REPORT OF GEOTECHNICAL EXPLORATION

FIRE STATION
YORK FIRE DEPARTMENT
1714 NORTH LINCOLN AVENUE
YORK, NEBRASKA

MARCH 12, 2024

SCHEMMER PROJECT NO. 09272.001

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March 12, 2024

Mr. Berry Redfern
Mayor
City of York, NE
100 East 4th Street
York, NE 68467

RE: Report of Geotechnical Exploration
Fire Station
York Fire Department
1714 North Lincoln Avenue, York, Nebraska
Schemmer Project No. 09272.001

Dear Mr. Redfern:

The Schemmer Associates Inc. has conducted a subsurface exploration program and prepared site preparation, parking lot, building area, and foundation recommendations for the referenced project. This work was performed in accordance with your authorization.

The opinions expressed in this Report are based upon our understanding of the proposed project and the data obtained from our subsurface exploration. Should there be any changes as the project develops, we should be requested to review such new conditions.

Thank you for this opportunity to work with you on this project. Should you have any questions, please contact us.

Sincerely,

THE SCHEMMER ASSOCIATES INC.

Loras A. Klostermann, P.E.
Senior Geotechnical Engineer
Shareholder

PROFESSIONAL CIVIL ENGINEER
LORAS A.
KLOSTERMANN
E-6498
3/12/2024
STATE OF NEBRASKA

Cc: Mr. Danieal Kerns, AIA, The Schemmer Associates Inc
Mr. Matthew J. Hubel, PE, CPSWQ, LEED AP BD+C, The Schemmer Associates Inc
Mr. Nathan Schmidt, PE, The Schemmer Associates Inc

PHONE 402.493.4800
FAX 402.493.7951
1044 North 115th Street, Suite 300
Omaha, Nebraska 68154-4436
SCHEMMER.COM

EXECUTIVE SUMMARY

The Schemmer Associates Inc. has completed this geotechnical exploration for the proposed New Fire Station for the City of York, Nebraska. This new structure will be built on the west half of the property currently used as a parking lot located northeast of the intersection of East 17th Street and North Lincoln Avenue. An existing retail, warehouse-type structure on the east half of the property will be demolished to make way for a new fire station parking and truck maneuvering area.

The project site was a residential neighborhood until the existing big-box store was constructed sometime in the early to mid-1970's. Available aerial photography suggests to us that 7 to 8 single-family residences with full basements existed on this property. The site was leveled to some degree to construct the existing retail building and the parking lots, but the grading plan for the previous site development has not been provided.

The site exists within the loessial uplands overlooking an alluvial terrace above the current floodplain of Beaver Creek. Soil consists of Peoria loess. We are aware that Loveland Formation underlain by Pleistocene Sand deposits exist below the Peoria loess. Bedrock below this area usually consists of layers of sandstone and siltstone with some shale. We did not encounter the Loveland Formation within a depth of 20 feet below existing grade. The Peoria loess at this site exists in a moist to very moist and stiff to medium stiff condition. A groundwater table was not encountered within a depth of 20 feet.

Due to the uncertainty of the completeness of previous house demolition, methods of demolished and backfilled, and the fact that fill soil does not support building components in the same manner as natural soils we recommend site preparation be completed prior to building construction. We recommend mass overexcavation and soil replacement below the building area to a depth of four feet below existing grade or five feet below the finished floor slab, whichever is deeper. Care shall be taken by the contractor to identify the old basement areas and be sure that no debris or poorly quality fill remains below the new building site. Any debris or poor-quality fill shall be removed and replaced. Additional recommendations are provided in this Report.

A building finished floor level of 1646.5 0 feet has been determined. This finished floor level will require placement of up to 4 feet of fill above existing grade at the southwest building corner. Significant settlement due to subsoil consolidation will occur below site areas where the fill thickness above existing grade exceeds 1 foot. We recommend the placement of a temporary surcharge to the residential portion of the fire station and a portion of the apparatus garage, the south part of the structure. Soil overexcavation but no surcharge is recommended for the rest of the apparatus garage area.

A single-story building with a partial second story level is proposed. A maximum column load of 50 kips with a maximum wall load of 5.5 kips per lineal foot were provided. The floor slab to support apparatus and equipment storage has a design load of 250 pounds per square foot. The office and residential portion of the slab-on-grade floor will support a design load of 150 pounds per square foot. A storm shelter will be constructed within a portion of the residential area. The site soils after site preparation are suitable for normal shallow footing and floor slab support.

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1.0 INTRODUCTION

1.1 Project Information

This Report summarizes subsoil exploration work, laboratory test results, and geotechnical engineering conclusions and recommendations by The Schemmer Associates Inc. (Schemmer) for design of the proposed York Fire Station for the York Fire Department in York, Nebraska. Recommendations for site preparation and parameters for structure design are provided.

1.2 Scope of Service

The scope of service for this subsoil exploration was limited to:

1. Advance five (5) soil borings to a depth of 20 feet below existing grade.
2. Perform laboratory tests to aid in classifying the soils and estimating their engineering properties; and,
3. Analyze results of laboratory testing to determine site recommendations regarding the following:
    a. Description of site soil conditions and significance of area geology.
    b. Foundation and site preparation recommendations to provide stable floor and building support.
    c. Minimum depth to suitable bearing material for foundations and allowable soil bearing pressures for shallow footing design.
    d. Recommendations for site preparation if soft or otherwise unsuitable soils are found at foundation and floor support levels.
    e. Recommended removal of existing structure components.
    f. Frost depth requirements for the foundation system.
    g. Recommendations for radon gas mitigation, if required.
    h. Analysis of site soil to ascertain the presence of potentially expansive soils or otherwise deleterious materials, and should they be found, provide recommendations to mitigate detrimental effects from these materials.
    i. Recommended types of fills and backfill soil materials and compaction requirements for support of structures.
    j. Active, passive, and at-rest lateral earth pressures for use in design of lateral earth-supporting footings to support wind and other lateral forces.
    k. Anticipation and management for drainage of surface water and groundwater.
    l. Pavement subgrade design recommendations.
    m. Floor subgrade design recommendations.
    n. Seismic design parameters required by building code; and
    o. Potential for settlement due to consolidation with recommendations to control potential building settlement due to placement of fill above existing grade and alleviate excess stress on structure components associated with settlements.

1.3 Report Format

The purposes of this Report are to describe our field observations, to present field and laboratory test results, and to provide geotechnical engineering recommendations based on the subsoil conditions encountered in conjunction with the proposed construction features. Provided in the Appendix to this Report are a Boring Location Plan, Logs of Test Borings, a Summary of Soil Test Results, a page describing Classification of Soils for Engineering Purposes, and a page listing General Notes defining symbols and terms listed on the boring logs and in this Report.

2.0 EXPLORATION RESULTS

2.1 Scope of Field Exploration

A total of five test borings, labeled B-1 through B-5, were advanced for these analyses on November 30, 2023, for the purpose of gathering area subsurface data. Boring locations were determined based on preliminary development information and the proposed construction characteristics. A building conceptual location onsite had not been determined until December of 2023. Additional building data and revised building layout were provided only recently by the design team.

Borings were placed at locations allowed by safety considerations and existing surface and subsurface features including existing buildings, buried and overhead utilities, and to provide coverage of the proposed construction areas. The driller contacted the One-Call utility locate system to remove conflicts with buried utility lines. The City of York was contacted to provide locations of any private utilities that might exist at the site and are not located by One-Call. The boring locations are shown on the Boring Location Plan provided in the Appendix to this Report.

2.2 Laboratory Test Program

Tests performed on the selected soil samples included water content, dry unit weight, unconfined compressive strength, Atterberg limits, and visual classification. Results of the laboratory tests are summarized in the Appendix to this Report. Each test was performed in conformance with the current ASTM or state-of-the-art test procedures at the Schemmer soil testing laboratory by trained technicians using calibrated equipment.

Based on the results of the testing program, the field boring logs were reviewed and supplemented as presented in the Appendix. These final logs represent our interpretation of the in-place soil conditions at each boring location.

2.3 General Geology

The general bedrock geology of this area consists of sandstone and siltstone with some shale bedrock of the Pennsylvanian Age. Bedrock was naturally covered by a vast sand and gravel deposit termed "Pleistocene Sand". Pleistocene Sand is a fine to coarse sand with gravel deposit placed about the time of the earliest area continental glaciers. Pleistocene Sand away from major creeks and rivers in this area was covered by Loveland Formation, a clay soil. Loveland Formation was subsequently covered by Peoria loess during the most recent glacial age within North America, the Wisconsin glacial period, with a thickness of more than 20 feet.

2.4 Site Surface Conditions

The area's upland topography consists of shallow rolling hills with shallow drainage swales. The project site was a residential neighborhood until the existing big-box store was constructed sometime in the early to mid-1970's. Available aerial photography suggests to us that four single-family residences with three to four detached garages existed over the west half of the property, within the proposed fire station building area. The available data suggests to us that three to four single-family houses with three to four detached garages existed in the area of the existing big-box store building, where new pavements will be constructed after demolition of the existing building. No data is available as to how those previously existing houses were demolished and if any debris remains onsite, buried below grade. We estimate the houses had full basements to depths of 7 to 8 feet below grade based on visual review of nearby homes from the streets.

The site was leveled to some degree to construct the existing retail building and parking lots. We estimate that soil was cut from the northeast corner of the site and some fill was placed over the southern half of the existing building area. The grading plan for the previous site development has not been provided.

Pavement and an existing building cover the entire site. Overhead light structures exist within the parking lot. No green spaces exist. Overhead power distribution lines exist within the alley that crosses the center of the site, in a north-south orientation. A sanitary sewer, gas main, and communication utilities are known to also exist within this alley.

2.5 Subsurface Conditions

The subsurface conditions encountered in the borings have been used to infer the general soil conditions at the site. Schemmer assumes the soil conditions between borings are fairly represented by the borings. If soil conditions other than those described below and as shown on the Boring Logs are found during construction, it is important that the geotechnical engineer from Schemmer be informed to evaluate the exposed conditions with respect to their effect on our recommendations.

The following is a brief review of the various layers of soil encountered in our soil borings. All depths given are relative to the ground surface at the time of drilling. Please refer to the boring logs in the Appendix for a more complete description of soil conditions at each boring location.

We are aware that 7 to 8 single family residences previously existed at this site. Our boring data did not find any filled basement excavation areas at the bored locations.

Table 1 on Page 5 is provided after these soil descriptions and contains short summations of the soils within each of the geologic descriptions.

Fill – Fill is soil placed by human activities. About six inches of Portland cement pavement exists at each of the five boring locations. Soil fill was found below the pavement at each boring location except for boring B-5. The fill extends to a depth of about 2 to 4 feet below the top of pavement and consists of firm lean clay. We could not determine when the fill was placed or by whom. This soil exists in a very moist and medium stiff to very stiff condition with the following measured in-place properties:

Water content – 24 to 28%
Dry unit weight – 94 to 100 pcf

Unconfined compressive strength – 1.89 to 2.87 tsf
Passing No. 200 sieve - >95%
Classification (Unified) – Lean Clay (CL)

Weathered Peoria Loess – The weathered surface of the Peoria loess soil was found only at boring B-5 below the pavement. This soil consists of very moist and medium stiff lean clay. A sample of this soil existing with medium plasticity with the following measured in-place properties:

Water content – 31%
Dry unit weight – 86 pcf
Unconfined compressive strength – 0.64 tsf
Passing No. 200 sieve - >95%
Classification (Unified) – Lean Clay (CL)

Peoria Loess – Eolian soil placed as dust by wind during the Wisconsin glacial age exists below the fill and weathered loess at each of the five boring locations. This soil consists of medium to low plasticity lean clay in a moist to very moist and medium stiff to stiff condition with the following measured in-place properties:

Water content – 20 to 31%
Dry unit weight – 89 to 99 pcf
Unconfined compressive strength – 0.55 top 1.99 tsf
Liquid limit – 34 to 44
Plastic limit – 21 to 24
Plasticity index – 12 to 21
Passing No. 200 sieve – >95%
Classification (Unified) – Lean Clay (C)

2.6 Groundwater Data

Groundwater levels should be expected to fluctuate seasonally and yearly from the groundwater readings noted on the boring logs. The evaluator should know the time of year that the borings were drilled and the history of precipitation prior to drilling when extrapolating water levels at other points in time using the groundwater readings from the boring logs. No groundwater level was encountered within a depth of 20 feet below grade at the boring locations at the time of our field work.

Ground surface elevation and groundwater data are listed on Table 2, found on Page 5.

2.7 Seismic Site Class

We understand the area of this project exists within a seismic zone that requires seismic building design per the 2018 International Building Code (IBC). We reviewed the site subsoil conditions in relationship to the criteria set forth in Section 1613.2.2 of the 2018 IBC in conjunction with Chapter 20 of the referenced "Minimum Design Loads for Building and Other Structures (ASCE/SEI 7-16)", 2016, published by ASCE. A boring to a depth of 100 feet was outside the project scope. Our borings were not advanced to bedrock. Based on the criterial of Chapter 20 of ASCE 7, we have estimated the Seismic Site Class based on experience and the soil conditions found at our boring locations. A Site Class of "D" is defined by this boring data. The project structural engineer shall use this Site Class value in seismic evaluation of the proposed project.

TABLE 1
Subsurface Soil Data

	Soil Layer Description		
	Fill	**Weathered Peoria Loess**	**Peoria Loess**
Found In Borings	B-1 through B-4	B-5	B-1 through B-5
Base Elevation, ft	1639 to 1647	1644	Below Boring Base
Water Content, %	24 to 28	31	20 to 31
Dry Unit Weight, pcf	94 to 100	86	89 to 99
Unconfined Strength, tsf	1.89 to 2.87	0.64	0.55 to 1.99
Atterberg Limits, LL / PL / PI	Not Measured	Not Measured	34-44 / 21-23 / 12-21
Standard Penetration Resistance (N), blows/ft	Not Measured	Not Measured	Not Measured
Passing No. 200 Sieve, %	>95, Estimated	>95, Estimated	>95, Estimated
Classification, Unified System	Lean Clay (CL)	Lean Clay (CL)	Lean Clay (CL)
Descriptors	Moist to Very Moist, Medium Stiff to Very Stiff	Very Moist, Medium Stiff	Moist to Very Moist, Medium Stiff to Stiff

TABLE 2
Boring Elevation and Groundwater Data

Boring Number	Date Drilled	Boring Depth, feet	Ground Surface Elevation	Groundwater Data			
				During Drilling		End of Drilling	
				Depth, ft	Elev., ft	Depth, ft	Elev., ft
B-1	11/30/23	20.0	1646.1	N/A	N/A	N/A	N/A
B-2	11/30/23	20.0	1649.1	N/A	N/A	N/A	N/A
B-3	11/30/23	20.0	1648.0	N/A	N/A	N/A	N/A
B-4	11/30/23	20.0	1643.4	N/A	N/A	N/A	N/A
B-5	11/30/23	20.0	1646.9	N/A	N/A	N/A	N/A

3.0 ENGINEERING RECOMMENDATIONS

3.1 Project Summary

The engineering recommendations made in this Report are based on our understanding of the project as discussed in the following paragraphs. The recommendations are valid for this specific set of project conditions. If the characteristics of the project should change from those indicated in this Section, it is important that this engineer be informed so that we can determine how the new conditions affect our recommendations.

A new fire station structure is proposed within the existing commercial property located northeast of the intersection of East 17th Street and North Lincoln Avenue in York, Nebraska. This new structure will have a total footprint area of about 22,000 square feet and will have a single finished floor level at 1646.50 feet. This new building can be considered as two structures with a common wall. The southern 85 feet of the structure is a residential/office space that is about 180 feet wide by 70 to 85 feet long consisting of a wood frame structure that will contain meeting, storage, kitchen, office rooms, and living quarters. The utility equipment rooms will be housed on a partial second story level above the report office of the main level. The northern 145 feet of the building will be a high ceiling apparatus and equipment storage garage using masonry and steel frame construction and covering an area of about 145 feet by 80 to 95 feet.

Pavements for driveways, parking lots, and truck maneuvering will exist over the east half of the property and between North Lincoln Avenue and the apparatus garage on the west side of the property. I understand that green spaces will be constructed on the edges of the property and around the residential portion of the building. A covered outdoor picnic area will be provided on the east side of the residential building portion.

The project structural engineer provided design loads. Design column loads of up to 50 kips with a maximum wall load of 5.5 kips per lineal foot were provided for the masonry and steel frame construction of the apparatus garage. The office and residential portions of the building will have a slab-on-grade floor supporting a design load of 150 pounds per square foot. Walls of the wood frame residential construction will exert a maximum load of 3 to 4 kips per foot. The apparatus garage and storage area will have a slab-on-grade floor supporting a design load of 250 pounds per square foot. I estimate that a structural control joint will provide structural separation in the east-west direction along the north edge of the storm shelter room, at the location of change from wood frame to masonry and steel frame construction.

The existing alley will be closed. Necessary grading cut to lower the elevation at the north edge of the property will result in construction of a 3-foot high retaining wall at the alley closure point. The gas main will be moved to a new location or relocated to a deeper elevation. The existing sanitary sewer will not be adversely impacted by the proposed construction. Existing overhead power lines will remain. It is possible the overhead power along with the phone and cable utility lines mounted on the power poles will be buried below grade, but this has not been finalized. Up to 4 feet of fill above existing grade will be placed over the area of the residential/office portion of the building. From 1.5 feet of fill to 2.5 feet of cut is required to achieve the finished floor grade of the apparatus garage area. Lesser amounts of cut and fill are required for the pavement area to the east of the new building.

I understand that the finished construction will have less impervious surface area that the existing site configuration. I therefore understand that stormwater detention is not required for the design of this project.

3.2 Site History

The site exists as a big-box retail building will parking lot. A warehouse type structure with driveways and loading dock areas occupies the east half of the site. Portland cement concrete pavement covers the parking lot area over the west half of the site and over all areas surrounding the building within the property. I understand the existing building and parking lot were constructed sometime in the early to mid-1970's. The existing building and parking pavements will be completely removed from the site.

Prior to construction of the big-box store, the site was 10 individual residential lots. The description of the properties was Lots 3 through 12, Block 18 of the New York Addition to the City of York, York County, Nebraska. Historic aerial photographs suggest that four individual single family residences existed on the western five lots. Each home had a detached garage. Historic aerial photographs suggest that three to four individual single family residences existed on the eastern five lots. Each home also had a detached garage. All garages were provided access from the alley that extended in a north-south direction through the center of the block. We estimate that each house had a basement extending 7 to 8 feet below grade.

All the homes were demolished prior to construction of the big-box store. We have no information on the demolitions. It is possible that the demolitions were complete with all debris removed from the site and backfilled with properly compacted clay fill. However, it is equally possible that some debris was buried in the old basement areas and simply covered by some compacted clay fill. Because we have no site data concerning the demolition, we must assume that some debris remains buried below the site until found otherwise. Our proposed site preparation is tailored to determine if buried debris remains.

The existing alley across the center of the site from north to south will be vacated in the area of this project. Existing utilities other than the sanitary sewer main will be relocated or placed to a deeper depth below grade. A soil retaining wall with about 3 feet of unbalanced soil height is required along the north end of the property, from the northwest property corner to across the alley width.

3.3 Geotechnical Overview

This section provides a short, general discussion of what we consider the geotechnical aspects of the site. Each of these items is discussed in greater detail within other sections of this Report.

A new fire station building will be constructed to replace and existing commercial/retail center. We understand the new building will replace the existing parking lot. New building construction will impact the utilities buried below the alley. There is a possibility that the existing overhead power distribution lines within the alley will be relocated underground along with the phone and cable utilities currently supported on the power poles. The gas main will be relocated. New pavement and green spaces will replace the existing warehouse-type structure.

The boring data suggests that the new building can be supported directly by the existing subsoil. However, we found that four houses with detached garages previously existed on the five lots that make up the western half of the property. We understand the houses were demolished sometime prior to construction of the commercial/retail center in the early to mid-1970's. The demolitions were done at separate times over a period of several years. Our experience finds a high probability that some of the building debris was buried onsite. The only conclusive manner to confirm that no deleterious materials remain is to investigate through site overexcavation.

Fill soils, no matter how well they are compacted, do not provide the same support characteristics as firm to stiff natural soils. Floor cracks always develop due to the nonuniform bearing characteristics below floors placed across areas that contain both fill and natural soil subgrade. The only way that we can provide suitable uniformity of a site that partly contains compacted soil fill and partially untouched natural is to overexcavate and place uniformly compacted fill below the entire new structure. Therefore, site preparation shall include overexcavation to a depth of 5 feet and replacement of the excavated soil with compacted clay fill.

The backfill in the areas of the previous houses on the west half of the site shall also be reviewed. The geotechnical engineer or his trained assistant shall be called to the site during the overexcavation to assist in identifying the locations of previous basement backfill areas through review of soil conditions to confirm that all buried debris has been removed and to confirm that the basement areas were properly backfilled.

The previous site construction data when coupled with the proposed building location creates the need to overexcavate the entire new fire station building area. We found no allowance to isolate building portions with structural construction joints to reduce the area of overexcavation.

Below the existing warehouse-type building area, the existing building footings and utilities shall be completely removed to the property lines, or to the tie-ins in the alley. Schemmer shall be required to monitor the removal of the existing structure and existing buried utilities and confirm that all utilities, sand backfill, footings, and all other building and pavement components have been removed.

After site preparation, the soil subgrade below the entire site will be suitable for support of the new building components using normal shallow footings. The soil subgrade after site preparation will provide proper support for the new floor slabs and pavement slabs.

3.4 Building and Site Subgrade Preparation

Heavily organic or root-infested topsoil shall be excavated from the ground surface and be stockpiled for later use in covering the finished landscaped areas after construction. All vegetation shall be stripped from construction areas before soil excavation, before soil fill placement, and before foundation installation. In general, we recommend the removal of topsoil to a depth of 6 inches at this site. Deeper stripping should be done if organic or deleterious materials remain.

Our data suggests that no topsoil is available on site to be stripped. Topsoil placement is required on all disturbed ground surfaces that will not be covered by sidewalks, pavement, or building components. Topsoil will need to be obtained from offsite. We recommend a minimum topsoil thickness of 8 inches at this site.

The existing building and parking light poles will be demolished. Demolition shall include all footings and utility pipes buried below ground. Only wire utilities not placed within conduits can remail below the new construction areas. Existing pavements shall be removed unless specifically shown to remain on the project plans. Other debris may be found to be buried below the site. Miscellaneous debris shall be collected from all construction areas along with the building demolition debris and be properly disposed of offsite in accordance with applicable laws.

Site preparation is required for the building area. Overexcavate to a depth of 5 feet below existing grade or to a depth of 5 feet below the finished floor grade, whichever is deeper. This overexcavation shall extend 5 feet beyond the outer edges of the building components. This building area shall include the signpost on the west side of the building and the handicap ramp along the south edge of the building. This overexcavation does not need to include the generator and transformer pad on the east side of the site. Fill the overexcavation area with properly compacted, structural soil fill in accordance with the requirements of this Report and the project specifications.

Care shall be taken to investigate the filled basement areas existing below the depth of the overexcavation described above for the new building area. If soft fill and/or building debris are found, these soils shall be overexcavated to the limits of the buried basement areas where encountered.

Overexcavation to a depth of 4 feet shall be completed over the footprint of the existing retail building. Because no building structure will be placed over the east half of the site, we will not require the old house basement areas to be investigated. We do not recommend overexcavation to a depth of 4 feet outside the demolition building area for the rest of the east half of the project area.

After overexcavation is completed, place soil fill to the finished subgrade level of the building and adjoining areas. We understand that a vapor barrier or radon gas collection layer consisting of granular materials might be placed directly below the new floor slabs. A granular layer is required below the floor slab for these layers. Below the apparatus garage floor, I require the granular base layer consist of crushed aggregate. If a radon gas collection system is required see Section 3.11 of this Report for our recommendations.

The finished subgrade of the building and parking areas shall be stable and be able to support loaded construction equipment and trucks without significant deformation. Proper soil materials shall be used to allow truck traffic on the site, as deemed necessary by the specific Contractor. Clean sand does not allow truck traffic. Acceptance of all fill subgrade shall require passing results of soil compaction tests and the proofroll test.

We recommend that a proofroll test be conducted immediately after final placement of soil fill in both the building and parking areas to confirm that the subgrade has sufficient stability. Fill compliance criteria for the parking, driveway, and the building areas shall include both compaction density and proofroll passing results. The contractor shall replace any deficient soil mass and conduct another proofroll test to show that the subgrade has been stabilized if unstable subgrade is noted by the geotechnical engineer or a testing technician during a proofroll test. The proofroll test is described in Section 3.13 of this Report.

If there is a lag in schedule between building area subgrade preparation and building construction of more than four months, the building area shall be subjected to another proofroll test and additional soil compaction density testing on the exposed surface prior to start of building construction.

There is always a potential for the pavement subgrade to be damaged during construction, between fill placement and pavement placement. We recommend the final proofroll test of the pavement subgrade be completed immediately prior to pavement placement. If subgrade damage occurred to cause this final proofroll test to fail, the contractor shall repair the damaged subgrade with new soil compaction density tests and a new proofroll test performed until passing results are achieved.

Our site preparation recommendations consider normal fill placement variation and surface weathering of the existing fill soils. We can take no responsibility for deleterious materials that may have been buried by others or the fill that was placed and tested for compliance by others. Although the procedures outlined above are designed to detect the presence of poor fill or deleterious materials, there is always the risk that some of those deleterious materials may remain below the construction areas. Our exploration detected no deposits of elastic clay or fat clay soil on the site.

In areas of new pavement that are outside the overexcavation limits described in the previous paragraphs, overexcavate the subgrade to a depth of 1 foot below base of pavement. Replace the soil as compacted fill meeting the requirements of compaction density and proofroll test. Overexcavation and fill placement shall extend 2 feet beyond the edges of the pavements.

Table 3 lists our site preparation recommendations.

TABLE 3
Site Preparation Recommendations

	Preparation Notes	
Item Description	**Material Removal**	**Material Reuse**
A. Topsoil Stripping.	Site data find no exposed topsoil onsite.	Cover all disturbed areas outside of pavement, sidewalk and building areas, at least 8" thick. Obtain suitable topsoil from offsite.
B. Remove Debris.	Excavated all debris detected onsite with removal of existing structures or at other locations.	Properly dispose offsite.
C. Building Area Subgrade Preparation. Extend to at least 5 feet outside of outer edges of building walls. Include Signpost on west side of building.	Perform only below the entire building area. Removal all soils, natural and fill, to depth of 5 feet below existing grade or 5 feet below finished floor grade, whichever is deeper. Extend to base of buried house basements, where encountered.	Clean overexcavated soil material can be used as structural fill if it meets the project soil fill specifications. Debris and poor quality fill materials excavated shall be properly disposed offsite.
D. Existing Warehouse Area Subgrade Preparation.	Removal all building and buried utility components to property line or to connections to utilities in alley. Overexcavation preexisting building area to depth of 4 feet below existing grade.	Clean overexcavated soil material can be used as structural fill if it meets the project soil fill specifications. Debris and poor quality fill materials excavated shall be properly disposed offsite.
E. Minimum Pavement Subgrade Preparation. Extend 2 feet outside pavement edges.	Overexcavate subgrade to a depth of 12" (1.0') below base of pavement elevation, unless overexcavated in the steps above on this Table.	Overexcavated material can be used as structural fill if it meets the project soil fill specifications.

Subgrade preparation consisting of overexcavation is not required below new sidewalks. However, the upper 12 inches of subgrade below sidewalks shall be compacted and tested for compliance with the project specifications for structural fill.

We recommend that a technician from Schemmer working under the supervision of the geotechnical engineer be onsite to observe removal of unsuitable materials prior to fill placement and to provide observations and testing during placement of structural fill. This is to verify that our recommendations have been correctly interpreted and to help evaluate compliance with the construction documents. We recommend that a preconstruction meeting be planned prior to the site preparation work to discuss our recommendations and project requirements in relation to the contractor's plan of action. All new fill soils shall be placed with compaction control testing.

No special site preparation is recommended below the generator pad and any other utility pads or pedestals to be constructed outside of the building. The soils at the base of all generator and utility pads shall be compacted to the requirements of structural fill to a depth of at least 12 inches below the base of these reinforced concrete pads. See the requirements of structural fill in Section 3.5 of this Report. We assume that all generator pads or utility pads will be properly reinforced to provide proper rigidity. The reinforced concrete pads will be placed upon the soil subgrade and will not bear below the depth of frost penetration. We understand that small movements associated with frost heave will not adversely affect the performance of equipment supported on these reinforced concrete pads. If small movements will adversely affect the equipment, then the pad shall be supported by footings bearing below frost depth of 3.5 feet.

3.5 Fill Requirements

Excavated topsoil materials and other overexcavated soils that are found to be unsuitable for reuse as compacted fill by the geotechnical engineer shall not be reused in new embankments or as fill below building and pavement areas. Topsoil excavated from the site can be reused as topsoil in landscape areas and the sides of the storm water detention ponds outside new pavement and building areas. If the topsoil contains debris, it shall be properly disposed of offsite. All debris and deleterious materials shall be removed from the site. Excess topsoil shall be removed from the site.

The stripped topsoil is not suitable for use in embankment fill and shall be stockpiled for reuse in covering future vegetated portions of the site after grading activities are completed. Stripped topsoil generally provides greater resistance to water erosion on slopes and provides a better seedbed to grow erosion-resistant plants on slopes and across the entire site. We understand that offsite topsoil will be obtained to place required topsoil on greenspaces of this project.

Clean overexcavated site soil can be reused below the building and pavement areas if it meets the requirements of this Report section. The water content of all soil shall be properly adjusted to a proper level for compaction before it is placed into a proposed fill location. Offsite borrow soil to be used for site structural fill shall meet the requirements of this Report section.

All soil to be used for fill is subject to approval by the geotechnical engineer, including onsite soils. Fills from an offsite borrow sources shall be approved by the geotechnical engineer prior to delivery to the site. Representative samples of the proposed fill and backfill materials should be submitted to the geotechnical engineer at least three days prior to placement so the necessary laboratory tests can be performed.

Material for use as site structural fill should be clean, inorganic, low to medium plasticity lean clay, CL[1], or silt ML[2], or a combination of these materials, with a liquid limit less than 45 and a plasticity

[1] Lean clay, lean clay with sand and sandy clay.
[2] Silt, silt with sand and sandy silt.

index less than 20. We assume the site fills will consist of clean clay or low plasticity silt with less than 20 precent sand content.

Sandy soils with classification of silty sand, SM[3] and clayey sand, SC[4] are not suitable for structural fill at this site. Organic soils with classification OH[5] or OL[6], and highly plastic clays with classification of CH[7] are not approved for general or structure fill at this site. Use of clean sand as a fill is not acceptable at this site, except for special drainage layers and a thin layer below interior floor slab or for MSE wall structural fill. Sandy soils with classification of poorly graded sand, SP[8], poorly graded sand with silt, SP-SM[9], well graded sand, SW[10], well graded sand with silt SW-SM[11], and any gravelly derivatives of these sandy soils are not acceptable for use as structural fill at this site.

We discourage the use of clean sand as a fill at this site, except for special drainage layers or for support of MSE soil retaining walls. We understand that subgrade drainage trenches will not be installed below the exterior pavements. We understand that building footing drains will not be installed. We understand that an MSE soil retaining wall might be constructed on this site.

Soil placed on slopes shall completely consist of structural quality soil fill. Slopes are structural entities and use of poor-quality fill within any portion of a slope and especially at the toe of a slope can initiate a future slope failure, even if the slope will only directly support green space. Compact all slope soil to the requirements of structural fill and then scarify the surface as necessary during seeding or placement of erosion control measures to provide a prepared seedbed.

Cohesive fill soils consisting partially of sand with lean clay and/or silt shall have the proper water content at the time of compaction, within +3% and -3% of optimum water, per ASTM D698-12(2021), Standard Proctor. Water content shall be adjusted to a proper level before the soil is compacted into embankments and as subgrade fill. Crushed aggregate shall be compacted at a water content that does not promote bulking, usually a nearly dry condition.

A granular fill base layer will be placed below all floor slabs. It will not be placed below the exterior pavements or sidewalks. We recommend the use of crushed aggregate consisting of crushed limestone or crushed concrete. Crushed asphalt and river-run gravel are not acceptable. The granular material shall consist of ¾- inch nominal size screened aggregate (less than 5% passing #40 sieve). If ¾-inch nominal size screened aggregate is not locally available, the nominal grain size of the aggregate can be between ¾-inch and 1.5-inch. However, the smallest grain size available within this range is recommended by Schemmer.

All structural quality clay fill should be placed in nearly level lifts, not more than 8-inch loose thickness, after the water content has been manipulated to within the levels stated in the previous paragraphs. Each fill lift must be compacted to the necessary unit weight before additional soil is added. All new structural fill below structures, pavements, sidewalks and in embankments shall

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[3] Silty sand.
[4] Clayey sand.
[5] Elastic Silt.
[6] Organic Clay or Organic Silt.
[7] Fat clay, fat clay with sand, and/or sandy fat clay.
[8] Poorly Graded Sand.
[9] Poorly Graded Sand with Silt.
[10] Well Graded Sand.
[11] Well Graded Sand with Silt.

be compacted to not less than 95% of the maximum dry unit weight determined by ASTM D698-12(2021), standard Proctor test.

Compact the upper 12 inches of the floor subgrade for the building and the subgrade below exterior pavement subgrade to at least 98 percent of the maximum dry density determined by ASTM D698-12(2021), standard Proctor test. The granular base placed below the floor slabs and on top of the soil subgrade shall also be compacted to at least 98 percent of the maximum dry density determined by ASTM D698-12(2021), standard Proctor test.

If sand base material is placed below the residential/office portion of the floor slab, it shall have a maximum thickness of 4 inches and shall not be used below the apparatus garage portion of this building. Sand cannot be considered for use as a floor aggregate base layer if a soil gas extraction system is installed. Clean sand from his area will be loosened by foot traffic during preparation for concrete placement and during concrete placement. It shall be compacted to at least 95 percent of the maximum dry density determined by ASTM D698-12(2021), standard Proctor test, but will likely become loose by the time the concrete is placed. We discourage the use of sand subgrade below the floors at this site.

The following Table 4 lists the project soil compaction recommendations.

TABLE 4
Site Compaction Recommendations

Material or Location	Fill and Subgrade Compaction Requirements*	
	Unit Weight*	Water Contend*
Cohesive Soil Lean Clay and low plasticity Silt.	95% Minimum unless otherwise noted	-3 to +3 from Optimum
Non-Cohesive Soil, Granular Base, Crushed Granular or Sand Base.	98% Minimum unless otherwise noted	Water Content that does not promote Bulking
Elastic Soils Fat Clay and Sandy Fat Clay	Do not use.	N/A
Upper 12 inches of Building and Upper 12 inches of Pavement Subgrade	Silty and/or Clayey Sand, 98% Minimum	-3 to +3 from Optimum
Sidewalks, upper 112 inches	Silty and/or Clayey Sand, 95% Minimum	-3 to +3 from Optimum
Utility Backfill	Silty and/or Clayey Sand, 95% Minimum unless otherwise noted	-3 to +3 from Optimum
Topsoil Replacement	85 to 92% Maximum	According to Material descriptions above

* per Standard Procter Test, ASTM D698-12(2021)

General fill in areas to support vegetation only should be compacted to not less than 85 percent and no more than 92 percent of the maximum dry unit weight determined by ASTM D698-12(2021). Topsoil should not be over compacted. Surface scarification may be required to allow initial root penetration. Tree root balls should not be placed into holes dug into compacted fill but should be placed on top of the grade with soil mounded around the root ball to allow drainage of excess water from around the roots until the roots can grow into the compacted soil fill.

We understand that erosion control BMP's will be placed to control water erosion from the site. The project design and construction teams must also consider controlling wind erosion dust from this site in this area.

3.6 Backfill

Backfill clay and silt soils placed over utilities and over drainpipes should also be of proper water content during compaction, within -3 to +3% of optimum water, per ASTM D698-12(2021), Standard Proctor. We suggest that thin fill lifts be used, and the trench edges be properly braced or sloped in accordance with OSHA standards. All backfill near or below floor, pavement or foundation elements shall be compacted to at least 95 percent of the maximum dry unit weight determined by ASTM D698-12(2021), Standard Proctor. Be sure to properly consolidate any granular base and be sure to compact the backfill on the sides and top of the new storm sewer to be placed.

Backfill over utility pipes placed in narrow excavations shall be compacted to at least 90 percent of the maximum dry unit weight determined by ASTM D698-12(2021), Standard Proctor. This assumes the utility location has been previously filled to finished subgrade elevation prior to placing the excavated utility. The upper 12 inches of utility backfill below pavements shall be compacted to at least 95 percent of the maximum dry unit weight determined by ASTM D698-12(2021), Standard Proctor. For wide trench excavations, the entire backfill shall be compacted to the requirements of structural fill found in Section 3.5 of this Report.

3.7 Fill-Related Settlement and Site Soil Heave

Placement of soil fill upon any soil subgrade above the level of previous maximum soil surface elevations will cause the subsoils to compress or consolidate under the new weight. New fill and finished floor height of up to 4 feet above existing grade will be placed. The existing clay subgrade will consolidate slowly under the new fill and building loads. Total settlement due to consolidation of up to 2 inches will occur. Due to the variable thickness of new fill above existing grades, differential settlement will occur. We recommend the placement of a temporary surcharge above finished grade over portions of the building area.

Place a temporary surcharge over the residential/office portion of the building. The temporary surcharge shall consist of compacted clay fill having a moist unit weight of at least 115 pounds per cubic foot. However, compacted density of each lift of surcharge does not need to be measured. The surcharge shall have a top elevation of 4.5 feet above finished floor elevation at Elevation 1651.00 feet. This elevation assumes a finished floor elevation of 1646.50 feet. Extend the top of surface a distance of 5 feet beyond the outer edges of the building. The surcharge shall be left in place for a period of 60 days. This top elevation may change if the finished floor level changes. If the finished floor level is different from Elevation 1159.75 in the fill area, the geotechnical engineer shall be hired to review and amend these recommendations.

Soil surcharge is also recommended within the southwest corner of the apparatus garage area, within the triangular area defined as 60 feet north and 50 feet east of the southwest corner of this area. The surcharge shall have a top elevation of 3 feet above finished floor elevation at Elevation 1649.5 feet. Extend this surcharge 5 feet beyond the edges of this area. This surcharge shall be left in place for a period of at least 45 days.

We recommend the installation of four settlement plates to monitor soil consolidation. We suggest the plates consist of buried 4-foot by 4-foot portions of all-weather ¾ inch thick plywood buried at the base of the new fill sections. A rod is then placed to the top of the plywood with a drill rig for monitoring. This installation allows better soil fill compaction uniformity.

Our analyses of the soils on this site finds that the clay subgrade has only a low potential to heave due to changes in soil water content. No elastic silts or clays were encountered. Recommendations to control soil heave are not necessary.

3.8 Foundation Recommendations

Shallow footings are recommended for support of building foundations. Site preparation recommendations are provided above.

3.8.1 Footing Depth, Frost Considerations. Exterior footings and footings adjacent to unheated rooms shall be placed at a depth of at least 42 inches below the lowest adjacent unheated interior grade or at a depth of 42 inches below the exterior grade to inhibit damage from frost action.

Interior footings that exist completely surrounded by heated rooms may be placed at any convenient depth as long as they bear at least 12 inches below the soil subgrade surface below the floor slab system.

Exterior utility and generator pads shall be supported at grade. We understand that this equipment is not adversely affected by temporary slab frost heave.

Structural stoops supported by footings shall be placed at all exterior swinging doors. An expansion joint of sufficient thickness that penetrates the entire pavement thickness shall be placed at all locations where exterior pavements or sidewalks abut building walls or structural stoops. Care shall be used to not allow exterior concrete to extend below siding or other exterior wall coverings.

We suggest a structural stoop be also placed outside overhead doors to inhibit snow melt water from entering the building during winter months because of exterior pavement frost heave. Without a structural stoop extending about 3 to 5 feet outside the overhead doors, snow melt and storm water will typically flow directly into the building if the exterior pavement is temporarily raised due to frost heave.

3.8.2 Foundation Types. Based on the available data, shallow continuous or spread footing foundations are considered suitable for support of proposed new structure loads at this site. This statement assumes the site preparation and other recommendations described in this Report are completed prior to footing installation.

We understand that soil retaining wall will be constructed along the north edge of the site. An unbalanced soil height of up to 3 feet is expected.

3.8.3 Allowable Bearing Pressure. A net allowable soil bearing pressure of 2,500 pounds per square foot is recommended for support of normally constructed shallow building footings on natural soils or on compacted soil fill after overexcavation. Exterior soil retaining walls and exterior utility and generator support slabs and pads shall be designed using a net allowable soil bearing pressure of 1,000 psf.

A factor of safety of 3 against general shear failure was utilized when calculating the soil bearing pressure. Footings shall be excavated into firm natural soils or properly compacted fill with the excavation sides being the forms for the footing concrete.

These recommendations assume the site preparation overexcavation and replacement with compacted soil fill is completed.

After footing excavation, care should be taken to avoid wetting soils exposed at the base of the footings. Footing subgrade should not be allowed to freeze before or after footings are poured. Concrete should not be placed upon wetted soils. If rain or other surface water ponds on the exposed footing base soils, the geotechnical engineer should be notified and be requested to provide suitable recommendations for construction, based on observed conditions at that time.

Conversely, it is also potentially damaging to the building to allow the soil at the base of the footing to dry prior to footing concrete placement. To reduce the potential for excessive wetting or drying of the foundation subgrade, we recommend the lower 8 inches of any footing excavation not be dug until the day the footing concrete will be poured or that the contractor protect the footing subgrade from weather conditions.

Construction during winter weather is a concern for shallow footings within buildings. Protect the subgrade of shallow interior footings placed above a depth of 3.5 feet from frost damage during winter construction until the building is properly heated.

3.8.4 Lateral Earth Pressure. Soil resistance to lateral forces will depend upon the depth of the footing below frost action and other factors that seasonally loosen soils. The following lateral earth pressures, expressed as equivalent fluid pressures without a factor of safety, are recommended in design of foundation walls to support lateral loads:

Passive Resistance	180 pcf
Active Pressure	50 pcf
At-Rest Pressure	65 pcf

Adhesion at the base of the footings supporting lateral load is estimated to be 650 psf. This adhesion value does not include a factor of safety.

The lateral load values provided here do not include water pressure loads. We are aware of no situation that would develop an unbalanced lateral water load below grade at this site.

3.8.5 Excavation Stability. The foundation excavations will generally extend into sandy fills or natural soils. We have no special excavation stability concerns with excavations within properly compacted fill or firm natural soils. However, some of the site soil may become blocky and some sandy soils will not allow vertical excavations without paving. Blocks of soil could fall into the excavations. Clean all loose soil from the excavations before placing concrete. Clean sand fill should not be used, since excavations in clean sand will likely cave.

In any case, conform to the regulations provided by the U.S. Government and OSHA concerning excavation safety, 29 CFR Part 1926, Occupational Safety and Health Standards - Excavations. Our boring data indicated no sand will be encountered within proposed excavation depths. For the clayey fill expected to be found in the footing excavations at this site, the soil is estimated to generally classify as Type C per 29 CFR Part 1926, Occupational Safety and Health Standards – Excavations. Soil conditions vary and it is necessary for the contractor to have a trained person onsite during construction to determine the actual exposed soil type during excavation, with the authority to properly direct the excavation safety. The geotechnical engineer or any of his staff members is not this person.

3.8.6 Foundation Settlements. After settlement due to the subsoil consolidation caused by fill placement has been stabilized, foundation settlements of less than 1 inch total and less than ½ inch differential in a 30-foot span are estimated under the anticipated building loading, as assumed in this Report, using the net allowable bearing pressure listed above for shallow trench footings and column footings. These values do not include any adverse effects of fill placement above preconstruction grades around the building area during and after construction.

3.8.7 Foundation Excavations. Footing concrete shall be placed in freshly dug excavation trenches. The sides of the trench shall be the form for the footings, or removable forms shall be used if the sides of the trenches cave. Stem walls or column pedestals may extend above the top of footing level.

The site preparation procedures recommended are tailored to uncover major subgrade soil imperfections prior to building construction. However, there is always the potential that some unknown poor foundation support zone could be discovered. It is expected that slight foundation deepening will be the most appropriate method to remove poor foundation support soils at localized areas if such conditions are uncovered.

The contractor shall not place fill in footing trenches to correct over-digs or wrong-footing placement. If the contractor cannot place extra concrete in these cases, the footing area of concern shall be completely filled with structural fill to the floor subgrade level and then dug again.

3.9 Foundation Drains

No exterior foundation drains shall be installed for non-basemented construction. Exterior foundation drains are used to protect a subterranean space such as a basement from inundation and from the application of lateral hydrostatic load on a basement wall or a soil retaining wall. A foundation drain will not reduce the water content at the footing subgrade support level. A foundation drain will only cause more water than necessary to be collected at the footing level of a non-basemented structure.

However, the finished floor grade will be up to 4 feet higher than the exterior grade on the south and west edges of the residential/office portion of the building. An interior foundation wall drain is recommended inside the exterior foundation walls where the difference from interior to exterior grade is 2 feet or greater. No drain shall be placed when the exterior grade is less than 2 feet below the finished floor grade. The base of this interior wall drain shall be 2 inches higher than the exterior grade. Place compacted clay backfill below the base of the interior foundation wall drain.

The suggested interior footing drain system consists of a filter geotextile, Mirafi 140N or approved equal, over the backfilled footing base. The geotextile shall cover the base of the drain and extend up the sides of the walls from the base to the top of the granular fill, folding over the top of the granular fill. Place a perforated pipe with diameter of 2 to 3 inches upon the geotextile. A filter sock should not be used around this perforated pipe. Cover the drainpipe with at least 12 inches of free-draining and clean granular material such as the granular material consisting of the same granular subgrade material used for the floor slab vapor barrier layer. above the 12 inch thick layer of granular fill, place a prefabricated drainage board material to the top of the soil subgrade below the floor. Compact soil fill above the granular layer and along the drainage board to finished soil subgrade level below the floor.

Provide weep holes through the base of the foundation wall, at a level of about 2 inches above the exterior grade. A minimum of one weep hole is required for each retaining wall face. One weep hole shall be placed at the lowest portion of any wall and at the low points of the exterior grade. Weep holes shall have a maximum spacing interval of 25 feet but shall not be hidden behind stairways of handicap ramps.

A footing drain is required behind all exterior soil retaining walls. The suggested retaining footing drain system consists of a filter geotextile, Mirafi 140N or approved equal, over the backfilled footing base. The geotextile shall cover the base of the drain and extend up the sides of the walls from the base to the top of the granular fill, folding over the top of the granular fill. Place a perforated pipe with diameter of 3 to 4 inches upon the geotextile. A filter sock should not be used around this perforated pipe. Cover the drainpipe with at least 12 inches of free-draining and clean granular material such as the granular material used to construct the working blanket. Extend the compacted granular fill to a level of 12 inches from the surface grade. Wrap the remaining geotextile fabric over the granular material. Backfill the top 12 inches of backfill with properly compacted soil fill for outside retaining walls. If the retaining wall has a pavement above it, be sure to place the pavement above a 12 inch thick layer of clay and pavement subgrade. The soil surface above the exterior retaining walls should be graded to keep water from flowing over the top of the wall.

Provide weep holes through the base of the wall, at a level of about 2 inches above the exterior grade or finished pavement elevation at the low side of the wall. A minimum of one weep hole is required for each retaining wall face. One weep hole shall be placed at the lowest portion of any wall. Weep holes shall have a maximum spacing interval of 20 feet.

Provide rodent resistant screens over all weep holes.

3.10 Grade-Supported Floor Slabs

All new fill soil beneath grade-supported interior floor slabs at this site should be mechanically compacted to at least 95 percent of the maximum dry unit weight of the soil, as determined by ASTM D698-12(2021), standard Proctor test. The upper 12 inches of subgrade shall be compacted to at least 98 percent of the maximum dry unit weight of the soil, as determined by ASTM D698-12(2021), standard Proctor test. The water content of clay soil being compacted should be within -3 and +3 percentage points from the optimum water content, also determined by ASTM D698-12(2021). All building subgrade fill will be placed before footings are installed as part of the site preparation recommendations.

Control of the water content of clayey or silty soil being compacted for subgrade is very important to reduce the potential for floor slab cracking. Although it is sometimes possible to achieve the recommended soil unit weight when compaction is performed at water contents outside of the recommended water content range, the stability of the subgrade will be significantly less if the soil is compacted when too wet or too dry, potentially resulting in uncontrolled floor slab cracking and panel joint failures.

A sand vapor barrier layer is commonly used below floor slabs. We find that sand in this area is difficult to properly compact and the sand will be loosened by normal foot traffic before and during concrete placement. We recommend that a vapor barrier in the form of a sand layer be used only if necessary. We recommend the sand layer by replaced by a layer of ¾ -inch to 1.5-inch nominal sized crushed Portland cement concrete or crushed limestone that has been screened to remove fines so that only 5 percent passes the No. 4 sieve. If a sand vapor barrier is necessary, we recommend the thickness be limited to 3 inches. A vapor barrier thickness of 4 or more inches may be installed if crushed aggregate is used.

We specify that the vapor barrier below the apparatus garage floor slab consists of crushed aggregate.

Do not allow water to soak into the aggregate base or vapor barrier. I have observed more than one warehouse where the crushed aggregate was allowed to be filled with water. I found that the excess water had remained in the aggregate decades after floor placement, adversely affecting the floor coverings above. Keep the aggregate or sand base material from being inundated with water before concrete floor placement. It this layer becomes wet, remove and replace it.

3.11 Radon Gas Mitigation System

Many of the projects I have been involved with over the past few years have begun to require that radon gas emissions be extracted from below the lower-level floor slabs. Others on the design team will determine if this gas extraction is required for this project. However, I have added this report section to aid the design team. If a radon gas mitigation system is not required, simply disregard this portion of this Report.

The radon gas removal system is a simple soil vapor extraction system. The same granular layer system can be used for radon gas removal, for normal groundwater seepage removal, and as the aggregate base below floors placed to reduce soil moisture diffusion through all floor slabs whether subjected to groundwater inflow or not. The following differences and similarities have been determined:

- A permeable granular base below the slab is required for all types of structures no matter if the building is basemented or not, and no matter if there is groundwater intrusion or not.
- A collector pipe system is required by systems that remove radon and groundwater, typically placed along the perimeter of the building, and at a predetermined spacing below the floor for large footprint structures with:
    - One or more sump pit(s) with pump(s) being required for the groundwater extraction system.
    - One or more air extraction pipe(s) with low volume gas extraction fan(s) and with pipes extending vertically above the floor level being required for the radon gas system.
- According to “The ANSI / AARST (American Association of Radon Scientist and Technologists) CC-1000 2018 Standards, "Soil Gas Control in New Construction of Buildings" the radon gas mitigation system needs to consist of:
    - Minimum 4 inches of granular layer directly below the plastic vapor barrier sheet installed at the base of the Portland cement concrete slab.

- With the granular material consisting of ¾- inch nominal size screened aggregate (less than 5 percent passing #200 sieve).

The system recommended by ANSI /AARST is suitable with a few notes and changes due to materials found in this region of the country.

The following should be noted:

1. The only material in this area that will meet the “gravel” gradation (size) requirement are crushed Portland cement concrete or crushed limestone (There are no other gravels available in this area).

2. If ¾-inch nominal size screened aggregate is not locally available, the nominal grain size of the aggregate can be between ¾-inch and 1.5-inch. However, the smallest grain size available within this range is recommended by Schemmer.

3. We recommend the crushed granular material be screened to have less than 5 percent passing the #40 sieve.

4. If the soil subgrade remains below the gravel layer and water is present (for a basement below the groundwater level), a filter layer needs to be placed on the soil subgrade between the subgrade and the gravel consisting of Mirafi 160N or approved equal. (Must be a needle-punched filter geotextile – “woven geotextiles and grids are not acceptable”). This layer is required to keep the soil from mixing into the open-graded granular material when water is present. (Please note that soil below any and all floor slabs will become very moist or wetter as a natural occurrence, even when the water table exists below the top of the soil subgrade level, in almost all environment conditions except for very arid areas.)

5. If soil subgrade remains well above the normal groundwater level and the floor does not exist in a basement condition, no woven geotextile filter geotextile shall be placed at the base of the aggregate layer.

6. Place the 4-inch-thick crushed stone and pack to firm condition as controlled by the project specifications.

7. Gas and/or water collection pipes shall be placed along the perimeter of the space and at column lines for large spaces. Only radon gas collection will be suitable at this location. We estimate that collection pipes will be necessary only along the perimeter, inside of the foundation walls, of the two building structure types. The pipes shall be 2-inch diameter perforated plastic. The backfill shall be packed to a firm condition.

8. The same gravel bed used for seepage water control should be used for radon gas (frankly all soil gas) control. No need to place two granular fill systems when used in basement floor conditions.

9. Water falls from the perforated pipes to the sump pit(s). Soil gases rise to within the granular bearing layer below the floor.

10. Collected water is pumped from the sump pit. However, no footing drains or sump pit are placed for non-basemented structures.

11. The air is extracted with a gas extraction pipe attached to the top of the buried perforated pipe(s) to remove soil gas. A small fan is usually installed within the extraction pipe to provide a slight vacuum to provide positive soil gas removal through the system and prevent casual escape of gases through the floor slab. For a combined water and soil gas system, I suggest that the builder seal the caps to the tops of each sump pit and attach the gas extraction pipe to the cap of each sump pit. For a system removing only soil gas without groundwater sump pits, I recommend the vertical extraction pipes be placed in inconspicuous locations near exterior walls and the floor slab around these vertical pipes be sealed. Then extend this pipe outside the building to a suitable height above grade. We expect that at least 2 air removal pipes will be installed for the proposed construction.

When I have reviewed gas removal systems by others retrofitted to existing basements (we usually have high radon levels measured in basements and not on floor levels above basements), the only thing the contractor has done is install a perimeter drain tile along the edges of the basement walls. This is the same drain tile used to remove excess groundwater. But instead of installing a sump pit, they install an exhaust pipe with a fan up through the floor and extending outside. No mass floor removal or change in subgrade aggregate is required.

3.12 Surface Drainage and Landscaping

The success of shallow foundations and slab-on-grade floors and pavements at this site is contingent upon keeping the subgrade soils at relatively constant water content, and by not allowing surface drainage a path to the subsurface below structures, below footings, or allow water to pond in aggregate below exterior pavements. We recommend grading to provide positive drainage away from all new building structures. Utility line backfill shall be properly compacted. Irrigation system lines (if installed) should be designed to limit surface water infiltration and introduction of water into soils adjacent to the structures, only to levels necessary to support the desired vegetation. Unregulated irrigation may be done away from buildings. Water lines and sewers should be watertight and tested after installation to reduce the risk of leakage. Leaking pipes shall be promptly repaired.

All features of this site, both interior and exterior, will be supported on a structural quality clay fill or firm natural soils. We expect that irrigation will be necessary to keep surface vegetation green during normal weather conditions.

Temporary grades should be established during construction to prevent runoff from entering excavations. Backfill adjacent to the building and pavements should be placed as soon as concrete structural strength requirements are met and should be graded to drain away from the building and pavements.

Final site grade should provide positive drainage away from buildings. For vegetation-covered areas a minimum gradient of 2.0 percent is recommended within 10 feet of the exterior of buildings. However, the slope may be decreased if the ground surface adjacent to the building is covered with concrete slabs or pavements. A minimum gradient of 0.5 percent is recommended for pavement surfaces next to and around buildings. Pavements and exterior slabs that abut the building should be carefully sealed against moisture intrusion at the joint. We recommend that grass-covered drainage swales also have a minimum gradient of 2.0 percent to allow drainage, especially if the grass is irrigated. Proper placement and compaction of utility and wall trench backfills will reduce unwanted water migration to foundation levels.

Any proposed landscape feature that exists in an area of potential ponding and surrounded by concrete curbs should be separately drained. Perforated pipes and connections to a storm sewer or other gravity drainage should be provided. Any irrigation system should be constructed and operated to prevent accumulation of water ponds near foundation walls.

3.13 Exterior Pavement Recommendations

New pavement will be placed as part of the proposed construction. Subgrade preparation recommendations are provided in Section 3.4 of this Report. Except for dedicated green spaces that are not part of structural slopes, all fills shall be properly compacted to structural fill quality.

Below a depth of 12 inches from the top of the subgrade, compact the soil fill in thin lifts to at least 95% of the maximum dry unit weight of the soil, as determined by ASTM D698-12(2021), standard Proctor test. Compact the upper 12 inches of pavement subgrade in thin lifts to at least 98% of the maximum dry unit weight of the soil, as determined by ASTM D698-12(2021), standard Proctor test as part of final subgrade preparation immediately prior to pavement placement. The water content of clay and silt soil being compacted should be within -2 and +4 percentage points from the optimum water content, also determined by ASTM D698-12(2021).

Schemmer recommends the site pavement subgrade be final prepared with additional surface density compaction testing performed immediately prior to placing the pavement. There is always the potential for rainfall or other inclement weather to occur between fill placement and pavement placement. If the soil surface is wetted by rainfall or disturbed in any way, the affected areas shall be scarified and compacted to the requirements of the previous paragraph.

Immediately prior to paving, the rolling stability of the pavement subgrade shall be evaluated in the presence of the geotechnical engineer or his trained representative through the rolling of a fully loaded tandem axle dump truck over the subgrade. The truck should hold about 10 yards of soil during this proof roll test. As the truck is driven slowly back and forth across the subgrade, the engineer will observe the subgrade deflection and rebound under the loaded tires. If excessive deflection is observed, it is an indication that a portion of the subgrade is too wet or otherwise unstable and that subgrade area will need to be overexcavated and replaced with properly conditioned and compacted subgrade soil fill.

We estimate the prepared subgrade when compacted in accordance with these recommendations will have a pavement modulus of subgrade reaction of about 125 psi/in or a CBR value of about 3. We recommend that the site modulus of subgrade reaction or CBR be evaluated during construction with appropriate laboratory or field testing.

Full-depth pavements and sidewalks supported directly on the compacted soil subgrade shall be used at this site. We recommend that granular fill in the form of a clean and drainable base course not be used below exterior pavements or sidewalks in this area. We understand that drain tile will not be constructed below exterior pavements at this site. Water will not drain from the granular base over the rather flat subgrade surface to be constructed at this site.

Periodic maintenance of pavements should be part of the site maintenance. Water that is allowed to pond on or adjacent to the pavement can saturate and soften the subgrade soils and subsequently accelerate subgrade and pavement deterioration.

We have not been provided with sufficient information to perform an in-depth analysis of the site pavements for thickness. However, based on the normal sizes of equipment as related to proposed subgrade preparation, we recommend the following:

Pavement used for fire apparatus:	9 inches of Portland cement concrete.
Pavement used for automobile parking:	6 inches of Portland cement concrete.

3.14 Additional Considerations

Soil in this area has a moderate potential for heaving due to winter frost action. Depending upon the subsurface moisture available, these soils can heave more than 1 inch during the winter season. Eventual frost heave potential is not significantly altered by degree of soil compaction or degree of available soil moisture. After several winter seasons, previously compacted soil will heave nearly as much as soil of similar type that has not been compacted. Providing efficient and complete drainage of the surface water runoff can decrease frost heave potential by decreasing the amount of water that soaks into the ground and is, therefore, available for future frost heaving. Provide a full-depth expansion joint between exterior pavements and building components to keep frost heave found below the pavement from lifting the adjacent building components.

External slab heaving due to winter frost action can cause serious access problems at exterior swinging doors. Structural stoops with footings placed below the normal frost depth of 42 inches are recommended at all swinging exterior doorways. Frost heave of pavements outside of overhead doors will frequently cause water from snow melt to flow into buildings. Therefore, we suggest that a structural stoop also be placed outside of the overhead doors.

The soil found at this site is typical of the area. Experience indicates that corrosion of buried metallic pipes will occur, and corrosion protection is recommended. Sulfate corrosion potential of Portland cement is generally minimal, and Type I Portland cement is suitable for use. Exterior concrete shall be air-entrained to reduce damage from frost action. If the concrete shall be hard trowel finished, that concrete must have no air entrainment.

4.0 CONSTRUCTION CONSIDERATIONS

All excavation work should be completed in accordance with OSHA standards. Where safe back-slopes cannot be provided, bracing designed by competent professionals should be installed. The results of our subsurface water measurements indicate that dewatering during construction will not be necessary for estimated excavation depths. Surface water runoff shall be diverted away from construction excavations during construction and away from sensitive structures after construction.

5.0 OBSERVATION AND TESTING

Since a project of this nature requires many soil-related judgments and decisions, we recommend that Schemmer be retained as part of the construction team. We recommend that a geotechnical engineer from Schemmer or their trained technician visually inspect all foundation excavations during placement and review all structural steel. We also recommend that a limited number of compaction tests be performed to document the degree of compaction obtained in backfill and structural fill. Fresh concrete shall be tested for compliance with the project specifications.

Schemmer is also available to perform necessary special inspections of building materials by our certified special inspectors and material testing technicians in accordance with the requirements of the building code. We have ICC trained technicians on our staff.

6.0 FIELD EXPLORATION PROCEDURES

6.1 Soil Sampling

The test borings were made with a truck-mounted CME 75 drilling and sampling rig using 4-inch solid stem exterior diameter continuous flight augers to advance the borings in accordance with ASTM D1452-16. Relatively undisturbed samples of cohesive soils were obtained with thin-walled tube samplers (Shelby tubes) in general accordance with ASTM D1587-15. These samples were packaged in appropriate containers and brought to our laboratory. Select samples were evaluated for in-place unit weight and strength.

6.2 Soil Classification

As the samples were obtained in the field, they were visually and manually classified by a geotechnical engineer with Schemmer in general accordance with ASTM D2487-17e1 and D2488-17e1. Representative portions of the samples were then returned to the laboratory for further examination and verification of field classification. Logs of the borings indicating the depth and identification of the various strata, water level information, and pertinent information regarding the method of maintaining and advancing the drill holes are included in the Appendix. Charts illustrating the soil classification procedure are also included in the Appendix.

7.0 STANDARD OF CARE

This Report has been prepared for the exclusive use of our client. The recommendations contained in this Report represent our professional opinions. These opinions were arrived at in accordance with currently accepted engineering procedures at this time and location. Other than this, no warranty, either expressed or implied, is intended.

PROFESSIONAL CIVIL ENGINEER
LORAS A. KLOSTERMANN
E-6498
3/12/2024
STATE OF NEBRASKA

THE SCHEMMER ASSOCIATES INC.

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 Nebraska.

Date: 3/12/2024

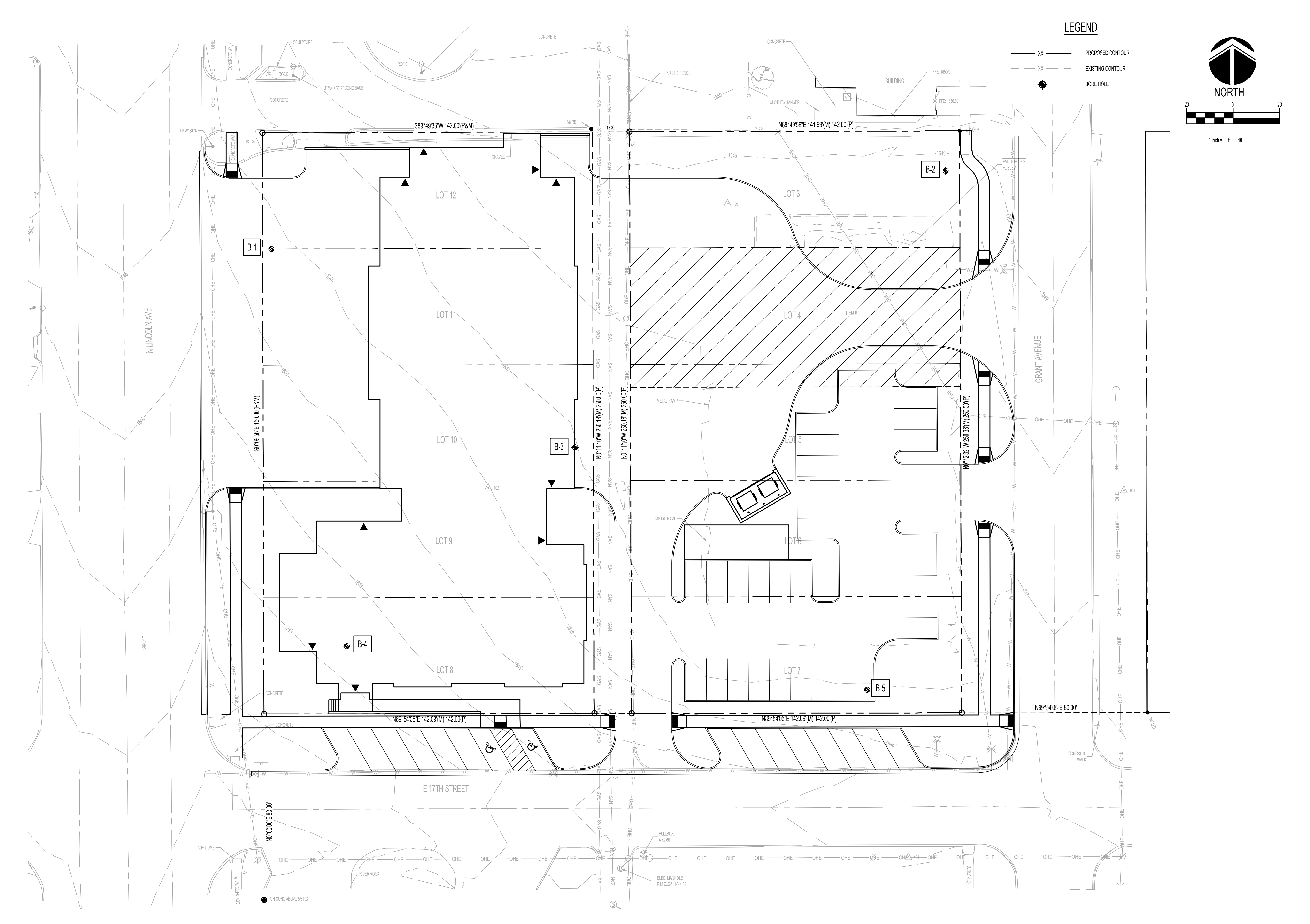
Loras A. Klostermann, P.E. No. E-6498

Geotechnical Engineer

My license renewal date is **December 31, 2025.**

Pages or sheets covered by this seal: All pages

APPENDIX



ISSUE DATE: 02/02/2024
REVISIONS:

No.:	DATE:	BY:	DESCRIPTION:

DESIGNED: LAK
DRAWN: APH
CHECKED: LAK

BORING PLAN

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1044 N 115TH STREET
SCHEMMER STATE LICENSE & RENEWAL DATE

CITY OF YORK, NE
YORK, NE FIRE STATION
NE CORNER OF E. 17TH STREET AND N LINCOLN
BORING LOCATION PLAN

PROJECT NO.: 09272.001

BORING

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3/11/2024 12:06:46 PM Hanke, Ana

The Schemmer Associates Inc
1044 N 115th Street, Suite 300
Omaha, NE 68154
Telephone: 402-493-4800

BORING NUMBER B-1

CLIENT City of York, Nebraska
PROJECT NAME Fire Station
PROJECT NUMBER 09272.001
PROJECT LOCATION 1714N Lincoln Ave., York, NE
DATE STARTED 11/30/24 **COMPLETED** 11/30/24
GROUND ELEVATION 1645.70 ft USGS **HOLE SIZE** 4 inches
DRILLING CONTRACTOR O'Malley Drilling Inc.
GROUND WATER LEVELS:
DRILLING METHOD 4" OD Continuous Flight Auger
AT TIME OF DRILLING --- None Encountered
LOGGED BY B. Ashcraft **CHECKED BY** L. Klostermann
AT END OF DRILLING --- None Encountered
NOTES
AFTER DRILLING --- Backfilled Immediately

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	WATER CONTENT (%)	DRY UNIT WT. (pcf)	UC STRENGTH (tsf)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0		Pavement, Portland Cement, 6 inches thick											
		(CL) Fill, Lean Clay, medium plasticity, dark brown, very moist, stiff, carbon nodules, ferrous stains, earthy odor	UD 1	56		4.50	26	94					
5		(CL) Peoria Loess, Lean Clay, medium plasticity, gray brown, moist, stiff, carbon nodules, ferrous stains, root holes, few root hairs, earthy odor	UD 2	100		3.50	25	92	1.281	34	22	12	
			UD 3	78		3.50	25						
10			UD 4	67		3.50	25	96	1.493				
15		(CL) Peoria Loess, Lean Clay, low plasticity, gray brown, moist to very moist, medium stiff to stiff, carbon nodules, ferrous stains, root holes, earthy odor	UD 5	67		3.50	26						
20			UD 6	78		3.00	29	92	0.701				

Bottom of borehole at 20.0 feet.

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BORING NUMBER B-2

CLIENT City of York, Nebraska
PROJECT NAME Fire Station
PROJECT NUMBER 09272.001
PROJECT LOCATION 1714N Lincoln Ave., York, NE
DATE STARTED 11/30/24 **COMPLETED** 11/30/24
GROUND ELEVATION 1648.53 ft USGS **HOLE SIZE** 4 inches
DRILLING CONTRACTOR O'Malley Drilling Inc.
GROUND WATER LEVELS:
DRILLING METHOD 4" OD Continuous Flight Auger
AT TIME OF DRILLING --- None Encountered
LOGGED BY B. Ashcraft **CHECKED BY** L. Klostermann
AT END OF DRILLING --- None Encountered
NOTES
AFTER DRILLING --- Backfilled Immediately

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	WATER CONTENT (%)	DRY UNIT WT. (pcf)	UC STRENGTH (tsf)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		Pavement, Portland Cement, 6 inches thick											
		(CL) Fill, Lean Clay, medium plasticity, dark gray brown, very moist, medium stiff to stiff, carbon nodules, ferrous stains, earthy odor	UD 1	100		3.50	27	94					
		(CL) Peoria Loess, Lean Clay, medium plasticity, gray brown, moist, stiff, carbon nodules, ferrous stains, root holes, few root hairs, earthy odor	UD 2	100		3.00	24	98	1.642				
5			UD 3	78		3.00	25	97	1.37				
			UD 4	67		3.00							
10		(CL) Peoria Loess, Lean Clay, low plasticity, gray brown, moist to very moist, medium stiff to stiff, carbon nodules, ferrous stains, root holes, earthy odor											
15			UD 5	89		3.00	25	92	1.026				
20			UD 6	100		2.50							

Bottom of borehole at 20.0 feet.

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BORING NUMBER B-3

CLIENT City of York, Nebraska
PROJECT NAME Fire Station
PROJECT NUMBER 09272.001
PROJECT LOCATION 1714N Lincoln Ave., York, NE
DATE STARTED 11/30/24 **COMPLETED** 11/30/24
GROUND ELEVATION 1646.98 ft USGS **HOLE SIZE** 4 inches
DRILLING CONTRACTOR O'Malley Drilling Inc.
GROUND WATER LEVELS:
DRILLING METHOD 4" OD Continuous Flight Auger
AT TIME OF DRILLING --- None Encountered
LOGGED BY B. Ashcraft **CHECKED BY** L. Klostermann
AT END OF DRILLING --- None Encountered
NOTES
AFTER DRILLING --- Backfilled Immediately

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	WATER CONTENT (%)	DRY UNIT WT. (pcf)	UC STRENGTH (tsf)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		Pavement, Portland Cement, 6 inches thick											
		(CL) Fill, Lean Clay, medium plasticity, dark brown, very moist, stiff, carbon nodules, ferrous stains, earthy odor	UD 1	100		4.50	28	95	1.89				
		(CL) Peoria Loess, Lean Clay, medium plasticity, gray brown, moist, stiff, carbon nodules, ferrous stains, root holes, few root hairs, earthy odor	UD 2	67		4.50	23	95		39	24	15	
5													
			UD 3	56		3.50	22	94	1.826				
			UD 4	100		4.50	20						
10													
		(CL) Peoria Loess, Lean Clay, low plasticity, gray brown, moist to very moist, medium stiff to stiff, carbon nodules, ferrous stains, root holes, earthy odor											
			UD 5	89		4.50	25	94	1.994				
15													
20			UD 6	100		4.50	24	94	1.592				

Bottom of borehole at 20.0 feet.

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BORING NUMBER B-4

CLIENT City of York, Nebraska
PROJECT NAME Fire Station
PROJECT NUMBER 09272.001
PROJECT LOCATION 1714N Lincoln Ave., York, NE
DATE STARTED 11/30/24 **COMPLETED** 11/30/24
GROUND ELEVATION 1643.40 ft USGS **HOLE SIZE** 4 inches
DRILLING CONTRACTOR O'Malley Drilling Inc.
GROUND WATER LEVELS:
DRILLING METHOD 4" OD Continuous Flight Auger
AT TIME OF DRILLING --- None Encountered
LOGGED BY B. Ashcraft **CHECKED BY** L. Klostermann
AT END OF DRILLING --- None Encountered
NOTES
AFTER DRILLING --- Backfilled Immediately

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	WATER CONTENT (%)	DRY UNIT WT. (pcf)	UC STRENGTH (tsf)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0	Pavement, Portland Cement, 6 inches thick											
	(CL) Fill, Lean Clay, medium plasticity, dark brown, moist, very stiff, carbon nodules, ferrous stains, earthy odor	UD 1	100		3.50	24	100	2.875				
	(CL) Peoria Loess, Lean Clay, medium plasticity, gray brown, moist, stiff, carbon nodules, ferrous stains, root holes, few root hairs, earthy odor	UD 2	89		4.50	23	96					
5		UD 3	100		3.50	24	95	1.508				
		UD 4	100		3.50	23	89	1.241	35	21	14	
10	(CL) Peoria Loess, Lean Clay, low plasticity, gray brown, moist to very moist, medium stiff to stiff, carbon nodules, ferrous stains, root holes, earthy odor											
15		UD 5	100		3.50	24	89	0.637				
20		UD 6	78		2.00	30	89	0.554				

Bottom of borehole at 20.0 feet.

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Omaha, NE 68154
Telephone: 402-493-4800

BORING NUMBER B-5

CLIENT City of York, Nebraska
PROJECT NAME Fire Station
PROJECT NUMBER 09272.001
PROJECT LOCATION 1714N Lincoln Ave., York, NE
DATE STARTED 11/30/24 **COMPLETED** 11/30/24
GROUND ELEVATION 1346.89 ft USGS **HOLE SIZE** 4 inches
DRILLING CONTRACTOR O'Malley Drilling Inc.
GROUND WATER LEVELS:
DRILLING METHOD 4" OD Continuous Flight Auger
AT TIME OF DRILLING --- None Encountered
LOGGED BY B. Ashcraft **CHECKED BY** L. Klostermann
AT END OF DRILLING --- None Encountered
NOTES
AFTER DRILLING --- Backfilled Immediately

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	WATER CONTENT (%)	DRY UNIT WT. (pcf)	UC STRENGTH (tsf)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		Pavement, Portland Cement, 6 inches thick											
		(CL) Weathered Peoria Loess, Lean Clay, medium plasticity, very dark gray brown, very moist, medium stiff, carbon nodules, ferrous stains, mealy, root holes, root hairs, earthy odor	UD 1	100		3.50	31	86	0.64				
		(CL) Peoria Loess, Lean Clay, medium plasticity, gray brown, moist, stiff, carbon nodules, ferrous stains, root holes, few root hairs, earthy odor	UD 2	56		3.50	25	98					
5			UD 3	67		3.50	26	99	1.317	44	23	21	
10			UD 4	100		3.50	27						
		(CL) Peoria Loess, Lean Clay, low plasticity, gray brown, moist to very moist, medium stiff to stiff, carbon nodules, ferrous stains, root holes, earthy odor											
15			UD 5	100		3.50	31	91	1.118				
20			UD 6	67		3.50	30						

Bottom of borehole at 20.0 feet.

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Fax: 712-329-9970

GEOTECHNICAL ENGINEERING DIVISION

SUMMARY OF SOIL TEST RESULTS

PROJECT: Fire Station
JOB NUMBER: 09272.001

CLIENT: City of York, Nebraska
DATE: 12/28/2023

LOCATION: 1714 North Lincoln Avenue, York, Nebraska

BORING No.	SAMPLE NO.	SAMPLE DEPTH (ft.)	SAMPLE DIAM. (in.)	SAMPLE LENGTH (in.)	WATER CONTENT (%)	UNIT WT. WET (pcf)	UNIT WT. DRY (pcf)	VOID RATIO (e)	SAT. (%)	UNCONFINED COMPRESSION q_u (tsf)	UNCONFINED COMPRESSION STRAIN (€, %)	SOIL CLASSIFICATION ATTERBERG LIMITS LL	PL	PI	PASSING #200 (%)	SYMBOL	REMARKS
B-1	UD-1	1-2.5'	2.728	3.9	26.3	118.7	94.0	0.78	90								
	UD-2	3.5-5'	2.732	5.8	24.5	115.0	92.4	0.81	81	1.281	6.15	34	22	12	>95	CL	Lean Clay
	UD-3	6-7.5'			25.2												
	UD-4	8.5-10'	2.832	5.7	24.6	119.6	96.0	0.74	89	1.493	5.28						
	UD-5	13.5-15'			25.9												
	UD-6	18.5-20'	2.786	5.7	29.0	118.3	91.7	0.82	94	0.701	5.21						
B-2	UD-1	1-2.5'	2.810	4.2	27.3	119.4	93.8	0.78	93								
	UD-2	3.5-5'	2.824	4.4	23.9	121.4	98.0	0.71	91	1.642	6.79						
	UD-3	6-7.5'	2.750	5.0	24.5	121.3	97.4	0.72	92	1.370	6.78						
	UD-4	8.5-10'															
	UD-5	13.5-15'	2.800	4.9	25.0	115.0	92.0	0.82	82	1.026	4.62						
	UD-6	18.5-20'															
B-3	UD-1	1-2.5'	2.733	5.8	27.8	121.4	94.9	0.76	98	1.890	7.22						
	UD-2	3.5-5'	2.852	2.7	22.5	116.8	95.3	0.76	80			39	24	15	>95	CL	Lean Clay
	UD-3	6-7.5'	2.812	4.1	21.7	114.8	94.3	0.77	75	1.826	5.12						
	UD-4	8.5-10'			19.5												
	UD-5	13.5-15'	2.859	5.7	24.7	116.7	93.6	0.79	84	1.994	5.91						
	UD-6	18.5-20'	2.862	5.2	24.2	116.7	94.0	0.78	83	1.592	11.64						
B-4	UD-1	1-2.5'	2.853	5.7	24.0	124.6	100.4	0.67	97	2.875	13.86						
	UD-2	3.5-5'	2.852	5.5	23.1	118.4	96.2	0.74	84								
	UD-3	6-7.5'	2.845	5.1	23.8	117.0	94.5	0.77	83	1.508	4.38						
	UD-4	8.5-10'	2.835	4.6	23.4	110.1	89.2	0.88	72	1.241	3.20	35	21	14	>95	CL	Lean Clay
	UD-5	13.5-15'	2.796	4.5	24.3	110.5	88.9	0.88	74	0.637	1.10						
	UD-6	18.5-20'	2.803	5.7	29.9	115.9	89.2	0.88	91	0.554	9.46						

Moisture Content by ASTM D2216, Unconfined Compression by ASTM D2166, Atterberg Limits by ASTM D4318, Classification by ASTM D2487

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fax: 712-329-9970

GEOTECHNICAL ENGINEERING DIVISION

SUMMARY OF SOIL TEST RESULTS

PROJECT: Fire Station

CLIENT: City of York, Nebraska

LOCATION: 1714 North Lincoln Avenue, York, Nebraska

JOB NUMBER: 09272.001

DATE: 12/28/23

BORING No.	SAMPLE NO.	SAMPLE DEPTH (ft.)	SAMPLE DIAM. (in.)	SAMPLE LENGTH (in.)	MOISTURE CONTENT (%)	DENSITY WET (pcf)	DENSITY DRY (pcf)	VOID RATIO (e)	SAT. (%)	UNCONFINED COMPRESSION q_u (tsf)	UNCONFINED COMPRESSION STRAIN (€, %)	SOIL CLASSIFICATION ATTERBERG LIMITS LL	PL	PI	PASSING #200 (%)	SYMBOL	REMARKS
B-5	UD-1	1-2.5'	2.699	5.8	31.3	113.0	86.1	0.94	89	0.640	11.52						
	UD-2	3.5-5'	2.832	5.0	24.8	121.8	97.6	0.72	93								
	UD-3	6-7.5'	2.385	4.4	26.0	124.3	98.7	0.70	100	1.317	11.19	44	23	21	>95	CL	Lean Clay
	UD-4	8.5-10'			26.9												
	UD-5	13.5-15'	2.745	5.7	30.5	119.2	91.4	0.83	98	1.118	5.34						
	UD-6	18.5-20'			30.2												

Moisture Content by ASTM D2216, Unconfined Compression by ASTM D2166, Atterberg Limits by ASTM D4318, Classification by ASTM D2487

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

(Based on Unified Soil Classification System)

ASTM: D 2487

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification: Group Symbol	Soil Classification: Group Name[B]
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	Cu ≥ 4 and 1 ≤ Cc ≤ 3[E]	GW	Well-graded gravel[F]
			Cu < 4 and/or 1 > Cc > 3[E]	GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML of MH	GM	Silty gravel[F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel[F, G, H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	Cu ≥ 6 and 1 ≤ Cc ≤ 3[E]	SW	Well-graded sand
			Cu < 6 and/or 1 > Cc > 3[E]	SP	Poorly graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G, H, I]
			Fines classify as CL or CH	SC	Clayey sand[G, H, I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line[J]	CL	Lean clay[K, L, M]
			PI < 4 or plots below "A" line[J]	ML	Silt[K, L, M]
		Organic	(Liquid limit -- oven dried) / (Liquid limit -- not dried) < 0.75	OL	Organic clay[K, L, M, N]
					Organic silt[K, L, M, O]
	Silts and Clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay[K, L, M]
			PI plots below "A" line	MH	Elastic silt[K, L, M]
		Organic	(Liquid limit -- oven dried) / (Liquid limit -- not dried) < 0.75	OH	Organic clay[K, L, M, P]
					Organic silt[K, L, M, Q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to the group name.

[C] Gravels with 5 to 12% fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay

[D] Sands with 5 to 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.

[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.

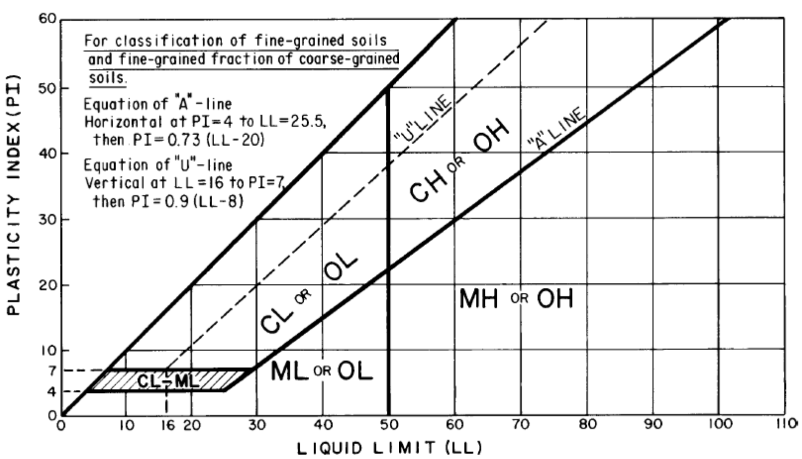
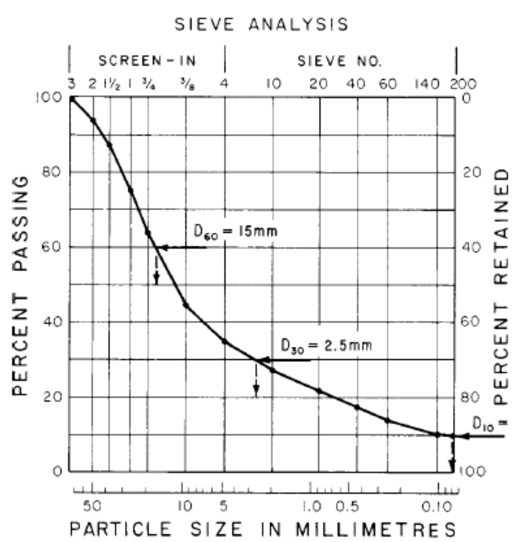


FIG. 4 Plasticity Chart



$Cu = \dfrac{D_{60}}{D_{10}} = \dfrac{15}{0.075} = 200$ $Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}} = \dfrac{(2.5)^2}{0.075 \times 15} = 5.6$

FIG. 5 Cumulative Particle-Size Plot

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GENERAL NOTES

DRILLING AND SAMPLING SYMBOLS

SS	:	Split-Barrel - 2" O.D., Unless Otherwise Noted
UD	:	Thin-Walled Tube - 3" O.D., Unless Otherwise Noted
GB	:	Bag Sample - From Cutting, Unless Otherwise Noted
T	:	Test Pit Grab Sample
REC	:	Sample Recovery, Percent
NSR	:	No Sample Recovered
NMR	:	No Measurement Recorded, Due to Drilling Fluid
NONE	:	No Groundwater Level Encountered Within Drilling Depth
MOIST	:	Moisture Condition
CONS	:	Consistency
SOIL CLASS	:	Soil Classification per ASTM D 2487, Unless Otherwise Noted (Unified System Symbols)
Fish	:	Fish Tail Drilling Bit
CFA	:	Continuous Flight Auger
HSA	:	Hollow Stem Auger

SOIL DESCRIPTION ABBREVIATIONS

med.	:	Medium, as in Medium Stiff or Medium Dense
sl.	:	Slightly, as in Slightly Moist

TEST SYMBOLS

MC	:	Moisture Content - % of Dry Soil Weight (ASTM D 2216)
SAT.	:	Saturation of Sample - %
q_u	:	Unconfined Compressive Strength (ASTM D 2166)
STRAIN	:	Strain at Maximum Strength (ASTM D 2166)
LL	:	Liquid Limit (ASTM D 4318)
PL	:	Plastic Limit (ASTM D 4318)
PI	:	Plasticity Index (ASTM 4318)
PASSING No. 200	:	Passing No. 200 Sieve (ASTM D 422)
▽	:	Groundwater Level Measurement

ADDITIONAL SYMBOLS

Pq	:	Penetrometer Reading - tons per square foot
Ts	:	Torvane Reading - tons per square foot
SPG	:	Specific Gravity (ASTM D 854)
SHL	:	Shrinkage Limit (ASTM D 427)
OC	:	Organic Content
pH	:	Hydrogen Ion Content
SC	:	Sulfate Ion Content - Parts/Million or mg/L
CC	:	Chloride Ion Content- Parts/Million or mg/L
C*	:	One-Dimensional Consolidation (ASTM D 2435)
Qc*	:	Triaxial Compression
DS*	:	Direct Shear (ASTM D 3080)
K*	:	Coefficient of Permeability - cm/sec
LR	:	Laboratory Resistivity - Ohm-cm (ASTM G 57)
RQD	:	Rock Quality Designation - Percent

* See attached data sheet or graph, if used.

Notes:

1. Standard "N" Penetration (ASTM D 1586): Blows per foot of a 140 pound hammer falling 30 inches on a 2 inch OD split-barrel sampler.

2. Water levels shown on the boring logs are the levels measured in the borings at the time and under the conditions indicated. In pervious soils, the indicated levels may reflect the location of the groundwater. In low permeability soils, the accurate determination of the groundwater levels is not possible with only short term observations. Please note that groundwater levels vary with time and location.

CONSISTENCY OF COHESIVE SOILS (CLAY)

Unconfined Compressive Strength, qu (tsf)	Consistency	N - blows / foot
< 0.25	Very Soft	< 2
0.25 - 0.50	Soft	2 - 4
0.50 - 1.00	Medium Stiff	5 - 8
1.00 - 2.00	Stiff	9 - 15
2.00 - 4.00	Very Stiff	16 - 30
> 4.00	Hard	> 30

RELATIVE DENSITY OF GRANULAR SOILS (SILT AND SAND)

N - blows / foot	Relative Density
0 - 3	Very Loose
4 - 9	Loose
10 - 29	Medium Dense
30 - 50	Dense
> 50	Very Dense

RELATIVE PARTICLE SIZES

Description	Sieve Size	
Boulder	> 12"	(+ 300 mm)
Cobble	3" - 12"	(75 mm - 300 mm)
Gravel		
Coarse	3/4" - 3"	(19 mm - 75 mm)
Fine	#4 - 3/4"	(4.75 mm - 19.0 mm)
Sand		
Coarse	#10 - #4	(2.0 mm - 4.75 mm)
Medium	#40 - #10	(0.425 mm - 2.0 mm)
Fine	#200 - #40	(0.075 mm - 0.425 mm)
Silt and Clay	Passes #200	(- 0.075 mm)

Classification as Silt or Clay Based on Plasticity

TERMINOLOGY DEFINITIONS

Dry	Powdery, No apparent moisture
Slightly Moist	Can feel moisture, but soil won't retain shape when remolded
Moist	Can feel moisture, Will remold easily, yet crumbles upon kneading
Very Moist	Can feel much moisture, Molds easily and does not crumble when kneaded
Wet	Saturated, Above liquid limit moisture content
Water-Bearing	Pervious soil below water level

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