<u>ATTACHMENT NO. 15</u>

GEOTECHNICAL ENGINEERING REPORT

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GEOTECHNICAL ENGINEERING REPORT

37^{TH} BOMBER SQUADRON OPERATIONS FACILITY
ELLSWORTH AIR FORCE BASE
BOX ELDER, SOUTH DAKOTA

Terracon Project No. 05035024
April 29, 2003

Prepared for:

KENNETH HAHN ARCHITECTS, INC.
Omaha, Nebraska

Prepared by:

TERRACON
Omaha, Nebraska

Terracon

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April 29, 2003

Kenneth Hahn Architects, Inc.
1343 South 75th Street
Omaha, NE 68124-1610

Attention: Mr. Kenneth Hahn

Re: Geotechnical Engineering Report
37th Bomber Squadron Operations Facility
Ellsworth Air Force Base
Box Elder, South Dakota
Terracon Project No. 05035024

Dear Mr. Hahn:

Terracon has completed the subsurface exploration for the referenced project. The accompanying geotechnical report presents the findings of the subsurface exploration and provides recommendations for the design and construction of foundations and pavements. General earthwork recommendations have also been included.

The test borings completed at the site encountered existing fill over native alluvial soils over shale (bedrock). In our opinion, the existing clayey fill and the native clays have a moderate to high potential to swell upon wetting. Therefore, we recommend that a fill and/or excavate-refill operation be performed within the building area to provide at least 3 feet of new compacted fill beneath the foundations and floor slabs. The fill material may consist of low-plasticity clayey borrow or the on-site clays that are chemically treated to reduce the soils' plasticity and affinity for water. Chemical treatment of the pavement subgrades may also be accomplished to reduce the swell potential in these soils as well. In following the recommendations within this report, support of the proposed building on shallow spread footings appears feasible.

We appreciate the opportunity to provide the geotechnical consulting services for this project. Please contact us if you have any questions regarding the contents of this report, or if we may be of further service to you.

Sincerely,
TERRACON

Jeffrey M. Kortan

Jeffrey M. Kortan, P.E.
Senior Geotechnical Engineer

Edward D. Prost, Jr., P.E.
South Dakota No. 6107

REGISTERED PROFESSIONAL REG. NO. 6107 EDWARD D. PROST Jr. SOUTH DAKOTA

JMK/EDP:jmk/yms

Enclosure

Copies to: Addressee (4)

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INTRODUCTION

This report presents the results of the subsurface exploration completed for the proposed 37^{th} Bomber Squadron Operations Facility located within the Ellsworth Air Force Base near Box Elder, South Dakota. The subsurface exploration included eighteen (18) conventional soil borings extending to depths of about 5 feet to 35 feet. The borings completed within the proposed building area were extended to depths of about 25 to 35 feet, and the borings completed within the areas of proposed access drives and parking areas were extended to depths of about 5 to 15 feet. The boring logs are included in Appendix A of this report. The boring locations are shown on the Subsurface Exploration Diagram also included in Appendix A. The Subsurface Exploration Diagram was made from a copy of the Site and Grading Plan provided to Terracon by Kenneth Hahn Architects, Inc.

The purposes of this report are to describe the subsurface conditions encountered in the borings, to analyze and evaluate the field and laboratory test data, and to provide geotechnical recommendations for the design and construction of foundations and pavements for the project. General site development and earthwork recommendations are also provided. Our work was completed in general accordance with our proposal-agreement 0502707, dated October 3, 2002.

PROJECT DESCRIPTION

The proposed 37^{th} Bomber Squadron Operations Facility is located along Bergstrom Drive and between Bergstrom Drive and Schilling Street on the Ellsworth Air Force Base. As part of this project, a section of Bergstrom Drive will be relocated to the east to accommodate the proposed east parking lot construction. We understand that the proposed operations facility will include the construction of a single-story, slab-on-grade office/warehouse building with paved parking lots to the north and east of the building, and paved access drives and parking to the south and west. The proposed site layout is shown on the Site and Grading Plan provided to Terracon by Kenneth Hahn Architects, Inc.

The proposed building has approximate plan dimensions of 450 feet long (northwest to southeast) by 90 to 120 feet wide (northeast to southwest). The proposed building will generally be metal-framed with exterior brick veneer. However, the central area of the building will include a glass atrium structure. The design loads for the building were not provided prior to the preparation of this report. However, based upon our experience with similar-type structures, we estimate maximum column loads less than about 75 kips, continuous wall loads less than about 3 to 4 kips per lineal foot, and maximum floor loads less than about 150 pounds per square foot (psf). If structural analyses determine design loads significantly higher than our estimated values, we recommend that this information be provided to Terracon for review and consideration with regard to the recommendations contained herein.

The finish floor elevations for the building step down from the north to the south. The northern area of the building is generally designated for office space and meeting rooms and has a proposed finish floor elevation of El. 3253.33 feet (Mean Sea Level Datum). The central area of the building will include the main lobby, an auditorium and additional office and meeting space. The central area has a proposed finish floor at El. 3248.33 feet. The southern area of the building will include additional office and meeting space, small storage areas and locker rooms. Truck-height overhead doors will also be provided along the south and west wall lines at the south end of the building for access into a large storage and maintenance area. The southern area of the building has a proposed finish floor at El. 3237.33 feet.

A parking lot canopy is proposed within the paved area southwest of the proposed building. The canopy has approximate plan dimensions of 170 feet by 20 feet. We understand that the canopy will be metal-framed with a metal roof.

The stepped design of the building floor levels will involve both interior and exterior grade-separation walls. Based upon the existing and proposed grades shown on the Site and Grading Plan, we anticipate cut depths within the building footprint on the order of about 6 to 7 feet at the north ends of each of the different floor levels. At the south ends of the three areas, the fill depths vary from about 1 foot to 8 feet.

Approximately 6 feet of cut and 11 feet of fill will be required for the construction of the access drives and pavements south and west of the building. The parking lot to the north and east of the building will be graded by cutting up to about 5 feet through the central area and filling up to about 8 feet near the south end. The north area of the east parking lot is essentially at grade. Cut slopes for the project are generally proposed at about 4 Horizontal to 1 Vertical (2H:1V) or flatter grades and fill slopes are planned as steep as about 3H:1V grades.

SUBSURFACE EXPLORATION AND FIELD TESTING PROCEDURES

The project geotechnical engineer determined the test boring locations for this project and the Renner & Sperlich Engineering Company staked the boring locations in the field for both horizontal and vertical control. The boring elevations were determined relative to Mean Sea Level datum and the elevations were forwarded to our office. The reported elevations at the test locations are included on the boring logs.

The borings were drilled with a rotary drilling rig using continuous flight augers and hollow stem augers to advance the boreholes. The drilling rig was mounted to an all-terrain, rubber-tired vehicle. Representative samples of the soil profile were obtained using split-barrel and Shelby tube sampling procedures. In the split-barrel sampling procedure, a standard 2-inch Outside Diameter (O.D.) split-barrel sampling spoon is driven into the ground with a 140-pound hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a typical 18-inch penetration is recorded as the standard penetration test (SPT) resistance, also referred to as N-values. These values are noted on the boring logs at the depths of occurrence. In Shelby tube sampling, a thin-walled, 3-inch Outside Diameter (O.D.) seamless steel tube with a sharp cutting edge is pushed hydraulically into the ground to obtain a relatively undisturbed sample. The samples were tagged for identification, sealed, and taken to the laboratory for testing and classification.

Portions of each of the split-spoon and Shelby tube samples were tested in the field for volatile hydrocarbons with a photo-ionization detector (PID) instrument. Glass jars were filled approximately one-half full with soil and then sealed. The samples were allowed to stabilize for at least 30 minutes at temperatures above 60 degrees Fahrenheit, and the head space vapor was then tested with the PID instrument. The concentration of volatile organic vapors emitted from the soil was measured in units of parts per million (ppm). The PID instrument does not directly measure hydrocarbon concentrations in soil, rather, the instrument measures hydrocarbon concentrations in vapors emitted from the soil. Therefore, PID responses provide a relative indication of petroleum hydrocarbon concentrations in a semi-quantitative fashion. Field samples were taken to the laboratory for additional physical review and laboratory testing.

The drill crew prepared field logs for each boring. These logs included visual classifications of the materials encountered during drilling as well as the driller's interpretation of the subsurface conditions between samples. Final boring logs included with this report represent an interpretation of the field logs and include modifications based on laboratory observation and tests of the samples.

LABORATORY TESTING

Representative samples of cohesive soils obtained by the thin-walled tube sampling procedure were tested for water content and density. Unconfined compressive strength tests were performed on samples of sufficient length and integrity. Hand penetrometer tests were also performed on the thin-walled tube soil samples. The hand penetrometer is a device that has been correlated with laboratory unconfined compressive strength and provides a relative indication of the strength and consistency of the soil sample. The split-barrel samples were tested for water content. Where appropriate with cohesive soil samples, the unconfined compressive strength was estimated with a calibrated hand penetrometer. Results of the laboratory tests are provided on the boring logs.

In addition to the standard testing described above, eight (8) Atterberg limits tests, four (4) particle-size distribution tests, four (4) swell/settlement tests, one (1) modified Proctor moisture-density test and one (1) California Bearing Ratio (CBR) test were performed within our soil mechanics laboratory. The Atterberg limits test results are included on the boring logs. The results for the remaining tests, except for the CBR test, are included in Appendix A. The CBR test results are included in the "Pavement Design" section of this report.

Four (4) soil samples were also shipped to an independent laboratory for corrosivity testing (chloride, sulfate and pH). Two (2) soil samples were shipped to a second independent laboratory and tested for volatile organic compounds (VOC's) and Total Extractable Hydrocarbons (TEH's). Test reports received from the independent laboratories are included in Appendix B.

The soil samples were reviewed and classified by the project geotechnical engineer. The samples were classified by visual-manual procedures in accordance with the enclosed General Notes and the Unified Soil Classification System. Estimated classification symbols for the soil types are indicated on the boring logs, and a brief description of the classification system is attached to this report.

SITE AND SUBSURFACE CONDITIONS

The proposed bomber squadron facility will be located within the previously graded and developed site between Bergstrom Drive and Schilling Street on the Ellsworth Air Force Base near Box Elder, South Dakota. A section of Bergstrom Drive will be relocated to the east to accommodate the construction of the proposed east parking lot. There is a small metal building, a block building and a shed located west of the existing Bergstrom Drive. There is existing asphalt paving around the buildings and an asphalt parking lot north of the buildings. The existing buildings and asphalt pavements will be removed for the new construction.

The project site slopes down to the south with approximately 35 feet of elevation change over about 700 feet. Slopes are generally gradual except for localized, approximate 5 to 10 feet high slopes that exist at grades of about 3H:1V or flatter. Ditch sideslopes east of Schilling Street exist at about 2H:1V grades.

Subsurface conditions encountered at each boring location are indicated on the individual boring logs. Stratification boundaries shown on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Based on the results of the borings, subsurface conditions can be generalized as follows.

The general subsurface profile encountered within the test borings consists of fill soils over undisturbed alluvial soils over weathered shale (bedrock). Alluvial soils have been transported and deposited by flowing water.

Fill soils were encountered to depths of about 4 to 28.5 feet. The fill was both granular and clayey in composition and varied from lean to fat clays to sand and gravel to crushed stone. The laboratory-determined dry densities of the fill ranged from about 87 pounds per cubic foot (pcf) to 119 pcf with moisture contents ranging from about 4 to 30 percent. In general, the lower moisture contents were determined within the granular fill layers. Hand penetrometer test results ranged from about 1,000 psf to greater than about 9,000 psf. Two (2) unconfined compressive strength test results were about 2,560 psf and 10,790 psf. Standard penetration test blow counts (N-values) within the fill ranged from about 5 to 39 blows per foot. Six (6) Atterberg limits tests were completed on samples of the clayey fill. Five of the six tests determined liquid limits between about 48 and 54 percent and plasticity indices between about 32 and 40 percent. One sample of "possible fill" from Boring 4 had a liquid limit of about 78 percent with a plasticity index of about 59 percent. A composite sample of the fill was collected and tested by the modified Proctor moisture-density test (ASTM D1557). The composite sample tested to a maximum dry density of about 118.6 pcf at an optimum moisture content of about 13.6 percent. Three (3) swell tests were also completed on samples of the fill. One test measured about 3.1 percent swell under a load of 100 psf. The other two swell tests measured swell pressures of about 2.0 and 2.8 tons per square foot (tsf), or about 4,000 to 5,600 psf.

The undisturbed alluvial soils were again described as both granular and clayey in composition, from sands and gravels to lean and fat clays. The cohesive clayey soils were stiff to hard in consistency and the granular soils were medium dense to extremely dense (according to recorded N-values). Natural dry densities ranged from about 98 to 109 pcf with natural moisture contents of about 2 to 25 percent. Again, the lower moisture contents were determined within the granular soils. N-values ranged from about 10 blows per foot to 66 blows for 6 inches of sampler penetration. Hand penetrometer test results ranged from about 2,500 psf to greater than about 9,000 psf. Three Atterberg limits tests completed on clayey soil samples determined liquid limits from about 48 to 59 percent with respective plasticity indices from about 34 to 43 percent. One swell test completed for the native fat clay measured about 2.1 percent swell under a load of 100 psf.

Weathered shale (bedrock) was encountered at the bottoms of six of the eighteen test borings at depths ranging from about 13.5 to 28.5 feet. The shale was described as soft. N-values within the shale ranged from about 14 to 34 blows per foot and hand penetrometer values ranged from about 4,500 psf to greater than about 9,000 psf. Natural moisture contents ranged from about 16 to 35 percent.

WATER LEVEL OBSERVATIONS

The borings were monitored while drilling and after borehole completion for the presence and level of groundwater. Groundwater was observed within two of the eighteen borings. Groundwater was noted within Boring 4 at a depth of about 28 feet after approximately 24 hours after borehole completion. Groundwater was noted within Boring 14 at a depth of about 10 feet while sampling. These measurements provide an estimate of the groundwater conditions existing on the site when the borings were completed. Long-term monitoring in cased holes or piezometers would be necessary to accurately evaluate the potential range of groundwater conditions, especially considering the low permeability of the on-site clayey soils. Consistent groundwater levels or perched groundwater conditions within the granular soils were not encountered.

Fluctuations of the groundwater level can occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Perched water conditions may also develop within the granular soils over the lower-permeability clays. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

ANALYSES AND RECOMMENDATIONS

General

Independent Laboratory Test Results

A PID instrument was utilized in the field to estimate the concentration of volatile organic vapors emitted from the soil. The field test results ranged from a zero (0) reading to approximately 4.8 parts per million (ppm). In our opinion, these results are relatively low and indicate that VOC and TEH concentrations within the soil samples would generally be undetectable or insignificant, if analyzed using laboratory methods. Nevertheless, to confirm this premise, two samples were selected for additional testing at an independent laboratory for VOC and TEH concentrations. One sample of native clayey soil and one sample of clayey fill, both with relatively high PID readings compared to the majority of the field test results, were selected for the additional testing at TestAmerica, Inc. in Cedar Falls, Iowa. The native lean clay sample from Boring 5 exhibited a PID response of 3.7 ppm and the lean clay fill sample from Boring 15 exhibited a PID response of 4.8 ppm.

The test report sheets received from TestAmerica, Inc. are included in Appendix B. Of the compounds tested for in the laboratory, only toluene was detected within the Boring 5 sample above the minimum detectable limit. A toluene concentration of 7.3 micrograms per kilogram (ug/kg) was reported. However, the EPA preliminary remediation guidelines for toluene in soil are 590 milligrams per kilogram (mg/kg) for residential sites and 2,000 mg/kg for commercial sites. The toluene concentration detected within the soil sample is approximately 4 to 5 orders of magnitude, or more, below the EPA guidelines. With the completion of these field and laboratory tests, it appears that contamination from VOC and TEH compounds is not significant at the Terracon drilling locations.

Four (4) soil samples were delivered to Midwest Laboratories, Inc. in Omaha, Nebraska to determine soil pH and chloride and sulfate concentrations. The test reports received from Midwest Laboratories, Inc. are included in Appendix B. We understand that the reported values will be reviewed by others to determine the soil corrosion potential.

Geotechnical Considerations

The test borings completed at the site encountered clay fill and granular fill over native alluvial sands and clays over shale (bedrock). The existing fill depths range from about 4 feet to 28.5 feet. Proposed site grading indicates that foundation excavations will penetrate the fill in northern and central areas of the building footprint for bearing in the undisturbed soils. In general, both the fill and the native soils within the building area appear to be of adequate strength to support the proposed structure. The laboratory-determined dry densities of the fill within the building area generally range from about 105 pcf to 114 pcf, which calculate to about 89 to 96 percent of the modified Proctor maximum dry density. One sample of the fill from Boring 8 had a dry density of about 99 pcf, which is approximately 83 percent of the modified Proctor value.

There is some risk involved with supporting a structure within existing fill materials due to the uncertainty of the presence of poorly compacted fill layers that may remain beneath foundations and floor slabs. The risk of adverse foundation and floor slab performance is reduced significantly if the fill was placed and compacted in a controlled manner, and field observation and compaction testing was completed during the fill placement. Risks can be further reduced with a thorough field and laboratory testing program during site exploration and additional field observation and testing during the construction phase. In our opinion, based upon laboratory testing and a visual review of the samples, the risk of adverse foundation and floor slab performance due to settlement/consolidation of the fill would be considered low.

Although the fill soils within the building area generally appear to exist at adequate strengths and densities, the moisture contents of the material are relatively low and near the plastic limits determined by the Atterberg limits tests. In addition, the plasticity indices determined by the Atterberg limits tests are typically higher than about 32 percent. Swell tests on samples of the fill measured potential swell of about 3.1 percent and swell pressures of about 2.0 and 2.8 tsf. The low *in situ* moistures, the high plasticity indices and the swell test results indicate that the fill material would have a moderate to high potential to swell upon wetting. Swelling soils beneath the structure could result in heaving of floor slabs and foundations. Similar Atterberg limits test results were measured on samples of the native clayey soils. A swell test on a sample of the native fat clay measured a potential swell of about 2.1 percent.

In order to provide a more uniform bearing surface beneath foundations and floor slabs, and to reduce the potential for soil swell, we recommend that the proposed foundations and floor slabs be supported on at least 3 feet of approved, conditioned fill soils. Aside from a thin, granular capillary layer beneath floor slabs, we recommend that the fill consist of low-plasticity, cohesive, clayey material. The conditioned, compacted clayey fill should provide adequate support for the foundations and floor slabs, and also provide a low-permeability zone that will significantly reduce the potential for groundwater infiltration and potential wetting of the foundation soils from the surface. We do not recommend that granular fill be used beneath the proposed footings because of the potential for groundwater or infiltrating surface water to pond on the clayey subgrade. Substantial design and construction efforts would have to be made to provide excellent drainage within the granular fill.

Granular fill may be considered within the proposed building footprint beneath the floor slab where potential future wetting of the clayey subgrade would be less likely. For this case, we recommend that granular fill extend up to 2 feet in depth and no deeper than 1 foot above proposed design footing bearing elevation. The granular fill should be underlain by at least 1 foot of approved clayey fill. With the use of deep granular fill, special care will have to be taken to prevent free water from accumulating within the fill above the clayey subgrade prior to the placement of the floor slab concrete. Granular fill removal and clayey subgrade reconditioning may be required following extensive or prolonged precipitation. Depending upon construction scheduling, it may not be practical to assume that the clayey subgrade can be prepared, the granular fill be placed and compacted, and the floor slab poured without interruption, especially considering the sizes of the north and south floor areas.

We recommend that the 3 foot zone of approved fill beneath footings and floor slabs be provided by procedures of filling and/or overexcavating and refilling. The use of thicker zones of approved fill would further reduce potential swell and heave movements. We recommend that the proposed fill material consist of low-plasticity, cohesive borrow material or the existing on-site clayey soils that have been chemically modified with lime or type C fly ash to reduce the soils' plasticity and affinity for water. The use of on-site material would eliminate trucking costs and the purchase of off-site borrow, but would include costs for materials (lime, fly ash), extra handling and mixing. In our opinion, chemically modified soil would provide a stronger, more stable product than simply utilizing off-site borrow. Chemically modified soil is also typically more resistant to wetting and softening.

Soil modification is a process that can be used successfully to increase soil stability and to lower soil plasticity and its affinity for water. However, the work should be completed by an earthwork contractor experienced in soil modification. Laboratory testing should also be performed prior to construction to confirm that the design mixture proposed by the contractor will exhibit the recommended soil parameters and swell properties. Continued field observation, field testing and laboratory testing should be accomplished during construction.

Experience has shown that sulfate in the soil can react with calcium from lime or fly ash resulting in expansion (swell) of the soil matrix. The sulfate concentrations reported by Midwest Laboratories, Inc. (169 mg/L to 2,619 mg/L) would generally be considered as moderate to severe with regard to a potential reaction with the modifying agents. Due to the wide range of sulfate concentrations within the tested on-site samples, procedures will have to be implemented to reduce the effects of sulfate-induced swell. Additional laboratory swell tests should also be performed to estimate the sulfate-induced swell potential and to assist in the establishment of adequate field procedures to reduce this swell, if necessary. These procedures may involve reaction periods of 24 to 48 hours, after mixing and before placement as fill.

It should be recognized that our recommended alternative for foundation and floor slab support will not eliminate the possibility of foundation and slab heave; however, movements should be substantially reduced and would tend to be more uniform. The use of deep foundations and structural floor slabs would further reduce the potential for heave movements in the structure, but, in our opinion, the additional costs involved for these systems would not be justified by the slight reduction in potential structural heave.

Site Preparation and Earthwork

Stripping of all existing vegetation, organic topsoil, existing asphalt paving and other materials unsuitable for re-use as engineered fill should be performed within all cut, fill, paving and building areas. A typical, stripping depth of about 9 inches is expected to be adequate in most areas of the site. However, deeper stripping could be required in localized areas. Actual stripping depths should be evaluated by a Terracon geotechnical representative at the time of construction.

Project scheduling may allow for some areas of existing pavement to remain in place while other phases of the project are being completed. Leaving the existing pavement in place, even temporarily, provides a stable working surface or storage area, and protects these areas of the site from potential disturbance and erosion during construction.

We recommend that existing fill and native undisturbed soils within the proposed building area be undercut to a depth of at least 3 feet below proposed foundations and floor slabs. The building area should be defined as the nominal dimensions of the building plus 10 feet all around. Deep excavations for exterior footings should extend at least 10 feet to the outside of the building and to at least 5 feet to the inside of the building, beyond proposed edges of footings. Excavations for interior footings should extend at least 5 feet beyond the edges of the footings.

Following stripping, undercutting within the building area and cutting to proposed subgrade elevation, the exposed soils in building and pavement areas should be proofrolled in the presence of a Terracon geotechnical representative. Proofrolling should be accomplished prior to the placement of any fill. Proofrolling aids in providing a firm base for compaction of fill and delineating soft or disturbed areas that may exist below subgrade level. Unsuitable areas observed at this time should be improved by scarification and recompaction or by undercutting and replacement with approved structural fill. Proofrolling may be accomplished with a fully loaded, tandem-axle, dump truck or other equipment providing an equivalent subgrade loading. A minimum gross weight of 25 tons is recommended for the proofrolling equipment.

After proofrolling, exposed clayey soils should be scarified to a 9-inch depth and moisture adjusted to within the range of 3 to 7 percent above the material's optimum moisture content for compaction, as determined by the modified Proctor procedure (ASTM D1557). The scarified clayey soils should be recompacted to at least 85 percent of the material's modified Proctor maximum dry density. Scarified soils that cannot be recompacted to the recommended degree should be undercut and replaced with stable fill.

All fill and backfill should be placed in lifts of 9 inches or less in loose thickness. We recommend that fill placed within the building area be compacted to at least 90 percent of the modified Proctor maximum dry density (ASTM D1557) for cohesive soils. All other fill, except for the top 9 inches of pavement subgrades, should be compacted to at least 85 percent (ASTM D1557). Cohesive structural fill should be placed and compacted at a moisture content within the range of 3 to 7 percent above the optimum moisture content as determined in the modified Proctor test.

Fill used beneath foundations and floor slabs should consist of approved clayey borrow or chemically modified on-site clays free of organic matter and debris. The fill, except as otherwise stated in this report, should be low plasticity cohesive soil. By our definition, low plasticity cohesive soil should have a liquid limit less than about 45 percent and a plasticity index between about 10 and 20 percent. The on-site existing fill and the undisturbed clayey soils are not suitable for use as fill and backfill within the building area without chemical modification. The existing fill and undisturbed soils can be used as fill outside of the building area without treatment. Some moisture conditioning will be required for proper compaction.

In addition to meeting the above soil parameters for a low plasticity soil, we recommend that chemically modified soils achieve a percent swell less than 0.5 percent under a confining load of 100 psf, as determined by the one-dimensional swell test, method A (ASTM D4546).

Utility Installation

We anticipate that excavations for proposed site utilities will be less than about 10 feet deep. The excavations may penetrate clayey and granular fill soils and clayey and granular native soils. At the time of drilling, groundwater was either not observed or was noted below the anticipated depths of the utilities. Dewatering and/or other special installation procedures do not appear to be necessary for utility installation at this site.

We anticipate that utilities will be installed in open-cut excavations and a trench shield will be used where necessary. All excavations should comply with requirements of OSHA 29 CFR, Part 1926, Subpart P, "Excavations and Trenches" and other applicable codes. Construction grading should provide for removal of surface water before it can soak into the soils in the bottoms of excavations. Such provisions could include sloping the ground surface to drain away from the excavation, and installing sump pits and pumps to remove surface water or precipitation that accumulates in the trench bottom. Spoil piles should be kept at least 8 to 10 feet back from the top of the excavation.

It should be noted that identification and classification of the individual soil types will require close attention whenever opening new sections of trench. Variations in soil conditions can occur between the widely spaced borings. OSHA regulations state that excavation safety is the responsibility of the contractor. However, a Terracon representative could be present during excavation to help identify and classify the soil layers exposed in trench sideslopes.

Where a stable trench subgrade can be maintained during construction, we anticipate that a Class C, Type 1 granular envelope would be sufficient. However, for PVC pipe, we recommend the granular envelope be extended to at least 12 inches above the top of the pipe.

We recommend that the granular bedding material used beneath, around and above the pipe consist of a well-graded, crushed stone, crushed concrete or sand and gravel with a maximum particle size of ¾ or 1 inch. A well-graded product is recommended to reduce the migration of the soils into the void space of the bedding material. The bedding material should not contain more than 10 percent material finer than the No. 200 sieve, and should be lightly compacted from the surface with vibratory compaction equipment until stable.

We recommend that backfill be placed in shallow, level lifts of 9 inches or less in loose thickness. The fill should be compacted to at least 85 percent of the modified Proctor maximum dry density (ASTM D1557) outside of the building area and to at least 90 percent (ASTM D1557) within the building area. The moisture content of the fill at the time of compaction should be within the range of 3 to 7 percent above the optimum moisture content for compaction. The on-site materials appear to be generally suitable for use as backfill outside of the building area. Low plasticity clayey borrow or chemically modified fill derived from the existing soils, as described in the "Site Preparation and Earthwork" section, should be used within the building area. Granular backfill soils within utility trenches should be limited to pipe bedding within the building area.

Floor Slab Subgrades

Low plasticity cohesive borrow or chemically modified fill, prepared as recommended in the "Site Preparation and Earthwork" section, should be suitable for support of grade-supported floor slabs. A granular capillary moisture barrier or leveling course may be used below the grade-supported floor slabs. If used as a capillary barrier, we recommend that the granular layer be at least 4 inches thick and contain less than 6 percent passing the No. 200 sieve. The clayey subgrade should be firm and moist, but not wet; and the granular base should not contain free water at the time floor concrete is placed. Clayey soils may absorb free water and swell, causing floor slab heave and cracking.

Care should be taken to maintain the prepared condition of the floor subgrades prior to slab construction. Subgrade soils that become saturated, desiccated, or otherwise disturbed should be reworked or replaced prior to granular base and slab concrete placement.

Spread Footing Foundations

With the earthwork completed as recommended in this report, the proposed foundations should bear on at least 3 feet of new compacted and tested fill. Footings bearing in this material may be designed for a maximum net allowable soil bearing pressure of 3,000 pounds per square foot. This is the maximum pressure that should be transmitted to the bearing soils in excess of the minimum surrounding overburden pressure. Isolated column footings should have a width of at least 30 inches and continuous wall footings should have a width of at least 16 inches.

Perimeter footings beneath continuously heated areas of the building should extend at least 4 feet below the lowest adjacent exterior finish grade for frost protection. Footings beneath unheated areas should extend at least 5 ½ feet below the lowest adjacent finished grade. In addition, we recommend that the bottoms of proposed footings not be located higher than a relationship of 2 Horizontal to 1 Vertical (2H:1V) from the edges of the footings to the bottoms of any paralleling or nearly paralleling utility trenches.

Care should be taken to minimize disturbance of the bearing soils. Clayey bearing surfaces should be cleaned of all loose, soft, wetted or otherwise disturbed material prior to placing concrete. Concrete should be placed as soon as practical after excavating.

Maximum total settlements of spread footing foundations designed and constructed on at least 3 feet of new compacted and tested fill are estimated to be less than about 1 inch. Differential settlements could occur due to varying foundation load and support conditions, but are estimated to be less than about 1/2-inch. Larger settlements may occur if poorly compacted existing fill is left below footing bottoms.

Lateral Earth Pressure and Foundation Drains

We recommend that walls supporting unbalanced backfill levels be designed to resist lateral active earth pressures based upon an equivalent fluid weight of backfill of 45 pcf, plus any appropriate surcharge for sloping backfill, floor loads, foundation loads, construction equipment loading, etc. We recommend that surcharge pressures be calculated as 40 percent of the uniform floor load. If foundation walls are restrained at the top to prevent wall rotation and the development of the lower active earth pressure defined above, we recommend that the walls be designed for an at-rest equivalent fluid weight of 55 pcf, plus any appropriate surcharge. These recommended pressures presume the use of compacted backfill and a footing drain system to prevent the buildup of hydrostatic pressures behind the walls. A unit weight of backfill of 125 pcf can be assumed in the design. For sliding resistance, we recommend that an allowable coefficient of friction of 0.25 be used between the bottom of the footing and the bearing material. If additional resistance against sliding is needed, an allowable passive resistance of 180 pcf times the depth below final grade can be used for keyways below footings or for sides of footings below frost depth and constructed neat against a vertical cut in the new compacted and tested fill without forming.

To intercept infiltrating surface water behind below-grade walls, we recommend that perimeter drains be installed at the foundation level. The invert of a drain line around a below-grade building area should be at least eight inches below the finished subgrade elevation on the low side of the wall. The drain line should be sloped to provide positive gravity drainage and should be surrounded by free-draining granular material graded to prevent the intrusion of fines, or an alternative free-draining granular material encapsulated with suitable filter fabric. At least a 2-foot wide section of free-draining granular fill should be used for backfill above the drain line and adjacent to the wall and should extend to within 2 feet of final grade for exterior walls. The granular backfill behind exterior walls should be capped with compacted cohesive fill to reduce infiltration of surface water into the drain system. In our opinion, free-draining granular fill is not necessary behind interior retaining walls. We recommend that foundation walls and interior retaining walls be backfilled with low plasticity cohesive borrow or chemically treated on-site clays.

Parking Canopy Foundation

We anticipate the proposed parking canopy southwest of the proposed building will be supported on either a drilled shaft foundation or a spread footing foundation. A spread footing foundation for the proposed canopy sign could be designed using the same recommendations as presented in the "Spread Footing Foundations" section of this report. However, the recommended allowable net bearing pressures could be increased by $^1/_3$ with respect to total dead loads plus short term wind or seismic loads.

The uplift resistance of a spread footing foundation can be calculated based on the effective weights of the foundations and overlying soils. An effective unit weight of 115 pcf could be used for natural sands, sand fill or clay fill soils, and 150 pcf could be used for concrete.

The soil mass providing uplift resistance should be calculated as the zone contained within planes that extend up and out from the top edges of the foundations to the ground surface at an angle of approximately 30 degrees from vertical. The ultimate uplift capacity should then be taken as the sum of the weight of soil in this zone plus the effective weight of the foundation. The ultimate combined uplift capacity should then be divided by a factor of safety of at least 1½ to obtain the allowable uplift capacity. This uplift capacity assumes that the soil over the foundation is properly compacted and protected from surface water infiltration and erosion.

Soil strength parameters for use in design of a drilled shaft foundation for support of the proposed pole sign were evaluated from the subsurface exploration information and laboratory test results. Based on the information obtained, the following parameters are recommended for design of the sign foundation.

Depth (feet)	Allowable Compressive Skin Friction (psf) FS=2	Allowable End Bearing Pressure (psf) FS=3
0 – 5 ½	---	---
5 ½ – 25	500	4,500

The allowable compressive capacity of the drilled shaft can be calculated by multiplying the embedded surface area of the shaft by the allowable skin friction and by adding the end-bearing capacity (shaft end area times the allowable bearing value). The upper 5 ½ feet below the ground surface should be neglected in the skin friction calculation due to frost effects.

Uplift capacity may be calculated using 75 percent of the recommended compressive skin friction values. Lateral capacity of drilled piers could be calculated using an equivalent fluid pressure of 350 pcf applied to the projected area of the pier. This value is anticipated to have a factor of safety of at least 2. The lateral resistance should be neglected to a depth of about 5½ feet below final grade due to frost action.

The allowable compressive skin friction and end bearing values provided above contain factors of safety of about 2 and 3, respectively. A Terracon representative should log the stratigraphy in the shaft to confirm that the subsurface soils are similar to those encountered in the borings and are capable of carrying the anticipated loads.

End bearing should be neglected unless a clean-out bucket is used to remove loose and disturbed soil from the bottom of the pier excavation. Concrete should be placed in the shaft the same day as excavation. If this is not possible, the shaft should be redrilled using a larger diameter auger and cleaned prior to placing concrete.

Conventional heavy-duty excavating equipment should be able to excavate the soils and weathered shale encountered in the test borings. Methods and equipment used for drilled shaft installation should leave the side and bottom of the shaft free of loose and disturbed material that would prevent the concrete from contacting undisturbed soil.

We recommend the drilled shaft foundation be designed with a minimum shaft diameter of 30 inches to facilitate cleaning of the bottom of the excavation. Based on the soils encountered in the borings near the canopy area, the use of slurry drilling techniques or temporary casing does not appear necessary. However, casing and other appropriate safety measures should be utilized if personnel is required to enter the excavation. Care should be taken so that the sides and bottom of the shaft excavation are not disturbed during construction. The bottom of the shaft should be free of loose soil before placing reinforcing steel and concrete.

A concrete slump of at least 6 inches is recommended to facilitate concrete placement. Concrete should be directed through the center of the reinforcing cage with special care taken to avoid contact with the reinforcing steel or the sides of the drilled shaft. Quality control personnel should record pertinent information as to diameters, length, location, plumbness, eccentricity, and other installation data.

A pier cap, if used, should extend at least 5 ½ feet below final grade for frost protection. If more than one shaft is used, group effects can be neglected and the total capacity of the group taken as a sum of the individual shaft capacities if adjacent shafts are separated by at least 3 shaft diameters (center-to-center). For a drilled shaft designed and constructed as recommended, total estimated settlements and lateral movements should not exceed about ½-inch.

Pavement Subgrades

All pavements should be supported on at least 9 inches of properly compacted subgrade or structural fill. This can be accomplished by filling or scarifying and recompacting. The upper 9 inches of clayey pavement subgrade fill should be compacted to at least 90 percent of the material's modified Proctor maximum dry density (ASTM D1557) at a water content within the range of 3 to 7 percent above the optimum moisture content for compaction. Clayey fill placed below this level should be compacted to at least 85 percent of the modified Proctor (ASTM D1557).

After the subgrade has been prepared, we recommend that the subgrade be proofrolled with a loaded tandem-axle dump truck. If any soft or yielding soils are detected, the soils should be scarified and recompacted or undercut and replaced with compacted and tested material. We recommend that the pavement be placed as soon as possible after subgrade compaction and proofrolling.

As an option, the clayey pavement subgrades can also be chemically treated to reduce the soil plasticity and affinity for water, thereby increasing stability and reducing the long-term, deteriorating effects of water. Following the proofroll and any undercutting and replacement, the upper 9 inches to 1 foot of the subgrade can be disked or milled, treated and recompacted.

Care should be taken to maintain the compacted condition of the subgrade soils prior to paving. Soils that become frozen, saturated, or otherwise disturbed should be removed or reworked prior to pavement construction. Utility trench and curb backfill placed beneath and beside pavements should be checked for proper compaction. Proper compaction of utility trench backfill is critical for the long-term performance of the pavements.

The clay soils at this site could be susceptible to pumping and frost heave if the soils become saturated. Shallow groundwater conditions are not anticipated. However, a granular base would allow infiltrating surface water to migrate and pond beneath the pavements. For this reason, we recommended that full-depth asphalt or Portland cement concrete pavement supported directly on compacted soil subgrades be considered for this project. A properly designed subdrain system with a sloping subgrade should be provided if a granular base is used.

Pavement Design

A CBR test result of 3.1 was determined for a composite sample of the clayey fill remolded to about 90 percent of the modified Proctor maximum dry density (ASTM D1557). The sample was compacted at a moisture content of about 14.0 percent.

We recommend that a CBR value of about 3 be used for design of asphaltic cement concrete pavement sections constructed on subgrades prepared as recommended in the "Pavement Subgrade" section of this report. A modulus of subgrade reaction (k) value of about 100 pci is estimated for design of Portland cement concrete pavement sections.

In parking lots subjected to light vehicle loads and low volumes, a full-depth asphaltic cement concrete section having a minimum total thickness of 5½ inches, or a Portland cement concrete pavement section having a minimum thickness of 5 inches, are typical. Driveway areas receiving higher traffic volumes and occasional light truck traffic require increased pavement thicknesses. A minimum 7-inch thick asphaltic concrete section or a minimum 6-inch thick Portland cement concrete section are typical in these areas. A minimum 7-inch thick Portland cement concrete section is recommended in truck loading/unloading areas, refuse pick-up areas, and other areas of heavy or concentrated loads.

The following asphaltic concrete mix design characteristics would be considered generally appropriate for this project.

	Marshall Stability, lbs.	Marshall Flow	Residual Air Voids, %	Voids In Mineral Aggregate, %	Minimum Field Compaction, %
Surface Course	1800	8-12	3-5	minimum 14	96
Base Course	1500	8-14	4-6	minimum 14	94

We recommend that high-grade asphalt cement be utilized within parking lot areas to support slow moving traffic and static load conditions. Higher grade asphalt cements are available that are less susceptible to rutting and creep under vehicle loads during warm periods.

Minimum surface course thicknesses of 2 inches in automobile areas and 3 inches in truck areas are recommended for asphaltic cement concrete pavement sections.

A Portland cement concrete mix design with a minimum modulus of rupture of 550 psi should be used for concrete pavements. This is roughly equivalent to a 28-day compressive strength of 4,000 psi. In addition, Portland cement concrete pavement should contain about 5 to 7 percent entrained air, and should have a maximum water to cement ratio of about 0.45.

A formal pavement design has not been completed for this project. The above recommended pavement sections are typical minimum values and thicker pavement sections could be used to reduce maintenance and extend the expected service life of the pavements. Periodic maintenance will also extend the service life of the pavements and should include patching and repair of deteriorated areas, crack sealing, and surface sealing. We recommend that a formal pavement design be completed if unusually high vehicle loads or frequencies are anticipated.

Minimizing subgrade saturation is an important factor in maintaining the subgrade strength. Water allowed to pond on or next to pavements could saturate the subgrade and cause premature pavement deterioration. Positive surface drainage should be provided away from the edges of paved areas, and all pavements should be sloped to provide rapid surface drainage. Additional measures that would reduce the risk of subgrade saturation would include crowning of pavement subgrades to drain toward the edges rather than the center, and installing perimeter subsurface drains next to irrigated planters or other areas where surface water could pond. Experience has shown that a properly designed pavement subdrain system can significantly increase the service life of a pavement.

Site Grading Considerations

Construction staging should provide drainage of surface water and precipitation away from the proposed building. Poor site drainage and ponding of surface water can increase the potential for frost heave or swell of foundation soils. We recommend that final grades for seeded and landscaped areas be sloped at least 5 percent within 15 feet around the buildings to provide positive drainage away from the foundations. Using cohesive backfill compacted to at least 85 percent of the modified Proctor maximum dry density adjacent to the building foundations would also help reduce surface water infiltration.

Roof drains should be extended so as not to discharge in lawn areas within 5 to 10 feet of the building. Excessive irrigation of landscaping vegetation should also be avoided near the building. The consequences of overuse, and leaking, of automated watering systems should be communicated to owners and/or maintenance personnel. Any utility leaks should be promptly repaired.

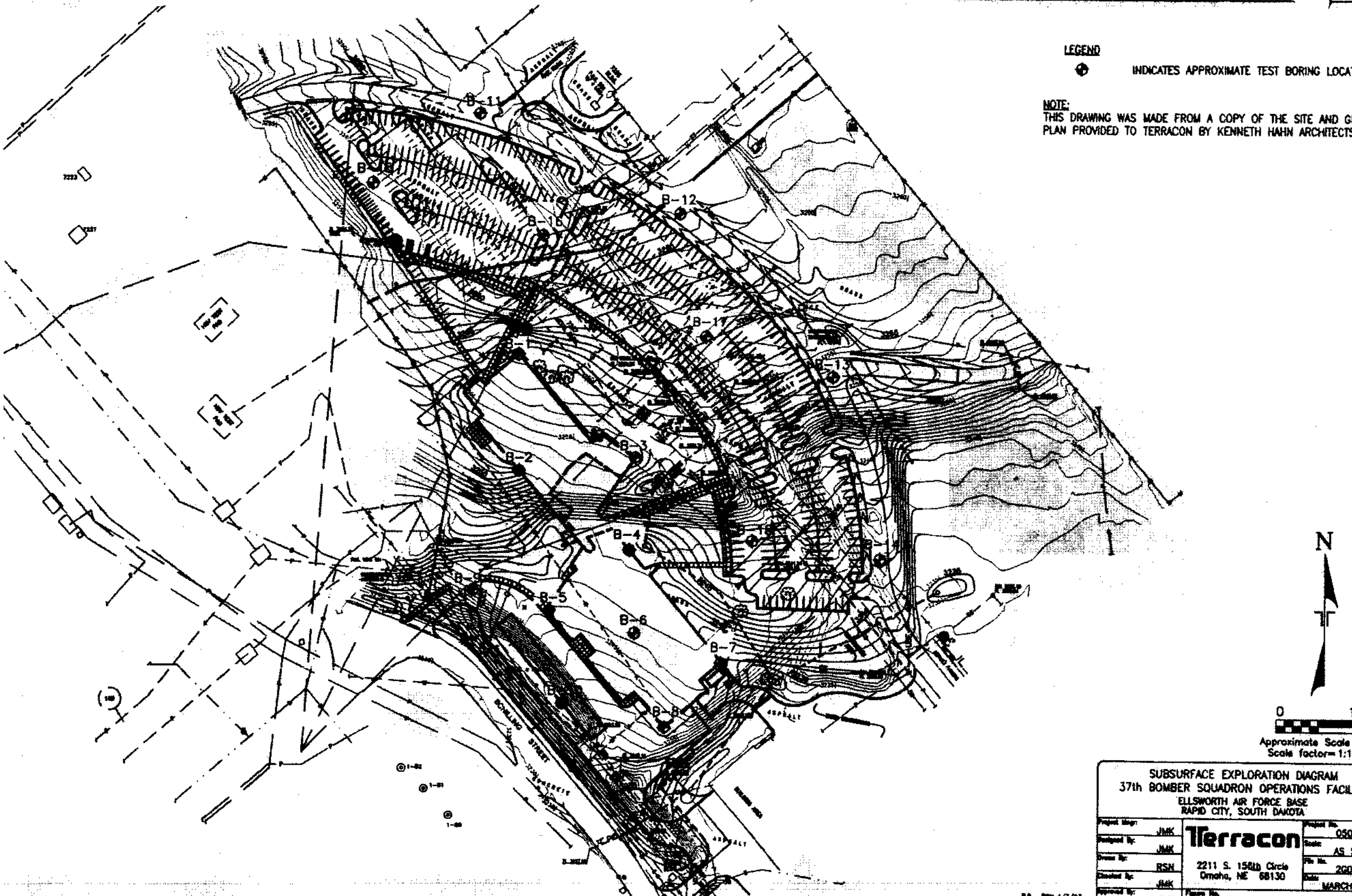
GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon should also be retained to provide testing and observation during excavation, grading, foundation and construction phases of the project.

The conclusions and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of biological pollutants or conditions. A limited environmental assessment was completed for VOC's and TEH's at the test boring locations. If the owner is concerned about additional contamination beyond that identified through Terracon's limited environmental assessment, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.



LEGEND

⊕ INDICATES APPROXIMATE TEST BORING LOCATION

NOTE:
THIS DRAWING WAS MADE FROM A COPY OF THE SITE AND GRADING PLAN PROVIDED TO TERRACON BY KENNETH HAHN ARCHITECTS, INC.

SUBSURFACE EXPLORATION DIAGRAM
37th BOMBER SQUADRON OPERATIONS FACILITY
ELLSWORTH AIR FORCE BASE
RAPID CITY, SOUTH DAKOTA

Project Mngr:	JMK	Terracon	Project No.	05035024
Designed By:	JMK		Scale:	AS SHOWN
Drawn By:	RSN	2211 S. 156th Circle	File No.	2G024802
Checked By:	JMK	Omaha, NE 68130	Date:	MARCH 2003
Approved By:	JMK	Figure No.		1

GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

SS : Split Spoon - 1⅜" I.D., 2" O.D., unless otherwise noted
ST : Thin-Walled Tube - 3" O.D., Unless otherwise noted
PA : Power Auger
HA : Hand Auger
DB : Diamond Bit - 4", N, B
AS : Auger Sample
HS : Hollow Stem Auger
PS : Piston Sample
WS : Wash Sample
FT : Fish Tail Bit
RB : Rock Bit
BS : Bulk Sample
PM : Pressuremeter
DC : Dutch Cone
WB : Wash Bore

Standard "N" Penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2 inch OD split spoon, except where noted.

WATER LEVEL MEASUREMENT SYMBOLS:

WL : Water Level
WCI : Wet Cave In
DCI : Dry Cave In
AB : After Boring
WS : While Sampling
WD : While Drilling
BCR : Before Casing Removal
ACR : After Casing Removal

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of ground water levels is not possible with only short term observations.

DESCRIPTIVE SOIL CLASSIFICATION:

Soil Classification is based on the Unified Soil Classification System and ASTM Designations D-2487 and D-2488. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; they are described as: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are described as: clays, if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse grained soils are defined on the basis of their relative in-place density and fine grained soils on the basis of their consistency. Example: Lean clay with sand, trace gravel, stiff (CL); silty sand, trace gravel, medium dense (SM).

CONSISTENCY OF FINE-GRAINED SOILS:

Unconfined Compressive Strength, Qu, psf	Consistency
< 500	Very Soft
500 - 1,000	Soft
1,001 - 2,000	Medium
2,001 - 4,000	Stiff
4,001 - 8,000	Very Stiff
8,001 -16,000	Hard
> -16,000	Very Hard

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) (of Components Also Present in Sample)	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) (of Components Also Present in Sample)	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

RELATIVE DENSITY OF COARSE-GRAINED SOILS:

N-Blows/ft.	Relative Density
0-3	Very Loose
4-9	Loose
10-29	Medium Dense
30-49	Dense
50-80	Very Dense
80+	Extremely Dense

GRAIN SIZE TERMINOLOGY

Major Component Of Sample	Size Range
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm)
Silt or Clay	Passing #200 sieve (0.075mm)

GENERAL NOTES

Sedimentary Rock Classification

DESCRIPTIVE ROCK CLASSIFICATION:

Sedimentary rocks are composed of cemented clay, silt and sand sized particles. The most common minerals are clay, quartz and calcite. Rock composed primarily of calcite is called limestone; rock of sand size grains is called sandstone, and rock of clay and silt size grains is called mudstone or claystone, siltstone, or shale. Modifiers such as shaly, sandy, dolomitic, calcareous, carbonaceous, etc. are used to describe various constituents. Examples: sandy shale; calcareous sandstone.

LIMESTONE	Light to dark colored, crystalline to fine-grained texture, composed of $CaCo_3$, reacts readily with HCl.
DOLOMITE	Light to dark colored, crystalline to fine-grained texture, composed of $CaMg(CO_3)_2$, harder than limestone, reacts with HCl when powdered.
CHERT	Light to dark colored, very fine-grained texture, composed of micro-crystalline quartz (SiO_2), brittle, breaks into angular fragments, will scratch glass.
SHALE	Very fine-grained texture, composed of consolidated silt or clay, bedded in thin layers. The unlaminated equivalent is frequently referred to as siltstone, claystone or mudstone.
SANDSTONE	Usually light colored, coarse to fine texture, composed of cemented sand size grains of quartz, feldspar, etc. Cement usually is silica but may be such minerals as calcite, iron-oxide, or some other carbonate.
CONGLOMERATE	Rounded rock fragments of variable mineralogy varying in size from near sand to boulder size but usually pebble to cobble size (½ inch to 6 inches). Cemented together with various cementing agents. Breccia is similar but composed of angular, fractured rock particles cemented together.

PHYSICAL PROPERTIES:

DEGREE OF WEATHERING

Slight	Slight decomposition of parent material on joints. May be color change.
Moderate	Some decomposition and color change throughout.
High	Rock highly decomposed, may be extremely broken.

HARDNESS AND DEGREE OF CEMENTATION

Limestone and Dolomite:

Hard	Difficult to scratch with knife.
Moderately Hard	Can be scratched easily with knife, cannot be scratched with fingernail.
Soft	Can be scratched with fingernail.

Shale, Siltstone and Claystone

Hard	Can be scratched easily with knife, cannot be scratched with fingernail.
Moderately Hard	Can be scratched with fingernail.
Soft	Can be easily dented but not molded with fingers.

Sandstone and Conglomerate

Well Cemented	Capable of scratching a knife blade.
Cemented	Can be scratched with knife.
Poorly Cemented	Can be broken apart easily with fingers.

BEDDING AND JOINT CHARACTERISTICS

Bed Thickness	Joint Spacing	Dimensions
Very Thick	Very Wide	>10′
Thick	Wide	3′ - 10′
Medium	Moderately Close	1′ - 3′
Thin	Close	2″ - 1′
Very Thin	Very Close	.4″ - 2″
Laminated	—	.1″ - .4″

Bedding Plane	A plane dividing sedimentary rocks of the same or different lithology.
Joint	Fracture in rock, generally more or less vertical or transverse to bedding, along which no appreciable movement has occurred.
Seam	Generally applies to bedding plane with an unspecified degree of weathering.

SOLUTION AND VOID CONDITIONS

Solid	Contains no voids.
Vuggy (Pitted)	Rock having small solution pits or cavities up to ½ inch diameter, frequently with a mineral lining.
Porous	Containing numerous voids, pores, or other openings, which may or may not interconnect.
Cavernous	Containing cavities or caverns, sometimes quite large.

Terracon

LOG OF BORING NO. 1

CLIENT: Kenneth Hahn Architects, Inc.	ARCHITECT: Kenneth Hahn Architects, Inc.
SITE: Ellsworth Air Force Base, Box Elder, South Dakota	PROJECT: 37th Bomber Squadron Operations Facility

Reported Surface Elev.: 3259.4 ft

Depth (strata), ft	DESCRIPTION	Elev., ft	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	TYPE	RECOVERY, in.	SPT - N ** BLOWS / ft.	TESTS: WATER CONTENT, %	DRY UNIT WT pcf	UNCONFINED STRENGTH, psf	ATTERBERG LIMITS TEST RESULTS, %
	Grass and thin root zone at surface					PA						
3.5	**(FILL) LEAN CLAY** with sand and calcium deposits Brown	3256			1	ST	7		16	112	6500*	
						PA						
4	**(FILL) LEAN CLAY** with sand Brown	3255.5		GW	2	SS	6 6	29	14		9000+*	
			5			PA						
6	**GRAVEL** with sand Brown, medium dense	3253.5		GW CH	3	SS	6 6	12	9			
						PA						
13	**SANDY FAT CLAY** Brown Very stiff	3246.5		CH	4	SS	12	10	19		7500*	LL=54 PL=14 PI=40
			10			PA						
18	**FAT CLAY** with sand Brown Very stiff	3241.5		CH	5	ST	12		22	100	5000*	LL=52 PL=14 PI=38
			15			PA						
23.5	**CLAYEY FINE TO MEDIUM SAND** Brown	3236		SC	6	ST	4		20	102	3000*	
			20			PA						
28.5	**MEDIUM TO COARSE SAND AND GRAVEL** with sandy lean clay layers Brown Medium dense	3231		SP	7	SS	12	29	8		9000+*	
			25			PA						
30	**WEATHERED SHALE** Olive-brown, soft	3229.5		CL	8	SS	12	26	32		8000*	
	BOTTOM OF BORING		30									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft			
WL	None	WD	None AB
WL			
WL			

Terracon

BORING STARTED	3-30-03		
BORING COMPLETED	3-30-03		
RIG	CME 550	FOREMAN	PG
APPROVED	JMK	JOB #	05035024

BOREHOLE 05035024.GPJ TERRACON.GDT 4/29/03

LOG OF BORING NO. 2

CLIENT	ARCHITECT
Kenneth Hahn Architects, Inc.	Kenneth Hahn Architects, Inc.
SITE: Ellsworth Air Force Base, Box Elder, South Dakota	PROJECT: 37th Bomber Squadron Operations Facility

Depth (ft)	DESCRIPTION (Reported Surface Elev.: 3251.8 ft)	Elev. (ft)	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N ** BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT pcf	TESTS: UNCONFINED STRENGTH, psf	TESTS: ATTERBERG LIMITS TEST RESULTS, %
	Grass and thin root zone at surface				PA						
	(FILL) LEAN CLAY with hairlike roots Dark brown			1	ST	9		17	107	4000*	
3.5		3248.5			PA						
	(FILL) FAT CLAY with calcium deposits, trace fine sand Brown			2	SS	12	19	12		9000+*	
				3	ST	6		18	108	9000+*	LL=52 PL=15 PI=37
					PA						
9		3243	CL	4	SS	6 6	18	17		9000+*	
	LEAN CLAY with sand Brown Very stiff				PA						
13.5		3238.5									
	LEAN CLAY with sand Brown and gray Very stiff		CL	5	SS	12	45	19		8500*	
					PA						
18.5		3233.5									
	WEATHERED SHALE Olive-brown Soft		CL	6	SS	18	17	19		8500*	
					PA						
			CL	7	SS	18	22	30		9000+*	
					PA						
	Olive-brown and dark gray below 28.5'		CL	8	SS	18	28	27		9000+*	
30	BOTTOM OF BORING	3222									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft			
WL	None	WD	None AB
WL			
WL			

Terracon

BORING STARTED	3-29-03
BORING COMPLETED	3-29-03
RIG	CME 550
FOREMAN	PG
APPROVED	JMK
JOB #	05035024

LOG OF BORING NO. 3

CLIENT	ARCHITECT
Kenneth Hahn Architects, Inc.	Kenneth Hahn Architects, Inc.
SITE: Ellsworth Air Force Base, Box Elder, South Dakota	PROJECT: 37th Bomber Squadron Operations Facility

Reported Surface Elev.: 3255.2 ft

Depth (ft)	Elev. (ft)	DESCRIPTION	USCS SYMBOL	SAMPLE NUMBER	TYPE	RECOVERY, in.	SPT - N ** BLOWS / ft.	WATER CONTENT, %	DRY UNIT WT pcf	UNCONFINED STRENGTH, psf	ATTERBERG LIMITS TEST RESULTS, %
		Grass and thin root zone at surface			PA						
		(FILL) SANDY LEAN CLAY with gravel, Brown		1	ST	5		11	113	9000+*	
3.5	3251.5				PA						
		(FILL) LEAN CLAY with sand, Brown		2	SS	12	19	11		9000+*	
5.5	3249.5				PA						
		FAT CLAY with fine to medium sand, Brown, Very stiff	CH	3	SS	12	12	13		9000+*	
					PA						
			CH	4	SS	12	15	18		9000+*	LL=59 PL=16 PI=43
					PA						
12.5	3242.5										
		GRAVEL with sand, Brown									
14	3241		GW	5	SS	12	24	14		9000+*	
		LEAN CLAY with sand and gravel, Brown and brown-gray, very stiff	CL		PA						
16	3239										
		SILTY SAND AND GRAVEL, Brown, Very dense	SM	6	SS	12	52	4			
20	3235				PA						
		WEATHERED SHALE, Olive-brown and dark gray, Soft	CL	7	SS	18	24	32		6500*	
					PA						
			CL	8	SS	18	26	35		7000*	
					PA						

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft			
WL	None	WD None	AB
WL			
WL			

BORING STARTED	3-29-03
BORING COMPLETED	3-29-03
RIG: CME 550	FOREMAN: PG
APPROVED: JMK	JOB #: 05035024

Terracon

LOG OF BORING NO. 3

CLIENT	ARCHITECT
Kenneth Hahn Architects, Inc.	Kenneth Hahn Architects, Inc.
SITE: Ellsworth Air Force Base, Box Elder, South Dakota	PROJECT: 37th Bomber Squadron Operations Facility

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N ** BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT pcf	TESTS: UNCONFINED STRENGTH, psf	TESTS: ATTERBERG LIMITS TEST RESULTS, %
	WEATHERED SHALE Olive-brown and dark gray Soft		CL	9	SS	18	23	31		9000+*	
35	3220	35									
	BOTTOM OF BORING										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None	WD ▼ None	AB
WL	▽	▼	
WL			

Terracon

BORING STARTED			3-29-03
BORING COMPLETED			3-29-03
RIG	CME 550	FOREMAN	PG
APPROVED	JMK	JOB #	05035024

BOREHOLE 05035024.GPJ TERRACON.GDT 4/29/03

LOG OF BORING NO. 4

CLIENT: Kenneth Hahn Architects, Inc.	ARCHITECT: Kenneth Hahn Architects, Inc.
SITE: Ellsworth Air Force Base, Box Elder, South Dakota	PROJECT: 37th Bomber Squadron Operations Facility

Reported Surface Elev.: 3243.3 ft

Graphic Log	Depth, ft.	Description	Elev.
Fill	0–3.5	Grass and thin root zone at surface **(FILL) LEAN TO FAT CLAY** with sand Brown	3240
Fill	3.5–8.5	**(FILL) SANDY LEAN CLAY** with calcium deposits Brown Gravel layer at 6'	3235
Fat clay	8.5–13.5	**FAT CLAY** with shale fragments (possible fill) Olive-brown Very stiff	3230
Shale	13.5–30	**WEATHERED SHALE** Olive-brown Soft	3213.5
	30	BOTTOM OF BORING	

USCS Symbol	Samples: Number	Type	Recovery, in.	SPT - N** Blows / ft.	Tests: Water Content, %	Dry Unit Wt pcf	Unconfined Strength, psf	Atterberg Limits Test Results, %
		PA						
	1	ST	11		18	105	4000*	
		PA						
	2	SS	12	16	13		9000+*	
		PA						
	3	SS	12	30	15		9000+*	
		PA						
CH	4	SS	12	13	24		8000*	LL=78 PL=19 PI=59
		PA						
CL	5	SS	18	19	30		4500*	
		PA						
CL	6	SS	18	34	31		8500*	
		PA						
CL	7	SS	18	28	28		9000+*	
		PA						
CL	8	SS	18	29	30		9000+*	

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft		
WL	None WD	None AB
WL	28 24 hr AB	
WL		

Terracon

BORING STARTED	3-29-03		
BORING COMPLETED	3-29-03		
RIG	CME 550	FOREMAN	PG
APPROVED	JMK	JOB #	05035024

BOREHOLE 05035024.GPJ TERRACON.GDT 4/29/03

LOG OF BORING NO. 5

CLIENT: Kenneth Hahn Architects, Inc.

ARCHITECT: Kenneth Hahn Architects, Inc.

SITE: Ellsworth Air Force Base, Box Elder, South Dakota

PROJECT: 37th Bomber Squadron Operations Facility

GRAPHIC LOG	DESCRIPTION (Reported Surface Elev.: 3240.8 ft)	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N ** BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT pcf	TESTS: UNCONFINED STRENGTH, psf	TESTS: ATTERBERG LIMITS TEST RESULTS, %
	Grass and thin root zone at surface **(FILL) LEAN TO FAT CLAY** with fine sand and calcium deposits Brown				PA						
				1	ST	10		13	114	9000+*	
				2	ST	10		12	114	9000+*	LL=50 PL=16 PI=34
					PA						
		5		3	ST	6		14	110	9000+*	
					PA						
	8 — 3233										
	SANDY LEAN CLAY Brown Very stiff		CL	4	ST	9		14	103	9000+*	
		10			PA						
	13 — 3228										
	LEAN CLAY, trace fine sand Brown Very stiff to hard		CL	5	ST	9		16	103	9000+*	
		15			PA						
	18 — 3223										
	LEAN CLAY with fine sand Brown Very stiff		CL	6	ST	8		17	109	9000+*	
		20			PA						
	Sandy silt layers below 23'		CL	7	ST	6		19	108	3500*	
		25			PA						
	28.5 — 3212.5										
	SILTY SAND AND GRAVEL Brown, dense		SM	8	SS	12	39	3			
	30 — 3211 BOTTOM OF BORING	30									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None	WD	▼ None AB
WL	▽		▼
WL			

Terracon

BORING STARTED	3-28-03
BORING COMPLETED	3-28-03
RIG CME 550	FOREMAN PG
APPROVED JMK	JOB # 05035024

BOREHOLE 05035024.GPJ TERRACON.GDT 4/29/03

LOG OF BORING NO. 6

CLIENT	ARCHITECT
Kenneth Hahn Architects, Inc.	Kenneth Hahn Architects, Inc.
SITE: Ellsworth Air Force Base, Box Elder, South Dakota	PROJECT: 37th Bomber Squadron Operations Facility

Depth / Elev.	DESCRIPTION (Reported Surface Elev.: 3241.6 ft)	DEPTH, ft.	USCS SYMBOL	NUMBER	TYPE	RECOVERY, in.	SPT - N** BLOWS / ft.	WATER CONTENT, %	DRY UNIT WT pcf	UNCONFINED STRENGTH, psf
	Grass and thin root zone at surface				HS					
	(FILL) LEAN CLAY with fine sand, trace calcium deposits			1	ST	4		19	108	7000*
3 / 3238.5	Dark brown				HS					
	(FILL) LEAN CLAY with fine sand			2	ST	9		13	112	9000+*
	Dark brown	5		3	SS	12	11	14		9000+*
8.5 / 3233					HS					
	(FILL) LEAN CLAY with fine sand, trace calcium deposits			4	SS	12	20	17		9000+*
13.5 / 3228	Brown	10			HS					
	(FILL) LEAN CLAY with sand			5	SS	12	16	14		
	Brown and dark brown	15			HS					
				6	SS	12	12	16		9000+*
23.5 / 3218		20			HS					
	(FILL) LEAN CLAY, trace fine sand			7	SS	12	14	18		3500*
28.5 / 3213	Brown and dark brown	25			HS					
	FINE TO MEDIUM SAND with gravel, trace cobbles		SP	8	SS	6	66/6"	4		
	Brown Extremely dense	30			HS					

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft			
WL	∇ None	WD ▼ None	AB
WL	∇	▼	
WL			

Terracon

BORING STARTED	3-29-03
BORING COMPLETED	3-29-03
RIG CME 550	FOREMAN PG
APPROVED JMK	JOB # 05035024

LOG OF BORING NO. 6

CLIENT	ARCHITECT
Kenneth Hahn Architects, Inc.	Kenneth Hahn Architects, Inc.
SITE: Ellsworth Air Force Base, Box Elder, South Dakota	PROJECT: 37th Bomber Squadron Operations Facility

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	TYPE	RECOVERY, in.	SPT - N ** BLOWS / ft.	TESTS: WATER CONTENT, %	DRY UNIT WT pcf	UNCONFINED STRENGTH, psf
	33.5 — 3208									
	FINE TO MEDIUM SAND with gravel, trace cobbles Brown, very dense		SP	9	SS	12	56	2		
	35 — 3206.5	35								
	BOTTOM OF BORING Auger refusal between 35' and 40'									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft				
WL	None	WD	None	AB
WL				
WL				

Terracon

BORING STARTED	3-29-03		
BORING COMPLETED	3-29-03		
RIG	CME 550	FOREMAN	PG
APPROVED	JMK	JOB #	05035024

BOREHOLE 05035024.GPJ TERRACON.GDT 4/29/03

LOG OF BORING NO. 7

CLIENT: Kenneth Hahn Architects, Inc.

ARCHITECT: Kenneth Hahn Architects, Inc.

SITE: Ellsworth Air Force Base, Box Elder, South Dakota

PROJECT: 37th Bomber Squadron Operations Facility

Graphic Log / Depth	Description (Reported Surface Elev.: 3241.7 ft)	Elev.	Depth, ft.	USCS Symbol	Samples: Number	Type	Recovery, in.	SPT - N ** Blows / ft.	Tests: Water Content, %	Dry Unit Wt pcf	Unconfined Strength, psf
	Grass and thin root zone at surface **(FILL) LEAN CLAY** with fine sand, Dark brown					PA					
					1	ST	12		13	108	9000+*
	Brown and dark brown below 3'				2	ST	5		11	112	9000+*
			5			PA					
	With sand and fine gravel below 5.5'				3	SS	12	18	13		9000+*
						PA					
					4	SS	12	12	14		9000+*
			10			PA					
	With fine to medium sand below 13.5'				5	SS	12	21	12		9000+*
			15			PA					
18.5		3223									
	SANDY LEAN CLAY, Brown, Very stiff			CL	6	SS	18	21	14		9000+*
			20			PA					
23.5		3218									
	MEDIUM TO COARSE SAND AND FINE GRAVEL with sandy lean clay layers, Brown, Dense			SP	7	SS	12	38	7		9000+*
			25			PA					
28.5		3213									
	HIGHLY WEATHERED SHALE, Olive-brown, soft			CL	8	SS	18	25	16		7500*
30	BOTTOM OF BORING	3211.5	30								

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None	WD ▼ None	AB
WL	▽	▼	
WL			

Terracon

BORING STARTED	3-30-03		
BORING COMPLETED	3-30-03		
RIG	CME 550	FOREMAN	PG
APPROVED	JMK	JOB #	05035024

LOG OF BORING NO. 8

CLIENT Kenneth Hahn Architects, Inc.	ARCHITECT Kenneth Hahn Architects, Inc.
SITE Ellsworth Air Force Base, Box Elder, South Dakota	PROJECT 37th Bomber Squadron Operations Facility

GRAPHIC LOG	DESCRIPTION (Reported Surface Elev.: 3236.9 ft)	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	TYPE	RECOVERY, in.	SPT - N ** BLOWS / ft.	TESTS: WATER CONTENT, %	DRY UNIT WT pcf	UNCONFINED STRENGTH, psf	ATTERBERG LIMITS TEST RESULTS, %
	Bare soil exposed at surface **(FILL) LEAN CLAY** with fine to coarse sand and fine gravel Dark brown				PA						
				1	ST	8		15	115	9000+*	
				2	ST	11		15	105	9000+*	
		5		3	ST	9		14	99	9000+*	LL=48 PL=16 PI=32
					PA						
8.5	3228.5										
	LEAN CLAY with fine sand Brown Very stiff to hard		CL	4	SS	12	46	16		9000+*	
		10			PA						
	Very stiff below 13.5'		CL	5	SS	18	16	16		9000+*	
		15			PA						
	With fine to medium sand below 18.5'		CL	6	SS	18	18	16		8500*	
		20			PA						
			CL	7	SS	18	19	17		7500*	
25	3212	25									
	BOTTOM OF BORING										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft			
WL	∇ None	WD ▼ None	AB
WL	∇	▼	
WL			

Terracon

BORING STARTED	3-29-03
BORING COMPLETED	3-29-03
RIG CME 550	FOREMAN PG
APPROVED JMK	JOB # 05035024

BOREHOLE 05035024.GPJ TERRACON.GDT 4/29/03

LOG OF BORING NO. 9

CLIENT: Kenneth Hahn Architects, Inc.	ARCHITECT: Kenneth Hahn Architects, Inc.
SITE: Ellsworth Air Force Base, Box Elder, South Dakota	PROJECT: 37th Bomber Squadron Operations Facility

Reported Surface Elev.: 3239.0 ft

Depth (layer bottom)	Description	Elev.	USCS Symbol	Sample Number	Type	Recovery, in.	SPT - N ** Blows / ft.	Water Content, %	Dry Unit Wt pcf	Unconfined Strength, psf
	Grass and thin root zone at surface				PA					
3	**(FILL) FAT CLAY** with fine to coarse sand Brown and dark brown	3236		1	ST	6		22	106	4000*
5	**(FILL) LEAN CLAY** with fine sand Dark brown	3234		2	ST	10		13	105	9000+*
8	**SANDY LEAN CLAY** (possible fill) Dark brown, very stiff to hard	3231	CL	3	ST	10		15	100	9000+*
					PA					
10	**LEAN TO FAT CLAY**, trace sand Brown, very stiff	3229	CL CH	4	ST	10		18	107	9000+*
	BOTTOM OF BORING									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft			
WL	None	WD	None AB
WL			
WL			

Terracon

BORING STARTED	3-28-03
BORING COMPLETED	3-28-03
RIG CME 550	FOREMAN PG
APPROVED JMK	JOB # 05035024

LOG OF BORING NO. 10

CLIENT: Kenneth Hahn Architects, Inc.	ARCHITECT: Kenneth Hahn Architects, Inc.
SITE: Ellsworth Air Force Base, Box Elder, South Dakota	PROJECT: 37th Bomber Squadron Operations Facility

GRAPHIC LOG	DESCRIPTION (Reported Surface Elev.: 3225.0 ft)	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	TYPE	RECOVERY, in.	SPT - N ** BLOWS / ft.	TESTS: WATER CONTENT, %	DRY UNIT WT pcf	UNCONFINED STRENGTH, psf
Fill	Grass and thin root zone at surface **(FILL) LEAN TO FAT CLAY**, trace sand and fine gravel Brown and dark brown				PA					
				1	ST	5		25	95	2000*
				2	ST	8		24	101	2500*
	5 — 3220	5								
CL	**LEAN CLAY**, trace sand Brown Stiff		CL	3	ST	8		23	101	8000*
					PA					
			CL	4	ST	11		25	100	4500*
		10			PA					
	13 — 3212									
CL	**LEAN CLAY** with fine sand pockets Brown, stiff		CL	5	ST	4		23	98	2500*
	15 — 3210	15								
	BOTTOM OF BORING									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft			
WL	∇ None	WD	▼ None AB
WL	∇		▼
WL			

Terracon

BORING STARTED	3-28-03		
BORING COMPLETED	3-28-03		
RIG	CME 550	FOREMAN	PG
APPROVED	JMK	JOB #	05035024

BOREHOLE 05035024.GPJ TERRACON.GDT 4/29/03

LOG OF BORING NO. 11

CLIENT: Kenneth Hahn Architects, Inc.	ARCHITECT: Kenneth Hahn Architects, Inc.
SITE: Ellsworth Air Force Base, Box Elder, South Dakota	PROJECT: 37th Bomber Squadron Operations Facility

GRAPHIC LOG	DESCRIPTION (Reported Surface Elev.: 3263.9 ft)	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N ** BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT pcf	TESTS: UNCONFINED STRENGTH, psf
	3 inches of ACC pavement at surface				PA					
	(FILL) LEAN CLAY with sand and fine gravel layers			1	SS	12	9	19		9000+*
3	Brown and dark gray — 3261				PA					
	(FILL) LEAN CLAY			2	ST	12		24	92	
5	Brown and dark brown — 3259	5								
	BOTTOM OF BORING									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft				
WL	∇ None	WD	▼ None	AB
WL	▼		▼	
WL				

Terracon

BORING STARTED	3-30-03
BORING COMPLETED	3-30-03
RIG CME 550	FOREMAN PG
APPROVED JMK	JOB # 05035024

BOREHOLE 05035024.GPJ TERRACON.GDT 4/29/03

LOG OF BORING NO. 12

CLIENT	ARCHITECT
Kenneth Hahn Architects, Inc.	Kenneth Hahn Architects, Inc.
SITE: Ellsworth Air Force Base, Box Elder, South Dakota	PROJECT: 37th Bomber Squadron Operations Facility

GRAPHIC LOG	DESCRIPTION (Reported Surface Elev.: 3262.0 ft)	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	TYPE	RECOVERY, in.	SPT - N ** BLOWS / ft.	TESTS: WATER CONTENT, %	DRY UNIT WT pcf	UNCONFINED STRENGTH, psf
	Grass and thin root zone at surface **(FILL) LEAN CLAY** with sand and fine gravel Dark brown				PA					
				1	ST	12		16	101	9000+*
					PA					
				2	SS	12	17	12		9000+*
		5			PA					
	With calcium deposits below 5.5'			3	SS	12	32	12		9000+*
					PA					
	Brown below 8.5'			4	SS	12	20	10		
	10 — 3252	10								
	BOTTOM OF BORING									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft		
WL ▽ None	WD ▼ None	AB
WL ▽	▽	
WL		

Terracon

BORING STARTED	3-30-03
BORING COMPLETED	3-30-03
RIG CME 550	FOREMAN PG
APPROVED JMK	JOB # 05035024

BOREHOLE 05035024.GPJ TERRACON.GDT 4/29/03

LOG OF BORING NO. 13

CLIENT	ARCHITECT
Kenneth Hahn Architects, Inc.	Kenneth Hahn Architects, Inc.
SITE: Ellsworth Air Force Base, Box Elder, South Dakota	PROJECT: 37th Bomber Squadron Operations Facility

Reported Surface Elev.: 3255.5 ft

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N ** BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT pcf	TESTS: UNCONFINED STRENGTH, psf
	Grass and thin root zone at surface **(FILL) LEAN CLAY**, trace fine sand Dark brown				PA					
				1	ST	8		17	98	6500*
				2	ST	5		21	102	6500*
		5		3	ST	10		22	104	8500*
					PA					
	8 — 3247.5									
	(FILL) LEAN TO FAT CLAY Brown			4	ST	5		24	100	4000*
	10 — 3245.5	10								
	BOTTOM OF BORING									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft				
WL	⊻ None	WD	▼ None	AB
WL	⊻		▼	
WL				

Terracon

BORING STARTED	3-30-03		
BORING COMPLETED	3-30-03		
RIG	CME 550	FOREMAN	PG
APPROVED	JMK	JOB #	05035024

LOG OF BORING NO. 14

CLIENT	ARCHITECT
Kenneth Hahn Architects, Inc.	Kenneth Hahn Architects, Inc.
SITE: Ellsworth Air Force Base, Box Elder, South Dakota	PROJECT: 37th Bomber Squadron Operations Facility

GRAPHIC LOG	DESCRIPTION (Reported Surface Elev.: 3236.0 ft)	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	TYPE	RECOVERY, in.	SPT - N ** BLOWS / ft.	TESTS WATER CONTENT, %	DRY UNIT WT pcf	UNCONFINED STRENGTH, psf
	Grass and thin root zone at surface				PA					
	(FILL) LEAN CLAY with sand Brown			1	ST	9		15	102	9000+*
				2	ST	8		26	97	2560 3500*
	With sand and gravel below 5'	5		3	ST	5		19	103	2500*
					PA					
	8.5 — 3227.5									
	LEAN CLAY with sand and fine gravel Brown ∇ Stiff		CL	4	SS	12	19	22		4000*
		10			PA					
	13.5 — 3222.5									
	WEATHERED SHALE Olive-brown, soft		CL	5	SS	18	19	37		
	15 — 3221	15								
	BOTTOM OF BORING									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft		
WL	∇ 10	WS ▼
WL	▼	▼
WL		

Terracon

BORING STARTED	3-30-03
BORING COMPLETED	3-30-03
RIG CME 550	FOREMAN PG
APPROVED JMK	JOB # 05035024

LOG OF BORING NO. 15

CLIENT	ARCHITECT
Kenneth Hahn Architects, Inc.	Kenneth Hahn Architects, Inc.
SITE: Ellsworth Air Force Base, Box Elder, South Dakota	PROJECT: 37th Bomber Squadron Operations Facility

Reported Surface Elev.: 3259.4 ft

DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	TYPE	RECOVERY, in.	SPT - N ** BLOWS / ft.	TESTS: WATER CONTENT, %	DRY UNIT WT pcf	UNCONFINED STRENGTH, psf
5 inches of ACC pavement at surface				PA					
(FILL) FINE TO COARSE SAND with thin lean clay layers Brown			1	SS	12	5	7		
				PA					
3.5 — 3256									
(FILL) LEAN CLAY Brown and dark brown			2	ST			22	107	9000+*
	5		3	ST			30	87	1000*
				PA					
Trace sand below 8'			4	ST	7		20	107	6500*
10 — 3249.5	10								
BOTTOM OF BORING									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft			
WL	None	WD	None AB
WL			
WL			

Terracon

BORING STARTED	3-30-03
BORING COMPLETED	3-30-03
RIG CME 550	FOREMAN PG
APPROVED JMK	JOB # 05035024

LOG OF BORING NO. 16

CLIENT	ARCHITECT
Kenneth Hahn Architects, Inc.	Kenneth Hahn Architects, Inc.
SITE: Ellsworth Air Force Base, Box Elder, South Dakota	PROJECT: 37th Bomber Squadron Operations Facility

GRAPHIC LOG	DESCRIPTION Reported Surface Elev.: 3263.2 ft	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, In.	SAMPLES: SPT - N ** BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT pcf	TESTS: UNCONFINED STRENGTH, psf
	Grass and thin root zone at surface **(FILL) CRUSHED STONE** with lean clay Brown				PA					
				1	ST	1		8	119	9000+*
					PA					
	5 — 3258	5		2	SS	6	15	13		3000*
	BOTTOM OF BORING									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft			BORING STARTED	3-30-03
WL ▽ None	WD ▼ None	AB	BORING COMPLETED	3-30-03
WL ▽	▼		RIG CME 550	FOREMAN PG
WL			APPROVED JMK	JOB # 05035024

Terracon

BOREHOLE 05035024.GPJ TERRACON.GDT 4/29/03

LOG OF BORING NO. 17

CLIENT: **Kenneth Hahn Architects, Inc.**

ARCHITECT: **Kenneth Hahn Architects, Inc.**

SITE: **Ellsworth Air Force Base, Box Elder, South Dakota**

PROJECT: **37th Bomber Squadron Operations Facility**

Reported Surface Elev.: 3257.7 ft

Depth to base, ft	Description	Elev. at base	Sample Number	Type	Recovery, in.	SPT - N ** Blows / ft.	Water Content, %	Dry Unit Wt pcf	Unconfined Strength, psf
3	Grass and thin root zone at surface. **(FILL) LEAN CLAY** with calcium deposits, trace fine sand. Dark brown	3254.5		PA					
			1	ST	11		20	110	8500*
5.5	**(FILL) LEAN CLAY** with fine sand. Dark brown	3252	2	ST	6		13	113	10790
8.5	**(FILL) LEAN CLAY** with sand and fine gravel. Brown	3249		PA					
			3	SS	12	39	7		
				PA					
10	**(FILL) SILTY FINE TO MEDIUM SAND**, trace coarse sand and fine gravel. Brown	3247.5	4	SS	12	19	4		
	BOTTOM OF BORING								

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft			
WL	None	WD	None AB
WL			
WL			

Terracon

BORING STARTED	3-30-03
BORING COMPLETED	3-30-03
RIG CME 550	FOREMAN PG
APPROVED JMK	JOB # 05035024

LOG OF BORING NO. 18

CLIENT	ARCHITECT
Kenneth Hahn Architects, Inc.	Kenneth Hahn Architects, Inc.
SITE: Ellsworth Air Force Base, Box Elder, South Dakota	PROJECT: 37th Bomber Squadron Operations Facility

GRAPHIC LOG	DESCRIPTION (Reported Surface Elev.: 3242.7 ft)	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	TYPE	RECOVERY, in.	SPT - N ** BLOWS / ft.	TESTS: WATER CONTENT, %	DRY UNIT WT pcf	UNCONFINED STRENGTH, psf	ATTERBERG LIMITS TEST RESULTS, %
	Grass and thin root zone at surface				PA						
	(FILL) LEAN CLAY Brown			1	ST	6		24	98	3000*	LL=48 PL=14 PI=34
	4 — 3238.5				PA						
	(FILL) FINE TO COARSE SAND AND GRAVEL with sandy clay layers	5		2	SS	12	30	10			
					PA						
				3	SS	12	45	7		7500*	
	8.5 — 3234				PA						
	HIGHLY WEATHERED SHALE Brown and olive-brown, soft		CL	4	SS	12	14				
	10 — 3232.5	10									
	BOTTOM OF BORING										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME Automatic Hammer

WATER LEVEL OBSERVATIONS, ft			
WL	None	WD	None AB
WL			
WL			

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BORING STARTED	3-28-03
BORING COMPLETED	3-28-03
RIG CME 550	FOREMAN PG
APPROVED JMK	JOB # 05035024

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification: Group Symbol	Soil Classification: Group Name[B]
Coarse Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	Cu ≥ 4 and 1 ≤ Cc ≤ 3[E]	GW	Well-graded gravel[F]
			Cu < 4 and/or 1 > Cc > 3[E]	GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	Cu ≥ 6 and 1 ≤ Cc ≤ 3[E]	SW	Well-graded sand[I]
			Cu < 6 and/or 1 > Cc > 3[E]	SP	Poorly graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines Classify as CL or CH	SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay[K,L,M,N]
					Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI lots below "A" line	MH	Elastic Silt[K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay[K,L,M,P]
					Organic silt[K,L,M,Q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

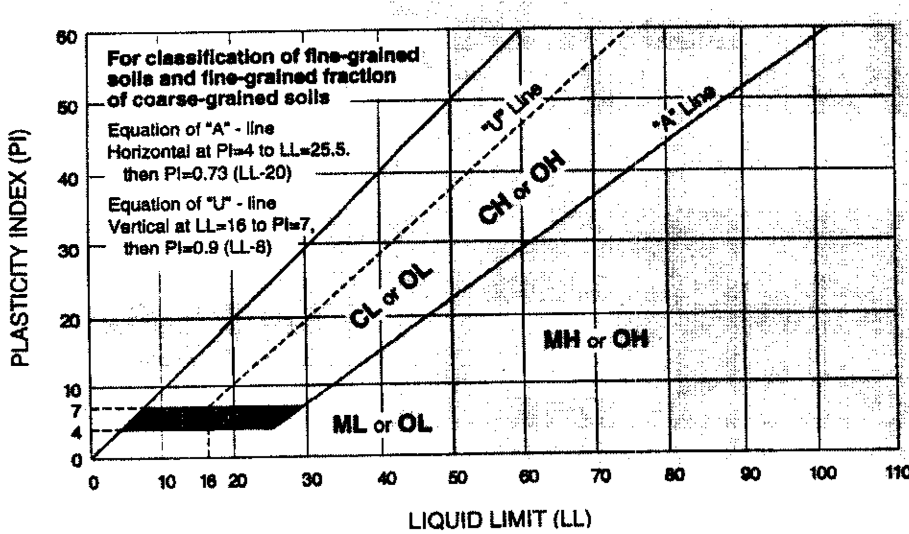
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



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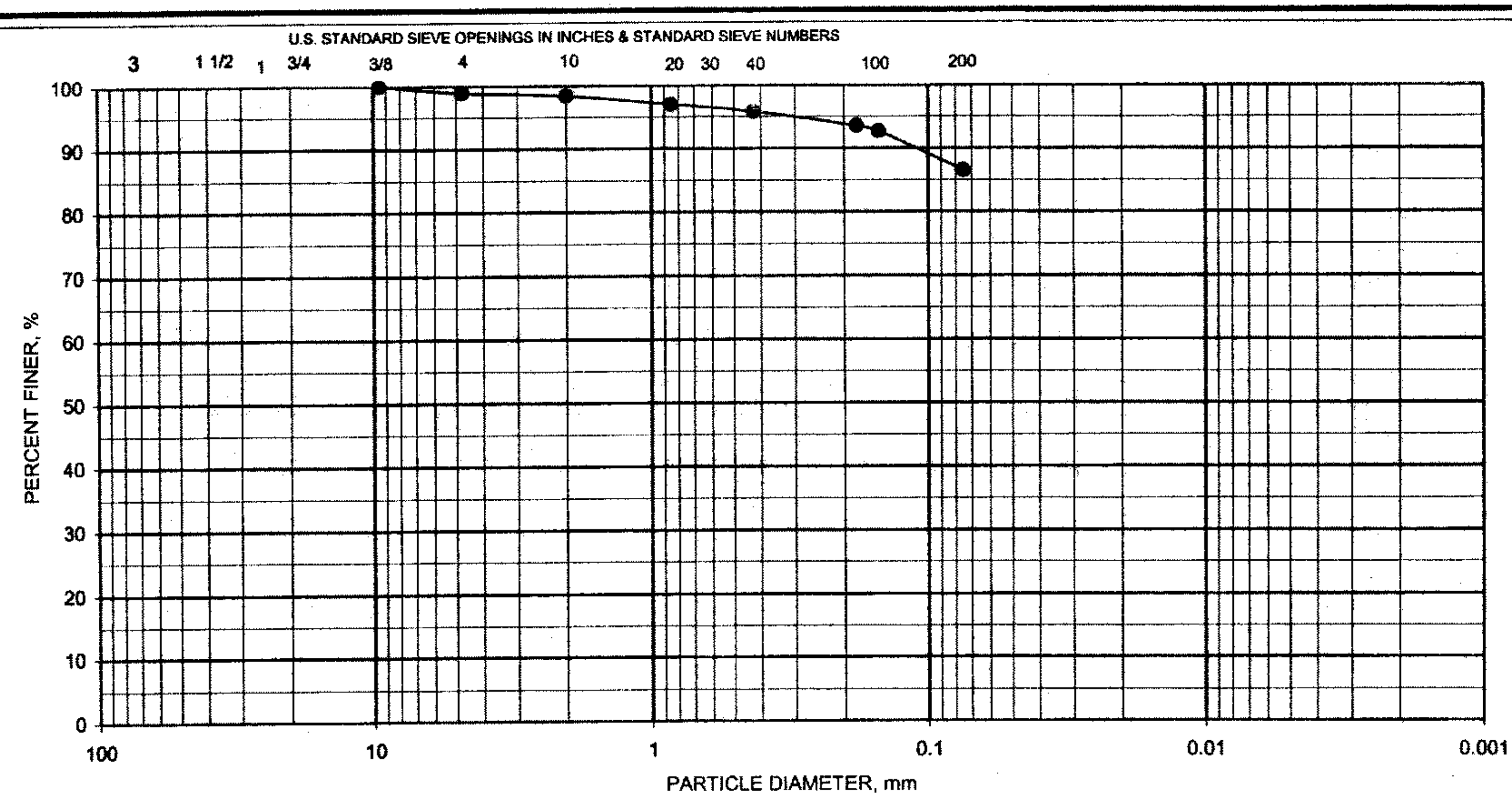

GRAVEL		Sand			Silt or Clay
Coarse	Fine	Coarse	Medium	Fine	

GRAIN SIZE DISTRIBUTION CURVE

BORING NO.	SAMPLE NO.	DEPTH, feet	ASTM DESCRIPTION	UNIFIED SYMBOL	NAT. WC, %	ATTERBERG LIMITS LL	PL	PI
B-1	4	8.5' - 10.0'	FAT CLAY, trace fine to medium sand.	CH	19	54	14	40

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Ellsworth AFB JOB NO. 05035024 DATE 4/23/2003

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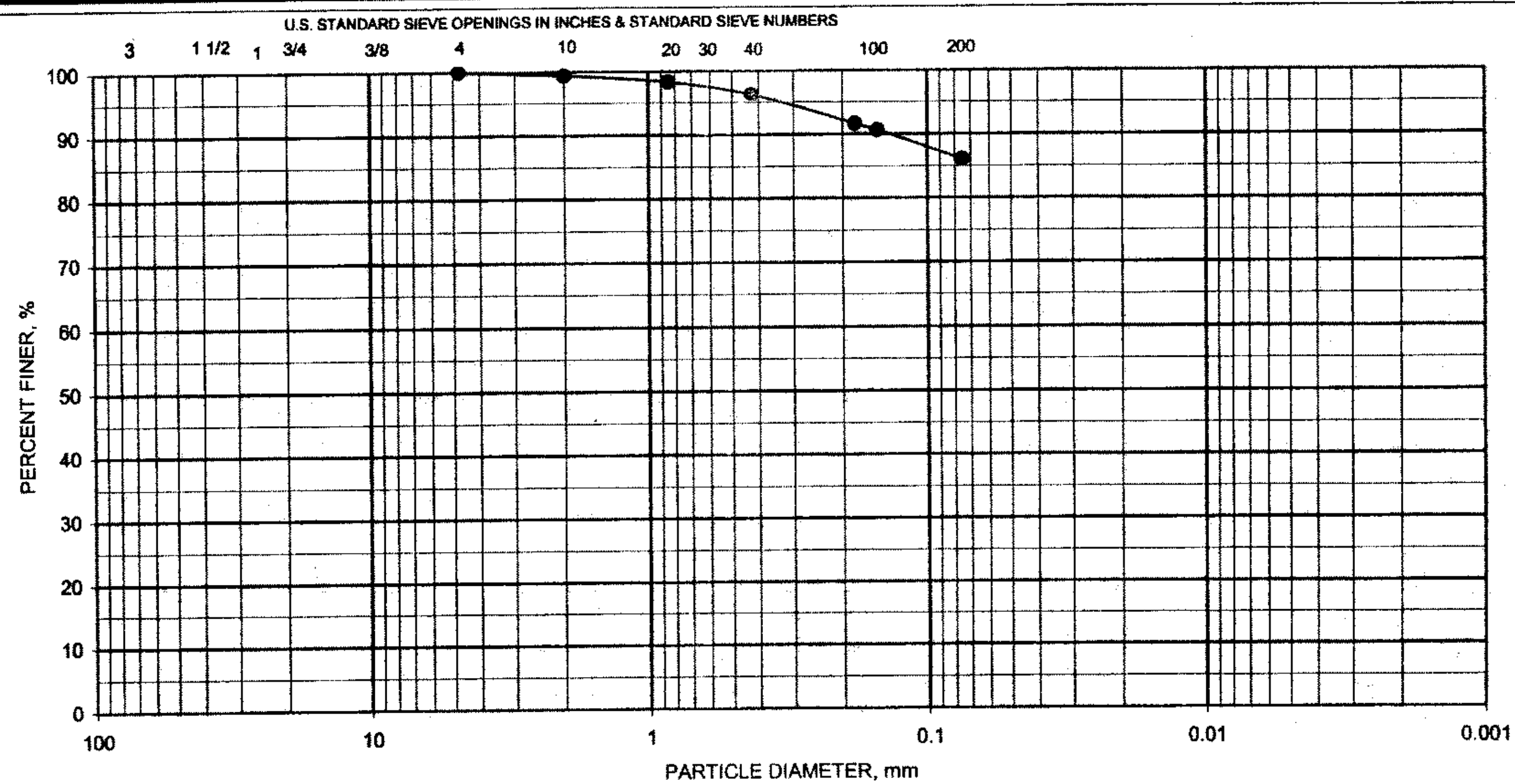

GRAVEL		Sand			Silt or Clay
Coarse	Fine	Coarse	Medium	Fine	

GRAIN SIZE DISTRIBUTION CURVE

BORING NO.	SAMPLE NO.	DEPTH, feet	ASTM DESCRIPTION	UNIFIED SYMBOL	NAT. WC, %	ATTERBERG LIMITS LL	PL	PI
B-2	3	5.0' - 6.0'	(FILL) FAT CLAY with calcium deposits, trace fine sand.	CH	18	52	15	37

PROJECT 37th Bomber Squadron Operations Facility

Ellsworth AFB JOB NO. 05035024 DATE 4/22/2003

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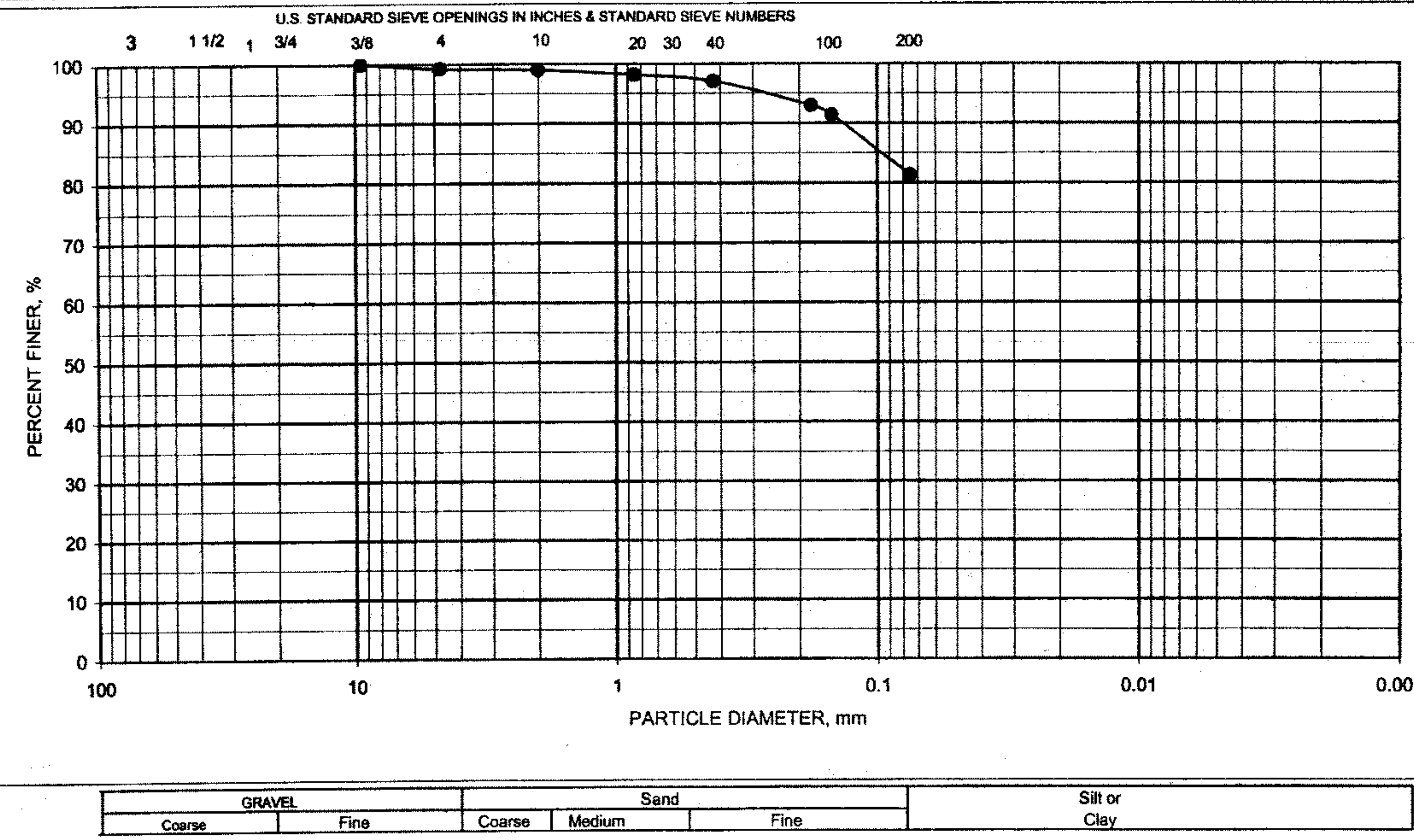
SA3



GRAIN SIZE DISTRIBUTION CURVE

BORING NO.	SAMPLE NO.	DEPTH, feet	ASTM DESCRIPTION	UNIFIED SYMBOL	NAT. WC, %	ATTERBERG LIMITS LL	PL	PI
B-3	4	8.5' - 10.0'	FAT CLAY with fine to medium sand.	CH	18	59	16	43

PROJECT 37th Bomber Squadron Operations Facility

Ellsworth AFB JOB NO. 05035024 DATE 4/22/2003

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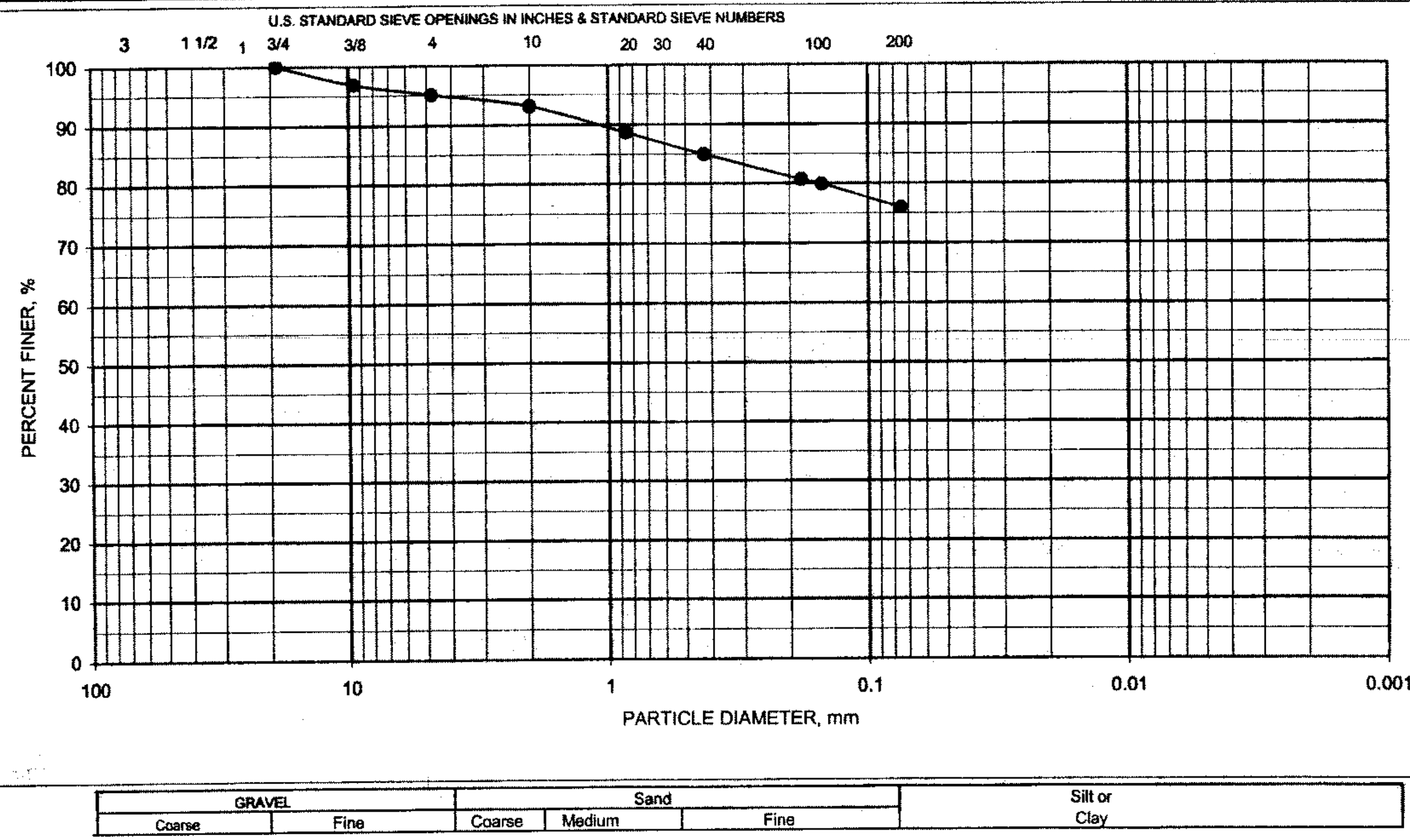
SA2



GRAIN SIZE DISTRIBUTION CURVE

BORING NO.	SAMPLE NO.	DEPTH, feet	ASTM DESCRIPTION	UNIFIED SYMBOL	NAT. WC, %	ATTERBERG LIMITS LL	PL	PI
B-8	3	5.0' - 7.0'	(FILL) LEAN CLAY with fine to coarse sand and fine gravel.	CL	14	48	16	32

PROJECT 37th Bomber Squadron Operations Facility

Ellsworth AFB JOB NO. 05035024 DATE 4/22/2003

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SA1

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Laboratory Compaction Characteristics of Soil

2211 South 156th Circle
Omaha, Nebraska 68130
(402) 330-2202

Client Name: Kenneth Hahn Architects, Inc.
Project Name: 37th Bomber Squadron Operations Facility
Location: Ellsworth Air Force Base
Box Elder, South Dakota

Project No.: 05035024 Date: 4/24/2003

TEST RESULTS

Maximum Dry Unit Wt.: 118.6 pcf
Optimum Water Content: 13.6 %

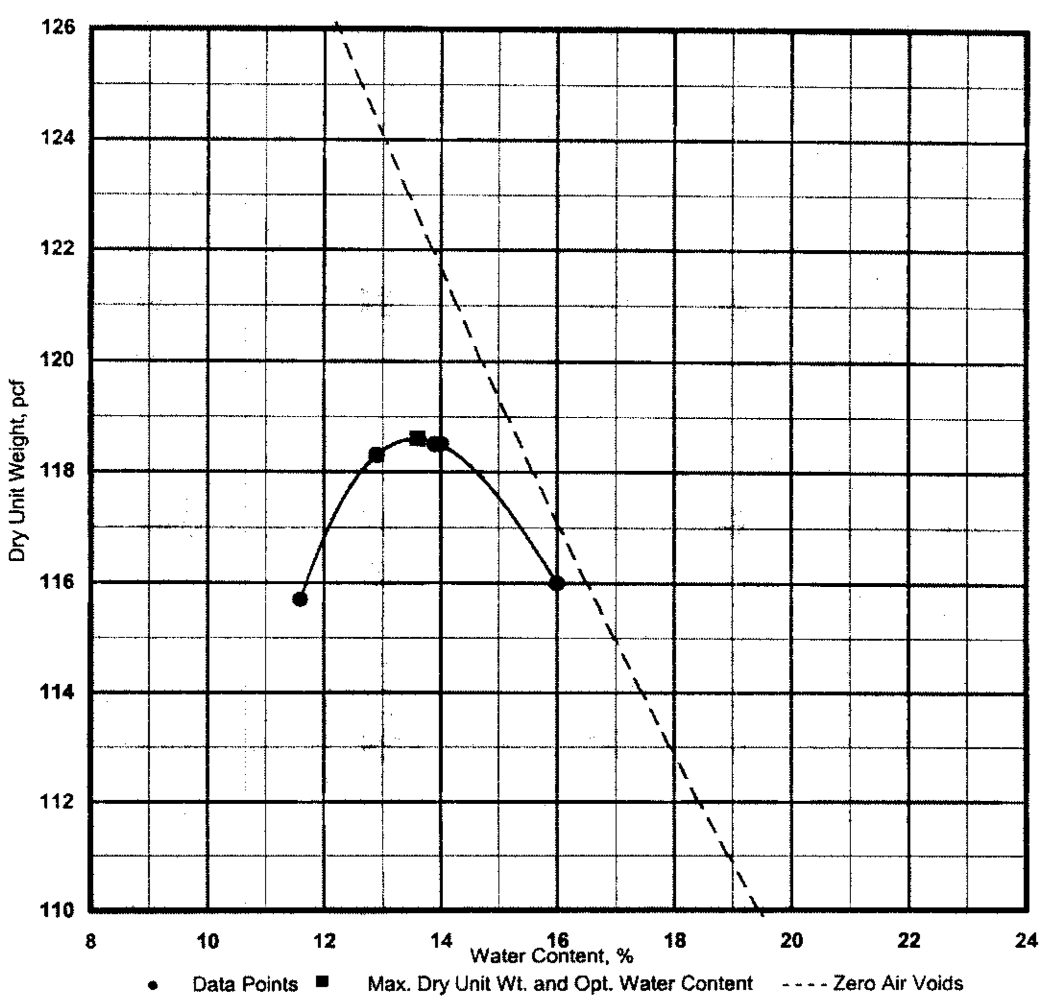
Source Material: Composite sample from on-site borings
Sample Description: Grayish-Brown Lean Clay with Sand

Material Designation: A Sample date: ____
Test Method: ASTM D1557
Test Procedure: A
Sample Preparation: Dry
Rammer: X Mechanical ____ Manual

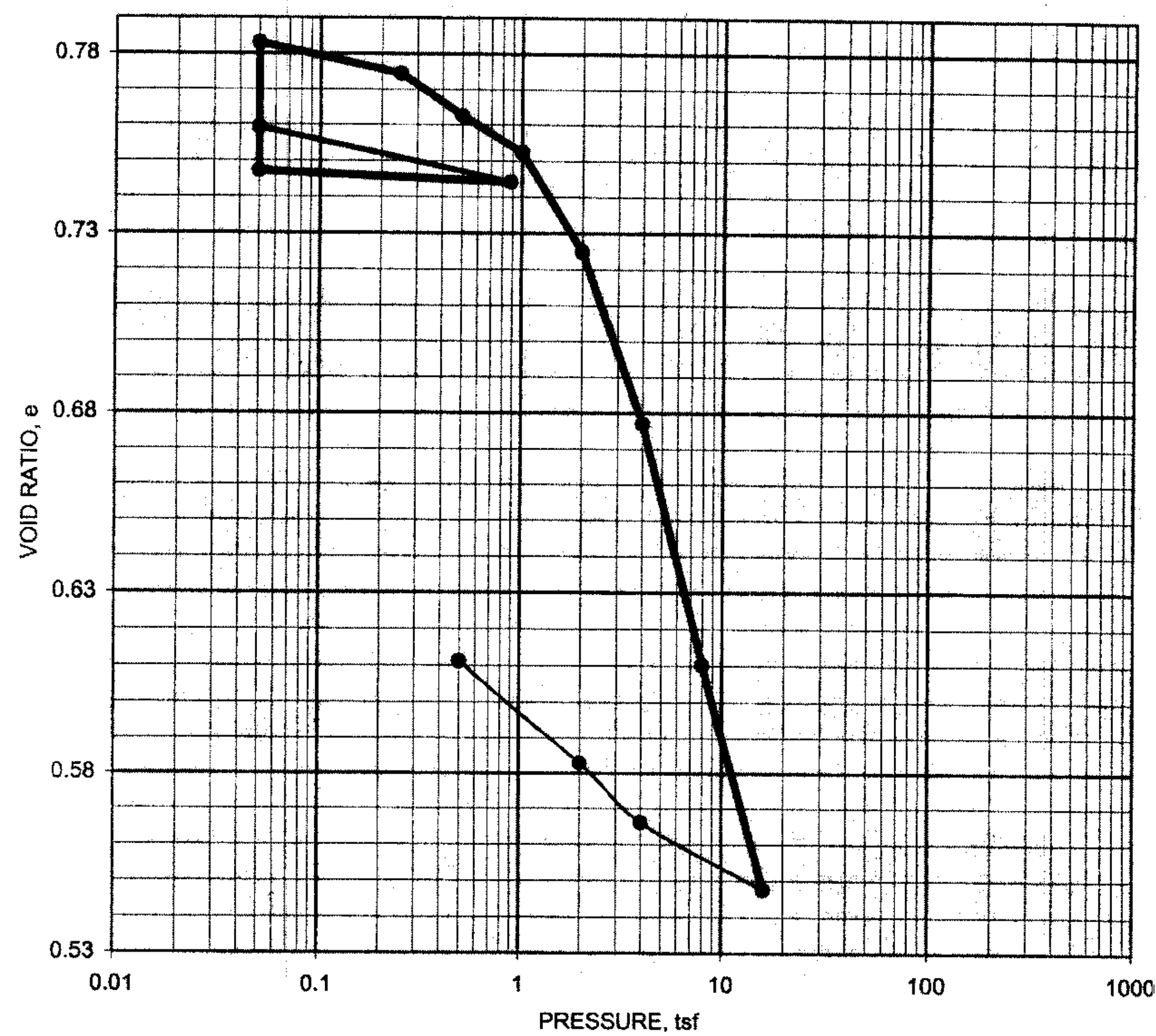
Liquid Limit: ____ Plastic Limit: ____
Plasticity Index: ____
% passing # 200 sieve: ____

Reviewed by: ____

Zero air voids for specific gravity of 2.68



ONE-DIMENSIONAL SWELL TEST, METHOD A
ASTM D4546



DIAMETER, mm	63.50	HEIGHT, mm	19.05	PROPERTY	BEFORE TEST	AFTER TEST
OVERBURDEN PRESSURE, tsf		0.88		MOISTURE, %	19.9	23.0
PRECONSOL. PRESSURE, tsf				DRY DENSITY, pcf	95.5	102.7
OVER CONSOLIDATION RATIO				SATURATION, %	70	100
COMPRESSION INDEX				VOID RATIO	0.766	0.611
REBOUND INDEX				SAMPLE TYPE	3" SHELBY TUBE	

LIQUID LIMIT	52	PLASTIC LIMIT	14	PLASTICITY INDEX	38	SPECIFIC GRAVITY	Assumed 2.70
SAMPLE DESCRIPTION	FAT CLAY with sand.						
BORING NO.	B-1	SAMPLE NO.	5	DEPTH, feet	13.0' - 15.0'		

Swell = 2.1%

37th Bomber Squadron Operations Facility
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05025607
4/25/2003

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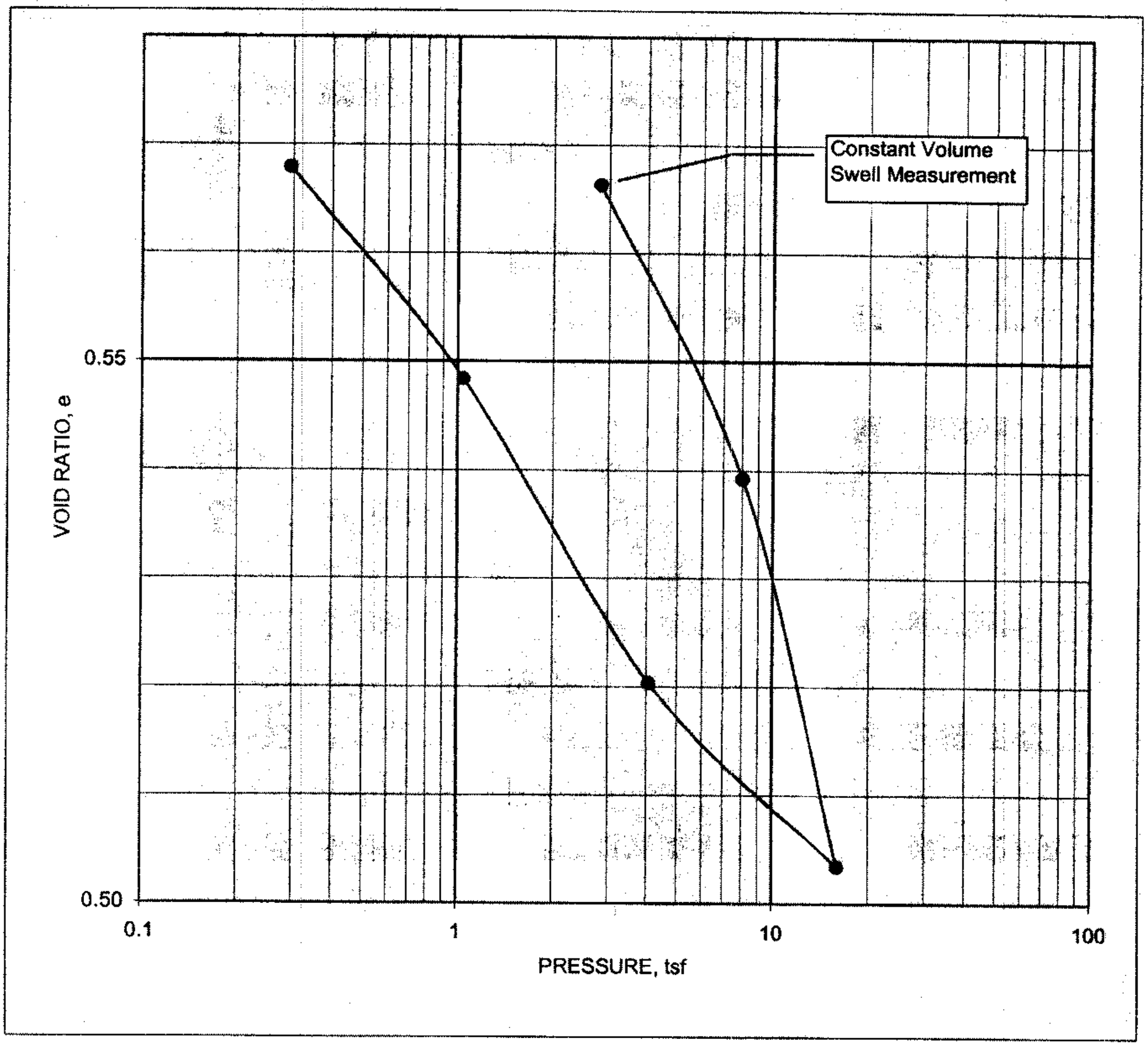
ONE-DIMENSIONAL SWELL TEST, METHOD C
ASTM D4546



DIAMETER, mm 63.50	HEIGHT, mm 25.40	PROPERTY	BEFORE TEST	AFTER TEST	
OVERBURDEN PRESSURE, tsf	0.34	MOISTURE, %	19.3	21.0	
PRECONSOL. PRESSURE, tsf	5.20	DRY DENSITY, pcf	106.8	107.6	
OVER CONSOLIDATION RATIO	15.3	SATURATION, %	91	100	
COMPRESSION INDEX	0.12	VOID RATIO	0.567	0.568	
REBOUND INDEX	0.041	SAMPLE TYPE	3" SHELBY TUBE		

LIQUID LIMIT	52	PLASTIC LIMIT	15	PLASTICITY INDEX	37	SPECIFIC GRAVITY	Assumed 2.680

SAMPLE DESCRIPTION (FILL) FAT CLAY with calcium deposits, trace fine sand.

BORING NO.	B-2	SAMPLE NO.	3	DEPTH, feet	5.0' - 6.0'

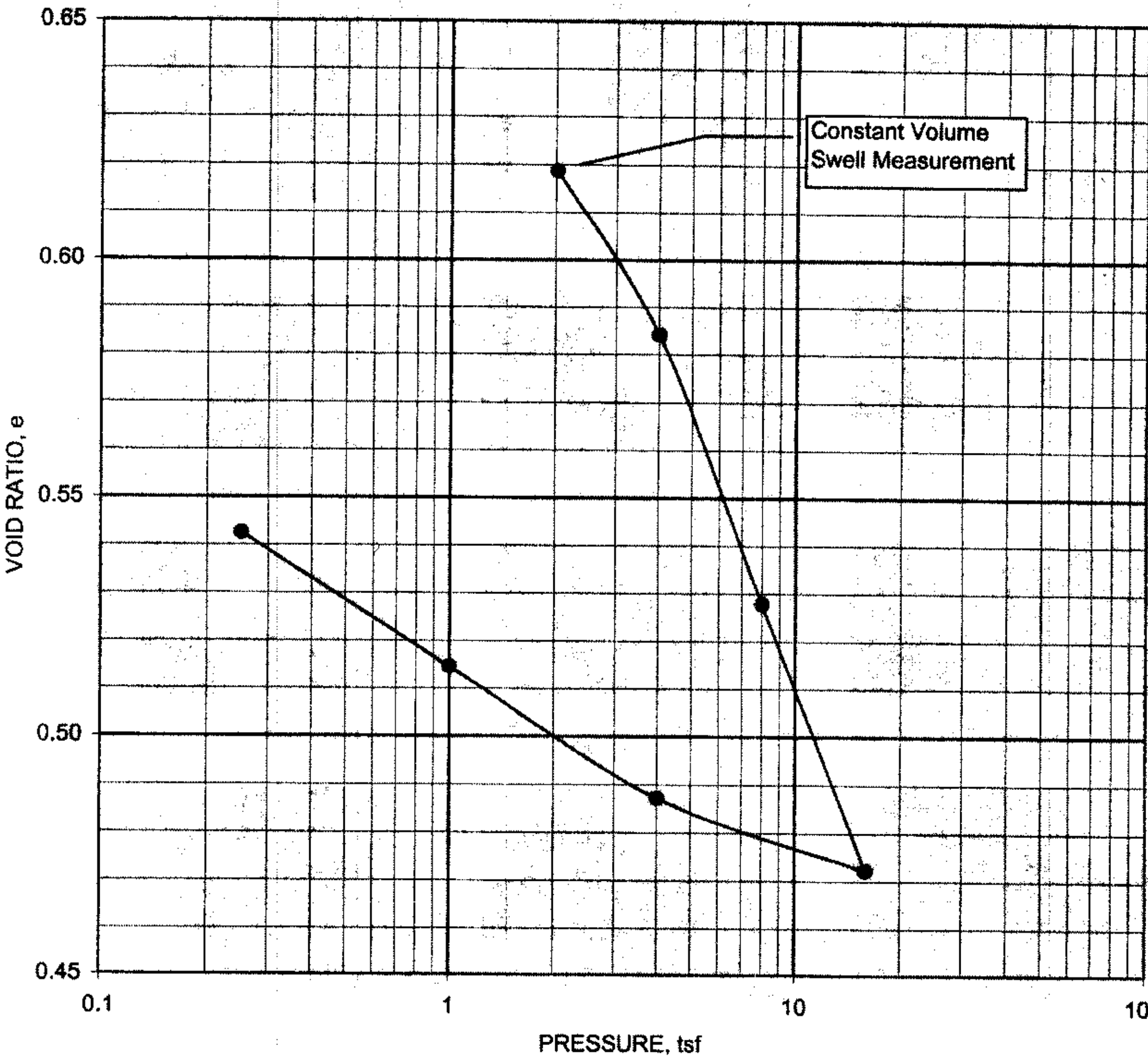
SWELL PRESSURE = 2.81 tsf

37th Bomber Squadron Operations Facility
Ellsworth AFB
05035024
4/21/2003

Terracon

37th Bomber Fac.SWELLC2

ONE-DIMENSIONAL SWELL TEST, METHOD C
ASTM D4546



DIAMETER, mm	63.50	HEIGHT, mm	25.40		
OVERBURDEN PRESSURE, tsf	0.34				
PRECONSOL. PRESSURE, tsf	3.00				
OVER CONSOLIDATION RATIO	8.8				
COMPRESSION INDEX	0.19				
REBOUND INDEX	0.046				

PROPERTY	BEFORE TEST	AFTER TEST
MOISTURE, %	10.6	19.6
DRY DENSITY, pcf	107.9	111.9
SATURATION, %	48	100
VOID RATIO	0.620	0.542
SAMPLE TYPE	3" SHELBY TUBE	

LIQUID LIMIT	50	PLASTIC LIMIT	16	PLASTICITY INDEX	34	SPECIFIC GRAVITY	Assumed 2.80

SAMPLE DESCRIPTION (FILL) FAT CLAY with fine sand and calcium deposits.

BORING NO.	B-5	SAMPLE NO.	3	DEPTH, feet	5.0' - 7.0'

SWELL PRESSURE = 2.02 tsf

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05035024
4/18/2003

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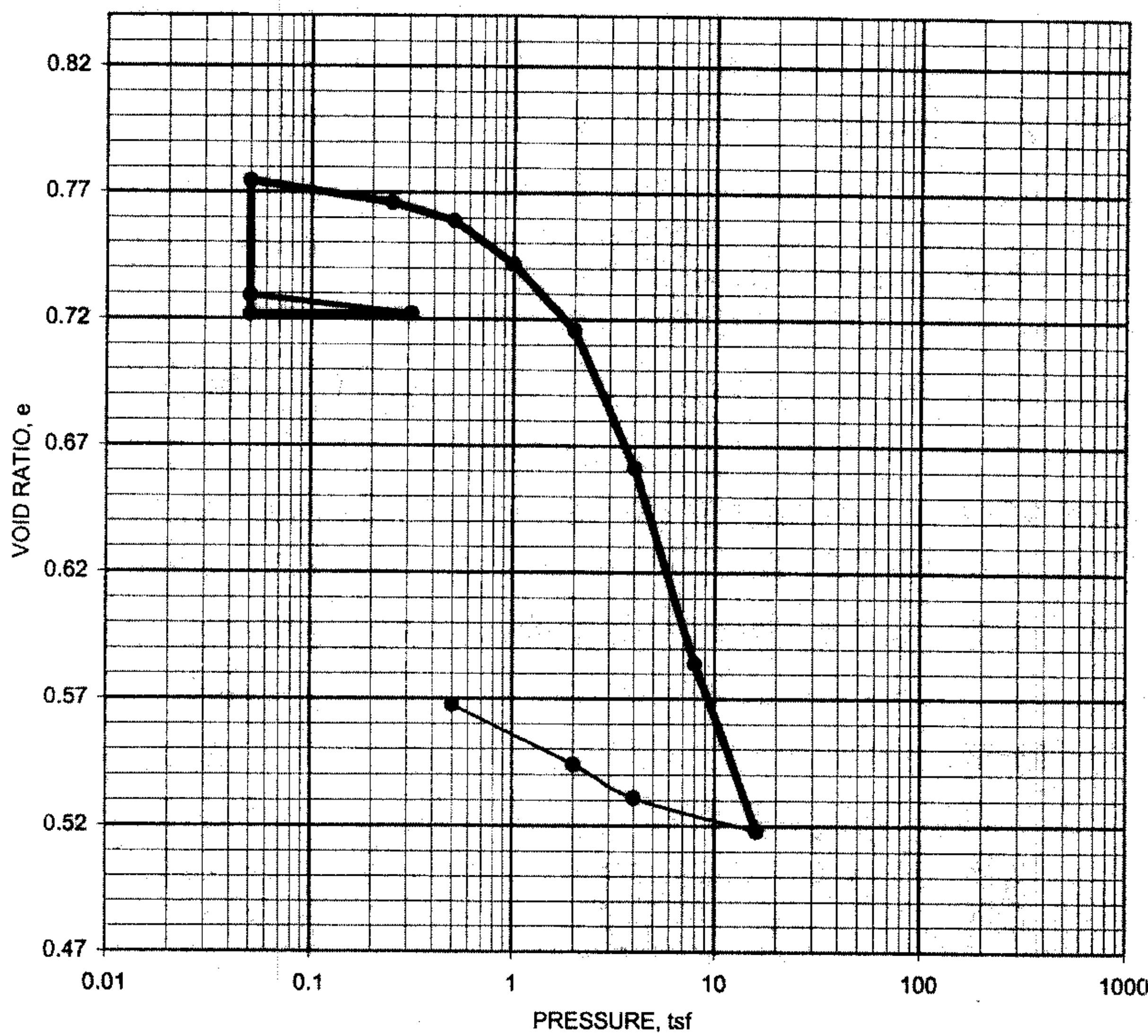
ONE-DIMENSIONAL SWELL TEST, METHOD A
ASTM D4546



DIAMETER, mm	63.50	HEIGHT, mm	19.05	PROPERTY		BEFORE TEST	AFTER TEST
OVERBURDEN PRESSURE, tsf		0.31		MOISTURE, %		14.6	20.8
PRECONSOL. PRESSURE, tsf				DRY DENSITY, pcf		97.3	107.5
OVER CONSOLIDATION RATIO				SATURATION, %		54	100
COMPRESSION INDEX				VOID RATIO		0.732	0.562
REBOUND INDEX				SAMPLE TYPE		3" SHELBY TUBE	
LIQUID LIMIT	48	PLASTIC LIMIT	16	PLASTICITY INDEX	32	SPECIFIC GRAVITY	Assumed 2.70
SAMPLE DESCRIPTION	(FILL) LEAN CLAY with fine to coarse sand and fine gravel.						
BORING NO.	B-8	SAMPLE NO.	3	DEPTH, feet	5.0' - 7.0'		

Swell = 3.1%

37th Bomber Squadron Operations Facility
Ellsworth AFB
05035024
4/25/2003

Terracon

TestAmerica INCORPORATED

ANALYTICAL AND QUALITY CONTROL REPORT

Jeff Kortan
TERRACON, INC.-OMAHA
2211 South 156th Circle
Omaha, NE 68130

04/08/2003

Job Number: 03.04031

Enclosed is the Analytical and Quality Control reports for the following samples submitted to the Cedar Falls Division of TestAmerica, Inc. for analysis.

Sample Number	Sample Description	Date Taken	Date Received
728372	B-5 23-24' #05035024	03/28/2003	04/04/2003
728373	B-15 5-6' #05035024	03/30/2003	04/04/2003

The Quality Control report is generated on a batch basis. All information contained in this report is for the analytical batch(es) in which your sample(s) were analyzed.

TestAmerica, Inc. certifies that the analytical results contained herein apply only to the specific samples analyzed.

Shawn Hayes for
Project Manager
R. L. Bindert

TestAmerica INCORPORATED

ANALYTICAL REPORT

Jeff Kortan
TERRACON, INC.-OMAHA
2211 South 156th Circle
Omaha, NE 68130

04/08/2003

Job Number: 03.04031

Client Project ID: Ellsworth AFB-Rapid City, SD #05035024

Analyte	Result	Flag	Units	Quantitation Limit	Date Analyzed	Analyst Initials	Prep Batch No.	Run Batch No.	Method Reference

SAMPLE NO. 728372 — SAMPLE DESCRIPTION B-5 23-24' #05035024 — DATE-TIME TAKEN 03/28/2003

Analyte	Result	Flag	Units	Quantitation Limit	Date Analyzed	Analyst Initials	Prep Batch No.	Run Batch No.	Method Reference
Solids, Total	85.47		%	0.01	04/04/2003	sas		2339	SM 2540 G
VOLATILES 8260 NON-AQUEOUS									
Acetone	<59		ug/kg dw	59	04/07/2003	mmk		1861	SW 8260B
Benzene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
Bromobenzene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
Bromochloromethane	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
Bromodichloromethane	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
Bromoform	<12		ug/kg dw	12	04/07/2003	mmk		1861	SW 8260B
Bromomethane	<23		ug/kg dw	23	04/07/2003	mmk		1861	SW 8260B
n-Butylbenzene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
sec-Butylbenzene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
tert-Butylbenzene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
Carbon tetrachloride	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
Chlorobenzene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
Chlorodibromomethane	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
Chloroethane	<23		ug/kg dw	23	04/07/2003	mmk		1861	SW 8260B
Chloroform	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
Chloromethane	<23		ug/kg dw	23	04/07/2003	mmk		1861	SW 8260B
2-Chlorotoluene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
4-Chlorotoluene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
1,2-Dibromo-3-chloropropane	<59		ug/kg dw	59	04/07/2003	mmk		1861	SW 8260B
1,2-Dibromoethane	<59		ug/kg dw	59	04/07/2003	mmk		1861	SW 8260B

TestAmerica
INCORPORATED

ANALYTICAL REPORT

Jeff Kortan
TERRACON, INC.-OMAHA
2211 South 156th Circle
Omaha, NE 68130

04/08/2003

Job Number: 03.04031

Client Project ID: Ellsworth AFB-Rapid City, SD #05035024

Analyte	Result	Flag	Units	Quantitation Limit	Date Analyzed	Analyst Initials	Prep Batch No.	Run Batch No.	Method Reference

SAMPLE NO. 728372 — SAMPLE DESCRIPTION B-5 23-24' #05035024 — DATE-TIME TAKEN 03/28/2003

Analyte	Result	Flag	Units	Quantitation Limit	Date Analyzed	Analyst Initials	Prep Batch No.	Run Batch No.	Method Reference
Dibromomethane	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
,2-Dichlorobenzene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
1,3-Dichlorobenzene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
1,4-Dichlorobenzene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
Dichlorodifluoromethane	<18		ug/kg dw	18	04/07/2003	mmk		1861	SW 8260B
1,1-Dichloroethane	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
1,2-Dichloroethane	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
1,1-Dichloroethene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
cis-1,2-Dichloroethene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
trans-1,2-Dichloroethene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
1,2-Dichloropropane	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
1,3-Dichloropropane	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
2,2-Dichloropropane	<23		ug/kg dw	23	04/07/2003	mmk		1861	SW 8260B
1,1-Dichloropropene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
cis-1,3-Dichloropropene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
trans-1,3-Dichloropropene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
Ethylbenzene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
Hexachlorobutadiene	<29		ug/kg dw	29	04/07/2003	mmk		1861	SW 8260B
Isopropylbenzene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
p-Isopropyltoluene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
Methylene chloride	<59		ug/kg dw	59	04/07/2003	mmk		1861	SW 8260B
MTBE	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B

TestAmerica

INCORPORATED

ANALYTICAL REPORT

Jeff Kortan
TERRACON, INC.-OMAHA
2211 South 156th Circle
Omaha, NE 68130

04/08/2003

Job Number: 03.04031

Client Project ID: Ellsworth AFB-Rapid City, SD #05035024

Analyte	Result	Flag	Units	Quantitation Limit	Date Analyzed	Analyst Initials	Prep Batch No.	Run Batch No.	Method Reference

SAMPLE NO. 728372 — SAMPLE DESCRIPTION B-5 23-24' #05035024 — DATE-TIME TAKEN 03/28/2003

Analyte	Result	Flag	Units	Quantitation Limit	Date Analyzed	Analyst Initials	Prep Batch No.	Run Batch No.	Method Reference
Naphthalene	<29		ug/kg dw	29	04/07/2003	mmk		1861	SW 8260B
Propylbenzene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
Styrene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
1,1,1,2-Tetrachloroethane	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
1,1,2,2-Tetrachloroethane	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
Tetrachloroethene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
Toluene	7.3		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
1,2,3-Trichlorobenzene	<29		ug/kg dw	29	04/07/2003	mmk		1861	SW 8260B
1,2,4-Trichlorobenzene	<29		ug/kg dw	29	04/07/2003	mmk		1861	SW 8260B
1,1,1-Trichloroethane	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
1,1,2-Trichloroethane	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
Trichloroethylene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
Trichlorofluoromethane	<23		ug/kg dw	23	04/07/2003	mmk		1861	SW 8260B
1,2,3-Trichloropropane	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
1,2,4-Trimethylbenzene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
1,3,5-Trimethylbenzene	<5.9		ug/kg dw	5.9	04/07/2003	mmk		1861	SW 8260B
Vinyl Chloride	<18		ug/kg dw	18	04/07/2003	mmk		1861	SW 8260B
Xylenes, Total	<18		ug/kg dw	18	04/07/2003	mmk		1861	SW 8260B
4-Bromofluorobenzene(surr)	99.0		%	1	04/07/2003	mmk		1861	SW 8260B
Dibromofluoromethane(surr)	100.0		%	1	04/07/2003	mmk		1861	SW 8260B
Toluene-d8(surr)	95.0		%	1	04/07/2003	mmk		1861	SW 8260B
Extraction Prep, soil	COMPLETE				04/04/2003	smm	2827		IOWA-OA2

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INCORPORATED

ANALYTICAL REPORT

Jeff Kortan
TERRACON, INC.-OMAHA
2211 South 156th Circle
Omaha, NE 68130

04/08/2003

Job Number: 03.04031

Client Project ID: Ellsworth AFB-Rapid City, SD #05035024

Analyte	Result	Flag	Units	Quantitation Limit	Date Analyzed	Analyst Initials	Prep Batch No.	Run Batch No.	Method Reference
SAMPLE NO. 728372	**SAMPLE DESCRIPTION B-5 23-24' #05035024**								**DATE-TIME TAKEN 03/28/2003**
EXTRACTABLE HYDROCARBONS-SOIL									
ɔtal Extractable Hydrocarbons	<12		mg/kg dw	12	04/07/2003	jaa	2827	4820	IA-OA2/S-8015
Diesel	<12		mg/kg dw	12	04/07/2003	jaa	2827	4820	IA-OA2/S-8015
Gasoline	<12		mg/kg dw	12	04/07/2003	jaa	2827	4820	IA-OA2/S-8015
Motor Oil	<12		mg/kg dw	12	04/07/2003	jaa	2827	4820	IA-OA2/S-8015
N-Octacosane (Surr.)	89		%	1.0	04/07/2003	jaa	2827	4820	IA-OA2/S-8015
SAMPLE NO. 728373	**SAMPLE DESCRIPTION B-15 5-6' #05035024**								**DATE-TIME TAKEN 03/30/2003**
Solids, Total	77.52		%	0.01	04/04/2003	sas		2339	SM 2540 G
VOLATILES 8260 NON-AQUEOUS									
Acetone	<64		ug/kg dw	64	04/07/2003	mmk		1861	SW 8260B
Benzene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
Bromobenzene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
Bromochloromethane	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
Bromodichloromethane	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
Bromoform	<13		ug/kg dw	13	04/07/2003	mmk		1861	SW 8260B
Bromomethane	<26		ug/kg dw	26	04/07/2003	mmk		1861	SW 8260B

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ANALYTICAL REPORT

Jeff Kortan
TERRACON, INC.-OMAHA
2211 South 156th Circle
Omaha, NE 68130

04/08/2003

Job Number: 03.04031

Client Project ID: Ellsworth AFB-Rapid City, SD #05035024

SAMPLE NO.	SAMPLE DESCRIPTION	DATE-TIME TAKEN
728373	B-15 5-6' #05035024	03/30/2003

Analyte	Result	Flag	Units	Quantitation Limit	Date Analyzed	Analyst Initials	Prep Batch No.	Run Batch No.	Method Reference
n-Butylbenzene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
sec-Butylbenzene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
tert-Butylbenzene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
Carbon tetrachloride	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
Chlorobenzene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
Chlorodibromomethane	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
Chloroethane	<26		ug/kg dw	26	04/07/2003	mmk		1861	SW 8260B
Chloroform	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
Chloromethane	<26		ug/kg dw	26	04/07/2003	mmk		1861	SW 8260B
2-Chlorotoluene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
4-Chlorotoluene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
1,2-Dibromo-3-chloropropane	<64		ug/kg dw	64	04/07/2003	mmk		1861	SW 8260B
1,2-Dibromoethane	<64		ug/kg dw	64	04/07/2003	mmk		1861	SW 8260B
Dibromomethane	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
1,2-Dichlorobenzene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
1,3-Dichlorobenzene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
1,4-Dichlorobenzene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
Dichlorodifluoromethane	<19		ug/kg dw	19	04/07/2003	mmk		1861	SW 8260B
1,1-Dichloroethane	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
1,2-Dichloroethane	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
1,1-Dichloroethene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
cis-1,2-Dichloroethene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B

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ANALYTICAL REPORT

Jeff Kortan
TERRACON, INC.-OMAHA
2211 South 156th Circle
Omaha, NE 68130

04/08/2003

Job Number: 03.04031

Client Project ID: Ellsworth AFB-Rapid City, SD #05035024

SAMPLE NO. 728373
SAMPLE DESCRIPTION B-15 5-6' #05035024
DATE-TIME TAKEN 03/30/2003

Analyte	Result	Flag	Units	Quantitation Limit	Date Analyzed	Analyst Initials	Prep Batch No.	Run Batch No.	Method Reference
rans-1,2-Dichloroethene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
.,2-Dichloropropane	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
1,3-Dichloropropane	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
2,2-Dichloropropane	<26		ug/kg dw	26	04/07/2003	mmk		1861	SW 8260B
1,1-Dichloropropene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
cis-1,3-Dichloropropene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
trans-1,3-Dichloropropene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
Ethylbenzene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
Hexachlorobutadiene	<32		ug/kg dw	32	04/07/2003	mmk		1861	SW 8260B
Isopropylbenzene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
p-Isopropyltoluene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
Methylene chloride	<64		ug/kg dw	64	04/07/2003	mmk		1861	SW 8260B
MTBE	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
Naphthalene	<32		ug/kg dw	32	04/07/2003	mmk		1861	SW 8260B
n-Propylbenzene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
Styrene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
1,1,1,2-Tetrachloroethane	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
1,1,2,2-Tetrachloroethane	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
Tetrachloroethene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
Toluene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
1,2,3-Trichlorobenzene	<32		ug/kg dw	32	04/07/2003	mmk		1861	SW 8260B
1,2,4-Trichlorobenzene	<32		ug/kg dw	32	04/07/2003	mmk		1861	SW 8260B

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ANALYTICAL REPORT

Jeff Kortan
TERRACON, INC.-OMAHA
2211 South 156th Circle
Omaha, NE 68130

04/08/2003

Job Number: 03.04031

Client Project ID: Ellsworth AFB-Rapid City, SD #05035024

SAMPLE NO. 728373
SAMPLE DESCRIPTION B-15 5-6' #05035024
DATE-TIME TAKEN 03/30/2003

Analyte	Result	Flag	Units	Quantitation Limit	Date Analyzed	Analyst Initials	Prep Batch No.	Run Batch No.	Method Reference
1,1,1-Trichloroethane	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
,1,2-Trichloroethane	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
.richloroethylene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
Trichlorofluoromethane	<26		ug/kg dw	26	04/07/2003	mmk		1861	SW 8260B
1,2,3-Trichloropropane	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
1,2,4-Trimethylbenzene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
1,3,5-Trimethylbenzene	<6.4		ug/kg dw	6.4	04/07/2003	mmk		1861	SW 8260B
Vinyl Chloride	<19		ug/kg dw	19	04/07/2003	mmk		1861	SW 8260B
Xylenes, Total	<19		ug/kg dw	19	04/07/2003	mmk		1861	SW 8260B
4-Bromofluorobenzene(surr)	96.0		%	1	04/07/2003	mmk		1861	SW 8260B
Dibromofluoromethane(surr)	95.0		%	1	04/07/2003	mmk		1861	SW 8260B
Toluene-d8(surr)	93.0		%	1	04/07/2003	mmk		1861	SW 8260B
Extraction Prep, soil	COMPLETE				04/04/2003	smm	2827		IOWA-OA2
EXTRACTABLE HYDROCARBONS-SOIL									
Total Extractable Hydrocarbons	<13		mg/kg dw	13	04/07/2003	jaa	2827	4820	IA-OA2/S-8015
Diesel	<13		mg/kg dw	13	04/07/2003	jaa	2827	4820	IA-OA2/S-8015
Gasoline	<13		mg/kg dw	13	04/07/2003	jaa	2827	4820	IA-OA2/S-8015
Motor Oil	<13		mg/kg dw	13	04/07/2003	jaa	2827	4820	IA-OA2/S-8015
N-Octacosane (Surr.)	90		%	1.0	04/07/2003	jaa	2827	4820	IA-OA2/S-8015

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QUALITY CONTROL REPORT
CONTINUING CALIBRATION VERIFICATION

Jeff Kortan
TERRACON, INC.-OMAHA
2211 South 156th Circle
Omaha, NE 68130

04/08/2003

Job Number: 03.04031

Analyte	Prep Batch No.	Run Batch No.	CCV True Value	Units	CCV Conc Found	CCV % Rec	Flag	Date Analyzed
VOLATILES 8260 NON-AQUEOUS								
Benzene		1861	50.0	ug/L	52.1	104		04/07/2003
Bromoform		1861	50.0	ug/L	60.9	122		04/07/2003
Chlorobenzene		1861	50.0	ug/L	51.1	102		04/07/2003
1,1-Dichloroethane		1861	50.0	ug/L	50.0	100		04/07/2003
1,1-Dichloroethene		1861	50.0	ug/L	48.3	97		04/07/2003
1,2-Dichloropropane		1861	50.0	ug/L	49.4	99		04/07/2003
Ethylbenzene		1861	50.0	ug/L	50.2	100		04/07/2003
MTBE		1861	50.0	ug/L	53.7	107		04/07/2003
1,1,2,2-Tetrachloroethane		1861	50.0	ug/L	54.4	109		04/07/2003
Toluene		1861	50.0	ug/L	49.7	99		04/07/2003
Trichloroethylene		1861	50.0	ug/L	50.6	101		04/07/2003
1,2,4-Trimethylbenzene		1861	50.0	ug/L	49.9	100		04/07/2003
1,3,5-Trimethylbenzene		1861	50.0	ug/L	50.7	101		04/07/2003
Vinyl Chloride		1861	50.0	ug/L	49.9	100		04/07/2003
Xylenes, Total		1861	150	ug/L	150	100		04/07/2003
4-Bromofluorobenzene(surr)		1861	100	%	104	104		04/07/2003
Dibromofluoromethane(surr)		1861	100	%	101	101		04/07/2003
Toluene-d8(surr)		1861	100	%	98	98		04/07/2003
EXTRACTABLE HYDROCARBONS-SOIL								
Diesel		4820	2,500	ppm	2,324	93		04/07/2003
Gasoline		4820	2,500	ppm	2,215	89		04/07/2003
Motor Oil		4820	2,500	ppm	2,317	93		04/07/2003

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QUALITY CONTROL REPORT
BLANKS

Jeff Kortan
TERRACON, INC.-OMAHA
2211 South 156th Circle
Omaha, NE 68130

04/08/2003

Job Number: 03.04031

Analyte	Prep Batch No.	Run Batch No.	Blank Value	Flag	Units	Quantitation Limit	Date Analyzed
VOLATILES 8260 NON-AQUEOUS							
Acetone		1861	<50		ug/kg	50	04/07/2003
Benzene		1861	<5.0		ug/kg	5.0	04/07/2003
Bromobenzene		1861	<5.0		ug/kg	5.0	04/07/2003
Bromochloromethane		1861	<5.0		ug/kg	5.0	04/07/2003
Bromodichloromethane		1861	<5.0		ug/kg	5.0	04/07/2003
Bromoform		1861	<10		ug/kg	10	04/07/2003
Bromomethane		1861	<20		ug/kg	20	04/07/2003
n-Butylbenzene		1861	<5.0		ug/kg	5.0	04/07/2003
sec-Butylbenzene		1861	<5.0		ug/kg	5.0	04/07/2003
tert-Butylbenzene		1861	<5.0		ug/kg	5.0	04/07/2003
Carbon tetrachloride		1861	<5.0		ug/kg	5.0	04/07/2003
Chlorobenzene		1861	<5.0		ug/kg	5.0	04/07/2003
Chlorodibromomethane		1861	<5.0		ug/kg	5.0	04/07/2003
Chloroethane		1861	<20		ug/kg	20	04/07/2003
Chloroform		1861	<5.0		ug/kg	5.0	04/07/2003
Chloromethane		1861	<20		ug/kg	20	04/07/2003
2-Chlorotoluene		1861	<5.0		ug/kg	5.0	04/07/2003
4-Chlorotoluene		1861	<5.0		ug/kg	5.0	04/07/2003
1,2-Dibromo-3-chloropropane		1861	<50		ug/kg	50	04/07/2003
1,2-Dibromoethane		1861	<50		ug/kg	50	04/07/2003
Dibromomethane		1861	<5.0		ug/kg	5.0	04/07/2003
1,2-Dichlorobenzene		1861	<5.0		ug/kg	5.0	04/07/2003
1,3-Dichlorobenzene		1861	<5.0		ug/kg	5.0	04/07/2003
1,4-Dichlorobenzene		1861	<5.0		ug/kg	5.0	04/07/2003
Dichlorodifluoromethane		1861	<15		ug/kg	15	04/07/2003
1,1-Dichloroethane		1861	<5.0		ug/kg	5.0	04/07/2003
1,2-Dichloroethane		1861	<5.0		ug/kg	5.0	04/07/2003
1,1-Dichloroethene		1861	<5.0		ug/kg	5.0	04/07/2003
cis-1,2-Dichloroethene		1861	<5.0		ug/kg	5.0	04/07/2003
trans-1,2-Dichloroethene		1861	<5.0		ug/kg	5.0	04/07/2003
1,2-Dichloropropane		1861	<5.0		ug/kg	5.0	04/07/2003
1,3-Dichloropropane		1861	<5.0		ug/kg	5.0	04/07/2003
2,2-Dichloropropane		1861	<20		ug/kg	20	04/07/2003

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QUALITY CONTROL REPORT
BLANKS

Jeff Kortan
TERRACON, INC.-OMAHA
2211 South 156th Circle
Omaha, NE 68130

04/08/2003

Job Number: 03.04031

Analyte	Prep Batch No.	Run Batch No.	Blank Value	Flag	Units	Quantitation Limit	Date Analyzed
1,1-Dichloropropene		1861	<5.0		ug/kg	5.0	04/07/2003
cis-1,3-Dichloropropene		1861	<5.0		ug/kg	5.0	04/07/2003
trans-1,3-Dichloropropene		1861	<5.0		ug/kg	5.0	04/07/2003
Ethylbenzene		1861	<5.0		ug/kg	5.0	04/07/2003
Hexachlorobutadiene		1861	<25		ug/kg	25	04/07/2003
Isopropylbenzene		1861	<5.0		ug/kg	5.0	04/07/2003
p-Isopropyltoluene		1861	<5.0		ug/kg	5.0	04/07/2003
Methylene chloride		1861	<50		ug/kg	50	04/07/2003
MTBE		1861	<5.0		ug/kg	5.0	04/07/2003
Naphthalene		1861	<25		ug/kg	25	04/07/2003
n-Propylbenzene		1861	<5.0		ug/kg	5.0	04/07/2003
Styrene		1861	<5.0		ug/kg	5.0	04/07/2003
1,1,1,2-Tetrachloroethane		1861	<5.0		ug/kg	5.0	04/07/2003
1,1,2,2-Tetrachloroethane		1861	<5.0		ug/kg	5.0	04/07/2003
Tetrachloroethene		1861	<5.0		ug/kg	5.0	04/07/2003
Toluene		1861	<5.0		ug/kg	5.0	04/07/2003
1,2,3-Trichlorobenzene		1861	<25		ug/kg	25	04/07/2003
1,2,4-Trichlorobenzene		1861	<25		ug/kg	25	04/07/2003
1,1,1-Trichloroethane		1861	<5.0		ug/kg	5.0	04/07/2003
1,1,2-Trichloroethane		1861	<5.0		ug/kg	5.0	04/07/2003
Trichloroethylene		1861	<5.0		ug/kg	5.0	04/07/2003
Trichlorofluoromethane		1861	<20		ug/kg	20	04/07/2003
1,2,3-Trichloropropane		1861	<5.0		ug/kg	5.0	04/07/2003
1,2,4-Trimethylbenzene		1861	<5.0		ug/kg	5.0	04/07/2003
1,3,5-Trimethylbenzene		1861	<5.0		ug/kg	5.0	04/07/2003
Vinyl Chloride		1861	<15		ug/kg	15	04/07/2003
Xylenes, Total		1861	<15		ug/kg	15	04/07/2003
4-Bromofluorobenzene(surr)		1861	98.0		%	1	04/07/2003
Dibromofluoromethane(surr)		1861	99.0		%	1	04/07/2003
Toluene-d8(surr)		1861	99.0		%	1	04/07/2003
EXTRACTABLE HYDROCARBONS-SOIL							
Total Extractable Hydrocarbons	2827	4820	<10		mg/kg	10	04/07/2003
Diesel	2827	4820	<10		mg/kg	10	04/07/2003
Gasoline	2827	4820	<10		mg/kg	10	04/07/2003

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QUALITY CONTROL REPORT
BLANKS

Jeff Kortan
TERRACON, INC.-OMAHA
2211 South 156th Circle
Omaha, NE 68130

04/08/2003

Job Number: 03.04031

Analyte	Prep Batch No.	Run Batch No.	Blank Value	Flag	Units	Quantitation Limit	Date Analyzed
Motor Oil	2827	4820	<10		mg/kg	10	04/07/2003
N-Octacosane (Surr.)	2827	4820	81		%	1.0	04/07/2003

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QUALITY CONTROL REPORT
LABORATORY CONTROL STANDARD

04/08/2003

Job No: 03.04031

Jeff Kortan
TERRACON, INC.-OMAHA
2211 South 156th Circle
Omaha, NE 68130

Analyte	Prep Batch Number	Run Batch Number	LCS Amount	Units	LCS Result	LCSD Result	LCS Percent Recovery	LCSD Percent Recovery	Control Limits	Relative Percent Difference
VOLATILES 8260 NON-AQUEOUS										
Benzene		1861	75.64	ug/kg	82.1		108.5		68 - 158	
Chlorobenzene		1861	75.64	ug/kg	72.6		96.0		65 - 155	
1,1-Dichloroethene		1861	75.64	ug/kg	83.2		110.0		58 - 148	
Ethylbenzene		1861	75.64	ug/kg	56.8		75.1		69 - 159	
MTBE		1861	75.64	ug/kg	95.6		126.4		71 - 161	
Toluene		1861	75.64	ug/kg	74.6		98.6		68 - 158	
1,2,4-Trichlorobenzene		1861	75.64	ug/kg	44.0		58.2		54 - 144	
Trichloroethylene		1861	75.64	ug/kg	83.0		109.7		61 - 151	
1,2,4-Trimethylbenzene		1861	75.64	ug/kg	73.3		96.9		68 - 158	
1,3,5-Trimethylbenzene		1861	75.64	ug/kg	71.4		94.4		66 - 156	
Xylenes, Total		1861	226.9	ug/kg	229		100.9		69 - 159	
4-Bromofluorobenzene(surr)		1861	100	%	100.0		100.0		75 - 119	
Dibromofluoromethane(surr)		1861	100	%	101.0		101.0		56 - 146	
Toluene-d8(surr)		1861	100	%	97.0		97.0		52 - 142	
EXTRACTABLE HYDROCARBONS-S										
Diesel	2827	4820	66.7	mg/kg	55.2		82.8		47 - 124	
Gasoline	2827	4820	1.0	mg/kg	NA				42 - 132	
Motor Oil	2827	4820	1.0	mg/kg	NA				43 - 133	
N-Octacosane (Surr.)	2827	4820	100	%	86		86.0		44 - 134	

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INCORPORATED

QUALITY CONTROL REPORT
MATRIX SPIKE/MATRIX SPIKE DUPLICATE

Jeff Kortan
TERRACON, INC.-OMAHA
2211 South 156th Circle
Omaha, NE 68130

04/08/2003

Job Number: 03.04031

Analyte	Prep Batch No.	Run Batch No.	Sample Result	Units	MS Spike Conc. Added	MS Result	MS %Rec.	MSD Spike Conc. Added	MSD Result	MSD % Rec.	RPD	Flag(
EXTRACTABLE HYDROCARBONS-SOIL												
Diesel	2827	4820	<10	mg/kg	65.1	56.6	87	66.4	56.0	84	1.1	
Gasoline	2827	4820	<10	mg/kg	0	NA	0	1.0	NA			
Motor Oil	2827	4820	<10	mg/kg	0.00000	NA	0	0.0	NA	0		

TestAmerica
INCORPORATED

QUALITY CONTROL REPORT
DUPLICATES

Jeff Kortan
TERRACON, INC.-OMAHA
2211 South 156th Circle
Omaha, NE 68130

04/08/2003

Job Number: 03.04031

Analyte	Prep Batch No.	Run Batch No.	Sample Result	Duplicate Sample Result	Units	RPD	Flag	Date Analyzed
Solids, Total		2339	85.47	86.04	%	0.7		04/04/2003
Solids, Total		2339	4.52	4.51	%	0.2		04/04/2003

TestAmerica
INCORPORATED

TestAmerica Job Number: 03.04031

ATTACHMENTS

Following are the sample receipt log and the chain of custody applicable to this analytical report.

Any abnormalities or departures from sample acceptance policy shall be documented on the "Sample Receipt and Temperature Log Form" and Sample Non-Conformance Form" (if applicable) included with this report.

For information concerning certifications of this facility or another TestAmerica facility please visit our website at **www.TestAmericaInc.com.**

This report shall not be reproduced, except in full, without written approval of the laboratory.

For questions regarding this report, please contact the individual who signed the analytical report.

Report Number
03-108-2041

Midwest Laboratories, Inc.

13611 "B" Street • Omaha, Nebraska 68144-3693 • (402) 334-7770 • FAX (402) 334-9121
www.midwestlabs.com

REPORT OF ANALYSIS

For: (1291) TERRACON INC
(402)330-2202

Date Reported: 04/18/03
Date Received: 04/14/03

Mail to: TERRACON INC
ROD BAUMANN
2211 S 156TH CIR
OMAHA NE 68130-

PO/Proj. #: 05035024
ELLSWORTH AFB

Lab number: 851339

Analysis	Level Found	Units	Detection Limit	Method	Analyst-Date
Sample ID: B-1 S-3					
Chloride	50	mg/L	5	EPA 9056/PASTE EXTRACT	rdh-04/17
Sulfate	2,619	mg/L	25	EPA 9056/PASTE EXTRACT	rdh-04/17
pH	8.0	S.U.		EPA 9045	jpt-04/16
Sample ID: B-8 S-2					
Chloride	39	mg/L	3	EPA 9056/PASTE EXTRACT	rdh-04/17
Sulfate	895	mg/L	10	EPA 9056/PASTE EXTRACT	rdh-04/17
pH	8.0	S.U.		EPA 9045	jpt-04/16
Sample ID: B-11 S-2					
Chloride	13	mg/L	1	EPA 9056/PASTE EXTRACT	rdh-04/17
Sulfate	169	mg/L	3	EPA 9056/PASTE EXTRACT	rdh-04/17
pH	7.6	S.U.		EPA 9045	jpt-04/16

The above analytical results apply only to the sample(s) submitted.

Midwest Laboratories, Inc.
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www.midwestlabs.com

REPORT OF ANALYSIS

Account: 1291 TERRACON INC
Report Number: 03-108-2041

Analysis	Level Found	Units	Detection Limit	Method	Analyst-Date
Sample ID: B-9 S-4					
Chloride	50	mg/L	3	EPA 9056/PASTE EXTRACT	rdh-04/17
Sulfate	1,118	mg/L	10	EPA 9056/PASTE EXTRACT	rdh-04/17
pH	7.6	S.U.		EPA 9045	jpt-04/16

Respectfully Submitted

Heather Ramig/Sue Ann Seitz/Rob Ferris
Client Services

The above analytical results apply only to the sample(s) submitted.

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