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August 10, 2016
Kleinfelder Project No. 20164613.001A/CSP16R43016

Mr. Gary Syling
Division Head Facilities
Pikes Peak Library District (PPLD)
Library 21c
1175 Chapel Hills Drive
Colorado Springs, Colorado 80920

Subject: **Pavement Evaluation Report**
PPLD Library 21c
1175 Chapel Hills Drive
Colorado Springs, Colorado 80920

Dear Mr. Syling:

This letter transmits Kleinfelder's report presenting the findings of our pavement evaluation for PPLD Library 21c located in Colorado Springs, Colorado. Our services were provided in general accordance with Task 001 of our Proposed Scope of Services dated January 25, 2016. The attached report states our understanding of the project and presents our exploration procedures, encountered conditions, and recommendations.

Kleinfelder evaluated the general pavement condition at the subject site, possible causes of pavement distress, and prepared recommendations for remedial construction to correct the observed pavement distress. As detailed in the attached report, pavements at the site are exhibiting a wide variety of types and severity levels of distress, primarily due to environmental conditions combined with the pavement approaching the end of its serviceable design life. We have recommended removing and replacing the existing asphalt concrete and completing minimal grading to improve site drainage. Subsequent phases of this project will include preparation of plans and specifications, and project closeout.

Kleinfelder appreciates the opportunity to provide engineering services for this project. Should you have any questions about the report or need additional services on this or any other project, please contact us.

Sincerely,

KLEINFELDER

JG T. McCall, EIT
Staff Geotechnical Engineer

Scott J. M. Sounart, PE (Colorado)
Senior Principal Professional

PAVEMENT EVALUATION
PPLD LIBRARY 21c
1175 CHAPEL HILLS DRIVE
COLORADO SPRINGS, COLORADO 80920
KLF PROJECT 20164613.001A

August 10, 2016

A Report Prepared for:

Mr. Gary Syling
Division Head Facilities
Pikes Peak Library District (PPLD)
Library 21c
1175 Chapel Hills Drive
Colorado Springs, Colorado 80920

DRAFT PAVEMENT EVALUATION REPORT
PPLD LIBRARY 21c
1175 CHAPEL HILLS DRIVE
COLORADO SPRINGS, COLORADO 80920

Prepared by:

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8/10/16

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August 10, 2016
Kleinfelder Project No.: 20164613.001A

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1 INTRODUCTION

1.1 PROJECT DESCRIPTION

This report presents the results of Kleinfelder's pavement evaluation conducted for the Pikes Peak Library District (PPLD) Library 21c, located at 1175 Chapel Hills Drive, Colorado Springs, Colorado, as shown on the Site Vicinity Map in Figure 1.

1.2 PURPOSE AND SCOPE

The purpose of this study was to obtain information regarding general pavement and related infrastructure asset conditions at the subject site, evaluate potential causes of the pavement distress, and provide recommendations for remediating the documented pavement and related infrastructure assets distress.

Kleinfelder services included the following:

- Performing a site walk to visually evaluate existing pavement conditions. As part of this site walk, we met with on-site personnel, visually observed site conditions, and identified areas exhibiting cracking and other pavement distress (including fatigue cracking, rutting, pot holes, water seepage, etc.);
- Conducting a limited pavement exploration that included advancing three borings through the existing asphalt to depths of 9 to 10 feet;
- Performing laboratory testing of the subgrade materials, as necessary;
- Evaluation and engineering analyses of the field and laboratory data collected to develop our geotechnical conclusions and recommendations; and
- Preparing this summary report presenting our findings and recommendations.

Our scope of services did not include environmental assessment or investigation for the presence or absence of hazardous or toxic materials in the soil, ground water, or surface water within or beyond the site studied. Any statements in the report regarding odors, staining of soils, or other unusual conditions observed are strictly for the information of PPLD.

2 FIELD EXPLORATION AND LABORATORY TESTING

2.1 FIELD OPERATIONS

Subsurface evaluation and visual pavement survey was perfomed by a qualified Kleinfdelder professional on March 29, 2016 and April 8, 2016 respectively. An exploration location plan is presented as Figure 2. The existing facility consists of approximately 160,000 square feet of asphalt concrete (AC) pavement for parking and drive lanes, with another 2,400 square feet of portland cement concrete (PCC) in the loading dock and ballot drop off area.

2.2 PAVEMENT AND SUBGRADE EXPLORATION

Three shallow borings (P-1 through P-3) were advanced to a maximum depth of 10 feet below ground surface (BGS) using a truck-mounted drill rig equipped with 4-inch-diameter solid-stem augers. Boring locations were located in the field using a hand held GPS unit. Approximate borehole locations are presented in the Exploration Location Plan in Figure 2.

Disturbed samples were collected at selected depths using a standard-penetration-test sampler (1.375-inch inside diameter/2-inch outside diameter). The samplers were advanced using a 140-lb cat-head hammer falling 30 inches. The number of blows necessary to advance the sampler in six-inch increments was recorded on the boring logs. The boreholes were backfilled with soil cuttings and capped with cold-patch asphalt.

During the field exploration, the soils encountered were visually classified, logged, and sampled by Kleinfelder's field representative. The recovered soil samples were placed in plastic bags to minimize moisture loss and transported to our laboratory for additional testing.

2.3 LABORATORY TESTING

Selected laboratory tests were performed on representative samples of the subgrade material recovered from the borings. Testing consisted of grain size analysis and moisture content determination. The results of these laboratory tests are provided in Appendix C.

3 EXISTING CONDITIONS

3.1 PAVEMENT THICKNESS

The asphalt pavement and aggregate base course (ABC) thickness were measured at each of our boring locations. Approximate thicknesses are summarized in Tables 3.1.

Table 1
Existing Pavement Section Thickness

Location	Approximate AC Thickness (in)	Approximate ABC Thickness (in)
P-1	4	4
P-2	3	3
P-3	3	3

3.2 SUBSURFACE CONDITIONS

Fill was encountered beneath the ABC at borings P-1 and P-2 to a depth of 1 foot and 9 feet BGS respectively. The fill was observed to consist of poorly-graded to well-graded sand with clay, brown, moist to wet, with occasional organics at boring P-2. The fill material is medium dense to dense based on field penetration tests. Documentation of placement procedures and compaction effort was not provided for the fill materials, therefore the fill materials encountered on-site should be considered un-documented.

Alluvium sand was encountered beneath the fill material at P-2 and beneath the ABC at P-3. The alluvium sand was observed to be poorly graded, brown, moist to wet, and generally medium dense to dense; alluvial sand was loose at 9 ft sample in P-2. Weathered sandstone was encountered beneath the fill material at boring P-1. The sandstone known locally as the Dawson Formation was observed to consist of fine to coarse grained sand, brown, moist, and was observed to be very dense based on field penetration tests.

Groundwater was not encountered during our subsurface investigation. Soil moisture levels and groundwater levels commonly vary over time depending on seasonal precipitation, irrigation practices, land use and runoff conditions. The soil moisture and groundwater data in this report pertain only to the locations and times at which the exploration was performed. Kleinfelder has not performed a hydrologic study to assess the seasonal groundwater conditions

3.3 PAVEMENT CONDITION SURVEY

The pavement construction or maintenance history for the store is unknown. A large number of cracks at the site have been sealed with a rubberized crack sealant, and numerous patches of various sizes have been applied. We understand from discussions with PPLD personnel the building was likely constructed in the mid 1980's and the property was vacant for approximatley 10 years prior to the library opening in 2014.

Pavement distress descriptions are presented in terms typical of those used in Federal Highway Administration (FHWA) pavement distress identification. The pavements obsersed at the site are experiencing wide spread distress consiting of moderate- to high-severity levels of transverse and longitudinal cracking, block cracking, fatigue (alligator) cracking, raveling, and rutting. The entrances and drive lanes have experienced the highest severity and most widespread pavement distress.

3.4 DEFINITIONS OF PAVEMENT DISTRESS

Longitudinal cracks generally occur along construction joints between the edges of the paving lanes. They are usually the least dense areas of a pavement. The primary causes of longitudinal cracking are poor compaction, shrinkage of the asphalt layer, poor construction materials or mix design, and longitudinal segregation due to improper paver operation. Generally, longitudinal cracking is not load related, unless the cracking is within a wheel path. Wheel path joint cracking may also occur under heavy load or tire pressures. Unsealed longitudinal cracking often leads to premature fatigue cracking along the joint, due to moisture infiltration into the underlying subgrade materials.

Transverse cracks run approximately perpendicular to the constructions joints or in random patterns. The primary causes of transverse cracking are environmental (thermal) conditions, combined with the advanced age of the pavement. Although asphalt pavement is a flexible material, when exposed to temperature cycles cracks form as the tensile forces exceed the tensile strength, which occurs more readily as the asphalt material becomes more brittle with age.

Transverse and longitudinal cracks can also be reflective of cracking in underlying pavement layers beneath the surface course.

Full depth transverse and longitudinal cracks can deteriorate to fatigue cracking. This is generally due to moisture infiltration into the underlying subgrade materials weakening the pavement support system. Fatigue cracking may also be caused by inadequate AC section thickness for the traffic volume or loads, weak or unstable subgrade materials, or exceedance of the design life. Cracking typically begins at the bottom of the asphalt surface where tensile stress and strain are at their peaks under traffic loading. Many fatigue-cracked areas begin as a series of parallel cracks that eventually join together. Fatigue cracking is considered a pavement failure. As fatigue cracking becomes severe, the interconnected cracks create small chunks of pavement, which can be dislodged as vehicles drive over them. High-severity fatigue cracking can develop into potholes. Potholes are small, bowl-shaped depressions in the pavement surface that penetrate all the way through the asphalt layer down to the base course.

Raveling is the wearing away of the pavement surface due to a loss of asphalt cement and aggregate. Raveling is usually indicative of hardened asphalt cement or significant oxidation of the asphalt concrete surface. Raveling may also be caused by excessive or abrasive traffic in the wheel paths. Polished or weathered aggregate is primarily caused by repeated traffic applications. When the aggregate in the surface becomes smooth, tire friction is reduced.

4 CONCLUSIONS AND RECOMMENDATIONS

Based on our subsurface investigation and pavement condition survey, the distress observed at the site is likely due to several contributing factors including moisture infiltration through unsealed and partially sealed cracks, load induced vertical stress, embrittlement, and reaching the likely end of it's service life. Due to the relatively thin pavement section observed in the borings (3 to 4 inches) milling of the existing pavement is notfeasible and typical crack and slurry seal options are not considered adequate long term solutions to address the severtiy of the distress observed across a majority of the site. For these reasons we recommend that the existing asphalt pavement section (including aggregate base as needed for site grading) be completely removed and replaced to provide a suitable pavement surface. Additionally, we recommend that the loading dock AC pavement be replaced with Portland Cement Concrete (PCC) pavement. The following sections present our pavement design and construction recommendations.

4.1 PAVEMENT SECTION DESIGN RECOMMENDATIONS

A pavement section is a layered system designed to distribute concentrated traffic loads to the subgrade. Performance of the pavement structure is directly related to the physical properties of the subgrade soils and traffic loadings. Soils are represented for pavement design purposes by means of a soil support value for flexible pavements, and this value is empirically related to strength. Pavement design procedures are based on strength properties of the subgrade and pavement materials. Kleinfelder performed the pavement design using the AASHTOware Program DARWin, which is based on the 1993 AASHTO Guide for Design of Pavement Structures.

4.1.1 Anticipated Pavement Subgrade Material

The pavement subgrade materials encountered in our borings consisted predominantly of sandy soils. Based on penetration test results we have assumed an R-value of 50 for the existing subgrade soils. A resilient modulus (M_R) of 13,100 pounds per square inch (psi) was determined from the following equation per section 4.2 of the City of Colorado Springs Pavement Design Criteria Manual.

$$M_r = 10^{\frac{S+18.72}{6.24}}, \qquad S = \frac{R\ value - 5}{11.29} + 3$$

4.1.2 Design Traffic Loadings

Based on site observations and discussions with PPLD personal we anticipate the majority of the parking lot pavement areas will be subjected to predominantly "light" automobile traffic, as well as infrequent "heavy" truck traffic. For design purposes, based on discussions with PPLD and the capacity of the parking lot, we have assumed average daily traffic volumes will consist of 500 cars and 5 trucks, which yields a minimum 18-kip, ESAL of 125,000 as the design load over a 20 year design life.

4.1.3 Design Sections

The recommended composite asphaltic concrete pavement and concrete pavement sections are presented in the following tables. The design pavement sections were calculated using sections 4.3 and 4.4 of the City of Colorado Springs Pavement Design Criteria Manual and the DARWin AASHTOware program. Strength coefficients of 0.44 and 0.10 were used for HMA pavement and existing ABC.

The following minimum pavement thickness recommendations presented below are based on completing the subgrade preparation as described in Section 5 below. A summary of DARWin pavement sections are presented in Appendix D.

Table 2
Composite Asphalt Pavement Section Thickness

Pavement Area	Composite Section HMA *Overlying* ABC
Parking Areas and Drive Lanes	4-inches HMA over 3-inches existing ABC

Table 3
Concrete Pavement Section Thickness

Pavement Area	Concrete Section PCC *Overlying* ABC
Loading Dock Area	6-inches over 6 inches ABC

Aggregate Base Course (ABC) should consist of crushed gravel, natural gravel, or crushed stone and filler constructed on the prepared subgrade. Aggregate Base Course should conform to the requirements of City of Colorado Springs City Engineering Standard Specifications and should be placed and compacted as specified herein. Existing ABC meeting the requirements stated above may be reused. The material should be placed in a uniform layer without segregation of size and compacted in loose lifts not to exceed 6 inches. The material should be compacted as recommended in Section 5 of this report.

Hot Mix Asphalt (HMA) pavement should consist of a bituminous plant mix composed of a mixture of aggregate and bituminous material that meets the requirements of a job-mix formula established by a qualified engineer. Asphalt/PCC mix design, all associated materials, construction standards, materials testing, and inspection shall conform to the City of Colorado Springs City Engineering Standard Specifications.

4.1.4 Drainage & Maintenance

The collection and diversion of surface drainage away from paved areas is extremely important to the satisfactory performance of pavement. Drainage design should provide for the removal of water and snow from paved areas and prevent the wetting of the subgrade soils.

Annual maintenance generally refers to crack filling and general surface sealers. We recommend implementation of at least annually, if not more frequently, a flatwork/pavement crack sealing program. This is very important to prevent surface water (especially from slow infiltration from sources such as snow melt) from entering cracks and wetting the subgrade. Due to temperature fluctuations in Colorado significant separations can also occur at interfaces between the asphalt pavement and curbs, concrete flatwork, and other features. These areas generally result in a high rate of premature distress and failure that can propagate well beyond the original problem area. Any cracks or openings in the finished pavement surface should be sealed and/or repaired as quickly as possible.

4.2 EXISTING PCC PAVEMENT AREAS

The majority of the PCC pavement areas are generally in acceptable condition and do not require mitigation beyond joint/crack sealant at this time. All cracks in these areas should be sealed immediately with an appropriate sealer, and joints be routed and resealed.

5 SITE AND SUBGRADE PREPARATION

5.1 GENERAL SITE PREPARATION

Site preparations should begin with removing the existing pavement sections. Construction debris, topsoil, organic, and other unsuitable materials encountered during the pavement removal should be removed from the site and disposed of or recycled in accordance with applicable laws and regulations. After removal of the existing pavement sections the site may be graded as needed to accommodate new pavement sections and improve site drainage, we anticipate minimal site grading (less than +/- 1 foot) will be required. The subgrade/ base material should be processed in accordance with the following section prior to placement of new pavement sections.

5.1.1 Subgrade Preparation

Following removal of existing asphalt and aggregate base course at areas that require site grading, subgrade soils should be prepared by scarifying the existing subgrade to a depth of at least 6-inches, moisture conditioning, and re-compacting per the requirements presented in Table 4 in section 5.2 below (subgrade soils consisting of sandstone bedrock should not be scarified). For areas that do not require site grading; following the removal of existing pavement, the aggregate base should be compacted in accordance with the requirements presented in Table 4 in section 5.2.

Following subgrade/aggregate base preparation as described above, the prepared subgrade/aggregate base must be evaluated by a qualified geotechnical engineer through observation of a proof roll with a loaded dump truck or other pneumatic-tired vehicle of similar size and weight to assess the subgrade condition. The purpose of the proof rolling is to locate soft, weak, or excessively wet soils present at the time of construction. Unsuitable materials observed during the evaluation and proof roll should be removed and replaced with properly-compacted fill/base material in accordance with section 5.2 of this report. Some amount of over-excavation should be anticipated during construction due to the presence of undocumented fill materials.

5.2 COMPACTION REQUIREMENTS

Fill materials should be placed in horizontal lifts compatible with the type of compaction equipment being used, moisture-conditioned, and compacted in accordance with following criteria:

Table 4
Fill Placement Criteria

Fill Location	Material Type	Percent Compaction (ASTM D-1557)	Moisture Content
General Subgrade Preparation	On-site Soils	95 minimum	± 2 % of optimum
Aggregate Base Course (ABC)	ABC Material (See Section 4.1.3)	95 minimum	± 2 % of optimum

A qualified geotechnical engineer or representative should observe placement and compaction of subgrade and aggregate base material and perform density tests to confirm that the material has been placed in accordance with project specifications. Fill should be placed in level lifts not exceeding 8-inches in loose thickness, and compacted to the specified percent compaction to produce a stable and firm surface. If field density tests indicate the required percent compaction has not been obtained or the surface is deemed unstable by the geotechnical engineer, the fill material should be reconditioned or stabilized as necessary and re-compacted to the required percent compaction before placing any additional material.

5.3 CONSTRUCTION IN WET OR COLD WEATHER

Earthwork/compaction operations can be significantly impacted by wet weather. Construction operations, equipment, and schedules should take this into account. Depending on critical project schedules, use of stabilization measures, light equipment, tracked equipment and construction storm water drainage control will be important considerations.

No grading fill, structural fill or other fill should be placed on frosted or frozen ground, nor should frozen material be placed as fill. Frozen ground should be allowed to thaw or be completely removed prior to placement of fill. If earthwork is performed during the winter months when freezing is a factor, a good practice is to cover the compacted fill with a “blanket” of loose fill each evening to help prevent the compacted fill from freezing. Prior to commencement of fill placement operations the next morning, the loose fill blanket must be entirely removed and allowed to thaw before incorporating it into the fill.

Concrete elements should not be installed on frozen soil/rock. All frozen soil should either be removed from beneath these elements altogether, or thawed and re-compacted. To avoid soil freezing, minimize the amount of time passing between excavation and construction. Use of blankets, soil cover, or heating, may be desired to help prevent the subgrade from freezing.

Asphalt pavement construction shall follow weather restrictions as presented in the Pikes Peak Region Asphalt Paving Specifications.

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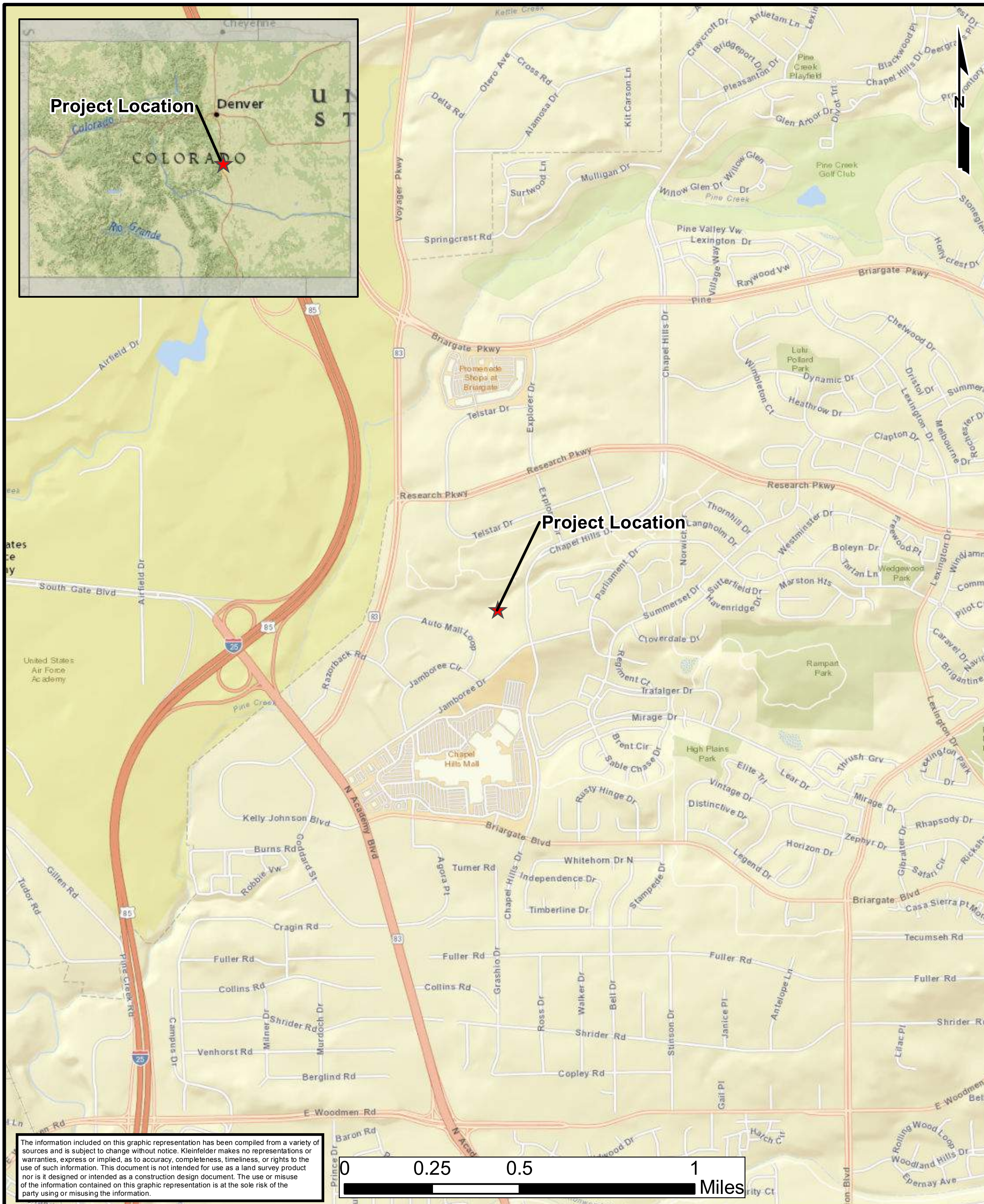
6 LIMITATIONS

The recommendations in this report are based on our field observations, laboratory testing, and our present understanding of the proposed construction. It is possible that subsurface conditions can vary between or beyond the points explored. If the conditions found during construction differ from those described in this report, please notify us immediately so that we can review our report in light of those conditions and provide supplemental recommendations as necessary. We should also review the report if the scope of the proposed construction, including the proposed loads or structure locations, changes from that described in this report.

Kleinfelder has prepared this report for the exclusive use of the Pike Peak Library District. The report was prepared in substantial accordance with the generally accepted standards of practice for geotechnical engineering as exist in the site area at the time of our investigation. No warranty is expressed or implied. The recommendations in this report are based on the assumption that Kleinfelder will be provided review comments and additional information as required to revise/refine recommendations. They also are based on the assumption that Kleinfelder will be retained to conduct an adequate program of construction testing and observation to evaluate compliance with our recommendations.

This report may be used only by the Client, and only for the purposes stated, within a reasonable time from its issuance, but in no event later than one year from the date of the report. Land use, site conditions (both on- and off-site), or other factors may change over time, so that additional investigation or revision of our recommendations may be required with the passage of time. It is the Client's responsibility to see that all parties to the project including the designer, contractor, and subcontractors, are made aware of this report in its entirety. The use of information contained in this report for bidding purposes shall be at the Contractor's option and risk. Any party other than the Client who wishes to use this report must notify Kleinfelder of such intended use. Based on that intended use of the report, Kleinfelder may require that additional work be performed and that an updated report be issued. Noncompliance with these requirements by the Client or anyone else will release Kleinfelder from any liability resulting from the use of this report by an unauthorized party.

FIGURES



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KLEINFELDER Bright People. Right Solutions. www.kleinfelder.com	PROJECT NO. 20164613 DRAWN: 6/2/2016 DRAWN BY: N.Peace CHECKED BY: J.McCall FILE NAME: Fig1_SiteVicinity_8x11.mxd	**Site Vicinity Map** PAVEMENT EVALUATION PPLD LIBRARY 21C COLORADO SPRINGS, COLORADO	FIGURE **1**

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PROJECT NO.	20164613
DRAWN:	6/2/2016
DRAWN BY:	N.Peace
CHECKED BY:	J.McCall
FILE NAME:	Fig2_ExplorationLocations_8x11.mxd

Exploration Location Plan

PAVEMENT EVALUATION
PPLD LIBRARY 21C
COLORADO SPRINGS, COLORADO

FIGURE

2

APPENDIX A
SITE PHOTOGRAPHS

Photograph 1: Moderate- to high-severity cracking and ponding in main entrance, looking south

Photograph 2: Partially sealed moderate-severity fatigue cracking, main entrance ADA parking, looking west.

Photograph 3: Low- to moderate-severity fatigue cracking, NE entrance (Area No. 3), looking north.

Photograph 4: Low-severity fatigue and joint cracking around patches, SW entrance area (Area No. 2), looking north.

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PPLD Library 21c Pavement Evaluation
Colorado Springs, Colorado
Photos Taken: April 08, 2016

Pavement Condition Photographs

Photograph 5: Low- to moderate-severity fatigue cracking, and patches, loading dock, looking southwest.

Photograph 6: high-severity edge cracking, fatigue cracking, settlement and ponding, loading dock, looking south.

Photograph 7: Isolated low-severity scaling, low-severity corner break, loading dock, looking west.

Photograph 8: low-severity fatigue cracking, low-severity raveling, loading dock area, looking south.

Photograph 9: High-severity edge cracks, low severity raveling southeast parking area, looking north.

Photograph 10: Sealed high-severity transverse cracking, southeast parking area, looking east.

Photograph 11: low-severity fatigue cracking, isolated pot holes, and rutting, northeast parking area, looking north.

Photograph 12: Low- to medium-severity fatigue cracking, partially sealed, northeast parking area, looking east.

Photograph 13: Low-severity fatigue cracking, partially sealed, lower (west) parking area, looking south.

Photograph 14: Low-severity fatigue cracking, partially sealed, lower (west) parking area, looking south.

Photograph 15: sealed high-severity longitudinal and transverse cracking, south parking area, looking west.

Photograph 16: Low-severity fatigue cracking, low- to moderate severity rutting, south parking area/drive lane, looking east.

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PPLD Library 21c Pavement Evaluation
Colorado Springs, Colorado
Photos Taken: April 08, 2016

Pavement Condition Photographs

APPENDIX B

BORING LOGS

SAMPLE/SAMPLER TYPE GRAPHICS

STANDARD PENETRATION SPLIT SPOON SAMPLER (2 in. (50.8 mm.) outer diameter and 1-3/8 in. (34.9 mm.) inner diameter)

GROUND WATER GRAPHICS

- WATER LEVEL (level where first observed)
- WATER LEVEL (level after exploration completion)
- WATER LEVEL (additional levels after exploration)
- OBSERVED SEEPAGE

NOTES

- The report and graphics key are an integral part of these logs. All data and interpretations in this log are subject to the explanations and limitations stated in the report.
- Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual or differ from those shown.
- No warranty is provided as to the continuity of soil or rock conditions between individual sample locations.
- Logs represent general soil or rock conditions observed at the point of exploration on the date indicated.
- In general, Unified Soil Classification System designations presented on the logs were based on visual classification in the field and were modified where appropriate based on gradation and index property testing.
- Fine grained soils that plot within the hatched area on the Plasticity Chart, and coarse grained soils with between 5% and 12% passing the No. 200 sieve require dual USCS symbols, ie., GW-GM, GP-GM, GW-GC, GP-GC, GC-GM, SW-SM, SP-SM, SW-SC, SP-SC, SC-SM.
- If sampler is not able to be driven at least 6 inches then 50/X indicates number of blows required to drive the identified sampler X inches with a 140 pound hammer falling 30 inches.

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

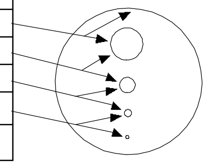
				Symbol	Description
COARSE GRAINED SOILS (More than half of material is larger than the #200 sieve)	GRAVELS (More than half of coarse fraction is larger than the #4 sieve)	CLEAN GRAVEL WITH <5% FINES	Cu≥4 and 1≤Cc≤3	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			Cu<4 and/ or 1>Cc>3	GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH 5% TO 12% FINES	Cu≥4 and 1≤Cc≤3	GW-GM	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES
				GW-GC	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES
			Cu<4 and/ or 1>Cc>3	GP-GM	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES
				GP-GC	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES
		GRAVELS WITH > 12% FINES		GM	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
				GC-GM	CLAYEY GRAVELS, GRAVEL-SAND-CLAY-SILT MIXTURES
	SANDS (More than half of coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH <5% FINES	Cu≥6 and 1≤Cc≤3	SW	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			Cu<6 and/ or 1>Cc>3	SP	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH 5% TO 12% FINES	Cu≥6 and 1≤Cc≤3	SW-SM	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES
				SW-SC	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES
			Cu<6 and/ or 1>Cc>3	SP-SM	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES
				SP-SC	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES
		SANDS WITH > 12% FINES		SM	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-GRAVEL-CLAY MIXTURES
				SC-SM	CLAYEY SANDS, SAND-SILT-CLAY MIXTURES

		Symbol	Description
FINE GRAINED SOILS (More than half of material is smaller than the #200 sieve)	SILTS AND CLAYS (Liquid Limit less than 50)	ML	INORGANIC SILTS AND VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, SILTS WITH SLIGHT PLASTICITY
		CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
		CL-ML	INORGANIC CLAYS-SILTS OF LOW PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
		OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (Liquid Limit greater than 50)	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
		CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
		OH	ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY

KLEINFELDER Bright People. Right Solutions.	PROJECT NO.: 20164613	GRAPHICS KEY	FIGURE
	DRAWN BY: MAP		
	CHECKED BY: JTM	PPLD Library 21C Pavement Evaluation 1175 Chapel Hills Drive Colorado Springs, Colorado	B-1
	DATE: 4/12/2016		
	REVISED: -		

GRAIN SIZE

DESCRIPTION		SIEVE SIZE	GRAIN SIZE	APPROXIMATE SIZE
Boulders		>12 in. (304.8 mm.)	>12 in. (304.8 mm.)	Larger than basketball-sized
Cobbles		3 - 12 in. (76.2 - 304.8 mm.)	3 - 12 in. (76.2 - 304.8 mm.)	Fist-sized to basketball-sized
Gravel	coarse	3/4 -3 in. (19 - 76.2 mm.)	3/4 -3 in. (19 - 76.2 mm.)	Thumb-sized to fist-sized
	fine	#4 - 3/4 in. (#4 - 19 mm.)	0.19 - 0.75 in. (4.8 - 19 mm.)	Pea-sized to thumb-sized
Sand	coarse	#10 - #4	0.079 - 0.19 in. (2 - 4.9 mm.)	Rock salt-sized to pea-sized
	medium	#40 - #10	0.017 - 0.079 in. (0.43 - 2 mm.)	Sugar-sized to rock salt-sized
	fine	#200 - #40	0.0029 - 0.017 in. (0.07 - 0.43 mm.)	Flour-sized to sugar-sized
Fines		Passing #200	<0.0029 in. (<0.07 mm.)	Flour-sized and smaller



MUNSELL COLOR

NAME	ABBR
Red	R
Yellow Red	YR
Yellow	Y
Green Yellow	GY
Green	G
Blue Green	BG
Blue	B
Purple Blue	PB
Purple	P
Red Purple	RP
Black	N

ANGULARITY

DESCRIPTION	CRITERIA
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

Rounded Subrounded Subangular Angular

PARTICLES PRESENT

Amount	Percentage
trace	<5
few	5-10
little	15-25
some	30-45
and	50
mostly	50-100

PLASTICITY

DESCRIPTION	LL	FIELD TEST
Non-plastic	NP	A 1/8-in. (3 mm.) thread cannot be rolled at any water content.
Low (L)	< 30	The thread can barely be rolled and the lump or thread cannot be formed when drier than the plastic limit.
Medium (M)	30 - 50	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump or thread crumbles when drier than the plastic limit
High (H)	> 50	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump or thread can be formed without crumbling when drier than the plastic limit

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

REACTION WITH HYDROCHLORIC ACID

DESCRIPTION	FIELD TEST
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

APPARENT / RELATIVE DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPT-N_{60} (# blows/ft)	MODIFIED CA SAMPLER (# blows/ft)	CALIFORNIA SAMPLER (# blows/ft)	RELATIVE DENSITY (%)
Very Loose	<4	<4	<5	0 - 15
Loose	4 - 10	5 - 12	5 - 15	15 - 35
Medium Dense	10 - 30	12 - 35	15 - 40	35 - 65
Dense	30 - 50	35 - 60	40 - 70	65 - 85
Very Dense	>50	>60	>70	85 - 100

NOTE: AFTER TERZAGHI AND PECK, 1948

CONSISTENCY - FINE-GRAINED SOIL

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (q_u)(psf)	CRITERIA
Very Soft	< 1000	Thumb will penetrate soil more than 1 in. (25 mm.)
Soft	1000 - 2000	Thumb will penetrate soil about 1 in. (25 mm.)
Firm	2000 - 4000	Thumb will indent soil about 1/4-in. (6 mm.)
Hard	4000 - 8000	Thumb will not indent soil but readily indented with thumbnail
Very Hard	> 8000	Thumbnail will not indent soil

STRUCTURE

DESCRIPTION	CRITERIA
Stratified	Alternating layers of varying material or color with layers at least 1/4-in. thick, note thickness
Laminated	Alternating layers of varying material or color with the layer less than 1/4-in. thick, note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

CEMENTATION

DESCRIPTION	FIELD TEST
Weakly	Crumbles or breaks with handling or slight finger pressure
Moderately	Crumbles or breaks with considerable finger pressure
Strongly	Will not crumble or break with finger pressure

KLEINFELDER Bright People. Right Solutions.	PROJECT NO.: 20164613 DRAWN BY: MAP CHECKED BY: JTM DATE: 4/12/2016 REVISED: -	SOIL DESCRIPTION KEY PPLD Library 21C Pavement Evaluation 1175 Chapel Hills Drive Colorado Springs, Colorado	FIGURE B-2

PLOTTED: 06/01/2016 12:30 PM BY: MPalmer

Date Begin - End:	3/29/2016	**Drilling Company:**	Custom Auger		**BORING LOG P-1**
Logged By:	J. McCall	**Drill Crew:**	Jacob		
Hor.-Vert. Datum:	Not Available	**Drilling Equipment:**	CME-55	**Hammer Type - Drop:**	140 lb. Cathead - 30 in.
Plunge:	-90 degrees	**Drilling Method:**	Solid Stem Auger		
Weather:	Sunny, 45°	**Exploration Diameter:**	4" in. O.D.		

FIELD EXPLORATION

Latitude: 38.95400° N
Longitude: -104.79360° W
Surface Condition: Asphalt

LABORATORY RESULTS

Depth (feet)	Graphical Log	Lithologic Description	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in.	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
		ASPHALT: 4 inches thick											
		AGGREGATE BASE: gravel with sand, 4 inches thick											
		Fill **Poorly graded SAND with Clay**: brown, moist		BC=20 30	12"								
		Dawson Formation: **Weathered SANDSTONE**: fine to medium-grained sub-angular sand, brown, moist, very dense, moderately to strongly cemented		BC=22 50/5"	11"								
		- fine to coarse-grained sand below 3.5 feet		BC=25 32 40	18"	SC	17.1		99	19			
5													
		- vertical seams of bluish gray at 7 feet		BC=26 50/6"	12"								
				BC=50/4"	4"	SC	14.0						
10													
15													

The boring was terminated at approximately 9 ft. below ground surface. The boring was backfilled with auger cuttings and patched at surface on March 29, 2016.

GROUNDWATER LEVEL INFORMATION:
Groundwater was not encountered during drilling or after completion.

GENERAL NOTES:
A Garmin GPSMAP 64s GPS unit was used to locate the exploration with an accuracy of 10 feet.

gINT FILE: PROJECTWISE: 20164613_ppld Library 21c Pavement Eval.gpj
gINT TEMPLATE: PROJECTWISE: KLF_STANDARD_GINT_LIBRARY_2016.GLB [KLF_BORING/TEST PIT SOIL LOG]

KLEINFELDER
Bright People. Right Solutions.

PROJECT NO.:	20164613	BORING LOG P-1	FIGURE
DRAWN BY:	MAP		
CHECKED BY:	JTM	PPLD Library 21C Pavement Evaluation 1175 Chapel Hills Drive Colorado Springs, Colorado	B-3
DATE:	4/12/2016		
REVISED:	-		PAGE: 1 of 1

Date Begin - End:	3/29/2016	**Drilling Company:**	Custom Auger
Logged By:	J. McCall	**Drill Crew:**	Jacob
Hor.-Vert. Datum:	Not Available	**Drilling Equipment:**	CME-55
Plunge:	-90 degrees	**Drilling Method:**	Solid Stem Auger
Weather:	Sunny, 45°	**Exploration Diameter:**	4" in. O.D.

BORING LOG P-2

Hammer Type - Drop: 140 lb. Cathead - 30 in.

FIELD EXPLORATION

Latitude: 38.95378° N
Longitude: -104.79260° W
Surface Condition: Asphalt

LABORATORY RESULTS

Depth (feet)	Graphical Log	Lithologic Description	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in.	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
		ASPHALT: 3 inches thick											
		AGGREGATE BASE: gravel with sand, 3 inches thick											
		Fill **Poorly graded SAND with Clay (SP-SC)**: fine to coarse-grained sub-rounded sand, brown, moist to wet, medium dense - 2" layer gray Clayey SAND (SC), fine to medium-grained sand at 1.7 feet - dense below 3 feet - 1" clayey layer with organics (wood, pine needles) at 4 feet		BC=5 10 15	18"	SP-SC	9.4		98	11			
						SP-SC	19.3						
													Harder drilling at 3 feet
				BC=14 20 26	18"								
5													
				BC=9 10 9	18"	SW-SC	7.6		100	12			
		Fill **Well-graded SAND with Clay (SW-SC)**: fine to coarse-grained, dark brown, moist, medium dense, occasional organics											
				BC=4 4 3									
		Alluvium **Poorly graded SAND (SP)**: fine to coarse-grained sub-rounded sand, gray, moist, loose											
10													
15													

The boring was terminated at approximately 10 ft. below ground surface. The boring was backfilled with auger cuttings and patched at surface on March 29, 2016.

GROUNDWATER LEVEL INFORMATION:
Groundwater was not encountered during drilling or after completion.
GENERAL NOTES:
A Garmin GPSMAP 64s GPS unit was used to locate the exploration with an accuracy of 10 feet.

KLEINFELDER
Bright People. Right Solutions.

PROJECT NO.:	20164613
DRAWN BY:	MAP
CHECKED BY:	JTM
DATE:	4/12/2016
REVISED:	-

BORING LOG P-2

PPLD Library 21C Pavement Evaluation
1175 Chapel Hills Drive
Colorado Springs, Colorado

FIGURE
B-4

KLEINFELDER - 4815 List Drive, Unit 115 | Colorado Springs, CO 80919 | PH: 719.632.3593 | FAX: 719.632.2648 | www.kleinfelder.com

Date Begin - End:	3/29/2016	Drilling Company:	Custom Auger	BORING LOG P-3
Logged By:	J. McCall	Drill Crew:	Jacob	
Hor.-Vert. Datum:	Not Available	Drilling Equipment:	CME-55	Hammer Type - Drop: 140 lb. Cathead - 30 in.
Plunge:	-90 degrees	Drilling Method:	Solid Stem Auger	
Weather:	Sunny, 45°	Exploration Diameter:	4" in. O.D.	

FIELD EXPLORATION / LABORATORY RESULTS

Latitude: 38.95203° N
Longitude: -104.79370° W
Surface Condition: Asphalt

Depth (feet)	Lithologic Description	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in.	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
	ASPHALT: 3 inches thick											
	AGGREGATE BASE: gravel with sand, 3 inches thick											
	Alluvium **Poorly graded SAND (SP)**: fine to coarse-grained sub-rounded sand, brown, moist to wet, dense		BC=14 20 22	18"	SP	5.5						
	- 2" layer, fine to medium-grained sand, dark brown at 2.5 feet											
			BC=15 15 15	18"								
5												
	Alluvium **Poorly graded SAND with Clay (SP-SC)**: fine to coarse-grained, sub-rounded, brown, moist, medium dense		BC=9 10 12	18"								
			BC=9 9 14	18"	SP-SC	4.0		100	7.5			
10												
15												

The boring was terminated at approximately 10 ft. below ground surface. The boring was backfilled with auger cuttings and patched at surface on March 29, 2016.

GROUNDWATER LEVEL INFORMATION:
Groundwater was not encountered during drilling or after completion.

GENERAL NOTES:
A Garmin GPSMAP 64s GPS unit was used to locate the exploration with an accuracy of 10 feet.

KLEINFELDER Bright People. Right Solutions.	PROJECT NO.: 20164613	BORING LOG P-3	FIGURE
	DRAWN BY: MAP		
	CHECKED BY: JTM	PPLD Library 21C Pavement Evaluation 1175 Chapel Hills Drive Colorado Springs, Colorado	B-5
	DATE: 4/12/2016		
	REVISED: -		PAGE: 1 of 1

APPENDIX C
LABORATORY TEST RESULTS

Exploration ID	Depth (ft.)	Sample Description	Water Content (%)	Dry Unit Wt. (pcf)	Sieve Analysis (%)			Atterberg Limits			Additional Tests
					Passing 3/4"	Passing #4	Passing #200	Liquid Limit	Plastic Limit	Plasticity Index	
P-1	3.5	SANDSTONE	17.1			99	19				
P-1	8.5	SANDSTONE	14.0								
P-2	1.0	FILL: POORLY GRADED SAND WITH CLAY	9.4			98	11				
P-2	2.0	FILL: POORLY GRADED SAND WITH CLAY	19.3								
P-2	6.5	FILL: WELL GRADED SAND WITH CLAY	7.6			100	12				
P-3	1.0	POORLY GRADED SAND	5.5								
P-3	8.5	POORLY GRADED SAND WITH CLAY	4.0			100	7.5				

Refer to the Geotechnical Evaluation Report or the supplemental plates for the method used for the testing performed above.
NP = NonPlastic

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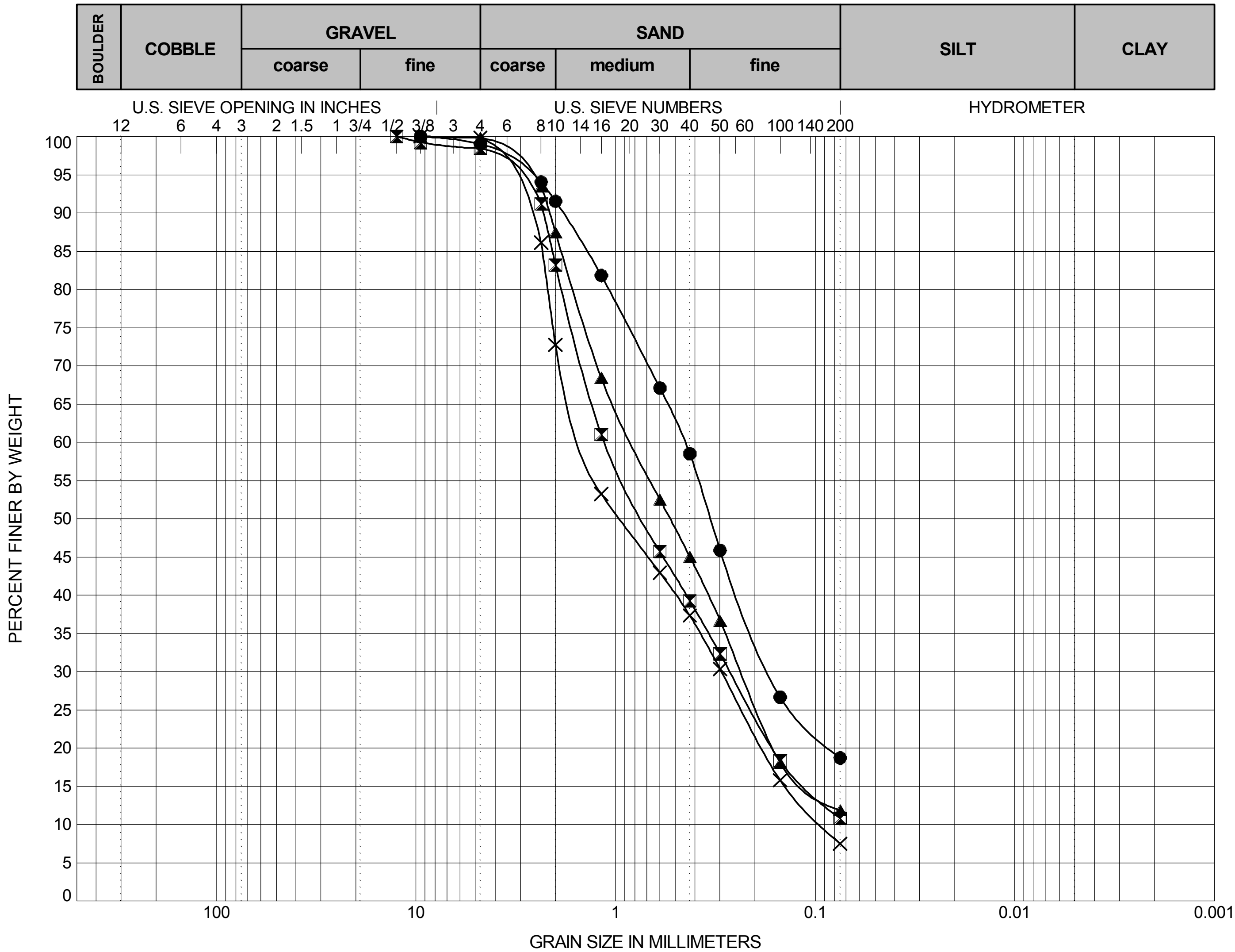
PROJECT NO.: 20164613
DRAWN BY: MAP
CHECKED BY: JTM
DATE: 4/12/2016
REVISED: -

LABORATORY TEST RESULT SUMMARY

PPLD Library 21C Pavement Evaluation
1175 Chapel Hills Drive
Colorado Springs, Colorado

TABLE
C-1



	Exploration ID	Depth (ft.)	Sample Description	LL	PL	PI
●	P-1	3.5	SANDSTONE	NM	NM	NM
⧗	P-2	1	FILL: POORLY GRADED SAND WITH CLAY	NM	NM	NM
▲	P-2	6.5	FILL: WELL GRADED SAND WITH CLAY	NM	NM	NM
×	P-3	8.5	POORLY GRADED SAND WITH CLAY	NM	NM	NM

	Exploration ID	Depth (ft.)	D_{100}	D_{60}	D_{30}	D_{10}	Cc	Cu	Passing 3/4"	Passing #4	Passing #200	%Silt	%Clay
●	P-1	3.5	9.5	0.451	0.169	NM	NM	NM		99	19	NM	NM
⧗	P-2	1	12.5	1.128	0.267	NM	0.91	16.19		98	11	NM	NM
▲	P-2	6.5	9.5	0.825	0.234	NM	1.09	13.58		100	12	NM	NM
×	P-3	8.5	9.5	1.417	0.295	0.092	0.67	15.32		100	7.5	NM	NM

Sieve Analysis and Hydrometer Analysis testing performed in general accordance with ASTM D422.
NP = Nonplastic
NM = Not Measured

Coefficients of Uniformity - $C_u = D_{60} / D_{10}$
Coefficients of Curvature - $C_C = (D_{30})^2 / D_{60} D_{10}$
D_{60} = Grain diameter at 60% passing
D_{30} = Grain diameter at 30% passing
D_{10} = Grain diameter at 10% passing

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PROJECT NO.: 20164613	SIEVE ANALYSIS	FIGURE
DRAWN BY: MAP		
CHECKED BY: JTM	PPLD Library 21C Pavement Evaluation 1175 Chapel Hills Drive Colorado Springs, Colorado	C-2
DATE: 4/12/2016		
REVISED: -		

APPENDIX D

DARWin OUTPUT RESULTS

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare Computer Software Product

Flexible Structural Design Module

Parking and Drive Lanes

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	125,000
Initial Serviceability	4.5
Terminal Serviceability	2
Reliability Level	85 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	13,100 psi
Stage Construction	1
Calculated Design Structural Number	1.86 in

Effective Roadbed Soil Resilient Modulus

Period	Description	Roadbed Resilient Modulus (psi)

Calculated Effective Modulus	- psi*

*Note: This value is not represented by the inputs or an error occurred in calculation.

Simple ESAL Calculation

Performance Period (years)	-
Two-Way Traffic (ADT)	-
Number of Lanes in Design Direction	-
Percent of All Trucks in Design Lane	- %
Percent Trucks in Design Direction	- %
Percent Heavy Trucks (of ADT) FHWA Class 5 or Greater	- %
Average Initial Truck Factor (ESALs/truck)	-
Annual Truck Factor Growth Rate	- %
Annual Truck Volume Growth Rate	- %
Growth	Simple
Total Calculated Cumulative ESALs	- *

*Note: This value is not represented by the inputs or an error occurred in calculation.

Rigorous ESAL Calculation

Performance Period (years)	-
Two-Way Traffic (ADT)	-

Number of Lanes in Design Direction	-
Percent of All Trucks in Design Lane	- %
Percent Trucks in Design Direction	- %

Vehicle Class	Percent of ADT	Annual % Growth	Average Initial Truck Factor (ESALs/ Truck)	Annual % Growth in Truck Factor	Accumulated 18-kip ESALs over Performance Period
Total	-	-	-	-	-

Growth	Simple
Total Calculated Cumulative ESALs	- *

*Note: This value is not represented by the inputs or an error occurred in calculation.

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	New HMA	0.44	1	4	-	1.76
2	Existing ABC	0.1	0.85	3	-	0.26
Total	-	-	-	7.00	-	2.02

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Rigid Structural Design Module

PPLD Library Loading Dock Area PCC

Rigid Structural Design

Pavement Type	JPCP
18-kip ESALs Over Initial Performance Period	125,000
Initial Serviceability	4.5
Terminal Serviceability	2
28-day Mean PCC Modulus of Rupture	650 psi
28-day Mean Elastic Modulus of Slab	3,500,000 psi
Mean Effective k-value	98 psi/in
Reliability Level	85 %
Overall Standard Deviation	0.34
Load Transfer Coefficient, J	4.2
Overall Drainage Coefficient, Cd	0.85
Calculated Design Thickness	5.95 in

Effective Modulus of Subgrade Reaction

Period	Description	Roadbed Soil Resilient Modulus (psi)	Base Elastic Modulus (psi)
1	spring/fall	18,000	20,000

Base Type	Granular
Base Thickness	6 in
Depth to Bedrock	1 ft
Projected Slab Thickness	6 in
Loss of Support Category	2
Effective Modulus of Subgrade Reaction	98 psi/in*

*Note: This value is not represented by the inputs or an error occurred in calculation.

APPENDIX E

IMPORTANT INFORMATION ABOUT THIS GEOTECHNICAL-ENGINEERING REPORT

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled.* No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be*, and, in general, *if you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely*. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.*

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration.*** Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

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