HARDIN-KIGHT ASSOCIATES, INC.
CONSULTING ENGINEERS

August 10, 2011

Project No.: 11174

EMH&T
5500 New Albany Road
Columbus, OH 43054

Attention: Mr. Todd Cunningham

Reference: Geotechnical Investigation
Veterans Affairs Medical Center – Dementia Unit
Martinsburg, Berkeley County, West Virginia

Dear Mr. Cunningham:

In accordance with your request, we have completed a geotechnical investigation for the above referenced project. Transmitted herein is a report of our findings and recommendations regarding site grading, foundations, pavements, utility construction, and related geotechnical considerations. The work was completed in accordance with our proposal dated July 9, 2011.

We appreciate the opportunity to assist you in this project. Please call us if you have any questions concerning geotechnical aspects of this site.

Very truly yours,

HARDIN-KIGHT ASSOCIATES, INC.

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Associate Engineer

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OVERVIEW OF CONCLUSIONS & RECOMMENDATIONS

The following is a summary of conclusions and recommendations regarding the recent subsurface investigation at the VAMC in Martinsburg, West Virginia.

1. The site is suitable for the proposed development. Building foundations may be supported on normal shallow spread footings proportioned for an allowable soil pressure of 3,000 psf.

2. Auger refusal was encountered in 7 of the 12 borings, at depths of 7 feet or more below the existing surface. Therefore, we anticipate that rock will be encountered only in excavations deeper than approximately 7 feet. A blasting contingency should be established.

3. Medium to high plasticity clayey soils were encountered throughout the depth of the borings. Based on the results of our laboratory testing, the clayey soils exhibit a moderate potential for swelling due to changes in moisture content. The clayey soils can also be considered to be low-strength with respect to pavement support. The highly plastic, low-strength clayey soils must not be present within the top foot of pavement and slab subgrade. It must either be removed and replaced with approved granular fill, or chemically treated with hydrated lime.

4. Existing fill was encountered in 3 of the borings. Based on the results of the borings, we anticipate that the majority of the fill will be able to be left in place. The fill should be proofrolled and compacted under the supervision of the geotechnical engineer prior to any fill placement, in accordance with the recommendations provided in this report. It is possible that some areas of fill, as well as existing foundations, utilities and other man-made structures, may require removal, based on the recommendations provided by the geotechnical engineer during construction.

5. Based on the results of the borings, we do not anticipate that problems associated with Karst topography will be encountered. However, due to the limitations inherent in the investigation, and the nature of the regional geology, it is possible that some problems may occur. Problems associated with Karst topography include differential settlement, piping and sinkholes. It is imperative that the basic precautions provided in this report be implemented. If problems arise, this office must be contacted immediately.

REPORT OF GEOTECHNICAL INVESTIGATION

**VAMC MARTINSBURG, WV
BERKELEY COUNTY, WEST VIRGINIA
AUGUST 2011**

1.0 INTRODUCTION

Submitted herein is our report of subsurface investigation for the proposed buildings to be constructed at the Veterans Affairs Medical Center (VAMC) in the Martinsburg area of Berkeley County, West Virginia. This investigation was undertaken in accordance with your request to evaluate the subsurface conditions and to make recommendations for design and construction of foundations, pavements, slabs, utilities and site grading. This report includes the results of exploratory drilling, engineering analysis, and recommendations.

Included in the field exploration were 12 Standard Penetration Test (SPT) borings, and 2 offset borings, located within the proposed building areas. Laboratory testing was performed on representative samples recovered during the subsurface exploration. Conclusions and recommendations regarding site development were derived from engineering analysis of field and laboratory data and review of the site plan.

We were provided with a site plan dated June 11, 2011, entitled *VAMC Martinsburg – Site Plan Option 7*, prepared by Evans, Mechwart, Hambleton & Titan, Inc. (EMH&T), the site engineer. The site plan indicates existing topography and site features and the layout of the proposed buildings and roadways. Proposed grades are not provided on the site plan. However, we were provided with approximate slab grades for the Phase 1 portion of the construction.

2.0 SITE CONDITIONS

The proposed Dementia Unit site is located on the western side of overall VAMC site, at the intersection of A Avenue and C Avenue, in Martinsburg, West Virginia. The site currently consists of a grassy field with scattered trees. A Avenue passes through the western side of the proposed site. The site is bounded by an existing building to the north, parking lots to the east and west, and a paved driveway to the south. A Site Location Map is included as Figure 1, in Appendix A.

Site topography is relatively flat, with the exception of a raised area surrounding the existing building on the northern side of the site. The site grades generally fall from the north towards the south and east. Based on the site plan, ground surface elevations range from a low elevation of approximately 496 feet above Mean Sea Level (MSL), on the southeastern corner of the site, to a high elevation of approximately 506, adjacent to the building. The site grades over the majority of the site range from El. 496 to El. 499 feet above MSL.

3.0 PROPOSED CONSTRUCTION

The proposed Dementia Unit is to consist of 5 new buildings. Only 3 of the proposed buildings, located on the northern portion of the site, are to be part of the Phase 1 construction. The two buildings on the southern portion of the site are considered "future buildings." The building to be located on the northwestern portion of the site is to be the first building constructed, along with a 2-story connector to the existing building. Connections are also planned for each of the future buildings. We understand that the proposed buildings will be 3-story slab-on-grade construction with column loads on the order of 100 to 160 kips. The slabs for each of the 3 initial buildings are to be at or near El. 498 feet above MSL.

Based on the site plan, we understand that the first building, which is to be located on the northwestern portion of the site, and the future building on the southwestern portion of the site, are to be situated across the existing A Avenue. That portion of A Avenue will be removed and reconstructed just west of the proposed building area, adjacent to the parking lot located to the west of the site. In addition, the parking area currently located on the eastern side of the site is to be expanded into the southeastern corner of the proposed site. A circular driveway is also planned for that area, adjacent to one of the future buildings.

The recommendations and conclusions contained in this report are based on the proposed construction as described above. If actual conditions vary from those described above, this office should be contacted to review this report and prepare alternate recommendations if needed.

4.0 INVESTIGATION

Our study included a review of the geological literature and performance of a field investigation and laboratory testing. The field investigation included drilling 12 Standard Penetration Test (SPT) borings at the locations indicated on the Boring Location Plan, included as Figure 2 within Appendix A. The Boring Location Plan is a version of the site plan provided by EMH&T, altered to show the boring locations. The borings were located by Hardin-Kight Associates (HKA) using existing site features. Therefore, the boring locations should be considered approximate.

The borings labeled as B-1 through B-9 were drilled in the area of the three initial buildings. Boring B-10 was drilled in the vicinity of the proposed Phase 1 building connector. Borings B-11 and B-12 were drilled at the proposed future building locations. All of the borings were planned to be drilled to a depth of 15 feet below the existing surface. However, auger refusal was encountered in 7 of the 12 borings prior to reaching the planned depth.

Standard Penetration Testing was performed as per ASTM Test Designation D 1586 *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils,* and soil samples were retrieved at 2.5-foot intervals to 10 feet and at 5-foot intervals, thereafter. Standard Penetration Testing involves driving a 2-inch O.D., 1 ⅜ -inch I.D. split-spoon sampler with a 140-pound hammer free-falling 30 inches. The SPT N-value, given as blows per foot (bpf), is defined as the total number of blows required to drive the sampler from 6 to 18 inches.

The soils have been visually classified in accordance with the Unified Soil Classification System (ASTM D 2488). Samples were returned to the laboratory for testing. Descriptions as provided on the logs are visual, supplemented by the laboratory test results. The boring logs are included in Appendix B. The existing ground surface elevations provided on the logs were interpolated from the topographic map on the site plan prepared by EMH&T, and should be considered approximate.

Groundwater levels were generally recorded in the borings during drilling, at the completion of the soil sampling and at approximately 24 hours after the completion of drilling.

5.0 SUBSURFACE CONDITIONS

5.1 Geology

We reviewed published literature regarding the geology and the Soil Survey of Berkeley County, West Virginia for the site. According to *Map 3 Geology of the Berkeley County Comprehensive Plan 2006*, the geologic type underlying the site is limestone. According to the *Geologic Map of the Frederick 30' x 60' Quadrangle, Maryland, Virginia, and West Virginia* (Southworth et al. 2008), the geo units underlying the site are the Chambersburg Formation and Rockdale Run Formation

The Rockdale Run Formation consists of cyclically bedded limestone and dolostone. The limestone is medium-bluish-gray, medium-gray, and dark-gray, fine to medium grained, thin to medium bedded, fossiliferous, and contains intraformational conglomerates, algal bioherms, bioclastic zones, burrow mottling, and chert nodules. The dolostone is laminated and displays abundant mud-cracks. The interbedded limestone and dolostone occur as cycles.

The Chambersburg Formation consists of interbedded limestone and calcareous shale. The limestone is medium- to medium-dark-gray, thin- to medium-bedded, knobby weathering and irregularly bedded, fine- to medium-grained. The calcareous shale is medium-dark to dark-gray.

Berkeley County is generally located in an area characterized by Karst topography. Karst topography refers to landscape where the bedrock is shaped or sculpted by the variable dissolution of the rock by water. The types of rock listed in the above referenced geologic units are forms of carbonate rock, which most commonly include limestone (calcium carbonate), dolostone (calcium-magnesium carbonate), and marble (calcium carbonate). Limestone is the most calcareous in nature and thus the most vulnerable to the variable dissolution. Geologic forces over time allow water to access the more soluble strata, which causes voids in the areas surrounding the more resistant strata. Potential problems for development that can occur in Karst terrain include differential settlement, piping and sinkholes.

For a more detailed description of the geologic unit, please refer to the above publications.

5.2 Soils

According to the NRCS Web Soil Survey *Soil Map - Berkeley County, West*, the subject site is underlain by Swanpond silt loam, 0-3% slopes (SwA) soils. The Swanpond soils are clayey residuum weathered from limestone located in karst valleys. They are described as moderately well drained. The typical profile consists of silt loam from 0 to 7 inches and clay from 7 to 65 inches. For small commercial buildings, they are rated as very limed due to shrink-swell soils, and for local roads and streets, they are rated as very limited due to low strength and shrink-swell soils.

The low strength and shrink-swell limitations listed in the soil description can be mitigated by removal and replacement or chemical treatment of the clayey soils in slab and pavement areas. These mitigations are discussed further in the *Analysis/Discussion* and *Recommendations* sections of this report.

5.3 Conditions Encountered

The conditions encountered are consistent with the geological and soils information. Approximately 0 to 4 inches of topsoil was encountered at the boring locations. Existing fill was encountered in Borings B-9, B-10 and B-12, from the surface to approximately 7.7 feet below existing grades. The fill at the boring locations consists of medium to highly plastic, lean to fat CLAY with varying amounts of sand and rock fragments. The fill was stiff to hard, referencing SPT "N" values ranging from 13 blows per foot (bpf) to 40 bpf.

Below the topsoil and existing fill, the natural soil at the site generally consists of medium to highly plastic, lean to fat CLAY, with varying amounts of sand and rock fragments. The natural soils are stiff to hard, referencing SPT "N" values ranging from 12 bpf to 50 blows for no penetration. The soils are residual in nature, developed in-place from chemical and physical decomposition of the parent rock material.

Groundwater was not encountered in the borings, either during drilling, or up to 24 hours after the completion of drilling.

Competent rock causing auger refusal was encountered in 7 of the 12 borings at depths ranging from 7 to 11.5 feet, corresponding to El. 485.6 to El. 494.7 feet above MSL. Offset borings were drilled at 2 of the boring locations which encountered auger refusal. The refusal depth in the offset borings was near in depth to that encountered in the original borings. We obtained samples of the rock during the investigation, which we returned to our laboratory for classification. The samples were classified as dolostone by our geologist.

The laboratory analysis for the samples from the borings indicate that the fine grained soils are moderately to highly plastic clays, with liquid limits ranging from 45 to 85 and plasticity indices ranging from 22 to 52. The natural moisture content for the clayey soils ranged from 17.5 to 30.7 percent, with an average moisture content of approximately 24 percent.

Due to the highly plastic nature of some of the clayey soils encountered in the borings, we performed swell tests on a clay sample taken from Boring B-3, from 5 to 6.5 feet. An unrestrained swelling test was performed with a vertical pressure of 125 psf, and the sample was re-tested with a vertical pressure of 3,000 psf. Water was admitted to the sample through porous disks and the vertical expansion of the sample was measured as a function of time. The expansion of the sample subjected to the 125 psf of pressure practically ceased after 1 day, and had an increase in thickness of 0.0259 inches, or

3.32% of the original volume. After the consolidation of the sample subjected to 3,000 psf of pressure, the increase in thickness practically ceased after just under 1 day, and had an increase in thickness of 0.0019 inches, or 0.24%. According to *Foundation Engineering, Second Edition* (Wiley, 1974), for a sample subject to a small vertical pressure a volume change ranging from 1.5 to 5 percent can be considered as medium swelling.

Detailed records of the conditions encountered are included on the attached Records of Soil Exploration (Boring Logs), included in Appendix B. Idealized soil profiles representing the subsurface conditions are presented as Figures 3 and 4. The laboratory test results are included in Appendix C.

6.0 ANALYSIS/DISCUSSION

In our opinion, the subsurface conditions on this site are well suited for the proposed construction. However, special consideration must be given to the highly plastic soils below pavements and slabs.

6.1 Earthwork

Based on the proposed building slabs at El. 498 feet above MSL, the majority of the building area will require excavations and controlled fill of 2 feet or less. The northern portion of the proposed building to be located on the northeastern portion of the site will require excavations of up to 6 feet.

Based on the results of the borings, we anticipate that the majority of the existing fill may be left in place. However, it is possible that fill, as well as foundations, utilities or other items associated with A Avenue, and the pavements and minor structures surrounding the existing building, will require removal. The decision on the possible removal of existing man-made fills, foundations, utilities, etc. must be made in the field by the geotechnical engineer.

Auger refusal was encountered in 7 of the borings at depths ranging from 7 to 11.5 feet, corresponding to El. 485.6 to El 494.7. Therefore, we do not anticipate that difficult excavations or competent rock will be encountered during site grading.

The on-site natural soils are generally considered to be suitable for use as compacted fill. However, the near surface soils contain low-strength fine grained materials. The low-strength soils should not be used within the top foot of pavement or slab subgrade. Alternatively, the on-site soils may be used as controlled fill if they are chemically treated with hydrated lime prior to the building and pavement construction.

It will likely be necessary to dry some of the soils in order to achieve the required compaction. It is important that fill be placed in accordance with the *Recommendations* section of this report.

The earthwork construction must be conducted in a manner that will minimize disturbance of the near surface soils especially at the pavement subgrades. The contractor must maintain positive drainage throughout the site and must control construction traffic to minimize disturbance to previously completed areas.

6.2 Foundations

Based on the results of the borings, the undisturbed soils on this site are suitable for support of the spread footings proportioned for an allowable bearing pressure of 3,000 psf. Soft or unsuitable soils may be encountered in the existing fill in isolated areas. Soft soils are not considered to be adequate for direct foundation support. The soft soils, when encountered, will need to be either compacted in place or removed to medium stiff to hard soils and replaced with controlled fill, in accordance with the *Recommendations* section of this report.

Groundwater was not encountered during drilling or observed in the borings at 24 hours after the completion of drilling. Therefore, we do not anticipate that the groundwater will be a major factor during construction. However, perched rainwater may exist in some isolated areas within the clayey soils. Standard construction dewatering techniques should be utilized when groundwater is encountered.

Rock was encountered in 7 of the borings from El. 485.6 to El. 494.7. The proposed slabs for the buildings are to be at or near El. 498. Therefore, we do not anticipate that rock will be encountered during foundation excavations. However, it is possible that rock could be encountered in isolated areas. The contractor should be prepared for difficult excavations. Although not considered likely, it is possible that blasting could be required in isolated areas.

6.3 Seismic Information

Utilizing the SPT data from the field exploration and the guideline set forth by the 2003 International Building Code (IBC 2003 – Table 1615.1.1), the site is classified as "Site Class C".

6.4 Floor Slabs

Floor slabs for the buildings can be designed as concrete slabs on grade. However, moderately to highly plastic soils were encountered in the borings. Based on the results of the laboratory swell tests conducted on the highly plastic soils, the potential for swell in the natural and fill soils does exist. The plastic soils must be removed from the top foot of slab subgrade and replaced with approved fill, or the existing soils must be modified with lime treatment, prior to slab construction. Once the soils are replaced or modified, the slab can be designed based on a modulus of subgrade reaction of 150 pci. The slabs should be designed and constructed in accordance with the *Recommendations* section of this report.

6.5 Subsurface Utilities

The natural soils are generally considered to be suitable for the support of the utility pipe systems. The soils encountered during utility installation can be generally used for trench backfill. However, low strength and/or highly plastic soils should not be used within the final foot of pavement or slab subgrade, unless the slab and pavement soils are to be chemically treated prior to construction.

Competent rock causing auger refusal was encountered in 7 of the borings, and is likely to be encountered during utility installations deeper than 7 feet below the existing grade. The very dense materials may be removed by conventional ripping techniques in some areas. However, blasting may be required for the deep excavations in some areas and should be anticipated.

The materials removed during construction may be wet of optimum and drying may be required to achieve compaction specifications for the backfill.

6.6 Pavements

The soils encountered are generally suitable for use in construction of compacted fill for the roadway areas. However, the low-strength, highly plastic clayey soils must not be used within the top foot of pavement subgrade. The final foot of fill must consist of granular material approved by the geotechnical engineer. Alternatively, the clayey soils may be used within the top foot of pavement subgrade if they are treated with hydrated lime under the supervision of the geotechnical engineer.

If a granular base course is used in the pavement section, as proposed, it is important that completed portions of the base be positively drained and protected from construction traffic, particularly after precipitation. Surface water which is trapped in the completed stone base may contribute to deterioration of the subgrade if construction traffic is allowed to traverse a saturated granular base. We suggest that the pavement areas be paved as soon as practical to reduce the potential for subgrade softening due to surface water and to reduce the possibility of disturbance due to traffic on an exposed pavement subgrade (even automobile traffic).

We have not been provided with traffic loading for the proposed roadways. In addition, subgrade CBR values will not be known until the nature of the pavement subgrade has been determined, i.e. imported granular fill or chemically treated on-site soils. We performed a preliminary pavement analysis, based on the assumed traffic loading and an estimated design CBR of 5.0. Please refer to the *Recommendations* section of this report for the preliminary pavement design.

6.7 Considerations for Karst Topography

The rock type observed during our investigation was determined to be dolostone, not the limestone typically associated with Karst topography. Therefore, we do not anticipate that problems associated with calcareous solution cavities will be a major concern for the project. However, it is possible that the dolostone may be thinly bedded above limestone, or that limestone may be present between the boring locations. In addition, it should be noted that the ability to examine the site geologic features is limited by the relatively small diameter of the boreholes. Basic precautions as provided in the *Recommendations* section of this report must be implemented to reduce the possibility of problems such as sinkholes, differential settlement and piping due to calcareous geology

7.0 RECOMMENDATIONS

7.1 Earthwork

1. We recommend that the existing ground surface in proposed building fill areas and to a minimum distance of 10 feet beyond the building limits be stripped of topsoil and root mat, where applicable.

2. We recommend that structural fill areas be proofrolled using a loaded tandem dump truck or a rubber tire roller with a gross weight in excess of 30 tons. The proofroll shall be performed in the presence of a geotechnical engineer or his representative. We recommend that soft or loose subgrade soils identified by the proofroll either be removed and replaced with suitably compacted structural fill or be manipulated and compacted until a satisfactory stable condition is obtained.

3. We recommend that existing fill be left in place if it is compacted, proofrolled and approved by the geotechnical engineer. Existing foundations and pavements should be completely removed and replaced with controlled, compacted fill. Existing foundations, utilities, pavements, etc. may be left in place as approved by the geotechnical engineer in conjunction with the owner and the site engineer.

4. We recommend that on-site native soils be used as controlled fill. However, we recommend that the on-site clayey soils not be used in the top foot of roadway or slab subgrade. Alternatively, the on-site clayey soils may be used in the top foot if they are treated with lime prior to construction.

5. We recommend that the structural fills in building areas and below the final foot within the pavement areas be compacted to a minimum of 95% of the maximum dry density as determined by the standard moisture density relationship test (ASTM D-698, AASHTO T-99). The top foot of pavement subgrade should be compacted to 100% of the maximum dry density.

6. We recommend that the hard clay chunks from excavations be pulverized and placed in lifts of 8 inches or less. We recommend that each layer of fill be tested and approved prior to placement of the succeeding layer. We recommend that fill which fails to meet the minimum compaction requirements be compacted and reworked until satisfactory compaction is obtained.

7. We recommend that off-site borrow soils proposed for use as structural fills meet the requirements for soil classifications GM, GP, GW, SM, SP or SW in accordance with the Unified Soil Classification System (D-2487). We recommend that the off-site borrow soils contain no more than 30% material passing the U.S. standard #200 sieve with a maximum plasticity index (PI) of 10.

7.2 Foundations

1. We recommend that the proposed buildings be founded on spread footings bearing on firm natural subsoils or suitably compacted structural fill and designed for an allowable soil bearing pressure of 3,000 psf.

2. We recommend that footings be at least 16 inches in width for continuous strip footings and 24 inches for isolated column footings. We recommend that exterior footings be located at a minimum depth of 30 inches for frost protection. Interior footings may be located at minimum depths below the slab. If foundation

construction is conducted during the winter months, interior footings must be protected from frost or lowered to 30 inches.

3. We recommend that the footing excavations for the buildings be inspected and tested by a representative of the soils engineer prior to concrete/stone aggregate placement. The soils engineer or his representative shall confirm that the subfoundation soils are suitable. If the subfoundation soils are found to be unsatisfactory, the footing shall be modified as directed by the soil engineer in conjunction with the structural engineer.

4. We recommend that loose/soft soils, as identified by a representative of the soils engineer, be removed from beneath the proposed foundations and replaced with controlled, compacted fill.

7.3 Seismic Information

1. We recommend that the site be classified as "Site Class C".

7.4 Floor Slabs

1. We recommend that ground floor slabs be designed as floating slabs, not rigidly connected to bearing walls or foundations to accommodate differential settlement between foundations and the slab.

2. We recommend that on-site clayey soils be removed from the top foot of slab subgrade and replaced with approved, granular fill. Alternatively, we recommend that the slab subgrade be treated with hydrated lime under the supervision of the geotechnical engineer.

3. We recommend that the slab be designed based on a modulus of subgrade reaction of 150 pci, provided that granular fill or chemically treated site soils are present within the top foot of pavement subgrade.

4. We recommend that a minimum 4-inch thick layer of free draining granular material be placed beneath floor slabs to improve drainage and provide a firm level surface for concrete placement. We recommend that a plastic vapor barrier be provided between the concrete and drainage layer to prevent dampness.

5. Prior to placement of the drainage layer, we recommend that the slab subgrade be inspected, tested and approved by a soils testing agency or the county building inspector. We recommend that soft/loose or wet areas that yield under

construction traffic be either compacted in place or removed and replaced with suitably compacted fill.

7.5 Subsurface Utilities

1. We recommend that a 6-inch granular bedding be placed beneath the pipe to provide uniform support when the pipe is supported on clayey soil, rock, or when groundwater is encountered.

2. We recommend that the low-strength soils not be used within the final foot of pavement or slab subgrade, unless the subgrade is to be chemically treated prior to construction.

3. We recommend that the contractor be prepared for difficult excavations, particularly for excavations deeper than approximately 7 feet below the existing surface. A contingency for blasting should be provided in the contract documents.

4. We recommend that utility backfill be compacted in accordance with the *Earthwork Recommendations* section of this report.

7.6 Pavements

1. We recommend that the pavement subgrade preparation be conducted in the presence of the geotechnical engineer or his representative. The completed work shall be tested and approved by the geotechnical engineer prior to construction of the succeeding work.

2. We recommend the final foot of pavement subgrade consist of off-site granular fill approved by the geotechnical engineer. Alternatively, clayey soil may be used for the final foot of pavement subgrade if they are treated with hydrated lime under the supervision of the geotechnical engineer.

3. We recommend that pavement subgrade be proofrolled using a loaded tandem dump truck or a rubber tire roller with a gross weight in excess of 30 tons. We recommend that soft, loose or wet conditions, identified during the proofroll, be corrected in accordance with the following procedures:

    a. materials may be removed and replaced with suitable fill materials compacted to the required density.

b. the materials may be reworked and recompacted until satisfactorily compacted to the required density.
c. unsatisfactory subgrade may be improved by installation of ground stabilization cloth and additional thickness of base material.
d. longitudinal underdrains shall be installed in poorly drained areas as directed.

4. We recommend that all additional work associated with pavement subgrade preparation be documented by the geotechnical engineering representative and approved by the owner's representative prior to implementation.

5. We recommend that the following pavement section be utilized for preliminary purposes, based on a design CBR of 5.0:

 1.5-inches Bituminous Surface Course
 3.0-inches Bituminous Base Course
 6.0-inches Graded Aggregate Base

 For the heavy-duty travel lanes we recommend the following pavement section be used for preliminary purposes:

 1.5-inches Bituminous Surface Course
 3.0-inches Bituminous Base Course
 8.0-inches Graded Aggregate Base

6. We recommend that the contractor proceed with the placement of pavement base course within twenty four hours after subgrade approval and proceed with the construction of the binder course within twenty four hours of the satisfactory construction of the base course. If precipitation occurs during the course of these operations, a re-evaluation by the geotechnical engineer is recommended prior to proceeding.

7. We recommend that the contract documents include provisions for placement for extra work associated with preparation of the pavement subgrade on a unit price basis for the following items:

 a. for undercut of unsuitable materials and removal to an on-site storage area; per cubic yard
 b. for undercut of unsuitable materials and off-site removal; per cubic yard

c. for replacement fill using on-site soils; per cubic yard
d. for replacement fill using off-site soils; per cubic yard
e. for ground stabilization cloth; per square yard
f. for longitudinal underdrain; per linear foot

8. We recommend that a final CBR testing program be implemented after the completion of rough grading and prior to the final pavement design. The preliminary pavement section may be altered based on the results of the final CBR laboratory testing.

7.7 Karst Topography

1. We recommend that suitable site drainage be provided during and after construction, including sloping site grades away from proposed structures.

2. We recommend that roof leaders for the proposed buildings be directed into the storm drain system.

3. We recommend that water tight storm drains be utilized.

4. If sinkholes are encountered during or after construction, we recommend that this office be contacted immediately and that they be treated on a case-by-case basis.

7.8 Construction Inspection and Testing

We recommend that the owner retain the services of a geotechnical engineer to:

1. Monitor earthwork operations including approval of the ground surface prior to placement of fill, proofrolling, and performance of compaction tests.

2. Observe foundation construction including inspection of the footing excavations and performance of modified penetration tests to confirm subfoundation soil suitability.

3. Test and inspect subgrade preparation for pavements including monitoring, proofrolling and confirming subgrade suitability prior to placement of base or surface courses.

8.0 LIMITATIONS

This report was prepared in accordance with generally accepted practice for geotechnical engineering in this area. It is intended for the use of the client for the specific site, as shown on Figure 2, for design purposes. The recommendations are based on the general description of the structures and site development as characterized above. If the project is substantially modified, this office should be notified so that we can review our recommendations to determine what impact the changes will have. We request the opportunity to review the site development and structural drawings as they become available.

The soil and water conditions discussed herein represent the conditions encountered at the locations of the exploratory borings as shown on the boring location plan. Variations in the soils between the boring locations and below the depths explored should be anticipated.

Attached are copies of our boring logs, site location map, boring location plan, soil profiles, and laboratory test results for your reference. If you have any questions concerning this report, please call our office.

Very truly yours,

HARDIN-KIGHT ASSOCIATES, INC.