GROUND ENGINEERING

Preliminary Geotechnical Evaluation
Anythink Nature Library
Thornton, Colorado

Prepared For:

Anythink Libraries

5877 E. 120th Avenue
Thornton, Colorado 80602

Attention: Ms. Pam Sandlian-Smith

Job Number: 22-3012 **April 11, 2022**

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PURPOSE AND SCOPE OF STUDY

This report presents the results of a preliminary geotechnical evaluation performed by GROUND Engineering Consultants, Inc. (GROUND) in support of the design and construction of the proposed library to be located northeast of East 136th Avenue and Monaco Street in Thornton, Colorado. Our study was conducted in general accordance with GROUND's Proposal Number 2202-0288 to Anythink Libraries dated February 17, 2022.

Field and office studies provided information obtained at the test hole locations regarding surface and subsurface conditions, including the existing site vicinity improvements. Material samples retrieved during the subsurface exploration were tested in our laboratory to assess the engineering characteristics of the site earth materials, and assist in our geotechnical analysis. Results of the field, office, and laboratory studies are presented below.

This report has been prepared to summarize the data obtained and to present our preliminary findings and conclusions based on the proposed development and the subsurface conditions encountered. The preliminary / initial information presented in this report is not sufficient for design. Additional, structure-specific subsurface exploration and site evaluation must be performed prior to final design and construction.

PLANNED DEVELOPMENT

We understand that the plans for the subject development have not been finalized, and that nature, size, locations of improvement may change during project planning. However, we understand that project plans call for an approximately 34,000 square-foot library building with associated parking areas, drive lanes, and landscaping on the subject 15-acre parcel. Other ancillary building and structures, such as a trailhead, are anticipated as well. If the proposed development differs significantly from that described above, GROUND should be notified to re-evaluate the conclusions and parameters contained herein.

SITE CONDITIONS

At the time of our exploration, the site generally consisted of undeveloped land vegetated with short to tall grasses and weeds. The site was bordered to the south by East 136th Avenue, undeveloped land and single-family residences to the west, oil and gas development and undeveloped land to the north, and a reach of the Pheasant Run drainage and undeveloped land to the east. Additional undeveloped land, single-family residences, and oil and gas development further surrounded the site. The site was located on a north-south trending ridge, with topographically higher areas generally in the middle and southern portions of the site. Grade changes across the site were approximately 30 feet.

It appears oil and gas facilities were previously associated with the western and northwestern portions of the project site. Based on our review of information available on the Colorado Oil & Gas Conservation Commission GIS Online mapping application[1] (COGCC), it appears a well and pump jack were located on the western portion of the site. Associated pipelines ran north from the well, extending beyond the northwestern corner of the site. Based on the documentation available in the website, the well was abandoned and the associated pipelines were removed between 2018 and 2019. Soil replacement/backfilling information is unknown by GROUND. Selected Google Earth historical aerial images are presented below with the approximate project extents indicated by the red polygon.

[1] *COGCC GIS Online,* Colorado Oil & Gas Conservation Commission, Department of Natural Resources. https://cogccmap.state.co.us/cogcc_gis_online/, accessed on 3/10/2022

INITIAL SUBSURFACE EXPLORATION

The subsurface exploration for the project was conducted in March 2022. Eight test holes were drilled with a conventional, buggy-mounted drill rig advancing 4-inch diameter solid stem continuous flight augers to evaluate the subsurface conditions as well as to retrieve samples for laboratory testing and analysis. The test holes were advanced at the approximate locations requested by Anythink Libraries to depths of approximately 18 to 38 feet below existing grade. A GROUND engineer directed the subsurface exploration, logged the borings in the field, and prepared samples for transport to our laboratory.

Samples of the subsurface materials were taken with a 2-inch inner diameter Modified California-type liner sampler. The samplers were driven into the substrata with blows from a 140-pound hammer falling 30 inches, a procedure similar to the Standard Penetration Test described by ASTM Method D1586. Penetration resistance values, when properly evaluated, indicate the relative density or consistency of soils. Depths at which the samples were taken, and associated penetration resistance values are shown on the test hole logs.

The approximate locations of the test holes are shown in Figure 1. Summary logs of the test holes are provided in Figure 2. A legend and notes are provided in Figure 3. Detailed logs of the test holes are provided in Appendix A.

LABORATORY TESTING

Samples retrieved from our borings were examined and visually classified in the laboratory by the project engineer. The limited laboratory testing performed for this study of soil samples included standard property tests, such as natural moisture contents, grain size analyses, and Atterberg limits. Swell-consolidation and a suite of corrosivity tests were completed on select samples as well. Laboratory tests were performed in general accordance with applicable ASTM protocols. Results of the laboratory testing program are summarized in Tables 1 and 2.

GEOLOGIC SETTING

Published geologic maps (Trimble and Machette, 1979[2]) depict the project area as underlain by Slocum Alluvium (**Qs**). These materials are described to be gravels with cobbles and boulders with abundant caliche. These surficial deposits are mapped as being underlain by the Paleocene and Cretaceous Denver Formation (**TKd**). A portion of that geologic map is reproduced below.

Alluvial deposits, in the project area, generally consist of sands, gravels, and cobbles with silts and clays beds and lenses. Boulders can be encountered locally. The cobbles and boulders present can be relatively large and can be awkward or difficult to handle and process. These larger clasts may not be suitable for reuse in project fills.

The Denver Formation, in the project area, typically consists of sandstones, claystones, and siltstone interbedded on various scales. The claystones typically are moderately to highly expansive and the formation includes well-cemented beds that can be very hard and difficult to excavate.

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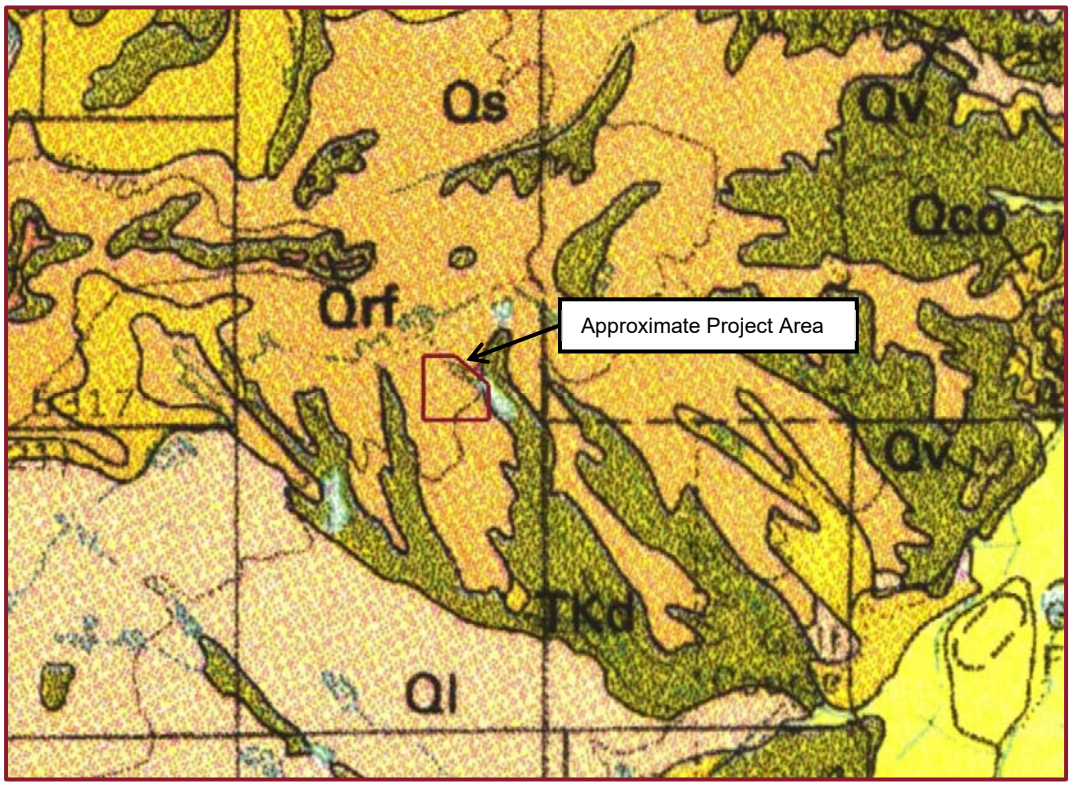
[2] Trimble, Donald E. and Machette, Michael N. (1979). *Geologic map of the Greater Denver Area, Front Range Urban Corridor, Colorado*. United States Geologic Survey. Miscellaneous Investigation Series, Map I-856-H. scale 1:100,000



GEOLOGIC HAZARDS

Expansive Soils Swelling clayey soils and bedrock change volume in response to changes in moisture content that can occur seasonally, or in response to changes in land use, including development. Expansion potentials vary with moisture contents, density, clay chemistry and mineralogy. The swell potential in any particular area can vary markedly both laterally and vertically due to the complex interbedding of the site soil and bedrock materials. Moisture changes also occur erratically, resulting in conditions that cannot always be predicted.

The shallow earth materials underlying the site generally consisted of clays and claystone, which, in the project area, commonly have relatively high potentials for swell. The plasticity of these materials ranged from moderately to highly plastic. Swells-consolidation testing of these materials indicated swells of about 1.4 and 2.1 percent against surcharge loads approximating in place overburden pressures. (See Table 1.) Additional, swells of similar and greater magnitudes have been measured in similar soils and bedrock in the greater project area. Swelling soils beneath a building's foundation or other improvements can

cause significant damage. Design-level geotechnical evaluations of individual building sites should include an assessment of the swelling materials in the foundation soils, so that appropriate, remedial design and construction remediation methods can be implemented.

Collapsible Soils Certain surficial deposits in Colorado, typically eolian (windblown) materials are known to be susceptible to local hydro-consolidation or "collapse." Hydro-consolidation consists of a significant volume loss due to restructuring of the constituent grains of the soil to a more compact arrangement upon wetting.

Eolian deposits were not mapped at the project site and were not identified in the test holes. Swell-consolidation testing performed a sample of claystone yielded a collapse of about 0.4 percent against a surcharge load approximating in place overburden pressures, (See Table 1.) but in a sample of bedrock, we do not consider that result to be significant. Therefore, we do not anticipate that the site soils present a significant risk of collapse. However, design level geotechnical evaluations of individual building sites should include an assessment of collapsible materials in the foundation soils, so that appropriate remedial design and construction can be implemented, where necessary.

Slope Stability and Erosion Mapping by Colton and others (1976)[3] and available map data base by the Colorado Geological Survey[4] did not depict landslide deposits on or immediately adjacent to the subject site. Evidence of recent landslides and/or other mass wasting was not observed at the site. The likelihood of project developments being affected by existing large scale, unanticipated slope instabilities is considered low, in general.

Radon In general, testing for the possible presence of radon gas prior to project development does not yield useful results regarding the potential accumulation of radon in completed structures. Radon accumulations typically are found in basements or other enclosed portions of buildings built in areas underlain at relatively shallow depths by granitic crystalline rock. The likelihood of encountering radon in concentrations exceeding applicable health standards on the subject site, underlain by relatively deep soils and

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[3] Colton, R.B., Holligan, J.A., Anderson, L.W., and Patterson, P.E. 1976, *Preliminary Map of Landslide Deposits in Colorado*, U.S. Geological Survey, Miscellaneous Investigation Series Map I-964.
[4] Colorado Landslide Inventory, Colorado Geological Survey, https://cologeosurvey.maps.arcgis.com

sedimentary bedrock, is significantly lower. However, radon mitigation systems can be necessary in Adams County.

Radon testing should be performed in each building on-site, after construction is completed. Proper ventilation usually is sufficient to mitigate potential radon accumulations. Building designs should accommodate such ventilation for all building areas.

Seismic Activity / Faulting Neither site reconnaissance nor review of available geologic maps indicated the trace of an active or potentially active fault traversing or immediately adjacent to the site. Therefore, the likelihood of surface fault rupture at the site is considered to be relatively low.

The closest extent of a documented active fault to the site is the Rocky Mountain Arsenal Fault, which is located approximately 2.5 miles to the southwest (Kirkham and Rogers, 1981[5]; Colorado Geological Survey, 2008[6]). This fault is approximately 15 miles in length, trends generally northwest/southeast and is considered to be a right-lateral, strike-slip fault. The most recent significant seismic movements associated with the fault occurred in the 1960's, generating earthquakes up to magnitude 5.5. Research performed by the U.S. Geological Survey concluded that a strong correlation existed between the seismic activity of this fault and pressure injection of liquid waste into a disposal well located at the nearby Rocky Mountain Arsenal. Pressure injection in the disposal well was discontinued in 1966 and only minor seismic activity along the fault has been recorded since. The risk of this fault giving rise to damaging, earthquake-induced ground motions at the site is considered to be relatively low given the low previously recorded seismic magnitudes.

The largest recorded earthquake (estimated magnitude 6.2 to 6.6) in Colorado occurred in November 1882. While the specific location of this earthquake is very uncertain, it is postulated to have occurred in the Front Range near Rocky Mountain National Park. Since the early 1960s, numerous earthquakes with magnitudes up to approximately 5, with the majority possessing magnitudes of 2 to 4, have been experienced within the state. On August 8, 2011 a magnitude 5.3 earthquake occurred south of Trinidad, Colorado.

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[5] Kirkham, R.M., and W. P. Rogers, 1981, *Earthquake Potential in Colorado, A Preliminary Evaluation*, Colorado Geological Survey, Bulletin 43.

[6] Colorado Geological Survey, 2008, *Preliminary Quaternary Fault and Fold Database, and Map Server*, http://geosurvey.state.co.us/Default.aspx?tabid=453.

Earthquakes with similar magnitudes, and potentially greater, are anticipated to continue by the USGS, throughout the state. Furthermore, based on the subsurface conditions at the site and the risks associated with this nearest fault, the risk of liquefaction of the site soils is considered low. Compared with other regions of Colorado, recorded earthquake frequency in the project area is moderate.

We anticipate that much of the project site likely will classify as Seismic Site Class D site in accordance with ASCE 7-16 (Table 20.3-1) based on extrapolation of available data to depth. Some portions of the project site, specifically locations with harder bedrock, may classify as Site Class C. However, additional studies will be required to assess the Seismic Site Class, and that information may indicate that another Seismic Site Class is appropriate.

Flooding A reach of the Pheasant Run drainage traverses near the northeastern margin of the site, but Flood Insurance Rate Map (FIRM) produced by for the area FEMA (2007)[7] for the area depicts the project site as Zone X – Area of Minimal Flood Hazard. Therefore, the site does not appear to be vulnerable to flooding with the exception of heavy rainfall and associated temporary ponding of run-off in areas of relatively slow surface drainage. However, the site and any grade changes should be evaluated by a civil engineer in this regard.

Wetland Potential Explicit designation of wetlands was not included as part of the scope of this study, but according to the U.S. Fish and Wildlife Service,[8] wetlands were mapped at and near the site. The Pheasant Run drainage at the northeastern boundary of the site is mapped as Freshwater Emergent Wetland (PEM1C). Areas of Freshwater Ponds (PUBF) are located to the east, north, and west of the stie. Riverine habitat (R4SBC) is mapped to the north of the site as well. During site development appropriate regulations concerning wetland protection, should be adhered to. An environmental consultant or other appropriate planning and design professional should be consulted for additional information.

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[7] Federal Emergency Management Administration, 2007, Flood Insurance Rate Map, Adams County, Colorado and Incorporated Areas, Map No. 08001C0308H, Panel 0308H, 1 inch = 500 feet.

[8] U.S. Fish and Wildlife Service, National Wetlands Inventory, accessed on 3/10/2022, www.fws.gov/wetlands

Mining Activity and Subsidence Review of available maps depicting mine workings and relative subsidence hazard maps prepared by the Colorado Geologic Survey (2012), [9] the Colorado Geological Survey, and other available published maps depicting areas of mine workings, did not indicate past mining activities near the subject parcel, other than the oil well discussed above. No obvious indications of mining activities were apparent on the site during the site reconnaissance. Therefore, there appears to be little potential for surface subsidence associated with consolidation of former mine workings at depth.

SUBSURFACE CONDITIONS

In general, the test holes penetrated approximately 6 inches of topsoil,[10] before penetrating native clays that extended to depths of 6 to 10 feet below existing grade. Beneath the native clays, weathered claystone was encountered and extended to depths of about 9 to 20 feet below existing grade. Firm, relatively unweathered claystone bedrock was encountered beneath the weathered claystone and extended to the depths explored.

We interpret the clays to be fine alluvial deposits. We interpret the claystones to be Denver Formation materials.

Fill soils were not recognized in the test holes, but may be present at the site, especially near Test Hole 5, given the grading in that area. (See the *Site Conditions* section of this report.) Delineation of the complete lateral and vertical extents of any fills at the site, and their composition, was beyond our present scope of services. If detailed soil compositions at the site are of significance, they should be evaluated using test pits.

It also should be noted that coarse gravel, cobbles, and boulders are not well represented in samples obtained from small diameter test holes. At this site, therefore, it should be anticipated that gravel and cobbles, may be present in the on-site soils even where not included in the general descriptions of the site soil types below. Similarly, coarse materials, including cobbles and possibly boulders, should be anticipated to be encountered locally in the alluvial clay layer.

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[9] Colorado Geologic Survey, 2012, *Statewide Historic Underground Coal Mine Extents and Reported Coal Mine-Related Subsidence Events Map,* kmz File.

[10] 'Topsoil' as used herein is defined geotechnically. The materials so described may or may not be suitable for landscaping or as a growth medium for plants that may be proposed for the project.

Clays consisted of clays with fine to medium sands and silts. They were moderately to highly plastic, loose to very stiff, non- to moderately plastic, slightly moist to moist, and brown to red brown in color. Iron staining and caliche were noted locally.

Weathered Claystone consisted of weathered claystone with local weathered fine to medium grained sandstones and siltstones. They were moderately to highly plastic, firm to medium hard, moist to very moist, and brown to gray in color. Iron staining was noted commonly.

Claystone consisted of claystone with local siltstone and fine to medium sandstone. They were moderately to highly plastic, medium hard to very hard, moist to wet, and gray brown to gray in color. Iron staining was noted locally.

Groundwater Groundwater was encountered in Test Hole 3 at a depth of approximately 28 feet below existing grade and in Test hole 6 at depth of approximately 25 feet below existing grade at the time of drilling. When checked at the end of drilling operations, groundwater was measured to be about 21½ feet below existing grade in Test Hole 3. The test holes were backfilled upon drilling completion per Code of Colorado Regulations (2 CCR 402-2). Groundwater levels can be expected to fluctuate, however, in response to annual and longer-term cycles of precipitation, irrigation, surface drainage, nearby rivers and creeks, land use, and the development of transient, perched water conditions.

The groundwater observations performed during our exploration must be interpreted carefully as they are short-term and do not constitute a groundwater study. In the event Anythink Libraries desires additional/repeated groundwater level observations, GROUND should be contacted to provide a cost estimate for this additional geotechnical evaluation.

Swell-Consolidation Testing Swell-consolidation testing yielded swells of about 1.4 and 2.1 percent and a consolidation of about 0.4 percent were measured against surcharge loads approximating the in place overburden pressures.

PRELIMINARY GEOTECHNICAL EVALUATION

Presented below are preliminary considerations and parameters regarding geotechnical aspects of the proposed development, which we understand will include relatively lightly load structures and cuts and fills on the order of 5 feet. The provided considerations and parameters are intended only to assist with preliminary project planning. Additional,

structure-specific studies must be performed to develop design-level geotechnical considerations and parameters.

General Geotechnical Risk Based on the preliminary information collected for this evaluation, presence of expansive soils and bedrock appear to be the primary geotechnical risk at the site. Swell-consolidation testing of these materials indicated swells of 1.4 and 2.1 percent and greater swells have been measured in sample of similar soils in the greater project area. Where improvements have been supported directly on these materials in the greater project area, damaging post-construction movements have resulted.

Additionally, undocumented fill soils maybe present at the site. These soils are likely associated with the former oil and gas development at the site and likely were not placed in a controlled manner, with respect moisture treatment and compaction. It should also be noted that an environmental assessment of the site soils was not included as part of our preliminary geotechnical evaluation. Where the environmental condition of the site soils, fill or native, are concern, they should be evaluated by an environmental consultant.

Anticipated Foundation/Floor Systems Below is a general discussion of potential foundation/floor systems within the project site. They are provided to assist in general overall project cost estimates but may not contain enough information for specific cost analyses. All discussions/parameters provided herein are subject to revisions and modifications after site-specific studies are performed.

Anticipated Foundation Systems

Drilled Pier Foundation Systems For the least risk of post-construction movement, a deep foundation system should be used to support the proposed structures. Commonly, deep foundations consisting of drilled piers or driven piles advanced into the underlying formational bedrock are used to reduce potential structural movements as a result of heave (expansive materials) or consolidation to an owner-acceptable level. Building specific conditions will need to be identified, verified, and evaluated to provide final parameters.

We anticipate that drilled piers may be designed for allowable end bearing pressures of 15,000 to 30,000 psf and skin friction values of 1,500 to 2,500 psf for the portion of the

pier penetrating 'comparatively unweathered' bedrock. Piers likely will require minimum lengths of 30 to 40 feet, and minimum penetrations into competent bedrock on the order of 10 to 20 feet. The actual pier lengths, however, should be determined by a structural engineer based on structure-specific geotechnical data.

Spread Footing Foundation Systems In general, structures underlain by properly moisture-density treated materials could be founded on shallow foundation systems designed for allowable soil bearing pressures of 2,000 to 2,500 psf. However, based on the swell and consolidation results, the remedial fill section required beneath a given building could be on the order of 10 to 15 feet below existing grades in order to reduce estimates of post-construction movements to about 1 inch, depending on local conditions. Such a remedial fill section may not be practical for certain buildings, however. The actual depths of remedial fill sections needed to meet post-construction movement targets should be based on structure-specific data and building specific movement tolerances.

Anticipated Floor Systems

Structural Floor Systems Structural floors will provide the least risk of excessive post-construction movements, commonly on the order of ½ inch or less. Where project floors are more sensitive post-construction movements, they should be constructed as a structural floor supported on deep foundation elements. Due to the nature of proposed construction, these systems may not be practical for all building structures.

Slab-on-Grade Floor Systems The on-site materials, exclusive of topsoil, vegetation, and any deleterious materials, are suitable to support lightly to moderately loaded slab-on-grade construction, provided they are properly moisture-density treated to a depth determined following a design level geotechnical evaluation. However, the depth of remedial fill section needed to sufficiently reduce estimates of post-construction movement may not be practical for certain buildings. Depth of remedial fill need to reduce estimates of post-construction movements to about 1 inch are anticipated to about 10 to 15 feet below existing grade. An allowable subgrade vertical modulus (K) value of 60 to 90 pci for a 1-foot by 1-foot plate could be assumed for preliminary slab design.

Exterior Flatwork It may be beneficial to support critical flatwork, such as flatwork at entrance and exits of buildings, on a fill section like that for a slab-on-grade floor or construct it as a structural floor to achieve similar performance. In other areas, it may be

beneficial to perform limited remedial earthwork beneath less critical flatwork to potentially reduce project costs but in turn increasing potential post-construction movements. Greater than typical flatwork maintenance, however, should be anticipated for this site.

Surface and Subsurface Drainage Wetting of the bearing soils can lead to loss of support and greater than anticipated settlements on most sites. Project plans should include establishment and maintenance of effective drainage (both surface and subsurface).

Underdrains can be a beneficial part of the site drainage program, and given the risk of heave at the site, the use of underdrains will help limit the risk of post-construction movements. Additionally, buildings with below-grade or partially below-grade levels should be provided with underdrains.

Preliminary Water-Soluble Sulfates The concentration of water-soluble sulfates measured in selected samples of site soils ranged was approximately 0.03 percent by weight (See Table 2). Such a concentration of soluble sulfates represents a **negligible** environment for sulfate attack on concrete exposed to these materials. Degrees of attack are based on the scale of 'negligible,' 'moderate,' 'severe' and 'very severe' as described in the “Design and Control of Concrete Mixtures,” published by the Portland Cement Association (PCA).

REQUIREMENTS TO PROTECT AGAINST DAMAGE TO
CONCRETE BY SULFATE ATTACK FROM EXTERNAL SOURCES OF SULFATE

Severity of Sulfate Exposure	**Water-Soluble Sulfate ($SO_4^{=}$) In Dry Soil** *(%)*	**Sulfate (SO_4) In Water** *(ppm)*	**Water Cementitious Ratio** *(maximum)*	**Cementitious Material Requirements**
Class 0	0.00 to 0.10	0 to 150	0.45	Class 0
Class 1	0.11 to 0.20	151 to 1500	0.45	Class 1
Class 2	0.21 to 2.00	1501 to 10,000	0.45	Class 2
Class 3	2.01 or greater	10,001 or greater	0.40	Class 3

Based on our preliminary test results and PCA and CDOT guidelines, the use of sulfate-resistant cement does not appear necessary. Additional structure-specific testing may indicate that a more sulfate resistant cement could be appropriate, however.

Preliminary Soil Corrosivity Data was obtained to support an initial assessment of the potential for corrosion of ferrous metals in contact with earth materials at the site, based on the conditions at the time of GROUND's evaluation. The test results are summarized in Table 2.

The American Water Works Association (AWWA, 2010)[11] has developed a point system scale used to predict corrosivity. Based on this scale and our test results the existing site materials appear to comprise a moderately corrosive environment for ferrous metals.

Preliminary Pavement Sections *The following initial or preliminary pavement sections are based on current grades and the shallow on-site soils. Actual pavement sections should be determined by design level studies.*

Preliminary Pavement Thicknesses We anticipate pavement sections for the private internal drives and parking areas may consist of a full depth asphalt section ranging from approximately 5 to 7 inches of asphalt. Equivalent composite sections could be used as well. A minimum section of 6 inches of Portland cement concrete underlain by at least 6 inches of Class 6 aggregate base course may also be necessary. Heavy truck traffic and loading/unloading areas should ideally be designed as a reinforced slab and consist of at least 6 to 7 inches of concrete underlain by at least 6 inches of Class 6 aggregate base course. Additionally, composite sections consisting of asphalt over aggregate base course may be utilized.

Potential Remedial Earthwork For private pavement areas, remedial earthwork will vary depending on the owner's tolerance for movement and level of future maintenance that the owner is willing to perform throughout the life of a facility. To achieve similar potential movements as a foundation/floor system, a similar fill section should be performed beneath pavement areas. Lesser depths of remedial earthwork may be performed, but will result in an increased potential for movement and subsequent pavement distress.

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[11] American Water Works Association ANSI/AWWA C105/A21.5-05 Standard.

Based on the materials encountered in preliminary test holes, we anticipate that remedial earthwork on the order of 24 to 36 inches could be appropriate.

PRELIMINARY PROJECT EARTHWORK

The following preliminary criteria and considerations are for private improvements; public roadways or utilities should be constructed in accordance with applicable municipal / agency standards. Additionally, these criteria and considerations are for general planning purposes. They should not be anticipated to be sufficient for all future site improvements. Adhering to them does not guarantee "Pad Ready" conditions, the requirements of which are not known at this time. In addition, building locations and layouts can change as project planning and development proceed.

General Considerations Site grading should be performed as early as possible in the construction sequence to allow settlement of fills and surcharged ground to be realized to the greatest extent prior to subsequent construction.

Prior to earthwork construction, vegetation (including root systems) and other deleterious materials should be removed and disposed of off-site or stockpiled for reuse evaluation. Relic underground utilities should be abandoned in accordance with applicable regulations, removed as necessary, and properly capped.

Topsoil present on-site should not be incorporated into ordinary fills. Instead, topsoil should be stockpiled during initial grading operations for placement in areas to be landscaped or for other approved uses. The topsoil encountered was not tested for quality and may not be suitable for all landscaping purposes.

Existing Fill Soils Fill was recognized during our subsurface exploration, and is likely present elsewhere on the site given the prior development. (See the *Site Conditions* section of this report.) Fill soils, where encountered, they should be evaluated for reuse as properly compacted fill. It should be anticipated that some of the excavated existing fill materials may not be suitable for replacement as backfill. A geotechnical engineer should be retained during site excavations to observe the excavated fill materials and provide parameters for its suitability for reuse.

Use of Existing Native Soils Based on the samples retrieved from the test holes, we anticipate that the existing site soils that are free of organic materials, coarse cobbles,

boulders, or other deleterious materials will be suitable, in general, for re-use as compacted fill.

Fragments of rock and cobbles, (as well as inert construction debris, e.g., concrete or asphalt) up to **3 inches** in maximum dimension may be included in project fills, in general. Such materials should be evaluated on a case-by-case basis where identified during earthwork. A geotechnical engineer should be consulted regarding appropriate parameters for usage of such materials on a case-by-case basis when such materials have been identified during earthwork. Standard parameters that likely will be generally applicable can be found in Section 203 of the current CDOT Standard Specifications for Road and Bridge Construction.

Imported Fill Materials Preliminarily, if it is necessary to import material to the site, the imported soils should be free of organic material, and other deleterious materials. **Imported material should consist of soils that have 75 percent or less passing the No. 200 Sieve and should have a plasticity index of less than 15.** Other import parameters may be appropriate for specific structures based on location and performance specific information. Representative samples of the materials proposed for import should be approved for specific uses prior to transport to the site.

Fill Platform Preparation Prior to filling, the top 12 inches of in-place materials on which fill soils will be placed should be scarified, moisture conditioned and properly compacted in accordance with the parameters below to provide a uniform base for fill placement.

If surfaces to receive fill expose loose, wet, soft, or otherwise deleterious material, additional material should be excavated, or other measures taken to establish a firm platform for filling. The surfaces to receive fill must be effectively stable prior to placement of fill.

Fill Placement Fill materials should be thoroughly mixed to achieve a uniform moisture content, placed in uniform lifts not exceeding 8 inches in loose thickness, and properly compacted.

Soils that classify as **GP, GW, GM, GC, SP, SW, SM, or SC** in accordance with the USCS classification system (granular materials) should be compacted to **95 or more percent** of

the maximum modified Proctor dry density at moisture contents within 2 percent of optimum moisture content as determined by ASTM D1557.

Soils that classify as **ML, MH, CL, or CH** should be compacted to **95 percent** of the maximum standard Proctor density at moisture contents from 1 percent below to 3 percent above the optimum moisture content as determined by ASTM D698.

No fill materials should be placed, worked, rolled while they are frozen, thawing, or during poor/inclement weather conditions.

Care should be taken with regard to achieving and maintaining proper moisture contents during placement and compaction. Materials that are not properly moisture conditioned may exhibit significant pumping, rutting, and deflection at moisture contents near optimum and above. The contractor should be prepared to handle soils of this type, including the use of chemical stabilization, if necessary.

Compaction areas should be kept separate, and no lift should be covered by another until relative compaction and moisture content within the ranges are obtained.

Settlements Settlements will occur in newly filled ground, typically on the order of 1 to 2 percent of the fill depth. This is separate from settlement of the existing soils left in place. For a 6-foot fill, for example, that corresponds to a total settlement of about 1 inch. If fill placement is performed properly and is tightly controlled, in GROUND's experience the majority (on the order of 60 to 80 percent) of that settlement typically will take place during earthwork construction, provided the contractor achieves the compaction levels indicated herein. The remaining potential settlements likely will take several months or longer to be realized, and may be exacerbated if these fills are subjected to changes in moisture content.

Cut and Filled Slopes Permanent site slopes supported by on-site soils up to 10 feet in height may be constructed no steeper than **3 : 1** (horizontal : vertical). In the event slopes greater than 10 feet in height are planned, a slope stability analysis should be performed. Minor raveling or surficial sloughing should be anticipated on slopes cut at this angle until vegetation is well re-established. Surface drainage should be designed to direct water away from slope faces.

Use of Squeegee Relatively uniformly graded fine gravel or coarse sand, i.e., "squeegee," or similar materials commonly are proposed for backfilling foundation excavations, utility trenches (excluding approved pipe bedding), and other areas where employing compaction equipment is difficult. In general, GROUND does not suggest this procedure.

EXCAVATION CONSIDERATIONS

Excavation Difficulty Test holes for the subsurface exploration were advanced to the depths indicated on the test hole logs by means of conventional, buggy-mounted, geotechnical drilling equipment. Practical drill rig refusal was not encountered at the time of subsurface exploration; however, hard and resistant bedrock has been encountered in greater project area. In general, we anticipate that the majority of the site soils likely will not present any unusual excavation difficulties for the proposed construction with conventional, heavy duty, excavating equipment. However, due to the nature of undocumented fill soils, which could be present on the site, project excavation could encounter construction debris or other deleterious materials that require greater that typical efforts to excavate, handle, and process.

Temporary Excavations Temporary unshored excavation slopes for other areas up to 10 feet in height should be cut no steeper than **1½ : 1** (horizontal : vertical) in the site soils and bedrock in the absence of seepage. Some surficial sloughing may occur on slope faces cut at this angle. As stated, local conditions encountered during construction, such as loose, dry sand, or soft or wet materials, or seepage will require flatter slopes. Stockpiling of materials should not be permitted closer to the tops of temporary slopes than 5 feet or a distance equal to the depth of the excavation, whichever is greater.

Should site constraints prohibit the use of the provided slope angles, temporary shoring should be used. The shoring should be designed to resist the lateral earth pressure exerted by structure, traffic, equipment, and stockpiles. GROUND can provide shoring design upon request.

Good surface drainage should be provided around temporary excavation slopes to direct surface runoff away from the slope faces. A properly designed swale should be provided at the top of the excavations. In no case should water be allowed to pond at the site. Slopes should be protected against erosion. Erosion along the slopes will result in

sloughing and could lead to a slope failure. Any excavations in which personnel will be working must comply with all OSHA Standards and Regulations (CFR 29 Part 1926). The contractor's "responsible person" should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. GROUND has provided the information above solely as a service to the Anythink Libraries, and is not assuming responsibility for construction site safety or the contractor's activities.

Groundwater Conditions Groundwater was encountered in the test holes as shallowly as about 21½ feet below existing grade. Therefore, we anticipate that it is unlikely that relatively shallow project excavations will encounter groundwater except for limited volumes of perched or transient groundwater. Groundwater levels can be expected to fluctuate, however, in response to annual and longer-term cycles of precipitation, irrigation, surface drainage, nearby rivers and creeks, land use, and the development of transient, perched water conditions.

ADDITIONAL EXPLORATION REQUIREMENTS

The above data and conclusions are based on preliminary subsurface exploration only. Additional geotechnical studies must be performed to further evaluate the site for building-specific parameters and conclusions regarding foundation and floor system, final site grading, and pavement sections.

LIMITATIONS

This report has been prepared for Anythink Libraries as it pertains to planning of the proposed nature library and related improvements as described herein. It should not be assumed to contain sufficient information for other parties or other purposes. Anythink Libraries has agreed to the terms, conditions, and liability limitations outlined in our proposal for the project. Reliance upon our report is not granted to any other potential owner, contractor, or lender. Requests for third-party reliance should be directed to GROUND in writing; granting reliance by GROUND is not guaranteed.

The preliminary geotechnical conclusions in this report were based on subsurface information from a limited number of exploration points, as shown in Figure 1, as well as the means and methods described herein. Subsurface conditions were interpolated between and extrapolated beyond these locations. It is not possible to guarantee the

subsurface conditions are as indicated in this report. Actual conditions exposed during construction may differ from those encountered during site exploration. In addition, a contractor who obtains information from this report for development of his scope of work or cost estimates does so solely at his own risk and may find the geotechnical information in this report to be inadequate for his purposes or find the geotechnical conditions described herein to be at variance with his experience in the greater project area. The contractor should obtain the additional geotechnical information that is necessary to develop his work scope and cost estimates with sufficient precision. This includes, but is not limited to, information regarding excavation conditions, earth material usage, current depths to groundwater, etc. Because of the necessarily limited nature of the subsurface exploration performed for this study, the contractor should be allowed to evaluate the site using test pits or other means to obtain additional subsurface information to prepare his bid.

If any information referred to herein is not well understood, it is imperative that Anythink Libraries or other user contact the author or a GROUND principal immediately. We will be available to meet to discuss the risks and remedial approaches presented in this report, as well as other potential approaches, upon request.

GROUND makes no warranties, either expressed or implied, as to the professional data, opinions or conclusions contained herein. Because of numerous considerations that are beyond GROUND's control, the economic or technical performance of the project cannot be guaranteed in any respect**.**

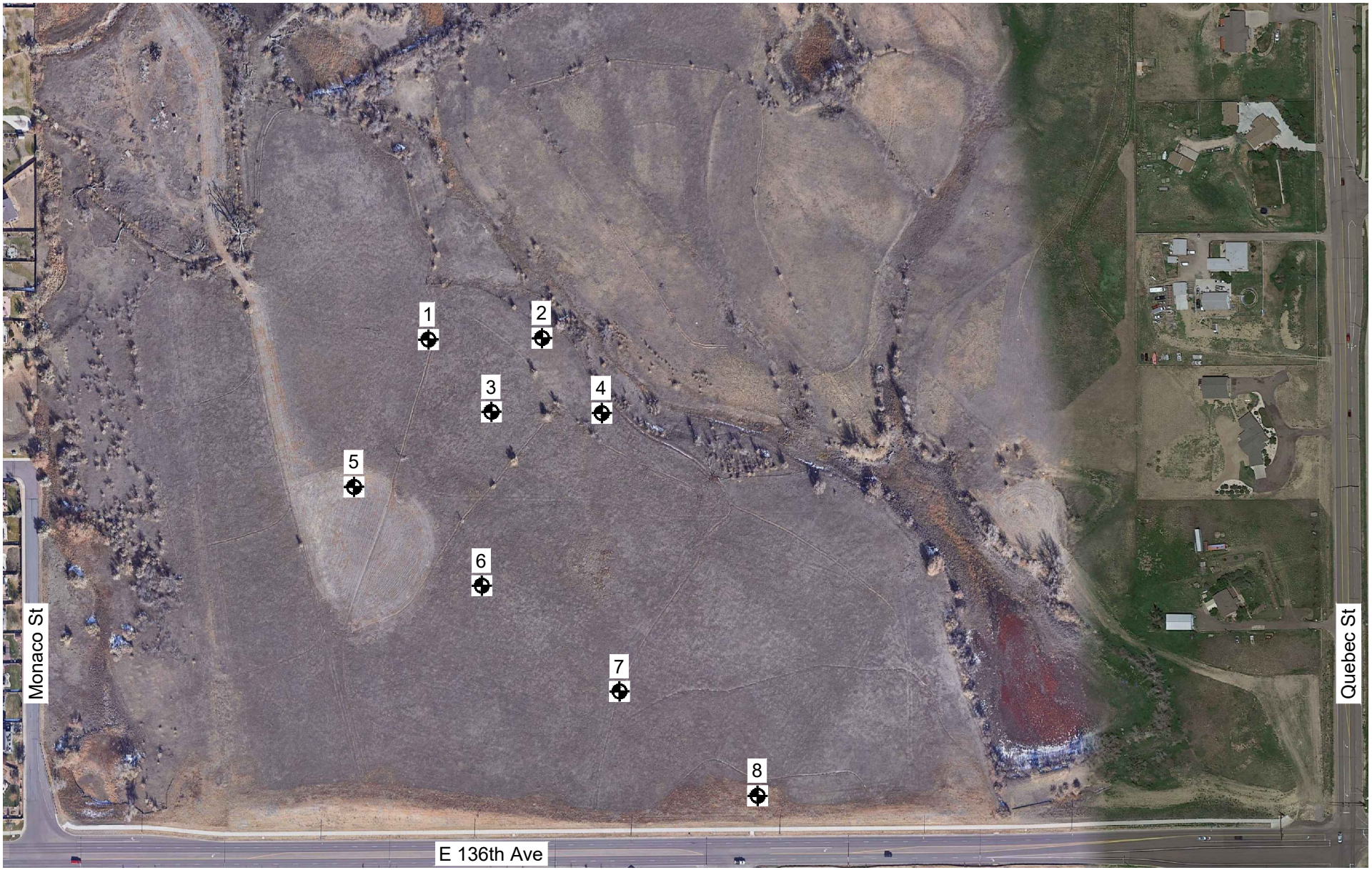
GROUND appreciates the opportunity to complete this portion of the project.

Sincerely,

GROUND Engineering Consultants, Inc.

Ben Fellbaum, P.G., E.I.

Reviewed by Brian H. Reck, P.G., C.E.G., P.E.



GOOGLE EARTH AERIAL IMAGE (10/5/2019)

1 Indicates test hole number and approximate location.

NOT TO SCALE

GROUND ENGINEERING

JOB NO.: 22-3012

FIGURE: 1

LOCATION OF TEST HOLES

GROUND ENGINEERING

LOGS OF THE TEST HOLES

CLIENT: Anythink Libraries

JOB NO: 22-3012

PROJECT NAME: Anythink Nature Library

PROJECT LOCATION: Thornton, CO

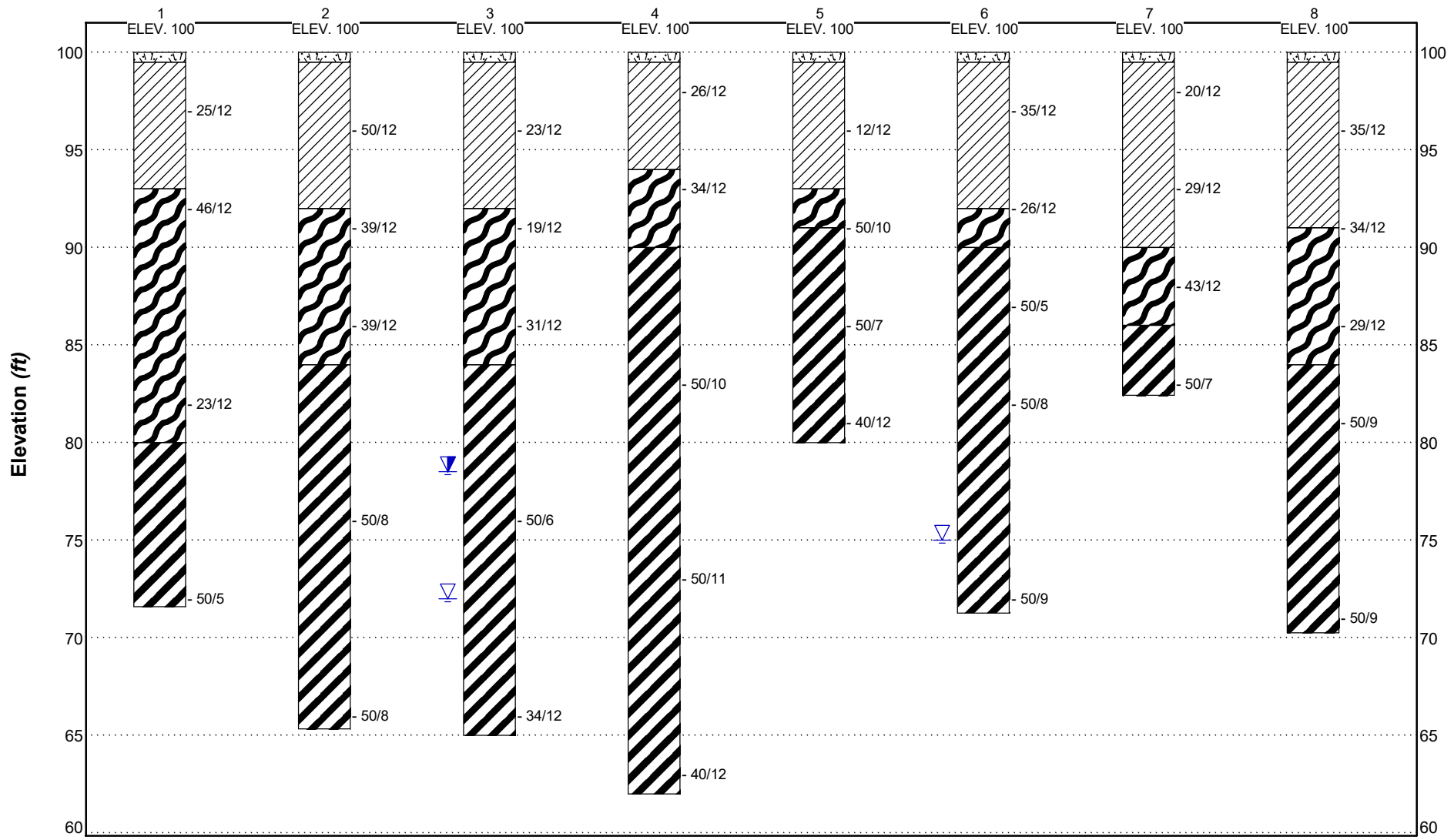


Figure 2

LEGEND AND NOTES

GROUND ENGINEERING

CLIENT: Anythink Libraries **PROJECT NAME:** Anythink Nature Library

JOB NO: 22-3012 **PROJECT LOCATION:** Thornton, CO

MATERIAL SYMBOLS

TOPSOIL

CLAY

WEATHERED CLAYSTONE

CLAYSTONE BEDROCK

NOTE: See Detailed Logs for Material descriptions.

SAMPLER SYMBOLS

Modified California Liner Sampler
23 / 12 Drive sample blow count indicates 23 blows of a 140 pound hammer falling 30 inches were required to drive the sampler 12 inches.

NOTES

1. Test holes were drilled on 3/1 and 3/2/2022 with 4" solid stem auger.

2. Locations of the test holes were determined approximately by pacing from features shown on the site plan provided.

3. Elevations of the test holes were not measured and the logs of the test holes are drawn to depth. Nominal elevation of "100 feet" indicates existing ground level at the test hole at the time of drilling.

4. The test hole locations and elevations should be considered accurate only to the degree implied by the method used.

5. The lines between materials shown on the test hole logs represent the approximate boundaries between material types and the transitions may be gradual.

6. Groundwater level readings shown on the logs were made at the time and under the conditions indicated. Fluctuations in the water level may occur with time.

7. The material descriptions on these logs are for general classification purposes only. See full text of this report for descriptions of the site materials & related information.

8. All test holes were immediately backfilled upon completion of drilling, unless otherwise specified in this report.

ABBREVIATIONS

Water Level at Time of Drilling, or as Shown

Water Level at End of Drilling, or as Shown

Water Level After 24 Hours, or as Shown

NV	No Value
NP	Non-Plastic

Figure 3

GROUND ENGINEERING

Job Number 22-3012

Anythink Nature Library

TABLE 1: SUMMARY OF LABORATORY TEST RESULTS

Sample Location		Natural Moisture Content	Natural Dry Density	Gradation	Atterberg Limits		Swell/Consolidation		USCS Equivalent Classification	AASHTO Equivalent Classification (Group Index)	Sample Description
Test Hole No.	Depth *(feet)*	*(%)*	*(pcf)*	Fines *(%)*	Liquid Limit	Plasticity Index	Volume Change *(%)*	Surcharge Pressure *(psf)*			
1	3	9.5	110.9	74.2	34	15	-	-	(CL)s	A-6 (10)	CLAY with Sand
2	9	12.5	118.1	90.8	45	24	1.4	1,100	CL	A-7-6 (23)	Weathered CLAYSTONE
2	14	20.4	102.8	92.3	61	30	-0.4	1,750	CH	A-7-5 (33)	Weathered CLAYSTONE
3	24	16.9	110.1	71.5	38	16	-	-	(CL)s	A-6 (10)	CLAYSTONE Bedrock
4	7	16.6	111.3	80.3	50	24	2.1	900	(CL)s	A-7-6 (20)	Weathered CLAYSTONE
5	9	19.2	100.8	76.4	30	10	-	-	(CL)s	A-4 (6)	CLAYSTONE Bedrock
6	3	11.0	111.5	73.3	41	17	-	-	(CL)s	A-7-6 (12)	CLAY with Sand
7	12	16.6	113.8	78.9	35	14	-	-	(CL)s	A-6 (10)	Weathered CLAYSTONE
8	9	13.8	121.0	62.7	36	17	-	-	s(CL)	A-6 (8)	Weathered CLAYSTONE

SD = Sample disturbed, NV = No value, NP = Non-plastic

GROUND ENGINEERING

Job Number 22-3012

Anythink Nature Library

TABLE 2: SUMMARY OF SOIL CORROSION TEST RESULTS

Sample Location		Water Soluble Sulfates	pH	Redox Potential	Sulfide Reactivity	Resistivity	USCS Equivalent Classification	AASHTO Equivalent Classification (Group Index)	Sample Description
Test Hole No.	Depth *(feet)*	*(%)*		*(mv)*		*(ohm-cm)*			
1	3	0.03	8.4	- 73	Trace	49,295	(CL)s	A-6 (10)	CLAY with Sand

APPENDIX A

Detailed Test Hole Logs

TEST HOLE 1

GROUND ENGINEERING

CLIENT: Anythink Libraries

PROJECT NAME: Anythink Nature Library

JOB NO: 22-3012

PROJECT LOCATION: Thornton, CO

Elevation (ft)	Depth (ft)	Graphic Log	Material Descriptions and Drilling Notes	Sample Type	Blow Count	Natural Moisture Content (%)	Natural Dry Density (pcf)	Percent Passing No. 200 Sieve	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	Swell/Consolidation (%) at Surcharge Pressure (psf)	Unconfined Compressive Strength (ksf)	USCS Equivalent Classification
100	0		**TOPSOIL**										
			CLAYS: Clays with fine to medium sands and silts. They were moderately to highly plastic, loose to very stiff, non- to moderately plastic, slightly moist to moist, and brown to red brown in color. Iron staining and caliche were noted locally.										
					25/12	9.5	110.9	74	34	15			(CL)s
95	5												
			WEATHERED CLAYSTONE: Weathered claystone with local weathered fine to medium grained sandstones and siltstones. They were moderately to highly plastic, hard to firm to medium hard, moist to very moist, and brown to gray in color. Iron staining was noted commonly.		46/12								
90	10												
85	15												
					23/12								
80	20												
			CLAYSTONE: Claystone with local siltstone and fine to medium sandstone. They were moderately to highly plastic, medium hard to very hard, moist to wet, and gray brown to gray in color. Iron staining was noted locally.										
75	25												
					50/5								

Bottom of borehole at Approx. 28.42 feet.

TEST HOLE 2

GROUND ENGINEERING

CLIENT: Anythink Libraries **PROJECT NAME:** Anythink Nature Library

JOB NO: 22-3012 **PROJECT LOCATION:** Thornton, CO

Elevation (ft)	Depth (ft)	Graphic Log	Material Descriptions and Drilling Notes	Sample Type	Blow Count	Natural Moisture Content (%)	Natural Dry Density (pcf)	Percent Passing No. 200 Sieve	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	Swell/Consolidation (%) at Surcharge Pressure (psf)	Unconfined Compressive Strength (ksf)	USCS Equivalent Classification
100	0		**TOPSOIL**										
			CLAYS: Clays with fine to medium sands and silts. They were moderately to highly plastic, loose to very stiff, non- to moderately plastic, slightly moist to moist, and brown to red brown in color. Iron staining and caliche were noted locally.										
95	5				50/12								
90	10		**WEATHERED CLAYSTONE:** Weathered claystone with local weathered fine to medium grained sandstones and siltstones. They were moderately to highly plastic, hard to firm to medium hard, moist to very moist, and brown to gray in color. Iron staining was noted commonly.		39/12	12.5	118.1	91	45	24	1.4 (1100)		CL
85	15				39/12	20.4	102.8	92	61	30	-0.4 (1750)		CH
80	20		**CLAYSTONE:** Claystone with local siltstone and fine to medium sandstone. They were moderately to highly plastic, medium hard to very hard, moist to wet, and gray brown to gray in color. Iron staining was noted locally.										
75	25				50/8								
70	30												
					50/8								

Bottom of borehole at Approx. 34.67 feet.

TEST HOLE 3

GROUND ENGINEERING

CLIENT: Anythink Libraries

PROJECT NAME: Anythink Nature Library

JOB NO: 22-3012

PROJECT LOCATION: Thornton, CO

Elevation (ft)	Depth (ft)	Graphic Log	Material Descriptions and Drilling Notes	Sample Type	Blow Count	Natural Moisture Content (%)	Natural Dry Density (pcf)	Percent Passing No. 200 Sieve	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	Swell/Consolidation (%) at Surcharge Pressure (psf)	Unconfined Compressive Strength (ksf)	USCS Equivalent Classification
100	0		**TOPSOIL**										
			CLAYS: Clays with fine to medium sands and silts. They were moderately to highly plastic, loose to very stiff, non- to moderately plastic, slightly moist to moist, and brown to red brown in color. Iron staining and caliche were noted locally.										
95	5				23/12								
90	10		**WEATHERED CLAYSTONE:** Weathered claystone with local weathered fine to medium grained sandstones and siltstones. They were moderately to highly plastic, hard to firm to medium hard, moist to very moist, and brown to gray in color. Iron staining was noted commonly.		19/12								
85	15				31/12								
80	20		**CLAYSTONE:** Claystone with local siltstone and fine to medium sandstone. They were moderately to highly plastic, medium hard to very hard, moist to wet, and gray brown to gray in color. Iron staining was noted locally.										
			Groundwater encountered at 21.5 feet approximately 1 day after drilling.										
75	25				50/6	16.9	110.1	72	38	16			(CL)s
			Groundwater encountered at 28 feet at time of drilling.										
70	30												
65	35				34/12								

Bottom of borehole at Approx. 35 feet.

TEST HOLE 4

GROUND ENGINEERING

CLIENT: Anythink Libraries

PROJECT NAME: Anythink Nature Library

JOB NO: 22-3012

PROJECT LOCATION: Thornton, CO

Elevation (ft)	Depth (ft)	Graphic Log	Material Descriptions and Drilling Notes	Sample Type	Blow Count	Natural Moisture Content (%)	Natural Dry Density (pcf)	Percent Passing No. 200 Sieve	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	Swell/Consolidation (%) at Surcharge Pressure (psf)	Unconfined Compressive Strength (ksf)	USCS Equivalent Classification
100	0		**TOPSOIL**										
			CLAYS: Clays with fine to medium sands and silts. They were moderately to highly plastic, loose to very stiff, non- to moderately plastic, slightly moist to moist, and brown to red brown in color. Iron staining and caliche were noted locally.		26/12								
95	5												
			WEATHERED CLAYSTONE: Weathered claystone with local weathered fine to medium grained sandstones and siltstones. They were moderately to highly plastic, hard to firm to medium hard, moist to very moist, and brown to gray in color. Iron staining was noted commonly.		34/12	16.6	111.3	80	50	24	2.1 (900)		(CL)s
90	10												
			CLAYSTONE: Claystone with local siltstone and fine to medium sandstone. They were moderately to highly plastic, medium hard to very hard, moist to wet, and gray brown to gray in color. Iron staining was noted locally.										
85	15												
					50/10								
80	20												
75	25												
					50/11								
70	30												
65	35												
					40/12								

Bottom of borehole at Approx. 38 feet.

TEST HOLE 5

GROUND ENGINEERING

CLIENT: Anythink Libraries **PROJECT NAME:** Anythink Nature Library

JOB NO: 22-3012 **PROJECT LOCATION:** Thornton, CO

Elevation (ft)	Depth (ft)	Graphic Log	Material Descriptions and Drilling Notes	Sample Type	Blow Count	Natural Moisture Content (%)	Natural Dry Density (pcf)	Percent Passing No. 200 Sieve	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	Swell/Consolidation (%) at Surcharge Pressure (psf)	Unconfined Compressive Strength (ksf)	USCS Equivalent Classification
100	0		**TOPSOIL**										
			CLAYS: Clays with fine to medium sands and silts. They were moderately to highly plastic, loose to very stiff, non- to moderately plastic, slightly moist to moist, and brown to red brown in color. Iron staining and caliche were noted locally.										
95	5				12/12								
			WEATHERED CLAYSTONE: Weathered claystone with local weathered fine to medium grained sandstones and siltstones. They were moderately to highly plastic, hard to firm to medium hard, moist to very moist, and brown to gray in color. Iron staining was noted commonly.										
90	10				50/10	19.2	100.8	76	30	10			(CL)s
			CLAYSTONE: Claystone with local siltstone and fine to medium sandstone. They were moderately to highly plastic, medium hard to very hard, moist to wet, and gray brown to gray in color. Iron staining was noted locally.										
85	15				50/7								
80	20				40/12								

Bottom of borehole at Approx. 20 feet.

TEST HOLE 6

GROUND ENGINEERING

CLIENT: Anythink Libraries

PROJECT NAME: Anythink Nature Library

JOB NO: 22-3012

PROJECT LOCATION: Thornton, CO

Elevation (ft)	Depth (ft)	Graphic Log	Material Descriptions and Drilling Notes	Sample Type	Blow Count	Natural Moisture Content (%)	Natural Dry Density (pcf)	Percent Passing No. 200 Sieve	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	Swell/Consolidation (%) at Surcharge Pressure (psf)	Unconfined Compressive Strength (ksf)	USCS Equivalent Classification
100	0		**TOPSOIL**										
			CLAYS: Clays with fine to medium sands and silts. They were moderately to highly plastic, loose to very stiff, non- to moderately plastic, slightly moist to moist, and brown to red brown in color. Iron staining and caliche were noted locally.										
					35/12	11.0	111.5	73	41	17			(CL)s
95	5												
			WEATHERED CLAYSTONE: Weathered claystone with local weathered fine to medium grained sandstones and siltstones. They were moderately to highly plastic, hard to firm to medium hard, moist to very moist, and brown to gray in color. Iron staining was noted commonly.		26/12								
90	10												
			CLAYSTONE: Claystone with local siltstone and fine to medium sandstone. They were moderately to highly plastic, medium hard to very hard, moist to wet, and gray brown to gray in color. Iron staining was noted locally.		50/5								
85	15												
					50/8								
80	20												
75	25		Groundwater encountered at 25 feet at time of drilling.										
					50/9								

Bottom of borehole at Approx. 28.75 feet.

TEST HOLE 7

GROUND ENGINEERING

CLIENT: Anythink Libraries **PROJECT NAME:** Anythink Nature Library

JOB NO: 22-3012 **PROJECT LOCATION:** Thornton, CO

Elevation (ft)	Depth (ft)	Graphic Log	Material Descriptions and Drilling Notes	Sample Type	Blow Count	Natural Moisture Content (%)	Natural Dry Density (pcf)	Percent Passing No. 200 Sieve	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	Swell/Consolidation (%) at Surcharge Pressure (psf)	Unconfined Compressive Strength (ksf)	USCS Equivalent Classification
100	0		**TOPSOIL**										
			CLAYS: Clays with fine to medium sands and silts. They were moderately to highly plastic, loose to very stiff, non- to moderately plastic, slightly moist to moist, and brown to red brown in color. Iron staining and caliche were noted locally.										
					20/12								
95	5												
					29/12								
90	10												
			WEATHERED CLAYSTONE: Weathered claystone with local weathered fine to medium grained sandstones and siltstones. They were moderately to highly plastic, hard to firm to medium hard, moist to very moist, and brown to gray in color. Iron staining was noted commonly.										
					43/12	16.6	113.8	79	35	14			(CL)s
85	15		**CLAYSTONE:** Claystone with local siltstone and fine to medium sandstone. They were moderately to highly plastic, medium hard to very hard, moist to wet, and gray brown to gray in color. Iron staining was noted locally.										
					50/7								

Bottom of borehole at Approx. 17.58 feet.

TEST HOLE 8

GROUND ENGINEERING

CLIENT: Anythink Libraries

PROJECT NAME: Anythink Nature Library

JOB NO: 22-3012

PROJECT LOCATION: Thornton, CO

Elevation (ft)	Depth (ft)	Graphic Log	Material Descriptions and Drilling Notes	Sample Type	Blow Count	Natural Moisture Content (%)	Natural Dry Density (pcf)	Percent Passing No. 200 Sieve	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	Swell/Consolidation (%) at Surcharge Pressure (psf)	Unconfined Compressive Strength (ksf)	USCS Equivalent Classification
100	0		**TOPSOIL**										
			CLAYS: Clays with fine to medium sands and silts. They were moderately to highly plastic, loose to very stiff, non- to moderately plastic, slightly moist to moist, and brown to red brown in color. Iron staining and caliche were noted locally.										
95	5				35/12								
90	10		**WEATHERED CLAYSTONE:** Weathered claystone with local weathered fine to medium grained sandstones and siltstones. They were moderately to highly plastic, hard to firm to medium hard, moist to very moist, and brown to gray in color. Iron staining was noted commonly.		34/12	13.8	121.0	63	36	17			s(CL)
85	15				29/12								
			CLAYSTONE: Claystone with local siltstone and fine to medium sandstone. They were moderately to highly plastic, medium hard to very hard, moist to wet, and gray brown to gray in color. Iron staining was noted locally.										
80	20				50/9								
75	25												
					50/9								

Bottom of borehole at Approx. 29.75 feet.