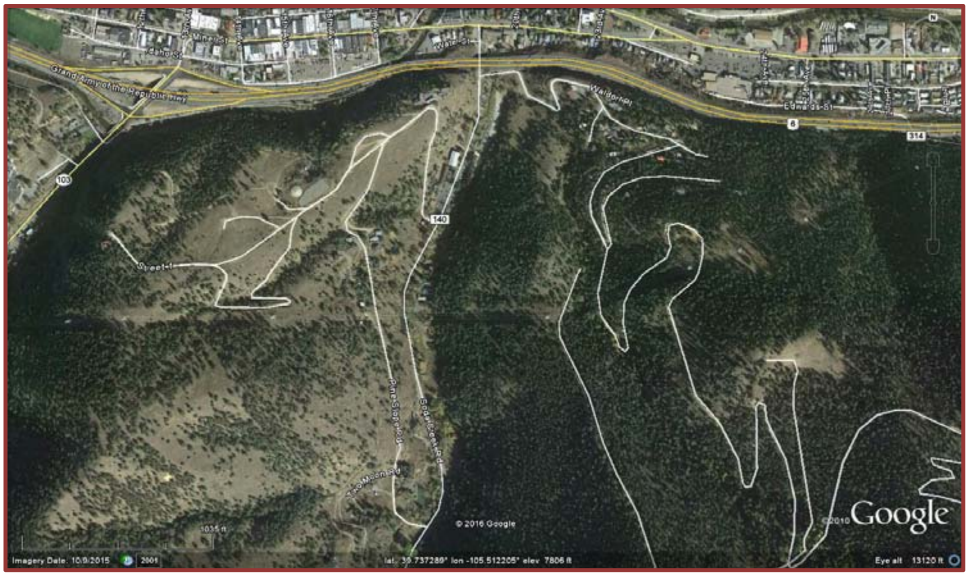
GROUND
ENGINEERING

Subsurface Exploration Program and Geotechnical Evaluation Soda Creek Road Improvements Idaho Springs, Colorado



Google Earth® Image

Prepared For:

JVA, Incorporated
47 Cooper Creek Way, Suite 328
Winter Park, Colorado 80482

Attention: Mr. Kevin Vecchiarelli

Job Number: 16-3573 **May 20, 2016**

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PURPOSE AND SCOPE OF STUDY

This report presents the results of a geotechnical evaluation performed by GROUND Engineering Consultants, Inc. (GROUND) in support of design and construction of improvements to Soda Creek Road in Idaho Springs, Colorado. Our study was conducted in general accordance with GROUND's Proposal No. 1603-0445b dated March 15, 2016. Results of the field, office, and laboratory studies are presented below.

Field and office studies provided information at the test hole locations regarding surface and subsurface conditions. Material samples retrieved during the subsurface exploration were tested in our laboratory to assess selected engineering characteristics of the site earth materials, and assist in the development of our geotechnical conclusions.

This report has been prepared to summarize the data obtained and to present our findings and conclusions based on the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of engineering considerations related to construction of the proposed improvements are included herein.

The geotechnical evaluation of the improvements to Miner Street was performed concurrently with this report.

PROPOSED CONSTRUCTION

We understand that the planned improvements will be performed within an approximate 3,500 linear foot section of existing Soda Creek Road from Miner Street to south of Pine Slope Road. Additionally, concrete flatwork improvements are also planned. Based on the existing topography, limited material cuts and fills are anticipated to achieve lines and grades for the project, likely on the order of 1 foot or less.

If the proposed construction differs significantly from that described above, GROUND should be notified to re-evaluate the conclusions and parameters herein.

ALIGNMENT CONDITIONS

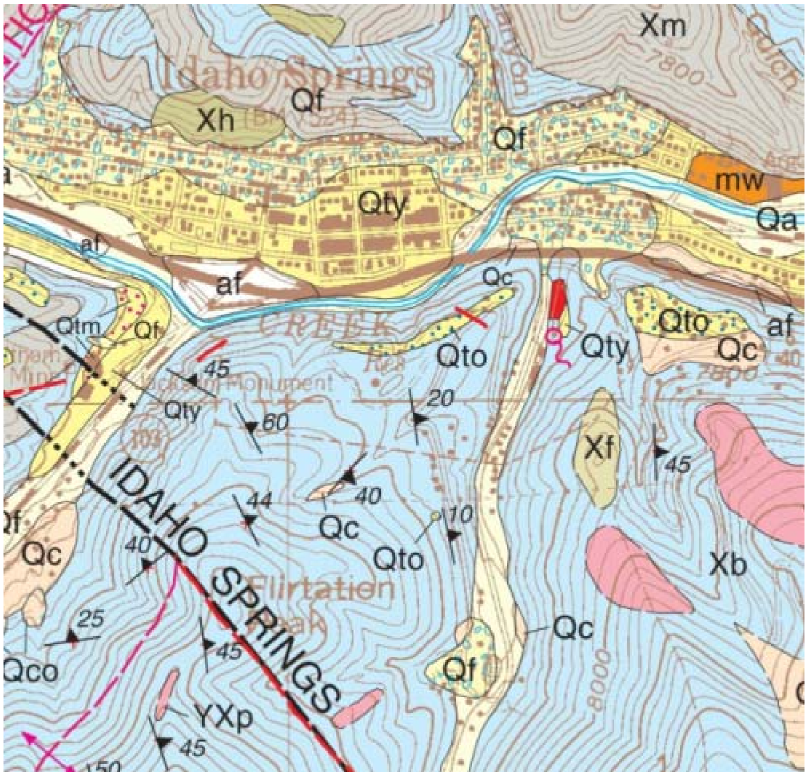
At the time of our subsurface exploration, Soda Creek Road descends gently at slopes up to approximately 5 percent to the north toward Miner Street. Slope direction varies locally along the alignment.

The two-lane alignment was asphalt-paved and served a mix of single-family residences with retail and commercial developments near Miner Street. Based on our observations during our exploration program, asphalt thicknesses ranged from approximately 2½ to 3½ inches with road base thicknesses ranging from approximately 2 to 3½ inches. The asphalt pavement exhibited moderate to severe pavement distress. Longitudinal and transverse cracking, block cracking, potholes, asphalt patching, and other signs of distress were observed along the alignment. Additionally, groundwater was observed in Test Hole 2 at a depth of approximately 2 feet below existing grade.

REGIONAL GEOLOGY

Published maps (e.g., Widmann, Kirkham, Beach, 2000[1]) depict the portions of the alignment as underlain by late Pleistocene Younger Terrace Alluvium (**Qty**) composed of poorly sorted, clast-supported, bouldery pebble and cobble gravels in a sandy matrix. Lenses of pebble gravel, pebbly sand, and fine to medium sand are noted as well as small boulders. Other portions of the alignment are mapped as underlain by Debris-Fan deposits (**Qf**) and Holocene Stream-Channel, Flood-Plain, and Low Terrace Alluvium (**Qa**). Both of these units are composed of sands, gravels, cobbles, and boulders interbedded with silts and clays locally. Early Proterozoic Biotite Gneiss (**Xb**) is mapped as underlying the overburden material.

[1] Widmann, B.L., Kirkham, R.M., and Beach, S.T., 2000, Geologic map of the Idaho Springs quadrangle, Clear Creek County, Colorado: Colorado Geological Survey, Open-File Report OF-00-2SR.



SUBSURFACE EXPLORATION

Subsurface exploration for the project was conducted in May 3, 2016. Seven (7) test holes were drilled with a conventional, truck-mounted, drilling rig to evaluate the subsurface conditions as well as to retrieve samples for laboratory testing and analysis. The test holes were advanced to approximate depths of 2 to 11 feet within the existing roadway alignment. Practical drill rig refusal was encountered in Test Holes 6 and 7 at depths of approximately 2 and 5½ feet below existing grade due to cobbles. The holes were offset, however, refusal was encountered at similar depths. A GROUND engineer directed the subsurface exploration, logged the test holes in the field, and prepared the soil samples for transport to our laboratory.

Samples of the subsurface materials were retrieved with a 2-inch I.D. California liner sampler. The sampler was driven into the substrata with blows from a 140-pound hammer falling 30 inches, in general accordance with (in the case of the Standard Penetration Test sampler) ASTM Method D1586. Penetration resistance values, when properly evaluated, indicate the relative density or consistency of soils. Depths at which the samples were obtained and associated penetration resistance values are shown on the test hole logs.

The approximate test locations are shown on Figure 1. Logs of the test holes are presented on Figures 2 and 3. Explanatory notes and a legend are provided on Figure 4. The test holes were not yet surveyed by a representative of the Client for location and elevation.

LABORATORY TESTING

Samples retrieved from our test holes were examined and visually classified in the laboratory by the project engineer. Laboratory testing of soil samples included standard property tests, such as natural moisture contents, grain size analyses, and Atterberg limits. R-value testing was completed on a composite bulk sample of alignment soils. Water-soluble sulfates were completed on selected samples, as well. Laboratory tests were performed in general accordance with applicable ASTM protocols. Results of the laboratory testing program are summarized in Table 1.

SUBSURFACE CONDITIONS

In general, the test holes penetrated 2½ to 3½ inches of asphalt (thicker and thinner sections of asphalt may be present along the alignment) before penetrating man-made fill and/or native sands and gravels that extended to depths of approximately 2 to 11 feet below existing grades. Road base was encountered in a few of the test holes beneath the asphalt consisting of thicknesses ranging from approximately 2 to 3½ inches (thicker and thinner sections may be present along alignment).

Complete delineation (composition, thickness, lateral extent) of the existing fill, gravel surfacing and asphalt materials were not included in our scope of service at this time. If this is important to the contractor, he should perform additional subsurface exploration by excavating test pits to further evaluate the fill materials, as needed.

Man-Made Fill consisted of silty to clayey sands with gravels. The sand was fine to coarse, non-plastic, moist, and brown to gray-brown to black in color.

Debris may be encountered in the fill materials. The contractor should expect to encounter and be prepared to handle other such deleterious materials in existing fill soils.

Sands and Gravels consisted of clean to clayey to silty sands and gravels with cobbles and boulders. The sand fraction was fine to coarse. They were slightly moist to moist, non to low plastic, and brown to gray-brown in color. Iron staining was observed locally.

Cobbles and boulders were encountered locally. Coarse gravel and larger clasts are not well represented in small diameter liner samples collected from 4-inch diameter test holes. Therefore, such materials (commonly found in in alluvial deposits, for example) may be present even where not called out in the material descriptions herein.

Groundwater was encountered within the alignment in Test Hole 2 at a depth of about 2 feet below existing grade. Groundwater levels can be expected to fluctuate, however, in response to annual and longer-term cycles of precipitation, irrigation, surface drainage, land use, and the development of transient, perched water conditions.

Specifically, it has been our experience that surface and groundwater levels fluctuate greatly in mountainous areas, primarily due to seasonal conditions such as spring runoff. These conditions are often highly variable and difficult to predict. Although these conditions generally exist for 1 to 3 months annually, their impact on design can be significant. This is particularly important for foundation and deep utility excavations, cut slopes, and culvert sizing, or during construction where effective surface drainage has not been established.

WATER-SOLUBLE SULFATES

The concentration of water-soluble sulfates measured in a selected sample obtained from the test holes ranged from less than the detectable limit of 0.01 to 0.02 percent by weight (See Table 1). Such concentrations of water-soluble sulfates represent a negligible degree of 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). The Colorado Department of Transportation (CDOT) utilizes a corresponding scale with 4 classes of severity of sulfate exposure (Class 0 to Class 3) as described in the published table below.

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 these data, no special, sulfate-resistant cement need be used in project concrete.

PROJECT EARTHWORK

General Considerations Alignment 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 and other deleterious materials should be removed and disposed of off-site. Relic underground utilities should be abandoned in accordance with applicable regulations, removed as necessary, and properly capped. A geotechnical engineer should be retained to test the excavation backfill during placement.

Existing Fill Soils Fill materials were recognized in the test holes during the subsurface exploration and may be present elsewhere on site. As a result, the actual extents and compositions of all fill materials are not known. Therefore, although much of the soils appeared suitable for re-use as compacted fill, some excavated 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 suggestions for its suitability for reuse, as needed.

Use of Existing Native Soils Overburden soils that are free of trash, organic material, construction debris, and other deleterious materials are suitable, in general, for placement as compacted fill. Organic materials should not be incorporated into project fills.

Fragments of rock, cobbles, and inert construction debris (e.g., concrete or asphalt) larger than 6 inches in maximum dimension will require special handling and/or placement to be incorporated into project fills. Cobbles and boulders larger than 6 inches in size were encountered in the native subsurface materials. In general, such materials should be placed as deeply as possible in the project fills, placed in non-structural areas, or exported off site. A geotechnical engineer should be consulted regarding appropriate usage of such materials on a case-by-case basis when such materials have been identified during earthwork. Standard parameters and procedures 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 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 less than 25 percent passing the No. 200 Sieve and should have a plasticity index of less than 10. Representative samples of the materials proposed for import should be tested and approved 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. Scarification and re-compaction need not be performed in trenches where bedding will be placed.

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.

Fill materials should be placed in accordance with CDOT's moisture and density specifications (i.e., 95 percent of the maximum dry density as determined by AASHTO T-180, the "modified Proctor", at moisture contents at within 2 percent of the optimum).

No fill materials should be placed, worked, or 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 provided ranges are obtained.

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). 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.

Soft and Wet Subgrade Conditions The following should be considered where soft, wet, and unstable subgrade conditions are encountered:

a. In areas where apparently stable conditions are found, the subgrade should be proof-rolled.

b. Pockets of weak or pumping soils should be excavated and replaced with pre-approved coarse granular fill (pit run) or road base. The depth of over-excavation will be on the order of 1 to 2 feet or more to provide a stable surface. The use of recycled concrete aggregate may be a cost effective alternative in this application.

c. In cases where placement of coarse aggregate fill does not result in stable conditions, it will be necessary to place a woven geotextile, Mirafi® RS 580i or equivalent fabric placed below the coarse aggregate fill.

d. The surface of the subgrade should be leveled prior to geosynthetic reinforcement placement. Very weak or pumping soils should be excavated and replaced with granular fill or road base for best performance. The geosynthetic reinforcement should be placed directly on the prepared subgrade. Placement should be performed in accordance with the manufacturer's recommendations.

e. Rolls should be overlapped in accordance with the manufacture's recommendations.

f. Geosythetic reinforcement will be disturbed under the wheel loads of heavy construction vehicles, especially track type vehicles, therefore no vehicle traffic should be allowed over the geosynthetic reinforcement until 8 or more inches of soil has been placed over. For very weak subgrades, an 18 to 24-inch "pioneer" or "first" lift may be required to stabilize the subgrade. Using a "pioneer" lift may increase total settlement.

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, truck-mounted, geotechnical drilling equipment. We do not anticipate significant excavation difficulties in the majority of the alignment with conventional heavy-duty excavation equipment in good working condition. However, the equipment should be capable of handling gravels, cobbles, and boulders.

Temporary Excavations and Personnel Safety Excavations in which personnel will be working must comply with all applicable OSHA Standards and Regulations, particularly CFR 29 Part 1926, OSHA Standards-Excavations, adopted March 5, 1990. 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 in this report solely as a service to JVA, Incorporated and the City of Idaho Springs, and is not assuming responsibility for construction site safety or the contractor's activities.

The contractor should take care when making excavations not to compromise the bearing or lateral support for any adjacent, existing improvements.

Temporary, un-shored excavation slopes up to 10 feet in height, in general, should be cut no steeper than 1½ : 1 (horizontal : vertical) in the on-site soils in the absence of seepage. Some surface sloughing may occur on the slope faces at these angles. Where seepage or flowing groundwater is encountered in shallow project excavations, the geotechnical engineer should be retained to evaluate the conditions and provide shoring design upon request.

Surface Water The contractor should take pro-active measures to control surface waters during construction and maintain good surface drainage conditions to direct waters away from excavations and into appropriate drainage structures. A properly designed drainage swale should be provided at the tops of the excavation slopes. In no case should water be allowed to pond near project excavations.

Temporary slopes should also be protected against erosion. Erosion along the slopes will result in sloughing and could lead to a slope failure.

Groundwater was encountered in Test Hole 2 at a depth of about 2 feet below existing grade within Soda Creek Road. Therefore, seepage and perched water conditions should be anticipated seasonally at relatively shallow depths during project excavations. Properly designed and installed de-watering systems may be required during utility installation and backfill. The de-watering system(s) should be designed for the contractor by a qualified engineer.

Should seepage or flowing groundwater be encountered in shallow project excavations, the slopes should be flattened as necessary to maintain stability or a geotechnical engineer should be retained to evaluate the conditions. The risk of slope instability will be significantly increased in areas of seepage along excavation slopes.

PAVEMENT SECTIONS

A pavement section is a layered system designed to distribute concentrated traffic loads to the subgrade. Performance of the pavement structure is directly related to the physical properties of the subgrade soils and traffic loadings. The standard care of practice in pavement design describes the flexible pavement section as a “20-year” design pavement period; however, most pavements will not remain in satisfactory condition without routine maintenance and rehabilitation procedures performed throughout the life of the pavement. Pavement sections for the roadway were developed in general accordance with applicable design guidelines and procedures of City of Idaho Springs, Clear Creek County, and the Colorado Department of Transportation (CDOT), as well as local pavement construction practice. At the time of this report preparation, the City of Idaho Springs did not have specific pavement design guidelines and specifications. According to discussions with City of Idaho Springs personnel and the Client, Clear Creek County specifications (*County of Clear Creek, Roadway Design and Construction Manual)* were utilized for the pavement design of Soda Creek Road

Subgrade Materials Based on the results of our field and laboratory studies, subgrade materials encountered in our test holes consisted predominantly of clayey sands and gravels. The majority of these materials generally consisted of A-1-a to A-1-b soils in accordance with the AASHTO classification system, with a Group Index value of 0.

An R-value of 53 was measured from a composite sample of site soils. An R-value of 53 corresponds to a resilient modulus of 14,525 psi, based on the CDOT correlation.

It is important to note that significant decreases in soil support as quantified by the resilient modulus have been observed as the moisture content increases above the optimum. Therefore, pavements that are not properly drained may experience a loss of the soil support and subsequent reduction in pavement life.

Anticipated Traffic Specific traffic loadings for Soda Creek Road were not available at the time of this report preparation. Therefore, information from the *County of Clear Creek, Roadway Design and Construction Manual* and our experience on similar project was used in conjunction with CDOT loading parameters to calculate the design 20-year, equivalent 18-kip single axle loadings ($ESAL_{18}$'s). The *Clear Creek County Roadway Design and Construction Manual* indicated a range of 2,000 to 3,500 vehicles per day over the design life of the pavement (Collector), for the subject reach of Soda Creek Road. For this reach and our experience, 3,500 vehicles per day over the design life of the pavement was estimated to be representative of the anticipated traffic for a 2-lane condition. Of these vehicles, 0.5 percent were estimated be combination (semi-trailer) trucks, 2 percent to be single-unit trucks, and 98.5 percent to be automobile traffic. Based on these data, a design value for flexible pavements of approximately 204,502 $ESAL_{18}$'s was calculated for a 20-year design life.

Pavement Sections The soil resilient modulus and the indicated $ESAL_{18}$ values were used to determine the required design structural numbers for the project pavements. The required structural number was then used to develop the pavement sections. Pavement designs for flexible pavements (HBA - hot bituminous asphalt) were based on the DARWin™ computer program that solves the 1993 AASHTO pavement design equations. A Reliability Level of 90 percent and a terminal serviceability of 2.5 were used in the pavement section designs for the proposed construction. Structural coefficients of 0.44 and 0.12 were used for new hot bituminous asphalt (HBA) and aggregate base course (CDOT Class 6 or Class 5), respectively. The pavement design calculations are presented in *Appendix A*. Minimum pavement sections are presented below.

Minimum Pavement Sections

Location	***Composite Section*** *(inches Asphalt / inches ABC)*
Soda Creek Road	4 / 4*

*Minimum Pavement Section per Clear Creek County

In addition, the pavement sections should not be constructed on clay (cohesive) soils. If clay soils are encountered at the time of construction, they should be overexcavated and replaced with at least 2 feet of granular materials exhibiting an R-value of 53 or higher.

Subgrade Preparation

Remedial Earthwork Although subgrade preparation to a depth of 12 inches is typical in the project area, pavement performance commonly can be improved by a greater depth of moisture-density conditioning of the soils. The contractor should be prepared to prepare the subgrade as outlined herein even where elevated subgrade moisture contents are encountered beneath the existing pavements. Shortly before paving, the pavement subgrade should be excavated and/or scarified to a depth of **12 inches or more**, moisture-conditioned and properly re-compacted. However, as noted above, any clayey soils exposed should be overexcavated and replaced with at least 2 feet of granular materials with an R-value of 53 or higher.

Subgrade preparation should extend the full width of the pavement from back-of-curb to back-of-curb. The subgrade for sidewalks and other project hardscaping also should be prepared in the same manner.

Criteria and standards for fill placement and compaction are provided in the *Project Earthwork* section of this report. The contractor should be prepared either to dry the subgrade materials or moisten them, as needed, prior to compaction.

Where adequate drainage cannot be achieved or maintained, excavation and replacement should be undertaken to a greater depth, in addition to the edge drains discussed below.

Proof Rolling Immediately prior to paving, the subgrade should be proof rolled with a heavily loaded, pneumatic tired vehicle. Areas that show excessive deflection during proof rolling should be excavated and replaced and/or stabilized. Areas allowed to pond prior to paving will require significant re-working prior to proof-rolling. Establishment of a firm paving platform (as indicated by proof rolling) is an additional requirement beyond proper fill placement and compaction. It is possible for soils to be compacted within the limits indicated in the *Project Earthwork* section of this report and fail proof rolling, particularly in the upper range of specified moisture contents.

Pavement Materials

Hot Bituminous Asphalt (HBA) The asphalt pavement shall consist of a bituminous plant mix composed of a mixture of high quality aggregate and bituminous material, which meets the requirements of a job-mix formula established by a qualified engineer. The asphalt material used should be based on a SuperPave Gyratory Design Revolution (N_{DES}) of 75. Grading SX may be acceptable using PG 58-28 asphalt cement binder. Pavement layer thickness should be placed at 1½ to 3 inch lifts.

Aggregate Base Course (ABC) The aggregate base material should meet the criteria of CDOT Class 6 or Class 5 road base. Aggregate base course should be placed in accordance with the *Project Earthwork* Section of this report.

Additional Observations The collection and diversion of surface drainage away from paved areas is extremely important to satisfactory performance of the pavements. The subsurface and surface drainage systems should be carefully designed to ensure removal of the water from paved areas and subgrade soils. Allowing surface waters to pond on pavements will cause premature pavement deterioration. Where topography, site constraints, or other factors limit or preclude adequate surface drainage, pavements should be provided with edge drains to reduce loss of subgrade support.

GROUND's experience indicates that longitudinal cracking is common in asphalt-pavements generally parallel to the interface between the asphalt and concrete structures such as curbs, gutters, or drain pans. Distress of this type is likely to occur even where the subgrade has been prepared properly and the asphalt has been compacted properly.

The standard care of practice in pavement design describes the flexible pavement section as a "20-year" design pavement; however, most pavements will not remain in satisfactory condition without routine, preventive maintenance and rehabilitation procedures performed throughout the life of the pavement. Preventive pavement treatments are surface rehabilitation and operations applied to improve or extend the functional life of a pavement. These treatments preserve, rather than improve, the structural capacity of the pavement structure. In the event the existing pavement is not structurally sound, the preventive maintenance will have no long-lasting effect. Therefore, a routine maintenance program to seal cracks, repair distressed areas, and perform thin overlays throughout the life of the pavement is suggested.

A crack sealing and fog seal and/or chip seal program should be performed on flexible pavements on a regular basis. After approximately 8 to 10 years, patching, additional crack sealing, and asphalt overlay may be required. Prior to future overlays, it is important that all transverse and longitudinal cracks be sealed with a flexible, rubberized crack sealant in order to reduce the potential for propagation of the crack through the overlay. Traffic volumes that exceed the values utilized by this report will likely necessitate the need of pavement maintenance practices on a schedule of shorter timeframe than that stated above. The greatest benefit of preventive maintenance is achieved by placing the treatments on sound pavements that have little or no distress.

CLOSURE

Geotechnical Review The author of this report should be retained to review project plans and specifications to evaluate whether they comply with the intent of the conclusions and parameters provided in this report. The review should be requested in writing.

The geotechnical conclusions and parameters presented in this report are contingent upon observation and testing of project earthworks by representatives of GROUND. If another geotechnical consultant is selected to provide materials testing, then that consultant must assume all responsibility for the geotechnical aspects of the project by concurring in writing with the measures in this report, or by providing alternative conclusions and geotechnical parameters.

Materials Testing The client should consider retaining a geotechnical engineer to perform materials testing during construction. The performance of such testing or lack thereof, however, in no way alleviates the burden of the contractor or subcontractor from constructing in a manner that conforms to applicable project documents and industry standards. The contractor or pertinent subcontractor is ultimately responsible for managing the quality of his work; furthermore, testing by the geotechnical engineer does not preclude the contractor from obtaining or providing whatever services that he deems necessary to complete the project in accordance with applicable documents.

Limitations This report has been prepared for JVA, Incorporated, as it pertains to design and construction of the proposed roadway improvements as described herein. It may not contain sufficient information for other parties or other purposes.

In addition, GROUND has assumed that project construction will commence by Spring/Summer, 2017. Any changes in project plans or schedule should be brought to the attention of a geotechnical engineer, in order that the geotechnical conclusions in this report may be re-evaluated and, as necessary, modified.

The geotechnical conclusions and criteria in this report relied upon subsurface exploration at 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.

If during construction, surface, soil, bedrock, or groundwater conditions appear to be at variance with those described herein, a geotechnical engineer should be retained at once, so that re-evaluation of the conclusions for this site may be made in a timely manner. In addition, a contractor who relies upon this report for development of his scope of work or cost estimates 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 is responsible for obtaining the additional geotechnical information that is necessary to develop his workscope and cost estimates with sufficient precision. This includes current depths to groundwater, etc.

ALL DEVELOPMENT CONTAINS INHERENT RISKS. It is important that ALL aspects of this report, as well as the estimated performance (and limitations with any such estimations) of proposed improvements are understood by JVA, Incorporated and the City of Idaho Springs. Utilizing these criteria and measures herein for planning, design, and/or construction constitutes understanding and acceptance of the conclusions with regard to risk and other information provided herein, associated improvement performance, as well as the limitations inherent within such estimates.

If any information referred to herein is not well understood, then JVA, Incorporated, the City of Idaho Springs, or anyone using this report, should 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.

This report was prepared in accordance with generally accepted soil and foundation engineering practice in the project area at the date of preparation. Current applicable codes may contain criteria regarding performance of structures and/or site improvements which may differ from those provided herein. Our office should be contacted regarding any apparent disparity. GROUND makes no warranties, either expressed or implied, as to the professional data, opinions or conclusions contained herein.

This document, together with the concepts and conclusions presented herein, as an instrument of service, is intended only for the specific purpose and client for which it was prepared. Reuse of or improper reliance on this document without written authorization and adaption by GROUND Engineering Consultants, Inc., shall be without liability to GROUND Engineering Consultants, Inc.

GROUND appreciates the opportunity to complete this portion of the project and welcomes the opportunity to provide the JVA, Incorporated or the City of Idaho Springs with a cost proposal for construction observation and materials testing prior to construction commencement.

Sincerely,

GROUND Engineering Consultants, Inc.

Amy Crandall, P.E.

Reviewed by Jason A. Smith, REM, P.E.

1
Indicates test hole number and approximate location.

(Not to Scale)

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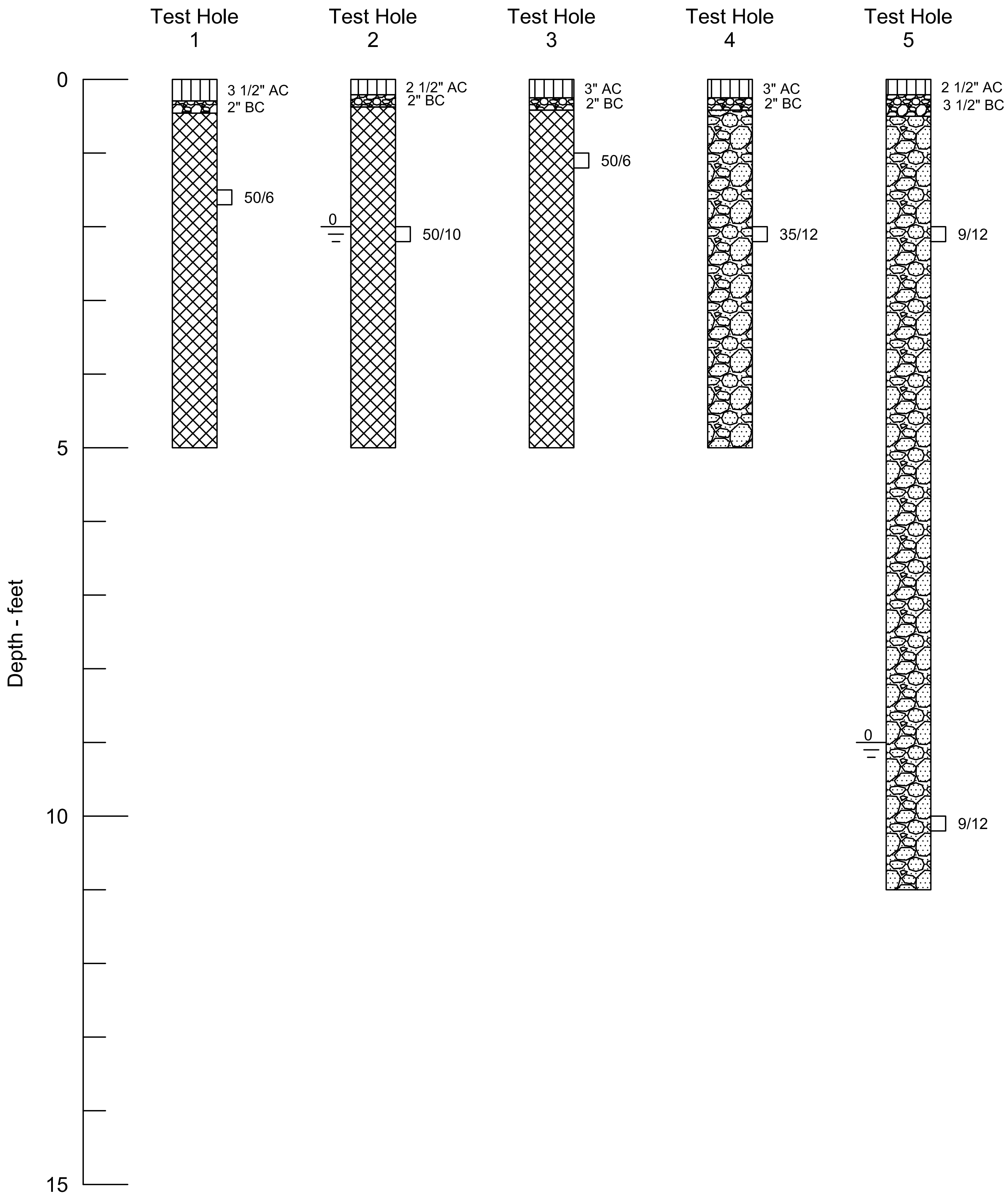
LOCATION OF TEST HOLES

JOB NO.: 16-3573	FIGURE: 1
CADFILE NAME: 3573SITE.DWG	



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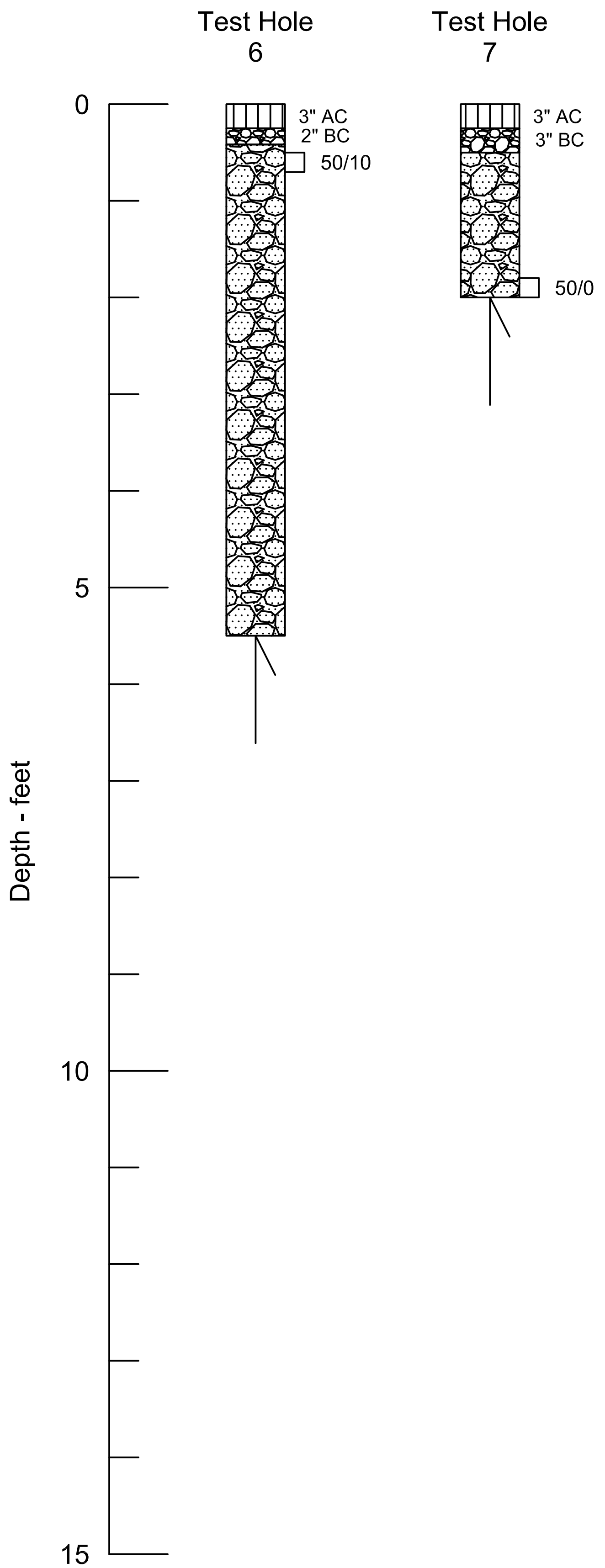
LOGS OF TEST HOLES

JOB NO.: 16-3573	FIGURE: 2
CADFILE NAME: 3573LOG01.DWG	



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LOGS OF TEST HOLES

JOB NO.: 16-3573	FIGURE: 3
CADFILE NAME: 3573LOG02.DWG	

LEGEND:

Asphalt

Base Course

Man-Made Fill: Silty to clayey sands with gravels. The sand was fine to coarse, non-plastic, moist, and brown to gray-brown to black in color.

Sands and Gravels: Clean to clayey to silty sands and gravels with cobbles and boulders. The sand fraction was fine to coarse. They were slightly moist to moist, non to low plastic, and brown to gray-brown in color. Iron staining was observed locally.

Drive sample, 2-inch I.D. California liner sample

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.

Practical Rig Refusal

0 Depth to water level and number of days after drilling that measurement was taken.

NOTES:

1) Test holes were drilled on 05/03/2016 with 4-inch diameter continuous flight augers.

2) Locations of the test holes were measured 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.

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 this legend are for general classification purposes only. See the full text of this report for descriptions of the site materials and related information.

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

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LEGEND AND NOTES

JOB NO.: 16-3573	FIGURE: 4
CADFILE NAME: 3573LEG.DWG	

GROUND
ENGINEERING CONSULTANTS

TABLE 1
SUMMARY OF LABORATORY TEST RESULTS

Sample Location		Natural	Natural	Gradation		Percent	Atterberg Limits		Water	USCS	AASHTO	
Test Hole No.	**Depth** *(feet)*	**Moisture Content** *(%)*	**Dry Density** *(pcf)*	**Gravel** *(%)*	**Sand** *(%)*	**Passing No. 200 Sieve**	**Liquid Limit**	**Plasticity Index**	**Soluble Sulfates** *(%)*	**Classifi-cation**	**Classifi-cation (GI)**	**Soil or Bedrock Type**
1	1.5	1.9	SD	17	78	5	NV	NP	-	SW-SM	A-1-b(0)	SAND with Silt and Gravel
2	2	8.9	SD	42	50	8	24	5	-	SP-SC	A-1-a(0)	SAND with Clay and Gravel
3	1	2.8	SD	42	55	3	NV	NP	<0.01	SW	A-1-a(0)	SAND with Gravel
4	2	5.0	SD	35	53	12	NV	NP	-	SP-SM	A-1-b(0)	SAND with Silt and Gravel
5	10	21.0	SD	13	82	5	NV	NP	-	SP-SM	A-1-b(0)	SAND with Silt
6	6	5.9	114.2	15	71	14	NV	NP	0.02	SM	A-1-b(0)	Silty SAND
7	1	2.5	SD	40	44	16	23	3	-	SM	A-1-b(0)	Silty SAND

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Appendix A: Pavement Design Calcuations

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare Computer Software Product

Network Administrator

Flexible Structural Design Module

Soda Creek Road

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	204,502
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	90 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	14,525 psi
Stage Construction	1
Calculated Design Structural Number	2.04 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	Asphalt	0.4	1	4	-	1.60
2	Aggregate Base Course	0.12	1	4	-	0.48
Total	-	-	-	8.00	-	2.08