Best Engineering Solutions and Technologies

GEOTECHNICAL ENGINEERING STUDY
43 BACKLAND COURT
BLUE RIVER, COLORADO
80424

PROJECT NUMBER 24-1121
JUNE 29, 2024

PREPARED FOR

ASPECT MOUNTAIN HOMES
PO BOX 2428
BRECKENRIDGE, COLORADO
80424

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EXECUTIVE SUMMARY

Best Engineering Solutions and Technologies, LLC (BEST) completed a geotechnical engineering study for the project located at 43 Backland Court in Blue River, Colorado. Design parameters and a discussion of geotechnical engineering considerations related to construction of the proposed residences are included in this report. A summary of the findings includes:

1. Subsurface explorations encountered native topsoil underlain by native gravelly sand with clay, cobbles, and boulders to the maximum depth explored of 8 feet Below Existing Grade (BEG). Groundwater was not encountered during the drilling. Fluctuations of the groundwater may occur seasonally or with precipitation events.

2. Based on the subsurface conditions encountered in the test pits and the nature of the proposed construction, we recommend the proposed structures be founded on spread footings bearing on native soils. Spread footings bearing as recommended should be designed for an allowable bearing pressure of 2,000 pounds per square foot (psf).

3. Native soils or imported structural fill are suitable for support of concrete slab-on-grade construction.

4. A representative of our office should observe the construction operations discussed in this report.

5. Protect all exposed soils from excessive drying or wetting during the construction process.

6. Detailed recommendations are made throughout this report. These must be reviewed to assure proper consideration in the design.

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PURPOSE AND SCOPE OF WORK

This report presents the results of a geotechnical engineering study for the project located at 43 Backland Court in Blue River, Colorado. The project site is shown on Figure 1. The study was conducted to provide foundation design and support of slab-on-grade recommendations.

Field exploration consisted of two exploratory test pits completed to collect information on the subsurface conditions. Samples of the soils collected during the field exploration were tested in the laboratory to determine their classification and engineering characteristics. The results of the field exploration and laboratory testing were analyzed to develop recommendations for foundation types, depths, and allowable soil-bearing pressures for the proposed building foundations.

This report has been prepared to summarize the data obtained during this study and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of geotechnical engineering considerations related to construction of the proposed residence are included in this report.

PROPOSED CONSTRUCTION

We understand that the proposed construction will consist of the construction of a new single family home, with slab-on-grade foundation. Conventional wood frame construction, with column loads expected to be low to moderate and typical of this type of structure, will be used above grade with cast-in-place concrete foundations below grade. The floors will be slab-on-grade. Site development is expected to include sidewalk and landscaped areas. Local utilities will generally be underground, except for surface storm runoff and overhead electric.

If the loadings, locations, or grading plans for the structures change significantly from those described above, we should be notified to re-evaluate the recommendations contained in this report.

SITE CONDITIONS

At the time of our field exploration, the property consisted of vacant lot. The site is bounded by residential single-family homes and vacant lots. The topography in the area slopes toward the north and west at an approximate elevation of 10,080 feet MSL.

FIELD EXPLORATION

The exploratory test pits were dug on May 29, 2024, approximately at the location shown on Figure 2 to evaluate the subsurface conditions. The test pits were dug using a small excavator rig and was logged by a representative of BEST. Samples of the soils were obtained using disturbed sampling methods and the depth of the test pits and samples are shown on the Test Pit Log, Figure 3 and Legend and Notes, Figure 4.

SUBSURFACE CONDITIONS

TP1: Native, Topsoil was encountered to a depth of 1.5 feet BEG. Native, gravelly sand with clay, cobbles, and boulders was encountered to the maximum explored depth of 8 feet BEG. **TP2**: Native, Topsoil was encountered to a depth of 1.5 feet BEG. Native, gravelly sand with clay, cobbles, and boulders was encountered to the maximum explored depth of 8 feet BEG. Groundwater was not encountered during the drilling. Fluctuations of the groundwater may occur seasonally or with precipitation events.

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Samples taken from the exploratory test pits were retained for laboratory testing and visually classified by a project engineer. The results of the tests performed on the samples obtained from the test pits are shown on Table 1. Laboratory testing included index property tests, such as moisture content and density, water soluble sulfate, swell/consolidation testing and minus #200 sieve analysis. The testing was performed on relatively undisturbed drive samples and were in general conformance with recognized test procedures, primarily, ASTM and Colorado Department of Transportation (CDOT).

FOUNDATION DESIGN RECOMMENDATIONS

The native soils are suitable to support lightly to moderately loaded building foundations. Based on the soil conditions encountered in the exploratory test pits and the nature of the proposed construction, we recommend that the structures be founded on spread footings bearing on native soils. The design and construction criteria presented below should be observed for a spread footing foundation system.

1. Footings placed on the native soils may be designed for an allowable soil bearing pressure of 2,000 pounds per square foot (psf). Based on experience it is expected that total settlement of the footings, designed and constructed as discussed in this section, would be approximately 1.5-inches or less. Differential settlement is estimated to be approximately ½ to ¾ of the total settlement. Most of this settlement will generally occur during the construction phase.

2. Spread footings placed on native soils should have a minimum footing width of 16 inches for continuous footings and 24 inches for isolated pads.

3. Exterior footings and footings beneath unheated areas should be provided with adequate soil cover above their bearing elevation for frost protection. Placement of foundations at least 36 inches below exterior grade is required by the City of Blue River.

4. Continuous foundation walls should be reinforced top and bottom to span local anomalies by assuming an unsupported length of at least 10 feet.

5. A grounding system (Ufer Ground) may be installed where the grounding system is contained within the exterior building wall and the concrete foundation wall. This is in place of having a copper ground rod installed adjacent to the foundation wall.

6. The lateral resistance of a spread footing placed on undisturbed native soils or properly compacted granular structural fill material will be a combination of the sliding resistance of the footing on the foundation materials and passive earth pressure against the side of the footing. Based on the soil characteristics, the resistance to sliding at the bottoms of the footings can be calculated based on a coefficient of friction of 0.55. Passive pressure against the sides of the footings can be calculated using an equivalent fluid unit weight of 315 pounds per cubic foot (pcf). The at-rest lateral pressures on the walls can be calculated using an equivalent fluid density of 65 psf per foot of depth. The active lateral earth pressures should be calculated using an equivalent fluid density of 40 psf per foot of depth. These lateral resistance values are working values.

7. All loose or soft soils should be removed, and the footings placed on native soils or properly compacted structural fill. The disturbed surface of the native soils should be compacted prior to concrete placement.

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8. Interior backfill should consist of onsite native soils and should be placed in uniform lifts not to exceed 10 inches thick and compacted to at least 98% of the standard Proctor (ASTM D 698) maximum dry density and within 2 percentage points of the optimum moisture content. Interior backfill should extend laterally beyond the edges of the footings at a distance at least equal to the depth of the fill below the footing subgrade. Prior to the fill placement, any loose subgrade soils should be compacted. Any wet and soft subgrade soils should be removed prior to fill placement. The backfill material should be free of snow and ice, vegetation, topsoil, organics, trash, construction debris, oversized rocks greater than 8 inches in diameter, and other deleterious material.

9. Exterior backfill may consist of the onsite native soils or imported structural fill and should be properly placed and compacted to reduce the risk of settlement and distress. Onsite backfill material placed on the exterior of the structure should be placed and compacted to at least 95% of the standard Proctor (ASTM D 698) maximum dry density within 2 percentage points of the optimum moisture content.

10. Backfill in pavement and walkway areas should also be compacted to at least 95% of the standard Proctor (ASTM D 698) maximum dry density and within 2 percentage points of the optimum moisture content. Care should be taken when compacting around the foundation walls and underground structures to avoid damage to the structure. Hand compaction procedures may be used to prevent excessive lateral pressures from exceeding the design values.

11. Backfill in landscaped areas may consist of native onsite soils or imported structural fill. It should be placed in uniform lifts and compacted to at least 90% of the standard Proctor (ASTM D 698) maximum dry density within 2 percentage points of the optimum moisture content.

12. Utility backfill should be compacted as appropriate for the proposed surface uses (landscape, building, pavement, etc.).

13. All foundation and retaining structures should be designed for appropriate hydrostatic and surcharge pressures, such as adjacent footings, traffic, construction materials, and equipment. The buildup of water behind a wall or an upward sloping backfill surface will increase the lateral pressure imposed on a foundation wall or retaining structure. An underdrain system should be provided to prevent hydrostatic pressure buildup behind the walls. The lateral resistance values identified above assume drained conditions behind the walls and a horizontal backfill surface. Refer to the Underdrain System section for further information. Minor cracking of concrete foundation walls should be expected.

14. Based on our testing, we recommend all concrete exposed to the onsite materials meet the cement requirements for Class 0 exposure of sulfate attack on concrete as presented in ACI 318-14. Alternatively, the concrete could meet the CDOT requirements for Class 0 exposure as presented in Section 601.04 of the CDOT Standard Specifications for Road and Bridge Construction (2019).

15. Depending upon depth of excavation and seasonal conditions, groundwater may be encountered within excavations on the site. Pumping from sumps may be utilized to control water within excavations, if necessary. BEST is available to provide further dewatering recommendations if this issue arises.

16. A BEST representative should observe all footing excavations prior to concrete placement to evaluate bearing conditions.

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FLOOR SLABS

The native soils are suitable to support lightly to moderately loaded slab-on-grade construction. To reduce the effects of differential movement, floor slabs should be separated from all bearing walls and columns with expansion joints, which allow unrestrained vertical movement. Interior non-bearing partitions resting on floor slabs should be provided with slip joints so that, if the slabs move, the movement cannot be transmitted to the interior structure. This detail is also important for wallboards, stairways and door frames. Slip joints which will allow at least 1.5 inches of vertical movement are recommended.

Floor slab control joints should be used to reduce damage due to shrinkage cracking. Joint spacing is dependent on slab thickness, concrete aggregate size, and slump, and should be consistent with recognized guidelines such as those of the Portland Cement Association (PCA) and American Concrete Institute (ACI). The joint spacing and slab reinforcement should be established by the designer based on experience and the intended slab use.

Fill placed beneath floor slabs may consist of native onsite soils, an imported structural fill, or non-expansive, predominantly granular material. The geotechnical engineer should evaluate the suitability of fill materials prior to placement.

Slab performance is greatly dependent on the amount of moisture introduced to the underlying soils, which could result in potential excessive movement causing uneven slabs and cracking. Proper surface grading and foundation drain installation will help to reduce water infiltration in the sub-slab soils. Recommendations within the Surface Drainage and the Underdrain System sections below, should be followed. Recommendations provided in this section are meant to reduce the possible distress caused by slab movement but will not completely eliminate risk. A structurally supported floor system should be used if the owner cannot tolerate potential movement.

SEISMIC CONSIDERATIONS

This area of Blue River is located in Seismic Design Category “B”. The soil at the foundation level has a very dense soil profile. The average soil profile in the top one-hundred feet provides an overall “stiff soil” profile, which provides a Site Class of “D”. Based on the subsurface profile, site seismicity, and the anticipated ground conditions; liquefaction is not a design consideration.

SURFACE DRAINAGE

Proper surface drainage is very important for acceptable performance of the slab-on-grade during construction and after the construction has been completed. The following recommendations should be used as guidelines and changes should be made only after consultation with the geotechnical engineer.

1. Excessive wetting or drying of the excavation and underslab areas should be avoided during construction.

2. The ground surface surrounding the exterior of the building should be sloped to drain away from the foundation in all directions. We recommend a minimum slope of 12 inches in the first 10 feet in unpaved areas and a minimum slope of 3 inches in the first 10 feet in paved areas. Free-draining wall backfill should be capped with approximately 2 feet of the onsite finer graded soils to facilitate surface drainage. Site drainage beyond the 10-foot zone should be designed to promote runoff and reduce infiltration. These slopes may be changed as required for handicap access points in accordance with the Americans with Disabilities Act.

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3. Xeriscaping should be considered with limited irrigation within 4 feet of the foundation walls. Roof downspouts and drains should discharge well beyond the limits of all backfill and onto splash blocks.

SLAB-ON GRADE – PLASTIC BARRIER

The slab-on-grade construction precludes the need for an underdrain system. It is recommended that an impermeable plastic sheet be placed beneath the floor slab in any living space to reduce moisture migration through the concrete slab. The sheet should be secured to the interior of the foundation walls. There should be a minimum one-foot side lap and at least two-feet of end lap.

HOMEOWNER PRECAUTIONS

All new construction has an adjustment period after construction is completed. Exterior and interior observation should be performed on a regular basis. The exterior backfill should be checked for positive drainage away from the foundation. No ponding of water should be observed. Roof downspouts and splash blocks should direct water away from the foundation. The discharge of any sump should be free of blockage and discharge away from the foundation.

DESIGN AND CONSTRUCTION SUPPORT SERVICES

Please consider retaining BEST to provide the following services:

1. Review of the project plans and specifications for conformance with the recommendations provided in this report.

2. Observation and testing to document that the intent of this report and that the requirements of the plans and specifications are being followed during construction.

3. Identification of possible variations in subsurface conditions from those encountered in this study, so that recommendations can be re-evaluated, if needed.

4. Preparation of a shoring plan, if necessary, for the protection of adjacent structures.

BEST is also available to assist the design team in preparing specifications for the geotechnical aspects of the project and performing additional studies, if necessary, to accommodate possible changes in the proposed construction.

LIMITATIONS

This study has been conducted in accordance with generally accepted geotechnical engineering practices in this area for exclusive use by the client for design purposes. Copying of this report or portions of this report without the express written permission of Best Engineering Solutions and Technologies, LLC (BEST), is specifically prohibited. We make no warranty either express or implied. The conclusions and recommendations submitted in this report are based upon data obtained from the exploratory test pits at the locations indicated on Fig. 2, and the proposed construction. This report may not reflect subsurface variations that occur between the explorations. The nature and extent of variations across the site may not become evident until site grading and excavations are performed. If fill, soil, rock or water conditions appear to be different from those described herein, BEST should be advised at once so that a re-evaluation of the recommendations presented in this report can be made. BEST is not responsible for liability associated with interpretation of subsurface data by others.

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The scope of services for this project does not include any environmental assessment of the site or identification of contaminated or hazardous materials or conditions. In addition, this study does not include determination of the presence, prevention, or possibility of mold or other biological contaminants developing in the future. If the owner is concerned about the potential for such contamination, other studies should be undertaken.

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TABLE 1.1
SUMMARY OF LABORATORY TEST RESULTS

PROJECT: 43 Backland Ct **PROJECT NO:** 24-1121 **DATE:** June 25, 2024
LOCATION: Breckenridge, CO **SOURCE:** Field Test Pit / Lab Testing

Test Pit No.	Depth (ft)	Sample Type (Note 1)	Nat. Dry Density (PCF)	Natural Moist. (%)	ATTERBERG LIMITS		GRADATION			% Swell and Consolidation	Additional Test Results (Note 3)	Soil Description
					LL	PI	% Gravel +No. 4	% Sand -No. 4 +No. 200	% Fines -No. 200			
TP-1	1.5-7	BS		8			34	56	10		WSS= 17.0	Gravelly sand with clay
TP-2	1.5-7.5	BS		6			44	48	8			Gravelly sand

NOTE 1- Sample Type
BS=Bag Sample
AS=Auger Sample
ST=Shelby Tube
CA=California Sample
RM=Remolded Sample
HD=Hand Drive
AD=Air Dried
SS=Split Spoon Sample

NOTE 2-Shear Strength Tests
C1= Unconfined Compression
C2=Miniature Compression
C3=Pocket Penetrometer
C4=Pocket Value

NOTE 3- Additional Test Results
TT=Triaxial Test
PT=Proctor
CT=Consolidation Test
RA=Radon Testing (pCi/L)
pH = pH of soil
OR = Organic content of soil
WSS=Water Soluble Sulfates

TABLE: 1

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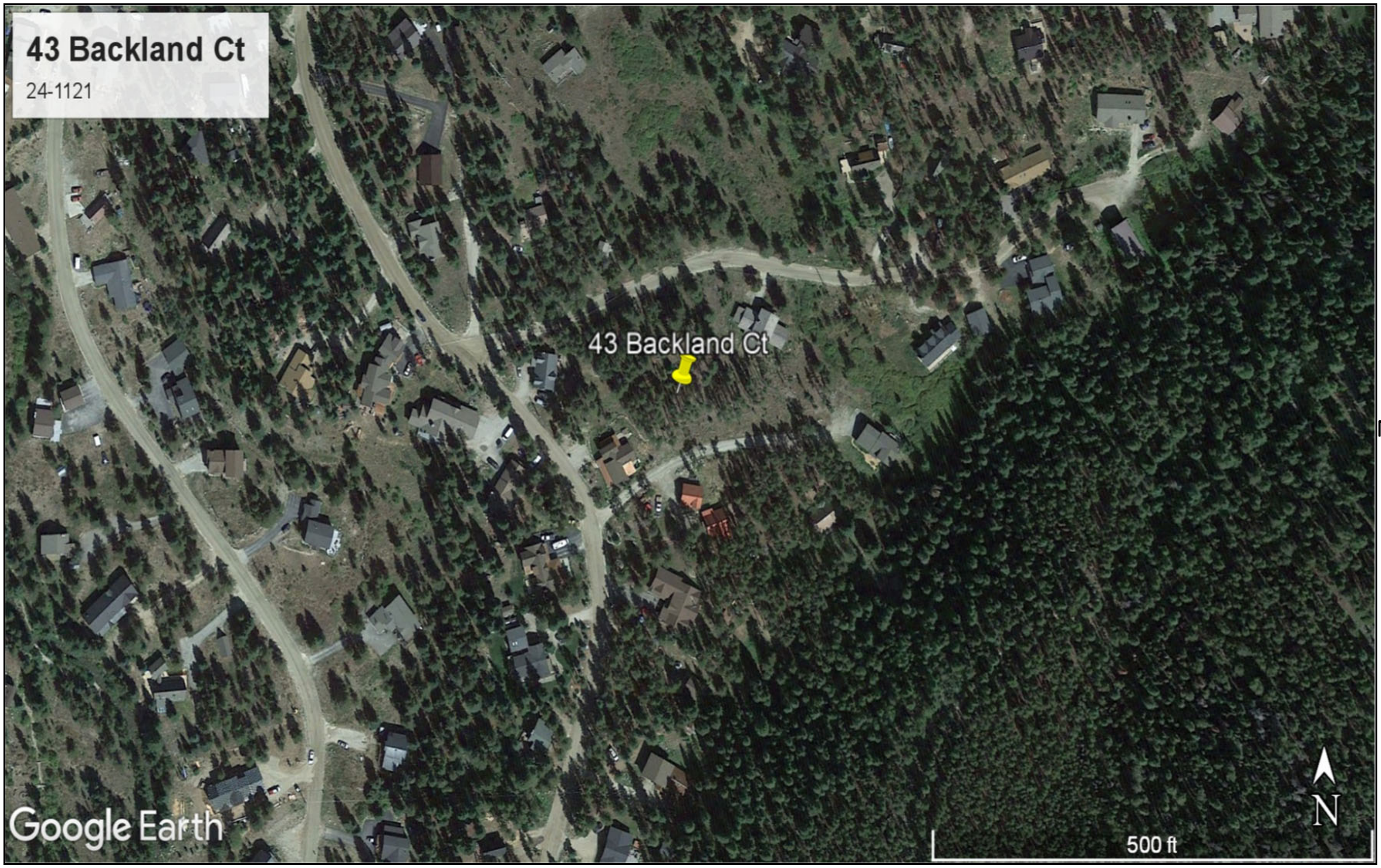
SITE MAP



N

Not to Scale

Project Number **24-1121**

Figure 1

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TEST PIT LOCATIONS

N
Not to Scale

LEGEND: TP-1 – Indicates approximate location of exploratory pit

Project Number 24-1121 **Figure 2**

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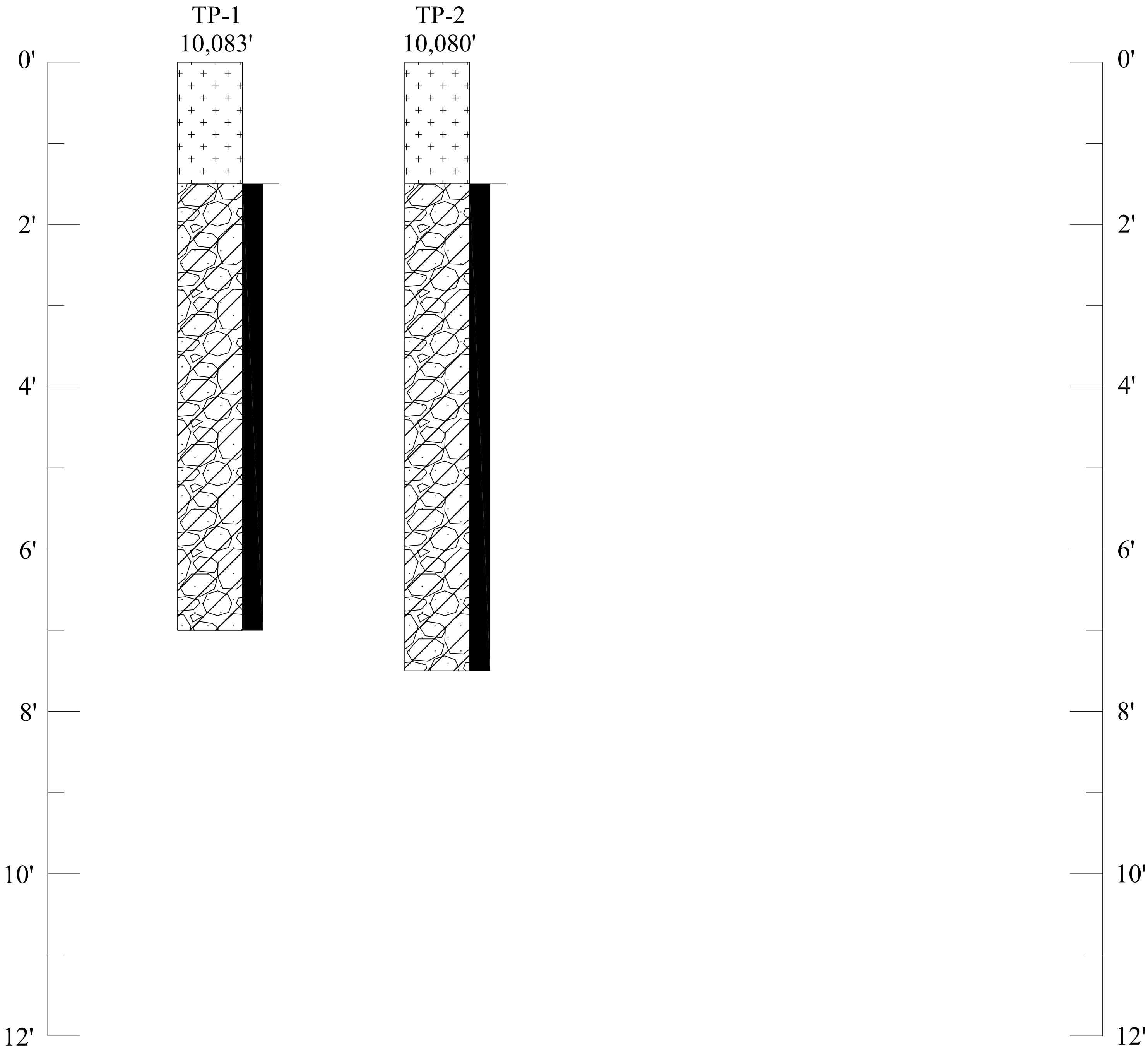
APPROXIMATE
TEST PIT ELEVATIONS



TEST PIT LOGS

Best Engineering Solutions and Technologies

Address:
1393 South Inca Street
Denver, CO 80223

Project Location:
43 Backland Ct
Breckenridge, Colorado

DRAWN BY: NAO
REVIEWED BY: CV
DATE: June 25, 2024

SCALE:
Vertical: N/A
Horizontal: N/A

PROJECT NO: 24-1121

FIGURE: 3

Topsoil

Gravelly sand to gravelly sand with clay, cobbles, and boulders, brown, moist

(0)

Water Level, Time After Drilling (0 = At Time of Drilling)

Disturbed Sample Collected

Undisturbed Sample Collected

X/12" Blow Counts; Number of Blows to Drive the Sampler 12-Inches (ASTM D-1586)

((X)) Depth of Caving Soils

Practical refusal of the mini excavator

NOTES:

1. The samples were collected on May 29, 2024 with a mini excavator.
2. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
3. The boring log(s) show subsurface conditions at the dates and locations indicated, and it is not warranted that they are representative of subsurface conditions at other locations or times.
4. Elevations are provided by Google Earth© and are considered approximate.

TEST PIT LOGS	Best Engineering Solutions and Technologies	*Address:* *1393 South Inca Street* *Denver, CO 80223*
Project Location: 43 Backland Ct Breckenridge, Colorado	**DRAWN BY:** NAO **REVIEWED BY:** CV **DATE:** June 25, 2024	**SCALE:** Vertical: N/A Horizontal: N/A
	PROJECT NO: 24-1121	**FIGURE: 4**