

GEOTECHNICAL EXPLORATION REPORT

Project Name:

Scoular Company – Sheridan Lake Storage Facility
Near Sheridan Lake, Colorado

Prepared for:

The Scoular Company



January 8, 2021

Olsson Project No. 020-3668

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APPENDICES

Appendix A: Site Location Plan, Boring Location Map

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January 8, 2021

The Scoular Company
Attn: Brad Perry
2027 Dodge Street
Omaha, Nebraska 68102

RE: Geotechnical Exploration
Scoular Company – Sheridan Lake Storage Facility
Near Sheridan Lake, Colorado
Olsson Project No. 020-3668

Dear Mr. Perry:

Olsson, Inc. has completed the authorized geotechnical exploration for the above referenced project. The geotechnical exploration was conducted to evaluate physical characteristics of subsurface conditions with respect to design and construction of the project. The enclosed report summarizes the project characteristics as we understand them, presents the findings of the borings and laboratory tests, discusses the observed subsurface conditions, and provides our geotechnical engineering recommendations.

We appreciate the opportunity to provide our geotechnical engineering services for this project. We are prepared to provide construction testing and inspection services on this project as well. If you have any questions or need further assistance, please contact us at your convenience.

Respectfully submitted,
Olsson, Inc.

A handwritten signature in blue ink, appearing to read "Nick Menefee".

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1. PROJECT UNDERSTANDING

1.1. Geotechnical Scope

This report presents the results of the geotechnical exploration performed for the proposed grain storage and handling structures located at the new Scoular Company facility near Sheridan Lake, Colorado.

The purpose of this exploration was to evaluate the subsurface conditions encountered at the site and based on these conditions, provide geotechnical design recommendations for the proposed concrete grain storage bins, bulk weigher, and grain tower and preliminary design recommendations for the future flat storage building. Our scope of services generally included the following tasks:

- Perform visual site observations and review available information regarding general geologic conditions.
- Drill nine soil test borings to depths of 21.5 to 66.5 feet within the proposed storage facility.
- Conduct a geotechnical engineering evaluation using information obtained from our field observations, soil test borings, laboratory tests, and information available regarding the proposed construction.
- Prepare this Geotechnical Exploration Report containing the soil test boring logs, laboratory test results, and a summary of our engineering evaluations and recommendations.

1.2. Site Location and Description

The proposed storage facility will be located approximately 5 miles east of Sheridan Lake, Colorado on Colorado Highway 96. At the time of our field exploration, the site surface comprised an agricultural field with bare soil and was accessible to a truck-mounted drilling rig. The approximate location of the new storage facility is shown in Figure 1.



Figure 1. 2016 Aerial Photograph.

1.3. Project Information

We understand the proposed concrete grain storage bins will be approximately 64 feet in diameter and up to 120 feet tall. Current plans include three storage bins, with plans for a future bin on the west side of the initial bins. A bulk weigher will provide loadout capabilities for the existing rail track to the south of the proposed structures. We understand a grain tower leg and reclaim (boot) pit will be constructed between the bins and the bulk weigher. We understand the grain storage bin floors will comprise concrete conical hoppers extending to a depth of approximately 23 feet below grade.

A future flat storage building is also planned for the new facility. We understand that the future structure will be approximately 180 feet by 500 feet in size and have a maximum grain storage height of 50 feet within the building. We anticipate loading in the center of the future building will be on the order of 2,400 psf. Final design, layout, and structural loading information for the flat storage building was not available at the time of this report. Additional analyses and potentially additional field exploration will be required when the flat storage building design is finalized.

Based on the estimated boring elevations, existing site grades range from a low elevation of approximately 4027.0 to a high elevation of 4031.0 within the proposed structures. While site grades had not been finalized at the time of this report, we estimate minimal fill will be required to achieve the design site grade.

We estimate maximum loads will be on the order of those provided in Table 1. If the structural loads exceed these values, the geotechnical engineer should be contacted to verify that the recommendations contained in this report remain valid.

Table 1. Maximum Applied Loads & Typical Settlement Tolerances

Structure	Maximum Applied Load	Total Settlement (inches)	Differential Settlement (inches)
Grain Storage Bin Floors	4,000 psf	5.0	3.0
Grain Storage Bin Walls	70 kips/linear foot	3.0	1.5
Reclaim Pits/Elevator Tower Legs	100 kips	3.0	1.5
Bulk Weigher	225 kips	3.0	1.5

2. EXPLORATION AND TEST PROCEDURES

2.1. Field Exploration

A drill crew from Elite Drilling advanced nine test borings for this exploration with a truck-mounted drilling rig using hollow-stem augers. Boring locations were selected by an **Olsson** geotechnical engineer and located in the field by the drill crew using a hand-held GPS unit. The approximate locations of the borings are shown on the Boring Location Map presented in Appendix A.

The borings extended to depths ranging from 21.5 to 66.5 feet below site grade at the time of our exploration. Soil samples were obtained at the intervals indicated on the boring logs presented in Appendix B. Samples with a “U” designation on the boring logs were obtained by hydraulically advancing a thin-walled tube sampler. Soil samples with an “SS” designation were obtained with a split-spoon barrel sampler while performing Standard Penetration Tests (SPT). Recovered samples were sealed in containers, labeled, and protected for transportation to the laboratory for testing.

The ground surface elevation at the boring locations were estimated using a commercial mapping utility. The provided surface elevations at the boring locations, rounded to the nearest half-foot, are presented on the boring logs.

The drill crew prepared field boring logs during drilling operations. The field logs include drilling and sampling methods, sampling intervals, groundwater measurements, and general descriptions of the observed soil conditions. The final boring logs presented in Appendix B represent our engineering interpretation of the field logs based on visual classification and laboratory testing of the collected samples.

2.2. Laboratory Testing

The soils encountered in the borings were visually classified and described in general accordance with the Unified Soil Classification System (USCS). We also performed laboratory tests to evaluate the engineering properties of the recovered soil samples. The testing program included moisture content, density/unit weight, unconfined compressive strength, Atterberg limits, #200 wash sieves, and consolidation testing. Laboratory test results are included on the soil boring logs presented in Appendix B and are summarized in Appendix C.

3. SUBSURFACE CONDITIONS

3.1. Subsurface Profile

The subsurface soils at this site comprised loess deposits overlying Tertiary Age Ogallala Formation deposits. The Ogallala deposits were in turn underlain by shale bedrock. The general characteristics of each soil stratum are summarized below, with more detailed descriptions provided on the boring logs in Appendix B.

Please note that the boring logs represent subsurface conditions at the specific boring locations at the time of our field exploration; variations may occur between or beyond the borings. The stratification lines shown on the logs represent the approximate boundary between material types. However, the transition between layers may be gradual. The depths referenced in the following paragraphs are relative to the site grade at the time of our exploration.

Loess

We encountered loess in each of the borings. Loess generally comprised lean clay (CL) containing varying amounts of fine to coarse sand, silt, and organics and were described as soft to very stiff, light brown to dark brown, and dry to wet.

Table 2. Loess Laboratory Test Results.

USCS Classification	Moisture Content (%)	Dry Density (pcf)	Unconfined Strength (tsf)	Atterberg Limits			% Passing P200	SPT "N" Values (bpf)
				Liquid Limit (%)	Plastic Limit (%)	Plastic Index (%)		
CL	9.0 – 19.0	78.1 – 113.3	0.3 – 0.9	35 - 37	18 - 19	17 - 18	69.0 – 87.4	4 - 18

Ogallala Formation

We encountered Ogallala formation in each of the borings except B-7, B-8, and B-9. Ogallala formation generally comprised fine to coarse sand and lean clay (CL) containing varying amounts of fine to coarse sand, fine gravel, clay, silt, and calcareous lenses and were described as medium dense to very dense, light brown to dark brown, and dry to wet. We encountered auger refusal in the Ogallala in borings B-2 and B-5

Table 3. Ogallala Formation Laboratory Test Results.

USCS Classification	Moisture Content (%)	Dry Density (pcf)	Unconfined Strength (tsf)	Atterberg Limits			% Passing P200	SPT "N" Values (bpf)
				Liquid Limit (%)	Plastic Limit (%)	Plastic Index (%)		
SC, SM, SP, CL	5.3 - 15.3	--	--	--	--	--	13.8 – 76.2	16 – 50/1"

Shale

We encountered shale in boring B-1. Shale was described as highly weathered to moderately weathered, very dark brown soft rock.

Table 4. Shale Laboratory Test Results.

USCS Classification	Moisture Content (%)	Dry Density (pcf)	Unconfined Strength (tsf)	Atterberg Limits			% Passing P200	SPT "N" Values (bpf)
				Liquid Limit (%)	Plastic Limit (%)	Plastic Index (%)		
SHALE	--	--	--	--	--	--	--	50/2" – 50/6"

3.2. Groundwater Summary

We encountered groundwater in our soil borings as summarized in Table 5 and as indicated on the boring logs presented in Appendix B.

Table 5. Groundwater Measurements.

Boring No.	Ground-water Depth While Drilling (feet)	Ground-water Elevation While Drilling	Ground-water Depth Immediately After Drilling (feet)	Ground-water Elevation Immediately After Drilling	Ground-water Depth After Drilling (feet)	Ground-water Elevation After Drilling
B-1	NP	NA	NE	NA	NE	NA
B-2	NE	NA	NE	NA	34.0	3994.0
B-3	37.0	3993.0	NE	NA	34.0	3996.0
B-4	39.0	3989.0	NE	NA	34.0	3994.0
B-5	37.0	3992.0	31.0	3998.0	34.0	3995.0
B-6	NE	NA	NE	NA	NP	NA
B-7	NE	NA	NE	NA	NP	NA
B-8	NE	NA	NE	NA	NP	NA
B-9	NE	NA	NE	NA	NP	NA

NE—Not Encountered; NP—Not Performed; NA—Not Applicable

The above groundwater measurements provide an indication of the on-site groundwater conditions at the time the borings were drilled but should not be construed to represent a permanent or absolute condition. Variations and uncertainties exist with relatively short-term water level observations in boreholes.

Groundwater levels will fluctuate with variations in precipitation, site grading, drainage, and adjacent land use. Perched groundwater conditions can also develop in seams of loose or granular soil. Long-term monitoring with piezometers generally provides a more representative indication of the potential range of groundwater conditions. Recommendations for addressing potential groundwater concerns during design and construction are presented in **Section 4.6** of this report.

4. SITE PREPARATION

4.1. General Site Preparation

Vegetation, topsoil, roots, and other deleterious materials deemed unsuitable by an Olsson geotechnical engineer or their authorized field representative should be removed from the proposed construction area and replaced with controlled fill. We recommend site clearing, grubbing, and stripping be performed during dry weather conditions. Operation of heavy equipment on the site during wet conditions could result in excessive rutting and mixing of organic debris with the underlying soils.

Prior to the placement of structural fill, we recommend the top 12 inches of subgrade soils exposed at the base of stripping or over-excavation operations be scarified and recompact in accordance with **Section 4.5** of this report. The recompact subgrade should be evaluated by an Olsson representative prior to fill placement.

Soils which cannot be adequately densified in-place should be removed and replaced with approved structural fill or stabilized under the direction of an Olsson representative. The extent of areas requiring removal or stabilization will depend on the conditions observed at the time of construction. Undercut areas should be backfilled with stable fill material similar in composition to the surrounding soils. If necessary, one or more layers of crushed stone may be considered to stabilize areas where wet soil or water are present. Geogrid or geosynthetic fabric may be used in conjunction with the crushed stone to provide additional stabilization. Chemical stabilization methods such as fly ash, cement kiln dust (CKD), or Portland cement could also be considered with direction from the geotechnical engineer.

Completion of the over-excavations recommended in **Section 4** of this report should consider the overlap of excavations beneath structures during construction. If the excavation slopes or extents for over-excavation of a particular structure extend below another proposed structure, the subgrade soils should be excavated to the lowest excavation depth across the entire footprint of the structure and backfilled to the base of foundation elevation to provide a uniform thickness of structural fill support beneath structures and reduce the risk of differential settlement beneath structures supported on differing structural fill depths.

Due to the susceptibility of on-site soils to saturation-induced collapse, it is critical that site grading provide efficient drainage of precipitation and surface runoff away from the grain legs and bin areas. In general, water should not be allowed to collect near any structure. Site grading could include a drainage ditch around the proposed structure(s) to collect and direct surface runoff or precipitation away from construction areas and new or existing structures.

4.2. Site Preparation – Grain Bins

The soils beneath the grain bins are considered highly compressible. If the hopper floors of the grain bins are constructed without remedial measures, the calculated total settlement potential is on the order of 15 inches. Because of the varying thickness of compressible soil beneath the bin floors and the transition to stiffer soils toward the centers of the bins, the risk of unacceptable differential settlement is further increased. In general, the compressible layer appears to be approximately 15 feet thick.

To reduce settlement to acceptable levels, we recommend the full depth of the compressible soils beneath the bin floors be over-excavated and recompacted or replaced with properly compacted structural fill. As noted above, the thickness of the compressible zone is anticipated to be on the order of 15 feet below current site grades. At a minimum, the soils should be removed from at least 5 feet beyond the outer perimeter of the bin footprints before transitioning back to existing site grades at a maximum slope of 1.5H:1V. The base of the over-excavation should be scarified, moisture conditioned as necessary, and compacted to meet project specifications and the recommendations of this report.

The uniformity and stability of the base of the final foundation excavation should be documented an Olsson geotechnical engineer or authorized field technician prior to reinforcing steel and concrete placement. Any unstable areas identified as part of the over-excavation operation should be discussed with the geotechnical engineer to evaluate whether additional remedial measures are needed prior to structural fill placement.

All structural fill placed within the footprint of the bins must be placed and compacted per **Section 4.5**. Placing uncompacted fill within or around the bins has the potential to retain and promote the movement of moisture and saturate foundation bearing soils. This can result in additional total and differential settlement around the structures.

4.3. Site Preparation – Bulk Weigher

Based on an estimated foundation bearing depth of 5 feet and an applied bearing pressure of 1,500 pounds per square foot (psf), we anticipate the compressible soils beneath the bulk weigher will exhibit settlement greater than 3 inches. To reduce settlement to acceptable levels, we recommend the compressible loess soils be over-excavated and recompacted or replaced to a depth of 2 feet below the base of the bulk weigher foundation. At a minimum, the soils should be removed from at least 5 feet beyond the perimeter of the foundation before transitioning back to existing site grades at a maximum slope of 1.5H:1V.

The uniformity and stability of the base of the final foundation excavation should be documented an Olsson geotechnical engineer or authorized field technician prior to reinforcing steel and concrete placement. Any unstable areas identified as part of the over-excavation operation should be discussed with the geotechnical engineer to evaluate whether additional remedial measures are needed prior to structural fill placement.

4.4. Site Preparation – Utilities

New underground utilities should be installed in accordance with local building codes. The use of granular pipe bedding for new utilities is acceptable, and the base of the utility trenches should be sloped to remove or redirect potential moisture accumulation away from buildings or to an off-site discharge point. Utility trenches in cohesive soil should be backfilled with cohesive structural fill placed in accordance with **Section 4.5** of this report. Trenches in granular soils can be backfilled with granular materials. Water infiltration and water migration into utility trenches in cohesive soils should be prevented before, during, and after construction. Excavations should not remain open if precipitation is anticipated.

4.5. Structural Fill

We recommend that off-site borrow soil have a liquid limit less than 45 and a plasticity index less than 25. Soils with Atterberg limits greater than these values will require removal or blending with less plastic materials. All structural fill soils should also be relatively free of organic materials (less than about 2 percent by weight), debris, and particles larger than 3 inches in nominal diameter.

Based on our site observations and Atterberg limits testing performed as part of this exploration, the on-site soils generally appear suitable for reuse as structural fill, though the moisture content of the soil must be increased prior to reuse. Samples of all proposed structural fill, including on-

site soils, should be submitted to Olsson at least seven days before placement for testing and approval.

Depending on the material used for structural fill, we recommend that the structural fill be thoroughly blended to prevent alternating layers of granular and cohesive materials. Alternating layers of granular and cohesive materials can create a perched water table if rainfall or runoff is trapped in granular soils placed above low permeability cohesive soils.

Proper lift thickness depends on the type of compaction equipment used, but in general, we recommend a maximum lift thickness of 8 inches in loose measurement. The soil should be compacted using equipment of appropriate type and size to achieve the recommendations presented in this report. In general, sheepsfoot or padfoot type compactors should be utilized on cohesive soils, while granular soils should be compacted using smooth-drum vibratory compactors. Water flooding is not an acceptable compaction method for any soil type.

Walk-behind rollers, vibrating plate compactors, or tamping rammers (commonly referred to as “jumping jacks”) can be used to achieve the specified compaction around manholes, behind retaining walls, or within footing and utility trenches. Lift thickness should be reduced to 4 inches in fill areas requiring such compaction equipment.

We recommend that structural fill and backfill be compacted in accordance with the criteria stated in Table 6. An Olsson field representative should periodically observe fill placement operations and perform field moisture-density tests to document whether moisture content and compaction requirements are being achieved.

The moisture content of suitable borrow soils should be within the ranges specified in Table 6. More stringent moisture limits may be necessary with certain soils. Adjustment of moisture content may be necessary to allow compaction in accordance with project specifications.

Table 6. Structural Fill Placement Guidelines.

Area of Fill Placement	Compaction Recommendation (ASTM D698-Standard Proctor)	Moisture Content (Percent of Optimum)
Cohesive Structural Fill – Fill placed <u>below and within 20 feet</u> of the grain bins, support tower leg, and bulk weigher.	98%	-1 to +3 percent
Granular Structural Fill – Fill <u>placed below and within 20 feet</u> of the grain bins, support tower leg, and bulk weigher.	98%*	As necessary to obtain density
Cohesive Structural Fill – Fill placed <u>beyond 20 feet of the perimeter</u> of the grain bins, support tower leg, and bulk weigher.	98%	-1 to +3 percent
Granular Structural Fill – Fill placed <u>beyond 20 feet of the perimeter</u> of the grain bins, support tower leg, and bulk weigher.	98%*	As necessary to obtain density
Utility trenches	98%	Optimum to +3 percent
Non-loaded landscaped/grass areas	92%**	As necessary to obtain density

* Or 70 percent Relative Density as described below. **Minor subsidence should be expected in these areas.

Granular fill materials may not produce a definable moisture-density curve when tested in accordance with ASTM D698 (Standard Proctor). Such materials could alternatively be compacted to a minimum of 70 percent relative density as determined by ASTM D4253 (Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table) and D4254 (Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculations of Relative Density).

Controlled low strength material (CLSM) or flowable fill may be considered for utility or other small backfills. We recommend flowable fill have a compressive strength between 100 and 300 pounds per square inch (psi). CLSM with a maximum compressive strength less than 300 psi can be readily excavated with a backhoe. CLSM can be placed in a single lift, without personnel entering the excavation and without the need for compaction equipment.

4.6. Drainage and Groundwater Considerations

We encountered groundwater at the time of our exploration as indicated in Table 5. While we do not anticipate groundwater will affect construction activities, variations in groundwater elevation could occur. Please note that variations in groundwater elevations can be expected from seasonal changes in rainfall, temperature, snowmelt, runoff, localized irrigation demand, or other factors.

During construction, provisions should be made to quickly remove seepage water or storm water from excavations. Water should not be allowed to collect near foundations, mat slabs, floor slabs, pavements, or retaining walls either during or after construction. Undercut or excavated areas should be sloped toward one corner to facilitate the collection and removal of rainwater or surface runoff.

The performance of the proposed structures depends on maintaining the moisture content of the subgrade soils throughout the life of the facility. To reduce the effects of moisture fluctuations in and around the structure, we recommend the providing efficient drainage of rainfall or surface runoff away from the structures.

4.7. Construction Equipment Mobility

Some of the soils encountered at this site may be susceptible to softening under the action of construction equipment traffic in combination with wet weather. Mitigation of equipment mobility problems and management of soft surficial soils will depend on the severity of the problem, the season in which construction is performed, and prevailing weather conditions.

General guidelines for reducing equipment mobility problems are as follows:

- Optimize surface water drainage at the site.
- Allow for rain days in the construction schedule and wait for dry weather conditions to prevail whenever possible. Avoid operating construction equipment on the site during wet conditions. Rutting the surface will aggravate mobility problems.
- Use construction equipment that is suited for the intended job under the site conditions. Heavy rubber-tired equipment typically requires better site conditions than light, track-mounted equipment.

If areas of the project site expose very moist or unstable soils, it may be acceptable to lightly scarify the unstable subgrade, allow the soils to dry, then recompact the soils. If additional subgrade stabilization is necessary, thin lifts (3- to 4-inches thick) of crushed (2- to 3-inch diameter top size particles) aggregates could be driven into the exposed subgrade until stable using a sheepsfoot roller. The use of geosynthetic fabric and/or geogrid below the aggregates could help reduce the overall aggregate thickness.

It is the responsibility of the earthwork contractor to utilize equipment and procedures that prevent unnecessary deterioration or damage to exposed subgrade soils. Olsson recommends that the final grading in building pads and pavement areas be performed utilizing LGP equipment that will minimize subgrade disturbance during excavation. Heavy, rubber-tired construction equipment is not recommended for use in low lying areas as these types of equipment are more likely to disturb potentially sensitive subgrade soils. The contractor should provide a uniform stable soil subgrade as part of the grading operations on this project.

Unstable soil subgrade identified across the project site, or instability related to repetitive construction traffic should be repaired prior to fill placement. If unstable soil conditions are encountered across the project site, the geotechnical engineer should evaluate and document these conditions and will recommend appropriate corrective action for removal and replacement or in-place stabilization.

Any soils that are disturbed by construction activity or adverse weather conditions should be corrected by the contractor to conform with project specifications and this report. Site grading should provide rapid drainage of water away from the building and pavement areas throughout construction.

4.8. Temporary Slopes and Excavations

Construction site safety is the sole responsibility of the general contractor. The contractor is also responsible for the means, methods, techniques, sequencing, and operations used during construction. Slope height, slope inclination, and excavation depths (including utility trench excavations) should in no case exceed those specified in local, state, or federal safety regulations; e.g., *OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926*, or successor regulations.

5. STRUCTURES

Based on the results of the soil test borings, laboratory testing, and our engineering evaluation, it is our opinion that the subsurface conditions are suitable for supporting the proposed elevator tower leg, bulk weigher, and boot pit tower on a shallow foundation system after soil improvements. We recommend that the proposed concrete storage bin walls be supported by a deep foundation system. Conical hopper floors for the grain bins may be supported directly on grade after soil improvements. Each structure is discussed in more detail in the sections below.

5.1. Bulk Weigher & Towers

Based on the results of our exploration and engineering evaluation, the proposed elevator tower, bulk weigher, and similar structures may be supported on a conventional shallow foundation system. Assuming the recommendations in **Section 4** are implemented and that the finished floor elevations (FFE) of the proposed structures are within 2 feet of the existing ground surfaces, the foundations will be supported on loess soils or structural fill. We recommend shallow foundations supported on loess or properly placed fill material be designed for maximum net allowable soil bearing pressures presented in Table 7.

Table 7. Allowable Soil Bearing Pressure and Estimated Settlements

Structure	Maximum Applied Load	Estimated Foundation Size (ft)	Assumed Bearing Depth Below Grade (ft)	Maximum Net Allowable Bearing Pressure (psf)	Anticipated Total Settlement (in)	Anticipated Differential Settlement (in)
Elevator Tower Legs	100 kips	7.5 x 7.5	10	2,000	3.0	1.5
Bulk Weigher	205 kips	20 x 13	5	1,500	3.0*	1.5*
Boot Pit Tower	225 kips	25 x 25	16	3,500	1.0	0.5

*After soil improvements as outlined in **Section 4.2**.

The net allowable bearing pressure is the bearing pressure in excess of the minimum surrounding overburden pressure at the foundation level. Generally, exterior footings and footings in unheated areas should bear at a minimum depth of 3.5 feet below the lowest adjacent final ground surface. In no case should footings have dimensions smaller than allowed by local building codes.

An ultimate soil-concrete friction coefficient of 0.35 may be used to evaluate sliding resistance of shallow foundations supported on undisturbed native soils or properly compacted structural fill. Please see **Section 5.4** for information regarding lateral earth pressures.

Soft or otherwise unsuitable soils could be encountered during foundation construction. Therefore, foundation subgrades should be observed by an Olsson representative to identify such soils and provide remediation recommendations, as necessary. After foundation subgrades have been observed and any required remedial measures are performed, concrete should be placed as quickly as possible to avoid exposure of the foundation subsoils to wetting, drying, or freezing. If foundation soils are subjected to such conditions, Olsson should be contacted to reevaluate the foundation bearing materials.

Provided shallow foundations are designed and constructed in accordance with the recommendations of this report, total post-construction settlements beneath the various structures will be less than the values presented in Table 7.

5.2. Grain Storage Bins

Bin Walls

Based on the existing site conditions, structural loading, and required settlement tolerance, the proposed grain bin walls must be supported on a deep foundation system comprising augered cast-in-place (ACIP) piles.

ACIP pile design should be based on the following:

- The ACIP piles should be designed using the allowable capacities provided in Tables 8 and 9. Allowable skin friction and end bearing values were determined using a factor of safety of 2.0. Skin friction should be neglected in the upper 3 feet from the adjacent ground surface due to frost penetration and desiccation. ACIP piles should bear a minimum of 40 feet below grade at an elevation of 3989 or lower.

Table 8. ACIP Pile Design Parameters.

Depth Below Ground Surface (feet)	Approximate Elevation (feet)	Allowable Compressive Skin Friction (psf)	Allowable Tension Skin Friction (psf)	Allowable End Bearing (psf)
0 – 3	4029 – 4026	--	--	--
3 – 6	4026 – 4023	650	485	--
6 – 15	4023 – 4014	380	285	--
15 – 25	4014 – 4004	1,200	600	--
25 – 35	4004 – 3994	670	500	--
35 – 50	3994 – 3979	1,200	900	100,000
50 – 65	3979 – 3964	1,500	1,100	150,000

Table 9. LPile Design Parameters.

Depth Below Ground Surface (feet)	Approximate Elevation (feet)	Effective Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)	LPile Soil Modulus, k, (pci)	Ultimate Soil Strain at 50% of Ultimate Compression, ϵ_{50}
0 – 3	4029 – 4026	95	--	--	--	--
3 – 6	4026 – 4023	95	--	1,300	335	0.0085
6 – 15	4023 – 4014	90	--	750	135	0.012
15 – 25	4014 – 4004	125	--	2,400	670	0.006
25 – 35	4004 – 3994	125	38	--	155	--
35 – 50	3994 – 3979	75	42	--	200	--
50 – 65	3979 – 3964	60	26	4,000	65	0.0035

- We note that auger refusal was encountered in some of our exploratory borings near a depth of approximately 42 feet. If structure loads require foundations deeper than this depth, high-torque, high crowd pressure ACIP pile rigs will likely be required. When extending ACIP piles into the very dense Ogallala Formation, care must be taken to avoid degrading the capacity of the pile through excessive auger rotation after practical refusal is encountered. Practical refusal is defined as auger penetration of 3 inches or less per minute. If the auger advances less than 3 inches over a one-minute period, drilling should be stopped.
- Center-to-center pile spacing should be greater than 3 pile diameters. No reduction in individual pile capacity for group action is needed for this spacing.

- The structural capacity of the piles should be determined using applicable building codes. In no case should the load applied to the pile exceed the allowable structural capacity of the pile—typically 1/3 of the nominal grout strength.
- Same-day installation of piles less than 6 pile diameters apart should be prohibited to reduce the risk of disturbance to piles containing uncured grout. The contractor should be responsible for any effects pile installation has on previously installed piles, and to lengthen the disturbed pile as directed by the geotechnical engineer. The addition of water to aid in drilling should not be allowed.
- Specifications should require the contractor to provide a grout pump that will maintain 10 feet of grout head pressure. We also recommend a minimum ACIP pile over-pump of 115 percent. These recommendations will help prevent pile necking and will fill voids that are created or encountered during pile construction.
- The entire cast-in-place pile be placed in a single continuous pour; no construction joints are to be allowed within the pile.
- An Olsson representative should be present full-time to observe pile installation.
- Total post-construction settlements of properly installed deep foundations are anticipated to be 1 inch or less with minimal differential settlements.

Conical Hopper Floors

After the over-excavation and recompaction of the compressible loess soils is completed as recommended in **Section 4.2** of this report, we estimate maximum total settlement beneath the grain bin hopper floors will be on the order of 3 inches with a differential settlement potential of about 2 inches or less between the base and perimeter of the cone. Please refer to **Section 5.6** for additional information regarding initial loading/filling of the grain bins.

While not included in our scope of service, we note that sheet pile or shoring could be necessary on the south side of the over-excavation within the railroad right of way.

5.3. Slab-on-Grade Subgrade Preparation

The soil subgrade supporting concrete slabs-on-grade is often disturbed during construction. Subgrades may also be disturbed by construction equipment traffic between the time of initial

grading and final concrete placement. Where applicable, we recommend the slab subgrade consist of a minimum of 12 inches of structural fill. We recommend that slab subgrades be compacted to a minimum 98 percent of maximum Standard Proctor (ASTM D698) dry density. Slab subgrade moisture content at the time of compaction should be maintained between 1 percent below and 3 percent above optimum.

We recommend the subgrade be tested for compaction using a nuclear moisture/density gauge to document that the soils have been reworked to the criteria above. Subgrades should also be evaluated by an experienced field technician using a T-probe to identify soft or unsuitable soil conditions in areas of limited access. If unstable soils, which cannot be adequately densified in place, are encountered, such soils should be removed and replaced with structural fill in accordance with the recommendations of this report. If the prepared subgrade soils have been exposed to adverse weather conditions, frost, excessive construction traffic, standing water, or similar conditions, the Olsson geotechnical engineer should be consulted to determine if corrective action is necessary.

It may be necessary to adjust the moisture content of the subgrade soils immediately prior to slab construction. Considering the slabs will be exposed to the elements, the subgrade soils will be exposed to repetitive freeze/thaw action. Additional movement should be anticipated in the subgrade soils as a result.

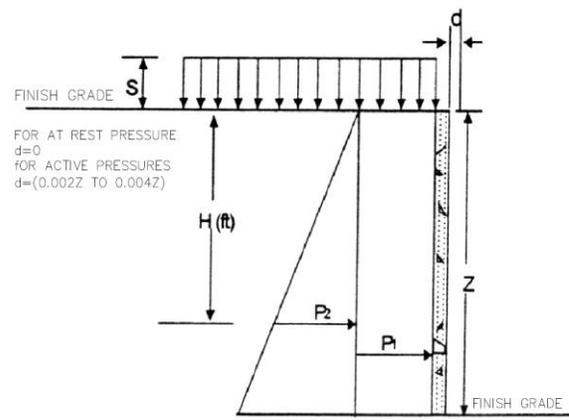
5.4. Lateral Earth Pressures

The following soil parameters are provided for designing grade retaining walls and/or foundation walls subject to lateral earth pressures. These parameters are based on the assumption that retained soils will be similar in composition to the on-site soils encountered during this investigation.

Walls which are rigidly restrained at the top and are essentially unable to deflect or rotate should be designed for at rest earth pressure conditions. Walls that are unrestrained at the top and are free to deflect or rotate slightly may be designed for active earth pressure conditions. The passive earth pressure condition is used to evaluate the resistance of soil to lateral loads. Table 10 presents recommended values of earth pressure coefficients and equivalent fluid densities based on our experience with soils in the area.

Table 10. Earth Pressure Parameters.

LEGEND OF SYMBOLS				
Z	Wall Height (ft)			
H	Depth Below Surface (ft)			
d	Wall Displacement (ft)			
S	Surcharge Load (psf)			
P₁	Surcharge Pressure (psf)			
P₂	Earth Load (psf)			
K	Coefficient of Earth Pressure			
G	Equivalent Fluid Density (pcf)			
PRESSURE CALCULATIONS				
SURCHARGE PRESSURE	$P_1 \text{ (psf)} = K \times S \text{ (psf)}$			
EARTH PRESSURE	$P_2 \text{ (psf)} = G \text{ (pcf)} \times H \text{ (ft)}$			
BACKFILL TYPE		FRICITION ANGLE	TOTAL SOIL DENSITY (pcf)	
COHESIVE	Lean Clay (CL)	26°	120	
GRANULAR*	Clean Sand or Gravel (SP, GP)	32°	120	
EARTH PRESSURE COEFFICIENT (K)		EQUIVALENT FLUID DENSITY (G)		
		DRAINED CONDITION (pcf)	UNDRAINED CONDITION (pcf)	
AT REST (K₀)	Cohesive	0.56	68	95
	Granular*	0.47	56	--
ACTIVE (K_a)	Cohesive	0.39	47	85
	Granular*	0.31	37	--
PASSIVE (K_p)	Cohesive	2.00	240	170
	Granular*	3.00	360	--



* We recommend granular backfill be permanently drained.

We developed the above parameters based on the following considerations:

- Equivalent fluid densities in Table 10 do not include a factor of safety or consider the effects of hydrostatic pressure, surcharge loading (P₁), point loads, or construction equipment loads.
- Mobilization of active pressure requires the wall rotate about the base, with top-of-wall movements (d) on the order of 0.002*Z to 0.004*Z (granular) or 0.010*Z to 0.020*Z (cohesive), where Z is the wall height.
- Mobilization of passive pressure requires a lateral wall movement (d) on the order of 0.020*Z to 0.060*Z (granular) or 0.020*Z to 0.040*Z (cohesive), where Z is the wall height.

- Drained earth pressure parameters assume a permanent drainage system is installed behind the wall to prevent the development of hydrostatic pressure.
- Backfill has a maximum unit weight of 120 pcf.
- The ground surface in front of and behind the wall is horizontal.

Backfill soils placed within a lateral distance from the face of the wall to 70 percent of the wall height should consist of granular material or select lean clay with a liquid limit less than 45. To utilize earth pressure parameters for granular materials, the granular backfill must extend out from the base of the wall at angles of 45 and 60 degrees from the vertical for the active and passive cases, respectively.

Sliding resistance along the base of a wall supported on suitable native soils or crushed limestone may be evaluated using ultimate sliding friction values of 0.35 or 0.45, respectively. Appropriate factors of safety should be applied to the calculated lateral earth pressures and sliding friction resistance. This factor of safety typically ranges from 1.5 to 2.0. Passive earth pressure resistance should be neglected within the frost zone (typically 3.5 feet).

If a foundation key is considered to resist lateral sliding loads using passive earth pressure, the key should be placed below the wall stem or to the toe side of the wall stem. Sliding resistance along the base of the foundation should be neglected within the passive earth pressure zone.

5.5. Seismic Site Classification

We have reviewed the subsurface data collected as part of this exploration as well as other available geologic data to evaluate the subsurface materials to a depth of 100 feet. Based on these data, we recommend the site be assigned a site soil classification of D as defined in Chapter 20 of ASCE 7-10 and the International Building Code.

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 Olsson for additional information regarding shear wave velocity profiling.

5.6. Initial Grain Loading

We recommend the initial filling of the grain bins be completed in stages (1/4 to 1/3 of the bin capacity in each stage) to allow for more controlled settlement of the bin floors and reduce the risk of sudden settlements caused by bearing capacity failure of the underlying soil. Adjacent bins should be loaded equally and simultaneously during the initial filling. The total and differential settlement of the bins should be monitored during construction and during the initial filling of the bins. If excessive or rapid settlement of the bins begins to occur, filling operations should cease immediately until movements have stabilized.

Some cracking and differential movement should be anticipated as the structures are loaded. Adjustments or modifications to the reclaim conveyors may be required after the structures have settled from the initial loading.

6. FUTURE FLAT STORAGE BUILDING

6.1. General Site Conditions

We understand that a future flat storage building is planned to the north of the grain storage bins discussed above. Design information was not finalized at the time of this report for the future storage building and additional analyses and potentially additional site investigation will be required after the final design information is determined.

Based on laboratory testing, preliminary structural loading information, and our engineering evaluation, we estimate settlement of the flat storage building could range from 4 to 8 inches. As such, improvements will be required to reduce post construction settlement to acceptable levels.

We estimate a surcharge to an elevation of approximately 10 feet above the proposed finished grade elevation will be required. The final surcharge height should be determined during the final geotechnical investigation for the flat storage building. We estimate surcharge settlement would be complete 30 to 60 days after completion of the surcharge placement.

An intermediate foundation or ground improvement system comprising Geopiers, vibro-stone columns or shallow ACIP piles used as a column supported embankment could also be considered to reduce settlement of the flat storage building.

Because the flat storage building will be located away from the first-phase facilities and the adjacent railroad track, a deep over-excavation and recompaction program could also be considered beneath the flat storage building. Though the final depth of the over-excavation must be evaluated as part of the final geotechnical analysis for the flat storage building, we estimate depth of over-excavation will be on the order of 10 to 15 feet.

6.2. Preliminary Shallow Foundation Design

Based on the results of our preliminary exploration and engineering evaluation, the proposed flat storage building may be supported on a conventional shallow foundation system with remediation of the proposed site as described above. We estimate shallow foundations supported on loess soils or properly compacted structural fill material may be designed for a net allowable soil bearing pressure between 1,500 and 2,500 pounds per square foot (psf). We estimate total post-

construction settlements for foundations sized using the above bearing pressures and following appropriate soil improvements will be less than 4 inches.

Please note that the above values are intended only to provide a range of possible design values for shallow foundations. Final foundation types, design values, or required soil improvement programs must be based on site-specific geotechnical exploration, site grading, and proposed structure types.

7. REPORT LIMITATIONS AND CLOSURE

The conclusions and recommendations presented in this report are based on the information available regarding the proposed construction, the results obtained from our soil test borings and sampling procedures, the results of the laboratory testing program, and our experience with similar projects. The soil test borings represent a limited 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 soil test borings. In these instances, adjustments to design and construction may be necessary.

This geotechnical report is based on the site plan and information provided to Olsson and our understanding of the project as noted in this report. 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.

The scope of this exploration did not include any environmental assessment for the presence of wetlands and/or hazardous or toxic materials in the soil or groundwater on or near the site. Any statements in this report regarding odors, discoloration, or suspicious conditions are strictly for the information of our client.

This report was prepared by the firm Olsson, Inc. under the direction of a Professional Engineer registered in the State of Colorado. The conclusions and recommendations contained herein are based on generally accepted professional geotechnical engineering practice at the time of this report, within this geographic area. No other warranty is expressed or implied. This report has been prepared for the exclusive use of the Scoular Company for specific application to the proposed project.

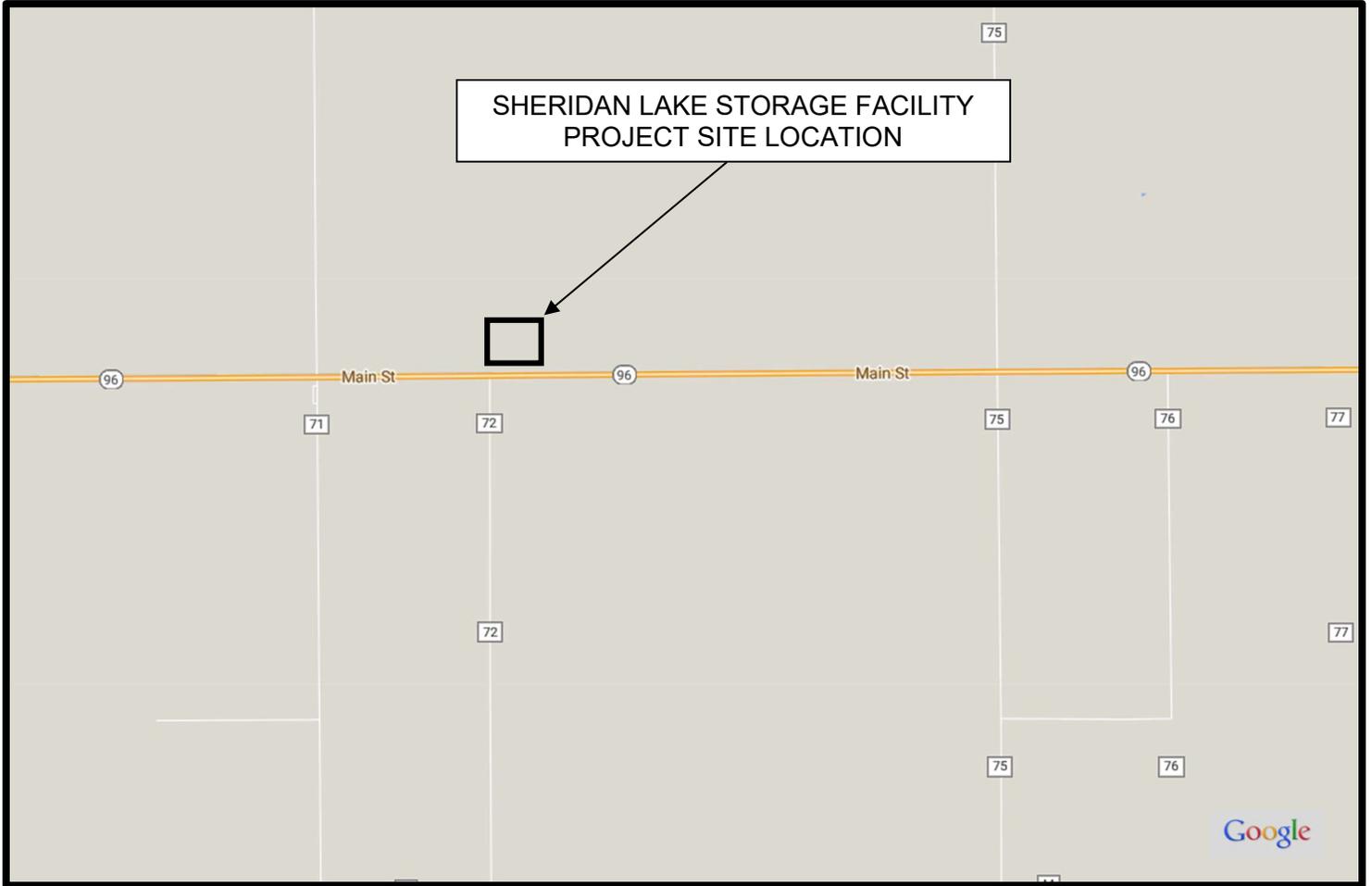
We trust that this report will assist you in the design and construction of the proposed project. Olsson appreciates the opportunity to provide our services on this project and looks forward to working with you during construction and on future projects. Should you have any questions, please do not hesitate to contact us.

\\oa.ad.oaconsulting.com\fnfs-ns1\projects\2020\3501-4000\020-3668\40-Design\Reports\FOPS\Report\Scoular Sheridan Lake Grain Bins.docx

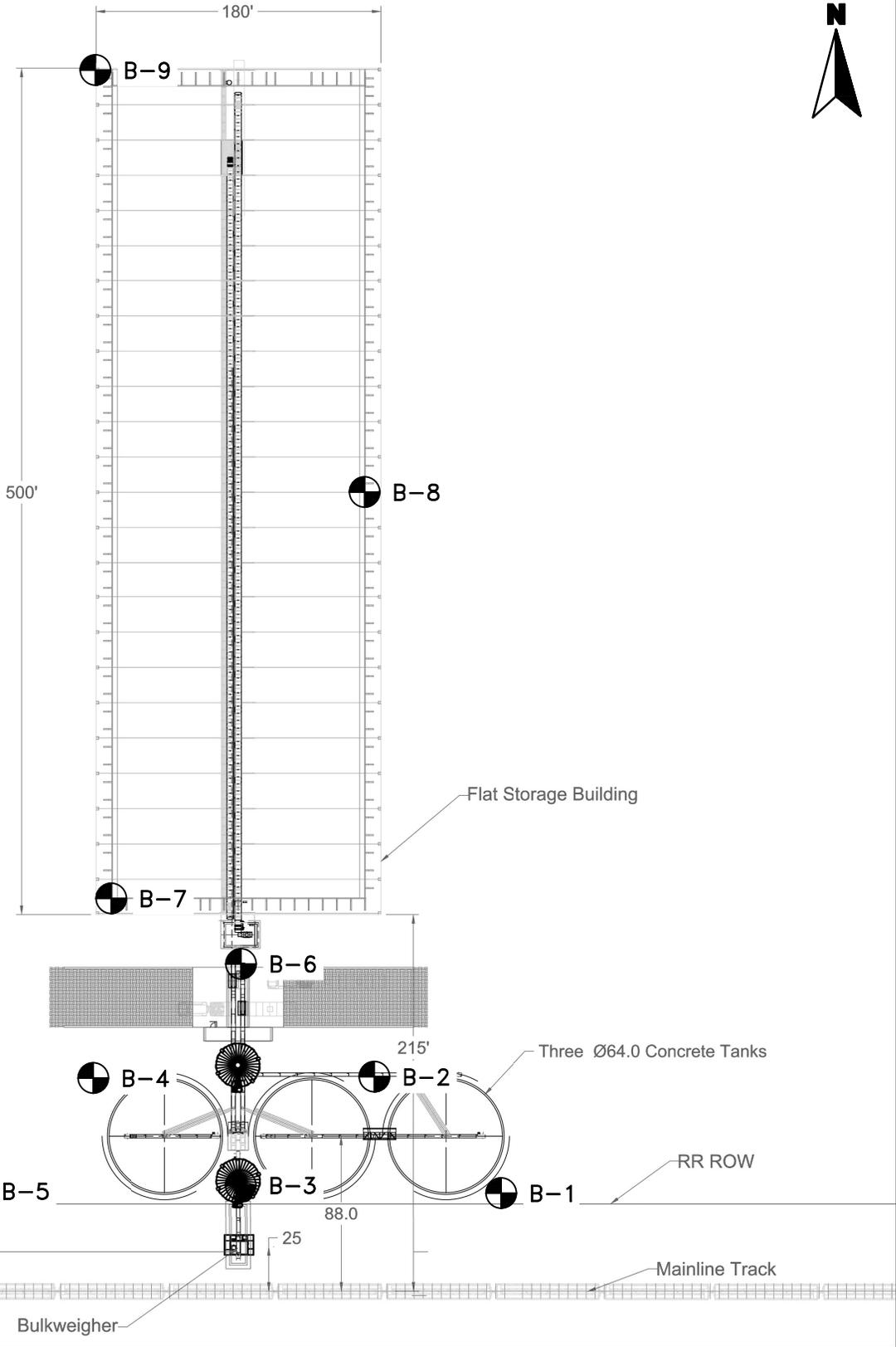
APPENDIX A

Site Location Plan

Boring Location Map

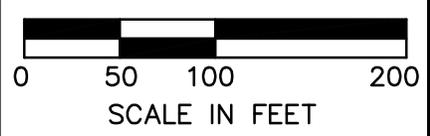


**SITE LOCATION PLAN
SHERIDAN LAKE STORAGE FACILITY
SHERIDAN LAKE, COLORADO
OLSSON PROJECT NO. 020-3668**



F:\2020\3501-4000\020-3668\40-Design\Reports\FOPS\DWG\020-3668
B:\apps\105
DATE: 12/22/2020 USER: anguyen

LEGEND	
	SOIL BORING LOCATION
PROJECT: 020-3668	
DATE: 12.22.20	DRAWN BY: ALN



BORING LOCATION MAP
SHERIDAN LAKE, COLORADO



1101 Libra Drive, Suite 2
Lincoln, NE 68512
TEL 402.458.5052
www.olsson.com

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	RB: Rock Bit	IAD: Immediately After Drilling
SPT: Standard Penetration Test Blows per 6.0"	PP: Pocket Penetrometer	AD: After Drilling

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

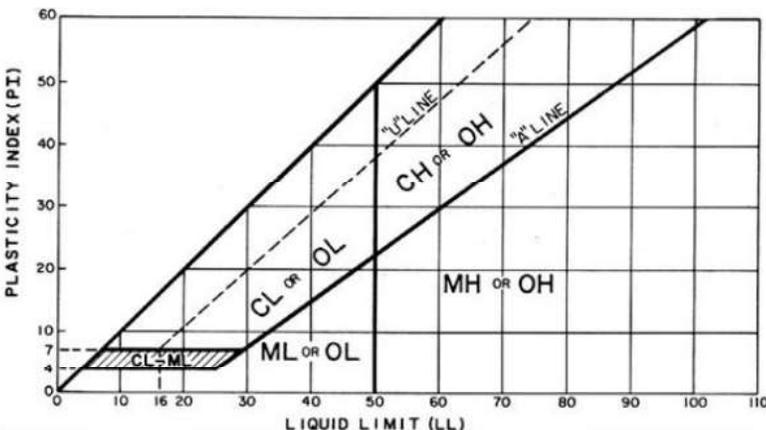
Descriptions of the soils encountered in the soil test borings were prepared using Visual-Manual Procedures for Descriptions and Identification of Soils.

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		COHESIONLESS SOILS		COMPONENT %	
<u>Consistency</u>	<u>Unconfined Compressive Strength (Qu) (tsf)</u>	<u>Relative Density</u>	<u>'N' Value</u>	<u>Description</u>	<u>Percent (%)</u>
Very Soft	<0.25	Very Loose	0 – 3	Trace	<5
Soft	0.25 – 0.5	Loose	4 – 9	Few	5 - 10
Firm	0.5 – 1.0	Medium Dense	10 – 29	Little	15 - 25
Stiff	1.0 – 2.0	Dense	30 – 49	Some	30 - 45
Very Stiff	2.0 – 4.0	Very Dense	≥ 50	Mostly	50 - 100
Hard	> 4.0				

PLASTICITY CHART



ROCK QUALITY DESIGNATION (RQD)

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



PROJECT NAME Sheridan Lake Storage Facility	CLIENT The Scoular Company
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PROJECT NUMBER 020-3668	LOCATION Sheridan Lake, Colorado
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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): 4031.0		0								
4030	LOESS <i>Lean clay (CL): Stiff, dark brown, slightly moist</i>			SS 1		5-6-6 N=12		12.1			
	<i>Lean clay (CL): Stiff, dark brown, slightly moist</i>				SS 2		4-5-7 N=12				
4025	<i>Lean clay (CL): Stiff, dark brown, slightly moist</i>			5	SS 3		6-7-7 N=14				
	<i>Lean clay (CL): Firm, tan, slightly moist</i>				SS 4		4-3-2 N=5				
4020	<i>Lean clay (CL): Firm, tan, slightly moist</i>			10	SS 5		3-3-3 N=6		12.2		
	<i>Lean clay (CL): Firm, tan, slightly moist</i>				SS 6		3-3-4 N=7				
4015	<i>Lean clay (CL): Very stiff, brown, moist, trace fine sand and silt</i>			15	SS 7		9-9-9 N=18				
			20.0'								

CONTINUED NEXT PAGE

WATER LEVEL OBSERVATIONS	OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/1/20	FINISHED: 12/1/20	
WD Not Performed		DRILL CØLITE DRILLING	DRILL RIG: CME 75	
IAD Not Encountered		DRILLER: DW	LOGGED BY: M. ALMAND	
AD Not Encountered		METHOD: HOLLOW STEM AUGER / ROTARY WASH		

PROJECT NAME Sheridan Lake Storage Facility	CLIENT The Scoular Company
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PROJECT NUMBER 020-3668	LOCATION Sheridan Lake, Colorado
-----------------------------------	--

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
4010	LOESS <i>Lean clay (CL): Very stiff, tan, moist</i>	[Hatched Pattern]	20	SS 8		7-8-9 N=17					
4005	OGALLALA FORMATION <i>Clayey sand (SC): Very dense, light brown, moist, mostly fine to coarse sand, some clay</i>	[Hatched Pattern]	25	SS 9		20-20-30 N=50		15.3			P-200 = 32.7%
4000	<i>Poorly graded sand (SP): Dense, dark brown, moist, mostly fine to coarse sand, trace fine gravel</i>	[Dotted Pattern]	30	SS 10		15-15-20 N=35					
3995	<i>Clayey sand (SC): Very dense, light brown, moist, mostly fine to coarse sand, little clay</i>	[Hatched Pattern]	35	SS 11		30-50					
	CONTINUED NEXT PAGE		40								

WATER LEVEL OBSERVATIONS	OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/1/20	FINISHED: 12/1/20
WD Not Performed		DRILL CØELITE DRILLING	DRILL RIG: CME 75
IAD Not Encountered		DRILLER: DW	LOGGED BY: M. ALMAND
AD Not Encountered		METHOD: HOLLOW STEM AUGER / ROTARY WASH	

PROJECT NAME: **Sheridan Lake Storage Facility** CLIENT: **The Scoular Company**

PROJECT NUMBER: **020-3668** LOCATION: **Sheridan Lake, Colorado**

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
3990	OGALLALA FORMATION <i>Clayey sand (SC): Very dense, light brown, moist, mostly fine to coarse sand, little clay</i>		40	NR 12		50/3"					
3985	<i>Clayey sand (SC): Very dense, light brown, moist, mostly fine to coarse sand, little clay</i>		45	NR 13		50/1"					
3980	SHALE <i>Highly weathered, soft rock, very dark brown</i>		50	SS 14		50					
3975	<i>Moderately weathered, soft rock, very dark brown</i>	55	MC 15		50/3"						SS: "N" = 50/6"
		60.0'	60								

CONTINUED NEXT PAGE

WATER LEVEL OBSERVATIONS	<p align="center">OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512</p>	STARTED: 12/1/20	FINISHED: 12/1/20
WD <input type="checkbox"/> Not Performed		DRILL CØLITE DRILLING	DRILL RIG: CME 75
IAD <input checked="" type="checkbox"/> Not Encountered		DRILLER: DW	LOGGED BY: M. ALMAND
AD <input checked="" type="checkbox"/> Not Encountered		METHOD: HOLLOW STEM AUGER / ROTARY WASH	

PROJECT NAME Sheridan Lake Storage Facility		CLIENT The Scoular Company										
PROJECT NUMBER 020-3668		LOCATION Sheridan Lake, Colorado										
ELEVATION (ft)	<input checked="" type="checkbox"/> Split Spoon <input type="checkbox"/> No Recovery <input checked="" type="checkbox"/> Modified California Sampler	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
3970		SHALE <i>Moderately weathered, soft rock, very dark brown</i>		60	MC 16		50/2"					SS: "N" = 50/5"
3965		<i>Moderately weathered, soft rock, very dark brown</i>		65	SS 17		50/4"					
BASE OF BORING AT 66.5 FEET												

WATER LEVEL OBSERVATIONS		OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/1/20	FINISHED: 12/1/20
WD	<input type="checkbox"/> Not Performed		DRILL CØLITE DRILLING	DRILL RIG: CME 75
IAD	<input checked="" type="checkbox"/> Not Encountered		DRILLER: DW	LOGGED BY: M. ALMAND
AD	<input checked="" type="checkbox"/> Not Encountered		METHOD: HOLLOW STEM AUGER / ROTARY WASH	

PROJECT NAME Sheridan Lake Storage Facility	CLIENT The Scoular Company
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PROJECT NUMBER 020-3668	LOCATION Sheridan Lake, Colorado
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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): 4028.0		0									
	LOESS											
	<i>Lean clay (CL): Firm, dark brown, slightly moist, trace organics</i>				SS 1		5-4-4 N=8					
4025	<i>Lean clay (CL): Stiff, dark brown, slightly moist</i>				SS 2		4-4-5 N=9		11.3			
	<i>Lean clay (CL): Soft, dark brown, slightly moist</i>			5	SS 3		4-2-2 N=4					
4020	<i>Lean clay (CL): Firm, dark brown, slightly moist</i>				U 4				13.9	90.4		
	<i>Lean clay (CL): Firm, dark brown, slightly moist</i>			10	SS 5		3-3-3 N=6					
4015	<i>Lean clay (CL): Firm, dark brown, slightly moist, trace fine sand</i>				SS 6		4-4-4 N=8					
	<i>Lean clay (CL): Very stiff, light brown, moist, trace fine sand</i>		15	SS 7		7-8-9 N=17		19.0				
4010												
			20.0'									

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WATER LEVEL OBSERVATIONS	OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/3/20	FINISHED: 12/3/20	
WD Not Encountered		DRILL CØLITE DRILLING	DRILL RIG: CME 75	
IAD Not Encountered		DRILLER: DW	LOGGED BY: M. ALMAND	
AD 34.0 ft after 24Hrs		METHOD: HOLLOW STEM AUGER		

PROJECT NAME Sheridan Lake Storage Facility	CLIENT The Scoular Company
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PROJECT NUMBER 020-3668	LOCATION Sheridan Lake, Colorado
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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
4005	LOESS <i>Lean clay (CL): Very stiff, dark brown, moist, trace fine to coarse sand</i>	[Hatched Pattern]	20	SS 8		7-9-9 N=18					
4000	OGALLALA FORMATION <i>Lean clay (CL): Hard, dark brown, moist, trace sand, heavy calcareous lenses</i>	[Hatched Pattern]	25	SS 9		9-13-22 N=35					
3995	<i>Poorly graded sand (SP): Dense, light brown, moist, mostly fine to coarse sand</i>	[Dotted Pattern]	30	SS 10		15-15-15 N=30					
3990	<i>Lean clay (CL): Very stiff, dark brown, wet, trace sand, calcareous lenses</i>	[Hatched Pattern]	35	SS 11		10-13-15 N=28					
	CONTINUED NEXT PAGE		40								

WATER LEVEL OBSERVATIONS	OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/3/20	FINISHED: 12/3/20
WD Not Encountered		DRILL CØLITE DRILLING	DRILL RIG: CME 75
IAD Not Encountered		DRILLER: DW	LOGGED BY: M. ALMAND
AD 34.0 ft after 24Hrs		METHOD: HOLLOW STEM AUGER	

PROJECT NAME Sheridan Lake Storage Facility	CLIENT The Scoular Company
---	--------------------------------------

PROJECT NUMBER 020-3668	LOCATION Sheridan Lake, Colorado
-----------------------------------	--

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
	<div style="display: flex; justify-content: space-between; font-size: small;"> <input checked="" type="checkbox"/> Split Spoon <input checked="" type="checkbox"/> Shelby Tube </div> <div style="display: flex; justify-content: space-between; font-size: small;"> <input type="checkbox"/> No Recovery </div>		40	NR 12		50/1"					
	OGALLALA FORMATION <i>Lean clay (CL): Hard, dark brown, wet, trace sand, calcareous lenses</i>		42.0'								

REFUSAL AT 42.0 FEET

WATER LEVEL OBSERVATIONS	OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/3/20	FINISHED: 12/3/20
WD <input checked="" type="checkbox"/> Not Encountered		DRILL CØLITE DRILLING	DRILL RIG: CME 75
IAD <input checked="" type="checkbox"/> Not Encountered		DRILLER: DW	LOGGED BY: M. ALMAND
AD <input checked="" type="checkbox"/> 34.0 ft after 24Hrs		METHOD: HOLLOW STEM AUGER	

PROJECT NAME Sheridan Lake Storage Facility	CLIENT The Scoular Company
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PROJECT NUMBER 020-3668	LOCATION Sheridan Lake, Colorado
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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	
4030	APPROX. SURFACE ELEV. (ft): 4030.0		0									
	LOESS											
	<i>Lean clay (CL): Stiff, dark brown, moist, trace organics</i>				SS 1		5-5-5 N=10					
	<i>Lean clay (CL): Stiff, light brown, dry</i>				SS 2		5-6-7 N=13		9.0			
4025	<i>Lean clay (CL): Stiff, light brown, dry</i>			5	U 3				9.1	80.5		
	<i>Sandy lean clay (CL): Stiff, light brown, slightly moist</i>				SS 4		4-5-6 N=11					
4020	<i>Sandy lean clay (CL): Stiff, light brown, slightly moist, trace fine sand</i>			10	SS 5		3-4-5 N=9		10.9			P-200 = 69.0%
	<i>Lean clay (CL): Firm, light brown, moist, trace fine sand</i>				U 6			0.7	18.1	90.2		
4015	<i>Lean clay (CL): Stiff, light brown, moist, trace fine sand</i>		15	SS 7		4-5-5 N=10						
4010		20.0'	20									

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WATER LEVEL OBSERVATIONS	OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/3/20	FINISHED: 12/3/20
WD ∇ 37.0 ft		DRILL CØELITE DRILLING	DRILL RIG: CME 75
IAD ∇ Not Encountered		DRILLER: DW	LOGGED BY: M. ALMAND
AD ∇ 34.0 ft after 24Hrs		METHOD: HOLLOW STEM AUGER	

PROJECT NAME Sheridan Lake Storage Facility	CLIENT The Scoular Company
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PROJECT NUMBER 020-3668	LOCATION Sheridan Lake, Colorado
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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
4010	OGALLALA FORMATION <i>Lean clay (CL): Very stiff, light brown, slightly moist, trace fine sand and silt, calcareous lenses</i>		20	SS 8		5-6-10 N=16		13.4			P-200 = 76.2%
4005			25	SS 9		10-15-16 N=31					
4000			30	SS 10		10-10-12 N=22					
3995	<i>Poorly graded sand (SP): Very dense, light brown, wet, mostly fine to coarse sand</i>		35	SS 11		50/4"					
3990			40								

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WATER LEVEL OBSERVATIONS	OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/3/20	FINISHED: 12/3/20
WD ∇ 37.0 ft		DRILL CØELITE DRILLING	DRILL RIG: CME 75
IAD ∇ Not Encountered		DRILLER: DW	LOGGED BY: M. ALMAND
AD ∇ 34.0 ft after 24Hrs		METHOD: HOLLOW STEM AUGER	

PROJECT NAME Sheridan Lake Storage Facility	CLIENT The Scoular Company
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PROJECT NUMBER 020-3668	LOCATION Sheridan Lake, Colorado
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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
3990	OGALLALA FORMATION <i>Poorly graded sand (SP): Very dense, light brown, wet, mostly fine to coarse sand</i>		40	SS 12		50/3"					
3985			45	NR 13		50/1"					
BASE OF BORING AT 46.5 FEET											

WATER LEVEL OBSERVATIONS	OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/3/20	FINISHED: 12/3/20
WD ∇ 37.0 ft		DRILL CØLITE DRILLING	DRILL RIG: CME 75
IAD ∇ Not Encountered		DRILLER: DW	LOGGED BY: M. ALMAND
AD ∇ 34.0 ft after 24Hrs		METHOD: HOLLOW STEM AUGER	

PROJECT NAME Sheridan Lake Storage Facility	CLIENT The Scoular Company
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PROJECT NUMBER 020-3668	LOCATION Sheridan Lake, Colorado
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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): 4028.0		0									
	LOESS											
	<i>Lean clay (CL): Firm, dark brown, slightly moist</i>				SS 1		4-4-4 N=8		11.1			
4025	<i>Lean clay (CL): Stiff, brown, slightly moist</i>				SS 2		5-6-4 N=10					
	<i>Lean clay (CL): Stiff, brown, slightly moist</i>			5	U 3				11.0	85.1		
4020	<i>Lean clay (CL): Very stiff, light brown, slightly moist, trace fine sand</i>				SS 4		4-6-10 N=16					
	<i>Lean clay (CL): Stiff, light brown, slightly moist, trace fine sand</i>			10	U 5				13.1	97.0		
4015	<i>Lean clay (CL): Stiff, light brown, slightly moist, trace fine sand</i>				SS 6		5-5-6 N=11					
	<i>Lean clay (CL): Stiff, light brown, moist, trace fine sand and silt</i>		15	SS 7		5-5-6 N=11		15.5			P-200 = 81.4%	
4010												
			20.0'									

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WATER LEVEL OBSERVATIONS	OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/1/20	FINISHED: 12/2/20
WD ∇ 39.0 ft		DRILL CØLITE DRILLING	DRILL RIG: CME 75
IAD ∇ Not Encountered		DRILLER: DW	LOGGED BY: M. ALMAND
AD ∇ 34.0 ft after 24Hrs		METHOD: HOLLOW STEM AUGER	

PROJECT NAME: **Sheridan Lake Storage Facility** CLIENT: **The Scoular Company**

PROJECT NUMBER: **020-3668** LOCATION: **Sheridan Lake, Colorado**

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
4005	OGALLALA FORMATION <i>Clayey sand (SC): Medium dense, light brown, moist, mostly fine sand, some clay</i>		20	SS 8		10-11-14 N=25					
4000	<i>Lean clay (CL): Hard, brown, moist, calcareous lenses</i>		25.0'	SS 9		30-30-27 N=57					
3995	<i>Poorly graded sand (SP): Medium dense, brown, moist, mostly fine to coarse sand</i>		30.0'	SS 10		9-12-14 N=26					
3990	<i>Clayey sand (SC): Very dense, brown, wet, mostly fine to coarse sand, little clay, trace silt</i>		35.0'	SS 11		28-50/3"					
	CONTINUED NEXT PAGE		40.0'								

WATER LEVEL OBSERVATIONS	OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/1/20	FINISHED: 12/2/20
WD 39.0 ft		DRILL CØELITE DRILLING	DRILL RIG: CME 75
IAD Not Encountered		DRILLER: DW	LOGGED BY: M. ALMAND
AD 34.0 ft after 24Hrs		METHOD: HOLLOW STEM AUGER	

PROJECT NAME Sheridan Lake Storage Facility				CLIENT The Scoular Company								
PROJECT NUMBER 020-3668				LOCATION Sheridan Lake, Colorado								
ELEVATION (ft)	 Split Spoon  Shelby Tube	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
3985		OGALLALA FORMATION <i>Clayey sand (SC): Very dense, brown, wet, mostly fine to coarse sand, little clay, trace fine gravel and silt</i>		40	SS 12		50/2"					
		<i>Clayey sand (SC): Very dense, brown, wet, mostly fine to coarse sand, little clay, trace fine gravel and silt</i>		45	SS 13		50/2"					

BASE OF BORING AT 46.5 FEET

46.5'

WATER LEVEL OBSERVATIONS		OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/1/20	FINISHED: 12/2/20
WD	▽ 39.0 ft		DRILL CØLITE DRILLING	DRILL RIG: CME 75
IAD	▼ Not Encountered		DRILLER: DW	LOGGED BY: M. ALMAND
AD	▽ 34.0 ft after 24Hrs		METHOD: HOLLOW STEM AUGER	

PROJECT NAME Sheridan Lake Storage Facility	CLIENT The Scoular Company
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PROJECT NUMBER 020-3668	LOCATION Sheridan Lake, Colorado
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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): 4029.0		0									
	LOESS											
	<i>Lean clay (CL): Stiff, dark brown, slightly moist</i>				SS 1	CL	4-5-6 N=11		10.2		35/17	
	<i>Lean clay (CL): Stiff, light brown, slightly moist</i>				SS 2		5-6-7 N=13					
4025												
	<i>Lean clay (CL): Stiff, light brown, slightly moist</i>			5	SS 3		6-6-7 N=13		13.0			
	<i>Lean clay (CL): Stiff, light brown, slightly moist</i>				U 4				14.8	88.1		
4020												
	<i>Lean clay (CL): Stiff, light brown, slightly moist</i>		10	SS 5		5-5-6 N=11						
	<i>Lean clay (CL): Stiff, light brown, slightly moist</i>			SS 6		4-5-6 N=11						
4015												
	<i>Lean clay (CL): Very stiff, light brown, slightly moist, trace fine sand</i>		15	U 7				13.8	113.3			
4010												
			20.0'									

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WATER LEVEL OBSERVATIONS	OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/2/20	FINISHED: 12/2/20
WD ∇ 37.0 ft		DRILL CØLITE DRILLING	DRILL RIG: CME 75
IAD ∇ 31.0 ft after 0 Hrs		DRILLER: DW	LOGGED BY: M. ALMAND
AD ∇ 34.0 ft after 24Hrs		METHOD: HOLLOW STEM AUGER	

PROJECT NAME Sheridan Lake Storage Facility	CLIENT The Scoular Company
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PROJECT NUMBER 020-3668	LOCATION Sheridan Lake, Colorado
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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
4005	LOESS Lean clay (CL): Very stiff, light brown, moist, trace fine sand	[Hatched Pattern]	20	SS 8		6-8-10 N=18					
4000	OGALLALA FORMATION Lean clay (CL): Hard, light brown, moist, calcareous lenses	[Hatched Pattern]	25	SS 9		15-25-40 N=65					
3995	Silty sand (SM): Medium dense, brown, dry, mostly fine to coarse sand, few silt, trace clay	[Dotted Pattern]	30	SS 10		10-11-14 N=25		5.3			P-200 = 13.8%
3990	Poorly graded sand (SP): Very dense, brown, wet, mostly fine to coarse sand, trace silt	[Dotted Pattern]	35	SS 11		50/3"					

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WATER LEVEL OBSERVATIONS	OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/2/20	FINISHED: 12/2/20
WD ▽ 37.0 ft		DRILL CØLITE DRILLING	DRILL RIG: CME 75
IAD ▼ 31.0 ft after 0 Hrs		DRILLER: DW	LOGGED BY: M. ALMAND
AD ▼ 34.0 ft after 24Hrs		METHOD: HOLLOW STEM AUGER	

PROJECT NAME Sheridan Lake Storage Facility	CLIENT The Scoular Company
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PROJECT NUMBER 020-3668	LOCATION Sheridan Lake, Colorado
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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
	<div style="display: flex; justify-content: space-between; align-items: center;"> <div style="text-align: center;"> Split Spoon </div> <div style="text-align: center;"> Shelby Tube </div> </div>		40	NR 12		50/0"					

OGALLALA FORMATION
Poorly graded sand (SP): Very dense, brown, wet, mostly fine to coarse sand, trace silt
REFUSAL AT 41.0 FEET

41.0'

WATER LEVEL OBSERVATIONS	OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/2/20	FINISHED: 12/2/20
WD ∇ 37.0 ft		DRILL CØLITE DRILLING	DRILL RIG: CME 75
IAD ∇ 31.0 ft after 0 Hrs		DRILLER: DW	LOGGED BY: M. ALMAND
AD ∇ 34.0 ft after 24Hrs		METHOD: HOLLOW STEM AUGER	

PROJECT NAME Sheridan Lake Storage Facility	CLIENT The Scoular Company
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PROJECT NUMBER 020-3668	LOCATION Sheridan Lake, Colorado
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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): 4028.0		0									
	LOESS											
	<i>Lean clay (CL): Stiff, light brown, slightly moist</i>				SS 1		5-5-5 N=10					
4025	<i>Lean clay (CL): Stiff, light brown, slightly moist</i>				SS 2		5-5-5 N=10		11.9			
				5								
	<i>Lean clay (CL): Firm, light brown, slightly moist, few fine sand</i>				SS 3		4-4-4 N=8		10.9			P-200 = 87.4%
4020	<i>Lean clay (CL): Firm, light brown, slightly moist</i>				SS 4		4-2-3 N=5					
				10								
	<i>Lean clay (CL): Firm, light brown, slightly moist</i>			U 5	CL					35/17		
4015	<i>Lean clay (CL): Firm, light brown, slightly moist, trace fine sand</i>			SS 6		2-3-3 N=6						
			15									
	<i>Lean clay (CL): Stiff, brown, slightly moist, trace fine sand and silt</i>			SS 7		6-7-8 N=15		14.9				
4010												
			20.0'									

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WATER LEVEL OBSERVATIONS	OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/3/20	FINISHED: 12/3/20	
WD Not Encountered		DRILL CØLITE DRILLING	DRILL RIG: CME 75	
IAD Not Encountered		DRILLER: DW	LOGGED BY: M. ALMAND	
AD Not Performed		METHOD: HOLLOW STEM AUGER		

PROJECT NAME: **Sheridan Lake Storage Facility** CLIENT: **The Scoular Company**

PROJECT NUMBER: **020-3668** LOCATION: **Sheridan Lake, Colorado**

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
	OGALLALA FORMATION <i>Lean clay (CL): Very stiff, brown, moist, trace fine sand and silt, calcareous lenses</i>		20	SS 8		9-11-13 N=24					
4005											
	<i>Clayey sand (SC): Medium dense, orangish brown, dry, mostly fine to coarse sand, little clay, trace silt, calcareous lenses</i>		25	SS 9		11-8-11 N=19					
4000											
	<i>Clayey sand (SC): Dense, brown, dry, mostly fine to coarse sand, little clay, trace silt, calcareous lenses</i>		30	SS 10		25-30-12 N=42		5.3			P-200 = 32.7%
3995											
	<i>Clayey sand (SC): Very dense, light brown, dry, mostly fine to coarse sand, little clay, trace silt, calcareous lenses</i>		35	SS 11		50/4"					
			36.5'								

BASE OF BORING AT 36.5 FEET

WATER LEVEL OBSERVATIONS		OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/3/20	FINISHED: 12/3/20
WD	∇ Not Encountered		DRILL CØELITE DRILLING	DRILL RIG: CME 75
IAD	∇ Not Encountered		DRILLER: DW	LOGGED BY: M. ALMAND
AD	∇ Not Performed		METHOD: HOLLOW STEM AUGER	

PROJECT NAME Sheridan Lake Storage Facility	CLIENT The Scoular Company
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PROJECT NUMBER 020-3668	LOCATION Sheridan Lake, Colorado
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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): 4028.0		0									
	LOESS											
	<i>Lean clay (CL): Stiff, light brown, slightly moist, trace organics</i>				SS 1		5-7-8 N=15					
4025	<i>Lean clay (CL): Stiff, light brown, slightly moist</i>				U 2				13.3	78.1		
	<i>Lean clay (CL): Stiff, light brown, slightly moist</i>			5								
	<i>Lean clay (CL): Stiff, light brown, slightly moist</i>				SS 3		4-5-4 N=9					
4020	<i>Lean clay (CL): Soft, light brown, moist</i>				U 4			0.3	15.2	79.1		
	<i>Lean clay (CL): Stiff, light brown, moist</i>		10									
	<i>Lean clay (CL): Stiff, light brown, moist</i>			SS 5		5-4-5 N=9						
4015												
	<i>Lean clay with sand (CL): Stiff, brown, moist, trace silt</i>		15									
				SS 6		6-7-6 N=13						
4010												
			20									

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WATER LEVEL OBSERVATIONS	OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/4/20	FINISHED: 12/4/20	
WD Not Encountered		DRILL CØLITE DRILLING	DRILL RIG: CME 75	
IAD Not Encountered		DRILLER: DW	LOGGED BY: M. ALMAND	
AD Not Performed		METHOD: HOLLOW STEM AUGER		

PROJECT NAME Sheridan Lake Storage Facility	CLIENT The Scoular Company
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PROJECT NUMBER 020-3668	LOCATION Sheridan Lake, Colorado
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ELEVATION (ft)	Split Spoon Shelby Tube <p style="text-align: center;">MATERIAL DESCRIPTION</p>	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
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	<p>LOESS</p> <p><i>Lean clay (CL): Very stiff, brown, moist, trace fine sand and silt</i></p>	20	SS 7	4-5-10 N=15							
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21.5'

BASE OF BORING AT 21.5 FEET

WATER LEVEL OBSERVATIONS	OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/4/20	FINISHED: 12/4/20
WD Not Encountered		DRILL CØLITE DRILLING	DRILL RIG: CME 75
IAD Not Encountered		DRILLER: DW	LOGGED BY: M. ALMAND
AD Not Performed		METHOD: HOLLOW STEM AUGER	

PROJECT NAME: **Sheridan Lake Storage Facility** CLIENT: **The Scoular Company**

PROJECT NUMBER: **020-3668** LOCATION: **Sheridan Lake, Colorado**

ELEVATION (ft)	Split Spoon Shelby Tube 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
4025	LOESS <i>Lean clay (CL): Stiff, dark brown, slightly moist</i>		0	SS 1	CL	5-5-5 N=10		14.0		37/18	
	<i>Lean clay (CL): Stiff, dark brown, slightly moist</i>				SS 2		4-5-6 N=11				
4020	<i>Lean clay (CL): Stiff, dark brown, slightly moist</i>			5	U 3						
	<i>Lean clay (CL): Stiff, light brown, moist, trace fine sand</i>				SS 4		4-5-4 N=9				
4015	<i>Lean clay (CL): Stiff, light brown, moist, trace fine sand</i>			10	U 5				15.1	85.5	
4010	<i>Lean clay (CL): Stiff, brown, moist</i>			15	SS 6		6-5-5 N=10				
			20.0'								

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WATER LEVEL OBSERVATIONS		OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/4/20	FINISHED: 12/4/20
WD	Not Encountered		DRILL CØLITE DRILLING	DRILL RIG: CME 75
IAD	Not Encountered		DRILLER: DW	LOGGED BY: M. ALMAND
AD	Not Performed		METHOD: HOLLOW STEM AUGER	

PROJECT NAME Sheridan Lake Storage Facility	CLIENT The Scoular Company
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PROJECT NUMBER 020-3668	LOCATION Sheridan Lake, Colorado
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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
	<div style="display: flex; justify-content: space-between; align-items: center;"> <div style="text-align: left;"> Split Spoon </div> <div style="text-align: left;"> Shelby Tube </div> </div>		20	SS 7		7-11-14 N=25					
	LOESS <i>Lean clay (CL): Very stiff, light brown, moist, trace fine sand and silt</i>										

BASE OF BORING AT 21.5 FEET

WATER LEVEL OBSERVATIONS	OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/4/20	FINISHED: 12/4/20	
WD Not Encountered		DRILL CØLITE DRILLING	DRILL RIG: CME 75	
IAD Not Encountered		DRILLER: DW	LOGGED BY: M. ALMAND	
AD Not Performed		METHOD: HOLLOW STEM AUGER		

PROJECT NAME Sheridan Lake Storage Facility	CLIENT The Scoular Company
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PROJECT NUMBER 020-3668	LOCATION Sheridan Lake, Colorado
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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): 4027.0		0									
	LOESS											
4025	<i>Lean clay (CL): Stiff, dark brown, slightly moist</i>				SS 1		4-5-4 N=9					
	<i>Lean clay (CL): Firm, dark brown, slightly moist</i>				U 2			0.9	12.6	89.9		
				5								
4020	<i>Lean clay (CL): Firm, light brown, slightly moist</i>				SS 3		2-2-3 N=5		10.9			
	<i>Lean clay (CL): Soft, light brown, slightly moist</i>				SS 4		5-2-2 N=4		11.5			
4015	<i>Lean clay (CL): Soft, light brown, slightly moist</i>		10									
				SS 5		3-2-2 N=4						
4010	<i>Lean clay (CL): Stiff, light brown, moist, trace fine sand</i>		15									
				SS 6		4-6-7 N=13						
			20									

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WATER LEVEL OBSERVATIONS	<p>OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512</p>	STARTED: 12/4/20	FINISHED: 12/4/20	
WD Not Encountered		DRILL CØLITE DRILLING	DRILL RIG: CME 75	
IAD Not Encountered		DRILLER: DW	LOGGED BY: M. ALMAND	
AD Not Performed		METHOD: HOLLOW STEM AUGER		

PROJECT NAME Sheridan Lake Storage Facility	CLIENT The Scoular Company
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PROJECT NUMBER 020-3668	LOCATION Sheridan Lake, Colorado
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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
	<div style="display: flex; justify-content: space-between; font-size: small;"> Split Spoon Shelby Tube </div>		20		SS 7	7-8-9 N=17					
	LOESS <i>Lean clay (CL): Very stiff, brown, moist, trace sand</i>										

BASE OF BORING AT 21.5 FEET

WATER LEVEL OBSERVATIONS	OLSSON, INC. 1101 LIBRA DRIVE, STE 2 LINCOLN, NEBRASKA 68512	STARTED: 12/4/20	FINISHED: 12/4/20	
WD Not Encountered		DRILL CØLITE DRILLING	DRILL RIG: CME 75	
IAD Not Encountered		DRILLER: DW	LOGGED BY: M. ALMAND	
AD Not Performed		METHOD: HOLLOW STEM AUGER		

APPENDIX C

Summary of Laboratory Test Results

PROJECT NAME: Sheridan Lake Storage Facility

CLIENT: The Scoular Company

PROJECT NUMBER: 020-3668

PROJECT LOCATION: Sheridan Lake, Colorado

BORING NUMBER	SAMPLE I.D.	SAMPLE DEPTH (ft)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	VOID RATIO	SATURATION (%)	UNCONFINED STRENGTH (tsf)	STRAIN (%)	ATTERBERG LIMITS			P-200	USCS CLASS.
									LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX		
B-1	SS-1	0.0 - 1.5'	12.1										
B-1	SS-5	10.0 - 11.5'	12.2										
B-1	SS-9	25.0 - 26.5'	15.3								32.7		
B-2	SS-2	2.5 - 4.0'	11.3										
B-2	U-4	7.5 - 9.0'	13.9	90.4	0.865	43.3							
B-2	SS-7	15.0 - 16.5'	19.0										
B-3	SS-2	2.5 - 4.0'	9.0										
B-3	U-3	5.0 - 6.5'	9.1	80.5	1.094	22.6							
B-3	SS-5	10.0 - 11.5'	10.9									69.0	
B-3	U-6	12.5 - 14.0'	18.1	90.2	0.869	56.3	0.7	9.1					
B-3	SS-8	20.0 - 21.5'	13.4									76.2	
B-4	SS-1	0.0 - 1.5'	11.1										
B-4	U-3	5.0 - 6.5'	11.0	85.1	0.980	30.2							
B-4	U-5	10.0 - 11.5'	13.1	97.0	0.737	48.0							
B-4	SS-7	15.0 - 16.5'	15.5									81.4	
B-5	SS-1	0.0 - 1.5'	10.2							35	18	17	CL
B-5	SS-3	5.0 - 6.5'	13.0										
B-5	U-4	7.5 - 9.0'	14.8	88.1	0.913	43.6							
B-5	U-7	15.0 - 16.5'	13.8	113.3	0.488	76.5							
B-5	SS-10	30.0 - 31.5'	5.3									13.8	
B-6	SS-2	2.5 - 4.0'	11.9										
B-6	SS-3	5.0 - 6.5'	10.9									87.4	
B-6	U-5	10.0 - 11.5'								35	18	17	CL
B-6	SS-7	15.0 - 16.5'	14.9										
B-6	SS-10	30.0 - 31.5'	5.3									32.7	
B-7	U-2	2.5 - 4.0'	13.3	78.1	1.159	31.1							
B-7	U-4	7.5 - 9.0'	15.2	79.1	1.130	36.4	0.3	2.2					
B-8	SS-1	0.0 - 1.5'	14.0							37	19	18	CL
B-8	U-5	10.0 - 11.5'	15.1	85.5	0.972	41.9							
B-9	U-2	2.5 - 4.0'	12.6	89.9	0.875	38.8	0.9	3.7					

OLSSON, INC.
1101 LIBRA DRIVE, STE 2
LINCOLN, NEBRASKA 68512



SUMMARY OF LABORATORY RESULTS

PROJECT NAME: Sheridan Lake Storage Facility

CLIENT: The Scoular Company

PROJECT NUMBER: 020-3668

PROJECT LOCATION: Sheridan Lake, Colorado

BORING NUMBER	SAMPLE I.D.	SAMPLE DEPTH (ft)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	VOID RATIO	SATURATION (%)	UNCONFINED STRENGTH (tsf)	STRAIN (%)	ATTERBERG LIMITS			P-200	USCS CLASS.
									LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX		
B-9	SS-3	5.0 - 6.5'	10.9										
B-9	SS-4	7.5 - 9.0'	11.5										



CLIENT	Olsson	BORING NO.	B-6
JOB NO.	2494-020	DEPTH	10-11.5'
PROJECT	Scoular Sheridan Lake	SAMPLE NO.	U-5
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	--	SAMPLED BY	--
DATE TESTED	12/15/20	DESCRIPTION	Shelby Tube
TECHNICIAN	DPM		

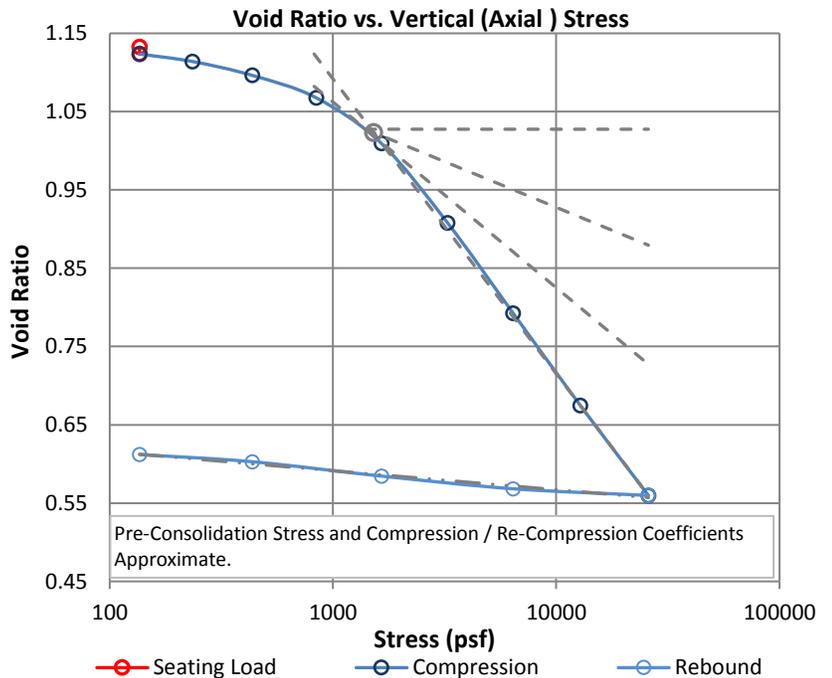
Sample Conditions

Before Test Mass of Wet Soil and Ring (g):	153.12	Initial Wet Density (pcf):	89.5
After Test Mass of Wet Soil and Ring (g):	160.51	Initial Dry Density (pcf):	77.6
Mass of Dry Soil, Ring, and Pan (g):	141.96	Initial Wet Density (kg/m ³):	1433
Diameter (in):	2.41	Initial Dry Density (kg/m ³):	1243
Initial Height (in):	1.00	Initial Moisture (%):	15.4
Mass of Ring (g):	45.97	Final Wet Density (pcf):	126.5
Mass of Pan (g):	3.10	Final Dry Density (pcf):	102.6
Assumed Specific Gravity:	2.65	Final Wet Density (kg/m ³):	2027
Initial Saturation (%):	36.0	Final Dry Density (kg/m ³):	1644
Final Saturation (%):	100.0	Final Moisture (%):	23.3

Consolidation Data

Coefficient of Compression:	0.377	Pre-Consolidation Stress (psf):	1520
Coefficient of Re-Compression:	0.024	Pre-Consolidation Stress (kPa):	73

Load (psf)	Void Ratio	Deformation (in)	Strain (%)
136	1.133	0.0000	0.00
Inundation	1.124	0.0042	0.42
235	1.114	0.0087	0.87
435	1.096	0.0170	1.70
843	1.068	0.0305	3.05
1649	1.009	0.0578	5.78
3263	0.908	0.1054	10.54
6408	0.793	0.1594	15.94
12816	0.675	0.2147	21.47
25885	0.560	0.2686	26.86
Rebound			
25885	0.560	0.2686	26.86
6408	0.568	0.2646	26.46
1649	0.584	0.2570	25.70
435	0.603	0.2484	24.84
136	0.612	0.2441	24.41
Internal			



NOTES:

CLIENT	Olsson	BORING NO.	B-8
JOB NO.	2494-020	DEPTH	5-6.5'
PROJECT	Scoular Sheridan Lake	SAMPLE NO.	U-3
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	--	SAMPLED BY	--
DATE TESTED	12/15/20	DESCRIPTION	Shelby Tube
TECHNICIAN	DPM		

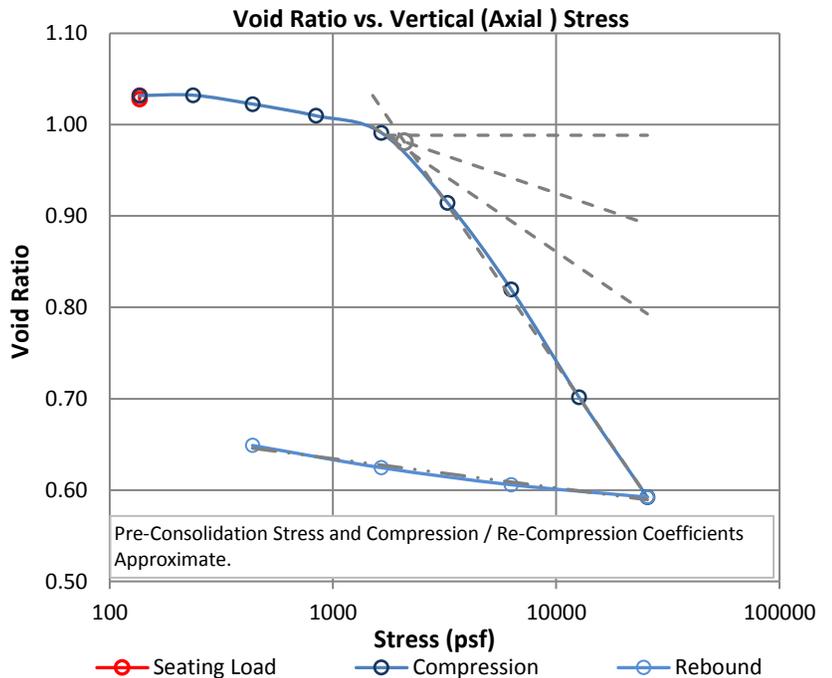
Sample Conditions

Before Test Mass of Wet Soil and Ring (g):	155.68	Initial Wet Density (pcf):	91.6
After Test Mass of Wet Soil and Ring (g):	167.81	Initial Dry Density (pcf):	81.6
Mass of Dry Soil, Ring, and Pan (g):	193.05	Initial Wet Density (kg/m ³):	1468
Diameter (in):	2.41	Initial Dry Density (kg/m ³):	1307
Initial Height (in):	1.00	Initial Moisture (%):	12.3
Mass of Ring (g):	45.95	Final Wet Density (pcf):	125.2
Mass of Pan (g):	49.42	Final Dry Density (pcf):	100.3
Assumed Specific Gravity:	2.65	Final Wet Density (kg/m ³):	2005
Initial Saturation (%):	31.9	Final Dry Density (kg/m ³):	1607
Final Saturation (%):	100.0	Final Moisture (%):	24.8

Consolidation Data

Coefficient of Compression:	0.357	Pre-Consolidation Stress (psf):	2090
Coefficient of Re-Compression:	0.032	Pre-Consolidation Stress (kPa):	100

Load (psf)	Void Ratio	Deformation (in)	Strain (%)
136	1.028	0.0000	0.00
Inundation	1.032	-0.0019	-0.19
236	1.032	-0.0021	-0.21
436	1.023	0.0027	0.27
839	1.010	0.0090	0.90
1648	0.991	0.0182	1.82
3263	0.914	0.0560	5.60
6281	0.820	0.1027	10.27
12658	0.702	0.1610	16.10
25601	0.592	0.2149	21.49
Rebound			
25601	0.592	0.2149	21.49
6281	0.606	0.2082	20.82
1648	0.624	0.1990	19.90
436	0.649	0.1870	18.70
Internal			



NOTES: