INFORMATION HANDOUT

For Contract No. 02-3E4104
At 02-Sha-299-0.3/7.1

Identified by
Project ID 0200020042

PERMITS

PLAC Condition Responsibility Summary

United States Army Corps of Engineers

WATER QUALITY

California Regional Water Quality Control Board

Central Valley Region (WDID No. 5A45CR00459)
Board Order No. 2012-0011-DWQ
NPDES Permit No. CAS 000003

AGREEMENTS

California Department of Fish and Wildlife

Notification No. 1600-2013-0349-R1

MATERIALS INFORMATION

Foundation Report for Sawpit Gulch

Addendum to Foundation Report for Sawpit Gulch

Final Hydraulic Report for Sawpit Gulch Culvert Extension

Geotechnical Design Report

Addenddum to Geotechnical Design Report

Potential Water Sources

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PLAC CONDITION RESPONSIBILITY (PCR) SUMMARY

General: This PCR Summary clarifies various PLAC requirements. Perform all work described in the PLACs on behalf of the Department unless otherwise stated below in Table 2. If a discrepancy exists between the PCR Summary and the PLAC, the PCR Summary governs.
Definitions: Agency: A board, agency, or other entity that issues a PLAC Activity: A task, event or other project element PLAC Condition: a work activity and/or submittal required by a PLAC

Table 1 - Clarification of PLAC Requirements

PLAC Name	Section of the PLAC	PLAC Requirement
All PLACs	Applicable PLAC sections	**Submittals:** Submit to the Engineer when PLAC conditions require: 1. Communications. The Engineer will contact the agencies. 2. Records to be maintained, within 5 working days after the activity. 3. Submittals 5 days before the agencies require them. The Engineer will review and submit to the agencies.
California Department of Fish and Wildlife Streambed Alteration Agreement Notification No: 1600-2013-0349-R1	Measures to Protect Fish and Wildlife Resources	Measure 1.4. Both the Contractor and Caltrans will agree to allow DFG personnel to enter the project site at any time, after notifying the Resident Engineer, to verify compliance with the Agreement
	Habitat and Species Protection	Measure 2.5- Sentence 2 "Permittee shall restrict all project activities to the designated work area and shall maintain all fencing, stakes, and flags until the completion of project activities."
	Construction Dewatering and In Stream Structures	Measure 2.19- A majority of the gravel will be required to be removed from the streambed. Exact amount will be determined by the Engineer
	Erosion and Sediment Control	Measure 2.25- Apply erosion control mix to hydroseed areas shown on the plans.

PLAC CONDITION RESPONSIBILITY (PCR) SUMMARY

Table 2 - Work to be Performed by the Department		
PLAC Name	**Section of the PLAC**	**PLAC Requirement**
North Coast Regional Water Quality Control Board General 401 Water Quality Certification Order for Technically-conditioned Certification WDID#5A45CR00459	Standard Conditions	All Requirements
Department of the Army Requirements: Letter Dated June 12, 2014 - File Number SPK-2013-00655	Special Conditions 1-4	Mitigation Requirements
	All Regional Conditions	All Regional Conditions
	NWP 14 Conditions 1, 5, 7, 8, 10, 15, 16, 17, 22, 23-31	Requirements listed in applicable sections
California Department of Fish and Wildlife Streambed Alteration Agreement Notification No: 1600-2013-0349-R1	Measures to Protect Fish and Wildlife Resources	Measure 1.3
	Measures to Protect Fish and Wildlife Resources	Measure 1.4. Both the Contractor and Caltrans will agree to allow DFG personnel to enter the project site at any time, after notifying the Resident Engineer, to verify compliance with the Agreement
	Habitat and Species Protection	Measure 2.5: Sentence 2 "After construction, the Permittee will replant native trees and shrubs as described in this agreement at a ratio of 1:1."
	Construction Dewatering and In stream Structures	Measure 2.11-2.13
	Erosion and Sediment Control	Measure 2.26

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DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO CA 95814-2922

REPLY TO
ATTENTION OF

June 12, 2014

Regulatory Division (SPK-2013-00655)

Mr. Chris Harvey
California Department of Transportation
1031 Butte Street, Suite 205
Redding, California 96001

Dear Mr. Harvey:

We are responding to your agent's November 5, 2013, request for a Department of the Army Nationwide Permit (NWP) 14 verification for the SR299 Buckhorn Grade Improvement Capstone (EA 02-3E410, PM 0.3/7.1) project. This approximately 218-acre project involves activities, including discharges of dredged or fill material, in waters of the United States construct drainage improvements along the highway. The project is located in Section 11, Township 32 North, Range 8 West, Mount Diablo Meridian, Latitude 40.63973°, Longitude -122.73050°, Whiskeytown, Shasta County, California.

Based on the information your agent provided, the proposed activity, resulting in approximately 0.3075 acre of permanent impact and approximately 0.0382 acre of temporary impact to waters of the U.S., is authorized by Nationwide Permit Number (NWP) 14, Linear Transportation Projects. Your work must comply with the general terms and conditions listed on the enclosed 2012 NWP 14 information sheets (enclosure 1), the Final Sacramento District NWP Regional Conditions for California (enclosure 2) especially #5, 6, 7, 9, 10, 11, 12, 13, 14, 19, and the following Special Conditions:

Special Conditions

1. To mitigate for approximately 0.31 acre of permanent impact to waters of the United States, you shall restore approximately 0.31 acre of waters of the U.S. as shown and described in the enclosed conceptual mitigation proposal, dated May 23, 2014, and revised June 4, 2014, entitled *SPK-2013-00655, Conceptual Mitigation Proposal for BGI Capstone, SHA 299 PM 0.3-7.1, Watershed Restoration in Whiskeytown National Recreation Area* (enclosure 3).

2. You shall develop a final comprehensive mitigation and monitoring plan, which must be approved by this office prior to initiation of construction activities within waters of the U.S. The plan shall include mitigation location and design drawings, vegetation plans, including target species to be planted, and final success criteria, and shall be presented in the format of the Sacramento District's Habitat Mitigation and Monitoring Proposal Guidelines, dated December 30, 2004. The purpose of this requirement is to ensure replacement of functions of the aquatic environment that would be lost through project implementation.

3. The map drawing entitled *Buckhorn Grade Improvement Capstone Project, Project Impact Map, Sheets 01-06*, dated November 22, 2013, is incorporated by reference as a condition of this authorization. Any deviations from the work as authorized, which result in additional impacts to waters of the U.S., including wetlands, must be coordinated with this office prior to impacts.

4. We understand the State of California, Department of Transportation (Caltrans) is the National Environmental Policy Act (NEPA) lead Federal agency for this project, and as such, will ensure compliance with NEPA and all other applicable Federal Laws. You shall include this office in all future consultation and coordination activities involving compliance with the Endangered Species Act, the Magnuson-Stevens Act, and the National Historic Preservation Act, as they pertain to the activities authorized herein, so that we may consult as appropriate or designate you to consult on our behalf.

5. No work shall occur within standing or flowing waters. Temporary dewatering structures (e.g. coffer dams) shall be deployed when the channel is naturally dry. Dewatering plans must be approved, in writing, by this office prior to commencement of construction activities. Plans, maps and/or drawings may be submitted electronically to regulatory-info@usace.army.mil.

6. Excavated materials from the permit area shall not be stockpiled or disposed of outside the permit area. Disposal and stockpile areas must be reviewed and approved by this office prior to commencement of construction activities. Plans, maps and/or drawings may be submitted electronically to regulatory-info@usace.army.mil.

7. If any of the above conditions are violated or unauthorized activities occur, you shall stop work immediately and notify this office. You shall provide us with a detailed description of the unauthorized activity(s), photo documentation, and any measures taken to remedy the violation.

8. You shall comply with all terms and condition of the enclosed January 30, 2014, (WDID#5A45CR00459) Section 401 Water Quality Certification (enclosure 4).

9. You must sign the enclosed *Compliance Certification* (enclosure 5) and return it to this office within 30 days after completion of the authorized work.

This verification is valid until March 18, 2017, when the existing NWPs are scheduled to be modified, reissued, or revoked. Furthermore, if you commence or are under contract to commence this activity before the date that the relevant NWP is modified, reissued or revoked, you will have twelve (12) months from the date of the modification, reissuance or revocation of the NWP to complete the activity under the present terms and conditions. Failure to comply with the General and Regional Conditions of this Nationwide Permit, or the project-specific Special Conditions of this authorization, may result in the suspension or revocation of your authorization.

We would appreciate your feedback. At your earliest convenience, please tell us how we are doing by completing the customer survey on our website under *Customer Service Survey*.

Please refer to identification number SPK-2013-00655 in any correspondence concerning this project. If you have any questions, please contact Mr. Peck Ha at our California North Branch Office, Regulatory Division, Sacramento District, U.S. Army Corps of Engineers, 1325 J Street, Room 1350, Sacramento, California 95814-2922, by email at *Peck.Ha@usace.army.mil*, or telephone at 916-557-6617. For more information regarding our program, please visit our website at *www.spk.usace.army.mil/Missions/Regulatory.aspx*.

Sincerely,

Nancy Aready Haley
Chief, California North Branch

Enclosures

cc: (w/o encls)
Mr. Emiliano Pro, Caltrans, emiliano.pro@dot.ca.gov
Mr. Elizabeth Lee, California Regional Water Quality Control Board, EMLee@waterboards.ca.gov
Mr. Paul Jones, U.S. Environmental Protection Agency, Region IX, Jones.Paul@epa.gov
Ms. Tina Bartlett, California Department of Fish and Game, TinaBartlett@wildlife.ca.gov
Mr. Ryan Olah, U.S. Fish and Wildlife Service, ryan_olah@fws.gov

Final Sacramento District Nationwide Permit
Regional Conditions for California, excluding the Lake Tahoe Basin

(Effective March 19, 2012 until March 18, 2017)

1.* When pre-construction notification (PCN) is required, the permittee shall notify the U.S. Army Corps of Engineers, Sacramento District (Corps) in accordance with General Condition 31 using either the South Pacific Division Preconstruction Notification (PCN) Checklist or a signed application form (ENG Form 4345) with an attachment providing information on compliance with all of the General and Regional Conditions. In addition, the PCN shall include:

a. A written statement describing how the activity has been designed to avoid and minimize adverse effects, both temporary and permanent, to waters of the United States;

b. Drawings, including plan and cross-section views, clearly depicting the location, size and dimensions of the proposed activity, as well as the location of delineated waters of the U.S. on the site. The drawings shall contain a title block, legend and scale, amount (in cubic yards) and area (in acres) of fill in Corps jurisdiction, including both permanent and temporary fills/structures. The ordinary high water mark or, if tidal waters, the mean high water mark and high tide line, should be shown (in feet), based on National Geodetic Vertical Datum (NGVD) or other appropriate referenced elevation. All drawings for activities located within the boundaries of the Los Angeles District shall comply with the September 15, 2010 Special Public Notice: *Map and Drawing Standards for the Los Angeles District Regulatory Division*, (available on the Los Angeles District Regulatory Division website at: www.spl.usace.army.mil/regulatory/); and

c. Numbered and dated pre-project color photographs showing a representative sample of waters proposed to be impacted on the site, and all waters of the U.S. proposed to be avoided on and immediately adjacent to the project site. The compass angle and position of each photograph shall be identified on the plan-view drawing(s) required in subpart b of this Regional Condition.

2. For all Nationwide Permits (NWPs), the permittee shall submit a PCN in accordance with General Condition 31 and Regional Condition 1, in the following circumstances:

a. For all activities that would result in the discharge of fill material into any vernal pool;

b. For any activity in the Primary and Secondary Zones of the Legal Delta, the Sacramento River, the San Joaquin River, and the immediate tributaries of these waters;

c. For all crossings of perennial waters and intermittent waters;

d. For all activities proposed within 100 feet of the point of discharge of a known natural spring source, which is any location where ground water emanates from a point in the ground excluding seeps or other discharges which lack a defined channel; and

e.* For all activities located in areas designated as Essential Fish Habitat (EFH) by the Pacific Fishery Management Council (i.e., all tidally influenced areas - Federal Register dated March 12, 2007 (72 FR 11092)), in which case the PCN shall include an EFH assessment and extent of proposed impacts to EFH. Examples of EFH habitat assessments can be found at: http://www.swr.noaa.gov/efh.htm.

3. The permittee shall record the NWP verification with the Registrar of Deeds or other appropriate official charged with the responsibility for maintaining records of title to or interest in real property for areas (1) designated to be preserved as part of compensatory mitigation for authorized impacts, including any associated covenants or restrictions, or (2) where boat ramps or docks, marinas, piers, and permanently moored vessels will be constructed or placed in or adjacent to navigable waters. The recordation shall also include a map showing the surveyed location of the preserved area or authorized structure.

* Regional Condition developed jointly between Sacramento District, Los Angeles District, and San Francisco District.

4. For all waters of the U.S. proposed to be avoided on a site, unless determined to be impracticable by the Corps, the permittee shall:

a. Establish and maintain, in perpetuity, a preserve containing all avoided waters of the U.S. to ensure that the functions of the aquatic environment are protected;

b. Place all avoided waters of the U.S. and any upland buffers into a separate parcel prior to discharging dredge or fill material into waters of the U.S., and

c. Establish permanent legal protection for all preserve parcels, following Corps approval of the legal instrument;

If the Corps determines that it is impracticable to require permanent preservation of the avoided waters, additional mitigation may be required in order to compensate for indirect impacts to the waters of the U.S.

5. For all temporary fills, the PCN shall include a description of the proposed temporary fill, including the type and amount of material to be placed, the area proposed to be impacted, and the proposed plan for restoration of the temporary fill area to pre-project contours and conditions, including a plan for the re-vegetation of the temporary fill area, if necessary. In addition, the PCN shall include the reason(s) why avoidance of temporary impacts is not practicable.

In addition, for all activities resulting in temporary fill within waters of the U.S., the permittee shall:

a. Utilize material consisting of clean and washed gravel. For temporary fills within waters of the U.S. supporting anadromous fisheries, spawning quality gravel shall be used, where practicable, as determined by the Corps, after consultation with appropriate Federal and state fish and wildlife agencies;

b. Place a horizontal marker (e.g. fabric, certified weed free straw, etc.) to delineate the existing ground elevation of the waters temporarily filled during construction; and

c. Remove all temporary fill within 30 days following completion of construction activities.

6. In addition to the requirements of General Condition 2, unless determined to be impracticable by the Corps, the following criteria shall apply to all road crossings:

a.* For all activities in waters of the U.S. that are suitable habitat for Federally-listed fish species, the permittee shall design all road crossings to ensure that the passage and/or spawning of fish is not hindered. In these areas, the permittee shall employ bridge designs that span the stream or river, including pier- or pile-supported spans, or designs that use a bottomless arch culvert with a natural stream bed;

b. Road crossings shall be designed to ensure that no more than minor impacts would occur to fish and wildlife passage or expected high flows, following the criteria listed in Regional Condition 6(a). Culverted crossings that do not utilize a bottomless arch culvert with a natural stream bed may be authorized for waters that do not contain suitable habitat for Federally listed fish species, if it can be demonstrated and is specifically determined by the Corps, that such crossing will result in no more than minor impacts to fish and wildlife passage or expected high flows;

c. No construction activities shall occur within standing or flowing waters. For ephemeral or intermittent streams, this may be accomplished through construction during the dry season. In perennial streams, this may be accomplished through dewatering of the work area. Any proposed dewatering plans must be approved, in writing, by the Corps prior to commencement of construction activities; and

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d. All bank stabilization activities associated with a road crossing shall comply with Regional Condition 19.

In no case shall stream crossings result in a reduction in the pre-construction bankfull width or depth of perennial streams or negatively alter the flood control capacity of perennial streams.

7.* For activities in which the Corps designates another Federal agency as the lead for compliance with Section 7 of the Endangered Species Act (ESA) of 1973 as amended, pursuant to 50 CFR Part 402.07, Section 305(b)(4)(B) of the Magnuson-Stevens Fishery Conservation and Management Act (EFH), pursuant to 50 CFR 600.920(b) and/or Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, pursuant to 36 CFR 800.2(a)(2), the lead Federal agency shall provide all relevant documentation to the Corps demonstrating any previous consultation efforts, as it pertains to the Corps Regulatory permit area (for Section 7 and EFH compliance) and the Corps Regulatory area of potential effect (APE) (for Section 106 compliance). For activities requiring a PCN, this information shall be submitted with the PCN. If the Corps does not designate another Federal agency as the lead for ESA, EFH and/or NHPA, the Corps will initiate consultation for compliance, as appropriate.

8. For all NWPs which require a PCN, the permittee shall submit the following additional information with the compliance certificate required under General Condition 30:

a. As-built drawings of the work conducted on the project site and any on-site and/or off-site compensatory mitigation, preservation, and/or avoidance area(s). The as-builts shall include a plan-view drawing of the location of the authorized work footprint (as shown on the permit drawings), with an overlay of the work as constructed in the same scale as the permit drawings. The drawing shall show all areas of ground disturbance, wetland impacts, structures, and the boundaries of any on-site and/or off-site mitigation or avoidance areas. Please note that any deviations from the work as authorized, which result in additional impacts to waters of the U.S., must be coordinated with the appropriate Corps office prior to impacts; and

b. Numbered and dated post-construction color photographs of the work conducted within a representative sample of the impacted waters of the U.S., and within all avoided waters of the U.S. on and immediately adjacent to the proposed project area. The compass angle and position of all photographs shall be similar to the pre-construction color photographs required in Regional Condition 1(c) and shall be identified on the plan-view drawing(s) required in subpart a of this Regional Condition.

9. For all activities requiring permittee responsible mitigation, the permittee shall develop and submit to the Corps for review and approval, a final comprehensive mitigation and monitoring plan for all permittee responsible mitigation prior to commencement of construction activities within waters of the U.S. The plan shall include the mitigation location and design drawings, vegetation plans, including target species to be planted, and final success criteria, presented in the format of the *Sacramento District's Habitat Mitigation and Monitoring Proposal Guidelines*, dated December 30, 2004, and in compliance with the requirements of 33 CFR 332.

10.* The permittee shall complete the construction of any compensatory mitigation required by special condition(s) of the NWP verification before or concurrent with commencement of construction of the authorized activity, except when specifically determined to be impracticable by the Corps. When mitigation involves use of a mitigation bank or in-lieu fee program, the permittee shall submit proof of payment to the Corps prior to commencement of construction of the authorized activity.

11. The permittee is responsible for all authorized work and ensuring that all contractors and workers are made aware and adhere to the terms and conditions of the permit authorization. The permittee shall ensure

* Regional Condition developed jointly between Sacramento District, Los Angeles District, and San Francisco District.

that a copy of the permit authorization and associated drawings are available and visible for quick reference at the site until all construction activities are completed.

12. The permittee shall clearly identify the limits of disturbance in the field with highly visible markers (e.g. construction fencing, flagging, silt barriers, etc.) prior to commencement of construction activities within waters of the U.S. The permittee shall maintain such identification properly until construction is completed and the soils have been stabilized. The permittee is prohibited from any activity (e.g. equipment usage or materials storage) that impacts waters of the U.S. outside of the permit limits (as shown on the permit drawings).

13. For all activities in which a PCN is required, the permittee shall notify the appropriate district office of the start date for the authorized work within 10 days prior to initiation of construction activities.

14. The permittee shall allow Corps representatives to inspect the authorized activity and any mitigation areas at any time deemed necessary to determine compliance with the terms and conditions of the NWP verification. The permittee will be notified in advance of an inspection.

15. For all activities located in the Mather Core Recovery Area in Sacramento County, as identified in the U.S. Fish and Wildlife Service's *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* dated December 15, 2005, NWPs 14, 18, 23, 29, 39, 40, 42, 43 and 44 are revoked from use in vernal pools that may contain habitat for Federally-listed threatened and/or endangered vernal pool species.

16. For activities located in the Primary or Secondary Zone of the Legal Delta, NWPs 29 and 39 are revoked.

17. For all activities within the Secondary Zone of the Legal Delta, the permittee shall conduct compensatory mitigation for unavoidable impacts within the Secondary Zone of the Legal Delta.

18. For NWP 12: Permittees shall ensure the construction of utility lines does not result in the draining of any water of the U.S., including wetlands. This may be accomplished through the use of clay blocks, bentonite, or other suitable material (as approved by the Corps) to seal the trench. For utility line trenches, during construction, the permittee shall remove and stockpile, separately, the top 6 – 12 inches of topsoil. Following installation of the utility line(s), the permittee shall replace the stockpiled topsoil on top and seed the area with native vegetation. The permittee shall submit a PCN for utility line activities in the following circumstances:

a. The utility line crossing would result in a discharge of dredged and/or fill material into perennial waters, intermittent waters, wetlands, mudflats, vegetated shallows, riffle and pool complexes, sanctuaries and refuges or coral reefs;

b. The utility line activity would result in a discharge of dredged and/or fill material into greater than 100 linear feet of ephemeral waters of the U.S.;

c. The utility line installation would include the construction of a temporary or permanent access road, substation or foundation within waters of the U.S.; or

d. The proposed activity would not involve the restoration of all utility line trenches to pre-project contours and conditions within 30 days following completion of construction activities.

19. For NWP 13 and 14: All bank stabilization activities shall involve either the sole use of native vegetation or other bioengineered design techniques (e.g. willow plantings, root wads, large woody debris, etc.), or a combination of hard-armoring (e.g. rip-rap) and native vegetation or bioengineered design

* Regional Condition developed jointly between Sacramento District, Los Angeles District, and San Francisco District.

techniques, unless specifically determined to be impracticable by the Corps. The permittee shall submit a PCN for any bank stabilization activity that involves hard-armoring or the placement of any non-vegetated or non-bioengineered technique below the ordinary high water mark or, if tidal waters, the high tide line of waters of the U.S. The request to utilize non-vegetated techniques must include information on why the sole use of vegetated techniques is not practicable.

20. For NWP 23: The permittee shall submit a PCN for all activities proposed for this NWP, in accordance with General Condition 31 and Regional Condition 1. The PCN shall include a copy of the signed Categorical Exclusion document and final agency determinations regarding compliance with ESA, EFH and NHPA, in accordance with General Conditions 18 and 20 and Regional Condition 7.

21. For NWP 27: The permittee shall submit a PCN for aquatic habitat restoration, establishment, and enhancement activities in the following circumstances:

a. The restoration, establishment or enhancement activity would result in a discharge of dredged and/or fill material into perennial waters, intermittent waters, wetlands, mudflats, vegetated shallows, riffle and pool complexes, sanctuaries and refuges or coral reefs; or

b. The restoration, establishment or enhancement activity would result in a discharge of dredged and/or fill material into greater than 100 linear feet of ephemeral waters of the U.S.

22. For NWPs 29 and 39: The channelization or relocation of intermittent or perennial drainages is not authorized, except when, as determined by the Corps, the relocation would result in a net increase in functions of the aquatic ecosystem within the watershed.

23.* Any requests to waive the 300 linear foot limitation for intermittent and ephemeral streams for NWPs 21, 29, 39, 40, 42, 43, 44, 50, 51 and 52, or to waive the 500 linear foot limitation along the bank for NWP 13, must include the following:

a. A narrative description of the stream. This should include known information on: volume and duration of flow; the approximate length, width, and depth of the waterbody and characteristics observed associated with an Ordinary High Water Mark (e.g. bed and bank, wrack line or scour marks); a description of the adjacent vegetation community and a statement regarding the wetland status of the adjacent areas (i.e. wetland, non-wetland); surrounding land use; water quality; issues related to cumulative impacts in the watershed, and; any other relevant information;

b. An analysis of the proposed impacts to the waterbody, in accordance with General Condition 31 and Regional Condition 1;

c. Measures taken to avoid and minimize losses to waters of the U.S., including other methods of constructing the proposed activity(s); and

d. A compensatory mitigation plan describing how the unavoidable losses are proposed to be offset, in accordance with 33 CFR 332.

24. For NWPs 29, 39, 40, 42, and 43: The permittee shall establish and maintain upland vegetated buffers in perpetuity, unless specifically determined to be impracticable by the Corps, next to all preserved open waters, streams and wetlands including created, restored, enhanced or preserved waters of the U.S., consistent with General Condition 23(f). Except in unusual circumstances, as determined by the Corps, vegetated buffers shall be at least 50 feet in width.

* Regional Condition developed jointly between Sacramento District, Los Angeles District, and San Francisco District.

25. For NWP 46: The discharge shall not cause the loss of greater than 0.5 acres of waters of the United States or the loss of more than 300 linear feet of ditch, unless specifically waived in writing by the Corps.

26. All NWPs except 3, 6, 20, 27, 32, and 38 are revoked for activities in histosols, fens, bogs and peatlands and in wetlands contiguous with fens. Fens are defined as slope wetlands with a histic epipedon that are hydrologically supported by groundwater. Fens are normally saturated throughout the growing season, although they may not be during drought conditions. For NWPs 3, 6, 20, 27, 32, and 38, the permittee shall submit a PCN to the Corps in accordance with General Condition 31 and Regional Condition 1. This condition does not apply to NWPs 1, 2, 8, 9, 10, 11, 24, 28, 35 or 36, as these NWPs either apply to Section 10 only activities or do not authorize impacts to special aquatic sites.

* Regional Condition developed jointly between Sacramento District, Los Angeles District, and San Francisco District.

Nationwide Permit Summary

U S Army Corps of Engineers
Sacramento District

33 CFR Part 330; Issuance of Nationwide Permits – March 19, 2012

14. Linear Transportation Projects. Activities required for the construction, expansion, modification, or improvement of linear transportation projects (e.g., roads, highways, railways, trails, airport runways, and taxiways) in waters of the United States. For linear transportation projects in non-tidal waters, the discharge cannot cause the loss of greater than 1/2-acre of waters of the United States. For linear transportation projects in tidal waters, the discharge cannot cause the loss of greater than 1/3-acre of waters of the United States. Any stream channel modification, including bank stabilization, is limited to the minimum necessary to construct or protect the linear transportation project; such modifications must be in the immediate vicinity of the project.

This NWP also authorizes temporary structures, fills, and work necessary to construct the linear transportation project. Appropriate measures must be taken to maintain normal downstream flows and minimize flooding to the maximum extent practicable, when temporary structures, work, and discharges, including cofferdams, are necessary for construction activities, access fills, or dewatering of construction sites. Temporary fills must consist of materials, and be placed in a manner, that will not be eroded by expected high flows. Temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations. The areas affected by temporary fills must be revegetated, as appropriate.

This NWP cannot be used to authorize non-linear features commonly associated with transportation projects, such as vehicle maintenance or storage buildings, parking lots, train stations, or aircraft hangars.

Notification: The permittee must submit a pre-construction notification to the district engineer prior to commencing the activity if: (1) the loss of waters of the United States exceeds 1/10-acre; or (2) there is a discharge in a special aquatic site, including wetlands. (See general condition 31.) (Sections 10 and 404)

Note: Some discharges for the construction of farm roads or forest roads, or temporary roads for moving mining equipment, may qualify for an exemption under Section 404(f) of the Clean Water Act (see 33 CFR 323.4).

A. **Regional Conditions**

1. **Regional Conditions for California, excluding the Tahoe Basin**

http://www.spk.usace.army.mil/Portals/12/documents/regulatory/nwp/2012_nwps/2012-NWP-RC-CA.pdf

2. **Regional Conditions for Nevada, including the Tahoe Basin**

http://www.spk.usace.army.mil/Portals/12/documents/regulatory/nwp/2012_nwps/2012-NWP-RC-NV.pdf

3. **Regional Conditions for Utah**

http://www.spk.usace.army.mil/Portals/12/documents/regulatory/nwp/2012_nwps/2012-NWP-RC-UT.pdf

4. **Regional Conditions for Colorado**.

http://www.spk.usace.army.mil/Portals/12/documents/regulatory/nwp/2012_nwps//2012-NWP-RC-CO.pdf

B. **Nationwide Permit General Conditions**

Note: To qualify for NWP authorization, the prospective permittee must comply with the following general conditions, as applicable, in addition to any regional or case-specific conditions imposed by the division engineer or district engineer. Prospective permittees should contact the appropriate Corps district office to determine if regional conditions have been imposed on an NWP. Prospective permittees should also contact the appropriate Corps district office to determine the status of Clean Water Act Section 401 water quality certification and/or Coastal Zone Management Act consistency for an NWP. Every person who may wish to obtain permit authorization under one or more NWPs, or who is currently relying on an existing or prior permit authorization under one or more NWPs, has been and is on notice that all of the provisions of 33 CFR §§ 330.1 through 330.6 apply to every NWP authorization. Note especially 33 CFR § 330.5 relating to the modification, suspension, or revocation of any NWP authorization.

☐ 1. **Navigation**.

☐ (a) No activity may cause more than a minimal adverse effect on navigation.

☐ (b) Any safety lights and signals prescribed by the U.S. Coast Guard, through regulations or otherwise, must be installed and maintained at the permittee's expense on authorized facilities in navigable waters of the United States.

☐ (c) The permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structure or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the permittee will be required, upon due notice from the Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

☐ 2. **Aquatic Life Movements.** No activity may substantially disrupt the necessary life cycle movements of those species of aquatic life indigenous to the waterbody, including those species that normally migrate through the area, unless the activity's primary purpose is to impound water. All permanent and temporary crossings of waterbodies shall be suitably culverted, bridged, or otherwise designed and constructed to maintain low flows to sustain the movement of those aquatic species.

☐ 3. **Spawning Areas**. Activities in spawning areas during spawning seasons must be avoided to the maximum extent practicable. Activities that result in the physical destruction (e.g., through excavation, fill, or downstream smothering by substantial turbidity) of an important spawning area are not authorized.

☐ 4. **Migratory Bird Breeding Areas.** Activities in waters of the United States that serve as breeding areas for migratory birds must be avoided to the maximum extent practicable.

☐ 5. **Shellfish Beds**. No activity may occur in areas of concentrated shellfish populations, unless the activity is directly related to a shellfish harvesting activity authorized by NWPs 4 and 48, or is a shellfish seeding or habitat restoration activity authorized by NWP 27.

☐ 6. **Suitable Material**. No activity may use unsuitable material (e.g., trash, debris, car bodies, asphalt, etc.). Material used for construction or discharged must be free from toxic pollutants in toxic amounts (see Section 307 of the Clean Water Act).

☐ 7. **Water Supply Intakes**. No activity may occur in the proximity of a public water supply intake, except where the activity is for the repair or improvement of public water supply intake structures or adjacent bank stabilization.

☐ 8. **Adverse Effects From Impoundments**. If the activity creates an impoundment of water, adverse effects to the aquatic system due to accelerating the passage of water, and/or restricting its flow must be minimized to the maximum extent practicable.

☐ 9. **Management of Water Flows**. To the maximum extent practicable, the pre-construction course, condition, capacity, and location of open waters must be maintained for each activity, including stream channelization and storm water management activities, except as provided below. The activity must be constructed to withstand expected high flows. The activity must not restrict or impede the passage of normal or high flows, unless the primary purpose of the activity is to impound water or manage high flows. The activity may alter the pre-construction course, condition, capacity, and location of open waters if it benefits the aquatic environment (e.g., stream restoration or relocation activities).

☐ 10. **Fills Within 100-Year Floodplains**. The activity must comply with applicable FEMA-approved state or local floodplain management requirements.

☐ 11. **Equipment**. Heavy equipment working in wetlands or mudflats must be placed on mats, or other measures must be taken to minimize soil disturbance.

☐ 12. **Soil Erosion and Sediment Controls**. Appropriate soil erosion and sediment controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date. Permittees are encouraged to perform work within waters of the United States during periods of low-flow or no-flow.

☐ 13. **Removal of Temporary Fills**. Temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations. The affected areas must be revegetated, as appropriate.

☐ 14. **Proper Maintenance**. Any authorized structure or fill shall be properly maintained, including maintenance to ensure public safety and compliance with applicable NWP general conditions, as well as any activity-specific conditions added by the district engineer to an NWP authorization.

☐ 15. **Single and Complete Project**. The activity must be a single and complete project. The same NWP cannot be used more than once for the same single and complete project.

☐ 16. **Wild and Scenic Rivers**. No activity may occur in a component of the National Wild and Scenic River System, or in a river officially designated by Congress as a "study river" for possible inclusion in the system while the river is in an official study status, unless the appropriate Federal agency with direct management responsibility for such river, has determined in writing that the proposed activity will not adversely affect the Wild and Scenic River designation or study status. Information on Wild and Scenic Rivers may be obtained from the appropriate Federal land management agency responsible for the designated Wild and Scenic River or study river (e.g., National Park Service, U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service).

☐ 17. **Tribal Rights**. No activity or its operation may impair reserved tribal rights, including, but not limited to, reserved water rights and treaty fishing and hunting rights.

☐ 18. **Endangered Species**.

☐ (a) No activity is authorized under any NWP which is likely to directly or indirectly jeopardize the continued existence of a threatened or endangered species or a species proposed for such designation, as identified under the Federal Endangered Species Act (ESA), or which will directly or indirectly destroy or adversely modify the critical habitat of such species. No activity is authorized under any NWP which "may affect" a listed species or critical habitat, unless Section 7 consultation addressing the effects of the proposed activity has been completed.

☐ (b) Federal agencies should follow their own procedures for complying with the requirements of the ESA. Federal permittees must provide the district engineer with the appropriate documentation to demonstrate compliance with those requirements. The district engineer will review the documentation and determine whether it is sufficient to address ESA compliance for the NWP activity, or whether additional ESA consultation is necessary.

☐ (c) Non-federal permittees must submit a pre-construction notification to the district engineer if any listed species or designated critical habitat might be affected or is in the vicinity of the project, or if the project is located in designated critical habitat, and shall not begin work on the activity until notified by the district engineer that the requirements of the ESA have been satisfied and that the activity is authorized. For activities that might affect Federally-listed endangered or threatened species or designated critical habitat, the pre-construction notification must include the name(s) of the endangered or threatened species that might be affected by the proposed work or that utilize the designated critical habitat that might be affected by the proposed work. The district engineer will determine whether the proposed activity "may affect" or will have "no effect" to listed species and designated critical habitat and will notify the non-Federal applicant of the Corps' determination within 45 days of receipt of a complete pre-construction notification. In cases where the non-Federal applicant has identified listed species or critical habitat that might be affected or is in the vicinity of the project, and has so notified the Corps, the applicant shall not begin work until the Corps has provided notification the proposed activities will have "no effect" on listed species or critical habitat, or until Section 7 consultation has been completed. If the non-Federal applicant has not heard back from the Corps within 45 days, the applicant must still wait for notification from the Corps.

☐ (d) As a result of formal or informal consultation with the FWS or NMFS the district engineer may add species-specific regional endangered species conditions to the NWPs.

☐ (e) Authorization of an activity by a NWP does not authorize the "take" of a threatened or endangered species as defined under the ESA. In the absence of separate authorization (e.g., an ESA Section 10 Permit, a Biological Opinion with "incidental take" provisions, etc.) from the U.S. FWS or the NMFS, The Endangered Species Act prohibits any person subject to the jurisdiction of the United States to take a listed species, where "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. The word "harm" in the definition of "take" means an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering.

☐ (f) Information on the location of threatened and endangered species and their critical habitat can be obtained directly from the offices of the U.S. FWS and NMFS or their world wide web pages at http://www.fws.gov/ or http://www.fws.gov/ipac and http://www.noaa.gov/fisheries.html respectively.

☐ 19. **Migratory Birds and Bald and Golden Eagles**. The permittee is responsible for obtaining any "take" permits required under the U.S. Fish and Wildlife Service's regulations governing compliance with the Migratory Bird Treaty Act or the Bald and Golden Eagle Protection Act. The permittee should contact the appropriate local office of the U.S. Fish and Wildlife Service to determine if such "take" permits are required for a particular activity.

☐ 20. **Historic Properties**.

☐ (a) In cases where the district engineer determines that the activity may affect properties listed, or eligible for listing, in the National Register of Historic Places, the activity is not authorized, until the requirements of Section 106 of the National Historic Preservation Act (NHPA) have been satisfied.

☐ (b) Federal permittees should follow their own procedures for complying with the requirements of Section 106 of the National Historic Preservation Act. Federal permittees must provide the district engineer with the appropriate documentation to demonstrate compliance with those requirements. The district engineer will review the documentation and determine whether it is sufficient to address section 106 compliance for the NWP activity, or whether additional section 106 consultation is necessary.

☐ (c) Non-federal permittees must submit a pre-construction notification to the district engineer if the authorized activity may have the potential to cause effects to any historic properties listed on, determined to be eligible for listing on, or potentially eligible for listing on the National Register of Historic Places, including previously unidentified properties. For such activities, the pre-construction notification must state which historic properties may be affected by the proposed work or include a vicinity map indicating the location of the historic properties or the potential for the presence of historic properties. Assistance regarding information on the location of or potential for the presence of historic resources can be sought from the State Historic Preservation Officer or Tribal Historic Preservation Officer, as appropriate, and the National Register of Historic Places (see 33 CFR 330.4(g)). When reviewing pre-construction notifications, district engineers will comply with the current procedures for addressing the requirements of Section 106 of the National Historic Preservation Act. The district engineer shall make a reasonable and good faith effort to carry out appropriate identification efforts, which may include background research, consultation, oral history interviews, sample field investigation, and field survey. Based on the information submitted and these efforts, the district engineer shall determine whether the proposed activity has the potential to cause an effect on the historic properties. Where the non-Federal applicant has identified historic properties on which the activity may have the potential to cause effects and so notified the Corps, the non-Federal applicant shall not begin the activity until notified by the district engineer either that the activity has no potential to cause effects or that consultation under Section 106 of the NHPA has been completed.

☐ (d) The district engineer will notify the prospective permittee within 45 days of receipt of a complete pre-construction notification whether NHPA Section 106 consultation is required. Section 106 consultation is not required when the Corps determines that the activity does not have the potential to cause effects on historic properties (see 36 CFR §800.3(a)). If NHPA section 106 consultation is required and will occur, the district engineer will notify the non- Federal applicant that he or she cannot begin work until Section 106 consultation is completed. If the non-Federal applicant has not heard back from the Corps within 45 days, the applicant must still wait for notification from the Corps.

☐ (e) Prospective permittees should be aware that section 110k of the NHPA (16 U.S.C. 470h-2(k)) prevents the Corps from granting a permit or other assistance to an applicant who, with intent to avoid the requirements of Section 106 of the NHPA, has intentionally significantly adversely affected a historic property to which the permit would relate, or having legal power to prevent it, allowed such significant adverse effect to occur, unless the Corps, after consultation with the Advisory Council on Historic Preservation (ACHP), determines that circumstances justify granting such assistance despite the adverse effect created or permitted by the applicant. If circumstances justify granting the assistance, the Corps is required to notify the ACHP and provide documentation specifying the circumstances, the degree of damage to the integrity of any historic properties affected, and proposed mitigation. This documentation must include any views obtained from the applicant, SHPO/THPO, appropriate Indian tribes if the undertaking occurs on or affects historic properties on tribal lands or affects properties of interest to those tribes, and other parties known to have a legitimate interest in the impacts to the permitted activity on historic properties.

☐ 21. **Discovery of Previously Unknown Remains and Artifacts**. If you discover any previously unknown historic, cultural or archeological remains and artifacts while accomplishing the activity authorized by this permit, you must immediately notify the district engineer of what you have found, and to the maximum extent practicable, avoid construction activities that may affect the remains and artifacts until the required coordination has been completed. The district engineer will initiate the Federal, Tribal and state coordination required to determine if the items or remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

☐ **22. Designated Critical Resource Waters**. Critical resource waters include, NOAA-managed marine sanctuaries and marine monuments, and National Estuarine Research Reserves. The district engineer may designate, after notice and opportunity for public comment, additional waters officially designated by a state as having particular environmental or ecological significance, such as outstanding national resource waters or state natural heritage sites. The district engineer may also designate additional critical resource waters after notice and opportunity for public comment.

☐ (a) Discharges of dredged or fill material into waters of the United States are not authorized by NWPs 7, 12, 14, 16, 17, 21, 29, 31, 35, 39, 40, 42, 43, 44, 49, 50, 51, and 52 for any activity within, or directly affecting, critical resource waters, including wetlands adjacent to such waters.

☐ (b) For NWPs 3, 8, 10, 13, 15, 18, 19, 22, 23, 25, 27, 28, 30, 33, 34, 36, 37, and 38, notification is required in accordance with general condition 31, for any activity proposed in the designated critical resource waters including wetlands adjacent to those waters. The district engineer may authorize activities under these NWPs only after it is determined that the impacts to the critical resource waters will be no more than minimal.

☐ **23. Mitigation**. The district engineer will consider the following factors when determining appropriate and practicable mitigation necessary to ensure that adverse effects on the aquatic environment are minimal:

☐ (a) The activity must be designed and constructed to avoid and minimize adverse effects, both temporary and permanent, to waters of the United States to the maximum extent practicable at the project site (i.e., on site).

☐ (b) Mitigation in all its forms (avoiding, minimizing, rectifying, reducing, or compensating for resource losses) will be required to the extent necessary to ensure that the adverse effects to the aquatic environment are minimal.

☐ (c) Compensatory mitigation at a minimum one-for-one ratio will be required for all wetland losses that exceed 1/10-acre and require pre-construction notification, unless the district engineer determines in writing that either some other form of mitigation would be more environmentally appropriate or the adverse effects of the proposed activity are minimal, and provides a project-specific waiver of this requirement. For wetland losses of 1/10-acre or less that require pre-construction notification, the district engineer may determine on a case-by-case basis that compensatory mitigation is required to ensure that the activity results in minimal adverse effects on the aquatic environment. Compensatory mitigation projects provided to offset losses of aquatic resources must comply with the applicable provisions of 33 CFR part 332.

☐ (1) The prospective permittee is responsible for proposing an appropriate compensatory mitigation option if compensatory mitigation is necessary to ensure that the activity results in minimal adverse effects on the aquatic environment.

☐ (2) Since the likelihood of success is greater and the impacts to potentially valuable uplands are reduced, wetland restoration should be the first compensatory mitigation option considered.

☐ (3) If permittee-responsible mitigation is the proposed option, the prospective permittee is responsible for submitting a mitigation plan. A conceptual or detailed mitigation plan may be used by the district engineer to make the decision on the NWP verification request, but a final mitigation plan that addresses the applicable requirements of 33 CFR 332.4(c)(2) – (14) must be approved by the district engineer before the permittee begins work in waters of the United States, unless the district engineer determines that prior approval of the final mitigation plan is not practicable or not necessary to ensure timely completion of the required compensatory mitigation (see 33 CFR 332.3(k)(3)).

☐ (4) If mitigation bank or in-lieu fee program credits are the proposed option, the mitigation plan only needs to address the baseline conditions at the impact site and the number of credits to be provided.

☐ (5) Compensatory mitigation requirements (e.g., resource type and amount to be provided as compensatory mitigation, site protection, ecological performance standards, monitoring requirements) may be addressed through conditions added to the NWP authorization, instead of components of a compensatory mitigation plan.

☐ (d) For losses of streams or other open waters that require pre-construction notification, the district engineer may require compensatory mitigation, such as stream rehabilitation, enhancement, or preservation, to ensure that the activity results in minimal adverse effects on the aquatic environment.

☐ (e) Compensatory mitigation will not be used to increase the acreage losses allowed by the acreage limits of the NWPs. For example, if an NWP has an acreage limit of 1/2-acre, it cannot be used to authorize any project resulting in the loss of greater than 1/2-acre of waters of the United States, even if compensatory mitigation is provided that replaces or restores some of the lost waters. However, compensatory mitigation can and should be used, as necessary, to ensure that a project already meeting the established acreage limits also satisfies the minimal impact requirement associated with the NWPs.

☐ (f) Compensatory mitigation plans for projects in or near streams or other open waters will normally include a requirement for the restoration or establishment, maintenance, and legal protection (e.g., conservation easements) of riparian areas next to open waters. In some cases, riparian areas may be the only compensatory mitigation required. Riparian areas should consist of native species. The width of the required riparian area will address documented water quality or aquatic habitat loss concerns. Normally, the riparian area will be 25 to 50 feet wide on each side of the stream, but the district engineer may require slightly wider riparian areas to address documented water quality or habitat loss concerns. If it is not possible to establish a riparian area on both sides of a stream, or if the waterbody is a lake or coastal waters, then restoring or establishing a riparian area along a single bank or shoreline may be sufficient. Where both wetlands and open waters exist on the project site, the district engineer will determine the appropriate compensatory mitigation (e.g., riparian areas and/or wetlands compensation) based on what is best for the aquatic environment on a watershed basis. In cases where riparian areas are determined to be the most appropriate form of compensatory mitigation, the district engineer may waive or reduce the requirement to provide wetland compensatory mitigation for wetland losses.

☐ (g) Permittees may propose the use of mitigation banks, in-lieu fee programs, or separate permittee-responsible mitigation. For activities resulting in the loss of marine or estuarine resources, permittee-responsible compensatory mitigation may be environmentally preferable if there are no mitigation banks or in-lieu fee programs in the area that have marine or estuarine credits available for sale or transfer to the permittee. For permittee-responsible mitigation, the special conditions of the NWP verification must clearly indicate the party or parties responsible for the implementation and performance of the compensatory mitigation project, and, if required, its long-term management.

(h) Where certain functions and services of waters of the United States are permanently adversely affected, such as the conversion of a forested or scrub-shrub wetland to a herbaceous wetland in a permanently maintained utility line right-of-way, mitigation may be required to reduce the adverse effects of the project to the minimal level.

☐ **24. Safety of Impoundment Structures**. To ensure that all impoundment structures are safely designed, the district engineer may require non-Federal applicants to demonstrate that the structures comply with established state dam safety criteria or have been designed by qualified persons. The district engineer may also require documentation that the design has been independently reviewed by similarly qualified persons, and appropriate modifications made to ensure safety.

☐ **25. Water Quality**. Where States and authorized Tribes, or EPA where applicable, have not previously certified compliance of an NWP with CWA Section 401, individual 401 Water Quality Certification must be obtained or waived (see 33 CFR 330.4(c)). The district engineer or State or Tribe may require additional water quality management measures to ensure that the authorized activity does not result in more than minimal degradation of water quality.

☐ **26. Coastal Zone Management**. In coastal states where an NWP has not previously received a state coastal zone management consistency concurrence, an individual state coastal zone management consistency concurrence must be obtained, or a presumption of concurrence must occur (see 33 CFR 330.4(d)). The district engineer or a State may require additional measures to ensure that the authorized activity is consistent with state coastal zone management requirements.

☐ **27. Regional and Case-By-Case Conditions**. The activity must comply with any regional conditions that may have been added by the Division Engineer (see 33 CFR 330.4(e)) and with any case specific conditions added by the Corps or by the state, Indian Tribe, or U.S. EPA in its section 401 Water Quality Certification, or by the state in its Coastal Zone Management Act consistency determination.

☐ **28. Use of Multiple Nationwide Permits**. The use of more than one NWP for a single and complete project is prohibited, except when the acreage loss of waters of the United States authorized by the NWPs does not exceed the acreage limit of the NWP with the highest specified acreage limit. For example, if a road crossing over tidal waters is constructed under NWP 14, with associated bank stabilization authorized by NWP 13, the maximum acreage loss of waters of the United States for the total project cannot exceed 1/3-acre.

☐ **29. Transfer of Nationwide Permit Verifications**. If the permittee sells the property associated with a nationwide permit verification, the permittee may transfer the nationwide permit verification to the new owner by submitting a letter to the appropriate Corps district office to validate the transfer. A copy of the nationwide permit verification must be attached to the letter, and the letter must contain the following statement and signature:

> "When the structures or work authorized by this nationwide permit are still in existence at the time the property is transferred, the terms and conditions of this nationwide permit, including any special conditions, will continue to be binding on the new owner(s) of the property. To validate the transfer of this nationwide permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below."
>
> ---
> (Transferee)
>
> ---
> (Date)

☐ **30. Compliance Certification**. Each permittee who receives an NWP verification letter from the Corps must provide a signed certification documenting completion of the authorized activity and any required compensatory mitigation. The success of any required permittee responsible mitigation, including the achievement of ecological performance standards, will be addressed separately by the district engineer. The Corps will provide the permittee the certification document with the NWP verification letter. The certification document will include:

☐ (a) A statement that the authorized work was done in accordance with the NWP authorization, including any general, regional, or activity-specific conditions;

☐ (b) A statement that the implementation of any required compensatory mitigation was completed in accordance with the permit conditions. If credits from a mitigation bank or in-lieu fee program are used to satisfy the compensatory mitigation requirements, the certification must include the documentation required by 33 CFR 332.3(l)(3) to confirm that the permittee secured the appropriate number and resource type of credits; and

☐ (c) The signature of the permittee certifying the completion of the work and mitigation.

☐ **31. Pre-Construction Notification**.

☐ (a) **Timing**. Where required by the terms of the NWP, the prospective permittee must notify the district engineer by submitting a pre-construction notification (PCN) as early as possible. The district engineer must determine if the PCN is complete within 30 calendar days of the date of receipt and, if the PCN is determined to be incomplete, notify the prospective permittee within that 30 day period to request the additional information necessary to make the PCN complete. The request must specify the information needed to make the PCN complete. As a general rule, district engineers will request additional information necessary to make the PCN complete only once. However, if the prospective permittee does not provide all of the requested information, then the district engineer will notify the prospective permittee that the PCN is still incomplete and the PCN review process will not commence until all of the requested information has been received by the district engineer. The prospective permittee shall not begin the activity until either:

☐ (1) He or she is notified in writing by the district engineer that the activity may proceed under the NWP with any special conditions imposed by the district or division engineer; or

☐ (2) 45 calendar days have passed from the district engineer's receipt of the complete PCN and the prospective permittee has not received written notice from the district or division engineer. However, if the permittee was required to notify the Corps pursuant to general condition 18 that listed species or critical habitat might be affected or in the vicinity of the project, or to notify the Corps pursuant to general condition 20 that the activity may have the potential to cause effects to historic properties, the permittee cannot begin the activity until receiving written notification from the Corps that there is "no effect" on listed species or "no potential to cause effects" on historic properties, or that any consultation required under Section 7 of the Endangered Species Act (see 33 CFR 330.4(f)) and/or Section 106 of the National Historic Preservation (see 33 CFR 330.4(g)) has been completed. Also, work cannot begin under NWPs 21, 49, or 50 until the permittee has received written approval from the Corps. If the proposed activity requires a written waiver to exceed specified limits of an NWP, the permittee may not begin the activity until the district engineer issues the waiver. If the district or division engineer notifies the permittee in writing that an individual permit is required within 45 calendar days of receipt of a complete PCN, the permittee cannot begin the activity until an individual permit has been obtained. Subsequently, the permittee's right to proceed under the NWP may be modified, suspended, or revoked only in accordance with the procedure set forth in 33 CFR 330.5(d)(2)..

☐ (b) <u>Contents of Pre-Construction Notification</u>: The PCN must be in writing and include the following information:

☐ (1) Name, address and telephone numbers of the prospective permittee;

☐ (2) Location of the proposed project;

☐ (3) A description of the proposed project; the project's purpose; direct and indirect adverse environmental effects the project would cause, including the anticipated amount of loss of water of the United States expected to result from the NWP activity, in acres, linear feet, or other appropriate unit of measure; any other NWP(s), regional general permit(s), or individual permit(s) used or intended to be used to authorize any part of the proposed project or any related activity. The description should be sufficiently detailed to allow the district engineer to determine that the adverse effects of the project will be minimal and to determine the need for compensatory mitigation. Sketches should be provided when necessary to show that the activity complies with the terms of the NWP. (Sketches usually clarify the project and when provided results in a quicker decision. Sketches should contain sufficient detail to provide an illustrative description of the proposed activity (e.g., a conceptual plan), but do not need to be detailed engineering plans);

☐ (4) The PCN must include a delineation of wetlands, other special aquatic sites, and other waters, such as lakes and ponds, and perennial, intermittent, and ephemeral streams, on the project site. Wetland delineations must be prepared in accordance with the current method required by the Corps. The permittee may ask the Corps to delineate the special aquatic sites and other waters on the project site, but there may be a delay if the Corps does the delineation, especially if the project site is large or contains many waters of the United States. Furthermore, the 45 day period will not start until the delineation has been submitted to or completed by the Corps, as appropriate;

☐ (5) If the proposed activity will result in the loss of greater than 1/10-acre of wetlands and a PCN is required, the prospective permittee must submit a statement describing how the mitigation requirement will be satisfied, or explaining why the adverse effects are minimal and why compensatory mitigation should not be required. As an alternative, the prospective permittee may submit a conceptual or detailed mitigation plan.

☐ (6) If any listed species or designated critical habitat might be affected or is in the vicinity of the project, or if the project is located in designated critical habitat, for non-Federal applicants the PCN must include the name(s) of those endangered or threatened species that might be affected by the proposed work or utilize the designated critical habitat that may be affected by the proposed work. Federal applicants must provide documentation demonstrating compliance with the Endangered Species Act; and

☐ (7) For an activity that may affect a historic property listed on, determined to be eligible for listing on, or potentially eligible for listing on, the National Register of Historic Places, for non-Federal applicants the PCN must state which historic property may be affected by the proposed work or include a vicinity map indicating the location of the historic property. Federal applicants must provide documentation demonstrating compliance with Section 106 of the National Historic Preservation Act.

☐ (c) Form of Pre-Construction Notification: he standard individual permit application form (Form ENG 4345) may be used, but the completed application form must clearly indicate that it is a PCN and must include all of the information required in paragraphs (b)(1) through (7) of this general condition. A letter containing the required information may also be used.

☐ (d) Agency Coordination:

☐ (1) The district engineer will consider any comments from Federal and state agencies concerning the proposed activity's compliance with the terms and conditions of the NWPs and the need for mitigation to reduce the project's adverse environmental effects to a minimal level.

☐ (2) For all NWP activities that require pre-construction notification and result in the loss of greater than 1/2-acre of waters of the United States, for NWP 21, 29, 39, 40, 42, 43, 44, 50, 51, and 52 activities that require pre-construction notification and will result in the loss of greater than 300 linear feet of intermittent and ephemeral stream bed, and for all NWP 48 activities that require pre-construction notification, the district engineer will immediately provide (e.g., via email, facsimile transmission, overnight mail, or other expeditious manner) a copy of the complete PCN to the appropriate Federal or state offices (U.S. FWS, state natural resource or water quality agency, EPA, State Historic Preservation Officer (SHPO) or Tribal Historic Preservation Office (THPO), and, if appropriate, the NMFS). With the exception of NWP 37, these agencies will have 10 calendar days from the date the material is transmitted to telephone or fax the district engineer notice that they intend to provide substantive, site-specific comments. The comments must explain why the agency believes the adverse effects will be more than minimal. If so contacted by an agency, the district engineer will wait an additional 15 calendar days before making a decision on the pre-construction notification. The district engineer will fully consider agency comments received within the specified time frame concerning the proposed activity's compliance with the terms and conditions of the NWPs, including the need for mitigation to ensure the net adverse environmental effects to the aquatic environment of the proposed activity are minimal. The district engineer will provide no response to the resource agency, except as provided below. The district engineer will indicate in the administrative record associated with each pre-construction notification that the resource agencies' concerns were considered. For NWP 37, the emergency watershed protection and rehabilitation activity may proceed immediately in cases where there is an unacceptable hazard to life or a significant loss of property or economic hardship will occur. The district engineer will consider any comments received to decide whether the NWP 37 authorization should be modified, suspended, or revoked in accordance with the procedures at 33 CFR 330.5.

☐ (3) In cases of where the prospective permittee is not a Federal agency, the district engineer will provide a response to NMFS within 30 calendar days of receipt of any Essential Fish Habitat conservation recommendations, as required by Section 305(b)(4)(B) of the Magnuson-Stevens Fishery Conservation and Management Act.

☐ (4) Applicants are encouraged to provide the Corps with either electronic files or multiple copies of pre-construction notifications to expedite agency coordination.

C. District Engineer's Decision

☐ 1. In reviewing the PCN for the proposed activity, the district engineer will determine whether the activity authorized by the NWP will result in more than minimal individual or cumulative adverse environmental effects or may be contrary to the public interest. For a linear project, this determination will include an evaluation of the individual crossings to determine whether they individually satisfy the terms and conditions of the NWP(s), as well as the cumulative effects caused by all of the crossings authorized by NWP. If an applicant requests a waiver of the 300 linear foot limit on impacts to intermittent or ephemeral streams or of an otherwise applicable limit, as provided for in NWPs 13, 21, 29, 36, 39, 40, 42, 43, 44, 50, 51 or 52, the district engineer will only grant the waiver upon a written determination that the NWP activity will result in minimal adverse effects. When making minimal effects determinations the district engineer will consider the direct and indirect effects caused by the NWP activity. The district engineer will also consider site specific factors, such as the environmental setting in the vicinity of the NWP activity, the type of resource that will be affected by the NWP activity, the functions provided by the aquatic resources that will be affected by the NWP activity, the degree or magnitude to which the aquatic resources perform those functions, the extent that aquatic resource functions will be lost as a result of the NWP activity (e.g., partial or complete loss), the duration of the adverse effects (temporary or permanent), the importance of the aquatic resource functions to the region (e.g., watershed or ecoregion), and mitigation required by the district engineer. If an appropriate functional assessment method is available and practicable to use, that assessment method may be used by the district engineer to assist in the minimal adverse effects determination. The district engineer may add case-specific special conditions to the NWP authorization to address site-specific environmental concerns.

☐ 2. If the proposed activity requires a PCN and will result in a loss of greater than 1/10- acre of wetlands, the prospective permittee should submit a mitigation proposal with the PCN. Applicants may also propose compensatory mitigation for projects with smaller impacts. The district engineer will consider any proposed compensatory mitigation the applicant has included in the proposal in determining whether the net adverse environmental effects to the aquatic environment of the proposed activity are minimal. The compensatory mitigation proposal may be either conceptual or detailed. If the district engineer determines that the activity complies with the terms and conditions of the NWP and that the adverse effects on the aquatic environment are minimal, after considering mitigation, the district engineer will notify the permittee and include any activity-specific conditions in the NWP verification the district engineer deems necessary. Conditions for compensatory mitigation requirements must comply with the appropriate provisions at 33 CFR 332.3(k). The district engineer must approve the final mitigation plan before the permittee commences work in waters of the United States, unless the district engineer determines that prior approval of the final mitigation plan is not practicable or not necessary to ensure timely completion of the required compensatory mitigation. If the prospective permittee elects to submit a compensatory mitigation plan with the PCN, the district engineer will expeditiously review the proposed compensatory mitigation plan. The district engineer must review the proposed compensatory mitigation plan within 45 calendar days of receiving a complete PCN and determine whether the proposed mitigation would ensure no more than minimal adverse effects on the aquatic environment. If the net adverse effects of the project on the aquatic environment (after consideration of the compensatory mitigation proposal) are determined by the district engineer to be minimal, the district engineer will provide a timely written response to the applicant. The response will state that the project can proceed under the terms and conditions of the NWP, including any activity-specific conditions added to the NWP authorization by the district engineer.

☐ 3. If the district engineer determines that the adverse effects of the proposed work are more than minimal, then the district engineer will notify the applicant either: (a) That the project does not qualify for authorization under the NWP and instruct the applicant on the procedures to seek authorization under an individual permit; (b) that the project is authorized under the NWP subject to the applicant's submission of a mitigation plan that would reduce the adverse effects on the aquatic environment to the minimal level; or (c) that the project is authorized under the NWP with specific modifications or conditions. Where the district engineer determines that mitigation is required to ensure no more than minimal adverse effects occur to the aquatic environment, the activity will be authorized within the 45-day PCN period, with activity-specific conditions that state the mitigation requirements. The authorization will include the necessary conceptual or detailed mitigation or a requirement that the applicant submit a mitigation plan that would reduce the adverse effects on the aquatic environment to the minimal level. When mitigation is required, no work in waters of the United States may occur until the district engineer has approved a specific mitigation plan or has determined that prior approval of a final mitigation plan is not practicable or not necessary to ensure timely completion of the required compensatory mitigation.

D. Further Information

1. District Engineers have authority to determine if an activity complies with the terms and conditions of an NWP.

2. NWPs do not obviate the need to obtain other federal, state, or local permits, approvals, or authorizations required by law.

3. NWPs do not grant any property rights or exclusive privileges.

4. NWPs do not authorize any injury to the property or rights of others.

5. NWPs do not authorize interference with any existing or proposed Federal project.

E. **Definitions**

Best management practices (BMPs): Policies, practices, procedures, or structures implemented to mitigate the adverse environmental effects on surface water quality resulting from development. BMPs are categorized as structural or non-structural.

Compensatory mitigation: The restoration (re-establishment or rehabilitation), establishment (creation), enhancement, and/or in certain circumstances preservation of aquatic resources for the purposes of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved.

Currently serviceable: Useable as is or with some maintenance, but not so degraded as to essentially require reconstruction.

Direct effects: Effects that are caused by the activity and occur at the same time and place.

Discharge: The term “discharge” means any discharge of dredged or fill material.

Enhancement: The manipulation of the physical, chemical, or biological characteristics of an aquatic resource to heighten, intensify, or improve a specific aquatic resource function(s). Enhancement results in the gain of selected aquatic resource function(s), but may also lead to a decline in other aquatic resource function(s). Enhancement does not result in a gain in aquatic resource area.

Ephemeral stream: An ephemeral stream has flowing water only during, and for a short duration after, precipitation events in a typical year. Ephemeral stream beds are located above the water table year-round. Groundwater is not a source of water for the stream. Runoff from rainfall is the primary source of water for stream flow.

Establishment (creation): The manipulation of the physical, chemical, or biological characteristics present to develop an aquatic resource that did not previously exist at an upland site. Establishment results in a gain in aquatic resource area.

High Tide Line: The line of intersection of the land with the water’s surface at the maximum height reached by a rising tide. The high tide line may be determined, in the absence of actual data, by a line of oil or scum along shore objects, a more or less continuous deposit of fine shell or debris on the foreshore or berm, other physical markings or characteristics, vegetation lines, tidal gages, or other suitable means that delineate the general height reached by a rising tide. The line encompasses spring high tides and other high tides that occur with periodic frequency but does not include storm surges in which there is a departure from the normal or predicted reach of the tide due to the piling up of water against a coast by strong winds such as those accompanying a hurricane or other intense storm.

Historic Property: Any prehistoric or historic district, site (including archaeological site), building, structure, or other object included in, or eligible for inclusion in, the National Register of Historic Places maintained by the Secretary of the Interior. This term includes artifacts, records, and remains that are related to and located within such properties. The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization and that meet the National Register criteria (36 CFR part 60).

Independent utility: A test to determine what constitutes a single and complete non-linear project in the Corps regulatory program. A project is considered to have independent utility if it would be constructed absent the construction of other projects in the project area. Portions of a multi-phase project that depend upon other phases of the project do not have independent utility. Phases of a project that would be constructed even if the other phases were not built can be considered as separate single and complete projects with independent utility.

Indirect effects: Effects that are caused by the activity and are later in time or farther removed in distance, but are still reasonably foreseeable.

Intermittent stream: An intermittent stream has flowing water during certain times of the year, when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from rainfall is a supplemental source of water for stream flow.

Loss of waters of the United States: Waters of the United States that are permanently adversely affected by filling, flooding, excavation, or drainage because of the regulated activity. Permanent adverse effects include permanent discharges of dredged or fill material that change an aquatic area to dry land, increase the bottom elevation of a waterbody, or change the use of a waterbody. The acreage of loss of waters of the United States is a threshold measurement of the impact to jurisdictional waters for determining whether a project may qualify for an NWP; it is not a net threshold that is calculated after considering compensatory mitigation that may be used to offset losses of aquatic functions and services. The loss of stream bed includes the linear feet of stream bed that is filled or excavated. Waters of the United States temporarily filled, flooded, excavated, or drained, but restored to pre-construction contours and elevations after construction, are not included in the measurement of loss of waters of the United States. Impacts resulting from activities eligible for exemptions under Section 404(f) of the Clean Water Act are not considered when calculating the loss of waters of the United States.

Non-tidal wetland: A non-tidal wetland is a wetland that is not subject to the ebb and flow of tidal waters. The definition of a wetland can be found at 33 CFR 328.3(b). Non-tidal wetlands contiguous to tidal waters are located landward of the high tide line (i.e., spring high tide line).

Open water: For purposes of the NWPs, an open water is any area that in a year with normal patterns of precipitation has water flowing or standing above ground to the extent that an ordinary high water mark can be determined. Aquatic vegetation within the area of standing or flowing water is either non-emergent, sparse, or absent. Vegetated shallows are considered to be open waters. Examples of "open waters" include rivers, streams, lakes, and ponds.

Ordinary High Water Mark: An ordinary high water mark is a line on the shore established by the fluctuations of water and indicated by physical characteristics, or by other appropriate means that consider the characteristics of the surrounding areas (see 33 CFR 328.3(e)).

Perennial stream: A perennial stream has flowing water year-round during a typical year. The water table is located above the stream bed for most of the year. Groundwater is the primary source of water for stream flow. Runoff from rainfall is a supplemental source of water for stream flow.

Practicable: Available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes.

Pre-construction notification: A request submitted by the project proponent to the Corps for confirmation that a particular activity is authorized by nationwide permit. The request may be a permit application, letter, or similar document that includes information about the proposed work and its anticipated environmental effects. Pre-construction notification may be required by the terms and conditions of a nationwide permit, or by regional conditions. A pre-construction notification may be voluntarily submitted in cases where pre-construction notification is not required and the project proponent wants confirmation that the activity is authorized by nationwide permit.

Preservation: The removal of a threat to, or preventing the decline of, aquatic resources by an action in or near those aquatic resources. This term includes activities commonly associated with the protection and maintenance of aquatic resources through the implementation of appropriate legal and physical mechanisms. Preservation does not result in a gain of aquatic resource area or functions.

Re-establishment: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former aquatic resource. Re-establishment results in rebuilding a former aquatic resource and results in a gain in aquatic resource area and functions.

Rehabilitation: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions to a degraded aquatic resource. Rehabilitation results in a gain in aquatic resource function, but does not result in a gain in aquatic resource area.

Restoration: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former or degraded aquatic resource. For the purpose of tracking net gains in aquatic resource area, restoration is divided into two categories: re-establishment and rehabilitation.

Riffle and pool complex: Riffle and pool complexes are special aquatic sites under the 404(b)(1) Guidelines. Riffle and pool complexes sometimes characterize steep gradient sections of streams. Such stream sections are recognizable by their hydraulic characteristics. The rapid movement of water over a course substrate in riffles results in a rough flow, a turbulent surface, and high dissolved oxygen levels in the water. Pools are deeper areas associated with riffles. A slower stream velocity, a streaming flow, a smooth surface, and a finer substrate characterize pools.

Riparian areas: Riparian areas are lands adjacent to streams, lakes, and estuarine-marine shorelines. Riparian areas are transitional between terrestrial and aquatic ecosystems, through which surface and subsurface hydrology connects riverine, lacustrine, estuarine, and marine waters with their adjacent wetlands, non-wetland waters, or uplands. Riparian areas provide a variety of ecological functions and services and help improve or maintain local water quality. (See general condition 23.)

Shellfish seeding: The placement of shellfish seed and/or suitable substrate to increase shellfish production. Shellfish seed consists of immature individual shellfish or individual shellfish attached to shells or shell fragments (i.e., spat on shell). Suitable substrate may consist of shellfish shells, shell fragments, or other appropriate materials placed into waters for shellfish habitat.

Single and complete linear project: A linear project is a project constructed for the purpose of getting people, goods, or services from a point of origin to a terminal point, which often involves multiple crossings of one or more waterbodies at separate and distant locations. The term "single and complete project" is defined as that portion of the total linear project proposed or accomplished by one owner/developer or partnership or other association of owners/developers that includes all crossings of a single water of the United States (i.e., a single waterbody) at a specific location. For linear projects crossing a single or multiple waterbodies several times at separate and distant locations, each crossing is considered a single and complete project for purposes of NWP authorization. However, individual channels in a braided stream or river, or individual arms of a large, irregularly shaped wetland or lake, etc., are not separate waterbodies, and crossings of such features cannot be considered separately.

Single and complete non-linear project: For non-linear projects, the term "single and complete project" is defined at 33 CFR 330.2(i) as the total project proposed or accomplished by one owner/developer or partnership or other association of owners/developers. A single and complete non-linear project must have independent utility (see definition of "independent utility"). Single and complete non-linear projects may not be "piecemealed" to avoid the limits in an NWP authorization.

Stormwater management: Stormwater management is the mechanism for controlling stormwater runoff for the purposes of reducing downstream erosion, water quality degradation, and flooding and mitigating the adverse effects of changes in land use on the aquatic environment.

Stormwater management facilities: Stormwater management facilities are those facilities, including but not limited to, stormwater retention and detention ponds and best management practices, which retain water for a period of time to control runoff and/or improve the quality (i.e., by reducing the concentration of nutrients, sediments, hazardous substances and other pollutants) of stormwater runoff.

Stream bed: The substrate of the stream channel between the ordinary high water marks. The substrate may be bedrock or inorganic particles that range in size from clay to boulders. Wetlands contiguous to the stream bed, but outside of the ordinary high water marks, are not considered part of the stream bed.

Stream channelization: The manipulation of a stream's course, condition, capacity, or location that causes more than minimal interruption of normal stream processes. A channelized stream remains a water of the United States.

Structure: An object that is arranged in a definite pattern of organization. Examples of structures include, without limitation, any pier, boat dock, boat ramp, wharf, dolphin, weir, boom, breakwater, bulkhead, revetment, riprap, jetty, artificial island, artificial reef, permanent mooring structure, power transmission line, permanently moored floating vessel, piling, aid to navigation, or any other manmade obstacle or obstruction.

Tidal wetland: A tidal wetland is a wetland (i.e., water of the United States) that is inundated by tidal waters. The definitions of a wetland and tidal waters can be found at 33 CFR 328.3(b) and 33 CFR 328.3(f), respectively. Tidal waters rise and fall in a predictable and measurable rhythm or cycle due to the gravitational pulls of the moon and sun. Tidal waters end where the rise and fall of the water surface can no longer be practically measured in a predictable rhythm due to masking by other waters, wind, or other effects. Tidal wetlands are located channelward of the high tide line, which is defined at 33 CFR 328.3(d).

Vegetated shallows: Vegetated shallows are special aquatic sites under the 404(b)(1) Guidelines. They are areas that are permanently inundated and under normal circumstances have rooted aquatic vegetation, such as seagrasses in marine and estuarine systems and a variety of vascular rooted plants in freshwater systems.

Waterbody: For purposes of the NWPs, a waterbody is a jurisdictional water of the United States. If a jurisdictional wetland is adjacent – meaning bordering, contiguous, or neighboring – to a waterbody determined to be a water of the United States under 33 CFR 328.3(a)(1)-(6), that waterbody and its adjacent wetlands are considered together as a single aquatic unit (see 33 CFR 328.4(c)(2)). Examples of "waterbodies" include streams, rivers, lakes, ponds, and wetlands.

02-3E4104
02-Sha-299-0.3/7.1
Project ID 0200020042

PERMITS

PLAC Condition Responsibility Summary

United States Army Corps of Engineers

WATER QUALITY

California Regional Water Quality Control Board

Central Valley Region (WDID No. 5A45CR00459)
Board Order No. 2012-0011-DWQ
NPDES Permit No. CAS 000003

AGREEMENTS

California Department of Fish and Wildlife

Notification No. 1600-2013-0349-R1

MATERIALS INFORMATION

Foundation Report for Sawpit Gulch

Addendum to Foundation Report for Sawpit Gulch

Final Hydraulic Report for Sawpit Gulch Culvert Extension

Geotechnical Design Report

Addenddum to Geotechnical Design Report

Potential Water Sources

Central Valley Regional Water Quality Control Board

30 January 2014

Emiliano Pro
California Department of Transportation
1031 Butte Street, Suite 205 MS 30
Redding, CA 96001

CLEAN WATER ACT §401 TECHNICALLY CONDITIONED WATER QUALITY CERTIFICATION FOR DISCHARGE OF DREDGED AND/OR FILL MATERIALS FOR THE BUCKHORN GRADE IMPROVEMENT CAPSTONE PROJECT (WDID#5A45CR00459), REDDING, SHASTA COUNTY

ACTION:

1. ☐ Order for Standard Certification
2. ■ Order for Technically-conditioned Certification
3. ☐ Order for Denial of Certification

WATER QUALITY CERTIFICATION STANDARD CONDITIONS:

1. This certification action is subject to modification or revocation upon administrative or judicial review, including review and amendment pursuant to §13330 of the California Water Code and §3867 of Title 23 of the California Code of Regulations (23 CCR).

2. This certification action is not intended and shall not be construed to apply to any discharge from any activity involving a hydroelectric facility requiring a Federal Energy Regulatory Commission (FERC) license or an amendment to a FERC license unless the pertinent certification application was filed pursuant to 23 CCR subsection 3855(b) and the application specifically identified that a FERC license or amendment to a FERC license for a hydroelectric facility was being sought.

3. The validity of any non-denial certification action shall be conditioned upon total payment of the full fee required under 23 CCR §3833, unless otherwise stated in writing by the certifying agency.

4. Certification is valid for the duration of the described project. California Department of Transportation shall notify the Central Valley Water Board in writing within 7 days of project completion.

ADDITIONAL TECHNICALLY CONDITIONED CERTIFICATION CONDITIONS:

In addition to the four standard conditions, California Department of Transportation shall satisfy the following:

1. California Department of Transportation shall notify the Central Valley Water Board in writing 7 days in advance of the start of any in-water activities.

2. Except for activities permitted by the U.S. Army Corps under §404 of the Clean Water Act, soil, silt, or other organic materials shall not be placed where such materials could pass into surface water or surface water drainage courses.

3. All areas disturbed by project activities shall be protected from washout or erosion.

4. California Department of Transportation shall maintain a copy of this Certification and supporting documentation (Project Information Sheet) at the Project site during construction for review by site personnel and agencies. All personnel (employees, contractors, and subcontractors) performing work on the proposed project shall be adequately informed and trained regarding the conditions of this Certification.

5. An effective combination of erosion and sediment control Best Management Practices (BMPs) must be implemented and adequately working during all phases of construction.

6. All temporarily affected areas will be restored to pre-construction contours and conditions upon completion of construction activities.

7. California Department of Transportation shall perform surface water sampling: 1) When performing any in-water work; 2) In the event that project activities result in any materials reaching surface waters or; 3) When any activities result in the creation of a visible plume in surface waters. The following monitoring shall be conducted immediately upstream out of the influence of the project and 300 feet downstream of the active work area. Sampling results shall be submitted to this office within two weeks of initiation of sampling and every two weeks thereafter. The sampling frequency may be modified for certain projects with written permission from the Central Valley Water Board.

Parameter	Unit	Type of Sample	Frequency of Sample
Turbidity	NTU	Grab	Every 4 hours during in water work
Settleable Material	ml/l	Grab	Same as above.
Visible construction related pollutants	Observations	Visible Inspections	Continuous throughout the construction period

8. Activities shall not cause turbidity increases in surface water to exceed:

   (a) where natural turbidity is less than 1 Nephelometric Turbidity Units (NTUs), controllable factors shall not cause downstream turbidity to exceed 2 NTU;
   (b) where natural turbidity is between 1 and 5 NTUs, increases shall not exceed 1 NTU;
   (c) where natural turbidity is between 5 and 50 NTUs, increases shall not exceed 20 percent;
   (d) where natural turbidity is between 50 and 100 NTUs, increases shall not exceed 10 NTUs;
   (e) where natural turbidity is greater than 100 NTUs, increases shall not exceed 10 percent.

   Except that these limits will be eased during in-water working periods to allow a turbidity increase of 15 NTU over background turbidity as measured in surface waters 300 feet downstream from the working area. In determining compliance with the above limits, appropriate averaging periods may be applied provided that beneficial uses will be fully protected. Averaging periods may only be assessed by prior permission of the Central Valley Water Board.

9. Activities shall not cause settleable matter to exceed 0.1 ml/l in surface waters as measured in surface waters 300 feet downstream from the project.

10. The discharge of petroleum products or other excavated materials to surface water is prohibited. Activities shall not cause visible oil, grease, or foam in the work area or downstream. California Department of Transportation shall notify the Central Valley Water Board immediately of any spill of petroleum products or other organic or earthen materials.

11. California Department of Transportation shall notify the Central Valley Water Board immediately if the above criteria for turbidity, settleable matter, oil/grease, or foam are exceeded.

12. California Department of Transportation shall comply with all Department of Fish and Wildlife 1600 requirements for the project.

13. The California Department of Transportation shall comply with their General NPDES Permit Order No 2012-0011-DWQ (NPDES No. CAS 000003) issued by the State Water Resources Control Board.

14. The Conditions in this water quality certification are based on the information in the attached "Project Information." If the information in the attached Project Information is modified or the project changes, this water quality certification is no longer valid until amended by the Central Valley Water Board.

15. In the event of any violation or threatened violation of the conditions of this Order, the violation or threatened violation shall be subject to any remedies, penalties, process, or sanctions as provided for under State law and section 401 (d) of the federal Clean Water Act. The applicability of any State law authorizing remedies, penalties, process, or

sanctions for the violation or threatened violation constitutes a limitation necessary to ensure compliance into this Order.

a. If California Department of Transportation or a duly authorized representative of the project fails or refuses to furnish technical or monitoring reports, as required under this Order, or falsifies any information provided in the monitoring reports, the applicant is subject to civil monetary liabilities, for each day of violation, or criminal liability.

b. In response to a suspected violation of any condition of this Order, the Central Valley Water Board may require California Department of Transportation to furnish, under penalty of perjury, any technical or monitoring reports the Central Valley Water Board deems appropriate, provided that the burden, including cost of the reports, shall be in reasonable relationship to the need for the reports and the benefits to be obtained from the reports.

c. California Department of Transportation shall allow the staff(s) of the Central Valley Water Board, or an authorized representative(s), upon the presentation of credentials and other documents, as may be required by law, to enter the project premises for inspection, including taking photographs and securing copies of project-related records, for the purpose of assuring compliance with this certification and determining the ecological success of the project.

ADDITIONAL STORM WATER QUALITY CONDITIONS:

California Department of Transportation shall also satisfy the following additional storm water quality conditions:

1. During the construction phase, California Department of Transportation must employ strategies to minimize erosion and the introduction of pollutants into storm water runoff. These strategies must include the following:

   (a) the Storm Water Pollution Prevention Plan (SWPPP) must be prepared during the project planning and design phases and before construction;
   (b) an effective combination of erosion and sediment control Best Management Practices (BMPs) must be implemented and adequately working prior to the rainy season and during all phases of construction.

2. California Department of Transportation must minimize the short and long-term impacts on receiving water quality from the Buckhorn Grade Improvement Capstone Project by implementing the following post-construction storm water management practices:

   (a) minimize the amount of impervious surface;
   (b) reduce peak runoff flows;
   (c) provide treatment BMPs to reduce pollutants in runoff;
   (d) ensure existing waters of the State (e.g., wetlands, vernal pools, or creeks) are not used as pollutant source controls and/or treatment controls;
   (e) preserve and, where possible, create or restore areas that provide important water quality benefits, such as riparian corridors, wetlands, and buffer zones;
   (f) limit disturbances of natural water bodies and natural drainage systems caused by development (including development of roads, highways, and bridges);

(g) use existing drainage master plans or studies to estimate increases in pollutant loads and flows resulting from projected future development and require incorporation of structural and non-structural BMPs to mitigate the projected pollutant load increases in surface water runoff;
(h) identify and avoid development in areas that are particularly susceptible to erosion and sediment loss, or establish development guidance that protects areas from erosion/ sediment loss;
(i) control post-development peak storm water run-off discharge rates and velocities to prevent or reduce downstream erosion, and to protect stream habitat.

3. California Department of Transportation must ensure that all development within the project provides verification of maintenance provisions for post-construction structural and treatment control BMPs. Verification shall include one or more of the following, as applicable:

(a) the developer's signed statement accepting responsibility for maintenance until the maintenance responsibility is legally transferred to another party; or
(b) written conditions in the sales or lease agreement that require the recipient to assume responsibility for maintenance; or
(c) written text in project conditions, covenants and restrictions for residential properties assigning maintenance responsibilities to a home owner's association, or other appropriate group, for maintenance of structural and treatment control BMPs; or
(d) any other legally enforceable agreement that assigns responsibility for storm water BMP maintenance.

4. Staff of the Central Valley Water Board has prepared total maximum daily load (TMDL) allocations that, once approved, would limit methylmercury in storm water discharges to the Sacramento-San Joaquin Delta. The Central Valley Water Board has scheduled these proposed allocations to be considered for adoption. When the Central Valley Water Board adopts the TMDL and once approved by the Environmental Protection Agency, the discharge of methylmercury may be limited from the proposed project. The purpose of this condition is to provide notice to California Department of Transportation that methylmercury discharge limitations and monitoring requirements may apply to this project in the future and also to provide notice of the Central Valley Water Board's TMDL process and that elements of the planned construction may be subject to a TMDL allocation.

REGIONAL WATER QUALITY CONTROL BOARD CONTACT PERSON:

George D. Day, P.E.,Redding Branch Office, 364 Knollcrest Drive, Suite 205, Redding, California 96002, (530) 224-4845

WATER QUALITY CERTIFICATION:

I hereby issue an order certifying that any discharge from California Department of Transportation, Buckhorn Grade Improvement Capstone Project (WDID# 5A45CR00459) will comply with the applicable provisions of §301 ("Effluent Limitations"), §302 ("Water Quality Related Effluent Limitations"), §303 ("Water Quality Standards and Implementation Plans"), §306 ("National Standards of Performance"), and §307 ("Toxic and Pretreatment Effluent

Standards") of the Clean Water Act. This discharge is also regulated under State Water Resources Control Board Water Quality Order No. 2003-0017 DWQ "Statewide General Waste Discharge Requirements For Dredged Or Fill Discharges That Have Received State Water Quality Certification (General WDRs)."

Except insofar as may be modified by any preceding conditions, all certification actions are contingent on (a) the discharge being limited and all proposed mitigation being completed in strict compliance with California Department of Transportation 's project description and the attached Project Information Sheet, and (b) compliance with all applicable requirements of the Water Quality Control Plan *for the Sacramento River and San Joaquin River*, Fourth Edition, revised October 2011 (Basin Plan).

Any person aggrieved by this action may petition the State Water Quality Control Board to review the action in accordance with California Water Code § 13320 and California Code of Regulations, title 23, § 2050 and following. The State Water Quality Control Board must receive the petition by 5:00 p.m., 30 days after the date of this action, except that if the thirtieth day following the date of this action falls on a Saturday, Sunday, or state holiday, the petition must be received by the State Water Quality Control Board by 5:00 p.m. on the next business day. Copies of the law and regulations applicable to filing petitions may be found on the Internet at: http://www.waterboards.ca.gov/public_notices/petitions/water_quality or will be provided upon request.

(for) PAMELA C. CREEDON
Executive Officer

GDD:lmw

Enclosure: Water Quality Order No. 2003-0017 DWQ

cc w/o enclosures: Mr. Matt Kelley, U.S. Army Corp of Engineers, Redding
Ms. Donna Cobb, Department of Fish and Wildlife, Region 1, Redding
City of Redding Planning Department, Redding
U.S. Fish and Wildlife Service, Sacramento
Mr. Bill Jennings, CALSPA, Stockton

cc w/o enclosures by email: U.S. EPA, Region 9, San Francisco
Mr. Bill Orme, SWRCB, Certification Unit, Sacramento

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PROJECT INFORMATION

Application Date: 23 December 2013

Application Complete Date: 28 January 2014

Applicant: California Department of Transportation, Attn: Emiliano Pro

Project Name: Buckhorn Grade Improvement Capstone Project

Application Number: WDID No. 5A45CR00459

U.S. Army Corps File Number: SPK-2013-00655

Type of Project: Realignment of approximately 4.3 miles of existing highway and improvement of 0.6 miles of highway.

Project Location: Section 07, Township 32 North, Range 07 West, MDB&M.
Latitude: 40°38'22" and Longitude: -122°43'49"

County: Shasta County

Receiving Water(s) (hydrologic unit): Sawpit Gulch and multiple unnamed tributaries to Willow Creek, which is tributary to Sacramento River. Shasta Bally Hydrologic Unit-Platina Hydrologic Subarea No. 524.36

Water Body Type: Riparian, Streambed

Designated Beneficial Uses: The Basin Plan for the Central Valley Water Board has designated beneficial uses for surface and ground waters within the region. Beneficial uses that could be impacted by the project include: Municipal and Domestic Water Supply (MUN); Agricultural Supply (AGR); Groundwater Recharge, Water Contact Recreation (REC-1); Non-Contact Water Recreation (REC-2); Warm Freshwater Habitat (WARM); Cold Freshwater Habitat (COLD); Cold Migration of Aquatic Organisms (MIGR); Spawning, Reproduction, and /or Early Development (SPWN); and Wildlife Habitat (WILD).

Project Description (purpose/goal): The Buckhorn Grade Improvement Capstone Project consists of realigning approximately 4.3 miles of existing highway and improve 0.6 miles of highway, by providing 12-foot travel lands with 8-foot paved shoulders (4-foot shoulder when adjacent to a truck climbing lane), improve the roadway geometrics, improve sight distance, increase the clear recovery zone, provide snow and rock catchment areas, and extend the existing truck climbing lanes to provide a continuous westbound climbing lane.

The project will involve tree and vegetation removal, earthwork (excavation and embankment construction – approximately 1,300,000 cubic yards), drainage improvements, paving, striping, retaining walls, installation of a new metal beam guardrail and signs, and right of way acquisition. Controlled blasting and rock fall protection may be included. The project will require three construction seasons to complete; currently anticipated to be the 2015, 2016, and 2017 seasons with tree removal beginning winter of 2014/2015.

There are four perennial drainage feature crossings within the project limits: Sawpit Gulch and three unnamed perennial stream features. In addition there are multiple ephemeral, intermittent, and roadway drainages channeled through culverts under the existing highway. One wetland is present within the project limits, located at post mile 0.64. Steep gradients and porous substrates found within the project limits are not conducive to holding water for long periods of time, accounting for the limited number of wetlands found within the project limits. This wetland will not be impacted by this project and will be protected from construction activities with the installation of Environmentally Sensitive Area fencing.

Existing drainage facilities will be removed, abandoned, extended, or remain unchanged depending on the location. New drainage facilities will be constructed to accommodate the new alignment. The new culverts will be used to convey the streams and storm-water runoff under the roadway to rock and gabions lined ditches. These lined ditches will be used to prevent erosion and reduce runoff energy. The fill slopes will be constructed with gabion lined mid-slope drainage benches to reduce slope length. Permanent sediment traps, slotted risers, and check dams will also be constructed at strategic locations to reduce sediment transport.

After the new highway alignment is constructed, portions of existing highway pavement will be removed. These areas will be maintained as turnouts, graded to blend into the existing topography, or used for drainage features; some areas may also be planted with native vegetation. Other portions of the existing highway will be left in place to provide access for private property owners and for maintenance purposes. An approved erosion control seed mix will be applied to all disturbed areas. A variety of construction equipment will be used for the project including dozers, scrapers, compactors, backhoes, excavators, and dump trucks. Equipment will be staged sequentially along each segment, and materials will be stored in existing upland areas within the project limits.

Preliminary Water Quality Concerns: Construction activities may impact surface waters with increased turbidity and settleable matter.

Proposed Mitigation to Address Concerns: California Department of Transportation will implement Best Management Practices (BMPs) to control sedimentation and erosion. All temporary affected areas will be restored to pre-construction contours and conditions upon completion of construction activities. California Department of Transportation will conduct turbidity and settleable matter testing during in-water work, stopping work if Basin Plan criteria are exceeded or are observed.

Fill/Excavation Area: Project implementation will permanently impact 0.22 acres of riparian and 0.087 acres of un-vegetated streambed and temporarily impact 0.016 acres of riparian and 0.022 acres of un-vegetated streambed.

Dredge Volume: Not Applicable

U.S. Army Corps of Engineers Permit Number: Nationwide Permit #14 (Linear Transportation Projects)

Department of Fish and Wildlife Streambed Alteration Agreement: California Department of Transportation applied for a Streambed Alteration Agreement on 25 November 2013. Lake & Streambed Alteration Agreement Number: 1600-2013-0349-R1

Possible Listed Species: None

Status of CEQA Compliance: The California Department of Transportation issued a final Notice of Determination approving a Mitigated Negative Declaration on 4 August 2009 in compliance with Section 21108 or 21152 of the Public Resources Code, stating the project will have a significant effect on the environment. Mitigation measures were made a condition of approval. A mitigation reporting or monitoring plan was not adopted for this project. An Environmental Impact Report was prepared for this project pursuant to the provisions of CEQA, and a statement of Overriding Consideration was adopted for this project. (State Clearinghouse Number 20020522057).

Compensatory Mitigation: The applicant must comply with the U.S. Army Corps of Engineers' requirements for compensatory mitigation for the impacts to jurisdictional water.

Application Fee Provided: On 28 December 2013 a certification application fee of $36,569.00 was submitted as required by 23 CCR §3833b(3)(A) and by 23 CCR §2200(e). A remaining certification fee of $9,103 was received on 9 January 2014 as required by 23 CCR §3833b(2)(A) and by 23 CCR § 2200(e).

STATE WATER RESOURCES CONTROL BOARD

WATER QUALITY ORDER NO. 2003 - 0017 - DWQ

STATEWIDE GENERAL WASTE DISCHARGE REQUIREMENTS FOR DREDGED OR FILL DISCHARGES THAT HAVE RECEIVED STATE WATER QUALITY CERTIFICATION (GENERAL WDRs)

The State Water Resources Control Board (SWRCB) finds that:

1. Discharges eligible for coverage under these General WDRs are discharges of dredged or fill material that have received State Water Quality Certification (Certification) pursuant to federal Clean Water Act (CWA) section 401.

2. Discharges of dredged or fill material are commonly associated with port development, stream channelization, utility crossing land development, transportation water resource, and flood control projects. Other activities, such as land clearing, may also involve discharges of dredged or fill materials (e.g., soil) into waters of the United States.

3. CWA section 404 establishes a permit program under which the U.S. Army Corps of Engineers (ACOE) regulates the discharge of dredged or fill material into waters of the United States.

4. CWA section 401 requires every applicant for a federal permit or license for an activity that may result in a discharge of pollutants to a water of the United States (including permits under section 404) to obtain Certification that the proposed activity will comply with State water quality standards. In California, Certifications are issued by the Regional Water Quality Control Boards (RWQCB) or for multi-Region discharges, the SWRCB, in accordance with the requirements of California Code of Regulations (CCR) section 3830 et seq. The SWRCB's water quality regulations do not authorize the SWRCB or RWQCBs to waive certification, and therefore, these General WDRs do not apply to any discharge authorized by federal license or permit that was issued based on a determination by the issuing agency that certification has been waived. Certifications are issued by the RWQCB or SWRCB before the ACOE may issue CWA section 404 permits. Any conditions set forth in a Certification become conditions of the federal permit or license if and when it is ultimately issued.

5. Article 4, of Chapter 4 of Division 7 of the California Water Code (CWC), commencing with section 13260(a), requires that any person discharging or proposing to discharge waste, other than to a community sewer system, that could affect the quality of the waters of the State,[1] file a report of waste discharge (ROWD). Pursuant to Article 4, the RWQCBs are required to prescribe waste discharge requirements (WDRs) for any proposed or existing discharge unless WDRs are waived pursuant to CWC section 13269. These General WDRs fulfill the requirements of Article 4 for proposed dredge or fill discharges to waters of the United States that are regulated under the State's CWA section 401 authority.

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[1] "Waters of the State" as defined in CWC Section 13050(e)

IT IS HEREBY ORDERED that WDRs are issued to all persons proposing to discharge dredged or fill material to waters of the United States where such discharge is also subject to the water quality certification requirements of CWA section 401 of the federal Clean Water Act (Title 33 United States Code section 1341), and such certification has been issued by the applicable RWQCB or the SWRCB, unless the applicable RWQCB notifies the applicant that its discharge will be regulated through WDRs or waivers of WDRs issued by the RWQCB. In order to meet the provisions contained in Division 7 of CWC and regulations adopted thereunder, dischargers shall comply with the following:

1. Dischargers shall implement all the terms and conditions of the applicable CWA section 401 Certification issued for the discharge. This provision shall apply irrespective of whether the federal license or permit for which the Certification was obtained is subsequently deemed invalid because the water body subject to the discharge has been deemed outside of federal jurisdiction.

2. Dischargers are prohibited from discharging dredged of fill material to waters of the United States without first obtaining Certification from the applicable RWQCB or SWRCB.

CERTIFICATION

The undersigned, Clerk to the Board, does hereby certify that the foregoing is a full, true, and correct copy of an order duly and regularly adopted at a meeting of the State Water Resources Control Board held on November 19, 2003.

AYE: Arthur G. Baggett, Jr.
Peter S. Silva
Richard Katz
Gary M. Carlton
Nancy H. Sutley

NO: None.

ABSENT: None.

ABSTAIN: None.

Debbie Irvin

Debbie Irvin
Clerk to the Board

02-3E4104
02-Sha-299-0.3/7.1
Project ID 0200020042

PERMITS

PLAC Condition Responsibility Summary

United States Army Corps of Engineers

WATER QUALITY

California Regional Water Quality Control Board

Central Valley Region (WDID No. 5A45CR00459)
Board Order No. 2012-0011-DWQ
NPDES Permit No. CAS 000003

AGREEMENTS

California Department of Fish and Wildlife

Notification No. 1600-2013-0349-R1

MATERIALS INFORMATION

Foundation Report for Sawpit Gulch

Addendum to Foundation Report for Sawpit Gulch

Final Hydraulic Report for Sawpit Gulch Culvert Extension

Geotechnical Design Report

Addenddum to Geotechnical Design Report

Potential Water Sources

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
NORTHERN REGION
601 LOCUST STREET
REDDING, CA 96001

STREAMBED ALTERATION AGREEMENT
NOTIFICATION NO. 1600-2013-0349-R1
Sawpit Gulch and other small tributaries, all tributary to Willow Creek

CALIFORNIA DEPARTMENT OF TRANSPORTATION
BUCKHORN GRADE IMPROVEMENT CAPSTONE PROJECT

This Streambed Alteration Agreement (Agreement) is entered into between the California Department of Fish and Wildlife (DFW) and the California Department of Transportation (Permittee) as represented by Mr. Chris Harvey.

RECITALS

WHEREAS, pursuant to Fish and Game Code (FGC) section 1602, Permittee notified DFW on November 27, 2013 that Permittee intends to complete the project described herein;

WHEREAS, pursuant to FGC section 1603, DFW has determined that the project could substantially adversely affect existing fish or wildlife resources and has included measures in the Agreement necessary to protect those resources;

WHEREAS, Permittee has reviewed the Agreement and accepts its terms and conditions, including the measures to protect fish and wildlife resources;

NOW THEREFORE, Permittee agrees to complete the project in accordance with the Agreement.

PROJECT LOCATION

The project is located along State Route 299, from post mile 0.3 to 7.1, approximately 20 miles west of Redding, in the County of Shasta, State of California.

PROJECT DESCRIPTION

The project will involve tree and vegetation removal, earthwork (excavation and embankment construction- approximately 1,300,000 cubic yards), drainage improvements, paving, striping, retaining walls, metal beam guardrail, signs, and right of way acquisition. Controlled blasting and rock fall protection may be included. The project will require three construction seasons to complete; currently anticipated to be the 2015, 2016, and 2017 seasons, with tree removal occurring during the winter of

2014. The Buckhorn Grade Improvement Capstone Project will not require bridges, viaducts, or tunnels nor does the project area contain any special status fish and/or plant species.

There are four perennial drainage feature crossings within the project limits: Sawpit Gulch and three unnamed perennial stream features. In addition there are multiple ephemeral, intermittent, and roadway drainages channeled through culverts under the existing highway. All of these streams and channels exhibit severe down cutting, and other signs of erosion on side slopes and embankments. This is due to very steep slopes and highly erodible soils within the project area. One wetland is present within the project limits, located at post mile 0.64. Steep gradients and porous substrates found within the project limits are not conducive to holding water for long periods of time, accounting for the limited number of wetlands found within the project limits. This wetland will not be impacted by this project and will be protected from construction activities with the installation of Environmentally Sensitive Area (ESA) fencing.

Sawpit Gulch – located at PM 6.30

Sawpit Gulch, a tributary to Willow Creek, is a perennial stream located on the existing alignment at existing post mile (EPM) 6.30. The stream has a well defined Ordinary High Water Mark (OHWM) with a width of 6-8 ft. Currently the stream is conveyed beneath the existing highway through a 10'x10' Reinforced Concrete Box (RCB) culvert. The existing 52.4' RCB culvert will be extended at the outlet to accommodate the roadway widening. Extending the RCB will require removal of the existing outlet head and wing walls. The RCB culvert will then be extended 32.4'. Approximately 45' of Rock Slope Protection (RSP) will be placed at the inlet of the RCB culvert while approximately 31.2' of RSP will be placed at the outlet. A 200' Mechanically Stabilized Embankment (MSE) retaining wall will be constructed at the outlet of the extended RCB culvert, parallel to the roadway. This MSE will serve to support the fill required to widen the roadway.

A temporary clear water diversion will be required for work at this location. The temporary fill materials for the water diversion may be placed within the permanent impact area upstream of the culvert inlet, and may consist of sandbags and plastic pipe. Once the drainage work is complete, temporary fills will be removed within 30 days.

Construction at Sawpit Gulch will permanently impact approximately 0.017 acres of perennial stream and 0.104 acres of riparian habitat.

Unnamed perennial stream – located at PM 0.64

The perennial stream which passes beneath the existing alignment at EPM 0.64 has an average OHWM width of 3'. As a result of construction at this location the culvert at EPM 0.64 will be connected to a newly placed culvert which will convey water beneath the new alignment. The newly placed culvert will be 514.5', adding to the existing 219.8' culvert for a total of 734.3'. This new drainage system will outlet to a new gabion lined ditch, down-slope of the new alignment. The gabion lined ditch will convey water back to the original stream location down slope of the new roadway alignment. A temporary clear water diversion may be required for work at this location. The temporary fill materials for the water diversion may be placed within the temporary impact area upstream of the culvert inlet, and may consist of sandbags and plastic pipe. Once the drainage work is complete, temporary fill material will be removed within 30 days and the project area returned to pre-construction contours. The area will then be treated with an erosion control seed mix.

Construction at this location will permanently impact approximately 0.0541 acres and temporarily impact approximately 0.004 acres of perennial stream. Additionally it is anticipated that approximately 0.721 acres of riparian habitat will be permanently impacted.

Unnamed perennial streams – located at PM 1.26 & 1.30

The two perennial streams, which are associated with two culverts located on the existing alignment at EPM 1.26 and 1.30, have an OHWM width ranging from 2-5 ft. and ultimately flow into Willow Creek. These perennial streams will be conveyed by newly constructed rock lined ditches to a new single culvert. This culvert will be placed at the new PM (NPM) 1.03 on the new alignment and will convey the water beneath the newly constructed roadway.

A temporary clear water diversion may be required for work at these locations. The temporary fill materials for the water diversion may be placed within the temporary impact areas upstream of the culvert inlets, and may consist of sandbags and plastic pipe. Once the drainage work is complete, temporary fills will be removed within 30 days and the project area returned to pre-construction contours and treated with erosion control seed mix.

Construction at these locations will result in approximately 0.0944 acres of permanent impact and 0.005 acres of temporary impact to the perennial streams. Construction will also result in approximately 0.711 acres of riparian habitat at these locations. The adjacent ephemeral channels which flow into these perennial streams do not contain riparian habitat.

Unnamed perennial stream – located at EPM 1.97

The perennial stream, which is currently conveyed beneath the existing alignment at EPM 1.97, has an average OHWM of 3 ft. A newly constructed rock lined ditch will convey this feature from the outlet of the existing culvert to a newly placed culvert at NPM 1.54 on the new alignment and convey water beneath the new roadway fill.

A temporary clear water diversion may be required for work at this location. The temporary fill materials for the water diversion may be placed within the temporary impact area upstream of the culvert inlet, and may consist of sandbags and plastic pipe. Once the drainage work is complete, temporary fills will be removed within 30 days and the project area returned to pre-construction contours and treated with erosion control seed mix.

Construction at this location will permanently impact approximately 0.045 acres and temporarily impact approximately 0.003 acres of perennial stream. Additionally it is anticipated that approximately 0.746 acres of riparian habitat will be permanently impacted.

Other Ephemeral & Intermittent Channels

Culverts will be removed, abandoned, replaced, or extended depending on the location, and new drainage facilities will be installed as needed. Work will be conducted during the low-flow / no-flow period, limited from May 1 to October 15.

Construction at these locations is anticipated to permanently impact approximately 0.089 acres of riparian habitat.

Willow Creek

All drainage features within the project limits are tributaries to Willow Creek. No work is planned for Willow Creek nor will the new alignment cross the creek.

The project will not have a significant impact, direct or indirect, on Willow Creek for the following reasons: (1) the overall alignment will move the highway further away from Willow Creek (increased buffer); (2) the combination of temporary and permanent stormwater treatment methods, BMPs, and erosion control methods will significantly reduce or effectively eliminate larger sediment from reaching receiving waters.

MEASURES TO PROTECT FISH AND WILDLIFE RESOURCES

1 Administrative Measures

Permittee shall meet each administrative requirement described below.

1.1 Documentation at Project Site. Permittee shall make the Agreement, any extensions and amendments to the Agreement, and all related notification materials and California Environmental Quality Act (CEQA) documents, readily available at the project site at all times and shall be presented to DFW personnel, or personnel from another state, federal, or local agency upon request.

1.2 Providing Agreement to Persons at Project Site. Permittee shall provide copies of the Agreement and any extensions and amendments to the Agreement to all persons who will be working on the project at the project site on behalf of Permittee, including but not limited to contractors, subcontractors, inspectors, and monitors.

1.3 Notification of Conflicting Provisions. Permittee shall notify DFW if Permittee determines or learns that a provision in the Agreement might conflict with a provision imposed on the project by another local, state, or federal agency. In that event, DFW shall contact Permittee to resolve any conflict.

1.4 Project Site Entry. Permittee agrees that DFW personnel may enter the project site at any time to verify compliance with the Agreement.

2 Avoidance and Minimization Measures

To avoid or minimize adverse impacts to fish and wildlife resources identified above, Permittee shall implement each measure listed below.

PROJECT TIMING

2.1 All work on the stream banks or within the stream channel, shall be confined to the period commencing May 1, and ending October 15, of any year in which this Agreement is valid when there is little or no stream flow. If there is flow in the stream the Permittee or its contractors may construct a clear water diversion to cleanly route water around the construction area. Weather conditions should be monitored daily, if the stream has clear water diversion, and the diversion constructed should be sized to accommodate 25 year potential thunder-storm events. If weather conditions permit, and the stream remains in low flow conditions or dry, the Permittee may perform work within the stream channel or on the banks after October 15, provided a written request is made to the Department at least 5 days before the proposed work period variance. Written approval from the Department for the proposed work period variance must be received by the Permittee prior to the start or continuation of work after October 15.

2.2 If work is performed within the stream channel or on the banks after October 15, the Permittee shall do all of the following:

a. Stage erosion and sediment control materials at the work site.

b. Monitor the seventy-two (72) hour forecast from the National Weather Service.

c. When the 72-hour forecast indicates a probability of precipitation of 60% or greater, or at the onset of any precipitation, ground disturbing activities shall cease and erosion control measures shall be implemented to stabilize exposed soils and prevent the mobilization of sediment into the stream channel or adjacent wetland or riparian areas.

HABITAT AND SPECIES PROTECTION

2.3 This Agreement does not authorize the take of any State threatened or endangered species. If the project could result in the "take" of a state listed threatened or endangered species, the Permittee has the responsibility to obtain from the Department, a California Endangered Species Act Permit (CESA 2081 Permit). The Department may formulate a management plan that will avoid or mitigate take. If appropriate, contact the Department CESA coordinator at (530) 225-2300.

2.4 The project is not expected to directly impact the Pacific fisher (*Martes pennanti*) or ringtail cat (*Bassariscus astutus*). Potential Pacific fisher and/or ringtail travel/foraging along the main stem of Willow Creek is not anticipated to be altered by the project construction activities as no work is planned for Willow Creek. Additionally, the straightening of the highway alignment as a result of this project will reduce the edge effect of the highway adjacent to drainages and streams. Wildlife underpasses were designed into the Twin Gulches safety project, which is currently in construction and located within the Buckhorn Grade Improvement Capstone Project limits. The project is not anticipated to result in trend toward Federal listing or loss of viability. Vegetation removal will occur outside of the period when ringtail cat and Pacific fisher young are unable to leave the denning site (approximately April through June). Artificial light sources introduced as part of construction activities will be shielded, when possible, throughout construction of the project.

2.5 Removal of existing vegetation shall not exceed the minimum necessary to complete operations. After construction, the Permittee will replant native trees and shrubs as described in this agreement at a ratio of 1:1. All unpaved disturbed areas will have erosion control materials (e.g. hydroseed, mulch, certified weed-free straw) applied at rates that are effective for preventing mobilization and movement of soils.

2.6 Construction equipment and personnel shall be restricted to the limits of the work area as shown on the project plans. No construction activities or habitat disturbance is authorized beyond this area. The Permittee or its contractors, will prepare a Storm Water Pollution Prevention Plan.

2.7 Take of migratory birds will be avoided during construction activities. In no case shall active nests with eggs or young be removed during construction.

2.8 Riparian vegetation removal will be kept to the minimum necessary for project construction. All material stockpiling and staging areas will be located within project right-of-way in upland areas. There will be no removal of riparian vegetation for staging and/or stockpiling purposes.

2.9 Foothill Yellow-legged Frog (FYLF; *Rana boylii*). Prior to the start of construction, a qualified biologist (qualified to survey for amphibians) will survey the Sawpit Gulch location to ensure no FYLF are present and to capture and relocate if any are found. No FYLF were detected during surveys within the Buckhorn Grade Improvement Capstone Project's other areas of disturbance. No work is planned for Willow Creek, thus potential FYLF presence in this creek will not be disturbed as a result of this project.

2.10 Wetlands. Wetland areas within the project area will be protected by establishing an Environmentally Sensitive Area (ESA) with fencing as a first order of work to prevent impacts by machinery or crews during construction. The project was designed to avoid the wetland located at post mile 0.64.

2.11 Migratory Birds. To avoid impacts to nesting birds, tree removal will be minimal and restricted to the period from November 1st through March 15th.

2.12 On-site mitigation for the loss of 2.371 acres of Valley Foothill Riparian habitat is not proposed due to the environmental setting within the project limits. The project area's rugged terrain and steep slopes do not provide areas that would allow restoration of sufficient acreage of riparian vegetation. Off-site mitigation for the loss of 2.371 acres of Valley Foothill Riparian habitat is proposed at a 3:1 ratio for a total creation of 7.113 acres of riparian habitat. The off-site mitigation shall be implemented at the Jelly's Ferry mitigation site. A planting and maintenance plan shall be developed for the mitigation at the Jelly's Ferry mitigation site and submitted to DFW for review and approval. The creation and establishment of riparian habitat shall be preserved in perpetuity at the Jelly's Ferry site.

2.13 Executive Order 13112 requires federal agencies to prevent and control the introduction and spread of invasive species, therefore all equipment shall be washed pre – and post - construction to prevent the spread of any noxious weeds. All areas left disturbed at the end of construction will be seeded and mulched to help prevent the establishment of invasive weeds. Only native species will be used for revegetation. Regular monitoring and maintenance of landscape plantings will be implemented to ensure continued growth of desired species. Any invasive species detected will be removed and destroyed to prevent the spread of seed or other propagules.

PETROLEUM, CHEMICAL AND OTHER POLLUTANTS

2.14 All construction-related materials and equipment shall be stored in designated staging areas located outside of the floodplain unless approved in writing by DFW.

2.15 As part of the proposed construction activities, heavy equipment (backhoe, excavator, etc.) may be required to work within and/or adjacent to perennial watercourses. Also, smaller equipment such as chainsaws may be necessary for vegetation removal within these drainages. Therefore, there is potential for chemical contamination as a result of a leak or spill of petroleum or hydraulic products within a channel. Measures will be taken to avoid or minimize potential chemical contamination, which will include no staging, storage and re-fueling of vehicles and equipment within 100 feet of any watercourse. The contractor will also be required to prepare a Storm Water Pollution Prevention Plan (SWPPP). In the event of a leak or spill, the project shall cease immediately and the Regional Water Quality Control Board (RWQCB) and CDFW shall be notified.

2.16 Refueling and vehicle maintenance shall be performed at least 100 feet from streams or other water bodies unless approved in writing by DFW. If equipment must be washed, washing will occur where the water cannot flow into a creek channel.

2.17 No equipment or machinery shall be operated within any flowing stream.

2.18 Any equipment or vehicles driven and/or operated within or adjacent to the stream channel shall be checked and maintained daily to prevent leaks of materials that, if introduced to water, could be deleterious to aquatic life, wildlife, or riparian habitat.

2.19 Stationary equipment such as motors, pumps, generators, and welders that contain deleterious materials, located adjacent to the stream channel shall be positioned over drip pans.

2.20 No debris, soil, silt, sand, bark, slash, sawdust, rubbish, cement or concrete or washings thereof, asphalt, paint or other coating material, oil or petroleum products or other organic or earthen material from any construction, or associated activity of whatever nature shall be allowed to enter into, or placed where it may be washed by rainfall or runoff into, waters of the State. When operations are completed, any excess materials or debris shall be removed from the work area. No rubbish shall be deposited within 150 feet of the high water mark of any stream or lake.

EROSION AND SEDIMENT CONTROL

2.21 The project shall at all time feature adequate erosion and sediment control devices to prevent the degradation of water quality.

2.22 Soils exposed by project operations shall be treated to prevent sediment runoff and transport. Erosion control measures shall include the proper installation and maintenance of approved Best Management Practices (BMPs) and may include applications of seed, certified weed-free straw, compost, fiber, stabilizing emulsion and mulch, or combinations thereof.

2.23 Soils adjacent to the stream channel that are exposed by project operations shall be adequately stabilized when rainfall is reasonably expected during construction, and immediately upon completion of construction, to prevent the mobilization of such sediment into the stream channel or adjacent riparian areas. National Weather Service forecasts shall be monitored by the Permittee to determine the chance of precipitation.

2.24 Following construction, all disturbed upland areas shall be stabilized and reseeded with an erosion control mix consisting of regionally appropriate, native grass and forb species.

2.25 All work within the watercourses shall take place during the summer lowflow period between May 1 and October 15.

2.26 A temporary stream diversion will be constructed to isolate the work area from the flowing stream.

2.27 If a gravel berm is utilized to divert stream flows, material shall consist of clean, pre-washed, uncrushed natural river rock. Gravel will be washed at least once and have a cleanliness value of 85 or higher (California Test No. 227). Particle size shall be graded with 95-100 percent passing a 4 or 5 inch screen, 25-35 percent passing a ¾ inch, 10-20percent passing a ½ inch screen, and 0-5 percent passing a ¼ inch screen (percent by dryweight) or approved by CDFW. Following construction, any gravel left in the stream channel shall be graded to a depth no greater than 6 inches. If any other materials are used to divert the stream flows, they shall be removed from the stream channel.

2.28 If groundwater is encountered during excavation and it is necessary to dewater, the groundwater will be pumped either to a portable tank, truck, or an adjacent upland area, making certain surface water will not be returned to the watercourse.

2.29 Temporary construction site BMPs will be implemented under a contractor prepared and agency approved Storm Water Pollution Prevention Plan (SWPPP) which will incorporate Caltrans best management practices (BMPs). The temporary BMPs are aimed at reducing erosion and subsequent sediment transport, and preventing accidental spills during construction and may include check dams, straw bales, hydraulic mulch, sediment traps, concrete washouts, fiber rolls, and temporary Hot Mix Asphalt (HMA) dikes.

2.30 Construction will take place during the summer, when flows are at their lowest. To isolate the work areas from stream flows during construction, temporary diversions will be constructed, as described in the Project Description. As previously mentioned, a SWPPP will be prepared describing the necessary erosion control measures. The SWPPP is the contractor's plan to ensure conformance with Caltrans' water pollution control requirements on the construction site. The SWPPP will incorporate appropriate best management practices (BMPs, http://www.dot.ca.gov/hq/construc/stormwater/CSBMPM_303_Final.pdf).

2.31 Following construction, all disturbed areas will be stabilized and re-seeded.

2.32 Temporary fills will be removed within 30 days after completion of work at a given location and/or prior to the onset of the rain season, and in accordance with the Section 401 and 404 Clean Water Act requirements. These areas will be returned to their pre-construction contours, and treated with erosion control seed mix.

2.33 Long-term measures to minimize impacts to Waters of the U.S. include: conveying runoff from disturbed areas through maintainable sediment traps, and rock and gabion lined ditches. Mid- slope benches will be constructed on embankments to reduce the slope length for runoff to accumulate and to convey that runoff to gabion lined ditches. Select material will be placed to veneer embankment slopes to reduce erosion of the decomposed granite slopes. These veneered slopes will also be covered with embedded erosion control blankets and seeded with a native seed mix to further reduce erosion.

CONTACT INFORMATION

Any communication that Permittee or DFW submits to the other shall be in writing and any communication or documentation shall be delivered to the address below by U.S. mail, fax, or email, or to such other address as Permittee or DFW specifies by written notice to the other.

To Permittee:

Mr. Chris Harvey
Project Manager
Department of Transportation
1031 Butte Street, MS 30
Redding, CA 96001
Fax: (530) 225-2455
Email: chris.harvey@dot.ca.gov
ec: emiliano.pro@dot.ca.gov

To DFW:

Department of Fish and Wildlife
Northern Region
601 Locust Street
Redding, CA 96001
Attn: Lake and Streambed Alteration Program – Dr. Richard Lis
Notification #1600-2013-0349-R1
Fax: (530) 225-2142
Email: Richard.Lis@wildlife.ca.gov.

LIABILITY

Permittee shall be solely liable for any violations of the Agreement, whether committed by Permittee or any person acting on behalf of Permittee, including its officers, employees, representatives, agents or contractors and subcontractors, to complete the project or any activity related to it that the Agreement authorizes.

This Agreement does not constitute DFW's endorsement of, or require Permittee to proceed with the project. The decision to proceed with the project is Permittee's alone.

SUSPENSION AND REVOCATION

DFW may suspend or revoke in its entirety the Agreement if it determines that Permittee or any person acting on behalf of Permittee, including its officers, employees, representatives, agents, or contractors and subcontractors, is not in compliance with the Agreement.

Before DFW suspends or revokes the Agreement, it shall provide Permittee written notice by certified or registered mail that it intends to suspend or revoke. The notice shall state the reason(s) for the proposed suspension or revocation, provide Permittee an opportunity to correct any deficiency before DFW suspends or revokes the Agreement, and include instructions to Permittee, if necessary, including but not limited to a directive to immediately cease the specific activity or activities that caused DFW to issue the notice.

ENFORCEMENT

Nothing in the Agreement precludes DFW from pursuing an enforcement action against Permittee instead of, or in addition to, suspending or revoking the Agreement.

Nothing in the Agreement limits or otherwise affects DFW's enforcement authority or that of its enforcement personnel.

OTHER LEGAL OBLIGATIONS

This Agreement does not relieve Permittee or any person acting on behalf of Permittee, including its officers, employees, representatives, agents, or contractors and subcontractors, from obtaining any other permits or authorizations that might be required under other federal, state, or local laws or regulations before beginning the project or an activity related to it.

This Agreement does not relieve Permittee or any person acting on behalf of Permittee, including its officers, employees, representatives, agents, or contractors and subcontractors, from complying with other applicable statutes in the FGC including, but not limited to, FGC sections 2050 et seq. (threatened and endangered species), 3503 (bird nests and eggs), 3503.5 (birds of prey), 5650 (water pollution), 5652 (refuse disposal into water), 5901 (fish passage), 5937 (sufficient water for fish), and 5948 (obstruction of stream).

Nothing in the Agreement authorizes Permittee or any person acting on behalf of Permittee, including its officers, employees, representatives, agents, or contractors and subcontractors, to trespass.

AMENDMENT

DFW may amend the Agreement at any time during its term if DFW determines the amendment is necessary to protect an existing fish or wildlife resource.

Permittee may amend the Agreement at any time during its term, provided the amendment is mutually agreed to in writing by DFW and Permittee. To request an amendment, Permittee shall submit to DFW a completed DFW "Request to Amend Lake or Streambed Alteration" form and include with the completed form payment of the corresponding amendment fee identified in DFW's current fee schedule (see Cal. Code Regs., tit. 14, § 699.5).

TRANSFER AND ASSIGNMENT

This Agreement may not be transferred or assigned to another entity, and any purported transfer or assignment of the Agreement to another entity shall not be valid or effective, unless the transfer or assignment is requested by Permittee in writing, as specified below, and thereafter DFW approves the transfer or assignment in writing.

The transfer or assignment of the Agreement to another entity shall constitute a minor amendment, and therefore to request a transfer or assignment, Permittee shall submit to DFW a completed DFW "Request to Amend Lake or Streambed Alteration" form and include with the completed form payment of the minor amendment fee identified in DFW's current fee schedule (see Cal. Code Regs., tit. 14, § 699.5).

EXTENSIONS

In accordance with FGC section 1605(b), Permittee may request one extension of the Agreement, provided the request is made prior to the expiration of the Agreement's term. To request an extension, Permittee shall submit to DFW a completed DFW "Request to Extend Lake or Streambed Alteration" form and include with the completed form payment of the extension fee identified in DFW's current fee schedule (see Cal. Code Regs., tit. 14, § 699.5). DFW shall process the extension request in accordance with FGC 1605(b) through (e).

If Permittee fails to submit a request to extend the Agreement prior to its expiration, Permittee must submit a new notification and notification fee before beginning or continuing the project the Agreement covers (Fish & G. Code, § 1605, subd. (f)). .

EFFECTIVE DATE

The Agreement becomes effective on the date of DFW's signature, which shall be: 1) after Permittee's signature; 2) after DFW complies with all applicable requirements under the California Environmental Quality Act (CEQA); and 3) after payment of the applicable FGC section 711.4 filing fee listed at: http://www.dfg.ca.gov/habcon/ceqa/ceqa_changes.html.

TERM

This Agreement shall expire on December 31, 2017, unless it is terminated or extended before then. All provisions in the Agreement shall remain in force throughout its term. Permittee shall remain responsible for implementing any provisions specified herein to protect fish and wildlife resources after the Agreement expires or is terminated, as FGC section 1605(a) (2) requires.

AUTHORITY

If the person signing the Agreement (signatory) is doing so as a representative of Permittee, the signatory hereby acknowledges that he or she is doing so on Permittee's behalf and represents and warrants that he or she has the authority to legally bind Permittee to the provisions herein.

AUTHORIZATION

This Agreement authorizes only the project described herein. If Permittee begins or completes a project different from the project the Agreement authorizes, Permittee may be subject to civil or criminal prosecution for failing to notify DFW in accordance with FGC section 1602.

CONCURRENCE

The undersigned accepts and agrees to comply with all provisions contained herein.

FOR DEPARTMENT OF TRANSPORTATION

Chris Harvey 3/28/2014

Chris Harvey
Project Manager

Date

FOR DEPARTMENT OF FISH AND WILDLIFE

4-15-14

Michael R. Harris
Habitat Conservation Planning Supervisor

Date

Prepared by: Richard Lis, Ph.D.
Senior Environmental Scientist

02-3E4104
02-Sha-299-0.3/7.1
Project ID 0200020042

PERMITS

PLAC Condition Responsibility Summary

United States Army Corps of Engineers

WATER QUALITY

California Regional Water Quality Control Board

Central Valley Region (WDID No. 5A45CR00459)
Board Order No. 2012-0011-DWQ
NPDES Permit No. CAS 000003

AGREEMENTS

California Department of Fish and Wildlife

Notification No. 1600-2013-0349-R1

MATERIALS INFORMATION

Foundation Report for Sawpit Gulch

Addendum to Foundation Report for Sawpit Gulch

Final Hydraulic Report for Sawpit Gulch Culvert Extension

Geotechnical Design Report

Addenddum to Geotechnical Design Report

Potential Water Sources

M e m o r a n d u m

Flex your power!
Be energy efficient!

To:	MR. GUDMUND SETBERG Chief Office of Bridge Design Branch 2 Division of Engineering Services	**Date:**	November 22, 2013
		File:	02-SHA-299-PM 0.3/7.1 0200020042 EA 02-3E410 Capstone Curve Improvement Project Sawpit Gulch Culvert Extension & Wall
Attn:	Mr. Grant Schuster		

From: **DEPARTMENT OF TRANSPORTATION**
Division of Engineering Services
Office of Geotechnical Design - North

Subject: Foundation Report for Box Culvert Extension, MSE Wall, & Type 1 Wall System at Sawpit Gulch

Scope of Work

Per your request, we are providing a Foundation Report (FR) for a box culvert extension and three wall structures to be located at Sawpit Gulch as part of the Capstone Realignment and Widening Safety Project, which is located on State Highway 299 from PM 0.3 to PM 7.1 in Shasta County, California. The existing Sawpit Gulch box culvert is located at postmile 6.2 (about station 264+35 in the project stationing). Plate 1 shows the location of Sawpit Gulch within the Capstone Project limits. The planned extension of the box culvert is approximately 26 feet (ft) along its center line. The wall structures consist of two mechanically stabilized earth (MSE) walls on opposite sides of the downstream end of the box culvert extension with the two faces of a singular Type 1 wall butted between their respective sides of the culvert and the Eastern MSE wall on one side and the Western MSE wall on the other. All four structures are addressed in this FR due to their juxtapositioning and the structural integration of the Type 1 wall with the box culvert extension, together with their general geological and geotechnical conditions.

This report discusses the geotechnical conditions as evaluated from field observations and field and laboratory test data. It provides recommendations and specifications for project design and construction.

Project Description

The Capstone Curve Improvement Safety Project involves the straightening and widening of slightly over 3.6 miles of SHA 299 roadway, primarily between postmile 0.3 to 2.5 and 5.5 to 7.1. The realignment is accomplished primarily through a combination of cuts and fills.

The four structures (box culvert extension, two MSE walls, and a Type 1 wall) that have been planned at Sawpit Gulch were not included in the original earthwork scope of the project. Their purpose is to realign the road while bypassing an archaeological site located near the northern edge of the existing roadway a few hundred ft west of the existing box culvert. They will accommodate both the widening and straightening of the roadway by shifting its location to the south, where the existing topography drops down into the bedrock banks and overflow deposits of Willow Creek in the area of its confluence with the waters of Sawpit Gulch.

The four structures are juxtaposed and integrated together, with the eastern MSE wall butting against the eastern flank of the Type 1 wall, while the western MSE wall is butted against the western side of the Type 1 wall. The Type 1 wall footing is continuous as it extends beneath the culvert extension and behind the culvert cut-off wall. A generalized view of this structural layout, together with the layout of the existing and planned roadway, is shown in Plate 2. The oblique, non-orthogonal angle with which the culvert extension intersects the planned wall face creates a triangular area in which there is inadequate space for the requisite MSE reinforcements that would allow the western MSE wall to continue eastward to butt against the box culvert extension. Therefore, in lieu of abutting the western MSE wall directly against the box culvert extension, a Type 1 wall was added here to the design by the Office of Structures Design. This Type 1 wall has two faces, one on each side of the outlet, with a wide common continuous footing beneath the culvert, as explained earlier and shown in the plans. The structures are doweled together here structurally. The top of the Type 1 wall is continuous above the culvert where it surrounds it.

The Western MSE wall is 50 ft wide and has a maximum height of about 12 ft, including the concrete barrier slab that brings the top of wall to the roadway finish grade. The Eastern MSE wall is 75 ft wide, with a maximum height of about 14 ft, including the concrete barrier slab. The Type 1 wall is 36 ft wide and has a maximum wall height (H) of 16 ft, including the concrete barrier slab atop the wall. The culvert extension is 38 ft and 10 ¾ inches long.

The elevation of the inlet invert flow surface for the proposed Sawpit Gulch culvert extension matches the existing outlet invert flow surface, at 1539.09 ft above mean sea level, while the outlet invert surface is 1538.31 ft. Design plans also show that the proposed Sawpit Gulch culvert extension has a design slope of 2%, which matches the existing culvert slope. The culvert extension does not require outlet wingwalls, as the Type 1 retaining wall serves as the wingwalls at the outer edges of the culvert extension.

Man-Made Features of Engineering and Construction Significance

A private residence located on the north side of the highway bordering the eastern side of Sawpit Gulch derives water from a spring located a few hundred ft south of Willow Creek. This spring water is transported to the house via a makeshift delivery system consisting of piping hung through the trees over Willow Creek and through the existing box culvert.

Field Investigation and Testing Program

Seismic refraction was the primary subsurface investigation method utilized for this report. A 165-foot long seismic line running roughly west-east was laid parallel to, and within 5 feet south of, the location of the faces of the proposed walls. Geophone spacing was 6.6 ft and the source was hammer and plate. The five-foot offset was due to a change in design wall type after the seismic data had been procured. Based on topography and bedrock outcrops at the site, our Office (Office of Geotechnical Design North - OGDN) believes the difference between the data obtained and the data likely to be procured from a new line located five feet to the north along the new wall face location would be insignificant. Data acquired from additional seismic lines tested nearby as part of the investigation for a nearby road cut proposed for this project was also utilized in making comparisons between rock quality and seismic velocities.

Reconnaissance of the immediate site and the nearby environment was performed at the beginning of the site investigation primarily to examine the bedrock exposure. Prior to this reconnaissance the immediate site was brushed by a Cal Fire work crew. Drilling was not performed due to the ample amount of bedrock exposure and the environmental and access issues within the high-water area of the creek.

Several geological reconnoiters were performed, observing ground alongside and in Sawpit Gulch Creek from about 250 ft above the existing culvert to about 40 ft below the culvert at the confluence of Sawpit Gulch waters and Willow Creek. Similar geological reconnoitering was performed on Willow Creek within 250 ft above and below the confluence. Similar rock exposed in a sizeable road cut on the north side of the existing roadway was also examined. Refraction seismic data was acquired on this outcrop, thereby allowing direct correlations in velocities to rock quality that could confidently be extrapolated to the bedrock beneath the planned walls in the vicinity of the Sawpit Gulch refraction line.

Shallow excavations of up to 3.5 ft were performed by hand using a digging bar and a shovel in the alluvial deposits overlying the bedrock in areas beneath where the structures are planned, in order to determine the general nature of these deposits.

Soil samples were collected from the alluvial materials in the vicinity of the planned western MSE wall and in the thalweg of Sawpit Gulch in the location planned for the box culvert extension. Water samples were collected from Sawpit Gulch in the area of the planned culvert extension.

Rock hardness was sampled extensively with a rock hammer in the field on rock outcrops in the area of the confluence, as well as on rock exposed in the outcrop along the north side of the roadway.

Laboratory Testing Program

Corrosion testing was performed on soil and water samples taken from the areas beneath the planned structures. Corrosion testing first involves pH and resistivity measurements, which are then followed by Chlorite and Sulfate measurements if the pH should fall below 5.5 and the resistivity measurements fall below 1000 ohm-cm.

No laboratory testing was performed on the strength of the bedrock in the area. Reconnaissance of outcrops included percussive (rock hammer) examination of the hardness of the rock and some generalized quantification of strength. Seismic velocities obtained from the seismic refraction data provided in-situ quantification of rock hardness and competence.

Site Geology and Subsurface Conditions

The geology of the Capstone Project area, including the Sawpit Gulch site, is shown in Plate 3. The site of the planned Sawpit Gulch structures is located entirely within rocks of the Devonian (about 419 to 359 million years ago) Balaklala Rhyolite (Db), which is composed of non-porphyritic quartz keratophyre and quartz keratophyre with quartz phenocrysts. The Balaklala Rhyolite at the structures site is surrounded primarily by rocks of the lower portion of the Mississippian-Carboniferous (359 to 318 million years ago) Bragdon Formation (Mbl), which, in this area, consists mostly of shale, mudstone, and siltstone, with subordinate tuff and conglomerate. The Balaklala Rhyolite at the structures site is also in contact with rocks of the Devonian Copley Greenstone (Dc) about 500 ft from the site of the planned structures.

The bedrock surface (Balaklala Rhyolite) beneath the face of the two MSE walls, the foundation of the Type 1 wall, and the outlet of the box culvert extension is delineated by the seismic refraction data as shown in Plate 4 (profile B). This bedrock has a seismic velocity of about 14,000 ft per second (fps), while the bedrock outcrop north (also Balaklala Rhyolite) of the existing roadway has a velocity of about 10,000 fps. The outcrop above the road is composed of hard competent rock. Comparison of the two seismic velocities indicates that the bedrock beneath the culvert extension and wall structures is at least of equal competence, though likely to be of even greater competence, as a founding material. The International Society of Rock Mechanics (ISRM) (1981) gives this a rock strength of R4, which means strong rock. According to the Caterpillar Handbook of Ripping (1983; 2000), this bedrock is considered unrippable based on its seismic velocity, even by a D11 caterpillar with either a single or multiple shank ripper.

The overburden material is shown in Plate 4 (Profile B) as the difference between the topography profile and the bedrock profile. Overburden material in the area of the box culvert extension is only about two feet thick. It consists of cobbles and boulders with sands. Overlying the bedrock beneath the footprint areas of the MSE walls, the Type 1 wall, and their backfill areas is alluvial material consisting of sands with gravel and cobbles (SW-GW) overlying a cobble deposit with sand and gravel. A layer of gravel and cobbles with sands similar in composition to that found in the existing thalweg, lies along the contact between this alluvial material and the bedrock, with a thickness of about 2 ft in the vicinity of the thalweg, likely thinning out within about 40 ft to the west and about 60 ft to the east. The overburden material in the area of the eastern MSE wall is generally about 6 ft thick along this profile until the topography begins rising, where it then thickens up to about 8 ft. This material contains some boulders, some deposited by the creek and others placed possibly by construction forces long ago as slope protection beneath the roadway.

Some of these boulders protrude above the overburden material; others sit on top of it. The overburden alluvial material is predominantly cohesionless and medium dense.

Geomorphic observations of local banks and erosion features indicate that surface water (Willow Creek and Sawpit Gulch waters) during a typical year will likely reach an elevation no higher than 1538.8 ft above sea level (see Plate 3) in the immediate vicinity of the box culvert extension outlet. These geomorphic observations also indicate that the 100-year flood level likely sits at about 1541 ft, while the 500-year flood level, though harder to infer due to the imprint of construction over 90 years ago on the site, sits somewhere around 1544 ft. Hydraulic calculations provided by District 2 Office of Design that were based on basin characteristics place the 100-year flood level at 1542 ft.

Assuming a moderately high hydraulic conductivity for the overburden material (non-cohesive, granular, sand and cobbles and gravel), it is estimated that ground water levels will equilibrate with elevations roughly equal to that of the nearby creeks in the vicinity of the planned structures when flow levels are sustained for a few days or more.

Based on previous culvert construction experience in other creeks tributary to Willow Creek in the area, it is possible that ground water may seep from bedrock fractures in or near the thalweg during construction when this portion of the site is excavated down to bedrock.

Due to the level topography and the competent bedrock the area of the planned structures is not likely to be susceptible to landslide hazards from below or above, and the competent bedrock geology indicates confident global stability in the nearby slopes that border the eastern and western ends of the MSE walls.

Faulting and Seismicity

Based on Caltrans Methodology for Developing Design Response Spectrum for Use in Seismic Design Recommendations (November 2012) and the subsurface condition discussed above, an average shear wave velocity (V_{S30}) of about 2500 ft per second was considered applicable for the upper 100 ft of the rock/soil at the project site.

Based on Caltrans ARS Online (2.2.06), an acceleration response spectrum taken by combining the probabilistic acceleration response spectrum developed from the USGS 2008 Interactive Deaggregation (Beta) model and the statewide minimum deterministic spectrum controls at the site. The active faults potentially having seismic impact on the project site are the Cascadia Subduction Zone (Fault ID 5), Keswick fault (Fault ID 35) and Big Lagoon – Bald Mountain Fault (Fault ID 9). With the above considered V_{S30}, Peak Ground acceleration (PGA) of 0.21 g is estimated to be applicable at the site.

Potential for liquefaction is considered minimal at the site due to rock. No known fault is projected towards or passing directly through the project site. Therefore, potential for surface rupture due to fault movement is null.

Corrosion and Abrasion Evaluation

Laboratory results indicate that the environment both upstream and in the vicinity of the proposed culvert is non-corrosive. Table 1 below presents corrosion test results performed for the Sawpit Gulch structures, as well as tests performed previously at nearby culverts, and tests from other tributaries further up Willow Creek whose waters primarily traverse the same type of rocks of the Bragdon Formation (Mbl) as those of Sawpit Gulch.

Table 1 Corrosion Test Results

Sample #	Sample Type	Location	pH	Resistivity (Ohm-Cm)
Samples Collected at Sawpit Gulch Site				
C824270	Soil	Soil on west side of Sawpit Gulch thalweg 10 ft downstream of existing culvert. In MSE wall and Type 1 wall location	6.27	10920
C824271	Soil	20 ft downstream of existing culvert, in stream bed	5.69	11058
C824272	Soil	Soil sample from east side of Sawpit Gulch thalweg in MSE wall location	7.18	11000
C824273	Water	Taken from mid stream at outlet of existing box culvert	7.66	3139
C824274	Water	Taken from mid-stream at outlet of existing box culvert	7.69	3488
Samples Collected at Twin Gulch				
C710498	Soil	Downstream of previous Trail Gulch culvert (prior to construction of existing culvert), PM 4.6	7.24	18200
C710499	Soil	Downstream of previous Trail Gulch culvert (prior to construction of existing culvert), PM 4.6	6.7	14188
MatLab-1	Soil	Trail Gulch Culvert PM 4.4	7.2	5927
Sample Collected on Tributary of Willow Creek Between Twin & Sawpit				
MatLab-3	Soil	Culvert East of Trail Gulch PM4.99	6.4	7988

The existing box culvert exhibits minor abrasion damage, with no more than about 1 inch of concrete appearing to have been removed locally in the most abraded locations and no rebar having been exposed.

Scour Evaluation

The following scour discussions are based on observations of the existing creek banks and deposits and the existing box culvert inlets and outlets, which have been in place for over 90 years. Marginal scour was observed at the inlet and none was observed at the outlet. Given that the flow gradient of the culvert extension is flatter (2.5% versus 3.4%) than that of the existing culvert, it would be reasonable to expect at least similarly scour potential to occur at the outlet of the culvert extension. However, the new location of the outlet may be more impacted, essentially ‘sideswiped’, by the waters of Willow Creek, particularly during moderately high and high waters. Because both the Type 1 wall and the culvert extension cut-off wall are founded in (2 inches into) bedrock, foundation instability due to scour is considered insignificant.

Although the RSP Revetment is not required in front of the Type 1 wall to prevent scour-induced structural instability, our Office recommends it in order to:

1) Provide continuity to the channel sides, allowing a more evenly flowing channel boundary.
2) Provide extra protection to the concrete wall toe.
3) Provide increased resistance to sliding.
4) Provide worthwhile yet economical protection, since it is a pay item that is already being installed nearby.

Global Stability Analysis

A global stability analysis was performed using Slope/W, a commercialized software published by Geo-Slope International Ltd. and the limit equilibrium methods developed by Bishop (1955), Janbu (1954) and Spencer (1967). Two dimensional models were developed based on the proposed wall dimensions and the subsurface conditions discussed above. The analysis studied a static load condition consisting of a uniform surcharge of 240 psf and a seismic loading condition consisting of a horizontal acceleration equal to one third of the above estimated PGA (0.21 g).

Based on the analysis, the proposed walls satisfy the minimum factors of safety required for global stability.

Foundation Recommendations

<u>Material Parameters</u>

We understand that the proposed Type 1 wall and the MSE walls will be designed and built in accordance with Caltrans 2010 Standard Plan B3-1 and Bridge Standard Detail Sheets XS 13-020-1 to XS 12-020-6. Based on the subsurface condition and analysis discussed above, it is our opinion that the soil parameters specified in the plan and the sheets are available at the site and the walls can be designed with the specified soil parameters.

Bearing Resistance and Conditions

We understand that a bearing capacity demand of 4 ksf is expected for the proposed walls. Based on the rock outcrop observations, the compressive wave velocities in the rock obtained from seismic refraction sounding, and utilizing AASHTO's recommendations (AASHTO LRFD Bridge Design Specifications, 4th Edition, 2007, Table C10.6.2.6.1-1), we judge that the required bearing capacity of 4 ksf is available at the site. Higher bearing capacity may also be available from the rock depending upon the demand and location.

We recommend that foundation be excavated down to bedrock, with a minimum 2-inch embedment, for both the culvert extension and the Type 1 wall. A minimum 2-inch key-in area in the bedrock is recommended for the culvert extension cut-off wall. Bottom and sides of foundation excavation should be made relative flat and smooth. We recommend backfilling the area between the bedrock and the bottom of the culvert structure with Class 3 permeable material.

Settlements

Based on the characteristic of the rock mass and the estimated rock strength, settlement of the standard Type 1 wall footing, which is to be directly founded on the rock, is estimated to be less than 0.5 inch. A majority of the eastern MSE wall will also be founded directly on rock. In some localized areas, the MSE wall will be founded on a minor (less than 2 ft) of the insitu medium dense soils as well as the standard structure backfill. As such, settlement of the eastern MSE wall is estimated to be on the order of 0.5 inch. The western MSE wall will be founded on the in-situ medium desne soils that are underlain by rock, and the maximum thickness of the insitu soils is about 8 ft. As such, settlement of the western MSE wall is estimated to be on the order of 1 inch.

Differential settlements of the Type 1 wall, the eastern MSE wall and the western MSE wall are estimated to be less than 0.5 inch, less than 0.5 inch, and less than 0.75 inch, respectively. Differential settlements between Type 1 wall and the eastern MSE wall and between Type 1 wall and western MSE wall are estimated to be less than 0.5 inch and 1 inch, respectively.

The estimated settlement is expected to be primarily elastic, which should take place during and immediately after construction. Therefore, no waiting period is recommended.

The settlement estimations are based on the above discussed subsurface condition. Actual subsurface conditions encountered during construction may be different from what is discussed herein. All foundation excavation and the actual subsurface condition encountered should be evaluated by the Engineering Geologist/Engineer.

RSP Revetments

Due primarily to scour concerns beneath the MSE walls as explained under **Scour Evaluation**, OGDN recommends the construction of an RSP revetment made from ¼-ton and 1-ton RSP as shown in Plate 5-A, -B, and -C, with drawing A, B, and C representing the Western MSE Wall, the Eastern MSE Wall, and the Type 1 Wall, respectively. The 1-ton and ¼-ton RSP must be founded directly on bedrock. The 1-ton RSP may be placed in a single line and the ¼-ton RSP should be placed in the dimensions shown. The ¼-ton RSP portion of the revetment shall have a maximum steepness of 1.5:1 (H:V) for the front exposed (to the creek) slope, a maximum steepness of 0.75:1 for the rear enclosed (beneath the MSE Wall reinforced area) slope, and a level platform at least 4 ft wide across the top with the leveling pad centered in the middle. Included in the front edge of this mass is a single line of 1-ton RSP as shown in Plate 5-A. Class 8 RSP fabric shall be placed across the RSP backslope to prevent migration of finer materials from beneath the MSE wall. The fabric shall lap horizontally atop the subgrade material for a minimum of 3 ft. and completely cover the backslope of the ¼-ton RSP as shown.

For the western MSE wall, the completed revetment may be buried by native soils as shown in Plate 5-A. For the eastern MSE wall, the revetment should be buried by additional ¼-ton RSP backfill as shown in Plate 5-B. For the Type 1 wall the RSP revetment should be constructed over the toe of the wall as shown in Plate 5-C.

Drainages

We recommend installation of two separate 2-foot high by 3-foot wide permeable material drainage blankets (each with an internal 4-inch perforated plastic pipe) that discharge through weep holes on the walls of the culvert extension. One blanket shall be continuously running through the Eastern MSE Wall into the eastern Type 1 wall face and connected to a weep hole in the culvert wall. The other blanket shall run behind the entire length of the Western MSE Wall into and through the space behind the face of the Type 1 Wall and then into the weep hole on the side of culvert. The blankets shall consist of Class 3 permeable material wrapped in Class 8 RSP fabric with a minimum 3-foot overwrap.

Construction Considerations

Based on previous culvert construction experience in other creeks tributary to Willow Creek in the area, there is a chance that ground water may seep from bedrock fractures in or near the thalweg during construction when this portion of the site is excavated down to bedrock.

Standard structural backfill (Caltrans Standard Specifications 2010, 19-3 Structure Excavation and Backfill) shall suffice for all four structures. Material excavated nearby (between stations 261+00 to 263+00 and between 265+40 and 266+00) as part of the Capstone Project may be used as backfill provided that rocks are crushed sufficiently to meet the specifications.

Should geotechnical problems be encountered during construction, the Office of Geotechnical Design North (OGDN) should be contacted.

If you have any questions or comments, please call (530) 225-3516.

J. SCOTT LEWIS, P.G., C.E.G., R.G.P.
Associate Engineering Geologist
Office of Geotechnical Design - North

Or call Mr. Thomas Song at (916) 227-1057.

THOMAS SONG, P.E.
Transportation Engineer Range D
Office of Geotechnical Design-North

ec: Al Trujillo
Chris Harvey (Project Manager)
Charlie Narwold
Reza Mahallati-OGDN File
Geotech (Archive Geodogg)
R.E. Pending File (Mike Feakes- Project Engineer)
District 2 O.E. (Deena Matagulay)
Byron Berger, D02 Materials Lab

Attachments

Plate 1. Aerial Photo of Capstone Project Area with Location of Sawpit Gulch & Other Areas.
Plate 2. Layout of Box Culvert Extension, MSE Walls, & Type 1 Wall
Plate 3. Topography, Wall, Bedrock, and Foundation Profiles
Plate 4. Geological Map of Capstone Project Area
Plate 5. Profiles of Foundation Footing RSP Revetments

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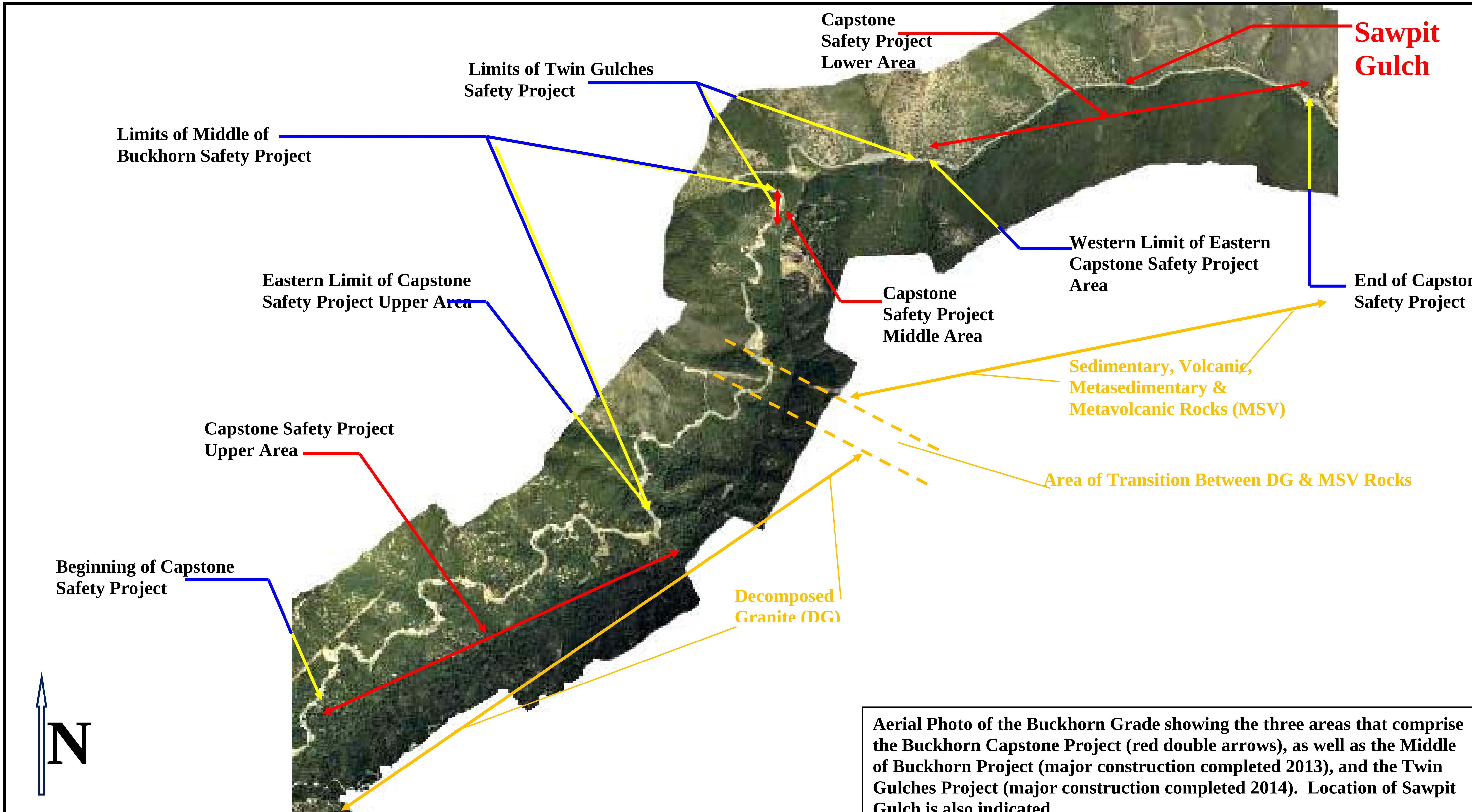
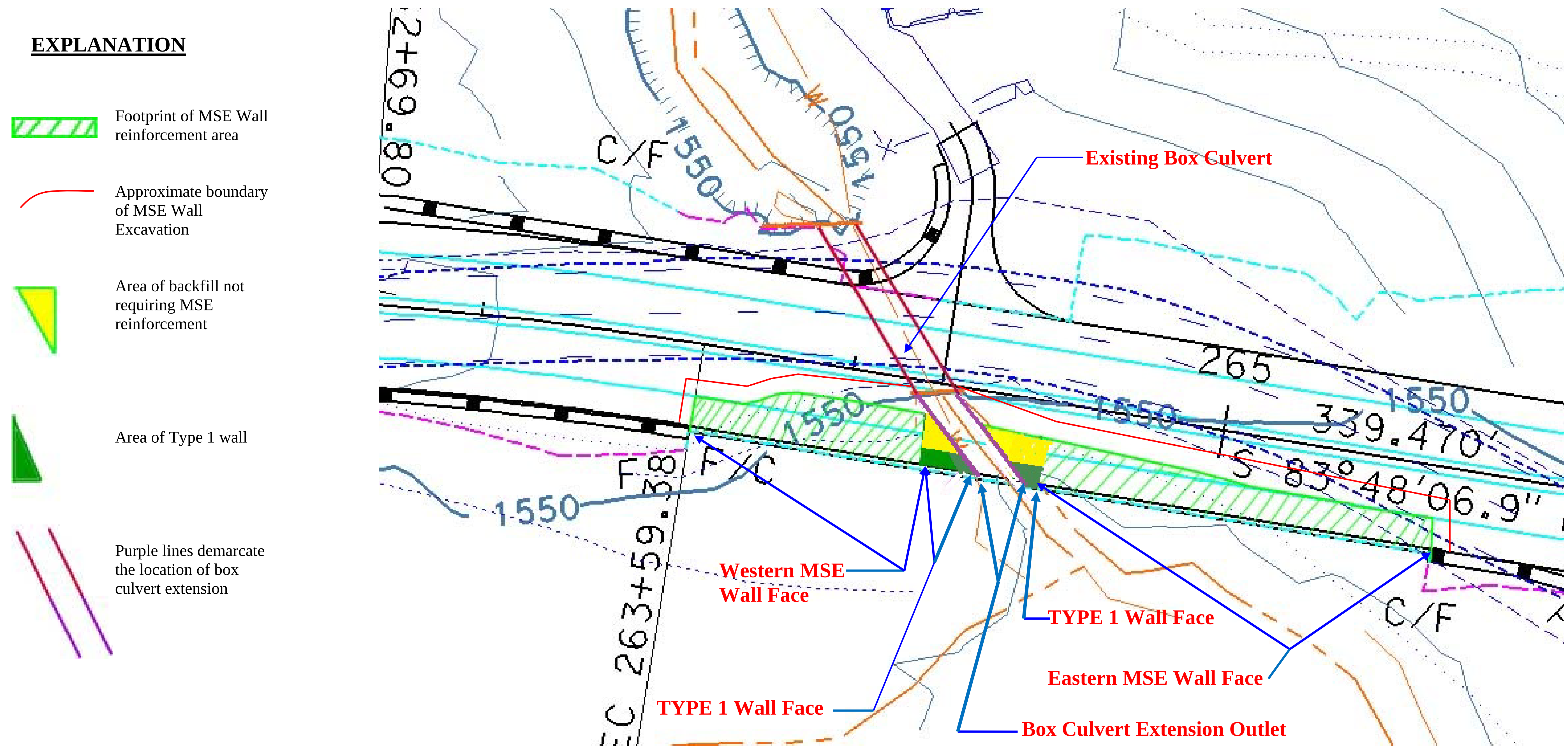
U.S. Dept. of Navy, 1982, Soil Mechanics Design Manual 7.1, U.S. govt. Printing Office, Washington D.C., 348 p.



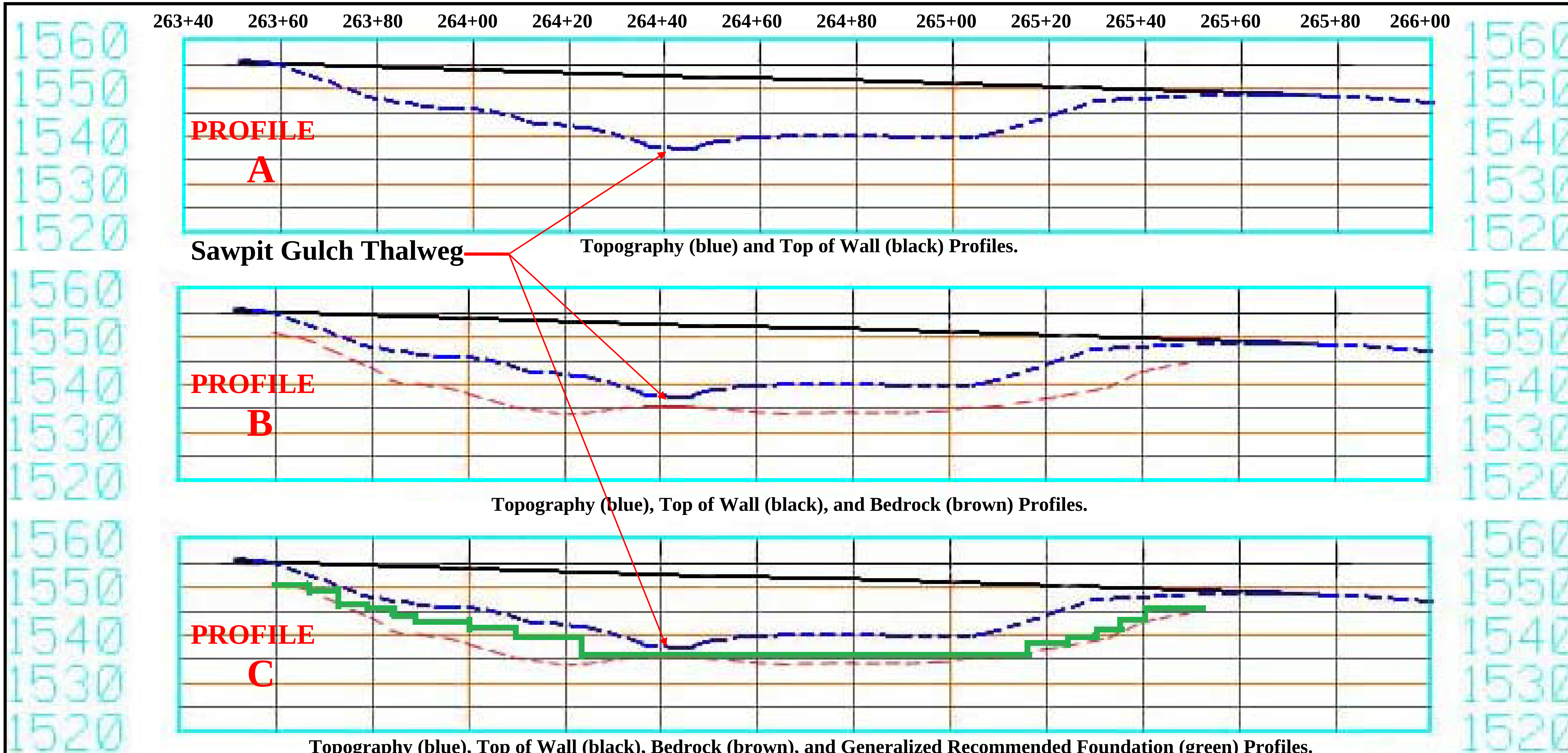
Aerial Photo of the Buckhorn Grade showing the three areas that comprise the Buckhorn Capstone Project (red double arrows), as well as the Middle of Buckhorn Project (major construction completed 2013), and the Twin Gulches Project (major construction completed 2014). Location of Sawpit Gulch is also indicated.

Caltrans	CALTRANS Division of Engineering Services Geotechnical Services Office of Geotechnical Design-North	EA: 02-3E4100 Date: NOVEMBER 2013	AERIAL PHOTO of CAPSTONE PROJECT AREA with LOCATION of SAWPIT GULCH & OTHER AREAS
		02-SHA-299 PM 0.3/7.1 FOUNDATION REPORT	Plate No.1



PLAN VIEW LAYOUT OF BOX CULVERT EXTENSION AND MSE WALL FOOTPRINT. Existing box culvert is shown by red lines. Box culvert extension is shown with purple lines. Footprint of MSE Wall is shown by light-green hachured area, assuming a reinforcement length of 0.75 times wall height. Dark green area is the two faces of a singular Type 1 wall with a single footing continuous beneath the culvert. Yellow area is where no reinforcement is required, only backfill. The green hachured area, the area of the culvert extension, the dark green area and the yellow area represent the ground area that must be excavated at least down to the foundation depth for each particular wall.

CALTRANS Division of Engineering Services Geotechnical Services Office of Geotechnical Design-North	EA: 02-3E4100 Date: NOVEMBER 2013	**LAYOUT of BOX CULVERT EXTENSION, MSE WALLS, & TYPE 1 WALL**	
	02-SHA-299 PM 0.3/7.1 FOUNDATION REPORT		Plate No. 2



Topography (blue) and Top of Wall (black) Profiles.

Topography (blue), Top of Wall (black), and Bedrock (brown) Profiles.

Topography (blue), Top of Wall (black), Bedrock (brown), and Generalized Recommended Foundation (green) Profiles.

TOPOGRAPHY, TOP OF WALL, BEDROCK, & FOUNDATION PROFILES. Topography is shown in blue, top of wall is shown in black, approximate bedrock location is shown in brown, and general location of bottom of wall foundations is shown in green. All elevations are in feet. Three-digit numbers across the top of highest profile represent approximate project stationing.

Caltrans	CALTRANS Division of Engineering Services Geotechnical Services Office of Geotechnical Design-North	EA: 02-3E4100 Date: November 2013	TOPOGRAPHY, WALL, BEDROCK, & FOUNDATION PROFILES
		02-SHA-299 PM 0.3/7.1 FOUNDATION REPORT	Plate No. 3

EXPLANATION
Geologic Units

Jurassic - Cretaceous

bhgd | bqd

Shasta Bally batholith.
bhgd *biotite hornblende granodiorite & quartz diorite*
bqd *coarse biotite granodiorite & quartz diorite*

gn

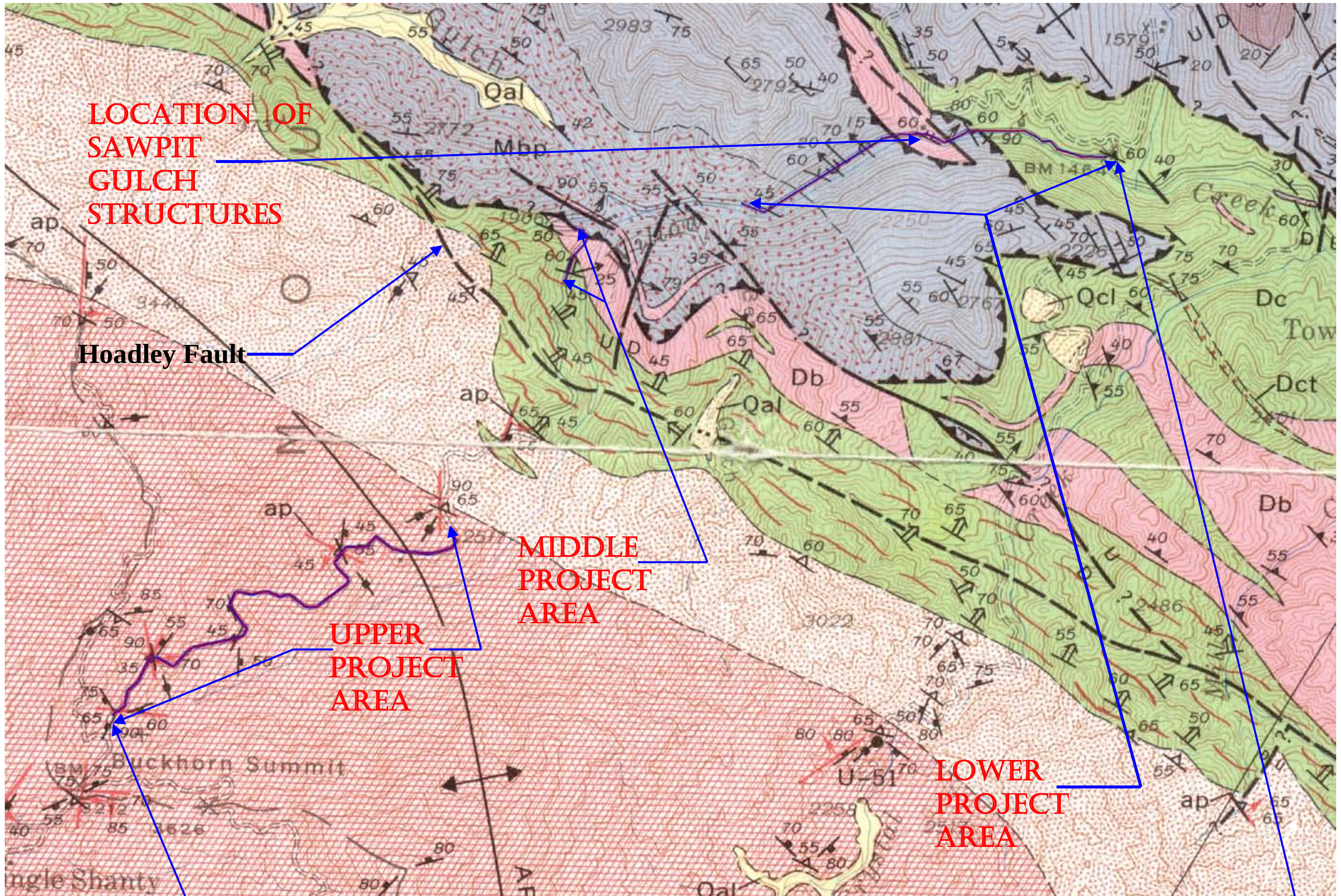
Gneiss and amphibolite derived from Copley, Balaklala and Bragdon Formations.

Mississippian-Carboniferous

Mbp | Mbu | Mbl | Mbc

Bragdon Formation.
Mbp. Phyllite created by contact metamorphism of Bragdon Formation with Shasta Bally Batholith.

Mbl. Consisting mostly of shale, mudstone, and siltstone, with subordinate tuff and conglomerate.



Western Project Limit (Postmile 0.3)   Eastern Project Limit (Postmile 7.1)

Devonian

Db — **Balaklala Rhyolite.** Non-porphyritic quartz keratophyre and quartz keratophyre containing quartz phenocrysts

Dc / Dct — **Copley Greenstone.** **Dc** Keratophyre, spilite, & metaandesite **Dct** tuff, shaly tuff, & shale

From *Geologic Map and Section of the French Gulch Quadrangle, Shasta and Trinity Counties, California* in *Geology of the French Gulch Quadrangle, Shasta and Trinity Counties, California* by J.P. Albers, 1964.

APPROXIMATE SCALE
(MILES)
0 — 2 M

EXPLANATION
Structural Features

Contact, showing dip
Long dashed where approximately located; short dashed where indefinite; dotted where concealed

Plunge of fold axis

Fault, showing dip
Dashed where approximately located; queried where probable; dotted where concealed. U, upthrown side; D, downthrown side

Inclined — Vertical
Attitude of beds

Strike and dip of beds and plunge of lineation

Vertical fault

Inclined — Vertical
Attitude of schistosity

Spring Creek thrust
Mainly between Bragdon formation and underlying rocks, but in places between Copley greenstone and tuff of the Balaklala rhyolite. Sawteeth on upper plate. Queried where doubtful; dotted where concealed

Strike and dip of schistosity and plunge of lineation

Inclined — Vertical
Attitude of compositional layering in gneiss

Strike and dip of compositional layering in gneiss, and plunge of lineation

Inclined — Vertical
Attitude of primary flow banding in granitic rocks as shown by alined crystals or inclusions

Strike and dip of sheeting

Inclined — Vertical
Attitude of cleavage

Inclined — Vertical
Attitude of joints

N

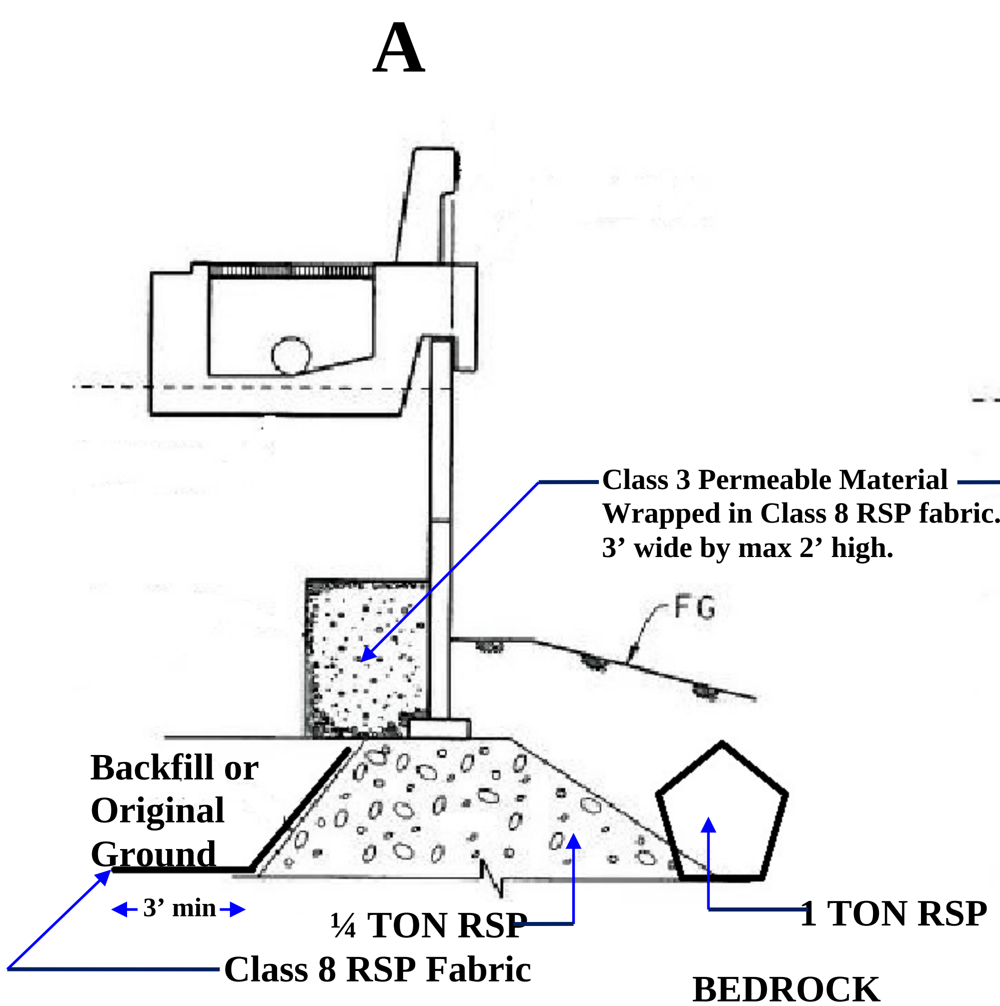
CALTRANS
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design-North

EA: 02-3E4100
Date: NOVEMBER 2013

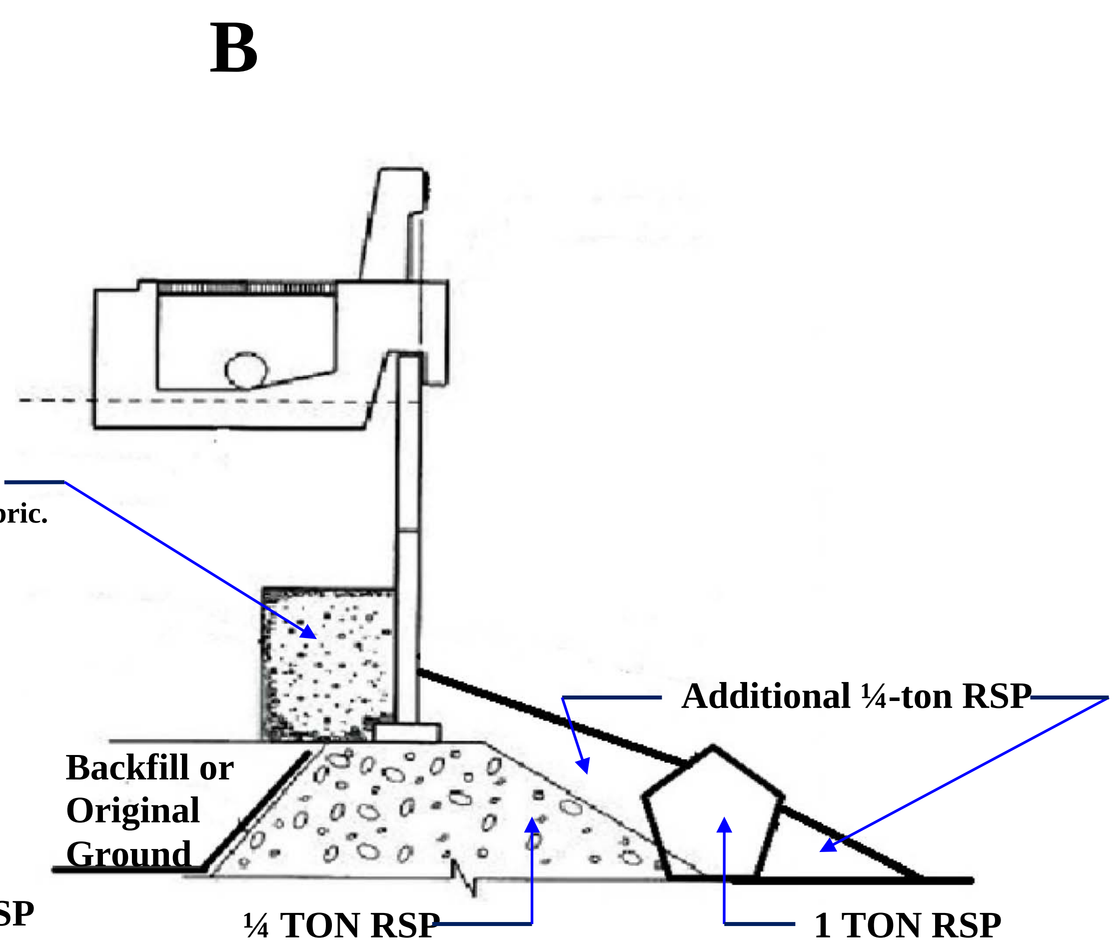
GEOLOGIC MAP OF CAPSTONE PROJECT AREA

02-SHA-299 PM 0.3/7.1
FOUNDATION REPORT

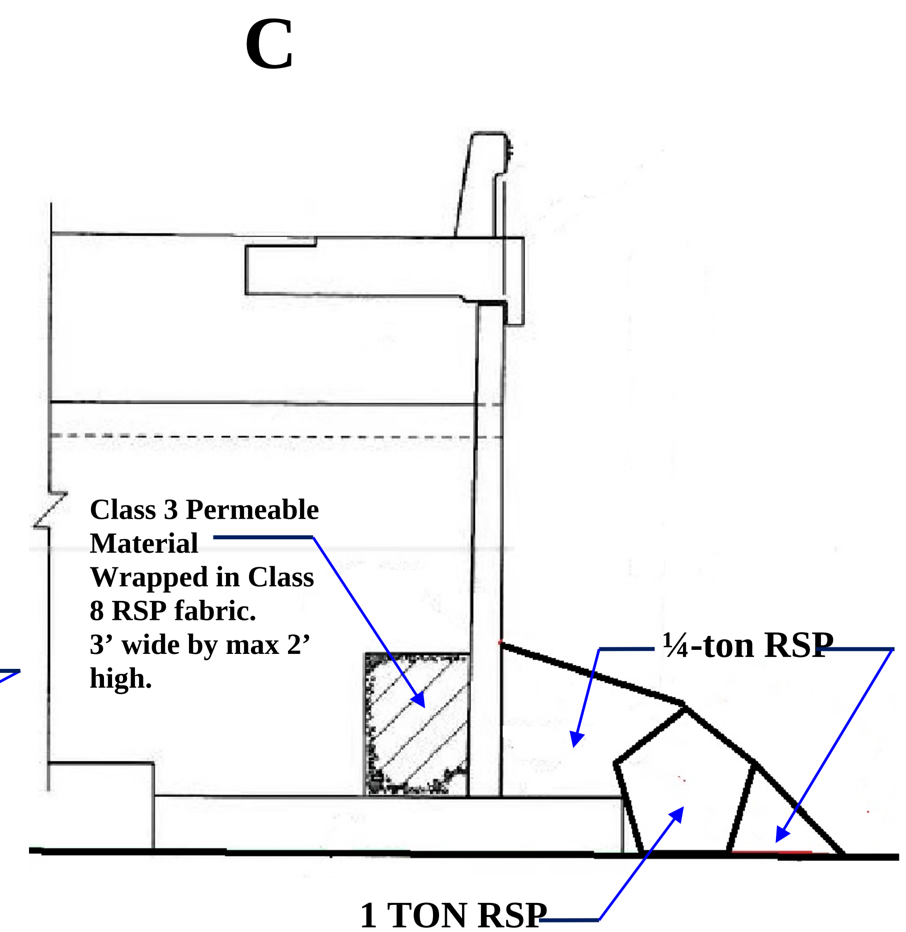
Plate No. 4



WESTERN MSE WALL



EASTERN MSE WALL



TYPE 1 WALL

TOPOGRAPHY, TOP OF WALL, BEDROCK, & FOUNDATION PROFILES. Topography is shown in blue, top of wall is shown in black, approximate bedrock location is shown in brown, and general location of bottom of wall foundations is shown in green. All elevations are in feet. Three-digit numbers across the top of highest profile represent project stationing.

Caltrans	CALTRANS Division of Engineering Services Geotechnical Services Office of Geotechnical Design-North	EA: 02-3E4100 Date: NOVEMBER 2013	**PROFILES of FOUNDATION FOOTING RSP REVETMENTS**
		02-SHA-299 PM 0.3/7.1 FOUNDATION REPORT	Plate No.5

02-3E4104
02-Sha-299-0.3/7.1
Project ID 0200020042

PERMITS

PLAC Condition Responsibility Summary

United States Army Corps of Engineers

WATER QUALITY

California Regional Water Quality Control Board

Central Valley Region (WDID No. 5A45CR00459)
Board Order No. 2012-0011-DWQ
NPDES Permit No. CAS 000003

AGREEMENTS

California Department of Fish and Wildlife

Notification No. 1600-2013-0349-R1

MATERIALS INFORMATION

Foundation Report for Sawpit Gulch

Addendum to Foundation Report for Sawpit Gulch

Final Hydraulic Report for Sawpit Gulch Culvert Extension

Geotechnical Design Report

Addenddum to Geotechnical Design Report

Potential Water Sources

State of California
Department of Transportation

California State Transportation Agency

M e m o r a n d u m

Flex your power!
Be energy efficient!

To: MR. GUDMUND SETBERG
Chief
Office of Bridge Design Branch 2
Division of Engineering Services

Attn: Mr. Grant Schuster

Date: January 21, 2014

File: 02-SHA-299-PM 0.3/7.1
0200020042
EA 02-3E410
Capstone Curve
Improvement Project
Sawpit Gulch Culvert
Extension & Wall

From: **DEPARTMENT OF TRANSPORTATION**
Division of Engineering Services
Geotechnical Services

Subject: Addendum to Foundation Report for Box Culvert Extension, MSE Wall, & Type 1 Wall System at Sawpit Gulch

This addendum to the initial (November 22, 2013) *Foundation Report for Box Culvert Extension, MSE Wall, and Type 1 Wall System at Sawpit Gulch* provides modified foundation recommendations for the proposed western MSE wall at the confluence of Sawpit Gulch and Willow Creek, which is part of the Capstone Realignment and Widening Safety Project located on State Highway 299 from PM 0.3 to PM 7.1 in Shasta County, California. The existing Sawpit Gulch box culvert is located at postmile 6.2 (about station 264+35 in the project stationing). The initial foundation report (FR) recommended a foundation design for the western MSE wall in which the bottom of the MSE wall and its leveling pad were situated atop ¼-ton RSP placed after the in-situ material was excavated down to bedrock. In response to comments from a headquarters review, this recommendation has been modified to the design shown in cross-section in Plate 1, in which the native soil is excavated only down to the base of the beginning of the MSE wall and its leveling pad. The material in front of the wall should be excavated down to bedrock, leaving a slope in front of the wall with a slope ratio of 1:1 (45°). This slope shall be covered with Class 10 RSP fabric that extends both beneath the leveling pad and out across the bedrock a minimum distance of 3 feet as shown in Plate 1. This shall be followed by Method B placement of ¼-ton RSP as shown in Plate 1, in order to provide scour protection. Lastly, in those areas where the pre-excavation original ground surface is higher than the top of this RSP, we recommend that the native material be restored atop the RSP as shown in Plate 1.

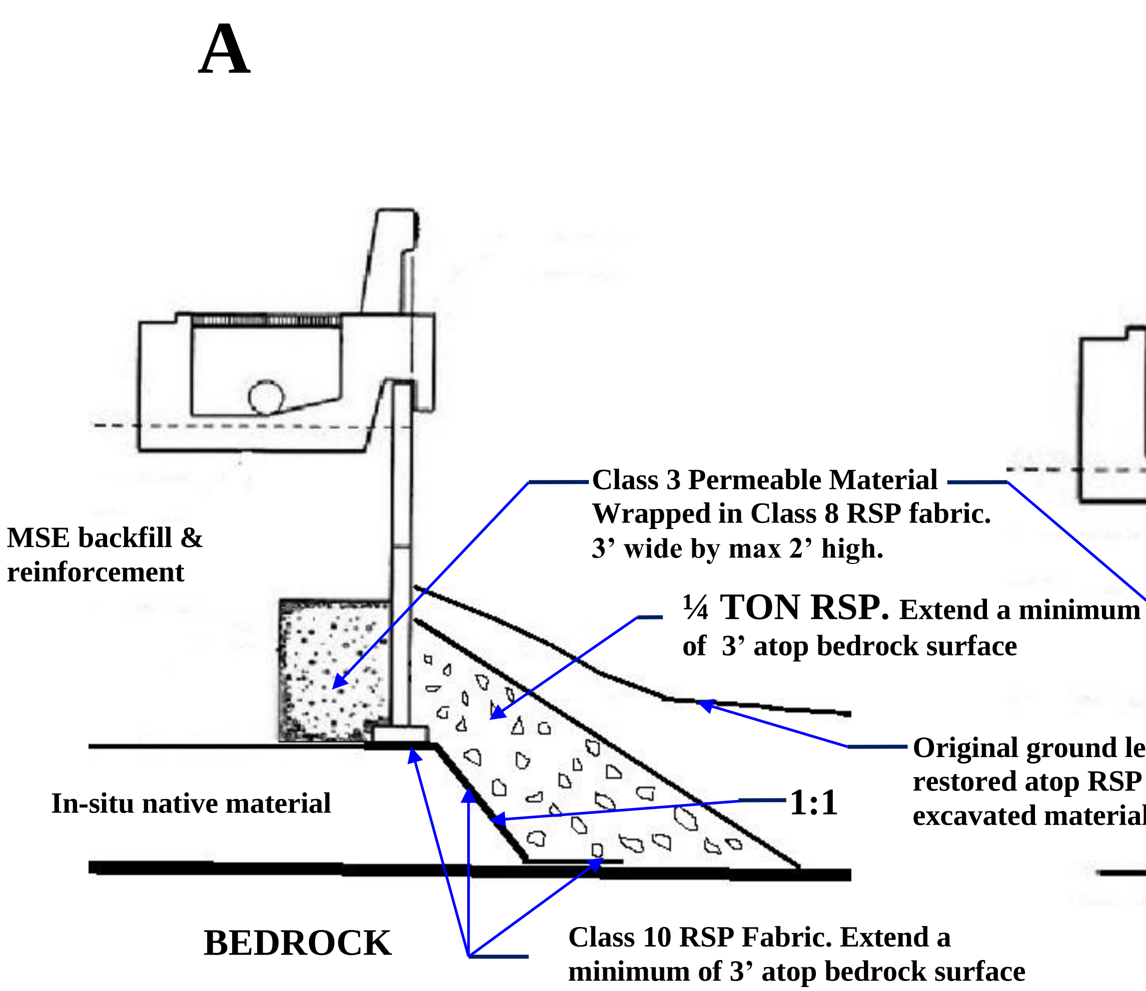
If you have any questions or comments regarding this addendum, please call Mr. Scott Lewis at (530) 225-3516.

J. SCOTT LEWIS, P.G., C.E.G., R.G.P.
Associate Engineering Geologist
Office of Geotechnical Design - North

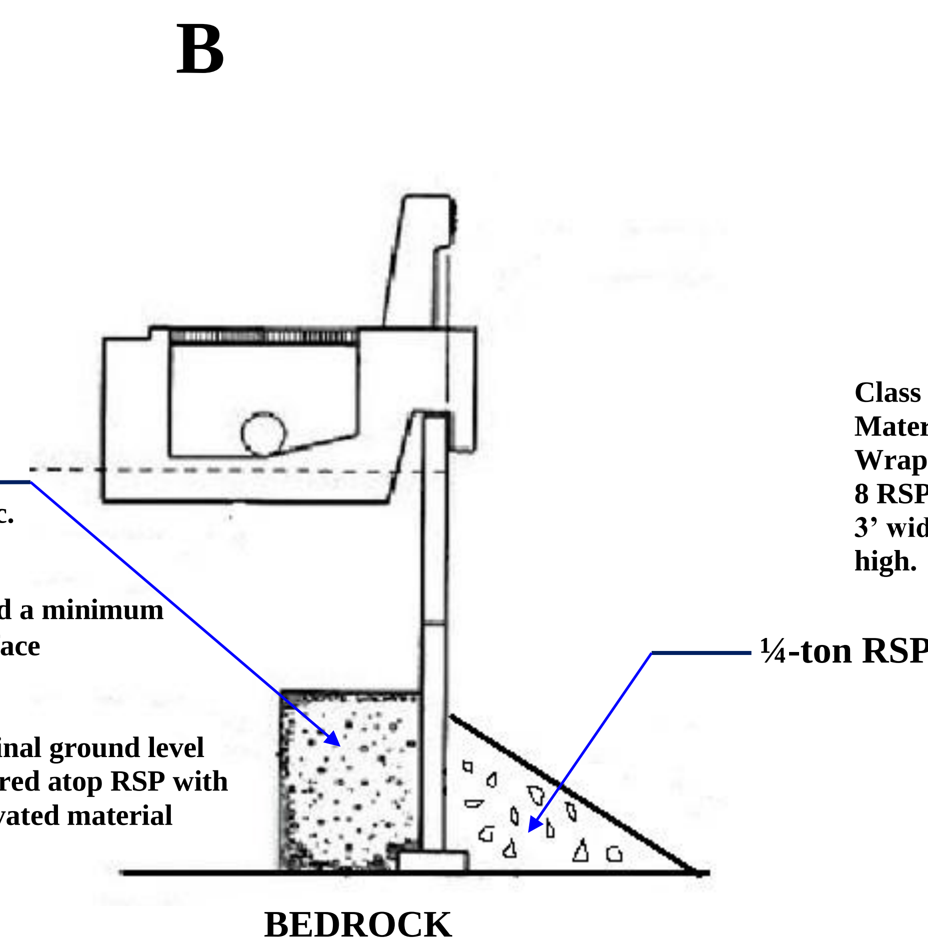
ec: Al Trujillo
Chris Harvey (Project Manager)
Reza Mahallati-OGDN File
Geotech (Archive Geodogg)
R.E. Pending File (Mike Feakes- Project Engineer)
District 2 O.E. (Deena Matagulay)
Byron Berger, D02 Materials Lab

Attachments

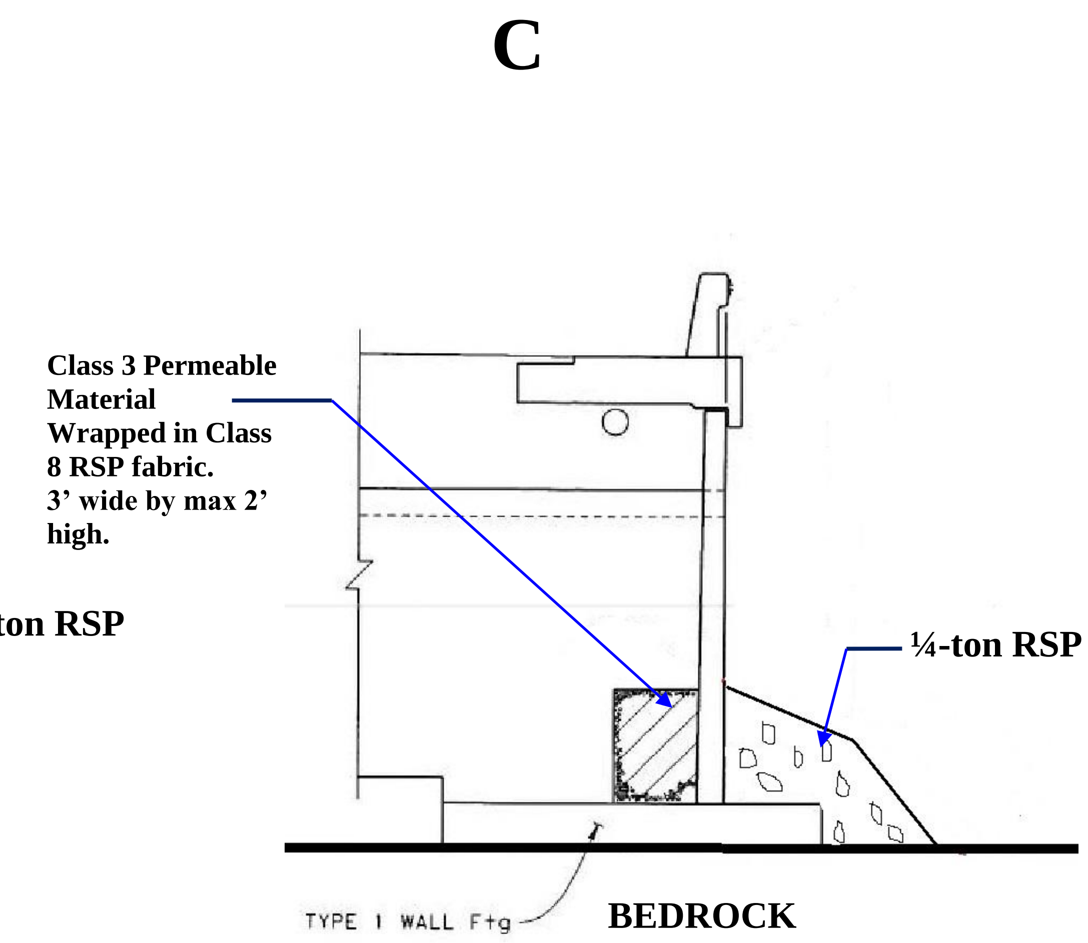
Plate 1. Profiles of Wall Foundations with RSP Revetments



WESTERN MSE WALL



EASTERN MSE WALL



TYPE 1 WALL

CROSS-SECTION FOUNDATION PROFILES. ¼ ton RSP revetments are placed in front of the toe of all walls for protection.

CALTRANS Division of Engineering Services Geotechnical Services Office of Geotechnical Design-North	EA: 02-3E4100 Date: JANUARY 2014	PROFILES of WALL FOUNDATION FOOTINGS with RSP REVETMENTS
	02-SHA-299 PM 0.3/7.1 FOUNDATION REPORT ADDENDUM	Plate No.1

02-3E4104
02-Sha-299-0.3/7.1
Project ID 0200020042

PERMITS

PLAC Condition Responsibility Summary

United States Army Corps of Engineers

WATER QUALITY

California Regional Water Quality Control Board

Central Valley Region (WDID No. 5A45CR00459)
Board Order No. 2012-0011-DWQ
NPDES Permit No. CAS 000003

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Notification No. 1600-2013-0349-R1

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Addenddum to Geotechnical Design Report

Potential Water Sources

State of California Department of Transportation
Division of Engineering Services
Office of Design & Technical Services

Structure Hydraulics

FINAL HYDRAULIC REPORT

Sawpit Gulch Culvert Extension

Located on State Route 299 in Shasta County

JOB:
Culvert Extension Project ID: 0200020042

LOCATION:
02-SHA-299-PM 6.3

PREPARED BY Ginger Lu, PE# 71324

Structure Hydraulics & Scour Mitigation
August 20, 2013

REVIEWED BY
Ronald McGaugh

This report has been prepared under my direction as the professional engineer in responsible charge of the work, in accordance with the provisions of the Professional Engineers Act of the State of California.

Hydrology/Hydraulics Report

General:

Structure Design proposes to add a 25' culvert extension to the existing Sawpit Gulch Culvert at Post Mile (PM) 6.3 for a roadway realignment project outside of Whiskeytown on State Route 299 in Shasta County (Figure 1). The outlet of the existing culvert on Sawpit Gulch is located roughly 30' away from the channel edge of Willow Creek and the proposed culvert extension will have its outlet right at the channel of Willow Creek.

Figure 1: Terrain Map

The existing culvert is a 10' wide and 10' rise Reinforce Concrete (RC) box with a skew of 34° to the existing roadway alignment. The existing culvert was assessed as good condition in the August 2012 inspection report. With the new roadway alignment, the existing culvert will need to be extended roughly 25' longer to span the new roadway. The total length of the culvert for the new alignment will be roughly 80'.

All the calculated values here are in **vertical datum NAVD 88**. This report makes reference to:

- Design sketch (NAVD 88) provided on 7/29/13 by Office of Structure Design, Branch 2
- Bridge Site Submittal (BSS, NAVD 1988) and survey information provided on 8/6/2013 by Office of Photogrammetry/ Primary Investigations
- Ken Hallis' culvert inspection/recommendation report on June 19, 2012.
- HDS #5, Hydraulic Design of Highway Culverts, 3rd edition (April, 2012), published by Federal Highway Administration, US Department of Transportation
- Flood Insurance Study (FIS) for Shasta County published by Federal Emergency Management Agency (FEMA, 3/17/2011)

Basin:

The Sawpit Gulch watershed is located on the north-eastern flank of the Whiskeytown National Recreation area in Shasta County. From the headwater at 4400' Elevation, Sawpit Gulch flows southeasterly and enters Willow Creek approximately at 1537' Elevation, roughly 30' downstream of the project site. This rural area is consisted of trees and brushes.

Using the Watershed Modeling System software (WMS version 9.1), this drainage area of Sawpit Gulch near the project site was mapped to be 3.28 square miles (mi^2) with average annual precipitation of 48.2 inches, and the channel bed slope was estimated to be 0.025 ft/ft.

Discharge:

No in-stream mining or logging activity is found on the record. Because the stream is a natural ungaged drainage basin located in a rural setting without significant storage basins upstream, National Streamflow Statistics Method (NSS) is used to approximate the 50-year and 100-year flood event, and the discharges in cubic feet per second (cfs) are tabulated in Table 1.

Table 1 Sawpit Gulch,
Drainage Area = 3.28 mi^2, Channel slope = 0.025 ft/ft

Flood Frequency	***50-year***	***100-year***
Flow Rate, cfs	1083	1305

Stage/Velocity:

Using a composite of the survey data with 10-meter DEM (NAVD 88), cross-sections of the channel are generated and exported into hydraulic analysis software - HEC-RAS (4.1.0). Due to the close proximity of the culvert position to Willow Creek (Figure 2), the upstream and downstream stretches of Willow Creek at the outlet of the proposed culvert extension were included with a section of Sawpit Gulch in the model for evaluating backwater effect. For the parameters used in HEC-RAS models, a roughness coefficient of 0.04 is assumed for the channel and a channel slope of 0.025 ft/ft as normal depth for the boundary condition.

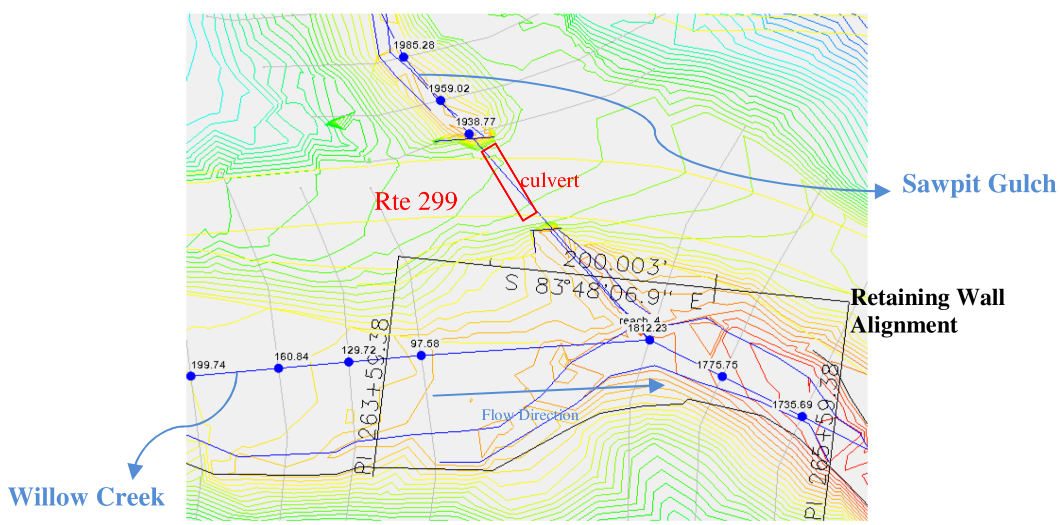

Figure 2: Schematic of River Junction

Culvert Analysis Program (HY-8, version 7.30), which utilizes different methodologies in analyzing culvert hydraulic, was also used to compare the hydraulic results at the culvert outlet. Without design GP with specified elevations, an outlet elevation of 1536.5' and a composite Manning's n of 0.02 for the entire 80' length of the culvert are assumed. The graphic illustrations of the existing and proposed conditions are shown in Figure 3 and Figure 4.

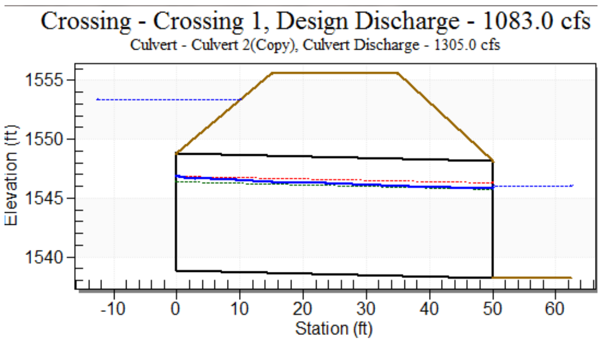

Figure 3: Existing Condition

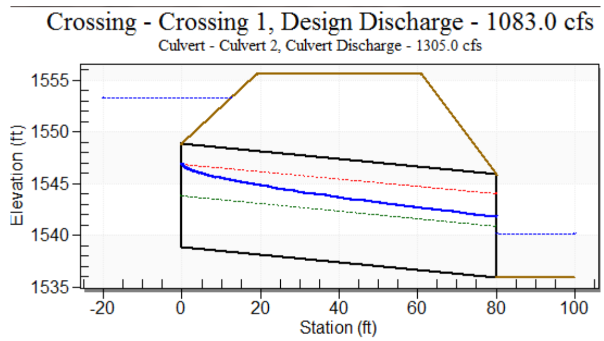

Figure 4: Proposed Condition

In Table 5, the listed hydraulic values under the inlet control are produced by the HY-8 model. In comparison between the existing and the proposed conditions, the culvert velocities increase but the tailwater surface elevations drop in the proposed condition. By elongating the culvert length, the hydraulic condition is slightly altered and the proposed condition is more susceptible to scour than the existing condition.

Table 5 HY-8 Culvert Hydraulic Results
(NAVD88) Channel slope = 0.025 ft/ft

	Q_{50} (1083 cfs)		Q_{100} (1305 cfs)	
	Existing	*Proposed*	*Existing*	*Proposed*
Culvert Length, ft	55	80	55	80
Tailwater Surface Elevation, ft	1545.8	1539.8	1546.0	1540.1
Tailwater Velocity, ft/s	11.1	10.0	11.6	10.5
Culvert Outlet Velocity, ft/s	16.3	18.8	17.0	19.7

Streambed/Drift:

In the August 2012 inspection, minor sediment accumulated in the culvert was noted. Judging from the photos and info given by Mr. Hallis (inspector), the bed materials appear to be consisted of sand, silt, gravel, cobbles and some big boulders and it didn't appear to have any degradation issue.

Summary & Recommendation:

- Fortunately, no back water effect is created by lengthening the existing culvert or from merging into Willow Creek. Due to the fast flow rate (19.7 ft/s), a 10' cutoff wall at the proposed culvert outlet and armoring the channel with 1-ton RSP rocks (D_{50}) or native boulders at the outlet plus approximately 10' long Willow Creek at the confluence are recommended to dissipate the energy. According to the inspector, large boulders (2-, 4- and 5- ton) were seen scattering in the channel of Willow Creek, so there may be enough supply of native rocks to armor the channel. During construction, please refer to Field Engineer for channel armoring recommendation.

- No grading plan is received at this point. When a grading plan is become available, please consult Structure Hydraulics for a better estimate of outflow conditions.

- In order to prevent water erosion downward from the top of the wall, a safety factor of 2' is added onto water surface elevation, which in this case yields Elevation 1542.1' at Station 264+35.00 on RW1 Line for the top of the MSE wall. The elevation at the top of the MSE walls along Willow Creek can be propagated by using a slope of 0.02 ft/ft (Vertical/Horizontal).

02-3E4104
02-Sha-299-0.3/7.1
Project ID 0200020042

PERMITS

PLAC Condition Responsibility Summary

United States Army Corps of Engineers

WATER QUALITY

California Regional Water Quality Control Board

Central Valley Region (WDID No. 5A45CR00459)
Board Order No. 2012-0011-DWQ
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California Department of Fish and Wildlife

Notification No. 1600-2013-0349-R1

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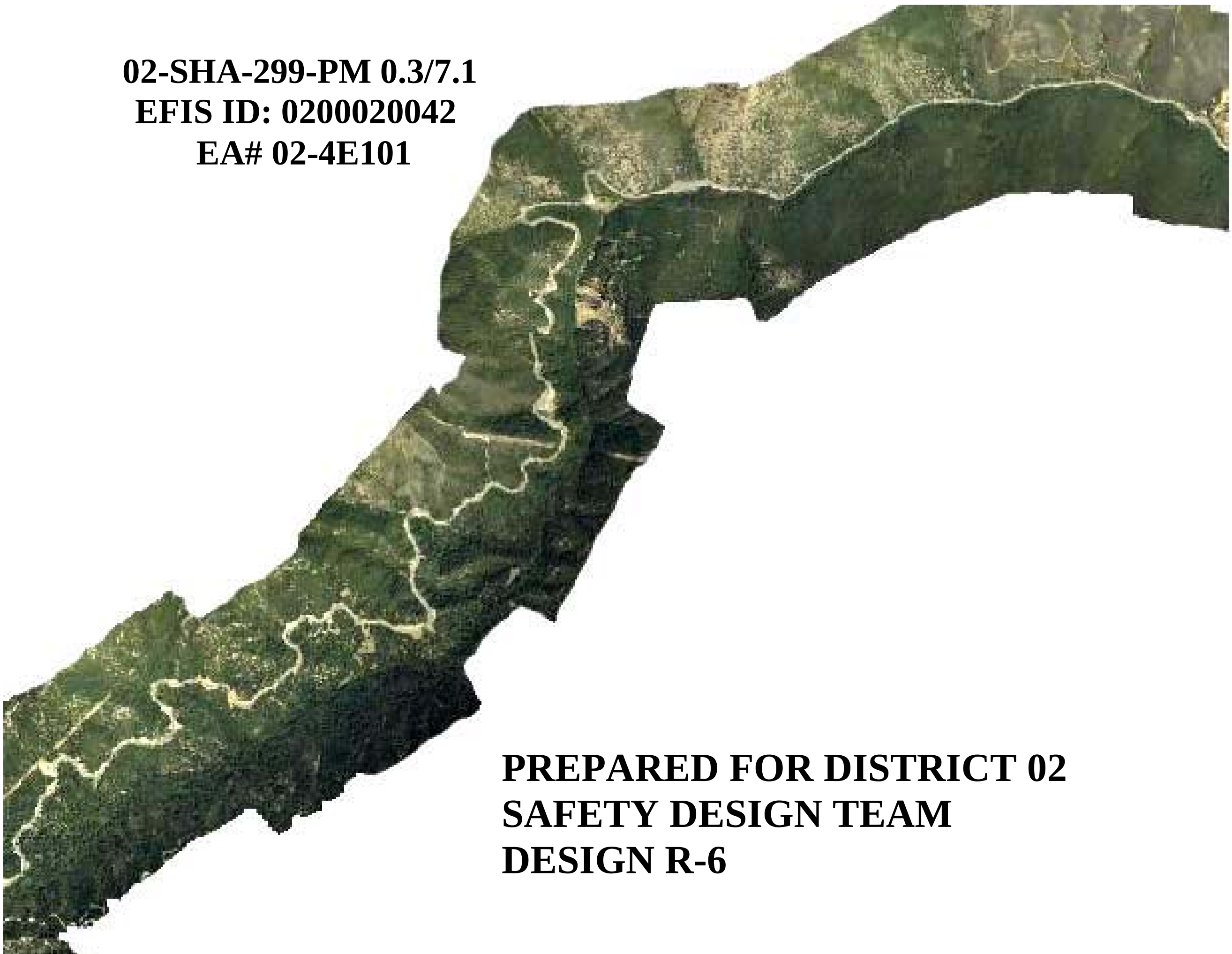
GEOTECHNICAL DESIGN REPORT

Capstone Curve Improvement Safety Project

State Highway 299

02-SHA-299-PM 0.3/7.1
EFIS ID: 0200020042
EA# 02-4E101



PREPARED FOR DISTRICT 02
SAFETY DESIGN TEAM
DESIGN R-6

By:

J. Scott Lewis
Certified Engineering Geologist-2257
Registered Geophysicist-1032

DIVISION of ENGINEERING SERVICES-GEOTECHNICAL SERVICES
OFFICE of GEOTECHNICAL DESIGN-NORTH

February 28, 2014

M e m o r a n d u m

Flex your power!
Be energy efficient!

To: **MR. AL TRUJILLO**
District 2 Safety Team Senior Engineer

Date: February 28, 2014

File: 02-SHA-299-PM 0.3/7.1
EFIS ID: 0200020042
EA 02-3E410
Capstone Safety Project

Attn: Mr. Mike Feakes
Transportation Engineer

From: **DEPARTMENT OF TRANSPORTATION**
Division of Engineering Services
Geotechnical Services

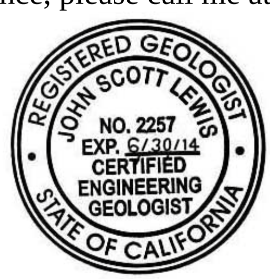
Subject: Geotechnical Design Report for Capstone (Buckhorn) Curve Improvement Safety Project

Per your request, we are providing a Geotechnical Design Report for the Capstone (Buckhorn) Curve Improvement Safety Project on State Highway 299 from PM 0.3 to PM 7.1 in Shasta County, California. This report defines the geotechnical conditions as evaluated from field and laboratory test data and used in the development of the geotechnical design. It provides recommendations and specifications for project design and construction.

Specific geotechnical aspects of this project that are addressed in this report include cut slopes, fill embankments, zoning of fills, select material, and rockfall mitigation. This project involves 3 structures that are addressed in a separate Foundation Report (FR), *Foundation Report for Box Culvert Extension, MSE Wall, & Type 1 Wall System at Sawpit Gulch* (Lewis & Song, 2013).

If you have any questions or require further assistance, please call me at (530) 225-3516.

J. SCOTT LEWIS, P.G., C.E.G., R.G.P.
Associate Engineering Geologist
Office of Geotechnical Design - North



ec: Al Trujillo – Senior Safety Design Team
Chris Harvey – Project Manager
Rezza Mahallati – OGDN File
Charlie Narwold – Senior OGDN Branch B
R.E. Pending File (Mike Feakes- Project Engineer)
Deena Matagulay – District 2 Office Engineer

Table of Contents

List of Tables

List of Plates
(Appendix A)

1. Introduction

This Geotechnical Design Report (GDR) is for the Capstone Realignment and Widening Safety Project on the Buckhorn Grade on State Highway 299 from PM 0.3 to 7.1 in Shasta County, California. Plate 1 presents a vicinity map showing the location of the project.

The Capstone Realignment and Widening Safety Project is the final of three large realignment projects on the Buckhorn Grade that have followed several completed smaller realignment projects on the Buckhorn Grade, all of which together cover the entire stretch of roadway between PM 0.0 and 7.25. The two other larger realignment projects include the Middle of Buckhorn Project (MOB; EA: 02-1E100_), which completed construction in the fall of 2013 as this report was being written, and the Twin Gulches Project (EA: 02-2E510_), which was half way through construction at writing time (Fall, 2013). The smaller projects include the Top of Buckhorn Project (TOB; EA: 02-39790_), the Yankee Gulch Project (EA: 02-2C580_), and the Bottom of Buckhorn Project (BOB; EA: 02-1C160_). Although the project limits for the Capstone Project extend from PM 0.3 to 7.1, the actual proposed improvements occur primarily within two stretches of highway: from PM 0.5 to 2.5 (referred to hereafter in this report as the 'Upper Project Area', due to its being higher in elevation and further up the Buckhorn Grade) and from PM 5.1 to 7.1 (referred to hereafter in this report as the 'Lower Project Area', due to its being lower in elevation and lower down on the Buckhorn Grade). A third area of proposed improvements involves the additional excavation of a cut slope between PM 4.3 to 4.5, a cut slope which is currently undergoing excavation at the time of this writing as part of the MOB project. This area is referred to hereafter in this report as the 'Middle Project Area', due to its being located between the Upper and Lower Project Areas. This GDR deals strictly with these three project areas.

Plate 2 presents an aerial view of the entire project site with the location of the MOB project, the Twin Gulches Project, and the three construction areas of the Capstone Project identified. Plate 3 presents an aerial view of the Upper Project Area with the general locations of fills and cut slopes identified. Plate 4 presents an aerial view of the Lower Project Area with the general locations of cut slopes identified.

2. Proposed Improvements and Existing Facilities

At the time of our investigation Highway 299 within the areas of proposed construction consisted primarily of a 2-lane roadway with a few pullouts, little to no shoulders, and two short winding passing lanes. Existing cut slope ratios are predominantly at 0.75:1, with a few having been rounded by sloughing and erosion to flatter ratios of about 1:1 in their upper reaches. Older existing cut slopes have a maximum height of over 110 feet (ft). Most older fill slopes stand at approximately 1.5:1 and have a maximum height of about 60 ft. Recently constructed cut slopes on the nearby MOB Project (included within the project postmile limits) are predominantly cut at 0.75:1 and have a maximum height of 150 ft. Fill slopes constructed on the MOB Project stand at 1.5:1 and have a maximum height of about 250 ft.

The proposed improvements generally utilize the route of the existing roadway location. Curves are smoothed by moving the proposed alignment atop large (up to 226 ft high) new fills and deeper into the existing cut slopes with cuts up to 160 ft high. These new fills and cuts are also used to create space for wider shoulders and longer and straighter passing lanes. While the existing design speed varies between 20 and 35 mph for the Upper Project Area and between 30 to 55 mph for the Lower Project Area, the improved curve radii of the new alignment raises the design speed for both project areas to a 35 to 55 mph range.

There are 21 main cuts proposed for this project, with a cut here being defined as any sizeable continuous stretch of cutting. A cut may also include a thru-cut as a single cut. Cuts are listed by station and number in Table 1. The first 12 cuts are located in the Upper Project Area, which is entirely in geologic material referred to within this GDR as decomposed granite (DG). Recommended cut slope ratios are 0.75:1 or 1:1 over 0.75:1 (dual slope ratio cut). Cuts 13, 14, and 15, which extend from about station 173+25 to 186+00, are in the Middle Project Area. These cuts involve further excavation on cuts constructed recently on the eastern end of the MOB Project. Recommended cut slope ratios for this Middle Project Area are either 0.75:1 or 1:1. The remaining 6 cuts (16 to 21) are located in the Lower Project Area in sedimentary, metasedimentary, metavolcanic, and volcanic rocks (sometimes referred to collectively in this report as SMV rocks for simplicity). Recommended cut slope ratios for this Lower Project Area vary from 0.75:1 to as steep as 0.3:1.

There are 7 large fills proposed for this project, all of which are located entirely within the Upper Project Area, which is also the area composed solely of DG. Only one fill (fill 8) is planned in the Lower Project Area, and it is substantially smaller than fills one through seven. There are no fills proposed in the Middle Project Area. All fills have been designed with a slope ratio of 1.5:1. All fills except fill 8 have an outer shell of select material (select material B) for protection against erosion, surficial sloughing, and shallow global instability. Fills are also listed in Table 1 by station and fill number.

In addition to these major cuts and fills, there are small incidental cuts and fills throughout the project, generally horizontal in nature, that are planned to lower (cut) or raise (fill) the present grade of the road, or to facilitate the merging of a fill with a cut. These shall be armored with select material A where erosion protection is deemed necessary.

Select materials A and B are obtained from specified locations within the material excavated in this project.

Only three structures are planned for this project: a box culvert extension, an MSE (Mechanically Stabilized Earth Wall) wall, and a Type 1 wall, all three integrally juxtaposed together at Sawpit Gulch in the Lower Project Area. The purpose of these structures is to allow both a widening and a straightening realignment of the road to the south where the existing topography drops down and into the banks and overflow deposits of Willow Creek. The realignment had originally planned to widen to the north by cutting north of the existing roadway, but the discovery of an archaeological site north of the roadway and immediately west of Sawpit Gulch pushed the realignment south into the confluence of Sawpit Gulch and Willow Creek, and introduced structures into the project. This extension and wall are late additions to the project, added as a result of archaeological finds on the north side of the highway, which was

Table 1. Cuts and Fills by Station and Number.

	CUTS							FILLS				
	BEGIN	END	CUT #	Max H (ft)	20' BENCH	Slope Ratio(s)		BEGIN	END	FILL #	Max Vert H (ft)	Max H (TtB) (ft)
UPPER	20+75	22+50	1	35		0.75:1						
								22+70	24+50	1	60	120
	24+60	26+50	2	50		0.75:1						
								26+75	32+75	2	155	226
	32+50	35+50	3	85		0.75:1						
	37+25	38+75	4	77		0.75:1						
	40+00	41+00	5	60		0.75:1						
	42+50	52+25	6	118		0.75:1 or 1:1 over 0.75:1		50+75	58+50	3	135	174
								61+25	63+50	4	70	123
	63+75	68+50	7	147	Y	0.75:1						
	69+50	78+25	8	115		0.75:1 or 1:1 over 0.75:1						
								78+70	84+40	5	132	209
	84+75	86+50	9	77		0.75:1						
								87+25	90+80	6	80	118
	90+60	93+50	10	85		0.75:1						
	93+50	96+50	11	80		0.75:1		94+00	97+15	7	25	115
	97+15	104+45	12	160	Y	0.75:1						
MIDDLE	173+25	176+00	13	112		0.75:1						
	176+75	179+25	14	90		0.75:1						
	180+00	186+00	15	125		1:1						
LOWER	224+00	249+00	16	105		0.75:1 or 0.75:1 over 0.5:1 or 0.75:1 over 0.5:1 over 0.3:1			All fills are designed with a 1.5:1 slope ratio. Cut Slopes in the Lower Project Area are designed with a triple slope ratio with a 0.75:1 slope at the top, a 0.5:1 slope ratio below that, and a 0.3:1 beneath that.			
	249+25	254+25	17	80		0.75:1 over 0.5:1						
	254+75	263+00	18	40		0.75:1 or 0.75:1 over 0.5:1						
	265+35	285+75	19	64		0.75:1 or 0.75:1 over 0.5:1 or 0.75:1 over 0.5:1 over 0.3:1						
	286+25	292+00	20	40		0.75:1 or 0.75:1 over 0.5:1						
	293+00	298+50	21	85	Y*			297+00	300+25	8	12	40

initially designed as a cut slope. A separate Foundation Report (FR), *Foundation Report for Box Culvert Extension, MSE Wall, & Type 1 Wall System at Sawpit Gulch* (Lewis & Song, 2013) has been prepared for these three structures.

3. Pertinent Reports and Investigations

This report includes a review of Caltrans, state, federal, and private publications. A search on the Caltrans Bridge Inspection Records Information System (BIRIS) Site yielded no information considered pertinent to the project investigation or report. A search on the Caltrans Intranet Document Retrieval System (DRS) site yielded As-Builts and Plans that were reviewed for information pertinent to this report. Though several of the entries are located outside of the three construction areas of the Capstone Project, they are still of value due to their location in geologic material similar to that which is found within the present project limits. Each entry typically comprises several pieces.

Caltrans work and research done since the 1960's in an effort to improve the entire Buckhorn Grade was perused, yielding considerable information and data of value. This includes previous work done by Prysock (1968, 1979), Duffy (1990; 2010), SHN (2002), James (1990-1996), Graves (2010) and Lewis (2011, January; 2011, October), and a collection of unpublished files in the District 2 Materials Lab. Most of this work has generally fallen under the umbrella of similar names such as the Buckhorn Grade Realignment Project, the Buckhorn Grade Improvement Project (02-270310), and others. The most important and relevant report is the GDR for the MOB Project (MOB) by Lewis (2011, January). In addition, the GDR and FR for the Twin Gulches Project (Lewis, 2011, October; 2011, April), which is located within the postmile limits of this project, also have some direct relevance to this project, due to a similarity in some rock types.

Caltrans literature, tools, and websites reviewed and/or utilized pertaining to seismic issues include the *Caltrans Fault Database* (Merriam, 2009), and the internal Caltrans website for calculating acceleration response spectra (ARS 2.2.06) curves.

Geologic literature reviewed include the *Geologic Map of California, Redding Sheet* (Strand, 1962), the *Fault Activity Map of California and Adjacent Areas* (Jennings, 1994), *Geology of the French Gulch Quadrangle Shasta and Trinity Counties California* (Albers, 1964), *Geology of Northern California* (Bailey, 1966), *Tectonic Accretion of the Klamath Mountains* (Irwin, 1981), and the French Gulch Quadrangle, California, 15-Minute Series (Topographic) (United States Geologic Survey, 1944).

Soil information was obtained from the Natural Resources Conservation Service (NRCS) Web Soil Survey Website (http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx) and the Soil Survey of Shasta County Area, California (1974).

Geological and geotechnical engineering literature and reports directly pertinent to the project area reviewed include *Trinity River Diversion Features of the Central Valley Project: Technical Record of Design and Construction, vol. I & II* (USBR, 1965), *Decomposed Granite* (Wagner, 1991), *Decomposed Granite in California* (Wagner, 1992), *Decomposed Granite as an Embankment Fill Material: Physical and Mechanical Properties- A Review* (Yapa, Mitchell, and Sitar, 1992a), *An Investigation on the Use of Decomposed Granite as an Earthfill Material* (Yapa, Mitchell, and Sitar, 1992b).

4. Physical Setting

The physical setting of the project and the surrounding area was reviewed to provide information that might aid the Offices of Design, Construction, and Environmental on climate, topography, drainage, and man-made and natural features. The project is located on the eastern side of Buckhorn Summit on State Highway 299 at an elevation ranging from about 1460 ft to 2800 ft above mean sea level.

The following is a discussion of the above review:

4.1. Climate

Climate information was obtained from the Western Regional Climate Data Center (http://www.wrcc.dri.edu/) weather station located at Whiskeytown Reservoir for the period of record from 1960 to 2009. The Whiskeytown Reservoir Station is located about 7 miles east of the project area at about 1295 ft above sea level, which is about 800 ft lower than the average elevation of the project area. The average annual precipitation at the Whiskeytown Reservoir Weather Station is about 62 inches, with over 95% in the form of rain (as opposed to minor snow). The majority of this precipitation falls between October and March. The average annual maximum and minimum air temperatures at the Whiskeytown Reservoir Weather Station are 73.0 °F and 48.7 °F, respectively. The average monthly extremes are 36.1°F in January and 95.8°F in July.

4.2. Topography and Drainage

The present highway climbs gradually but steadily as it moves generally southwestward (decreasing stationing) through the project. The highway is notched into the slopes above and northwest of Willow Creek, which it follows fairly closely as it heads towards the pass at Buckhorn Summit, some 0.3 miles west of the project's western terminus. Both above and below the road the slopes are consistently steep throughout the entire length of the project.

Throughout the project, surface water flows from north of the road to south of the road, down to Willow Creek between 200 and 270 ft below the highway. All drainages except within the project limits except Willow Creek are ephemeral, with surface flow occurring only during and shortly after storm events in the minor drainages, while water flows fairly regularly most of the year in the major drainages of Sawpit Gulch, Trail Gulch, and Water Gulch, only to dry up in the late summer during most years.

4.3. Man-made and Natural Features of Engineering and Construction Significance

Man-made features that may potentially have an impact on the project, or be impacted by the project, include drainage inlets and culverts, access to a BLM dirt road at about station 108+00, and overhead high-voltage transmission lines. The Clear Creek Water Diversion Tunnel, which carries water from Lewiston Lake to Whiskeytown Lake, passes beneath the project at considerable depth and should neither be impacted by, nor have an impact upon, the project.

The Lewiston Road, an unpaved road that leaves SHA 299 at the eastern terminus of the project and that travels all the way to the town of Lewiston in neighboring Trinity County, will be impacted by the planned cut slopes at the eastern end of the project. This impact will result in the slight relocation and widening of about the first 600 ft of this dirt road.

Willow Creek runs parallel to sub-parallel with the present and proposed highway alignment just a few hundred ft downslope of the project area before flowing directly into Whiskeytown Lake, the centerpiece for the National Park Service's Whiskeytown National Recreation Area, a few miles to the east.

4.4. Regional Geology and Seismicity

The project lies within the Eastern Klamath Belt in the southeastern portion of the Klamath Mountains Geologic Province (Irwin, 1966). Within the project region the Eastern Klamath Belt is composed of the Ordovician (about 440 to 500 million years ago) Trinity Ultramafic Sheet beneath Devonian (about 345 to 400 million years ago) to Middle Jurassic (about 165 to 190 million years ago) metavolcanic, sedimentary and metasedimentary rocks, which collectively dip together to the east as a result of tectonic accretion (Irwin, 1981). The late Jurassic (about 135 million years ago) Shasta Bally Batholith, the largest granitic pluton (a large rising body of magma that cools and crystallizes below the surface) in the Eastern Klamath Belt, is found along the western edge of the eastern Klamath Belt in the project region. It is composed primarily of quartz diorite to granodiorite, with three facies- a coarse biotite facies, a fine biotite facies, and a biotite-hornblende facies. Structural and mineralogical evidence indicate that the pluton was forcibly intruded into the older metavolcanic, sedimentary, and metasedimentary rocks. The Devonian Copley Greenstone, which unconformably overlies the Trinity Ultramafic sheet, is composed of keratophyre, spilite, and meta-andesite with a few localized lenses of tuff and shale. The Balaklala Rhyolite intertongues with, and unconformably overlies, the Copley Greenstone, and is composed of porphyritic and non-porphyritic quartz keratophyre with some minor tuff, tuffaceous shale, and breccia. The Balaklala is unconformably overlain by the Bragdon Formation, which is composed of conglomerate and sandstone interbedded with siltstone and shale, as well as subordinate tuff and mudstone. Some elongate portions of the Bragdon Formation parallel to, and in close proximity to, the northeastern edge of the Shasta Bally Batholith have been metamorphosed into phyllite, while other pieces of the Bragdon, together with some portions of the Copley and Balaklala Formations, have been metamorphosed into gneiss and amphibolite, all in response to the intrusion of the batholith.

Faults are present in the rocks north and east of the Shasta Bally batholith (Albers, 1964), an area that includes the project area. These consist of the irregular low-angle faults of the Spring Creek Thrust system and high-angle normal faults, which include the Hoadley fault that runs through the middle of the MOB project, which is in the middle of the Capstone Project. These faults are old and not considered active.

The nearest active faults are the Keswick Fault (less than 10 miles east-northeast of the project area), the Battle Creek Fault (southeast of project area), and the Bartlett Springs Fault system (southwest of project area). The Keswick Fault, a fairly recent discovery (USBR, 2004) that was located seimogenically, is located at depth on the subducting oceanic plate that dips into the earth beneath the project area and the area to the east of the project. The Keswick Fault has no surface expression or ground rupture.

4.5 Soil Survey Mapping

Six different series of soils, as classified by the USDA Soil Conservation Service (SCS; Klaseen & Ellison, 1974), comprising seven soil types are mapped in the project area: (AuF_2) Auburn very rocky clay loam with 50 to 70 percent of slopes eroded; (CbF) Chaix sandy loam with 50 to 70 percent slopes (2:1 to 1.43:1); (CaF3) Chaix coarse sandy loam with 50 to 70 percent slopes- severely eroded (2:1 to 1.43:1); (CsF) Colluvial land; (MaG) Marpa gravelly loam with 30 to 50 percent slopes; (MeG) Millsholm Gravelly Loam with 50 to 75 percent slopes; and (NdE) Neuns very stony loam with 8 to 50 percent slopes. Pertinent engineering material properties of these soils as they potentially impact the project are discussed later in section 7.2.

4.6 Naturally Occurring Asbestos (NOA)

Geologic units mapped (Albers, 1964) in the project area are not known to typically contain naturally occurring asbestos (NOA) deposits. According to the map contained within the report referenced by the State of California Air Resources Board (California Dept of Conservation, 2000), the project site is not mapped as an area likely to contain NOA. No native serpentine exists within the project area.

Non-native serpentine (dumped or imported as fill material) was observed within the upper project area in a couple of locations below the roadway. Serpentinite RSP was used in these locations to stabilize the slope below the roadway. The proposed design realignment completely avoids this material, as the new roadway cuts deeper into the slope above the road in these locations and essentially pulls further away from the location of the serpentinite RSP. Therefore, this material does not warrant consideration in this project.

5. Exploration

5.1 Drilling and Sampling

Based on the amount of borehole data already in existence for the Buckhorn grade (either within the project limits or nearby), support cost resource constraints, and an assessment by OGDN of the relative value of additional boring data versus seismic data and information available from existing cut slopes, the Project Development Team (PDT) made the joint decision to utilize only existing borings for this project and not perform any additional borings. Integral to this decision was the assessment by OGDN that this entailed some risk, albeit moderately low. One boring (see Appendix C, boring B02-4) was completed by SHN consultants (2002) within the project limits as part of the subsurface investigation for the earlier broader Buckhorn Grade Improvement Project, a project that had been intermittently ongoing for several decades, but had been discontinued since a recent group of safety projects (with this project, Capstone, being the finale) was achieving the same overall goal of realignment and improvement. Also included in this drilling effort by SHN for this earlier improvement project were eight additional borings on the Buckhorn Grade (but outside of the project limits) in material similar to that within the Capstone Curve Improvement project. These include borings B02-1, B02-2, B02-3, and B02-5 (Appendix C) that were drilled in DG material, and borings B02-6, B02-7, B02-8, and B02-9 (Appendix C) in metasedimentary material quite similar to some of the metasedimentary material in the Lower Project Area. Earlier Caltrans work by Prysock (1968, 1979) involved drilling in DG and metasedimentary material near the project boundaries. Several other investigators also drilled and sampled the Buckhorn Grade. Their work is discussed in later sections.

Finally, eight samples (appendix D, borings BH05, BH06, BH07, BH08, BH09, BH10, BH11, BH12) were collected by OGDN from within different depths of several large DG cuts within the MOB Project while it was under construction, which occurred during the investigative phase of the Capstone Project. Visual inspection of existing DG cuts slopes on both the MOB and Capstone Projects led to the conclusion that enough similarity existed between them to validate this approach. Sample locations within the MOB Project were chosen based on visual and hand identification of the DG. This approach of using cuts in a neighboring project allowed for sampling of material at varying depths within cuts where the true bulk of fill material comes from.

Soils were sampled during field surveys performed specifically for this project using a small shovel and pick ax, and evaluated with field methods.

5.2. Geologic Mapping

A portion of a geologic map produced by Albers (1964) that includes the project area and neighboring terrain is shown in Plate 5.

Analysis of aerial photos of the project area and nearby surroundings was performed prior to, during, and after field work.

Geologic reconnaissance was conducted along the road, in select locations on slopes above and below the highway, and in some geologically representative locations west and east of the project area. Reconnaissance was partially limited by the extensive brush that exists in some locations within the project area. Linear swaths of brush were cleared by Cal Fire for Caltrans where seismic refraction work was planned by OGDN. These swaths, which were about 4 ft wide and up to 300 ft in length, permitted additional surficial evaluation of the soils and geology. Information obtained from these efforts, together with information garnered through a literature search, was plotted on aerial photographs taken from the Caltrans Digital Highway Inventory Photography Program (DHIPP) and Google Earth, as well as draft design layouts of the proposed realignment.

5.3 Geophysical Studies

14 seismic refraction lines were shot specifically for this project for the evaluation of cut and fill subsurface conditions. In addition, a single refraction line was shot at Sawpit Gulch to provide subsurface information for the Foundation Report for the planned structures at the confluence of Sawpit Gulch and Willow Creek. Finally, two seismic lines shot in 2004 for the Bottom of Buckhorn Project (BOB), which was located within the limits of the Lower Project Area, were also utilized for this project. Travel-time curves, velocity models, and depth sections for these lines are shown at the end of Appendix B. The locations of all 17 seismic refraction lines are shown on Plate 6 (Upper Project Area) and Plate 7 (Lower Project Area).

6. Geotechnical Testing

Geotechnical testing performed specifically for this report involved 8 direct shear tests (ASTM D3080) at the Caltrans lab in Headquarters to determine shear strength parameters for the DG. These tests were performed on samples collected from within DG cuts being excavated in the MOB project, as discussed in section 5.1. These tests were based on a single compaction test (CT test method 216) at a relative compaction of 93%, which OGDN had found during the MOB project to generally be the highest compaction readily achieved without excessive working by the contractor. The single test was deemed sufficient (rather than a separate compaction test for each sample) because the general nature of the DG material in all the samples was considered similar enough with regards to compaction. The direct shear tests were each performed at three confining pressure ranges in order to establish the Mohr strength curve from which the C and φ parameters were determined: 1500 psi, 2500 psi, and 3500 psi.

In-situ density tests were performed in several locations within the DG of the MOB project in order to calculate a more refined estimate of the grading factor for the ongoing MOB project. The density numbers obtained were then later utilized in conjunction with surveyed measurements of excavated quantities and compacted fill quantities to determine a grading factor for the DG material of both the MOB project and the Capstone Project.

Other geotechnical testing has been performed by various investigators on the material from the Buckhorn Grade. Several samples collected as part of a previous effort to realign the Buckhorn

Grade had been analyzed for gradation, Atterberg Limits, corrosivity (resistance, pH, and chlorite/sulfate values), φ angle, and cohesion (C) (triaxial tests) by SHN (2002). Their test results are given in Appendix C. Additional sampling and lab testing done by Caltrans and other investigators in the past in the project area or nearby in similar material was available and utilized in the analyses and design presented in this report. These include gradation analyses, Atterberg limits determinations, corrosion tests (pH, resistivity), triaxial soil tests, direct shear tests, and shallow boring field notes culled from the archives of the District 2 Materials Lab, as well as work done by USBR (1965), Prysock (1968), Prysock (1979), Solbos (1990), Duffy (1992; 2010), Yapa et al (1993), and Lewis (2011; January (Middle of Buckhorn Project)).

7. Geotechnical Conditions

7.1 Site Geology

7.1.1 Lithology

The lithology of the upper project area is composed strictly of granitic rocks. The lithology of the lower project area is composed of sedimentary, volcanic, metasedimentary, and metavolcanic rocks. The lithology of the middle project area is composed of metavolcanic rocks. As mentioned earlier in section 2, for ease of discussion the sedimentary, metamorphic, and volcanic rocks will sometimes be collectively referred to as SMV Rocks when separate distinction is unnecessary. Plate 5 presents a portion of a Geologic Map published by Albers (1964) that covers the three project areas.

Granitic Rocks (DG)

The granitic rocks of the upper project area are located within the northeastern portion of the Shasta Bally Batholith and consist of biotite hornblende granodiorite and quartz diorite. The roughly top 50 to 250 ft of these granitics are in various stages of decomposition ranging from slightly weathered to residual soil. Similar variously decomposed granitic rocks around the world are collectively and fairly unanimously referred to as decomposed granite, or ‘DG’ for short, in the literature by multiple researchers and engineering geologists. The ‘DG’ descriptor will be similarly applied in this report despite its conflict with the Caltrans’ Logging Manual, just as it was in a report for the previous MOB project, to facilitate consistency with the numerous investigations reported in the literature on decomposed granite that will be drawn upon in this report. Descriptors are applied to this term to further specify the degree of weathering and decomposition. These include slightly weathered, moderately weathered, intensely weathered, decomposed, and residual soil. DG weathering descriptions are based on field observations in conjunction with seismic refraction results.

DG exposed within the project area varies from slightly weathered DG to DG residual soil. Slightly weathered DG is exposed primarily in the deeper portions of a few MOB cuts, as well inside the slopes of a couple of proposed cuts, based on seismic refraction velocities, actual cuts observed on the MOB project, and geological reconnaissance of other areas of the northeastern part of the batholith. The bulk of the material to be excavated in the proposed DG cuts is considered to be moderately weathered DG with lesser varying quantities of intensely weathered and decomposed DG, and with residual DG soil typically above it. The larger cuts are expected to reveal slightly weathered DG in their cores. Corestones (spheroid-shaped cobbles and boulders within the DG matrix that are less weathered than the remaining matrix) are evident in a few existing cut slopes within the upper project area and will likely compose about 2 % to 5% of the DG material proposed for excavation within the project. Plate 8 shows photos of several different DG cuts, some with corestones.

Sedimentary, Metamorphic and Volcanic Rocks (SMV)

The middle area of the project, where a cut slope excavated during the MOB Project will be further excavated during the Capstone Project, is in rocks of the Balaklala Rhyolite (Db), which is a silicic quartz rich keratophyre.

The rocks found in the Lower Project Area consist of 1) the Balaklala Rhyolite (Db), 2) phyllite derived from the contact (with the rising Shasta Bally Batholith) metamorphosis of shale and siltstone, together with slightly metamorphosed conglomerate and sandstone, all derived from the Bragdon Formation (Mbp); 3) non-metamorphosed shale, mudstone, siltstone and subordinate tuff and conglomerate all of the Bragdon Formation (Mbl); and 4) metavolcanic keratophyre, spilite and metandesite of the Copley Greenstone (Dc).

7.1.2 Structure

Although there are some broad large scale structural features (flow banding) within the granitic Shasta Bally Batholith, these are not evident at the outcrop or cut slope scale and have no impact on the geological engineering properties of the material as it pertains to this project. Being an intrusive rock, the granite has no foliation or bedding structures.

The batholith does display numerous aplite (quartz and alkali feldspar) dike structures, typically in clusters or swarms. These dikes are typically a few inches thick up to about 6 inches thick within the project area, though thicker ones greater than 2 ft wide can be found elsewhere in the batholith. Having been injected into cross joint structures within the batholiths, these dikes are typically oriented at various azimuths at high angle to the local surface of the batholith. Observations of these dikes in present cut slopes indicate that they generally do not pose stability issues for cut slopes, although that possibility cannot be wholly discounted for the proposed cuts. A swarm of these dikes can be seen in the photo in Plate 9.

Thin dike-like structures filled with clay that are likely related to these aplite dike structures can be found occasionally in various locations in existing DG cut slopes. Like the aplite dikes, they appear to be localized, fairly high angle, and of varying strike. Unlike the aplite dikes, there is some evidence in both existing cut slopes and newly excavated cut slopes of the MOB project that blocks of DG can occasionally become destabilized along these clay-filled fractures. Because they are fairly localized, of high to vertical angle, of varying strike (azimuth), and typically do not appear to continue for more than 300 to 400 ft, their potential for creating future instability in proposed cuts is difficult to predict. These clay filled fractures did cause instability in a portion of a through-cut during the construction of the MOB project that required additional cutting and removal of material to stabilize the final cut slope, so they should not simply be ignored. On the other hand, these clay filled fractures are evident on numerous existing cut slopes and have been revealed on several newly excavated cut slopes of the MOB project, yet no evidence of instability or sliding has been observed in these locations.

The majority of the metamorphic (Mbp) and non-metamorphic (Mbl) Bragdon rocks, which compose the material in Cuts 16, 17, 18 and a small part of Cut 19, are composed of phyllite, shale, slate, and sandstone beds, which present themselves as bedding structures or relict bedding structures. These structures are generally dipping about 40° to 55° at an azimuth between 45° and 80° (northeast to east-northeast). Spacing in this layering typically varies from about 1 inch to 12 inches with a rough average of about 2 to 3 inches, while a few areas, particularly some areas with sandstone layers, are more massive and have layers up to three ft thick. Nearly all of the discontinuities between beds are tight and lack infilling of any kind. Layer surfaces are smooth to slightly rough. Large scale undulations vary from negligible to about ¼ inch from trough to crest over a distance of about 12 inches.

Further east or upstation, the rocks of the Balaklala Rhyolite do not show prominent bedding structures, but do contain a localized sheeting structure, likely a relict of a chronological separation between different flows. This structure appears to dip in the same general azimuthal direction as the Bragdon rocks with a dip of about 60°. This structure is not widespread, at least not apparently so, and it is not so clearly obvious. It was first identified by OGDN on the geological map by Albers (1964), which then prompted a field search to locate it. It is tight and shows no physical discontinuity.

The remaining rocks to the east that lie within the lower project area, the Copley Greenstone, contains localized pillow structures, and localized cooling fractures of varying orientations. Contacts between either slightly different compositions- or perhaps flows- can be found occasionally.

The Hoadley Fault, a normal fault that dips generally towards the northeast, runs through the middle of the project postmile limits from the southeast to the northwest, crossing the roadway in the vicinity of about postmile 3.5. The geomorphic expression of the fault can clearly be seen in various locations northwest and southeast of the project. A topographic low seen to the southeast (on opposite side of the Willow Creek drainage) from the roadway is such an example. The fault does not cut through any construction area of the project (Lower, Middle, or Upper Project Areas).

7.1.3 Natural Slope Stability

Natural slopes within the project area are considered stable in their current morphology. No large or small scale sloughing or sliding was observed.

Stable native slopes in the DG terrain presently found on the Buckhorn Grade vary in slope ratio from about 0.9:1 to nearly flat on the ridge crests. The bulk of the steeper portions of the native DG slopes within the project limits and right-of-way tend to cluster at about 1.25:1.

Slope stability in the area of the Bragdon Formation rocks (metamorphosed and non-metamorphosed) is almost entirely structurally controlled along bedding or remnant bedding layering. Slopes on the north side (south-facing) of the Willow Creek drainage, the side that the project is located within, are capable of forming and maintaining steeper slope ratios than those that exist on the south side (north-facing) side of the drainage, due to the predominant northeast dipping structural grain in the underlying bedrock. Existing slope geomorphology is primarily a function of surficial erosion and weathering of the uppermost bedrock layers rather than structural features. Predominant slope ratios rise as steep as 1.8:1, with slopes dipping into north-south ravines holding stable slope ratios as steep as 1.25:1.

Most natural slopes further to the east in the area where rocks of the Balaklala Rhyolite and the Copley Greenstone are found are highly stable, due to the more massive structure and fairly high strength of these rocks together with the moderately limited weathering rind of soil atop the bedrock in these areas. Stable slope ratios as steep as 1:1 can be found within drainage ravines in these areas, though the predominant steep slope ratio is more typically about 1.25:1. Some exceptions to the general stability of these areas are a few of the slopes underlain by the western reaches of the Copley Greenstone (approximately between stations 274+00 and 283+00) where seeps and/or groundwater close to the surface have both increased weathering depths and slightly weakened the surficial geology.

7.2 Soils

Field reconnaissance and field evaluation of soils in the project area, together with laboratory tests performed by previous investigators, produced soil descriptions based on engineering properties and strongly linked to the geological sources. Soil boundaries generally follow the general lithology boundaries (section 7.1.1) quite closely, with those soils weathered from DG being almost exclusively composed of silty sands (soil symbol SM), with some minor sandy silt (soil symbol ML) and even less prevalent clayey sand (soil symbol SC). These soils are generally well- to excessively-drained, non-plastic with no apparent shrink-swell potential, and low in corrosivity.

The soils in the lower project area, consist primarily of moderate to well-drained clayey sands with gravel (SC), established colluvial soils composed of gravel and sand with finer silts infilling the interstitial voids (GC), and sandy silts (soil symbol ML). All of the above soils are underlain by sedimentary, metasedimentary or metavolcanic rock at relatively shallow depths (generally 12 to 30 inches), with the exception of the colluvial soils which can be found in thicker localized sections up to about 10 ft in thickness. The bulk of these soils have low plasticity (PI average of about 10, with some soils up to about 15), and low to no shrink-swell potential.

7.3 Surface Water and Groundwater

No year-round streams are present within the three project areas. Over a dozen drainages run generally perpendicular to the length of the project and the roadway, some of which see ephemeral flows during storm events, while others contain flow a majority of the year but do typically dry up during the summer months. The vast majority of the time, however, these drainages act as funneling pathways for groundwater to travel down to Willow Creek. Groundwater elevations vary widely throughout the project area and with the seasons. During the winter wet season groundwater is typically closer to the ground surface. Storm-fed groundwater likely travels through the residual DG soil throughout the upper project area, both above and below the roadway. Some of this groundwater does intercept the DG cuts, increasing erosion. Surface water runoff is usually mild to non-existent in the DG soils due to its high permeability and ability to rapidly absorb runoff. Storm-fed groundwater travels through the residual soils of the SMV rocks and the upper weathered sections of the rocks in the lower project area, but at slower rates. During significant and steady storms, surface water on the SMV residual soils often overcome the percolation capacity of these soils and create mild sheet flow conditions locally.

No problematic seeps were observed in areas proposed for slope cutting in the upper project area, which leads OGDN to conclude that groundwater is unlikely to create problems for the proposed DG cuts, either during construction or after. The one area within the Upper Project Area that has had historic seepage and groundwater induced slope problems was avoided entirely by the project realignment. It is possible that the proposed cuts might intercept a significant groundwater flow path that is hidden at present. It is also possible that the groundwater table might be intercepted during the cutting process, though this is considered of low probability based on field evidence. Should groundwater be intercepted in the cutting process of the DG slopes it will create some short-term difficulties for construction, but would likely not create any long-term problems, since the groundwater table typically re-equilibrates to the new cut faces and ceases to seep within a few weeks or months after being revealed.

Seeps were observed during the summer months in the thalwegs of the drainage basins downslope from the roadway in the Upper Project Area, likely a result of groundwater being restricted at shallow depths by harder rock in these areas. Fills 1 through 7 are planned for these areas, which means that appropriate underdrain and blanket systems should be installed prior to construction of the fills (see section 8.2.6).

Seepage was observed in many of the existing cut faces within the Lower Project Area between stations 273+00 and 282+00. The groundwater conditions in this station interval will likely result in some mild sloughs of cuts during construction.

7.4 Erosion

DG and Residual DG Soils

DG soils are known to be considerably erosive (Keller, 1992). DG soils were found by Andre and Anderson (1961) to be the most erodible of eight different parent type materials tested at 168 different sites in California. DG rock (slightly weathered to intensely weathered DG) is also likely the most erodible of the most prevalent geologic parent materials in the state. Accelerated erosion is considered to be a given whenever DG soils are disturbed (Megahan, 1992).

Native DG slopes within the upper project area have developed a relatively thin veneer of topsoil in most locations that is generally protected by duff and established vegetation, making these slopes fairly immune to the significant erosion that can otherwise be caused by surface sheet flow of rainfall runoff and rainfall impact (splash erosion). This protection is not, however, generally sufficient to protect the native DG slopes from natural or man-made concentrated surface flow.

DG cut slopes are considered to be highly erosive, according to some studies in the literature (Megahan, 1992). There are several variables, however, that can come into play that would seem to lessen the degree of that assessment, at least based on observations of the DG cut slopes on the Buckhorn Grade. These variables mainly involve the steepness of the cuts and the degree of weathering of the DG. The DG cuts on the Buckhorn Grade, which were all cut basically at 0.75:1, still generally retain this overall slope ratio, although the planarity of the original cuts has long been gone, replaced by an undulating and convoluted surface in which the ‘weaker’ DG grains have been, and are still being, selectively removed. Informal observations over the past dozen years or so by OGDN has led to the conclusion that the predominant method by which nature dislodges these DG grains is freeze-thaw, not rain-drop impact or surface flow. Rain and surface flow serve to move grains downslope that have already been dislodged by freeze-thaw. Erosion and its influence on cut slope design is discussed further in Section 8.1.5.

SMV Rocks and Soils

Erosion in the lower project area, which involves the SMV rocks, their residual soils, and a few colluvial soils, is considered insignificant. Erosion in soils derived from some of these rocks can be moderately high when moderately sloping surfaces are left unprotected by vegetation, and even more especially when positioned in the paths of sheet flow or concentrated surface water. Existing SMV residual soils within the lower project area appear to be sufficiently protected and unsusceptible to these situations at the time of this writing.

7.5 Project Site Seismicity

Based on Caltrans Methodology for Developing Design Response Spectrum for Use in Seismic Design Recommendations (November 2012) and the subsurface conditions discussed above, an average shear wave velocity (Vs30) of about 2500 ft per second was considered applicable for the upper 100 ft of the rock/soil at the project site.

Based on Caltrans ARS Online (2.2.06), a combination of the probabilistic acceleration spectrum developed from the USGS 2008 Interactive Deaggregation (Beta) model and the statewide minimum deterministic spectrum requirement, the active faults potentially having seismic control on the project site are the Cascadia Subduction Zone (Fault ID 5), Keswick Fault (Fault ID 35) and Big Lagoon – Bald Mountain Fault (Fault ID 9). With the Vs30 considered above, a peak ground acceleration (PGA) of 0.21 g is estimated to be applicable at the site.

Potential for liquefaction is considered low at the site due to rock. No known active fault is projected towards or passing directly through the project site. Therefore, potential for surface rupture due to fault movement is null.

8. Geotechnical Analysis and Design

8.1. Cuts and Excavations

8.1.1 Cut Slopes

DG Cut Slopes

The existing weathered DG cut slopes and the more recently excavated DG cut slopes from the MOB project provide empirical evidence regarding stability and performance. They are likely the best source of geotechnical information available for determining stability and behavior of the future proposed cuts because they were cut in essentially the same material and at the same slope ratio (0.75:1) as the ones planned for the Capstone project. Analyzing proposed DG cuts for global stability with limit equilibrium methods is limited by the breadth and variability of assumptions that must be made with input parameters and modeling boundaries, due primarily to the variable weathering of the DG and the fact that most of the DG is not a soil (approximately 10 to 15 % of the DG material proposed for excavation is likely residual DG soil). Kinematic structurally based methods are even more poorly suited for analysis of proposed DG cuts because the rock has few structural discontinuities and does not typically fail along structural modes (such as planar, wedge, toppling).

Because DG typically fails in more of a circular failure mode akin to failure in soil slopes, rather than along planar features like many rock masses, limit equilibrium methods would generally offer the best analysis approach to assist in designing DG cut slopes if not for the parameter assumptions. These methods require the input of C, φ, and γ parameters, and while the determination or estimation of γ would be easy and straightforward, the determination of C and φ values would be subject to significantly large assumptions that would carry with them significantly large errors and/or substantially large variations in Factor of Safety (FOS) values. This large variation would essentially render the analysis results fairly useless in producing valid constrained FOS values for specific slope ratios.

Wyllie and Mah (2004) and Hoek and Bray (1977) state that slope failure in highly weathered rock masses is likely to occur as a circular failure and is most typically analyzed as closely fractured rock with randomly oriented discontinuities. Pertinent discontinuity data (structural kinematic data), however, is not available in the DG, so this approach is considered untenable without again incurring large assumptions. An additional approach involving strength modulii could be employed, but this would also suffer equally from the burden of assumptions.

In light of these analytic shortcomings and the substantial availability of empirical evidence in the existing DG cut slopes, the proposed DG cut slopes have been analyzed and designed based primarily on field observations, seismic refraction results (to determine depth of weathering and degrees of decomposition), and information available in the literature.

Most existing Buckhorn DG cut slopes are 60 to 80 years old (based on as-built records and DRS files) and are predominantly sloped at 0.75:1, with a very few areas (typically near the top of a cut) having slope ratios tending towards 1:1, the flatter ratios often being the result of erosion and sloughing in the predominantly upper soil layer subsequent to their construction, processes that are discussed more in a later section (8.1.5) on erosion. The taller existing cut slopes range from about 60 to 100 ft in height. Having stood for 60 to 80 years, these cuts offer good empirical evidence that these 0.75:1 DG cut slopes are generally globally stable up to at least 100 ft, with the potential for the upper soil layer of some slopes to lay themselves back over time to a slope ratio between 0.75:1 and 1:1.

Though not having undergone the same test of time as the older existing cuts, the newer DG cut slopes of the MOB project, some of which were almost two years old at the time of this writing, provide some additional empirical evidence regarding global stability, including evidence for higher cuts. The tallest DG MOB cut is approximately 170 ft in height, while two others approach 135 ft and 125 ft in height. Detailed observations of these DG cuts during construction by OGDN confirmed earlier interpretations of seismic refraction data that the deeper cores inside the cuts grade steadily into less weathered, stronger rock that is capable of resisting the increased driving forces that occur at the bottom of higher cuts. This is strong empirical evidence that, at least in the case of the Buckhorn Grade, large heights do not contribute to or incite global instability in the DG cuts.

There is one caveat, however, where this general global stability of large DG cuts may fail, and that is where a pre-existing planar weakness exists in a kinematically disadvantageous orientation. The clay dikes mentioned earlier in section 7.1.2 potentially provide such a weakness, and there has been a case of that occurring on the MOB DG cuts. In a portion of the 170-foot high MOB thru-cut there were several weathered clay dikes oriented nearly vertical and almost, but not quite, perpendicular to the cut surface. The large weight of the upper cut provided such a substantial driving force that a portion of the cut slope began creeping laterally towards the road along the low φ clay dike in a scissor-like movement relative to the other side of the clay dike after rains wetted the clay. OGDN and the Office of Construction assessed the situation, resulting in a recommendation to reduce some of this driving force by removing approximately the top 40 ft of DG. Once the material was cut off, the movement stopped. Although these clay dikes have been observed in some of the other MOB and older DG cut slopes, none of them have evolved into a similar failure-inducing surface.

Though approximately 85% or more of the cut slope surfaces of the MOB 0.75:1 DG cuts proved stable during and after construction, there were two circular-type (Mohr-Coulomb behavior; i.e., C and φ) failures that occurred, one requiring benching and another that was left to establish its own equilibrium with time. These failures, the surfaces of which were no deeper than about 6 to 8 ft in from the cut slope face, started above the top of the cut hinge point in the soil layer and extended about one-fourth to one-third down the slope face. Though primarily circular in cross-section, the lower portion of the failure tended more towards a planar geometry in which the plane defined a wedge that thinned out as it propagated downward. These failures were driven by a reduction in the resisting forces in the soil at the top of cut, which was incapable of supporting itself at 0.75:1, and therefore failed circularly. This failed material, in turn, increased the load on the slightly stronger material below, which failed as wedge that thinned downward until the failure surface daylighted on the new cut face.

The option of laying all of the DG cut slopes back flatter than 0.75:1 was considered briefly during the geotechnical investigation period for MOB, but this idea was dismissed for numerous reasons. Laying the slope back at a flatter slope ratio significantly increases excavation quantities and right-of-way limits dramatically (because the catch points for the flatter slopes go far up the already steep natural slopes of the Buckhorn Grade), increases the area of disturbance, and exposes the slope to a slightly more direct rainfall impact angle- all considered negative impacts. Some researchers and people involved in the MOB and Capstone projects feel that flatter slopes would be better because of erosion issues, something that OGDN disagrees with and which is discussed further in section 8.1.5 below.

These circular failures discussed above could be addressed by flattening the tops of all DG cuts to 1:1 for the Capstone project. This, however, is considered to be an overreaction, since a majority of the top edges of the DG cuts did not experience such failures. Cutting most DG cut slopes at a single slope ratio of 0.75:1 (as opposed to a dual slope ratio with 1:1 over 0.75:1) is considered a reasonable risk approach that will save the project money in comparison to cutting the tops of all DG cuts at 1:1. The upper reaches of cut slopes whose tops remain fairly accessible during construction should not be excavated at 1:1 initially, because they can be repaired by benching or trimming by an excavator should the need arise. Smaller cut slopes that fail at the top can be left to establish their own equilibrium, because the DG material typically breaks up with the release of potential energy, coming down as more of a granular soil that will likely have little to no impact upon the travelled way; therefore, these should not be designed with a 1:1 top slope ratio either. The best candidates for 1:1 ‘rounding’ of the upper portion of the cut include 1) slopes that are exceptionally high, and 2) slopes that have significantly thick soil layers on their tops (as determined by refraction data). In the case of the exceptionally high slopes, an alternative to cutting the top at 1:1 involves a mid-slope bench that would split the direct falling distance between the top of the slope and the roadway below, thereby reducing by at least half the potential energy (and the resultant kinetic energy once in motion) of any potential sloughs, which greatly reduces the risk of the failed material significantly impacting the travelled way. The bench option also increases the stability of the overall slope by increasing the mass at the bottom of the slope relative to the top (essentially flattening the slope with less than half of the excavation quantity increase). The possibility that this mid-slope bench might eventually serve as a launching point for rockfall, as benches can often do when not properly maintained, is considered moot because the DG material does not contain rock capable of producing rockfall (see section 8.1.4), with the exception of some corestones, which are not considered abundant enough to be problematic. Sloughed material does not demonstrate run-out at the toe of a slope like rocks do, but instead breaks apart mostly into individual grains and small clumps, a process that disperses the kinetic energy.

Cutting the DG cut slopes at a steeper slope ratio is not favored by OGDN. No steeper slope ratios have been found to be recommended in the literature for DG, while the preponderance of empirical and research data indicate that 0.75:1 is the preferred steep slope ratio.

Based on the above discussion, OGDN concludes the following:
1) Cuts 1, 2, 3, 4, 5, 7, 9, 10, 11, and 12 should be cut at 0.75:1.
2) Cut 6 (118 ft high) and Cut 8 (115 ft high) should be designed with a dual (compound) slope ratio with the upper 15 to 20 ft (vertical distance) of the cut at 1:1 and the lower portion of the cut at 0.75:1.
3) Cut 7 (147 feet high) and Cut 12 (160 feet high) should be designed with a 20-foot wide mid-slope bench that slopes back towards the cut slope.

SMV Cut Slopes

Most present SMV cut slopes have slope ratios around 0.75:1 with a few locations being as steep as 0.5:1. A majority of these cuts are over 70 years old, with some having been constructed over 80 years ago, according to as-built drawings and DRS records. The present condition and appearance of the SMV cut slopes are thought to be fairly similar to the original cut faces, with the exception of some small localized planar failures (in sedimentary and metasedimentary rocks) that likely occurred soon after their construction, as well as the long-term raveling of localized periodic rockfall. In addition, a few small localized sloughs have occurred where the upper soil layer was both thicker and weaker (lower φ angle based on less angular material or more fines) than the great majority of the upper soil layers observed atop the SMV rocks. Based on these observations OGDN infers that the rock portions of the SMV slopes are globally stable at 0.75:1, and that a large majority of the upper soil layers are as well.

Kinematic analysis of the bedding, or relict bedding, of the sedimentary and metasedimentary rocks indicate that these rocks are structurally stable relative to the orientation of the proposed cut faces, regardless of the steepness of the proposed cuts. As was discussed earlier in section 7.1.2, these bedding structures are generally dipping about

40° to 55° at an azimuth between 45° and 80°. The planned cut slope faces dip 53° (0.75:1) to 73° (0.3:1) at azimuths varying between about 170° and 200°. Because the dip azimuths of the planned cut faces differ from those of the geologic structure by a difference in azimuth of at least 90° or more, the situation is considered stable kinematically. The volcanics and metavolcanics do not possess these prominent bedding structures or other similar layering and are not susceptible to kinematic failure. Sheeting structures in the volcanics that were mentioned earlier are very few, and those actually observed by OGDN had dips oriented into the proposed cut faces where the difference in dip azimuth between the structure and the planned cut faces was at least 90°, much like the bedding structures discussed above.

Examination of the quality and hardness of the SMV rocks in the lower project area, together with seismic refraction results, indicate that the rock quality is sufficient in many places, particularly at depth, to stably support cut slope ratios steeper than 0.75:1, given the above conclusion that the slopes are stable kinematically. Therefore, in an effort to reduce excavation quantities while maximizing rockfall catchment widths (section 8.1.4), cut slopes have been designed utilizing two or three slope ratios on a single slope (dual or triple slope ratio cut slopes). The top portions of most cuts have slope ratios of 0.75:1, which, based on field observations, is justified because of long-term stability observed in even the uppermost portions of existing cuts. At some depth (determined perpendicular to the native topographic surface) this slope ratio changes to 0.5:1 when the rock is deemed competent enough. This depth is determined from seismic refraction results together with exposures on existing cuts where a few slope ratios have stood well in weaker material (slower seismic velocities) at 0.5:1. In a majority of the proposed cuts the rock quality and strength improves sufficiently with depth that an additional steepening to a 0.3:1 cut slope ratio is implemented. This additional steepening at depth is based primarily on seismic refraction results, together with previous experience (Twin Gulch project) where nearby triple slope ratios were designed and constructed in the same or similar rocks based on seismic data. A generic cross-section drawing of such a cut slope is shown in Plate 10, which also demonstrates how the transition depths between the topmost slope (S1) and the second slope (S2), as well as the transition depth between second slope and the third (S3) or bottommost slope, are measured. A few cut slopes have top slope ratios of 1:1, because of locally thick soil layers and/or empirical evidence of a weaker soil layer. These give way to 0.75:1 at increased depth. The table in Appendix E provides recommendations for slope ratios and the depths at which they begin for all cut slopes based on station intervals.

Cuts 13 and 14 in the Middle Project Area are in metavolcanic rocks (Balaklala Rhyolite) that display foliation and cooling structures that are favorably oriented relative to the planned cut face orientations, and are therefore considered stable kinematically. In the case of Cut 15 (station 180+00 to186+00), the final cut of the middle project area, the relative orientations become unfavorable. This potential for instability was noted in the original design of the cut slope here for the MOB project, but a decision was made by the PDT to take the risk of cutting the slope at 0.75:1. Excavation of the slope during the MOB project resulted in some local instability and shallow cut slope failures that clearly indicated the stability limit of structure and cut face orientation was being approached. Because the additional cutting called for in the Capstone project requires an additional rotation of the cut face towards the alignment of the structure at its up-station end, and because the structure dips predominantly at about 45°, OGDN recommends a 1:1 (45°) cut.

Overwintering of Cut Slopes

Discussions with the PDT from the onset of this project have assumed an early decision to make the project a three year project, with slope cuts being allowed to winter over through at least one interim wet season, while the contractor is present to deal with instabilities and storm water issues related to the newly excavated cut slopes. This project is opting for relatively steep and high cut slopes, some of which are not conservatively designed and not without some mild stability risk. Overwintering will allow the newly cut slopes to experience their first post-cutting season with the traveled way located at a considerable distance from the toe of these slopes. This is important because this first post-cutting season is the period of time when the slopes are most likely to undergo the major portion of any sloughing, sliding, mass wasting, or rockfall they might be primed to do. Overwintering will also allow observation of the new cut slopes to better identify any additional work that may need to be done to them before considering them complete and signing off on construction.

8.1.2 Rippability

Rippability assessments are made based on seismic velocity (P waves), rock type, and rock fracture and joint characteristics. Seismic velocity correlations are based on two different scales, each with differing rippability assessments depending upon ripping equipment and rock type. Caltrans has its own internal non-rock-type specific correlation scale between seismic velocity and rippability based on a Caterpillar D9 Series bulldozer with a single-toothed ripper:

Velocity (ft/s)	(Caltrans)	Rippability
< 3445		Easily Ripped
3446 – 4921		Moderately Difficult
4922 – 6562		Difficult
> 6563		Not Rippable

A rock-type specific seismic velocity scale based on a larger bulldozer (Caterpillar D10 with a single shank ripper) taken from a handbook published by Caterpillar (1982; 2010) is also presented here to provide the contractor with a wider range of rippability information. For granitic rocks (and a D10 with a single shank ripper) the following scale applies:

Velocity (ft/s)	(DG)	Rippability
≤ 7800		Rippable
7800 – 9000		Marginally Rippable
> 9000		Non-Rippable

For basaltic rocks (and a D10 with a single shank ripper) the following scale applies:

Velocity (ft/s)	(Basalt)	Rippability
≤ 8,300		Rippable
8,300 – 9,200		Marginally Rippable
> 9,200		Non-Rippable

For metamorphic schist (and a D10 with a single shank ripper) the following scale applies:

Velocity (ft/s)	(Schist)	Rippability
≤ 8000		Rippable
8000 – 10,000		Marginally Rippable
> 10,000		Non-Rippable

For shale (and a D10 with a single shank ripper) the following scale applies:

Velocity (ft/s)	(Shale)	Rippability
≤ 10,000		Rippable
10,000 – 12,000		Marginally Rippable
> 12,000		Non-Rippable

For conglomerate (and a D10 with a single shank ripper) the following scale applies:

Velocity (ft/s)	(Conglomerate)	Rippability
≤ 9,000		Rippable
9,000 – 11,000		Marginally Rippable
> 11,000		Non-Rippable

All DG cuts (Cuts 1 thru 12) are considered easily rippable based on both the Caltrans and Caterpillar seismic velocity rippability scales, field observations of pertinent geological characteristics, planned depths of cuts, and seismic refraction results.

85% of cuts 13, 14, and 15 (Middle Project Area) are considered easily rippable based on Caltrans seismic velocity rippability scale, with the remaining 15% (predominantly that material in the back and bottom of the cuts) being considered moderately difficult to rip based on the same Caltrans scale. 100% of the material in these three cuts is considered rippable based on the Caterpillar seismic velocity rippability scales.

Based on the non-rock-type specific Caltrans rippability scale above, approximately 14% of the material planned for excavation in the Lower Project Area is considered easily rippable to moderately difficult to rip, while 58% is considered difficult to rip and 28% is considered unrippable.

Based on the Caterpillar scales presented above, and the rock type observed in the existing cut slopes and shown in the geological map on Plate 5, approximately 17% of the material proposed for excavation in the Lower Project Area is considered non-rippable, 4% is considered marginally rippable, and the remaining 79% is considered rippable.

The locations deemed marginally rippable and unrippable are located in portions of all cuts (Cuts 16 thru 21) within the Lower Project Area. These are typically, but not exclusively, in the deeper (horizontally and vertically) areas of the larger cuts.

Based on the rippability descriptions discussed above, some method of excavation beyond standard ripping and cutting with an excavator or dozer blade will be necessary in some locations. If blasting is chosen, it should be performed following Caltrans specifications for controlled blasting with pre-splitting methods employed for the final cut face.

8.1.3 Grading factor

The three grading factors provided in this section are based on an assumed relative compaction of 93% (see section 8.2) for the embankments.

The grading factor for the material in the Upper Project Area (essentially all the DG material) is estimated to be 1.045, which indicates that there should be 4.5% swell of the volume of that material between its in-situ volume and its volume after excavation and subsequent placement-compaction in a fill. This was calculated based on field and laboratory compaction tests of DG cuts and fills during the MOB construction, together with surveying calculations (for volumes) performed under the direction of OGDN.

The grading factor for the material proposed for excavation in the Middle Project Area (non-DG SMV rock) is estimated to be 1.05, which indicates that there should be a 5.0% swell of the volume of that material between its in-situ volume and its volume after excavation and subsequent placement-compaction in a fill. This estimation was based on a combination of shrink-swell estimates provided by construction during the MOB project, seismic refraction velocities and their earthwork factor correlation to similar rocks (Caltrans, 1972; Caltrans, 1978), and engineering judgment.

The grading factor for the material in the Lower Project Area (non-DG SMV rocks) is estimated to be 1.098, which indicates that there should be 9.8% swell of the volume of that material between its in-situ volume and its volume after excavation and subsequent placement-compaction in a fill. This estimation was based on a combination of shrink-swell estimates provided by construction from the BOB project, seismic refraction velocities and their earthwork factor correlation to similar rocks (Smith et al., 1972; Stephens, 1978), and engineering judgment.

8.1.4 Rockfall

The project earthwork balance and need of a substantial amount of good fill material and select material for fill protection (see section 8.2 and 8.2.3), in conjunction with PDT discussions, resulted in catchment being chosen by OGDN as the sole mitigation solution to potential rockfall problems arising from the new cut slopes. Catchment analysis and design was done integrally in conjunction with cut slope design, and was based on field observations of present catchments and performance, field observations and data on present geological conditions, catchment tables by Pierson, et al (2001), and simulated runs through the Colorado Rockfall Simulation Program software (CRSP; Jones, et al, 2000). Catchment tables from Pierson et al (2001), which are only provided for slopes up to 80 ft, were extrapolated to fit the higher cut slopes of this project, as was done for the earlier Twin Gulch project. These extrapolations, which were based on non-linear spline-derived curves, were evaluated during the Twin Gulch project with modeling runs on CRSP.

Catchment is generally defined as the unpaved shoulder laying flat or sloping away from the pavement back towards the toe of the cut slope. For the purposes of analysis, that definition is expanded here to include the paved shoulder space outside of the edge of traveled way (ETW) for containing run-out (rocks that have already impacted the ground and that are then rolling and/or bouncing further away from the slope towards the travelled way. CRSP runs were performed solely to determine how equivalent a flat paved shoulder was to an unpaved shoulder with a backslope of 6:1 for the purpose of containing run-out. The conservative result of this analysis is that generally eight ft of paved shoulder is roughly equivalent to two ft of unpaved catchment with a backslope of 6:1 for the purpose of containing runout. This two feet was then implemented when determining catchment widths for runout containment via the tables and charts of Pierson et. al. (2001) for proposed cut slopes. Based on discussions with the PDT, catchment width designs resulting in a runout containment of about 80% was deemed acceptable, since the higher 90% to 95% containment values demanded economically unattainable catchment widths that would break the project budget.

With regards to direct impacts, catchment width was designed primarily to catch at least 95% of impacts. When determining catchment width for direct impacts, paved shoulder was not considered as catchment, because pavement is highly ineffective in absorbing direct impact energy. These widths were also determined via the tables and charts of Pierson et. Al. (2001).

Upper Project Area

Rockfall is not expected to be a problem in the Upper Project Area, due to its being composed entirely of DG cuts. Corestones may very occasionally fall from existing cut slopes due to weathering and/or erosion of the surrounding DG matrix, but the frequency of these events is considered very low, according to reports by maintenance personnel, so this was not considered to be problematic by OGDN during cut slope and catchment design.

Recommended catchment widths in the Upper Project Area are 8 ft wide, except where there is a passing lane, in which case they are only 4 ft wide. In addition, they are all paved, because rockfall is not an issue here, as mentioned above. These catchments are actually designed to catch granular sloughs off the DG cut slopes.

Middle Project Area

Rockfall is not considered to become a problem for cuts 13 and 14 in the Middle Project Area following their planned cutting. The eastern end of Cut 15, could potentially pose some rockfall and stability issues if cut at 0.75:1, as originally planned at the early design phase of the MOB project, but OGDN recommendations for this portion of the slope were altered to a 1:1 slope ratio for the Capstone project (section 8.1), which together with a minimum 8-foot catchment backsloped at 6:1, will provide 95% containment for direct impacts and, when accompanied by the planned 8 foot paved shoulder that has a super-elevation sloping towards the catchment, will provide containment for over 60% of rock run-out. In order to contain over 90% of rock run-out, catchment should be increased to 16 ft. The frequency of rockfall here is likely not going to be too great, based on historical observations (discussion with maintenance), except perhaps for a few years following construction when the slopes are equilibrating to their new cut faces. Based on these criteria, the PDT decided to keep unpaved catchment at 8ft.

Lower Project Area

Rockfall presently occurs from some localized parts of the cut slopes in this area. This involves slopes cut in all of the different rock types present here. Though the frequency is not especially high, it is enough to be considered a minor problem. Almost all existing catchment ditches slope away from the roadway at 4:1 and are typically only 2 feet in width. Because of this rockfall history and the significant increase in height of the planned cuts relative to the existing cuts, catchments should be increased to a minimum of 8 ft wide at 6:1 backslope. Higher slope heights require wider catchments. Cut slope tables in Appendix E provide recommended catchment widths (for 6:1 backslope) along with slope ratios for the cuts by stationing for the Lower Project Area. These catchment widths are deemed sufficient to contain over 95% of direct impacts and contain between 80% and 90% of potential runout. No alternative rockfall mitigation method, such as mesh drapery is required or recommended.

8.1.5 Syn- & Post-Construction Sloughing and Erosion - Potential and Control

Because issues regarding erosion have always been a very important consideration in the development of this project for both the PDT and those involved in storm water runoff and sediment transport, this section attempts to discuss in some detail the various aspects of the erosion issues as they pertain to the final geotechnical design.

SMV Cuts

Proposed cut slopes in the SMV Rocks, which is essentially the lower project area (cuts 16 thru 21) and the middle project area (cuts 13, 14, and 15), are not expected to present any significant erosion problems, due to the predominantly rocky nature expected of the new faces. The tops of these cuts may expose surfaces locally with a significant amount of silt and smaller amounts of sand and clay that will be subject to erosion and sediment transport during storms. The majority of all the cuts in the lower project area are composed of rock that will not support vegetation growth or contribute significant sediment transport to storm water. Applying mulch to these portions of the slopes, seeded or otherwise, serves no constructive purpose and or viable environmental goal.

DG Cuts

Background erosion rates in DG cuts on the Buckhorn Grade are clearly higher than background erosion rates from cuts in other geologic environments in the Klamath Mountains along the SHA 299-TRI 299 corridor. Erosion debris aprons accumulate continually at the bottom of all DG cut slopes, regardless of age. Plate 11 shows photos of different Shasta Bally Batholith DG cut slopes, some with their erosion aprons still in place (not removed by maintenance).

The post-cutting evolution (sculpting) of DG cut faces that OGDN predicts will occur following the cutting of the proposed DG slopes in this project (Cuts 1 thru 12) begins with both sloughing and erosional processes at a maximum for that slope. Generally, the sloughing process (a form of surficial or shallow instability) asymptotically approaches zero typically within 2 to 3 wet seasons, with sloughing becoming very infrequent within 5 years. Erosion follows the same general asymptote, with the general background erosion level for DG cuts reached within 5 years or less. This 3 to 5 year asymptotic decline model of post-construction cut face evolution for DG is based on over 12 years of observations of the Buckhorn Grade DG cut slopes both old and new, earlier observations of DG slopes elsewhere, conversations with maintenance personnel, and background research on DG decomposition. Some believe the evolution is faster. According to Megahan and Kidd (1972), surface erosion from DG cuts decreases rapidly during the first and second year after cutting, so that by the end of the second year after disturbance erosion rates remain fairly constant, though still fairly high (higher than undisturbed DG slopes).

Erosion and Cut Slope Ratio. Erosion control begins with design in the choosing of cut slope ratio, which may influence the amount of erosion to be expected. In studies on DG from the Idaho Batholith, Megahan (1993) found that steeper road cuts in DG erode faster, which he states is contradictory to what some road builders advocate. Megahan (1993) states, “DG road cuts will eventually end up at the natural angle of repose; it depends whether you want it now or later.” This generalized statement is somewhat in contradiction, however, to the evidence available on the present Buckhorn Grade, where a significant majority of the over 60 pre-MOB DG road cut faces remained predominantly at, or fairly close to, the original slope ratio of 0.75:1 that they were cut at over 70 years before. In deference to Megahan’s work, however, it should be stated that the tops of some of these cut faces have been laid back to something approaching a 1:1 slope by erosion (or sloughing). A few of the main cut faces have been flattened slightly to, for example, 0.8:1 or a few even to 1:1. The question is partly a matter of what time framework is relevant, since eventually all slopes will be eroded down to sea level, given enough time. Further contradicting Megahan’s work is the observation that the tops of many Buckhorn Grade DG slopes, having been protected by a duff layer or vegetation, have shown no sign of being laid back and the cut faces beneath these tops remain at about 0.75:1. The process of splash erosion, which is the erosive force induced by raindrops impacting upon the individual DG grains and dislodging them, should be lessened by steeper slopes due to the reduction in the amount of raindrops striking a certain amount of exposed surface area per rain event, as well as a reduction in the dislodging force of the raindrop applied in the normal direction (to the slope). This reduction in the normal component of the raindrop force would only reduce erosion, however, when the remnant rock strength provided by the remnant grain-to-grain connections was strong enough to resist the dislodging force imparted by the tangential component of the raindrop force. Observations of the DG cut faces on the Buckhorn Grade seem to indicate that the large majority of them do retain sufficient strength on most of their surfaces. Some material is still dislodged, but it does not appear to be any more than that which occurs where a few cut faces are moderately flatter. Splash erosion likely occurs more at steeper slope ratios when the DG is completely weathered to a residual soil state, but is likely insignificant when the DG retains at least a small amount of secondary or primary crystalline bonds between grains.

A cut slope ratio of 0.75:1 was chosen over flatter slope ratios for the DG slopes because they reduce the amount of disturbed area and the amount of area made susceptible to erosion, because they have demonstrated a relatively good resistance to erosion in most cases for (for DG cuts), because they have demonstrated long-term slope stability, and because they are economically feasible.

Erosion and Surface Water Flow. Water flow, both on the surface and in the subsurface, has the most significant role in the erosion of DG. After a road is cut into a DG slope a portion of the subsurface flow is now intercepted by the road cut. The flatter the cut the less amount of flow is intercepted, but it is still intercepted, so this difference, though present, is not considered significant. Subsurface flow, if even slightly above the general background level for this area, however, will have a very significant effect upon both steep and flat cut slopes. Indeed, it is just such subsurface flow that is believed to have caused some, if not all, of the relatively few badly eroded cut slopes present on the Buckhorn Grade (all outside of this present project area). The most severely eroded and slough-sculpted cut slope on the Buckhorn Grade exists in the vicinity of a spring dubbed ‘Old Faithful’ around Postmile 0.65 (SHA 299). Surface water runoff, if significant enough to build up or become concentrated, will have a strong erosional impact on the DG cut slopes, flat or steep, but steeper slopes will be affected more due to higher flow velocities. Design must be very careful not to create, purposely or inadvertently, situations that will subject the DG cut slopes to such surface flow.

Erosion Control. Various kinds of post-construction erosion control measures have been studied and implemented on DG material (Megahan et al, 1992; Megahan et al, 1993; Bethlahmy and Kidd, 1966; Ohlander, 1964; Haynes, 1992) including numerous studies and experiments on the Grass Valley Creek Watershed (on the Shasta Bally Batholith) and the Buckhorn Grade, some of which involved Caltrans personnel and projects. A list of methods that have been considered for application on DG cuts includes, but is not limited to 1) erosion control blankets with materials ranging from various grasses and legumes to small trees, fiber, mulches, emulsions, synthetic jutes, straw wattles; 2) gabion baskets or half baskets filled with rock; 3) various benching approaches and steps cut into the cut faces with plantings typically composed of small trees; 4) side cast angular rock (for cuts of 1:1 or flatter); and 5) basic seed-fertilizer-stabilizer mulch mixes that are sprayed on the faces. While all these methods have demonstrated some effectiveness in some locations and situations on DG cuts, they all have limitations with respect to the Buckhorn project. Blankets, mulches and other similar methods are quite likely to be rendered ineffective by the shallow sloughing that is expected to occur over a significant percentage of the cut faces during the first wet season. Straw wattles staggered periodically on the faces might be mildly effective, as some wattles would likely escape removal by sloughing, but this success would probably only be localized (except at the bottom of the cut slope where they have the best chance of success). Side cast rock will not work on the steep 0.75:1 slopes. Besides being very costly, gabion and half-basket methods would likely suffer considerable failure due to larger sloughs and the likelihood that erosion would still occur beneath some baskets, eventually resulting in failure from undermining. Benching methods would probably have the best success rate of the methods presented above, but would not be without problems, most notably their potential to destabilize the shallow surface layers of the DG by allowing excessive water quantities to percolate into the DG. Benching with small conifer tree plantings was performed on a DG cut on the Buckhorn Grade in 2002 at about postmile 1.0 (SHA 299) with mixed results. The upper portion of the slope failed completely, partly due to the presence of DG residual soil typically found at the apices of such cuts, and partly due to the water percolation promoted by the benches. Most of the lower portion of this slope remains intact with plantings at the time of this writing. However, there are still aprons of DG debris observed at the bottom of these benched slopes, comparable to aprons observed at the bottom of other unprotected cut faces. In addition, such benching and planting is labor and equipment intensive, and therefore, considerably costly, particularly considering the surface area of DG cut faces planned for this project.

The primary and most important objective of erosion control is the protection of the water quality of the watershed, primarily Willow Creek and Whiskeytown Lake. The use of sediment traps, sediment detention basins, and widely used BMP’s (Best Management Practices, such as wattles and silt fences) between the cut slopes and at the entry ways into the watershed represent an approach to erosion control that doesn’t reduce the amount of material coming off the cut slopes, but instead acts to prevent the material from reaching the waterways. These methods can have a high success rate in preventing most sediment, particularly the sands that makes up the bulk of the DG erosion, from entering the waterways.

8.2 Embankments

A 1.5:1 slope ratio was chosen for the fills in this project, based on multiple factors and parameters, including properties of the material to be used in the proposed fills, height of the fills, constraints limiting the spatial footprint of the fills (environmental issues, proximity to Willow Creek), the successful construction and performance of similar large fills in the MOB project, costs, and risks. Because of their magnitude, any flattening of the fill slope ratios would greatly increase right-of-way needs, earthwork volumes and costs, and environmental costs, and would quickly push the toes of some fills into Willow Creek, which would then require either a sizeable retaining or culvert structure. The success obtained during the MOB project further negates any idea of flattening the fills. Additional φ (angle of internal friction) values obtained for this project that are noticeably higher than values utilized during geotechnical design and analysis on the MOB project might possibly suggest looking into steepening the fill slope ratios slightly in order to reduce earthwork volumes and costs. The relatively small cost benefit, when weighed against the potential risks (failure, heavy discharge into the creek and eventually into Whiskeytown Lake) and the overriding prerogative of the PDT to be fairly conservative with risk when it comes to the fills, indicate that good engineering judgment prevails by maintaining a 1.5:1 slope ratio for the fills of the Capstone project.

Examination of Caltrans records (DRS), including As-Builts, plans, and other construction information, indicated that most of the existing fills within the Upper Project Area and those fills within the MOB project prior to MOB construction, were constructed between 1920 and 1935. Records indicated, and field observations corroborated, that these fills were constructed at 1.5:1. Repairs done to these fills over the ensuing years appear to be in response to damage primarily incurred by excessive concentrated surface water, not by slope instability. Field reconnaissance of these fills revealed no signs of apparent stability issues such as circular slumps, or bulges from such circular failures. This evidence supports building the proposed fills at 1.5:1, although none of this pre-MOB empirical evidence addressed the significantly larger size of the fills proposed for the Capstone and MOB projects. The successful construction and two year performance (at the time of this writing) on the MOB project of 7 large (up to 270 ft in height) fills at 1.5:1, at least four of which were built primarily with DG material (the material which presents the greatest geotechnical concern), fill this void in the empirical evidence for stability at such slope ratios and size.

The material properties of the rock and soil to be used in constructing the fills were investigated in great detail during the geotechnical work on the MOB project to assure that the appropriate values were chosen for φ (angle of internal friction), C (cohesion), and γ (unit weight) for all materials to be used in fill construction. This is discussed below in the section (8.2.1) on embankment material.

These parameters were iteratively utilized in analytic modeling runs employing limit equilibrium methods to determine if these materials could be used to construct 1.5:1 fills with a minimum factor of safety (FOS) of 1.3. This is discussed below in the section (8.2.2) on stability analysis.

Rocky material excavated from a designated location within the Lower Project Area shall be used to armor smaller fill areas where surface water runoff could potentially cause rilling and erosion. This material, designated as Select Material A (SM-A), is discussed below in the section (8.2.3) on embankment select material.

Rocky material excavated from locations designated within the Lower Project Area shall be used to armor the fill slopes with an external 9.2 foot (horizontally) encapsulation of rocky material primarily intended to provide protection against erosion, as well as provide additional stability to the outer edges of the fills. This material, designated as Select Material B (SM-B), is discussed below in section 8.2.3.

8.2.1 Embankment Material

The fills are to be built from material excavated from the DG, sedimentary, volcanic, and metamorphic rocks and the soil overburden atop these rocks. The material properties of these excavated materials, as they pertain to fill construction, are discussed here.

Sedimentary, Metamorphic, and Volcanic (SMV) Rocks and Derivative Soils

The excavated rocks from the lower project area should possess considerable stability at slope ratios as steep as 1:1 (45˚), due to the general strength of all of these rocks and the angularity they possess when excavated. Excavation of these rocks is certain to produce predominantly subangular to angular, blocky to slightly elongate or slightly tabular shapes, based on field observations of intact rock on the existing slopes, rock shed from the slopes and found in catchment ditches, and observations by OGDN of rock excavated during other recent Buckhorn Grade projects in rocks similar and/or identical to those in the Capstone project, including the MOB, BOB and Yankee Gulch projects Even though the cohesion of these rocks in excavated form is essentially zero, these shapes indicate that the excavated metamorphic rock will possess a high φ angle and impart significant stability upon the material at slope ratios up to about 1:1. Fills constructed at 1.5:1 from these rock types excavated from the Buckhorn Grade during the MOB, BOB, Twin Gulches, and Yankee Gulch projects presented no problems during construction and have performed flawlessly since their construction, which for some (Yankee Gulch) has been as long as 10 years ago. Observations at a disposal site fill constructed at a slope ratio of 1.5:1 at approximately postmile 3.5, which is constructed of slightly less angular metavolcanic rocky material (mostly Copley Greenstone) excavated from another project a couple miles east of this project on the Buckhorn Grade completed a few years prior to this report, indicate that this material is very stable at 1.5:1 (33.7˚). Based on these observations, this material has an assumed φ angle of 40˚ and a C of 0.

The soil atop and derived from the rocks in the Lower project Area makes up probably no more than about 5 to 10 % of the total material planned for excavation in the lower project area. It usually comprises a relatively shallow portion of the planned excavation profile. No lab tests were performed on this material, partly because of its relatively small percentage in the total excavation mass, and because field reconnaissance work indicated that the material was competent fill building material. Unlike a few soil areas detected in the MOB project where fat clays and some thick silts were clearly identified in both lab and field tests as being poor fill builders with significantly low φ angles (as low as 15°), no such problematic soils were found within the lower Capstone project area. Soil veneer on relatively steep (up to 1:1) native slopes showed no signs of slumping or stability issues. Hand samples excavated from the surface or at the brows of existing cuts with a small shovel were identified predominantly as sands with some clay and silt, the bulk of which would probably be classified as either a SC or SM soil. Field tests for plasticity found no samples in which the PI was higher than about 10, which was interpreted to mean the soil likely had low swell potential and moderate cohesion. The sand grains were typically subangular to angular (except for a few small localized river cobble deposits), indicating that the φ angles for these samples were likely at least above 30°.

DG Rocks and Soils.

Information regarding the material properties and behavior of DG, particularly as they pertain to fill construction, has been obtained from numerous sources including 1) Caltrans records (DRS, Materials Lab, logs of test borings), 2) research and materials investigations done by Caltrans and consultants for the Buckhorn Grade Realignment Project (Prysock, 1968; Prysock, 1979; Duffy, 1990; SHN, 2002; Graves, 2010), 3) research and materials investigations done specifically on the Shasta Bally Batholith DG, or involving the Shasta Bally Batholith, by other investigators (Solbos, 1990;Yapa et al, 1992a; Yapa et al, 1993; Zornberg et al, 1995a; Zornberg et al, 1995b), 4) research and investigations performed on DG at multiple locations around the world, 5) observations of DG fills present on the Buckhorn Grade for over 70 years, and 6) first-hand observations of the construction and two-year performance of large fills (up to 270 ft in height from toe to top) on the MOB project.

The great majority of DG samples in all of the studies mentioned above were classified (based on gradation and sieve analysis) as silty sands (SM) with a few of them being clayey sands (SC) or sandy silt (ML). The same is true for the Shasta Bally Batholith samples. Dry unit weights varied from about 111 pounds per cubic foot (pcf) to 126 pcf for Shasta Bally samples. The average of all these values is 116 pcf, while the median is 121 pcf. Preliminary stability modeling runs indicated that heavier dry unit weights produced lower Factor of Safety (FOS) values, so the higher value of 121 pcf was used for the analyses discussed in section 8.2.2 in order to be slightly conservative.

The φ angle of the DG is the most important parameter when considering DG as fill material, especially since cohesion is typically very low or non-existent. Studies on weathered and decomposed DG from other locations around the world have yielded φ angles ranging from 26˚ to 51˚ (Li and Mejia, 1967; Peda, 1967; Gwilford and Chan, 1969; Ucheda and Others, 1968; Onitsuka and Others, 1985; Matsuo and Others, 1970; Furukawa and Fujita, 1990; Onitsuka and Yashitake, 1990; Nishida and Kagawa, 1972; Lee, 1991; and MacFarland, 1990), with the average of these values being somewhere between 35˚ to 36˚. Keller (1992) presents a table of material properties for DG that includes φ angles for the Shasta Bally Batholith (33˚ to 35˚) and other locations in California, including the Sierra Nevada, that range from 26˚ to 44˚. Shear test data by SHN (2002) on Shasta Bally Batholith material taken from different depths from borings produced φ angles ranging from 31˚ to 38˚, with the mean value being about 35˚. Samples taken from a location within the Upper Project Area by Yapa et al (1993) were subjected to over a dozen triaxial and direct shear tests at different confining pressures and different compaction levels (90% and 95%), and yielded an average φ angle between 36.5˚ and 37˚. Triaxial (CD) tests performed by Solbos (1990) on DG from the Buckhorn Grade resulted in a φ angle of 37.3˚. Triaxial tests performed on clay-silt DG (CL-ML and ML-SM) material from the Grass Valley Creek area (on the west side of Buckhorn summit) produced φ angles of 29˚

(USBR, 1965) and 28˚ (ML-SM; Solbos, 1990). Triaxial (CD) tests by Caltrans (Prysock, 1968; Prysock, 1979) on DG found east of the present project, apparently near the Greenhorn Mine on the other side of Willow Creek, yielded φ values from 26.5˚ to 32˚, while later work by Caltrans (Duffy, 1990) on Buckhorn DG somewhere within the upper project area yielded a φ angle of 42.6˚, one of the higher values cited. Finally, 8 samples collected at various depths and locations within the depths of a few large DG cuts during construction of the MOB project underwent direct shear tests at the Caltrans HQ lab that produced significantly high φ angles of 45.7°, 53.1°, 57.9°, 49.1°, 55.5°, 53.8°, 59.1° and 58.4°. Table 2 below presents a compilation of parameter values for Buckhorn DG from multiple sources.

It is suspected that the DG tested by Solbos and Prysock was soil, not intact weathered granite, and had undergone some fluvial working, based on the locations and the soil classifications of these samples. This might help to explain the lower φ angles of these materials relative to the higher values determined by Duffy, Yapa et al, and the tests on the MOB samples. The φ angle values obtained from the direct shear tests on the MOB material are considerably higher than the values obtained by the other investigators. This is likely a result of several factors. First, the inherent weaknesses of the direct shear test do tend to drive the values up, although this is not considered to be as significant a problem in cohesionless material (like DG) as it is in cohesive soils. Secondly, the material tested came directly from deep within intact decomposed granite and had not undergone any fluvial, chemical, or physical weathering or particle breakage, which may have allowed particle angularity to remain as high as possible.

An important issue discussed in the literature that may have significance to the larger fills proposed for the present project is the processes that weathered DG undergoes during the construction, compaction, and long-term internal evolution of a fill that can reduce its φ angle. The primary processes that occur to potentially cause this reduction are particle breakage and separation of aggregated particles. The literature indicates that this φ angle reduction occurs under moderate to heavy loading, which becomes more likely as the size of a fill increases. Breakage can be both compaction-induced and load-induced, and can also be affected by soaking and saturation.

In a dozen triaxial tests on Shasta Bally Batholith DG at 95% relative compaction Yapa et al (1993) found that the peak angle of shear resistance (φ) decreased with increasing confining pressure from 50˚ (at 2088 psf) to 46˚ (at 4175 psf) to 43˚ (at 6265 psf) to 42˚ (at 8355 psf) to 39˚ (at 12,531 psf) to 38.5˚ (at 19,000 psf) to 38˚ (at 31,000 psf). Differences in relative compaction affect the φ angle of the DG, with higher compaction resulting in higher φ angles. In the same study cited above, Yapa et al (1993) found that Shasta Bally Batholith DG compacted at 95% has φ values 2˚ to 5˚ higher than the same DG compacted at 90%. At 90% relative compaction the φ angle was about 36˚ at a confining pressure of 31,000 psf. Although the highest fill proposed for the present project is about 226 ft, the highest vertical column of compacted soil in any of these fills is inside this fill and is about 155 ft, which, at 125 pcf, adds up to about 19,375 psf at the bottom of the column. The present project then, with a maximum vertical load of about 19,375 psf, corresponds to a minimum φ angle of about 38.5˚ for material compacted at

Table 2. Material properties of Shasta Bally Batholith Decomposed Granite (DG).

SHASTA BALLY BATHOLITH DECOMPOSED GRANITE (DG)												
SOURCE	PM	BORING	DEPTH (ft)	LL	PL	PI	SOIL NAME	SYMBOL	Φ	C	TEST	Dry Density (pcf)
SHN	0.01	B02-1	10	0	0	0	silty sand	SM	31	4028	DS	111
SHN	0.01	B02-1	15	0	0	0	Silty Sand	SW-SM			DS	
SHN	0.01	B02-1	20	23	23	0	silty sand	SM	36	511	DS	112
SHN	0.01	B02-1	25	0	0	0	silty sand	SM			DS	
SHN	0.14	B02-2	10	31	28	3	silty sand	SM			DS	
SHN	0.14	B02-2	15	30	26	4	silty sand	SM			DS	
SHN	0.14	B02-2	20	29	28	1	silty sand	SM	38	438	DS	119
SHN	0.14	B02-2	25	28	24	4	silty sand	SM			DS	
SHN		B02-2	30	29	24	5	silty sand	SM	34	705	DS	121
SHN		B02-2	35	23	22	1	silty sand	SM			DS	
SHN		B02-2	40	0	0	0	silty sand	SM	33	692	DS	113
SHN		B02-3	10	29	25	4	silty sand	SM	37	24	DS	126
SHN		B02-3	15	32	21	11	clayey sand	SC	33	665	DS	123
SHN		B02-3	20	0	0	0	silty sand	SM			DS	
SHN		B02-4	10								DS	
SHN	3.2	B02-5	5	34	25	9	silty sand	SM			DS	
SHN	3.2	B02-5	10	0	0	0	silty sand	SM			DS	
SHN	3.2	B02-5	15	31	29	2	silty sand	SM			DS	
SHN	3.2	B02-5	20	25	22	3	silty sand	SM			DS	
SHN	3.2	B02-5	25	34	24	10	silty sand	SM			DS	
SHN	3.2	B02-5	30	38	21	17	sandy silt	ML			DS	
SHN	3.2	B02-5	35	29	29	0	silty sand	SM	35	624	DS	121
SHN	3.2	B02-5	40	35	24	11	clayey sand	SC			DS	
Lewis	2.9	BH05	5				silty sand	SM	45.7	0.002	DS	
Lewis	2.9	BH06	25				silty sand	SM	53.1	0.001	DS	
Lewis	2.7	BH07	5				silty sand	SM	57.9	-103	DS	
Lewis	2.7	BH08	25				silty sand	SM	49.1	0.001	DS	
Lewis	2.7	BH09	35				silty sand	SM	55.5	302	DS	
Lewis	3	BH10	10				silty sand	SM	53.8	779	DS	
Lewis	3.2	BH11	10				silty sand	SM	59.1	-563	DS	
Lewis	3.2	BH12	25				silty sand	SM	58.4	-656	DS	
Pysk(68)		BS-2-1							31.5	1000	TX	
Pysk(68)		BS-2-2							32	800	TX	
Pysk(68)		BS-2-3							31	3600	TX	
Pysk(68)		BS-2-4							26.5	7000	TX	
Pysk(79)		BS-2							28	6000	TX	
USBR		33R-1			26	6		CL-ML	29	1524		

Table2. Material properties of Shasta Bally Batholith Decomposed Granite (DG) (continued).

SHASTA BALLY BATHOLITH DECOMPOSED GRANITE (DG)												
SOURCE	PM	BORING	DEPTH (ft)	LL	PL	PI	SOIL NAME	SYMBOL	Φ	C	TEST	Dry Density (pcf)
		33R-2				NP		SM-ML				
		33R-3				NP	Sandy Silt	ML				
Duffy		B2R-1				NP	Silty Sand	SM				
		B2R-4				NP	Silty Sand	SM				
		B2R-5				NP	Silty Sand	SM				
		B2Ra				NP	Silty Sand	SM	42.6	563		
Solbos		X89			28	3		ML-SM	28	877		
		X90				NP		SM	37.3	1100		
Yapa et. al	0.6					NP		SW-SM	38-50		TX-95	
						NP		SW-SM	36.5-45		TX-90	

SOURCES: SHN (2002); Prysock, et. al, (1968); Prysock (1979); USBR (1960); Duffy (1992); Yapa et. Al, (1993); Solbos (1990); Lewis (2011, this project)

DS Direct Shear TX Triaxial
TX-90 Triaxial at 90% Compaction
TX-95 Triaxial at 95% Compaction

95% and about 36.5˚ for 90% compaction. Interpolating for a 93% relative compaction, which is the compaction value planned for this project (see paragraph after next), results in a φ angle of about 37.5° at the base of the largest fill. Other studies on DG elsewhere have found somewhat similar decreases with overburden pressure, although the range of φ values varied depending upon the locale.

Based on the above discussions, the representative φ angle for the DG fill that was used for slope stability analyses on the MOB project had a value of 35˚.

Saturation level during compaction can also have an effect upon the final φ angle of DG, although what that final effect may be is not altogether clear, based on the somewhat conflicting results cited in the literature. Miura and others (1983) conducted tests with varying levels of wetting and drying and found that wetting reduced the strength, which then induced greater particle breakage. Miura and others (1983) also found, however, that significant particle breakage and densification in specimens that were wetted and redried seems to have actually made them stronger, as indicated by higher φ angles. This study and that of Onitsuka et al (1985) and Feda (1977) seemed to indicate that the maximum long term shear strength will be achieved for the DG fills when water content is kept at or slightly above optimum. Several investigators (Lee, 1991; Prysock, 1968, 1979; Yapa, Mitchell, and Sitar, 1992) tested the results of compacting Buckhorn DG at 90%, 93%, and/or 95% of maximum dry density with varying amounts of water (less than optimum, optimum, and over-optimum or saturation). The different compaction efforts and water contents had differing effects upon particle breakage, final density, and the φ angle of the DG. Their findings seemed to indicate that moisture content should be held at 2% to 3%

below optimum to achieve the highest long-term φ angle. The apparent conflicts between these studies may stem from a difference in focus or concern between particle breakage and final long-term shear strength. Because the latter studies investigated actual Buckhorn DG material, these studies are considered more valid and pertinent to this project.

A relative compaction of 93% at 2 to 3% below optimum water content was recommended for the MOB project in order to obtain the best long-term φ angle possible. This compaction level was chosen based on earlier construction experience working with smaller DG fills on the TOB project where they found that 93% relative compaction was generally the highest compaction level reached without having to require that the contractor work the material more than normal. Due to the absence of direct control over the optimum water content within the Caltrans' compaction testing specifications, the easiest way for a contractor to achieve compaction higher than about 93% was to apply excessive water, which is contrary to the 2 to 3% below optimum water content recommended in the paragraph above in order to achieve the highest long term φ angle. Unfortunately, due to some errors in putting together the final project package the MOB project contract went to bid with a 90% relative compaction called for. In spite of this error, observations by OGDN during MOB construction and discussions with the on-site materials testers indicated that most compaction tests on the DG material produced average relative compaction results around 92% relative compaction without requiring additional efforts on the part of the contractor. Based on these factors, OGDN recommends a relative compaction of 93% at 2 to 3% below optimum water content for the Capstone Project fills. In addition, since the Caltrans' compaction test methodology does not specify water content directly, the resident Engineer (RE) should at least be informed that 2 to 3% below optimum water content is the preferred water content for optimum stability results.

Based on the above discussions regarding φ angle, the higher φ angle values observed in the additional direct shear test data obtained since the MOB Project GDR was written, and the knowledge and experience gained from the MOB project fill construction and performance, one might be justified in raising the representative φ angle for the DG fill slope stability analyses from 35° to 36°. However, the analyses performed with the 35° φ angle for the MOB Project produced results that were sufficient to meet the FOS requirements of 1.3. Raising the φ angle would obviously raise the FOS, which isn't really necessary- unless one was considering steepening the fill slope from a 1.5:1 (33.7°) to a 1.4:1 (35.5°) or 1.35:1 (36.5°) slope ratio. Given the significant size of these fills, the lack of empirical evidence supporting large DG fills at slope ratios steeper than 1.5:1, and the PDT interest in being conservative with risks regarding fills, OGDN feels that steepening the planned fills for the Capstone Project is not a good idea and would not be in line with good engineering judgment. Therefore, there is no valid reason to steepen the fill slope ratios or to increase the φ angle used for the slope stability analyses.

The recent direct shear tests performed on the MOB cuts that were discussed above resulted in three C values that were almost negligible, and the remaining 5 values in the 500 to 1000 psf range. Values for C in DG were presented in many of the investigations mentioned above. These varied from about 20 psf to about 4000 psf. The very high C values were rare and were associated with DG material classified as a clay (CL), which is not typical DG material. Moderately high C values (500 to 1000 psf) were typically associated with DG classified as clayey sands (SC) or sandy silts (ML). The lower and certainly most common C values (100 to 500 psf) were typically associated with DG classified as silty sands (SM). Based on C values published in investigations on Shasta Bally Batholith and field observations of the proposed DG cuts, C values between 100 and 500 psf should be considered reasonable for use in stability analyses, with 400 psf being chosen as the representative value for analysis.

8.2.2 Embankment Stability Analysis

Slope stability analyses were performed for the fills in the MOB project for several different materials, including DG and metamorphic rocks. The MOB DG is essentially the same as that of the Capstone DG, at least in terms of parameter values, except perhaps for the fact, as briefly discussed above, that the φ angle might be set higher in lieu of the additional direct shear test results. This idea of increasing the φ angle, however, was discouraged in the above discussion. Therefore, the slope stability analyses performed for the MOB DG is completely valid for the Capstone DG and is consequently utilized here in this report.

The slope stability analyses for the MOB metamorphic rocks can likewise be applied to the Capstone sedimentary, volcanic, and metamorphic rocks as well, since the φ angle for the capstone rocks should be at least of equal value to the MOB metamorphic rocks, if not higher, since the Capstone rocks are of less weathered, generally harder, and equally angular. Consequently, the slope stability analyses already performed for the MOB rocks will be utilized here for the Capstone SMV rocks.

Table 3. Stability analysis results for a 1.5:1 fill constructed with DG.

RUN	ϕ	C (psf)	γ (pcf)	FOS
1	35	0	116	1.05
2	35	200	116	1.28
3	35	300	116	1.35
4	35	400	116	1.41
5	35	500	116	1.47
6	36	200	116	1.3
7	34	0	116	1.02
8	34	500	116	1.34
9	35	400	123	1.35
10	35	400	108	1.34

Limit equilibrium methods available in Slope/W (2004) that utilize only force equations (Janbu simplified), and both force and moment equations together (Bishop's simplified, Bishop's Comprehensive, Spencer, GLE) were all employed in the analyses.

Slope stability analysis was performed for the DG material. C, φ, and γ values were varied in these analyses to understand parameter sensitivity. C values ranged from 0 to 500 psf, φ from 34˚ to 36˚, and γ from 108 to 123 pcf, based on laboratory values.

Table 3 shows some of the main results of the stability analysis for the DG. Resultant FOS values ranged from 1.02 to 1.47, with a C of 0 and a φ of 34˚ producing the lowest FOS of 1.02, while a C of 500 psf and a φ of 35˚ produced the highest FOS of 1.47. Cohesion demonstrated a somewhat misleadingly significant effect on the FOS, more than the φ angle did, so long as the φ angle was above the angle of the slope (33.7˚ = 1.5:1). The low FOS values resulting from runs with no cohesion were all due to very localized, highly surficial circular failures, not deeper global circular failures. This primarily demonstrates the importance of cohesion in preventing surficial sloughs on the fill faces. Otherwise, the effect of cohesion, though important, was far less than that of the φ angle in achieving higher FOS values related to actual deep-seated global stability. When C was set at 0, γ had a small but noticeable effect (0.05 difference) upon the FOS, but otherwise its effect was essentially negligible. The highlighted row for Run 4 in Table 3 contains the parameter values and the FOS (1.41) considered most representative of the DG fills. In light of the very high φ angles obtained from the most recent direct shear tests, the φ angle of 35° shown in run 4 is considered to be highly conservative as it could probably be comfortably increased at least two degrees if desired. This is not necessary, however, to more than meet the minimum FOS standard of 1.3.

The second MOB slope stability analysis that will be utilized here is the set performed on the MOB metamorphic rocks, which, as mentioned above, are very similar or analogous to the Capstone SMV rocks in regards to an angle of internal friction, or φ. In the case of the MOB analyses the rocks were mixed in with 5% of the overburden soil, which is fairly representative of the likely percent of overburden soil that will occur in the case of the Capstone rocks. This mix is essentially what is referred to as the Capstone Select B material (discussed below in section 8.2.3). MOB soil parameters were based on a problematic soil identified in the MOB project that had φ angles as low as 15° and an average value of about 22°. As was mentioned above, these low φ angle soils were not found in the Capstone lower project area; instead, Capstone soils hand identified throughout the lower project area clearly had higher φ angles. The MOB analyses use these parameter values (the sole difference being the lower φ angle since the cohesion used is not that high and is likely equal or close for the Capstone soils). This would make the application of the MOB soil φ angle values a very conservative analysis for the Capstone material. Based on the 95/5 ratio, the parameter values can be estimated as a linear mix as demonstrated in the following equations. A C value of 40 psf was estimated as such (with 800 psf for the soil and 0 psf for the rock):

$$C = (0.05*800 \text{ psf})+(0.95*0.0 \text{ psf}) = 40 \text{ psf}.$$

Since the soil will likely be present in quantities only sufficient to bind the rock pieces together by filling in between the voids, our engineering judgement feels that this linear mixing of the parameter values is fairly valid.

The calculation of a φ value in the same linear fashion is probably not as valid, because the low φ angle of the soil likely does not impact the material mass as a whole to the same extent as does that of the rock, due to the relatively small quantity of soil. The relative paucity of the soil mass likely delegates the soil to the interstitial voids, a situation where the angular nature of the rocks and their overall effect on φ angle is not significantly diminished. This means that a linear mix approach to calculating the φ angle would be fairly conservative (i.e., produce a lower φ angle than the material mass would likely truly possess). Therefore, its use here is justified as a conservative approach. This produces a φ angle of about 44˚:

$$\varphi = (0.05*22^\circ)+(0.95*45^\circ) = 43.85^\circ.$$

The γ value can be determined by a similar linear mix without adding or reducing conservatism:

$$\gamma = (0.05*108 \text{ pcf})+(0.95*116 \text{ pcf}) = 115.6 \text{ pcf}.$$

Analyses based on these parameter values resulted in a FOS of 1.55 for the rocks.

An additional slope stability modeling was performed utilizing the DG and the rocks together with the rocks placed as select material B as described below. This essentially eliminated the need for any cohesion whatsoever in the DG to achieve a FOS above 1.3. This is briefly discussed in section 8.2.3 below.

8.2.3 Embankment Select Material

The fills should be built so as to maximize, when possible and practical, the beneficial innate properties of the material. Consequently, we introduce here divisions of the material to be used in fill construction, and how these differing materials should best be utilized.

General Fill Material
The bulk of the fills shall be constructed with general fill material excavated from the Lower, Middle, and Upper Project Areas. General fill material includes all DG material, as well as all Sedimentary, volcanic, and metamorphic material not included as either Select Material A or B.

Select Material A (SM-A)
Select material A (SM-A) is a 2-inch minus material that will be used to protect certain fill, DG, and bench surfaces (cuts) from erosion. The placement locations for SM-A are shown in the design plans. SM-A material shall be compacted to at least 90% relative compaction. The borrow location for SM-A material is located inside cut 16 in the Lower Project Area

between the station intervals 227+50 and 228+50. Its location within the cut is depicted in cross-section 'C' on Plate 12. The gradation and quality specifications for SM-A are shown in Table 4 below. Table 5 presents the location and depth of both select material A (SM-A) (highlighted in blue) and select material B (SM-B) borrow locations. Plate 12 shows the station intervals and the locations and geometry of select material B (SM-B) borrow within the particular cuts.

Table 4. Select Material A (SM-A) specifications.

Gradation Requirements			Quality Requirements		
Sieve Size	Percent Passing		Test	CTM	Requirement
2"	100		SE	217	25
1"	75-100		R-value (min)	301	50
3/4"	65-85		PI	204	1-7
No. 4	40-60		% Crush Particles	205	75
No. 30	12-30		Durability Index (min)	229 c & f	35
No. 200	5-15		Unit Weight (pcf, min)	212 (Rodding Method)	105

Select Material B (SM-B)

The Select B material (SM-B) is composed of bedrock material (does not include grubbed or organic material, overlying soil, or highly weathered bedrock) considered by OGDN to be of sufficient strength and quality. SM-B shall be used to encapsulate the outer 9.2 horizontal ft (5 ft perpendicular to face) of all fills. Its rocky, angular to sub-angular nature is expected to have a φ angle somewhere around 45˚, making it quite stable on a 1.5:1 face. The stability of SM-B in a 1.5:1 fill was analyzed in the previous section (8.2.2) on embankment stability analysis as MVS rock. The resultant FOS was 1.55. The primary purpose of SM-B is to provide protection against erosion (see section 8.2.5) for all fills. In addition, SM-B will add extra global stability to the outer shell of the fills, particularly DG fills, which, based on the modeling simulations discussed above, could otherwise possibly be susceptible to localized, shallow, large-radius circular failures due to low cohesion. Finally, SM-B encapsulation will also act as a barrier inside of which a filter bridge may form that will function to stop the migration of fines from within the DG fills. The exposed faces of all 7 fills in the Upper Project Area should be encapsulated by SM-B.

Additional slope stability runs were performed on the DG fill models discussed in the above section, but with an outer layer of SM-B (the rocks analyzed in the above section) applied as described in the paragraph above and cohesion in the DG reduced to 0. In spite of the total absence of C in the DG, the presence of SM-B produced a FOS of 1.4. This indicates numerically that the benefit of the SM-B is not just to erosion protection, but also to global slope stability, which is important because cohesion in DG is highly variable and, therefore, is not a very reliable parameter.

Table 5. Depth to select material by station. Most material is select B (SM-B). Select A (SM-A) is highlighted in blue. Asterisks indicate excavation geometry different than typical. See Plate 12 cross-sections for geometry.

STATION	Depth (ft) to B Material	STATION	Depth (ft) to B Material	STATION	Depth (ft) to B Material	STATION	Depth (ft) to B Material	STATION	Depth (ft) to B Material
224+75	5	235+75	10	246+50	12	260+25	9	283+00	14
225+00	5	236+00	10	246+75	12	260+50	9	283+25	12
225+25	5	236+25	10	247+00	12	260+75	9	283+50	12
225+50	5	236+50	10	247+25	12	261+00	9	283+75	10
225+75	5	236+75	10	247+50	12	261+10to265+65:no B		283+85to287+40:no B	
226+00	5	237+00	10	247+75	12	265+50	10	287+25	14
226+25	5	237+25	10	248+00	12	265+75	10	287+50	14
226+50	5	237+50	10	248+25	12	266+00	10	287+75	14
226+75	5	237+75	10,8*	248+50	12	266+25	10	288+00	14
227+00	5	238+00	10,8*	248+60to249+30:no B		266+50	10	288+25	14
227+25	5	238+25	10,8*	249+50	12	266+75	10	288+50	14
227+50	5	238+50	10,8*	249+75	12	267+00	10	288+75	14
227+75	5	238+58	10,8*	250+00	12	267+25	10	289+00	14
228+00	5	238+75	10	250+25	12	267+50	10	289+25	14
228+25	5	239+00	10	250+50	12	267+75	10	289+50	14
228+50	5	239+25	1	250+75	12	268+00	10	289+75	14
228+75	5	239+50	10*	251+00	12	268+25	10	290+00	14
229+00	4	239+75	10	251+25	12	268+50	10	290+25	14
229+25	4	240+00	12	251+50	12	268+75	10	290+50	14
229+50	4	240+25	12	251+75	12	269+00	10	290+75	14
229+75	4	240+50	12	252+00	12	269+25	10	291+00	14
230+00	4	240+75	12	252+25	12	269+50	10	291+25	14
230+25	4	241+00	12	252+50	12	269+75	10	291+50	14
230+50	4	241+25	12	252+75	12	270+00	10	291+65to293+40:no B	
230+75	4	241+50	12	253+00	12	270+25	10	293+25	12
231+00	4	241+75	12	253+25	12	270+50	10	293+50	12
231+25	4	242+00	12	253+50	12	270+75	10	293+75	12
231+50	4	242+25	12	253+75	12	271+00	10	294+00	12
231+75	4	242+50	12	254+00	12	271+25	10	294+25	12
232+00	4	242+75	12	254+10to256+90:no B		271+50	10	294+50	12
232+25	4	243+00	12	256+75	9	271+75	10	294+75	12
232+50	4	243+25	12	257+00	9	272+00	8	295+00	10
232+75	4	243+50	12	257+25	9	272+25	7	295+25	10
233+00	5	243+75	12	257+50	9	272+50	7	295+50	10
233+25	5	244+00	12	257+75	9	272+60to260+35:no B		295+75	10
233+50	8	244+25	12	258+00	9	280+25	7	296+00	10
233+75	4*	244+50	12	258+25	9	280+50	7	296+25	8
234+00	4*	244+75	12	258+50	9	280+75	12	296+50	6
234+25	4	245+00	12	258+75	9	281+00	10	296+75	4
234+50	4	245+25	12	259+00	9	281+25	10	297+00	3
234+75	10	245+50	12,8*	259+25	9	281+35to282+40:no B		297+25	3
235+00	10	245+75	12	259+50	9	282+25	14	297+50	3
235+25	10	246+00	12	259+75	9	282+50	14	297+75	3
235+50	10	246+25	12	260+00	9	282+75	14	298+00	0

Designation of the location of SM-B was determined through a combination of geological reconnaissance and mapping, together with interpretations of seismic refraction results. Boundaries were then drawn in the field by OGDN directly onto cut slope cross-sections spaced at 25-foot station intervals provided by the project design team. These were then entered into the design software to produce cut slope cross-sections with the Select B material boundaries shown. These cross-sections are shown in Plate 12. These SM-B borrow locations exist in a majority of the cut slopes in the Lower Project Area. This plate also shows the depth from the surface to the select material for each station interval. These depths are typically determined perpendicular to the slope of the original ground, based on the fact that the weathering front for the geo materials typically moves into the slope in a direction perpendicular to the slope face, since the weathering front is more or less parallel to the original slope face. There are exceptions to this principal, particularly when there has been sloughing or failures within the existing slope or if the geology has been determined by field reconnaissance and/or seismic refraction to be inconsistent with such a weathering model.

Calculations by the design team have determined that the SM-B material delineated within the cross-sections shown in Plate 12 should yield about 249,093 $yards^3$ of SM-B. Calculations by the design team also indicate that about 149647 $yards^3$ of SM-B material will be required to properly encapsulate all 7 fills.

SM-B material should not be placed on the fill slope as a later veneer after the fill has been constructed. SM-B material shall be placed in horizontal lifts simultaneously with the general fill material, lift for lift, so that the individual lifts of the general fill material and the horizontally juxtaposed SM-B material are intertongued and compacted simultaneously. There shall be no rock larger than 2 feet (maximum diameter) within the SM-B encapsulation material when it is compacted on the fill. A schematic showing the encapsulation and its lift-by-lift placement is shown in Plate 13.

8.2.4 Embankments - Founding and Settlement

All the large primary fills are located in the upper project area where they are founded on DG sediments overlying granitic bedrock. Based on borings performed over the past 30 years (USBR, 1965; SHN, 2002; Graves, 2010) and field reconnaissance and observations of the founding slopes and incised thalwegs within the DG below the roadway by OGDN, it is estimated that the DG founding conditions generally involve about 5 to 15 ft of residual soil, which overlies roughly another 5 to 100 ft of decomposed to moderately weathered DG before encountering fresh granite. Refraction results beneath Fill 3, which is the second largest fill in the project with a maximum vertical height of 135 ft and a maximum toe-to-top height of 174 ft, indicate that the fill will be founded upon roughly 5 to 8 ft of DG-derived sands that overlie about 22 to 25 ft of highly weathered DG. Hard, sound granite (Seismic V_p = 9708 ft/s) lies at a depth of about 30 ft. OGDn considers these to be relatively good founding conditions because the compressible material (DG-derived sands) is not only relatively thin but it is also composed of sand, which will compress almost instantaneously during fill construction.

Each of the 7 fills constructed on these general founding conditions will likely undergo no more than 2 inches of settlement concurrent with fill construction due to the compaction of the founding material (sands).

Fill 8, which is located in the eastern end of the lower project area, is founded on competent bedrock slopes and will experience negligible foundation settlement.

Post-construction settlement activity within the compacted fills is expected to be minimal. The 93% relative compaction requirement recommended for these fills should minimize internal settlement, and the general granular nature of both the fill material and the sandy material overlying the bedrock will settle almost exclusively concurrent with construction.

8.2.5 Embankments-Erosion

With over 75 percent of the fill material planned for this project being composed of DG-derived sands, the fills would be expected to be extremely susceptible to erosion if left unprotected, even to the point of fill failure or loss, particularly if surface flow were to be misdirected during a significant storm event on to unprotected DG surfaces. Such erosion could result in the loss of more than just the roadway portion of the fill within a single large storm event. Lesser flows, such as overland sheet flow, could also destroy an unprotected DG fill over a series of a few storms.

In contrast to the unprotected erosion scenarios discussed above, fills constructed with a thick encapsulation of Select Material B (SM-B) will be substantially armored and protected against erosion, even though the entire interior is composed of DG-derived material. All the primary fills (1 through 7) should be encapsulated by 9.2 horizontal feet (5 ft thick perpendicular to the slope face) of SM-B. This material should be laid down and compacted simultaneously with the general fill material, lift by lift. SM-B should not be placed on the slope face as a later side-cast veneer.

Fill 8, which is located at the eastern end of the lower project area, does not require such encapsulation, primarily because it is assumed that it will be constructed of material excavated nearby from within the lower project area, material that is mostly rocky.

The top unpaved, horizontal to sub-horizontal, fill surfaces of the major fills, as well as the smaller grade-elevating fills, should be armored to protect their surfaces against erosion and rilling with a minimum of 6 inches of compacted (90%) Select Material A (SM-A) atop these surfaces.

8.2.6 Embankments - Drainage

As mentioned before in section 7.3, a few seeps were observed in some of the larger drainage basins that lie at the base of the founding areas of some of the primary fills. As a standard precaution against interior erosion of the fills due to piping, the primary thalwegs of all drainages beneath all 7 primary fills should have drainage systems installed between the existing ground and the new fill. These systems systems involve four primary sections:

1) an underdrain system that collects water and directs it down the existing thalweg (beneath the future fill), 2) collectors or joints that combines these underdrains together, 3) a central underdrain that directs the water down the central thalweg and discharges it beyond the toe of the fill, and 4) a small energy dissipator at the point of discharge that prevents erosion. The tributary and central underdrain systems should consist of an 8-inch perforated pipe surrounded by an annular minimum of 8 inches of angular drain rock that is then wrapped in non-woven type B RSP fabric. The collectors or joint areas should consist of the same materials as the underdrains.

Present culverts in the locations of the future fills should be properly abandoned (concreted and plugged) to prevent groundwater from finding them and focusing water directly at the foundation of the future fills.

9. Construction Considerations

9.1 Construction Advisories

Prior to cutting slopes, vegetation should be completely cleared and grubbed within the excavation and fill slope lines to prevent organics from being included in fill material. Trees larger than 6" at chest height that are situated within 5 feet outside of the excavation lines should also be cut. Smaller vegetation may remain in place in this area outside of the cut zone. Stumps from the trees cut within this 5-foot zone shall be left in place at a height of 10 inches to 24 inches above the surrounding ground.

Cuts excavated during the first and second season of construction should be allowed to weather the following rainy/wet season without cover or protection. Appropriate and necessary BMP and storm water protection measures should be in place below them and proper BMP methods should be followed to prevent sediment discharge violations. This exposure of the unprotected cuts to the weathering season is intended to instigate the sloughing processes of the DG cut slopes that are expected to occur during the first post-cutting wet season, and expose any localized planar weaknesses, failures, or rockfall issues that the SMV rock cut slopes may possess. Following the wet season, cut slopes shall be evaluated by OGDN and the Office of Construction to determine which slopes might require trimming, additional cutting, and or scaling during the final construction season. In addition, trees located near the top hinge points of some cut slopes may be deemed problematic after undergoing the interim wet season, and shall be designated for cutting during the following construction season. Problematic trees include those that appear likely to fall soon, and those that are close enough to a newly developed edge (from wet season sloughing) that they could act as levers under the force of winds to cause the top of slope to fail further.

Cut slopes in the SMV rocks (lower project area) are likely to shed some rockfall during construction, so appropriate caution around these cuts should be exercised.

9.2 Construction Considerations that Influence Design

If possible, project staging, and possibly specifications and plans, should be formulated so that as many DG cut slopes can be excavated as possible before the final construction season. This will allow the maximum amount of cut slope exposure to precipitation, which will help to expose any weaknesses in the new cut slope so that it can be addressed during the final construction season before traffic is put beneath it.

9.3 Construction Monitoring

Cut slopes should be monitored visually during excavation, primarily to look for loose rock or sections of rock that might pose a hazard for construction workers. Such monitoring will also serve to detect problems early, should they arise, so that changes, if necessary, to the cut slope design may be implemented as early in the construction process as possible. Visual monitoring basically entails observing the slope above a cut and looking for cracks and fissures that are precursory to tension cracks that would indicate potential slope failure or sloughing. Visual monitoring also entails observation of the cut face for cracks and notable shifts of material.

Periodic visual monitoring of the cut slopes and the areas in front of them through the wet season is considered necessary to make sure that BMP installations are not destroyed, rendered useless by sloughing, or overloaded by erosional debris, and that they are functioning as intended. This monitoring is also important so that cut slope evolution can be observed and understood in order to better plan for any possible trimming or additional cutting that may be required.

9.4 Differing or Problematic Site Conditions

Should differing site conditions arise during construction please contact ODGN.

10. Recommendations and Specifications

10.1. Cut Slopes

- Prior to cutting slopes, it is recommended that trees larger than 6" at chest height that are situated within 5 feet (outside) of the excavation lines be cut. Stumps from trees cut within this 5-foot zone shall be left at a height of 10 inches to 24 inches above surrounding ground.

- Recommended cut slope ratios for the DG cut slopes, which involve all cuts in the upper project area, are almost entirely 0.75:1. The upper 15 ft of a few DG cuts shall be cut at 1:1. See tables in Appendix E for specific station by station recommendations.

- Recommended cut slope ratios for the middle project area are 0.75:1 (station 173+25 to 176+00 and 176+75 to 179+25) and 1:1 for station 180+00 to186+00.

- Recommended cut slope ratios for the lower project area are 1:1, 0.75:1, 1:1 above 0.75:1 (dual slope ratio cut slope), and 0.75:1 above 0.5:1 above 0.3:1 (triple slope ratio cut slope). See tables in Appendix E for specific station by station recommendations.

- 20-foot wide benches are recommended for the mid-slopes of Cut 7, Cut 12, and Cut 21. The bench in Cut 21 also serves as a section of the Lewiston Road. Benches on Cuts 7 and 12 should be sloped back towards the cut face at 10:1 or steeper. The bench/road on Cut 21 should be outsloped at 2%. Longitudinal slope on the benches at Cuts 7 and 12 can be steep if necessary, since these are not intended to be fully accessed by maintenance forces.

- It is recommended that as many cut slopes as possible be cut early in the project and then be allowed to overwinter unprotected during the interim wet seasons of the three year construction phase.

- Blasting, if chosen by the contractor as a means of excavating any cut slope, must be performed subject to controlled blasting and presplitting specifications such as those provided in the SSP for rock excavation. We recommend to the Office Engineer that the Roadway Excavation SSP be modified so it refers the contractor to the rock excavation specification involving pre-splitting techniques. Regardless of whether the contractor elects to blast or not, we recommend that all excavation be lumped under roadway excavation, not rock excavation, and that specifications are amended accordingly for this job to make it clear that payment for all excavation is at the roadway excavation price, regardless if blasting is performed or not. For purposes of bidding, this report (as part of the materials handout) provides estimates regarding the variability in rippability (section 8.1.2) that can be expected, and upon which the contractor can base his bid.

- Temporary BMP's are recommended at the bottom of all excavated cut slopes during the interim construction wet season.

- We recommend that temporary sand traps be specifically designed and put in place during the construction phase to capture sediment expected during the interim wet seasons.

- It is recommended that permanent BMP's and sand traps be installed near the end of the final construction season to prevent sediment discharge into waterways leading to Willow Creek. These shall be designed for the long-term and to be reasonably serviceable by maintenance forces.

- Minimum 8-foot wide paved shoulders with a 5 to 8% backslope are recommended at the base of all cut slopes in the upper project area for slough catchment.

- Minimum 8-foot wide unpaved shoulders with a 5 to 8% backslope are recommended at the base of all cut slopes in the Middle Project Area and the Lower Project Area for rockfall catchment. In many locations within the lower Project Area significantly wider catchments are recommended. See Appendix E for station by station specifics.

10.2 Embankments

- It is recommended that the 7 major fills proposed for this project be constructed at a slope ratio of 1.5:1 and that they be compacted to at least 93% compaction (CTM216).

- It is recommended that Select Material B (SM-B) be used to encapsulate the outer 9.2 horizontal ft (5 ft perpendicular to face) of all 7 primary fill slopes.

- It is recommended that Select Material A (SM-A) be used to protect certain other fill surfaces as shown in the plans. It is recommended that SM-A be excavated from Cut 7 between the station interval 227+50 to 228+50 as shown in the plans and discussed in section 8.2.3. The recommended gradation and quality specifications for SM-A are presented in Table 3 in Section 8.2.3.

- It is recommended that Select Material B (SM-B) and Select Material A (SM-A) be obtained from those locations designated and shown in cross-section in Plate 12 and described in section 8.2.3. The select material (SM-A & SM-B) should come from the bedrock material at these locations and shall not include grubbed or organic material. Overburden soil lying on top of the bedrock should also be excluded. The same cross-sections showing the dimensions of the SM-B in-situ in Plate 12 are included in the project plans.

- It is recommended that SM-B material be placed in horizontal lifts simultaneously with the general fill material, lift for lift, so that the individual lifts of the general fill material and the horizontally juxtaposed SM-B material are compacted simultaneously as depicted in Plate 13. It is recommended that SM-B material not be placed on the fill slope as a later veneer after the fill has been constructed. It is recommended that no rock larger than 2 feet (maximum diameter) shall be compacted within the SM-B encapsulation material.

- Because the rockiness of SM-B material precludes its amenability to compaction testing by standard methods (CTM216), compaction of SM-B material shall be done by rolling with a compactor a number of passes deemed sufficient in the judgment of the Resident Engineer or two passes, whichever is greater.

- It is recommended that all fill faces (the encapsulating surfaces) be sprayed with some type of hydro seed mulch sometime after the completion of the fill.

- It is recommended that the installation of underdrains within the primary thalwegs that presently exist beneath all the future fills be constructed prior to, or during, fill construction. These shall be constructed according to the details in section 8.2.6, the project plans, and project specifications.

- Present culverts in the locations of the future fills should be properly abandoned (concreted and plugged) to prevent groundwater from finding them and focusing water directly at the foundation of the future fills.

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APPENDICES

APPENDIX A.

Plates 1 –13.

APPENDIX B.

Seismic Refraction Results

APPENDIX C.

Laboratory Tests and Log of Test Borings (LOTB’s) by SHN (2002)

APPENDIX D.

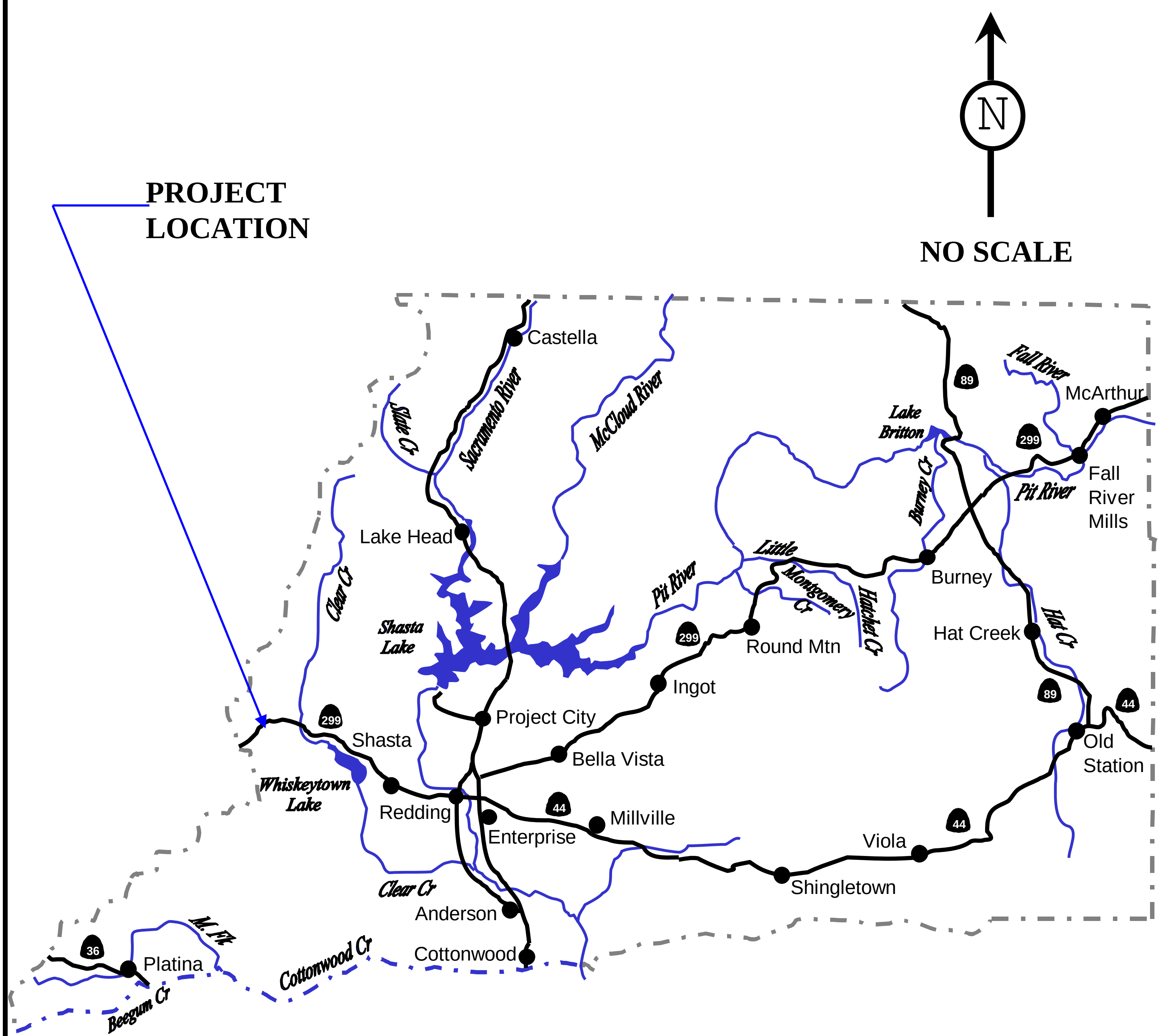
Direct Shear Laboratory Tests (Caltrans, 2013)

APPENDIX E.

Lower Project Area Cut Slope Ratios and Catchment Widths by Station

APPENDIX A

LIST OF PLATES



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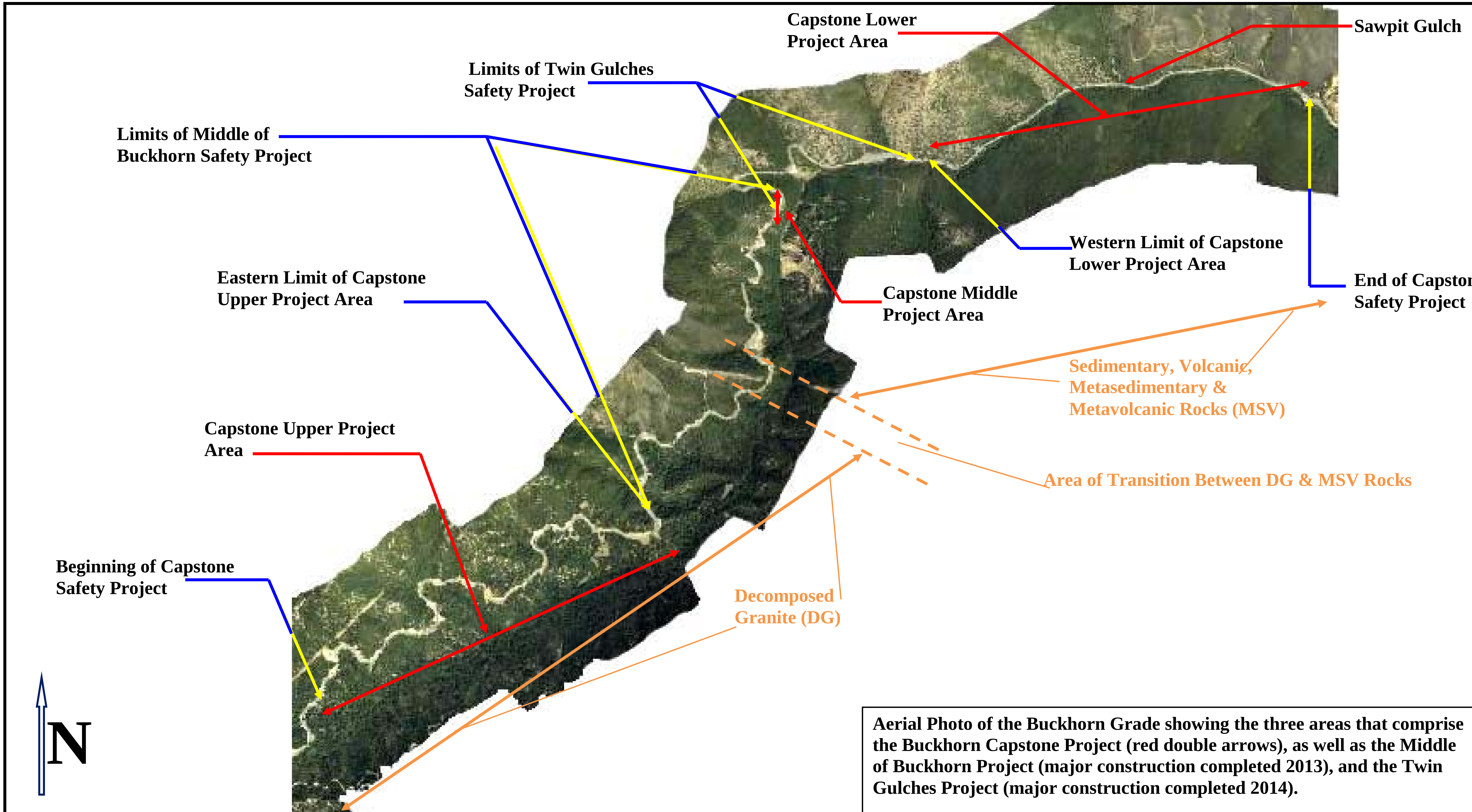
EA: 02-3E4101	**PROJECT LOCATION**	
Date: February 2014		
02-SHA-299 PM 0.3/7.1 GEOTECHNICAL DESIGN REPORT		Plate No. 1



Aerial Photo of the Buckhorn Grade showing the three areas that comprise the Buckhorn Capstone Project (red double arrows), as well as the Middle of Buckhorn Project (major construction completed 2013), and the Twin Gulches Project (major construction completed 2014).

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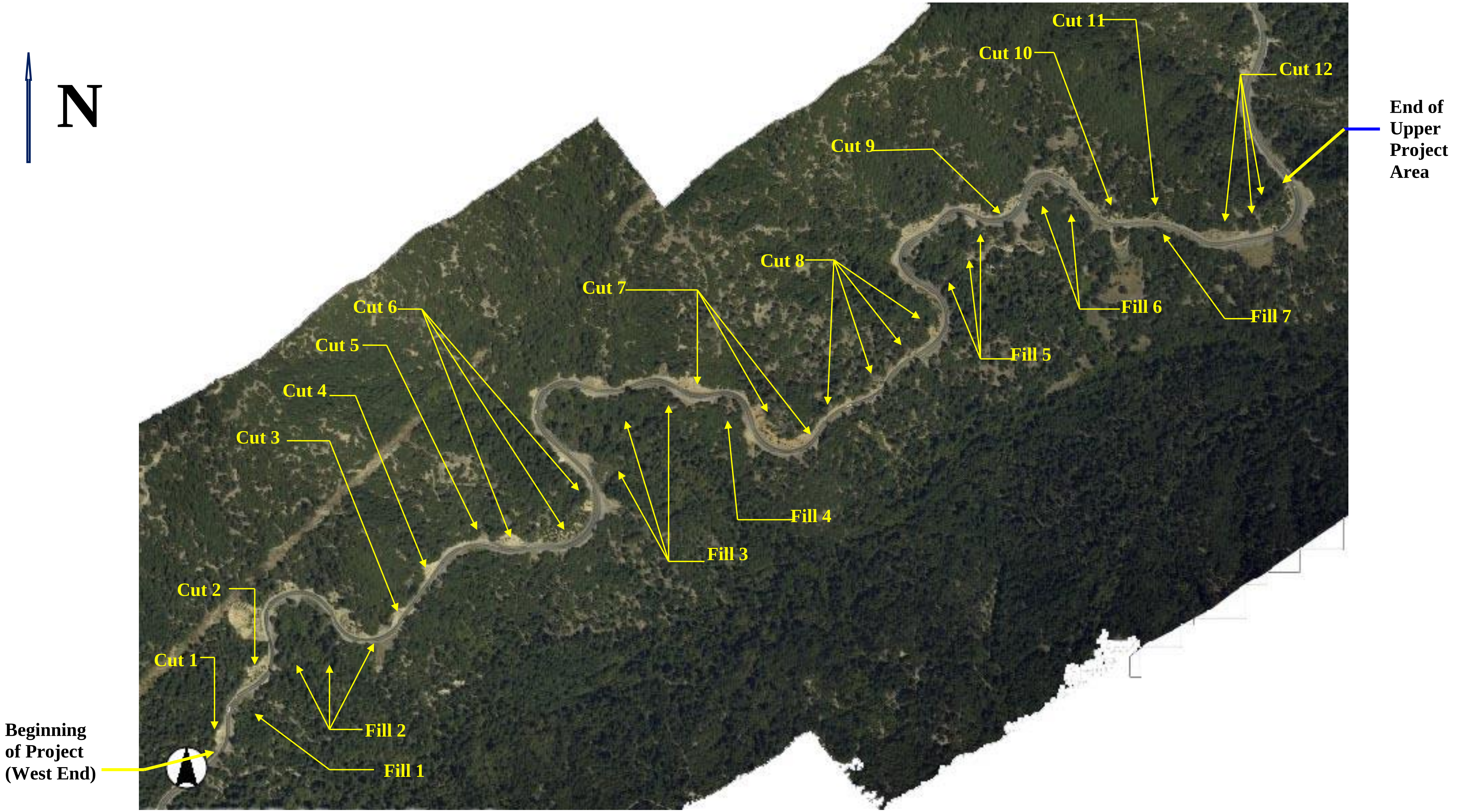
EA: 02-3E4101	AERIAL PHOTO OF CAPSTONE PROJECT AREA	
Date: February 2014		
02-SHA-299 PM 0.3/7.1 GEOTECHNICAL DESIGN REPORT		Plate No. 2



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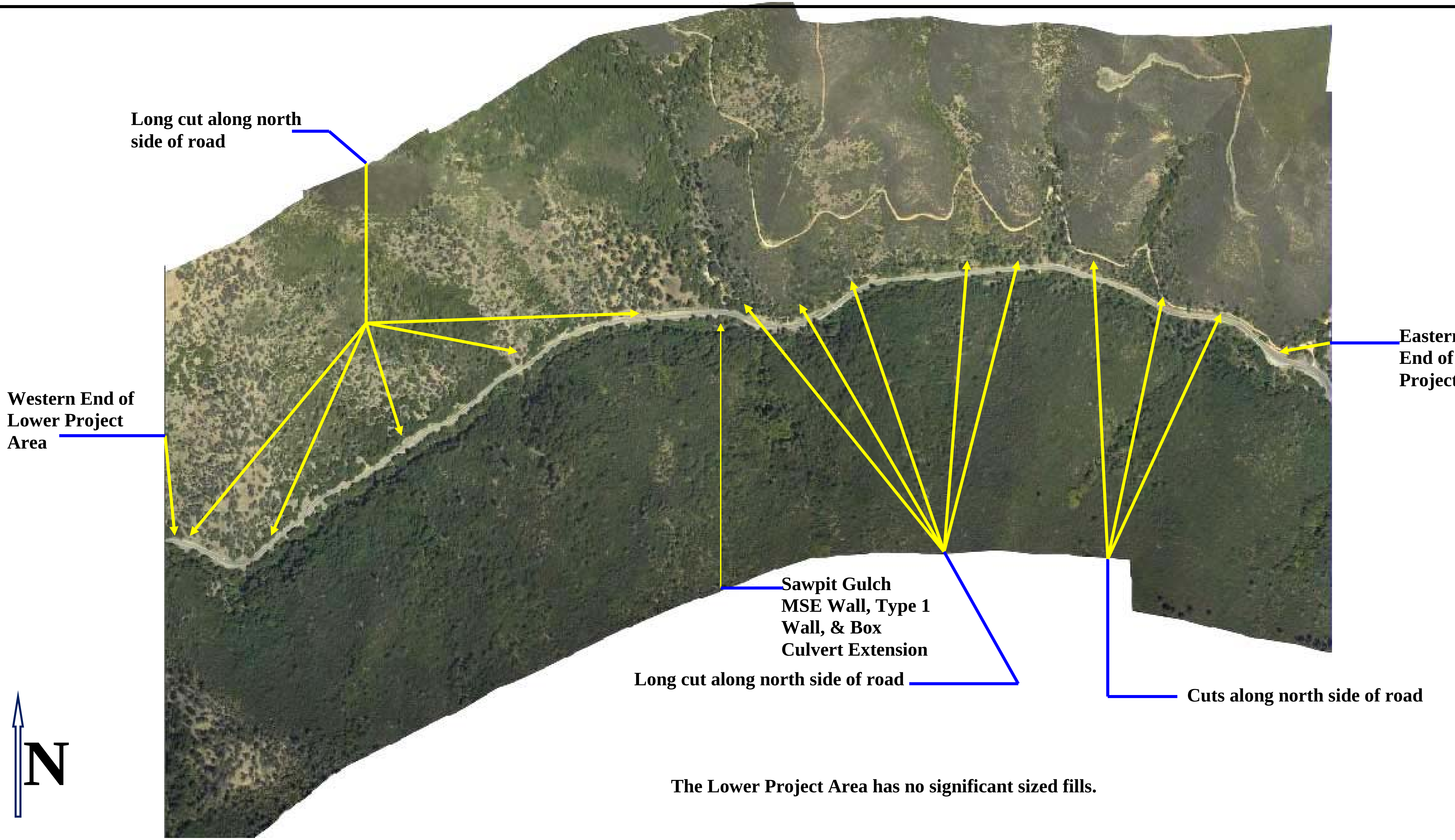
EA: 02-3E4101

Date: February 2014

AERIAL PHOTO OF UPPER PROJECT AREA SHOWING LOCATIONS OF FILLS AND CUTS

02-SHA-299 PM 0.3/7.1
GEOTECHNICAL DESIGN REPORT

Plate No. 3



CALTRANS Division of Engineering Services Geotechnical Services Office of Geotechnical Design-North	EA: 02-3E4101 Date: February 2014	AERIAL PHOTO OF LOWER PROJECT AREA SHOWING LOCATIONS OF CUTS	
	02-SHA-299 PM 0.3/7.1 GEOTECHNICAL DESIGN REPORT		Plate No. 4

EXPLANATION

Geologic Units

Jurassic - Cretaceous

bhgd | bqd

Shasta Bally batholith.
bhgd *biotite hornblende granodiorite & quartz diorite*
bqd *coarse biotite granodiorite & quartz diorite*

gn

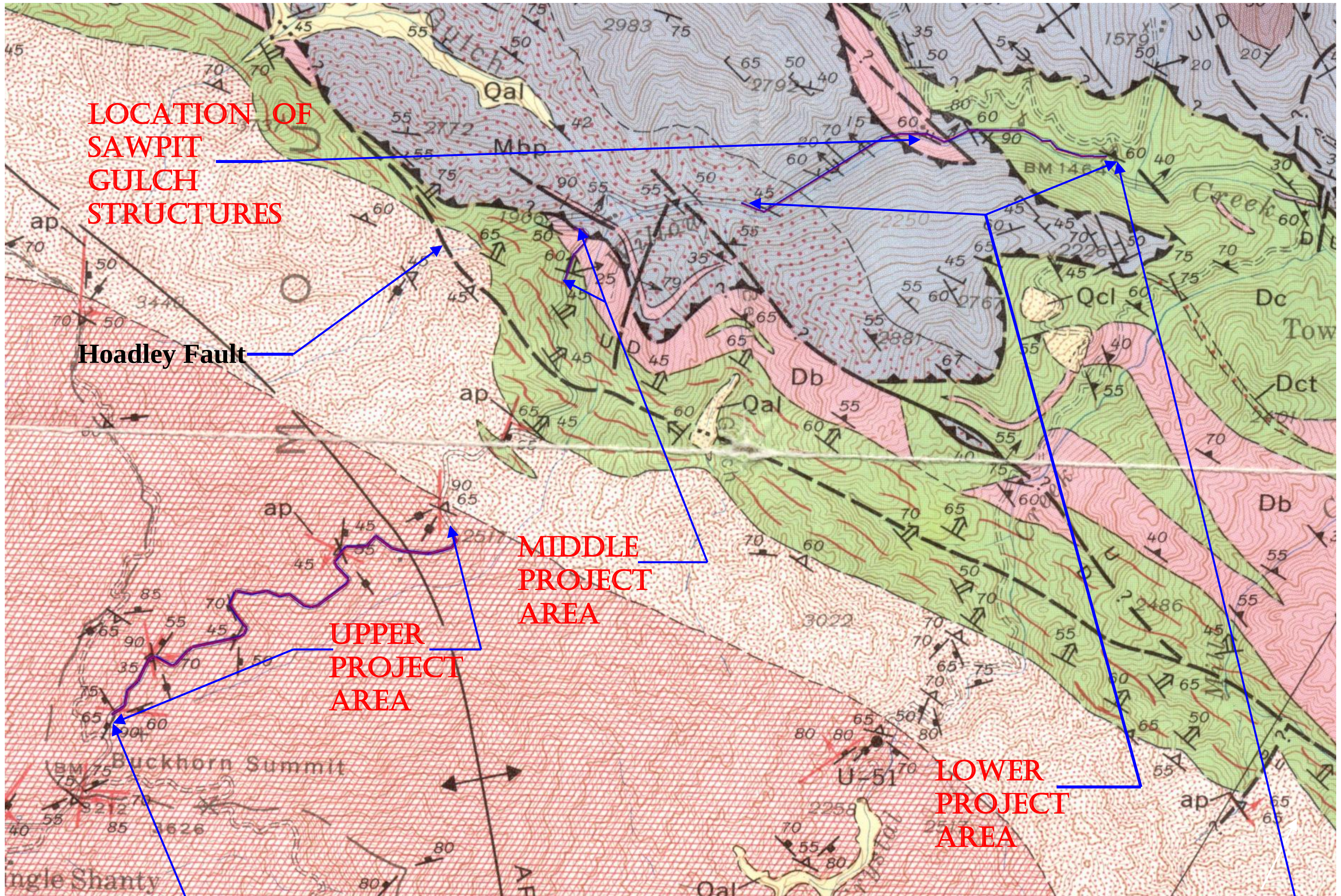
Gneiss and amphibolite derived from Copley, Balaklala and Bragdon Formations.

Mississippian-Carboniferous

Mbp | Mbu | Mbl | Mbc

Bragdon Formation.
Mbp. Phyllite created by contact metamorphism of Bragdon Formation with Shasta Bally Batholith.

Mbl. Consisting mostly of shale, mudstone, and siltstone, with subordinate tuff and conglomerate.



Western Project Limit (Postmile 0.3) **Eastern Project Limit (Postmile 7.1)**

Devonian

Db — **Balaklala Rhyolite.** Non-porphyritic quartz keratophyre and quartz keratophyre containing quartz phenocrysts

Dc, Dct — **Copley Greenstone.**
Dc Keratophyre, spilite, & metaandesite
Dct tuff, shaly tuff, & shale

From *Geologic Map and Section of the French Gulch Quadrangle, Shasta and Trinity Counties, California* in *Geology of the French Gulch Quadrangle, Shasta and Trinity Counties, California* by J.P. Albers, 1964.

N

EXPLANATION

Structural Features

Contact, showing dip
Long dashed where approximately located; short dashed where indefinite; dotted where concealed

Fault, showing dip
Dashed where approximately located; queried where probable; dotted where concealed. U, upthrown side; D, downthrown side

Vertical fault

Spring Creek thrust
Mainly between Bragdon formation and underlying rocks, but in places between Copley greenstone and tuff of the Balaklala rhyolite. Sawteeth on upper plate. Queried where doubtful; dotted where concealed

Plunge of fold axis

Inclined — Vertical
Attitude of beds

Strike and dip of beds and plunge of lineation

Inclined — Vertical
Attitude of schistosity

Strike and dip of schistosity and plunge of lineation

Inclined — Vertical
Attitude of compositional layering in gneiss

Strike and dip of compositional layering in gneiss, and plunge of lineation

Inclined — Vertical
Attitude of primary flow banding in granitic rocks as shown by alined crystals or inclusions

Strike and dip of sheeting

Inclined — Vertical
Attitude of cleavage

Inclined — Vertical
Attitude of joints

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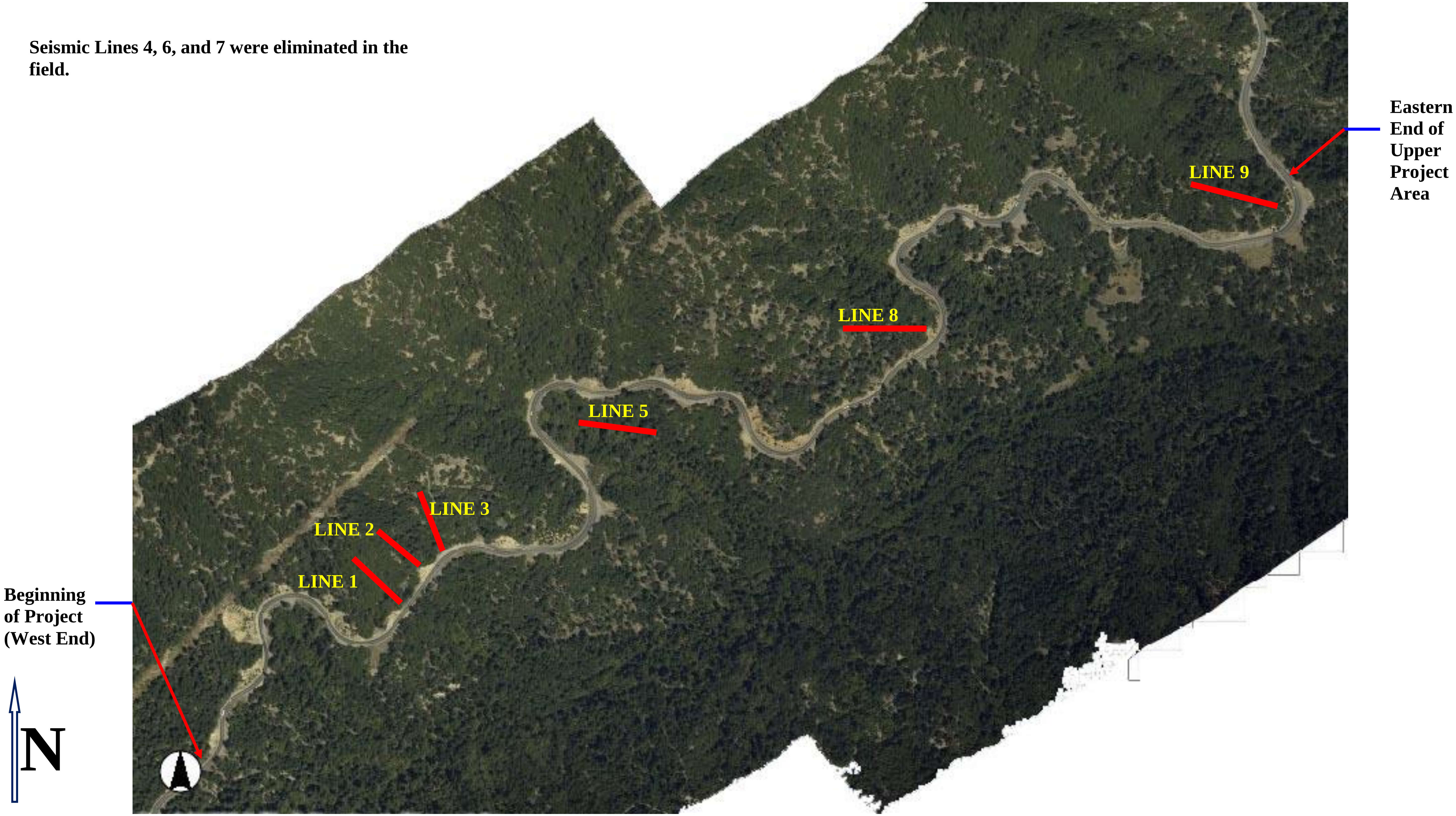
EA: 02-3E4101	**GEOLOGIC MAP OF CAPSTONE PROJECT AREA**	
Date: February 2014		
02-SHA-299 PM 0.3/7.1 **GEOTECHNICAL DESIGN REPORT**		Plate No. 5

Seismic Lines 4, 6, and 7 were eliminated in the field.



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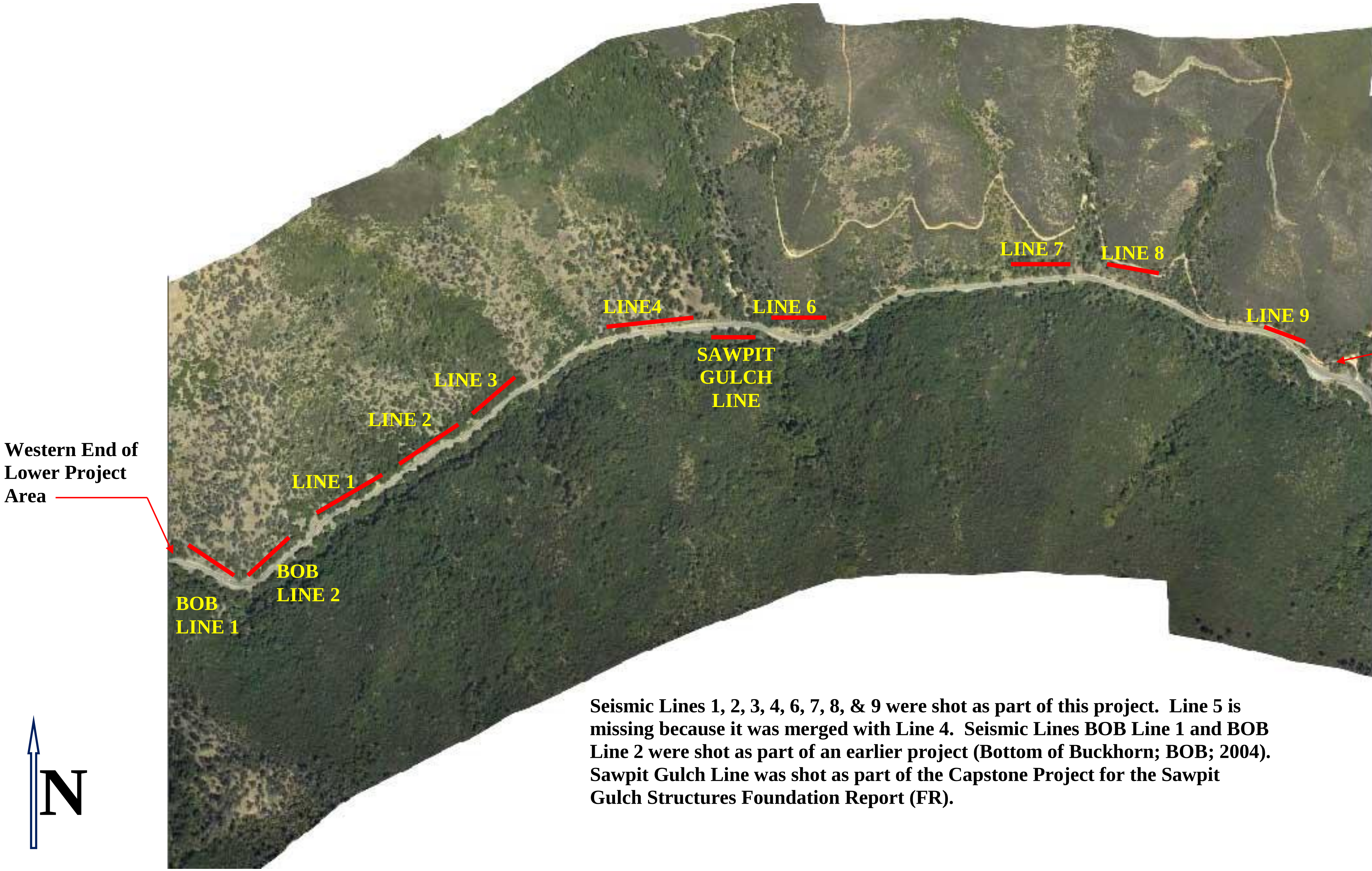
EA: 02-3E4101	AERIAL PHOTO OF UPPER PROJECT AREA SHOWING LOCATIONS OF SEISMIC LINES
Date: February 2014	
02-SHA-299 PM 0.3/7.1 GEOTECHNICAL DESIGN REPORT	Plate No. 6



Seismic Lines 1, 2, 3, 4, 6, 7, 8, & 9 were shot as part of this project. Line 5 is missing because it was merged with Line 4. Seismic Lines BOB Line 1 and BOB Line 2 were shot as part of an earlier project (Bottom of Buckhorn; BOB; 2004). Sawpit Gulch Line was shot as part of the Capstone Project for the Sawpit Gulch Structures Foundation Report (FR).

CALTRANS Division of Engineering Services Geotechnical Services Office of Geotechnical Design-North	EA: 02-3E4101 Date: February 2014	**AERIAL PHOTO OF LOWER CAPSTONE PROJECT AREA w/ SEISMIC LINE LOCATIONS**	
	02-SHA-299 PM 0.3/7.1 **GEOTECHNICAL DESIGN REPORT**		Plate No. 7

Photos of DG Cut Slopes from the Buckhorn Grade.

A) Cut slope is highly sculpted. Weathered corestones lend rugged look to surface and play strong part in shaping face. Location west of project.

B) Moderately weathered DG with numerous unweathered to slightly weathered corestones. Located in upper project area.

C) Coarse grained, slightly to moderately weathered DG. Located in MOB Project Area.

D) Slightly to moderately weathered DG with slightly weathered corestones. Located in upper project area.

E) Moderately weathered DG with two distinct slightly weathered corestones. Located in upper project area.

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	02-SHA-299 PM 0.3/7.1 **GEOTECHNICAL DESIGN REPORT**	Plate No.8

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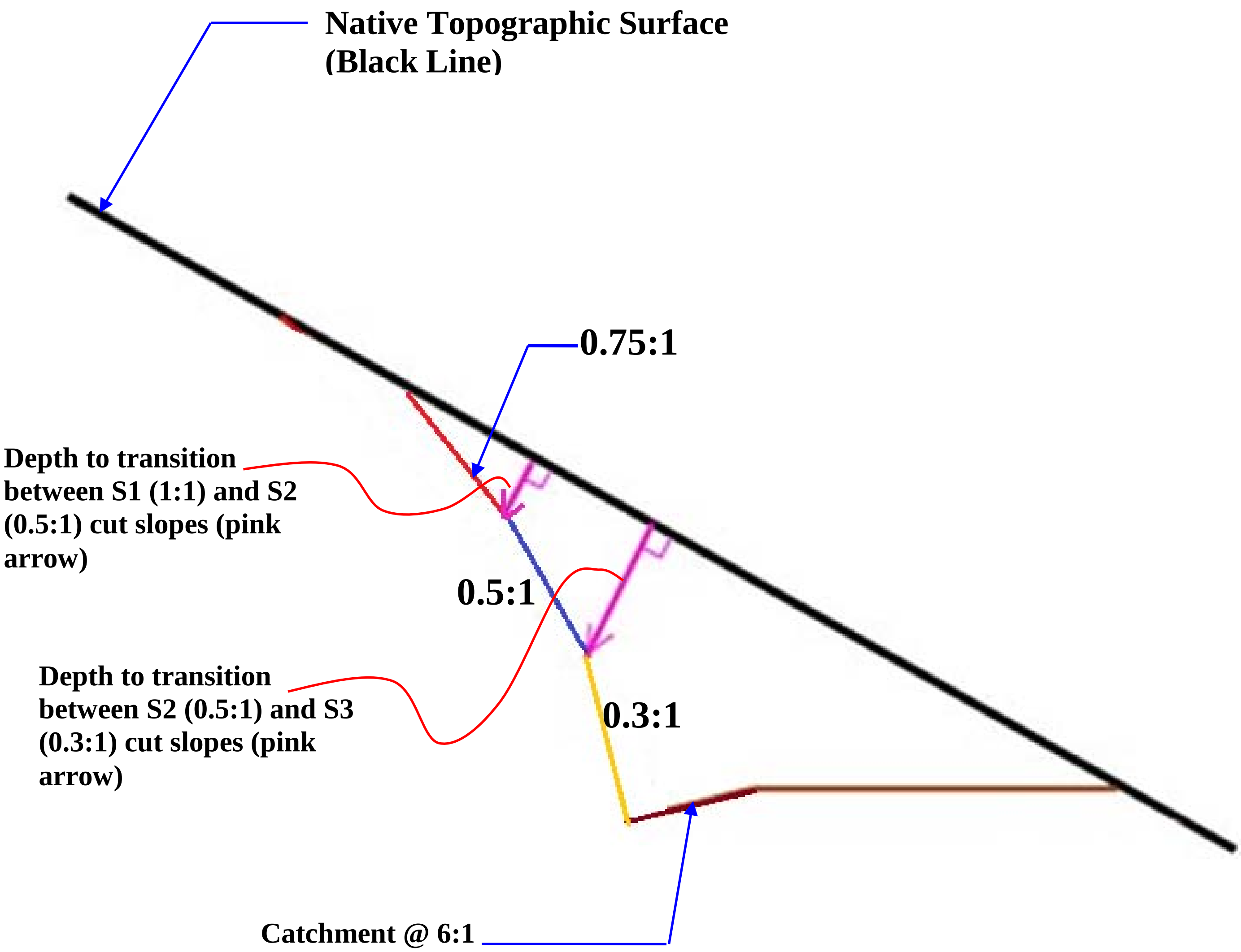
EA: 02-3E4101

Date: February 2014

PHOTO OF APLITE DIKE SWARM IN DG CUT SLOPE

02-SHA-299 PM 0.3/7.1
GEOTECHNICAL DESIGN REPORT

Plate No.9



Cross-Sectional Drawing Showing a Triple Slope Ratio Cut Slope and the Determination of the Transition Depths. The top part of the cut has a slope ratio of 0.75:1 (red), the middle portion of the cut has a 0.5:1 slope ratio (blue), and the bottom of the cut has a 0.3:1 slope ratio (yellow). The catchment has a backslope of 6:1. The depth given in the tables in Appendix E at which a transition between slope ratios occurs is determined perpendicular to the native topographic surface, as is shown by the pink arrows. This is based on the fact that weathering generally decreases and rock quality generally increases with depth parallel to the native topographic surface in the project area. This has been demonstrated in seismic refraction profiles and field observations of existing cut slopes.

CALTRANS Division of Engineering Services Geotechnical Services Office of Geotechnical Design-North	EA: 02-2E4101 Date: February 2014	TRIPLE SLOPE RATIO CUT SLOPE	
	02-SHA-299 PM 0.3/7.1 GEOTECHNICAL DESIGN REPORT		Plate No. 10

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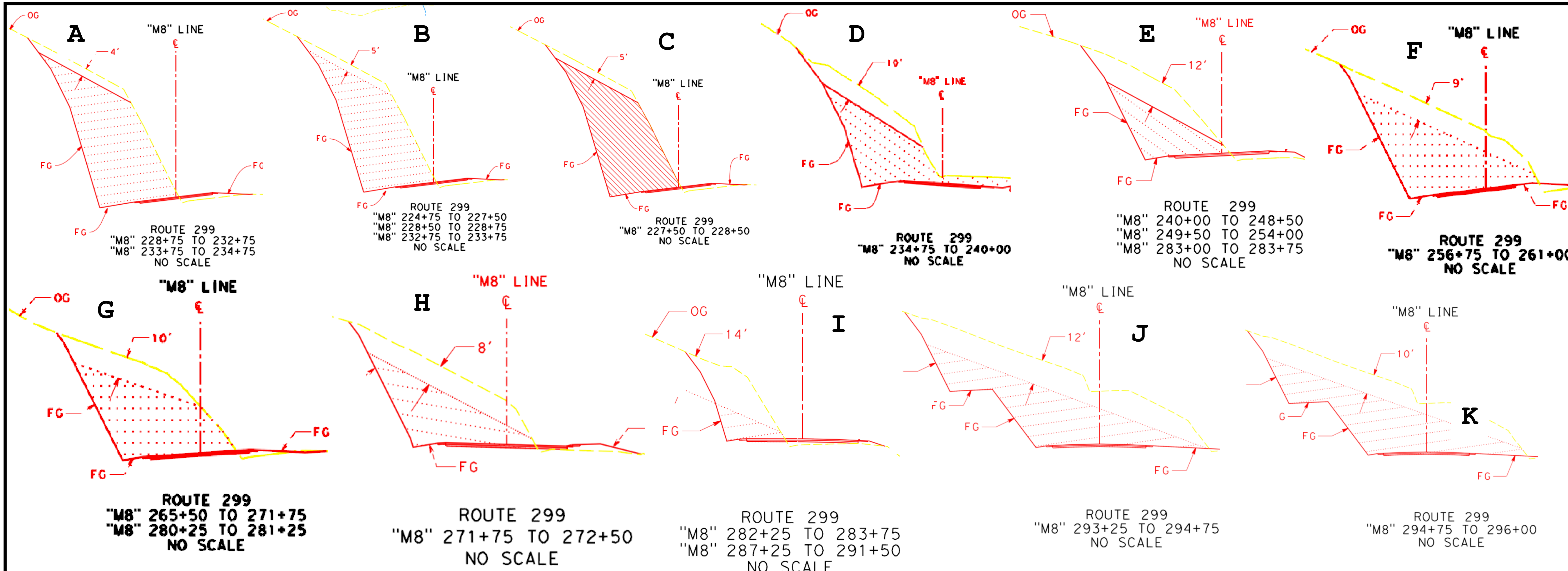
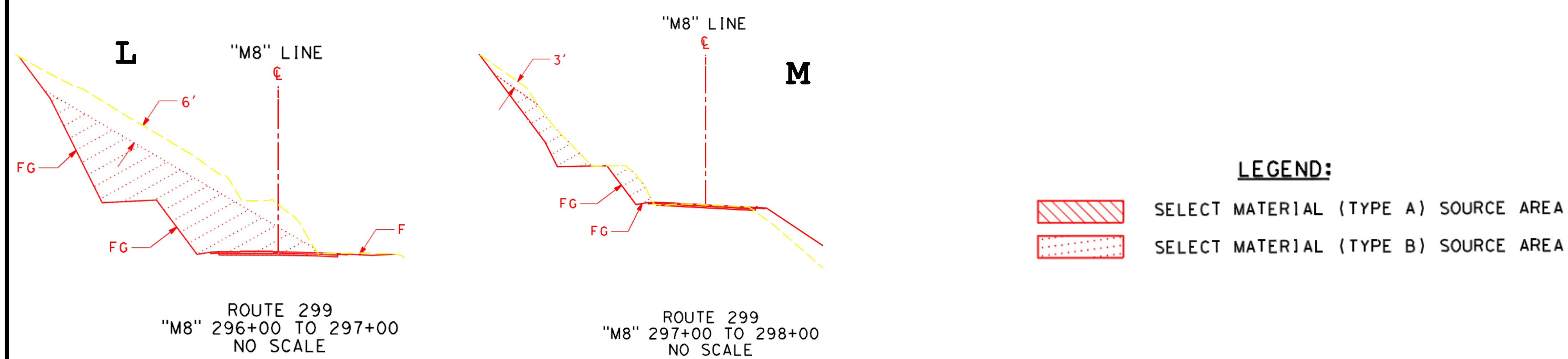
EA: 02-3E4101	**PHOTOS OF EROSION IN DECOMPOSED GRANITE**	
Date: February 2014		
02-SHA-299 PM 0.3/7.1 **GEOTECHNICAL DESIGN REPORT**		Plate No.11





EXPLANATION

Cross-sections showing location of select material within the broader cut slope excavation. Cross-sections are displayed left to right and top to bottom in sequence based on stationing, with higher stations listed as well when the same cross-section applies. All cross-sections except cross-section 'C' show locations of Select B Material. Cross-section 'C' shows location of Select A Material.

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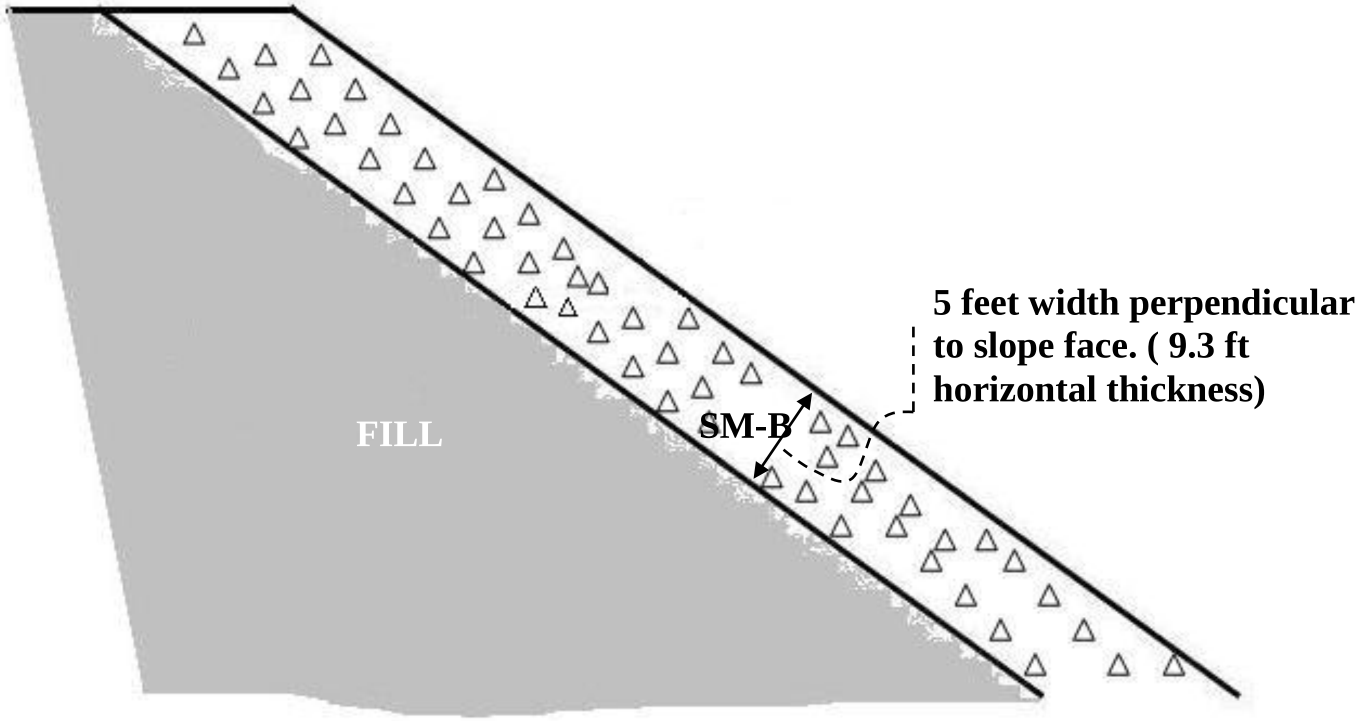
EA: 02-3E4101

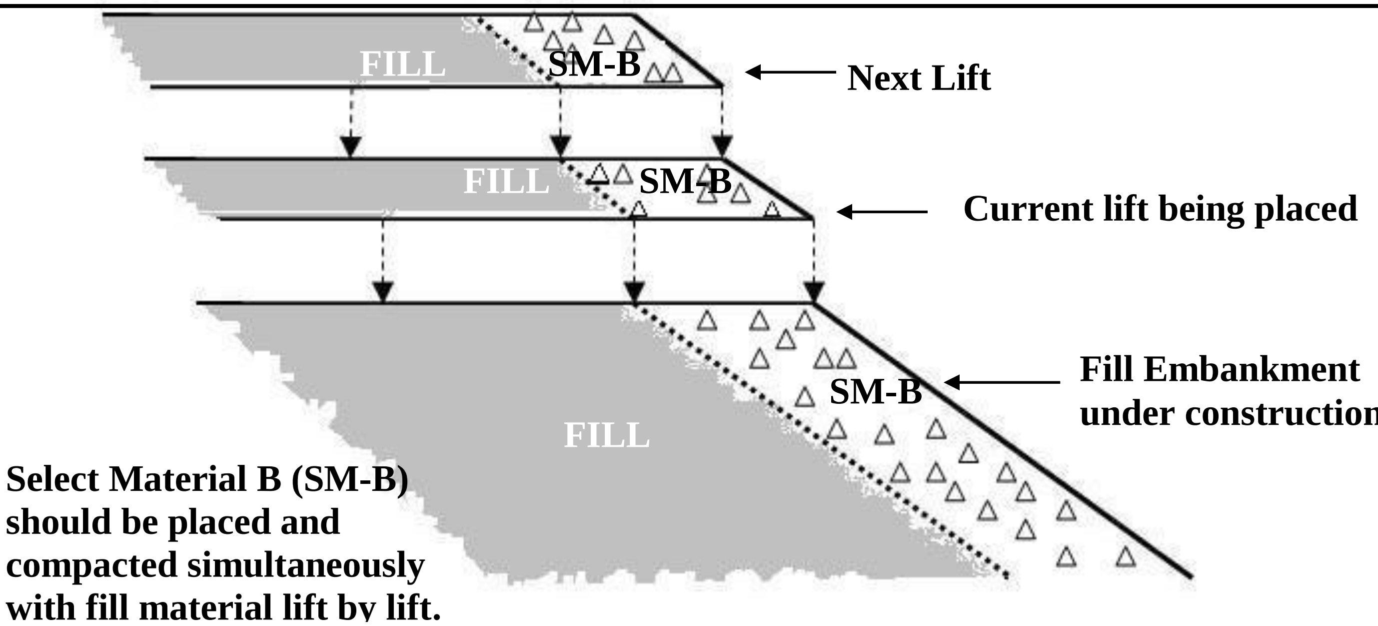
Date: February 2014

SELECT MATERIAL (SM-A & SM-B) LOCATIONS & EXCAVATION CROSS-SECTIONS

02-SHA-299 PM 0.3/7.1
GEOTECHNICAL DESIGN REPORT

Plate No. 12





Fill Encapsulated by Select Material B (SM-B). Upper drawing depicts a fill embankment constructed with fill material encapsulated by 5 ft (Perpendicular to slope face) of compacted SM-B. Lower drawing shows schematically that SM-B should be placed and compacted simultaneously with fill material lift by lift. SM-B is not to be applied as a later veneer. The faces of all fills shall be encapsulated as shown.

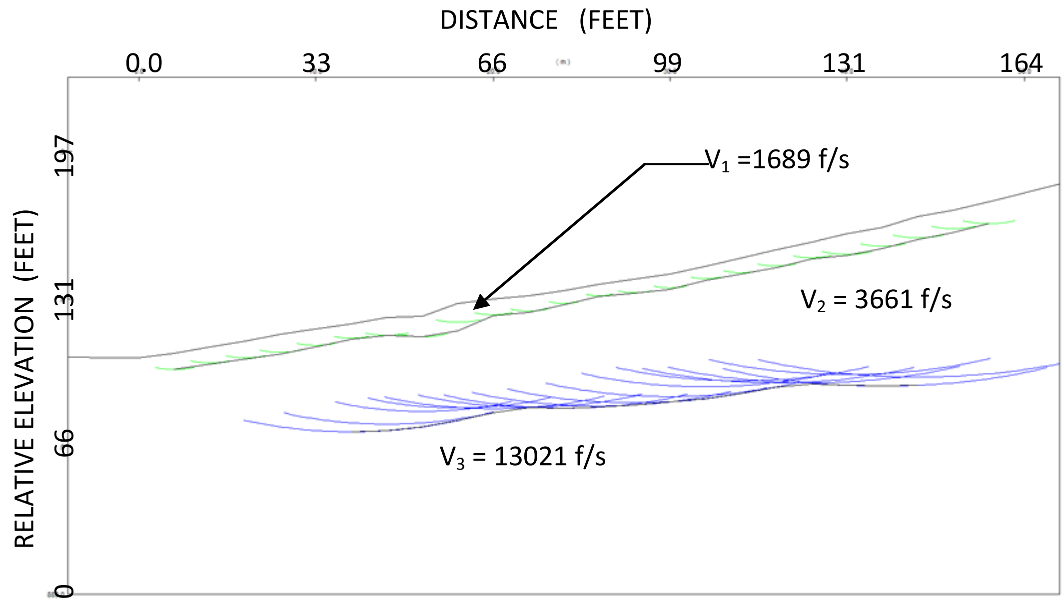
Caltrans CALTRANS Division of Engineering Services Geotechnical Services Office of Geotechnical Design-North	EA: 02-3E4101 Date: February 2014	**FILLS ENCAPSULATED BY SELECT MATERIAL**
	02-SHA-299 PM 0.3/7.1 GEOTECHNICAL DESIGN REPORT	Plate No.13

APPENDIX B

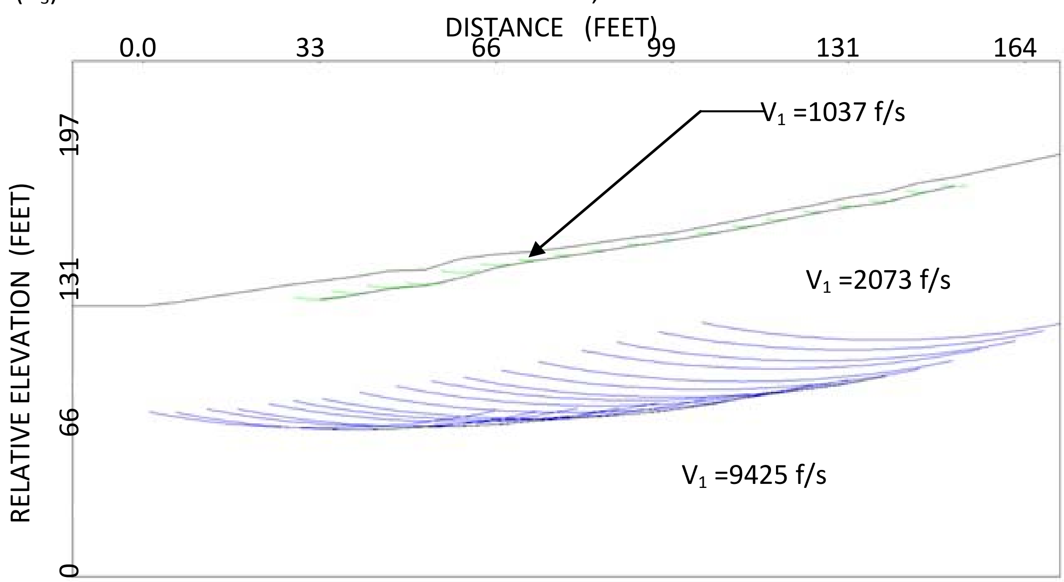
SEISMIC REFRACTION RESULTS

(Data and Processing results provided by Caltrans' Geology and Geophysics Group, 2013)

<u>UPPER PROJECT AREA</u>



Seismic Depth Section with velocities for Upper Area Seismic Refraction Line 1. Depth to unrippable granite(V_3) is about 55 ft. Elevations shown are relative, not absolute.

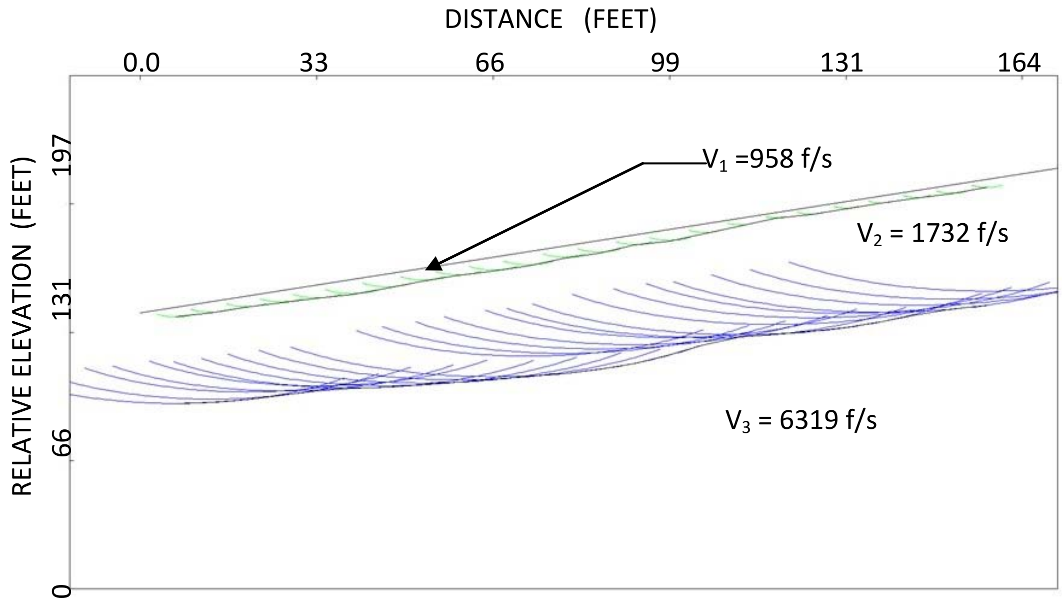


Seismic Depth Section with velocities for Upper Area Seismic Refraction Line 2. Depth to unrippable granite(V_3) is about 75 ft. Elevations shown are relative, not absolute.

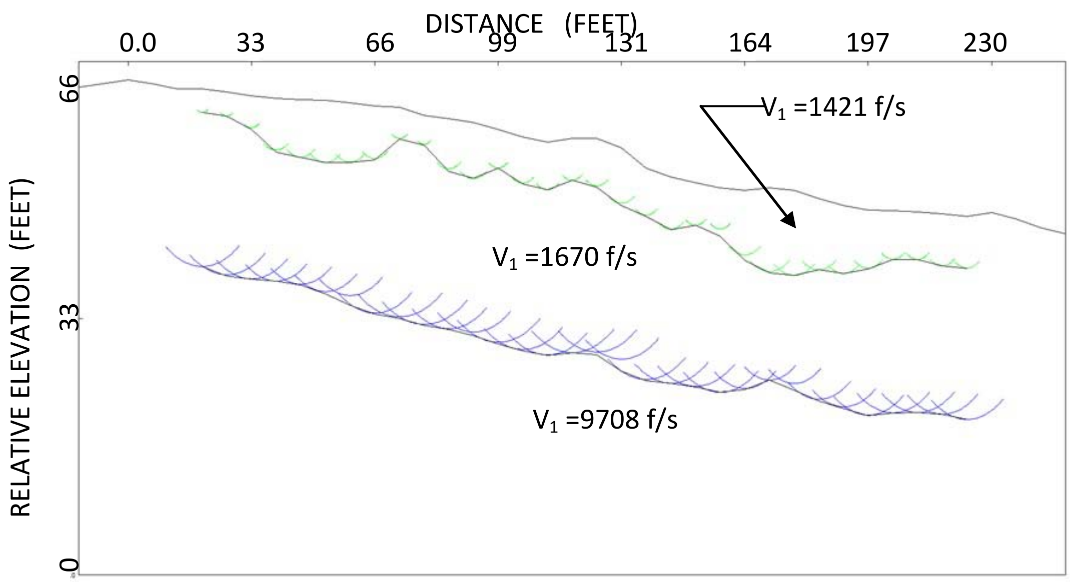
APPENDIX B

SEISMIC REFRACTION RESULTS

UPPER PROJECT AREA



Seismic Depth Section with velocities for Upper Area Seismic Refraction Line 3. Depth to hard DG (V_3) is about 55 ft. Elevations shown are relative, not absolute.

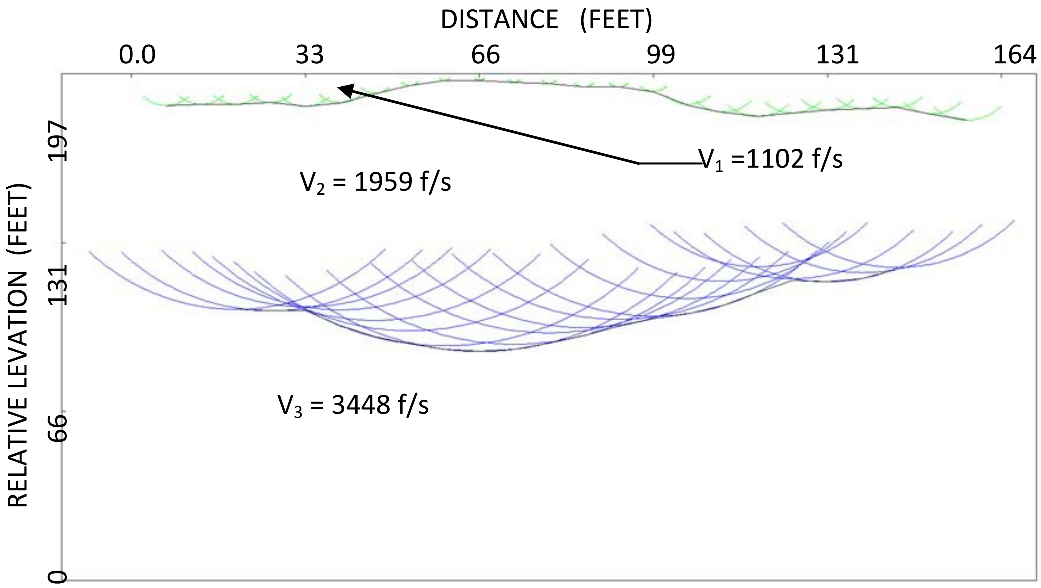


Seismic Depth Section with velocities for Upper Area Seismic Refraction Line 5. Depth to unrippable Granite (V3) is about 30 ft. Elevations shown are relative, not absolute.

APPENDIX B

SEISMIC REFRACTION RESULTS

UPPER PROJECT AREA

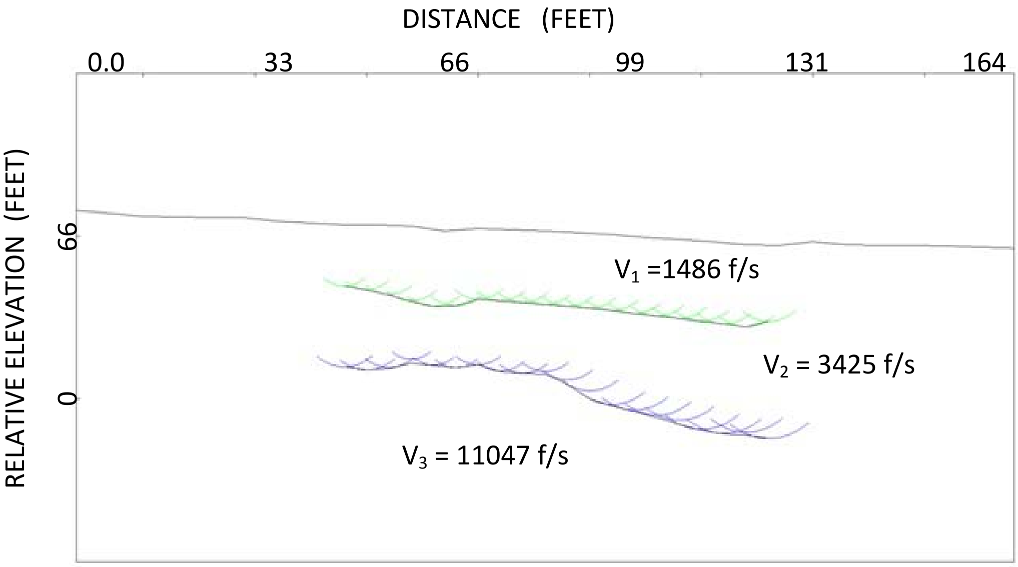


Seismic Depth Section with velocities for Upper Area Seismic Refraction Line 9. Depth to harder DG (V_3) is about 78 to 88 ft. Elevations shown are relative, not absolute.

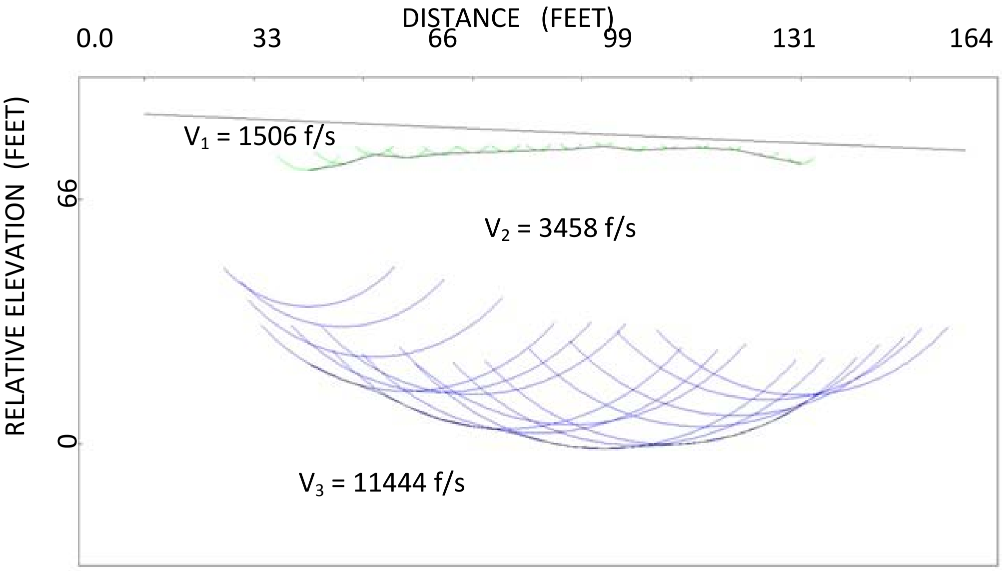
APPENDIX B

SEISMIC REFRACTION RESULTS

<u>LOWER PROJECT AREA</u>



Seismic Depth Section with velocities for Lower Project Area Seismic Refraction Line 1. Elevations shown are relative, not absolute.

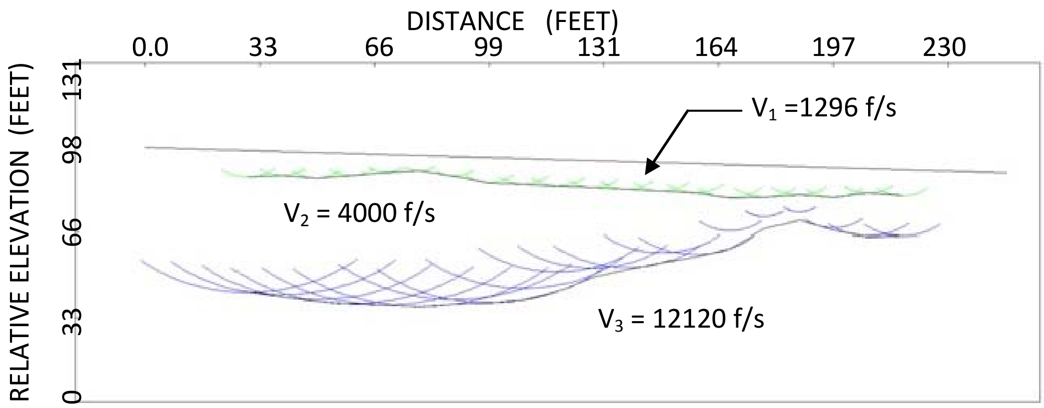


Seismic Depth Section with velocities for Lower Project Area Seismic Refraction Line 2. Elevations shown are relative, not absolute.

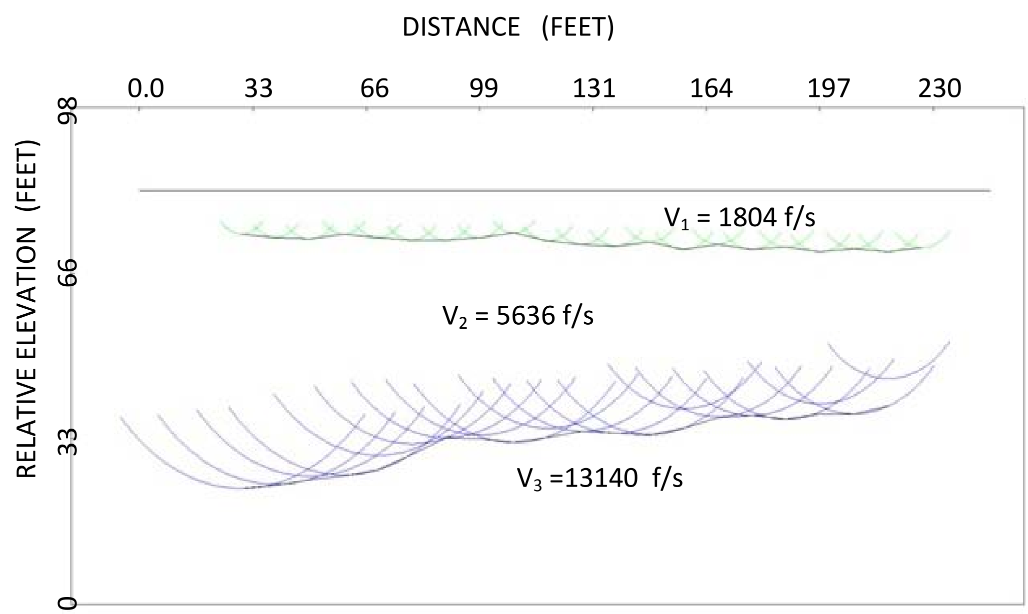
APPENDIX B

SEISMIC REFRACTION RESULTS

LOWER PROJECT AREA



Seismic Depth Section with velocities for Lower Project Area Seismic Refraction Line 3. Elevations shown are relative, not absolute.

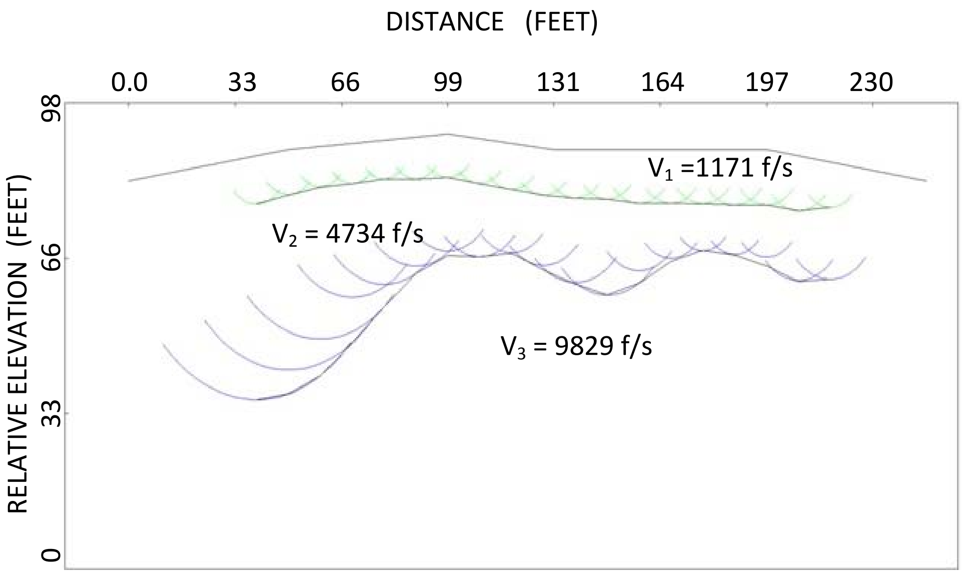


Seismic Depth Section with velocities for Lower Project Area Seismic Refraction Line 4. Elevations shown are relative, not absolute.

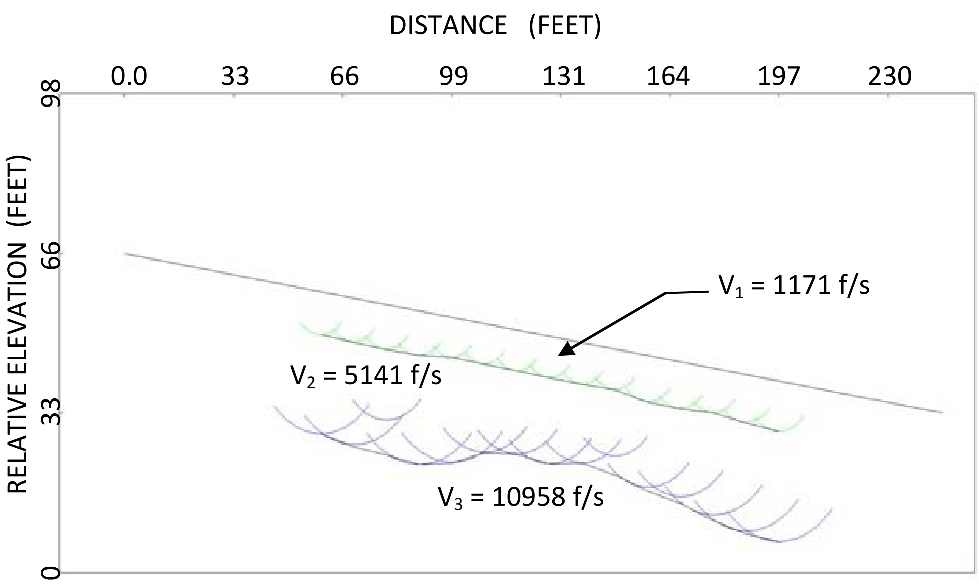
APPENDIX B

SEISMIC REFRACTION RESULTS

LOWER PROJECT AREA



Seismic Depth Section with velocities for Lower Project Area Seismic Refraction Line 6. Elevations shown are relative, not absolute.

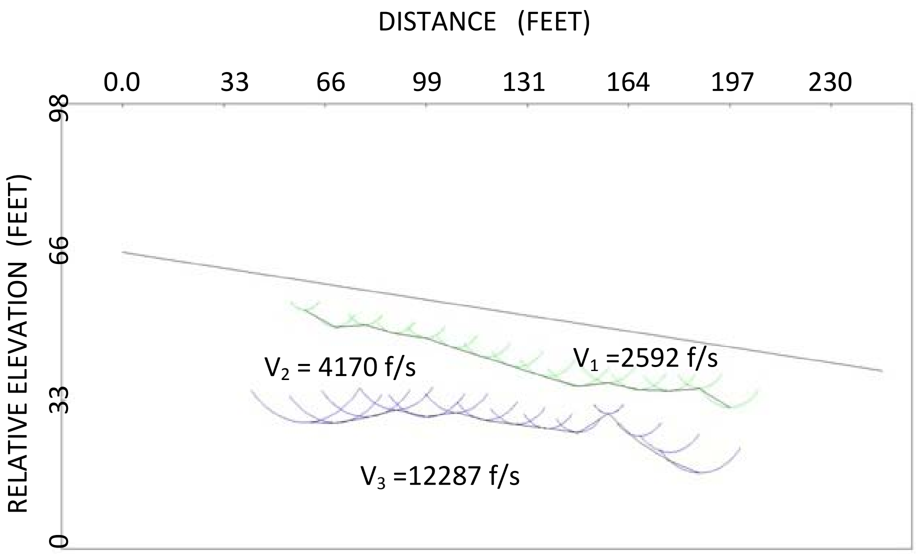


Seismic Depth Section with velocities for Lower Project Area Seismic Refraction Line 7. Elevations shown are relative, not absolute.

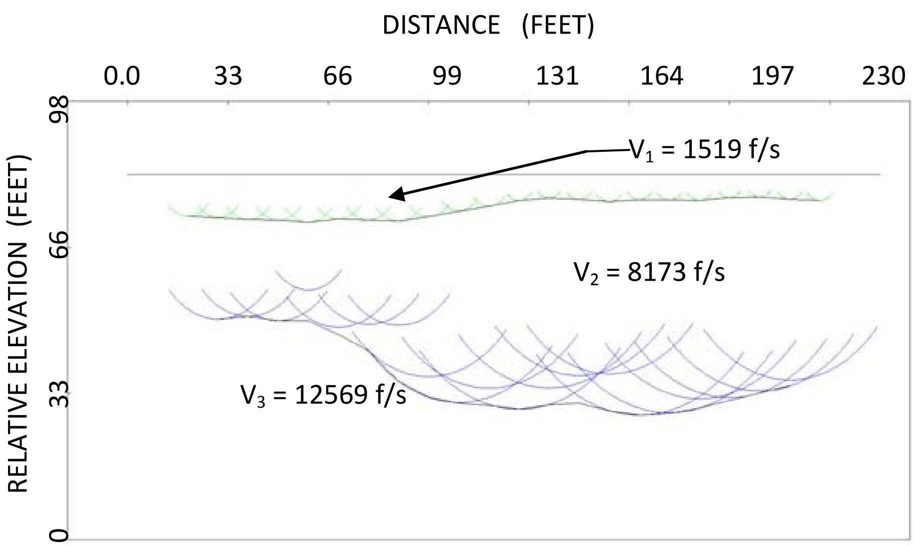
APPENDIX B

SEISMIC REFRACTION RESULTS

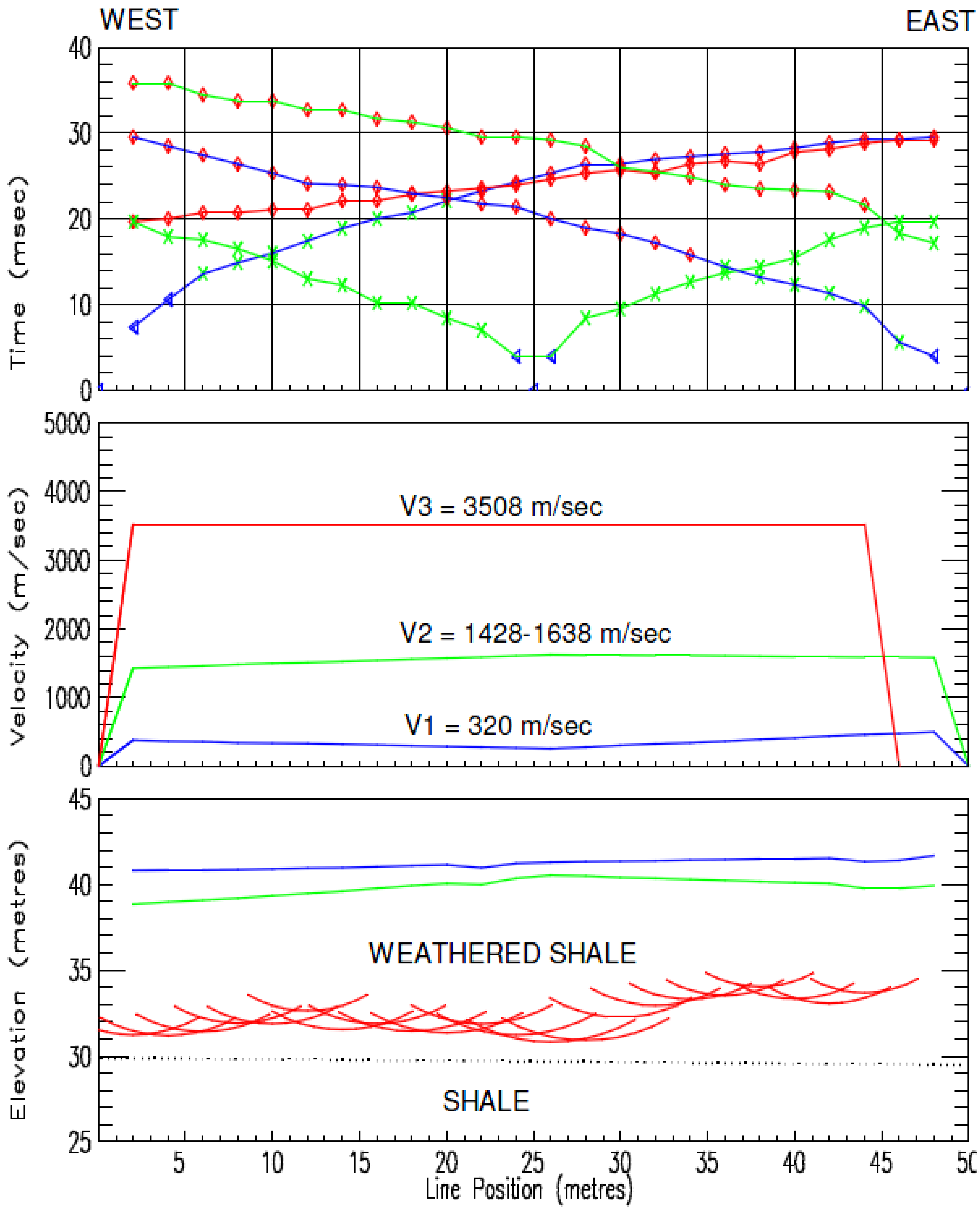
LOWER PROJECT AREA



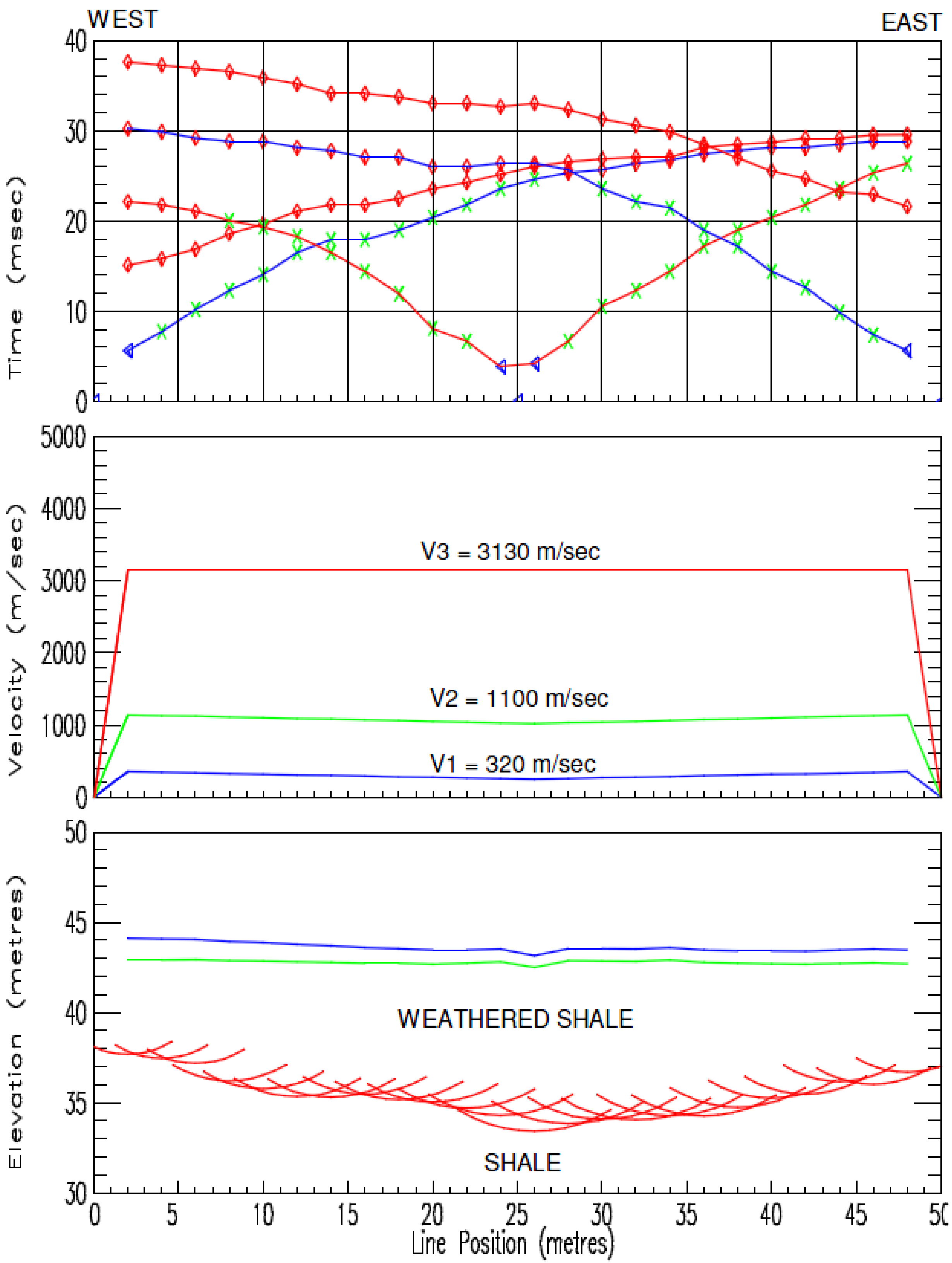
Seismic Depth Section with velocities for Lower Project Area Seismic Refraction Line 8. Elevations shown are relative, not absolute.



Seismic Depth Section with velocities for Lower Project Area Seismic Refraction Line 9. Elevations shown are relative, not absolute.



Bottom of Buckhorn (BOB) Seismic Line 1. Travel Time Curves (Top), Velocity Model (Middle) and Depth Section (Bottom) for Bottom of Buckhorn Project (BOB) Seismic Line 1. Dotted line indicates approximate elevation of road grade.



Bottom of Buckhorn (BOB) Seismic Line 2. Travel Time Curves (Top), Velocity Model (Middle) and Depth Section (Bottom) for Bottom of Buckhorn Project (BOB) Seismic Line 2.

APPENDIX C

Laboratory Test Results and Logs of Test Borings

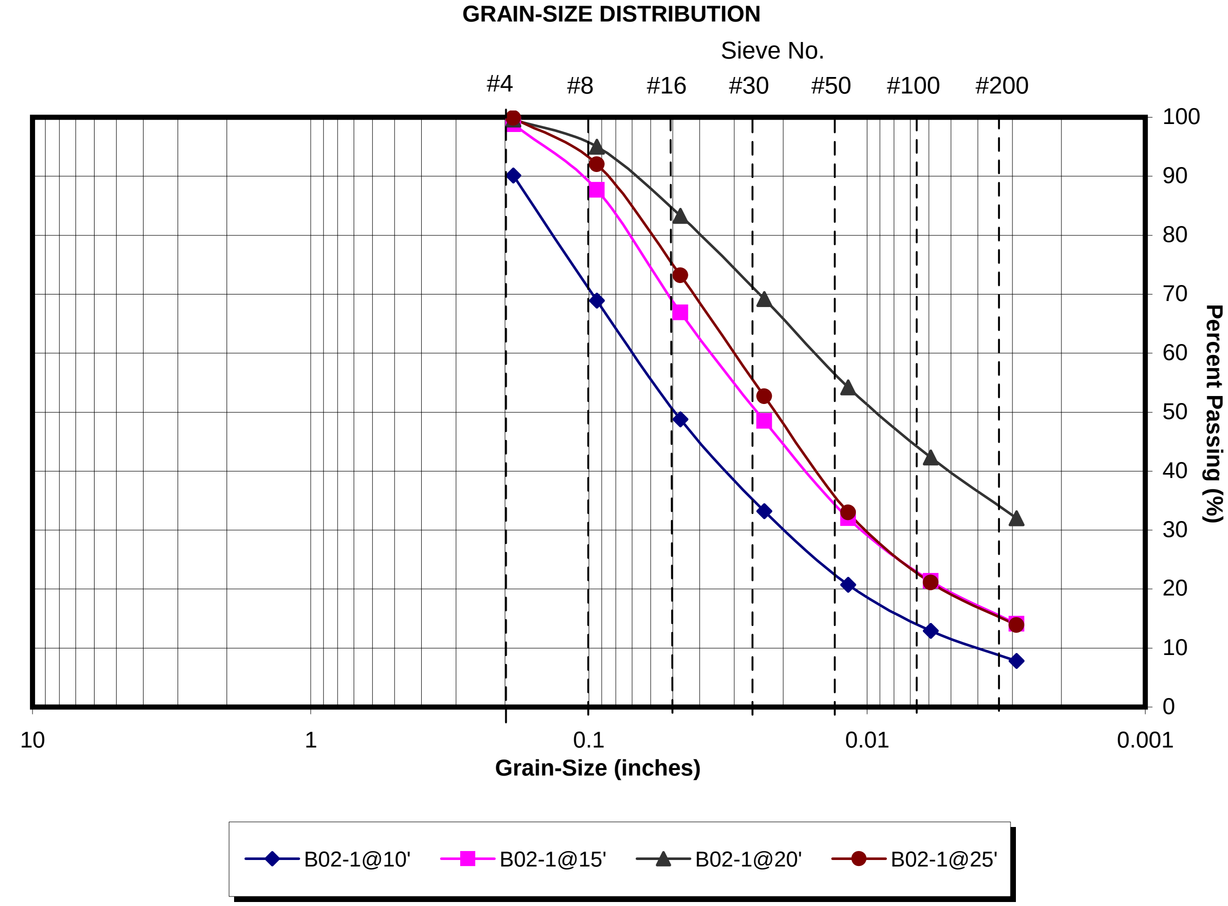
Performed under contract by SHN Consultants (2002)

For Caltrans (EA 02-270310)

1. **Gradation Analyses**
   B02-1, B02-2, B02-3, B02-5, B02-6, B02-7, B02-8
2. **Atterberg Limits & Classifications**
   B02-1, B02-2, B02-3, B02-5, B02-7, B02-8
3. **Direct Shear Tests**
   B02-1@10’, B02-1@20’, B02-2@20’, B02-2@30’, B02-2@40’
   B02-3@10’, B02-3@15’, B02-5@35’, B02-7@10’, B02-7@5’, B02-8@15’, B02-8@20’
4. **Logs of Test Borings**
   B02-1, B02-2, B02-3, B02-4, B02-5, B02-6, B02-7, B02-8

Project: Buckhorn Grade
Location of Project: Shasta Co., CA
Client: Caltrans

Project No.: 502001.02
Tested By: SHN
Date of Testing: 09/17/2002

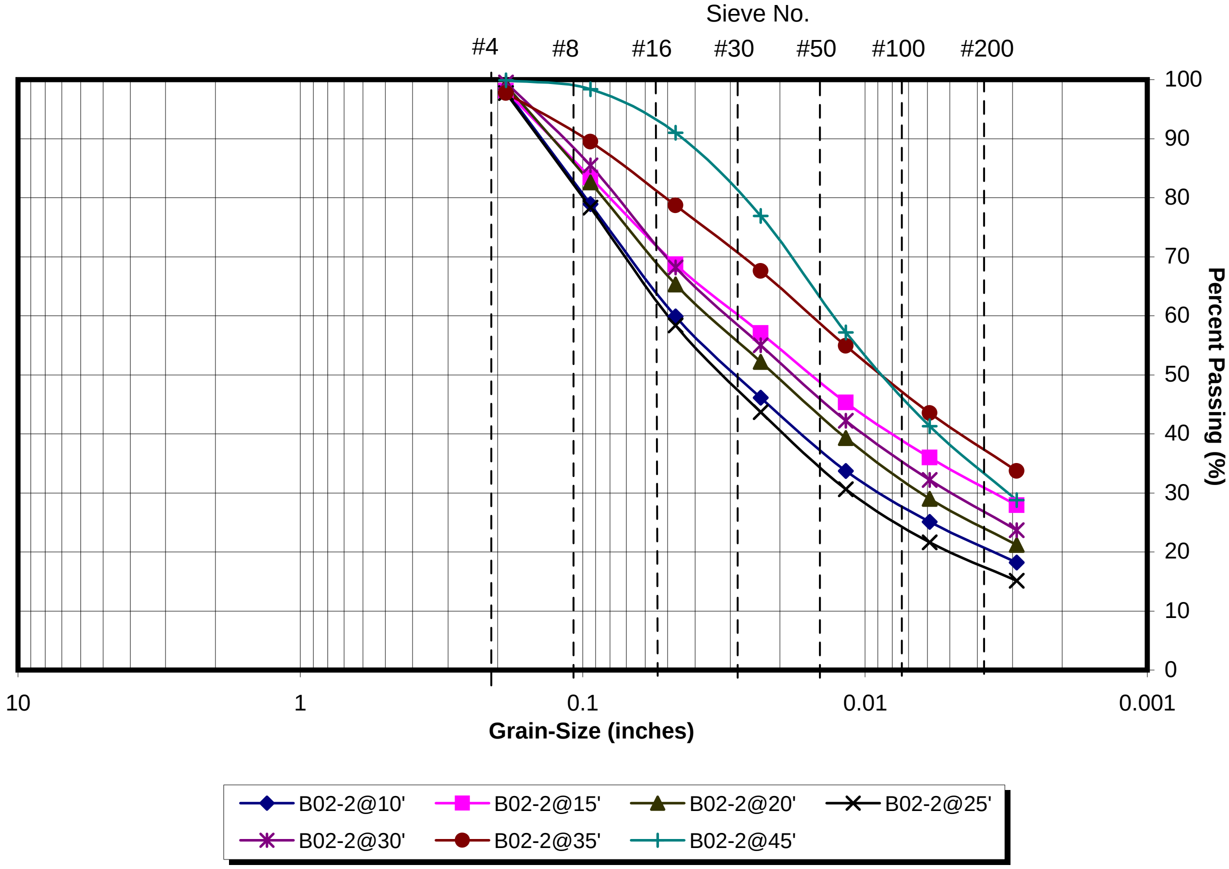


Drill Hole No.	B02-1	B02-1	B02-1	B02-1			
Sample	2	3	4	5			
Depth (ft)	10	15	20	25			
Sieve (inches)	Percent Passing (%)						
3							
2							
1							
0.75							
0.5							
0.375							
0.187	90.1	98.8	99.6	99.9			
0.0929	68.9	87.7	95	92			
0.0465	48.8	66.9	83.3	73.2			
0.0236	33.2	48.5	69.2	52.7			
0.0118	20.7	32	54.2	33			
0.00591	12.9	21.4	42.3	21.1			
0.00295	7.8	14.1	32	13.9			

Project: Buckhorn Grade
Location of Project: Shasta Co., CA
Client: Caltrans

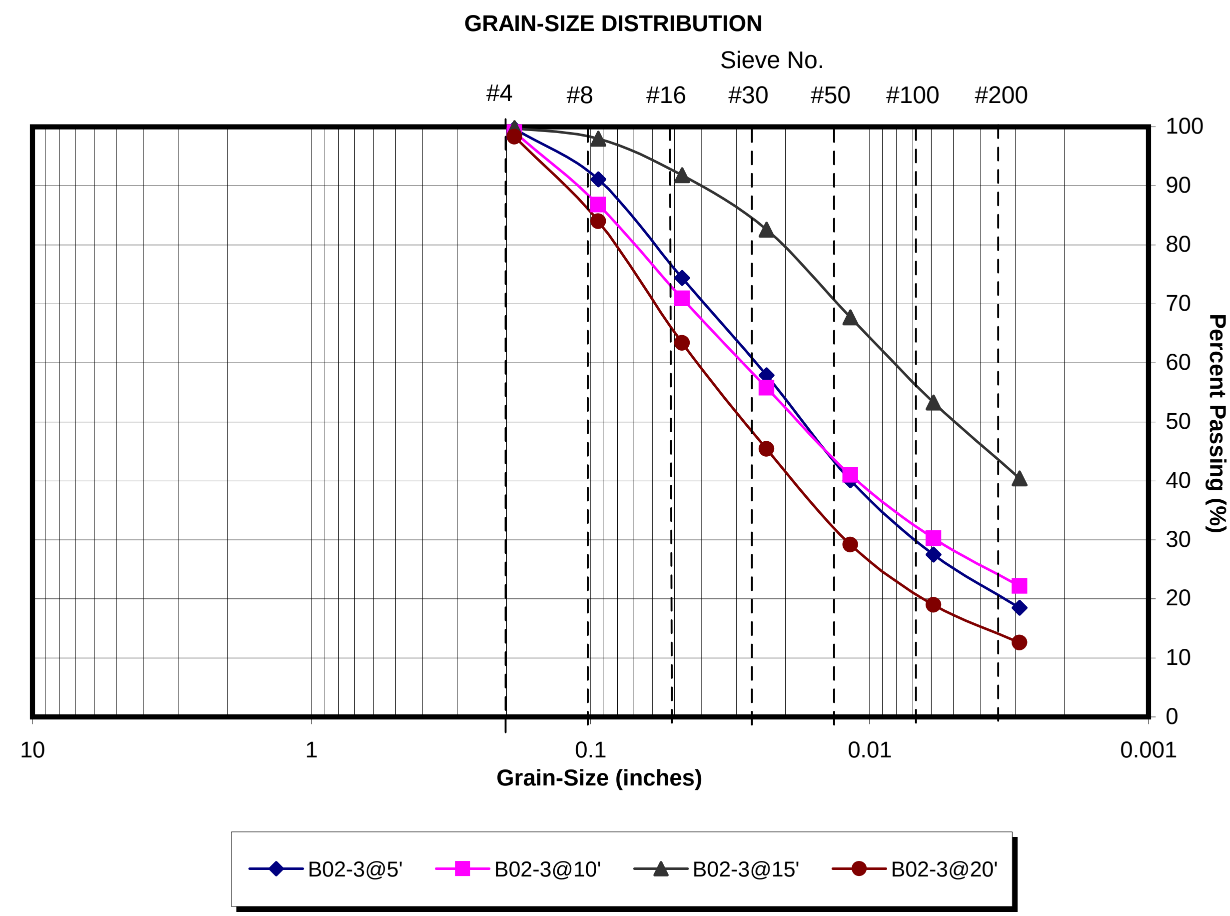
Project No.: 502001.021
Tested By: SHN
Date of Testing: 09/17/2002

GRAIN-SIZE DISTRIBUTION



Drill Hole No.	B02-2	B02-2	B02-2	B02-2	B02-2	B02-2	B02-2
Sample	2	3	4	5	6	7	9
Depth (ft)	10	15	20	25	30	35	45
Sieve (inches)	Percent Passing (%)						
3							
2							
1							
0.75							
0.5							
0.375							
0.187	98.1	98.1	99	97.7	99.5	97.7	99.9
0.0929	78.9	83.4	82.6	78.3	85.5	89.5	98.4
0.0465	59.9	68.7	65.3	58.4	68.2	78.7	91
0.0236	46.1	57.1	52.2	43.7	55	67.6	76.9
0.0118	33.7	45.3	39.3	30.6	42.2	54.9	57.2
0.00591	25.1	36	29	21.6	32.2	43.5	41.3
0.00295	18.2	27.9	21.2	15.1	23.7	33.7	28.8

Project:	Buckhorn Grade	**Project No.:**	502001.02
Location of Project:	Shasta Co., CA	**Tested By:**	SHN
Client:	Caltrans	**Date of Testing:**	09/17/2002

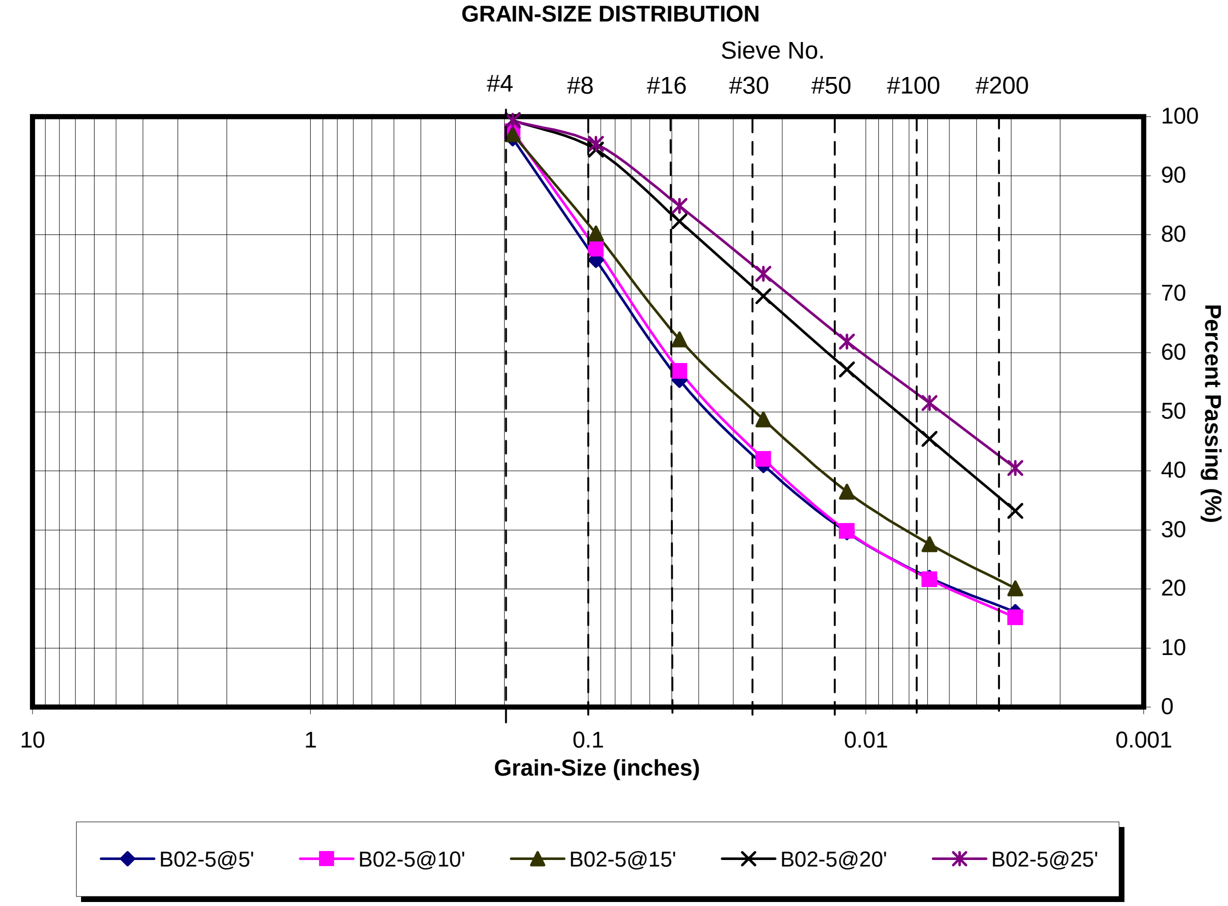


Drill Hole No.	B02-3	B02-3	B02-3	B02-3			
Sample	1	2	3	4			
Depth (ft)	5	10	15	20			
Sieve (inches)	**Percent Passing (%)**						
3							
2							
1							
0.75							
0.5							
0.375							
0.187	99.7	99.1	99.8	98.3			
0.0929	91.1	86.8	98	84			
0.0465	74.4	70.9	91.8	63.4			
0.0236	57.9	55.8	82.6	45.4			
0.0118	40.1	41	67.7	29.2			
0.0059	27.5	30.3	53.3	19			
0.0029	18.5	22.2	40.4	12.6			

Borehole B02-3
Buckhorn Grade

Project: Buckhorn Grade
Location of Project: Shasta Co., CA
Client: Caltrans

Project No.: 502001.02
Tested By: SHN
Date of Testing: 09/17/2002

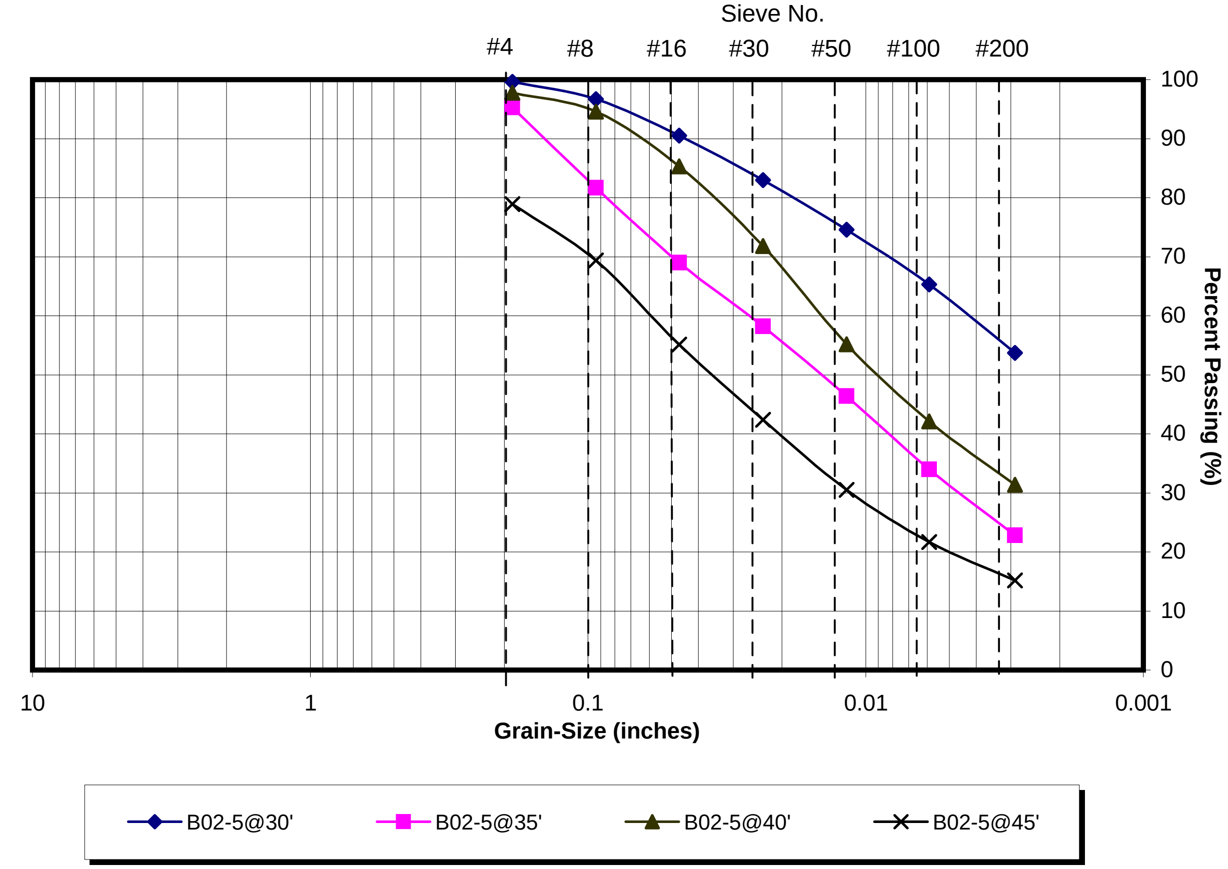


Drill Hole No.	B02-5	B02-5	B02-5	B02-5	B02-5		
Sample	1	2	3	4	5		
Depth (ft)	5	10	15	20	25		
Sieve (inches)	Percent Passing (%)						
3							
2							
1							
0.75							
0.5							
0.375							
0.187	96.3	97.5	97	99.4	99.3		
0.0929	75.7	77.6	80.2	94.4	95.4		
0.0465	55.4	56.9	62.3	82.3	84.9		
0.0236	41	42	48.7	69.6	73.4		
0.0118	29.6	29.8	36.5	57.2	61.9		
0.00591	21.9	21.6	27.6	45.4	51.5		
0.00295	16.1	15.2	20.1	33.2	40.5		

Borehole B02-5
Buckhorn Grade

Project: Buckhorn Grade	**Project No.:** 502001.02
Location of Project: Shasta Co., CA	**Tested By:** SHN
Client: Caltrans	**Date of Testing:** 09/17/2002

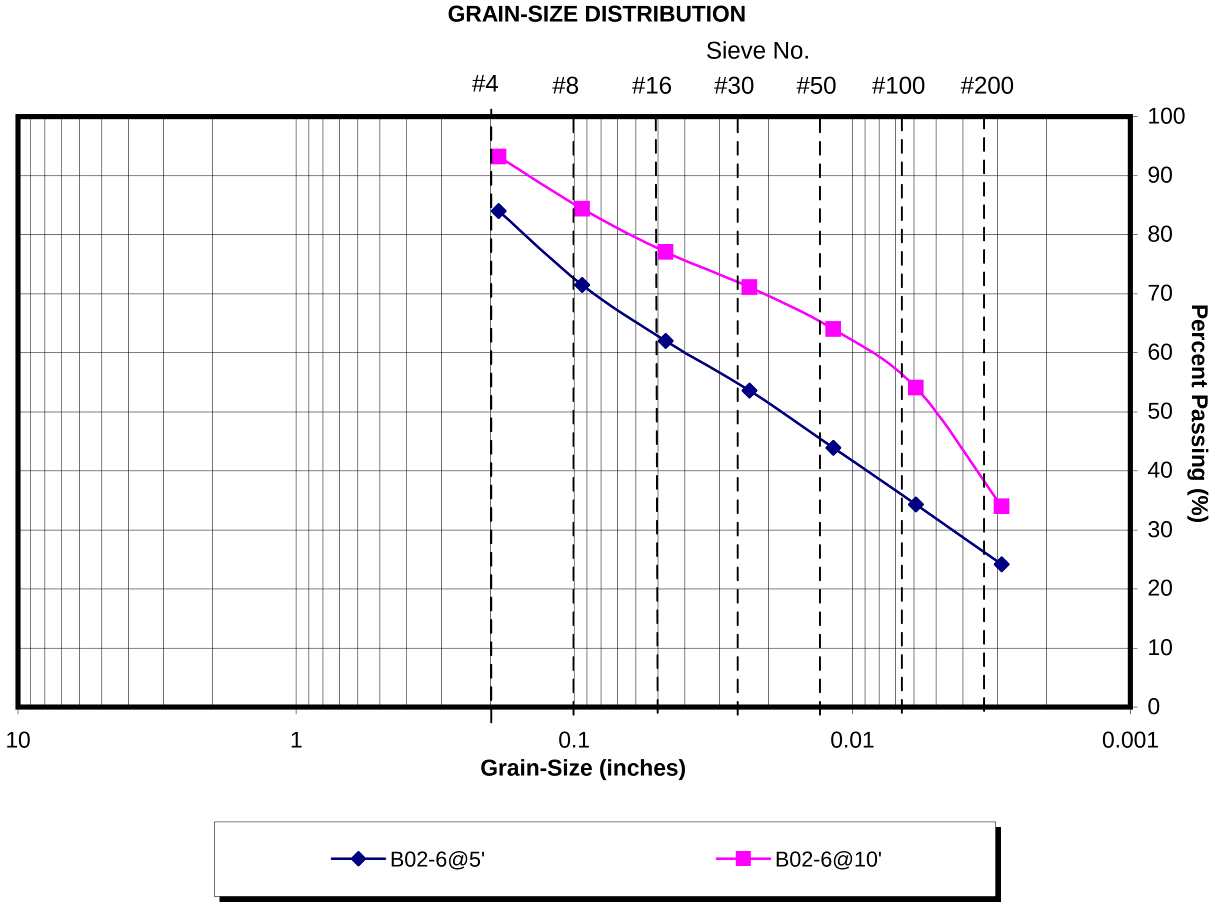
GRAIN-SIZE DISTRIBUTION



Drill Hole No.	B02-5	B02-5	B02-5	B02-5			
Sample	6	7	8	9			
Depth (ft)	30	35	40	45			
Sieve (inches)	**Percent Passing (%)**						
3							
2							
1							
0.75							
0.5							
0.375							
0.187	99.6	95.3	97.8	78.9			
0.0929	96.7	81.7	94.6	69.4			
0.0465	90.5	69	85.3	55.1			
0.0236	83	58.2	71.8	42.4			
0.0118	74.6	46.4	55.2	30.5			
0.00591	65.3	34	42.1	21.7			
0.00295	53.7	22.8	31.4	15.2			

Borehole B02-5 (cont.)
Buckhorn Grade

Project:	Buckhorn Grade
Location of Project:	Shasta Co., CA
Client:	Caltrans
Project No.:	502001.02
Tested By:	SHN
Date of Testing:	09/17/2002

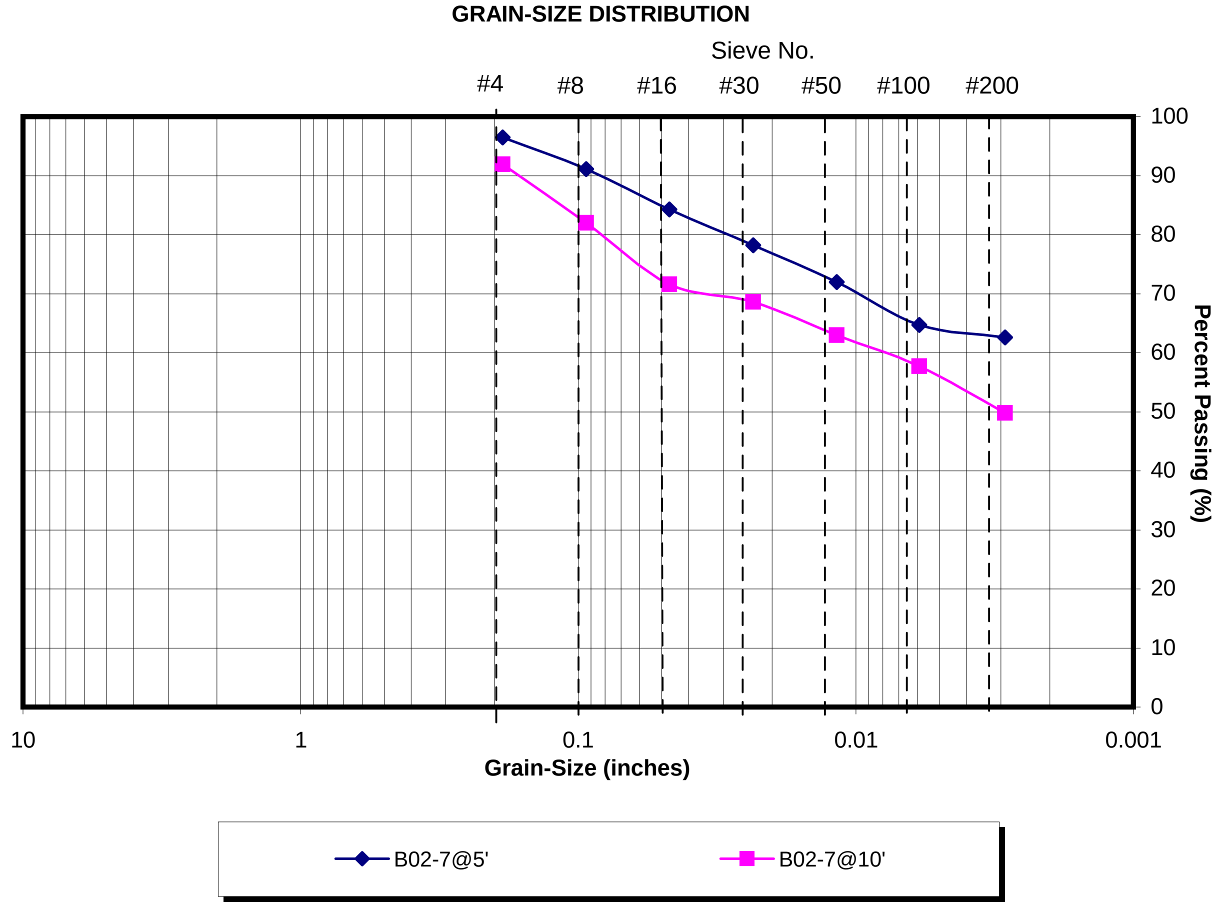


Drill Hole No.	B02-6	B02-6					
Sample	1	2					
Depth (ft)	5	10					
Sieve (inches)	**Percent Passing (%)**						
3							
2							
1							
0.75							
0.5							
0.375							
0.187	84	93.2					
0.0929	71.5	84.4					
0.0465	62	77.1					
0.0236	53.6	71.1					
0.0118	43.9	64					
0.00591	34.3	54.1					
0.00295	24.2	34					

Borehole B02-6
Buckhorn Grade

Project: Buckhorn Grade
Location of Project: Shasta Co., CA
Client: Caltrans

Project No.: 502001.02
Tested By: SHN
Date of Testing: 09/17/2002

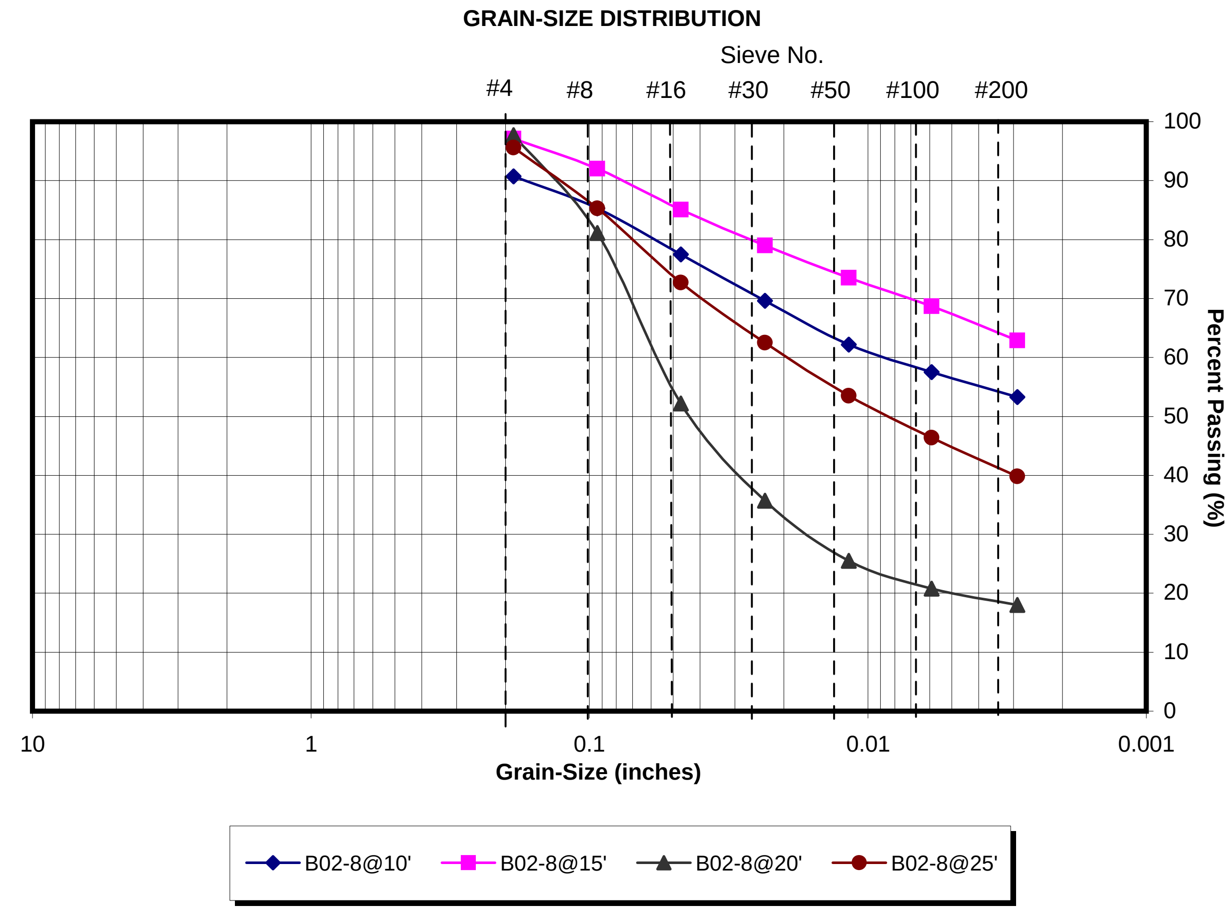


Drill Hole No.	B02-7	B02-7					
Sample	1	2					
Depth (ft)	5	10					
Sieve (inches)	Percent Passing (%)						
3							
2							
1							
0.75							
0.5							
0.375							
0.187	96.5	91.9					
0.0929	91.1	82					
0.0465	84.3	71.6					
0.0236	78.2	68.6					
0.0118	72	63					
0.00591	64.7	57.7					
0.00295	62.6	49.8					

Borehole B02-7
Buckhorn Grade

Project: Buckhorn Grade
Location of Project: Shasta Co., CA
Client: Caltrans

Project No.: 502001.02
Tested By: SHN
Date of Testing: 09/17/2002



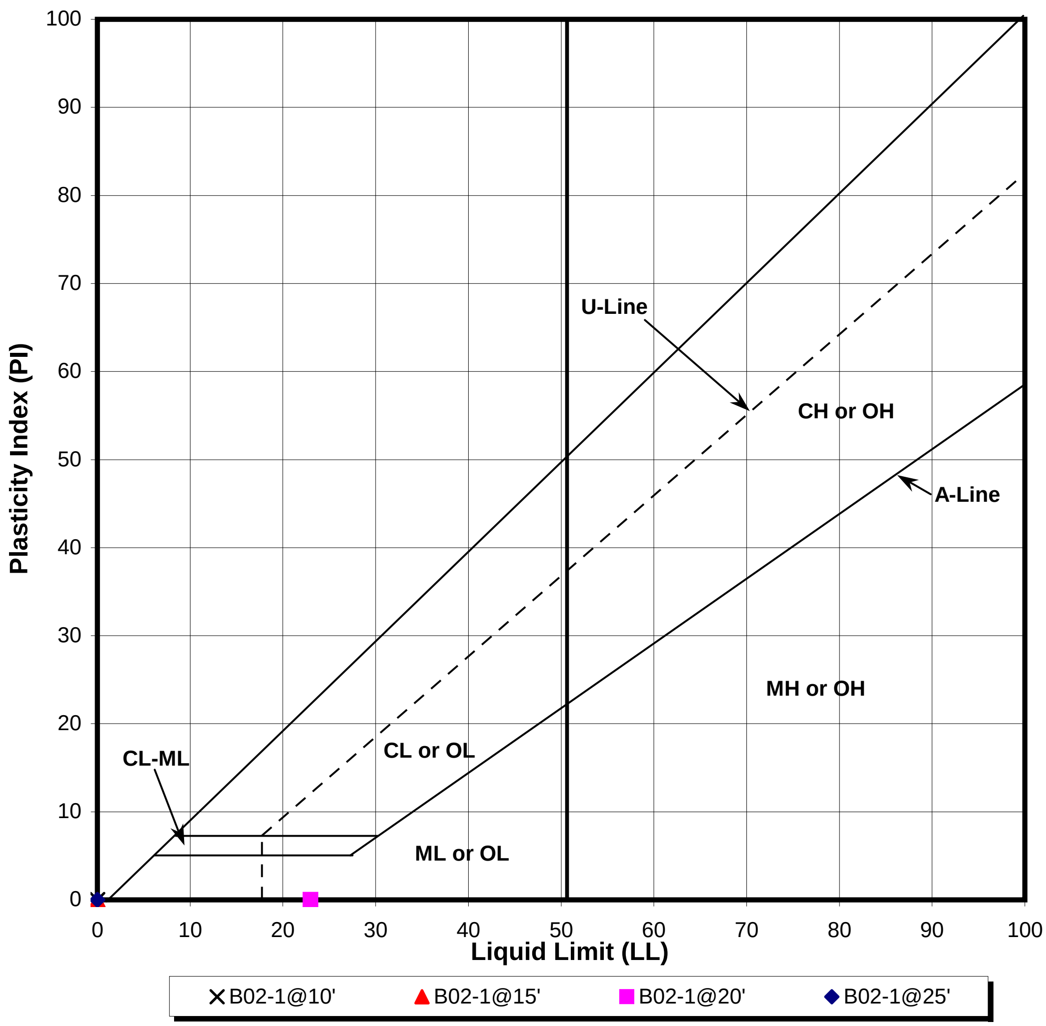
Drill Hole No.	B02-8	B02-8	B02-8	B02-8			
Sample	2	3	4	5			
Depth (ft)	10	15	20	25			
Sieve (inches)	Percent Passing (%)						
3							
2							
1							
0.75							
0.5							
0.375							
0.187	90.7	97.1	97.7	95.6			
0.0929	85.3	92	81.1	85.3			
0.0465	77.5	85.1	52.2	72.7			
0.0236	69.6	79	35.7	62.5			
0.0118	62.2	73.5	25.5	53.5			
0.0059	57.5	68.7	20.8	46.4			
0.0029	53.3	62.9	18	39.8			

Borehole B02-8
Buckhorn Grade

Project: Buckhorn Grade
Client: Caltrans

Project No.: 502001.021
Date of Testing: 09/17/2002

ATTERBERG LIMITS



LEGEND			CLASSIFICATION	ATTERBERG LIMITS TEST RESULTS		
Location	Depth, ft	Sample No.		Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
B02-1	10.0	2	Silty SAND (SM)	0	0	0
B02-1	15.0	3	SAND with silt (SW-SM)	0	0	0
B02-1	20.0	4	Silty SAND (SM)	23	23	0
B02-1	25.0	5	Silty SAND (SM)	0	0	0

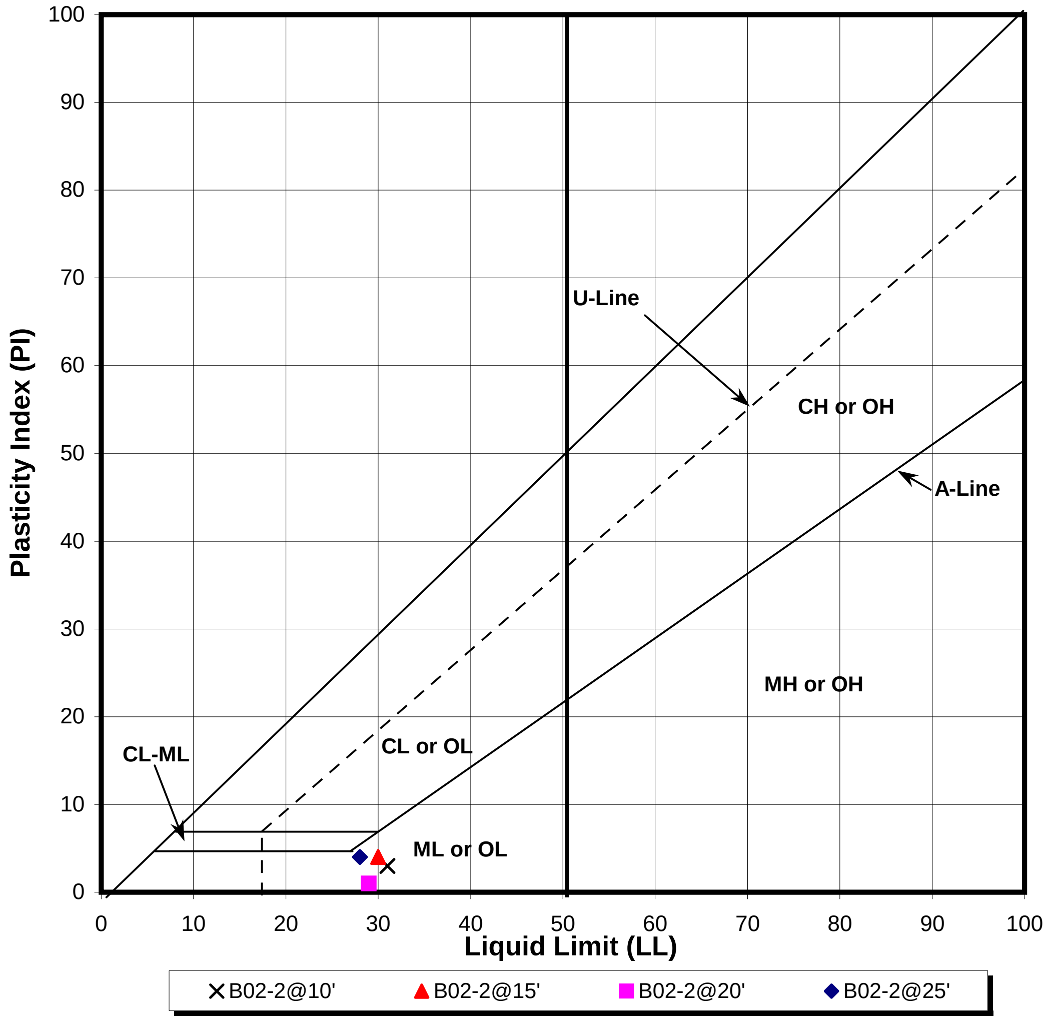
ASTM D4318 & D2487

Borehole B02-1
Buckhorn Grade

Project: Buckhorn Grade
Client: Caltrans

Project No.: 502001.021
Date of Testing: 09/20/2002

ATTERBERG LIMITS



LEGEND			CLASSIFICATION	ATTERBERG LIMITS TEST RESULTS		
Location	Depth, ft	Sample No.		Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
B02-2	10.0	2	Silty SAND (SM)	31	28	3
B02-2	15.0	3	Silty SAND (SM)	30	26	4
B02-2	20.0	4	Silty SAND (SM)	29	28	1
B02-2	25.0	5	Silty SAND (SM)	28	24	4

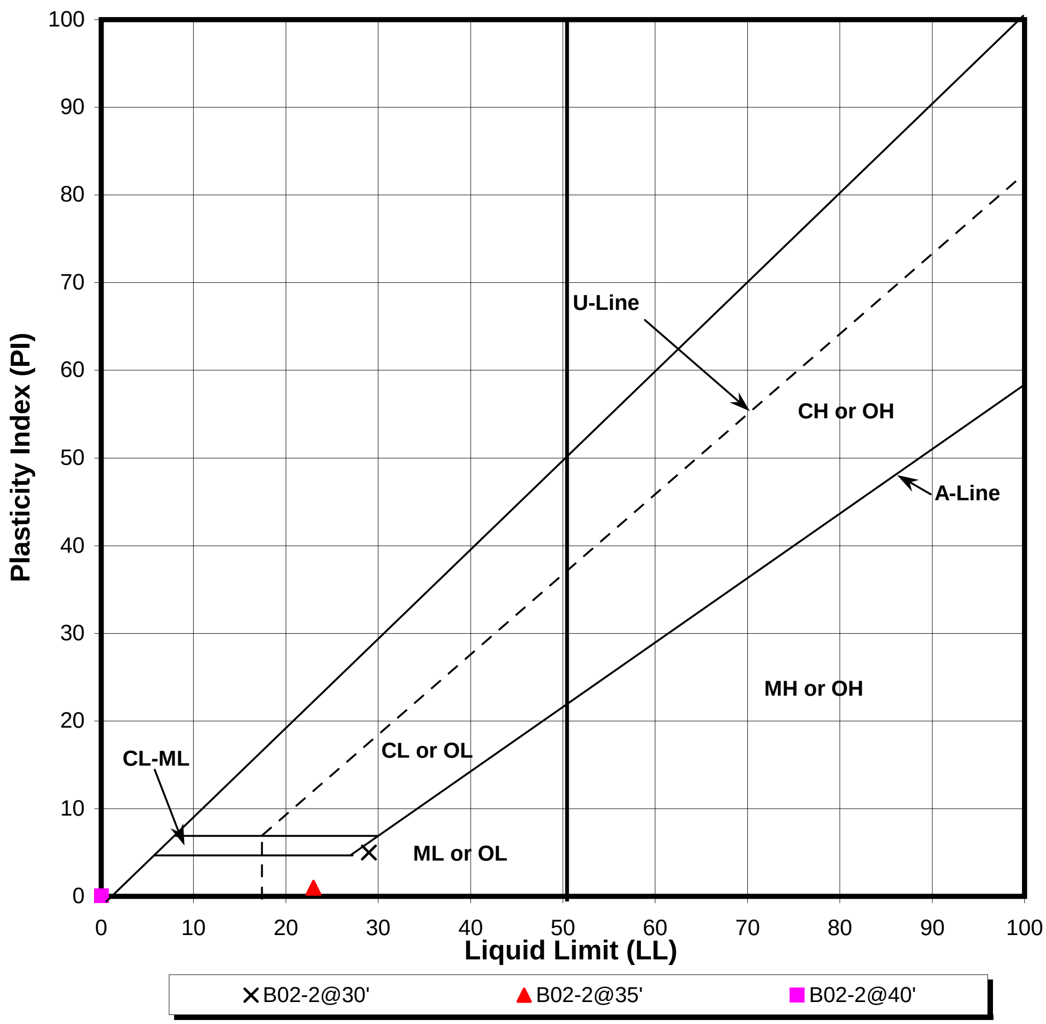
ASTM D4318 & D2487

Borehole B02-2
Buckhorn Grade

Project: Buckhorn Grade
Client: Caltrans

Project No.: 502001.021
Date of Testing: 09/20/2002

ATTERBERG LIMITS



LEGEND			CLASSIFICATION	ATTERBERG LIMITS TEST RESULTS		
Location	Depth, ft	Sample No.		Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
B02-2	30.0	6	Silty SAND (SM)	29	24	5
B02-2	35.0	7	Silty SAND (SM)	23	22	1
B02-2	40.0	8	Silty SAND (SM)	0	0	0

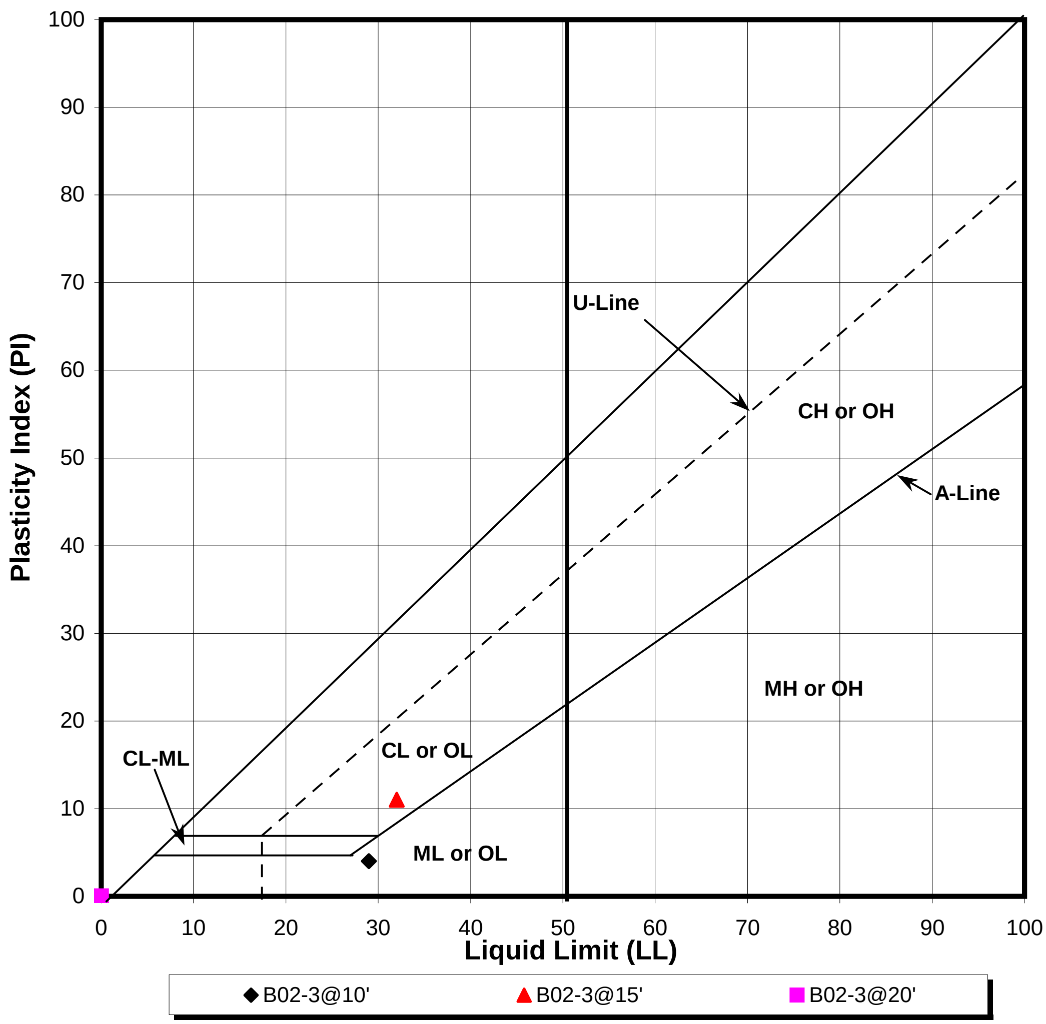
ASTM D4318 & D2487

Borehole B02-2 (cont.)
Buckhorn Grade

Project: Buckhorn Grade
Client: Caltrans

Project No.: 502001.021
Date of Testing: 09/20/2002

ATTERBERG LIMITS



LEGEND			CLASSIFICATION	ATTERBERG LIMITS TEST RESULTS		
Location	Depth, ft	Sample No.		Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
B02-3	10.0	2	Silty SAND (SM)	29	25	4
B02-3	15.0	3	Clayey SAND (SC)	32	21	11
B02-3	20.0	4	Silty SAND (SM)	0	0	0

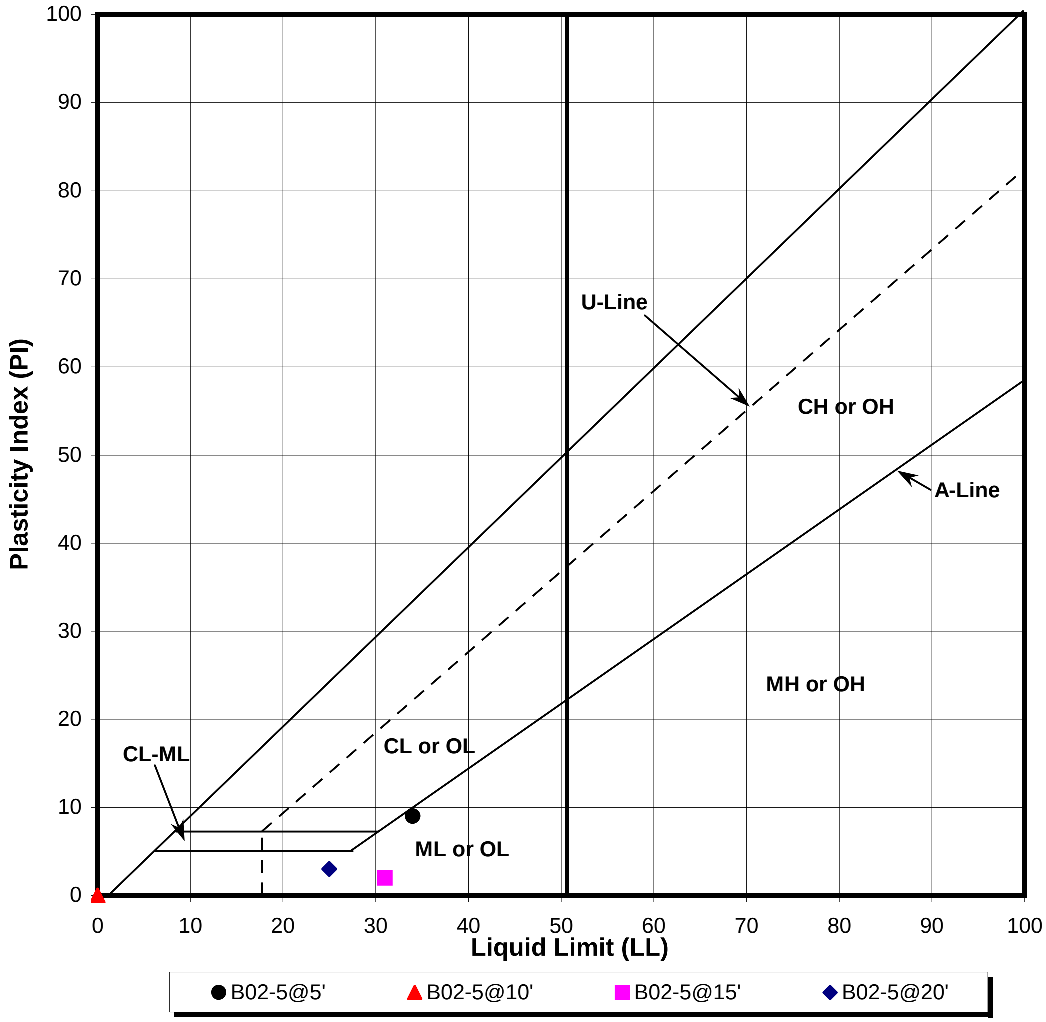
ASTM D4318 & D2487

Borehole B02-3
Buckhorn Grade

Project: Buckhorn Grade
Client: Caltrans

Project No.: 502001.021
Date of Testing: 09/17/2002

ATTERBERG LIMITS



LEGEND			CLASSIFICATION	ATTERBERG LIMITS TEST RESULTS		
Location	Depth, ft	Sample No.		Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
B02-5	5.0	1	Silty SAND (SM)	34	25	9
B02-5	10.0	2	Silty SAND (SM)	0	0	0
B02-5	15.0	3	Silty SAND (SM)	31	29	2
B02-5	20.0	4	Silty SAND (SM)	25	22	3

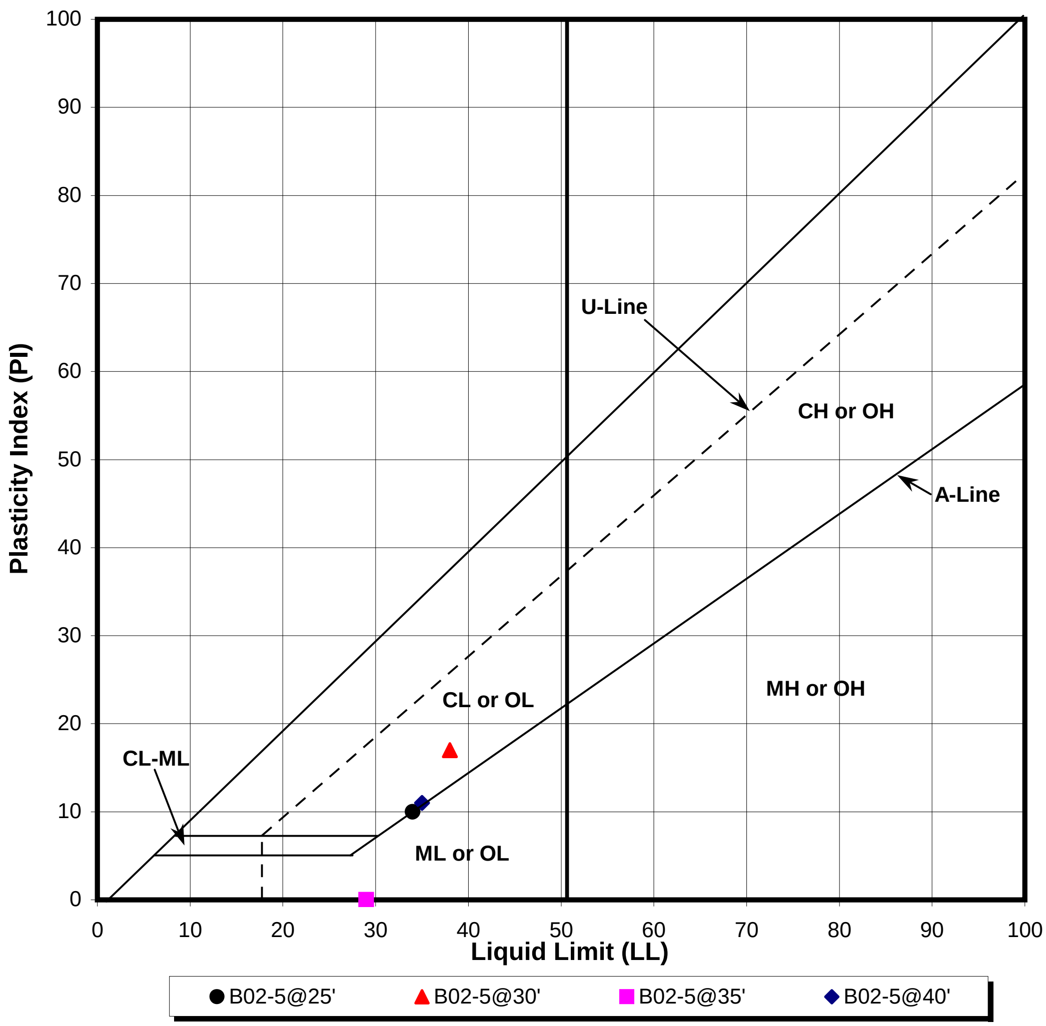
ASTM D4318 & D2487

Borehole B02-5
Buckhorn Grade

Project: Buckhorn Grade
Client: Caltrans

Project No.: 502001.021
Date of Testing: 09/17/2002

ATTERBERG LIMITS



LEGEND			CLASSIFICATION	ATTERBERG LIMITS TEST RESULTS		
Location	Depth, ft	Sample No.		Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
B02-5	25.0	5	Silty SAND (SM)	34	24	10
B02-5	30.0	6	Sandy SILT (ML)	38	21	17
B02-5	35.0	7	Silty SAND (SM)	29	29	0
B02-5	40.0	8	Clayey SAND (SC)	35	24	11

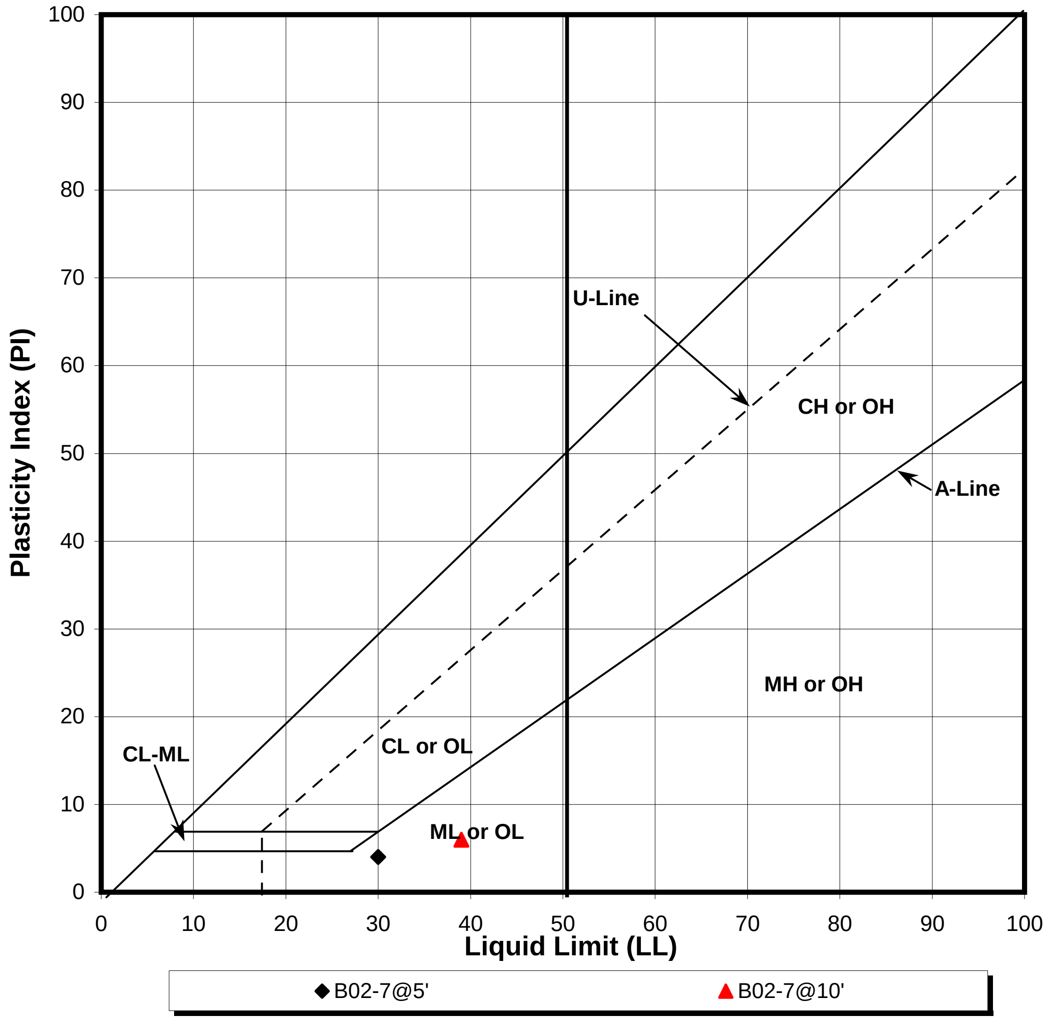
ASTM D4318 & D2487

Borehole B02-5 (cont.)
Buckhorn Grade

Project: Buckhorn Grade
Client: Caltrans

Project No.: 502001.021
Date of Testing: 09/20/2002

ATTERBERG LIMITS



LEGEND			CLASSIFICATION	ATTERBERG LIMITS TEST RESULTS		
Location	Depth, ft	Sample No.		Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
B02-7	5.0	1	Sandy SILT (ML)	30	26	4
B02-7	10.0	2	Sandy SILT (ML)	39	33	6

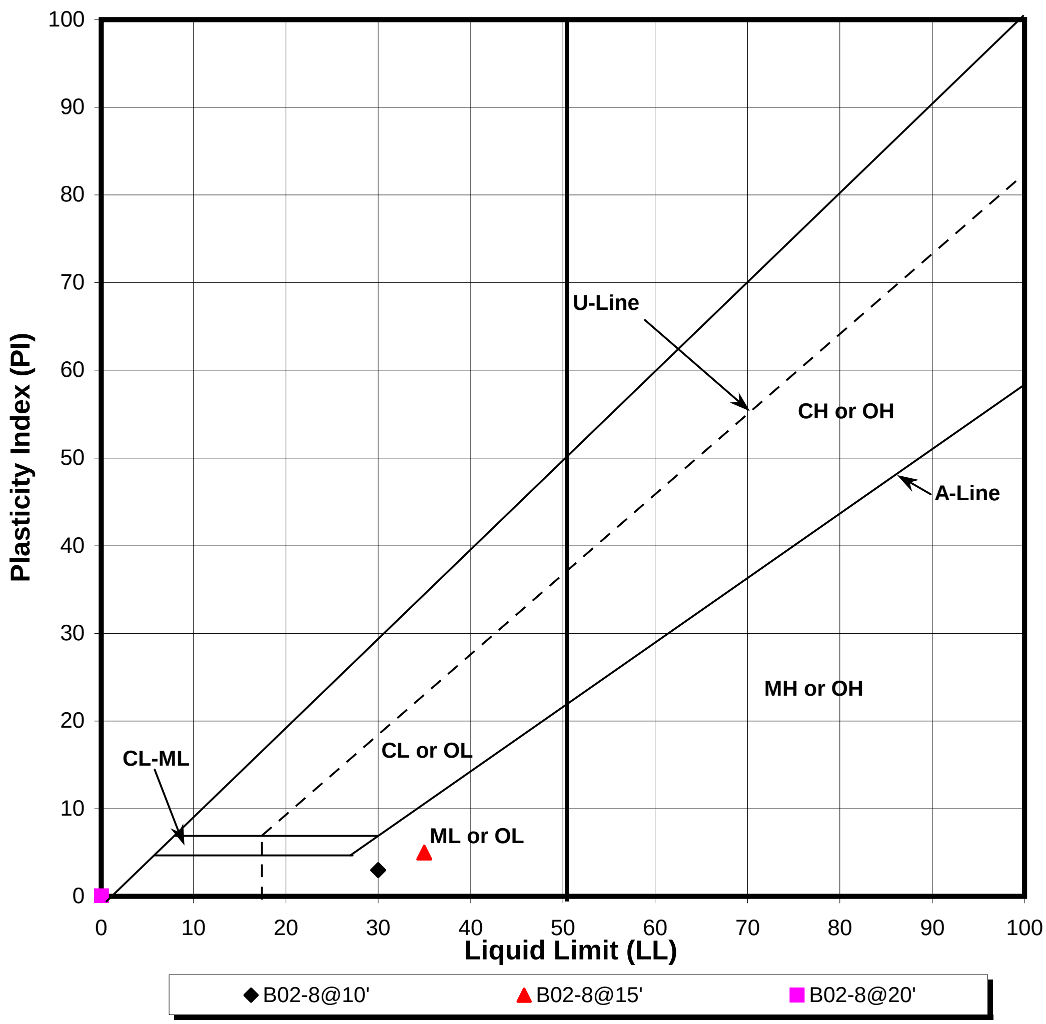
ASTM D4318 & D2487

Borehole B02-7
Buckhorn Grade

Project: Buckhorn Grade
Client: Caltrans

Project No.: 502001.021
Date of Testing: 09/20/2002

ATTERBERG LIMITS



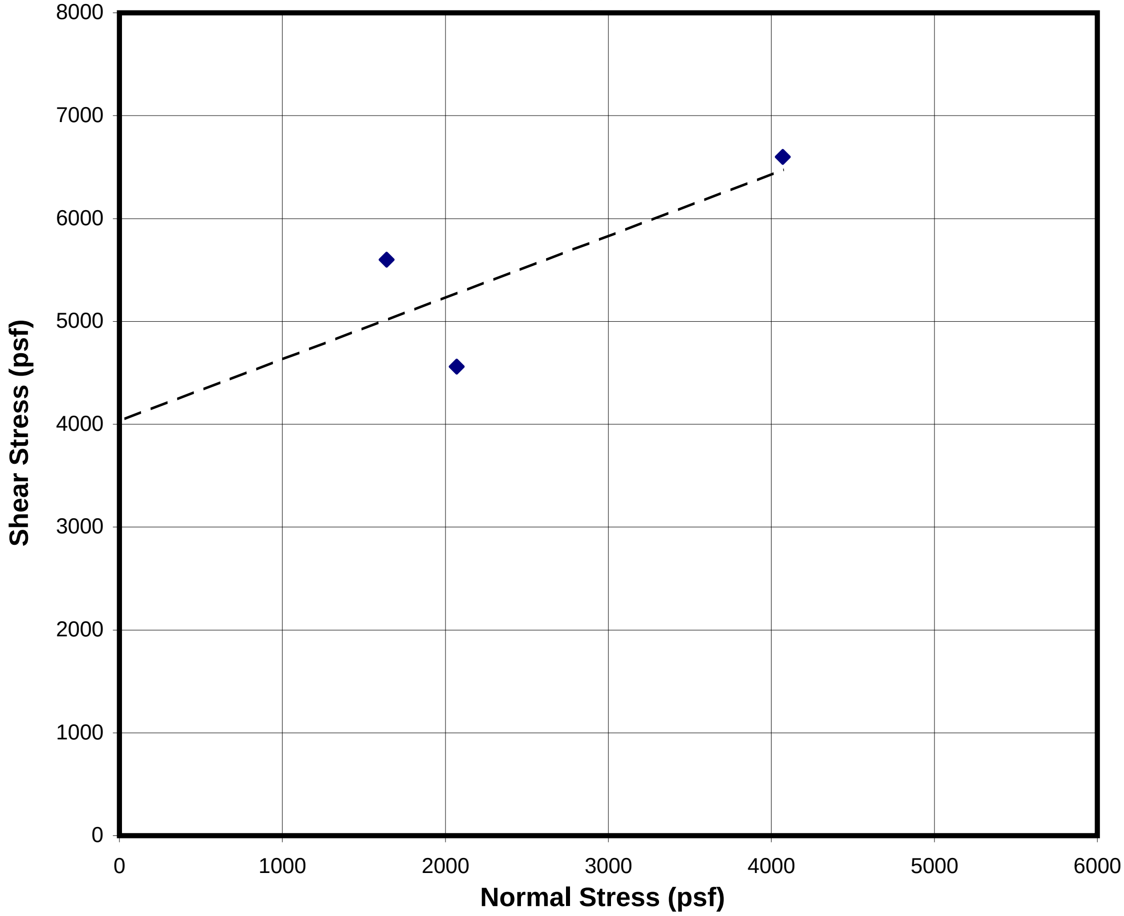
LEGEND			CLASSIFICATION	ATTERBERG LIMITS TEST RESULTS		
Location	Depth, ft	Sample No.		Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
B02-8	10.0	2	Sandy SILT (ML)	30	27	3
B02-8	15.0	3	Sandy SILT (ML)	35	30	5
B02-8	20.0	4	Silty SAND (SM)	0	0	0

ASTM D4318 & D2487

Borehole B02-8
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/19/2002
		Sample No.:	B02-1@10'

DIRECT SHEAR DATA



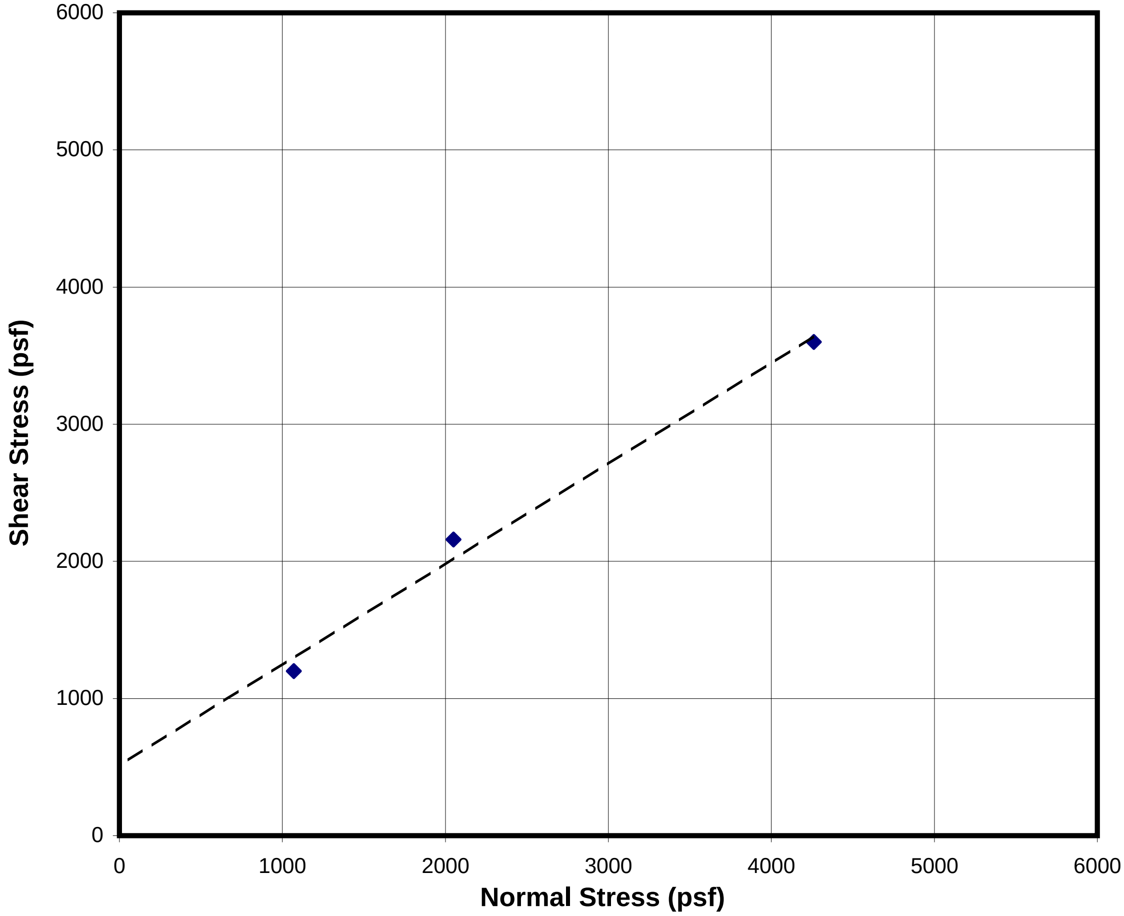
B02-1@10'			
Angle of Internal Friction:	31	degrees	Test Type
Cohesion :	4028	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial Water Content (%)	Initial Dry Density (pcf)	Final Water Content (%)	Final Dry Density (pcf)
1	1640	5600	9	112.3	15.3	112.9
2	2070	4560	7	114.9	8.7	115.3
3	4070	6600	7.9	107.5	9	111.2

Sample B02-1@10ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/13/2002
		Sample No.:	B02-1@20'

DIRECT SHEAR DATA



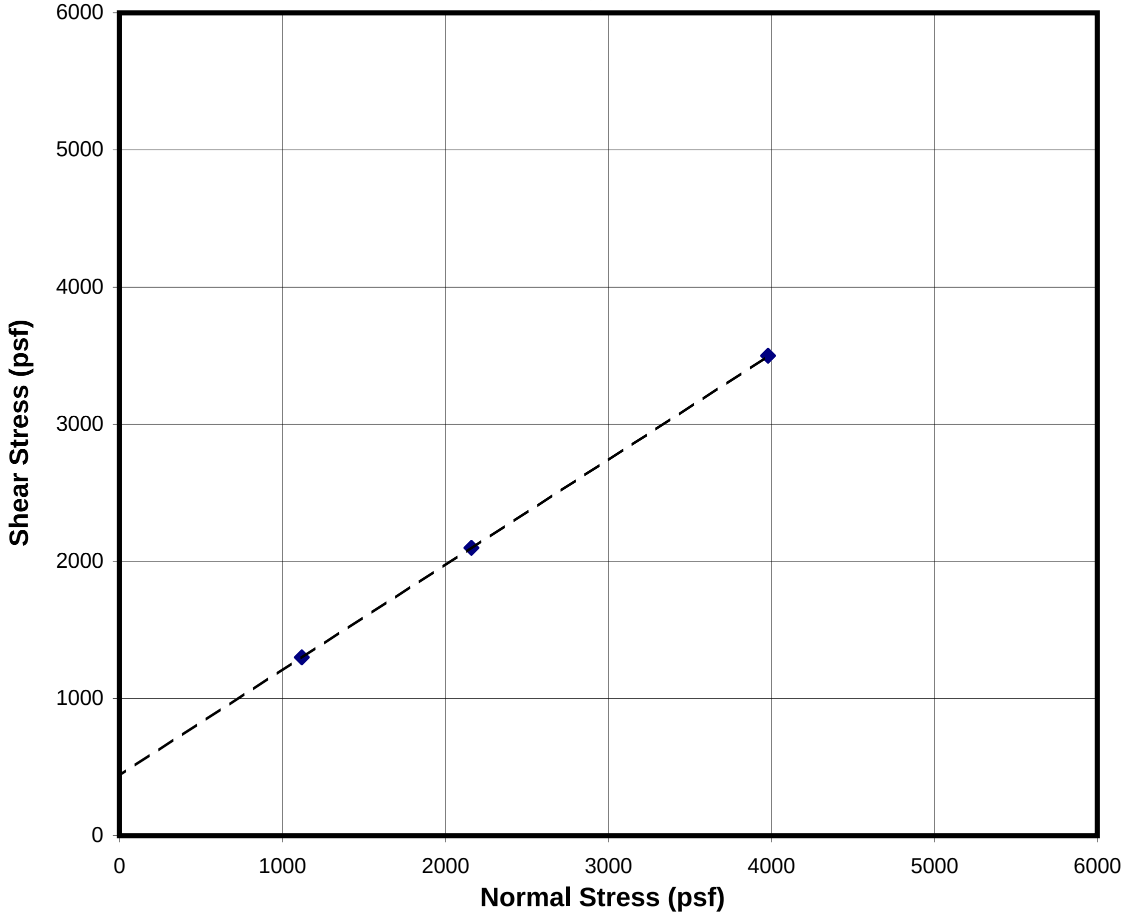
B02-1@20'			
Angle of Internal Friction:	36	degrees	Test Type
Cohesion :	511	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial Water Content (%)	Initial Dry Density (pcf)	Final Water Content (%)	Final Dry Density (pcf)
1	1070	1200	16.7	105	16.4	106.7
2	2050	2160	15.1	107.6	16.9	110.2
3	4260	3600	15.4	108.5	16.7	111.6

Sample B02-1@20ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/18/2002
		Sample No.:	B02-2@20'

DIRECT SHEAR DATA



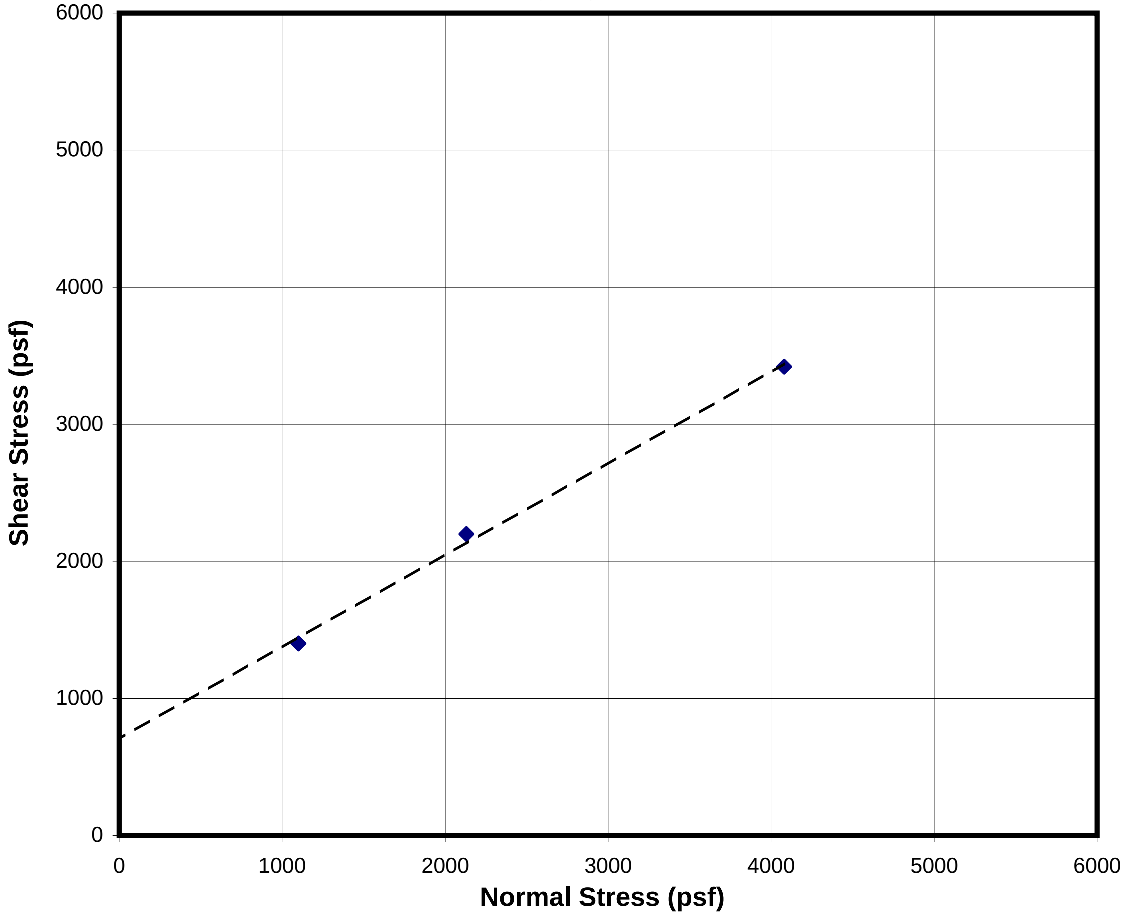
B02-2@20'			
Angle of Internal Friction:	38	degrees	Type
Cohesion :	438	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial		Final	
			Water Content (%)	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)
1	1120	1300	9.9	116.9	12.1	118.3
2	2160	2100	10.7	112.8	12.4	115.7
3	3980	3500	9.8	115.6	11.8	118.8

Sample B02-2@20ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/19/2002
		Sample No.:	B02-2@30'

DIRECT SHEAR DATA



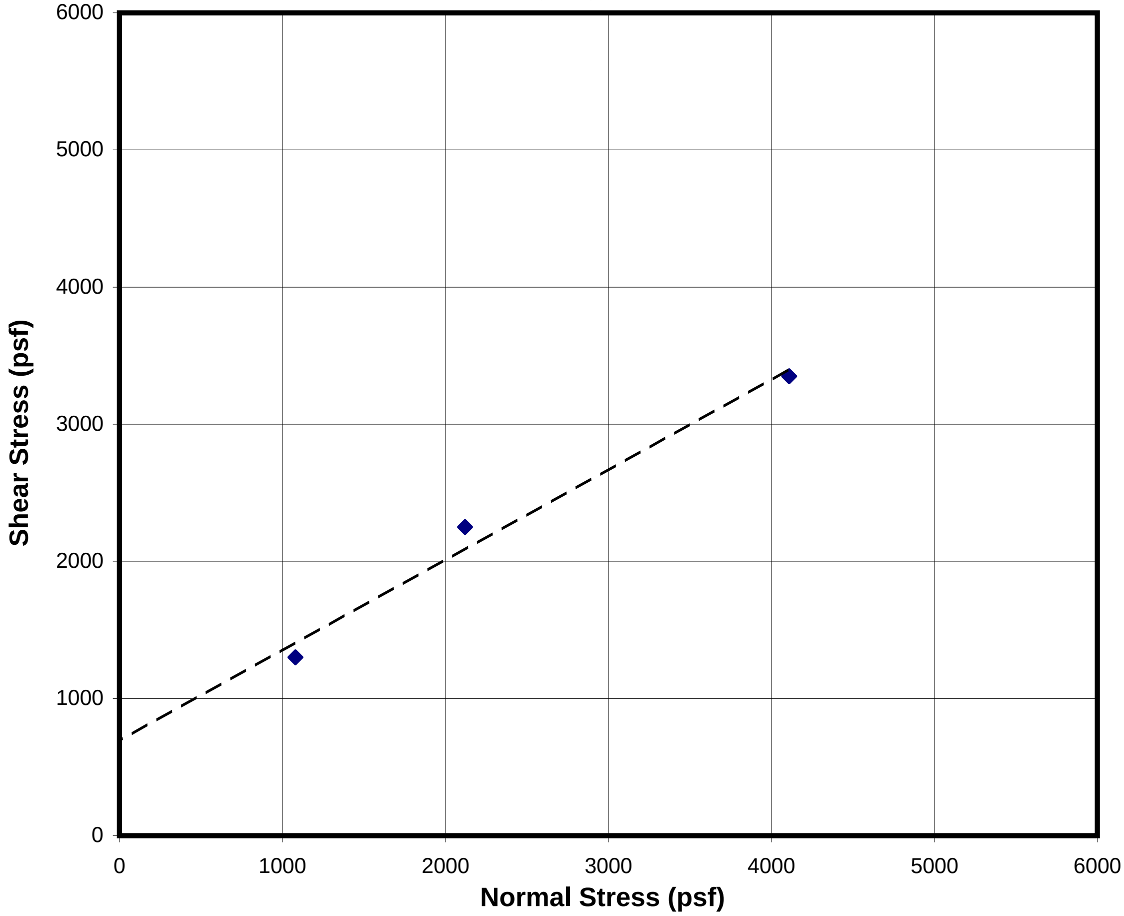
B02-2@30'			
Angle of Internal Friction:	34	degrees	Type
Cohesion :	705	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial Water Content (%)	Initial Dry Density (pcf)	Final Water Content (%)	Final Dry Density (pcf)
1	1100	1400	12.2	112.3	16.4	114.2
2	2130	2200	12.4	116.2	14.1	118.7
3	4080	3420	11.9	117.3	13.9	120.5

Sample B02-2@30ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/14/2002
		Sample No.:	B02-2@40'

DIRECT SHEAR DATA



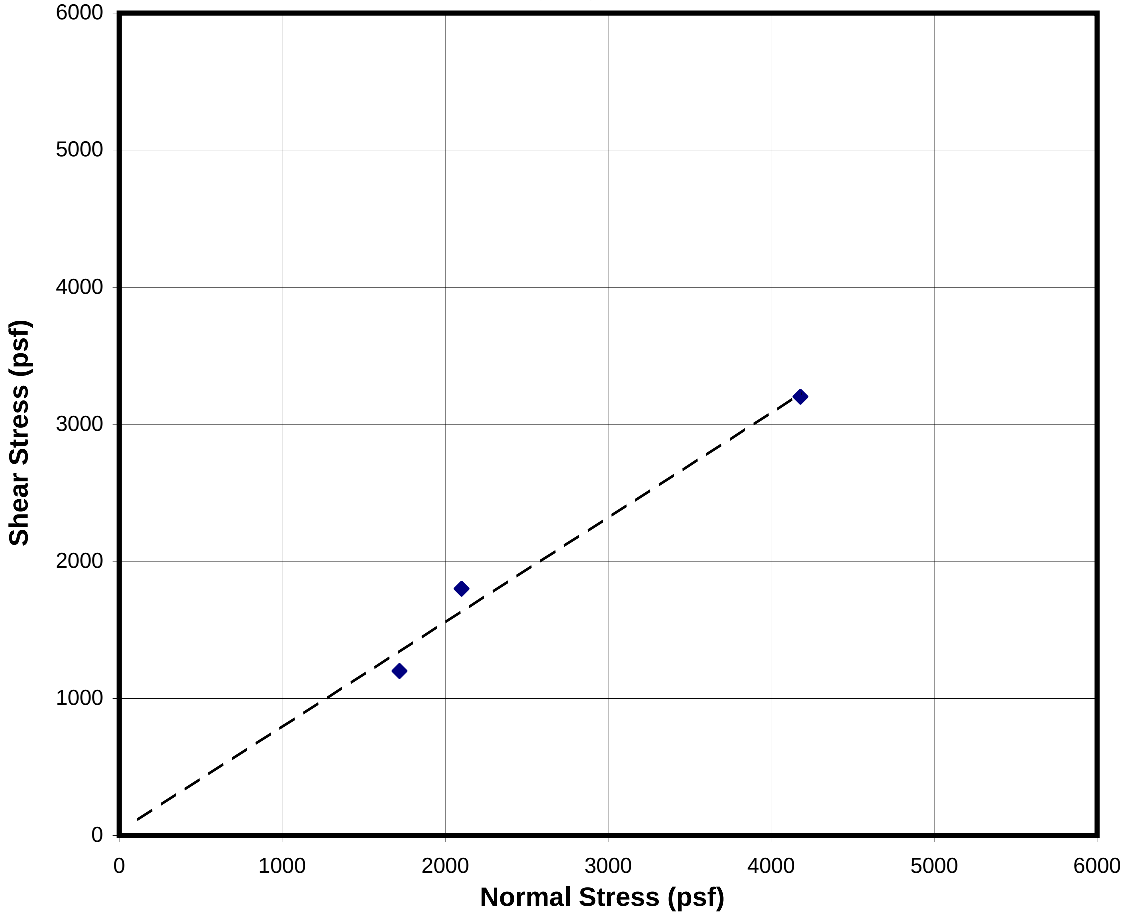
B02-2@40'			
Angle of Internal Friction:	33	degrees	Type
Cohesion :	692	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial		Final	
			Water Content (%)	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)
1	1080	1300	16.6	109.7	17.8	113.0
2	2120	2250	16.5	109.5	18.3	112.1
3	4110	3350	16.5	103.3	19.8	108.7

Sample B02-2@40ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/17/2002
		Sample No.:	B02-3@10'

DIRECT SHEAR DATA



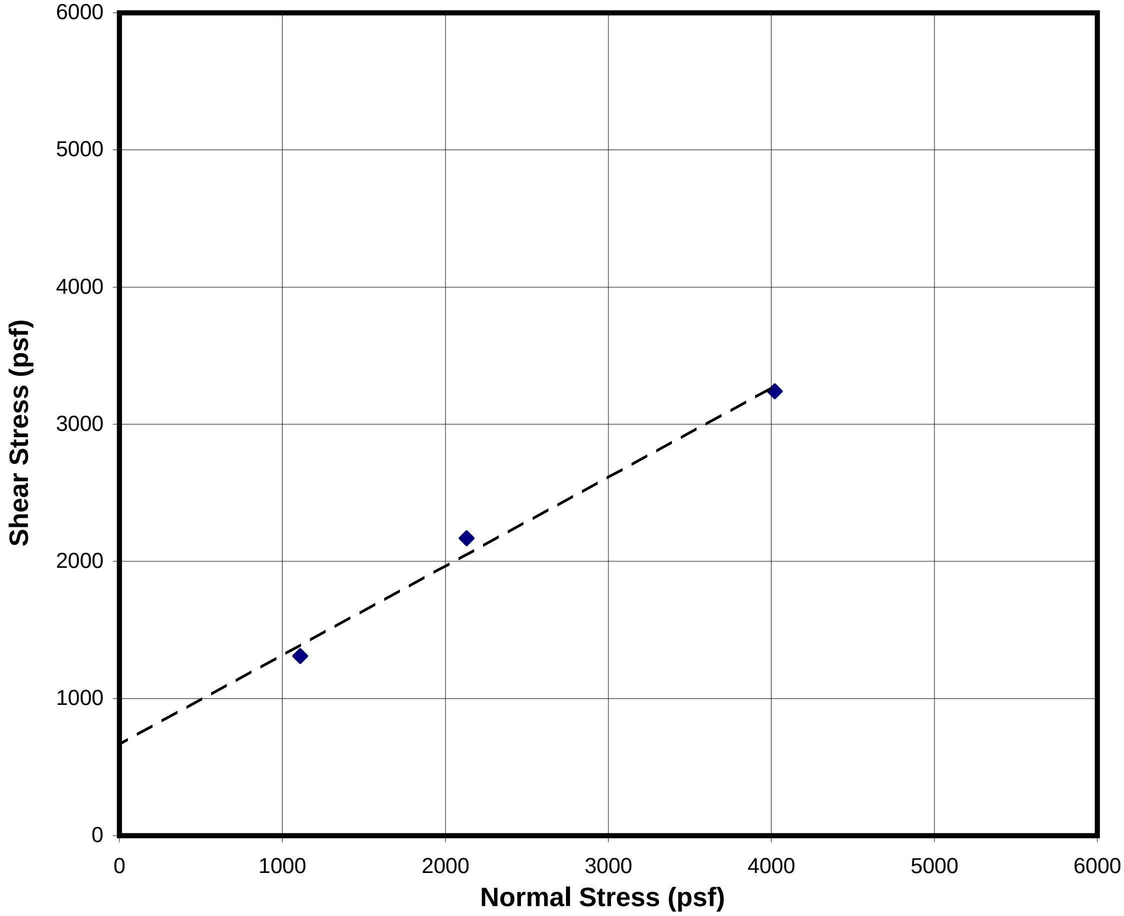
B02-3@10'			
Angle of Internal Friction:	37	degrees	Type
Cohesion :	24	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial		Final	
			Water Content (%)	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)
1	1720	1200	3.5	124.4	10.7	125.7
2	2100	1800	4.2	117.3	9.9	119.8
3	4180	3200	3.9	119.5	7.2	124.3

Sample B02-3@10ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/16/2002
		Sample No.:	B02-3@15'

DIRECT SHEAR DATA



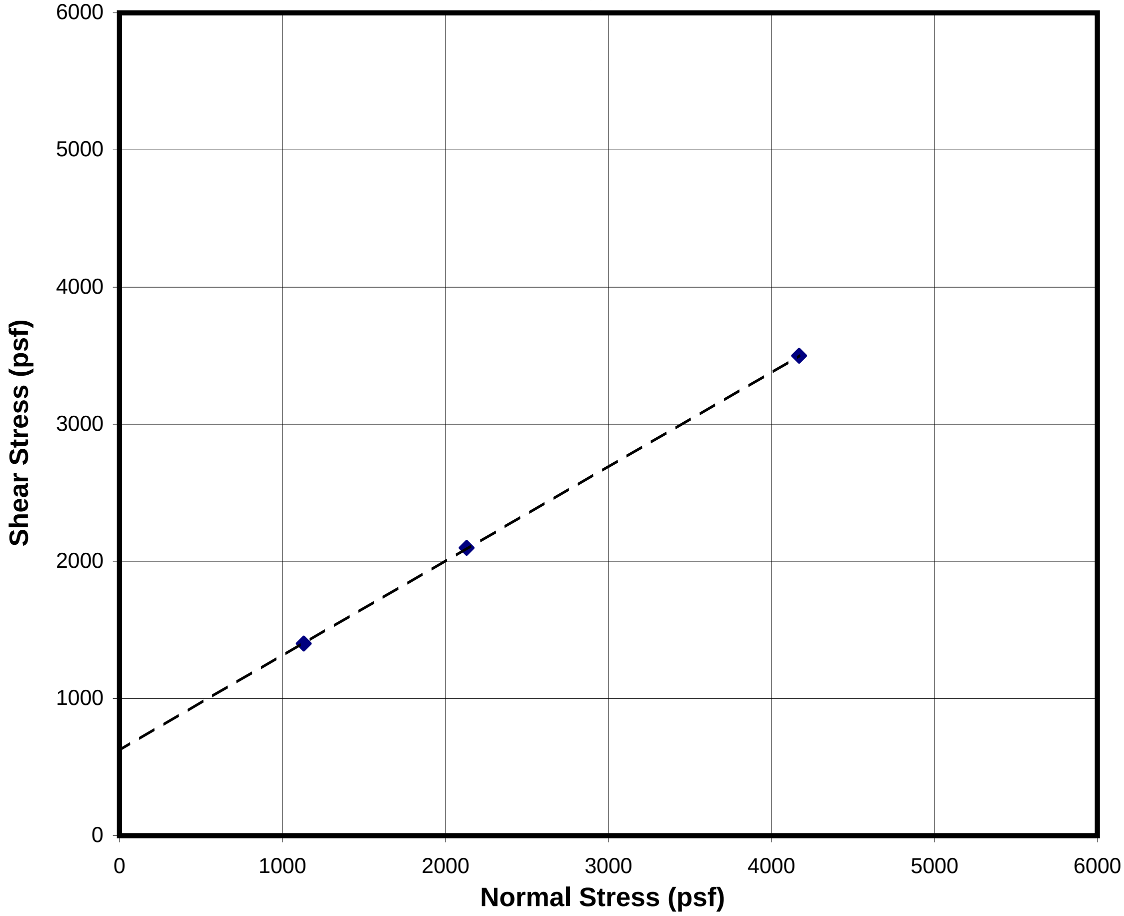
B02-3@15'			
Angle of Internal Friction:	33	degrees	Type
Cohesion :	665	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial Water Content (%)	Initial Dry Density (pcf)	Final Water Content (%)	Final Dry Density (pcf)
1	1110	1310	9.7	112.5	17.4	113.7
2	2130	2170	10.1	116.2	11.0	118.2
3	4020	3240	7.6	119.9	13.9	123.1

Sample B02-3@15ft.
Buckhorn Grade

Project:	Buckhorn Grade
Location of Project:	Shasta Co., California
Client:	CALTRANS
Project No.:	502001.021
Tested By:	SHN
Test Date:	09/18/2002
Sample No.:	B02-5@35'

DIRECT SHEAR DATA



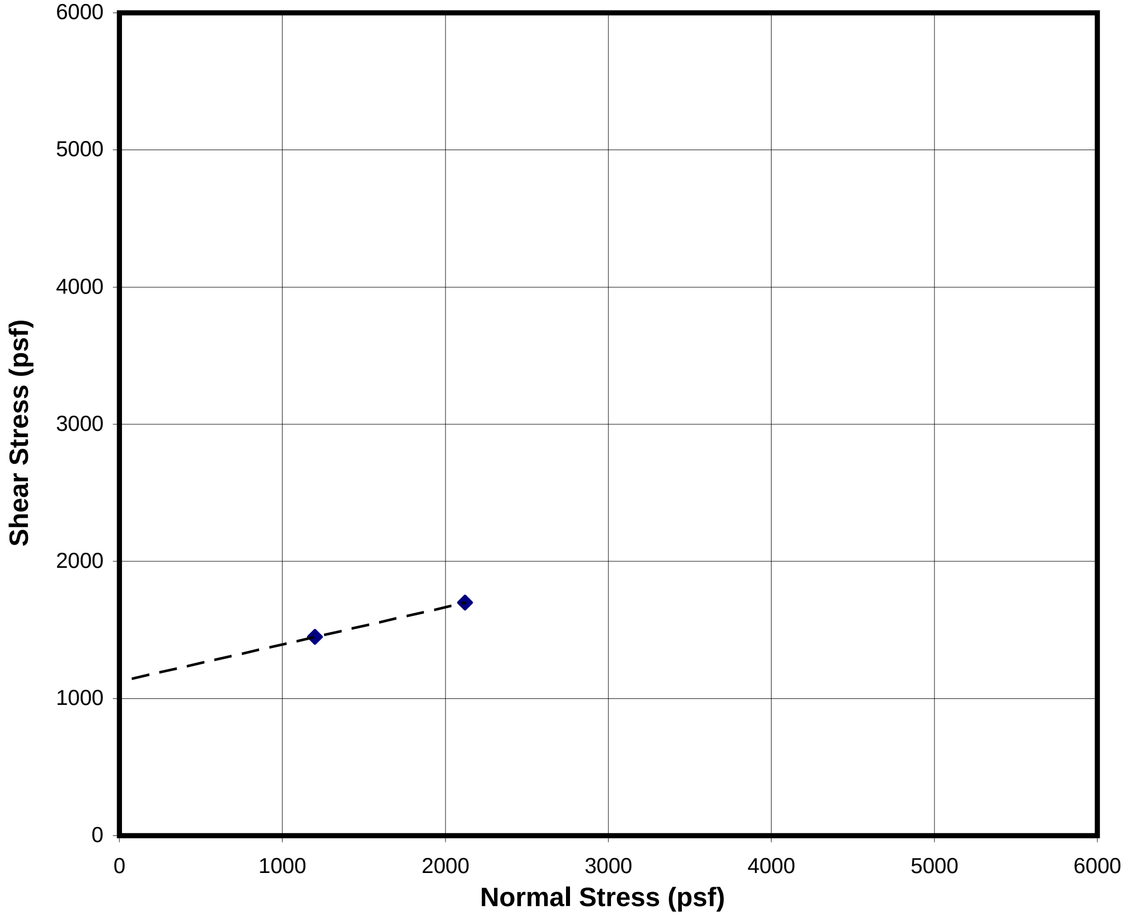
B02-5@35'			
Angle of Internal Friction:	35	degrees	Type
Cohesion :	624	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial		Final	
			Water Content (%)	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)
1	1130	1400	9.3	114.9	10.8	116.4
2	2130	2100	9.5	117.5	9.6	120.5
3	4170	3500	9.6	117.3	13.2	120.8

Sample B02-5@35ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/13/2002
		Sample No.:	B02-7@10'

DIRECT SHEAR DATA



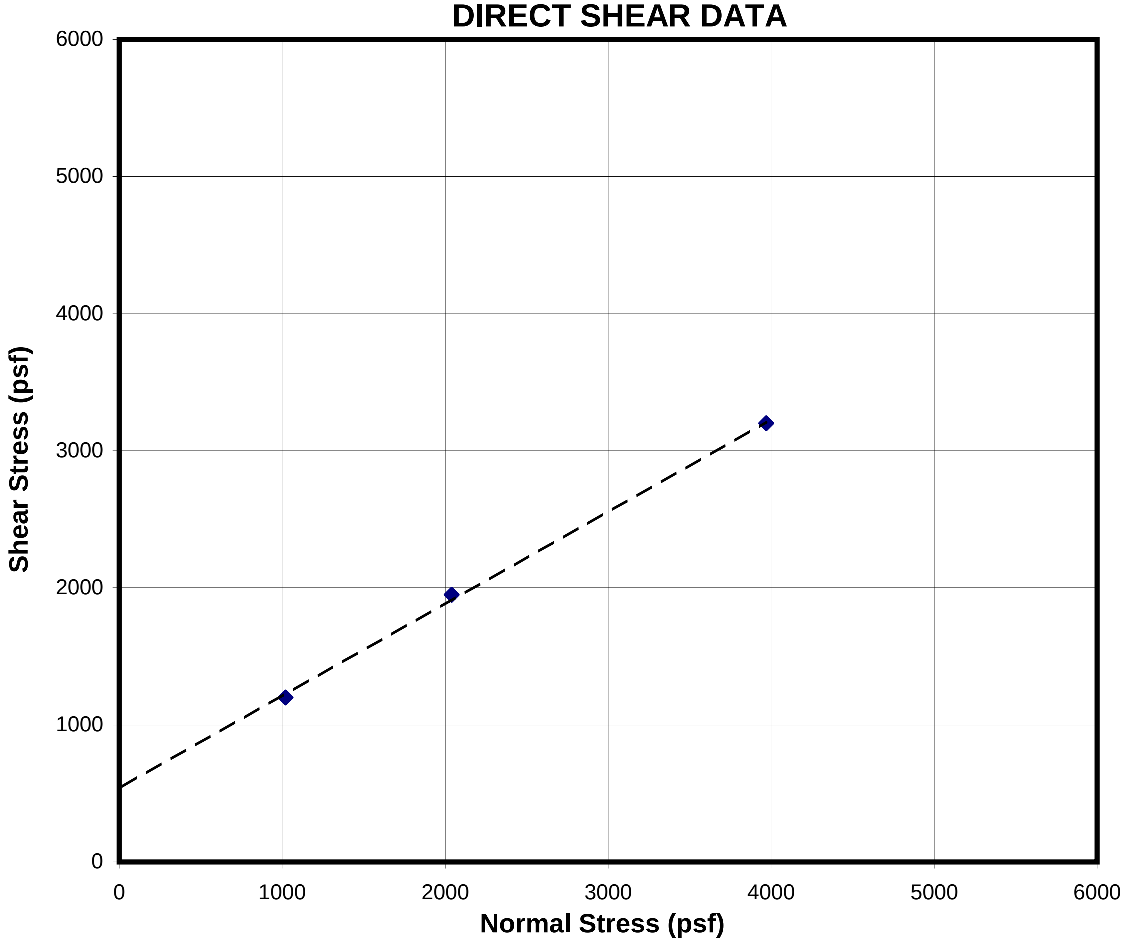
B02-7@10'			
Angle of Internal Friction:	15	degrees	Type
Cohesion :	1124	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial		Final	
			Water Content (%)	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)
1	1200	1450	15.0	107.5	18.1	108.4
2	2120	1700	13.5	107.3	18.7	109.0

Sample B02-7@10ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/19/2002
		Sample No.:	B02-7@5'

DIRECT SHEAR DATA



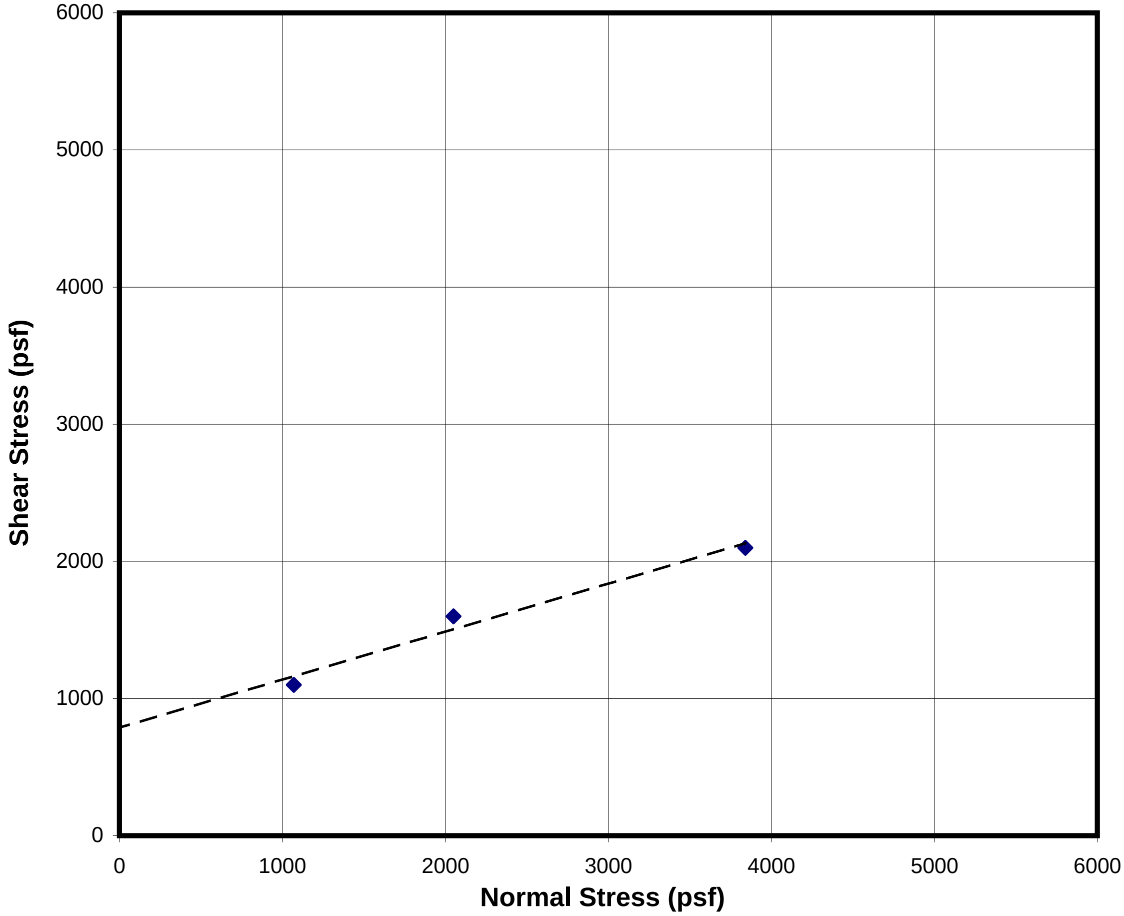
B02-7@5'			
Angle of Internal Friction:	34	degrees	Type
Cohesion :	537	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial		Final	
			Water Content (%)	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)
1	1020	1200	9.4	104.0	12.5	105.3
2	2040	1950	9.1	106.9	11.1	109.5
3	3970	3200	9.8	101.4	11.7	107.1

Sample B02-7@5ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/19/2002
		Sample No.:	B02-8@15'

DIRECT SHEAR DATA



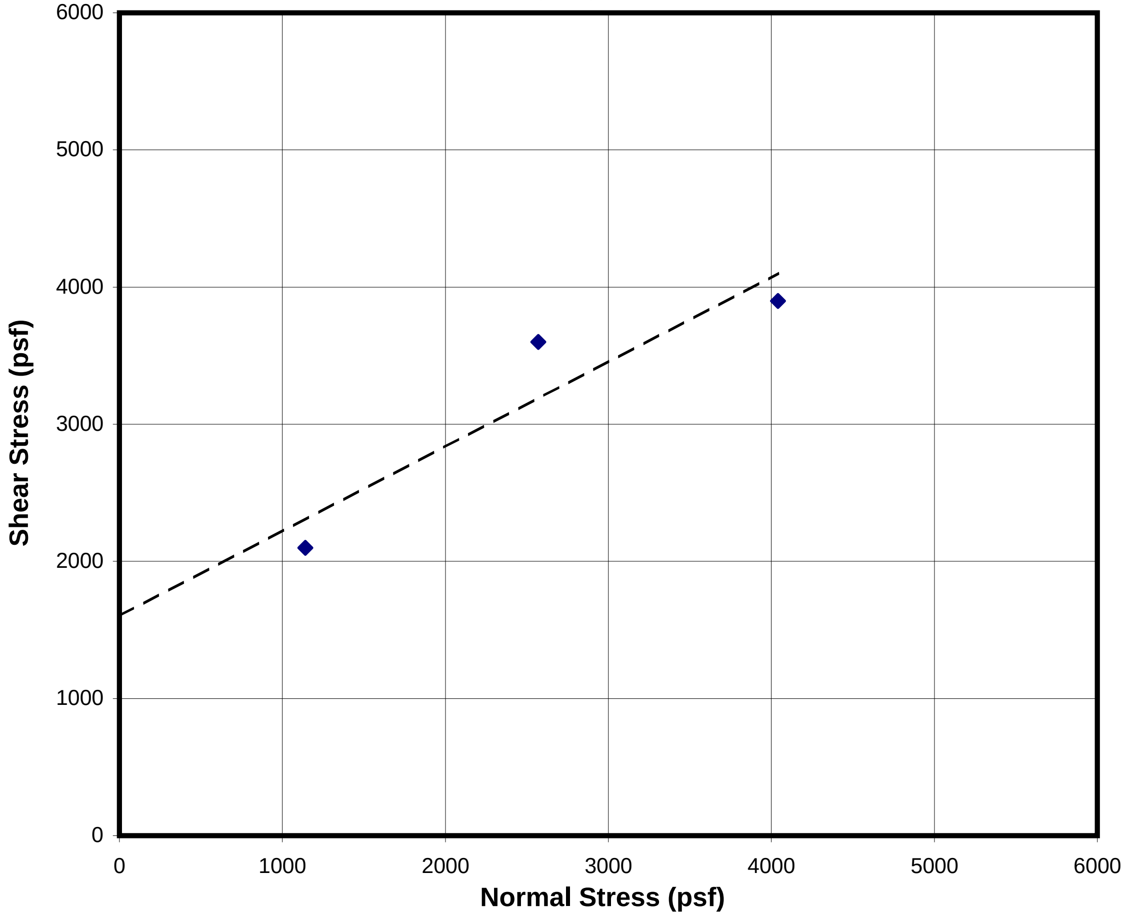
B02-8@15'				
Angle of Internal Friction:	19	degrees	Type
Cohesion :	786	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial		Final	
			Water Content (%)	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)
1	1070	1100	17.2	107.4	20.6	108.3
2	2050	1600	14.7	109.5	19.3	111.4
3	3840	2100	15.6	106.7	20.0	110.2

Sample B02-8@15ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/14/2002
		Sample No.:	B02-8@20'

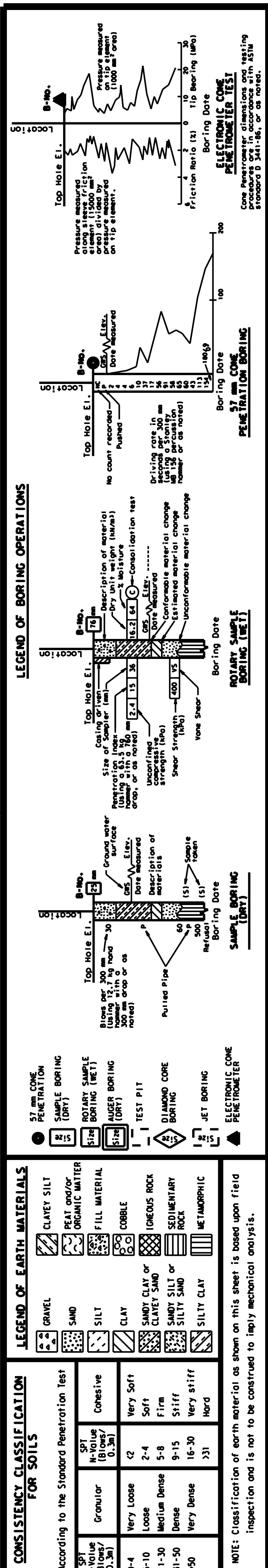
DIRECT SHEAR DATA

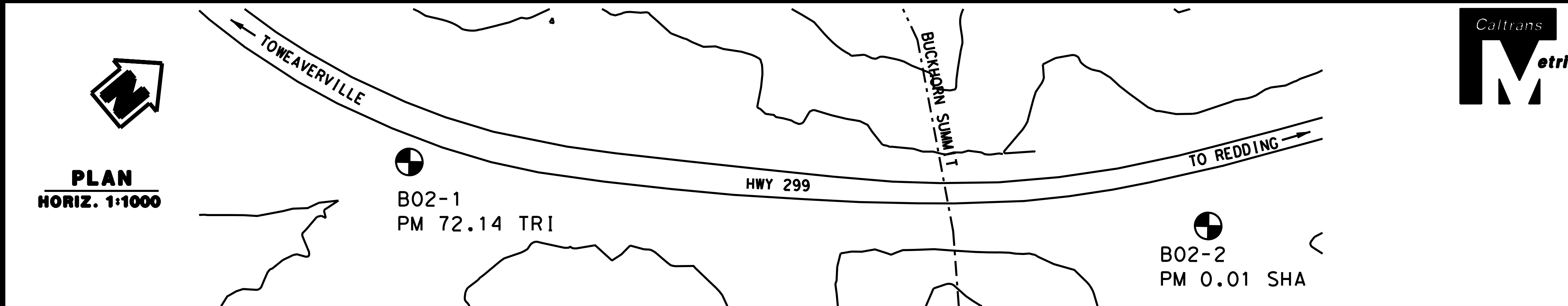


B02-8@20'				
Angle of Internal Friction:	32	degrees	Type
Cohesion :	1602	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial		Final	
			Water Content (%)	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)
1	1140	2100	10.9	116.9	13.1	118.1
2	2570	3600	9.8	121.7	12.2	123.4
3	4040	3900	8.4	118.8	11.9	122.2

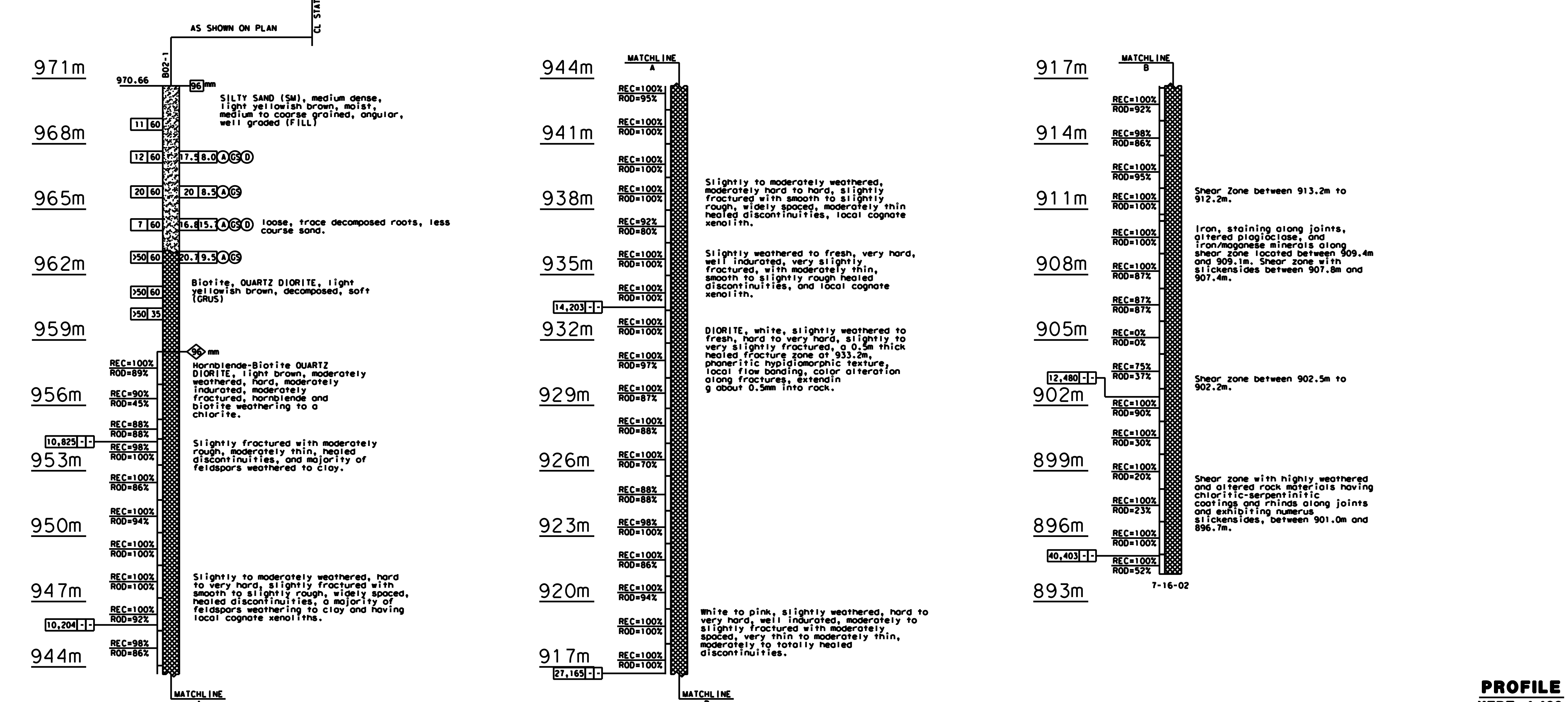
Sample B02-8@20ft.
Buckhorn Grade





BENCH MARK

Description	Northing	Easting	Elevation
B02-1	644,678.204	1,937,805.161	970.662



PROFILE
VERT. 1:100

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET No	TOTAL SHEETS
02	SHASTA	299	116.48	1	1

9/26/02
CERTIFIED ENGINEER GEOLOGIST

REGISTERED GEOLOGIST — JAMES A. BIANCHIN — No. EG No. 1644 — Exp. 6-2005 — CERTIFIED ENGINEERING GEOLOGIST — STATE OF CALIFORNIA

PLANS APPROVAL DATE

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SHN CONSULTING ENGINEERS & GEOLOGISTS, INC.
480 Hemsted Drive (530)221-5424
Redding, CA 96002 FAX (530)221-0135

JOB No. 502001.021 LOCATION: BUCKHORN GRADE

DESIGN OVERSIGHT	DRAWN BY	M. JURING	D. LINDSAY
SIGN OFF DATE	CHECKED BY	J. BIANCHIN	FIELD INVESTIGATION BY: DATE: SEE BORINGS

PREPARED FOR THE STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

PROJECT ENGINEER
BRIDGE NO.
KILOMETER POST

BUCKHORN GRADE
LOG OF TEST BORINGS

GEOTECHNICAL LOG OF TEST BORINGS SHEET (METRIC) (REV 2/1/00)

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 10 20 30 40 50 60 70 80 90 100

CU
EA 02-270310
FILE => $REQUEST

DISREGARD PRINTS BEARING EARLIER REVISION DATES
REVISION DATES (PRELIMINARY STAGE ONLY) 9-26-02
SHEET 1 OF 1

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

LOTB-02-1.dgn 1/7/2011 2:10:04 PM

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET No	TOTAL SHEETS
02	SHASTA	299	116.48	1	1

CERTIFIED ENGINEER GEOLOGIST 9/26/02

PLANS APPROVAL DATE

REGISTERED GEOLOGIST JAMES A. BIANCHIN No. EG No. 1644 Exp. 6-2005 CERTIFIED ENGINEERING GEOLOGIST STATE OF CALIFORNIA

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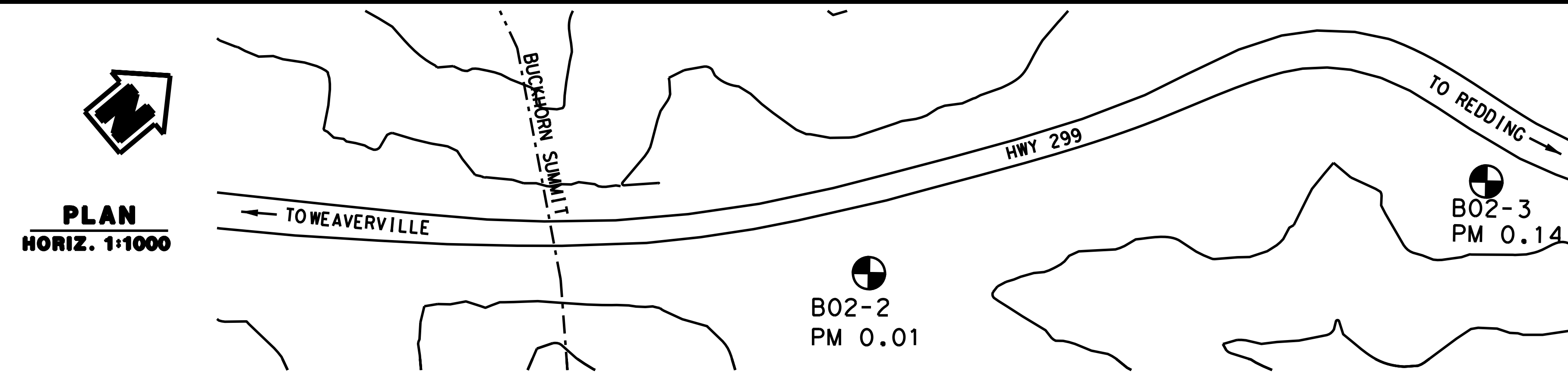
Redding, CA 96002FAX (530)221-0135

JOB No. 502001.021 LOCATION: BUCKHORN GRADE

Caltrans Metric

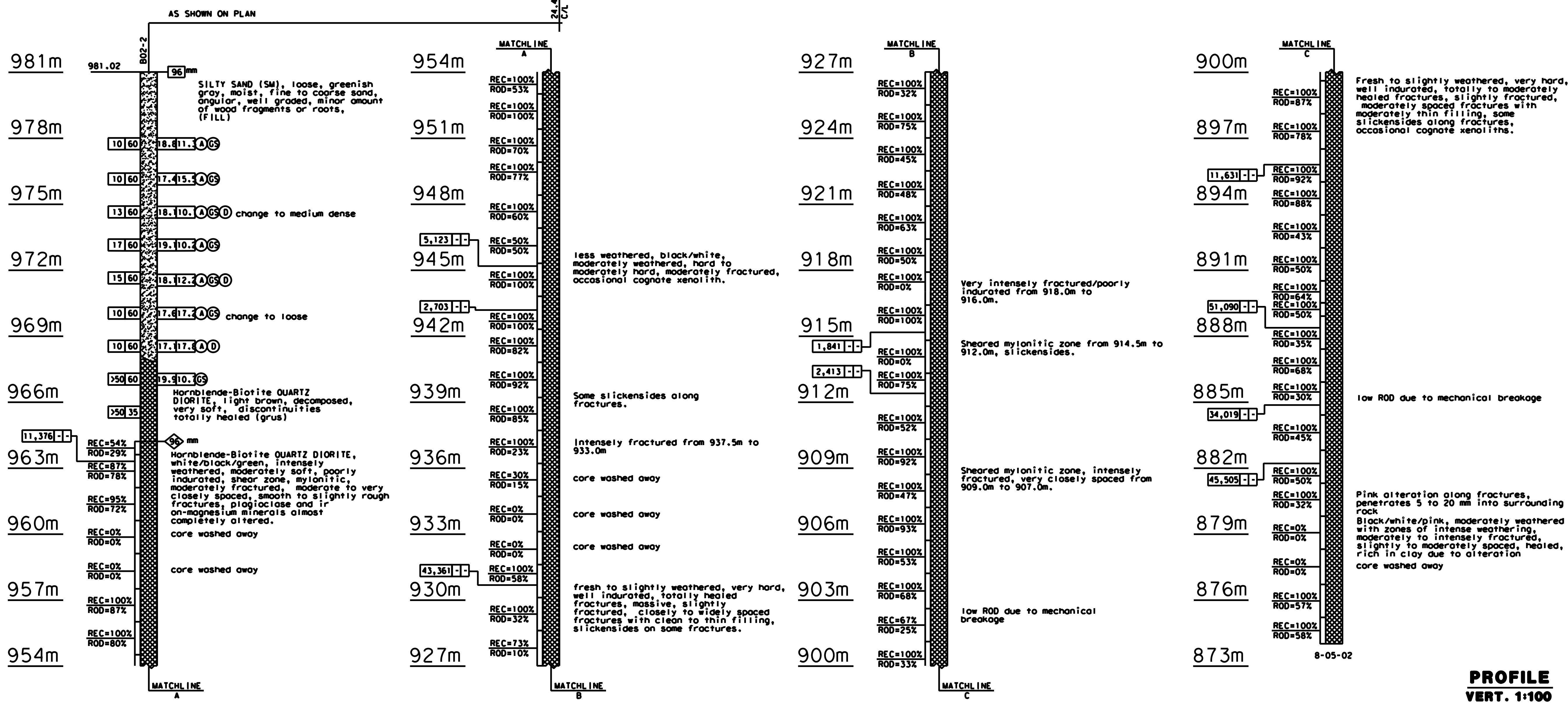
PLAN

HORIZ. 1:1000



BENCH MARK

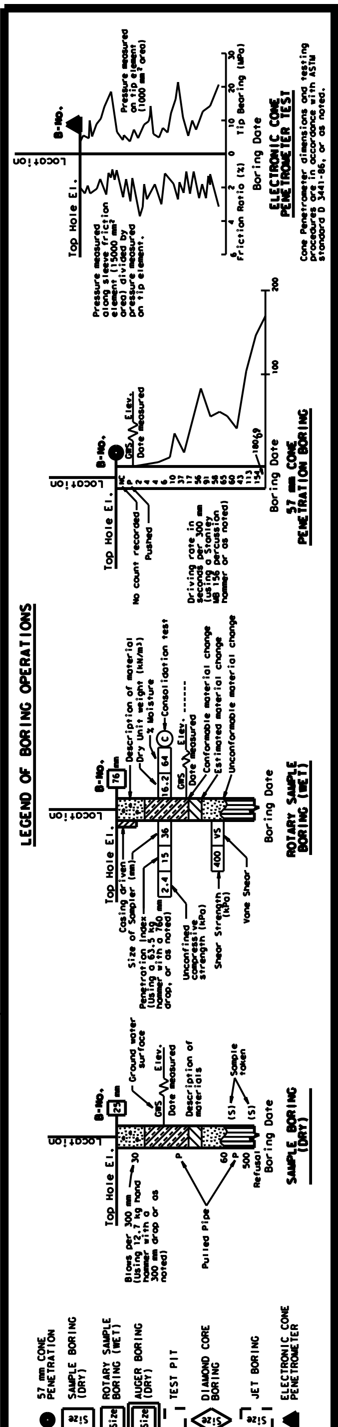
Description	Northing	Easting	Elevation
B02-2	644,890.258	1,938,014.160	981.018



PROFILE

VERT. 1:100

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN



LEGEND OF EARTH MATERIALS: GRAVEL, SAND, SILT, CLAY, SANDY CLAY or CLAYEY SAND, SANDY SILT or SILTY SAND, SILTY CLAY, CLAYEY SILT, PEAT and/or ORGANIC MATTER, FILL MATERIAL, COBBLE, IGNEOUS ROCK, SEDIMENTARY ROCK, METAMORPHIC

NOTE: Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

CONSISTENCY CLASSIFICATION FOR SOILS — According to the Standard Penetration Test

Granular	SPT N-Value (Blows/0.3m)	Cohesive	SPT N-Value (Blows/0.3m)
Very Loose	0-4	Very Soft	<2
Loose	5-10	Soft	2-4
Medium Dense	11-30	Firm	5-8
Dense	31-50	Stiff	9-15
Very Dense	>50	Very stiff	16-30
		Hard	>31

DESIGN OVERSIGHT	DRAWN BY	M. JURING	D. LINDSAY	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	PROJECT ENGINEER	BRIDGE NO.	BUCKHORN GRADE
SIGN OFF DATE	CHECKED BY	J. BIANCHIN	FIELD INVESTIGATION BY: DATE: SEE BORINGS			KILOMETER POST	LOG OF TEST BORINGS

GEOTECHNICAL LOG OF TEST BORINGS SHEET (METRIC) (REV 2/1/00)

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 10 20 30 40 50 60 70 80 90 100

CU EA 02-270310

DISREGARD PRINTS BEARING EARLIER REVISION DATES — REVISION DATES (PRELIMINARY STAGE ONLY) 9-26-02 — SHEET 1 OF 1

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

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DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET No	TOTAL SHEETS
02	SHASTA	299	116.48	1	1

CERTIFIED ENGINEER GEOLOGIST 9/26/02

REGISTERED GEOLOGIST — JAMES A. BIANCHIN No. EG No. 1644 Exp. 6-2005 CERTIFIED ENGINEERING GEOLOGIST — STATE OF CALIFORNIA

PLANS APPROVAL DATE

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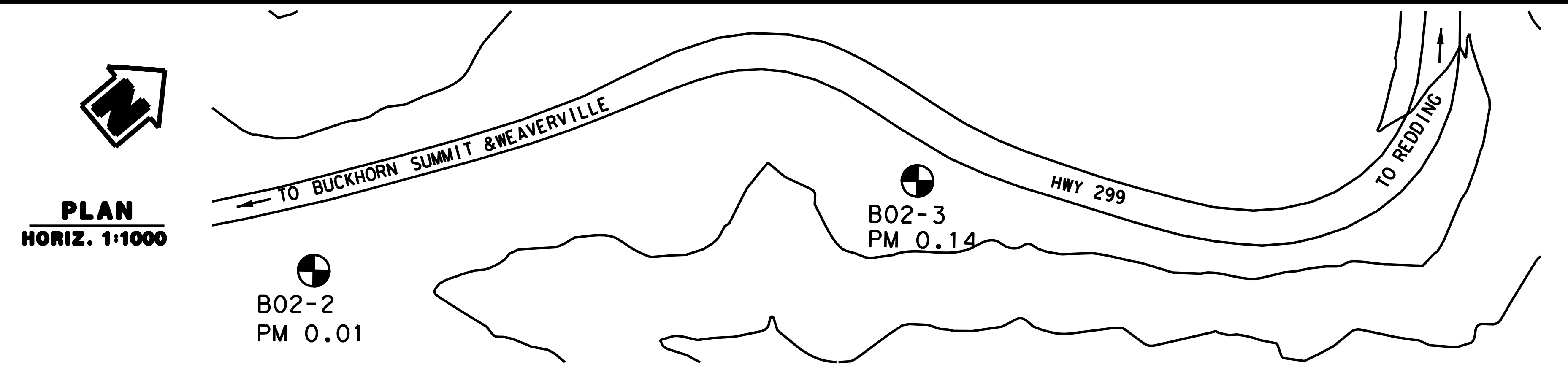
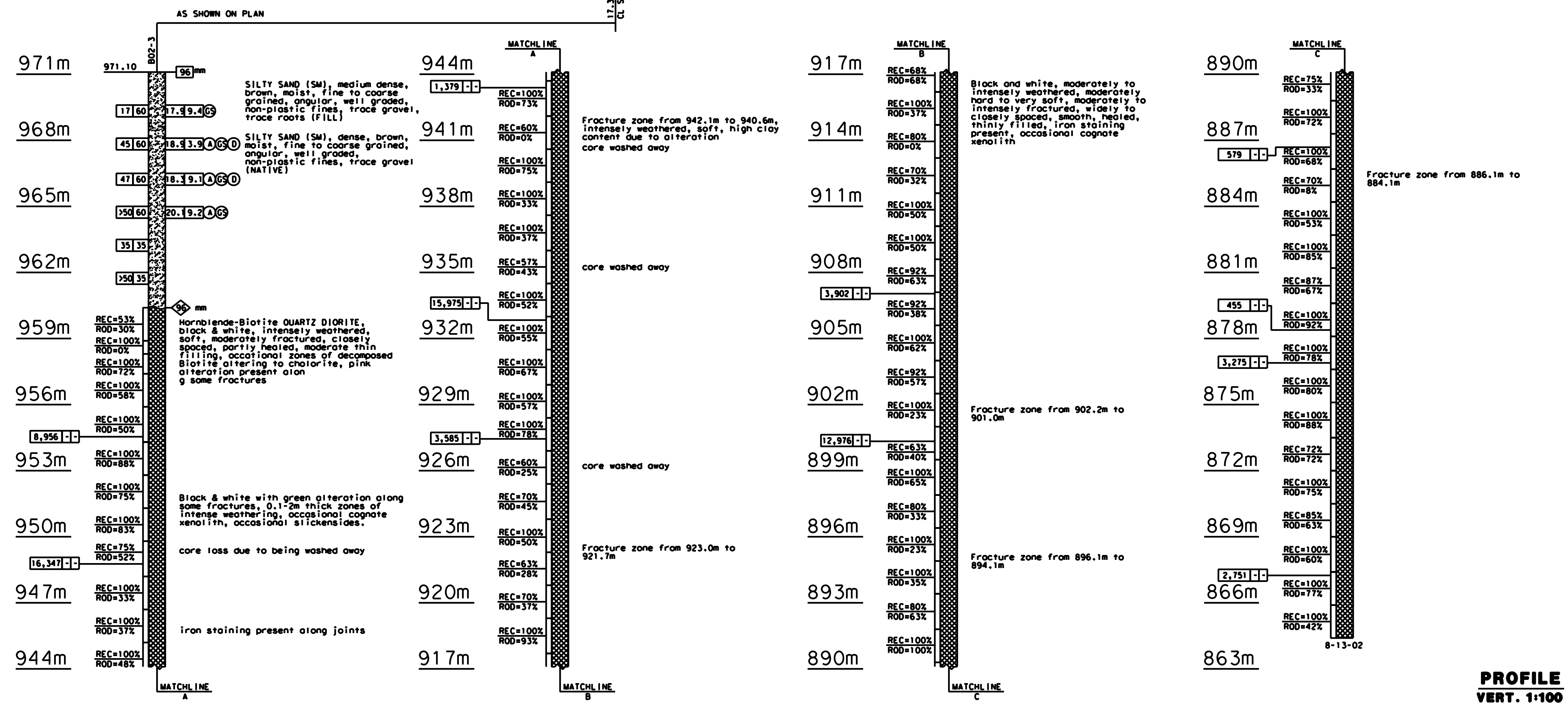
JOB No. 502001.021 LOCATION: BUCKHORN GRADE

Caltrans Metric



BENCH MARK

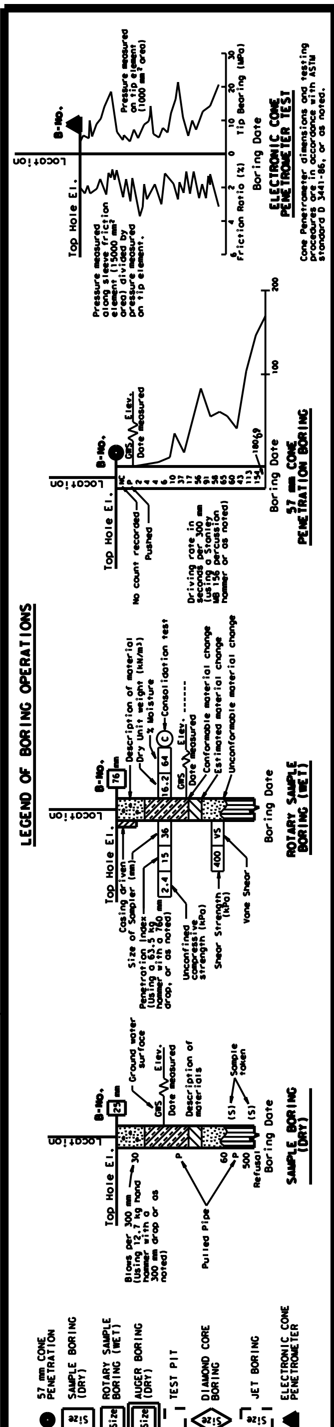
Description	Northing	Easting	Elevation
B02-3	645,053.676	1,938,114.492	971.1



PROFILE
VERT. 1:100

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

LEGEND OF BORING OPERATIONS



LEGEND OF EARTH MATERIALS

GRAVEL, SAND, SILT, CLAY, SANDY CLAY or CLAYEY SAND, SANDY SILT or SILTY SAND, SILTY CLAY, CLAYEY SILT, PEAT and/or ORGANIC MATTER, FILL MATERIAL, COBBLE, IGNEOUS ROCK, SEDIMENTARY ROCK, METAMORPHIC

CONSISTENCY CLASSIFICATION FOR SOILS

According to the Standard Penetration Test

SPT N-Value (Blows/0.3m)	Granular	SPT N-Value (Blows/0.3m)	Cohesive
0-4	Very Loose	<2	Very Soft
5-10	Loose	2-4	Soft
11-30	Medium Dense	5-8	Firm
31-50	Dense	9-15	Stiff
>50	Very Dense	16-30	Very stiff
		>31	Hard

NOTE: Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

DESIGN OVERSIGHT	DRAWN BY	M. JURING	D. LINDSAY	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	PROJECT ENGINEER	BRIDGE NO.	BUCKHORN GRADE
SIGN OFF DATE	CHECKED BY	J. BIANCHIN	FIELD INVESTIGATION BY: DATE: SEE BORINGS			KILOMETER POST	LOG OF TEST BORINGS

GEOTECHNICAL LOG OF TEST BORINGS SHEET (METRIC) (REV 2/1/00)

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 10 20 30 40 50 60 70 80 90 100

CU
EA 02-270310

DISREGARD PRINTS BEARING EARLIER REVISION DATES → 9-26-02

REVISION DATES (PRELIMINARY STAGE ONLY) SHEET 1 OF 1

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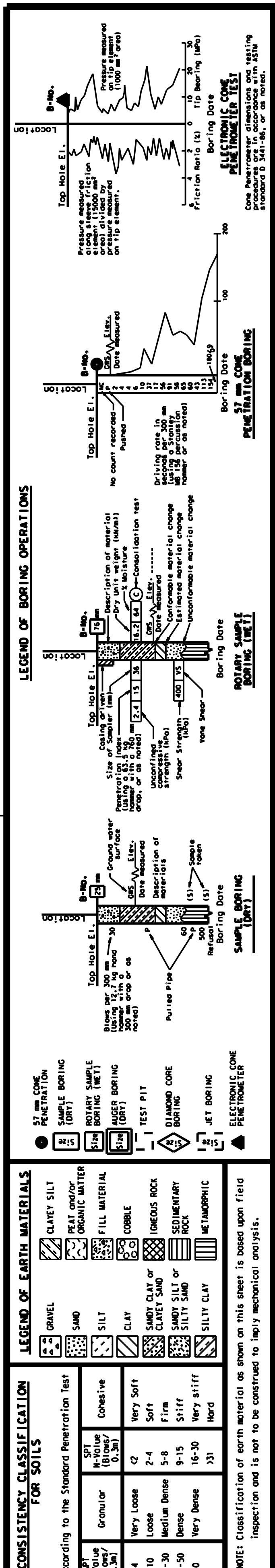

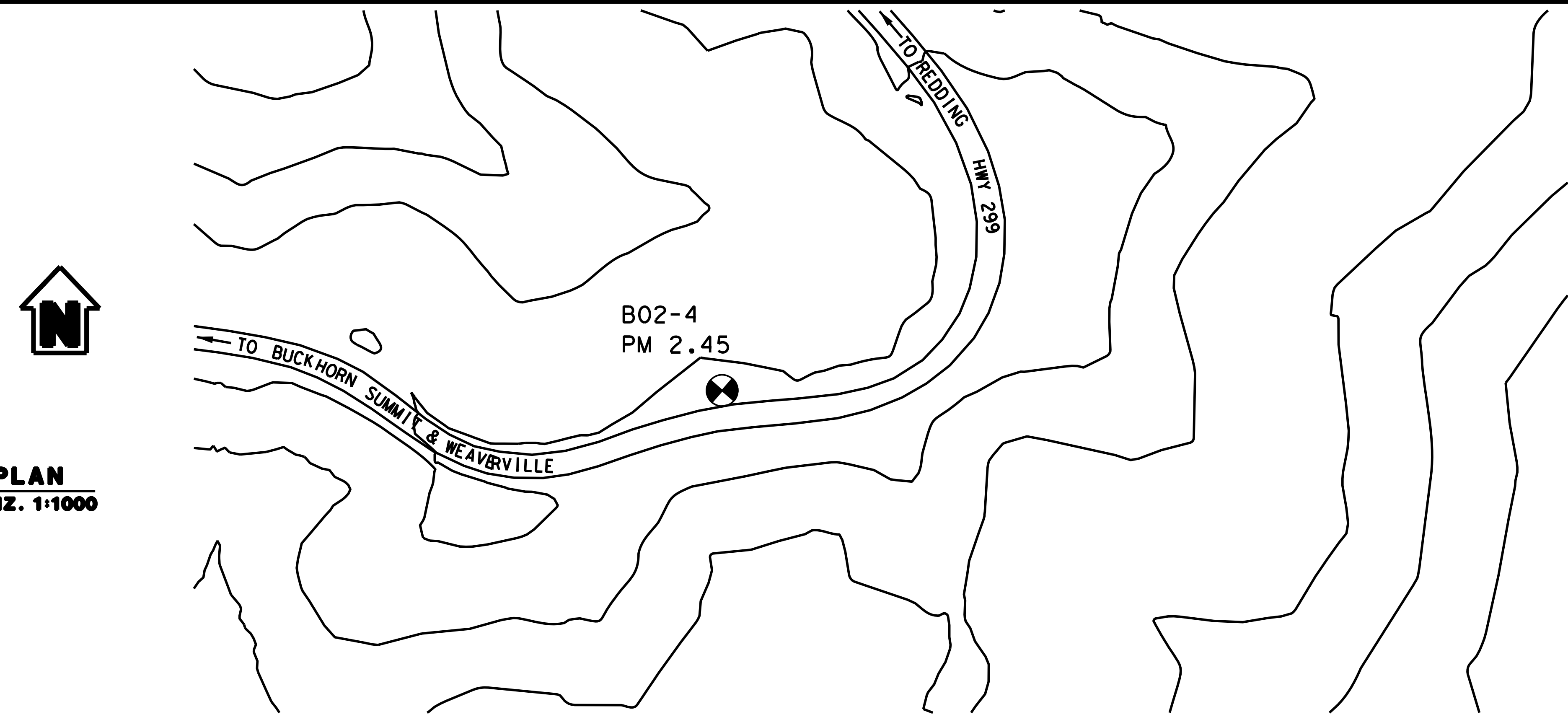

PLAN
HORIZ. 1:1000

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET No	TOTAL SHEETS
02	SHASTA	299	116.48	1	1

CERTIFIED ENGINEER GEOLOGIST 9/26/02

REGISTERED GEOLOGIST — JAMES A. BIANCHIN — No. EG No. 1644 — Exp. 6-2005 — CERTIFIED ENGINEERING GEOLOGIST — STATE OF CALIFORNIA

PLANS APPROVAL DATE

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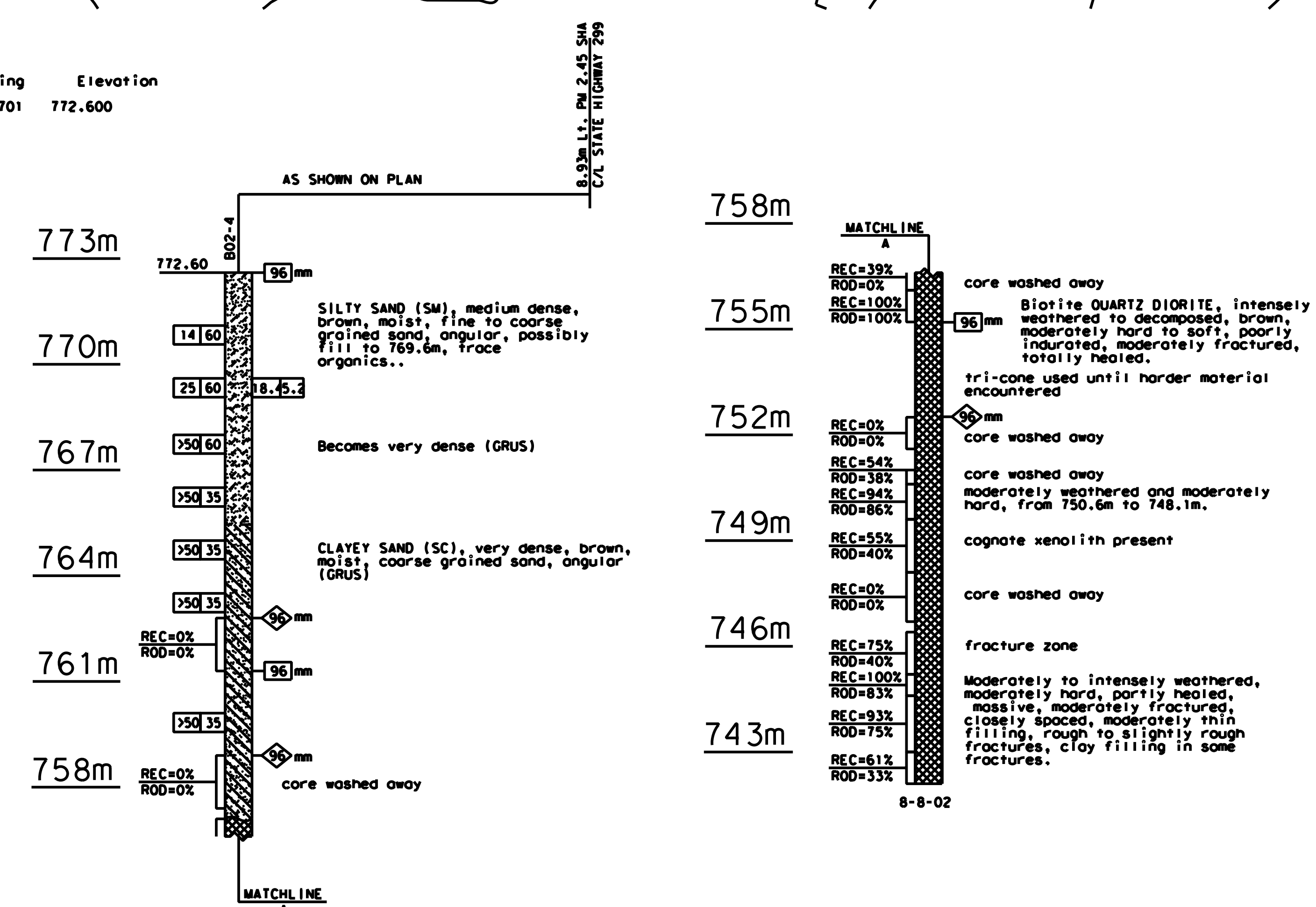
480 Hemsted Drive (530)221-5424
Redding, CA 96002FAX (530)221-0135

JOB No. 502001.021 LOCATION: BUCKHORN GRADE

BENCH MARK

Description	Northing	Easting	Elevation
B02-4	646,356.959	1,940,150.701	772.600



PROFILE
VERT. 1:100

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

DESIGN OVERSIGHT	DRAWN BY	M. JURING	D. LINDSAY
SIGN OFF DATE	CHECKED BY	J. BIANCHIN	FIELD INVESTIGATION BY: DATE: SEE BORINGS

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

PROJECT ENGINEER

BRIDGE NO.

KILOMETER POST

BUCKHORN GRADE
LOG OF TEST BORINGS

GEOTECHNICAL LOG OF TEST BORINGS SHEET (METRIC) (REV 2/1/00)

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 10 20 30 40 50 60 70 80 90 100

CU
EA 02-270310

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) 9-26-02

SHEET 1 OF 1

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

LOTB-02-4.dgn 1/7/2011 2:20:22 PM

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET No	TOTAL SHEETS
02	SHASTA	299	116.48	1	1

JB 9/26/02
CERTIFIED ENGINEER GEOLOGIST

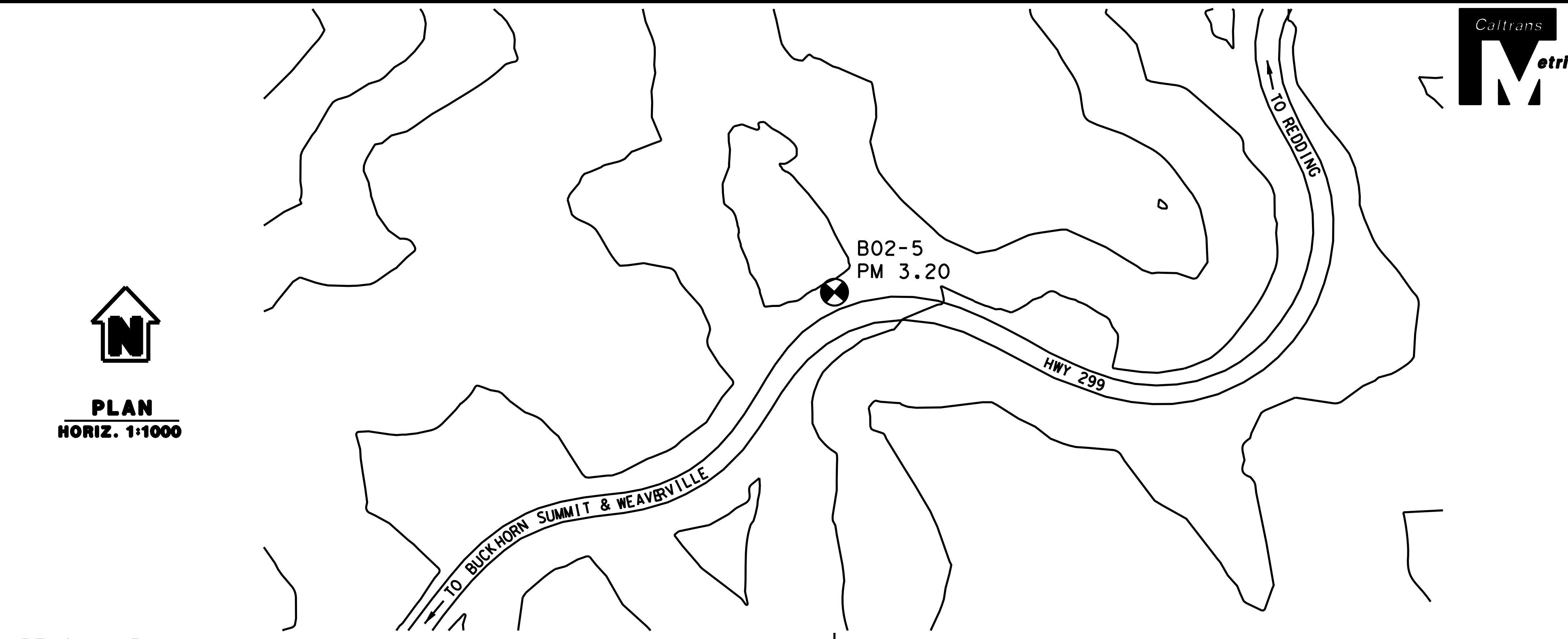
PLANS APPROVAL DATE

REGISTERED GEOLOGIST · JAMES A. BIANCHIN · No. EG No. 1644 · Exp. 6-2005 · CERTIFIED ENGINEERING GEOLOGIST · STATE OF CALIFORNIA

SHN CONSULTING ENGINEERS & GEOLOGISTS, INC.
480 Hemsted Drive (530)221-5424
Redding, CA 96002 FAX (530)221-0135

JOB No. 502001.021 LOCATION: BUCKHORN GRADE

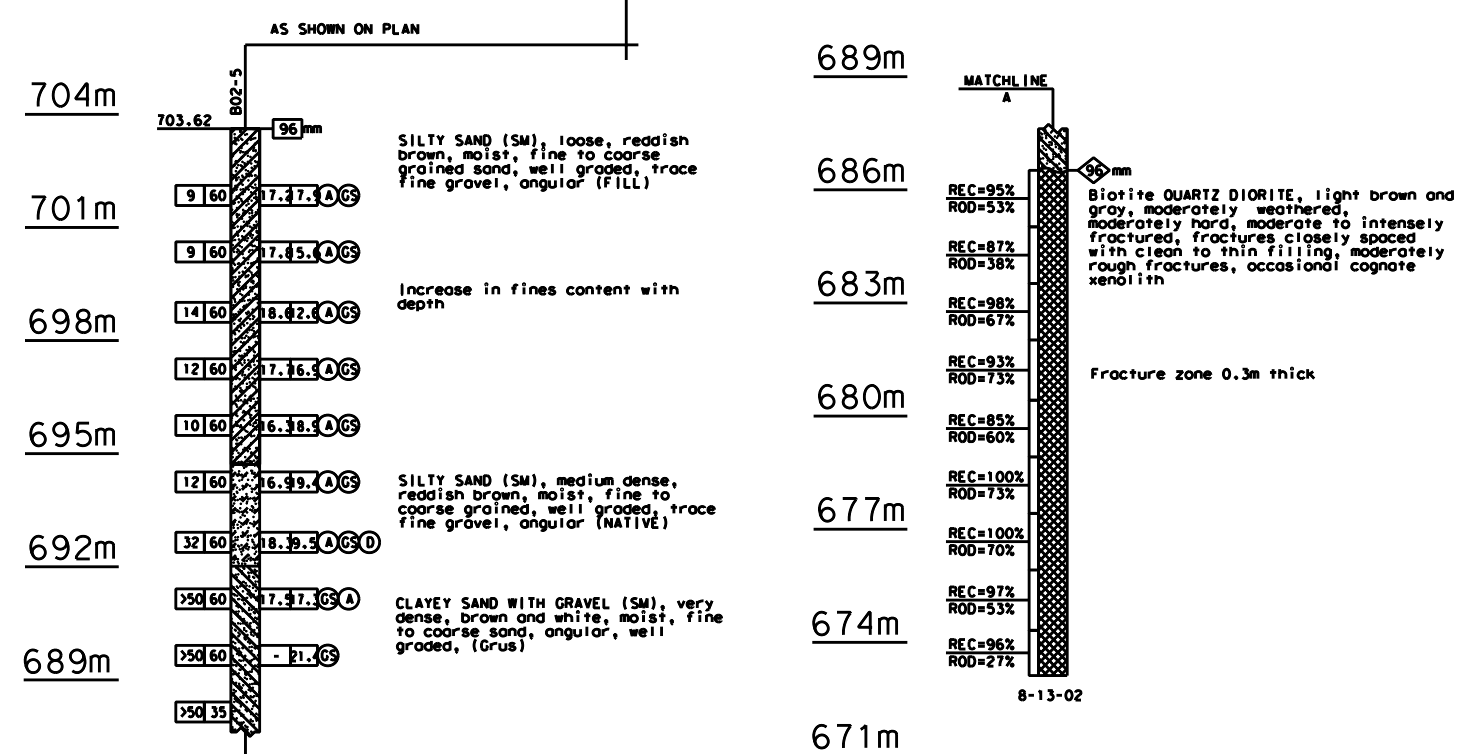
Caltrans Metric



PLAN
HORIZ. 1:1000

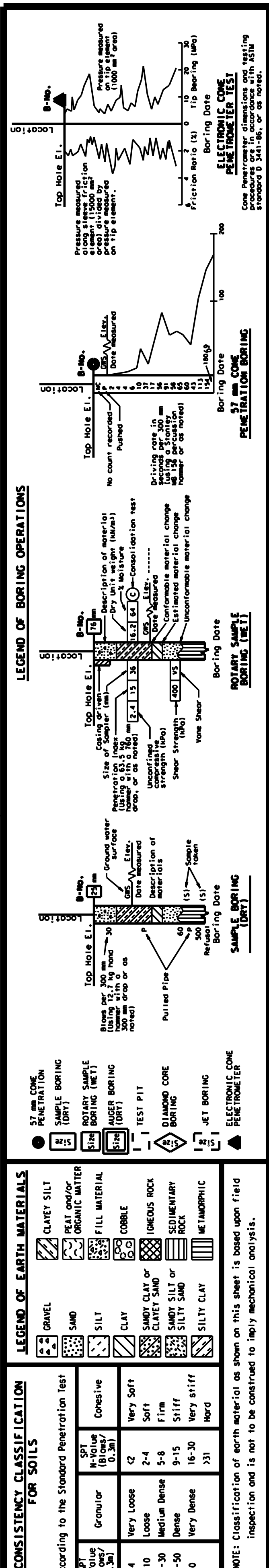
BENCH MARK

Description	Northing	Easting	Elevation
B02-5	647,069.223	1,940,536.737	703.617



PROFILE
VERT. 1:100

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN



DESIGN OVERSIGHT	DRAWN BY	M. JURING	D. LINDSAY	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	PROJECT ENGINEER	BRIDGE NO.	BUCKHORN GRADE
SIGN OFF DATE	CHECKED BY	J. BIANCHIN	FIELD INVESTIGATION BY: DATE: SEE BORINGS			KILOMETER POST	LOG OF TEST BORINGS

GEOTECHNICAL LOG OF TEST BORINGS SHEET (METRIC) (REV 2/1/00)

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 10 20 30 40 50 60 70 80 90 100

CU
EA 02-270310

FILE => $REQUEST

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) 9-26-02

SHEET 1 OF 1

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

LOTB-02-5.dgn 1/7/2011 2:21:51 PM

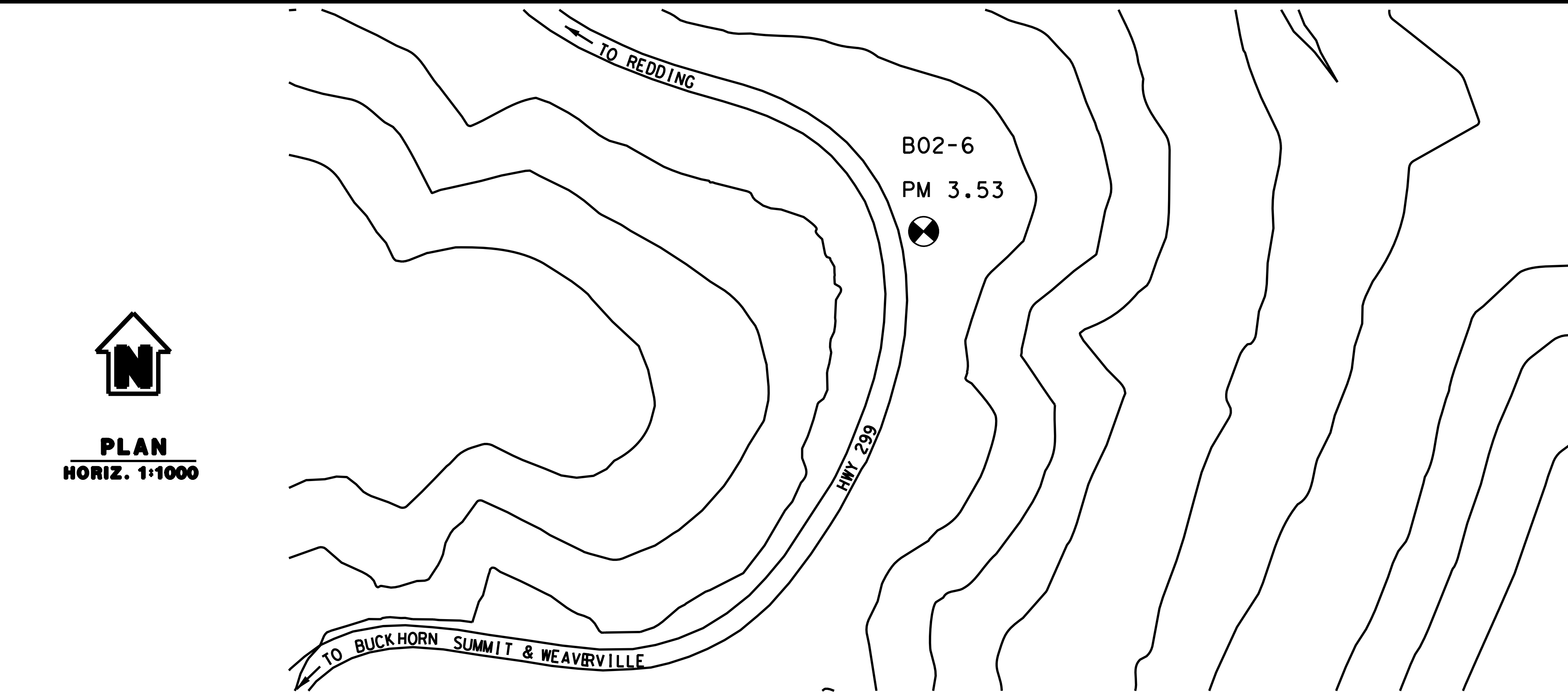
CERTIFIED ENGINEER GEOLOGIST 9/26/02

PLANS APPROVAL DATE

REGISTERED GEOLOGIST — JAMES A. BIANCHIN — No. EG No. 1644 — Exp. 6-2005 — CERTIFIED ENGINEERING GEOLOGIST — STATE OF CALIFORNIA

SHN CONSULTING ENGINEERS & GEOLOGISTS, INC.
480 Hemsted Drive (530)221-5424
Redding, CA 96002 FAX (530)221-0135

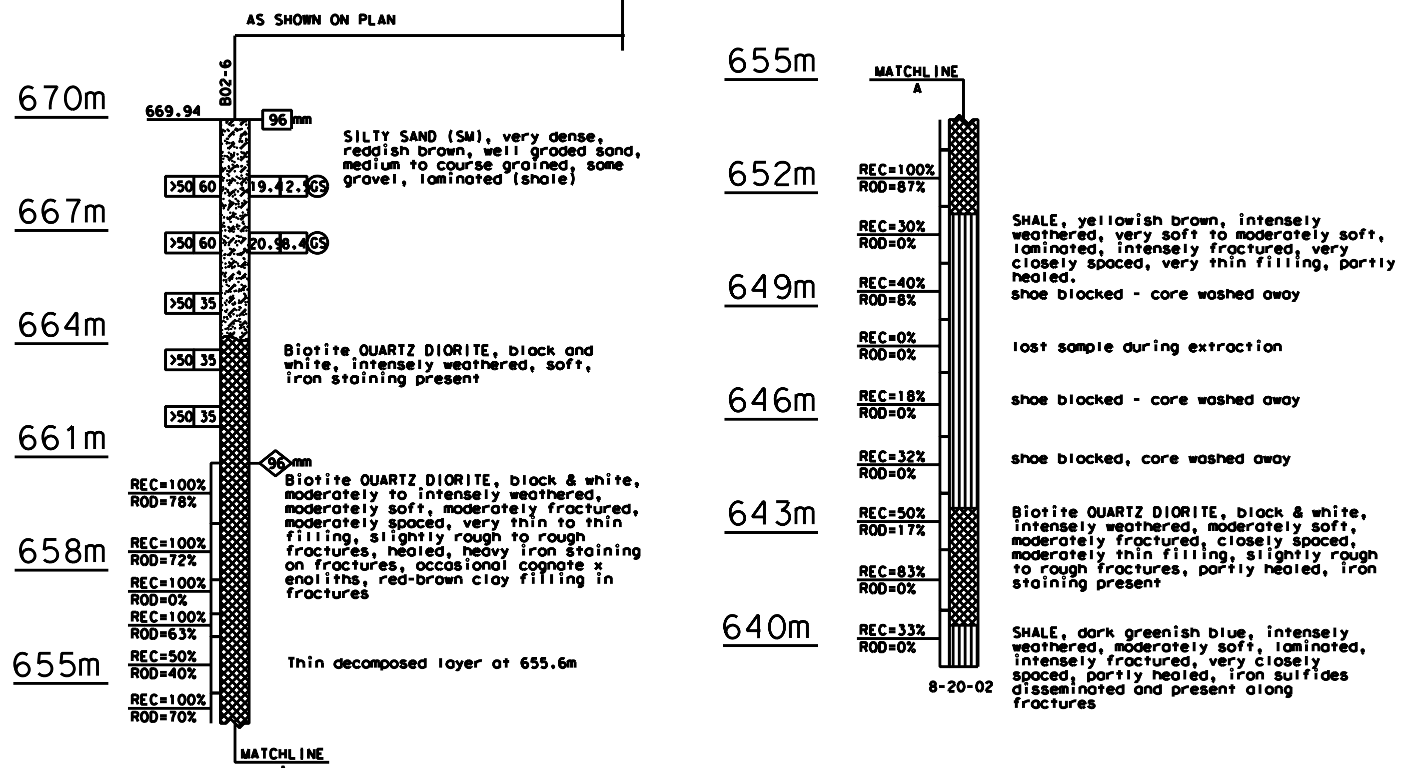
JOB No. 502001.021 LOCATION: BUCKHORN GRADE



PLAN
HORIZ. 1:1000

BENCH MARK

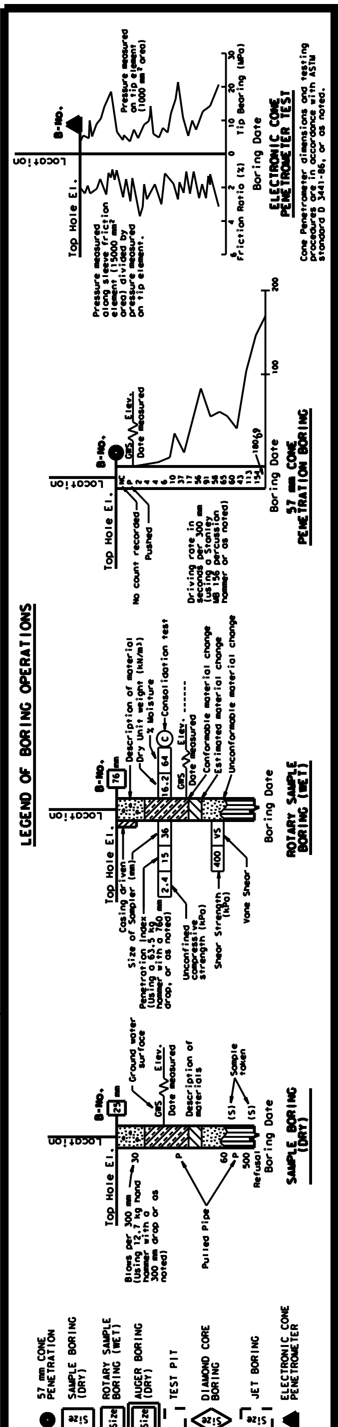
Description	Northing	Easting	Elevation
B02-6	647,336.070	1,940,917.039	669.939



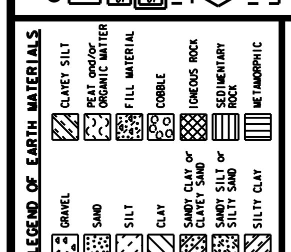
PROFILE
VERT. 1:100

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

LEGEND OF BORING OPERATIONS



LEGEND OF EARTH MATERIALS



CONSISTENCY CLASSIFICATION FOR SOILS

According to the Standard Penetration Test

SPT N-Value (Blows/0.3m)	Granular	SPT N-Value (Blows/0.3m)	Cohesive
0-4	Very Loose	<2	Very Soft
5-10	Loose	2-4	Soft
11-30	Medium Dense	5-8	Firm
31-50	Dense	9-15	Stiff
>50	Very Dense	16-30	Very stiff
		>31	Hard

NOTE: Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

DESIGN OVERSIGHT	DRAWN BY	M. JURING	D. LINDSAY	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	PROJECT ENGINEER	BRIDGE NO.	BUCKHORN GRADE
SIGN OFF DATE	CHECKED BY	J. BIANCHIN	FIELD INVESTIGATION BY: DATE: SEE BORINGS			KILOMETER POST	LOG OF TEST BORINGS

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET No	TOTAL SHEETS
02	SHASTA	299	116.48	1	1

CERTIFIED ENGINEER GEOLOGIST 9/26/02

REGISTERED GEOLOGIST JAMES A. BIANCHIN No. EG No. 1644 Exp. 6-2005 CERTIFIED ENGINEERING GEOLOGIST STATE OF CALIFORNIA

PLANS APPROVAL DATE

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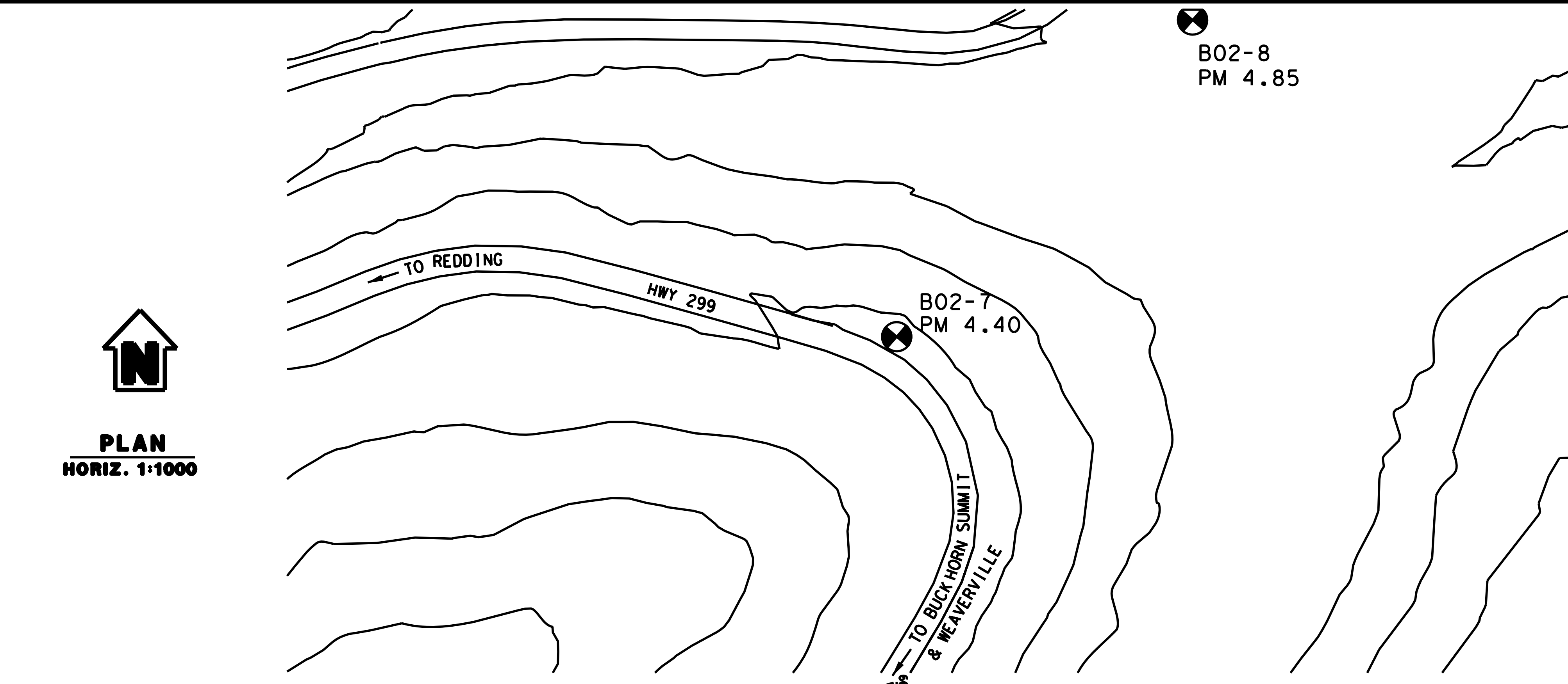
480 Hemsted Drive (530)221-5424
Redding, CA 96002FAX (530)221-0135

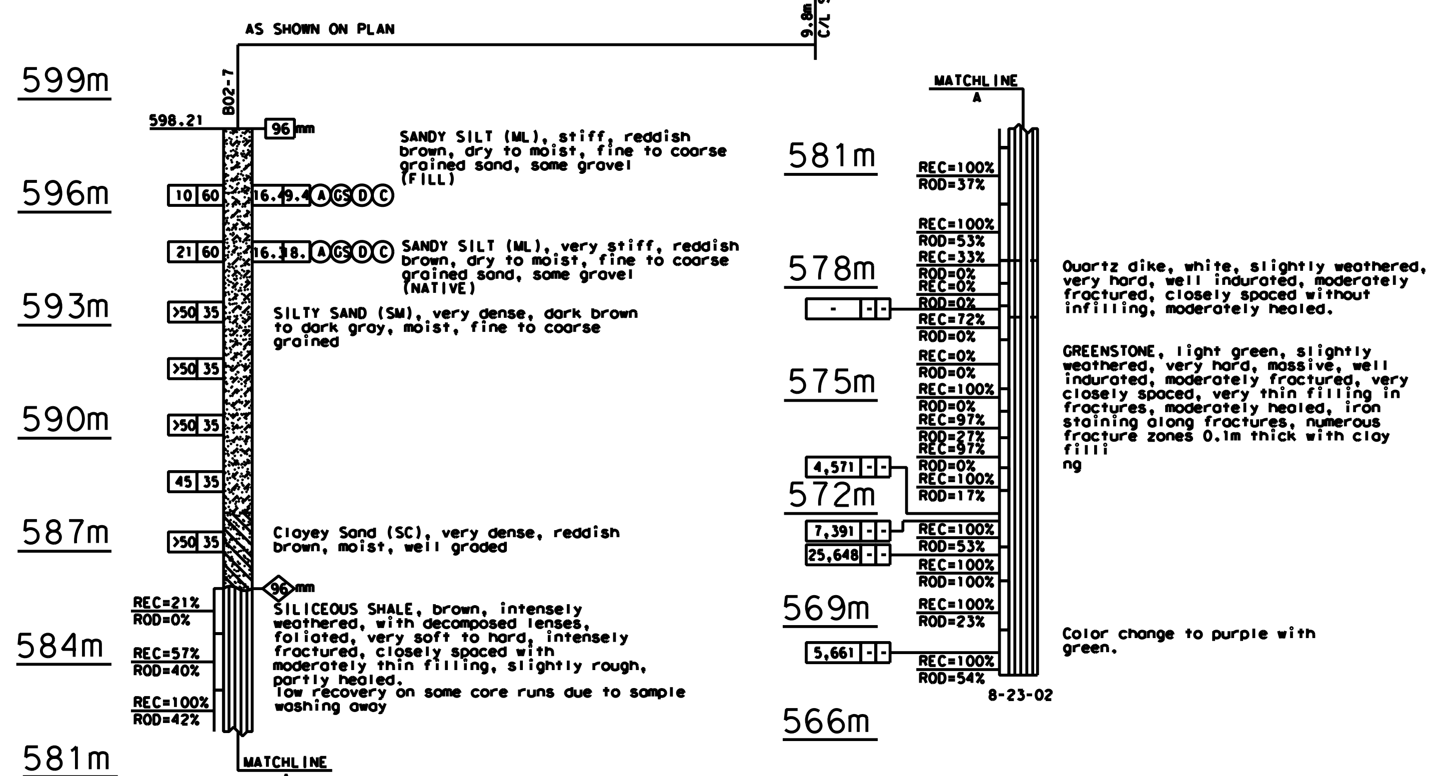
JOB No. 502001.021 LOCATION: BUCKHORN GRADE



PLAN
HORIZ. 1:1000

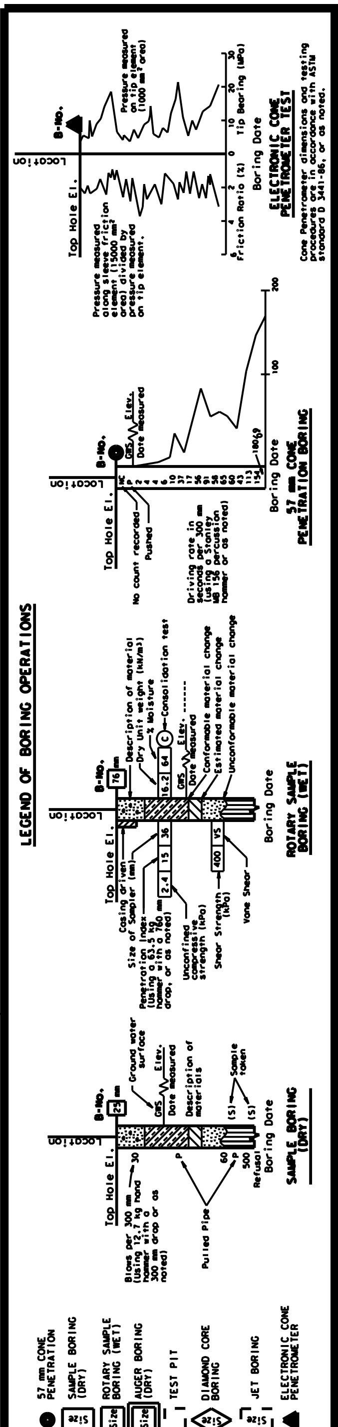
BENCH MARK

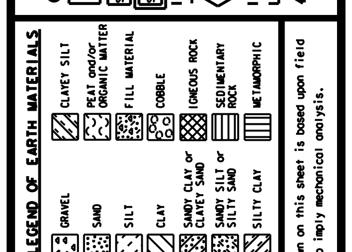
Description	Northing	Easting	Elevation
B02-7	648,371.500	1,940,961.186	598.212



PROFILE
VERT. 1:100

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN





CONSISTENCY CLASSIFICATION FOR SOILS

According to the Standard Penetration Test

SPT N-Value (Blows/0.3m)	Granular	SPT N-Value (Blows/0.3m)	Cohesive
0-4	Very Loose	<2	Very Soft
5-10	Loose	2-4	Soft
11-30	Medium Dense	5-8	Firm
31-50	Dense	9-15	Stiff
>50	Very Dense	16-30	Very stiff
		>31	Hard

NOTE: Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

DESIGN OVERSIGHT	DRAWN BY: M. JURING	D. LINDSAY FIELD INVESTIGATION BY:	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION
SIGN OFF DATE	CHECKED BY: J. BIANCHIN	DATE: SEE BORINGS	PROJECT ENGINEER

BRIDGE NO.
KILOMETER POST

BUCKHORN GRADE
LOG OF TEST BORINGS

GEOTECHNICAL LOG OF TEST BORINGS SHEET (METRIC) (REV 2/1/00)

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 10 20 30 40 50 60 70 80 90 100

CU
EA 02-270310

DISREGARD PRINTS BEARING EARLIER REVISION DATES → 9-26-02

REVISION DATES (PRELIMINARY STAGE ONLY) SHEET 1 OF 1

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

LOTB-02-7.dgn 1/7/2011 2:24:10 PM

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET No	TOTAL SHEETS
02	SHASTA	299	116.48	1	1

Caltrans Metric

CERTIFIED ENGINEER GEOLOGIST 9/26/02

REGISTERED GEOLOGIST — JAMES A. BIANCHIN — No. EG No. 1644 — Exp. 6-2005 — CERTIFIED ENGINEERING GEOLOGIST — STATE OF CALIFORNIA

PLANS APPROVAL DATE

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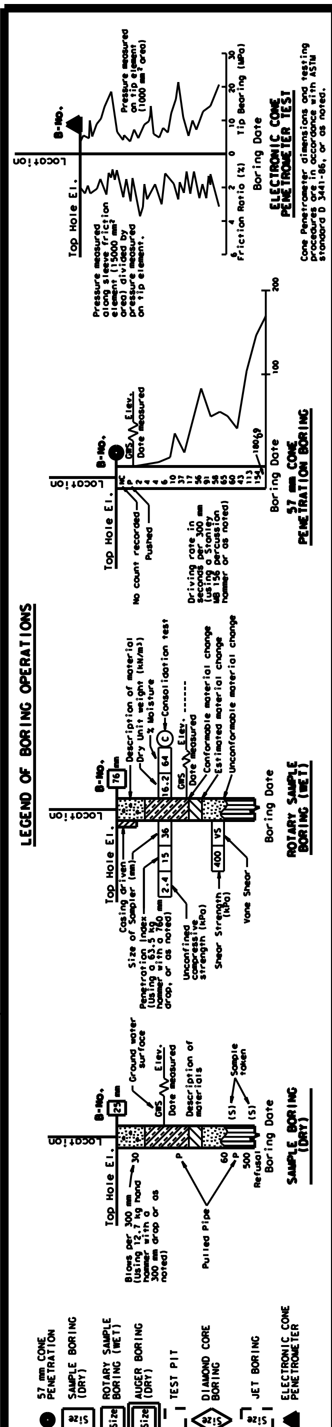
480 Hemsted Drive (530)221-5424
Redding, CA 96002 FAX (530)221-0135

JOB No. 502001.021 LOCATION: BUCKHORN GRADE



LEGEND OF EARTH MATERIALS

GRAVEL, SAND, SILT, CLAY, SANDY CLAY or CLAYEY SAND, SANDY SILT or SILTY SAND, SILTY CLAY, CLAYEY SILT, PEAT and/or ORGANIC MATTER, FILL MATERIAL, COBBLE, IGNEOUS ROCK, SEDIMENTARY ROCK, METAMORPHIC

CONSISTENCY CLASSIFICATION FOR SOILS

According to the Standard Penetration Test

SPT N-Value (Blows/0.3m)	Granular	SPT N-Value (Blows/0.3m)	Cohesive
0-4	Very Loose	<2	Very Soft
5-10	Loose	2-4	Soft
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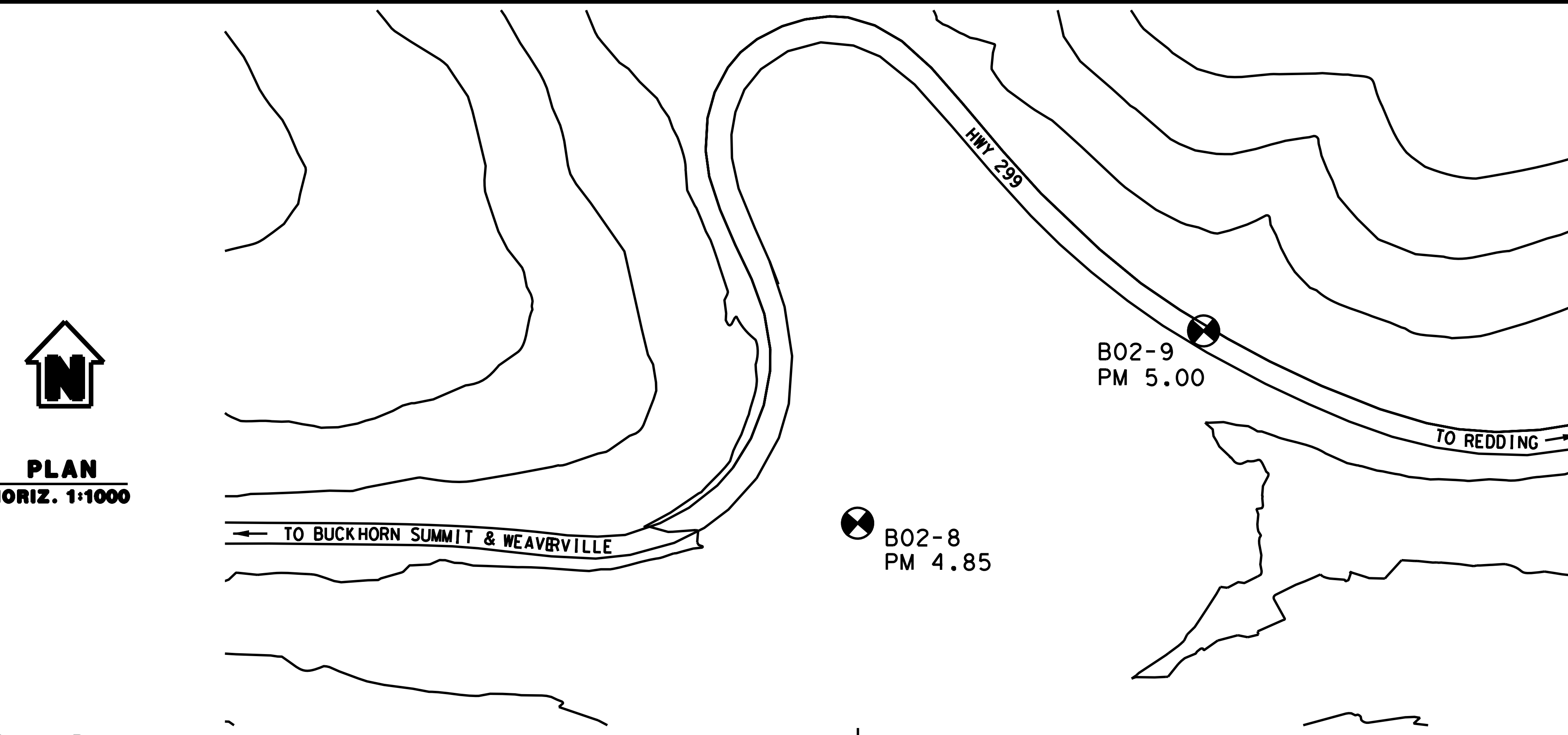
31-50	Dense	9-15	Stiff
>50	Very Dense	16-30	Very stiff
		>31	Hard

NOTE: Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

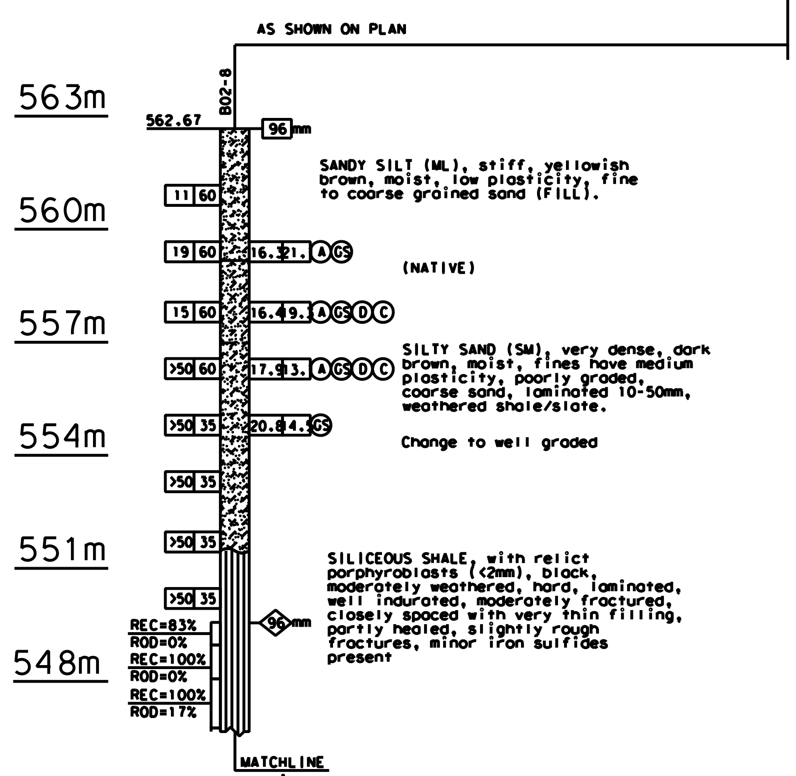
PLAN

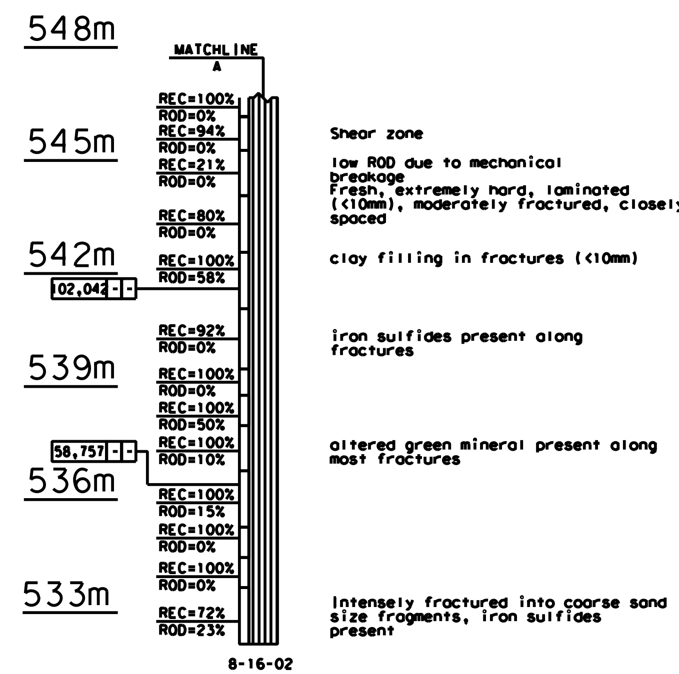
HORIZ. 1:1000



BENCH MARK

Description	Northing	Easting	Elevation
B02-8	648,479.123	1,941,061.623	562.667





PROFILE

VERT. 1:100

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

DESIGN OVERSIGHT	DRAWN BY	M. JURING	D. LINDSAY	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	PROJECT ENGINEER	BRIDGE NO.	BUCKHORN GRADE
SIGN OFF DATE	CHECKED BY	J. BIANCHIN	FIELD INVESTIGATION BY: DATE: SEE BORINGS			KILOMETER POST	LOG OF TEST BORINGS

GEOTECHNICAL LOG OF TEST BORINGS SHEET (METRIC) (REV 2/1/00)

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 10 20 30 40 50 60 70 80 90 100

CU EA 02-270310

FILE => $REQUEST

DISREGARD PRINTS BEARING EARLIER REVISION DATES → 9-26-02

REVISION DATES (PRELIMINARY STAGE ONLY) SHEET 1 OF 1

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

LOTB-02-8.dgn 1/7/2011 2:25:19 PM

<u>APPENDIX D</u>

Laboratory Direct Shear Tests

Performed by Caltrans Materials Lab, Folsom Blvd., Sacramento (2013)

BH05

BH06

BH07

BH08

BH09

BH10

BH11

BH12

Caltrans

DIVISION OF
ENGINEERING SERVICES
OFFICE OF GEOTECHNICAL SUPPORT
GEOTECHNICAL LABORATORY
5900 Folsom Boulevard
Sacramento, CA 95819

Date: 1/10/2013

To: Scott Lewis / GDN

From: Lilibeth C. Purta / (916) 227-5239

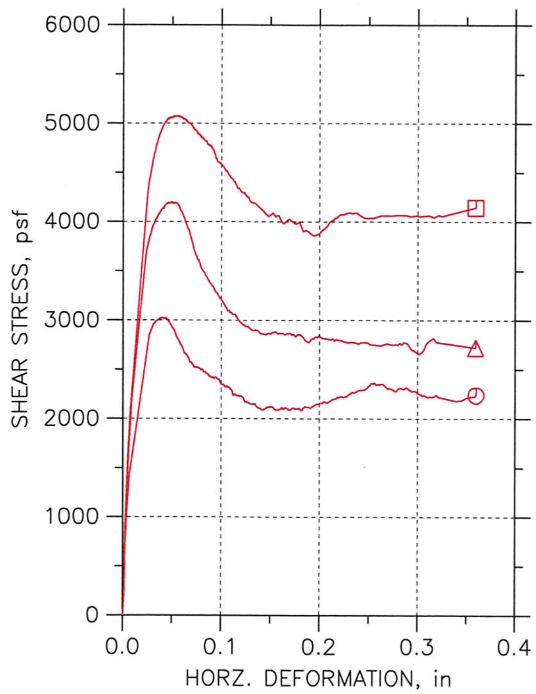
RE: Laboratory Test Report -- EA: 02-3E4100
Project: 0200020042
GL 12-063

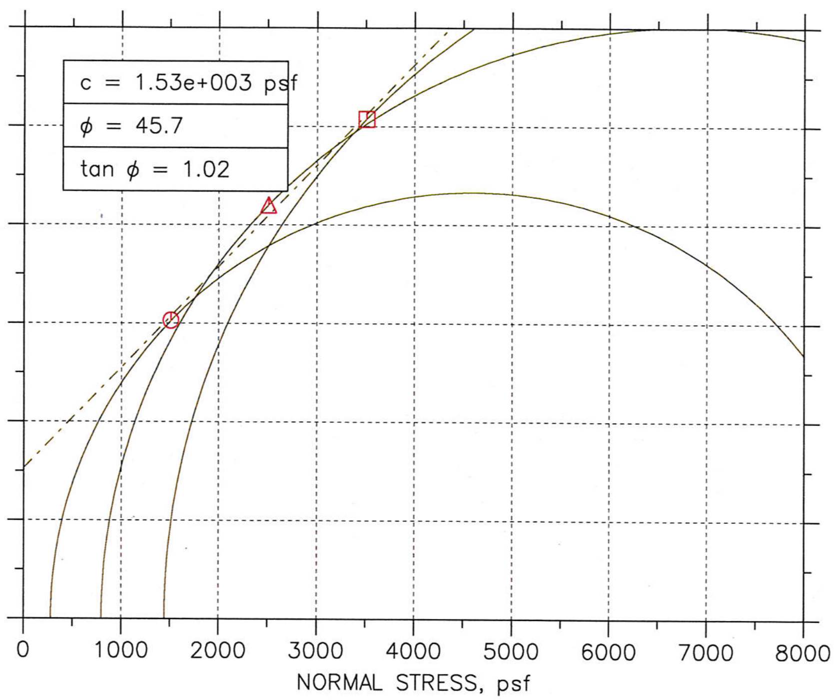
Final test results.

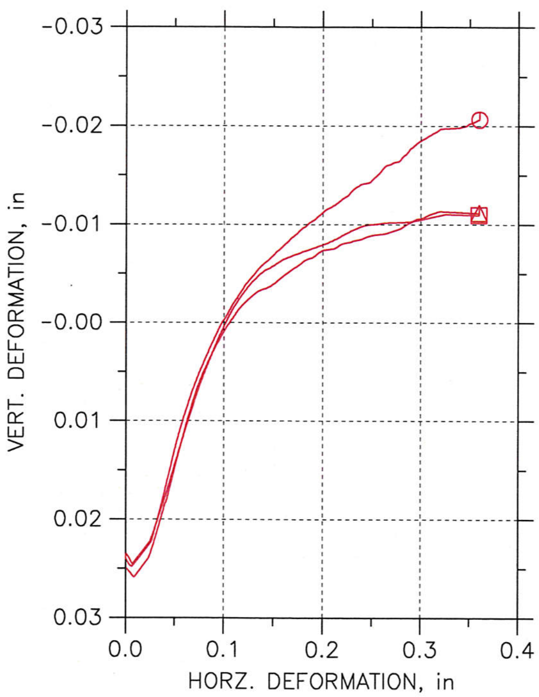
Note: All remaining test specimens will be disposed of in 30 calendar days from the release date of the final test results.

AAP®
AASHTO R18

DIRECT SHEAR TEST REPORT







Symbol		○	△	□	
Test No.		DS12032A	DS12032B	DS12032C	
Sample No.		05	05	05	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	1.944	1.944	1.944	
	Area, in^2	2.9681	2.9681	2.9681	
	Height, in	1	1	1	
	Water Content, %	9.47	9.35	9.77	
	Dry Density, pcf	119.6	120.55	119.38	
	Saturation, %	62.43	63.38	64.06	
	Void Ratio	0.40937	0.39826	0.41194	
Consol. Height, in		0.97835	0.9766	0.97711	
Consol. Void Ratio		0.37886	0.36554	0.37963	
Final	Water Content, %	16.12	15.31	15.79	
	Dry Density, pcf	117.18	119.22	118.09	
	Saturation, %	99.28	99.90	99.78	
	Void Ratio	0.43838	0.41379	0.42737	
Normal Stress, psf		1509.1	2507.8	3510.1	
Max. Shear Stress, psf		3024.2	4198.7	5073.8	
Ult. Shear Stress, psf		2236.2	2718.7	4142.3	
Time to Failure, min		4.5291	5.5837	6.335	
Disp. Rate, in/min		0.01	0.01	0.01	
Implied Specific Gravity		2.70	2.70	2.70	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	
Plasticity Index		---	---	---	

Project: BUCKHORN CLOSURE	
Location: 02-SHA-299-0.5-2.5	
Project No.: 02-3E4100	
Boring No.: BH	
Sample Type: REMOLD	

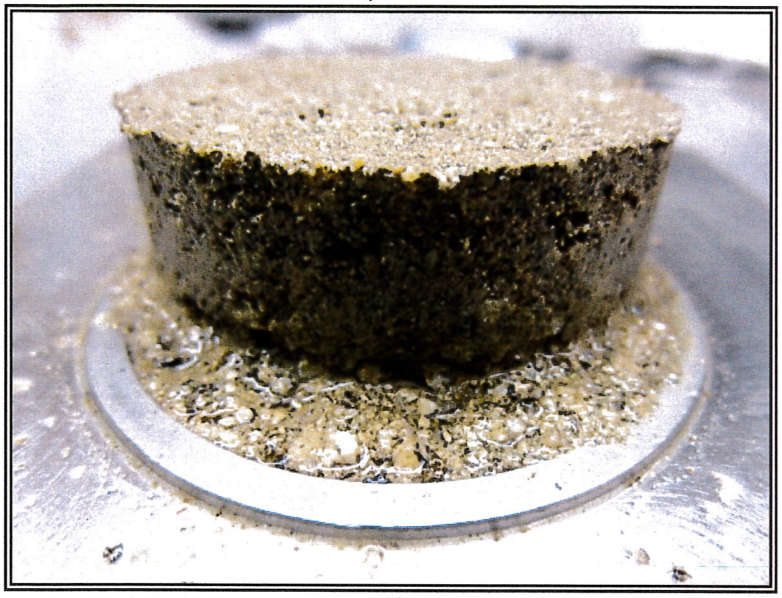
Description: Moist, Medium Dense, Brown Sand with Silt. Remolded to 93% RC of BH 04A & 4B

Remarks: ASTM D 3080. Sample description is not a soil classification.

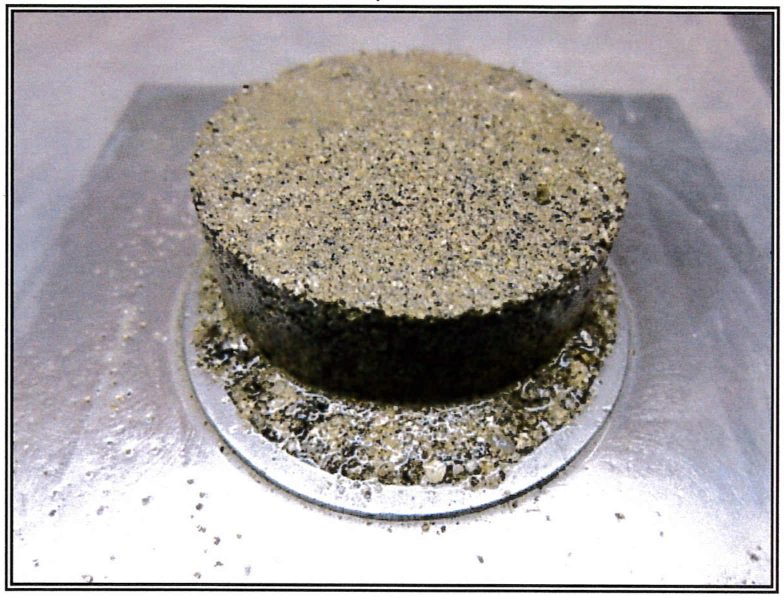
1/10/13

Fri, 04-JAN-2013 14:31:20

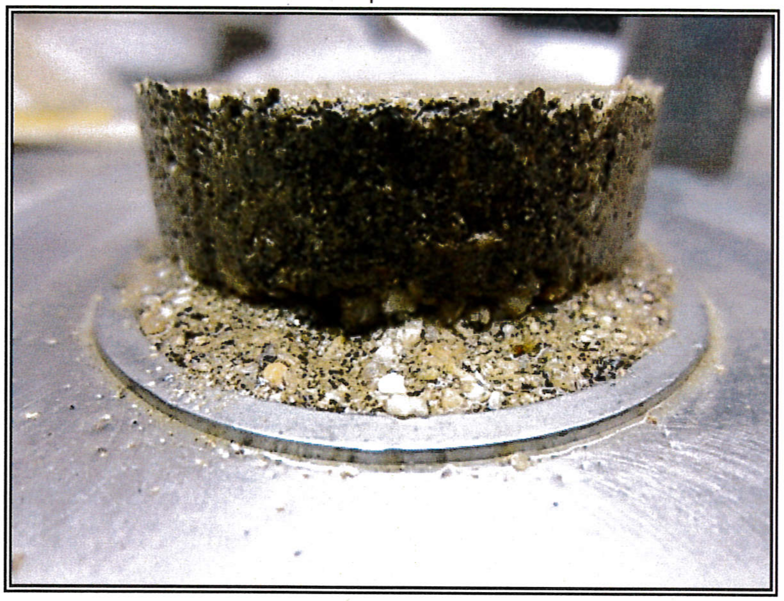
DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 05
Test Specimen A



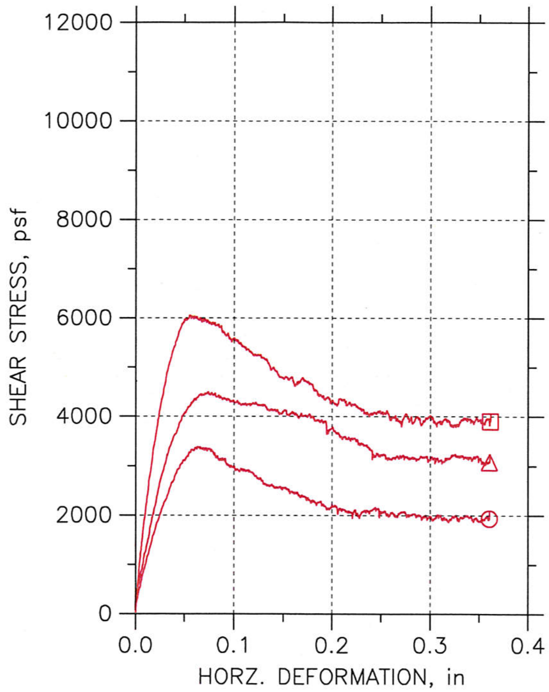
DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 05
Test Specimen B

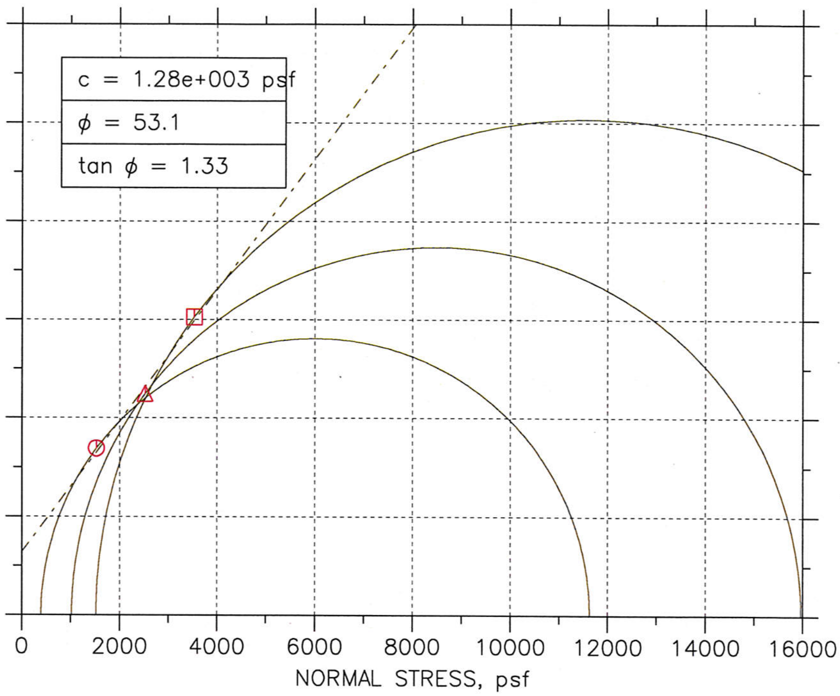


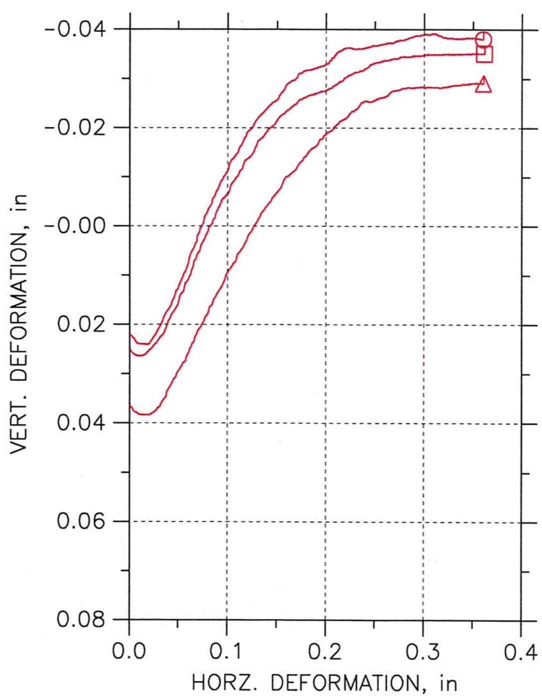
DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 05
Test Specimen C



DIRECT SHEAR TEST REPORT







		Symbol	○	△	□	
		Test No.	DS12033A	DS12033B	DS12033C	
		Sample No.	06	06	06	
		Shape	Circular	Circular	Circular	
Initial		Dimension, in	1.944	1.944	1.944	
		Area, in^2	2.9681	2.9681	2.9681	
		Height, in	1	1	1	
		Water Content, %	8.64	8.32	8.27	
		Dry Density, pcf	120.26	120.39	121.03	
		Saturation, %	58.13	56.12	56.88	
		Void Ratio	0.40155	0.40005	0.39263	
		Consol. Height, in	0.98009	0.96681	0.97563	
		Consol. Void Ratio	0.37365	0.35359	0.35868	
Final		Water Content, %	16.01	15.99	15.69	
		Dry Density, pcf	115.86	117	116.93	
		Saturation, %	95.04	97.98	95.98	
		Void Ratio	0.45479	0.44067	0.4415	
		Normal Stress, psf	1522	2521.4	3536.5	
		Max. Shear Stress, psf	3375.2	4491.1	6052.6	
		Ult. Shear Stress, psf	1927.4	3072	3901.8	
		Time to Failure, min	6.7597	8.1038	6.0973	
		Disp. Rate, in/min	0.01	0.01	0.01	
		Implied Specific Gravity	2.70	2.70	2.70	
		Liquid Limit	---	---	---	
		Plastic Limit	---	---	---	
		Plasticity Index	---	---	---	

Project: BUCKHORN CLOSURE

Location: 02-SHA-299-0.5-2.5

Project No.: 02-3E4100

Boring No.: BH

Sample Type: REMOLD

Description: Very Moist, Dense, Dark Medium Brwon, Coarse Sand with Few Silt. Remolded to 93%RC of BH 04A & 4B.

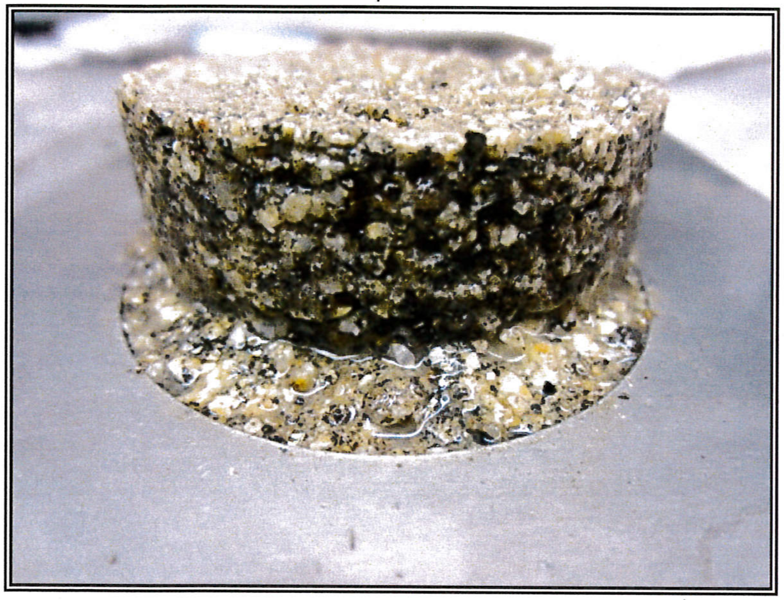
Remarks: ASTM D 3080. Sample description is not a soil classification.

1/10/13

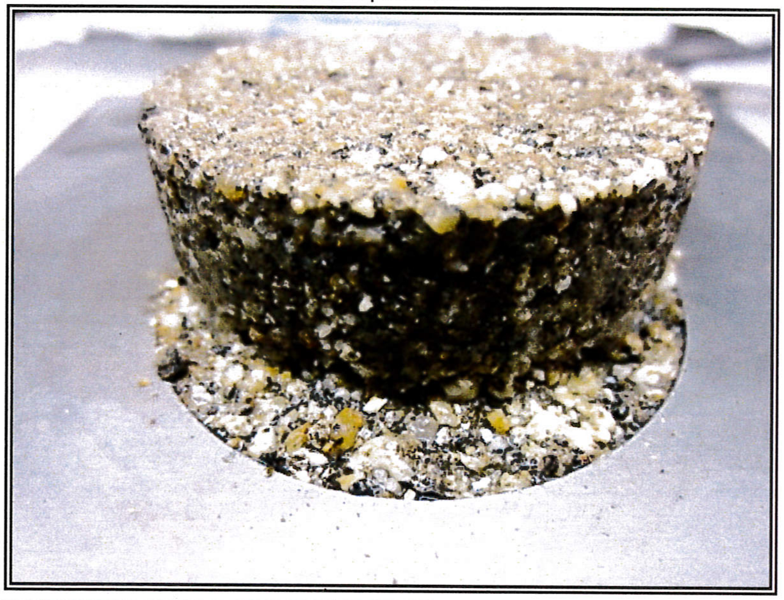
Fri, 04-JAN-2013 14:32:05

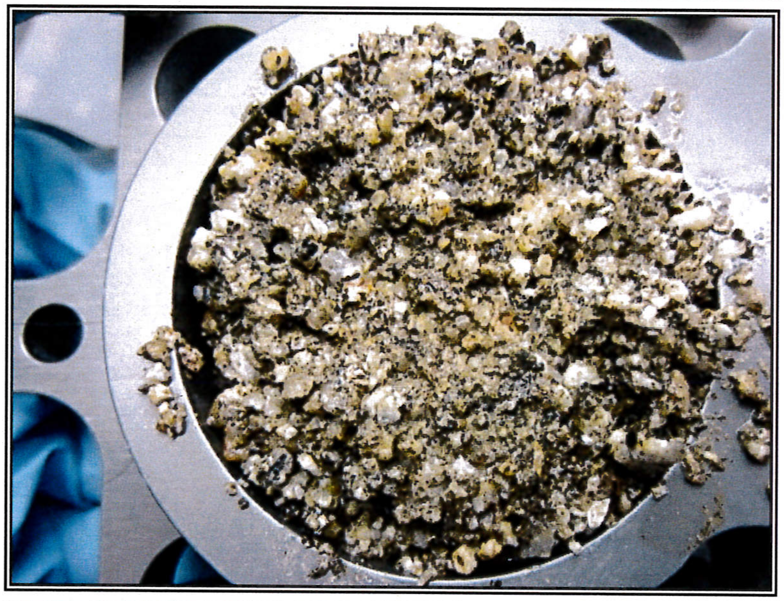
DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 06
Test Specimen A

DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 06
Test Specimen B

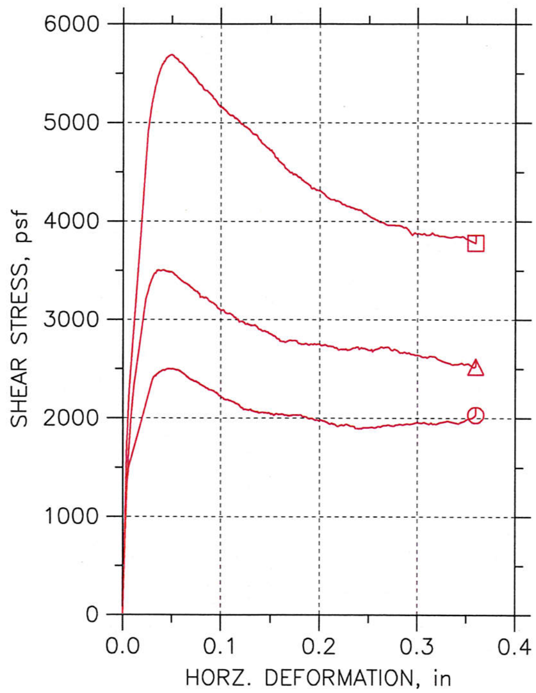


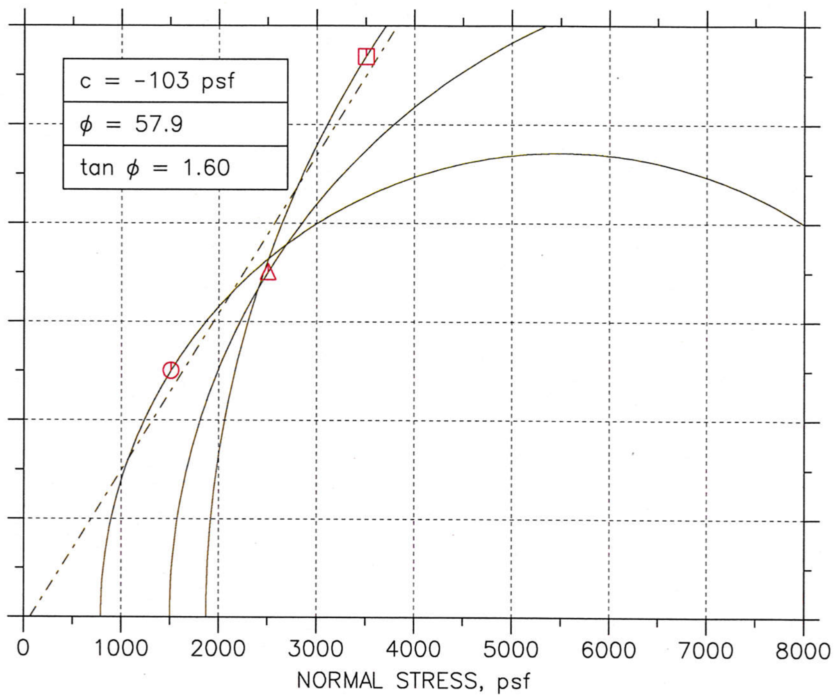
DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 06
Test Specimen C

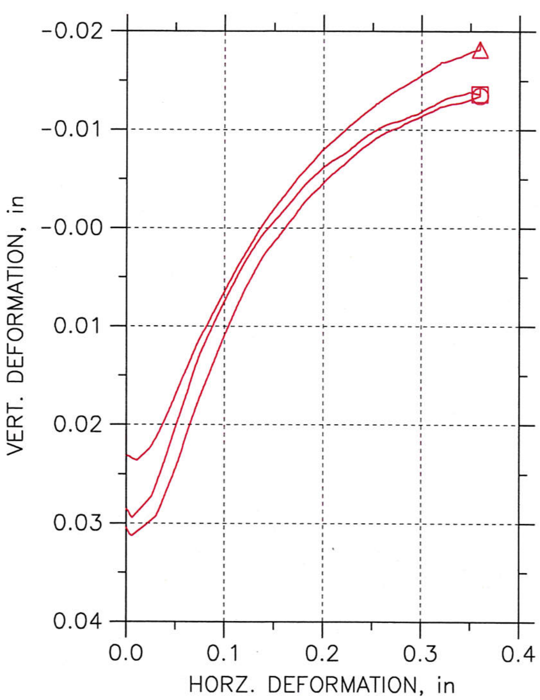




DIRECT SHEAR TEST REPORT







Symbol		○	△	□	
Test No.		DS12034A	DS12034B	DS12034C	
Sample No.		07	07	07	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	1.944	1.944	1.944	
	Area, in^2	2.9681	2.9681	2.9681	
	Height, in	1	1	1	
	Water Content, %	9.09	9.19	9.46	
	Dry Density, pcf	120.01	120.14	119.37	
	Saturation, %	60.67	61.55	62.00	
	Void Ratio	0.40455	0.40304	0.4121	
Consol. Height, in		0.97232	0.9776	0.97256	
Consol. Void Ratio		0.36567	0.37162	0.37335	
Final	Water Content, %	15.61	15.81	15.91	
	Dry Density, pcf	118.42	118	117.76	
	Saturation, %	99.58	99.64	99.63	
	Void Ratio	0.4234	0.42847	0.43129	
Normal Stress, psf		1509.1	2505	3505.4	
Max. Shear Stress, psf		2502.1	3504	5687.4	
Ult. Shear Stress, psf		2032	2523.2	3778.7	
Time to Failure, min		5.2325	4.7193	5.5782	
Disp. Rate, in/min		0.01	0.01	0.01	
Implied Specific Gravity		2.70	2.70	2.70	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	
Plasticity Index		---	---	---	

Project: BUCKHORN CLOSURE
Location: 02-SHA-299-0.5-2.5
Project No.: 02-3E4100
Boring No.: BH
Sample Type: REMOLD

Description: Light Moist, Redd Brown, Med Dense, Silty Sand (Highly Decomp Granite). Remold to 93%RC of BH 04A & 04B.

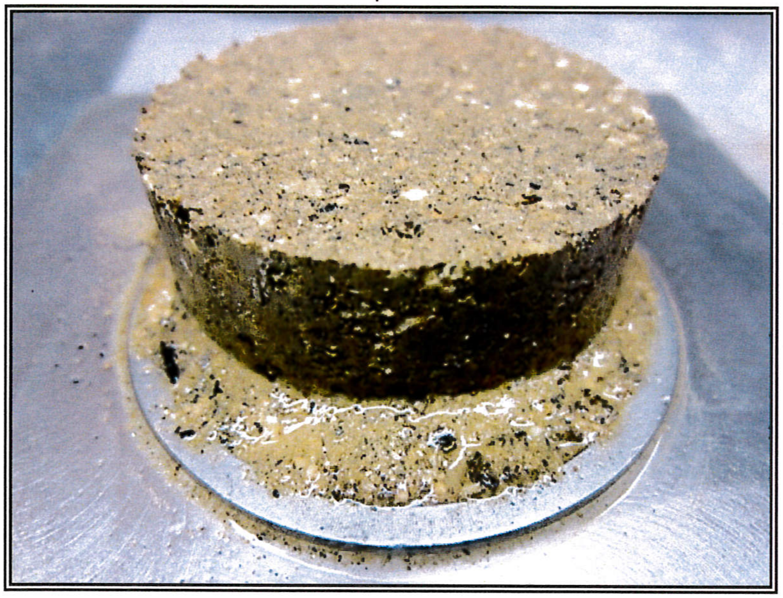
Remarks: ASTM D 3080. Sample description is not a soil classification.

1/10/13

Fri, 04-JAN-2013 16:29:30

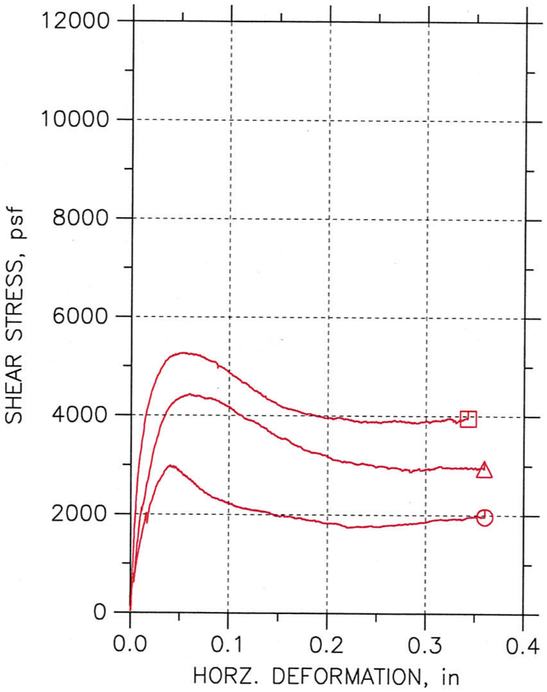
DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 07
Test Specimen A

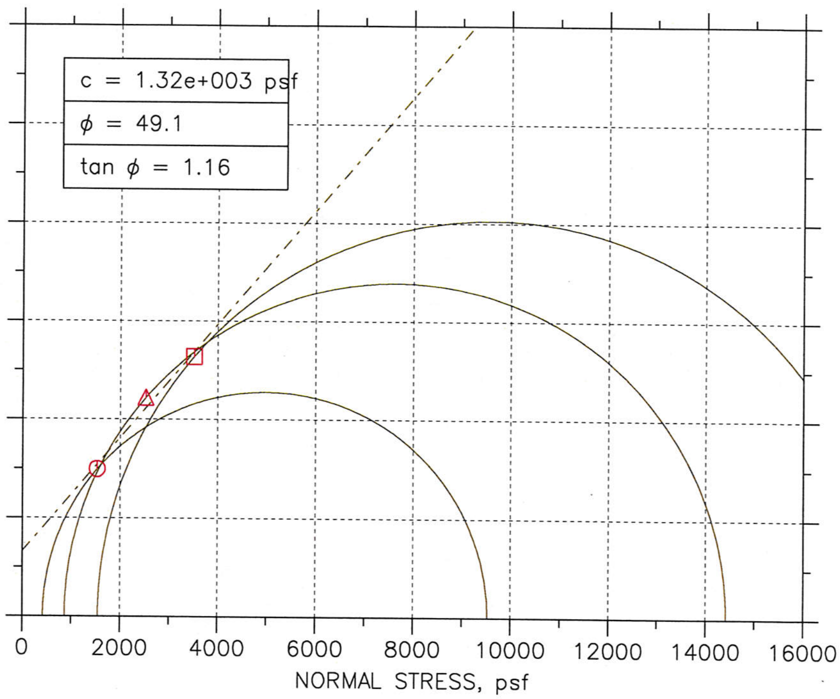
DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 07
Test Specimen B

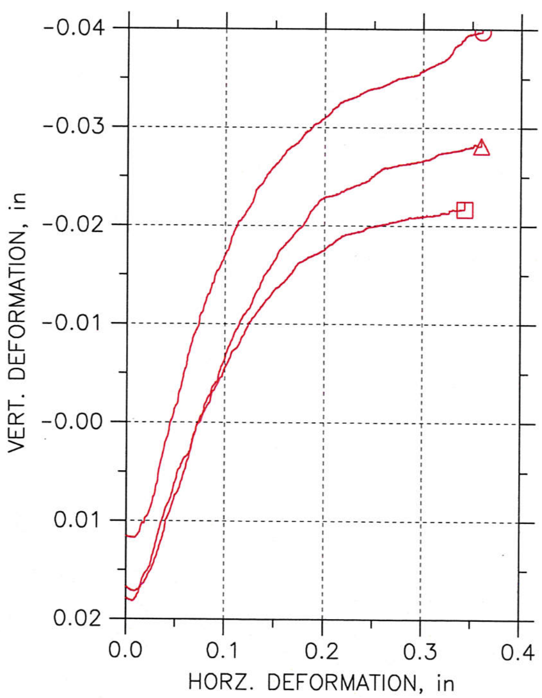


DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 07
Test Specimen C

DIRECT SHEAR TEST REPORT







Symbol		○	△	□	
Test No.		DS12035A	DS12035B	DS12035C	
Sample No.		08	08	08	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	1.944	1.944	1.944	
	Area, in^2	2.9681	2.9681	2.9681	
	Height, in	1	1	1	
	Water Content, %	9.13	9.12	9.35	
	Dry Density, pcf	119.49	119.62	119.37	
	Saturation, %	60.04	60.20	61.29	
	Void Ratio	0.41058	0.40907	0.4121	
Consol. Height, in		0.98907	0.98361	0.98324	
Consol. Void Ratio		0.39517	0.38597	0.38843	
Final	Water Content, %	13.75	16.52	9.35	
	Dry Density, pcf	114.93	116.35	116.84	
	Saturation, %	79.55	99.44	57.06	
	Void Ratio	0.46662	0.44866	0.44266	
Normal Stress, psf		1531.1	2521.4	3513	
Max. Shear Stress, psf		2981.9	4436.2	5271.2	
Ult. Shear Stress, psf		1957.4	2932.2	3956.7	
Time to Failure, min		4.6007	6.6537	7.2402	
Disp. Rate, in/min		0.01	0.01	0.01	
Implied Specific Gravity		2.70	2.70	2.70	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	
Plasticity Index		---	---	---	

Project: BUCKHORN CLOSURE

Location: 02-SHA-299-0.5-2.5

Project No.: 02-3E4100

Boring No.: BH

Sample Type: REMOLD

Description: Moist, Dense, Reddish Brown, Silty Sand (Highly Decomposed Granite). Remolded to 93%RC of BH 04A & 04B

Remarks: ASTM D 3080. Sample description is not a soil classification.

1/10/13

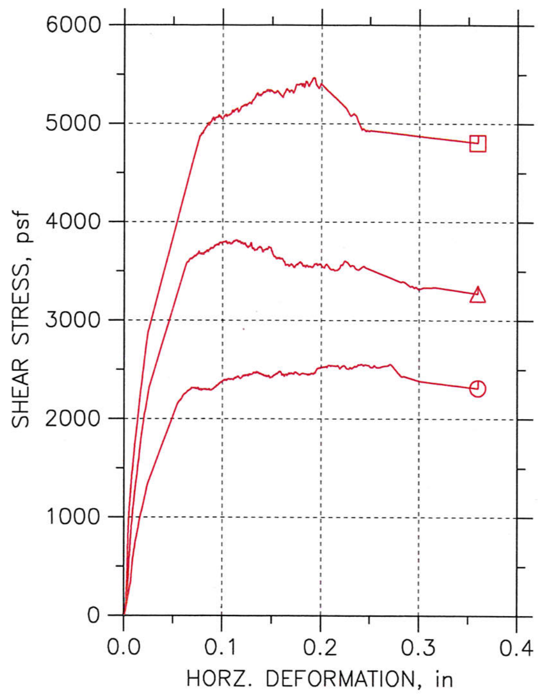
Fri, 04-JAN-2013 16:39:14

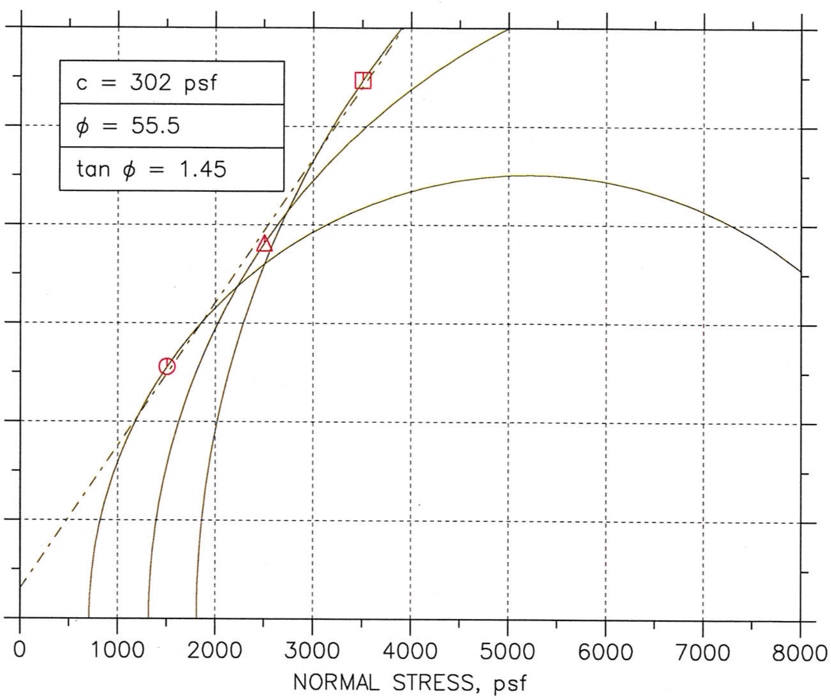
DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 08
Test Specimen A

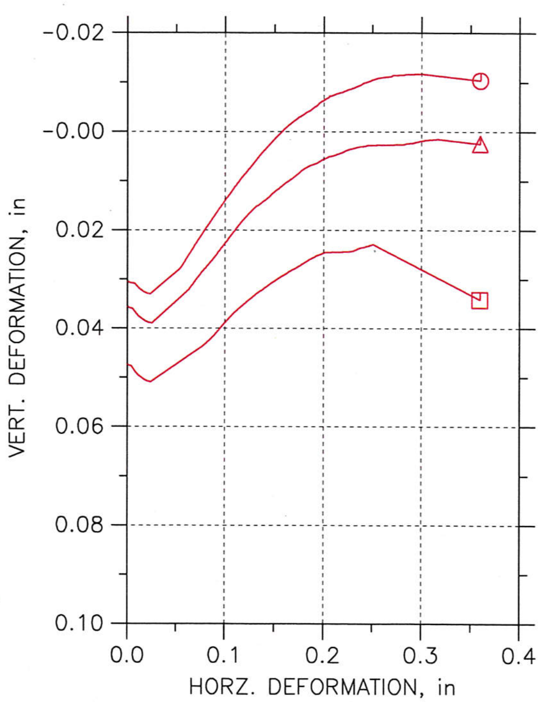
DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 08
Test Specimen B

DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 08
Test Specimen C

DIRECT SHEAR TEST REPORT







Symbol		○	△	□	
Test No.		DS12036A	DS12036B	DS12036C	
Sample No.		09	09	09	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	1.944	1.944	1.944	
	Area, in^2	2.9681	2.9681	2.9681	
	Height, in	1	1	1	
	Water Content, %	9.32	8.88	9.00	
	Dry Density, pcf	119.75	120.01	119.75	
	Saturation, %	61.78	59.25	59.65	
	Void Ratio	0.40756	0.40455	0.40756	
Consol. Height, in		0.97114	0.96562	0.95338	
Consol. Void Ratio		0.36693	0.35626	0.34194	
Final	Water Content, %	14.90	13.26	13.29	
	Dry Density, pcf	118.53	120.31	123.99	
	Saturation, %	95.32	89.31	99.84	
	Void Ratio	0.42201	0.40095	0.35942	
Normal Stress, psf		1503.5	2505	3506.4	
Max. Shear Stress, psf		2554.1	3813	5466.4	
Ult. Shear Stress, psf		2309.3	3268.9	4801.7	
Time to Failure, min		24.833	12.068	19.837	
Disp. Rate, in/min		0.01	0.01	0.01	
Implied Specific Gravity		2.70	2.70	2.70	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	
Plasticity Index		---	---	---	

Project: BUCKHORN CLOSURE

Location: 02-SHA-299-0.5-2.5

Project No.: 02-3E4100

Boring No.: BH

Sample Type: REMOLD

Description: Very Moist, Dense, Dark Gray Sand w/Silt. Remolded to 93%RC of BH 04A & 04B.

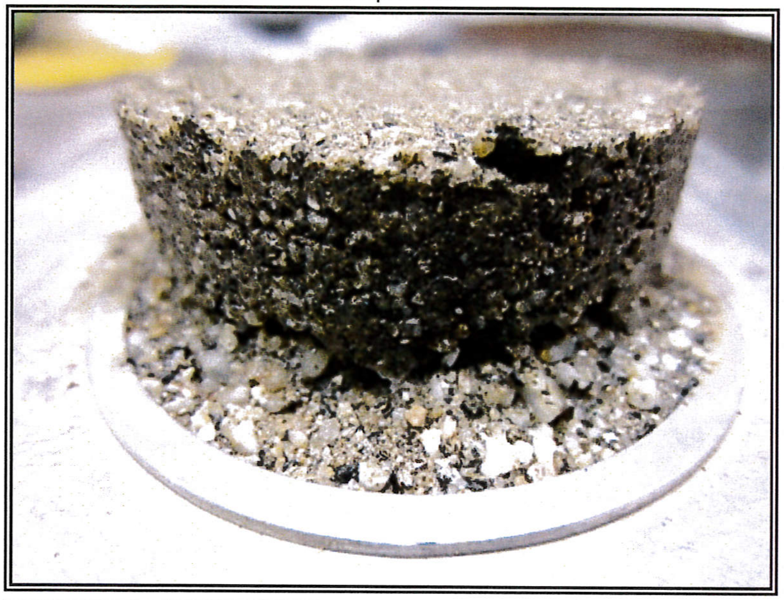
Remarks: ASTM D 3080. Sample description is not a soil classification.

1/10/13

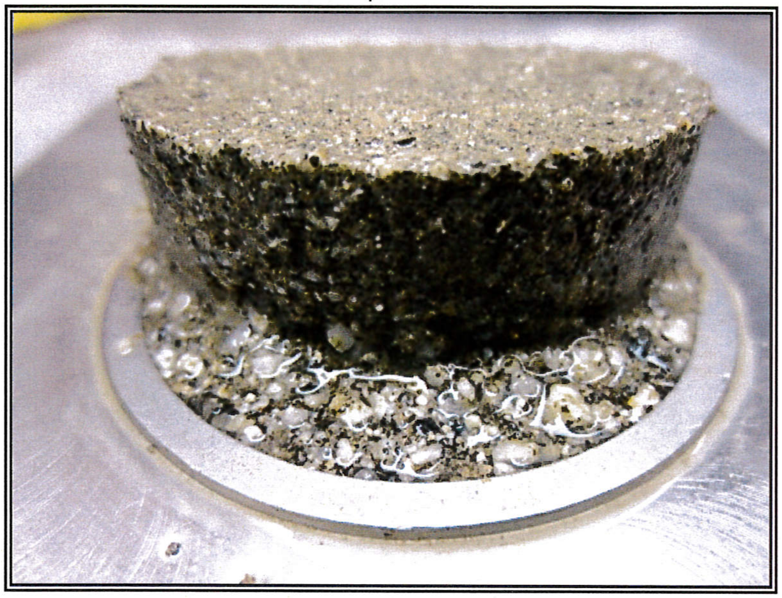
Tue, 08-JAN-2013 10:40:13

DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 09
Test Specimen A

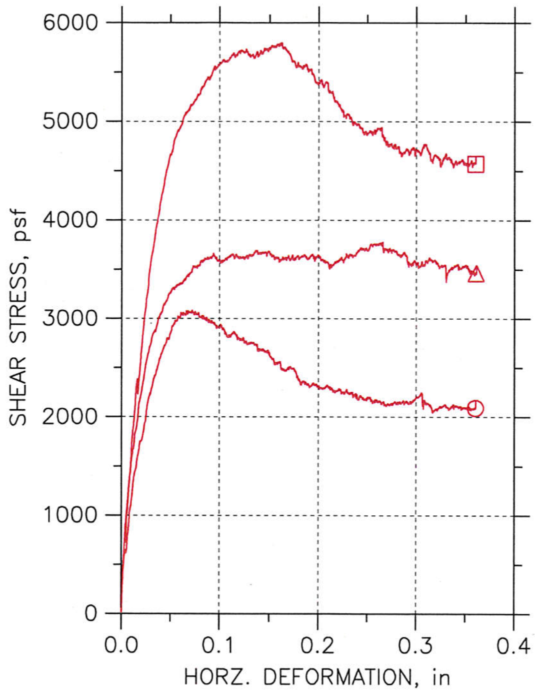
DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 09
Test Specimen B

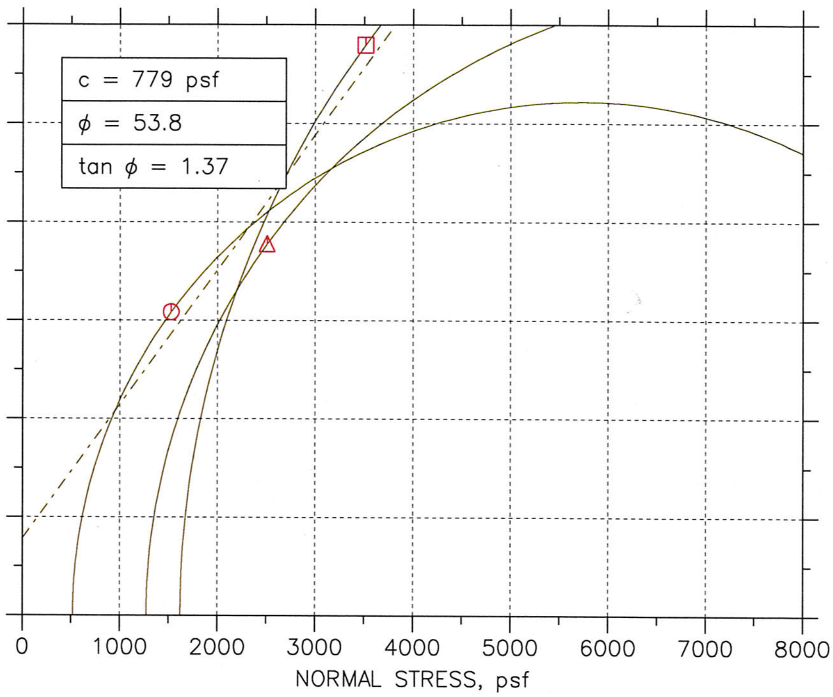


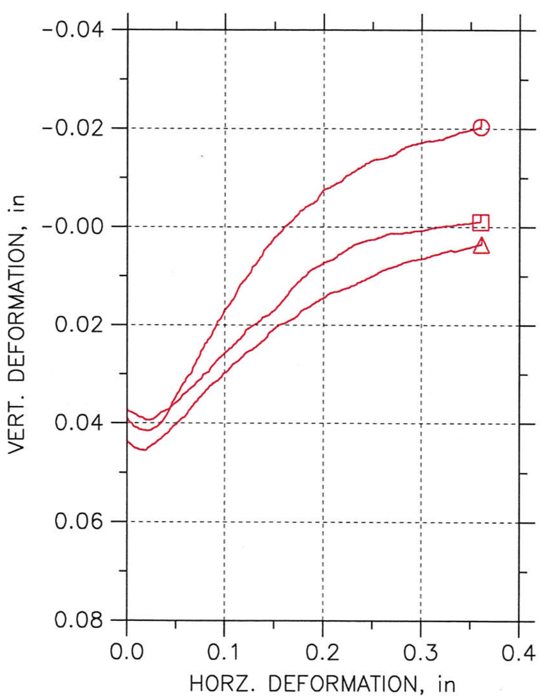
DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 09
Test Specimen C



DIRECT SHEAR TEST REPORT







Symbol		○	△	□	
Test No.		DS12037A	DS12037B	DS12037C	
Sample No.		10	10	10	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	1.944	1.944	1.944	
	Area, in^2	2.9681	2.9681	2.9681	
	Height, in	1	1	1	
	Water Content, %	8.69	5.73	8.64	
	Dry Density, pcf	121.16	120.91	120.26	
	Saturation, %	59.96	39.27	58.13	
	Void Ratio	0.39115	0.39411	0.40155	
Consol. Height, in		0.9628	0.95949	0.96296	
Consol. Void Ratio		0.3394	0.33763	0.34964	
Final	Water Content, %	14.62	14.33	14.83	
	Dry Density, pcf	118.75	121.35	120.15	
	Saturation, %	94.12	99.46	99.42	
	Void Ratio	0.41936	0.38903	0.40288	
Normal Stress, psf		1525.9	2507	3514.3	
Max. Shear Stress, psf		3082.5	3775.1	5793.9	
Ult. Shear Stress, psf		2089.4	3458.8	4570.8	
Time to Failure, min		7.9205	26.835	16.98	
Disp. Rate, in/min		0.01	0.01	0.01	
Implied Specific Gravity		2.70	2.70	2.70	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	
Plasticity Index		---	---	---	

Project: BUCKHORN CLOSURE

Location: 02-SHA-299-0.5-2.5

Project No.: 02-3E4100

Boring No.: BH

Sample Type: REMOLD

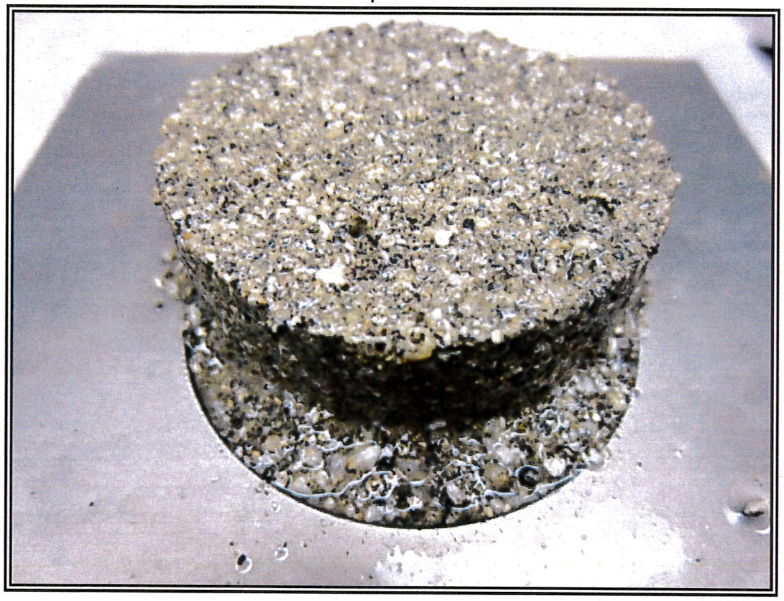
Description: Very Moist, Dense, Dark Grey, Silt with Sand. Remolded to 93%RC of BH 04A & 04B.

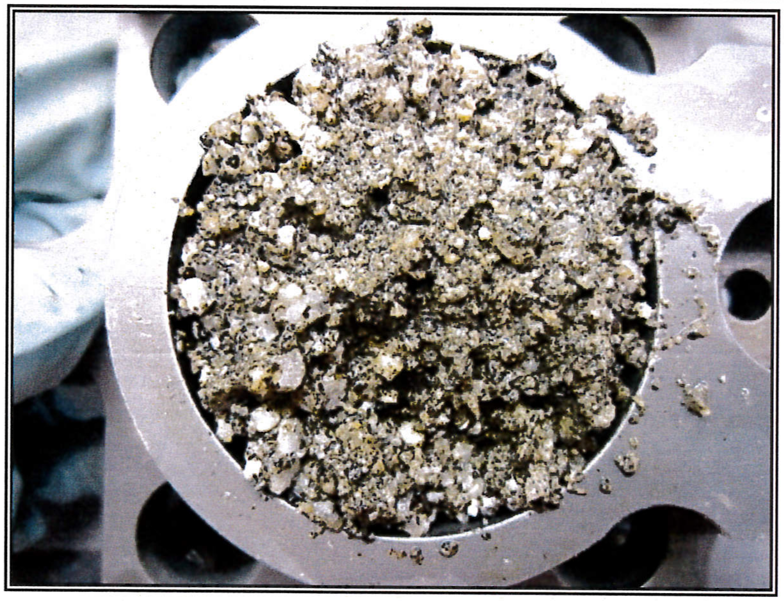
Remarks: ASTM D 3080. Sample description is not a soil classification.

1/10/13

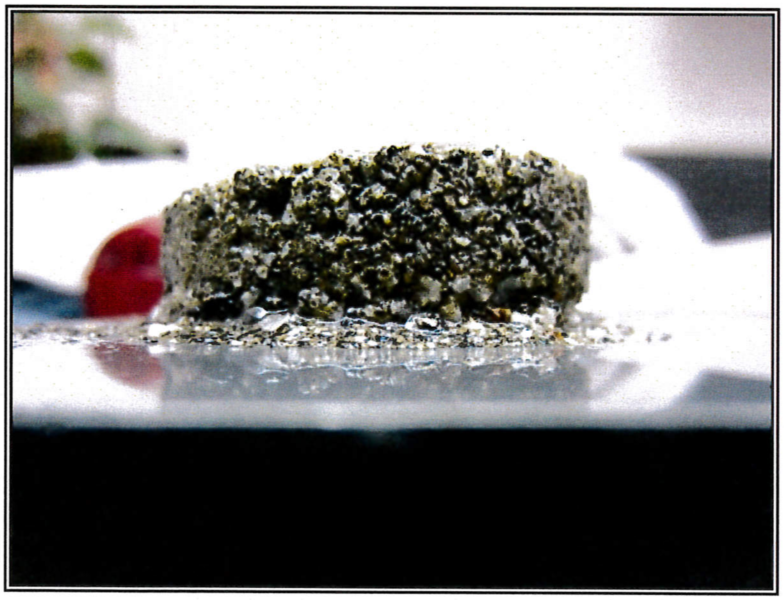
Tue, 08-JAN-2013 10:45:14

DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 10
Test Specimen A

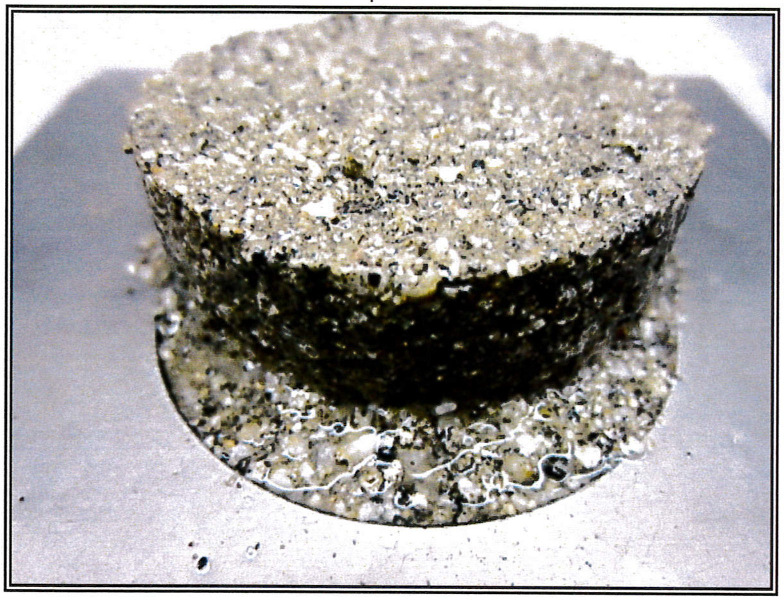


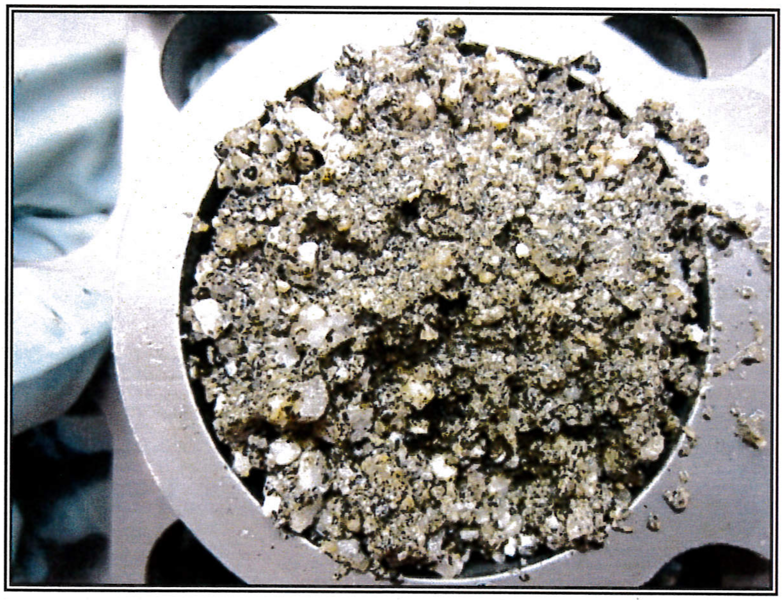


DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 10
Test Specimen B

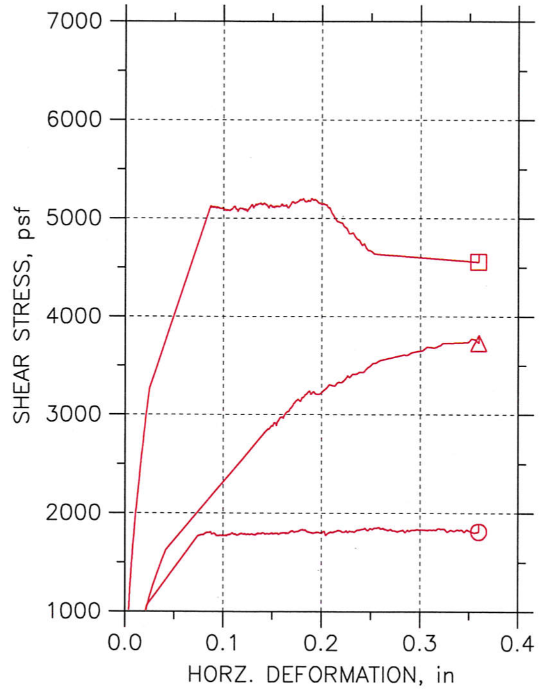


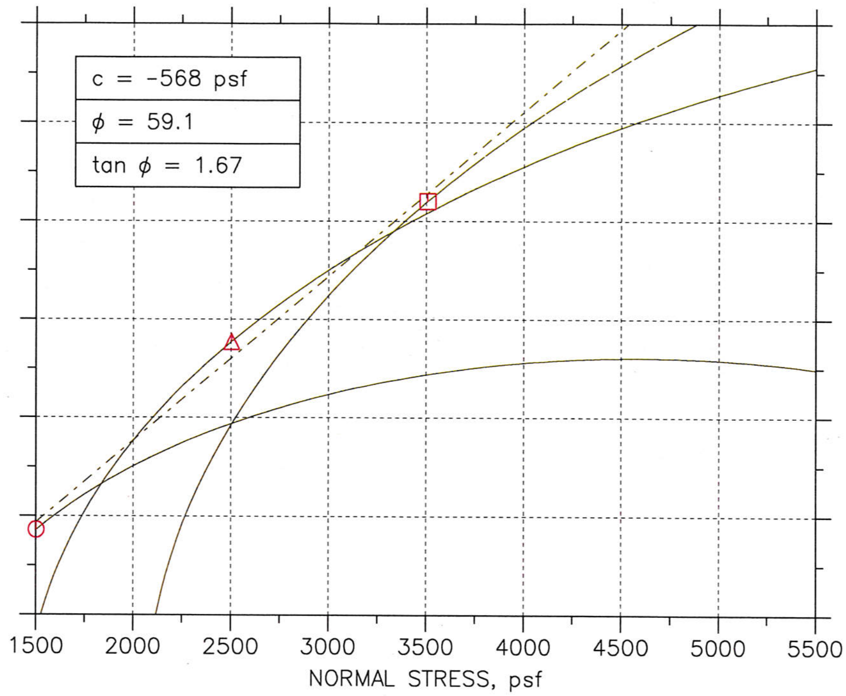
DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 10
Test Specimen C

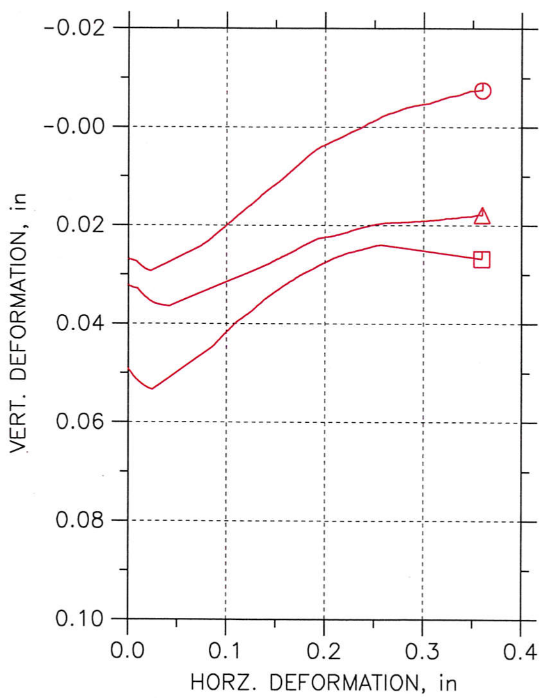




DIRECT SHEAR TEST REPORT





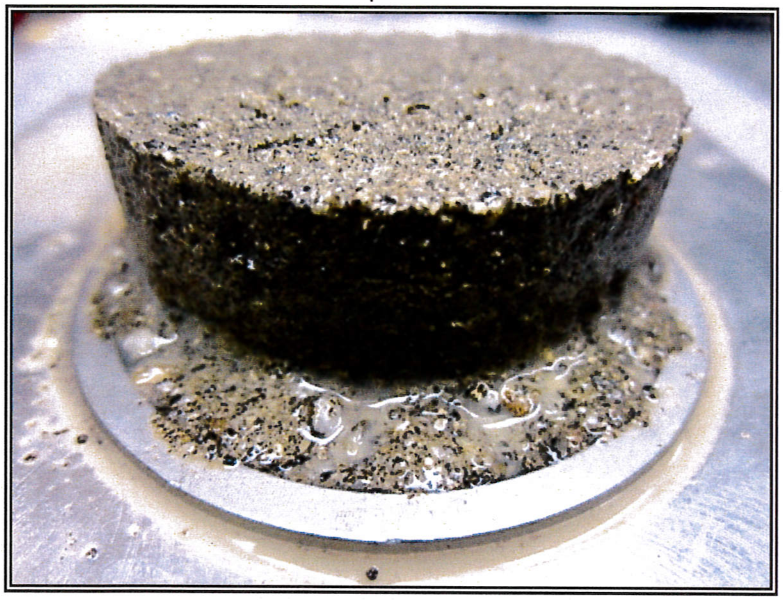


Symbol		○	△	□	
Test No.		DS12038A	DS12038B	DS12038C	
Sample No.		11	11	11	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	1.944	1.944	1.944	
	Area, in^2	2.9681	2.9681	2.9681	
	Height, in	1	1	1	
	Water Content, %	9.09	9.57	8.35	
	Dry Density, pcf	120.01	119.37	121.42	
	Saturation, %	60.67	62.70	58.08	
	Void Ratio	0.40455	0.4121	0.38821	
Consol. Height, in		0.9747	0.96904	0.95307	
Consol. Void Ratio		0.36901	0.36837	0.32306	
Final	Water Content, %	15.29	14.30	12.90	
	Dry Density, pcf	119.12	121.55	124.77	
	Saturation, %	99.51	99.84	99.24	
	Void Ratio	0.41496	0.38674	0.35088	
Normal Stress, psf		1502.6	2503.1	3507.3	
Max. Shear Stress, psf		1855.9	3771.7	5199.7	
Ult. Shear Stress, psf		1808.4	3728.5	4557	
Time to Failure, min		26.537	35.425	18.861	
Disp. Rate, in/min		0.01	0.01	0.01	
Implied Specific Gravity		2.70	2.70	2.70	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	
Plasticity Index		---	---	---	

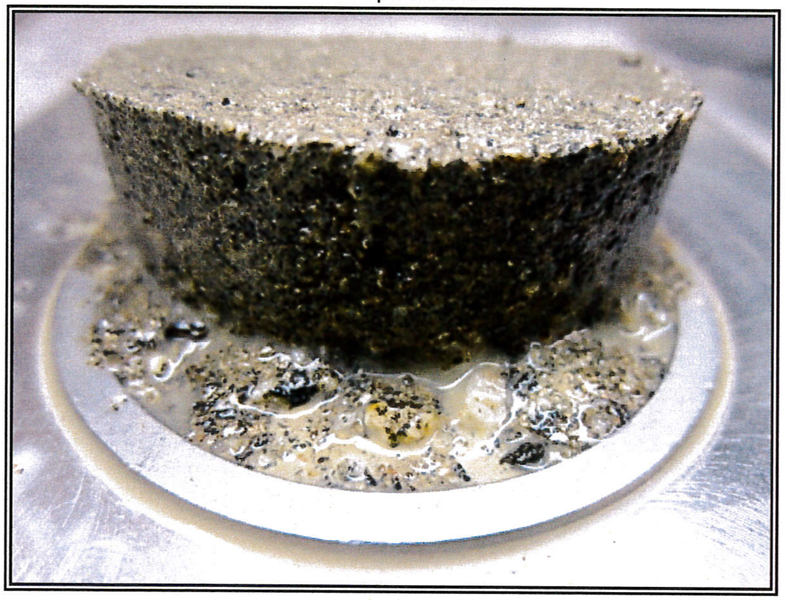
Project: BUCKHORN CLOSURE	
Location: 02-SHA-299-0.5-2.5	
Project No.: 02-3E4100	
Boring No.: BH	
Sample Type: REMOLD	
Description: Moist, Dense, Dark Grey, Sand with Silt. Remolded to 93%RC of BH 04A & 04B.	
Remarks: ASTM D 3080. Sample description is not a soil classification.	1/10/13

Tue, 08-JAN-2013 10:53:31

DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 11
Test Specimen A

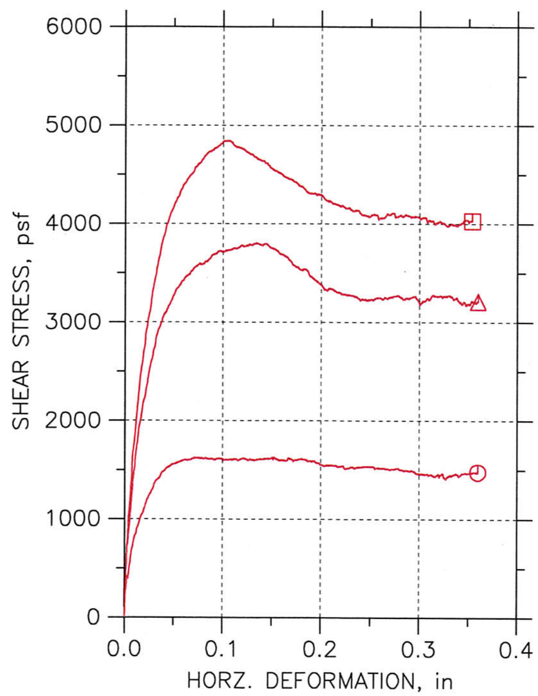


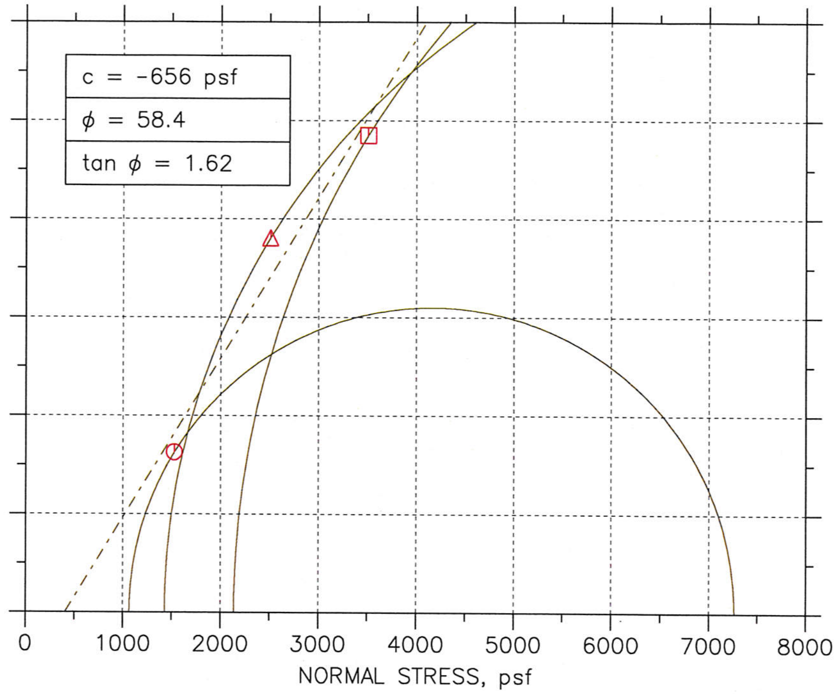
DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 11
Test Specimen B

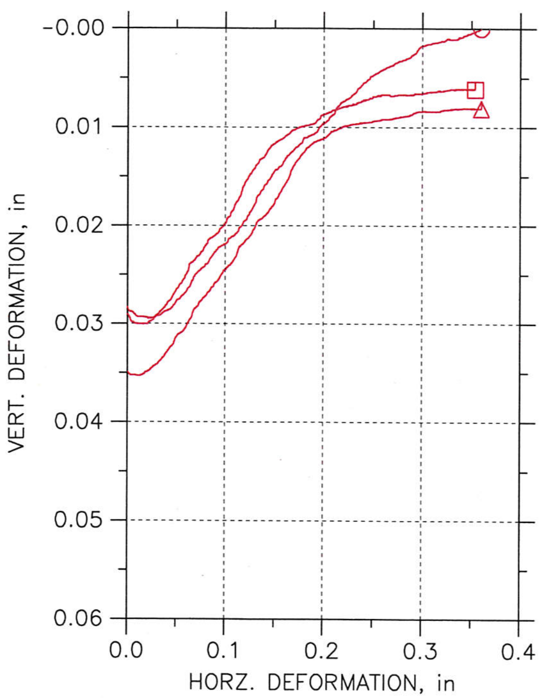


DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 11
Test Specimen C

DIRECT SHEAR TEST REPORT







	Symbol	○	△	□	
	Test No.	DS12039A	DS12039B	DS12039C	
	Sample No.	12	12	12	
	Shape	Circular	Circular	Circular	
Initial	Dimension, in	1.944	1.944	1.944	
	Area, in^2	2.9681	2.9681	2.9681	
	Height, in	1	1	1	
	Water Content, %	9.32	9.09	8.88	
	Dry Density, pcf	119.75	120.01	120.01	
	Saturation, %	61.78	60.67	59.25	
	Void Ratio	0.40756	0.40455	0.40455	
	Consol. Height, in	0.97513	0.96586	0.97211	
	Consol. Void Ratio	0.37255	0.35659	0.36537	
Final	Water Content, %	15.01	14.44	14.65	
	Dry Density, pcf	119.76	120.99	120.76	
	Saturation, %	99.42	99.17	99.95	
	Void Ratio	0.4075	0.39309	0.39583	
	Normal Stress, psf	1527.2	2507	3509	
	Max. Shear Stress, psf	1625.5	3802.5	4846.5	
	Ult. Shear Stress, psf	1475.3	3206.6	4025.9	
	Time to Failure, min	15.757	13.762	11.879	
	Disp. Rate, in/min	0.01	0.01	0.01	
	Implied Specific Gravity	2.70	2.70	2.70	
	Liquid Limit	---	---	---	
	Plastic Limit	---	---	---	
	Plasticity Index	---	---	---	

Project: BUCKHORN CLOSURE

Location: 02-SHA-299-0.5-2.5

Project No.: 02-3E4100

Boring No.: BH

Sample Type: REMOLD

Description: Moist,

Remarks: ASTM D 3080. Sample description is not a soil classification.

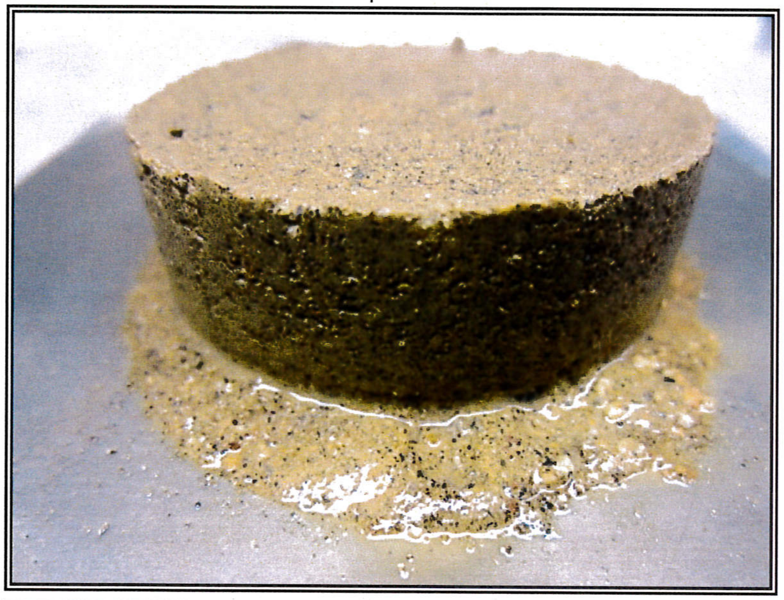
1/10/13

Tue, 08-JAN-2013 11:02:36

DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 12
Test Specimen A

DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 12
Test Specimen B

DIRECT SHEAR
JOB : 02-3E4100
SAMPLE : BH 12
Test Specimen C



APPENDIX E

Cut Slope Ratio and Catchment Recommendations by Station for Lower Project Area

The table included here presents recommendations for cut slopes and catchments for the Lower Project Area (From Station 223+75 to the eastern end of the project at station 301+50).

The first part of the table covers stations 223+75 to 293+00. This presents the minimum recommended catchment width (unpaved shoulder at 6:1 backslope), the top slope ratio (S1), the second slope ratio (S2), the third slope ratio (S3), the depth to slope break between the top slope ratio and the second slope ratio (S1/S2), and the depth to break between the second slope ratio and the third slope ratio (S2/S3). The relative locations of the three slope ratios and the methodology of determining the depth to break between two slope ratios is described in the text in section 8.1.1

The second part of the table, which is presented on the final page of this appendix, covers the eastern end of the project from stations 293+25 to 301+50. This stretch of cut slopes has a 25-foot wide road within the cut slope geometry that also serves as a bench for rockfall mitigation. The second part of the table is arranged beginning with the minimum catchment width, the primary cut (the portion of the cut below the bench) slope ratio, the bench width (Lewiston Road Width), the slope ratio of the top portion of the second cut (the cut above the bench), the depth to the break in slope between the top and bottom portions of the second cut (again, this is the cut above the bench), and the slope ratio of the bottom part of the second cut).

These tables and their recommendations are explained more thoroughly within the text in section 8.1.1.

STATION	CATCHMENT WIDTH (MIN)	SLOPE RATIO 1	SLOPE RATIO 2	SLOPE RATIO 3	Depth to Slope Break (ft)	
	(ft)	(S1)	(S2)	(S3)	(S1/S2)	(S2/S3)
223+75	8	0.75:1	0.5:1	NO	10	NO
224+00	10	0.75:1	0.5:1	NO	10	NO
224+25	12	0.75:1	0.5:1	0.3:1	10	25
224+50	14	0.75:1	0.5:1	0.3:1	10	25
224+75	14	0.75:1	0.5:1	0.3:1	10	25
225+00	16	0.75:1	0.5:1	0.3:1	10	25
225+25	16	0.75:1	0.5:1	0.3:1	10	25
225+50	16	0.75:1	0.5:1	0.3:1	10	25
225+75	18	0.75:1	0.5:1	0.3:1	10	25
226+00	20	0.75:1	0.5:1	0.3:1	10	25
226+25	20	0.75:1	0.5:1	0.3:1	10	25
226+50	23	0.75:1	0.5:1	0.3:1	10	25
226+75	26	0.75:1	0.5:1	0.3:1	10	25
227+00	27	0.75:1	0.5:1	0.3:1	10	25
227+25	29	0.75:1	0.5:1	0.3:1	10	25
227+50	31	0.75:1	0.5:1	0.3:1	10	25
227+75	32	0.75:1	0.5:1	0.3:1	10	25
228+00	32	0.75:1	0.5:1	0.3:1	10	25
228+25	32	0.75:1	0.5:1	0.3:1	10	25
228+50	31	0.75:1	0.5:1	0.3:1	10	25
228+75	31	0.75:1	0.5:1	0.3:1	10	25
229+00	30	0.75:1	0.5:1	0.3:1	10	25
229+25	30	0.75:1	0.5:1	0.3:1	10	25
229+50	24	0.75:1	0.5:1	0.3:1	10	25
229+75	24	0.75:1	0.5:1	0.3:1	10	25
230+00	24	0.75:1	0.5:1	0.3:1	10	25
230+25	24	0.75:1	0.5:1	0.3:1	10	25
230+50	24	0.75:1	0.5:1	0.3:1	10	25
230+75	22	0.75:1	0.5:1	0.3:1	10	25
231+00	20	0.75:1	0.5:1	0.3:1	10	25
231+25	20	0.75:1	0.5:1	0.3:1	10	25
231+50	24	0.75:1	0.5:1	0.3:1	10	25
231+75	26	0.75:1	0.5:1	0.3:1	10	25
232+00	28	0.75:1	0.5:1	0.3:1	10	25
232+25	30	0.75:1	0.5:1	0.3:1	10	25
232+50	30	0.75:1	0.5:1	0.3:1	10	25
232+75	30	0.75:1	0.5:1	0.3:1	10	25
233+00	30	0.75:1	0.5:1	0.3:1	10	25
233+25	28	0.75:1	0.5:1	0.3:1	10	25
233+50	27	0.75:1	0.5:1	0.3:1	10	25
233+75	26	0.75:1	0.5:1	0.3:1	10	25
234+00	24	0.75:1	0.5:1	0.3:1	10	25
234+25	24	0.75:1	0.5:1	0.3:1	10	25
234+50	24	0.75:1	0.5:1	0.3:1	10	25
234+75	24	0.75:1	0.5:1	0.3:1	10	25
235+00	24	0.75:1	0.5:1	0.3:1	10	25
235+25	24	0.75:1	0.5:1	0.3:1	10	25
235+50	24	0.75:1	0.5:1	0.3:1	10	25
235+75	24	0.75:1	0.5:1	0.3:1	10	25

STATION	CATCHMENT WIDTH (MIN)	SLOPE RATIO 1	SLOPE RATIO 2	SLOPE RATIO 3	Depth to Slope Break (ft)	
	(ft)	(S1)	(S2)	(S3)	(S1/S2)	(S2/S3)
236+00	24	0.75:1	0.5:1	0.3:1	10	25
236+25	25	0.75:1	0.5:1	0.3:1	10	25
236+50	26	0.75:1	0.5:1	0.3:1	10	25
236+75	26	0.75:1	0.5:1	0.3:1	10	25
237+00	26	0.75:1	0.5:1	0.3:1	10	25
237+25	26	0.75:1	0.5:1	0.3:1	10	25
237+50	25	0.75:1	0.5:1	0.3:1	10	25
237+75	24	0.75:1	0.5:1	0.3:1	10	25
238+00	24	0.75:1	0.5:1	0.3:1	10	25
238+25	22	0.75:1	0.5:1	0.3:1	10	25
238+50	20	0.75:1	0.5:1	0.3:1	10	25
238+75	16	0.75:1	0.5:1	0.3:1	10	25
239+00	10	0.75:1	0.5:1	0.3:1	10	25
239+25	8	0.75:1	0.5:1	0.3:1	10	25
239+50	8	0.75:1	0.5:1	no	10	no
239+75	10	0.75:1	0.5:1	no	10	no
240+00	12	0.75:1	0.5:1	no	10	no
240+25	13	0.75:1	0.5:1	no	10	no
240+50	14	0.75:1	0.5:1	no	10	no
240+75	14	0.75:1	0.5:1	no	10	no
241+00	14	0.75:1	0.5:1	no	10	no
241+25	14	0.75:1	0.5:1	no	10	no
241+50	15	0.75:1	0.5:1	no	10	no
241+75	15	0.75:1	0.5:1	no	10	no
242+00	14	0.75:1	0.5:1	no	10	no
242+25	14	0.75:1	0.5:1	no	10	no
242+50	15	0.75:1	0.5:1	no	10	no
242+75	15	0.75:1	0.5:1	no	10	no
243+00	16	0.75:1	0.5:1	0.3:1	10	45
243+25	16	0.75:1	0.5:1	0.3:1	10	45
243+50	17	0.75:1	0.5:1	0.3:1	10	45
243+75	18	0.75:1	0.5:1	0.3:1	10	45
244+00	20	0.75:1	0.5:1	0.3:1	10	45
244+25	18	0.75:1	0.5:1	0.3:1	10	45
244+50	18	0.75:1	0.5:1	0.3:1	10	45
244+75	18	0.75:1	0.5:1	0.3:1	10	45
245+00	18	0.75:1	0.5:1	0.3:1	10	45
245+25	18	0.75:1	0.5:1	0.3:1	10	45
245+50	17	0.75:1	0.5:1	0.3:1	10	45
245+75	16	0.75:1	0.5:1	0.3:1	10	45
246+00	16	0.75:1	0.5:1	0.3:1	10	45
246+25	16	0.75:1	0.5:1	0.3:1	10	45
246+50	15	0.75:1	0.5:1	0.3:1	10	45
246+75	14	0.75:1	0.5:1	0.3:1	10	45
247+00	14	0.75:1	0.5:1	0.3:1	10	45
247+25	14	0.75:1	0.5:1	0.3:1	10	40
247+50	12	0.75:1	0.5:1	0.3:1	10	35

STATION	CATCHMENT WIDTH (MIN)	SLOPE RATIO 1	SLOPE RATIO 2	SLOPE RATIO 3	Depth to Slope Break (ft)	
	(ft)	(S1)	(S2)	(S3)	(S1/S2)	(S2/S3)
247+75	12	0.75:1	0.5:1	0.3:1	10	35
248+00	10	0.75:1	0.5:1	0.3:1	10	35
248+25	10	0.75:1	0.5:1	no	10	no
248+50	8	0.75:1	0.5:1	no	10	no
248+75	8	0.75:1	no	no	no	no
249+00	no	no	no	no	no	no
249+25	8	0.75:1	0.5:1	no	10	no
249+50	10	0.75:1	0.5:1	no	10	no
249+75	10	0.75:1	0.5:1	no	10	no
250+00	12	0.75:1	0.5:1	no	10	no
250+25	14	0.75:1	0.5:1	0.3:1	10	45
250+50	14	0.75:1	0.5:1	0.3:1	10	45
250+75	15	0.75:1	0.5:1	0.3:1	10	45
251+00	15	0.75:1	0.5:1	0.3:1	10	45
251+25	15	0.75:1	0.5:1	0.3:1	10	45
251+50	15	0.75:1	0.5:1	0.3:1	10	45
251+75	15	0.75:1	0.5:1	0.3:1	10	45
252+00	15	0.75:1	0.5:1	0.3:1	10	45
252+25	15	0.75:1	0.5:1	0.3:1	10	45
252+50	15	0.75:1	0.5:1	0.3:1	10	45
252+75	15	0.75:1	0.5:1	0.3:1	10	45
253+00	14	0.75:1	0.5:1	0.3:1	10	45
253+25	14	0.75:1	0.5:1	no	10	no
253+50	14	0.75:1	0.5:1	no	10	no
253+75	12	0.75:1	0.5:1	no	10	no
254+00	10	0.75:1	0.5:1	no	10	no
254+25	8	0.75:1	no	no	no	no
254+50	8	0.75:1	no	no	no	no
254+75	8	0.75:1	0.5:1	no	10	no
255+00	8	0.75:1	0.5:1	no	10	no
255+25	10	0.75:1	0.5:1	no	10	no
255+50	10	0.75:1	0.5:1	no	10	no
255+75	10	0.75:1	0.5:1	no	10	no
256+00	10	0.75:1	0.5:1	no	8	no
256+25	8	0.75:1	0.5:1	no	8	no
256+50	8	0.75:1	0.5:1	no	8	no
256+75	8	0.75:1	0.5:1	no	8	no
257+00	8	0.75:1	0.5:1	no	8	no
257+25	8	0.75:1	0.5:1	0.3:1	8	20
257+50	8	0.75:1	0.5:1	0.3:1	8	20
257+75	8	0.75:1	0.5:1	0.3:1	8	20
258+00	10	0.75:1	0.5:1	0.3:1	8	20
258+25	10	0.75:1	0.5:1	0.3:1	8	20
258+50	10	0.75:1	0.5:1	0.3:1	8	20
258+75	10	0.75:1	0.5:1	0.3:1	8	20
259+00	10	0.75:1	0.5:1	0.3:1	8	20

STATION	CATCHMENT WIDTH (MIN)	SLOPE RATIO 1	SLOPE RATIO 2	SLOPE RATIO 3	Depth to Slope Break (ft)	
	(ft)	(S1)	(S2)	(S3)	(S1/S2)	(S2/S3)
259+25	10	0.75:1	0.5:1	0.3:1	8	20
259+50	9	0.75:1	0.5:1	0.3:1	8	20
259+75	9	0.75:1	0.5:1	0.3:1	8	20
260+00	9	0.75:1	0.5:1	0.3:1	8	20
260+25	9	0.75:1	0.5:1	0.3:1	8	20
260+50	8	0.75:1	0.5:1	0.3:1	8	20
260+75	8	0.75:1	0.5:1	0.3:1	8	20
261+00	8	0.75:1	0.5:1	no	8	no
261+25	8	0.75:1	0.5:1	no	8	no
261+50	8	0.75:1	no	no	no	no
261+75	8	0.75:1	no	no	no	no
262+00	8	0.75:1	no	no	no	no
262+25	8	0.75:1	no	no	no	no
262+50	8	0.75:1	no	no	no	no
262+75	8	0.75:1	no	no	no	no
263+00	8	0.75:1	no	no	no	no
263+25	NA	NA	NA	NA	NA	NA
263+50	NA	NA	NA	NA	NA	NA
263+75	NA	NA	NA	NA	NA	NA
264+00	NA	NA	NA	NA	NA	NA
264+25	NA	NA	NA	NA	NA	NA
264+50	NA	NA	NA	NA	NA	NA
264+75	NA	NA	NA	NA	NA	NA
265+00	NA	NA	NA	NA	NA	NA
265+25	NA	NA	NA	NA	NA	NA
265+50	8	0.75:1	0.5:1	NO	3	NO
265+75	10	0.75:1	0.5:1	NO	3	NO
266+00	11	0.75:1	0.5:1	NO	3	NO
266+25	12	0.75:1	0.5:1	NO	3	NO
266+50	12	0.75:1	0.5:1	NO	3	NO
266+75	12	0.75:1	0.5:1	NO	3	NO
267+00	14	0.75:1	0.5:1	NO	3	NO
267+25	14	0.75:1	0.5:1	NO	3	NO
267+50	14	0.75:1	0.5:1	NO	3	NO
267+75	14	0.75:1	0.5:1	NO	3	NO
268+00	14	0.75:1	0.5:1	NO	3	NO
268+25	14	0.75:1	0.5:1	NO	3	NO
268+50	14	0.75:1	0.5:1	NO	3	NO
268+75	14	0.75:1	0.5:1	NO	3	NO
269+00	14	0.75:1	0.5:1	NO	3	NO
269+25	14	0.75:1	0.5:1	0.3:1	3	22
269+50	14	0.75:1	0.5:1	0.3:1	3	22
269+75	14	0.75:1	0.5:1	0.3:1	3	22
270+00	14	0.75:1	0.5:1	0.3:1	3	22
270+25	12	0.75:1	0.5:1	0.3:1	3	22
270+50	12	0.75:1	0.5:1	0.3:1	3	22

STATION	CATCHMENT WIDTH (MIN)	SLOPE RATIO 1	SLOPE RATIO 2	SLOPE RATIO 3	Depth to Slope Break (ft)	
	(ft)	(S1)	(S2)	(S3)	(S1/S2)	(S2/S3)
270+75	12	0.75:1	0.5:1	0.3:1	3	22
271+00	12	0.75:1	0.5:1	0.3:1	3	22
271+25	12	0.75:1	0.5:1	0.3:1	3	22
271+50	12	0.75:1	0.5:1	0.3:1	3	22
271+75	12	0.75:1	0.5:1	0.3:1	3	25
272+00	12	0.75:1	0.5:1	0.3:1	3	28
272+25	12	0.75:1	0.5:1	0.3:1	3	30
272+50	10	0.75:1	0.5:1	no	3	no
272+75	8	0.75:1	0.5:1	no	5	no
273+00	8	0.75:1	0.5:1	no	8	no
273+25	8	0.75:1	0.5:1	no	10	no
273+50	8	0.75:1	0.5:1	no	10	no
273+75	8	0.75:1	0.5:1	no	10	no
274+00	8	0.75:1	0.5:1	no	10	no
274+25	8	0.75:1	0.5:1	no	10	no
274+50	8	0.75:1	0.5:1	no	7	no
274+75	8	1.0:1.0	0.75:1	no	5	no
275+00	8	1.0:1.0	0.75:1	no	3	no
275+25	8	1.0:1.0	0.75:1	no	3	no
275+50	8	1.0:1.0	0.75:1	no	3	no
275+75	8	1.0:1.0	0.75:1	no	3	no
276+00	8	1.0:1.0	0.75:1	no	3	no
276+25	8	1.0:1.0	0.75:1	no	3	no
276+50	8	1.0:1.0	0.75:1	no	3	no
276+75	8	1.0:1.0	0.75:1	no	3	no
277+00	8	1.0:1.0	0.75:1	no	3	no
277+25	8	1.0:1.0	0.75:1	no	3	no
277+50	8	1.0:1.0	0.75:1	no	3	no
277+75	8	1.0:1.0	0.75:1	no	3	no
278+00	8	1.0:1.0	0.75:1	no	3	no
278+25	8	1.0:1.0	0.75:1	no	3	no
278+50	8	1.0:1.0	0.75:1	no	3	no
278+75	8	1.0:1.0	0.75:1	no	3	no
279+00	8	1.0:1.0	0.75:1	no	3	no
279+25	8	1.0:1.0	0.75:1	no	3	no
279+50	8	1.0:1.0	0.75:1	no	3	no
279+75	8	1.0:1.0	0.75:1	no	3	no
280+00	8	0.75:1	0.5:1	0.3:1	5	15
280+25	8	0.75:1	0.5:1	0.3:1	5	15
280+50	8	0.75:1	0.5:1	0.3:1	5	15
280+75	8	0.75:1	0.5:1	0.3:1	5	15
281+00	8	0.75:1	0.5:1	0.3:1	5	15
281+25	8	0.75:1	0.5:1	0.3:1	5	15
281+50	8	0.75:1	0.5:1	0.3:1	5	15
281+75	8	0.75:1	0.5:1	0.3:1	5	15
282+00	8	0.75:1	0.5:1	0.3:1	5	15

STATION	CATCHMENT WIDTH (MIN)	SLOPE RATIO 1	SLOPE RATIO 2	SLOPE RATIO 3	Depth to Slope Break (ft)	
	(ft)	(S1)	(S2)	(S3)	(S1/S2)	(S2/S3)
282+25	8	0.75:1	0.5:1	0.3:1	5	15
282+50	8	0.75:1	0.5:1	0.3:1	5	15
282+75	8	0.75:1	0.5:1	0.3:1	5	15
283+00	8	0.75:1	0.5:1	0.3:1	5	15
283+25	8	0.75:1	0.5:1	0.3:1	5	15
283+50	8	0.75:1	0.5:1	0.3:1	5	15
283+75	8	0.75:1	0.5:1	0.3:1	5	15
284+00	8	0.75:1	0.5:1	0.3:1	5	15
284+25	8	0.75:1	no	no	no	no
284+50	8	0.75:1	no	no	no	no
284+75	8	0.75:1	no	no	no	no
285+00	8	0.75:1	no	no	no	no
285+25	8	0.75:1	no	no	no	no
285+50	8	0.75:1	no	no	no	no
285+75	NA	NA	NA	NA	NA	NA
286+00	NA	NA	NA	NA	NA	NA
286+25	8	0.75:1	no	no	no	no
286+50	8	0.75:1	no	no	no	no
286+75	8	0.75:1	0.5:1	0.3:1	5	20
287+00	8	0.75:1	0.5:1	0.3:1	5	20
287+25	8	0.75:1	0.5:1	0.3:1	5	20
287+50	10	0.75:1	0.5:1	0.3:1	5	20
287+75	10	0.75:1	0.5:1	0.3:1	5	20
288+00	10	0.75:1	0.5:1	0.3:1	5	20
288+25	10	0.75:1	0.5:1	0.3:1	5	20
288+50	8	0.75:1	0.5:1	0.3:1	5	20
288+75	8	0.75:1	0.5:1	0.3:1	5	20
289+00	8	0.75:1	0.5:1	0.3:1	5	20
289+25	8	0.75:1	0.5:1	0.3:1	5	20
289+50	8	0.75:1	0.5:1	0.3:1	5	20
289+75	8	0.75:1	0.5:1	0.3:1	5	20
290+00	8	0.75:1	0.5:1	0.3:1	5	20
290+25	8	0.75:1	0.5:1	0.3:1	5	20
290+50	8	0.75:1	0.5:1	0.3:1	5	20
290+75	8	0.75:1	0.5:1	0.3:1	5	20
291+00	8	0.75:1	0.5:1	0.3:1	5	20
291+25	8	0.75:1	0.5:1	0.3:1	5	20
291+50	8	0.75:1	0.5:1	no	5	no
291+75	8	0.75:1	0.5:1	no	5	no
292+00	8	0.75:1	no	no	no	no
292+25	NA	NA	NA	NA	NA	NA
292+50	NA	NA	NA	NA	NA	NA
292+75	NA	NA	NA	NA	NA	NA
293+00	8	0.75:1	no	no	no	no

	CATCHMENT WIDTH (MIN)	Primary Cut	Lewiston Road width	second cut - top	top cut depth	second cut-
293+25	8	0.75:1	25	0.75:1	8	0.5:1
293+50	8	0.75:1	25	0.75:1	8	0.5:1
293+75	8	0.75:1	25	0.75:1	8	0.5:1
294+00	10	0.75:1	25	0.75:1	8	0.5:1
294+25	10	0.75:1	25	0.75:1	8	0.5:1
294+50	10	0.75:1	25	0.75:1	8	0.5:1
294+75	10	0.75:1	25	0.75:1	8	0.5:1
295+00	10	0.75:1	25	0.75:1	8	0.5:1
295+25	10	0.75:1	25	0.75:1	8	0.5:1
295+50	10	0.75:1	25	0.75:1	8	0.5:1
295+75	10	0.75:1	25	0.75:1	8	0.5:1
296+00	10	0.75:1	25	0.75:1	8	0.5:1
296+25	10	0.75:1	25	0.75:1	8	0.5:1
296+50	10	0.75:1	25	0.75:1	8	0.5:1
296+75	10	0.75:1	25	0.75:1	8	0.5:1
297+00	10	0.75:1	25	0.75:1	8	0.5:1
297+25	10	0.75:1	25	0.75:1	8	0.5:1
297+50	10	0.75:1	25	0.75:1	8	0.5:1
297+75	10	0.75:1	25	0.75:1	8	0.5:1
298+00	8	0.75:1	25	0.75:1	8	0.5:1
298+25	NA	NA	NA	NA	NA	NA
301+50	NA	NA	NA	NA	NA	NA

02-3E4104
02-Sha-299-0.3/7.1
Project ID 0200020042

PERMITS

PLAC Condition Responsibility Summary

United States Army Corps of Engineers

WATER QUALITY

California Regional Water Quality Control Board

Central Valley Region (WDID No. 5A45CR00459)
Board Order No. 2012-0011-DWQ
NPDES Permit No. CAS 000003

AGREEMENTS

California Department of Fish and Wildlife

Notification No. 1600-2013-0349-R1

MATERIALS INFORMATION

Foundation Report for Sawpit Gulch

Addendum to Foundation Report for Sawpit Gulch

Final Hydraulic Report for Sawpit Gulch Culvert Extension

Geotechnical Design Report

Addenddum to Geotechnical Design Report

Potential Water Sources

M e m o r a n d u m

Flex your power!
Be energy efficient!

To: MR. AL TRUJILLO
District 2
Safety Team Senior Engineer

Date: May 16, 2014

File: 02-SHA-299-PM 0.3/7.1
0200020042
EA 02-3E410
Capstone Curve
Improvement Project

Attn: Mr. Mike Feakes
Transportation Engineer

From: **DEPARTMENT OF TRANSPORTATION**
Division of Engineering Services
Geotechnical Services

Subject: Addendum to Geotechnical Design Report Regarding Geotechnical Conditions at Planned Site of Jack and Bore Welded Steel Pipe

This addendum to the initial (February 28, 2014) *Capstone Curve Improvement Safety Project Geotechnical Design Report* (GDR) provides specific geotechnical information for the site of a planned jack and bore installation of a welded steel pipe (WSP). This addendum does not supersede, change or conflict with any information provided in the initial GDR. The Capstone Curve Improvement Project is located on State Highway 299 from PM 0.3 to PM 7.1 in Shasta County, California. The planned WSP installation is located at station 36+75 and is referred to in the plans as drainage system no. 70.

Two primary geotechnical issues are addressed in this addendum. The first involves the evaluation of the potential for gaseous emissions from soils or bedrock during the jacking, boring, and construction of the 30” by 90.7-foot WSP at station 36+75. The second issue is the nature of the geological material and how it will effect the jack and bore operation.

The WSP is being installed in what has been defined in the GDR as the Upper Project Area, which is composed geologically of granitic rocks of the Shasta Bally Batholith. These rocks are mildly to completely decomposed within the upper one hundred to three hundred feet below the ground surface. In keeping with the description practiced in the GDR, this material is collectively called DG. Unweathered granite exists at depth, based on seismic refraction data and a few borings within the Upper Project Area that were drilled within the past 30 years. No borings were performed in the immediate vicinity of the site of the proposed WSP installation, but Log of Test borings (LOTBs) from the Upper Project Area are available in the appendices of the project GDR.

The specific location of the planned jacking and boring of the WSP is an old fill constructed when the highway was upgraded almost 100 years ago. The material in this fill almost certainly consists entirely of DG. This determination is based partly on surface observations of the fill. It is also inferred by the clear lack of any other in-situ geological material within several miles, combined with the knowledge that fills are usually constructed of material that has been cut nearby, a construction methodology probably even more true 100 years ago than today due to the limited technological resources available in the past for moving large volumes of excavated soil considerable distances and uphill against gravity. The nearby cuts, which are the likely source of the fill material, are composed of moderately to completely decomposed DG with only a relative few, mafic-enriched, moderately weathered, granitic corestones. Based on experience working with similarly decomposed DG on previous projects nearby and information discussed in the GDR, this DG was likely placed and compacted as fill as a coarse, poorly graded sand (SP). The few corestones would have similarly been turned to sand by the excavation, emplacement, and compaction activities. This sandy material, devoid of cobbles, should be very amenable to augering.

No known history exists of any type of hydrocarbon sources having been exploited or discovered in the DG of the upper Project Area, nor is there any geological precedent for any such hydrocarbon deposits to exist within these rocks or the fill. Therefore, there is no reason to believe that any naturally occurring hydrocarbon gases will be encountered at this site.

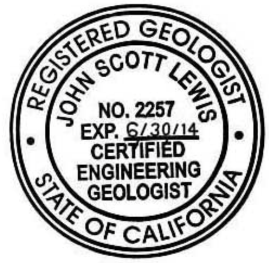
The potential for man-made sources of hydrocarbon gases at the site was evaluated. An examination of engineering documents going back to the original construction of the highway around the second decade of the 20^{th} century revealed nothing indicative that the site had been developed as a fueling or fuel storage site, or anything akin to such activity. Old aerial photos, though non-existent back to the time of origin of the highway, show no indication of any type of hydrocarbon storage facility or activity.

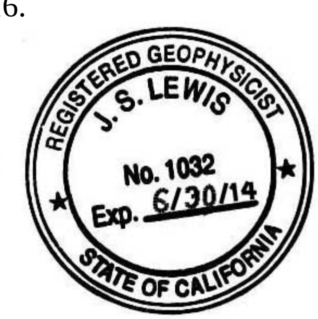
In conclusion:

1) No apparent potential for hydrocarbon-based gases exists at the site of the proposed Sawpit Gulch box culvert extension.
2) No evidence indicative of any water borne gases, sulfurous or otherwise, was found at the site of the proposed WSP installation.
3) The fill through which the WSP will be bored and jacked is composed of compacted, medium dense, poorly graded, sand (SP).
4) Our Office (Office of Geotechnical Design North) recommends auger boring as the preferred jack and bore method.

If you have any questions or comments, please call me at (530) 225-3516.

J. SCOTT LEWIS, P.G., C.E.G., P.G.P.
Associate Engineering Geologist
Office of Geotechnical Design - North





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02-3E4104
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Project ID 0200020042

PERMITS

PLAC Condition Responsibility Summary

United States Army Corps of Engineers

WATER QUALITY

California Regional Water Quality Control Board

Central Valley Region (WDID No. 5A45CR00459)
Board Order No. 2012-0011-DWQ
NPDES Permit No. CAS 000003

AGREEMENTS

California Department of Fish and Wildlife

Notification No. 1600-2013-0349-R1

MATERIALS INFORMATION

Foundation Report for Sawpit Gulch

Addendum to Foundation Report for Sawpit Gulch

Final Hydraulic Report for Sawpit Gulch Culvert Extension

Geotechnical Design Report

Addenddum to Geotechnical Design Report

Potential Water Sources

Potential Water Sources

It is the responsibility of the contractor to acquire an adequate and reliable source of water for construction activities for this project. Potential sources of water near the project location are included in, but not limited to, the following list.

Potable suppliers:
Centerville Water District
(530) 246-0680

City of Redding
(530) 224-6040

Clear Creek Community Service District
(530) 357-2121

Non-Potable suppliers:
Centerville Water District
(530) 246-0680

McConnell Foundation
(530) 222-0696