



**GEOTEK ENGINEERING  
& TESTING SERVICES, INC.**

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July 16, 2009

Ellerbe Becket, Inc.  
2380 McGee Street, Suite 200  
Kansas City, MO 64108

Attn: Mr. J. Christopher Gale, AIA

Subj: Geotechnical Exploration  
Proposed Surgical Suite Addition  
Veterans Memorial Medical Center  
2501 W. 22<sup>nd</sup> Street  
Sioux Falls, South Dakota  
GeoTek #09-457

This correspondence presents our written report of the geotechnical exploration program for the referenced project. Our work was performed in accordance our contractual agreement dated May 5, 2009. We are transmitting five copies of our report for your use.

We thank you for the opportunity of providing our services on this project and look forward to continued participation during the design and construction phases. If you have any questions regarding this report, please contact our office at (605) 335-5512.

Respectfully Submitted,  
GeoTek Engineering & Testing Services, Inc.

Jeff Christensen, PE  
Geotechnical Manager

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**APPENDIX A**

SITE SKETCH  
BORING LOGS  
SOILS CLASSIFICATION SHEET  
SYMBOLS AND DESCRIPTIVE TERMINOLOGY  
LABORATORY TEST DATA SHEETS

**GEOTECHNICAL EXPLORATION  
PROPOSED SURGICAL SUITE ADDITION  
VETERANS MEMORIAL MEDICAL CENTER  
2501 W. 22<sup>ND</sup> STREET  
SIOUX FALLS, SOUTH DAKOTA  
GEOTEK #09-457**

**INTRODUCTION**

**Project Information**

This report presents the results of the recent geotechnical exploration program for the proposed Surgical Suite Addition at the Veterans Memorial Medical Center in Sioux Falls, South Dakota.

**Scope of Services**

Our work was performed in accordance with our contractual agreement dated May 5, 2009. The authorized scope of services included the following:

1. To perform seven (7) standard penetration test (SPT) borings to explore the subsurface conditions at the project site.
2. To perform laboratory tests including moisture content, dry density, unconfined compressive strength, Atterberg limits (liquid limit and plastic limit), triaxial compression and consolidation.
3. To prepare an engineering report including the results of the field and laboratory tests as well as our geotechnical engineering opinions and recommendations regarding the following:
  - Site preparation and excavation/filling procedures;
  - Foundation types and depths, allowable bearing capacity and estimated potential settlements of foundations;
  - Floor slab support;
  - Foundation backfill;
  - Comments regarding factors that may impact the constructability and final performance of the project;
  - Quality control observations and testing.

The scope of our work was intended for geotechnical purposes only. This scope of work did not include determining the presence or extent of environmental contamination at the site or to characterize the site relative to wetlands status.

## **SITE AND SUBSURFACE CONDITIONS**

### **Site Location and Description**

The project site is located at the existing facility for Royal C. Johnson Veterans Memorial Medical Center at 2501 W. 22<sup>nd</sup> Street in Sioux Falls, South Dakota. The area of the proposed building addition is located south of the existing Hospital Building #5. The topography of the site generally slopes slightly downward to the southeast. Based on the temporary benchmark datum, the surface elevations at the boring locations varied from 1503.4 feet at boring #6 to 1499.5 feet at boring #7. The top nut of the fire hydrant located along the north side of the private drive (Benchmark #1) was used as a temporary benchmark. An elevation of 1504.81 feet was furnished for the benchmark.

### **Subsurface Conditions**

Seven (7) test borings were performed at the site from June 8 to June 17, 2009. The subsurface conditions encountered at the test boring locations are illustrated by means of the boring logs included in Appendix A. We wish to point out that the subsurface conditions at other times and locations at the site may differ from those found at our test boring locations. If different conditions are encountered during construction, it is necessary that you contact us so that our recommendations can be reviewed.

The subsurface conditions encountered at the boring locations consist of 2 to 3 ½ feet of existing fill materials at the surface overlying lean clay (loess) soils that extended to depths varying from 19 ½ feet to 24 ½ feet. Sandy lean clay (glacial till) soils were encountered beneath the loess soils and extended to the termination depth of the borings. Silty sand (outwash) soils were encountered from 39 ½ feet to 44 ½ feet at boring #2. We encountered refusal at a depth of 98.7 feet at boring #5. It is our opinion that the refusal is likely the Sioux Quartzite bedrock.

The consistency of the lean clay (loess) soils varied from soft to firm. The consistency of the sandy lean clay (glacial till) soils varied from firm to hard. The density of the silty sand (outwash) soils was dense. The consistency and density of the soils are indicated by the standard penetration resistance (“N”) values as shown on the boring logs.

### **Water Levels**

Groundwater measurements were not made at the boring locations because drilling fluid was used to advance the borings. However, an auxiliary borehole was performed on June 11, 2009 adjacent to boring #4 in order to collect 3-inch diameter Shelby tube samples for laboratory testing. This auxiliary borehole was left open for a period six days for groundwater measurements. The time and level of the groundwater readings are recorded on the boring log. Groundwater was measured at a depth 19 ½ feet at the boring.

The water levels indicated on the boring logs may not be an accurate indication of the depth or lack of subsurface groundwater. A long period of time is generally required for subsurface water to stabilize in the impervious soils encountered at the boring locations. Long term groundwater monitoring was not included in our work scope.

Subsurface groundwater levels should be expected to fluctuate seasonally and yearly from the groundwater readings recorded at the borings. Fluctuations occur due to varying seasonal and yearly rainfall amounts and snowmelt, as well as other factors. It is possible that the subsurface groundwater levels during or after construction could be significantly different than the time the borings were performed.

## **ENGINEERING REVIEW AND RECOMMENDATIONS**

### **Project Design Data**

The project will consist of constructing a new Surgical Suite Building Addition at the Veterans Memorial Medical Center in Sioux Falls, South Dakota. The proposed building addition will initially be a one-story slab-on-grade structure with a mechanical penthouse and an elevator that will extend to the 4<sup>th</sup> floor. We understand the structure will be designed for future expansion

consisting of two additional floors. The structure will have a reinforced concrete frame construction with column loads on the order of 55 kips to 365 kips for the initial construction and 110 kips to 1350 kips for the final construction. We understand the finish floor elevation of the proposed building addition will be at elevation 1498.5 feet.

The above information/assumptions are important factors in our review and recommendations. If there are any corrections or additions to the above-mentioned data, it is necessary that you contact us so that we can review our recommendations with regards to the revised plans.

### **Discussion**

Lean clay (loess) soils were encountered at the boring locations and extended to depths of 19 ½ feet to 24 ½ feet. Based upon the results of the test borings and laboratory tests, it is our opinion that the loess soils have low strength characteristics and are not suitable for foundation support of the proposed building addition.

It is our opinion that an alternative foundation system will be required for support of the proposed structure. The first option consists of using a deep foundation system of belled drilled shafts bearing in the glacial till soils. A second option consists of using a deep foundation system of auger-cast piles bearing in the glacial till soils. The third option consists of an intermediate foundation system that utilizes rammed aggregate piers to reinforce the existing materials for support of a spread footing foundation system. Each of these options is discussed in the following sections.

### **Belled Drilled Shafts**

It is our opinion that a deep foundation system consisting of belled drilled shafts and grade beams can be used for foundation support of the proposed building addition. The belled drilled shafts would develop capacity from end-bearing within the sandy lean clay (glacial till) soils. We recommend the drilled shafts extend a minimum of 15 feet into the sandy lean clay (glacial till) soils. It is our opinion that the drilled shafts can be designed using an allowable end-bearing value of 12.0 kips per square foot (ksf).

The diameter of the bell should not exceed 2.5 times the diameter of shaft. Temporary casing will likely be required to secure caving soils and seal off groundwater. Areas of waterbearing sand may be randomly encountered within the glacial till soils that would require modifying the bottom elevation of the shaft in order to provide a suitable condition for belling. Removal of large diameter casing introduces the risk of creating voids in the shaft. Extreme care should be taken during casing removal to maintain a positive head of concrete above the bottom of the casing at all times. If groundwater is encountered within the shaft excavation, a sump pump or series of pumps should be used for groundwater control within the shaft excavation. Concrete placed under water should be pumped or placed with a tremie pipe. The discharge pipe should be maintained below the surface of the concrete at all times.

We recommend that the drilled shafts be constructed in accordance with Section 336 of the American Concrete Institute Manual of Concrete Practice. The success of the drilled shaft installation will likely be dependent upon the qualifications of the drilled shaft contractor and experience with similar subsurface conditions.

### **Auger-Cast Piles**

It is our opinion that a deep pile foundation system consisting of auger-cast piles can be used for foundation support of the proposed building addition. The auger-cast piles would develop capacity from a combination of end-bearing and side friction.

Typically, the most economical diameter for auger-cast piles is 16 inches. We estimate an allowable capacity of 85 tons per pile for 16-inch auger-cast piles extending to a depth of 60 feet below existing ground surface.

The recommended pile lengths are only estimates and must be confirmed by an appropriate test pile program. The actual pile lengths should be determined in the field by a testing program at the start of installation. We recommend that a minimum of two test piles be tested in accordance with the Standard Test Method for Deep Foundations Under Static Axial Compressive Load (ASTM:D1443), in order to verify the design capacity.



### **Rammed Aggregate Piers**

We have spoken to Geopier Foundation Company, Inc. regarding the suitability of installing rammed aggregate piers at the project site. Based on our discussion, we understand that Geopier rammed aggregate pier elements can be used to reinforce the lean clay (loess) soils at the site beneath spread footing foundations. The Geopier system will substantially increase the allowable bearing pressure while reducing total settlements. We understand that an allowable soil bearing pressure on the order of 4,500 pounds per square foot could likely be used for design of spread footings that are supported by Geopier rammed aggregate pier elements. The piers are constructed by augering 24 to 36-inch diameter holes to suitable soils and backfilling the holes with thin lifts of compacted aggregate. Compaction densifies the aggregate and increases the lateral stress in the surrounding materials. We recommend the rammed aggregate piers be designed by a licensed professional engineer specializing in the design of rammed aggregate piers. We can provide contact information for Geopier Foundation Company, Inc.

### **Settlement**

For the deep foundation alternatives consisting of belled drilled shafts and auger-cast piles, no unusual settlements are expected. For the initial construction, we estimate total settlement to be on the order of  $\frac{1}{4}$  to  $\frac{1}{2}$  inch. We estimate that the increased loads from the future additional floors will increase the total settlement by an additional  $\frac{1}{4}$  to  $\frac{1}{2}$  inch. We estimate the differential settlements to be approximately one-half of the estimated total settlement amounts. Unknown soil conditions at the site that are different from those depicted at the boring locations could increase the amount of expected settlement. We recommend an appropriate construction joint be provided between the existing building and the proposed addition in order to accommodate the anticipated differential movement between the two structures.

The settlements associated with the rammed aggregate pier alternative are influenced by the size, depth and spacing of the pier elements. Typically, the designer of the rammed aggregate piers is able to provide estimated settlement amounts.

### **Seismic Site Classification**

It is our opinion that the soils encountered at the boring locations correspond to a Site Class D (stiff soil) as defined in Table 1613.5.2 of the 2006 International Building Code.

### **Frost Protection**

We recommend all footings be placed at a sufficient depth for frost protection. The perimeter footings for heated buildings should be placed such that the bottom of the footing is a minimum of 4 feet below finished exterior grade. Interior footings in heated buildings can be placed beneath the floor slab. Footings for unheated areas and canopies, or footings that are not protected from frost during freezing temperatures, should be placed at a minimum depth of 5 feet below the lowest adjacent grade.

### **Floor Slab**

We recommend site preparation in the floor slab area consist of removing the existing fill materials in order to expose the lean clay (loess) soils. We recommend the upper 8 inches of the lean clay (loess) soils be scarified and compacted to a minimum of 95 percent of standard Proctor density (ASTM:D698). This procedure should be followed by placing compacted granular structural fill up to the design floor grade. Structural fill placed in the floor slab area should consist of pit-run or processed sand or gravel having a maximum particle size of 3 inch with less than 15 percent by weight passing the #200 sieve. The structural fill materials should be placed and uniformly compacted in thin lifts to a minimum of 95 percent of standard Proctor density (ASTM:D698).

We recommend placing a layer of free-draining sand fill directly beneath the floor slabs in order to provide a working surface for the placement of concrete and to serve as a capillary barrier. This free-draining granular fill should have less than 40 percent by weight passing the #40 sieve and less than 5 percent by weight passing the #200 sieve. We recommend placing a minimum of 6 inches of free-draining sand fill beneath on-grade floor slabs.

It is our opinion that the floor slab can be designed using a soil modulus of subgrade reaction (k value) of 75 psi/inch for a clay subgrade.

### **Exterior Foundation Backfill**

We recommend either granular soils or non-organic clay soils having a liquid limit less than 45 be used as exterior foundation backfill for the frost-depth footings of slab-on-grade structures. If granular soils are used for backfill in areas that will not have asphalt or concrete surfacing, we recommend capping the sand with 1 to 2 feet of clayey soil to minimize infiltration of surface waters. The exterior foundation backfill soils should be placed and compacted according to our previous recommendations in the section entitled Site Preparation - Filling. The foundation walls should be braced prior to backfilling or they should be backfilled evenly on both sides to reduce the risk of damaging the walls.

### **Site Drainage**

Proper site drainage should be provided during and after construction. General site grading should direct all surface waters away from the excavations. Any water that accumulates in the excavations should be removed as soon as possible.

It is important that a positive slope be provided away from the structure for proper drainage. Finished grades should be sloped away from the structure with a minimum slope of 1 inch per foot starting at the foundation and extending to at least 10 feet beyond the excavation line. If pavement will be placed immediately next to the structure, a slope of at least ¼ inch per foot away from the foundation should be used for the pavement, if possible. The joint between the pavement and the foundation should be properly sealed and maintained. Roof run off water should be controlled with a well-maintained system of gutters and downspouts with extensions to remove the run off water away from the structure.

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## **CONSTRUCTION CONSIDERATIONS**

### **Groundwater and Surface Water**

Water may enter the excavations due to subsurface water, precipitation or surface run off. As previously mentioned, the clayey soils encountered at the boring locations are relatively poor draining. As a result, water that enters the excavations will likely become trapped or “perched”. It will likely be possible to remove and control water entering the excavation using normal sump pumping techniques due to the low permeable characteristics of the predominant clayey soils encountered at the boring locations. However, lenses and layers of sand may be encountered, requiring more extensive dewatering techniques depending upon the subsurface water levels present during construction and the required excavation depths. Any water that accumulates in the bottom of the excavation should be immediately removed and surface drainage away from the excavation should be provided during construction.

### **Disturbance of Soils**

The predominant clayey soils encountered at the boring locations are susceptible to disturbance and can experience strength loss caused by construction traffic and/or additional moisture. Precautions will be required during earthwork activities in order to reduce the risk of soil disturbance. The excavation should be performed with a track-driven excavator (backhoe) having a smooth cutting edge on the bucket to minimize soil disturbance. If the soils become disturbed, additional excavation and filling will be required.

### **Cold Weather Precautions**

If site preparation and construction is anticipated during cold weather, we recommend all foundations, slabs and other improvements that may be affected by frost movements be insulated from frost penetration during freezing temperatures. If filling is performed during freezing temperatures, all frozen soils, snow and ice should be removed from the areas to be filled prior to placing the new fill. The new fill should not be allowed to freeze during transit, placement and compaction. Concrete should not be placed on frozen subgrades. Frost should not be allowed to

penetrate below the footings. If floor slab subgrades freeze, we recommend the frozen soils be removed and replaced, or completely thawed, prior to placement of the floor slab. The subgrade soils will likely require reworking and recompacting due to the loss of density caused by the freeze/thaw process.

### **Excavation Sideslopes**

All excavations must comply with the requirements of OSHA 29 CFR, Part 1926, Subpart P, "Excavations and Trenches". This document states that the excavation safety is the responsibility of the contractor. Reference to this OSHA requirement should be included in the project specifications.

### **Observations and Testing**

This report was prepared using a limited amount of information for the project and a number of assumptions were necessary to help us develop our conclusions and recommendations. It is recommended that our firm be retained to review the geotechnical aspects of the final design plans and specifications to check that our recommendations have been properly incorporated into the design documents.

The recommendations submitted in this report have been made based on the subsurface conditions encountered at the test boring locations. It is possible that there are subsurface conditions at the site that are different from those represented by the borings. As a result, on-site observation during construction is considered integral to the successful implementation of the recommendations. We believe that qualified field personnel need to be on-site at the following times to observe the site conditions and effectiveness of the construction.

### **Excavation**

We recommend that a geotechnical engineer or geotechnical engineering technician working under the direct supervision of a geotechnical engineer observe all excavations for foundations, slabs and pavements. These observations are recommended to determine if the exposed soils are similar to those encountered at the boring locations, if unsuitable soils have been adequately

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removed and if the exposed soils are suitable for support of the proposed construction. These observations should be performed prior to placement of fill or foundations.

### **Testing**

After the subgrade is observed by a geotechnical engineer/technician and approved, we recommend a representative number of compaction tests be taken during the placement of the structural fill and backfill placed below foundations, slabs and pavements, beside foundation walls and behind retaining walls. The tests should be performed to determine if the required compaction has been achieved. As a general guideline, we recommend at least one test be taken for every 2,000 square feet of structural fill placed in building and paved areas, at least one test for every 75 to 100 feet in trench fill, and for every 2-foot thickness of fill or backfill placed. The actual number of tests should be left to the discretion of the geotechnical engineer. Samples of proposed fill and backfill materials should be submitted to our laboratory for testing to determine their compliance with our recommendations and project specifications.

## **SUBSURFACE EXPLORATION PROCEDURES**

### **Test Borings**

Seven (7) standard penetration test (SPT) borings were drilled from June 8 to June 17, 2009 with a truck rig equipped with hollow-stem auger. Soil sampling was performed in accordance with the procedures described in ASTM:D1586. Using this procedure, a 2-inch O.D. split barrel sampler is driven into the soil by a 140-pound weight falling 30 inches. After an initial set of 6 inches, the number of blows required to drive the sampler an additional 12 inches is known as the penetration resistance, or “N” value. The “N” value is an index of the relative density of cohesionless soils and the consistency of cohesive soils. In addition, thin walled tube samples were obtained according to ASTM:D1587, where indicated by the appropriate symbol on the boring logs.

The borings were backfilled with on-site materials and some settlement of these materials can be expected to occur. Final closure of the holes is the responsibility of the client or property owner.

The soil samples collected from the boring locations will be retained in our office for a period of one month after the date of this report and will then be discarded unless we are notified otherwise.

### **Soil Classification**

As the samples were obtained in the field, they were visually and manually classified by the crew chief according to ASTM:D2488. Representative portions of all samples were then sealed and returned to the laboratory for further examination and for verification of the field classification. In addition, selected samples were then submitted to a program of laboratory tests. Where laboratory classification tests (sieve analysis and Atterberg limits) have been performed, classifications according to ASTM:D2487 are possible. Logs of the borings indicating the depth and identification of the various strata, the “N” value, the laboratory test data, water level information and pertinent information regarding the method of maintaining and advancing the drill holes are also attached in Appendix A. Charts illustrating the soil classification procedures, the descriptive terminology and the symbols used on the boring logs are also attached in Appendix A.

### **Water Level Measurements**

Groundwater measurements were not made at the boring locations because drilling fluid was used to advance the borings. However, an auxiliary borehole was performed on June 11, 2009 adjacent to boring #4 in order to collect 3-inch diameter Shelby tube samples for laboratory testing. This auxiliary borehole was left open for a period six days for groundwater measurements. The time and level of the groundwater readings are recorded on the boring log.

The water levels indicated on the boring logs may not be an accurate indication of the depth or lack of subsurface groundwater. A long period of time is generally required for subsurface water to stabilize in the impervious soils encountered at the boring locations. Long term water level monitoring was not included in our scope of work.

Subsurface groundwater levels should be expected to fluctuate seasonally and yearly from the groundwater readings recorded at the borings. Fluctuations occur due to varying seasonal and yearly rainfall amounts and snowmelt, as well as other factors. It is possible that the subsurface groundwater levels during or after construction could be significantly different than the time the borings were performed.

### **Laboratory Tests**

Laboratory tests were performed on selected samples to aid in determining the index and strength properties of the soils. The index tests consisted of moisture content, dry density, Atterberg limits and consolidation. The strength tests consisted of unconfined compressive strength and triaxial compression. The laboratory tests were performed in accordance with the appropriate ASTM procedures. The results of the laboratory tests are shown on the boring logs opposite the samples upon which the tests were performed or on the data sheets included in Appendix A.

### **LIMITATIONS**

The recommendations and professional opinions submitted in this report were based upon the data obtained through the sampling and testing program at the boring locations. We wish to point out that because no exploration program can totally reveal the exact subsurface conditions for the entire site, conditions between borings and between samples and at other times may differ from those described in our report. Our exploration program identified subsurface conditions only at those points where samples were retrieved or where water was observed. It is not standard engineering practice to continuously retrieve samples for the full depth of the borings. Therefore, strata boundaries and thicknesses must be inferred to some extent. Additionally, some soils layers present in the ground may not be observed between sampling intervals. If the subsurface conditions encountered at the time of construction differ from those represented by our borings, it is necessary to contact us so that our recommendations can be reviewed. The variations may result in altering our conclusions or recommendations regarding site preparation or construction procedures, thus, potentially affecting construction costs.



This report is for the exclusive use of the addressee and its representatives for the use in design of the proposed project described herein and preparation of construction documents. Without written approval, we assume no responsibility to other parties regarding this report. Our conclusions, opinions and recommendations may not be appropriate for other parties or projects.

### **STANDARD OF CARE**

The recommendations submitted in this report represent our professional opinions. Our services for your project were performed in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering profession currently practicing at this time and area.

This report was prepared by:  
GeoTek Engineering & Testing Services, Inc.

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Jeff Christensen, PE  
Geotechnical Manager

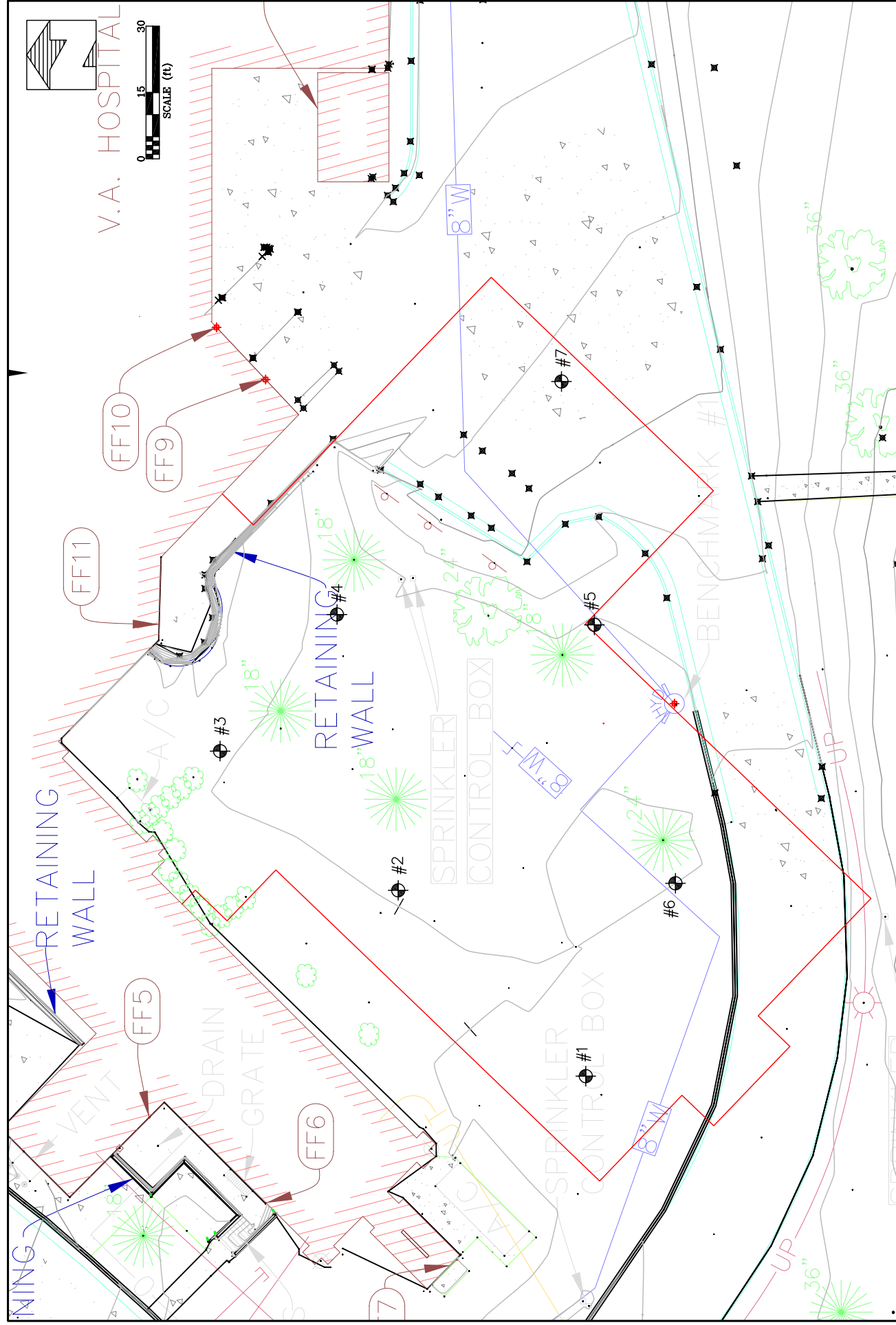


FIGURE 1  
SOIL BORING LOCATION MAP  
PROPOSED SURGICAL SUITE ADDITION  
V.A. HOSPITAL  
2501 W. 22ND STREET  
SIOUX FALLS, SD

PROJECT#:09-457

CHECKED BY:

TESTING SERVICES, INC.

GEOTEK ENGINEERING &  
TESTING SERVICES, INC.

GEOTEK # 09-457

BORING NO. 1 (1 of 2)

PROJECT Proposed Surgical Suite Addition, Veterans Memorial Medical Center, 2501 W. 22nd Street, Sioux Falls, SD

| DEPTH<br>in<br>FEET      | DESCRIPTION OF MATERIAL  |                  |                 |                  |                | GEOLOGIC<br>ORIGIN            | N     | WL     | SAMPLE   |                | LABORATORY TESTS |     |    |    |      |
|--------------------------|--|------------------|-----------------|------------------|----------------|-------------------------------|-------|--------|----------|----------------|------------------|-----|----|----|------|
|                          |  |                  |                 |                  |                |                               |       |        | NO.      | TYPE           | WC               | D   | LL | PL | QU   |
|                          | SURFACE ELEVATION    1503.0 ft   |                  |                 |                  |                |                               |       |        |          |                |                  |     |    |    |      |
| 2                        | <b>FILL, MOSTLY CLAY:</b> brown, dry   |                  |                 |                  |                | FILL                          |       |        | 1        | FA             |                  |     |    |    |      |
|                          | <b>LEAN CLAY:</b> brown and gray mottled, moist, firm to soft, (CL)              |                  |                 |                  |                | LOESS                         | 7     |        | 2        | SPT            |                  |     |    |    |      |
|                          |  |                  |                 |                  |                |                               | 7     |        | 3        | SPT            |                  |     |    |    |      |
|                          |  |                  |                 |                  |                |                               | 5     |        | 4        | SPT            | 25               |     |    |    |      |
|                          |  |                  |                 |                  |                |                               | 4     |        | 5        | SPT            | 30               |     |    |    |      |
|                          |  |                  |                 |                  |                |                               |       |        |          |                |                  |     |    |    |      |
|                          |  |                  |                 |                  |                |                               | 3     |        | 6        | SPT            | 27               |     |    |    |      |
| 19½                      | <b>SANDY LEAN CLAY:</b> a little gravel, brown, moist, stiff to very stiff, (CL) |                  |                 |                  |                | GLACIAL<br>TILL               | 10    |        | 7        | SPT            | 23               | 101 |    |    | 3000 |
|                          |  |                  |                 |                  |                |                               | 17    |        | 8        | SPT            | 20               | 108 |    |    | 6600 |
|                          |  |                  |                 |                  |                |                               | 19    |        | 9        | SPT            | 21               | 108 |    |    | 6900 |
| WATER LEVEL MEASUREMENTS |  |                  |                 |                  |                |                               | START | 6-8-09 | COMPLETE | 6-8-09 1:49 pm |                  |     |    |    |      |
| DATE                     | TIME   | SAMPLED<br>DEPTH | CASING<br>DEPTH | CAVE-IN<br>DEPTH | WATER<br>LEVEL | METHOD<br>Rotary Mud Drilling |       |        |          |                |                  |     |    |    |      |
| --                       | --   | --               | --              | --               | --             |                               |       |        |          |                |                  |     |    |    |      |
| --                       | --   | --               | --              | --               | --             |                               |       |        |          |                |                  |     |    |    |      |
| --                       | --   | --               | --              | --               | --             |                               |       |        |          |                |                  |     |    |    |      |
| --                       | --   | --               | --              | --               | --             | CREW CHIEF    Gordv Hawkey    |       |        |          |                |                  |     |    |    |      |

GEOTECHNICAL TEST BORING 09-457.GPJ GEOTEKENG.GDT 7/16/09










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Sioux Falls, SD 57104  
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# GEOTECHNICAL TEST BORING LOG

GEOTEK # **09-457**

BORING NO. **1 (2 of 2)**

PROJECT **Proposed Surgical Suite Addition, Veterans Memorial Medical Center, 2501 W. 22nd Street, Sioux Falls, SD**

| DEPTH<br>in<br>FEET      | DESCRIPTION OF MATERIAL  | GEOLOGIC<br>ORIGIN  | N               | WL              | SAMPLE  |                               | LABORATORY TESTS  |   |     |    |    |  |  |
|--------------------------|--|---|-----------------|-----------------|---|-------------------------------|---|---|-----|----|----|--|--|
|                          |  |   |                 |                 | NO.   | TYPE                          | WC  | D   | LL  | PL | QU |  |  |
|                          | ↓ SURFACE ELEVATION    1503.0 ft   |   |                 |                 |   |                               |   |   |     |    |    |  |  |
| 44½                      | <b>SANDY LEAN CLAY:</b> a little gravel, brown, moist, stiff to very stiff, (CL) <i>(Continued from previous page)</i> |  | GLACIAL<br>TILL | 20              |   | 10                            |    | SPT   |     |    |    |  |  |
|                          | 22   |   |                 | 11              |  | SPT                           |   |   |     |    |    |  |  |
|                          | <b>SANDY LEAN CLAY:</b> a little gravel, brown mottled, moist, very stiff, (CL)  |   | GLACIAL<br>TILL | 23              |   | 12                            |    | SPT   |     |    |    |  |  |
|                          | 49½  | <b>SANDY LEAN CLAY:</b> a little gravel, brown, moist, very stiff to hard, (CL)   |                 | GLACIAL<br>TILL | 19  |                               | 13  |  | SPT |    |    |  |  |
|                          |  |   |                 | 20              |   | 14                            |  | SPT   |     |    |    |  |  |
| 61                       |  |   |                 | 35              |   | 15                            |  | SPT   |     |    |    |  |  |
|                          | Bottom of borehole at 61 feet.   |   |                 |                 |   |                               |   |   |     |    |    |  |  |
| WATER LEVEL MEASUREMENTS |  |   |                 | START           | 6-8-09  |                               | COMPLETE  | 6-8-09 1:49 pm  |     |    |    |  |  |
| DATE                     | TIME   | SAMPLED DEPTH   | CASING DEPTH    | CAVE-IN DEPTH   | WATER LEVEL   | METHOD<br>Rotary Mud Drilling |   |   |     |    |    |  |  |
| --                       | --   | --  | --              | --              | --  |                               |   |   |     |    |    |  |  |
| --                       | --   | --  | --              | --              | --  |                               |   |   |     |    |    |  |  |
| --                       | --   | --  | --              | --              | --  |                               |   |   |     |    |    |  |  |
| --                       | --   | --  | --              | --              | --  | CREW CHIEF    Gordv Hawkey    |   |   |     |    |    |  |  |

GEOTECHNICAL TEST BORING 09-457.GPJ GEOTEKENG.GDT 7/16/09













**GEOTEK ENGINEERING  
& TESTING SERVICES, INC.**  
909 E. 50th Street North  
Sioux Falls, SD 57104  
605-335-5512 Fax 605-335-0773

# GEOTECHNICAL TEST BORING LOG

GEOTEK # **09-457**

BORING NO. **2 (1 of 2)**

PROJECT **Proposed Surgical Suite Addition, Veterans Memorial Medical Center, 2501 W. 22nd Street, Sioux Falls, SD**

| DEPTH<br>in<br>FEET      | DESCRIPTION OF MATERIAL   |                  |                 |                  | GEOLOGIC<br>ORIGIN | N                             | WL     | SAMPLE  |   | LABORATORY TESTS  |     |    |    |    |      |
|--------------------------|---|------------------|-----------------|------------------|--------------------|-------------------------------|--------|---|---|---|-----|----|----|----|------|
|                          |   |                  |                 |                  |                    |                               |        | NO.   | TYPE  | WC  | D   | LL | PL | QU |      |
|                          | ↓ SURFACE ELEVATION    1503.0 ft  |                  |                 |                  |                    |                               |        |   |   |   |     |    |    |    |      |
| 2                        | <u>FILL, MOSTLY CLAY</u> : black, moist   |                  |                 |                  | FILL               |                               |        | 1   |  | FA  |     |    |    |    |      |
|                          | <u>LEAN CLAY</u> : brown, moist, firm, (CL)                                       |                  |                 |                  |                    | LOESS                         | 7      | 2   |   |  | SPT |    |    |    |      |
| 4½                       | <u>LEAN CLAY</u> : brown and gray mottled, moist, firm to soft, (CL)              |                  |                 |                  | LOESS              | 5                             | 3      |    | SPT   |   |     |    |    |    |      |
|                          |   |                  |                 |                  |                    | 8                             | 4      |    | SPT   |   |     |    |    |    |      |
|                          |   |                  |                 |                  |                    | 7                             | 5      |    | SPT   |   |     |    |    |    |      |
|                          |   |                  |                 |                  |                    | 4                             | 6      |    | SPT   |   |     |    |    |    |      |
|                          |   |                  |                 |                  |                    | 9                             | 7      |    | SPT   |   |     |    |    |    |      |
| 19½                      | <u>SANDY LEAN CLAY</u> : a little gravel, brown, moist, stiff to very stiff, (CL) |                  |                 |                  | GLACIAL<br>TILL    | 9                             | 7      |   | SPT   | 23  | 105 |    |    |    | 1900 |
|                          |   |                  |                 |                  |                    | 17                            | 8      |  | SPT   |   |     |    |    |    |      |
|                          |   |                  |                 |                  |                    | 16                            | 9      |  | SPT   |   |     |    |    |    |      |
| WATER LEVEL MEASUREMENTS |   |                  |                 |                  |                    | START                         | 6-8-09 |   | COMPLETE  | 6-8-09 4:35 pm  |     |    |    |    |      |
| DATE                     | TIME  | SAMPLED<br>DEPTH | CASING<br>DEPTH | CAVE-IN<br>DEPTH | WATER<br>LEVEL     | METHOD<br>Rotary Mud Drilling |        |   |   |   |     |    |    |    |      |
| --                       | --  | --               | --              | --               | --                 |                               |        |   |   |   |     |    |    |    |      |
| --                       | --  | --               | --              | --               | --                 |                               |        |   |   |   |     |    |    |    |      |
| --                       | --  | --               | --              | --               | --                 |                               |        |   |   |   |     |    |    |    |      |
| --                       | --  | --               | --              | --               | --                 | CREW CHIEF    Gordv Hawkey    |        |   |   |   |     |    |    |    |      |

GEOTECHNICAL TEST BORING 09-457.GPJ GEOTEKENG.GDT 7/16/09



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# **GEOTECHNICAL TEST BORING LOG**

GEOTEK # **09-457**

BORING NO. **2 (2 of 2)**

PROJECT **Proposed Surgical Suite Addition, Veterans Memorial Medical Center, 2501 W. 22nd Street, Sioux Falls, SD**

| DEPTH<br>in<br>FEET   | DESCRIPTION OF MATERIAL<br>↓ SURFACE ELEVATION    1503.0 ft | GEOLOGIC<br>ORIGIN | N | WL | SAMPLE |      | LABORATORY TESTS |   |    |    |    |
|---|---|--------------------|---|----|--------|------|------------------|---|----|----|----|
|   |   |                    |   |    | NO.    | TYPE | WC               | D | LL | PL | QU |
| 39½<br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><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GEOTECHNICAL TEST BORING 09-457.GPJ GEOTEKENG.GDT 7/16/09



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Sioux Falls, SD 57104  
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# GEOTECHNICAL TEST BORING LOG

GEOTEK # **09-457**

BORING NO. **3 (1 of 2)**

PROJECT **Proposed Surgical Suite Addition, Veterans Memorial Medical Center, 2501 W. 22nd Street, Sioux Falls, SD**

| DEPTH<br>in<br>FEET  | DESCRIPTION OF MATERIAL          |  |  |  |  | GEOLOGIC<br>ORIGIN | N | WL | SAMPLE |      | LABORATORY TESTS |   |    |    |    |
|--|----------------------------------|--|--|--|--|--------------------|---|----|--------|------|------------------|---|----|----|----|
|  |                                  |  |  |  |  |                    |   |    | NO.    | TYPE | WC               | D | LL | PL | QU |
|  | ↓ SURFACE ELEVATION    1503.3 ft |  |  |  |  |                    |   |    |        |      |                  |   |    |    |    |
| 3½<br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><b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|                                  |  |  |  |  |                    |   |    |        |      |                  |   |    |    |    |

GEOTECHNICAL TEST BORING 09-457.GPJ GEOTEKENG.GDT 7/16/09



**GEOTEK ENGINEERING  
& TESTING SERVICES, INC.**  
909 E. 50th Street North  
Sioux Falls, SD 57104  
605-335-5512 Fax 605-335-0773

# GEOTECHNICAL TEST BORING LOG

GEOTEK # **09-457**

BORING NO. **3 (2 of 2)**

PROJECT **Proposed Surgical Suite Addition, Veterans Memorial Medical Center, 2501 W. 22nd Street, Sioux Falls, SD**

| DEPTH<br>in<br>FEET      | DESCRIPTION OF MATERIAL   | GEOLOGIC<br>ORIGIN | N   | WL            | SAMPLE      |                               | LABORATORY TESTS |   |    |    |    |  |
|--------------------------|---|--------------------|---|---------------|-------------|-------------------------------|------------------|---|----|----|----|--|
|                          |   |                    |   |               | NO.         | TYPE                          | WC               | D | LL | PL | QU |  |
|                          | ↓ SURFACE ELEVATION    1503.3 ft  |                    |   |               |             |                               |                  |   |    |    |    |  |
| 44½                      | <b>SANDY LEAN CLAY:</b> a little gravel, brown, moist, firm to very stiff, (CL) <i>(Continued from previous page)</i> | GLACIAL TILL       | 20  |               | 10          | X SPT                         |                  |   |    |    |    |  |
|                          |   |                    | 22  |               | 11          | X SPT                         |                  |   |    |    |    |  |
|                          | <b>SANDY LEAN CLAY:</b> a little gravel, brown and gray mottled, moist, very stiff, (CL)                              | GLACIAL TILL       | 19  |               | 12          | X SPT                         |                  |   |    |    |    |  |
|                          |   |                    | 18  |               | 13          | X SPT                         |                  |   |    |    |    |  |
|                          |   |                    | 16  |               | 14          | X SPT                         |                  |   |    |    |    |  |
| 56                       | <b>LEAN CLAY:</b> brown, moist, stiff, (CL)   | GLACIAL TILL       |   |               |             |                               |                  |   |    |    |    |  |
| 61                       |   |                    | 13  |               | 15          | X SPT                         |                  |   |    |    |    |  |
|                          | Bottom of borehole at 61 feet.  |                    |   |               |             |                               |                  |   |    |    |    |  |
| WATER LEVEL MEASUREMENTS |   |                    | START    6-8-09    COMPLETE    6-9-09 1:57 pm |               |             |                               |                  |   |    |    |    |  |
| DATE                     | TIME  | SAMPLED DEPTH      | CASING DEPTH                                  | CAVE-IN DEPTH | WATER LEVEL | METHOD<br>Rotary Mud Drilling |                  |   |    |    |    |  |
| --                       | --  | --                 | --  | --            | --          |                               |                  |   |    |    |    |  |
| --                       | --  | --                 | --  | --            | --          |                               |                  |   |    |    |    |  |
| --                       | --  | --                 | --  | --            | --          |                               |                  |   |    |    |    |  |
| --                       | --  | --                 | --  | --            | --          | CREW CHIEF    Gordv Hawkey    |                  |   |    |    |    |  |

GEOTECHNICAL TEST BORING 09-457.GPJ GEOTEKENG.GDT 7/16/09





**GEOTEK ENGINEERING  
& TESTING SERVICES, INC.**  
909 E. 50th Street North  
Sioux Falls, SD 57104  
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# GEOTECHNICAL TEST BORING LOG

GEOTEK # **09-457**

BORING NO. **4 (1 of 2)**

PROJECT **Proposed Surgical Suite Addition, Veterans Memorial Medical Center, 2501 W. 22nd Street, Sioux Falls, SD**

| DEPTH<br>in<br>FEET      | DESCRIPTION OF MATERIAL  | GEOLOGIC<br>ORIGIN | N   | WL               | SAMPLE         |                               | LABORATORY TESTS |   |    |    |    |  |
|--------------------------|--|--------------------|---|------------------|----------------|-------------------------------|------------------|---|----|----|----|--|
|                          |  |                    |   |                  | NO.            | TYPE                          | WC               | D | LL | PL | QU |  |
|                          | ↓ SURFACE ELEVATION    1502.8 ft   |                    |   |                  |                |                               |                  |   |    |    |    |  |
| 3½                       | <b>FILL, MOSTLY CLAY:</b> dark brown, moist                                      | FILL               | 6   | ▼                | 1              | FA                            |                  |   |    |    |    |  |
|                          |  |                    | 2   |                  | SPT            |                               |                  |   |    |    |    |  |
|                          | <b>LEAN CLAY:</b> brown, moist, soft, (CL)                                       | LOESS              | 4   |                  | 3              | SPT                           |                  |   |    |    |    |  |
|                          |  |                    | 2   |                  | 4              | SPT                           |                  |   |    |    |    |  |
| 9½                       | <b>LEAN CLAY:</b> brown and gray mottled, moist, firm to soft, (CL)              | LOESS              | 6   |                  | 5              | SPT                           |                  |   |    |    |    |  |
|                          |  |                    | 3   |                  | 6              | SPT                           |                  |   |    |    |    |  |
| 21                       |  |                    | 4   |                  | 7              | SPT                           |                  |   |    |    |    |  |
|                          | <b>SANDY LEAN CLAY:</b> a little gravel, brown, moist, stiff to very stiff, (CL) | GLACIAL<br>TILL    | 12  |                  | 8              | SPT                           |                  |   |    |    |    |  |
|                          |  |                    | 20  |                  | 9              | SPT                           |                  |   |    |    |    |  |
| WATER LEVEL MEASUREMENTS |  |                    | START    6-9-09    COMPLETE    6-9-09 4:32 pm |                  |                |                               |                  |   |    |    |    |  |
| DATE                     | TIME   | SAMPLED<br>DEPTH   | CASING<br>DEPTH                               | CAVE-IN<br>DEPTH | WATER<br>LEVEL | METHOD<br>Rotary Mud Drilling |                  |   |    |    |    |  |
| 6-15-09                  | 11:17 am   | 24                 | --  | 23               | ▼ 19.5         |                               |                  |   |    |    |    |  |
| 6-17-09                  | 11:16 am   | 24                 | --  | 23               | ▼ 19.5         |                               |                  |   |    |    |    |  |
| --                       | --   | --                 | --  | --               | --             |                               |                  |   |    |    |    |  |
| --                       | --   | --                 | --  | --               | --             | CREW CHIEF    Gordv Hawkey    |                  |   |    |    |    |  |

GEOTECHNICAL TEST BORING 09-457.GPJ GEOTEKENG.GDT 7/16/09











**GEOTEK ENGINEERING  
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909 E. 50th Street North  
Sioux Falls, SD 57104  
605-335-5512 Fax 605-335-0773

# GEOTECHNICAL TEST BORING LOG

GEOTEK # **09-457**

BORING NO. **4 (2 of 2)**

PROJECT **Proposed Surgical Suite Addition, Veterans Memorial Medical Center, 2501 W. 22nd Street, Sioux Falls, SD**

| DEPTH<br>in<br>FEET      | DESCRIPTION OF MATERIAL<br>↓ SURFACE ELEVATION    1502.8 ft  | GEOLOGIC<br>ORIGIN  | N               | WL  | SAMPLE      |                               | LABORATORY TESTS  |   |    |    |    |  |
|--------------------------|--|---|-----------------|---|-------------|-------------------------------|---|---|----|----|----|--|
|                          |  |   |                 |   | NO.         | TYPE                          | WC  | D | LL | PL | QU |  |
|                          | <b>SANDY LEAN CLAY:</b> a little gravel, brown, moist, stiff to very stiff, (CL) <i>(Continued from previous page)</i> |   | GLACIAL<br>TILL | 20  |             | 10                            |  SPT   |   |    |    |    |  |
| 39½                      | <b>SANDY LEAN CLAY:</b> a little gravel, brown mottled, moist, very stiff, (CL)  |   | GLACIAL<br>TILL | 27  |             | 11                            |  SPT   |   |    |    |    |  |
| 44½                      | <b>SANDY LEAN CLAY:</b> a little gravel, brown, moist, very stiff, (CL)  |   | GLACIAL<br>TILL | 20  |             | 12                            |  SPT   |   |    |    |    |  |
| 49½                      | <b>SANDY LEAN CLAY:</b> a little gravel, brown and gray mottled, moist, very stiff, (CL)                               |   | GLACIAL<br>TILL | 18  |             | 13                            |  SPT |   |    |    |    |  |
|                          |  |   |                 | 18  |             | 14                            |  SPT |   |    |    |    |  |
| 59½                      | <b>SANDY LEAN CLAY:</b> a little gravel, brown and dark gray mottled, moist, very stiff, (CL)                          |  | GLACIAL<br>TILL | 18  |             | 15                            |  SPT |   |    |    |    |  |
| 61                       | Bottom of borehole at 61 feet.   |   |                 |   |             |                               |   |   |    |    |    |  |
| WATER LEVEL MEASUREMENTS |  |   |                 | START    6-9-09    COMPLETE    6-9-09 4:32 pm |             |                               |   |   |    |    |    |  |
| DATE                     | TIME   | SAMPLED DEPTH   | CASING DEPTH    | CAVE-IN DEPTH                                 | WATER LEVEL | METHOD<br>Rotary Mud Drilling |   |   |    |    |    |  |
| 6-15-09                  | 11:17 am   | 24  | --              | 23  | ▼ 19.5      |                               |   |   |    |    |    |  |
| 6-17-09                  | 11:16 am   | 24  | --              | 23  | ▼ 19.5      |                               |   |   |    |    |    |  |
| --                       | --   | --  | --              | --  | --          |                               |   |   |    |    |    |  |
| --                       | --   | --  | --              | --  | --          | CREW CHIEF    Gordv Hawkey    |   |   |    |    |    |  |

GEOTECHNICAL TEST BORING 09-457.GPJ GEOTEKENG.GDT 7/16/09















**GEOTEK ENGINEERING  
& TESTING SERVICES, INC.**  
909 E. 50th Street North  
Sioux Falls, SD 57104  
605-335-5512 Fax 605-335-0773

# GEOTECHNICAL TEST BORING LOG

GEOTEK # **09-457**

BORING NO. **5 (1 of 3)**

PROJECT **Proposed Surgical Suite Addition, Veterans Memorial Medical Center, 2501 W. 22nd Street, Sioux Falls, SD**

| DEPTH<br>in<br>FEET      | DESCRIPTION OF MATERIAL  |                  |                 |                  |                | GEOLOGIC<br>ORIGIN   | N   | WL              | SAMPLE  |      | LABORATORY TESTS  |   |    |     |    |  |
|--------------------------|--|------------------|-----------------|------------------|----------------|--|---|-----------------|---|------|---|---|----|-----|----|--|
|                          |  |                  |                 |                  |                |  |   |                 | NO.   | TYPE | WC  | D   | LL | PL  | QU |  |
|                          | ↓ SURFACE ELEVATION    1502.1 ft   |                  |                 |                  |                |  |   |                 |   |      |   |   |    |     |    |  |
| 2                        | <b>FILL, MOSTLY CLAY:</b> dark brown, moist                                      |                  |                 |                  |                |   | FILL  |                 |   | 1    |  FA  |   |    |     |    |  |
|                          | <b>LEAN CLAY:</b> brown and gray mottled, moist, firm to soft, (CL)              |                  |                 |                  |                |  | LOESS   | 7               |   | 2    |  SPT |   |    |     |    |  |
|                          |  |                  |                 |                  | 8              |  |   | 3               |  SPT   |      |   |   |    |     |    |  |
|                          |  |                  |                 |                  | 7              |  |   | 4               |  SPT   |      |   |   |    |     |    |  |
|                          |  |                  |                 |                  | 6              |  |   | 5               |  SPT   |      |   |   |    |     |    |  |
|                          |  |                  |                 |                  | 3              |  |   | 6               |  SPT |      |   |   |    |     |    |  |
|                          |  |                  |                 |                  | 4              |  |   | 7               |  SPT |      |   |   |    |     |    |  |
| 24½                      | <b>SANDY LEAN CLAY:</b> a little gravel, brown, moist, stiff to very stiff, (CL) |                  |                 |                  |                |  |  | GLACIAL<br>TILL | 14  |      | 8   |  SPT | 21 | 107 |    |  |
|                          |  |                  |                 |                  | 17             |  |   | 9               |  SPT |      |   |   |    |     |    |  |
| WATER LEVEL MEASUREMENTS |  |                  |                 |                  |                |  | START    6-10-09    COMPLETE  |                 |   |      |   |   |    |     |    |  |
| DATE                     | TIME   | SAMPLED<br>DEPTH | CASING<br>DEPTH | CAVE-IN<br>DEPTH | WATER<br>LEVEL | METHOD<br>Rotary Mud Drilling  |   |                 |   |      |   |   |    |     |    |  |
| --                       | --   | --               | --              | --               | --             |  |   |                 |   |      |   |   |    |     |    |  |
| --                       | --   | --               | --              | --               | --             |  |   |                 |   |      |   |   |    |     |    |  |
| --                       | --   | --               | --              | --               | --             |  |   |                 |   |      |   |   |    |     |    |  |
| --                       | --   | --               | --              | --               | --             | CREW CHIEF    Gordv Hawkey   |   |                 |   |      |   |   |    |     |    |  |

GEOTECHNICAL TEST BORING 09-457.GPJ GEOTEKENG.GDT 7/16/09



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# GEOTECHNICAL TEST BORING LOG

| GEOTEK # <b>09-457</b>  |  |                    |                 |                  |                | BORING NO. <b>5 (2 of 3)</b>        |                  |     |    |    |      |  |
|---|--|--------------------|-----------------|------------------|----------------|-------------------------------------|------------------|-----|----|----|------|--|
| PROJECT <b>Proposed Surgical Suite Addition, Veterans Memorial Medical Center, 2501 W. 22nd Street, Sioux Falls, SD</b> |  |                    |                 |                  |                |                                     |                  |     |    |    |      |  |
| DEPTH<br>in<br>FEET   | DESCRIPTION OF MATERIAL<br>↓ SURFACE ELEVATION <u>1502.1 ft</u>  | GEOLOGIC<br>ORIGIN | N               | WL               | SAMPLE         |                                     | LABORATORY TESTS |     |    |    |      |  |
|   |  |                    |                 |                  | NO.            | TYPE                                | WC               | D   | LL | PL | QU   |  |
| 49½   | <b>SANDY LEAN CLAY:</b> a little gravel, brown, moist, stiff to very stiff, (CL) <i>(Continued from previous page)</i> | GLACIAL<br>TILL    | 23              |                  | 10             | X SPT                               |                  |     |    |    |      |  |
|   |  |                    | 20              |                  | 11             | X SPT                               | 19               | 112 | 41 | 14 | 5000 |  |
|   |  |                    | 19              |                  | 12             | X SPT                               |                  |     |    |    |      |  |
|   |  | GLACIAL<br>TILL    | 20              |                  | 13             | X SPT                               |                  |     |    |    |      |  |
|   |  |                    | 30              |                  | 14             | X SPT                               |                  |     |    |    |      |  |
|   |  |                    | 36              |                  | 15             | X SPT                               | 16               | 118 |    |    | 6400 |  |
|   |  |                    | 33              |                  | 16             | X SPT                               |                  |     |    |    |      |  |
| WATER LEVEL MEASUREMENTS  |  |                    |                 |                  |                | START <u>6-10-09</u> COMPLETE _____ |                  |     |    |    |      |  |
| DATE  | TIME   | SAMPLED<br>DEPTH   | CASING<br>DEPTH | CAVE-IN<br>DEPTH | WATER<br>LEVEL | METHOD<br>Rotary Mud Drilling       |                  |     |    |    |      |  |
| --  | --   | --                 | --              | --               | --             |                                     |                  |     |    |    |      |  |
| --  | --   | --                 | --              | --               | --             |                                     |                  |     |    |    |      |  |
| --  | --   | --                 | --              | --               | --             |                                     |                  |     |    |    |      |  |
| --  | --   | --                 | --              | --               | --             | CREW CHIEF Gordy Hawkey             |                  |     |    |    |      |  |

GEOTECHNICAL TEST BORING 09-457.GPJ GEOTEKENG.GDT 7/16/09



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# GEOTECHNICAL TEST BORING LOG

GEOTEK # **09-457**

BORING NO. **5 (3 of 3)**

PROJECT **Proposed Surgical Suite Addition, Veterans Memorial Medical Center, 2501 W. 22nd Street, Sioux Falls, SD**

| DEPTH<br>in<br>FEET      | DESCRIPTION OF MATERIAL<br>↓ SURFACE ELEVATION    1502.1 ft   | GEOLOGIC<br>ORIGIN | N            | WL            | SAMPLE      |                               | LABORATORY TESTS |   |    |    |    |  |
|--------------------------|---|--------------------|--------------|---------------|-------------|-------------------------------|------------------|---|----|----|----|--|
|                          |   |                    |              |               | NO.         | TYPE                          | WC               | D | LL | PL | QU |  |
| 84½                      | <b>SANDY LEAN CLAY:</b> a little gravel, brown and gray mottled, moist, very stiff to hard, (CL)<br><i>(Continued from previous page)</i> | GLACIAL TILL       | 35           |               | 17          | X SPT                         |                  |   |    |    |    |  |
|                          |   |                    | 32           |               | 18          | X SPT                         |                  |   |    |    |    |  |
|                          |   |                    | 32           |               | 19          | X SPT                         |                  |   |    |    |    |  |
|                          |   | 44                 | 20           |               | X SPT       |                               |                  |   |    |    |    |  |
|                          |   | 49                 | 21           |               | X SPT       |                               |                  |   |    |    |    |  |
| 94½                      | <b>SANDY LEAN CLAY:</b> a little gravel, brown and dark gray mottled, moist, hard, (CL)   | GLACIAL TILL       |              | 22            | X SPT       |                               |                  |   |    |    |    |  |
| 98.7                     | <b>SANDY LEAN CLAY:</b> a little gravel, dark gray, moist, hard, (CL)   | GLACIAL TILL       | 48           |               |             |                               |                  |   |    |    |    |  |
|                          | Refusal at 98.7 feet.<br>Bottom of borehole at 98.7 feet.   |                    |              |               |             |                               |                  |   |    |    |    |  |
| WATER LEVEL MEASUREMENTS |   |                    |              |               |             | START    6-10-09    COMPLETE  |                  |   |    |    |    |  |
| DATE                     | TIME  | SAMPLED DEPTH      | CASING DEPTH | CAVE-IN DEPTH | WATER LEVEL | METHOD<br>Rotary Mud Drilling |                  |   |    |    |    |  |
| --                       | --  | --                 | --           | --            | --          |                               |                  |   |    |    |    |  |
| --                       | --  | --                 | --           | --            | --          |                               |                  |   |    |    |    |  |
| --                       | --  | --                 | --           | --            | --          |                               |                  |   |    |    |    |  |
| --                       | --  | --                 | --           | --            | --          | CREW CHIEF    Gordv Hawkey    |                  |   |    |    |    |  |

GEOTECHNICAL TEST BORING 09-457.GPJ GEOTEKENG.GDT 7/16/09



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# GEOTECHNICAL TEST BORING LOG

GEOTEK # **09-457**

BORING NO. **6 (1 of 2)**

PROJECT **Proposed Surgical Suite Addition, Veterans Memorial Medical Center, 2501 W. 22nd Street, Sioux Falls, SD**

| DEPTH<br>in<br>FEET      | DESCRIPTION OF MATERIAL  | GEOLOGIC<br>ORIGIN | N  | WL            | SAMPLE      |                               | LABORATORY TESTS |     |    |    |      |  |
|--------------------------|--|--------------------|--|---------------|-------------|-------------------------------|------------------|-----|----|----|------|--|
|                          |  |                    |  |               | NO.         | TYPE                          | WC               | D   | LL | PL | QU   |  |
|                          | ↓ SURFACE ELEVATION    1503.4 ft   |                    |  |               |             |                               |                  |     |    |    |      |  |
| 2                        | <b>FILL, MOSTLY CLAY:</b> dark brown, dry                                  | FILL               |  |               | 1           | FA                            |                  |     |    |    |      |  |
|                          | <b>LEAN CLAY:</b> brown, moist, firm, (CL)                                 | LOESS              | 7  |               | 2           | SPT                           |                  |     |    |    |      |  |
| 4½                       | <b>LEAN CLAY:</b> brown and gray mottled, moist, firm to soft, (CL)        | LOESS              | 7  |               | 3           | SPT                           |                  |     |    |    |      |  |
|                          |  |                    | 6  |               | 4           | SPT                           |                  |     |    |    |      |  |
|                          |  |                    | 6  |               | 5           | SPT                           |                  |     |    |    |      |  |
|                          |  |                    | 4  |               | 6           | SPT                           |                  |     |    |    |      |  |
|                          |  |                    | 5  |               | 7           | SPT                           |                  |     |    |    |      |  |
| 21                       | <b>SANDY LEAN CLAY:</b> a little gravel, brown, moist, stiff to hard, (CL) | GLACIAL<br>TILL    | 14   |               | 8           | SPT                           | 23               | 104 |    |    | 4200 |  |
|                          |  |                    | 22   |               | 9           | SPT                           |                  |     |    |    |      |  |
| WATER LEVEL MEASUREMENTS |  |                    | START    6-10-09    COMPLETE    6-10-09 11:18 am |               |             |                               |                  |     |    |    |      |  |
| DATE                     | TIME   | SAMPLED DEPTH      | CASING DEPTH                                     | CAVE-IN DEPTH | WATER LEVEL | METHOD<br>Rotary Mud Drilling |                  |     |    |    |      |  |
| --                       | --   | --                 | --   | --            | --          |                               |                  |     |    |    |      |  |
| --                       | --   | --                 | --   | --            | --          |                               |                  |     |    |    |      |  |
| --                       | --   | --                 | --   | --            | --          |                               |                  |     |    |    |      |  |
| --                       | --   | --                 | --   | --            | --          | CREW CHIEF    Gordv Hawkey    |                  |     |    |    |      |  |

GEOTECHNICAL TEST BORING 09-457.GPJ GEOTEKENG.GDT 7/16/09










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# GEOTECHNICAL TEST BORING LOG

GEOTEK # **09-457**

BORING NO. **6 (2 of 2)**

PROJECT **Proposed Surgical Suite Addition, Veterans Memorial Medical Center, 2501 W. 22nd Street, Sioux Falls, SD**

| DEPTH<br>in<br>FEET      | DESCRIPTION OF MATERIAL  | GEOLOGIC<br>ORIGIN   | N               | WL               | SAMPLE         |  | LABORATORY TESTS  |   |    |    |    |  |  |     |
|--------------------------|--|--|-----------------|------------------|----------------|--|---|---|----|----|----|--|--|-----|
|                          |  |  |                 |                  | NO.            | TYPE   | WC  | D   | LL | PL | QU |  |  |     |
|                          | ↓ SURFACE ELEVATION    1503.4 ft   |  |                 |                  |                |  |   |   |    |    |    |  |  |     |
| 61                       | <b>SANDY LEAN CLAY:</b> a little gravel, brown, moist, stiff to hard, (CL) <i>(Continued from previous page)</i> |  | GLACIAL<br>TILL | 20               |                | 10   |  | SPT   |    |    |    |  |  |     |
|                          |  |  |                 |                  |                | 25   | 11  |    |    |    |    |  |  | SPT |
|                          |  |  |                 |                  |                | 21   | 12  |    |    |    |    |  |  | SPT |
|                          |  |  |                 |                  |                | 23   | 13  |  |    |    |    |  |  | SPT |
|                          |  |  |                 |                  |                | 31   | 14  |  |    |    |    |  |  | SPT |
|                          |  |  |                 |                  |                | 35   | 15  |  |    |    |    |  |  | SPT |
|                          | Bottom of borehole at 61 feet.   |  |                 |                  |                |  |   |   |    |    |    |  |  |     |
| WATER LEVEL MEASUREMENTS |  |  |                 |                  |                | START    6-10-09    COMPLETE    6-10-09 11:18 am |   |   |    |    |    |  |  |     |
| DATE                     | TIME   | SAMPLED<br>DEPTH   | CASING<br>DEPTH | CAVE-IN<br>DEPTH | WATER<br>LEVEL | METHOD<br>Rotary Mud Drilling                    |   |   |    |    |    |  |  |     |
| --                       | --   | --   | --              | --               | --             |  |   |   |    |    |    |  |  |     |
| --                       | --   | --   | --              | --               | --             |  |   |   |    |    |    |  |  |     |
| --                       | --   | --   | --              | --               | --             |  |   |   |    |    |    |  |  |     |
| --                       | --   | --   | --              | --               | --             | CREW CHIEF    Gordv Hawkey                       |   |   |    |    |    |  |  |     |

GEOTECHNICAL TEST BORING 09-457.GPJ GEOTEKENG.GDT 7/16/09



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# GEOTECHNICAL TEST BORING LOG

GEOTEK # **09-457**

BORING NO. **7 (1 of 2)**

PROJECT **Proposed Surgical Suite Addition, Veterans Memorial Medical Center, 2501 W. 22nd Street, Sioux Falls, SD**

| DEPTH<br>in<br>FEET      | DESCRIPTION OF MATERIAL  | GEOLOGIC<br>ORIGIN | N  | WL               | SAMPLE         |                               | LABORATORY TESTS |   |    |    |    |  |
|--------------------------|--|--------------------|--|------------------|----------------|-------------------------------|------------------|---|----|----|----|--|
|                          |  |                    |  |                  | NO.            | TYPE                          | WC               | D | LL | PL | QU |  |
|                          | ↓ SURFACE ELEVATION    1499.5 ft   |                    |  |                  |                |                               |                  |   |    |    |    |  |
| 2                        | <b>FILL, MOSTLY CLAY:</b> dark brown, moist, 6" of concrete at the surface               | FILL               |  |                  | 1              | FA                            |                  |   |    |    |    |  |
|                          | <b>LEAN CLAY:</b> brown, moist, firm, (CL)   | LOESS              | 7  |                  | 2              | SPT                           |                  |   |    |    |    |  |
| 4½                       | <b>LEAN CLAY:</b> brown and gray mottled, moist, firm to soft, (CL)                      | LOESS              | 7  |                  | 3              | SPT                           |                  |   |    |    |    |  |
|                          |  |                    | 8  |                  | 4              | SPT                           |                  |   |    |    |    |  |
|                          |  |                    | 4  |                  | 5              | SPT                           |                  |   |    |    |    |  |
|                          |  |                    | 3  |                  | 6              | SPT                           |                  |   |    |    |    |  |
| 19½                      | <b>SANDY LEAN CLAY:</b> a little gravel, brown, moist, stiff, (CL)                       | GLACIAL<br>TILL    | 13   |                  | 7              | SPT                           |                  |   |    |    |    |  |
| 24½                      | <b>SANDY LEAN CLAY:</b> a little gravel, brown and gray mottled, moist, very stiff, (CL) | GLACIAL<br>TILL    | 15   |                  | 8              | SPT                           |                  |   |    |    |    |  |
| 29½                      | <b>SANDY LEAN CLAY:</b> a little gravel, brown, moist, very stiff, (CL)                  | GLACIAL<br>TILL    | 21   |                  | 9              | SPT                           |                  |   |    |    |    |  |
| WATER LEVEL MEASUREMENTS |  |                    | START    6-11-09    COMPLETE    6-17-09 11:07 am |                  |                |                               |                  |   |    |    |    |  |
| DATE                     | TIME   | SAMPLED<br>DEPTH   | CASING<br>DEPTH                                  | CAVE-IN<br>DEPTH | WATER<br>LEVEL | METHOD<br>Rotary Mud Drilling |                  |   |    |    |    |  |
| --                       | --   | --                 | --   | --               | --             |                               |                  |   |    |    |    |  |
| --                       | --   | --                 | --   | --               | --             |                               |                  |   |    |    |    |  |
| --                       | --   | --                 | --   | --               | --             |                               |                  |   |    |    |    |  |
| --                       | --   | --                 | --   | --               | --             | CREW CHIEF    Gordv Hawkey    |                  |   |    |    |    |  |

GEOTECHNICAL TEST BORING 09-457.GPJ GEOTEKENG.GDT 7/16/09





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# GEOTECHNICAL TEST BORING LOG

GEOTEK # **09-457**

BORING NO. **7 (2 of 2)**

PROJECT **Proposed Surgical Suite Addition, Veterans Memorial Medical Center, 2501 W. 22nd Street, Sioux Falls, SD**

| DEPTH<br>in<br>FEET            | DESCRIPTION OF MATERIAL<br>↓ SURFACE ELEVATION    1499.5 ft   | GEOLOGIC<br>ORIGIN  | N            | WL            | SAMPLE      |  | LABORATORY TESTS |   |    |    |    |       |
|--------------------------------|---|---|--------------|---------------|-------------|--|------------------|---|----|----|----|-------|
|                                |   |   |              |               | NO.         | TYPE   | WC               | D | LL | PL | QU |       |
| 49½                            | <b>SANDY LEAN CLAY:</b> a little gravel, brown, moist, very stiff, (CL) <i>(Continued from previous page)</i> | GLACIAL TILL  | 20           |               | 10          | X SPT  |                  |   |    |    |    |       |
|                                |   |   | 18           |               | 11          | X SPT  |                  |   |    |    |    |       |
|                                |   |   | 20           |               | 12          | X SPT  |                  |   |    |    |    |       |
|                                | 49½   | <b>SANDY LEAN CLAY:</b> a little gravel, brown and gray mottled, moist, very stiff, (CL)      | GLACIAL TILL |               | 19          | 13   |                  |   |    |    |    | X SPT |
|                                | 54½   | <b>SANDY LEAN CLAY:</b> a little gravel, brown and dark gray mottled, moist, very stiff, (CL) | GLACIAL TILL |               | 20          | 14   |                  |   |    |    |    | X SPT |
| 61                             |   |   | 21           | 15            | X SPT       |  |                  |   |    |    |    |       |
| Bottom of borehole at 61 feet. |   |   |              |               |             |  |                  |   |    |    |    |       |
| WATER LEVEL MEASUREMENTS       |   |   |              |               |             | START    6-11-09    COMPLETE    6-17-09 11:07 am |                  |   |    |    |    |       |
| DATE                           | TIME  | SAMPLED DEPTH   | CASING DEPTH | CAVE-IN DEPTH | WATER LEVEL | METHOD<br>Rotary Mud Drilling                    |                  |   |    |    |    |       |
| --                             | --  | --  | --           | --            | --          |  |                  |   |    |    |    |       |
| --                             | --  | --  | --           | --            | --          |  |                  |   |    |    |    |       |
| --                             | --  | --  | --           | --            | --          |  |                  |   |    |    |    |       |
| --                             | --  | --  | --           | --            | --          | CREW CHIEF    Gordv Hawkey                       |                  |   |    |    |    |       |

GEOTECHNICAL TEST BORING 09-457.GPJ GEOTEKENG.GDT 7/16/09

# SOIL CLASSIFICATION CHART

| MAJOR DIVISIONS   |   |   | SYMBOLS |   | TYPICAL DESCRIPTIONS   |
|---|---|---|---------|---|--|
|   |   |   | GRAPH   | LETTER  |  |
| COARSE GRAINED SOILS<br><br>MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE | GRAVEL AND GRAVELLY SOILS<br><br>MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE | CLEAN GRAVELS<br><br>(LITTLE OR NO FINES)               |         | GW  | WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES  |
|   |   |   |         | GP  | POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES  |
|   |   | GRAVELS WITH FINES<br><br>(APPRECIABLE AMOUNT OF FINES) |         | GM  | SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES   |
|   |   |   |         | GC  | CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES  |
|   | SAND AND SANDY SOILS<br><br>MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE       | CLEAN SANDS<br><br>(LITTLE OR NO FINES)                 |         | SW  | WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES  |
|   |   |   |         | SP  | POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES   |
|   |   | SANDS WITH FINES<br><br>(APPRECIABLE AMOUNT OF FINES)   |         | SM  | SILTY SANDS, SAND - SILT MIXTURES  |
|   |   |   |         | SC  | CLAYEY SANDS, SAND - CLAY MIXTURES   |
| FINE GRAINED SOILS<br><br>MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE  | SILTS AND CLAYS<br><br>LIQUID LIMIT LESS THAN 50  |   |         | ML  | INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY |
|   |   |   |         | CL  | INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS                  |
|   |   |   |         | OL  | ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY  |
|   | SILTS AND CLAYS<br><br>LIQUID LIMIT GREATER THAN 50                                       |   |         | MH  | INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS  |
|   |   |   |         | CH  | INORGANIC CLAYS OF HIGH PLASTICITY   |
|   |   |   |         | OH  | ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS  |
| HIGHLY ORGANIC SOILS  |   |   | PT      | PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS |  |

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

# BORING LOG SYMBOLS AND DESCRIPTIVE TERMINOLOGY

## SYMBOLS FOR DRILLING AND SAMPLING

| <u>Symbol</u> | <u>Definition</u>   |
|---------------|---|
| Bag           | Bag sample  |
| CS            | Continuous split-spoon sampling   |
| DM            | Drilling mud  |
| FA            | Flight auger; number indicates outside diameter in inches   |
| HA            | Hand auger; number indicates outside diameter in inches   |
| HSA           | Hollow stem auger; number indicates inside diameter in inches   |
| LS            | Liner sample; number indicates outside diameter of liner sample   |
| N             | Standard penetration resistance (N-value) in blows per foot   |
| NMR           | No water level measurement recorded, primarily due to presence of drilling fluid  |
| NSR           | No sample retrieved; classification is based on action of drilling equipment and/or material noted in drilling fluid or on sampling bit |
| SH            | Shelby tube sample; 3-inch outside diameter   |
| SPT           | Standard penetration test (N-value) using standard split-spoon sampler  |
| SS            | Split-spoon sample; 2-inch outside diameter unless otherwise noted  |
| WL            | Water level directly measured in boring   |
| ▼             | Water level symbol  |

## SYMBOLS FOR LABORATORY TESTS

| <u>Symbol</u> | <u>Definition</u>   |
|---------------|---|
| WC            | Water content, percent of dry weight; ASTM:D2216                    |
| D             | Dry density, pounds per cubic foot                                  |
| LL            | Liquid limit; ASTM:D4318  |
| PL            | Plastic limit; ASTM:D4318   |
| QU            | Unconfined compressive strength, pounds per square foot; ASTM:D2166 |

## DENSITY/CONSISTENCY TERMINOLOGY

| <u>Density</u> |                | <u>Consistency</u> |
|----------------|----------------|--------------------|
| <u>Term</u>    | <u>N-Value</u> | <u>Term</u>        |
| Very Loose     | 0-4            | Soft               |
| Loose          | 5-8            | Firm               |
| Medium Dense   | 9-15           | Stiff              |
| Dense          | 16-30          | Very Stiff         |
| Very Dense     | Over 30        | Hard               |

## PARTICLE SIZES

| <u>Term</u>   | <u>Particle Size</u> |
|---------------|----------------------|
| Boulder       | Over 12"             |
| Cobble        | 3" – 12"             |
| Gravel        | #4 – 3"              |
| Coarse Sand   | #10 – #4             |
| Medium Sand   | #40 – #10            |
| Fine Sand     | #200 – #40           |
| Silt and Clay | passes #200 sieve    |

## DESCRIPTIVE TERMINOLOGY

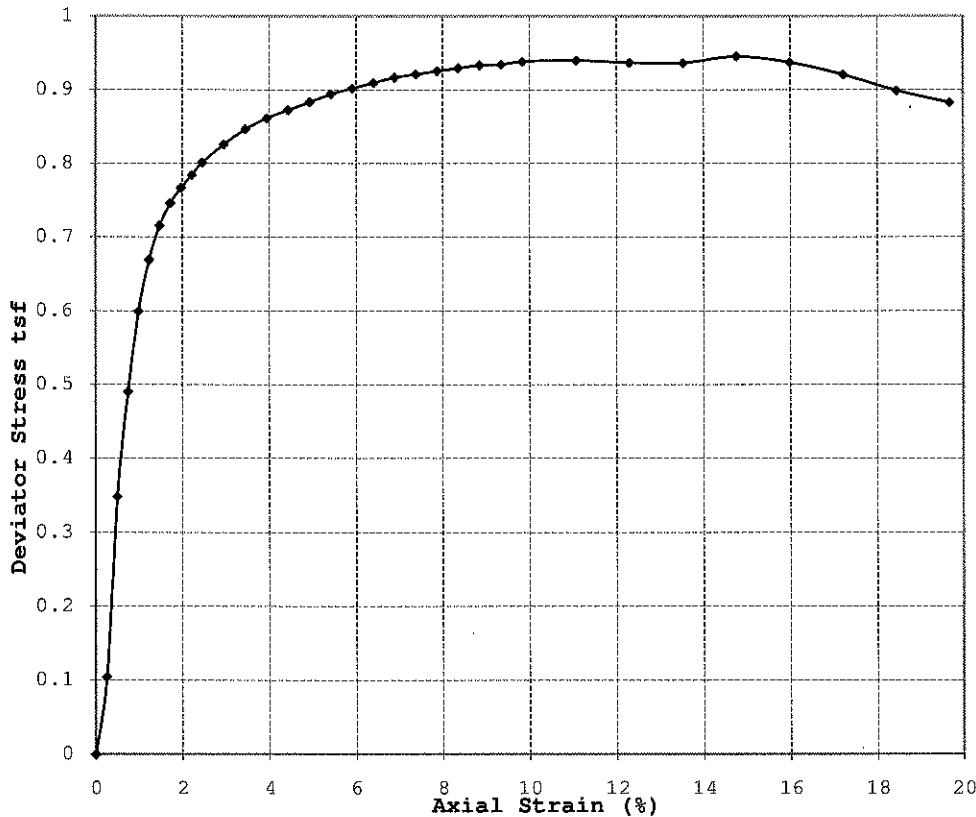
| <u>Term</u>  | <u>Definition</u>              |
|--------------|--------------------------------|
| Dry          | Absence of moisture, powdery   |
| Frozen       | Frozen soil                    |
| Moist        | Damp, below saturation         |
| Waterbearing | Pervious soil below water      |
| Wet          | Saturated, above liquid limit  |
| Lamination   | Up to ½" thick stratum         |
| Layer        | ½" to 6" thick stratum         |
| Lens         | ½" to 6" discontinuous stratum |

## GRAVEL PERCENTAGES

| <u>Term</u>       | <u>Range</u> |
|-------------------|--------------|
| A trace of gravel | 2-4%         |
| A little gravel   | 5-15%        |
| With gravel       | 16-50%       |

# Triaxial U-U Stress/Strain Curves

Project: Veteran's Memorial Medical Center - #09-457 Job: 7048  
 Client: Geotek Engineering & Testing Services, Inc. Date: 6/19/09  
 Remarks: Specimens trimmed to given sizes; Allowed to adjust under applied confining pressures for about 10 minutes.

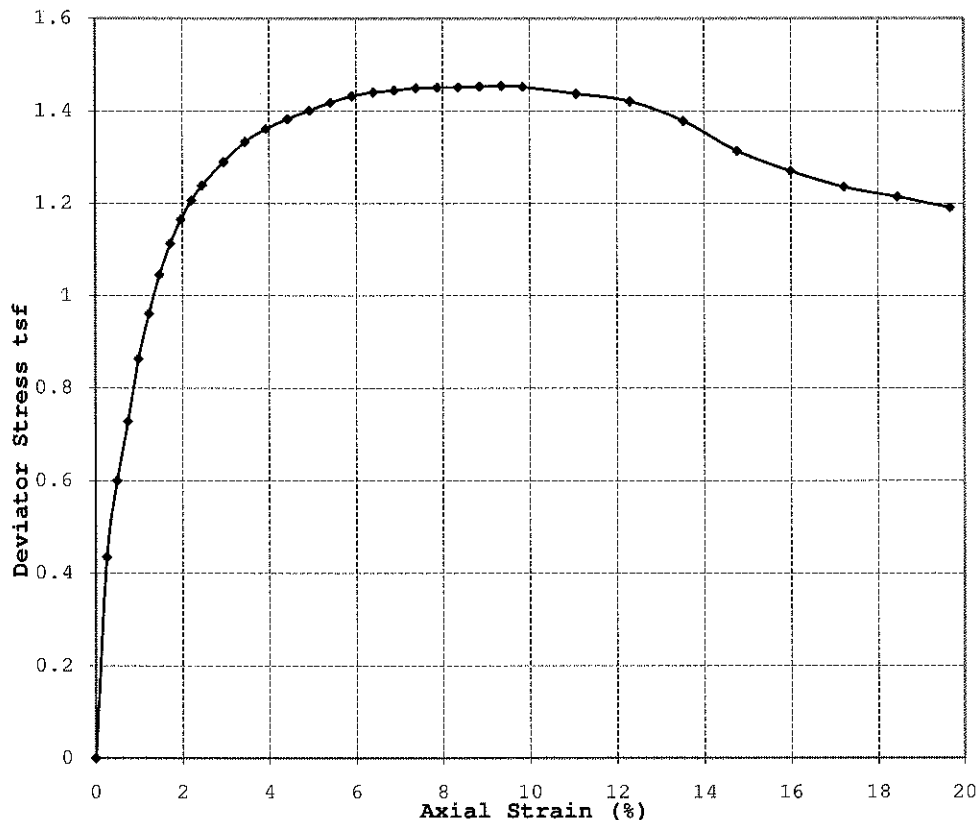
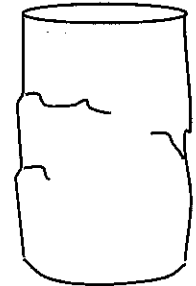


Boring: SB-4 Depth: 6 - 8 (Bot)  
 Sample #: \_\_\_\_\_  
 Soil Type: Lean Clay (CL)

Strain Rate (in/min): 0.050  
 Sample Type: 3T  
 Dia. (in): 1.94 Ht. (in): 4.07  
 Height to Diameter Ratio: 2.09

Max Deviator Stress: 0.95 tsf  
 Strain at Failure (%): 14.76  
 Confining Pressure: 0.42 tsf  
 W.C. (%): 18.5  
 Yd (pcf): 81.8

Sketch of Specimen After Failure



Boring: SB-4 Depth: 16 - 18 (Bot)  
 Sample #: \_\_\_\_\_  
 Soil Type: Lean Clay w/a few decomposed Roots (CL)

Strain Rate (in/min): 0.050  
 Sample Type: 3T  
 Dia. (in): 1.94 Ht. (in): 4.07  
 Height to Diameter Ratio: 2.09

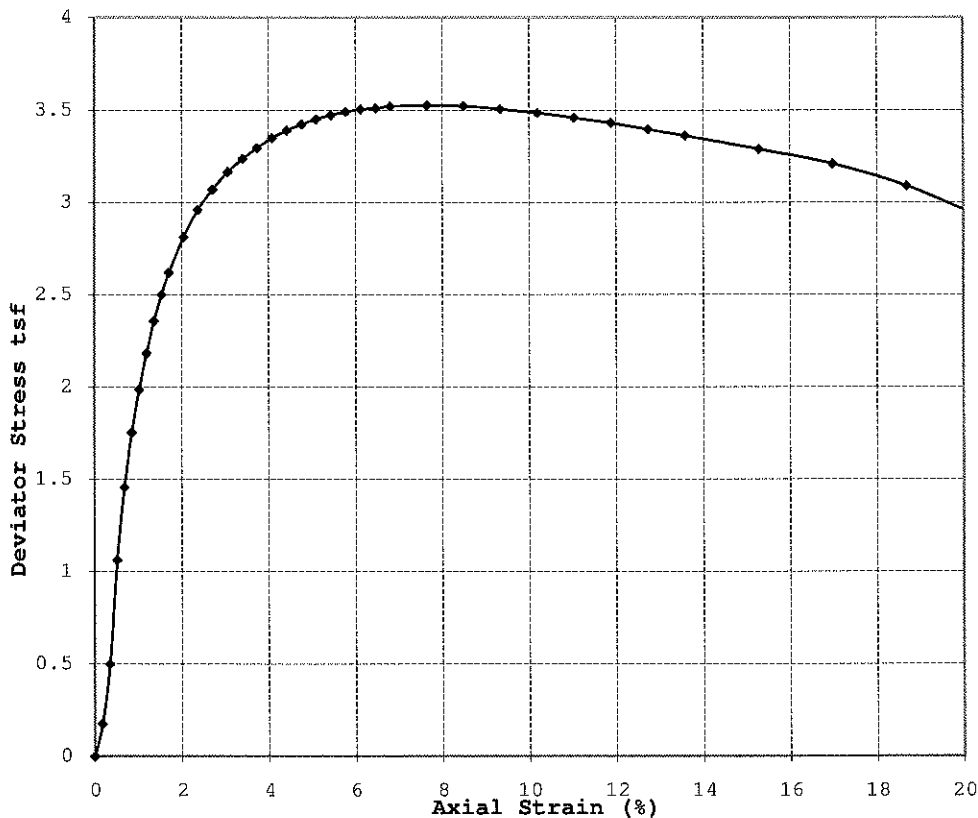
Max Deviator Stress: 1.45 tsf  
 Strain at Failure (%): 9.35  
 Confining Pressure: 1.01 tsf  
 W.C. (%): 27.3  
 Yd (pcf): 95.7

Sketch of Specimen After Failure



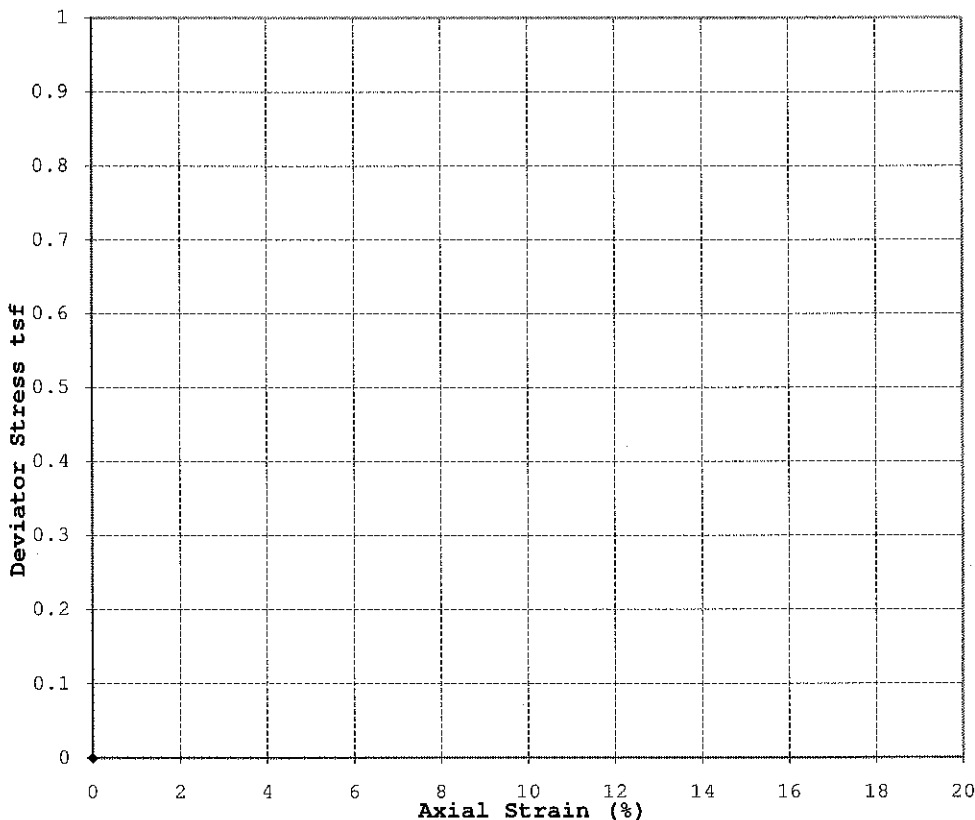
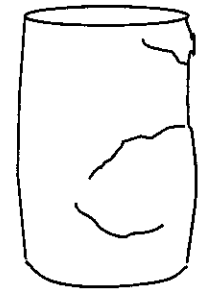
# Triaxial U-U Stress/Strain Curves

Project: Veteran's Memorial Medical Center - #09-457 Job: 7048  
 Client: Geotek Engineering & Testing Services, Inc. Date: 6/19/09  
 Remarks: Specimens trimmed to given sizes; Allowed to adjust under applied confining pressures for about 10 minutes.



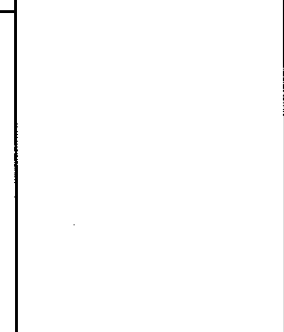
Boring: SB-4 Depth: 25 - 27  
 Sample #:  
 Soil Type: Lean Clay w/Sand & a trace of Gravel (CL)  
 Strain Rate (in/min): 0.050  
 Sample Type: 3T  
 Dia. (in): 2.89 Ht. (in): 5.89  
 Height to Diameter Ratio: 2.04  
 Max Deviator Stress: 3.53 tsf  
 Strain at Failure (%): 7.64  
 Confining Pressure: 1.37 tsf  
 W.C. (%): 21.1  
 Yd (pcf): 106.6

Sketch of Specimen After Failure

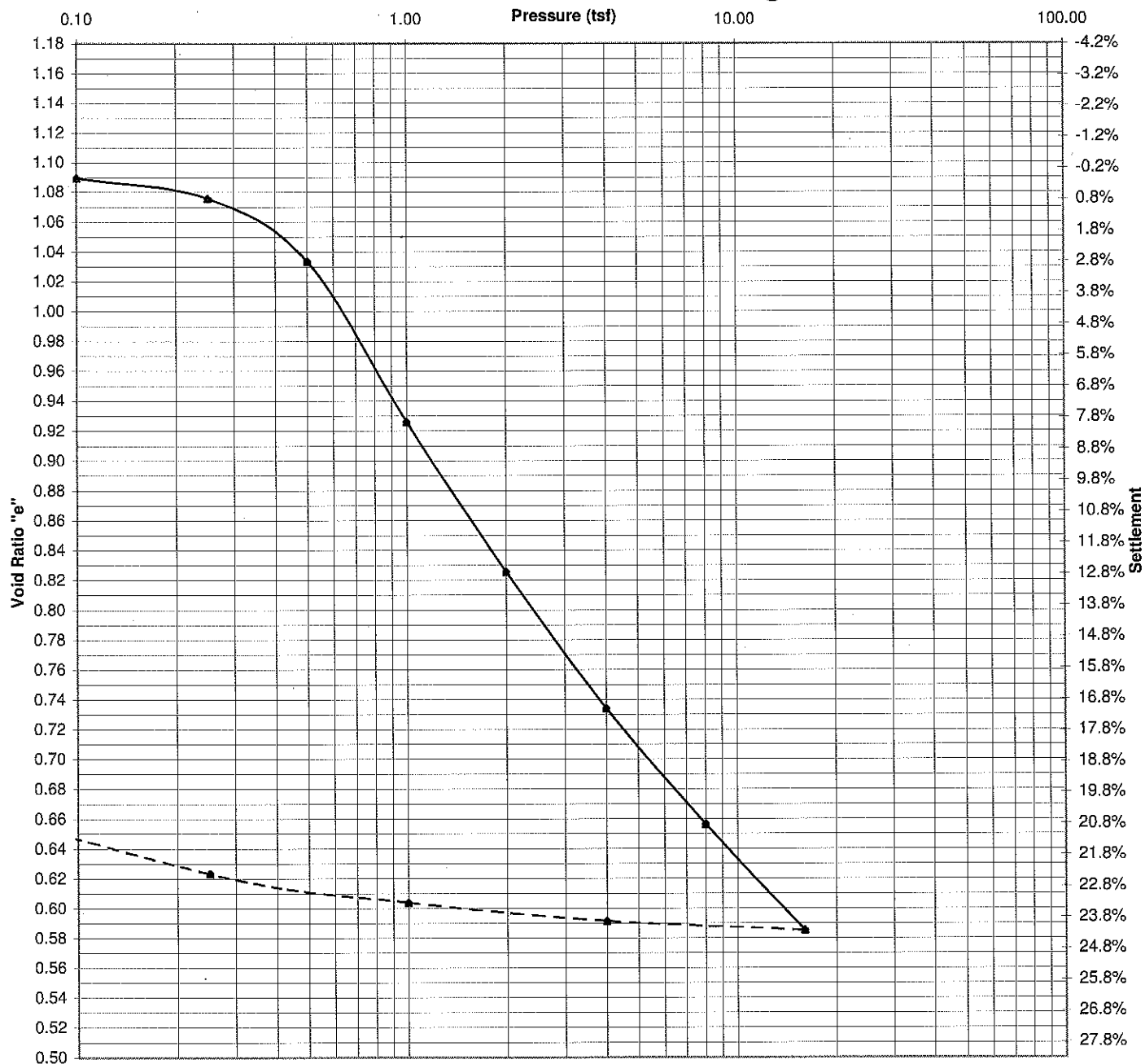


Boring: Depth:  
 Sample #:  
 Soil Type:  
 Strain Rate (in/min):  
 Sample Type:  
 Dia. (in): Ht. (in):  
 Height to Diameter Ratio:  
 Max Deviator Stress: tsf  
 Strain at Failure (%):  
 Confining Pressure: tsf  
 W.C. (%):  
 Yd (pcf):

Sketch of Specimen After Failure



# Void Ratio and % Settlement vs. Log of Pressure



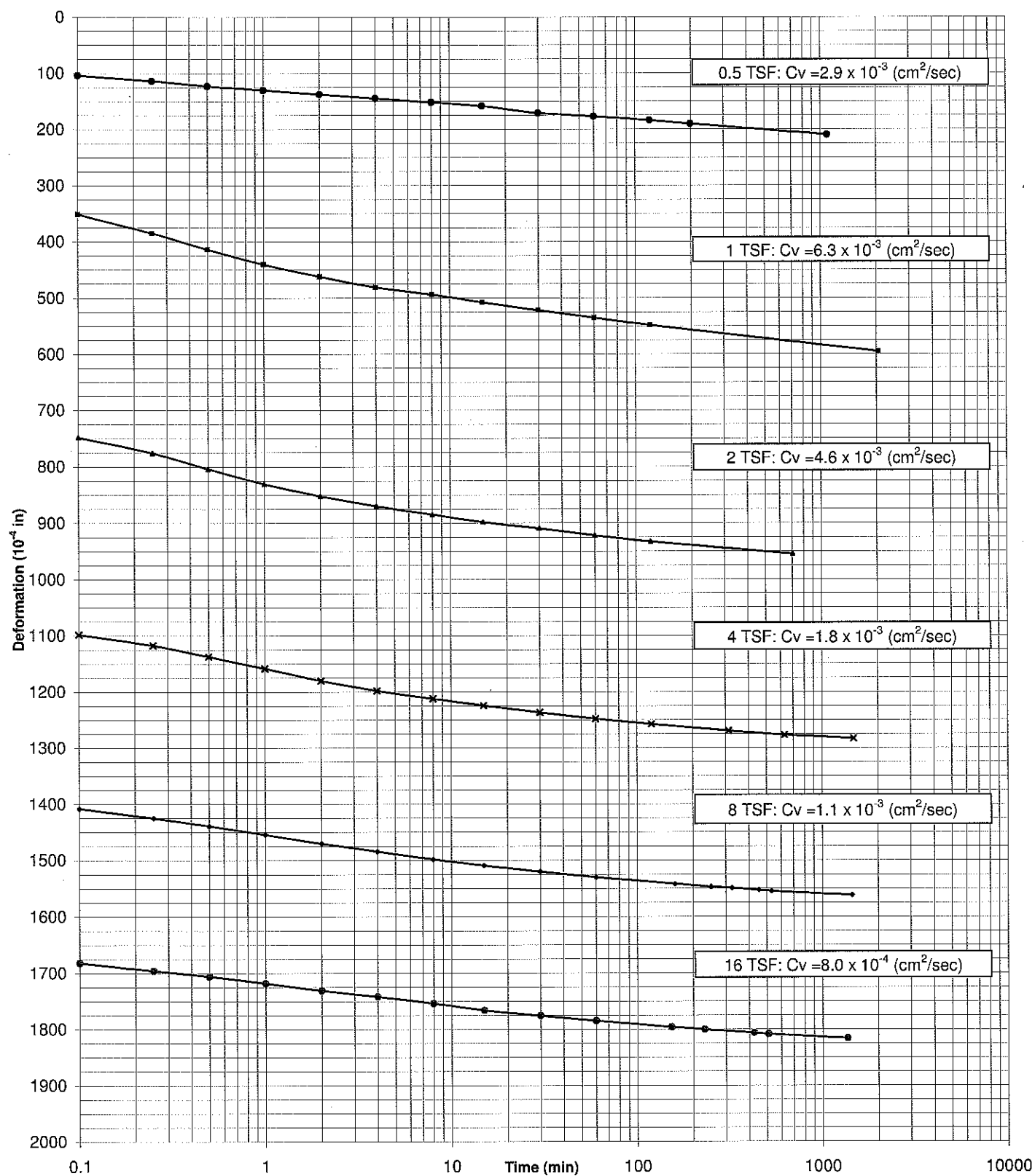
|  |                             |                                      |                        |  |                    |
|--|-----------------------------|--------------------------------------|------------------------|--|--------------------|
| Project: Veteran's Memorial Medical Center - #09-457 |                             |                                      |                        | Date: 6/23/09                          |                    |
| Sample #:  | Boring #: SB-4              | Depth ft: 6-8 (Mid)                  |                        | Job #: 7048                            |                    |
| Soil Type: Lean Clay (CL)                            |                             |                                      |                        |  |                    |
| Initial W/C (%): 18.7                                | Dry Density (pcf): 81.2     | LL:                                  | PL:                    | PI:                                    | Gs: 2.72 (Assumed) |
| Organic Content (%):                                 | Initial Height (in.): 0.750 | Diameter (in.): 2.507                | e <sub>0</sub> = 1.092 |  |                    |
| Preconsolidation Pressure (P <sub>c</sub> ):         | 0.42 tsf                    | Compression Index (C <sub>c</sub> ): | 0.30                   | Recompression Index (C <sub>r</sub> ): | ≈ 0.05             |
| Remarks:   |                             |                                      |                        |  |                    |

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# Consolidation Log of Time Curves



Project: Veteran's Memorial Medical Center - #09-457

Date: 6/23/09

Sample #:

Boring #: SB-4

Depth ft: 6-8 (Mid)

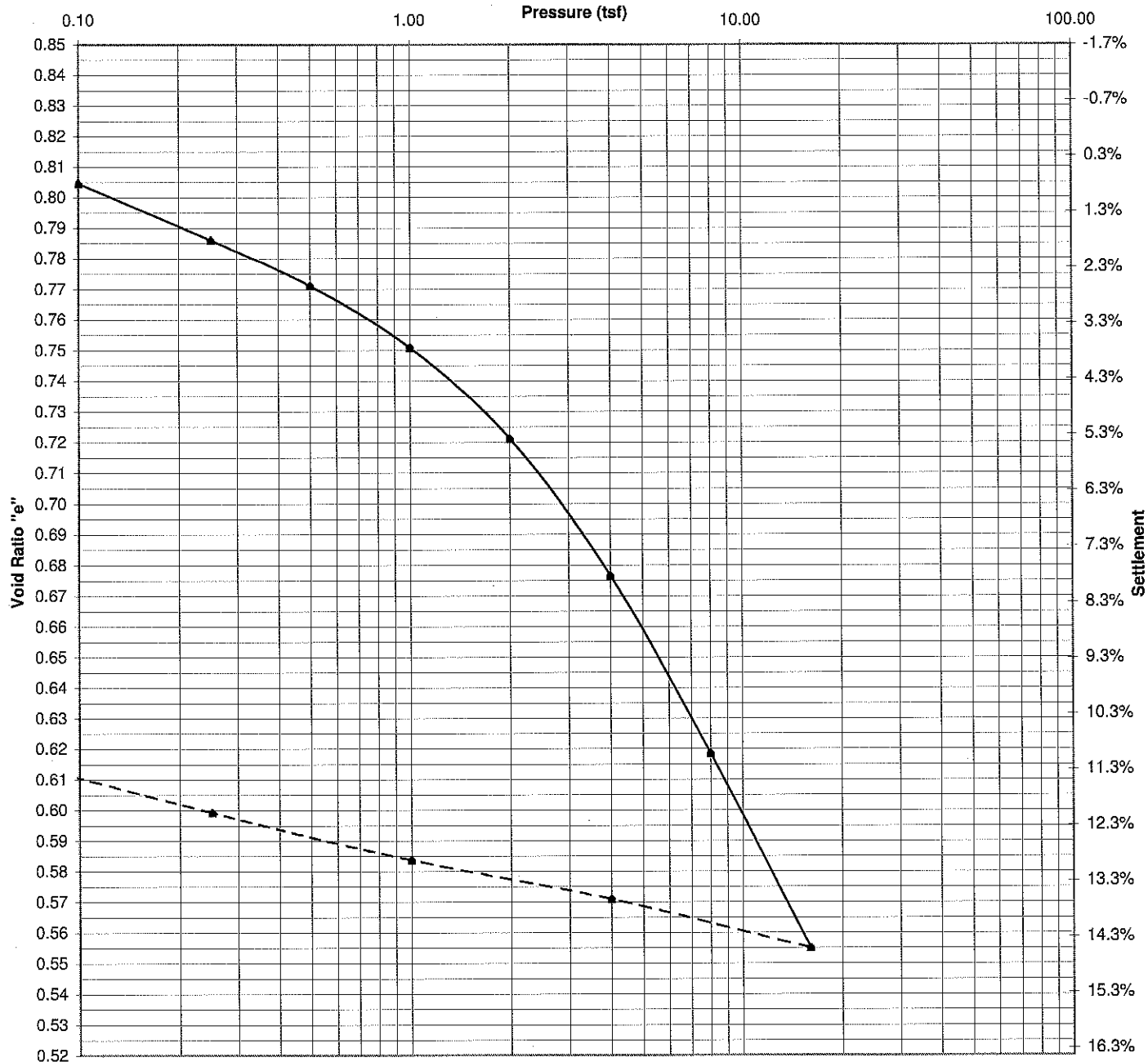
Job #: 7048

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**TESTING, INC.**

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# Void Ratio and % Settlement vs. Log of Pressure



|  |  |   |  |  |               |                        |
|--|--|---|--|--|---------------|------------------------|
| Project: Veteran's Memorial Medical Center - #09-457 |  |   |  |  | Date: 6/23/09 |                        |
| Sample #:  |  | Boring #: SB-4                            |  | Depth ft: 16-18 (Mid)                  |               | Job #: 7048            |
| Soil Type: Lean Clay w/a few decomposed roots (CL)   |  |   |  |  |               |                        |
| Initial W/C (%): 28.6                                |  | Dry Density (pcf): 93.3                   |  | LL:                                    | PL:           | PI:                    |
| Organic Content (%):                                 |  | Initial Height (in.): 0.685               |  | Diameter (in.): 2.504                  |               | e <sub>0</sub> = 0.820 |
| Preconsolidation Pressure (P <sub>c</sub> ): 2.2 tsf |  | Compression Index (C <sub>c</sub> ): 0.21 |  | Recompression Index (C <sub>r</sub> ): |               | ≈ 0.03                 |
| Remarks:   |  |   |  |  |               |                        |

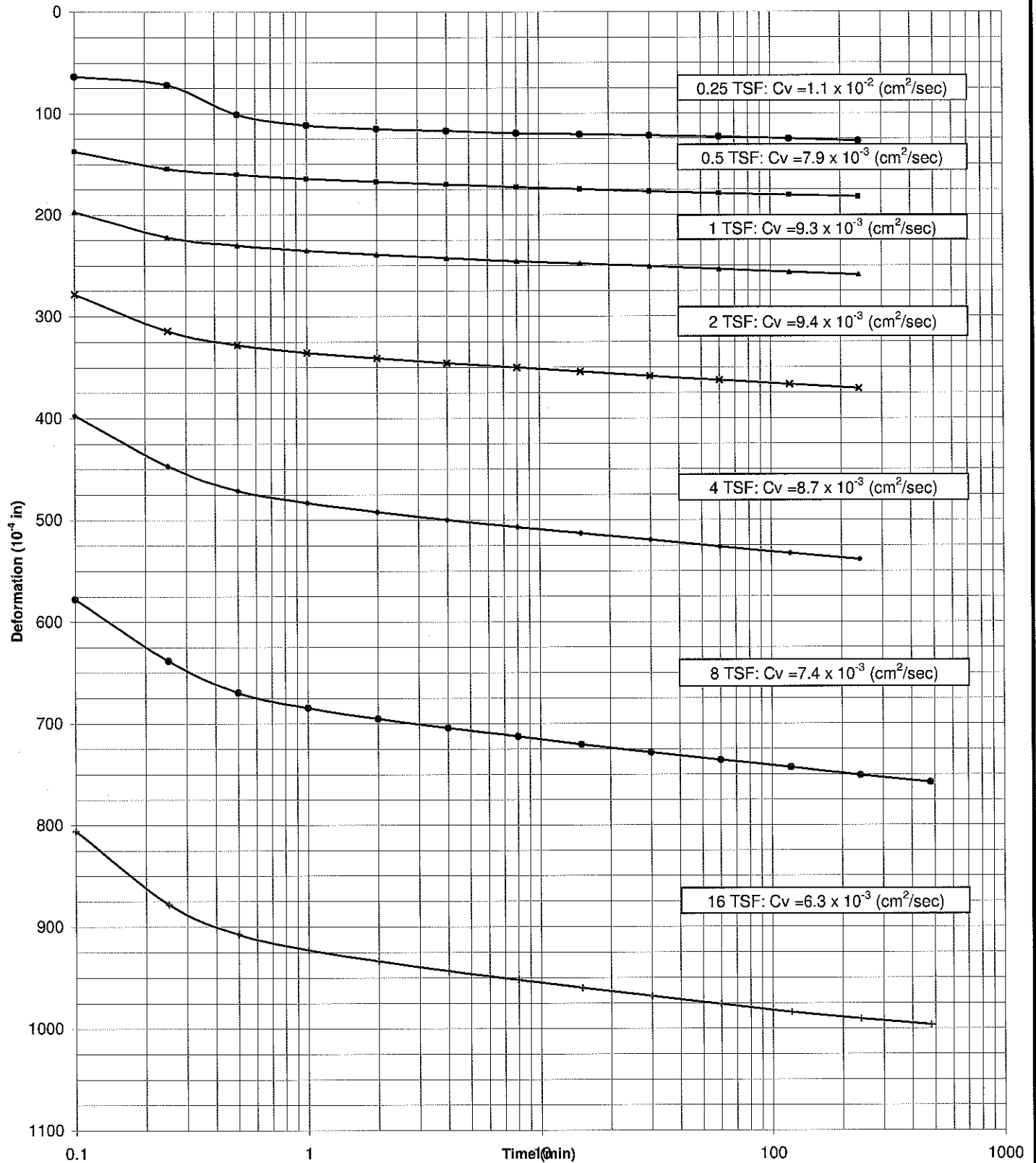
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## Consolidation Log of Time Curves



Project: Veteran's Memorial Medical Center - #09-457

Date: 6/23/09

Sample #:

Boring #: SB-4

Depth ft: 16-18 (Mid)

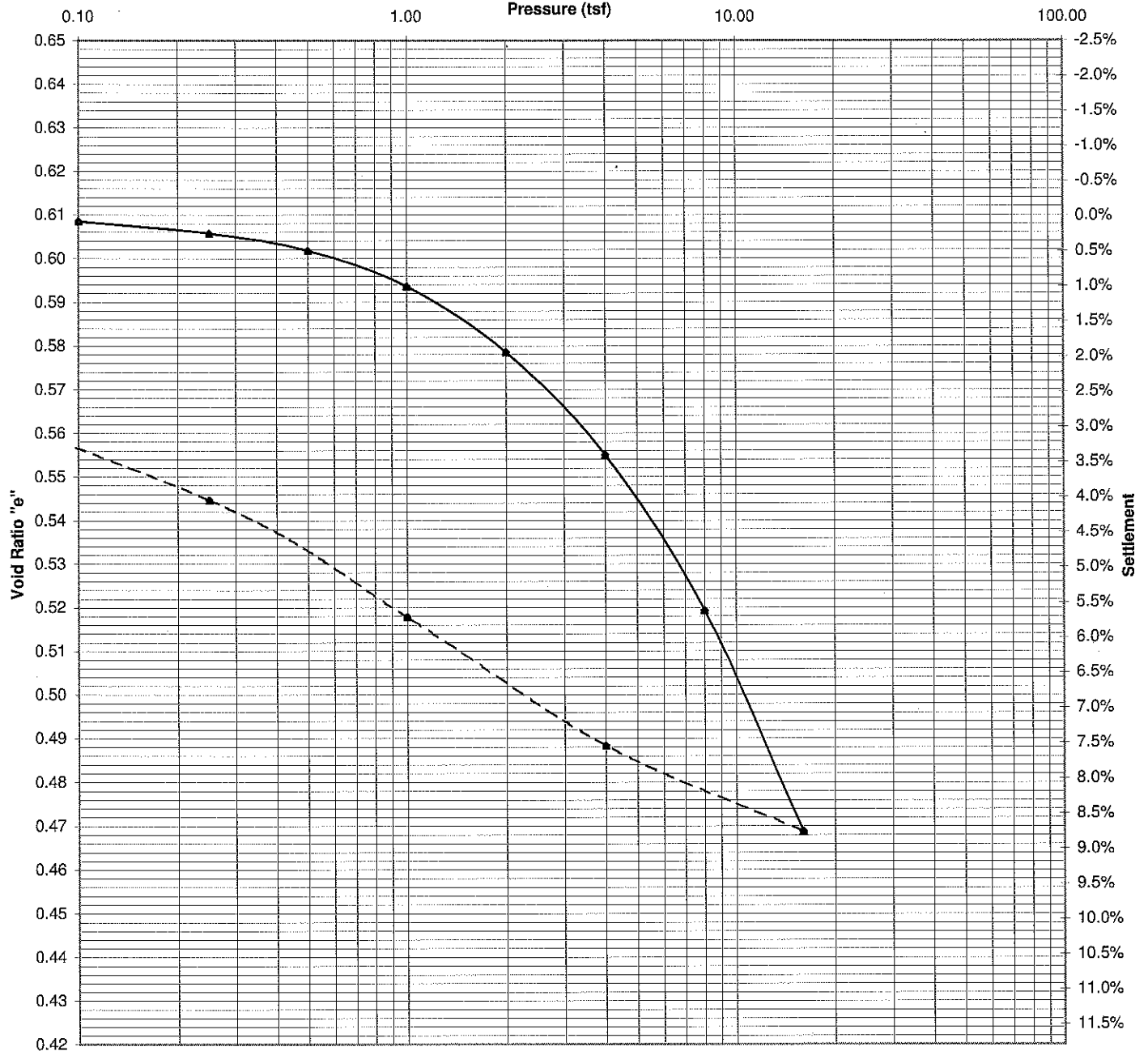
Job #: 7048

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# Void Ratio and % Settlement vs. Log of Pressure



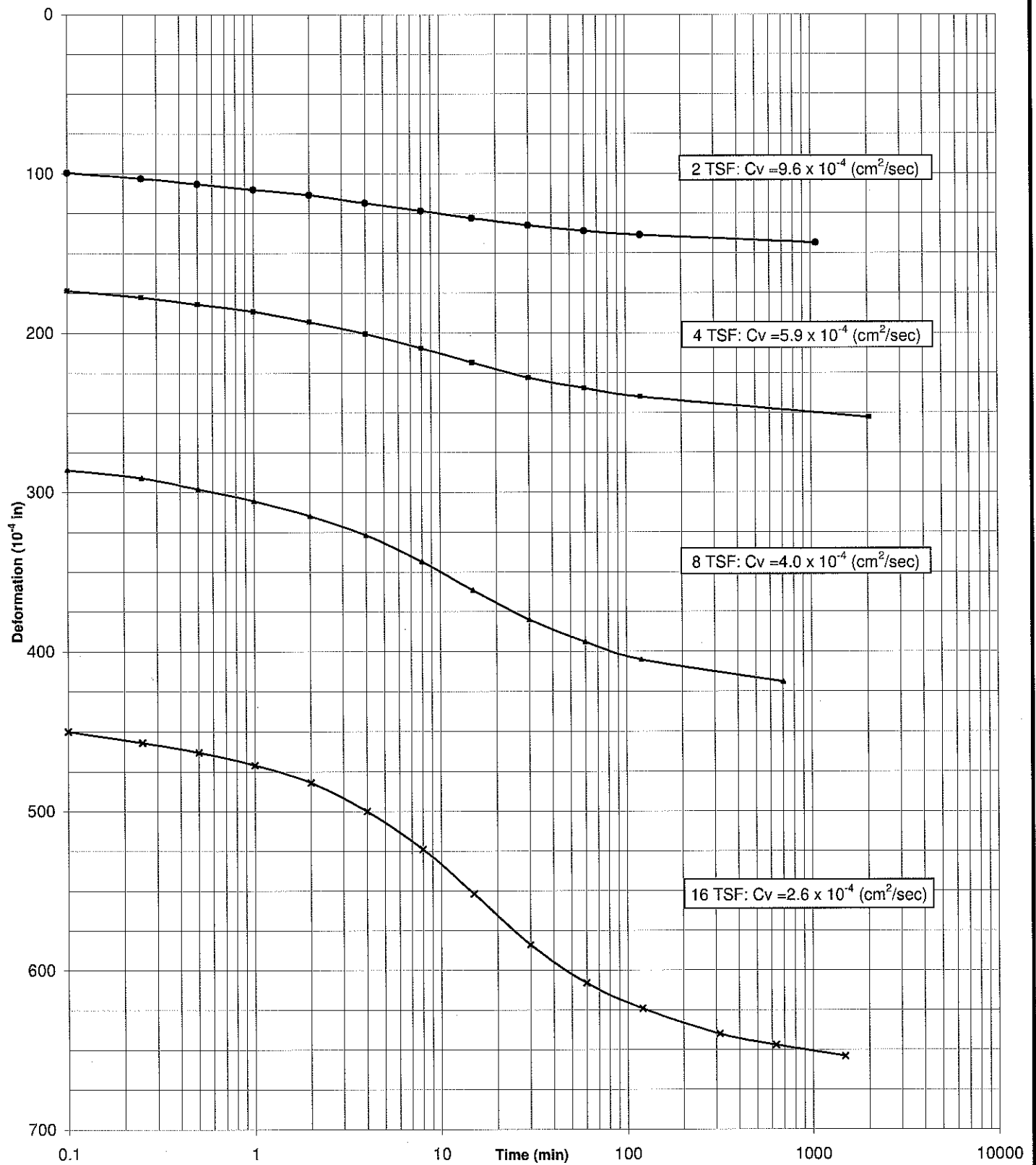
|  |  |                             |  |                              |               |                                  |  |
|--|--|-----------------------------|--|------------------------------|---------------|----------------------------------|--|
| Project: Veteran's Memorial Medical Center - #09-457   |  |                             |  |                              | Date: 6/23/09 |                                  |  |
| Sample #:  |  | Boring #: SB-4              |  | Depth ft: 25-27 (Top)        |               | Job #: 7048                      |  |
| Soil Type: Lean Clay w/sand and a trace of gravel (CL) |  |                             |  |                              |               |                                  |  |
| Initial W/C (%): 21.7                                  |  | Dry Density (pcf): 105.5    |  | LL: PL: PI:                  |               | Gs: 2.72 (Assumed)               |  |
| Organic Content (%):                                   |  | Initial Height (in.): 0.749 |  | Diameter (in.): 2.503        |               | e <sub>o</sub> = 0.609           |  |
| Preconsolidation Pressure (Pc):                        |  | 3.4 tsf                     |  | Compression Index (Cc): 0.16 |               | Recompression Index (Cr): ≅ 0.03 |  |
| Remarks:   |  |                             |  |                              |               |                                  |  |

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## Consolidation Log of Time Curves



Project: Veteran's Memorial Medical Center - #09-457

Date: 6/23/09

Sample #:

Boring #: SB-4

Depth ft: 25-27 (Top)

Job #: 7048

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