Geologic/Geotechnical Report, "Via Princessa Road Alignment and Adjacent Parcels Feasibility Study," prepared by Allen E. Seward Engineering Geology, Inc., September 13, 2010

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September 13, 2010 Job No.: 10-2254C

City of Santa Clarita
Department of Public Works
23920 Valencia Boulevard, Suite 300
Santa Clarita, CA 91355

Attention: Mr. Harry Corder

Subject: **GEOLOGIC/GEOTECHNICAL REPORT**
Via Princessa Road Alignment and adjacent parcels Feasibility Study

Project: Via Princessa Road Alignment and adjacent parcels owned by NTS, Camarillo, Sikand, Pacific Crest Santa Clarita, Golden Valley High School, and Department of Water and Power
City of Santa Clarita, California

References: at end of text

Dear Mr. Corder:

Per our proposal dated June 22, 2009 we have prepared this brief summary report, maps and cross sections describing (illustrating) the general landslide geometry, our conclusions regarding the stability of the landslide, and preliminary recommendations for mitigation. It is our understanding that the preliminary recommendations contained in this report will be used by others as part of the economic feasibility assessment of the parcels adjacent (NTS, Camarillo, Sikand, Pacific Crest Santa Clarita, Golden Valley High School, and Department of Water and Power) to the proposed Via Princessa Road Alignment from Sheldon Avenue to Golden Valley Road.

The conclusions in this report are based on our recent findings combined with our previous findings performed for Pacific Terra and data from other consultants that worked on and adjacent to the project site.

The scope of work is described below.

1.0 SCOPE OF INVESTIGATION

This investigation included the following tasks:

1. Review of pertinent in-house data compiled by this office.
2. Review of the published references listed at the end of this report.
3. Review of previous consultant data and reports acquired by this firm addressing the site and the mapped landslides referenced at the end of this report.
4. Review of the following aerial photographs:

YEAR	PHOTOS	SCALE	AGENCY
1928	E-246 and E-247	1"=1,675' (±)	Fairchild
9/28/1959	AXJ-16W-63, 64and 65	1"=2,000' (±)	USDA
8/24/1980	780-213 and 780-214	1"=4,000'(±)	USDA

5. Coordination with Underground Service Alert, Impact Sciences, N.T.S., the City of Santa Clarita, equipment contractors, and Sikand.
6. Geologic field mapping of the site.
7. Guide the dozer operator during building of access roads.
8. Drilling, sampling and logging of 3 additional 24" bucket-auger borings drilled to a maximum depth of 100 feet.
9. Laboratory testing of selected bulk and ring (Modified California Drive and hand driven) samples obtained during our subsurface investigations. Testing included dry density and moisture content of in-situ soils, Atterberg Limits, and direct re-shear.
10. Review of the site topography provided to our office in computerized format (AutoCAD), by Sikand. This computerized map was used as the base for our 100-scale Preliminary Geologic Map, **Plate I**. We make no representations regarding the accuracy of the base map.
11. Geologic and Geotechnical review of the 1"=600' scale plan – Conceptual Plan, dated 6/16/09. This plan was prepared by Sikand Engineering and illustrates the road

alignment with proposed grading contours and preliminary limits of potential grading. This plan is used as the base map for our Preliminary Landslide Remediation Map (**Plate II**). We make no representation regarding the accuracy of the base map.

12. Incorporation of data collected for this investigation with our previously collected data (Pacific Terra) and previous consultant's data. Transfer of this data into an AutoCAD format onto a comprehensive Preliminary Geologic Map (**Plate I**). Geologic interpretation of the data transferred to the Preliminary Geologic Map.

13. Preparation of 4 new cross sections and revision of 2 previous consultants cross sections illustrating anticipated geologic conditions and the proposed grades shown on the Sikand Conceptual Plan, dated 6/16/09.

14. Perform slope stability analysis on the interpreted basal slide plane and potential mitigations measures.

15. Preparation of this report summarizing the results of our investigations and our conclusions and recommendations.

2.0 BACKGROUND

This office previously performed limited geologic and geotechnical investigations for the large landside complex on the NTS property, which included excavating, logging, and sampling of three 24" diameter bucket-auger borings (B-1, B-2 and B-3) drilled to a maximum depth of 126 ft. For our most recent investigation 3 additional 24" diameter bucket-auger borings (B-4, B-5 and B-6) were drilled to a maximum depth of 100 ft.

Previous engineering geology and geotechnical investigations for the site and vicinity include studies by Geolabs-Westlake Village, GeoKinetics, Kovacs-Byer & Associates, Converse Consultants, Petra Geotechnical, Robert Stone & Associates, Leighton and Associates, and RT Frankian and Associates. See references at the end of text for reviewed reports.

3.0 PROPOSED DEVELOPMENT

The City of Santa Clarita plan for improving the City's infrastructure is considering the westward extension of Via Princessa from its existing westernmost portion located approximately 250 ft west of Sheldon Avenue to Golden Valley Road. This proposed road alignment traverses property owned by NTS, Camarillo, Gunjit Sikand, Pacific Crest Santa Clarita, LLC, Golden Valley High School, and Department of Water and Power. It is our

understanding that construction will need financial participation in part by the development of the parcels adjacent to the proposed Via Princessa Road Alignment. Sikand Engineering provided a Conceptual Grading concept of how the adjacent properties may be developed.

4.0 GEOLOGIC FINDINGS

For a detailed description of the local and regional geology and the Geologic Units shown on the Preliminary Geologic Map and Cross Sections please refer to our Geologic/Geotechnical Report dated August 13, 2010 "EIR-Level Review of Road Alignment for Via Princessa East from Golden Valley Road to 250 feet West of Sheldon Avenue".

Numerous investigations and studies relating to the megalithic landslide complex have occurred on and adjacent to the project site. Review of the extensive references and associated data listed at the end of this report indicate agreement on the existence of a large landslide complex composed of ancient to historically active landsliding. Some work interprets portions of this landslide as being disturbed bedrock based on the relatively intact appearance of the rock observed in borings and cut-slopes. However, based on the geomorphology, variable bedding attitudes and the presence of a continuous weak clay plane at a specific horizon encountered in all of our exploratory borings, the majority of the subject site is underlain by landslide affected bedrock of the Saugus Formation. The weak clay horizon is referred to herein as the Friendly Valley Horizon (FVH) which occurs at or very near the boundary of the Saugus Formation (TQs) and the upper facies of the subjacent Sunshine Ranch member of the Saugus Formation (Tsr). The FVH encountered in our borings generally consists of dark brown plastic claystone varying from 1 ft to 1.5 ft in thickness. Many of the borings performed by others did not extend deep enough to encounter the FVH and indicate in-place bedrock on their boring logs. However, many of the bedding attitudes on these logs do not match the regional geologic structure. This is a fairly common mistake in translational (block) landslides within the Saugus Formation where thick sequences of sandstone occur above a relatively thin clay plane and the consultants' data base is limited. Translational type landslide failures are sometimes more difficult to discern particularly in the main body of the landslide where it is less disturbed than the lateral margins (toe and headscarp) where the rock is more noticeable disturbed.

Some of the landslide materials encountered in our borings (B-1 and B-5) appear relatively intact above the FVH, however other borings (B-3 and B-6) located up dip of these borings exhibited caving and typical landslide features (discontinuous and disrupted bedding, internal faulting fractures, etc...) to depths extending down to the FVH.

Based on our subsurface explorations (B-1 through B-6) wherein the FVH was encountered in each boring the FVH is not as steep as originally postulated by Geolabs (2001) (and hence not as deep to the northwest) and more closely corresponds to Geolabs (2001) "clay plane" horizon. We have revised and extended R.T. Frankian's (2007) Cross Section BB-BB' (now $BB_{(RTF)}$-BB°) to show these relationships.

The outer boundary of the landslide complex is shown in bold and the internal landslide boundaries are shown with a thinner line type. The headscarp of the original ancient landslide failure has been eroded away such that the FVH daylights directly to the south east on the backside of the existing ridgeline. The graben features shown on the Preliminary Geologic Map are indicative of subsequent landslide movements.

The limits of the toe of this landslide north of the project site are not well constrained but based on the consistency of the known FVH on the site we have projected it to the northwest on the Cross Sections and Maps.

Geologic structure beneath the landslide complex consists of northeasterly striking and gently (5-10°) northwest dipping Sunshine Ranch member of the Saugus Formation (Tsr). The structure in the bedrock changes from northeasterly striking to north striking to northwest striking with westerly to south westerly dips on the south eastern portion of the project site closer to the San Gabriel fault.

5.0 LANDSLIDE STABILITY ANAYLSES

We constructed four cross sections (4-4', 5-5', 6-6' and 7-7') and updated two cross sections by others (Geolabs B-B' and R.T. Frankian's BB-BB') to illustrate the landslide geometry, existing grades and proposed grades shown on Sikand Conceptual Plan dated 6/16/09.

Analyses were performed to evaluate the stability of landslide deposits located beneath areas of proposed cuts and fills associated with the proposed grades shown on the Sikand Conceptual Plan. The stability analyses utilized cross sections 4-4', $B_{(GL)}$-$B'_{(GL)}$, 6-6', and 7-7' for evaluation of gross slope stability. Spencer's complete equilibrium procedure was used to determine the minimum **static** safety factors corresponding to complete noncircular (i.e. planar) slip surfaces along landslide planes. Potential ground water conditions were also included in the analyses and modeled as an assumed perched condition to 10 ft above the basal slide plane.

A pseudo-static procedure is typically used to provide an indication of slope stability (or instability) under seismic loading by introducing an additional static horizontal force that is equal to the soil weight multiplied by a "seismic" (pseudo-static) coefficient, *k*. However, application of this seismic coefficient to landslides with low-angle slide planes (less than about 12 degrees) may yield unrepresentative safety factors due to the disproportionate increase in the ratio of the driving force to resisting force as compared to landslides that are more steeply inclined. Therefore, pseudo-static safety factors were not evaluated during this study due to the shallow dip angles (less than 12 degrees) of landslide planes at the project site. Alternate methods to evaluate the stability of landslides under earthquake loading should be considered in a future design phase.

Based on our analyses, the need for stabilization measures were explored and design of these measures was performed, as needed, in a step-by-step fashion utilizing computer-based numerical slope stability analyses. Generally, the lower portions of the landslide have safety factors greater than 1.50. The upper portions yielded safety factors less than 1.50 and required mitigation measures to obtain safety factors greater than 1.50. The mitigation included shear keys that can typically be constructed during standard grading operations. The mitigation measures (i.e. shear keys) are illustrated on the analyzed cross sections and on the Preliminary Landslide Remediation Map (**Plate II**).

Shear strength parameters were generally obtained from prior consultant reports for adjacent developments that are part of the same landslide complex. Shear strength parameters for landslide plane material are based on results of direct (multiple) shear tests conducted during this investigation on hand-driven ring specimens collected from the basal landslide plane (e.g. Geolabs horizon), and on direct shear test results published by Geolabs for the same landslide plane. A summary of the shear strength parameters used in the slope stability analyses are presented below.

GEOLOGIC UNIT	MOIST UNIT WT. (PCF)	PHI (DEG)	COHESION (PSF)
Compacted Fill	130	30	300
Landslide Mass (Qls)	130	33	400
Landslide Plane (Horizon)	130	6	300

6.0 CONCLUSIONS

In order to obtain a factor of safety greater than 1.50 (static) for the landslide mass two shear keys were needed on three of the analyzed cross sections (4-4', 6-6' and $B_{(GL)}$-$B'_{(GL)}$). One shear key was needed on cross section 7-7'. The shear keys range from 20 to 80 feet in depth below proposed grades and 60 to 220 feet in width from "toe to heel" excluding backcuts and forecuts. We have shown the location and elevations of "toe and heel" at each of the calculated cross sections on the Preliminary Landslide Remediation Map. The landslide mass down slope of the northern most keyway calculates stable with a factor of safety greater than 1.50 for static conditions.

For preliminary planning purposes we have extended the calculated shear keys laterally. The exact location of the shear keys will need to be refined during subsequent phases of work.

Additional geologic and geotechnical studies will need to be performed in order to refine the three dimensional geometry and geotechnical characteristics of the various landslides within this landslide complex. Owing to the preliminary nature of performed investigation and evaluation studies of the landslide complex, the size and location of the shear keyway should be considered extremely preliminary.

Temporary stability of backcuts will need to be evaluated once landslide and proposed grade geometries are better defined.

Landslides may be stabilized with Buttress Fills or Shear Keys designed by the Project Geotechnical Engineer based on results of slope stability analyses; landslide material can be entirely removed and replaced with certified compacted fill. Landslides underlying cut pads or road areas may be removed, or partially removed if the project Geologist and Geotechnical Engineer conclude that the landslide is stable and sufficiently consolidated to build on. Landslides located in fill areas may be completely removed if the project Engineering Geologist and Geotechnical Engineer conclude that the landslide mass is susceptible to significant settlement and/or not stable to build upon. Landslides located in fill areas may be partially removed if the project Engineering Geologist and Geotechnical Engineer conclude that the landslide mass is stable and not susceptible to significant settlement. Some of the relatively intact landslide blocks appear to be suitable for support of fills and structures.

7.0 LIMITATIONS

This report has been prepared by Allan E. Seward Engineering Geology, Inc. (AESEGI) 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 to be transferable. Prior to use by others, AESEGI must be notified, since additional work may be required to update this report.

Additional investigation will be required to prepare recommendations for subsequent phases of development. In the event that any modifications in the design or location of the proposed development are planned, a written review by this firm will be required.

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 proposed development.

Typically, faulting is confined to the area adjacent to a known fault. However, absolute assurance against future fault displacement is not possible in tectonically active regions because new faults can form over time as orientation and magnitude of deformational forces change in the earth's crust. Therefore, the location and magnitude of ground surface rupture during a seismic event cannot be forecast.

In performing these professional services, AESEGI 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. The information and recommendations presented in this report are based on results of subsurface investigations and laboratory testing performed by AESEGI and presented in other consultants reports (see references), and on our experience and judgment. It should be recognized that subsurface conditions can vary in time, and laterally, and with depth at a given site. Since the conclusions and recommendations presented in this report are based on limited observations, our **conclusions** and **recommendations** are **professional opinions** and are **not meant** to be a control of nature. Therefore, AESEGI makes no other **warranty** either expressed or **implied**.

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

Respectfully submitted,

Stuart K. Mayes, CEG 2169
Senior Associate Geologist

Kevin P. Callahan, PE 72202
Professional Engineer

Reviewed by:

Eric J. Seward, CEG 2110
Principal Engineering Geologist
Vice President

The following attachment and Appendix complete this report.

References

APPENDIX A – (Plates in pockets)

Preliminary Geologic Map (1"=100')	**Plate I**
Preliminary Landslide Remediation Map (1"=200')	**Plate II**
Cross Sections 4-4', 5-5' and 6-6'	**Plate III**
Cross Sections 7-7', $BB_{(RTF)}$-BB° and $B_{(GL)}$-$B'_{(GL)}$	**Plate IV**

Distribution: (3) City of Santa Clarita
Attn: Mr. Harry Corder
(2) Impact Science
Attn: Ms. Susan Tebo

REFERENCES

Report by Allan E. Seward Engineering Geology, Inc.

1. **Geologic/Geotechnical Summary Report**
EIR Level Review the Road Alignment for Via Princessa East from Golden Valley Road to 250 Feet West of Sheldon Avenue
Via Princessa Road Extension
City of Santa Clarita, California
Dated August 13, 2010 – JN: 10-2254C

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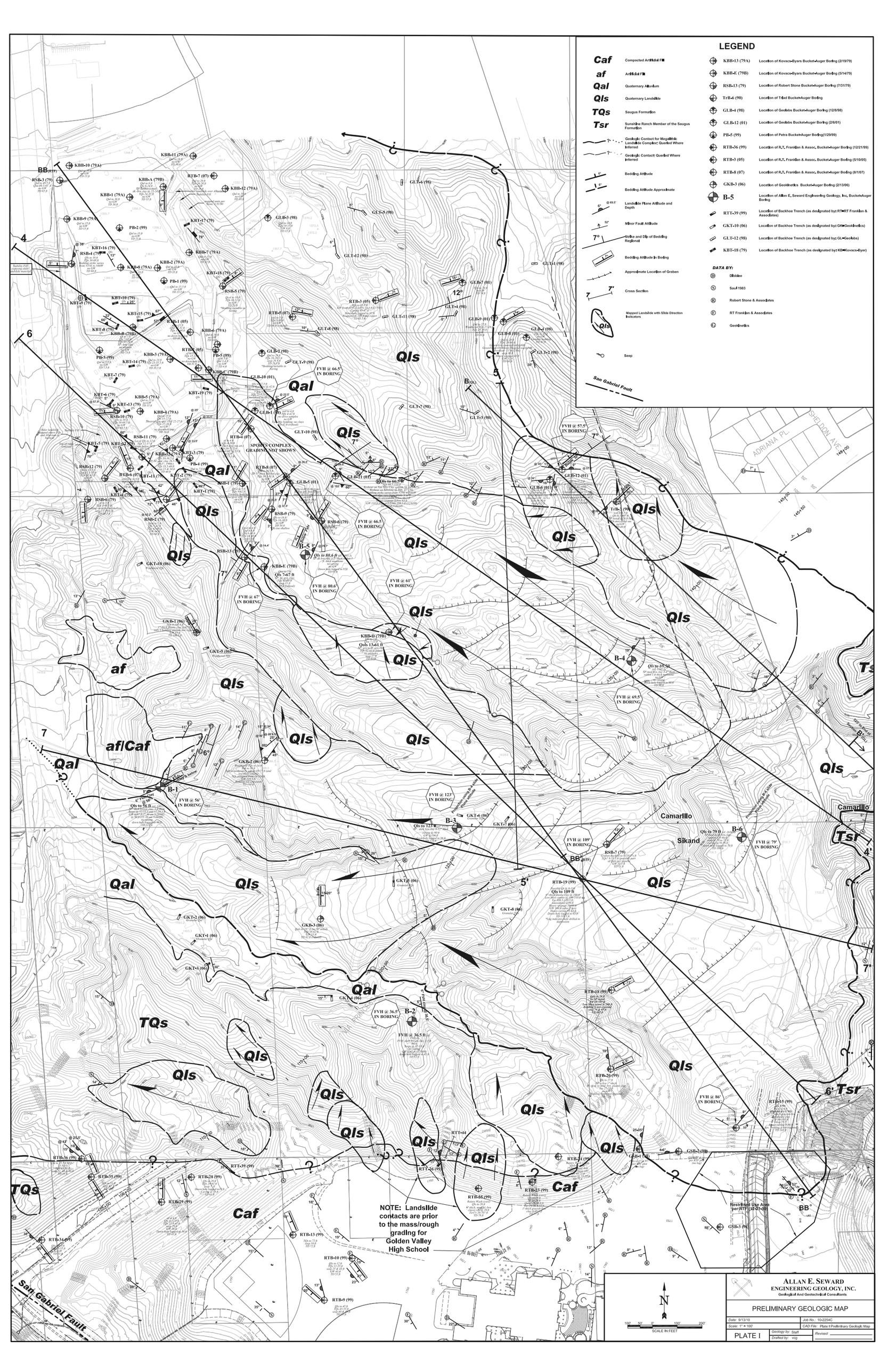
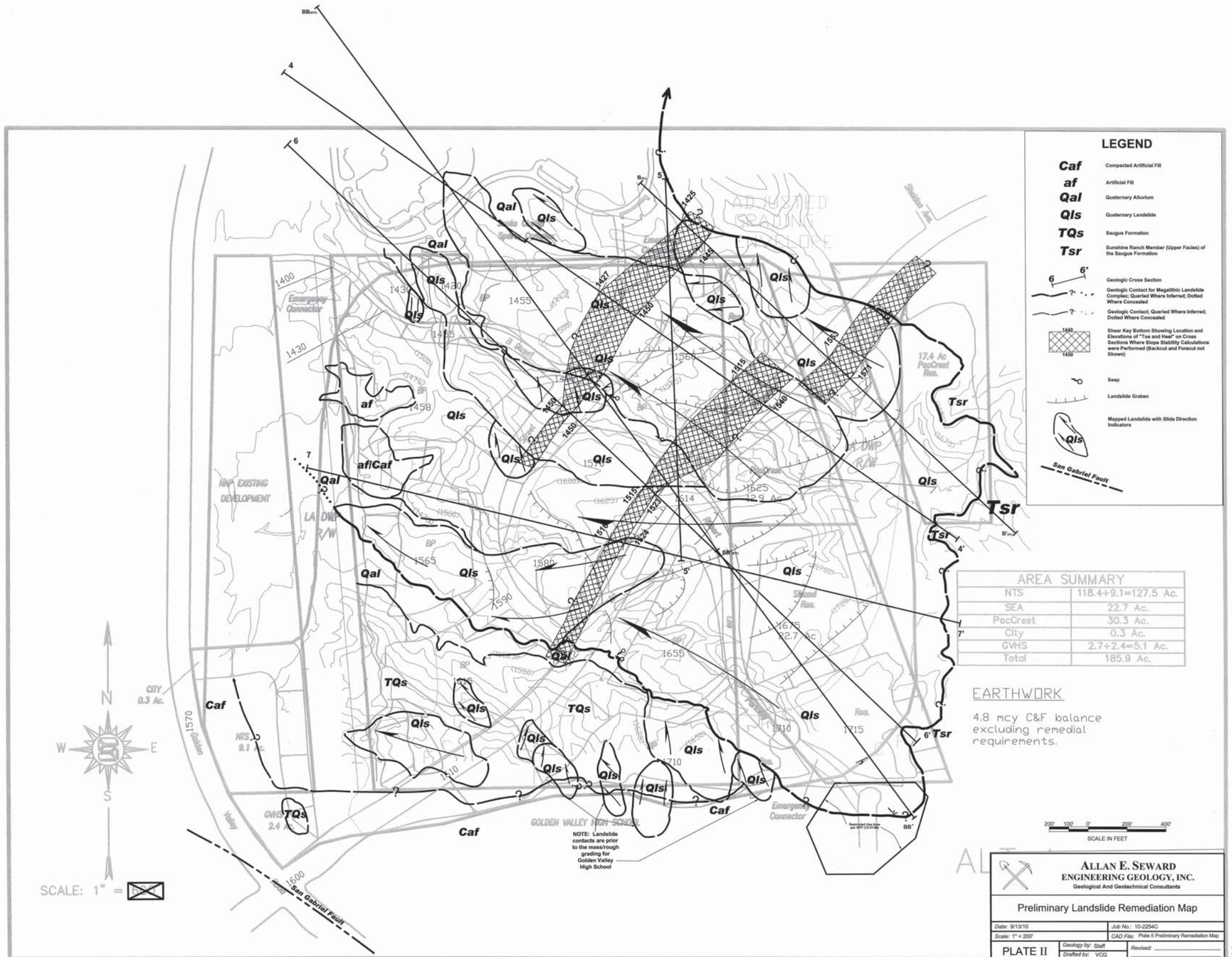
Appendix A


LEGEND
Caf Compacted Artificial Fill
af Artificial Fill
Qal Quaternary Alluvium
Qls Quaternary Landslide
TQs Saugus Formation
Tsr Sunshine Ranch Member of the Saugus Formation
Geologic Contact for Mega/Rock Landslide Complex: Quarried Where Inferred
Geologic Contact: Quarried Where Inferred
Bedding Attitude
Bedding Attitude Approximate
Landslide Plane Attitude and Depth
Minor Fault Attitude
Strike and Dip of Bedding Regional
Bedding Attitude in Boring
Approximate Location of Graben
Cross Section
Mapped Landslide with Slide Direction Indicators
Seep
San Gabriel Fault
KBB-13 (79A) Location of Kovacs-Byars Bucket-Auger Boring (2/1/979)
KBB-E (79B) Location of Kovacs-Byars Bucket-Auger Boring (5/14/79)
RSB-13 (79) Location of Robert Stone Bucket-Auger Boring (7/31/79)
TrB-6 (90) Location of Triad Bucket-Auger Boring
GLB-4 (98) Location of Geolabs Bucket-Auger Boring (12/8/98)
GLB-12 (01) Location of Geolabs Bucket-Auger Boring (2/6/01)
PB-5 (99) Location of Petra Bucket-Auger Boring(1/29/99)
RTB-36 (99) Location of R.T. Franklin & Assoc. Bucket-Auger Boring (12/21/99)
RTB-3 (05) Location of R.T. Franklin & Assoc. Bucket-Auger Boring (5/10/05)
RTB-8 (07) Location of R.T. Franklin & Assoc. Bucket-Auger Boring (8/1/07)
GKB-3 (06) Location of GeoKinetics Bucket-Auger Boring (2/13/06)
B-5 Location of Allan E. Seward Engineering Geology, Inc. Bucket-Auger Boring
RTT-39 (99) Location of Backhoe Trench (as designated by RT=RT Franklin & Associates)
GKT-10 (86) Location of Backhoe Trench (as designated by GK=GeoKinetics)
GLT-12 (98) Location of Backhoe Trench (as designated by GL=Geolabs)
KBT-18 (79) Location of Backhoe Trench (as designated by KB=Kovacs-Byer)
DATA BY:
D Dibblee
S Saul 1983
R Robert Stone & Associates
F RT Franklin & Associates
G GeoKinetics
NOTE: Landslide contacts are prior to the mass/rough grading for Golden Valley High School
Restricted Use Area per RTF 02-21-08
ADRIANA PL.
SHELDON AVE.
Camarillo
Sikand
SCALE IN FEET
ALLAN E. SEWARD ENGINEERING GEOLOGY, INC.
Geological And Geotechnical Consultants
PRELIMINARY GEOLOGIC MAP
Date: 9/13/10
Job No.: 10-2254C
Scale: 1" = 100'
CAD File: Plate I Preliminary Geologic Map
PLATE I
Geology By: Staff
Drafted By: wg
Revised:



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

Preliminary Landslide Remediation Map

Date: 9/13/10 | Job No.: 10-2254C
Scale: 1" = 200' | CAD File: Plate II Preliminary Remediation Map
PLATE II | Geology by: Staff | Drafted by: VCG | Revised:

PREPARED FOR:
NTS, et. al.

ATTN:

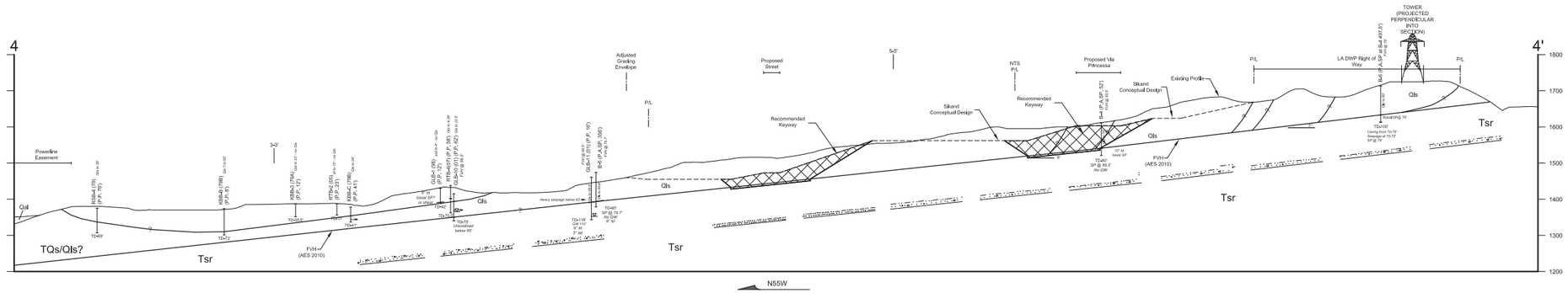
	DATE	REVISION	BY	APP
1	06/16/09	CUT FILL LINES, GRADING ENVELOPE, MISC	YCC	

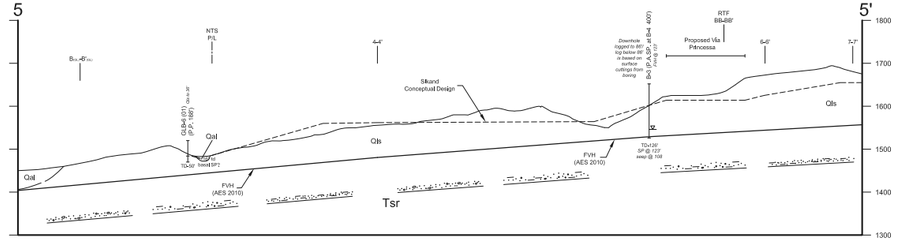
SCALE: 1"=200' | CH'D BY: | APPROVED BY: | DATE: 05/04/09 | W.O. NO. 5100-051-03 | SHEET 1 OF

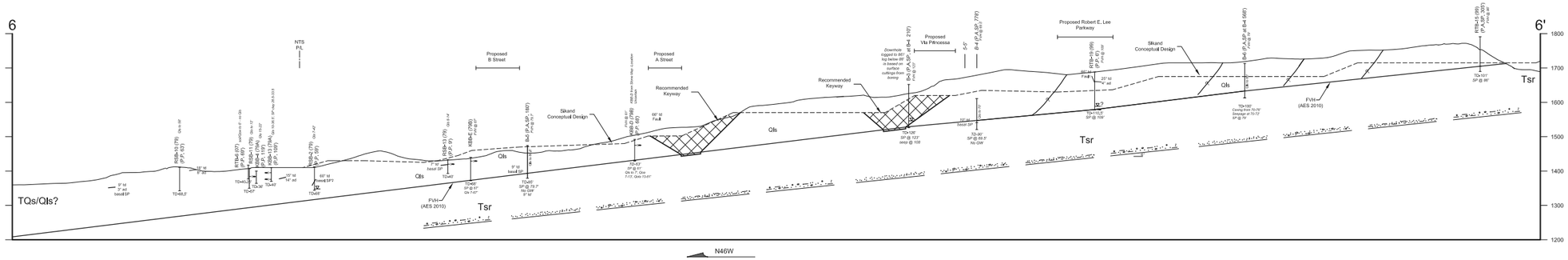
SIKAND
Engineering | Planning | Surveying
15230 Burbank Blvd., Suite B 100, Van Nuys CA 91411
www.sikand.com

CONCEPTUAL PLAN
for Property
Adjacent to Via Princessa
E'ly of Golden Valley Rd.

Y:\Newhall\Tentative\X:\sikand\5100-051\planning\exhibits\NTS Conceptual Plan Additions.dwg







Note: KBB-D & E Boring Locations are Second Hand from Law (Stone) Mgt.--Kevins Beyer Map Missing

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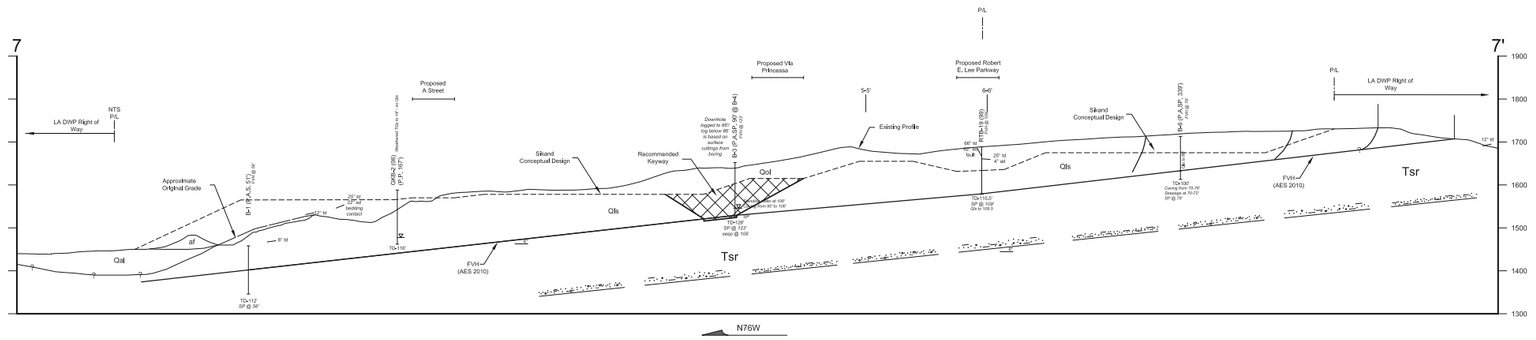
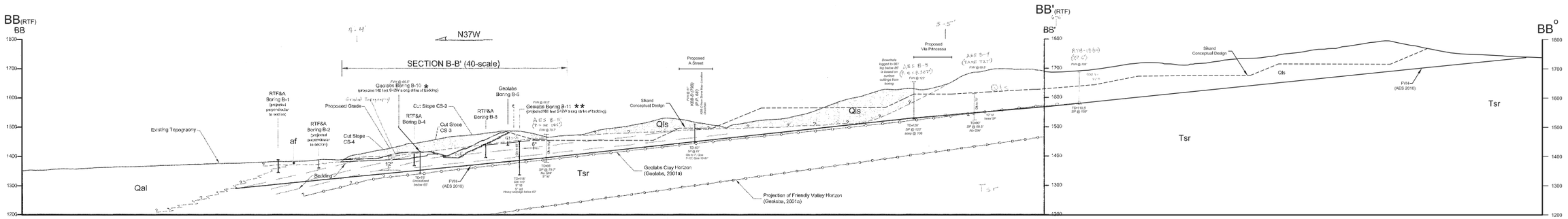
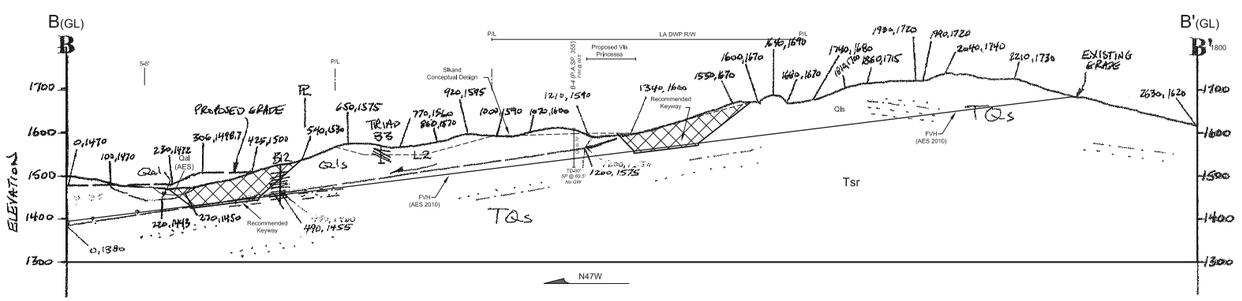
Geological And Geotechnical Consultants

Cross Sections 4-4', 5-5' and 6-6'

Date: 9/13/10	Job No.: 10-2254C
Scale: 1" = 100'	CAD File: Plates III and IV Cross Sections
PLATE III	Geology by: Staff; Drafted by: vcg; Revised:







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ENGINEERING GEOLOGY, INC.
Geological And Geotechnical Consultants

Cross Sections 7-7', $BB_{(RTF)}$-BB' and $B_{(GL)}$-$B'_{(GL)}$

Date: 9/13/10	Job No.: 10-2254C
Scale: 1" = 100'	CAD File: Plates III and IV Cross Sections
PLATE IV	Geology by: Staff
	Drafted by: YCG
	Revised: