Appendix D

Reconnaissance and Geotechnical Update; Proposed Trail Improvements Between Murphy Way and Escondido Canyon

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June 15, 2016

Mountains Recreation & Conservation Authority
570 West Avenue 26, Suite 100
Los Angeles, CA 90065

Attention: Ms. Jessica Nguyen

SUBJECT: RECONNAISSANCE AND GEOTECHNICAL UPDATE REPORT; PROPOSED TRAIL IMPROVEMENTS BETWEEN MURPHY WAY AND ESCONDIDO CANYON, CITY OF MALIBU; CALIFORNIA.

REFERENCE: Reconnaissance of Engineering Geologic Constraints to Development; Proposed Park, Parking and Trail Improvements in Ramirez Canyon, Escondido Canyon, Corral Canyon, Along Latigo Canyon Road and at Malibu Bluff State Park; City of Malibu; California; September 21, 2009

1.0 Introduction

At the request of Ms. Jessica Nguyen of the Mountains Recreation & Conservation Authority (MRCA), and in accordance with MRCA Agreement No. 2016-00000040, Southwestern Engineering Geology has completed an update to our previous reconnaissance-level geologic study of a system of parks and trails proposed in the City of Malibu, California. The referenced report provided discussions of geological conditions present at each of several proposed development areas, and presented professional opinions regarding constraints imposed on the proposed improvements by these geologic conditions. This update report addresses proposed trail alignments between Murphy Way and the Escondido Falls Trail, and provides general geotechnical recommendations for construction. Once detailed trail plans are available, additional recommendations may be necessary to address specific sections of the trail alignment.

2.0 Proposed Improvements

This report addresses the trail alignment proposed within the City of Malibu between Murphy Way and Escondido Canyon as depicted on plans provided for our use by MRCA. The plans for this trail segment were prepared by Stantec titled "Coastal Slope Trail, Ramirez Canyon Park to Escondido Canyon Park" dated January 5, 2016. Sheet 8 of these plans depicts the trail alignment and is attached as the base for the Geologic Map presented at a reduced scale as Plate 1. Based on a review of this illustration, we note no significant differences in the current plan from the alignment proposed in 2009.

The trail segment begins on the east side of Murphy Way, slightly less than 1.5 miles north of Pacific Coast Highway, and descends about 550 feet to a tributary of the Escondido Canyon drainage. The trail then continues along this tributary drainage about 1000 feet to where it will join the existing Escondido Falls Trail in Escondido Canyon. The descent incorporates several sections of broad switchbacks and a long descending incline across easterly to northeasterly facing slopes that are inclined at gradients up to about 1.5:1.

3.0 Geologic Conditions

The proposed trail alignments traverse slopes underlain by Middle Miocene-aged Topanga Formation or "Topanga Group" as designated by Yerkes and Campbell (1980) covered by native soil and/or colluvium. The Topanga Group includes a thick stratigraphic section primarily of marine sandstone, siltstone, clay shale and volcanic materials. Sedimentary units are expected to be most prevalent along the proposed trail alignment. Near-surface bedrock is expected to be highly fractured and degraded to a texture of clay shale fragments in a matrix of sandy clay to clayey sand.

The bedrock material is covered by surface soil and colluvium that is expected to range from less than one foot on the steeper slope sections to more than 10 feet on the more gently inclined, lower sections. Soil and colluvium is anticipated to consist of clayey sand to sandy clay, grading downward to support an increasing percentage of clay shale fragments, and ultimately into bedrock consisting of highly fractured and weathered siltstone, sandstone and shale.

4.0 Trail Descriptions and Constraints

A field reconnaissance of existing conditions along the trail alignment was conducted by the undersigned engineering geologist and geotechnical engineer on January 11, 2016 following a brief meeting with Ms. Judi Tamasi (MRCA) and a short discussion with Mr. Bret Foster (Stantec). The site was found to remain in essentially the same condition as was described in our referenced report, and the proposed trail remains subject to the general constraints outlined on pages 20 and 21 of that report (SWEG, 2009).

The following outlines surface conditions specific to the trail alignment currently under consideration based on our recent site reconnaissance. While we consider this discussion to be a reasonably comprehensive assessment of conditions along the proposed alignment, we strongly recommend that the brush be cut low along the alignments once more detailed, construction-level plans are available. This will allow a more specific assessment of subtle topographic features that might need to be accommodated during trail construction. Note that Localities G through I are indicated on Plate 1. Localities A through F refer to features along other trail alignments not under consideration in this report.

The alignment descends from the east side of Murphy Way into a tributary of Escondido Canyon, and continues to join the existing Escondido Falls Trail about one-half mile to the east. The descent from Murphy Way begins across a series of broad switchbacks on an easterly facing slope inclined at about 1.75:1. The shoulder of Murphy Way is covered with a thick accumulation of wood chips that exceed the 36-inch depth that could be effectively probed during our field reconnaissance. These materials will not be suitable for trail support.

Immediately below Murphy Way, two steep-sided erosion gullies extend the full height of the descending slope. Where observed in the upper 100 feet or so, the gullies range up to about eight feet deep and locally about 20 feet across at the top. We expect they become progressively deeper and wider lower on the slope. Neither gully is visible on aerial photography flown in 1928 prior to construction of Murphy Way. The northern gully may be visible on aerial photographs taken in 1952 as a very subtle lineament, but is well developed by 1965. The southern gully developed at some point between 1973 and 1990. The gullies are presumed to have developed in response to uncontrolled drainage from Murphy Way, and to continue to accommodate some degree of discharge from the road. The current trail alignment involves multiple crossings of both of these gullies (Plate 1, Location G). We expect that some type of wooden bridge with minimal abutments will prove the most effective means of crossing these gullies. Although we anticipate some abbreviated setback requirements will be acceptable for abutment foundations relative to the primary descending slope, abutment foundations should be founded in bedrock and maintain a minimum setback of five feet from gulley side slopes. Greater setbacks may be necessary if the gulley exceeds a depth of ten feet.

The first set of switchbacks carries the trail to a point on the descending slope about 75 to 100 feet above the tributary drainage. From this point, the trail extends about ¼ to ½ mile southeasterly, descending gently across the east-facing slope. Over much of this distance, the supporting slope is inclined at a gradient slightly gentler than 1.5:1, and is densely covered with brush. A side-swale occurs near the midpoint of this section at Locality H (Plate 1). The specific topography of this swale was not observed during our reconnaissance due to the dense brush; but may be deeply incised. A bridge crossing may be necessary at this location.

At the eastern limits of the slope, the alignment descends the nose of a ridge across a series of broad switchbacks to the bottom of the tributary, and then southeastward along the bottom of the drainage to where it meets the existing Escondido Falls Trail. The alignment joins the drainage near the toe of a mapped landslide (Plate 1, Locality I). This landslide is not anticipated to have any significant impact on the proposed trail construction, nor is the construction anticipated to impact the landslide. We anticipate that some sort of low bridge, puncheon or engineered swale will be necessary where the trail crosses the tributary drainage and possibly at the main drainage of Escondido Canyon.

5.0 Conclusions and Recommendations

5.1 General

- Based on a review of available geotechnical data supplemented by our recent field observation, the proposed trail is considered feasible from a geotechnical standpoint provided the recommendations presented in this report are followed and incorporated in the planning, design and construction of the project. Recommendations presented in this report are preliminary in nature and should be updated, and revised as necessary, when more detailed plans become available.

- At this time we expect that most of the trail construction will consist of "landscaping level" construction including low cut and fill slopes and rock or wood retaining structures less than three feet high. This type of construction is considered "non-engineered" in the sense that it is likely to be developed largely within the relatively loose, surface soil profile, and the design and construction is not supported by specific engineering analysis of soil properties, foundation loads or slope stability. We anticipate that construction of this type can be completed using readily available guidelines such as the USFS Trail Standards. When final trail development plans become available, additional geotechnical recommendations may be warranted where local, unique challenges may warrant more substantial structures. Depending on the final details of trail construction, it may be necessary to excavate trenches in selected locations to further delineate the depth to material adequate for foundation support.

- Engineered, settlement sensitive structures are not anticipated at this time. Should such structures be proposed in the future, mitigation measures may be necessary to reduce the potential for adverse impact due to settlement of underlying materials. Mitigation measures may include overexcavation of unsuitable materials and placing them back in the excavation as engineered, compacted fill or deepening foundations to competent underlying materials. Engineering-level recommendations are provided below for general reference, and to inform decision makers of the greater degree of construction effort necessary to support such structures should they come under future consideration. These recommendations are not intended to govern the construction of simple trails or revetments fewer than three feet high, constructed of natural materials.

- In order to control the cost and minimize the need for extensive mitigation measures, we suggest limiting trail tread width. Narrower tread widths will help to minimize construction and maintenance challenges on steeper slopes. Wider tread widths can be readily accommodated in relatively flatter bedrock areas such as ridge tops. Trail treads should be underlain by cut to the degree possible.

- Construction of elevated boardwalks may be considered to provide access in steeper hillside areas as further discussed below.

- It must be recognized that trail construction in most areas will occur in surficial materials that are unlikely to possess a factor of safety of 1.5 against surficial failure as is normally accepted as the standard for residential construction. This factor of safety probably cannot be achieved for the typical trail construction. Trails and associated fills and structures bearing in the surface soil profile should be expected to be subject to erosion, creep, shallow slumps and other processes that commonly affect surface soils on moderately steep slopes. Therefore periodic maintenance and repair should be anticipated. The degree of maintenance can be reduced somewhat by judiciously balancing cost and constructability against greater foundation depths for revetments and more thorough ground preparation prior to trail fill placement. In general; however, standard approaches to trail construction and management are considered reasonable for the use intended, provided no nearby properties may be compromised.

- Evaluation of the stability of slopes (surficial, gross rotational, and translational) affecting the proposed trail is outside the scope of this investigation and therefore, is not addressed herein. The stability of the slopes adjacent to the proposed trail can be evaluated; however this would require a scope of work including subsurface exploration, laboratory testing and engineering analyses. If needed, a proposal with the additional scope of services and more detailed information on such investigation can be provided.

5.2 Site Preparation and Earthwork

5.2.1 General

This section provides general recommendations for the removal and recompaction of unsuitable materials in support of engineered grading. Additional geotechnical recommendations will be provided, as necessary, when detailed development plans for the hiking trail become available. Engineered grading should be performed in compliance with applicable codes.

5.2.2 Clear and Grub

Within all proposed construction areas and areas to receive compacted fill, all existing trees and root systems, vegetation, trash, and debris should be removed prior to the start of grading and construction. Any existing above ground and underground utilities within the proposed development area should also be identified, removed, or re-routed as necessary. Remaining utilities, if any, should be discussed with the project geotechnical consultant and if necessary, additional geotechnical recommendations for grading may be provided.

5.2.3 Removal and Recompaction (Overexcavation)

The proposed trail areas are generally underlain by a veneer of various thicknesses of unsuitable soils, colluvium, and/or weathered bedrock. All are generally considered unsuitable materials for structural support. Hence, in areas to be used for the support of settlement-sensitive structures, all unsuitable materials should be removed to competent native bedrock materials.

After removals are performed as indicated above, and prior to placement of any engineered, compacted fill, the bottom of removal areas should be observed, and tested if necessary, by the project geotechnical consultant. Based on available information, our best estimate of the depth of removals is expected to be on the order of 3 to 5 feet below existing grade. However, deeper local areas of soft/loose, disturbed, or unsuitable weathered bedrock may be encountered. In this case, deeper removal may be required as determined by the project geotechnical consultant.

Voids and areas disturbed by removal of trees, utilities or other buried structures should be overexcavated a minimum of 2 feet below the depth of disturbed soils into competent native materials, and replaced with compacted fill as described below.

5.2.4 Fill Materials

Fill materials should be free from organic matter, roots, rocks larger in size than 6 inches, and any other deleterious materials. We expect most of the excavated on-site materials will be suitable for use as backfill material, with the exception of rocks larger than 6 inches. The need for import fill is not expected, but if required it should have non-expansive to low expansion potential characteristics (in the zero to 50 expansion index range). In any case, the source of import fill should be evaluated and tested as deemed necessary by the project geotechnical consultant prior to the material being hauled to the site.

5.2.5 Fill Placement

The bottom of excavations, after all removals are completed as addressed above, should be scarified to about 6-12 inches, moisture conditioned to slightly above the optimum moisture content, and compacted to at least 90 percent of the maximum dry density as determined by ASTM D1557 (90% relative compaction).

Fill materials should be moisture conditioned to slightly above the optimum moisture content (2 to 4 percent over optimum), placed in thin layers not exceeding 6 inches of un-compacted thickness, and compacted to at least 90% relative compaction.

Fill placed on sloping ground steeper than a 5(h):1(v) gradient should be keyed and benched into competent native materials (example: bedrock), and built as a fill slope to the entire height of the slope. Fill slopes shall be over-built a minimum of 3 feet (horizontally) and cut back to the compacted core upon completion of the slope face. Constructed fill slopes shall be compacted as described above, with each fill lift being compacted at a minimum 2 percent gradient sloping towards into the backcut of the slope being constructed. Our recommendations for fill slopes are limited to slopes with a maximum height of six feet, inclined at a maximum gradient of 1.5:1. If needed, higher and/or steeper fill slopes would require further evaluation and analyses, and possibly additional mitigation measures.

5.2.6 Soil Shrinkage

Excavated materials are expected to shrink when backfilled and compacted as required above. Based on general experience and the limited data available, we anticipate soil (fill) shrinkage to be between 15 to 20 percent. Bedrock may bulk (volume increase) between zero to 5%. These numbers are rough estimates. Additional field exploration and additional testing will be required to obtain more accurate estimates.

5.2.7 Utility Trench Backfill

All exterior and interior utility trenches (if any) should be properly backfilled. Backfill materials should be similar in engineering characteristics to adjacent fill. Backfilled materials should be moisture conditioned to slightly above the optimum moisture content (2 to 4 percent above optimum), and compacted to at least 90% relative compaction (95% in the upper 1 foot if located within paving areas). The use of granular backfill materials such as sand or gravel, or sand jetting should not be allowed, unless approved by the project geotechnical consultant.

5.3 Temporary Excavations

All temporary excavations, including overexcavations and utility trench excavations should comply with the Occupational Safety & Health Administration (OSHA), Cal OSHA, and any other applicable regulatory agency requirements. Excavations deeper than 5 feet (if any) should be shored or laid back at a 3/4(horizontal):1(vertical), or flatter to 10 feet below the adjacent grade. No surcharge loads should be placed, nor should equipment operate, within a setback distance from the top of excavation side slopes that is equal to the depth of excavations.

5.4 Rock Hardness/Rippability

Grading the trails is expected to involve some excavation of about 3 to 5 feet of cut unless deeper excavation is required for utility installation and foundation excavation. Some of the open cuts and/or excavations are expected to be within bedrock areas. Based on available data regarding existing geotechnical conditions at the site, weathered bedrock is expected to be encountered in the deepest excavations and difficult excavation is not anticipated. However, the possibility of encountering local hard bedrock (for example, slightly weathered/unoxidized sandstone, siltstone and volcanic basalt) that would require specialized excavation equipment (for example, a jack hammer) cannot be precluded.

5.5 Engineered Retaining Walls

5.5.1 General

We do not currently anticipate that engineered retaining walls will be used to complete grading at the site. Recommendations are presented below for the engineering design of retaining walls higher than 3, but less than six feet high, should they be considered in the future. Foundation design of engineered retaining walls should be in accordance with the Foundation Section below.

5.5.2 Active Earth Pressure

Retaining walls that are capable of rotating/deflecting at the top to develop active earth pressure may be designed for the following equivalent fluid pressure:

Backfill Gradient	Active Equivalent Fluid Pressure psf/ft
Level	45
2:1	58
1½:1	70

The above equivalent fluid pressure recommended values assume that retaining walls are backfilled with clayey soils, similar to on-site soils, and a backdrain is installed behind the retaining to prevent the build-up of hydrostatic pressure. Although unexpected, the potential for lateral surcharge pressure on retaining walls due to adjacent foundations, structures, and/or traffic loads should be evaluated when grading plans become available.

5.5.3 Backdrain

Retaining walls should be provided with a back drain consisting of 3 cubic feet per linear foot of ¾- to 1½-inch gravel surrounding a 4-inch diameter schedule 40 or SDR-35 PVC or ABS perforated plastic pipe supported 3 inches from the bottom of the gravel. Perforations in the pipe should be placed down to allow for the most efficient drainage. Pipes should have a minimum gradient of 2% to an approved area drain or storm drain system. The gravel and pipe should be encased in a non-woven geofabric with a minimum grab tensile strength of 0.53 kN (kilonewtons), a maximum apparent opening size of 0.21 mm (millimeters), and a minimum permittivity (water penetration) of 1.5 per second. The geofabric should be lapped a minimum of 24 inches. The area above the gravel pocket should then be backfilled with a free-draining, non-expansive material with a Sand Equivalent of 30 or greater.

Alternatively, weep holes may be used as a backdrain system. In order to facilitate drainage of the retaining wall backfill we recommend that 2 inch diameter weep holes be either cast within the wall brick/masonary during placement, or drilled into the wall after placement of the shotcrete. These holes should be located approximately 3 inches above the trail contact level with the wall, and be horizontally spaced 18 inches on center. A blanket of at least 12 inches thick of highly permeable materials such gravel or clean sand should be placed behind the backfill to facilitate drainage through the weep-holes.

The upper 18 inches of wall backfill should consist of a low permeability, for example clayey, material to limit surface water infiltration into the wall. Walls that face interior areas (if any) should be properly waterproofed with an acceptable bituminous waterproofing system such as Miradri or an approved equivalent.

5.6 Foundations and Passive Earth Pressure

Engineered improvements such as a) ADA-compliant walkways, stairs, and ramps, b) retaining walls, c) bridges or boardwalks, and d) larger diameter culverts may be supported by a conventional reinforced concrete foundation system bearing on stable bedrock or a minimum of 12 inches of newly placed engineered fill compacted to 90 percent of maximum dry density per the latest version of ASTM D1557. For foundations supported on compacted fill, the over-excavation/backfill should extend at least 24 inches beyond the foundation footprint, or a distance equal to the depth of fill below the footings, whichever is greater.

Conventional shallow foundations in the form of continuous and spread footings should be a minimum of 12 and 15 inches wide, respectively, and 24 inches below the lowest adjacent grade. Retaining wall foundations may be designed for a maximum allowable bearing capacity of 3,000 and 2,000 psf for footings embedded in approved bedrock and engineered fill, respectively. For the purpose of selecting a bearing capacity value, a foundation supported by less than 12 inches of compacted fill over competent bedrock may be treated as a foundation supported on bedrock.

The above bearing capacity values may be increased by one third when transient loads such as wind and seismic loads are considered. Lateral loads on foundations may be resisted by friction at the base of the footing and passive earth pressure. The following allowable values for lateral resistance (no factor of safety used) should be used in the design of foundations:

Material Type	***Bedrock***	***Compacted fill***
Coefficient of Friction	0.5	0.4
Passive Equivalent Fluid Pressure*	400 pcf	250 pcf

* The upper 12 inches of subgrade susceptible to weathering effects should be ignored from providing passive resistance.

Footing excavations should be square and level, and should be free from all sloughed and loose materials. Water should not be allowed to collect and pond inside footing excavations.

Continuous footings should be reinforced with a minimum of one #4 rebar at the top and bottom (total of 2 rebars), or per the structural recommendations, but not less than what is recommended above.

5.7 Setback

Chapter 18 of the California Building Code (CBC) provides requirements for foundation to slope setback. Horizontal setbacks from descending slopes should be measured from the edge of footing to the top of competent materials on the face of the slope. Uncertified fill placed on the face of slope and weathered materials should be excluded from the setback distance. However, a reduced setback from the code requirements may be considered based on risk assessment, consideration of geotechnical conditions at specific location, and engineering analyses.

5.8 Boardwalk Access

In certain steep hillside areas where grading can be very difficult, boardwalk access may be considered. A boardwalk is a wide platform along the trail alignment that may be supported by piles (piers) in the middle and cantilevered evenly on both sides of the pier. Assuming piles that are two feet in diameter and a trail platform that is six feet wide, the boardwalk would cantilever by about two feet on each side. The piles should extend at least three feet into underlying competent (unweathered) bedrock. Other platform widths may affect the pile diameter. Alternative foundation designs may also be considered.

5.9 Settlement

Total static (non-earthquake) settlement for foundations prepared as addressed above is estimated not to exceed ½ inch. Differential settlement depends on foundation loads and compressibility of underlying materials. For similarly loaded footings, maximum differential settlement is not expected to exceed ¼ inch. Foundation excavation should be observed by the project geotechnical consultant or engineering geologist to verify the assumed quality of supporting materials

The potential for hydroconsolidation and seismic settlement of foundations supported on bedrock or engineered compacted fill placed on competent bedrock is expected to be insignificant.

5.10 Exterior Floor Slabs

If needed, for example to create an observation platform, conventional slabs-on-grade may be used as floor slabs. Conventional slabs should be a minimum of 4 inches thick over two inches of clean coarse sand, and be reinforced with a minimum of #4 rebar placed at 18 inches on center, in each direction (unless more stringent reinforcement requirements are specified by the project structural engineer). Reinforcement would be supported on concrete chairs or other acceptable means of supporting the reinforcement in the center of the slab. “Hooking” or “pulling” of reinforcement during concrete placement is not an acceptable means of suspending reinforcement in the center of the slab.

Crack control joints should be made at a maximum spacing of 8 feet, or per the structural engineer recommendations. Crack control joints should consist of a tooled joint, sawcut, or plastic or felt expansion joint placed within the fresh concrete. If sawcuts are utilized, these should be made to a depth of 1½ to 2 inches within 24 hours of concrete pouring. Finishing and curing of floor slabs should be performed in accordance with the American Concrete Institute (ACI) standards. Adding excessive water to the concrete above the allowable limit increases the potential for shrinkage cracks; therefore this should be avoided.

Deepened reinforced edges around the floor slabs should be considered to reduce the potential for water migration underneath the slab. We recommend using a deepened edge depth of 18 inches below the top of the slab. The deepened edge should be reinforced as recommended by the structural engineer.

5.11 Seismic Design

Seismic design should be in accordance with the latest California Building Code requirements. A Site Class C may be considered in selecting the seismic design parameters.

5.12 Drainage and Crossings

Our original report recommended that trails be designed with an inslope tread. The intent was to actively collect and manage runoff accumulated on the trail. The current plan depicts trails with a 2% outslope tread with the intent to prevent any concentration of drainage on the trail. We defer to the judgment of the project civil engineer in this area.

The current plan will require crossings for a number of local drainages (gullies, creeks, swales, ravines), which may require more extensive mitigation during construction than would a stretch of trail along a constant grade (steep or shallow). Where the trail crosses existing drainages, crossings may utilize bridges or puncheons, or engineered swales or culverts installed to transport surface run off from the upslope side of the trail to the down slope side. Once detailed plans area developed for the trail alignment, geotechnical exploration should be completed to better define specific geologic conditions in the abutment areas.

6.0 Limitations

This report is prepared for use by the Santa Monica Mountains Conservancy, Mountains Recreation and Conservation Authority and their authorized agents and should not be considered transferable. In the event that any modifications in the design or location of the proposed development, as discussed herein, are planned, the conclusions and recommendations contained in this report will require a written review by Southwestern Engineering Geology with respect to the planned modifications. Prior to use by others, the subject site and this report should be reviewed by Southwestern Engineering Geology to determine if any additional work is required to update this report.

The findings presented in this report are valid as of this date and may be invalidated wholly or partially by changes outside our control. Therefore, this report is subject to review and should not be relied upon after a period of one year or if any significant changes are made. The recommendations are based on the preliminary information provided at the start of the investigation. Any changes of this information may require additional work.

It is the intent of this report to aid in the design of the described project. Implementation of the advice presented in this report is intended to reduce risk associated with construction projects. The professional opinions contained in this report are not intended to imply total performance of the project or guarantee that unusual conditions will not be discovered during or after construction.

This study has been conducted in accordance with generally accepted engineering geologic practices for studies of this magnitude. Our conclusions and recommendations are based on a specific proposed development plan, field observations of the site conditions, and interpretations of data available at the surface. These interpretations rely on the assumption that available data can reasonably be extrapolated across the property using sound geologic judgement. Therefore, our conclusions and recommendations are professional opinions and are not meant to be a control of nature; no warranty is either expressed or implied.

This report is not intended for use as a bid document. Any person using this report for bidding or construction purposes should perform such independent investigation as they deem necessary to satisfy themselves as to the surface and subsurface conditions to be encountered. The nature and extent of variations in subsurface conditions may not become evident until construction.

Please be aware that the contract fee for our services to prepare this report does not include additional work that may be required such as construction observation, addendum reports and plan review. Where additional services are requested or required, you will be billed for any equipment costs and on an hourly basis for consultation or analysis.

This report is issued with the understanding that it is the responsibility of the Owner, or of their representative to ensure that the information and recommendations contained herein are called to the attention of the Architect and

Engineers for the project and are incorporated into the plan, and that the necessary steps are taken to see that the Contractor carries out such recommendations in the field.

This report should not be duplicated without the written consent of this firm.

This opportunity to be of service is appreciated. Should you have any questions concerning this report, please give us a call at (805) 625-0485.

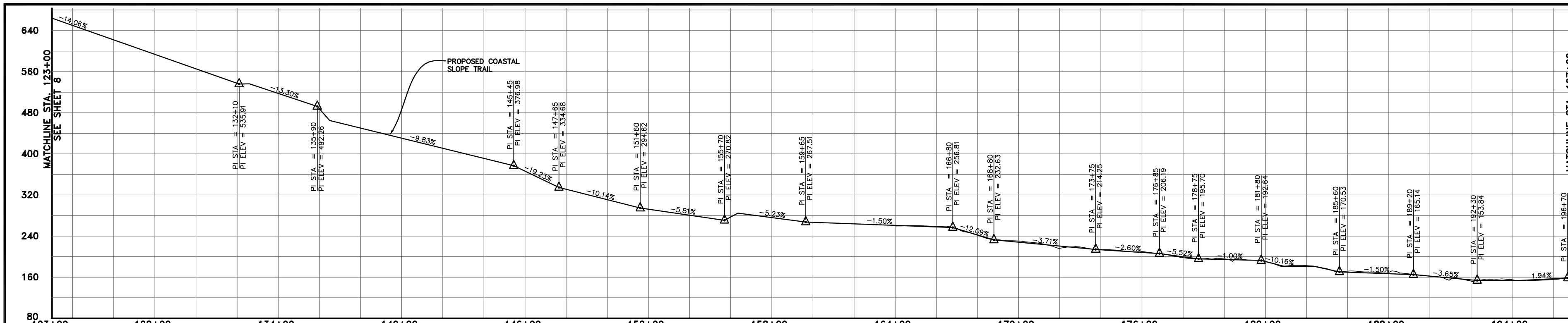
Sincerely,

Christopher J. Sexton
Certified Engineering Geologist 1441
(Expires 11-30-2016)

Ali Abdel-Haq
Registered Geotechnical Engineer 2308
(Expires 12-31-2017)

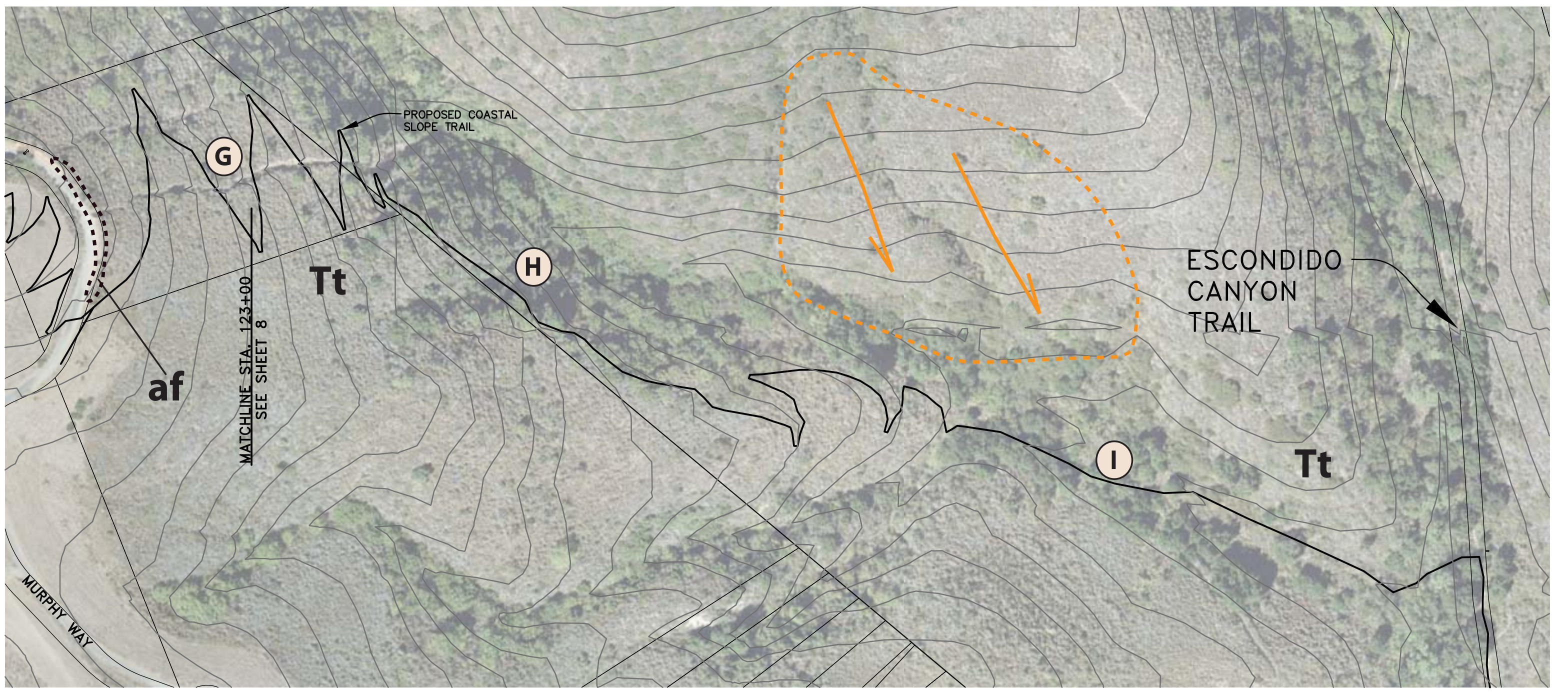
Distribution: (2) Mountains Recreation and Conservation Authority
Attention: Ms. Jessica Nguyen

Attachments: Plate 1



MURPHY WAY TO ESCONDIDO CANYON PROFILE

SCALE: 1"=250' HORZ; 1"=100'



Geologic Map

Legend

- Qal - Recent Alluvium
- Tt - Topanga Formation
- af - Artificial Fill
- Geologic Contact
- Landslide
- I - Locality
  Discussed in text

MURPHY WAY TO ESCONDIDO CANYON PLAN

COASTAL SLOPE TRAIL

RAMIREZ CANYON PARK TO ESCONDIDO CANYON PARK

FOR REDUCED PLANS
ORIGINAL SCALE IN INCHES
0 1 2 3

Plate 1

Mountains Recreation and Conservation Authority

Ramirez Canyon to Escondido Canyon Trail | January, 2016

Southwestern Engineering Geology | Project No. 1-208/707-2006

Stantec
111 EAST VICTORIA STREET
SANTA BARBARA, CA
www.stantec.com

DESIGN JHC CHECKED BEF

BRET FOSTER DATE:
PROJECT ENGINEER
R.C.E. 48,267 (EXP. 06-30-16)

PLAN AND PROFILE – MURPHY WAY
SANTA MONICA MOUNTAINS CONSERVANCY
MOUNTAINS RECREATION & CONSERVATION AUTHORITY
MALIBU, CALIFORNIA

P&S PROJECT NO. 13638.05
SHEET 8 OF 11
PLAN DATE JANUARY 5, 2016

34-ENG SAVE DATE: 1/5/2016 12:38:15 PM PLOT BY:Foster, Bret PLOT DATE:1/5/2016 1:07:09 PM PLOT SCALE:1:10

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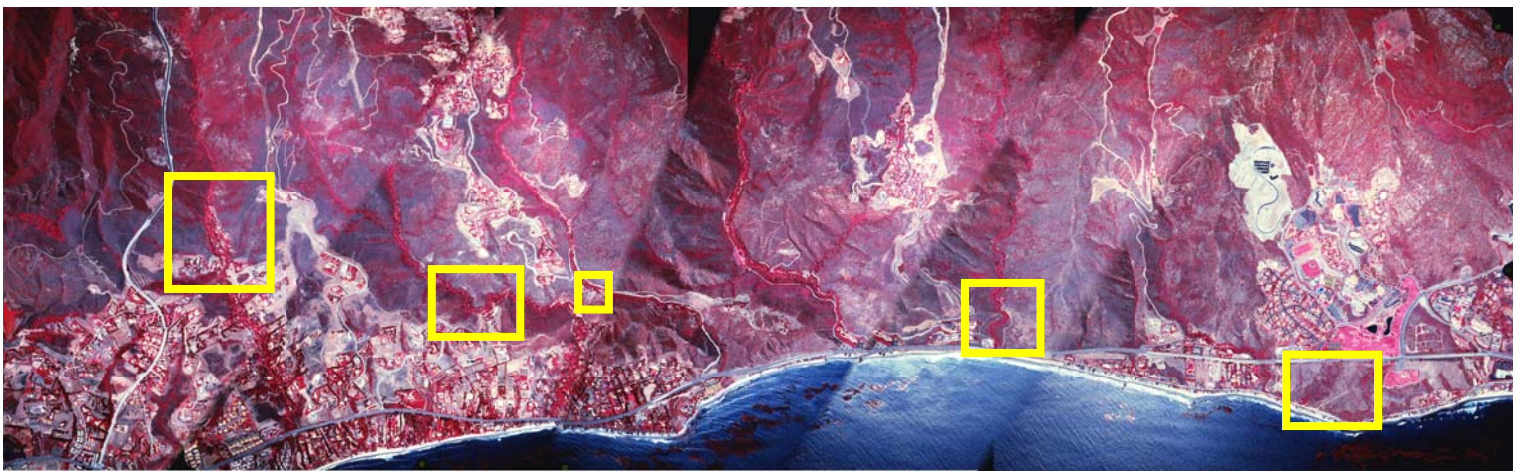
RECONNAISSANCE OF ENGINEERING GEOLOGIC CONSTRAINTS
PROPOSED PARK, PARKING & TRAIL IMPROVEMENTS
RAMIREZ CANYON, ESCONDIDO CANYON, CORRAL CANYON, ALONG LATIGO CANYON ROAD AND AT MALIBU BLUFF STATE PARK
CITY OF MALIBU, CALIFORNIA.



Prepared for
Mountains Recreation & Conservation Authority

Project No. 1-208/707-2006

Southwestern Engineering Geology ***September 21, 2009***

Mountains Recreation & Conservation Authority
570 West Avenue 26, Suite 100
Los Angeles, CA 90065

September 21, 2009

Attention: Ms. Lisa Soghor

SUBJECT: **RECONNAISSANCE OF ENGINEERING GEOLOGIC CONSTRAINTS TO DEVELOPMENT; PROPOSED PARK, PARKING AND TRAIL IMPROVEMENTS IN RAMIREZ CANYON, ESCONDIDO CANYON, CORRAL CANYON, ALONG LATIGO CANYON ROAD AND AT MALIBU BLUFF STATE PARK; CITY OF MALIBU; CALIFORNIA**.

Part I - Introduction

At the request of Ms. April Winecki of Dudek & Associates, Inc., and Ms. Lisa Soghor of the Mountains Recreation & Conservation Authority, and in accordance with contract documents (MRCA-105/07), Southwestern Engineering Geology has completed a reconnaissance-level geologic study of four park areas located in Ramirez Canyon, Escondido Canyon, Corral Canyon and Malibu Bluff State Park, and a proposed parking area along Latigo Canyon Road in the City of Malibu, California. Also addressed are improvements to two existing access routes: 1) along Via Acero between Ramirez Canyon Road and Kanan Dume Road, and 2) along Ramirez Canyon Road between the park entrance and Delaplane Road, and then along Delaplane Road and Winding Way to Pacific Coast Highway. This report describes the scope of study and presents professional opinions regarding geologic constraints of concern with respect to the proposed trail, parking and campsite improvements.

The report is organized in four parts. Part I describes the scope of work and provides a descriptive overview of regional surface and geologic conditions. Part II presents general discussions of geologic constraints common to the Malibu area. Part III provides more detailed descriptions of conditions at each park site, with constraints evaluation with respect to specific proposed improvements followed by discussions of mitigation measures appropriate for the specific improvement. Part IV provides a brief summary statement of principal conclusions.

Intent

The study described in this report was undertaken as a first step in identifying, evaluating, and addressing geotechnical conditions at each of the five sites in Malibu, California. The report provides information and preliminary recommendations to support project planning and conceptual-level design. Site-specific, design-level geotechnical studies will be completed for each park site and selected trail areas during development of construction plans for project infrastructure and buildings. The findings and advice provided in this report should be considered preliminary. During the final design, development of recommendations for individual park features and trails, which may involve further geotechnical exploration, would be required.

Scope of Work

This investigation was directed at reviewing the general geotechnical conditions that underlie the various sites, and analysis of geotechnical constraints likely to be encountered during future improvement efforts. The study was limited to research of existing documents and aerial of available surface exposures. No subsurface exploration was completed during the course of this investigation.

This investigation was completed between August 2006 and September 2009, and included the following specific tasks as outlined in proposals dated July 27, 2006, March, 28, 2007 and July 29, 2009:

- Review of stereoscopic aerial photographs taken between 1928 and 2002.

- Review of pertinent published geotechnical and geologic information on file in our office;
- Review of available pertinent records on file with the City of Malibu;
- Review of conceptual Public Access Enhancement Plans, Sheets 1 through 23 of 23 (Penfield & Smith, 2009)
- Reconnaissance-level geologic surface mapping and field review of selected features identified during the research and air photo evaluation. Reconnaissance of the Corral Canyon and Escondido Canyon sites was completed on August 25, 2006. Reconnaissance of the Ramirez Canyon site was completed on September 14, 2006. These sites were re-visited in September of 2009 to verify that conditions had not changed significantly since the original field reconnaissance. Reconnaissance of the Latigo Canyon site and Malibu Bluff State Park was completed on September 17, 2009.
- Limited Geotechnical Engineering reconnaissance of selected areas.
- Review of seismic hazards likely to affect the property;
- Analysis of geotechnical constraints likely to be encountered during the proposed parking, campsite and trail improvements;
- Preparation of Geologic Maps for each site (Plates 1 through 5). These maps incorporate available data from several published sources, supplemented by field mapping completed by this office, and in some cases, limited data from private consultant studies. The maps illustrate the distribution of bedrock and surficial materials (alluvium, colluvium, artificial fill, landslide deposits, etc.). Geologic Maps were prepared using photo-topographic maps provided by the client for use in preparing this study. Southwestern Engineering Geology makes no representations regarding the accuracy of these base maps;
- Preparation of this geologic report to present professional opinions regarding the existing site conditions and constraints that should be considered in planning for the proposed improvements.

<u>Previous Investigations</u>

Previous investigations utilized in the preparation of this report include small scale maps and accompanying reports published by a variety of professional organizations and government agencies. Also reviewed were limited, site-specific studies commissioned from private consultants for nearby developments. These private studies were prepared based on subsurface explorations with a specific emphasis on engineering geology and geotechnical engineering. Where appropriate, the results were incorporated into the current evaluation. Consultant studies are public record on file with the City of Malibu (See References).

<u>Proposed Development</u>

Base maps provided for use in this study indicate that only limited improvements are proposed. These improvements include camp sites, self-contained restroom facilities, parking areas, water lines and trail improvements. Specific construction details of these improvements are not available at this time. With few exceptions, proposed modifications to existing grades are anticipated to be minimal and no habitable structures are proposed. Trail construction is expected to follow techniques such as those outlined in the United States Forest Service Standards for Construction and Maintenance of Trails (hereafter USFS Standards). All restroom facilities are self-contained chemical/composting units. No new facilities for subsurface discharge of wastewater effluent are proposed.

<u>Site Description</u>

The study areas primarily include parts of four parks located in Corral, Escondido, and Ramirez Canyons, and at Malibu Bluffs, and a small area along Latigo Canyon Road (See Location Map, Figure 1). A series of proposed trails will extend from the parking areas at Kanan Dume Road to Corral Canyon, and then north through Corral Canyon to link with the Santa Monica Mountains backbone trail (Figure 2). The park sites are located in the City of Malibu, California, and range in size from about 30 to about 200 acres. The parks in Corral and Escondido Canyons and at Malibu Bluffs are largely undeveloped, with limited existing development of surrounding areas. The Latigo Road site was previously developed as a single-family residence. The Ramirez Canyon park site is set among existing residential structures and existing park facilities. Typical canyon slopes range up to heights of about 1000 feet, and are inclined at overall gradients of about 2:1 (Horizontal to Vertical), with local sections ranging up to nearly vertical. Park sites are covered with vegetation typical of Riparian, Coastal Sage Scrub and Chaparral plant communities common in coastal southern California. More detailed descriptions of each park site are provided below under "Engineering Geology Considerations".

Geologic Conditions

The park sites are located in the western Transverse Ranges geomorphic province of California, in the coastal Malibu area, on the southern side of the Santa Monica Mountains. The Santa Monica Mountains consist of metamorphic and crystalline Jurassic and Cretaceous rocks overlain by a sequence of Miocene-aged marine and non-marine sedimentary rocks. Regional, north-south directed compressional forces associated with the "big bend" of the San Andreas fault have deformed these rocks into a broad, east-plunging anticline in which the northern and southern limbs of the fold generally correspond with the northern and southern flanks of the mountains. In the coastal Malibu area, this pattern of deformation is complicated by subsidiary tight folds and faults where sedimentary and volcanic rocks have been tectonically interleaved by repeated movement along low-angle reverse faults of the Malibu Coast fault system. Shallow subsurface conditions beneath the park sites are characterized by deformed bedrock, poorly consolidated alluvial deposits, faults and landslides. Major geologic structures and the overall distribution of earth materials in the vicinity of the park and trail improvements are depicted on the Regional Geologic Maps (Figures 3a & 3b). Geologic conditions (in particular stratigraphic designations) indicated on Plates 1 through 5 are simplified from these regional maps.

Earth Materials

Earth materials identified on the park sites include artificial fill, beach sand, alluvium, colluvium (slopewash), Older Alluvial Deposits, landslide deposits, and bedrock assigned to the Monterey, Trancas, and Topanga Formations, and andesitic and basaltic flows and breccias assigned to the Conejo Volcanics. Distributions of these materials within each camp area are depicted on Plates 1 through 5.

Artificial Fill (af)

Artificial fill in the vicinity of the park sites includes road fills such as those that support Pacific Coast Highway and Kanan Road, and a variety of thin fill wedges typical of sidecast fills placed on the downslope sides of existing trails. These fills typically consist of bedrock fragments in a matrix of sand, silt and clay. Minor fills are expected to be loose and dry. The quality of the road fill will vary with the age and nature of construction.

Modern Beach Sand (Qb)

Beach sand is deposited by wave action in the modern surf zone. This material typically consist of very uniform (well-sorted/poorly graded), fine- to medium-grained sand that is pale yellow-brown and virtually uncemented.

Alluvium (Qal)

Alluvium includes the recent stream channel deposits that occur in the low-lying areas of each park site as well as abandoned stream terraces elevated slightly above the modern channels. This material typically ranges from very fine-grained, silty sand to cobble-size with few boulders; but overall is best characterized as pale- to moderate-brown, medium- to coarse-grained sand and silty sand with local gravel lenses. Near the lower end of Corral Canyon, alluvial deposits are finer-grained where the canyon broadens at the outlet to the ocean.

Quaternary Colluvium (Qcol)

Slopes, swales and side-canyons tributary to main drainages at each park site are covered with colluvium consisting of poorly sorted bedrock fragments in a matrix of sand, silt and clay. This material forms below the immediate surface horizon of organic soil as an accumulation of debris from normal erosion and bedrock weathered in place, altered by organic acids and chemical weathering. They are generally poorly consolidated and relatively low-strength. The depths of these materials can vary significantly from a foot or two on slopes, to much greater depths at the lower reaches of side swales. This material occurs on nearly all slopes.

Older Alluvium (Qoa)

Materials accumulated on marine terraces elevated about 100 to 300 feet above the main drainage in the southern portion of the Corral Canyon park site and about 100 feet above the modern shoreline at Malibu Bluffs are mapped here as Older Alluvium. These units consist of weakly consolidated gravel, sand, silt and clay that were deposited on wave-cut platforms. The lower sections of the deposits are typically gravelly and consist of pebble- to boulder-sized, rounded clasts. This gravelly unit is overlain by a section of marine sand that is in turn overlain by nonmarine clay, sand and sandy gravel. A thick section of colluvium mapped by Yerkes and Wentworth (1965) at Corral Canyon is undifferentiated, and included within Older Alluvium on the maps presented with this report.

Bedrock- Monterey Formation (Tm)

Monterey Formation bedrock is mapped beneath all of the sites except Ramirez Canyon. The Monterey Formation includes thin-bedded marine shale, siltstone and very fine-grained, silty sandstone, with local hard, dolomitic beds. In the vicinity of the park sites, the Monterey Formation is affected by fractures, tight folds, shears and brecciation. Gypsum and yellowish mineralization (probably jarosite) is common along fracture surfaces. The unit is commonly considered to be a Middle to Upper Miocene stratigraphic equivalent to the Modelo Formation mapped north of the Malibu Coast fault.

Bedrock - Trancas Formation (Tr)

Miocene-aged Trancas Formation is mapped beneath all of the sites except the parking area along Latigo Canyon Road. The Trancas Formation primarily includes sequences of marine sandstone, mudstone and clay shale with lesser thicknesses of sedimentary breccia. Intraformational shearing is common and in some areas, the shearing is so extreme that original bedding is masked. Sandstone units commonly occur as boudins or lenses. The Trancas Formation is locally interbedded with the Monterey Shale and differentiation of these two units can be difficult (Yerkes, 1979). Prior to about 1979, rocks assigned to the Trancas Formation were referred to as "Unit B".

Bedrock – Conejo Volcanics (Tv)

Andesitic breccias are mapped beneath all of the sites except Corral Canyon. Dibblee (1993) includes all of these rocks within the Conejo Volcanics. Campbell et. al. (1970) assigns these rocks to the Zuma Volcanics where they crop out south of the Malibu Coast fault. For the purposes of this report, all volcanic rocks are discussed as the Conejo Volcanics.

Bedrock- Topanga Formation (Tt)

Middle Miocene-aged Topanga Formation or “Topanga Group” as designated by Yerkes and Campbell (1980) is mapped beneath the Corral Canyon and Ramirez Canyon park sites. The Topanga Group includes a thick stratigraphic section primarily of marine sandstone, siltstone, clay shale and volcanic materials. The group is subdivided in to a large number of members, differentiated largely on the basis of differing fossil assemblages. No attempt has been made to differentiate these members for the purposes of this report.

Landslides

A variety of different types of landslides are mapped within the park sites. These range in size from small slumps, debris flows and rockfalls to large, deep seated failures of significant depth and lateral extent. Landslides indicated on the maps included with this report (Plates 1 through 5) were identified based on review of published and unpublished geologic data, examination of field exposures and suggestive geomorphic features observed on aerial photographs and in the field. A few of the mapped landslides are marked by clear boundaries that suggest recent and repeated movements. Larger landslides can cover many acres and typically consist of highly fractured rock resting above some type of low-strength slip surface. Surficial slumps, debris flows and rockfalls are more localized, and typically consist of chaotic mixtures of angular rock fragments in a matrix of sand, silt and clay.

The various types of landslides are differentiated on the geologic map. Landslides that show clear indications of recent or repeated activity are also indicated.

Geologic Structure

Geologic Structure beneath the park sites reflects intense deformation along the Malibu Coast fault. Branches of the Malibu Coast fault extend through all of the study areas. The Malibu Coast fault includes a series of intercalated thrust sheets in a wide zone that extends from offshore to about one mile onshore. Overall the zone strikes generally east-west and dips northward at moderate to steep angles. The main break of the Malibu Coast fault typically is characterized by thick gouge and crush zones up to about 75 feet wide. Sedimentary units are deformed into east- to west-trending folds and are affected by primarily north-dipping, east- to west-trending faults and shears. Internal shearing is common. Bedrock immediately north of the fault is deformed into east- to west-trending folds with limbs that dip at moderate to steep angles. In the immediate vicinity of the park sites, northerly dips tend to predominate south of the Malibu Coast fault and southerly dips predominate north of the Malibu Coast fault. Smaller-scale, secondary structures such as minor folds, fractures and joints cannot be mapped effectively at the map scale used for this study.

Groundwater

Each of the canyon park areas includes a stream with seasonal flow. Groundwater is expected to be present at shallow depths in the alluvial sediments of the stream beds and immediately adjacent stream terraces. Beneath the elevated sections of each park site, groundwater will occur along joints and fractures, and in sandstone of the bedrock formations. Groundwater may also accumulate in landslide debris and along basal contacts of marine terraces. Groundwater occurring in these "perched" conditions will produce localized springs where flow intercepts the ground surface.

Perched groundwater levels will vary in response to prolonged precipitation, poor control of surface runoff, or irrigation on nearby developed properties. Elevated levels of perched groundwater will contribute to increased erosion and reduced slope stability. Landslides indicated to have experienced recent, periodic or creeping movement should be expected to reactivate in response to elevated levels of perched groundwater.

Part II - Engineering Geology Considerations

Although all sites share a variety of constraints in common, each has areas where the existing conditions warrant specific discussion in light of the proposed improvements. The following discussions provide information regarding constraints commonly encountered in Malibu, along with general comments regarding typical approaches to mitigation. Site-specific mitigation measures are discussed in Part III of this report where more detailed descriptions of physiographic and geologic conditions at each park site are presented along with a discussion of the impacts of these conditions on specific proposed improvements.

Artificial Fill

Construction on artificial fill of poor quality can result in subsequent settlement damage to the completed improvements. Pavements may crack, sag and wear poorly overall. Poorly constructed hillside fills can pose a stability hazard if they become saturated. Improvements placed on existing artificial fill should incorporate design specifications to mitigate these issues. Mitigation measures most commonly applied include removal and recompaction of poor quality fill, and extending foundations through the fill soil.

Colluvium

Colluvium occurs on nearly all slopes, but is not differentiated on the geologic maps. Nonetheless, this material is significant with respect to this study because we anticipate that only shallow excavation will be desired in constructing trails. Where trails are proposed on hillsides, they will probably be supported largely on colluvium and highly weathered bedrock. These materials are subject to continual downhill creep and when saturated can fail as debris flows and shallow slumps. Adequate performance of future trail improvements can be achieved through appropriate design that incorporates careful control of surface drainage and periodic maintenance.

Landslides

A variety of different types of landslides common in the Malibu area occur on the park sites. Indicated landslides have been identified largely based on interpreting geomorphic indictors in the field and on aerial photographs. Extensive subsurface exploration would be required to verify the interpreted limits and evaluate the degree of stability of these features. Such studies may need to be completed in particularly sensitive areas or where substantial structural improvements are proposed. Utilization of most landslide areas for limited, short-term activities such as walking trails or picnic areas is considered low-risk and appropriate. Renewed movements in most landslides are likely to occur in response to seismic events, and during or immediately following periods of intense precipitation. We understand that the parks will be closed during flash flood/flood warnings and urban/small town flood advisories. This will provide a large measure of mitigation with respect to life safety issues. The various types of "landslide" hazards with a potential to affect the park sites are outlined as follows.

Debris Flow & Rockfall

Much of the hillside area in Malibu is characterized as having a moderate to high potential for debris flows and rockfall. Debris flows can range from viscous, slow-moving flows, to liquefied slugs of mud and rock that travel downslope at high rates of speed. The debris flow hazard is particularly acute where debris becomes saturated near the upper end of tributary drainages and swales. Rockfall is a particular problem where erosion in well-cemented sandstone and volcanic deposits has left hard rock exposed in steep outcrops above descending slopes. Free-face joints develop in the steep exposures and isolate blocks of sandstone that weather loose and roll down the adjacent slope. In some cases the "blocks" can be very large. Similarly, cobbles and boulders can erode from gravels at the base of the elevated terrace deposits and roll down adjacent slopes.

Slope Creep

Slope creep refers to the nearly imperceptible downhill movement that occurs where surficial materials – particularly cohesive surficial materials – are present on steep slopes. Movement is driven mainly by a combination of gravity and soil expansion. Slope creep can cause long term deterioration of slope improvements founded in surficial materials. Trail improvements founded at shallow depth will require periodic maintenance to mitigate the effects of slope creep.

Shallow Slumps

Typical shallow slumps are rotational failures that develop in thick soil horizons on steep slopes, usually in response to saturation of the near-surface materials. In some cases, debris from shallow rotational failures can mobilize into debris flows on steeper slopes.

Bedrock Failures

Bedrock failures can develop where weak or tectonically degraded rock is exposed in steep slopes. Mechanics of the movement can be either rotational, where a circular failure surface develops through a mass of weak rock, or translational, where movement occurs at specific horizons along structural weaknesses in the rock. Both types of failures tend to occur in response to periods of unusually high precipitation, though movement can be delayed for periods of weeks, and creep movement can occur almost continuously.

Landslides and Flooding

Yerkes and Wentworth (1965) discussed the possibility that the Corral Canyon drainage could be dammed by landslide debris upstream of the park site during a period of high runoff. They estimated that rapid erosion of such a landslide dam could result in a major flood on the order of 10,000cfs. Large landslides are mapped upstream of each of the canyon park sites. The potential for this type of flood is considered extremely remote, and can easily be mitigated relative to life safety concerns through appropriate park management. Detailed hydrology studies for this project are being provided by another consultant.

Sea Cliff Retreat

Erosion and retreat of coastal bluffs are common geologic hazards that face development in the nearshore area of southern California. Measures such as sea walls, slope facing, rip rap, etc. will slow the process; however, it cannot be stopped. The most effective mitigation measure is the use of judicious setback distances in the original project design. The amount of setback distance to be provided for any given development must be determined based on an analysis of the historic database of sea cliff retreat in the area, study of the structural and mechanical properties of the constituent rocks, the configuration and width of any protective beach, and consideration of the anticipated purpose and life-span of a particular project.

Although sea cliff retreat is commonly discussed in terms of average retreat rates of inches per year, the actual retreat occurs sporadically following mechanical and chemical deterioration which proceeds on a daily basis. Daily deterioration weakens the outer edges of cliffs with few noticeable effects beyond negligible mass wasting and headward erosion of gullies. Periodically, commonly during winters characterized by persistent rainfall and large storm waves, existing gullies are severely eroded and the weakened cliffs collapse either as rockfalls or as larger rotational and translational failures.

Daily processes which contribute to gradual slope degradation include, but are not limited to the following:

- Raindrop impact;
- Diurnal ground fluctuations (earth tides);
- Mechanical damage due to roots;
- Salt wedging due to the formation of salt crystals in cracks and joints from repeated application and evaporation of sea water;
- Ocean waves. These contribute both directly via impact of the wave itself and the debris it may carry, and indirectly through the removal of protective beaches and talus slopes. A high, wide, natural beach is probably the single most effective deterrent to sea cliff retreat;
- Foot and vehicle (including bicycles) traffic;
- Seepage forces (spring sapping) in areas where subsurface water "daylights" in the cliff face.
- Piping due to ground water movement through soft materials;
- Burrowing rodent activity. This not only degrades the shallow internal structure of the slope, but also provides ready passages for the introduction of surface runoff to the subsurface environment.

Rates of sea cliff retreat can vary significantly between one location and another as a result of complex interactions between geologic and climatic conditions. Similarly, estimates of retreat rate published by a variety of workers for the same stretch of coastline can vary depending on the methods and accuracy of analysis. Retreat rates of two to six inches per year are commonly reported along the southern California coastline.

<u>Hard Rock/Difficult Excavation</u>

Volcanic rock and hard sandstone that occur in the bedrock units mapped below the study areas and along the trail alignments can be difficult to excavate – particularly using the hand labor typically employed in trail construction. Where hard bedrock material exists in outcrop and at shallow depth, and cannot be avoided, the need for jackhammers or some similar excavation technique should be anticipated. Although isolated hard bedrock units could be encountered nearly anywhere along the trail alignment, they should be expected in areas where trails will cross volcanic bedrock. General areas where volcanic bedrock should be anticipated along the proposed trail alignments are indicated on Figure 2.

<u>Expansive Soils</u>

Surface soils at most of the campsite areas were noted to be characterized by networks of large ground cracks. These suggest that the surface soils are expansive. Highly expansive soils are commonly reported in consultant studies completed in Malibu. Soil expansion can contribute to downhill creep, and can damage poorly designed foundations. Proper placement, design and maintenance of the future facilities can mitigate the effects of expansive soils. Mitigation measures most commonly applied include careful moisture control both during and following construction, deepened and/or strengthened foundations, and replacement of the expansive materials.

<u>Seismic Considerations</u>

The park sites are situated in an area that is currently experiencing north-south compressional deformation. This deformation is expressed as east-west trending folds and faults that bound topographic and structural basins between the northern edges of the Los Angeles and Ventura Basins. Periodically earthquakes occur along these structures. Recent earthquakes have ranged in size from very small events that can only be detected instrumentally to larger events such as the San Fernando Earthquake of 1971, the Whittier Narrows Earthquake of 1987, the Sierra Madre Earthquake of 1991 and the Northridge Earthquake of 1994.

Possible hazards associated with earthquakes include co-seismic fault rupture, strong ground shaking, ground failure from a variety of causes, and tsunamis. Many environmental factors contribute to the severity of each of these aspects of the earthquake hazard. This complicates attempts to provide site-specific, quantitative, predictive analysis. The following paragraphs provide general discussions of each of these possible hazards as they may pertain to the park sites and proposed improvements.

Fault Rupture

Following the San Fernando Earthquake of 1971, the State of California adopted legislation that required the state geologist to establish "Special Studies Zones" (now known as “California Earthquake Fault Zones”) around certain segments of the San Andreas, Hayward, Calaveras and San Jacinto faults. The legislation is known as the Alquist-Priolo Special Studies Zones Act of 1972. The act requires owners to obtain geologic studies prior to development of properties located within a certain distance of the "zoned" fault to address the potential for future fault rupture. Over the years, additional faults throughout California have been "zoned" where studies have provided evidence of ground rupture during Holocene time (approximately the last 11,000 years). However, not all faults currently thought to have been active during the last 11,000 years have been zoned.

The Malibu Coast fault passes through each of the study areas. This fault is part of a structural zone that extends essentially from Fontana to west of Santa Cruz Island. The Malibu coast fault is a major structural element of coastal southern California; however, the capacity of the fault to generate earthquakes and ground rupture is not well understood. Most local practitioners consider that the Malibu Coast fault remains active, though with a low potential as the primary source of an earthquake, or for generating either primary or secondary ground rupture. A short section of the Malibu Coast fault is classified as active and is included within a “California Earthquake Fault Zone” by the State of California. This zone extends from just west of the Corral Canyon park site, through the Latigo Canyon parking area, to the west edge of the Escondido Canyon park site. Approximate locations of various traces of the Malibu Coast fault are indicated on the Regional Geologic Maps (Figures 3a and 3b). The associated Earthquake Fault Zone is indicated on the Seismic Hazards Map (Figure 4).

Campsites are proposed near traces of the Malibu Coast fault in Corral Canyon, Escondido Canyon, the Latigo Trailhead, and at Malibu Bluffs (Plates 1, 2, 4 & 5). The northern half of the Escondido Canyon park site is included in an Alquist-Priolo Earthquake Fault zone, as is all of the Latigo Site. The potential for ground rupture along the Malibu Coast is fault generally considered quite low. No habitable structures are proposed within the Earthquake Fault Zone where it crosses park sites. Given that no habitable structures are proposed and the relatively low occupancy rates of the proposed campsites, the potential hazards associated with fault ground rupture are considered low.

Ground Shaking

All of the park sites are likely to be subject to some level of ground shaking in response to earthquakes that occur on southern California faults. The most prominent of these faults is the San Andreas fault located about 47miles to the northeast. Numerous other faults judged to remain active occur within a 50 mile radius. Major earthquakes along any of these faults could generate strong ground shaking at the park sites. Seismic hazard evaluation reports prepared by the California Geological Survey provide probabilistic estimates of peak ground accelerations to be anticipated at given locations with a 10% probability of exceedance over the next 50 years. Estimates provided in the vicinity of the park sites range from about 0.40g to 0.50g depending on the location and nature of the underlying material.

The most immediate hazard likely to develop as a result of strong ground shaking is rockfall or other local slope failures, or reactivation of existing landslides. Closing campgrounds during periods of high precipitation and avoiding locating camping areas below rocky outcrops should provide adequate mitigation of this potential hazard. Strong ground shaking could also damage structures of poor design or construction. Ground accelerations associated with strong earthquakes along the Malibu Coast fault would probably substantially exceed the values noted above. The probability of a strong earthquake along the Malibu Coast fault is considered to be very low.

Ground Failure

Ground failure includes a variety of hazards that occur as a direct response to ground shaking during seismic events. Examples include liquefaction and lateral spreading, settlement, both shallow- and deep-seated slope failures, and shattered ridges.

Liquefaction: Liquefaction can occur when granular soils with very specific engineering properties are saturated and subjected to cyclic loading during an earthquake. Elevation of pore pressures leads to a loss of shearing strength with a resultant loss of bearing capacity. Spreading occurs when liquefied soils begin to move laterally, carrying any overburden along with them. Lateral spreading can occur along very low gradients.

Liquefaction potential at the park sites appears to be limited to the stream bottoms where high groundwater may saturate loosely consolidated soils. Stream beds in the Corral Canyon, Ramirez Canyon and Malibu Bluffs park sites are identified as areas likely to be prone to liquefaction on Seismic Hazards Maps prepared by the California Geological Survey (Figure 4). The State of California requires that structures intended for human occupancy (defined as 2000 man-hours per year) be investigated relative to the risk of liquefaction, and mitigated to provide "reasonable protection of the public safety". Generally this implies mitigation to a level such that liquefaction will not cause collapse of buildings intended for human occupancy, but in most cases, not to a level of no ground failure at all (California Geological Survey, 2008). The level of investigation and mitigation to be applied for non-habitable structures is generally a matter of judgement of acceptable risk based on such considerations as the type and use of structure proposed and the associated susceptibility to damage from ground failure, the level of damage acceptable, and the facility of future repair, and the potential impacts of failure on the adjacent environment and improvements. Proposed camp improvements currently do not include any structures defined as habitable. The need for evaluation and mitigation of the liquefaction hazard relative to the proposed roadway, campsite and trail improvements should be evaluated on a case-by-case basis as detailed design plans become available.

Settlement: Seismic settlement occurs as a result of densification of poorly consolidated materials in response to seismic shaking. Seismic settlement of artificial fills occurred both during the San Fernando and Northridge earthquakes with the settlement causing moderate to severe damage where structures were located across cut/fill transitions. The potential for seismic settlement at the park sites is likely to be limited to those areas underlain by unconsolidated sediments in the streambeds, and to areas where fills are placed to accommodate improvements.

Seismically Induced Slope Failures: Shallow failures on steep slopes are common during large seismic events. These range from debris flows, rockfalls and shallow slumps and ravels, to re-activation of large, deep-seated failures. Shallow failures typically occur on steeper slopes and are common during larger earthquake events, even under dry conditions. Larger failures may reactivate in part due to elevated groundwater pore pressures. The Northridge Earthquake generated hundreds of shallow slope failures throughout the affected area. Deeper failures were relatively rare and primarily occurred in undeveloped areas.

Essentially all of the elevated slopes in the park sites are identified as areas that may be prone to seismically induced slope failure on Seismic Hazards Maps prepared by the California Geological Survey (Figure 4). Strong ground shaking can be expected to generate rockfalls, debris flows and slumps on steeper slopes. Initiation and reactivation of larger landslides could also occur. Locating proposed improvements outside of areas potentially affected by these hazards will provide a large measure of mitigation.

Shattered Ridges: Steep, narrow ridges can "shatter" due to focusing of seismic energy. Shattered ridges can contribute to subsequent slope failures when earthquakes are followed by unseasonably high rainfall. Strong ground motion in the Malibu area could lead to shattering along local ridgelines.

Tsunami

Tsunamis are long-period sea waves generated in response to sudden changes in sea-floor topography. Typically these changes occur associated with earthquakes or less commonly with large sub-sea landslides. These waves can reach great heights when they enter shallow water near shorelines. Run-up heights vary considerably. Heights as great as nearly 100 feet are known, however, heights of ten to twenty feet are more common. Tsunamis can affect areas at great distances from the source of the original wave. For instance, the Alaskan earthquake of 1964 generated a tsunami that resulted in run-up of nearly 20 feet in Crescent City, California.

Small tsunamis have been recorded in southern California on numerous occasions. Areas west of Santa Barbara may have experienced tsunamis as high as 50 feet following the earthquakes of 1812 (Yerkes and Wentworth, 1965).

The Escondido Canyon and Ramirez Canyon study areas are located approximately one mile upstream from the shoreline along narrow canyons at elevations of 100 feet or more above mean sea level. Potential hazards associated with tsunamis are considered negligible to non-existent at these sites. A geologic evaluation for a nuclear power plant proposed at the Corral Canyon park site was prepared by the United States Geologic Survey in 1965 (Yerkes and Wentworth, 1965). This study did not preclude the possibility that the site was within reach of a large tsunami or even large storm waves. Many factors contribute to the generation of large shoreline waves as a result of tsunamis, and there is no practical quantitative way to evaluate the potential for tsunamis at a given shoreline location. At this time, we know of no historical record of shoreline damage from tsunamis in the Malibu area, nor are we aware of any geomorphic studies that suggest such occurrences during the Late Quaternary.

Part III – Park Site Developments and Constraints Analysis

Each of the park sites represents unique geologic and geomorphic environments. Developments are subject to specific constraints depending on their locations within the park and the anticipated underlying conditions. The following paragraphs summarize the local physiographic and geologic conditions present at each park site and discuss geologic constraints anticipated for specific developments.

Corral Canyon - Site Description and Proposed Developments

The study area in Corral Canyon includes about 75 acres at the lower end of the canyon just north of Pacific Coast Highway (Plate 1). Corral Canyon drains a watershed of about 2300 acres. Slopes reach heights of about 500 feet and are inclined at overall gradients of about 2:1, with local sections approaching vertical. Corral Canyon Creek generally runs year round and broadens just north of Pacific Coast Highway where it discharges to the ocean.

The site is underlain by three bedrock units, separated by significant reverse faults of the Malibu Coast fault zone. The bedrock is pervasively sheared and fractured; three through-going faults have been differentiated on the Geologic Map. The main trace of the Malibu Coast fault separates Topanga Formation bedrock from the Monterey and Trancas Formations near the northern edge of the study area. Bedding south of the Malibu Coast fault is overturned and typically inclined to the north at angles ranging from 45 degrees to nearly vertical. The seemingly uniform structure does not reflect the intense internal folding that is actually present, but cannot be adequately represented at the map scale.

Surficial units differentiated on the attached Geologic Map include artificial fill (primarily along Pacific Coast Highway), beach sand, alluvium and older alluvium (on elevated terraces), and landslides. Beach sand may be present below parts of the road fill for Pacific Coast Highway. Artificial fill is present below Pacific Coast Highway, as sidecast along existing trails, and as backfill in exploratory trenches that were excavated up to about 50 feet deep. A trench about 300 feet long and 50 feet deep was excavated in the bottom of the canyon. The exact alignment of this trench is not known. Another set of trenches was excavated on the slope near Camp Area #1 (Location 7). These trenches were typically about ten feet deep, but with sections that extended to depths of up to about 45 feet. Artificial fill is present as backfill in all of these areas, but is not specifically differentiated as such on the geologic map.

The mapped landslides are generally considered to be relatively deep rotational or translational failures involving significant thicknesses of bedrock. Several landslides are marked by pronounced scarps that suggest recent periodic or creep type movement. Weber (1983) reports movements in two landslides that occurred in the park area in 1978 and 1982. The field condition of some of the landslides suggests even more recent movement. All of the landslides are associated with suggestive geomorphology clearly visible on aerial photographs dating to the 1920's.

Improvements proposed at the Corral Canyon park site include an ADA (Americans with Disabilities Act) trailhead service vehicle access and parking near Pacific Coast Highway, a camp area including nine hike-in camp locations, two ADA Accessible campsites, and a trail restroom on the elevated terrace above the east side of

Corral Canyon at Pacific Coast Highway, and a second camp area and restroom on the east bank of the creek, near the north end of the study area. A water line is proposed within existing trail improvements from the parking area at Pacific Coast Highway to restroom facilities at each of the proposed camp areas. A 10,000 gallon water tank is proposed above the elevated terrace at Location 6. Existing trails will be improved as required between the parking area and each camp area.

During the field reconnaissance, we traversed from the approximate location of the proposed trailhead access and parking area to the location of proposed Camp Area #1, and then north to proposed Camp Area #2. Specific issues noted during this traverse are discussed below. Location numbers are keyed to Plate 1.

1. Location 1 is defined at the ADA Trailhead Service Vehicle Access and Parking area. This area occurs just east of the abutment for the bridge that supports Pacific Coast Highway over Corral Canyon. The abutment is essentially a retaining wall about six feet high. A 24” water line is supported along the landward side of the bridge and presumably extends eastward under the proposed parking area (Photo 1). The area immediately behind this wall and probably for some distance eastward is expected to be underlain by artificial fill associated with grading of Pacific Coast Highway. This road has been developed in stages since at least the early 1900’s. The quality of any fill in this area is unknown. Any excavations in this area should consider the likelihood that the water line is present at shallow depth.

2. A water line is proposed to extend from the trailhead access area to provide a water service near each restroom facility. This water line will extend approximately along the existing trail. The water line crosses a landslide at the point where the trail to the elevated terrace switches back to the south. Although we do not anticipate wholesale re-activation of this failure under normal conditions, differential settlement and creep movements might occur. Such movements could damage the water line. Long term leakage from the water line could adversely impact the stability of the landslide. Water lines that extend across this area should be constructed of materials that can accommodate at least some minimal movement without rupture, and buried at shallow depth to allow rapid assessment of any leaks that might develop.

   Where trails progress up steeper slopes, constructing the outside edges will probably require placing minor amounts of artificial fill. The water line should be aligned on the uphill side of the trail to avoid any differential settlement or creep that might occur in the fill material.

3. At Location 3, the existing trail extends along a bench less than ten feet wide cut into sandstone and siltstone of the Monterey Formation. Steep slopes occur both above and below the trail. The descending slope is estimated to be 50 to 60 feet high, and is inclined at about 60 degrees overall, with some sections inclined as steep as about 80 degrees (Photo 2). Talus along the upslope edge of the trail suggests the slopes ravel continuously. A need for periodic maintenance should be expected. The possibility of losing part of the trail at this location due to slope failure cannot be excluded. Water infiltration into this slope will enhance the likelihood of failure. Ideally the water line proposed along this bench would be re-routed or deleted. If no alternative exists, the water line should be buried just below the surface to allow ready assessment of any leaks that might develop. Camp management practices should incorporate periodic inspection for evidence of leaks along this section of trail.

4. Camp Area #2 is proposed near a landslide that is clearly recently active, and probably creeps to some degree every winter (Photo 3). The debris is clayey and highly degraded. This material may be prone to flow failures. Steep perimeter scarps near the upper end of the landslide may be prone to minor rockfall and debris flow. Landslide movement should be expected during or shortly following periods of unusually high rainfall. Campground limits should be maintained outside the boundaries of this landslide. This will effectively mitigate associated hazards.

5. Branches of the Malibu Coast fault are mapped near both Camp Area #1 and Camp Area #2. A moderate slope extends above Camp Area #2. No particular evidence of past instability on the slope was observed. No habitable structures are proposed in either camp area, and camp occupancy rates are anticipated to be relatively low. The potential hazards associated with fault ground rupture through the camp areas are considered low.

6. A 10,000 gallon water tank is proposed near the top of a steep, westerly descending slope (Penfield & Smith, 2009, Sheet 20 of 23, Construction Note 13). Specific studies based on subsurface exploration should be performed to evaluate geotechnical conditions in this area. Slope stability concerns may be reduced if the tank is moved easterly to increase the distance from the descending slope. For planning purposes, the tank location should be maintained behind a 2:1 projection from the toe of the descending slope.

7. The hike-in camp areas in Camp Area #1 are located in the vicinity where trenches up to nearly 50 feet deep were excavated during a fault study competed in 1965 (Yerkes and Wentworth,1965). The published study does not include information indicating whether the trench backfill was compacted. The likelihood is that the backfill was not compacted, and could be prone to saturation and settlement. Backfill materials encountered during the minor excavations anticipated for the future campsites should be evaluated on a case-by-case basis. Where necessary, loose fill can be removed to an appropriate depth and replaced as compacted fill to reduce infiltration and help maintain positive drainage. General recommendations for appropriate removal depths can be provided during the design stage of plan development.

<u>Escondido Canyon- Site Description and Proposed Developments</u>

The study area in Escondido Canyon includes about 60 acres located about one mile upstream from the coastline. Escondido Canyon drains a watershed of about 2300 acres (Plate 2). Slopes reach heights of about 500 feet and are inclined at average gradients of about 2:1, with many sections inclined at 1.5:1 or steeper. Escondido Canyon Creek generally runs year round and is contained in a narrow channel across the study area.

The site is underlain by Conejo Volcanics, Trancas Formation and Monterey Formation. As mapped by Dibblee (1993) Conejo Volcanics are in depositional contact with the Trancas Formation at the south edge of the study area. The northern contact of the Trancas sequence is in fault contact with a second section of volcanic rock. The northern boundary of this volcanic section is also a fault which juxtaposes the volcanic section against bedrock of the Monterey Formation. Available mapping indicates that bedding in the Trancas Formation dips at moderate to steep angles both to the north and to the south, and that bedding in the Monterey Formation dips predominantly southward at steep angles. A branch of the Malibu Coast fault is included within a California Earthquake Fault Zone that encompasses the north half of the study area. The only surficial units differentiated on the attached Geologic Map are landslides, alluvium in the creek bottom, and a minor area of artificial fill. Thick sections of colluvium are present, but are not differentiated. The large landslide mapped at the northern boundary of the property is likely a deep rotational failure involving a significant thickness of bedrock. Other mapped landslides are likely to be related to creep and shallow slumping in thick surficial colluvium and weathered bedrock.

Improvements proposed at the Escondido Canyon park site include a 12,000 ft^2 (20 to 25 spaces) parking area with a self-contained restroom near the current eastern terminus of Winding Way (Photo 4). A water line will extend along the existing trail alignment to a proposed camp area with a self-contained restroom (Location 4).

During the field reconnaissance, we traversed the study area from east to west along the creek bottom. Specific issues noted during this traverse are discussed below. Location numbers are keyed to Plate 2.

1. The proposed parking area (Location 1) appears likely to require construction of a fill slope and/or a retaining wall to heights of about ten feet. The construction is proposed within a mapped landslide, and is likely underlain by a thick section of expansive colluvium and/or landslide debris. Consultant explorations were completed in this area by GeoSoils, Inc. (GeoSoils, Inc., Tentative Tract 36706, 1979a-d). These explorations encountered clayey surface soils to depths of nearly 20 feet, and highly sheared bedrock to the maximum depth of exploration of 45 feet. The consultant could not identify a well-defined slip surface at depth and as a result, could not verify with certainty that the area either was or was not underlain by landslide debris. The consultant provided stability calculations that supported an adequate factor of safety based on an assumed slip surface configuration, and concluded that the area was sufficiently stable to support a proposed roadway. The consultant offered an interpretation that the area was actually underlain by stream terrace deposits rather than landslide debris, but retained the interpreted landslide on the maps included with the report.

GeoSystems, Inc. (GSI) explored the upper sections of the landslide (above Winding Way) and identified a plastic clay horizon at a depth of about 27 feet (GSI, 27364 Winding Way, 1988, 1989). Based on the geomorphology of the area and the subsurface data available at that time, GSI interpreted either a landslide or thick colluvium to a depth of about 30 feet. A conforming factor of safety was calculated for the overall landslide using an assumed slip surface configuration, and based on these analyses; GSI concluded that the area was suitable for a proposed roadway. GSI recommended that where the landslide extended onto the property under consideration, it should be included in a "Restricted Use Area". This designation indicates that future construction should not be allowed without additional exploration and testing.

In 2006 the existing road was observed to be cracked and settling during the site reconnaissance. This disturbance was most likely related to settlement and downhill creep of the fill material along the outside edge of the roadway, as no evidence of movement was observed outside the immediate vicinity of the roadway shoulder (Photo 5). During the reconnaissance completed in preparing the current report, the cracked section of road had been recently repaved and the descending slope had been track-walked. Details of the extent of this work are not available.

A geotechnical evaluation of the proposed parking area should be completed during the design stage of plan development to provide recommendations based on the existing site conditions and specific design elements proposed. This evaluation may indicate that the area has an adequate factor of safety against future slope failure, and will retain that adequate factor of safety following the proposed improvements. In this case, site conditions related primarily to soil settlement or expansion can be mitigated through routine design and construction practices intended to accommodate the engineering properties of the subsurface soils, and through proper maintenance and control of surface drainage.

If the future evaluation indicates that the site does not have an adequate factor of safety against future slope failure, substantial stabilization measures may be necessary. Alternatives that may be considered include, but are not necessarily limited to:

- Removal of the unstable material and construction of a buttress fill. This option would probably require excavation to depths of about 30 feet, and possibly would require temporary stabilization measures for the upslope area while the excavation is underway. Control of subsurface water below the fill would require either a pump system, or a trench to allow subsurface drains below the fill to discharge at the surface.
- Stabilization of the proposed parking lot area using soldier piles, or a combination of soldier piles and tiebacks.

Once the area is properly characterized, the need for such mitigation measures can be evaluated in terms of acceptable risk both to the proposed developments and to offsite areas.

2. At Location No. 2 the fill along the outside edge of the maintenance road is eroded due to concentration of surface runoff (Photo 6). Standard trail construction techniques can be used to restore this area to a level acceptable to accommodate hike-in traffic. Normal maintenance and control of surface runoff should mitigate the potential for recurrence of this erosion.
3. Where the access from Winding Way crosses Escondido Creek, the trail is supported on a fill 10 to 15 feet high that surrounds a CMP drain placed to accommodate the stream flow. The fill is eroded and the trail is partially undermined (Photos 7 & 8). The trail crossing should be expected to continue to deteriorate and eventually will need to be replaced; however, the current condition appears to be adequate to support hike-in traffic. Normal park management including periodic inspection, maintenance, and if necessary, repair should be adequate to monitor changes in the current condition and to mitigate potential degradation of the crossing.
4. The proposed camp area is located partially within the limits of a mapped landslide, and a trace of the Malibu Coast fault is mapped in the vicinity. No evidence of recent landslide movement was noted during site reconnaissance in 2006 or 2009. Sudden, significant movement is considered unlikely under existing conditions. No habitable structures are proposed in either camp area, and camp occupancy rates

are anticipated to be relatively low. With proper park management, short term camping is considered a low risk and appropriate utilization of this area.

5. Camp areas are proposed within a mapped landslide in an area that appears to experience significant overland flow. Surface drainage from Winding Way appears to be directed through this area. Movement associated with the mapped landslide is expected to occur primarily as creep and erosion in highly expansive soils. The potential for sudden and significant landslide movement is considered extremely remote, and can easily be mitigated relative to life safety concerns through appropriate park management. Campsites established in this area can be expected to require regular maintenance.

<u>Ramirez Canyon- Site Description and Proposed Developments</u>

The study area in Ramirez Canyon includes about 200 acres located about a mile upstream from the coastline. Ramirez Canyon drains a watershed of about 2300 acres (Plates 3A and 3B). Slopes reach heights of nearly 1000 feet and are inclined at overall gradients up to 1.25:1 (horizontal to vertical). Local sections are inclined at 1:1 or steeper. The park site is set in the bottom of the deeply incised Ramirez Canyon among existing residential structures now in use as park support facilities. South of the park, Ramirez Canyon is developed with estate-style residential structures. Ramirez Canyon Creek runs year round. Beginning near the north end of the park site, the creek bed has been modified with retaining walls and linings.

The southern part of the study area is underlain by Topanga Formation, and the north by Conejo Volcanics. The contact between these two units is depositional. A trace of the Malibu Coast fault is mapped across the extreme southern end of the study area. Bedrock south of the fault is mapped as Trancas Formation. Bedding in the volcanic unit and in the Topanga Formation dips predominantly to the south, though local folds are recognized in consultant studies. Bedding in the thin sliver of Trancas Formation that occurs in the study area is probably variable, but most likely dips mainly to the north.

Surficial units differentiated on the attached Geologic Map include artificial fill (primarily along Kanan Dume Road), alluvium, and landslides. The mapped landslides are very large and are mapped mainly on the basis of suggestive geomorphology observed on aerial photographs. For the most part these are likely to be composites of shallow creep, debris flows and slides, rockfalls, and limited areas of deeper bedrock failures. We know of no subsurface studies of these features. Smaller landslides occur as well. Some of these have well defined scarps that suggest recent movement.

Improvements proposed at the Ramirez Canyon park site include three parking areas along Kanan Dume Road, ADA camp areas and an ADA day use area at the south end of the park. A second ADA camp area is planned in the area of existing tennis courts (to be demolished); several camp areas are planned on the east side of the existing meadow. A trail is proposed into the park from the Kanan Dume parking areas.

Field reconnaissance began along Kanan Dume Road to review the proposed parking areas, followed by reconnaissance of each of the proposed development areas. Specific issues noted during the reconnaissance are discussed below. Location numbers are keyed to Plates 3A and 3B.

1. Parking areas along Kanan Dume Road are proposed near locations where turnouts already exist. All appear to be at least partially underlain by roadfill along Kanan Dume Road; the northernmost parking area lies within the limits of a possible landslide. Existing improvements include a series of power poles and an associated electric meter/transformer box installed at grade. The current conceptual plan (Penfield & Smith, 2009, Sheet 6 of 23) indicates that retaining walls are planned along the outside edges of these parking areas approximately along the power pole alignment. Geotechnical studies based on subsurface exploration will be necessary to provide specific foundation recommendations for these walls. Deepened foundations will probably be required both to penetrate artificial fill that may be present and to meet foundation setback requirements.

2. ADA Camp Areas are proposed at the south end of the site, on benches elevated above the east side of the creek. Improvements to the existing parking area are proposed as well, and appear to require low retaining walls. The benches have been created using a combination of retaining walls up to about six feet high, and minor cut and fill grading. Artificial fill at the downslope edges of each of the benched areas appears to be uncompacted. This existing condition poses no immediate concern provided the fill is

not used to support structures. Adequate performance of existing conditions at the camp areas can be expected with periodic maintenance and control of surface drainage to prevent infiltration or concentrated flow across the surface. Specific foundation recommendations for retaining walls can be provided based on subsurface exploration and testing as the plan moves forward into the design phase.

3. A second ADA Day Use Area is proposed at the south end of the park on the west bank of the creek above a rock retaining wall that extends to heights of about eight feet. The creek flows immediately at the base of the wall. The wall likely supports a wedge of artificial fill. The engineering characteristics of both the wall and wall backfill are not known. The current plan (Penfield & Smith, 2009, Sheet 4 of 23) indicates that the wall will be removed and replaced with a maximum 2:1 slope with rock rip-rap protection at the toe. This area appears to be suitable for the intended use provided the existing artificial fill is not used for structural support. A program of periodic inspection and maintenance should be implemented, and surface drainage should be strictly controlled to prevent infiltration or concentrated flow across the surface.

4. The tennis court area is supported by rock retaining walls that extend up to estimated heights of about 12 feet. Ramirez Canyon Creek flows immediately at the toe of the wall. The wall likely supports a wedge of artificial fill that extends below the tennis court area. The engineering characteristics of both the wall and wall backfill are not known. This area appears to be suitable for the intended use provided the artificial fill is not used for structural support and no new structural loads are imposed on the existing wall. Improvements should not rely on the structural performance of these walls unless details of the design are verified. No new loads should be imposed at or near the existing walls unless additional engineering analysis verifies the suitability of the existing improvements to accept the new loads. A program of periodic inspection and maintenance should be implemented, and surface drainage should be strictly controlled to prevent infiltration or concentrated flow across the surface.

5. Several camp areas are proposed on the slope above the east side of the Meadow in the vicinity of a series of existing rock retaining walls. The exact locations of the camp areas are not clear in the field. The west-facing slope that ascends immediately from the edge of the meadow appears to be free of significant rock outcrops. Large, rocky outcrops do occur in a steep, narrow canyon that ascends to the east. A rock retaining wall about eight feet high retains slough in the canyon bottom and provides a catchment area below the most likely source of rock debris; however, the possibility that debris from a large topple in the canyon might overtop the wall and continue toward the meadow cannot be precluded based on the preliminary reconnaissance and available topographic control. For planning purposes, the Meadow Campsites should remain south of a line perpendicular to the axis of Ramirez Canyon, located about 100 feet north of the north corner of the driveway to the caretaker's residence. If campsites are desired north of this line, specific areas can be evaluated during plan development.

6. A footbridge is proposed where the trail will cross Ramirez Canyon Creek. Details for the bridge construction are not available at this time. At this location, the creek is confined in a fairly narrow channel between a natural slope on the west, and a rock retaining wall on the east. The slope is inclined at a gradient estimated to be about 30 to 35 degrees and is covered with colluvium that is expected to be fairly thin. Acceptable foundation material is probably available at fairly shallow depths.

   The base of the rock retaining wall is located about five feet above the streambed which extends at one location to within about six feet of the base of the wall (Photos 9 & 10). The wall is about three feet wide and seven feet high. The wall likely supports artificial fill. Details of the wall construction are unknown.

   The plan indicates a "Creek Enhancement" in this area. Whether the wall and backfill will remain following the enhancement is not clear from the plan. The wall may prove an unreliable support for the east end of the bridge over the long term. A number of alternative foundation concepts could be considered. If necessary, specific recommendations can be provided at a later stage of plan development.

7. A repair was observed under construction in 2006 on the slope that rises immediately west of the Barwood (Photo 11). The failure appears to have developed below an existing trail, likely due to poor drainage control. Trail construction between the Kanan Road parking areas and the proposed facilities is anticipated to traverse slopes of similar gradient with similar subsurface conditions. A discussion of

general issues for consideration in developing trail alignments is presented below under "Trail Alignments".

8. One camp area is proposed above the east side of the Meadow behind a rock retaining wall about eight feet high. Rocky outcrops occur on steep slopes above this area (Photo 12). Local accumulations of talus indicate periodic rockfall generated from these outcrops. A seismic event could result in a significant topple and rockfall. This camp area should be deleted from the plans.

9. The alignment of Via Acero ascends from the bottom of Ramirez Canyon to Kanan Dume Road south of the proposed parking areas (Figure 2). The alignment is paved from the bottom of the canyon to a residential construction site located about three-quarters of the way up the slope. Above this point, the alignment is unpaved. The upper two-thirds of the existing road extend along the crest of northerly and westerly descending slopes.

   Unspecified improvements are proposed to utilize this route as an emergency access. A landslide is mapped on the slope that descends below the northerly part of the alignment. The section just above Kanan Road extends along the top of a steep road cut. Specific design plans should be evaluated based on subsurface exploration and testing to adequately evaluate geotechnical conditions that could impact the upper section of the Via Acero alignment.

Widening Ramirez Canyon Road and Delaplane Road

The current plan indicates that Ramirez Canyon Road will be widened between the park entrance and Delaplane Road, and that Delaplane Road will be widened from Ramirez Canyon Road to Pacific Coast Highway (Figure 2). Conceptual details indicate the roads will be widened "as necessary to comply with ingress/egress requirements" (Penfield & Smith, Sheet 23 of 23, Detail J).

Most of Ramirez Canyon road lies on alluvial fill in the bottom of Ramirez Canyon, or on colluvial aprons at the edges of the canyon. Limited amounts of fill are expected to be present along the margins of the existing road associated with past construction for approaches to residential structures. Seasonal groundwater is anticipated in the alluvium at shallow depth; the entire alignment along Ramirez Canyon is included in a State of California Liquefaction Hazard Zone (Figure 4). Colluvium is expected to be expansive. Geotechnical studies based on subsurface exploration and testing would be necessary to characterize geotechnical conditions in detail, and if desired, to assess the actual liquefaction hazard along the alignment. Proper engineering design and construction can be expected to mitigate geotechnical constraints to an acceptable level for the proposed roadway.

Delaplane Road climbs a gentle slope from an elevation of about 80 ft in the bottom of Ramirez Canyon to an elevation of about 190 ft where it joins Winding Way. Slopes inclined at about 2:1 ascend and descend to residential property from the edges of the existing pavement (Photo 13). Consultant studies east and west of this section of Delaplane Road indicate the slopes are likely underlain by a section of Older Alluvium (terrace deposits) of variable thickness overlying above Monterey Formation bedrock. Retaining structures will likely be required to maintain existing slope gradients if the existing road is to be widened appreciably. Retaining walls on descending slopes will probably require deepened foundations.

Along the proposed alignment, Delaplane Road crosses alluvium, older alluvium, and the Ramirez Canyon fault which juxtaposes Trancas Formation bedrock above Monterey Formation. Minor fill should be expected along the margins of the existing road. Geotechnical conditions will vary somewhat where the road crosses the different underlying formations and topographic conditions. Future improvements will need to accommodate variability in the engineering characteristics of the underlying materials including moderately to highly expansive soils and tightly folded and sheared bedrock. Overall considerations associated with the proposed road improvements can be effectively mitigated with routine engineering design and construction practices based on site-specific geotechnical analyses.

Latigo Parking Area

A small parking and camp area is proposed just under one mile north of Pacific Coast Highway on an abandoned building pad that occupies a low ridge dividing Latigo Canyon from Escondido Canyon (Plate 4). The north side of the ridge descends about 25 feet at a fairly gentle gradient of about 3:1 (H:V). The south side of the ridge descends about 250 feet to Via Escondido Drive at an overall gradient of about 2:1.

As mapped by Dibblee (1993), the Malibu Coast fault traverses the Latigo study area from east to west just south of the proposed parking lot where it juxtaposes Conejo Volcanics on the south against Monterey Formation on the north. As mapped by Campbell et. al. (1970, 1996) two branches of the fault pass through the site on either side of the proposed parking lot isolating a small sliver of Trancas Formation between the volcanic unit and the Monterey Formation. Available data suggests that bedding in the volcanic unit is variable but dips generally toward the north. Bedding in the Monterey and Trancas Formations dips at moderate to steep angles both to the north and the south.

Surficial units differentiated on the attached Geologic Map include the alluvium in the bottom of Latigo Canyon, artificial fill and landslide debris. Alluvium is restricted mainly to the low-lying area between Latigo Canyon Road and the ridgeline where the parking lot is proposed. This material has accumulated behind a concrete access constructed between the road and the ridge. Consultant studies indicate this alluvial material is about 15 feet thick, and that groundwater occurs at a depth of about 10 feet (Robertson, 1996a, b). Artificial fill is present along Latigo Canyon Road, along the perimeter of the abandoned building pad and driveway ramp, and as dumped spoil piles along the edges of interior access roads. Spoil piles are not differentiated on Plate 4.

Aerial photographs flown in 1952 show that the property was occupied by a single-family residence in the approximate location of the proposed parking area. Consultant reports (Robertson, 1996a) indicate that this original residence was destroyed by fire, and replaced with a modular structure in about 1979. The modular structure was removed after the site was damaged by a landslide in 1995. Remnants of the structure remain in the proposed parking area; the remains of a patio slab are present on the landslide debris which is displaced about 20 to 30 feet below the original pad grade. The landslide measures just under 200 feet across the widest point, and about 400 feet from the edge of the headscarp to the toe of the debris. Robertson estimated debris with a thickness of about 30 feet, and established a foundation setback plane located at a depth of about 45 feet below the proposed parking lot area. The landslide displaces the top of the ridge and the existing trail that previously extended along the south flank of the ridge (Photo 14). Ground cracks mapped by Robertson (1996a) extend well into the proposed parking lot area. A sewage system that serviced the modular structure is indicated to be located at the east end of the proposed parking area.

Improvements are proposed on the ridgeline and in the bottom of the shallow canyon adjacent to Latigo Canyon Road. Improvements proposed on the ridgeline include a 10-space parking area, a self-contained restroom, a 10,000 gallon water tank, a camp host station, an ADA accessible campsite, and a standard campsite. Three standard campsites are proposed in the low area just off the access from Latigo Canyon Road.

Field reconnaissance at the Latigo Canyon site included the low-lying area adjacent to Latigo Canyon Road, the ridgeline, and about ¼ mile west of the site where trail improvements are proposed along the existing alignment of Winding Way. The existing landslide will be a significant constraint to improvements proposed on this site. Movement likely continues in the existing debris; the presence of ground cracks observed by Robertson suggests that the headscarp can be expected to enlarge (extend further into the ridge) over time. Safely constructing the parking lot, water tank and other ridgetop improvements, if feasible at all, will require deep exploration, testing and analysis, and will likely require extensive stabilization measures including some combination of grading, deep soldier piles and tieback anchors. The ridgeline and the landslide debris must be considered a geotechnically sensitive area. Any improvements in these areas (including trails) must be carefully evaluated not only with respect to the stability of the improvement, but also with respect to any adverse impacts that the improvements may have on the existing conditions. Periodic inspection of the landslide area should be incorporated as part of the site utilization plans. Regardless of site utilization, drainage improvements should be considered. Should trails be proposed across the landslide debris, a program of surface and subsurface monitoring should also be considered.

<u>Malibu Bluffs State Park</u>

The Malibu Bluffs State Park study area includes about 65 acres located on a coastal mesa above Malibu Road and below Pacific Coast Highway, roughly between Malibu Canyon Road and John Tyler Drive (Plate 5). Camp areas are situated on a terrace surface elevated about 100 feet above the shoreline and dissected by the lower end of Marie Canyon. Marie Canyon originally drained a watershed of roughly 400 acres, though the watershed has been heavily modified with residential tract developments. A storm drain outlet structure discharges onsite at the upper end of Marie Canyon; an inlet structure at the lower end carries runoff to the shoreline. The drainage east of Marie Canyon collects runoff from a parking lot along Winter Mesa Drive and the adjacent mesa area. At the lower end of this drainage, runoff is contained in an open, concrete-lined drainage channel and directed beneath Malibu Road to the shoreline. The mesa topography is characterized by gentle slopes of moderate relief with elevations ranging from about 180 to 200 feet along Pacific Coast Highway, to roughly 100 feet at the top of the bluff that descends to Malibu Road. Incised canyons have side slopes inclined at overall gradients of up to about 2:1 with local steeper areas, and extending to heights of about 80 feet. The descending bluffs are inclined at gradients between roughly 1.5:1 and 2:1, and reach heights of about 85 feet. An open, concrete tank is present in the northeastern part of the property. The tank was constructed prior to 1952. The purpose of the tank is not known.

The main camp area is directly underlain by terrace deposits designated here as Qoa. Yerkes and Campbell (1980) differentiate non-marine coastal terrace deposits exposed at the surface from a thin underlying layer of Pleistocene-aged marine beach deposits that consist of sand, silty sand and gravel. These units are not differentiated for the purposes of this study. The flat-lying terrace deposits overlie bedrock units that include the Trancas Formation, the Monterey Formation and the Conejo Volcanics. The Monterey Formation is juxtaposed against the volcanic unit across the Malibu Coast fault that is mapped across the property as a concealed feature with a northwest to east-west trend. The exact location is not well constrained. The fault is mapped to displace the Pleistocene-aged marine terrace unit; however, clear evidence of Holocene activity is lacking, so the fault is not included in a California Earthquake Fault Zone at this location. Regional mapping indicates that bedding in the Monterey Formation and Conejo Volcanics is inclined generally to the north at steep angles. Bedding in the Trancas Formation is less well-defined. Logs of borings completed for consultant studies for properties along Malibu Road indicate that bedding is locally contorted and that the rock is very highly sheared, fractured, and degraded overall. The degraded rock is quite weak and commonly fails in landslides where exposed in steep slopes. Yerkes and Campbell (1980) and Dibblee (1993a) both map virtually the entire bluff within the park site east of Marie Canyon within large, rotational landslides. Similar landslides also are mapped on the slopes of Marie Canyon. Studies commissioned by the County of Los Angeles (Slosson and Moran, 1979; Lockwood Singh, 1979) differentiate limited areas of the bluff that lie outside landslide boundaries; however, for preliminary planning purposes the entire area between the edge of the bluff and Malibu Road should be considered to be underlain by landslide. Some of the landslides may experience renewed movement following periods of high seasonal precipitation.

Improvements proposed at the Malibu Bluffs park site are primarily constrained to the mesa platform, and include three parking areas with host cottages, four hike-in camp areas with multiple individual campsites, one ADA Accessible camp area, a small footbridge across Marie Canyon, six self-contained restrooms and two 10,000 gallon water tanks. Two bridges will be necessary to provide vehicular access across the western drainage between Parking Lots 1 and 2. Improvements proposed on the bluffs include a three-space parking area with a restroom adjacent to Malibu Road, a small footbridge, a small picnic area and trails that descend from the mesa to Malibu Road.

The bluff must be considered a geologically sensitive area. Improvements on the bluff must be carefully designed to consider the local geologic conditions and to minimize erosion and prevent infiltration of moisture to the underlying landslide debris. Periodic repair or replacement of these improvements should be anticipated. With these caveats and mitigations, the improvements proposed on the bluff are considered an appropriate land-use of this area.

Field reconnaissance included traverses across all of the proposed camp areas, along the incised drainages, along the top and toe of the bluff, and along the northern edge of the parcel adjacent to Pacific Cast Highway. Specific issues noted during the reconnaissance are discussed below. Location numbers are keyed to Plate 5.

1. The Malibu Coast fault extends near proposed camp areas and camp host cottages proposed at each parking area. The cottages are currently planned as self-contained (composting restrooms), permanent structures with occupancy rates anticipated to be less than 2000 man-hours per year. The nearest cottage is located nearly 100 feet from the mapped trace of the fault. With proper park management, short term

camping is considered low risk with respect to fault rupture hazard, and an appropriate utilization of the camp areas.

2. Two bridges for vehicle access are proposed across the drainage just west of Marie Canyon. Side slopes are inclined at gradients of about 35 degrees overall, with sections nearing 45 degrees. Bridge design should be based on a geotechnical evaluation of the stability of these slopes. Deepened foundations should be anticipated to provide appropriate setback distances from the face of the descending slope. Foundations for these bridges can be established in either the Older Alluvium or the underlying bedrock. Specific foundation recommendations will be developed at the design stage of plan development.

3. Foot trails are proposed from the mesa to Malibu Road and at the edge of the bluff that extends between Marie Canyon and the easterly adjacent canyon. Bluff retreat along this section was roughly evaluated by visually comparing the bluff configuration expressed on aerial photographs flown in 1928 with Google Earth imagery obtained in late 2007. Without persistent, well-defined landmarks, visual comparisons do not allow sufficient resolution to make reliable estimates of retreat rates. Nonetheless, comparison of the two images reflects very little change in the bluff configuration over the 80-year interval. One notable exception occurs where a narrow channel has eroded an estimated 90 feet into the bluff relative to the position in 1928 (Note 3a, Plate 5). Despite a low retreat rate overall, the existing trail is locally being eroded where it passes near the blufftop (Photo 15). Consideration should be given to establishing an appropriate buffer between proposed trails and the edge of the existing bluff to reduce the potential for erosion due to increased foot traffic along the blufftop. Foot traffic on the bluffs outside of the established trails should be discouraged. Trail resources on the bluff should be designed and constructed to prevent ponding or concentration of rainfall either on the trail or on the natural areas adjacent to the trail, with runoff collected and directed to Malibu Road using appropriate devices. The trail along the bluff edge should be designed to intercept and control any runoff from the upslope mesa to prevent sheetflow over the bluff. Where existing trails are abandoned, they should be restored as close as practicable to a natural condition while maintaining proper drainage.

4. Parking improvements along Malibu Road will be completed in a level area adjacent to the road currently occupied by a small garden (Photo 16). Details of the proposed parking improvement at the toe of the bluff are not currently available. Slosson and Moran (1979) identified this general area as part of an old landslide that likely "involved most of the old sea cliff". The depth of the older landslide is unknown. More recent landslides within the older landslide mass were described as relatively thin failures above the elevation of Malibu Road. Construction at this location is anticipated to include light paving, and placement of a self-contained restroom. As with any construction proposed in the bluff area, these improvements should be carefully evaluated. However, the types of construction currently anticipated are not expected to adversely impact local geotechnical conditions.

5. A picnic area is proposed south of the bluff trail about 200 feet above the trail entrance from Malibu Road. Lockwood-Singh (1979) identified this area as an ancient (inactive) landslide. Foot traffic should be discouraged on the bluff outside of the picnic facilities and established trails. Drainage from the picnic area should be collected and directed to Malibu Road using appropriate devices. Water should not be allowed to pond in the picnic area, and the picnic area should be designed and constructed to avoid creating ponding conditions in adjacent natural areas.

6. Current trail alignments require footbridges across Marie Canyon at the upper end about 100 feet below the existing storm drain outlet structure, and at the lower end just above the inlet structure that carries flow in Marie Canyon to the shoreline. At both of these locations, the banks of Marie Canyon are underlain by landslide debris. Specifics regarding the stability of these landslides are not known. Periodic movement likely occurs in these landslides in response to stream erosion at the toe. Stream banks near the upper crossing are very steep in some areas, and heavily vegetated. Construction of the necessary footbridges will be facilitated if specific details of the local conditions are considered in choosing the location of the crossing. Periodic maintenance and repair should be anticipated.

7. Parking Lots 1 and 2 are proposed at the north edge of the property near steep road cuts that descend to Pacific Coast Highway. These slopes are inclined at 35 to 40 degrees and reach estimated heights of

about 20 to 25 feet. Improvements proposed at the top of these slopes should incorporate sufficient foundation setback. For planning purposes, foundations should extend below a 2:1 projection from the toe of the existing slope. Specific engineering evaluation of the site materials may allow a steeper setback projection.

Trail Alignments

A network of trails is proposed beginning at the parking areas along Kanan Dume Road, linking the proposed camp areas between Kanan Dume Road and Corral Canyon, and continuing north up Corral Canyon to connect with the Santa Monica Mountains Backbone Trail at the Mesa Peak Motorway. Approximate locations of proposed trails are illustrated on Figure 2. Generally trails are proposed at five feet wide, with rare exceptions as narrow as four feet or as wide as six feet. Much of the trail proposed between the camp areas will follow existing trails and dirt road alignments. Many of these areas will require only minor modifications to existing grade to achieve the desired trail configuration. Others will require construction of new trails over sloping ground. Most existing slopes are inclined at gradients of about 2:1. Notable exceptions occur where the trail descends from the Kanan Dume parking, and where the trail ascends out of Ramirez Canyon. Although these trail alignments avoid the steepest slopes inclined at 1:1 or steeper, both will traverse slopes that are inclined at gradients of about 1.5:1, with local sections that are somewhat steeper than 1.5:1. These areas, and isolated areas of steep topography in Corral Canyon are indicated Figure 2.

Underlying bedrock conditions are expected to have limited influence on trail construction or performance. Most trails will likely be constructed on shallow surface soil, colluvium and weathered bedrock that cover nearly all natural slopes in the coastal canyons of Malibu. Trail construction is anticipated to conform to standard guidelines such as the USFS Standards. Where slopes are inclined at gradients of less than 2:1, the desired trail configurations can be achieved using standard construction techniques creating cut and fill slopes inclined at maximum gradients of 2:1 or slightly steeper, and to heights of less than about two feet. Where trails traverse steeper slopes, cut and fill slopes may need to be inclined at gradients that exceed what can reasonably be justified. Retaining structures up to about three feet high may be necessary to support trails on these slopes. Higher structures may be necessary where trails cross incised swales on steep slopes. USFS Standards provide general guidelines for construction of rock and log retaining walls. Retaining structures based on some variation of these guidelines should provide an acceptable means of trail development. Specific foundation recommendations for these structures can be developed based on subsurface exploration and testing in specific areas once plan development has advanced to a stage where trail alignments have been finalized based on detailed topographic information. Limited tread widths in steeper areas would help to reduce the heights and costs of any structural improvements that might be required for trail construction.

Trail construction on slopes is expected to interrupt and concentrate the normal overland flow of surface runoff. This can lead to greater erosion if concentrated drainage is discharged uncontrolled. Where surface runoff is allowed to pond, greater infiltration can contribute to debris flows and shallow slumping. Trail improvements should be designed with adequate drainage control to prevent uncontrolled discharge or ponding. As a general rule, trails should be constructed with an inslope tread (inclined toward the cut side of the trail) and provided with appropriate drainage control devices such that surface runoff is not allowed to pond on the tread, or flow uncontrolled. Treads should be designed so that runoff is removed as quickly as possible. Ideally, runoff should be carried via non-erodible devices to appropriate natural drainages or designed drainage systems. Where strict control of runoff is not practical, discharge points should be based on specific engineering evaluation of proposed discharge locations, with rip rap pads or other control or dispersion devices to mitigate the potential for excessive downslope erosion. Random placement of waterbars should not be allowed. Particular care must be employed where trails will be constructed upslope of existing residential structures (Figures 2 and 5). An annual program of inspection and maintenance should be implemented. Necessary repairs should be completed prior to each rainy season.

Trail construction is anticipated to be completed primarily in surficial materials. Although a factor of safety of 1.5 against surficial failure is normally accepted as the standard for residential construction, this factor of safety probably cannot be achieved for typical trail construction. Therefore, periodic maintenance and repair should be anticipated. In general, this approach to trail construction and management is considered reasonable for the use intended provided no nearby properties may be compromised.

Trails will cross several areas either mapped as landslides or identified as landslides during the recent reconnaissance. These areas are indicated on Figure 2. A more detailed review of these areas should be performed during future plan development. For planning purposes, the landslides indicated at Corral Canyon and Latigo Canyon (east of the Latigo Parking site) are not considered particularly sensitive areas. The minimal construction required for trail development is considered unlikely to adversely impact these landslides. Use of these areas for trail construction is considered acceptable provided proper drainage and maintenance recommendations are incorporated into trail design and management, and assuming that the need for periodic trail repair is acceptable.

The proposed trail will also cross landslides in Escondido Canyon, just below Latigo Canyon Road. The trail in this area is proposed above existing residential properties along the unpaved alignment of Winding Way. Field reconnaissance was completed along this alignment from the parking area proposed along Latigo Canyon Road, to a point about one-quarter mile to the west. Several existing slope failures were identified along this short traverse (Photo 17, Figure 5). An existing debris flow located just west of the parking area stripped surface soils from the upslope area. The accumulated debris nearly blocks the existing trail to a depth of about four feet. This failure demonstrates the sensitivity of surface soils in this area, and emphasizes the need for careful control of drainage on the future trails.

At the Latigo Parking area, the trail is proposed across the landslide that damaged a home that previously occupied the site. The landslide destroyed the graded bench in the Winding Way alignment over a distance of about 200 feet. The surface of the debris is broken and irregular. Surface runoff appears likely to accumulate in the crown of the landslide along the base of the headscarp.

Further west, the existing bench crosses an older landslide. This landslide is likely similar in character to the landslide below the parking area, but with a softer surface topography due to the effects of long term weathering and erosion. The boundaries of this landslide illustrated on Figure 5 reflect mapping by Campbell, et. al. (1970, 1996) and Dibblee (1993b), though local geomorphology supports interpretations of landslide boundaries that extend substantially further to the west of the boundaries shown on the published studies. This landslide area and the landslide below the proposed Latigo Parking area are both significant features that have displaced many thousands of cubic yards of earth. Both are probably either unstable, or only marginally stable. The Latigo Parking area landslide lies above the cul-de-sac in Via Escondido. Via Escondido is a private road. The landslide further west is located above the residence at 6100 Via Escondido. Trail development on either of these features must be considered very carefully. At a minimum, trail construction in these areas must be designed with minimal grading, and without adding additional driving force to the landslide mass. Trail construction must avoid creating areas on or off the trail where surface drainage will concentrate or pond, and as far as possible, repair of any existing areas of concentrated drainage or ponding should be incorporated into trail construction plans. Trails should be designed to collect upslope runoff that reaches the trail, and all trail drainage must be strictly controlled. A program of periodic inspection, maintenance and monitoring would need to be incorporated into trail management along this section.

Part IV - Summary Conclusions

Most improvements proposed at the four park sites are generally minimal or simple enhancements of existing facilities. Primary constraints likely to affect these minimal improvements include fairly common geotechnical conditions that are routinely mitigated to a less than significant impact through normal engineering design, construction, and maintenance/management practices. Site specific geotechnical investigations will be necessary in selected areas to properly characterize subsurface conditions for design purposes. These geotechnical studies should be completed as planning proceeds from the conceptual to the design level. Provided the recommendations outlined herein are implemented, these proposed improvements are considered geologically feasible and acceptable for the intended use.

Parking areas proposed along Winding Way at the Escondido Canyon site, and at the Latigo Parking site will require detailed geotechnical investigations to evaluate slope stability issues and provide appropriate design parameters for the proposed improvements. Substantial stabilization efforts should be anticipated at both locations. Stabilization of the ridgeline at the Latigo Parking area may not be realistically feasible.

LIMITATIONS

This report is prepared for use by the Santa Monica Mountains Conservancy, Mountains Recreation and Conservation Authority and their authorized agents and should not be considered transferable. Prior to use by others, the subject site and this report should be reviewed by Southwestern Engineering Geology to determine if any additional work is required to update this report.

The findings presented in this report are valid as of this date and may be invalidated wholly or partially by changes outside our control. Therefore, this report is subject to review and should not be relied upon after a period of one year or if any significant changes are made. The recommendations are based on the preliminary information provided at the start of the investigation. Any changes of this information may require additional work.

It is the intent of this report to aid in the preliminary conceptual design of the described project. Implementation of the advice presented in this report is intended to reduce risk associated with construction projects. The professional opinions contained in this report are not intended to imply total performance of the project or guarantee that unusual conditions will not be discovered during or after construction.

This study has been conducted in accordance with generally accepted engineering geologic practices for studies of this magnitude. Our conclusions and recommendations are based on a specific proposed development plan, field observations of the site conditions, and interpretations of data available at the surface. These interpretations rely on the assumption that available data can reasonably be extrapolated across the property using sound geologic judgement. Therefore, our conclusions and recommendations are professional opinions and are not meant to be a control of nature; no warranty is either expressed or implied.

This report is not intended for use as a basis for engineering design of structures, or as bid document. Detailed geotechnical studies should be completed during the design phase of any significant construction proposed as part of this project. Any person using this report for bidding or construction purposes should perform such independent investigation as they deem necessary to satisfy themselves as to the surface and subsurface conditions to be encountered. The nature and extent of variations in subsurface conditions may not become evident until construction.

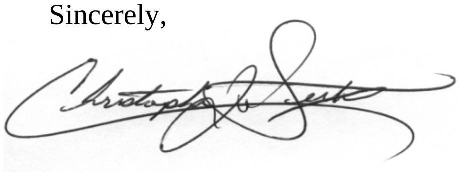
Please be aware that the contract fee for our services to prepare this report does not include additional work that may be required such as construction observation, addendum reports and plan review. Where additional services are requested or required, you will be billed for any equipment costs and on an hourly basis for consultation or analysis.

This report is issued with the understanding that it is the responsibility of the Owner, or of their representative to ensure that the information and recommendations contained herein are called to the attention of the Architect and Engineers for the project and are incorporated into the plan, and that the necessary steps are taken to see that the Contractor carries out such recommendations in the field.

This report should not be duplicated without the written consent of this firm.

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

Sincerely,



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Attachments:		References Plates 1 – 5 Figures 1 - 5 Photos 1 - 17

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City of Malibu; 1996c; Geotechnical Review Letter – 5837 Latigo Canyon Road, Malibu, California; Review letter dated November 22, 1996.

Robertson Geotechnical, Inc.; 1996a; Engineering Geologic and Geotechnical Engineering Exploration, Proposed House Relocation Due to Slide, Freedman Property, 5837 Latigo Canyon Road Malibu, California; Consultant report dated February 8, 1996; Project No. 2063FRLA.628.

Robertson Geotechnical, Inc.; 1996b; Addendum Report, Response to City of Malibu Engineering Geologic and Geotechnical Review, Proposed House Relocation Due to Slide, Freedman Property, 5837 Latigo Canyon Road Malibu, California; Consultant report dated April 4, 1996; Project No. 2063FRLA.628.

Robertson Geotechnical, Inc.; 1996c; Addendum Report No. 2, Proposed Relocation of Private Sewage Disposal System, House Relocation Due to Slide, Freedman Property, 5837 Latigo Canyon Road Malibu, California; Consultant report dated October 10, 1996; Project No. 2063FRLA.628.

5767 Latigo Canyon Road

GeoConcepts, Inc.; 2008a; Preliminary Geologic and Soils Engineering Investigation; Proposed Single Family Residence to Replace Residence Destroyed by Fire; 5767 Latigo Canyon Road, Malibu, California; Consultant report dated February 4, 2008; Project No. 3703.

GeoConcepts, Inc.; 2008b; Supplemental Report No. 1; 5767 Latigo Canyon Road, Malibu, California; Consultant report dated March 17, 2008; Project No. 3703.

GeoConcepts, Inc.; 2008c; Supplemental Report No. 2; 5767 Latigo Canyon Road, Malibu, California; Consultant report dated April 29, 2008; Project No. 3703.

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5750 Ramirez Canyon Road

Los Angeles County Department of Public Works; 1983; Geologic Review Letter – 5750 Ramirez Canyon Road, Malibu, California; Review Letter Dated April 15, 1983.

5802 Ramirez Canyon Road

Foundation Engineering Company; 1980; geotechnical Report for a Partially Graded Park Site; 5802 Ramirez Canyon Road, Malibu, California; Consultant Report dated October 31, 1980 (title page only).

Los Angeles County Department of Public Works; 1965; Geologic Review Letter – 5802 Ramirez Canyon Road, Malibu, California; Review Letter Dated June 28, 1965.

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Los Angeles County Department of Public Works; 1980; Geologic Review Letter – 5802 Ramirez Canyon Road, Malibu, California; Review Letter Dated December 30, 1980.

Los Angeles County Department of Public Works; 1981; Geologic Review Letter – 5802 Ramirez Canyon Road, Malibu, California; Review Letter Dated April 20, 1981.

<u>5805 Ramirez Canyon Road</u>

Los Angeles County Department of Public Works; 1975; Geologic Review Letter – 5805 Ramirez Canyon Road, Malibu, California; Review Letter Dated August 1, 1975.

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<u>6300 Ramirez Canyon Road</u>

California GeoSystems, Inc.; 1987; Seepage Pit Excavation Observations, 6300 Ramirez Canyon Road, Malibu, California; Consultant report dated August 17, 1978; Project No. GS87-163X

California GeoSystems, Inc.; 1987; Preliminary Soils and Engineering Geologic Investigation Report for Proposed Single-Family Residence, 6300 Ramirez Canyon Road, Malibu, California; Consultant report dated November 3, 1987; Project No. GS87-895

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California GeoSystems, Inc.; 1988; Response to Review Sheets, 6300 Ramirez Canyon Road, Malibu, California; Consultant report dated November 30, 1988; Project No. GS87-895-5.

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California GeoSystems, Inc.; 1991; Final As-Built Geotechnical and Final Compaction Report for Primary Structural Fill Placed on Lot 1, Parcel Map 20084, 6300 Ramirez Canyon Road, Malibu, California; Consultant report dated January 11, 1991; Project No. GS91-C03.

California GeoSystems, Inc.; 1993; Supplemental Soils and Engineering-Geologic Report for Proposed Garage and Caretaker's Residence, Lot 2, Parcel Map 20084, 6300 Ramirez Canyon Road, Malibu, California; Consultant report dated August 7, 1993; Project No. GS93-806.

Miller Geosciences Inc.; 1996; Preliminary Soils and Engineering Geologic Investigation Report for Proposed Tennis Court, Pavilion and Barn, Lot 2, Parcel Map 20084, 6300 Ramirez Canyon Road, Malibu, California; Consultant report dated August 20, 1996; Project No. M96-508.

Miller Geosciences Inc.; 1997; Supplement to Preliminary Soils and Engineering Geologic Investigation o Proposed Tennis Court, Pavilion and Barn, Lot 2, Parcel Map 20084, 6300 Ramirez Canyon Road, Malibu, California; Consultant report dated April 24, 1997; Project No. M96-508-1.

Miller Geosciences Inc.; 2001; Engineering Geologic and Geotechnical Investigation, Deck and Spa Distress, 6300 Ramirez Canyon Road, Malibu, California; Consultant report dated March 8, 2001; Project No. M00-602.

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Los Angeles County Tentative Tract 36706 (Winding Way/Escondido Canyon)

GeoSoils, Inc.; 1979a; Preliminary Geotechnical Investigation, Tentative Tract No. 36706, Malibu, Los Angeles County, California; Consultant report dated May 11, 1979; Project No. 895-VN

GeoSoils, Inc.; 1979b; Second Addendum to Preliminary Geologic and Soil Report, Tentative Tract No. 36706, Malibu, California; Consultant report dated September 26, 1979; Project No. 895-VN

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28315 Via Acero Road

Los Angeles County Department of Public Works; 1980; Geologic Review Letter – 28305 Via Acero (Parcel 9), Malibu, California; Review Letter Dated June 13, 1980.

American Geotechnical; 1985; Geotechnical Engineering Report, Proposed Residential Development, 28315 Via Acero, Malibu, Los Angeles County, California; Consultant report dated December 5, 1985; Project No. 1530.01.

28640 Via Acero Road

City of Malibu; 2007; Geotechnical Review Letter – 28640 Via Acero Drive, Malibu, California; Review letter dated February 6, 2007.

GeoConcepts, Inc.; 2006; Supplemental Report No. 3; 28640 Via Acero Drive, Malibu, California; Consultant report dated December 22 , 2006; Project No. 1946.

GeoConcepts, Inc.; 2007; Supplemental Report No. 5; 28640 Via Acero Drive, Malibu, California; Consultant report dated June 18, 2007; Project No. 1946.

6100 Via Escondido

Action Engineering Consultants; 1978; Preliminary Soils Investigation – Proposed Development at 6100 Via Escondido, Malibu, California; Consultant report dated September 2, 1978; Project No. 165003.

John D. Merrill, Consulting Engineering Geologists; 1978; Engineering Geologic Report, 6100 Via Escondido, Malibu, California; Consultant report dated September 20, 1978; Project No. 84629.

John D. Merrill, Consulting Engineering Geologists; 1980; Engineering Geologic Memorandum, 6100 Via Escondido, Malibu, California; Consultant report dated October 27, 1980; Project No. 84629.

27364 Winding Way

GeoSystems; 1997a; Updated Soils and Engineering-Geologic Investigation for Proposed Single Family Residence, Lot 3, Parcel Map 20433, 27364 Winding Way, Malibu, California; Consultant report dated July 17, 1997; Project No. GS97-507.

GeoSystems; 1997b; Response to City of Malibu Geology and Geotechnical Engineering Review Sheet, dated October 23, 1997, 27364 Winding Way, Malibu, California; Consultant report dated November 17, 1997; Project No. GS97-507-1.

GeoSystems; 1998; Response to City of Malibu Geology and Geotechnical Engineering Review Sheet, dated April 29, 1998, 27364 Winding Way, Malibu, California; Consultant report dated May 12, 1998; Project No. GS97-507-2.

GeoSystems; 1998; Final As-Built Engineering Geologic and Final Compaction Report for the Proposed Residential Building Pad Placed on Lot 3, Parcel Map 20433, 27364 Winding Way, Malibu, California; Consultant report dated September 2, 1998; Project No. GS98-C802.

GeoSystems, Inc.; 1988; Preliminary Soils and Engineering Geologic Investigation Report for Proposed Tentative Parcel Map No 20433, Three Lots on 4.32 Acres, Lot 7, Tract 12935, M.B. 248, Pages 39 & 40, Winding Way, Malibu, California; Consultant report dated December 20, 1988; Project No. GS88-926.

GeoSystems, Inc.; 1989a; Addendum to Preliminary Soils and Engineering Geologic Investigation Report Tentative Parcel Map No 20433, Winding Way, Malibu, California; Consultant report dated June 8, 1989; Project No. GS88-926-1.

GeoSystems, Inc.; 1991; Final As-Built Engineering Geologic and Final Compaction Report for Access Roadway and Proposed Single-Family Residence at 27364 Winding Way, Lot 3, Malibu, California; Consultant report dated August 28, 1991; Project No. GS91-C167.

GeoSystems, Inc.; 1991; Compaction Report for Utility Trench Backfill at 27364 Winding Way, Malibu, California; Consultant report dated October 21, 1991; Project No. GS91-C167-1.

Miller Steven B.; 1989b; Report on Percolation Testing for Sewage Effluent, Tentative Parcel map 20433, Three Lots, 27364 Winding Way, Malibu, California; Consultant report dated January 19, 1989; Project No. M88-1201P.

<u>27380 Winding Way</u>

Baseline Consultants Inc.; 1981a; Proposed Residential Site; 27380 Winding Way, Malibu, California; Consultant report dated July 14, 1981; Project No. 819-071.

Baseline Consultants Inc.; 1981b; Proposed Residential Site; 27405 (?) (Corrected by hand to 27380) Winding Way, Malibu, California; Consultant report dated July 14, 1981; Project No. 819-071.

Baseline Consultants Inc.; 1988; 27380 Winding Way, Malibu, California; Consultant report dated December 13, 1988; Project No. 819-118.

Baseline Consultants Inc.; 1989; Response to County of Los Angeles Geotechnical Engineering Review Sheet dated March 22, 1989, 27380 Winding Way Road, Malibu, California; Consultant report dated March 29, 1989; Project No. 819-039.

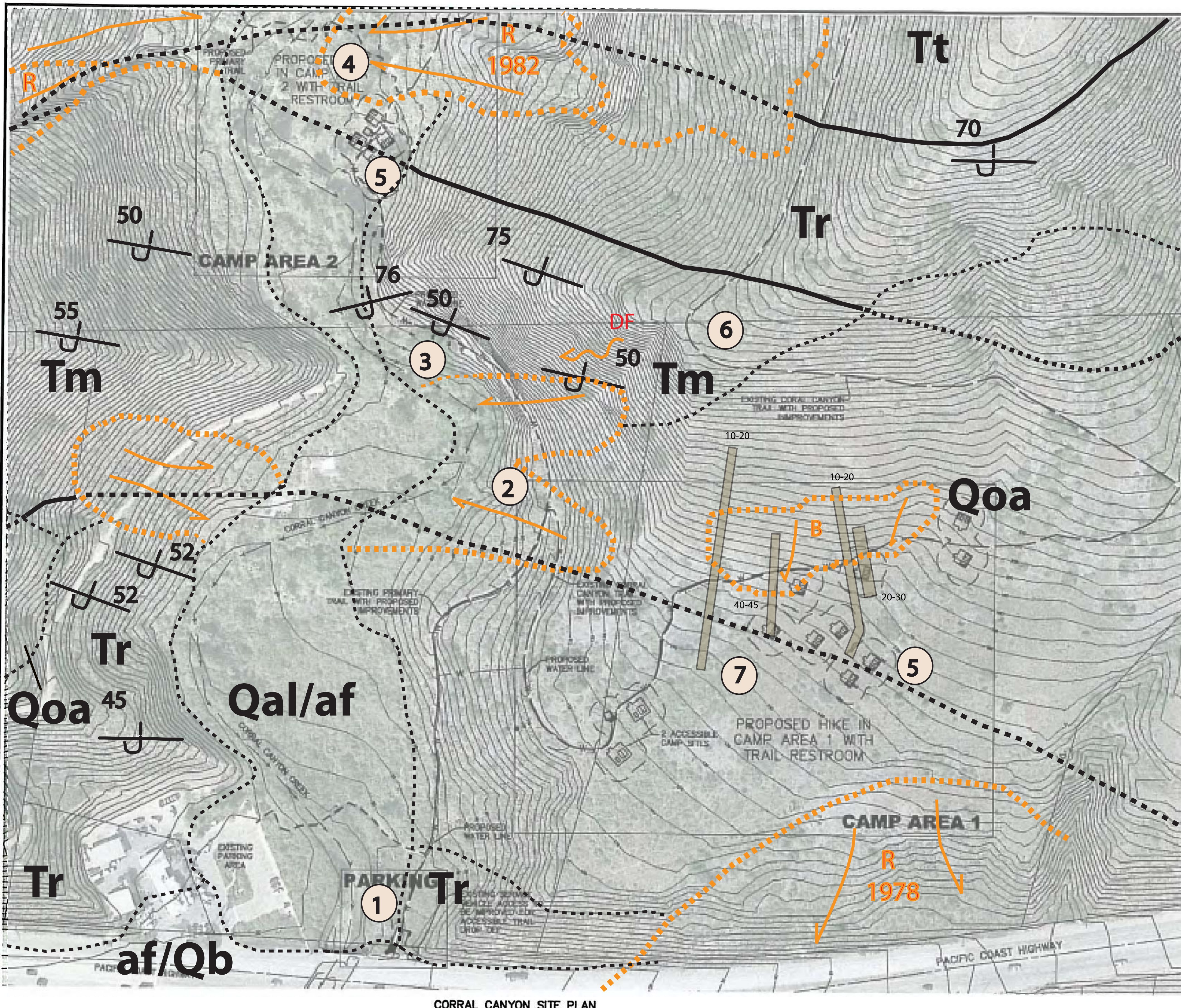
Baseline Consultants Inc.; 1989; Results of Compaction Tests, 27380 Winding Way Road, Malibu, California; Consultant report dated August 7, 1989; Project No. 089-039.

Harley Tucker, Inc.; 1989; As-Built Geologic Report, 27380 Winding Way, Malibu Area , Los Angeles County, California; Consultant report dated August 9, 1989; Project No. 4665-2.88.

AERIAL PHOTOGRAPHS REVIEWED

SOURCE	YEAR	FLIGHT#	PHOTO #	APPX. SCALE
Fairchild Aerial Surveys	1928	C-300	J-15, 16, 33&34 H-32 through H-34 H42 through H-44 H84 through H-86	1" = 1,500'
Fairchild Aerial Surveys	1945	9800	15-1552, 1553, 1554	1” = 1,200’
U.S.D.A.	1952	AXJ-1K	14 through 16 23 through 25 50 through 52 74 through 77	1" = 1,800'
U.S.D.A.	1952	AXJ-14K	39 & 40	1" = 1,800'
U.S.D.A.	1953	AXI-10K	116	1" = 1,800'
U.S.D.A.	1959	AXJ-10W	184 & 185	1" = 1,800'
Los Angeles County Flood Control District	1965	1933-01	296 through 297 310 through 314	1” = 3000’
Los Angeles County	1969	South County	1-4, 1-5, 1-13 & 1-17	1” = 2000’
Los Angeles County	1973	U2 Flight	32 through 34; 404 & 405	1” = 2,600’
Teledyne Geotronics	1975	7500C	26A-1 & 26A-2	1”= 1,940’
U.S.D.A.	1989	1832	3 & 4	1" = 3,700'
NASA	2000	Malibu	15 – 20	1" = 1,475'
NASA	2002	Malibu	129 - 135	1" = 1,475'

Geologic Map Corral Canyon



Legend

Qal/af - Recent Alluvium
(with artificial fill from 1965 trench excavation- exact location unknown)

af/Qb - Artificial Fill over Beach Sand

Qoa - Older Alluvium

Tm - Monterey Formation

Tt - Topanga Formation

Tr - Trancas Formation

50 - Bedding - Upright

60 - Bedding - Overturned

1982 - Landslide
R - Recent movement with date if known - movement may be more recent than indicated
B - Buried below younger deposits

DF - Debris Flow Scar

- Geologic Contact

- Malibu Coast Fault
Various Branches
Dotted Where Buried

7 - Locality
Described in text

40-45 - Exploratory Fault Trench
Showing maximum depths estimated from logs. Excavated in 1965

N

CONCEPT

Plate 1

DUDEK
621 CHAPALA STREET
SANTA BARBARA, CA 93101
(805) 963-0651

Mountains Recreation and Conservation Authority
Corral, Escondido, & Ramirez Canyon, Latigo Parking, & Malibu Bluffs | September 21, 2009
Southwestern Engineering Geology | Project No. 1-208/707-2006

Penfield & Smith
Engineers · Surveyors · Planners
· Construction Management ·
111 East Victoria Street, Santa Barbara, CA 93101
Phone: (805) 963-9532 Fax: (805) 966-9801

DESIGN ____ CHECKED ____
____ DATE: ____
PROJECT ENGINEER
(EXP. 06-30-08)

CITY OF MALIBU
REVIEWED BY:
SIGNATURE DATE

SITE PLAN
CORRAL CANYON
LOCAL COASTAL PROGRAM AMENDMENT
MALIBU, CALIFORNIA

34-ENG SAVE DATE: 4/11/2008 4:13:11 PM PLOT BY: Janna Christ PLOT DATE: 4/14/2008 10:07:43 AM PLOT SCALE: 1:1

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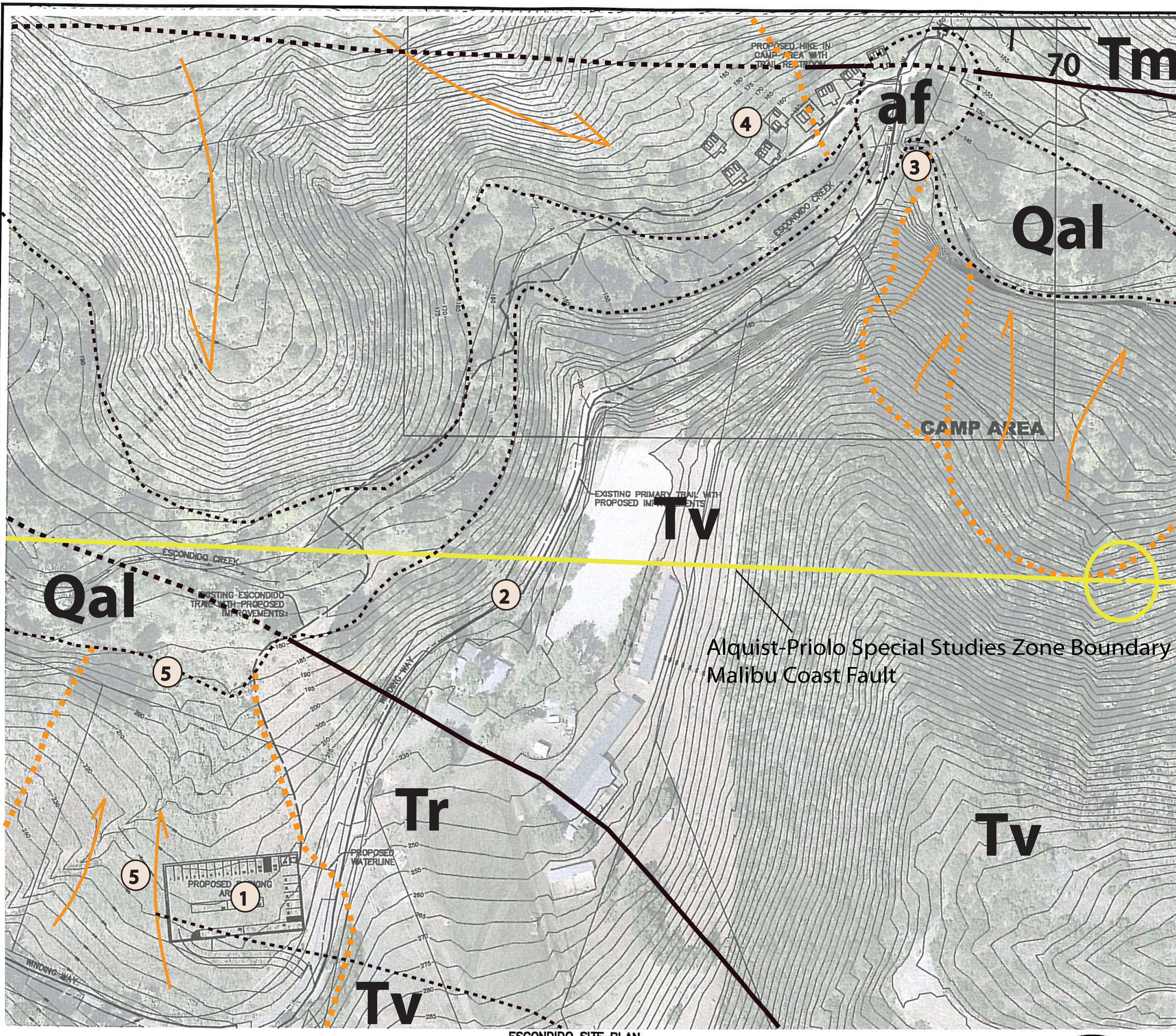

Geologic Map
Escondido Canyon

Legend

Qal	- Recent Alluvium
Tm	- Monterey Formation
Tr	- Trancas Formation
Tv	- Conejo Volcanics
af	- Artificial Fill
50	- Bedding - Upright
	- Landslide
	- Geologic Contact
	- Malibu Coast Fault Various Branches Dotted Where Buried
5	- Locality Described in text

N

0 60 120 180

CONCEPT

Plate 2	DUDEK 621 CHAPALA STREET SANTA BARBARA, CA 93101 (805) 963-0651	Mountains Recreation and Conservation Authority Corral, Escondido, & Ramirez Canyon, Latigo Parking, & Malibu Bluffs — September 21, 2009 Southwestern Engineering Geology — Project No. 1-208/707-2006	Penfield & Smith Engineers · Surveyors · Planners · Construction Management · 111 East Victoria Street, Santa Barbara, CA 93101 Phone: (805) 963-9532 Fax: (805) 966-9801	DESIGN ______ CHECKED ______ ______ DATE: ______ PROJECT ENGINEER (EXP. 06-30-08)	CITY OF MALIBU REVIEWED BY: SIGNATURE ______ DATE ______

SITE PLAN
ESCONDIDO CANYON
LOCAL COASTAL PROGRAM AMENDMENT
MALIBU, CALIFORNIA

PLOT SCALE:1:1 PLOT DATE:4/14/2008 10:04:56 AM PLOT BY:Janna Christ
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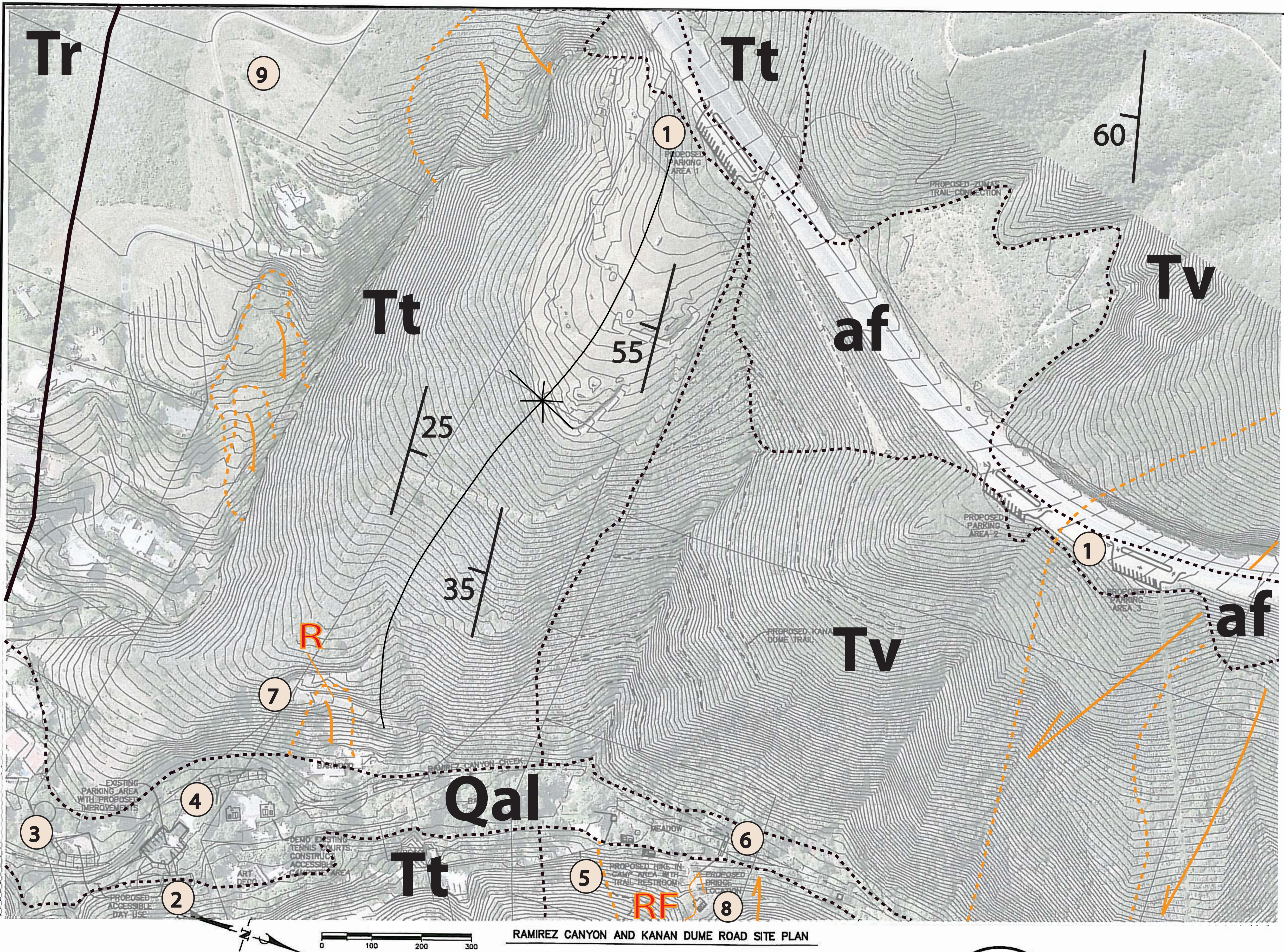
Geologic Map Ramirez Canyon (Sheet 1)



RAMIREZ CANYON AND KANAN DUME ROAD SITE PLAN

Legend

- Qal - Recent Alluvium
- af - Artificial Fill
- Tt - Topanga Formation
- Tr - Trancas Formation
- Tv - Conejo Volcanics
- 50 - Bedding - Upright
- Landslide
  - R - Recent movement
  - SF - Primarily surficial creep and shallow failures
- RF - Rockfall Source
- Syncline
- Geologic Contact
- Malibu Coast Fault
  - Various Branches
  - Dotted Where Buried
- 9 - Locality
  - Described in text

PLOT SCALE:1:1
PLOT DATE:4/14/2008 9:57:40 AM
PLOT BY:Jenna Christ
34-ENG SAVE DATE: 4/14/2008 9:44:49 AM

CONCEPT

Plate 3A	DUDEK 621 CHAPALA STREET SANTA BARBARA, CA 93101 (805) 963-0651	Mountains Recreation and Conservation Authority Corral, Escondido, & Ramirez Canyon, Latigo Parking, & Malibu Bluffs — September 21, 2009 Southwestern Engineering Geology — Project No. 1-208/707-2006	Penfield & Smith Engineers · Surveyors · Planners · Construction Management · 111 East Victoria Street, Santa Barbara, CA 93101 Phone: (805) 963-9532 Fax: (805) 966-9801	DESIGN ___ CHECKED ___ DATE: ___ PROJECT ENGINEER (EXP. 06-30-08)	CITY OF MALIBU REVIEWED BY: SIGNATURE ___ DATE ___	SITE PLAN – RAMIREZ CANYON RAMIREZ CANYON & KANAN DUME PARKING LOCAL COASTAL PROGRAM AMENDMENT MALIBU, CALIFORNIA

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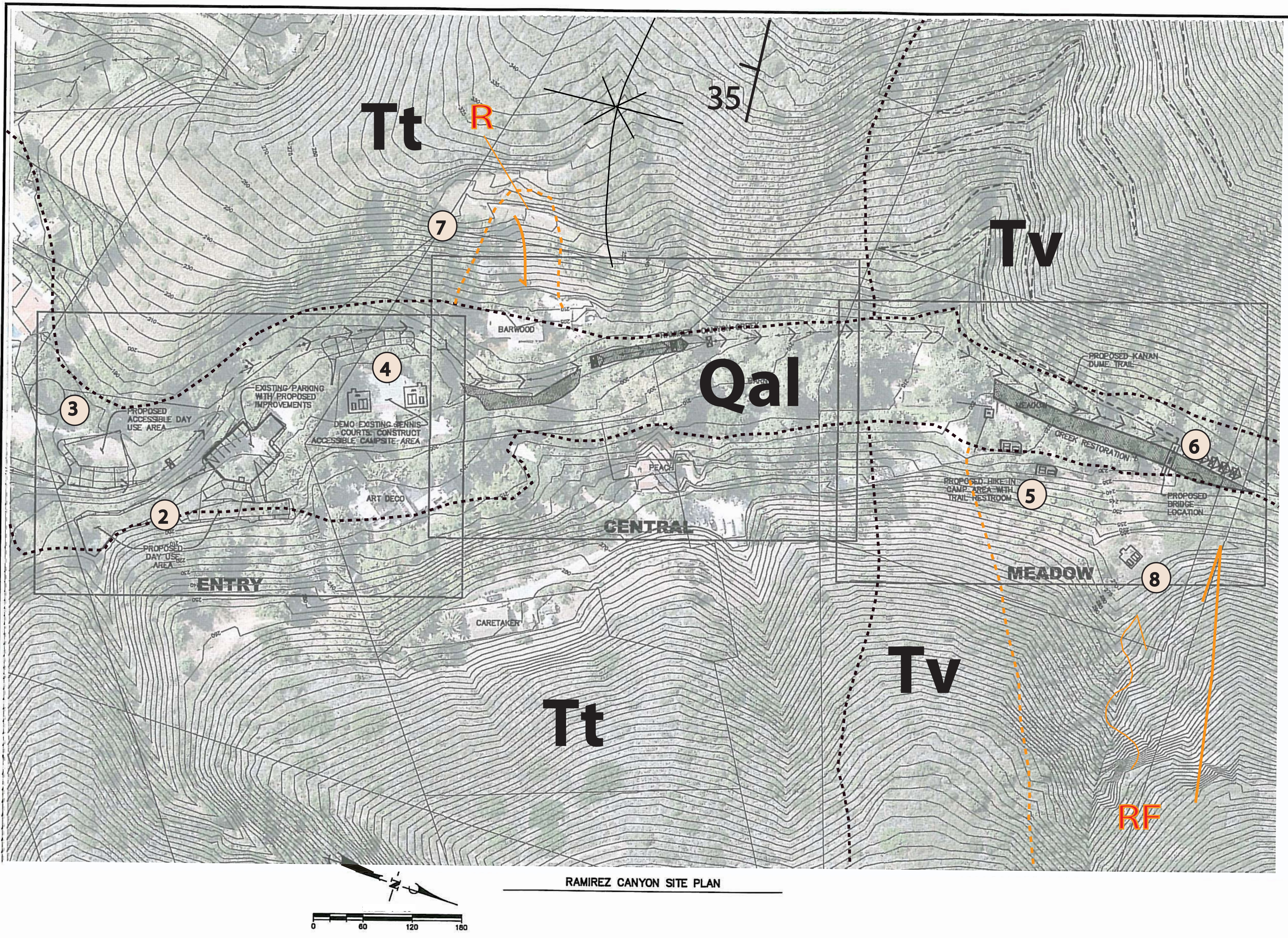
Geologic Map
Ramirez Canyon
(Sheet 2)



Legend

Qal	- Recent Alluvium
Tt	- Topanga Formation
Tr	- Trancas Formation
Tv	- Conejo Volcanics
50	- Bedding - Upright
	- Landslide R - Recent movement SF- Primarily surficial creep and shallow failures
RF	- Rockfall Source
	- Syncline
	- Geologic Contact
8	- Locality Described in text

PLOT SCALE:1:1 PLOT DATE:4/14/2008 10:02:50 AM PLOT BY:Jenna Christ 34-ENG SAVE DATE: 4/14/2008 9:41:46 AM

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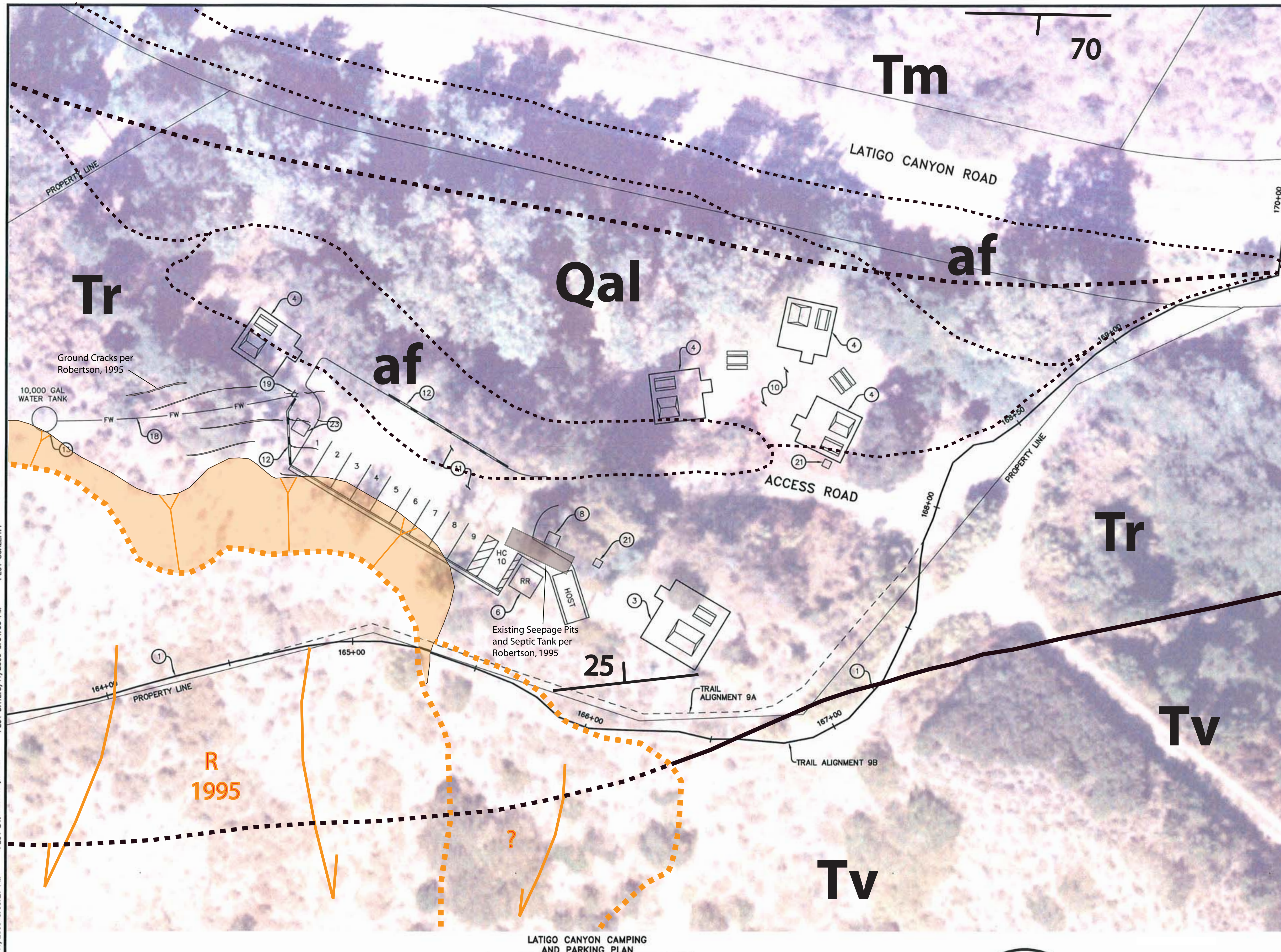
CONCEPT

Plate 3B	DUDEK 621 CHAPALA STREET SANTA BARBARA, CA 93101 (805) 963-0651	Mountains Recreation and Conservation Authority Corral, Escondido, & Ramirez Canyon, Latigo Parking, & Malibu Bluffs — September 21, 2009 Southwestern Engineering Geology — Project No. 1-208/707-2006	Penfield & Smith Engineers · Surveyors · Planners · Construction Management · 111 East Victoria Street, Santa Barbara, CA 93101 Phone: (805) 963-9532 Fax: (805) 966-9801	DESIGN ___ CHECKED ___ DATE: ___ PROJECT ENGINEER (EXP. 06-30-08)	CITY OF MALIBU REVIEWED BY: SIGNATURE DATE	SITE PLAN RAMIREZ CANYON LOCAL COASTAL PROGRAM AMENDMENT MALIBU, CALIFORNIA

Geologic Map Latigo Parking



Legend

Qal - Recent Alluvium

Tm - Monterey Formation

Tv - Conejo Volcanics

Tr - Trancas Formation

af - Artificial Fill

50 - Bedding

Landslide - Shaded area indicates well-defined headscarp inclined at 60-80 degrees
R - Date of original failure periodic/creeping movement likley continues
? - Questionable

Geologic Contact

Malibu Coast Fault - Various Branches Dotted Where Buried

N

0 20 40 60

CONCEPT

Plate 4	DUDEK 621 CHAPALA STREET SANTA BARBARA, CA 93101 (805) 963-0651	Mountains Recreation and Conservation Authority Corral, Escondido, & Ramirez Canyon, Latigo Parking, & Malibu Bluffs — September 21, 2009 *Southwestern Engineering Geology* — Project No. 1-208/707-2006	Penfield & Smith Engineers · Surveyors · Planners · Construction Management · 111 East Victoria Street, Santa Barbara, CA 93101 Phone: (805) 963-9532 Fax: (805) 966-9801	DESIGN CHECKED DATE: PROJECT ENGINEER (EXP. 06-30-08)	CITY OF MALIBU REVIEWED BY: SIGNATURE DATE	CAMPING AND PARKING PLAN LATIGO CANYON SANTA MONICA MOUNTAINS CONSERVANCY MALIBU, CALIFORNIA

34-ENG SAVE DATE: 8/11/2009 3:03:21 PM PLOT BY: Carrie Poytress PLOT DATE: 8/11/2009 3:04:00 PM PLOT SCALE: 1:1

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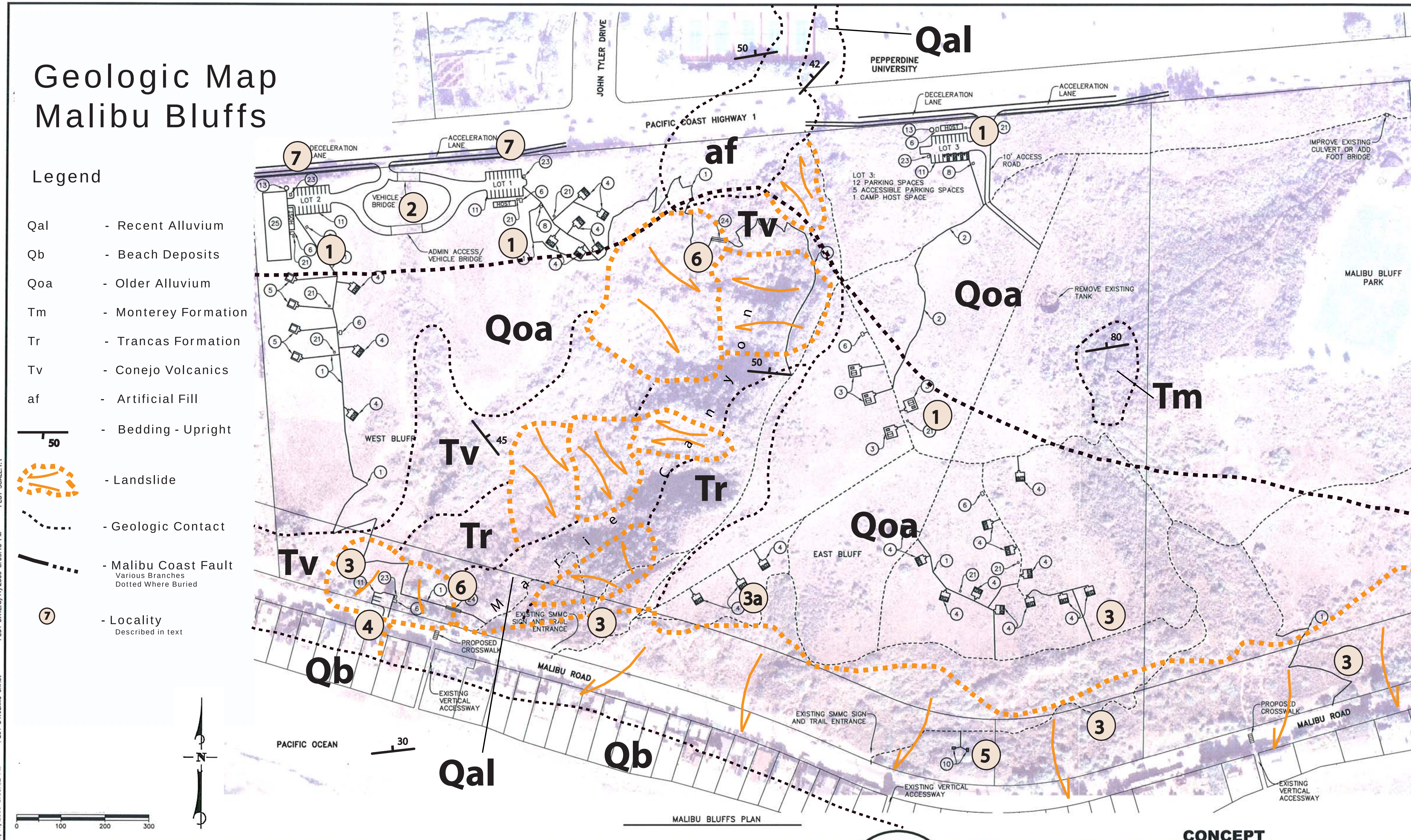

Plate 5	DUDEK 621 CHAPALA STREET SANTA BARBARA, CA 93101 (805) 963-0651	Mountains Recreation and Conservation Authority Corral, Escondido, & Ramirez Canyon, Latigo Parking, & Malibu Bluffs — September 21, 2009 *Southwestern Engineering Geology* — Project No. 1-208/707-2006	Penfield & Smith Engineers · Surveyors · Planners · Construction Management · 111 East Victoria Street, Phone: (805) 963-9532 Santa Barbara, CA 93101 Fax: (805) 966-9801	DESIGN CHECKED DATE: PROJECT ENGINEER (EXP. 06-30-10)	CITY OF MALIBU REVIEWED BY: — SIGNATURE DATE	PLAN MALIBU BLUFFS SANTA MONICA MOUNTAINS CONSERVANCY MALIBU, CALIFORNIA

Location Map

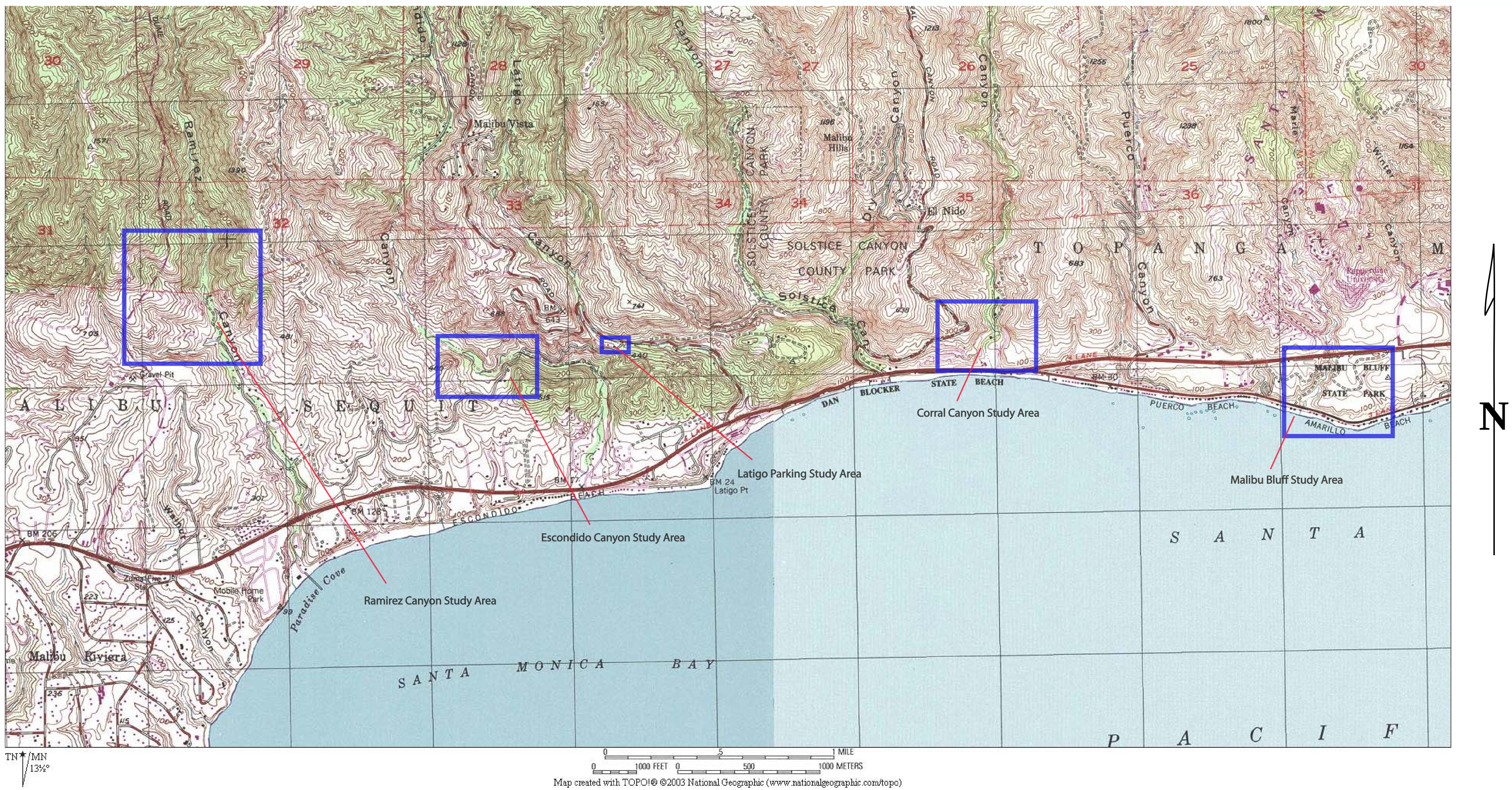

Figure 1

Mountains Recreation and Conservation Authority	
Corral, Escondido, & Ramirez Canyon, Latigo Parking and Malibu Bluffs	September 21, 2009
Southwestern Engineering Geology	Project No. 1-208/707-2006

Proposed Trail & Access Map

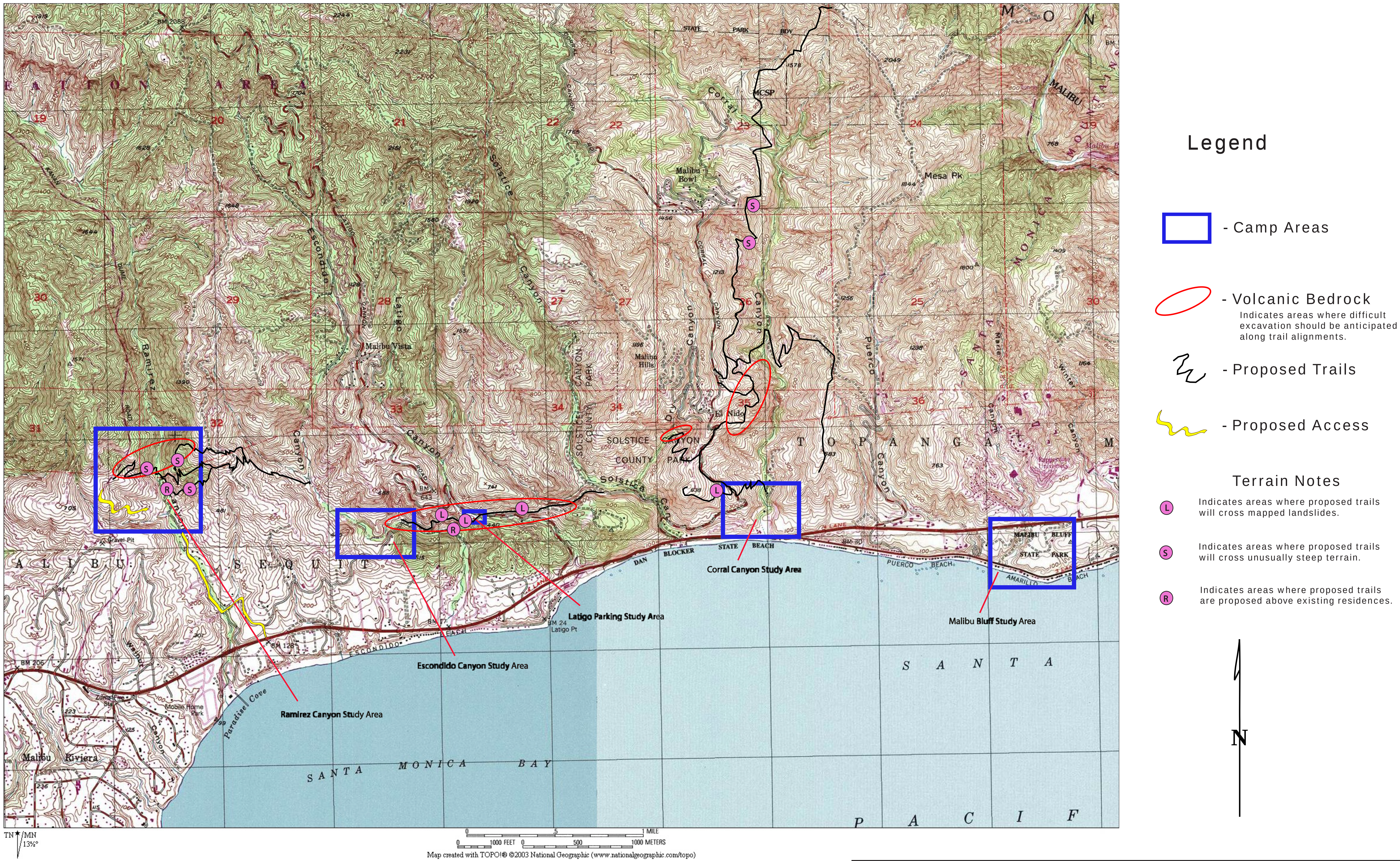

Figure 2

Mountains Recreation and Conservation Authority	
Corral, Escondido, & Ramirez Canyon, Latigo Parking and Malibu Bluffs	September 21, 2009
Southwestern Engineering Geology	Project No. 1-208/707-2006