CIVIL SOLUTIONS
ENGINEERING THE EARTH®

GEOTECHNICAL ENGINEERING REPORT

Grandview Reserve Development
Alexandria, Kentucky

March 5, 2026
Project No.: 25-1055

Prepared For:
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Mason, Ohio

Prepared By:
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March 5, 2026

D.R. Horton, Inc.
4705 Duke Dr. Ste. 250
Mason, OH 45040

Attn: [redacted]
P: [redacted]
E: [redacted]

Re: Geotechnical Engineering Report
Grandview Reserve Development
1671 Grandview Rd, Alexandria, KY 41001
Project No. 25-1055

Dear [redacted]:

Civil Solutions has completed a geotechnical study for the above-referenced project. This study was performed in general accordance with our proposal number 25-5176 dated April 17, 2025. This report presents our findings of the subsurface exploration and contains geotechnical recommendations relative to the design and construction of the proposed residential development, comprising 44 single-family homes, a detention pond, two retaining walls, and a community space with a gazebo structure.

We appreciate the opportunity to be of service to you on this project. Please contact us if you have any questions concerning this report or if we may be of further assistance as the project develops.

Sincerely,
Civil Solutions

Katie Reichert

Andrew Lageman
Andrew Lageman (Mar 5, 2026 10:41:41 EST)

Katie Reichert, P.E.
Project Engineer

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1.0 INTRODUCTION

1.1. Purpose & Scope of Work

A geotechnical engineering report has been completed for the project located at 1671 Grandview Road in Alexandria, Kentucky. The report assesses the existing soil conditions and provides recommendations for the design and construction of the proposed residential development. The study included excavating 14 test pits to a maximum depth of 8.5 feet beneath the existing ground surface, collecting and visually classifying soil samples, formulating geotechnical recommendations, and preparing this report.

These services were performed to provide geotechnical engineering recommendations relative to:

- Site soil and rock conditions
- Site preparation
- Earthwork and benching
- Fill placement
- Foundation design and construction
- Seismic site classification
- Pavement design and construction
- MSE retaining wall design and construction
- Detention space

2.0 PROJECT INFORMATION

The property is located at 1671 Grandview Drive in Alexandria, Kentucky. It is approximately 31 acres in size and is currently undeveloped. A residential development, including 43 single-family homes, has been proposed for the site. Additionally, the development features a detention pond, two site retaining walls, and a community space with a gazebo structure.

The property contains a maximum elevation of approximately 820.0 feet MSL near the western boundary at Grandview Road. From the ridge at the center of the property, the slope decreases to the east, west, and south to a minimum level of 656.0 feet MSL. The slopes terminate into existing streams.

Extensive earthwork and fill placement are proposed to construct the individual building lots. Topography for this project was referenced from the Northern Kentucky Geographic Information System, and Cardinal Engineering completed site civil plans.

Figure 1: *Project Aerial*

Figure 2: *Proposed Development Plan Provided by Client*

3.0 FIELD EXPLORATION AND VISUAL CLASSIFICATION

3.1. Field Exploration

Test pits were performed with a mini-excavator to assess the existing subsurface conditions. The Test Pit Location Plan in the appendix shows the test locations marked in the field by Civil Solutions personnel.

Selected soil samples were collected and stored to maintain moisture and integrity. Groundwater observations were documented during and immediately following excavation. After their completion, the test pits were backfilled with the excavated material.

The Civil Solutions geotechnical engineer maintained logs during the excavations, including descriptions of the materials encountered, the depths at which the soil strata changed, levels at which groundwater or seepage was encountered, and other pertinent information developed during excavation operations.

4.0 ENCOUNTERED SUBSURFACE CONDITIONS

The general subsurface profile at the site consisted of a layer of topsoil and undocumented fill underlain by cohesive native soils, completely weathered shale, and interbedded shale and limestone bedrock. Generalized descriptions of each major soil stratum encountered during our subsurface exploration are included below. A summary of the encountered soil stratum is provided in *Table 1: Summary of Encountered Soil Stratum*. Please refer to the site observation report in the appendix for specific details and descriptions of each collected soil sample. The stratification boundaries represent the approximate location of changes in soil; however, the transition between materials may be gradual in situ.

Table 1 - Summary of Encountered Soil Stratum

Soil Layer	Classification	Description
1	Existing Fill	Brown, lean clay
2	Native Cohesive	Brown and gray, lean clay with silt
3	Weathered Shale & Interbedded Limestone	Brown and gray shale with limestone slabs

4.1. Overburden Soils

Existing fill soils were encountered in 1 of the 14 test pits performed at the site. The fill extended 18 inches below the existing grade. Compaction records for the existing fill soils are not available. Therefore, this material is considered undocumented.

Fine-grained, native, cohesive soils were encountered beneath the existing fill layer or beneath existing grades where no fill was encountered. The material was classified as brown lean and fat clay with silt. Some root hairs and organics were also present in this layer. This native clay was encountered to a maximum depth of 6.0 feet below the existing grades.

Fat clays were encountered in the upper three feet of test pits TP-2, TP-3, TP-9, TP-11, TP-12 and TP-13. Plastic clays are sensitive to changes in moisture and can experience large volume changes. These clays are also susceptible to creep-type movements on even moderately sloped hillsides. Foundations bearing in this material should be extended below the active zone (the depth below the ground surface subject to changing moisture conditions). Sump pumps, drains, and vegetation can cause shrinkage of this material that may cause damage to structures.

4.2. Bedrock

Weathered shale and interbedded limestone were encountered at each of the test pit locations. The depth of rock is summarized in *Table 2: Summary of Stratification Depths*. The bedrock was classified as brown to gray weathered shale and limestone. The amount of weathering of the shale rock generally decreased with depth. This material is very soft in terms of rock hardness.

Table 2 - Summary of Stratification Depths

Test Pit	Native Clay (ft.)	Brown Weathered Shale (ft.)	Interbedded Shale & Limestone (ft.)
TP-1	0.0 - 2.5	2.5 - 5.7	5.7+
TP-2	0.0 - 2.0	2.0 - 4.0	4.0+
TP-3	0.0 - 3.0	3.0 - 4.3	4.3+
TP-4	0.0 - 3.0	3.0 - 7.5	7.5+
TP-5	0.0 - 5.0	5.0 - 6.0	6.0+
TP-6	0.0 - 6.0	6.0 - 8.0	8.0+
TP-7	0.0 - 5.0	5.0 - 6.5	6.5+
TP-8	N.E.	0.0 - 4.0	4.0+
TP-9	0.0 - 3.0	3.0 - 4.3	4.3+
TP-10	0.0 - 2.0	N.E.	2.0+
TP-11	0.0 - 2.0	2.0 - 3.0	3.0+
TP-12	0.0 - 3.0	3.0 - 4.0	4.0+
TP-13	0.0 - 3.0	N.E.	3.0+
TP-14	0.0 - 4.0	N.E.	4.0+
**N.E. - Layer was not encountered at the test pit location			

Based on regional geologic mapping and site reconnaissance, the parent bedrock underlying the subject property consists of interbedded units of the Fairview Formation and the Kope Formation, both of Upper Ordovician age.

The Kope Formation is characterized by fissile, fossiliferous shale interbedded with thin limestone layers. It is generally weak, highly weathered near the surface, and prone to slaking, slope instability, and poor drainage characteristics. The Kope Formation can degrade into a soft, clay-like material when exposed to moisture and air.

The Fairview Formation, which conformably overlies the Kope, comprises a greater proportion of limestone beds alternating with shale, giving it slightly improved mechanical stability relative to the Kope.

4.3. Groundwater

The test pits were observed while drilling and immediately after completion for the presence and level of groundwater. Groundwater seepage was encountered in test pit TP-5 at an approximate depth of 6.0 feet. This was not unexpected because TP-5 was performed at the toe of the slope and adjacent to an existing creek.

Short-term levels do not necessarily represent the static groundwater table at the site. Groundwater level fluctuations occur due to seasonal variations in rainfall, runoff, and other factors that may not have been present when the test pits were performed. A longer period may be necessary for a groundwater level to develop and stabilize within an excavation of these materials.

5.0 CONCLUSIONS AND RECOMMENDATIONS

These recommendations are based on our understanding of the project, discussions with the client, recent field testing, and previous geotechnical engineering experience throughout the region. Building loads were unavailable for review before the completion of this report. Once the final building structural loads are known, we can finalize our recommendations as an addition to our current scope of work.

5.1. Site Preparation

The site is predominantly undeveloped but contains a gravel road and a detention pond. All topsoil, undocumented fill soils, vegetation, and root mats should be removed within the proposed structural areas (building footprint, entrance drive, paved driveways, retaining walls, and detention space). Topsoil is unsuitable for reuse as structural fill and should be hauled off-site or stockpiled for reuse in landscaping areas.

Mature trees located within or near the structural areas will require the complete removal of the root bulb before structural fill is placed or construction begins. Any tree stump holes should be thoroughly cleaned out and backfilled according to the recommendations in **Section 5.2**. The soil near the removed trees should be undercut to depths where it does not consist of significant roots and organics. Civil Solutions should be present during the site preparation to evaluate the exposed subgrade soils before building construction or the placement of structural fill.

5.2. Structural Fill

All proposed fill areas should be prepared according to **Section 5.1. Site Preparation**. Structural fills consist of materials used below or within 10 feet of proposed structures, pavements, retaining walls, or slopes.

Onsite Soils

Onsite soils can be reused in landscaping areas and selectively reused in pavement and structural areas. The soil material used for structural fill should be free of organic material (less than 4 percent), vegetation, or other deleterious substances. Lean clay, with a liquid limit of less than 40 and a maximum plasticity index of 20, is the preferred fill material. Soils with high plasticity are not recommended for use as structural fill. The maximum soil particle size should not exceed 3 inches. Soil layer 3 identified in *Table 1: Summary of Encountered Soil Stratum* is suitable for reuse based on the subsurface exploration. The actual suitability of the soils should be determined in the field during construction.

The site contains high volumes of weathered shale, which may be suitable for use as structural fill if properly prepared. Weathered shale often appears in large slabs that require mechanical breakdown before use. Shale pieces should be reduced to soil-like gradation, typically not exceeding 18 x 12 x 4 inches in dimension. Larger fragments, especially limestone floaters, must be broken down to avoid nesting and ensure uniform compaction. Water should be added uniformly to initiate slaking of shale, transforming it into a more workable and compactable mass. Heavy tamping-foot rollers are recommended for achieving proper breakdown and compaction.

The KYTC Special Shale Compaction Provision is widely referenced for success in preventing embankment failures. It includes thin lift placement, heavy compaction with vibratory and static sheepsfoot rollers, controlled water addition, and monitoring for durability and water content consistency. Field experience confirms that adopting these standards significantly reduces long-term maintenance and embankment failures.

Imported Soils

Cohesive soils imported for use as structural fill must meet all requirements in the Onsite Soils section above. They should be free of organic material (less than 4 percent), vegetation, or other deleterious substances. Lean clay, with a liquid limit of less than 40 and a maximum plasticity index of 20, is the preferred fill material. Soils with high plasticity are not recommended for use as structural fill unless they are sufficiently dried or mixed.

Granular soils meeting the USCS classification of GW and GM may also be used. The maximum soil particle size should not exceed 4 inches. The proposed import soils should be tested (Standard Proctors) and approved by the project geotechnical engineer before import and use onsite. The proposed import soils should be tested and approved by the project geotechnical engineer before import and use onsite.

Fill Placement & Compaction Requirements

Frozen material is not suitable for placement, and no fill shall be placed on a frozen subgrade.

Fill material should be placed on properly prepared subgrade in maximum 8.0-inch-thick loose lifts if compacted by heavy, self-propelled compaction equipment or in maximum 4.0 to 6.0-inch-thick loose lifts if compacted by light, hand-guided equipment.

Fill material in structural areas and slope benches must be compacted to 98% of the material's Standard Proctor maximum dry density. Fill material in non-structural areas, such as landscape areas, can be compacted to 95% of the material's Standard Proctor maximum dry density if there are no future building plans.

The moisture content of the structural fill material should be +/-3% of optimum for low-plasticity cohesive fills and +/-2% of optimum for granular fills at the time of compaction. The project geotechnical engineer should test and approve each compacted lift before placing any subsequent lifts.

Existing Pond Fill Placement & Compaction Requirements

The property includes a man-made earthen dam pond with an 18-inch culvert and a 10-foot outlet near TP-10, draining downslope. Lots 33-36 of the proposed development plans are located in the area of the existing pond. Filling the detention pond will be required to establish the proposed grading plan. Before fill placement, the pond must be dewatered. Discharge must comply with the Kentucky Clean Water Act to prevent watershed contamination.

Given the pond's proximity to future foundations and native cohesive soils, it should be over-excavated and replaced with structural fill to eliminate soft zones. Proper drainage is critical—installing an underdrain (e.g., perforated PVC pipe in gravel and filter fabric) from the pond's low point to daylight on a slope will prevent water entrapment and instability. It is important to maintain a path for water to escape from the lowest point of the excavation.

Any unsuitable soils (e.g., muck) must be replaced with competent material. Fill should be placed on prepared subgrade in ≤8.0-inch lifts (heavy equipment) or 4.0–6.0-inch lifts (light equipment), compacted to 98% Standard Proctor maximum dry density (95% in non-structural areas). Moisture content should be ±3% of optimum for cohesive fills and ±2% for granular. Each lift must be tested and approved by the geotechnical engineer.

5.3. Temporary Excavations

Open-cut excavations can be utilized onsite where sufficient space exists between existing structures and the proposed excavation. It is recommended that open-cut excavations deeper than 4.0 feet and less than 20.0 feet be performed per the *OSHA Technical Manual Section V: Chapter 2 - Excavations: Hazard Recognition in Trenching and Shoring*. The encountered soil layers are presented in Table 3 - OSHA Soil Types & Excavation Layback with their designated OSHA soil type and maximum height-to-depth ratio.

Table 3 - OSHA Soil Types & Excavation Layback

Soil Layer	Classification	OSHA Soil Type	Length:Depth Ratio
1	Existing Fill	Type C	1-1/2 : 1
2	Native Cohesive	Type B	1 : 1
3	Weathered Shale & Interbedded Limestone	Stable Rock	Vertical

It is recommended that temporary slopes be examined periodically to evaluate any potential destabilizing effects of surface water erosion or subsurface seepage conditions. Some sloughing of excavation side slopes may occur, requiring remedial work, redressing, or removal. The open-cut excavations will likely be exposed to varying weather conditions. Geotextile fabrics, heavy-duty tarps, heavy-mil plastics, or other forms of protective blankets could be placed to protect the excavation slopes from climatic factors. These protections should be placed before rain events and removed immediately afterward to allow the slopes to dry.

Soils should not be stockpiled on or at the crest of the slopes, as this may destabilize the excavation. A professional engineer should design all permanent and proposed cuts near existing structures or infrastructure.

5.4. Utilities

Soft or unsuitable materials should be removed from the bottom of utility trench excavations and replaced with structural fill or appropriate bedding material. Trenching parallel to existing foundations should be avoided below a 1:1 line projected from the bottom outside edge of the footing. All trench excavations should be completed according to **Section 5.3. Temporary Excavations**.

Utility trenches should be backfilled with approved onsite or imported soils from one foot above the utility to the proposed grade. All backfill must meet the requirements and be placed and compacted with lightweight compaction equipment, according to **Section 5.2. Structural Fill**.

Utility trenches under buildings should be sealed with a trench plug to prevent water infiltration into the buildings. The plug should encapsulate the utility and consist of clay or CDF. The plug should extend a minimum of 5 feet from the edge of the building.

5.5. Foundation Recommendations

Weathered shale and interbedded limestone bedrock was encountered in the upper 8.0 feet across the project site. Shallow spread footings bearing in stiff lean clay or weathered shale bedrock are appropriate for the proposed structures. We anticipate basement excavations will penetrate the bedrock. Bearing in native lean clay or structural fill is also appropriate if the structures do not have basements, or if the basement excavations do not encounter bedrock. Fat clay is unsuitable for direct foundation support due to its heightened risk of shrink and swell with fluctuating moisture conditions.

Spread Footings

Bearing all footings within the same material is essential, as differential settlement may occur from bearing foundations on varying soil conditions. If any portion of the basement excavation encounters weathered shale, the remaining excavation should be undercut to also bear in weathered shale. The undercut may be backfilled with compacted engineered fill or lean concrete as depicted in Figure 3.

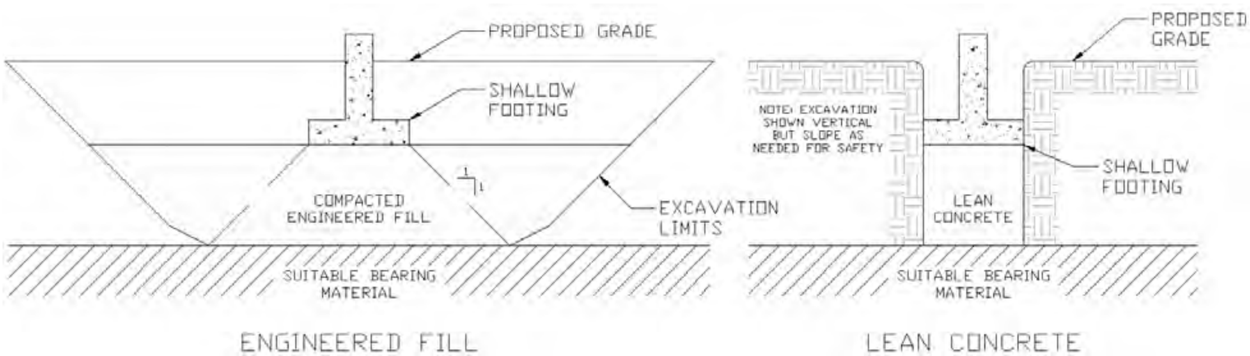

Figure 3: *Undercut Backfill Options*

Rectangular/square and strip footings within stiff lean clay or highly weathered brown shale can be designed for a maximum allowable bearing capacity of 3,000 psf and 6,000 psf, respectively. Regardless of the possibility that loadings would allow for smaller sizes, rectangular/square and strip footings should not be less than 24 inches and 18 inches wide, respectively.

Following the foundation excavation, the bearing subgrade must be closely inspected by a geotechnical engineer's representative before the steel and concrete placement. Footing inspections should include visual assessment and hand auger probes to identify the presence of weak or yielding zones.

Following approval of the bearing subgrade by geotechnical personnel, reinforcing steel and concrete may be placed in the foundation excavation. All concrete shall be placed neatly against the excavation walls to avoid forming and backfilling. Drainage shall be maintained away from foundations both during and after construction.

Onsite soils consisting of native clay and shale experience volume changes with fluctuations in moisture content. For this reason, concrete should be placed on the same day excavations are performed, and care shall be taken to avoid significant changes in moisture content. All footing excavations shall be free of loose debris or water during concrete placement.

Planters and other mulched landscaping areas surrounding the residences must be properly drained. Planters shall not be permitted to drain into utility trenches, which could carry water to the foundation area. Trees shall not be planted within 20 feet of the structures. If large-diameter trees are proposed, they should be planted at least the distance of the mature drip line plus the distance of 10 feet away from the structures. This reduces the potential of transpiration taking moisture from the foundation soil, resulting in a shrinkage of bearing soils.

Lastly, underground utility service trenches that enter the residences shall be sloped away from the buildings and backfilled with free-draining, granular material. The purpose of this configuration is to minimize the potential for moisture outside of the building to migrate to the foundation areas and to drain the interior portion of the residences during construction.

5.6. Lateral Earth Pressure – Subsurface Retaining Walls

Several retaining walls and subsurface retaining walls (basement walls) are anticipated throughout the development. The magnitude and distribution of the lateral earth pressure depend on the wall type, size, and degree of restraint against rotation at its top, surcharge load and distribution, backfill type, and compaction. Walls categorized as unyielding or "rigid" are designed for at-rest earth pressure. Alternatively, free-standing walls that can experience deflection are designed for active earth pressure. Recommended at-rest and active earth pressure cases are provided below:

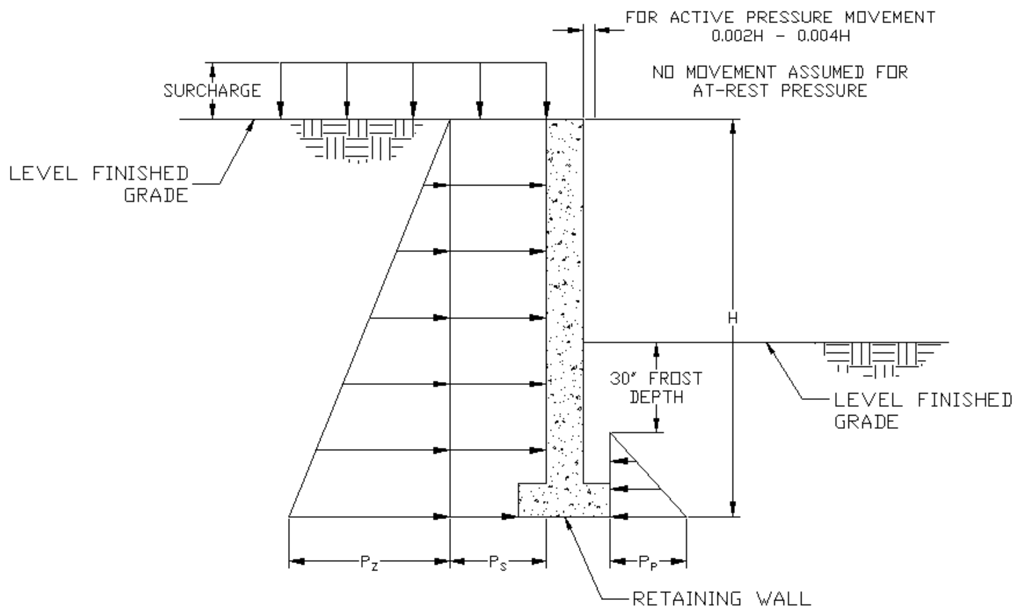

Figure 4: *Lateral Earth Pressure Diagram*

Table 4: Lateral Earth Pressures

Earth Pressure Condition[1]	Coefficient for Material Type[1]		Equivalent Fluid Pressures (psf)[1,2,3]
Active (k_a)	Fine-Grained	0.41	(50)H
At-Rest (k_o)	Fine-Grained	0.58	(70)H
Passive (k_p)[4]	Fine-Grained	2.46	(295)H

1. Based on a maximum moist unit weight of γ = 120 pcf and the following internal friction angles: Fine-Grained = 25°
2. Assumes an unsaturated condition and proper installation of recommended drainage materials
3. Does not include construction surcharges
4. For structure embedments below frost zone

The above parameters assume that the wall backfill is completely drained. Drainage should be provided using a minimum of 3 feet of relatively well-graded, free-draining granular material having no more than 7 percent passing the No. 200 sieve behind the wall. Backfill should be placed in loose lifts having a maximum 4 to 6-inch thickness. Each lift should be compacted to 98% maximum dry density (Standard Proctor, ASTM D 698).

Hand compaction equipment should be utilized within 5 feet of the wall face to avoid over-stressing the wall. The use of heavy compaction equipment should be avoided near the walls. To prevent surface water runoff from directly infiltrating the granular backfill, a layer of cohesive soil (12 to 18 inches thick) should cap the surface of the granular backfill and be sloped away from the wall.

Positive drainage must be provided through foundation drains. Wall drains shall consist of a minimum 4-inch-diameter perforated drain pipe surrounded by 6 to 8 inches of clean, coarse, free-draining gravel. The gravel shall be encased in a suitable geotextile fabric to minimize siltation of fines into the gravel. Proper drainage must be provided to prevent the development of hydrostatic pressure behind the walls. Allowing hydrostatic pressure to accumulate will result in lateral earth pressures substantially higher than previously recommended.

5.7. Segmental Retaining Wall

Two retaining walls are proposed across the development to support the proposed excavation and fill placement. Wall #1 extends approximately 310 feet in the east-west direction north of the proposed paved drive. The retaining wall supports the existing grade above the proposed excavation for the building pads (cut wall). Retaining Wall #2 extends approximately 80 feet in the east-west direction north of the proposed excavation. The retaining wall supports the existing grade at the property boundary.

Figure 5: *Aerial view with construction overlay of retaining walls*

Segmental Retaining Wall

A segmental retaining wall is appropriate to support the proposed excavations across the site. A gravity wall system is preferred over an MSE system due to the proximity of property lines and limits of excavations. Specifically, a Redi Rock gravity wall system is proposed.

Test pits TP-8 and TP-9 were excavated near the proposed wall alignments. These test pits encountered varying depths of native cohesive material overlying weathered shale bedrock. The approximate elevations of existing grade, proposed grade, and bedrock are presented in Table 5 - Anticipated Bedrock Elevation Along Retaining Wall.

Table 5 - Anticipated Bedrock Elevation Along Retaining Wall

Test Pit No.	Test Pit Location	Existing Grade (ft.)	Proposed Grade (ft.)	Bedrock Elevation (ft.)
TP-8	Wall 1	806.0*	802.0	806.0
TP-9	Wall 2	810.0*	800.0	807.0

**Elevations referenced from the proposed site plan prepared by Cardinal Engineering*

We recommend bearing the retaining wall foundations in weathered shale bedrock. It is important to bear the entire wall on the same material to mitigate the potential for differential settlement. If shale is deeper than anticipated in localized areas, overexcavation and replacement with properly compacted crushed stone or engineered fill may be used to re-establish a competent leveling pad subgrade, subject to geotechnical approval.

The proposed retaining walls will support head slopes and/or toe slopes. The wall designer must account for these conditions and incorporate the necessary embedment. The retaining wall system should be designed in accordance with the National Concrete Masonry Association (NCMA) design guidelines, including the procedures outlined in NCMA Design Manual for Segmental Retaining Walls, as well as the manufacturer's specifications for the Redi-Rock system.

Segmental Retaining Wall Construction

Construction of the two retaining walls may commence once the site has been adequately cleared of deleterious material. Upon completion of the site excavations, geotechnical personnel should examine the foundation soil to confirm its suitability for supporting the retaining wall.

Once approved, a 12-inch angular aggregate leveling pad will be placed atop the foundation soil. The leveling pad strengthens the base of the wall and provides a level surface upon which to lay the first course of blocks. It is recommended that the leveling pad be compacted to a minimum of 98% standard proctor before laying the wall units.

Water management is of utmost importance throughout construction and thereafter. Surface water should not be permitted to pond near the top or toe of the wall. The property upslope of the wall should be graded to route water away from the retaining wall location and prevent water from flowing over the top of the wall. In addition, four-inch diameter drain pipes should be installed every 50 feet which daylight through the face of the retaining wall. The purpose of the drain pipes is to prevent hydrostatic pressure from accumulating behind the wall face.

Upon completion of the wall construction and backfill placement, a 6-inch cap should be placed above the wall. Topsoil and grass may also be planted to restore the site to its previous ground conditions.

5.8. Fill Slope Construction

A large fill slope is proposed across the southern portion of the development to raise the grade and create level plots for residential construction. Fill material should be placed in horizontal lifts and should be adequately benched into the natural slope per the criteria discussed below.

Fill operations should commence at the lowest part of the slope in the proposed fill areas. The structural fill should be placed in horizontal lifts and should be adequately benched into the natural slope. Slope benches should expose weathered or unweathered shale and limestone bedrock. A keyway should be constructed at the lowest part of the fill slope and should extend a minimum of 3 feet within shale and limestone bedrock. The base of the keyway should have a minimum width of 10 feet, and should slope back into the hillside at a 1% grade.

The initial bench above the keyway should be at least 10 feet in width and should expose horizontally bedded shale and limestone bedrock. The entire base of these benches should be cut into shale and limestone bedrock. In addition, the base of these benches should be sloped slightly downward into the slope at a 1% grade.

Bench drains should be installed at the back edge of the benches, consisting of a minimum of 6 inches of washed 57 stone on all sides of a 6-inch perforated plastic drain tile. An outlet should be provided every 50 feet.

The remaining benches constructed upslope from the toe benches should be at least 8 feet wide and configured such that the maximum bench width-to-height ratio does not exceed 2H:1V. After removing the overburden soils, the structural fill could then be benched into natural overburden soils of at least stiff consistency.

We recommend that all fill slopes be constructed at a 2.5H:1V slope or flatter to reduce potential sloughing. The controlled fill slopes should be built steeper than 2.5H:1V and then cut back to the planned slope to provide a well-compacted face. These slopes should be seeded/fertilized and mulched as soon as practical.

The structural fill material should be free of organics, topsoil, debris, or other deleterious substances. We recommend that all structural fill be placed in 8-inch maximum loose lifts and compacted to 98% of the maximum standard proctor density, as determined by ASTM D 698. It is recommended that the moisture content of cohesive fill soils (PI>10) be adjusted to within ±3% of the optimum moisture content. Less plastic soils (PI<10) should have a moisture content within +2% of optimum when placing and compacting the soil.

The predominant materials to be excavated within the project site will likely be topsoil, medium stiff to stiff native cohesive soils, and weathered shale bedrock. Past experience has shown that the highly weathered shale can be excavated using conventional excavating equipment. All limestone floaters and slabs encountered within the overburden and bedrock material should be broken down to a maximum 18 x 12 x 4-inch-thick dimension before incorporation into the engineered fill. No nesting of limestone floaters should be allowed.

Each fill lift should be compacted to at least 98% of the Standard Proctor Density as established by ASTM D 698 as confirmed with field density testing. We recommend that the moisture content and density specifications carry equal weight in determining a satisfactory test result. Construction monitoring and testing by a geotechnical representative throughout structural fill operations is recommended.

Once the excavations, benching, and fill placement are completed, the slope should be seeded/sodded.

5.9. Cut Slope Construction

Site excavations are proposed to facilitate grading of the planned residential building lots. Subsurface conditions are anticipated to consist of approximately 1 to 6 feet of native clay overlying competent weathered shale bedrock. Excavations will therefore encounter a relatively thin mantle of cohesive soil underlain by bedrock that is expected to provide adequate bearing and overall stability when properly exposed and managed during construction.

Cut slopes created to establish the building lots should be designed to account for the differing behavior of the near-surface clay and the underlying weathered shale. A minimum slope inclination of approximately 2.5H:1V or flatter is recommended to reduce the potential for sloughing or softening during wet conditions.

During excavation, the clay mantle should be removed or benched into the underlying shale so that the finished slope is properly seated in competent material and not supported by a thin veneer of clay that could detach over time. Where taller cut slopes are required, benches should be incorporated at reasonable vertical intervals to intercept minor raveling, reduce runoff velocities, and provide maintenance access.

Excavation activities should include observation of the weathered shale to identify bedding orientations, jointing, weak seams, or zones of slaking that could influence stability. If bedding planes or discontinuities are observed to daylight toward the slope face, localized flattening of the slope, additional benching, or rock stabilization measures may be warranted.

Surface water management will be important to maintain long-term slope stability. A swale or interceptor ditch should be constructed along the crest of the cut slope to prevent surface runoff from flowing over the slope face. Any seepage encountered at the interface between the clay and shale should be controlled using localized subdrain systems or other drainage measures to prevent saturation of the clay and potential erosion of the slope face. Temporary construction drainage should also be maintained during grading operations to prevent uncontrolled water discharge over freshly cut slopes.

Construction of the cut slopes and retaining wall should be performed under the observation of a qualified geotechnical professional so that subsurface conditions exposed during excavation can be evaluated and slope geometries adjusted if necessary to address localized variations in soil or rock conditions.

5.10. Slope Stability

Slopes are present throughout the subject property and adjacent to the proposed development. Hillside slippage and evidence of landslides were not identified during the site investigation. For long-term stability purposes, it is of utmost importance that:

- ❖ All building foundations be extended through the fat clay to bear within stiff lean clay or weathered shale bedrock.
- ❖ Material excavated for the structures, utilities, and retaining walls not be stockpiled on any slope for an extended amount of time.
- ❖ All planned retaining walls socket into the shale bedrock layer. Furthermore, we recommend that all proposed retaining walls be designed by Civil Solutions.
- ❖ No construction procedures inhibit positive drainage. The site plan and proposed grading plan shall incorporate all necessary drainage provisions to prevent oversaturating the slopes.

- ❖ The site grading design efficiently flattens slopes where possible and does not intentionally steepen slopes without the addition of retaining structures.
- ❖ Vegetation removal be limited to only those areas involved in the construction activities.
- ❖ All areas of land exposed during construction be revegetated and restored as soon as practical to blend with the surrounding terrain. All excavations shall have stable side slopes and be constructed so that revegetation can occur readily.
- ❖ All permitted excavation and fill operations be reviewed by a qualified soils technician under the direction of a registered professional geotechnical engineer.
- ❖ The designer takes into consideration the impact of hillside development on off-site slopes adjacent to the property (i.e. slopes that continue beyond the project limits).

Offsite Slopes

The proposed subdivision development introduces new roadway construction, lot grading, and associated stormwater conveyance features on a hillside setting with steep existing topography. In this context, "off-site slopes" include (1) existing natural hillsides beyond the limits of disturbance and property boundaries, and (2) downslope areas that may be influenced by changes in runoff, groundwater conditions, or grading near the project perimeter.

To minimize the likelihood of off-site slope instability or erosion, the following design and construction controls should be considered:

- ❖ Maintain setbacks from slope crests and toes. Keep permanent fills, building loads, and concentrated drainage features away from the top edge of off-site slopes and avoid disturbing toe areas.
- ❖ Control drainage discharge locations. Use lined conveyances where needed, provide energy dissipation at outlets, and avoid releasing concentrated flows onto steep unprotected slopes. Where feasible, match pre-development flow paths and distribute discharge.
- ❖ Limit infiltration near steep slopes. If stormwater infiltration is proposed, place facilities away from slope crests and evaluate subsurface seepage impacts; consider lined systems or underdrains where appropriate.
- ❖ Implement perimeter controls, check dams, stabilized construction entrances, and rapid revegetation. Sequence grading to minimize exposed areas and duration.
- ❖ Observe excavations and subgrade conditions during construction; monitor known seep areas; and adjust measures promptly if wet conditions or instability indicators appear.

Off-site slope impacts are most commonly driven by (1) concentrated runoff and outlet erosion, (2) changes in subsurface moisture and seepage, and (3) grading or loading near slope crests/toes. With appropriate setbacks, carefully controlled drainage routing and discharge protection, limited infiltration near steep slopes, and strong construction-phase erosion control and sequencing, the risk of adverse off-site slope effects can be reduced.

5.11. Floor Slabs

We recommend that the subgrade for the floor slabs (basement floor or unexcavated garage floors) consist of non-yielding, very stiff natural soils, highly weathered shale, or quality-controlled structural fill. Shale deteriorates and softens when exposed to freeze/thaw and wetting/drying cycles. Deteriorated shale bedrock must be removed from the exposed shale subgrade immediately before placing the granular base and floor slab concrete. A lean concrete mud mat may be considered to protect the shale bedrock from deteriorating during construction.

It is recommended that a compacted granular base consisting of KYTC dense graded aggregate specified under KYTC Standard Specification Section 805 crushed limestone, sand and gravel, or approved equivalent be placed between the approved subgrade and the floor slab. The granular base shall be at least 4 inches thick in shale subgrade areas and 6 inches thick in soil subgrade areas.

The granular base will create a leveling course to help achieve uniform slab thickness, provide uniform load transfer, and aid in curing the concrete at the top and bottom of the floor slab. If directed by the architect, a vapor barrier shall be placed between the prepared subgrade and the floor slab in areas where a floor covering is planned.

The final subgrade must be free of water or wet material. If it becomes wet due to rain or other causes, the water should be removed, and wet or water-softened soils stripped to expose drier material. The final subgrade preparation should be performed immediately before concrete placement to minimize the deterioration of the subgrade soils.

Floor slabs for the main and upper levels should be designed as structural slabs that can restrain the proposed foundation walls. A professional engineer registered in Kentucky should design the wall and slab system.

5.12. Pavement Recommendations

The pavement areas will likely be constructed predominantly on the lean clay subgrade. We recommend all pavement areas be proof-rolled with a fully loaded tandem-axle dump truck immediately before paving operations to determine the presence of soft or yielding surface soils. Weak or problematic areas identified during the proof roll must be stabilized or undercut to stable soils and replaced with engineered fill.

The pavement's performance depends significantly on proper preparation and compaction of the subgrade and drainage. The subgrade soil shall be graded properly to prevent ponding. Likewise, the pavement surface should have adequate cross-slope to facilitate positive drainage. We recommend that transverse or longitudinal slopes of 1 inch in every 10 feet be provided minimally.

Surface water runoff from the structure should be intercepted, collected, and not permitted to flow onto the proposed pavement or infiltrate the pavement base and subgrade materials. Water from rainfall, snow melt, or groundwater seepage that infiltrates the base and subgrade may reduce the subgrade bearing capacity and longevity of the pavement. We recommend using perimeter swales, edge drains, curbs, or a combination of these features.

The pavement design is assumed to be performed by others. We recommend using a subgrade California Bearing Ratio (CBR) of 3 for asphalt pavement design. A modulus of subgrade reaction of 100 PCI can be used for concrete pavement design. These values assume that the subgrade is prepared according to **Section 5.1. Site Preparation** and **Section 5.2. Structural Fill** of this report.

5.13. Detention Pond

The proposed development requires a detention pond on the northern portion with an overflow into the natural intermittent stream to the East. Structural components have not been provided throughout the proposed 65,600 cubic foot detention basin.

The detention pond structural fill should be prepared according to **Section 5.1. Site Preparation** and **Section 5.2. Structural Fill** of this report.

It is also important that the detention space be maintained to promote positive drainage. Civil Solutions recommends clearing heavy vegetation throughout the designated detention spaces. Large-growth trees, including all root bulbs, should be removed. These materials are problematic because they may block outlet structures. Blockages caused by vegetation or debris can reduce the efficiency of the drainage system.

We recommend introducing vegetation that promotes drainage near the existing detention space (i.e., ornamental grasses, low-growing shrubs, and foliage). These low-lying plants prevent erosion of the side slopes and slow water movement toward the basin.

Infiltration Considerations

It is our understanding that the proposed detention basin will be dry. Based on the recent field investigation results, we anticipate that structural fill material, native cohesive soils, and weathered shale bedrock will be present throughout the proposed detention area. The hydraulic conductivities associated with the encountered subsurface soils are not characteristic of high infiltration losses.

Based on the detention basin design, we do not anticipate steady-state flow developing within the detention area, and infiltration rates are negligible. Nonetheless, the potential for infiltration losses may be reduced by placing a 6-inch clay cap across the proposed detention basin.

6.0 CLOSING

The analysis and recommendations presented in this report are based upon the data obtained from the test pits performed at the indicated locations and other information discussed in this report. This report does not reflect variations that may occur between test pits, across the site, or due to the modifying effects of weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided as necessary.

The scope of services for this project 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. Other studies should be undertaken if the owner is concerned about the potential for such contamination or pollution.

This report has been prepared for the exclusive use of our client for specific application to the study discussed and has been prepared under generally accepted geotechnical engineering practices. No warranties, either expressed or implied, are intended or made. The conclusions and recommendations contained in this report shall not be considered valid If changes in the nature, design, or location of the study as outlined in this report are planned unless Civil Solutions reviews the changes and either verifies or modifies the conclusions of this report in writing.

OVERALL PLAN VIEW
SCALE: 1" = 60'

SCALE: 1" = 60'
0 60 120

PRELIMINARY
Apr 28, 2025

NO	REVISION	DATE
1		
2		
3		
4		
5		
6		
7		
8		
9		

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GRANDVIEW RESERVE RESIDENTIAL DEVELOPMENT

1671 GRANDVIEW ROAD
ALEXANDRIA, KENTUCKY
CAMPBELL COUNTY

TEST BORING LOCATION PLAN

FILE: Boring Location.dwg
ISSUED: 12-20-24

PLOTTED: Apr 28, 2025 - 2:30pm PLOTTED BY: kreichert
DRAWING: C:\Users\KREICH~1.CSA\AppData\Local\Temp\AcPublish_21728\Boring Location.dwg: Proposed Boring Locations (2)

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OBSERVATION REPORT

PROJECT: Grandview Reserve Development

DATE: 04/29/2025-4/30/25

ADDRESS: 1671 Grandview Rd, Alexandria, KY

CONTRACTOR: Civil Solutions

OBSERVED BY: Sarah Tomlinson

REVIEWED BY: Katie Reichert, P.E.

WEATHER: Overcast

TEMPERATURE: 65°

WORK COMPLETED PER PLAN: YES

INSPECTION NOTES: Civil Solutions reported to the site as requested. The purpose of the site visit was to monitor and document test pits for a geotechnical investigation at the site, located off Grandview Road.

The site contains multiple valleys and ridges, a manmade pond and a creek. Proposed development includes 44 homes with paved roads. A total of 14 test pits were performed across the site. See below for test pit results:

Test Pit #1:
0" - 4": Topsoil with organics and roots
4" - 8": Red clay (evidence of burn in the area)
8" - 2.5': Brown and gray lean clay with silt
2.5' - 5.7': Brown weathered shale
5.7' - 7.0: Brown shale interbedded with limestone
Test pit terminated at 7.0', refusal on limestone.

Test Pit #2:
0" - 6": Topsoil with organics and roots
6" - 2.0': Brown fat clay
2.0' - 4.0': Completely weathered brown shale
4.0' - 7.0': Brown shale interbedded with limestone
Test pit terminated at 7.0', refusal on limestone

Test Pit #3:
0" - 6": Topsoil with organics and roots
6" - 3.0': Brown fat clay
3.0' - 4.3': Completely weathered brown shale
4.3' - 7.0': Brown shale interbedded with limestone
Test pit terminated at 7.0', refusal on limestone

Test Pit #4:
0" - 6": Topsoil with organics and roots
6" - 3.0': Brown clay with silt
3.0' - 7.5': Completely weathered brown shale interbedded with limestone
7.5' - 8.5': Brown and gray weathered shale
Test pit terminated at 8.5', no refusal

Test Pit #5:
0.0' - 1.0': Topsoil/roots
1.0' - 5.0': Native lean clay with sand, moist
5.0' - 6.0': Completely weathered brown shale
6.0'+: Weathered grey and brown shale; groundwater seepage at 6.0' (test pit adjacent to creek)
Test pit terminated

Test Pit #6:
0.0’ - 0.5’: Topsoil/roots
0.5’ - 6.0’: Native lean clay with silt
6.0’ - 8.0’: Completely weathered brown shale
8.0’+: Weathered gray and brown shale
Test pit terminated

Test Pit #7:
0” - 6”: Topsoil with organics and roots
6” - 5.0’: Brown clay with silt, soft to medium stiff, moist
5.0’: Limestone layer
5.0’ - 6.5’: Brown highly weathered shale
6.5 - 8.0’: Brown and gray weathered shale
Test pit terminated, very large limestone slabs encountered

Test Pit #8:
0” - 4.0’: Brown weathered shale interbedded with limestone
Test pit terminated at 4.0’, refusal on limestone

Test Pit #9:
0” - 6”: Topsoil with organics and roots
6” - 3.0’: Brown fat clay
3.0’ - 4.3’: Completely weathered brown shale
4.3’ - 7.0’: Brown shale interbedded with limestone
Test pit terminated at 7.0’, refusal on limestone

Test Pit #10:
0” - 6”: Topsoil with organics and roots
6” - 2.0’: Brown clay with silt
2.0’ - 5.7’: Brown shale interbedded with limestone
Test pit terminated at 5.7’, refusal on limestone

Test Pit #11:
0” - 4”: Topsoil with organics and roots
4” - 2.0’: Brown fat clay
2.0’ - 3.0’: Completely weathered brown shale, manganese dioxide staining
3.0’ - 4.0’: Brown shale interbedded with limestone
Test pit terminated at 4.0’, refusal on limestone

Test Pit #12:
0” - 6”: Topsoil with organics and roots
6” - 3.0’: Brown fat clay
3.0’ - 4.0’: Completely weathered brown shale
4.0’ - 5.5’: Brown and gray shale
Test pit terminated at 5.5’, refusal on limestone

Test Pit #13:
0” - 4”: Topsoil with organics and roots
4”-1.5’: Brown clay FILL
1.5’ - 3.0’: Brown fat clay
3.0’ - 6.7’: Brown shale interbedded with limestone
Test pit terminated at 6.7’, refusal on limestone

Test Pit #14:
0” - 6”: Topsoil with organics and roots
6” - 4.0’: Native brown lean clay with sand
4.0’ - 6.5’: Brown shale interbedded with limestone
Test pit terminated at 6.5’, refusal on limestone

Test Pit #1

Test Pit #2

Test Pit #3

Test Pit #4

Test Pit #5

Test Pit #6

Large limestone slabs in Test Pit #7

Test Pit #8

Test Pit #9

Test pit #10

Test pit #11

Test pit #12

Test pit #13

Test pit #14

DESCRIPTION OF SOIL TERMS

The following terminology was used to describe soils throughout this report and is generally adapted from ASTM 2487/2488 and ODOT Specifications for Geotechnical Explorations.

Granular Soils - The relative compactness of granular soils is described as:
ODOT A-1, A-2, A-3, A-4 (non-plastic) or USCS GW, GP, GM, GC, SW, SP, SM, SC, ML (non-plastic)

Description	Blows per foot – SPT (N_{60})		
Very Loose	Below		5
Loose	5	-	10
Medium Dense	11	-	30
Dense	31	-	50
Very Dense	Over		50

Cohesive Soils - The relative consistency of cohesive soils is described as:
ODOT A-4, A-5, A-6, A-7, A-8 or USCS ML, CL, OL, MH, CH, OH, PT

Description	Blows per foot – SPT (N_{60})			Unconfined Compression (tsf)
Very Soft	Below		2	UCS ≤ 0.25
Soft	2	-	4	0.25 < UCS ≤ 0.5
Medium Stiff	5	-	8	0.5 < UCS ≤ 1.0
Stiff	9	-	15	1.0 < UCS ≤ 2.0
Very Stiff	16	-	30	2.0 < UCS ≤ 4.0
Hard	Over		30	UCS > 4.0

Gradation - The following size-related denominations are used to describe soils:

Soil Fraction		USCS Size	ODOT Size
Boulders		Larger than 12"	Larger than 12"
Cobbles		12" to 3"	12" to 3"
Gravel	coarse	3" to ¾"	3" to ¾"
	fine	¾" to 4.75 mm (¾" to #4 Sieve)	¾" to 2.0 mm (¾" to #10 Sieve)
Sand	coarse	4.75 mm to 2.0 mm (#4 to #10 Sieve)	2.0 mm to 0.42 mm (#10 to #40 Sieve)
	medium	2.0 mm to 0.42 mm (#10 to #40 Sieve)	-
	fine	0.42 mm to 0.074 mm (#40 to #200 Sieve)	0.42 mm to 0.074 mm (#40 to #200 Sieve)
Silt		0.074 mm to 0.005 mm (#200 to 0.005 mm)	0.074 mm to 0.005 mm (#200 to 0.005 mm)
Clay		Smaller than 0.005 mm	Smaller than 0.005 mm

Modifiers of Components - Modifiers of components are as follows:

Term	Range		
Trace	0%	-	10%
Little	10%	-	20%
Some	20%	-	35%
And	35%	-	50%

Moisture Table - The following moisture-related denominations are used to describe cohesive soils:

Term	Range - USCS	Range - ODOT
Dry	0% to 10%	Well below Plastic Limit
Damp	>2% below Plastic Limit	Below Plastic Limit
Moist	2% below to 2% above Plastic Limit	Above PL to 3% below LL
Very Moist	>2% above Plastic Limit	
Wet	≥ Liquid Limit	3% below LL to above LL

Organic Content – The following terms are used to describe organic soils:

Term	Organic Content (%)
Slightly organic	2-4
Moderately organic	4-10
Highly organic	>10

Bedrock – The following terms are used to describe bedrock hardness:

Term		Blows per foot – SPT (N)		
Very Soft		Below		50
Soft		50/5"	–	50/6"
Medium Hard		50/3"	–	50/4"
Hard		50/1"	–	50/2"
Very Hard	50/0"			

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept* *responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are <u>not</u> final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are <u>Not</u> Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will <u>not</u> of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are <u>not</u> building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

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