

# Lifeway Foods Expansion

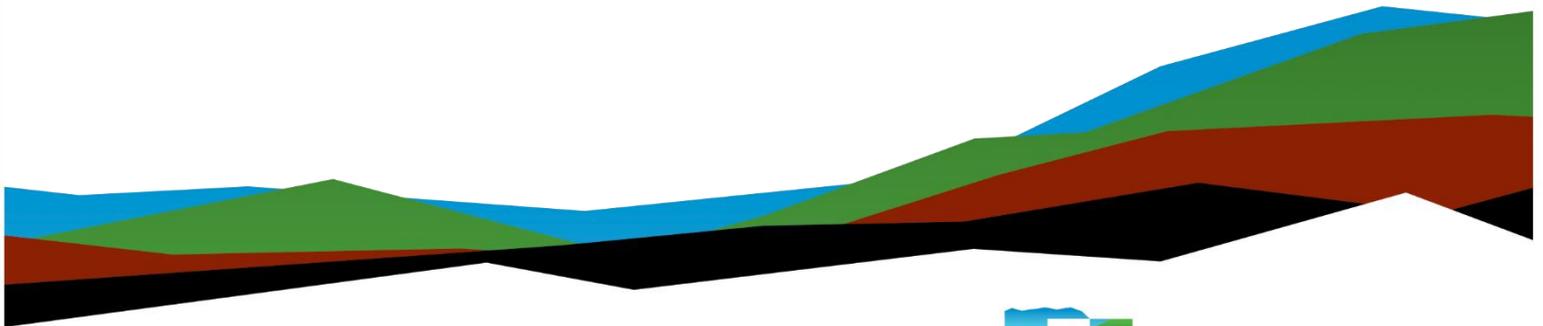
## Geotechnical Engineering Report

December 5, 2025 | Terracon Project No. 58255308

Waukesha, Wisconsin

### Prepared for:

12 Gauge Construction, LLC  
4125 Terminal Drive, Suite 100  
McFarland, WI 53558



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December 5, 2025

12 Gauge Construction, LLC  
4125 Terminal Drive, Suite 100  
McFarland, WI 53558

Attn: Jim Worthington  
Email: jimw@12gcc.com

Re: Geotechnical Engineering Report  
Lifeway Foods Expansion  
2101 Delafield Street  
Waukesha, WI  
Terracon Project No. 58255308

Dear Mr. Worthington:

We have completed the scope of Geotechnical Engineering services for the referenced project in general accordance with the Agreement of services dated October 21, 2025. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

**Terracon**

Jordan Altekruise, E.I.T.  
Staff Engineer

Jeremy Thomas, P.E.  
Senior Engineer

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## Attachments

**Exploration and Testing Procedures**

**Site Location and Exploration Plans**

**Exploration and Laboratory Results**

**Supporting Information**

**Note:** This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the  Terracon logo will bring you back to this page. For more interactive features, please view your project online at [client.terracon.com](http://client.terracon.com).

Refer to each individual Attachment for a listing of contents.

## Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services for the construction of an addition to the existing Lifeway Foods facility in Waukesha, WI. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Demolition considerations
- Foundation design and construction
- Considerations for construction adjacent to the existing facility
- Floor slab design and construction
- Lateral earth pressures
- Seismic considerations per IBC
- Frost considerations
- Design and construction of pavements

The geotechnical engineering Scope of Services for this project included the advancement of four test borings, laboratory testing, engineering analysis, and preparation of this report.

Drawings showing the site and boring locations are shown on the [Site Location](#) and [Exploration Plan](#), respectively. The results of the laboratory testing performed on soil samples obtained from the site during our field exploration are included on the boring logs in the [Exploration Results](#) section.

## Project Description

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
<b>Information Provided</b>	An email request for proposal was provided by 12 Gauge, dated October 16, 2025. A site aerial and preliminary drawing for the expansion were provided, requested boring locations were marked on these drawings.

Item	Description
<b>Project Description</b>	The project consists of the construction of an addition on the east side of the existing Lifeway Foods factory.
<b>Proposed Structure</b>	The proposed expansion has an area of approximately 45,000 square feet. Based on the drawing provided, it appears the expansion will be used for a bottling assembly line and associated pallet racking.
<b>Building Construction</b>	We anticipate the building will be steel framed with insulated metal panel walls.
<b>Finished Floor Elevation</b>	Finished floor elevation is unknown at this time but assumed to be within 1 to 2 feet of existing grade and that it will match the finished floor of the existing building.
<b>Maximum Loads</b>	<p>We were not provided the maximum column, wall, and slab loads. We will use the following assumed loads in estimating settlement based on our experience with similar projects.</p> <ul style="list-style-type: none"> <li>■ Columns: up to 225 kips</li> <li>■ Walls: 3 to 5 kips per linear foot (klf)</li> <li>■ Slabs: 250 pounds per square foot (psf)</li> </ul>
<b>Grading/Slopes</b>	Not provided but assumed to be within 1 to 2 feet of existing grade.
<b>Below-Grade Structures</b>	None anticipated
<b>Free-Standing Retaining Walls</b>	None anticipated
<b>Pavements</b>	<p>It is assumed that some current site pavements will be replaced or rehabilitated as part of this expansion project.</p> <p>Unless traffic information is provided prior to the report, we assume that the traffic classification will consist of:</p> <ul style="list-style-type: none"> <li>■ Class I: Parking stalls for autos and pickup trucks</li> <li>■ Class III: Industrial parking lots and truck stall, as well as driveways and loading/unloading zones</li> </ul> <p>The pavement design period is 20 years.</p>
<b>Building Code</b>	2021 IBC

Terracon should be notified if any of the above information is inconsistent with the planned construction, especially the grading limits, as modifications to our recommendations may be necessary.

## Site Conditions

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
<b>Parcel Information</b>	The project is located at 2101 Delafield Street in Waukesha, WI. Latitude/Longitude (approximate) 43.0315° N, 88.2421° W See <a href="#">Site Location</a>
<b>Existing Improvements</b>	The site is currently occupied by an existing Lifeway Foods factory
<b>Existing Topography</b>	Based on Google Earth, existing elevations vary from approximately 922 to 926 feet
<b>Current Ground Cover</b>	Asphalt

## Geotechnical Characterization

We completed a total of four borings within the new building expansion area. The following table lists the number and depth of borings performed.

Number of Borings	Approximate Boring Depth <sup>1</sup>	Location
4	16 to 20	East side of the existing facility

1. Feet below existing ground surface.

### Subsurface Profile

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting, and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of the site. Conditions observed at each exploration point are indicated on the individual logs. The individual logs can be found in the [Exploration Results](#) attachment of this report.

Model Layer	Layer Name	General Description
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<b>1</b>	<b>Surficial Material</b>	Asphalt approximately 4 to 6 inches thick, and aggregate base course approximately 6 to 8 inches thick.
<b>2</b>	<b>Existing Fill Materials</b>	Crushed rock and asphalt.
<b>3</b>	<b>Native Non-Cohesive Soils</b>	Sandy silt with gravel and poorly graded sand with trace gravel. Observed in a medium dense to very dense condition with SPT N-values ranging from 18 to 50/1" blows per foot. Moisture contents ranged from 1 percent to 9 percent. Auger refusal was met in boring B-1 on possible cobbles and boulders.

The geotechnical characterization forms the basis of our geotechnical evaluation of site preparation, foundation options and pavement options. As noted in **General Comments**, the characterization is based upon widely spaced exploration points across the site, and variations are likely.

Conditions encountered at each boring location are indicated on the individual boring logs shown in the **Exploration Results** section and are attached to this report. Stratification boundaries on the boring logs represent the approximate location of changes in native soil types; in situ, the transition between materials may be gradual.

### Subsurface Water Conditions

The borings were observed during drilling and at the completion of drilling for the presence and level of groundwater. Free groundwater was not observed within the borings during or at the completion of drilling. Based on the granular nature of the soils, it is assumed that the long-term ground water level is below the depth of our explorations.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project

## Geotechnical Overview

The results of this exploration indicate that the subsurface conditions at the site are generally suitable for the use of typical shallow foundations for support of the proposed structural loads.

The **Shallow Foundations** section addresses foundation support recommendations for the structure. It is our opinion that the building can be supported on shallow foundations bearing on the native sand soils that have been recompacted after excavating. The shallow foundations may be proportioned for a net allowable bearing pressure of 4,000 psf.

Existing fill soils were observed in borings B-3 and B-4 to depths of 3.5 to 6 feet. This existing fill should not be used to support the foundations of the planned structure. If the owner is willing to accept some risk associated with additional settlement, the floor slabs of the structure could be supported on this material. If this risk of additional settlement is not acceptable, the existing fill should be removed in its entirety.

Support of pavements and floor slabs on or above existing fill materials is discussed in this report. However, even with the recommended construction procedures, an inherent risk remains for the owner that compressible fill or unsuitable material, within or buried by the fill, will not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill but can be reduced by following the recommendations contained in this report. To take advantage of the cost benefit of not removing the entire amount of undocumented fill, the owner must be willing to accept the risk of increased differential performance which can result in increased cracking and abrupt differential settlement. Should this risk be acceptable, pavements and floor slabs can be supported by the in-place fill material.

The recommendations contained in this report are based upon the results of field and laboratory testing (presented in the **Exploration Results**), engineering analyses, and our current understanding of the proposed project. The **General Comments** section provides an understanding of the report limitations.

## Earthwork

The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations, pavements, floor slabs, and utility trenches.

### Demolition

It is understood that the existing building will remain in place during the construction of the expansion. It is unknown if structures were previously constructed within the footprint of the planned building expansion. If present, remnants of former structures within the footprint of the expansion should be removed, including any foundations, floor slabs, and utilities. This should also include removal of all poorly compacted trench backfill extending into the proposed building area.

## Site Preparation

Existing asphalt and concrete pavement, topsoil, vegetation, and any loose, soft, or otherwise unsuitable materials should be removed from proposed construction areas. Remnants of the former structures should also be removed, including any foundations, floor slabs, and utilities.

A Terracon representative should observe proofcompaction of the exposed soils. proofcompaction can be accomplished using a minimum 4-foot diameter smooth drum roller with a gross weight of at least 10 tons, or similarly loaded equipment. We recommend this type of equipment based on the presence of granular materials. Dump trucks or other rubber tired equipment may cause excessive rutting and cause unnecessary undercuts and subgrade removal. Areas that display excessive deflection (pumping) or rutting during proofcompaction operations should be improved by scarification and compaction, or by removal and replacement with an approved gradation of crushed stone aggregate.

After an acceptable subgrade condition is achieved, the placement and compaction of new fills may begin, as appropriate. The placement and compaction of all base course and fill soils should be monitored by a representative of the geotechnical engineer. Fill and base course placement should be done in accordance with the State of Wisconsin’s Standard Specifications for Highway and Structure Construction.

## Fill Material Types

Fill required to achieve design grade should be classified as structural fill and general fill. Structural fill is material used below, or within 10 feet of structures, pavements, or constructed slopes. General fill is material used to achieve grade outside of these areas. Earthen materials used for structural and general fill should meet the following material property requirements.

Soil Type <sup>1, 2</sup>	USCS Classification	Acceptable Locations for Placement
Cohesive	CL <sup>3</sup> , CL/ML <sup>3</sup> (LL ≤ 45 and PI ≤ 20)	Not recommended for structural fill due to the presence of mostly granular soils at this site. Can be used as general fill.
Granular	GW, GP, GM, GC SW, SP, SM, SC 5% to 15% passing #200 sieve	Backfill for utilities and foundations. Can also be used below/adjacent to floor slabs. and pavement foundations. If used below pavements, drainage should be considered. Can be used as general fill.

Soil Type <sup>1, 2</sup>	USCS Classification	Acceptable Locations for Placement
Granular	Crushed limestone or crushed concrete meeting WisDOT Section 305 for 1¼ dense graded base	Undercut areas below foundations. Aggregate base below slabs and pavements. Can also be used for utility and structural backfill.

1. Structural fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to Terracon for evaluation prior to use on this site.
2. Any organic materials, rock fragments larger than 3 inches, and other unsuitable materials should be removed prior to use as structural fill.
3. Highly susceptible to frost; unstable when wet, are commonly used for pavement support with the knowledge that additional maintenance and/or shorter pavement life are likely.

## Existing Fill

As noted in Geotechnical Characterization, borings B-3 and B-4 encountered previously placed fill to depths ranging from about 3.5 to 6 feet. We have no records to indicate the degree of control, and consequently, the fill is considered unreliable for support of foundations. Support of pavements and floor slabs on or above existing fill soils is discussed in this report. However, even with the recommended construction procedures, inherent risk exists for the owner that compressible fill or unsuitable material, within or buried by the fill will not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill but can be reduced by following the recommendations contained in this report. A higher level of maintenance of the pavements should be anticipated if the fill is left in place.

The entire area should be proofcompacted, to aid in delineating areas of soft or otherwise unsuitable soil. Once unsuitable materials have been remediated, and the subgrade has passed the proofcompaction test, backfill to finished subgrade elevation can begin. The existing undocumented fill that was removed can be evaluated for reuse as structural fill.

## Fill Placement and Compaction Requirements

Structural and general fill should meet the following compaction requirements.

Item	Description
<p><b>Maximum Fill Lift Thickness</b></p>	<ul style="list-style-type: none"> <li>■ 9 inches or less in loose thickness when heavy, self-propelled compaction equipment is used</li> <li>■ 4 inches in loose thickness when hand-guided equipment (i.e., a jumping jack or plate compactor) is used</li> </ul>
<p><b>Minimum Compaction Requirements <sup>1, 2, 3</sup></b></p>	<ul style="list-style-type: none"> <li>■ Structural Fills: 95% of the maximum dry density as obtained by the modified Proctor (ASTM D1557)</li> <li>■ General Fills: 90% of the maximum dry density as obtained by the modified Proctor (ASTM D1557)</li> </ul>
<p><b>Moisture Content Range <sup>1</sup></b></p>	<ul style="list-style-type: none"> <li>■ within 2% below to 3% above the modified Proctor optimum moisture content at the time of placement and compaction</li> <li>■ granular materials should be compacted within workable moisture levels</li> </ul>

1. We recommend that structural fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.
2. If the granular material is coarse sand, crushed limestone, or gravel, is of a uniform size, or has a low fines content, compaction should be observed to ensure that each lift is placed in the recommended thickness and compacted using proper equipment. The clean granular soils should be compacted to at least 65% of relative density until they are not observed to yield.
3. Specifically, moisture levels should be maintained to achieved compaction without bulking during placement or pumping when proofrolled.

### Utility Trench Backfill

Any soft or unsuitable materials encountered at the bottom of utility trench excavations should be removed and replaced with structural fill or bedding material in accordance with the specifications for the utility be supported. This recommendation is particularly applicable to utility work requiring grade control and/or in areas where subsequent grade raising could cause settlement in the subgrade supporting the utility. Trench excavation should not be conducted below a downward 1.5 horizontal:1 vertical projection from existing foundations without engineering review of shoring requirements and geotechnical observation during construction.

Trench backfill should be mechanically placed and compacted as discussed earlier in this report. Compaction of initial lifts should be accomplished with hand-operated tampers or other lightweight compactors. Where trenches are placed beneath slabs or footings, the backfill should satisfy the gradation and expansion index requirements of engineered fill discussed in this report. Flooding or jetting for placement and compaction of backfill is not recommended.

## Grading and Drainage

All grades must provide effective drainage away from the building during and after construction and should be maintained throughout the life of the structure. Water retained next to the building can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. The roof should have gutters/drains with downspouts that discharge onto splash blocks at a distance of at least 10 feet from the building.

Exposed ground should be sloped and maintained at a minimum 5 percent away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure's maintenance program. Where paving or flatwork abuts the structure, a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

## Earthwork Construction Considerations

Terracon should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation, proofrolling, placement and compaction of controlled compacted fills, backfilling of excavations into the completed subgrade, and just prior to construction of building floor slabs.

Upon completion of filling and grading, care should be taken to maintain the soil subgrade's moisture content. Construction traffic over completed soil subgrades should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Any water that collects over or adjacent to construction areas should be promptly removed. If the subgrade should become frozen, desiccated, saturated, or disturbed, the affected material should be removed and replaced with structural fill, or these materials should be scarified,

moisture conditioned, and recompacted prior to floor slab construction and observed by Terracon.

Where present, care should be taken to avoid disturbance of prepared subgrade soils. The on-site soils are easily disturbed, especially by construction traffic. Construction traffic should not operate directly on saturated or low strength soils. If the subgrade becomes saturated, desiccated, or disturbed, the affected materials should either be scarified and compacted or be removed and replaced as previously discussed. Subgrades should be observed and tested by Terracon prior to construction.

Based on conditions encountered at the boring locations earthwork activities are not expected to encounter sustained or prevalent groundwater in the area of the buildings.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, as well as other applicable codes, and in accordance with any applicable local, state, and federal safety regulations. The contractor should be aware that slope height, slope inclination, and excavation depth should in no instance exceed those specified by these safety regulations.

Flatter slopes than those dictated by these regulations may be required depending upon the soil conditions encountered and other external factors. These regulations are strictly enforced and if they are not followed, the owner, the contractor, and/or earthwork and utility subcontractor could be liable and subject to substantial penalties. Under no circumstances should the information provided in this report be interpreted to mean that Terracon is responsible for construction site safety or the contractor's activities. Construction site safety is the sole responsibility of the contractor who shall also be solely responsible for the means, methods, and sequencing of the construction operations.

## Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of adequate removal of topsoil, demolition/backfilling of existing structures/pavements/utilities, proofrolling, and mitigation of areas delineated by the proofroll to require mitigation.

Each lift of compacted fill, if required, should be tested, evaluated, and reworked as necessary until approved by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the building areas and 5,000 square feet in pavement areas. One density and water content test for every 50 linear feet of compacted utility trench backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. If unanticipated conditions are encountered, the Geotechnical Engineer should be contacted to discuss mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer’s evaluation of subsurface conditions, including assessing variations and associated design changes.

## Shallow Foundations

As noted in the **Geotechnical Characterization** Fill soils were encountered at borings B-3 and B-4 within the proposed expansion extending to depths of about 3.5 to 6 feet below existing grades; however deeper fill associated with the existing building may be encountered.

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for newly constructed shallow foundations. We do not recommend that the existing fill soils be used for support of foundations.

### Design Parameters – Compressive Loads

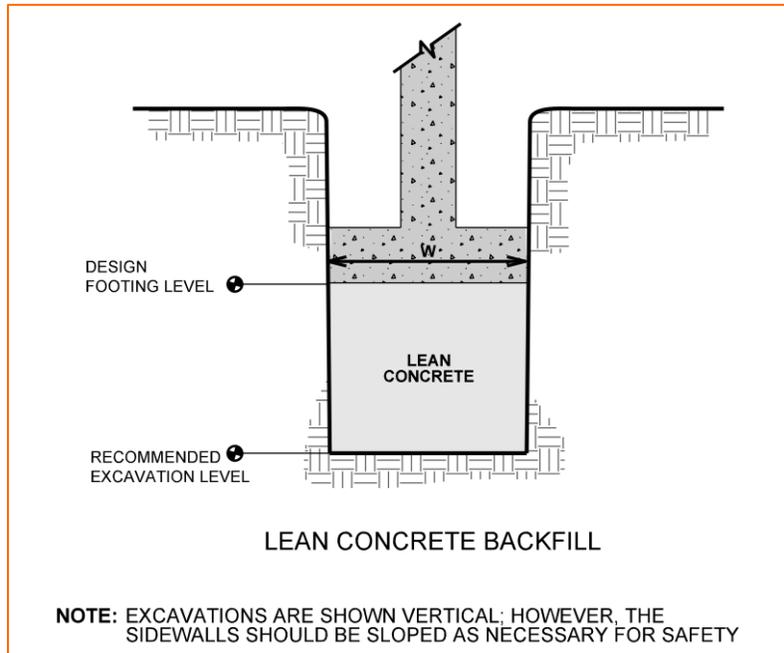
Item	Description
<b>Maximum Net Allowable Bearing pressure</b> <sup>1, 2</sup>	4,000 psf
<b>Required Bearing Stratum</b> <sup>3</sup>	Native sand soils of $\geq 9$ bpf, or structural fill or lean concrete extending to suitable native soils. <b>Granular bearing soils must be recompactd as recommended below prior to construction of foundations.</b> Existing fill soils are not considered suitable for new foundations.
<b>Minimum Foundation Dimensions</b>	Columns: 30 inches Continuous: 18 inches
<b>Minimum Embedment below Finished Grade</b> <sup>4</sup>	Exterior footings for unheated buildings: 60 inches Exterior footings for heated buildings: 48 inches Interior footings in heated buildings: 18 inches
<b>Estimated Total Settlement from Structural Loads</b> <sup>2</sup>	Less than about 1 inch

Item	Description
	<ol style="list-style-type: none"><li>1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. An appropriate factor of safety has been applied. These bearing pressures can be increased by 1/3 for transient loads unless those loads have been factored to account for transient conditions. Values assume that exterior grades are no steeper than 20% within 10 feet of structure.</li><li>2. Values provided are for maximum loads noted in <b>Project Description</b>.</li><li>3. Unsuitable or soft soils should be over-excavated and replaced per the recommendations presented in the <b>Earthwork</b>.</li><li>4. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.</li><li>5. Differential settlements are measured over a span of 50 feet.</li></ol>

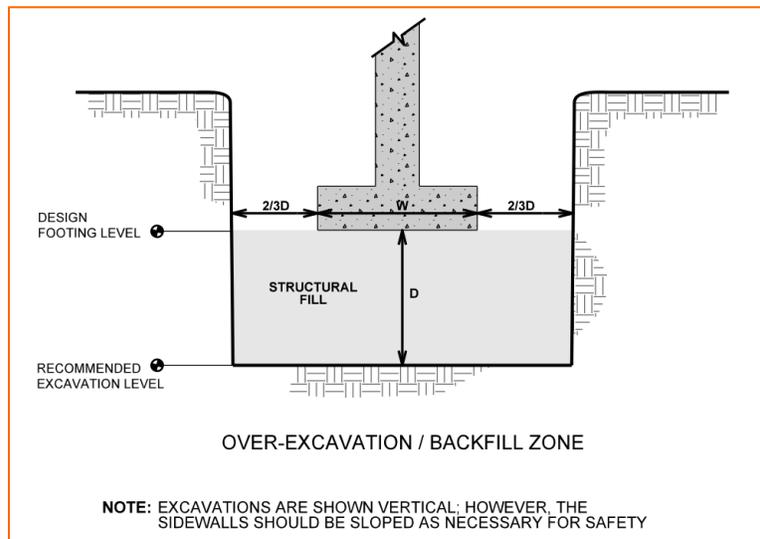
## Foundation Construction Considerations

As noted in **Earthwork**, the foundation excavations should be evaluated under the direction of the Geotechnical Engineer. If unsuitable material is encountered at the planned bearing level, the material should be overexcavated and replaced, or the foundations should be extended to bear at a deeper depth on suitable native soils. Illustrations of overexcavation and backfill can be found below. All foundation excavations should be free of water and soft/loose soil, prior to placing concrete/structural fill should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

Over-excavation for lean concrete backfill placement below footings should be conducted as shown below..



Over-excavation for structural fill placement below footings should be conducted as shown below. The over-excavation should be backfilled up to the footing base elevation, with structural fill placed, as recommended in the **Earthwork** section.



### Construction Adjacent to the Existing Building

Terracon has not been provided with drawings which show the bearing depth of the foundations for the existing building. The design team should carefully evaluate the bearing depth of the existing foundation relative to the recommended bearing depth of the foundations for the planned expansion. If the excavation for the new foundations

extends below the foundation of the existing structure, shoring or underpinning of the existing building may be required. If excavations for the planned construction encroach within a zone extending at 1.5 horizontal or 1 vertical from the base of the existing footings, supplemental support for the existing building should be provided. Shoring or underpinning designed by a Professional Engineer with experience with similar projects should be installed to prevent settlement of the existing structure and to maintain a safe excavation for the construction of the planned building expansion foundations.

We recommend an instrumentation and monitoring program is developed and implemented for the existing building which will establish tolerable deflection and vibrations levels. The instrumentation and monitoring program should provide thresholds where work will be stopped, if exceeded, to prevent damage to the existing structure. Terracon can assist with the development and implementation of this monitoring program in collaboration with the building owner and structural engineer for the projects under a separate agreement.

## Floor Slabs

Design parameters for floor slabs assume the requirements for **Earthwork** have been followed. Specific attention should be given to positive drainage away from the structure and positive drainage of the aggregate base beneath the floor slab. If the owner elects to construct any at-grade floor slabs on the existing fill, they have accepted the inherent risk that compressible fill or unsuitable material, within or buried by the fill may not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill but can be reduced by following the requirements and recommendations in the **Earthwork** section.

### Floor Slab Design Parameters

Item	Description
<b>Floor Slab Support</b> <sup>1</sup>	Suitable non-organic native soil, existing fill that is observed to be stable during proofcompacting, or new structural fill materials that have been prepared in accordance with the <b>Earthwork</b> section and tested/approved by Terracon
<b>Granular Leveling Course</b>	A minimum 4 inches of well-graded crushed stone meeting WisDOT Section 310 for an open graded base course material compacted to non-yielding condition
<b>Modulus of Subgrade Reaction</b>	150 pounds per square inch per inch (psi/in)

Item	Description
1.	Floor slabs should be structurally independent of building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, when the project includes humidity-controlled areas, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Saw-cut contraction joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations, refer to the ACI Design Manual. Joints or cracks should be sealed with a waterproof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

### Floor Slab Construction Considerations

Floor slab subgrade soils should be prepared as discussed in the **Earthwork** section of this report. On most project sites, site grading is generally accomplished early in the construction phase; however, as construction proceeds, the subgrade may be disturbed due to utility excavations, construction traffic, desiccation, rainfall, etc. As a result, the floor slab subgrade may not be suitable for placement of the granular layer and concrete, and corrective measures will be required. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed, and structural fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

Terracon should review the condition of the floor slab subgrades immediately prior to placement of the granular leveling course and construction of the slabs. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas containing backfilled trenches. Areas where unsuitable conditions are located should be repaired by removing and replacing the affected material with properly

## Seismic Considerations

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7.16 and the International Building Code (IBC). During this geotechnical field investigation, soil borings were completed at the site to a maximum depth of about 20 feet. Based on the soil conditions encountered and our experience with the geology in the vicinity of the project site, **Seismic Site Classification D** can be used for the design of the proposed structures. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic condition of the general area. Additional deeper borings or a site-specific seismic evaluation using geophysical methods would be required to further define the seismic site class.

## Frost Considerations

The soils on this site are frost susceptible, and water present or migrating beneath structures in non-climate-controlled areas can affect the performance of the slabs on-grade, sidewalks and pavements. Exterior slabs should be anticipated to heave during winter months. If frost action needs to be eliminated in critical areas, we recommend the use of non-frost susceptible (NFS) fill or structural slabs (for instance, structural stoops in front of building doors). Placement of NFS material in large areas may not be feasible; however, the following recommendations are provided to help reduce potential frost heave:

- Provide surface drainage away from the building and slabs.
- Grade subgrades, so groundwater potentially perched in overlying more permeable subgrades and/or engineered-fills, slope toward a site drainage system.
- Place NFS fill as backfill beneath slabs and pavements critical to the project.
- Place a 3 horizontal to 1 vertical (3H:1V) transition zone between NFS fill and other soils.
- Place NFS materials in critical sidewalk areas.

As an alternative to extending NFS fill to the full frost depth, consideration can be made to placing extruded polystyrene or cellular concrete under a buffer of at least 2 feet of NFS material. Footings for heated structures should be 48 inches below perimeter grade and 60 inches below perimeter grade for unheated structures.

## Pavements

### General Pavement Comments

Estimates of minimum pavement thicknesses are provided for the traffic conditions. Site preparation is a critical aspect of pavement performance. The minimum pavement thicknesses are based on the subgrade being prepared as recommended in the **Earthwork** section.

There is often a time lapse between the end of grading operations and the commencement of paving. Subgrades prepared early in the construction process can become disturbed by construction traffic. Non-uniform subgrades often result in poor pavement performance and local failures relatively soon after pavements are constructed. Depending on the paving equipment used by the contractor, measures may be required to improve subgrade strength to greater depths for support of heavily loaded trucks. Improvements should be made as recommended in **Earthwork**.

Before paving, and in areas recommended by Terracon, pavement subgrades should be proofrolled in the presence of a Terracon representative. Proofrolling of the subgrade should help locate soft, yielding, or otherwise unsuitable soil at or just below the exposed subgrade level. Unsuitable areas observed at this time should be improved by scarification and compaction or be removed and replaced with structural fill. Proofrolling should be accomplished with a fully loaded, tandem-axle dump truck with a minimum gross weight of 25 tons or other equipment providing an equivalent subgrade loading. If the exposed soil is granular, proofcompaction should be performed. Proofcompaction can be accomplished using a smooth drum vibratory roller with a gross weight of at least 10 tons and minimum diameter of 4 feet or other equipment providing an equivalent subgrade loading.

Designs for new pavement sections for this project have been based on the procedures outlined in the 1993 Guideline for Design of Pavement Structures by the American Association of State Highway and Transportation Officials (AASHTO-1993). Pavement design methods are intended to provide structural sections with adequate thickness over a particular subgrade such that wheel loads are reduced to a level the subgrade can support.

### Pavement Section Thicknesses

All pavements should be designed for the types and volumes of traffic, subgrade, and drainage conditions that are anticipated. Terracon was not provided with anticipated traffic loading information; therefore, the traffic usage and loading should be provided to Terracon so that the thickness recommendations provided below can be verified prior to using them for final design.

The minimum thicknesses provided are based on 18-kip Equivalent Single Axle Load Applications (ESAL<sub>18</sub>) over a 20-year design life, which are provided in the table below.

Traffic patterns and anticipated loading conditions are as follows:

<b>Design Traffic</b>		
<b>Pavement Type</b>	<b>Location</b>	<b>Flexible Design ESAL's Values</b>
Standard Duty	Passenger car parking areas	30,000
Heavy Duty	Drive areas	300,000

The following pavement design parameters were used in our evaluation of estimating minimum pavement sections for the project.

<b>Pavement Design Input</b>		
<b>Input Parameter</b>	<b>Asphalt</b>	<b>Concrete</b>
Reliability	85%	85%
Initial Serviceability	4.2	4.5
Terminal Serviceability	2.0	2.0
Standard Deviation	0.45	0.35
Load Transfer	---	3.6
Drainage	1.0	1.0

Based upon the estimated design parameters listed above, we have developed recommended minimum pavement sections for Asphaltic Concrete (AC) and Portland Cement Concrete (PCC) pavements, where the subgrade appears firm under proofrolling at the time of construction. The recommended minimum pavement sections are provided in the following table. Greater pavement and/or base course thicknesses may be required for greater expected traffic loads and volumes, or if poorer subgrade conditions are encountered.

The following table provides our estimated minimum thickness of AC pavements.

### Asphaltic Concrete (AC) Design

Layer	Thickness (inches)	
	Standard Duty Pavement	Heavy Duty Pavement
AC Surface <sup>1</sup>	1.5	2
AC Binder <sup>2</sup>	2	3
Aggregate Base <sup>3</sup>	8	9

1. Surface course, WisDOT Specifications for No. 4 (12.5 mm) Hot Mix Asphalt (HMA)
2. Binder course, WisDOT Specifications for No. 3 (19.0 mm) HMA
3. The base course aggregate beneath the new pavement should conform to the 1-1/4-inch Dense Graded Base listed in Section 305 of the WisDOT Standard Specifications (current edition)

The following table provides our estimated minimum thickness of PCC pavements.

### Portland Cement Concrete (PCC) Design

Layer	Thickness (inches)	Thickness (inches)	
	Standard Duty Pavement	Loading Dock Slabs <sup>3</sup>	Heavy Duty Pavement and Dumpster Pad <sup>3</sup>
PCC <sup>1</sup>	5	7	7
Aggregate Base <sup>2</sup>	6	6	6

1. Portland cement concrete pavements are recommended for roadways and areas subjected to repeated truck traffic, truck turning areas, and trash container pads. Trash container pads should be large enough to support the container and the tipping axle of the trash collection vehicle.
2. The base course aggregate beneath the new pavement should conform to the 1-1/4-inch Dense Graded Base listed in Section 305 of the WisDOT Standard Specifications (current edition).
3. PCC should be considered for areas of anticipated heavy traffic, fire trucks, delivery trucks, or concentrated loads (e.g., dumpster pads), and areas with repeated turning or maneuvering of heavy vehicles.

## Pavement Drainage

The pavement sections provided above are based on no significant increase in the subgrade moisture contents. Paved areas should be sloped to provide rapid drainage of surface water and to drain water away from the pavement edges. Water should not be allowed to accumulate on or adjacent to the pavement, since this could saturate and soften the subgrade soils and subsequently accelerate pavement deterioration. Periodic maintenance of the

pavements will be required. Cracks should be sealed, and areas exhibiting distress should be repaired promptly to help prevent further deterioration. Even with periodic maintenance, some movement and related cracking may still occur, and repairs may be required.

## Pavement Maintenance

The pavement sections represent minimum recommended thicknesses and, as such, periodic upkeep should be anticipated. Preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Pavement care consists of both localized (e.g., crack and joint sealing and patching) and global maintenance (e.g., surface sealing). Additional engineering consultation is recommended to determine the type and extent of a cost-effective program. Even with periodic maintenance, some movements and related cracking may still occur, and repairs may be required.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to paved areas should slope down from the edges at a minimum 2%.
- Subgrade and pavement surfaces should have a minimum 2% slope to promote proper surface drainage.
- Install pavement drainage systems surrounding areas anticipated for frequent wetting.
- Install joint sealant and seal cracks immediately.
- Seal all landscaped areas in or adjacent to pavements to reduce moisture migration to subgrade soils.
- Place compacted, low permeability backfill against the exterior side of curb and gutter.
- Place curb, gutter and/or sidewalk directly on clay subgrade soils rather than on unbound granular base course materials.

## General Comments

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the

Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials, or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly affect excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety and cost estimating including excavation support and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

# Exploration and Testing Procedures

## Field Exploration

Number of Borings	Approximate Boring Depth <sup>1</sup>	Location
4	16 to 20	East side of the existing facility

1. Feet below existing ground surface.

**Boring Layout and Elevations:** Terracon personnel laid out the borings based on the planned structure locations and the locations of existing utilities which are present at the site. Coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ±20 feet) and using existing site features.

**Subsurface Exploration Procedures:** The borings were advanced their full depth using continuous flight hollow stem augers. Four samples were obtained in the upper 10 feet of each boring, and at 5-foot intervals thereafter to termination depths. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon is driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. The samples were placed in appropriate containers, taken to our laboratory for testing, and classified by the project engineer. In addition, we observed and recorded subsurface water levels during drilling and after boring completion. The borings were backfilled with bentonite chips and auger cuttings after drilling.

Our exploration team prepared field boring logs as part of standard drilling operations. These logs include sampling depths, penetration distances, and other relevant sampling information, visual classifications of materials encountered during drilling, and our interpretation of subsurface conditions between samples. Report logs were prepared from the field logs and incorporated the project engineer's interpretation of the field logs and include modifications based on observations and laboratory tests of the samples in our laboratory.

## Laboratory Testing

The samples were tested in the laboratory to measure their natural water content which are provided on the boring logs in **Exploration Results**. The samples were also classified in the laboratory based on visual observation, texture, and plasticity. The soil descriptions presented on the boring logs are in accordance with the General Notes and

## Geotechnical Engineering Report

Lifeway Foods Expansion | Waukesha, WI

December 5, 2025 | Terracon Project No. 58255308



Unified Soil Classification System (USCS) included in [Supporting Information](#). The estimated USCS group symbols for native soil samples are shown on the boring logs, and a brief description of the USCS is included in [Supporting Information](#).

**Geotechnical Engineering Report**

Lifeway Foods Expansion | Waukesha, WI

December 5, 2025 | Terracon Project No. 58255308



# Attachment

## Site Location and Exploration Plans

### **Contents:**

Site Location Plan

Exploration Plan

Note: All attachments are one page unless noted above.

## Site Location



DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

## Exploration Plan

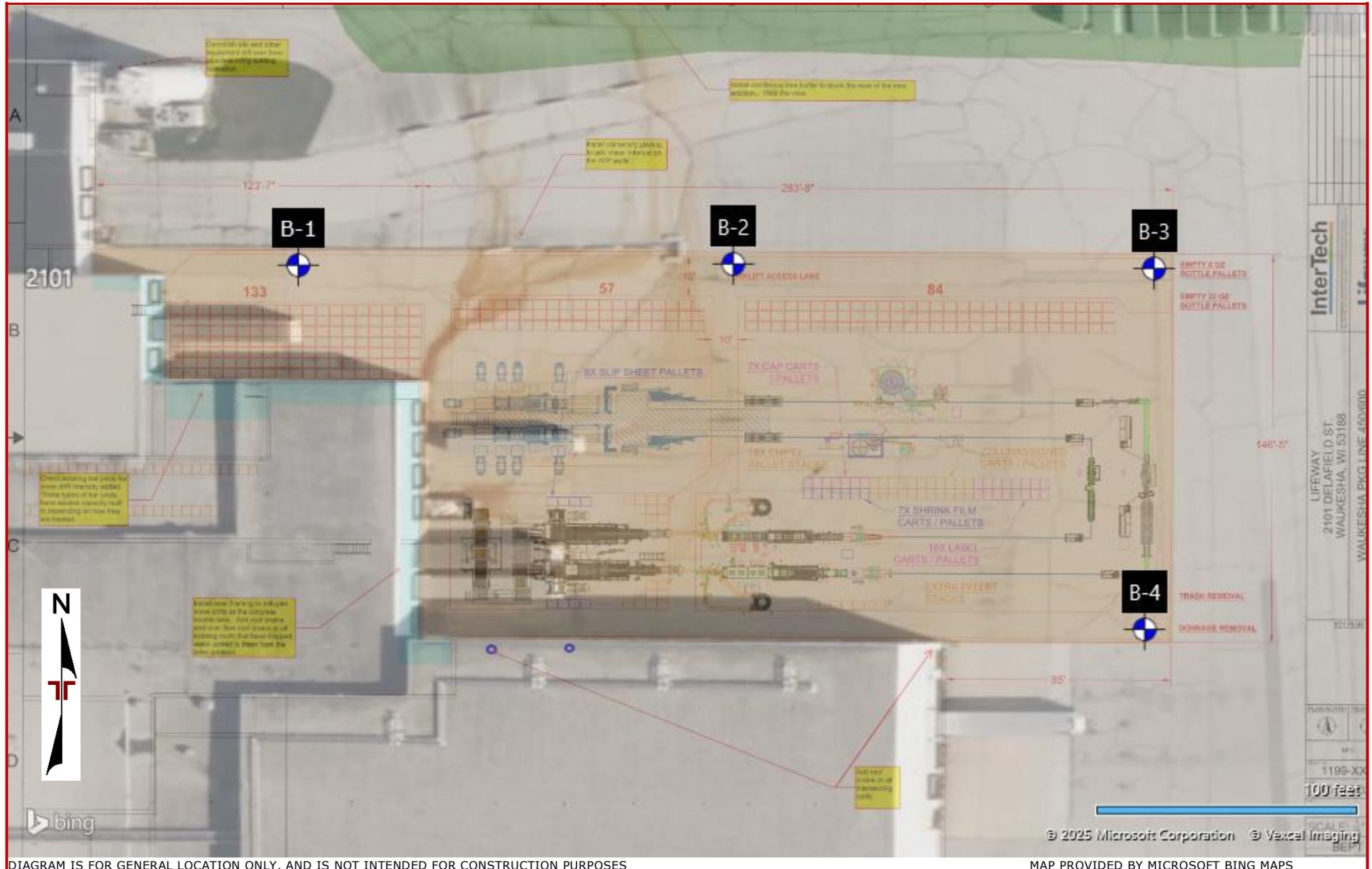


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

# Exploration and Laboratory Results

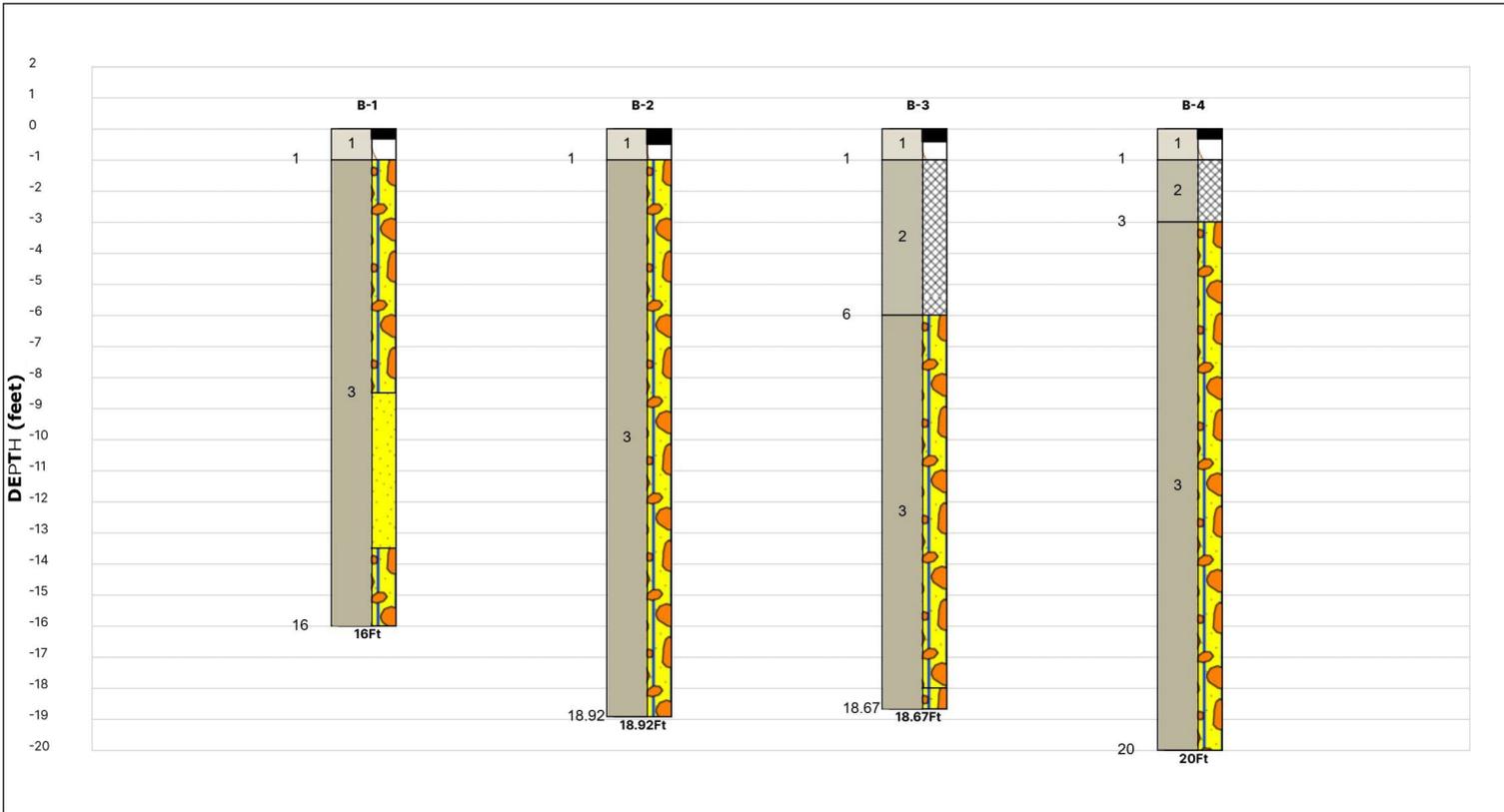
## **Contents:**

GeoModel

Boring Logs (B-1 to B-4)

Note: All attachments are one page unless noted above.

## GeoModel



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions

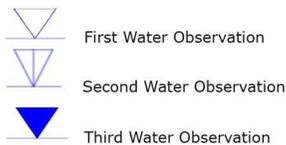
#	Layer Name	General Description
1	Surficial Material	Asphalt approximately 4 to 6 inches thick, and aggregate base course approximately 6 to 8 inches thick.
2	Existing Fill Material	Crushed rock and asphalt.
3	Native Non-Cohesive Soil	Sandy silt with gravel and poorly graded sand with trace gravel. Observed in a medium dense to very dense condition.

Legend		
	ASPHALT	
	Sandy Silt with Gravel	
	Aggregate Base Course	
	Poorly Graded Sand	

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time.  
 Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

### Notes:

Layering shown on this figure has been developed by the geotechnical engineer for purpose of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.  
 Numbers adjacent to soil column indicate depth below ground surface.



## BORING LOG NO. B-1

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	
1		0.3	<b>ASPHALT</b> , (4" thick)		-0.3					
		1.0	<b>AGGREGATE BASE COURSE</b> , (8" thick)		-1.0					
3			<b>SANDY SILT WITH GRAVEL (ML)</b> , brown, moist, medium dense to dense, possible fill			X	10	5-12-8 N = 20	6	
				5		X	18	5-11-7 N = 18	5.9	
					5		X	18	7-18-18 N = 36	5.8
					10		X	18	8-22-45 N = 67	0.9
					15		X	18	17-27-39 N = 66	5.9
		8.5	<b>POORLY GRADED SAND (SP)</b> , trace gravel, fine to medium grained, tan, dry, very dense		-8.5					
		13.5	<b>SANDY SILT WITH GRAVEL (ML)</b> , brown, moist, very dense, possible cobbles and boulders		-13.5					
			<b>Boring Refusal at 16 Ft</b>							

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (if any).  
 See Supporting Information for explanation of symbols and abbreviations.

**Notes**

**Water Level Observations**

Groundwater not encountered

**Abandonment Method**

Boring backfilled with auger cuttings and bentonite chips. Surface capped with concrete upon completion.

**Drill Rig**  
 Subcontractor-7822DT Geoprobe

**Hammer Type**  
 Automatic

**Driller**  
 CS Drilling

**Logged By**  
 Jordan A

**Boring Started**  
 11/07/2025

**Boring Completed**  
 11/07/2025

## BORING LOG NO. B-2

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)
1		0.5	<b>ASPHALT</b> , (6" thick)		-0.5				
		1.0	<b>AGGREGATE BASE COURSE</b> , (6" thick)		-1.0				
3			<b>SANDY SILT WITH GRAVEL (ML)</b> , brown, moist, medium dense to very dense	5		X	16	5-8-12 N = 20	5.6
				10		X	18	13-24-34 N = 58	6.7
				10		X	18	15-31-19 N = 50	6.5
				10		X	18	15-38-48 N = 86	4.5
				15		X	9	26-50/3"	7.6
				18.92		X	3	50/5"	3.7
			<b>Boring Terminate at 18.92 Ft</b>						

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).  
 See Supporting Information for explanation of symbols and abbreviations.

**Notes**

**Water Level Observations**

Groundwater not encountered

**Abandonment Method**

Boring backfilled with auger cuttings and bentonite chips. Surface capped with concrete upon completion.

**Drill Rig**

Subcontractor-7822DT Geoprobe

**Hammer Type**

Automatic

**Driller**

CS Drilling

**Logged By**

Jordan A

**Boring Started**

11/07/2025

**Boring Completed**

11/07/2025

## BORING LOG NO. B-3

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)
1	ASPHALT	0.4	<b>ASPHALT</b> , (5" thick)		-0.4				
	AGGREGATE BASE COURSE	1.0	<b>AGGREGATE BASE COURSE</b> , (7" thick)		-1.0				
2	FILL		<b>FILL</b> - crushed rock, brown and white			X	3	18-50/5"	2.4
						X	5	11-33-36 N = 69	0.9
3	SANDY SILT WITH GRAVEL	6.0	<b>SANDY SILT WITH GRAVEL (ML)</b> , brown, moist, very dense		-6.0	X	16	20-48-48 N = 96	5.4
						X	18	25-46-44 N = 90	4.5
						X	13	21-40-50/1"	7.6
		18.0	grayish brown		-18.0	X	1	50/2"	3.7
			<b>Boring Terminate at 18.67 Ft</b>						

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (if any).  
 See Supporting Information for explanation of symbols and abbreviations.

**Notes**

**Water Level Observations**

Groundwater not encountered

**Abandonment Method**

Boring backfilled with auger cuttings and bentonite chips. Surface capped with concrete upon completion.

**Drill Rig**

Subcontractor-7822DT Geoprobe

**Hammer Type**

Automatic

**Driller**

CS Drilling

**Logged By**

Jordan A

**Boring Started**

11/07/2025

**Boring Completed**

11/07/2025

## BORING LOG NO. B-4

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)
1	[Solid black box]	0.3	<b>ASPHALT</b> , (4" thick)		-0.3				
	[Cross-hatched box]	1.0	<b>AGGREGATE BASE COURSE</b> , (8" thick)		-1.0				
2	[Cross-hatched box]		<b>FILL</b> - crushed asphalt				2	50/4"	2.1
	[Cross-hatched box]	3.0			-3.0				
	[Yellow box with orange dots]		<b>SANDY SILT WITH GRAVEL (ML)</b> , brown, dense to very dense						
3	[Yellow box with orange dots]			5		X	18	8-17-14 N = 31	8.1
	[Yellow box with orange dots]					X	18	7-17-23 N = 40	7.2
	[Yellow box with orange dots]			10		X	18	9-16-22 N = 38	9.4
	[Yellow box with orange dots]					X	8	38-50/4"	5.2
	[Yellow box with orange dots]			15		X	18	26-47-49 N = 96	5.3
			<b>Boring Terminate at 20 Ft</b>						

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (if any).  
 See Supporting Information for explanation of symbols and abbreviations.

**Notes**

**Water Level Observations**

Groundwater not encountered

**Abandonment Method**

Boring backfilled with auger cuttings and bentonite chips. Surface capped with concrete upon completion.

**Drill Rig**

Subcontractor-7822DT Geoprobe

**Hammer Type**

Automatic

**Driller**

CS Drilling

**Logged By**

Jordan A

**Boring Started**

11/07/2025

**Boring Completed**

11/07/2025

## Supporting Information

### **Contents:**

General Notes

Unified Soil Classification System

Note: All attachments are one page unless noted above.

# General Notes

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS		
SAMPLING	WATER LEVEL	FIELD TESTS
 <b>Auger</b>  <b>Split Spoon</b>  <b>Shelby Tube</b>  <b>Macro Core</b>  <b>Ring Sampler</b>  <b>Rock Core</b>  <b>Grab Sample</b>  <b>No Recovery</b>	 Water Initially Encountered  Water Level After a Specified Period of Time  Water Level After a Specified Period of Time Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Subsurface water level variations will occur over time. In low permeability soils, accurate determination of subsurface water levels is not possible with short term water level observations.	<b>(HP) Hand Penetrometer</b> <b>(T) Torvane</b> <b>(b/f) Standard Penetration Test (blows per foot)</b> <b>(PID) Photo-Ionization Detector</b> <b>(OVA) Organic Vapor Analyzer</b> <b>(DCP) Dynamic Cone Penetrometer</b>

**DESCRIPTIVE SOIL CLASSIFICATION**

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

**LOCATION AND ELEVATION NOTES**

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

**STRENGTH TERMS**

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve) Density determined by Standard Penetration Resistance		CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve) Consistency determined by laboratory shear strength testing, field visual-manual procedures, or standard penetration resistance		
Descriptive Term (Density)	Standard Penetration or N-Value Blows/Ft.	Descriptive Term (Consistency)	Unconfined Compressive Strength, Qu, tsf	Standard Penetration or N-Value Blows/Ft.
Very Loose	0 - 3	Very Soft	Less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

**RELATIVE PROPORTIONS OF SAND AND GRAVEL**

Descriptive term(s) of other constituents	Percent (%) of dry weight
Trace	< 15
With	15 - 29
Modifier	> 30

**RELATIVE PROPORTIONS OF FINES**

Descriptive term(s) of other constituents	Percent (%) of dry weight
Trace	< 5
With	5 - 12
Modifier	> 12

**GRAIN SIZE TERMINOLOGY**

Major component of sample	Particle size
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm)
Silt or Clay	Passing #200 sieve (0.075mm)

**PLASTICITY DESCRIPTION**

Term	Plasticity Index
Non plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

# Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests <sup>A</sup>				Soil Classification		
				Group Symbol	Group Name <sup>B</sup>	
<b>Coarse-Grained Soils:</b> More than 50% retained on No. 200 sieve	<b>Gravels:</b> More than 50% of coarse fraction retained on No. 4 sieve	<b>Clean Gravels:</b> Less than 5% fines <sup>C</sup>	$Cu \geq 4$ and $1 \leq Cc \leq 3$ <sup>E</sup>	GW	Well-graded gravel <sup>F</sup>	
			$Cu < 4$ and/or $[Cc < 1$ or $Cc > 3.0]$ <sup>E</sup>	GP	Poorly graded gravel <sup>F</sup>	
		<b>Gravels with Fines:</b> More than 12% fines <sup>C</sup>	Fines classify as ML or MH	GM	Silty gravel <sup>F, G, H</sup>	
			Fines classify as CL or CH	GC	Clayey gravel <sup>F, G, H</sup>	
	<b>Sands:</b> 50% or more of coarse fraction passes No. 4 sieve	<b>Clean Sands:</b> Less than 5% fines <sup>D</sup>	$Cu \geq 6$ and $1 \leq Cc \leq 3$ <sup>E</sup>	SW	Well-graded sand <sup>I</sup>	
			$Cu < 6$ and/or $[Cc < 1$ or $Cc > 3.0]$ <sup>E</sup>	SP	Poorly graded sand <sup>I</sup>	
		<b>Sands with Fines:</b> More than 12% fines <sup>D</sup>	Fines classify as ML or MH	SM	Silty sand <sup>G, H, I</sup>	
			Fines classify as CL or CH	SC	Clayey sand <sup>G, H, I</sup>	
<b>Fine-Grained Soils:</b> 50% or more passes the No. 200 sieve	<b>Silts and Clays:</b> Liquid limit less than 50	<b>Inorganic:</b>	$PI > 7$ and plots above "A" line <sup>J</sup>	CL	Lean clay <sup>K, L, M</sup>	
			$PI < 4$ or plots below "A" line <sup>J</sup>	ML	Silt <sup>K, L, M</sup>	
		<b>Organic:</b>	$\frac{LL \text{ oven dried}}{LL \text{ not dried}} < 0.75$	OL	Organic clay <sup>K, L, M, N</sup>	
					Organic silt <sup>K, L, M, O</sup>	
	<b>Silts and Clays:</b> Liquid limit 50 or more	<b>Inorganic:</b>	PI plots on or above "A" line	CH	Fat clay <sup>K, L, M</sup>	
			PI plots below "A" line	MH	Elastic silt <sup>K, L, M</sup>	
		<b>Organic:</b>	$\frac{LL \text{ oven dried}}{LL \text{ not dried}} < 0.75$	OH	Organic clay <sup>K, L, M, P</sup>	
					Organic silt <sup>K, L, M, Q</sup>	
<b>Highly organic soils:</b>	Primarily organic matter, dark in color, and organic odor			PT	Peat	

- <sup>A</sup> Based on the material passing the 3-inch (75-mm) sieve.
- <sup>B</sup> If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
- <sup>C</sup> 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.
- <sup>D</sup> 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.
- <sup>E</sup>  $Cu = D_{60}/D_{10}$      $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
- <sup>F</sup> If soil contains  $\geq 15\%$  sand, add "with sand" to group name.
- <sup>G</sup> If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
- <sup>H</sup> If fines are organic, add "with organic fines" to group name.
- <sup>I</sup> If soil contains  $\geq 15\%$  gravel, add "with gravel" to group name.
- <sup>J</sup> If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
- <sup>K</sup> If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
- <sup>L</sup> If soil contains  $\geq 30\%$  plus No. 200 predominantly sand, add "sandy" to group name.
- <sup>M</sup> If soil contains  $\geq 30\%$  plus No. 200, predominantly gravel, add "gravelly" to group name.
- <sup>N</sup>  $PI \geq 4$  and plots on or above "A" line.
- <sup>O</sup>  $PI < 4$  or plots below "A" line.
- <sup>P</sup>  $PI$  plots on or above "A" line.
- <sup>Q</sup>  $PI$  plots below "A" line.

