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GEOTECHNICAL REPORT

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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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