

GEOTECHNICAL EXPLORATION REPORT

Proposed 24-7 Travel Store

1980 South Range Ave

Colby, Kansas

GSI Project No. 2173068A
June 4, 2021

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	<p>I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Kansas.</p> <p><u>David Edwards</u> <u>06/04/2021</u> David A. Edwards, P.E. Date</p> <p>My license renewal date is April 30, 2022. <i>Sections covered by this seal: Sections 1 through 6 and all pages included as appendices within this bound document.</i></p>
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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.

Geotechnical 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 civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you 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 the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- 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. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by:* the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly

problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of 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.

Environmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* 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 environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold-prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical-engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

Membership in the Geotechnical Business Council of 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. Confer with your GBC-Member geotechnical engineer for more information.



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1. INTRODUCTION

1.1 General

This report summarizes the findings of our geotechnical exploration for the proposed 24-7 Travel Store located at 1980 South Range Avenue in Colby, Kansas. The scope of work was outlined in our proposal dated April 23, 2021. Mr. Mark Augustine of Triplett, Inc. authorized this exploration on April 23, 2021.

The purpose of this geotechnical study is to explore the subsurface conditions at the proposed site with exploratory borings, evaluate the engineering properties of the subsurface materials with appropriate field and laboratory tests, and perform engineering analyses for developing design and construction recommendations for the proposed project.

1.2 Project Description

The proposed project will be located at 1980 South Range Ave, Colby, Kansas. We understand the development will consist of a new convenience store, fuel pump islands, fuel island canopies for passenger cars and tractor-trailers, underground fuel storage tanks, and pavement improvements. The single-story convenience store structure will be of concrete masonry unit (CMU) construction with a concrete slab-on-grade floor. We estimate the structure will have maximum column and continuous wall loads on the order of 20 kips and 2 kips per linear foot, respectively.

Based on our experience with similar structures, we anticipate the base of the canopy foundations will be placed approximately 5 feet below the finished pavement elevation and will support maximum compressive loads on the order of 45 kips and uplift loads on the order of 15 kips.

We anticipate that the pavements on the east portion of the site will support predominately light passenger car traffic, while the remainder of the parking and drive areas will support predominantly tractor-trailer traffic.

We assume site grading required to bring the building pad to the desired elevation will be minimal, with cuts or fills less than 2 feet. Please contact us if site grading will be more significant so we may evaluate and, if necessary, adjust our recommendations.

A site plan is included in Appendix A for reference.

2. FIELD EXPLORATION

We drilled 10 borings for this geotechnical exploration on May 4, 2021 with a CME 45 truck-mounted drilling rig using 3.25-inch inside diameter hollow stem augers. We drilled the borings at the locations and to the depths as indicated in Table 2.1 below.

Table 2.1: Soil Boring Schedule

Structure	Borings	Boring Depth (ft.)
Underground Storage Tanks	B-1	25.0
Convenience Store	B-2 & B-3	15.0
Truck Fuel Canopy	B-4	15.0
Passenger Vehicle Canopy	B-5	15.0
High Volume Parking/Drive Areas	B-6 to B-10	5.0

We selected boring locations based on a preliminary site plan provided to us by Mr. Augustine in his request for proposal. GSI personnel established field locations by using a handheld GPS unit with an accuracy of +/- 6 feet. The boring locations in relation to existing and proposed features are indicated on the Boring Location Plan included in Appendix A. The boring locations should be considered accurate only to the degree implied by the methods used in their determination.

We interpolated ground surface elevations at the boring locations using elevations obtained from ground surface profiling provided by Google Earth. The ground surface elevations at the borings are shown on the boring logs included in Appendix B. The boring elevations should be considered accurate only to the degree implied by the methods used in their determination.

Our drill crew obtained soil samples at the intervals shown on the boring logs in Appendix B. Recovered samples were sealed in plastic containers, labeled, and protected for transportation to the laboratory for further examination, testing, and classification.

We obtained split-barrel samples (designated "Split Spoon" or "S" samples) while performing Standard Penetration Tests (SPT) with a 1-3/8 inch I.D. thick-walled sampler, driven using an automatic hammer in general accordance with ASTM D1586, "*Penetration Test and Split-Barrel Sampling of Soils.*" The "N" value, reported in blows per foot (bpf), equals the number of blows

required to drive the sampler through the last 12 inches of the 18-inch sample interval using a 140-pound hammer falling 30 inches.

We obtained undisturbed samples (designated “Shelby Tube” or “U” samples) with 3-inch O.D. thin-walled tube samplers, hydraulically pushed in general accordance with ASTM D1587, “*Thin-Walled Tube Sampling of Soils for Geotechnical Purposes.*”

Our drilling personnel prepared field boring logs during drilling operations. These field logs report drilling and sampling methods, sampling intervals, groundwater measurements and the subsurface conditions we encountered. At the conclusion of drilling, our drill crew made groundwater measurements, backfilled the borings in accordance with Kansas state regulations, and patched the asphalt and concrete pavements where necessary.

3. SITE CONDITIONS

3.1 Regional Geology

This project site lies within the High Plains geomorphic region of western Kansas. The topography in this region is typified by flatlands and gently rolling hills occasionally dissected by alluvial channels. Soil stratigraphy generally comprises Pleistocene Age loess deposits and recent-stage sand dunes underlain by the Tertiary Age Ogallala Formation. Loess deposits comprise wind-blown silt and clay particles, while the Ogallala Formation includes clay, silt, and gravel with occasional zones of cemented materials. The bedrock in the High Plains area was eroded significantly during the Tertiary Age and as such, the thickness of the Ogallala Formation can approach 350 feet.

3.2 Surface Conditions

The project site comprises an existing 24-7 Travel Store facility with associated passenger vehicle and truck fuel canopies, underground storage tanks, and asphalt and concrete paved parking and drive areas. The site is bound by South Range Avenue to the east, the Woofter Construction & Irrigation Facility to the west, a Subway restaurant to the north, and J & B Meat Market to the south. The site slopes downgradient from south to north with approximately seven feet of elevation change across the development area.

3.3 Subsurface Conditions

Although we observed some variability, the subsurface materials we encountered within the depths of exploration generally comprised approximately 6 inches of asphalt or concrete pavements or gravel at the surface, underlain by lean clay with varying amounts of sand. General descriptions of the strata we encountered are presented below, while more detailed subsurface information is presented on the boring logs located in Appendix B. Please note that the indicated depths are relative to the site grade at the time of our exploration.

We encountered lean clay with varying amounts of sand in all ten borings, underlying the various surface materials, and extending to the scheduled boring termination depths at 5, 15, and 25 feet below the current site grade. This material varied in color from dark brown to brown or dark yellowish brown to light yellowish brown or yellowish brown and was classified as dry to moist. We measured Standard Penetration Test (SPT) N-values between 2 and 16 blows per foot (bpf) and unconfined compressive strengths between 1.49 and 3.22 kips per square foot (ksf), indicating that the lean clay is in a very soft to stiff condition.

3.4 Groundwater Conditions

Our drill crew made water level observations during drilling and after completion of the borings to evaluate groundwater conditions. We did not encounter groundwater in any of our soil borings.

The groundwater conditions we observed during our exploration program should not be construed to represent an absolute or permanent condition. Uncertainty is involved with short-term water level observations in boreholes. Available Kansas Geological Survey (KGS) water well records in the area indicate static groundwater levels between 87 and 174 feet below grade.

The free groundwater surface or groundwater table within unconfined aquifers is generally a subdued reflection of surface topography. Water generally flows downward from upland positions (recharge zones) to low lying areas or surface water bodies (discharge zones). As such, the groundwater level and the amount and level of any perched water on the site may be expected to fluctuate with variations in precipitation, site grading, drainage and adjacent land use. Long-term monitoring utilizing piezometers or observation wells is required to evaluate the potential range of groundwater conditions.

3.5 Seismic Site Classification

We have reviewed the boring logs and laboratory test data for this project. We have also reviewed other geologic data from the general area available to us for further information on the soils extending to a depth of 100 feet below the existing grade.

Based on the above resources, we estimate that the weighted average N-value for soil across this depth is greater than 15, but less than 50 blows per foot (bpf). As defined in Chapter 20 of ASCE 7-10 as well as the 2012 version of the International Building Code, this building site is assigned a Site Class of D.

Seismic site classification can also be determined by directly measuring the shear wave velocity of the subsurface soils. Direct measurement of the shear wave velocity may indicate a higher site class could be used for structural design. Please contact GSI for additional information regarding shear wave velocity profiling.

4. LABORATORY TESTING

Our engineering staff reviewed the field boring logs to outline the depth, thickness and extent of the soil strata. The samples taken from the borings were examined in our laboratory and visually classified in general accordance with ASTM D2488, “*Description and Identification of Soils (Visual-Manual Procedure)*.” We established a testing program to evaluate the engineering properties of the recovered samples. A GSI technician performed laboratory testing in general accordance with the following current ASTM test methods:

- Moisture Content (ASTM D2216, “*Laboratory Determination of Water (Moisture) Content of Soil and Rock*”)
- Unit Weight (ASTM D7263, “*Laboratory Determination of Density (Unit Weight) of Soil Specimens*”)
- Atterberg Limits (ASTM D4318, “*Liquid Limit, Plastic Limit, and Plasticity Index of Soils*”)
- Minus No. 200 Sieve Wash (ASTM D1140, “*Amount of Material in Soils Finer Than the No. 200 (75- μ m) Sieve*”)
- Unconfined Compressive Strength (ASTM D2166, “*Unconfined Compressive Strength of Cohesive Soil*”)

Laboratory test results are presented on the boring logs in Appendix B and are tabulated in Appendix C.

Moisture content and unit weight tests were used to evaluate the existing moisture-density condition of the soils. The Atterberg limits and Minus No. 200 sieve tests were used to help classify the soils under the Unified Soils Classification System. The Atterberg limits were also used to evaluate the plasticity characteristics of the soils. Unconfined compression tests were used to define the stress-strain characteristics and related shear strength of the soils.

The following data summarize our laboratory test results. We used these data to develop the allowable bearing values, anticipated settlements, and other geotechnical design criteria for the project.

- Natural Moisture Content..... 3.9 to 25.0%
- Wet Density..... 113.9 to 121.5 lb/ft³
- Dry Density..... 96.1 to 97.8 lb/ft³

- Unconfined Compressive Strength 1.49 to 3.22 kips/ft²
- Liquid Limit 34 to 41
- Plastic Limit 23 to 24
- Plasticity Index 11 to 17
- Percent Passing the No. 200 Sieve 69.6 to 97.7%
- Standard Penetration Test (SPT 'N' blows per foot) 2 to 16

Based on the results of this testing program, we reviewed and supplemented the field logs to arrive at the final logs as presented in Appendix B. The final logs represent our interpretation of the field logs and reflect the additional information obtained from the laboratory testing. Stratification boundaries indicated on the boring logs were based on observations made during drilling, an extrapolation of information obtained by evaluating samples from the borings, and comparisons of similar engineering characteristics. Locations of these boundaries are approximate and the transitions between soil types may be gradual rather than clearly defined.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 General Geotechnical Considerations

We understand that the current 24-7 Travel Store facility and all associated canopies and underground storage tanks will be removed as a part of this development. Demolition rubble and debris should be removed from the site and all excavations resulting from demolition activities should be backfilled with materials meeting the requirements of LVC material as defined in Section 5.2.3 and be placed in accordance with the recommendations provided in Section 5.2.4.

The subsurface conditions at this site include highly compressible clay and allowable soil bearing capacities as low as 500 psf at depths between 2.5 and 15 feet below the current site grade. The soils we encountered in the borings are generally capable of supporting the loads of the various structures on shallow foundations only after soil improvements as described in Section 5.3.

The near-surface clay soils we encountered at the site generally exhibit low plasticity and limited shrink/swell potential. These soils may be used for direct support of floor slabs or pavements, if properly moisture conditioned and compacted as outlined later in this report.

We did not encounter groundwater within the depths of our exploration program. Available Kansas Geological Survey (KGS) water well records in the area indicate static groundwater levels between 87 and 174 feet below grade. We do not anticipate that groundwater will be encountered within the expected depths of excavation.

5.2 Earthwork

5.2.1 Site Preparation

Existing structures, including underground storage tanks, located within the proposed development area must be removed and the associated foundations and slabs-on-grade excavated. Excavations resulting from demolition activities must be filled with an engineered structural fill that is placed, moisture conditioned and compacted in accordance with the following paragraphs.

We recommend existing utilities within the proposed building area be relocated to avoid passing beneath the new structures. Abandoned utility pipes that cannot be removed must be plugged with grout to reduce the potential for future collapse or moisture migration into the subgrade soils.

Excavations resulting from utility removal must be replaced with engineered structural fill as outlined in Section 5.2.4.

In preparing the site for construction, existing pavements, surface vegetation and topsoil containing a significant percentage of organic matter should be removed from the areas beneath structures and any other areas that are to be paved, cut or receive fill. The removal depth for this site is expected to be approximately 6 inches. However, the removal depth should be monitored during stripping and adjusted as required. The demolition debris should be removed from the site, while the topsoil may stockpiled for later use in landscaping of unpaved or non-structural areas.

Prior to fill placement, the top 9 inches of the ground surface in fill areas should be scarified, moisture conditioned and recompacted in accordance with Section 5.2.4 to eliminate a plane of weakness along the contact surface.

The completed subgrade should be proof rolled with a loaded tandem axle dump truck or equivalent (loaded water truck, loaded concrete mixer or motor grader with a minimum weight of 20 tons). A proof-roll is considered acceptable if no ruts greater than one inch deep appear behind the loaded vehicle, and no pumping or weaving is observed as the wheels pass over the area. Any soft or unsuitable areas should be compacted or removed and replaced with stable fill material similar in composition to the surrounding soils. If necessary, clean materials such as crushed concrete or crushed stone may be used to stabilize areas where wet soil or water is present. Geogrid or structural geotextile may be used in conjunction with crushed concrete or stone to provide additional stabilization.

Whether in cut or fill, the final subgrade surface must be maintained in a stable condition at the moisture content and level of compaction identified in Section 5.2.4. Verification and maintenance of the completed subgrade may require scarification, moisture conditioning, recompaction, and proof rolling.

5.2.2 General Structural Fill

General structural fill may be used for mass site grading, landscaping applications or as utility trench backfill outside of building areas. General structural fill may also be used to within 12 inches of the base of any granular cushion beneath floor slabs and to within 12 inches of the base of any vehicular

or pedestrian pavements. In the former applications, low volume change materials are required immediately below the floor slabs or pavements (low volume change material is discussed in the following section).

General structural fill may comprise cohesive or granular material but should be free from organic matter or debris. Granular materials used as general structural fill should be well graded, have a maximum particle size of 1.5 inches, and meet KDOT freeze/thaw durability and sulfate soundness requirements. Off-site material used as general structural fill should have a liquid limit (LL) of less than 50 and a plastic index (PI) of less than 30.

If free of organic matter or debris, the on-site soils may be reused as general structural fill within the areas outlined above.

5.2.3 Low Volume Change Material (LVC)

Low volume change (LVC) material as specified for use below floor slabs and pavements must consist of granular material or cohesive soil with a liquid limit (LL) less than 40 and a plasticity index (PI) between 10 and 20. Granular material used as LVC must have sufficient cohesion to form a compactable, uniform and stable subgrade. This typically translates to a material with greater than 15 percent fines (percent passing the No. 200 sieve) and a maximum particle size of 1.5 inches. Silty gravel (such as KDOT AB-3), crushed concrete with a maximum particle size of 1.5 inches, or limestone screenings are also acceptable LVC materials. Granular materials with less than 15 percent fines may be used within confined areas such as within foundation stem walls. LVC materials should be free of organic matter or debris.

The on-site lean clay soils may be considered LVC material as defined in this section, if properly moisture conditioned and recompacted in place as outlined in the following section.

5.2.4 Compaction of Engineered Structural Fills

Unless otherwise noted, fill materials should be placed in loose lifts not to exceed 9 inches and be compacted to a minimum of 95 percent of the maximum dry unit weight obtained from ASTM D698 (Standard Proctor). Moisture content at the time of compaction should be controlled to between optimum and 4 percent above optimum moisture content.

Granular fill materials which produce a definable moisture-density curve when tested according to ASTM D698 should be compacted to a minimum of 95 percent of the maximum dry unit weight obtained from ASTM D698. Granular fill materials which do not produce a definable moisture-density curve should be compacted to a minimum of 75 percent relative density (ASTM D4253, “*Maximum Index Density and Unit Weight of Soils Using a Vibratory Table*” and ASTM D4254, “*Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density*”). Granular materials should be placed at a moisture content that will achieve the desired densities. Please note that relative density and standard Proctor tests measure different parameters and are not interchangeable.

In general, proper compaction of cohesive soils can be achieved with sheepsfoot or pneumatic-type compactors, while compaction of granular soils can be achieved with smooth-drum or smooth-plate vibratory compactors. Water flooding or “jetting” is not an acceptable compaction method for any soil type.

5.2.5 Utility Trench Backfill

As a minimum, utility trench backfill material should meet the requirements of general structural fill as defined in Section 5.2.2. Where utility trenches pass beneath the structures, pavements or flatwork, the upper foot of utility backfill should meet the requirements of LVC material as defined in Section 5.2.3. Backfill soils in utility trenches must be placed in lifts of 6 inches or less in loose thickness and be compacted in accordance with Section 5.2.4.

Controlled low strength material (CLSM) or flowable fill may also be used for utility backfills. We recommend designing flowable fill with a compressive strength between 50 and 300 pounds per square inch (psi). CLSM with a maximum compressive strength less than 300 psi can be readily excavated with a backhoe. The intent for the CLSM is to provide a backfill that can be placed in a single lift, without personnel entering the excavation and without the need for compaction equipment.

Where used beneath pavements, flatwork or the structures, CLSM should be terminated a minimum of one foot below the structure, floor slab, or pavement subgrade elevation. To provide uniform support beneath pavements, flatwork, and the structures, the fill placed over the CLSM should be of similar composition as the surrounding bearing materials and be constructed as moisture-conditioned and compacted engineered structural fill in accordance with Section 5.2.4.

5.2.6 Foundation Backfill

As a minimum, backfill soils for formed foundations should meet the requirements of general structural fill as defined in Section 5.2.2. However, we recommend fill around foundations meet the requirements of LVC material as defined in Section 5.2.3. The use of LVC material to backfill foundations is intended to help reduce lateral swell pressures on the foundation wall and reduce desiccation cracking adjacent to the structure, which can provide a pathway for water to infiltrate the foundation subgrade. If other cohesive materials are used to backfill foundations, the risk of differential movements caused by water infiltration into the foundation subgrade may be increased.

We also recommend the upper 18 inches of exterior foundation backfill have sufficient cohesion to direct surface water away from the structure. Granular materials such as sand and gravel are not suitable for use as exterior foundation backfill in the surficial 18 inches.

Backfill soils around formed foundations must be placed in lifts of 6 inches or less in loose thickness and be moisture conditioned and compacted in accordance with Section 5.2.4. Care should be exercised during compaction to avoid applying excessive stress to the foundation surfaces. Where both sides of a foundation wall are backfilled, the fill should be placed simultaneously in uniform lifts on both sides of the wall to reduce unbalanced lateral loads.

5.2.7 Underground Storage Tank Backfill

Underground storage tank basins must be backfilled with a freely draining granular material meeting KDHE specifications. A minimum of 12 inches of pea gravel (3/8" maximum nominal diameter) should be placed between the floor of the excavation and the installed tank to act as a cushion for the tank.

The excavation should be backfilled from the top of the pea gravel to the top of the tank with pea gravel or highly porous sand. On-site material may be used to backfill from the top of the porous material to the base of the overlying pavement subgrade (bottom of LVC zone) provided it is free of large rocks, debris or foreign materials. A separation geotextile should be placed above the granular backfill to prevent fines from migrating into the granular material. Backfilling and compaction operations must be performed in accordance with the tank manufacturer's recommendations.

5.2.8 Correction of Unsuitable Foundation Soils

If soft, loose, or otherwise unsuitable soils are encountered at the base of any foundations, an over-excavation and replacement/recompaction procedure will be required. The unsuitable soils beneath the foundations should be removed to the required depth, with the excavation extending laterally 9 inches in all directions for each vertical foot of over-excavation. Structural fill for the over-excavated areas should be of similar composition as the surrounding materials or meet the requirements of LVC material as defined in Section 5.2.3. Backfill material should be compacted in accordance with Section 5.2.4. CLSM, as defined in Section 5.2.5 may also be used to backfill over-excavated areas.

5.2.9 Excavation Slopes

Vertical cuts and excavations may stand for short periods of time, but should not be considered stable in any case. All excavations should be sloped back, shored, or shielded for the protection of workers. As a minimum, trenching and excavation activities should conform to federal and local regulations.

The clay soils we encountered in the upper 5 feet of the test borings generally classify as a type "C" soil according to OSHA's Construction Standards for Excavations. In general, the maximum allowable slope for shallow excavations of less than 20 feet in a type "C" soil is 1.5H:1.0V, although other provisions and restrictions may apply. If different soil types are encountered, the maximum allowable slope may be different.

The Contractor is responsible for designing any excavation slopes or temporary shoring. The Contractor must also be aware that slope height, slope inclination, and excavation depths (including utility trench excavations) should in no case exceed those specified in federal, state, or local safety regulations, such as OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations.

The information presented in this section is solely for our client's reference. **GSI assumes no responsibility for site safety or the implementation of proper excavation techniques.**

5.3 Foundations

5.3.1 General Foundation Recommendations

The subsurface conditions at this site include highly compressible clay and allowable soil bearing capacities as low as 500 psf at depths between 2.5 and 15 feet below the current site grade. The soils we encountered in the borings are generally capable of supporting the loads of the various structures on shallow foundations only after soil improvements as described below.

5.3.2 Shallow Foundations

Based on the subsurface conditions revealed by the boring and testing program, this site appears suitable for use of a shallow foundation system only after improvements as discussed in the following paragraphs. The selection of an allowable soil bearing pressure for shallow foundation elements must fulfill two requirements. First, the foundation load must be sufficiently less than the ultimate soil bearing capacity to ensure stability. Second, the total and differential settlements must not exceed amounts which will produce adverse behavior of the superstructure.

In order to meet the previous criteria, we have explored both the bearing capacity and the load settlement characteristics of the subsurface materials using maximum column and continuous wall loads on the order of 20 kips and 2 kips per linear foot, respectively, for the convenience store and maximum compressive loads on the order of 45 kips and uplift loads on the order of 15 kips in the canopy areas. The allowable soil bearing pressure is based on a factor of safety of three against the ultimate bearing capacity of the soil, with additional consideration given to limiting settlement to acceptable levels. In our analysis, we used a maximum allowable total settlement of 1 inch and a maximum allowable differential settlement of $\frac{3}{4}$ of an inch within 25 linear feet or between the fuel canopy columns. These limits are generally considered acceptable for most structures.

Convenience Store Foundations

A program of over-excavation and replacement will be required to support the anticipated loads of the proposed structure on shallow foundations. The program of over-excavation and replacement will require excavations extending 2 feet below the bottom of footing elevation vertically and widening the excavation laterally a minimum of 18 inches beyond the edges of the foundation elements. The bottom 6 inches of the excavation should then be scarified, moisture conditioned, and recompactd as outlined in Section 5.2.4. The over-excavated lean clay materials may be re-used as engineered structural fill beneath the footings.

A net allowable soil bearing pressure of 2,000 pounds per square foot (psf) may be used to size shallow foundation elements bearing on 2.5 feet of properly constructed engineered fill.

Pump Island Canopy Foundations

A program of over-excavation and replacement will be required to support the anticipated pump island canopy foundation loads on shallow foundations. The program of over-excavation and replacement will require excavations extending 5 feet below the bottom of footing elevation vertically and widening the excavation laterally a minimum of 5 feet beyond the edges of the foundation elements. The bottom 6 inches of the excavation should then be scarified, moisture conditioned, and recompacted as outlined in Section 5.2.4. The over-excavated lean clay materials may be re-used as engineered structural fill beneath the footings.

A net allowable soil bearing pressure of 2,000 pounds per square foot (psf) may be used to size shallow foundation elements bearing on 5.5 feet of properly constructed engineered fill.

General Foundation Recommendations

Please note that proper construction of the fill is critical to the performance of the recompacted soil and the proposed structure. Therefore, we require that an engineer or technician from GSI perform foundation subgrade observations and testing for this project during structural backfill and foundation placement to verify that structural fill is placed correctly and that foundation bearing conditions are acceptable. The net allowable bearing capacity indicated below is only valid if the structural backfill is properly constructed.

The allowable bearing pressure is expressed in terms of the net pressure transferred to the soil. The net allowable bearing pressure is defined as the total structural dead load including the weight of the foundation elements, less the weight of the soil excavated for the foundation elements. This value may be increased by one-third for transient loading conditions such as wind or seismic forces.

All exterior and any interior foundation elements exposed to freezing conditions should be constructed at least 3 feet below the surrounding exterior grade to help reduce the effects of frost and seasonal moisture changes. Interior footings, which will be protected from the effects of frost, may be founded 1.5 feet below finished floor elevation.

We recommend that concrete be placed as soon as practical after footing excavation, with as little disturbance to the bearing soil as possible. Footing excavations should be free of loose soil or debris. Loose or disturbed soil must be removed or compacted prior to foundation construction. Water that collects in the excavations should be promptly removed to prevent softening of the foundation supporting soils prior to concrete placement. In addition, we recommend all excavations be observed by our geotechnical personnel prior to placement of concrete for the possible presence of unsuitable bearing soils. If unsuitable bearing soils are encountered during construction, these areas should be corrected in accordance with Section 5.2.8.

If shallow foundations are designed and constructed in accordance with the recommendations presented, total settlements are not expected to exceed 1 inch with differential settlements less than $\frac{3}{4}$ of an inch within 25 linear feet or between the fuel canopy columns.

5.4 Floor Slabs

The soils we encountered at this site generally exhibit moderate to low plasticity and limited shrink/swell potential. Most slabs-on-grade will experience some amount of vertical movement, which the Owner must be willing to accept. Recommendations to help reduce the risk of slab movement are presented below.

To provide uniform support for floor slabs and reduce the potential for subgrade volume change, we recommend all floor slabs bear on a minimum of 12 inches of moisture conditioned and compacted LVC material as defined in Section 5.2.3. The placement and compaction of the LVC material should conform to the recommendations in Section 5.2.4 of this report. Depending on final site grades, this LVC layer could comprise on-site soils that have been moisture-conditioned and recompacted in place.

By constructing a 12-inch layer of low plasticity, low volume change material immediately beneath the floor slab and closely controlling the moisture and density of the scarified soil and new fill materials, it is our opinion that the potential for detrimental floor slab movement will be sufficiently reduced. A greater thickness of low volume change material beneath the floor slab may further reduce potential slab movement. If even slight slab movements are not acceptable, please contact GSI for further floor slab recommendations.

We recommend a 2- to 4-inch thick granular cushion be placed beneath the floor slab in addition to the low plasticity, low volume change material. This layer should be free-draining, well-graded and compacted by vibration prior to placing the floor slab.

We also recommend the moisture content of upper 9 inches of the subgrade be checked prior to placement of a sand base, reinforcing steel or concrete floor slab. If the moisture content of the subgrade is below optimum, we recommend the subgrade be scarified, moisture conditioned and recompacted according to Section 5.2.4.

In many construction projects, the moisture content of the floor slab subgrade is tested during grading of the site. The subgrade then remains exposed until floor slab placement occurs several weeks later. In this situation, even LVC material is subject to some swell movement if not properly moisture conditioned prior to slab placement. Periodic applications of water will help maintain the proper moisture content of subgrade soils. The risk of differential movements can be reduced by creating and properly preparing a LVC zone beneath the slab as well as ensuring proper drainage is maintained around the structure at all times.

In finished areas, the floor covering manufacturer should be consulted regarding the use of a vapor retarder beneath floor slabs. If a vapor retarder is recommended by the floor covering manufacturer, it should conform to the manufacturer's specifications to maintain the product warranty. In other areas, vapor retarder should be placed in accordance with recommendations outlined in ACI 302.1R-15, "Guide to Concrete Floor and Slab Construction."

5.5 Pavement Recommendations

The asphalt and Portland cement concrete pavement recommendations provided below are separated into a regular duty, and a heavy duty section. To perform properly, the pavement sections require that the subgrade be prepared in accordance with the recommendations in Section 5.5.1.

5.5.1 Pavement Subgrade Preparation

Pavement performance is directly affected by the degree of compaction, uniformity, and stability of the subgrade. The stability and quality of the pavement subgrade is particularly important where high traffic volume and heavy axle loads are anticipated. Based on the subsurface conditions encountered at the boring locations, the pavement subgrade will comprise low plasticity clay soils.

If vehicular and pedestrian pavements will be placed on native soils, we recommend the top 12 inches of the subgrade be moisture conditioned and recompact as outlined in Section 5.2.4 of this report. If off-site soils are used to raise the site grade, we recommend these materials meet the requirements of LVC material as defined in Section 5.2.3.

The top 12 inches of pavement subgrade should be compacted to a minimum of 95 percent of the maximum dry unit weight determined by ASTM D698. The moisture content should also be controlled to between optimum and 4 percent above the optimum moisture content.

To detect any localized areas of instability, the final subgrade should be proof rolled with a loaded tandem axle dump truck or equivalent (loaded water truck, loaded concrete mixer or motor grader with a minimum weight of 20 tons) immediately prior to placement of the concrete or asphalt. Unstable areas should be removed and replaced or reworked to provide a more uniform subgrade. If necessary, clean materials such as crushed concrete or crushed stone may be used to stabilize areas where wet soil or water is present. Geogrid or structural geotextile may be used in conjunction with crushed concrete or stone to provide additional stabilization.

We also recommend the moisture content of the subgrade be checked prior to paving. If the moisture content is below optimum, we recommend the subgrade be scarified, moisture conditioned and recompact according to Section 5.2.4.

5.5.2 Recommended Design Sections

The pavement sections for this project are based on our experience with similar pavements and a design life of 15 to 20 years. The regular duty pavement sections are intended for passenger car and light truck traffic and parking areas. The heavy-duty pavement sections are intended for areas that will experience high traffic volumes or heavy axle loads such as main access drives or delivery truck routes. Portland cement concrete pavements are recommended for areas with frequent start-stop or turning traffic such as entrance and exit aprons or the parking stalls closest to buildings, areas that support stationary loads such as dumpsters, and areas that could be exposed to fuel spills, such as around the fuel pump islands.

Our recommendations for full-depth asphalt and Portland cement concrete pavement sections are presented in the following tables.

Table 5.5.2-1: Full-Depth ACC Pavement Design Recommendations

	Regular Duty Section	Heavy Duty Section
KDOT BM-2 Wear Course (in.)	2.0	2.0
KDOT BM-2 Base Course (in.)	4.5	6.5
LVC Subgrade	12.0 (minimum)	12.0 (minimum)

**LVC subgrade placed and compacted in accordance with Section 5.5.1.*

Table 5.5.2-2: PCC Pavement Design Recommendations

	Thickness (Inches)		
	Sidewalks & Pedestrian Areas	Regular Duty Section	Heavy Duty Section
KDOT MA-2 Air Entrained Portland Cement Concrete (in.)	4.0	6.0	7.0
LVC Subgrade	12.0 (minimum)	12.0 (minimum)	12.0 (minimum)

**LVC subgrade placed and compacted in accordance with Section 5.5.1.*

Please note that pavement thickness recommendations or requirements provided by the fuel tank manufacturer may supersede these recommendations, provided the alternate pavement thicknesses are greater than those presented above.

5.5.3 Asphaltic Cement Concrete Pavement Construction

We recommend that both the asphalt surface and base coarse aggregate gradations meet KDOT SM-12.5A (SR-12.5A if recycled asphalt is included) with a performance graded asphalt binder meeting KDOT PG 64-22. If recycled asphalt is included in the mixes, we recommend that a maximum of 15% RAP be used in the surface course and that a maximum of 20% RAP be used in the base courses.

Asphalt should be placed at an ambient temperature above 40 degrees Fahrenheit. Asphalt temperature at the time of compaction should be between 265 and 330 degrees Fahrenheit. We recommend the initial asphalt lift placed directly on the subgrade should be compacted to a minimum

of 94 percent of the Marshall density with subsequent asphalt lifts compacted to a minimum of 96 percent of the Marshall density. Please note that recommendations regarding compaction temperature and percentage for a specific pavement design should supersede these recommendations.

All asphaltic concrete mix designs should be submitted to GSI and reviewed to determine if the designs are consistent with the recommendations given in this report. We also recommend a GSI representative be present during paving operations to help ensure adherence to project pavement specifications.

5.5.4 General Pavement Considerations

Pavement service life can be significantly reduced if the pavement is constructed on a poor subgrade, if poor surface or subsurface drainage is present, or if the pavement is not maintained properly. We emphasize the importance of preparing the pavement subgrade in accordance with the procedures listed in the previous sections of this report.

Drainage of surface and subsurface water is also a critical component of pavement performance. Wetting of the subgrade soils or base course will cause loss of support strength resulting in premature pavement distress. Surface drainage should be designed to remove all water from paved areas. All curbs, including those surrounding pavement islands, should be backfilled as soon as possible after construction of the pavement. Backfill should be compacted and sloped to prevent water from ponding and infiltrating under the pavement. Regular active maintenance of pavements, which includes filling of cracks and joints, is required to minimize water infiltration and lengthen pavement life.

5.6 Earth Retaining Structures/Underground Storage Tanks

Earth-retaining structures should be designed to withstand lateral earth pressures caused by adjacent soil and applied surcharge loads. The magnitude of the lateral earth pressure will depend on the height of the walls, stiffness of the walls, magnitude of the surcharge loads behind the walls, and the backfill and existing soil conditions behind the walls.

Table 5.6-1: Lateral Earth Pressure Coefficients

Soil Type (USCS Symbol)	Wet Unit Weight (pcf)	Drained Friction Angle (Φ')	At Rest (K_o)	Active (K_a)	Passive (K_p)
Lean Clay (CL)	125	27	0.55	0.38	2.66
Granular Backfill* (SP, SW)	115	32	0.47	0.31	3.25
Granular Backfill* (GP, GW)	125	35	0.43	0.27	3.69

**Values for material compacted in accordance with Section 5.2.4*

The values provided above are empirical and are based on basic testing as well as our experience with similar materials. These values also assume a vertical wall with a horizontal retained surface behind the wall. Lateral earth pressure parameters for granular backfill may be used only if the granular backfill extends upward from the heel of the wall at a slope shallower than 1.0H:1.0V. Please contact us if different backfill materials or wall geometries are a consideration for this project.

5.7 Surface Drainage and Landscaping

The success of the shallow foundation system, slab-on-grade floor system, and pavement sections is contingent upon keeping the moisture content of subgrade soils as constant as possible and not allowing surface drainage to have a path to the subsurface soils. Positive surface drainage away from structures must be maintained throughout the life of the structures. Landscaped areas should be designed and constructed such that irrigation and other surface water will be collected and carried away from foundation elements. Pavements should be sloped or crowned to direct surface water to storm sewer systems or detention/retention ponds.

During construction, temporary grades should be established to prevent runoff from entering excavations or footing trenches. Backfill should be placed as soon as concrete structural strength requirements are met and should be graded to drain away from the building.

The final grade of the foundation backfill and any overlying pavements should have a positive slope away from foundation walls on all sides. We typically recommend a minimum slope of one inch per foot for the first 5 to 10 feet for uncovered surfaces. However, the slope may be decreased if the

ground surface adjacent to foundations is covered with concrete slabs or asphalt pavements. For other areas of the site, we recommend a minimum slope of two percent. Pavements and exterior slabs that abut structures should be carefully sealed against moisture intrusion at the joint. All downspouts and faucets should discharge onto splash blocks that extend at least five feet from the building line or be tied into the storm drain system. Splash blocks should slope away from the foundation walls.

The placement of vegetation and plantings next to the foundation should be minimized. Where landscaping is required, we recommend considering plants and vegetation that require minimal irrigation. Irrigation within ten feet of the foundation should be carefully controlled and minimized.

5.8 Construction Considerations

If construction of the project is to be performed during periods of freezing temperatures, steps should be taken to prevent the soils under floor slabs, footings, or pavements from freezing. In no case should the fill materials, floor slabs, foundations, pavements, or other exterior flat work be placed on frozen or partially frozen materials. Frozen materials should be removed and replaced with a suitable material as described in earlier sections of this report.

Construction performed during periods of high precipitation may result in saturated unstable soils, and caving or sloughing of excavations. Control of soil moisture will be necessary for successful soil compaction, and to maintain soil bearing capacity.

5.9 Construction Observation and Quality Assurance

We recommend that GSI review those portions of the plans and specifications that pertain to foundations and earthwork to evaluate consistency with our findings and recommendations. GSI will provide up to 2 hours of engineering support services at no charge to review project documents for adherence to our recommendations.

Site grading, including proof-rolling, replacement or recompaction of material, and placement of fill and backfill, should be observed by a quality assurance technician from GSI under the direction of a registered professional engineer. The technician should perform density tests and make any other observations necessary to assure that the requirements of the specifications are being achieved.

It is the opinion of GSI that construction observation by the geotechnical engineer of record or his designated representative is necessary to complete the design process. Field observation services are viewed as essential and a continuation of the design process. Unless these services are provided by GSI, the geotechnical engineer will not be responsible for improper use of our recommendations or failure by others to recognize conditions which may be detrimental to the successful completion of the project.

GSI will be available to make field observations and provide consultation services as may be necessary. A written proposal outlining the cost of construction testing services such as soil, concrete, steel, and pavement quality assurance can be provided upon request.

6. CLOSING REMARKS AND LIMITATIONS

This report is presented in broad terms to provide an assessment of the subsurface conditions and their potential effect on the adequate design and economical construction of the proposed structures and pavement. The analyses, conclusions, and recommendations contained in this report are based on the site conditions existing at the time of the exploration, the project layout described herein, and the assumption that the information obtained from our ten borings is representative of subsurface conditions throughout the site.

Any changes in the design or location of the proposed structure should be assumed to invalidate the conclusions and recommendations given in this report until we have had the opportunity to review the changes and, if necessary, modify our conclusions and recommendations accordingly. If subsurface conditions different from those encountered in the explorations are observed during construction or appear to be present beneath excavations, GSI should be advised at once so that the conditions can be reviewed and recommendations reconsidered where necessary.

If there is a substantial lapse in time between the submission of this report and the start of construction, or if site conditions or the project layout have significantly changed (due to further development of grading plans, natural causes, or construction operations at or adjacent to the site), we recommend that this report be reviewed to determine the applicability of our previous conclusions and recommendations.

Our geotechnical exploration and subsequent recommendations address only the design and construction considerations contained in this report. We make no warranty for the contents of this report, neither expressed nor implied, except that our professional services were performed in accordance with engineering principles and practices generally accepted at this time and location.

The scope of services for this exploration did not include a wetlands evaluation, an environmental assessment, or an investigation for the presence of hazardous or toxic materials in the soil, surface water, groundwater, or air within or adjacent to this site. If contamination is suspected or is a concern, we recommend the scope of this study be expanded to include an environmental assessment.

This report was prepared by the firm of GSI Engineering, LLC (GSI) under the supervision of a professional engineer registered in the State of Kansas. Report preparation was in accordance with

generally accepted geotechnical engineering practices for the exclusive use of our client for evaluating the design of the project as it relates to the geotechnical aspects discussed herein. Recommendations are based on the applicable standards of the profession at the time of this report within this geographic area. GSI Engineering, LLC will not be responsible for misrepresentation of this report resulting from partial reproduction or paraphrasing of its contents.

We appreciate the opportunity to be of service on this project. Please contact us if we can provide further information regarding the contents of this report or the scope and cost of additional services.

Respectfully submitted,
GSI Engineering, LLC

A handwritten signature in blue ink, appearing to read 'Nicolas De La Rosa'.

Nicolas De La Rosa
Staff Geotechnical Engineer

A handwritten signature in blue ink, appearing to read 'David A. Edwards'.

David A. Edwards, P.E.
Principal Geotechnical Engineer

NDLR/DAE

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APPENDIX A

General Vicinity Map
Boring Location Plan



FIG. #:	1	PROJ. #:	2173068A
DATE:	05/28/2021	SCALE:	NTS
DRAWN BY:	NDR	PROJECT MANAGER:	CDP



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GENERAL VICINITY MAP
24/7 TRAVEL STORE
COLBY, KANSAS



FIG. #:	2	PROJ. #:	2173068A
DATE:	05/28/2021	SCALE:	NTS
DRAWN BY:	NDR	PROJECT MANAGER:	CDP


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BORING LOCATION PLAN
24/7 TRAVEL STORE
COLBY, KANSAS

APPENDIX B

Boring Logs

Key to Symbols

Legend & Nomenclature

Unified Soil Classification System (USCS)

Rock Descriptors

BORING LOG No. B-1

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-1	See Boring Location Plan	3211 ft.	Google Earth	P. Pulkrabek	J. Cellers
WATER LEVEL OBSERVATIONS			TYPE OF SURFACE		DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	Gravel		CME 45
N.E.	N.E.	Boring Plugged After Drilling	3.25-inch Inside Diameter Hollow Stem Augers		TOTAL DEPTH 25.0 ft.

DEP. FT.	SAMPLE DATA			SOIL DESCRIPTION			LABORATORY DATA			ELEV. FT.
	SAMPLE NO. & TYPE	"N" (BLOWS /FT)	% REC.	COLOR, CONSISTENCY, MOISTURE		USCS CLASS.	MC %	Dry Dens. pcf	q _u ksf	
				GEOLOGIC DESCRIPTION & OTHER REMARKS						
				6" GRAVEL	0.5'					
	S-1	4		LEAN CLAY w/ SAND - brown, moist, medium stiff, trace gravel LL=34; PL=23; PI=11		CL	25.0			
	U-2	N/A		- as above						
5	S-3	2		LEAN CLAY - yellowish brown, moist, soft % Pass #200: 91.0	5.0'		22.3			3206
				- medium stiff, else as above						
10	S-4	4		- as above			21.0			3201
				- as above						
15	S-5	5		- as above		CL	20.7			3196
				- as above						
20	S-6	7		- as above						3191
				- as above						
25	S-7	7		- as above						3186
				Bottom of Boring @ 25'		25.0'				
30										3181
35										3176
40										3171



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LOCATION: Colby, Kansas
JOB NO.: 2173068A
DATE: May 4, 2021

BORING LOG No. B-2

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-2	See Boring Location Plan	3209 ft.	Google Earth	P. Pulkrabek	J. Cellers
WATER LEVEL OBSERVATIONS			TYPE OF SURFACE		DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	Asphalt		CME 45
N.E.	N.E.	Boring Plugged After Drilling	DRILLING METHOD		TOTAL DEPTH
			3.25-inch Inside Diameter Hollow Stem Augers		15.0 ft.

DEP. FT.	SAMPLE DATA			SOIL DESCRIPTION			LABORATORY DATA			ELEV. FT.	
	SAMPLE NO. & TYPE	"N" (BLOWS /FT)	% REC.	COLOR, CONSISTENCY, MOISTURE		USCS CLASS.	MC %	Dry Dens. pcf	q _u ksf		
				GEOLOGIC DESCRIPTION & OTHER REMARKS							
				6" ASPHALT	0.5'						
	S-1	8		LEAN CLAY w/ SAND - brown, moist, stiff, medium to fine sand			16.7				
	S-2	10		- dark brown, else as above		CL	19.0				
5										3204	
	S-3	4		SANDY LEAN CLAY - dark brown to yellowish brown, moist, medium stiff, coarse sand to fine gravel, else as above		CL	18.2				
	S-4	4		LEAN CLAY - yellowish brown, moist, medium stiff	8.5'		16.7				
10						CL				3199	
	S-5	5		- as above							
15				Bottom of Boring @ 15'							3194
20											3189
25											3184
30											3179
35											3174
40											3169



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BORING LOG No. B-3

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-3	See Boring Location Plan	3210 ft.	Google Earth	P. Pulkrabek	J. Cellers
WATER LEVEL OBSERVATIONS			TYPE OF SURFACE		DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	Gravel		CME 45
N.E.	N.E.	Boring Plugged After Drilling	DRILLING METHOD		TOTAL DEPTH
			3.25-inch Inside Diameter Hollow Stem Augers		15.0 ft.

DEP. FT.	SAMPLE DATA			SOIL DESCRIPTION			LABORATORY DATA			ELEV. FT.
	SAMPLE NO. & TYPE	"N" (BLOWS /FT)	% REC.	COLOR, CONSISTENCY, MOISTURE		USCS CLASS.	MC %	Dry Dens. pcf	q _u ksf	
				GEOLOGIC DESCRIPTION & OTHER REMARKS						
				6" GRAVEL	0.5'					
	S-1	11		SANDY LEAN CLAY - dark brown, slightly moist, stiff % Pass #200: 69.6		CL	13.3			
	S-2	12		LEAN CLAY W/ SAND - dark brown, slightly moist, stiff			12.3			
5				- moist, trace calcium deposits, else as above		CL	15.7			3205
	S-3	12								
	S-4	4		LEAN CLAY - dark brown to yellowish brown, slightly moist, soft			18.5			3200
10						CL				
	S-5	6		- medium stiff, as above						
15				Bottom of Boring @ 15'						3195
20										3190
25										3185
30										3180
35										3175
40										3170



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DATE: May 4, 2021

BORING LOG No. B-4

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-4	See Boring Location Plan	3206 ft.	Google Earth	P. Pulkrabek	J. Cellers
WATER LEVEL OBSERVATIONS			TYPE OF SURFACE		DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	Asphalt		CME 45
N.E.	N.E.	Boring Plugged After Drilling	DRILLING METHOD		TOTAL DEPTH
			3.25-inch Inside Diameter Hollow Stem Augers		15.0 ft.

DEP. FT.	SAMPLE DATA			SOIL DESCRIPTION			LABORATORY DATA			ELEV. FT.
	SAMPLE NO. & TYPE	"N" (BLOWS /FT)	% REC.	COLOR, CONSISTENCY, MOISTURE		USCS CLASS.	MC %	Dry Dens. pcf	q _u ksf	
				GEOLOGIC DESCRIPTION & OTHER REMARKS						
				6" ASPHALT	0.5'					
	S-1	4		LEAN CLAY W/ SAND - dark brown, slightly moist, medium stiff, fine sand, trace calcium deposits	0.5'	CL	14.4			
	S-2	11		LEAN CLAY - dark brown, moist, stiff, some sand, trace calcium deposits LL=41; PL=24; PI=17	2.5'		19.2			
5				- as above						3201
	U-3	N/A					18.4	96.1	3.22	
10	S-4	3		- yellowish brown, soft, else as above		CL	17.3			3196
15	S-5	5		- medium stiff, else as above						3191
				Bottom of Boring @ 15'						
20										3186
25										3181
30										3176
35										3171
40										3166



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BORING LOG No. B-5

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-5	See Boring Location Plan	3212 ft.	Google Earth	P. Pulkrabek	J. Cellers
WATER LEVEL OBSERVATIONS			TYPE OF SURFACE		DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	Concrete		CME 45
N.E.	N.E.	Boring Plugged After Drilling	DRILLING METHOD		TOTAL DEPTH
			3.25-inch Inside Diameter Hollow Stem Augers		15.0 ft.

DEP. FT.	SAMPLE DATA			SOIL DESCRIPTION			LABORATORY DATA			ELEV. FT.	
	SAMPLE NO. & TYPE	"N" (BLOWS /FT)	% REC.	COLOR, CONSISTENCY, MOISTURE		USCS CLASS.	MC %	Dry Dens. pcf	q _u ksf		
				GEOLOGIC DESCRIPTION & OTHER REMARKS							
				6" CONCRETE	0.5'						
	S-1	7		LEAN CLAY W/ SAND - brown to dark brown, moist, medium stiff			17.2				
	S-2	11		- stiff, else as above		CL	21.7				
5										3207	
	U-3	N/A		LEAN CLAY - dark brown, moist, medium stiff, some sand	5.0'		24.2	97.8	1.49		
10	S-4	3		- yellowish brown, soft, else as above		CL	20.3			3202	
15	S-5	6		- medium stiff, else as above						3197	
				Bottom of Boring @ 15'							
20										3192	
25										3187	
30										3182	
35										3177	
40										3172	



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BORING LOG No. B-6

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-6	See Boring Location Plan	3212 ft.	Google Earth	P. Pulkrabek	J. Cellers
WATER LEVEL OBSERVATIONS			TYPE OF SURFACE		DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	Concrete		CME 45
N.E.	N.E.	Boring Plugged After Drilling	DRILLING METHOD		TOTAL DEPTH
			3.25-inch Inside Diameter Hollow Stem Augers		15.0 ft.

DEP. FT.	SAMPLE DATA			SOIL DESCRIPTION			LABORATORY DATA			ELEV. FT.
	SAMPLE NO. & TYPE	"N" (BLOWS /FT)	% REC.	COLOR, CONSISTENCY, MOISTURE		USCS CLASS.	MC %	Dry Dens. pcf	q _u ksf	
				GEOLOGIC DESCRIPTION & OTHER REMARKS						
				0.5'	6" CONCRETE					
	S-1	4			LEAN CLAY - brown, moist, medium stiff, trace calcium deposits, iron nodules		17.4			
	S-2	8			- stiff, else as above		19.6			
5										3207
	S-3	4			- dark yellowish brown, medium stiff, else as above % Pass #200: 90.7		19.5	97.4		
	U-4	N/A			- as above	CL	17.2			
10										3202
	S-5	4			- light yellowish brown, else as above		N/A			
15					Bottom of Boring @ 15'					3197
20										3192
25										3187
30										3182
35										3177
40										3172



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BORING LOG No. B-7

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-7	See Boring Location Plan	3210 ft.	Google Earth	P. Pulkrabek	J. Cellers
WATER LEVEL OBSERVATIONS			TYPE OF SURFACE		DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	Gravel		CME 45
N.E.	N.E.	Boring Plugged After Drilling	3.25-inch Inside Diameter Hollow Stem Augers		TOTAL DEPTH 5.0 ft.

DEP. FT.	SAMPLE DATA			SOIL DESCRIPTION			LABORATORY DATA			ELEV. FT.
	SAMPLE NO. & TYPE	"N" (BLOWS /FT)	% REC.	COLOR, CONSISTENCY, MOISTURE GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	MC %	Dry Dens. pcf	q _u ksf		
	S-1	15		6" GRAVEL SANDY LEAN CLAY - brown, moist, stiff, trace iron nodules	CL	15.4				
	S-2	12		LEAN CLAY - brown, moist, stiff, trace calcium deposits	CL	20.2				
5	S-3	5		LEAN CLAY W/ SAND - yellowish brown, slightly moist, medium stiff	CL	19.2			3205	
				Bottom of Boring @ 6.5'						
10									3200	
15									3195	
20									3190	
25									3185	
30									3180	
35									3175	
40									3170	



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BORING LOG No. B-8

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-8	See Boring Location Plan	3205 ft.	Google Earth	P. Pulkrabek	J. Cellers
WATER LEVEL OBSERVATIONS			TYPE OF SURFACE		DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	Asphalt		CME 45
N.E.	N.E.	Boring Plugged After Drilling	DRILLING METHOD		TOTAL DEPTH
			3.25-inch Inside Diameter Hollow Stem Augers		5.0 ft.

DEP. FT.	SAMPLE DATA			SOIL DESCRIPTION			LABORATORY DATA			ELEV. FT.
	SAMPLE NO. & TYPE	"N" (BLOWS /FT)	% REC.	COLOR, CONSISTENCY, MOISTURE		USCS CLASS.	MC %	Dry Dens. pcf	q _u ksf	
				GEOLOGIC DESCRIPTION & OTHER REMARKS						
				8" ASPHALT						
	S-1	9		LEAN CLAY - brown, dry, stiff,	1.0'		3.9			
	S-2	7		- moist, medium stiff, trace calcium deposits, else as above % Pass #200: 92.1		CL	21.4			
5										3200
	S-3	9		- dark brown, else as above			19.8			
				Bottom of Boring @ 6.5'						
10										3195
15										3190
20										3185
25										3180
30										3175
35										3170
40										3165



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BORING LOG No. B-9

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-9	See Boring Location Plan	3209 ft.	Google Earth	P. Pulkrabek	J. Cellers
WATER LEVEL OBSERVATIONS			TYPE OF SURFACE		DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	Asphalt		CME 45
N.E.	N.E.	Boring Plugged After Drilling	3.25-inch Inside Diameter Hollow Stem Augers		5.0 ft.

DEP. FT.	SAMPLE DATA			SOIL DESCRIPTION			LABORATORY DATA			ELEV. FT.	
	SAMPLE NO. & TYPE	"N" (BLOWS /FT)	% REC.	COLOR, CONSISTENCY, MOISTURE		USCS CLASS.	MC %	Dry Dens. pcf	q _u ksf		
				GEOLOGIC DESCRIPTION & OTHER REMARKS							
				6" ASPHALT	0.5'						
	S-1	5		LEAN CLAY - yellowish brown, moist, medium stiff, trace iron nodules			18.9				
	S-2	2		- soft, else as above		CL	16.7				
5				- as above						3204	
	S-3	3					17.9				
				Bottom of Boring @ 6.5'							
10										3199	
15										3194	
20										3189	
25										3184	
30										3179	
35										3174	
40										3169	



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BORING LOG No. B-10

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-10	See Boring Location Plan	3205 ft.	Google Earth	P. Pulkrabek	J. Cellers
WATER LEVEL OBSERVATIONS			TYPE OF SURFACE		DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	Gravel		CME 45
N.E.	N.E.	Boring Plugged After Drilling	3.25-inch Inside Diameter Hollow Stem Augers		5.0 ft.

DEP. FT.	SAMPLE DATA			SOIL DESCRIPTION		LABORATORY DATA			ELEV. FT.
	SAMPLE NO. & TYPE	"N" (BLOWS /FT)	% REC.	COLOR, CONSISTENCY, MOISTURE	USCS CLASS.	MC %	Dry Dens. pcf	q _u ksf	
				GEOLOGIC DESCRIPTION & OTHER REMARKS					
	S-1	16		6" GRAVEL LEAN CLAY - dark yellowish brown, slightly moist, stiff, trace iron nodules	CL	14.6			
	S-2	12		- dark brown, moist, trace calcium deposits, else as above		15.9			
5				- very stiff, slightly moist, else as above					3200
	S-3	16		Bottom of Boring @ 6.5'		13.6			
10									3195
15									3190
20									3185
25									3180
30									3175
35									3170
40									3165



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KEY TO SYMBOLS

Symbol Description

Strata symbols



Gravel



Sandy Low Plasticity Clay



Low plasticity
clay



Paving



EXTRA: zigzag lines

Notes:

1. The exploratory boring was advanced on May 7, 2021, using 3.25-inch inside diameter hollow stem augers.
2. These logs are subject to the limitations, conclusions, and recommendations outlined in this report.

Boring Log Legend and Nomenclature

Items shown on boring logs refer to the following:

1. **Depth** - Depth below ground surface or drilling platform
2. **Sample** -Types designated by letter:
 - A - Disturbed sample, obtained from auger cuttings or wash water.
 - S - Split barrel sample, obtained by driving a 2-inch split-barrel sampler unless otherwise noted.
 - C - California liner sample, obtained using a thick-walled liner sampler containing 2-inch-diameter liner tubes.
 - U - Undisturbed sample, obtained using a thin-walled tube, 3-inch-diameter, or as noted, and open sampling head.

Recovery - Recovery is expressed as a percentage of the length recovered to the total length pushed, driven or cored.

Resistance - Resistance is designated as follows:

 - P - Sample pushed in one continuous movement by hydraulic rig action.
 - 12 - The Standard Penetration Resistance is the number of blows for the last 12 inches of penetration of split spoon sampler, driven by a 140-pound hammer falling 30 inches.
 - 50/4" - Number of blows to drive sampler distance shown.
3. **Soil Description** - Description of material according to the Unified Soil Classification: word description giving soil constituents, consistency or density, and other appropriate classification characteristics. Geologic name or type of deposit and other pertinent information, where appropriate, is shown under Geologic Description or other Remarks. A solid line indicates the approximate location of stratigraphic change.
4. **Lab Data** – Laboratory test data.
5. **Legend**

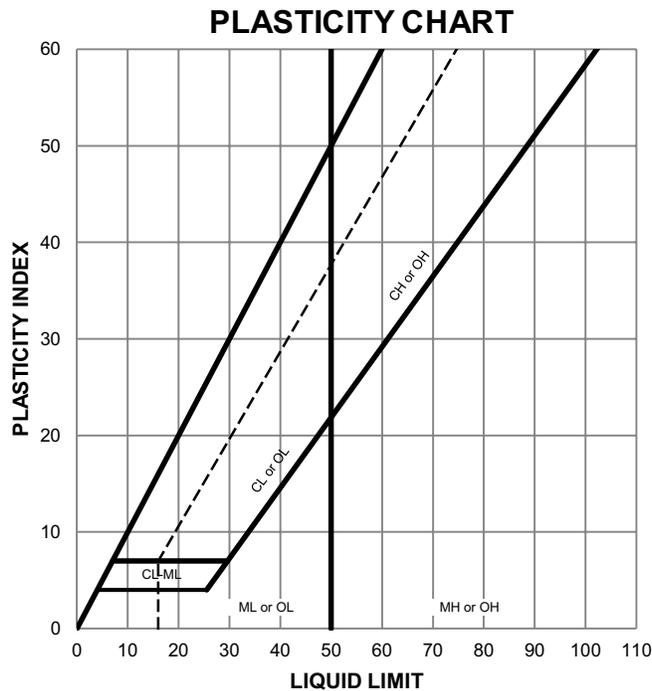
A.D. — After drilling	N.A. — Not Applicable
A.T.D. — At time of drilling	N.D. — Not detectable due to
C.F.A. — Continuous flight auger	drilling method
D.W.L. — Drill water loss	N.E. — None encountered
D.W.R. — Drill water return	N.R. — Not recorded
E.D. — End of drilling	R.Q.D. — Rock quality designation
H.B. — Hole backfilled	R.W.B. — Rotary wash boring
6. **Limitations** - The lines between materials shown on the boring logs represent approximate boundaries between material types and the changes may be gradual. Water level readings shown on the logs were made at the time and under the conditions indicated. Fluctuations in the water levels may occur with time. The boring logs in this report are subject to the limitations, explanations and conclusions of this report.

UNIFIED SOIL CLASSIFICATION SYSTEM

GROUP NAME	GROUP SYMBOL	SOIL DESCRIPTION	COMMENTS
Peat	Pt	Highly Organic Soils	50% or More Is Smaller than No. 200 Sieve
Fat Clay	CH	Clay - Liquid Limit \Rightarrow 50*	
Elastic Silt	MH	Silt - Liquid Limit \Rightarrow 50*	
Lean Clay	CL	Clay - Liquid Limit $<$ 50*	
Silt	ML	Silt - Liquid Limit $<$ 50*	
Silty Clay	CL-ML	Silty Clay*	
Clayey Sand	SC	Sands with 12 to 50% Smaller than No. 200 Sieve	More than 50% Is Larger than No. 200 Sieve and % Sand $>$ % Gravel
Silty Sand	SM	Sands with 5 to 12% Smaller than No. 200 Sieve	
Poorly-Graded Sand with Clay	SP-SC	Sands with Less than 5% Smaller than No. 200 Sieve	
Poorly-Graded Sand with Silt	SP-SM		
Well-Graded Sand with Clay**	SW-SC		
Well-Graded Sand with Silt**	SW-SM		
Poorly-Graded Sand	SP	Gravels with 12 to 50% Smaller than No. 200 Sieve	
Well-Graded Sand**	SW		
Clayey Gravel	GC	Gravels with 5 to 12% Smaller than No. 200 Sieve	More than 50% Is Larger than No. 200 Sieve and % Gravel $>$ % Sand
Silty Gravel	GM		
Poorly-Graded Gravel with Clay	GP-GC		
Poorly-Graded Gravel with Silt	GP-GM		
Well-Graded Gravel with Clay**	GW-GC		
Well-Graded Gravel with Silt**	GW-GP		
Poorly-Graded Gravel	GP	Gravels with Less than 5% Smaller than No. 200 Sieve	
Well-Graded Gravel**	GW		

*See Plasticity Chart for definition of silts and clays. If organic, use OL or OH.

**See definition of well-graded



LEGEND OF TERMS

MOISTURE CONDITIONS
Dry, Slightly Moist, Moist, Very Moist, Wet (Saturated)

SOIL CONSISTENCY

Fine-Grained Soils

Description	SPT (N)	UCS (q_u , tsf)
Very Soft	0-2	0-0.25
Soft	2-4	0.25-0.50
Medium Stiff	4-8	0.50-1.0
Stiff	8-16	1.0-2.0
Very Stiff	16-32	2.0-4.0
Hard	$>$ 32	$>$ 4.0

Coarse-Grained Soils

Description	SPT (N)
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	$>$ 50

CLASSIFICATION OF SANDS & GRAVELS

Boulders	Cobbles	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Fines (Silt or Clay)
10"	3"	3/4"	#4	#10	#40	#200	

Well-Graded Sands (SW): $C_u \geq 6$ and $1 \leq C_c \leq 3$

Well-Graded Gravels (GW): $C_u \geq 4$ and $1 \leq C_c \leq 3$



APPENDIX C

Field & Laboratory Test Results

SUMMARY OF FIELD AND LABORATORY TESTS

BORING NO.	SAMPLE NO.	SAMPLE DEPTH (ft.)	DIA. (in.)	MOISTURE CONTENT (%)	UNIT WEIGHT		VOID RATIO (e)	SAT. (%)	UNCONF. COMPR. STR. (ksf)	ATTERBERG LIMITS			PASS NO. 200 (%)	SPT "N" (blows /ft)	USCS SOIL CLASS.
					WET (pcf)	DRY (pcf)				LL	PL	PI			
B-1	S-1	0.5-2.0		25.0						34	23	11		4	CL w/ Sand
	U-2	2.0-4.0												N/A	CL w/ Sand
	S-3	5.0-6.5		22.3									91.0	2	CL
	S-4	8.5-10.0		21.0										4	CL
	S-5	13.5-15.0		20.7										5	CL
	S-6	18.5-20.0												7	CL
	S-7	23.5-25.0												7	CL
B-2	S-1	0.5-2.0		16.7										8	CL w/ Sand
	S-2	2.5-4.0		19.0										10	CL w/ Sand
	S-3	5.0-6.5		18.2										4	Sandy CL
	S-4	8.5-10.0		16.7										4	CL
	S-5	13.5-15.0												5	CL
B-3	S-1	0.5-2.0		13.3									69.6	11	Sandy CL
	S-2	2.5-4.0		12.3										12	CL w/ Sand
	S-3	5.0-6.5		15.7										12	CL w/ Sand
	S-4	8.5-10.0		18.5										4	CL
	S-5	13.5-15.0												6	CL
B-4	S-1	0.5-2.0		14.4										4	CL w/ Sand
	S-2	2.5-4.0		19.2						41	24	17		11	CL
	U-3	5.0-7.0	2.77	18.4	113.9	96.1	0.720	68	3.22					N/A	CL
	S-4	8.5-10.0		17.3										3	CL
	S-5	13.5-15.0												5	CL
B-5	S-1	0.5-2.0		17.2									73.6	7	CL w/ Sand
	S-2	2.5-4.0		21.7										11	CL w/ Sand
	U-3	5.0-7.0	2.85	24.2	121.5	97.8	0.691	93	1.49					N/A	CL
	S-4	8.5-10.0		20.3										3	CL
	S-5	13.5-15.0												6	CL
B-6	S-1	0.5-2.0		17.4										4	CL
	S-2	2.5-4.0		19.6										8	CL
	S-3	5.0-6.5	2.86	19.5	116.4	97.4	0.698	74				90.7		4	CL
	U-4	8.0-10.0		17.2										N/A	CL
	S-5	13.5-15.0												4	CL
B-7	S-1	0.5-2.0		15.4										15	Sandy CL
	S-2	2.0-3.5		20.2										12	CL
	S-3	3.5-5.0		19.2										5	CL w/ Sand
B-8	S-1	0.5-2.0		3.9										9	CL
	S-2	2.0-3.5		21.4								92.1		7	CL
	S-3	3.5-5.0		19.8										9	CL



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LOCATION Colby, Kansas	
PROJECT NUMBER 2173068A	DATE June 3, 2021

