GEOTECHNICAL ENGINEERING REPORT

MID-CONTINENT PUBLIC LIBRARY
LEE'S SUMMIT BRANCH
LEE'S SUMMIT, MISSOURI

Prepared For:

Mid-Continent Public Library
15616 E. 24 Highway
Independence, Missouri

March 11, 2021
Olsson Project No. A18-03300.650

olsson

March 11, 2021

Mid-Continent Public Library
Attn: Mr. Jake Wimmer
15616 E. 24 Highway
Independence, Missouri 64050

Re: Geotechnical Engineering Report
Mid-Continent Public Library: Lee's Summit Branch
Lee's Summit, Missouri
Olsson Project No. A18-03300.650

Dear Mr. Wimmer,

Olsson has completed the authorized Geotechnical Engineering Report for the above referenced project. The enclosed report summarizes our understanding of the project, presents the findings of the borings and laboratory tests, discusses the observed subsurface conditions, and based on those conditions, provides geotechnical engineering design recommendations for this project.

We appreciate the opportunity to provide our geotechnical engineering services for this project. If you have any questions or need further assistance, please contact us at your convenience.

Respectfully submitted,
Olsson, Inc.

IAN ANDREW
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3/11/21
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A. PROJECT UNDERSTANDING

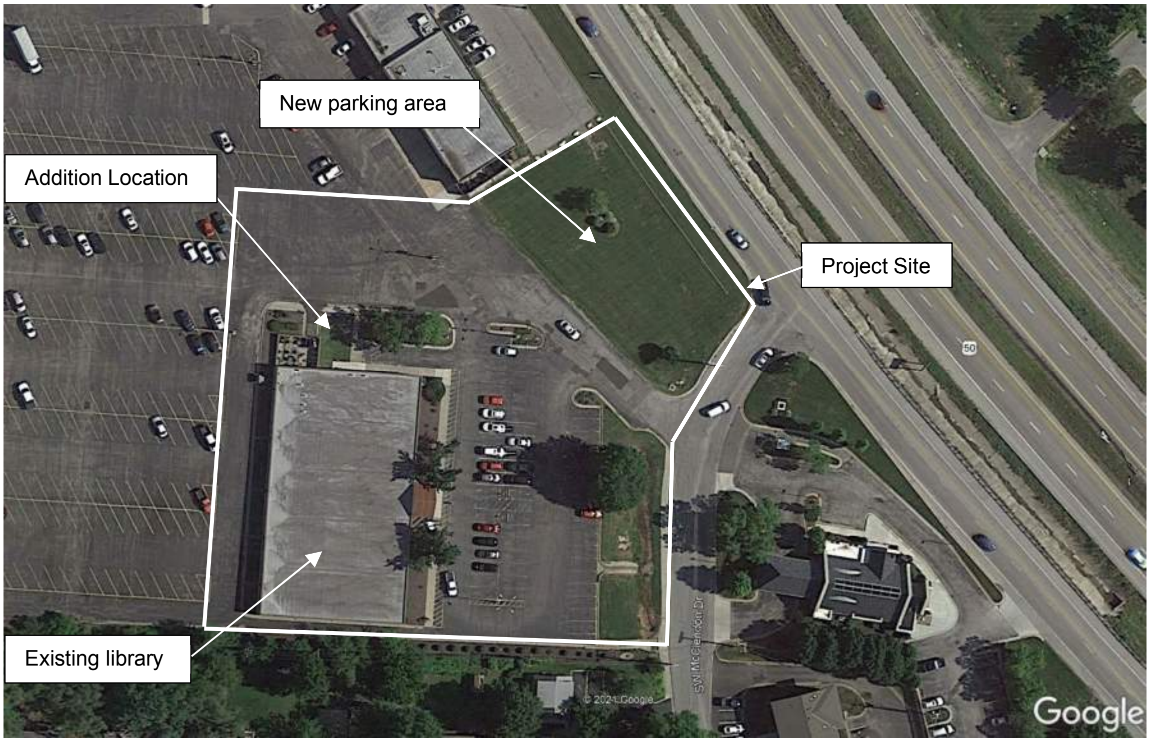
A.1. GEOTECHNICAL SCOPE

This Geotechnical Engineering Report presents the results of the subsurface exploration preformed for the Mid-Continent Public Library's (MCPL) project at their Lee's Summit branch. As part of the project, we drilled a total of five borings: three for the proposed addition and two for the new parking/drive areas. The approximate locations of the borings are shown on the Boring Location Plan in Appendix A. The associated Borehole Reports are presented in Appendix B. The purpose of our field exploration was to evaluate the existing subsurface conditions at the time of drilling, and based on those conditions, provide geotechnical design recommendations for the support of shallow foundations, floor slabs, and pavements.

A.2. SITE INFORMATION

The existing library is located at 150 NW Oldham Parkway in Lee's Summit, Missouri (Figure 1). Prior to construction of the existing library the site was a paved parking lot. We were not made aware of any foundation related distresses within the existing library.

Figure 1: Project Site

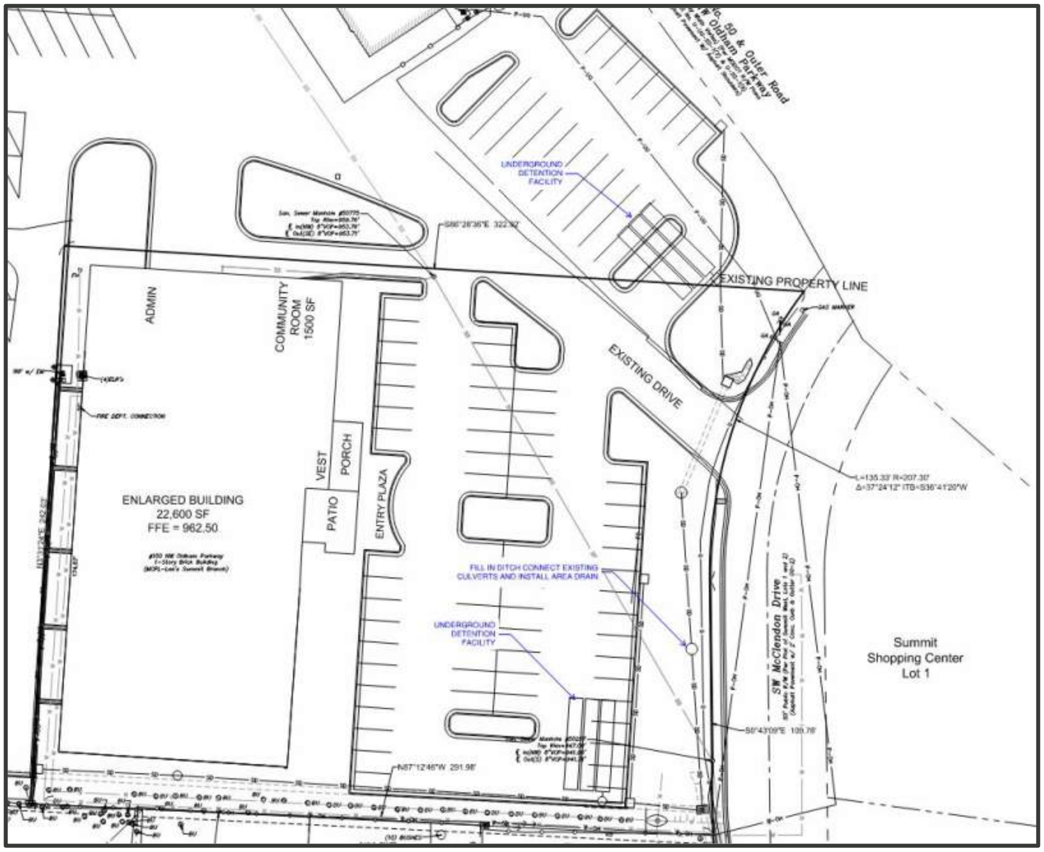


At the time of this report, the proposed new parking area to the northeast was grass covered with few trees. This area also sloped down to the east from the west. The library addition is planned along the north side of the existing structure. At this time, the proposed area for the library addition contains an asphaltic concrete (AC) drive, Portland cement concrete (PCC) facilities (trash receptacle pad, curbing, and sidewalk), shrubs and trees in the landscaped areas, and a wooden fence enclosing the trash receptacle pad.

A.3. PROJECT INFORMATION

We understand that the project consists of an addition to the existing library, construction of a new parking lot, and a mill/overlay of one drive path on site. The planned 6,100 square foot addition consists of a new administration room and a 1,500 square foot community room, each with a finished floor elevation (FFE) matching the existing library (962.50 feet). The new 28-stall parking lot is planned northeast of the library. The project layout is presented below in Figure 2.

Figure 2: Project Layout



We anticipate maximum column and wall loads for the new addition to be 60 kips and 6 kips per linear foot, respectively. If actual loads are greater than expected, ***Olsson*** should be contacted to review the information and provide additional recommendations, as necessary. We further anticipate that cuts of up to 7 feet will be required near the northwest corner of the planned building addition, where the existing trash receptacle pad is located.

B. EXPLORATORY AND TEST PROCEDURES

B.1. FIELD EXPLORATION

We drilled five borings at the site. The boring locations were determined by a Geotechnical Engineer with Olsson based on the proposed site layout. The drill crew located each boring in the field using GPS coordinates. The approximate locations of the borings are shown on the Boring Location Plan in Appendix A. We estimated the boring elevations by approximating the boring locations on a site topographic map and interpolating between contour elevations. At the time of this report, a topographic map was not available for determining boring elevations at locations B-4 and B-5. The interpolated elevations are reported on the logs to the nearest foot and should be considered accurate to the degree they were measured. True surface elevations could differ.

A truck mounted drill rig, equipped with continuous flight augers, was used to advance the borings to depths ranging from 3 to 10 feet below the ground surface. Samples were obtained from the subsurface soils using thin-walled sampling tubes hydraulically pushed into the soil. We sealed, labeled, and returned the samples to our laboratory for further testing and classification. We backfilled the borings and patched the pavements prior to leaving the site. Soil sampling depths are reported on the Borehole Reports.

The drill team prepared a field log of materials encountered at each boring. These field logs include visual classifications of the materials encountered during the drilling process as well as the drillers' interpretation of the subsurface conditions between the samples. The drill crew also made water level observations in each boring at the times and under the conditions noted on the borehole reports. The Borehole Reports presented in Appendix B represent the engineer's interpretation of the field logs and include modifications based on observations and laboratory tests of the samples.

B.2. LABORATORY TESTING

At our laboratory, we visually classified the soil samples in accordance with the Unified Soil Classification System (USCS). We measured the moisture content and density of all samples. Unconfined compressive strength tests were performed on select tube samples. Atterberg limits tests were performed on the lower tube sampled from Boring B-1 and the upper tube sampled from Boring B-4. Laboratory test results are provided on the respective Borehole Reports.

C. SUBSURFACE CONDITIONS

C.1. SUBSURFACE STRATIGRAPHY

The subsurface conditions shown on the Borehole Reports represent conditions at the specific boring locations at the times they were drilled. Variations may occur between or beyond the borings. The stratification lines shown on the Borehole Reports represent the approximate locations of changes in soil and bedrock types. The actual transitions between materials occurs gradually. Based on the borings, the subsurface conditions at the project site can be generalized as follows.

In paved areas (B-1 through B-3), we observed AC pavement thicknesses of 2.5 inches, 5 inches, and 6 inches, respectively. Beneath the pavement at borings B-1 through B-3 and beneath the developed zone in boring B-4 and B-5, we encountered previously placed fill soils consisting of highly plastic (fat) clays with varying moisture contents and consistencies throughout. The fill layer was 3 to 3.5 feet thick. The fill was likely placed during construction of the parking lot, prior to development of the existing library. We encountered stiff native fat clays beneath the fill at Borings B-1, B-4, and B-5. The native fat clay soils terminated at a depth of 10 feet in borings B-4 and B-5. Limestone bedrock was encountered beneath the native soils at B-1 and the fill soils at B-2 and B-3. We encountered practical auger refusal on the limestone bedrock at depths of 8 feet (B-1) and 3 feet (B-2 and B-3), as measured from the ground surface.

C.2. GROUNDWATER OBSERVATION

We measured groundwater levels at the borings during and immediately upon completion of drilling operations. Free water was not encountered in the boreholes at these times. The lack of groundwater in the borings should not be construed to represent a permanent or stable condition. Variations and uncertainties exist with relatively short-term water level observations in boreholes. Water levels can and should be anticipated to vary between boring locations, as well as over time within specific borings. Water typically collects near the interface between different materials, such as soil and bedrock. Groundwater levels can be expected to fluctuate with variations in precipitation, site grading, drainage, and adjacent land use. Long term monitoring with piezometers generally provides a more representative reflection of the potential range of groundwater conditions.

D. GEOTECHNICAL CONSIDERATIONS

Limestone bedrock was encountered within the proposed building addition at approximate elevations ranging 959 feet (B-3) to 960 feet (B-1 and B-2). Based on the planned finished floor elevation of 962.5 feet, excavation of limestone bedrock should be anticipated during construction of exterior footings. Depending on the depths of planned utilities, limestone could be encountered in utility excavations near borings B-1 through B-3. In our experience, materials that can be penetrated with flight augers can typically be excavated using heavy duty construction equipment such as large backhoes/trackhoes with rock teeth or ripper equipped dozers. Excavations below the depths of auger refusal or in confined areas, such as utility trenches, may be more difficult and may require hard rock removal techniques.

As previously discussed, apparent fill material was encountered near the ground surface beneath the new structure and parking area. We are unaware if moisture and density tests were conducted on the fill at the time of placement. Foundations, floor slabs and pavements supported on the existing fills that have not been compacted under controlled conditions may not perform predictably and could experience unacceptable amounts of total and differential settlement, including voiding beneath floor slabs. The settlement, in turn, could lead to significant cracking within walls and grade supported floor slabs, depressions and cracking in parking and drive areas, misaligned doors and windows, and other related issues. We recommend the existing fill material be entirely removed from the building footprint areas, as well as any other settlement sensitive areas, and replaced with structural fill. The zone of fill removal should extend laterally at least five feet beyond the edges of the proposed building footprint.

In our opinion, the existing fill could remain in place beneath parking and drive areas, provided the owner is aware of and accepts the risks associated with the fill. These risks include depressions forming within the parking lot area and cracking within pavement sections. To reduce these risks, we recommend removing the upper 24 inches of existing fill within the areas to be covered with asphaltic concrete or Portland cement concrete pavement.

Since the project consist of a new addition to an existing structure, care should be taken during construction of the foundations, floor slabs, and utilities to not disturb the bearing material beneath and around these existing features. Where possible, excavations below existing footings and grade-beams should not extend below an imaginary plane extending out and down from the outside edge of the existing footings at a slope of approximately 2H:1V. Even with these criteria, excavations that extend below the level of existing foundations should be backfilled the same day they are excavated. Where this is impractical, shoring or underpinning of existing foundations may be required. Some overlap in stress distribution from new and existing footings could occur, which may cause minor movement of existing footings and the supported structures. Maintaining a clear distance, at least equal to the width of the new column spread footings, between the edges of the new and existing footings could significantly reduce this risk. Connections between the new and existing structures should be designed to allow for the anticipated differential movement.

E. SITE PREPARATION

E.1. GENERAL SITE PREPARATION

Site preparation should commence with the stripping of any vegetation and any loose, soft, frozen, or otherwise unsuitable materials from construction areas. This should include the existing pavements and any fill material encountered beneath the structure. Removal of any trees from the pavement areas should also be accomplished at this time, and care should be taken to thoroughly remove root systems. These materials should be carefully separated to avoid incorporation of organic materials into structural fills on site. A zone of desiccated soils may exist in the vicinity of the trees. Materials that were disturbed during the removal of trees and zones of desiccated soils should be moisture conditioned and compacted according to the recommendations presented herein or undercut and replaced with approved structural fill. Curbs, gutters, concrete sidewalks, trash receptacle pads, pavements and any other below grade features that conflict with the planned construction should be demolished and cleared from the site. Areas disturbed during demolition operations should be thoroughly evaluated by a representative of ***Olsson*** prior to placement of fill. Care must be taken to ensure that foundations, utilities planned to remain at this site, and foundation bearing materials are not disturbed during site preparation. Where existing or abandoned underground utilities are encountered within the proposed building or pavement areas, the trench backfill should be evaluated by a representative of ***Olsson*** to determine if the backfill should be undercut and replaced. Site stripping, grubbing, and clearing operations should be performed during dry weather conditions as the operation of heavy equipment on this site during wet conditions could result in excessive rutting and mixing of construction debris with the underlying soils.

After completion of rough grading in cut areas and prior to placement of any new fill in areas below design grade, we recommend that the exposed ground surface be proofrolled with a loaded tandem axle dump truck weighing at least 20 tons, or similar equipment. Proofrolling operations should be observed by an ***Olsson*** representative. Unstable and unsuitable soils revealed by proofrolling should be removed and replaced with structural fill. Care should be exercised during proofrolling adjacent to the existing building to avoid damaging the existing structure.

Following proofrolling and any necessary subgrade replacement/remediation, the moisture content of the exposed grade should be evaluated in all construction areas. Where moisture contents are outside the range recommended for controlled fill, the upper 9 inches of exposed subgrade should be scarified, moisture conditioned, and recompacted to a minimum of 95 percent of the material's Standard Proctor maximum dry density (ASTM Specification D-698) at a moisture content between optimum and 4 percent above optimum.

E.2. FILL AND COMPACTION RECOMMENDATIONS

All structural fill and backfill should consist of approved materials, free of organic matter (organic content less than 5 percent), and free of debris. Also, the soils should not contain particle sizes larger than three inches. Imported fill materials, if necessary, should generally exhibit a liquid limit less than 60 and a plasticity index less than 30. Samples of all proposed fill materials should be submitted to the geotechnical engineer of record prior to use on the site. Laboratory Proctor compaction tests and classification tests should be performed on any proposed fill material prior to use on the site. The on-site materials appear to be suitable for use as structural fill but should not be used as low volume change material.

We recommend that structural fill and backfill be compacted in accordance with the criteria provided in Table 1. An ***Olsson*** representative should observe fill placement operations and perform field density tests, as required.

Table 1: Fill Placement and Compaction Guidelines

Fill Placement	Material	*** Compaction Recommendations	Moisture Content (Percent of Optimum)
Granular Layer – 4" below floor slabs	** ASTM C-33 No. 57 Aggregate	65% of Relative Density	As necessary to obtain density
Low Volume Change (LVC) – 18" below base of granular layer	PL < 50 PI < 25	95%	As necessary to obtain density
	** MoDOT Type 5 Baserock		
Structural Fill – On-site soils	On-site Cohesive Soils	95%	0 to +4 percent
Structural Fill – Imported	LL < 60 PI < 30	95%	0 to +4 percent
Pavement Subgrade – 6" of Aggregate Base	** MoDOT Type 5 Baserock	95%	As necessary to obtain density
Pavement Subgrade – 9" of Chemically Stabilized Clay	* Fly Ash (15%)/ Lime (5%)/ Cement (5%)	95%	-1 to +3 percent

* Based on dry unit weights. ** Or equivalent. *** As per ASTM D698, standard Proctor test.

Suitable fill materials should be placed in loose lifts of 8 inches or less. Vibrating plate compactors, jumping jack compactors or walk behind sheepsfoot compactors may be used to facilitate compaction within small excavations such as in utility trenches, around manholes, or behind retaining walls. Loose lift thicknesses of 4 inches or less are recommended where small compaction equipment are used.

If required, the moisture content of suitable borrow soils at the time of compaction should generally be maintained between the ranges specified in Table 1. More stringent moisture limits may be necessary with certain soils and some adjustments to moisture contents may be necessary to achieve compaction in accordance with project specifications.

E.3. DRAINAGE AND GROUNDWATER CONSIDERATIONS

Water should not be allowed to collect at the ground surfaces near foundation, floor slab, or new pavement areas, either during or after construction. Provisions should be made to quickly remove accumulating seepage water or storm water runoff from excavations. Undercut or excavated areas should be sloped toward one corner to allow rainwater or surface runoff to be quickly collected and gravity drained or pumped from construction areas. Subgrade soils that are exposed to precipitation or runoff should be evaluated by ***Olsson*** prior to the placement of new fill, reinforcing steel, or concrete, to determine if corrective action is required.

To minimize concerns related to improper or inadequate drainage, we recommend the following:

- Site grading should provide for efficient drainage of seepage, rainfall, and surface runoff away from new structures and pavement.
- Roof run-off should be collected and transferred directly to the storm sewer system or directed to a location with positive and rapid drainage away from new structures and pavements.
- External hose connections in unpaved areas should incorporate splash blocks to prevent accidental flooding of foundation bearing or backfill soils. External hose connections should have cut-off valves inside the building to prevent accidental or unauthorized use.
- Maintenance personnel should be informed of the potential problems associated with watering near the building.

F. STRUCTURES

F.1. SHALLOW FOUNDATION

Based on the planned FFE of 962.5 feet at the time of this report and the results of our borings, the foundations for the planned addition may bear on limestone bedrock, stiff natural clay, and controlled engineered fill. Support of the building addition on different materials is expected. In our opinion, support of the proposed buildings on the different materials would be possible if some differential performance of the footings and slabs can be accepted. Provided that abrupt changes in bearing materials over short distances are avoided, it is our opinion that differential settlement should occur gradually across the building area as the transition from footings and slabs supported on bedrock to native soil to fill occurs gradually. Strict moisture and density control of the proposed fill sections will be important to limit potential differential settlement between building elements supported on compacted fill and elements supported on bedrock and native clay soils. Provided the total and differential settlements and the construction delays described in this report are acceptable to the owner, the recommendations presented herein would allow use of a shallow foundation system to support the building. If no risk of differential settlement can be tolerated, the footings for each building will need to bear on similar materials. To accomplish this, footings may need to be extended downward, possibly requiring adjusting the floor elevation or location of the structure on site to minimize the amount of fill placed within the building footprint.

Shallow foundations bearing on the recommended materials may be proportioned for a maximum net allowable bearing pressure of 2,000 pounds per square foot (psf). The net allowable soil bearing pressure refers to the bearing pressure at foundation level in excess of surrounding overburden pressure.

Exterior footings should bear at a minimum depth of 3 feet below the adjacent final ground surface to provide frost protection and to provide foundation support below the typical level of seasonal moisture variation in the soil. Continuous footings should have a minimum foundation width of 16 inches. A minimum footing width of 30 inches should be used for isolated column footings. Earth formed trench footings should have a minimum width of 12 inches and should be designed with sufficient reinforcement to span a minimum of 10 feet when acting as a continuous grade beam under the foundation loads.

Lightly loaded interior partition walls (applying less than 750 pounds per linear foot (plf)) may be supported directly on the slab-on-grade floor. Depending on the floor slab design and the specific wall loads, it may be necessary to increase the floor slab reinforcement or provide a thickened slab cross-section below the interior walls. For interior walls with loads greater than 750 plf, we recommend a footing be installed, independent of the floor slab, to properly distribute the wall loads to the underlying soils and reduce the potential for floor slab damage.

The base of all foundation excavations should be free of all water and loose soil prior to placing steel reinforcement and concrete. ***Olsson*** should observe the foundation bearing material at each footing prior to the placement of concrete or reinforcing steel.

After foundation subgrades have been observed and evaluated by an ***Olsson*** representative, concrete should be placed as soon as possible to avoid subjecting the exposed soils to drying, wetting, or freezing conditions. If the foundation subgrade soils are subjected to such conditions, ***Olsson*** should be contacted to reevaluate the foundation bearing materials.

Foundations constructed based on the recommendations provided in this report would be expected to experience post construction settlements up to 1 inch. Differential settlements on the order of 1 inch may occur gradually as the transition in bearing materials from bedrock to native soil to controlled fill occurs gradually. Abrupt changes in bearing materials over short distances should be avoided. Differential settlements of less than 1 inch between the existing building and the addition are expected. Application of new loads near existing footings may result in minor settlement of the existing footings.

Care should be exercised during construction of foundations adjacent to the existing building to avoid negatively influencing the existing structure. Footings located adjacent to the existing building should be supported at the same level as the existing foundations. Excavations near the existing buildings should not be extended deeper than the bottom of existing footings without shoring or underpinning of the existing foundations. Even with the recommended precautions, existing footings may experience some settlement.

F.2. FLOOR SLAB SUBGRADE PREPARATION

At minimum, the upper 18 inches of floor slab subgrade should be constructed of compacted low volume change (LVC) fill material. Using LVC material within this zone will further reduce the risk of future slab movement associated with the underlying expansive (highly plastic) soils. By our definition, LVC material should consist of low plasticity cohesive soils (liquid limit less than 50 and plasticity index less than 25) or densely graded granular materials with at least 15 percent of the materials fines passing the No. 200 sieve (e.g., MoDOT Type-5 baserock). The LVC fill should be compacted as recommended in the *E.2. Fill and Compaction Recommendations* section of this report.

After proper placement of the LVC fill in the building area, the recommended subgrade moisture content and density should be maintained until the floor slabs are constructed. Disturbed areas of the completed subgrade should be reconditioned to meet the recommendations of this report prior to placement of the granular leveling course and construction of the slabs. At minimum, a 4-inch-thick, compacted, free-draining granular leveling course (ASTM C-33 Size No. 57 aggregate or similar) should be placed below the floor slabs to provide uniform support. This layer is in addition to the 18-inch-thick LVC layer described above. Subgrade should be graded to provide positive drainage within the granular layer. If moisture vapor transmission through the concrete slab is a concern (e.g., if moisture-sensitive floor coverings will be used), a vapor barrier should be used. For floor slab thickness design, a modulus of subgrade reaction of 100 pounds per cubic inch (pci) can be used; this modulus applies where floor slabs are supported on a layer of LVC placed and compacted as recommend herein.

The procedures recommended above may not eliminate all future subgrade volume change and resultant floor slab movement. However, the outlined procedures should significantly reduce the potential for subgrade volume change. Common construction practice is to tie the slab-on-grade into the foundation elements to limit the impact of differential movement at doorways and windows. Depending on the location of construction joints in the slab, the rigidity of the slab and foundation connections, and the magnitude of actual movement that occurs, some minor cracking within the floor slab could occur and should be anticipated.

F.3. SITE SEISMIC CLASSIFICATION

For this project site, the soil conditions encountered are consistent with the definition of Site Class "C" (Very Dense Soil and Soft Rock profile) as defined in ASCE 07-16.

G. PAVEMENTS

G.1. PAVEMENT SUBGRADE PREPARATION

We understand that a new asphaltic concrete (AC) parking area is planned to the northeast of the existing library (see Figure 1). At a minimum, full depth pavement should be supported by 9 inches of chemically stabilized subgrade. Based on our experience with construction of pavements on clay subgrade soils similar to those encountered at this project site, stabilization of the upper 9 inches of subgrade soils with 15 percent of Class "C" fly ash, or 5 percent hydrated lime or cement (percentages based on dry unit weights) would develop a more stable subgrade, less susceptible to changes in moisture content, freeze/thaw, and disturbance during paving. The chemically stabilized subgrade soils should be compacted to a minimum of 95 percent of the material's maximum dry density and moisture conditioned to within one percentage point below to three percentage points above optimum. These recommended density and moisture contents are based on ASTM Specification D-698.

In leu of chemical stabilization, AC pavements may be supported by a 6-inch-thick gravel base consisting of well graded granular material, such as MoDOT Type 5 baserock (or equivalent) placed over 9 inches of on-site or imported subgrade prepared in accordance with the recommendations presented in section *F.2. Fill and Compaction Recommendations* of this report. The gravel baserock should be compacted to a minimum of 95 percent of the material's maximum dry density as defined by ASTM Specification D-698. The baserock should be moisture conditioned to a level necessary to obtain the required density.

We recommend that the prepared subgrade extend a minimum of 2-feet outside the pavements, where feasible. ***Olsson*** should be present during subgrade preparation to observe, document, and test compaction of the materials at the time of placement. As recommended for all prepared soil subgrades, heavy, repetitive construction traffic should be controlled, especially during periods of wet weather, to minimize subgrade disturbance.

Construction scheduling often involves grading and paving by separate contractors and can involve a time lapse between the end of grading operations and the commencement of paving operations. The final prepared subgrade should be proof rolled with a loaded tandem axil dump truck weighing at least 20-tons (or equivalent soil loading) within 48 hours prior to paving. Proofrolling operations should be observed and documented by ***Olsson***. Unstable or unsuitable soils revealed by proofrolling should be reworked to provide a stable subgrade or removed and replaced with structural fill. If a significant precipitation event occurs after evaluation, if paving is delayed more than 2 days after initial observation, or if the surface becomes disturbed, the subgrade should be reevaluated by ***Olsson*** prior to paving to determine if corrective action is necessary. The subgrade should be in its final form at the time of the review.

It is important that the pavements' subgrade support be relatively uniform, with no abrupt changes in the degree of support. Non-uniform pavement support can occur because of varying soil moisture contents or soil types, or where improperly placed utility backfill has been placed across or through areas to be paved. Improper subgrade preparation, such as inadequate vegetation removal, failure to identify soft or unstable areas by proofrolling, and inadequate or improper compaction, can also produce non-uniform subgrade support.

G.2. ESTIMATES OF PAVEMENT SECTION THICKNESS

Table 2 summarizes typical pavement sections for full depth asphaltic concrete (AC), AC with a granular base, and full depth Portland cement concrete. The sections represent typical minimum thicknesses. Routine maintenance of these pavement will be required, consisting of periodic seal coats, possibly one intermediate mill, and regular crack maintenance.

Table 2: Minimum Recommended Pavement Sections

Parking Areas	Drive Areas	Heavy Vehicle Areas
Full Depth AC: 2" AC Surface 4" AC Base 9" Chemically Stabilized Soils AC with Granular Base: 2" AC Surface 3" AC Base 6" MoDOT Type 5 Baserock 9" Prepared Subgrade	Full Depth AC: 2" AC Surface 6" AC Base 9" Chemically Stabilized Soils AC with Granular Base: 2" AC Surface 4" AC Base 6" MoDOT Type 5 Baserock 9" Prepared Subgrade	Full Depth PCC: 8" PCC 4" Clean Rock Base 9" Chemically Stabilized Soils *Applies to trash receptacle pads

PCC pavements are recommended for trash receptacle pads and other areas where heavy wheel loads will be concentrated. Concrete pavements in these areas should have a minimum thickness of 8 inches. It is also recommended that a 4-inch leveling, and drainage course of clean, crushed rock be placed below all PCC pavements. The clean rock base for PCC pavements should be uniform. The granular section should be graded to adjacent storm sewer inlets and provisions should be made to provide drainage from the granular section into the storm sewers. Drainage of the granular base is particularly important where two different pavement sections (such as AC and PCC) abut, so that water does not pond beneath the pavements and saturate the subgrade soils. We further recommend that the length of concrete sections be such that no heavy truck wheels rest on asphaltic concrete sections during loading/unloading operations.

The performance of the pavements will be dependent upon a number of factors, including subgrade conditions at the time of paving, rainwater runoff, and traffic. Rainwater runoff should not be allowed to seep below pavements from adjacent areas. Pavements should be sloped approximately ¼ inch per foot to provide for rapid surface drainage.

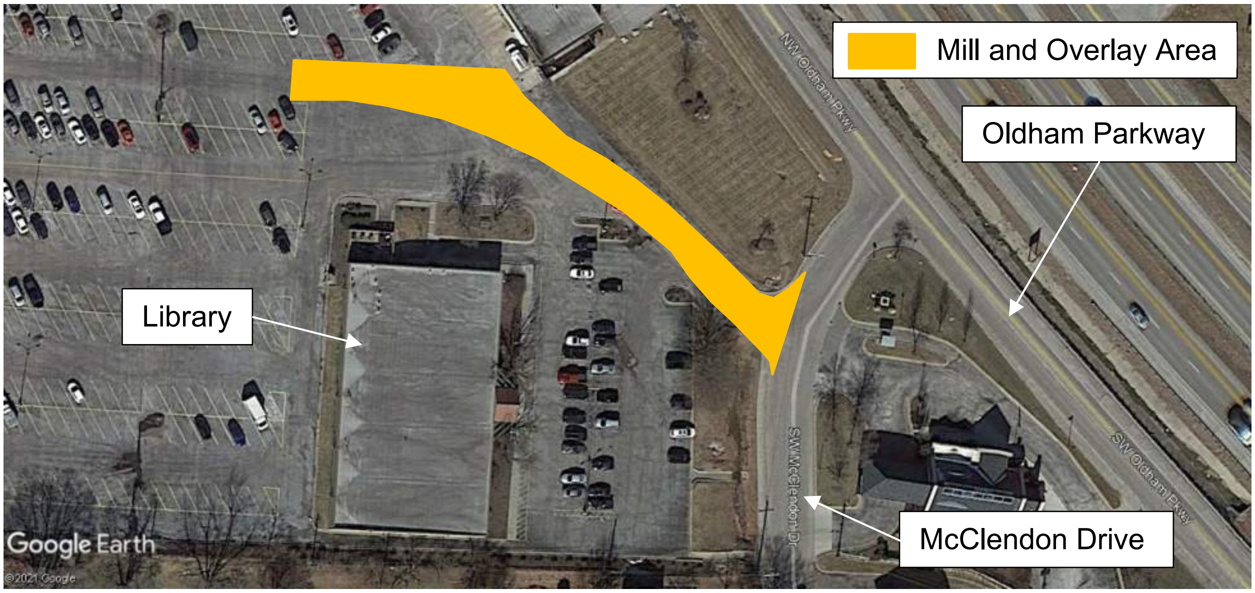
Proper drainage below the pavement section helps prevent softening of the subgrade and has a significant impact on pavement performance and pavement life. Therefore, we recommend that a granular blanket drain be constructed at all storm sewer inlets within the pavement areas. The blanket drain should consist of clean, crushed rock extending a minimum of 6 inches below pavement subgrade level. The blanket drains should extend radially a minimum of 8 feet from each of the storm sewer inlets. The grade within the blanket drain should be sloped toward the storm sewer inlet, and weep holes should be drilled through the inlet to provide drainage of the granular section into the inlet. Placement of a geotextile filter fabric across the weepholes could be considered to prevent loss of aggregate through the weep holes.

Construction equipment traffic on the pavements has not been considered in the above noted typical sections. If construction scheduling dictates that the pavements will be subjected to traffic by construction equipment, increasing the pavement thickness should be considered to include the effects of additional traffic loading. Construction traffic should not be allowed on partially completed pavements as the pavements will not have adequate structural capacity and could be damaged.

G.3. PAVEMENT MILL AND OVERLAY RECOMMENDATIONS

As previously mentioned, the drive path between the library and the new parking area is planned to be milled and overlayed with new asphaltic concrete. The approximate extent of the of the mill and overlay section is shown in Figure 3 below. Boring B-3 indicated that the existing pavement consists of 6 inches of asphaltic concrete. In our opinion, the section outlined by Figure 3 is suitable for mill and overlay operations. Localized full depth patches will be needed where severe fatigue cracking, potholes or rutting is evident.

Figure 3: Extent of Mill and Overlay Area



We recommend removing a minimum depth of 2 inches of the existing asphaltic concrete pavement during milling operations. Once the asphalt has been milled, but before the overlay is applied, all existing cracks should be sealed in accordance with *Section 413.50 Bituminous Pavement Crack Sealing* of the 2018 Missouri Standard Specification for Highway Construction. Many pavements that are structurally sound after the construction of a new overlay prematurely exhibit a cracking pattern similar to that which existed in the underlying pavement. Reflective cracks destroy surface continuity, decrease structural strength, and allow water to enter the pavement layers. Thus, the problems that weakened the old pavement are extended upwards into the new overlay. Therefore, once the cracks are sealed and full depth patches are complete, we recommend that a paving fabric, such as Glassgrid®, be placed to separate the new asphalt overlay from the existing asphaltic concrete and to inhibit reflective cracking. A thin (1/2" thick) leveling and binding course of asphalt should be placed atop of the existing asphalt surface and below the paving fabric. After the paving fabric is positioned, AC overlay can be applied.

H. LIMITATIONS

H.1. CONSTRUCTION OBSERVATIONS AND TESTING

We recommend that all earthwork during construction be monitored by a representative of ***Olsson,*** including site preparation, placement of all structural fill and trench backfill, and pavement subgrades. The purpose of these services would be to provide ***Olsson*** the opportunity to observe the soil conditions encountered during construction, evaluate the applicability of the recommendations presented in this report to the soil conditions encountered, and recommend appropriate changes in design or construction procedures if conditions differ from those described herein.

H.2. LIMITATIONS

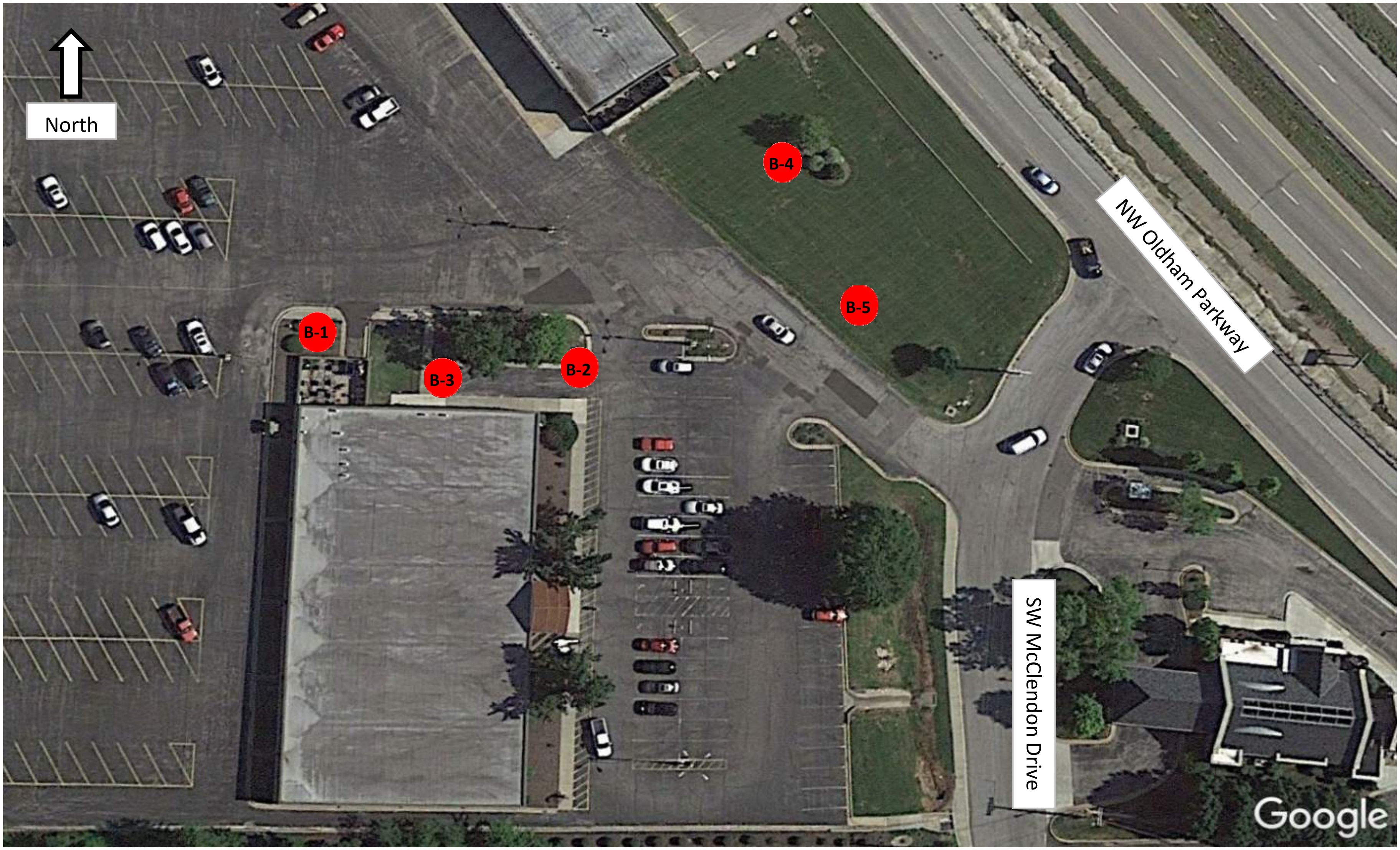
The conclusions and recommendations presented in this report are based on the information available regarding the proposed construction, the results obtained from our borings and laboratory testing program, and our experience with similar projects. The borings represent a very small statistical sampling of subsurface soils and it is possible that conditions may be encountered during construction that are substantially different from those indicated by the borings. In these instances, adjustments to design and construction may be necessary.

This geotechnical report is based on the site plan and our understanding of the project's information as provided to ***Olsson***. Changes in the location or design of new structures could significantly affect the conclusions and recommendations presented in this geotechnical report. ***Olsson*** should be contacted in the event of such changes to determine if the recommendations of this report remain appropriate for the revised site design.

This report was prepared under the direction and supervision of a Professional Engineer registered in the State of Missouri with the firm of **Olsson, Inc.** The conclusions and recommendations contained herein are based on generally accepted, professional, geotechnical engineering practices at the time of this report, within this geographic area. No warranty, express or implied, is intended or made. This report has been prepared for the exclusive use of **Mid-Continent Public Library** and their authorized representatives for the specific application to the proposed project described herein.

APPENDIX A

Boring Location Plan



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Boring Location Plan

Scale: n.t.s.
Project No. A18-0330.65
Approved by: JDP
Date: 2/9/2021

MCPL- Lee's Summit Branch
Lee's Summit, Missouri

APPENDIX B

Symbols and Nomenclature
Boring Logs

SYMBOLS AND NOMENCLATURE

DRILLING NOTES

DRILLING AND SAMPLING SYMBOLS

SS:	Split-Spoon Sample (1.375” ID, 2.0” OD)	HSA:	Hollow Stem Auger	NE:	Not Encountered
U:	Thin-Walled Tube Sample (3.0” OD)	CFA:	Continuous Flight Auger	NP:	Not Performed
CS:	Continuous Sample	HA:	Hand Auger	NA:	Not Applicable
BS:	Bulk Sample	CPT:	Cone Penetration Test	% Rec:	Percent of Recovery
MC:	Modified California Sampler	WB:	Wash Bore	WD:	While Drilling
GB:	Grab Sample	FT:	Fish Tail Bit	IAD:	Immediately After Drilling
SPT:	Standard Penetration Test Blows per 6.0”	RB:	Rock Bit	AD:	After Drilling
				CI:	Cave-In

DRILLING PROCEDURES

Soil samples designated as “U” samples on the boring logs were obtained in using Thin-Walled Tube Sampling techniques. Soil samples designated as “SS” samples were obtained during Penetration Test using a Split-Spoon Barrel sampler. The standard penetration resistance ‘N’ value is the number of blows of a 140 pound hammer falling 30 inches to drive the Split-Spoon sampler one foot. Soil samples designated as “MC” were obtained in using Thick-Walled, Ring-Lined, Split-Barrel Drive sampling techniques. Recovered samples were sealed in containers, labeled, and protected for transportation to the laboratory for testing.

WATER LEVEL MEASUREMENTS

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

SOIL PROPERTIES & DESCRIPTIONS

Descriptions of the soils encountered in the soil test borings were prepared using Visual-Manual Procedures for Descriptions and Identification of Soils.

PARTICLE SIZE

Boulders	12 in. +	Coarse Sand	4.75mm-2.0mm	Silt	0.075mm-0.005mm
Cobbles	12 in.-3 in.	Medium Sand	2.0mm-0.425mm	Clay	<0.005mm
Gravel	3 in.-4.75mm	Fine Sand	0.425mm-0.075mm		

COHESIVE SOILS

Consistency	Unconfined Compressive Strength (Qu) (tsf)
Very Soft	<0.25
Soft	0.25 – 0.5
Firm	0.5 – 1.0
Stiff	1.0 – 2.0
Very Stiff	2.0 – 4.0
Hard	> 4.0

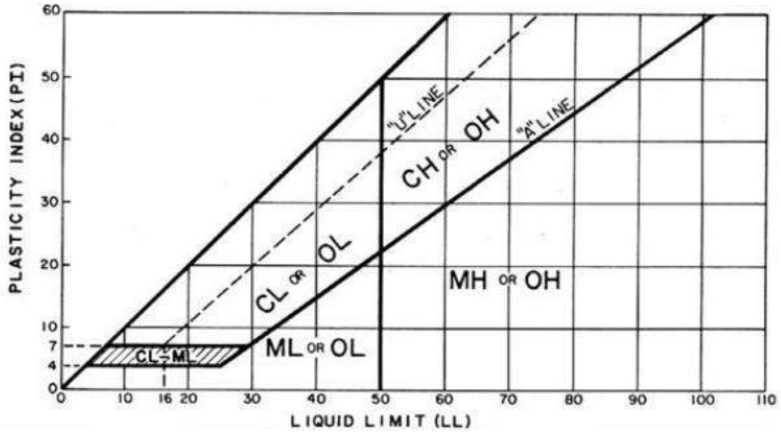
COHESIONLESS SOILS

Relative Density	‘N’ Value
Very Loose	0 – 3
Loose	4 – 9
Medium Dense	10 – 29
Dense	30 – 49
Very Dense	≥ 50

COMPONENT %

Description	Percent (%)
Trace	<5
Few	5 - 10
Little	15 - 25
Some	30 - 45
Mostly	50 - 100

PLASTICITY CHART



ROCK QUALITY DESIGNATION (RQD)

Description	RQD (%)
Very Poor	0 – 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 – 100

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BOREHOLE REPORT NO. B-1

Sheet 1 of 1

PROJECT NAME **Mid-Continent Public Structural & Civil Evaluations**	CLIENT **Mid-Continent Public Library**
PROJECT NUMBER **A18-0330**	LOCATION **Lee's Summit, Missouri**

■ Shelby Tube

ELEVATION (ft)	MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
	APPROX. SURFACE ELEV. (ft): 967		0.0								
	ASPHALTIC CONCRETE ***0.3'***										
	FILL *Dark brown clay, trace fine sand, moist*										
965.0				U 1			2.3	27.8	93.0		
			2.5								
	3.0'										
	FAT CLAY *Stiff, brown with light brown, moist, trace fine sand*			U 2	CH		1.2	28.1	94.9	56/38	
962.5											
			5.0								
960.0											
			7.5								
	7.9'										
	LIMESTONE ***8.0'***										

REFUSAL AT 8.0 FEET

WATER LEVEL OBSERVATIONS	
WD	∇ Not Encountered
IAD	▼ Not Encountered
AD	▼ Not Encountered

OLSSON, INC.
1700 E. 123RD STREET
OLATHE, KANSAS 66061

STARTED:	3/2/21	FINISHED:	3/2/21
DRILL CO.:	OLSSON	DRILL RIG:	CME 45B
DRILLER:	T. KETTLER	LOGGED BY:	C. HAACK
METHOD: CONTINUOUS FLIGHT AUGER			

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BOREHOLE REPORT NO. B-2

Sheet 1 of 1

PROJECT NAME **Mid-Continent Public Structural & Civil Evaluations**	CLIENT **Mid-Continent Public Library**
PROJECT NUMBER **A18-0330**	LOCATION **Lee's Summit, Missouri**

■ Shelby Tube ⌶ Grab Sample

ELEVATION (ft)	**MATERIAL DESCRIPTION**	**GRAPHIC LOG**	**DEPTH** (ft)	**SAMPLE TYPE NUMBER**	**CLASSIFICATION** (USCS)	**BLOWS/6" N-VALUE**	**UNC. STR.** (tsf)	**MOISTURE** (%)	**DRY DENSITY** (pcf)	**LL/PI** (%)	**ADDITIONAL DATA/ REMARKS**
	APPROX. SURFACE ELEV. (ft): 962		0.0								
	ASPHALTIC CONCRETE ***0.5'***	■									
	FILL *Yellowish brown with dark gray and light gray clay, trace fine sand, moist*	▨									
960.0		▨		■ U 1				28.9	91.6		PP = 1.5 tsf
	2.9'	▨	2.5								
	LIMESTONE ***3.0'***			⌶ GB 2				26.0			

REFUSAL AT 3.0 FEET

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
IAD	▼ Not Encountered
AD	▼ Not Encountered

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DRILL CO.:	OLSSON	DRILL RIG:	CME 45B
DRILLER:	T. KETTLER	LOGGED BY:	C. HAACK
METHOD: CONTINUOUS FLIGHT AUGER			

BOREHOLE REPORT NO. B-3

Sheet 1 of 1

PROJECT NAME **Mid-Continent Public Structural & Civil Evaluations**	CLIENT **Mid-Continent Public Library**
PROJECT NUMBER **A18-0330**	LOCATION **Lee's Summit, Missouri**

■ Shelby Tube

ELEVATION (ft)	MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
	APPROX. SURFACE ELEV. (ft): 963		0.0								
962.5	***ASPHALTIC CONCRETE*** ***0.5'***	■									
	FILL *Light brown with dark gray clay, trace fine sand, moist*	▨	2.5	■ U 1			3.4	24.4	100.5		
960.0	***2.9'***										
	LIMESTONE ***3.0'***										

REFUSAL AT 3.0 FEET

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
IAD	▼ Not Encountered
AD	▼ Not Encountered

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OLATHE, KANSAS 66061

STARTED:	3/2/21	FINISHED:	3/2/21
DRILL CO.:	OLSSON	DRILL RIG:	CME 45B
DRILLER:	T. KETTLER	LOGGED BY:	C. HAACK
METHOD: CONTINUOUS FLIGHT AUGER			

BOREHOLE REPORT NO. B-4

Sheet 1 of 1

PROJECT NAME **Mid-Continent Public Structural & Civil Evaluations**	CLIENT **Mid-Continent Public Library**
PROJECT NUMBER **A18-0330**	LOCATION **Lee's Summit, Missouri**

■ Shelby Tube

ELEVATION (ft)	MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
	TOPSOIL **0.2'**		0.0								
	FILL *Dark brown with light brown clay, trace fine sand, moist* **3.0'**		2.5	U 1	CH		1.1	28.8	92.7	53/35	
	FAT CLAY *Very stiff, dark gray, moist, trace fine sand* *grades to stiff at 8 feet*		5.0	U 2			2.4	27.9	94.3		
			7.5								
	10.0'		10.0	U 3			1.2	32.2	87.4		

BASE OF BORING AT 10.0 FEET

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
IAD	▼ Not Encountered
AD	▼ Not Encountered

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OLATHE, KANSAS 66061

STARTED:	3/2/21	FINISHED:	3/2/21
DRILL CO.:	OLSSON	DRILL RIG:	CME 45B
DRILLER:	T. KETTLER	LOGGED BY:	C. HAACK
METHOD: CONTINUOUS FLIGHT AUGER			

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BOREHOLE REPORT NO. B-5

Sheet 1 of 1

PROJECT NAME **Mid-Continent Public Structural & Civil Evaluations**	CLIENT **Mid-Continent Public Library**
PROJECT NUMBER **A18-0330**	LOCATION **Lee's Summit, Missouri**

■ Shelby Tube

ELEVATION (ft)	**MATERIAL DESCRIPTION**	**GRAPHIC LOG**	**DEPTH** (ft)	**SAMPLE TYPE NUMBER**	**CLASSIFICATION** (USCS)	**BLOWS/6" N-VALUE**	**UNC. STR.** (tsf)	**MOISTURE** (%)	**DRY DENSITY** (pcf)	**LL/PI** (%)	**ADDITIONAL DATA/ REMARKS**
			0.0								
	TOPSOIL ***0.2'***										
	FILL *Dark brown and light brown clay, trance fine sand, moist*		2.5	U 1			1.7	30.4	89.5		
	3.5' ***FAT CLAY*** *Stiff, dark brown, moist, trace fine sand and gravel* *grades to firm at 8 feet*		5.0	U 2			1.3	28.3	94.2		
			7.5								
	10.0'		10.0	U 3			0.7	31.9	90.1		

BASE OF BORING AT 10.0 FEET

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
IAD	▼ Not Encountered
AD	▼ Not Encountered

OLSSON, INC.
1700 E. 123RD STREET
OLATHE, KANSAS 66061

STARTED:	3/2/21	FINISHED:	3/2/21
DRILL CO.:	OLSSON	DRILL RIG:	CME 45B
DRILLER:	T. KETTLER	LOGGED BY:	C. HAACK
METHOD: CONTINUOUS FLIGHT AUGER			