Geotechnical Exploration and Foundation Recommendations
149 North Gilpin Street
Denver, Colorado 80218

Project Number 22-002

April 8, 2022

Prepared For
Patrick Cashen Architect
2160 South Milwaukee Street
Denver, Colorado 80210

Cushman Geoscience LLC
747 Sheridan Boulevard, Unit 4D, Lakewood, CO 80214
720-502-6123
Reports@CushGeo.com
Observations@CushGeo.com

CONTENTS

Tables

Attachments

As requested, Cushman Geoscience LLC (CG) has prepared geotechnical engineering recommendations for the proposed structure(s) planned for the subject site.

Scope of Work

The scope included drilling an exploratory boring, obtaining soils and/or bedrock samples at intervals in the bore hole, and subjecting the samples to various laboratory tests as outlined herein and providing geotechnical recommendations.

The recommendations presented herein are based on the subsurface conditions observed in the boring and the laboratory testing results. Additional subsurface exploration and/or laboratory testing may result in recommendations that may differ to some degree than those presented herein. There is no guarantee or warranty as to the uniformity of subsurface materials and conditions at the subject site. An additional discussion of the limitations of geotechnical engineering is included in Appendix A.

Existing Construction and Site Conditions

The site is currently occupied by a single-family residence built in 1922 according to City and County of Denver records. The existing structure is two stories over a basement. Based on the age of the structure and the soils in the area we assume that the existing structure has a shallow foundation.

At the time of the exploration the lot was vegetated with a good cover of irrigated grass, bushes, and trees. The site is elevated relative to the street and alley. A site plan is presented in Figure 1.0.

Surficial Geology on the site is mapped as undifferentiated alluvium of Upper Holocene age according to Shroba, R.R., 1980, Geologic map and physical properties of the surficial and bedrock units of the Englewood quadrangle, Denver, Arapahoe, and Adams Counties, Colorado: U.S. Geological Survey, Geologic Quadrangle Map GQ-1524. Bedrock below the upper soil appears to be Denver and Arapahoe Formations of Paleocene and Upper Cretaceous age.

The site is underlain by soil and bedrock with a low swell potential according to Hart, Stephen S., 1974, Potentially Swelling Soil and Rock in the Front Range Urban Corridor, Colorado: Colorado Geological Survey, Environmental Geology 7.

Portions of the geologic and swell potential maps are shown in Figures 1.1 and 1.2.

Proposed Construction

The existing garage will be converted to living space. A new attached garage is planned. The structure(s) will have steel reinforced concrete foundations and will be built with wood and/or steel framing and possible veneer materials. Structural loading will be relatively light consistent with the proposed construction, on the order of 300 to 3,000 pounds per linear foot. Site grading will be minimal.

If the proposed construction varies significantly from that described above or herein, CG should be notified to re-evaluate the recommendations provided in this report, as necessary.

Subsurface Exploration

The subsurface exploration was performed by drilling one (1) test boring (B-1) on the lot at the approximate location shown in Figure 1.0. The boring was drilled on March 16, 2022, with a 4-inch diameter, solid stem auger powered by a CME-45 drill rig.

As noted in the Boring Logs, Figure 2.0, samples were obtained by driving a “modified California” sampler and a “split spoon” sampler into the subsurface materials at selected depths during drilling. The modified California sampler is a steel barrel sampler with a 2-inch inside diameter and a 2.5 inch outside diameter that is fitted with 4-inch long brass liners during sampling to facilitate retrieval and transport of relatively undisturbed samples of the subsurface materials. The split spoon sampler is a steel barrel sampler with a 1.625-inch inside diameter of and a 2.0-inch outside diameter that returns a disturbed sample.

The sampler was driven into the subsurface materials using a 140-pound hammer falling through a height of 30 inches. The number of blows required to drive the sampler 12 inches is recorded and provides an indication of the relative density of granular materials and relative consistency of cohesive, fine-grained soils.

Subsurface Conditions

Subsurface conditions encountered in the test boring, B-1, are summarized in Table 1 (below). A log of the test boring is presented in Figure 2.0. *Note: all measurements are approximate based on tools and methods used in the field.*

Table 1: Subsurface Conditions Summary

Boring No.	Depth (feet)	Soil Description
B-1	0 - 0.3	Portland cement concrete, 4 inches
	0.3 - 4.5	Sand, silty to slightly clayey, moist, loose, gray, brown
	4.5 - 30	Sand, fine to coarse grained, silty to clean, moist to saturated, loose to medium dense, tan, pink, brown

Bedrock was not encountered.

Groundwater encountered during drilling and measurements after drilling are summarized in Table 2 (below). *Note: all measurements are approximate based on tools and methods used in the field.*

Table 2: Groundwater Summary

Boring No.	Time Relative to Drilling	Groundwater Depth (feet)	Boring Depth (feet)
B-1	During drilling	26 (Approximate)	30 (Approximate)
	10 minutes after	26.0	26.5
	1 day after	Dry	26.5

Laboratory Test Results

Samples obtained during the geotechnical exploration program were returned to our laboratory where the soil descriptions and the boring log were reviewed by a senior geotechnical engineer or senior engineering geologist. Selected samples were then tested in the laboratory for moisture content, dry density, percent passing the No. 200 sieve, and swell consolidation potential. Results of the laboratory tests are presented next to the boring log in Figure 2.0, in Table 3 (below), and in Figure 3.0.

Table 3: Laboratory Test Results Summary

Boring No.	Depth (feet)	Moisture Content (%)	Dry Density (pcf)	Amount of Material Passing No. 200 Sieve (%)	Swell Potential (%)	Swell Pressure (psf)	Swell Risk
B-1	4	22.4	100	59	-0.3	N/A	N/A
B-1	9	2.4	107	7	-	-	-
B-1	14	5.5	98	5	-	-	-
B-1	19	3.1	-	3	-	-	-

Discussion of Expansive Soils

The amount of volume change that results when a sample of soil or bedrock is inundated with water under a constant pressure is measured in the Denver swell-consolidation test as the swell/expansion or consolidation potential. The swell pressure is the amount of pressure that is then required to compress the sample back to the volume before inundation.

The geotechnical engineering practice in the Colorado Front Range area uses a relative classification to evaluate the expansion potential of soil and bedrock. The expansion potential is categorized as low, moderate, high, or very high based on the swell potential. The following table presents the relative classifications. Additional information regarding risk is presented in Appendix A.

Table 4: Summary of Risk Categories

Slab Performance Risk Category	Representative Percent Swell (500 psf Surcharge)	Representative Percent Swell (1000 psf Surcharge)
Low	0 to < 3	0 to < 2

Slab Performance Risk Category	Representative Percent Swell (500 psf Surcharge)	Representative Percent Swell (1000 psf Surcharge)
Moderate	3 to < 5	2 to < 4
High	5 to < 8	4 to < 6
Very High	8 or greater	6 or greater

Source: Colorado Association of Geotechnical Engineers, 1996.

Note: The representative percent swell values presented are not necessarily measured values. Rather, they are a judgment of the swell of the soil and bedrock profile likely to influence slab performance.

Site Preparation and Fill

Prior to site grading, areas to be graded should be stripped of surface vegetation, topsoil, debris, and other deleterious material. Stripped materials should be wasted off site in accordance with applicable regulations. However, non-hazardous stripped soil with vegetation can be used as shallow fill in non-structural, landscaped areas of the site. **All undocumented fill and demolition debris should be removed from below the planned foundations and floor slabs and replaced with properly compacted structural fill.**

Fill Material: Frozen material, ice, snow, cobbles larger than 3 inches, organic material, debris, and other deleterious material should be excluded from fill materials.

Imported fill material should be non-expansive at the recommended placement moisture content and density, classify as a coarse-grained material (sand or gravel) by the Unified Soil Classification System (USCS), and have a liquid limit less than 40 and a plasticity index less than 20. Suitable imported structural materials would be: CDOT Class 5 or 6 road base, CDOT Class 1 Structure Backfill, or a manufactured 'crusher fines' material.

CG should be contacted at Observations@CushGeo.com to test and evaluate whether proposed on-site or imported materials are suitable structural fill.

Fill Placement: Fill should be placed in lifts 8 inches or less in loose thickness, moisture conditioned and compacted. Structural fill, including below footings and foundation wall backfill in areas of external and interior flatwork (i.e., sidewalks, driveways, garage slabs) should be compacted to at least 95% or more of the standard Proctor Maximum Dry Density (MDD) per ASTM D698. Fill in non-structural areas should be compacted to at least 90% of the MDD.

Fill which classifies as silt, sand, or gravel by the USCS should be compacted within a moisture content range of 3 percent below to 3 percent above the Optimum Moisture Content (OMC) and fill which classifies as clay by the USCS should be compacted within a moisture content range of OMC to 3 percent above OMC.

Site Excavation

The excavations should be performed in accordance with OSHA 1926 Subpart P under the supervision of the contractor’s Competent Person.

- The **upper silty, clayey sand** soil (to a depth of about 4.5 feet below grade) classifies as cohesive Type B allowing for a maximum excavation slope of 45° (1:1 Horizontal to Vertical).
- The l**ower silty to clean sand** soil (approximately 4.5 feet below grade) classifies as Type C allowing for a maximum excavation slope of 34° (1.5:1 Horizontal to Vertical).
- The thickness of the upper silty, clayey sand soil is approximate. **Where clean sand soils are encountered within the cut, the entire excavation depth should be excavated per the Type C** recommendations.
- The soil classification should be confirmed by the contractor’s Competent Person during excavation.
- The slopes may require to be further laid back if seepage or instability is observed in the foundation excavations.
- The contractor should manage construction traffic and the placement of excavation spoils to maintain excavation slope stability.

If site constraints prevent appropriate excavation sloping, the foundation excavation can be shored using drilled concrete piers. Our office can prepare an excavation shoring design for this project if needed.

Foundation Recommendations

A spread footing foundation supported on native soils or properly compacted structural fill (as described in Site Preparation) is recommended to support the proposed structure. Based on the age of the structure and the soils in the area CG assumes that the existing structure has a shallow foundation. Matching existing and new/addition foundation types is recommended. **The existing foundation type should be confirmed, and our office should be contacted for pier recommendation if the existing foundation is drilled piers.**

- New foundations at the garage, crawlspace, or porch elevation, about 3 - 4 feet below grade, should be designed based on a maximum allowable soil bearing pressure of 1,200 pounds per square foot (psf)

Additional spread footing foundation design and construction considerations:

1. Total movement is estimated to be 1 inch or less, and differential movements are expected to be ½ to ¾ of the total movements.

2. Spread footings should have a minimum width of 18 inches for continuous footings placed on material as described above, and 24 inches for isolated pads.
3. Footings should have a minimum embedment (soil cover) of 1 foot for bearing capacity considerations.
4. Footings placed beneath unheated areas should have at least 36 inches of covering soils to protect from frost. This depth should be verified with the local building department.
5. Friction between the footing and its subsoil and passive earth pressures (of the soils on the side of the footing) provide lateral resistance to the spread footings. See Table 5: Lateral Soil Resistance Values for recommended values.
6. The foundation system should be reinforced to span an unsupported length of 10 feet.
7. Some areas of soft and/or loose soils may be encountered in the foundation excavations. Soft or disturbed soils observed in the foundation excavation should be compacted in place or removed and replaced with structural fill, as noted above in Site Preparation.
8. **A representative of our office must observe the foundation excavation prior to foundation construction and/or fill placement**. Contact CG at *Observations@CushGeo.com*.
9. The foundation excavation should be protected from runoff, and multiple wetting and drying cycles. Runoff into the foundation excavation should be avoided.
10. Cement meeting the requirements of Type II should be used in the concrete on this site.

Foundation Walls

Foundation wall backfill should be in accordance with the Site Preparation and Fill section of this report.

Foundation walls which are laterally supported and expected to undergo a minimal amount of movement should be designed with a lateral "at-rest" earth pressure. The earth pressure can be reduced for "active" conditions where significant wall deflection can occur, such as at site retaining walls. The following lateral soil resistance factors are recommended:

Table 5: Lateral Soil Resistance Values

Soil	Coefficient of Friction (against concrete)	Earth Pressure (pcf)		
		At Rest	Active	Passive
sand, silty, slightly clayey	0.35	50	35	240

These pressures assume drained conditions behind the foundation walls. The buildup of water behind a foundation wall will increase the lateral pressures on the wall. All foundation walls should be designed for appropriate hydrostatic and surcharge pressures such as: adjacent buildings, traffic, construction materials and equipment.

Floor Slabs

The onsite soils can support slab-on-grade construction with a low risk of slab heave due to potentially expansive soils. Potential floor slab heave of less than 1 inch exists on the site near the ground surface assuming a depth of moisture variation ("depth of wetting") of about 20 feet. Structural floors should be used if this potential movement is not acceptable to the client.

Past performance of existing slabs on grade can be considered when evaluating the risk of slab on grade performance for this site.

Slab Design: Slabs should be designed and constructed in accordance with ACI 302.1 Guide to Concrete Floor and Slab Construction. To reduce the effects of differential movement, slabs on grade should be separated from all bearing walls and columns with isolation joints that allow for unrestrained vertical movement. Control joints should also be provided throughout the slab.

Cracks and movement of the slabs supported on grade can be transmitted through rigid floor coverings. Performance expectations should be taken into consideration in the selection of floor slab coverings.

Where plumbing lines enter through the slab, positive breaks should be provided. Connections to mechanical equipment should be flexible.

Partitions should not be designed or constructed to bear on slabs supported on grade. A void (typically 3 inches) should be established below or above partitions during construction and monitored and maintained by the owner after construction. The void space can be covered with a molding strip that is not attached to the partition.

Floor Slab Subgrade: The subgrade should be prepared as noted above in Site Preparation. Where encountered, soft or disturbed soils should be compacted on grade or removed and replaced with structural fill as noted above in Site Preparation. Unless the soil is well drained, a 4-inch-thick gravel base course should be placed on the prepared subgrade, as specified in IRC R506.2.2. The soils on this site are **not** well drained so a gravel layer is recommended

Plastic Moisture Barrier: A vapor retarder should be placed between the concrete floor slab and the prepared subgrade or base course, as specified in IRC R506.2.3.

Radon

Radon may be a potential concern in Colorado. If a crawlspace is constructed it should be well ventilated. If a gravel layer is placed beneath the floor slab it can be incorporated into a radon abatement system if this becomes necessary in the future. The local building department should be contacted for more information regarding radon issues in this area. Radon Prevention methods should conform to EPA Radon Mitigation Standards: *EPA 402-R-93-078, October 1993 and revised April 1994.*

Radon levels in the existing structure can also be considered when evaluating the need for a radon mitigation system for the new structure(s).

Mold

Mold can develop in crawlspaces that become damp under certain conditions. If a crawlspace is constructed, it should be well ventilated. A vapor barrier should be placed on exposed soil to help control indoor moisture levels and should be sealed at the edges and seams. A professional hygienist should be contacted to address any potential mold concerns and mitigation methods. Refer to *A Brief Guide to Mold, Moisture and Your Home for additional information: EPA 402-K-02-003, dated September 2010*, for more information.

Crawlspace Recommendations *(If Applicable)*

A health and safety professional with experience in the design of crawlspaces can be consulted to provide recommendations to reduce moisture infiltration into crawlspaces. Such recommendations may include lining the crawlspace with polyethylene plastic that is sealed and mechanically attached to the foundation. Plastic should not be attached to the foundation within 6 inches of untreated wood members of the framing or flooring. Also, plastic should not be attached to metal framing members such as column posts but can be attached to concrete foundations supporting column posts.

Subsurface Drainage *(If Applicable)*

It is recommended that below grade, habitable or usable spaces be protected from surface water infiltration with a perimeter drain system in accordance with IRC R405.1. The drainage system can be either an interior or exterior type. Details of typical drainage systems are presented in Appendix B. CG understands that new below grade space is **not** planned.

Surface Drainage

The following drainage precautions should be observed and maintained during and after construction:

1. Excessive wetting of the foundation excavation and sub-floor soils should be avoided.

2. Exterior backfill should be placed as recommended herein.

3. The ground should be sloped away from the building. A minimum slope of 10% in the first 5 to 10 feet in landscaped areas and 3% in paved areas is recommended.

4. If a 10-foot zone is not possible, then a lined, well-defined swale should be created at least 5 feet from the foundation and sloped parallel with the wall with a minimum slope of 2 percent to intercept the surface water and transport it around and away from the structure.

5. Homeowners must maintain the surface grading and drainage recommended in this report to help prevent water from being directed toward and/or ponding near the foundations. Failure to maintain

positive surface drainage away from the structure may result in localized differential vertical movement of foundations and slabs.

6. Roof downspouts should discharge well beyond foundation wall backfill zones.

7. Plastic membranes should not be placed adjacent to the foundation walls. A pervious textile should be used to control weed growth.

8. Any settling of foundation or foundation wall backfill should be re-graded to maintain the slopes noted above.

Exterior Flatwork

The subgrade soils should be scarified and compacted to at least 95% of the standard Proctor maximum dry density near the optimum moisture content in areas of driveway pavement or approach apron for a garage, if constructed. Proof-rolling of these areas is recommended. Soft and deflecting areas should be removed and replaced with properly compacted fill.

Limitations and Exclusions

This study has been conducted in accordance with generally accepted geotechnical engineering practices using the degree of care and skill ordinarily exercised by members of the same profession currently practicing under the same or similar circumstances in this area, and for use by the client for design purposes at the named site. CG makes no warranties, expressed or implied.

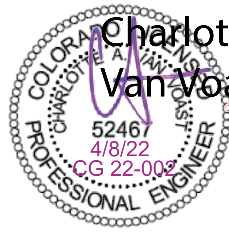
The conclusions and recommendations presented in this report are based on the data obtained from the exploratory boring(s) drilled at the approximate location presented in Figure 1.0, and the proposed construction. An additional discussion of the limitations of geotechnical engineering practices is presented in Appendix A. An environmental assessment (ESA Phase I or II) of the site is outside our scope of work for this project. This report should also not be considered as an indication of the absence of or as an evaluation of any potential environmental, geologic, or mining hazards for the subject site.

If during construction, fill, soil, or water conditions appear to be different than that presented in this report, CG should be contacted to reevaluate the recommendations presented herein as necessary. *A representative of our office must observe foundation excavations, pier installation, backfill operations, and foundation bearing strata, as applicable, to confirm the recommendations of this report.*

If you have any questions regarding this report, please contact our office.

Cushman Geoscience LLC

Prepared by: Reviewed by:



Charlotte Van Voast

Digitally signed by Charlotte Van Voast
Date: 2022.04.08 12:33:16 -06'00'

Yvonne M. Allmaras, M.S.
Senior Engineer

Charlotte Van Voast, P.E.
Senior Geotechnical Engineer

Attachments – Figures 1.0 - 3.0
Appendix A: Important Information about This Report
Appendix B: Foundation Drain Details

Distribution: **Digitally Stamped PDF via email to addressee, printed copies mailed upon request**

References

Foundations and Earth Structures, Naval Facilities Engineering Command Design Manuals 7.01 and 7.02, 09-01-1986

Guideline for Slab Performance Risk Evaluation and Residential Basement Floor System Recommendations, Colorado Association of Geotechnical Engineers, 1996.

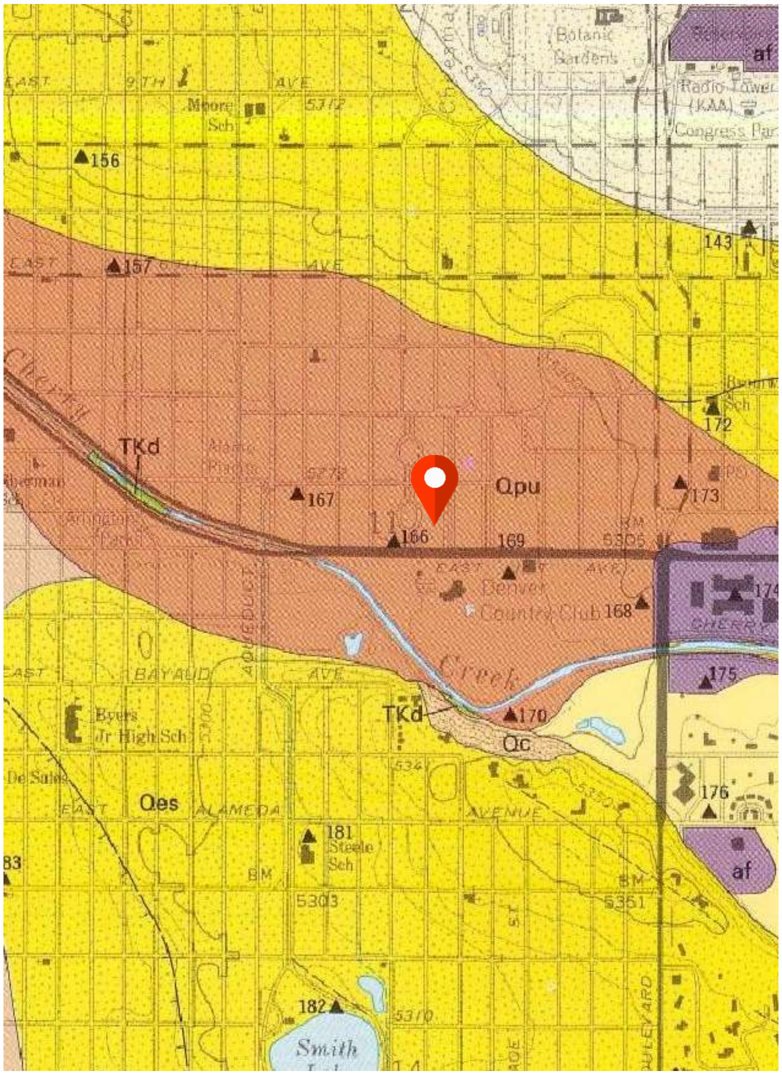
N

NOTES: 1) Not to Scale

2) ⊕ Indicates location of exploratory test boring.

CUSHMAN GEOSCIENCE	149 N. Gilpin St., Denver, CO	PROJECT NO. 22-002
	SITE PLAN	FIGURE NO. 1.0

N



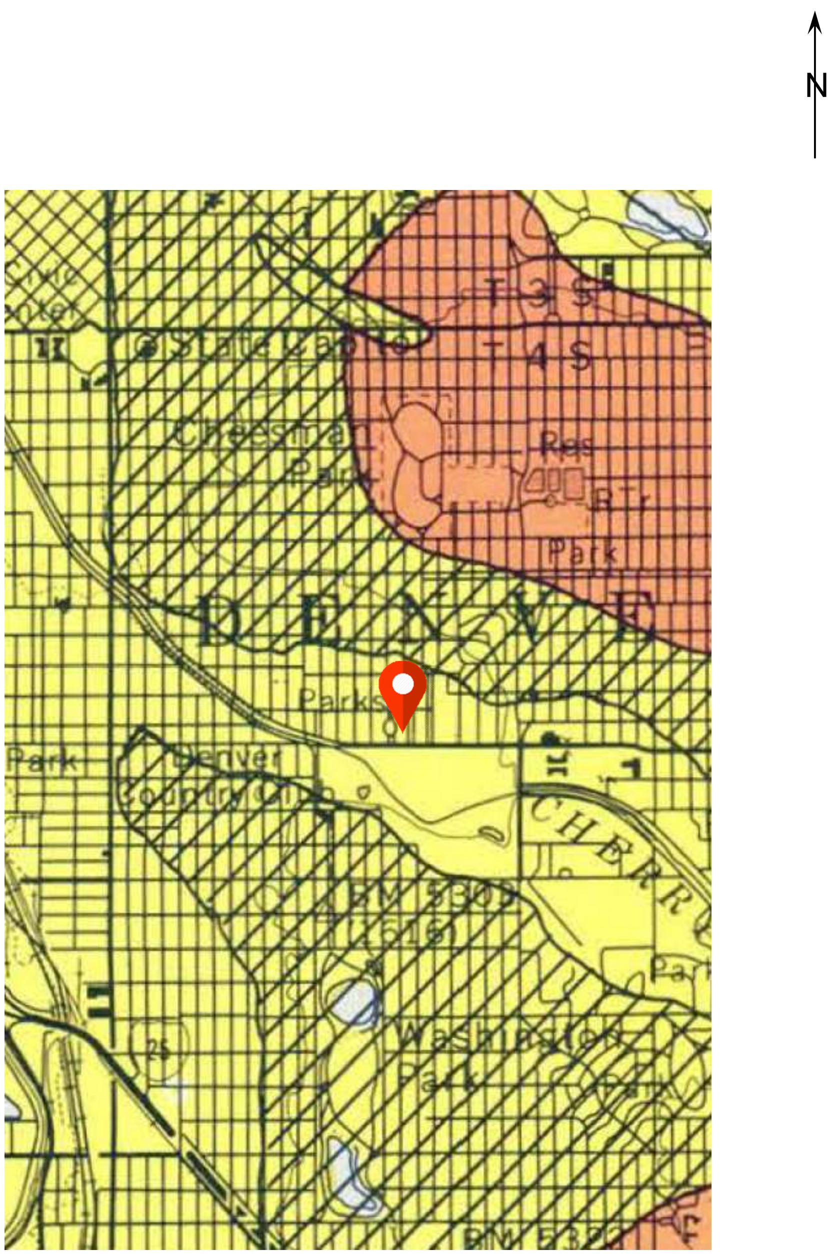
Qpu

UNDIFFERENTIATED ALLUVIUM (UPPER HOLOCENE)—Deposits of post-Piney Creek alluvium and Piney Creek Alluvium along Cherry Creek, west of Glendale, where units are too extensively modified by urban development to permit mapping. Includes large areas of artificial fill along Cherry Creek

SITE LOCATION

SOURCE: Shroba, R.R., 1980, Geologic map and physical properties of the surficial and bedrock units of the Englewood quadrangle, Denver, Arapahoe, and Adams Counties, Colorado: U.S. Geological Survey, Geologic Quadrangle Map GQ-1524

CUSHMAN GEOSCIENCE	149 N. Gilpin St., Denver, CO	PROJECT NO. 22-002
	Geologic Map	FIGURE NO. 1.1

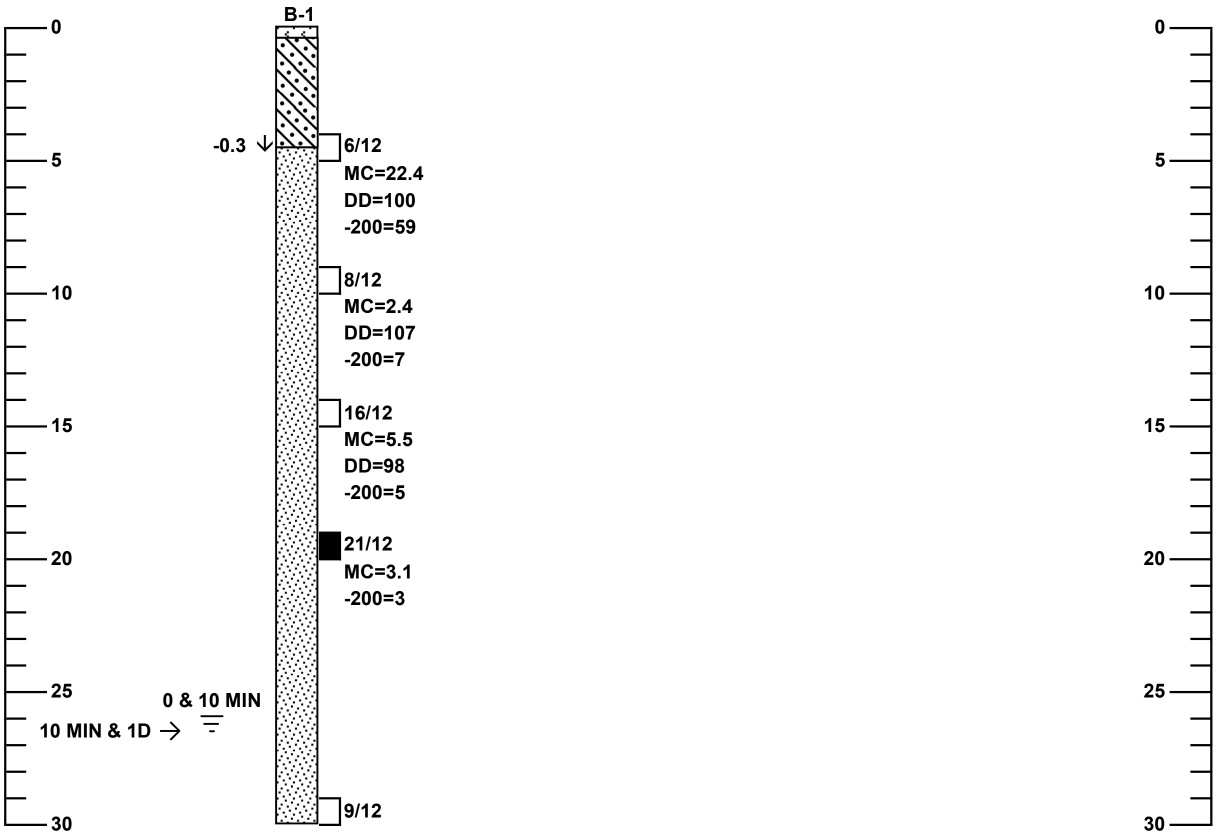


LOW SWELL POTENTIAL: *This category includes several bedrock formations and many surficial deposits. The thickness of the surficial deposits may be variable, therefore, bedrock with a higher swell potential may locally be less than 10 ft below the surface.*

SITE LOCATION

SOURCE: Hart, Stephen S., 1974, Potentially Swelling Soil and Rock in the Front Range Urban Corridor, Colorado: Colorado Geological Survey, Environmental Geology 7

CUSHMAN GEOSCIENCE	149 N. Gilpin St., Denver, CO	PROJECT NO. 22-002
	Swell Potential Map	FIGURE NO. 1.2



LEGEND:

PORTLAND CEMENT CONCRETE, 4 INCHES

SAND, SILTY TO SLIGHTLY CLAYEY, MOIST, LOOSE, GRAY, BROWN

SAND, FINE TO COARSE GRAINED, SILTY TO CLEAN, MOIST TO SATURATED, LOOSE TO MEDIUM DENSE, TAN, PINK, BROWN

INDICATES A "MODIFIED CALIFORNIA" SAMPLER WAS DRIVEN

INDICATES A "SPLIT SPOON" SAMPLER WAS DRIVEN

6/12 INDICATES THAT 6 BLOWS WITH A 140 POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A MODIFIED CALIFORNIA SAMPLER 12 INCHES INTO THE SUBSURFACE SOILS

-0.3 ↓ INDICATES AMOUNT OF VOLUME CHANGE (%) AND DIRECTION OF SAMPLE MOVEMENT ON WETTING

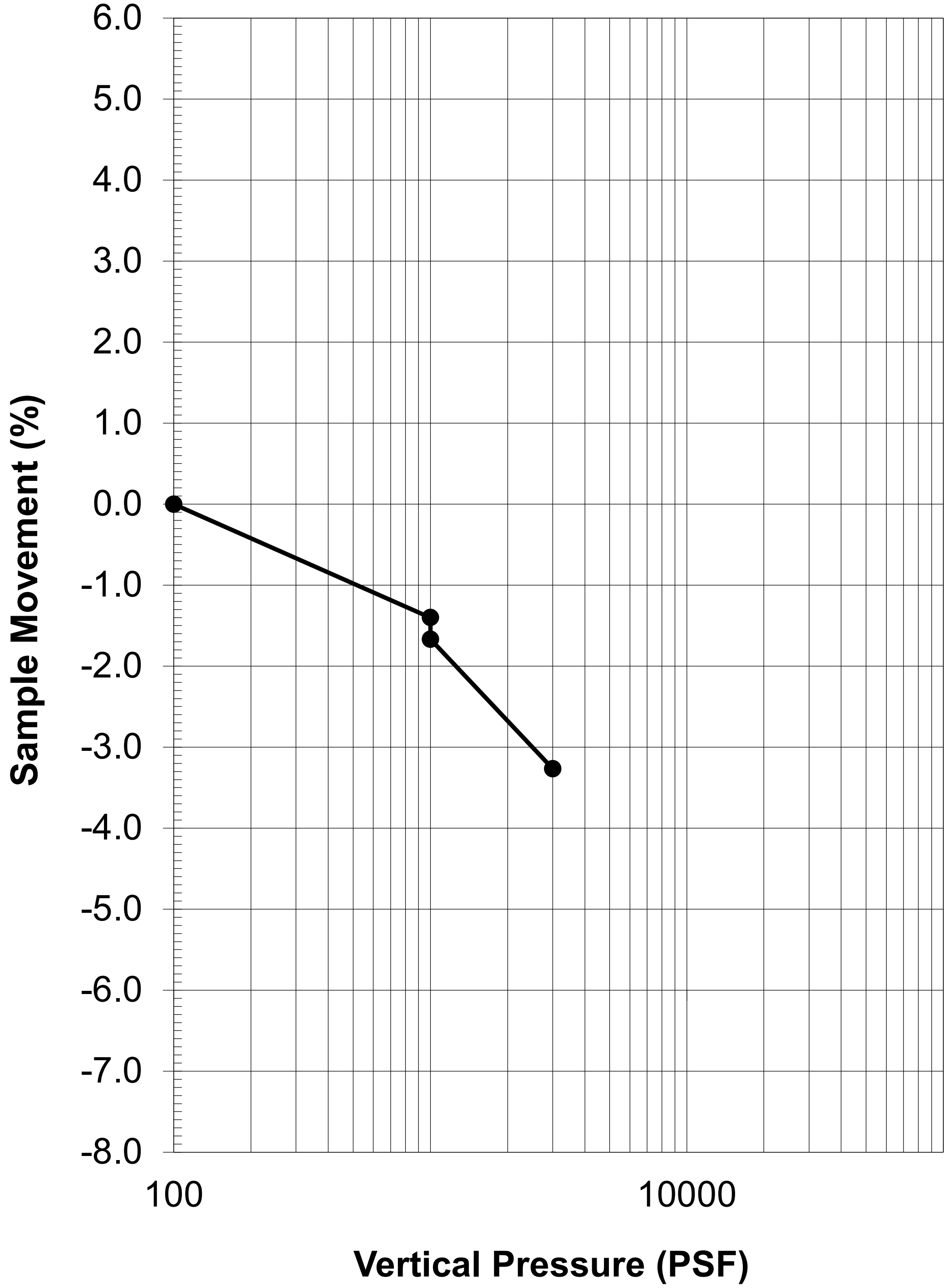
1 INDICATES DEPTH TO GROUNDWATER AND NUMBER OF DAYS AFTER DRILLING WAS OBSERVED

1 → INDICATES BORING DEPTH AND NUMBER OF DAYS AFTER DRILLING OBSERVED

MC= INDICATES MOISTURE CONTENT (%) OF SAMPLE
DD= INDICATES DRY DENSITY (pcf) OF SAMPLE
-200= INDICATES AMOUNT OF MATERIAL PASSING NO. 200 SIEVE (%)

NOTES:
1) THE BORING WAS DRILLED ON MARCH 16, 2022 WITH A 4-INCH DIAMETER, SOLID-STEM AUGER POWERED BY A CME-45 DRILL RIG.
2) THE LOCATION OF THE BORING WAS DETERMINED APPROXIMATELY IN THE FIELD BY TAPING OR PACING FROM FEATURES ON THE SITE PLAN AND SHOULD ONLY BE CONSIDERED ACCURATE TO THE DEGREE IMPLIED BY THE METHOD USED.
3) CHANGES BETWEEN MATERIAL TYPES ARE APPROXIMATE AND TRANSITIONS MAY BE GRADUAL. GROUNDWATER ELEVATIONS MAY VARY SEASONALLY AND FROM YEAR TO YEAR DEPENDING ON CLIMATE AND OTHER FACTORS.

CUSHMAN GEOSCIENCE	149 N. Gilpin St., Denver, CO	PROJECT NO. 22-002
	BORING LOG, LEGEND & NOTES	FIGURE NO. 2.0



Sample Description:		Clay, very sandy, silty	
Boring No.	B-1	Moisture Content (%)	22.4
Depth (ft)	4	Dry Density (pcf)	100
		Swell (%)	-0.3
		Swell Pressure (psf)	N/A

CUSHMAN GEOSCIENCE	149 N. Gilpin St., Denver, CO	Project No.	22-002
	SWELL-CONSOLIDATION TEST	Figure No.	3.0

Appendix A
Important Information about this Report

The data collected by Cushman Geoscience LLC (CG) during this geotechnical exploration was used to provide geotechnical information and recommendations based on subsurface conditions for the site evaluated, the potential effects of those conditions on the proposed structure, and recommended foundation type for the proposed structure. The stratification lines shown on the boring log(s) are approximate and actual transitions between materials may be more gradual or more rapid than indicated on the boring log(s). Actual subsurface conditions encountered during construction may differ from the subsurface conditions presented herein. This uncertainty can not be eliminated due the variable nature of geologic conditions. Material characteristics and engineering properties of soil and bedrock may vary between samples and between borings. The actual material characteristics and engineering properties of the soil or bedrock may differ from interpretations based on sampled soil and bedrock. Quantitative conclusions prior to construction regarding the geotechnical performance of a structure are not possible due to the potential variability of subsurface conditions. Engineering judgment and experience are used to evaluate the most likely geotechnical performance of the structure and provide geotechnical recommendations for the structure. There are no guaranties or warranties implied or expressed.

The owner and client must understand that uncertainties are associated with geotechnical engineering and must determine the level of risk they are willing to accept for the proposed construction. The level of risk can be reduced, but not eliminated by more extensive exploration and sampling of the site and additional laboratory testing, which would cost more money and take more time. To reduce the level of uncertainty, the report should only be used by the referenced client for the referenced project and the construction described in the report unless authorized in writing by CG. CG should be consulted to review changes to the proposed construction such as the nature, size, configuration, orientation, location or weight of proposed improvements. Additionally, the practice of geotechnical engineering is continually developing knowledge and experience, and it must be understood that recommendations are based on the state of the practice at the location and time the report was prepared. The report should not be used more than three years after issuance unless reviewed and revised if needed by CG.

The geotechnical engineering practice in the Colorado Front Range area uses a relative classification to evaluate the expansive potential of soils and bedrock. The expansive potential is categorized as low, medium, high or very high based on the swell potential. The following table presents the relative classifications.

Table No. 1 - Risk Categories

Slab Performance Risk Category	Representative Percent Swell (500 psf Surcharge)	Representative Percent Swell (1000 psf Surcharge)
Low	0 to< 3	0 to< 2
Moderate	3 to < 5	2 to < 4
High	5 to < 8	4 to < 6
Very High	8 or greater	6 or greater

Source: Colorado Association of Geotechnical Engineers, "Guideline for Slab Performance Risk Evaluation and Residential Basement Floor System Recommendations (Denver Metropolitan Area), December 1996

The slab performance generally associated with the slab performance risk categories are as follows:

Low	slab cracking, differential movement and heave
Moderate	slab cracking, differential movement and heave, partial framing void and furnace plenum closure
High to Very High	large slab cracking, differential movement and heave, closed framing void and furnace plenum

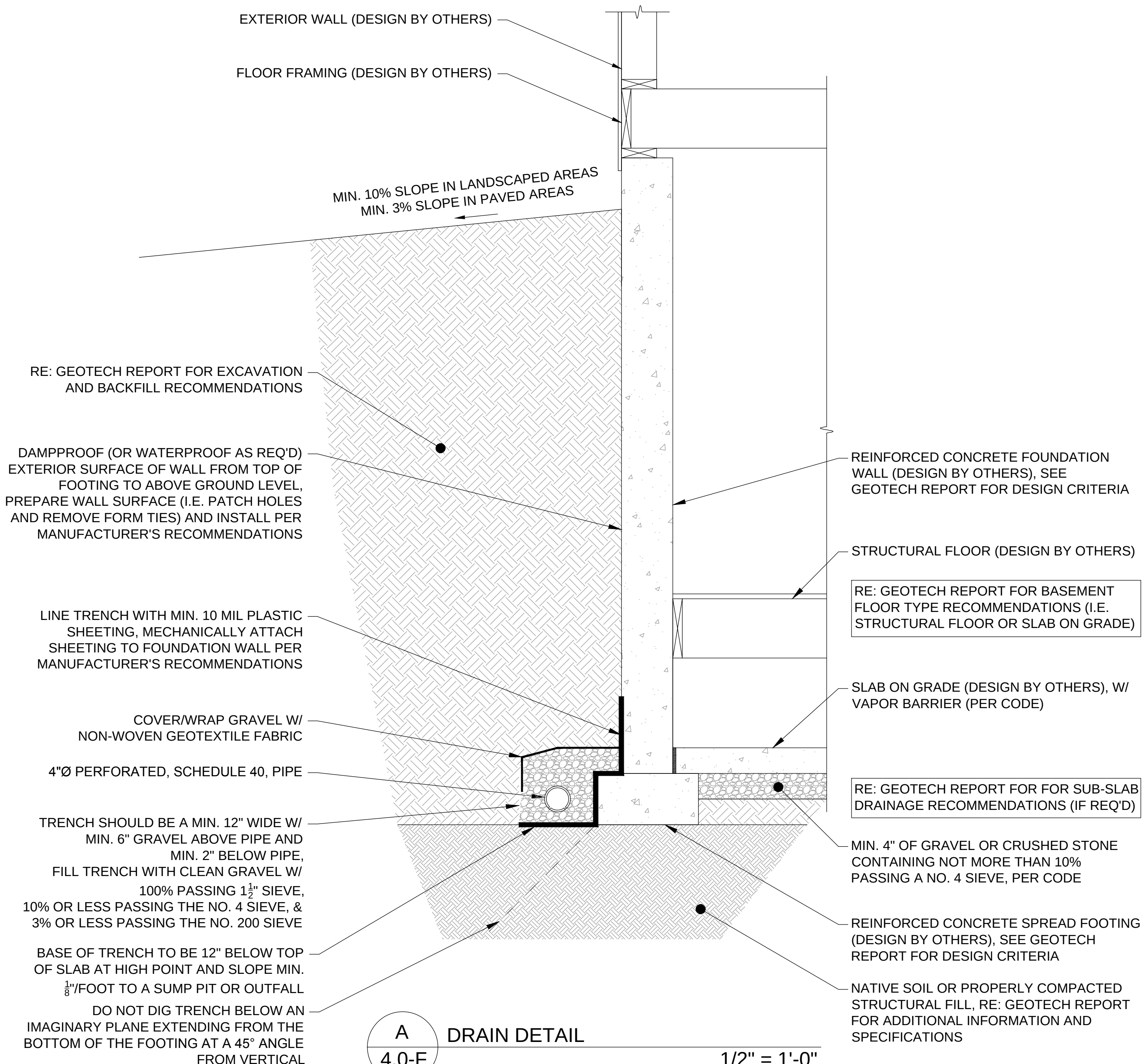
Note: More or less damage can occur in any risk category due to the variable nature of soil and bedrock.

It is important to note that measured swell or expansion is not the only criteria used in developing foundation and floor recommendations. Other factors considered in the development of foundation and floor recommendations are:

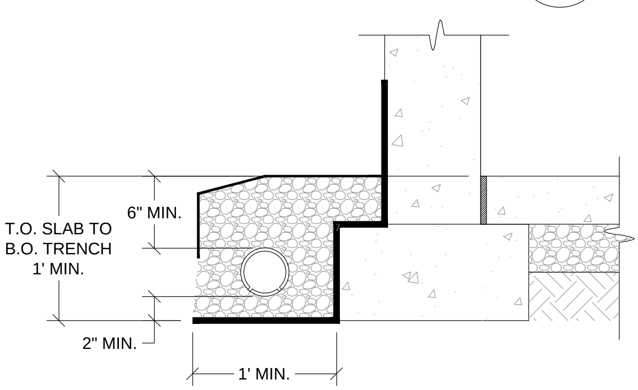
a. Soil and bedrock variability,
b. Stratigraphy,
c. Groundwater depth during field activities and potential groundwater depth after construction,
d. Surface water features and site drainage,
e. Post construction landscaping and irrigation conditions,
f. Construction details and proposed use, and
g. Local experience.

Landscaping of the site following construction and owner maintenance will greatly affect the performance of structures on sites with expansive soil or bedrock. Typically, moisture contents of subsurface soils and bedrock increase after construction due to surface irrigation and the cut off of evaporation that occurs when a slab or building is constructed. Poor owner maintenance, such as ground surfaces sloping towards foundations or slabs and irrigated landscaping adjacent to buildings, will increase the potential for slab and foundation movement by increasing the potential for moisture content changes in the subsurface soils. The property owner or buyer, and anyone he or she plans to sell the house to, must understand the risks associated with construction in areas with expansive soils and must assume the responsibility for maintenance of the structure and the site. The owner and prospective purchasers should review "A Guide to Swelling Soils for Colorado Homebuyers and Homeowners," a special publication (SP43) of the Colorado Geological Survey, which helps homebuyers and homeowner understand and take measures to reduce the potential for damage due to expansive soils.

APPENDIX B
FOUNDATION DRAIN DETAILS



A
4.0-F
DRAIN DETAIL
1/2" = 1'-0"

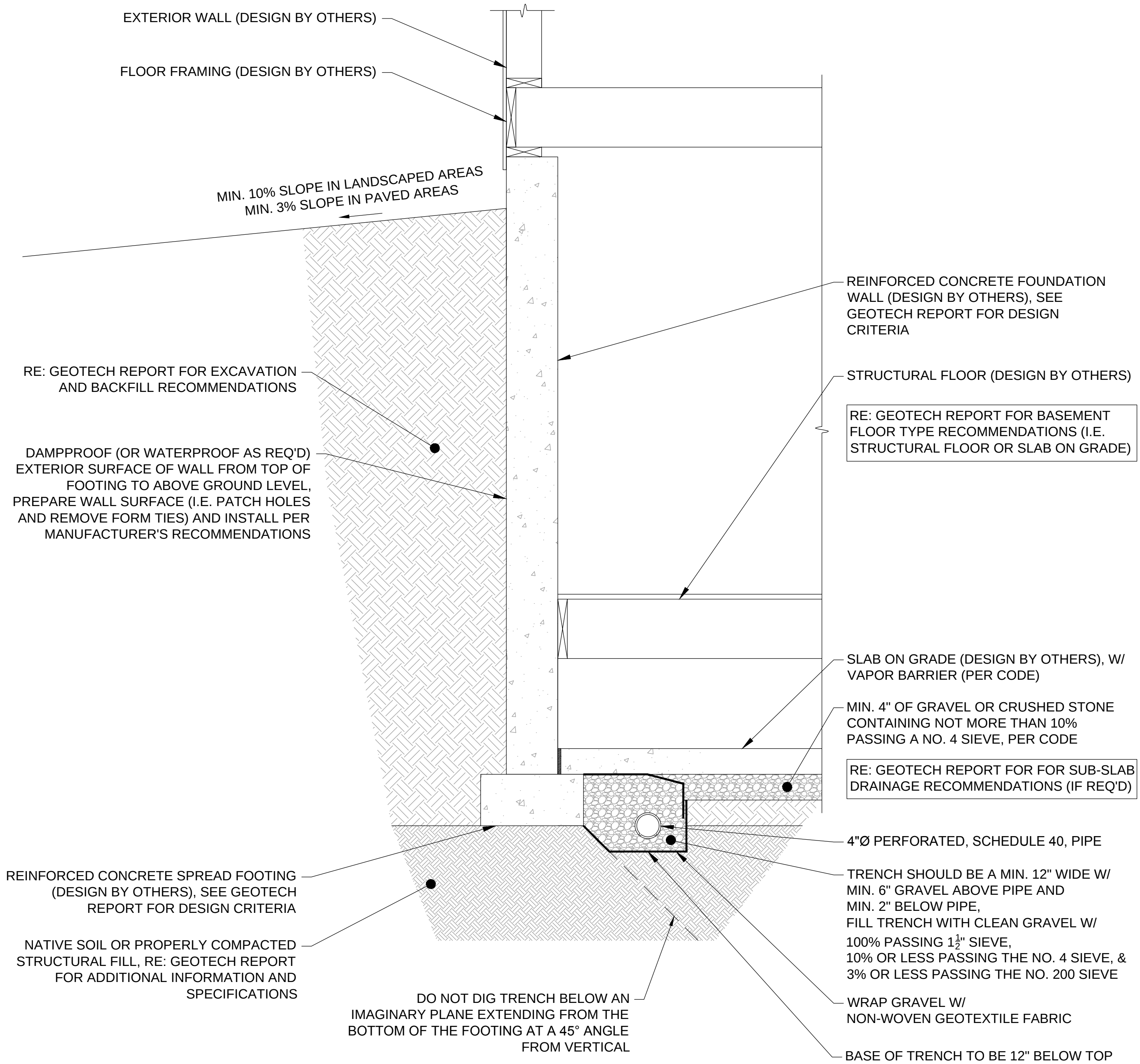


B
4.0-F
DRAIN DIMENSIONS
3/4" = 1'-0"

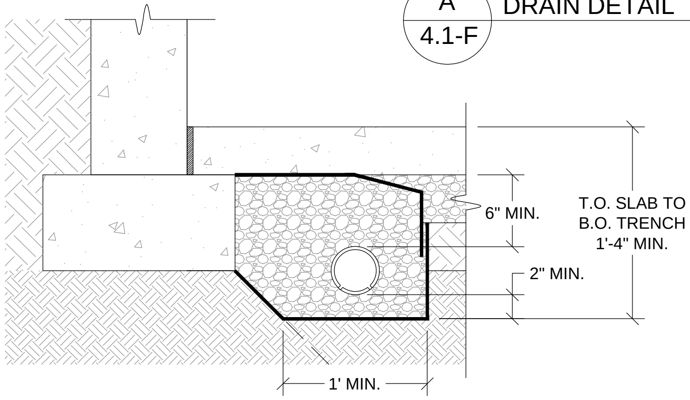
CUSHMAN GEOSCIENCE LLC

EXTERIOR DRAIN - FOOTING FOUNDATION

FIGURE NO. 4.0-F



A
4.1-F
DRAIN DETAIL
1/2" = 1'-0"



B
4.1-F
DRAIN DIMENSIONS
3/4" = 1'-0"

CUSHMAN GEOSCIENCE LLC	INTERIOR DRAIN - FOOTING FOUNDATION	FIGURE NO. 4.1-F