Pavement design will be reviewed after project is approved. Submit pavement design to pcdpavementreview@elpasoco.com.

3/23/2023

Gravel Road Design Report

Proposed Mariah Trail Subdivision, Filing No. 1

El Paso County, Colorado

VIVID Project No.: D23-2-587

VIVID Engineering Group

March 23, 2023

Report prepared for:
Daryn Strop
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GRAVEL ROAD DESIGN REPORT
Proposed Mariah Trail Subdivision, Filing No. 1
El Paso County, Colorado
VIVID Project No. D23-2-587

Prepared by:

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Table of Contents

1.0 INTRODUCTION

1.1 GENERAL

This report presents the results of a geotechnical investigation and gravel road pavement design performed for the proposed extension of Mariah Trail as part of the proposed new Mariah Trail Subdivision, Filing No. 1 development in El Paso County, Colorado. An attached Vicinity Map (Figure 1) shows the general location of the project. This work was authorized by Mr. Daryn Strop of Wayne Anthony Custom Homes.

This report includes our recommendations relating to the geotechnical aspects of project design and construction. The conclusions and recommendations stated in this report are based upon the subsurface conditions found at the locations of our exploratory borings at the time our exploration was performed. They also are subject to the provisions stated in the report section titled **Additional Services & Limitations**. Our findings, conclusions, and recommendations should not be extrapolated to other areas or used for other projects without our prior review. Furthermore, they should not be used if the site has been altered, or if a prolonged period has elapsed since the date of the report, without VIVID's prior review to determine if they remain valid.

1.2 PROJECT DESCRIPTION

The overall development project includes the re-platting and development of a 35-acre parcel into a residential subdivision. Six lots are planned that will vary from approximately 5 to 7 acres in size. The property has no current improvements and is in a generally native condition. The development will include the extension of Mariah Trail (approximately 1000 feet) into the subdivision. This report provides the results of the investigation, lab testing, and engineering recommendations related to design of the roadway extension. A proposed site layout is shown on Figure 2, attached to this report.

1.3 PURPOSE AND SCOPE

The purpose of our investigation was to explore and evaluate subsurface conditions at an approximate 500-foot spacing along the approximate roadway alignment and, based upon the conditions found, to develop recommendations relating to the design of the "pavement" which is to be a gravel surfaced road. Our conclusions and recommendations in this report are based upon analysis of the data from our field exploration, laboratory tests, and our experience with similar soil and geologic conditions in the area.

VIVID's scope of services included:

- A visual reconnaissance to observe surface and geologic conditions at the project site and locating the exploratory borings;
- Obtain permission to enter the private property for fieldwork activities;
- Notify the Colorado One-call Center (Colorado 811) to locate utilities;
- The drilling of three exploratory borings along the proposed Mariah Trail extension and one boring at the location of a possible drainage feature.
- Laboratory testing of selected samples obtained during the field exploration to evaluate relevant physical, geologic, and engineering properties of the soil.
- Preparation of this report, which includes a description of the proposed project, a description of the surface and subsurface site conditions found during our investigation, and recommendations for pavement section design for the proposed gravel surfaced road.

2.0 FIELD EXPLORATION AND LABORATORY TESTING

2.1 FIELD EXPLORATION

A field exploration performed on March 3, 2023 included the drilling of three exploratory borings along the approximate alignment of the proposed Mariah Trail extension and one boring at the approximate location of a potential site drainage feature. The locations of the borings are presented on Figure 2 – Field Exploration Plan. A summary of the subsurface exploration is presented in Table 1, below.

Table 1
Summary of Subsurface Exploration

Boring Designation	Approximate Boring Depth [feet, below ground surface]	Approximate Depth to Groundwater [feet, below ground surface]	Approximate Depth to Weathered Bedrock [feet, below ground surface]
B-1	10	None Encountered	4
B-2	10	None Encountered	None Encountered
B-3	10	None Encountered	2.5
B-4	10	None Encountered	7.5

Borings were performed with a truck-mounted CME-45 drill rig equipped with 4-inch outside diameter, continuous-flight, solid-stem auger. Samples were taken with a 2.5-inch O.D./2.0-inch I.D., California-type sampler, and by bulk methods. Penetration tests were obtained at the various sample depths as well.

Appendix A to this report includes logs of the borings describing the subsurface conditions. The lines defining boundaries between soil and rock types on the logs are based upon drill behavior and interpolation between samples and are therefore approximate. Transition between soil and rock types may be abrupt or may be gradual.

2.2 LABORATORY TESTING

Laboratory tests were performed on selected soil samples to estimate their relative engineering properties. Tests were performed in general accordance with the following methods of ASTM or other recognized standards-setting bodies, and local practice:

- Description and Identification of Soils (Visual-Manual Procedure)
- Classification of Soils for Engineering Purposes
- Moisture Content and Unit Weight
- Sieve Analysis of Fine and Coarse Aggregates
- Liquid Limit, Plastic Limit, and Plasticity Index
- Swell/Settlement
- R-value

Results of the laboratory tests are included in Appendix B of this report. Selected test results are also shown on the boring logs in Appendix A.

3.0 SITE CONDITIONS

3.1 SURFACE

The site is a vacant 35 acres and is currently covered with native grasses and shrubs. The parcel is a generally mild south and east sloping parcel with one shallow alluvial valley. Sparse residential properties surround the parcel.

3.2 GEOLOGY

Prior to drilling, the site geology was evaluated and is summarized in our separate Geology and Soils Evaluation Report, dated March 21, 2023. In summary, review of available site geologic mapping indicated the anticipated soils would include surficial alluvium soils underlain by bedrock of the Dawson Formation. The mapping is generally consistent with our explorations.

3.3 SUBSURFACE

VIVID explored the subsurface conditions by drilling, logging, and sampling 3 exploratory borings along the roadway alignment and a 4th boring in the area of a possible future drainage feature, as approximately shown on Figure 2. These borings were drilled to a depth of approximately 10 feet below the existing ground surface. The general profile encountered in our borings consisted of:

Surface Alluvium Soils

Below a thin topsoil layer, the surficial soils generally ranged from clayey SAND and silty SAND to silty, clayey SAND. The tested samples classified as SC, SM, SC-SM, and CL-ML according to the Unified Soil Classification System (USCS) and A-2-4 and A-4 according to the American Association of State Highway and Transportation Officials (AASHTO) classification system. These soils generally were light brown to brown in color, slightly moist, and field penetration testing (blow counts) indicated the relative density of the sand soils was generally medium dense to dense. A zone of sandy silty CLAY was encountered between approximately 4 and 7.5 feet below the ground surface in boring B-4 which was drilled at the location of the potential drainage feature but outside the location of the proposed roadway alignment.

Weathered Sandstone

Predominantly weathered sandstone of the Dawson Formation was encountered underlying the units described above in all borings except B-2 at depths of approximately 2.5 to 7.5 feet below the ground surface and extended to the maximum depth explored of approximately 10 feet. The weathered sandstone materials were light brown in color, slightly moist, and field penetration testing (blow counts) indicated the relative density of the weathered sandstone materials was medium hard to hard. The weathered sandstone bedrock was poorly to uncemented.

The boring logs in Appendix A should be reviewed for more detailed descriptions of the subsurface conditions at each of the boring locations explored.

3.3.1 Groundwater

Groundwater was not encountered in any of our explorations at the time of drilling. Groundwater levels commonly vary over time and space depending on seasonal precipitation, irrigation practices, land use, and runoff conditions. These conditions and the variations that they create often are not apparent at the time of field investigation.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 GEOTECHNICAL FEASIBILITY OF PROPOSED CONSTRUCTION

VIVID found no subsurface conditions during this investigation that would preclude construction of the improvements essentially as planned, provided the recommendations in this report are incorporated into the design and construction of the project.

4.2 CONSTRUCTION CONSIDERATIONS

4.2.1 General

All site preparation and earthwork operations should be performed in accordance with applicable codes, safety regulations and other local, State or Federal guidelines.

4.2.2 Subgrade Preparation for General Site Grading

Initial site work should consist of completely removing (grubbing) organic material/topsoil to expose the underlying native soils devoid of any organics or other deleterious materials from all areas to be filled and areas to be cut. All material should be removed for offsite disposal in accordance with local laws and regulations or, if appropriate, stockpiled in proposed landscaped areas for future use. Areas to receive fill should be evaluated by the geotechnical engineer prior to the placement of any fill materials.

After performing the required excavations and prior to the placement of compacted fill, processing of subgrade soils should be performed. This should include scarifying the subgrade to a depth of at least 8 inches, moisture conditioning, and compacting as recommended in Section 4.2.5 of this report. Where unstable conditions exist and proper moisture conditioning and compaction is not feasible, stabilization of the subgrade as described in below will be required. All fill materials should be placed on a horizontal plane and placed in loose lifts not to exceed 6 inches in thickness, unless otherwise accepted by the geotechnical engineer.

4.2.3 Excavation Characteristics

We anticipate cuts and fills for general roadway grading may be on the order of about 1 to 3 feet or less. Based on this anticipated grading it is assumed that most of the grading will be performed in the soils above the bedrock at our specific boring locations. The boring logs in Appendix A should be reviewed to evaluate material type that is anticipated to be encountered once final grading plans are completed. We believe that excavation of the on-site soils and weathered sandstone can be readily accomplished using standard-duty excavating equipment.

All excavations must comply with applicable local, State and Federal safety regulations, and particularly with the excavation standards of the Occupational Safety and Health Administration (OSHA). Construction site safety, including excavation safety, is the sole responsibility of the Contractor as part of its overall responsibility for the means, methods and sequencing of construction operations. VIVID's recommendations for excavation support are intended for the Client's use in planning the project, and in no way relieve the Contractor of its responsibility to construct, support and maintain safe slopes. Under no circumstances should the following recommendations be interpreted to mean that VIVID is assuming responsibility for either construction site safety or the Contractor's activities.

We believe that the unsaturated soils on this site will classify as Type C materials using OSHA criteria. OSHA requires that unsupported cuts in Type C materials be laid back to ratios no steeper than 1½:1

(horizontal to vertical). However, the hard and intact on-site sandstone may be classified as Type B material. OSHA requires that unsupported cuts up to 20 feet in height be laid back to ratios no steeper than 1H:1V (horizontal to vertical) for a Type B material. In general, we believe that these slope ratios will be temporarily stable under unsaturated conditions. Where groundwater occurs, flatter slopes will be required. Please note that the actual determination of soil type and allowable sloping must be made in the field by an OSHA-qualified "competent person."

Although erosion analysis is beyond the scope of our analysis, it is generally recommended that embankment slopes, if any, be armored and/or well vegetated (with appropriate grass cover) to assist in reducing the influence of water that may flow over the face of the embankment, regardless of embankment material type. Water should be channeled away from the slope face to reduce the possibility of erosion due to water flow.

4.2.4 Fill Materials

Roadway Grading and Embankment Fill

The on-site soils may be used for general site grading fill, provided organics and other deleterious materials are removed. If imported site grading fill is required at this site, it should consist of soils similar to or better than the on-site soils and at a minimum meet the design R-value listed in Section 4.3.2 of this report. A sample of any imported site grading fill material should be submitted to our office for approval and testing at least 1 week prior to stockpiling at the site.

4.2.5 Fill Placement and Compaction

Fill materials placed for roadway subgrade, embankments, utility/culvert trenches, and gravel surface should be placed in horizontal lifts compatible with the type of compaction equipment being used, moisture conditioned, and compacted in accordance with Appendices J and K of the El Paso County Engineering Criteria Manual. Fill should be placed in level lifts not exceeding 6 inches in loose thickness and compacted to the specified percent compaction to produce a firm and stable surface. If field density tests indicate the required percent compaction has not been obtained, the fill material should be reconditioned as necessary and re-compacted to the required percent compaction before placing any additional material.

4.2.6 Utility Trench Backfill

Backfill material should be essentially free of plant matter, organic soil, debris, trash, other deleterious matter and rock particles larger than 4 inches. However, backfill material in the "pipe zone" (from the trench floor to 1 foot above the top of pipe) should not contain rock particles larger than 1 inch. Strictly observe any requirements specified by the utility agency for bedding and pipe-zone fill. In general, backfill above the pipe zone in utility trenches should be placed in lifts of 6 to 8 inches, and compacted using power equipment designed for trench work. Backfill in the pipe zone should be placed in lifts of 8 inches or less and compacted with hand-held equipment. Compact trench backfill as recommended per the El Paso County Engineering Criteria Manual.

4.2.7 Construction in Wet or Cold Weather

If earthwork is performed during the winter months when freezing is a factor, no grading fill, structural fill or other fill should be placed on frosted or frozen ground, nor should frozen material be placed as fill. Frozen ground should be allowed to thaw or be completely removed prior to placement of fill. A good

practice is to cover the compacted fill with a "blanket" of loose fill to help prevent the compacted fill from freezing.

If structures (if any) are erected during cold weather, concrete elements should not be constructed on frozen soil. Frozen soil should be completely removed from beneath the concrete elements, or thawed, scarified and recompacted. The amount of time passing between excavation or subgrade preparation and placing concrete should be minimized during freezing conditions to prevent the prepared soils from freezing. The use of blankets, soil cover or heating as required may be utilized to prevent the subgrade from freezing.

4.2.8 Construction Testing and Observation

Testing and construction observation should take place under the direction of VIVID to support that engineer's professional opinion as to whether the earthwork does or does not substantially conform to the recommendations in this report. Furthermore, the opinions and conclusions of a geotechnical report are based upon the interpretation of a limited amount of information obtained from the field exploration. It is therefore not uncommon to find that actual site conditions differ somewhat from those indicated in the report. The geotechnical engineer should remain involved throughout the project to evaluate such differing conditions as they appear, and to modify or add to the geotechnical recommendations, as necessary.

4.2.9 Drainage

During construction, grade the site such that surface water can drain readily away from the roadway surface areas. Promptly pump out or otherwise remove any water that may accumulate in excavations or on subgrade surfaces and allow these areas to dry before resuming construction. The use of berms, ditches and similar means may be used to prevent stormwater from entering the work area and to convey any water off site efficiently.

4.2.10 Permanent Cut and Fill Slopes

If required, permanent cut and fill slopes exposing the materials encountered in our borings are anticipated to be stable at slope ratios as steep as 3:1 (horizontal to vertical) under dry conditions. The site soils are known to have significant erodibility characteristics. A 3:1 (horizontal to vertical) or shallower slope will result in less erosion and maintenance issues. New slopes should be revegetated as soon as possible after completion to reduce erosion problems. Slopes steeper than that recommended above are possible with proper earth retention and erosion control designs.

4.3 GRAVEL ROAD RECOMMENDATIONS

4.3.1 General

Our investigation was performed in general accordance with the El Paso County Pavement Design Criteria Manual. We understand that a new gravel roadway surface will be constructed for the proposed extension of Mariah Trail. Included herein is the minimum thickness, material type and gradation/plasticity index requirements for gravel materials that meet the El Paso County Engineering Criteria requirements.

4.3.2 Anticipated Subgrade Material

Our borings indicate the roadway subgrade soils comprise mainly of existing silty to clayey SAND materials. Under the AASHTO classification system, the soils under the proposed roadway will classify as A-2-4 with

some potential for A-4 soils. These soils are generally considered to provide fair to port support for roadway surfaces. A Hveem stabilometer (R-Value) test was performed on combined bulk samples of soils obtained from the upper approximate 4 feet of borings B-1 through B-3 and resulted in an R-value of 12.

The following sections describe in more detail the design recommendations for areas requiring new gravel road construction.

4.3.3 Roadway Subgrade Preparation

Any obviously unsuitable materials present (e.g., debris, organic materials, waste) should be completely removed. Remove the stripped materials for offsite disposal in accordance with local laws and regulations.

Prior to placement of a new gravel road surface, processing of the subgrade should be performed as described in Section 4.2.2. Prior to placing the new gravel section, the prepared subgrade should be proof-rolled with a heavily loaded pneumatic-tired vehicle (such as a fully-loaded water truck) after preparation. Areas that pump or deform significantly under heavy wheel loads are not stable and should be stabilized. The method and extent of stabilization should conform to the El Paso County Pavement Design Criteria Manual and Engineering Specifications. The final stabilization approach/method and depth shall be approved by the Engineer.

Although there is some swell potential of the underlying pavement subgrade soils, we do not generally recommend any depth of "moisture treatment" to mitigate swell for gravel roads. This is because any movement of the subgrade that is transferred to the gravel surface would be leveled with typical planned grading of the roadway.

4.3.4 Gravel Surface Thickness

Based on Section D.3.6 of Appendix D of the El Paso County Pavement Design Criteria and Report manual, a minimum thickness of 6 inches of gravel meeting the requirements presented below shall be used.

4.3.5 Gravel Surface Materials

Gravel materials used for a new gravel road surface, gravel shoulders, or repairing other gravel surfaces should conform to the specifications provided in Table 2 below, found within Section D.5.6 of Appendix D of the El Paso County Engineering Criteria Manual. The gravel material should be placed in a uniform layer without segregation of size to a compacted maximum lift thickness of 6 inches. Gravel materials should be moisture conditioned and compacted as described in Appendices J and K of the El Paso County Engineering Criteria Manual.

Table 2
Material Requirements for Gravel for Gravel Roads

Sieve Designation	Percent Passing by Weight
¾"	100
#4	50 - 78
#8	37 - 67
#40	13 - 35
#200	4 - 15
Plastic Index (PI)	4 - 12

4.3.6 Gravel Road Construction Considerations

All site preparation, earthwork operations and construction materials should be performed in accordance with applicable codes, safety regulations and other local, State or Federal guidelines as applicable including, but not limited to:

- El Paso County Engineering Standard Specifications;
- Colorado Department of Transportation (CDOT), as applicable, and included by reference, and;
- El Paso County Pavement Design Criteria Manual.

Of particular importance are those specifications directed towards embankment construction, subgrade compaction, and utility trench compaction.

5.0 ADDITIONAL SERVICES & LIMITATIONS

5.1 ADDITIONAL SERVICES

Attached to this report is a document by the Geoprofessional Business Association (GBA) that summarizes limitations of geotechnical reports as well as additional services that are required to further confirm subgrade materials are consistent with that encountered at the specific boring locations presented in this report. This document should be read in its entirety before implementing design or construction activities. Examples of other services beyond completion of a geotechnical report are necessary or desirable to complete a project satisfactorily include:

- Review of design plans and specifications to verify that our recommendations were properly interpreted and implemented.
- Attendance at pre-bid and pre-construction meetings to highlight important items and clear up misunderstandings, ambiguities, or conflicts with design plans and specifications.
- Performance of construction observation and testing which allows verification that existing materials at locations beyond our borings are consistent with that presented in our report, construction is compliant with the requirements/recommendations, evaluation of changed conditions.

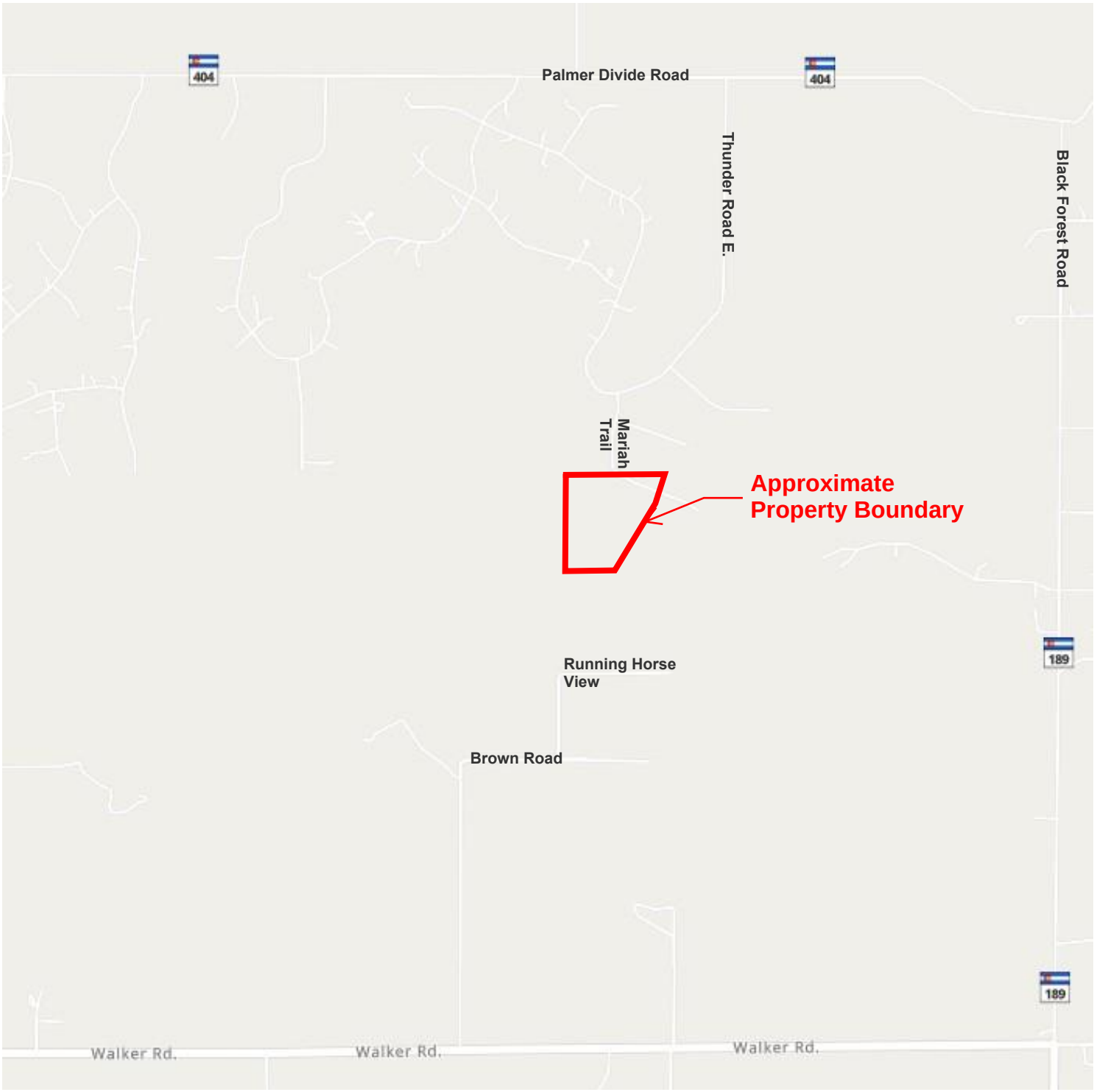
5.2 LIMITATIONS

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of VIVID's profession practicing in the same locality, under similar conditions and at the date the services are provided. Our conclusions, opinions, and recommendations are based on a limited number of observations and data. It is possible that conditions could vary between or beyond the data evaluated. VIVID makes no other representation, guarantee, or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

This report may be used only by the Client and the registered design professional in responsible charge and only for the purposes stated for this specific engagement within a reasonable time from its issuance, but in no event later than two (2) years from the date of the report.

The work performed was based on project information provided by Client. If Client does not retain VIVID to review any plans and specifications, including any revisions or modifications to the plans and specifications, VIVID assumes no responsibility for the suitability of our recommendations. In addition, if there are any changes in the field to the plans and specifications, Client must obtain written approval from VIVID's engineer that such changes do not affect our recommendations. Failure to do so will vitiate VIVID's recommendations.

Figures



N

Not to Scale. Base image obtained from www.mapquest.com, 2023

VIVID Engineering Group	Project No: D23-2-587 Date: 1/31/23 Drawn by: JA Reviewed by: WJB	**VICINITY MAP** Mariah Trail Subdivision, Filing No. 1 El Paso County, Colorado	Figure **1**

Not to Scale

The information included on this graphic representation has been compiled from a variety of sources and is subject to change without notice. Vivid makes no representations or warranties, express or implied, as to the accuracy, completeness, timeliness or right to the use of such information. This document is not intended for use as a land survey product nor is it designed or intended as a construction design document. The use or misuse of the information contained on this graphic representation is at the sole risk of the party using or misusing the information.

REFERENCE:

Base image obtained from Polaris Surveying, dated 2/21/23.

LEGEND

B-1 Approximate Boring Location

VIVID Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, CO 80907
719-896-4356

Project No. D23-2-587

Date: March 21, 2023

Drawn by: BTM

Reviewed by: WJB

FIELD EXPLORATION PLAN

Mariah Trail Subdivision, Filing No. 1
El Paso County, Colorado

Figure 2

Appendix A

Logs of Exploratory Borings

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KEY TO SYMBOLS

CLIENT Wayne Anthony Custom Homes

PROJECT NAME Mariah Trail Subdivision, Filing No. 1

PROJECT NUMBER D23-2-587

PROJECT LOCATION South Terminus of Mariah Trail

LITHOLOGIC SYMBOLS
(Unified Soil Classification System)


CL-ML: USCS Low Plasticity Silty Clay


SC: USCS Clayey Sand


SC-SM: USCS Clayey Sand


SM: USCS Silty Sand


WEATHERED SANDSTONE

SAMPLER SYMBOLS


Grab Sample


2" I.D. Modified California Sampler (MC)

ABBREVIATIONS

LL - LIQUID LIMIT (%)
PI - PLASTIC INDEX (%)
MC - MOISTURE CONTENT (%)
DD - DRY DENSITY (PCF)
NP - NON PLASTIC
FINES- PERCENT PASSING NO. 200 SIEVE

Vivid Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

BORING NUMBER B-1

CLIENT Wayne Anthony Custom Homes
PROJECT NAME Mariah Trail Subdivision, Filing No. 1
PROJECT NUMBER D23-2-587
PROJECT LOCATION South Terminus of Mariah Trail
DATE STARTED 3/3/23 **COMPLETED** 3/3/23
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR Custom Auger Drilling (CME-45)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY J. Adams **CHECKED BY** W. Barreire
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0	GB				Clayey SAND, brown, slightly moist, medium dense to dense
2.5	MC	15-22	MC = 8.7% DD = 118.9 pcf Swell = 4.9% when wetted under 200 psf load		
	GB				
4.0					**Dawson Formation** Weathered SANDSTONE, poorly cemented, light brown, slightly moist, moderately hard
5.0	MC	17-32			
7.5					
10.0	MC	20-20			
					Bottom of borehole at 10.0 feet.

Vivid Engineering Group, Inc.
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BORING NUMBER B-2

CLIENT Wayne Anthony Custom Homes
PROJECT NAME Mariah Trail Subdivision, Filing No. 1
PROJECT NUMBER D23-2-587
PROJECT LOCATION South Terminus of Mariah Trail
DATE STARTED 3/3/23 **COMPLETED** 3/3/23
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR Custom Auger Drilling (CME-45)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY J. Adams **CHECKED BY** W. Barreire
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0	GB				Silty to Clayey SAND, light brown, slightly moist, medium dense
2.5	MC	10-15	MC = 4.6% DD = 108.7 pcf Swell = 1.1% when wetted under 200 psf load		
	GB				
5.0	MC	10-16	MC = 3.5% DD = 106.5 pcf LL = NP PL = NP Fines = 32.0%		
7.5					
10.0	MC	16-20			10.0

Bottom of borehole at 10.0 feet.

Vivid Engineering Group, Inc.
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BORING NUMBER B-3

CLIENT Wayne Anthony Custom Homes
PROJECT NAME Mariah Trail Subdivision, Filing No. 1
PROJECT NUMBER D23-2-587
PROJECT LOCATION South Terminus of Mariah Trail
DATE STARTED 3/3/23 **COMPLETED** 3/3/23
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR Custom Auger Drilling (CME-45)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY J. Adams **CHECKED BY** W. Barreire
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0	GB				Silty, Clayey SAND, light brown, slightly moist, medium dense to dense
2.5	MC	32-40	MC = 2.9% DD = 131.9 pcf LL = 23 PL = 16 Fines = 23.0%	2.5	**Dawson Formation** Weathered SANDSTONE, poorly cemented, light brown, slightly moist, moderately hard
	GB				
5.0	MC	24-29	MC = 2.9% DD = 106.1 pcf Compression = 1.5% when wetted under 200 psf load		
7.5					
10.0	MC	15-24		10.0	

Bottom of borehole at 10.0 feet.

Vivid Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
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BORING NUMBER B-4

CLIENT Wayne Anthony Custom Homes
PROJECT NAME Mariah Trail Subdivision, Filing No. 1
PROJECT NUMBER D23-2-587
PROJECT LOCATION South Terminus of Mariah Trail
DATE STARTED 3/3/23 **COMPLETED** 3/3/23
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR Custom Auger Drilling (CME-45)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY J. Adams **CHECKED BY** W. Barreire
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0	GB				Silty SAND, light brown, slightly moist, medium dense
2.5	MC	7-7	MC = 4.7% DD = 98.7 pcf LL = 20 PL = 17 Fines = 40.0%		
	GB				
				4.0	
5.0	MC	9-12	MC = 5.6% DD = 106.3 pcf LL = 24 PL = 19 Fines = 50.0%		Sandy, Silty CLAY, light brown, moist, very stiff
7.5				7.5	**Dawson Formation** Weathered SANDSTONE, poorly cemented, light brown, slightly moist, medium hard to hard
10.0	MC	25-40		10.0	

Bottom of borehole at 10.0 feet.

Appendix B

Geotechnical Laboratory Test Results

Vivid Engineering Group, Inc.
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SUMMARY OF LABORATORY RESULTS

CLIENT Wayne Anthony Custom Homes **PROJECT NAME** Mariah Trail Subdivision, Filing No. 1

PROJECT NUMBER D23-2-587 **PROJECT LOCATION** South Terminus of Mariah Trail

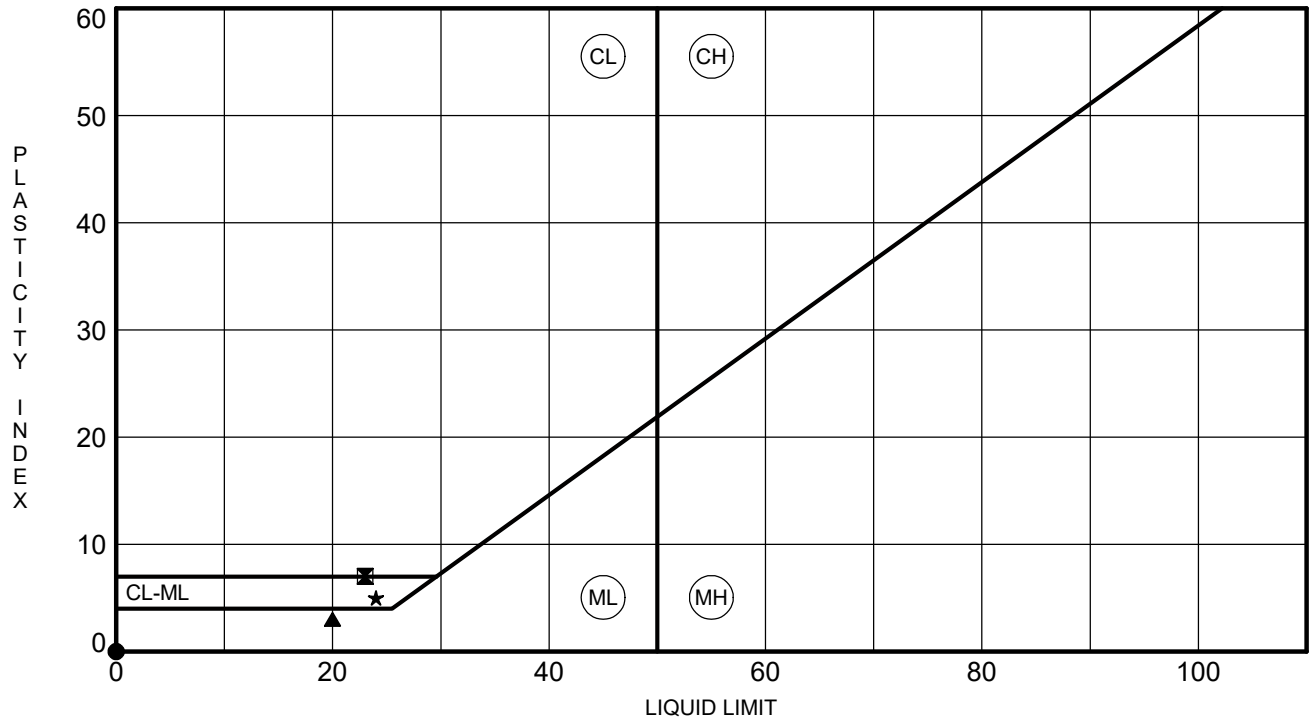
Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)		
B-1	2.0							8.7	118.9		
B-2	2.0							4.6	108.7		
B-2	4.0	NP	NP	NP	2	32	SM	3.5	106.5		
B-3	2.0	23	16	7	9.5	23	SC-SM	2.9	131.9		
B-3	4.0							2.9	106.1		
B-4	2.0	20	17	3	9.5	40	SM	4.7	98.7		
B-4	4.0	24	19	5	9.5	50	CL-ML	5.6	106.3		

Vivid Engineering Group, Inc.
1053 Elkton Drive
Colorado Springs, Colorado 80907
Telephone: 719-896-4356
Fax: 719-896-4357

ATTERBERG LIMITS' RESULTS

CLIENT Wayne Anthony Custom Homes **PROJECT NAME** Mariah Trail Subdivision, Filing No. 1

PROJECT NUMBER D23-2-587 **PROJECT LOCATION** South Terminus of Mariah Trail



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-2**	**4.0**	**NP**	**NP**	**NP**	**32**	**SILTY SAND(SM)**
⊠	**B-3**	**2.0**	**23**	**16**	**7**	**23**	**SILTY, CLAYEY SAND(SC-SM)**
▲	**B-4**	**2.0**	**20**	**17**	**3**	**40**	**SILTY SAND(SM)**
★	**B-4**	**4.0**	**24**	**19**	**5**	**50**	**SANDY SILTY CLAY(CL-ML)**

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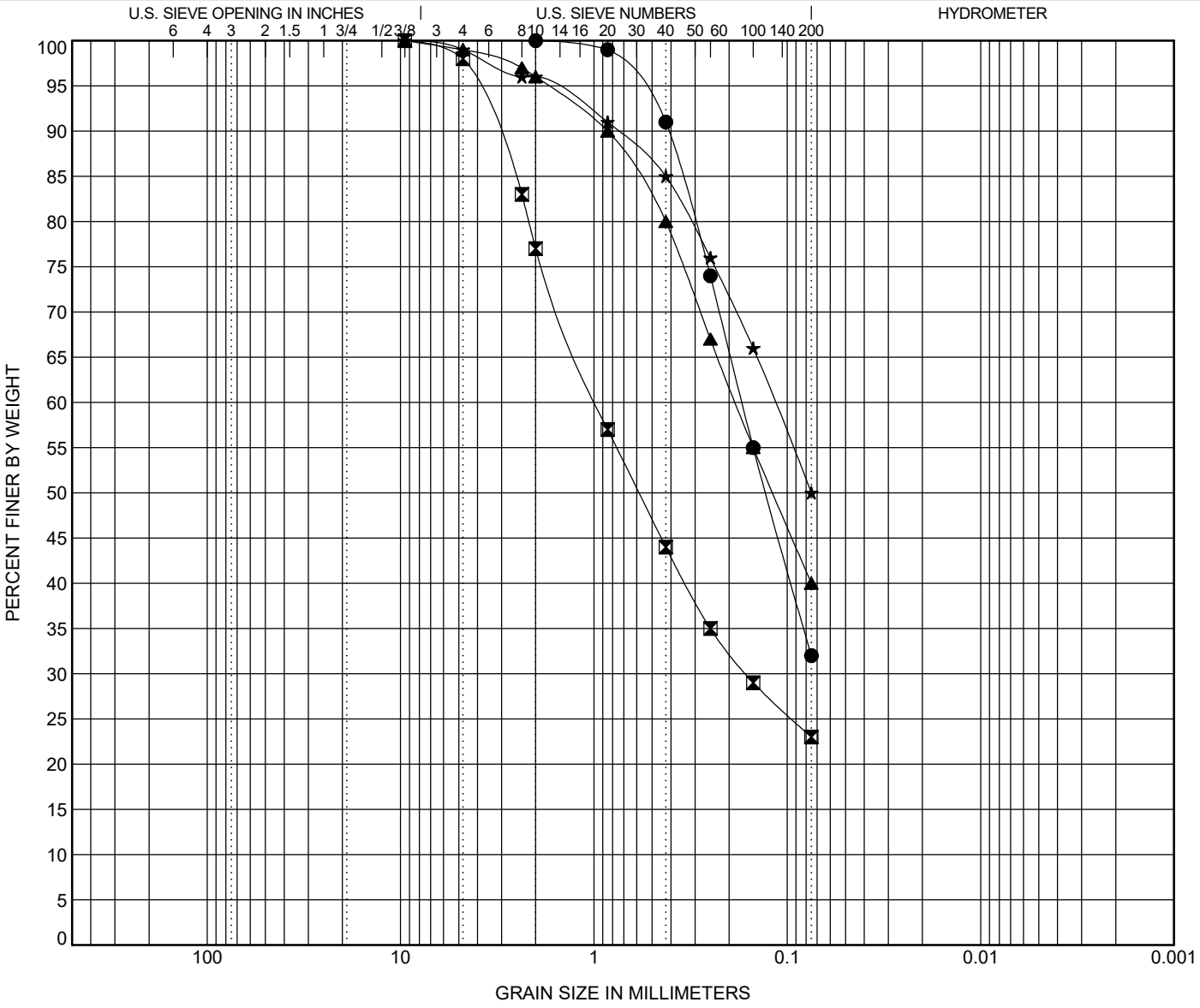
GRAIN SIZE DISTRIBUTION

CLIENT Wayne Anthony Custom Homes **PROJECT NAME** Mariah Trail Subdivision, Filing No. 1

PROJECT NUMBER D23-2-587 **PROJECT LOCATION** South Terminus of Mariah Trail



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

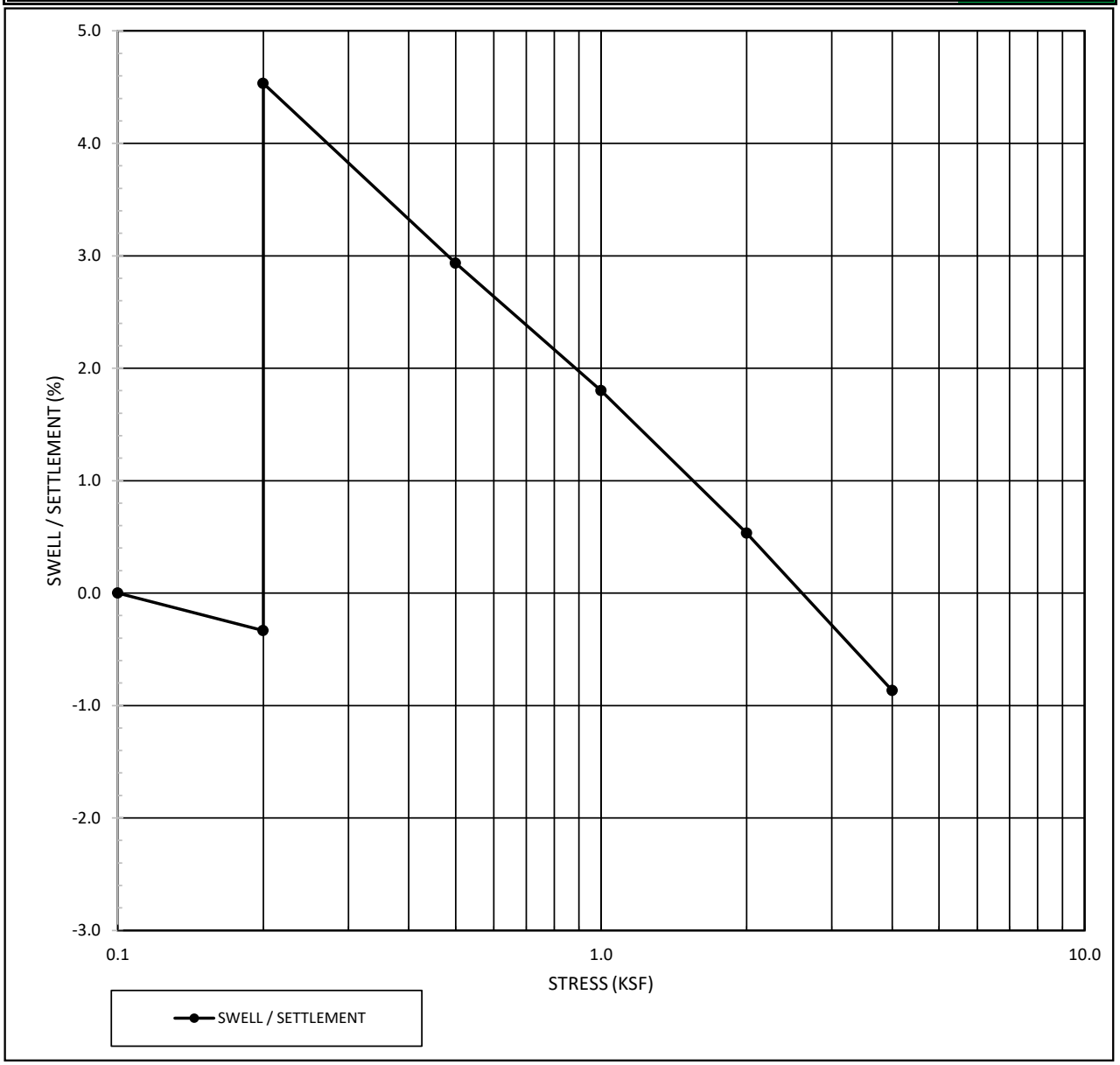
BOREHOLE		DEPTH	Classification	LL	PL	PI	Cc	Cu
●	B-2	4.0	SILTY SAND(SM)	NP	NP	NP		
⊠	B-3	2.0	SILTY, CLAYEY SAND(SC-SM)	23	16	7		
▲	B-4	2.0	SILTY SAND(SM)	20	17	3		
★	B-4	4.0	SANDY SILTY CLAY(CL-ML)	24	19	5		

BOREHOLE		DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-2	4.0	2	0.172			0.0	68.0	32.0	
⊠	B-3	2.0	9.5	0.966	0.163		2.0	75.0	23.0	
▲	B-4	2.0	9.5	0.186			1.0	59.0	40.0	
★	B-4	4.0	9.5	0.116			1.0	49.0	50.0	

VIVID Engineering Group, Inc.

Project Name:	Mariah Trail Subdivision, Filing No. 1	**Date**	3/3/2023
Project No.:	D23-2-587		
Boring ID.:	B-1	**Sample Depth (ft)**	2
Sample Description:	Clayey SAND, brown, slightly moist		

	%
Swell @ Wetting Weight:	**4.9**

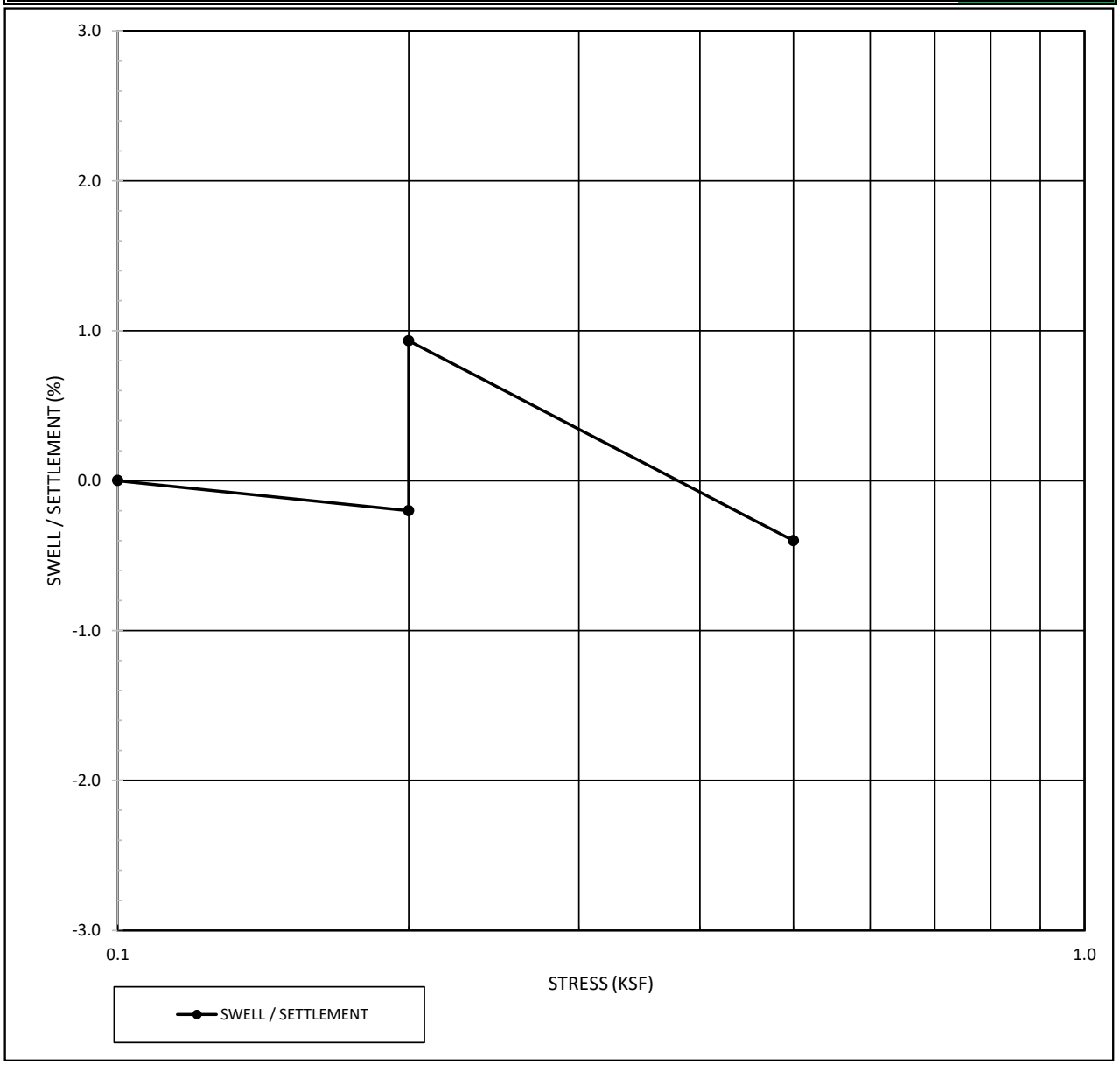


Initial Condition	
Moisture Content %	**8.7**
Dry Density (pcf)	**118.9**
Post-Swell Condition	
Moisture Content %	**17.7**

VIVID Engineering Group, Inc.

Project Name:	Mariah Trail Subdivision, Filing No. 1	**Date**	3/3/2023
Project No.:	D23-2-587		
Boring ID.:	B-2	**Sample Depth (ft)**	2
Sample Description:	Clayey SAND, light brown, slightly moist		

	%
Swell @ Wetting Weight:	**1.1**

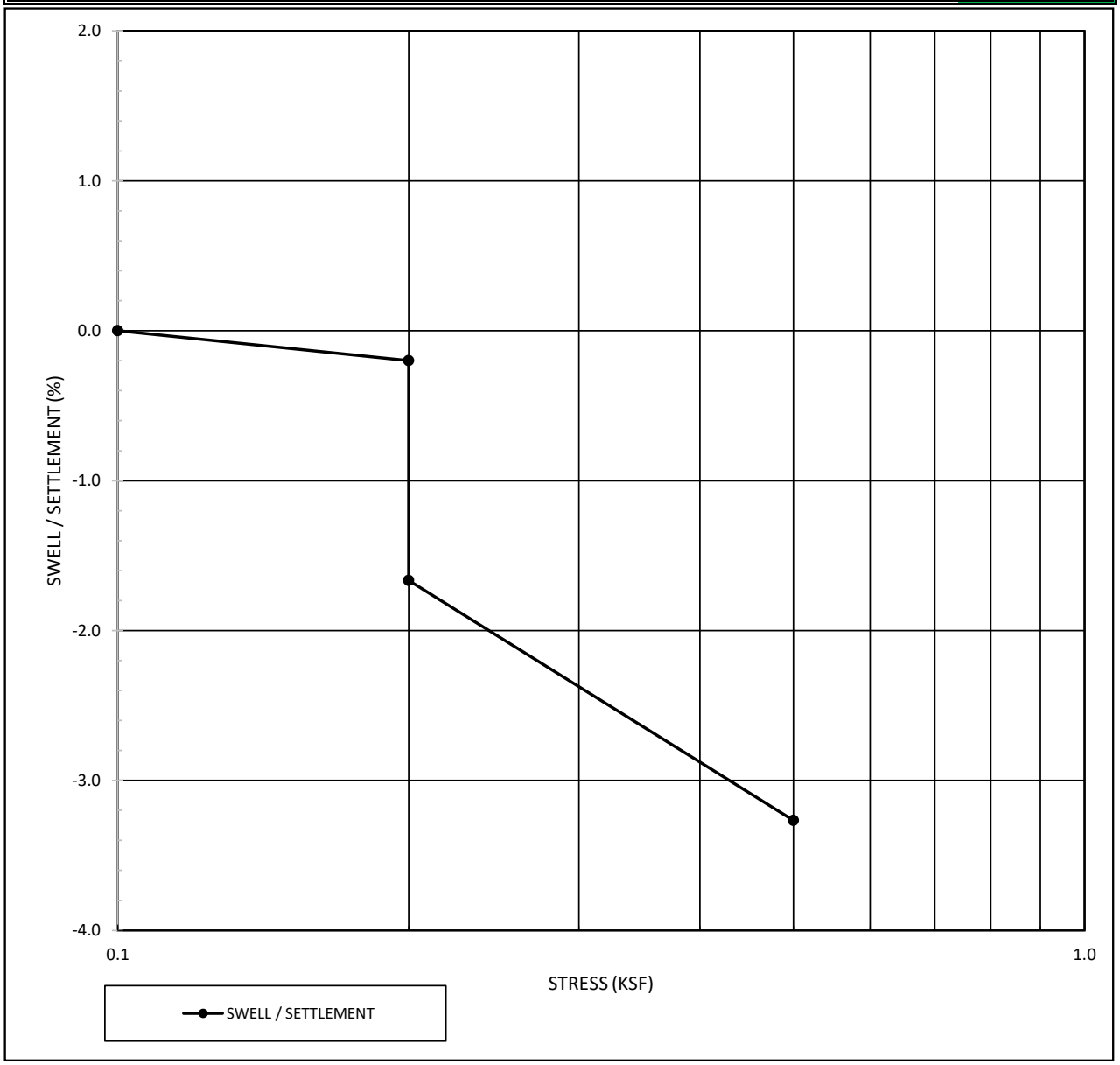


Initial Condition	
Moisture Content %	**4.6**
Dry Density (pcf)	**108.7**
Post-Swell Condition	
Moisture Content %	**18.1**

VIVID Engineering Group, Inc.

Project Name:	Mariah Trail Subdivision, Filing No. 1	**Date**	3/16/2023
Project No.:	D23-2-587		
Boring ID.:	B-3	**Sample Depth (ft)**	4
Sample Description:	Weathered SANDSTONE, light brown, slightly moist		

	%
Compression @ Wetting Weight:	**-1.5**



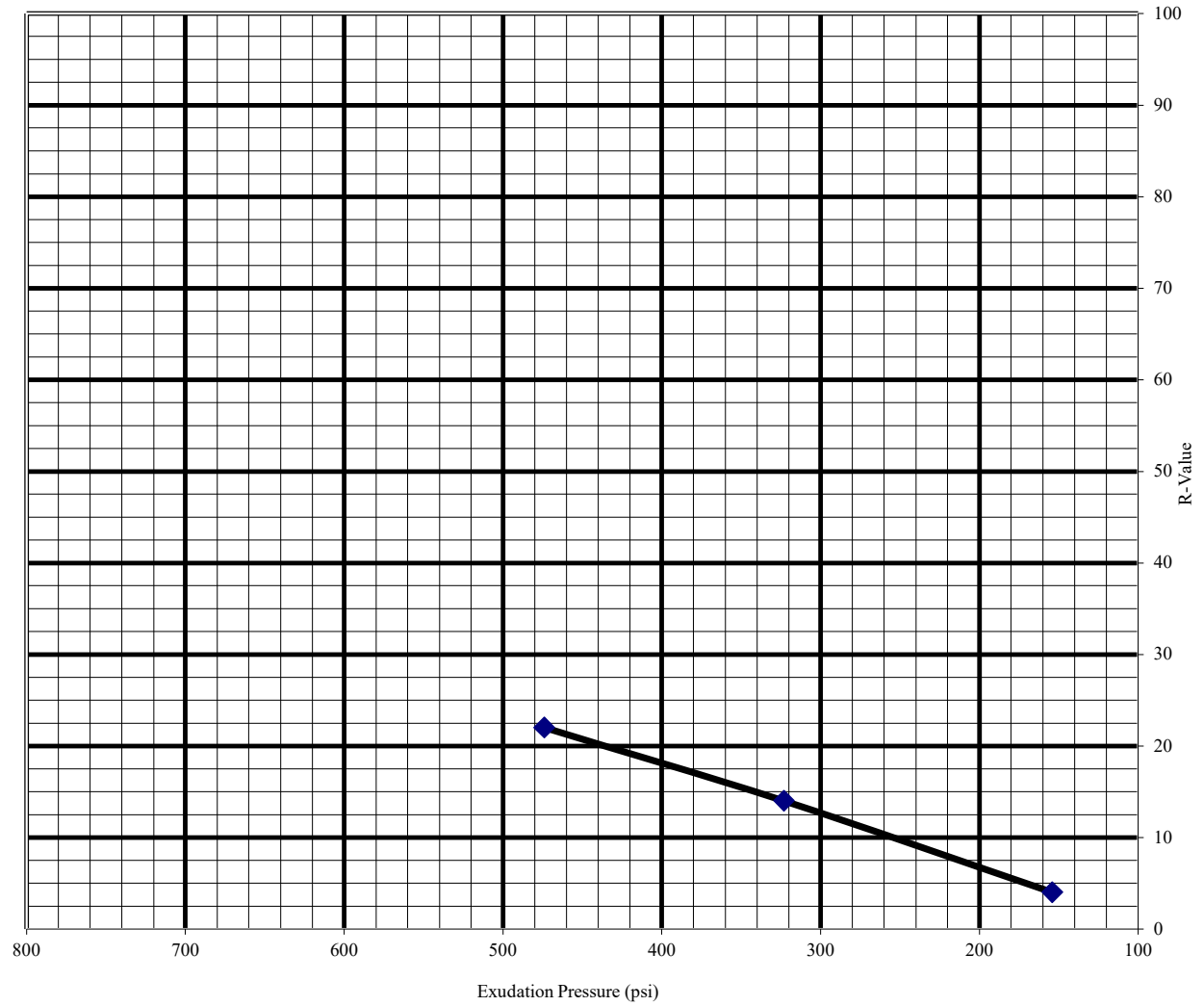
Initial Condition	
Moisture Content %	**2.9**
Dry Density (pcf)	**106.1**
Post-Swell Condition	
Moisture Content %	**13.5**

3885 Forest Street
Denver, CO 80207

Vivid Engineering Group
R-Value Test Report

Project Number:	D23-2-587	**Project Name:**	Mariah Trail Subdivision, Filing No. 1
Sample Id:	N/A	**Depth (ft):**	0-4'
Location:	B-1 to B-3 Combined	**Classification:**	N/A
Date Sampled:	3/3/2023	**Date Tested:**	3/9/2023

R-Value at 300 psi exudation pressure = **12**



Test No.	Compact. Press. (psi)	Density (pcf)	Moist. (%)	Horizont. Pressure (psi)'@ 160 psi	Sample Height (in).	Exud. Pressure (psi)	R Value	R Value Correct.
1	180	123.0	8.9	110	2.49	474	22	22
2	160	117.0	10.5	129	2.63	323	12	14
3	120	111.8	12.9	148	2.62	154	4	4

Sampled by: WJB **Tested by:** AX **Checked by:** CV

Rev. 12-13-2022

Appendix C

Important Information About Your Geotechnical Engineering Report

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 not 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 Not 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 not 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 not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

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