02225, Clay Barrier Layer
Section 02228, Angular Stone Erosion Protection and Aggregate
Section 06645, Geotextiles

1.3 QUALITY ASSURANCE

1.3.1 Tests:

A. The services of a qualified testing laboratory shall be engaged by the CONTRACTOR to make tests and determine acceptability of all fill or material as listed below. The laboratory shall be acceptable to the ENGINEER.

B. Required Tests:

1. Soil Material Samples from Off-Site: Gradation, ASTM D 422, ASTM D4318, ASTM D5084, Priority Pollutant Semi-volatile Compounds, EPA Method 8270, Priority Pollutant Volatile Organic Compounds, EPA Method 8260, Priority Pollutant Metals, EPA Method 6010 (HG Method), Pesticides, EPA Method 8081, PCB, EPA Method 8082, Herbicides, EPA Method 8151, Radionuclides, and EPA Method 901.1. All test results shall be in conformance with the New Jersey Non-Residential Soil Remediation Standards (NJAC 7:26D).

2. Compacted Cover Soil Material: Compaction, ASTM D 1557, ASTM D 1556 and ASTM D6938.

1.3.2 Permits and Regulations:

A. CONTRACTOR shall obtain all necessary permits for work.

B. CONTRACTOR shall perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction and any other permits required for this project.

1.4 SUBMITTALS

1.4.1 Test Reports:

A. Submit six (6) copies of the following reports directly to ENGINEER from the testing service, with copy to the CONTRACTOR:

1. All tests for soil material.
2. Compliance testing during construction.
3. Field density tests.
4. Optimum moisture - maximum density curve for each soil.

B. Testing shall conform to the following as a minimum.

1. Tests on material

a) Soil material: Environmental and radiological tests for soil material from off-site shall be performed at a frequency of 1 per 5,000 cubic yards if from a natural borrow source. Material that is not from a natural borrow source shall be tested at a frequency of 1 per 2,500 cubic yards.

2. Field density and moisture tests:

   a) Soil material: CONTRACTOR shall conduct one (1) test every 8,500 square feet per each lift. A Troxler Nuclear Moisture-Density gauge shall be used for all field density tests. Test locations shall be tied into a facility grid system 50 foot square. Test reports shall note the grid location point and lift for each test. CONTRACTOR shall establish and maintain grid points for each lift of material placed.

3. Moisture-density curve for soil material used in construction.

4. CONTRACTOR will conduct one ASTM D1557, ASTM D4318 and ASTM D5084 for every 5,000 cubic yards of the soil material, and one ASTM D422 for every 3,000 cubic yards of the soil material.

1.4.2. Submit six (6) samples of the Soil Layer materials required.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

Not Applicable.

2.2 ENGINEERED BARRIER COVER SOIL LAYER MATERIAL

2.2.1 Soil Material

A. Soil material as a component of the Engineered Barrier shall be provided as shown on the Contract Drawings. Soil shall be placed where shown or specified on the Drawings, or as otherwise directed by ENGINEER.

B. Soil shall be low plasticity inorganic soil borrow with adequate shear strength properties. The material shall be an earthen soil which is free of vegetation, ice or frozen material, wood, glass, metal, or other deleterious material. The maximum particle size shall be 3 inches and free of sharp edges for all soil.

C. Soil material shall meet the following requirements:

   1. Soil Material

      a) Permeability: The coefficient of hydraulic conductivity, k, shall not be more permeable than 1.0×10^{-5} cm/s.

      b) Internal Shear Strength: All Cover Soil material must adhere to the range of cohesion/internal friction angle properties specified below:

Cohesion (psf)	Internal Friction Angle (Φ)
0	37
10	36
20	34
35	32
45	30

The tests shall be performed for a minimum of three normal stresses that simulate field loading conditions. The following normal loads shall be used, 100 psf, 300 psf, 500 psf.

c) U.S Standard Sieve analysis parameters:
i. 100% passing 3-inch square sieve (see A2 above)
ii. Less than or equal to 30% passing No. 200 sieve

d) Plasticity index (PI) <15

e) The CONTRACTOR shall submit to the ENGINEER engineering calculations prepared by a licensed New Jersey Professional Engineer, shop drawings, proposed quality assurance and quality control measures, product information, laboratory test results and all other necessary and applicable data to the ENGINEER.

f) The soil material shall be tested in accordance with ASTM D 5321, based on soil type and geosynthetics used and shall exhibit an interface friction angle of >27°.

D. Provide approved soil materials, free of contaminated soil, clay, rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetable and other deleterious matter.

E. Soil shall comply with the New Jersey Non-Residential Soil Remediation Standards (NJAC 7:26D) and radiological constituents in the soil shall not exceed five (5) picocuries per gram of any isotope excluding Potassium-40, uranium and thorium. Radiological constituents shall not exceed 2.5 picocuries per gram for uranium and shall not exceed 11.9 picocuries per gram for thorium.

PART 3 - EXECUTION

3.1 INSTALLATION

3.1.1 The ENGINEER or his representative will examine the areas and conditions under which excavating, filling, and grading are to be performed and notify the CONTRACTOR of conditions CONTRACTOR may encounter that are detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3.1.2 CONTRACTOR shall provide the ENGINEER or his representative with clean, unused, scalable 5-gallon pails with handles and lids to obtain samples. CONTRACTOR shall provide personnel to the ENGINEER or his representative to collect samples.

3.1.3 Prior to procurement of material and starting construction, the CONTRACTOR shall have submitted and received approvals for the materials based on the testing required in this Section.

3.1.4 Soil material shall be pushed using low pressure equipment and a minimum of 8 inches of material shall be kept beneath the tracks at all times. It is imperative that the CONTRACTOR makes every reasonable effort to minimize the potential for Cover Soil to adversely affect the underlying geotextile and drainage layer via penetration. Therefore, low pressure equipment shall be used to place cover materials. Equipment operators shall not be permitted to make sharp turns or quick stops.

3.1.5 Soil material shall be placed on all areas as shown on the Drawings or as directed by the ENGINEER and as described in these Specifications. The thickness of each lift prior to compaction of the soil material shall be no greater than eight (8) inches. Total compacted thickness of the soil material shall be as shown on the Drawings. Compaction of the soil material shall be accomplished by suitable compaction equipment, subject to approval by the ENGINEER.

3.1.6 The soil material shall be placed and compacted as necessary to achieve the required permeabilities and shear strength. The cover material shall be compacted to 90 percent of Modified Proctor (ASTM D1557). The moisture content of the material shall be maintained within 3 percent of optimum moisture. CONTRACTOR shall not work wet soil material that cannot support equipment.

3.1.7 If changes in the material occur, the ENGINEER shall verify the material is from an approved source and the ENGINEER and/or Quality Assurance Officer (QAO) may require additional testing in accordance with Paragraph 1.3, Part A (2) of this Section. If the material is not from an approved source or if the material is determined to not be acceptable by the ENGINEER or QAO, the CONTRACTOR shall be notified that the material is not approved. The ENGINEER and QAO shall reject any work performed by the CONTRACTOR using the new material until the appropriate testing is conducted and the material is approved by the ENGINEER and QAO.

3.1.8 The thickness of the in-place soil material will be checked after the completion of the work on a grid pattern not to exceed 50-foot by 50-foot by digging, by hand, with a plastic shovel in the presence of and as directed by the ENGINEER and QAO. The size of the test hole shall not be less than one-foot in diameter. Measurements shall be made perpendicular to the slope. The CONTRACTOR shall be responsible for digging holes in the soil material to allow for the measurements to be taken by the ENGINEER. After measurements have been made, the CONTRACTOR shall backfill the holes with soil material, and hand tamp. During digging and backfill of test holes, the CONTRACTOR shall use plastic shovels and exercise care not to damage any materials. Any such damage shall be repaired at the expense of the CONTRACTOR.

3.1.9 The CONTRACTOR shall be responsible for repairing damage to the soil material between testing and acceptance.

3.1.10 All soil samples are to be obtained under the direction of the ENGINEER and QAO.

3.1.11 Final acceptance of soil material is dependent on:

a. Satisfying the minimum requirement of thickness from the selected alternative as shown on the Contract Drawings measured perpendicular to the slope.

b. Cover material meeting all the physical/analytical properties listed in this Section Section.

3.1.12. Any damage, disturbance, or settlement that occurs as a result of the CONTRACTOR'S stockpiling of material or equipment at the facility shall be the responsibility of the CONTRACTOR to repair and/or supply additional materials to compensate for settlement caused by the CONTRACTOR'S actions.

3.2 SOURCE QUALIFICATION TESTING

3.2.1 Prior to acceptance of soil from the borrow source or stockpile site, the CONTRACTOR shall provide the following soil analyses to the ENGINEER:

A. Results of interface friction test performed for the interface between the proposed Cover Soil and proposed geosynthetic in accordance with ASTM Standard Test Method D 5321 (latest revision) performed under saturated conditions, with a 24-hour saturation period prior to the test, Determining the Coefficient of Soil/Geosynthetic Friction by the Direct Shear Method. The test shall be performed for a minimum of three normal stresses applied to bracket the normal stress at the interface being tested.

B. Results of compaction tests conducted in accordance with ASTM D 1557 (latest revision), Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.

C. Results of Atterberg limits, plastic and liquid limit, and plasticity index conducted in accordance with ASTM D 4318 (latest revision), Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

D. Results of the particle-size analysis conducted in accordance with ASTM D 421/422 (latest revision). Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants/Test Method for Particle Size Analysis of Soils.

E. Results of hydraulic conductivity testing conducted in accordance with ASTM D 5084 (latest revision), Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.

F. Results of chemical analyses conducted in accordance with the requirements of this Specification Section.

G. Results of radiological analysis conducted in accordance with EPA Method 901.1.

3.2.2. Unless otherwise stated, soil materials shall be tested prior to construction for the following at the indicated intervals in the table below. The following test frequencies shall be consistent with paragraph 1.4.1, Part B of this section.

ITEM	FREQUENCY
Interface friction test (ASTM D5321)	Initial test (one time)
Soil Compaction test (ASTM D1557)	See paragraph 1.4.1, Part B, (4) of this Section.
Atterberg, liquid, plastic limits (ASTM D4318)	See paragraph 1.4.1, Part B, (4) of this Section.
Particle size analysis (ASTM D421/422)	See paragraph 1.4.1, Part B, (4) of this Section.
Environmental Testing (1)	See paragraph 1.4.1, Part B, (1) of this Section.
Radiological Testing (EPA 901.1)	See paragraph 1.4.1, Part B, (1) of this Section.
Hydraulic conductivity (ASTM D5084)	See paragraph 1.4.1, Part B, (4) of this Section.
US Standard Sieve Analysis 1/4-inch sieve #200 sieve	Initial test (one time)

Notes: (1) Environmental Testing is representative of the tests and associated test methods detailed in paragraph 1.1 References, of this section.

3.3 ADDITIONAL QA/QC TESTING

3.3.1 Soil Material

A. Quality Assurance and Control Testing:

1. The ENGINEER or QAO may at his discretion perform quality assurance and control testing during construction. This testing is in addition to all other tests required to be conducted by the CONTRACTOR.

2. The ENGINEER or QAO will collect representative samples from each material source of Cover Soil for testing at a frequency determined by the ENGINEER and QAO.

3. The Cover Soil shall exhibit an interface friction angle in accordance with the values as specified in Section 2.2(A) of this specification. Materials tested by the ENGINEER or QAO exhibiting results not meeting the interface friction angle

requirements will be rejected; or the CONTRACTOR may be required to furnish additional test data, at his expense, to demonstrate acceptability of the material.

END OF SECTION

SECTION 02228

ANGULAR STONE EROSION PROTECTION AND AGGREGATE

PART 1 GENERAL

1.1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
ASTM C 117	Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
ASTM C 127	Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
ASTM C 131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
ASTM C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
ASTM C 295-90	Standard Guide for Petrographic Examination of Aggregates for Concrete.

ENVIRONMENTAL PROTECTION AGENCY

EPA Method 901.1	Radionuclides, Gamma Emitting.

NUCLEAR REGULATORY COMMISSION

NUREG-1623	Design of Erosion Protection for Long-Term Stabilization

1.2. EXTENT OF WORK

1.2.1 Scope:

A. This Specification Section describes the requirements for placing angular stone erosion protection and crushed angular aggregate materials for the construction of the erosion control layer, filter bedding layer, biointrusion/drainage layer and perimeter erosion protection aprons for the Shieldalloy Storage Yard engineered barrier.

B. CONTRACTOR shall provide all labor, materials, tools, equipment, testing and services necessary for the placement of broken and crushed angular stone and angular crushed rock aggregate materials for the engineered barrier as shown on the Drawings and specified, or as otherwise directed by the ENGINEER.

1.3. QUALITY ASSURANCE

1.3.1 Tests:

A. The services of a qualified testing laboratory shall be engaged by the CONTRACTOR to conduct tests and determine acceptability of the angular stone erosion protection or aggregate material as listed below. The laboratory shall be acceptable to the ENGINEER.

B. Required Tests:

1. Angular stone erosion protection and crushed angular granular aggregate materials for erosion protection cover, bedding layer, root penetration/cap drainage layer and perimeter erosion protection: Gradation, ASTM D 117 and ASTM D 136; Specific Gravity (Saturated Surface Dry Basis) and Absorption, ASTM C 127; Sodium Sulfate Soundness, ASTM C88 (5 cycles); Abrasion, ASTM C131 (100 revolutions); and EPA Method 901.1.

2. Stone used for erosion protection materials: Petrographic Examination, ASTM C-295-90.

C. The frequency of tests shall be in accordance with Section 3.3.1 of this Specification for the total amount produced at the quarry for this project regardless of number of sizes of materials produced.

1.3.2 Quality Requirements

A. All broken stone and crushed stone aggregate materials used shall meet the following requirements as tested by the CONTRACTOR:

1. The tests specified in Section 1.3.1 B shall be taken at the frequency specified in Section 3.3.1 for each material type. The score for each test is determined by multiplying the appropriate weighing factor by the score (0 to 10) based on the specific test results. The final score for each sample is the ratio of the sum of the individual test scores (four tests) to the maximum possible score, expressed as a percentage. To be acceptable, the final score must be no less than 80 percent for the erosion protection cover, riprap and filter bedding material as presented in Table 2-2.

Table 2-2 Scoring Criteria for Determining Rock Quality

Laboratory Test	Weighting Factor	Score										
	Igneous	10	9	8	7	6	5	4	3	2	1	0
Sp. Gravity	9	2.75	2.70	2.65	2.60	2.55	2.50	2.45	2.40	2.35	2.40	2.25
Absorption %	2	0.10	0.30	0.50	0.67	0.83	1.0	1.5	2.0	2.5	3.0	3.5
Sodium Sulfate %	11	1	3	5	6.7	8.3	10	12.5	15	20	25	30
LA Abrasion (100 revs.) %	1	1	3	5	6.7	8.3	10	12.5	15	20	25	30

1. Scores were derived from Tables 6.2, 6.5, and 6.7 of NUREG/CR-2642 - "Long-Term Survivability of Riprap for Armoring Uranium Mill Tailings and Covers: A Literature Review," 1982.
2. Weighting Factors are derived from Table 7 of "Petrographic Investigations of Rock Durability and Comparisons Various Test Procedures," by G. W. DuPuy, Engineering Geology, July 1965. Weighing factors are based on inverse ranking of test methods for each rock type.

2. Only igneous, diabase rock will be accepted.

3. Radiological constituents in the rock shall not exceed five (5) picocuries per gram of any isotope excluding Potassium-40, uranium and thorium. Radiological constituents shall not exceed 2.5 picocuries per gram for uranium and shall not exceed 11.9 picocuries per gram for thorium.

B. Source Quality Control

1. The materials shall be inspected and tested by the CONTRACTOR, ENGINEER and Quality Assurance Officer (QAO) to ensure that they meet all requirements of this Specification. Gradation requirements will be tested by the CONTRACTOR at the quarry and placement location.

2. The CONTRACTOR shall provide a qualified engineering geologist or soils technician to monitor materials acquisition and production to ensure that only materials acceptable under Article 2.1 as confirmed by the ENGINEER and QAO are processed. During excavation or blasting of materials, the CONTRACTOR, ENGINEER and QAO will inspect the facility to ensure that stripping and material selection procedures are adequate to prevent inclusion of deleterious materials in processed materials. The ENGINEER and QAO reserve the right to inspect and test the materials.

3. The CONTRACTOR will perform gradation tests for select bedding material and for each type of riprap. The tests will be performed in accordance with the

requirements of ASTM C136. There will be at least four tests performed with an initial test and one test for every third (by volume) of the total material produced.

1.4. SUBMITTALS

1.4.1 Test Reports:

A. Submit six (6) copies of the test reports directly to ENGINEER from the testing service, with copy to the QAO:

B. Testing shall conform to the requirements as indicated in the specific material specification sections.

1.4.2 Submit six (6) samples of all materials.

PART 2 PRODUCTS

A. General

1. Material Sources: Erosion protection stone and aggregate materials shall be obtained from the Dyer Quarry in Birdsboro, PA.

2. Approval of the Dyer Quarry as the source does not mean that all materials excavated will meet the requirements of this Specification. Processing will be utilized to meet the gradation and quality requirements of Section 1.3.

3. The diabase rock has been shown to be below the background radioactive level (see Section 1.3.2.A(3) and free from other contamination.

4. Material shall be dense, sound, angular, resistant to abrasion, and shall be free from cracks, seams, and other defects as shown in the petrographic examination and during field inspection.

5. Quality and Gradation Tests: Tests shall be performed as presented in Section 1.3.

B. Subcontractor-Proposed Sources

Not Applicable

C. Gradation Requirements

1. Materials shall be reasonably well-graded within the following limits:

a. Broken and Crushed Angular Stone:

i. Gradation: Broken and crushed angular stone materials shall be reasonably well-graded within the limits presented in Table 2.3. The sizes are specified in terms of square openings of U.S. Standard Sieves or by the Nominal Sizes of the Materials.

ii. Maximum Size: No individual piece shall be greater than 90 percent of the layer thickness.

Table 2-3 Broken and Crushed Angular Stone Gradations

Material	Graded Stone Size (in)			U.S. Standard Sieve Size (Nominal) (Square Openings) Percent Passing							
	Max.	d_{50}	Min.	18-inch	12-inch	10-inch	6-inch	5-inch	4-inch	3 - inch	2-inch
(6" – 18" Riprap)	18	12	6	100	40 - 60	10 - 30	0	0	0	0	0
4" – 6" Riprap	10	5	3	100	100	100	100	40 - 60	10 - 40	0	0
2" – 4" Crushed Stone	4	3	2	100	100	100	100	100	100	40 - 60	0

b. Angular Crushed Rock Aggregate Material:

i. Aggregate material shall be obtained from borrow areas approved by the ENGINEER. The quarry shall process the materials, as required, to meet the gradation requirements specified below.

c. Gradation: Aggregate material shall be reasonably well-graded within the following limits:

Table 2-4 Aggregate Gradations

	Aggregate Size (in.)		
	Maximum	d_{50}	Minimum
½" – 1½" Crushed Stone	2	1	3/8
$^1/_8$" – ½" Crushed Stone	½	¼	1/8

Table 2-4 Note: Processed crushed concrete from onsite sources meeting the requirements of the $^1/_8$" – ½" crushed stone may used to cover the medium SMC material prior to placement of the fine SMC material in the final stockpile (see Article 3.2.1 of Specification Section 02220).

PART 3 – EXECUTION

3.1 PLACEMENT AND COMPACTION

3.1.1 Erosion protection materials shall be handled, loaded, transported, stockpiled, and placed in a manner that avoids nonconformance with specifications due to segregation and degradation, including materials moved to and from stockpiles.

3.1.2. Subgrade preparation shall include:

A. Stone and aggregate materials shall be placed upon the smooth prepared and compacted underlying cap component layer consisting of the material shown on the Decommissioning Plan drawing details and as required by the specifications for the material. The underlying material shall be properly installed to the specified grades and shall not be uneven.

B. The maximum slope of the subgrade may not exceed 3 horizontal to 1 vertical at any point.

C. A topographic survey of the completed underlying material will be made to verify slope, for thickness verification of subsequent layers and as a basis for CONTRACTOR payment.

3.1.3 Where the required stone or aggregate material thickness is six inches or less, the bedding material shall be spread and compacted in one layer.

3.1.4 Placing of material by methods that will tend to segregate particle sizes within the layer will not be permitted.

3.1.5 Stone and aggregate material, up to a maximum nominal size of 12 inches, may be placed by end- dumping and may be spread by bull-dozers or other suitable equipment.

3.1.6 Dumped stone material shall be placed to its full course thickness in one operation and in such a manner as to avoid displacing the bedding material. The larger stones shall be well-distributed throughout the mass. The finished stone layer shall be free from pockets of small stones and clusters of larger stones. Placing stone by dumping into chutes or by similar methods likely to cause segregation of the various sizes will not be permitted. The desired distribution of the various sizes of stones throughout the mass shall be obtained by selective loading of the material at the quarry or other source, by controlled dumping of successive loads during final placing, or by other methods of placement that will produce the specified results. Rearranging of individual stones by mechanical equipment or by hand may be required to the extent necessary to obtain a well-keyed and reasonably well-graded distribution of stone sizes as specified above. Larger pieces of stone may require individual placement by equipment. Hand arrangement will be required only to the extent necessary to secure acceptable results. Stones shall be selected and positioned so as to produce an essentially solid, densely placed face of rock with all stones firmly wedged in place. Any stones that are not firmly wedged shall be adjusted and additional selected stones inserted or existing stones replaced, so as to achieve a solid interlock.

3.1.7 For stone placed by clam-shell or similar equipment, hand arrangement will be required only to the extent necessary to secure the results specified herein. Stones shall be selected individually and positioned manually under experienced supervision so as to produce an essentially solid layer with all stones firmly wedged in place. Any stones that are not firmly wedged, in the opinion of the ENGINEER, shall be adjusted by crow-bars or similar tools and additional selected stones inserted, or existing stones replaced, so as to achieve solid interlock.

3.1.8 Each layer of stone shall be track-walked by two passes of a Caterpillar D5 bulldozer or equal unless otherwise approved by the ENGINEER. Stone shall be spread in a manner that will achieve full coverage and a uniformly distributed well-keyed, densely- placed layer.

3.1.9 Construction equipment other than spreading and compaction equipment shall not be allowed to move over the placed stone material and aggregate material layers except at equipment crossovers as designated by the ENGINEER. Fill materials shall be placed temporarily at equipment crossovers to prevent degradation of placed stone materials. Each crossover shall be cleaned of all contaminating materials and approved by the ENGINEER before additional materials are placed in these areas. Other construction equipment may move over placed stone and aggregate layers. The ENGINEER may restrict such traffic to minimize damage to completed layers. Areas of riprap and bedding layers damaged by construction equipment shall be restored to meet the requirements of the Specifications.

3.2 TOLERANCES

3.2.1 The material layers shall be placed generally to the limits and thicknesses shown on the Drawings within the following tolerances:

A. The top of the stone and aggregate subgrade shall not have a slope steeper than 3 horizontal to 1 vertical (3:1). No visible gullies, ditches or other features which would allow for surface water flow concentrations will be accepted.

B. Top of aggregate material shall be within ±0.1 foot of the design elevations as determined from the survey of the underlying material and the aggregate surface.

C. The in-place thickness of stone material shall be between 90 percent and 125 percent of the thickness shown.

D. Local irregularities not exceeding the thickness limits above will be permitted provided that such irregularities do not form noticeable mounds, ridges, swales or depressions that in the opinion of the ENGINEER could cause concentrations of surface runoff or form ponds or gullies.

E. The material placed meets the gradation requirements specified.

F. Stone layer thickness will be directly measured on a 50 foot grid to determine that minimum thickness requirements are met using rebar grade stakes pre-painted with the appropriate layer thickness.

3.2.2 Materials segregated or not placed according to the above requirements shall be regraded or adjusted, or removed and replaced using appropriate equipment, to conform with the tolerances and limits given above.

3.2.3 Materials not meeting the requirements of this Section shall be removed and replaced with specified materials. Rejected materials shall be disposed of at designated disposal sites. Materials not meeting the grading requirements shall be reprocessed or discarded. The ENGINEER may require modification of the processing and grading operations to ensure that the specified grading requirements are met.

3.2.4 During placement of riprap material and bedding material, the CONTRACTOR shall perform a minimum of four gradation tests in accordance with Article 3.4.1B below. An initial sample shall be obtained and tested during the early stages of placement activities. Additional samples shall be obtained and tested when approximately one-third and two-thirds of the total volume of material has been placed, and a final sample shall be obtained and tested near completion of placement activities.

3.3 MATERIALS TESTING

3.3.1 Materials Testing Frequency

A. The stone and aggregate materials of each type shall be tested by the CONTRACTOR at a certified commercial testing laboratory during production in accordance with the following:

Specific Gravity (SSD) ASTM C-127 Absorption ASTM C-127 Soundness (5 cycles) ASTM C-88 Abrasion (100 revolutions) ASTM C-131

The results shall be submitted for analysis and subsequent acceptance or rejection of the material represented by the test results, based on engineering calculations. The Contractor's rock production and placement schedules shall allow sufficient time for rock durability testing and subsequent submittal review such that all materials can be accepted (or rejected) prior to delivery to the facility.

B. Each type of stone and aggregate material shall be tested by the CONTRACTOR at a certified commercial testing laboratory for gradation in accordance with ASTM C-117 and ASTM C-136, as applicable. Test results shall be in accordance with these Specifications.

C. The stone and aggregate material of each type shall be tested by the CONTRACTOR a minimum of four times. The materials shall be tested initially prior to the delivery of any materials to the facility and at the beginning of placement. Thereafter, the test frequency shall be three tests for each type material when approximately one-third and two-thirds of the total volume of material has been produced or placed. A final set of durability tests shall be performed near completion of production for each type of material. A final gradation test shall be performed near completion of placement for each type of material. When representative bedding and riprap materials are considered under-sized for tests, sufficiently large parent material shall be obtained for testing, or these tests will not be utilized in the scoring process.

D. The CONTRACTOR shall ensure that at least one petrographic examination shall be made by a qualified geologic laboratory for each rock type used for erosion protection materials. Testing shall be performed in accordance with ASTM C- 295-90.

3.4 INSPECTIONS

A. Daily visual inspections shall be performed by the ENGINEER and QAO to verify that quality-related activities are performed in accordance with requirements. Daily visual inspections performed by qualified and certified inspection personnel shall be accomplished during execution of the various work activities to verify compliance to the above-listed criteria.

B. Erosion Protection

The excavation, production, stockpiling, transportation, placement, and compaction of the erosion protection stone materials shall receive adequate inspection to verify the following:

1) proper techniques are employed to prevent degradation of the material due to improper handling;
2) distribution is uniform;
3) voids are kept as minimal as possible; and
4) proper gradation and lift thickness are maintained.

Inspections will be performed by the ENGINEER and QAO at the material source, as required, to verify compliance with the specification requirements. Stone material shall be visually inspected to verify that the material is dense, sound, angular rock, resistant to abrasion, and free from cemented cracks, seams, and other defects, as shown in the petrographic examination.

For placement control purposes, a 25' x 25' or larger, test area shall be constructed for each type of stone using material meeting gradation and thickness requirements, as specified. This section will be used to show what material meeting specifications looks like after placement, and to calibrate "eyes" of inspectors and other interested persons. If properly constructed on the embankment, the test section can become part of the completed erosion protection.

END OF SECTION

SECTION 02290

LYSIMETER CONSTRUCTION

PART 1 - GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRASNPORTATION OFFICIALS (AASHTO)

AASHTO M-288	Standard Specification for Geotextile Specification for Highway Applications

ASTM INTERNATIONAL (ASTM)

ASTM D 1004	Test Method for Initial Tear Resistance of Plastic Film and Sheeting
ASTM D 1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D 1238	Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D1248	Specification for Polyethylene Plastics Molding and Extrusion Materials
ASTM D 1505	Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D 1603	Test Method for Carbon Black in Olefin Plastics
ASTM D 1784	Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2464	Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

ASTM D 2467	Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D3350	Polyethylene Plastic Pipe and Fittings Materials
ASTM D 3895	Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
ASTM D 4218	Standard Test Method for Determination of Carbon Black in Polyethylene Compounds
ASTM D 4355	Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
ASTM D 4491	Water Permeability of Geotextiles by Permittivity
ASTM D 4533	Trapezoid Tearing Strength of Geotextiles
ASTM D 4595	Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D 4632	Grab Breaking Load and Elongation of Geotextiles
ASTM D 4716	Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
ASTM D 4751	Determining Apparent Opening Size of a Geotextile
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
	ASTM D 5199 Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
ASTM D 5397	Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test

ASTM D 5596	Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
ASTM D 5994	Standard Test Method for Measuring Core Thickness of Textured Geomembranes
ASTM D 6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
ASTM D 6693	Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
ASTM D 7005	Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites
ASTM D 7466	Standard Test Method for Measuring the Asperity Height of Textured Geomembrane

GEOSYNTHETIC RESEARCH INSTITUTE (GSI)

GRI GC8	Determination of the Allowable Flow Rate of a Drainage Geocomposite
GRI GM 17	Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes

1.2 EXTENT OF WORK

CONTRACTOR shall provide all labor, materials, tools, equipment, and services necessary for the construction of lysimeters as shown on the Drawings and Specifications, or as otherwise directed by the ENGINEER.

1.3 QUALITY ASSURANCE

1.3.1 Manufacturer's Qualifications:

Material manufacturers shall be specialists in the manufacture of the particular material specified. Manufacturers shall provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of similar material design and workmanship. Standard products shall have been in satisfactory commercial or industrial use for 2 years prior to the proposed installation date. The 2 year installation requirement shall include applications of equipment and materials under similar circumstances and of similar size.

1.3.2 Submittals:

1. Shop Drawings:

   a. CONTRACTOR shall submit six (6) copies of manufacturer's data.

   b. No materials shall be shipped until the required submittals have been submitted, reviewed, and accepted by the ENGINEER.

1.3.3 Manufacturer's Quality Control:

The Manufacturer shall be responsible for establishing and maintaining a quality control program to assure compliance with the requirements of this Specification Section. Documentation describing the quality control program shall be made available upon request. Manufacturing quality control sampling and testing shall be performed in accordance with the manufacturer's quality control program and this Specification Section.

1.4 PAYMENT

Lysimeters installed and accepted will be paid for at the respective contract unit price in the bidding schedule. This unit price shall include the cost of materials, equipment, installation, testing, and other costs associated with installation of the lysimeter.

1.5 SUBMITTALS

ENGINEER approval is required for submittals with a "E" designation; submittals not having a "E" designation are for CONTRACTOR Quality Control approval. The following shall be submitted in accordance with SUBMITTAL PROCEDURES Section:

1.6.1 SD-03 Product Data

A minimum of 30 days prior to scheduled placement, manufacturer's product data shall be submitted to the ENGINEER for review and acceptance.

a. Linear Low Density Polyethylene (LLDPE) Liner, E
b. Triplanar Geocomposite, E
c. PVC Pipe and Fittings, E
d. HDPE Pipe and Fittings, E
e. Pea Gravel, E
f. Well Cover, E

1.6.2 SD-13 Certificates

a. Warranties, E

Provide warranties for all liner materials, geocomposite materials, and pipes/fittings against defects in workmanship for a period of 1 year from the date of installation.

1.7 DELIVERY, STORAGE AND HANDLING

1.7.1 Delivery

The ENGINEER and Quality Assurance Officer (QAO) shall be notified a minimum of 24 hours prior to delivery and unloading of lysimeter materials to the site. All materials shall be packaged, shipped, and unloaded in a manner which will not cause damage to the materials. All materials shall be labeled with the manufacturer's name, material type, and product identification (material/model/part number).

1.7.2 Storage

All lysimeter materials shall be protected from construction equipment, chemicals, sparks and flames, temperatures in excess of 160 degrees F, or any other environmental condition that may damage the physical properties of the materials. Materials shall be elevated off the ground in an area where water will not accumulate, and all materials are protected from punctures, abrasions and excessive dirt and/or moisture. Keep interior of pipes and fittings free of dirt and debris.

1.7.3 Handling

All lysimeter materials shall be handled to prevent damage to materials and in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 LINEAR LOW DENSITY POLYETHYLENE (LLDPE) LINER

All LLDPE Liner material shall be textured polyethylene as shown on the drawings. LLDPE resin shall be new, first quality, compounded and manufactured specifically for producing the liner material. Natural resin (without carbon black) shall meet the requirements shown on Table 2.1:

Table 2.1: Raw Material Properties

Property	**Test Method**	**LLDPE**
Density (g/cm3)	ASTM D 1505	≥0.915
Melt Flow Index (g/10 min)	ASTM D 1238 (190/2.16)	≤1.0
OIT (minutes)	ASTM D 3895 (1 atm/200^{0}C)	≥100

LLPDE materials shall not exceed a combined maximum total of 1 percent by weight of additives other than carbon black. LLDPE liner shall be free of holes, pinholes as verified by on-line electrical detection, bubbles, blisters, excessive contamination by foreign matter, and nicks and cuts on roll edges. LLDPE liner material is to be supplied in roll form. All LLDPE sheets produced at the factory shall be inspected prior to shipment for compliance with the physical property requirements of this Specification Section and be tested by an acceptable method of inspecting for pinholes. If pinholes are located the material shall be rejected and replaced by a material free of pinholes.

The Textured surface LLDPE liner shall meet the requirements shown on Table 2.1 below:

Table 2.2: LLDPE Liner Properties

TESTED PROPERTY VALUE	TEST METHOD	FREQUENCY	MINIMUM AVERAGE VALUE			
			40 mil	60 mil	80 mil	100 mil
Thickness, (minimum ave) mil (mm) Lowest individual reading (-10%)	ASTM D 5994	every roll	40 (1.00) 36 (0.91)	60 (1.50) 54 (1.40)	80 (2.00) 72 (1.80)	100 (2.50) 90 (2.28)
Density, g/cm^3	ASTM D 1505	200,000 lb	0.92	0.92	0.92	0.92
Tensile Properties (each direction) Strength at Break, lb/in-width (N/mm) Elongation at Break, %	ASTM D 6693, Type IV Dumbell, 2 ipm G.L. 2.0 in (51 mm)	20,000 lb	115 (20) 500	168 (29) 500	224 (39) 500	270 (47) 500
Tear Resistance, lb (N)	ASTM D 1004	45,000 lb	25 (111)	38 (169)	50 (222)	60 (266)
Puncture Resistance, lb (N)	ASTM D 4833	45,000 lb	65 (289)	95 (422)	125 (556)	140 (622)
Carbon Black Content, % (Range)	ASTM D 1603*/4218	20,000 lb	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note[1]	Note[1]	Note[1]	Note[1]
Asperity Height, mil (mm)	ASTM D 7466	second roll	18 (0.45)	18 (0.45)	18 (0.45)	18 (0.45)
Oxidative Induction Time, min	ASTM D 3895, 200° C; O2, 1 atm	200,000 lb	>140	>140	>140	>140

Table 2.2 Notes:

1. Dispersion applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.

2.1.1 LLDPE Liner material shall be:

1. GSE UltraFlex Textured Geomembrane produced by GSE Lining Technology, Inc.
2. Or equal.

The LLDPE manufacturer shall have manufactured a minimum of 10,000,000 square feet of polyethylene geomembrane during the last year.

2.2 TRIPLANAR GEOCOMPOSITE

The triplanar geocomposite drainage material shall be comprised of a tri-axial geonet structure with thermally bonded nonwoven geotextiles on both sides. The tri–axial geonet shall consist of thick main–ribs with diagonally placed top and bottom–ribs. The material shall be capable of providing high transmissivity in a soil environment under both low and high loads and will have properties conforming to the values and test methods listed on Table 2.3 below:

Table 2.3: Triplanar Geocomposite Properties

PROPERTY	TEST METHODS	UNITS	VALUE	QUALIFER	TEST FREQUENCY
Resin					
Density	ASTM D 1505	g/cm^3	0.94	MAV	lot
Melt Flow Index	ASTM D 1238	g/10min	1.0	MAX	lot
Geonet Core[1]					
Structure[2]	Tri-axial				
Geonet Cross-Rob Spacing	Calibered	inch (mm)	0.43 (11.0)	MAX	50,000 sf
Geonet Main-Rib Spacing	Calibered	inch (mm)	0.47 (12.0)	typical	50,000 sf
Unsupported Aperture Area		$inch^2$ (mm^2)	0.3 (195)	MAX	50,000 sf
Tensile Strength - MD	ASTM D 4595	lb/ft (kN/m)	1200 (17.5)	± 10%	50,000 sf
Creep Reduction Factor[3]	GRI-GC8	-			
@ 25,000 psf, 20°C			1.2		
@ 15,000 psf, 40°C			1.2		
Thickness	ASTM D 5199	mil (mm)	300 (7.6)	± 10%	50,000 sf
Carbon Black	ASTM D 4218	%	2-3	range	50,000 sf
Geotextile[1]					
U.V. Resistance (500 hrs)	ASTM D 4355	%	70		Per formula
Serviceability Class	AASHTO M-288		Class 1		
Grab Tensile	ASTM D 4632	lbs (N)	202 (900)	MARV	100,000 sf
Grab Elongation	ASTM D 4632	%	50	MARV	100,000 sf
Tear Strength	ASTM D 4533	lbs (N)	79 (350)	MARV	100,000 sf
Puncture Resistance	ASTM D 4833	lbs (N)	110 (490)	MaxARV	100,000 sf
AOS3[3]	ASTM D 4751	US Sieve (mm)	80 0.18)	MARV	500,000 sf
Permittivity[3]	ASTM D 4491	Sec^{-1}	1.0	MARV	500,000 sf
Geocomposite					
Roll Sizes	12.5 ft x 200 ft (3.9 m x 61 m)				
Peel Adhesion - MD	ASTM D 7005	lb/in (g/in)	1.0 (454)	MAV	100,000 sf
Transmissivity[4] - MD (m^2/sec) Gradient/Load	ASTM D 4716 GRI - BC8	1,000 psf (48 kPa)	15,000 psf (720 kPa)		
0.1		$4.0*10^{-3}$	$2.0*10^{-3}$	MAV	200,000 sf
0.02		$7.0*10^{-3}$	$3.5*10^{-3}$	MAV	200,000 sf

Table 2.3 Notes:

1 Geotextile and geonet properties listed are prior to lamination.
2 Creep Reduction Factor shall be based on 10,000 hour test duration, extrapolated to 30 years, under the corresponding compressive load and temperature
3 Hydraulic properties: AOS and permittivity shall be applicable to the top filter geotextile.

4 Geocomposite transmissivity shall be measured by manufacturer per ASTM D 4716 with testing boundary conditions as follows: steel plate/Ottawa sand/geocomposite/60 mil HDPE geomembrane/steel plate, and seating period of 100 hours according to GRI–GC8, with the stronger side of the geocomposite facing the soft boundary condition as indicated with top (soil)/bottom (liner) label on the rolls. Digital indicator of hydraulic gradient is required during the transmissivity measurement at low gradients.

5 Table 2.3 Qualifiers: MARV=Minimum Average Roll Value (MARV), MAV=Minimum Average Value, MAX=Maximum Value, MaxARV=Maximum average roll value.

2.2.1 Triplanar Geocomposite material shall be:

1. Tendrain 7100-2 Double-Sided Geocomposite produced by Tenax Corporation
2. Or equal.

2.3 PIPING

Piping shall be installed as shown in the project drawings.

2.3.1 Polyvinyl Chloride (PVC) Pipe and Fittings

All PVC pipe and fittings used for lysimeter construction shall be Schedule 80, unless otherwise specified, as shown on the project drawings. Pipe shall be Type I, Grade 1 conforming to the requirements of ASTM-D-1784 and ASTM-D-1785. Pipe shall be rigid, homogeneous throughout, and free from visible cracks, holes, foreign inclusions, and other defects. All PVC pipe and fittings shall be installed with socket-type joints conforming to the requirements of ASTM D-2467 (using PVC solvent cement, conforming to ASTM D-2564), or with flanged or screwed joints conforming to ASTM D-2464.

2.3.2 Polyethylene Pipe

Polyethylene piping material and fittings used for lysimeter construction shall be Type III C5 P34 as tabulated in ASTM D-1248, and have recommended designation values of 3-3-5-4-3-3-C or better as referenced in ASTM D 3350. The polyethylene pipe shall have a minimum rating of 100 psi and minimum thickness equivalent to SDR-11 or as shown on the Contract Drawings. The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign materials, blisters, wrinkles and dents. The pipe shall be marked with an easily legible and permanent surface mark specifically identifying the manufacturers by name or trademark and the size, schedule, and type of pipe. All polyethylene piping and fittings shall be joined by the heat fusion process producing homogeneous sealed, leak-tight joints in accordance with manufacturer's recommendations and procedures.

2.4 PEA GRAVEL

Pea gravel used in lysimeter construction shall be a washed, free draining, naturally rounded stone material $^3/_8$" in diameter with minimum diameter of ¼" and a maximum diameter of ½". No specific gradation shall be required.

2.5 GEOTEXTILE

Geotextile shall be a needle punched, nonwoven fabric meeting the requirements of Specification Section 06645.

2.6 STAINLESS STEEL WELL COVER

The HDPE standpipe shall protected by a stainless steel well riser cover. The well cover shall be manufactured of 12" diameter, schedule 5, 304 stainless steel. All parts of the well cover, including hinge, cap, and lockable hasp shall be stainless steel.

2.7 CAST–IN–PLACE CONCRETE

The stainless steel well covers shall be set into a concrete footing. Concrete for the footing shall be ASTM C94/C94M, using 3/4 inch maximum-size aggregate, and having minimum compressive strength of 4000 psi at 28 days.

PART 3 - EXECUTION

3.1 INSTALLATION

3.1.1 LLDPE Liner Installation

Prior to placement of the liner material, hand excavate the location of the low point in the lysimeter. Remove any underlying objects from the lysimeter area that might damage the lysimeter liner and hand compact the underlying material.

Visually inspect the liner during installation for imperfections. If imperfections are found, remove the entire section and replace with a new liner free from defects.

Installation of liner material shall be performed in a manner that will comply with the following guidelines:

1. Unroll liner using methods that will not damage liner and will protect underlying surface from damage.
2. Place ballast (commonly sandbags) on the liner, in a manner which will not damage the liner, to prevent movement following placement.
3. Personnel walking on liner shall not engage in activities or wear shoes that could damage it. Smoking will not be permitted on the liner.
4. Do not allow vehicular traffic directly on liner.

If the overlying geocomposite and clay barrier will not be immediately placed above the liner (immediately meaning that precipitation or clay wetting events could occur between liner placement and placement of the overlying materials), place wooden forms around the liner and overlap the edges of the liner over the wood forms. The wood forms will be used to mitigate stormwater runoff entering the lysimeter.

Where the outlet piping from the lysimeter exits the bottom of the low point collection area and transitions to the conveyance piping, punch a hole the same size as the piping inside diameter using a sharp cylindrical punch. Do not cut or tear the liner. Do not damage liner during piping installation. Do not punch hole until immediately before piping installation.

Prior to placing the pea gravel materials in the lysimeter low point collection area, cover the outlet piping and low area with geotextile as shown on the project drawings.

3.1.1.1 Field Seaming

Field seaming shall not be permitted. Lysimeter liners shall be constructed from a single piece of liner.

3.1.1.2 Repair Procedures

Repair of damaged pieces of liner shall not be permitted. If imperfections are found, remove the entire section and replace with a new liner free from defects.

3.1.2 Triplanar Geocomposite Installation

Prior to placement of the geocomposite, ensure that the underlying LLDPE liner material is free of dirt and debris. The installer shall handle all geocomposite materials in such a manner as to ensure it is not damaged in any way. Precautions shall also been taken to prevent damage to underlying liner during placement of the geocomposite. Install the geocomposite such that the machine direction is running in the upslope-downslope orientation (not cross-slope). Place ballast (commonly sandbags) on the geocomposite, in a manner which will not damage the liner, to prevent movement following placement. During geocomposite installation care shall be taken to prevent any soil particles from migrating into the geonet core.

3.1.2.1 Seams and Overlaps

The geonet and each component of the geocomposite (geonet & geotextiles) will be secured or seamed to the like component at overlaps. Adjacent edges of the geonet along the roll length of the geonet/geocomposite, should be overlapped 2-3 inches. These overlaps shall be joined by tying the geonet cores together with white or yellow plastic fasteners (minimum tensile strength of 100 lbs). These ties shall be spaced at a maximum of every 5 feet along the length of the material. The bottom layer of geotextile shall be overlapped, unless the Engineer specifies differently. The top layers of geotextiles shall be sewn together. Geotextiles shall be overlapped a minimum of 1 inch prior to seaming.

3.1.2.2 Repair of Damaged Geocomposite Components (Geonet and Geotextile)

Repair of damaged geocomposite components will not be permitted. If a damaged geocomposite component is found, remove the entire section and replace with a geocomposite section free from defects.

3.1.2.3 Placement of Clay Material Over Geocomposite

Placement of the cover clay material shall proceed immediately following the placement of the geocomposite. All geocomposites shall be covered within 14 days. Cover material shall be placed in a manner to assure that the geocomposite is not damaged. No construction equipment shall operate directly on the geocomposite. The cover material above the geocomposite shall be placed by hand in 4" maximum lifts and compacted with a hand tamper (see Article 1.4.4 of Specification Section 02225). Add additional cover material and compact (in 4" lifts) until the cover thickness above the geocomposite is sufficient for the ground pressure of any equipment to be operated above the geocomposite, as presented below.

Maximum Equipment Ground Pressure (psi)	Minimum Cover Thickness (inches)
< 5	12
5 - 10	18
>10	24

Compaction of the initial lift placed over the geocomposite must be performed carefully in a manner that does not damage the geocomposite.

The cover material shall be placed on the geocomposite from the bottom of the slope proceeding upwards and in a manner which prevents instability of the cover material, minimize wrinkles, and mitigates potential damage to the geocomposite.

3.1.2.4 Excavation of Clay Cover Material

Excavation of clay cover material over the geocomposite shall be completed by hand with plastic shovels.

3.1.3 Piping Installation

Piping shall be installed principally as shown on the project drawings. Refer to the drawings to ensure all required fittings are provided. Provide whatever piping and fittings are necessary, whether shown on the drawings or not, to complete the system as required.

3.1.3.1 General Requirements

A. No defective pipe or fittings shall be used in piping systems. Any piece discovered to be defective shall be removed and replaced by a sound and satisfactory piece.
B. Any fitting showing a crack and any fitting or pipe which has received a severe blow that may have caused an incipient fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from work.
C. Every pipe and fitting shall be cleaned of all debris and dirt before being used and shall be kept clean until accepted in completed work.
D. Pipe and fittings shall be accurately installed to required lines and grades. Care shall be taken to preserve a good alignment.

E. All joints shall be made in clean dry conditions and in strict accordance with manufacturer's recommendations.
F. Remove fins and burrs from pipe and fittings.
G. Cut pipe accurately to measurements established at the site and work into place without springing or forcing.
H. Replace pipe or fitting that does not allow sufficient space for proper installation of joint material with new pipe or fittings or proper dimensions.
I. Grade the piping in straight lines; avoid the formation of any dips or low points. Support pipe at its proper elevation and grade; ensure firm and uniform support. Wood support blocking will not be permitted.
J. Lay pipe so that the full length of each section of pipe and each fitting will rest solidly on the pipe bedding. Fine SMC material will be used for pipe bedding. Any material larger than ¼" shall be removed from the bedding area prior to pipe placement.
K. Cover piping to a depth of 12" with Fine SMC material or clay (as shown on the project drawings). Cover shall be free of material larger than ¼". Place first 12" of cover in maximum 6" lifts and compact each lift with a hand tamper.

3.1.3.2 Polyethylene Pipe and Fittings

All pipes shall be marked in accordance with the latest acceptable standards for the "Marking of Pipe" such as specified by ASME. Mark number and weight and/or pipe schedule shall be conspicuously painted on each piece.

Polyethylene shall be joined using the heat fusion method in strict accordance with manufacturer's recommendations and procedures. Install fusion machine on pipe. Install pipe trimmer and trim both faces to be joined. Clean pipe to remove any remaining trimming ribbons. Align piping in clamp, check for square alignment of pipe faces to be fused. Retract moveable clamp, roll in and center heater plate with adapter between pipe sections. For all sizes, apply a strong, firm, continuous pressure until complete melt bead can be seen on main. Heat piping at the required temperature and for the required length of time specified by the manufacturer. Retract removable clamp and cleanly remove heater plate. Bring melted surfaces together rapidly. DO NOT SLAM. Apply continuous progressive pressure until proper fusion bead is formed. Maintain pressure until joint has cooled. Check newly formed fusion beads. If beads are not of sufficient size (as recommended by the manufacturer), cut out fusion weld and repeat process.

END OF SECTION

SECTION 02935

TURF

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1909	Fertilizer (cancelled February 14, 1996)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 602	(1995a) Agricultural Liming Materials
ASTM D 977	(1998) Emulsified Asphalt
ASTM E 11	(1985) Wire-Cloth Sieves for Testing Purposes

DEPARTMENT OF AGRICULTURE (DOA)

DOA FSA	Federal Seed Act Rules and Regulations of the Secretary of Agriculture

1.2 EXTENT OF WORK

Provide seedbed preparation, topsoiling, liming, fertilizing, seeding, and mulching of all newly graded finish earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the CONTRACTOR'S operation.

1.3 SUBMITTALS

ENGINEER'S approval is required for submittals with a "E" designation; submittals not having a "E" designation are for CONTRACTOR Quality Control approval. The following shall be submitted in accordance with the Submittal Procedures Section:

1.3.1 SD-07 Schedules; E

a. Equipment List

A list of proposed seeding and mulching equipment to be used in performance of turfing operations, including descriptive data and calibration tests.

1.3.2 SD-08 Statements; E

a. Maintenance Report

Written record of maintenance work performed.

b. Turf Establishment Period

Written calendar time period for the turf establishment period. When there is more than one turf establishment period, the boundaries of the turfed area covered for each period shall be described.

c. Delivery Schedule

Submit at least 10 days before delivery.

1.3.3 SD-13 Certificates; E

Certificates of compliance certifying that materials meet the requirements specified, prior to the delivery of materials. Certified copies of the reports for the following materials shall be included:

a. Seed

For mixture, percent pure live seed, minimum percent germination and hard seed, maximum percent weed seed content, date tested and state certification.

b. Fertilizer

For chemical analysis, composition percent.

c. Agricultural Limestone

For calcium carbonate equivalent and sieve analysis.

d. Topsoil

For pH, particle size, chemical analysis and mechanical analysis.

1.4 DELIVERY

1.4.1 Fertilizer and Lime

Deliver materials to the facility in original, unopened containers bearing the manufacturer's chemical analysis, name, trade name, trademark, and indication of conformance to state and Federal laws. In lieu of containers, furnish fertilizer and lime in bulk, with a certificate indicating the above information, accompanying each delivery.

1.4.2 Seed

Deliver seed to the facility in original sealed packages bearing the producer's guaranteed analysis for percentages of mixtures, purity, germination, weed seed content, and inert material. Label in conformance with USDA Federal Seed Act and applicable state seed laws. Wet, moldy, or otherwise damaged seed will be rejected.

1.5 STORAGE AND HANDLING

Store lime, fertilizer, and seed in dry locations away from contaminants. Protect seed from drying out. Do not drop or dump materials from vehicles.

PART 2 PRODUCTS

2.1 SEED

State-certified seed of the latest season's crop shall be provided in original sealed packages bearing the producer's guaranteed analysis for percentages of mixture, purity, germination, hard seed, weed seed content, and inert material. Mix seed, as applicable, onsite in the presence of the ENGINEER.

Seed mixtures shall be proportioned by weight as follows:

Common Name	Mixture Percent by Weight	Percent Pure Live Seed
Red Fescues	50	95
Redtop	20	92
Perennial Ryegrass	30	95

Weed seed shall not exceed 1 percent by weight of the total mixture. Wet, moldy, or otherwise damaged seed shall be rejected.

2.2 SOIL AMENDMENTS

Soil amendments shall consist of lime, fertilizer, organic soil amendments and soil conditioners meeting the following requirements.

2.2.1 Lime

ASTM C 602, commercial agricultural limestone containing a minimum of 94 percent of total carbonates, 80 percent calcium, and 14 percent magnesium. Provide the following

ASTM E 11 gradation: minimum 100 percent passing the No. 20 sieve and 75 percent passing the No. 100 sieve.

2.2.2 Fertilizer

CID A-A-1909, Type I/Class 2, except provide Type II for hydroseeding. Granular fertilizer shall contain a minimum percentage by weight of 10 percent nitrogen, 10 percent available phosphoric acid, and 10 percent potash.

2.3 TOPSOIL

Natural, friable soil representative of productive, well-drained soils in the area; free of subsoil, stumps, rocks larger than 1 inch in diameter, brash, weeds, toxic substances, and other material detrimental to plant growth.

Furnish topsoil from approved offsite sources meeting the requirements described in the following Table 2.3-1.

TABLE 2.3-1

USDA Soil Survey Investigation Report No. 1, Laboratory Test for:	Acceptable Limits
Sand Content	20 - 75 percent by weight
Silt Content	10 - 60 percent by weight
Clay Content	5 - 30 percent by weight
Organic Material (Walkley-Block)	1.5 percent
pH	5.5 to 7.0
Soluble Salts	600 ppm maximum

2.4 MULCH

Mulch shall be free from weeds, mold, and other deleterious materials.

2.4.1 Straw

Straw shall be stalks from oats, wheat, rye, barley, or rice furnished in air-dry condition and with a consistency for placing with commercial mulch-blowing equipment.

2.4.2 Hay

Hay shall be native hay, sudan-grass hay, broomsedge hay, or other herbaceous mowings furnished in an air-dry condition suitable for placing with commercial mulch-blowing equipment.

2.4.3 Wood Cellulose Fiber

Wood cellulose fiber shall not contain any growth or germination-inhibiting factors and shall be dyed an appropriate color to facilitate visual metering during application. Composition on air-dry weight basis: 9 to 15 percent moisture, pH range from 3.5 to 5.0.

2.5 WATER

Water shall not contain elements toxic to plant life.

2.6 EROSION CONTROL MATERIAL

Soil erosion control shall conform to the following:

2.6.1 Soil Erosion Control Blanket

Machine produced mat of wood excelsior formed from a web of interlocking wood fibers, covered on one side with either knitted straw blanket-like mat construction, covered with biodegradable plastic mesh, or interwoven biodegradable thread, plastic netting or twisted kraft paper cord netting.

2.6.2 Soil Erosion Control Fabric

Knitted construction of polypropylene yarn with uniform mesh openings 3/4 to 1 inch square with strips of biodegradable paper. Filler paper strips shall last 6 to 8 months.

2.6.3 Soil Erosion Control Net

Heavy, twisted jute mesh weighing approximately 1.22 pounds per linear yard and 4 feet wide with mesh openings of approximately 1 inch square.

2.6.4 Soil Erosion Control Chemicals

High-polymer synthetic resin or cold-water emulsion of selected petroleum resins.

2.6.5 Hydrophilic Colloids

Hydrophilic colloids shall be physiologically harmless to plant and animal life, without phytotoxic agents. Colloids shall be naturally occurring, silicate powder based, and shall form a water insoluble membrane after curing. Colloids shall resist mold growth.

2.6.6 Anchors

Erosion control anchor material shall be as recommended by the manufacturer.

PART 3 EXECUTION

3.1 SEEDING TIMES AND CONDITIONS

3.1.1 Seeding Time

Seed shall be sown from March 1st to May 15th for spring planting and from September 1st to October 30th for fall planting.

3.1.2 Turfing Conditions

Turf operations shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture or other unsatisfactory conditions prevail, the work shall be stopped when directed. When special conditions warrant a variance to the turf operations, proposed times shall be submitted to and approved by the ENGINEER.

3.2 FACILITY PREPARATION

3.2.1 Grading

The CONTRACTOR shall verify that finished grades are as indicated on drawings, and the placing of topsoil has been completed in accordance with the Earthwork Section of these specifications.

3.2.2 Subgrade

After areas to be seeded have been brought to the required subgrade, thoroughly till to minimum depth of 6 inches by scarifying, disking, harrowing, or other approved methods. After tillage, remove debris and stones larger than 1 inch remaining on the surface.

3.2.3 Final Grade

Immediately prior to placing topsoil, scarify subgrade to a 2-inch depth for bonding of topsoil with subsoil. Spread topsoil evenly to a minimum depth of 4 inches. Do not spread topsoil when frozen or excessively wet or dry.

3.2.3.1 If there is insufficient on-site topsoil meeting specified requirements for topsoil, then provide topsoil from offsite sources meeting the requirements of Article 2.3 of this section.

3.2.3.2 Correct irregularities in finished surfaces to eliminate depressions. Protect finished topsoil areas from damage by vehicular or pedestrian traffic.

3.2.4 Application of Soil Amendments

3.2.4.1 Lime

Lime shall be applied at the rate of 3,000 pounds per acre, or 70 pounds per 1000 square feet. Lime shall be incorporated into the soil to a minimum depth of 4 inches or may be incorporated as part of the tillage operation.

3.2.4.2 Fertilizer

Fertilizer shall be applied at the rate of 1,000 pounds per acre, or 23 pounds per 1000 square feet. Fertilizer shall be incorporated into the soil to a minimum depth of 4 inches and may be incorporated as part of the tillage or hydroseeding operation.

3.3 SEEDING

3.3.1 General

Prior to seeding, any previously prepared seedbed areas compacted or damaged by interim rain, traffic or other cause, shall be reworked to restore the ground condition previously specified. Seeding operations shall not take place when the wind velocity will prevent uniform seed distribution.

3.3.2 Equipment Calibration

The equipment to be used and the methods of turfing shall be subject to the inspection and approval of the ENGINEER prior to commencement of turfing operations. Immediately prior to the commencement of turfing operations, the CONTRACTOR shall conduct turfing equipment calibration tests in the presence of the ENGINEER.

3.3.3 Applying Seed

Apply seed within 24 hours after seedbed preparation. Sow seed with approved sowing equipment using one or a combination of the following methods at a rate of 240 pounds per acre. Sow one-half the seed in one direction, and sow the remainder at right angles to the first sowing.

3.3.3.1 Broadcast Seeding

Seed shall be uniformly broadcast using broadcast or drop seeders. Seed shall be covered uniformly to a maximum depth of 1/4 inch in clayey soils and 1/2 inch in sandy soils. Cover seed by spike tooth harrow, raking, or other approved devices.

3.3.3.2 Drill Seeding

Use cultipacker seeders, grass seed drills, or other approved methods. Drill seed uniformly to maximum depth of 1/4 inch in clayey soils and 1/2 inch in sandy soils. Cover seed by spike tooth harrow, cultipacker, or other approved devices.

3.3.3.3 Rolling

Immediately after seeding, except for slopes 3-horizontal-to-1 vertical and greater, the entire area shall be firmed with a roller not exceeding 90 pounds for each foot of roller width. Areas seeded with seed drills equipped with rollers shall not be rolled.

3.3.4 Hydroseeding

Seed and fertilizer shall be added to water and thoroughly mixed at the rates specified. Wood cellulose fiber mulch shall be added at the rates recommended by the manufacturer after the seed, fertilizer and water have been thoroughly mixed, to produce a homogeneous slurry. Seed shall not remain in water containing fertilizer for more than 1 hour prior to application, unless otherwise approved. Keep liquid fertilizer agitated during application. Slurry shall be uniformly applied under pressure over the entire area. Immediately following application of slurry mix, make separate application of wood cellulose mulch at the rate of 1,000 pounds (dry weight) per acre. When hydraulically sprayed on the ground, material shall form a blotter-like cover impregnated uniformly with the grass seed. Cover shall allow rainfall or applied water to percolate to underlying soil. The hydroseeded area shall not be rolled.

3.3.5 Mulch

3.3.5.1 Straw or Hay Mulch

Straw or hay mulch shall be spread uniformly at the rate of 1.5 tons per acre. Mulch shall be spread by hand, blower-type mulch spreader or other approved method. Mulching shall be started on the windward side of relatively flat areas or on the upper part of a steep slope and continued uniformly until the area is covered. The mulch shall not be bunched. All seeded areas shall be mulched on the same day as the seeding.

3.3.5.2 Mechanically Anchoring

Immediately following spreading, the mulch shall be anchored to the soil by a V-type-wheel land packer, a scalloped-disk land packer designed to force mulch into the soil surface, or other suitable equipment.

3.3.5.3 Non-Asphaltic Tackifier

Hydrophilic colloid shall be applied at rate recommended by manufacturer. Apply with hydraulic equipment suitable for mixing and applying uniform mixture of tackifier.

3.3.5.4 Spreading Asphalt Adhesive Coated Mulch

Straw or hay mulch shall be spread simultaneously with asphalt adhesive at the rate of 1.5 tons per acre by using power mulch equipment which shall be equipped with suitable asphalt pump and nozzle. The adhesive-coated mulch shall be applied evenly over the surface. Sunlight shall not be completely excluded from penetration to the ground surface.

3.3.5.5 Wood Cellulose Fiber

Wood cellulose fiber mulch for use with the hydraulic application of seed and fertilizer shall be applied as part of the hydroseeding operation.

3.3.6 Water

Watering shall be started within 7 days after completing the seeded area. Water shall be applied at a rate sufficient to ensure moist soil conditions to a minimum depth of 1 inch. Run-off and puddling shall be prevented.

3.4 EROSION CONTROL

3.4.1 Erosion Control Material

Erosion control material, where indicated or required, shall be installed in accordance with manufacturer's instructions. Placement of the erosion control material shall be accomplished without damage to installed material or without deviation to finished grade.

3.5 RESTORATION AND CLEAN UP

3.5.1 Restoration

Existing turf areas, pavements and facilities that have been damaged from the turfing operation shall be restored to original condition at CONTRACTOR'S expense.

3.5.2 Clean Up

Excess and waste material shall be removed from the planting operation and shall be disposed of offsite. Adjacent paved areas shall be cleaned.

3.6 PROTECTION OF TURFED AREAS

Immediately after turfing, the area shall be protected against traffic or other use by erecting barricades and providing signage as required, or as directed by the ENGINEER.

3.7 TURF ESTABLISHMENT PERIOD

3.7.1 Commencement

The Turf Establishment Period for establishing a healthy stand of turf shall begin on the first day of work under this section and shall end three (3) months after the last day of turfing operations required by this contract. Written calendar time period shall be furnished to the ENGINEER for the Turf Establishment Period. When there is more than one turf establishment period, describe the boundaries of the turfed area covered for each period.

3.7.2 Satisfactory Stand of Turf

3.7.2.1 Seeded Area

A satisfactory stand of turf from the seeding operation for a field area is defined as a minimum of 10 grass plants per square foot. The total bare spots shall not exceed 2 percent of the total seeded area.

3.7.3 Maintenance During Establishment Period

3.7.3.1 General

Maintenance of the turfed areas shall include eradicating weeds, eradicating insects and diseases, protecting embankments and ditches from erosion, maintaining erosion control materials and mulch, protecting turfed areas from traffic, mowing, and watering.

3.7.3.2 Mowing

Lawn areas shall be mowed to a minimum height of 2 inches when the average height of the turf becomes 4 inches. Clippings shall be removed when the amount of cut turf is heavy enough to damage the turfed areas.

3.7.3.3 Watering

Watering shall be at intervals to obtain a moist soil condition to a minimum depth of 1 inch. Frequency of watering and quantity of water shall be adjusted in accordance with the growth of the turf. Run-off, puddling and wilting shall be prevented.

3.7.3.4 Repair

The CONTRACTOR shall re-establish, as specified herein, eroded, damaged or barren areas. Mulch shall also be repaired or replaced as required.

3.7.3.5 Maintenance Report

A written record shall be furnished to the ENGINEER of the maintenance work performed.

3.8 FINAL ACCEPTANCE

3.8.1 Preliminary Inspection

Prior to the completion of the Turf Establishment Period, a preliminary inspection shall be held by the ENGINEER. Time for the inspection shall be established in writing. The acceptability of the turf in accordance with the Turf Establishment Period shall be determined. An unacceptable stand of turf shall be repaired as soon as turfing conditions permit.

3.8.2 Final Inspection

A final inspection shall be held by the ENGINEER to determine that deficiencies noted in the preliminary inspection have been corrected. Time for the inspection shall be established in writing.

3.9 MEASUREMENT AND PAYMENT

Turf shall be measured and paid for on a unit cost basis per acre and all costs in connection therewith shall be included in the cost of the Turf Bid Item.

END OF SECTION

SECTION 06645

GEOTEXTILES

PART 1 - GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 4354(1999; R 2004)	Sampling of Geosynthetics for Testing
ASTM D 4355(2007)	Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D 4491(1999a; R 2004e1)	Water Permeability of Geotextiles by Permittivity
ASTM D 4533(2004)	Trapezoid Tearing Strength of Geotextiles
ASTM D 4632(1991; R 2003)	Grab Breaking Load and Elongation of Geotextiles
ASTM D 4751(2004)	Determining Apparent Opening Size of a Geotextile
ASTM D 4759(2002)	Determining the Specification Conformance of Geosynthetics
ASTM D 4833(2000e1)	Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 4873(2002)	Identification, Storage, and Handling of Geosynthetic Rolls and Samples
ASTM D 5199 (2001)	Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
ASTM D 5261 (1992)	Standard Test Method for Measuring Mass per Unit Area of Geotextiles

1.2 EXTENT OF WORK

CONTRACTOR shall provide all labor, materials, tools, equipment, testing, and services necessary for the placement of geotextile as filter layers for the engineered control barrier as shown on the Drawings and specified, or as otherwise directed by the ENGINEER.

1.3 QUALITY ASSURANCE

1.3.1 Manufacturer's Qualifications:

1. Geotextile manufacturer shall be a specialist in the manufacture of the particular geotextile.

1.3.2 Submittals:

1. Shop Drawings:

    a. CONTRACTOR shall submit six (6) copies of manufacturer's data, specifications, installation instructions and dimensions.

    b. CONTRACTOR shall submit six (6) copies of an affidavit certifying that each geotextile furnished complies with all requirements specified herein.

    c. No geotextile shall be shipped until the affidavit is submitted to ENGINEER.

1.4 MEASUREMENT

Measurement shall be made of the as-built surface area in square yards covered by geotextile. Allowance will be made for geotextile in anchor and/or drainage trenches but no allowance will be made for waste, overlaps, damaged materials, repairs, or materials used for the convenience of the CONTRACTOR.

1.5 PAYMENT

Geotextile installed and accepted will be paid for at the respective contract unit price in the bidding schedule. This unit price shall include the cost of materials, equipment, installation, testing, and other costs associated with placement of the geotextile.

1.6 SUBMITTALS

ENGINEER approval is required for submittals with a "E" designation; submittals not having a "E" designation are for CONTRACTOR Quality Control approval. The following shall be submitted in accordance with SUBMITTAL PROCEDURES Section:

SD-03 Product Data

Thread, E

A minimum of 30 days prior to scheduled use, proposed thread type for sewn seams along with data sheets showing the physical properties of the thread.

Manufacturing Quality Control Sampling and Testing, E

A minimum of 30 days prior to scheduled use, manufacturer's quality control manual.

SD-04 Samples

Quality Assurance Samples and Tests, E

Samples for quality assurance testing; 30 days shall be allotted in the schedule to allow for testing.

SD-07 Certificates

Geotextile, E

A minimum of 30 days prior to scheduled use, manufacturer's certificate of compliance stating that the geotextile meets the requirements of this section. The certificate of compliance shall be attested to by a person having legal authority to bind the geotextile manufacturer.

1.7 DELIVERY, STORAGE AND HANDLING

Delivery, storage, and handling of geotextile shall be in accordance with ASTM D 4873.

1.7.1 Delivery

The ENGINEER and Quality Assurance Officer (QAO) shall be notified a minimum of 24 hours prior to delivery and unloading of geotextile rolls. Rolls shall be packaged in an opaque, waterproof, protective plastic wrapping. The plastic wrapping shall not be removed until deployment. If quality assurance samples are collected, rolls shall be immediately rewrapped with the plastic wrapping. Geotextile or plastic wrapping damaged during storage or handling shall be repaired or replaced, as directed. Each roll shall be labeled with the manufacturer's name, geotextile type, roll number, roll dimensions (length, width, gross weight), and date manufactured.

1.7.2 Storage

Rolls of geotextile shall be protected from construction equipment, chemicals, sparks and flames, temperatures in excess of 160 degrees F, or any other environmental condition that may damage the physical properties of the geotextile. To protect geotextile from becoming saturated, rolls shall either be elevated off the ground or placed on a sacrificial sheet of plastic in an area where water will not accumulate.

1.7.3 Handling

Geotextile rolls shall be handled and unloaded with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Rolls shall not be dragged along the ground, lifted by one end, or dropped to the ground.

PART 2 - PRODUCTS

2.1 GEOTEXTILE

2.1.1 Geotextile shall be a needle punched, nonwoven fabric composed of filaments which are formed into a stable network such that the filaments retain their relative position. Filter fabric shall be inert to biological degradation and naturally encountered chemicals, alkalis, and acids. The geotextile shall conform, as a minimum, to the following:

Fabric Property	Unit	Typical Test Method	Value[1]
Unit Weight (mass per unit area)	oz/yd^2	ASTM D 5261	12
Thickness	mils	ASTM D 5199	110
Grab Tensile Strength	lb	ASTM D 4632	320
Grab Tensile/Elongation	%	ASTM D 4632	50
Puncture Strength	lb	ASTM D 4833	190
Trapezoid Tear Strength (MD)	lb	ASTM D 4533	125
Apparent Opening Size	mm	ASTM D 4751	0.150
Falling Head Permeability, “k”	cm/sec	ASTM D 4491	0.29
UV Resistance (500 hrs)	%	ASTM D 4355	70

NOTES:

1. Values listed represent minimum values each roll delivered to the facility shall meet when tested in accordance with the specified ASTM test method.

2.1.2 Geotextile filter fabric shall be:

1. NW12 produced by GSE Lining Technology, Inc.
2. Or equal.

2.2 MANUFACTURING QUALITY CONTROL SAMPLING AND TESTING

The Manufacturer shall be responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available upon request. Manufacturing quality control sampling and testing shall be performed in accordance with the manufacturer's approved quality control manual. As a minimum, geotextiles shall be randomly sampled for testing in accordance with ASTM D 4354, Procedure A. Acceptance of geotextile shall be in accordance with ASTM D 4759. Tests not meeting the specified requirements shall result in the rejection of applicable rolls.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

3.1.1 All geotextiles shall be weighted with sandbags or the equivalent when required. Such sandbags shall be installed during placement and shall remain until replaced with cover material.

3.1.2 CONTRACTOR shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile.

3.1.3 During placement of geotextile, care shall be taken not to entrap in the geotextile stone, excessive dust, or moisture that could damage the geotextile, generate clogging, or hamper subsequent seaming.

Geotextiles shall not be exposed to precipitation prior to being installed, and shall not be exposed to direct sunlight for more than 15 days. Any materials not complying with this requirement shall be removed and replaced at no cost to the OWNER.

3.1.4 CONTRACTOR shall not operate equipment on geotextiles without the specified depth of cover.

3.1.5 Excavation of fill material over geotextiles shall be completed by hand with plastic shovels.

3.2 GEOTEXTILE

3.2.1 Geotextile fabrics shall be deployed in the direction of the slope unless otherwise directed by ENGINEER.

3.2.2 Geotextile fabrics shall be overlapped 3 inches and sewn as detailed on Contract Drawings unless otherwise approved by ENGINEER. Overlaps shall be oriented in the direction of filling.

3.2.3 Any bum mark, material defect or tear in the fabric shall be repaired as follows:

1. A fabric patch shall be sewn into place using a double sewn lock stitch (1/4 inch to 3/4 inch apart and no closer than 1 inch from any edge).

2. On slopes with a grade less than 8%, the CONTRACTOR may use a fabric patch heat welded in place with a minimum of 24 inches overlap in all directions.

3. Should any damaged area exceed 10 percent of the width of the roll, the roll shall be cut, overlapped and sewn to form a new seam.

3.3 PLACEMENT OF SOIL AND AGGREGATE MATERIALS

3.3.1 Placement of the cover soil is recommended to proceed immediately following placement and inspection of the geotextile.

3.3.2 When applying soil and aggregate material, no equipment generally speaking shall drive directly across geotextile. If a vehicle has to be driven on top of the geotextile, the vehicle shall be driven in a fashion not to damage the geotextile. Acceleration or deceleration shall be in a smooth and gentle manner. Operator shall not make any sudden turns or stops when driving on the geotextile. If any tear or local damage occurs to the geotextile, patching technique as described in the above section shall be used.

3.3.3. The specified fill material shall be placed and spread utilizing vehicles with a low ground pressure (LGP). The cover soil shall be placed on the geotextile from the bottom of the slope proceeding upwards and in a manner, which prevents instability of the cover soil or damage to the geotextile. Unless otherwise specified by the ENGINEER, all equipment for spreading fill material overlying the geotextile shall comply with the following:

Maximum Equipment Ground Pressure (psi)	Minimum Separation Thickness (inches)
< 5	8
5 - 10	18
>10	24

3.3.4. Compaction of the initial lift placed over the geotextile must be performed in a manner that does not damage the geotextile.

3.4 QUALITY ASSURANCE SAMPLES AND TESTS

3.4.1 Quality Assurance Samples

The CONTRACTOR shall notify the ENGINEER and QAO prior to the collection of quality assurance samples. Samples shall be collected upon delivery to the facility for quality assurance testing in accordance with ASTM D 4354, Procedure B. Lot size for quality assurance sampling shall be considered to be the shipment quantity of the product or a truckload of the product, whichever is smaller. The unit size shall be considered one roll of geotextile at a frequency of one per 100,000 square feet. Samples shall be identified with a waterproof marker by manufacturer's name, product identification, lot number, roll number, and machine direction. The date and a unique sample number shall also be noted on the sample. The outer layer of the geotextile roll shall be discarded prior to sampling a roll. Samples shall then be collected by cutting the full-width of the geotextile sheet a minimum of 3 feet long in the machine direction. Rolls which are sampled shall be immediately resealed in their protective covering.

3.4.2 Quality Assurance Tests

The CONTRACTOR shall provide quality assurance samples to an Independent Laboratory. Samples will be tested to verify that geotextile meets the requirements specified in Section 2.1.1 of this specification. Test method ASTM D 4355 shall not be performed on the collected samples. Geotextile product acceptance shall be based on ASTM D 4759. Tests not meeting the specified requirements shall result in the rejection of applicable rolls.

END OF SECTION

SECTION 13100

SOIL MOISTURE SENSOR

PART 1 - GENERAL

1.1 REFERENCES

None

1.2 EXTENT OF WORK

CONTRACTOR shall provide all labor, materials, tools, equipment, testing, and services necessary to furnish and install in-situ soil moisture sensors, cable connectors, and provide required data reader device in the Clay Barrier layer of the Engineered Barrier as shown on the Drawings and specified, or as otherwise directed by the ENGINEER.

1.3 QUALITY ASSURANCE

1.3.1 Manufacturer's Qualifications:

1. In-situ soil moisture sensor and data reader manufacturer shall be a specialist in the manufacture of in-situ soil monitoring equipment.

1.3.2 Submittals:

1. Shop Drawings:

   a. CONTRACTOR shall submit six (6) copies of manufacturer's data, specifications, installation instructions and dimensions.

1.4 MEASUREMENT

Measurement shall be made on a per station basis where each soil moisture monitoring station shall consist of three in-situ soil moisture sensors. ENGINEER shall measure the number of stations as they are completed by the CONTRACTOR.

1.5 PAYMENT

In-situ soil moisture monitoring stations installed and accepted will be paid for at the respective contract unit price in the bidding schedule. This unit price shall include the cost of materials, equipment, installation, testing, and other costs associated with placement of the in-situ soil moisture monitoring stations.

1.6 SUBMITTALS

ENGINEER approval is required for submittals with a "E" designation; submittals not having a "E" designation are for CONTRACTOR Quality Control approval. The following shall be submitted in accordance with SUBMITTAL PROCEDURES Section:

1.6.1 Product Data

In-Situ Soil Moisture Sensor, E

A minimum of 30 days prior to scheduled use, proposed In-Situ Soil Moisture Sensor including copies of manufacturer's data, specifications, installation instructions, and user's manual.

In-Situ Soil Moisture Sensor Data Reader, E

A minimum of 30 days prior to scheduled use, proposed In-Situ Soil Moisture Sensor Data Reader including copies of manufacturer's data, specifications, installation instructions, and user's manual.

In-Situ Soil Moisture Sensor Cable Connector, E

A minimum of 30 days prior to scheduled use, proposed In-Situ Soil Moisture Sensor Cable Connector including copies of manufacturer's data, specifications, installation instructions, and user's manual.

1.7 DELIVERY, STORAGE AND HANDLING

Delivery, storage, and handling of materials shall proceed as indicated below.

1.7.1 Delivery

The ENGINEER and Quality Assurance Officer (QAO) shall be notified a minimum of 24 hours prior to delivery and unloading of materials. Materials damaged during storage or handling shall be repaired or replaced, as directed. Materials shall be labeled with the manufacturer's name, equipment type, and date manufactured.

1.7.2 Storage

Materials shall be protected from temperatures in excess of 160 degrees F or any other environmental condition that may damage the materials.

1.7.3 Handling

Materials shall not be dropped or handled in such a way as to damage the sensitive electronics contained within.

PART 2 - PRODUCTS

2.1 IN-SITU SOIL MOISTURE SENSOR

2.1.1 In-situ soil moisture sensors shall be provided that measure, at a minimum, soil temperature, soil moisture, soil electrical conductivity and the complex dielectric permittivity. The in-situ soil moisture sensors shall be designed for many years of service buried in soil and be manufactured of materials that protect the internal electrical components from the corrosive and the reactive properties of soil. The in-situ soil moisture sensors shall conform, as a minimum, to the following:

Parameter	**Accuracy/Precision**
Temperature (C)	+/- 0.6 Degrees Celsius(From -30^{o} to 36^{o}C)
Soil Moisture wfv (m^{3} m^{-3})	+/- 0.03 wfv (m^{3} m^{-3}) Accuracy
Soil Moisture wfv (m^{3} m^{-3})	+/- 0.003 wfv (m^{3} m^{-3}) Precision
Electrical Conductivity (S/m) TUC*	+/- 0.0014 S/m or +/- 1%
Electrical Conductivity (S/m) TC**	+/- 0.0014 S/m or +/- 5%
Real/Imaginary Dielectric Constant TUC*	+/- 0.5 or +/- 1%
Real/Imaginary Dielectric Constant TC*	+/- 0.5 or +/- 5%

*TUC Temperature uncorrected full scale

**TC Temperature corrected from 0 to 35^{o}C

2.1.2 In-Situ Soil Moisture Sensors shall be:

1. Hydra Probe Soil Sensor Analog (Stevens Water Monitoring System, Inc.)
2. Or equal.

2.2 IN-SITU SOIL MOISTURE SENSOR DATA READER

2.2.1 An in-situ soil moisture sensor data reader shall be provided that connects to the provided in-situ soil moisture sensor and acquires, logs, and displays a real time reading of, at a minimum, soil temperature, soil moisture, soil electrical conductivity and the complex dielectric permittivity. The device shall interface with a PC to download logged data. The in-situ soil moisture sensor data reader shall be designed for many years of service and be manufactured of materials that provide water resistance and protection during field use. The in-situ soil moisture sensor data reader shall conform, as a minimum, to the following:

Parameter	**Requirement**
User ID Sites	255 sites
Logged Data Memory	3000 readings
Interface	RS-232 serial cable to PC
Accuracy	Full accuracy of in-situ soil moisture sensor
Sample Time	2 seconds
Batteries	4 AA cell batteries
Battery Life	3000 measurements (typical)
Backup	Separate battery retains logged value
Operating Temperature	-5 C to +50 C
Rain / Dust proof	

2.2.2 In-Situ Soil Moisture Sensor Data Reader shall be:
1. Soil Moisture Data Reader (Stevens Water Monitoring System, Inc.)
2. Or equal.

2.3 IN-SITU SOIL MOISTURE SENSOR CABLE CONNECTOR

2.3.1 In-situ soil moisture sensor cable connectors shall be provided for each in-situ soil moisture sensor to allow for connection to the data reader. The in-situ soil moisture sensor cable connector shall be designed for many years of service and be manufactured of materials that provide water resistance and protection from the elements.

2.3.2 In-Situ Soil Moisture Sensor Cable Connector shall be:
1. Cable Connector (Stevens Water Monitoring System, Inc.)
2. Or equal.

2.4 MANUFACTURING QUALITY CONTROL SAMPLING AND TESTING

The Manufacturer shall be responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available upon request. Manufacturing quality control sampling and testing shall be performed in accordance with the manufacturer's approved quality control manual.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

3.1.1 Each in-situ soil moisture sensor is made up of sensitive electrical probes and electronics. The CONTRACTOR shall observe the following precautions:

- Do not subject the probe to extreme heat over 70 degrees Celsius (160 F).
- Do not subject the probe to fluids with a pH less than 4.
- Do not subject the probe to strong oxidizers like bleach, or strong reducing agents.
- Do not subject the probe to polar solvents such as acetone.
- Do not subject the probe to chlorinated solvents such as dichloromethane.
- Do not subject the probe to strong magnetic fields.
- Do not use excessive force to drive the probe into the soil because the tines could bend. If the probe has difficulty going into the soil due to rocks, simply relocate the probe to an area slightly adjacent.
- Do not remove the probe from the soil by pulling on the cable.
- While the direct burial cable is very durable, it is susceptible to abrasion and cuts by shovels. The CONTRACTOR should use extra caution not to damage the cable or probe if the probe needs to be excavated for relocation.
- Do not place the probes in places where they could get run over by construction equipment. The probe may be sturdy enough to survive getting run over by equipment if it is buried; however, this should be avoided since the compaction of the soil

column from the weight of the equipment will affect the hydrology and thus the soil moisture data.

- Do not place more than one probe in proximity while logging data. More than one probe in close proximity while powered may create an electrolysis affect that may damage the probe.

3.2 INTALLATION OF IN-SITU SOIL MOISTURE SENSORS

3.2.1 Six (6) In-Situ Soil Moisture Monitoring Stations shall be installed as indicated on the Contract Drawings. Each station shall consist of three (3) in-situ soil moisture sensors buried at various depths as indicated on the Contract Drawings.

3.2.2 CONTRACTOR shall dig a pit at each In-Situ Soil Moisture Monitoring Station into the compacted clay. The pit shall be dug following placement and compaction of the Clay Barrier layer per the Contract Drawings and Specifications.

3.2.3 CONTRACTOR shall dig the pit per the Contract Drawings in a way to ensure a flat undisturbed wall in which to install the sensors. The most critical thing about the installation of the sensors is the soil needs to be undisturbed and the base plate of the sensor needs to be flush with the soil.

3.2.4 CONTRACTOR shall use a paint scraper or similar device to smooth the surface of the soil where the sensor is to be installed. It is important to have the soil flush with the base plate to avoid a gap. If there is a gap, the sensor signal will average the gap into the soil measurement and create errors.

3.2.5 CONTRACTOR shall avoid rocking the sensor back and forth since this will disturb the soil and create a void space around the tines. It is imperative that the bulk density of the soil in the sensor's measurement volume remain unchanged from the surrounding soil. If the bulk density changes, the volumetric soil moisture measurement and the soil electrical conductivity will change.

3.2.6 CONTRACTOR shall gather sensor cables to one location and thread up through 2-inch schedule 40 PVC conduit per the Contract Drawings.

3.3 BACKFILL OF SOIL AROUND IN-SITU SOIL MOISTURE SENSORS

3.3.1 After the sensors are securely installed into the wall of the pit, the pit needs to be carefully backfilled with the soil that came out it.

3.3.2 CONTRACTOR shall thoroughly scarify the walls and bottom of the pit to ensure good clay backfill bonding.

3.3.3 For every one (1) foot of soil put back into the pit, the soil should be compacted. Compaction can be done by trampling the soil with feet and body weight. Mechanical compactors can also be used, though typically they are not required. Extra care must be taken not to disturb the sensors that have exposed heads, cables, and conduits when compacting the soil.

3.3.4 CONTRACTOR shall ensure compaction of soil in pit is comparable to surrounding soil. If the soil is not compacted well while it is being backfilled, the compaction and bulk density of the backfill will be considerably less than the native undisturbed soil around it. After a few months, the backfilled soil will begin to compact on its own and return to a steady state bulk density. The sensor will effectively be residing in two soil columns. The tines will be in the undisturbed soil column, and the head, cable and conduit will be in the backfill column that is undergoing movement. The compaction of the backfilled soil may dislodge the probe and thus affect the measurement volume of the sensor. After the sensors are installed, avoid equipment traffic in the vicinity of the probes until overlying structural materials are placed.

3.4 INSTALLATION OF CONDUIT AND ROAD BOXES

3.4.1 CONTRACTOR shall thread sensor cables up through 2-inch schedule 40 PVC conduit, backfilled with crushed stone and sealed at the surface with bentonite clay per the Contract Drawings.

3.4.2 CONTRACTOR shall finish PVC conduit at the surface with an 8-inch steel road box and cover set within a 24-inch by 8-inch deep concrete pad per the Contract Drawings. Road box shall have a 12-long collar.

3.5 QUALITY ASSURANCE AND TESTING

3.5.1 The CONTRACTOR shall test each in-situ soil moisture sensor in the presence of the ENGINEER prior to installation. The CONTRACTOR shall test the sensors with a soil sample compacted to the same specifications as the Clay Barrier layer and with a known moisture content. The Contractor shall ensure the measured moisture content is +/- 5% of actual moisture content.

3.5.2 The ENGINEER will approve the sensor for installation upon a passing result.

END OF SECTION

Appendix 19.7 - Engineering Evaluations

APPENDIX 19.7
ENGINEERED BARRIER DESIGN BASIS

1.0 Stability, Liquefaction, Settlement

1.1 Introduction

This Appendix presents the geotechnical information, methods, input and results of the static and dynamic stability, liquefaction and settlement associated with the consolidated material to be covered with an engineered barrier at the SMC facility located at 75.016° W and 39.541° N in the borough of Newfield, New Jersey. NRC Regulatory Guide 3.11, Revision 3, November 2008, entitled Design, Construction and Inspection of Embankment Retention Systems at Uranium Recovery Facilities, was used to develop the geotechnical investigation and testing program and perform geotechnical engineering analysis. Where more recent updates of analytical methods presented in referenced documents were available from the authors, these were used to perform the engineering analyses.

1.2 Site Geology

The SMC facility is located within the New Jersey Coastal Plain consisting of Cretaceous to Miocene aged sands, silts, clays and occasional gravels. The eastern half of the SMC facility is underlain by the Bridgeton Formation which is estimated to have been deposited by erosion from the Beacon Hill Plain some eight million years ago. The western half of the SMC facility is underlain by the older Cohansey Formation (10 to 15 million years old). The Bridgeton and Cohansey formations are the more recent Miocene aged deposits that overlay much older Cretaceous aged deposits extending to more than 1,500 feet to bedrock. The soils underlying the facility are generally sandy soils with varying amounts of silts and clays. Occasional discontinuous thin lenses of clays and silty clays are found at varying depths. Refer to Attachment A to this Appendix for copies of references on the site geology.

A geotechnical investigation was performed in the area of the proposed engineered barrier in late January 2009. The investigation was performed in accordance with the Storage Yard Geotechnical Investigation Work Plan, prepared by TRC, dated December 2008 and transmitted to the NRC on December 17, 2008. A copy of the work plan is contained in Attachment B to this Appendix. A total of five test borings (GB-1 thru GB-5) were advanced to depth ranging from 9.14 to 11.58 meters (30 to 38 feet) below grade. Continuous soil samples were collected and Standard Penetration Resistance Testing (SPT) (ASTM D1586) performed. Soil samples were analyzed for Grain Size Analysis (ASTM D422), Atterberg Limits (ASTM D4318) and Soil Classification (ASTM D2487). There were two thin-walled Shelby tube samples collected from thin silty clay lenses in accordance with ASTM D1587. Only soil collected from the Shelby tube at GB-1 9.14-9.75m (30-32 ft.) was suitable for Triaxial Shear – Consolidated Undrained testing (ASTM D4767) and Incremental Consolidation testing (ASTM D2435). Refer to Attachment C to this Appendix for a copy of the test boring location plan, test boring logs and geologic cross-sections. Refer to Attachment D for the geotechnical test results on the soil samples.

The soil deposits that lie beneath the area where the various slag, baghouse dust and soil materials will be consolidated beneath an engineered barrier system is composed of generally medium compact sand and silt fill material mixed with varying amounts of gravel sized slag pieces to a elevation of 29.26m (96 ft.) to 30.4m (100 ft.) vertical site datum (NAVD 83). Below the fill material lays generally medium compact silty sand and poorly graded sand with silt to the full depth sampled around elevation 21.3m (70 ft.) Two discontinuous thin lenses of medium stiff clay were sampled in test boring GB-1 and GB-5 at an elevation of approximately 20.11m to 21.33m (66 ft. to 70 ft.) The groundwater table for the area around the proposed engineered barrier has been monitored for many years via a network of monitoring wells that surround the facility. The water table in the Storage Yard has a slight gradient in a northeast to southwest direction between elevation 28.34m and 28.04m (93 ft. and 92 ft). This is based upon recent groundwater monitoring from wells surrounding the Storage Yard.

1.3 <u>Critical Conditions and Geometery</u>

Stability analyses are performed under scenarios that represent the critical conditions for barrier construction and operation. The materials being placed beneath the engineered barrier and the components of the barrier system do not present any stability critical conditions that are not manageable through controlled construction methods. The critical conditions requiring evaluation are the static and dynamic stability conditions expected during the 1,000 year life of the engineered barrier.

The engineered barrier is a rectangular berm with a top width of approximately 27.43m (90 ft)., bottom width of approximately 88.39m (290 ft.), top length of approximately 190.5m (625 ft.) and bottom length of approximately 246.8m (810 ft.) The top has a center high point running along its length and slopes 4% to the north and south. The side slopes of the berm have a slope of 33.3% (18.4^{o}). The high point of the berm in the center is at approximate elevation 40.54m (133.0 ft.), which when measured from the lowest elevation of 29.87m (98.0 ft.) at the toe on the south side, makes the maximum height 10.67m (35.0 ft.) Attachment E of this Appendix contains the Slope Stability Model Location Plan (DWG S-1), which shows grading for the engineered barrier and the location of the critical section (X-X'). The Slope Stability Model Section (DWG S-2) is also included in Attachment E.

The critical section for slope stability (Section X-X' on Slope Stability Model Location Plan) evaluation was selected from the center high point to the south along the lowest elevation of the toe of slope. This section will result in the lowest passive wedge resistance in any direction around the berm and result in the most conservative estimate of the factors of safety for slope stability.

Slope stability analyses were performed by calculating factors of safety along circular failure surfaces as well as block/wedge failures. Critical failure surface analyses were conducted to evaluate both deeper full slope failures and shallow engineered barrier system failures. Block/wedge failure analysis was targeted to only shallow failure in the clay layer of the engineered barrier. The worst case high water flood condition resulting from the Probable Maximum Flood (Elev. 105.0 ft.) was also evaluated.

1.4 Material Properties

Materials properties used in slope stability and liquefaction analyses for engineered barrier materials are based on typical referenced values for the specified materials and defined properties as specified. The coarse and medium slags are expected to behave like crushed rock due to their angularity. The baghouse dust and other fine materials are expected to behave like non-plastic silt and fine sand. The fill and natural soil deposits are defined by the laboratory testing performed and the blow counts from the SPT. Relative Densities (D_R) for the natural soil deposit cohesionless materials were derived from the Correlations Between Relative Density and Standard Penetration Resistance figure in accordance with Gibbs and Holtz, USBR Earth Manual, 1960. This method uses the SPT blows per foot in combination with the effective vertical stress. Attachment F of this appendix contains the computed D_R for each layer of soil as defined by the sample intervals in each soil boring. A copy of the cited Gibbs and Holtz figure is also provided. The average D_R ranged from 61% to 79%, with the average submerged D_R range of 56% to 70%. This D_R places the in-situ soils to a depth of approximately 9.14m (30 ft.) below the bottom of the engineered barrier in the category of medium compact cohesionless soils.

The angles of internal friction used in the slope stability calculations for the cohesionless natural soils and cohesionless engineered barrier materials were selected from Correlations of Strength Characteristics for Granular Soils, Figure 7, from NAVFAC 0525-LP-300-7055 – Soil Mechanics – Design Manual 7.1, dated May 1982. The figure, provided in Attachment F to this Appendix, shows the selection of the angle of internal friction of a soil based upon the D_R and the soil type for cohesionless materials. The angle of internal friction and cohesion intercept for the tested natural clay lense from test boring GB-1 is based on the actual laboratory result. The internal friction angle and cohesion intercept for the engineered barrier clay layer is as specified.

The soil types, soil layer numbers and geotechnical properties for the engineered barrier materials and the underlying soils are provided on Section X-X' in Attachment E of this Appendix and are summarized below, from top to bottom.

Material Properties Used in Stability Analyses

Soil	Material	Angle of Internal	Cohesion	Moist Unit	Sat. Unit
Layer #	Type	Friction (degrees)	(PSF)	Weight (PCF)	Weight (PCF)
1	Crushed Stone	40	0	135	140
2	Barrier Cover Soil	35	0	135	140
3	Barrier Clay Soil	15	250	125	130
4	Baghouse Dust & Fin	32	0	125	135
5	Medium Slag	38	0	135	140
6	Coarse Slag	40	0	135	140
7	Silty Sand	33	0	115	130
8	Clay (GB-1 30'-32')	20	300	130	140

1.5 Stability Analysis Methods

Stability analyses involve comparing the shearing stresses along potential failure surfaces with the available shearing resistance along those surfaces. The factor of safety is the ratio of the available shear strength to the developed maximum shear stress. The computer program STABL for Windows 2.0, 2003 by Geotechnical Software Solutions, LLC was selected to perform static and dynamic slope stability analyses. In accordance with NRC Regulatory Guide 3.11, Rev. 3, STABL provide a means to (1) consider complex slope geometries and subsurface soil layering, (2) use a number of different types of soil in the analysis, (3) search for circular, wedge, and noncircular failure surfaces, (4) consider different models to represent soil strength, and (5) consider different loading conditions. A copy of the STABL analytical methods is provided in Attachment G to this Appendix.

Conventional limit equilibrium methods of slope stability analysis evaluate the equilibrium of a soil mass tending to move down slope under the influence of gravity. STABL provides analysis of the range of conditions required by NRC Regulatory Guide 3.11, Rev. 3 as follows:

- *Method of Slices*—This method divides the free body into many vertical slices, and the equilibrium of each slice is considered. The best known and most widely used versions of this method are the Simplified Bishop Method, JANBU Simplified Method and Spencer's Method. The analyses consider both shallow slip surfaces that run through the embankment as well as deep slip surfaces that run beneath the embankment.

- *Wedge Method*—This method is used whenever the failure surface can be satisfactorily approximated by a series of straight lines (usually two or three). STABL uses the Janbu Wedge Method for these analyses. Also used for this type of analysis is the method developed by R.M. Koerner and T.-Y. Soong as presented in Geosynthetics International, 2005, 12, No. 1 and entitled Analysis and design of veneer cover soils. A copy of this method is also included in Attachment G of this Appendix.

Seismic stability analyses of the engineered barrier system were performed using the STABL program. In this approach, the stability of a potential sliding mass is determined assuming static loading conditions and the computation accounts for the effects of an earthquake by including an equivalent horizontal force acting on the potential sliding mass. The horizontal force representing earthquake effects is expressed as the product of the weight of the sliding mass and a seismic coefficient. The value of the seismic coefficient was selected on the basis of the seismicity of the site based upon United States Geologic Service (USGS) site specific published Peak Horizontal Ground Acceleration (PHGA) for a Mean Return Time of 2,475 years and an Annual Exceedance Rate of 0.000406.

Liquefaction potential analyses for the saturated, cohesionless soils, the dynamic analysis procedures developed by Seed et al. cited in Ref. 29 of the NRC Regulatory Guide 3.11, Rev. 3 was used as the basis for assessing the stability and deformation of the embankment during earthquakes. The updated procedure developed by Seed et. al. presented in the U.S. Department of Transportation Federal Highway Administration Publication FHWA HI-99-012, entitled Geotechnical Earthquake Engineering, was used to perform the liquefaction analysis. A copy of the document is found in Attachment H to this Appendix. This type of analysis is used to predict the development of the liquefaction zone and the anticipated movements, deformation, and stability of the embankment and its foundation.

As defined in NRC Regulatory Guide 3.11, the loading conditions to be evaluated in embankment stability analyses and corresponding minimum factors of safety are as follows:

Loading Condition	**Minimum Factor of Safety**
End of construction	1.3
Maximum pool with steady seepage	1.5
Earthquake	1.0
Liquefaction Potential	1.0

1.6 Settlement Analysis

The evaluation of settlement for an embankment system like the engineered barrier planned at this facility is based upon the soil conditions underlying the embankment and the variability of the soil stratigraphy. Total settlement and differential settlements which may cause cracking and/or excessive strain in the embankment and engineered barrier system components were evaluated. The magnitude of the anticipated settlement in compressible clays and silty clays is estimated from the results of laboratory consolidation tests on undisturbed samples recovered from the strata. The magnitude of settlement in the cohesionless soils is based upon SPT testing performed during the test boring program. A conservative method for computing total settlement, developed by Schmertmann, entitled Static Cone to Compute Static Settlement over Sand, Journal of Soil Mechanics and Foundations Division, ASCE, Vol. 96, No. SM3, 1976, is used to assess the magnitude of settlement in cohesionless materials anticipated during the construction of the engineered barrier. The method is summarized in Figure 6 – Instantaneous Settlement of Isolated Footings on Coarse-Grained Soils, from NAVFAC 0525-LP-300-7055 – Soil Mechanics – Design Manual 7.1, dated May 1982. A copy of this figure is contained in Attachment I of this Appendix, along with the settlement calculations.

Settlement calculations were made using the loading conditions imposed by the embankment to be constructed from the consolidated material and the engineered barrier system. The loading condition used in the calculation assumes the maximum proposed fill height superimposed over the top width of the completed embankment plus one-half of the slope width on each side. This resulted in a total width of 51.82m (170 feet) used in the calculation of the load footprint. The relative density of the subgrade soils was found to average approximately at 60%. Based on these conditions the total settlement estimated is only 3.56cm (1.4 inches). This amount of settlement is insignificant for embankment and barrier system construction and all will occur rapidly during filling of each layer of the embankment. By the time the clay barrier and other engineered barrier layers are placed, most of the overall settlement will have taken place. Differential settlement will not pose a problem at this site due to the uniformity of the subgrade soils. The thin layer of clay found at test boring GB-1 will not pose any problem with differential and time rate of settlement. The fact that this area of the proposed engineered barrier is currently covered by the tallest and largest slag piles, has therefore sufficiently preloaded the soil in this area and any settlement that could occur has already taken place.

1.7 Static Stability Analysis

Static stability analysis of the embankment comprised of the consolidated materials covered with the engineered barrier system sitting upon the site subgrade soils was performed using the computer program STABL. The model critical section and soil profile input parameters are as previously discussed in this Appendix and the referenced Attachments. Three methods within the STABL program were used to assess stability factors of safety, the Simplified Bishop Method, Janbu Simplified Method and Spencer's Method. The computer model runs were set-up to provide evaluation of factors of safety against failure for both deeper failures that penetrate the underlying subgrade soils and failure within the embankment and engineered barrier system. Attachment J of this Appendix contains all of the static STABL modeling results, including plots of the critical failure surfaces, all failure surfaces analyzed and histograms of the factors of safety for the generated surfaces. The static stability was computed using both the natural ground water table surface and an extreme water surface from the Probable Maximum Flood (PMF) Elevation of 32.0m (105 ft.). The minimum static stability factor of safety based on all STABL model analyses is 2.006 using the Modified Janbu Method with an extreme high water elevation of 105 ft. from the PMF. This satisfies the static stability factor of safety requirement of 1.5 stipulated in NRC Regulatory guide 3.11, Rev. 3. The following is a summary of all of the minimum factors of safety computed from each of the STABL program runs:

Model Run #	Method	Failure Surface	Water Table	Factor of Safety
1	Janbu Circular	Shallow (Deep Assessed)	Natural	2.225
1	Bishop Circular	Shallow (Deep Assessed)	Natural	2.261
1	Spencer Slices	Shallow (Deep Assessed)	Natural	2.275
3	Janbu Circular	Shallow (Deep Assessed)	Natural	2.191
3	Bishop Circular	Shallow (Deep Assessed)	Natural	2.251
3	Spencer Slices	Shallow (Deep Assessed)	Natural	2.262
4	Janbu Circular	Deep (Shallow Assessed)	Extreme	2.006
4	Bishop Circular	Shallow (Deep Assessed)	Extreme	2.076
4	Spencer Slices	Shallow (Deep Assessed)	Extreme	2.085
1	Janbu Wedge	Shallow (Clay Barrier)	Natural	2.187
	Janbu Wedge	Shallow (Clay Barrier)	Extreme	2.183
	Koerner/Soong Wedge	Shallow (Clay Barrier)	Natural	2.386

1.8 Seismic Stability Analysis

The SMC facility is located in an area of New Jersey that has relatively low seismic hazard potential. This fact is evidenced by a peak horizontal ground acceleration (PHGA) value of only 0.08468g for a mean return time of 2,475 years or a chance of 2% exceedence in a 50 year period. The PHGA for a 975 year mean return time is 0.04195g. This information is obtained from the United States Geologic Service (USGS) National Seismic Hazard Mapping database. The closest mapped geologic faults are located to the north of Philadelphia nearly 64.36km (40 miles) away from the facility.

The STABL program was utilized to assess seismic stability of the engineered barrier embankment and the underlying soils. The PHGA value of 0.08468g for the 2,475 year mean return time was selected for the analyses to model the most conservative estimate of seismic potential for the life of the engineered barrier. The model takes as input the same parameters used for the static stability analyses and the peak horizontal and vertical acceleration from the seismic event. The vertical acceleration is of lower magnitude than the horizontal acceleration, but in order to model the most conservative scenario, the PHGA was used for both input values.

The STABL model runs were set up to produce analyses of both deep and shallow failure modes, with the natural water table. The minimum seismic stability factor of safety found was 1.571 using the Modified Janbu Method with a shallow circular failure through the engineered barrier. This satisfies the NRC Regulatory Guide 3.11, Rev. 3 criterion of a factor of safety of greater than 1.0 for seismic conditions. When the 975 year mean return time PHGA of 0.04195g is used the factor of safety rises to 1.783. Attachment K of this Appendix contains all of the seismic STABL model results, including plots of the critical failure surfaces, all failure surfaces analyzed and histograms of the factors of safety for the generated surfaces. The following is a summary of all of the minimum factors of safety computed from each of the STABL program runs:

Model Run #	Method	Failure Surface	Water Table	Factor of Safety
1	Janbu Circular	Deep (Shallow Assessed)	Natural	1.660
1	Bishop Circular	Shallow (Deep Assessed)	Natural	1.743
1	Spencer Slices	Shallow (Deep Assessed)	Natural	1.756
2	Janbu Circular	Shallow	Natural	1.571
2	Bishop Circular	Shallow	Natural	1.640
2	Spencer Slices	Shallow	Natural	1.649
	Janbu Block	Shallow	Natural	1.766
	Koerner/Soong Wedge	Shallow (Clay Barrier)	Natural	1.772

1.9 Liquefaction Analysis

The liquefaction factors of safety were evaluated by the method cited earlier. The first step in the process is to assess the liquefaction potential based upon the screening criteria established in NRC Regulatory Guide 3.11, Rev. 3 and contained in Chapter 8.2 of the FHWA HI-99-012 publication provided in Attachment H to this Appendix. These are:

Geologic Age and Origin: Miocene and older deposits below the SMC facility are Pre-Pleistocene and therefore have very low liquefaction potential according to the cited reference.

Fines Content and Plasticity Index: The saturated soils underlying the SMC facility are generally non-plastic and have fines content generally ranging between 10% and 15%. This means the shallow saturated soils are susceptible to liquefaction.

Saturation: The natural water table lies approximately 6 ft. to 8 ft. below the bottom of the proposed engineered barrier. This means saturation is close enough to the surface to allow liquefaction.

Depth Below Ground Surface: The proposed embankment and engineered barrier system will have its bottom above the water table, so liquefaction could affect the system.

Soil Penetration Resistance: The Standard Penetration Test (SPT) results from the soil test borings show most soil layers below the water table with values below 30, suggesting that the soils are susceptible to liquefaction.

Since several of the screening criteria suggest the soils underlying the site are potentially susceptible to liquefaction, the Simplified Procedure for liquefaction potential assessment of sands and silts described in FHWA Publication No. HI-99-012 was performed. This procedure was originally developed by Seed and Idriss (1982) and progressively revised, extended and refined to the procedure contained in the FHWA publication. The stepwise procedure provided in Section 8.3.2 of the FHWA document was followed for this site. Only soils that lie beneath the natural water table were included in the liquefaction assessment. The results of the SPT from each of the five (5) test borings GB-1 thru GB-5 were summarized in separate spreadsheets for liquefaction assessment. The SPT results are listed in two (2) foot soil sampling intervals, which allow assessment of each sample interval for liquefaction potential.

The selection of the design earthquake magnitude is based upon the USGS National Seismic Hazard database for a 2,475 year mean return time assessment. The Peak Seismic Hazard (PSH) Deaggregation on NEHRP BC Rock from the 2008 database was selected from the USGS website to determine the PHGA, mean seismic magnitude and modal seismic magnitude for the SMC facility's Newfield location. This database presents the statistical site specific earthquake information in a format that separates the magnitude-distance (M-R) pair data into contribution to the overall seismic hazard. The mean deaggregation provides the weighted mean values of M and R for all sources that contribute to the hazard. The modal value yields the M and R pair having the largest contribution in the deaggregation of each grid location. For regions like the SMC site exhibiting more than one significant seismic source the modal values are much more representative, and the mean values are not recommended for use in liquefaction hazard analysis. The other factor influencing the use of the modal M-R values is that the mean M-R value represents an event that is more than six times the distance (61.1 km vs. 9.6 km) from the site than the modal values. The attenuation of the mean event that would occur in this geologic setting with very deep overburden deposits would be significant. The PSH Deaggregation on NEHRP BC Rock results for both the 2,475 year mean return time and the 975 year mean return time for the SMC site are found in Attachment L of this Appendix.

The calculations performed as required by the Simplified Method contained in Section 8.3.2 of the FHWA publication were set-up in a spreadsheet for each boring location. The results using the modal earthquake value of 4.8 magnitude for the 2,475 year mean return time event were used in the analysis. No adjustment was made for attenuation of the event in order to simulate a worst case condition. Copies of the spreadsheets showing each step in the Simplified Procedure process are located in Attachment M of this Appendix. The results show that there is not a single soil layer evaluated that has a factor of safety less than 1.0 and the overall average factor of safety is 5.81. This satisfies the NRC Regulatory Guide 3.11, Rev. 3 criterion of a factor of safety of greater than 1.0 for liquefaction assessment. The results demonstrate the low potential for liquefaction at the SMC site such that there is no need for further detailed analysis and no need to incorporate reinforcement measures to account for liquefaction. The following is a summary of the liquefaction factor of safety results for each test boring location showing the average and lowest factors of safety:

Boring Location	Average Factor of Safety	Minimum Factor of Safety (Depth)
GB-1	8.44	1.36 (8.53m (28 ft.))
GB-2	6.67	2.64 (9.75m (32 ft.))
GB-3	5.09	3.26 (10.36m (34 ft))
GB-4	3.22	1.66 (10.97m 36 ft))
GB-5	5.64	3.10 (4.87m (16 ft.))

2.0 Erosion Protection

To protect the engineered barrier against erosion, the barrier was designed in accordance with NUREG-1757 and NUREG-1623, Design of Erosion Protection for Long-Term Stabilization. NUREG-1623 provides methods, guidelines and procedures to be used for designing long-term protection with respect to erosion, with the following specific performance objectives: 1) preventing radioactive releases due to erosion; 2) providing long-term stability; 3) designing for minimal maintenance; and 4) meeting radon release limits. Therefore, an engineered barrier designed in accordance with this guidance will be effective both with institutional controls in place and under an assumed loss of institutional controls.

The NUREG-1623 guidance requires that a barrier be designed to resist severe localized rainfall events and large floods on nearby streams. The engineered barrier has been designed to meet the flooding and erosion protection criteria of NUREG-1623 using the Probable Maximum Precipitation (PMP) as the design rainfall event and the Probable Maximum Flood (PMF) as the design flood. The PMP is the estimated depth of rainfall for a given duration, drainage area, and time of year for which there is almost no risk of exceedance. The PMP approaches and approximates the maximum rainfall that is physically possible within the limits of contemporary hydrometeorological knowledge and techniques and is based on the concept that there is a limit to the amount of water the atmosphere can hold. Use of the PMP in estimating the PMF results in an estimate of a hypothetical flood that is considered to be the most severe that is reasonably possible. In NUREG-1623, NRC staff conclude that it is reasonable and prudent to use the PMF as the design flood where reasonable assurance of non-exceedance for a period of 1,000 years is desired. By designing to protect against erosion under PMP and PMF conditions, protection will also be provided under less severe, more common storm events.

NUREG-1623 outlines various cover design options. The design of the angular stone erosion control layer to be installed over the top and sides of the engineered barrier at the SMC site in accordance with the guidelines of NUREG-1623 ensures that the engineered barrier meets cover design option 3 (i.e., soil covers totally protected by a layer of rock riprap on both the top and side slopes as defined in NUREG-1623). NUREG-1623 states, in part, that "The preferred options to design a cover system are Options 1, 2, and 3; such designs will be stable and will be effective for a 1,000 year period."

The engineered barrier design for the Newfield facility includes four types of processed rock to provide erosion protection in accordance with NUREG-1623: two sizes of crushed stone, one gravel/crushed stone filter bedding and a larger riprap material. The following are general descriptions of each:

- Engineered Barrier Top Surface - On the flatter top surface of the engineered barrier, the crushed stone surficial layer consists of 3 inches of ½- to 1½-inch crushed stone (d_{50} = 1 inch).

- Engineered Barrier Side Slopes - On the steeper side slopes, the surficial erosion control layer consists of 6 inches of 2- to 4-inch crushed stone (d_{50} = 3 inches), underlain by 6 inches of 1/8- to ½-inch gravel/crushed stone filter bedding (d_{50} = 1/4 inch).

- Filter Bedding - The filter bedding layer is provided to bed the surficial crushed stone, prevent stone penetration into the underlying soil layer, and prevent soil erosion at the stone/soil interface.

- Riprap - Larger riprap protection is provided at the toe of the side slopes and consists of 15 inches of 4- to 6-inch riprap (d_{50}= 5 inches). Where drainage channels are present at the toe of the side slopes (i.e., along the western, northern, and eastern sides of the engineered barrier), the riprap consists of 24 inches of 6- to 18-inch riprap (d_{50} = 12 inches).

A description of the erosion protection design process and associated calculations, which were conducted in accordance with Appendix D of NUREG-1623, are provided in Attachment N. The drainage design is discussed in more detail in Section 1.3 of this Appendix.

The design of the erosion protection system, including the riprap at the base of the slopes, is sufficient to protect the engineered barrier from the effects of the PMF without the need for additional stone riprap or other protection below the estimated PMF elevation.

The stone materials to be used on the surface of the barrier have been selected and sized to meet the durability requirements of NUREG-1623 and NUREG-1757. Construction specifications and QA/QC construction procedures defined in Appendix 19.8 are in accordance with NUREG-1623 guidance that will ensure the quality and proper placement of the riprap. Petrographic analyses and available published data provide information on the absence or presence of heterogeneities that could impact the potential degradation of the rock. NUREG-1623 notes that compliance with the NUREG-1623 methodology "will provide reasonable assurance of the effectiveness of the rock over the design lifetime of the project."

SMC intends to secure all of the processed rock and stone from a diabase rock source at the Dyer Quarry, located in Birdsboro, PA, approximately 85 miles northwest of the site. The diabase sill is generally a massive and uniform intrusion into the regional sandstone and siltstone rock (country rock). It is hundreds of feet wide and over 1,000 feet thick. The quarry has been processing the diabase sill since approximately 1930.

A detailed description of the selection of the Dyer Quarry as the source for the durable rock cover for the engineered barrier, including the geology, chemistry and durability of the diabase, can be found in Attachment O. As documented therein, a durability analysis of the rock source in accordance with NUREG-1623 procedures results in a rock score of 94.7%, which is significantly higher than the 80% rock score referenced in NUREG-1623 as designating a high quality rock. This durability analysis score is also supported by the general absence of adverse minerals and heterogeneities that could impact long-term durability and by natural and manmade analogs that provide long-term evidence of resistance to weathering.

While the erosion control features have been designed in accordance with guidance developed to eliminate the need for ongoing maintenance, inspections of the surface of the engineered barrier will be conducted following construction to ensure that erosion does not occur (see Appendix 19.9).

3.0 Frost Protection

The design of the engineered barrier ensures the protection of the 3-foot thick clay layer against possible frost damage for a 1,000-year predicted frost penetration recurrence interval. To further assess frost penetration based on local climatic data, more extreme recurrence intervals, and differences between the thermal properties of soil versus crushed stone, TRC retained the services of Professor Arthur DeGaetano, Director of the NOAA Northeast Regional Climate Center (NRCC) in Ithaca, NY. Dr. DeGaetano has published a number of papers on extreme value frost depth prediction[1,2,3,4]. Dr. DeGaetano performed mathematical modeling on behalf of TRC to determine the sensitivity of frost depths to various conditions and recurrence intervals for a uniform layer of cover soil (silty sand) versus a uniform layer of crushed stone. Although gravel/ crushed stone is not susceptible to frost damage and is known to provide frost protection to underlying soil (e.g., as quantified for ballast in railroad design documents such as Army/Air Force TI 850-02, March 2000) the degree of protection may not be equivalent to that provided by a finer grained material. Based on the results of the analyses by Dr. DeGaetano, maximum seasonal frost depths for the 1,000-year recurrence interval were estimated to be 40 inches for silty sand and 48 inches for crushed stone. The thickness of cap materials above the clay layer was conservatively increased to 48 inches to correspond to the results for a uniform layer of crushed stone, despite the fact that 50 to 68 percent of that proposed thickness (24 inches on the side slopes, 33 inches on the top slopes) will actually be comprised of cover soil. Details regarding the methods utilized for the extreme frost penetration assessment, conservative assumptions made, and supporting information are further provided below.

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[1] DeGaetano, A.T., and Wilks, D.S. (2002). "Extreme-Value Climatology of Maximum Soil Freezing Depths in Contiguous United States." J. Cold Regions Engineering, Vol. 16, No. 2.

[2] DeGaetano, A.T., et al. (2001). "Physical Simulation of Maximum Seasonal Soil Freezing Depth in the United States Using Routine Weather Observations." J. Applied Meteorology, Vol. 40.

[3] DeGaetano, A.T., et al. (1996). "A Physically Based Model of Soil Freezing in Humid Climates Using Air Temperature and Snow Cover Data." J. Applied Meteorology, Vol. 35.

[4] Northeast Regional Climate Center (1996). Atlas of Soil Freezing Depth Extremes for the Northeastern United States.

As previously mentioned, a mathematical model developed and described in publications by Dr. DeGaetano of the NOAA NRCC was utilized for frost depth prediction. The model (hereinafter, NRCC model) was designed to be readily compatible with basic meteorological data available from the U.S. National Weather Service Cooperative Observer Network of weather stations. The NRCC model is characterized as a physically based, one-dimensional heat flow model that estimates the depth of soil freezing using a daily time step. Observed air temperatures specify conditions at the model's upper boundary. The lower model boundary is set at 2 meters below the surface and assigned a daily temperature using a harmonic function based on the average air temperature for the April 1–March 31 period that commences before the winter season of interest, and the particular day of the year. Between these boundaries, additional boundaries are defined at the air-ground or snow-ground interface, and up to two transitions between frozen and unfrozen soil. Given the resulting temperatures, the model's governing equations are solved using a daily time step for 1) the temperature at the air-ground or snow-ground interface, and 2) the depth of the transitions between frozen and unfrozen soil.

Model input data were selected to be site and project specific. Relevant parameters in the NRCC model include temperature (most importantly) as well as moisture, porosity, and mineral composition. Temperature data from two long-term National Weather Service Cooperative Observer Network stations in southern New Jersey – Millville and Belleplain State Forest – as well as data from Philadelphia International Airport were used to assess the depth of winter soil freezing in the vicinity of Newfield, New Jersey. Millville, Belleplain State Forest, and Philadelphia International Airport are located approximately 10 miles south, 20 miles south, and 20 miles north of the site, respectively. Daily average temperatures were available for these sites from 1950-2008, with the exception of Belleplain State Forest where the data record ended in 2007. Missing data at each site was reportedly minimal. In cases where missing temperature data did occur, data from one of the other sites was substituted.

As a physically based model, the NRCC model incorporates a number of features designed to enhance realism and accuracy within the limits of a daily time step. These features include the ability to account for the impact of both changing snow cover and soil moisture content on frost depth based on local temperature, precipitation, and ambient snow cover data. As a conservative measure given the project conditions and the facility location in southern New Jersey, the ground surface was modeled as bare soil for all of the modeling performed. Various references indicate that maximum seasonal frost depth penetration is greater for bare soil as compared to the conditions of ambient snow cover or turf due to the lack of associated insulating value[4,5]. Precipitation data were not utilized in this assessment due to the fact that the NRCC model addresses infiltration in a manner that is not directly applicable to steep slopes incorporating drainage layers. Instead, a sensitivity analysis was performed in which selected soil moisture contents were held constant for the duration of each freezing season.

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[5] Smith, G.M. and Rager, R.E. (2002). "Protective Layer Design in Landfill Covers Based on Frost Protection". J. Geotech. and Geoenv. Eng., Vol. 28, No. 9.

For cover soil, the analysis incorporated moisture contents ranging from approximately 5 to 20 percent of bulk volume, corresponding to approximately 2 to 10 percent of bulk weight, depending on bulk density specified for a given scenario. For crushed stone, moisture contents were selected ranging from 1 to 5 percent, corresponding to approximately 0.5 to 3% of bulk weight, again depending on specified bulk density. It is important to note here that these entire ranges are biased towards low values, since low values will yield the most conservative estimate of frost penetration depth. As reported in various sources and confirmed by Dr. DeGaetano as part of this assessment, drier soils allow deeper frost penetration (to the extent that enough water is present to freeze, and without consideration of the extent of damage) due to the loss of the thermal protection associated with the latent heat of fusion and low thermal diffusivity of water[4,5]. The lower limits in moisture content selected for the soil and crushed stone in the sensitivity analyses are supported by various references. For example, 10 percent volumetric moisture content was characterized as very dry in published frost depth modeling of Idaho soils using the NRCC model[3]. This value approximates the long-term, steady state moisture content measured up to eight feet below the surface of a vegetated, monolithic soil barrier with 5:1 slopes (H:V) artificially maintained in a moisture-stressed state using impermeable panels.[6] Similarly, a volumetric moisture content of 5 percent by volume was considered extremely dry for frost depth modeling of soils in Ithaca, NY[3]. Moisture contents of 1.6 percent to 3.6% by volume were utilized to predict maximum frost depth in graded aggregate and granular fill materials proposed beneath impermeable pavement in Stratford, Connecticut[7]. Lastly, based on the Rawls and Brakensiek equation, the lower boundary of long term soil moisture content approaches 2.6% (by weight) as clay and organic matter contents approach zero[8].

Lastly, the NRCC model requires input of mineral composition and porosity. In the NRCC model, a primary distinction is made between minerals containing quartz crystals and those not containing quartz crystals (e.g., minerals associated with feldspar). Since quartz crystals have a thermal conductivity approximately four times as high as that of most other mineral components, high quartz contents have the potential to increase frost depth penetration, all other factors being equal. For purposes of sensitivity analyses, expected ranges in quartz content were bracketed between 60 and 80 percent for the cover soil based on published values[9] and 5 and 20 percent for

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[6] U.S. Nuclear Regulatory Commission (1989). NUREG/CR-4918, Vol. 10 (1997). "Control of Water Infiltration Into Near Surface Low-Level Waste Disposal Units."

[7] U.S. Army Corps. of Engineers/ Cold Regions Research & Engineering Laboratory (1997). "Frost-Susceptibility Testing and Predictions for the Raymark Superfund Site." Special Report 97-31.

[8] U.S. Nuclear Regulatory Commission (1989). Regulatory Guide 3.64. "Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Cover."

[9] Peters-Lidard, C.D., et al. (1997). "The Effect of Soil Thermal Conductivity Parameterization on Surface Energy Fluxes and Temperatures," J. Am. Meteor. Soc.

the crushed stone based on measured values for the proposed diabase material, which are included in Attachment P. Selected porosity values selected ranged from 15 to 35 percent for cover soil and 30 to 45 percent for the crushed stone, again as supported by published values[10,11,12]. Lower boundary values of 15 percent and 30 percent for soil and crushed stone are conservatively low for the material (silty sand) and planned methods of placement and mechanical compaction. With respect to the group of parameters being modeled, it is the lower end of the range in porosity that is more important for purposes of obtaining a conservative estimate of frost depth. All other factors being equal, lower porosity values are associated with increased grain-to-grain contacts, which tend to increase frost depth penetration. The actual, as-built variability in the cover soil porosity can be reasonably controlled within a much narrower range than that utilized in the sensitivity analysis, whereas the porosity of the stone will vary by location due to the different ranges in gradation.

Based on the actual weather station data and specified soil properties, the NRCC model was used to compute the soil freezing depths for each day in the 1950-2008 period. For each July-June freezing season, the deepest soil freezing depth was retained, creating an annual maximum series of 59 soil freezing depths. These were fitted to the Gumbel distribution using the appropriate function in the "R" software package (version 2.6.2). By setting the shape parameter to 0.0, the distribution takes the form of the Gumbel distribution. Based on the fit distribution, the depths of soil freezing associated with the 2, 50, 100, 200, 500 and 1000-year recurrence intervals were computed.

As expected and confirmed by the results of the sensitivity analyses performed by Dr. DeGaetano using the NRCC model in Table 1 of Attachment P the recurrence interval has a large impact on the predicted frost depth. However, it should be noted that this at least partly reflects the long time scales investigated (up to 1,000 years) and there appears to be a tailing effect (a declining rate of frost depth as the recurrence interval increases), not uncommon in prediction of natural phenomena using extreme value scenarios (e.g., storms). Location of the weather station within an approximately 40 mile north-south span did not have a particularly large effect on frost depth. The deepest frost penetrations were predicted for the Millville station, perhaps due to its inland, non-urban setting. Of the remaining parameters, moisture content appeared to have the greatest impact (drier soils froze deeper) with porosity having a modest impact and quartz content an almost negligible impact. Frost depth appeared to be more sensitive to the total amount of water present than the percent saturation of theoretically available pore space. These conclusions were applicable for both the cover soil (silty sand) and crushed stone. In the overall sensitivity analyses, frost depth varied by a maximum of 5 inches for the cover soil and 14 inches for the crushed stone (Millville station, 1000-year recurrence interval).

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[10] LandSaver of Wethersfield, Connecticut. (2006). Tech Sheet #1, Porosity of Structural Backfill.

[11] Rowe, R.K. ed. (2001). Geotechnical and Geoenvironmental Engineering Handbook.

[12] Winterkorn and Hsai-Yang Fang (1975). Foundation Engineering Handbook.

To provide a basis for comparison of the frost depths predicted by the NRCC model, an analysis was performed of 100-year frost depths predicted by the modified Berggren equation using air-freeze indices and methods described in U.S. Army/ Air Force publication AFR 88-19[13]. Publications by Dr. DeGaetano indicate that the modified Berggren equation approach and the NRCC model generally yield similar predictions of maximum seasonal frost depth for a given recurrence interval. However, for the input parameters associated with the conditions studied, the NRCC model reportedly tends to be more conservative than the modified Berggren equation approach for bare ground conditions and less conservative when snow cover is modeled. In order to perform the analysis, the 100 year air-freeze index (506 deg. F-days) was obtained, as well as a freezing season length (90 days) for Millville station (506 from Dr. DeGaetano based on published NOAA data). For determining the surface freeze index from the air freeze index, a surface correction factor, N, equal to 0.9, was utilized based on recommendations from Dr. DeGaetano, which also agrees with the value used in predicting 200-year frost depth penetrations for modeled rock-covered or vegetated barriers in Utah[14].

However, problems were encountered using the charts provided in AFR 88-19 for obtaining values of parameters used in the modified Berggren equation. For example, due to the bias toward low moisture contents selected for the engineered barrier, in some cases it was difficult to interpolate certain values from the charts, or it was necessary to extrapolate beyond the limits of the chart, or both. In addition, the charts in AFR 88-19 are based on an unspecified mineral composition, and, according to Dr. DeGaetano, reflect a different relationship between thermal conductivity and soil moisture content than the one used in the NRCC model. Specifically for the purpose of better addressing freezing of drier soils, the NRCC model adjusts thermal conductivity versus moisture content using the Campbell equation, which, according to Dr. DeGaetano yields thermal conductivities that more closely match recent published values compared to those in the AFM charts[15,16]. In any case, for the scenarios considered to be reasonable worst case scenarios (Case Nos. 9 and 18) the frost depths predicted by the modified Berggren equation using the AFM charts were reasonably close to those predicted by the NRCC model. In particular, the 100 year frost depth predicted by TRC using the modified Berggren equation was within 0.4 inches of the NRCC model result for the Case No. 9 (cover soil). For

[13] U.S. Army/ Air Force (1988). "Arctic and Subarctic Construction Calculation Methods for Determination of Depths of Freeze and Thaw in Soils". TM 5-852-6. AFR 88-19, Vol. 6.

[14] U.S. Department of Energy (2008). Final Remedial Action Plan and Site Design for Stabilization of Moab Title I Uranium Mill Tailings at the Crescent Junction, Utah Disposal Site. DOE-EM/GJ1547.

[15] Abu-Hamdeh (2001). "Soil and Water: Measurement of the Thermal Conductivity of Sandy Loam and Clay Loam Soils using Single and Dual Probes." J. Ag. Eng. Research, Vol. 80.

[16] Côté, J. and J. Konrad (2005). "Thermal conductivity of base-course materials." Canadian Geotechnical Journal, Vol. 42.

Case No. 18 (crushed stone), the modified Berggren equation frost depth was approximately 16 inches less than that predicted by the NRCC model.

The design of the engineered barrier thickness of 48 inches above the clay layer is based on NRCC model output for the 1,000-year recurrence interval, Millville station results for Case No. 18 in the sensitivity analyses: crushed stone with 2% water content by volume, 10% quartz content (proposed diabase) and 40% porosity. As previously discussed, this worst case scenario and other modeled scenarios entailed a number of conservative assumptions in conjunction with the extreme recurrence interval. For example, no credit is being taken for the greater frost protection afforded by the cover soil as compared to crushed stone, even though cover soil will comprise 50 to 68 percent of the proposed 48-inch thickness (24 inches of cover soil on the side slopes, 33 inches of cover soil on the top slopes). Additionally, the modeling was performed assuming no snow cover and limited pore water would be available to mitigate frost penetration during the entire freezing season.

Given the proposed layered design of the cap, which includes 48 inches of material overlying the three-foot thick clay layer, frost penetration is not expected to result in degradation of clay layer performance. Certain properties of the cover soil and crushed stone that may affect frost depth (e.g., porosity/ bulk density, mineral composition) will be specified to fall within required ranges, which will be monitored and controlled during construction. Such properties will not be subject to degradation over time in a manner that will reduce frost protection, as described in other sections. Evidence indicates that the most damaging effects of frost may be caused by desiccation as the freezing front moves downward, and by the formation of ice lenses[17] although recent studies suggest that, for reasons requiring further investigation, desiccation cracking of clay is not inevitable, even within the frost zone[18]. In addition to providing frost protection to the underlying materials, the crushed stone layer of the engineered barrier ensures a well drained condition, thereby avoiding the accumulation of perched water that can lead to formation of ice lenses and frost heaves. In any case, results from the modeling demonstrate that the clay layer will lie beyond the frost zone even for recurrence intervals as long as 1,000 years.

4.0 Protection Against Infiltration

To provide an engineered barrier that severely limits infiltration, a compacted clay layer will be incorporated within the barrier. While the clay layer provides a low-permeability barrier to infiltration, it is the combination of the clay layer with the other layers of the engineered barrier

[17] Benson, C.H. (2000). "Liners and Covers for Waste Containment." Proc. Fourth Kansai Intl. Geotechnical Forum.

[18] Maine Department of Environmental Protection (2005). "Implementation of a Sealed Double-Ring Infiltrometer to Evaluate the Long-Term Hydraulic Performance of the Barrier Soil Layer Component of a Composite Landfill Cover System – Norridgewock, Maine."

that provides the overall protection against those natural mechanisms that, if uncontrolled, can result in infiltration through an engineered barrier system.

Numerous studies including field and laboratory testing have been conducted to evaluate engineered barrier designs and help identify those barrier features that have the greatest impact on the ultimate percolation of precipitation through the barrier and into the underlying materials. These studies include the Alternative Cover Assessment Project (ACAP), where twelve demonstration field sites were established nationwide (including a Department of Energy uranium mine tailings disposal site in Monticello, UT) to support the study of various cover designs over a period of five years. The majority of these studies have been conducted on landfill cover designs that meet the RCRA Subtitle C and Subtitle D performance standards for engineered covers for hazardous and solid waste disposal facilities. As a result, the total cover thicknesses that have been studied are typically less than the engineered barrier cover thickness proposed for the SMC facility (the Monticello site is one exception) and some of the cover designs (referred to as conventional designs) include synthetic barriers (e.g., geomembranes or geosynthetic clay liners). For the covers constructed with only natural barrier materials (i.e., that do not contain geomembranes or geosynthetic clay liners), eight soil cover designs were characterized by monolithic covers (i.e., a thick layer of finer-textured soil overlain by topsoil representative of evapotranspiration covers) and six were characterized by capillary barriers (including a simple two-layer fine-over-coarse design to enhance the storage capacity of the overlying finer-textured layer). The Monticello site was the only design that included a clay barrier at depth, overlain by a drainage/biointrusion layer, similar to the SMC engineered barrier design.

These studies show that the greatest impacts to percolation through soil engineered barriers are post-construction impacts associated with freeze/thaw mechanisms, wetting/drying (desiccation) mechanisms, root penetration, and burrowing animal penetration, which can alter the hydraulic properties of the soil layers and the hydrology of the cover system. As indicated in NUREG-1623 and other design guidance, erosion and migration of fine particles represent other potential degradation mechanisms. Studies conducted in Maine[19] on sites characterized by 0.5 feet of vegetative cover over 1.5 feet of compacted marine silty clay concluded that, amongst various factors, desiccation appears to be the most important contributor to the hydraulic degradation of the barriers evaluated. In the ACAP studies, some of the engineered barriers behaved in accordance with water balance principles (i.e., percolation occurred through the infiltration barrier when the soil water storage exceeded the calculated storage capacity during intense spring rainfalls); however, in some cases barriers exhibited increased percolation following a period of extensive drying, suggesting that desiccation cracks or root channels penetrated the cover, thus providing preferential pathways for infiltration.[20] For vegetated barriers with less

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[19] Department of Environmental Protection, State of Maine, An Assessment of Landfill Cover System Soil Barrier Layer Hydraulic Performance Final Paper, May 2001.
[20] Albright, et al., *Field Water Balance of Landfill Final Covers,* Journal of Environmental Quality, 33:2317-2332, 2004.

permeable soils (i.e., soils with as-built saturated hydraulic conductivities of 1 x 10^{-6} cm/sec or less), significant increases in saturated hydraulic conductivity were measured from initial construction conditions to post-construction conditions after up to four years of service.[21] However, this study noted that soil specimens tested for the study were obtained from the upper 12 inches, and acknowledged that smaller changes in hydraulic properties may occur at deeper depths. At the Monticello site, which more closely represents the SMC design, no percolation was reported through the barrier over four years of monitoring.[22]

Each of the aforementioned mechanisms has the potential to affect overall barrier performance by impacting either the resistive portion of the barrier (i.e., clay layer) or one or more of the other components of the engineered barrier system. The following discussions clarify the reasons why the engineered barrier, functioning as an integrated system of seven layers, will resist changes induced by these mechanisms and remain effective in preventing water infiltration over the long-term, even assuming loss of institutional controls.

4.1 Desiccation Due to Wetting/ Drying Cycles

Degradation of hydraulic performance due to desiccation has been attributed to wetting and drying cycles, particularly when extended periods of drying are involved. As plastic soil such as clay dries, it loses pore water, resulting in shrinkage of the soil mass and subsequent cracking and desiccation. Desiccation of clay is believed to lead to the development of preferential flow pathways due to shrinking/swelling and ultimately the formation of macroscopic cracks. In a worst case scenario, the upper half of the three-foot thick clay layer may experience moisture fluctuations presumably leading to development of such cracks. This type of worst case scenario would be associated with extensive cover soil degradation over time, combined with a severe, prolonged drought, and is extremely unlikely. As further explained below, the upper layers of the engineered barrier will further protect the clay layer from desiccation under various conditions, including during extended periods of dry weather, by isolating it from gradients that contribute to the migration of water as a liquid or a vapor.

Due to the minimal amount of biodegradable organic matter (wood, plant matter, or other materials) or reactive material in the consolidated materials, or in the cover materials themselves, strong thermal gradients will not be generated from within the engineered barrier. Since the upper surface of the clay layer has been placed at a depth of four feet beneath cover soil and crushed rock, the sheer thickness of overlying material will provide substantial thermal insulation (as indicated in the discussion of frost depth penetration) from thermal gradients generated outside the cap by weather conditions. Consequently, the thickness of the overlying material will help limit evaporation from the surface of the clay layer. In addition, the gradation of the silty sand cover soil, with a thickness of 24 to 33 inches, will be specified to maximize its

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[21] Benson, et al., *Postconstruction Changes in the Hydraulic Properties of Water Balance Cover Soils*, Journal of Geotechnical and Geoenvironmental Engineering, ASCE, 349-359, April 2007.
[22] Albright, et al., *Field Water Balance of Landfill Final Covers*, Journal of Environmental Quality, 33:2317-2332, 2004.

moisture retention, suppressing evaporation from the clay layer by helping to maintain a constant relative humidity above the clay layer. Given the relatively low permeability of the cover soil and the capillary break created by the underlying crushed stone biointrusion/ drainage layer, rapid drying of the cover soil due to gravity drainage will be avoided. To the extent that evaporation may induce upward migration of stored pore water under capillary action (often described as wicking) such migration will not extend into the clay layer due to the intervening presence of the crushed stone biointrusion/drainage layer. For example, inspection of a four foot thick, soil-only (i.e., no geomembrane) resistive barrier with 3:1 (H:V) slopes in Milwaukee, Wisconsin, showed that a layer of coarse grained material between the cover soil and low permeability soil prevented desiccation cracking of the soil, whereas desiccation cracking occurred within three years in barriers without such a layer[23]. Successful overall performance (low measured percolation) of resistive, soil-only barriers was attributed in part to the presence of this coarse grained layer beneath the finer grained cover soil, described as an inverted capillary break, at this site, as well as another site with milder slopes at Hill Air Force Base in Utah[23]. Inverted capillary breaks are also known as reverse capillary barriers, and have been used to control upward water migration and thereby limit oxygen diffusion in reactive mine waste covers[24].

Rather than drying out, evidence indicates that, based on the proposed engineered barrier configuration and climatic conditions, the moisture content of the clay layer will remain near as-built levels. For example, moisture contents measured within the plastic, silty clay layer of a vegetated, soil-only barrier with 5:1 slopes in Beltsville, Maryland showed little seasonal or annual variation over a seven year post-construction monitoring period, despite the comparatively thin capillary break (six inches of pea gravel) and shallow depth of the clay surface (two feet below the barrier surface)[25]. At another test plot in Beltsville, having the same 5:1 slopes, pea gravel, and clay layer, but with the vegetated cover soil completely replaced by riprap, the moisture content of the clay actually increased slightly compared to the as-built condition over an eight year period. A similar increase in moisture content was measured over four years in the clay layer of a seven foot thick, vegetated, soil-only resistive barrier tested at Hill Air Force Base. Results from the Beltsville, Maryland tests demonstrate that, given the associated lack of evapotranspiration by plants, a rock layer alone will prove sufficient to limit moisture loss from a clay layer due to evaporation in temperate, humid climates, such as encountered in the Newfield vicinity. The ability of rock layers to suppress evaporation has been demonstrated at other sites as well, including Hanford, Washington[23]. Results from both

[23] Albright, W.H., et al/ Desert Research Institute (2002). "Alternative Cover Assessment Project – Phase I Report". Publication No. 41183.

[24] Benson, C.H. (2000). "Liners and Covers for Waste Containment." Proc. Fourth Kansai Intl. Geotechnical Forum.

[25] NUREG/CR-4918, Vol. 10. (1997). "Control of Water Infiltration Into Near Surface Low-Level Waste Disposal Units".

Beltsville and Hills Air Force Base tests demonstrate the effectiveness of an inverted capillary break for preventing desiccation of clay layers beneath vegetated caps, especially under prolonged, dry conditions, such as experienced in arid climates.

The gradation of the silty sand cover soil will be specified to maximize its moisture retention and minimize drying between rainfall events. This gradation will suppress evaporation from the clay by helping to maintain a constant relative humidity above the clay layer. Moisture retention will be maximized in part by including sufficient silt and clay particles in the cover soil. More specifically, the cover soil will incorporate a broad grain size distribution, and will be moderately compacted, resulting in fewer large pores and a narrower pore size distribution, both of which have been shown to help maximize moisture retention over a wide range of matric suctions[26]. Cover soil installed such that large pores and broad pore size distributions are avoided also has been shown to be more resistant to changes in moisture holding capacity over time due to various degradation mechanisms. Although the cover soil will contain a significant portion of fine particle sizes, the clay content will be restricted to ensure a low plasticity. Various studies completed at sites in Maine, Illinois, Utah, and other states demonstrate that well-graded, low plasticity soils provide a reasonably low hydraulic conductivity, which, due to the soil's resistance to shrinking and swelling, remains stable over time even in shallow soils[23,27]. In any case, although the gradation of the cover soil will be optimized to maximize moisture retention across a wide range of matric suctions, the humid climate and the presence of rock cover may at least initially play a more important role in minimizing moisture loss from the cover soil and, in turn, from the clay layer. For the all controls fail condition where vegetation is eventually allowed to cover the surface of the cap and develop roots in the cover soil, the presence of a capillary break/ inverted capillary break (the drainage/biointrusion layer) will continue to ensure that the clay layer is protected from desiccation.

In order to help ensure the same level of protection from desiccation demonstrated in the aforementioned studies, proper construction quality control measures have been incorporated in the design. Provisions include laboratory analyses of the clay to determine optimal compaction moisture contents, laboratory analyses of the clay to determine relations between moisture content and desiccation cracking, and careful moisture monitoring and maintenance during construction. Based on the results of the cited studies, post-construction irrigation of the clay layer is not expected to be necessary. However, as an additional layer of conservatism, the design includes extended post-construction monitoring of moisture contents using moisture sensors embedded in the clay layer. Post-construction irrigation of the clay layer has been proposed as a potential worst-case scenario if monitoring demonstrates moisture levels are approaching a threshold associated with crack formation. If monitoring of the soil moisture

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[26] Benson, C.H., et al. (2007). "Postconstruction Changes in the Hydraulic Properties of Water Balance Cover Soils." J. Geotech and Geoenv. Eng. Vol. 133, No.4.

[27] Maine DEP (2001). "An Assessment of Landfill Cover System Soil Barrier Layer Hydraulic Performance – Final Paper"

sensors after construction shows the soil moisture content of the clay barrier layer is approaching that at which cracks may develop, the use of irrigation or the potential construction of permeable zones in the cover soil of the engineered barrier to maintain acceptable soil moisture levels will be evaluated. The specifics of the permeable zones or irrigation requirements will also be developed based upon the laboratory testing results and will be incorporated into the Long-Term Control Plan. In any case, lysimeters are included to monitor the performance of the engineered barrier in resisting infiltration

4.2 Freeze/Thaw Design

As mentioned in the previous discussions of frost and freeze-thaw design, it is believed that frost penetration has the potential to impact the hydraulic properties of a soil layer due to desiccation that may occur as the freezing front moves downward, or by the formation of ice lenses. Given the well drained condition ensured by the one-foot thick biointrusion/ drainage layer, perched water will not accumulate in either the cover soil or the clay layer, thereby avoiding the formation of ice lenses. Furthermore, studies mentioned in the separate discussion of frost penetration indicate that desiccation cracking of clay is not inevitable, even within the frost zone. In any case, under the currently proposed thickness of material overlying the clay barrier (four feet of cover soil and crushed stone) recently performed frost depth modeling demonstrated that the clay layer would lie below the freezing front for recurrence intervals as long as 1,000 years.

4.3 Erosion

In order to preserve the hydraulic properties and shielding capabilities of the engineered barrier, it is important to prevent the migration of fine grained materials, particularly from the cover soil layer, due to precipitation. Due to the limited infiltration into the drainage layer, erosive forces on the surface of the clay layer will be minimized. The compacted clay layer will resist erosive forces due to the high degree of cohesion between particles. Closer to the surface of the engineered barrier, fine particles in the silty sand cover soil layer are protected by the proper design and installation of crushed stone, with geotextiles for additional protection and for restricting downward migration of particles[28]. The use of a rock-protected soil cover above the clay layer is one of the preferred designs listed in NUREG-1623. Stone erosion protection for the engineered barrier was designed in accordance with NUREG-1623 to accommodate the Probable Maximum Precipitation (PMP) event, which corresponds to a depth of rainfall for which there is almost no risk of exceedance based on the limits of contemporary hydrometeorological knowledge and techniques. As a result, the characteristics (size, shape, density) and placement of the rock cover will allow it to withstand erosive forces and continue to protect the underlying fine-grained materials from the associated maximum storm velocities across the entire cap. This capability applies to all of the stone layers, including the combined riprap and filter bedding on the side slopes, the large riprap at the toe of the slope, and the large

[28] A landfill cover that included a geotextile between the soil and biointrusion layer at a depth of approximately 2.3 feet was evaluated after 10 years in place and the geotextile layer was found to be intact, with no holes or tears (Breshears, et. al, 2005, Ecohydrology Monitoring and Excavation of Semiarid Landfill Covers a Decade after Installation.

riprap in the channels and aprons (recently modified to incorporate a wider channel bottom and address other factors, as described in a separate section). In addition, based on the results of rock durability testing and scoring in accordance with procedures contained in NUREG-1623 and NUREG-1757, the selected stone is highly resistant to weathering by various mechanisms. Construction quality control procedures have been specified for source testing and proper placement of the stone to ensure suitable, long-term function as passive erosion control. Given the design of the stone layers in accordance with NUREG-1623 and NUREG-1757, even a loss of institutional controls would have little effect on long-term erosion control, and erosion mechanisms will not impact long-term performance of the engineered barrier. Severe storms will not significantly alter the placement of the stone layers, which will therefore continue to protect the underlying fine materials from erosion. However, as an added measure of conservatism, and to account for other factors such as potential biointrusion, provisions for post-construction inspections of the riprap are included as part of the design.

The potential exists for clogging of the drainage layer due to migration of fine particles from various sources. Such sources could potentially include fine particles generated from weathering of the crushed stone, from windblown dust and debris, or from erosion of the cover soil. With regard to weathering of the stone, the greatest potential for such weathering is associated with the riprap located on the surface of the cap, as opposed to stone within the drainage layer. However, particles generated at, or depositing on, the surface of the cap would be subject to filtration through the cover soil and two layers of geotextile before reaching the drainage layer. In any case, because of the durability of the selected stone, generation of fine particles due to weathering of the stone will be minimal. The silty sand cover soil represents a more likely source of fine particles which could potentially enter the drainage layer. The previously described gradation of the cover soil and associated low vertical flow velocities, and the filtration provided by a strong, properly installed geotextile, will severely limit vertical migration of such particles into the drainage layer, as demonstrated in the leachate collection system of a landfill in Ontario, Canada[29]. The geotextile will become an increasingly effective filter over time. However, even in a worst-case scenario of a long-term, large scale failure of the geotextile, migration of fine particles into the drainage layer would not significantly affect the capacity of the drainage layer, or associated infiltration through the clay layer. As indicated in the section addressing seepage analysis, even an event as extreme as the PMP would only result in an average water table depth in the drainage layer of approximately 1 mm for combined flow from the top and side slopes (assuming a cover soil permeability of 1×10^{-4} cm/s, and a drainage layer permeability of 1×10^{-1} cm/s). This depth of flow is insignificant relative to the thickness of the drainage layer (approximately 305 mm) demonstrating that the drainage layer can accommodate substantial accumulation of particles.

[29] Benson, C.H. (2001). "Waste Containment: Strategies and Performance." Australian Geomechanics.

4.4 Biointrusion

Performance of the engineered barrier in preventing infiltration is primarily a function of the overall integrity of the clay barrier layer. As previously mentioned, significant increases in saturated hydraulic conductivity of cover materials have been measured over periods of up to four years, but this was only demonstrated for shallow, vegetated soils[21]. Increases in hydraulic conductivity in shallow soils are typically attributed to post-construction mechanisms such as wetting and drying, freezing and thawing, increasing root penetration, and burrowing of worms and insects. The configuration of the engineered barrier layers, will limit the impacts associated with wetting and drying or freezing and thawing. Many aspects of the barrier design will also deter penetration of either plant roots, burrowing animals, or both. Features inhibiting biointrusion include thick layers of relatively large stones on the surface and below the surface of the cap, a textural/ capillary break below the cover soil layer, a large capacity drainage layer with a low extractable moisture content, careful placement and mechanical compaction of soil layers to increase bulk density, and a deep clay barrier layer with inherently small pore sizes and relatively low oxygen content (due to moisture levels). These multiple deterrents will help ensure ample time for detection and correction of potential biointrusion as part of the post-construction programs.

Even under a loss of institutional controls scenario, biointrusion would proceed slowly. First, the riprap voids must begin to fill with windblown dust, debris, and seeds sufficiently to support plant growth. Next, in the eastern part of the country, establishment of vegetation is a successional process that generally begins with grasses and weedy annual herbs[30]. Establishment of such vegetation and certain associated insect populations (e.g., worms) will not adversely impact overall barrier performance, since such vegetation is shallow rooted, and in fact its presence is often encouraged on engineered barriers. Establishment of vegetation such as grass will shift the water balance in favor of more evapotranspiration and less runoff during the growing season, but this will not increase percolation through the clay layer. By virtue of the sheer thickness of materials above the clay barrier layer (four feet) most early successional vegetation and large burrowing animals are precluded from reaching the clay barrier layer[30]. Given the overall barrier thickness (seven feet) and multiple deterrents to root growth previously discussed, widespread breaching of the deep, three-foot thick clay barrier layer is extremely unlikely.

4.5 Long-Term Performance

In terms of preventing migration of potentially leachable contaminants, the overall performance of the engineered barrier is largely determined by its ability to limit infiltration or percolation into the consolidated, regulated material. The methods used to estimate the expected ranges in infiltration are described in Attachment Q. To provide further clarification to information presented therein, the original estimates entailed conservative, conventional engineering

[30] Smith, E.D. et al. (1997). "Natural Physical and Biological Processes Compromise the Long-Term Performance of Compacted Soil Caps". Barrier Technologies for Environmental Management: Summary of a Workshop.

calculations for estimating infiltration, derived completely independently of RESRAD calculations. RESRAD cannot be used to directly assess infiltration through a multilayer cap or account for changes in properties of such layers over time. Therefore, it was necessary to first estimate realistic infiltration rates independently, and then adjust certain parameters within RESRAD to ensure matching infiltration rates.

Of the two conventional approaches used to estimate infiltration, the first utilizes a simplified water balance approach. This first approach, which yields infiltration estimates ranging from 2.8 to 7.1 cm/year, can be considered an indirect estimate, in that evaporation and runoff were calculated from basic engineering equations, and infiltration was then assumed to equal the balance of precipitation falling on the cap. Due to the humid climate of the Northeast United States, there is typically an annual net gain of moisture in water balance calculations. The second approach, yielding infiltration estimates ranging from 0.62 to 6.2 cm/year, can be considered a more direct method, in that infiltration through the cap was approximated using Darcy's Law and conservative assumptions about hydraulic properties of the clay layer, further described below.

Due to complex interrelationships between the relevant factors, certain simplifying assumptions were used for estimating infiltration via the indirect, water balance approach. In particular, runoff of water from, and storage of water within, the cover soil are neglected. Annual evapotranspiration is assumed to equal potential evapotranspiration and was calculated by the Thornthwaite method using monthly temperature and daylight data. Annual runoff is calculated using the Rational Equation, with the intensity parameter assumed to equal the difference between annual precipitation and annual evapotranspiration. Since the engineered barrier is designed to have a rock-protected surface not inherently supportive of vegetation, this calculation may more closely represent a loss of institutional controls. Under such a scenario, vegetation may become widely established, in which case the difference between actual evapotranspiration (which is difficult to estimate) and potential evapotranspiration would become less significant. Due to the faster timescale of runoff compared to evapotranspiration, however, variations in estimates of evapotranspiration are outweighed by the aforementioned, conservative neglect of runoff from, and storage within, the cover soil. If, for example, the runoff from the cover soil were incorporated by using a runoff coefficient of 0.8 instead of zero, then the amount of infiltration reaching the drainage layer (this time neglecting evapotranspiration, and again neglecting pore water storage) would equal 21 cm/year (105 cm/yr of precipitation times 0.2). Using the as-designed runoff coefficient of 0.9 for the clay layer, the amount of infiltration through the clay layer would equal 2.1 cm/year. This estimate is slightly less than the as-designed estimate of 2.8 cm/year, in which evapotranspiration was assumed to remove a large portion of precipitation before it reached the drainage layer.

It is important to note that, although other methods exist for estimating surface runoff, the Rational Equation is widely used for estimating runoff from small watersheds and manmade structures with various slopes and types of surfaces. Use of the Rational Equation is the method suggested by RESRAD documentation and certain NUREG documentation. For example, NUREG 1623 (pages D-5 to D-7) provides an example of using the Rational Equation for producing conservative estimates of flow on riprap covered slopes of similar lengths to those proposed for the engineered barrier. When applied in these types of applications, the Rational Equation typically underestimates runoff[31], and therefore conservatively overestimates infiltration. In contrast, using an equation for flow through porous media, such as the Darcy's Law equation for unconfined flow through saturated porous media becomes problematic, since this equation starts becoming less valid for flow through gravel sized particles and turbulent flow conditions[32]. In addition, it would still be necessary to determine a method to partition flows between lateral runoff and vertical infiltration.

Although the use of the Rational Equation is justified in this case, it is important to apply proper values for the overall runoff coefficient, which ranges from 0.75 to 0.9. In particular, the lowest estimate of the runoff coefficient appropriately represents the worst case scenario (loss of institutional controls and long-term degradation) in order to provide the most conservative estimate of infiltration. For the surface of the clay layer, a worst-case runoff coefficient of 0.75 was determined, based on correction factors for slope ($c_1 = 0$), soil type ($c_2 = 0.2$), and soil cover ($c_3 = 0.05$). A zero value for c_1 is appropriate to represent both the 4% top and 33% side slopes. Although RESRAD Table E.1 lists a c_1 value of 0.1 for slopes up to approximately 4.7% (the maximum slope listed in the table) this value reflects runoff from larger areas with more variable slopes (e.g., gently rolling hills) compared to the engineered barrier. Therefore, this value does not reflect the more rapid runoff and shallow lateral transmission, which limits deeper percolation on steep, uniform slopes[31]. Similarly, this value does not account for reduced infiltration during the winter due to frozen zones[32]. A value for c_2 of 0.2 is appropriate to represent the surface of the clay under degraded conditions. Under worst case conditions, such as long-term migration of fine particles previously described, the tight, impervious clay may eventually develop runoff characteristics closer to that of a clay loam. Lastly, a value of 0.05 is very conservative for correction factor c_3, since the interface of the clay and drainage layer will provide much less resistance to flow than vegetation and debris encountered in a field or forest. A value of 0.05 for c_3 can be considered to represent a condition of unmitigated, long-term biointrusion reaching the surface of the clay layer.

To summarize the results of the simplified water balance approach, as-built conditions can be expected to yield an annual infiltration rate of 2.8 cm/year. In the case of a loss of institutional controls, and under worst case, long-term, degraded conditions, infiltration was estimated as 7.1 cm/year. A more probable estimate of infiltration for under degraded conditions is 5.0 cm/year.

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[31] Rowe, R.K., ed. (2001). Geotechnical and Geoenvironmental Engineering Handbook.

[32] Gray, D.M., ed. (1970). Handbook on the Principles of Hydrology.

As previously mentioned, the more direct method of estimating infiltration through the clay layer, using the Darcy's Law equation for unconfined flow through saturated porous media, yielded infiltration values ranging from 0.62 to 6.2 cm/year. These values are lower than, but reasonably close to, the infiltration estimates derived from the simplified water balance approach (2.8 to 7.1 cm/year). To further clarify this approach, it is important to describe the conservative assumptions incorporated into the calculations. In particular, runoff from, and storage within the cover soil was again neglected, and it was assumed that water would be in contact with the clay surface for as many days of the year as significant precipitation occurred (72 days based on published climatic data for local rainfall events exceeding 0.10 inches). A hydraulic gradient of unity was assumed. Although this is a common assumption for unsaturated soils of uniform texture and moisture content below the root zone[33], it is a conservative assumption to use with clay having a high moisture content, and for which saturated hydraulic conductivity values are being applied. Note that previously cited studies have confirmed that deep clay layers of engineered barriers exhibit stable, high moisture contents without necessarily becoming saturated. In any case, the as-designed, saturated hydraulic conductivity value of 1×10^{-7} cm/s for the clay layer yielded an infiltration rate of 0.62 cm/year, whereas a saturated hydraulic conductivity of 1×10^{-6} cm/s yielded an infiltration rate of 6.2 cm/year. Given the protection provided to the clay layer against the potentially most damaging degradation mechanisms, such as desiccation and biointrusion, the hydraulic conductivity of 1×10^{-6} cm/s represents a reasonable worst-case scenario for increased permeability of the clay layer. Dividing the resulting infiltration estimates of 0.62 to 6.2 cm/year by the annual precipitation yields annual runoff coefficients of 0.8 to 0.97, which reaffirms the somewhat lower runoff coefficient values used in the simplified water balance approach.

As an additional level of conservatism, the engineered barrier design incorporates extended post-construction monitoring of infiltration using lysimeters installed immediately beneath the clay layer.

5.0 Drainage Design

While the engineered barrier is designed to prevent infiltration, some precipitation will infiltrate the surficial layers of the barrier and will be managed by the biointrusion/drainage layer, thus allowing for maintenance of clay moisture content.

The biointrusion/drainage layer was designed to handle flow that infiltrates through the cover soil layer. The drainage layer will be constructed of 12 inches of 2- to 4-inch stone (d_{50} = 3 inches) with an estimated permeability of 10 cm/s.

This layer was examined for stability under water seepage conditions using an online stability calculator found at www.landfilldesign.com. The design calculator is based on well-established

[33] Stephens, D.B. (1995). Vadose Zone Hydrology.

force balance equations established by Koerner and Soong.[34] As indicated in Attachment R, models were run using input values for cover soil permeabilities of 1 x 10^{-5} cm/s (as designed) and 1 x 10^{-4} cm/s using the PMP event rain intensity. Model output indicated a factor of safety (FS) for slope stability due to seepage forces of at least 1.847. Under worst-case conditions (PMP rainfall event and 10^{-4} cm/sec permeability), the average depth of flow along the biointrusion/drainage layer and clay interface on the 3:1 slopes would be 1.36 mm. This height represents only 0.4% of the total biointrusion/drainage layer thickness. Water conveyed by this layer will eventually drain from the toe of the engineered barrier and be conveyed to perimeter drainage channels.

Drainage channels will carry the water from the northern edge of the engineered barrier around the western and eastern sides and eventually convey the water to a wide, shallow drainage basin on the southern side of the restricted area. The riprap-lined channels surrounding the engineered barrier were designed to accommodate runoff flow from the PMP event. The wide, shallow drainage basin on the southern side of the engineered barrier is designed to act as storage for stormwater runoff and will be graded to direct water away from the engineered barrier and towards a two-pipe culvert that discharges into the former thermal cooling pond, located to the southwest of the Storage Yard. The culvert is sized to convey flow from the 100-year design storm. The combined storage capacity of the former thermal cooling pond and the wide, shallow basin is sufficient to store all runoff associated with the 100-year storm. The southern edge of the shallow basin incorporates a 650-foot-long overflow weir, reinforced with a granite curbing buried at ground level. Any rain event larger than the 100-year storm up to the PMP event will fill both the former thermal cooling pond and the wide, shallow basin, and water will eventually flow over the weir at the southern end of the basin. The soil grading just outside the basin is designed such that flow from the basin will be uniformly spread across the 650-foot-wide weir and directed overland towards the nearby Hudson Branch. Drainage channel sizing, 100-year storm calculations and culvert sizing are provided in Attachment S.

[34]Koerner, R. M. & Soong, T-Y. (2005). Analysis and design of veneer cover soils. *Geosynthetics International*, Special Issue on the Giroud Lectures, **12**, No. 1, 28–49

ATTACHMENT A
New Jersey Geologic Information

Hydrostratigraphy of the New Jersey Coastal Plain: Sequences and facies predict continuity of aquifers and confining units

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ABSTRACT: The regional extent and connectivity of Cretaceous to Miocene aquifer sands in the New Jersey Coastal Plain are evaluated using detailed facies analysis within a sequence stratigraphic framework. We correlate sequences from continuous coreholes using well logs to trace strike and dip sections throughout this region, allowing us to predict the continuity of confining units and aquifer sands. Marine sequences follow a predictable shallowing upward pattern: fine-grained shelf and prodelta sediments grade upward into delta front and shallow-marine sands, corresponding to confining unit-aquifer couplets. Aquifer sands deposited in marine shelf environments tend to be continuous on the 10+ km (6.2 mi) scale and are traceable for >60 km (37.3 mi) along strike and >25 km (15.5 mi) along dip. Confining units for these marine sequences are typically shelf or prodelta silty clays that are even more laterally continuous than their associated aquifer sands. Marginal marine to non-marine sequences are more difficult to predict due to a lack of continuous marine marker beds, difficulty in interpreting paleoenvironments of thick sand beds, and lack of fossil material except pollen for biostratigraphy. Marginal to non-marine sequences are generally less continuous, though some show surprising lateral continuity along strike (>60 km [37.3 mi]), reflecting the widespread extent of delta front environments. We conclude that sequence stratigraphy provides a predictive framework for aquifers and confining units, but that regional and local differences in sediment supply and tectonics affect the development of the hydrostratigraphic framework.

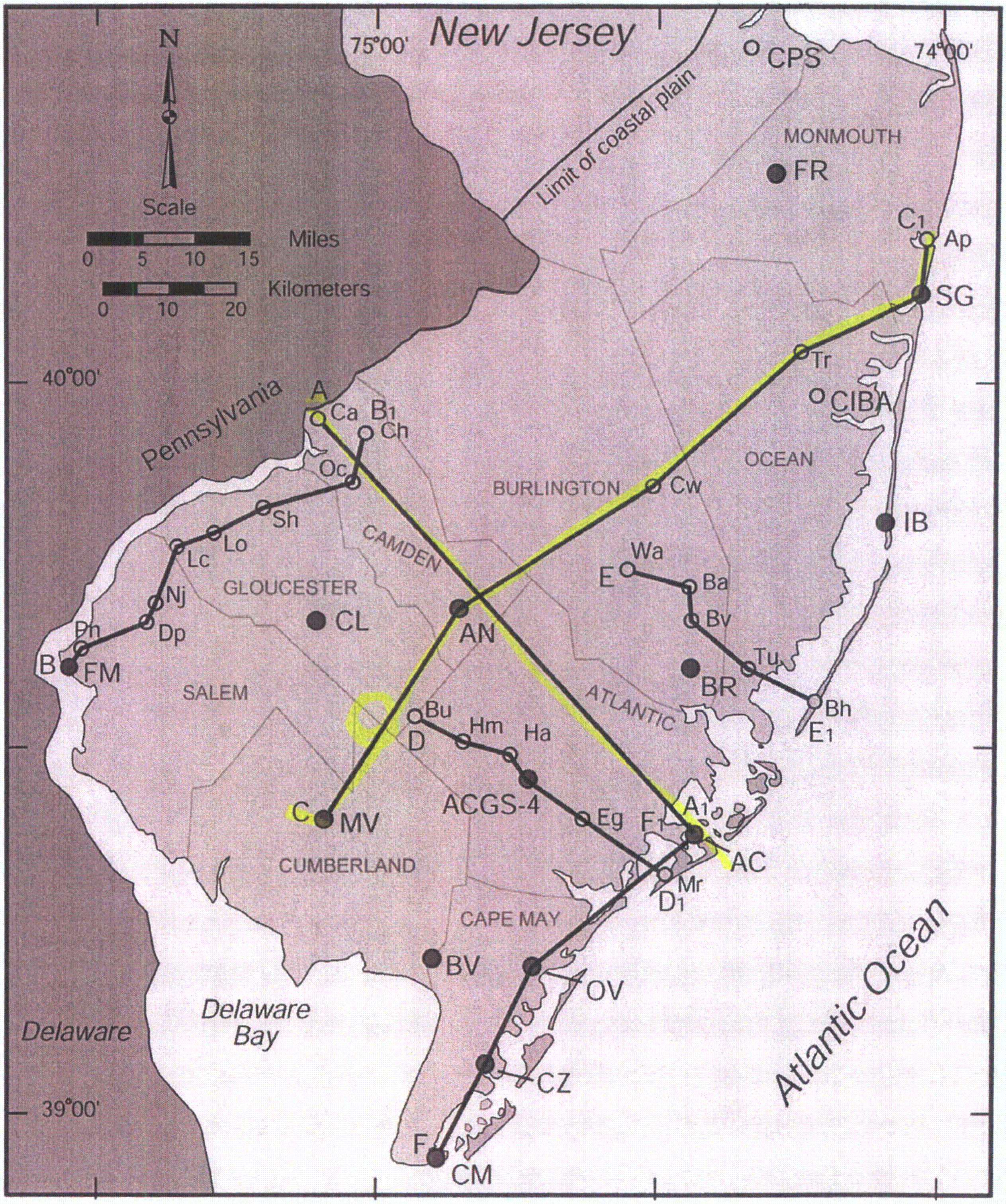
INTRODUCTION

The Atlantic Coastal Plain (Long Island through Florida) consists predominantly of Cretaceous-Holocene sands, silts, clays and occasional gravels that contain an essential source of groundwater for millions of people. The water-bearing unconsolidated sands (aquifers) are heavily utilized due to population growth, yet are easily contaminated in the shallow subsurface. Many coastal plain confined aquifers communicate over large distances (km-10's km scale), especially those deposited in marine environments, though some are locally restricted (e.g., non-marine sands). Confining units may be regionally continuous or very discontinuous depending on the environment of deposition. Any attempt to predict the distribution of aquifers and confining units in the coastal plain must consider the facies and environments of deposition.

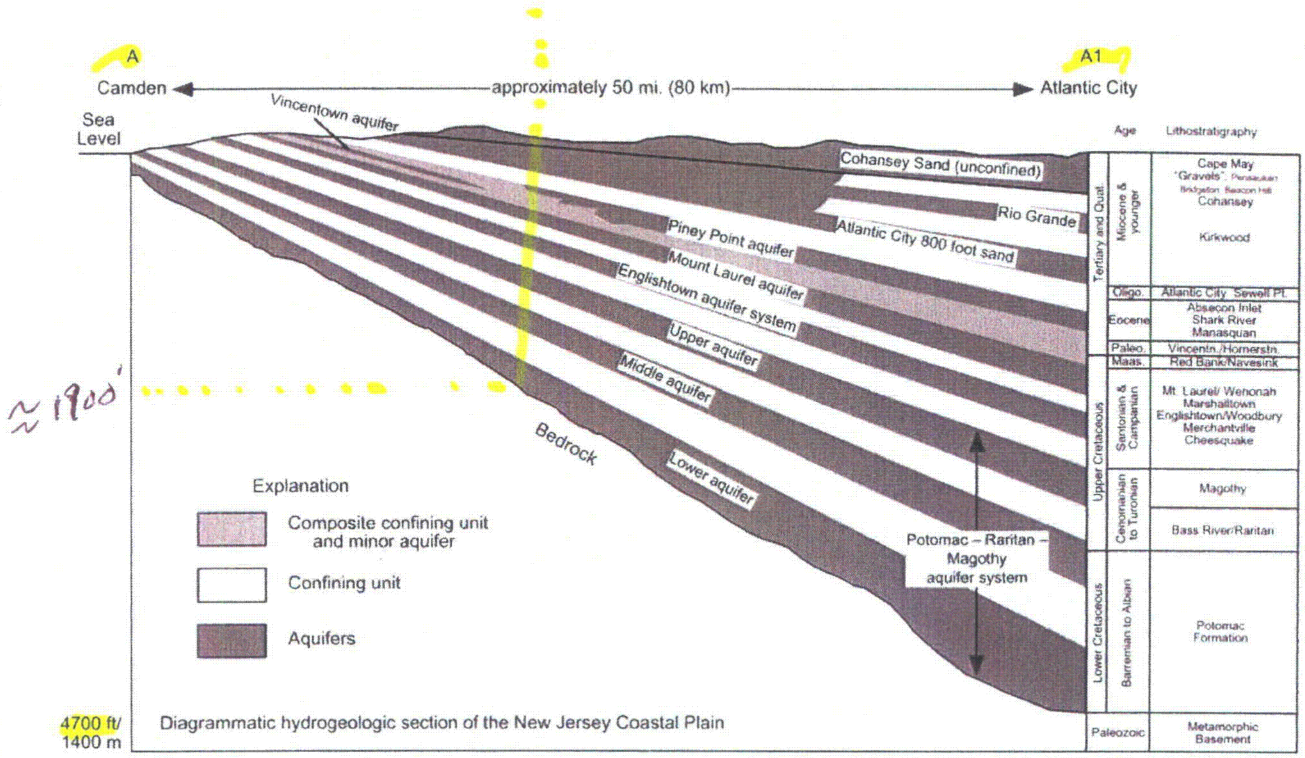
Previous hydrostratigraphic investigations in the New Jersey Coastal Plain (text-figs. 1, 2) have delineated aquifers and confining units primarily from outcrops and subsurface geophysical logs. Zapecza (1989) developed a hydrogeologic framework using downhole geophysical logs to map major aquifers and confining units (text-fig. 2). Geophysical logs must be groundtruthed by comparison with geological samples, especially core samples. Lithologic units are initially identified and named in updip, thin, deeply-weathered outcrops; these formational names are then applied downdip to lithologic and hydrologic units by logs. However, hydrogeologic units named after thin, weathered outcrop sections often lead to mistaken and forced correlations in thicker, more fossiliferous downdip sections. Equivalency of units based on geophysical characteristics assumes that correlations made in wells deep in the basin are equivalents of units named in outcrop areas (text-fig. 2), often without any supporting geologic criteria. Problems can arise with these correlations; for example, downdip units may have no outcropping equivalent. Downdip and along strike facies changes can also create erroneous correlations and flawed hydrogeologic frameworks.

Sequences are unconformity-bounded units that comprise the building blocks of the stratigraphic record and provide a means of predicting facies changes (Mitchum et al. 1977; Vail et al. 1977). Sequence stratigraphy has long provided predictions about petroleum reservoirs and impermeable caps (Vail et al. 1977) and has potential for similar applications in groundwater predictions. Since the advent of its use for basin-scale petroleum exploration in the 1970s, sequence stratigraphy has evolved into an important tool for finer-scale stratigraphic problems in industry such as reservoir geology. Hydrogeologic investigations face many of the same challenges as petroleum geology, chief among them delineating the fine-scale stratigraphy of aquifers (analogous to reservoirs) and confining units (analogous to traps).

Sequence stratigraphic studies of the New Jersey Coastal Plain have provided new insights into fundamental controls on the stratigraphic record, demonstrating that sequence boundaries are causally related to sea-level lowerings (Miller et al. 1998, 2004). Facies changes within these sequences generally follow predictable patterns. Tectonics and sediment supply affect the distribution of sequences and the type of facies found within individual sections (Browning et al., in press), though the repeti-



TEXT-FIGURE 1
New Jersey location map showing counties, United States Geological Survey coreholes, Leg 150X and 174AX coreholes, and various water wells used to construct reference sections and cross sections shown on text-figs. 3, 4, 7, 8, 10, and 11. County boundaries (Salem, Cumberland, etc.) are shown as thin gray lines. Coreholes (closed circles): AC - 150X Atlantic City; ACGS 4 - Atlantic County Girl Scout Camp #4; AN - 174AX Ancora; BR - 174AX Bass River; BV - Belleplain; CIBA - Ciba-Geigy; CL - Clayton; CM - 150X Cape May; CPS - CPS/Madison Industries; CZ - 174AX Cape May Zoo; FM - 174AX Fort Mott; FR - Freehold; IB - 150X Island Beach; MV - 174AX Millville; OV - 174AX Ocean View; SG - 174AX Sea Girt. Geophysical logs (open circles): Ap - Asbury Park; Ba - Oswego Lake; Bh - Beach Haven; Bu - Buena; Bv- Bass River Township; Ca - Camden; Ch - Cherry Hill; Cw - Chatsworth; Dp - Dupont; Eg - Egg Harbor; Ha - Hamilton; Hm - Hamilton 2; Lc - Landtect Corp; Lo - Lopes; Mr - Margate; Nj - NJ Turnpike; Oc - Owens Corning; Pn - Pennsville; Sh - Shell; Tr - Toms River; Tu - Tuckerton; Wa - Washington Township.



TEXT-FIGURE 2
Generalized hydrostratigraphic dip section (modified after Martin 1998) and corresponding lithostratigraphic units from Camden to Atlantic City.

tive and predictable facies successions that are found regionally can only be explained by a repetitive process such as sea-level change (Miller et al. 1998, 2004). Sugarman and Miller (1997) used available Miocene continuous coreholes to develop a sequence stratigraphy and improved hydrogeologic framework for New Jersey Coastal Plain Miocene strata.

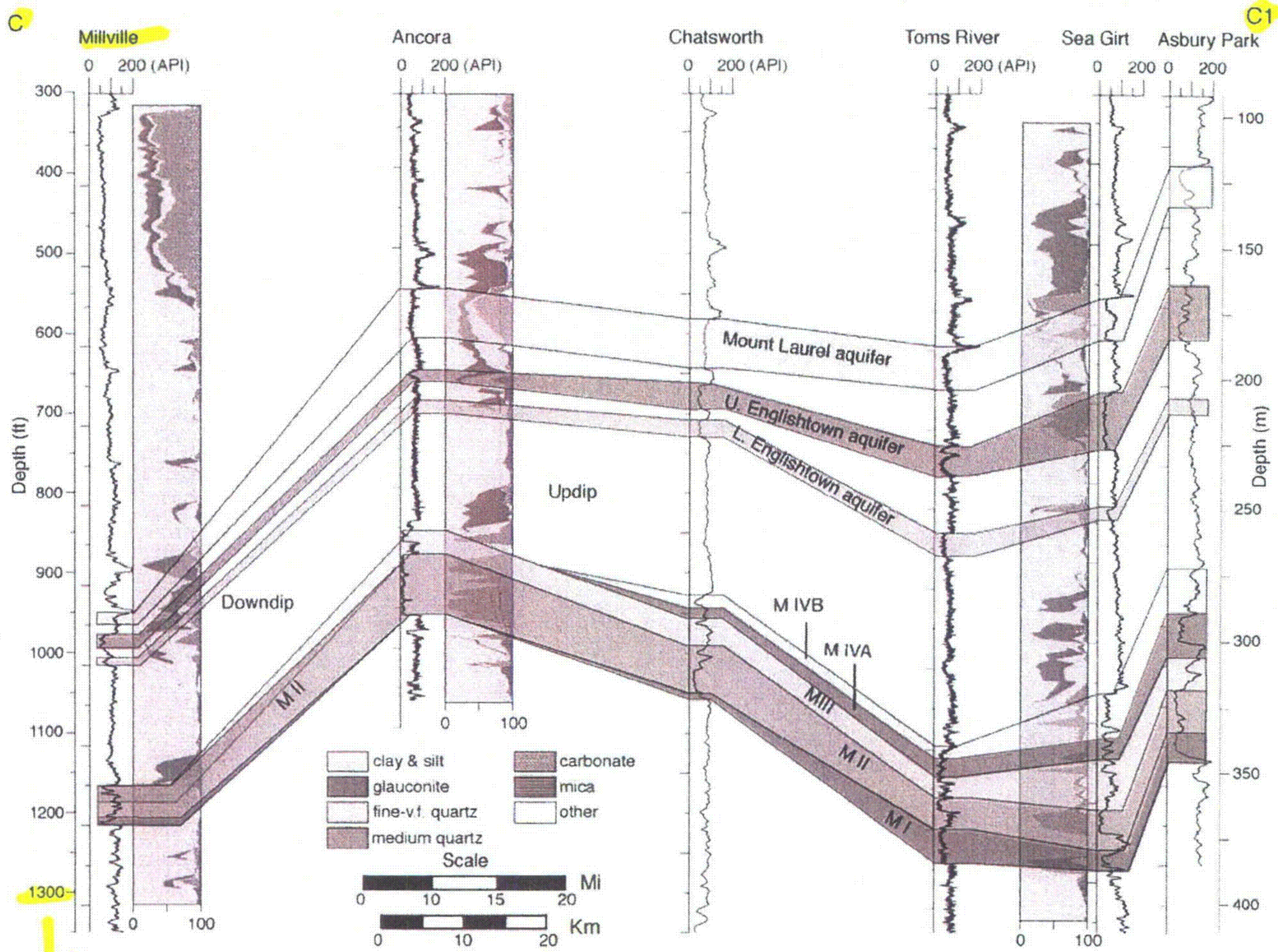
Recent drilling in New Jersey has provided continuous core records (text-fig. 1) that allow us to develop an integrated sequence and hydrogeologic framework for the coastal plain from the oldest sediments (mid-Cretaceous Potomac Formation) through the Miocene. Continuous coring and logging provide a registry of sediments and logs that allows regional correlation to sections with only well logs or cuttings. Continuous coring was very rare in the coastal plain until 1984, when the USGS began a campaign of shallow (305m [1000 ft] or less) boreholes with the ACGS-4 (Mays Landing), Freehold, Clayton, and Belleplain coreholes (Owens et al. 1998). Subsequently, drilling onshore by ODP Legs 150X (Island Beach, Atlantic City, and Cape May coreholes) and 174AX (Bass River, Ancora, Ocean View, Bethany Beach (DE), Fort Mott, Millville, Sea Girt, and Cape May Zoo) has continuously cored and geophysically logged over 4267 m (14,000 ft) of sediment from deeper (365 to 596 m [1200 to 1956 ft] total depth) downdip locations for stratigraphic and hydrogeologic investigations (text-fig. 1) (Miller et al. 1998, 2002).

We combine results from continuous coreholes with wireline logs from intervening water wells (text-fig. 1) to develop a sequence stratigraphic framework, place hydrogeologic units into this framework, and reinterpret the distribution and connectivity of aquifers using sequence stratigraphic concepts from the base of the coastal plain (the mid-Cretaceous Potomac Formation) through the Miocene. We restrict this study to well-characterized aquifers for which new data are available, focusing on sequences and aquifers within the Potomac (Berriasian-lowermost Cenomanian), Magothy (upper Turonian-lower Santonian), Englishtown (mid-Campanian), Mount Laurel (upper Campanian), and Kirkwood (lower-middle Miocene) Formations.

METHODS

Continuous coreholes were drilled in specific areas of the New Jersey Coastal Plain (text-fig. 1) to evaluate and improve the hydrogeologic framework of Zapecza (1989), including the delineation of aquifers and confining units. Geophysical logs were obtained from each corehole. We integrated published (Owens et al. 1988, 1998; Sugarman et al. 1993, 2004, 2005; Miller et al. 1994, 1998; 2005; Miller and Snyder 1997) lithostratigraphic, biostratigraphic, Sr-isotopic, and well log data to develop a subsurface sequence stratigraphic framework to guide mapping of the geometry of aquifers and confining units. An essential element of sequence stratigraphic mapping was the identification of unconformities using reworked and bioturbated intervals, phosphatic buildups and associated high gamma-ray spikes, major changes in depositional environments, biostratigraphic evidence, and Sr-isotope age estimates.

Sequences bracketed by unconformities were subdivided into facies. The New Jersey Coastal Plain contains facies deposited in a variety of marine, marginal marine, and nonmarine settings. The marine environments include clastic shelf and prodelta deposits. Marginal marine deposits include delta front, wave-dominated shoreline, and estuarine sediments, while the nonmarine settings include upper and lower delta plain/fluvial deposits. We developed facies models based on studies of modern depositional environments (e.g. deltas) and their various



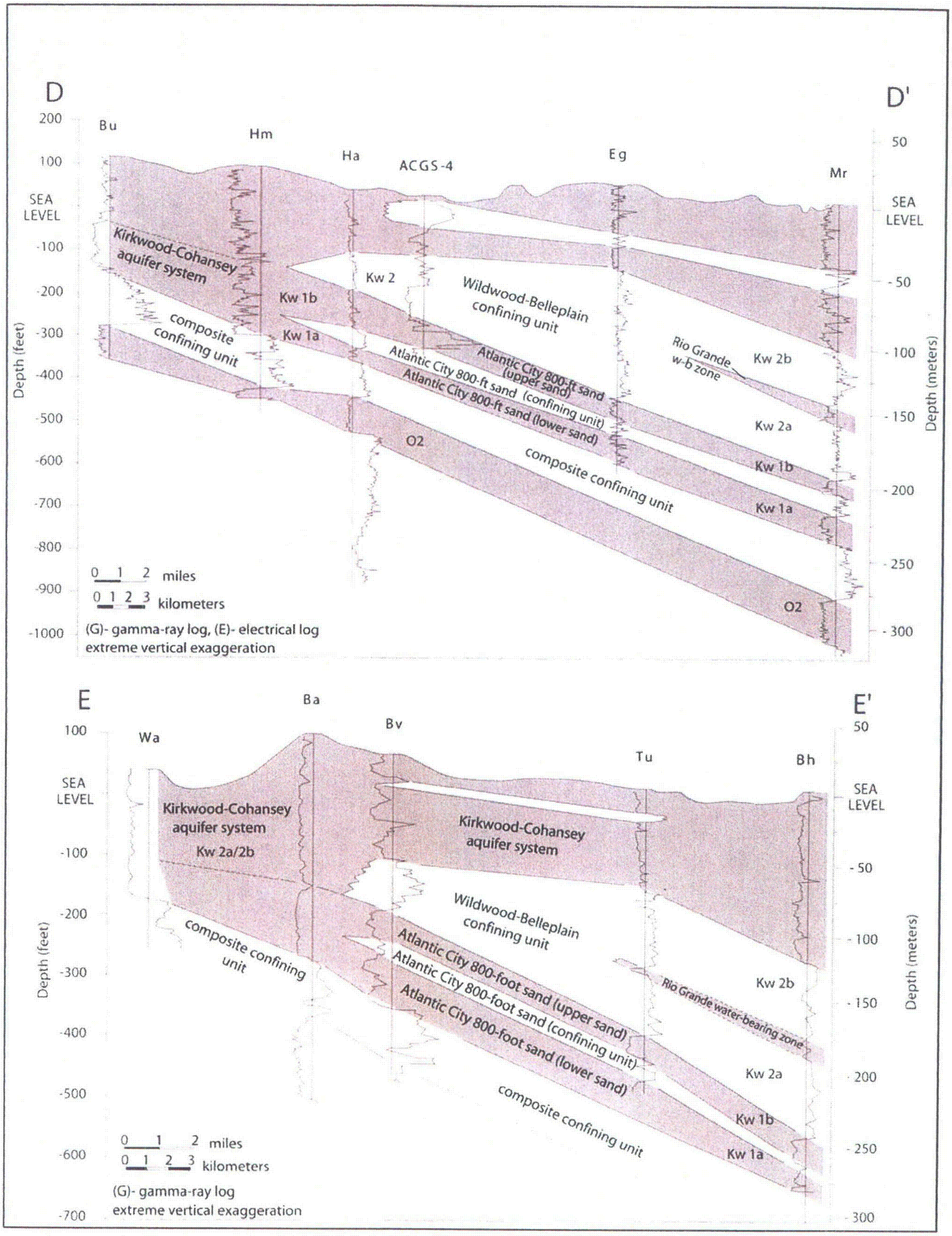
TEXT-FIGURE 7
Well log correlation of the Magothy and upper Englishtown sequences, and the lower Englishtown and Mount Laurel aquifers. This strike section (see text-figure 1 for corehole and gamma log locations) covers almost the entire New Jersey Coastal Plain.

may extend from New Jersey into Delaware. They can be traced on gamma logs within New Jersey a distance of 40km (24 miles; text-fig. 4). Such widespread sand sheets are difficult to explain using the anastomosing stream model. The thick, widespread nature of the sand body at the base of the Potomac unit 3 (text-fig. 3, the upper P_3 aquifer on text-fig. 4) has the geometry of a delta front shoreline sand (text-fig. 5), although no direct marine evidence (e.g., marine fossils) has been uncovered within them. If this interpretation of a delta front environment is correct, then at least for Potomac unit 3, the sediments may represent a transgressive regressive cycle, with delta-front sands (Fig. 5) being prograded over by an anastomosed river system or delta-plain deposits, including lower delta plain interdistributary lakes, marshes and swamps, and upper delta plain deeply weathered soils.

The alternate interpretation to delta front is that these sand bodies are sand ridges contained within the lower delta chenier plain similar to the modern Orinoco (Wells and Coleman 1981). However, the lateral extent of the Potomac 3 sands (text-fig. 4) is more consistent with a delta front origin. We have less data to trace the Potomac 2 sands; they can be shown to extend 6 km (3.7 mi) along an oblique dip profile and 8km (5mi) along an oblique strike profile (text-fig. 4), and could be interpreted as either delta front or alluvial plain deposits.

THE MAGOTHY FORMATION AND AQUIFERS: DELTAIC INFLUENCES

The Upper Cretaceous (upper Turonian to lower Santonian) Magothy Formation crops out along the Raritan River and sporadically along the Cretaceous outcrop belt extending through New Jersey, with the type section in Maryland (Darton 1893). It comprises the Upper PRM aquifer of Zapecza (1989)(text-figs. 2, 3), part of the most productive aquifer system in the state. It is composed of relatively thick fine-coarse grained quartz sands intercalated with thin bedded, carbonaceous clays and silts. The Magothy Formation was deposited in fluvial to marginal marine environments interpreted as lower delta plain to delta front (Owens et al. 1998). Large sheet sands characterize the aquifers and these are interpreted as being deposited in delta-front, marginal marine environments (Owens et al. 1998). To the southwest towards Delaware, the Magothy dramatically thins (e.g., Fort Mott, text-fig. 4), with the sediments preserved primarily in incised valleys (McLaughlin and Benson 2005).



TEXT-FIGURE 9
Well log dip correlation of Miocene Kirkwood sequences and aquifers. See text-figure 1 for location of the sections and gamma logs.

UNEARTHING NEW JERSEY

NEW JERSEY GEOLOGICAL SURVEY Vol. 1, No. 2 Summer 2005
Department of Environmental Protection

MESSAGE FROM THE STATE GEOLOGIST

The New Jersey Geological Survey (NJGS) provides geoscience information to government agencies, consultants, industry, environmental groups and the public. The work of the Survey covers large regional issues of environmental concern and economic development, as well as smaller, educational studies. This volume of *Unearthing New Jersey* highlights four projects that illustrate the wide range of work performed at NJGS.

Geologic events during the past 10 million years are Scott Stanford's newsletter subject. The landscape and surface features that we see today in New Jersey were shaped during this time. Valleys, ridges, plains, and uplands all were formed by river erosion and deposition and glacial activity in northern New Jersey. Scott has reconstructed past New Jersey landscapes, tied them to changes in sea level and linked them to North America's glacial history. Geologic evidence of changing sea level not only provides information to scientists on the possible impact of future global climate change, but informs government agencies and elected officials who are concerned with this important issue.

Mike Serfes and Ray Bousenberry present information on the redesigned Ambient Ground-Water Quality Monitoring Network (AGWQMN). This network consists of shallow wells that are sampled periodically to evaluate land use impacts on ground-water quality in agricultural, urban, suburban and undeveloped areas. The data shows that total dissolved solids and a variety of trace elements, nutrients, volatile organic hydrocarbons (VOC) and pesticides are present at significantly higher levels in wells located in agricultural and urban areas in comparison to undeveloped areas. This clearly illustrates the impact of our land use on ground water quality.

Steve Spayd and Mike Serfes summarize the Survey's work investigating the distribution of arsenic in wells that draw ground water from Piedmont Aquifers. Their study of the source, nature, and extent of arsenic in ground water has determined it to be naturally occurring in aquifers located in the Stockton, Passaic, and Lockatong Formations. The number of private wells exceeding the new standard (effective January 2006) of 5 ug/L (5ppb) is around 15% in the Piedmont. Helping to remedy this problem, the Survey coordinated a study of efficient, cost effective, user friendly, and environmentally sound water treatment technologies that remove arsenic from residential well water.

Finally, John Dooley presents new findings on the formation of rare minerals on pyrite (FeS_2) nodules from the Woodbridge Clay Member of the Raritan Formation (Upper Cretaceous) near Sayreville. After collection, the nodules were found coated with a fuzzy white bloom of metal sulfates formed by the oxidation of pyrite. In the natural environment, weathering and dissolution of these sulfate minerals during storm runoff can acidify streams, lead to acidic groundwater and rapidly increase metal loading to surface waters.

The Survey welcomes feedback on the content and format of the newsletter (http://www.njgeology.org/comments.html). Other recent geologic activities and digital publications of the Survey are noted in the newsletter and elsewhere on the Survey's Web site. Printed maps and reports are available to the public through the DEP Maps and Publications Office (609) 777-1038, P.O. Box 438, Trenton, N.J. 08625-0438, and a publications price list is maintained on the Web. Staff are available to answer your questions 8 a.m. - 5 p.m. Monday through Friday by calling (609) 292-1185.

Karl W. Muessig
New Jersey State Geologist

THE GEOLOGIC HISTORY OF NEW JERSEY'S LANDSCAPE

By Scott Stanford

The rocks under New Jersey were formed by geologic events occurring as long ago as 1.3 billion years, but the landscape etched into those rocks is much younger. Within the past 10 million years rivers formed the valleys, ridges, plains, and uplands of the state by erosion and deposition. In northern New Jersey, glaciers shaped the final surface features of the landscape within the past 2 million years. Sediments that were laid down by rivers and glaciers, and by marine currents in estuaries and coastal areas, are the record of these events. These sediments, known as surficial deposits, overlie bedrock and Coastal Plain deposits and are distinguished from the older formations by their recognizable relationship to landforms associated with today's geography.

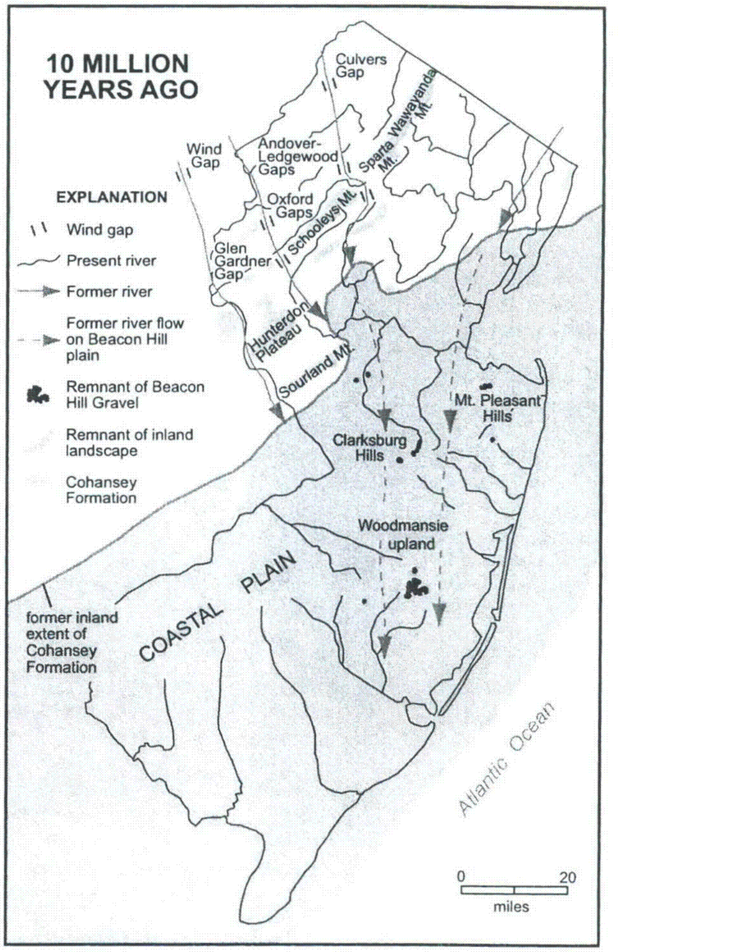


Figure 1. Landscape features ten million years ago.

By mapping these deposits we can reconstruct past landscapes.

As a coastal state, the history of New Jersey's landscape is closely tied to changes in sea level. Located in a tectonically quiet area where the land rises and subsides very slowly and moderately, sea level in New Jersey mostly reflects the amount of water in the ocean. The global volume of sea water is largely determined by the size of glaciers in Antarctica and the northern polar regions. Vast amounts of water have alternately been locked up as ice or melted into the oceans. Thus, the development of New Jersey's landscape is directly linked to the Earth's glacial history.

10 MILLION YEARS AGO

Between 15 and 10 million years ago there was a significant increase in the size of Antarctic glaciers. In fact, so much water evaporated from the oceans and fell as snow in the polar regions that global sea level dropped between 150 and 250 feet. Across the southeastern two-thirds of New Jersey the sea withdrew and sand was deposited in beaches, tidal channels and deltas, and nearshore bars. Today these sands comprise the Cohansey Formation, which covers much of southern New Jersey. The current northern edge of the Cohansey is at an elevation of about 350 feet in some places, indicating that these sands once extended inland to about the position shown on figure 1.

By about 10 million years ago, sea level had dropped and exposed a flat sandy coastal plain. Rivers flowing across this plain to the Atlantic Ocean deposited a broad, thin sheet of sand and gravel, the remnants of which are known as the Beacon Hill Gravel (fig. 1), preserved on the highest hills in the Coastal Plain. These include the Clarksburg and Mount Pleasant Hills in Monmouth County and the Woodmansie upland in Ocean and Burlington Counties. Similar upland river gravels dating from this time occur along the inner edge of the Coastal Plain in Pennsylvania, Delaware, Maryland, and Virginia.

The Beacon Hill deposits do not extend into northern New Jersey. However, the gravel sources have been identified, and together with the slope of the Beacon Hill river plain, indicate that the northern part of the state was at that time crossed by several south-flowing rivers (fig. 1). Evidence of these vanished rivers are seen in the aligned sets of gaps in Kittatinny Mountain and the Highlands, through which no rivers flow today, which are located several hundred feet above modern valley bottoms. Such gaps are known as *wind gaps* and mark former river courses. The position of these

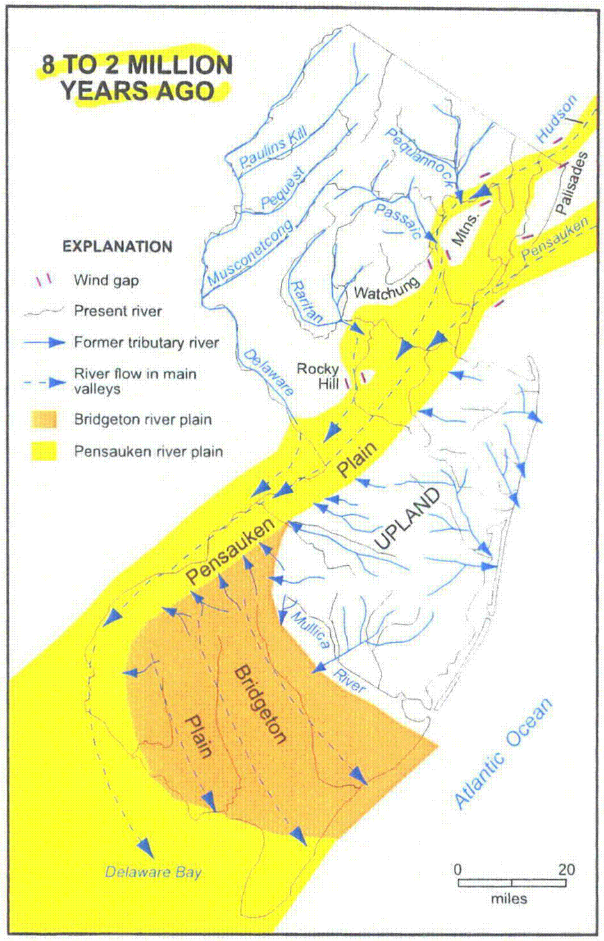


Figure 2. Landscape features between eight and two million years ago.

gaps high above present valleys show that during deposition of the Beacon Hill Gravel, the landscape of northern New Jersey was more subdued than it is today. Ridges and uplands like Kittatinny Mountain and the Highlands rose gently, perhaps 100-300 feet above surrounding lowlands, rather than the 500- 1000 feet of today. The flat tops of Schooleys Mountain, Sourland Mountain, and the Hunterdon Plateau (fig. 1) are relicts of that subdued landscape. Similar flat-summit areas were likely present farther north, such as atop the Sparta Mountain-Wawayanda Mountain upland, but these were subsequently eroded by glaciers and are no longer flat.

The south-flowing river system in the Coastal Plain gradually shifted to the southwest and, by perhaps 8 million years ago, eroded a new valley west of the Beacon Hill Plain. A lower sand and gravel river plain was deposited by this system across southern New Jersey (fig. 2). These deposits are known as the Bridgeton Formation. Today remnants of this plain form the flat uplands between the Mullica River and Delaware Bay. As the new valley was eroded and the Bridgeton Plain laid down, the region to the northeast of the plain became an upland. Local streams draining this upland

NJGS
1835

STATE OF NEW JERSEY
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ATTACHMENT B
Geotechnical Investigation Work Plan

SHIELDALLOY METALLURGICAL CORPORATION

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December 17, 2008

John J. Hayes, Jr.
U.S. Nuclear Regulatory Commission
FSME/DWMEP/DURLD
11545 Rockville Pike
Rockville, Maryland 20852-2738

Re: Transmittal of Storage Yard Geotechnical Investigation Work Plan

Dear Mr. Hayes:

Please find enclosed one hard copy and one electronic copy (on CD) of the "Storage Yard Geotechnical Investigation Work Plan," prepared for Shieldalloy Metallurgical Corporation (SMC). The intent of this document is to describe geotechnical investigation activities to be conducted in response to a draft RAI provided by the Nuclear Regulatory Commission (NRC) to SMC in November 2008 that indicated additional geotechnical information was necessary to further support stability, settlement and liquefaction analyses. These analyses will ultimately be presented in Rev. 1b of the Decommissioning Plan.

This document is being presented for informational purposes only. SMC expects the investigations will be conducted in mid to late January.

In the meantime, if you have any questions/comments or if I can provide you with additional information, please call me at (856)362-8680.

Sincerely,

David R Smith

David R. Smith
Radiation Safety Officer

cc:

Hoy E. Frakes – Shieldalloy Metallurgical Corporation (via e-mail)
David J. White – Shieldalloy Metallurgical Corporation (via e-mail)
Barbara E. Flowers – Shieldalloy Metallurgical Corporation (w/ enclosure)
Matias F. Travieso-Diaz, Esq. – Pillsbury Winthrop Shaw Pittman (via e-mail)

Carol D. Berger, CHP – Integrated Environmental Management, Inc (via e-mail)
Jean Oliva, PE – TRC Environmental (via e-mail)
Mark Roberts – USNRC Region I (w/ enclosure)

STORAGE YARD GEOTECHNICAL INVESTIGATION WORK PLAN

DECOMMISSIONING PLAN
SHIELDALLOY METALLURGICAL CORPORATION
NEWFIELD, NEW JERSEY

Prepared for
Shieldalloy Metallurgical Corporation
Newfield, New Jersey

Prepared by
TRC
Windsor, Connecticut

TRC Project No. 105106.000100.000000
December 2008

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1 Geotechnical Boring Depths
2 Geotechnical Analysis Frequency

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(continued)

FIGURES

1 Site Location Map and Geotechnical Boring Locations

APPENDICES

A Historical Subsurface Information

1.0 INTRODUCTION

This work plan describes the geotechnical investigations to be conducted in the Storage Yard area at the Shieldalloy Metallurgical Corporation (SMC) facility in Newfield, New Jersey. This work plan details the approach and procedures that will be followed to ensure the geotechnical investigation objective described in Section 1.1 below is achieved in a manner consistent with relevant U.S. Nuclear Regulatory Commission (NRC) guidance.

Processing of ores that contain natural radioactivity was performed at the Newfield facility for a number of years pursuant to a radioactive materials license issued by the NRC. The facility's operations resulted in the presence at the site of ferrocolumbium slag, baghouse dust, and other materials containing uranium, thorium and their progeny. Those materials have been stored since their generation in the eastern portion of the plant property, in an area referred to as the Storage Yard.

As part of the site-wide decommissioning plan (DP), SMC proposes to consolidate these materials within the Storage Yard and cover them with an engineered barrier to provide for their long term management. A site plan of the Storage Yard, presented in Figure 1, shows the locations of the existing material stockpiles and the outline of the proposed engineered barrier area. Access to the Storage Yard is and will remain restricted, and the area will be maintained and monitored in accordance with the terms and conditions of a Long Term Control (LTC) License to be issued by the NRC.

In August 2008, SMC submitted an interim draft of the engineered barrier design for NRC review and comment. In draft Requests for Additional Information (RAIs) provided by the NRC to SMC in November 2008, the NRC indicated that additional information from subsurface geotechnical investigations (either existing geotechnical investigations or additional investigations to be conducted) was necessary to further support stability, settlement and liquefaction analyses. The NRC referenced Regulatory Guide 3.11, Rev 3 (ML082380144) as one source of guidance on the information needed to support the liquefaction analysis.

1.1 Objective

The objective of the activities described in this work plan is to sufficiently characterize the geotechnical properties of the soil underlying the proposed engineered barrier to support the performance of stability, settlement and liquefaction analyses for the engineered barrier design. To meet this objective, this work plan presents a description of previously collected geotechnical data and a sampling and analysis plan for the collection of the additional geotechnical information to assist in such characterization.

1.2 Summary of Previous Investigations

Shallow soil borings (generally 6 to 8 feet below ground surface) were previously performed during Superfund environmental investigations within the Storage Yard conducted in 1990. Deeper geotechnical data (generally collected to depths of approximately 25 feet below ground surface, but some as deep as 140 feet) were also collected as part of these environmental investigations, including well installations in areas outside of but adjacent to the Storage Yard. During the environmental investigations, soil samples were analyzed for various environmental parameters. Figure 1 shows both the soil boring and monitoring well locations. Available boring logs for those locations are presented in Appendix A.

Data from historical soil borings and monitoring well installations indicate that the geology of the Storage Yard area of the site is primarily comprised of medium to fine sand. Gravel, clay, and traces of silt have been encountered in a few borings at various depths, but these soil types comprise only a small percentage of the soils found at this location.

Numerous sampling events of the monitoring wells have shown that the depth to ground water ranges from an average of approximately 6 feet in the southeast corner to 14 feet in the northwest corner of the Storage Yard area. Figure 1 shows the locations of the existing monitoring wells around the Storage Yard area.

1.3 Proposed Investigation

The purpose of additional geotechnical sampling will be to further define the soil geotechnical characteristics under the proposed engineered barrier. Therefore, sampling will extend to a depth of 30 feet or more below grade, to an elevation of approximately 72 feet relative to the vertical datum NGVD 1929. The exact depth at each sample location will be dependent on the local ground elevation. The proposed depth below ground surface for each boring is listed in Table 1.

Five geotechnical boring locations are proposed at the locations shown on Figure 1. The proposed locations were selected in accordance with the guidance in NRC Regulatory Guide 3.11 (ML082380144) so as to more fully delineate subsurface geologic conditions beneath the engineered barrier area while performing investigations in those areas within the Storage Yard that are accessible to drilling equipment. In accordance with the NRC guidance, geotechnical boring locations were chosen approximately along the engineered barrier axis and at critical locations perpendicular to the axis to establish geologic cross-sections that cover the entire barrier footprint. Based on historical boring logs, it is expected that medium to fine sands will be the predominant soil types beneath the engineered barrier.

Samples will be collected for analyses of structural characteristics, as detailed in Table 2. At each of the boring locations, blow counts will be recorded from the Standard Penetration Resistance Test (SPT) (ASTM D1586) on a continuous basis; soil classification, grain size, and Atterberg limits will be analyzed every two feet; triaxial shear and consolidation tests will be analyzed only on cohesive silts and clays, if present; and Shelby tube samples (ASTM D1587) will be collected from cohesive silts and clay layers, if present. If visual inspection of the samples indicates a dramatic change in soil type, the number of samples may be adjusted for that boring location.

Table 1: Geotechnical Boring Depths

Boring Number	Ground Surface Elevation (ft above sea level)	Depth of Boring (ft below ground surface)
GB-1	102	30
GB-2	106	34
GB-3	110	38
GB-4	108	36
GB-5	102	30

Table 2: Geotechnical Analysis Frequency

Analysis	Method	Frequency
Standard Penetration Blow Counts	ASTM D 1586	Every 2 feet; continuous
Soil Classification	ASTM D 2487	Every 2 feet; continuous
Grain Size Analysis (w/Hydrometer)	ASTM D 422	Every 2 feet; continuous
Atterberg Limits	ASTM D 4318	Every 2 feet; continuous
Triaxial Shear (Consolidated, Undrained)	ASTM D 4767	As necessary
Incremental Consolidation	ASTM D 2435	As necessary

2.0 SAMPLING AND ANALYSIS

To provide soil parameters for a detailed analysis of soil static and dynamic stability, settlement, and liquefaction during the design life of the engineered barrier, the procedures outlined in the following subsections will be implemented.

2.1 Soil Sampling

A track-mounted hollow-stem auger rig utilizing 8-inch outside diameter augers will be used for the geotechnical borings. Split-spoon soil samples will be collected from the borings at 2-foot intervals on a continuous basis to the bottom of the boring (estimated to be at least 30 feet below ground surface, see Table 1). The SPT consists of a 2-inch outside diameter by 1.375-inch inside diameter split-spoon sampler with a 140-pound hammer free-falling 30-inches in accordance with ASTM D 1586. Blow counts will be recorded and the soil samples will be geologically logged by a TRC field geologist/scientist.

A TRC field geologist/scientist will collect samples in accordance with Table 1 and Section 3.1 of this report. Before soils are placed in the sample bags, Integrated Environmental Management, Inc. (IEM) will screen the soil samples for radioactivity content pursuant to IEM Radiation Safety Procedure No. RSP-034, "Screening for Radium in Soil", as modified for work at the Newfield site. Any soil with screening levels that are statistically in excess of background levels will not be submitted for laboratory analysis. Leftover clean soils from the auger spoils and split-spoon sampler will be spread on the ground surface after logging.

2.2 Sample Identification

Soil samples will be assigned a field identification number that will reference the boring location and sample depth. The following is an example of a soil sample identification number:

Sample Identification:

Example: GB-1 (2-4)

where: GB - Geotechnical Boring
1 - Location Number per the Map Grid
(2-4) - Sample Depth (feet below grade)

2.3 Sample Analysis

At each boring location, samples will be collected every two (2) feet and analyzed at an off-site laboratory pursuant to the following industry standards: for soil classification (ASTM D 2487), grain size (ASTM D 422), and Atterberg limits (ASTM D 4318). Triaxial shear (ASTM D 4767) and incremental consolidation analyses (ASTM D 2435) will be performed if silts and clay soils are encountered.

If visual inspection of the samples indicates a dramatic change in soil type, the number and frequency of samples will be increased as appropriate for that boring location.

3.0 SAMPLE HANDLING AND QA/QC PROCEDURES

This section describes sample management methodologies and QA/QC procedures associated with the sampling efforts.

3.1 Sample Handling and Shipping

One-gallon zip-top polyethylene bags will be used to contain the split-spoon soil samples. The samples will be double-bagged to ensure no leakage. For 2-foot interval split-spoon samples, one bag should be sufficient to contain the sample.

After visual logging, photographing, and soil classification, each sample will be transferred to a stainless-steel bowl and mixed with a stainless-steel spoon to homogenize the sample. The soil will then be transferred to the polyethylene bag. Bags will be labeled with a permanent marker at the time of sampling. The information recorded on the label will include:

- Project name/project number/location;
- Sample identifier/number;
- Analysis to be performed;
- Date of collection;
- Number of containers (i.e., 1 of 2, etc.); and
- Sampler's initials.

After the sample bags for a given sampling event have been filled, they will be screened for radiological constituents in accordance with IEM Radiation Safety Procedure RSP-034, as modified for the radionuclides of interest at the Newfield site, with only those samples that are statistically similar to background released for laboratory analysis. (The actual release criteria will be determined at the time of sample collection and will be based upon the screening results of samples collected from known background areas.) The screened samples will then be placed in a storage container such as a cooler to protect them from damage (cooling the samples is not necessary). Samples will be delivered to the off-site laboratory for analysis as soon as practical after the sampling event.

3.2 Chain-of-Custody Records

A sample is considered to be under custody if:

- it is in your possession, or
- it is in your view, after being in your possession, or
- it was in your possession and you locked it up, or
- it is in a designated secure area.

TRC will maintain a traceable chain-of-custody record from sample collection until laboratory analysis. Part of this process involves the completion of a chain-of-custody record for each sample. A chain-of-custody record will accompany the sample from the field to the laboratory. The laboratory will maintain one file copy and a copy of the completed original will be returned to TRC along with the analytical report. This record will be used to document sample custody transfer from the sampler, to a shipper, or to the laboratory, and also to verify the date of sample receipt by the laboratory.

3.3 Laboratory Sample Custody

TRC will notify the laboratory of upcoming field sampling activities and subsequent sample transfer to the laboratory. This notification will include information concerning the number and type of samples to be shipped, as well as the anticipated sample arrival date. In the event of discrepant documentation, the laboratory will immediately contact TRC as part of the corrective action process. A qualitative assessment of each sample container will be performed to note any anomalies, such as broken bags. This assessment will be recorded as part of the incoming chain-of-custody procedure.

A laboratory chain-of-custody record will accompany the sample or sample fraction through final analysis for sample control.

The laboratory will return any unused soil sample volumes to the SMC Radiation Safety Officer (RSO) after analysis is completed.

3.4 Field Quality Control Samples

Field quality control samples are not required under this geological boring work plan.

3.5 Laboratory Quality Control Samples

The laboratory that performs the analyses will maintain a Quality Assurance Program and associated written quality plan. The plan will include the following components at a minimum:

- organizational chart;
- corrective action process/procedures;
- floor plan and equipment information, including preventative maintenance;
- professional profiles of key employees;
- discussion of Standard Operating Procedures (SOPs) used by the laboratory, including SOPs for sample handling within the laboratory;
- list of all laboratory equipment;
- discussion of instrument calibration procedures;
- discussion of analytical calibration standards;
- list of analytical methods used by the laboratory, with associated reporting limits and accuracy and precision standards;
- sample tracking procedures; and
- description of the routine use of quality control check samples.

3.6 Laboratory Documentation

The data package from the laboratory will contain, at a minimum, the following information:

- methods of analysis provided;
- sample collection, preparation and analysis dates;
- sample results; and
- chain of custody from the time of collection, through receipt at the lab.

3.7 Field Equipment Decontamination Procedures

Sampling equipment used to obtain samples for laboratory analysis during environmental investigations, (i.e. auger bits, spoons, and bowls), will be decontaminated using the following procedures:

- Wash and scrub with low phosphate detergent (Alconox) in tap water;
- Rinse with tap water;
- Distilled and deionized water rinse;
- Air dry on clean polyethylene sheeting;
- Wrap in aluminum foil, shiny side out for transport (if not being used immediately).

Decontamination rinsates will be collected and contained for subsequent determination of proper handling and/or disposal. All equipment will be monitored for residual contamination pursuant to SMC Radiation Safety Procedure No. RSP-009, "Contamination Control" and decontaminated as necessary.

Radiological screening of soil samples, equipment, and personnel will be in accordance with IEM Radiation Safety Procedure No. RSP-034 as modified for this specific investigation.

3.8 Field Instrument Calibration Procedures

No field instruments are expected to be used by TRC personnel during this investigation. The calibration, maintenance and daily operational testing of field instrumentation used for radiological screening will be as described in IEM Radiation Safety Procedure No. RSP-008, "Instrumentation".

4.0 RECORD KEEPING

Record keeping will include the management of on-site monitoring data and sampling documentation within permanent field logbooks as well as the maintenance of project-related information within project files. Documentation management procedures are described below.

4.1 Field Logbooks

TRC will oversee the maintenance of field logbooks. Field logbooks will be bound books, preferably with consecutively numbered pages. Field logbooks will be maintained by the field investigation team members to provide a daily record of significant events, observations, and measurements during any field investigation activities and will be signed and dated daily.

Information pertinent to the field investigations and/or sampling will be recorded in the logbooks and entries will include the following information (at a minimum):

- Name and title of author, date and time of entry, and physical/ environmental conditions during field activity;
- Names of the other members of the field crew;
- Names and titles of any subcontractors or site visitors;
- Type of sampling activity;
- Location of sampling activity;
- Description of sampling point(s);
- Date and time of sample collection;
- Sample media (i.e., soil);
- Sample collection method;
- Number and volume of sample(s) taken;
- Analyses to be performed;
- Sample identification number(s);
- Field observations;
- Any field measurements made, such as blow counts and soil classification; and

- References for maps and photographs of the sampling site(s).

Original data recorded in the field logbooks will be written with waterproof ink. None of the logbooks will be destroyed or discarded, even if they are illegible or contain inaccuracies. Photocopies of field book entries will be made and kept in the TRC project file.

If an error is made on an accountable document assigned to an individual, that individual will make corrections by crossing a line through the error and entering the correct information and initialing the cross-out. The erroneous information will not be obliterated. Any subsequent error discovered on an accountable document will be corrected by the person who made the entry, and will be initialed and dated, as appropriate.

4.2 Project File

The TRC Project Manager will serve as file custodian. The project file will contain all incoming materials related to the project such as sketches, correspondence, authorizations, and logs. These documents will be placed in the project file as soon as possible. If correspondence is needed for reference by project personnel, a copy will be made rather than manipulating the original.

Examples of the types of records that will be maintained in the project file are:

- Field documents;
- Correspondence;
- Photographs;
- Laboratory data;
- Reports; and
- Subcontract agreements.

4.3 Laboratory Reporting

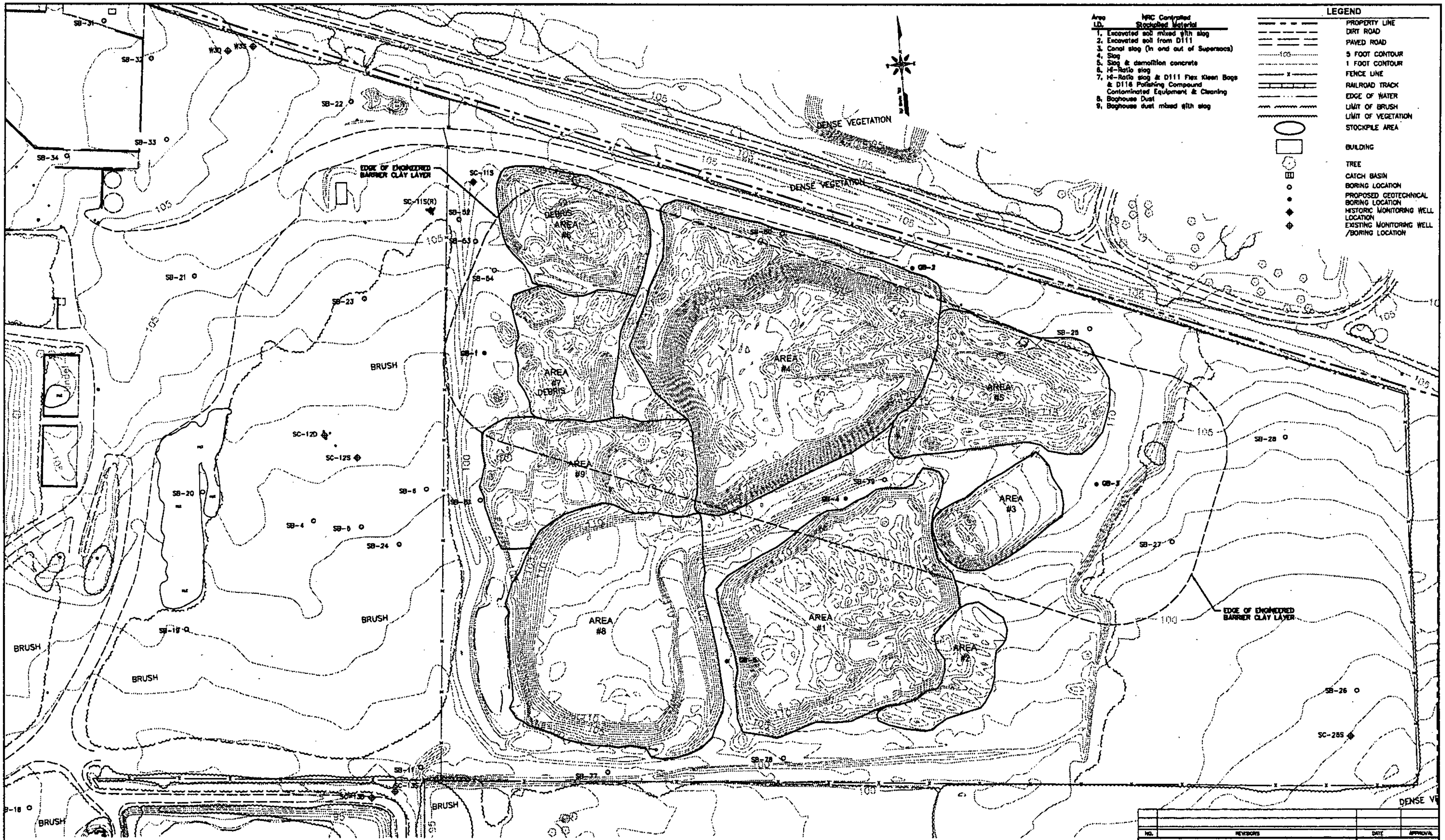
The data packages will contain, at a minimum, the following information:

- methods of analysis and method conformance summary;
- sample collection, preparation and analysis dates;
- sample results; and
- external chain of custody.

4.4 Survey

Sampling locations will be marked in the field using a flag that designates the name of the sampling location. Locations will be documented by GPS having sub-meter accuracy and reference to existing fixed features, such as buildings.

FIGURES



SOURCE:
PHOTOMETRIC SURVEY BY PROMAPS
DATED JANUARY 18, 2005.

NOTE:
HORIZONTAL DATUM IS NEW JERSEY STATE PLANE COORDINATES NAD '83.

VERTICAL DATUM IS NAVD 88.

GRAPHIC SCALE

NO.	REVISIONS	DATE	APPROVAL

SHIELDALLOY METALLURGICAL CORPORATION
NEWFIELD, NEW JERSEY
DECOMMISSIONING PLAN FOR THE NEWFIELD FACILITY
REV. 1B INTERIM

TRC

STORAGE YARD
ENGINEERED BARRIER

EXISTING CONDITIONS WITH PROPOSED GEOTECHNICAL BORING LOCATIONS

DESIGN:	MAP	12/03/08
DRAWN:	KOH	12/03/08
CHECKED:	CRS	12/03/08
SCALE: 1"=40'		

DRAWING
FIGURE 1

APPENDIX A

Dan Raviv Associates, Inc. 57 E. Willow Street Millburn, NJ 07041	WELL COMPLETION REPORT	WELL NO. SC #11

PROJECT NO.: 83C152
PROJECT NAME: SHIELDALLOY
CONTRACTOR: VANCE SKINNER WATER SUPPLY
LOCATION: NEWFIELD, NJ
SHEET NO. 1 OF 3

GRADE ELEVATION:
START (DATE): 31 AUG 88
FINISH (DATE): 1 SEPT 88
DRILLER: BILL SKINNER
DRAI GEOL.: K. GAGNON

	DRIVE SAMPLER	CORE BARREL
TYPE:	SPLIT SPOON	
INSIDE DIAMETER (IN.):	3	
HAMMER WEIGHT (LB.):	140	
HAMMER FALL (IN.):	24	

DRILLING EQUIPMENT & PROCEDURES
RIG TYPE: FAILING MP1500
BIT TYPE: 6" DRAG
DRILL MUD: QUIK-GEL
SAMPLER TYPE: SPLIT SPOON

DEPTH (FEET) FROM GRADE	SAMPLER BLOWS PER 6 IN.	SAMPLE NUMBER & RECOVERY	STRATA DEPTH (FEET)	GRAPHIC LOG	VISUAL CLASSIFICATION AND REMARKS 0-3' LITH FROM TRENCH DUG NEARBY
					SAND, brown-green. Mostly medium grained, mod. sorting. Lots of fine to med. slag fragments. Some 6-12" pieces of slag
1					
					SAND, dk. brown. Some roots and organics. Only slag are large pieces
2					
					SAND, brown/red. Medium grained, x-well sorted. Some clay.
3					
4					Same sand as above.
	10				
	11				
5	20	15"			
	30				
6	19				As above. Slightly more red in color.
	24				
7	26	18"			

GROUND WATER LEVEL DATA

DATE	TIME	ELASPED (HOUR)	DEPTH (FEET) FROM GRADE TO: BOTTOM OF CASING	BOTTOM OF HOLE	GROUND WATER
			27'	27'	17.48

SUMMARY
OVERBURDEN (LIN FT.) 27
ROCK CORED (LIN FT.) 0
SAMPLES

DRAI 1/88

Dan Raviv Associates, Inc. 57 E. Willow Street Millburn, NJ 07041	WELL COMPLETION REPORT	WELL NO. SC # 11 SHEET NO. 2 OF 3

DEPTH (FEET) FROM GRADE	SAMPLER BLOWS PER 6 IN.	SAMPLE NUMBER & RECOVERY	STRATA DEPTH (FEET)	GRAPHIC LOG	VISUAL CLASSIFICATION AND REMARKS
	38				
8	25				SAND, brown. Fine to coarse grained, poorly sorted. Some fine gravel, occasional medium gravel
	58				
9	60	24"			
	70				
10	30				SAND (80%), yellow-brown. Coarse to fine grained, poorly sorted. Well-rounded. Gravel (10%), fine grained. Clay matrix
	54				
11	52	12"			
	38				
12	46				SAND and GRAVEL, dk. brown. Poorly sorted, well-rounded. Moist.
	48				
13	40	10"			
	26				
14	24				As above, lighter brown, more clay. Very moist.
	30				
15	22	8"			
	20				
16	5				
	20				SAND, brown/red. Medium grained, better sorted. Very moist.
17	21	4"			

Dan Raviv Associates, Inc. 57 E. Willow Street Millburn, NJ 07041	WELL COMPLETION REPORT	WELL NO. SC 11 SHEET NO. 3 OF 3

DEPTH (FEET) FROM GRADE	SAMPLER BLOWS PER 6 IN.	SAMPLE NUMBER & RECOVERY	STRATA DEPTH (FEET)	GRAPHIC LOG	VISUAL CLASSIFICATION AND REMARKS
	16				
18					Lithology not recorded below 18'
27					Total depth drilled and cased. 2" PVC well

Dan Raviv Associates, Inc.

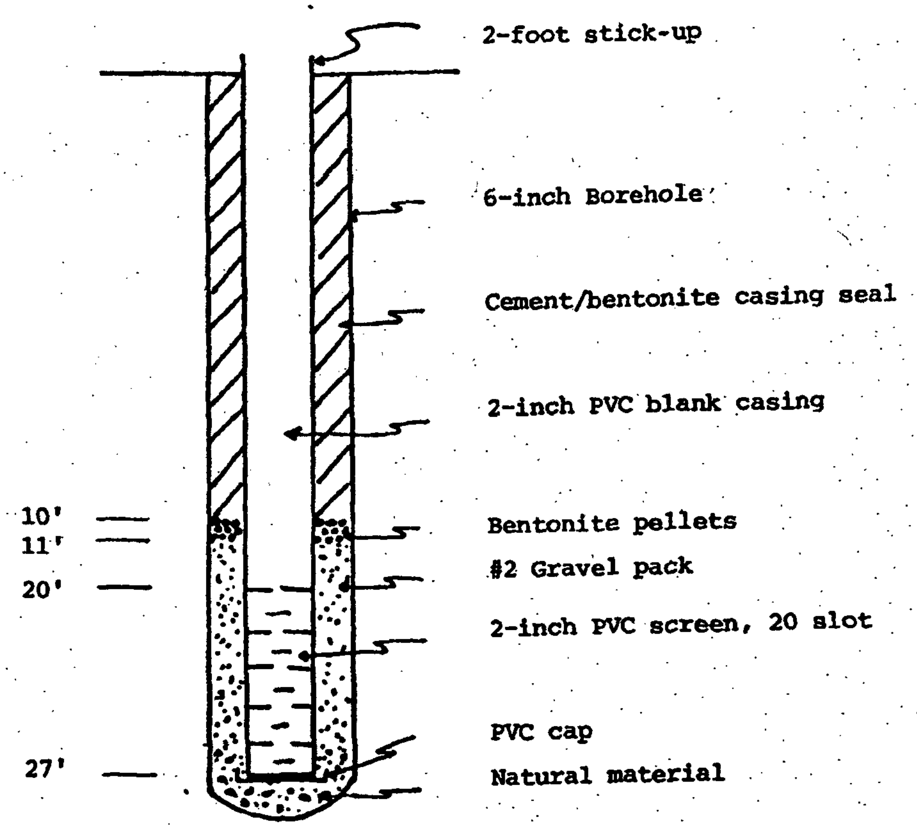
57 East Willow Street, Millburn, New Jersey 07041

Job No. 83C152

PROJECT Shieldalloy SUBJECT Well Construction Details

COMPUTATION SC11

COMPUTED BY Keith Gagnon DATE 15Dec.88 CHECKED BY ______ DATE ______



NOT TO SCALE

Total Depth Drilled : 27'

Total Depth Cased : 27'

Dan Raviv Associates, Inc. 57 E. Willow Street Millburn, NJ 07041	WELL COMPLETION REPORT	WELL NO. SC 12

PROJECT NO.: 83C152
PROJECT NAME: Shield Alloy
CONTRACTOR: Vance Skinner Water Supply
LOCATION: Newfield, NJ
SHEET NO. 1 OF 2

GRADE ELEVATION:
START (DATE): 2 Sept 88
FINISH (DATE): 2 Sept 88
DRILLER: Bill Skinner
DRAI GEOL.: K. Gagnon

	DRIVE SAMPLER	CORE BARREL
TYPE:	SPLIT SPOON	
INSIDE DIAMETER (IN.):	3	
HAMMER WEIGHT (LB.):	140	
HAMMER FALL (IN.):	24	

DRILLING EQUIPMENT & PROCEDURES
RIG TYPE: FAILING Mod# 1500
BIT TYPE: 6" DRAG
DRILL MUD: QUIK-GEL
SAMPLER TYPE: SPLIT SPOON

DEPTH (FEET) FROM GRADE	SAMPLER BLOWS PER 6 IN.	SAMPLE NUMBER & RECOVERY	STRATA DEPTH (FEET)	GRAPHIC LOG	VISUAL CLASSIFICATION AND REMARKS
	10, 14	12"			SAND, lt. yellow-brown. (100%) Medium grained, x-well sorted. Well-rounded, some black organics
1	13, 11	12"			Same as above, but no organics and increasing red in color with depth
2	10, 9	12"			6" SAND, yellow brown. Well sorted med. grained. Trace of fine gravel and clay 6" Same sand. More yellow color, less clay
3					
4					Drilled to 5'.
5	46, 66	10"			SAND, yellow-brown. Poorly sorted, mostly medium grained. Some fine gravel. Moist
6					
7					Drilled to 8'.

GROUND WATER LEVEL DATA

DATE	TIME	ELAPSED (HOUR)	DEPTH (FEET) FROM GRADE TO: BOTTOM OF CASING	BOTTOM OF HOLE	GROUND WATER
			25	25	12

SUMMARY
OVERBURDEN (LIN FT.) 25
ROCK CORED (LIN FT.) 0
SAMPLES

Dan Raviv Associates, Inc. 57 E. Willow Street Millburn, NJ 07041	WELL COMPLETION REPORT	WELL NO. SC 12 SHEET NO. 2 OF 2

DEPTH (FEET) FROM GRADE	SAMPLER BLOWS PER 6 IN.	SAMPLE NUMBER & RECOVERY	STRATA DEPTH (FEET)	GRAPHIC LOG	VISUAL CLASSIFICATION AND REMARKS
8	42				Same as 5-6' interval. More red in color
	50				
9	57	18"			
	76				
10	48				SAND, dk. yellow-brown. Poorly sorted, mostly med. grained. Well-rounded. Some clay matrix. Very wet.
	54				
11	46	18"			
	40		▼		
12					Lithology not recorded below 12'
25					Total depth drilled and cased. 2" - PVC well

DRAI 4/88

Dan Raviv Associates, Inc.

57 East Willow Street, Millburn, New Jersey 07041

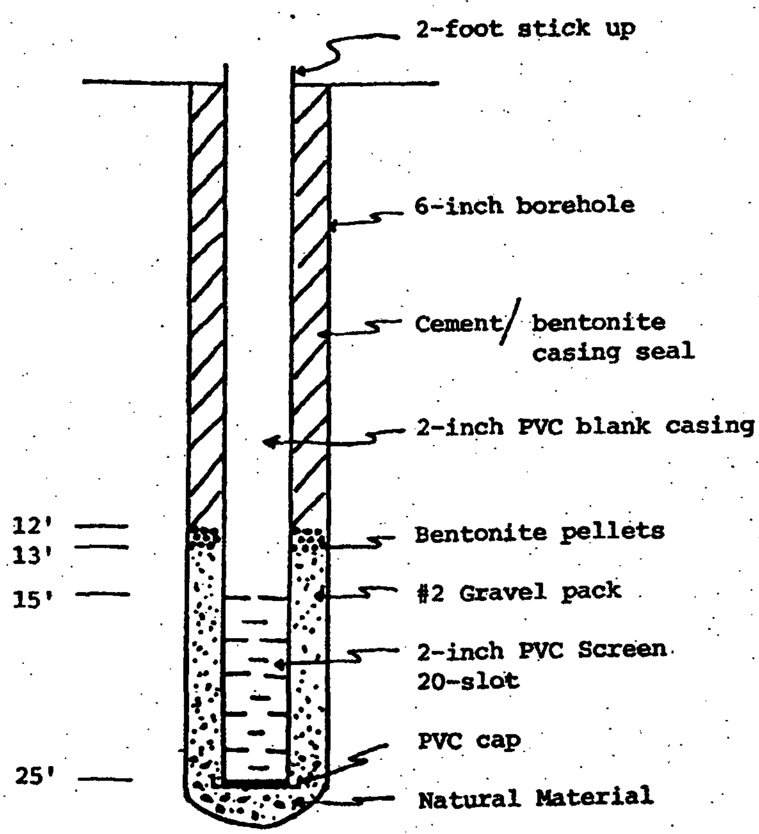
Page 1 of 1

Job No. 83C152

PROJECT Shieldalloy SUBJECT Well Construction Details

COMPUTATION SG12

COMPUTED BY Keith Gagnon DATE 12/15/88 CHECKED BY ______ DATE ______



NOT TO SCALE

Total Depth Drilled : 25'

Total Depth Cased : 25'

Dan Raviv Associates, Inc.
57 E. Willow Street Millburn, NJ 07041

WELL COMPLETION REPORT

WELL NO. SC 13
SHEET NO. 1 OF 2

PROJECT NO.: 83C152
PROJECT NAME: ShieldAlloy
CONTRACTOR: Vance Skinner Water Supply
LOCATION: Newfield, NJ

GRADE ELEVATION:
START (DATE): 9 SEPT 88
FINISH (DATE): 10 SEPT 88
DRILLER: BILL SKINNER
DRAI GEOL.: K. GAGNON

	DRIVE SAMPLER	CORE BARREL
TYPE:	SPLIT SPOON	
INSIDE DIAMETER (IN.):	3	
HAMMER WEIGHT (LB.):	140	
HAMMER FALL (IN.):	24	

DRILLING EQUIPMENT & PROCEDURES
RIG TYPE: FALLING No. 1500
BIT TYPE: 6" DRAG
DRILL MUD: QUIK-GEL
SAMPLER TYPE: SPLIT SPOON

DEPTH (FEET) FROM GRADE	SAMPLER BLOWS PER 6 IN.	SAMPLE NUMBER & RECOVERY	STRATA DEPTH (FEET)	GRAPHIC LOG	VISUAL CLASSIFICATION AND REMARKS
1					
2					
3					
4					
5	8				
	6				
6	7	0			
	18				
7	16				Clay (see page 2)

GROUND WATER LEVEL DATA

DATE	TIME	ELASPED (HOUR)	BOTTOM OF CASING	BOTTOM OF HOLE	GROUND WATER
			25	26	

(DEPTH (FEET) FROM GRADE TO: BOTTOM OF CASING, BOTTOM OF HOLE, GROUND WATER)

SUMMARY
OVERBURDEN (LIN FT.) 26
ROCK CORED (LIN FT.) 0
SAMPLES

Dan Raviv Associates, Inc.
57 E. Willow Street Millburn, NJ 07041

WELL COMPLETION REPORT

WELL NO. SC 13
SHEET NO. 2 OF 2

DEPTH (FEET) FROM GRADE	SAMPLER BLOWS PER 6 IN.	SAMPLE NUMBER & RECOVERY	STRATA DEPTH (FEET)	GRAPHIC LOG	VISUAL CLASSIFICATION AND REMARKS
	45				3" CLAY, hard, grey / tan. With med. gravel (well-rounded)
8	40	12"			9" SAND, dk. yellow-brown. Poorly sorted, mostly med. grained. Clay matrix. Dry, compact. Some fine gravel!
	60				
9	17				
	42				SAND, dk. yellow-brown. Mostly medium grained, Less gravel. Very well compacted. Some matrix clay. Very moist.
10	49	10"			
	55				
11					Lithology not recorded below 11'
26'					Total depth drilled: 26' Total depth cased: 25' 2" PVC well

DRAI 4/88

Dan Raviv Associates, Inc.

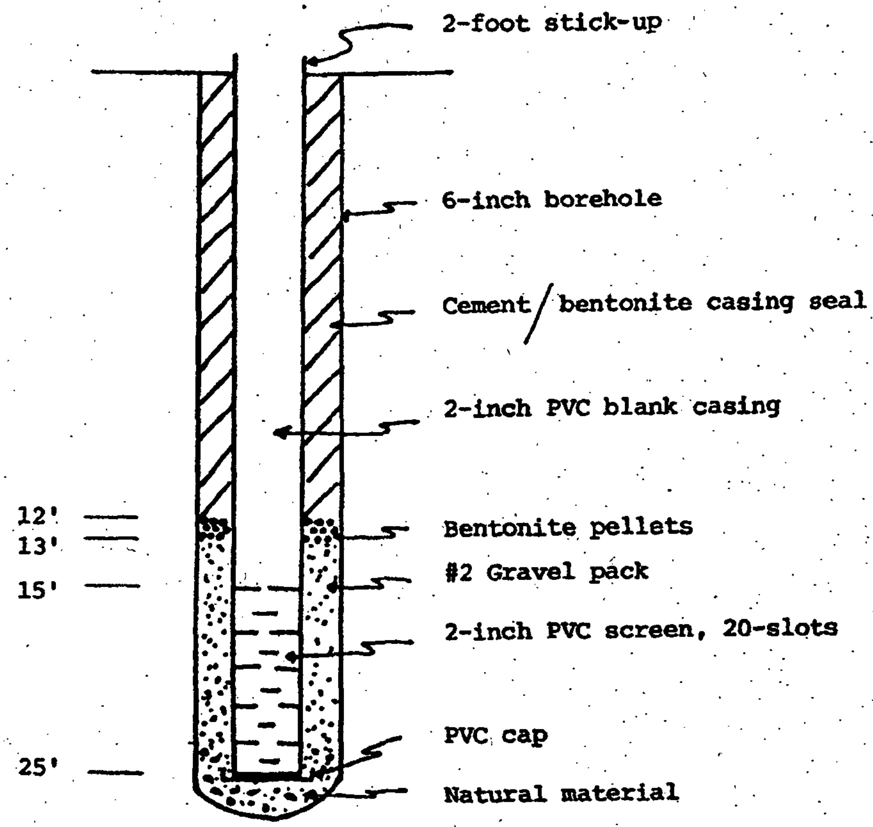
57 East Willow Street, Millburn, New Jersey 07041

Job No. 83C152

PROJECT Shieldalloy SUBJECT Well Construction Details

COMPUTATION SC 13

COMPUTED BY Keith Gagnon DATE 15Dec88 CHECKED BY ______ DATE ______



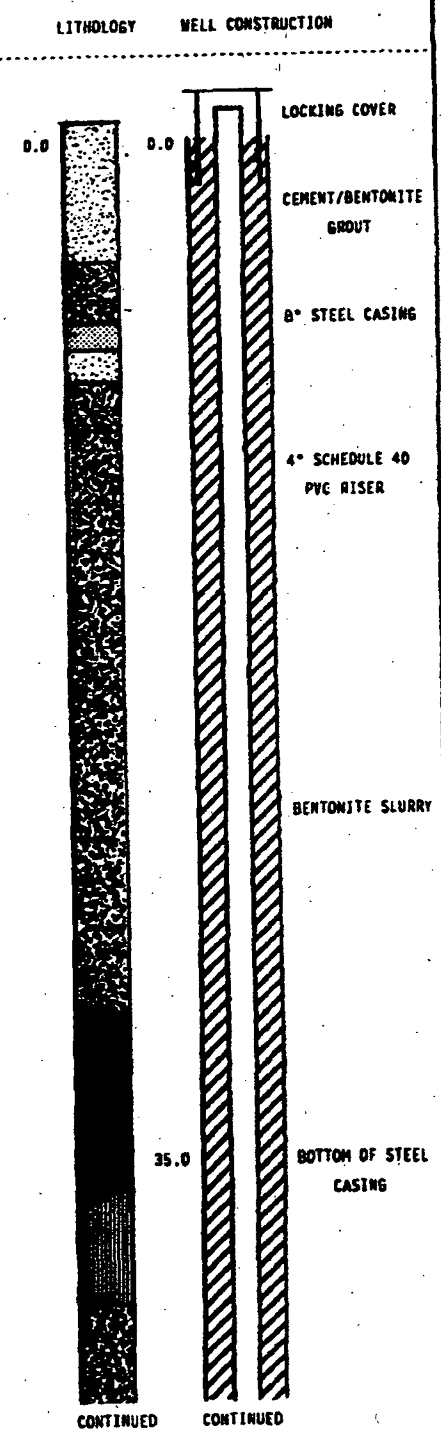
NOT TO SCALE

Total Depth Drilled: 26'

Total Depth Cased : 25'

BORING NO.:	SC-12D	CONTRACTOR:	EMPIRE SOILS	DATE STARTED:	11/16/90
PROJECT NO.:	7650-N51	DRILLERS:	KENNEY, EDWARDS	DATE COMPLETED:	11/19/90
PROJECT:	SHIELD ALLOY	TRC INSPECTOR:	MCMORROW	WATER TABLE LEVEL:	9.0 FT
CLIENT:	SMC	DRILLING METHOD:	MUD ROTARY	LOCATION:	N 258008.45
LOCATION:	NEWFIELD, NJ	GROUND ELEVATION:	102.16		E 1901049.83
BORING DEPTH:	142 FT	INNER CASING ELEVATION:	103.19	NJDEP PERMIT NUMBER:	3135226-0

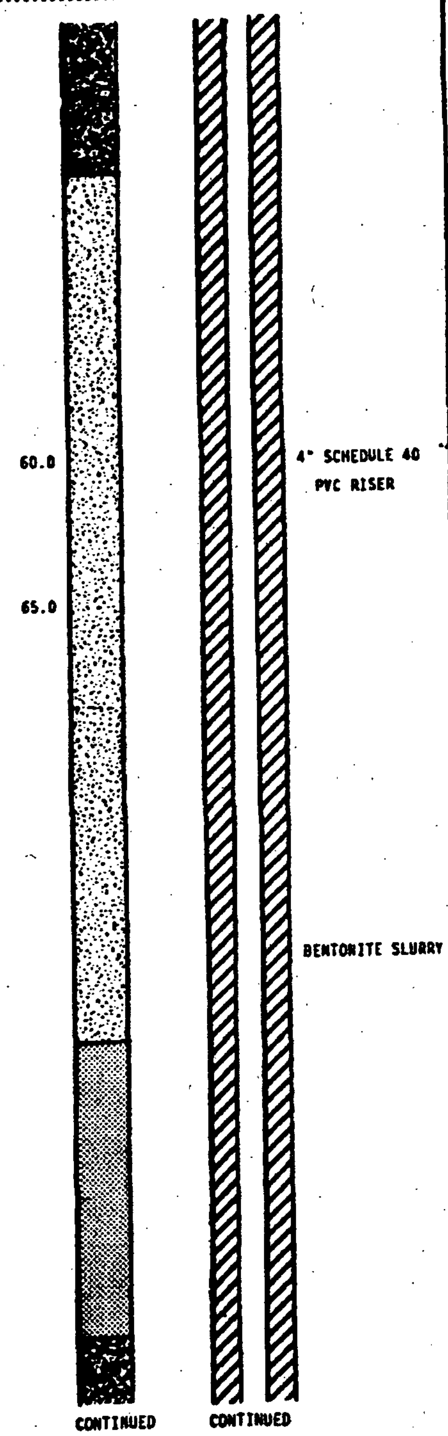
DEPTH (FT)	BLOWS	SOIL DESCRIPTION
0 - 2	9 11	DARK BROWN, FINE TO MEDIUM SAND, TRACE SILT, MOIST
	5 7	RECOVERY = 22"
2 - 4	7 6	BROWN FINE TO MEDIUM SAND, MOIST
	6 6	RECOVERY = 18"
4 - 6	5 8	BROWN/ORANGE FINE TO COARSE SAND, TRACE GRAVEL, MOIST
	9 8	RECOVERY = 22"
6 - 8	6 5	0-12" BROWN FINE SAND, LITTLE SILT, TRACE CLAY, MOIST
	10 15	12-20" BROWN/ORANGE FINE TO MEDIUM SAND, MOIST
8 - 10	13 11	BROWN/ORANGE FINE TO COARSE SAND, TRACE SILT, WET
	8 8	RECOVERY = 24"
15 - 17	4 5	BROWN FINE TO COARSE SAND, TRACE GRAVEL, WET
	4 6	RECOVERY = 8"
20 - 22	8 7	BROWN/ORANGE FINE TO COARSE SAND
	7 6	RECOVERY = 10"
25 - 27	10 9	BROWN/ORANGE FINE TO COARSE SAND, LITTLE GRAVEL
	8 11	RECOVERY = 6"
30 - 32	6 1	0-3" SAME AS ABOVE
	1 3	3-10" DARK GRAY CLAY, VERY STIFF
35 - 37	3 4	0-12" LT. GRAY CLAY, LITTLE SILT
	5 8	12-18" BROWN SILT, SOME FINE SAND, TRACE CLAY, MOIST
40 - 42	2 3	BROWN FINE TO COARSE SAND
	3 5	RECOVERY = 8"



CONTINUED ON NEXT PAGE

DEPTH (FT)	BLOWS	SOIL DESCRIPTION
45 - 47	2 8 9 13	BROWN FINE TO COARSE SAND RECOVERY - 12"
50 - 52	3) 5 30 30	LT. BROWN FINE TO MEDIUM SAND, TRACE SILT RECOVERY - 4"
55 - 57	5 11 15 20	SAME AS ABOVE WITH THIN WHITE LAYERS OF SILT THROUGHOUT RECOVERY - 14"
60 - 62	10 15 20 20	LT. BROWN TO WHITE FINE TO MEDIUM SAND RECOVERY - 14"
65 - 67	9 15 21 21	LT. BROWN FINE TO MEDIUM SAND RECOVERY - 12"
70 - 72	10 15 33 37	SAME AS ABOVE RECOVERY - 8"
75 - 77	22 24 28 32	SAME AS ABOVE RECOVERY - 12"
80 - 82	20 19 17 18	BROWN FINE SAND, TRACE SILT RECOVERY - 2"
85 - 87	10 12 11 20	LT. BROWN FINE SAND, TRACE SILT RECOVERY - 22"
90 - 92	15 29 16 18	LT. BROWN FINE TO COARSE SAND RECOVERY - 12"

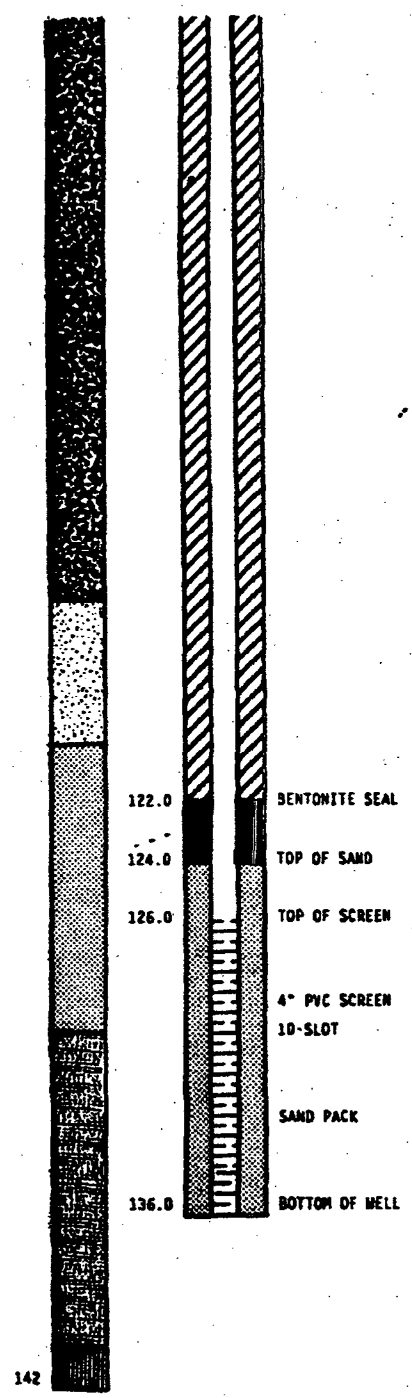
LITHOLOGY   WELL CONSTRUCTION



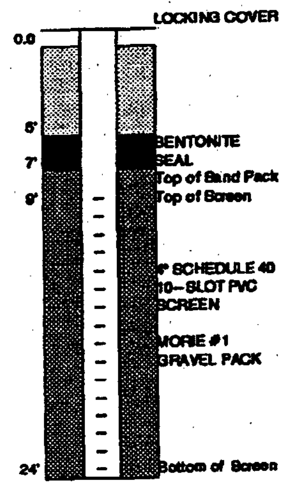
CONTINUED ON NEXT PAGE

DEPTH (FT)	BLOWS	SOIL DESCRIPTION
95 - 97	19 21 32 29	LT. BROWN FINE TO COARSE SAND RECOVERY - 12"
100 - 102	35 42 67 65	BROWN/ORANGE FINE TO COARSE SAND, TRACE SILT RECOVERY - 8"
105 - 107	25 52 67 100	SAME AS ABOVE RECOVERY - 14"
110 - 112	34 100/5"	SAME AS ABOVE RECOVERY - 8"
115 - 117	100/5"	BROWN/RED FINE TO MEDIUM SAND, TRACE SILT RECOVERY - 3"
120 - 122	12 11 19 28	BROWN FINE SAND, LITTLE SILT RECOVERY - 10"
125 - 127	12 22 20 18	LT. BROWN FINE SAND, LITTLE SILT RECOVERY - 12"
130 - 132	6 6 9 9	DARK GRAY FINE SAND AND SILT RECOVERY - 14"
135 - 137	5 6 5 8	SAME AS ABOVE RECOVERY - 20"
140 - 142	3 5 12 16	0-18" SAME AS ABOVE 18-24" DARK GRAY SILT, SOME CLAY END OF BORING - 142 FT

LITHOLOGY WELL CONSTRUCTION



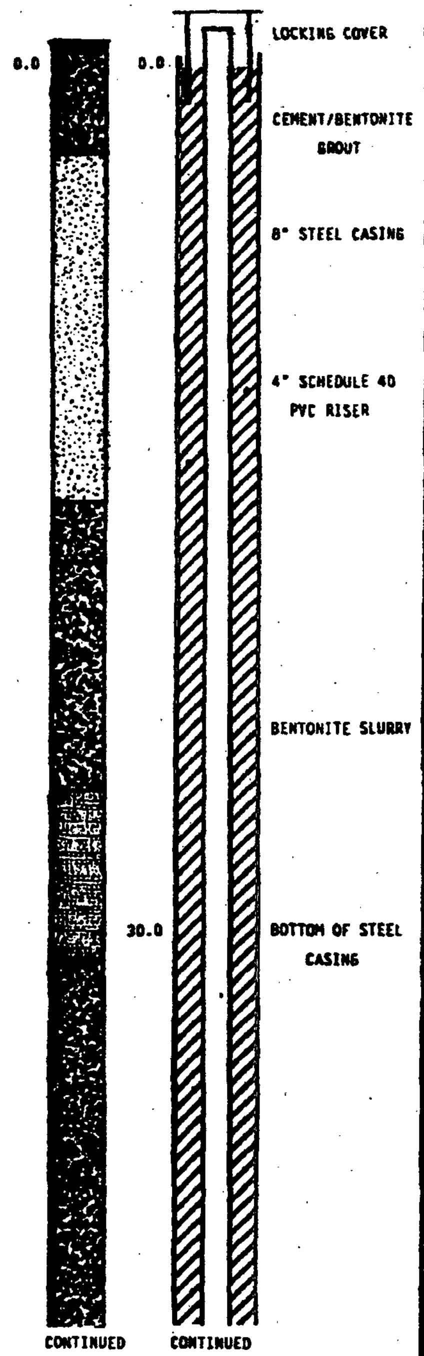
BORING NO.:	SC–11S (R)	CONTRACTOR:	UNI–TECH DRILLING	DATE STARTED:	7/1/92
PROJECT NO.:	7650–N51	DRILLERS:	FRECK	DATE COMPLETED:	7/1/92
PROJECT:	SHIELDALLOY	SMC INSPECTOR:	VALENTI	STATIC WATER LEVEL:	91.10 FT
CLIENT:	SMC	DRILLING METHOD:	MUD ROTARY	NJDEP PERMIT NUMBER:	31–39500
LOCATION:	NEWFIELD, NJ	GROUND ELEVATION:	108.91 FT		
BORING DEPTH:	24 FT	CASING ELEVATION:	108.12 FT		

DEPTH (FT)	BLOWS		SOIL DESCRIPTION	WELL CONSTRUCTION
0 – 2			AUGERED TO 5'	
5 – 7	3 6	4 7	ORANGE TO LIGHT BROWN SILTY SAND WITH GRAVEL	
10 – 12	2 5	4 2	ORANGE–LIGHT BROWN SILTY SAND WITH GRAVEL	
15 – 17	2 3	2 3	ORANGE–TAN GRAVEL	
20 – 22	3 6	3 7	ORANGE–TAN GRAVEL	
	END OF BORING = 24'			

BORING NO.:	SC-13D	CONTRACTOR:	EMPIRE SOILS	DATE STARTED:	11/20/90
PROJECT NO.:	7650-N51	DRILLERS:	KENNEY, EDWARDS	DATE COMPLETED:	11/21/90
PROJECT:	SHIELD ALLOY	TRC INSPECTOR:	MCMORROW	WATER TABLE LEVEL:	5.5 FT
CLIENT:	SMC	DRILLING METHOD:	MUD ROTARY	LOCATION:	N 257662.57
LOCATION:	NEWFIELD, NJ	GROUND ELEVATION:	99.67		E 1901067.82
BORING DEPTH:	142 FT	INNER CASING ELEVATION:	101.99	NJDEP PERMIT NUMBER:	3135227-8

DEPTH (FT)	BLOWS	SOIL DESCRIPTION
0 - 2	2 3	BROWN/ORANGE FINE TO COARSE SAND, TRACE GRAVEL, MOIST
	3 3	RECOVERY = 18"
2 - 4	4 1	0-8" SAME AS ABOVE
	2 3	8-12" DARK BROWN FINE TO MEDIUM SAND, TRACE SILT
4 - 6	4 2	0-12" SAME AS 8-12" ABOVE
	2 2	12-24" GRAY FINE TO MEDIUM SAND, TRACE SILT, WET
10 - 12	10 8	BROWN FINE TO MEDIUM SAND, TRACE SILT, TRACE GRAVEL
	15 12	RECOVERY = 8"
15 - 17	4 4	BROWN/ORANGE FINE TO COARSE SAND, TRACE GRAVEL
	4 4	RECOVERY = 6"
20 - 22	3 4	LT. BROWN FINE TO COARSE SAND, TRACE SILT
	4 6	RECOVERY = 8"
25 - 27	1 1	0-4" BLACK FINE TO MEDIUM SAND, TRACE SILT
	1 2	4-8" DARK GRAY SILT AND FINE SAND
30 - 32	3 7	0-12" GRAY SILT, LITTLE FINE SAND, LITTLE CLAY
	12 15	12-24" BROWN FINE TO COARSE SAND, TRACE SILT
35 - 37	7 8	LT. BROWN FINE TO COARSE SAND, TRACE SILT
	13 16	RECOVERY = 12"
40 - 42	7 13	LT. BROWN FINE TO COARSE SAND
	11 12	RECOVERY = 8"

LITHOLOGY WELL CONSTRUCTION



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DEPTH (FT)	BLOWS	SOIL DESCRIPTION
45 - 47	10 14 17 25	LT. BROWN FINE TO COARSE SAND RECOVERY - 8"
50 - 52	8 19 21 24	LT. BROWN FINE TO COARSE SAND, TRACE SILT RECOVERY - 10"
55 - 57	8 14 21 25	SAME AS ABOVE RECOVERY - 10"
60 - 62	5 15 18 19	SAME AS ABOVE, COLORS RANGE FROM REDDISH BROWN, TO WHITE, TO LT. BROWN BACK TO REDDISH BROWN. RECOVERY - 8"
65 - 67	15 20 30 30	REDDISH BROWN FINE TO MEDIUM SAND, TRACE COARSE SAND, TRACE SILT RECOVERY - 12"
70 - 72	21 44 64 62	SAME AS ABOVE RECOVERY - 18"
75 - 77	23 36 34 39	SAME AS ABOVE RECOVERY - 14"
80 - 82	23 30 50/5"	SAME AS ABOVE RECOVERY - 14"
85 - 87	20 30 33 37	SAME AS ABOVE RECOVERY - 12"
90 - 92	17 35 32 30	RED FINE TO MEDIUM SAND, TRACE SILT RECOVERY - 12"

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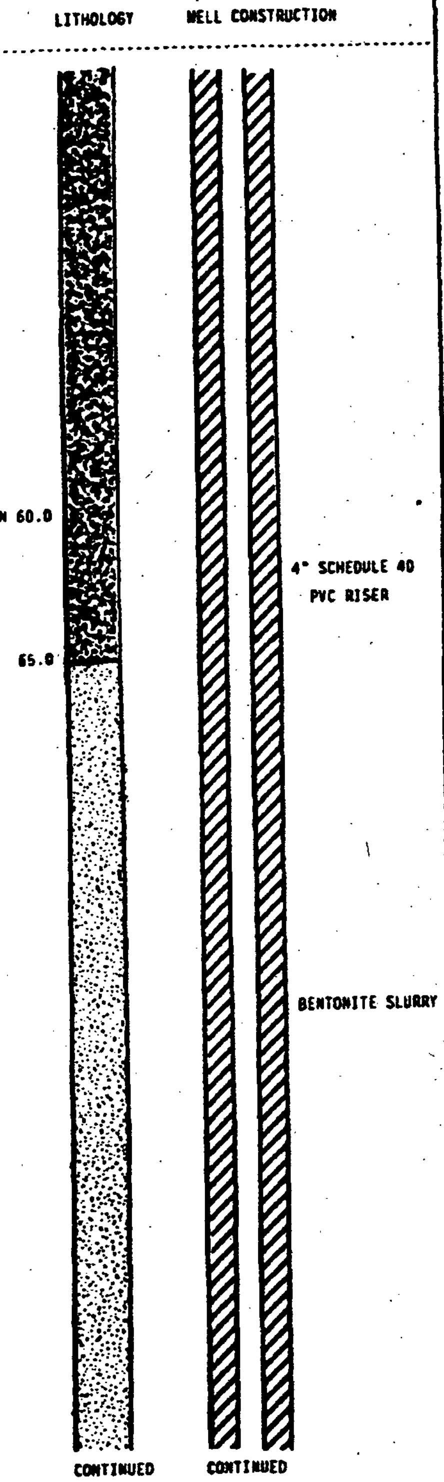
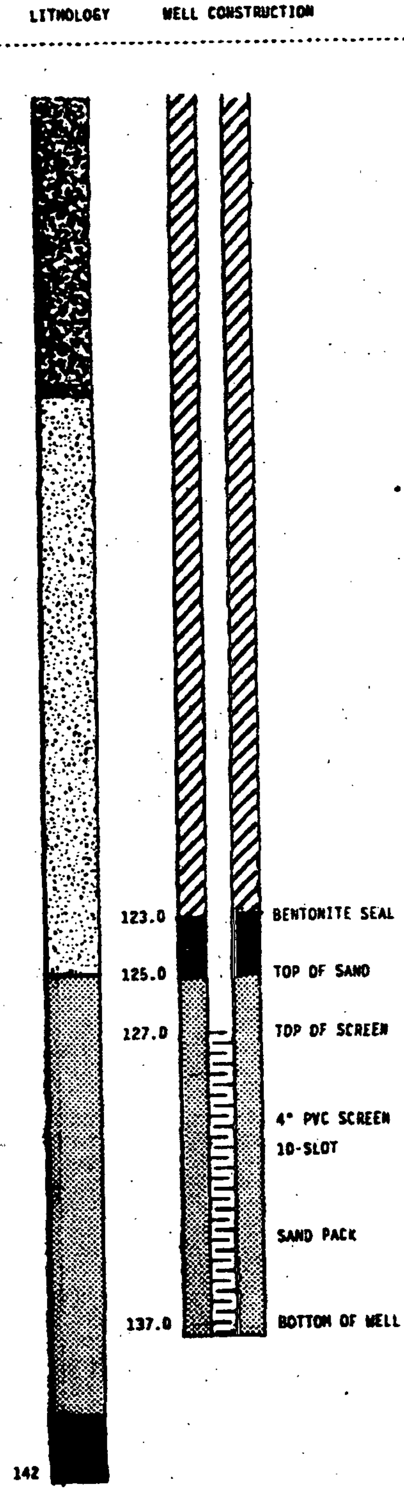


DEPTH (FT)	BLOWS	SOIL DESCRIPTION
95 - 97	22 30	0-12" RED/BROWN FINE TO COARSE SAND, TRACE SILT
	16 30	12-18" RED/BROWN FINE SAND, LITTLE SILT, TRACE CLAY
100 - 102	13 20	RED/BROWN FINE TO COARSE SAND, TRACE SILT
	24 36	RECOVERY - 14"
105 - 107	21 63	BROWN/ORANGE FINE TO MEDIUM SAND, TRACE SILT
	53 69	RECOVERY - 16"
110 - 112	15 29	SAME AS ABOVE
	45 50/1"	RECOVERY - 18"
115 - 117	17 80	BROWN/ORANGE FINE TO MEDIUM SAND, TRACE SILT
	100/5"	RECOVERY - 12"
120 - 122	8 20	LT. BROWN FINE TO MEDIUM SAND WITH STRINGS OF GRAY CLAY AT 2"
	22 22	RECOVERY - 8"
125 - 127	13 23	LT. BROWN FINE SAND, TRACE SILT
	33 30	RECOVERY - 12"
130 - 132	WOR 17	DARK GRAY FINE SAND, TRACE SILT
	25 24	RECOVERY - 14"
135 - 137	5 8	SAME AS ABOVE
	17 16	RECOVERY - 20"
140 - 142	6 6	DARK GRAY SILT AND CLAY
	10 9	RECOVERY - 24"
		END OF BORING - 142 FT



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WOODWARD-MOORHOUSE & ASSOCIATES, INC.

LOG OF WELL W3 **SHEET 1 OF** 4

PROJECT: Shieldalloy Monitoring Well Program	PROJECT NO.: 72C75AW
LOCATION: Approx 100 ft east of concrete apron on east side of Dept. 1N	ELEVATION AND DATUM:
DRILLING AGENCY: V. Skinner Water Supply Systems	SURVEYING AGENCY:
DRILLING EQUIPMENT: Failing 1500 S Hydraulic Rotary 20 ft rod lengths 22 ft kelly stroke	DATE STARTED: 10 MAY 1974
SIZE AND TYPE OF BIT: 5 inch drag bit, 8 inch reamer	DATE FINISHED: 17 MAY 1974
CASING: 4 inch (nominal) white PVC 1120, Schd 40; 4 inch slotted (.03 inch) white PVC screen	COMPLETION DEPTH: 142 ft
SAMPLER: cuttings collected from wash over a 5 ft interval; 5 ft long, 4 inch (telescoping) brass screen used for water	ROCK DEPTH: —
	NO. SOIL SAMPLES: 29; UNDIST: ; CORE:
	NO. WATER SAMPLES: FIELD 7; COMMERCIAL 8*
	DRILLER: Bill Skinner, Tom Kollmer } driller; John Kobrich helper
	INSPECTOR: Bruce S. Yare

ELEV. FT.	CASING	ROD	DESCRIPTION	pH	CONDUCTIVITY μmhos/cm	DEPTH. FT.	SAMPLE NO.	REMARKS
	4 inch white PVC casing		Gravelly, Clayey SAND; medium grained, very poorly sorted; subangular-subround; dark red-brown; orange-brown mud matrix, gravel up to 2 inch diam, mixed w/ black top soil 5 YR 5/6 Light Brown			0–5	1 COMP-WP	START 10 MAY 1974 1545 1/4 bag Revert. Augered to set conductor pipe
			Gravelly, Clayey SAND; medium grained; poorly sorted; subangular-subround; dark red brown; orange brown mud matrix; granule size gravel 5 YR 5/6 Light Brown			5–10	2 COMP-WP	dark red brown wash
			Gravelly, Clayey SAND; medium grained; poorly sorted; subangular-subround; dark red brown; orange-brown mud matrix; granule size gravel 5 YR 5/6 Light Brown			10–15	3 COMP-WP	dark red brown wash
	4 inch PVC screen		Gravelly, Clayey SAND; medium grained; poorly sorted; subangular-subround; dark orange brown; orange brown mud matrix; granule size gravel 10 R 4/6 Moderate Reddish Brown	7.0	980	15–20	4 COMP-[illegible]	bright orange brown wash. Marsh funnel 42 sec
	4 inch white PVC casing		Clayey Gravelly SAND; medium grained, moderately sorted, subangular-subround; dark orange brown; orange brown mud matrix; granule size gravel 5 YR 5/6 Light Brown			20–25	5 COMP-WP	FINISH 10 MAY 1974 1715. START 13 MAY 1974 0830. 1/4 bag Revert
			SAND; medium grained; moderately sorted; subang-subrd; dk orange brown, orange brown mud matrix; iron oxide staining on bands/grains 5 YR 5/6 Light Brown					
			Sandy GRAVEL; granule size; poorly sorted; subangular-subround; light red brown; orange brown and white mud matrix; medium grained sand 10 R 5/4 Pale Reddish Brown			25–30	6 COMP-WP	
	4 inch PVC screen					30–	7 -WP	

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* 1 dummy sample

LOG OF WELL W3

SHEET 2 OF 4

ELEV. FT.	CASING	ROD	DESCRIPTION	pH	CON-DUC-TIVITY µ mhos/cm	DEPTH, FEET	SAMPLE NO.		REMARKS
	4inch PVC [illegible]						7	COMP	dark orange brown wash
	4inch white PVC casing	2	Sandy, Clayey GRAVEL; granule size; very poorly sorted; subangular-subround; light red-brown; orange-brown and white mud matrix; medium grained sand 10R 5/4 Pale Red. Brown CLAY, grayish black, white and orange-brown	6.8	605	35	8	COMP-JARS(2)	W3-2 water sample, 4l Marsh funnel 46 sec screen had to be pushed past clay layer
			Sandy, Clayey GRAVEL; granule size; very poorly sorted; subangular-subround; light red brown; orange-brown and white mud matrix; medium grained sand 10R 5/4 Pale Reddish Brown			40	9	COMP-WP	red brown wash
			Gravelly, Clayey SAND; medium grained; very poorly sorted; subangular-subround; light red brown; orange-brown mud matrix; granule size gravel 10R 5/4 Pale Reddish Brown			45	10	COMP-WP	red brown wash
		3	Clayey SAND; medium grained; moderately sorted; subangular-subround; light red brown; orange-brown mud matrix 10R 5/4 Pale Reddish Brown			50	11	COMP-WP	red brown wash
			Clayey SAND; fine grained; well sorted; subangular-subround; light red brown; orange brown mud matrix 10R 5/4 Pale Reddish Brown	4.5	128	55	12	COMP-JARS(2)	red brown wash
			SAND; medium grained; moderately sorted; subangular-subround; light red brown; orange-brown and white mud matrix 10R 5/4 Pale Reddish Brown			60	13	COMP-WP	1/4 bag Revert red brown wash
			SAND; medium grained; poorly sorted; subangular-subround; light red brown; orange brown and white mud matrix 10R 5/4 Pale Reddish Brown			65	14	COMP-WP	red brown wash
		4	Clayey SAND; medium grained; poorly sorted; subangular-subround; light red brown; orange brown and white mud matrix 10R 5/4 Pale Reddish Brown			70	15	COMP-WP	red brown wash
			Clayey SAND; medium grained; poorly sorted; subangular-subround; light red brown; orange brown and white mud matrix 10R 5/4 Pale Reddish Brown	4.5	74	75	16	COMP-JARS(2)	Marsh funnel 40 sec red brown wash W3-4 water sample, 4l
						80			

2/74

FINISH 8 MAY 1974 1700

WOODWARD-MOORHOUSE & ASSOCIATES, INC.

LOG OF WELL W3

ELEV. FT.	CASING	ROD	DESCRIPTION	pH	CONDUCTIVITY (µ mhos/cm)	DEPTH, FEET	SAMPLE NO.	REMARKS
						80		START 14 MAY 1974 0830 Marsh funnel 41 sec
	4 inch white PVC casing		Gravelly SAND; medium grained; poorly sorted, subangular-subround; light red brown; orange brown and white mud matrix, salmon pink clay lumps 10 R 5/4 Pale Reddish Brown			85	17 COMP-WP	light brown wash
			Gravelly SAND; medium grained; poorly sorted, subangular-subround; light red brown; orange brown + white mud matrix; salmon pink clay lumps; granule size gravel 10 R 5/4 Pale Reddish Brown			90	18 COMP-WP	considerable amount of salmon pink clay in wash; light brown wash
			Gravelly SAND; medium grained; poorly sorted, subangular-subround; light red brown; orange brown + white mud matrix; salmon pink + orange brown clay lumps; granule size gravel 10 R 5/4 Pale Reddish Brown			95	19 COMP-WP	light brown wash
			Gravelly SAND; medium grained; poorly sorted, subangular-subround; light red brown; orange brown + white mud matrix; salmon pink clay lumps; granule size gravel 10 R 5/4 Pale Reddish Brown	5.5	60	100	20 COMP-JARS(2)	W3-5 water sample, 4E; light brown wash Marsh funnel 42 sec 1/5 bag Revert
			SAND; medium grained; moderately well sorted; subangular-subround; light red brown; orange brown + salmon pink mud matrix 10 R 5/4 Pale Reddish Brown SAND; medium grained; poorly sorted; subangular-subround; dark red brown; Fe_2O_3 matrix; iron oxide crust on sand grains 10 R 4/6 Moderate Reddish Brown			105	21 COMP-WP	bit bucking (Jersey stone?) dark red brown wash; light brown wash
			SAND; coarse grained; poorly sorted; subangular-subround; dark red brown; Fe_2O_3 matrix; iron oxide crust on sand grains 10 R 4/6 Moderate Reddish Brown Clayey SAND; coarse grained; very poorly sorted; subang-subrd; Fe_2O_3, etc, red + white mud matrix; iron oxide crusts on sand grains 10 R 4/6 Moderate Reddish Brown			110	22 COMP-WP	red brown wash
			Clayey SAND; fine grained; very poorly sorted; subangular-subround; orange brown; orange brown and white mud matrix, cohesive 5 YR 5/6 Light Brown			115	23 COMP-WP	red brown wash
			Clayey SAND; fine grained; very poorly sorted; subangular-subround; orange brown; orange brown mud matrix; orange brown, white, and pink clay lumps; cohesive 5 YR 5/6 Light Brown	5.5	54	120	24 COMP-JARS(2)	light brown wash Marsh funnel 40 sec; red brown wash; orange brown clay in wash; orange brown wash 1/4 bag Revert
	4 inch PVC screen		Sandy Clayey GRAVEL; granule size, very poorly sorted, subrnd-subrd; dark red brown; orange brown and red mud matrix; cohesive; fine sand 10 R 4/6 Moderate Reddish Brown			125	25 COMP-WP	bit bucking and advancing very slowly; dark red brown wash, clay lumps in wash
			Gravelly Clayey SAND; fine sand; very poorly sorted; subangular-subround				26 WP	dark red brown wash

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LOG OF WELL W3

ELEV. FT.	CASING	ROD	DESCRIPTION	pH	CON-DUC-TIVITY μ mhos/cm	DEPTH, FEET	SAMPLE NO.		REMARKS
	#2 Gravel Backfill		dark red brown, orange brown mud matrix; red clay lumps; cohesive; granule size gravel 10R 4/6 Moderate Reddish Brown			130	26	COMP	dark red brown wash
			Clayey SAND; fine grained; well sorted; subangular - subround. orange gray; gray black mud matrix; orange brown, red & white clay lumps; cohesive 5R 4/2 Grayish Red			135	27	COMP · WP	dark red brown wash considerable amount of clay lumps in wash dark brown wash
			Clayey SAND; fine grained; well sorted; subangular & subround; gray black; gray black mud matrix; orange brown & white clay lumps; cohesive N4 Medium Gray	5.5	35		28	COMP · SAR(2)	dark brown wash gray brown wash ← drill starts to go more easily into formation W3-7 water sample 4l
			Sandy CLAY; fine grained sand; orange brown, red and white clay lumps; gray black N4 Medium Dark Gray			140	29	COMP · SAR(1)	dark gray brown wash black clay drilling up in lumps

FINISH 14 MAY 1974

Dummy Sample
W3-8, 160ft
same as W3-5, 100ft

GROUT + GRAVEL PACKING

0-13 ft cement grout

13-22 ft #2 Gravel formation stabilizer

22-27 ft cement grout

27-37 ft #2 Gravel formation stabilizer

37-115 ft cement grout

115-142 ft #2 Gravel backfill

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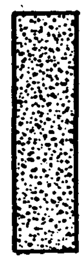
BORING NO.:	SB-4	BORING DEPTH:	10.0 FT	DATE STARTED:		11/06/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:		11/06/90
PROJECT:	SHIELD ALLOY	DRILLERS:	KENNEY, EDWARDS	GROUND ELEVATION:		100.1
CLIENT:	SMC	TRC INSPECTOR:	MCMORROW	LOCATION:	N	257929.23
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E	1901029.22

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION
0 - 2	33 25		0-14" DARK BROWN FINE TO MEDIUM SAND, SOME GRAVEL, TRACE SILT
	20 17		14-24" BROWN FINE TO MEDIUM SAND, TRACE SILT
2 - 4	12 19		BROWN FINE TO MEDIUM SAND, TRACE SILT, TRACE GRAVEL
	26 40		RECOVERY - 24"
4 - 6	80 55		SAME AS ABOVE, MOIST
	65 60		RECOVERY - 20"
6 - 8	68 75		SAME AS ABOVE
	63 45		RECOVERY - 18"
8 - 10	10 6		SAME AS ABOVE, WET
	4 4		RECOVERY - 12"

END OF BORING - 10 FT

LITHOLOGY



BORING NO.: SB-5
PROJECT NO.: 7650-N51
PROJECT: SHIELD ALLOY
CLIENT: SMC
LOCATION: NEWFIELD, NJ

BORING DEPTH: 8.0 FT
CONTRACTOR: EMPIRE SOILS
DRILLERS: KENNEY, EDWARDS
TRC INSPECTOR: MCMORROW
DRILLING METHOD: SPLIT SPOONS

DATE STARTED: 11/06/90
DATE COMPLETED: 11/06/90
GROUND ELEVATION: 99.7
LOCATION: N 257916.23
E 1901075.3

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION	LITHOLOGY
0 - 2	6 11		BROWN/GRAY FINE TO MEDIUM SAND, TRACE SILT	0.0
	6 5		RECOVERY - 24"	
2 - 4	3 3		BROWN FINE TO COARSE SAND, TRACE SILT, TRACE GRAVEL, MOIST	
	5 7		RECOVERY - 24"	
4 - 6	7 6		SAME AS ABOVE, MOIST	
	7 7		RECOVERY - 24"	
6 - 8	7 6		SAME AS ABOVE, WET AT 7.5 FT.	
	9 10		RECOVERY - 20"	8.0

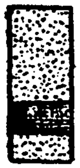
END OF BORING - 8 FT

BORING NO.:	SB-6	BORING DEPTH:	6.0 FT	DATE STARTED:	11/06/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/06/90
PROJECT:	SHIELD ALLOY	DRILLERS:	KENNEY, EDWARDS	GROUND ELEVATION:	100.1
CLIENT:	SMC	TRC INSPECTOR:	MCMORROW	LOCATION:	N 257950.09
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1901138.27

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION
0 - 2	6 22		DARK BROWN FINE TO MEDIUM SAND, LITTLE SILT, TRACE GRAVEL
	16 10		RECOVERY - 24"
2 - 4	9 6		BROWN FINE TO MEDIUM SAND, LITTLE SILT, TRACE GRAVEL, MOIST
	7 6		RECOVERY - 24"
4 - 6	7 8		0-12" LT. BROWN FINE SAND AND SILT, TRACE CLAY, WET
	9 6		12-18" BROWN FINE TO MEDIUM SAND, TRACE SILT, MOIST

LITHOLOGY

0.0

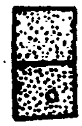


6.0

END OF BORING - 6 FT

BORING NO.:	SB-11	BORING DEPTH:	4.0 FT	DATE STARTED:	11/14/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/14/90
PROJECT:	SHIELD ALLOY	DRILLERS:	MATT, BOB	GROUND ELEVATION:	103.0
CLIENT:	SMC	TRC INSPECTOR:	MULLEN, DRAKE	LOCATION:	N 257687.72
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1901109.52

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION	LITHOLOGY
0 - 2	1 4 5 2		TAN/BROWN MEDIUM TO FINE SAND, LITTLE GRAVEL AND SILT, MOIST RECOVERY - 16"	0.0
2 - 4	2 2 2 2		TAN/ORANGE COARSE TO MEDIUM SAND, LITTLE GRAVEL, TRACE SILT, MOIST RECOVERY - 16"	4.0



END OF BORING - 4 FT

BORING NO.:	SB-1B	BORING DEPTH:	4.0 FT	DATE STARTED:	11/08/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/08/90
PROJECT:	SHIELD ALLOY	DRILLERS:	KENNEY, EDWARDS	GROUND ELEVATION:	97.6
CLIENT:	SMC	TRC INSPECTOR:	MCMORROW	LOCATION:	N 257682.1
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1900737

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION	LITHOLOGY
0 - 2	5 10 4 2		BROWN FINE TO MEDIUM SAND, LITTLE SILT, TRACE GRAVEL, MOIST RECOVERY - 20"	0.0
2 - 4	2 2 1 2		BROWN FINE TO MEDIUM SAND, LITTLE SILT, WET AT 3.5 FT RECOVERY - 24"	4.0
			END OF BORING - 4 FT	

BORING NO.:	SB-19	BORING DEPTH:	6.0 FT	DATE STARTED:	11/09/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/09/90
PROJECT:	SHIELD ALLOY	DRILLERS:	KENNEY, EDWARDS	GROUND ELEVATION:	100.1
CLIENT:	SMC	TRC INSPECTOR:	MCMORROW	LOCATION:	N 257837.03
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1900900.23

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION	LITHOLOGY
0 - 2	7 6		BROWN FINE TO MEDIUM SAND, TRACE SILT	0.0
	5 5		RECOVERY - 14"	
2 - 4	2 2		SAME AS ABOVE, MOIST	
	1 2		RECOVERY - 16"	
4 - 6	4 8		SAME AS ABOVE, MOIST	
	7 8		RECOVERY - 14"	6.0

END OF BORING - 6 FT

BORING NO.:	SB-20	BORING DEPTH:	10.0 FT	DATE STARTED:	11/06/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/06/90
PROJECT:	SHIELD ALLOY	DRILLERS:	MATT, BOB	GROUND ELEVATION:	101.7
CLIENT:	SMC	TRC INSPECTOR:	MULLEN, DRAKE	LOCATION:	N 257965.91
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1900926.82

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION
0 - 2	28 26		BROWN MEDIUM TO FINE SAND, SOME SILT, LITTLE GRAVEL
	26 34		RECOVERY - 8"
2 - 4	17 24		ORANGE MEDIUM TO FINE SAND, SOME FINE GRAVEL, LITTLE SILT
	17 26		RECOVERY - 24"
4 - 6	18 20		SAME AS ABOVE
	20 24		RECOVERY - 16"
6 - 8	20 22		SAME AS ABOVE
	24 26		RECOVERY - 22"
8 - 10	20 18		ORANGE COARSE TO FINE SAND, LITTLE SILT, TRACE GRAVEL, WET
	16 16		RECOVERY - 24"

LITHOLOGY

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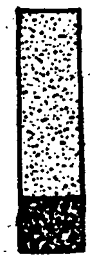

10.0

END OF BORING - 10 FT

BORING NO.:	SB-21	BORING DEPTH:	8.0 FT	DATE STARTED:	11/09/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/09/90
PROJECT:	SHIELD ALLOY	DRILLERS:	KENNEY, EDWARDS	GROUND ELEVATION:	106.7
CLIENT:	SMC	TRC INSPECTOR:	MCMORROW	LOCATION:	N 258171.29
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1900936.43

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION
0 - 2	10 9		0-16" DARK BROWN FINE TO MEDIUM SAND, LITTLE GRAVEL, TRACE SILT
	5 6		16-20" WOOD
2 - 4	3 4		DARK BROWN FINE SAND, SOME SILT, LITTLE GRAVEL
	8 6		RECOVERY - 12"
4 - 6	8 13		0-12" SAME AS ABOVE
	7 6		12-24" FINE TO COARSE SAND, TRACE GRAVEL, TRACE SILT, MOIST
6 - 8	4 3		SAME AS 12-24" ABOVE, MOIST
	2 4		RECOVERY - 24"

END OF BORING - 8 FT

LITHOLOGY

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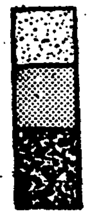


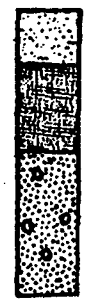
8.0

BORING NO.:	SB-22	BORING DEPTH:	12.0 FT	DATE STARTED:	11/06/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/06/90
PROJECT:	SHIELD ALLOY	DRILLERS:	MATT, BOB	GROUND ELEVATION:	107.8
CLIENT:	SMC	TRC INSPECTOR:	MULLEN, DRAKE	LOCATION:	N 258320.97
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1901098.36

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION
0 - 2	25 18 17 15		BROWN MEDIUM TO FINE SAND, SOME SILT, LITTLE GRAVEL RECOVERY - 16"
2 - 4	14 15 10 15		BROWN FINE SAND AND SILT, SOME GRAVEL RECOVERY - 12"
4 - 6	15 20 24 26		SAME AS ABOVE RECOVERY - 12"
6 - 8	17 21 23 25		BROWN/ORANGE COARSE TO MEDIUM SAND, SOME GRAVEL, TRACE SILT, MOIST RECOVERY - 24"
8 - 10	7 6 5 5		SAME AS ABOVE, MOIST RECOVERY - 24"
10 - 12	4 4 4 4		BROWN/ORANGE COARSE TO MEDIUM SAND, LITTLE GRAVEL AND SILT, WET RECOVERY - 24"

LITHOLOGY

0.0



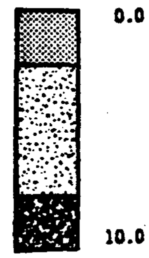
12.0

END OF BORING - 12 FT

BORING NO.:	SB-23	BORING DEPTH:	10.0 FT	DATE STARTED:	11/12/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/12/90
PROJECT:	SHIELD ALLOY	DRILLERS:	MATT, BOB	GROUND ELEVATION:	104.6
CLIENT:	SMC	TRC INSPECTOR:	MULLEN, DRAKE	LOCATION:	N 258136.19
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1901095.32

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION
0 - 2	4 14 7 4		BROWN COARSE TO FINE SAND, SOME GRAVEL, LITTLE SILT RECOVERY - 18"
2 - 4			BROWN MEDIUM TO FINE SAND, LITTLE GRAVEL AND SILT RECOVERY - 2"
4 - 6	8 20 12 6		NO RECOVERY
6 - 8	4 5 6 7		NO RECOVERY
8 - 10	4 5 7 10		BROWN COARSE TO FINE SAND, SOME GRAVEL, TRACE SILT, MOIST RECOVERY - 8"

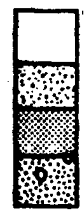
LITHOLOGY



END OF BORING - 10 FT

BORING NO.:	SB-24	BORING DEPTH:	8.0 FT	DATE STARTED:	11/06/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/06/90
PROJECT:	SHIELD ALLOY	DRILLERS:	MATT, BOB	GROUND ELEVATION:	99.1
CLIENT:	SMC	TRC INSPECTOR:	MULLEN, DRAKE	LOCATION:	N 257900.02
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1901107.82

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION	LITHOLOGY
0 - 2			SAMPLE NOT COLLECTED	0.0
2 - 4	30 40 16 10		BROWN MEDIUM TO FINE SAND, SOME GRAVEL, TRACE SILT RECOVERY - 18"	
4 - 6	7 11 27 60		BROWN FINE SAND, SOME SILT, LITTLE GRAVEL, TRACE CLAY, MOIST RECOVERY - 24"	
6 - 8	30 30 16 18		BROWN COARSE TO MEDIUM SAND, SOME GRAVEL, LITTLE FINE SAND, TRACE SILT, WET. RECOVERY - 20"	8.0



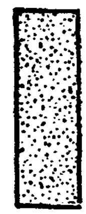
END OF BORING - 8 FT

BORING NO.:	SB-25	BORING DEPTH:	8.0 FT	DATE STARTED:	11/12/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/12/90
PROJECT:	SHIELD ALLOY	DRILLERS:	KENNEY, EDWARDS	GROUND ELEVATION:	111.2
CLIENT:	SMC	TRC INSPECTOR:	MCMORROW	LOCATION:	N 258047.65
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1901778.3

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION
0 - 2	5 13		0-6" GRAY COARSE SAND AND GRAVEL
	7 10		6-18" FINE TO MEDIUM SAND, LITTLE SILT, TRACE GRAVEL
2 - 4	8 8		SAME AS 6-18" ABOVE
	9 9		RECOVERY - 18"
4 - 6	13 14		BROWN FINE TO MEDIUM SAND, TRACE GRAVEL, TRACE SILT
	12 12		RECOVERY - 18"
6 - 8	15 10		SAME AS ABOVE
	7 5		RECOVERY - 20"

LITHOLOGY

0.0



8.0

END OF BORING - 8 FT

BORING NO.:	SB-26	BORING DEPTH:	8.0 FT	DATE STARTED:	11/12/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/12/90
PROJECT:	SHIELD ALLOY	DRILLERS:	KENNEY, EDWARDS	GROUND ELEVATION:	100.7
CLIENT:	SMC	TRC INSPECTOR:	MCMORROW	LOCATION:	N 257681.27
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1902000.27

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION	LITHOLOGY
0 - 2	11 24		0-4" BROWN F-C SAND, LITTLE SILT 4-8" GREEN F. SAND AND GRAVEL	0.0
	17 12		8-18" BROWN/GRAY FINE TO MEDIUM SAND, TRACE GRAVEL	
2 - 4	12 25		LT. BROWN FINE TO COARSE SAND AND GRAVEL	
	17 13		RECOVERY = 12"	
4 - 6	13 25		BROWN FINE TO COARSE SAND, TRACE SILT, TRACE GRAVEL, GREEN STAIN AT	
	14 23		2-6". RECOVERY = 12"	
6 - 8	18 7		BROWN FINE TO COARSE SAND, TRACE SILT, TRACE GRAVEL, MOIST AT TIP	
	9 9		RECOVERY = 20"	8.0

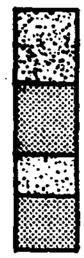
END OF BORING = 8 FT

BORING NO.:	SB-27	BORING DEPTH:	10.0 FT	DATE STARTED:	11/07/90
PROJECT NO.:	7650-N61	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/07/90
PROJECT:	SHIELD ALLOY	DRILLERS:	KENNEY, EDWARDS	GROUND ELEVATION:	106.4
CLIENT:	SMC	TRC INSPECTOR:	MCMORROW	LOCATION:	N 257837.58
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1901838.88

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION
0 - 2	2 8		0-6" BROWN FINE TO MEDIUM SAND, LITTLE GRAVEL
	12 6		6-12" BLACK MEDIUM TO COARSE SAND, LITTLE FINE SAND, LITTLE GRAVEL
2 - 4	8 3		0-12" BLACK/BROWN FINE TO MEDIUM SAND, LITTLE GRAVEL, TRACE SILT
	4 3		12-18" FINE SAND, SOME SILT, MOIST
4 - 6	5 8		SAME AS 12-18" ABOVE
	10 12		
6 - 8	25 18		BROWN FINE TO MEDIUM SAND, TRACE SILT.
	20 22		RECOVERY = 24"
8 - 10	22 30		BROWN FINE SAND, SOME SILT, VERY COMPETENT, MOIST
	43 44		

LITHOLOGY

0.0



10.0

END OF BORING = 10 FT

BORING NO.: SB-28
PROJECT NO.: 7650-N51
PROJECT: SHIELD ALLOY
CLIENT: SMC
LOCATION: NEWFIELD, NJ

BORING DEPTH: 8.0 FT
CONTRACTOR: EMPIRE SOILS
DRILLERS: KENNEY, EDWARDS
TRC INSPECTOR: MCMORROW
DRILLING METHOD: SPLIT SPOONS

DATE STARTED: 11/12/90
DATE COMPLETED: 11/12/90
GROUND ELEVATION: 108.7
LOCATION: N 257928.17
E 1901954.1

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION	LITHOLOGY
0 - 2	12 25		DARK BROWN FINE TO MEDIUM SAND, TRACE GRAVEL, TRACE SILT	0.0
	26 24		RECOVERY - 18"	
2 - 4	25 8		DARK BROWN FINE TO MEDIUM SAND, LITTLE SILT, TRACE GRAVEL	
	8 10		RECOVERY - 12"	
4 - 6	9 7		BROWN FINE TO COARSE SAND, TRACE GRAVEL	
	9 10		RECOVERY - 24"	
6 - 8	12 12		SAME AS ABOVE	
	9 12		RECOVERY - 18"	8.0

END OF BORING - 8 FT

BORING NO.:	SB-31	BORING DEPTH:	8.0 FT	DATE STARTED:	11/08/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/08/90
PROJECT:	SHIELD ALLOY	DRILLERS:	MATT, BOB	GROUND ELEVATION:	103.2
CLIENT:	SMC	TRC INSPECTOR:	MULLEN, DRAKE	LOCATION:	N 258416.02
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1900871.08

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION	LITHOLOGY
			AUGERED THROUGH 1 FT OF CONCRETE	
1 - 2.5	5 10 6		BROWN/GREEN MEDIUM SAND, SOME GRAVEL, TRACE SILT RECOVERY - 14"	0.0
2.5 - 4	4 5 5		BROWN/ORANGE COARSE TO FINE SAND, SOME GRAVEL, MOIST RECOVERY - 12"	
4 - 6	4 5 7 9		SAME AS ABOVE, MOIST RECOVERY - 20"	
6 - 8			SAME AS ABOVE, MOIST RECOVERY - 24"	8.0

END OF BORING - 8 FT

BORING NO.:	SB-32	BORING DEPTH:	12.0 FT	DATE STARTED:	11/08/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/08/90
PROJECT:	SHIELD ALLOY	DRILLERS:	MATT, BOB	GROUND ELEVATION:	103.8
CLIENT:	SMC	TRC INSPECTOR:	MULLEN, DRAKE	LOCATION:	N 258377.67
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1900912.62

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION
0 - 2	12 15		GREENISH BROWN COARSE TO FINE SAND, SOME GRAVEL, TRACE SILT, MOIST
	15 18		RECOVERY - 18"
2 - 4	12 11		BROWN COARSE TO FINE SAND, SOME GRAVEL, TRACE SILT
	10 12		RECOVERY - 18"
4 - 6	14 18		ORANGE/BROWN COARSE TO FINE SAND, SOME GRAVEL, TRACE SILT
	16 18		RECOVERY - 20"
6 - 8	14 15		BROWN/ORANGE COARSE SAND, SOME MEDIUM TO FINE SAND, LITTLE GRAVEL,
	18 16		TRACE SILT, MOIST. RECOVERY - 24"
8 - 10	14 14		SAME AS ABOVE, MOIST
	14 14		RECOVERY - 24"
10 - 12	5 5		SAME AS ABOVE, WET
	5 5		RECOVERY - 24"

LITHOLOGY

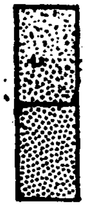
0.0

12.0

END OF BORING - 12 FT

BORING NO.:	SB-33	BORING DEPTH:	8.0 FT	DATE STARTED:	11/08/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/08/90
PROJECT:	SHIELD ALLOY	DRILLERS:	MATT, BOB	GROUND ELEVATION:	105.0
CLIENT:	SMC	TRC INSPECTOR:	MULLEN, DRAKE	LOCATION:	N 258300.91
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1900920.88

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION	LITHOLOGY
0 - 2	20 35 25 15		BROWN MEDIUM TO FINE SAND, SOME GRAVEL, LITTLE SILT RECOVERY - 12"	0.0
2 - 4	8 9 5 8		ORANGE COARSE TO MEDIUM SAND, SOME GRAVEL, TRACE SILT, MOIST RECOVERY - 20"	
4 - 6	7 8 8 9		ORANGE/BROWN MEDIUM SAND, SOME GRAVEL, LITTLE SILT, MOIST RECOVERY - 24"	
6 - 8	6 6 7 8		SAME AS ABOVE RECOVERY - 24"	8.0



END OF BORING - 8 FT

BORING NO.: SB-34
PROJECT NO.: 7650-N51
PROJECT: SHIELD ALLOY
CLIENT: SMC
LOCATION: NEWFIELD, NJ

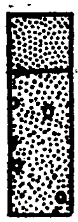
BORING DEPTH: 8.0 FT
CONTRACTOR: EMPIRE SOILS
DRILLERS: MATT, BOB
TRC INSPECTOR: MULLEN, DRAKE
DRILLING METHOD: SPLIT SPOONS

DATE STARTED: 11/08/90
DATE COMPLETED: 11/08/90
GROUND ELEVATION: 103.4
LOCATION: N 268294.13
E 1900825.64

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION
			AUGERED THROUGH 1 FT OF CONCRETE
1 - 2.5	3 3 4		BROWN/ORANGE MEDIUM SAND, SOME GRAVEL, TRACE SILT
2.5 - 4	3 3 3		ORANGE COARSE TO MEDIUM SAND, SOME GRAVEL RECOVERY - 10"
4 - 6	3 4 9 10		SAME AS ABOVE, MOIST RECOVERY - 24"
6 - 8	7 8 9 10		SAME AS ABOVE, MOIST RECOVERY - 24"

LITHOLOGY

0.0



8.0

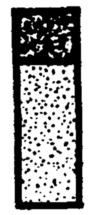
END OF BORING - 8 FT

BORING NO.:	SB-52	BORING DEPTH:	8.0 FT	DATE STARTED:	11/12/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/12/90
PROJECT:	SHIELD ALLOY	DRILLERS:	KENNEY, EDWARDS	GROUND ELEVATION:	111.0
CLIENT:	SMC	TRC INSPECTOR:	MCMORROW	LOCATION:	N 258202.36
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1901190.74

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION
0 - 2	17 27 23 16		DARK BROWN/GREEN FINE TO COARSE SAND, TRACE GRAVEL, TRACE SILT RECOVERY - 18"
2 - 4	12 8 6 6		BROWN FINE TO MEDIUM SAND, TRACE ROCK FRAGMENTS RECOVERY - 18"
4 - 6	10 13 12 9		SAME AS ABOVE RECOVERY - 16"
6 - 8	10 10 13 11		SAME AS ABOVE RECOVERY - 22"

LITHOLOGY

0.0

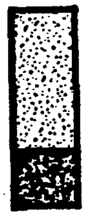


8.0

END OF BORING - 8 FT

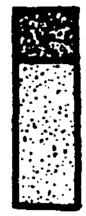
BORING NO.:	SB-53	BORING DEPTH:	8.0 FT	DATE STARTED:	11/12/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/12/90
PROJECT:	SHIELD ALLOY	DRILLERS:	KENNEY, EDWARDS	GROUND ELEVATION:	105.6
CLIENT:	SMC	TRC INSPECTOR:	MCMORROW	LOCATION:	N 258180.65
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1901204.42

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION	LITHOLOGY
0 - 2	13 13		BROWN/GREEN FINE TO MEDIUM SAND, TRACE SILT, TRACE GRAVEL	0.0
	14 6		RECOVERY - 18"	
2 - 4	8 7		BROWN/GREEN FINE TO MEDIUM SAND, TRACE SILT.	
	4 5		RECOVERY - 16"	
4 - 6	7 5		BROWN FINE TO MEDIUM SAND, TRACE SILT	
	6 9		RECOVERY - 24"	
6 - 8	10 12		BROWN FINE TO COARSE SAND, LITTLE GRAVEL	
	12 12		RECOVERY - 18"	8.0'



END OF BORING - 8 FT

BORING NO.:	SB-54	BORING DEPTH:	8.0 FT	DATE STARTED:	11/12/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/12/90
PROJECT:	SHIELD ALLOY	DRILLERS:	KENNEY, EDWARDS	GROUND ELEVATION:	105.4
CLIENT:	SMC	TRC INSPECTOR:	MCMORROW	LOCATION:	N 258151.9
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1901220.14

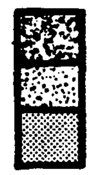
DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION	LITHOLOGY
0 - 2	6 19 24 13		BROWN FINE TO COARSE SAND, SOME FRACTURED ROCK, GREEN STAINING AT 6". RECOVERY - 16"	 0.0
2 - 4	8 5 5 4		BROWN FINE TO MEDIUM SAND, TRACE SILT RECOVERY - 20"	
4 - 6	3 6 5 6		BROWN FINE TO MEDIUM SAND, TRACE SILT, TRACE GRAVEL RECOVERY - 20"	
6 - 8	7 11 8 8		BROWN FINE TO MEDIUM SAND, LITTLE ROCK FRAGMENT, TRACE SILT. SLIGHT ODOR.	8.0

END OF BORING - 8 FT

BORING NO.:	SB-77	BORING DEPTH:	6.0 FT	DATE STARTED:	11/14/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/14/90
PROJECT:	SHIELD ALLOY	DRILLERS:	MATT, BOB	GROUND ELEVATION:	99.0
CLIENT:	SMC	TRC INSPECTOR:	MULLEN, DRAKE	LOCATION:	N 257667.3
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1901286.21

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION
0 - 2	20 31 55 80		BROWN GRAVEL AND COARSE SAND WITH GREEN STAINING RECOVERY - 20"
2 - 4	26 18 12 12		BROWN/GREEN MEDIUM TO FINE SAND RECOVERY - 18"
4 - 6	6 6 10 12		ORANGE FINE SAND, SOME SILT AND GRAVEL, TRACE CLAY, WET RECOVERY - 20"

LITHOLOGY



0.0

6.0

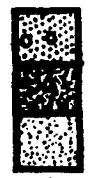
END OF BORING - 6 FT

BORING NO.: SB-7B
PROJECT NO.: 7650-N51
PROJECT: SHIELD ALLOY
CLIENT: SMC
LOCATION: NEWFIELD, NJ

BORING DEPTH: 6.0 FT
CONTRACTOR: EMPIRE SOILS
DRILLERS: MATT,BOB
TRC INSPECTOR: MULLEN, DRAKE
DRILLING METHOD: SPLIT SPOONS

DATE STARTED: 11/12/90
DATE COMPLETED: 11/12/90
GROUND ELEVATION: 101.3
LOCATION: N 257656.11
E 1901452.85

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION	LITHOLOGY
0 - 2	1 4 4 5		ORANGE COARSE TO MEDIUM SAND, SOME SILT, MOIST	0.0
2 - 4	3 3 2 2		ORANGE COARSE TO FINE SAND, LITTLE GRAVEL, TRACE SILT, MOIST	
4 - 6	8 6 6 5		MEDIUM TO FINE SAND, LITTLE SILT, TRACE CLAY, MOIST	6.0



END OF BORING - 6 FT

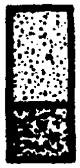
BORING NO.:	SB-79	BORING DEPTH:	4.0 FT	DATE STARTED:	11/12/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/12/90
PROJECT:	SHIELD ALLOY	DRILLERS:	KENNEY, EDWARDS	GROUND ELEVATION:	108.3
CLIENT:	SMC	TRC INSPECTOR:	MCMORROW	LOCATION:	N 257920.88
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1901572.02

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION	LITHOLOGY
0 - 2	2 3		BROWN FINE TO COARSE SAND, TRACE GRAVEL, TRACE SILT, MOIST	0.0
	5 5		RECOVERY - 18"	
2 - 4	8 11		SAME AS ABOVE WITH ROCK FRAGMENTS	
	12 10		SPLIT SPOON SATURATED	4.0

END OF BORING - 4 FT

BORING NO.:	SB-80	BORING DEPTH:	6.0 FT	DATE STARTED:	11/12/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/12/90
PROJECT:	SHIELD ALLOY	DRILLERS:	KENNEY, EDWARDS	GROUND ELEVATION:	104.1
CLIENT:	SMC	TRC INSPECTOR:	MCMORROW	LOCATION:	N 258162.43
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1901494.61

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION	LITHOLOGY
0 - 2	1 3 3 2		BROWN/BLACK FINE TO MEDIUM SAND, TRACE SILT, MOIST RECOVERY - 18"	0.0
2 - 4	3 3 2 3		SAME AS ABOVE, MOIST RECOVERY - 18"	
4 - 6			BROWN FINE TO COARSE SAND, TRACE SILT, WET AT TIP RECOVERY - 20"	6.0



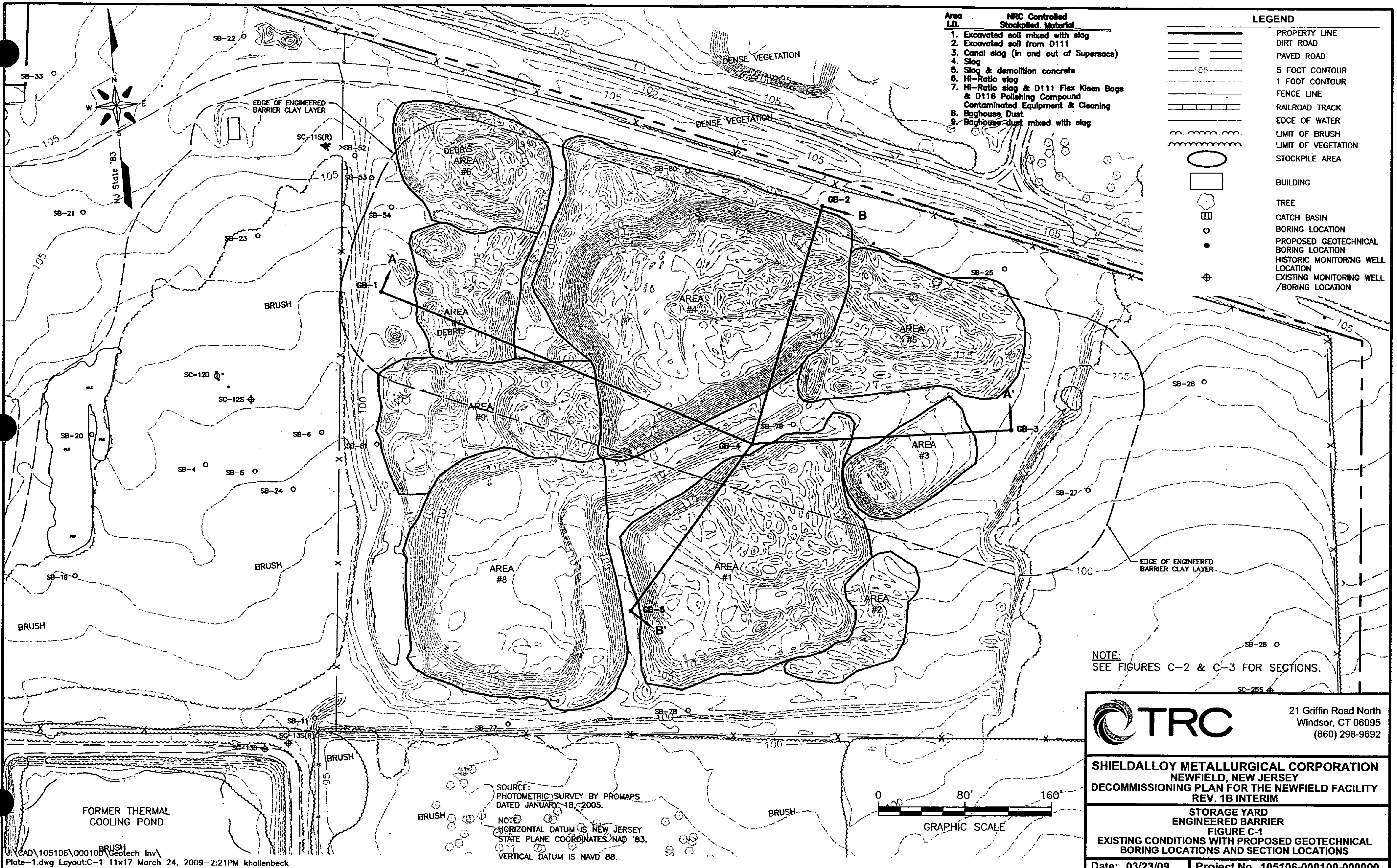
END OF BORING - 6 FT

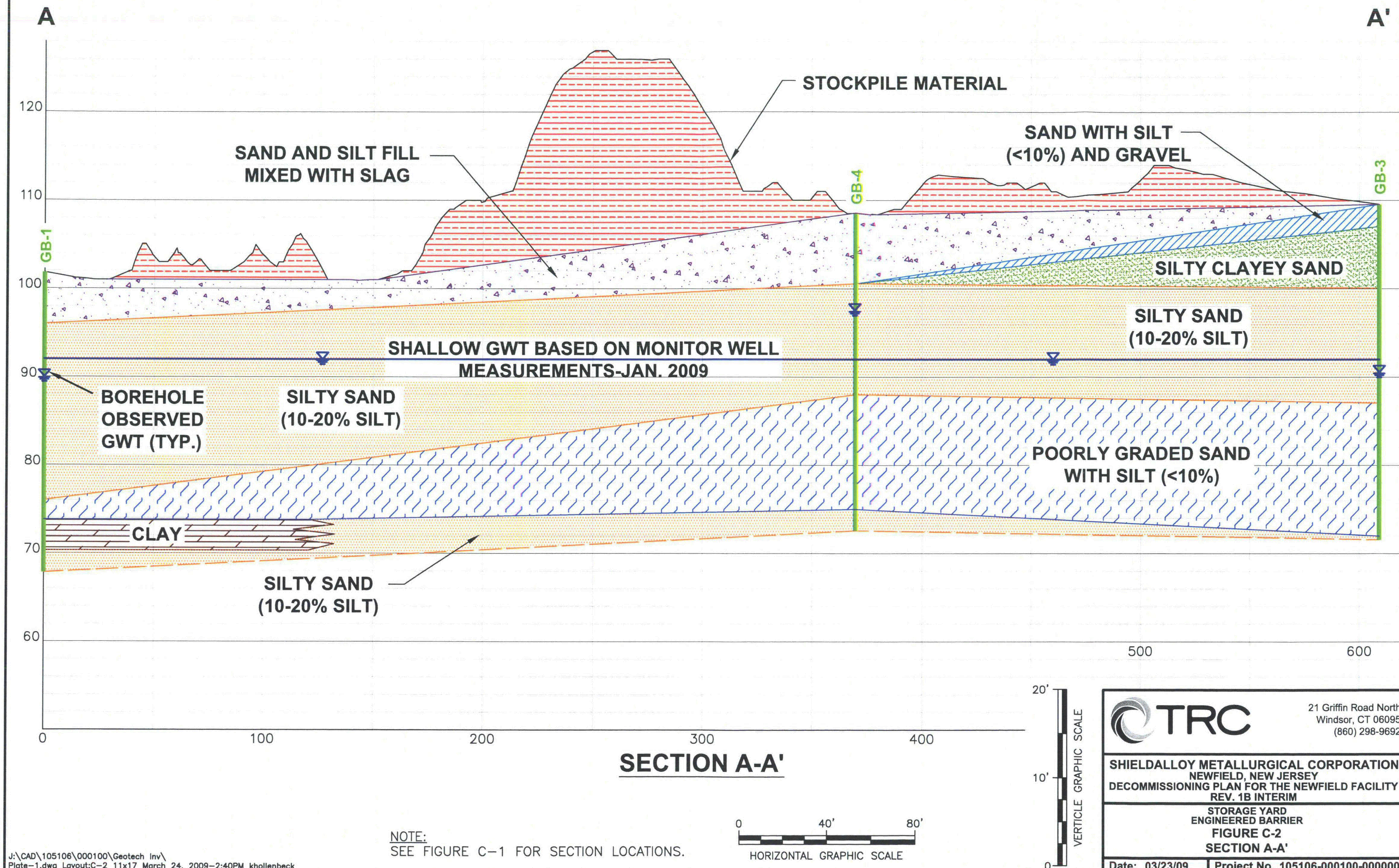
BORING NO.:	SB-B1	BORING DEPTH:	6.0 FT	DATE STARTED:	11/09/90
PROJECT NO.:	7650-N51	CONTRACTOR:	EMPIRE SOILS	DATE COMPLETED:	11/09/90
PROJECT:	SHIELD ALLOY	DRILLERS:	KENNEY, EDWARDS	GROUND ELEVATION:	99.5
CLIENT:	SMC	TRC INSPECTOR:	MCMORROW	LOCATION:	N 257935.01
LOCATION:	NEWFIELD, NJ	DRILLING METHOD:	SPLIT SPOONS		E 1901188.14

DEPTH (FT)	BLOWS	HNU (PPM)	SOIL DESCRIPTION	LITHOLOGY
0 - 2	1 1 2 3		BROWN FINE TO COARSE SAND, LITTLE GRAVEL, TRACE SILT RECOVERY - 12"	0.0
2 - 4	6 7 6 6		SAME AS ABOVE, MOIST RECOVERY - 12"	
4 - 6	5 6 7 12		0-6" SAME AS ABOVE 6-10" BROWN FINE SAND AND SILT, WET 10-14" FINE TO MEDIUM SAND, TRACE SILT	6.0

END OF BORING - 6 FT

ATTACHMENT C
Site Geology Cross Sections & Boring Logs


Area I.D. | NRC Controlled Stockpiled Material
1. Excavated soil mixed with slag
2. Excavated soil from D111
3. Canal slag (In and out of Supersacs)
4. Slag
5. Slag & demolition concrete
6. Hi-Ratio slag
7. Hi-Ratio slag & D111 Flex Kleen Bags & D116 Polishing Compound Contaminated Equipment & Cleaning
8. Baghouse Dust
9. Baghouse dust mixed with slag
LEGEND
PROPERTY LINE
DIRT ROAD
PAVED ROAD
5 FOOT CONTOUR
1 FOOT CONTOUR
FENCE LINE
RAILROAD TRACK
EDGE OF WATER
LIMIT OF BRUSH
LIMIT OF VEGETATION
STOCKPILE AREA
BUILDING
TREE
CATCH BASIN
BORING LOCATION
PROPOSED GEOTECHNICAL BORING LOCATION
HISTORIC MONITORING WELL LOCATION
EXISTING MONITORING WELL /BORING LOCATION
NJ State '83
EDGE OF ENGINEERED BARRIER CLAY LAYER
DENSE VEGETATION
BRUSH
DEBRIS AREA #6
AREA #7 DEBRIS
AREA #4
AREA #5
AREA #9
AREA #3
AREA #8
AREA #1
AREA #2
GB-1
GB-2
GB-3
GB-4
GB-5
A
A'
B
B'
FORMER THERMAL COOLING POND
NOTE: SEE FIGURES C-2 & C-3 FOR SECTIONS.
SOURCE: PHOTOMETRIC SURVEY BY PROMAPS DATED JANUARY 18, 2005.
NOTE: HORIZONTAL DATUM IS NEW JERSEY STATE PLANE COORDINATES NAD '83.
VERTICAL DATUM IS NAVD 88.
0 80' 160'
GRAPHIC SCALE
TRC
21 Griffin Road North
Windsor, CT 06095
(860) 298-9692
SHIELDALLOY METALLURGICAL CORPORATION
NEWFIELD, NEW JERSEY
DECOMMISSIONING PLAN FOR THE NEWFIELD FACILITY
REV. 1B INTERIM
STORAGE YARD
ENGINEERED BARRIER
FIGURE C-1
EXISTING CONDITIONS WITH PROPOSED GEOTECHNICAL BORING LOCATIONS AND SECTION LOCATIONS
Date: 03/23/09
Project No. 105106-000100-000000
J:\CAD\105106\000100\Geotech Inv\
Plate-1.dwg Layout:C-1 11x17 March 24, 2009-2:21PM khollenbeck



SECTION A-A'

NOTE:
SEE FIGURE C-1 FOR SECTION LOCATIONS.

J:\CAD\105106\000100\Geotech Inv\
Plate-1.dwg Layout:C-2 11x17 March 24, 2009-2:40PM khollenbeck

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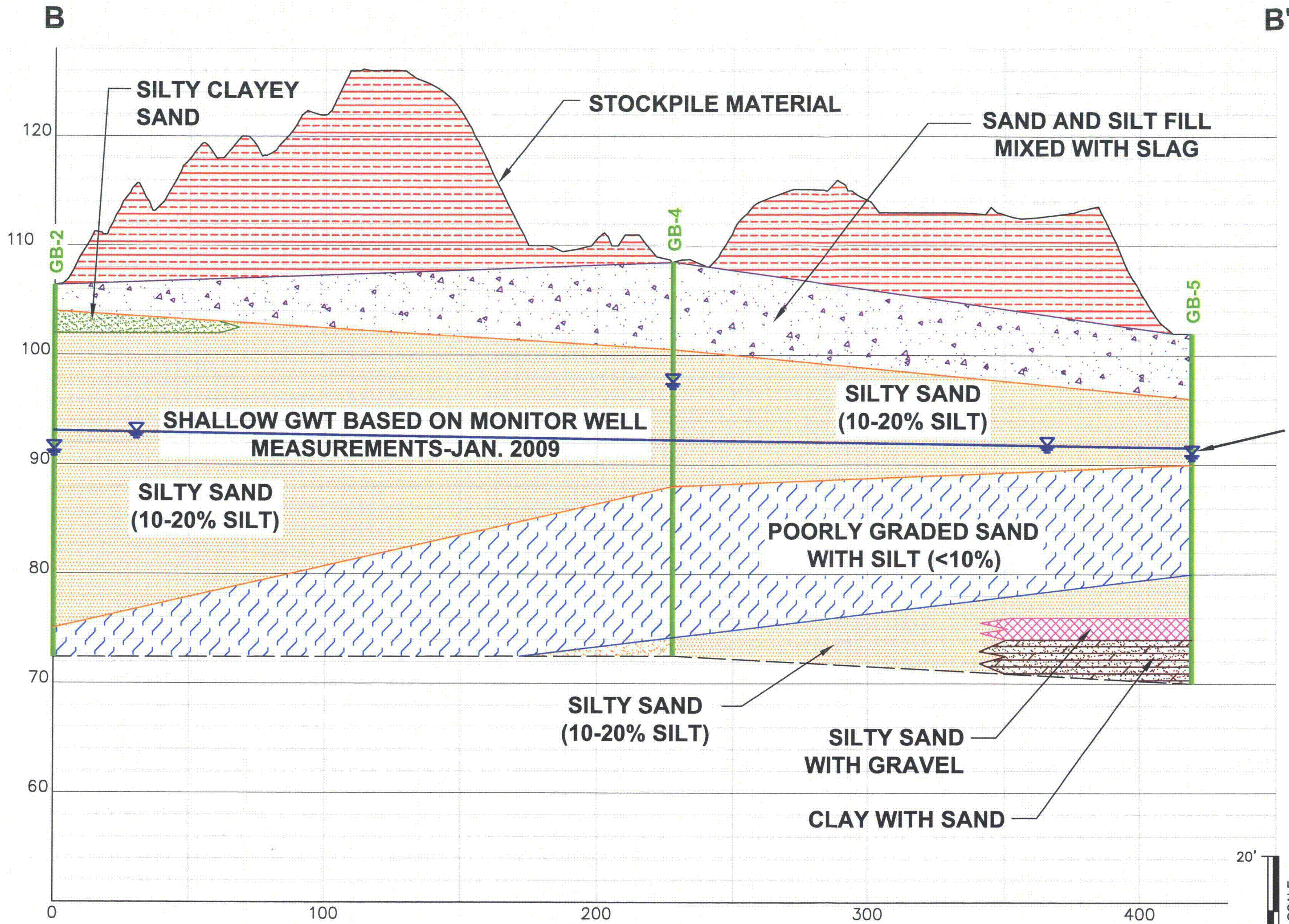
21 Griffin Road North
Windsor, CT 06095
(860) 298-9692

SHIELDALLOY METALLURGICAL CORPORATION
NEWFIELD, NEW JERSEY
DECOMMISSIONING PLAN FOR THE NEWFIELD FACILITY
REV. 1B INTERIM

STORAGE YARD
ENGINEERED BARRIER
FIGURE C-2
SECTION A-A'

Date: 03/23/09 | Project No. 105106-000100-000000



SECTION B-B'

NOTE:
SEE FIGURE C-1 FOR SECTION LOCATIONS.

0 40' 80'
HORIZONTAL GRAPHIC SCALE

20' 10' 0
VERTICLE GRAPHIC SCALE

J:\CAD\105106\000100\Geotech Inv\
Plate-1.dwg Layout:C-3 11x17 March 24, 2009-2:40PM khollenbeck

TRC
21 Griffin Road North
Windsor, CT 06095
(860) 298-9692

SHIELDALLOY METALLURGICAL CORPORATION
NEWFIELD, NEW JERSEY
DECOMMISSIONING PLAN FOR THE NEWFIELD FACILITY
REV. 1B INTERIM

STORAGE YARD
ENGINEERED BARRIER
FIGURE C-3
SECTION B-B'

Date: 03/23/09 | Project No. 105106-000100-000000

PROJECT:

Storage Yard Geotechnical Investigation

GB-1

TRC

BORING LOCATION: SMC Storage Yard		COORDINATES (NJ PLANE SYSTEM - NAD83) EASTERLY: 346,446	NORTHERLY: 258,328
DRILLING CONTRACTOR: Unitech: Mike Conover/Tom Brown		DATE STARTED: 1/28/09	DATE FINISHED: 1/28/09
DRILLING METHOD: Hollow Stem Auger		TOTAL DEPTH (ft.): 34	MEASURING POINT: Ground Surface
DRILLING EQUIPMENT: Track-mounted CME 55 LC		DEPTH TO WATER (ft): 12	GROUND SURFACE ELEVATION (NAVD 88): 102
SAMPLING METHOD: 2" Split-spoon		LOGGED BY: Chris Carlson	

DESCRIPTION

Depth (feet)	Observed Groundwater	Recovery	Blow Counts	Lithology	Field	Laboratory
0		1.5	12 9 11 7		0.0'-2.0' Light brown F-SAND, little silt, little m-sand, trace slag, little concrete, trace wood	0.0'-2.0' Sample not submitted for analysis
		1.1	13 7 6 5		2.0'-4.0' Light green brown F-SAND, trace silt, little m-sand, trace slag, trace wood	2.0'-4.0' Sample not submitted for analysis
5		0.5	2 2 2 3		4.0'-6.0' Light brown F-SAND, little m-sand, trace silt, trace c-sand, trace f-gravel	4.0'-6.0' Poorly graded sand with silt and gravel (SP-SM) (ASTM)
		0.6	7 5 5 4		6.0'-8.0' Orange brown F-M SAND, trace silt, trace clay, little f-gravel (black)	6.0'-8.0' Sample not submitted for analysis
		1.8	5 6 6 9		8.0'-10.0' Orange brown F-M SAND, little c-sand, little clay, little f-gravel	8.0'-10.0' Silty sand (SM) (ASTM)
10		1.1	4 4 6 9		10.0'-12.0' Orange brown F-M SAND, little silt, trace c-sand, trace f-gravel	10.0'-12.0' Silty sand (SM) (ASTM)
	12	1.7	2 3 5 5		12.0'-14.0' Orange yellow-brown F-M SAND, little c-sand, trace silt	12.0'-14.0' Poorly graded sand with silt (SP-SM)(ASTM)
15		2.0	5 8 8 9		14.0'-16.0' Orange yellow-brown M-C SAND, little f-sand, trace silt	14.0'-16.0' Poorly graded sand with silt (SP-SM)(ASTM)
		2.0	10 12 12 14		16.0'-18.0' Yellow brown M-C SAND, little f-sand, trace silt, trace f-gravel	16.0'-18.0' Sample not submitted for analysis
		1.5	9 10 11 11		18.0'-20.0' Orange yellow-brown M-C SAND, little f-sand, trace silt, trace f-gravel	18.0'-20.0' Sample not submitted for analysis
20		1.7	5 6 11 14		20.0'-22.0' Orange yellow-brown F-M SAND, little c-sand, trace silt, trace f-gravel	20.0'-22.0' Silty sand (SM) (ASTM)
		1.9	11 13 17 22		22.0'-24.0' Orange yellow-brown F-M SAND, little c-sand, trace silt, trace f-gravel	22.0'-24.0' Sample not submitted for analysis
25		1.0	9 10 10 15		24.0'-26.0' Yellow brown M-C SAND, little f-sand, little f-gravel, trace silt	24.0'-26.0' Silty sand with gravel (SM) (ASTM)
		0.8	5 3 2 3		26.0'-28.0' Orange yellow-brown M-C SAND, little f-sand, little f-gravel	26.0'-28.0' Poor graded sand (SP) (ASTM)
		1.2	2 2 3 4		28.0'-28.7' Yellow orange-brown M-C SAND, little f-sand, trace clay, trace f-gravel 28.7'-30.0' Light red gray CLAY	28.0'-29.0' Silty sand (SM) (ASTM) 29.0'-30.0' Sample not submitted for analysis
30		1.1	3 2 2 3		30.0'-32.0' Light red-gray CLAY	30.0'-32.0' Fat Clay (CH) (ASTM)
		0.9	4 6 7 12		32.0'-33.0' Light red gray CLAY 33.0'-34.0' Light yellow-brown M-C SAND, little f-sand, trace clay	32.0'-33.0' Sample not submitted for analysis 33.0'-34.0' Silty sand (SM) (ASTM)

PROJECT:

Storage Yard Geotechnical Investigation

GB-2

TRC

BORING LOCATION: SMC Storage Yard		COORDINATES (NJ PLANE SYSTEM - NAD83) EASTERLY: 346,857 NORTHERLY: 258,372	
DRILLING CONTRACTOR: Unitech: Mike Conover/Tom Brown		DATE STARTED: 1/28/09	DATE FINISHED: 1/29/09
DRILLING METHOD: Hollow Stem Auger		TOTAL DEPTH (ft.): 34	MEASURING POINT: Ground Surface
DRILLING EQUIPMENT: Track-mounted CME 55 LC		DEPTH TO WATER (ft): 15	GROUND SURFACE ELEVATION (NAVD 88): 106
SAMPLING METHOD: 2" Split-spoon		LOGGED BY: Chris Carlson	

Depth (feet)	Observed Groundwater	Recovery	Blow Counts	Field Description	Laboratory Description
0		1.8	18 13 14 19	0.0'-0.5' Grey F-GRAVEL, some f-sand 0.5-2.0' Light brown F-SAND, little m-sand, trace slag	0.0'-2.0' Silty sand (SM) (ASTM)
		1.4	8 5 4 7	2.0'-4.0' Brown F-SAND, trace clay, trace silt, trace f-gravel	2.0'-4.0' Silty clayey sand (SC-SM) (ASTM)
5		1.6	3 3 5 5	4.0'-6.0' Orange brown F-SAND, trace clay, tace silt, trace f-gravel	4.0'-6.0' Sample not submitted for analysis
		1.2	4 5 4 5	6.0'-8.0' Orange brown F-SAND, trace c-sand, trace f-gravel	6.0'-8.0' Silty sand (SM) (ASTM)
		1.5	3 4 5 6	8.0'-10.0' Orange brown F-SAND, trace c-sand, trace f-gravel	8.0'-10.0' Poorly graded sand with silt (SP-SM) (ASTM)
10		0.5	1 1 1 4	10.0'-12.0' Orange brown F-SAND, trace m-sand, trace c-sand	10.0'-12.0' Well-graded sand with silt (SW-SM) (ASTM)
		2.0	15 21 22 11	12.0'-14.0' Orange brown F-SAND, little m-sand, trace silt, trace f-gravel	12.0'-14.0' Silty sand (SM) (ASTM)
15	15	1.7	5 7 9 10	14.0'-16.0' Orange brown F-M SAND, little c-sand, trace silt, trace f-gravel	14.0'-16.0' Sample not submitted for analysis
		1.0	7 8 11 9	16.0'-18.0' Orange brown F-M SAND, little c-sand, trace silt, trace f-gravel	16.0'-18.0' Sample not submitted for analysis
		1.2	3 5 5 7	18.0'-20.0' Orange brown F-M SAND, little c-sand, little f-gravel	18.0'-20.0' Silty sand with gravel (SM) (ASTM)
20		1.0	6 4 4 5	20.0'-22.0' Orange brown F-M SAND, little c-sand, little f-gravel	20.0'-22.0' Sample not submitted for analysis
		1.3	4 7 7 7	22.0'-24.0' Orange brown M-C SAND, little f-sand, little f-gravel	22.0'-24.0' Poorly graded sand with silt and gravel (SP-SM) (ASTM)
25		1.0	5 7 6 8	24.0'-26.0' Orange brown M-C SAND, trace f-sand, trace f-gravel	24.0'-26.0' Sample not submitted for analysis
		2.0	4 5 4 6	26.0'-28.0' Orange brown C-SAND, some f-gravel, little f-m sand	26.0'-28.0' Well-graded sand with silt and gravel (SW-SM) (ASTM)
		0.4	12 10 11 12	28.0'-30.0' Orange brown C-SAND, little f-gravel, little f-m sand, trace c-gravel	28.0'-30.0' Sample not submitted for analysis
30		1.5	4 3 5 7	30.0'-30.5' Orange brown M-C SAND, little f-sand, trace f-gravel 30.5'-32.0' Orange gray brown F-M SAND, little c-sand	30.0'-32.0' Well-graded sand with silt (SW-SM) (ASTM)
		1.3	2 5 5 6	32.0'-34.0' Orange brown F-M SAND, little c-sand	32.0'-34.0' Poorly graded sand with silt (SP-SM) (ASTM)

PROJECT:

Storage Yard Geotechnical Investigation

GB-3

TRC

BORING LOCATION: SMC Storage Yard		COORDINATES (NJ PLANE SYSTEM - NAD83) EASTERLY: 347,014	NORTHERLY: 258,151
DRILLING CONTRACTOR: Unitech: Mike Conover/Chuck Searles		DATE STARTED: 1/29/09	DATE FINISHED: 1/29/09
DRILLING METHOD: Hollow Stem Auger		TOTAL DEPTH (ft.): 38	MEASURING POINT: Ground Surface
DRILLING EQUIPMENT: Track-mounted CME 55 LC		DEPTH TO WATER (ft): 19	GROUND SURFACE ELEVATION (NAVD 88): 110
SAMPLING METHOD: 2" Split-spoon		LOGGED BY: Chris Carlson	

DESCRIPTION

Depth (feet)	Observed Groundwater	Recovery (0 1 2)	Blow Counts	Lithology	Field	Laboratory
0		1.7	11 9 9 11		0.0'-0.5' Gray brown F-SAND, some silt, trace f-gravel 0.5'-1.1' Orange brown F-M SAND, trace silt, trace f-gravel 1.1'-2.0' Gray brown F-SAND, trace f-gravel	0.0'-2.0' Well-graded sand with silt and gravel (SW-SM) (ASTM)
		2.0	9 9 12 16		2.0'-2.9' Dark gray brown F-SAND, trace f-gravel 2.9'-4.0' Dark brown F-SAND, little silt, little clay, little f-gravel	2.0'-2.9' Sample not submitted for analysis 2.9'-4.0' Sample not submitted for analysis
5		1.6	9 12 12 18		4.0'-6.0' Dark brown F-SAND, little silt, little clay, trace f-gravel	4.0'-6.0' Silty clayey sand (SC-SM) (ASTM)
		1.7	17 18 22 16		6.0'-6.5' Dark brown F-SAND, little silt, little clay, trace f-gravel 6.5'-8.0' Orange brown F-M SAND, little silt, little clay, trace f-gravel	6.0'-8.0' Clayey sand (SC) (ASTM)
		0.9	14 12 12 13		8.0'-10.0' Dark brown F-SAND, little silt, little clay, trace f-gravel	8.0'-10.0' Sample not submitted for analysis
10		2.0	8 7 6 7		10.0'-11.5' Orange brown F-C SAND, little silt, little clay, trace f-gravel 11.5'-12.0' Orange brown F-SAND, trace m-c sand	10.0'-12.0' Silty sand (SM) (ASTM)
		1.5	7 12 10 9		12.0'-14.0' Orange brown F-M SAND, little c-sand, trace f-gravel	12.0'-14.0' Sample not submitted for analysis
15		1.5	7 9 9 9		14.0'-16.0' Orange brown F-M SAND, little c-sand, trace f-gravel	14.0'-16.0' Sample not submitted for analysis
		1.8	10 6 7 9		16.0'-18.0' Orange brown F-M SAND, little c-sand, trace f-gravel	16.0'-18.0' Silty sand (SM) (ASTM)
	19	1.6	6 8 7 7		18.0'-20.0' Orange brown F-SAND, little m-c sand, trace f-gravel	18.0'-20.0' Sample not submitted for analysis
20		1.8	5 5 5 7		20.0'-22.0' Orange brown M-C SAND, little f-sand, trace silt, trace f-gravel	20.0'-22.0' Silty sand (SM) (ASTM)
		1.5	6 11 8 8		22.0'-24.0' Orange brown M-C SAND, little f-gravel, little f-sand	22.0'-24.0' Sample not submitted for analysis
25		2.0	7 6 8 9		24.0'-26.0' Orange brown M-C SAND, little f-gravel, little f-sand	24.0'-26.0' Poorly graded sand with silt and gravel (SP-SM) (ASTM)
		.3	5 8 10 11		26.0'-28.0' Orange brown C-SAND, little f-m sand, little f-gravel	26.0'-28.0' Sample not submitted for analysis
		1.6	6 8 10 12		28.0'-30.0' Orange brown C-SAND, some f-gravel, little f-m sand	28.0'-30.0' Well-graded sand with silt and gravel (SW-SM) (ASTM)
30		1.6	8 7 7 12		30.0'-32.0' Orange brown C-SAND, some f-gravel, little f-m sand	30.0'-32.0' Sample not submitted for analysis
		1.2	6 6 7 7		32.0'-34.0' Orange brown C-SAND, some f-gravel, little f-m sand	32.0'-34.0' Well-graded sand with silt and gravel (SW-SM) (ASTM)
35		2.0	6 12 12 14		34.0'-35.7' Orange brown C-SAND, some f-gravel, little f-m sand	34.0'-35.7' Sample not submitted for analysis
		2.0	5 10 7 5		35.7'-36.0' Light yellow brown F-M SAND, trace c-sand, trace f-gravel 36.0'-37.1' Orange brown C-SAND, some f-gravel, little f-m sand 37.1'-38.0' Orange brown F-SAND, trace m-c sand, trace f-gravel	35.7'-36.0' Sample not submitted for analysis 36.0'-38.0' Poorly graded sand with silt (SP-SM) (ASTM)

PROJECT: **Storage Yard Geotechnical Investigation**		**GB-4**	TRC
BORING LOCATION: SMC Storage Yard		COORDINATES (NJ PLANE SYSTEM - NAD83) EASTERLY: 346,775	NORTHERLY: 258,159
DRILLING CONTRACTOR: Unitech: Mike Conover/Chuck Searles		DATE STARTED: 1/30/09	DATE FINISHED: 1/30/09
DRILLING METHOD: Hollow Stem Auger		TOTAL DEPTH (ft.): 36	MEASURING POINT: Ground Surface
DRILLING EQUIPMENT: Track-mounted CME 55 LC		DEPTH TO WATER (ft): 11	GROUND SURFACE ELEVATION (NAVD 88): 108
SAMPLING METHOD: 2" Split-spoon		LOGGED BY: Chris Carlson	

DESCRIPTION

Depth (feet)	Recovery	Blow Counts	Field	Laboratory
0.0-2.0	1.2	10, 12, 100/3, --	0.0'-2.0' Gray brown F-SAND & SILT, little f-gravel (slag)	0.0'-2.0' Silty sand with gravel (SM) (ASTM)
2.0-4.0	0	--, --, --, --	2.0'-4.0' NO RECOVERY; Augered through obstruction	2.0'-4.0' No Recovery
4.0-6.0	0.5	3, 5, 5, 8	4.0'-6.0' Gray brown F-SAND & SILT, little f-gravel (slag)	4.0'-6.0' Silty sand with gravel (SM) (ASTM)
6.0-8.0	0.3	2, 2, 3, 2	6.0'-8.0' Gray brown F-SAND & SILT, little f-gravel (slag)	6.0'-8.0' Sample not submitted for analysis
8.0-10.0	0.6	3, 3, 3, 2	8.0'-8.2' Black SLAG 8.2'-10.0' Orange brown F-M SAND, trace c-sand, trace f-gravel	8.0'-10.0' Silty sand (SM) (ASTM)
10.0-12.0	1.4	2, 2, 1, 5	10.0'-12.0' Orange brown F-M SAND, little c-sand, trace f-gravel	10.0'-12.0' Silty sand (SM) (ASTM)
12.0-14.0	1.5	5, 6, 7, 7	12.0'-14.0' Orange brown M-C SAND, little f-sand, trace f-gravel	12.0'-14.0' Sample not submitted for analysis
14.0-16.0	1.4	5, 5, 5, 5	14.0'-16.0' Orange brown M-C SAND, little f-sand, trace f-gravel	14.0'-16.0' Silty sand (SM) (ASTM)
16.0-18.0	1.3	6, 7, 6, 6	16.0'-18.0' Orange brown F-M SAND, little c-sand, trace silt, trace f-gravel	16.0'-18.0' Sample not submitted for analysis
18.0-20.0	0.9	4, 5, 5, 4	18.0'-20.0' Orange brown F-M SAND, little c-sand, trace silt, trace f-gravel	18.0'-20.0' Poorly graded sand with silt (SP-SM) (ASTM)
20.0-22.0	1.0	5, 4, 4, 6	20.0'-22.0' Orange brown F-M SAND, little c-sand, trace silt, trace f-gravel	20.0'-22.0' Sample not submitted for analysis
22.0-24.0	0.9	3, 3, 5, 6	22.0'-24.0' Orange brown F-M SAND, little c-sand, trace silt, trace f-gravel	22.0'-24.0' Poorly graded sand with silt (SP-SM) (ASTM)
24.0-26.0	0.8	3, 5, 6, 8	24.0'-26.0' Orange brown F-M SAND, little c-sand, trace silt, trace f-gravel	24.0'-26.0' Sample not submitted for analysis
26.0-28.0	1.3	4, 6, 7, 9	26.0'-28.0' Orange brown F-M SAND, little c-sand, trace silt, trace f-gravel	26.0'-28.0' Poorly graded sand with silt (SP-SM) (ASTM)
28.0-30.0	0.7	4, 3, 5, 8	28.0'-30.0' Orange brown F-M SAND, little c-sand, trace silt, trace f-gravel	28.0'-30.0' Sample not submitted for analysis
30.0-32.0	0.8	4, 4, 5, 6	30.0'-32.0' Orange brown F-M SAND, little c-sand, trace silt, trace f-gravel	30.0'-32.0' Poorly graded sand with silt (SP-SM) (ASTM)
32.0-34.0	1.0	6, 8, 12, 8	32.0'-32.5' Orange brown F-M SAND, little c-sand, trace silt, trace f-gravel 32.5'-34.0' Orange brown F-SAND, trace m-c sand, trace silt	32.0'-32.5' Sample not submitted for analysis 32.5'-34.0' Sample not submitted for analysis
34.0-36.0	1.3	1, 2, 2, 2	34.0'-36.0' Orange brown F-SAND, trace m-c sand, trace f-gravel, trace silt	34.0'-36.0' Silty sand (SM) (ASTM)

PROJECT: Storage Yard Geotechnical Investigation	GB-5	TRC
BORING LOCATION: SMC Storage Yard	COORDINATES (NJ PLANE SYSTEM - NAD83) EASTERLY: 346,649 NORTHERLY: 258,014	
DRILLING CONTRACTOR: Unitech: Mike Conover/Kinard Lopez	DATE STARTED: 1/29/09	DATE FINISHED: 1/30/09
DRILLING METHOD: Hollow Stem Auger	TOTAL DEPTH (ft.): 32	MEASURING POINT: Ground Surface
DRILLING EQUIPMENT: Track-mounted CME 55 LC	DEPTH TO WATER (ft): 11	GROUND SURFACE ELEVATION (NAVD 88): 102
SAMPLING METHOD: 2" Split-spoon	LOGGED BY: Chris Carlson	

Depth (feet)	Observed Groundwater	Recovery	Blow Counts	Lithology	DESCRIPTION Field	DESCRIPTION Laboratory
0		0.0	5, 6, 50/2, --		0.0'-2.0' NO RECOVERY; Likely due to boulder/slag	0.0'-2.0' No Recovery
		0.5	100/6, --, --, --		2.0'-4.0' Gray F-SAND & SILT, some f-c gravel (pulverized)	2.0'-4.0' Well-graded gravel with silt and sand (GW-GM) (ASTM)
5		0.0	--, --, --, --		4.0'-6.0' NO RECOVERY; Augered through obstruction	4.0'-6.0' No Recovery
		1.7	3, 2, 2, 10		6.0'-8.0' Light brown gray F-SAND, some silt, some clay, trace f-gravel	6.0'-8.0' Silty sand (SM) (ASTM)
		1.8	11, 8		8.0'-8.9' Dark gray black F-SAND, little silt, little clay, trace f-gravel	8.0'-9.0' Sample not submitted for analysis
			10, 10		8.9'-10.0' Orange brown F-M SAND, trace c-sand, trace f-gravel	9.0'-10.0' Silty sand (SM) (ASTM)
10	11	1.5	8, 6, 5, 8		10.0'-12.0' Orange brown F-M SAND, trace c- sand, trace f-gravel	10.0'-12.0' Sample not submitted for analysis
		1.7	4, 5, 5, 7		12.0'-14.0' Orange brown F-M SAND, little c-sand, trace f-gravel	12.0'-14.0' Poorly graded sand with silt (SP-SM) (ASTM)
15		1.7	3, 4, 5, 5		14.0'-16.0' Orange brown F-M SAND, little c-sand, trace f-gravel	14.0'-16.0' Sample not submitted for analysis
		1.9	3, 5, 8, 8		16.0'-18.0' Orange brown F-M SAND, little c-sand, trace f-gravel	16.0'-18.0' Poorly graded sand with silt (SP-SM) (ASTM)
		1.1	7, 5, 7, 8		18.0'-20.0' Orange brown F-M SAND, little c-sand, trace f-gravel	18.0'-20.0' Sample not submitted for analysis
20		1.2	5, 5, 7, 8		20.0'-22.0' Orange brown F-M SAND, little c-sand, trace f-gravel	20.0'-22.0' Poorly graded sand with silt (SP-SM) (ASTM)
		1.2	5, 7, 9, 7		22.0'-24.0' Orange brown F-M SAND, little c-sand, trace f-gravel	22.0'-24.0' Silty sand (SM) (ASTM)
25		1.2	7, 6, 6, 7		24.0'-26.0' Orange brown F-M SAND, little c-sand, trace f-gravel	24.0'-26.0' Sample not submitted for analysis
		1.9	4, 8, 10		26.0'-27.5' Orange brown F-M SAND, little c-sand, trace f-gravel	26.0'-28.0' Silty sand with gravel (SM) (ASTM)
			10		27.5'-28.0' Red gray CLAY, trace f-gravel	
		2.0	4, 5		28.0'-29.0' Orange brown F-M SAND, little c-sand, trace f-gravel	28.0'-29.0' Sample not submitted for analysis
			8, 8		29.0'-30.0' Red gray CLAY	29.0'-30.0' Sample not submitted for analysis
30		1.4	4, 5, 6, 9		30.0'-32.0' Red gray CLAY	30.0'-32.0' Fat clay with sand (CH) (ASTM)

ATTACHMENT D
Geotechnical Laboratory Test Results

GeoTesting
express
a subsidiary of Geocomp Corporation

1145 Massachusetts Avenue
Boxborough, MA 01719
978 635 0424 Tel
978 635 0266 Fax

Transmittal

TO:

Mr. Carl Stopper
TRC Environmental Corp.
21 Griffin Road North
Windsor, CT 06095

DATE: 2/23/09	GTX NO: 8837
RE: SMC Stockyard Geotech Borings Project	

COPIES	DATE	DESCRIPTION
	2/23/09	**February 2009 Laboratory Test Reports**

REMARKS:

SIGNED: Joe

Joe Tomei – Laboratory Manager

APPROVED BY: Mark Dobday

Mark Dobday, P.G. – Laboratory Manager

CC:

GeoTesting
express
a subsidiary of Geocomp Corporation

Boston
Atlanta
New York
www.geocomp.com/geotesting

February 23, 2009

Mr. Carl Stopper
TRC Environmental Corp.
21 Griffin Road North
Windsor, CT 06095

Re: SMC Stockyard Geotech Borings Project (GTX-8837)

Dear Mr. Stopper:

Enclosed are the test results you requested for the above referenced project. GeoTesting Express, Inc. (GTX) received 51 soil samples from you on February 4, 2009. These samples were labeled as follows:

Sample	Depth	Sample	Depth
GB-1	4-6 ft	GB-3	16-18 ft
GB-1	8-10 ft	GB-3	20-22 ft
GB-1	10-12 ft	GB-3	24-26 ft
GB-1	12-14 ft	GB-3	28-30 ft
GB-1	14-16 ft	GB-3	32-34 ft
GB-1	20-22 ft	GB-3	36-38 ft
GB-1	24-26 ft	GB-4	0-2 ft
GB-1	26-28 ft	GB-4	4-6 ft
GB-1	28-29 ft	GB-4	8-10 ft
GB-1	33-34 ft	GB-4	10-12 ft
GB-1 (S)	30-32 ft	GB-4	14-16 ft
GB-2	0-2 ft	GB-4	18-20 ft
GB-2	2-4 ft	GB-4	22-24 ft
GB-2	6-8 ft	GB-4	26-28 ft
GB-2	8-10 ft	GB-4	30-32 ft
GB-2	10-12 ft	GB-4	34-36 ft
GB-2	12-14 ft	GB-5	2-4 ft
GB-2	18-20 ft	GB-5	6-8 ft
GB-2	22-24 ft	GB-5	9-10 ft
GB-2	26-28 ft	GB-5	12-14 ft
GB-2	30-32 ft	GB-5	16-18 ft
GB-2	32-34 ft	GB-5	20-22 ft
GB-3	0-2 ft	GB-5	22-24 ft
GB-3	4-6 ft	GB-5	26-28 ft
GB-3	6-8 ft	GB-5	30-32 ft
GB-3	10-12 ft		

GTX performed the following tests on these samples:

9 Grain Size Analyses (ASTM D 422) – sieve portion only
42 Grain Size Analyses (ASTM D 422) with Hydrometer
50 Atterberg Limits (ASTM D 4318)

51 USCS Soil Classifications (ASTM D 2487)
1 Incremental Consolidation Test (ASTM D 2435)
1 Three-Point CU Triaxial Shear Test Series (ASTM D 4767)
1 Shelby Tube X-Ray (ASTM D 4452)

As requested, the hydrometer portion of the grain size analysis was only performed if the sample contained greater than 10% passing the No. 200 sieve. A copy of your test request is attached.

The results presented in this report apply only to the item tested. This report shall not be reproduced except in full, without written approval from GeoTesting Express. The remainder of the sample will be retained for a period of sixty (60) days and will then be discarded unless otherwise notified by you. Please call me if you have any questions or require additional information. Thank you for allowing GeoTesting Express the opportunity of providing you with testing services. We look forward to working with you again in the future.

Respectfully yours,

Joe Tomei
Laboratory Manager

GeoTesting
express
a subsidiary of Geocomp Corporation

1145 Massachusetts Avenue
Boxborough, MA 01719
978 635 0424 Tel
978 635 0266 Fax

Geotechnical Test Report

February 23, 2009

GTX-8837
SMC Stockyard
Geotech Borings
Project

Newfield, NJ

Prepared for:

TRC Environmental Corp.

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	---	Tested By:	ap
Sample ID:	---	Test Date:	02/18/09	Checked By:	jdt
Depth :	---	Test Id:	146580		

USCS Classification - ASTM D 2487-06

Boring ID	Sample ID	Depth	Group Name	Group Symbol	Gravel, %	Sand, %	Fines, %
---	GB-1	4-6 ft	Poorly graded sand with silt and gravel	SP-SM	43.4	47.0	9.6
---	GB-1	8-10 ft	Silty sand	SM	13.0	72.8	14.2
---	GB-1	10-12 ft	Silty sand	SM	9.5	77.8	12.7
---	GB-1	12-14 ft	Poorly graded sand with silt	SP-SM	1.3	87.6	11.1
---	GB-1	14-16 ft	Poorly graded sand with silt	SP-SM	1.5	87.2	11.3

Remarks: Grain Size analysis performed by ASTM D422, results enclosed
Atterbeg Limits performed by ASTM 4318, results enclosed

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: ---	Tested By:	ap
Sample ID:---	Test Date: 02/18/09	Checked By:	jdt
Depth : ---	Test Id: 146585		

USCS Classification - ASTM D 2487-06

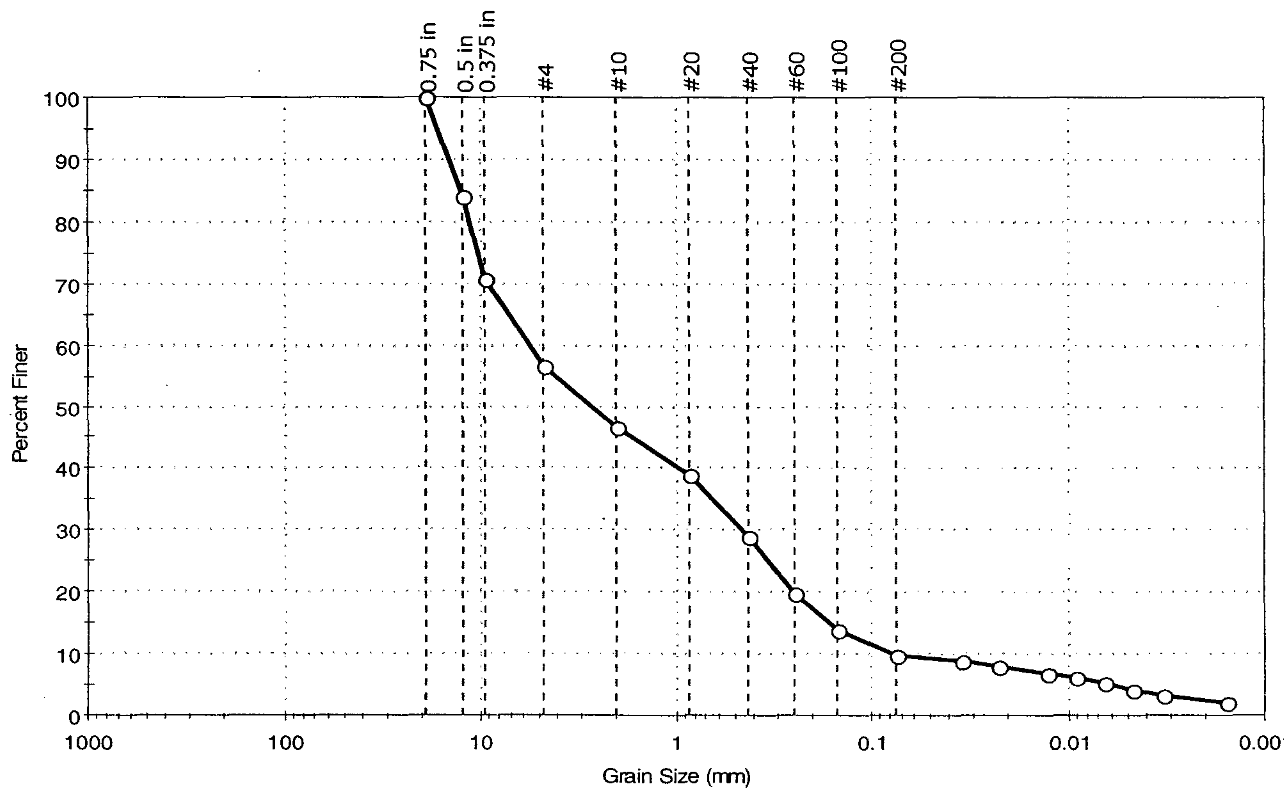
Boring ID	Sample ID	Depth	Group Name	Group Symbol	Gravel, %	Sand, %	Fines, %
---	GB-1	20-22 ft	Silty sand	SM	2.4	84.9	12.7
---	GB-1	24-26 ft	Silty sand with gravel	SM	15.9	72.0	12.1
---	GB-1	26-28 ft	Poorly graded sand	SP	10.6	87.9	1.5
---	GB-1	28-29 ft	Silty sand	SM	1.3	80.9	17.8
---	GB-1	33-34 ft	Silty sand	SM	0.0	80.7	19.3

Remarks: Grain Size analysis performed by ASTM D422, results enclosed
Atterbeg Limits performed by ASTM 4318, results enclosed

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-1	Test Date: 02/11/09	Checked By:	jdt
Depth : 4-6 ft	Test Id: 146476		
Test Comment: ---			
Sample Description: Moist, dark yellowish brown sand with silt and gravel			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	43.4	47.0	9.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	84		
0.375 in	9.50	71		
#4	4.75	57		
#10	2.00	47		
#20	0.85	39		
#40	0.42	29		
#60	0.25	20		
#100	0.15	14		
#200	0.075	10		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0347	9		
---	0.0228	8		
---	0.0129	7		
---	0.0093	6		
---	0.0066	5		
---	0.0047	4		
---	0.0033	3		
---	0.0016	2		

Coefficients

D_{85} =12.8300 mm D_{30} =0.4582 mm

D_{60} =5.6014 mm D_{15} =0.1640 mm

D_{50} =2.6625 mm D_{10} =0.0799 mm

C_u =70.105 C_c =0.469

Classification

ASTM Poorly graded sand with silt and gravel (SP-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-1	Test Date:	02/11/09	Checked By:	jdt
Depth :	4-6 ft	Test Id:	146526		

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

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-1	---	4-6 ft	23	n/a	n/a	n/a	n/a	Poorly graded sand with silt and gravel (SP-SM)

71% Retained on #40 Sieve
Dry Strength: NONE
Dilentancy: RAPID
Toughness: n/a
The sample was determined to be Non-Plastic

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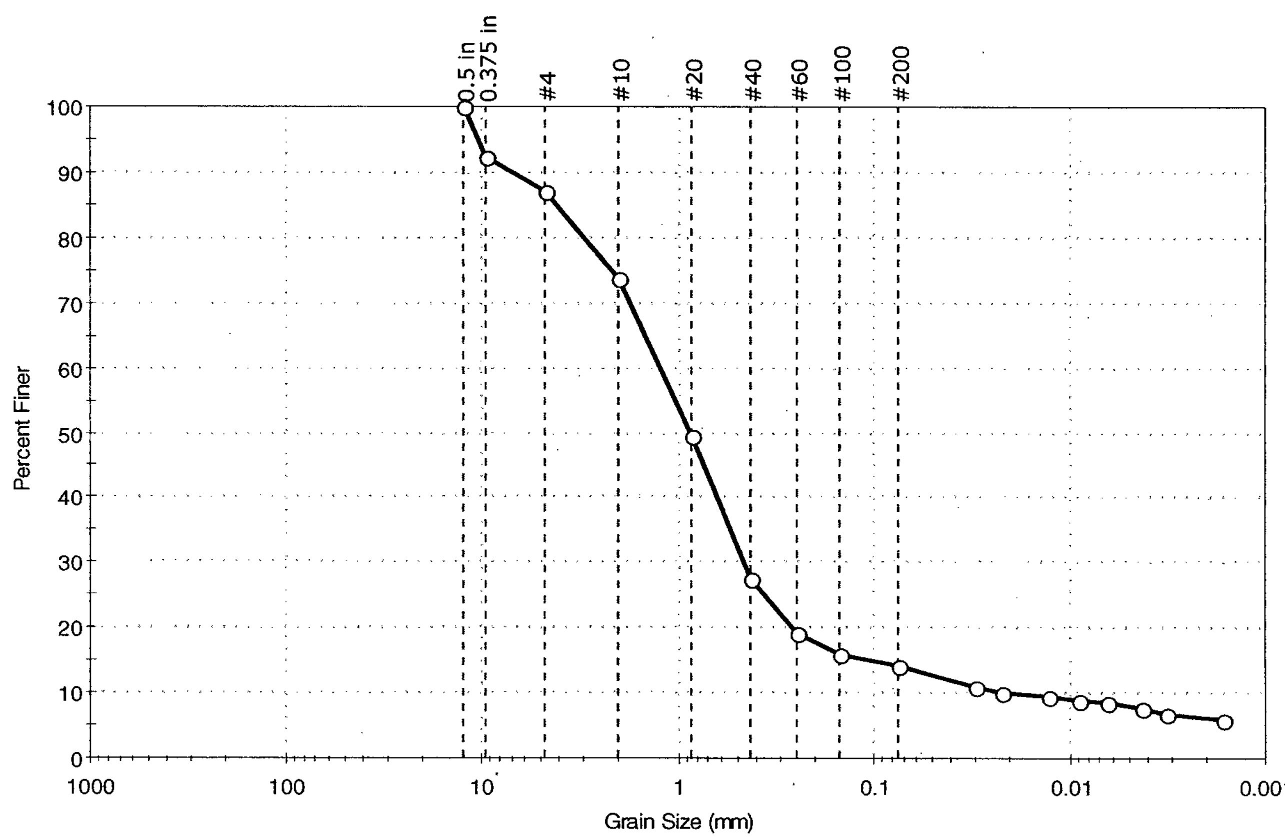
GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.		
Project:	SMC Stockyard Geotech Borings		
Location:	Newfield, NJ	Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-1	Test Date: 02/16/09	Checked By:	jdt
Depth : 8-10 ft	Test Id: 146477		
Test Comment:	---		
Sample Description:	Moist, yellowish brown silty sand		
Sample Comment:	---		

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	13.0	72.8	14.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	92		
#4	4.75	87		
#10	2.00	74		
#20	0.85	50		
#40	0.42	28		
#60	0.25	19		
#100	0.15	16		
#200	0.075	14		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0303	11		
---	0.0220	10		
---	0.0128	9		
---	0.0089	9		
---	0.0064	8		
---	0.0043	8		
---	0.0032	7		
---	0.0017	6		

Coefficients

D_{85} =4.1714 mm | D_{30} =0.4596 mm

D_{60} =1.2264 mm | D_{15} =0.1020 mm

D_{50} =0.8609 mm | D_{10} =0.0197 mm

C_u =N/A | C_c =N/A

Classification

ASTM Silty sand (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-1	Test Date:	02/16/09	Checked By:	jdt
Depth :	8-10 ft	Test Id:	146527		
Test Comment:	---				
Sample Description:	Moist, yellowish brown silty sand				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
✳	GB-1	---	8-10 ft	12	n/a	n/a	n/a	n/a	Silty sand (SM)

72% Retained on #40 Sieve

Dry Strength: MEDIUM

Dilentancy: RAPID

Toughness: n/a

The sample was determined to be Non-Plastic

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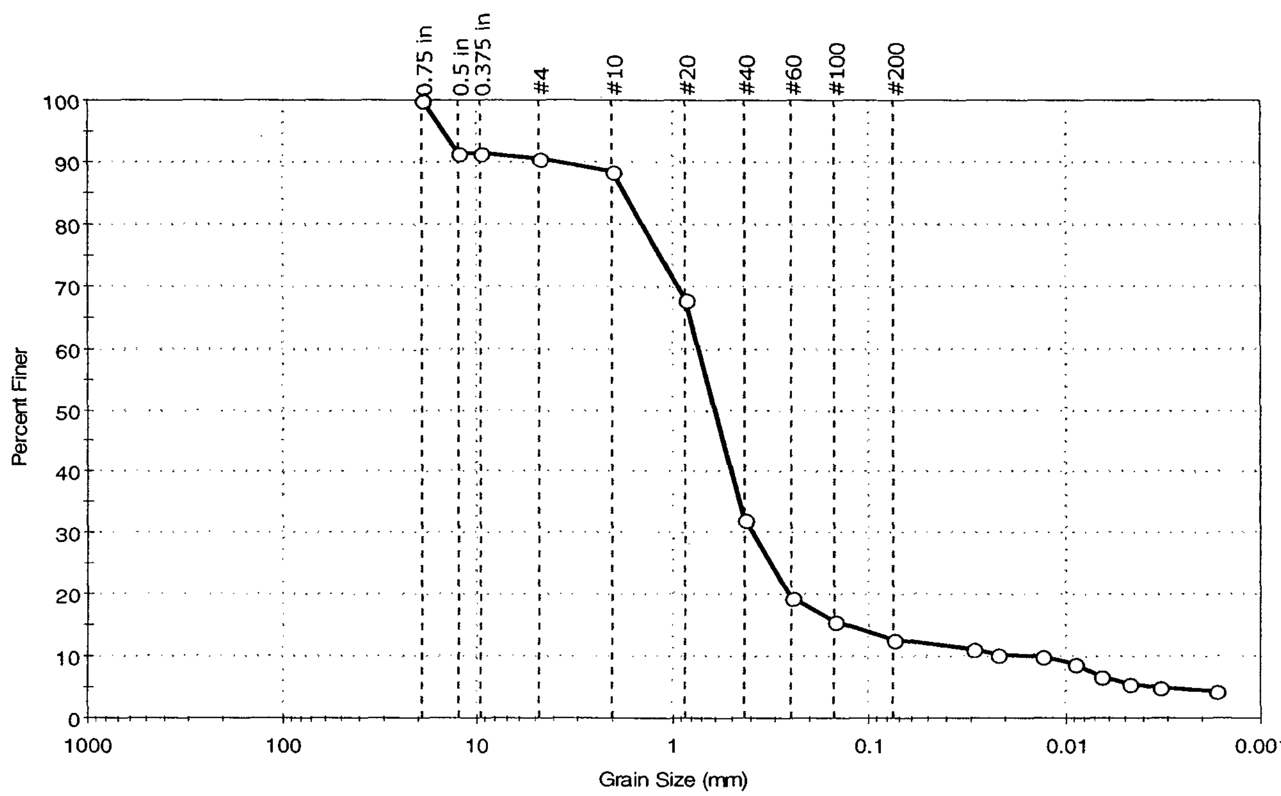
GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-1	Test Date: 02/16/09	Checked By:	jdt
Depth : 10-12 ft	Test Id: 146478		

Test Comment: ---
Sample Description: Moist, reddish brown silty sand
Sample Comment: ---

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	9.5	77.8	12.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	92		
0.375 in	9.50	92		
#4	4.75	90		
#10	2.00	88		
#20	0.85	68		
#40	0.42	32		
#60	0.25	19		
#100	0.15	16		
#200	0.075	13		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0300	11		
---	0.0222	10		
---	0.0130	10		
---	0.0091	9		
---	0.0065	7		
---	0.0047	6		
---	0.0033	5		
---	0.0017	4		

Coefficients

D_{85} =1.7385 mm	D_{30} =0.3894 mm
D_{60} =0.7311 mm	D_{15} =0.1288 mm
D_{50} =0.6019 mm	D_{10} =0.0130 mm
C_u =N/A	C_c =N/A

Classification

ASTM Silty sand (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-1	Test Date:	02/16/09	Checked By:	jdt
Depth :	10-12 ft	Test Id:	146528		
Test Comment:	---				
Sample Description:	Moist, reddish brown silty sand				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-1	---	10-12 ft	20	n/a	n/a	n/a	n/a	Silty sand (SM)

68% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

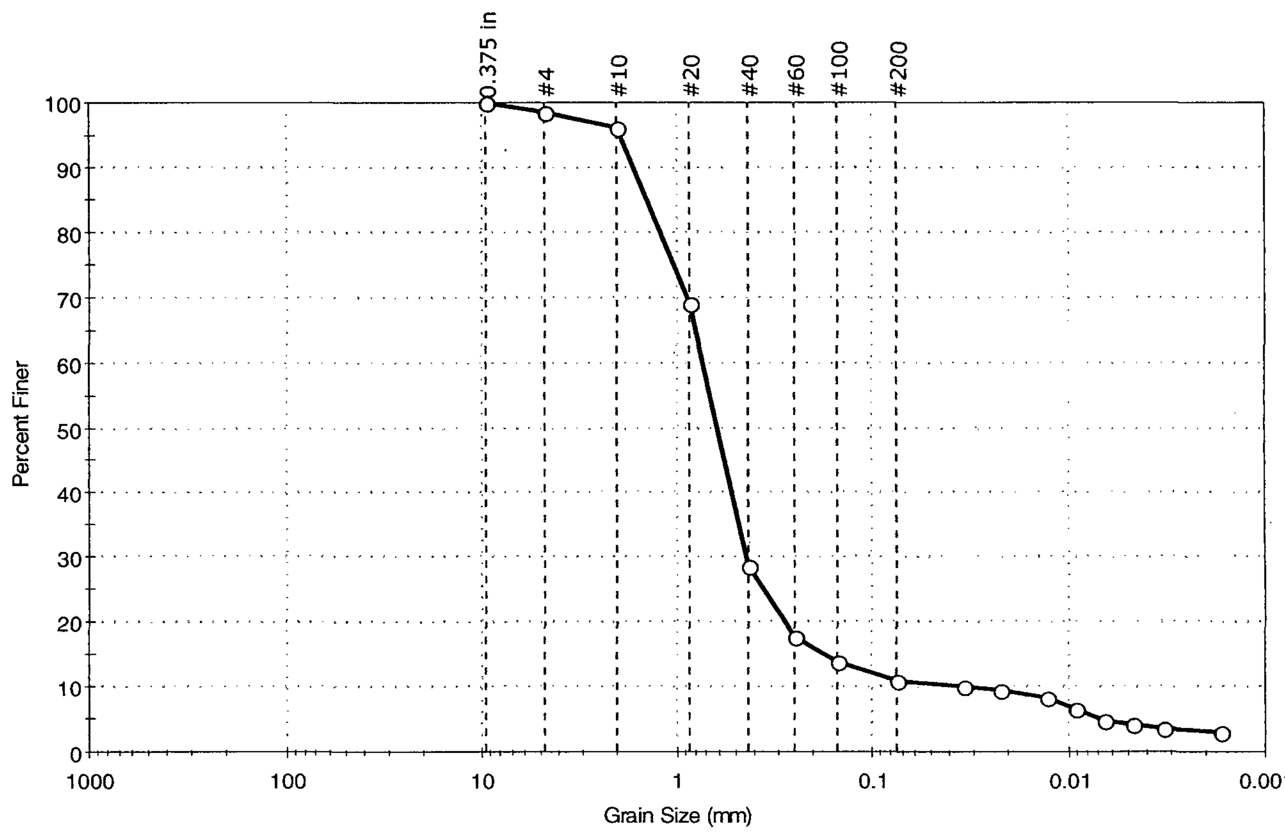
Toughness: n/a

The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.		
Project:	SMC Stockyard Geotech Borings		
Location:	Newfield, NJ	Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-1	Test Date: 02/16/09	Checked By:	jdt
Depth : 12-14 ft	Test Id: 146479		
Test Comment:	---		
Sample Description:	Moist, reddish brown sand with silt		
Sample Comment:	---		

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	1.3	87.6	11.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	96		
#20	0.85	69		
#40	0.42	29		
#60	0.25	18		
#100	0.15	14		
#200	0.075	11		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0341	10		
---	0.0224	9		
---	0.0129	8		
---	0.0093	6		
---	0.0066	5		
---	0.0047	4		
---	0.0033	3		
---	0.0017	3		

Coefficients

D_{85} =1.4120 mm | D_{30} =0.4346 mm
D_{60} =0.7290 mm | D_{15} =0.1746 mm
D_{50} =0.6135 mm | D_{10} =0.0365 mm
C_u =19.973 | C_c =7.098

Classification

ASTM Poorly graded sand with silt (SP-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

printed 2/18/2009 10:29:46 AM

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID:GB-1	Test Date: 02/16/09	Checked By:	jdt
Depth : 12-14 ft	Test Id: 146529		
Test Comment: ---			
Sample Description: Moist, reddish brown sand with silt			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-1	---	12-14 ft	20	n/a	n/a	n/a	n/a	Poorly graded sand with silt (SP-SM)

71% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

Toughness: n/a

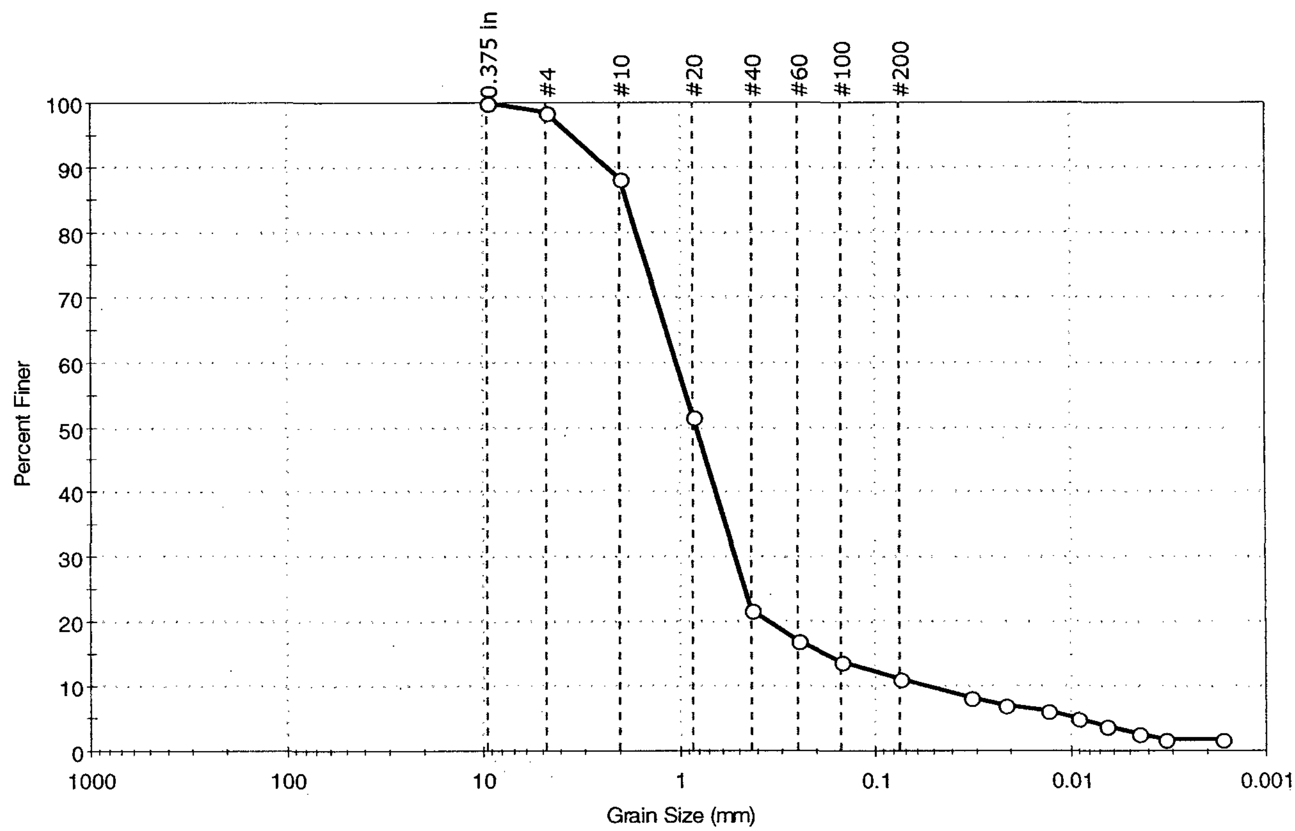
The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	jbr
Sample ID:	GB-1	Test Date:	02/16/09	Checked By:	jdt
Depth :	14-16 ft	Test Id:	146480		

Test Comment: ---
Sample Description: Moist, brownish yellow sand with silt
Sample Comment: ---

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	1.5	87.2	11.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	88		
#20	0.85	51		
#40	0.42	22		
#60	0.25	17		
#100	0.15	14		
#200	0.075	11		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0325	8		
---	0.0219	7		
---	0.0132	6		
---	0.0093	5		
---	0.0066	4		
---	0.0045	3		
---	0.0033	2		
---	0.0017	2		

Coefficients

D_{85} = 1.8551 mm D_{30} = 0.5143 mm
D_{60} = 1.0363 mm D_{15} = 0.1766 mm
D_{50} = 0.8208 mm D_{10} = 0.0528 mm
C_u = 19.627 C_c = 4.834

Classification

ASTM Poorly graded sand with silt (SP-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-1	Test Date:	02/16/09	Checked By:	jdt
Depth :	14-16 ft	Test Id:	146530		

Test Comment: ---
Sample Description: Moist, brownish yellow sand with silt
Sample Comment: ---

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-1	---	14-16 ft	20	n/a	n/a	n/a	n/a	Poorly graded sand with silt (SP-SM)

78% Retained on #40 Sieve
Dry Strength: NONE
Dilentancy: RAPID
Toughness: n/a
The sample was determined to be Non-Plastic

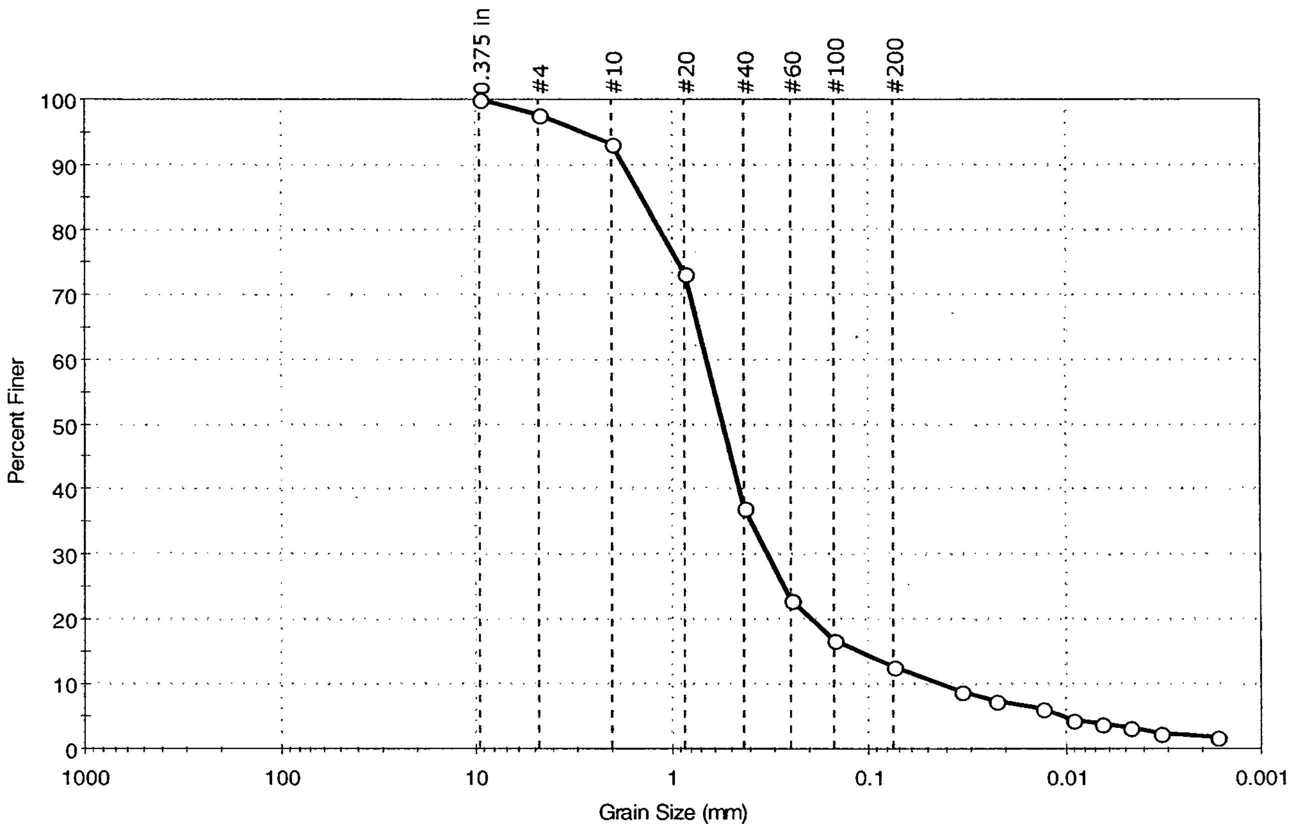
printed 2/18/2009 12:41:05 PM

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-1	Test Date: 02/16/09	Checked By:	jdt
Depth : 20-22 ft	Test Id: 146481		

Test Comment: ---
Sample Description: Moist, reddish brown silty sand
Sample Comment: ---

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	2.4	84.9	12.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	98		
#10	2.00	93		
#20	0.85	73		
#40	0.42	37		
#60	0.25	23		
#100	0.15	17		
#200	0.075	13		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0340	9		
---	0.0226	7		
---	0.0131	6		
---	0.0093	4		
---	0.0066	4		
---	0.0047	3		
---	0.0033	2		
---	0.0017	2		

Coefficients

D_{85} =1.4024 mm — D_{30} =0.3260 mm
D_{60} =0.6589 mm — D_{15} =0.1103 mm
D_{50} =0.5440 mm — D_{10} =0.0439 mm
C_u =N/A — C_c =N/A

Classification

ASTM Silty sand (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-1	Test Date:	02/16/09	Checked By:	jdt
Depth :	20-22 ft	Test Id:	146531		
Test Comment:	---				
Sample Description:	Moist, reddish brown silty sand				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-1	---	20-22 ft	18	n/a	n/a	n/a	n/a	Silty sand (SM)

63% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

Toughness: n/a

The sample was determined to be Non-Plastic

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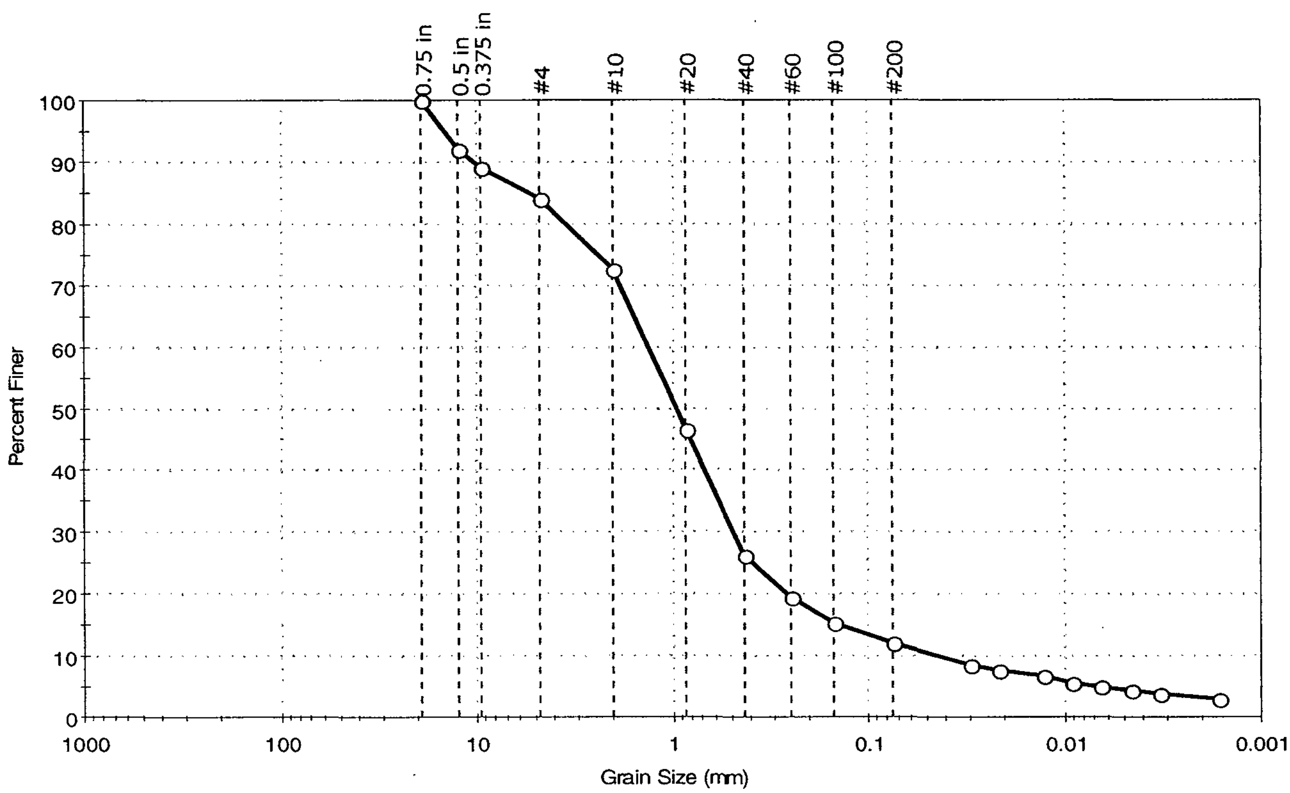
GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-1	Test Date: 02/16/09	Checked By:	jdt
Depth : 24-26 ft	Test Id: 146482		

Test Comment: ---
Sample Description: Moist, brownish yellow silty sand with gravel
Sample Comment: ---

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	15.9	72.0	12.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	92		
0.375 in	9.50	89		
#4	4.75	84		
#10	2.00	73		
#20	0.85	47		
#40	0.42	26		
#60	0.25	19		
#100	0.15	15		
#200	0.075	12		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0304	9		
---	0.0218	8		
---	0.0130	7		
---	0.0092	6		
---	0.0065	5		
---	0.0046	4		
---	0.0033	4		
---	0.0017	3		

Coefficients

D_{85} =5.3947 mm D_{30} =0.4816 mm
D_{60} =1.3247 mm D_{15} =0.1437 mm
D_{50} =0.9527 mm D_{10} =0.0440 mm
C_u =N/A C_c =N/A

Classification

ASTM Silty sand with gravel (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED
Sand/Gravel Hardness : HARD

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GeoTesting express
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Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-1	Test Date:	02/16/09	Checked By:	jdt
Depth :	24-26 ft	Test Id:	146532		
Test Comment:	---				
Sample Description:	Moist, brownish yellow silty sand with gravel				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-1	---	24-26 ft	12	n/a	n/a	n/a	n/a	Silty sand with gravel (SM)

74% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

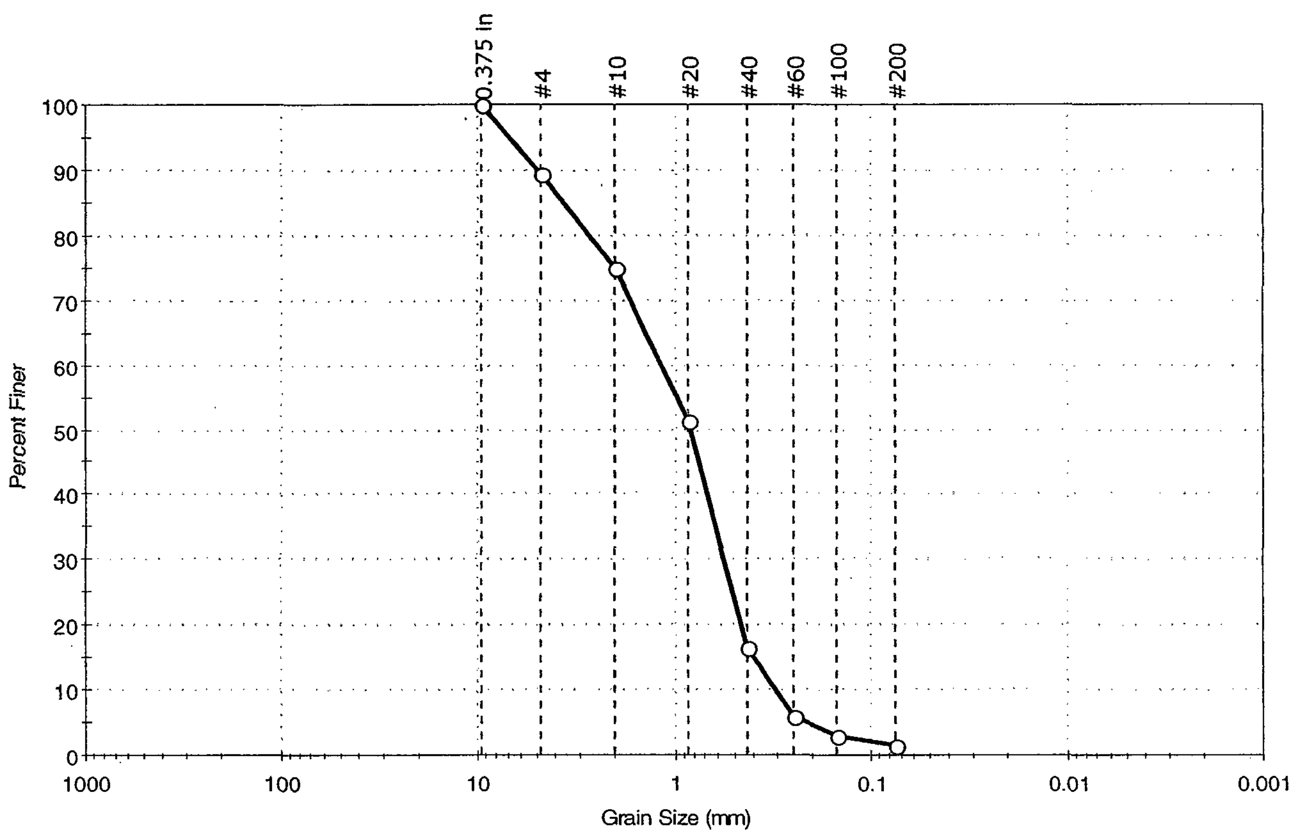
Toughness: n/a

The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.		
Project:	SMC Stockyard Geotech Borings		
Location:	Newfield, NJ	Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-1	Test Date: 02/16/09	Checked By:	jdt
Depth : 26-28 ft	Test Id: 146483		
Test Comment:	Less than 10% fines, Hydrometer not performed		
Sample Description:	Moist, yellowish red sand		
Sample Comment:	Less than 5% fines, Atterberg Limits not performed		

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	10.6	87.9	1.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	89		
#10	2.00	75		
#20	0.85	51		
#40	0.42	17		
#60	0.25	6		
#100	0.15	3		
#200	0.075	1		

Coefficients

D_{85} =3.6461 mm D_{30} =0.5555 mm
D_{60} =1.1609 mm D_{15} =0.3941 mm
D_{50} =0.8262 mm D_{10} =0.3071 mm
C_u =3.780 C_c =0.866

Classification

ASTM   Poorly graded sand (SP)

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

Sample/Test Description

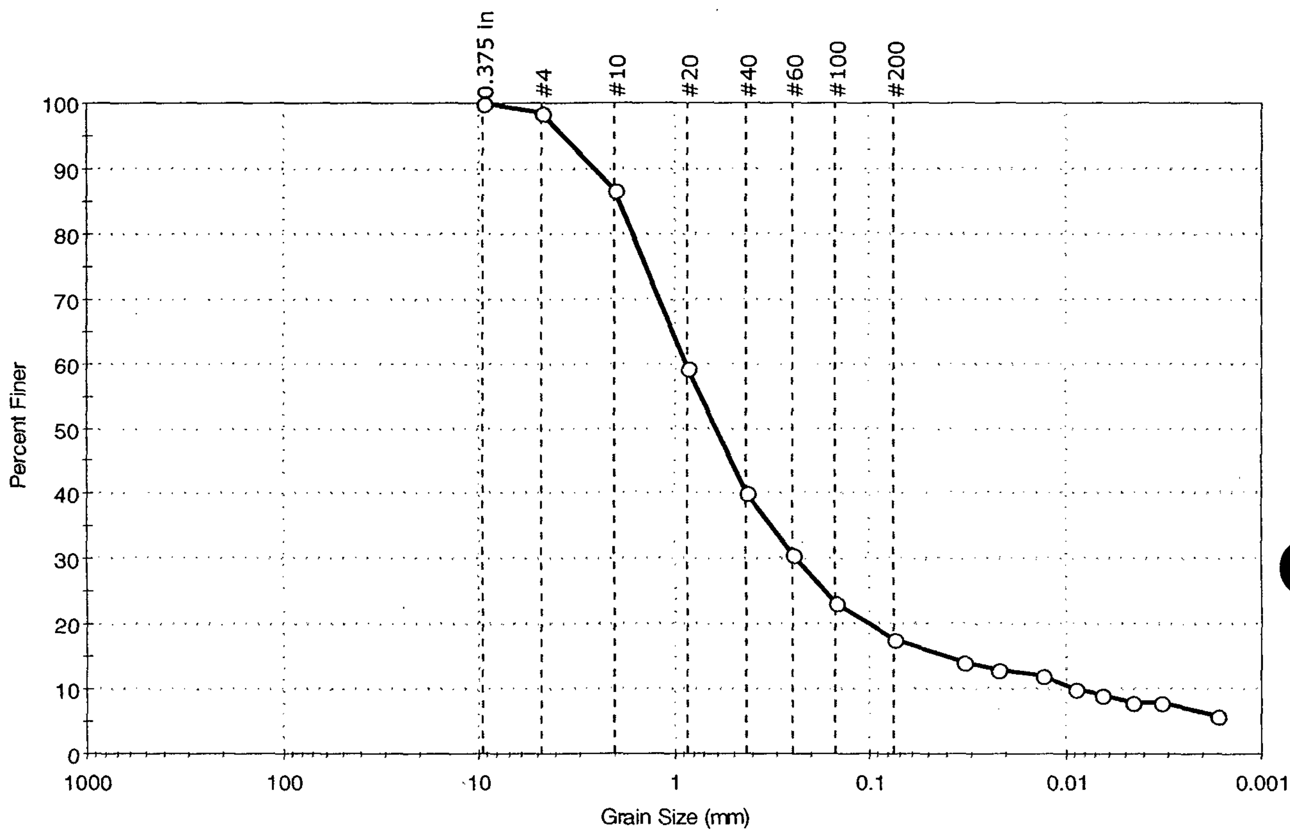
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-1	Test Date: 02/16/09	Checked By:	jdt
Depth : 28-29 ft	Test Id: 146484		
Test Comment: ---			
Sample Description: Moist, yellowish brown silty sand			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	1.3	80.9	17.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	87		
#20	0.85	59		
#40	0.42	40		
#60	0.25	31		
#100	0.15	23		
#200	0.075	18		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0335	14		
---	0.0225	13		
---	0.0132	12		
---	0.0091	10		
---	0.0066	9		
---	0.0046	8		
---	0.0033	8		
---	0.0017	6		

Coefficients

D_{85} =1.9005 mm	D_{30} =0.2383 mm
D_{60} =0.8708 mm	D_{15} =0.0413 mm
D_{50} =0.6087 mm	D_{10} =0.0090 mm
C_u =N/A	C_c =N/A

Classification

ASTM Silty sand (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-1	Test Date:	02/16/09	Checked By:	jdt
Depth :	28-29 ft	Test Id:	146534		
Test Comment:	---				
Sample Description:	Moist, yellowish brown silty sand				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-1	---	28-29 ft	19	n/a	n/a	n/a	n/a	Silty sand (SM)

60% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

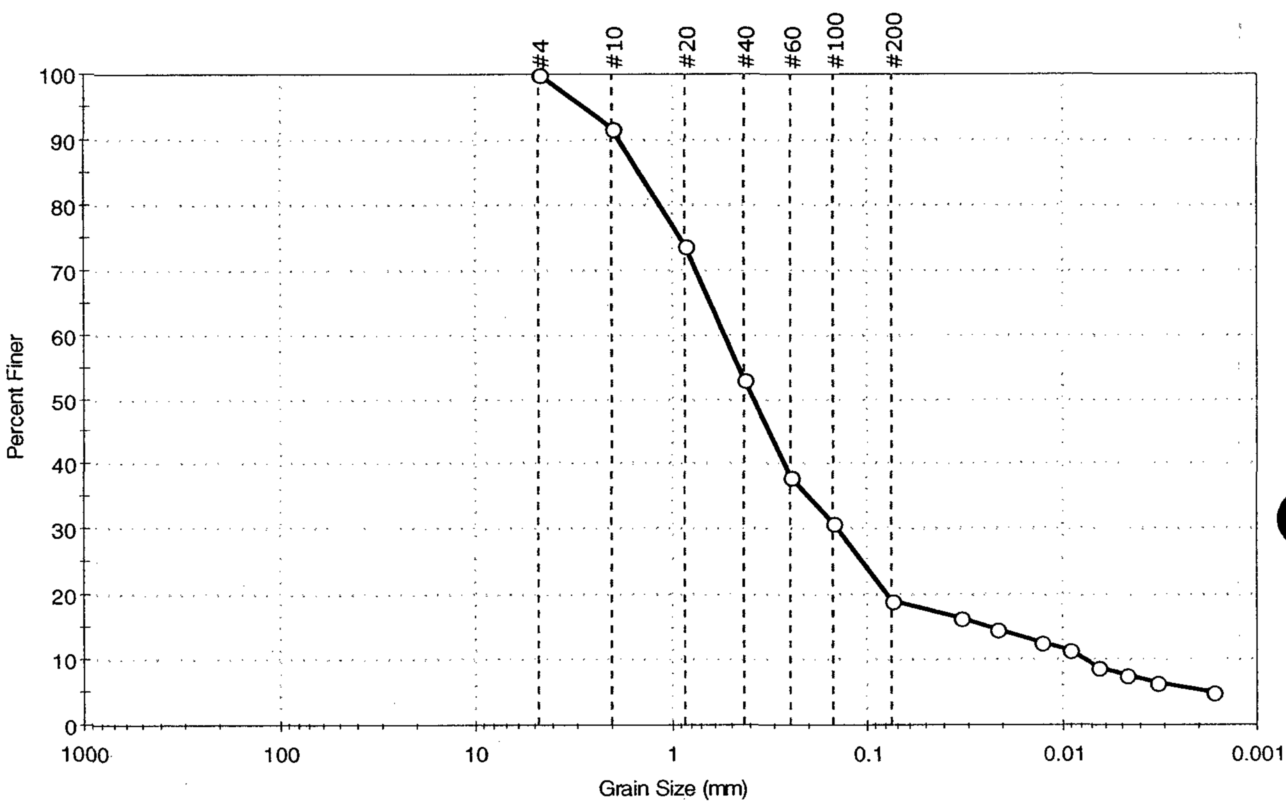
Toughness: n/a

The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	jbr
Sample ID:	GB-1	Test Date:	02/16/09	Checked By:	jdt
Depth :	33-34 ft	Test Id:	146485		
Test Comment:	---				
Sample Description:	Moist, yellow silty sand				
Sample Comment:	---				

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	—	80.7	19.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	92		
#20	0.85	74		
#40	0.42	53		
#60	0.25	38		
#100	0.15	31		
#200	0.075	19		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0334	17		
---	0.0216	15		
---	0.0130	13		
---	0.0093	11		
---	0.0065	9		
---	0.0047	8		
---	0.0033	6		
---	0.0017	5		

Coefficients

D_{85} = 1.4551 mm D_{30} = 0.1418 mm
D_{60} = 0.5343 mm D_{15} = 0.0235 mm
D_{50} = 0.3798 mm D_{10} = 0.0076 mm
C_u = N/A C_c = N/A

Classification

ASTM   Silty sand (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
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Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID:GB-1	Test Date: 02/16/09	Checked By:	jdt
Depth : 33-34 ft	Test Id: 146535		
Test Comment: ---			
Sample Description: Moist, yellow silty sand			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-1	---	33-34 ft	13	n/a	n/a	n/a	n/a	Silty sand (SM)

47% Retained on #40 Sieve

Dry Strength: HIGH

Dilentancy: SLOW

Toughness: n/a

The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	---	Tested By:	ap
Sample ID:	---	Test Date:	02/17/09	Checked By:	jdt
Depth :	---	Test Id:	146591		

USCS Classification - ASTM D 2487-06

Boring ID	Sample ID	Depth	Group Name	Group Symbol	Gravel, %	Sand, %	Fines, %
---	GB-2	0-2 ft	Silty sand	SM	9.5	71.6	18.9
---	GB-2	2-4 ft	Silty, clayey sand	SC-SM	3.7	69.1	27.2
---	GB-2	6-8 ft	Silty sand	SM	0.3	86.6	13.1
---	GB-2	8-10 ft	Poorly graded sand with silt	SP-SM	0.6	89.2	10.2
---	GB-2	10-12 ft	Well-graded sand with silt	SW-SM	4.8	85.0	10.2
---	GB-2	12-14 ft	Silty sand	SM	2.2	77.6	20.2

Remarks: Grain Size analysis performed by ASTM D422, results enclosed
Atterbeg Limits performed by ASTM 4318, results enclosed

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID: ---		Sample Type: ---		Tested By:	ap
Sample ID:---		Test Date:	02/16/09	Checked By:	jdt
Depth : ---		Test Id:	146596		

USCS Classification - ASTM D 2487-06

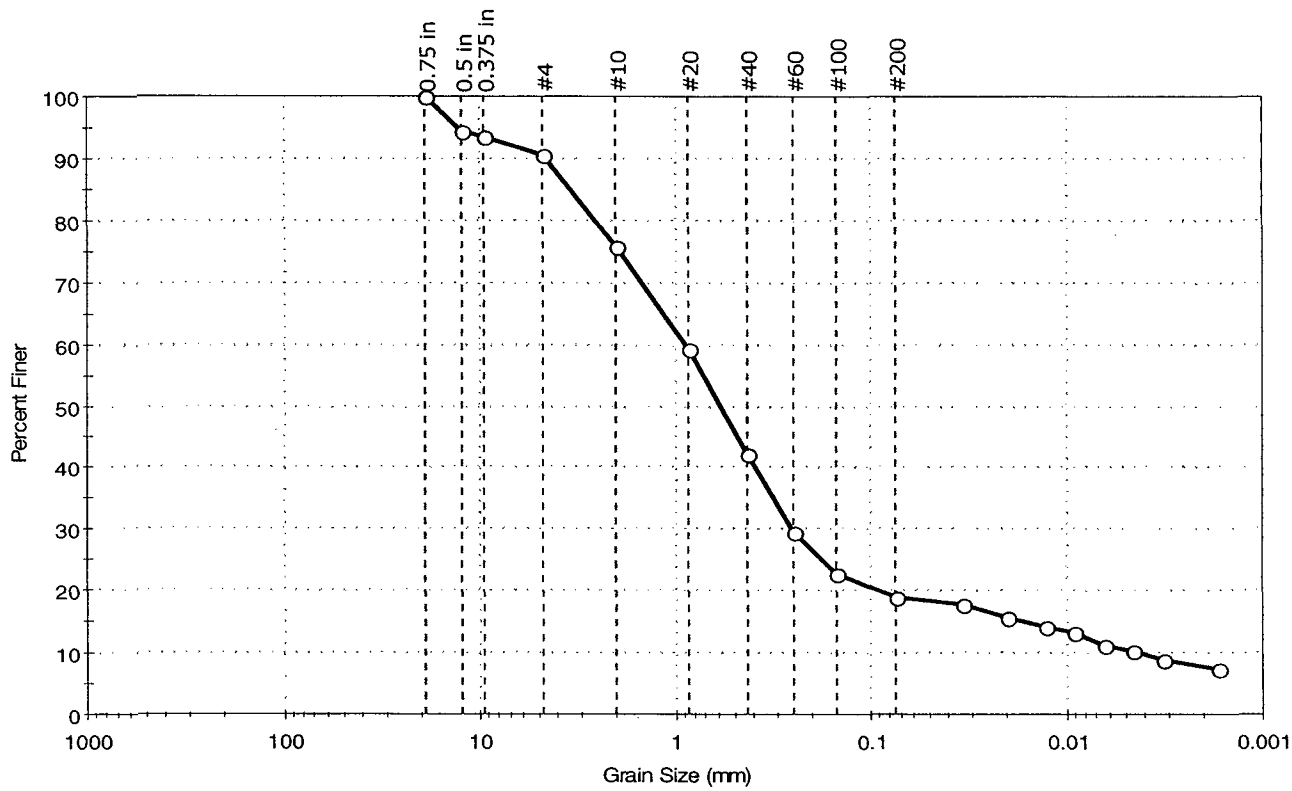
Boring ID	Sample ID	Depth	Group Name	Group Symbol	Gravel, %	Sand, %	Fines, %
---	GB-2	18-20 ft	Silty sand with gravel	SM	24.9	62.7	12.4
---	GB-2	22-24 ft	Poorly graded sand with silt and gravel	SP-SM	20.6	69.0	10.4
---	GB-2	26-28 ft	Well-graded sand with silt and gravel	SW-SM	31.9	58.4	9.7
---	GB-2	30-32 ft	Well-graded sand with silt	SW-SM	12.7	77.0	10.3
---	GB-2	32-34 ft	Poorly graded sand with silt	SP-SM	1.4	91.8	6.8

Remarks: Grain Size analysis performed by ASTM D422, results enclosed
Atterbeg Limits performed by ASTM 4318, results enclosed

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	jbr
Sample ID:	GB-2	Test Date:	02/16/09	Checked By:	jdt
Depth :	0-2 ft	Test Id:	146486		
Test Comment:	---				
Sample Description:	Moist, yellowish brown silty sand				
Sample Comment:	---				

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	9.5	71.6	18.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	94		
0.375 in	9.50	94		
#4	4.75	91		
#10	2.00	76		
#20	0.85	59		
#40	0.42	42		
#60	0.25	30		
#100	0.15	23		
#200	0.075	19		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0340	18		
---	0.0202	16		
---	0.0128	14		
---	0.0091	13		
---	0.0065	11		
---	0.0046	10		
---	0.0032	9		
---	0.0017	7		

Coefficients

D_{85} = 3.4286 mm	D_{30} = 0.2542 mm
D_{60} = 0.8770 mm	D_{15} = 0.0168 mm
D_{50} = 0.5834 mm	D_{10} = 0.0042 mm
C_u = N/A	C_c = N/A

Classification

ASTM Silty sand (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID:GB-2	Test Date: 02/16/09	Checked By:	jdt
Depth : 0-2 ft	Test Id: 146536		
Test Comment: ---			
Sample Description: Moist, yellowish brown silty sand			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-2	---	0-2 ft	12	n/a	n/a	n/a	n/a	Silty sand (SM)

58% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

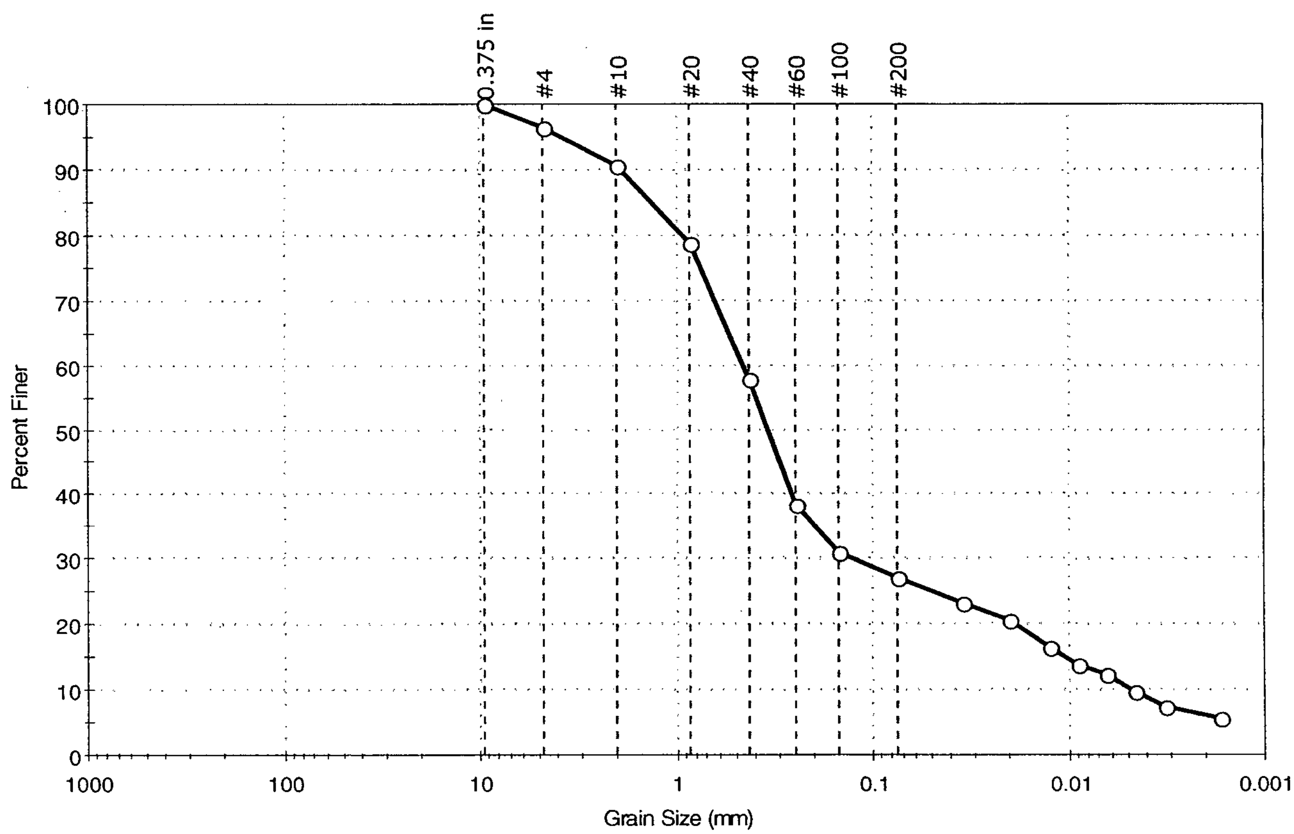
Toughness: n/a

The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.		
Project:	SMC Stockyard Geotech Borings		
Location:	Newfield, NJ	Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID: GB-2	Test Date: 02/16/09	Checked By:	jdt
Depth : 2-4 ft	Test Id: 146487		
Test Comment:	---		
Sample Description:	Moist, brown silty, clayey sand		
Sample Comment:	---		

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	3.7	69.1	27.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	96		
#10	2.00	91		
#20	0.85	79		
#40	0.42	58		
#60	0.25	38		
#100	0.15	31		
#200	0.075	27		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0349	23		
---	0.0201	21		
---	0.0125	16		
---	0.0090	14		
---	0.0064	12		
---	0.0046	10		
---	0.0033	7		
---	0.0017	5		

Coefficients

D_{85} = 1.3244 mm D_{30} = 0.1256 mm
D_{60} = 0.4574 mm D_{15} = 0.0105 mm
D_{50} = 0.3441 mm D_{10} = 0.0048 mm
C_u = N/A C_c = N/A

Classification

ASTM   Silty, clayey sand (SC-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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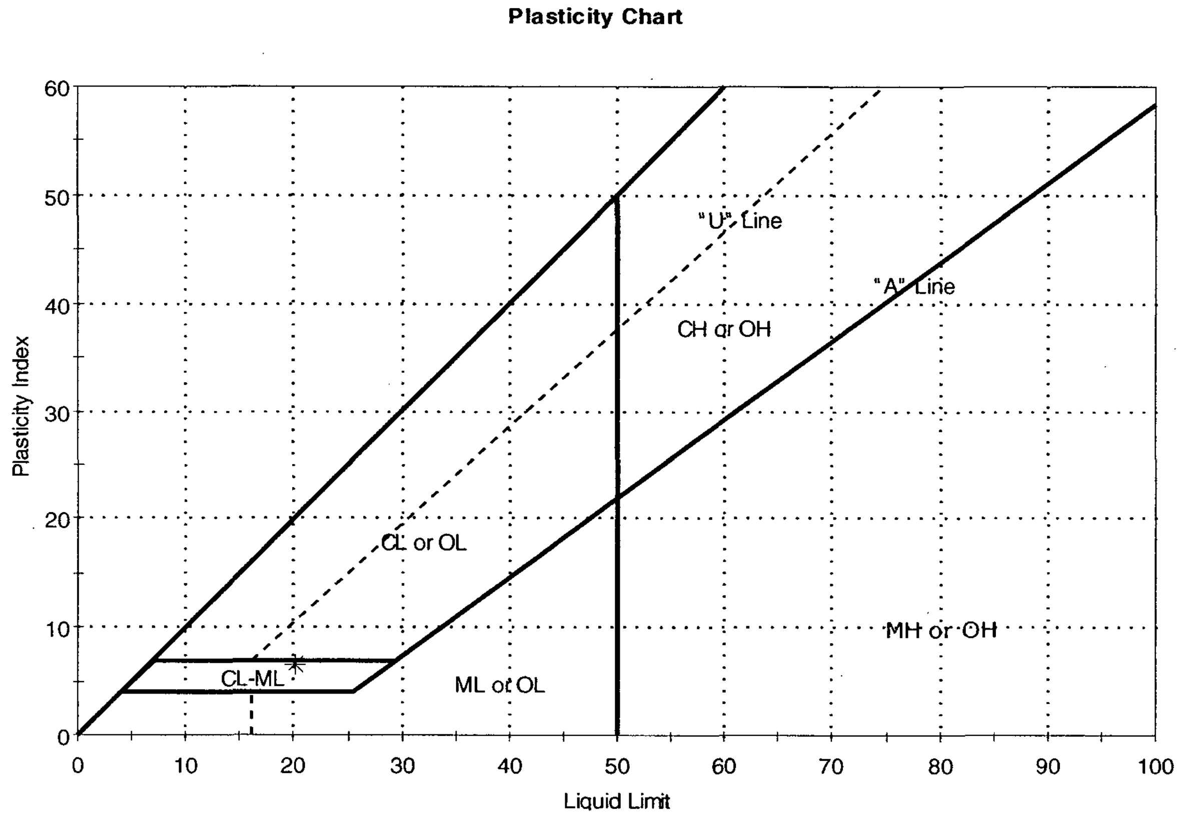
GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-2	Test Date:	02/16/09	Checked By:	jdt
Depth :	2-4 ft	Test Id:	146537		
Test Comment:	---				
Sample Description:	Moist, brown silty, clayey sand				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05



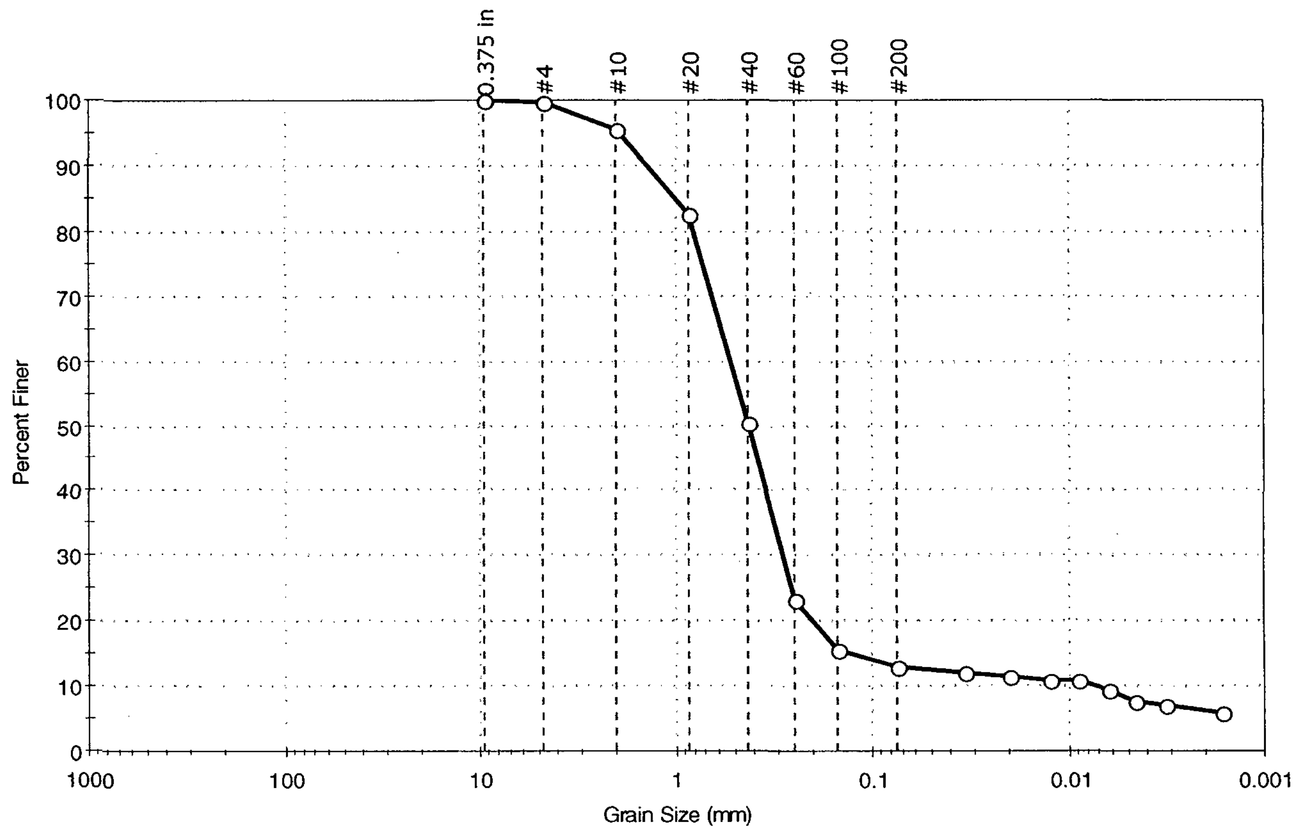
Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-2	---	2-4 ft	10	20	14	6	-1	Silty, clayey sand (SC-SM)

Sample Prepared using the WET method
42% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilentancy: SLOW
Toughness: LOW

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID: GB-2	Test Date: 02/16/09	Checked By:	jdt
Depth : 6-8 ft	Test Id: 146488		
Test Comment: ---			
Sample Description: Moist, reddish brown silty sand			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.3	86.6	13.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	95		
#20	0.85	82		
#40	0.42	50		
#60	0.25	23		
#100	0.15	16		
#200	0.075	13		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0346	12		
---	0.0201	11		
---	0.0127	11		
---	0.0090	11		
---	0.0062	10		
---	0.0046	8		
---	0.0033	7		
---	0.0017	6		

Coefficients

D_{85} =1.0024 mm D_{30} =0.2848 mm
D_{60} =0.5232 mm D_{15} =0.1295 mm
D_{50} =0.4219 mm D_{10} =0.0071 mm
C_u =N/A C_c =N/A

Classification

ASTM Silty sand (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-2	Test Date:	02/16/09	Checked By:	jdt
Depth :	6-8 ft	Test Id:	146538		
Test Comment:	---				
Sample Description:	Moist, reddish brown silty sand				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-2	---	6-8 ft	8	n/a	n/a	n/a	n/a	Silty sand (SM)

50% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

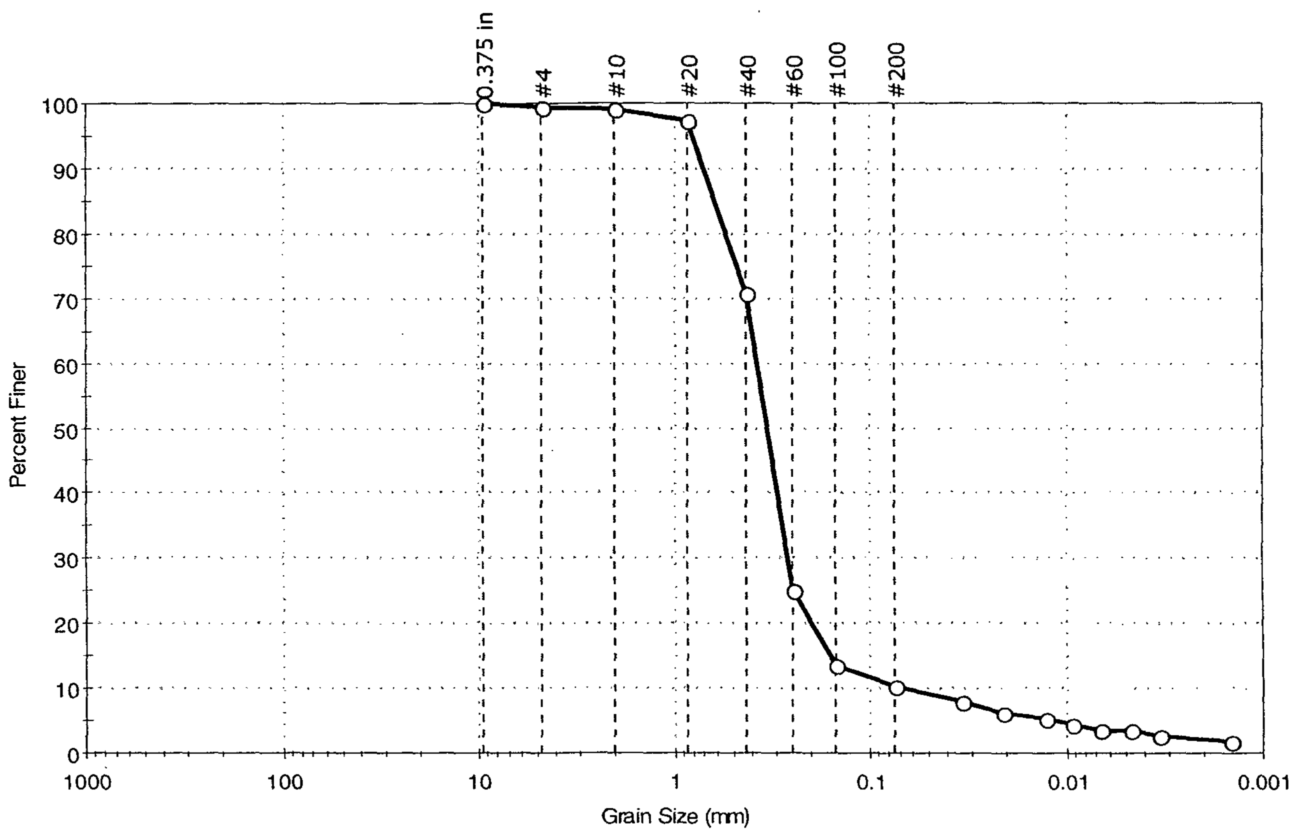
Toughness: n/a

The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-2	Test Date: 02/12/09	Checked By:	jdt
Depth : 8-10 ft	Test Id: 146489		
Test Comment: ---			
Sample Description: Moist, brownish yellow sand with silt			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.6	89.2	10.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	99		
#20	0.85	97		
#40	0.42	71		
#60	0.25	25		
#100	0.15	14		
#200	0.075	10		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0341	8		
---	0.0211	6		
---	0.0130	5		
---	0.0094	4		
---	0.0067	4		
---	0.0047	4		
---	0.0033	3		
---	0.0015	2		

Coefficients

D_{85} =0.6159 mm D_{30} =0.2648 mm
D_{60} =0.3752 mm D_{15} =0.1598 mm
D_{50} =0.3340 mm D_{10} =0.0697 mm
C_u =5.383 C_c =2.681

Classification

ASTM Poorly graded sand with silt (SP-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID:GB-2	Test Date: 02/12/09	Checked By:	jdt
Depth : 8-10 ft	Test Id: 146539		

Test Comment: ---
Sample Description: Moist, brownish yellow sand with silt
Sample Comment: ---

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

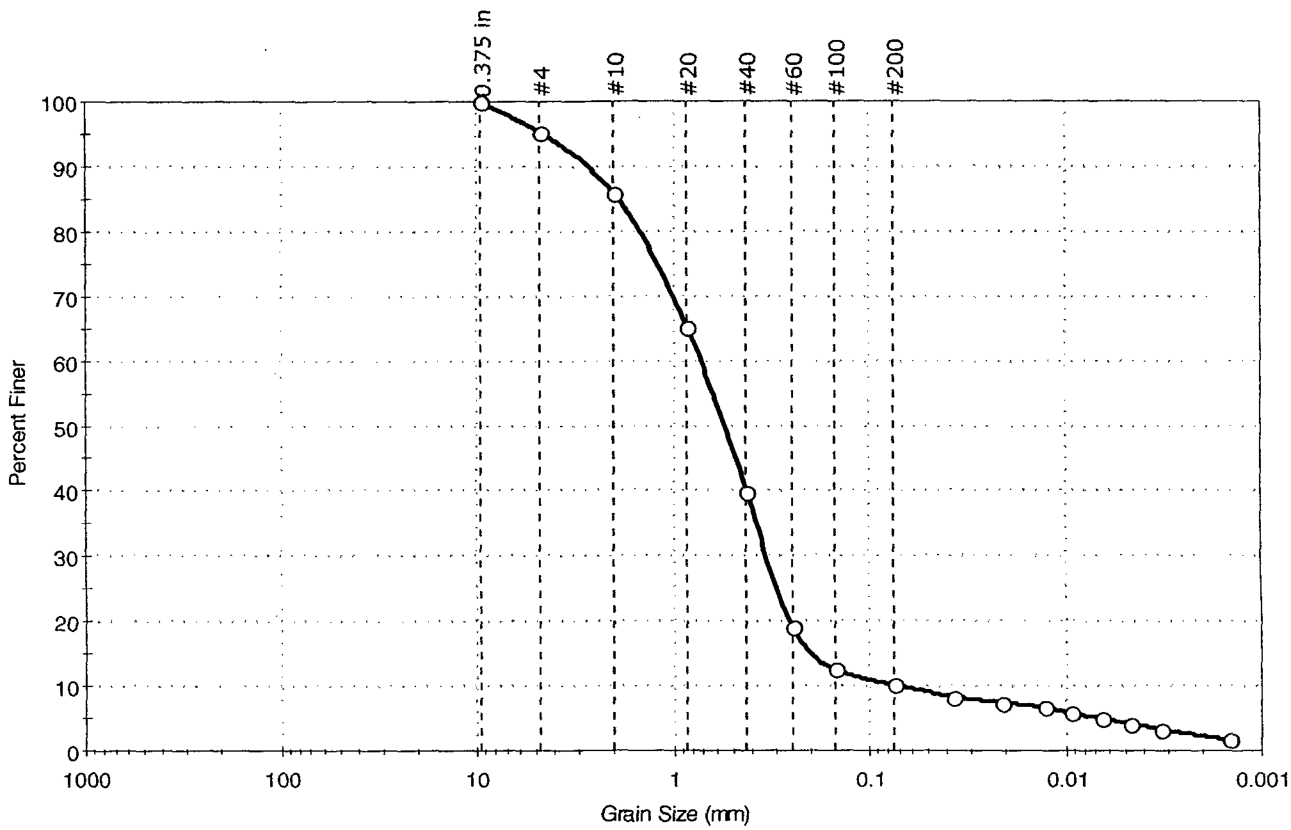
Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-2	---	8-10 ft	8	n/a	n/a	n/a	n/a	Poorly graded sand with silt (SP-SM)

29% Retained on #40 Sieve
Dry Strength: NONE
Dilentancy: RAPID
Toughness: n/a
The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-2	Test Date: 02/12/09	Checked By:	jdt
Depth : 10-12 ft	Test Id: 146490		
Test Comment: ---			
Sample Description: Moist, brownish yellow sand with silt			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	4.8	85.0	10.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	95		
#10	2.00	86		
#20	0.85	65		
#40	0.42	40		
#60	0.25	19		
#100	0.15	13		
#200	0.075	10		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0373	8		
---	0.0214	7		
---	0.0129	7		
---	0.0094	6		
---	0.0066	5		
---	0.0047	4		
---	0.0033	3		
---	0.0015	2		

Coefficients

D_{85} =1.9410 mm | D_{30} =0.3298 mm
D_{60} =0.7398 mm | D_{15} =0.1794 mm
D_{50} =0.5620 mm | D_{10} =0.0701 mm
C_u =10.553 | C_c =2.097

Classification

ASTM Well-graded sand with silt (SW-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
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Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID:GB-2	Test Date: 02/12/09	Checked By:	jdt
Depth : 10-12 ft	Test Id: 146540		

Test Comment: ---
Sample Description: Moist, brownish yellow sand with silt
Sample Comment: ---

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

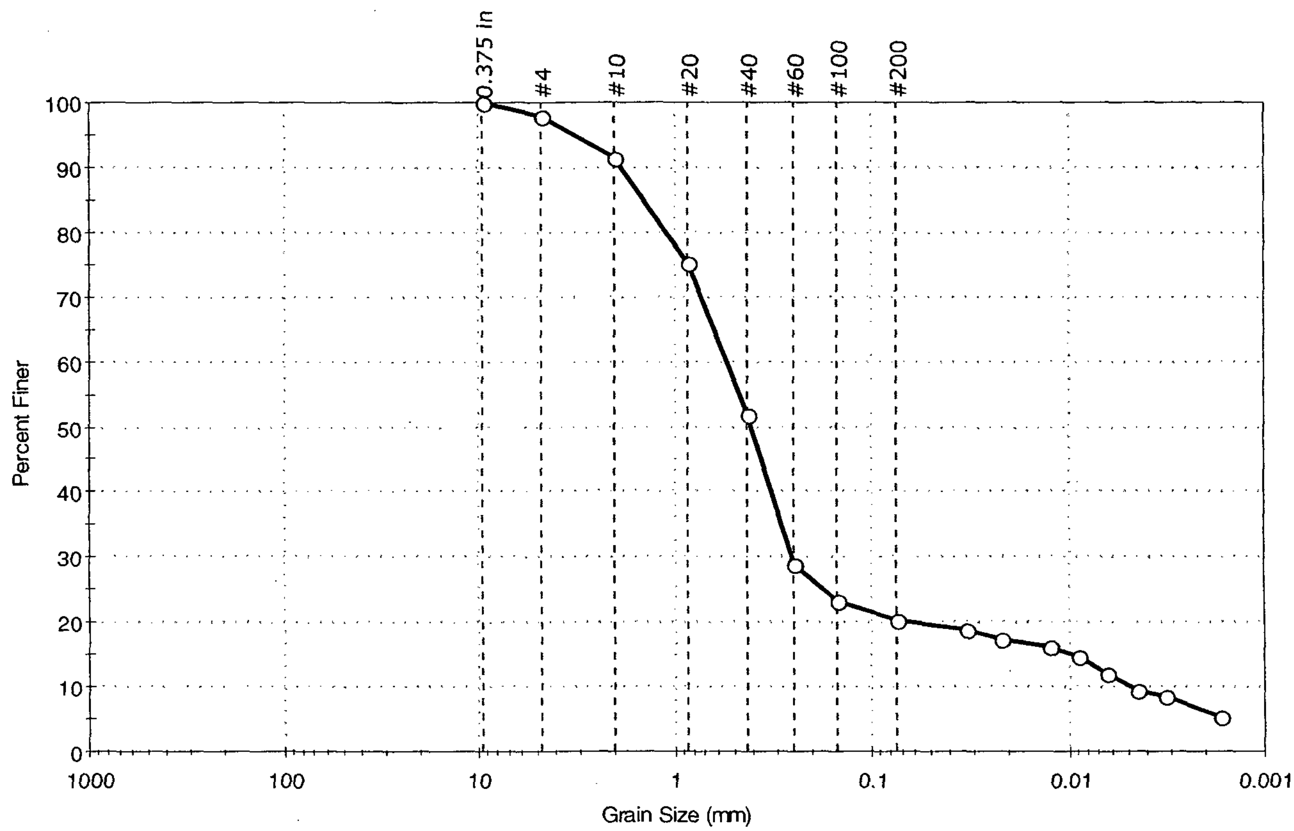
Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-2	---	10-12 ft	8	n/a	n/a	n/a	n/a	Well-graded sand with silt (SW-SM)

60% Retained on #40 Sieve
Dry Strength: NONE
Dilentancy: RAPID
Toughness: n/a
The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-2	Test Date: 02/16/09	Checked By:	jdt
Depth : 12-14 ft	Test Id: 146491		
Test Comment: ---			
Sample Description: Moist, brownish yellow silty sand			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	2.2	77.6	20.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	98		
#10	2.00	92		
#20	0.85	75		
#40	0.42	52		
#60	0.25	29		
#100	0.15	23		
#200	0.075	20		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0331	19		
---	0.0220	17		
---	0.0125	16		
---	0.0090	15		
---	0.0064	12		
---	0.0045	9		
---	0.0032	9		
---	0.0017	5		

Coefficients

D_{85} =1.4208 mm D_{30} =0.2569 mm
D_{60} =0.5398 mm D_{15} =0.0094 mm
D_{50} =0.4061 mm D_{10} =0.0049 mm
C_u =N/A C_c =N/A

Classification

ASTM   Silty sand (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED
Sand/Gravel Hardness : HARD

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GeoTesting express
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Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID:GB-2	Test Date: 02/16/09	Checked By:	n/a
Depth : 12-14 ft	Test Id: 146541		

Test Comment: ---
Sample Description: Moist, brownish yellow silty sand
Sample Comment: ---

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

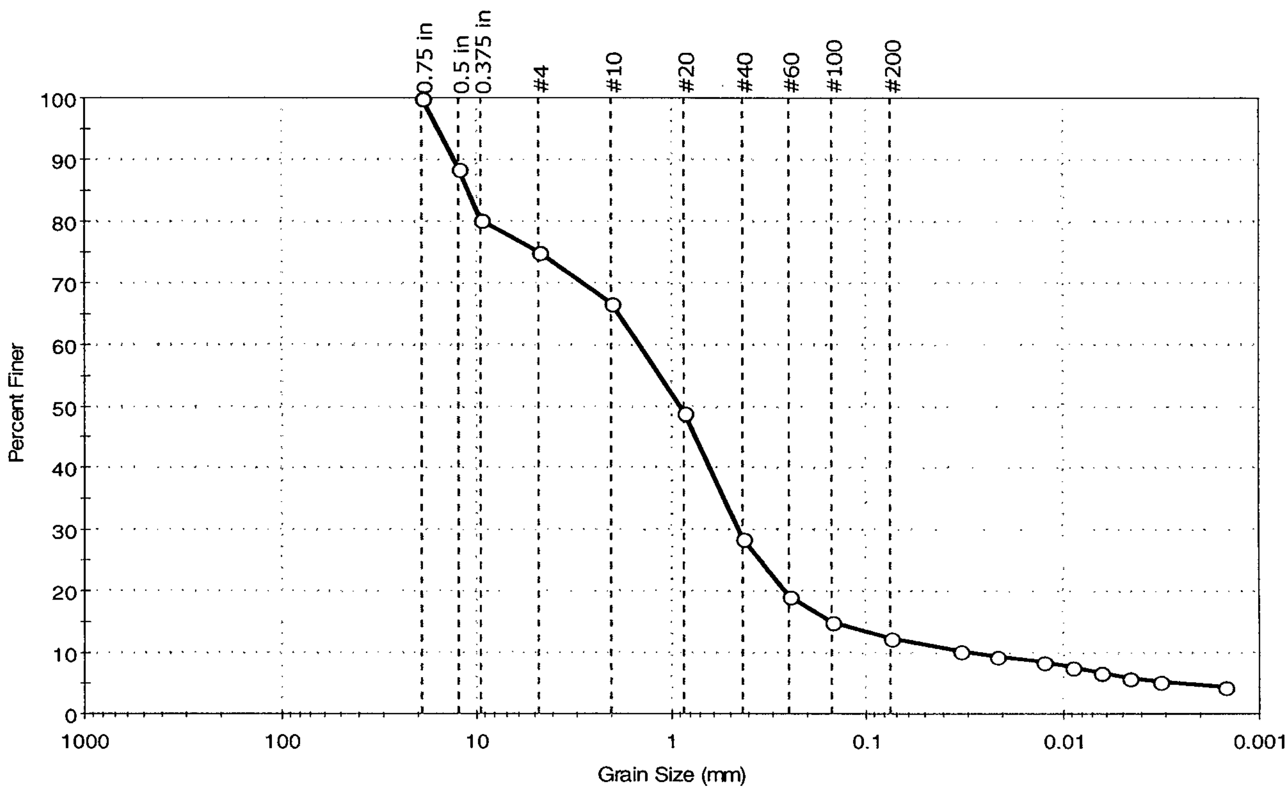
Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-2	---	12-14 ft	11	n/a	n/a	n/a	n/a	Silty sand (SM)

48% Retained on #40 Sieve
Dry Strength: MEDIUM
Dilentancy: RAPID
Toughness: n/a
The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-2	Test Date: 02/10/09	Checked By:	jdt
Depth : 18-20 ft	Test Id: 146492		
Test Comment: ---			
Sample Description: Moist, yellow silty sand with gravel			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	24.9	62.7	12.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	89		
0.375 in	9.50	80		
#4	4.75	75		
#10	2.00	67		
#20	0.85	49		
#40	0.42	29		
#60	0.25	19		
#100	0.15	15		
#200	0.075	12		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0337	10		
---	0.0218	9		
---	0.0126	9		
---	0.0090	8		
---	0.0064	7		
---	0.0046	6		
---	0.0032	5		
---	0.0015	4		

Coefficients

D_{85} = 11.1226 mm	D_{30} = 0.4437 mm
D_{60} = 1.4450 mm	D_{15} = 0.1499 mm
D_{50} = 0.8952 mm	D_{10} = 0.0292 mm
C_u = N/A	C_c = N/A

Classification

ASTM Silty sand with gravel (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
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Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-2	Test Date:	02/10/09	Checked By:	jdt
Depth :	18-20 ft	Test Id:	146542		
Test Comment:	---				
Sample Description:	Moist, yellow silty sand with gravel				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-2	---	18-20 ft	15	n/a	n/a	n/a	n/a	Silty sand with gravel (SM)

71% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

Toughness: n/a

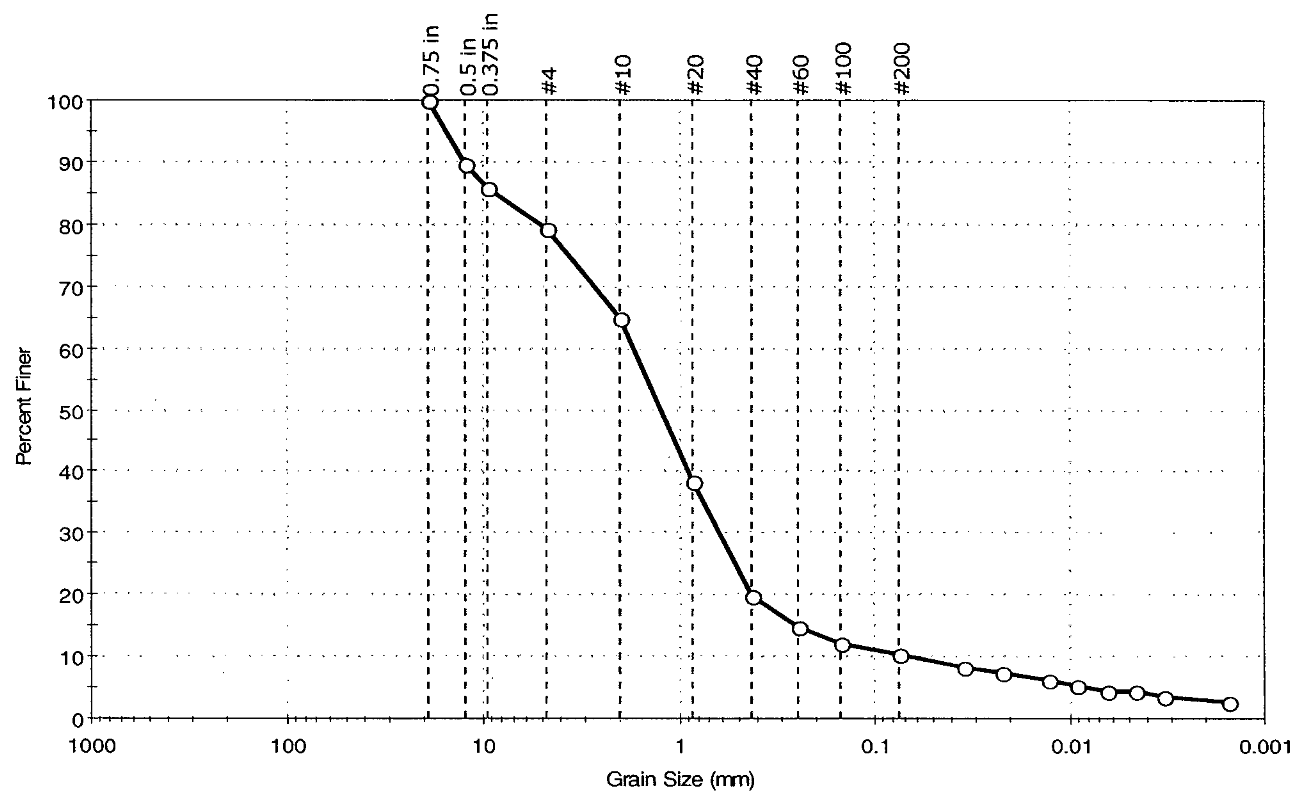
The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-2	Test Date: 02/10/09	Checked By:	jdt
Depth : 22-24 ft	Test Id: 146493		

Test Comment: ---
Sample Description: Moist, yellow sand with silt
Sample Comment: ---

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	20.6	69.0	10.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	90		
0.375 in	9.50	86		
#4	4.75	79		
#10	2.00	65		
#20	0.85	38		
#40	0.42	20		
#60	0.25	15		
#100	0.15	12		
#200	0.075	10		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0354	8		
---	0.0220	7		
---	0.0127	6		
---	0.0092	5		
---	0.0065	5		
---	0.0046	5		
---	0.0033	4		
---	0.0015	3		

Coefficients

D_{85} =8.6002 mm
D_{30} =0.6248 mm
D_{60} =1.7111 mm
D_{15} =0.2541 mm
D_{50} =1.2403 mm
D_{10} =0.0655 mm
C_u =26.124
C_c =3.483

Classification

ASTM: Poorly graded sand with silt and gravel (SP-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
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Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-2	Test Date:	02/10/09	Checked By:	jdt
Depth :	22-24 ft	Test Id:	146543		
Test Comment:	---				
Sample Description:	Moist, yellow sand with silt				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-2	---	22-24 ft	18	n/a	n/a	n/a	n/a	Poorly graded sand with silt and gravel (SP-SM)

80% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

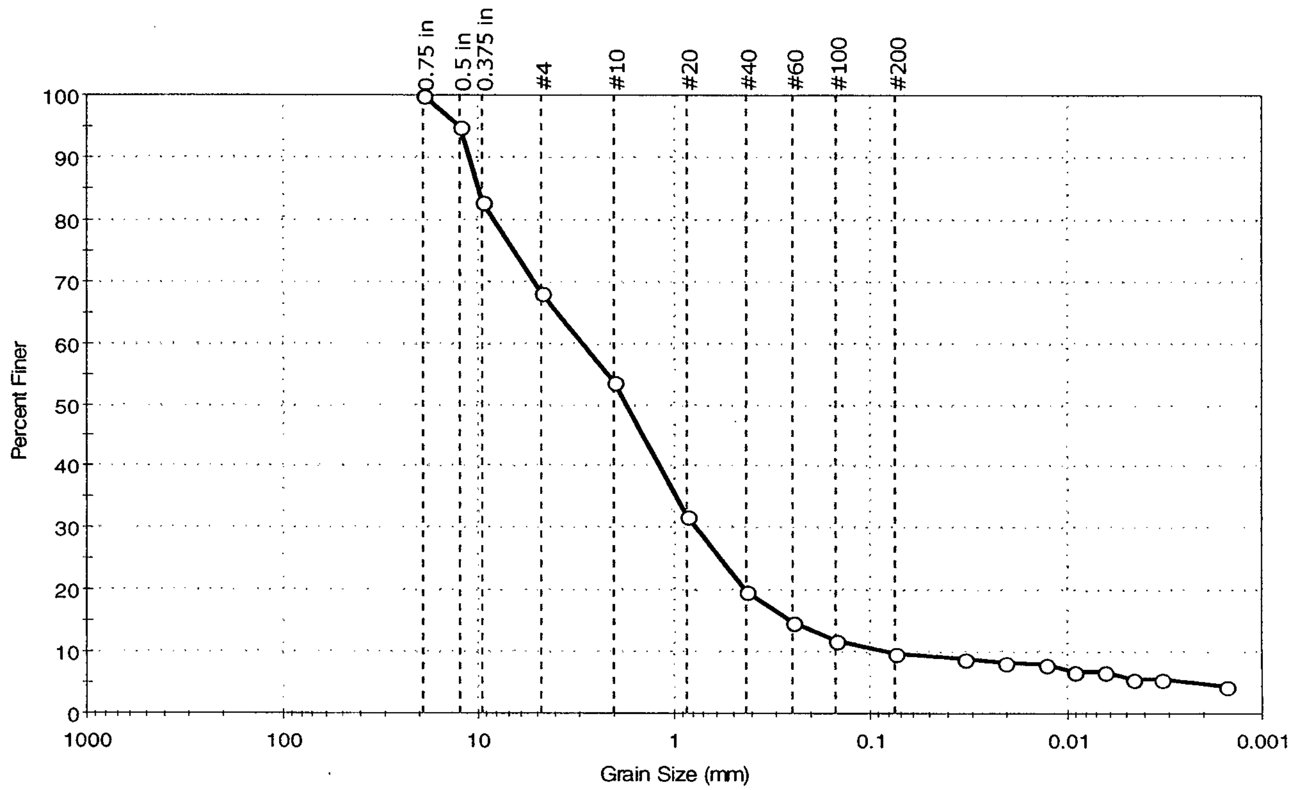
Toughness: n/a

The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	jbr
Sample ID:	GB-2	Test Date:	02/10/09	Checked By:	jdt
Depth :	26-28 ft	Test Id:	146494		
Test Comment:	---				
Sample Description:	Moist, yellow sand with silt and gravel				
Sample Comment:	---				

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	31.9	58.4	9.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	95		
0.375 in	9.50	83		
#4	4.75	68		
#10	2.00	54		
#20	0.85	32		
#40	0.42	20		
#60	0.25	15		
#100	0.15	12		
#200	0.075	10		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0334	9		
---	0.0207	8		
---	0.0127	8		
---	0.0091	7		
---	0.0065	7		
---	0.0046	6		
---	0.0033	6		
---	0.0015	4		

Coefficients

D_{85} = 9.9490 mm D_{30} = 0.7645 mm
D_{60} = 2.9257 mm D_{15} = 0.2550 mm
D_{50} = 1.7363 mm D_{10} = 0.0818 mm
C_u = 35.767 C_c = 2.442

Classification

ASTM Well-graded sand with silt and gravel (SW-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
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Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-2	Test Date:	02/10/09	Checked By:	jdt
Depth :	26-28 ft	Test Id:	146544		
Test Comment:	---				
Sample Description:	Moist, yellow sand with silt and gravel				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-2	---	26-28 ft	18	n/a	n/a	n/a	n/a	Well-graded sand with silt and gravel (SW-SM)

80% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

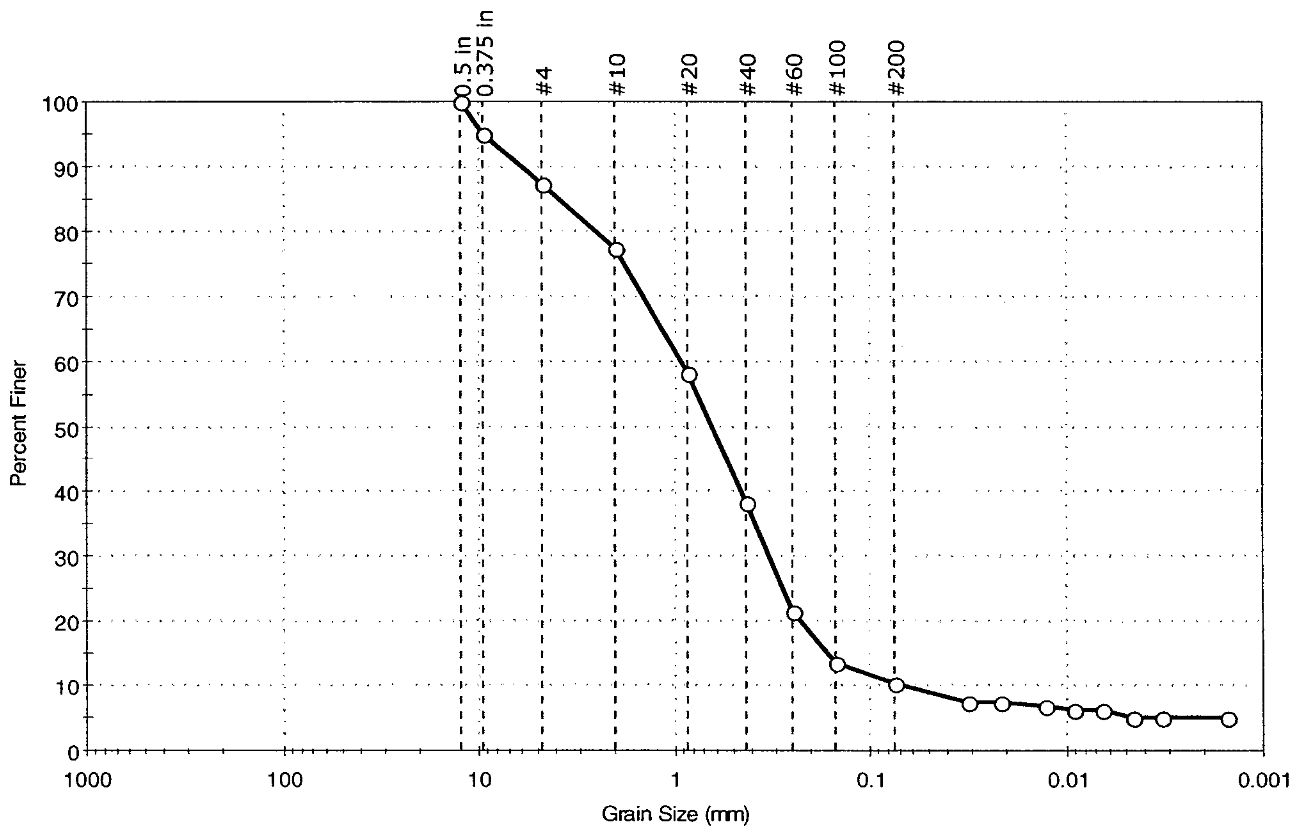
Toughness: n/a

The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	jbr
Sample ID:	GB-2	Test Date:	02/10/09	Checked By:	jdt
Depth :	30-32 ft	Test Id:	146495		
Test Comment:	---				
Sample Description:	Moist, yellow sand with silt				
Sample Comment:	---				

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	12.7	77.0	10.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	95		
#4	4.75	87		
#10	2.00	77		
#20	0.85	58		
#40	0.42	38		
#60	0.25	22		
#100	0.15	14		
#200	0.075	10		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0321	7		
---	0.0216	7		
---	0.0129	7		
---	0.0092	6		
---	0.0066	6		
---	0.0046	5		
---	0.0033	5		
---	0.0015	5		

Coefficients

D_{85} =3.9069 mm D_{30} =0.3263 mm
D_{60} =0.9219 mm D_{15} =0.1635 mm
D_{50} =0.6383 mm D_{10} =0.0692 mm
C_u =13.322 C_c =1.669

Classification

ASTM Well-graded sand with silt (SW-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting
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Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-2	Test Date:	02/10/09	Checked By:	jdt
Depth :	30-32 ft	Test Id:	146545		
Test Comment:	---				
Sample Description:	Moist, yellow sand with silt				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-2	---	30-32 ft	17	n/a	n/a	n/a	n/a	Well-graded sand with silt (SW-SM)

62% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

Toughness: n/a

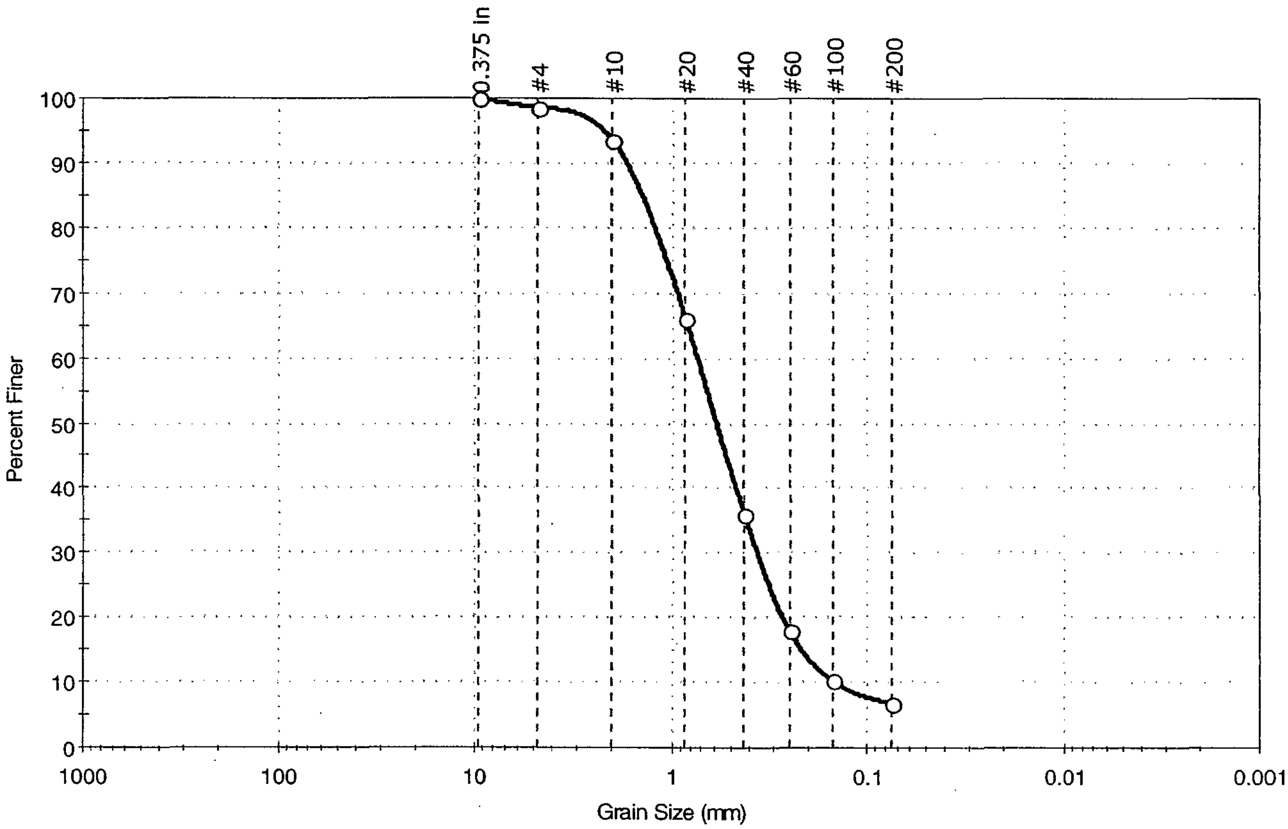
The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	jbr
Sample ID:	GB-2	Test Date:	02/16/09	Checked By:	jdt
Depth :	32-34 ft	Test Id:	146496		

Test Comment: Less than 10% Fines, Hydrometer not performed
Sample Description: Moist, yellow sand with silt
Sample Comment: ---

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	1.4	91.8	6.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	94		
#20	0.85	66		
#40	0.42	36		
#60	0.25	18		
#100	0.15	10		
#200	0.075	7		

Coefficients

D_{85} =1.5334 mm	D_{30} =0.3562 mm
D_{60} =0.7387 mm	D_{15} =0.2047 mm
D_{50} =0.5870 mm	D_{10} =0.1433 mm
C_u =5.155	C_c =1.199

Classification

ASTM Poorly graded sand with silt (SP-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-2	Test Date:	02/16/09	Checked By:	jdt
Depth :	32-34 ft	Test Id:	146546		
Test Comment:	---				
Sample Description:	Moist, yellow sand with silt				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-2	---	32-34 ft	19	n/a	n/a	n/a	n/a	Poorly graded sand with silt (SP-SM)

64% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

Toughness: n/a

The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	---	Tested By:	ap
Sample ID:	---	Test Date:	02/18/09	Checked By:	jdt
Depth :	---	Test Id:	146601		

USCS Classification - ASTM D 2487-06

Boring ID	Sample ID	Depth	Group Name	Group Symbol	Gravel, %	Sand, %	Fines, %
---	GB-3	0-2 ft	Well-graded sand with silt and gravel	SW-SM	18.5	71.3	10.2
---	GB-3	4-6 ft	Silty, clayey sand	SC-SM	12.9	63.8	23.3
---	GB-3	6-8 ft	Clayey sand	SC	11.7	66.6	21.7
---	GB-3	10-12 ft	Silty sand	SM	1.0	81.2	17.8
---	GB-3	16-18 ft	Silty sand	SM	2.1	84.8	13.1

Remarks: Grain Size analysis performed by ASTM D422, results enclosed
Atterbeg Limits performed by ASTM 4318, results enclosed

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID: ---		Sample Type: ---		Tested By:	ap
Sample ID:---		Test Date:	02/18/09	Checked By:	jdt
Depth : ---		Test Id:	146606		

USCS Classification - ASTM D 2487-06

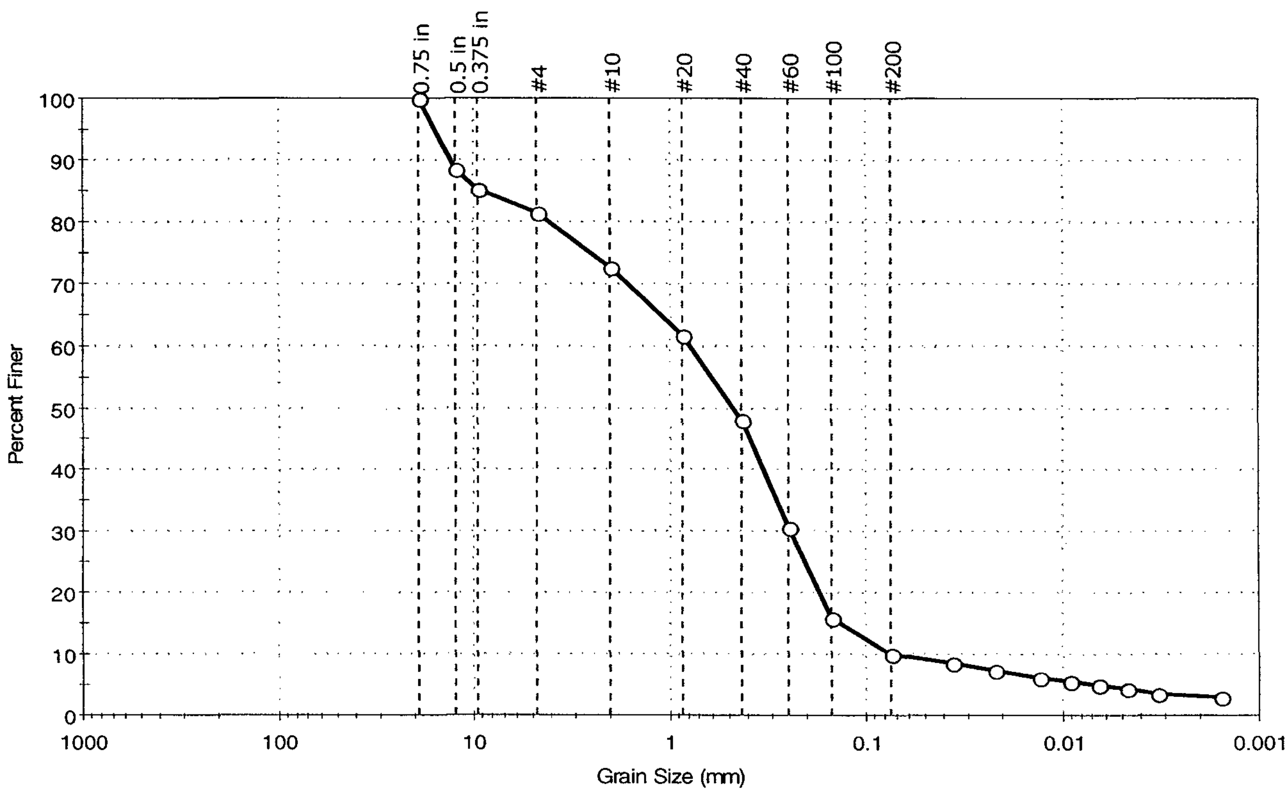
Boring ID	Sample ID	Depth	Group Name	Group Symbol	Gravel, %	Sand, %	Fines, %
---	GB-3	20-22 ft	Silty sand	SM	10.4	74.4	15.2
---	GB-3	24-26 ft	Poorly graded sand with silt and gravel	SP-SM	25.2	68.0	6.8
---	GB-3	28-30 ft	Well-graded sand with silt and gravel	SW-SM	34.1	58.9	7.0
---	GB-3	32-34 ft	Well-graded sand with silt and gravel	SW-SM	36.2	58.2	5.6
---	GB-3	36-38 ft	Poorly graded sand with silt	SP-SM	10.7	82.9	6.4

Remarks: Grain Size analysis performed by ASTM D422, results enclosed
Atterbeg Limits performed by ASTM 4318, results enclosed

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-3	Test Date: 02/12/09	Checked By:	jdt
Depth : 0-2 ft	Test Id: 146497		
Test Comment: ---			
Sample Description: Moist, brown sand with silt and gravel			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	18.5	71.3	10.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	89		
0.375 in	9.50	85		
#4	4.75	81		
#10	2.00	73		
#20	0.85	62		
#40	0.42	48		
#60	0.25	31		
#100	0.15	16		
#200	0.075	10		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0368	9		
---	0.0224	7		
---	0.0132	6		
---	0.0093	6		
---	0.0066	5		
---	0.0047	4		
---	0.0033	4		
---	0.0016	3		

Coefficients

D_{85} =8.9246 mm D_{30} =0.2441 mm
D_{60} =0.7779 mm D_{15} =0.1338 mm
D_{50} =0.4669 mm D_{10} =0.0695 mm
C_u =11.193 C_c =1.102

Classification

ASTM Well-graded sand with silt and gravel (SW-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
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Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID:GB-3	Test Date: 02/12/09	Checked By:	jdt
Depth : 0-2 ft	Test Id: 146547		
Test Comment: ---			
Sample Description: Moist, brown sand with silt and gravel			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-3	---	0-2 ft	10	n/a	n/a	n/a	n/a	Well-graded sand with silt and gravel (SW-SM)

52% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

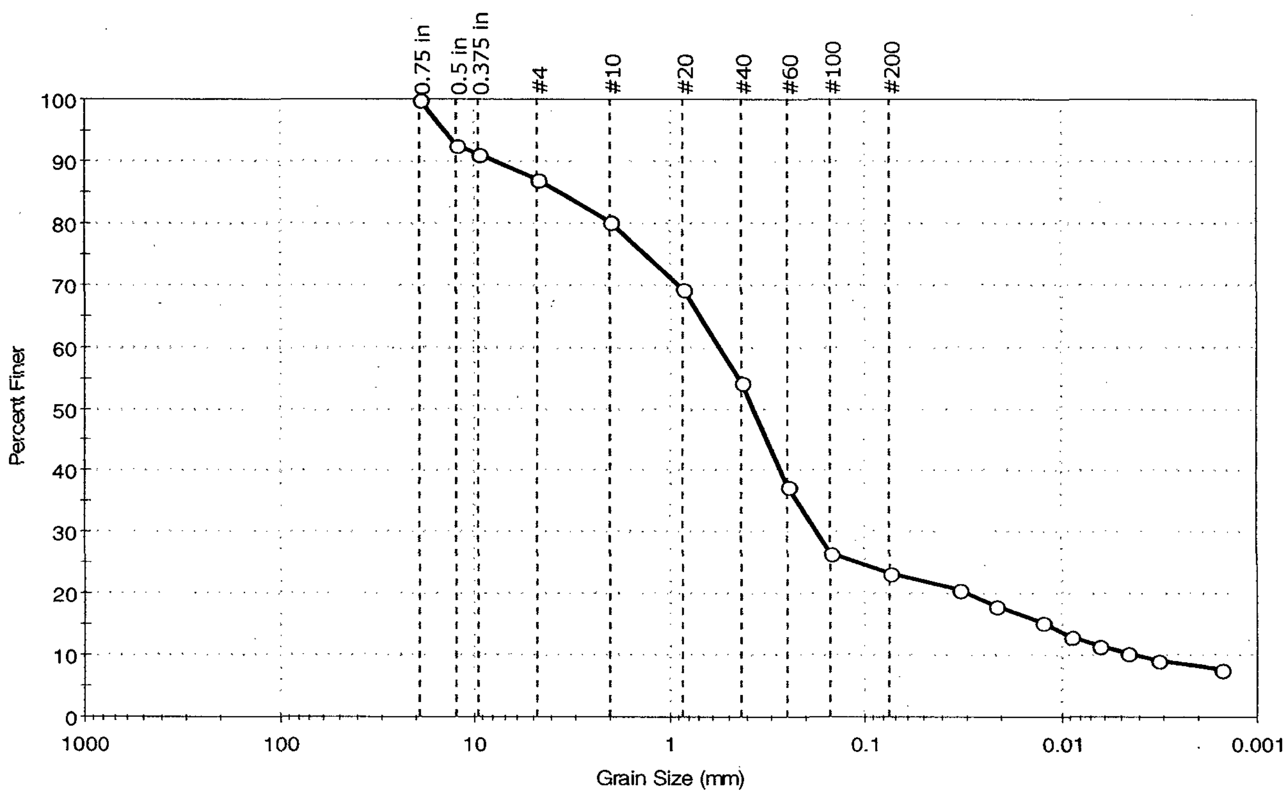
Toughness: n/a

The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID: GB-3	Test Date: 02/12/09	Checked By:	jdt
Depth : 4-6 ft	Test Id: 146498		
Test Comment: ---			
Sample Description: Moist, brown silty, clayey sand			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	12.9	63.8	23.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	93		
0.375 in	9.50	91		
#4	4.75	87		
#10	2.00	80		
#20	0.85	69		
#40	0.42	54		
#60	0.25	37		
#100	0.15	27		
#200	0.075	23		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0337	21		
---	0.0216	18		
---	0.0127	15		
---	0.0090	13		
---	0.0064	12		
---	0.0046	10		
---	0.0032	9		
---	0.0015	8		

Coefficients

D_{85} = 3.6569 mm D_{30} = 0.1757 mm
D_{60} = 0.5562 mm D_{15} = 0.0120 mm
D_{50} = 0.3723 mm D_{10} = 0.0042 mm
C_u = N/A C_c = N/A

Classification

ASTM Silty, clayey sand (SC-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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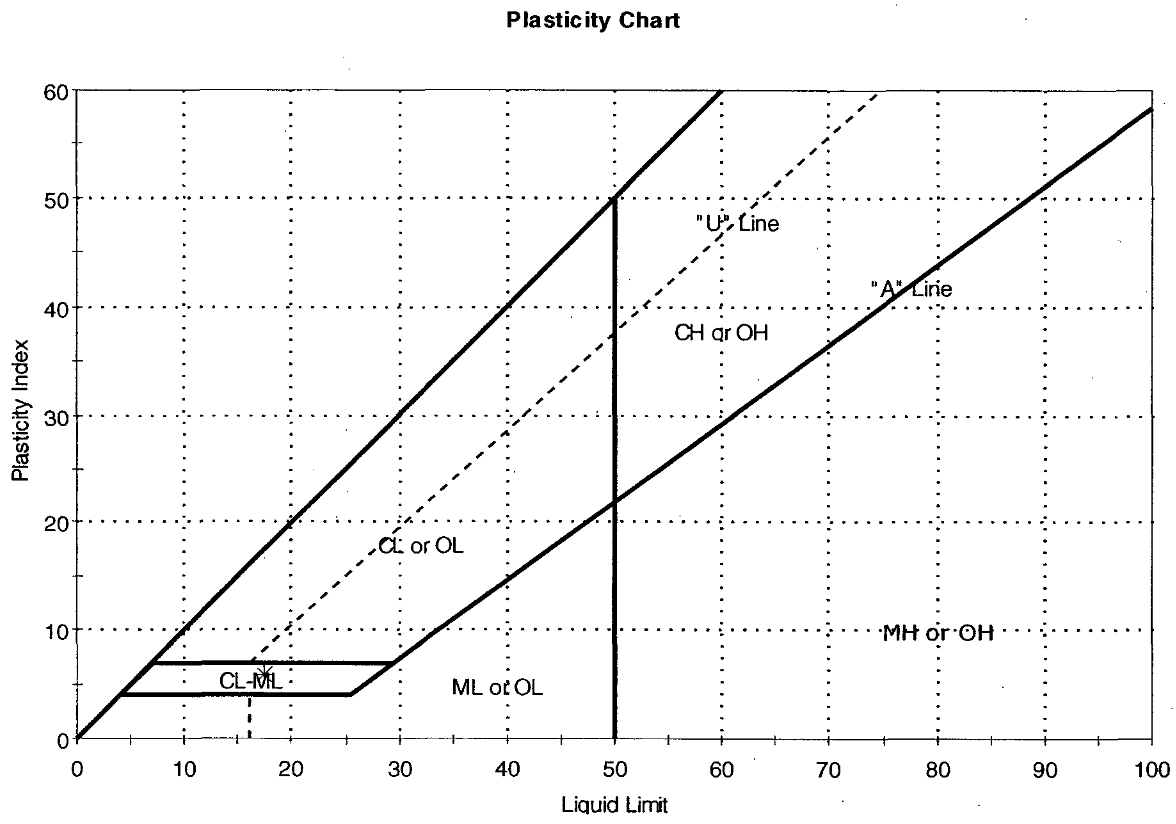
Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID:GB-3	Test Date: 02/17/09	Checked By:	jdt
Depth : 4-6 ft	Test Id: 146548		
Test Comment: ---			
Sample Description: Moist, brown silty, clayey sand			
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
*	GB-3	---	4-6 ft	9	17	12	5	-1	Silty, clayey sand (SC-SM)

Sample Prepared using the WET method

46% Retained on #40 Sieve

Dry Strength: VERY HIGH

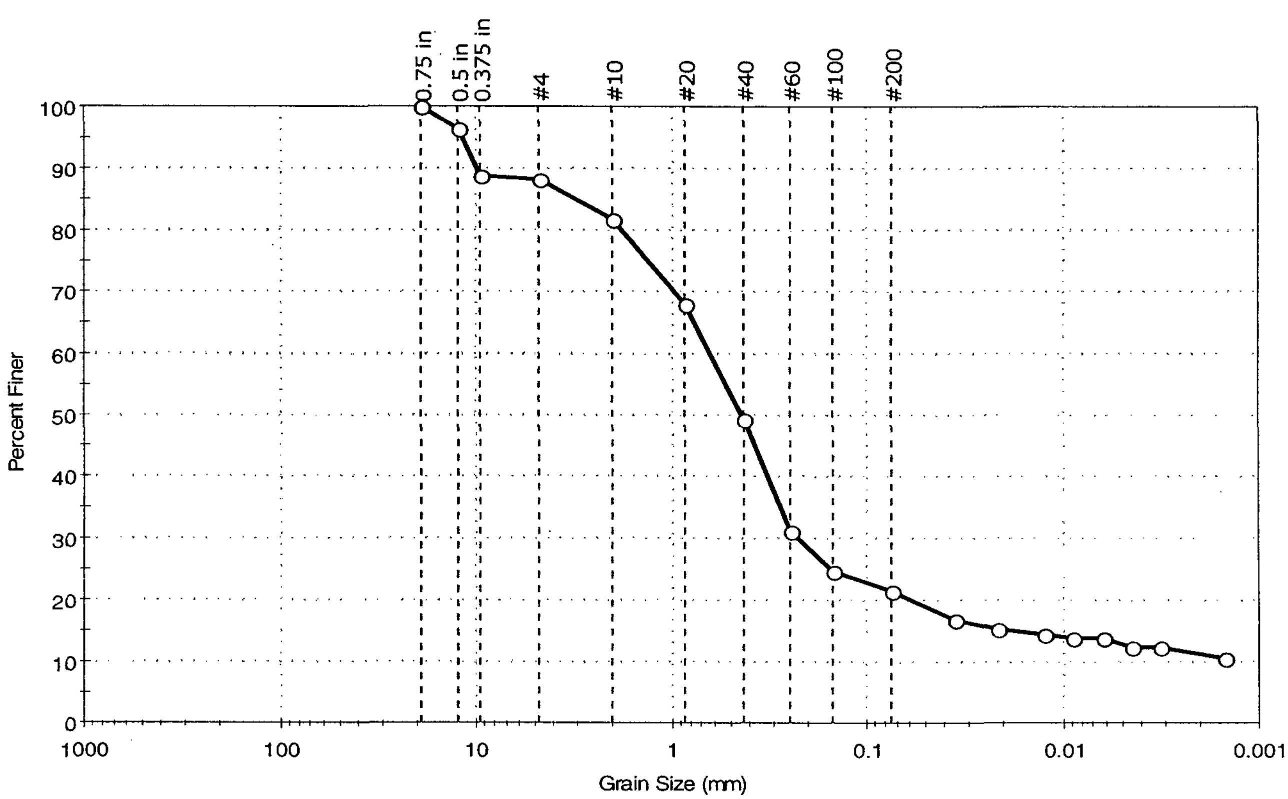
Dilentancy: SLOW

Toughness: LOW

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	jbr
Sample ID:	GB-3	Test Date:	02/12/09	Checked By:	jdt
Depth :	6-8 ft	Test Id:	146499		
Test Comment:	---				
Sample Description:	Moist, yellowish brown clayey sand				
Sample Comment:	---				

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	11.7	66.6	21.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	97		
0.375 in	9.50	89		
#4	4.75	88		
#10	2.00	82		
#20	0.85	68		
#40	0.42	49		
#60	0.25	31		
#100	0.15	25		
#200	0.075	22		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0357	17		
---	0.0215	15		
---	0.0127	15		
---	0.0090	14		
---	0.0063	14		
---	0.0045	12		
---	0.0032	12		
---	0.0015	11		

Coefficients

D_{85} =3.1046 mm — D_{30} =0.2255 mm
D_{60} =0.6351 mm — D_{15} =0.0171 mm
D_{50} =0.4381 mm — D_{10} =0.0010 mm
C_u =N/A — C_c =N/A

Classification

ASTM — Clayey sand (SC)

AASHTO — Clayey Gravel and Sand (A-2-6 (1))

Sample/Test Description

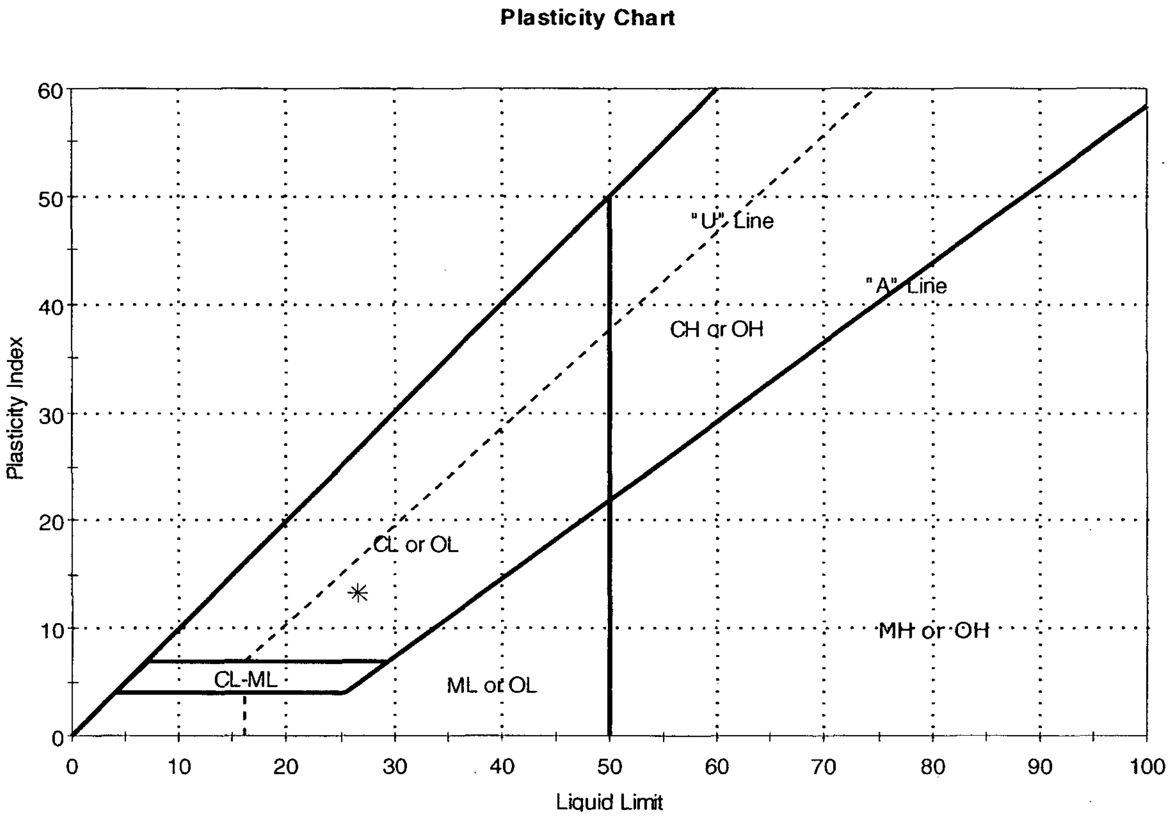
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-3	Test Date:	02/17/09	Checked By:	jdt
Depth :	6-8 ft	Test Id:	146549		
Test Comment:	---				
Sample Description:	Moist, yellowish brown clayey sand				
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
✳	GB-3	---	6-8 ft	8	27	13	14	0	Clayey sand (SC)

Sample Prepared using the WET method

51% Retained on #40 Sieve

Dry Strength: VERY HIGH

Dilentancy: RAPID

Toughness: LOW

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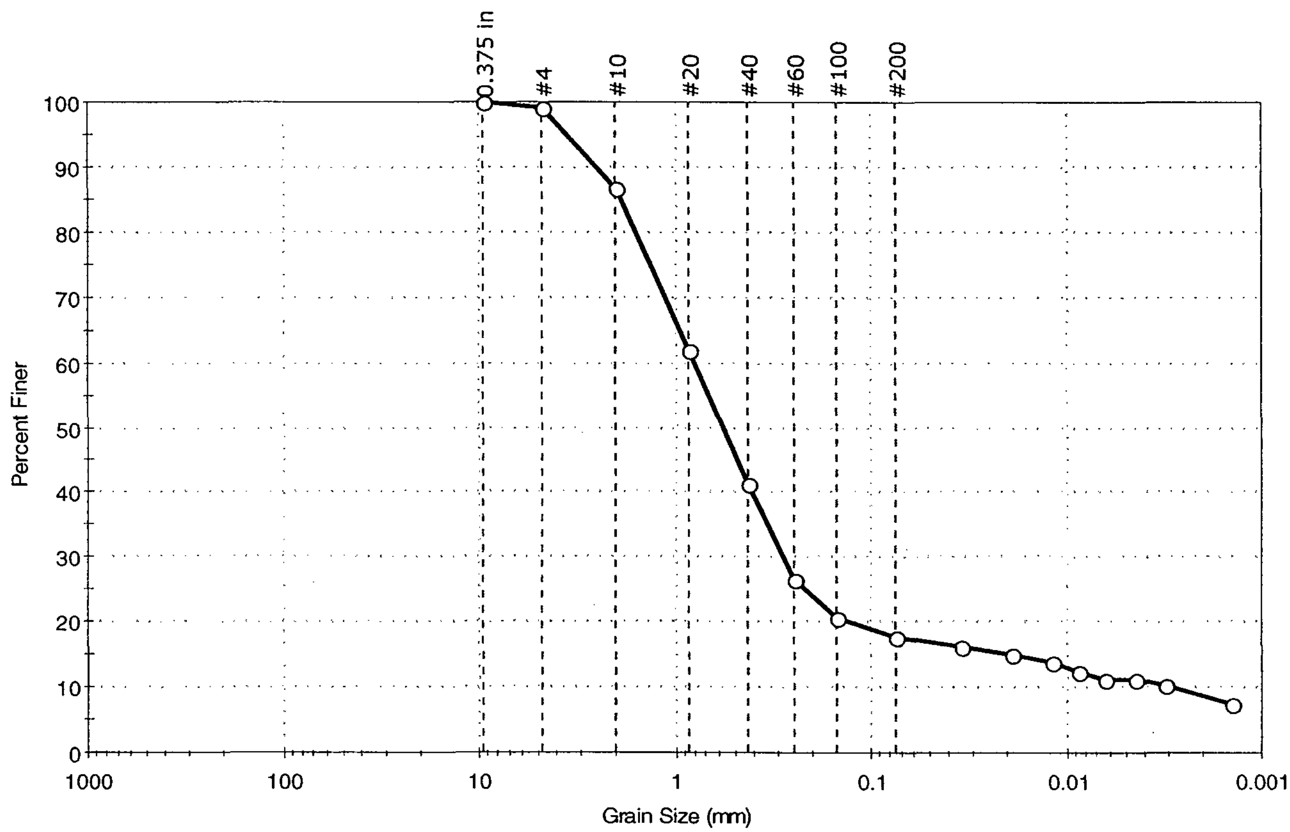
Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-3	Test Date: 02/11/09	Checked By:	jdt
Depth : 10-12 ft	Test Id: 146500		
Test Comment: ---			
Sample Description: Moist, yellowish brown silty sand			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	1.0	81.2	17.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	87		
#20	0.85	62		
#40	0.42	41		
#60	0.25	27		
#100	0.15	21		
#200	0.075	18		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0350	16		
---	0.0194	15		
---	0.0121	14		
---	0.0087	12		
---	0.0064	11		
---	0.0045	11		
---	0.0032	10		
---	0.0014	7		

Coefficients

D_{85} =1.8815 mm	D_{30} =0.2825 mm
D_{60} =0.7965 mm	D_{15} =0.0195 mm
D_{50} =0.5702 mm	D_{10} =0.0030 mm
C_u =N/A	C_c =N/A

Classification

ASTM Silty sand (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
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Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID:GB-3	Test Date: 02/11/09	Checked By:	jdt
Depth : 10-12 ft	Test Id: 146550		
Test Comment: ---			
Sample Description: Moist, yellowish brown silty sand			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-3	---	10-12 ft	11	n/a	n/a	n/a	n/a	Silty sand (SM)

59% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

Toughness: n/a

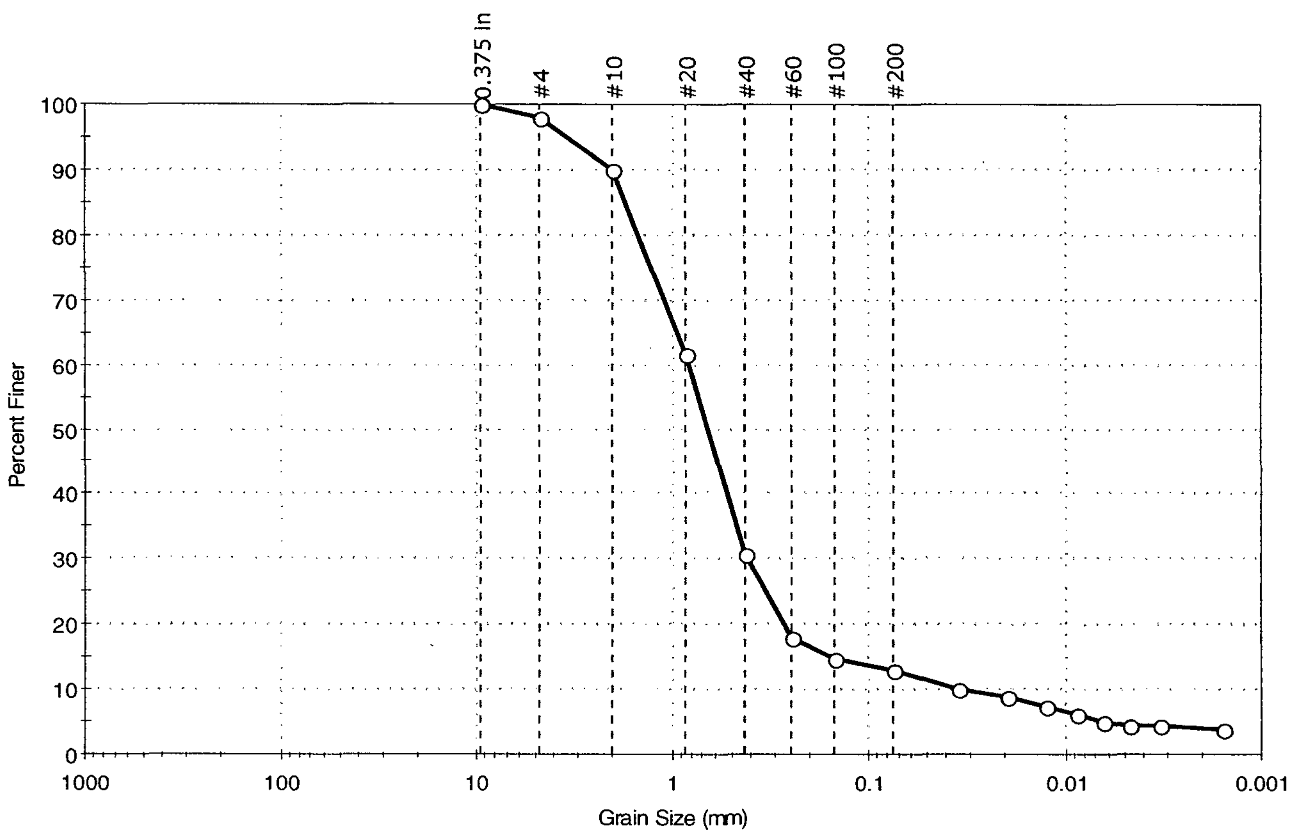
The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	jbr
Sample ID:	GB-3	Test Date:	02/11/09	Checked By:	jdt
Depth :	16-18 ft	Test Id:	146501		

Test Comment: ---
Sample Description: Moist, yellowis brown silty sand
Sample Comment: ---

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	2.1	84.8	13.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	98		
#10	2.00	90		
#20	0.85	62		
#40	0.42	31		
#60	0.25	18		
#100	0.15	15		
#200	0.075	13		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0347	10		
---	0.0197	9		
---	0.0127	7		
---	0.0089	6		
---	0.0064	5		
---	0.0047	4		
---	0.0033	4		
---	0.0016	4		

Coefficients

D_{85} = 1.7162 mm	D_{30} = 0.4110 mm
D_{60} = 0.8213 mm	D_{15} = 0.1576 mm
D_{50} = 0.6553 mm	D_{10} = 0.0350 mm
C_u = N/A	C_c = N/A

Classification

ASTM Silty sand (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
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Client:	TRC Environmental Corp.		
Project:	SMC Stockyard Geotech Borings		
Location:	Newfield, NJ	Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID:GB-3	Test Date: 02/11/09	Checked By:	jdt
Depth : 16-18 ft	Test Id: 146551		
Test Comment:	---		
Sample Description:	Moist, yellowis brown silty sand		
Sample Comment:	---		

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-3	---	16-18 ft	10	n/a	n/a	n/a	n/a	Silty sand (SM)

69% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

Toughness: n/a

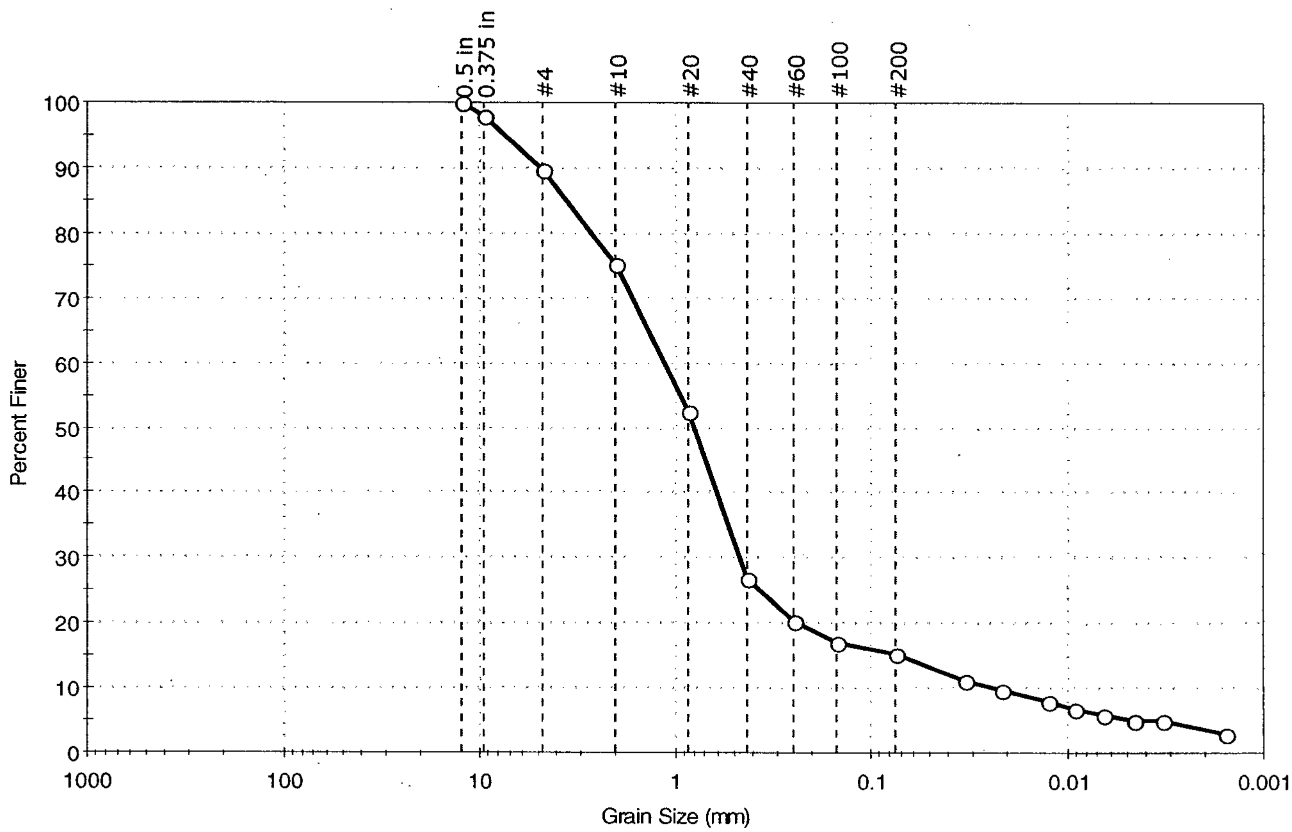
The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	jbr
Sample ID:	GB-3	Test Date:	02/11/09	Checked By:	jdt
Depth :	20-22 ft	Test Id:	146502		

Test Comment: ---
Sample Description: Moist, yellowish brown silty sand
Sample Comment: ---

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	10.4	74.4	15.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	98		
#4	4.75	90		
#10	2.00	75		
#20	0.85	52		
#40	0.42	27		
#60	0.25	20		
#100	0.15	17		
#200	0.075	15		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0336	11		
---	0.0217	10		
---	0.0125	8		
---	0.0091	7		
---	0.0065	6		
---	0.0046	5		
---	0.0033	5		
---	0.0016	3		

Coefficients

D_{85} =3.6109 mm D_{30} =0.4621 mm
D_{60} =1.1282 mm D_{15} =0.0721 mm
D_{50} =0.7946 mm D_{10} =0.0231 mm
C_u =N/A C_c =N/A

Classification

ASTM   Silty sand (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape :

Sand/Gravel Hardness :

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GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID:GB-3	Test Date: 02/11/09	Checked By:	jdt
Depth : 20-22 ft	Test Id: 146552		
Test Comment: ---			
Sample Description: Moist, yellowish brown silty sand			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-3	---	20-22 ft	13	n/a	n/a	n/a	n/a	Silty sand (SM)

73% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

Toughness: n/a

The sample was determined to be Non-Plastic

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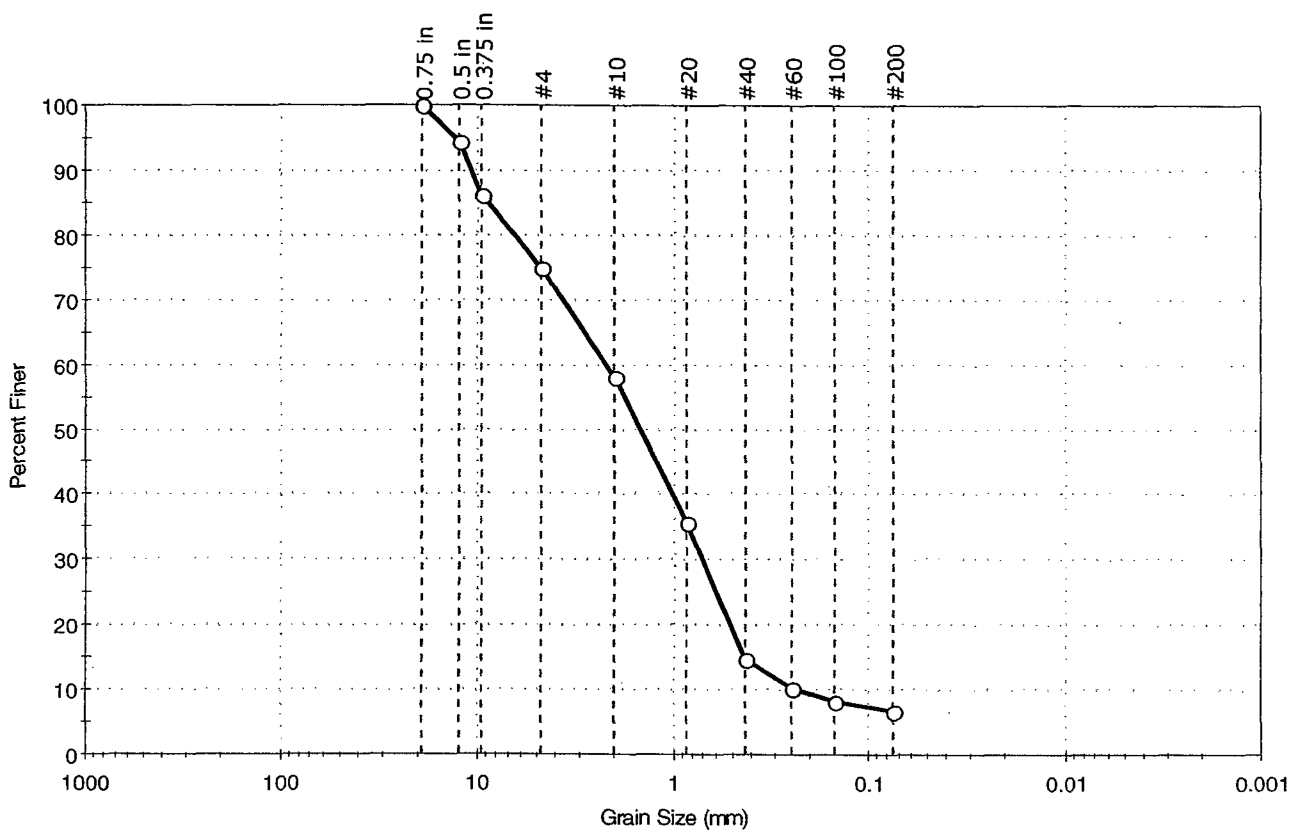
GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-3	Test Date: 02/11/09	Checked By:	jdt
Depth : 24-26 ft	Test Id: 146503		

Test Comment: Less than 10% fines, Hydrometer not performed
Sample Description: Moist, yellowish brown sand with silt and gravel
Sample Comment: ---

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	25.2	68.0	6.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	94		
0.375 in	9.50	86		
#4	4.75	75		
#10	2.00	58		
#20	0.85	36		
#40	0.42	15		
#60	0.25	10		
#100	0.15	8		
#200	0.075	7		

Coefficients

D_{85} = 8.8625 mm D_{30} = 0.7050 mm
D_{60} = 2.2126 mm D_{15} = 0.4272 mm
D_{50} = 1.4720 mm D_{10} = 0.2290 mm
C_u = 9.662 C_c = 0.981

Classification

ASTM Poorly graded sand with silt and gravel (SP-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID: GB-3	Test Date: 02/11/09	Checked By:	jdt
Depth : 24-26 ft	Test Id: 146553		

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

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-3	---	24-26 ft	12	n/a	n/a	n/a	n/a	Poorly graded sand with silt and gravel (SP-SM)

85% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

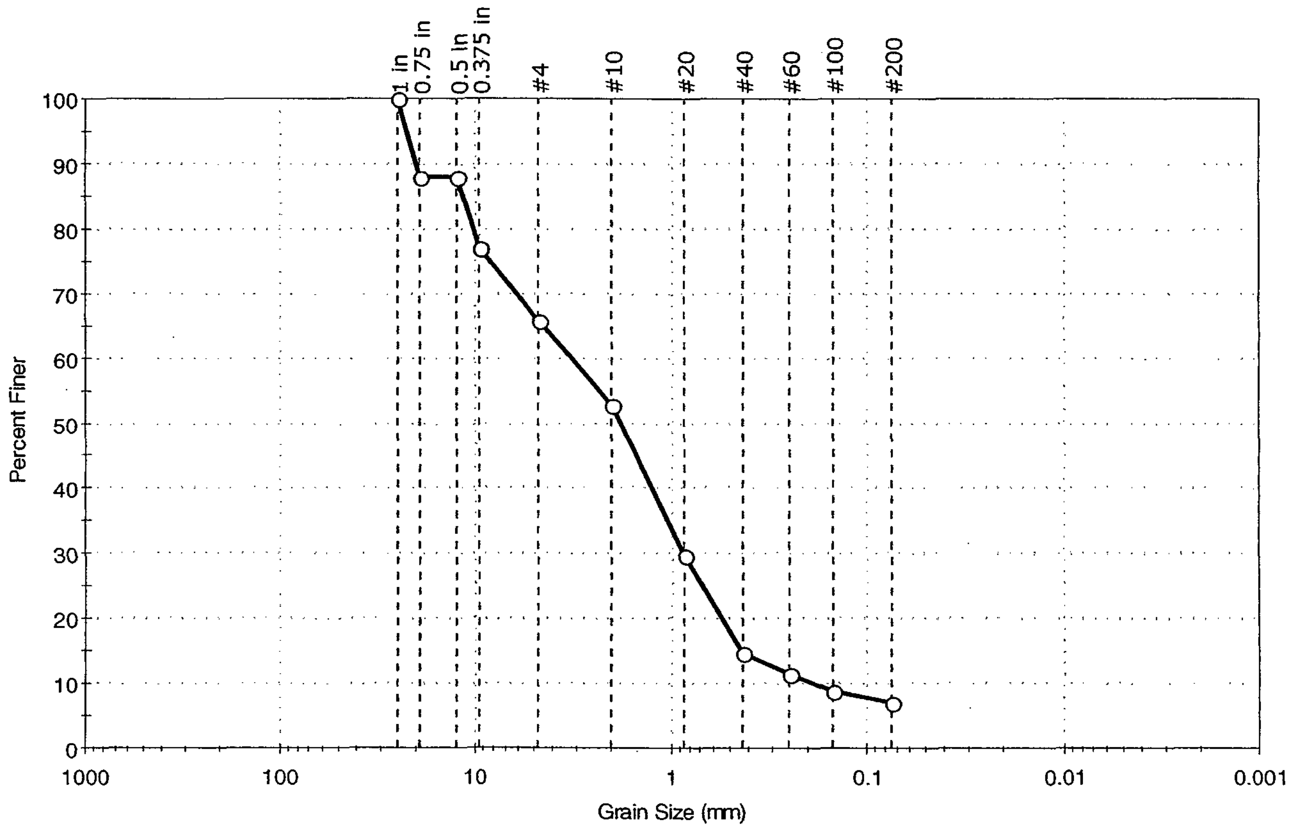
Toughness: n/a

The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID: GB-3	Test Date: 02/11/09	Checked By:	jdt
Depth : 28-30 ft	Test Id: 146504		
Test Comment: Less than 10% fines, Hydrometer not performed			
Sample Description: Moist, yellow sand with silt and gravel			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	34.1	58.9	7.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	88		
0.5 in	12.50	88		
0.375 in	9.50	77		
#4	4.75	66		
#10	2.00	53		
#20	0.85	30		
#40	0.42	15		
#60	0.25	11		
#100	0.15	9		
#200	0.075	7		

Coefficients

D_{85} =11.6235 mm D_{30} =0.8549 mm
D_{60} =3.2054 mm D_{15} =0.4308 mm
D_{50} =1.7935 mm D_{10} =0.1884 mm
C_u =17.014 C_c =1.210

Classification

ASTM Well-graded sand with silt and gravel (SW-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID: ---		Sample Type:	bag	Tested By:	cam
Sample ID:GB-3		Test Date:	02/11/09	Checked By:	jdt
Depth :	28-30 ft	Test Id:	146554		
Test Comment:	---				
Sample Description:	Moist, yellow sand with silt and gravel				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-3	---	28-30 ft	13	n/a	n/a	n/a	n/a	Well-graded sand with silt and gravel (SW-SM)

85% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

Toughness: n/a

The sample was determined to be Non-Plastic

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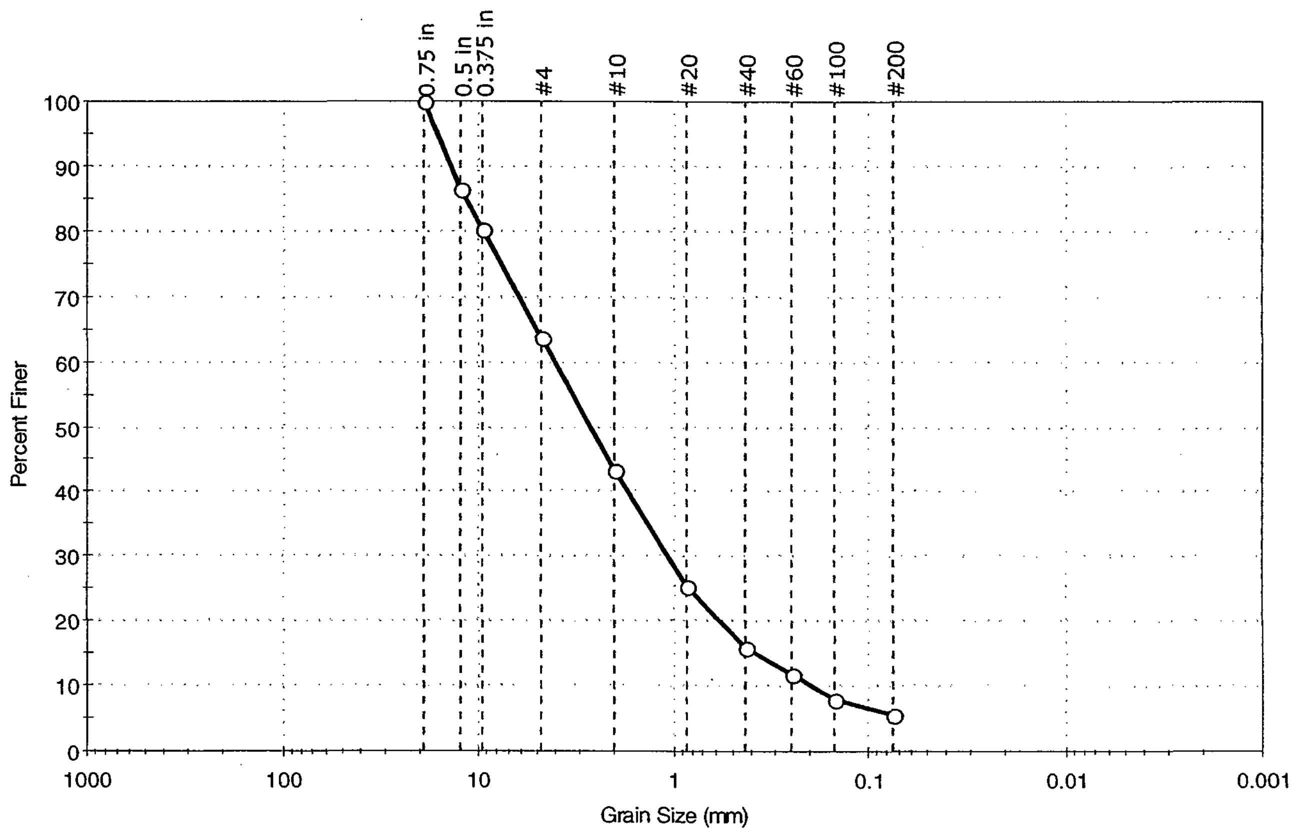
GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-3	Test Date: 02/11/09	Checked By:	jdt
Depth : 32-34 ft	Test Id: 146505		
Test Comment: Less than 10% fines, Hydrometer not performed			
Sample Description: Moist, yellow sand with silt and gravel			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	36.2	58.2	5.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	86		
0.375 in	9.50	80		
#4	4.75	64		
#10	2.00	43		
#20	0.85	25		
#40	0.42	16		
#60	0.25	12		
#100	0.15	8		
#200	0.075	6		

Coefficients

D_{85} =11.7126 mm D_{30} =1.0566 mm
D_{60} =4.0493 mm D_{15} =0.3817 mm
D_{50} =2.6574 mm D_{10} =0.1955 mm
C_u =20.713 C_c =1.410

Classification

ASTM   Well-graded sand with silt and gravel (SW-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-3	Test Date:	02/11/09	Checked By:	jdt
Depth :	32-34 ft	Test Id:	146555		
Test Comment:	---				
Sample Description:	Moist, yellow sand with silt and gravel				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-3	---	32-34 ft	14	n/a	n/a	n/a	n/a	Well-graded sand with silt and gravel (SW-SM)

84% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

Toughness: n/a

The sample was determined to be Non-Plastic

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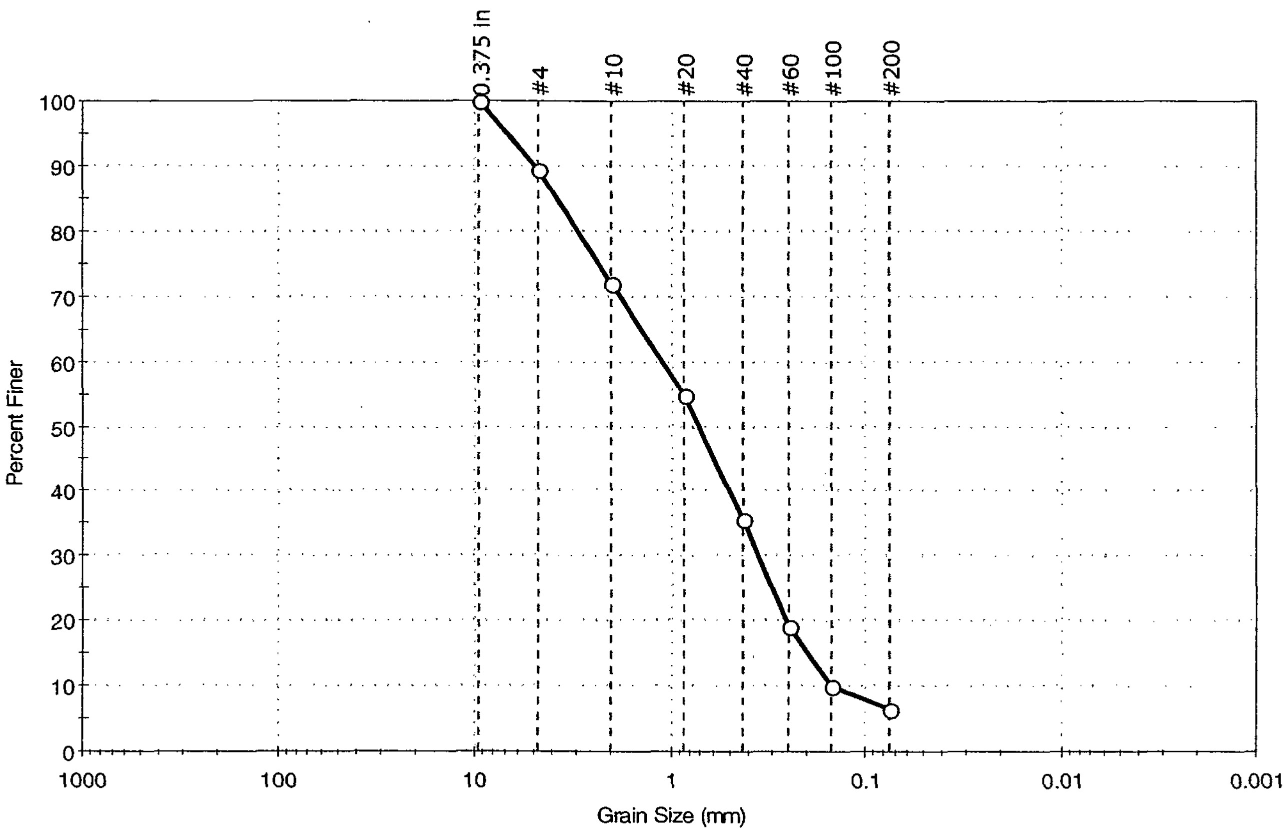
GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-3	Test Date: 02/11/09	Checked By:	jdt
Depth : 36-38 ft	Test Id: 146506		
Test Comment: Less than 10% fines, Hydrometer not performed			
Sample Description: Moist, yellowish brown sand with silt			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	10.7	82.9	6.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	89		
#10	2.00	72		
#20	0.85	55		
#40	0.42	36		
#60	0.25	19		
#100	0.15	10		
#200	0.075	6		

Coefficients

D_{85} =3.8413 mm D_{30} =0.3525 mm

D_{60} =1.1030 mm D_{15} =0.1965 mm

D_{50} =0.7132 mm D_{10} =0.1455 mm

C_u =7.581 C_c =0.774

Classification

ASTM Poorly graded sand with silt (SP-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-3	Test Date:	02/11/09	Checked By:	jdt
Depth :	36-38 ft	Test Id:	146556		
Test Comment:	---				
Sample Description:	Moist, yellowish brown sand with silt				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-3	---	36-38 ft	15	n/a	n/a	n/a	n/a	Poorly graded sand with silt (SP-SM)

64% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

Toughness: n/a

The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID: ---		Sample Type: ---		Tested By:	ap
Sample ID:---		Test Date:	02/18/09	Checked By:	jdt
Depth : ---		Test Id:	146611		

USCS Classification - ASTM D 2487-06

Boring ID	Sample ID	Depth	Group Name	Group Symbol	Gravel, %	Sand, %	Fines, %
---	GB-4	0-2 ft	Silty sand with gravel	SM	19.5	56.3	24.2
---	GB-4	4-6 ft	Silty sand with gravel	SM	16.1	61.6	22.3
---	GB-4	8-10 ft	Silty sand	SM	11.5	73.0	15.5
---	GB-4	10-12 ft	Silty sand	SM	5.2	80.1	14.7
---	GB-4	14-16 ft	Silty sand	SM	14.6	72.0	13.4

Remarks: Grain Size analysis performed by ASTM D422, results enclosed
Atterbeg Limits performed by ASTM 4318, results enclosed

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	---	Tested By:	ap
Sample ID:	---	Test Date:	02/18/09	Checked By:	jdt
Depth :	---	Test Id:	146616		

USCS Classification - ASTM D 2487-06

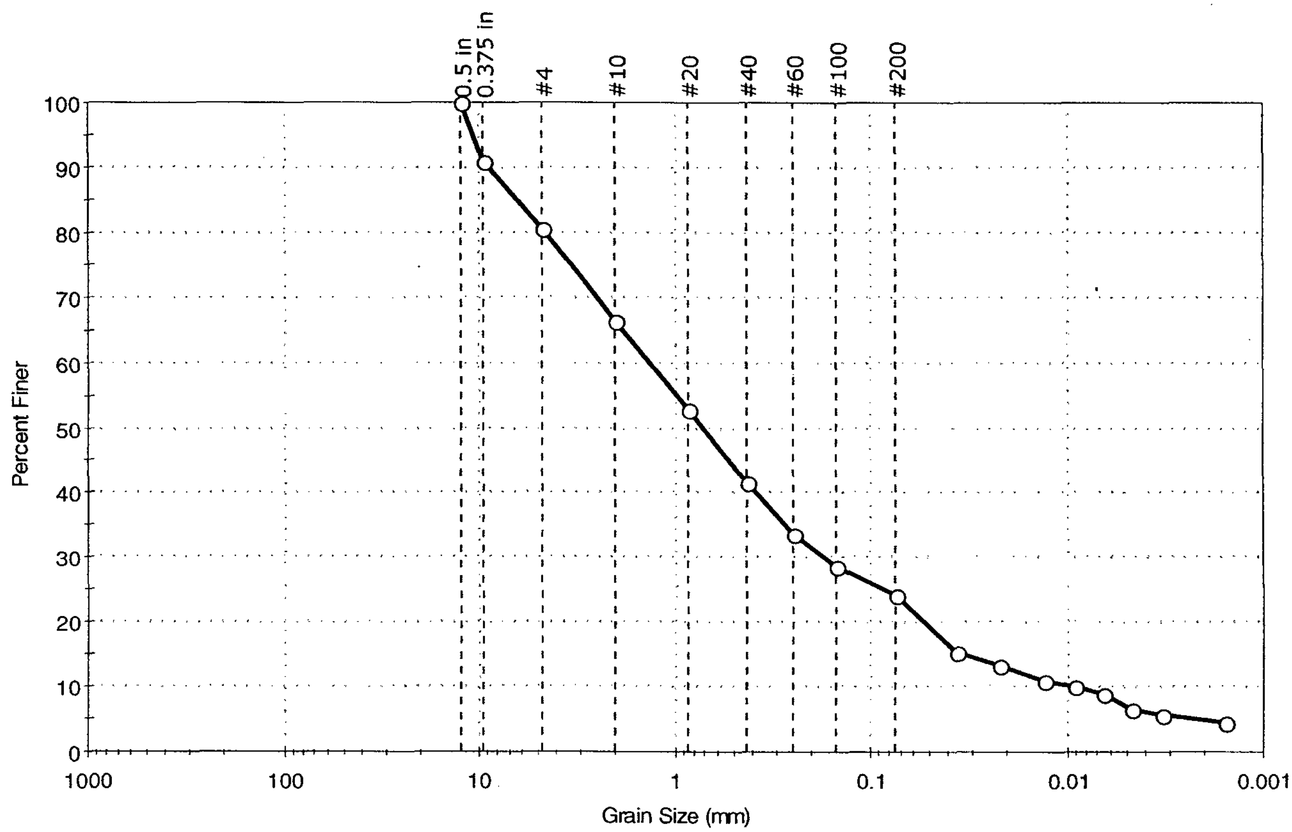
Boring ID	Sample ID	Depth	Group Name	Group Symbol	Gravel, %	Sand, %	Fines, %
---	GB-4	18-20 ft	Poorly graded sand with silt	SP-SM	12.3	76.5	11.2
---	GB-4	22-24 ft	Poorly graded sand with silt	SP-SM	4.2	88.2	7.6
---	GB-4	26-28 ft	Poorly graded sand with silt	SP-SM	0.3	93.7	6.0
---	GB-4	30-32 ft	Poorly graded sand with silt	SP-SM	3.8	89.3	6.9
---	GB-4	34-36 ft	Silty sand	SM	1.9	83.7	14.4

Remarks: Grain Size analysis performed by ASTM D422, results enclosed
Atterbeg Limits performed by ASTM 4318, results enclosed

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-4	Test Date: 02/12/09	Checked By:	jdt
Depth : 0-2 ft	Test Id: 146507		
Test Comment: ---			
Sample Description: Moist, gray silty sand with gravel			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	19.5	56.3	24.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	91		
#4	4.75	81		
#10	2.00	66		
#20	0.85	53		
#40	0.42	42		
#60	0.25	34		
#100	0.15	29		
#200	0.075	24		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0371	15		
---	0.0222	13		
---	0.0132	11		
---	0.0093	10		
---	0.0066	9		
---	0.0047	7		
---	0.0033	5		
---	0.0016	4		

Coefficients

D_{85} =6.4261 mm D_{30} =0.1720 mm

D_{60} =1.3394 mm D_{15} =0.0339 mm

D_{50} =0.7174 mm D_{10} =0.0096 mm

C_u =N/A C_c =N/A

Classification

ASTM Silty sand with gravel (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID:GB-4	Test Date: 02/12/09	Checked By:	jdt
Depth : 0-2 ft	Test Id: 146557		
Test Comment: ---			
Sample Description: Moist, gray silty sand with gravel			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-4	---	0-2 ft	19	n/a	n/a	n/a	n/a	Silty sand with gravel (SM)

58% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

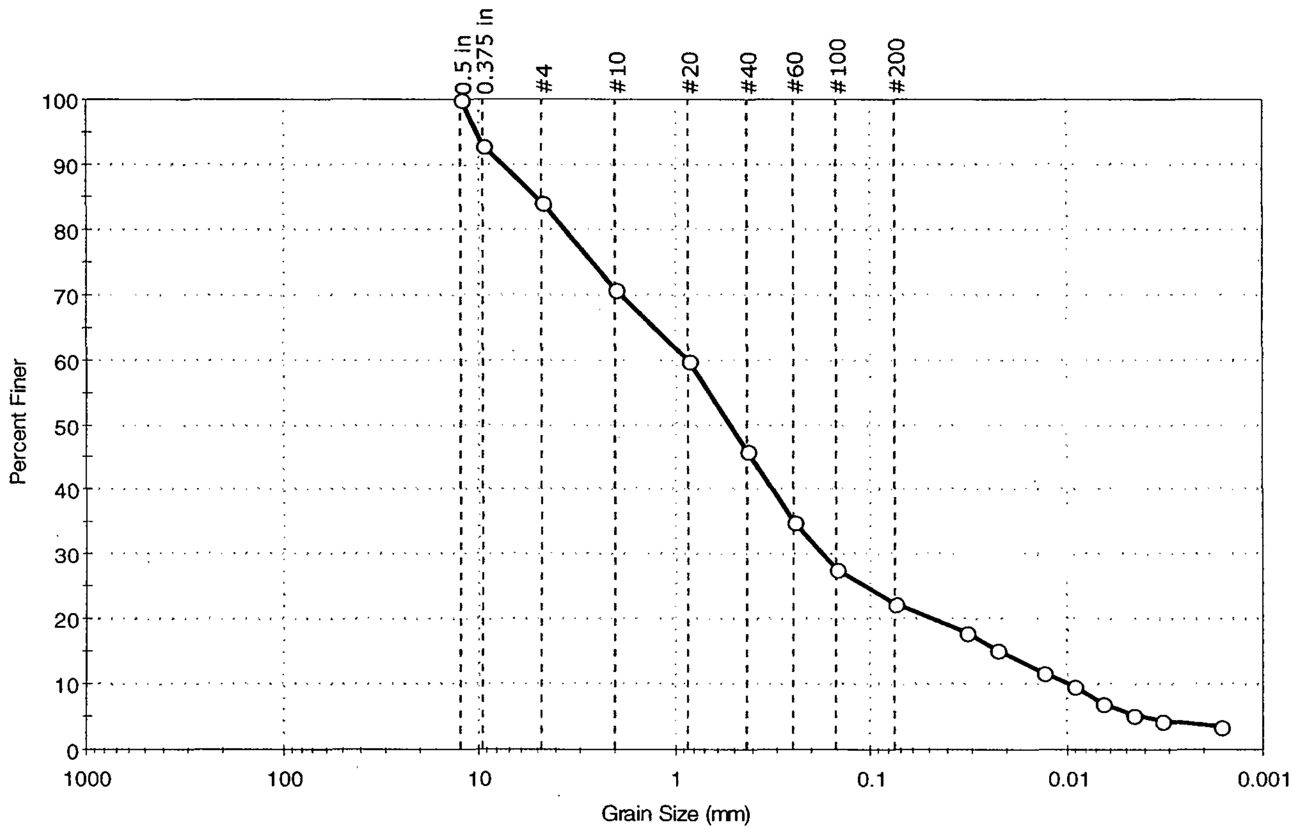
Toughness: n/a

The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID: GB-4	Test Date: 02/16/09	Checked By:	jdt
Depth : 4-6 ft	Test Id: 146508		
Test Comment: ---			
Sample Description: Moist, olive gray silty sand with gravel			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	16.1	61.6	22.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	93		
#4	4.75	84		
#10	2.00	71		
#20	0.85	60		
#40	0.42	46		
#60	0.25	35		
#100	0.15	28		
#200	0.075	22		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0328	18		
---	0.0226	15		
---	0.0131	12		
---	0.0092	10		
---	0.0066	7		
---	0.0046	5		
---	0.0033	4		
---	0.0017	4		

Coefficients

D_{85} = 5.1586 mm	D_{30} = 0.1748 mm
D_{60} = 0.8578 mm	D_{15} = 0.0218 mm
D_{50} = 0.5182 mm	D_{10} = 0.0095 mm
C_u = N/A	C_c = N/A

Classification

ASTM Silty sand with gravel (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-4	Test Date:	02/16/09	Checked By:	jdt
Depth :	4-6 ft	Test Id:	146558		
Test Comment:	---				
Sample Description:	Moist, olive gray silty sand with gravel				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-4	---	4-6 ft	21	n/a	n/a	n/a	n/a	Silty sand with gravel (SM)

54% Retained on #40 Sieve

Dry Strength: MEDIUM

Dilentancy: SLOW

Toughness: n/a

The sample was determined to be Non-Plastic

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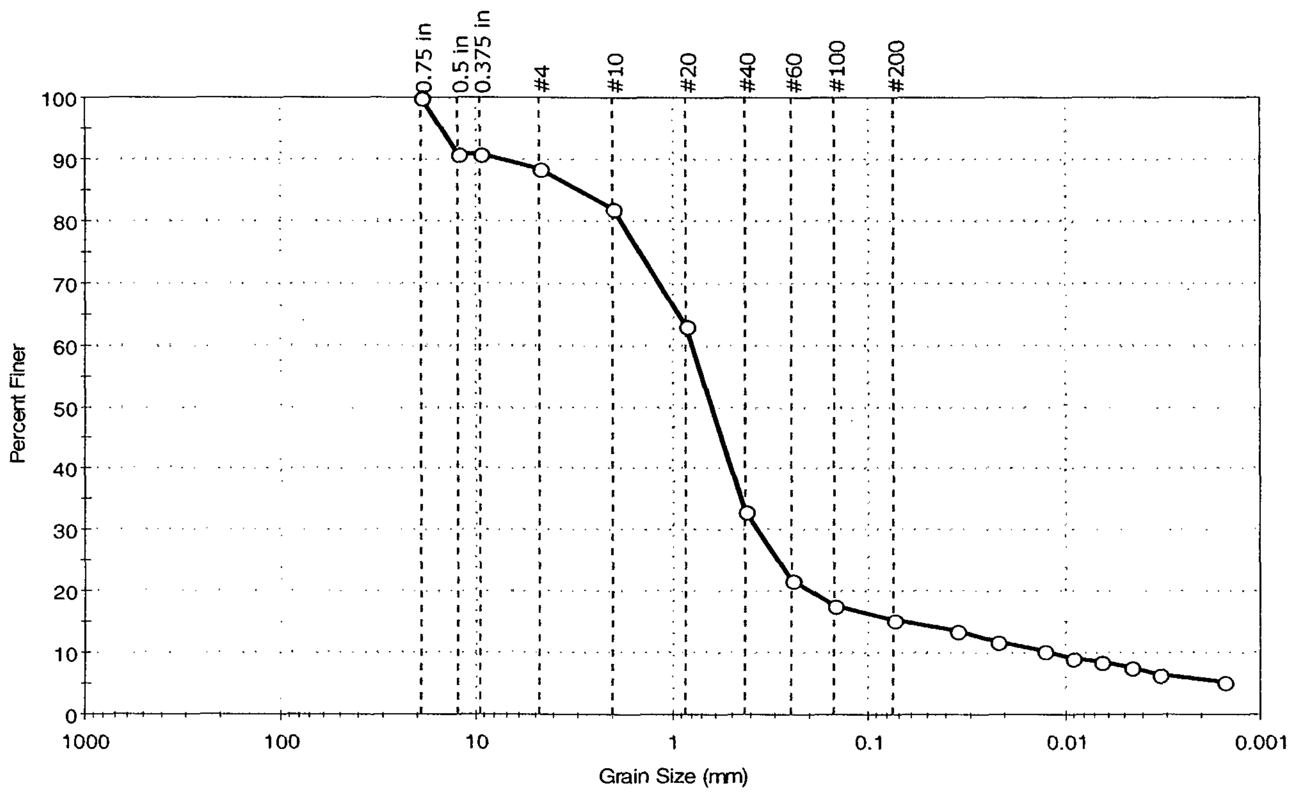
GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	jbr
Sample ID:	GB-4	Test Date:	02/12/09	Checked By:	jdt
Depth :	8-10 ft	Test Id:	146509		
Test Comment:	---				
Sample Description:	Moist, dark yellowish brown silty sand				
Sample Comment:	---				

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	11.5	73.0	15.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	91		
0.375 in	9.50	91		
#4	4.75	88		
#10	2.00	82		
#20	0.85	63		
#40	0.42	33		
#60	0.25	22		
#100	0.15	18		
#200	0.075	15		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0361	14		
---	0.0220	12		
---	0.0130	10		
---	0.0092	9		
---	0.0065	8		
---	0.0046	8		
---	0.0033	6		
---	0.0015	5		

Coefficients

D_{85} =3.0095 mm	D_{30} =0.3669 mm
D_{60} =0.7890 mm	D_{15} =0.0623 mm
D_{50} =0.6266 mm	D_{10} =0.0118 mm
C_u =N/A	C_c =N/A

Classification

ASTM Silty sand (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape :

Sand/Gravel Hardness :

printed 2/18/2009 11:26:17 AM

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID:GB-4	Test Date: 02/12/09	Checked By:	jdt
Depth : 8-10 ft	Test Id: 146559		
Test Comment: ---			
Sample Description: Moist, dark yellowish brown silty sand			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-4	---	8-10 ft	13	n/a	n/a	n/a	n/a	Silty sand (SM)

67% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

Toughness: n/a

The sample was determined to be Non-Plastic

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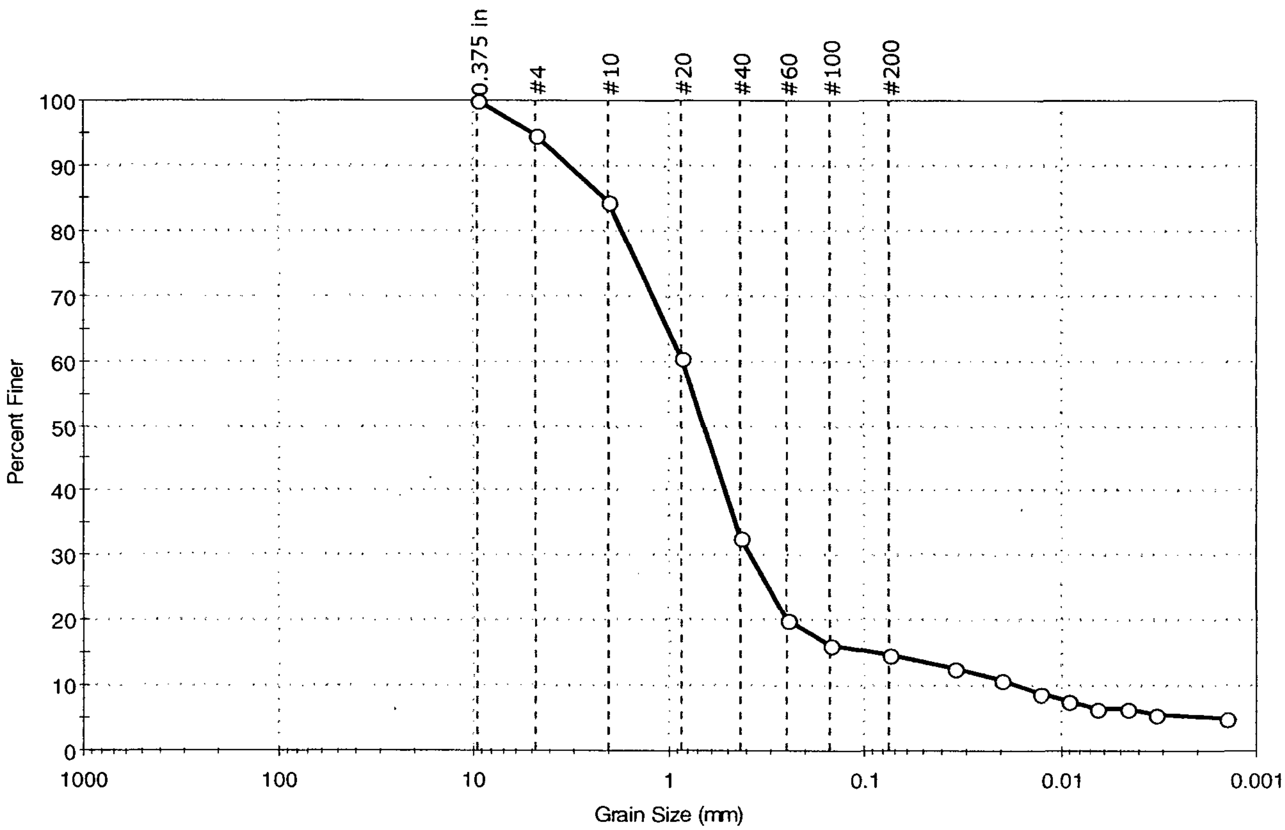
GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-4	Test Date: 02/12/09	Checked By:	jdt
Depth : 10-12 ft	Test Id: 146510		
Test Comment: ---			
Sample Description: Moist, yellowish brown silty sand			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	5.2	80.1	14.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	95		
#10	2.00	84		
#20	0.85	60		
#40	0.42	33		
#60	0.25	20		
#100	0.15	16		
#200	0.075	15		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0348	13		
---	0.0204	11		
---	0.0129	9		
---	0.0092	8		
---	0.0065	6		
---	0.0046	6		
---	0.0033	6		
---	0.0014	5		

Coefficients

D_{85} =2.1093 mm
D_{30} =0.3778 mm
D_{60} =0.8407 mm
D_{15} =0.0860 mm
D_{50} =0.6542 mm
D_{10} =0.0165 mm
C_u =N/A
C_c =N/A

Classification

ASTM Silty sand (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID:GB-4	Test Date: 02/12/09	Checked By:	jdt
Depth : 10-12 ft	Test Id: 146560		
Test Comment: ---			
Sample Description: Moist, yellowish brown silty sand			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-4	---	10-12 ft	13	n/a	n/a	n/a	n/a	Silty sand (SM)

67% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

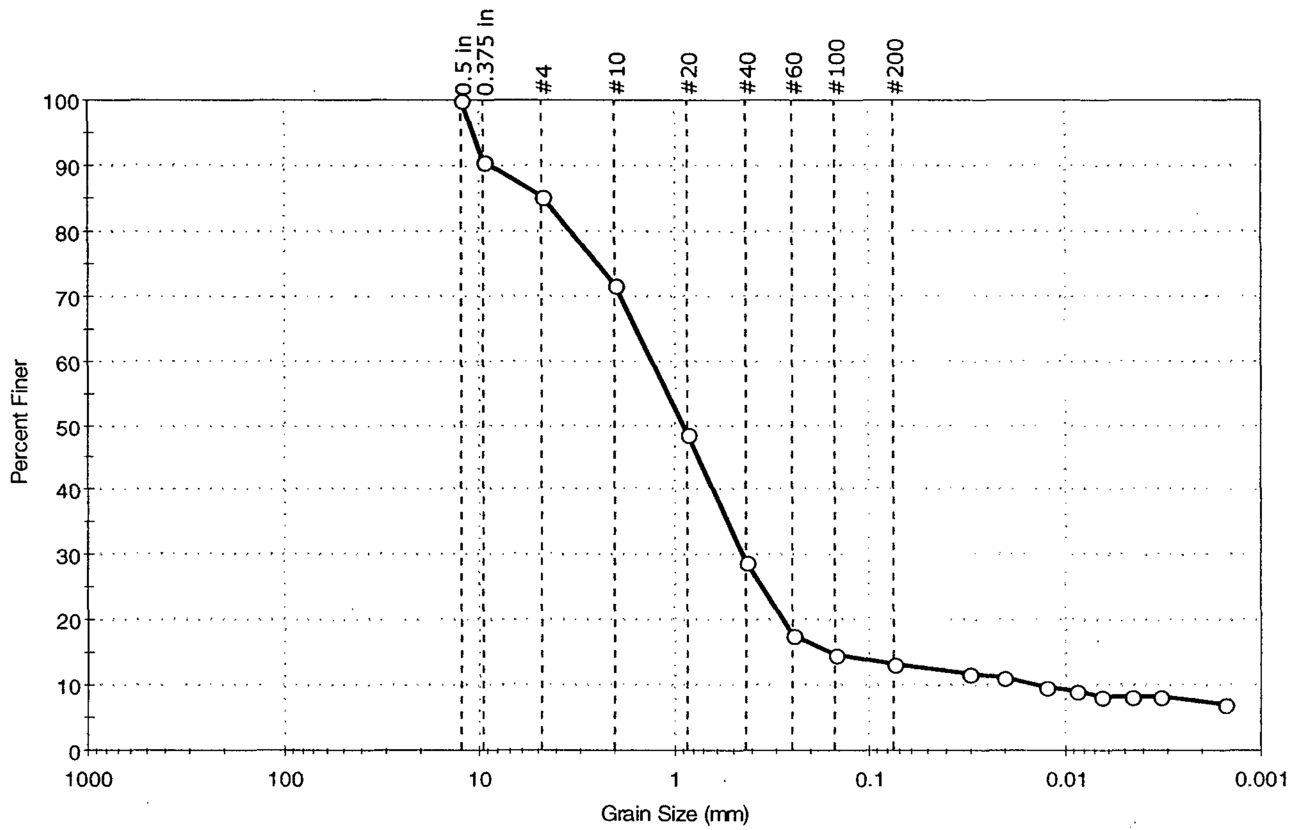
Toughness: n/a

The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-4	Test Date: 02/11/09	Checked By:	jdt
Depth : 14-16 ft	Test Id: 146511		
Test Comment: ---			
Sample Description: Moist, yellowish brown silty sand			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	14.6	72.0	13.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	91		
#4	4.75	85		
#10	2.00	72		
#20	0.85	49		
#40	0.42	29		
#60	0.25	18		
#100	0.15	15		
#200	0.075	13		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0313	12		
---	0.0205	11		
---	0.0124	10		
---	0.0088	9		
---	0.0066	8		
---	0.0046	8		
---	0.0033	8		
---	0.0015	7		

Coefficients

D_{85} =4.6390 mm　D_{30} =0.4430 mm
D_{60} =1.2985 mm　D_{15} =0.1587 mm
D_{50} =0.8945 mm　D_{10} =0.0138 mm
C_u =N/A　C_c =N/A

Classification

ASTM　Silty sand (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID:GB-4	Test Date: 02/11/09	Checked By:	jdt
Depth : 14-16 ft	Test Id: 146561		

Test Comment: ---
Sample Description: Moist, yellowish brown silty sand
Sample Comment: ---

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

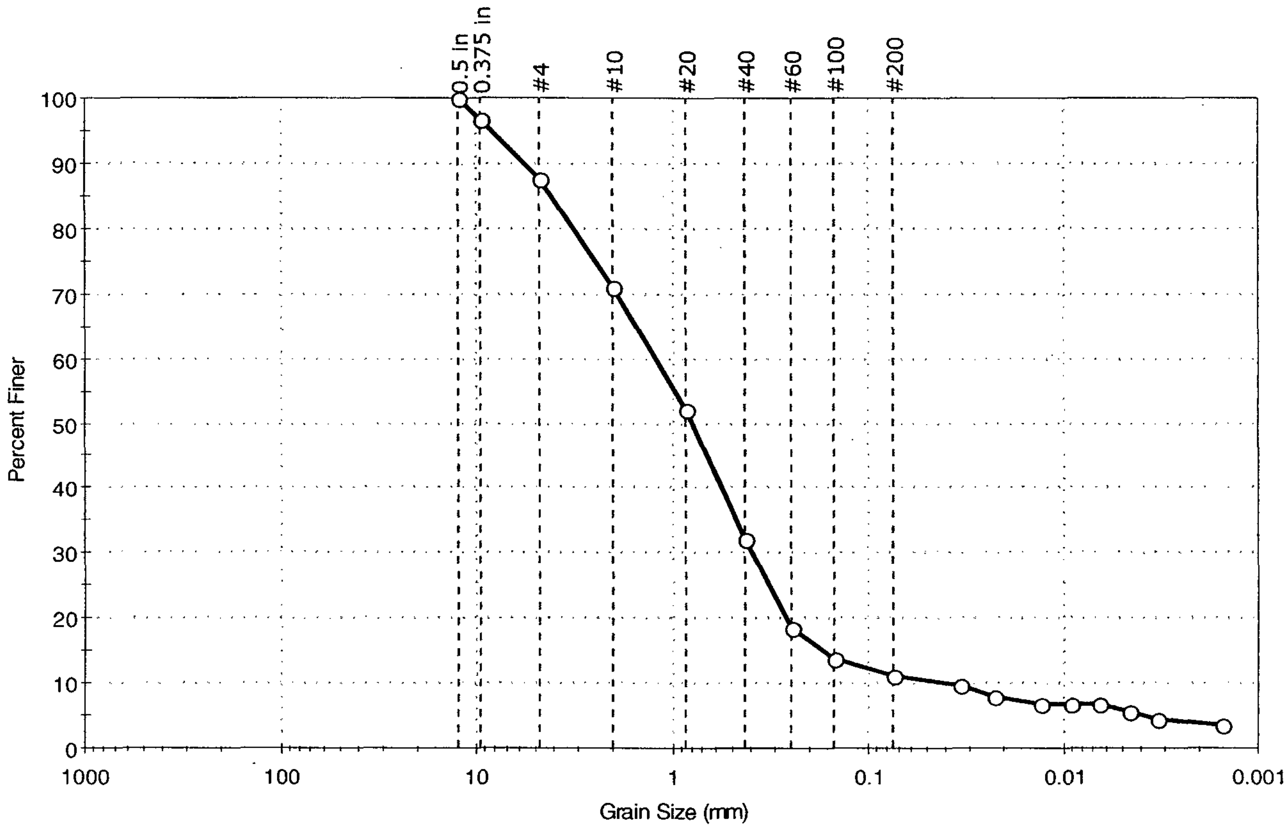
Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-4	---	14-16 ft	11	n/a	n/a	n/a	n/a	Silty sand (SM)

71% Retained on #40 Sieve
Dry Strength: NONE
Dilentancy: RAPID
Toughness: n/a
The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-4	Test Date: 02/12/09	Checked By:	jdt
Depth : 18-20 ft	Test Id: 146512		
Test Comment: ---			
Sample Description: Moist, yellowish brown sand with silt			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	12.3	76.5	11.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	97		
#4	4.75	88		
#10	2.00	71		
#20	0.85	52		
#40	0.42	32		
#60	0.25	19		
#100	0.15	14		
#200	0.075	11		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0345	10		
---	0.0229	8		
---	0.0130	7		
---	0.0093	7		
---	0.0065	7		
---	0.0047	6		
---	0.0033	5		
---	0.0015	3		

Coefficients

D_{85} =4.1403 mm
D_{30} =0.3924 mm
D_{60} =1.2139 mm
D_{15} =0.1718 mm
D_{50} =0.7892 mm
D_{10} =0.0402 mm
C_u =30.197
C_c =3.155

Classification

ASTM Poorly graded sand with silt (SP-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-4	Test Date:	02/12/09	Checked By:	jdt
Depth :	18-20 ft	Test Id:	146562		
Test Comment:	---				
Sample Description:	Moist, yellowish brown sand with silt				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-4	---	18-20 ft	14	n/a	n/a	n/a	n/a	Poorly graded sand with silt (SP-SM)

68% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

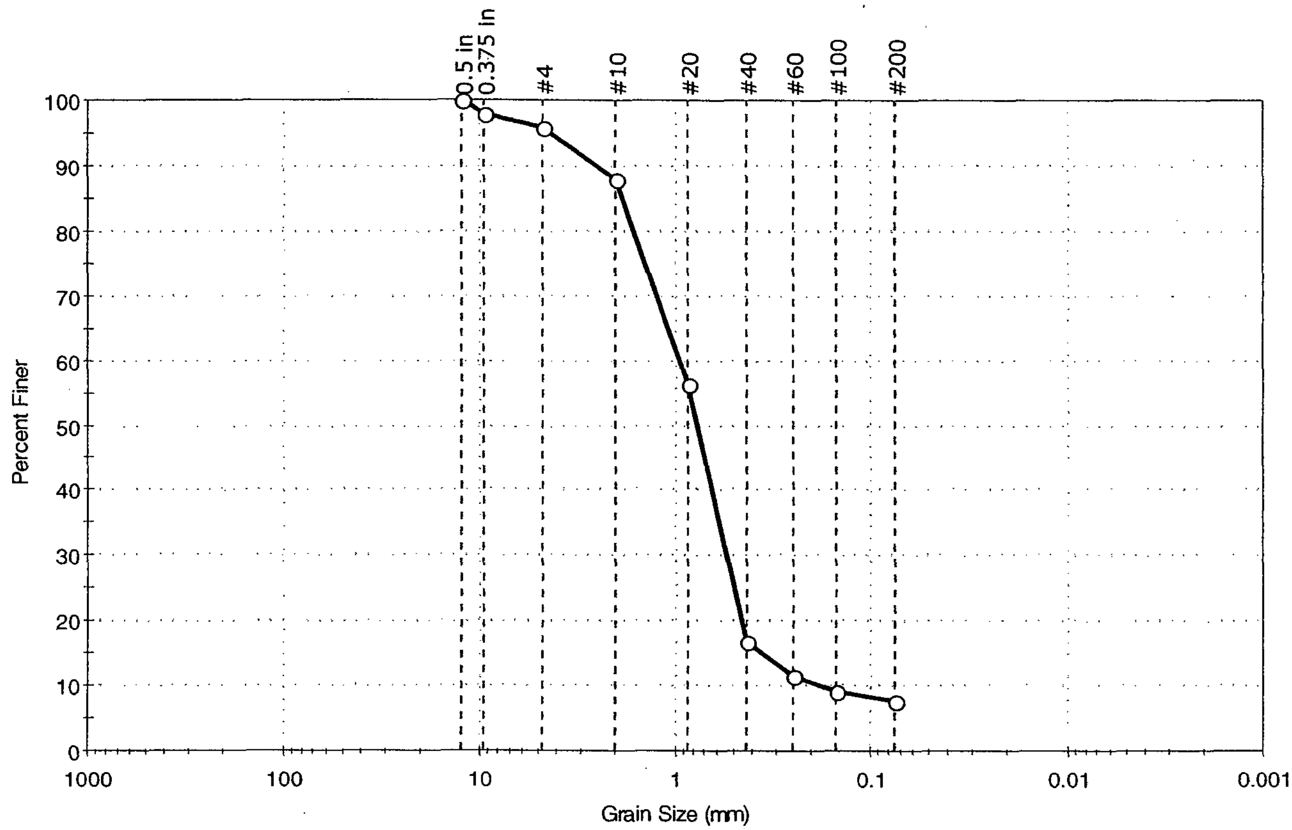
Toughness: n/a

The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-4	Test Date: 02/11/09	Checked By:	jdt
Depth : 22-24 ft	Test Id: 146513		
Test Comment:	Less than 10% fines, Hydrometer not performed		
Sample Description:	Moist, yellow sand with silt		
Sample Comment:	---		

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	4.2	88.2	7.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	98		
#4	4.75	96		
#10	2.00	88		
#20	0.85	56		
#40	0.42	17		
#60	0.25	11		
#100	0.15	9		
#200	0.075	8		

Coefficients

D_{85} =1.8431 mm　　D_{30} =0.5348 mm

D_{60} =0.9380 mm　　D_{15} =0.3524 mm

D_{50} =0.7602 mm　　D_{10} =0.1843 mm

C_u =5.090　　C_c =1.654

Classification

ASTM　Poorly graded sand with silt (SP-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.		
Project:	SMC Stockyard Geotech Borings		
Location:	Newfield, NJ	Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID:GB-4	Test Date: 02/11/09	Checked By:	jdt
Depth : 22-24 ft	Test Id: 146563		
Test Comment:	---		
Sample Description:	Moist, yellow sand with silt		
Sample Comment:	---		

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-4	---	22-24 ft	22	n/a	n/a	n/a	n/a	Poorly graded sand with silt (SP-SM)

83% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

Toughness: n/a

The sample was determined to be Non-Plastic

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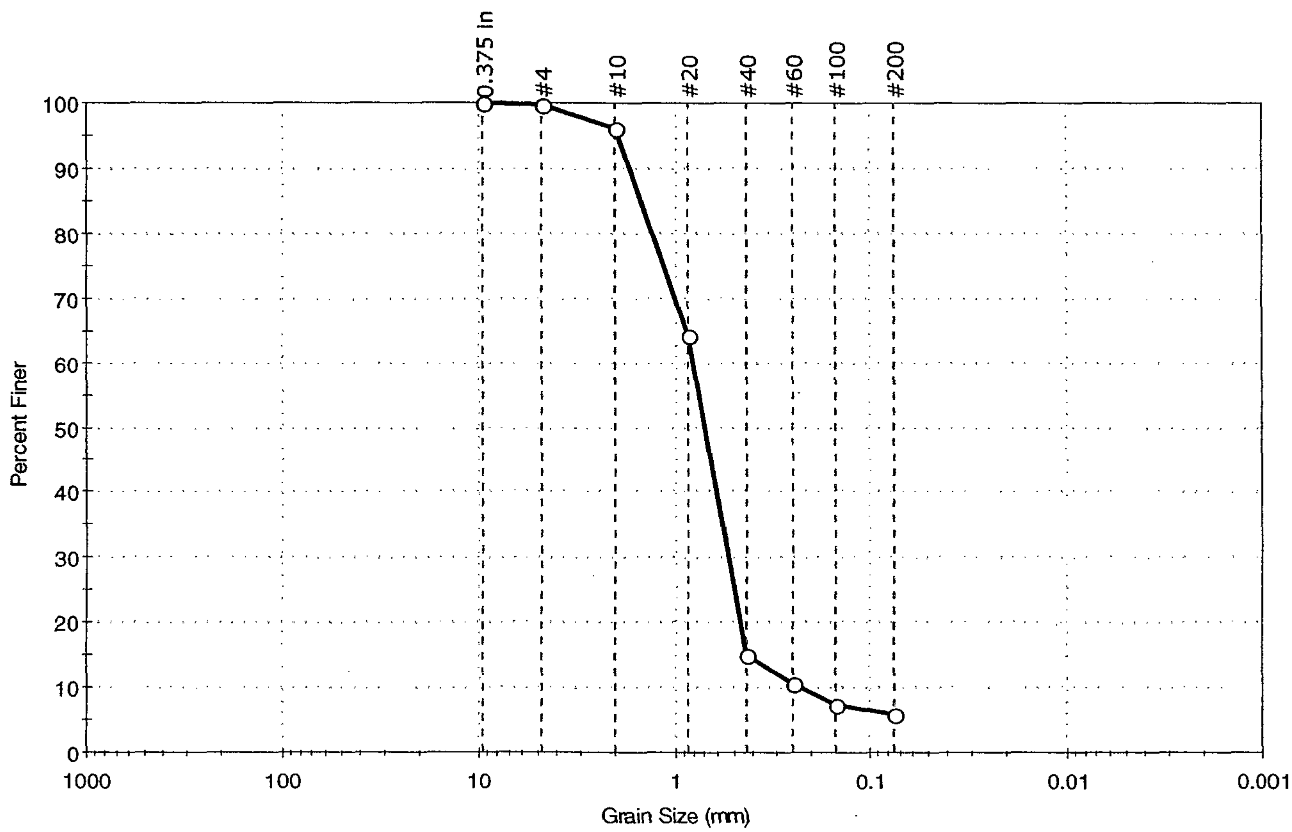
GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.		
Project:	SMC Stockyard Geotech Borings		
Location:	Newfield, NJ	Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-4	Test Date: 02/11/09	Checked By:	jdt
Depth : 26-28 ft	Test Id: 146514		
Test Comment:	Less than 10% fines, Hydrometer not performed		
Sample Description:	Moist, yellow sand with silt		
Sample Comment:	---		

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.3	93.7	6.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	100		
#10	2.00	96		
#20	0.85	64		
#40	0.42	15		
#60	0.25	11		
#100	0.15	7		
#200	0.075	6		

Coefficients

D_{85} =1.4842 mm D_{30} =0.5248 mm
D_{60} =0.8002 mm D_{15} =0.4250 mm
D_{50} =0.6953 mm D_{10} =0.2244 mm
C_u =3.566 C_c =1.534

Classification

ASTM Poorly graded sand with silt (SP-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-4	Test Date:	02/11/09	Checked By:	jdt
Depth :	26-28 ft	Test Id:	146564		
Test Comment:	---				
Sample Description:	Moist, yellow sand with silt				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-4	---	26-28 ft	20	n/a	n/a	n/a	n/a	Poorly graded sand with silt (SP-SM)

85% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

Toughness: n/a

The sample was determined to be Non-Plastic

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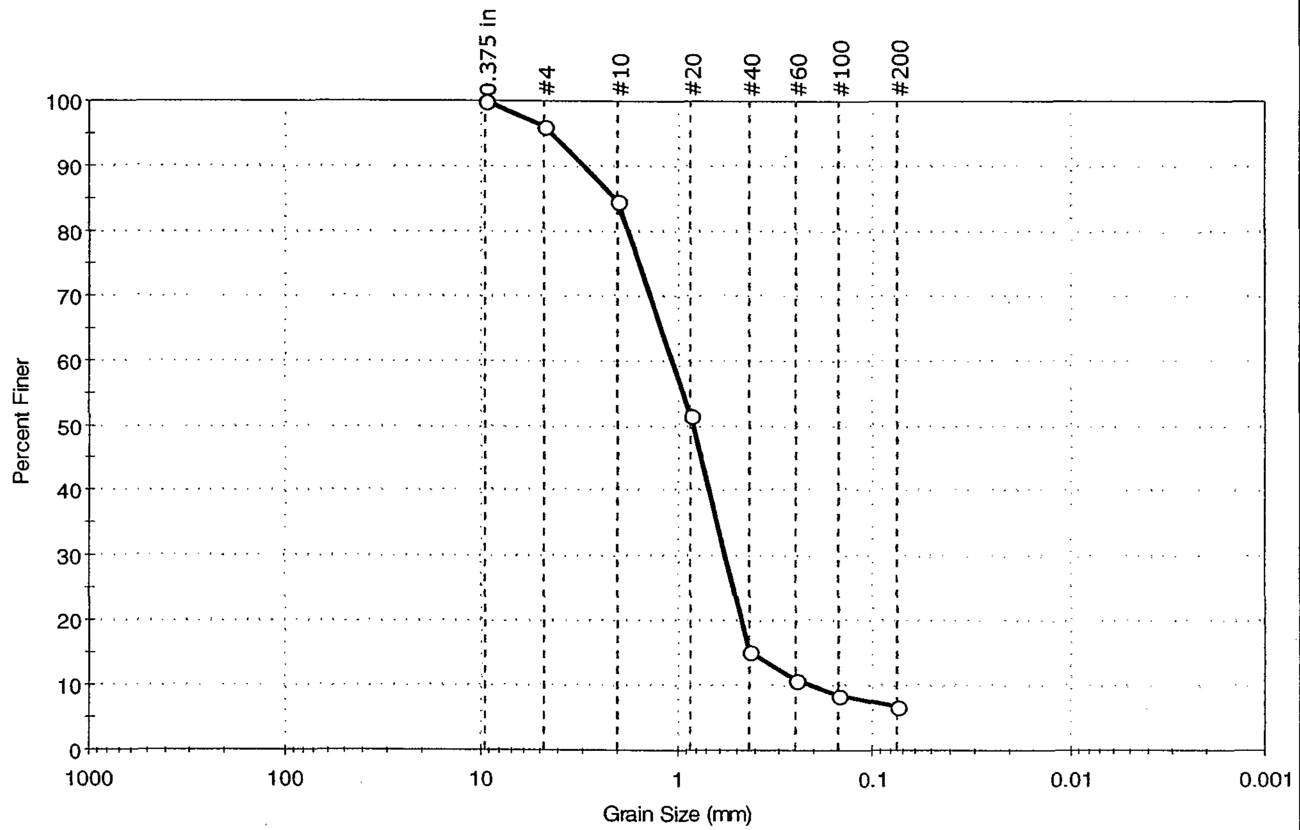
GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	jbr
Sample ID:	GB-4	Test Date:	02/12/09	Checked By:	jdt
Depth :	30-32 ft	Test Id:	146515		
Test Comment:	Less than 10% fines, Hydrometer not performed				
Sample Description:	Moist, yellow sand with silt				
Sample Comment:	---				

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	3.8	89.3	6.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	96		
#10	2.00	85		
#20	0.85	52		
#40	0.42	15		
#60	0.25	11		
#100	0.15	9		
#200	0.075	7		

Coefficients

D_{85} =2.0357 mm — D_{30} =0.5620 mm
D_{60} =1.0555 mm — D_{15} =0.4043 mm
D_{50} =0.8242 mm — D_{10} =0.2001 mm
C_u =5.275 — C_c =1.495

Classification

ASTM — Poorly graded sand with silt (SP-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-4	Test Date:	02/12/09	Checked By:	jdt
Depth :	30-32 ft	Test Id:	146565		
Test Comment:	---				
Sample Description:	Moist, yellow sand with silt				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-4	---	30-32 ft	18	n/a	n/a	n/a	n/a	Poorly graded sand with silt (SP-SM)

85% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

Toughness: n/a

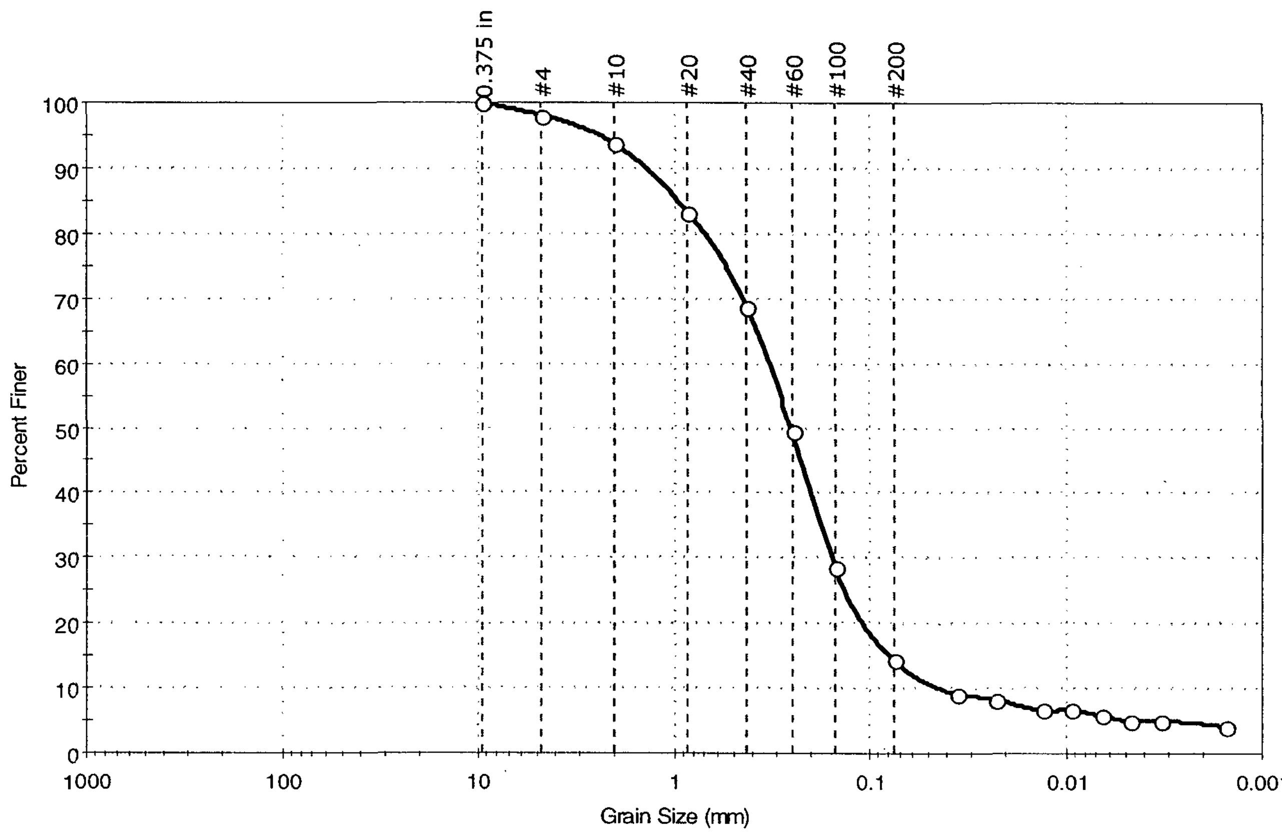
The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	jbr
Sample ID:	GB-4	Test Date:	02/11/09	Checked By:	jdt
Depth :	34-36 ft	Test Id:	146516		

Test Comment: ---
Sample Description: Moist, yellowish brown silty sand
Sample Comment: ---

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	1.9	83.7	14.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	98		
#10	2.00	94		
#20	0.85	83		
#40	0.42	69		
#60	0.25	49		
#100	0.15	29		
#200	0.075	14		
	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0358	9		
---	0.0227	8		
---	0.0132	7		
---	0.0093	7		
---	0.0066	6		
---	0.0047	5		
---	0.0033	5		
---	0.0016	4		

Coefficients

D_{85} = 0.9808 mm D_{30} = 0.1553 mm
D_{60} = 0.3344 mm D_{15} = 0.0772 mm
D_{50} = 0.2538 mm D_{10} = 0.0403 mm
C_u = N/A C_c = N/A

Classification

ASTM Silty sand (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID:GB-4	Test Date: 02/11/09	Checked By:	jdt
Depth : 34-36 ft	Test Id: 146566		
Test Comment: ---			
Sample Description: Moist, yellowish brown silty sand			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-4	---	34-36 ft	17	n/a	n/a	n/a	n/a	Silty sand (SM)

31% Retained on #40 Sieve

Dry Strength: MEDIUM

Dilentancy: RAPID

Toughness: n/a

The sample was determined to be Non-Plastic

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	---	Tested By:	ap
Sample ID:	---	Test Date:	02/18/09	Checked By:	jdt
Depth :	---	Test Id:	146621		

USCS Classification - ASTM D 2487-06

Boring ID	Sample ID	Depth	Group Name	Group Symbol	Gravel, %	Sand, %	Fines, %
---	GB-5	2-4 ft	Well-graded gravel with silt and sand	GW-GM	51.2	38.0	10.8
---	GB-5	6-8 ft	Silty sand	SM	4.1	72.8	23.1
---	GB-5	9-10 ft	Silty sand	SM	5.1	79.1	15.8
---	GB-5	12-14 ft	Poorly graded sand with silt	SP-SM	2.8	86.9	10.3
---	GB-5	16-18 ft	Poorly graded sand with silt	SP-SM	6.7	82.9	10.4

Remarks: Grain Size analysis performed by ASTM D422, results enclosed
Atterbeg Limits performed by ASTM 4318, results enclosed

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: ---	Tested By:	ap
Sample ID:---	Test Date: 02/04/09	Checked By:	jdt
Depth : ---	Test Id: 146625		

USCS Classification - ASTM D 2487-06

Boring ID	Sample ID	Depth	Group Name	Group Symbol	Gravel, %	Sand, %	Fines, %
---	GB-5	20-22 ft	Poorly graded sand with silt	SP-SM	2.6	86.6	10.8
---	GB-5	22-24 ft	Silty sand	SM	3.8	82.0	14.2
---	GB-5	26-28 ft	Silty sand with gravel	SM	19.4	64.2	16.4
---	GB-5	30-32 ft	fat clay with sand	CH	0.0	18.9	81.1

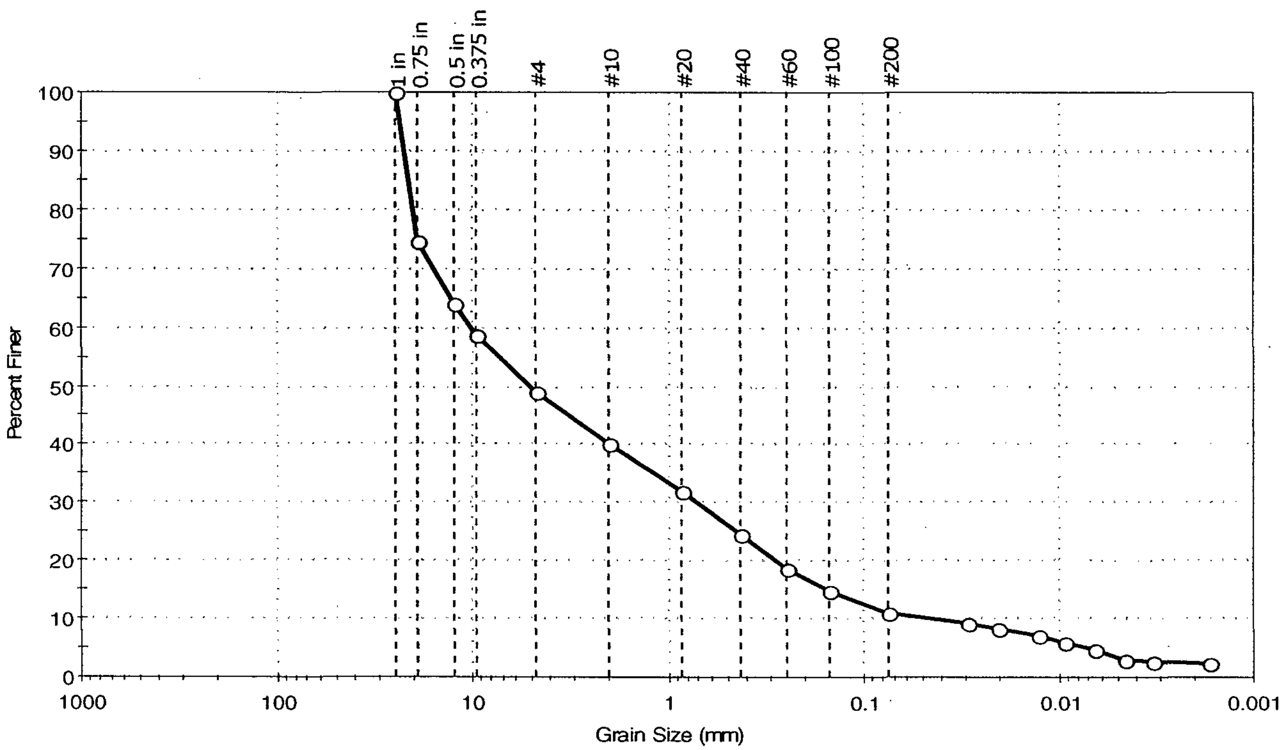
Remarks: Grain Size analysis performed by ASTM D422, results enclosed
Atterbeg Limits performed by ASTM 4318, results enclosed

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	jbr
Sample ID:	GB-5	Test Date:	02/16/09	Checked By:	jdt
Depth :	2-4 ft	Test Id:	146517		

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

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	51.2	38.0	10.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	75		
0.5 in	12.50	64		
0.375 in	9.50	59		
#4	4.75	49		
#10	2.00	40		
#20	0.85	32		
#40	0.42	24		
#60	0.25	19		
#100	0.15	15		
#200	0.075	11		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0300	9		
---	0.0205	8		
---	0.0129	7		
---	0.0093	6		
---	0.0066	5		
---	0.0046	3		
---	0.0033	3		
---	0.0017	2		

Coefficients

D_{85} =21.2389 mm | D_{30} =0.7102 mm
D_{60} =10.1989 mm | D_{15} =0.1576 mm
D_{50} =5.1545 mm | D_{10} =0.0457 mm
C_u =223.171 | C_c =1.082

Classification

ASTM: Well-graded gravel with silt and sand (GW-GM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID:GB-5	Test Date: 02/16/09	Checked By:	jdt
Depth : 2-4 ft	Test Id: 146567		

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

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-5	---	2-4 ft	19	n/a	n/a	n/a	n/a	Well-graded gravel with silt and sand (GW-GM)

76% Retained on #40 Sieve

Dry Strength: MEDIUM

Dilentancy: RAPID

Toughness: n/a

The sample was determined to be Non-Plastic

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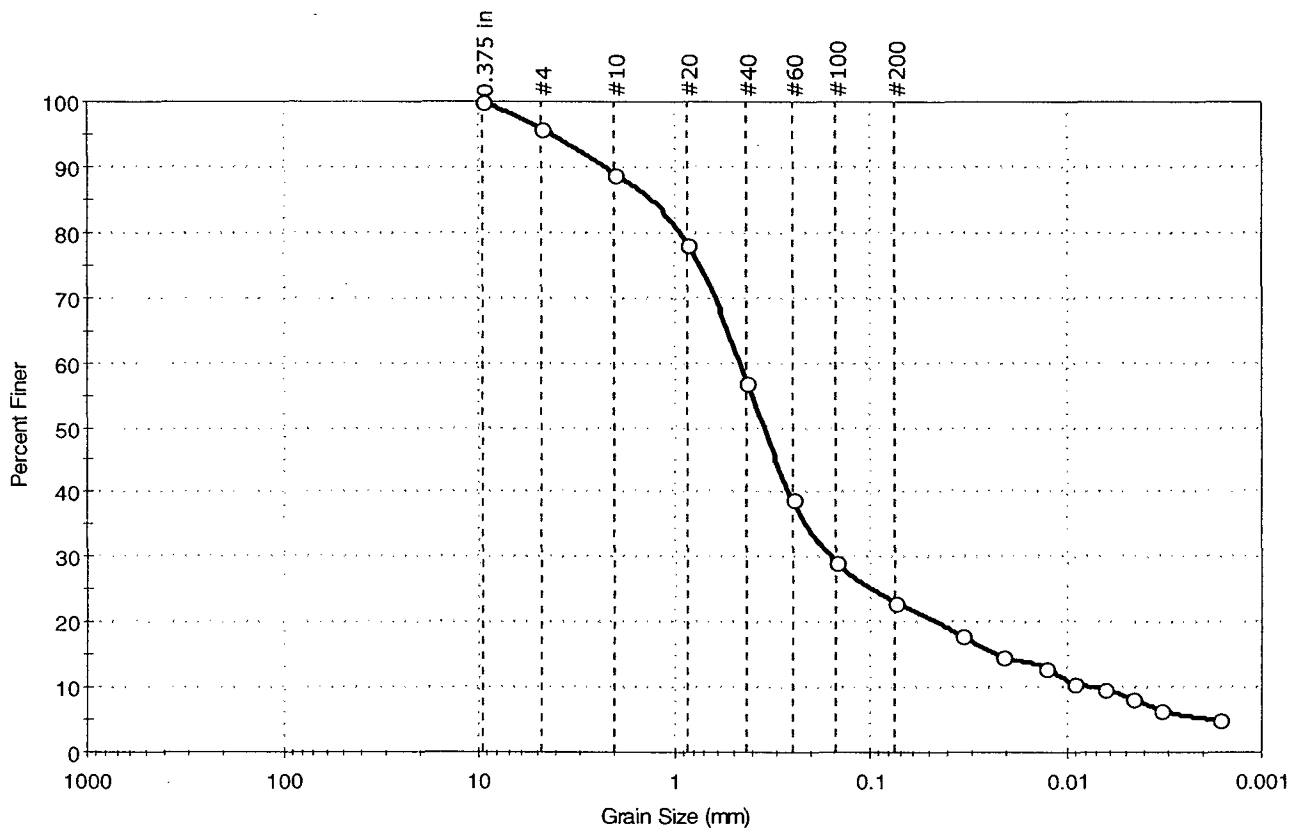
GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-5	Test Date: 02/10/09	Checked By:	jdt
Depth : 6-8 ft	Test Id: 146518		
Test Comment: ---			
Sample Description: Moist, yellowish brown silty sand			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	4.1	72.8	23.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	96		
#10	2.00	89		
#20	0.85	78		
#40	0.42	57		
#60	0.25	39		
#100	0.15	29		
#200	0.075	23		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0346	18		
---	0.0213	15		
---	0.0129	13		
---	0.0092	11		
---	0.0065	10		
---	0.0046	8		
---	0.0033	7		
---	0.0017	5		

Coefficients

D_{85} =1.4685 mm — D_{30} =0.1556 mm
D_{60} =0.4688 mm — D_{15} =0.0223 mm
D_{50} =0.3461 mm — D_{10} =0.0070 mm
C_u =N/A — C_c =N/A

Classification

ASTM Silty sand (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-5	Test Date:	02/10/09	Checked By:	jdt
Depth :	6-8 ft	Test Id:	146568		
Test Comment:	---				
Sample Description:	Moist, yellowish brown silty sand				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-5	---	6-8 ft	19	n/a	n/a	n/a	n/a	Silty sand (SM)

43% Retained on #40 Sieve
Dry Strength: HIGH
Dilentancy: SLOW
Toughness: n/a
The sample was determined to be Non-Plastic

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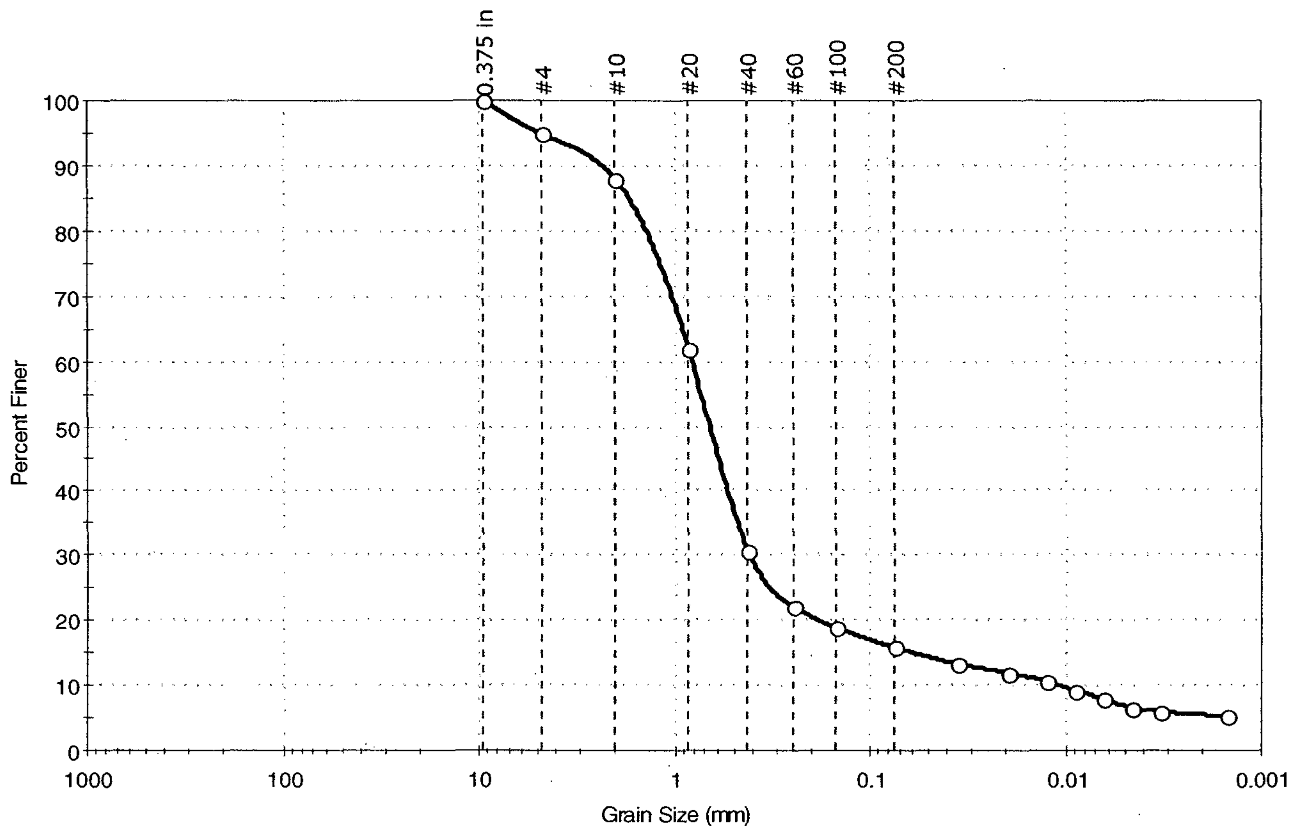
GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-5	Test Date: 02/10/09	Checked By:	jdt
Depth : 9-10 ft	Test Id: 146519		
Test Comment: ---			
Sample Description: Moist, brown silty sand			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	5.1	79.1	15.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	95		
#10	2.00	88		
#20	0.85	62		
#40	0.42	31		
#60	0.25	22		
#100	0.15	19		
#200	0.075	16		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0355	13		
---	0.0197	12		
---	0.0126	11		
---	0.0090	9		
---	0.0065	8		
---	0.0046	7		
---	0.0033	6		
---	0.0015	5		

Coefficients

D_{85} =1.8136 mm　　D_{30} =0.4063 mm

D_{60} =0.8162 mm　　D_{15} =0.0592 mm

D_{50} =0.6531 mm　　D_{10} =0.0108 mm

C_u =N/A　　C_c =N/A

Classification

ASTM　Silty sand (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID:GB-5	Test Date: 02/10/09	Checked By:	jdt
Depth : 9-10 ft	Test Id: 146569		
Test Comment: ---			
Sample Description: Moist, brown silty sand			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-5	---	9-10 ft	8	n/a	n/a	n/a	n/a	Silty sand (SM)

69% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

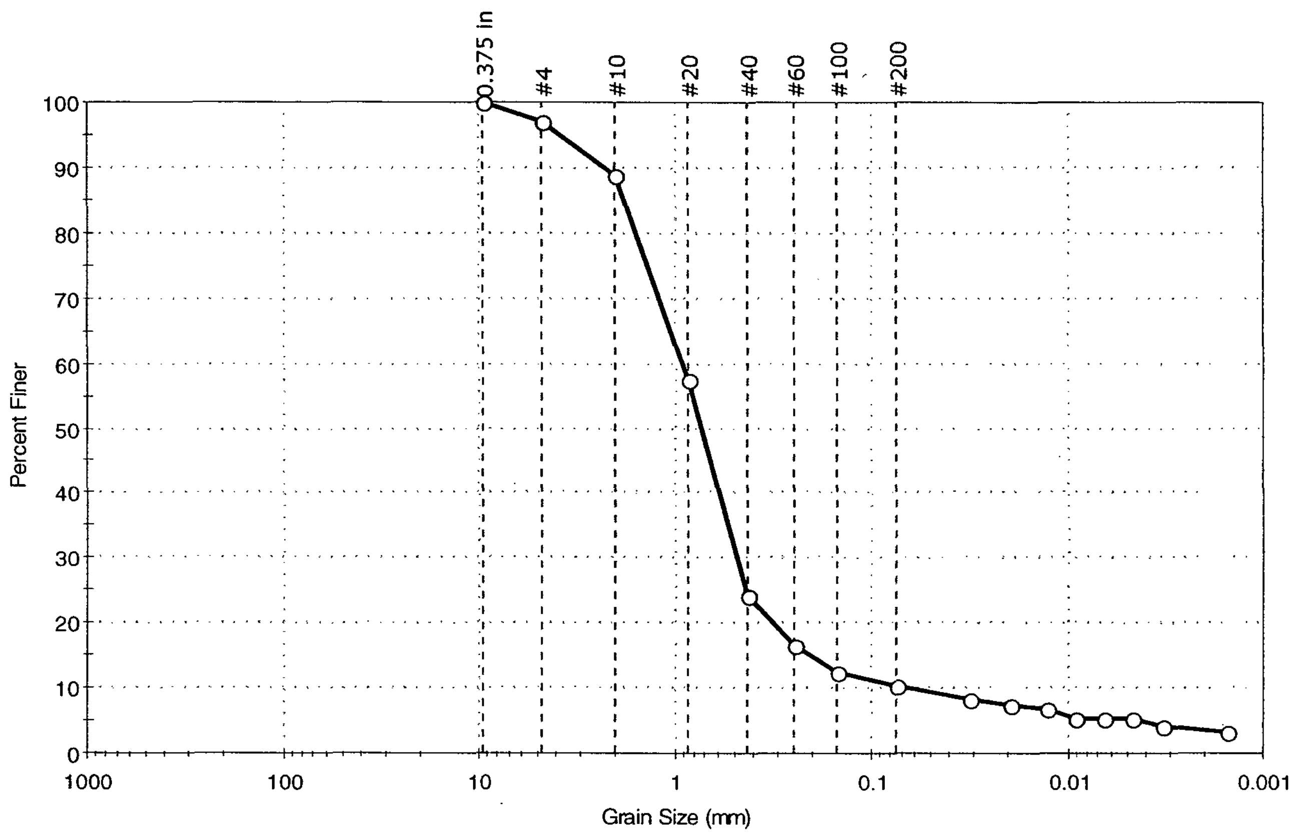
Toughness: n/a

The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	jbr
Sample ID:	GB-5	Test Date:	02/10/09	Checked By:	jdt
Depth :	12-14 ft	Test Id:	146520		
Test Comment:	---				
Sample Description:	Moist, yellow sand with silt				
Sample Comment:	---				

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	2.8	86.9	10.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	97		
#10	2.00	89		
#20	0.85	57		
#40	0.42	24		
#60	0.25	17		
#100	0.15	12		
#200	0.075	10		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0321	8		
---	0.0199	7		
---	0.0128	7		
---	0.0092	5		
---	0.0066	5		
---	0.0047	5		
---	0.0033	4		
---	0.0015	3		

Coefficients

D_{85} = 1.8016 mm	D_{30} = 0.4794 mm
D_{60} = 0.9122 mm	D_{15} = 0.2065 mm
D_{50} = 0.7281 mm	D_{10} = 0.0674 mm
C_u = 13.534	C_c = 3.738

Classification

ASTM Poorly graded sand with silt (SP-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-5	Test Date:	02/10/09	Checked By:	jdt
Depth :	12-14 ft	Test Id:	146570		
Test Comment:	---				
Sample Description:	Moist, yellow sand with silt				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-5	---	12-14 ft	18	n/a	n/a	n/a	n/a	Poorly graded sand with silt (SP-SM)

76% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

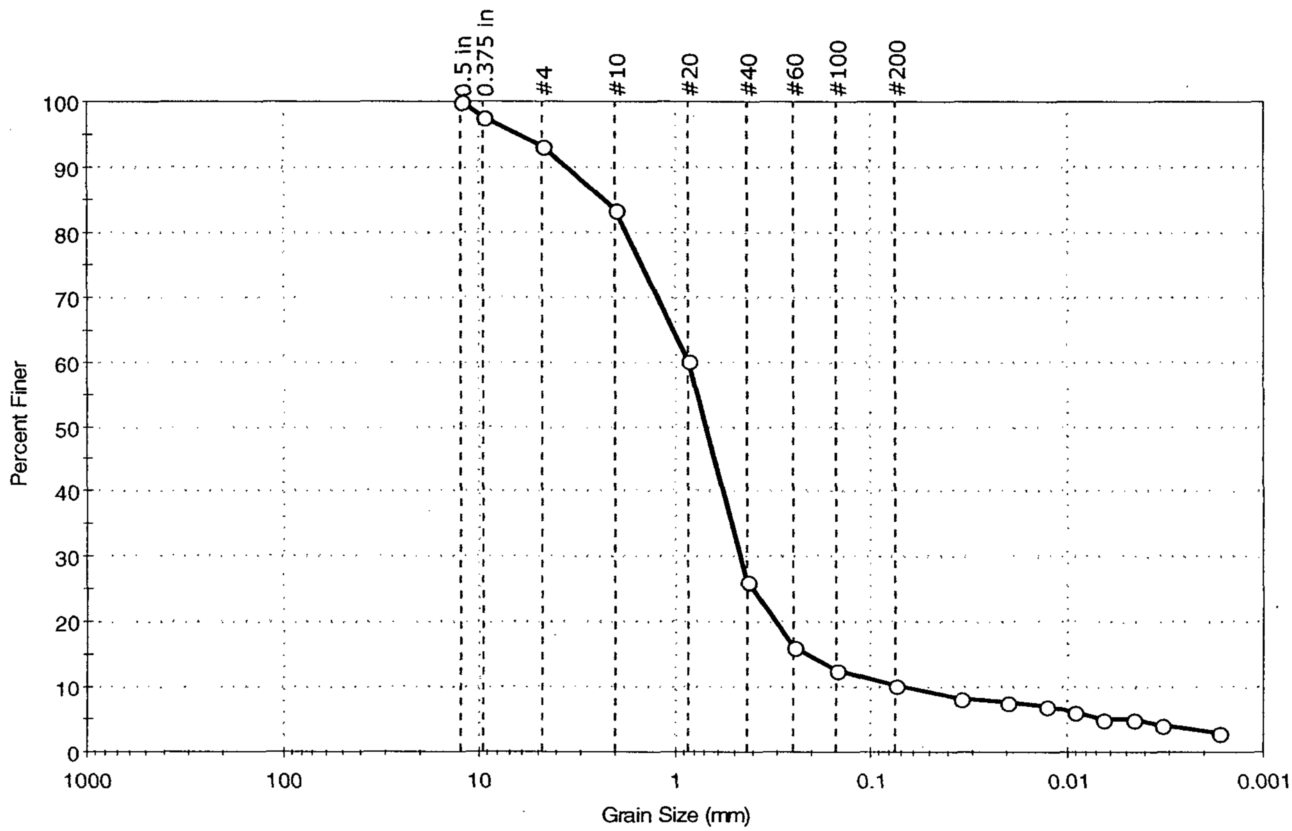
Toughness: n/a

The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-5	Test Date: 02/10/09	Checked By:	jdt
Depth : 16-18 ft	Test Id: 146521		
Test Comment: ---			
Sample Description: Moist, yellow sand with silt			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	6.7	82.9	10.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	98		
#4	4.75	93		
#10	2.00	83		
#20	0.85	60		
#40	0.42	26		
#60	0.25	16		
#100	0.15	13		
#200	0.075	10		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0352	8		
---	0.0204	8		
---	0.0128	7		
---	0.0092	6		
---	0.0066	5		
---	0.0046	5		
---	0.0033	4		
---	0.0017	3		

Coefficients

D_{85} = 2.2883 mm
D_{30} = 0.4584 mm
D_{60} = 0.8464 mm
D_{15} = 0.2129 mm
D_{50} = 0.6899 mm
D_{10} = 0.0650 mm
C_u = 13.022
C_c = 3.819

Classification

ASTM Poorly graded sand with silt (SP-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-5	Test Date:	02/10/09	Checked By:	jdt
Depth :	16-18 ft	Test Id:	146571		
Test Comment:	---				
Sample Description:	Moist, yellow sand with silt				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-5	---	16-18 ft	17	n/a	n/a	n/a	n/a	Poorly graded sand with silt (SP-SM)

74% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

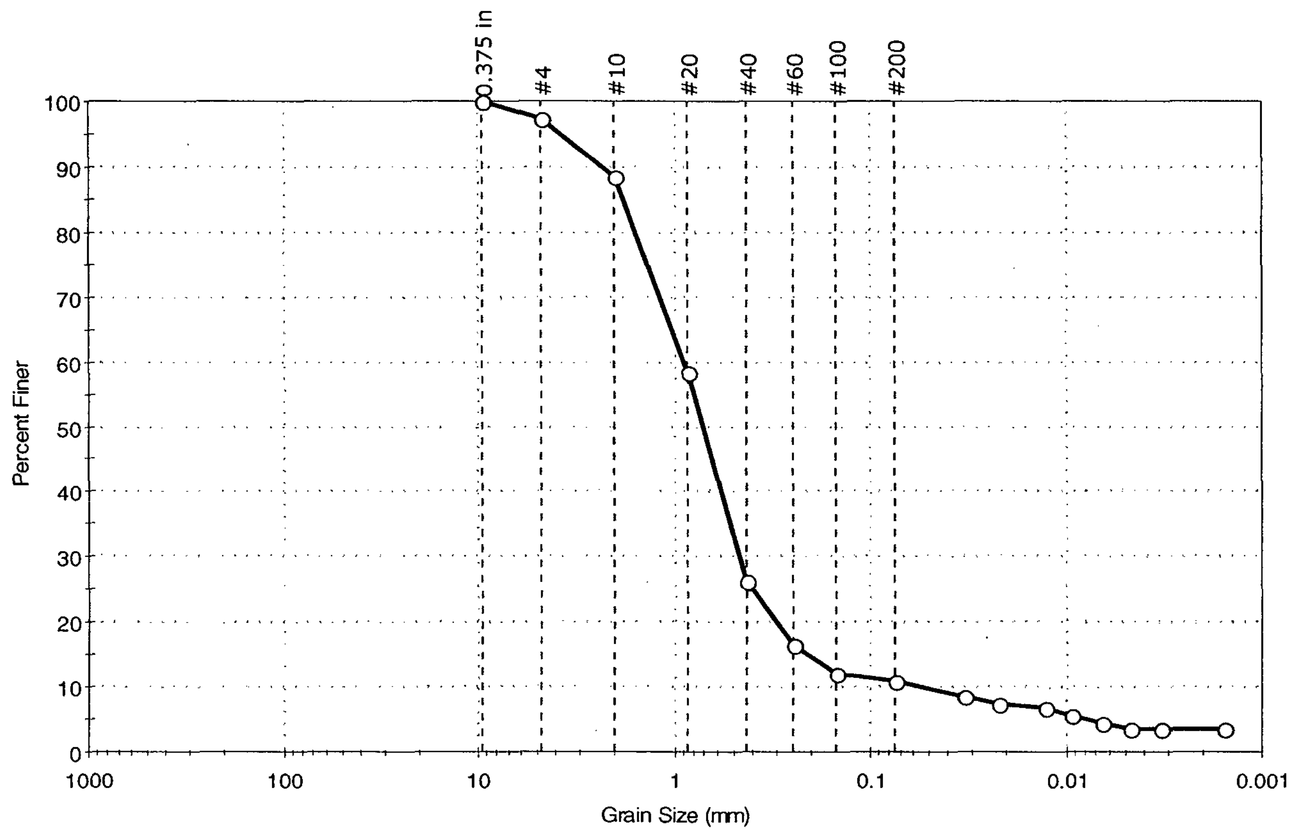
Toughness: n/a

The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-5	Test Date: 02/12/09	Checked By:	jdt
Depth : 20-22 ft	Test Id: 146522		
Test Comment: ---			
Sample Description: Moist, brownish yellow sand with silt			
Sample Comment: ---			

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	2.6	86.6	10.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	97		
#10	2.00	89		
#20	0.85	58		
#40	0.42	26		
#60	0.25	16		
#100	0.15	12		
#200	0.075	11		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0330	9		
---	0.0222	7		
---	0.0129	7		
---	0.0093	6		
---	0.0066	5		
---	0.0047	3		
---	0.0033	3		
---	0.0016	3		

Coefficients

D_{85} =1.8057 mm D_{30} =0.4611 mm

D_{60} =0.8873 mm D_{15} =0.2096 mm

D_{50} =0.7084 mm D_{10} =0.0555 mm

C_u =15.987 C_c =4.317

Classification

ASTM Poorly graded sand with silt (SP-SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID:GB-5	Test Date: 02/12/09	Checked By:	jdt
Depth : 20-22 ft	Test Id: 146572		
Test Comment: ---			
Sample Description: Moist, brownish yellow sand with silt			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-5	---	20-22 ft	18	n/a	n/a	n/a	n/a	Poorly graded sand with silt (SP-SM)

74% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

Toughness: n/a

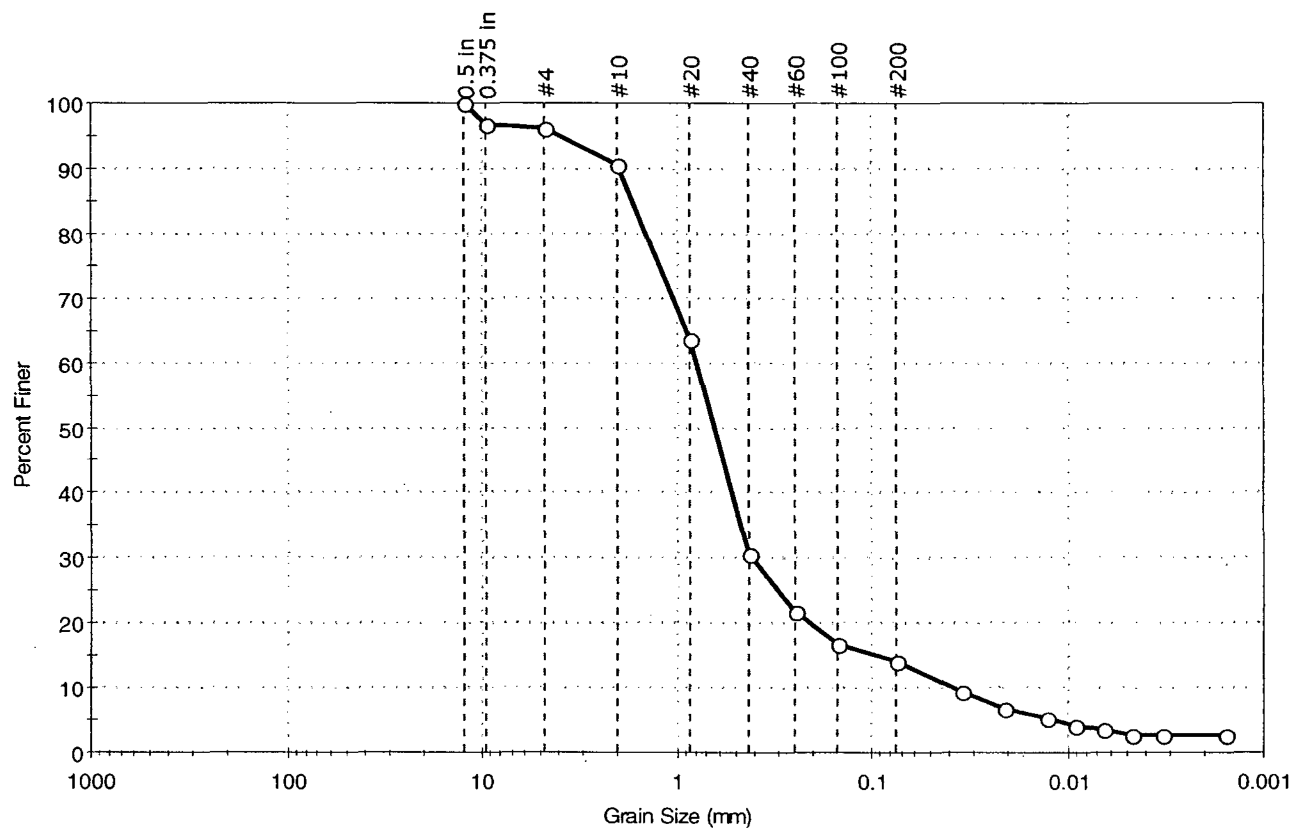
The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-5	Test Date: 02/10/09	Checked By:	jdt
Depth : 22-24 ft	Test Id: 146523		

Test Comment: ---
Sample Description: Moist, yellow silty sand
Sample Comment: ---

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	3.8	82.0	14.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	97		
#4	4.75	96		
#10	2.00	91		
#20	0.85	64		
#40	0.42	31		
#60	0.25	22		
#100	0.15	17		
#200	0.075	14		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0349	10		
---	0.0212	7		
---	0.0127	5		
---	0.0093	4		
---	0.0066	3		
---	0.0047	3		
---	0.0033	3		
---	0.0016	3		

Coefficients

D_{85} =1.6723 mm | D_{30} =0.4097 mm
D_{60} =0.7847 mm | D_{15} =0.0922 mm
D_{50} =0.6370 mm | D_{10} =0.0377 mm
C_u =N/A | C_c =N/A

Classification

ASTM Silty sand (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
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Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-5	Test Date:	02/10/09	Checked By:	jdt
Depth :	22-24 ft	Test Id:	146573		
Test Comment:	---				
Sample Description:	Moist, yellow silty sand				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

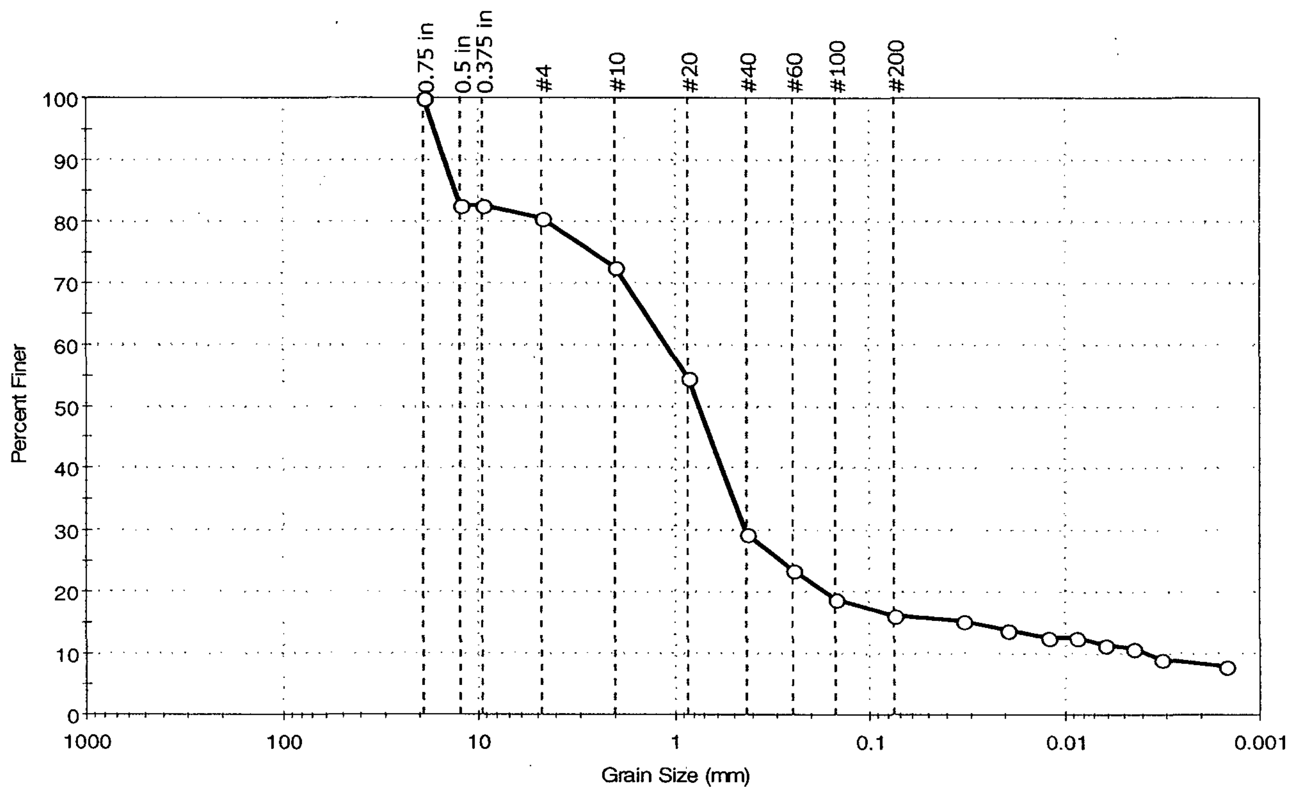
Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-5	---	22-24 ft	14	n/a	n/a	n/a	n/a	Silty sand (SM)

69% Retained on #40 Sieve
Dry Strength: NONE
Dilentancy: RAPID
Toughness: n/a
The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.		
Project:	SMC Stockyard Geotech Borings		
Location:	Newfield, NJ	Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-5	Test Date: 02/10/09	Checked By:	jdt
Depth : 26-28 ft	Test Id: 146524		
Test Comment:	---		
Sample Description:	Moist, yellowish brown silty sand with gravel		
Sample Comment:	one stone greater than 1/2-inch		

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	19.4	64.2	16.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	83		
0.375 in	9.50	83		
#4	4.75	81		
#10	2.00	73		
#20	0.85	55		
#40	0.42	29		
#60	0.25	23		
#100	0.15	19		
#200	0.075	16		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0335	15		
---	0.0197	14		
---	0.0123	13		
---	0.0089	13		
---	0.0063	11		
---	0.0045	11		
---	0.0032	9		
---	0.0015	8		

Coefficients

D_{85} =13.2589 mm
D_{30} =0.4322 mm
D_{60} =1.1009 mm
D_{15} =0.0289 mm
D_{50} =0.7505 mm
D_{10} =0.0038 mm
C_u =N/A
C_c =N/A

Classification

ASTM Silty sand with gravel (SM)

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

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	cam
Sample ID:GB-5	Test Date: 02/10/09	Checked By:	jdt
Depth : 26-28 ft	Test Id: 146574		
Test Comment: ---			
Sample Description: Moist, yellowish brown silty sand with gravel			
Sample Comment: one stone greater than 1/2-inch			

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	GB-5	---	26-28 ft	18	n/a	n/a	n/a	n/a	Silty sand with gravel (SM)

71% Retained on #40 Sieve

Dry Strength: MEDIUM

Dilentancy: RAPID

Toughness: n/a

The sample was determined to be Non-Plastic

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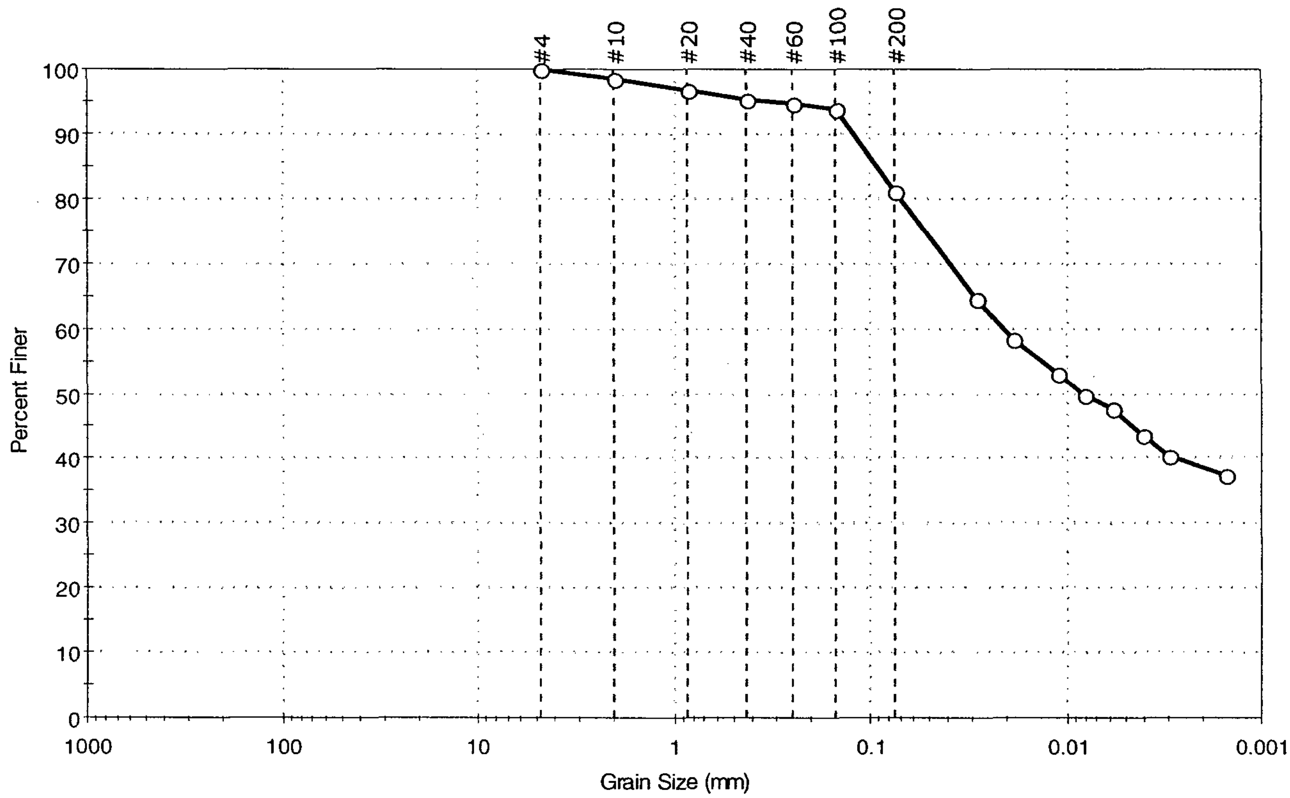
GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: bag	Tested By:	jbr
Sample ID:GB-5	Test Date: 02/16/09	Checked By:	jdt
Depth : 30-32 ft	Test Id: 146525		

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

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	18.9	81.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	98		
#20	0.85	97		
#40	0.42	95		
#60	0.25	95		
#100	0.15	94		
#200	0.075	81		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0290	65		
---	0.0188	58		
---	0.0112	53		
---	0.0081	50		
---	0.0058	48		
---	0.0041	44		
---	0.0030	40		
---	0.0015	37		

Coefficients

D_{85} = 0.0931 mm	D_{30} = N/A
D_{60} = 0.0211 mm	D_{15} = N/A
D_{50} = 0.0082 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM fat clay with sand (CH)

AASHTO Clayey Soils (A-7-6 (50))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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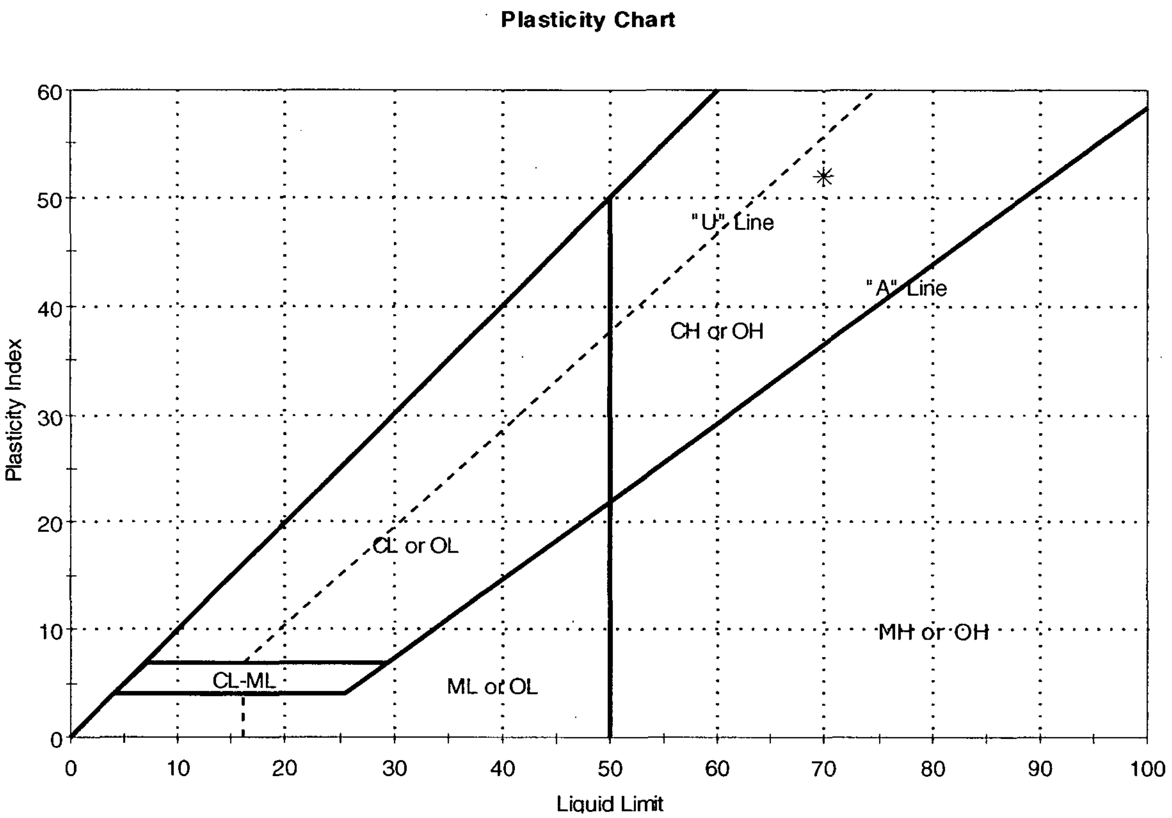
GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	GB-5	Test Date:	02/17/09	Checked By:	jdt
Depth :	30-32 ft	Test Id:	146575		
Test Comment:	---				
Sample Description:	Moist, yellowish brown clay with sand				
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
*	GB-5	---	30-32 ft	21	70	18	52	0	fat clay with sand (CH)

Sample Prepared using the WET method

5% Retained on #40 Sieve

Dry Strength: VERY HIGH

Dilentancy: SLOW

Toughness: LOW

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.				
Project:	SMC Stockyard Geotech Borings				
Location:	Newfield, NJ			Project No:	GTX-8837
Boring ID: ---		Sample Type:	tube	Tested By:	ap
Sample ID:GB-1 (S)		Test Date:	02/18/09	Checked By:	jdt
Depth :	30-32 ft	Test Id:	146628		
Test Comment:	---				
Sample Description:	Moist, pale yellow clay				
Sample Comment:	---				

USCS Classification - ASTM D 2487-06

Boring ID	Sample ID	Depth	Group Name	Group Symbol	Gravel, %	Sand, %	Fines, %
---	GB-1 (S)	30-32 ft	fat clay	CH	0.0	14.5	85.5

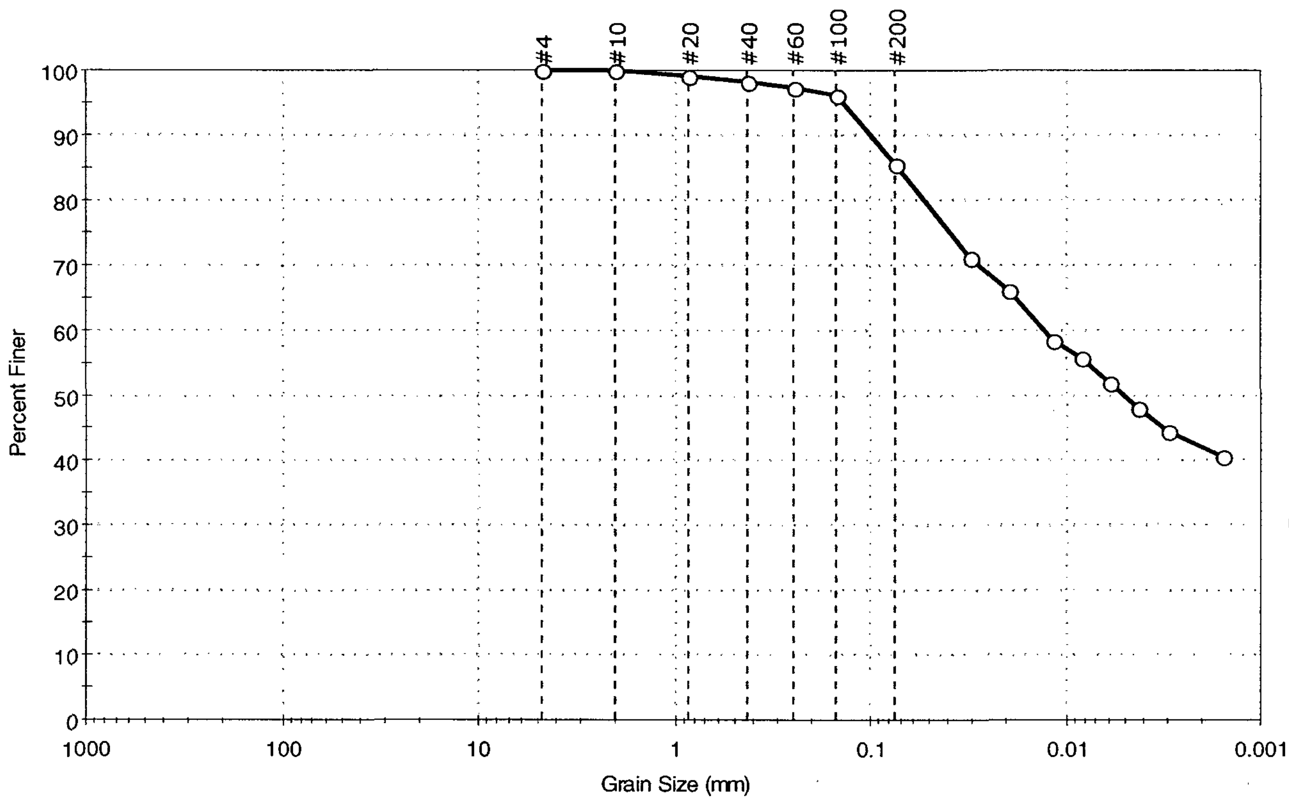
Remarks: Grain Size analysis performed by ASTM D422, results enclosed
Atterbeg Limits performed by ASTM 4318, results enclosed

GeoTesting express

a subsidiary of Geocomp Corporation

Client:	TRC Environmental Corp.		
Project:	SMC Stockyard Geotech Borings		
Location:	Newfield, NJ	Project No:	GTX-8837
Boring ID: ---	Sample Type: tube	Tested By:	jbr
Sample ID:GB-1 (S)	Test Date: 02/17/09	Checked By:	jdt
Depth : 30-32 ft	Test Id: 146626		
Test Comment:	---		
Sample Description:	Moist, pale yellow clay		
Sample Comment:	---		

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



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	14.5	85.5

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	98		
#60	0.25	97		
#100	0.15	96		
#200	0.075	86		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0310	71		
---	0.0199	66		
---	0.0117	58		
---	0.0084	56		
---	0.0060	52		
---	0.0043	48		
---	0.0030	44		
---	0.0016	41		

Coefficients

D_{85} =0.0727 mm D_{30} =N/A

D_{60} =0.0132 mm D_{15} =N/A

D_{50} =0.0050 mm D_{10} =N/A

C_u =N/A C_c =N/A

Classification

ASTM fat clay (CH)

AASHTO Clayey Soils (A-7-6 (39))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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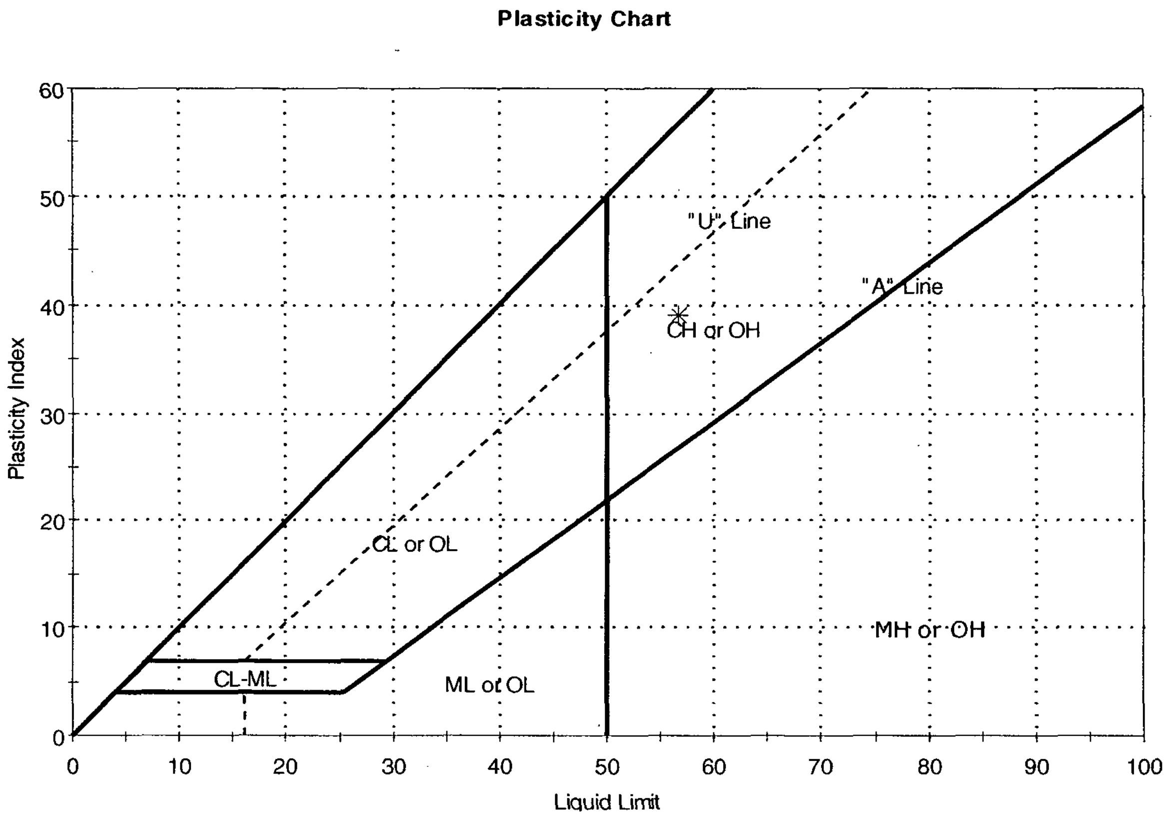
GeoTesting express
a subsidiary of Geocomp Corporation

Client: TRC Environmental Corp.			
Project: SMC Stockyard Geotech Borings			
Location: Newfield, NJ		Project No:	GTX-8837
Boring ID: ---	Sample Type: tube	Tested By:	cam
Sample ID: GB-1 (S)	Test Date: 02/18/09	Checked By:	jdt
Depth : 30-32 ft	Test Id: 146627		
Test Comment: ---			
Sample Description: Moist, pale yellow 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
*	GB-1 (S)	---	30-32 ft	23	57	18	39	0	fat clay (CH)

Sample Prepared using the WET method
2% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilentancy: NONE
Toughness: LOW

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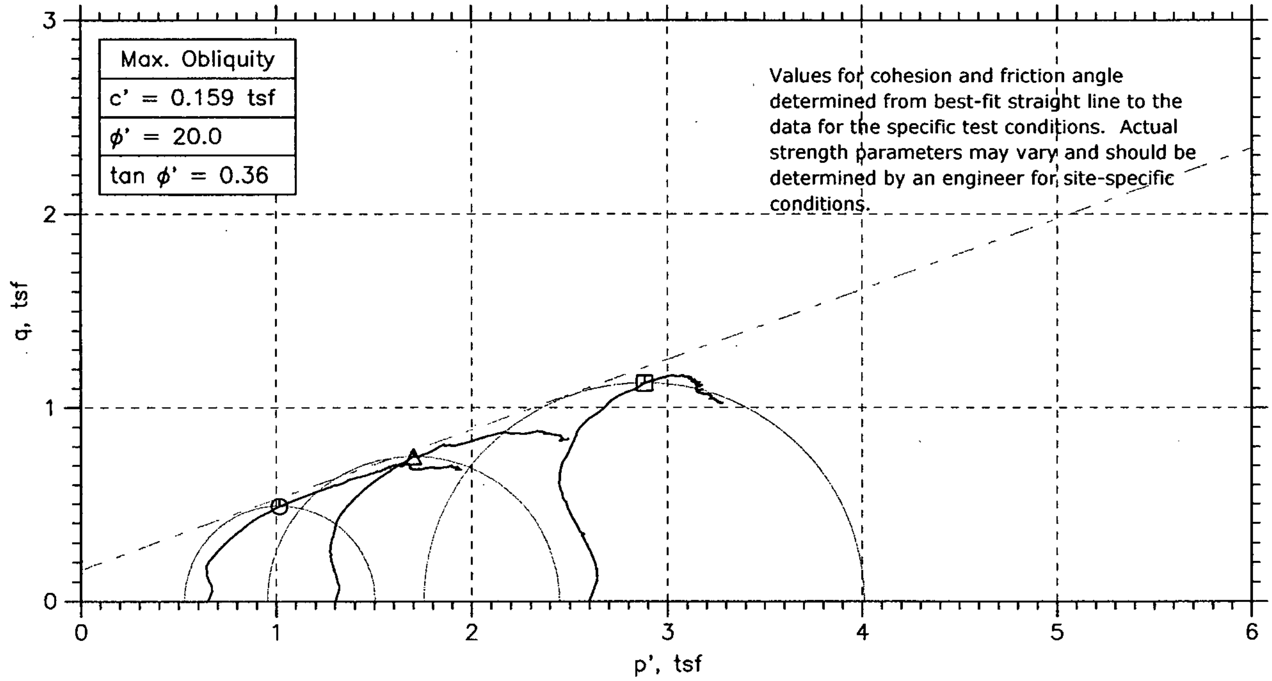
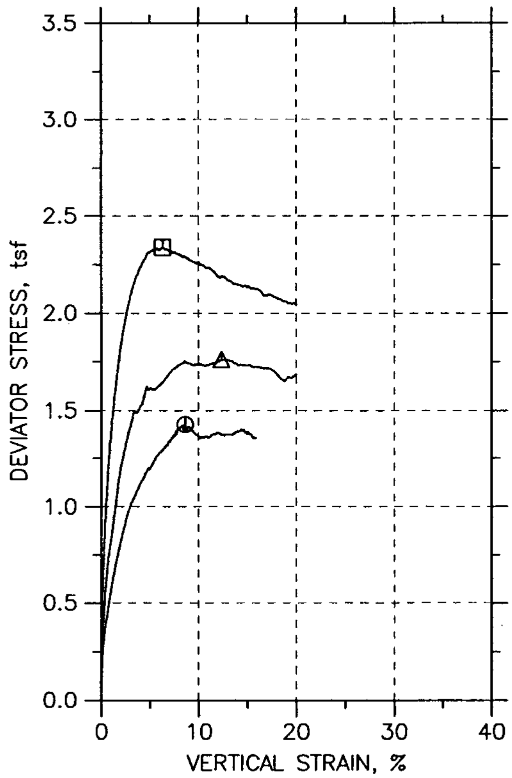
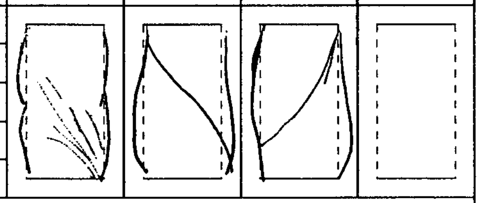
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		O	△	□	
Sample No.		GB-1(S)	GB-1(S)	GB-1(S)	
Test No.		CU-1-1A	CU-1-2	CU-1-3	
Depth		30-32	30-32	30-32	
Initial	Diameter, in	2.01	2.01	2.01	
	Height, in	4.1	4.15	4	
	Water Content, %	23.1	22.4	21.4	
	Dry Density, pcf	99.69	101.2	106.1	
	Saturation, %	86.0	86.1	92.6	
	Void Ratio	0.753	0.728	0.648	
Before Shear	Water Content, %	23.7	23.0	21.1	
	Dry Density, pcf	105.1	106.2	109.9	
	Saturation*, %	100.0	100.0	100.0	
	Void Ratio	0.663	0.645	0.59	
	Back Press., tsf	9.36	11.3	11.29	
Ver. Eff. Cons. Stress, tsf		.6503	1.302	2.601	
Shear Strength, tsf		.7141	.8809	1.169	
Strain at Failure, %		8.63	12.4	6.33	
Strain Rate, %/min		0.016	0.016	0.016	
B-Value		0.95	0.94	0.94	
Estimated Specific Gravity		2.8	2.8	2.8	
Liquid Limit		57	57	57	
Plastic Limit		18	18	18	



GeoTesting express, a subsidiary of Geocomp Corporation	
	Project: SMC Stockyard
	Location: Newfield, NJ
	Project No.: GTX-8837
	Boring No.: ---
	Sample Type: tube
	Description: Moist, pale yellow clay
	Remarks: System B

Phase calculations based on start and end of test.

* Saturation is set to 100% for phase calculations.

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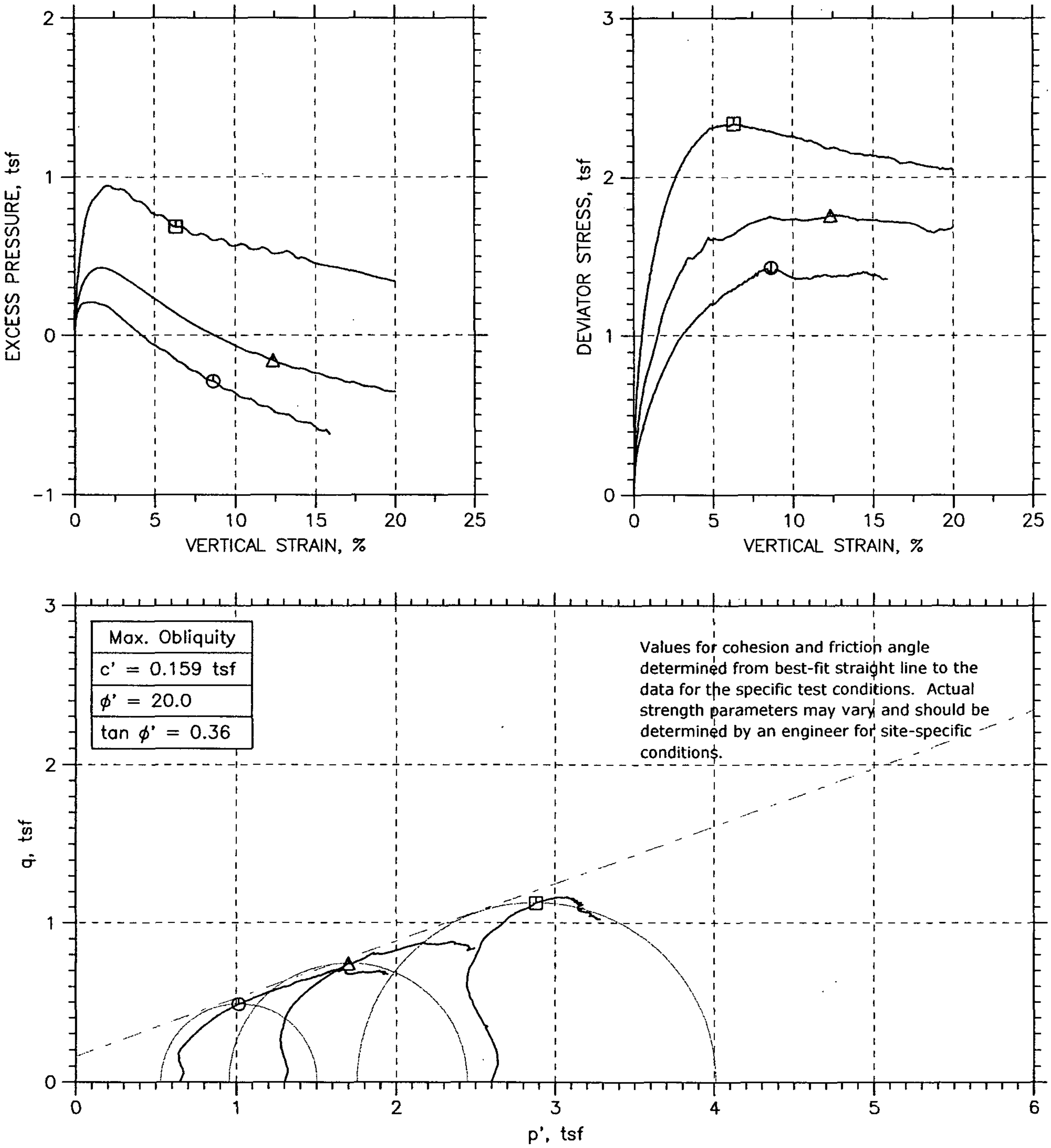
CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	GB-1(S)	CU-1-1A	30-32	md	02/16/09	jdt		8837-CU-1-1An.dat
△	GB-1(S)	CU-1-2	30-32	md	02/11/09	jdt		8837-CU-1-2n.dat
□	GB-1(S)	CU-1-3	30-32	md	02/12/09	jdt		8837-CU-1-3n.dat

GeoTesting express, a subsidiary of Geocomp Corporation			
	Project: SMC Stockyard	Location: Newfield, NJ	Project No.: GTX-8837
	Boring No.: ---	Sample Type: tube	
	Description: Moist, pale yellow clay		
	Remarks: System B		

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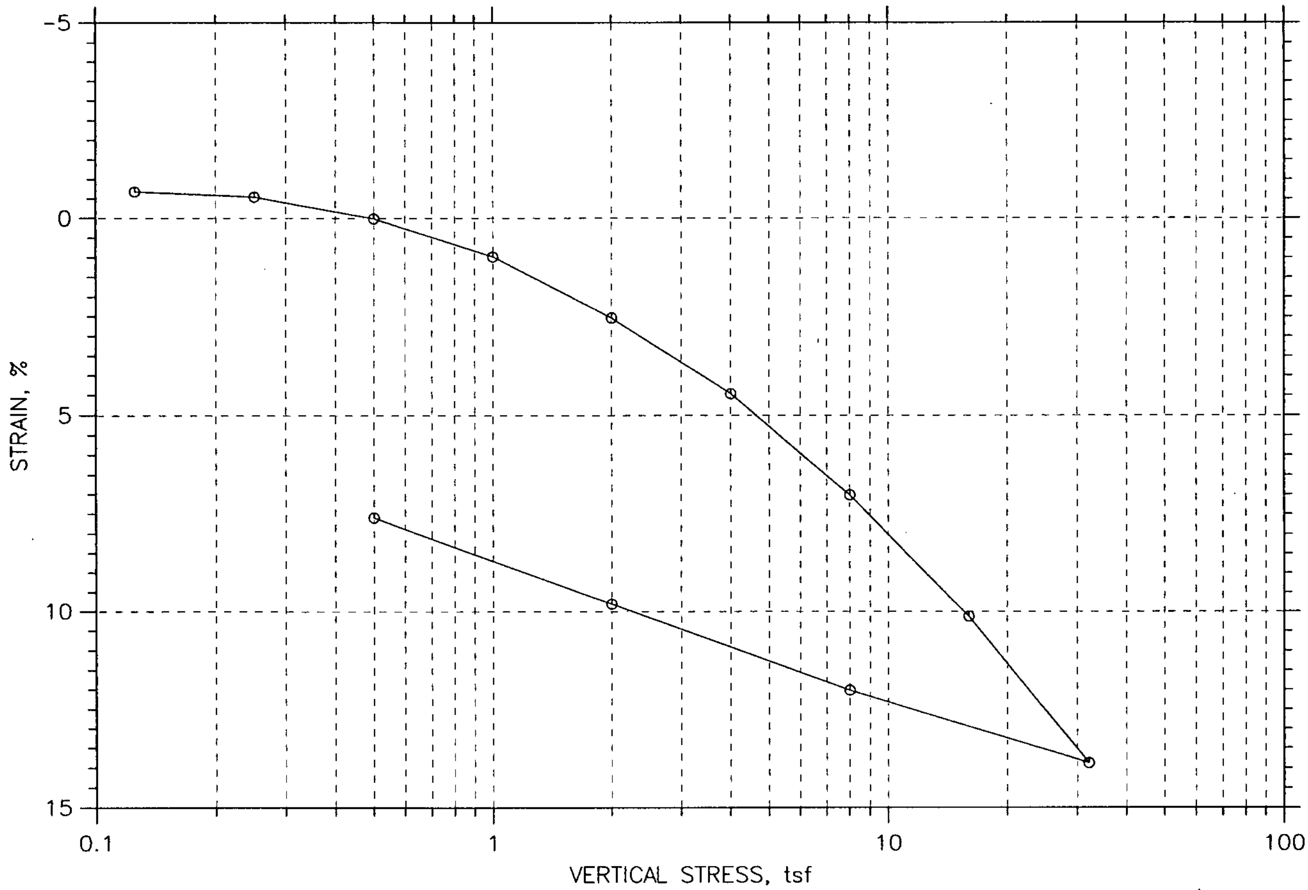
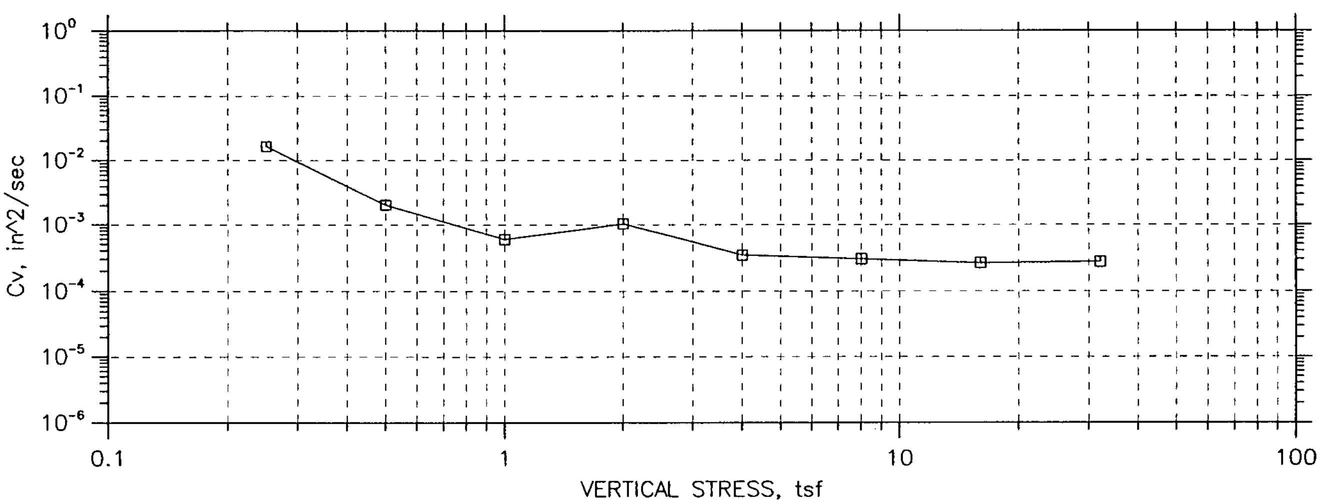
CONSOLIDATION TEST DATA

SUMMARY REPORT





GeoTesting express a subsidiary of Geocomp Corporation	Project: SMC Stockyard	Location: Newfield, NJ	Project No.: GTX-8837
	Boring No.: ---	Tested By: md	Checked By: jdt
	Sample No.: GB-1 (S)	Test Date: 02/12/09	Depth: 30-32 ft
	Test No.: C-1	Sample Type: tube	Elevation: ---
	Description: Moist, pale yellow clay		
	Remarks: System F		

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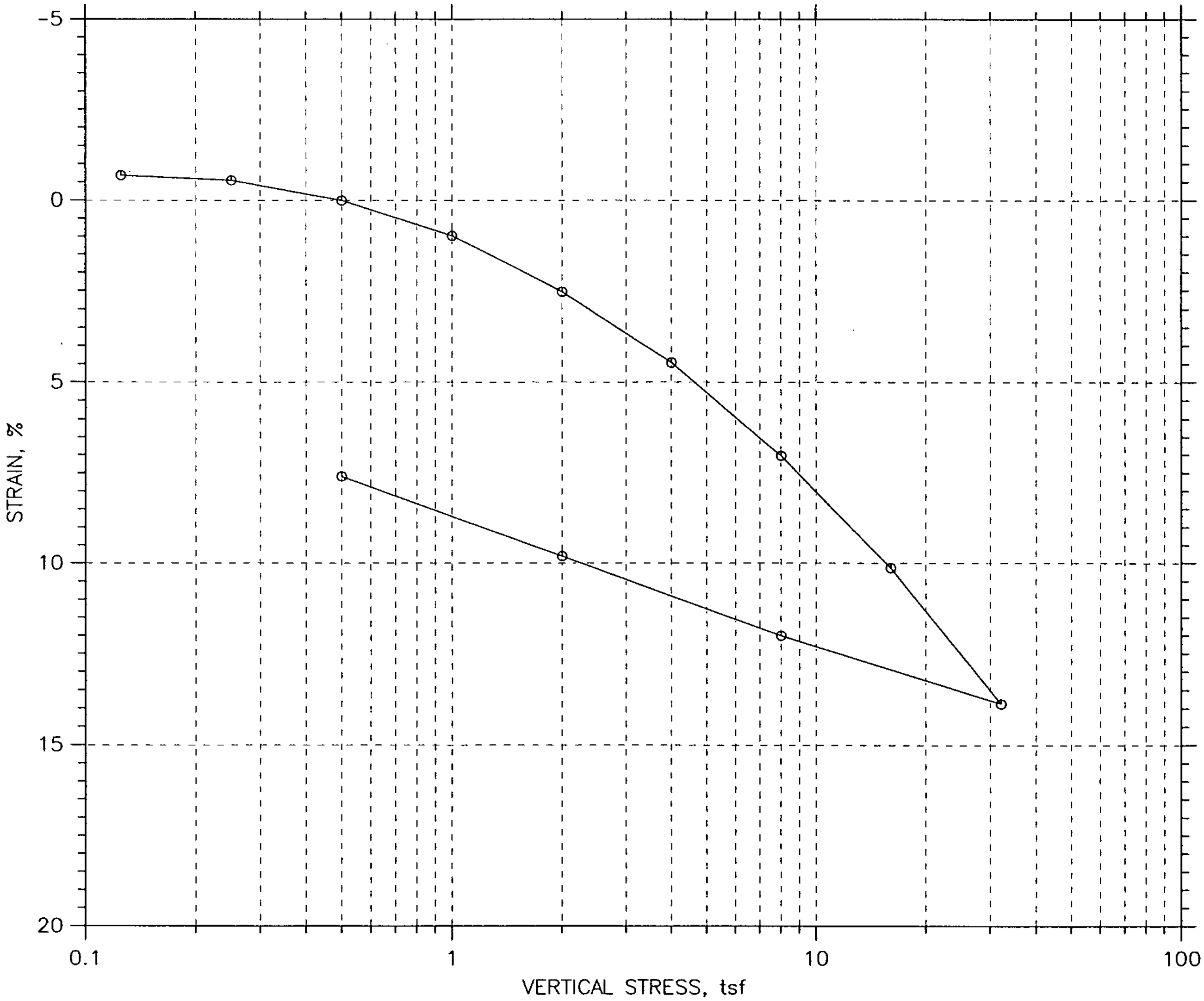
CONSOLIDATION TEST DATA

SUMMARY REPORT



					Before Test	After Test
Overburden Pressure: ---				Water Content, %	20.15	18.07
Preconsolidation Pressure: ---				Dry Unit Weight, pcf	107.2	116.1
Compression Index: ---				Saturation, %	89.50	100.00
Diameter: 2.5 in		Height: 1 in		Void Ratio	0.63	0.51
LL: 57	PL: 18	PI: 39	GS: 2.80			

GeoTesting express, a subsidiary of Geocomp Corporation	Project: SMC Stockyard	Location: Newfield, NJ	Project No.: GTX-8837
	Boring No.: ---	Tested By: md	Checked By: jdt
	Sample No.: GB-1 (S)	Test Date: 02/12/09	Depth: 30-32 ft
	Test No.: C-1	Sample Type: tube	Elevation: ---
	Description: Moist, pale yellow clay		
	Remarks: System F		

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CONSOLIDATION TEST DATA

Project: SMC Stockyard
Boring No.: ---
Sample No.: GB-1 (S)
Test No.: C-1

Location: Newfield, NJ
Tested By: md
Test Date: 02/12/09
Sample Type: tube

Project No.: GTX-8837
Checked By: jdt
Depth: 30-32 ft
Elevation: ---

Soil Description: Moist, pale yellow clay
Remarks: System F

Estimated Specific Gravity: 2.80
Initial Void Ratio: 0.63
Final Void Ratio: 0.51

Liquid Limit: 57
Plastic Limit: 18
Plasticity Index: 39

Initial Height: 1.00 in
Specimen Diameter: 2.50 in

	Before Consolidation		After Consolidation	
	Trimmings	Specimen+Ring	Specimen+Ring	Trimmings
Container ID	Shoe	RING		ash
Wt. Container + Wet Soil, gm	204.14	276.95	274.08	171.15
Wt. Container + Dry Soil, gm	172.05	249.11	249.11	146.2
Wt. Container, gm	8.33	110.96	110.96	8.14
Wt. Dry Soil, gm	163.72	138.15	138.15	138.06
Water Content, %	19.60	20.15	18.07	18.07
Void Ratio	---	0.63	0.51	---
Degree of Saturation, %	---	89.50	100.00	---
Dry Unit Weight, pcf	---	107.22	116.07	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

CONSOLIDATION TEST DATA

Project: SMC Stockyard
Boring No.: ---
le No.: GB-1 (S)
No.: C-1

Location: Newfield, NJ
Tested By: md
Test Date: 02/12/09
Sample Type: tube

Project No.: GTX-8837
Checked By: jdt
Depth: 30-32 ft
Elevation: ---

Soil Description: Moist, pale yellow clay
Remarks: System F

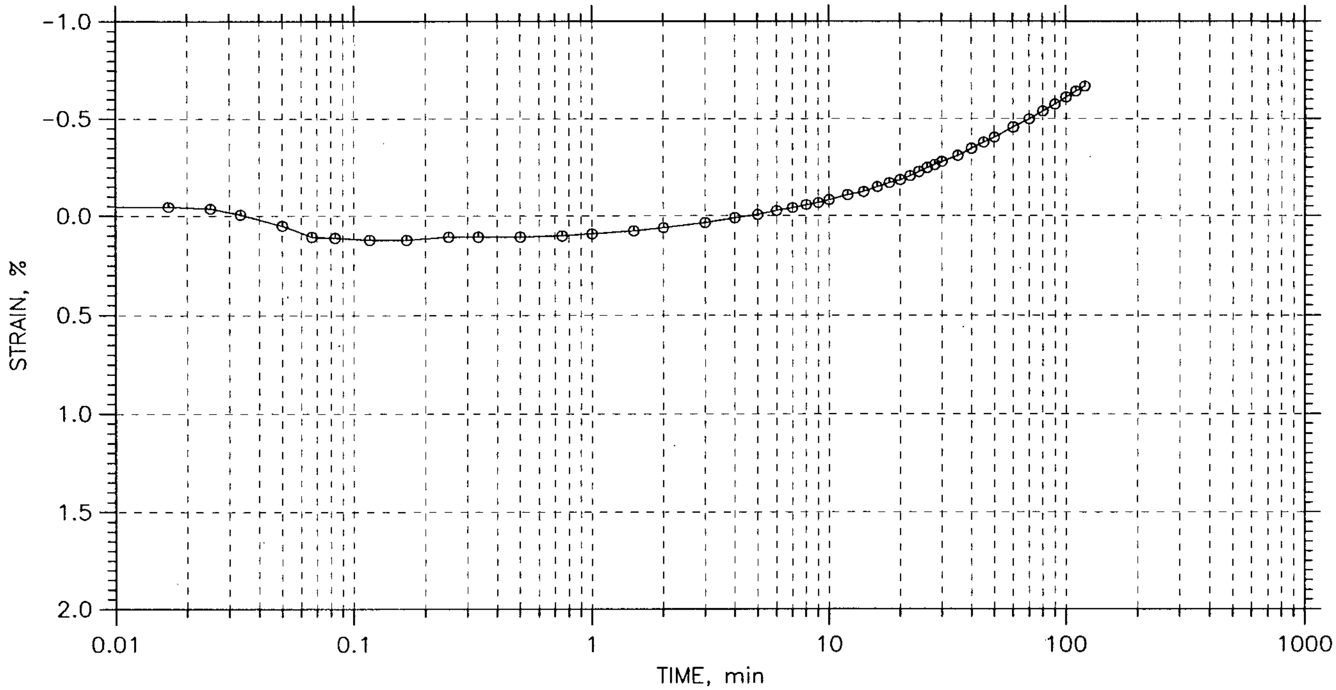
	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	T50 Fitting Sq.Rt. min	T50 Fitting Log min	Coefficient of Consolidation Sq.Rt. in^2/sec	Coefficient of Consolidation Log in^2/sec	Coefficient of Consolidation Ave. in^2/sec
1	0.125	-0.006645	0.641	-0.66	0.0	0.0	0.00e+000	0.00e+000	0.00e+000
2	0.25	-0.005292	0.639	-0.53	0.1	0.0	1.57e-002	0.00e+000	1.57e-002
3	0.5	0.0003045	0.630	0.03	0.4	0.0	2.00e-003	0.00e+000	2.00e-003
4	1	0.01003	0.614	1.00	1.4	0.0	5.88e-004	0.00e+000	5.88e-004
5	2	0.02563	0.589	2.56	0.8	0.0	1.02e-003	0.00e+000	1.02e-003
6	4	0.04499	0.557	4.50	2.2	0.0	3.40e-004	0.00e+000	3.40e-004
7	8	0.07055	0.515	7.06	2.4	0.0	2.99e-004	0.00e+000	2.99e-004
8	16	0.1015	0.465	10.15	2.6	0.0	2.61e-004	0.00e+000	2.61e-004
9	32	0.1391	0.404	13.91	2.3	0.0	2.72e-004	0.00e+000	2.72e-004
10	8	0.1204	0.434	12.04	0.0	0.0	2.69e-002	3.00e-002	2.83e-002
11	2	0.09832	0.470	9.83	6.9	0.0	9.39e-005	0.00e+000	9.39e-005
12	0.5	0.0763	0.506	7.63	28.9	0.0	2.37e-005	0.00e+000	2.37e-005

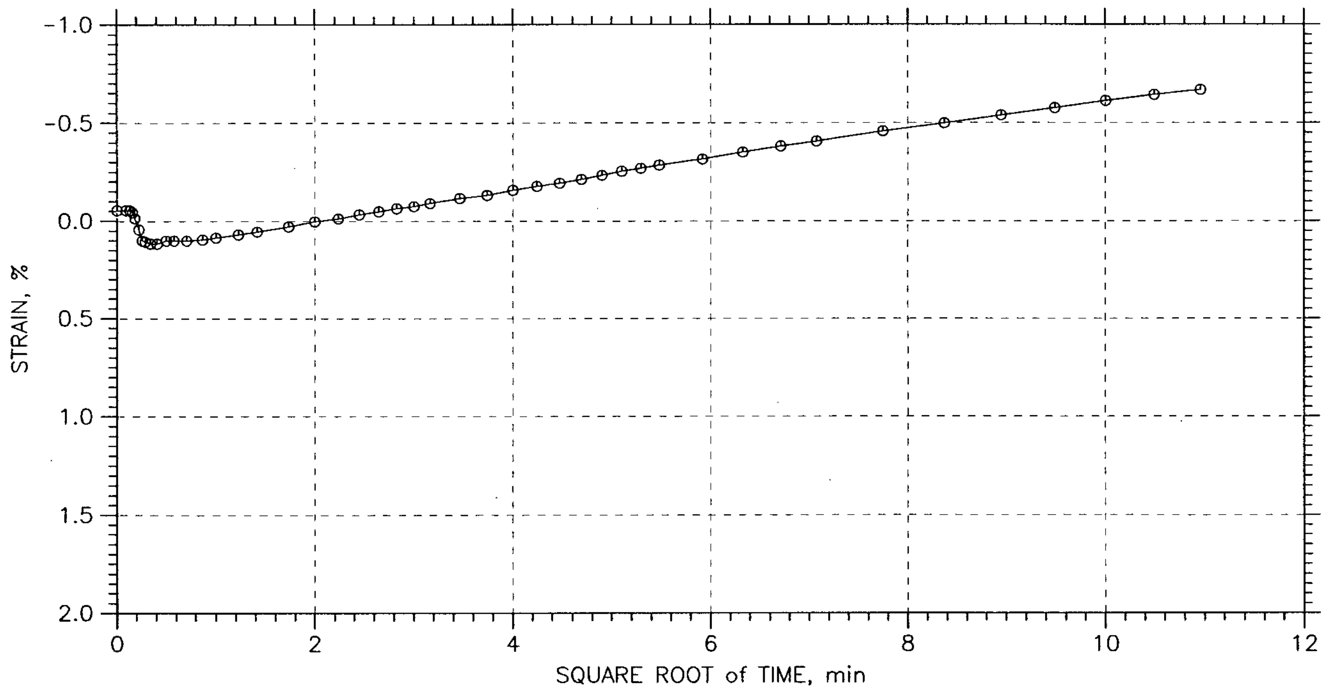
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 1 of 12

Stress: 0.125 tsf





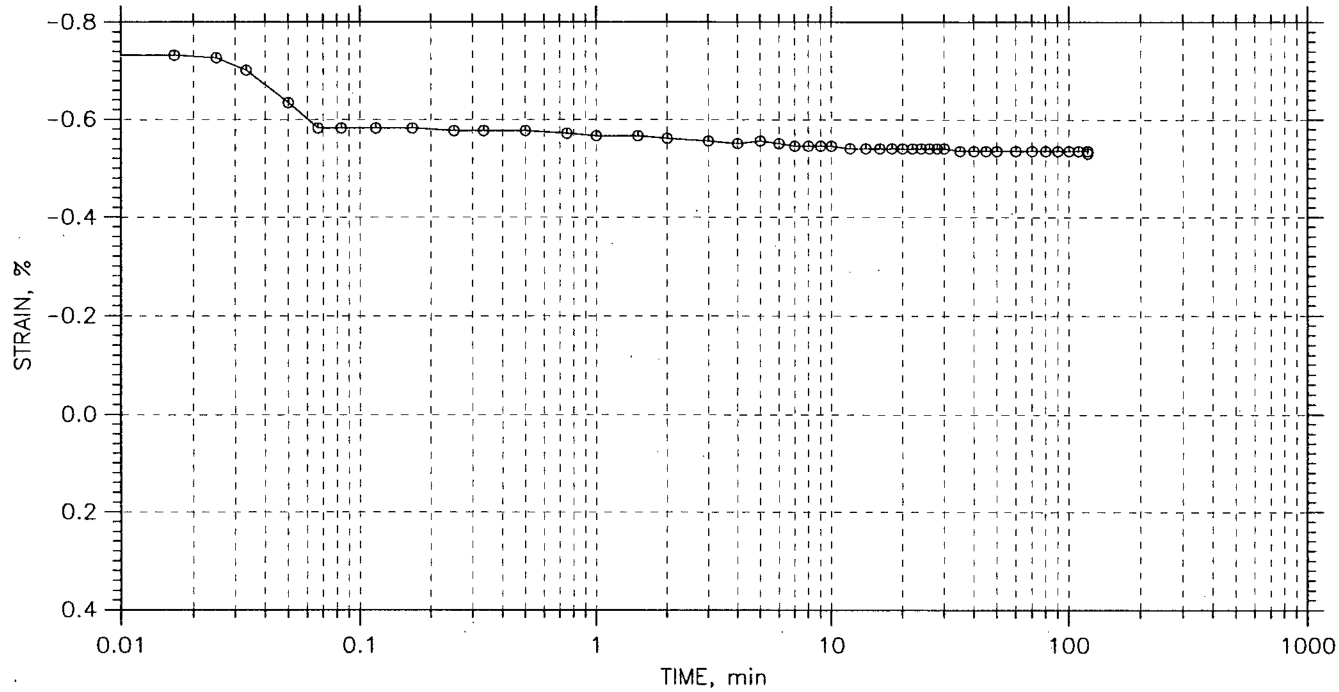
GeoTesting express a subsidiary of Geocomp Corporation	Project: SMC Stockyard	Location: Newfield, NJ	Project No.: GTX-8837
	Boring No.: ---	Tested By: md	Checked By: jdt
	Sample No.: GB-1 (S)	Test Date: 02/12/09	Depth: 30-32 ft
	Test No.: C-1	Sample Type: tube	Elevation: ---
	Description: Moist, pale yellow clay		
	Remarks: System F		

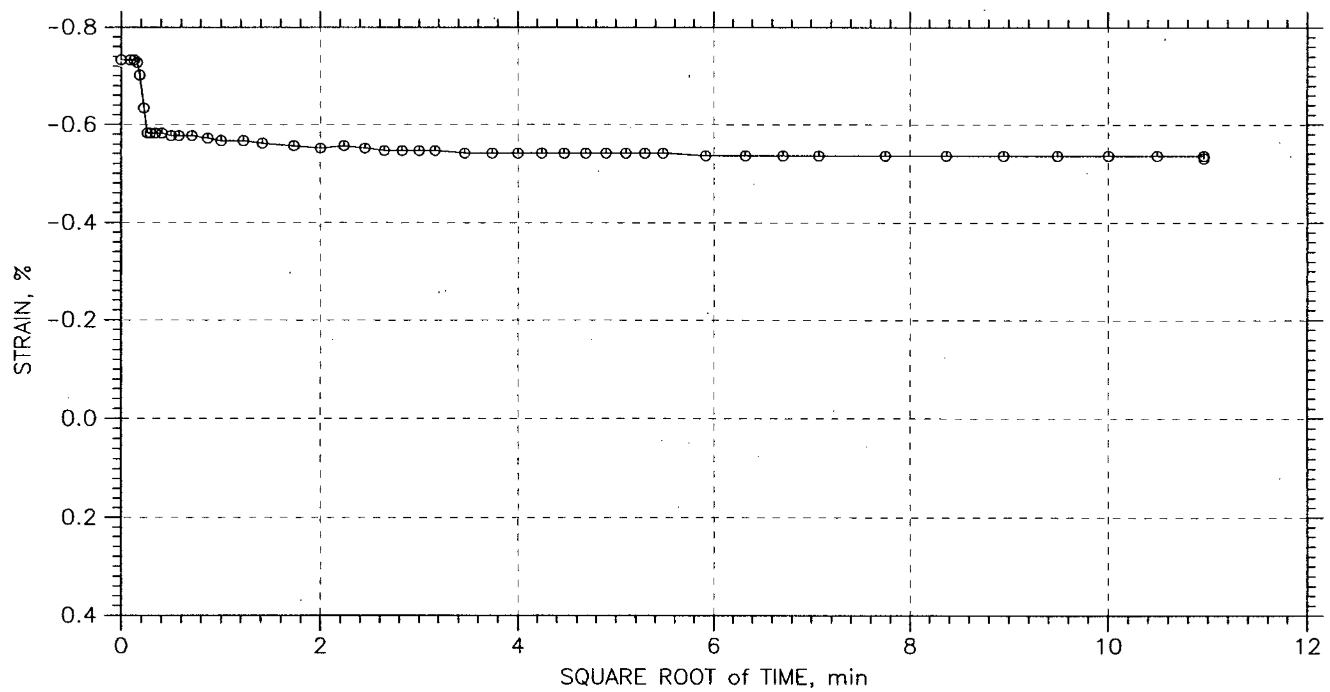
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 2 of 12

Stress: 0.25 tsf





GeoTesting express a subsidiary of Geocomp Corporation	Project: SMC Stockyard	Location: Newfield, NJ	Project No.: GTX-8837
	Boring No.: ---	Tested By: md	Checked By: jdt
	Sample No.: GB-1 (S)	Test Date: 02/12/09	Depth: 30-32 ft
	Test No.: C-1	Sample Type: tube	Elevation: ---
	Description: Moist, pale yellow clay		
	Remarks: System F		

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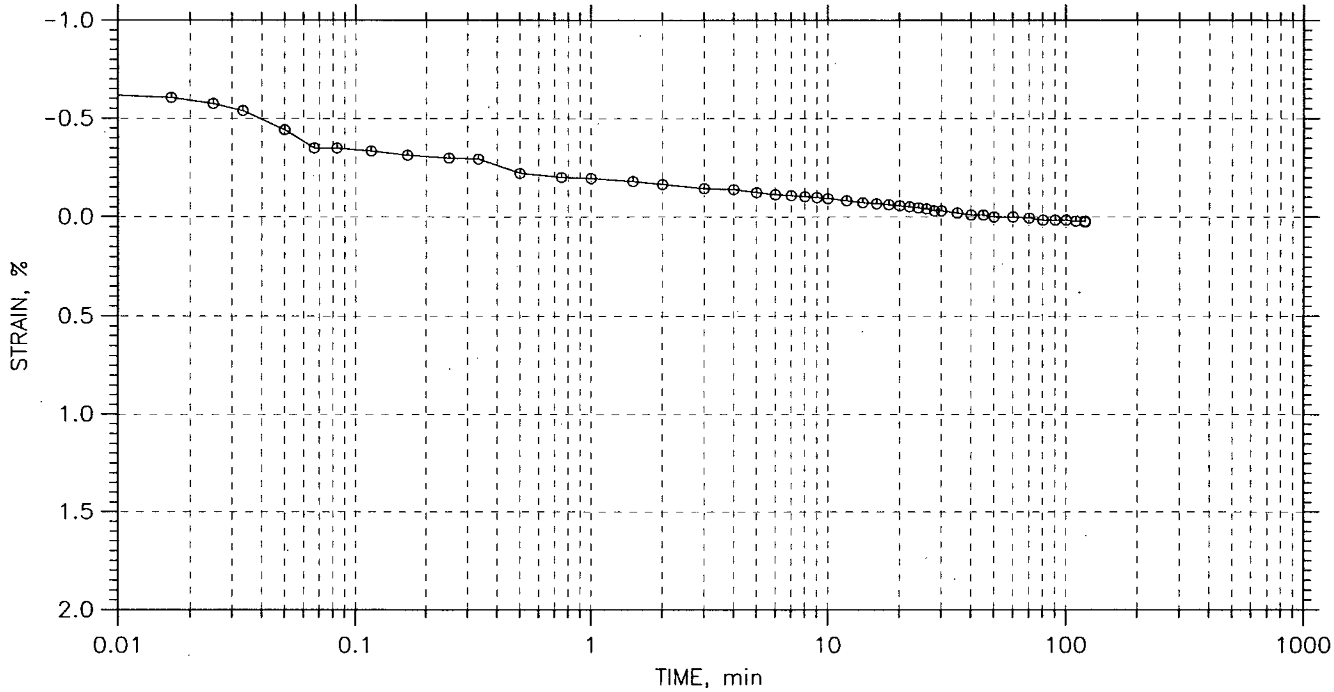
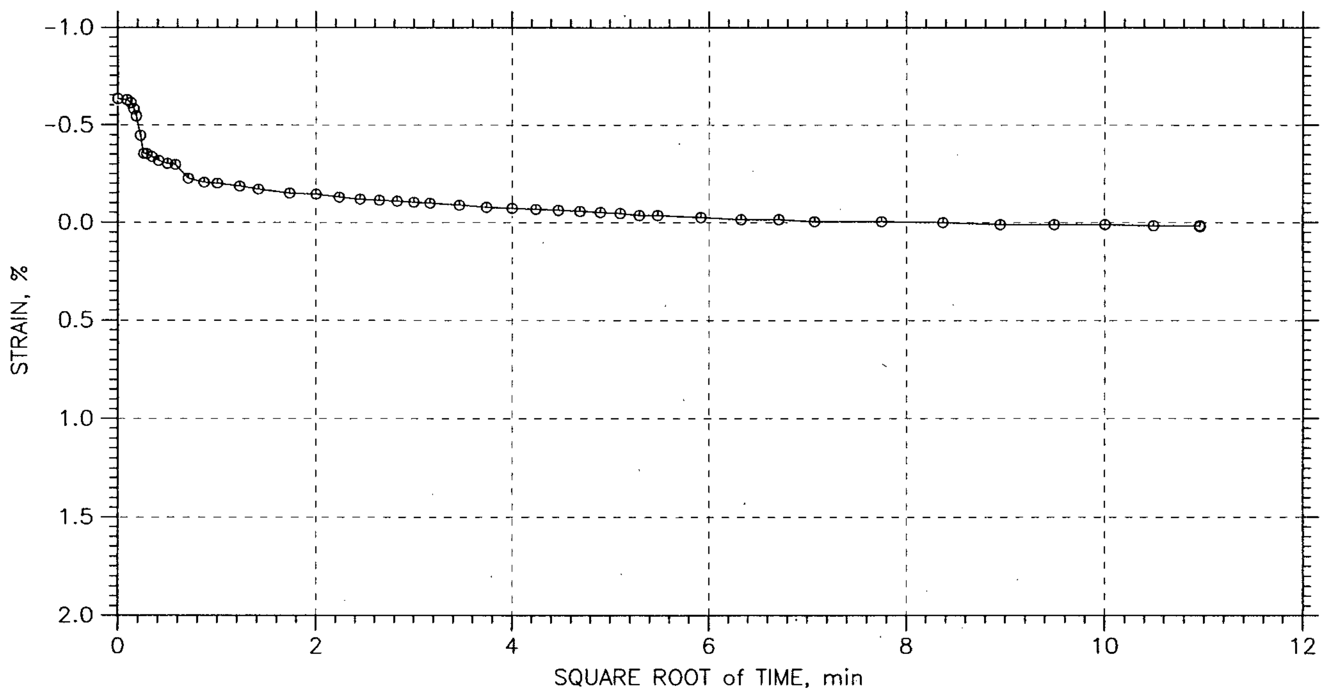
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 3 of 12

Stress: 0.5 tsf





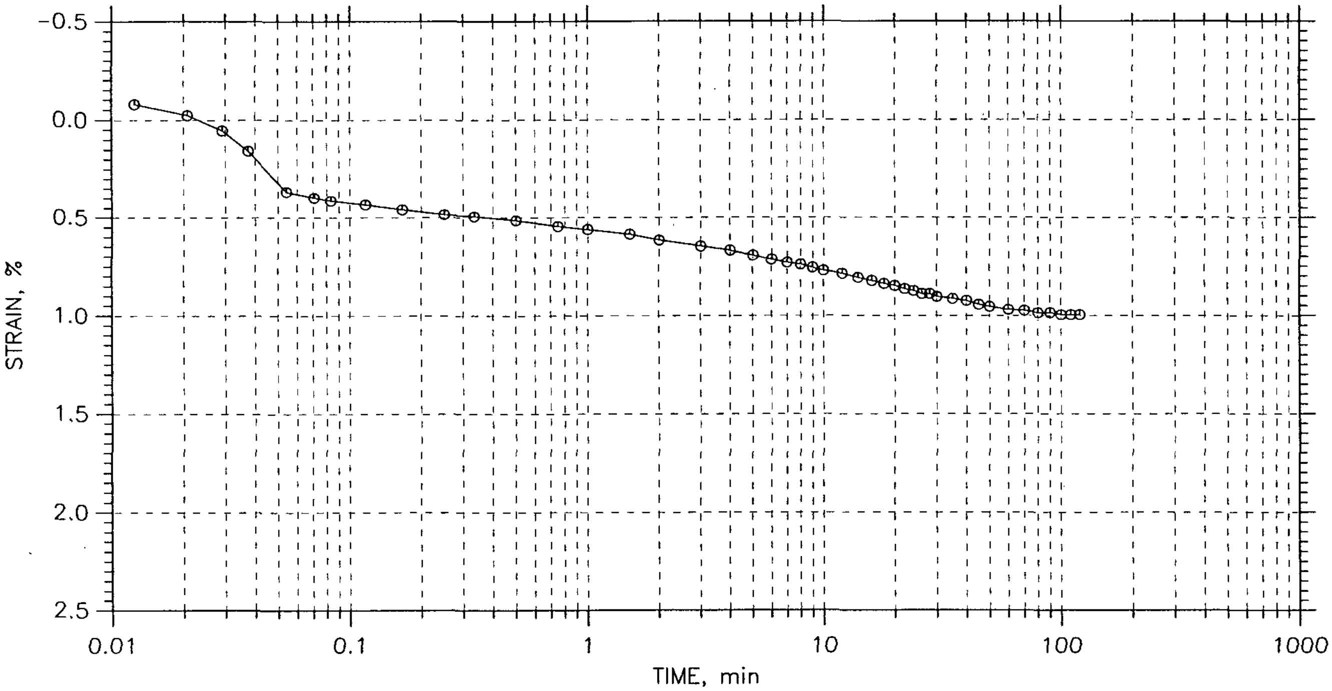
GeoTesting express a subsidiary of Geocomp Corporation	Project: SMC Stockyard	Location: Newfield, NJ	Project No.: GTX-8837
	Boring No.: ---	Tested By: md	Checked By: jdt
	Sample No.: GB-1 (S)	Test Date: 02/12/09	Depth: 30-32 ft
	Test No.: C-1	Sample Type: tube	Elevation: ---
	Description: Moist, pale yellow clay		
	Remarks: System F		

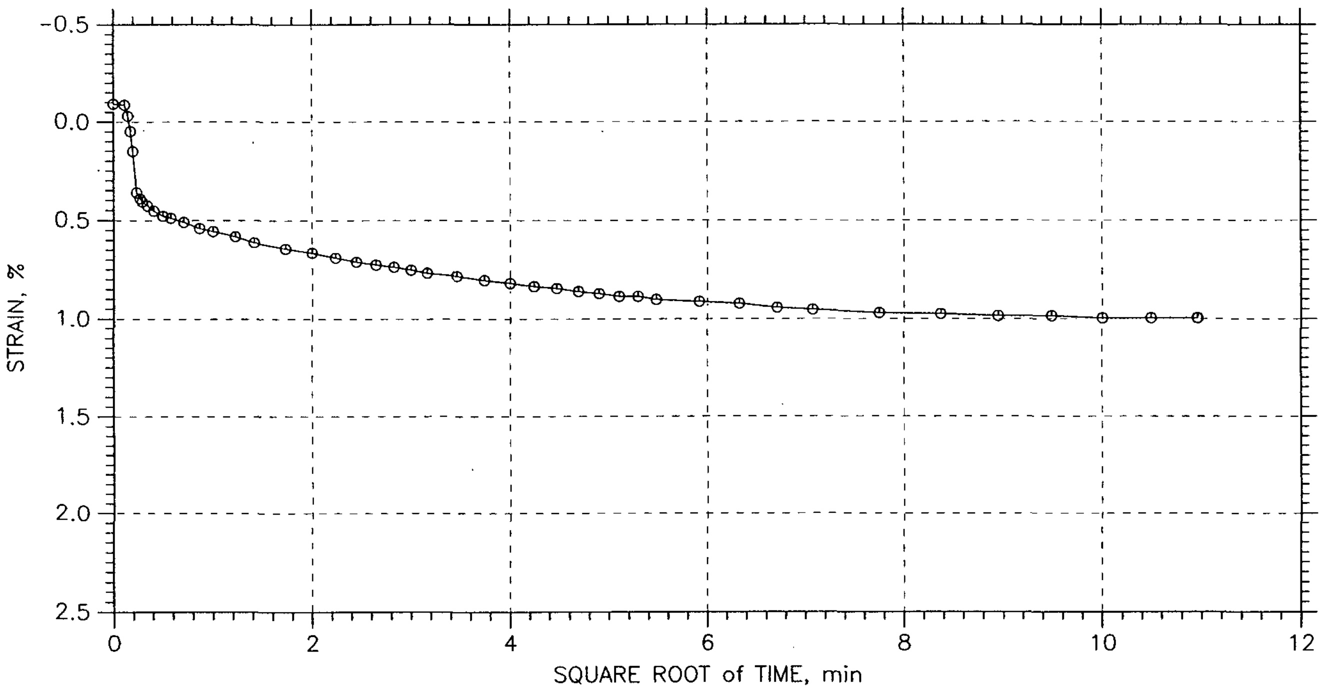
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 4 of 12

Stress: 1. tsf





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Project: SMC Stockyard	Location: Newfield, NJ	Project No.: GTX-8837
Boring No.: ---	Tested By: md	Checked By: jdt
Sample No.: GB-1 (S)	Test Date: 02/12/09	Depth: 30-32 ft
Test No.: C-1	Sample Type: tube	Elevation: ---
Description: Moist, pale yellow clay		
Remarks: System F		

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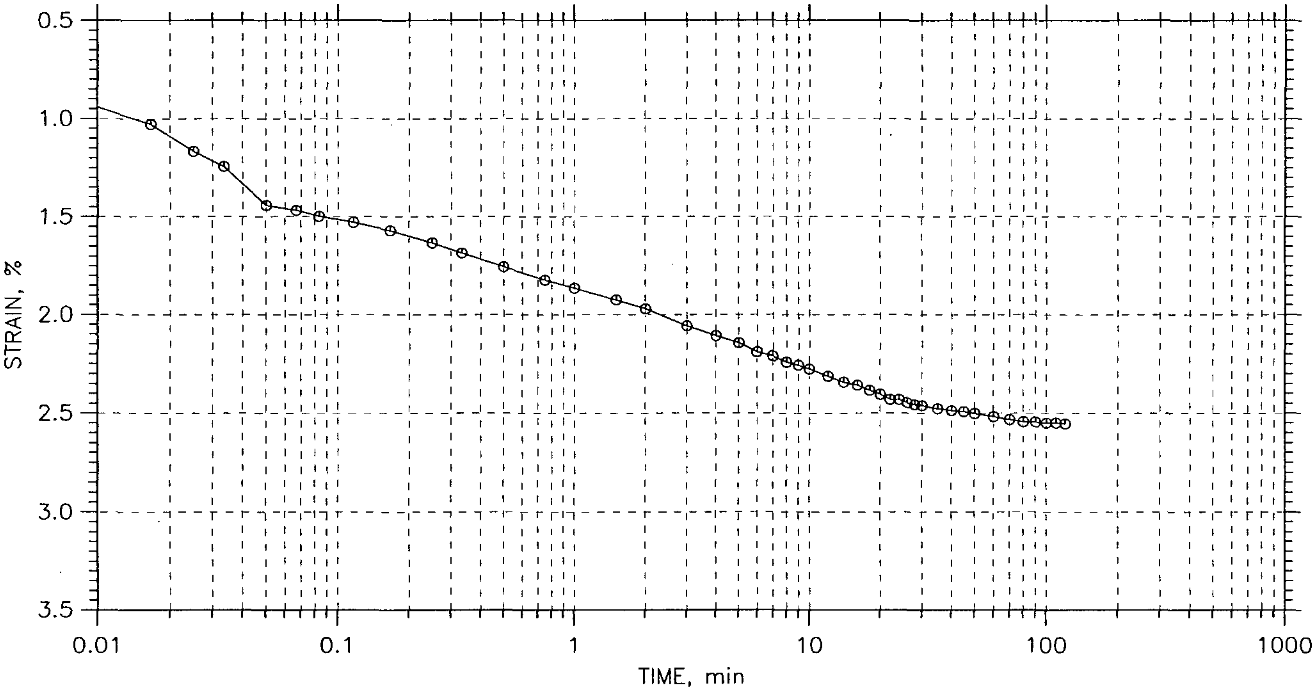
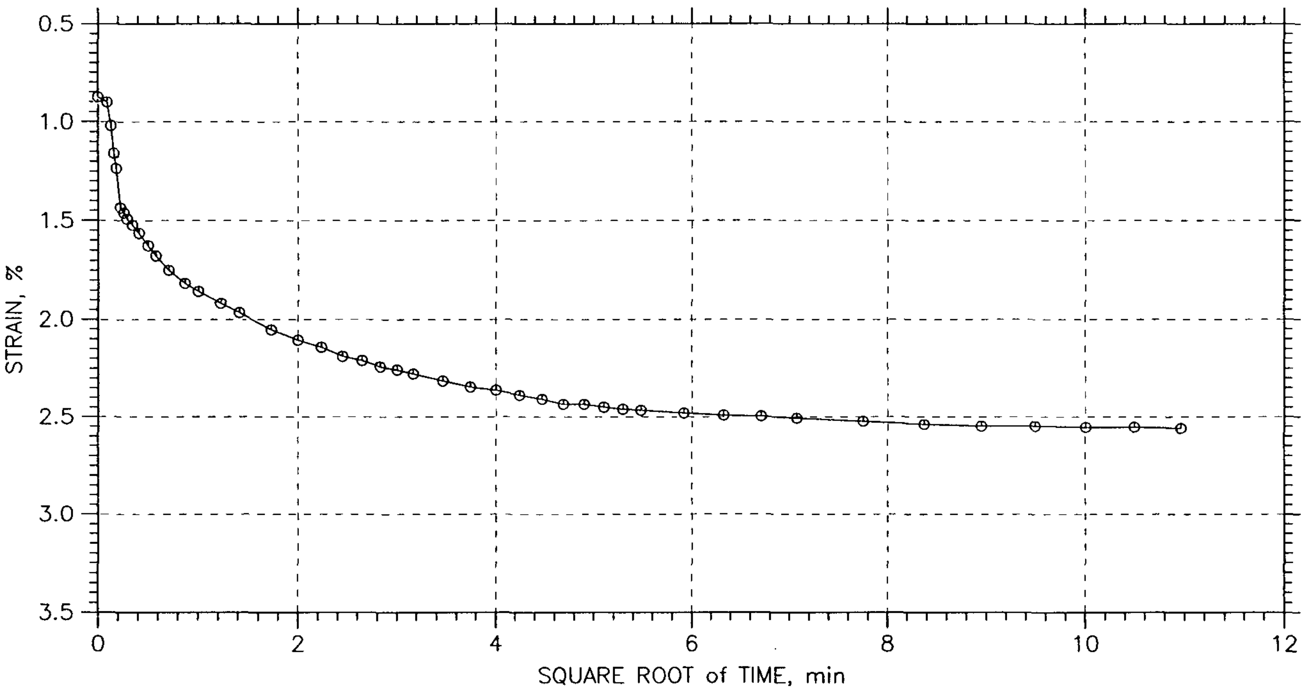
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 5 of 12

Stress: 2. tsf





GeoTesting express a subsidiary of Geocomp Corporation			
	Project: SMC Stockyard	Location: Newfield, NJ	Project No.: GTX-8837
	Boring No.: ---	Tested By: md	Checked By: jdt
	Sample No.: GB-1 (S)	Test Date: 02/12/09	Depth: 30-32 ft
	Test No.: C-1	Sample Type: tube	Elevation: ---
	Description: Moist, pale yellow clay		
	Remarks: System F		

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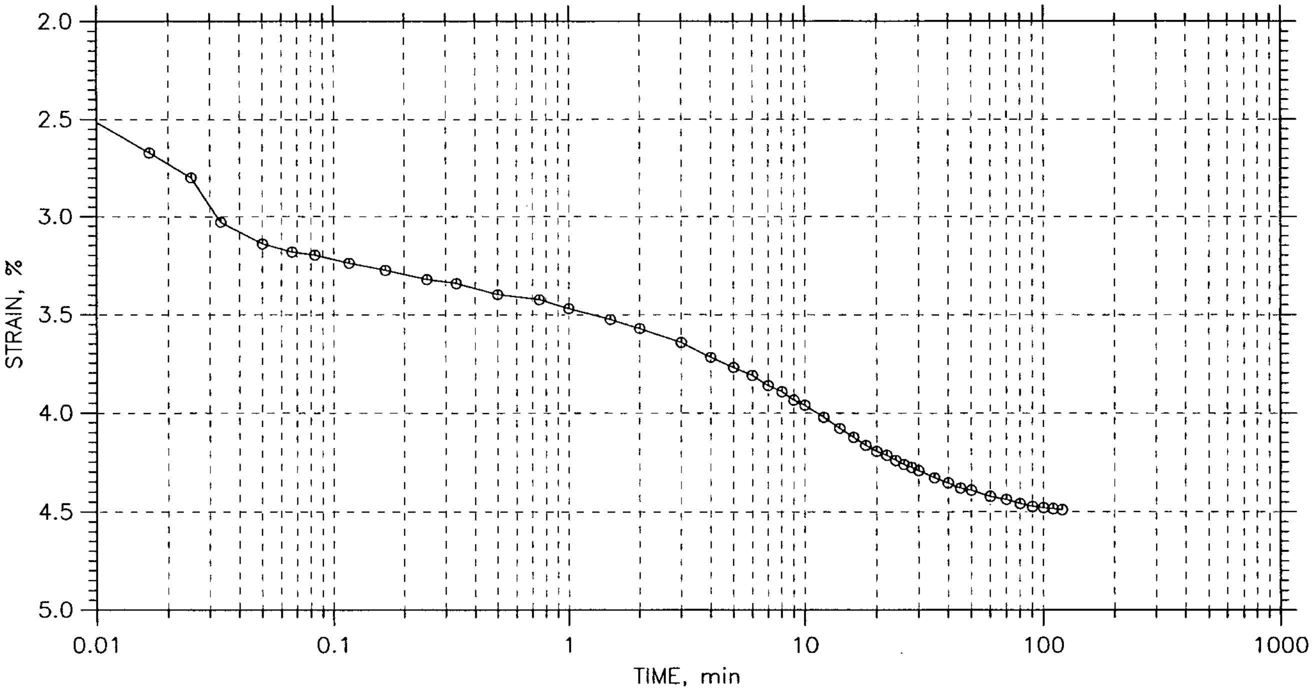
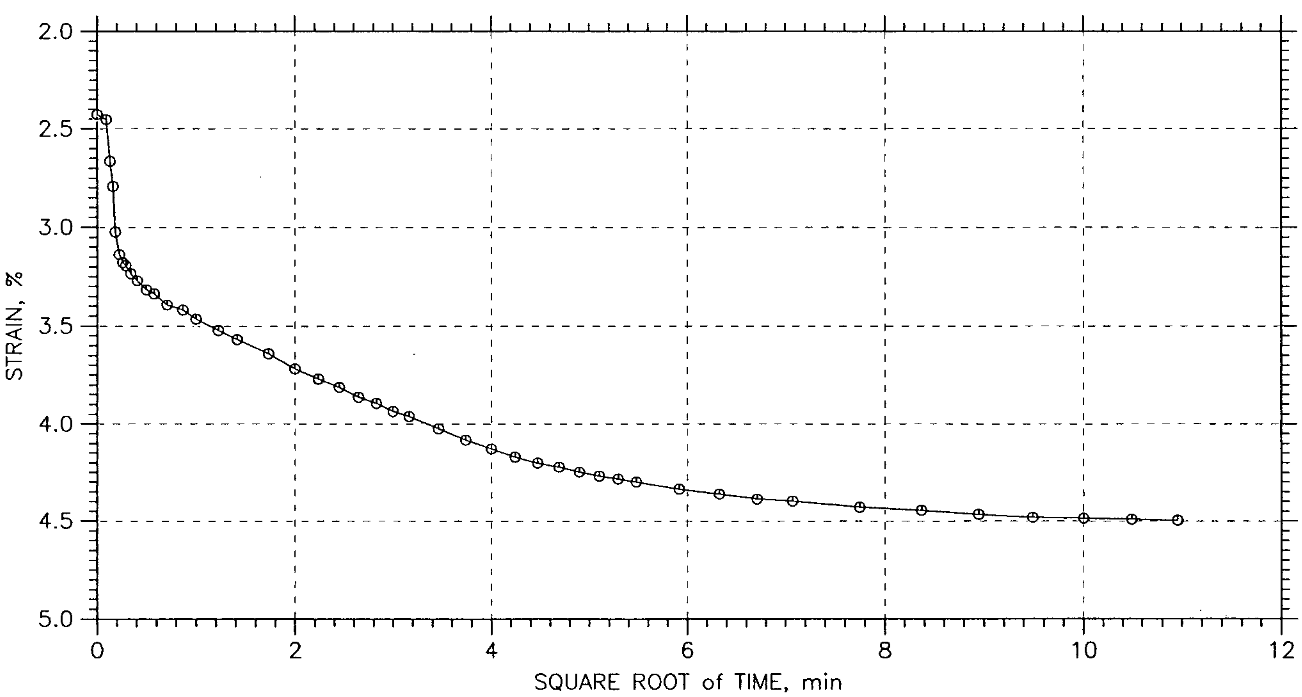
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 6 of 12

Stress: 4. tsf





GeoTesting express, a subsidiary of Geocomp Corporation	Project: SMC Stockyard	Location: Newfield, NJ	Project No.: GTX-8837
	Boring No.: ---	Tested By: md	Checked By: jdt
	Sample No.: GB-1 (S)	Test Date: 02/12/09	Depth: 30-32 ft
	Test No.: C-1	Sample Type: tube	Elevation: ---
	Description: Moist, pale yellow clay		
	Remarks: System F		

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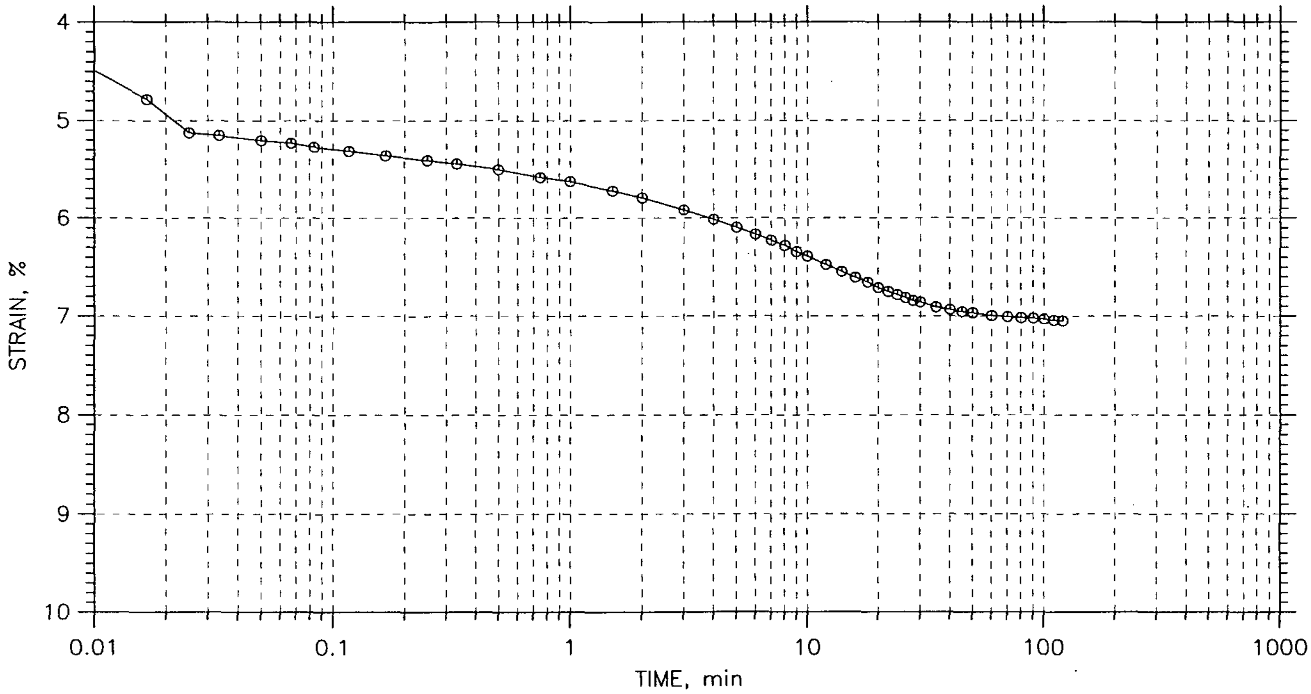
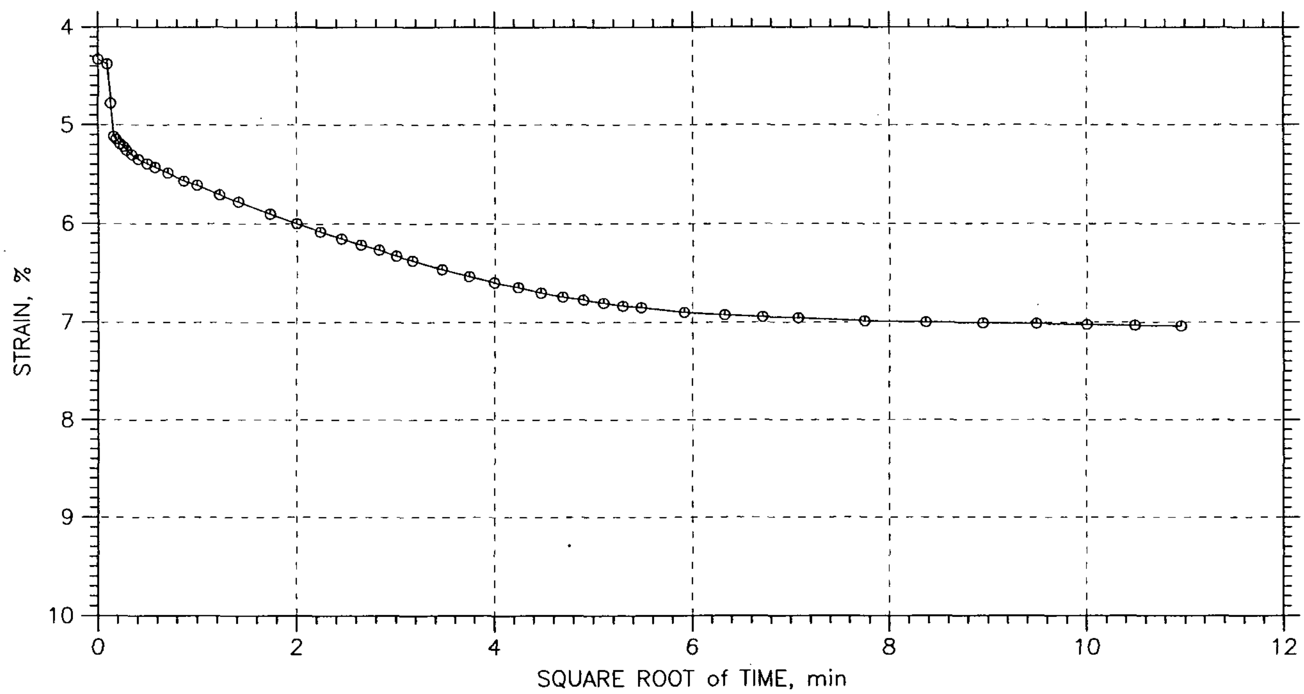
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 7 of 12

Stress: 8. tsf





GeoTesting express a subsidiary of Geocomp Corporation	Project: SMC Stockyard	Location: Newfield, NJ	Project No.: GTX-8837
	Boring No.: ---	Tested By: md	Checked By: jdt
	Sample No.: GB-1 (S)	Test Date: 02/12/09	Depth: 30-32 ft
	Test No.: C-1	Sample Type: tube	Elevation: ---
	Description: Moist, pale yellow clay		
	Remarks: System F		

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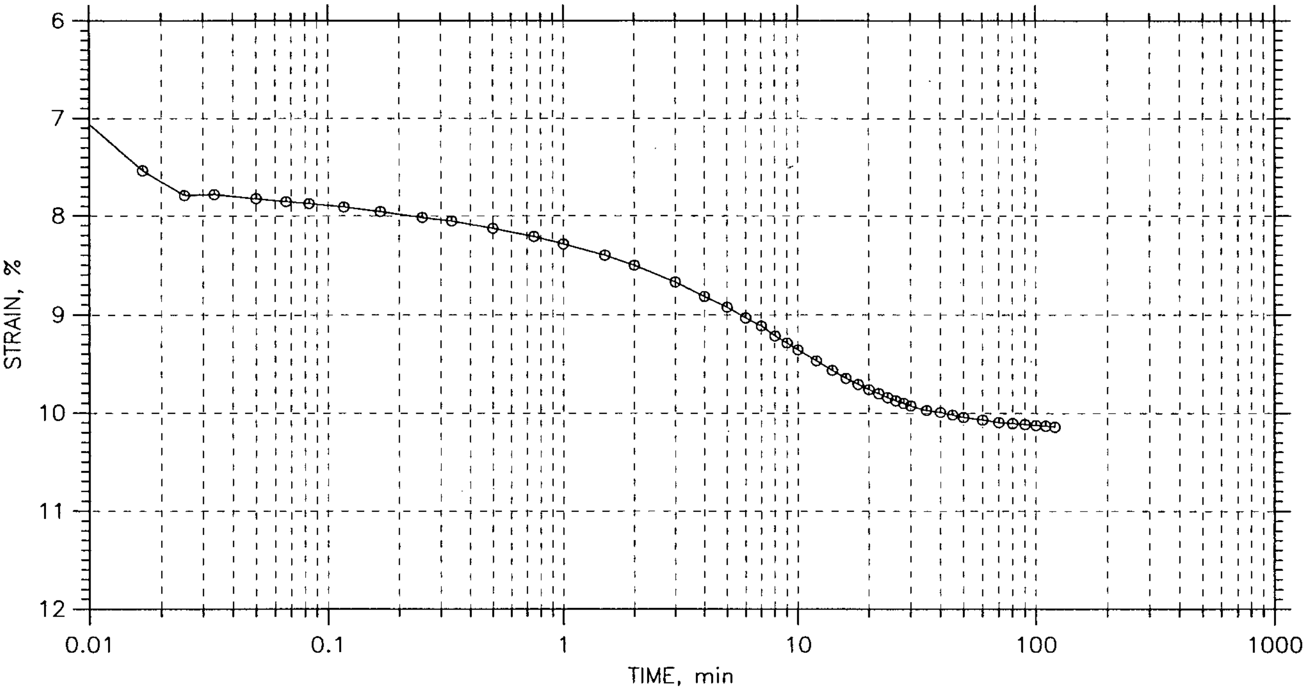
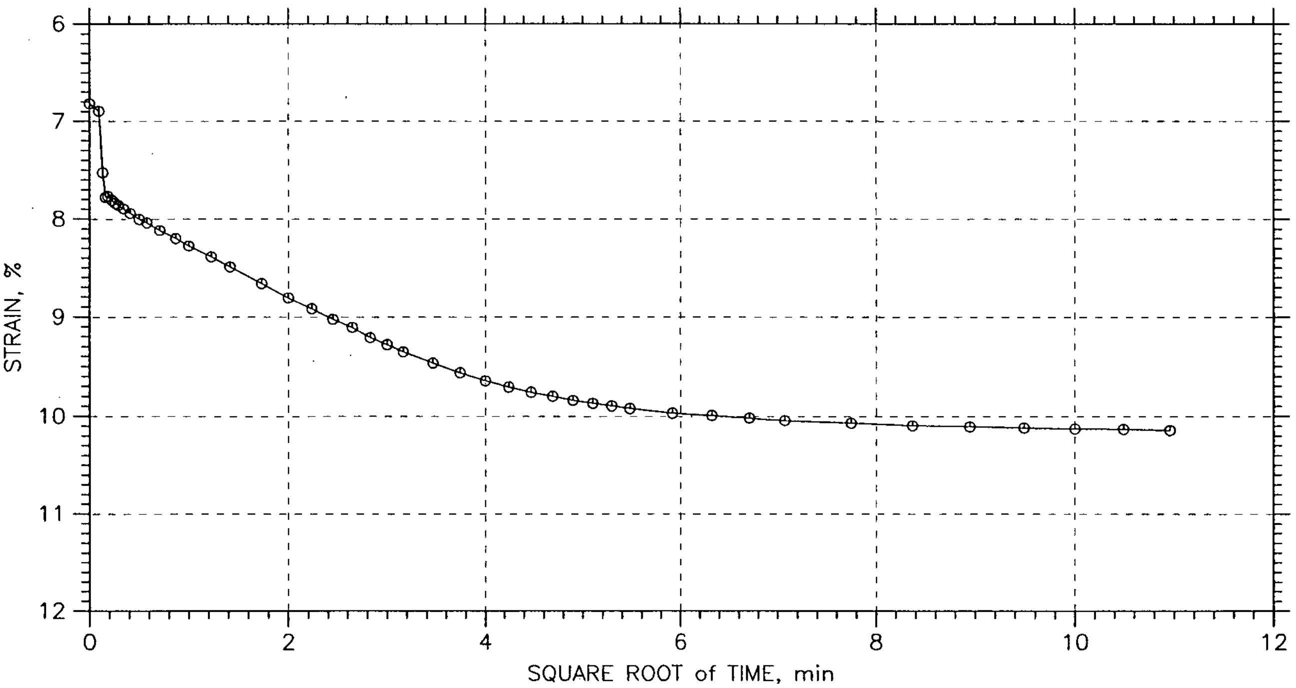
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 8 of 12

Stress: 16. tsf





GeoTesting express a subsidiary of Geocomp Corporation	Project: SMC Stockyard	Location: Newfield, NJ	Project No.: GTX-8837
	Boring No.: ---	Tested By: md	Checked By: jdt
	Sample No.: GB-1 (S)	Test Date: 02/12/09	Depth: 30-32 ft
	Test No.: C-1	Sample Type: tube	Elevation: ---
	Description: Moist, pale yellow clay		
	Remarks: System F		

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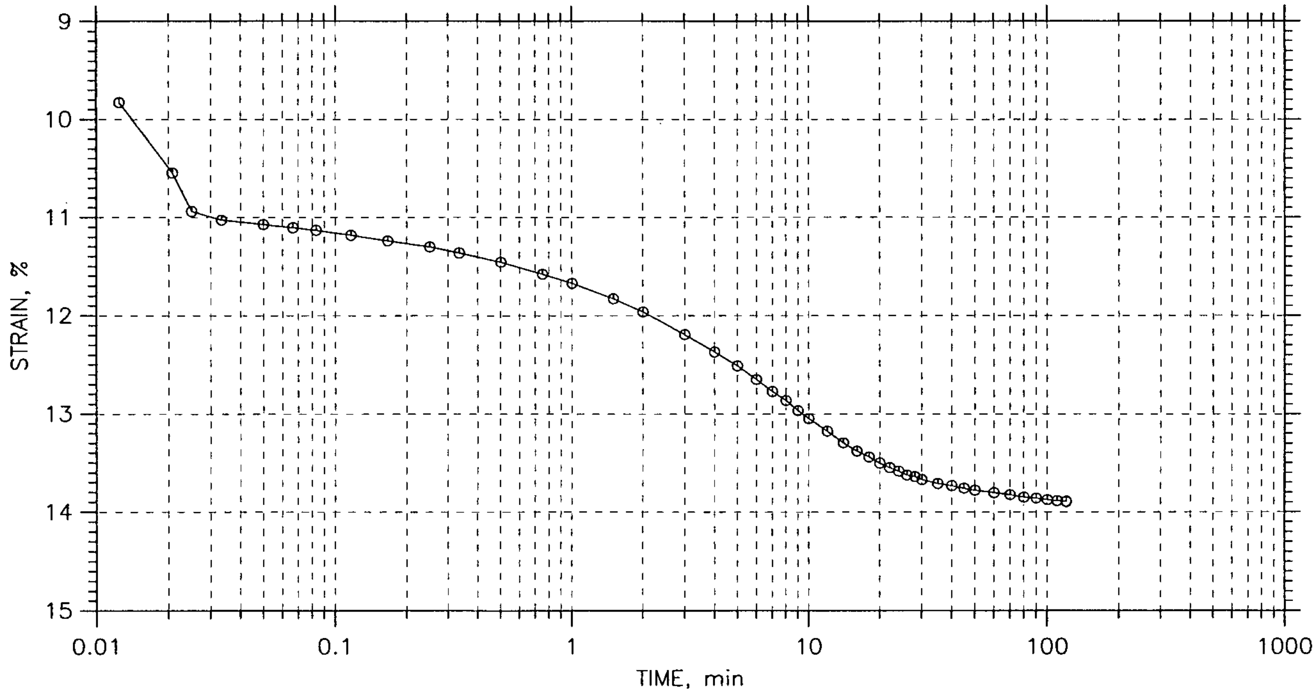
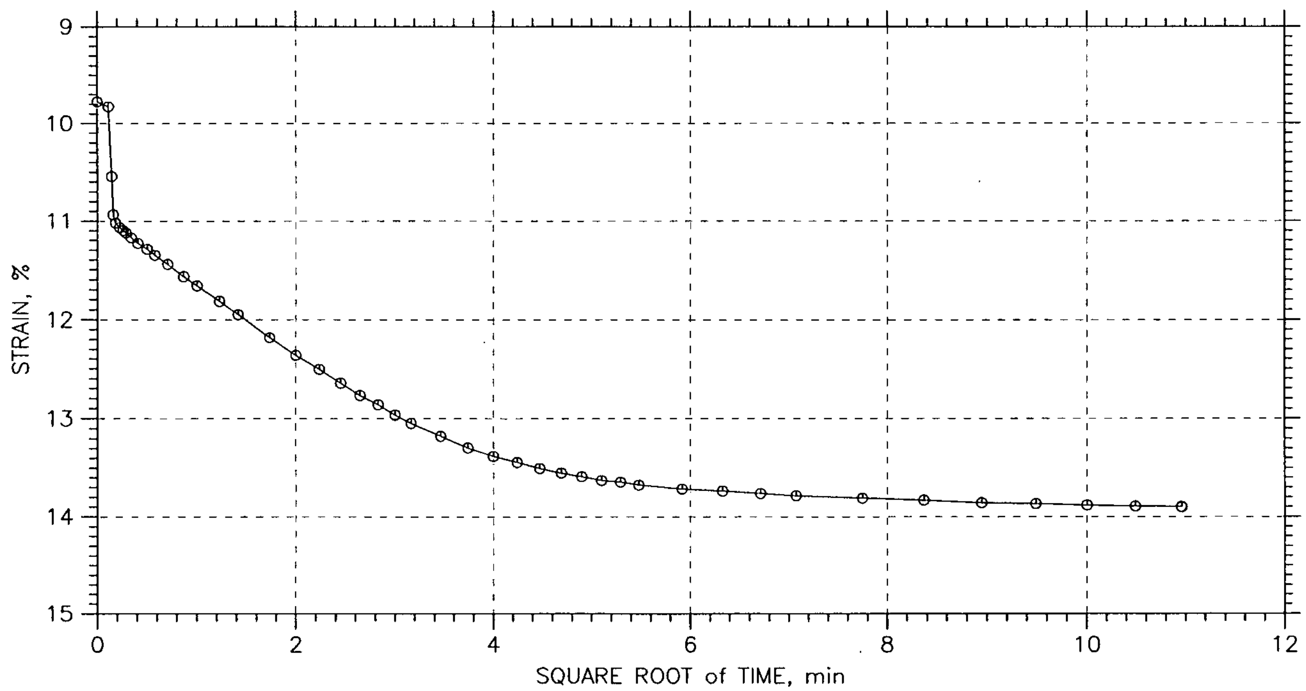
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 9 of 12

Stress: 32. tsf





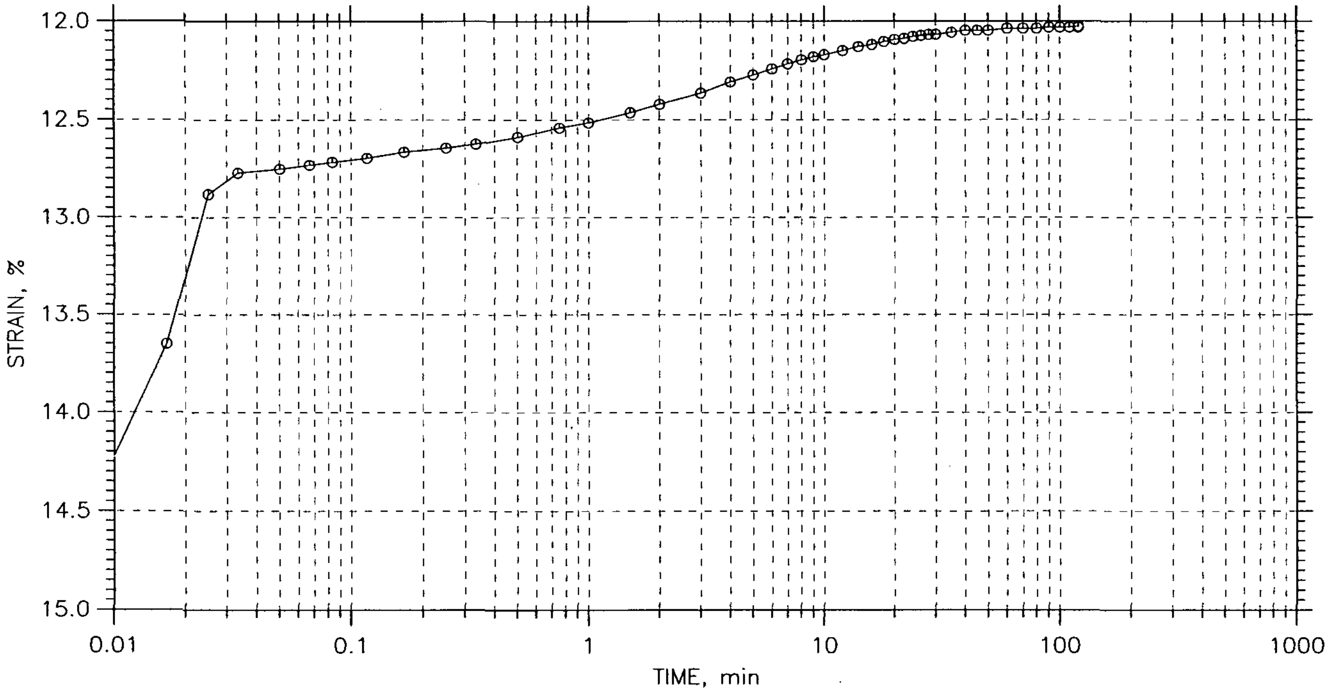
GeoTesting express a subsidiary of Geocomp Corporation	Project: SMC Stockyard	Location: Newfield, NJ	Project No.: GTX-8837
	Boring No.: ---	Tested By: md	Checked By: jdt
	Sample No.: GB-1 (S)	Test Date: 02/12/09	Depth: 30-32 ft
	Test No.: C-1	Sample Type: tube	Elevation: ---
	Description: Moist, pale yellow clay		
	Remarks: System F		

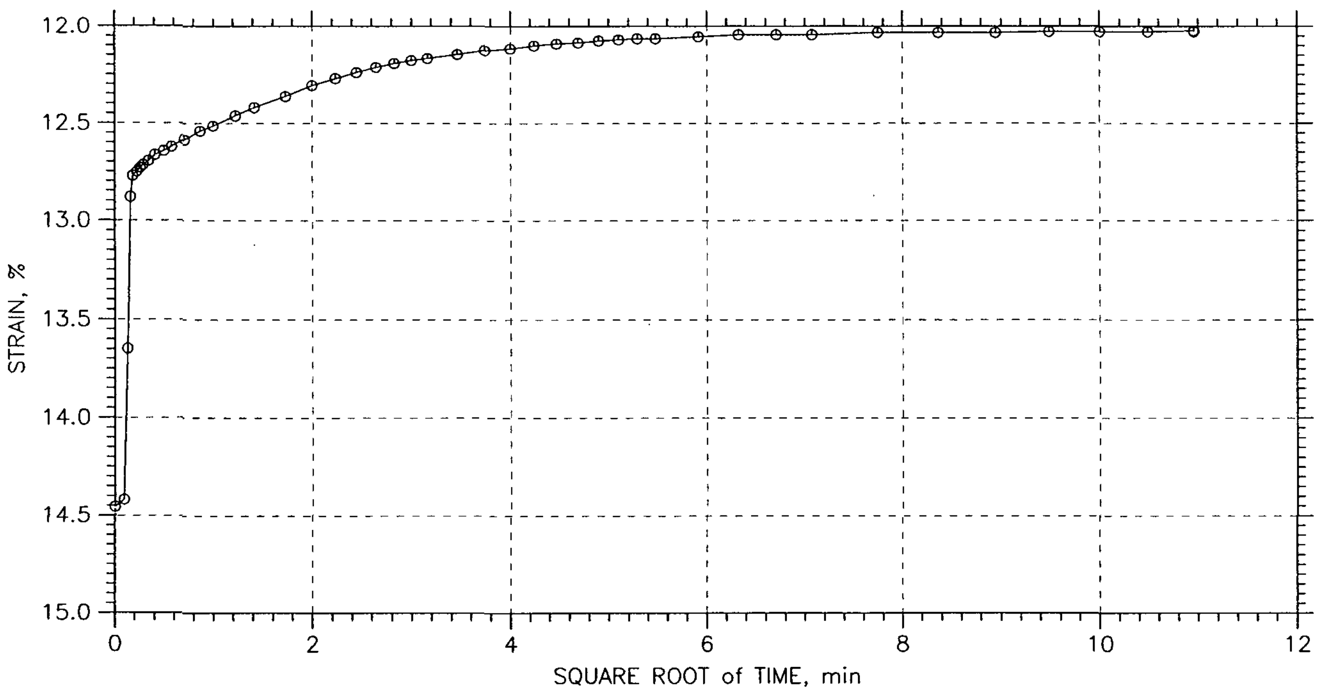
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 10 of 12

Stress: 8. tsf





GeoTesting express a subsidiary of Geocomp Corporation	Project: SMC Stockyard	Location: Newfield, NJ	Project No.: GTX-8837
	Boring No.: ---	Tested By: md	Checked By: jdt
	Sample No.: GB-1 (S)	Test Date: 02/12/09	Depth: 30-32 ft
	Test No.: C-1	Sample Type: tube	Elevation: ---
	Description: Moist, pale yellow clay		
	Remarks: System F		

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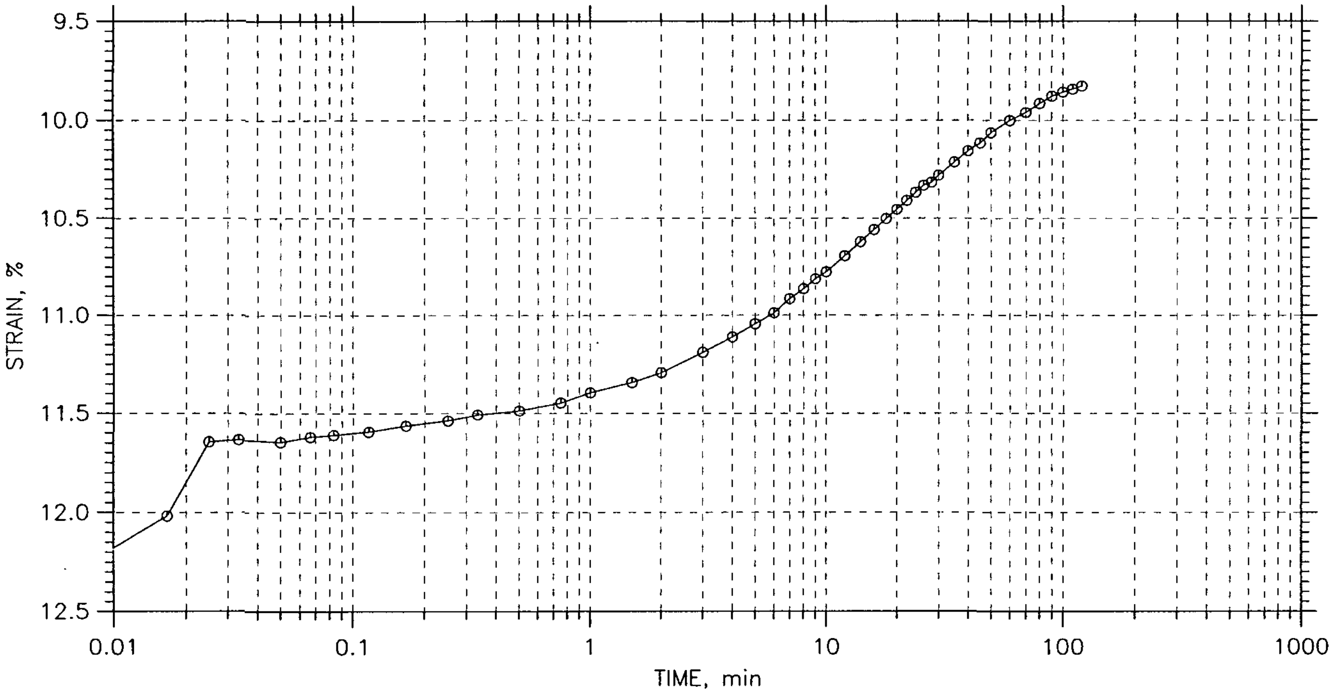
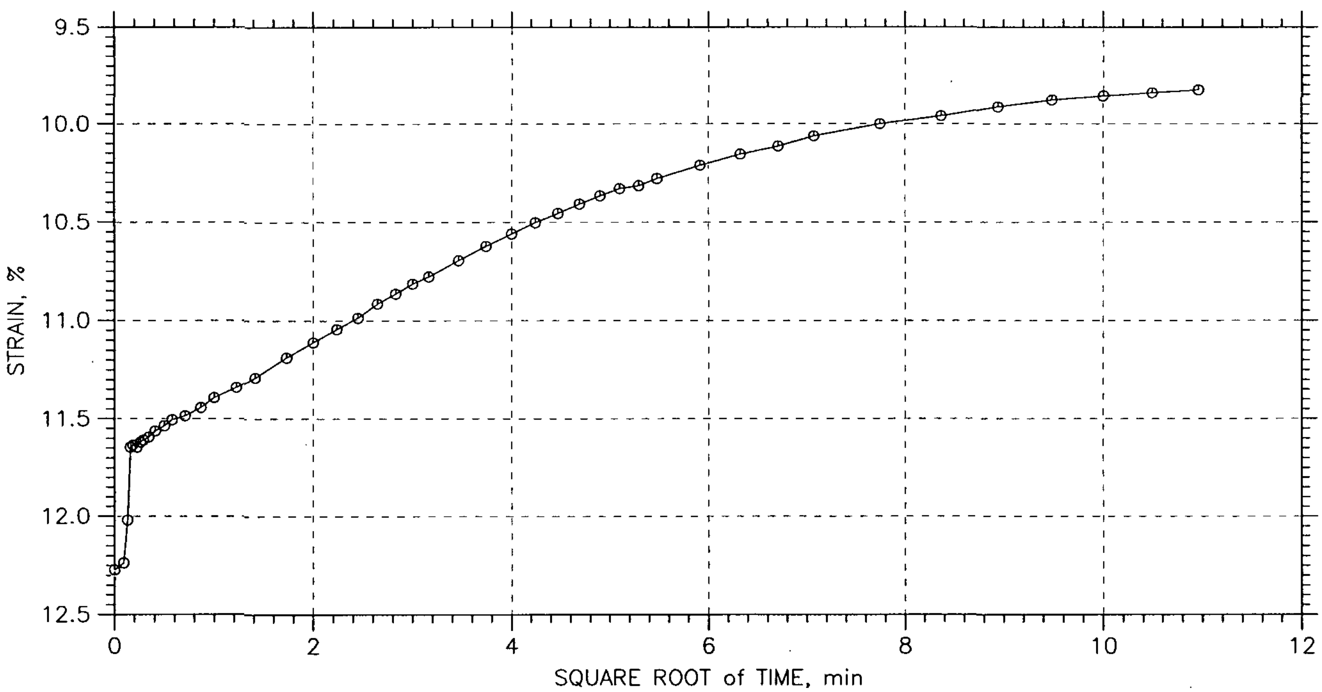
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 11 of 12

Stress: 2. tsf





GeoTesting express a subsidiary of Geocomp Corporation	Project: SMC Stockyard	Location: Newfield, NJ	Project No.: GTX-8837
	Boring No.: ---	Tested By: md	Checked By: jdt
	Sample No.: GB-1 (S)	Test Date: 02/12/09	Depth: 30-32 ft
	Test No.: C-1	Sample Type: tube	Elevation: ---
	Description: Moist, pale yellow clay		
	Remarks: System F		

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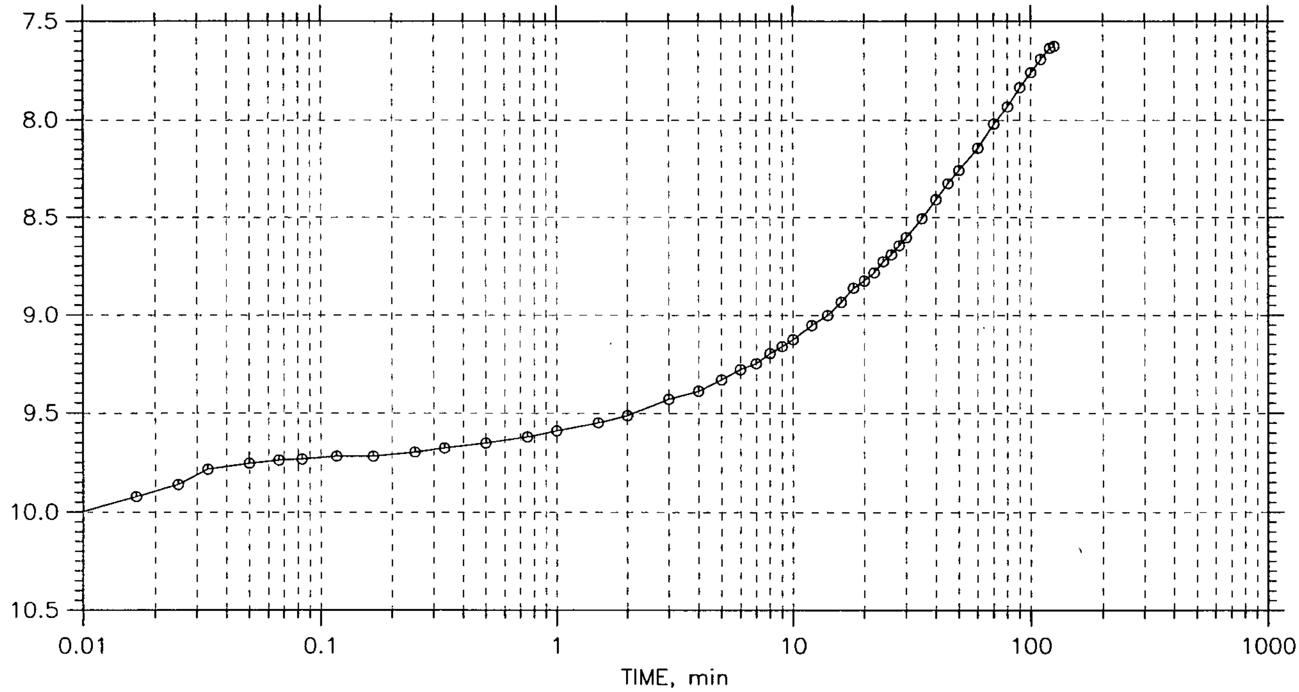
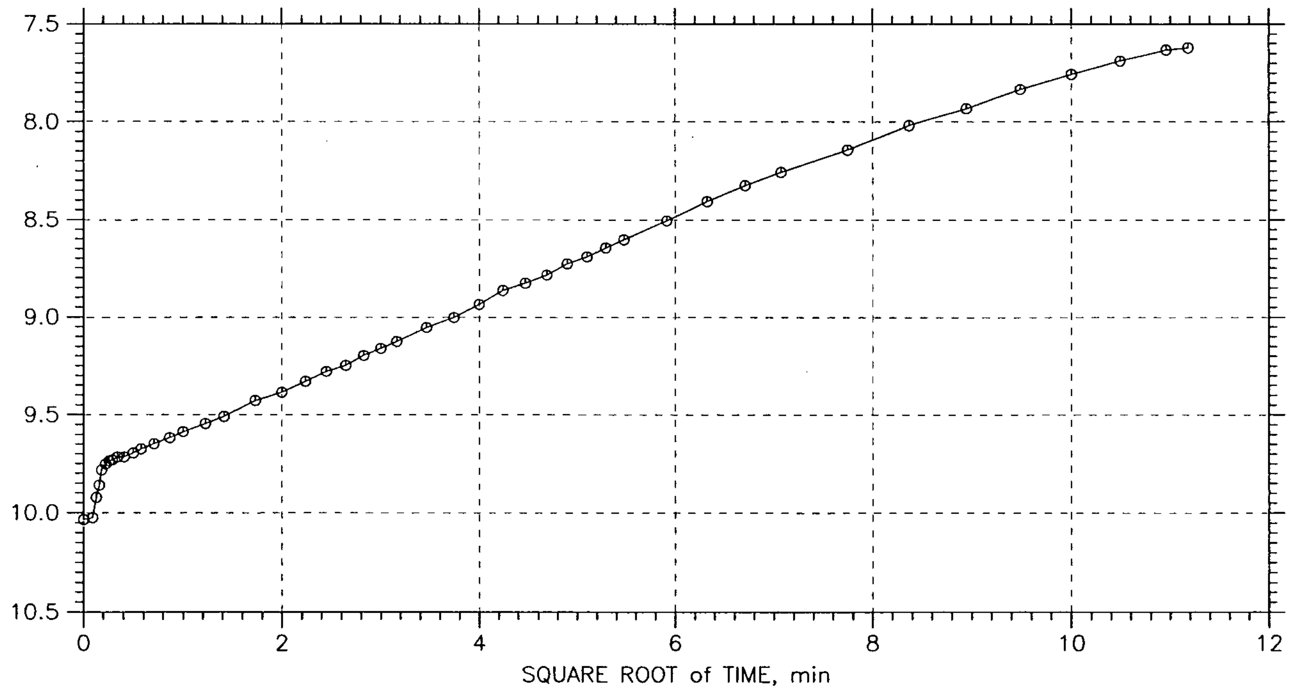
CONSOLIDATION TEST DATA

TIME CURVES

Constant Load Step: 12 of 12

Stress: 0.5 tsf



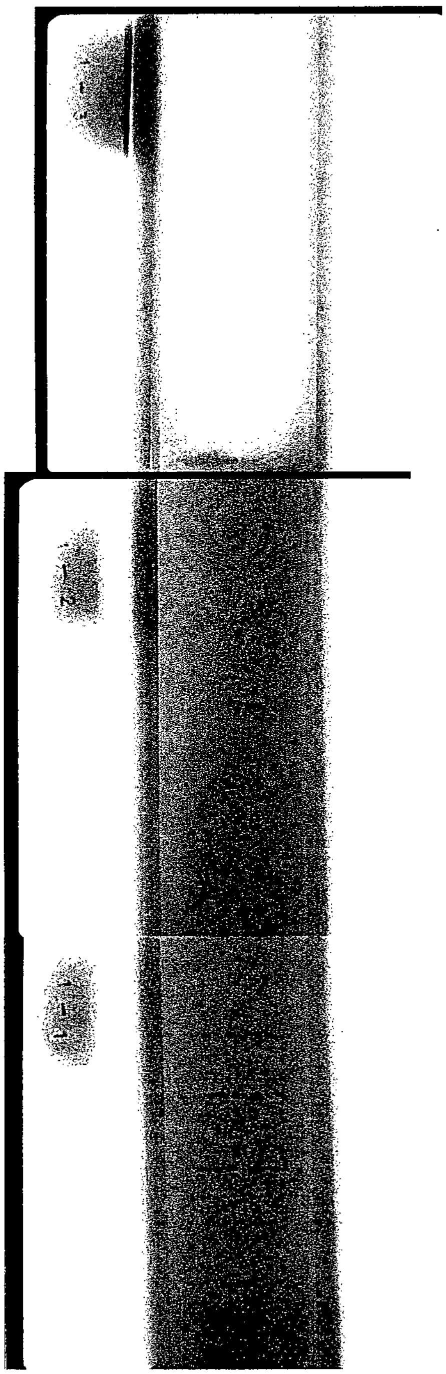


GeoTesting express a subsidiary of Geocomp Corporation			
	Project: SMC Stockyard	Location: Newfield, NJ	Project No.: GTX-8837
	Boring No.: ---	Tested By: md	Checked By: jdt
	Sample No.: GB-1 (S)	Test Date: 02/12/09	Depth: 30-32 ft
	Test No.: C-1	Sample Type: tube	Elevation: ---
	Description: Moist, pale yellow clay		
	Remarks: System F		

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	TRC Environmental
Project Name:	SMC Stockyard Geotech Borings
Project Location:	Newfield NJ
GTX #:	8837
Test Date:	02/12/09
Tested By:	ema/md
Checked By:	jdt
Boring ID:	GB-1 (S)
Sample ID:	69754
Depth, ft:	30-32

X-Ray of Soil Sample by ASTM D 4452



Top of Tube

Middle of Tube

Bottom of Tube

TRC
21 Griffin Road North
Windsor, CT 06095
860.298.9692 FAX 860.298.6399

Field Chain-of-Custody Record

Receiving Laboratory	Report to:	Invoice to:	Project ID/No.	Samples Collected by (signature)
GeoTesting Express Inc. 1145 Massachusetts Avenue Boxborough, MA 01719	Carl Stopper cstopper@trcsolutions.com	Same	SMC Stockyard Geotech Borings Newfield, NJ 105106.000100.000000	Christopher E. Carlson Name (printed)

Sample No.	Location/ID	Date Sampled	Sample Matrix: Water	Soil	Air	Other	Analyses Requested	Container Desc.
	GB-1 (4-6)	1/28/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-1 (8-10)	1/28/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-1 (10-12)	1/28/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-1 (12-14)	1/28/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-1 (14-16)	1/28/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-1 (20-22)	1/28/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-1 (24-26)	1/28/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-1 (26-28)	1/28/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-1 (28-29)	1/28/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-1 (33-34)	1/28/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag

Chain-of-Custody Record

Bottles Relinquished from Lab by	Date/Time	Samples Relinquished by	Date/Time	Samples received by	Date/Time
			2/3 3:30 pm		2/3/09 15:30
Bottles received in field by	**Date/Time**	**Samples Relinquished by**	**Date/Time**	**Samples received in LAB by**	**Date/Time**

Comments/Special Instructions: ***Atterberg Limits per ASTM D 4318 should be included for any sample which contains a sufficient proportion of fines below the 425-um (No 40) sieve to conduct the analysis.***

Turn-Around Time Requested- Specify Date Expected if RUSH Requested: DATE DUE FOR RUSH:

_____ STANDARD _______RUSH(Define)_______

TRC

21 Griffin Road North
Windsor, CT 06095
860.298.9692 FAX 860.298.6399

Field Chain-of-Custody Record

Receiving Laboratory	Report to:	Invoice to:	Project ID/No.	
GeoTesting Express Inc. 1145 Massachusetts Avenue Boxborough, MA 01719	Carl Stopper cstopper@trcsolutions.com	Same	SMC Stockyard Geotech Borings Newfield, NJ 105106.000100.000000	Samples Collected by (signature) Christopher E. Carlson Name (printed)

Sample No.	Location/ID	Date Sampled	Sample Matrix: Water	Soil	Air	Other	Analyses Requested	Container Desc.
	GB-1 (30-32) S	1/28/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422, Atterberg Limits per ASTM D 4318, Incremental Consolidation per ASTM D 2435 and Triaxial Shear per ASTM D 4767.	Shelby Tube
							Effective Stress = 1.3 tons/ft^2 (Existing Conditions) Consolidation Pressures (Tons/ft^2) = 0.125, 0.250, 0.50, 1.00, 2.00, 4.00 and 8.00.	

Chain-of-Custody Record

Bottles Relinquished from Lab by	Date/Time	Samples Relinquished by	Date/Time	Samples received by	Date/Time
		J. Nuqued	2/3 330	Robert Jumth	2/3/09 15:30

Bottles received in field by	Date/Time	Samples Relinquished by	Date/Time	Samples received in LAB by	Date/Time

Comments/Special Instructions: Please conduct an x-ray of shelby tube to assess sample condition prior to opening and contact Carl Stopper to discuss any concerns or issues prior to proceeding.

Turn-Around Time Requested- ***Specify Date Expected if RUSH Requested: DATE DUE FOR RUSH:***

_____ STANDARD _____ RU[illegible] (Define) _____

TRC
21 Griffin Road North
Windsor, CT 06095
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Field Chain-of-Custody Record

Receiving Laboratory	Report to:	Invoice to:	Project ID/No.	
GeoTesting Express Inc. 1145 Massachusetts Avenue Boxborough, MA 01719	Carl Stopper cstopper@trcsolutions.com	Same	SMC Stockyard Geotech Borings Newfield, NJ 105106.000100.000000	Samples Collected by (signature) Christopher E. Carlson Name (printed)

Sample No.	Location/ID	Date Sampled	Sample Matrix: Water	Soil	Air	Other	Analyses Requested	Container Desc.
	GB-2 (0-2)	1/28/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-2 (2-4)	1/28/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-2 (6-8)	1/28/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-2 (8-10)	1/28/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-2 (10-12)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-2 (12-14)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-2 (18-20)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-2 (22-24)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-2 (26-28)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-2 (30-32)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-2 (32-34)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag

Chain-of-Custody Record

Bottles Relinquished from Lab by	Date/Time	Samples Relinquished by	2/3 3:30 Date/Time	Samples received by	2/3/09 15:40 Date/Time
Bottles received in field by	Date/Time	Samples Relinquished by	Date/Time	Samples received in LAB by	Date/Time

Comments/Special Instructions: ***Atterberg Limits per ASTM D 4318 should be included for any sample which contains a sufficient proportion of fines below the 425-um (No 40) sieve to conduct the analysis.***

***Turn-Around Time Requested-** <u>**Specify Date Expected if RUSH Requested: DATE DUE FOR RUSH:**</u>*

_____ STANDARD _______RUSH(Define)_______

TRC

21 Griffin Road North
Windsor, CT 06095
860.298.9692 FAX 860.298.6399

Field Chain-of-Custody Record

Receiving Laboratory	Report to:	Invoice to:	Project ID/No.	
GeoTesting Express Inc. 1145 Massachusetts Avenue Boxborough, MA 01719	Carl Stopper cstopper@trcsolutions.com	Same	SMC Stockyard Geotech Borings Newfield, NJ 105106.000100.000000	Samples Collected by (signature) Christopher E. Carlson Name (printed)

Sample No.	Location/ID	Date Sampled	Sample Matrix: Water	Soil	Air	Other	Analyses Requested	Container Desc.
	GB-3 (0-2)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-3 (4-6)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-3 (6-8)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-3 (10-12)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-3 (16-18)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-3 (20-22)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-3 (24-26)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-3 (28-30)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-3 (32-34)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-3 (36-38)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag

Chain-of-Custody Record

Bottles Relinquished from Lab by	Date/Time	Samples Relinquished by	Date/Time	Samples received by	Date/Time
		[signature]	2/3 3:30	[signature]	2/3/09 15:30
Bottles received in field by	**Date/Time**	**Samples Relinquished by**	**Date/Time**	**Samples received in LAB by**	**Date/Time**

Comments/Special Instructions: ***Atterberg Limits per ASTM D 4318 should be included for any sample which contains a sufficient proportion of fines below the 425-um (No 40) sieve to conduct the analysis.***

Turn-Around Time Requested- Specify Date Expected if RUSH Requested: DATE DUE FOR RUSH:

_____ STANDARD _____RUSH (define)_____

TRC
21 Griffin Road North
Windsor, CT 06095
860.298.9692 FAX 860.298.6399

Field Chain-of-Custody Record

Receiving Laboratory	Report to:	Invoice to:	Project ID/No.	Samples Collected by (signature)
GeoTesting Express Inc. 1145 Massachusetts Avenue Boxborough, MA 01719	Carl Stopper cstopper@trcsolutions.com	Same	SMC Stockyard Geotech Borings Newfield, NJ 105106.000100.000000	Christopher E. Carlson Name (printed)

Sample No.	Location/ID	Date Sampled	Sample Matrix: Water	Soil	Air	Other	Analyses Requested	Container Desc.
	GB-4 (0-2)	1/30/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-4 (4-6)	1/30/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-4 (8-10)	1/30/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-4 (10-12)	1/30/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-4 (14-16)	1/30/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-4 (18-20)	1/30/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-4 (22-24)	1/30/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-4 (26-28)	1/30/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-4 (30-32)	1/30/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-4 (34-36)	1/30/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag

Chain-of-Custody Record

Bottles Relinquished from Lab by	Date/Time	Samples Relinquished by	Date/Time	Samples received by	Date/Time
		S. Rupwest	2/3 3:30	Robert Lunte	2/3/09 15:30
Bottles received in field by	**Date/Time**	**Samples Relinquished by**	**Date/Time**	**Samples received in LAB by**	**Date/Time**

Comments/Special Instructions: ***Atterberg Limits per ASTM D 4318 should be included for any sample which contains a sufficient proportion of fines below the 425-um (No 40) sieve to conduct the analysis.***

Turn-Around Time Requested- Specify Date Expected if RUSH Requested: DATE DUE FOR RUSH:

_____ STANDARD _____RUSH(Define)_____

TRC
21 Griffin Road North
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Field Chain-of-Custody Record

Receiving Laboratory	Report to:	Invoice to:	Project ID/No.	Samples Collected by (signature)
GeoTesting Express Inc. 1145 Massachusetts Avenue Boxborough, MA 01719	Carl Stopper cstopper@trcsolutions.com	Same	SMC Stockyard Geotech Borings Newfield, NJ 105106.000100.000000	Christopher E. Carlson Name (printed)

Sample No.	Location/ID	Date Sampled	Sample Matrix: Water	Soil	Air	Other	Analyses Requested	Container Desc.
	GB-5 (2-4)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-5 (6-8)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-5 (9-10)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-5 (12-14)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-5 (16-18)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-5 (20-22)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-5 (22-24)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-5 (26-28)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag
	GB-5 (30-32)	1/29/2009		X			Soil Classification per ASTM D 2487, Grain Size Analysis (w/Hydrometer) per ASTM D 422	Ziplock Bag

Chain-of-Custody Record

Bottles Relinquished from Lab by	Date/Time	Samples Relinquished by	Date/Time	Samples received by	Date/Time
			2/3 3:30		2/3/09 15:30
Bottles received in field by	**Date/Time**	**Samples Relinquished by**	**Date/Time**	**Samples received in LAB by**	**Date/Time**

Comments/Special Instructions: ***Atterberg Limits per ASTM D 4318 should be included for any sample which contains a sufficient proportion of fines below the 425-um (No 40) sieve to conduct the analysis.***

Turn-Around Time Requested-** **Specify Date Expected if RUSH Requested: DATE DUE FOR RUSH:

_____ STANDARD _____RU[illegible] (Define)_____

GeoTesting
express

WARRANTY and LIABILITY

GeoTesting Express (GTX) warrants that all tests it performs are run in general accordance with the specified test procedures and accepted industry practice. GTX will correct or repeat any test that does not comply with this warranty. GTX has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material.

GTX may report engineering parameters that require us to interpret the test data. Such parameters are determined using accepted engineering procedures. However, GTX does not warrant that these parameters accurately reflect the true engineering properties of the *in situ* material. Responsibility for interpretation and use of the test data and these parameters for engineering and/or construction purposes rests solely with the user and not with GTX or any of its employees.

GTX's liability will be limited to correcting or repeating a test which fails our warranty. GTX's liability for damages to the Purchaser of testing services for any cause whatsoever shall be limited to the amount GTX received for the testing services. GTX will not be liable for any damages, or for any lost benefits or other consequential damages resulting from the use of these test results, even if GTX has been advised of the possibility of such damages. GTX will not be responsible for any liability of the Purchaser to any third party.

Commonly Used Symbols

A	pore pressure parameter for $\Delta\sigma_1 - \Delta\sigma_3$
B	pore pressure parameter for $\Delta\sigma_3$
CIU	isotropically consolidated undrained triaxial shear test
CR	compression ratio for one dimensional consolidation
C_c	coefficient of curvature, $(D_{30})^2 / (D_{10} \times D_{60})$
C_u	coefficient of uniformity, D_{60}/D_{10}
C_c	compression index for one dimensional consolidation
C_α	coefficient of secondary compression
c_v	coefficient of consolidation
c	cohesion intercept for total stresses
c'	cohesion intercept for effective stresses
D	diameter of specimen
D_{10}	diameter at which 10% of soil is finer
D_{15}	diameter at which 15% of soil is finer
D_{30}	diameter at which 30% of soil is finer
D_{50}	diameter at which 50% of soil is finer
D_{60}	diameter at which 60% of soil is finer
D_{85}	diameter at which 85% of soil is finer
d_{50}	displacement for 50% consolidation
d_{90}	displacement for 90% consolidation
d_{100}	displacement for 100% consolidation
E	Young's modulus
e	void ratio
e_c	void ratio after consolidation
e_o	initial void ratio
G	shear modulus
G_s	specific gravity of soil particles
H	height of specimen
PI	plasticity index
i	gradient
K_o	lateral stress ratio for one dimensional strain
k	permeability
LI	Liquidity Index
m_v	coefficient of volume change
n	porosity
PI	plasticity index
P_c	preconsolidation pressure
p	$(\sigma_1 + \sigma_3) / 2$, $(\sigma_v + \sigma_h) / 2$
p'	$(\sigma'_1 + \sigma'_3) / 2$, $(\sigma'_v + \sigma'_h) / 2$
p'_c	p' at consolidation
Q	quantity of flow
q	$(\sigma_1 - \sigma_3) / 2$
q_f	q at failure
q_o, q_i	initial q
q_c	q at consolidation
S	degree of saturation
SL	shrinkage limit
s_u	undrained shear strength
T	time factor for consolidation

T	temperature
t	time
U, UC	unconfined compression test
UU, Q	unconsolidated undrained triaxial test
u_a	pore gas pressure
u_e	excess pore water pressure
u, u_w	pore water pressure
V	total volume
V_g	volume of gas
V_s	volume of solids
V_v	volume of voids
V_w	volume of water
V_o	initial volume
v	velocity
W	total weight
W_s	weight of solids
W_w	weight of water
w	water content
w_c	water content at consolidation
w_f	final water content
w_l	liquid limit
w_n	natural water content
w_p	plastic limit
w_s	shrinkage limit
w_o, w_i	initial water content
α	slope of q_f versus p_f
α'	slope of q_f versus p_f'
γ_t	total unit weight
γ_d	dry unit weight
γ_s	unit weight of solids
γ_w	unit weight of water
ε	strain
ε_{vol}	volume strain
ε_h, ε_v	horizontal strain, vertical strain
μ	Poisson's ratio, also viscosity
σ	normal stress
σ'	effective normal stress
σ_c, σ'_c	consolidation stress in isotropic stress system
σ_h, σ'_h	horizontal normal stress
σ_v, σ'_v	vertical normal stress
σ_1	major principal stress
σ_2	intermediate principal stress
σ_3	minor principal stress
τ	shear stress
φ	friction angle based on total stresses
φ'	friction angle based on effective stresses
φ'_r	residual friction angle
φ_{ult}	φ for ultimate strength