Appendix F
Geologic and Geotechnical Report

ALLAN E. SEWARD
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GEOLOGIC AND GEOTECHNICAL REPORT

EIR-Level Review of Road Alignments for Dockweiler Road and Lyons Avenue

Dockweiler Road Extension to Lyons Avenue Including the
New Lyons Avenue Crossing over the Railroad Tracks
City of Santa Clarita, California

Prepared for:

Hall and Foreman, Inc.
25152 Springfield Court, Suite 350
Santa Clarita, CA 91355

Job No: 14-2393
Dated: October 17, 2014

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October 17, 2014 Job No: 14-2393

Hall and Foreman, Inc.
25152 Springfield Court, Suite 350
Santa Clarita, California 91355

Attention: Mr. Henrik Nazarian

Subject: **GEOLOGIC AND GEOTECHNICAL REPORT**
EIR-Level Review of the Road Alignments for Dockweiler Drive and Lyons Avenue

Project: Dockweiler Road Extension to Lyons Avenue Including the
New Lyons Avenue Crossing over the Railroad Tracks
Newhall Area
City of Santa Clarita, California

References: At end of text

Dear Mr. Nazarian:

This preliminary geologic and geotechnical evaluation report of the project site presents has been prepared for incorporation into an Environmental Impact Report (EIR) for the proposed improvements for the extension of Dockweiler Drive and the Lyons Avenue railroad crossing. This report summarizes our opinions regarding the geologic and geotechnical conditions at the above-referenced project site and their effects on the proposed improvements.

1.0 PROPOSED PROJECT

The proposed project consists of future road alignments for extension of Lyons Avenue from its current northeastern terminus at Railroad Avenue to a future intersection with proposed Dockweiler Drive approximately 600 ft. to the northeast. This includes a proposed at-grade crossing over the existing Southern Pacific railroad tracks and a crossing over Newhall Creek using a box culvert to connect to the proposed extension of Dockweiler Drive. Dockweiler Drive is proposed to extend from a point of connection at the Master's College property boundary northwesterly for approximately 2,000 feet to the intersection of Arch Street and 12th Street. Aden Avenue is to extend from its current southerly terminus to intersect with the future Dockweiler Drive approximately 250 ft. to the south.

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In addition, three alternatives to the proposed project were provided by Hall and Foreman, Inc. Alternatives 1, 2 and 3 present various omissions of portions of the above described proposed roads and upgrade or closure to the existing railroad crossing at 13^{th} Street. Copies of exhibits prepared by Hall and Foreman Inc. showing the proposed project and alternatives are included for reference.

2.0 SCOPE OF REVIEW

This report summarizes geologic and geotechnical conditions in the vicinity of the proposed road alignments and provides general geologic and geotechnical recommendations for submittal in an Environmental Impact Report. Potential impacts to or caused by the proposed development have been identified. Mitigation measures to lesson or avoid impacts are also suggested in this report.

This investigation included the following tasks:

1. Coordination with Hall and Foreman, Inc.
2. Review of the Project Site Map (undated), Proposed Project dated 8/13/13, Alternatives 1, 2 and 3 dated 8/12/13, Existing Conditions on Lyons Avenue (undated), and Location Map of Study Intersections (undated) prepared by Hall and Foreman, Inc.
3. Review of the published geologic reports and maps referenced at the end of this report.
4. Review of the referenced consultant reports and our investigation report for the adjacent Old Town Newhall Library.
5. Review of Alquist-Priolo earthquake fault zone and seismic hazard maps for the Newhall Quadrangle.
6. Site reconnaissance to assess the existing geologic conditions and exposures of the geologic units.
7. Review of the following aerial photographs:

YEAR	PHOTO	SCALE	AGENCY
1928	C300 E191 & E192	1″=~2,000′	Fairchild
3/29/68	4-122 and 4-123	1″=~2,000′	U.S.D.A.
3/8/81	PW 11484-4	1″=~1,400′	Pacific Western

8. Review of Division of Oil, Gas and Geothermal Resources records (online) and the Munger Map Book to assess if any oil wells have been drilled at the site.

9. Review of Los Angeles County Flood Control District (LACFCD) records to assess if any water wells have been drilled near the proposed road alignments.
10. Evaluation of historic high ground water elevations at the project site.
11. Preliminary assessment of potential compressibility and consolidation of soils at the site.
12. Evaluation of potential ground rupture hazard at the site.
13. Evaluation of potential ground accelerations that could be generated at the site during future earthquakes on nearby faults.
14. Preliminary assessment of potential for liquefaction of in-situ site soils and for liquefaction-induced phenomena, including lateral spreading and liquefaction-induced settlement.
15. Preliminary assessment of potential static and seismic settlements at the site and of potential mitigation options.
16. Preliminary assessment of the potential for corrosive and expansive soils and mitigation options.
17. Preparation of a Geologic Map utilizing the undated Project Site Map provided to our office on 10/8/14 as a base.
18. Preparation of this report, which summarizes the geologic and geotechnical conditions at the site, their potential impacts to the proposed road alignments and railroad crossing, and our preliminary geotechnical recommendations.

3.0 SITE DESCRIPTION

The project site is located in the downtown Newhall area of the City of Santa Clarita. The proposed road alignments are located on the alluvial flood plain and hillside areas adjacent to Newhall Creek. The majority of the proposed road alignment for Lyons Avenue traverses undeveloped land, except for areas where artificial fill and railroad ballast have been placed to elevate and support the existing railroad double tracks. Dumped fill with abundant blocks of asphalt and concrete and other miscellaneous debris has been placed on the southwest bank of Newhall Creek, just northeast of the proposed at-grade railroad crossing. The proposed road alignment of Dockweiler Drive also traverses undeveloped land and a storage yard utilized by Los Angeles County Department of Public Works. The site is covered with light to moderate growth of natural grasses and chaparral. Details of the site topography are shown on the base map used for the Geologic Map (see Plate I). Elevations at the site range from approximately 1255 to 1370 ft above mean sea level.

4.0 GEOLOGIC AND GEOTECHNICAL CONDITIONS

4.1 Geologic Setting

The site is located within the central part of the Transverse Ranges geomorphic province of southern California, in the eastern portion of the Ventura Basin. The Ventura Basin has been tectonically down-warped in the geologic past to produce a large-scale synclinal structure in which a thick sequence of Cenozoic sediments has accumulated. In the vicinity of the proposed road alignments, much of the hillside area along the northeastern margin of Newhall Creek consists of bedrock of the Quaternary-age Pacoima Formation (Qp). The relatively flat flood plain southwest of Newhall Creek is underlain by sub-horizontal alluvium deposited (Qal). The Pacoima Formation and alluvial deposits are underlain by bedrock of the Plio-Pleistocene, nonmarine Saugus Formation (TQs). No faults or folds have been identified at the project site on the referenced published geologic map of the area. A Geologic Overview Map (see **Figure 2)** based on Geologic Map of the Newhall Quadrangle (Dibblee, 1996) is provided at the end of this report.

4.2 Geologic Structure

The natural slopes at the project site are underlain by sub-horizontally bedded Pacoima Formation in erosional unconformable contact over Plio-Pleistocene non-marine sediments of the Saugus Formation. The Saugus Formation in the vicinity of the subject site generally strikes roughly east to west and dips gently to the north (Treiman, 1987; and Dibble, 1996).

The Saugus Formation bedding measured in northern bank of the Newhall Creek strikes N70W and dips 5° north. The measured bedding is generally consistent with regional geologic maps and the geologic structure as documented during a previous investigation and published report (see references).

4.3 Geologic Units

The Geologic Map (see **Plate I**) enclosed in the Appendix of this report illustrates the approximate limits of exposed geologic units based on field observations and the referenced published geologic maps. Artificial fill and railroad ballast have been placed below the railroad tracks. Pavement and aggregate base have been placed beneath existing roadways. General descriptions of geologic units provided below are based the prior geologic observation in the vicinity of the project site, and the exposures in the banks of Newhall Creek in the vicinity of the proposed box culvert.

4.3.1 Saugus Formation (TQs)

Bedrock of the Plio-Pleistocene-age Saugus Formation (TQs) is exposed along the lower portion of the northerly eroded bank of Newhall Creek, just east of the proposed road alignment. The Saugus Formation sediments consist dominantly of gray to light brown sandstone and conglomeratic sandstone with scattered greenish-gray siltstone and silty sandstone (Treiman, 1987). Bedding within the Saugus Formation varies from predominately massive and indistinct to cross-bedded to locally well-developed planes on lensing, fine-grained units. Local variance in bedding orientations is common and is due to cross bedding and/or channelized (erosional) contacts.

4.3.2 Pacoima Formation (Qp)

Bedrock of the Quaternary-age Pacoima Formation (Qp) mantles the majority of the hillside area along the northern margin of Newhall Creek. This formation has been designated as “Older Dissected Surficial Sediments or Qog” after Dibblee, 1996; however, these terrace deposits have been assigned to the Pacoima Formation (of Oakeshott, 1958) by Treiman (CDMG, 1987). For this report, the nomenclature by Treiman is used.

The bedrock generally consists of lensing, crudely stratified, light yellowish-brown to yellowish-brown to brown, silty to clayey, fine- to coarse-grained sandstone with some gravel, cobbles and rare boulders. Bedding is generally crude to locally well defined. Generally the bedrock is concealed by a mantling of soil and colluvium. However, the eroded banks of the Newhall Creek expose unweathered bedrock.

4.3.3 Quaternary Alluvium (Qal)

Quaternary Alluvium (Qal) underlies the existing surficial artificial fill materials located westerly of Newhall Creek south of 12^{th} Street, and easterly of Newhall Creek north of 12^{th} Street. Based on data obtained by this firm for the adjacent Old Town Newhall Library site, the alluvium is anticipated to consist of interbedded layers of poorly graded sand, silty sand, and gravelly sand. Interbedded layers of sandy silts and clays may also be present. These materials are typically medium dense to dense in the upper 30 to 40 ft. with locally loose conditions in the upper 10 ft.

4.3.4 Recent Stream Channel Deposits (Qsc)

Quaternary Stream channel deposits (Qsc) are located within the active Newhall Creek channel. These deposits consist of recent alluvium that has been reworked due to heavy runoff during periodic rains. Stream channel deposits are very similar to the Quaternary alluvium and generally consist of silty sands, sands, and gravels with cobbles.

4.3.5 Quaternary Colluvium (Qc)

Colluvium (Qc) is a non-bedded, heterogeneous accumulation of soil and weathered bedrock deposited by gravity on all but the steepest slopes. These deposits have been mapped based on review of the topography where the estimated thickness is greater than about 3 feet.

4.3.6 Artificial Fill (af)

Artificial fill (af) was apparently placed below the existing railroad tracks to elevate the tracks above the Newhall Creek Flood Plain. The engineering characteristics of this material are currently unknown.

4.3.7 Dumped Fill (df)

Dumped fill (df) is present along the active stream margins of Newhall Creek at the vicinity of the proposed Lyons Avenue road alignment. The dumped fill consists of fill soils with abundant debris (asphalt, concrete, construction trash, metal, vehicle tires). Also present near the proposed alignment is an abandoned vehicle that is partially buried.

4.3.8 Railroad Ballast

Railroad ballast consisting of crushed natural rock was placed to support and elevate the two sets of railroad tracks at the site.

4.4 Landslides

Review of the referenced published geologic maps indicates that no landslides have been mapped at or adjacent to the site. Review of aerial photographs lack geomorphic features that would indicate prior landslide movement.

4.5 Ground Water

Review of historic ground water data from the Seismic Hazard Map for the Newhall Quadrangle, Water-Resources Investigation using Analog Model Techniques in the Saugus-Newhall Area (Robson, 1972), and Los Angeles Flood Control District (LACFCD) water well records indicates that historic high ground water levels are between 75 and 100 ft. below the existing surface at the project site. The locations of nearby water wells are shown on the Water Well Location Map (see **Figure 2)** and the historic ground water levels for each well obtained from LACFCD records are provided in Summary of LAFCD Water Well Data (see **Table 1)**. In addition, ground water was not encountered in subsurface explorations performed by this firm to a depth of 50 ft in the alluvium for the adjacent Old Town Newhall Library. However, temporary perched ground water conditions may exist below Newhall Creek following periods of significant rainfall and runoff.

A low potential exists for temporary, perched ground water conditions to develop within the bedrock of the Pacoima formation. Perched ground water can contribute to slope instability in natural slopes and cut slopes. To prevent build-up of water, subdrains are typically recommended in canyon areas in which fill will be placed and back drains for slopes that are to be constructed as Stability Fills or Buttress Fills.

Due to the historic high ground water elevations and the elevated nature of portions of the road alignment, ground water is not expected to significantly affect the project, provided the proposed grading is evaluated from a geotechnical standpoint during the design stage and the geotechnical recommendations are implemented during construction.

5.0 POTENTIAL CONSTRAINTS, IMPACTS, AND MITIGATION OPTIONS

5.1 Seismic Considerations

5.1.1 Introduction

The subject site lies within the seismically active southern California region. Earthquake-related hazards typically include ground rupture, ground shaking, and ground failure.

5.1.2 Ground Rupture

Review of the Alquist-Priolo Earthquake Fault Zone Map for the Newhall Quadrangle, the Seismic Safety Element of the L.A. County General Plan, and the published Geologic Maps referenced at the end of this report indicates that no active or potentially active faults traverse the project site. Review of the site topography and the aerial photographs listed at the beginning of this report did not reveal any lineaments or other indicators suggestive of faulting at the site. The nearest known active fault is the San Gabriel Fault, which is 3.7 km from the site at its nearest point (see **Table 2** for a list of regional faults near the site and **Figure 3** for a map of the fault locations). Therefore, the probability of fault-related ground rupture at the site is considered to be very low.

5.1.3 Ground Motion

Peak ground acceleration (PGA) consistent with maximum considered earthquake (MCE) ground motions were evaluated at the site for bedrock (Site Class B) and alluvial (Site Class C) soil conditions in accordance with the 2013 California Building Code and ASCE 7-10. The mapped MCE geometric mean (MCE_G) peak ground accelerations

(PGA_M) adjusted for Site Class effects were first evaluated using the U.S. Seismic Design Maps web tool provided by the United States Geological Survey (USGS). The MCE_G PGA_M was then evaluated for a 2 percent probability of exceedance within a 50-year period using the USGS 2008 Interactive Deaggregation web tool. The PGA_M calculated using the probabilistic procedure is based on estimated values of shear wave velocity (V_{s30}) within the range designated for the corresponding Site Class. The estimated PGA_M for bedrock (1.10g) and alluvial (1.03g) soil conditions was taken as the lesser of the mapped geometric mean peak ground accelerations and the probabilistic geometric mean peak ground accelerations indicated in the table below.

Geologic Unit	Site Class	Estimated shear wave velocity, V_{s30} (m/s)	MCE_G PGA_M	
			Mapped	Probabilistic
Bedrock	C	455	1.10g	1.17g
Alluvium	D	270	1.10g	1.03g

5.1.4 Ground Failure

Ground failure is a general term for seismically induced, secondary, permanent ground deformation caused by strong ground motion. This includes liquefaction, lateral spreading, ground lurching, seismic settlement of poorly consolidated materials (dynamic densification), differential materials response, sympathetic movement on weak bedding planes or non-causative faults, slope failures, and shattered ridge effects.

The majority of the project site is underlain by bedrock materials that are not susceptible to liquefaction. The alluvial soils present the site (see Geologic Map, **Plate I**) are not designated on the State of California Seismic Hazard Zone Map for the Newhall Quadrangle as a zone in which investigation of potentially liquefiable materials is required. The depth to historic high ground water at the site is greater than 50 ft. Based on the preceding factors, the potential for liquefaction and associated seismic settlements and lateral spreading is therefore considered very low.

Relatively loose granular alluvial soils located within and adjacent to the active Newhall Creek channel and within minor tributary canyons adjacent to the road alignment may be prone to dynamic densification as a result of future earthquake shaking. Evaluation of the potential for dynamic densification should be performed at the design stage. Typically the potential for dynamic densification of these materials can be mitigated by removal of the materials and then replacing them as compacted fill. Potential for seismic settlement (dynamic densification) is negligible in the bedrock portions of the site.

The hillside areas directly adjacent to the road alignment are designated on the State of California Seismic Hazard Zone Map for the Newhall Quadrangle as a zone in which investigation of potential for earthquake-induced landslides is required (see **Figure 4**). The potential for earthquake-induced slope failures and surficial failures on the critical natural and proposed design slopes will need to be evaluated at the design stage and, if necessary, provide mitigation measures. Cut and fill slopes constructed per the California Building Code typically are not subject to earthquake-induced failures. Typical mitigation for slopes prone to earthquake-induced failures include avoidance, removal of surficially unstable materials, laying back the slope to a shallower gradient, buttressing, construction of shear keyways, or debris basins and walls that may be designed to divert and/or collect the calculated volume of material expected to fail. Additionally, no landslides have been mapped at the project site. Due to the relatively shallow dip of the bedding of the Pacoima Formation and the Saugus Formation bedrock, and of the flat-lying alluvial deposits that underlie the site, the potential for differential materials response and slippage along weak bedding planes is considered to be negligible.

5.2 Slope Stability

Proposed slopes, future grades, and existing grades are not shown on the current project plans. It is anticipated that both cut and fill slopes will be necessary at various locations along the proposed alignments and that cut slopes will expose Saugus Formation and Pacoima Formation bedrock. These proposed slopes should be designed and constructed at gradients of 2:1 horizontal to vertical or shallower. All constructed slopes should be evaluated by a geotechnical firm for conformance to applicable requirements/standards for gross and surficial slope stability. If it is determined that proposed slopes do not satisfy required factor of safety requirements for gross slope stability, mitigation measures will have to be designed based on results of slope stability analyses. If surficial stability of the proposed slopes is determined to be insufficient, measures to mitigate surficial stability will be required. This may include but not be limited to the following:

1. Avoidance.
2. Stability fills.
3. Flattening of slopes to 3:1 (h:v), or flatter.
4. Seeding/planting of slopes.
5. Guniting of slopes.
6. Mechanically Stabilized Earth (MSE) slopes.

Natural slopes adjacent to the proposed road alignments exposing adverse geologic bedding conditions or steep gradients should be evaluated. If it is determined that these slopes do not satisfy required factor of safety requirements the natural slopes may be stabilized with Buttress Fills or Shear Keys designed by the Project Geotechnical Engineer.

Laboratory testing of fill source materials is required to evaluate both gross and surficial stability of the proposed fill slopes, including remedial Buttress Fills and Stability Fills. Shear strength testing should be performed on soil samples that represent the mixture of materials that will be placed in the proposed fills.

Steep natural slopes adjacent to the proposed road alignment should also be evaluated for potential debris flow hazards. Avoidance of the hazard by selective structural locations, construction of impact or debris walls and/or debris basins, control of run-off or removal of loose surficial materials can be used to mitigate debris flow hazards.

5.3 Deep Fills

Based on preliminary review of the proposed road alignments, deep fill areas (i.e. fills deeper than 40 ft below proposed grade) are not anticipated.

5.4 Soil Compressibility

Rapidly buried, unsaturated sediments, such as colluvium and alluvium, commonly contain extensive voids and, as a consequence, are subject to hydro-compression (collapse) settlement when inundated. Hydro-compression occurs when water enters sediments and reorients the sediment particles into a more compact arrangement with fewer and smaller voids. Compacted fills and structures constructed over deposits prone to hydro-compression may experience settlement and associated distress and damage.

Based on explorations for the adjacent Old Town Newhall Library site, alluvial soils at the project site are anticipated to be typically medium dense to depths of 30 to 40 ft, with local loose zones in the upper 10 ft. The density of the artificial fill placed below the railroad tracks is currently undefined. The potential for settlement within these units should be addressed in more detail during a future geotechnical investigation at the design stage.

If soils subject to hydro-compression or consolidation are identified at the site, settlement and potential adverse impacts to the proposed road improvements can be mitigated by removal and recompaction of loose or soft material.

The phenomenon of hydro-compression does not apply to the bedrock deposits that underlie most of the site. Further exploration should be performed at the site to evaluate if hydro-compression-prone materials, such as colluvium, are present in areas where pavements or compacted fills are proposed.

5.5 Erosion Potential and Drainage

Fill, bedrock, and soil materials at the site will be susceptible to erosion if drainage features to control sheet flow over the ground surface are not provided. The drainage features should be designed to prevent water from ponding on graded areas and from flowing over natural or constructed slopes, and should direct surface water to designed debris basins or natural drainage courses, where applicable. Debris material generated by erosion of site materials should be contained inside the site boundaries.

The potential for erosion of the banks of Newhall Creek should be evaluated by the project civil engineer.

5.6 Dam Inundation and Flooding

No dams currently exist in the Newhall Creek Drainage and the site is not in a dam inundation area per the Flood and Inundation Hazard Map (Plate 6) of the Los Angeles County Safety Element of the General Plan. The potential for dam inundation is therefore considered nonexistent. The potential for flooding of Newhall Creek should be evaluated by the project Civil Engineer.

5.7 Construction Considerations

5.7.1 Rippability

The site is underlain by Saugus Formation, Pacoima Formation, Quaternary alluvium and artificial fill. These materials can be ripped with standard grading equipment.

5.7.2 Oversized Material

The alluvial and bedrock materials underlying the site may contain significant quantities of oversized material. Additionally, the dumped fill located along the southwest bank of Newhall Creek contains common blocks of asphalt and concrete as well as scattered boulders, car parts, and other oversized debris. Any oversized material that may be encountered during construction should not be incorporated into potential compacted fill during grading operations. Specifications and guidelines for handling and disposal should be addressed by the project geotechnical engineer at the design stage.

5.7.3 Expansion Potential of Soils

The site alluvial materials are generally granular and are not typically expansive in nature. However, fine-grained units of the Saugus Formation are known to have significant expansion potential when exposed to water. In addition, Pacoima formation bedrock, artificial fill, colluvium and alluvial deposits present at the site may contain material with significant expansion potential. Expansive materials at the site should be evaluated by the Project Geotechnical Engineer during the grading plan stage of development. Expansion potential of site soils can be mitigated by controlling the water content and density of fill soils, by specifying embedment and reinforcement of structures, and by removing the expansive materials and replacing them with compacted material with low expansion potential.

5.7.4 Soil Corrosivity

Past experience with similar soils on nearby sites suggests that the on-site soils likely have a low concentration of sulfate and chloride, and low acidity. This indicates a low potential for corrosion of concrete and, therefore, it is anticipated that Type I or II Portland cement will be satisfactory for use at the site. The resistivity of similar soils near the site tested by this firm indicates that they are typically moderately corrosive to ferrous metals. The corrosive characteristics of the site soils should be verified with laboratory testing at the design stage. If corrosive soils are encountered, options to mitigate potential corrosive soils include protective wraps and coatings for buried metal pipes and special types of cement that are resistant to corrosion.

5.7.5 Shrinkage and Bulking of Materials

Typically, soil, colluvium, uncompacted artificial fill, alluvial deposits, and terrace deposits (i.e. Pacoima formation bedrock) reduce in volume (“shrink”) by up to about 10 percent when excavated and subsequently recompacted. In contrast, Saugus Formation bedrock typically increases in volume (“bulk”) by up to about 5 percent when excavated and recompacted. In order to evaluate the cut-fill balance of the proposed grading, shrinkage/bulking of on-site materials including landslide debris should be estimated at the design stage.

5.8 Retaining Walls

The grades at the northeast end of Lyons Avenue and adjacent portions of Railroad Avenue will need to be raised in order to tie into the existing grade at the railroad crossing. It is our understanding that retaining walls may be used to accommodate the changes from the proposed grades to adjacent properties proposed to remain at existing grades. Geotechnical parameters for these walls and for design of the proposed box culvert and associated wing walls for the Newhall Creek crossing should be addressed at the design stage.

5.9 Oil Wells and Water Wells

Review of the Munger Map Book and California Division of Oil and Gas records indicates that no oil wells have been drilled on or immediately adjacent to the site. If any undocumented oil wells are encountered during future construction operations at the site, their location(s) should be surveyed and the current well conditions evaluated.

Review of LACFCD records indicates that water wells have been drilled in the vicinity of the proposed road alignments (see Water Well Location Map, **Figure 2**). If one of these water well is within the proposed road alignment, or if a water well is encountered during future construction operations at the site, the location should be surveyed and the potential impacts to well conditions should be evaluated.

6.0 PROJECT FEASIBILITY

The proposed development is feasible from a geologic and geotechnical standpoint and will be safe from geologic hazards provided that the geologic and geotechnical recommendations outlined in this report, along with appropriate building and grading codes, are taken into account during the planning, design and construction phases of the project.

7.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations summarize the primary geologic and geotechnical issues that may impact the proposed development:

1. Potential for primary ground rupture on a fault at the site is considered to be **low.**
2. Peak ground acceleration (PGA) consistent with maximum considered earthquake (MCE) ground motions is expected to be 1.03g in alluvial portions of the site (and 1.10g in portions of the site where bedrock outcrops or is present at shallow depth.
3. The alluvium that underlies portions of the site is **not** designated as potentially liquefiable on the State of California Seismic Hazard Zone Map for the Newhall Quadrangle. In addition, historic high ground water elevations are greater than 50 ft in depth. Therefore the potential for liquefaction of alluvium is considered **very low**.
4. The potential for seismic settlement (dynamic densification) during future seismic events is non-existent in the bedrock portions for the site but should be evaluated in site alluvial soils, colluvium, and existing artificial fills to remain in place.
5. All slopes should be evaluated by the Project Geotechnical Engineer at the planning and design stages. The hillside area of the site **is** designated on the State of California Seismic Hazard Zone Map to have earthquake-induced slope instability. However, the potential for earthquake-induced slope failures is considered **low** provided that future

geologic and geotechnical evaluations and recommendations for slope stability are incorporated into design and construction.

6. No landslides have been mapped on the subject site.

7. Stability of cut slopes that are constructed at gradients of 2:1 or shallower are anticipated to expose favorable bedding conditions and be grossly stable. However, cut slopes will require subsurface investigation to determine the specific geologic conditions for evaluation by the Geotechnical Engineer. Remedial measures will be required where ascending or descending cut slopes are not stable as determined by geologic or geotechnical stability analyses.

8. A study should be conducted at the design stage to confirm the geologic conditions of natural slopes. This study should include subsurface investigation to determine the specific geologic conditions for evaluation by the Geotechnical Engineer. Remedial measures will be required where ascending or descending slopes are not stable as determined by geologic or geotechnical stability analyses.

9. A study should be conducted at the design stage to evaluate potential debris flow hazards on steep natural slopes ascending from the proposed road alignments. Avoidance of the hazard by selective structural locations, construction of impact or debris walls and/or debris basins, control of run-off or removal of loose surficial materials can be used to mitigate debris flow hazards.

10. Rapidly buried silty sediments such as thick colluvium and alluvium may be subject to hydro-compression. A study should be conducted to evaluate the hydro-compression potential of colluvial deposits and portions of the alluvium. Materials characterized as susceptible to hydro-compression tests in the laboratory can be mitigated by removal prior to the placement of fill. Specific recommendations should be provided at the design stage.

11. The bedrock is moderately consolidated, which indicates that grading operations can be performed with conventional equipment.

12. Cobbles and small boulders are likely present within the alluvium and bedrock. This oversize material may present difficulties during cutting operations with some types of equipment. In addition, oversize material will require special handling during fill construction.

13. A study should be conducted to evaluate the expansive potential of fine-grained soils during the design stage. If potentially expansive units are encountered in the street grades during construction, they should be evaluated by Expansion Index (EI) tests by

the Project Geotechnical Engineer relative to mitigations. The expansive material can be removed to a specified depth determined by the Project Geotechnical Engineer and replaced with soil with very low to non-expansive characteristics. Alternatively, the expansive soil may be treated with additives to lower the expansion potential.

14. Soils on site may be corrosive to concrete and ferrous metals. Soil moisture, chemistry, and other physical characteristics all have important effects on corrosivity. Testing during development will indicate what special measures, such as cement type in concrete and corrosion protection for metallic pipes, may be required for construction.

15. Planting and irrigation of cut slopes and fill slopes should be included in future design phases in order to improve surficial stability of slopes and to mitigate potential for erosion.

8.0 LIMITATIONS

This report has been prepared by Allan E. Seward Engineering Geology, Inc. for the exclusive use of the City of Santa Clarita and its design consultants for the specific site discussed herein. This report should not be considered transferable. Prior to use by others, this firm must be notified, as additional work may be required to update this report.

In the event that any modification in the location or design of the proposed development is planned, the conclusions and recommendations contained in this report will require a written review by this firm with respect to the planned modifications.

The proposed development is located in southern California, a geologically and tectonically active region, where large magnitude, potentially destructive earthquakes are common. Therefore, ground motions from moderate or large magnitude earthquakes could affect the project site during the design life of the project. The current standards for construction provided in the California Building Code are designed to safeguard against major failures and loss of life, but are not intended to prevent damage, maintain function or provide for easy repair. Conformance to code standards does not constitute any kind of guarantee or assurance that significant structural damage will not occur in the event of a maximum level of earthquake ground motion. However, it is reasonable to expect that a well-planned and constructed structure will not collapse in a major earthquake and that protection of life will be reasonably provided, but not with complete assurance.

Typically, faulting is confined to the area adjacent to a known fault. However, absolute assurance against future fault displacement in other areas is not possible in tectonically active regions because new faults can form over time and long inactive (pre-Holocene) faults may be reactivated in response to evolving tectonic stresses and geologic conditions in the earth's crust. Therefore, the timing, location and magnitude of new ground surface ruptures during a seismic event cannot be known with certainty.

In performing these professional services, this firm has used the degree of care and skill ordinarily exercised under similar circumstances by reputable geologists and geotechnical engineers practicing in this or similar localities. It should be recognized that subsurface conditions can vary in time, and laterally, and with depth at a given site. Therefore, our conclusions and recommendations are **professional opinions** and are **not meant** to be a control of nature. We make no other **warranty** either **expressed** or **implied**.

This opportunity to be of service is appreciated. If you have any questions regarding this report, please contact us.

Respectfully submitted,

Eric J. Seward, CEG 2110
Principal Engineering Geologist
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The following attachment and appendix complete this report.

References

APPENDIX A

Geologic Overview Map	Figure	1
Water Well Location Map	Figure	2
Fault and Earthquake Epicenter Location Map	Figure	3
Seismic Hazard Map	Figure	4
Summary of LAFCD Water Well Data	Table	1
Summary of Nearby Faults	Table	2
Exhibit for Proposed Project, Alternatives 1, 2, and 3		
Geologic Map	Plate	I

Distribution: (1) David Evans and Associates, Inc. (Hard copy and 1 Electronic copy)
Attn: Mr. Gabriel Rodriguez
(1) Hall and Foreman, Inc. (Electronic copy only)
Attn: Mr. Henrik Nazarian

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Reports by Geotechnologies, Inc.

1. **Preliminary Geotechnical Engineering Investigation**
   Proposed Mixed Use Development
   Northwest Corner of 13th Street and Arch Street
   Newhall, California
   Dated: June 18, 2004 – File No. 18648

2. **Soil Cement Bank Specifications**
   Proposed Residential Development,
   Northwest Corner of 13th Street and Arch Street
   Newhall, Santa Clarita, California
   Dated: September 13, 2005 – File No. 18648

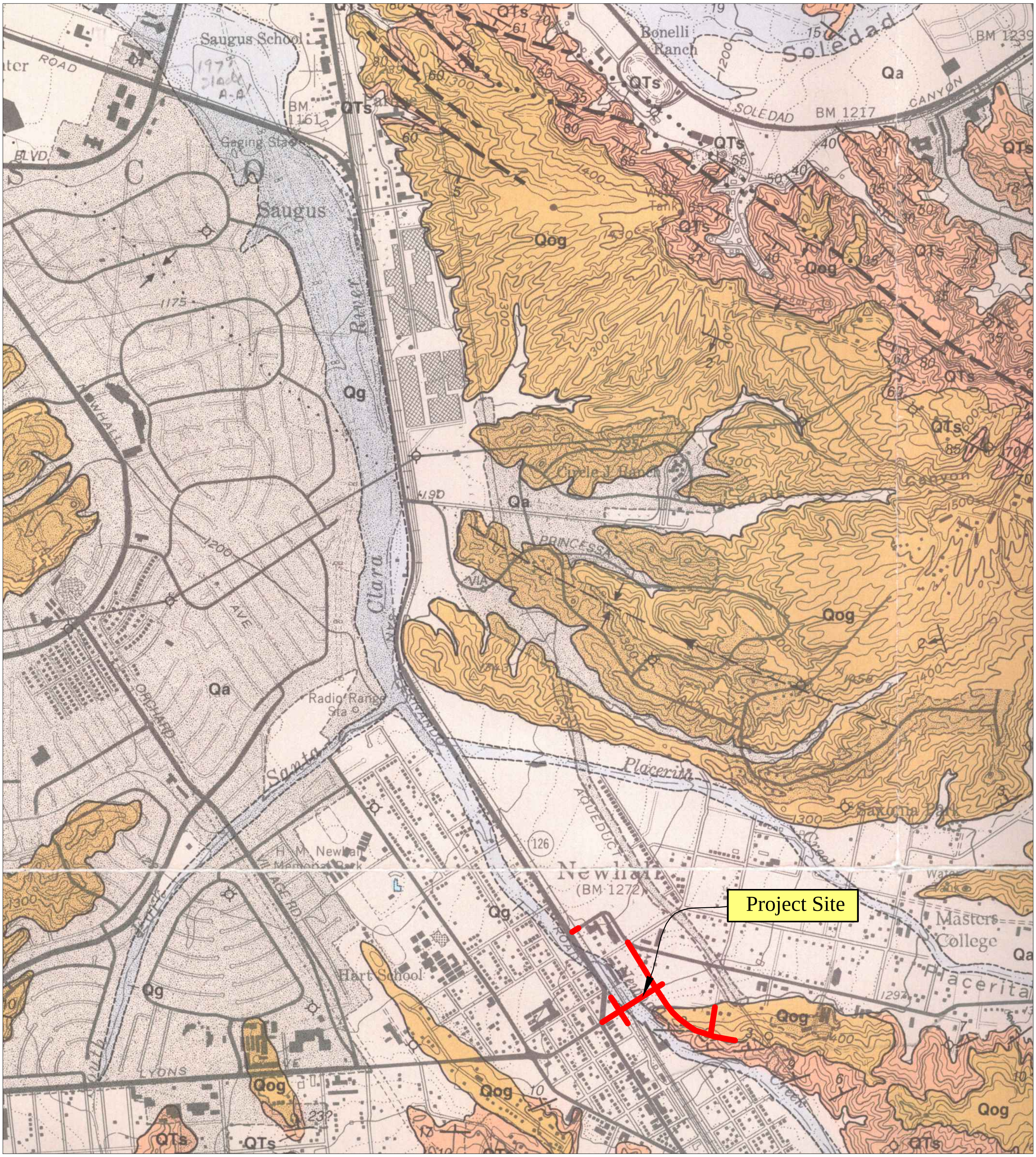
Reports by Allan E. Seward Engineering Geology, Inc

3. **Geologic/Geotechnical Report**
   Preliminary Geologic and Geotechnical Report
   Review of Site Conditions
   Old Town Newhall Library
   Area Adjacent to Spruce Street, Between Lyons Avenue and 11th Street
   City of Santa Clarita, California
   Dated: June 4, 2009 – JN: 09-2280

4. **Geologic and Geotechnical Report**
   EIR-Level Review of Site Conditions
   At-Grade Railroad Crossing for Lyons Avenue Extension
   Newhall Area
   City of Santa Clarita, California
   Dated: January 7, 2010 – JN: 10-2303I

5. **Geologic/Geotechnical Report**
   Laboratory Testing for Scour Analysis and Preliminary Pavement Design
   The Construction of Dockweiler Roar Extension to Lyons Avenue Including the New Lyons Avenue Crossing Over the Railroad Tracks
   City of Santa Clarita, California
   City of Santa Clarita Project No. S3023
   Dated August 26, 2014 – JN: 14-2393

Appendix A



Source: Dibblee Geological Foundation Map #DF-56, (Dibblee, 1996)

Approximate Scale: 1"=2,000'

Qa - Quaternary Alluvium
Qog - Quaternary Older Gravels
QTs - Saugus Formation

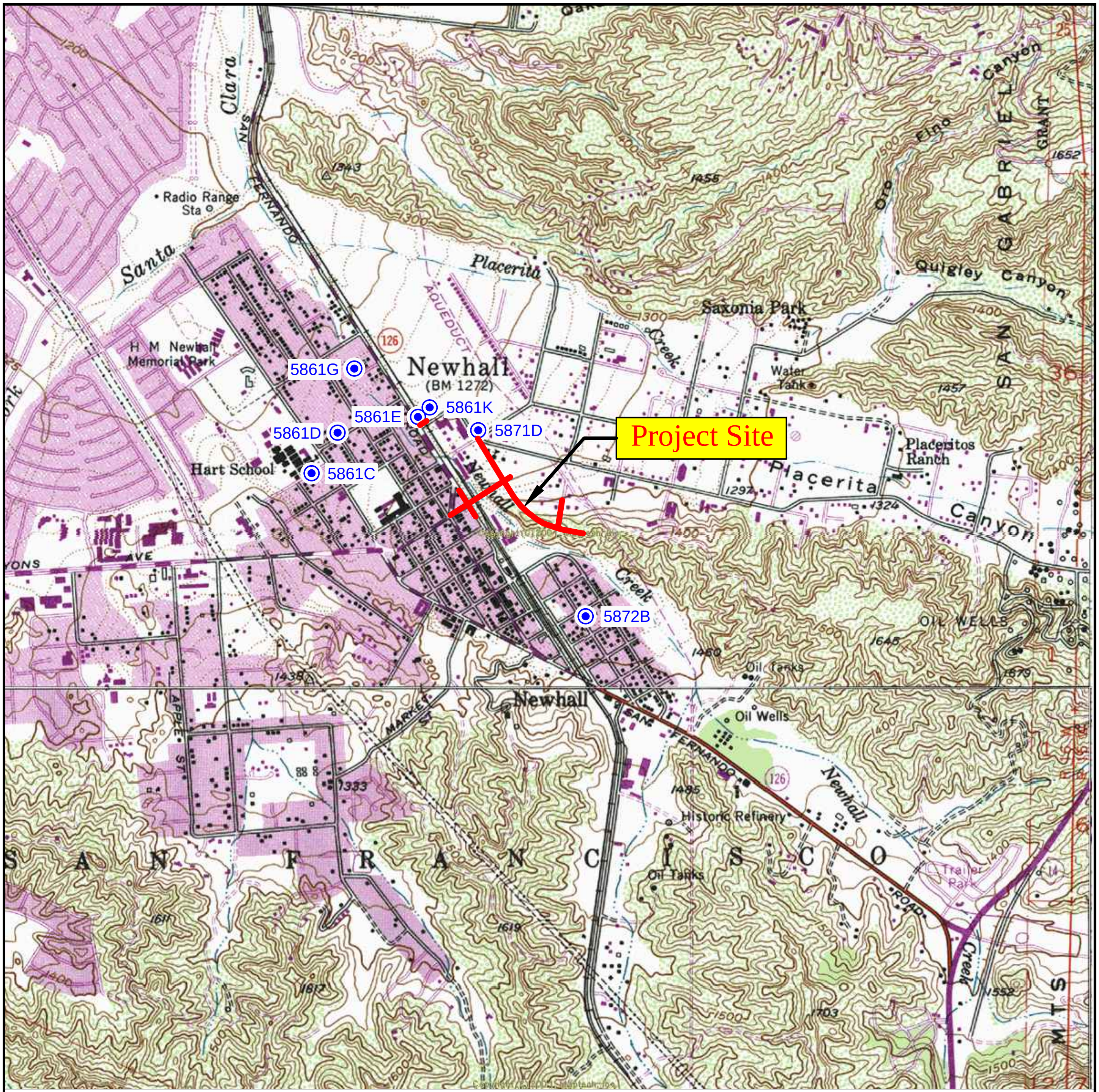
N

FIGURE 1

ALLAN E. SEWARD
ENGINEERING GEOLOGY, INC.
Geological and Geotechnical Consultants

GEOLOGIC OVERVIEW MAP

Job No.: 14-2393	*Date: 10/17/14*



Legend

6981E Location of LACFCD water well

Source: U.S. Geological Survey Newhall, and Oat Mountain Quadrangles, Dated 1952 (Photorevised 1969), Dated 1952 (Photorevised 1969), Respectively

Approximate Scale: 1"=2,000'

NOTE: THIS IS NOT A SURVEY OF THE PROPERTY

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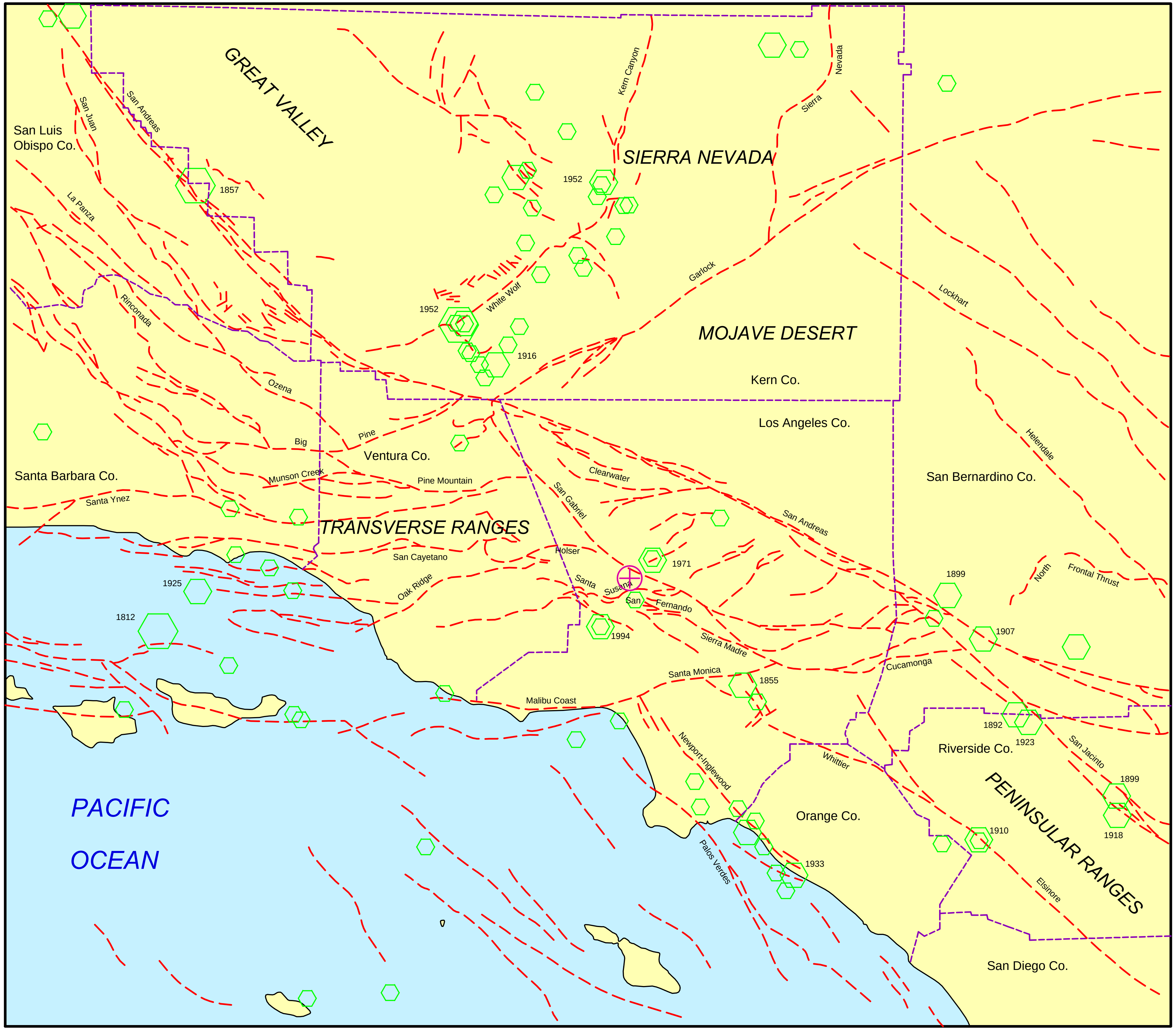
Figure 2

ALLAN E. SEWARD
ENGINEERING GEOLOGY, INC.
Geological And Geotechnical Consultants

WATER WELL LOCATION MAP

Job No.: 14-2393	Date: 10/17/14



40 30 20 10 0 40 KILOMETERS

Approximate Scale 1 : 1,250,000

30 20 10 0 30 MILES

EXPLANATION

APPROXIMATE LOCATION OF MAJOR KNOWN FAULTS

San Andreas

EARTHQUAKE EPICENTERS

Location	Magnitude
⬡	5.0 - 5.9
⬡	6.0 - 6.9
⬡	7.0 - 7.9

APPROXIMATE LOCATION OF SUBJECT SITE

Compiled and modified from: Jennings (1994), Real et al. (1978), Yerkes (1985), Ziony and Jones (1989), and Shakal et al. (1994)

N

ALLAN E. SEWARD
ENGINEERING GEOLOGY, INC.
Geological and Geotechnical Consultants

FAULT AND EARTHQUAKE EPICENTER LOCATION MAP

Job No.: 14-2393

Date: 10/15/14 | *Figure:* 3

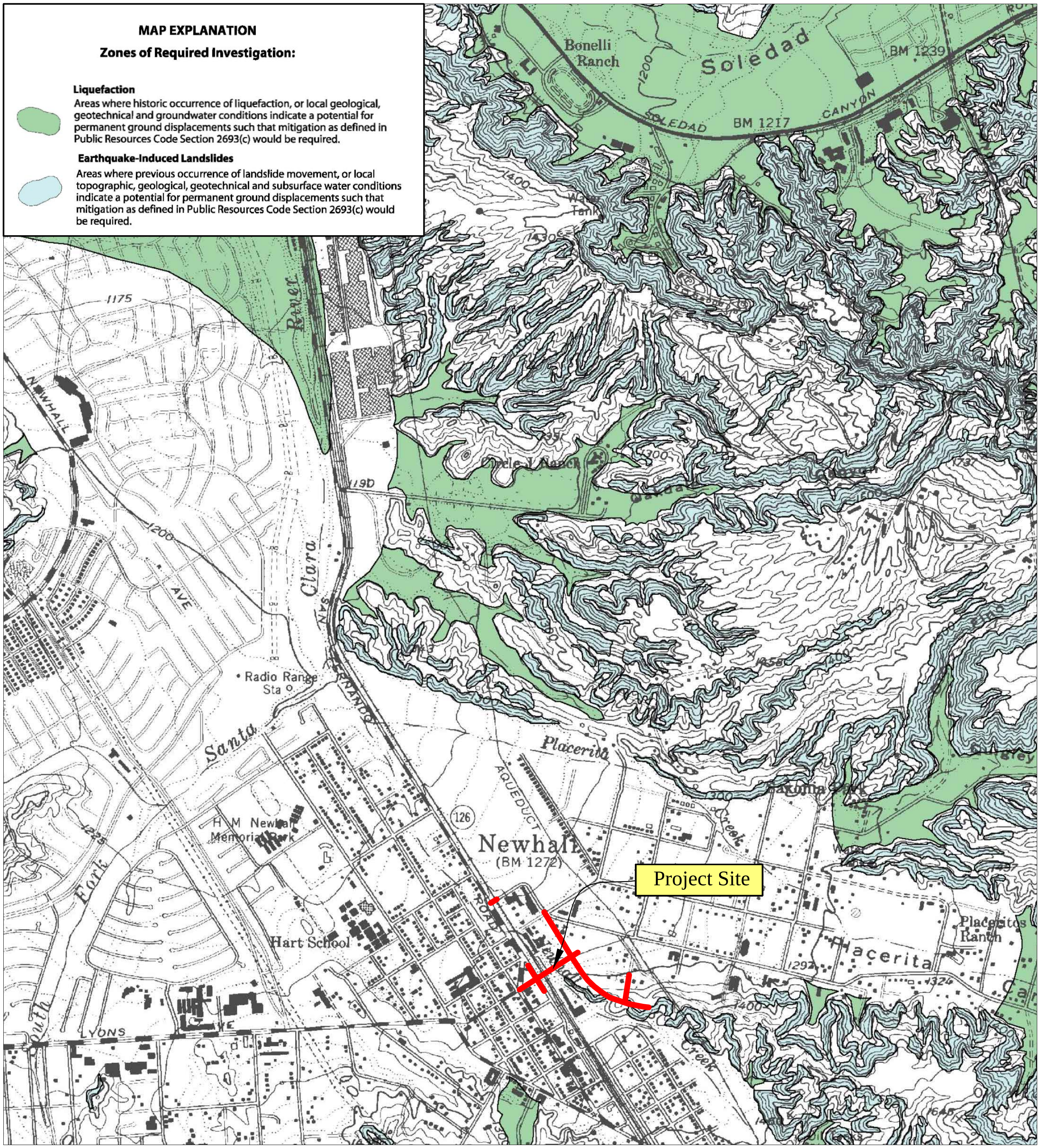


Figure 4

Source: Seismic Hazard Zones Maps for the Newhall Quadrangle - Official Map Released 1/1/98

Approximate Scale: 1"=2,000'

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ALLAN E. SEWARD
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Geological and Geotechnical Consultants

Seismic Hazard Map

Job No.: 14-2393	*Date:* 10/17/14

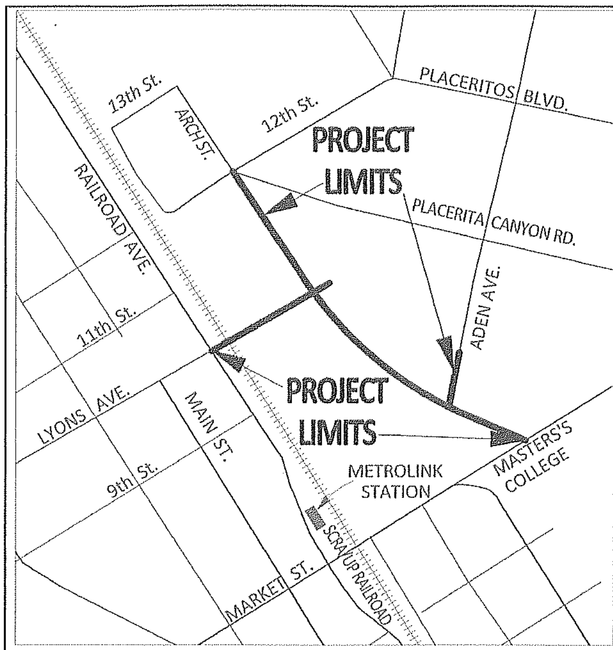
Table 1 – SUMMARY OF LACFCD WATER WELL DATA

LACFCD Well Number	Surface Elevation	Historic High			Historic Low			Monitoring Period
		Depth	Elevation	Date	Depth	Elevation	Date	
5861C	1231.0	47.5	1183.5	11/24/58	179.3	1051.7	11/7/68	11/7/57 to 4/30/81
5861D	1236.5	103.2	1133.8	12/11/56	202.1	1034.4	10/28/67	12/11/56 to 11/30/88
5861E	1249.0	102.0*	1147.0	11/29/60	212.0	1037.0	10/15/91	11/19/59 to 10/15/08
		33.0**	1216.0	10/15/05				
5861G	1232.0	71.0	1161.0	4/14/76	81.3	1150.7	5/13/83	4/11/76 to 5/13/83
5861K	1250.0	102.0	1148.0	11/15/06	222.0	1028.0	10/15/91	10/15/91 to 10/15/08
5871D	1270.0	100.2	1169.8	4/6/73	230.8	1039.2	10/30/91	10/22/48 to 11/6/06
5872B	1290.0	66.6	1223.4	5/5/80	78.4	1211.6	11/8/77	4/14/76 to 4/8/86

Note: All depths and elevations in feet
* The historic high depth to ground water recorded between 1959 and 2000 is 102.0 ft
** The historic high depth to ground water recorded between 2000 and 2008 is 33.0 ft

Table 2 – SUMMARY OF NEARBY FAULTS

Fault Name	Closest Distance to Site (km)		Maximum Magnitude	Slip Rate (mm/yr)
	Surface Trace	Surface Projection of Rupture Area		
San Gabriel	3.7	3.7	7.0	1.0
Holser	4.3	3.1	6.5	0.4
Northridge (E. Oak Ridge)	5.1	5.1	6.9	1.5
Santa Susana	7.1	0.0	6.6	5.0
Sierra Madre (San Fernando)	9.9	4.7	6.7	2.0
Verdugo	16.7	15.8	6.7	0.5
Oak Ridge (on shore)	17.8	17.8	6.9	4.0
San Cayetano	22.2	22.2	6.8	6.0
Sierra Madre	24.5	21.4	7.0	3.0
Simi-Santa Rosa	26.7	26.7	6.7	1.0
San Andreas	33.1	33.1	7.8	34.0



PROPOSED PROJECT
N.T.S.

Hall & Foreman, Inc.
Engineering · Planning · Surveying
25152 SPRINGFIELD COURT, SUITE 350 · SANTA CLARITA, CA 91355 · 661-284-7400

Job Number: 120197.0000
Date: 8/13/13
Scale:
Sheet 1 of 1 Sheets

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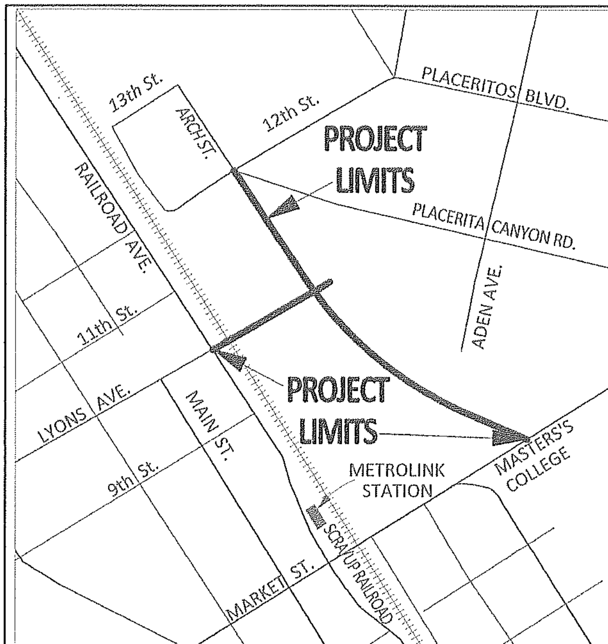

ALTERNATIVE 1
N.T.S.

Hall & Foreman, Inc.
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25152 SPRINGFIELD COURT, SUITE 350 · SANTA CLARITA, CA 91355 · 661-284-7400

Job Number: 120197.0000
Date: 8/12/13
Scale:
Sheet 1 of 1 Sheets

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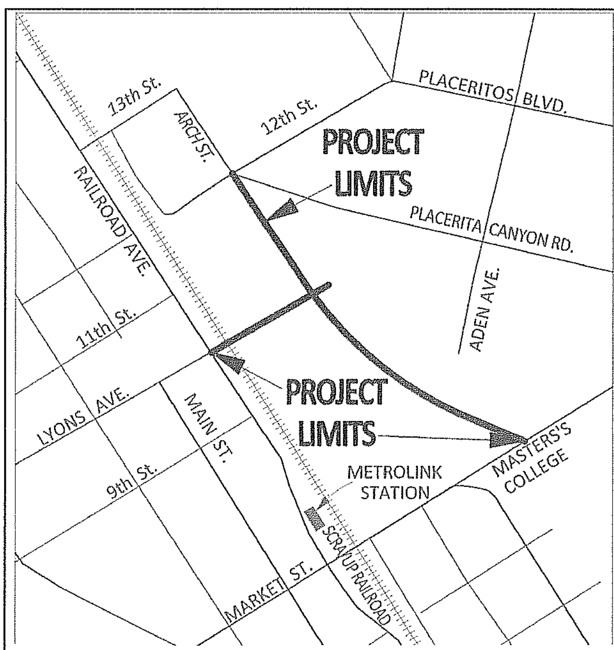

ALTERNATIVE 2
N.T.S.

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25152 SPRINGFIELD COURT, SUITE 350 · SANTA CLARITA, CA 91355 · 661-284-7400

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Sheet 1 of 1 Sheets

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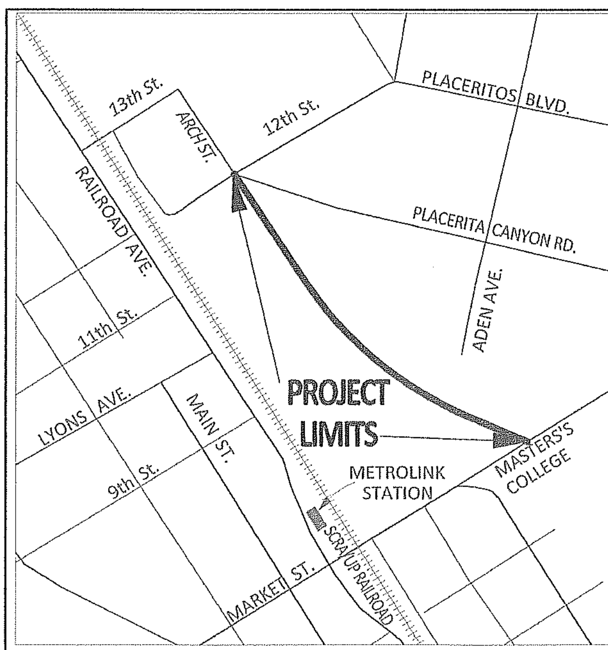

ALTERNATIVE 3
N.T.S.

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25152 SPRINGFIELD COURT, SUITE 350 · SANTA CLARITA, CA 91355 · 661-284-7400

Job Number: 120197.0000
Date: 8/12/13
Scale:
Sheet 1 of 1 Sheets

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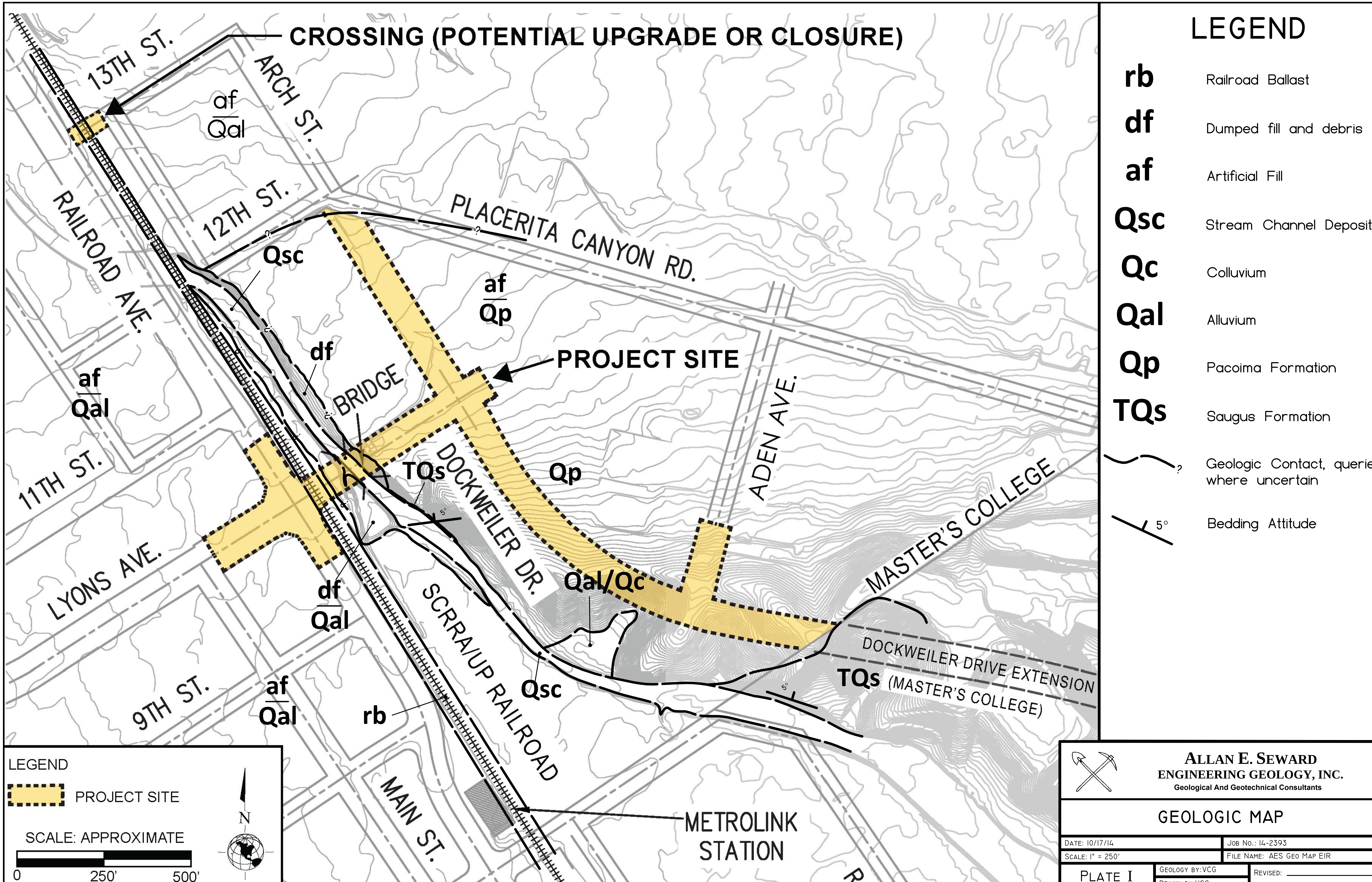

CROSSING (POTENTIAL UPGRADE OR CLOSURE)
13TH ST.
12TH ST.
11TH ST.
9TH ST.
ARCH ST.
RAILROAD AVE.
LYONS AVE.
PLACERITA CANYON RD.
ADEN AVE.
DOCKWEILER DR.
MASTER'S COLLEGE
SCRRA/UP RAILROAD
MAIN ST.
PROJECT SITE
BRIDGE
DOCKWEILER DRIVE EXTENSION
TQs (MASTER'S COLLEGE)
METROLINK STATION
af/Qal
af/Qp
df/Qal
Qsc
df
Qp
TQs
Qal/Qc
rb
LEGEND
rb Railroad Ballast
df Dumped fill and debris
af Artificial Fill
Qsc Stream Channel Deposits
Qc Colluvium
Qal Alluvium
Qp Pacoima Formation
TQs Saugus Formation
Geologic Contact, queried where uncertain
5° Bedding Attitude
LEGEND
PROJECT SITE
SCALE: APPROXIMATE
0 250' 500'
N
ALLAN E. SEWARD
ENGINEERING GEOLOGY, INC.
Geological And Geotechnical Consultants
GEOLOGIC MAP
DATE: 10/17/14
JOB NO.: 14-2393
SCALE: 1" = 250'
FILE NAME: AES GEO MAP EIR
PLATE I
GEOLOGY BY: VCG
DRAWN BY: VCG
REVISED: