Appendix A

2014 Geotechnical Report

SNOWDROP ROAD PROJECT

FOR

Assessment District 2018-1
UNINCOPORATED RANCHO CUCAMONGA, CALIFORNIA

PROJECT NO.: 30.30.0009

GEOTECHNICAL INVESTIGATION
PROPOSED ROADWAY AND DRAINAGE IMPROVEMENTS
NORTHERN PORTION OF ARCHIBALD AVENUE
SNOW DROP ROAD AND
NORTHERN PORTION OF HAVEN AVENUE
ALTA LOMA AREA
SAN BERNARDINO COUNTY, CALIFORNIA

PREPARED FOR COUNTY OF SAN BERNARDINO
SPECIAL DISTRICTS DEPARTMENT
JOB NO. 14095-3

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March 17, 2014

County of San Bernardino
Special Districts Department
157 West Fifth Street, Second Floor
San Bernardino, California 92415
Attention: Mr. Andrew Crider, P.E.

Job No. 14095-3

Dear Mr. Crider:

Attached herewith is the Geotechnical Investigation report prepared for the proposed Snow Drop Road roadway and drainage improvements in the Alta Loma area San Bernardino County, California.

This report was based upon a scope of services generally outlined in our proposal, dated February 7, 2014, and other written and verbal communications.

We are pleased to provide geotechnical services for this project. If you have questions or comments concerning this report, please contact this firm at your convenience.

Respectfully submitted,
CHJ CONSULTANTS

James F. Cooke, P.E.
Managing Engineer

JFC/RJJ:lb

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INTRODUCTION

During February and March 2014, a geotechnical investigation was performed by this firm for the proposed Snow Drop Road roadway and drainage improvements in the Alta Loma area of San Bernardino County, California. Project plans prepared by Associated Engineers, Inc. indicate that the improvements for the roadway will include grading and widening for existing roadway; local realignment; addition of curbs, retaining walls and concrete aprons; engineered fills and new asphalt concrete (AC) pavement.

The purposes of this investigation were to explore and evaluate the geotechnical/geologic conditions along the alignment and to provide appropriate geotechnical recommendations for design and construction of the proposed improvements. Data from our exploratory borings are intended to provide information as to the conditions encountered at the locations tested.

To orient our investigation for the alignment, a plan set titled "Roadway and Drainage Improvements - Snow Drop Road, Tract No. 15952", at a 1-inch to 40-feet scale, dated March 19, 2013, was furnished for our use. Aerial photographs from Google Earth and County of San Bernardino Flood Control District were also utilized in our investigation. The approximate location of the alignment is shown on the attached Geologic Index Map (Enclosure "A-1"). Project details are presented on an annotated plan set as Enclosures "A-2.1" to "A-2.9".

The results of our investigation, together with our conclusions and recommendations, are presented in this report.

SCOPE OF SERVICES

The scope of services provided during this geotechnical investigation included the following:

- Review of literature and maps
- A geological reconnaissance and mapping of the alignment and adjacent area
- Marking the exploration locations and notification of Underground Service Alert
- Placement of 20 explorations including borings and backhoe trenches along the subject alignment
- Logging and sampling of explorations for testing and evaluation
- Laboratory testing on selected samples to classify and characterize the material encountered
- Evaluation of the geotechnical data to develop site-specific recommendations for site preparation and grading, foundation design, lateral earth pressures for retaining wall design and mitigation of potential geotechnical constraints, as well as recommendations for pavement structural design.
- Preparation of this report

PROJECT CONSIDERATIONS

Improvements for the roadway will include grading and widening for the existing roadway; local realignment; addition of curbs, retaining walls and concrete aprons; engineered fills and new AC pavement. Drainage improvements include several storm drain pipes with associated headwalls, splash pads, rip rap energy dissipators and inlet structures. Retention basins and erosion protection structures are also planned. Road realignment and placement of deep fill embankments to provide a flatter road gradient are planned at selected locations. Canyon fills will be placed locally to provide a wider roadway and/or accommodate property boundaries. Retaining walls are planned to limit the height of uphill cuts and support outboard road fills. These slopes are designed at 2 horizontal (h):1

vertical (v). The feasibility of using steeper slope gradients in bedrock materials is addressed in this report.

The focus of our investigation included the following:

- Presence and condition of existing road fills at canyon crossings
- Potential of the bedrock slopes to accommodate gradients steeper than 2(h) to 1(v)
- Rippibility of bedrock materials
- Conditions of existing subgrade soils and bedrock to accept engineered fills
- Conditions of retaining wall footing subgrade
- Potential for groundwater or seepage effects to construction
- Thickness of AC pavement and subgrade conditions beneath existing roadways

SITE DESCRIPTION

The roadway alignment extends northward on Haven Avenue from Tackstem Street, westward approximately 0.4 mile from the northern terminus of Haven Avenue as paved Snow Drop Road, continues westward as a dirt road for a distance of approximately 0.2 mile, becomes a sinuous paved road extending generally westward to a point approximately 0.15 mile east of the northern terminus of Archibald Avenue, extends west to Archibald, then southward as Archibald Avenue to a point approximately 0.10 mile north of La Colima Drive. For the purposes of this report, the section of the alignment between Haven Avenue and Archibald Avenue is referred to as Snow Drop Road. The alignment traverses hilly terrain of a dissected older alluvial fan and bedrock uplift formed by the activity of the Cucamonga fault zone. A series of south trending drainages, small canyons and ridgelines define the site topography. The Cucamonga fault zone crosses the alignment at three locations (described in detail in a later section of this report).

The existing AC surface includes sections in relatively good condition and sections that are deteriorated and thin. Repairs and patches are present locally. Approximately 14 large-lot residential structures are located along and accessed by the existing roadway. Several drainages cross the alignment and are improved with fill over culvert crossings. Evidence of buried utilities, including communications, electrical and water lines, was observed along Snow Drop Road. Overhead utilities are present locally. An unfinished retaining wall and associated open excavation face are present south of the alignment between Stations 56+00 and 58+00.

FIELD INVESTIGATION

The soil conditions along the subject alignment were explored by means of 16 exploratory borings and 4 backhoe trenches. The exploratory borings were drilled with a truck-mounted CME 75 drill rig equipped for soil sampling. The maximum depth attained by drilling was 31-1/2 feet. Backhoe trenches were excavated with a rubber-tire backhoe to a maximum depth of 7-1/2 feet. The approximate locations of our explorations are indicated on the attached Alignment Map (Appendix A).

Continuous logs of the subsurface conditions, as encountered within the explorations, were recorded at the time of drilling/excavation by a geologist from this firm. Modified California samplers (3-inch outer diameter and 2-3/8-inch inner diameter) were utilized in our investigation. Relatively undisturbed samples were obtained by driving the modified California sampler (a split-spoon ring sampler) ahead of the borings at selected levels. The penetration resistance was recorded on the boring logs as the number of hammer blows used to advance the sampler in 6-inch increments (or less if noted). Samplers are driven with an automatic hammer that drops a 140-pound weight 30 inches for each blow. After the required seating, samplers are advanced up to 18 inches, providing up to three sets of blowcounts at each sampling interval. The recorded blows are raw numbers without any corrections such as for hammer type (automatic vs. manual cathead) or sampler size [California sampler vs. standard penetration test (SPT) sampler]. Both relatively undisturbed and bulk samples of typical soil types obtained were returned to the laboratory in sealed containers for testing and evaluation.

Our exploratory boring/trench logs, together with our in-place blowcounts per 6-inch increment, are presented in Appendix "B". The stratification lines presented on the boring logs represent approximate boundaries between soil types, which may include gradual transitions.

At the completion of drilling/excavation, all explorations were backfilled to the initial grade of the ground surface with soil boring cuttings and tamped using the drilling augers or backhoe bucket. Where borings were placed in pavement, AC cold patch was utilized to cap the borings. It is possible that some settlement of the backfilled material may occur. Monitoring boring locations for any settlement of backfill is not within the scope of this investigation.

More detailed descriptions of the subsurface soil conditions encountered within our exploratory borings are presented on the attached boring logs (Appendix "B").

LABORATORY INVESTIGATION

Included in our laboratory testing program were field moisture content tests on all samples returned to the laboratory and field dry density tests on all relatively undisturbed ring samples. The results are included on the boring logs. Optimum moisture content - maximum dry density relationship were established for typical soil types to evaluate the relative compaction and recompaction characteristics of the subsoils. Both relatively undisturbed and remolded direct shear tests were performed on selected samples in order to provide shear strength parameters for bearing pressure and earth pressure evaluations. Sieve analysis and Atterberg tests were performed for classification and preliminary pavement design purposes. R-value tests were performed on probable pavement subgrade soil to develop criteria for preliminary pavement design recommendations. Selected samples of material were delivered to HDR|Schiff, Inc. for corrosivity analysis.

The laboratory test results are presented in Appendix "C".

SUBSURFACE SOIL CONDITIONS

The alignment is situated on the south flank of the San Gabriel Mountains and traverses young bouldery alluvial-fan sediments, older gravelly terrace deposits and gneissic bedrock. Colluvium derived from terrace and bedrock units and formed by natural raveling of slopes is present locally in the subsurface within canyons. A Geologic Index Map showing the general geologic conditions is presented as Enclosure "A-1". A more detailed depiction of the geologic conditions is presented on Enclosures "A-2.1 through "A-2.9". The following provides a description of each geologic unit.

Fill (f)

Fill was encountered as locally derived materials placed during grading along roadways and as canyon fills. The deepest fills were at drainage crossings. Fill at Exploratory Boring No. 4 included large debris or rocks that resulted in refusal to the drill auger at 13 feet below the existing ground surface (bgs). The remaining explorations were completed to final depth without refusal. Based on surface conditions and the results of drilling, fills between Stations 61+00 and 66+00 and 81+00 and 82+00 may contain oversize rock or debris. Debris or rock may also be present in fills at other drainage crossings. Side-cast road fill resulting from cut/fill grading was observed locally. The areas of significant fill identifiable by surface features, topography or explorations are indicated on Enclosures "A-2.1" through "A-2.9". Fill may be present in areas outside these mapped locations.

Recent Alluvium (Qa)

Alluvium of active drainages consists of fine- to coarse-grained silty sand and sand with gravel, cobbles and boulders. Alluvium sourced from Deer Canyon is present along the extension of Haven Avenue and includes abundant durable cobble- and boulder-size clasts in a sandy matrix. Alluvium encountered at the crossings of smaller drainages along Snow Drop Road is sourced in gneissic bedrock that forms an angular gravelly silty sand material with few boulder-size clasts.

Alluvial-Fan Sediments (Qyf)

Alluvial-fan deposits consisting of unconsolidated to slightly consolidated, coarse-grained sand to bouldery alluvium were encountered along Haven Avenue and Archibald Avenue. This unit includes several ages of alluvium generated by debris flow and stream outwash from the San Gabriel Mountains; therefore, the volume, size and durability of the cobble- and boulder-size fraction varies with location. Alluvial-fan sediments along Haven Avenue are derived from Deer Canyon and include abundant durable cobble- and boulder-size rocks. The alluvium along Archibald Avenue is older and less durable, containing fewer large clast sizes.

Very Old Alluvial-Fan Sediments (Qvof)

Alluvial fan deposits consisting of slightly consolidated, silty sand with weathered gravel- to boulder-size clasts were encountered along Snow Drop Road. This unit is characterized by reddish brown color and weathered clasts. The upper portion of this unit includes a sandy clay layer (paleosol) where undisturbed by grading. These sediments are Pleistocene age and relatively dense. Cut slopes at gradients of 1-1/2(h) to 1(v) are suitable for permanent slopes in this unit.

Granulitic Gneiss (Pm)

Crystalline bedrock consisting of foliated gneiss forms surface exposures along the western portion of the alignment and in the area of Exploratory Boring No. 3. This material forms resistant cut slopes and generates a gravelly silty sand material upon excavation. Existing cuts stand at relatively steep angles within the alignment. A reddish-brown clayey sand (paleosol) is present in the upper few feet of this unit where undisturbed by grading. The bedrock is considered rippable with heavy grading equipment, and blasting is not anticipated within the depths and limits of the proposed road alignment. Cut slopes at gradients of 1-1/2(h) to 1(v) are suitable for permanent slopes in the bedrock. Scaling to remove loose blocks should be performed when excavations of rock slope faces approach finished grade.

With the exception of Exploratory Boring No. 4, refusal to advance of exploratory borings was not encountered. No caving was observed upon removal of the drill augers. Caving occurred in the trench sidewalls of Exploratory Trench Nos. 9 and 11 that exposed unconsolidated, very young alluvium in the upper 3 to 4 feet. A summary of explorations is included as Enclosure "E-2".

Groundwater was not encountered within any of the exploratory borings.

Some soil materials encountered during this investigation may have sufficient amounts of clay to be critically expansive. Critically expansive soils should not be utilized as backfill material for walls or structures, if possible. Specialized construction procedures to specifically resist expansive soil forces may be necessary if the clayey material is utilized in structural areas such as wall backfill. Additional evaluation of soils by the geotechnical engineer for expansion potential should be conducted as necessary on the specific material to be utilized during the grading operation.

FAULTING AND SEISMIC SHAKING

As shown on Enclosure "A-1", the alignment crosses the active Cucamonga fault zone along the Haven Avenue portion and at two locations along the Archibald Avenue portion. The Cucamonga fault is a reverse fault that places older crystalline basement rocks onto relatively younger alluvial materials. Evidence of recent activity on this fault includes fresh scarps, sag ponds and disrupted Holocene alluvium (Dutcher and Garrett, 1963; Yerkes, 1985; Morton and Yerkes, 1987). Multiple anastomosing fault splays are evident in the geomorphology of the mountain front from San Antonio Canyon to the Lytle Creek area. This fault is capable of generating strong ground shaking and rupturing the ground surface. Engineered structures such as retaining walls or drainage structures are not planned near the mapped traces of the Cucamonga fault zone; therefore, damage to proposed roadway improvements by surface rupture is anticipated to be limited to AC paving.

As for all areas of southern California, there is a potential for seismic shaking from the Cucamonga fault or other regional faults to occur during the lifetime of the alignment. Therefore, engineered structures, such as retaining walls, should be designed according to the seismic design standards of the current building code. The seismic design parameters for the alignment are provided in the following section.

SEISMIC DESIGN CONSIDERATIONS

Based on the geologic setting of and subsurface data from the site, the geologic materials underlying the site can be classified as Site Class "C, dense soil or soft rock" and "D, stiff soil", according to the 2013 California Building Code (CBC).

Summary of Seismic Design Parameters		
Site Class	**C**	**D**
Mapped Spectral Acceleration Parameters	$S_s = 3.03$ and $S_1 = 1.12$	$S_s = 3.03$ and $S_1 = 1.12$
Site Coefficients	$F_a = 1.0$ and $F_v = 1.3$	$F_a = 1.0$ and $F_v = 1.5$
Adjusted Maximum Considered Earthquake Spectral Response Parameters	$S_{MS} = 3.03$ and $S_{M1} = 1.45$	$S_{MS} = 3.03$ and $S_{M1} = 1.68$
Design Spectral Acceleration Parameters	$S_{DS} = 2.02$ and $S_{D1} = 0.97$	S_{DS} 2.02 and $S_{D1} = 1.12$

The recommended peak ground acceleration (PGA) for the design earthquake ground motion based on a site-specific evaluation is 0.94g.

GROUNDWATER AND LIQUEFACTION

Groundwater was not encountered within any of the explorations performed for the project. Very moist soil conditions were observed in Exploratory Boring No. 12 beneath the existing unpaved roadway. This area includes a roadway fill that blocks a drainage channel. The channel crossing lacks a conduit to carry storm flows beneath the road. The moist soil condition is anticipated to be mitigated by addition of a pipe at this crossing during construction of the proposed roadway improvements. For the remainder of the alignment, water may occur in bedrock fractures or as "perched" water on the bedrock/colluvium interface and/or bedrock/alluvium interface locally. The alignment is not located within a groundwater production area, and active wells are not known to exist within the site.

Liquefaction is a process in which strong ground shaking causes saturated soils to lose their strength and behave as a fluid (Matti and Carson, 1991). Ground failure associated with liquefaction can result in severe damage to structures. The geologic conditions for increased susceptibility to liquefaction are: 1) shallow groundwater (generally less than 50 feet in depth); 2) presence of unconsolidated sandy alluvium, typically Holocene in age; and 3) strong ground shaking. All three of these conditions must be present for liquefaction to occur. Based upon groundwater conditions and subsurface materials including shallow bedrock material, liquefaction is not considered to be a significant hazard to this site, and further analysis is not warranted.

CONCLUSIONS

On the basis of our field and laboratory investigations, it is the opinion of this firm that the proposed street improvements, retaining walls and channel crossings are feasible from a geotechnical standpoint, provided the recommendations contained in this report are implemented during design and construction.

Based on the depth to groundwater and bedrock, liquefaction is not considered a hazard at the site.

Fill was encountered to variable depths at drainage crossings within the alignment and was noted as side-cast road fill locally. These materials are undocumented with respect to relative density (compaction) as they now exist. Complete removal of the undocumented fill should be performed prior to placement of any additional fill or construction of drainage or retaining structures. Additional removals due to loose soils may also be necessary in isolated areas.

The native soils and bedrock encountered were classified as silty sand and clayey sand and were generally in medium dense to very dense states. The on-site soils should provide suitable backfill material for areas other than pipe bedding, provided that they are free of any organic or other deleterious materials and that larger cemented particles are reduced to a suitable size.

The results of sand equivalent tests and visual observation indicate that most of the on-site soils are not suitable for use as pipe bedding. However, should more granular soil be encountered, the contractor may have sand equivalent tests performed to determine suitability of the material for use as pipe bedding. Results of the testing should be submitted to the client for final determination of suitability. Because mechanical compaction may not be effective within the pipe zone, consideration could be given to utilizing a lean sand/cement slurry as an alternative. Refer to the "Pipe Bedding and Backfills" section later in this report.

Mixing and moisture treating the backfill material outside of the excavation prior to pipeline backfilling will help to prevent overly wet "pumping" conditions during the backfill operation.

Some soil materials encountered during this investigation may have sufficient amounts of clay to be critically expansive. Critically expansive soils should not be utilized as backfill material for walls or structures, if possible. Specialized construction procedures to specifically resist expansive soil forces may be necessary if the clayey material is utilized in structural areas such as wall backfill. Additional evaluation of soils by the geotechnical engineer for expansion potential should be conducted as necessary on the specific material to be utilized during the grading operation.

Preliminary data indicates that cut and fill slopes should be constructed no steeper than 2(h):1(v) except as noted. Cut slopes at gradients of 1-1/2(h):1(v) are suitable for permanent slopes in the bedrock [Granulitic Gneiss (Pm)]. Scaling to remove loose blocks should be performed when excavations of rock slope faces approach finished grade.

The soils encountered within exploratory borings are classified as a Type "B" soil in accordance with the CAL/OSHA (2013) excavation standards and, as such, temporary excavations should not be inclined steeper than 1(h):1(v).

RECOMMENDATIONS

DESIGN ACCELERATION PARAMETERS:

Based on the geologic setting of and subsurface data from the site, the geologic materials underlying the site can be classified as Site Class "C, dense soil or soft rock" and "D, stiff soil", according to the 2013 CBC.

Summary of Seismic Design Parameters

Site Class	**C**	**D**
Mapped Spectral Acceleration Parameters	$S_s = 3.03$ and $S_1 = 1.12$	$S_s = 3.03$ and $S_1 = 1.12$
Site Coefficients	$F_a = 1.0$ and $F_v = 1.3$	$F_a = 1.0$ and $F_v = 1.5$
Adjusted Maximum Considered Earthquake Spectral Response Parameters	$S_{MS} = 3.03$ and $S_{M1} = 1.45$	$S_{MS} = 3.03$ and $S_{M1} = 1.68$
Design Spectral Acceleration Parameters	$S_{DS} = 2.02$ and $S_{D1} = 0.97$	S_{DS} 2.02 and $S_{D1} = 1.12$

The recommended PGA for the design earthquake ground motion based on a site-specific evaluation is 0.94g.

GENERAL SITE PREPARATION:

It is imperative that no construction operations be performed without the presence of a representative of the geotechnical engineer. An on-site, pre-job meeting with the County of San Bernardino, the construction manager, the contractor and the geotechnical engineer should occur prior to all construction-related operations. Operations undertaken at the site without the geotechnical engineer present may result in exclusions of affected areas from the final compaction report for the project.

Construction of the subject project should be performed, at a minimum, in accordance with these recommendations and with applicable portions of the County of San Bernardino, Road Planning and Design Standards and CAL/OSHA (2013) requirements. The following recommendations are presented for your assistance in establishing proper construction criteria.

INITIAL SITE PREPARATION:

All areas of construction should be stripped of significant vegetation and other deleterious materials. These materials should be removed from the site for disposal. Any conflicting existing utility lines should be traced, removed and rerouted from the project area.

Any existing undocumented fill encountered during construction should be completely removed where possible and cleaned of significant deleterious materials before being reused as compacted fill.

Cavities created by removal of subsurface obstructions, such as structures and utility lines, should be thoroughly cleaned of loose soil, organic matter and other deleterious materials; shaped to provide access for construction equipment; and either backfilled as recommended for compacted fill or filled with slurry.

COMPACTED FILLS:

The on-site soils should provide adequate quality fill material, provided they are free from roots, other organic matter and deleterious materials. Unless approved by the geotechnical engineer, rock or similar irreducible material with a maximum dimension greater than 8 inches should not be buried or placed in fills.

Import fill should be inorganic, non-expansive granular soils free from rocks or lumps greater than 6 inches in maximum dimension. The contractor shall notify the geotechnical engineer of import sources sufficiently ahead of their use so that the sources can be observed and approved as to the physical characteristic of the import material. For all import material, the contractor shall also submit current verified reports from a recognized analytical laboratory indicating that the import has a "not applicable" (Class S0) potential for sulfate attack based upon current (ACI) criteria and is not corrosive to ferrous metal and copper. In addition, a report should be submitted addressing environmental aspects of any proposed import material. The reports should be accompanied by a written statement from the contractor that the laboratory test results are representative of all import material that will be brought to the job. If imported fill is to be utilized in structural areas, it should meet the same strength requirement which was utilized to design the structure.

Fill should be spread in near-horizontal layers, approximately 8 inches in thickness. Thicker lifts may be approved by the geotechnical engineer if testing indicates that the grading procedures are adequate to achieve the required compaction. Each lift should be spread evenly, thoroughly mixed during spreading to attain uniformity of the material and moisture in each layer, brought to near optimum moisture content and compacted to a minimum relative compaction of 90 percent in accordance with the current version of ASTM D1557. Fill deeper than 10 feet should be compacted at a minimum of 95 percent relative compaction to reduce the settlement potential.

SHRINKAGE AND SUBSIDENCE:

Based upon the relative compaction of the native soils tested during this investigation and the relative compaction anticipated for compacted fill soils, we estimate a compaction shrinkage of approximately 0 to 5 percent. Therefore, 1.0 cubic yards to 1.05 cubic yards of in-place soil material would be necessary to yield 1 cubic yard of properly compacted fill material. In addition, we would anticipate subsidence of approximately 0.1 foot or less. These values are exclusive of losses due to stripping or the removal of other subsurface obstructions, if encountered, and may vary due to differing conditions within the project boundaries and the limitations of this investigation.

Values presented for shrinkage and subsidence are estimates only. Final grades should be adjusted, and/or contingency plans to import or export material should be made to accommodate possible variations in actual quantities during site grading.

PREPARATION OF FILL AREAS:

Prior to placing fill, the surfaces of all areas to receive fill should be scarified to a depth of 6 inches or more. The scarified soils should be brought to near optimum moisture and recompacted to at least 90 percent relative compaction in accordance with the current version of ASTM D1557 prior to refilling the excavation to grade as properly compacted fill.

PREPARATION OF FOOTING AREAS:

All footings should rest upon at least 12 inches of properly compacted fill material or suitably dense native soils. The subexcavation should extend horizontally beyond the footing lines a minimum distance of 5 feet where possible. The bottom of the excavation should then be scarified to a depth of at least 6 inches, brought to near optimum moisture and recompacted to at least 90 percent relative compaction in accordance with ASTM D1557 prior to refilling the excavation to grade as properly compacted fill.

FOUNDATION DESIGN:

The concrete culvert and retaining wall footings may be safely founded on conventional spread foundations, bearing entirely on a minimum of 12 inches of compacted fill or suitably dense native soils. Footings should be a minimum of 12 inches wide and should be established at a minimum depth of 24 inches below the anticipated scour depth. Foundations should not span from compacted fill to dense native material unless accommodations are made for differential settlement within the structure.

Foundations placed within the stream channel should extend below the anticipated scour depth. The depth of scour should be evaluated by a hydraulic engineer. Exploratory borings and grain size distribution data obtained in this investigation could be utilized in the scour evaluation.

Soil-bearing pressure for each geologic unit is given in Enclosure "E-1". The geologic unit chosen should be based on the type of material the foundation is embedded in. The Alignment Maps ("A-2.1"-"A-2.9") should be utilized to provide the necessary geologic unit. These are allowable bearing pressures, and increases for width and depth as well as a maximum capacity are provided. These bearing values may be increased by one-third for wind or seismic loading.

For footings thus designed and constructed, we would anticipate a maximum static settlement of 1 inch or less. Differential settlement between similarly loaded adjacent footings is expected to be approximately one-half the total settlement. These settlement estimates do not include seismically induced settlement.

LATERAL LOADING:

Resistance to lateral loads will be provided by passive earth pressure and base friction. Passive and base friction for each geologic unit are given in Enclosure "E-1". The geologic unit chosen should be based upon the type of material the foundation is embedded in. The Alignment Maps ("A-2.1"–"A-2.9") should be utilized to provide the necessary geologic unit. These are ultimate values and do not include a factor of safety other than conservative modeling of the soil strength parameters. Base friction and passive earth pressure may be combined without reduction but should not be increased by one-third during seismic loadings.

For preliminary retaining wall design purposes utilizing the existing on-site native and fill materials, lateral earth pressure for each geologic unit is given in Enclosure "E-1". The geologic unit chosen should be based upon the type of material the structure will retain. The Alignment Maps ("A-2.1"–"A-2.9") should be utilized to provide the necessary geologic unit. If it is unknown what material will be retained, the most conservative material should be chosen. These are ultimate values and do not include a factor of safety other than conservative modeling of the soil strength parameters. The "at-rest" condition applies to braced walls that are not free to tilt. The "active" condition applies to unrestrained cantilevered walls where wall movement is anticipated. The structural designer should use judgment in determining the wall fixity and may utilize values interpolated between the "at-rest" and "active" conditions where appropriate. These values should be verified prior to construction when the backfill materials and conditions have been determined. We have included 2(h):1(v) sloping backfill pressures also. If import material is to be utilized for backfill, an engineer from this firm should verify the backfill has equivalent or superior strength values. Toe bearing pressure for walls on soils not bearing against compacted fill or suitably dense native soils, as described earlier in the section "Preparation of Footing Areas", should not exceed the 2013 CBC values.

Backfill behind retaining walls should consist of a soil of sufficient granularity that the backfill will properly drain. The granular soil should be classified per the Unified Soil Classified System as GW, GP, SW, SP, SW-SM or SP-SM. Critically expansive soils (expansion index greater than 20) should not be used as backfill material. Existing on-site soil may be critically expansive at certain locations or elevations. This firm should be contacted in order to evaluate the specific suspected material at the time of exposure. Additional recommendations can be provided at that time. Surface drainage should be provided to prevent ponding of water behind walls. A drainage system should be installed behind all retaining walls consisting of either of the following:

1. A 4-inch diameter perforated PVC (Schedule 40) pipe or equivalent at the base of the stem encased in 2 cubic feet of granular drain material per linear foot of pipe; or

2. Synthetic drains such as Enkadrain, Miradrain, Hydraway 300, or equivalent

Perforations in the PVC pipe should be 3/8-inch in diameter. Granular drain material should be wrapped with filter cloth to prevent clogging of the drains with fines. Below grade walls should be waterproofed to prevent nuisance seepage. Water should outlet to an approved drain.

Foundation concrete should be placed in neat excavations with vertical sides, or the concrete should be formed and the excavations properly backfilled as recommended for site fill.

SLOPE CONSTRUCTION:

Preliminary data indicate that cut and fill slopes should be constructed no steeper than 2(h):1(v) except as noted. Cut slopes at gradients of 1-1/2(h):1(v) are suitable for permanent slopes in the bedrock [Granulitic Gneiss (Pm)]. Scaling to remove loose blocks should be performed when excavations of rock slope faces approach finished grade. Fill slopes should be overfilled during construction and then cut back to expose fully compacted soil. A suitable alternative would be to compact the slopes during construction and then roll the final slopes to provide dense, erosion-resistant surfaces.

Where fills are to be placed against existing slopes steeper than 5(h):1(v), the existing slopes should be benched into competent native materials to provide a series of level benches to seat the fill and to remove the compressive and permeable topsoil. The benches should be a minimum of 8 feet in width, constructed at approximately 2-foot vertical intervals. In addition, a shear key should be constructed across the toe of the slope. The shear key should be a minimum of 15 feet wide and should penetrate a minimum of 2 feet beneath the toe of the slope into firm competent soils. A typical shear key and slope benching detail is contained in Appendix "D".

SLOPE CREEP:

The outer, upper portions of cut and fill slopes will be subject to potential long-term movement due to creep or erosion forces. All proposed improvements planned near or on the top of slopes, including garden walls, flatwork and pools, should be designed and constructed to minimize the effects of this movement. Where possible, improvements should be designed as far from the top of the slope as possible. At a minimum, footings should be designed so that there is a least a 5-foot separation from the face of the slope to the face of the footing. This may necessitate deepened footings. The actual design of such walls will be based on the wall loading conditions and the earth pressure required to resist these loads. This will fall under the purview of the wall designer, who should consult this firm if additional earth pressure information is required.

SLOPE PROTECTION:

Inasmuch as the native materials are highly susceptible to erosion by wind and running water, it is our recommendation that the slopes at the project be planted as soon as possible after completion. The use of succulent ground covers, such as iceplant or sedum is not recommended. If watering is necessary to sustain plant growth on slopes, then the watering operation should be monitored to assure proper operation of the water system and to prevent over watering.

Measures should be provided to prevent surface water from flowing over slope faces.

Rodent infestation can also be a serious issue with respect to slope stability. Rodent tunneling and burrowing alters the strength of the soil and can allow water to infiltrate the soil, resulting in ultimate slope failure. Rodent burrows can also provide direct access for surface water to the slope face, causing surficial slope "blowouts". Although a maintenance issue, we recommend that measures be taken to prevent rodent infestation in slopes.

TRENCH EXCAVATION:

Native material encountered within our exploratory borings are classified as a Type "B" soil in accordance with the CAL/OSHA (2013) excavation standards. All trench excavation should be performed in accordance with CAL/OSHA excavation standards. Temporary excavations in native material should not be inclined steeper than 1(h):1(v) for a maximum trench depth of 20 feet. For trench excavations deeper than 20 feet, this firm should be contacted.

PIPE BEDDING AND BACKFILLS:

Pipe Bedding

Pipe bedding material should meet and be placed according to the "Greenbook" or other project specifications. Pipe bedding should be uniform, free-draining granular material with a sand equivalent of at least 30. A majority of our sand equivalent tests performed on soil indicate a sand equivalent of less than 30. Based upon these results, the on-site materials would not be suitable and should not be utilized for pipe bedding.

Considering the density of the bedrock material, jetting should not be utilized for densification of pipe bedding or backfill.

Densification of imported bedding and backfill material by mechanical means may prove to be impractical to achieve the relative compaction specified by the "Greenbook" for the pipe zone. Without jetting to help ensure the in-filling of any voids beneath and around the pipe and because it would be difficult or impossible to adequately perform compaction tests or verify the conditions within the lower portion of the pipe zone, consideration should be given to utilizing a lean sand/cement slurry densified by vibrators for the pipe zone. The use of slurry would lend itself to this project because any additional removals or stabilization of unsuitable subgrade soils would be minimized. Other advantages of utilizing slurry typically include time savings, no need for compaction testing and better overall performance with greatly reduced settlement potential to better support the street and related construction.

Backfill

Backfill should be compacted following the recommendations in the "Compacted Fills" section of this report.

Soils required to be compacted to at least 95 percent relative compaction, such as street subgrade and finish grade, should be moisture treated to near optimum moisture content not exceeding 2 percent above optimum.

To avoid pumping, backfill material should be mixed and moisture treated outside of the excavation prior to lift placement in the trench.

A lean sand/cement slurry should be considered to fill any cavities, such as void areas created by caving or undermining of soils beneath existing improvements or pavement to remain, or any other areas that would be difficult to properly backfill, if encountered.

EXPANSIVE SOILS:

Some soil materials encountered during this investigation may have sufficient amounts of clay to be critically expansive (expansion index greater than 20). Critically expansive soils should not be utilized as backfill material for walls or structures, if possible. Specialized construction procedures to specifically resist expansive soil forces may be necessary if the clayey material is utilized in structural areas such as wall backfill. As an alternative, mixing of the on-site soils in order to reduce the expansion potential to "very low" is considered feasible. With proper mixing of the expansive soils, their potential can be reduced to "very low". The success of reduction or elimination of the expansive soil potential depends on the grading operation and on the volume and expansion potential of the soils encountered. Monitoring of the soil expansion potential by the geotechnical engineer during the grading operation should be performed regularly. Additional evaluation of soils by the geotechnical engineer for expansion potential should be conducted as necessary on the specific material to be utilized during the grading operation.

SLABS-ON-GRADE:

To provide adequate support, concrete slabs-on-grade should bear on a minimum of 12 inches of compacted soil. Concrete slabs-on-grade should be a minimum of 4 inches in thickness. Concrete Arizona crossing thickness should be a minimum of 6 inches in thickness. The soil should be compacted to 95 percent relative compaction. The final pad surfaces should be rolled to provide smooth, dense surfaces.

Concrete building slabs subjected to heavy loads, such as materials storage and/or forklift traffic, should be designed by a registered civil engineer competent in concrete design. A modulus of vertical subgrade reaction of 150 pounds per cubic inch can be utilized in the design of slabs-on-grade for the proposed project.

PRELIMINARY FLEXIBLE PAVEMENT DESIGN:

Based on our preliminary sampling and testing (average R-value of 32) and on traffic indices, the structural sections tabulated below should provide satisfactory pavement for the subject alignment.

Traffic Index	Recommended Street Section
4.0	0.25' AC / 0.33' AB Class 2
4.5	0.25' AC / 0.33' AB Class 2
5.0	0.25' AC / 0.45' AB Class 2
5.5	0.30' AC / 0.60' AB Class 2
6.0	0.30' AC / 0.65' AB Class 2
6.5	0.35' AC / 0.70' AB Class 2
7.0	0.35' AC / 0.80' AB Class 2
7.5	0.40' AC / 0.85' AB Class 2
8.0	0.40' AC / 0.90' AB Class 2

AB = Aggregate Base HMA = Hot Mix Asphalt

The above structural sections are predicated upon proper compaction of utility trench backfill, if any, and subgrade soils, with the upper 12 inches of subgrade soils and all AB material brought to a relative compaction of at least 95 percent in accordance with ASTM D1557 prior to paving. The HMA and AB should meet Standards & Specifications requirements.

It should be noted that the above pavement designs were based upon the results of preliminary sampling and testing performed on this project. Therefore, the values provided here should be verified by additional sampling and testing during construction when the actual subgrade soils are exposed.

The existing AC surface includes sections in relatively good condition and sections that are deteriorated and thin. AC in the deteriorated and thin sections may either be peeled up and removed for disposal or recycling or be ground up, stockpiled and incorporated into the subgrade. With the existing AC removed and subgrade cut, the upper 12 inches of subgrade soils should be scarified, moisture treated to near optimum moisture content and recompacted to at least 95 percent relative compaction (ASTM D1557). No additional subexcavation of the subgrade soils should be necessary unless wet or otherwise unsuitable soils are uncovered. With the native subgrade compacted and tested, the pre-moistened base material should be placed and compacted to at least 95 percent relative compaction (ASTM D1557). Should repairs to the subgrade require base thicknesses greater than 8 inches, base should be placed in 8-inch or less lifts and compacted as above.

Overlays of the existing AC sections in relatively good condition may be possible if sufficient AC and base exist. Thicknesses of the AC and base encountered are provided on the exploratory boring or test pit logs. It appears that the paved portion of Haven Avenue between Station Nos. 88 and 112 may be suitable for an overlay pavement section of an additional 0.15 foot of rubberized hot mix asphalt. Archibald Avenue appears not to be suitable for overlay.

Should wet or otherwise unsuitable areas be encountered during grading, deeper removals and replacement with base material may be necessary. Care should be taken to avoid disturbing the existing utilities and their laterals. Should problems arise due to shallow utilities, this firm should be contacted in order to provide specific recommendations.

Further evaluation and testing of the actual subgrade soils encountered during construction should be performed to verify the preliminary structural pavement sections provided.

CHEMICAL/CORROSIVITY TESTING:

Selected samples of materials were delivered to HDR|Schiff, Inc. for soil corrosivity testing. Laboratory testing consisted of pH, resistivity and major soluble salts commonly found in soils. The results of the laboratory tests performed by HDR|Schiff, Inc. appear in Appendix "C".

These tests have been performed to screen the site for potentially corrosive soils. CHJ Consultants does not practice corrosion engineering.

For Boring No. 6 at the Surface

Values from the soil tested are considered potentially "mildly" corrosive to ferrous metals at as-received condition and "corrosive" at saturated condition. Specific corrosion control measures, such as coating of the pipe with non-corrosive material or alternative non-metallic pipe material, are considered to be needed if there is a potential for saturated soils.

The ammonium level did not indicate a concern as to corrosion of buried copper. The nitrate level did indicate a concern as to corrosion of buried copper.

Results of the soluble sulfate testing indicate a "not applicable" (Class S0) anticipated exposure to sulfate attack. Based upon the criteria from Table 4.2.1. of the American Concrete Institute Manual of Concrete Practice (2011), no special measures, such as specific cement types or water-cement ratios, will be needed for this "not applicable" exposure to sulfate attack.

The soluble chloride content of the soils tested was not at levels high enough to be of concern with respect to corrosion of reinforcing steel. The results should be considered in combination with the soluble chloride content of the hardened concrete in determining the effect of chloride on the corrosion of reinforcing steel.

For Boring No. 14 at the Surface

Values from the soil tested are considered potentially "mildly" corrosive to ferrous metals at as-received condition and "moderately" corrosive at saturated condition. Specific corrosion control measures, such as coating of the pipe with non-corrosive material or alternative non-metallic pipe material, are considered to be needed if there is a potential for saturated soils.

The ammonium and nitrate levels did not indicate a concern as to corrosion of buried copper.

Results of the soluble sulfate testing indicate a "not applicable" (Class S0) anticipated exposure to sulfate attack. Based upon the criteria from Table 4.2.1. of the American Concrete Institute Manual of Concrete Practice (2011), no special measures, such as specific cement types, water-cement ratios, etc., will be needed for this "not applicable" exposure to sulfate attack.

The soluble chloride content of the soils tested was not at levels high enough to be of concern with respect to corrosion of reinforcing steel. The results should be considered in combination with the soluble chloride content of the hardened concrete in determining the effect of chloride on the corrosion of reinforcing steel.

CHJ Consultants does not practice corrosion engineering. If further information concerning the corrosion characteristics, or interpretation of the results submitted herein, is required, then a competent corrosion engineer could be consulted.

PRE-JOB CONFERENCE:

It is imperative that no clearing and/or construction operations be performed without the presence of a representative of the geotechnical engineer. An on-site pre-job meeting with the owner, the contractor and the geotechnical engineer should occur prior to all construction-related operations. It should be stressed that operations undertaken at the site without the presence of the geotechnical engineer may result in exclusions of affected areas from the final compaction report for the project.

CONSTRUCTION OBSERVATION:

All construction operations should be observed by a representative of the geotechnical engineer. The geotechnical engineer's field representative will provide observation and field testing and will not provide any supervising or directing of the actual work of the contractor, his employees or agents. Neither the presence of the geotechnical engineer's field representative nor the observations and testing by the geotechnical engineer shall excuse the contractor in any way for defects discovered in his work. It is understood that the geotechnical engineer will not be responsible for job or site safety on this project, which will be the sole responsibility of the contractor.

LIMITATIONS

CHJ Consultants has striven to perform our services within the limits prescribed by our client, and in a manner consistent with the usual thoroughness and competence of reputable geotechnical engineers and engineering geologists practicing under similar circumstances. No other representation, express or implied, and no warranty or guarantee is included or intended by virtue of the services performed or reports, opinion, documents, or otherwise supplied.

This report reflects the testing conducted on the site as the site existed during the investigation, which is the subject of this report. However, changes in the conditions of a property can occur with the passage of time, due to natural processes or the works of man on this or adjacent properties. Changes in applicable or appropriate standards may also occur whether as a result of legislation, application or the broadening of knowledge. Therefore, this report is indicative of only those conditions tested at the time of the subject investigation, and the findings of this report may be invalidated fully or partially by changes outside of the control of CHJ Consultants. This report is therefore subject to review and should not be relied upon after a period of one year.

The conclusions and recommendations in this report are based upon observations performed and data collected at separate locations, and interpolation between these locations, carried out for the project and the scope of services described. It is assumed and expected that the conditions between locations observed and/or sampled are similar to those encountered at the individual locations where observation and sampling was performed. However, conditions between these locations may vary significantly. Should conditions that appear different from those described herein be encountered in the field by the client or any firm performing services for the client or the client's assign, this firm should be contacted immediately in order that we might evaluate their effect.

If this report or portions thereof are provided to contractors or included in specifications, it should be understood by all parties that they are provided for information only and should be used as such.

The report and its contents resulting from this investigation are not intended or represented to be suitable for reuse on extensions or modifications of the project, or for use on any other project.

CLOSURE

We appreciate this opportunity to be of service and trust this report provides the information desired at this time. Should questions arise, please do not hesitate to contact this office.

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NO. 2396
CERTIFIED ENGINEERING GEOLOGIST
Exp. 06-30-15
STATE OF CALIFORNIA

Respectfully submitted,
CHJ CONSULTANTS

John S. McKeown

John S. McKeown, E.G. 2396
Project Engineer

REGISTERED PROFESSIONAL ENGINEER
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No. 3012
Exp. 12-31-15
GEOTECHNICAL
STATE OF CALIFORNIA

James F. Cooke, G.E. 3012
Managing Engineer

Robert J. Johnson, P.E.
President

JSM/JFC/RJJ:lb

REFERENCES

American Concrete Institute, 2011, Manual of Concrete Practice, Part 3, Table 4.2.1.

BNi Building News, 2012, "Greenbook" Standard Specifications for Public Works Construction, 2012 Edition: Public Works Standards, Inc.

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Dutcher, L.C., and Garrett, A.A., 1963, Geologic and hydrologic features of the San Bernardino area, California, with reference to underflow across the San Jacinto fault: U.S. Geological Survey Water Supply Paper 1419.

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Matti, J. C., and Carson, S.E., 1991, Liquefaction susceptibility in the San Bernardino Valley and vicinity, southern California - A regional evaluation: U.S. Geological Survey Bulletin 1898.

Morton, D.M. and Matti, J.C., 2001, Geologic Map of the Cucamonga Peak 7.5-Minute Quadrangle, San Bernardino County, California, U.S. Geological Survey Open-File Report 01-311, scale 1"=2,000 feet.

Morton, D.M., and Yerkes, R.F., 1987, Introduction to surface faulting in the Transverse Ranges, California, in Morton, D.M., and Yerkes, R.F., eds.: Recent reverse faulting in the Transverse Ranges, California: U.S. Geological Survey Professional Paper 1339, p. 1-5.

Yerkes, R. F., 1985, Earthquake and surface faulting sources - Geologic and seismologic setting, in Ziony, J.I., ed., Evaluating earthquake hazards in the Los Angeles region: U.S. Geological Survey Professional Paper 1360, Pages 25-41.

LIST OF AERIAL IMAGERY

Google Earth web-based software application, aerial images dated October 1, 1995; June 5, 2002; December 30, 2003; March 9, 2005; January 30, 2006; April 12, 2007; June 5, 2009; November 14, 2009; March 11, 2011; June 7, 2012; and March 21, 2013.

San Bernardino County Flood Control District, November 10, 1955, black and white aerial photograph no. 6-34.

San Bernardino County Flood Control District, January 28, 1966, black and white aerial photograph nos. 35 and 36.

San Bernardino County Flood Control District, January 7, 1976, black and white aerial photograph nos. 48 and 49.

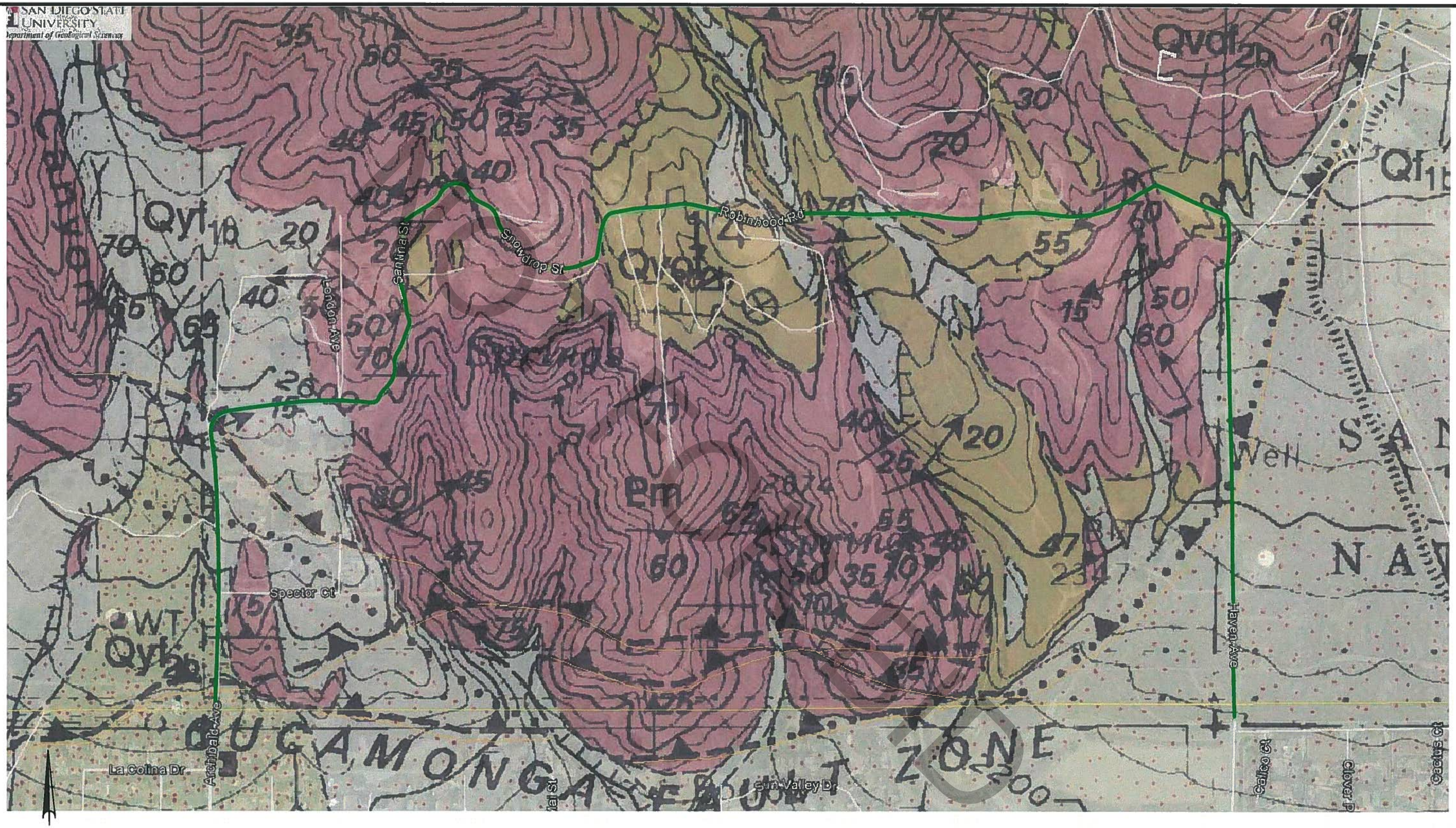
San Bernardino County Flood Control District, February 25, 1986, black and white aerial photograph nos. 178 and 179.

San Bernardino County Flood Control District, April 20, 1996, black and white aerial photograph nos. 212 and 213.

San Bernardino County Flood Control District, January 19, 2005, black and white aerial photograph nos. 17-11 and -12.

APPENDIX "A"

GEOTECHNICAL MAPS



-N-

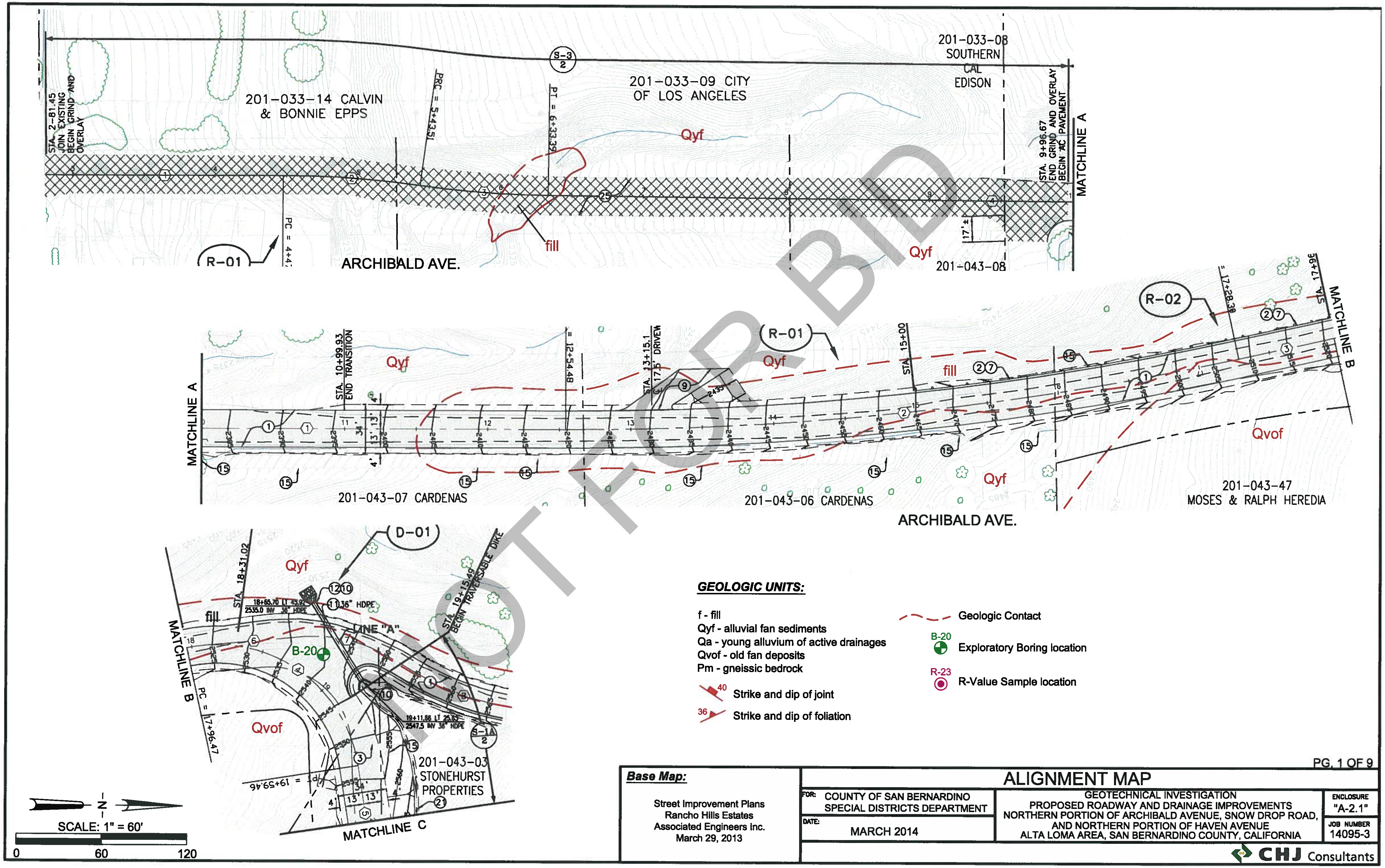
SCALE: 1" = 500'

0 500 1000

GEOLOGIC INDEX MAP

FOR: COUNTY OF SAN BERNARDINO SPECIAL DISTRICTS DEPARTMENT	GEOTECHNICAL INVESTIGATION PROPOSED ROADWAY AND DRAINAGE IMPROVEMENTS NORTHERN PORTION OF ARCHIBALD AVENUE, SNOW DROP ROAD, AND NORTHERN PORTION OF HAVEN AVENUE ALTA LOMA AREA, SAN BERNARDINO COUNTY, CALIFORNIA	ENCLOSURE "A-1"
DATE: MARCH 2014		JOB NUMBER 14095-3

CHJ Consultants



GEOLOGIC UNITS:

f - fill
Qyf - alluvial fan sediments
Qa - young alluvium of active drainages
Qvof - old fan deposits
Pm - gneissic bedrock

40	Strike and dip of joint
36	Strike and dip of foliation
— — —	Geologic Contact
B-20	Exploratory Boring location
R-23	R-Value Sample location

PG. 1 OF 9

Base Map:

Street Improvement Plans
Rancho Hills Estates
Associated Engineers Inc.
March 29, 2013

ALIGNMENT MAP

FOR: COUNTY OF SAN BERNARDINO
SPECIAL DISTRICTS DEPARTMENT

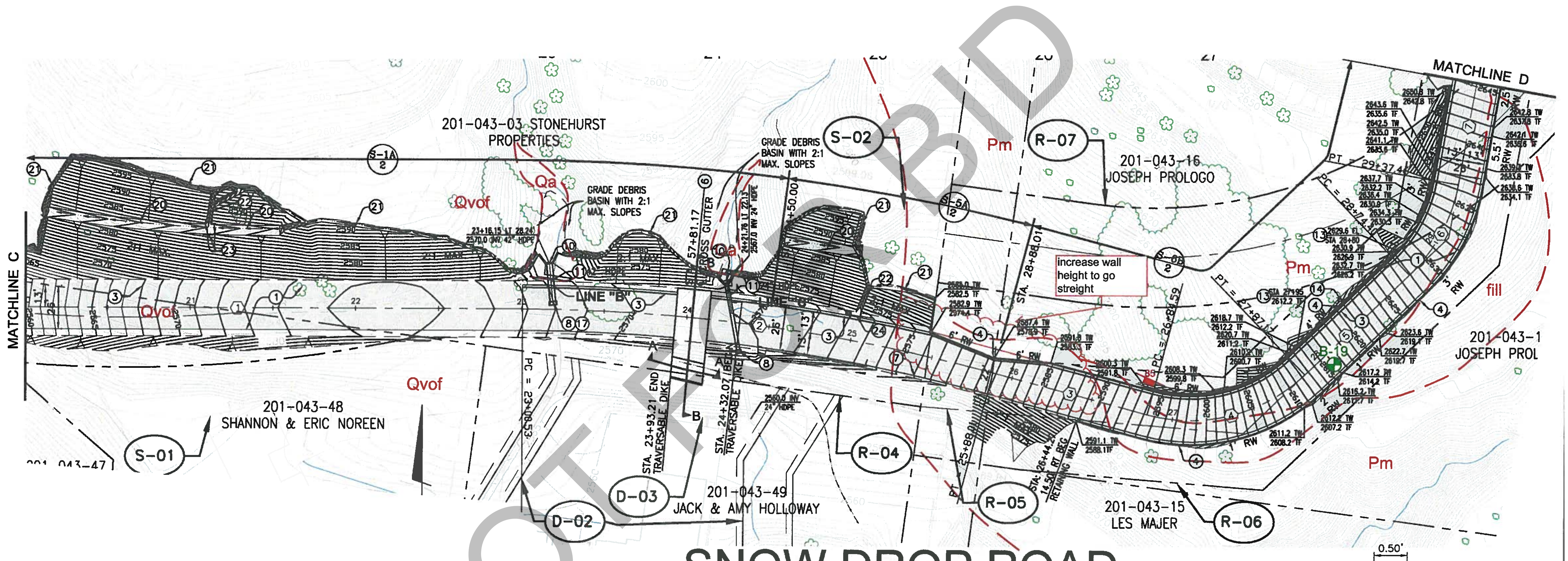
DATE: MARCH 2014

GEOTECHNICAL INVESTIGATION
PROPOSED ROADWAY AND DRAINAGE IMPROVEMENTS
NORTHERN PORTION OF ARCHIBALD AVENUE, SNOW DROP ROAD,
AND NORTHERN PORTION OF HAVEN AVENUE
ALTA LOMA AREA, SAN BERNARDINO COUNTY, CALIFORNIA

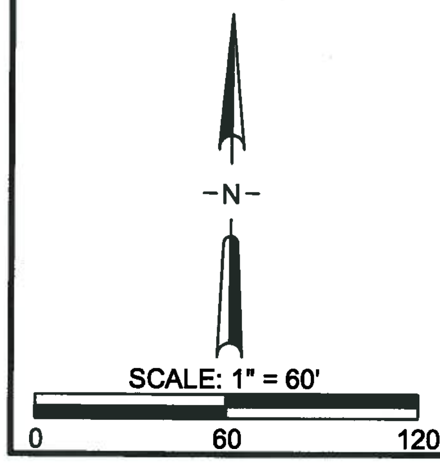
ENCLOSURE "A-2.1"

JOB NUMBER 14095-3

CHJ Consultants



SNOW DROP ROAD



GEOLOGIC UNITS:

f - fill
Qyf - alluvial fan sediments
Qa - young alluvium of active drainages
Qvof - old fan deposits
Pm - gneissic bedrock

40 Strike and dip of joint
36 Strike and dip of foliation

Geologic Contact
B-20 Exploratory Boring location
R-23 R-Value Sample location

Base Map:

Street Improvement Plans
Rancho Hills Estates
Associated Engineers Inc.
March 29, 2013

PG. 2 OF 9

ALIGNMENT MAP

FOR: COUNTY OF SAN BERNARDINO
SPECIAL DISTRICTS DEPARTMENT

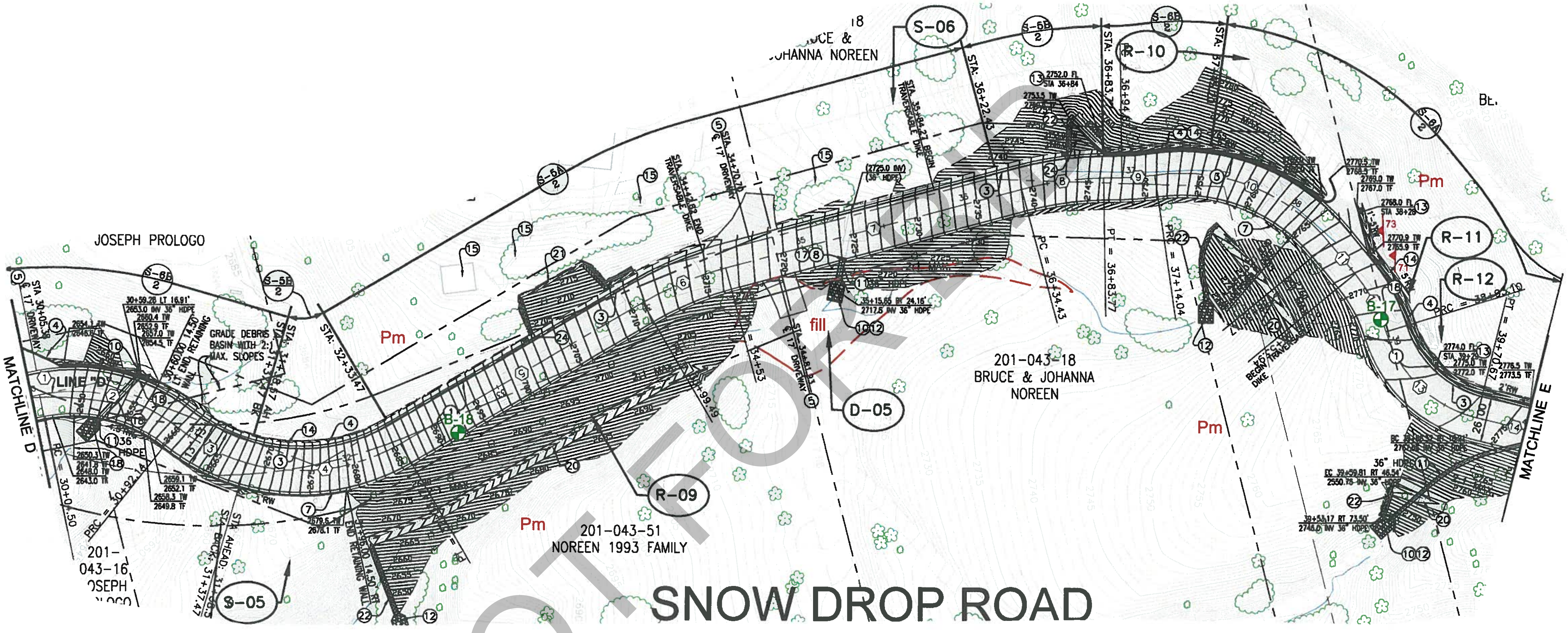
DATE: MARCH 2014

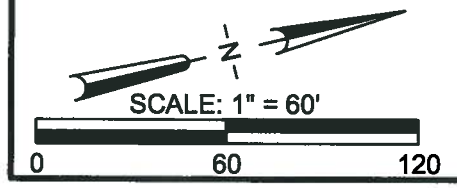
GEOTECHNICAL INVESTIGATION
PROPOSED ROADWAY AND DRAINAGE IMPROVEMENTS
NORTHERN PORTION OF ARCHIBALD AVENUE, SNOW DROP ROAD,
AND NORTHERN PORTION OF HAVEN AVENUE
ALTA LOMA AREA, SAN BERNARDINO COUNTY, CALIFORNIA

ENCLOSURE
"A-2.2"

JOB NUMBER
14095-3

CHJ Consultants





GEOLOGIC UNITS:

f - fill
Qyf - alluvial fan sediments
Qa - young alluvium of active drainages
Qvof - old fan deposits
Pm - gneissic bedrock

40 Strike and dip of joint
36 Strike and dip of foliation

Geologic Contact
B-20 Exploratory Boring location
R-23 R-Value Sample location

Base Map:

Street Improvement Plans
Rancho Hills Estates
Associated Engineers Inc.
March 29, 2013

PG. 3 OF 9

ALIGNMENT MAP

FOR: COUNTY OF SAN BERNARDINO
SPECIAL DISTRICTS DEPARTMENT

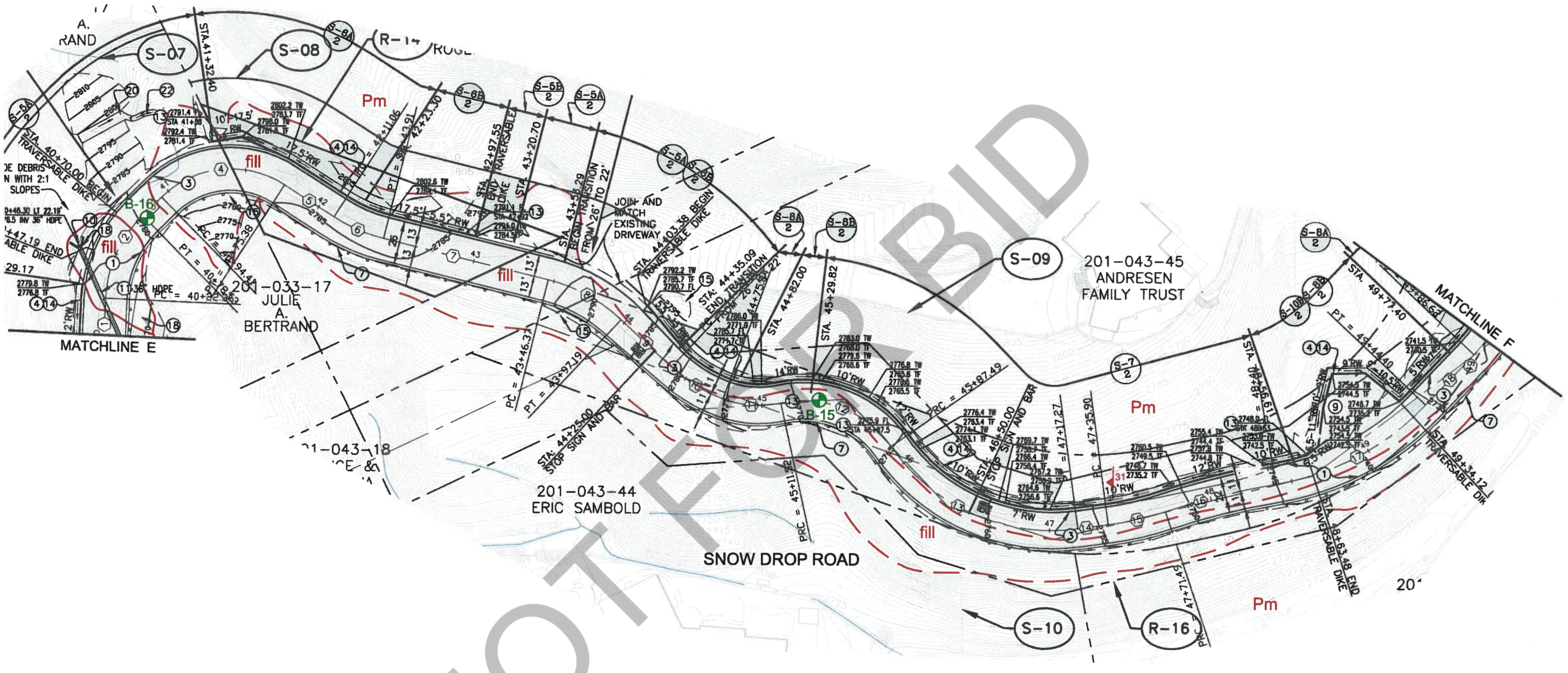
DATE: MARCH 2014

GEOTECHNICAL INVESTIGATION
PROPOSED ROADWAY AND DRAINAGE IMPROVEMENTS
NORTHERN PORTION OF ARCHIBALD AVENUE, SNOW DROP ROAD,
AND NORTHERN PORTION OF HAVEN AVENUE
ALTA LOMA AREA, SAN BERNARDINO COUNTY, CALIFORNIA

ENCLOSURE "A-2.3"

JOB NUMBER 14095-3

CHJ Consultants



SCALE: 1" = 60'

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GEOLOGIC UNITS:

f - fill
Qyf - alluvial fan sediments
Qa - young alluvium of active drainages
Qvof - old fan deposits
Pm - gneissic bedrock

40 Strike and dip of joint
36 Strike and dip of foliation

- - - Geologic Contact
B-20 Exploratory Boring location
R-23 Radius Value Sample location

Base Map:

Street Improvement Plans
Rancho Hills Estates
Associated Engineers Inc.
March 29, 2013

ALIGNMENT MAP

FOR: COUNTY OF SAN BERNARDINO
SPECIAL DISTRICTS DEPARTMENT

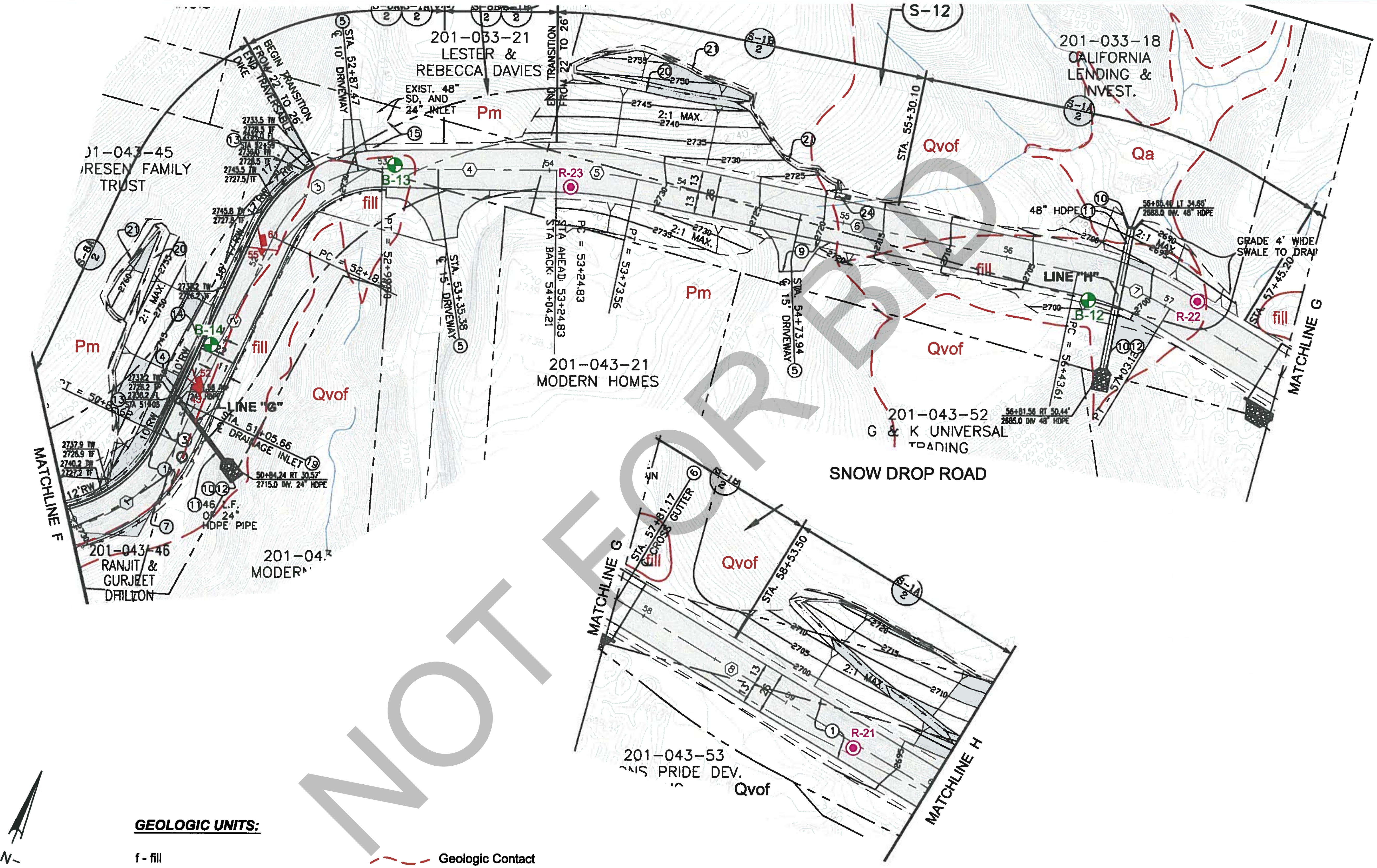
DATE: MARCH 2014

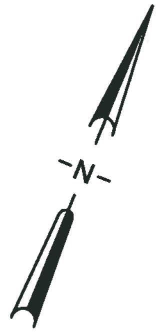
GEOTECHNICAL INVESTIGATION
PROPOSED ROADWAY AND DRAINAGE IMPROVEMENTS
NORTHERN PORTION OF ARCHIBALD AVENUE, SNOW DROP ROAD,
AND NORTHERN PORTION OF HAVEN AVENUE
ALTA LOMA AREA, SAN BERNARDINO COUNTY, CALIFORNIA

ENCLOSURE
"A-2.4"

JOB NUMBER
14095-3

CHJ Consultants





GEOLOGIC UNITS:

- f - fill
- Qyf - alluvial fan sediments
- Qa - young alluvium of active drainages
- Qvof - old fan deposits
- Pm - gneissic bedrock

40 Strike and dip of joint

36 Strike and dip of foliation

Geologic Contact

B-20 Exploratory Boring location

R-23 R-Value Sample location

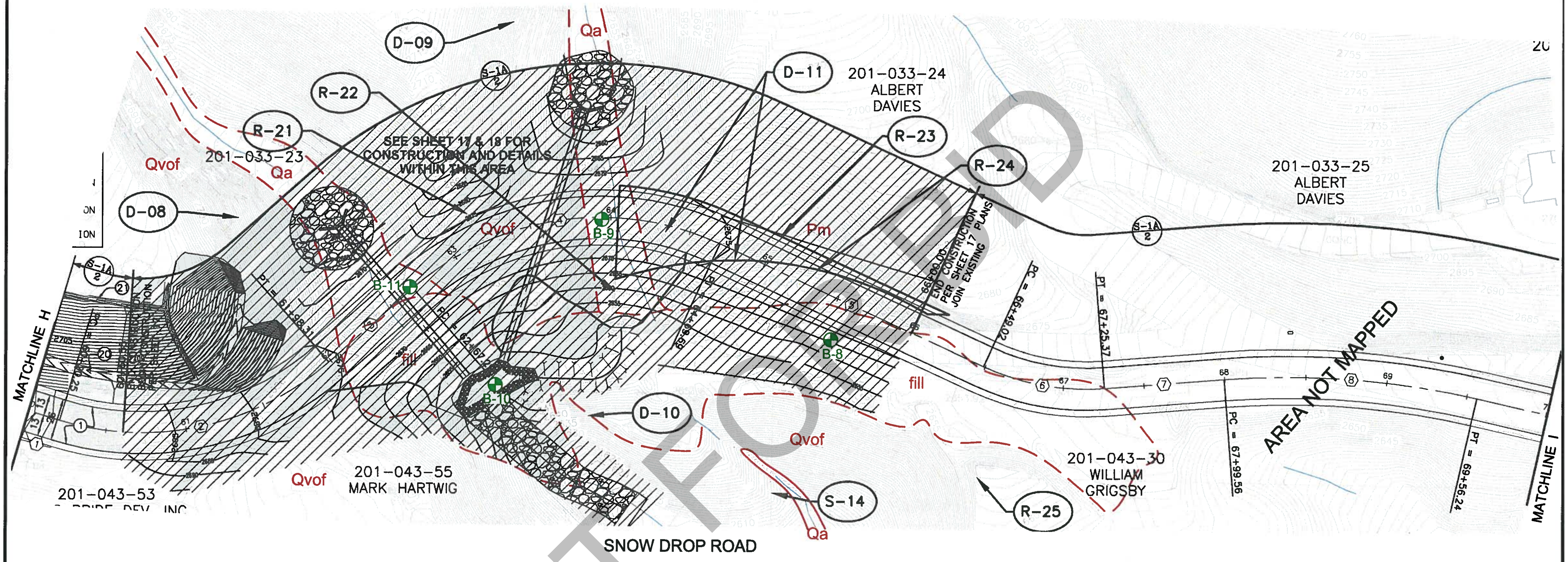
Base Map:

Street Improvement Plans
Rancho Hills Estates
Associated Engineers Inc.
March 29, 2013

ALIGNMENT MAP

FOR:	COUNTY OF SAN BERNARDINO SPECIAL DISTRICTS DEPARTMENT	GEOTECHNICAL INVESTIGATION PROPOSED ROADWAY AND DRAINAGE IMPROVEMENTS NORTHERN PORTION OF ARCHIBALD AVENUE, SNOW DROP ROAD, AND NORTHERN PORTION OF HAVEN AVENUE ALTA LOMA AREA, SAN BERNARDINO COUNTY, CALIFORNIA	ENCLOSURE "A-2.5"
DATE:	MARCH 2014		JOB NUMBER 14095-3

CHJ Consultants



-N-

SCALE: 1" = 60'

0 60 120

GEOLOGIC UNITS:

f - fill
Qyf - alluvial fan sediments
Qa - young alluvium of active drainages
Qvof - old fan deposits
Pm - gneissic bedrock

40 Strike and dip of joint

36 Strike and dip of foliation

Geologic Contact

B-20 Exploratory Boring location

R-23 R-Value Sample location

Base Map:

Street Improvement Plans
Rancho Hills Estates
Associated Engineers Inc.
March 29, 2013

PG. 6 OF 9

ALIGNMENT MAP

FOR: COUNTY OF SAN BERNARDINO
SPECIAL DISTRICTS DEPARTMENT

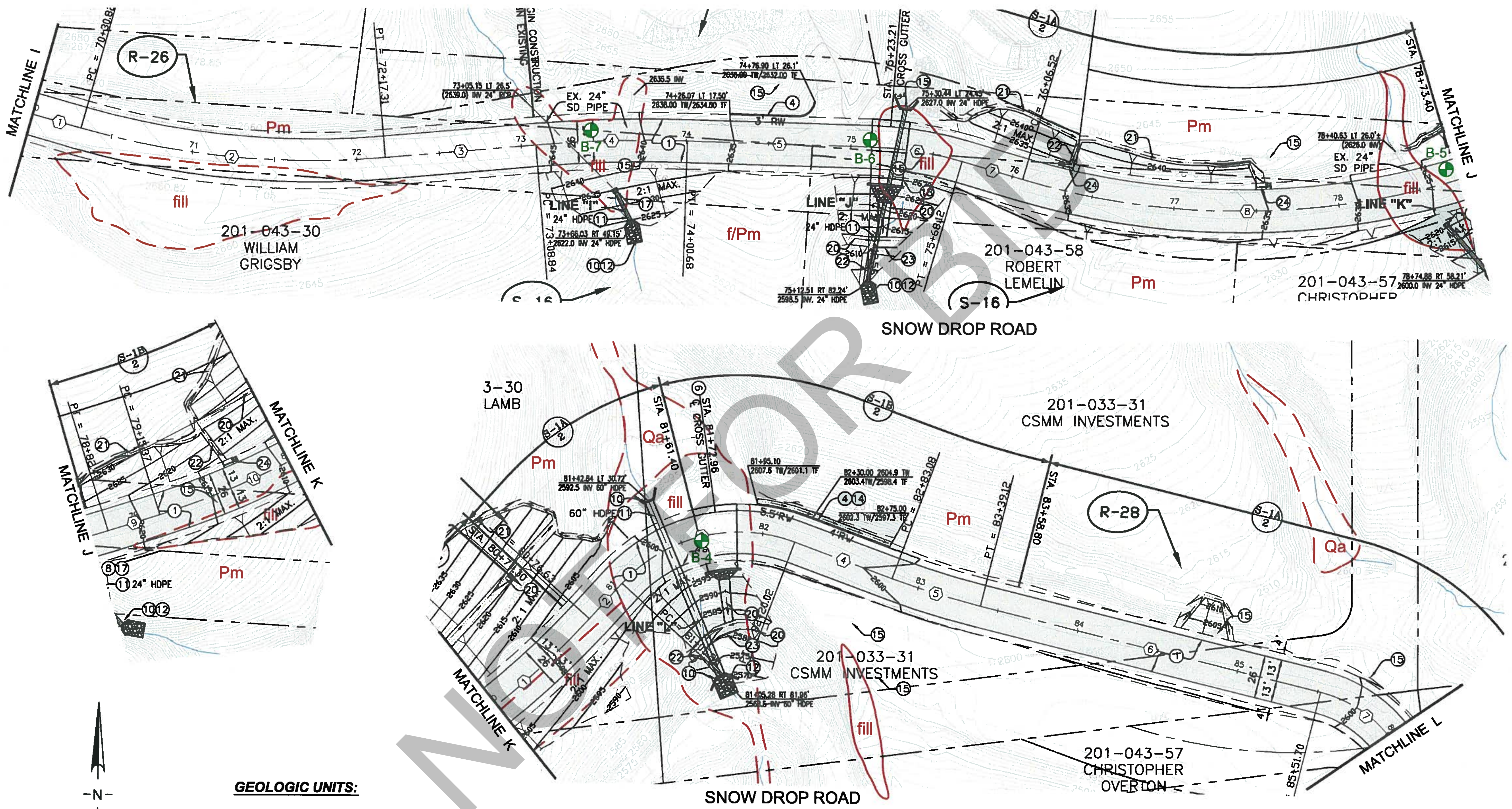
DATE: MARCH 2014

GEOTECHNICAL INVESTIGATION
PROPOSED ROADWAY AND DRAINAGE IMPROVEMENTS
NORTHERN PORTION OF ARCHIBALD AVENUE, SNOW DROP ROAD,
AND NORTHERN PORTION OF HAVEN AVENUE
ALTA LOMA AREA, SAN BERNARDINO COUNTY, CALIFORNIA

ENCLOSURE
"A-2.6"

JOB NUMBER
14095-3

CHJ Consultants



SCALE: 1" = 60'

0 60 120

GEOLOGIC UNITS:

f - fill
Qyf - alluvial fan sediments
Qa - young alluvium of active drainages
Qvof - old fan deposits
Pm - gneissic bedrock

40 Strike and dip of joint

36 Strike and dip of foliation

Geologic Contact

B-20 Exploratory Boring location

R-23 R-Value Sample location

Base Map:

Street Improvement Plans
Rancho Hills Estates
Associated Engineers Inc.
March 29, 2013

ALIGNMENT MAP

FOR: COUNTY OF SAN BERNARDINO
SPECIAL DISTRICTS DEPARTMENT

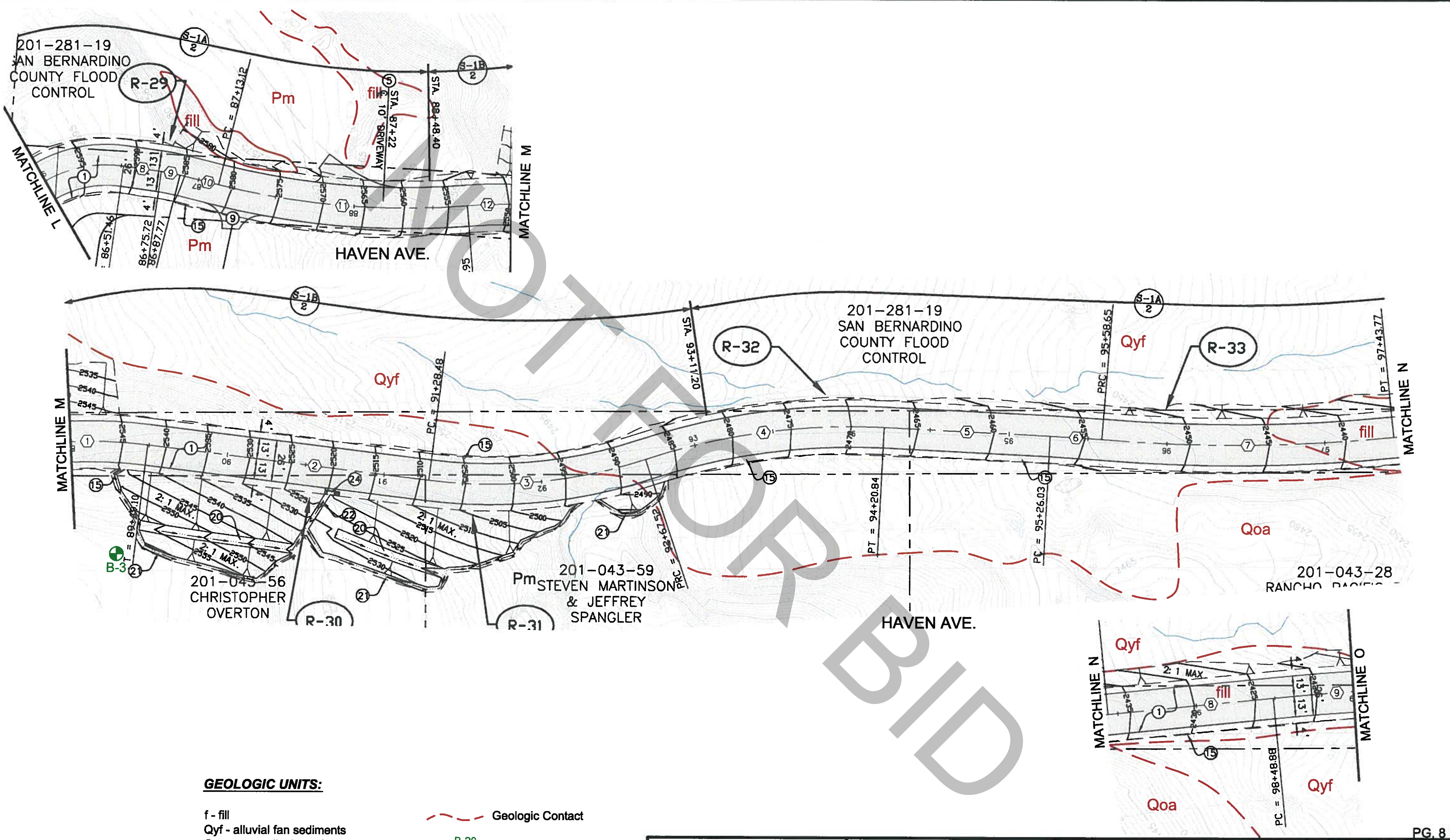
GEOTECHNICAL INVESTIGATION
PROPOSED ROADWAY AND DRAINAGE IMPROVEMENTS
NORTHERN PORTION OF ARCHIBALD AVENUE, SNOW DROP ROAD,
AND NORTHERN PORTION OF HAVEN AVENUE
ALTA LOMA AREA, SAN BERNARDINO COUNTY, CALIFORNIA

DATE: MARCH 2014

ENCLOSURE "A-2.7"

JOB NUMBER 14095-3

CHJ Consultants



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SCALE: 1" = 60'

0 60 120

GEOLOGIC UNITS:

f - fill
Qyf - alluvial fan sediments
Qa - young alluvium of active drainages
Qvof - old fan deposits
Pm - gneissic bedrock

40 Strike and dip of joint
36 Strike and dip of foliation

Geologic Contact

B-20 Exploratory Boring location

R-23 R-Value Sample location

Base Map:

Street Improvement Plans
Rancho Hills Estates
Associated Engineers Inc.
March 29, 2013

PG. 8 OF 9

ALIGNMENT MAP

FOR: COUNTY OF SAN BERNARDINO
SPECIAL DISTRICTS DEPARTMENT

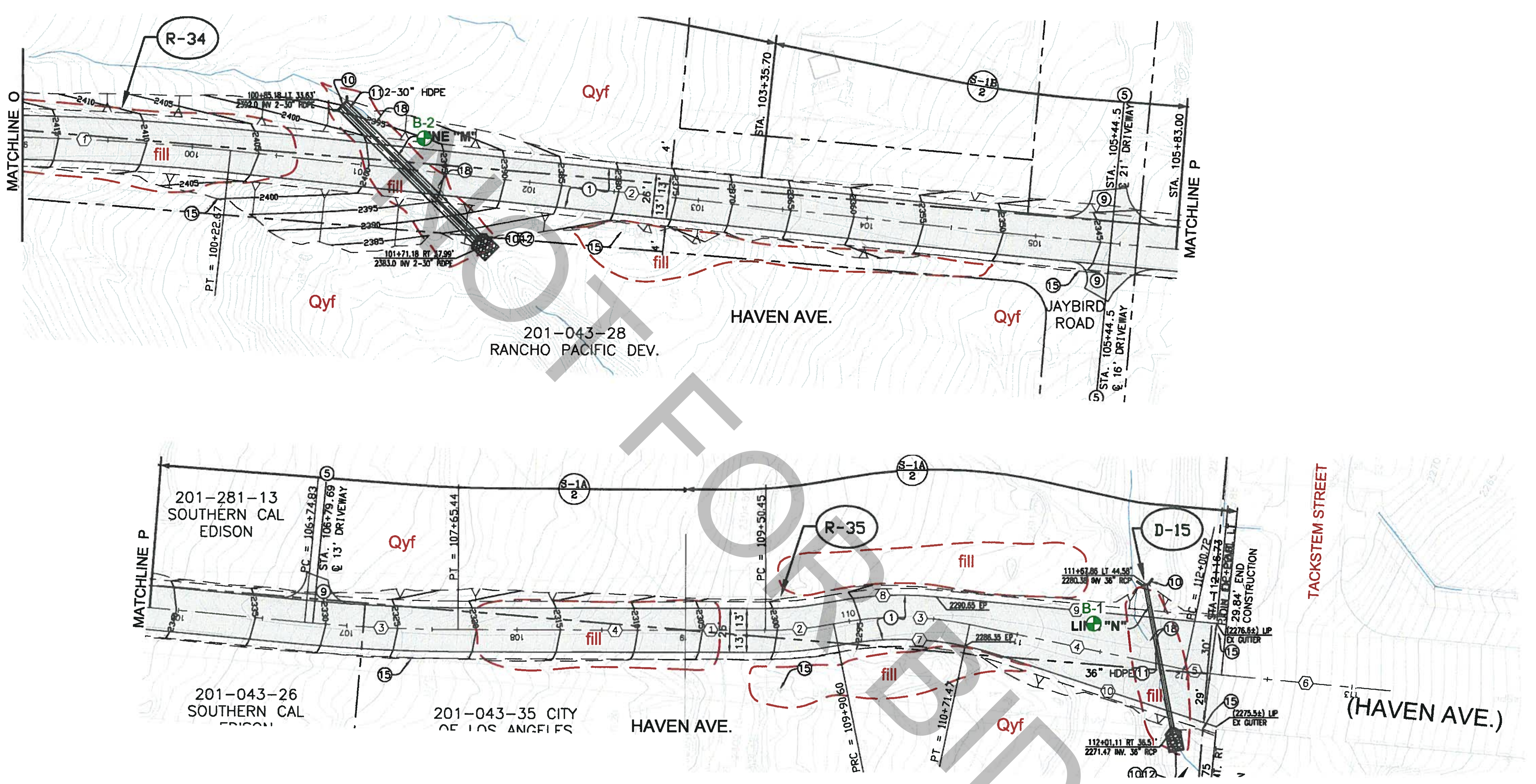
DATE: MARCH 2014

GEOTECHNICAL INVESTIGATION
PROPOSED ROADWAY AND DRAINAGE IMPROVEMENTS
NORTHERN PORTION OF ARCHIBALD AVENUE, SNOW DROP ROAD,
AND NORTHERN PORTION OF HAVEN AVENUE
ALTA LOMA AREA, SAN BERNARDINO COUNTY, CALIFORNIA

ENCLOSURE "A-2.8"

JOB NUMBER 14095-3

CHJ Consultants



SCALE: 1" = 60'

0 60 120

GEOLOGIC UNITS:

f - fill
Qyf - alluvial fan sediments
Qa - young alluvium of active drainages
Qvof - old fan deposits
Pm - gneissic bedrock

40 Strike and dip of joint

36 Strike and dip of foliation

Geologic Contact

B-20 Exploratory Boring location

R-23 R-Value Sample location

Base Map:

Street Improvement Plans
Rancho Hills Estates
Associated Engineers Inc.
March 29, 2013

PG. 9 OF 9

ALIGNMENT MAP

FOR: COUNTY OF SAN BERNARDINO
SPECIAL DISTRICTS DEPARTMENT

DATE: MARCH 2014

GEOTECHNICAL INVESTIGATION
PROPOSED ROADWAY AND DRAINAGE IMPROVEMENTS
NORTHERN PORTION OF ARCHIBALD AVENUE, SNOW DROP ROAD,
AND NORTHERN PORTION OF HAVEN AVENUE
ALTA LOMA AREA, SAN BERNARDINO COUNTY, CALIFORNIA

ENCLOSURE "A-2.9"

JOB NUMBER 14095-3

CHJ Consultants

APPENDIX "B"

EXPLORATION LOGS

KEY TO LOGS

LEGEND OF LAB/FIELD TESTS:

AL	Atterberg Limit (ASTM D4318)
Blows	A measure of the penetration resistance of soil expressed as the number of hammer blows required to advance the indicated sampler 6 inches (or less if noted). Samplers are driven with an automatic hammer that drops a 140-pound weight 30 inches for each blow. After the required seating, samplers are advanced up to 18 inches ahead of the boring, providing up to three sets of blows per drive.
Bulk	Indicates Disturbed or Bulk Sample
Cor.	Chemical/Corrosivity Tests (Caltrans 417, 422 and 643)
Dist.	Indicates Disturbed Sample
DS	Direct Shear Test (ASTM D3080)
MDC	Maximum Density - Optimum Moisture Determination (ASTM D1557)
N.R.	Indicates No Recovery of Sample
Ring	Indicates Relatively Undisturbed Ring Sample. Relatively undisturbed ring samples are obtained with a modified California sampler (3.0" O.D. and 2.42" I.D.) lined with rings driven with a 140-pound weight falling 30 inches.
RV	R-value (CT 301)
SA	Sieve Analysis (ASTM D422)
SE	Sand Equivalent Test (ASTM D2419)

Enclosure "B" (2 of 3)
Job No. 14095-3

UNIFIED SOIL CLASSIFICATION SYSTEM

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

COARSE-GRAINED SOILS (more than 50% of material is larger than No. 200 sieve size)		
	Clean Gravels (Less than 5% fines)	
GRAVELS More than 50% of coarse fraction larger than No.4 sieve size	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
	GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
	Gravels with fines (More than 12% fines)	
	GM	Silty gravels, gravel-sand-silt mixtures
	GC	Clayey gravels, gravel-sand-clay mixtures
	Clean Sands (Less than 5% fines)	
SANDS 50% or more of coarse fraction smaller than No.4 sieve size	SW	Well-graded sands, gravelly sands, little or no fines
	SP	Poorly graded sands, gravelly sands, little or no fines
	Sands with fines (More than 12% fines)	
	SM	Silty sands, sand-silt mixtures
	SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (50% or more of material is smaller than No. 200 sieve size)		
SILTS AND CLAYS Liquid limit less than 50%	ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts with slight plasticity
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid limit 50% or greater	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	CH	Inorganic clays of high plasticity, fat clays
	OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS	PT	Peat and other highly organic soils

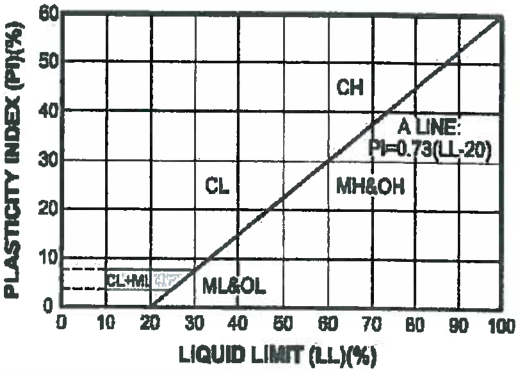
LABORATORY CLASSIFICATION CRITERIA

GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}^2}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
GC	Atterberg limits above "A" line with P.I. greater than 7	
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{D_{30}^2}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for SW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
SC	Atterberg limits above "A" line with P.I. greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), Coarse-grained soils are classified as follows:

Less than 5 percent	GW, GP, SW, SP
More than 12 percent	GM, GC, SM, SC
5 to 12 percent	Borderline cases requiring dual symbols

PLASTICITY CHART



SOIL CONSISTENCY

Compactness of Granular Soils

Description	**Approximate Relative Density (%)**
Very Loose	0-15
Loose	15-40
Medium Dense	40-70
Dense	70-85
Very Dense	85-100

Consistency of Plastic Soils

Description	**Approximate Shear Strength (psf)**
Very Soft	Less than 250
Soft	250-500
Medium Stiff	500-1,000
Stiff	1,000-2,000
Very Stiff	2,000-4,000
Hard	More than 4,000

EXPLORATORY TRENCH NO. 1

Date Excavated: 2/20/14
Client: County of San Bernardino Special Services Department
Equipment: Rubber Tire Backhoe
Bucket Size: 18" Bucket
Surface Elevation(ft):
Logged by: JMcK
Station No.: N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES DENSITY	SAMPLES BULK	RELATIVE COMP. (%)	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
		Asphalt Concrete, 4-1/8"	Fill						
		Aggregate Base, 4"							
		(SM) Silty Sand, fine to coarse, with gravel and boulders, dark gray brown							
1					▨		3.3		DS, MDC
2									
3									
4		(SP) Sand, fine to coarse, with cobbles and boulders to 24" in size, few silt	Native - Qyf						
5									
		END OF TRENCH NO REFUSAL, NO GROUNDWATER SLIGHT CAVING, NO BEDROCK FILL TO 3.5' - 4.5'							
6									
7									
8									
9									

CHJ

SNOW DROP
RANCHO CUCAMONGA, CALIFORNIA

Job No. 14095-3

Enclosure B-1

EXPLORATORY TRENCH NO. 2

Date Excavated: 2/20/14
Client: County of San Bernardino Special Services Department
Equipment: Rubber Tire Backhoe
Bucket Size: 18" Bucket
Surface Elevation(ft):
Logged by: JMcK
Station No.: N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES		RELATIVE COMP. (%)	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
				DENSITY	BULK				
		Asphalt Concrete, 5-1/2"	Fill						
1		(GP-GM) Gravel with sand, silt, and boulders to 30" in size			▨		3.4		
		(SM) Silty Sand, fine to medium, black							
2		(SP) Sand, fine to coarse, with gravel and boulders to 30 in size", few silt	Native - Qyf						
3									
4									
5									
6		END OF TRENCH NO REFUSAL, NO GROUNDWATER SLIGHT CAVING, NO BEDROCK FILL TO 2.0' - 2.25'							
7									
8									
9									

TRENCH_LOG_10_FT 14095-3.GPJ CHJ.GDT 3/18/14

EXPLORATORY BORING NO. 3

Date Drilled: 2/18/14
Client: County of San Bernardino Special Services Department
Equipment: CME 75 Truck Rig
Driving Weight / Drop: 140 lbs./ 30 in.
Surface Elevation(ft):
Logged by: JMcK
Measured Depth to Water(ft): N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6 IN.	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
0	▨	(CL) Silty Clay, with sand, fine, red orange with weathered angular bedrock fragments	Native		▩		11.0		
	▨		Weathered Pm	☒		21 25 45	10.3	113	Ring
5	▨			☒		40 50/5"	10.3	110	Ring
7	▩	Gneiss bedrock returned as (ML) Sandy Silt, fine, with clay, light brown. Bedrock has angular clasts 1" to 4", and is highly weathered, cemented and dense	Pm		▩		11.3		
10	▩			☒		18 50	2.7	115	Ring
15	▩			☒	▩	42 50/1"	7.1 5.5	98	Ring
20	▩			☒		29 50/5"	4.2 1.5	108 Dist.	Ring
25	▩			☒		50	N.R.	N.R.	Ring
		END OF BORING NO REFUSAL, NO CAVING NO GROUNDWATER, NO FILL GNEISS BEDROCK AT 7'							
30									

EXPLORATORY BORING NO. 4

Date Drilled: 2/21/14

Client: County of San Bernardino Special Services Department

Equipment: CME 75 Truck Rig

Driving Weight / Drop: 140 lbs./ 30 in.

Surface Elevation(ft):

Logged by: JMcK

Measured Depth to Water(ft): N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES		BLOWS/6 IN.	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
				DRIVE	BULK				
	■	Asphalt Concrete, 5-1/8"	Fill		▩		3.4		
	░	(SM) Silty Sand, fine, with gravel to 2.5", gray brown		☒		5 8 9	4.5	Dist.	Ring
			Auger Chatter 3' to 5'						
5	▨	(SM) Clayey Sand, fine, with silt and gravel to 1", gray brown		☒	▩	7 14 12	2.3 5.8	119	SA, MDC, Ring
			Refusal - moved boring 2' south						
10	░	(SM) Silty Sand, fine to medium with coarse, with gravel to 1.5", light brown		☒		12 14 11	5.8 6.6	114	Ring
		END OF BORING NO CAVING, NO BEDROCK NO GROUNDWATER, FILL TO 13' REFUSAL ON BOULDER AT 13'	Auger Chatter						
15									
20									
25									
30									

EXPLORATORY BORING NO. 5

Date Drilled: 2/21/14

Client: County of San Bernardino Special Services Department

Equipment: CME 75 Truck Rig

Driving Weight / Drop: 140 lbs./ 30 in.

Surface Elevation(ft):

Logged by: JMcK

Measured Depth to Water(ft): N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6 IN.	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
		(SM) Silty Sand, fine to coarse, brown	Native - Qa		▨		6.2		SA
				☒		15 19 17	6.8	121	DS, Ring
5				☒		14 25 23	5.4	119	Ring
		Gneiss Bedrock returned as (SM) Silty Sand, fine to medium, few gravel to 3/4"	Pm						
10				☒		26 50/5"	5.2	112	Ring
					▨		5.8		
		END OF BORING NO REFUSAL, NO CAVING NO GROUNDWATER, NO FILL GNEISS BEDROCK AT 8'							
15									
20									
25									
30									

EXPLORATORY BORING NO. 6

Date Drilled: 2/21/14

Client: County of San Bernardino Special Services Department

Equipment: CME 75 Truck Rig

Driving Weight / Drop: 140 lbs./ 30 in.

Surface Elevation(ft):

Logged by: JMcK

Measured Depth to Water(ft): N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6 IN.	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
		Asphalt Concrete, 2-1/8"	Base on						
		Aggregate Base, 4"	Native soil - Qa		▨		8.2		
		(SC) Clayey Sand, fine to medium, with silt, brown		☒		14 17 21	8.9	121	AL, Cor., SA DS, Ring
5		(SM) Silty Sand, fine to medium with coarse, with clay and gravel to 1/2", mottled brown to light brown		☒		9 12 13	7.5	116	Ring
					▨		6.9		
			Heavy grinding						
10				☒		9 11 13	5.5	105	Ring
15				☒		25 50/4.5"	10.8	114	Ring
		Gneiss bedrock returned as (SC) Clayey Sand, fine to medium, stiff, brown	Pm		▨		13.7		
20				☒		14 25 35	13.2	121	Ring
		END OF BORING NO REFUSAL, NO CAVING NO GROUNDWATER, NO FILL GNEISS BEDROCK AT 17'							
25									
30									

CHJ

SNOW DROP
RANCHO CUCAMONGA, CALIFORNIA

Job No. 14095-3

Enclosure B-6

EXPLORATORY BORING NO. 7

Date Drilled: 2/18/14
Client: County of San Bernardino Special Services Department
Equipment: CME 75 Truck Rig
Driving Weight / Drop: 140 lbs./ 30 in.
Surface Elevation(ft):
Logged by: JMcK
Measured Depth to Water(ft): N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6 IN.	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
		Asphalt Concrete, 1-1/4"	Fill		▨		6.4		
		(ML) Sandy Silt, fine, with gravel to 1/4", light brown		☒		13 14 10	5.7	110	Ring
5				☒		11 14 10	8.4	120	Ring
		(SM) Silty Sand, fine, with gravel to 1/2", brown	Qa		▨		6.1		
10				☒		21 50	3.5	123	Ring
		Gneiss bedrock, foliated	Pm						
15				☒		25 50/5"	3.7	Dist.	Ring
		END OF BORING NO REFUSAL, NO CAVING NO GROUNDWATER, FILL TO 8' GNEISS BEDROCK AT 14'							
20									
25									
30									

EXPLORATORY BORING NO. 8

Date Drilled: 2/18/14

Client: County of San Bernardino Special Services Department

Equipment: CME 75 Truck Rig

Driving Weight / Drop: 140 lbs./ 30 in.

Surface Elevation(ft):

Logged by: JMcK

Measured Depth to Water(ft): N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6 IN.	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
		(SM) Silty Sand, fine with medium, light brown	Fill		▨		4.1		
				☒		17 30 43	2.9	125	DS, Ring
5		(SM) Silty Sand, fine with medium, trace gravel to 1/2", brown	Native - Qvof	☒		34 50	5.0	134	Ring
					▨		4.7		
10				☒		30 32 34	4.7	123	Ring
15		(SM) Silty Sand, fine to medium, with angular gravel to 1", brown		☒		13 22	3.7	124	Ring
					▨	30	6.5		
		END OF BORING NO REFUSAL, NO CAVING NO GROUNDWATER, NO BEDROCK FILL TO 5'							
20									
25									
30									

EXPLORATORY TRENCH NO. 9

Date Excavated: 2/20/14
Client: County of San Bernardino Special Services Department
Equipment: Rubber Tire Backhoe
Bucket Size: 18" Bucket
Surface Elevation(ft):
Logged by: JMcK
Station No.: N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES DENSITY	SAMPLES BULK	RELATIVE COMP. (%)	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
		(SM) Silty Sand, fine to medium, with gravel to 3", light brown	Native - Qa		▨		2.9		MDC
1									
2									
3		Debris flow sediments returned as (SM) Silty Sand, fine to medium with coarse, with cobbles and boulders to 42" in size, light brown	Qvof						
4									
5									
6									
7		END OF TRENCH NO REFUSAL, NO GROUNDWATER MODERATE CAVING, NO BEDROCK NO FILL							
8									
9									

CHJ

SNOW DROP
RANCHO CUCAMONGA, CALIFORNIA

Job No. 14095-3

Enclosure B-9

EXPLORATORY BORING NO. 10

Date Drilled: 2/18/14

Client: County of San Bernardino Special Services Department

Equipment: CME 75 Truck Rig

Driving Weight / Drop: 140 lbs./ 30 in.

Surface Elevation(ft):

Logged by: JMcK

Measured Depth to Water(ft): N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6 IN.	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
		(SM) Silty Sand, fine with medium, trace gravel to 2", light brown	Fill		▨		2.9		
				☒		50	2.6	121	Ring
5				☒		19 40 49	3.0	125	Ring
			Auger Chatter 6' to 7'						
		(SM) Silty Sand, fine with medium, trace gravel to 1/2", red brown	Native - Qa		▨		5.2		
10		(SM) Silty Sand, fine to medium, with gravel, light brown	Rock in shoe	☒		11 14 17	2.8	Dist.	Ring
					▨		4.0		
15				☒		30 50/4"	2.2	118	Ring
		END OF BORING NO REFUSAL, NO CAVING NO GROUNDWATER, NO BEDROCK FILL TO 9'							
20									
25									
30									

EXPLORATORY TRENCH NO. 11

Date Excavated: 2/20/14
Client: County of San Bernardino Special Services Department

Equipment: Rubber Tire Backhoe
Bucket Size: 18" Bucket

Surface Elevation(ft):
Logged by: JMcK
Station No.: N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES DENSITY	SAMPLES BULK	RELATIVE COMP. (%)	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
		(SM) Silty Sand, fine to coarse, with gravel, bedded, light brown	Native - Qa		▨		2.7		
1									
2									
3									
4		Debris flow sediments, (SM) Silty Sand, fine to coarse, with gravel, cobbles to 8" in size, and few boulders to 20" in size, light brown							
5									
6									
7									
		END OF TRENCH NO REFUSAL, NO GROUNDWATER NO CAVING??, NO BEDROCK NO FILL							
8									
9									

CHJ

SNOW DROP
RANCHO CUCAMONGA, CALIFORNIA

Job No. 14095-3
Enclosure B-11

EXPLORATORY BORING NO. 12

Date Drilled: 2/18/14
Client: County of San Bernardino Special Services Department
Equipment: CME 75 Truck Rig
Driving Weight / Drop: 140 lbs./ 30 in.
Surface Elevation(ft):
Logged by: JMcK
Measured Depth to Water(ft): N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6 IN.	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
0	░	(SM) Silty Sand, fine, with clay, light brown	Fill		▩		7.4		
			Drive on clast	☒		50/4"	4.5	96	Ring
4	░	(SM) Silty Sand, fine to medium, with clay, red brown			▩		7.7		
5				☒		24 35 42	N.R.	N.R.	Ring
10	░	(SM) Silty Sand, fine to coarse, with clay and angular gravel to 1/2", red brown		☒		3 4 5	13.0	116	Ring
					▩		9.7		
15	▨	(SC) Clayey Sand, fine to coarse, brown		☒		4 5 7	16.8	112	Ring
					▩		16.3		
20	▨	(SC) Clayey Sand, fine to coarse, with silt, red brown, plastic	Native - Qvof	☒		3 6 8	17.6	113	Ring
					▩		15.7		AL, SA
25				☒		6 7 7	15.5	106	DS, Ring
30	░	(SM) Silty Sand, fine to coarse, with clay, brown		☒		3 20 16	10.7	117	Ring
					▩		15.3		
		END OF BORING NO REFUSAL, NO CAVING NO GROUNDWATER, NO BEDROCK FILL TO 20'							

EXPLORATORY BORING NO. 13

Date Drilled: 2/18/14

Client: County of San Bernardino Special Services Department

Equipment: CME 75 Truck Rig

Driving Weight / Drop: 140 lbs./ 30 in.

Surface Elevation(ft):

Logged by: JMcK

Measured Depth to Water(ft): N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6 IN.	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
		(SM) Silty Sand, fine to medium with clay and weathered gravel to 1/2", light brown	Fill		▨		10.6		
				☒		12 17 20	8.7	120	Ring
5				☒		5 6 7	7.9	111	Ring
10		(SM) Silty Sand fine to coarse, brown	Native - Qa	☒	▨	16 11 10	10.6 8.3	108	Ring
15				☒		15 19 22	6.8	131	Ring
20				☒		5 6 5	6.5	112	Ring
25				☒		4 6 19	4.1	121	Ring
30		(SM) Silty Sand, fine to coarse, with gravel and cobbles, light brown		☒		46 50/3"	10.3	113	Ring
		END OF BORING NO REFUSAL, NO CAVING NO GROUNDWATER, NO BEDROCK FILL TO 10'							

EXPLORATORY BORING NO. 14

Date Drilled: 2/18/14
Client: County of San Bernardino Special Services Department
Equipment: CME 75 Truck Rig
Driving Weight / Drop: 140 lbs./ 30 in.
Surface Elevation(ft):
Logged by: JMcK
Measured Depth to Water(ft): N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES		BLOWS/6 IN.	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
				DRIVE	BULK				
	▨	Asphalt Concrete, 2-1/2"	Asphalt on Native Pm		▩		6.9		AL, Cor., SA
	▨	Gneiss bedrock, foliated and weathered, returns as (SM) Silty Sand, fine with medium, with clay, light brown		☒		18 28 50/4"	5.2	129	Ring
5	▨		Auger Chatter	☒		17 46 50/4"	3.1	131	Ring
10	▨			☒		30 50/3"	5.5	116	Ring
		END OF BORING NO REFUSAL, NO CAVING NO GROUNDWATER, NO FILL GNEISS BEDROCK AT 0.21'							
15									
20									
25									
30									

EXPLORATORY BORING NO. 15

Date Drilled: 2/21/14
Client: County of San Bernardino Special Services Department
Equipment: CME 75 Truck Rig
Driving Weight / Drop: 140 lbs./ 30 in.
Surface Elevation(ft):
Logged by: JMcK
Measured Depth to Water(ft): N/A

DEPTH (ft)	VISUAL CLASSIFICATION	REMARKS	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6 IN.	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
0	Asphalt Concrete, 1-3/4"	Fill						
	(SM) Silty Sand, fine with medium, few gravel to 1/2", light brown			▨		4.4		
			☒		6 7 9	3.6	109	Ring
5			☒		6 6 5	4.2	99	Ring
10	Gneiss bedrock returned as (SM) Silty Sand, fine, light brown	Native - Pm	☒		50/5"	2.8	113	Ring
				▨		2.7		
15			☒		50/5"	2.2	119	Ring
	END OF BORING NO REFUSAL, NO CAVING NO GROUNDWATER, NO FILL GNEISS BEDROCK AT 10'							
20								
25								
30								

EXPLORATORY BORING NO. 16

Date Drilled: 2/21/14

Client: County of San Bernardino Special Services Department

Equipment: CME 75 Truck Rig

Driving Weight / Drop: 140 lbs./ 30 in.

Surface Elevation(ft):

Logged by: JMcK

Measured Depth to Water(ft): N/A

DEPTH (ft)	VISUAL CLASSIFICATION	REMARKS	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6 IN.	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
0	Asphalt Concrete, 1-7/8"	Fill						
	Fill material, 3.5"	Native - Pm		▨		6.0		
	(SC) Clayey Sand, fine to coarse, with silt, yellow brown		☒		14 12 13	6.4	111	AL, SA DS, Ring
5			☒		12 15 12	6.7	91	Ring
10		Auger Chatter	☒	▨	9 22 33	1.8 2.5	124	Ring
	Gneiss bedrock returned as (SM) Silty Sand, fine to medium, with angular gravel to 3/4", light brown, moderately weathered							
15			☒		50/3.5"	N.R.	N.R.	Ring
	END OF BORING							
	NO REFUSAL, NO CAVING NO GROUNDWATER, FILL TO 0.45' GNEISS BEDROCK AT 7'							
20								
25								
30								

EXPLORATORY BORING NO. 17

Date Drilled: 2/21/14
Client: County of San Bernardino Special Services Department
Equipment: CME 75 Truck Rig
Driving Weight / Drop: 140 lbs./ 30 in.
Surface Elevation(ft):
Logged by: JMcK
Measured Depth to Water(ft): N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6 IN.	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
	▨	Asphalt Concrete, 2-1/4"	Base on Native Pm						
	▨	Aggregate Base, 3-7/8"			▨		5.0		
	▨	Gneiss bedrock returned as (SM) Silty Sand, fine with medium, light brown		☒		22 50	4.6	118	Ring
5	▨			☒		50/5"	5.1	107	Ring
		END OF BORING NO REFUSAL, NO CAVING NO GROUNDWATER, NO FILL GNEISS BEDROCK AT 6"							
10									
15									
20									
25									
30									

10331-3 14095-3.GPJ CHJ.GDT 3/18/14

EXPLORATORY BORING NO. 18

Date Drilled: 2/21/14
Client: County of San Bernardino Special Services Department
Equipment: CME 75 Truck Rig
Driving Weight / Drop: 140 lbs./ 30 in.
Surface Elevation(ft):
Logged by: JMcK
Measured Depth to Water(ft): N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6 IN.	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
		Asphalt Concrete, 2-1/8"	Base on Native Pm						
		Aggrgate Base, 4"			▨		5.4		
	▨	Gneiss bedrock returned as (SM) Silty Sand, fine with medium, with angular gravel to 1", light brown		☒		20 39 50/3"	6.2	119	Ring
5	▨								
		END OF BORING NO REFUSAL, NO CAVING NO GROUNDWATER, NO FILL GNEISS BEDROCK AT 6"							
10									
15									
20									
25									
30									

EXPLORATORY BORING NO. 19

Date Drilled: 2/21/14
Client: County of San Bernardino Special Services Department
Equipment: CME 75 Truck Rig
Driving Weight / Drop: 140 lbs./ 30 in.
Surface Elevation(ft):
Logged by: JMcK
Measured Depth to Water(ft): N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6 IN.	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
	▨	Gneiss bedrock returned as (SM) Silty Sand, fine, with angular gravel to 1/2", light brown	Native - Pm		▩		4.5		
	▨			☒		48 50/4.5"	4.7	110	Ring
5	▨			☒		50/5"	N.R.	N.R.	Ring
		END OF BORING							
10		NO REFUSAL, NO CAVING NO GROUNDWATER, NO FILL GNEISS BEDROCK AT SURFACE							
15									
20									
25									
30									

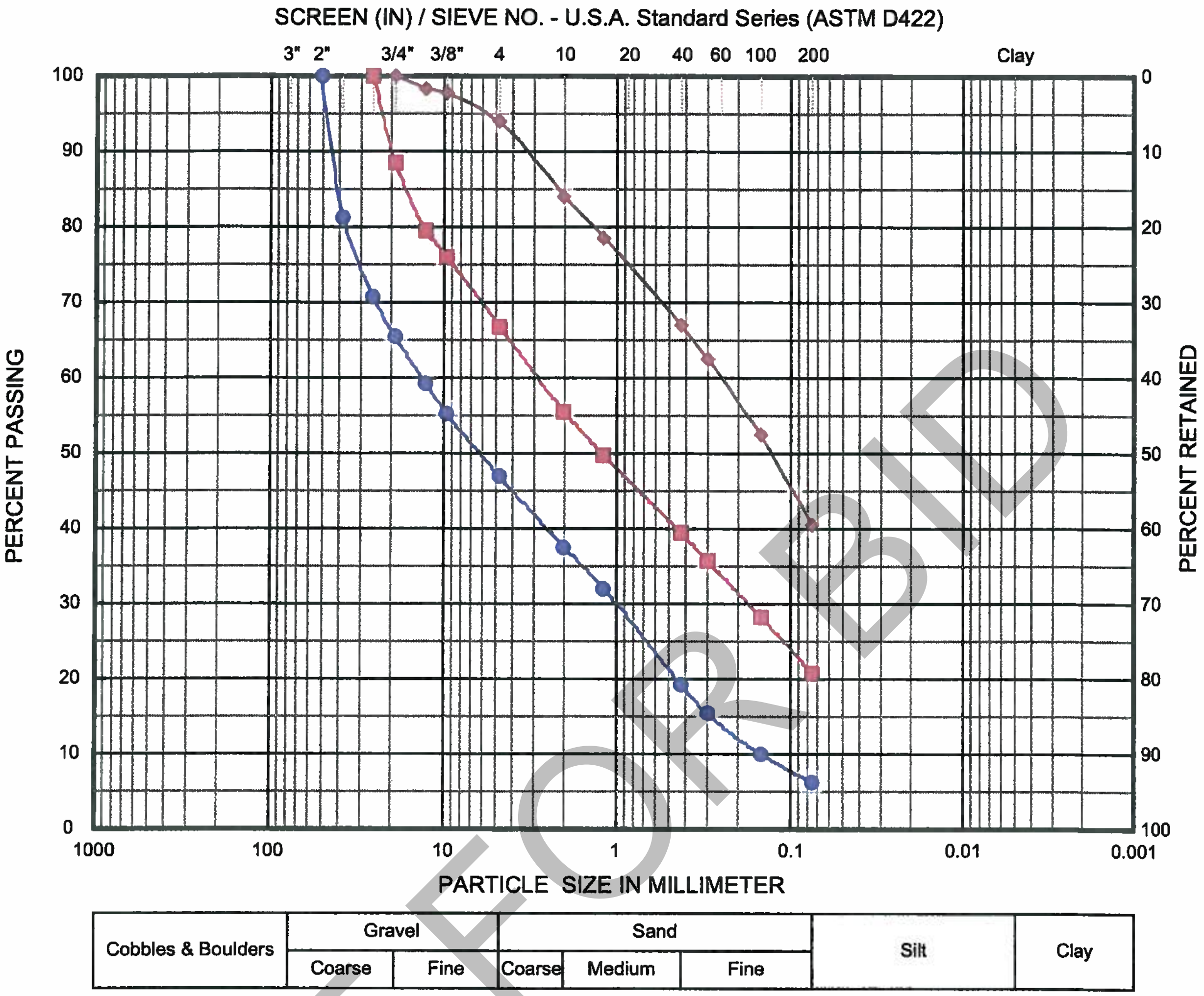
EXPLORATORY BORING NO. 20

Date Drilled: 2/21/14
Client: County of San Bernardino Special Services Department
Equipment: CME 75 Truck Rig
Driving Weight / Drop: 140 lbs./ 30 in.
Surface Elevation(ft):
Logged by: JMcK
Measured Depth to Water(ft): N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6 IN.	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
		Asphalt Concrete, 2-1/8"	Asphalt on Native Qvof		▨		8.4		
		(SM) Silty Sand, fine to medium with coarse, with clay, gravel, and weatered clasts of bedrock to 3", dark brown		☒		18 14 17	12.1	119	Ring
5				☒		8 22 26	6.0	117	Ring
10		(SC) Clayey Sand, fine to coarse, few gravel, brown		☒		17 23 27	8.8	114	Ring
					▨		10.1		
		Gneiss bedrock returned as (SM) Silty Sand, fine, with angular gravel to 3/4", light brown	Pm						
15				☒		50/5"	6.6	90	Ring
		END OF BORING NO REFUSAL, NO CAVING NO GROUNDWATER, NO FILL GNEISS BEDROCK AT 13'							
20									
25									
30									

APPENDIX "C"

LABORATORY TESTING



	Boring No.	Depth	Gravel	Sand	Fines	Clay	D_{10}	D_{30}	D_{50}	D_{60}	C_u	C_c
●	2	0.0	53.0	40.7	6.3		0.1489	0.994	6.198	13.300	89.3	0.5
	(GP-GM) Poorly-graded gravel with silt and sand											
■	4	6.0	33.2	46.0	20.8			0.175	1.214	2.856		
	(SM) Silty sand with gravel											
◆	5	0.0	6.1	53.5	40.4				0.128	0.250		
	(SM) Silty sand, fine to coarse											

PARTICLE SIZE DISTRIBUTION (ASTM D422)

Project:	Snow Drop Road Roadway and Drainage Improvements				
Location:	Alta Loma Area of County of San Bernardino, California				
Job Number:	14095-3	Engineer:	JFC	Enclosure:	C-1

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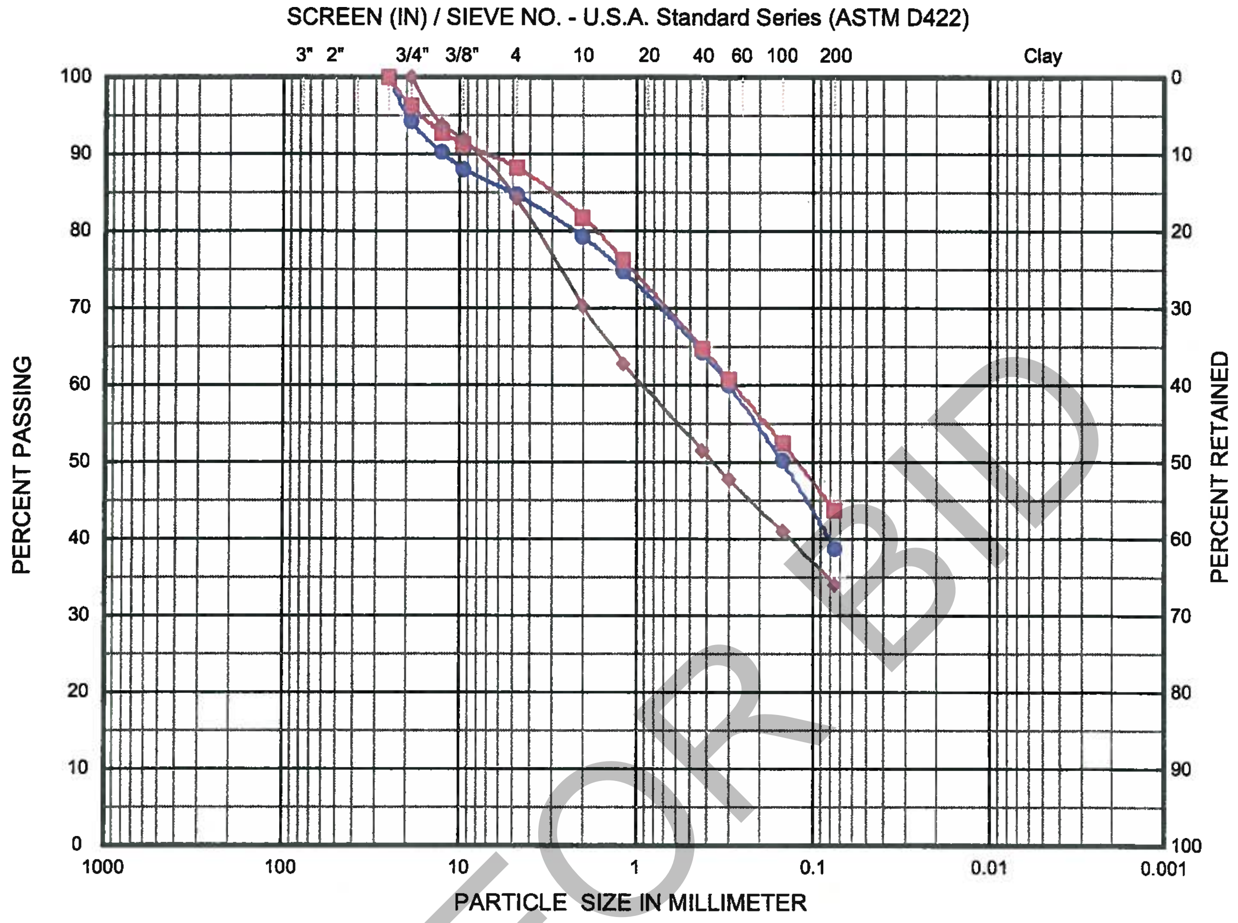

Cobbles & Boulders	Gravel		Sand			Silt	Clay
	Coarse	Fine	Coarse	Medium	Fine		

	Boring No.	Depth	Gravel	Sand	Fines	Clay	D_{10}	D_{30}	D_{50}	D_{60}	C_u	C_c
●	6	0.0	15.4	45.8	38.8			0.044	0.149	0.301		
	(SC) Clayey sand with gravel											
■	12	21.0	11.8	44.5	43.7				0.122	0.283		
	(SC) Clayey sand, fine to coarse											
◆	14	0.0	15.8	50.2	34.0			0.051	0.371	0.932		
	(SC) Clayey sand with gravel, fine to coarse											

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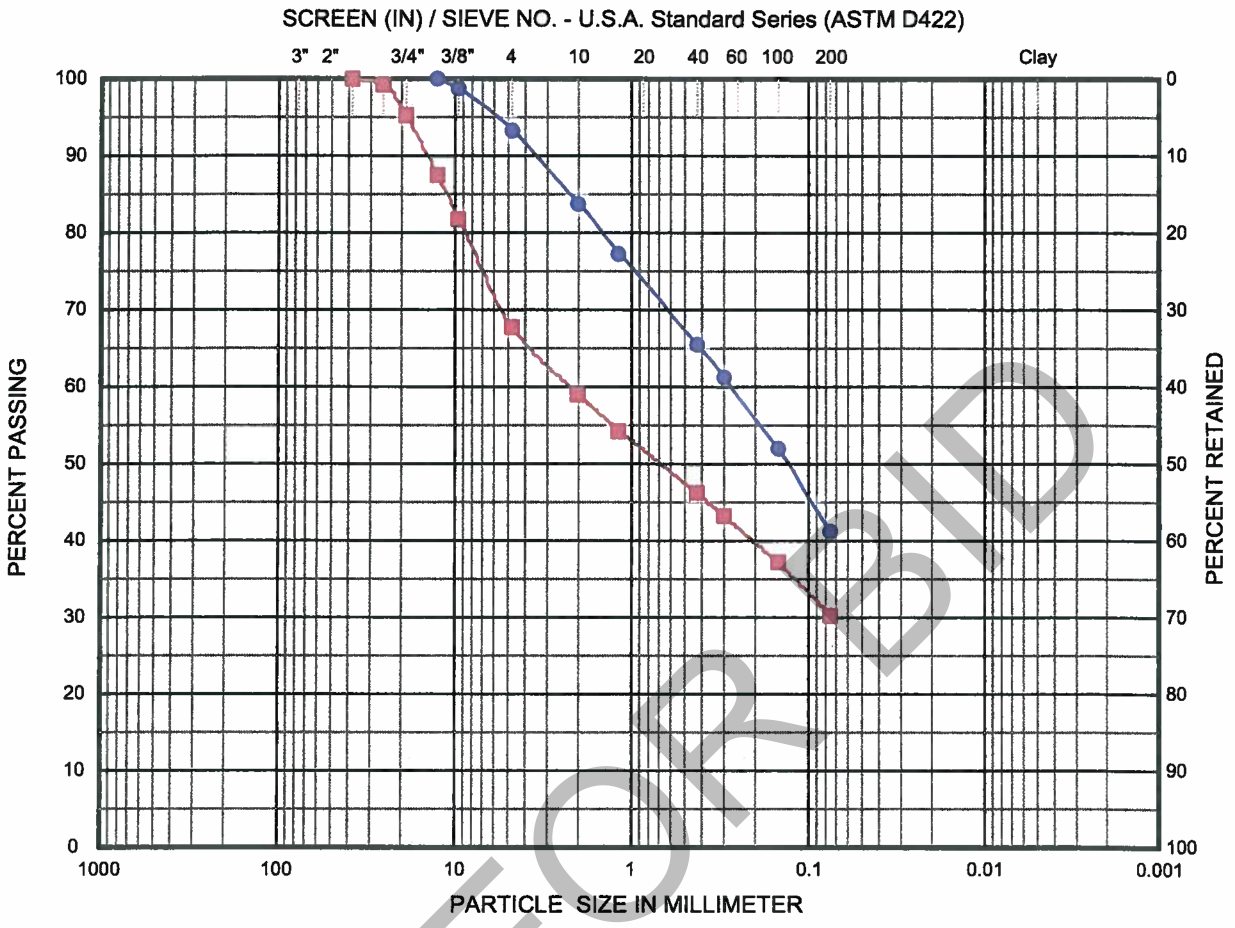
PARTICLE SIZE DISTRIBUTION (ASTM D422)

Project:	Snow Drop Road Roadway and Drainage Improvements
Location:	Alta Loma Area of County of San Bernardino, California

Job Number:	14095-3	Engineer:	JFC	Enclosure:	C-2



Cobbles & Boulders	Gravel		Sand			Silt	Clay
	Coarse	Fine	Coarse	Medium	Fine		

	Boring No.	Depth	Gravel	Sand	Fines	Clay	D_{10}	D_{30}	D_{50}	D_{60}	C_u	C_c
●	16	0.0	6.7	51.9	41.3				0.130	0.273		
	(SC) Clayey sand, fine to coarse											
🟥	20	0.0	32.3	37.3	30.3			0.072	0.685	2.235		
	(SM) Silty sand with gravel											

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PARTICLE SIZE DISTRIBUTION (ASTM D422)

Project:	Snow Drop Road Roadway and Drainage Improvements				
Location:	Alta Loma Area of County of San Bernardino, California				
Job Number:	14095-3	Engineer:	JFC	Enclosure:	C-3

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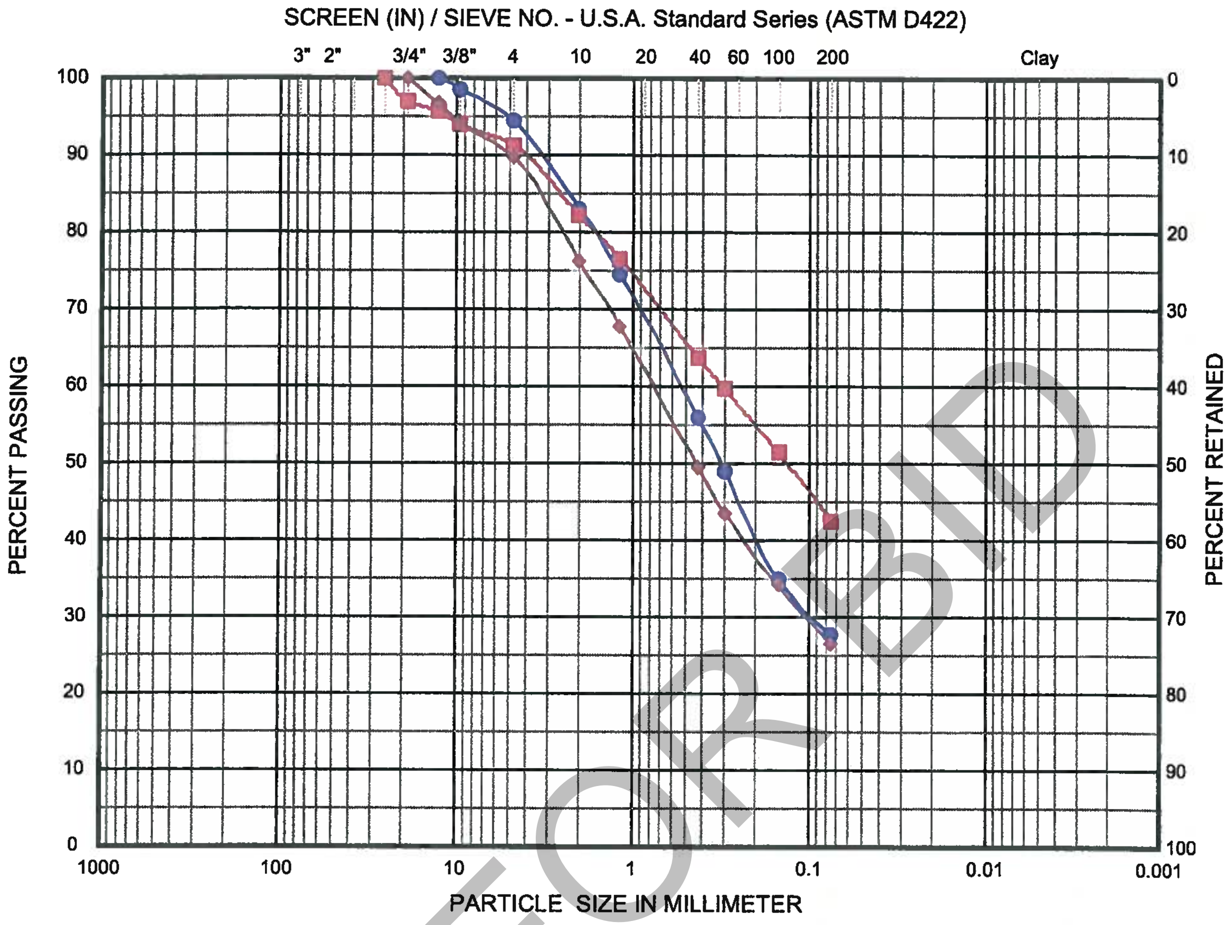

Cobbles & Boulders	Gravel		Sand			Silt	Clay
	Coarse	Fine	Coarse	Medium	Fine		

	Boring No.	Depth	Gravel	Sand	Fines	Clay	D_{10}	D_{30}	D_{50}	D_{60}	C_u	C_c
●	Rv-21	0.0	5.6	66.8	27.7			0.097	0.314	0.524		
	(SM) Silty sand, fine to coarse											
■	Rv-22	0.0	8.7	48.7	42.6				0.133	0.309		
	(SM) Silty sand, fine to coarse											
◆	Rv-23	0.0	10.2	63.3	26.5			0.104	0.439	0.765		
	(SM) Silty sand, fine to coarse											

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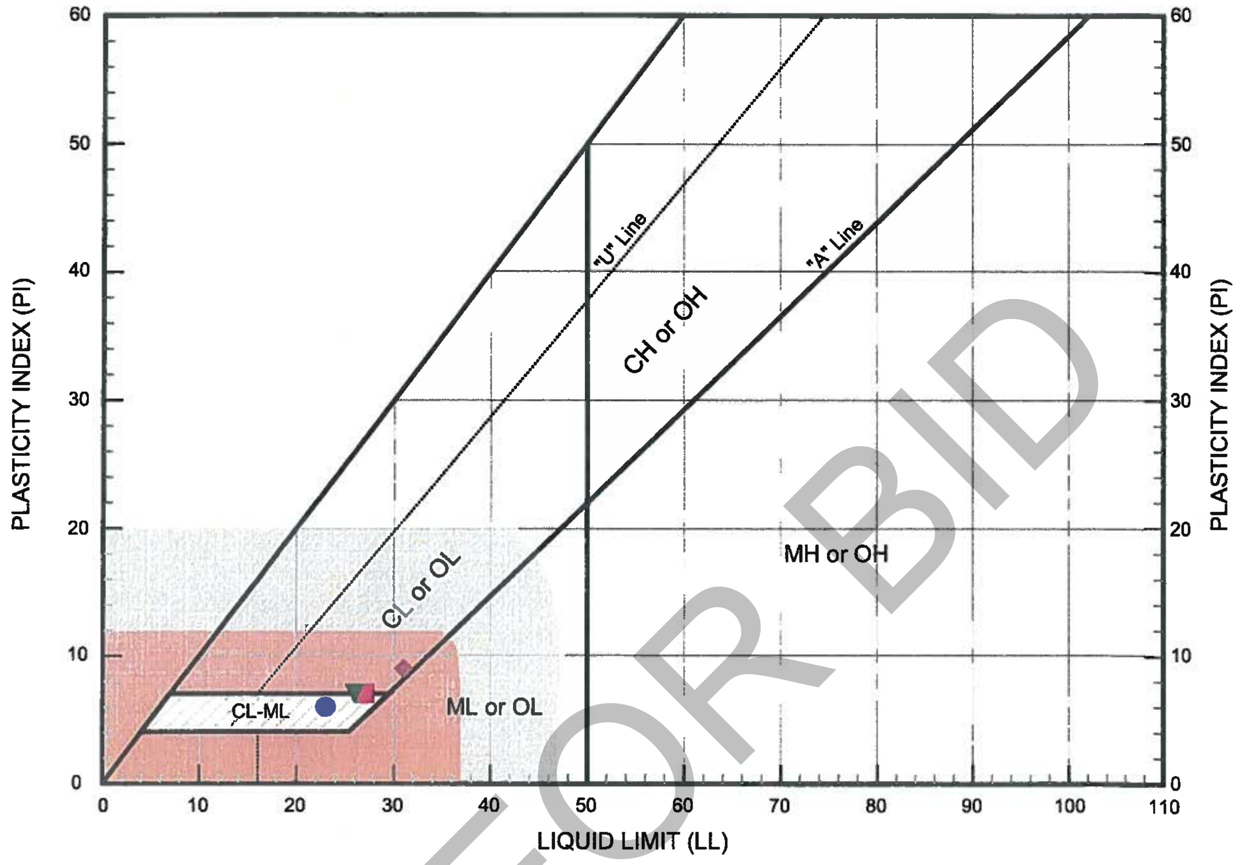
PARTICLE SIZE DISTRIBUTION (ASTM D422)

Project:	Snow Drop Road Roadway and Drainage Improvements		
Location:	Alta Loma Area of County of San Bernardino, California		
Job Number: 14095-3	Engineer: JFC	Enclosure:	C-4

Prepared at 3/17/2014 11:20:35 AM



	Boring No.	Depth (ft)	USCS Classification	PL	LL	PI
●	6	0.0	(SC) Clayey sand with gravel	17	23	6
■	12	21.0	(SC) Clayey sand, fine to coarse	20	27	7
◆	14	0.0	(SC) Clayey sand with gravel, fine to coarse	22	31	9
▼	16	0.0	(SC) Clayey sand, fine to coarse	19	26	7

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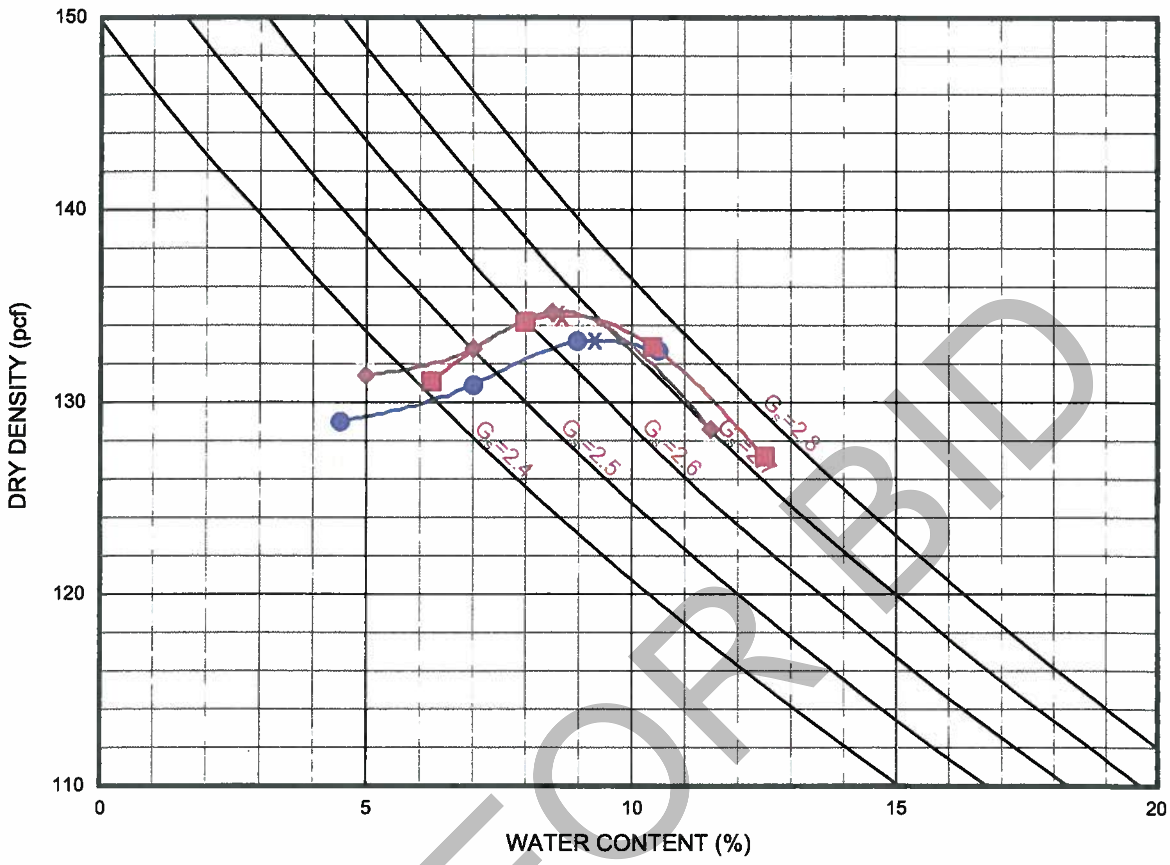
PLASTICITY CHART (ASTM D4318)

Project:	Snow Drop Road Roadway and Drainage Improvements				
Location:	Alta Loma Area of County of San Bernardino, California				
Job Number:	14095-3	Engineer:	JFC	Enclosure:	C-5



	Boring No.	Depth (ft)	USCS Classification	γ_{dmax} (pcf)	w_o (%)
●	1	0.0	(SM) Silty sand, fine to coarse	133.3	9.3
■	4	6.0	(SM) Silty sand with gravel	134.5	8.7
◆	9	0.0	(SM) Silty sand, fine to medium	134.7	8.6

COMPACTION CURVES (ASTM D1557)

Project:	Snow Drop Road Roadway and Drainage Improvements		
Location:	Alta Loma Area of County of San Bernardino, California		
Job Number: 14095-3	Engineer: JFC	Enclosure:	C-6

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Prepared at 3/17/2014 11:20:35 AM

	Boring No.	Depth (ft)	γ_d (pcf)	w (%)	C_{pk} (psf)	ϕ_{pk} (°)	C_{rs} (psf)	ϕ_{rs} (°)
●	1A	1	120.0	9.0	308.1	36.8	115.1	34.9
	(SM) Silty sand, fine to coarse / Remolded (RC=90%)							
■	5	1	121.0	6.8	109.9	38.6	190.7	35.2
	(SM) Silty sand, fine to coarse / Undisturbed							
◆	6	1	121.0	8.9	323.3	34.1	230.1	34.7
	(SC-SM) Clayey silty sand, fine to medium / Undisturbed							

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DIRECT SHEAR TESTS (ASTM D3080)

Project:	Snow Drop Road Roadway and Drainage Improvements				
Location:	Alta Loma Area of County of San Bernardino, California				
Job Number:	14095-3	Engineer:	JFC	Enclosure:	C-7

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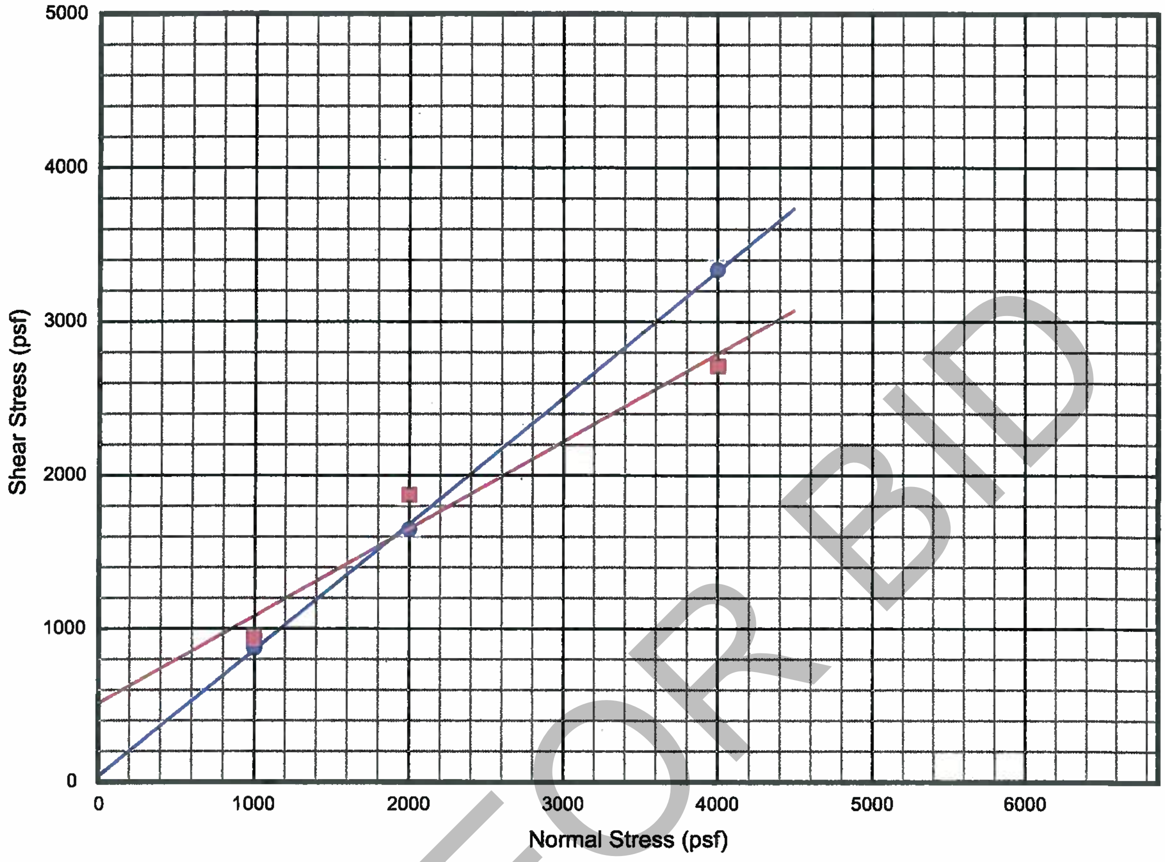

	Boring No.	Depth (ft)	γ_d (pcf)	w (%)	C_{pk} (psf)	ϕ_{pk} (°)	C_{rs} (psf)	ϕ_{rs} (°)
●	8	1	125.0	2.9	0.0	42.2	38.5	39.4
	(SM) Silty sand, fine with medium / Undisturbed							
🟥	12	25	106.4	15.5	654.2	28.2	515.1	29.6
	(SC-SM) Clayey silty sand, fine to coarse / Undisturbed							

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DIRECT SHEAR TESTS (ASTM D3080)

Project:	Snow Drop Road Roadway and Drainage Improvements				
Location:	Alta Loma Area of County of San Bernardino, California				
Job Number:	14095-3	Engineer:	JFC	Enclosure:	C-8

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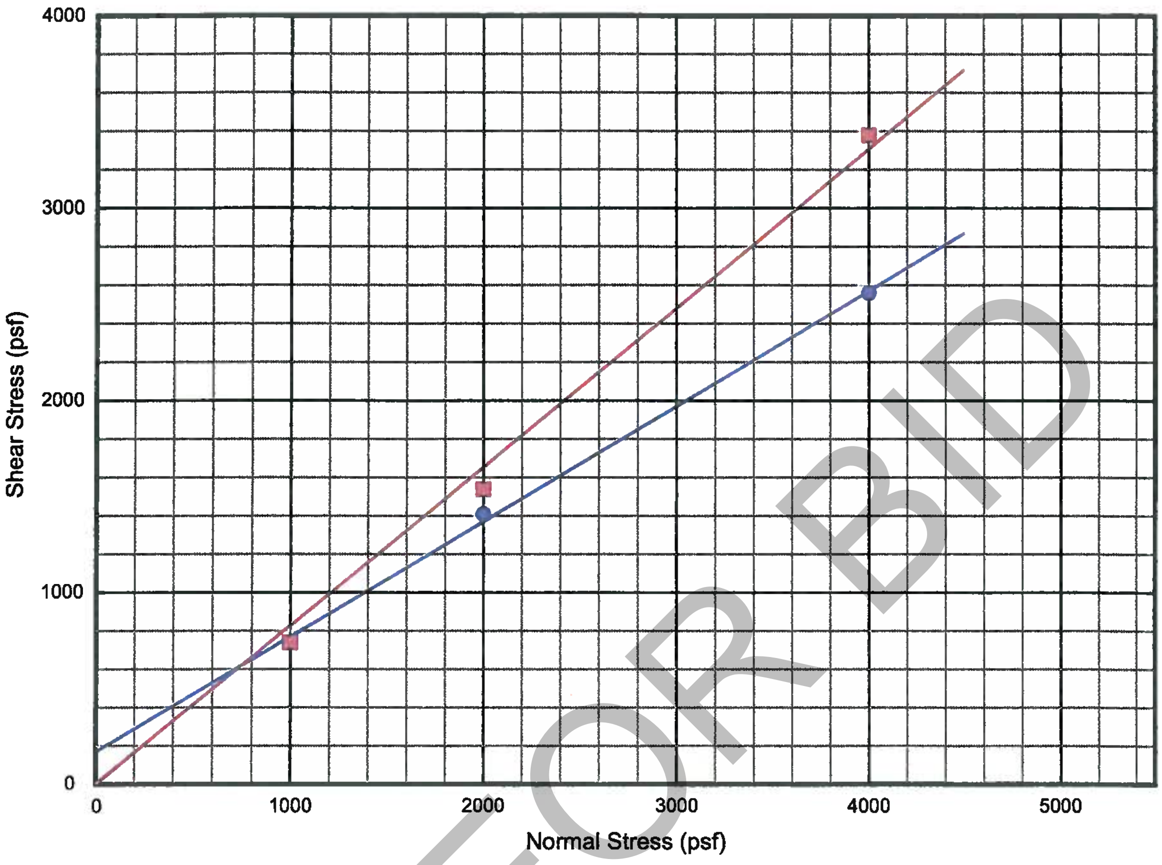

	Boring No.	Depth (ft)	γ_d (pcf)	w (%)	C_{pk} (psf)	ϕ_{pk} (°)	C_{rs} (psf)	ϕ_{rs} (°)
●	16	1	111.0	6.4	142.1	31.8	168.9	30.9
	(SC-SM) Clayey silty sand, fine to coarse / Undisturbed							
■	16	5	91.0	6.7	0.0	39.9	0.0	39.6
	(SC-SM) Clayey silty sand, fine to coarse / Undisturbed							

DIRECT SHEAR TESTS (ASTM D3080)

Project:	Snow Drop Road Roadway and Drainage Improvements		
Location:	Alta Loma Area of County of San Bernardino, California		
Job Number:	14095-3	Engineer:	JFC
Enclosure:	C-9		

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R-VALUE (CALTRANS 301)

Sample No.	Rv-21	Rv-22	Rv-23
Depth (ft)	0.0	0.0	0.0
Classification	SM	SC-SM	SM
Sand Equivalent	19	11	19
R-value	51	11	35

TEST DATA SUMMARY

Project:	Snow Drop Road Roadway and Drainage Improvements				
Location:	Alta Loma Area of County of San Bernardino, California				
Job Number:	14095-3	Engineer:	JFC	Enclosure:	C-10

HDR | SCHIFF

Enclosure "C-11"

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Corrosion Control and Condition Assessment (C3A) Department

Table 1 - Laboratory Tests on Soil Samples

C.H.J. Consultants
SBCSD Snow Drop Rd
Your #14095-3, HDR|Schiff #14-0140LAB
5-Mar-14

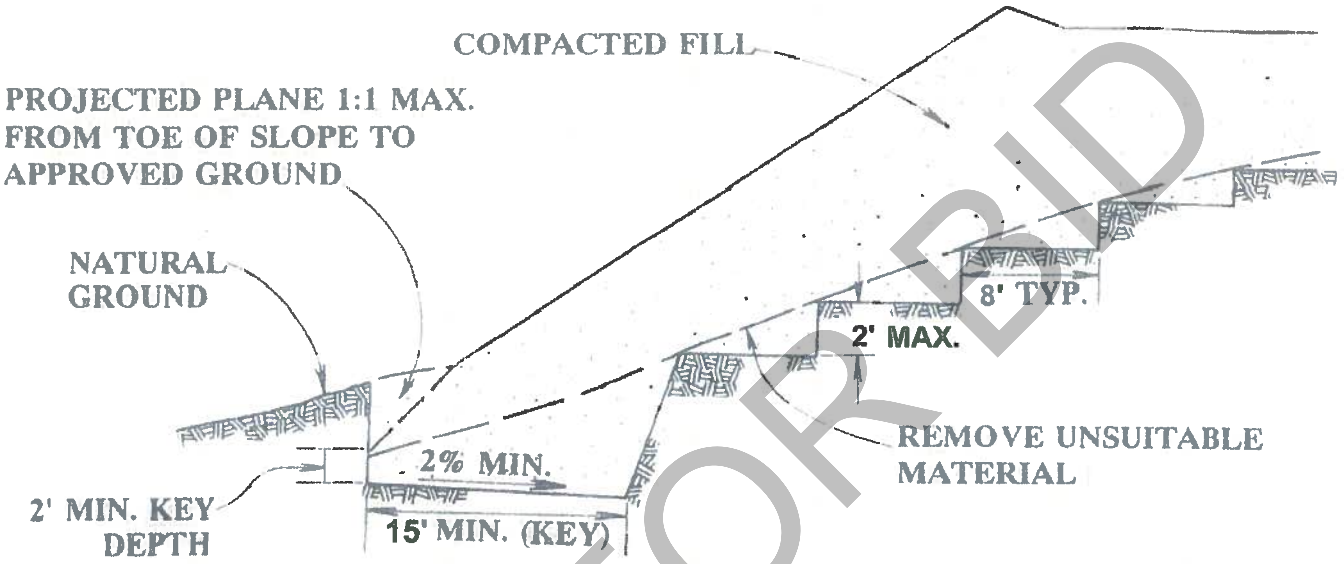
Sample ID

			6A	14A
Resistivity		**Units**		
as-received		ohm-cm	17,200	32,000
saturated		ohm-cm	1,440	4,000
pH			7.3	5.8
Electrical Conductivity		mS/cm	0.19	0.05
Chemical Analyses				
Cations				
calcium	Ca^{2+}	mg/kg	128	22
magnesium	Mg^{2+}	mg/kg	29	10
sodium	Na^{1+}	mg/kg	30	43
potassium	K^{1+}	mg/kg	6.8	4.8
Anions				
carbonate	CO_3^{2-}	mg/kg	ND	ND
bicarbonate	HCO_3^{1-}	mg/kg	159	34
fluoride	F^{1-}	mg/kg	4.3	1.5
chloride	Cl^{1-}	mg/kg	3.6	23
sulfate	SO_4^{2-}	mg/kg	45	41
phosphate	PO_4^{3-}	mg/kg	ND	ND
Other Tests				
ammonium	NH_4^{1+}	mg/kg	ND	ND
nitrate	NO_3^{1-}	mg/kg	257	ND
sulfide	S^{2-}	qual	ND	ND
Redox		mV	ND	ND

Electrical conductivity in millisiemens/cm and chemical analysis were made on a 1:5 soil-to-water extract.
mg/kg = milligrams per kilogram (parts per million) of dry soil.
Redox = oxidation-reduction potential in millivolts
ND = not detected
na = not analyzed

APPENDIX "D"

KEY AND BENCHING DETAIL



FILL SLOPE

NOTES: ① - DIMENSIONS SHOWN SUBJECT TO FIELD CHANGE BASED ON ENGINEER'S JUDGEMENT

② - BENCHING REQUIRED WHEN FILLING OVER NATURAL GROUND STEEPER THAN 5H : 1V

KEY AND BENCHING DETAIL

FOR: COUNTY OF SAN BERNARDINO SPECIAL DISTRICTS DEPARTMENT	GEOTECHNICAL INVESTIGATION PROPOSED ROADWAY AND DRAINAGE IMPROVEMENTS NORTHERN PORTION OF ARCHIBALD AVENUE, SNOW DROP ROAD, AND NORTHERN PORTION OF HAVEN AVENUE ALTA LOMA AREA, SAN BERNARDINO COUNTY, CALIFORNIA	ENCLOSURE "D-1"
DATE: MARCH 2014		JOB NUMBER 14095-3

APPENDIX "E"

BEARING CAPACITY AND EARTH PRESSURES

Enclosure "E-1"

Geologic Unit	Φ	Deg. (C)	Backfill: Active Earth Pressure/Coefficient		Backfill: At-Rest Earth Pressure/Coefficient		Passive Earth Pressure/ Coefficient	Coefficient of Friction	Allowable Bearing Capacity/ Maximum	Increases	
			Level	2:1 Slope	Level	2:1 Slope				1-ft width	1-ft depth
Fill F	34	0	38/0.28	56/0.42	60/0.44	93/0.69	475/3.54	0.45	2,000/4,000	500	1,000
Recent Alluvium (Qa)	34	100	38/0.28	56/0.42	60/0.44	93/0.69	475/3.54	0.45	2,500/5,000	500	1,000
Alluvium-Fan Sediment (Qyf)	34	100	38/0.28	56/0.42	60/0.44	93/0.69	475/3.54	0.45	2,500/5,000	500	1,000
Very Old Alluvium-Fan Sediment (Qvof)	34	0	38/0.28	56/0.42	60/0.44	93/0.69	475/3.54	0.45	2,000/4,000	500	1,000
Granulitic Gneiss (Pm)	36	0	35/0.26	50/0.37	56/0.41	87/0.64	500/3.85	0.48	2,500/5,000	1,000	1,500
Weathered Granulitic Gneiss (Pm)	30	75	45/0.33	72/0.54	68/0.50	106/0.78	400/3.00	0.38	2,000/3,000	250	500

Enclosure "E-2"

Summary of Explorations

Exploration No.	Station	Total Depth (ft.)	Depth of Fill/ Native Contact (ft.)	Depth to Bedrock (ft.)	Type
1	111+30	5-1/2	4-1/2	NE	Backhoe
2	101+25	5-1/2	2-1/4	NE	Backhoe
3	89+15	26-1/2	0	1	HSA
4	81+60	13	>13	NE	HSA
5	78+70	11-1/2	0	8	HSA
6	75+10	21-1/2	1	17	HSA
7	73+35	16-1/2	8	14	HSA
8	65+55	16-1/2	5	NE	HSA
9	63+95	7	NE	NE	Backhoe
10	62+70	16-1/2	9	NE	HSA
11	62+30	7-1/2	NE	NE	Backhoe
12	56+55	31-1/2	20	NE	HSA
13	53+05	31-1/2	10	NE	HSA
14	51+40	11-1/2	0	0	HSA
15	45+30	16-1/2	10	10	HSA
16	40+80	16-1/2	0	0	HSA
17	38+90	6-1/2	0	0	HSA
18	32+80	6-1/2	0	0	HSA
19	28+05	6-1/2	0	0	HSA
20	18+80	16-1/2	0	13	HSA
21*	59+50	1/2	--	--	Backhoe
22*	57+05	1/2	--	--	Backhoe
23*	54+10	1/2	--	--	Backhoe

HSA = 8" diameter hollow-stem auger
NE = not encountered
*R-value test sample