U.S. Department of Transportation

Federal Highway Administration

SOUTH FORK SMITH RIVER ROAD

CA PFH 112-1(1)

FINAL GEOTECHNICAL DESIGN REPORT

Report # CA-FX-0112-08-01

Geotechnical Services Branch
August 2008

Federal Lands Highway

Commitment to Excellence

Technical Services

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

CENTRAL FEDERAL LANDS HIGHWAY DIVISION
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CA PFH 112-1(1)
SOUTH FORK SMITH RIVER ROAD
SIX RIVERS NATIONAL FOREST
DEL NORTE COUNTY, CALIFORNIA

INTRODUCTION

Project Description

This report presents the findings of a subsurface investigation and provides geotechnical recommendations for the repair and stabilization of select sites along the South Fork Smith River Road. The 10.3 mile route begins north of Hiouchi, CA, at approximately milepost (MP) 3.6 on County Road 427, continues through the junction of County Roads 427 and 405 and ends at approximate MP 13.9 on County Road 405. Project CA PFH 112-1(1) includes the replacement of four one-lane bridge structures, and the widening of four one-lane travelway sections. A Project Vicinity Map and Project Location Map are presented in Figure 1 of Appendix A.

Specifically, the bridge sites proposed for replacement include the Rock Creek Bridge at MP 7.7, the Boulder Creek Bridge at MP 8.8, the Steven Memorial Bridge at MP 12.7, and the Hurdy Gurdy Creek Bridge at MP 13.9. Each of the existing structures has a total width of 14 feet, while each of the proposed structures will have a total width of 32 feet, allowing two-way traffic.

The existing Rock Creek Bridge is a single span structure, approximately 100 feet in length. The proposed bridge at Rock Creek will also be a single span structure with a length of 115 feet. The existing Boulder Creek Bridge is a single span structure, approximately 50 feet in length. The proposed bridge at Boulder Creek will be a single span structure with a length of 105 feet. The existing Steven Memorial Bridge is a three span structure, approximately 330 feet in length, while the proposed structure will consist of three spans with a length of 360 feet. The existing Hurdy Gurdy Bridge is a single span structure with a length of approximately 170 feet. The proposed bridge at Hurdy Gurdy Creek will be a single span structure with a length of 190 feet.

The four one-lane travelway sections designated for reconstruction and widening include Sites A through D. Each site will be widened to approximately 28 feet.

Site A begins at MP 3.6 and extends approximately 900 feet to the south and is currently 13 feet wide, as the roadway narrows from two lanes to one lane. The paved roadway through this site is stable with no significant cracking or distress. The narrowest section of this site is on a tangent. An existing 6 to 9 foot high gabion wall supports the roadway through this narrow section. The gabion wall is stable and has only suffered minor damage from rockfall debris. The adjacent slopes through this site have experienced localized distress as evidenced by the rockfall debris and remnants of shallow erosional features. The slope ratios below the roadway range from 1.5H:1V and 1H:1V with little vegetation. The South Fork of the Smith River abuts the roadway at this site, several hundred feet below the roadway elevation. The slope ratios above the roadway are predominately 1H:1V with little vegetation. The cut slope extends approximately 120 feet above the

roadway. It appears that some excavation into this colluvial slope was required during the original roadway construction. This excavation oversteepened the slope and caused a continual and significant loss of material, as the scarp crept up the slope. There is evidence that the scarp is continuing to retreat up the slope. The existing slope contains a number of loose rock blocks and boulders which contribute to the rockfall potential at this site. The existing catchment area width (3 feet) is not adequate for containing most of the rockfall at this site. There are significantly more stable and steeper bedrock outcrops on either end of the colluvial slope.

Site B begins at MP 7.8 and extends approximately 400 feet to the south. The roadway at this site is approximately 19 feet wide, as the roadway narrows from two lanes to one lane. The existing roadway through this site is stable with no evidence of significant distress or cracking. The roadway alignment through this site consists of large radii reverse curves. The South Fork of the Smith River abuts the roadway at this site, at a significant distance below the roadway elevation. The adjacent slopes below the road are fairly stable. Two small areas below the roadway show signs of previous failure, but are currently stable, as evidenced by the vegetation growth and the rock outcropping evident nearby. Slope ratios below the roadway range from 1.5H:1V to near vertical in rock outcrops. Slope ratios above the roadway range between 1H:1V and 0.5H:1V and are predominately in stable rock. During the original roadway construction, the alignment through this site was constructed primarily in cut, with little or no fill required. Numerous seeps along the cutslope were observed that flow water year round. Adjacent slopes are sparsely to moderately vegetated.

Site C begins at MP 10.5, at approximate Station 505+50, and extends approximately 2,400 feet to the south. The current roadway width varies between 12 and 18 feet. The South Fork of the Smith River abuts the roadway at this site several hundred feet below the roadway elevation. Generally, the existing roadway through the site is stable, with only small areas of cracking or distress of any consequence. There is an existing 16 foot high MSE wall structure between Stations 511+00 and 515+50, and a rock buttress above the road between Stations 511+50 and 513+50. Both structures were constructed as an ERFO repair several years ago and both appear to be stable. There is some significant cracking and roadway distress near Station 519+00. The narrowest section of the roadway through this site is between Stations 520+00 and 522+00. The adjacent slopes below the road range from 1.5H:1V to 0.5H:1V. The only noted area of slope instability below the roadway is between Stations 520+00 and 522+00, where the slope has become oversteepened due to significant erosion. During the original roadway construction, the alignment through this site was constructed primarily in cut, with little or no fill required. Generally, the cutslopes have revegetated very well, with no noted areas of instability and slopes ranging from 1H:1V to 0.5H:1V.

Site D begins at MP 13.3 and extends approximately 350 feet to the south. Site D has an existing width of 19 feet. The existing roadway through this site is stable with no significant distress. The roadway alignment through this site consists of a large radius curve. The South Fork of the Smith River abuts the roadway at this site at a significant distance below the roadway elevation. During the original roadway construction, the alignment through this site was constructed primarily in cut, with little or no fill required. The existing slope ratios below the roadway range from 1H:1V to 0.75H:1V and are fairly

stable. There are two small areas below the roadway that have previously failed, but both appear to now be stable. Slope ratios above the roadway range between 0.5H:1V and 0.3H:1V and are predominately in stable rock. Adjacent slopes are moderately vegetated.

Project Setting and Climate

The project sites are located approximately 10 miles due east of Crescent City, CA. The land is primarily forested and mountainous. Most of the Smith River Basin lacks significant population. Small communities within the local vicinity of the project include Smith River, Hiouchi, Gasquet, and Big Flat.

In the Smith River watershed, summers are relatively dry and mild, and winters are cool and wet. In general, variations in climate are caused primarily by distance from the coast and elevation. The project sites are located within 12 miles of the coast, allowing marine air flows to moderate temperatures and increase humidity. Average temperatures range between 36° F and 72° F, with extreme temperatures ranging between 5° F and 110° F.

Mean annual precipitation, as measured at the Big Flat weather station, just south of the project sites, is 102 inches. Precipitation in this area is highly seasonal, with about 90% occurring between October and April. During this period, storms come off the Pacific Ocean and move through the Smith River area, typically remaining for several days.

Distribution of precipitation is influenced by the interaction of air flow and topography. More precipitation falls on slopes that face southwest into the wind. Precipitation increases with elevation, but also decreases with distance from the coast.

Regional and Site Geology

The project site lies within the western foothills of the Klamath Mountains. Uplift of the Klamath Mountains is related to the movement of tectonic plates within the Cascadia subduction zone, as the ocean floor is sliding beneath the North American plate. Various geologic materials on the oceanic plate have been broken off, bent, and added to the edge of the continent as a result of this sliding. This accumulation includes marine sedimentary and volcanic rocks from the ocean floor that have been metamorphosed to varying degrees. One of the geologic materials that has been added to the continental margin during subduction is peridotite. During the subduction process, the peridotite has been chemically weathered to varying degrees to produce serpentinized peridotite. Above the peridotite, is the Josephine ophiolite, which lies on the South Fork Mountain throughst fault, above the younger Fransican complex rocks. The ophiolite mainly consists of basalt and gabbro.

The project location is mainly within ultramafic rocks of the western Jurassic belt, some of which are partially serpentinized. Rocks along the belt are generally volcanic in origin and also include peridotite, gabbro, and diabase. The surrounding area is dominated by classic Jurassic marine sedimentary rocks and greenstone of the Galice formation, as shown in Figure 2 of Appendix A.

The region is characterized by mountains with rounded ridges, steep sides, and narrow canyons. There are narrow floodplains and high terraces along the Smith River and its

tributaries. Landslides, frequently caused by over saturated soils and hydrostatic forces, are a common feature of the landscape. Mass wasting, or slope movement, and fluvial erosion are the main geomorphic processes.

Regional and Local Seismic Setting

The Klamath Mountains are traversed by many faults, including two major throughst faults that extend roughly north and south, and dip to the east. Numerous additional faults are located offshore within 14 miles of the coast. The Trinidad Fault and the Little Salmon Fault, south of the project site, may also affect the Klamath Mountains during seismic activity.

Based on AASHTO Division IA – Seismic Design Guidelines, a peak horizontal ground acceleration of 0.32g was selected for this project. Per AASHTO recommendations, the horizontal seismic coefficient to be used in design of freestanding abutments or retaining walls is equal to one-half the peak ground acceleration, or 0.16g. The predominant soil profile along this route is Type I, as characterized by AASHTO.

Geologic Hazards

Ground motions caused by an earthquake are influenced not only by the distance from the fault plans, but also by the geology found at the site. Amplified ground motions are expected in areas underlain by sand dunes or alluvial materials within the Smith River watershed. Materials prone to liquefaction or amplified ground motions are not expected to be encountered at any of the project sites.

Many areas throughout the Klamath Mountains are susceptible to rock fall generated by earthquakes. Intense ground motions can trigger landslides especially following heavy rains when soils are saturated. Several slopes in the vicinity of the project sites have experienced massive landslides, but it is not known if they were primarily caused by ground motions or loss of soil shear strength caused by heavy rains.

Except for the gentle coastal plain, most of the Smith River Basin is inherently landslide prone (California Department of Fish and Game, 1980). Areas composed of weak rock, such as the Galice and Franciscan formations, are especially subject to erosion, mass wasting, and sediment production.

In January 1970, following heavy rains, a large landslide fell from the northeast face of Rattlesnake Mountain, just north of the project sites, and blocked the South Fork Smith River. Known as the Rattlesnake Slide, it eventually covered nearly a square mile and moved between 1.5 and 2 million cubic yards (California Department of Fish and Game, 1980), with some estimating that it moved over 5 million cubic yards of material. Road building activity at the toe of the mountain and construction of logging roads on the upper slopes were likely contributors to the landslide, coupled with heavy precipitation. The slide blocked the South Fork for several hours, creating a lake two miles long and 50 feet deep. When the river breached this blockage, a large wave of water was released, but caused little damage downstream.

There are over a thousand landslides in the Smith River Basin, including hundreds over 200 feet wide (California Department of Fish and Game, 1980). Landslide events, such as the Rattlesnake Slide on the South Fork and various smaller events, are likely to continue to occur along the South Fork, especially during periods of high precipitation and as mass wasting and erosion continue along the canyon walls.

PROCEDURES AND RESULTS

Exploratory Borings

A multi-phase subsurface investigation program was managed by Central Federal Lands Highway Division (CFLHD) Geotechnical personnel. Crux Subsurface Inc., Spokane, WA, provided the drilling services for Phases 1, 2, and 3 of the investigation. Ten borings were completed during phase 1 at Sites A, B, C, and D, between November 16 and 18, 2004. All borings were completed using a Burley 5500-2 truck mounted drill rig. Borings were advanced through overburden soils using a casing advancer system, while rock core drilling was completed using an HQ3 triple tube coring system. Inclinometer casing was installed in one borehole at Site A and another at Site C.

Four borings were completed during Phase 2 of the investigation at the Steven Memorial Bridge site between September 27 and 30, 2005. All borings were completed by a Burley 5500-1 track mounted drill rig. Borings were advanced through overburden soils using a casing advancer system, while rock core drilling was completed using an HQ3 triple tube coring system. Helicopter assistance was required to place the rig at two of the boring locations.

Nineteen borings were completed during Phase 3 of the investigation at Sites A and C, the Boulder Creek Bridge, the Rock Creek Bridge, and the Hurdy Gurdy Creek Bridge, between October 11 and 20, 2005. Kleinfelder Inc. provided personnel on-site to monitor field operations and log the borings. Borings were completed by a Burley 4500-1 track mounted drill rig, a Burley 5500-1 track mounted drill rig, and a Burley 5500-2 truck mounted drill rig. Borings were advanced through overburden soils using a casing advancer system, while rock coring was completed using an HQ3 triple tube coring system. Borings were completed simultaneously at Site C because of a needed road closure to access boring locations. Inclinometer casing was installed in four of the completed boreholes at Site C.

Eight backhoe test pits were completed during Phase 4 of the investigation in the cutslopes at Sites A and C. The test pits were completed on March 12, 2007 in an effort to supplement boring information. Del Norte County provided an operator and John Deere 310SE backhoe to complete the test pits.

Fourteen borings were completed during Phase 5 of the investigation at Sites A, B, C, and D, as well as the north approach to the Steven Memorial Bridge. Salisbury and Associates, Inc, Spokane, WA provided the drilling services for phase 5 of the investigation, between June 19 and 29, 2007. Yeh and Associates provided personnel on-site to monitor field operations and log the borings. Borings were completed using a Viper GH-5 platform drill

rig utilizing BX wireline coring techniques. The platform drill was used to access boring location above and below the existing roadway. Crane support was required to access many of the boring locations.

Boring location plans are provided in Appendix B. Boring logs from each subsurface investigation phase are provided in Appendix C. Photos of the drill rig set up at each boring location and recovered core samples are located in Appendix J.

Sampling

Sampling of materials beneath the tip of hollow stem augers was performed as borings were advanced. Sampling was typically conducted at 5-foot intervals to the termination depth of the boring or auger refusal. Soil samples were recovered with a 2-inch outside diameter split-barrel sampler in accordance with AASHTO T200-87. Representative portions of recovered samples were preserved for laboratory testing. The sampling sequence for the borings is summarized on the boring logs attached in Appendix C.

Percent core recovery (CR) and rock quality designation (RQD) were determined for each core run to provide a quantitative basis for evaluation of the conditions of the rock. Core recovery is simply defined as the length of recovered material divided by the total length of the core run, and is presented as a percentage. The RQD is defined as the cumulative length of core pieces over 4 inches in length divided by the total length of the core run. Both the core recovery and RQD provide qualitative indication as to the competency and structural integrity of the investigated rock mass.

Field Tests and Measurements

Standard penetration tests (SPT) were performed and resistances were recorded during the recovery of each split barrel sample, in accordance with AASHTO T206-87. The sampler was driven into the soil using an automatic hammer. Sample recovery measurements were made and recorded for each sampling attempt. A field description by color and texture was made for each recovered sample.

Data Summary

The results of field tests and measurements were recorded on field logs and appropriate data sheets at the time of the investigation. The data sheets and logs contain information concerning the boring methods; samples attempted and recovered; indications of the presence of various materials such as gravel, pebbles, organic matter, etc.; and observations of groundwater. They also contain interpretations by the field personnel of the conditions based on the performance of the drilling equipment and cuttings brought to the surface. Therefore, the field data represent both factual and interpretative information.

The boring logs, provided in Appendix C, represent a compilation of field and laboratory data and description of the soil samples by a geotechnical engineer. These records occasionally do not include all data recorded on field logs and data sheets, but do include all information considered relevant to the design and construction recommendations, as contained in this report.

Groundwater elevations were not measured during the subsurface investigation due to the use of water in the wireline coring process. Fluctuations in the ground water level due to seasonal and climatic effects is expected.

Laboratory Testing

At the conclusion of the fieldwork, index tests were conducted on 30 soil samples recovered from completed borings. Laboratory tests on the samples included gradation (AASHTO T-27) and Atterberg limits (AASHTO T-89, T-90). Results of these tests were used to classify the soils according to AASHTO M-145 and to verify field logs, which were then updated as required. Classification in this manner provides an indication of the soil's mechanical properties. A summary of the test results is contained in Table 1. Index test results are represented in Appendix D.

Table 1. Index Test Summary.

Boring	Station	Sample	Sample Depth (ft)	%-200	LL	PI	Classification
B-RC1	207+75	SPT 1,2	8.0-14.5	18	*	*	*
B-BC1	408+20	SPT 1,2	3.0-9.5	28	26	3	A-2-4
B-BC1	408+20	SPT 3,4	13.0-18.3	7.6	*	*	*
B-SM1	608+40	SPT 1	0.0-4.5	24	36	8	A-2-4
B-SM3	611+20	SPT 1,2	6.0-11.5	5.1	*	*	*
B-SM4	612+25	SPT 1	5.0-6.5	39	24	6	A-4
B-SM4	612+25	SPT 2	10.0-10.5	15	20	3	A-1-b
B-HG2	808+40	SPT 1,2,3	9.0-20.5	15	27	4	A-1-a
B-HG3	809+90	SPT 1,2	3.5-10.0	15	29	6	A-1-a
B-HG4	809+90	SPT 1	3.5-5.0	24	25	3	A-1-b
B-HG5	810+15	SPT 1	8.5-10.0	17	27	5	A-1-b
B-HG6	808+32	SPT 1,2	9.0-15.5	17	26	5	A-1-b
B-A1	107+00	SPT 1,2,3	2.0-13.5	14	25	6	A-1-a
B-A1	107+00	SPT 3,4	13.0-19.5	7.9	*	*	*
B-A2	109+00	SPT 1,2,3	2.5-19.0	9.5	22	5	A-1-a
B-C1	528+24	SPT 1,3	2.0-12.7	11	NV	NP	A-1-a

Table 1 Cont. Index Test Summary.

Boring	Station	Sample	Sample Depth (ft)	%-200	LL	PI	Classification
B-C2	525+55	SPT 1,3	2.0-15.0	13	25	5	A-1-a
B-C3	512+12	SPT 3	12.0-13.5	17	24	5	A-1-b
B-C3	512+12	SPT 4,5,7	17.0-32.3	21	25	5	A-1-b
B-C4	508+09	SPT 2,3,4	7.0-18.5	14	25	5	A-1-a
B-C5	510+50	SPT 1	15.5-17.0	35	28	13	A-2-6
P-C5	521+03	SPT 1	3.5-5.0	11	24	5	A-1-a
B-C6	519+29	SPT 2,3,4,5	8.8-25.3	11	20	4	A-1-a
B-C6	519+29	SPT 7,9	33.8-45.3	10	*	*	*
B-C7	523+40	SPT 1,3,4,6	4.0-30.5	17	24	3	A-1-b
SI-C2	519+80	SPT 3,4,5,6,7	15.5-37.0	7.8	18	1	A-1-a
SI-C3	520+20	SPT 1,2	4.0-10.5	11	*	*	*
SI-C4	521+45	SPT 1,2	5.5-17.0	10	*	*	*
SI-C5	521+85	SPT 4,5,6	19.0-30.5	8.8	*	*	*
B-D2	706+48	SPT 1,2,3	2.0-15.0	6.1	24	5	A-1-a

Notes: NP – Non-plastic NA – Not Applicable
NV – No Value * Insufficient amount of material to complete test

Nineteen unconfined compression tests (ASTM D 2938) were performed on representative samples of native materials recovered during the subsurface investigation. The tests were performed to determine the unconfined compressive strength of bedrock materials for use in bridge foundation design and slope stability analysis. During the test, an axial load is continuously applied and increased until a peak load and failure are observed. Each of the tests was conducted on HQ size rock core, measuring 2.4 inches in diameter. A summary of the test results is presented in Table 2. Unconfined compression test results are contained in Appendix D.

Table 2. Unconfined Compression Test Summary.

Boring	Station	Sample Depth (ft)	Classification	Compressive Strength (psi)
B-RC1	207+75	19.0-20.3	Metagabbro	1,210(1)
B-RC1	207+75	32.0-33.0	Metagabbro	29,250
B-RC2	209+00	5.5-6.0	Metagabbro	41,540
B-RC2	209+00	29.5-31.0	Metagabbro	49,900
B-BC1	408+20	15.5-16.6	Congolomerate(2)	1,410
B-BC1	408+20	19.0-19.7	Conglomerate	23,560
B-BC2	409+25	21.8-22.6	Conglomerate	28,020
B-BC2	409+25	36.2-37.8	Serpentinite	22,240
B-SM1	608+40	20.0-20.8	Gneiss	18,540
B-SM1	608+40	22.0-23.0	Gneiss	20,390
B-SM1	608+40	29.0-30.0	Gneiss	21,230
B-SM2	609+40	6.7-8.0	Gneiss	11,590
B-SM2	609+40	12.5-14.0	Gneiss	9,280
B-SM1	608+40	20.0-20.8	Gneiss	18.540
B-A1	107+00	24.0-24.9	Metagabbro	49,220
B-B1	308+46	4.0-4.7	Peridotite	5,490(1)
B-B1	308+46	5.5-6.1	Peridotite	41,440
SI-C2	519+80	13.0-14.0	Metagabbro	24,100
SI-C3	520+20	39.0-39.7	Metagabbro	18,270

Notes: (1) – Sample failed along serpentinite vein.
(2) – Rock fragments in a soil matrix.

Five point load tests (ASTM D 5731) were performed on representative samples of native materials obtained during the subsurface investigation. The tests were performed by subjecting the sample to an increasing concentrated point load until failure occurred. The measured load at failure is used to calculate the point load strength index and to estimate the uniaxial compressive strength of the sample.

A summary of the test results is presented in Table 3. Point load test results are

represented in Appendix D.

Table 3. Point Load Test Summary.

Boring	Station	Sample Depth (ft)	Classification	Point Load Strength Index (psi)	Compressive Strength (psi)
B-A2	109+00	19.0-20.5	Metagabbro	860	19,830
B-BC1	408+20	29.0-29.5	Serpentinite	1,300	29,910
B-BC7	523+40	37.5-38.0	Metagabbro	160	3,760
SI-C4	521+45	12.4-13.0	Metagabbro	760	17,380
SI-C4	521+45	28.5-29.0	Metagabbro	660	15,130

Four geochemical tests were performed on representative material samples to evaluate their potential to corrode buried steel structures and concrete. Testing for resistivity and pH were performed in general accordance with AASHTO T 288 and T 289, respectively. For structural and drainage elements, with the exception of MSE walls, a soil is considered to have a low corrosion potential if the resistivity is greater than 1,000 ohm-cm, as defined by CalTrans (2003). Soils with a resistivity greater than 1,000 ohm-cm indicates that the sulfate and chloride contents are low, resulting in a low corrosion potential. Backfill used in MSE walls must meet the electrochemical requirements of Section 704 of the FP-03. A summary of the test results is provided in Table 4. Geochemical test results are contained in Appendix D. In general, the tested soils from the project sites exhibited low potential to corrode buried steel or concrete structures.

Table 4. Geochemical Test Summary.

Boring	Station	Sample Depth (ft)	pH	Resistivity (ohm-cm)	Corrosion Potential to Structures	Corrosion Potential to Drainage Elements	Corrosion Potential to MSE Walls(1)
B-A1/B-A2	Varies	Varies	8.2	4,180	Low	Low	Unknown
B-B1	Varies	Varies	9.4	4,910	Low	Low	Unknown
B-C1/B-C7	Varies	Varies	8.0	6,630	Low	Low	Low
B-D1/B-D2	Varies	Varies	7.3	5,110	Low	Low	Low

Notes: (1) – Tests for sulfates and chlorides are not required when the pH is between 6.0 and 8.0 and the resistivity is greater than 5000 ohm-cm per the FP-03.

Findings

A total of two borings, B-RC1 and B-RC2, were completed at the proposed Rock Creek Bridge location. The borings advanced at the proposed location for Abutment 1 and Abutment 2 encountered weathered, fractured gabbro bedrock at the ground surface to depths ranging from 33.0 to 37.5 feet below the ground surface, the borehole termination depth. Core recovery within the gabbro, between the two borings, ranged from 11 to 100 percent, with an average recovery of 79 percent. RQD's ranged from 0 to 100, with an average RQD of 44. Rock quality, as correlated to core recovery and RQD, was highly variable throughout the length of the both borings.

A total of two borings, B-BC1 and B-BC2, were completed at the proposed Boulder Creek Bridge location. The borings advanced at the proposed locations for Abutment 1 (B-BC1) and Abutment 2 (B-BC2) encountered silty sand with gravels, cobbles and boulders, ranging from 9.5 to 18.3 feet in depth from the ground surface. Gabbro bedrock was encountered beneath the silty sand to depths ranging from 47.4 to 48.0 feet, the borehole termination depth. Core recovery within the gabbro, between the two borings, ranged from 39 to 100 percent, with an average recovery of 87 percent. RQD's ranged from 0 to 83, with an average RQD of 31. Rock quality, as correlated to core recovery and RQD, was highly variable throughout the length of the both borings.

A total of four borings, B-SM1 through B-SM4, were completed at the proposed Steven Memorial Bridge location. The borings advanced at the proposed locations for Abutment 1 (B-SM1), Pier 1 (B-SM2), and Pier 2 (B-SM3) encountered silty sand with cobbles and boulders, ranging from 0 to 11.8 feet in depth from the ground surface. Bedrock, consisting of gneiss, was encountered beneath the silty sand to depths ranging from 30.0 to 39.0 feet, the borehole termination depth. Boring B-SM2 encountered bedrock at the ground surface. Core recovery within the gneiss ranged from 94 to 100 percent, with an average recovery of 99 percent. RQD's ranged from 48 to100, with an average RQD of 88.

Boring B-SM4, conducted at the proposed location for Abutment 2, encountered 6.5 feet of clayey sand with gravels and boulders. Serpentinite bedrock was encountered beneath the clayey sand to a depth of 70.0 feet, the borehole termination depth. Core recovery within the serpentinite ranged from 20 to 100 percent, with an average recovery of 87 percent. RQD's ranged from 0 to 78, with an average RQD of 27.

A total of six borings, B-HG1 through B-HG6, were completed at the proposed Hurdy Gurdy Bridge location. The borings advanced at the proposed location for Abutment 1 and Abutment 2 encountered silty sand with boulders, ranging from 0 to 22 feet in depth below the ground surface. Bedrock, consisting of black slate, was encountered beneath the silty sand to depths ranging from 9.0 to 47.0 feet, the borehole termination depth. Core recovery within the slate ranged from 34 to 100 percent. RQD's were zero for all completed core runs, due to the frequent cleavage planes persistent throughout the rock.

A total of seven borings, B-A1, B-A2, SI-A1, 07A-01, 07A-02, 07A-03, and 07A-04, were

completed along the length of Site A. Borings B-A1, B-A2, and SI-A1 were advanced within the roadway and generally encountered silty sand with gravel and rock fragments to a depth of between 16 and 22 feet below the ground surface. SPT N values conducted in overburden soils ranged between 5 and refusal. Gray green mettagabbro bedrock, was encountered beneath the silty sand to depths ranging from 40.0 to 70.0 feet, the borehole termination depths. Core recovery in the bedrock ranged between 25 and 100 percent, with an average recovery of 71 percent, while RQD's ranged between 0 and 56. Inclinometer casing was installed in Boring SI-A1 to a depth of 70.0 feet below the ground surface and anchored into competent rock.

Borings 07A-1 through 07A-04 were generally completed on the cutslope above the road and encountered sandy gravel to depths ranging from 1.8 to 30 feet below the ground surface. Bedrock was encountered beneath the sandy gravel to depths ranging from 10.0 to 28.0 feet, the borehole termination depths. Core recovery in the bedrock ranged between 73 and 100 percent, with an average recovery of 86 percent, while RQD's ranged between 0 and 64.

A total of four borings, B-B1, 07B-01, 07B-02, and 07B-03 were completed at Site B. Boring B-B1 and 07B-02 were completed within the existing roadway and generally encountered silty sand with gravel and rock fragments to depths ranging from 3.0 to 4.0 feet below the ground surface. Bedrock, consisting of gray peridotite, was encountered beneath the silty sand to depths ranging from 15.2 to 17.0 feet, the borehole termination depths. Core recovery in the bedrock ranged between 91 and 100 percent, while RQD's ranged between 0 and 78.

Borings 07B-01 and 07B-02 were completed below the roadway on the adjacent fill slope. Silty sand with gravel was encountered to depths ranging from 4.0 to 18.0 feet below the ground surface. Bedrock, consisting of gray peridotite, was encountered beneath the silty sand to depths ranging from 15.2 to 25.4 feet, the borehole termination depths. Core recovery in the bedrock ranged between 73 and 100, while RQD's ranged between 18 and 70.

A total of sixteen borings, B-C1 through B-C7, P-C5, SI-C1 through SI-C5, and 07C-02 through 07C-04 were completed at Site C. Borings B-C1 through B-C7, P-C5, and SI-C1 through SI-C5 were complete within the existing roadway and generally encountered silty sand with gravel and rock fragments to depths ranging from 7 to 53.8 feet below the ground surface. SPT N values conducted in overburden soils ranged from 6 to refusal. Bedrock, consisting of peridotite and metagabbro, was encountered beneath the sitly sand to depths ranging from 28.5 to 55.5 feet, the borehole termination depths. Core recovery in the bedrock ranged between 17 and 100 percent, while RQD's ranged between 0 and 100, with an average value of 28. Inclinometer casing was installed in Borings SI-C1 through SI-C5 and anchored into competent rock. A piezometer was constructed in Boring P-C5.

Boring 07C-02 through 07C-04 were completed on the cutslope above the roadway. Boring 07C-01 was not completed due to time constraints encountered during phase 5 of the subsurface investigation. Silty sand with gravel, cobbles, and boulders were encountered to depths ranging from 17.5 to 47.0 feet below the ground surface, which were the borehole termination depths.

A total of five borings, B-D1, B-D2, 07D-01, 07D-02, and 07D-03 were completed at Site D. Borings B-D1, B-D2, and 07D-03 were completed within the existing roadway and generally encountered sandy gravel to depth ranging between 2.5 and 18.5 feet below the ground surface. SPT's conducted in overburden soils ranged between 7 and 21. Bedrock, consisting of gray mettagabbro, was encountered beneath the sandy gravel to depth ranging from 10.2 to 23.5, the borehole termination depths. Core recovery in the bedrock was 100 percent, while RQD's ranged from 31 to 95.

Borings 07D-01 and 07D-02 were completed below the roadway on the adjacent fill slope. Sandy gravel was encountered to depths ranging from 6.0 to 18.0 feet below the ground surface. Bedrock, consisting of gray mettagabbro, was encountered beneath the sandy gravel to depths ranging from 15.7 to 28.0 feet, the borehole termination depths. Core recovery in the bedrock ranged 98 to 100 percent, while RQD's ranged from 53 to 65.

Eight test pits were completed above the inboard ditch at Sites A, B, C, and D in an effort to determine depth to bedrock. The test pits generally encountered silty sands with gravel and rock fragments. Detailed logs were not kept during the completion of test pits, as non of the completed test pits encountered rock.

Seismic Refraction Survey

A geophysical investigation using seismic refraction techniques was completed at Sites A, B, C, and D on October 26 and 27, 2005 by CFLHD Geotechnical personnel. The seismic refraction survey was completed to supplement boring information, and to better define the subsurface profile. Two seismic lines were surveyed along the in-board ditch at Site A. One seismic line was surveyed along the in-board ditch at Site B. A total of seven seismic lines were surveyed at Site C, five of which were along the in-board ditch, while the others were conducted near the centerline or the existing roadway and on the fill slope below the roadway. One seismic line was surveyed along the in-board lane at Site D. One seismic line was also surveyed perpendicular to the design centerline at the proposed east abutment of the Hurdy Gurdy Creek Bridge. The intent of the survey was to estimate the soil/rock interface elevation, and to provide relative layer velocities for estimating rock rippability. Summit Peak Technologies processed the seismic refraction data.

Generally, velocities of the investigated soil layers ranged between approximately 2,000 and 4,000 ft/sec. Seismic lines conducted at the proposed Hurdy Gurdy Creek Bridge site and Sites B and D encountered bedrock at various depths, with seismic velocities ranging between 6,000 and 10,000 ft/sec. Lower seismic velocities in rock units may only be an indication of intense jointing within a strong rock mass. The location of seismic survey lines and the results of the seismic refraction surveys are available in Appendix E. The results of the seismic refraction surveys should not be used independently of the boring logs and should only be used to make general interpretations of the ground mass.

Slope Movement

Slope inclinometer casings were installed in one boring at Site A and five boring at Site C to allow for ground deformation measurement to determine if the suspected landslide areas at these sites are currently active. The "A" axis of each inclinometer casing was

approximately downhill, along the presumed slide axis, while the "B" axis was approximately perpendicular to the "A" axis. Depth readings are with respect to the top of the casing, which is approximately equal to the ground surface.

Slope inclinometers SI-A1 and SI-C1 were completed under phase 1 of the subsurface investigation on November 19, 2004 at Site A and C, respectively. Both inclinometers were initially read on December 22, 2004. A magnitude 7.0 earthquake occurred on June 15, 2005 about 90 miles southwest of Crescent City, CA. Inclinometer readings taken after the earthquake showed some signs of slope movement, with up to 0.20 inches of movement recorded at a depth of approximately 40 to 50 feet below the ground surface. Subsequently, slope inclinometers SI-C2 through SI-C5 were installed to better determine the extent and magnitude of slope movement at Site C. These inclinometers were installed on October 18 and 19, 2005 and were initially read on October 25, 2005. Each inclinometer was read at regular intervals from 2005 through 2007.

Subsequent readings revealed that little to no movement was occurring in any of the inclinometers. Movement in inclinometers SI-A1, SI-C2, SI-C3, SI-C4, and SI-C5 was limited to less than 0.20 inches in both the A and B axes. Movement in inclinometer SI-C1 was 0.50 inches in the A axis and 0.25 inches in the B axis. The increased movement in this inclinometer is most likely due to the 2005 earthquake. Significant incremental movement between successive readings was not observed for any of the installed inclinometers. Cumulative displacement plots are provided for each inclinometer in Appendix F.

The observed movement can best be described as slope creep, which is common for northern California and the investigated soils. Based on the results of the inclinometer surveys, neither Site A nor C is experiencing large scale, deep seated landslide movements.

ANALYSIS

Bridge Foundations

Due to the relative depth of competent bearing material, drilled shafts are recommended for the following foundations:

- Abutment 1 of the Rock Creek Bridge
- Abutment 1 and 2 of the Boulder Creek Bridge
- Abutment 1, Pier 1, Pier 2, and Abutment 2 of the Steven Memorial Bridge
- Abutment 1 and 2 of the Hurdy Gurdy Creek Bridge

The drilled shaft analysis for each of the above foundations is based on the lower portions of the shaft being socketed into rock. Based on load and factor resistance design (LRFD), the applied strength limit state resistance factor for base resistance in rock, per the Canadian Geotechnical Society, is 0.50. The applied strength limit state resistance factor for side resistance in rock, per Horvath and Kenney is 0.55. The side resistance provided by overburden soils is generally neglected in the shaft capacity analysis when shafts are socketed into rock. The side resistance within the rock socket is governed by the compressive strength of concrete (f'c) used in the shaft, as the unconfined compressive

strength of the rock at each foundations structure is greater than the strength of concrete. For the analysis of all substructures, except Pier 1 and 2 of the Steven Memorial Bridge, the base resistance provided by the rock socket was also neglected due to the relatively large amount of settlement required to mobilize the full base resistance.

The base resistance provided by the rock socket in Pier 1 and 2 of the Steven Memorial Bridge was accounted for because of the relatively large size (5-6 feet in diameter) of the rock socket. In this case the side resistance in overburden soils and in the rock socket was neglected.

A total of four unconfined compressive strength tests were conducted on recovered core samples from borings at the proposed Rock Creek Bridge location. Compressive strengths of the gabbro bedrock samples ranged from 1,210-49,900 psi. The low compressive strength was discounted, as failure occurred along serpentinite veins, an unlikely failure mode for the intact rock mass. In neglecting the low strength reading, the average unconfined compressive strength was 40,230 psi.

A total of four unconfined compressive strength tests were conducted on recovered core samples from borings at the proposed Boulder Creek Bridge location. One of the tests was conducted on a sample of cemented sand and gravel, and yielded a compressive strength of 1,410 psi. Compressive strengths of the gabbro rock samples ranged from 22,240-28,020 psi, with an average unconfined compressive strength of 24,610 psi.

A total of five unconfined compressive strength tests were conducted on recovered core samples from borings at the proposed Steven Memorial Bridge location. Compressive strengths of the gneiss samples ranged from 9,280 to 21,230 psi, with an average unconfined compressive strength of 16,206 psi.

Due to the fractured nature of the slate recovered from the borings conducted at the proposed Hurdy Gurdy Bridge location, neither unconfined compressive strength tests or point load tests were completed. Presumptive values for the unconfined compressive strength of slate range from 21,000 to 30,000 psi. Note that presumptive values in published literature are typically considered factored values. A conservative value of 5,000 psi for the unconfined compressive strength of the slate is recommended, due to the fractured and fissile nature of the rock.

The unconfined compressive test results were converted to a maximum shear resistance using commonly employed methods, per AASHTO specifications. These resistances were then used to calculate a total factored resistance for a drilled shaft based on the diameter and length of the rock socket.

Due to the presence of bedrock at or near the ground surface of the proposed Abutment 2 location of the Rock Creek Bridge, a spread footing is recommended. The factored bearing capacity to be used in the spread footing design of Abutment 2 of the Rock Creek Bridge is 20 ksf, incorporating a strength limit state resistance factor of 0.60. It is recommended that a strength limit state resistance factor of 0.80 be used in the spread footing sliding analysis.

Fill Walls

Various types of retaining walls, including mechanically stabilized earth (MSE) walls and tieback soldier pile walls, were evaluated as potential solutions for obtaining the required roadway width at Sites A, B, C, and D. The potential for shifting the roadway alignment into the cutslope to gain the required roadway width is not considered feasible at Site A and C because of the steep upslope terrain, resulting in an unstable, high cutslope or relatively expensive cut wall. Shifting the roadway alignment into the cutslope is also not considered feasible at Sites B and D because of the relatively high rock vertical rock slopes already present and the presence of a protected plant species at Site B. Tieback soldier pile walls were eliminated from further analysis because of cost considerations. Therefore, MSE walls are the recommended fill wall type for Sites A, B, C, and D.

The MSE wall analyses follow the design methodology and guidelines in the AASHTO "Standard Specifications for Highway Bridges," 17th Edition (2002). Per AASHTO, the required minimum factors of safety for these walls are listed in Table 5.

Table 5. Required Minimum Factors of Safety

Design Component	Minimum Factor of Safety	
	Static	Seismic
Bearing Capacity	2.5	1.5
Overturning	2.0	1.5
Sliding	1.5	1.1
Global Stability	1.3	1.1
Eccentricity	<L/6	<L/3

The MSE walls were preliminarily evaluated using the Mechanically Stabilized Earth Walls (MSEW 3.0) program developed by ADAMA Engineering. The design methodology used by MSEW is consistent with current AASHTO and FHWA guidelines for assessment of the internal and external stability of MSE walls.

The proposed MSE walls were evaluated based on the existing site conditions and available subsurface information. The engineering properties of soils used in the analyses were based on conservative estimates, as shown in Table 6. Cross sections were evaluated where the wall height was at its maximum and/or where the slope in front of the fill wall was the steepest. A water table was not considered in the analyses, as the wall system will include interior drainage and is considered free draining. A traffic surcharge of 250 psf was modeled in the analyses.

Table 6. Soil Parameters – MSE Wall External Stability Analysis

Soil Description	Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)
Reinforced Fill	120	34	0
Retained Fill	120	38	0
Foundations Soils	120	38	0

A pseudo-static analysis was conducted to account for seismic loading on the external stability factors of safety. A peak horizontal ground acceleration of 0.32g was used based on AASHTO guidelines. The use of the full value of the peak ground acceleration in seismic external stability calculations assumes that no lateral displacement of the wall is allowed. This assumption can result in an overly conservative wall design. To provide a more economical structure, seismic design allowing for small lateral deformations may be preferred. AASHTO Specifications allow the lateral seismic earth pressure to be reduced by allowing a 50 percent reduction of the peak ground acceleration if outward lateral movements of the wall can be tolerated. A further reduction may be warranted upon completion of a simplified Newmark analysis. This analysis, consistent with current Caltrans practice, correlates the horizontal seismic coefficient to the allowable lateral wall displacement (Griswell, 2008). A horizontal seismic coefficient of 0.12, based on an allowable lateral wall displacement of 8 inches, is recommended for external wall and global stability analyses. A horizontal seismic coefficient of 0.32 is recommended for internal wall analyses, including pullout capacity and reinforcement rupture, to be consistent with the assumption that the MSE wall will behave as a rigid block under seismic loading.

Based on the results of the analyses, the proposed MSE wall system will meet the required minimum factors of safety as described in Table 5, with a minimum reinforcement length equal to 70 percent of the wall height.

Deep Patches

A deep patch was evaluated as a potential repair solution for a portion of Site C, between Station 518+26 and 519+00, experiencing surficial distress. Deep patches are a cost effective technique for repairing and stabilizing areas of roadways damaged by subsidence or cracking. Deep patch analysis was performed using the Deep Patch Road Embankment Repair Application Guide, developed by the US Forest Service. Based on the preliminary analysis, a patch depth of 6.0 feet, with biaxial geogrid layers spaced vertically at 1.0 foot, will provide adequate stability to prevent or slow movement of the fill slope.

Cut Walls

In an effort to reduce the height and allow for more manageable construction of potential MSE fill walls, cut walls are proposed at Sites A and C. Subsurface investigations conducted on the cutslopes along portions of Sites A and C did not reveal the presence of competent rock at or near the ground surface. Therefore, a cut wall system will be required, as the wall must be constructed at a higher slope angle than can be considered stable for the investigated soils at the sites. Laying the slopes back at a shallower angle was not considered feasible because of the height and steepness of existing cutslopes. To achieve an aesthetically pleasing, natural appearance, a soil nail wall with a wire mesh face was considered. The wire mesh allows the wall face to revegetate and regain its natural appearance. Soil nail wall analysis was completed using Goldnail, version 3.11.

The proposed soil nail walls were evaluated based on the existing site conditions and available subsurface information. The engineering properties of soils used in the analyses were based on conservative estimates, as shown in Table 3. Cross sections were evaluated

where the wall height was at its maximum. A seismic load of 0.16g was considered in external and global stability analyses.

Based on the results of the analyses, the proposed soil nail wall system will meet the required minimum global factor of safety of 1.3 with a soil nail length of 30 feet, a horizontal and vertical soil nail spacing of 5 feet, and a nail inclination of 15° below horizontal.

Due to existing alignment constraints on the west approach of the Steven Memorial Bridge a small cut wall may be required. For aesthetic and geometric reasons, a rockery was chosen. The rockery was evaluated using modified design methodologies based on gravity wall design (FHWA Rockery Design and Construction Guidelines, 2006), using the required minimum factors of safety in Table 2.

The proposed rockery was evaluated based on the existing site conditions and available subsurface information. The engineering properties of soils used in the analyses were based on conservative estimates, as shown in Table 3. Cross sections were evaluated where the wall height was at its maximum, approximately 12 feet. A water table was not considered in the analyses, as the wall system will include interior drainage. A seismic load of 0.16g was considered in external and global stability analyses.

Based on the results of the analyses, the proposed rockery wall system will meet the required minimum factors of safety as described in Table 5, with a minimum base width of 6 feet.

Global Stability Analysis

Global slope stability analysis was performed on proposed fill and cut walls at each site using Slide, Version 5.0, the two dimensional, limit equilibrium computer program from RocScience. The Simplified Bishop methods of slices was used with isotropic soil and rock parameters for the slope stability analysis of static and pseudo-static conditions. The engineering properties of soils used in the analyses were based on conservative estimates, as shown in Table 7. Cross sections were evaluated where the wall height was at its maximum and/or where the slope in front of the fill wall was the steepest. A water table was not considered in the analyses, as the wall system will include interior drainage and is considered free draining. A traffic surcharge of 250 psf was modeled in the analyses. A minimum factor of safety of 1.3 was used for evaluation of static conditions.

The pseudo-static method of anlaysis approximates the effects of ground motion on a slope by incorporating an equivalent static horizontal force acting on the slope. The equivalent static horizontal force is the product of a seismic coefficient and the weight of the slope in the zone of potential failure. The force is assumed to pass through the center of gravity of the potential failure zone and has a corresponding moment arm. The resulting moment increases the total moment acting on the slope. A horizontal seismic coefficient of 0.12 was considered in the global stability analyses, as discussed in the **Fill Walls** section. A minimum factor of safety of 1.1 was used for evaluation of the seismic conditions.

Table 8 provides a summary of the preliminary global stability analyses for the proposed fill and cut walls. Global stability analysis for analyzed cross sections is provided in Appendix G.

Table 7. Soil Parameters – Global Stability Analysis

Soil Description	Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)
Reinforced Fill	120	34	0
Native Soil/Weathered Rock	120	38	200
Bedrock	135	45	500

Table 8. Summary of Global Stability Analyses

Site	Station	Cut/Fill Wall	Total Wall Height (ft)	Foreslope (Degrees)	FOS (Static)	FOS (Seismic)
A	104+50	Fill	15	35	1.43	1.15
A	106+10	Fill	32	45	1.33	1.13
A	107+00	Cut	35	-	1.44	1.11
B	308+50	Fill	30	40	1.45	1.44
C	520+50	Cut	45	-	1.30	1.11
C	520+80	Fill	30	45	1.37	1.15
D	706+50	Fill	20	45-55	1.35	1.14

Rockfall Protection System

Existing cutslope ratios along Site A are generally greater than the angle of repose of the material present, as these slopes have been a continual source for rockfall issues. This area has required frequent maintenance to keep rockfall debris off the roadway. The main source area is between Station 107+00 and 109+00, as the colluvial slope extends approximately 200 feet above the roadway. On either side of this area, rock outcrops were observed. These outcrops contain large rock blocks with adverse jointing and fracture patterns. To date, no mitigation measures have been employed at this site.

Due to the loose colluvial material along and at the top of existing slopes, and the slope heights, it is not feasible to design a cutslope that would prevent future rockfall events. Excavating higher up the slope could propagate further instability and create a larger treatment area. Other rockfall mitigation alternatives were investigated for this site.

Rockfall mitigation can typically be divided into three categories: avoidance and/or relocation, upslope stabilization, and downslope protection. Avoidance and relocation methods are typically the most expensive method, but offer the most effective rockfall mitigation. Due to project scope constraints, constructability limitations, and costs, avoidance and relocation are not feasible alternatives for this site. Upslope stabilization methods attempt to keep the rock in place and are implemented within the source area. Methods include scaling and trimming, rock bolts, and anchored mesh and nets. Downslope protection methods vary in their effectiveness based on their ability to stop rocks with differing levels of energy. These methods include ditches or berms, catch fences, and walls. Catch fences and walls were eliminated from further consideration because of cost, width requirements, and aesthetic reasons. Fences and walls are typically

designed to resist rockfall energies much higher than those generated at Site A. Ditches and berms used to retain rockfall were not considered feasible alternatives, because of increased width requirements at this already narrow site. Therefore, upslope stabilization methods are the preferred rockfall protection system for Site A.

Rock bolts are used to stabilize loose blocky rock masses by providing confinement. The overall factor of safety of the rock mass is increased by increasing or maintaining the shear resistance on potential failure surfaces. Anchors are typically steel bars inserted into a drilled hole and bonded to the rock with epoxy or cement grout. Anchor spacing, length, and size are dependent on the rock mass conditions and desired effectiveness.
Scaling is done to remove unstable, protruding, or overhanging rocks. Hand pry bars, hydraulic splitters or jacks, or chemical expanders are used to remove the unstable material. Scaling can also be accomplished by mechanical means through the use of a crane dragging dozer tracks or logging chains across the slope. Scaling can typically be accomplished very quickly and at a relatively low cost, but is only considered a temporary or short-term rockfall mitigation option.

Anchored mesh or nets are commonly used as a rockfall mitigation method. Typically, the cable net or mesh is anchored to the top of the slope and is loosely draped or pinned to the slope surface. Draped mesh allows loose rock and debris to gradually migrate underneath the system eventually coming to rest in the catchment ditch that can periodically be cleaned out.

RECOMMENDATIONS AND SUMMARY

General Information

The proposed roadway improvements for this project are feasible if the geotechnical constraints are mitigated as summarized by the information contained in this report. The proposed alignment is underlain by granular materials and rock and in some areas, bedrock may be encountered within 5 feet of the ground surface. Both types of material are considered good to excellent roadway support materials. One area of subexcavation will be necessary as outlined in the **Site Preparation** section. Significant excavations and/or temporary shoring will be required during MSE wall construction, as discussed in the **Temporary Excavations** section. Mass grading operations are discussed in the **Grading Requirements** section.

Four one-lane bridges are proposed for replacement, and design and construction of the bridge foundations should follow the recommendations presented in the **Bridge Foundation Recommendations** section. Widening of four one-lane travelway sections is proposed for this project, and the design and construction of MSE and soil nail walls to accomplish the required widening should follow the recommendations presented in the **MSE Wall Recommendations** and **Soil Nail Wall Recommendations** sections. A rockfall protection system is proposed at Site A to mitigate the existing high rockfall risk, and the deisgn and construction of this system should follow the recommendations presented in the **Rockfall Protection System Recommendations** section.

Site Preparation

Clearing and grubbing of the project sites should be performed in accordance with Section 201 of the FP-03. In general, it is not anticipated that any areas of difficulty will be encountered during the clearing and grubbing operation, although some cobbles and boulders were present near the ground surface at the proposed location of the Boulder Creek and Hurdy Gurdy bridges.

Based on conditions encountered during the subsurface investigation, it is not likely that a significant depth of topsoil will be present at any of the project sites. For estimation purposes, it should be assumed that no topsoil will be stripped and stockpiled for re-use on the project.

Silty sand with gravel is the predominant soil type found along the project, and was generally classified as A-1-a, A-1-b, or A-2-4 soils with little plasticity. These materials exhibit good to excellent characteristics for use as embankment material. Native soils used in embankments should be compacted to 95% of maximum density according to the requirements of Section 204 of the FP-03.

Based on visual inspection of the roadway, a portion of Site C between Station 518+00 and 519+00 should be subexcavated and replaced with a deep patch. Details of the subexcavation and deep patch construction should follow the recommendations presented in the **Deep Patch Recommendations** section.

Temporary Excavations

Temporary excavations with near-vertical walls should be stable to a depth of approximately 5 feet. For excavations, less than 10 feet in height, temporary slopes may have a maximum inclination of 4V:3H. Excavations to greater depths will require shoring or more shallow back wall inclinations to maintain adequate stability. Regulations amended in Subpart P of 29 Code of Federal Regulations (CFR) 1926.652 require that temporary excavation slopes be no greater than those presented in Table 9 for excavations less than 20 feet in height.

Table 9. Temporary Slope Requirements.

Soil or Rock Type(1)	Maximum Allowable Slopes
Rock	Vertical
Type A	4V:3H
Type B	1V:1H
Type C	2V:3H

Notes: (1) Type A soils are cohesive, non-fissured soils with a minimum unconfined compressive strength of 3,000 psf. Type B soils are cohesive, non-fissured soils with an unconfined compressive strength between 1,000 psf and 3,000 psf. Type C soils are cohesive, non-fissured soils with an unconfined compressive strength less than 1,000 psf.

Based on results of the subsurface investigation, the site materials throughout the project can predominately be classified as Type B soils. Qualified geotechnical or geological personnel should examine any area thought to be in question during construction. All

temporary excavations should be performed and stabilized in accordance with local, state, and OSHA standards.

In an effort to maintain use of one lane of the roadway during MSE wall construction, temporary shoring walls are anticipated at Sites A, C, and D. It is anticipated that a majority of the excavation at Site B for the MSE wall will occur in fractured rock, and therefore no shoring walls are expected.

A proposed MSE wall will be constructed in front of an existing MSE wall at Site C between Stations 511+00 and 514+50. The existing wall is performing well and will not be disturbed. The new MSE wall will be somewhat greater in height than the existing wall, requiring excavation immediately below the toe of the existing wall. A temporary shoring wall will be required to stabilize the excavation and maintain the stability of the existing wall, while allowing traffic to be maintained. Because of the complex issues surrounding the construction of this shoring wall, it may require stabilization measures beyond the other shoring walls to be constructed on this project.

Grading Requirements

Due to the limited amount of local borrow sources or waste areas, and to maximize cut to fill balance on this project, it is anticipated that the majority of roadway excavation will be used in the construction of roadway embankments and to backfill MSE walls. It is anticipated that native materials will meet the requirements of wall backfill and select wall backfill, per Section 704 of the FP-03. Because of the widening that is occurring at Sites A, B, C, and D, a quantity of select wall backfill will be imported during MSE wall construction.

Many of the excavations along this project will occur in partially serpentinized rock and/or soil. Serpentine and its parent material, ultramafic rock, is abundant in the Klamath Mountains. Serpentine rock often contains chrysotile asbestos, a naturally occurring fibrous mineral. Airborne asbestos fibers pose a potential health risk to persons at or near the project site. The California Air Resources Board (CARB) has adopted statewide control measures which prohibits the use of serpentine or ultramafic rock for unpaved surfacing and controls dust emissions from construction, grading, and surface mining in areas with these rock units. The CARB requires that an Asbestos Dust Mitigation Plan be in place prior to the commencement of any construction or grading activity. Details of the mitigation plan requirements are provided in the Appendices of the SCR's. Specific testing to determine the presence or levels of airborne asbestos fibers within the encountered soil and rock units were not conducted during the subsurface investigation.

The native soils at the Rock Creek and Boulder Bridge sites are contaminated with the Port Orford Cedar root fungus. All soils excavated at these sites must remain at these locations due to the potential spread of the fungus. If approved by the CO, excavated materials from these locations may be used at either the Rock Creek or Boulder Creek construction sites with the balance of excavated materials being wasted at a location approved by the CO.

It is anticipated that roadway excavations conducted along the project may encounter rock requiring carefully planned and uniquely adapted blasting approaches to achieve

engineered road cuts that are structurally sound and aesthetically pleasing. Controlled blasting methods that utilize the natural geologic bedding planes and joint structured in a predicted and controlled manner to form the final cut slopes and to minimize back break beyond the trim line should be used.

It is anticipated that structure excavations at Sites B and D will occur in fractured rock. The contractor will be required to make the final determination on the rippability characteristics of encountered material based on review of the boring logs, seismic refraction survey results, and equipment capabilities.

Shrink/Swell Factor Recommendations

On-site soils encountered at Site A, Site C, and the proposed bridge locations generally consist of silty sands and gravels. It is estimated that such soils will have a shrink percentage of 10 percent, corresponding to a shrink/swell factor of 0.91.

The proposed excavations at Sites B and D will generally be conducted in weathered, highly fractured rock. It is estimated that the excavated rock will have a swell percentage of 10 percent, corresponding to a shrink/swell factor of 1.10.

The recommended shrink swell factors are based on published data (PDDM, 2007) and no field or laboratory testing was conducted to assist in shrink/swell factor determination.

Bridge Foundation Recommendations

Due to the relative depth of competent bearing material, drilled shafts are recommended for the foundation of Abutment 1 of the Rock Creek Bridge; Abutments 1 and 2 of the Boulder Creek Bridge; Abutment 1, Pier 1, Pier 2, and Abutment 2 of the Steven Memorial Bridge; and Abutments 1 and 2 of the Hurdy Gurdy Creek Bridge. Tables 10 and 11 detail the factored geotechnical resistance for the foundation of those substructures founded on drilled shafts. The tables are based on various rock socket diameters and lengths. It is recommended that the shaft diameter above the rock socket be increased by 6 inches to allow for the appropriate rock coring tools to be placed in the hole.

The base resistance of the rock socket is neglected for all substructure units except Piers 1 and 2 of the Steven Memorial Bridge, because of the movement required to mobilize the full base capacity, as detailed in Table 10. The side resistance is governed by the unconfined compressive strength of the concrete (f'_c), as the unconfined compressive strength of the rock at each foundation structure is greater than the strength of the concrete. Therefore, the factored resistance provided by the shaft at each foundation unit is the same, depending on the socket geometry. The applied resistance factor for side resistance in rock, per Horvath and Kenney, is 0.55.

Table 11 outlines the factored geotechnical resistance for the substructure units of Pier 1 and 2 of the Steven Memorial Bridge. Because of the relatively large diameter of rock sockets planned at these substructure units, the design is based soley on base resistance, and side resistance is neglected. The base resistance is governed by the unconfined compressive strength of the rock mass, as well as the rock socket diameter, but is

independent of rock socket length. The applied resistance factor for base resistance in rock, per the Canadian Geotechnical Society, is 0.50.

Tables 12-15 contain the maximum elevation for the top of the drilled shaft rock sockets at each foundation structure. **The socket length for the Abutment 2 shafts of the Steven Memorial Bridge should be limited to a length of 15 feet to prevent breakthrough into a weaker serpentinite layer.**

Table 10. Factored Side Resistance per Shaft (kips)

Factored Resistance (kips) per shaft			
Rock Socket Diameter (in)	**Rock Socket Length (ft)**		
	5	**10**	**15**
12	190	390	580
18	290	580	870
24	390	780	1170
30	480	970	1460
36	580	1170	1750
42	680	1360	2040
48	780	1560	2340
54	870	1750	2630
60	970	1950	2920
66	1070	2140	3220
72	1170	2340	3510
78	1260	2530	3800
84	1360	2730	4090

Note: Factored resistance is based on a side resistance of 157 psi, using a side resistance factor of 0.55, and the base resistance is neglected.

Table 11. Factored End Resistance per Shaft (kips).

Factored Resistance (kips) per shaft			
Rock Socket Diameter (in)	**Rock Socket Length (ft)**		
	5	**10**	**15**
12	200	200	200
18	450	450	450
24	810	810	810
30	1270	1270	1270
36	1830	1830	1830
42	2490	2490	2490
48	3250	3250	3250
54	4120	4120	4120
60	5080	5080	5080
66	6150	6150	6150
72	7320	7320	7320
78	8590	8590	8590
84	9970	9970	9970

Note: Factored resistance is based on an end resistance of 3600 psi, using an end resistance factor of 0.50, and the side resistance is neglected.

Table 12. Max. Socket Elevation
Rock Creek Bridge

	Elevation (ft)
Abutment 1	390.0

Table 13. Max. Socket Elevation
Boulder Creek Bridge

	Elevation (ft)
Abutment 1	452.0
Abutment 2	460.0

Table 14. Max. Socket Elevation
Steven Memorial Bridge

	Elevation (ft)
Abutment 1	558.0
Pier 1	533.0
Pier 2	520.0
Abutment 2	548.0

Table 15. Max. Socket Elevation
Hurdy Gurdy Creek Bridge

	Elevation (ft)
Abutment 1	609.0
Abutment 2	603.0

A lateral load analysis should be conducted on a single shaft from each substructure unit using the following soil parameters. Tables 16-19 detail the lateral load response parameters for the portion of the shafts embedded in rock for each foundation structure. Table 20 details the lateral load response parameters for the portion of the shafts embedded in native, alluvial materials or structural backfill.

Table 16. Lateral Load Parameters (Rock Socket),
Rock Creek Bridge

	Abutment 1
Soil Type	Rock
Effective Unit Weight	0.08 pci
Elastic Modulus	4.5×10^6 psi
Unconfined Comp. Strength	29,000 psi
RQD (Average)	40
k_{rm} (stiffness constant)	0.0005

Table 17. Lateral Load Parameters (Rock Socket),
Boulder Creek Bridge

	Abutment 1/ 2
Soil Type	Rock
Effective Unit Weight	0.08 pci
Elastic Modulus	4.5×10^6 psi
Unconfined Comp. Strength	25,000 psi
RQD (Average)	30
k_{rm} (stiffness constant)	0.0005

Table 18. Lateral Load Parameters (Rock Socket), Steven Memorial Bridge

	Abutment 1/Pier 2	Abutment 2
Soil Type	Rock	Weak Rock
Effective Unit Weight	0.08 pci	0.08 pci
Elastic Modulus	$5x10^6$ psi	$0.25x10^6$ psi
Unconfined Comp. Strength	9,000 psi	3,000 psi
RQD (Average)	85	27
$\mathbf{k_{rm}}$	0.0005	0.00005

Table 19. Lateral Load Parameters (Rock Socket), Hurdy Gurdy Creek Bridge

	Abutment 1/2
Soil Type	Rock
Effective Unit Weight	0.08 pci
Elastic Modulus	$0.5x10^6$ psi
Unconfined Comp. Strength	5,000 psi
RQD (Average)	0
$\mathbf{k_{rm}}$	0.00005

Table 20. Lateral Load Parameters (Sand)

Soil Type	Sand
Unit Weight	0.07 pci
Effective Unit Weight	0.035 pci
K value (above WT)	90 pci
K value (below WT)	60 pci
Internal friction angle	30 deg.

Due to the presence of bedrock at the ground surface of the proposed Abutment 2 location of the Rock Creek Bridge, a spread footings is recommended. The factored bearing capacity to be used in the spread footing design is 20 ksf, incorporating a strength limit state resistance factor of 0.60. It is recommended that a resistance factor of 0.80 be used in the spread footing sliding analysis. This factor corresponds to the placement of mass concrete on sand. It is recommended that the bottom of the Abutment 2 footing of the Rock Creek Bridge be founded at a maximum elevation of 404.0 feet.

Drilled Shaft Design Considerations

Historically, the efficiency of groups of drilled shafts in rock has not been a concern. Therefore, no efficiency reduction is proposed for the drilled shaft design. However, the center-to-center spacing of drilled shafts should be kept to a minimum of four shaft diameters to avoid interference between adjacent shafts during construction.

Elastic settlements of the drilled shafts are estimated to be less than ½ inch. Settlements will be immediate and essentially complete at the end of construction. Differential settlements are not anticipated.

Abutment Design Recommendations

Abutments and wing walls should be designed to resist lateral earth pressures and other applicable lateral loads in accordance with the AASHTO Specifications. Lateral earth pressure is influenced by the strength of the abutment backfill, the presence of water, and the ability of the abutment or wall to move in response to lateral loads. Other loads, such as live loads, construction loads, and soil compaction loads should also be considered.

Unbalanced water behind an abutment or wall adds significant pressure and should be avoided by using permeable backfill (FP-03, Section 703.04) against backfilled structures and assuring a free draining gravity outlet for captured water. Remaining backfill should consist of select granular backfill (FP-03, Section 704.10).

The coefficient of at-rest earth pressure should be used for design if the wall is so restrained that it cannot be expected to rotate (deflect at the top) 0.002 times the wall height. The recommended coefficient of at-rest earth pressure is 0.44, which corresponds to an equivalent fluid pressure of 55 pcf. Where the wall can be expected to rotate, a coefficient of active earth pressure should be used for wall design. The recommended coefficient of active earth pressure is 0.28, which corresponds to an equivalent fluid pressure of 35 pcf.

MSE Wall Recommendations

An MSE wall system is recommended to obtain the required roadway width for Sites A, B, C, and D based on the results of the subsurface investigation and analyses. It is recommended that the MSE wall system be constructed with a minimum reinforcement length equal to 70 percent of the wall height (0.7H) or 8 feet, whichever is greater for Sites A, C, and D. Shoring walls will be required at Sites A, C, and D to ensure stability of structure excavations and allow for maintenance of traffic. A temporary lane width of 13 feet is required. Shoring walls and MSE wall reinforcement lengths will be required to accommodate this width.

Due to the relatively shallow nature of the bedrock at Site B, a truncated wall, with a reduced reinforcement length, is recommended. Because the wall backslope will be constructed in rock, the MSE wall will be required to resist reduced lateral earth pressures. It is recommended that the truncated wall have a minimum reinforcement length equal to 50 percent of the wall height (0.5H) or 8 feet, whichever is greater, for wall heights 18 feet in height or greater and where rock is present in the backslope of the wall excavation. For wall heights less than 18 feet in height at Site B, a minimum reinforcement length of 70 percent of the wall height (0.7H) or 8 feet, whichever is greater, is recommended.

A truncated wall is also recommended at Site C, between Stations 511+00 and 514+50, where a proposed MSE structure is to be constructed in front of the existing MSE wall to establish the necessary roadway width. The existing wall appears to be performing well and shows no significant signs of distress. Therefore, it is assumed that the existing MSE wall will continue to resist a majority of the lateral earth pressures at this site. It is recommended that the truncated wall have a minimum reinforcement length equal to 50 percent of the wall height (0.5H) or 8 feet, whichever is greater. It is recommended that

the reinforcement for this wall be extended to the face of the existing wall to prevent differential settlement from occurring immediately in front of the existing MSE wall face.

For all wall sites, the recommended minimum embedment depth is 2.0 feet and the minimum setback width is 6.0 feet for walls less than 20.0 feet in height and 8.0 feet for walls 20.0 feet or greater in height. AASTHO recommends a minimum wall embedment of 2 feet and a minimum setback of 4 feet. The increased setback is primarily due to meeting bearing capacity requirements. Calculated allowable bearing capacities for the anticipated range of MSE wall heights are provided in the following table, and are based on a static factor of safety of 2.5, and a seismic factor of safety of 1.5.

Table 21. Allowable Bearing Capacity.

Total MSE Wall Height (ft)	Static Allowable Bearing Capacity (psf)	Seismic Allowable Bearing Capacity (psf)
10.0	4,900	6,400
15.0	4,900	7,400
20.0	6,500	9,900
25.0	8,200	10,600
30.0	7,300	8,500

The use of granular soils for backfilling retaining walls is recommended to provide lower lateral earth pressures and drainage. It is recommended that the reinforced and retained portions of the wall system be backfilled with select wall backfill and wall backfill, respectively. Granular backfill materials should meet the requirements of Subsection 704.13 of the FP-03.

Based on laboratory testing results, on-site, native soils at Sites A through D will generally meet the requirements for select wall backfill and wall backfill. A few samples recovered from Site C are considered marginally acceptable to meeting the requirements of Subsection 704.13.

MSE wall detail drawings are provided in Appendix H.

Deep Patch Recommendations

It is recommended that a portion of Site C, between Station 518+26 and 519+00, be reconstructed with the use of a deep patch, in which the existing soil fill material be subexcavated and replaced with aggregate base and biaxial geogrid reinforcement layers. It is recommended that the deep patches be constructed to a depth of 6.0 feet, with layers of biaxial geogrid reinforcement spaced every 1.0 feet. The biaxial geogrid reinforcement should have a minimum length of 10 feet and a minimum, long term design strength (allowable tensile strength) of 500 lb/ft. Detail drawings of the deep patch are provided in Appendix H.

Soil Nail Wall Recommendations

It is recommended that the proposed cut wall along Sites A and C be constructed with a

soil nail wall. The wall should be constructed at a 2V:1H slope ratio. Soil nails should be Grade 75, galvanized #8 all thread bars with a maximum horizontal and vertical spacing of 5 feet. The soil nails should be a minimum of 30 feet in length. If competent rock is encountered within the plan soil nail length, the nails may be shortened, as approved by the CO and provided the nails have sufficient pullout capapcity. A minimum drill hole diameter of 4 inches is recommended for soil nail installation. The following ultimate strength soil parameters were used in the preliminary design of the soil nail wall and are derived from FHWA publication No. SA-96-069R Manual for Design and Construction of Soil Nail Walls, and the subsurface investigation. The recommended ultimate bond stress is expected to be conservative and can be revised following verification testing prior to construction.

Table 22. Soil Parameters for Soil Nail Wall Design.

Soil Unit	Cohesion (psf)	Friction Angle (degrees)	Unit Weight (pcf)	Ultimate Bond Stress (psi)
Colluvium	200	38	120	15.0

Verification and proof testing should be performed on designated soil nails. Pre-production verification testing should be performed prior to installation of production nails to verify the contractor's installation method and the assumed ultimate bond stress of the nail to the ground. A minimum of two verification tests are recommended for each wall site. Verification nails should be located just beyond the limits of the proposed soil nail wall and placed such that the contractor can install the nails without significant excavation. Excavation of the soil nail wall should proceed only after results of the verification test and design assumptions are approved. Test nails should have both a bonded and unbonded length. Prior to testing, only the bonded length of the test nail should be grouted. The temporary unbonded length of the test nail should be a minimum of 3 feet. The bonded length of the test nail is determined based on the production nail bar grade and size, such that the allowable structural load of the bar is not exceeded during testing, but should not be less than 10 feet. It is recommended that proof testing be conducted on a minimum of 5 percent of the production nails in each row or a minimum of one test per row. The CO, after nail installation, is responsible for identifying nails to be proof tested.

The soil nail wall facing system should be constructed of galvanized, high strength wire mesh with a type 5.C permanent erosion control matting placed underneath the mesh to allow revegetation of the slope. The erosion control matting should consist of a three-dimensional matrix of polymer fibers with a minimum thickness of 0.5 inches. The erosion control matting should have a minimum void space of 90% to allow hydroseed and bonded fiber matrix applications to infill the matrix and germinate within the soil. The anchored wire mesh system should be tensioned to a load of at least 11.0 kips. All components of the wire mesh system should have a powder coating of black pigmentation for aesthetic purposes

To maintain stability of the excavated face, the exposed unsupported final excavation face cut height should not exceed 8 feet or the short-term stand-up height of the ground, whichever is less. It is also recommended that excavation not proceed to the next lower lift or more than 100 feet along any given lift until nail installation, wire mesh placement, attachment of bearing plates and nuts, and nail testing have been completed and accepted

in the current lift.

Rockery Wall Recommendations

It is recommended that the proposed cut wall along the west approach to the Steven Memorial Bridge be constructed with a rockery. It is recommended that the base width of the rockery be a minimum of 6 feet. The base rock should also be embedded a minimum of 1 foot.

The rockery should be backfilled with free-draining, minus 6 inch, granular materials. This granular material will also serve as the drainage system for the wall and reduce the buildup of pore water pressures behind the wall. A 4-inch-diameter perforated PVC collector pipe should be installed within the drainage layer near the base of the wall. Type I-B geotextile should be placed along the backslope prior to placement of the drainage layer. Detail drawings of the proposed rockery wall are provided in Appendix H.

Rockfall Protection System Recommendations

Rockfall mitigation measures are recommended for the unstable slope conditions at Site A, generally between Station 107+00 and 109+00, above the proposed soil nail wall. Loose rock blocks and debris along the slope should be removed through scaling efforts. Scaling operations should be limited to clearing loose debris without disturbing a larger area of the natural slope. In concert with these scaling efforts the crest and sides of the slope should be rounded to limit the amount of potentially unstable overburden material and vegetation.

Upon completion of scaling and rounding of the colluvial slope, it is recommended that a wire mesh/cable net system be placed along the slope to prevent further instability and rockfall potential. The mesh should be constructed of galvanized, double twist, hexagonal netting. The cable net should be constructed with 0.25 inch diameter, galvanized cables with a maximum opening of 8 inches. All components of the wire mesh/cable net system should have a powder coating of black pigmentation for aesthetic purposes. Alternatively, a high tensile strength mesh may be used in place of the mesh/cable net system, provided that it has equivalent strength properties to the mesh/cable net system. Proposed alternate systems require approval by the CO.

The system should be anchored to the top of the slope with Grade 75, epoxy coated #8 all thread bars, a minimum of 5 feet long, with a maximum spacing of 10 feet. The anchors should be placed in a single row 10 to 15 feet above the crest of the existing disturbed slope. A maximum test load of 10.0 kips is recommended for each anchor.

Mesh pins and binding wire should be used to keep the wire mesh within 24 inches of the slope face to prevent large rock blocks from freely migrating beneath the wire mesh. The mesh/cable net system should overhang the top of the soil nail wall by a minimum of 5 feet to prevent rock blocks from entering the travelway.

It is also recommended that the potentially unstable rock blocks adjacent to the colluvial slope be stabilized with rock bolts. Specific locations of rock bolts will be identified in the field during construction by the CO, in consultation with the CFLHD geotechnical

engineer. It is recommended that the tensioned rock bolts be constructed of Grade 75, epoxy coated #8 all thread bars, a minimum of 10 feet long. The rock bolts should be oriented normal to the joint surface to maximize the normal stress along the joint surface. A design load of 20 kips is recommended for each bolt. For aesthetic purposes it is recommended that after tensioning of the rock bolts, the bearing plate and head assembly be removed and the bolt cut flush with the ground surface.

Construction Considerations

Site Access: Access plans for each site should be developed by the contractor and submitted to the CO for approval.

DISCLAIMER/LIMITATIONS CLAUSE

The subsurface explorations and tests described in the section on Procedures and Results have been conducted in accordance with standard practices and procedures (except as specifically noted). The results of these explorations and tests represent conditions at the specific locations indicated. Subsurface conditions between these locations may vary. The Analysis section and the Recommendations section in this report include interpretations and recommendations developed by the Government in the process of preparing the design. These interpretations are not intended as a substitute for the personal investigation, independent interpretation, and judgment of the Contractor.

REFERENCES

American Association of State Highway and Transportation Officials (AASTHO). Standard Specifications for Highway Bridges, 17th Edition, 2002.

California Department of Fish and Game. Smith River draft waterway management plan, 1980

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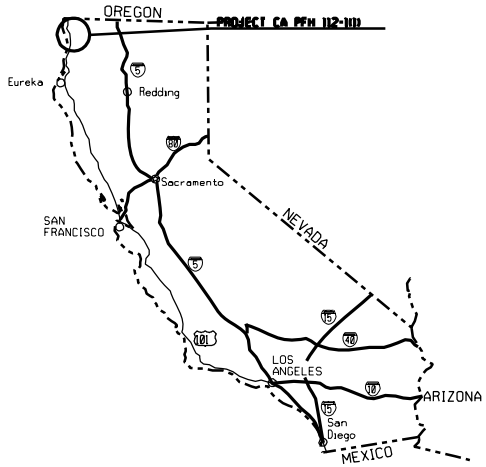
Griswell, Kathryn. Caltrans Geotechnical Engineer. Personal communication, March 10, 2008. 916-227-7330.

APPENDIX A – Figures

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
16	CA	PFH 112-1(1)	1	1



KEY MAP OF CALIFORNIA

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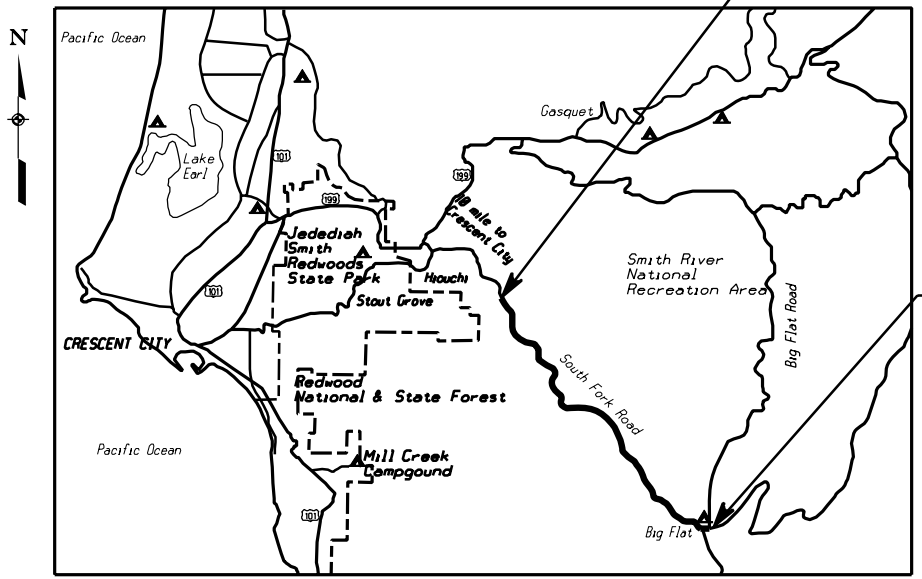
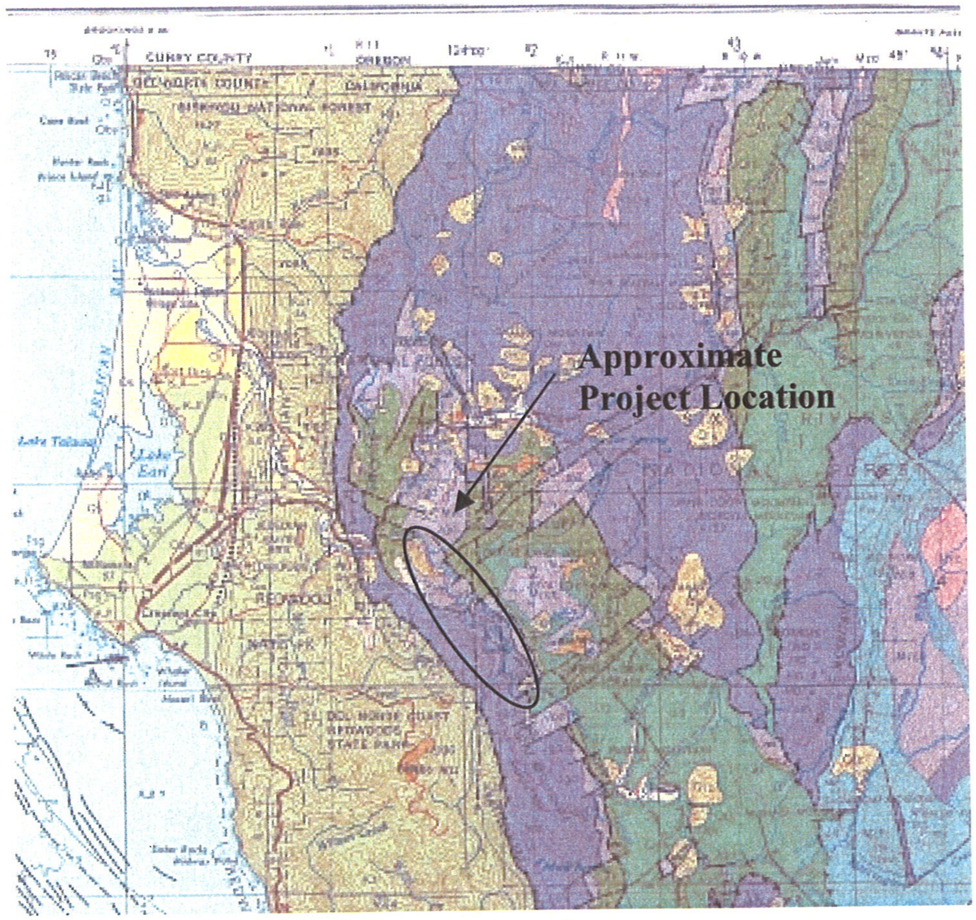
CA PFH 112-1(1)
Sta. 103+00



END PROJECT
CA PFH 112-1(1)
Sta. 814+00

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
EASTERN FEDERAL LANDS HIGHWAY DIVISION
STERLING, VIRGINIA

FIGURE 1
LOCATION AND VICINITY MAP



Qls	Landslide deposits
Mwi	Wimer Formation *(Marine; friable yellow siltstone, sandstone, and conglomerate)*
KJf	Franciscan Complex* *(ss-sandstone, shale, conglomerate; ch-chert; gs-greenstone and locally chert; mg-metagraywacke; sfm-South Fork Mountain Schist; rc-schist of Redwood Creek; ◆ -blueschist blocks)* *Horizontal pattern denotes melange terrane

MESOZOIC — JURASSIC — WESTERN JURASSIC BELT

	Galice Formation
	Volcanic rocks
Jgd	Gabbro, diorite, and related rocks
	Ultramafic rocks—partially to completely serpentinized

Figure 2 – Localized Geologic Map

Taken from: Wagner, D.L., and Saucedo, G.J., 1987

U.S. DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION CENTRAL FEDERAL LANDS HIGHWAY DIVISION LAKEWOOD, COLORADO	FIGURE 2 GEOLOGIC MAP	REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
		16	CA	PFH 112-1(1)	1	1

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APPENDIX B – Boring Location Plans

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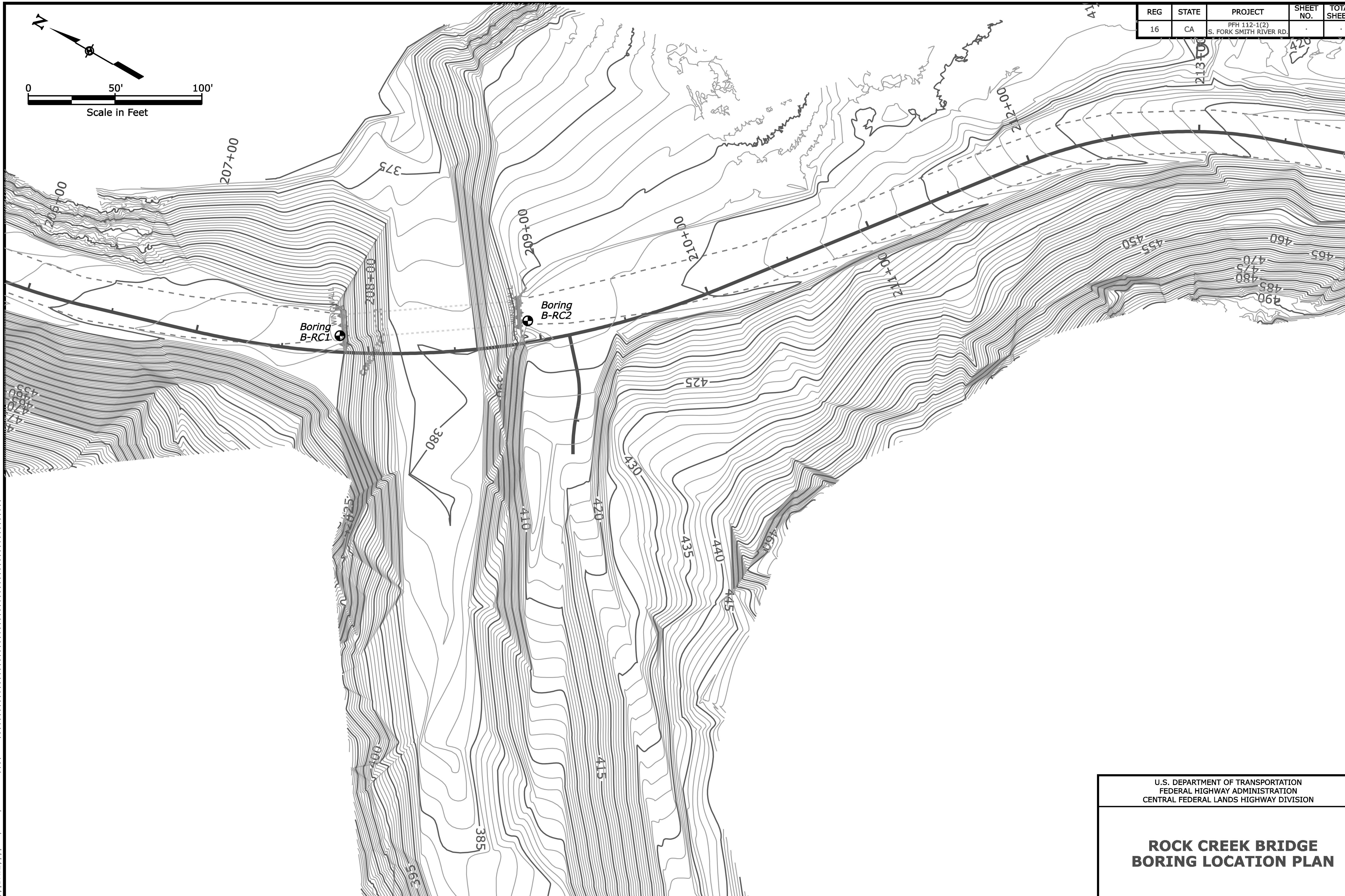

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U.S. DEPARTMENT OF TRANSPORTATION
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CENTRAL FEDERAL LANDS HIGHWAY DIVISION

ROCK CREEK BRIDGE
BORING LOCATION PLAN

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
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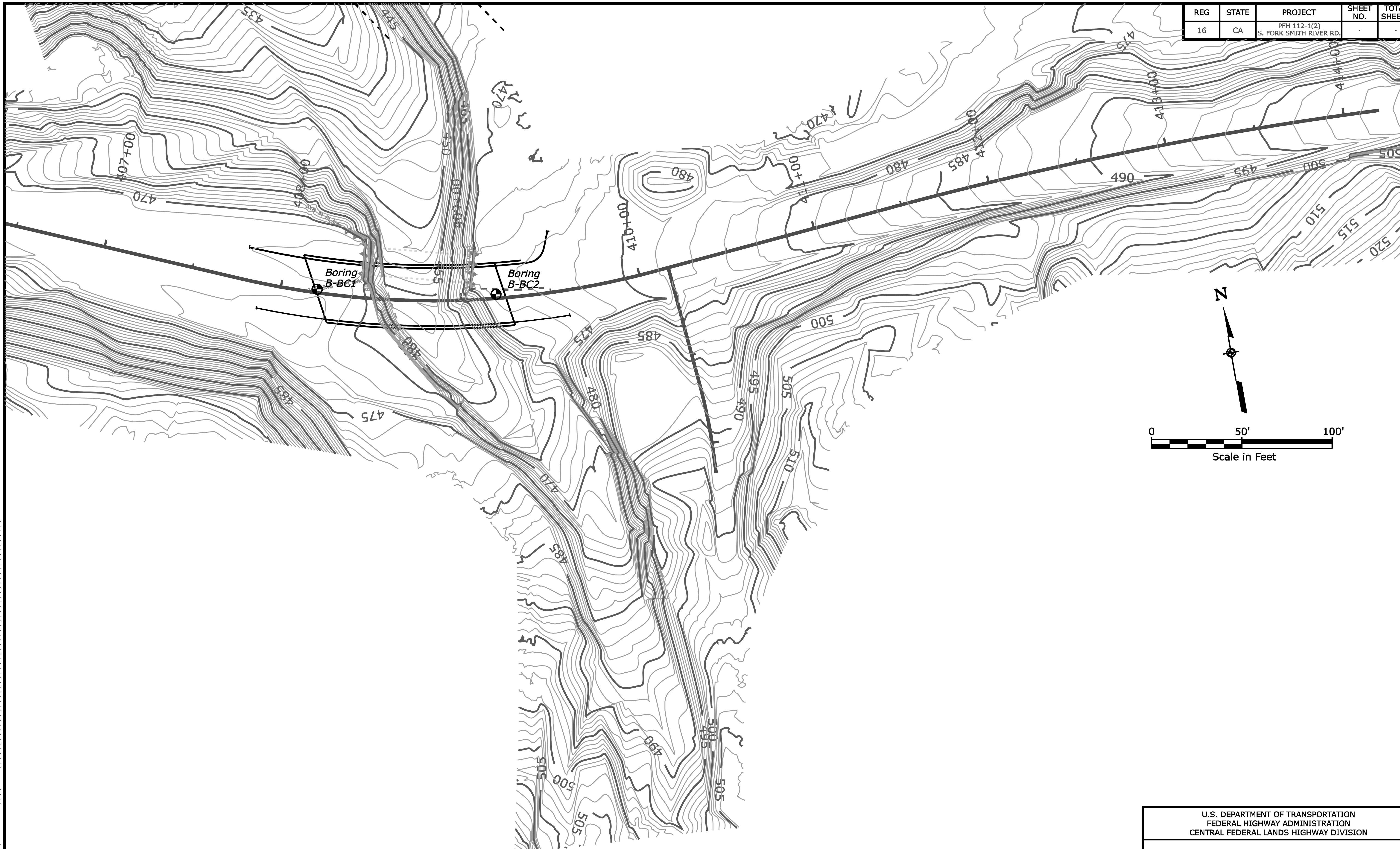

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CENTRAL FEDERAL LANDS HIGHWAY DIVISION

BOULDER CREEK BRIDGE
BORING LOCATION PLAN

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
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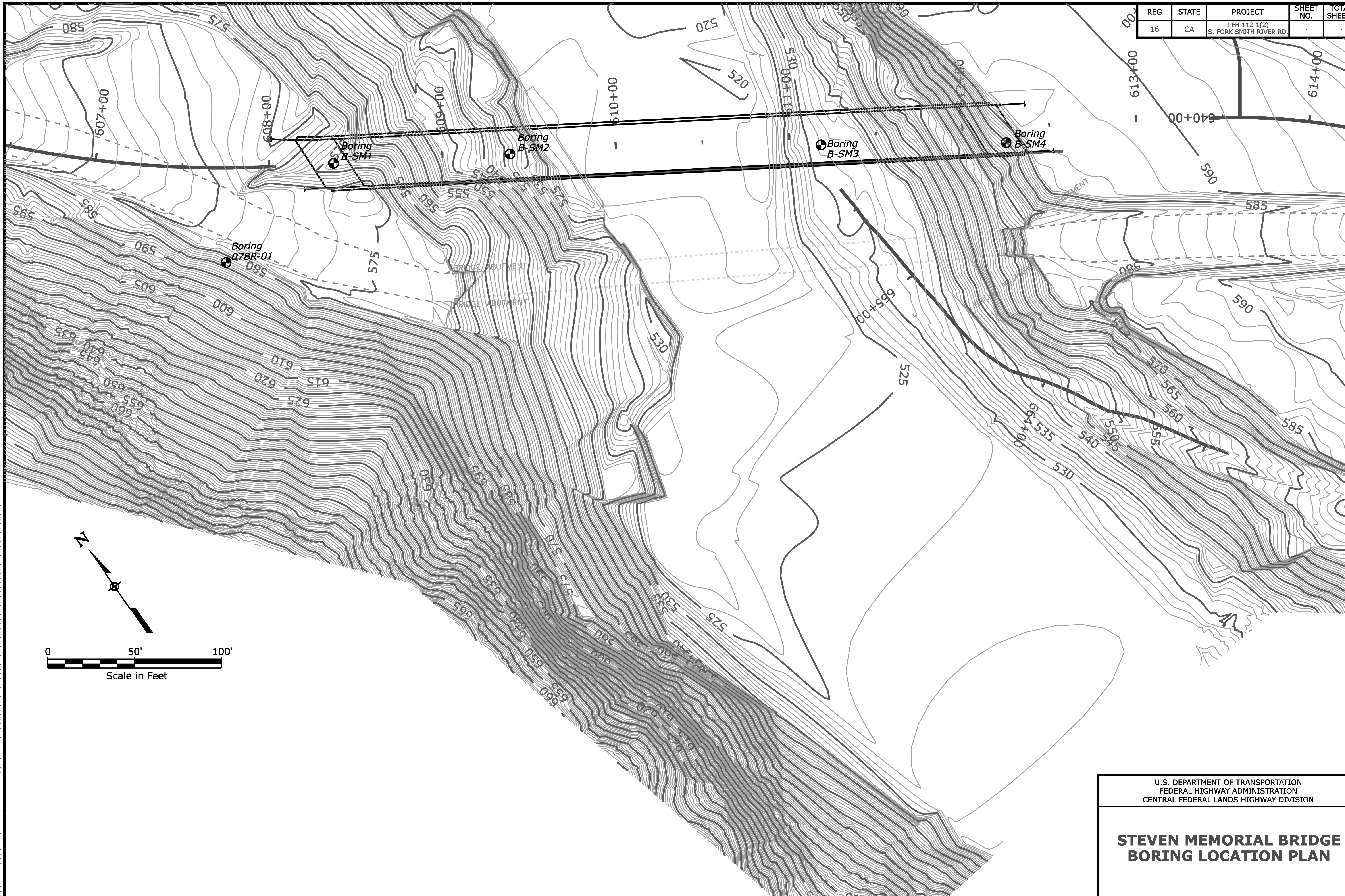

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CENTRAL FEDERAL LANDS HIGHWAY DIVISION

STEVEN MEMORIAL BRIDGE
BORING LOCATION PLAN

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
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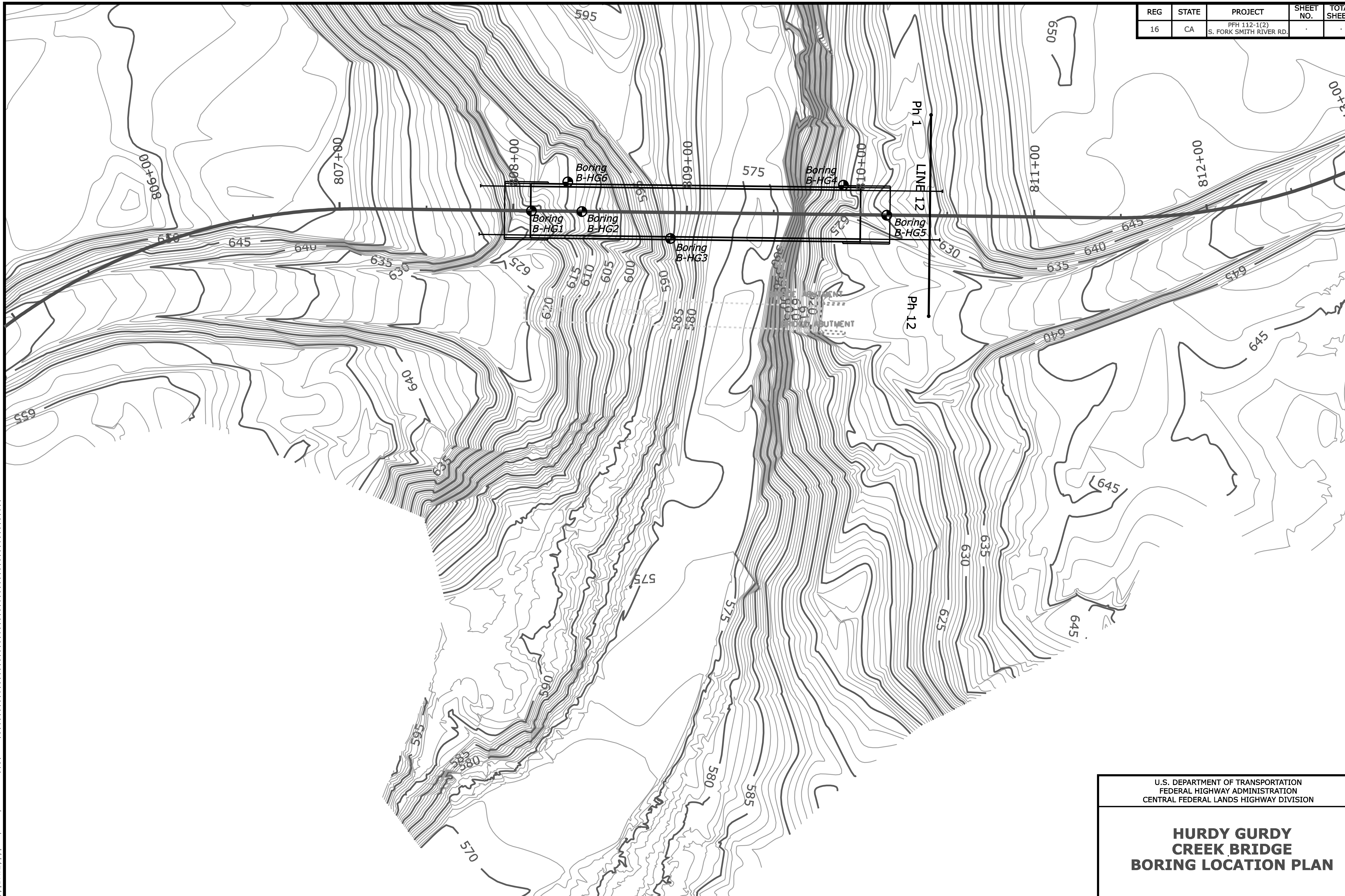

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U.S. DEPARTMENT OF TRANSPORTATION
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CENTRAL FEDERAL LANDS HIGHWAY DIVISION

HURDY GURDY CREEK BRIDGE BORING LOCATION PLAN

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
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CENTRAL FEDERAL LANDS HIGHWAY DIVISION

SITE A
BORING LOCATION PLAN
Sheet 1 of 2

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
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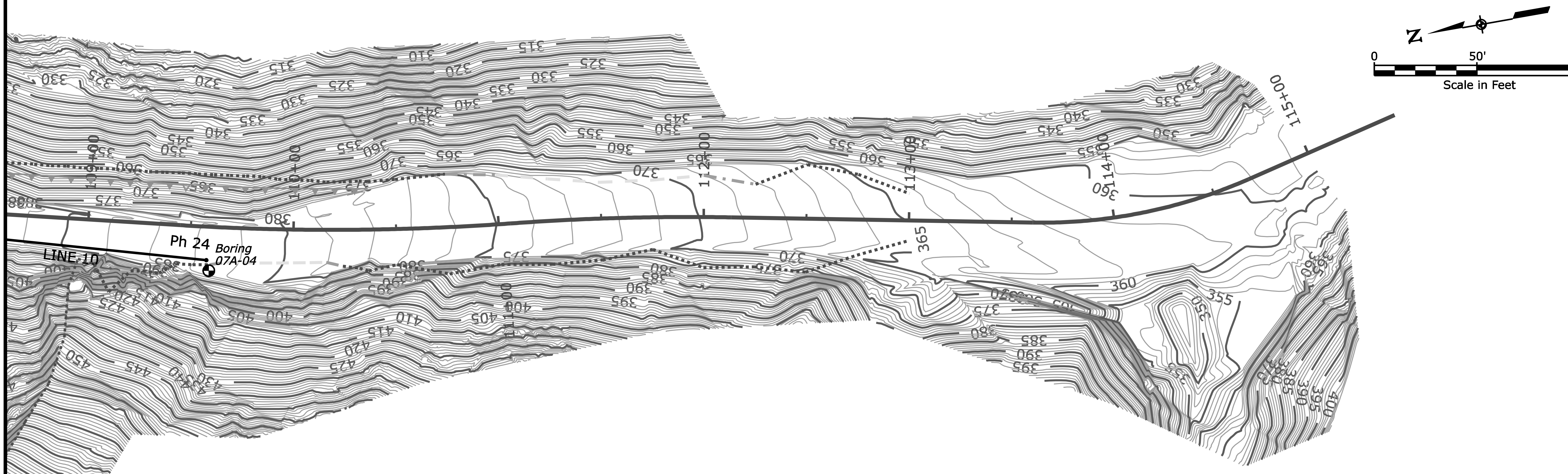

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SITE A
BORING LOCATION PLAN
Sheet 2 of 2

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
5	CA	PFH 112-1(1) S. FORK SMITH RIVER RD.	.	.

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SITE B
BORING LOCATION PLAN

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
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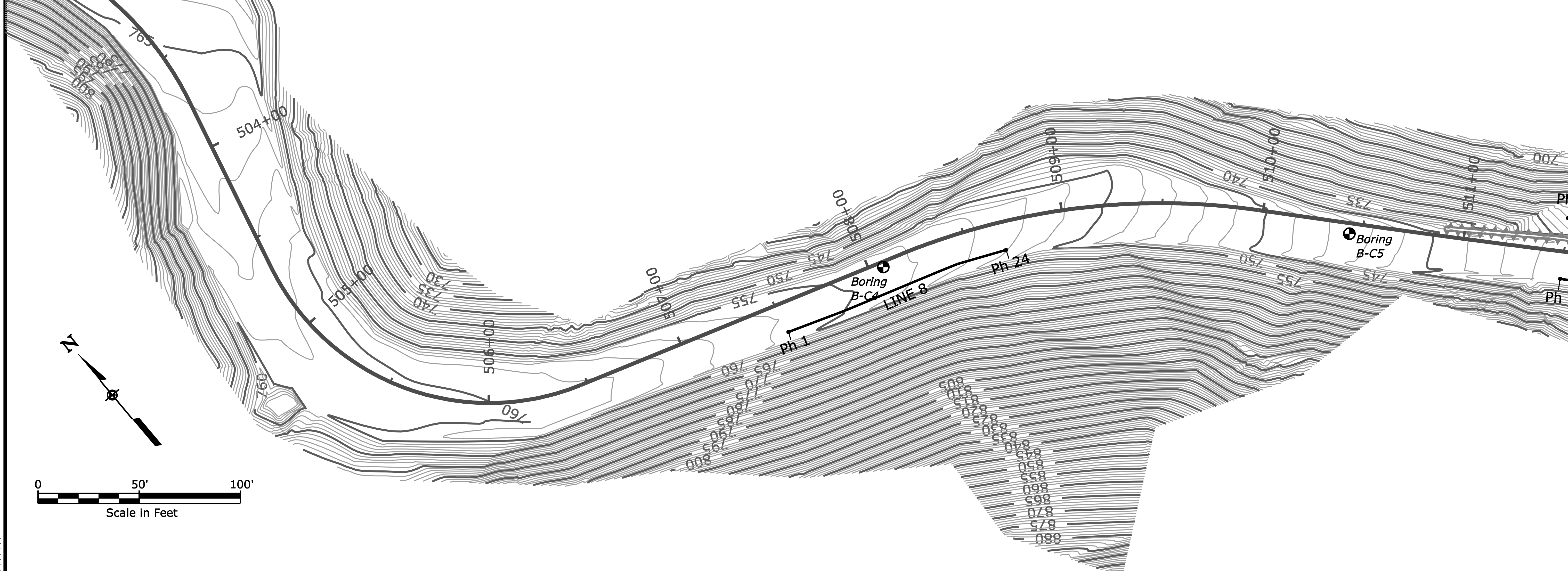

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CENTRAL FEDERAL LANDS HIGHWAY DIVISION

SITE C
BORING LOCATION PLAN
Sheet 1 of 4

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
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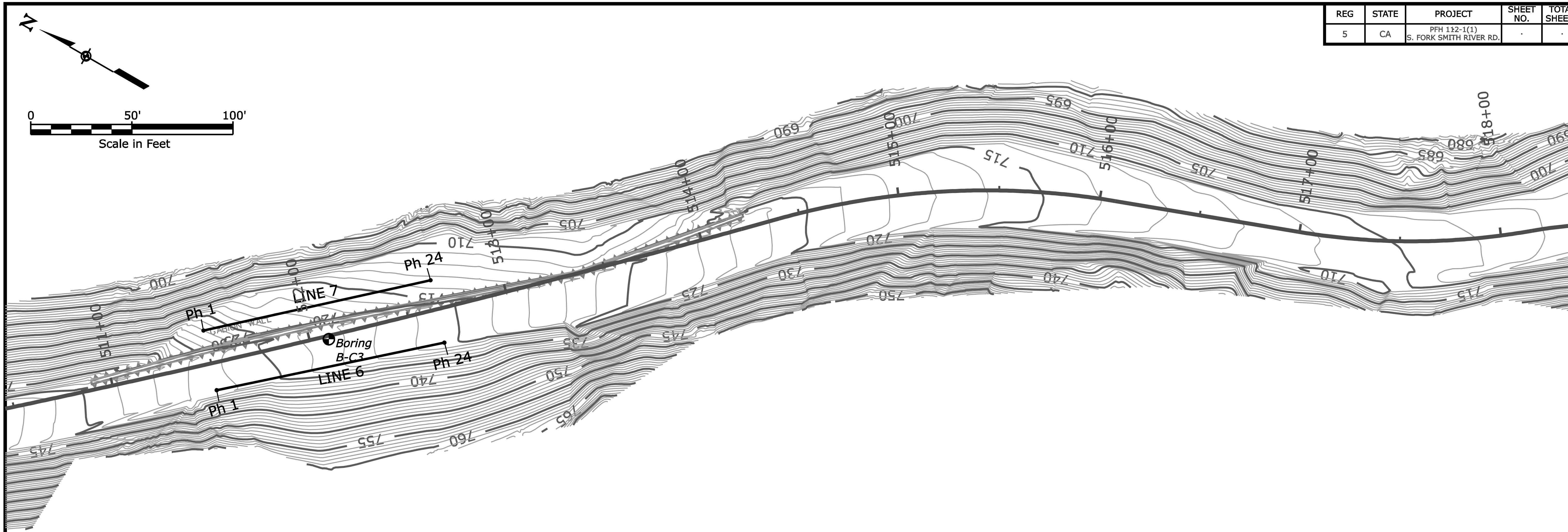

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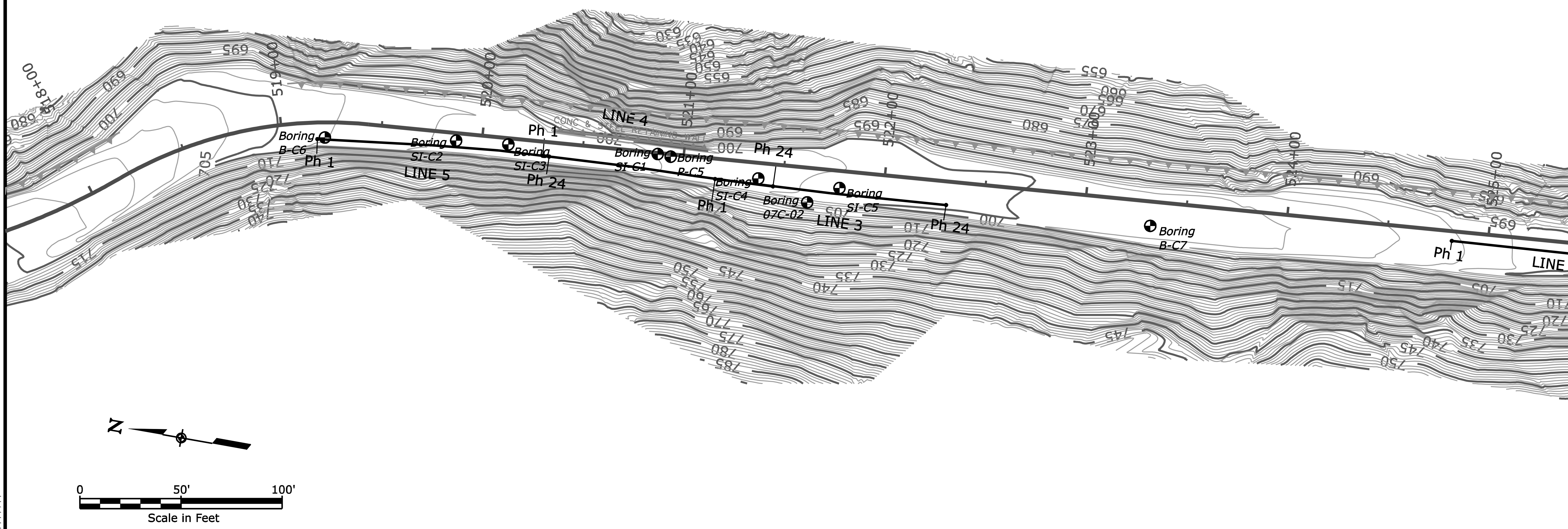
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

SITE C
BORING LOCATION PLAN
Sheet 2 of 4

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
5	CA	PFH 112-1(1) S. FORK SMITH RIVER RD.	.	.

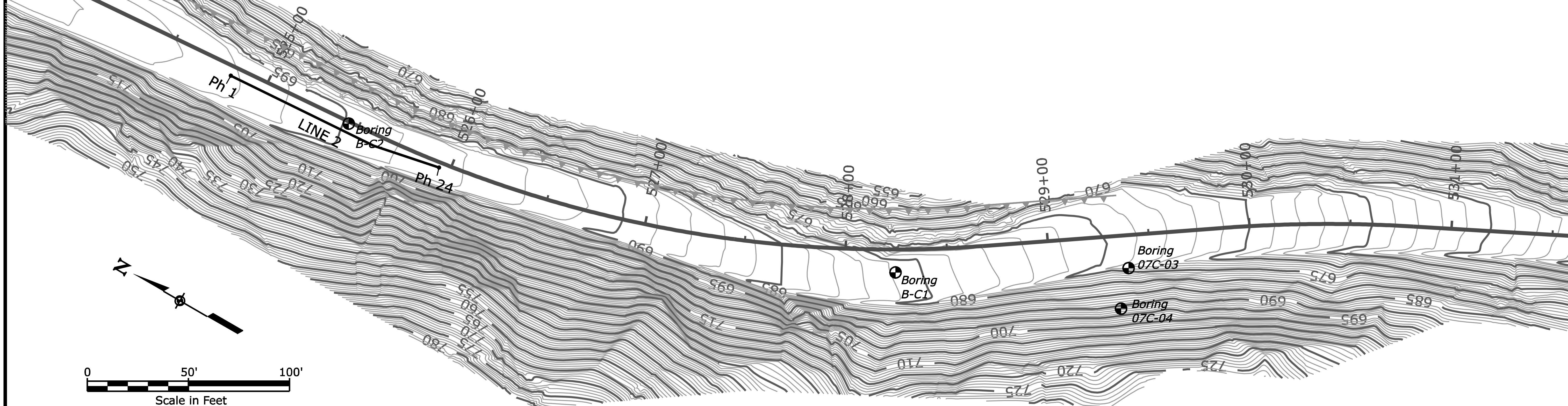


$$$$DGN$$ $TIME$ $$$$DATE$$$$

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

SITE C
BORING LOCATION PLAN
Sheet 3 of 4

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
5	CA	PFH 112-1(1) S. FORK SMITH RIVER RD.	C10	·

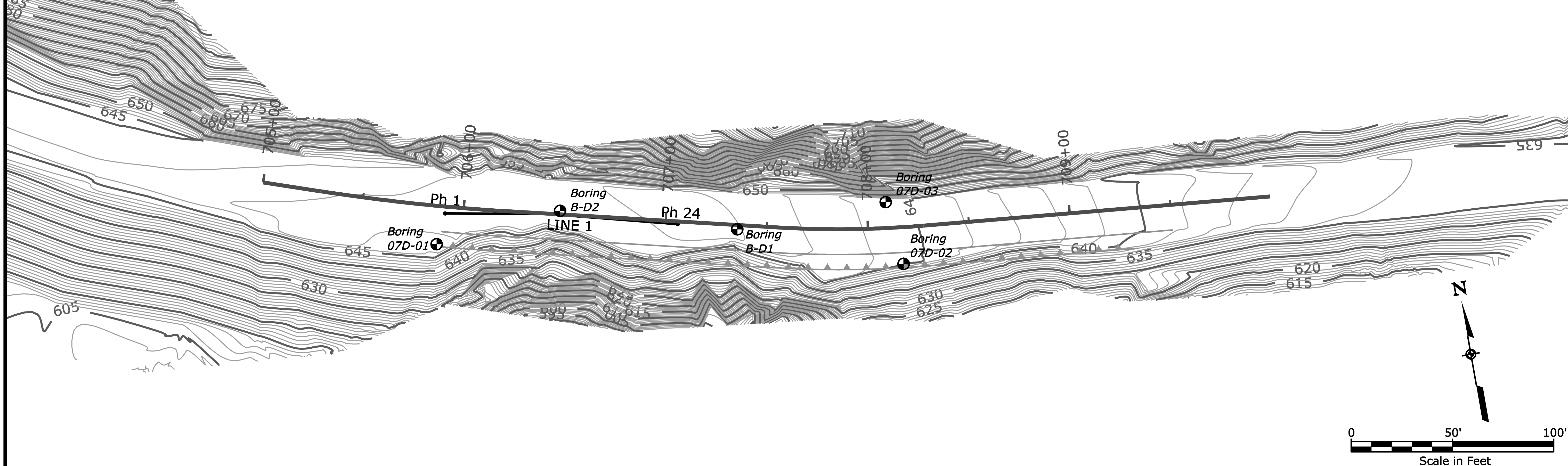


$$$$DATE$$$$ $TIME$ $$$$DGN$$

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

SITE C
BORING LOCATION PLAN
Sheet 4 of 4

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
5	CA	PFH 112-1(1) S. FORK SMITH RIVER RD.	.	.



$$$$DGN$$
$TIME$
$$$$DATE$$$$

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

SITE D
BORING LOCATION PLAN

APPENDIX C – Boring Logs

BORING LOG LEGEND AND TERMINOLOGY

1. Color.
2. Soil density or consistency.
3. Primary Constituent - Major grain size (IN CAPS).
4. Secondary Constituent:
   - Coarse-grained - 30% to 50% of secondary coarse-grained constituent (i.e. sandy, gravelly).
   - Fine-grained - Based on plasticity and determined by Atterberg limits test (i.e. silty, clayey).
5. Additional Constituents:
   - Coarse-grained - 'with some' - 10% to 30%; 'trace of' - less than 10%.
   - Fine-grained* - 'with some' - 5% to 12%; 'trace of' - less than 5%.
6. Moisture Content - Dry (D), Moist (M), Wet (W).

* Index tests and/or plasticity tests are performed to determine whether the terms "silt" or "clay" are used.

SOIL DENSITY AND CONSISTENCY CORRELATED TO SPT

GRANULAR SOIL		COHESIVE SOIL	
BLOWS	DENSITY	BLOWS	CONSISTENCY
0 - 4	Very Loose	0 - 1	Very Soft
5 - 10	Loose	2 - 4	Soft
11 - 24	Medium Dense	5 - 8	Medium Stiff
25 - 50	Dense	9 - 15	Stiff
Over 50	Very Dense	16 - 30	Very Stiff
		31 - 60	Hard
		Over 60	Very Hard

PARTICLE SIZE

Millimeters (and above)	Inches (and above)	U. S. Standard Sieve No.	Soil Type	Abbreviation
			Boulder	Bldr.
– 305	12		Cobble	Cobb
— 76	3		Gravel	Grav
— 5	3/16		Sand	SD
– 0.074		4	Silt	SI
– 0.002		200	Clay	CL

SYMBOLS FOR SAMPLE TYPES

AS	-	Auger sample (disturbed sample) AASHTO T 203.
SPT	-	Standard Penetration Test (disturbed sample) AASHTO T 206.
CS	-	California Sample (driven same as SPT).
ST	-	Shelby Tube Sample (undisturbed sample) AASHTO T 207.
RCN	-	Nx/Nq Rock Core AASHTO T 225.
RCH	-	Hx/Hq Rock Core.

Job:_____ Date: _____

YEH AND ASSOCIATES, INC. GEOTECHNICAL ENGINEERING CONSULTANTS	Project: South Fork Smith River Road, CA Project Number: 27-200 Date:

Legend for Symbols Used on Borehole Logs

Sample Types

Rock Core

Split Spoon Sample

Soil Lithology

Poorly-graded Sandy Gravel

Gravelly Silt

Silty Sand

Asphalt

Silty Gravel

Poorly-graded Gravelly Sand

Bedrock Lithology

SCHISTOSE or GRANITIC GNEISS

Lab Test Abbreviations

MC-Moisture Content
DD-Dry Density
#200-Percent Passing #200 Sieve
LL-Liquid Limit
PL-Plastic Limit
PI-Plastic Index
S-Sulphate Content
S/C-Swell/Consolidation
UCCS-Unconfined Compressive Strength
Re-Resistivity
PtL-Point Load Test
AASHTO-AASHTO Classification
USCS-USCS Classification

* Indicates that gradation analysis was performed, Atterberg limits were not performed, but the USCS classification was applied assuming non plastic characteristics

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-RC1	Date: November 2004	Sheet 1 of 1
Boring Location: STA 207+75, CL	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 10/14/05	Completed: 10/14/05	
Field Logged By: J. Hunyadi (Kleinfelder)	Ground Elev: ft.	Weather: sunny, warm	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1				1.83 61%			0.0 - 19.0 ft. Silty sand and rock fragments RCH 1 Rec. 1.83 ft. of silty sand and rock fragments. 8 minute run.
RCH 2	5			2.50 50%			RCH 2 Rec. 2.5 ft. of silty sand and rock fragments.
SPT 1				0.17 11%			SPT 1 Rec. 0.17 ft. of silty sand and gravels.
RCH 3	10			3.00 86%			RCH 3 Rec. 3 ft. of silty sand and rock fragments.
SPT 2				0.67 45%			SPT 2 Rec. 0.67 ft. of silty sand and rock fragments.
RCH 4	15			1.42 41%	0		RCH 4 Rec. 1.42 ft. of silty sand and rock fragments.
RCH 5	*19* 20			3.00 100%	48		RCH 5 Rec. 3 ft. of dark gray metagabbro, mod. fractured, sl. weathered, 45° joints infilled with serpentinite to 19.5' and decomposed from 19.5' to 21'. Unconfined compressive strength = 1210 psi and unit weight = 156.8 pcf for sample from 19.0' to 20.3'. 19.0 - 33.0 ft. Dark gray metagabbro
RCH 6				2.00 100%	0		RCH 6 Rec. 2 ft. of dark gray metagabbro, highly fractured, 45° to nearly vertical joints infilled with serpentinite and slickensided to 21', and decomposed from 21' to 22'.
RCH 7	25			5.00 100%	97		RCH 7 Rec. 5 ft. of dark gray metagabbro, sl. fractured, sl. weathered, hard, 45° joints infilled with serpentinite and slickensides present.
RCH 8	30			5.00 100%	53		RCH 8 Rec. 5 ft. of dark gray metagabbro, sl. fractured, sl. weathered, hard, 45° joints infilled with serpentinite and slickensides present. Unconfined compressive strength = 29.3 ksi and unit weight = 176.8 pcf for sample from 32.0' to 33.0'.
	33 35						BHT at 33.0 ft.

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-RC2	Date: November 2004	Sheet 1 of 1
Boring Location: STA 209+00, CL	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 10/13/05	Completed: 10/14/05	
Field Logged By: J. Hunyadi (Kleinfelder)	Ground Elev: ft.	Weather: sunny, warm	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1	3			2.49 83%			0.0 - 3.0 ft. Silty sand and rock fragments. RCH 1 Rec. 2.49 ft. of silty sand and rock fragments. 12 minute run.
RCH 2	5			5.00 100%	63		3.0 - 37.7 ft. Dark gray metagabbro RCH 2 Rec. 5 ft. of dark gray gabbro, mod. fractured, fresh, near vertical joints infilled with serpentinite and slickensides and medium brown silt. Unconfined compressive strength = 41.5 ksi and unit weight = 185.1 pcf for sample from 5.5' to 6.0'. 12 minute run.
RCH 3	10			4.75 95%	70		RCH 3 Rec. 4.75 ft. of dark gray metagabbro, mod. fractured, fresh, near vertical joints infilled with serpentinite and slickensides and medium brown silt. Same as RCH #2. 11 minute run.
RCH 4	15			3.24 81%	13		RCH 4 Rec. 3.24 ft. of dark gray metagabbro,highly fractured, near vertical joints infilled with serpentinite and slickensides. Decomposed from 16' to 16.5'.
RCH 5				1.00 100%	0		RCH 5 Rec. 1 ft. of dark gray metagabbro, intensely fractured, sl. weathered, near vertical joints infilled with serpentinite and slickensides.
RCH 6	20			3.50 100%	35		RCH 6 Rec. 3.5 ft. of dark gray metagabbro, hard, sl. weathered, mod. to highly fractured, near vertical joints joints infilled with serpentinite and slickensides.
RCH 7				1.33 89%	66		RCH 7 Rec. 1.33 ft. of dark gray metagabbro, hard, fresh, some 45° joints infilled with serpentinite and slickensides.
RCH 8	25			4.50 100%	54		RCH 8 Rec. 4.5 ft. of dark gray metagabbro, hard, fresh, some 45° joints infilled with serpentinite and slickensides.
RCH 9				0.50 100%	100		RCH 9 Rec. 0.5 ft. of dark gray metagabbro, hard, fresh, some 45° joints infilled with serpentinite and slickensides.
RCH 10	30			4.92 98%	66		RCH 10 Rec. 4.92 ft. of dark gray metagabbro, hard, fresh, some 45° joints infilled with serpentinite and slickensides. Unconfined compressive strength = 49.9 ksi and unit weight = 186.8 pcf for sample from 29.5' to 31.0'.
RCH 11	35			3.00 100%	39		RCH 11 Rec. 3 ft. of dark gray metagabbro, sl. weathered, highly fractured, near vertical joints infilled with serpentinite and slickensides.
RCH 12	37.7			1.42 95%	0		RCH 12 Rec. 1.42 ft. of dark gray metagabbro, sl. weathered, highly fractured, near vertical joints infilled with serpentinite and slickensides.
	40						BHT at 37.5 ft.

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-BC1	Date: November 2004	Sheet 1 of 2
Boring Location: STA 408+20, CL	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 10/12/05	Completed: 10/12/05	
Field Logged By: J. Hunyadi (Kleinfelder)	Ground Elev: ft.	Weather: PC, warm	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1				2.50 83%			0.0 - 11.0 ft. Silty sand with cobbles and boulders RCH 1 Rec. 2.5 ft. of cobbles and boulders with light brown silty sand. 9 minute run.
SPT 1			SM	0.83 55%		17/19/16	SPT 1 Rec. 0.83 ft. of brown silty sand with gravels, moist.
RCH 2	5			3.50 100%			RCH 2 Rec. 3.5 ft. of cobbles and boulders with light brown silty sand. 11 minute run.
SPT 2			SM	1.25 83%		2/2/2	SPT 2 Rec. 1.25 ft. of light brown silty sand.
RCH 3	10 11			3.50 100%			RCH 3 Rec. 3.5 ft. of light brown silty sand with cobbles from 9.5' to 11' and conglomerate from 11' to 13'. 10 minute run. 11.0 - 22.0 ft. Conglomerate
SPT 3				0.42 100%		50-5"	SPT 3 Rec. 0.42 ft. of fractured conglomerate (small gravels with brown silty sand).
RCH 4	15			4.40 96%			RCH 4 Rec. 4.4 ft. of conglomerate (small gravels cemented with coarse sand). Unconfined compressive strength = 1410 psi and unit weight = 140.7 pcf for sample from 15.5' to 16.6'. 13 minute run.
SPT 4				0.33 100%		50-4"	SPT 4 Rec. 0.33 ft. of fractured conglomerate (broken small gravels).
RCH 5	20 22			4.39 94%	80		RCH 5 Rec. 4.39 ft. of conglomerate to about 22' then weathered serpentinite. Unconfined compressive strength = 23.6 ksi and unit weight = 166.8 pcf for sample from 19.0' to 19.7'. 14 minute run. 22.0 - 47.4 ft. Gray green serpentinite.
RCH 6	25			4.65 93%	21		RCH 6 Rec. 4.65 ft. of gray green serpentinite.
	30						RCH 7 Rec. 3.65 ft. of gray green serpentinite. Estimated unconfined compressive strength from point load test = 29.9 ksi for sample from 29' to 29.5'. 21 minute run.

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

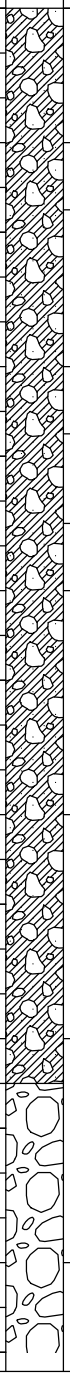
Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-BC1	Date: November 2004	Sheet 2 of 2
Boring Location: STA 408+20, CL	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 10/12/05	Completed: 10/12/05	
Field Logged By: J. Hunyadi (Kleinfelder)	Ground Elev: ft.	Weather: PC, warm	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 7				3.65 73%	23		
RCH 8	35			4.42 88%	0		RCH 8 Rec. 4.42 ft. of gray green serpentinite. Estimated unconfined compressive strength from point load test = 3760 psi for sample from 37.5' to 38'. 18 minute run.
RCH 9	40			4.65 93%	55		RCH 9 Rec. 4.65 ft. of gray green serpentinite. 20 minute run.
RCH 10	45			3.65 83%	40		RCH 10 Rec. 3.65 ft. of gray green serpentinite.
	47.4						BHT at 47.4 ft.
	50						
	55						
	60						

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)		Boring No. B-BC2	Date: November 2004	Sheet 1 of 2
Boring Location: STA 409+25, CL		Type of Boring: Wireline Core		
Coordinates:		Casing Used:	Size:	
Drill: Burley 5500-1 Track	Driller: Crux Subsurface	Boring Began: 10/12/05	Completed: 10/13/05	
Field Logged By: J. Hunyadi		Ground Elev: ft.	Weather: PC, warm	
Revisions/Final By: C. Martinez		Water Depth:		
		Date:		
		Time:		



Run/Samp No.	Depth (feet)	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1			2.75 92%			0.0 - 24.0 ft. Silty sand with cobbles and boulders RCH 1 Rec. 2.75 ft. of cobbles and boulders (gabbro) mixed with brown silty sand. 8 minute run.
SPT 1		SM	0.42 28%		5/23/14	SPT 1 Rec. 0.42 ft. of cobbles and boulders (gabbro) mixed with brown silty sand, moist.
RCH 2	5		2.33 67%			RCH 2 Rec. 2.33 ft. of boulders (gabbro) mixed with brown silty sand, moist. 10 minute run.
SPT 2		SM	0.17 11%		8/3/5	SPT 2 Rec. 0.17 ft. of small gravels and brown silty sand, moist.
RCH 3	10		1.83 92%	0		RCH 3 Rec. 1.83 ft. of silty sand and rock fragments.
RCH 4			1.50 100%	72		RCH 4 Rec. 1.5 ft. of silty sand and rock fragments.
RCH 5	15		4.00 80%	22		RCH 5 Rec. 4 ft. of silty sand and rock fragments.
RCH 6	20		5.00 100%	55		RCH 6 Rec. 5 ft. of silty sand and rock fragments.
RCH 7	24 25		4.00 80%	8		RCH 7 Rec. 4 ft. of conglomerate 24.0 - 31.5 ft. Conglomerate
RCH	30		2.66	0		RCH 8 Rec. 2.66 ft. of conglomerate

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-BC2	Date: November 2004	Sheet 2 of 2
Boring Location: STA 409+25, CL	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 10/12/05	Completed: 10/13/05	
Field Logged By: J. Hunyadi	Ground Elev: ft.	Weather: PC, warm	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
8				76%			
	31.5						
RCH 9				1.50 100%	0		31.5 - 48.0 ft. Gray green serpentinite. RCH 9 Rec. 1.5 ft. of gray green serpentinite.
RCH 10				0.38 48%	47		RCH 10 Rec. 0.38 ft. of gray green serpentinite.
RCH 11	35			0.67 39%	0		RCH 11 Rec. 0.67 ft. of gray green serpentinite.
RCH 12				0.50 100%	0		RCH 12 Rec. 0.5 ft. of gray green serpentinite.
RCH 13				2.00 100%	83		RCH 13 Rec. 2 ft. of gray green serpentinite. Unconfined compressive strength = 22.2 ksi and unit weight = 184.4 pcf for sample from 36.2' to 37.8'.
RCH 14	40			3.33 95%	31		RCH 14 Rec. 3.33 ft. of gray green serpentinite.
RCH 15				1.50 100%	66		RCH 15 Rec. 1.5 ft. of gray green serpentinite.
RCH 16	45			5.00 100%	25		RCH 16 Rec. 5 ft. of gray green serpentinite.
	48						BHT at 48.0 ft.
	50						
	55						
	60						

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-SM1	Date: November 2004	Sheet 1 of 2
Boring Location: STA 608+40, CL	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 9/28/05	Completed: 9/28/05	
Field Logged By: C. Martinez	Ground Elev: ft.	Weather: Sunny	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1				3.00 75%			0.0 - 8.4 ft. Red brown to gray clayey and silty sand, gravels, cobbles and boulders. RCH 1 Rec. 3 ft. of red to gray clayey sand and cobbles. 9 minute run.
SPT 1	5		SM	1.33 89%		19/22/25	SPT 1 Rec. 1.33 ft. of gray silty sand and gravels, sl. moist.
RCH 2	8.4			3.20 91%			RCH 2 Rec. 3.2 ft. of red to gray clayey sand and cobbles and white gray gneiss at 8.4'. 9 minute run. 8.4 - 39.0 ft. White gray gneiss.
RCH 3	10			5.00 100%	48		RCH 3 Rec. 5 ft. of white gray gneiss. 9½ minute run.
RCH 4	15			5.00 100%	80		RCH 4 Rec. 5 ft. of white gray gneiss. 10½ minute run.
RCH 5	20			5.00 100%	92		RCH 5 Rec. 5 ft. of white gray gneiss. Unconfined compressive strength = 18.5 and 20.4 ksi and unit weight = 189.4 and 188.6 pcf for (2) sample from 20' to 20.8' and 22' to 23'. 9 minute run.
RCH 6	25			5.00 100%	80		RCH 6 Rec. 5 ft. of white gray gneiss. 11 minute run.
	30						RCH 7 Rec. 5 ft. of white gray gneiss. Unconfined compressive strength = 21.2 ksi and unit weight = 189.9 pcf

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-SM1	Date: November 2004	Sheet 2 of 2
Boring Location: STA 608+40, CL	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 9/28/05	Completed: 9/28/05	
Field Logged By: C. Martinez	Ground Elev: ft.	Weather: Sunny	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 7				5.00 100%	100		for sample from 29' to 30'. 10 minute run.
RCH 8	35			5.00 100%	100		RCH 8 Rec. 5 ft. of white gray gneiss. 10 minute run.
	39 40						BHT at 39.0 ft.
	45						
	50						
	55						
	60						

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-SM2	Date: November 2004	Sheet 1 of 1
Boring Location: STA 609+40, CL	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 9/30/05	Completed: 9/30/05	
Field Logged By: C. Martinez	Ground Elev: ft.	Weather: Sunny	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1				4.70 94%	60		0.0 - 30.0 ft. White and gray gneiss with dark gray basalt dikes RCH 1 Rec. 4.7 ft. of white and gray gneiss. 13 minute run.
RCH 2	5			5.00 100%	60		RCH 2 Rec. 5 ft. of white and gray gneiss. Unconfined compressive strength = 11.6 ksi and unit weight = 188.0 pcf for sample from 6.7' to 8.0'. 12 minute run.
RCH 3	10			5.00 100%	84		RCH 3 Rec. 5 ft. of white and gray gneiss. Unconfined compressive strength = 9.3 ksi and unit weight = 187.5 pcf for sample from 12.5' to 14.0'. 13 minute run.
RCH 4	15			5.00 100%	62		RCH 4 Rec. 5 ft. of white and gray gneiss with dark gray basalt dikes. 13 minute run.
RCH 5	20			5.00 100%	82		RCH 5 Rec. 5 ft. of dark gray basalt dike with bands of white and gray gneiss. 12 minute run.
RCH 6	25			5.00 100%	82		RCH 6 Rec. 5 ft. of white and gray gneiss. 11 minute run.
	30						BHT at 30.0 ft.

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)		Boring No. B-SM3	Date: November 2004	Sheet 1 of 2
Boring Location: STA 611+20, 3 ft. RT		Type of Boring: Wireline Core		
Coordinates:		Casing Used:	Size:	
Drill: Burley 5500-1 Track	Driller: Crux Subsurface	Boring Began: 9/29/05	Completed: 9/29/05	
Field Logged By: C. Martinez		Ground Elev: ft.	Weather: Sunny	
Revisions/Final By: C. Martinez		Water Depth:		
		Date:		
		Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1	5			3.80 63%			RCH 1 Rec. 3.8 ft. of gravels, cobbles and gray coarse sand. 16½ minute run.
SPT 1				0.42 28%		20/32/11	SPT 1 Rec. 0.42 ft. of gray sl. silty sand and gravels.
RCH 2	10			4.00 114%			RCH 2 Rec. 4 ft. of mostly cobbles and sl. silty sand and gravels. 13 minute run.
SPT 2	11.8			0.25 50%		50-6"	SPT 2 Rec. 0.25 ft. of gray sl. silty sand and gravels.
RCH 3	15			4.50 100%	100		RCH 3 Rec. 4.5 ft. of gravels and cobbles (0.3') and 4.2' of white and gray gneiss. 10½ minute run. 11.8 - 31.0 ft. White and gray gneiss
RCH 4	20			5.00 100%	96		RCH 4 Rec. 5 ft. of white and gray gneiss. 9½ minute run.
RCH 5	25			5.00 100%	90		RCH 5 Rec. 5 ft. of white and gray gneiss. 8 minute run.
RCH 6	30			5.00 100%	90		RCH 6 Rec. 5 ft. of white and gray gneiss. 8 minute run.

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-SM3	Date: November 2004	Sheet 2 of 2
Boring Location: STA 611+20, 3 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 9/29/05	Completed: 9/29/05	
Field Logged By: C. Martinez	Ground Elev: ft.	Weather: Sunny	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
	31						
							BHT at 31.0 ft.
	35						
	40						
	45						
	50						
	55						
	60						

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-SM4	Date: November 2004	Sheet 1 of 3
Boring Location: STA 612+25, 10 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 9/27/05	Completed: 9/27/05	
Field Logged By: C. Martinez	Ground Elev: ft.	Weather: Sunny	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1				2.30 46%			0.0 - 6.5 ft. Brown clayey sand with cobbles and boulders RCH 1 Rec. 2.3 ft. of yellow brown clayey sand, cobbles and boulders (boulder on surface). 14½ minute run.
	5						
SPT 1			SC-SM	0.58 39%		7/10/12	SPT 1 Rec. 0.58 ft. of yellow brown clayey sand, sl. moist.
	6.5						
RCH 2				3.50 100%			6.5 - 70.0 ft. Serpentinite RCH 2 Rec. 3.5 ft. of yellow brown decomposed serpentinite. 12½ minute run.
	10						
SPT 2			SM	0.50 100%		30/10-0	SPT 2 Rec. 0.5 ft. of yellow brown decomposed serpentinite.
RCH 3				4.00 89%	0		RCH 3 Rec. 4 ft. of green decomposed to moderately weathered serpentinite. 17½ minute run.
	15						
RCH 4				4.10 82%	0		RCH 4 Rec. 4.1 ft. of green decomposed to moderately weathered serpentinite. 12 minute run.
	20						
RCH 5				4.60 92%	8		RCH 5 Rec. 4.6 ft. of green decomposed to moderately weathered serpentinite. 12½ minute run.
	25						
RCH 6				3.75 75%	18		RCH 6 Rec. 3.75 ft. of green decomposed to moderately weathered serpentinite. 15½ minute run.
	30						

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-SM4	Date: November 2004	Sheet 2 of 3
Boring Location: STA 612+25, 10 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 9/27/05	Completed: 9/27/05	
Field Logged By: C. Martinez	Ground Elev: ft.	Weather: Sunny	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 7				5.00 100%	78		RCH 7 Rec. 5 ft. of green moderately weathered serpentinite. 9½ minute run.
	35						
RCH 8				5.00 100%	60		RCH 8 Rec. 5 ft. of green moderately weathered serpentinite. 11 minute run.
	40						
RCH 9				5.00 100%	26		RCH 9 Rec. 5 ft. of green moderately weathered serpentinite. 10½ minute run.
	45						
RCH 10				5.00 100%	26		RCH 10 Rec. 5 ft. of green moderately weathered serpentinite. 10 minute run.
	50						
RCH 11				3.00 60%	0		RCH 11 Rec. 3 ft. of green moderately weathered serpentinite. 10½ minute run.
	55						
RCH 12				1.00 20%	0		RCH 12 Rec. 1 ft. of green moderately weathered serpentinite. 11 minute run.
	60						

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-SM4	Date: November 2004	Sheet 3 of 3
Boring Location: STA 612+25, 10 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 9/27/05	Completed: 9/27/05	
Field Logged By: C. Martinez	Ground Elev: ft.	Weather: Sunny	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 13				5.00 100%	48		RCH 13 Rec. 5 ft. of green moderately weathered serpentinite. 14 minute run.
	65						
RCH 14				5.00 100%	68		RCH 14 Rec. 5 ft. of green moderately weathered serpentinite. 14½ minute run.
	70						
	70						BHT at 70.0 ft.
	75						
	80						
	85						
	90						

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)		Boring No. B-HG1	Date: November 2004	Sheet 1 of 2
Boring Location: STA 808+10, CL		Type of Boring: Wireline Core		
Coordinates:		Casing Used:	Size:	
Drill: Burley 5500-1 Track	Driller: Crux Subsurface	Boring Began: 10/15/05	Completed: 10/15/05	
Field Logged By: J. Hunyadi (Kleinfelder)		Ground Elev: ft.	Weather: cloudy, cool, rain	
Revisions/Final By: C. Martinez		Water Depth:		
		Date:		
		Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1				2.40 60%			RCH 1 Rec. 2.4 ft. of boulder (gabbro) and brown silty sand.
SPT 1	5			0.42 28%		7/9/7	SPT 1 Rec. 0.42 ft. of brown sandy silt with slate and gabbro fragments.
RCH 2				1.80 51%			RCH 2 Rec. 1.8 ft. of boulders (gabbro) and light brown silty sand.
SPT 2	10			0.92 61%		5/8/9	9.0 - 34.0 ft. Black slate SPT 2 Rec. 0.92 ft. of broken (pulverized) slate, flaky, dry.
RCH 3				2.25 64%	0		RCH 3 Rec. 2.25 ft. of dark gray slate, fractured along 45° planes. Iron oxide staining along cleavage planes.
RCH 4	15			2.50 100%	0		RCH 4 Rec. 2.5 ft. of dark gray slate, fractured along 45° planes. Iron oxide staining along cleavage planes.
RCH 5				2.50 100%	0		RCH 5 Rec. 2.5 ft. of dark gray slate, fractured along 45° planes. Iron oxide staining along cleavage planes.
RCH 6	20			1.20 60%	0		RCH 6 Rec. 1.2 ft. of dark gray slate, fractured along 45° planes. Iron oxide staining along cleavage planes.
RCH 7				2.13 71%	0		RCH 7 Rec. 2.13 ft. of dark gray slate, fractured along 45° planes. Iron oxide staining along cleavage planes.
RCH 8	25			2.30 92%	0		RCH 8 Rec. 2.3 ft. of dark gray slate, fractured along 45° planes. Iron oxide staining along cleavage planes.
RCH 9				2.30 92%	0		RCH 9 Rec. 2.3 ft. of dark gray slate, fractured along 45° planes. Iron oxide staining along cleavage planes.
	30						RCH 10 Rec. 2.5 ft. of dark gray slate, fractured along 45° planes. Iron oxide staining along cleavage planes.

BORING LOG

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FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)		Boring No. B-HG1	Date: November 2004	Sheet 2 of 2
Boring Location: STA 808+10, CL		Type of Boring: Wireline Core		
Coordinates:		Casing Used:	Size:	
Drill: Burley 5500-1 Track	Driller: Crux Subsurface	Boring Began: 10/15/05	Completed: 10/15/05	
Field Logged By: J. Hunyadi (Kleinfelder)		Ground Elev: ft.	Weather: cloudy, cool, rain	
Revisions/Final By: C. Martinez		Water Depth:		
		Date:		
		Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 10				2.50 100%	0		
RCH 11	34			2.30 92%	0		RCH 11 Rec. 2.3 ft. of dark gray slate, fractured along 45° planes. Iron oxide staining along cleavage planes.
	35						BHT at 34.0 ft.
	40						
	45						
	50						
	55						
	60						

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-HG2	Date: November 2004	Sheet 1 of 2
Boring Location: STA 808+40, CL	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 10/15/05	Completed: 10/15/05	
Field Logged By: J. Hunyadi (Kleinfelder)	Ground Elev: ft.	Weather: cloudy, cool, rain	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1				2.83 71%			RCH 1 Rec. 2.83 ft. of cobble/boulder (gabbro) and dark brown silty sand, moist.
RCH 2	5			2.67 53%			RCH 2 Rec. 2.67 ft. of small gravels and silty sand, moist.
SPT 1	10		SM	0.67 45%		12/10/8	SPT 1 Rec. 0.67 ft. of gabbro rock fragments and light brown silty sand.
RCH 3				1.33 38%			RCH 3 Rec. 1.33 ft. of gravels and cobbles.
SPT 2	15		SM	0.75 50%	0	5/13/13	SPT 2 Rec. 0.75 ft. of gravel and cobbles mixed with silty sand.
RCH 4				1.75 50%	0		RCH 4 Rec. 1.75 ft. of rock fragments (weathered gabbro) mixed with brown silty sand.
SPT 3	20		SM	0.42 28%		5/8/4	SPT 3 Rec. 0.42 ft. of gravels (gabbro) mixed brown silty sand.
RCH 5	22			2.50 71%	0		RCH 5 Rec. 2.5 ft. of gravel and cobbles (gabbro) mixed with dark gray to light brown silty sand from 20.5' to 24.0' and black slate with near horizontal cleavage planes from 22.0' to 24.0'. 22.0 - 47.0 ft. Black slate
RCH 6	25			1.75 35%	0		RCH 6 Rec. 1.75 ft. of black slate with 45° cleavage planes.
RCH	30			2.00			RCH 7 Rec. 2 ft. of black slate with 45° cleavage planes.

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-HG2	Date: November 2004	Sheet 2 of 2
Boring Location: STA 808+40, CL	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 10/15/05	Completed: 10/15/05	
Field Logged By: J. Hunyadi (Kleinfelder)	Ground Elev: ft.	Weather: cloudy, cool, rain	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
7				100%	0		
RCH 8				2.67 89%	0		RCH 8 Rec. 2.67 ft. of black slate with 45° cleavage planes.
RCH 9	35			1.75 70%	0		RCH 9 Rec. 1.75 ft. of black slate (same as RCH #8).
RCH 10				2.25 90%	0		RCH 10 Rec. 2.25 ft. of black slate (same as RCH #8).
RCH 11	40			2.00 100%	0		RCH 11 Rec. 2 ft. of black slate (same as RCH #8).
RCH 12				2.92 97%	0		RCH 12 Rec. 2.92 ft. of black slate (same as RCH #8).
RCH 13	45			1.92 96%	0		RCH 13 Rec. 1.92 ft. of black slate (same as RCH #8 with quartz seam 46').
RCH 14	*47*			1.00 100%	0		RCH 14 Rec. 1 ft. of black slate (same as RCH #8).
	50						BHT at 47.0 ft.
	55						
	60						

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)		Boring No. B-HG3	Date: November 2004	Sheet 1 of 2
Boring Location: STA 809+90, 17 ft. RT		Type of Boring: Wireline Core		
Coordinates:		Casing Used:	Size:	
Drill: Burley 5500-1 Track	Driller: Crux Subsurface	Boring Began: 10/16/05	Completed: 10/16/05	
Field Logged By: J. Hunyadi (Kleinfelder)		Ground Elev: ft.	Weather: Sunny	
Revisions/Final By: C. Martinez		Water Depth:		
		Date:		
		Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1				0.92 26%			RCH 1 Rec. 0.92 ft. of gravels and cobbles (gabbro). 7 minute run.
SPT 1			SM	0.75 50%		8/15/20	SPT 1 Rec. 0.75 ft. of gray green silty sand, dry to sl. moist.
RCH 2	5			2.17 62%			RCH 2 Rec. 2.17 ft. of gravels and cobbles (gabbro) mixed with dark brown sandy silt. 8 minute run.
SPT 2			SM	0.58 39%		6/6/4	SPT 2 Rec. 0.58 ft. of brown silty sand with rock (gabbro) fragments.
RCH 3	10			2.33 67%	0		RCH 3 Rec. 2.33 ft. of broken boulders (gabbro and serpentinite) and brown silty sand. 12 minute run.
RCH 4	15			4.75 95%	25		RCH 4 Rec. 4.75 ft. of dark gray gabbro to 15.5, decomposed and weathered gabbro mixed with gray silty sand from 15.5' to 18.5'.
RCH 5	20			3.58 90%	0		RCH 5 Rec. 3.58 ft. of dark gray gabbro boulders mixed with gray silty sand to 22' and black slate with 45° cleavage planes from 22' to 22.5'. 22.0 - 30.5 ft. Black slate
RCH 6	22			0.88 88%	0		RCH 6 Rec. 0.87 ft. of black slate
RCH 7	25			3.50 100%	0		RCH 7 Rec. 3.5 ft. of black slate (same as RCH #6).
RCH 8				1.50 100%	0		RCH 8 Rec. 1.5 ft. of black slate (same as RCH #6).
RCH 9	30			2.00 100%	0		RCH 9 Rec. 2 ft. of black slate (same as RCH #6).

BORING LOG

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CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)		Boring No. B-HG3	Date: November 2004	Sheet 2 of 2
Boring Location: STA 809+90, 17 ft. RT		Type of Boring: Wireline Core		
Coordinates:		Casing Used:	Size:	
Drill: Burley 5500-1 Track	Driller: Crux Subsurface	Boring Began: 10/16/05	Completed: 10/16/05	
Field Logged By: J. Hunyadi (Kleinfelder)		Ground Elev: ft.	Weather: Sunny	
Revisions/Final By: C. Martinez		Water Depth:		
		Date:		
		Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
	30.5						BHT at 30.5 ft.
	35						
	40						
	45						
	50						
	55						
	60						

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-HG4	Date: November 2004	Sheet 1 of 1
Boring Location: STA 809+90, 15 ft. LT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 10/17/05	Completed: 10/17/05	
Field Logged By: J. Hunyadi (Kleinfelder)	Ground Elev: ft.	Weather: clear, cool	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1				1.58 45%			RCH 1 Rec. 1.58 ft. of gravels and cobbles (gabbro) mixed with dark brown silty sand, moist.
SPT 1			SM	1.33 89%		3/3/13	SPT 1 Rec. 1.33 ft. of light brown silty sand, dry to sl. moist.
	5						
RCH 2				2.17 62%			RCH 2 Rec. 2.17 ft. of boulders (gabbro) mixed with brown silty sand between boulders.
SPT 2				0.63 63%		23/50-6"	SPT 2 Rec. 0.62 ft. of gravels and cobbles (gabbro) with gray silty sand.
	10						
RCH 3				3.67 92%	0		RCH 3 Rec. 3.67 ft. of boulders (gabbro) with gray silty sand and serpentinite staining between boulders.
RCH 4	15			3.50 100%	0		RCH 4 Rec. 3.5 ft. of boulders (gabbro) with gray silty sand and black slate at 15'. 15.0 - 27.0 ft. Black slate
	15						
RCH 5				1.33 89%	0		RCH 5 Rec. 1.33 ft. of black slate with 45° cleavage planes.
RCH 6				3.27 131%	0		RCH 6 Rec. 3.27 ft. of black slate with 45° cleavage planes (same as RCH #5).
	20						
RCH 7				2.33 93%	0		RCH 7 Rec. 2.33 ft. of black slate with 45° cleavage planes (same as RCH #5).
RCH 8				2.50 100%	0		RCH 8 Rec. 2.5 ft. of black slate with 45° cleavage planes (same as RCH #5).
	25						
RCH 9				1.00 100%	0		RCH 9 Rec. 1 ft. of black slate with 45° cleavage planes (same as RCH #5).
	27						BHT at 27.0 ft.
	30						

BORING LOG SOUTHFORK.GPJ FHWA_CO.GDT 5/18/06

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-HG5	Date: November 2004	Sheet 1 of 1
Boring Location: STA 810+15, CL	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 10/17/05	Completed: 10/17/05	
Field Logged By: J. Hunyadi (Kleinfelder)	Ground Elev: ft.	Weather: sunny, warm	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1				2.00 57%			RCH 1 Rec. 2 ft. of boulders (gabbro) mixed with poorly graded brown silty sand.
RCH 2	5			4.34 87%			RCH 2 Rec. 4.34 ft. of boulders (gabbro) from 3.5' to 4.5' and gravels mixed with poorly graded brown silty sand from 4.5' to 8.5'.
SPT 1			SM	0.58 39%		6/5/7	SPT 1 Rec. 0.58 ft. of brown silty sand, dry to sl. moist.
RCH 3	10 12.5			2.17 62%			RCH 3 Rec. 2.17 ft. of boulders (gabbro) mixed with brown silty sand from 10' to 12.5' and black slate, intensely fractured along 45° cleavage planes. 12.5 - 21.0 ft. Black slate
SPT 2				0.17 34%		50-6"	SPT 2 Rec. 0.17 ft. of black slate, broken up by SPT spoon.
RCH 4	15			3.67 92%	0		RCH 4 Rec. 3.67 ft. of Black slate, 45° cleavage planes with iron oxide staining.
RCH 5	20 21			2.83 94%	0		RCH 5 Rec. 2.83 ft. of black slate (same as RCH #4).
	25 30						BHT at 21.0 ft.

BORING LOG SOUTHFORK.GPJ FHWA_CO.GDT 5/18/06

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)		Boring No. B-HG6	Date: November 2004	Sheet 1 of 1
Boring Location: STA 808+32, 17 ft. LT		Type of Boring: Wireline Core		
Coordinates:		Casing Used:	Size:	
Drill: Burley 5500-1 Track	Driller: Crux Subsurface	Boring Began: 10/20/05	Completed: 10/20/05	
Field Logged By: J. Hunyadi (Kleinfelder)		Ground Elev: ft.	Weather: foggy, cool	
Revisions/Final By: C. Martinez		Water Depth:		
		Date:		
		Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1				3.00 75%			RCH 1 Rec. 3 ft. of boulders (gabbro) mixed with dark brown silty sand.
RCH 2	5			3.50 70%			RCH 2 Rec. 3.5 ft. of boulders (gabbro) mixed with dark brown silty sand.
SPT 1			SC-SM	0.33 44%			SPT 1 Rec. 0.33 ft. of brown silty sand.
RCH 3	10			3.17 75%			RCH 3 Rec. 3.17 ft. of boulders (gabbro) mixed with dark brown silty sand (same as RCH #2).
SPT 2	15		SC-SM	0.58 39%			SPT 2 Rec. 0.58 ft. of brown silty sand (same as SPT #1).
RCH 4				0.00 0%	0		RCH 4 No recovery. No recovery.
SPT 3	20			0.00 0%	0		SPT 3 No recovery. No recovery.
RCH 5	*21*			2.50 71%	0		RCH 5 Rec. 2.5 ft. of black slate with 45° cleavage planes and green serpentinite. 21.0 - 28.4 ft. Black slate and green serpentinite
RCH 6	25 *28.4*			4.04 92%	0		RCH 6 Rec. 4.04 ft. of light green serpentinite and black slate with 45° cleavage planes.
	30						BHT at 28.4 ft.

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-A1	Date: November 2004	Sheet 1 of 2
Boring Location: STA 107+00, 8 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-2 Unimog / Driller: Crux Subsurface	Boring Began: 10/19/05	Completed: 10/19/05	
Field Logged By: Justin T. (Kleinfelder)	Ground Elev: ft.	Weather: cloudy, rainy	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1				0.58 19%			0.0 - 22.0 ft. Asphalt pavement (thickness not recorded), silt, sand, gravels and rock fragments. RCH 1 Rec. 0.58 ft. of asphalt pavement and light brown sandy silt and gravel. 3 minute run.
SPT 1				0.00 0%		50-0	SPT 1 No recovery. Bouncing on rock fragment.
RCH 2	5			5.00 100%			RCH 2 Rec. 5 ft. of rock fragments with light brown silt. Lost water return at 6.25'. 12 minute run. 7.5 ft. Lost water return
SPT 2				0.00 0%		50-0	SPT 2 No recovery. Bouncing on rock fragment.
RCH 3	10			4.00 80%			RCH 3 Rec. 4 ft. of rock fragments with light brown silt.
SPT 3				0.42 28%		9/15/21	SPT 3 Rec. 0.42 ft. of sandy gravel with some silt.
RCH 4	15			1.25 36%	0		RCH 4 Rec. 1.25 ft. of light gray green metagabbro (boulder?). 10 minute run.
SPT 4				0.17 11%		6/3/2	SPT 4 Rec. 0.17 ft. of sandy gravel with some silt.
RCH 5	20			0.67 19%	0		RCH 5 Rec. 0.67 ft. of light gray green metagabbro. 16 minute run. 22.0 - 40.0 ft. Light gray green metagabbro.
SPT 5	22			0.17 25%		36/50-2"	SPT 5 Rec. 0.17 ft. of light gray green metagabbro.
RCH 6	25			3.33 87%	41		RCH 6 Rec. 3.33 ft. of light gray green metagabbro. Unconfined compressive strength = 49.2 ksi and unit weight = 180.4 pcf for sample from 24.0' to 24.9'. 12 minute run.
	30						RCH 7 Rec. 4.5 ft. of light gray green metagabbro.

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)		Boring No. B-A1	Date: November 2004	Sheet 2 of 2
Boring Location: STA 107+00, 8 ft. RT		Type of Boring: Wireline Core		
Coordinates:		Casing Used:	Size:	
Drill: Burley 5500-2 Unimog	Driller: Crux Subsurface	Boring Began: 10/19/05	Completed: 10/19/05	
Field Logged By: Justin T. (Kleinfelder)		Ground Elev: ft.	Weather: cloudy, rainy	
Revisions/Final By: C. Martinez		Water Depth:		
		Date:		
		Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 7				4.50 82%	56		
SPT 6				0.00 0%		50-4"	SPT 6 No recovery. light gray green metagabbro.
							RCH 8 Rec. 3.42 ft. of light gray green metagabbro.
	35						
RCH 8				3.42 73%	36		
SPT 7				0.17 100%		50-2"	SPT 7 Rec. 0.17 ft. of light gray green metagabbro.
							RCH 9 Rec. 1.42 ft. of light gray green metagabbro.
RCH 9	*40*			1.42 78%			
	40						BHT at 40.0 ft.
	45						
	50						
	55						
	60						

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-A2	Date: November 2004	Sheet 1 of 2
Boring Location: STA 109+00, 3 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-2 Unimog / Driller: Crux Subsurface	Boring Began: 10/20/05	Completed: 10/21/05	
Field Logged By: Justin T. (Kleinfelder)	Ground Elev: ft.	Weather: foggy, cool	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1							0.0 - 16.0 ft. Asphalt pavement (thickness not recorded), silt, sand, gravels and rock fragments. RCH 1 asphalt pavement and light brown sandy silt and gravel fill. 6 minute run.
SPT 1			GP-GC	1.17 78%		13/23/29	SPT 1 Rec. 1.17 ft. of light brown sandy silt and gravel fill.
RCH 2	5			2.10 60%			RCH 2 Rec. 2.1 ft. of light brown sandy silt and gravel fill. 12 minute run.
SPT 2			GP-GC	0.00 0%		12/13/16	SPT 2 No recovery.
RCH 3	10			0.80 23%			RCH 3 Rec. 0.8 ft. of light brown sandy silt and gravel fill. 14 minute run
SPT 3			GP-GC	0.42 28%		5/5/8	SPT 3 Rec. 0.42 ft. of light brown sandy silt and gravel fill.
RCH 4	15 *16*			2.75 79%			RCH 4 Rec. 2.75 ft. of light brown sandy silt and gravel fill with some serpentinite and schist boulders to 16' and light gray green metagabbro, hard, mod. fractured with light brown silt infilling from 16' to 17.5'. 16.0 - 52.5 ft. Light gray green metagabbro.
SPT 4				0.92 61%		26/16/23	SPT 4 Rec. 0.92 ft. of light gray green metagabbro, hard, mod. fractured with light brown silt infilling.
RCH 5	20			3.50 100%	26		RCH 5 Rec. 3.5 ft. of light gray green metagabbro, hard, mod. fractured with light brown silt infilling. Estimated unconfined compressive strength from point load test = 19.8 ksi for sample from 19' to 20.5'.
SPT 5						50-0	SPT 5 Bouncing on rock.
RCH 6	25			2.90 58%	8		RCH 6 Rec. 2.9 ft. of light gray green metagabbro, hard, mod. fractured with light brown silt infilling.
RCH	30			2.50			RCH 7 Rec. 2.5 ft. of light gray green metagabbrot, hard, mod. fractured with light brown silt infilling and some off-white orthoclase, becomes less fractured at 30.5'.

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)		Boring No. B-A2	Date: November 2004	Sheet 2 of 2
Boring Location: STA 109+00, 3 ft. RT		Type of Boring: Wireline Core		
Coordinates:		Casing Used:	Size:	
Drill: Burley 5500-2 Unimog	Driller: Crux Subsurface	Boring Began: 10/20/05	Completed: 10/21/05	
Field Logged By: Justin T. (Kleinfelder)		Ground Elev: ft.	Weather: foggy, cool	
Revisions/Final By: C. Martinez		Water Depth:		
		Date:		
		Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
7				50%	20		
RCH 8	35			2.58 52%	0		RCH 8 Rec. 2.58 ft. of light gray green metagabbro, hard, mod. fractured with light brown silt infilling and iron stained in fractures.
RCH 9	40			3.50 70%	40		RCH 9 Rec. 3.5 ft. of light gray green metagabbro, hard, mod. fractured with light brown silt infilling.
RCH 10	45			4.67 93%	25		RCH 10 Rec. 4.67 ft. of light gray green metagabbro, hard, mod. fractured with light brown silt infilling.
RCH 11	50			3.33 67%	28		RCH 11 Rec. 3.33 ft. of light gray green metagabbro, hard, mod. fractured with light brown silt infilling.
	52.5						BHT at 52.5 ft.
	55						
	60						

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. SI-A1	Date: November 2004	Sheet 1 of 3
Boring Location: STA 108+06, 9 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-2 Unimog / Driller: Crux Subsurface	Boring Began: 11/18/04	Completed: 11/19/04	
Field Logged By: S. Deppmeier	Ground Elev: 388.7 ft.	Weather: Showers to PC	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1				0.25 13%			0.0 - 20.0 ft. Silty sand, gravel and rock fragments. RCH 1 Rec. 0.25 ft. of gravels. 8½ minute run.
SPT 1			GC-GM	0.92 61%		20/16/16	SPT 1 Rec. 0.92 ft. of silty sand and gravel.
RCH 2	5			0.33 9%			RCH 2 Rec. 0.33 ft. of light brown silty sand and gravel. 11 minute run.
SPT 2			GC-GM	0.75 50%		11/19/14	SPT 2 Rec. 0.75 ft. of silty sand and gravel.
RCH 3	10			0.25 7%			RCH 3 Rec. 0.25 ft. of silty sand and gravel. 18 minute run.
SPT 3			GC-GM	0.58 39%		14/29/25	SPT 3 Rec. 0.58 ft. of silty sand and gravel.
RCH 4	15			3.30 94%			RCH 4 Rec. 3.3 ft. of gravel and cobble-size rock fragments. 10½ minute run.
SPT 4				0.25 17%		13/13/27	SPT 4 Rec. 0.25 ft. of gravels.
RCH 5	*368.7* 20			1.80 51%			RCH 5 Rec. 1.8 ft. of gravel and light gray green metagabbro. 9½ minute run. 20.0 - 70.0 ft. Light gray green metagabbro.
RCH 6	25			3.90 78%			RCH 6 Rec. 3.9 ft. of light gray green metagabbro. 19½ minute run.
RCH 7	30			4.10 82%			RCH 7 Rec. 4.1 ft. of light gray green metagabbro. 24 minute run.

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. SI-A1	Date: November 2004	Sheet 2 of 3
Boring Location: STA 108+06, 9 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-2 Unimog / Driller: Crux Subsurface	Boring Began: 11/18/04	Completed: 11/19/04	
Field Logged By: S. Deppmeier	Ground Elev: 388.7 ft.	Weather: Showers to PC	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 8	35			3.40 68%			RCH 8 Rec. 3.4 ft. of light gray green metagabbro. 24 minute run.
RCH 9	40			4.10 82%			RCH 9 Rec. 4.1 ft. of light gray green metagabbro. 22 minute run.
RCH 10	45			4.70 94%			RCH 10 Rec. 4.7 ft. of light gray green metagabbro. 21½ minute run.
RCH 11	50			3.70 74%			RCH 11 Rec. 3.7 ft. of light gray green metagabbro. 18 minute run.
RCH 12	55			1.40 28%			RCH 12 Rec. 1.4 ft. of light gray green metagabbro. 37½ minute run.
RCH 13	60			2.00 40%			RCH 13 Rec. 2 ft. of light gray green metagabbro. 10 minute run.

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. SI-A1	Date: November 2004	Sheet 3 of 3
Boring Location: STA 108+06, 9 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-2 Unimog / Driller: Crux Subsurface	Boring Began: 11/18/04	Completed: 11/19/04	
Field Logged By: S. Deppmeier	Ground Elev: 388.7 ft.	Weather: Showers to PC	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 14	65			3.40 68%			RCH 14 Rec. 3.4 ft. of light gray green metagabbro. 20 minute run.
RCH 15	*318.7* 70			3.00 100%			RCH 15 Rec. 3 ft. of light gray green metagabbro. 11 minute run.
	75						BHT at 70.0 ft.
	80						
	85						
	90						

YEH AND ASSOCIATES, INC. GEOTECHNICAL ENGINEERING CONSULTANTS	Project: South Fork Smith River Road, CA Project Number: 27-200 Date:	Boring: **07A-01** Sheet 1 of 1

Boring Began: 6/26/2007
Drilling Method: BX Wireline
Drill: GH-5 Viper
Driller: Salisbury & Associates
Logged By: B. Francis
Final By: B. Francis
Inclination: Vertical

Completed: 6/26/2007
Drill Bit: BX
Casing: Steel Casing
Weather: Partly cloudy and warm

Total Depth: 15.2 ft
Ground Elevation: 400.0 ft
Location: Station 105+50, offset 6' Rt
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
			43					**0.0 - 0.4 ft.** ASPHALT. **0.4 - 4.5 ft. sandy GRAVEL**, brown to dark gray, no plasticity, dry to damp, medium dense to very dense, subangular to angular, (landslide debris).	
			78						
395	5		100	33				**4.5 - 15.2 ft. GRANITIC GNEISS**, dark gray and white - black, predominantly decomposed to fresh, medium hard to very hard, joint spacing very close to close, moderate angle, open fractures, clay infilling, slightly rough surfaces.	
390	10		100	0				Shear Zone 11'-12.5'.	
			100	61					
385	15							Bottom of Hole at 15.2 ft.	
380	20								
375	25								

YEH AND ASSOCIATES, INC. GEOTECHNICAL ENGINEERING CONSULTANTS	Project: South Fork Smith River Road, CA Project Number: 27-200 Date:	Boring: **07A-02** Sheet 1 of 1

Boring Began: 6/26/2007
Drilling Method: BX Wireline
Drill: GH-5 Viper
Driller: Salisbury & Associates
Logged By: B. Francis
Final By: B. Francis
Inclination: Vertical

Completed: 6/26/2007
Drill Bit: BX
Casing: Steel Casing
Weather: Partly cloudy and warm

Total Depth: 9.8 ft
Ground Elevation: 417.0 ft
Location: Station 105+50, offset 30' Rt
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
			47					**0.0 - 1.8 ft. sandy GRAVEL**, brown to dark gray, no plasticity, dry to damp, medium dense to very dense, subangular to angular, (landslide debris).	
415			100	48				**1.8 - 9.8 ft. GRANITIC GNEISS**, dark gray and white - black, predominantly decomposed to slightly weathered, medium hard to very hard, joint spacing very close to close, low angle, open fractures, clay infilling, rough surfaces.	
	5							Shear Zone 6'-7'.	
410			91	23					
	10							Bottom of Hole at 9.8 ft.	
405									
	15								
400									
	20								
395									
	25								
390									

YEH AND ASSOCIATES, INC. GEOTECHNICAL ENGINEERING CONSULTANTS	Project: South Fork Smith River Road, CA Project Number: 27-200 Date:	Boring: **07A-03** Sheet 1 of 1

Boring Began: 6/27/2007
Drilling Method: BX Wireline
Drill: GH-5 Viper
Driller: Salisbury & Associates
Logged By: B. Francis
Final By: B. Francis
Inclination: Vertical

Completed: 6/27/2007
Drill Bit: BX
Casing: Steel Casing
Weather: Partly cloudy and warm

Total Depth: 28.0 ft
Ground Elevation: 404.0 ft
Location: Station 108+00, offset 35' Rt
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
			41					**0.0 - 8.0 ft. sandy GRAVEL**, brown to dark gray, no plasticity, dry to damp, very dense, subangular to angular, (landslide debris).	
400			100						
	5		0						
			17		4/50/6"	50/6"			
			100						
			100					**8.0 - 23.5 ft. SCHISTOSE GNEISS**, dark gray, predominantly decomposed to moderately weathered, medium hard, joint spacing very close, low angle, healed fractures, clay infilling, slightly rough surfaces.	
395	10		83	21					
			100	0				Shear Zone 11'-12'.	
390	15		95	33					
			73	0					
385	20		83	21				Shear Zone 18'-19'. Shear Zone 22'-22.8'.	
380	25		96	64				**23.5 - 28.0 ft. SCHISTOSE GNEISS**, dark gray, slightly weathered to fresh, very hard, joint spacing close to moderately close, high angle, open fractures, iron oxide stains, very rough surfaces.	
375								Bottom of Hole at 28.0 ft.	

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: South Fork Smith River Road, CA
Project Number: 27-200 Date:

Boring: **07A-04**
Sheet 1 of 1

Boring Began: 6/23/2007
Drilling Method: BX Wireline
Drill: GH-5 Viper
Driller: Salisbury & Associates
Logged By: B. Francis
Final By: B. Francis
Inclination: Vertical

Completed: 6/23/2007
Drill Bit: BX
Casing: Steel Casing
Weather: Partly cloudy and warm

Total Depth: 30.1 ft
Ground Elevation: 382.0 ft
Location: Station 109+60, offset 13' Rt
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
			14					**0.0 - 0.3 ft.** Asphalt.	
								0.3 - 30.1 ft. sandy GRAVEL with some silt, brown and white-brown, no plasticity, damp, medium dense to dense, subangular to angular.	
380			100						
			58						
			94						
	5		39						
375			91						
			48						
			100						
	10		77						
370			17						
	15		38						
365			74						
	20		70						
360			67						
	25		75						
355			38						
	30								

Bottom of Hole at 30.1 ft.

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-B1	Date: November 2004	Sheet 1 of 1
Boring Location: STA 308+45, 1 ft. LT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-2 Unimog / Driller: Crux Subsurface	Boring Began: 11/17/04	Completed: 11/17/04	
Field Logged By: S. Deppmeier	Ground Elev: 517.5 ft.	Weather: Sunny	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1				0.40 20%			0.0 - 3.0 ft. Silty sand and rock fragments. RCH 1 Rec. 0.4 ft. of gravel size rock fragments. 7 minute run.
SPT 1	*514.5*			0.40 40%		13/12/50-0	SPT 1 Rec. 0.4 ft. of mostly gravel size rock fragments.
RCH 2	5			4.00 100%			3.0 - 17.0 ft. Dark gray peridotite. RCH 2 Rec. 4 ft. of dark gray peridotite with serpentinite and iron oxide staining between joints. 10 minute run. Unconfined compressive strength = 5490 and 41,440 psi and unit weight = 175.3 and 177.8 pcf for (2) samples from 4.0 to 4.7 and from 5.5' to 6.1'.
RCH 3				1.70 94%			RCH 3 Rec. 1.7 ft. of dark gray peridotite with serpentinite and iron oxide staining between joints. 11 minute run.
RCH 4	10			2.90 91%			RCH 4 Rec. 2.9 ft. of dark gray peridotite with serpentinite and iron oxide staining between joints. 12 minute run.
RCH 5	15			5.00 100%			RCH 5 Rec. 5 ft. of dark gray peridotite with serpentinite and iron oxide staining between joints. 10 minute run.
	500.5						BHT at 17.0 ft.
	20						
	25						
	30						

BORING LOG SOUTHFORK.GPJ FHWA_CO.GDT 5/18/06

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: South Fork Smith River Road, CA
Project Number: 27-200 Date:

Boring: **07B-01**
Sheet 1 of 1

Boring Began: 6/19/2007
Drilling Method: BX Wireline
Drill: GH-5 Viper
Driller: Salisbury & Associates
Logged By: B. Francis
Final By: B. Francis
Inclination: Vertical

Completed: 6/19/2007
Drill Bit: BX
Casing: Steel Casing
Weather: Partly cloudy and warm

Total Depth: 25.4 ft
Ground Elevation: 505.0 ft
Location: Station 306+50, offset 18' Lt
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
			64					**0.0 - 18.0 ft. sandy GRAVEL**, dark brown and dark gray, no plasticity, damp, medium dense to very dense, subangular, (landslide debris).	
			54						
			51						
500	5								
			89						
495	10								
			65						
490	15		33						
			69						
			100	0				**18.0 - 25.4 ft. SCHISTOSE GNEISS**, gray and dark gray, slightly weathered, medium hard to hard, joint spacing very close to moderately close, moderate angle, open fractures, iron oxide infilling, slightly rough surfaces.	
485	20		100	70					
			100	32					
			73	18					
480	25								
								Bottom of Hole at 25.4 ft.	

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: South Fork Smith River Road, CA
Project Number: 27-200 Date:

Boring: **07B-02**
Sheet 1 of 1

Boring Began: 6/22/2007
Drilling Method: BX Wireline
Drill: GH-5 Viper
Driller: Salisbury & Associates
Logged By: B. Francis
Final By: B. Francis
Inclination: Vertical

Completed: 6/22/2007
Drill Bit: BX
Casing: Steel Casing
Weather: Partly cloudy and warm

Total Depth: 15.2 ft
Ground Elevation: 501.0 ft
Location: Station 306+00, offset 6' Rt
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
			60					**0.0 - 0.4 ft.** ASPHALT.	
500			100					**0.4 - 4.5 ft. sandy GRAVEL**, brown and dark gray, no plasticity, damp, dense to very dense, subangular to angular, (landslide debris).	
			54						
	5		75	30				**4.5 - 15.2 ft. SCHISTOSE GNEISS**, dark gray, predominantly decomposed to slightly weathered, medium hard to hard, joint spacing very close to close, low angle, open fractures, clay infilling, slightly rough surfaces. Shear Zone 6'-7'.	
495									
			100	62					
	10								
490									
			95	65					
	15								
								Bottom of Hole at 15.2 ft.	
485									
	20								
480									
	25								
475									

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: South Fork Smith River Road, CA
Project Number: 27-200 Date:

Boring: **07B-03**
Sheet 1 of 1

Boring Began: 6/25/2007
Drilling Method: BX Wireline
Drill: GH-5 Viper
Driller: Salisbury & Associates
Logged By: B. Francis
Final By: B. Francis
Inclination: 15

Completed: 6/25/2007
Drill Bit: BX
Casing: Steel Casing
Weather: Partly cloudy and warm

Total Depth: 15.2 ft
Ground Elevation: 517.0 ft
Location: Station 308+40, offset 6' Lt
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
			58					**0.0 - 0.3 ft.** ASPHALT. **0.3 - 4.0 ft. sandy GRAVEL**, brown and gray, no plasticity, damp, medium dense to very dense, subangular to angular, (landslide debris).	
	5		100	0				**4.0 - 9.0 ft. SCHISTOSE GNEISS**, dark gray with green, predominantly decomposed to moderately weathered, soft to medium hard, joint spacing very close, moderate angle, healed fractures, Serpentine infilling, slickensided.	
			100	0					
	10		100	78				**9.0 - 15.2 ft. SCHISTOSE GNEISS**, dark gray with green, moderately weathered to fresh, medium hard to very hard, joint spacing close to moderately close, moderate angle, healed fractures, Serpentine infilling, slickensided.	
			100	43					
	15							Bottom of Hole at 15.2 ft.	
	20								
	25								

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-C1	Date: November 2004	Sheet 1 of 1
Boring Location: STA 528+24, 5.5 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-2 Unimog / Driller: Crux Subsurface	Boring Began: 11/16/04	Completed: 11/16/04	
Field Logged By: S. Deppmeier	Ground Elev: 681.0 ft.	Weather: PC	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1	*680.6*			0.83 42%			0.0 - 0.4 ft. Asphalt pavement RCH 1 Rec. 0.83 ft. of asphalt pavement (4½") and brown sand and gravel (5½"). 0.4 - 14.5 ft. Sand and gravel, minor clay.
SPT 1			GP-GC	0.90 100%		15/50-5"	SPT 1 Rec. 0.9 ft. of brown sandy gravel and clay.
RCH 2	5			0.40 10%			RCH 2 Rec. 0.4 ft. of brown sand and gravel.
SPT 2				0.00 0%		4/3/4	SPT 2 No recovery.
RCH 3	10			0.50 14%			RCH 3 Rec. 0.5 ft. of brown sand and gravel.
SPT 3			GP-GC	0.40 57%		35/50-2"	SPT 3 Rec. 0.4 ft. of brown sandy gravel and clay.
RCH 4	*666.5* 15			2.40 56%			RCH 4 Rec. 2.4 ft. of green gray peridotitie. 14.5 - 22.0 ft. Green gray peridotite
RCH 5	20			3.10 62%	24		RCH 5 Rec. 3.1 ft. of green gray peridotitie.
RCH 6	*659* 25			5.00 100%	70		22.0 - 27.0 ft. Gray gabbro RCH 6 Rec. 5 ft. of gray gabbro.
	654 30						BHT at 30.0 ft.

BORING LOG SOUTHFORK.GPJ FHWA_CO.GDT 5/18/06

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-C2	Date: November 2004	Sheet 1 of 1
Boring Location: STA 525+55, 5 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 11/16/04	Completed: 11/16/04	
Field Logged By: C. Martinez	Ground Elev: 695.0 ft.	Weather: PC	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RUN 1							0.0 - 16.5 ft. Asphalt pavement (thickness not recorded), sand, gravels and rock fragments (cobbles), minor amount of silt. RUN 1 asphalt pavement and sandy gravel.
SPT 1			GM	0.50 33%		6/7/8	SPT 1 Rec. 0.5 ft. of brown sandy gravel, with some silt, sl. moist.
RUN 2							RUN 2 boulder size rock fragments. Lost water return at 4'.
RCH 1	5			1.00 25%			RCH 1 Rec. 1 ft. of sandy gravels and cobbles. 7½ minute run.
RCH 2	10			1.00 40%			RCH 2 Rec. 1 ft. of gravels. 3 minute run.
SPT 2				0.42 28%		4/8/20	SPT 2 Rec. 0.42 ft. of gravels.
RCH 3				1.00 100%			RCH 3 Rec. 1 ft. of sandy gravel and cobbles. 3½ minute run.
SPT 3			GM	0.50 33%		4/4/5	SPT 3 Rec. 0.5 ft. of brown sandy gravel, with some silt.
RCH 4	15 *678.5*			2.00 57%	14		RCH 4 Rec. 2 ft. of green gray peridotite. 16.5 - 28.5 ft. Green gray peridotite
RCH 5	20			2.75 55%	19		RCH 5 Rec. 2.75 ft. of green gray peridotite.
RCH 6	25 *666.5*			5.00 100%	16		RCH 6 Rec. 5 ft. of green gray peridotite.
	30						BHT at 28.5 ft.

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-C3	Date: November 2004	Sheet 1 of 2
Boring Location: STA 512+12, 0.5 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-2 Unimog / Driller: Crux Subsurface	Boring Began: 11/16/04	Completed: 11/17/04	
Field Logged By: S. Deppmeier	Ground Elev: 733.5 ft.	Weather: PC	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1				1.00 50%			0.0 - 34.1 ft. brown sandy gravel with silt/clay. RCH 1 Rec. 1 ft. of brown sand and gravel.
SPT 1				0.60 40%		30/30/50	SPT 1 Rec. 0.6 ft. of brown sandy gravel, trace of clay.
RCH 2	5			0.50 14%			RCH 2 Rec. 0.5 ft. of brown sandy gravel with clay.
SPT 2				0.40 27%		30/27/27	SPT 2 Rec. 0.4 ft. of brown sandy gravel with clay.
RCH 3	10			0.40 11%			RCH 3 Rec. 0.4 ft. of gravel pieces. Blocked off at 10'.
SPT 3			GC-GM	0.90 60%		10/16/17	SPT 3 Rec. 0.9 ft. of brown sandy gravel with clay.
RCH 4	15			0.80 23%			RCH 4 Rec. 0.8 ft. of brown sandy gravel with clay. 15½ minute run.
SPT 4			GC-GM	0.33 83%		50-5"	SPT 4 Rec. 0.33 ft. of brown sandy gravel with clay.
RCH 5	20			0.33 7%			RCH 5 Rec. 0.33 ft. of brown sandy gravel with clay.
SPT 5			GC-GM	0.80 53%		8/10/12	SPT 5 Rec. 0.8 ft. of brown sandy gravel with silt/clay.
RCH 6	25			0.25 7%			RCH 6 Rec. 0.25 ft. of brown sandy gravel with silt/clay. 9 minute run.
SPT 6				0.00 0%		8/13/11	SPT 6 No recovery.
	30						RCH 7 Rec. 0.33 ft. of brown sandy gravel with silt/clay. 13 minute run.

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-C3	Date: November 2004	Sheet 2 of 2
Boring Location: STA 512+12, 0.5 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-2 Unimog / Driller: Crux Subsurface	Boring Began: 11/16/04	Completed: 11/17/04	
Field Logged By: S. Deppmeier	Ground Elev: 733.5 ft.	Weather: PC	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 7				0.33 9%			
SPT 7			GC-GM	0.17 68%		50-3"	SPT 7 Rec. 0.17 ft. of brown sandy gravel with silt/clay.
RCH 8	*699.3* 35						RCH 8 brown sandy gravel with silt/clay to 34.1, then green gray metagabbro. 14 minute run. 34.1 - 42.0 ft. green gray metagabbro.
RCH 9	40 *691.5*						RCH 9 green gray metagabbro. 20 minute run.
	45 50 55 60						BHT at 42.0 ft.

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-C4	Date: November 2004	Sheet 1 of 1
Boring Location: STA 508+09, 1 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 11/16/04	Completed: 11/16/04	
Field Logged By: C. Martinez	Ground Elev: 754.4 ft.	Weather: PC	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RUN 1							0.0 - 19.0 ft. Asphalt pavement (thickness not recorded), sand, gravels and rock fragments (cobbles). RUN 1 Asphalt pavement and sandy gravel and cobble-size rock fragments.
SPT 1				0.00 0%		4/3/5	SPT 1 No recovery.
RUN 2	5						RUN 2 sandy gravel and cobble-size rock fragments.
SPT 2			GC-GM	0.42 28%		6/7/5	SPT 2 Rec. 0.42 ft. of brown sandy gravel.
RUN 3	10						RUN 3 same as Run #2.
SPT 3			GC-GM	0.50 33%		11/13/27	SPT 3 Rec. 0.5 ft. of brown sandy gravel.
RUN 4	15						RUN 4 sandy gravel and cobble-size rock fragments.
SPT 4			GC-GM	0.50 33%		6/10/10	SPT 4 Rec. 0.5 ft. of brown sandy gravel.
RCH 1	*735.4* 20			4.30 86%	42		RCH 1 Rec. 4.3 ft. of gray gabbro, fine-grained, fractured. 8½ minute run. 19.0 - 28.5 ft. Gray gabbro
RCH 2	25			4.40 88%	38		RCH 2 Rec. 4.4 ft. of gray gabbro, fine-grained, fractured. 8½ minute run.
	725.9 30						BHT at 28.5 ft.

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-C5	Date: November 2004	Sheet 1 of 2
Boring Location: STA 510+50, 3.5 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 4500 Track / Driller: Crux Subsurface	Boring Began: 10/20/05	Completed: 10/20/05	
Field Logged By: Libby K. (Kleinfelder)	Ground Elev: ft.	Weather:	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1	0.7			1.00 18%			0.0 - 0.7 ft. Asphalt pavement RCH 1 Rec. 1 ft. of asphalt pavement (8") and fill (4"). 0.7 - 22.0 ft. clay and sand, gravels, cobble and boulder size rock fragments.
SPT 1	5			0.00 0%		2/5/6	SPT 1 No recovery.
RCH 2				1.17 33%			RCH 2 Rec. 1.17 ft. of gravel comprised of schist, gabbro and serpentinite with gray brown to tan clay and sand with some cobbles and boulders.
SPT 2	10			0.17 11%		6/4/5	SPT 2 Rec. 0.17 ft. of gravel and gray to tan clay and sand.
RCH 3				1.10 31%			RCH 3 Rec. 1.1 ft. of gravel comprised of schist, gabbro and serpentinite with gray brown to tan clay and sand with some cobbles and boulders.
SPT 3	15		SC	1.17 78%		7/16/29	SPT 3 Rec. 1.17 ft. of rock fragments comprised of schist, gabbro and serpentinite with gray brown to tan clayey sand.
RCH 4				2.40 69%			RCH 4 Rec. 2.4 ft. of gravel comprised of schist, gabbro and serpentinite with gray brown to tan clay and sand with some cobbles and boulders.
SPT 4	20			0.67 45%		12/23/49	SPT 4 Rec. 0.67 ft. of gravel comprised of schist, gabbro and serpentinite with gray brown to tan clay and sand with some cobbles and boulders.
RCH 5	22 24			3.00 86%			22.0 - 24.0 ft. Gray and white schist RCH 5 Rec. 3 ft. of gray and white schist, hard, sl. fractured to 24' and dark gray and white gabbro and serpentinite with tan clay and sand infilling from 24' to 25.5'. Unconfined compressive strength = 15.5 ksi and unit weight = 192.3 pcf for sample from 23' to 24.5'.
SPT 5	25			0.00 0%		50-4"	24.0 - 55.5 ft. Dark gray (and white) gabbro SPT 5 No recovery.
RCH 6				1.75 37%			RCH 6 Rec. 1.75 ft. of dark gray and white gabbro and serpentinite with tan clay and sand infilling.
	30						

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-C5	Date: November 2004	Sheet 2 of 2
Boring Location: STA 510+50, 3.5 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 4500 Track / Driller: Crux Subsurface	Boring Began: 10/20/05	Completed: 10/20/05	
Field Logged By: Libby K. (Kleinfelder)	Ground Elev: ft.	Weather:	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
SPT 6				0.00 0%		50-3"	SPT 6 No recovery.
RCH 7	35			2.75 58%			RCH 7 Rec. 2.75 ft. of dark gray and white gabbro, hard, unfractured from 31' to 32.5' and dark gray gabbro, highly fractured with serpentinite with tan clay infilling from 32.5' to 35.5'.
SPT 7				0.00 0%		18/30/50	SPT 7 No recovery.
RCH 8				1.42 95%	0		RCH 8 Rec. 1.42 ft. of dark gray gabbro, highly fractured with gabbro and serpentinite with tan clay infilling.
RCH 9	40			1.50 75%	0		RCH 9 Rec. 1.5 ft. of dark gray gabbro, highly fractured with gabbro and serpentinite with tan clay infilling.
RCH 10	45			3.10 62%	20		RCH 10 Rec. 3.1 ft. of dark gray gabbro, highly fractured with gabbro and serpentinite with tan clay infilling.
RCH 11				2.67 107%	27		RCH 11 Rec. 2.67 ft. of dark gray gabbro, highly fractured with gabbro and serpentinite with tan clay infilling.
RCH 12	50			2.30 92%	0		RCH 12 Rec. 2.3 ft. of dark gray gabbro, highly fractured with gabbro and serpentinite with tan clay infilling.
RCH 13				2.42 97%	0		RCH 13 Rec. 2.42 ft. of dark gray gabbro, highly fractured with gabbro and serpentinite with tan clay infilling.
RCH 14	55			2.42 97%	17		RCH 14 Rec. 2.42 ft. of dark gray gabbro, highly fractured with gabbro and serpentinite with tan clay infilling.
	55.5						BHT at 55.5 ft.
	60						

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)		Boring No. B-C6	Date: November 2004	Sheet 1 of 2
Boring Location: STA 519+29, 4 ft. RT		Type of Boring: Wireline Core		
Coordinates:		Casing Used:	Size:	
Drill: Burley 5500-1 Track	Driller: Crux Subsurface	Boring Began: 10/11/05	Completed: 10/11/05	
Field Logged By: J. Hunyadi (Kleinfelder)		Ground Elev: ft.	Weather: sunny, warm	
Revisions/Final By: C. Martinez		Water Depth:		
		Date:		
		Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1	0.5			1.25 33%			0.0 - 0.5 ft. Asphalt pavement RCH 1 Rec. 1.25 ft. of asphalt pavement (6") and light gray metagabbro fragments and light brown silty sand. 5 minute run. 0.5 - 53.8 ft. Light gray metagabbro fragments and light brown silty sand.
SPT 1				0.67 50%		7/24/50-4"	SPT 1 Rec. 0.67 ft. of light gray metagabbro gravel-size fragments and light brown silty sand.
RCH 2	5			2.57 70%			RCH 2 Rec. 2.57 ft. of light gray metagabbro rock fragments and light brown silty sand.
SPT 2	10		GP-GC	0.25 17%		4/4/4	SPT 2 Rec. 0.25 ft. of light gray sandy gravel with some silt, moist.
RCH 3				2.00 57%			RCH 3 Rec. 2 ft. of light gray metagabbro fragments and brown silty sand.
SPT 3	15		GP-GC	0.42 28%		8/9/6	SPT 3 Rec. 0.42 ft. of light gray sandy gravel with some silt.
RCH 4				3.00 86%	0		RCH 4 Rec. 3 ft. of light gray metagabbro fragments and light brown silty sand.
SPT 4	20		GP-GC	0.42 28%		7/9/7	SPT 4 Rec. 0.42 ft. of light gray sandy gravel with some silt.
RCH 5				2.08 59%			RCH 5 Rec. 2.08 ft. of light gray metagabbro fragments and light brown silty sand.
SPT 5	25		GP-GC	0.42 28%		6/11/37	SPT 5 Rec. 0.42 ft. of light gray sandy gravel with some silt.
RCH 6				2.83 81%	24		RCH 6 Rec. 2.83 ft. of light gray metagabbro fragments and light brown silty sand.
SPT 6	30			0.50 33%		34/9/10	SPT 6 Rec. 0.5 ft. of light brown silty sand.

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-C6	Date: November 2004	Sheet 2 of 2
Boring Location: STA 519+29, 4 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 10/11/05	Completed: 10/11/05	
Field Logged By: J. Hunyadi (Kleinfelder)	Ground Elev: ft.	Weather: sunny, warm	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 7				3.00 86%	33		RCH 7 Rec. 3 ft. of light gray metagabbro fragments and light brown silty sand.
SPT 7	35			0.33 22%		14/47/28	SPT 7 Rec. 0.33 ft. of light gray metagabbro fragments and light brown silty sand.
RCH 8				2.67 76%	17		RCH 8 Rec. 2.67 ft. of light gray metagabbro fragments and light brown silty sand.
SPT 8	40			0.38 25%		8/4/5	SPT 8 Rec. 0.38 ft. of light gray metagabbro, fractured, mixed with light brown silty sand.
RCH 9				2.42 69%	0		RCH 9 Rec. 2.42 ft. of light gray metagabbro fragments and light brown silty sand.
SPT 9	45			0.50 33%		5/7/9	SPT 9 Rec. 0.5 ft. of light gray metagabbro fragments and light brown silty sand.
RCH 10				3.50 100%	20		RCH 10 Rec. 3.5 ft. of light gray metagabbro fragments and light brown silty sand.
SPT 10	50			0.33 22%		25/37/14	SPT 10 Rec. 0.33 ft. of light gray metagabbro fragments and light brown silty sand.
RCH 11	*53.8*			3.33 95%	26		RCH 11 Rec. 3.33 ft. of light gray metagabbro fragments and light brown silty sand. 17 minute run.
	55						BHT at 53.8 ft.
	60						

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)		Boring No. B-C7	Date: November 2004	Sheet 1 of 2
Boring Location: STA 523+40, 2.5 ft. RT		Type of Boring: Wireline Core		
Coordinates:		Casing Used:	Size:	
Drill: Burley 5500-1 Track	Driller: Crux Subsurface	Boring Began: 10/11/05	Completed: 10/12/05	
Field Logged By: J. Hunyadi (Kleinfelder)		Ground Elev: ft.	Weather: sunny, warm	
Revisions/Final By: C. Martinez		Water Depth:		
		Date:		
		Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1 SPT 1	0.4 / 1		GM	2.25 56% 0.58 11%		4/4/2	0.0 - 0.4 ft. Asphalt pavement. RCH 1 Rec. 2.25 ft. of asphalt pavement (5"), gravel base (7") and light brown silty sand and rock fragments. SPT 1 Rec. 0.58 ft. of light brown silty sand and gravel, moist. 0.4 - 1.0 ft. Base course 1.0 - 36.5 ft. Light gray metagabbro fragments and light brown silty sand.
	5						
RCH 2				1.83 52%	12		RCH 2 Rec. 1.83 ft. of light brown silty sand and boulder-size rock fragments.
SPT 2	10			0.21 14%		5/5/17	SPT 2 Rec. 0.21 ft. of light brown silty sand.
RCH 3				2.33 67%	0		RCH 3 Rec. 2.33 ft. of light gray schist fragments with light brown silty sand.
SPT 3	15		GM	0.42 28%		5/6/6	SPT 3 Rec. 0.42 ft. of light brown silty sand and gravel, moist.
RCH 4				2.75 79%	0		RCH 4 Rec. 2.75 ft. of light to dark gray metagabbro, extensively fractured, weathered, brown silty sand infilling.
SPT 4	20		GM	0.58 39%		8/8/10	SPT 4 Rec. 0.58 ft. of light brown silty sand and gravel, moist.
RCH 5				1.92 55%	12		RCH 5 Rec. 1.92 ft. of light gray metagabbro fragments and light brown silty sand.
SPT 5	25			0.25 17%		5/10/11	SPT 5 Rec. 0.25 ft. of gravel.
RCH 6				2.75 79%	14		RCH 6 Rec. 2.75 ft. of light gray metagabbro fragments and light brown silty sand.
SPT	30		GM	0.42		5/10/11	SPT 6 Rec. 0.42 ft. of light brown silty sand and gravel, moist.

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-C7	Date: November 2004	Sheet 2 of 2
Boring Location: STA 523+40, 2.5 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 10/11/05	Completed: 10/12/05	
Field Logged By: J. Hunyadi (Kleinfelder)	Ground Elev: ft.	Weather: sunny, warm	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
6				28%			
RCH 7				2.17 62%	12		RCH 7 Rec. 2.17 ft. of light gray metagabbro fragments and light brown silty sand.
SPT 7				0.08 19%		50-5"	SPT 7 Rec. 0.08 ft. of broken rock fragments.
RCH 8	35 36.5			3.75 82%	44		RCH 8 Rec. 3.75 ft. of light gray metagabbro fragments and light light gray metagabbro to 36.5' and light gray metagabbro from 36.5' to 39'. 16 minute run. Estimated unconfined compressive strength from point load test = ksi for sample from 37.5' to 38'. 36.5 - 44.0 ft. Light gray metagabbro.
RCH 9	40 44			5.00 100%	100		RCH 9 Rec. 5 ft. of light gray metagabbro, fractured, near vertical joints, iron oxide staining on joints, quartzite seam in joint at 42'. 14 minute run.
	45 50 55 60						BHT at 44.0 ft.

BORING LOG

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CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. SI-C1	Date: November 2004	Sheet 1 of 2
Boring Location: STA 520+96, 18 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 11/18/04	Completed: 11/19/04	
Field Logged By: C. Martinez	Ground Elev: 701.9 ft.	Weather: Showers to PC	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RUN 1	*701.3*						0.0 - 0.6 ft. Asphalt pavement RUN 1 asphalt pavement (7") and brown sand and gravel. 8 minute run. 0.6 - 34.8 ft. Sand, gravel, cobble and boulder size rock fragments.
RUN 2	5						RUN 2 brown sand and gravel.
RUN 3	10						RUN 3 gravel to boulder size rock fragments.
RUN 4	15						RUN 4 gravel to cobble-size rock fragments.
RUN 5	20						RUN 5 gravel to cobble-size rock fragments.
RCH 1	25			1.80 36%			RCH 1 Rec. 1.8 ft. of concrete crib (from existing retaining wall) and sandy gravel.
	30						RCH 2 Rec. 1.5 ft. of gravel and cobble-size rock fragments. 9½ minute run.

BORING LOG

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FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. SI-C1	Date: November 2004	Sheet 2 of 2
Boring Location: STA 520+96, 18 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 11/18/04	Completed: 11/19/04	
Field Logged By: C. Martinez	Ground Elev: 701.9 ft.	Weather: Showers to PC	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 2				1.50 30%			
RCH 3	*667.1* 35						RCH 3 gravel and cobble-size rock fragments (1.0') and 3.7' of gray (gneissic) metagabbro. 9½ minute run. 34.8 - 50.0 ft. Gray (gneissic) metagabbro.
RCH 4	40			5.00 100%	66		RCH 4 Rec. 5 ft. of gray (gneissic) metagabbro.
RCH 5	45			5.00 100%	80		RCH 5 Rec. 5 ft. of gray (gneissic) metagabbro.
RCH 6	*651.9* 50			1.50 100%	80		RCH 6 Rec. 1.5 ft. of gray (gneissic) metagabbro.
	55						BHT at 50.0 ft.
	60						

BORING LOG

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CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)		Boring No. SI-C2	Date: November 2004	Sheet 1 of 2
Boring Location: STA 519+80, 12 ft. RT		Type of Boring: Wireline Core		
Coordinates:		Casing Used:	Size:	
Drill: Burley 4500 Track	Driller: Crux Subsurface	Boring Began: 10/19/05	Completed: 10/19/05	
Field Logged By: Libby K. (Kleinfelder)		Ground Elev: ft.	Weather: cloudy, rainy	
Revisions/Final By: C. Martinez		Water Depth:		
		Date:		
		Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1	0.4			2.75 50%			0.0 - 0.4 ft. Asphalt pavement RCH 1 Rec. 2.75 ft. of asphalt pavement (5") and fill consisting of gravels and light brown silty sand. 0.4 - 12.0 ft. Silty sand and rock fragments
	5						
SPT 1				0.17 11%		8/3/10	SPT 1 Rec. 0.17 ft. of fractured metagabbro (rock fragments?).
RCH 2				1.67 48%			RCH 2 Rec. 1.67 ft. of fractured metagabbro (rock fragments?).
	10						
SPT 2				0.17 11%		17/31/18	SPT 2 Rec. 0.17 ft. of fractured metagabbro (rock fragments?).
	12						
RCH 3				3.17 91%			12.0 - 50.0 ft. Light gray metagabbro. RCH 3 Rec. 3.17 ft. of fractured metagabbro (rock fragments?) to 12' and light gray metagabbro, highly fractured with tan silty sand from 12' to 15.5'. Unconfined compressive strength = 24.1 ksi and unit weight = 191.9 pcf for sample from 13' to 14'.
	15						
SPT 3			GP-GM	0.33 22%		15/14/13	SPT 3 Rec. 0.33 ft. of light gray metagabbro, highly fractured with tan silty sand.
RCH 4				1.67 48%			RCH 4 Rec. 1.67 ft. of light gray metagabbro, highly fractured tan silty sand with serpentinite and gabbro seams, moderately hard.
	20						
SPT 4			GP-GM	0.42 28%		12/13/10	SPT 4 Rec. 0.42 ft. of light gray metagabbro, highly fractured tan silty sand with serpentinite and gabbro seams, moderately hard.
RCH 5				1.58 63%			RCH 5 Rec. 1.58 ft. of light gray metagabbro, highly fractured tan silty sand with serpentinite and gabbro seams, moderately hard.
RCH 6				0.17 17%			RCH 6 Rec. 0.17 ft. of light gray metagabbro, highly fractured tan silty sand with serpentinite and gabbro seams, moderately hard.
	25						
SPT 5			GP-GM	0.17 11%		9/16/15	SPT 5 Rec. 0.17 ft. of light gray metagabbro, highly fractured tan silty sand with serpentinite and gabbro seams, moderately hard.
RCH 7				2.00 57%			RCH 7 Rec. 2 ft. of light gray metagabbro, highly fractured tan silty sand with serpentinite and gabbro seams, moderately hard.
	30						

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CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. SI-C2	Date: November 2004	Sheet 2 of 2
Boring Location: STA 519+80, 12 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 4500 Track / Driller: Crux Subsurface	Boring Began: 10/19/05	Completed: 10/19/05	
Field Logged By: Libby K. (Kleinfelder)	Ground Elev: ft.	Weather: cloudy, rainy	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
SPT 6			GP-GM	0.33 22%		21/30/38	SPT 6 Rec. 0.33 ft. of light gray metagabbro, highly fractured tan silty sand with serpentinite and gabbro seams, moderately hard.
RCH 8	35			2.00 57%			RCH 8 Rec. 2 ft. of light gray metagabbro, highly fractured tan silty sand with serpentinite and gabbro seams, moderately hard.
SPT 7			GP-GM	0.50 33%		8/10/22	SPT 7 Rec. 0.5 ft. of light gray metagabbro, highly fractured tan silty sand with serpentinite and gabbro seams, moderately hard.
RCH 9				0.70 100%	0		RCH 9 Rec. 0.7 ft. of light gray metagabbro, highly fractured tan silty sand with serpentinite and gabbro seams, moderately hard.
RCH 10	40			2.75 98%	39		RCH 10 Rec. 2.75 ft. of light gray metagabbro, highly fractured tan silty sand with serpentinite and gabbro seams, moderately hard.
SPT 8				0.00 0%		50-4"	SPT 8 No recovery.
RCH 11	45			3.00 64%	9		RCH 11 Rec. 3 ft. of light gray metagabbro, highly fractured tan silty sand with serpentinite and gabbro seams, moderately hard.
RCH 12	50			3.67 82%	0		RCH 12 Rec. 3.67 ft. of light gray metagabbro, highly fractured tan silty sand with serpentinite and gabbro seams, moderately hard.
	50						BHT at 50.0 ft.
	55						
	60						

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CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. SI-C3	Date: November 2004	Sheet 1 of 2
Boring Location: STA 520+20, 16 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 10/19/05	Completed: 10/19/05	
Field Logged By: J. Hunyadi (Kleinfelder)	Ground Elev: ft.	Weather: cloudy, rainy	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1	0.7			2.92 73%			0.0 - 0.7 ft. Asphalt pavement RCH 1 Rec. 2.92 ft. of asphalt pavement (8"), light gray gabbro (fragments?) infilled with light brown silty sand. 8 minute run. 0.7 - 11.5 ft. Silty sand with cobble and boulder size rock fragments.
SPT 1	5			0.58 39%		6/5/6	SPT 1 Rec. 0.58 ft. of small gravels (schist) infilled with light brown silty sand, moist.
RCH 2				2.75 79%			RCH 2 Rec. 2.75 ft. of cobbles and boulders (schist, gabbro and serpentinite) and light brown silty sand. 9 minute run.
SPT 2	10			0.58 39%		9/12/12	SPT 2 Rec. 0.58 ft. of light brown silty sand with cobble size rock fragments (schist).
RCH 3	11.5			2.25 64%			RCH 3 Rec. 2.25 ft. of light gray green metagabbro, mod. hard, mod. fractured, serpentinite staining on joints, some iron oxide staining and infilled with light brown silty sand. 9 minute run. 11.5 - 20.5 ft. light gray green metagabbro, fractured.
SPT 3	15			0.50 33%		17/6/15	SPT 3 Rec. 0.5 ft. of fractured metagabbro cobble-size rock fragments.
RCH 4				3.50 100%	43		RCH 4 Rec. 3.5 ft. of light gray green metagabbro, mod. hard, sl. weathered, 45° to near vertical joints, iron oxide staining and calcite infilling. 12 minute run.
SPT 4	20			0.83 55%		31/25/15	SPT 4 Rec. 0.83 ft. of light gray green metagabbro, fractured.
RCH 5	20.5 22			3.00 86%	0		20.5 - 22.0 ft. Sandy silt with cobble-size rock fragments. RCH 5 Rec. 3 ft. of light green sandy silt with cobble-size rock fragment of fractured sepentinite from 20.5' to 22' and light gray green metagabbro, mod. fractured, 45° to near vertical joints, iron oxide staining and calcite infilling. 22.0 - 44.0 ft. Light gray green metagabbro, fractured.
SPT 5				0.30 33%		28/50-5"	SPT 5 Rec. 0.3 ft. of light gray green metagabbro, fractured.
RCH 6	25			4.08 100%	35		RCH 6 Rec. 4.08 ft. of light gray green metagabbro, mod. hard, mod. fractured, 45° joints, iron oxide staining.
	30						RCH 7 Rec. 5 ft. of light gray green metagabbro, moderately hard, 45° to near vertical joints, sl. weathered.

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CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. SI-C3	Date: November 2004	Sheet 2 of 2
Boring Location: STA 520+20, 16 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 10/19/05	Completed: 10/19/05	
Field Logged By: J. Hunyadi (Kleinfelder)	Ground Elev: ft.	Weather: cloudy, rainy	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 7				5.00 100%	38		
RCH 8	35			5.00 100%	86		RCH 8 Rec. 5 ft. of light gray green metagabbro, hard, heavily sheared, sl. fractured.
RCH 9	40			5.00 100%	100		RCH 9 Rec. 5 ft. of light gray green metagabbro, hard to very hard, heavily sheared, fresh. Unconfined compressive strength = 18.3 ksi and unit weight = 184.5 pcf for sample from 39' to 39.7'.
	44 45						BHT at 44.0 ft.
	50						
	55						
	60						

BORING LOG

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CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. SI-C4	Date: November 2004	Sheet 1 of 2
Boring Location: STA 521+45, 17 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-2 Unimog / Driller: Crux Subsurface	Boring Began: 10/18/05	Completed: 10/18/05	
Field Logged By: Justin T. (Kleinfelder)	Ground Elev: ft.	Weather: clear, warm	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1	5			1.17 21%			0.0 - 7.0 ft. asphalt pavement and silty sand and gravel (fill). RCH 1 Rec. 1.17 ft. of asphalt pavement and fill. 25 minute run.
SPT 1	7			0.42 28%		10/14/19	SPT 1 Rec. 0.42 ft. of silty sand and gravel.
RCH 2	10			2.17 62%			7.0 - 52.5 ft. Light gray green metagabbro, infilled with light brown silt and sand. RCH 2 Rec. 2.17 ft. of light gray green metagabbro, fractured, iron staining with light brown silty sand. 22 minute run.
SPT 2				0.00 0%		7/8/11	SPT 2 No recovery.
RCH 3	15			1.58 45%			RCH 3 Rec. 1.58 ft. of light gray green metagabbro, fractured, iron staining with light brown silty sand. 16 minute run. Estimated unconfined compressive strength from point load test = 17.38 ksi for sample from 12.4' to 13'.
SPT 3				0.50 33%		23/15/16	SPT 3 Rec. 0.5 ft. of light gray green metagabbro, fractured, iron staining with light brown silty sand and a trace of serpentinite.
RCH 4	20			1.83 52%			RCH 4 Rec. 1.83 ft. of light gray green metagabbro, fractured, iron staining with light brown silty sand. 13 minute run.
SPT 4				0.50 33%		24/21/13	SPT 4 Rec. 0.5 ft. of light gray green metagabbro, fractured, iron staining with light brown silty sand.
RCH 5	25			1.92 55%			RCH 5 Rec. 1.92 ft. of light gray green metagabbro, fractured, iron staining with light brown silty sand. 10 minute run
SPT 5				0.00 0%		9/11/10	SPT 5 No recovery.
RCH 6	30			2.25 64%	10		RCH 6 Rec. 2.25 ft. of light gray green metagabbro, fractured, with iron staining. 14 minute run. Estimated unconfined compressive strength from point load test = 15.13 ksi for sample from 28.5' to 29'.

BORING LOG

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Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. SI-C4	Date: November 2004	Sheet 2 of 2
Boring Location: STA 521+45, 17 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-2 Unimog / Driller: Crux Subsurface	Boring Began: 10/18/05	Completed: 10/18/05	
Field Logged By: Justin T. (Kleinfelder)	Ground Elev: ft.	Weather: clear, warm	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
SPT 6				0.25 50%		50-6"	SPT 6 Rec. 0.25 ft. of light gray green metagabbro.
RCH 7				3.83 96%	29		RCH 7 Rec. 3.83 ft. of light gray green metagabbro, fractured, infilled with light brown silt. 10 minute run.
SPT 7	35					50-0	SPT 7 Bouncing on rock.
RCH 8				2.83 94%	0		RCH 8 Rec. 2.83 ft. of light gray green metagabbro, fractured, infilled with light brown silt.
RCH 9				1.33 67%	0		RCH 9 Rec. 1.33 ft. of light gray green metagabbro, fractured, infilled with light brown silt.
RCH 10	40			1.42 28%	0		RCH 10 Rec. 1.42 ft. of light gray green metagabbro, fractured, infilled with light brown silt.
RCH 11	45			2.67 67%	35		RCH 11 Rec. 2.67 ft. of light gray green metagabbro, fractured, infilled with light brown silt.
RCH 12	50			2.17 62%	14		RCH 12 Rec. 2.17 ft. of light gray green metagabbro, fractured, infilled with light brown silt.
	52.5						BHT at 52.5 ft.
	55						
	60						

BORING LOG

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FEDERAL HIGHWAY ADMINISTRATION
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Project Name: South Fork Smith River Road, CA PFH 112-1(1)		Boring No. SI-C5	Date: November 2004	Sheet 1 of 2
Boring Location: STA 521+85, 14 ft. RT		Type of Boring: Wireline Core		
Coordinates:		Casing Used:	Size:	
Drill: Burley 5500-1 Track	Driller: Crux Subsurface	Boring Began: 10/18/05	Completed: 10/18/05	
Field Logged By: J. Hunyadi (Kleinfelder)		Ground Elev: ft.	Weather: clear, warm	
Revisions/Final By: C. Martinez		Water Depth:		
		Date:		
		Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1	0.3			2.25 56%			0.0 - 0.3 ft. Asphalt pavement RCH 1 Rec. 2.25 ft. of asphalt pavement (4"), gravel fill (6") and boulders mixed with silty sand. 9 minute run. 0.3 - 16.0 ft. Light brown silty sand and cobble and boulder size rock fragments.
SPT 1	5			0.00 0%		9/35/41	SPT 1 No recovery.
RCH 2				1.83 52%			RCH 2 Rec. 1.83 ft. of silty sand and rock fragments. 10 minute run.
SPT 2	10			0.00 0%		5/6/5	SPT 2 No recovery.
RCH 3				2.67 76%	0		RCH 3 Rec. 2.67 ft. of small gravels and cobbles mixed with light brown silty sand. 12 minute run.
SPT 3	15			0.42 28%		5/5/12	SPT 3 Rec. 0.42 ft. of rock (gabbro) fragments.
RCH 4	16			2.75 79%	0		RCH 4 Rec. 2.75 ft. of light gray green metagabbro, mod. fractured, near vertical joints with iron oxide staining and infilled with calcite and light brown silty sand. 13 minute run. 16.0 - 52.5 ft. Light gray green metagabbro.
SPT 4	20			0.42 28%		7/8/8	SPT 4 Rec. 0.42 ft. of broken light gray green metagabbro with light brown silty sand.
RCH 5				2.66 76%	0		RCH 5 Rec. 2.66 ft. of light gray green metagabbro, some gabbro, hard, mod. fractured, sl. weathered, interspersed with gabbro gravels and light brown silty sand. 10 minute run.
SPT 5	25			0.58 39%		9/10/14	SPT 5 Rec. 0.58 ft. of broken light gray green metagabbro with light brown silty sand.
RCH 6				3.00 86%	12		RCH 6 Rec. 3 ft. of light gray green metagabbro, hard, fractured, sl. weathered pieces of rock, with light brown silty sand.
SPT	30			0.42		10/11/14	SPT 6 Rec. 0.42 ft. of rock fragments consisting of gabbro with light brown silty sand.

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. SI-C5	Date: November 2004	Sheet 2 of 2
Boring Location: STA 521+85, 14 ft. RT	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 10/18/05	Completed: 10/18/05	
Field Logged By: J. Hunyadi (Kleinfelder)	Ground Elev: ft.	Weather: clear, warm	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
6				28%			
RCH 7				2.67 76%	0		RCH 7 Rec. 2.67 ft. of light gray green metagabbro and light gray gabbro cobble and boulder size rock fragments infilled with light brown silty sand.
SPT 7	35			0.17 11%		12/15/17	SPT 7 Rec. 0.17 ft. of rock fragments consisting of gabbro.
RCH 8				2.08 59%	0		RCH 8 Rec. 2.08 ft. of light gray green metagabbro, hard, fractured, with light brown to tan silty sand.
SPT 8	40			0.50 33%		7/15/19	SPT 8 Rec. 0.5 ft. of rock fragments consisting of metagabbro.
RCH 9				2.25 64%	11		RCH 9 Rec. 2.25 ft. of light gray green metagabbro, hard, highly fractured, with light brown silty sand.
RCH 10	45			5.00 100%	63		RCH 10 Rec. 5 ft. of light gray green metagabbro, mod. hard, highly fractured, 45° to near vertical joints, infilled with calcite, quartz and some iron oxide staining.
RCH 11	50			3.00 86%	0		RCH 11 Rec. 3 ft. of light gray green metagabbro, soft, decomposed.
	52.5						BHT at 52.5 ft.
	55						
	60						

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)		Boring No. P-C5	Date: November 2004 / Sheet 1 of 2
Boring Location: STA 521+03, 18 ft. RT		Type of Boring: Wireline Core	
Coordinates:		Casing Used:	Size:
Drill: Burley 5500-1 Track	Driller: Crux Subsurface	Boring Began: 11/18/04	Completed: 11/18/04
Field Logged By: C. Martinez		Ground Elev: 701.8 ft.	Weather: Sunny
Revisions/Final By: C. Martinez		Water Depth:	
		Date:	
		Time:	

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1	*701.2*			2.60 74%			0.0 - 0.6 ft. Asphalt pavement RCH 1 Rec. 2.6 ft. of asphalt pavement (7") and brown sand and gravel. 8 minute run. 0.6 - 35.5 ft. Brown sand, gravels, cobbles and boulders
SPT 1			GP-GC	0.75 50%		6/7/8	SPT 1 Rec. 0.75 ft. of brown sand and gravel, sl. moist,
RCH 2	5			2.30 66%			RCH 2 Rec. 2.3 ft. of gravel to boulder size rock fragments. 9 minute run.
SPT 2				0.10 33%		5-4"/10-0	SPT 2 Rec. 0.1 ft. of gravels.
RCH 3	10			1.00 21%			RCH 3 Rec. 1 ft. of gravel to cobble-size rock fragments.
RCH 4	15			2.50 50%			RCH 4 Rec. 2.5 ft. of sand, gravel and cobble-size rock fragments. 6 minute run.
RCH 5	20			2.10 42%			RCH 5 Rec. 2.1 ft. of sand, gravel and cobble-size rock fragments. 9½ minute run.
RCH 6	25			2.80 56%			RCH 6 Rec. 2.8 ft. of gravel and cobble-size rock fragments. 9½ minute run.
	30						RCH 7 Rec. 3.8 ft. of gravel and cobble-size rock fragments. 9 minute run.

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)		Boring No. P-C5	Date: November 2004	Sheet 2 of 2
Boring Location: STA 521+03, 18 ft. RT		Type of Boring: Wireline Core		
Coordinates:		Casing Used:	Size:	
Drill: Burley 5500-1 Track	Driller: Crux Subsurface	Boring Began: 11/18/04	Completed: 11/18/04	
Field Logged By: C. Martinez		Ground Elev: 701.8 ft.	Weather: Sunny	
Revisions/Final By: C. Martinez		Water Depth:		
		Date:		
		Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 7				3.80 76%			
RCH 8	*666.3* 35 *663.3*			4.70 94%	68		RCH 8 Rec. 4.7 ft. of gravel and cobble-size rock fragments (1.0') and 3.7' of gray metagabbro. 9½ minute run. 35.5 - 38.5 ft. Gray metagabbro
	40 45 50 55 60						BHT at 38.5 ft.

BORING LOG SOUTHFORK.GPJ FHWA_CO.GDT 5/18/06

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: South Fork Smith River Road, CA
Project Number: 27-200 Date:

Boring: **07C-02**
Sheet 1 of 2

Boring Began: 6/28/2007
Drilling Method: BX Wireline
Drill: GH-5 Viper
Driller: Salisbury & Associates
Logged By: B. Francis
Final By: B. Francis
Inclination: Vertical

Completed: 6/29/2007
Drill Bit: BX
Casing: Steel Casing
Weather: Cool and Rain

Total Depth: 47.0 ft
Ground Elevation: 710.0 ft
Location: Station 521+70, offset 15' Rt of exis. EOP
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
			29					**0.0 - 9.0 ft. silty SAND** with some gravel, brown and brown-white, no plasticity, damp, medium dense, subangular, (landslide debris).	
			46						
705	5								
			43						
			68					**9.0 - 41.0 ft. silty GRAVEL** with some sand and cobbles, brown and brown-white, no plasticity, damp, medium dense to very dense, subangular to angular, (landslide debris).	
700	10								
			88						
			32						
			42						
695	15								
			19						
			58						
			46						
690	20		67						
			35						
			48						
685	25		46						
			77						
			100						
			100						

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: South Fork Smith River Road, CA
Project Number: 27-200 Date:

Boring: **07C-02**
Sheet 2 of 2

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
			58						
			92						
			68						
675	35		64						
			50						
			59						
670	40		68						
			20					**41.0 - 47.0 ft. silty SAND** with some gravel, brown and dark gray, no plasticity, damp, dense, subrounded to subangular, (landslide debris).	
665	45		21						
								Bottom of Hole at 47.0 ft.	
660	50								
655	55								
650	60								
645	65								

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: South Fork Smith River Road, CA
Project Number: 27-200 Date:

Boring: **07C-03**
Sheet 1 of 1

Boring Began: 6/25/2007
Drilling Method: BX Wireline
Drill: GH-5 Viper
Driller: Salisbury & Associates
Logged By: B. Francis
Final By: B. Francis
Inclination: 50

Completed: 6/25/2007
Drill Bit: BX
Casing: Steel Casing
Weather: Partly cloudy and warm

Total Depth: 29.5 ft
Ground Elevation: 674.0 ft
Location: Station 529+50, offset 6' Rt
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
675			23					**0.0 - 29.5 ft. gravelly SAND**, brown and gray, no plasticity, damp, medium dense to very dense, subangular to angular, (landslide debris).	
	5		10						
680			40						
	10		53						
			83						
685			100						
	15		53						
			43						
	20		23						
690			38						
	25		38						
								Bottom of Hole at 29.5 ft.	

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: South Fork Smith River Road, CA
Project Number: 27-200 Date:

Boring: **07C-04**
Sheet 1 of 1

Boring Began: 6/28/2007
Drilling Method: BX Wireline
Drill: GH-5 Viper
Driller: Salisbury & Associates
Logged By: B. Francis
Final By: B. Francis
Inclination: Vertical

Completed: 6/28/2007
Drill Bit: BX
Casing: Steel Casing
Weather: Cool and Rain

Total Depth: 17.5 ft
Ground Elevation: 681.0 ft
Location: Station 529+40, offset 25' Rt
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
680			48					**0.0 - 17.5 ft. gravelly SAND** with some silt, brown and brown-white, no plasticity, damp, dense, subangular to subrounded, (landslide debris).	
			34						
	5								
675			25						
			23						
	10		21						
670									
			33						
	15								
665			38						
								Bottom of Hole at 17.5 ft.	Inner barrel dislodged, lost hole
	20								
660									
	25								
655									

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)		Boring No. B-D1	Date: November 2004	Sheet 1 of 1
Boring Location: STA 707+36, 4 ft. RT		Type of Boring: Wireline Core		
Coordinates:		Casing Used:	Size:	
Drill: Burley 5500-1 Track	Driller: Crux Subsurface	Boring Began: 11/17/04	Completed: 11/17/04	
Field Logged By: C. Martinez		Ground Elev: 648.1 ft.	Weather: Sunny	
Revisions/Final By: C. Martinez		Water Depth:		
		Date:		
		Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1	*647.8*			2.85 81%			0.0 - 0.3 ft. Asphalt pavement RCH 1 Rec. 2.85 ft. of asphalt pavement (3"), sandy gravel and cobble-size rock fragments (2.6'). Lost water return at 3'. 0.3 - 3.8 ft. Sandy gravel and rock fragments
SPT 1	*644.3*					10-0	SPT 1 Bouncing.
RCH 2	5			5.00 100%	95		RCH 2 Rec. 5 ft. of gravels (0.3') and gray (gneissic) metagabbro. 10½ minute run. 3.8 - 13.5 ft. Gray (gneissic) metagabbro
RCH 3	10			5.00 100%	31		RCH 3 Rec. 5 ft. of gray (gneissic) metagabbro. 9½ minute run.
	634.6						BHT at 13.5 ft.
	15						
	20						
	25						
	30						

BORING LOG SOUTHFORK.GPJ FHWA_CO.GDT 5/18/06

BORING LOG

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

Project Name: South Fork Smith River Road, CA PFH 112-1(1)	Boring No. B-D2	Date: November 2004	Sheet 1 of 1
Boring Location: STA 706+48, CL	Type of Boring: Wireline Core		
Coordinates:	Casing Used:	Size:	
Drill: Burley 5500-1 Track / Driller: Crux Subsurface	Boring Began: 11/17/04	Completed: 11/17/04	
Field Logged By: C. Martinez	Ground Elev: 648.1 ft.	Weather: Sunny	
Revisions/Final By: C. Martinez	Water Depth:		
	Date:		
	Time:		

Run/Samp No.	Depth *Elevation* (feet)	Graphic Log	U.S.C.S.	Length Recov. feet ----- % Rec.	RQD	SPT Blows per 6 in	Description: (Density, Color, Type, Moisture, Other)
RCH 1	*648*			1.60 46%			0.0 - 0.1 ft. Asphalt pavement RCH 1 Rec. 1.6 ft. of asphalt pavement (1.5"), and gravel and cobble-size rock fragments. 0.1 - 18.5 ft. Sandy gravel and rock fragments
SPT 1			GP-GC	0.10 7%		3/3/4	SPT 1 Rec. 0.1 ft. of sand and gravel.
	5						
RCH 2				1.30 37%			RCH 2 Rec. 1.3 ft. of sand and gravel. 6 minute run.
SPT 2			GP-GC	0.25 17%		7/6/5	SPT 2 Rec. 0.25 ft. of sand and gravel.
	10						
RCH 3				1.80 51%			RCH 3 Rec. 1.8 ft. of sand and gravel. 8 minute run.
SPT 3			GP-GC	0.50 33%		10/10/11	SPT 3 Rec. 0.5 ft. of sand and gravel.
	15						
RCH 4				2.50 71%			RCH 4 Rec. 2.5 ft. of sand and gravel. 9 minute run.
	629.6						
RCH 5				5.00 100%	48		18.5 - 23.5 ft. Gray (gneissic) metagabbro RCH 5 Rec. 5 ft. of gray (gneissic) metagabbro. 11 minute run.
	20						
	624.6						BHT at 23.5 ft.
	25						
	30						

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: South Fork Smith River Road, CA
Project Number: 27-200 Date:

Boring: **07D-01**
Sheet 1 of 1

Boring Began: 6/21/2007
Drilling Method: BX Wireline
Drill: GH-5 Viper
Driller: Salisbury & Associates
Logged By: B. Francis
Final By: B. Francis
Inclination: Vertical

Completed: 6/22/2007
Drill Bit: BX
Casing: Steel Casing
Weather: Partly cloudy and warm

Total Depth: 28.0 ft
Ground Elevation: 645.0 ft
Location: Station 706+05, offset 19' Rt
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 18.0 ft. gravelly SAND, brown, no plasticity, damp, loose*, subangular, (landslide debris).	Set Casing to 4.5'
640	5		17						
			28		3/2/3	5			*Drilling fluids infiltrated sample zone
635	10		17						
630	15		16						
			100	0				**18.0 - 28.0 ft. GRANITIC GNEISS**, dark gray and white - black, moderately weathered, medium hard, joint spacing close, moderate angle, open fractures, iron oxide infilling, rough surfaces.	
625	20		98	53				Shear Zone 23'-24'.	
620	25		100	63					
								Bottom of Hole at 28.0 ft.	

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: South Fork Smith River Road, CA
Project Number: 27-200 Date:

Boring: **07D-02**
Sheet 1 of 1

Boring Began: 6/20/2007
Drilling Method: BX Wireline
Drill: GH-5 Viper
Driller: Salisbury & Associates
Logged By: B. Francis
Final By: B. Francis
Inclination: Vertical

Completed: 6/20/2007
Drill Bit: BX
Casing: Steel Casing
Weather: Partly cloudy and warm

Total Depth: 15.7 ft
Ground Elevation: 643.0 ft
Location: Station 708+25, offset 18' Rt
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 6.0 ft. sandy GRAVEL with some clay, brown, no to medium plasticity, damp to moist*, very dense, angular, (landslide debris).	
640									
			83						Set casing to 4'
	5		46		26/50-5"	50-5"			*Drilling fluids infiltrated sampling zone
								6.0 - 15.7 ft. GRANITIC GNEISS white - black and dark gray, moderately weathered to slightly weathered, medium hard, joint spacing very close to close, low angle, clay infilling, slightly rough surfaces.	
635			100	56					
	10								
			100	61				Shear Zone 10.5'-11.5'.	
630			100	65					
	15								
								Bottom of Hole at 15.7 ft.	
625									
	20								
620									
	25								
615									

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: South Fork Smith River Road, CA
Project Number: 27-200 Date:

Boring: **07D-03**
Sheet 1 of 1

Boring Began: 6/21/2007
Drilling Method: BX Wireline
Drill: GH-5 Viper
Driller: Salisbury & Associates
Logged By: B. Francis
Final By: B. Francis
Inclination: Vertical

Completed: 6/21/2007
Drill Bit: BX
Casing: Steel Casing
Weather: Partly cloudy and warm

Total Depth: 10.2 ft
Ground Elevation: 645.0 ft
Location: Station 708+20, offset 7' Lt
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.3 ft. ASPHALT.	
			100					**0.3 - 2.5 ft. gravelly SAND** with some cobbles, brown and gray, no plasticity, damp, dense to very dense, subangular to angular.	
			83						
			100					**2.5 - 10.2 ft. SCHISTOSE GNEISS** dark gray and white, moderately weathered to slightly weathered, medium hard to hard, joint spacing very close to close, high angle, open fractures, clay infilling, slightly rough surfaces.	
640	5		100	53				Shear Zone 7'-8'.	
			100	73					
635	10							Bottom of Hole at 10.2 ft.	
630	15								
625	20								
620	25								

APPENDIX D – Laboratory Data

U.S. Department of Transportation
Federal Highway Administration

Central Federal Lands Highway Division Laboratory

An AASHTO and ISO Accredited Laboratory

AASHTO R18 ISO/IEC 17025

Report of Soil or Aggregate Tests

Project: California PFH 112-1 (1) South Fork Smith River

Submitted By: Charlie Martinez and Steve Deppmeier

Date Reported: 12/13/2004

Sample Number	Lab Number		04-1827-SB	04-1828-SB	04-1829-SB	04-1830-SB	04-1831-SB
	Field Number		B-A1 SPT 1,2,3	B-C1 SPT 1 & 3	B-C2 SPT 1 & 3	B-C3 SPT #3	B-C3 SPT 4,5,7
Sample Location	Station or Location		MP 3.85	MP 10.93	MP 11.02	MP 10.8	MP 10.8
	Offset		Left	3' Left	4' Left	4' Left	4' Left
	Depth		2.0'-13.5'	2.0'-12.7'	2.0'-15.0'	12.0'-13.5'	17.0'-32.25'
AASHTO T 11, T 27 & T 88 Washed Sieve Analysis % Passing	3"	75.0 mm					
	1 1/2"	37.5 mm	100				
	1"	25.0 mm	94	100	100	100	100
	3/4"	19.0 mm	82	90	96	83	95
	1/2"	12.5 mm	71	81	75	71	79
	3/8"	9.5 mm	63	72	66	62	62
	#4	4.75 mm	49	52	49	48	45
	#8	2.36 mm					
	#10	2.00 mm	36	37	37	38	36
	#16	1.18 mm	31	30	31	34	32
	#30	600 µm					
	#40	425 µm	24	21	23	26	27
	#50	300 µm					
	#100	150 µm	17	14	16	20	23
	#200	75 µm	14	11	13	17	21
		20 µm					
		2 µm					
		1 µm					
AASHTO T 255	Moisture, %						
AASHTO T 89 & T 90	Liquid Limit		25	NV	25	24	25
	Plasticity Index		6	NP	5	5	5
Soil Classification	AASHTO M 145		A-1-a (0)	A-1-a (0)	A-1-a (0)	A-1-b (0)	A-1-b (0)
	ASTM D 2487		GC-GM	GP-GC	GM	GC-GM	GC-GM
AASHTO T 190	R-Value						
AASHTO T 288	Min. Resistivity, ohm-cm						
AASHTO T 289	pH						
AASHTO Method	Optimum Moisture, %						
	Maximum Dry Density, pcf						

Distribution:

	Num. / Project File
Laboratory	Darrell Harding
Geotechnical	Charlie Martinez
Pavements	Steve Deppmeier
Materials	1 Copy

Remarks:

Reported By:

Darrell Harding

U.S. Department of Transportation
Federal Highway Administration

Central Federal Lands Highway Division Laboratory

An AASHTO and ISO Accredited Laboratory

AASHTO R18 ISO/IEC 17025

Report of Soil or Aggregate Tests

Project: California PFH 112-1 (1) South Fork Smith River

Submitted By: Charlie Martinez and Steve Deppmeier

Date Reported: 12/13/2004

Sample Number	Lab Number		04-1832-SB	04-1833-SB	04-1834-SB	04-1835-SB	04-1836-SB
	Field Number		B-C4 SPT 2,3,4	P-C5 SPT #1	B-D2 SPT 1,2,3	B-DN 1 SPT #2	B-DN 1 SPT 3,4
Sample Location	Station or Location		MP 10.7	MP 10.93	MP 13.5	Sta 2+15	Sta 2+15
	Offset		5' Left	3' Left	5' Right	6' Left	6' Left
	Depth		7.0'-18.5'	3.5'-5.0'	2.0'-15.0'	8.5'-10.0'	13.5'-20.0'
AASHTO T 11, T 27 & T 88 Washed Sieve Analysis % Passing	3"	75.0 mm					
	1 1/2"	37.5 mm	100	100	100		
	1"	25.0 mm	97	90	86	100	100
	3/4"	19.0 mm	88	78	76	94	99
	1/2"	12.5 mm	73	65	64	85	96
	3/8"	9.5 mm	64	59	53	78	94
	#4	4.75 mm	47	45	28	56	86
	#8	2.36 mm					
	#10	2.00 mm	36	32	19	44	70
	#16	1.18 mm	31	26	16	38	61
	#30	600 µm					
	#40	425 µm	23	19	11	27	43
	#50	300 µm					
	#100	150 µm	17	14	8	19	28
	#200	75 µm	14	11	6.1	14	19
		20 µm					
		2 µm					
		1 µm					
AASHTO T 255	Moisture, %						
AASHTO T 89 & T 90	Liquid Limit		25	24	24	25	NV
	Plasticity Index		5	5	5	6	NP
Soil Classification	AASHTO M 145		A-1-a (0)	A-1-a (0)	A-1-a (0)	A-1-a (0)	A-1-b (0)
	ASTM D 2487		GC-GM	GP-GC	GP-GC	GC-GM	SM
AASHTO T 190	R –Value						
AASHTO T 288	Min. Resistivity, ohm-cm						
AASHTO T 289	pH						
AASHTO Method	Optimum Moisture, %						
	Maximum Dry Density, pcf						

Distribution:

Laboratory	Num. / Project File Darrell Harding
Geotechnical	Charlie Martinez
Pavements	Steve Deppmeier
Materials	1 Copy

Remarks:

Reported By:

Darrell Harding

U.S. Department of Transportation
Federal Highway Administration

Central Federal Lands Highway Division Laboratory

An AASHTO and ISO Accredited Laboratory

Report of Soil or Aggregate Tests

AASHTO R18 ISO/IEC 17025

Project: California PFH 112-1 (1) South Fork Smith River Road

Submitted By: Daniel Alzamora

Date Reported: 12/29/2005

Sample Number	Lab Number		05-1481-SB	05-1482-SB	05-1483-SB	05-1485-SB	05-1487-SB
	Hole Number		B-A1	BA2	B-RC1	B-BC1	B-HG2
	Field Number		SPT # 3 & 4	SPT # 1,2,3	SPT # 1 & 2	SPT # 3 & 4	SPT # 1,2,3
Sample Location	Station or Location		107+00	109+00	207+75	408+20	808+40
	Offset				CL	CL	
	Depth	Feet	13-19.5	2.5-19	8-14.5	13-18.3	9-20.5
AASHTO T 11, T 27 & T 88 Washed Sieve Analysis % Passing	3"	75.0 mm					
	1 1/2"	37.5 mm	100	100	100		100
	1"	25.0 mm	86	72	91	100	91
	3/4"	19.0 mm	75	61	81	93	91
	1/2"	12.5 mm	58	56	72	89	86
	3/8"	9.5 mm	50	47	64	77	75
	#4	4.75 mm	35	33	52	58	60
	#8	2.36 mm					
	#10	2.00 mm	25	24	42	41	44
	#16	1.18 mm	21	21	37	32	37
	#30	600 µm					
	#40	425 µm	15	16	30	17	27
	#50	300 µm					
	#100	150 µm	10	12	23	11	19
	#200	75 µm	7.9	9.5	18	7.6	15
		20 µm					
		2 µm					
		1 µm					
AASHTO T 255	Moisture, %						
AASHTO T 89 & T 90	Liquid Limit			22			27
	Plasticity Index			5			4
Soil Classification	AASHTO M 145			A-1-a (0)			A-1-a (0)
	ASTM D 2487			GP-GC			SM
AASHTO T 190	R –Value						
AASHTO T 288	Min. Resistivity, ohm-cm						
AASHTO T 289	pH						
AASHTO Method	Optimum Moisture, %						
	Maximum Dry Density, pcf						

Distribution:

	Num. / Project File
Laboratory	Darrell Harding
Geotechnical	Daniel Alzamora
Materials	1 Copy

Remarks:
Where no liquid limit / plasticity index and classification appear, an insufficient amount of material was provided.

For all the samples, less than 10 % of the required quantity was furnished for gradation determination.

Reported By:

Darrell Harding

US Department of Transportation
Federal Highway Administration

Central Federal Lands Highway Division Laboratory

An AASHTO and ISO Accredited Laboratory

AASHTO R18 ISO/IEC 17025

Report of Soil or Aggregate Tests

Project: California PFH 112-1 (1) South Fork Smith River Road

Submitted By: Daniel Alzamora

Date Reported: 12/29/2005

Sample Number	Lab Number		05-1488-SB	05-1489-SB	05-1490-SB	05-1491-SB	05-1492-SB
	Hole Number		B-HG3	B-HG4	B-HG5	B-HG6	B-C5
	Field Number		SPT # 1 & 2	SPT # 1	SPT # 1	SPT # 1 & 2	SPT # 1
Sample Location	Station or Location		809+90	809+90	810+15	808+32	510+50
	Offset		17' Right	15' Left	CL	17' Left	4' Left
	Depth	Feet	3.5-10	3.5-5	8.5-10	9-15.5	15.5-17
AASHTO T 11, T 27 & T 88 Washed Sieve Analysis % Passing	3"	75.0 mm					
	1 1/2"	37.5 mm					100
	1"	25.0 mm	100			100	93
	3/4"	19.0 mm	87	100		86	88
	1/2"	12.5 mm	78	98	100	81	86
	3/8"	9.5 mm	74	95	90	74	82
	#4	4.75 mm	64	86	82	63	77
	#8	2.36 mm					
	#10	2.00 mm	49	74	67	48	67
	#16	1.18 mm	42	65	56	40	62
	#30	600 µm					
	#40	425 µm	30	46	37	29	52
	#50	300 µm					
	#100	150 µm	20	31	23	21	42
	#200	75 µm	15	24	17	17	35
		20 µm					
		2 µm					
		1 µm					
AASHTO T 255	Moisture, %						
AASHTO T 89 & T 90	Liquid Limit		29	25	27	26	28
	Plasticity Index		6	3	5	5	13
Soil Classification	AASHTO M 145		A-1-a (0)	A-1-b (0)	A-1-b (0)	A-1-b (0)	A-2-6 (1)
	ASTM D 2487		SM	SM	SM	SC-SM	SC
AASHTO T 190	R –Value						
AASHTO T 288	Min. Resistivity, ohm-cm						
AASHTO T 289	pH						
AASHTO Method	Optimum Moisture, %						
	Maximum Dry Density, pcf						

Distribution:

Laboratory	Num. / Project File
	Darrell Harding
Geotechnical	Daniel Alzamora
Materials	1 Copy

Remarks:
For all the samples, less than 10 % of the required quantity was furnished for gradation determination.

Reported By:

Darrell Harding

Form FHWA 1702 Rev. 12/01

U.S. Department of Transportation
Federal Highway Administration

Central Federal Lands Highway Division Laboratory

An AASHTO and ISO Accredited Laboratory

AASHTO R18 ISO/IEC 17025

Report of Soil or Aggregate Tests

Project: California PFH 112-1 (1) South Fork Smith River Road

Submitted By: Daniel Alzamora

Date Reported: 12/29/2005

Sample Number	Lab Number		05-1493-SB	05-1494-SB	05-1495-SB	05-1496-SB	05-1497-SB
	Hole Number		B-C6	B-C6	B-C7	SI-C2	SI-C3
	Field Number		SPT# 2,3,4,5	SPT # 7 & 9	SPT#1,3,4,6	SPT# 3,4,5,6,7	SPT # 1 & 2
Sample Location	Station or Location		519+30	519+30	523+40	519+80	520+20
	Offset		CL	CL	CL		
	Depth	Feet	8.8-25.3	33.8-45.3	4-30.5	15.5-37	4-10.5
AASHTO T 11, T 27 & T 88 Washed Sieve Analysis % Passing	3"	75.0 mm					
	1 1/2"	37.5 mm	100			100	100
	1"	25.0 mm	84	100	100	95	87
	3/4"	19.0 mm	81	80	91	91	72
	1/2"	12.5 mm	64	60	73	77	59
	3/8"	9.5 mm	56	55	67	67	52
	#4	4.75 mm	40	41	49	46	37
	#8	2.36 mm					
	#10	2.00 mm	30	29	37	28	28
	#16	1.18 mm	25	24	33	22	24
	#30	600 µm					
	#40	425 µm	19	18	26	15	19
	#50	300 µm					
	#100	150 µm	14	13	21	10	14
	#200	75 µm	11	10	17	7.8	11
		20 µm					
		2 µm					
		1 µm					
AASHTO T 255	Moisture, %						
AASHTO T 89 & T 90	Liquid Limit		20		24	18	
	Plasticity Index		4		3	1	
Soil Classification	AASHTO M 145		A-1-a (0)		A-1-b (0)	A-1-a (0)	
	ASTM D 2487		GP-GC		GM	GP-GM	
AASHTO T 190	R –Value						
AASHTO T 288	Min. Resistivity, ohm-cm						
AASHTO T 289	pH						
AASHTO Method	Optimum Moisture, %						
	Maximum Dry Density, pcf						

Distribution:

	Num. / Project File
Laboratory	Darrell Harding
Geotechnical	Daniel Alzamora
Materials	1 Copy

Remarks:
Where no liquid limit / plasticity index and classification appear, an insufficient amount of material was provided.

For all the samples, less than 10 % of the required quantity was furnished for gradation determination.

Reported By:

Darrell Harding

Form FHWA 1702 Rev. 12/01

Central Federal Lands Highway Division Laboratory

An AASHTO and ISO Accredited Laboratory

U.S. Department of Transportation
Federal Highway Administration

Report of Soil or Aggregate Tests

AASHTO R18 ISO/IEC 17025

Project: California PFH 112-1 (1) South Fork Smith River Road

Submitted By: Daniel Alzamora

Date Reported: 12/29/2005

Sample Number	Lab Number		05-1498-SB	05-1499-SB		05-1503-SB	
	Hole Number		SI-C4	SI-C5		B-BC1/B-BC2	
	Field Number		SPT# 1 & 2	SPT # 4,5,6		SPT# 1 & 2	
Sample Location	Station or Location		521+45	521+85		408+20/409+25	
	Offset					CL	
	Depth	Feet	5.5-17	19-30.5		3-9.5	
AASHTO T 11, T 27 & T 88 Washed Sieve Analysis % Passing	3"	75.0 mm					
	1 1/2"	37.5 mm		100			
	1"	25.0 mm	100	79		100	
	3/4"	19.0 mm	78	65		89	
	1/2"	12.5 mm	63	53		85	
	3/8"	9.5 mm	53	47		81	
	#4	4.75 mm	34	37		75	
	#8	2.36 mm					
	#10	2.00 mm	24	26		69	
	#16	1.18 mm	21	22		66	
	#30	600 µm					
	#40	425 µm	16	16		61	
	#50	300 µm					
	#100	150 µm	13	11		42	
	#200	75 µm	10	8.8		28	
		20 µm					
		2 µm					
		1 µm					
AASHTO T 255	Moisture, %						
AASHTO T 89 & T 90	Liquid Limit					26	
	Plasticity Index					3	
Soil Classification	AASHTO M 145					A-2-4 (0)	
	ASTM D 2487					SM	
AASHTO T 190	R –Value						
AASHTO T 288	Min. Resistivity, ohm-cm						
AASHTO T 289	pH						
AASHTO Method	Optimum Moisture, %						
	Maximum Dry Density, pcf						

Distribution:

Num. / Project File	
Laboratory	Darrell Harding
Geotechnical	Daniel Alzamora
Materials	1 Copy

Remarks:

Where no liquid limit / plasticity index and classification appear, an insufficient amount of material was provided.

For all the samples, less than 10% of the required quantity was furnished for gradation determination.

After the transmittal was received, Daniel Alzamora requested B-BC 1 & B-BC 2 1&2 be combined before testing.

Reported By:

Darrell Harding

Form FHWA 1702 Rev 12/01

U.S. Department of Transportation
Federal Highway Administration

Central Federal Lands Highway Division Laboratory

An AASHTO and ISO Accredited Laboratory

AASHTO R18 ISO/IEC 17025

Report of pH & Resistivity Tests

Project: California PFH 112-1(1) South Fork Smith River Road

Date Reported: 01/5/2006

Laboratory Numbers: 05-(1504-1507)-C

Submitted By: Martinez / Alzamora

Material Type: Rock Cores

Material Source: -----

Tested For: AASTHO T 288 & T 289

Field Sample Number: 1

Test Results

Field Number	Lab Number	Boring Number	Station Number	Depth	pH	Resistivity (ohm.cm)
1	05-1504-C	B-A1&A2	Varies	Varies	8.2	4180
1	05-1505-C	B-B1	Varies	Varies	9.4	4910
1	05-1506-C	C1 to C7	Varies	Varies	8.0	6630
1	05-1507-C	B-D1&D2	Varies	Varies	7.3	5110

The cores were crushed in a jaw-type laboratory crusher. This material may not be representative of that produced by the contractor's crushing operation.

Both AASHTO T 288 (Resistivity) and T 289 (pH) are test procedures intended for soils only.

Distribution:
Laboratory
Geotechnical
Materials

Num. / Project File
Darrell Harding
Daniel Alzamora
1 Copy

Reported By:

Darrell Harding

US Department of Transportation
Federal Highway Administration

Central Federal Lands Highway Division Laboratory

An AASHTO and ISO Accredited Laboratory

AASHTO R18 ISO/IEC 17025

Report of Soil or Aggregate Tests

Project: California PFH 112-1 (1) South Fork Smith River Road

Submitted By: Charlie Martinez

Date Reported: 11/14/2005

Sample Number	Lab Number		05-1380-SB	05-1381-SB	05-1382-SB	05-1383-SB	
	Hole Number		B-SM 1	B-SM 3	B-SM 4	B-SM 4	
	Field Number		SPT #1	SPT #1 & 2	SPT #1	SPT #2	
Sample Location	Station or Location		Abut 1	Pier 2	Abut 2	Abut 2	
	Offset						
	Depth	Feet	0-4.5*	6-11.5	5-6.5	10-10.5	
AASHTO T 11, T 27 & T 88 Washed Sieve Analysis % Passing	3"	75.0 mm					
	1 1/2"	37.5 mm	100	100			
	1"	25.0 mm	92	90	100		
	3/4"	19.0 mm	89	80	89		
	1/2"	12.5 mm	85	66	87	100	
	3/8"	9.5 mm	79	55	84	98	
	#4	4.75 mm	70	43	80	85	
	#8	2.36 mm					
	#10	2.00 mm	59	28	76	56	
	#16	1.18 mm	53	20	73	44	
	#30	600 µm					
	#40	425 µm	41	12	63	29	
	#50	300 µm					
	#100	150 µm	31	7	49	20	
	#200	75 µm	24	5.1	39	15	
		20 µm					
		2 µm					
		1 µm					
AASHTO T 255	Moisture, %						
AASHTO T 89 & T 90	Liquid Limit		36	**	24	20	
	Plasticity Index		8	**	6	3	
Soil Classification	AASHTO M 145		A-2-4 (0)	**	A-4 (0)	A-1-b (0)	
	ASTM D 2487		SM	**	SC-SM	SM	
AASHTO T 190	R –Value						
AASHTO T 288	Min. Resistivity, ohm-cm						
AASHTO T 289	pH						
AASHTO Method	Optimum Moisture, %						
	Maximum Dry Density, pcf						

Distribution:

	Num. / Project File
Laboratory	Darrell Harding
Geotechnical	Charlie Martinez
Materials	1 Copy

Remarks: * Baggie marked as 4' – 5.5' sample depth.

** An insufficient amount of material was furnished to perform plasticity and classification testing.

Testing was performed on the entire submitted sample. AASHTO test procedures require approximately 10 to 50 times more mass.

Reported By:

Darrell Harding

Form FHWA 1702 Rev. 12/01

Central . .deral Lands Highway Divisio. ..aboratory

An AASHTO and ISO Accredited Laboratory

U.S. Department of Transportation
Federal Highway Administration

Report of Unconfined Compressive Strength Tests

AASHTO R18 ISO/IEC 17025

Project: California PFH 112-1 (1) South Fork Smith River Road

Laboratory Numbers: See Below

Date Reported: 1/12/2006

Submitted By: Martinez / Alzamora

Material Type: Rock Cores

Material Source: --

Tested For: Unconfined Compressive Strength / Unit Weight

Field Sample Numbers: See Below

Test Results

Laboratory Number	05-1519-C	05-1521-C	05-1522-C	05-1523-C
Field Number	RC1	RC1	RC2	RC1
Boring Number	B-A1	B-B1	B-B1	B-BC1
Station	107+00	308+46	308+46	408+20
Offset (ft)	NA	3.4 Left	3.4 Left	CL
Depth (ft)	24-24.9	4-4.7	5.5-6.1	15.5-16.6
Length (in)	5.53	5.49	5.56	5.51
Diameter (in)	2.41	2.39	2.39	2.42
L/D Ratio	2.3	2.3	2.3	2.3
Total Load (lbf)	224,440	24,646*	189,250	6501**
Compressive Strength (psi)	49,220	5490	41,440	1410
Unit Weight (pcf)	180.4	175.3	177.8	140.7

* This core broke along a vein of light colored mineral material. **This core appears to be rock fragments in a soft matrix. The matrix failed while the aggregate did not fracture.

Laboratory Number	05-1524-C	05-1525-C	05-1527-C	05-1529-C
Field Number	RC1	RC1	RC3	RC1
Boring Number	B-BC1	B-BC2	B-BC2	B-RC1
Station	408+20	409+25	409+25	207+75
Offset (ft)	CL	CL	CL	CL
Depth (ft)	19-19.7	21.8-22.6	36.2-37.8	19-20.3
Length (in)	5.48	5.45	5.52	5.48
Diameter (in)	2.41	2.41	2.41	2.40
L/D Ratio	2.3	2.3	2.3	2.3
Total Load (lbf)	107,420	127,770	101,400	5450¤
Compressive Strength (psi)	23,560	28,020	22,240	1210
Unit Weight (pcf)	166.8	181.4	184.4	156.8

¤ This core contained numerous veins of light colored mineral material. The core failed along these veins.

Distribution:
Laboratory
Geotechnical
Materials

Num. / Project File
Darrell Harding
Daniel Alzamora
1 Copy

Reported By:

For
Darrell Harding

Form FHWA 1742 Rev 12/01

Central Federal Lands Highway Division Laboratory

An AASHTO and ISO Accredited Laboratory

U.S. Department of Transportation
Federal Highway Administration

AASHTO R18 ISO/IEC 17025

Report of Unconfined Compressive Strength Tests

Project: California PFH 112-1 (1) South Fork Smith River Road

Laboratory Numbers: See Below

Date Reported: 1/12/2006

Submitted By: Martinez / Alzamora

Material Type: Rock Cores

Material Source: --

Tested For: Unconfined Compressive Strength / Unit Weight

Field Sample Numbers: See Below

Test Results

Laboratory Number	05-1531-C	05-1532-C	05-1533-C	05-1534-C
Field Number	RC3	RC1	RC2	RC1
Boring Number	B-RC1	B-RC2	B-RC2	B-C5
Station	207+75	209+00	209+00	510+50
Offset (ft)	CL	CL	CL	4 Left
Depth (ft)	32-33	5.5-6	29.5-31	23-24.5
Length (in)	5.57	4.99	5.51	5.48
Diameter (in)	2.40	2.40	2.40	2.40
L/D Ratio	2.3	2.1	2.3	2.3
Total Load (lbf)	132,220	187,780	225,550	69,911
Compressive Strength (psi)	29,250	41,540	49,900	15,470
Unit Weight (pcf)	176.8	185.1	186.8	192.3

Laboratory Number	05-1535-C	05-1536-C	05-1537-C	05-1540-C
Field Number	RC1	RC2	RC3	RC2
Boring Number	B-SM1	B-SM1	B-SM1	B-SM2
Station	608+40	608+40	608+40	609+40
Offset (ft)	CL	CL	CL	CL
Depth (ft)	20-20.8	22-23	29-30	6.7-8.0
Length (in)	5.53	5.22	5.60	5.47
Diameter (in)	2.40	2.40	2.40	2.40
L/D Ratio	2.3	2.2	2.3	2.3
Total Load (lbf)	83,806	92,169	95,941	52,395
Compressive Strength (psi)	18,540	20,390	21,230	11,590
Unit Weight (pcf)	189.4	188.6	189.9	188.0

Distribution:
Laboratory
Geotechnical
Materials

Num / Project File
Darrell Harding
Daniel Alzamora
1 Copy

Reported By:

For
Darrell Harding

Form FHWA 1742 Rev 12/01

Report of Miscellaneous Tests

Project: California PFH 112-1 (1) South Fork Smith River Road

Laboratory Numbers: See Below

Date Reported: 1/12/2006

Submitted By: Martinez / Alzamora

Material Type: Rock Cores

Material Source: --

Tested For: Unconfined Compressive Strength / Unit Weight

Field Sample Numbers: See Below

Test Results

Laboratory Number	05-1541-C	05-1546-C	05-1548-C
Field Number	RC3	RC1	RC2
Boring number	B-SM2	SI-C2	SI-C3
Station	609+40	519+80	520+20
Offset (ft)	CL	NA	NA
Depth (ft)	12.5-14	13-14	39-39.7
Length (in)	5.51	5.44	5.44
Diameter (in)	2.40	2.40	2.41
L/D ratio	2.3	2.3	2.3
Total Load (lbf)	41,962	108,940	83,307
Compressive Strength (psi)	9280	24,100	18,270
Unit Weight (pcf)	187.5	191.9	184.5

Testing was not requested on the following samples:

- B-BC2 RC2
- B-BC2 RC4
- B-RC1 RC2
- B-SM1 RC4
- B-SM2 RC1
- B-SM2 RC4

Testing was requested on the following samples; however; due to the fractured nature and/or length of the core they could not be trimmed to meet the required L/D ratio requirement of 2.0 to 2.5:

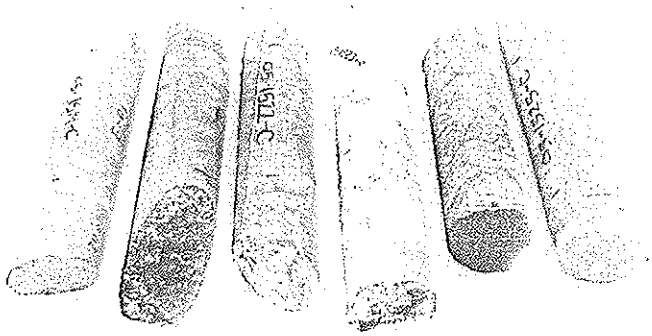
- BA2 RC1
- B-SM3 RC1
- B-SM4 RC1
- B-SM4 RC2
- SI-C3 RC1
- SI-C4 RC1

Distribution:
Laboratory
Geotechnical
Materials

Num. / Project File
Darrell Harding
Daniel Alzamora
1 Copy

Reported By:

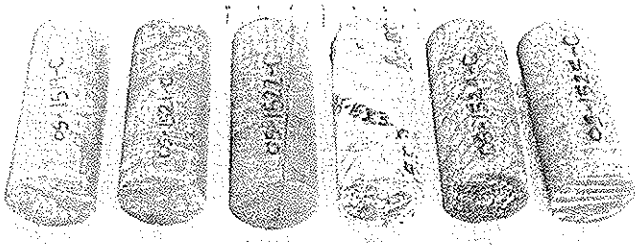
For
Darrell Harding



05-1519-C, 05-1521-C, 05-1522-C, 05-1523-C,
05-1524-C & 05-1525-C

Left to Right

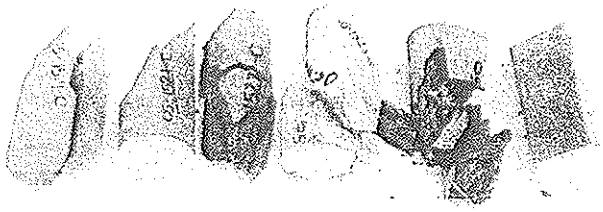
Compressive Strength Samples as Received



05-1519-C, 05-1521-C, 05-1522-C, 05-1523-C,
05-1524-C & 05-1525-C

Left to Right

Trimmed Compressive Strength Samples



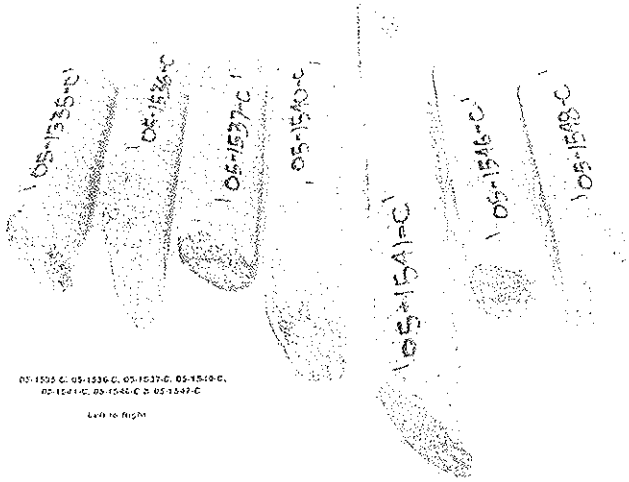
Left to Right

Tested Compressive Strength Samples

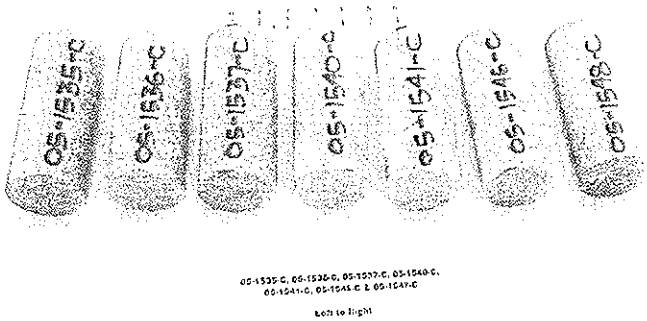
Compressive Strength Samples as Received

Trimmed Compressive Strength Samples

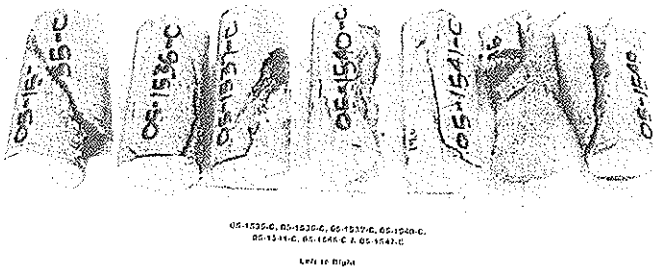
Tested Compressive Strength Samples



Compressive Strength Samples as Received



Trimmed Compressive Strength Samples



Tested Compressive Strength Samples

U.S. Department of Transportation
Federal Highway Administration

Report of Load Strength Index

AASHTO R18 ISO/IEC 17025

Project: California PFH 112-1 (1) South Fork Smith River Road

Laboratory Numbers: See Below

Report Revised: 2/14/2006

Submitted By: Martinez / Alzamora

Original Date Reported: 1/24/2006

Material Source: --

Material Type: Rock Cores

Tested For: ASTM D 5731 Determination of The Load Strength Index of Rock

Field Sample Numbers: See Below

Test Results

Lab Number	05-1508-C	05-1510-C	05-1511-C	05-1517-C	05-1518-C
Field Number	RC1	RC1	RC1	RC1	RC2
Boring Number	BA2	B-BC1	B-C7	SI-C4	SI-C4
Station	109+00	408+20	523-40*	521+45	521+45
Offset	NA	CL	CL	CL	CL
Depth, Feet	19-20.5	29-29.5	37.5-38	12.4-13	28.5-29
Thickness, mm (in.)	60.86 (2.40)	61.12 (2.41)	61.19 (2.41)	60.97 (2.40)	61.00 (2.40)
Width, mm (in.)	64.77 (2.55)	64.14 (2.53)	68.00 (2.68)	63.95 (2.52)	62.15 (2.45)
Point Load Strength Index MPa (psi)	5.95 (860)	8.97 (1300)	1.13 (160)	5.21 (760)	4.53 (660)
Estimated Uniaxial Compressive Strength MPa (psi)	136.7 (19,830)	206.2 (29,910)	25.9 (3760)	119.8 (17,380)	104.3 (15,130)

*Per the sample transmittal.

Testing was requested on the following samples; however; due to the fractured nature and/or length of the core they could not be trimmed to meet the required minimum dimension of 30mm (1.18 in.):

- BA2 RC2
- B-HG1 RC1
- B-HG1 RC2
- B-HG3 RC1
- B-HG4 RC1
- B-HG5 RC1

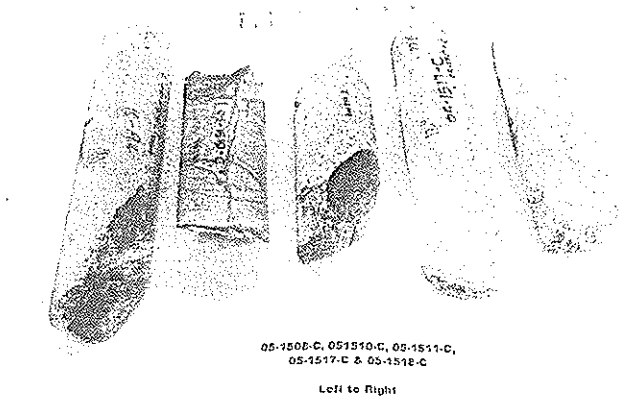
The test report was revised by the addition of English units at the request of Charlie Martinez. The SI units were retained to stay consistent with the ASTM test standard.

Distribution:
Laboratory
Geotechnical
Materials

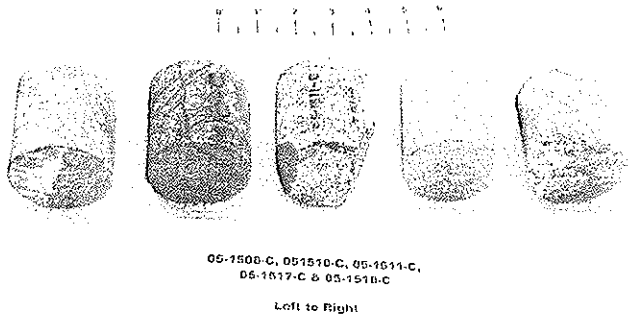
Num. / Project File
Darrell Harding
Martinez / Alzamora
1 Copy

Reported By:

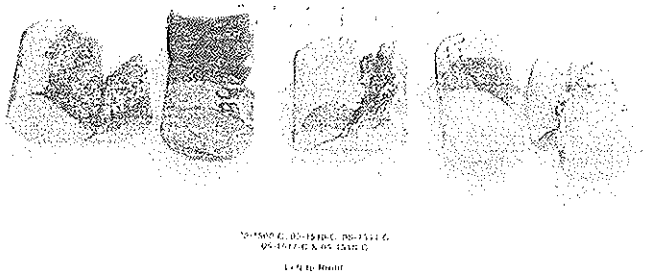
For
Darrell Harding



Point Load Samples as Received



Trimmed Point Load Samples



Tested Point Load Samples

APPENDIX E – Seismic Refraction Survey Data

Seismic Refraction Surveys

INTRODUCTION

Seismic refraction surveys are often used to enhance subsurface geotechnical investigations where laterally discontinuous soil and rock units are anticipated and/or drilling access may be physically or economically limited. Refraction surveys can provide quick and affordable subsurface characterization over large areas, providing both strata characterization and rock mass physical parameters useful in developing construction alternatives. However, the method does rely on several simplifying assumptions the user should be aware of, limiting its application in some settings.

CONDUCTING THE SURVEY

Seismic refraction involves placing a line of regularly spaced sensors (geophones) on the surface and measuring the relative arrival time of seismic energy transmitted from a specified source location. Refraction data are recorded in the field using a portable seismograph, multiple geophones (generally 12 per line), a repeatable seismic source, and a power source. For example, a 24-channel Geometrics SmartSeis seismograph is used for data collection and display by CFLHD. Geophones, generally <15Hz, are vertically implanted in the ground at a predetermined spacing (5-6 m) to record travel times and amplitude of the seismic energy traveling through the earth. Typical seismic sources include such things as a sledgehammer striking a metal plate, shotgun source (e.g., Seisgun), or possibly light explosive charges. Sledgehammer sources are generally used for depths less than 10-15 m; whereas explosives may be required in soft ground conditions for depths up to 30 m. Seismic sources generate both compression (P) and shear (S) waves and, although either may be used for subsurface imaging, P waves are preferred since they are not absorbed by saturated soil units (shear waves cannot transmit through water). Seismic energy travels with a compression velocity that is characteristic of the density, porosity, structure, and water content of each geologic layer.

The design of a seismic refraction survey reflects the anticipated soil/rock velocities to be encountered, overburden depths to be interrogated, and the end-use of the data (e.g., subgrade evaluation or deep foundation design). With this knowledge, a plan is developed which defines the data collection parameters best suited for a successful survey. These parameters include the length of the geophone spread, spacing between the geophones, expected “first-break” arrival times at each of the geophones, and the best locations for off-end shots. Normally, five seismic source locations are selected for each seismic spread; one at each end of the spread (forward and reverse shots), one at a predetermined distance from each end of the spread (off-end shots), and one between the two centermost geophones within the spread (center shot). Multiple shot points permit improved delineation of soil/rock interfaces throughout the depths covered by the survey.

Data processing and interpretation at CFLHD is conducted using the SeisImager interactive refraction interpretation code. Using this software, seismic refraction data is refined, analyzed, and interpreted using either the *intercept-time term* inversion method or the *tomographic* inversion method. If the time inversion method is used, the subsurface profile is resolved into distinct layers with average velocities. The tomographic inversion method conducts a similar analysis as that of the time inversion method, but portrays the subsurface velocity profile as color-coded gradient plot. Both methods are equally useful for identifying key subsurface units and their distribution along the survey.

Seismic refraction surveys are commonly used to characterize:

- Thickness and lateral continuity of specific soil/rock units;
- Depths to competent subsurface layers or the soil/rock interface; and
- Absolute soil/rock unit velocities for estimating material rippability.

The color-coded sectional plots (shown in this appendix) represent the subsurface velocity distribution – which *may or may not represent the distribution of material types*. Saturated soil zones, localized differences in soil density, and increased frequency of jointing within a given rock unit are all examples of structural features within a rock or soil type that may substantially alter the velocity at that location. A particular velocity can represent more than one rock or soil setting, largely influenced by the presence of structures. For example, a moderate to dense sandy soil may have a similar velocity to a highly jointed and weathered granite rock mass. Successful interpretation requires correlation to nearby borings or surface outcrop maps. Seismic surveys are not intended to supplant more traditional subsurface sampling investigations, but aid in quickly and economically extending subsurface characterization over larger areas – "filling-in" the gaps between discrete borings.

LIMITATIONS OF THE METHOD

A restrictive limitation of seismic refraction is that each of the successively deeper refractors (soil/rock layers) must have a higher velocity than the one above. This limitation is not generally restrictive when attempting to characterize bedrock depths (deeper rock units almost always have higher velocities); however, situations do arise where overlying soil or rock units have higher velocities than the lower units (e.g., saturated clays over loose sands, or volcanic extrusive over sedimentary rock). For this reason, **seismic refraction surveys should always be correlated to subsurface borings to determine applicability of the results.**

Another restriction involves imaging in saturated soils – seismic energy is transmitted through the saturated soil mass at the velocity of water (1,400-1,600 m/s), *not* the velocity of the unsaturated soil. If saturated soils overlie weak rock units, or strong units with frequent discontinuities (e.g., highly jointed granite), the boundary may become indistinguishable.

Background seismic noise, propagating through both the ground and air (e.g., commuter traffic, construction equipment, nearby blasting operations, moving water, wind, etc.), may interfere with data collection, obscuring refraction survey arrival times and making analysis and interpretation difficult to impossible. Oftentimes, this problem can be overcome by

employing various filtering techniques, “stacking” the source signals, or by using larger impact sources. In general, “noisy” data leads to greater uncertainty in data refinement and interpretation.

Seismic refraction results are presented as representing subsurface conditions in a *vertical* plane directly beneath the survey line. While for most cases this may be true, source-to-receiver raypaths may actually be traveling out of this vertical plane, through nearby higher-velocity materials (e.g., in the case of steeply dipping strata). *In discontinuous ground, or settings with highly variable deposition, seismic surveys could result in inaccurate subsurface profiles.*

South Fork Smith River Road Project
CA PFH 112-1(1)
Location of Seismic Refraction Lines

Line #	Site	Begin Station Phone 1	End Station Phone 24	Offset distance from existing edge of pavement
1	D	705+91	707+05	5 ft left of right edge
2	C	524+98	526+10	10 ft right of left edge
3	C	521+26	522+42	1 ft left of right edge
4	C	520+40	521+54	1 ft left of right edge
5	C	519+20	520+40	1 ft left of right edge
6	C	511+52	512+67	1 ft left of right edge
7	C	511+52	512+67	17 ft left of proposed CL
8	C	507+54	508+69	1 ft left of right edge
9	B	307+89	309+04	1 ft left of right edge
10	A	108+43	109+58	1 ft left of right edge
11	A	106+39	107+56	1 ft left of right edge
12	Hurdy Gurdy Bridge	810+40	Phone 12, 810+40	12 phones 8 ft on center perpendicular to C.L. at station 810+40, Phone 1 at 48 ft left of C.L., Phone 12 at 48 ft right of C.L.

Need Norting, Easting, and Elevation along existing road for the following points:

a. 24 points every 5 ft from begining to end station. Line 12 has 12 points at 8 ft on center
b. Point between phone 12 and 13, Line 12 point at C.L. at sta 810+10
c. Points 10 ft from begin and end of line
d. Points 40 ft from begin and end of line, Line 12 78 ft left of C.L. and 73 ft right of C.L.

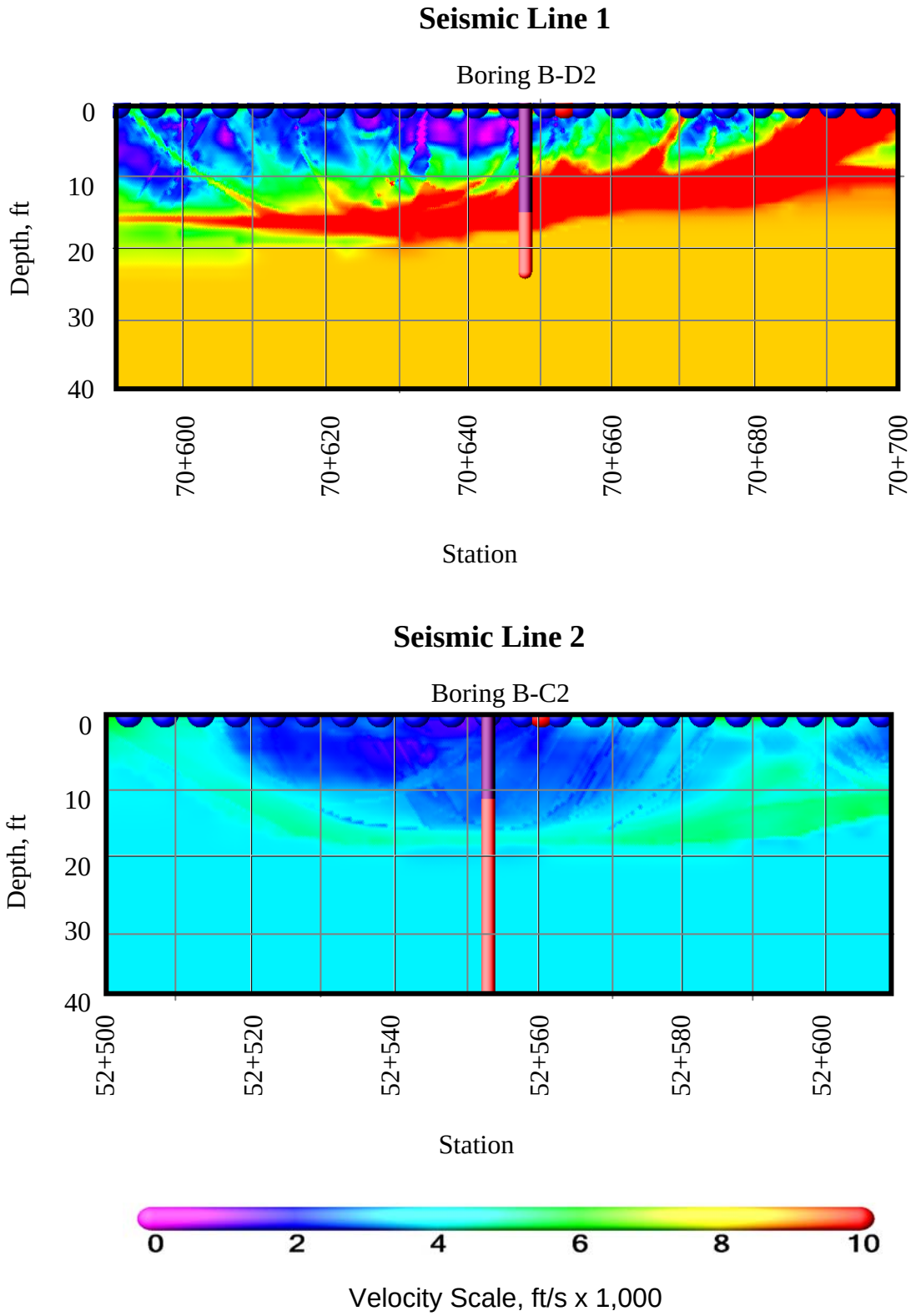
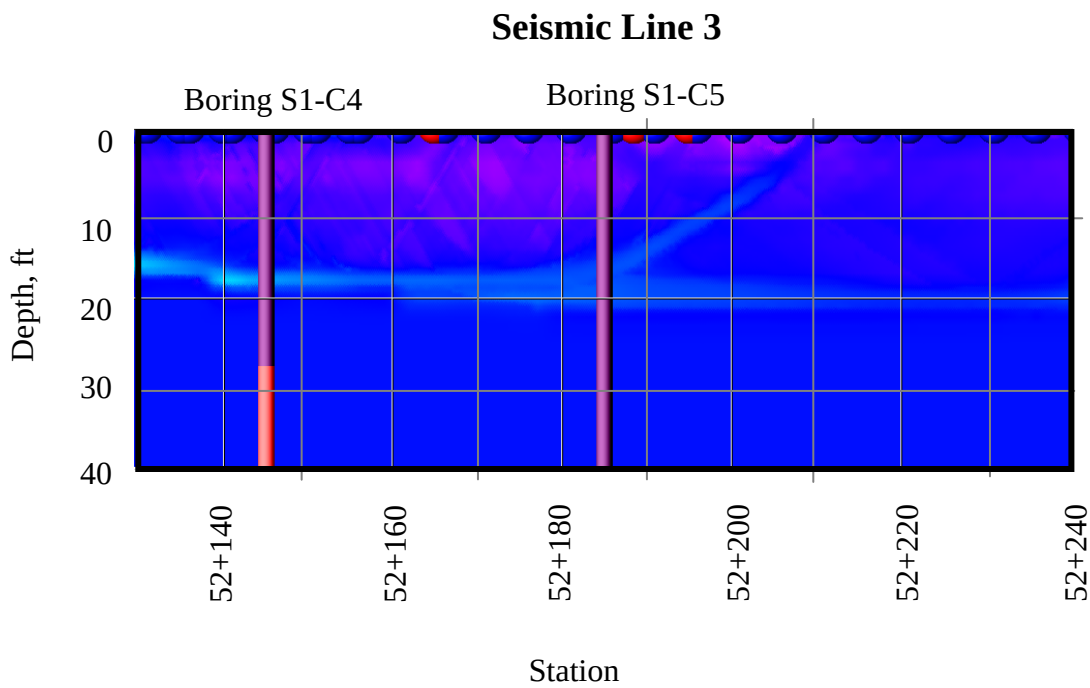


Figure E1 .- Seismic Refraction Tomography Results. Lines 1 and 2.

S. Fork Smith River Road
CA PFH 112-1(1)



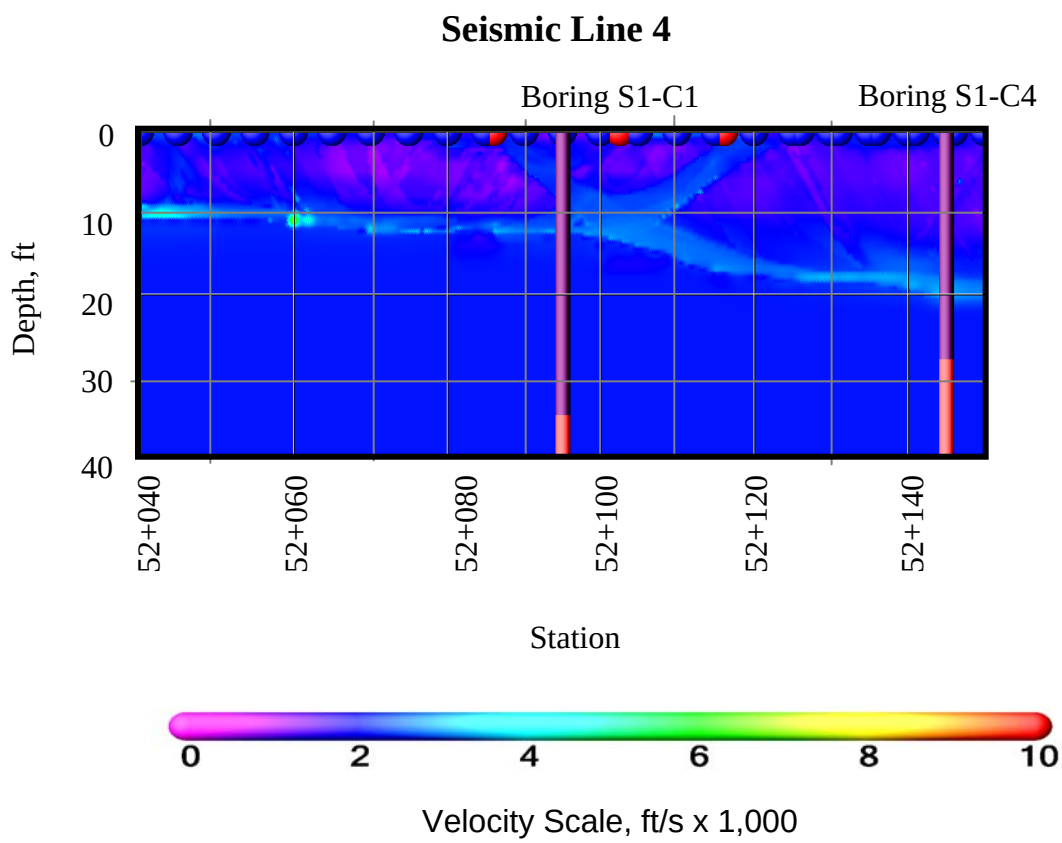


Figure E2 .- Seismic Refraction Tomography Results.
Lines 3 and 4.

S. Fork Smith River Road
CA PFH 112-1(1)

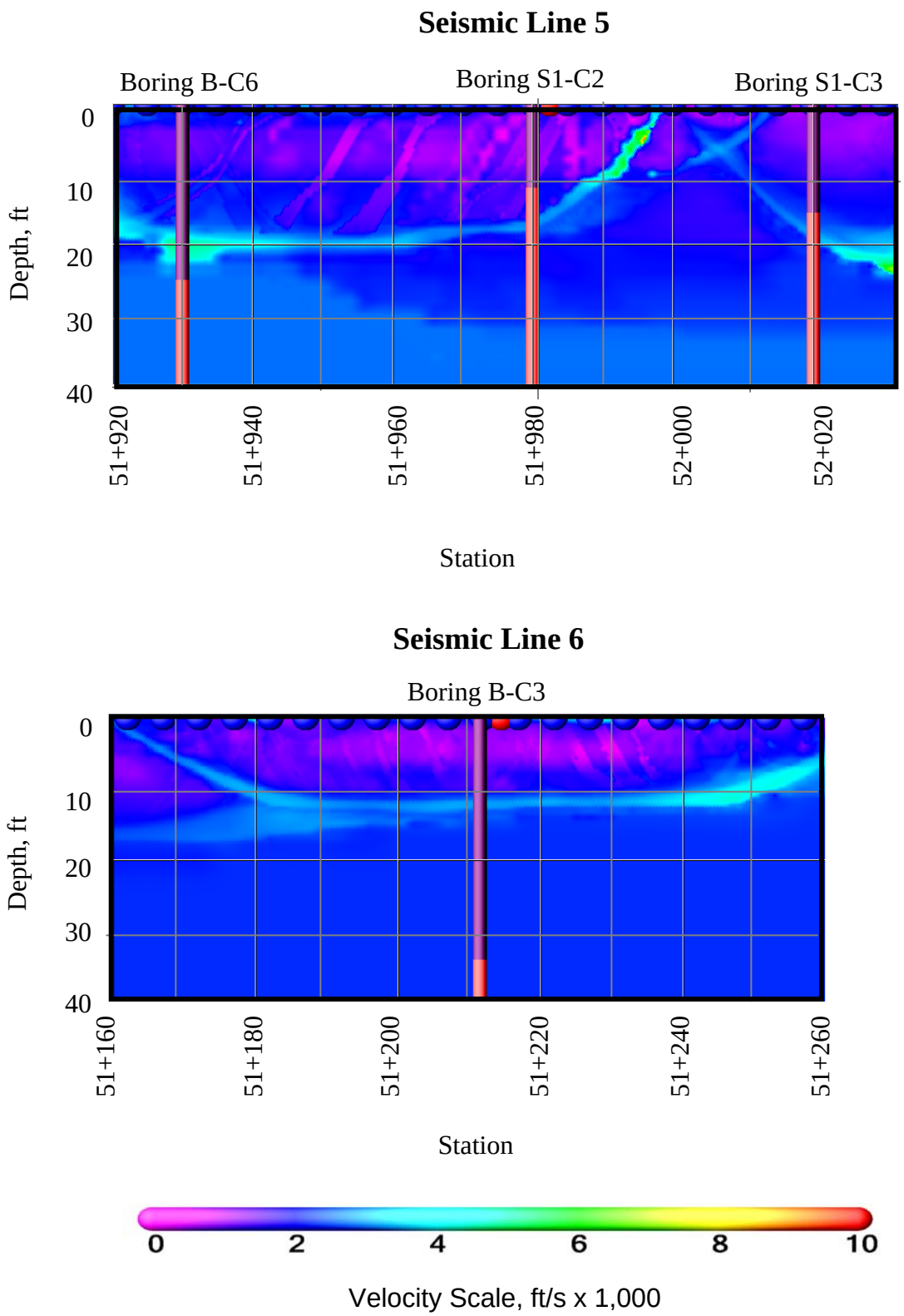
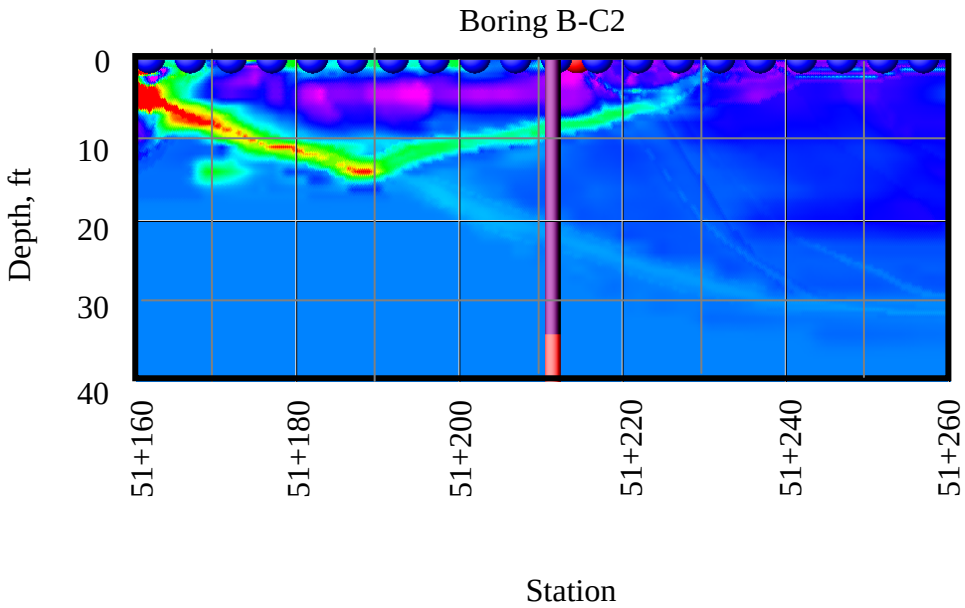


Figure E3 .- Seismic Refraction Tomography Results. Lines 5 and 6.

S. Fork Smith River Road
CA PFH 112-1(1)

Seismic Line 7



Seismic Line 8

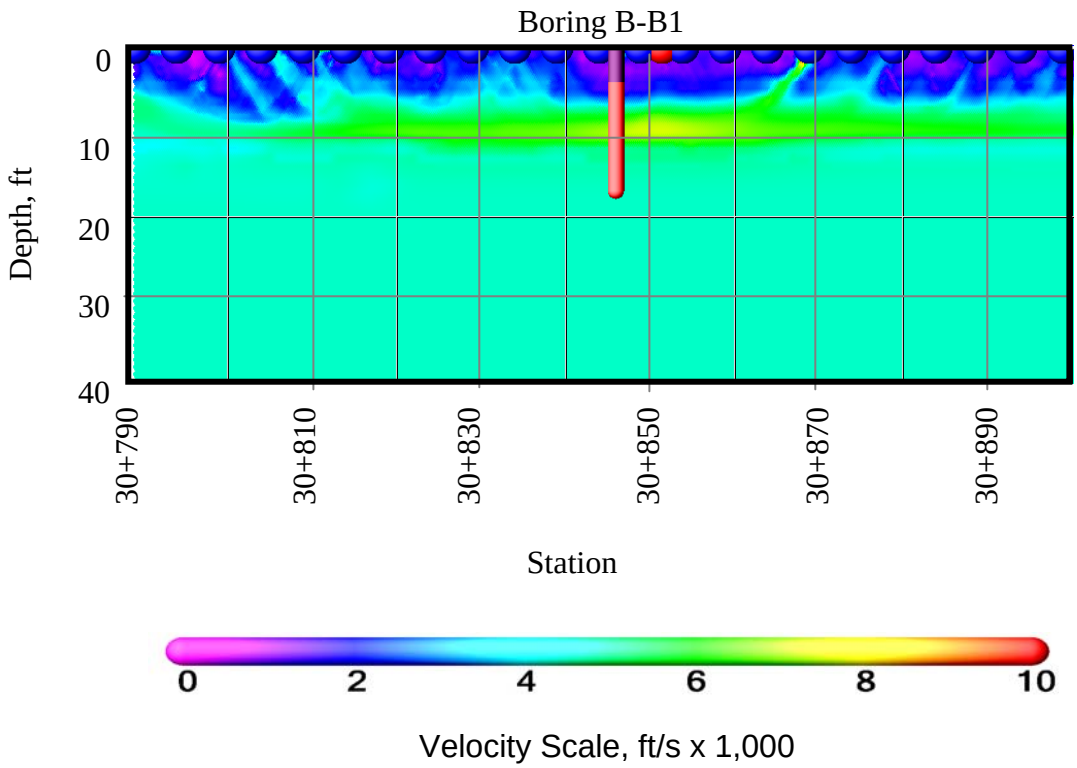
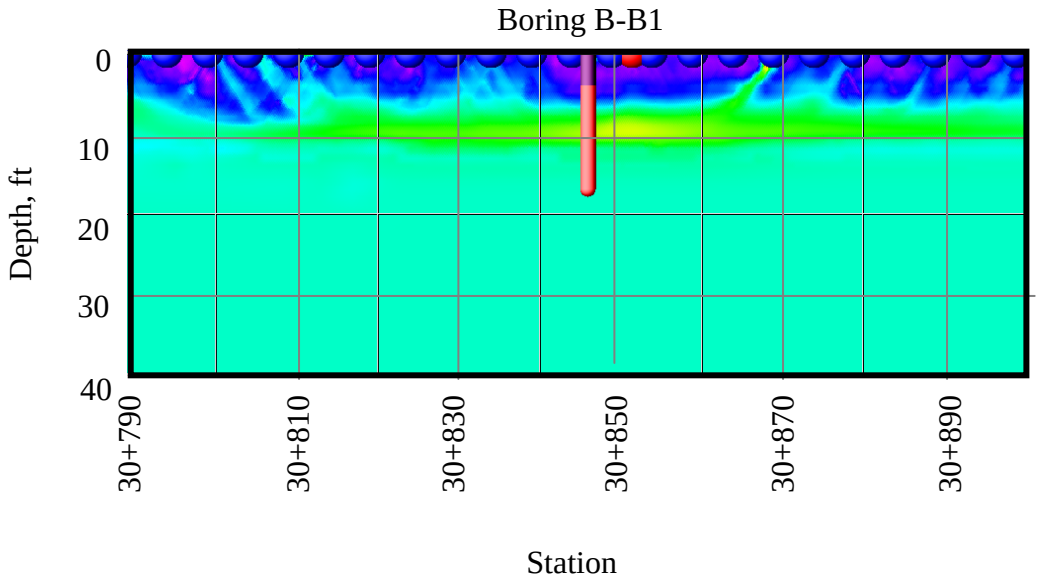


Figure E4 .- Seismic Refraction Tomography Results. Lines 7 and 8.

S. Fork Smith River Road
CA PFH 112-1(1)

Seismic Line 9



Seismic Line 10

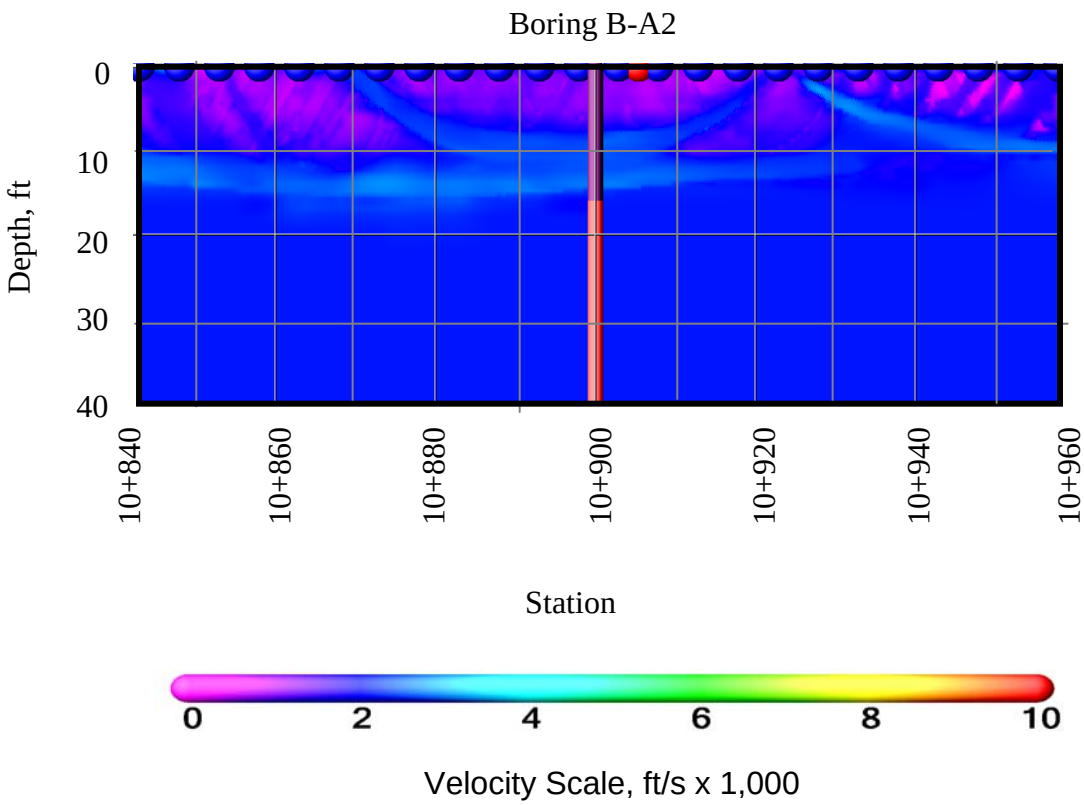
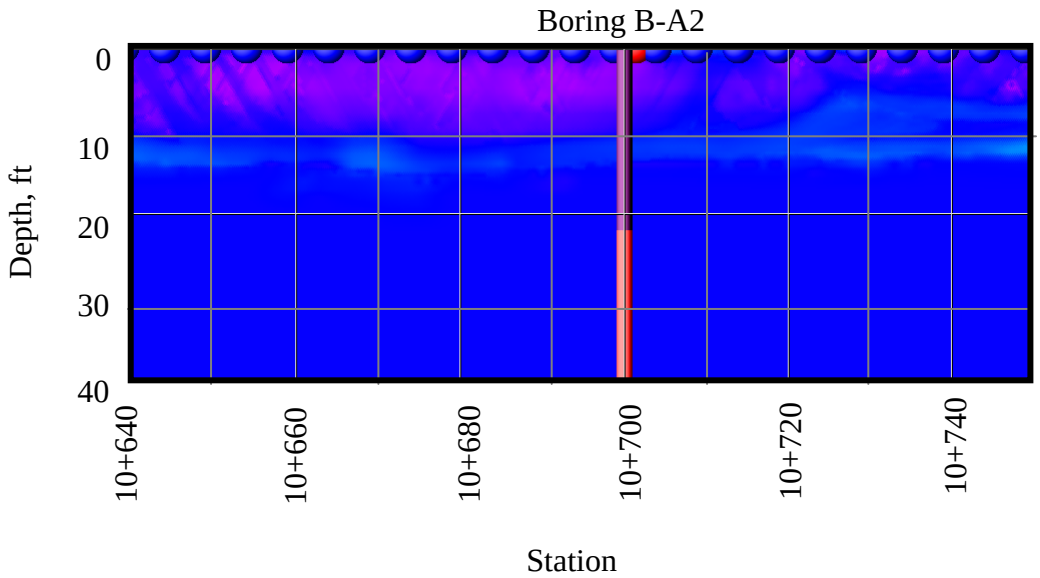


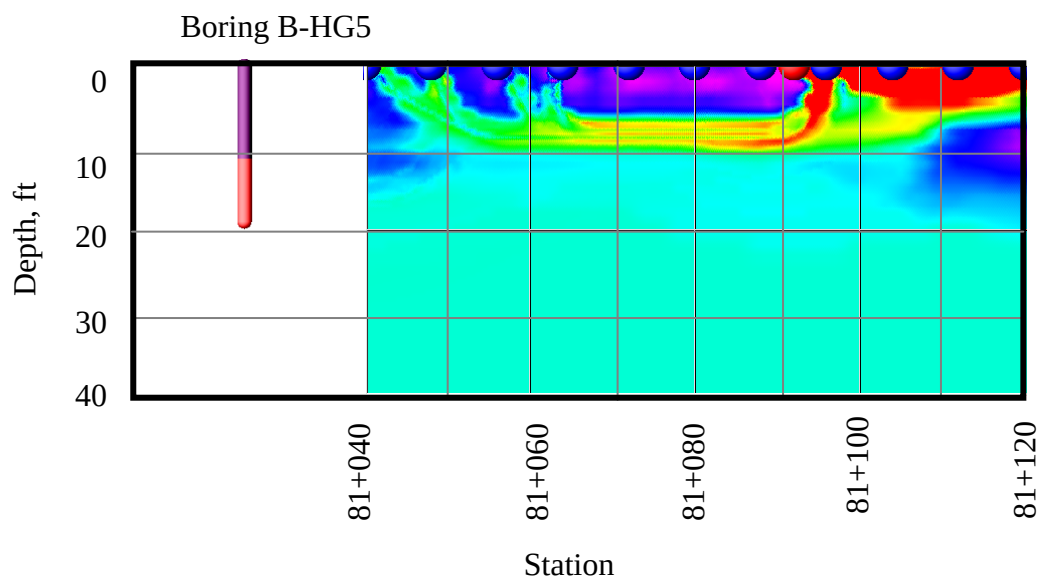
Figure E5 .- Seismic Refraction Tomography Results. Lines 9 and 10.

S. Fork Smith River Road
CA PFH 112-1(1)

Seismic Line 11



Seismic Line 12



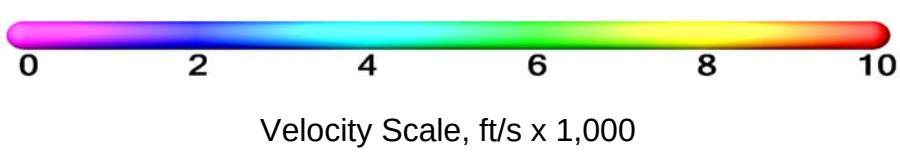
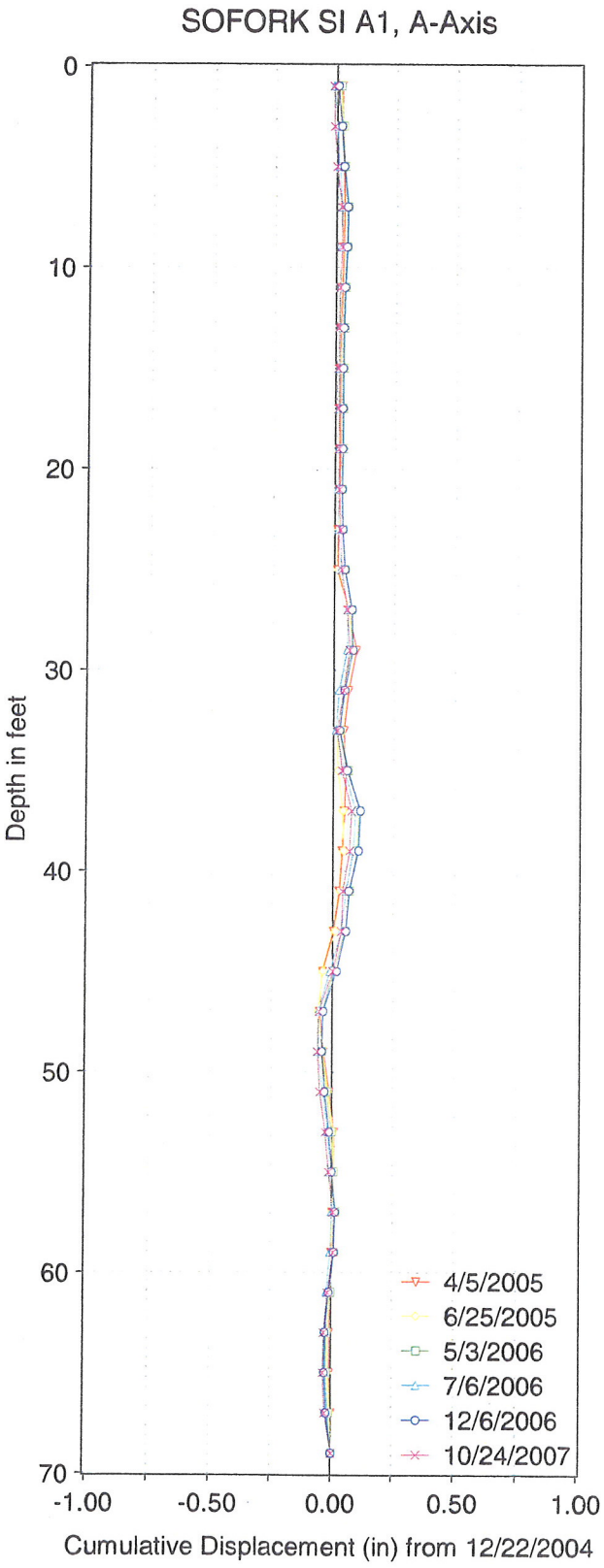


Figure E6 .- Seismic Refraction Tomography Results. Lines 11 and 12.

S. Fork Smith River Road
CA PFH 112-1(1)

APPENDIX F – Inclinometer Data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10
20
30
40
50
60
70
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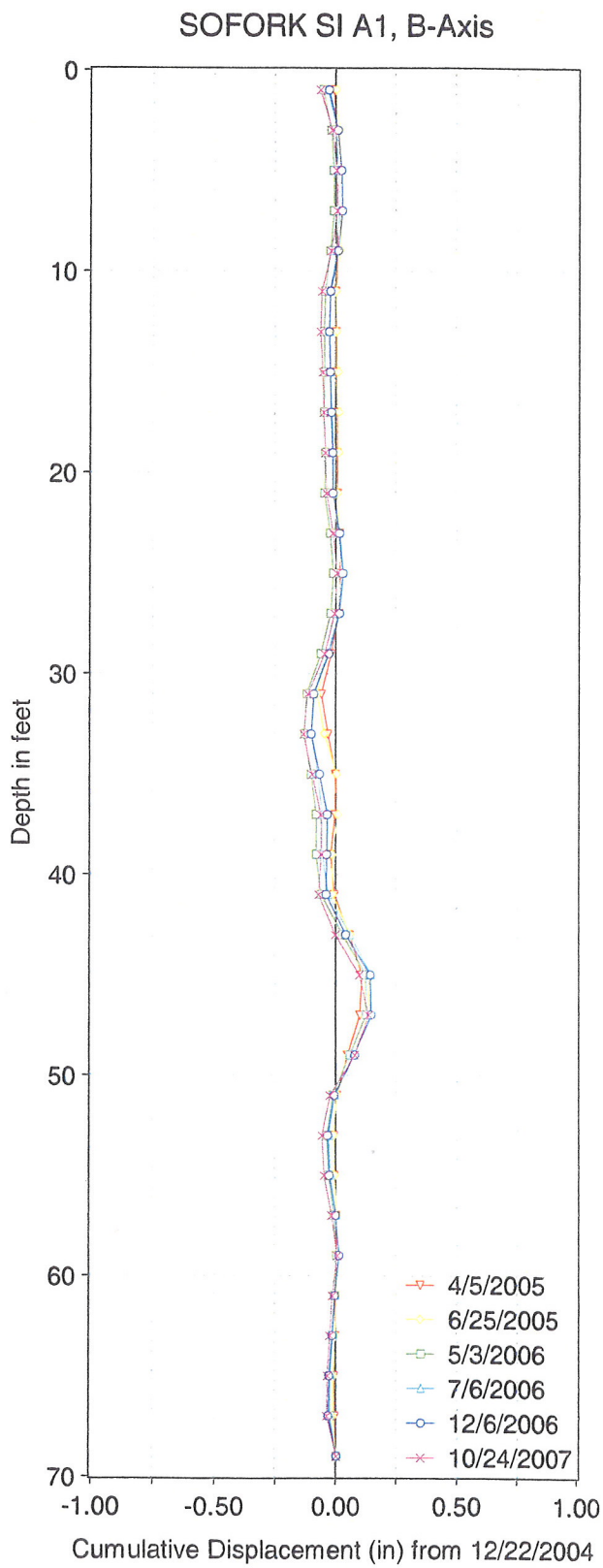
-0.50
0.00
0.50
1.00
Cumulative Displacement (in) from 12/22/2004
4/5/2005
6/25/2005
5/3/2006
7/6/2006
12/6/2006
10/24/2007


SOFORK SI A1, B-Axis
Depth in feet
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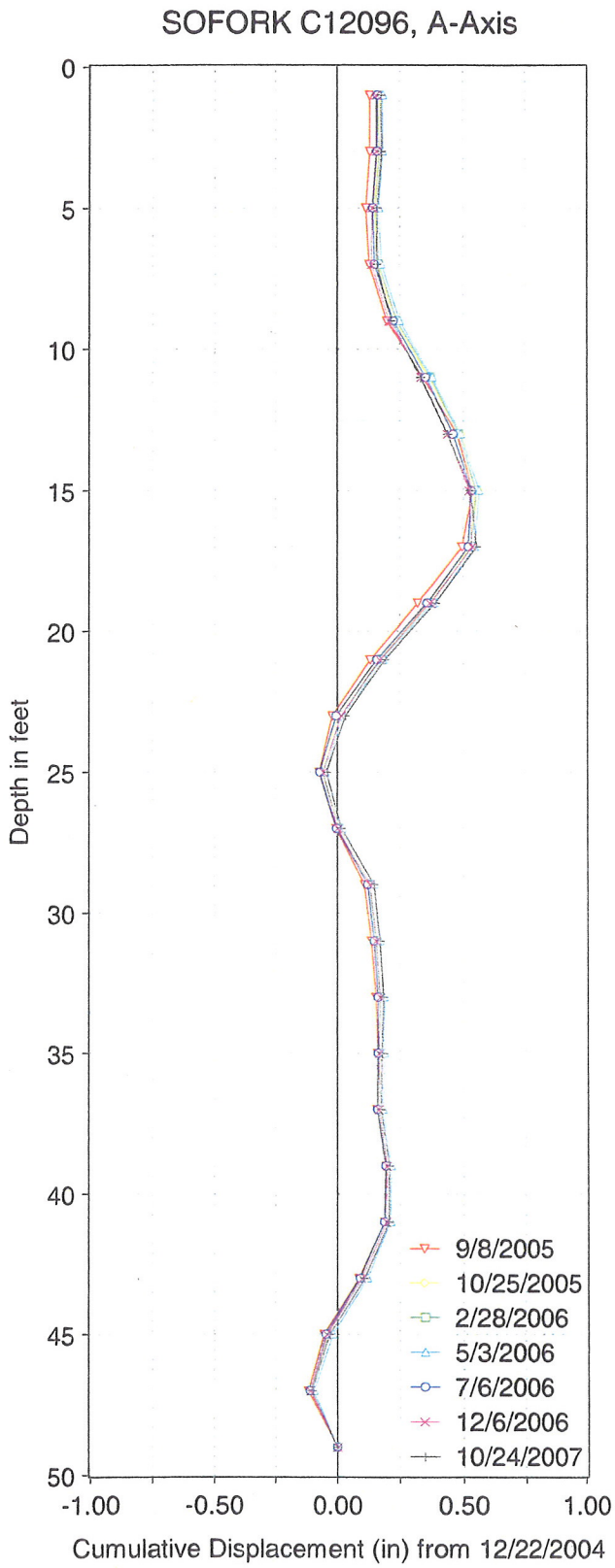
10
20
30
40
50
60
70
-1.00
-0.50
0.00
0.50
1.00
Cumulative Displacement (in) from 12/22/2004
4/5/2005
6/25/2005
5/3/2006
7/6/2006
12/6/2006
10/24/2007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Depth in feet
Cumulative Displacement (in) from 12/22/2004
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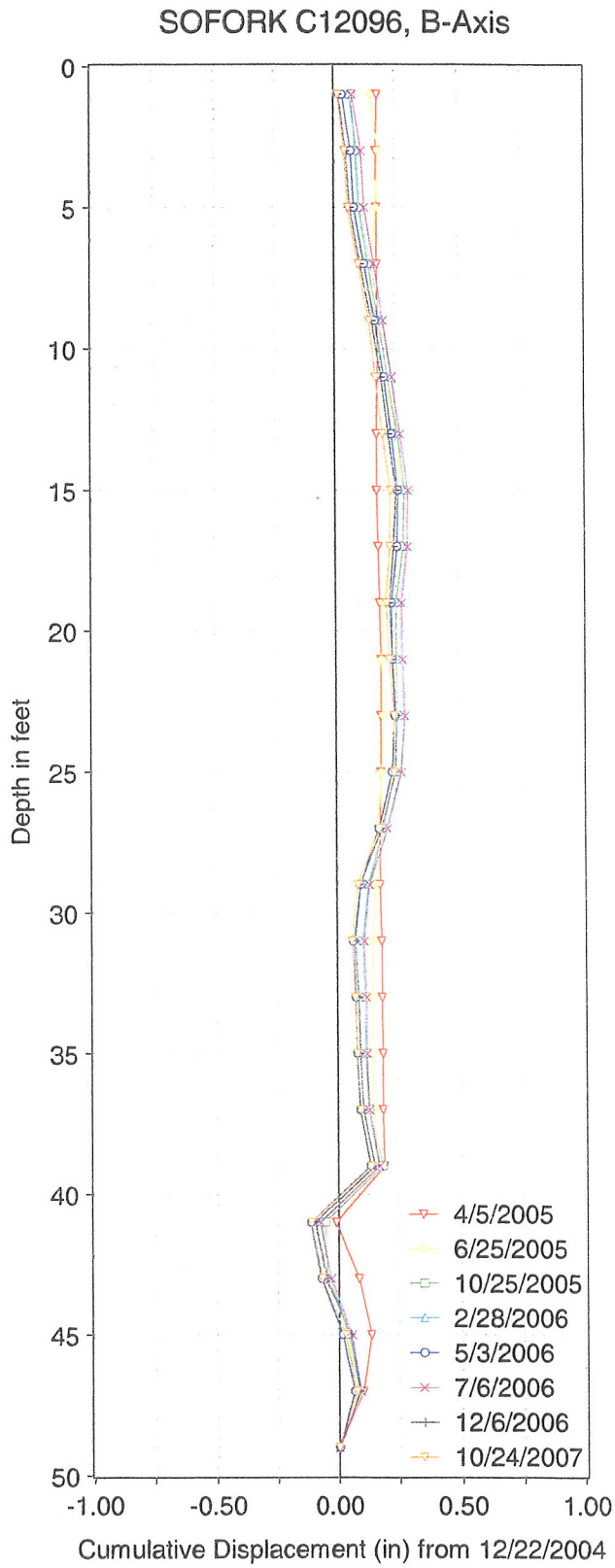
2/28/2006
5/3/2006
7/6/2006
12/6/2006
10/24/2007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Cumulative Displacement (in) from 12/22/2004
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6/25/2005
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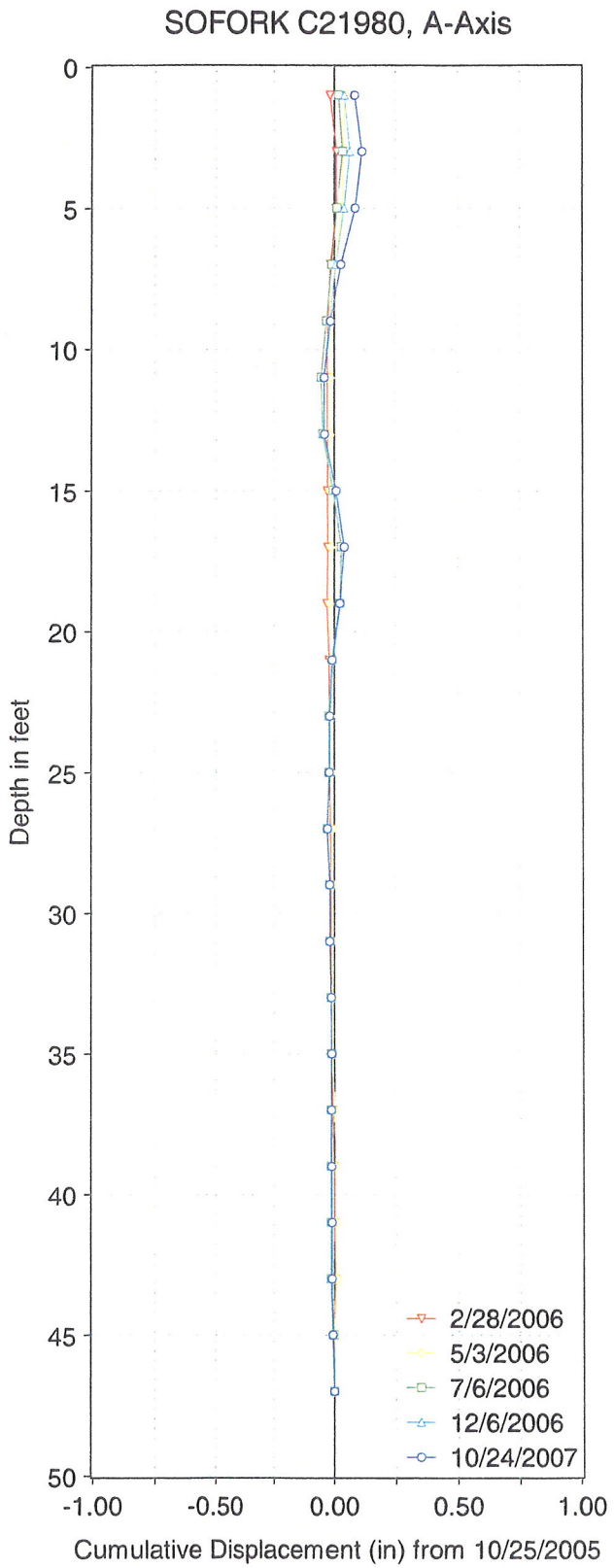
2/28/2006
5/3/2006
7/6/2006
12/6/2006
10/24/2007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35
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45
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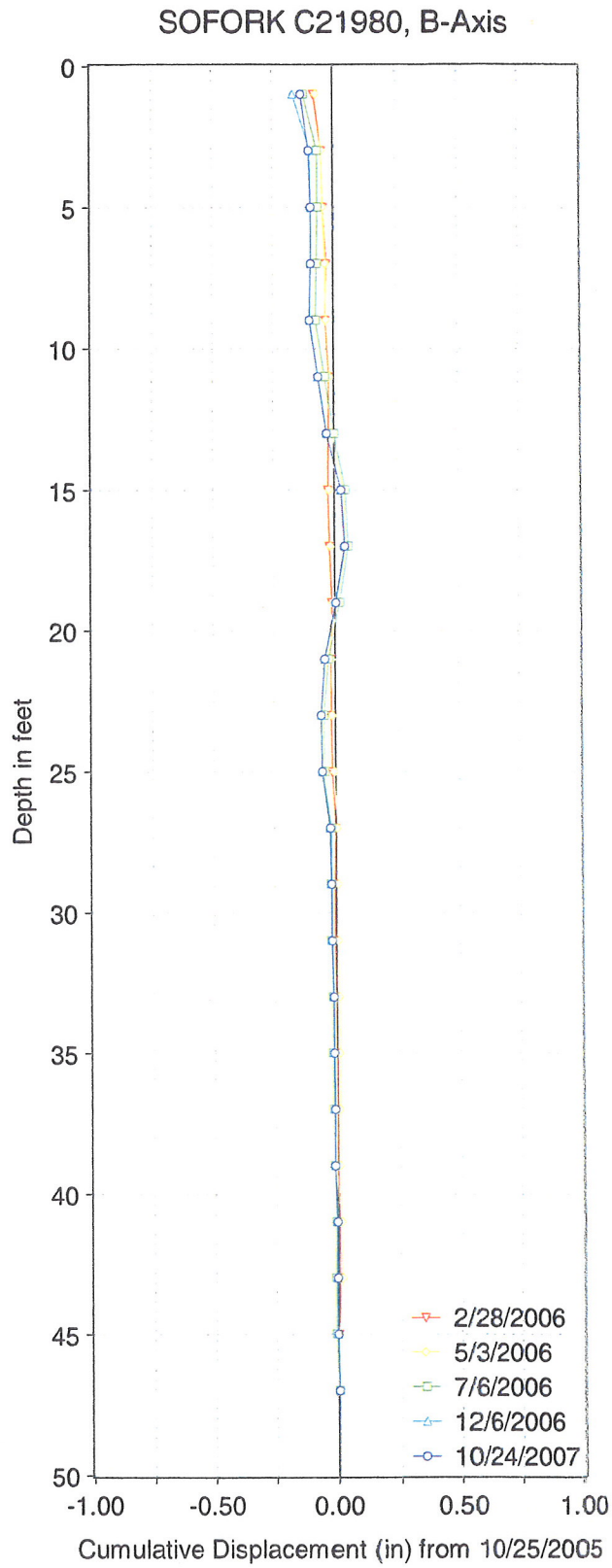
0.00
0.50
1.00
Cumulative Displacement (in) from 10/25/2005
2/28/2006
5/3/2006
7/6/2006
12/6/2006
10/24/2007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45
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0.00
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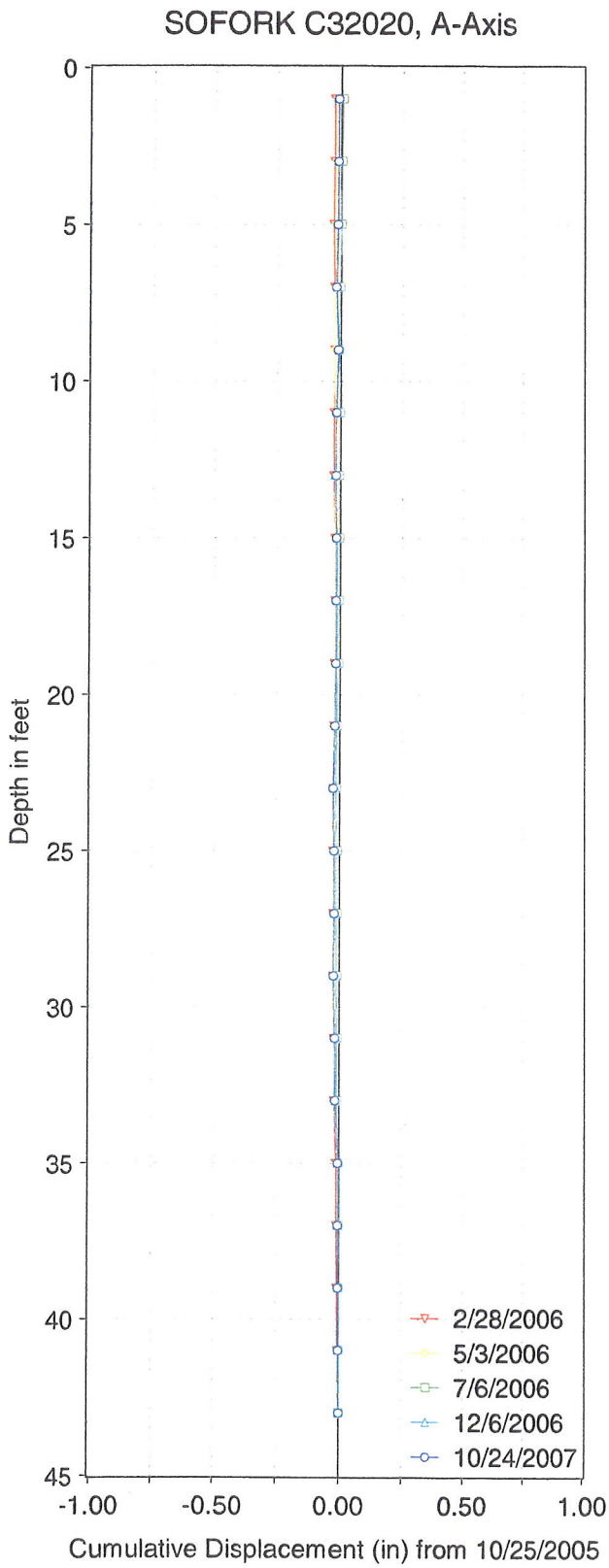
1.00
Cumulative Displacement (in) from 10/25/2005
2/28/2006
5/3/2006
7/6/2006
12/6/2006
10/24/2007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45
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0.00
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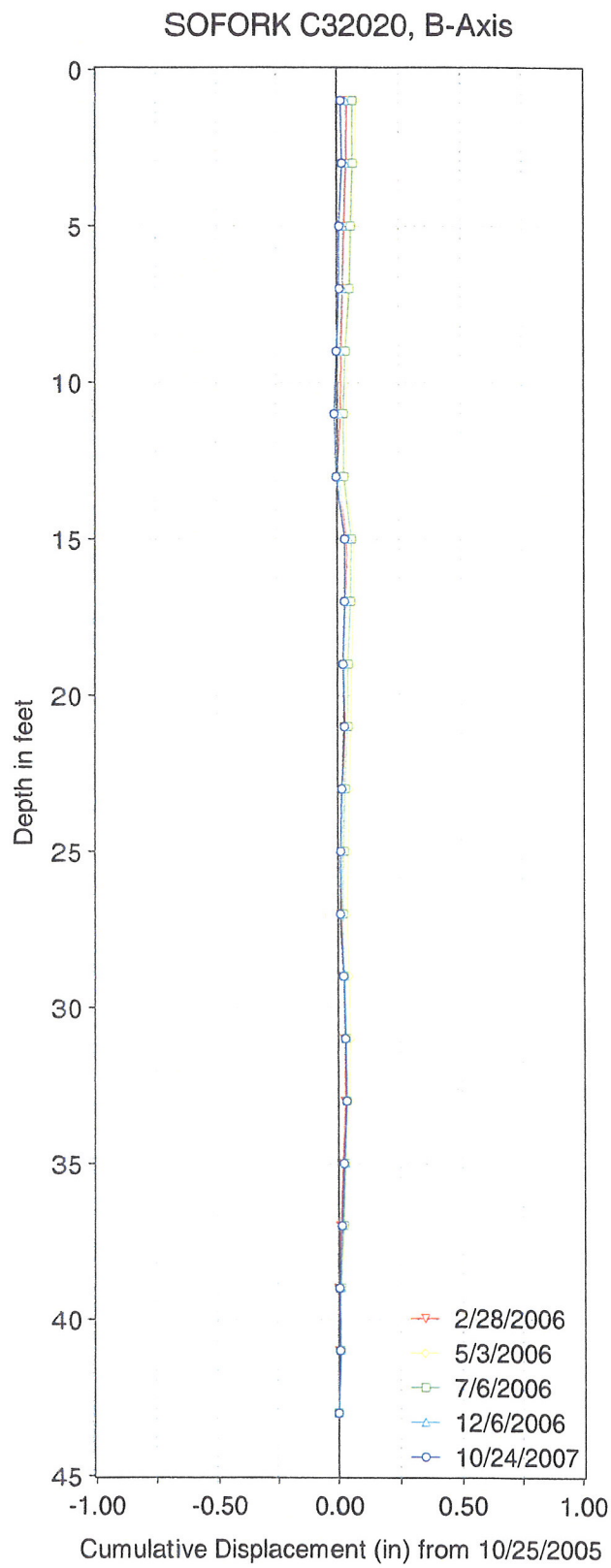
1.00
Cumulative Displacement (in) from 10/25/2005
2/28/2006
5/3/2006
7/6/2006
12/6/2006
10/24/2007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20
25
30
35
40
45
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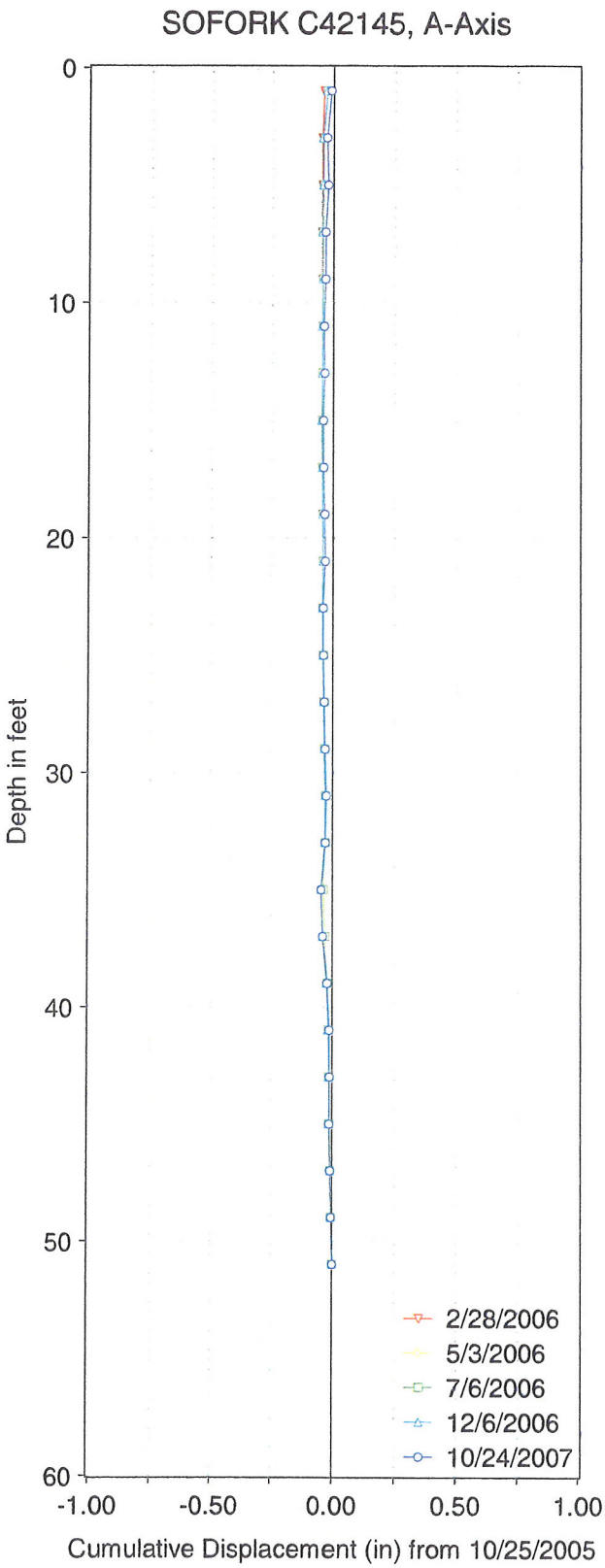
-0.50
0.00
0.50
1.00
Cumulative Displacement (in) from 10/25/2005
2/28/2006
5/3/2006
7/6/2006
12/6/2006
10/24/2007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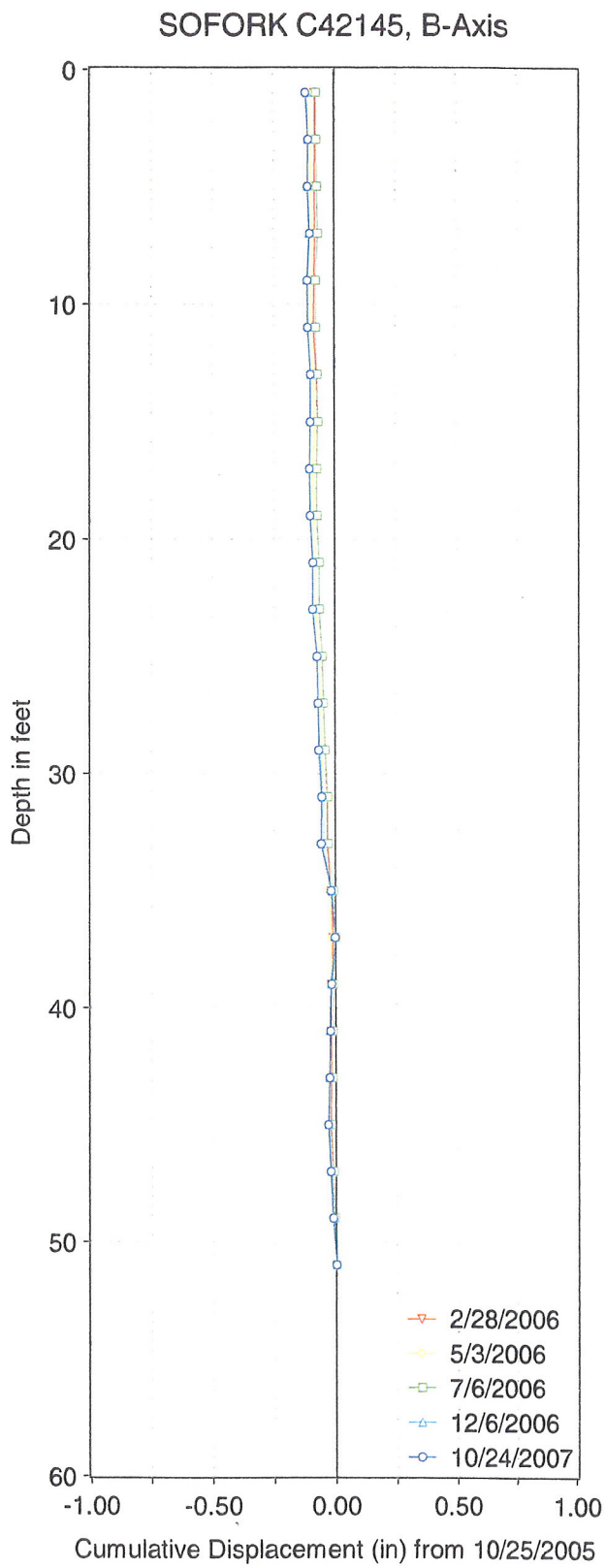
5/3/2006
7/6/2006
12/6/2006
10/24/2007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30
40
50
60
-1.00
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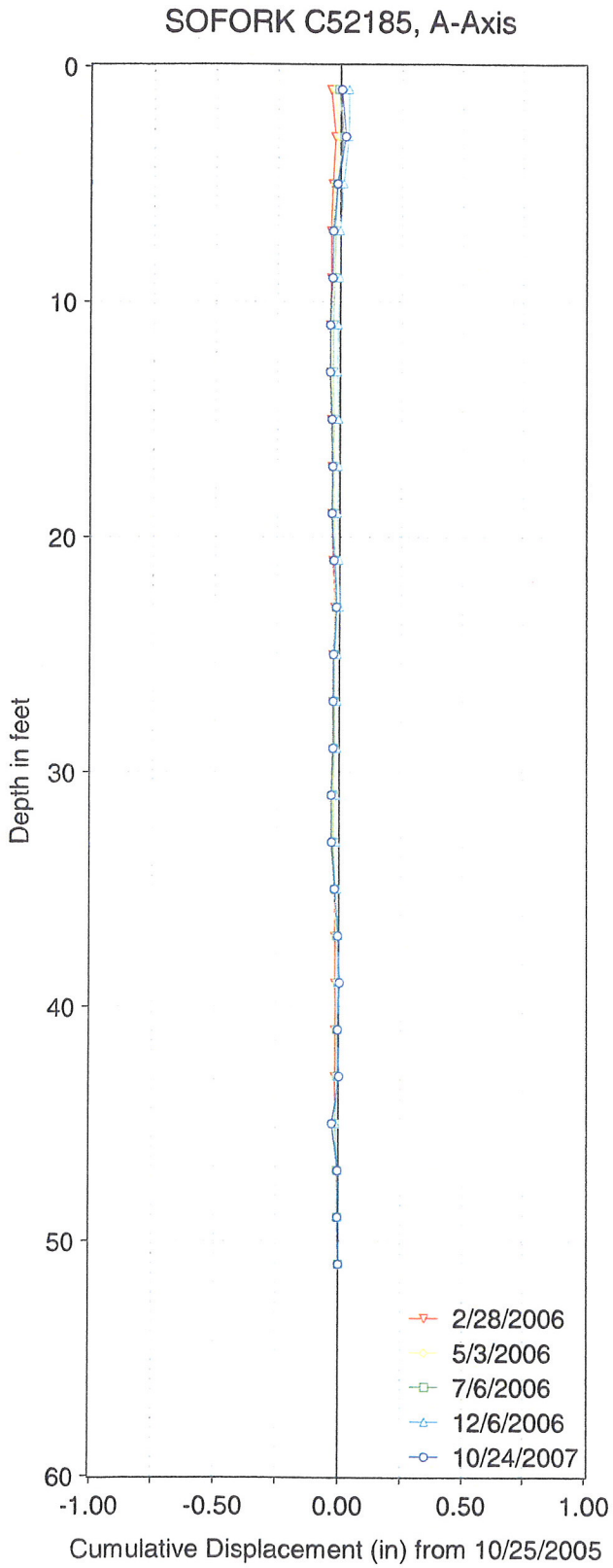
0.00
0.50
1.00
Cumulative Displacement (in) from 10/25/2005
2/28/2006
5/3/2006
7/6/2006
12/6/2006
10/24/2007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30
40
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0.00
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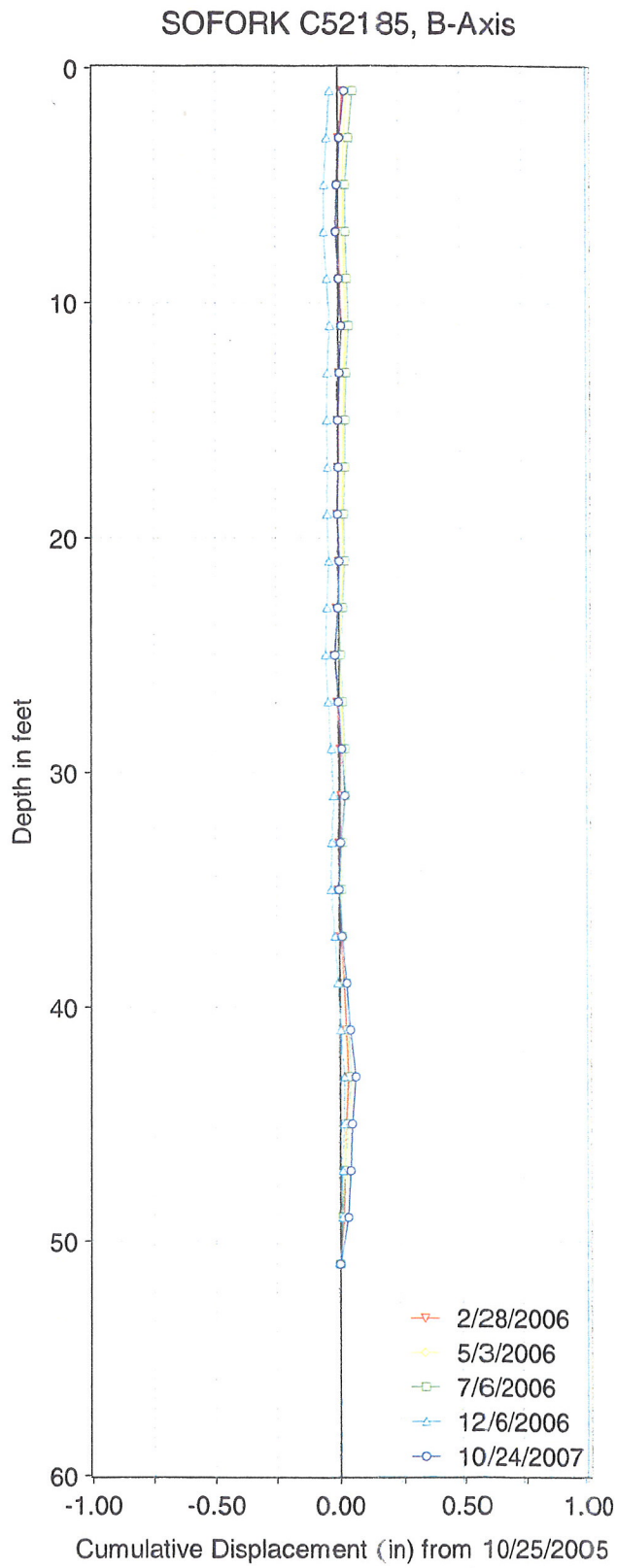
1.00
Cumulative Displacement (in) from 10/25/2005
2/28/2006
5/3/2006
7/6/2006
12/6/2006
10/24/2007


SOFORK C52185, B-Axis
Depth in feet
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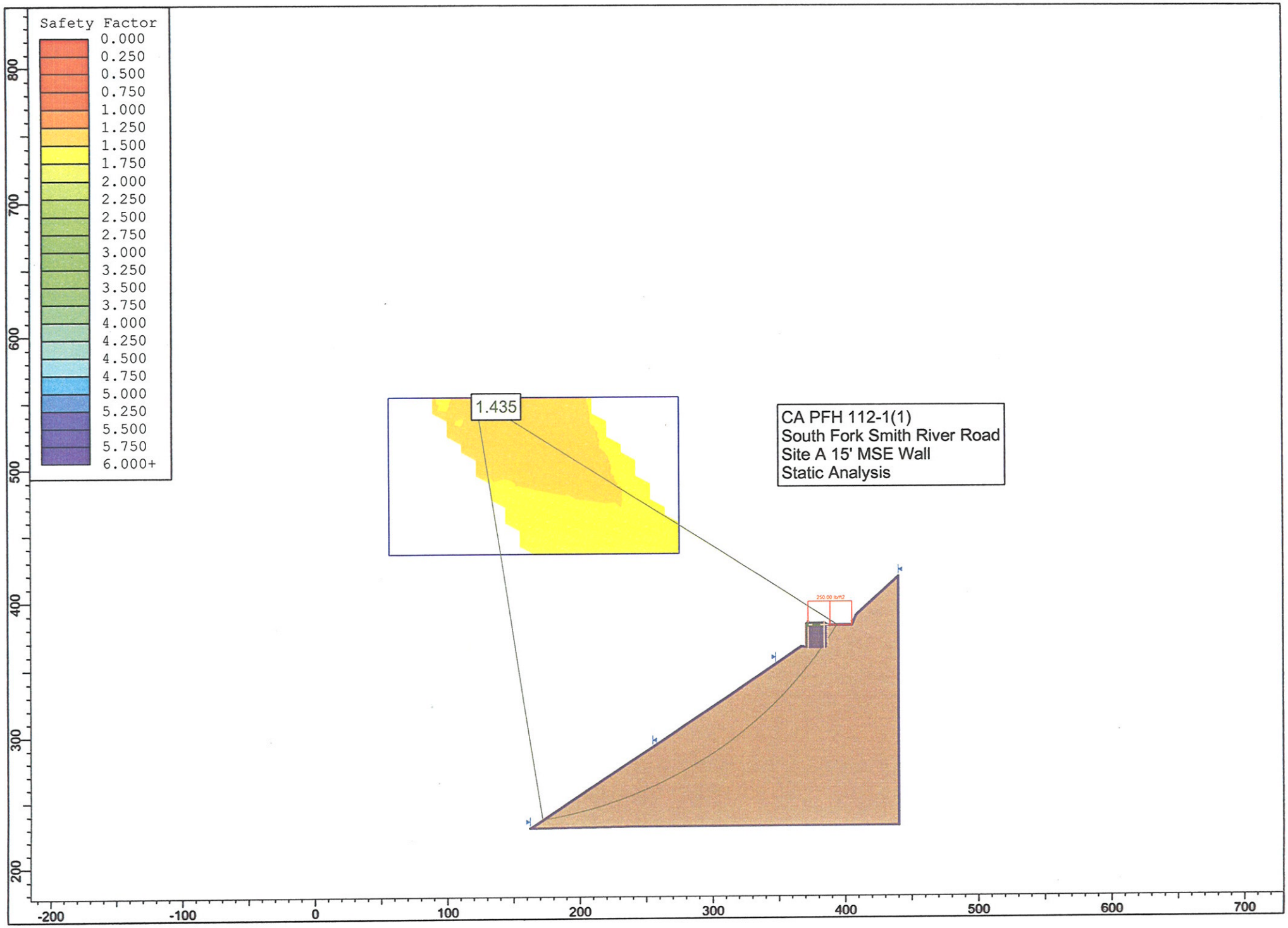
10
20
30
40
50
60
-1.00
-0.50
0.00
0.50
1.00
Cumulative Displacement (in) from 10/25/2005
2/28/2006
5/3/2006
7/6/2006
12/6/2006
10/24/2007

APPENDIX G – Analysis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1.000
1.250
1.500
1.750
2.000
2.250
2.500
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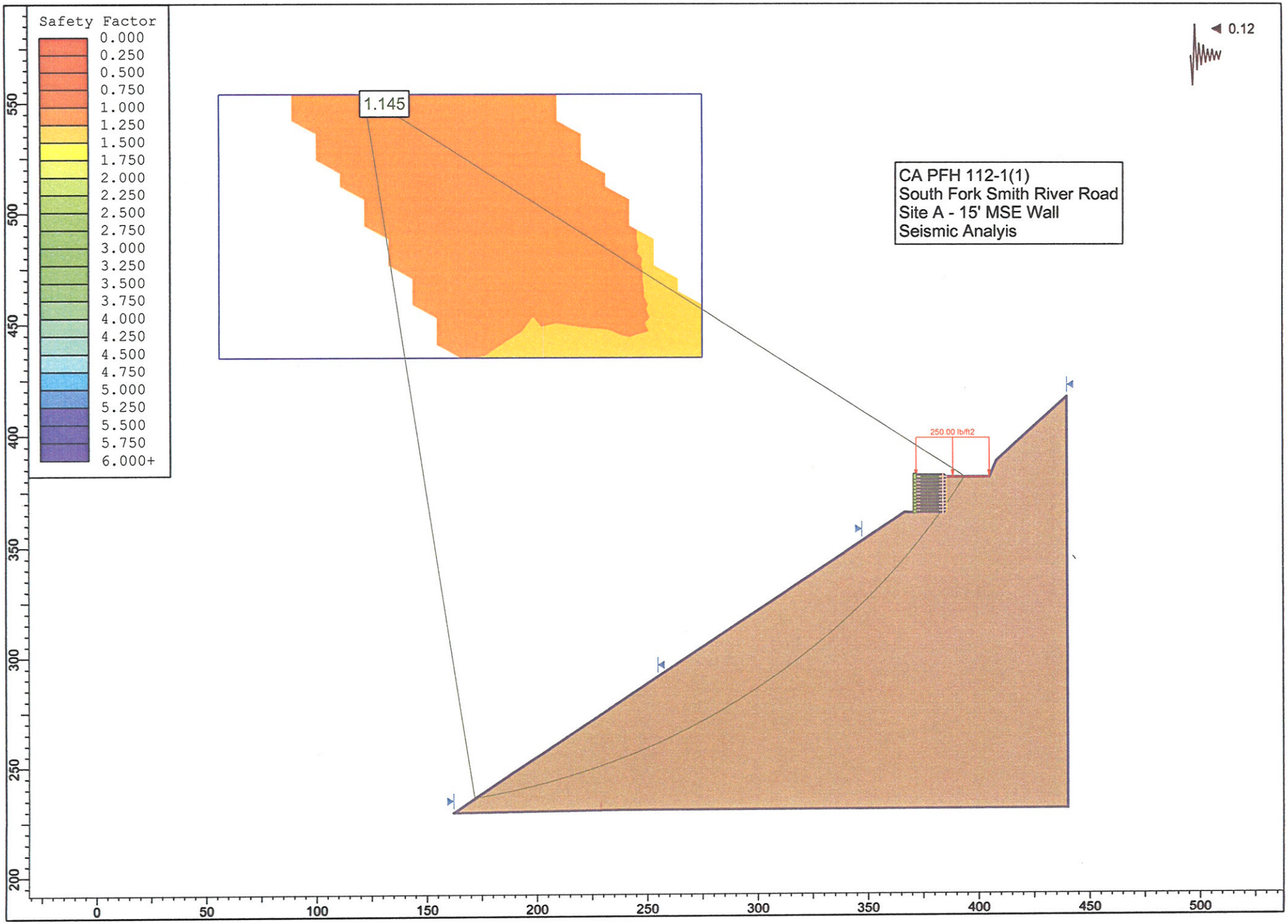
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
1.435
CA PFH 112-1(1)
South Fork Smith River Road
Site A 15' MSE Wall
Static Analysis
250.00 lb/ft2
800
700
600
500
400
300
200
-200
-100
0
100
200
300
400
500
600
700


Safety Factor
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0.750
1.000
1.250
1.500
1.750
2.000
2.250
2.500
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3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
1.145
0.12
CA PFH 112-1(1)
South Fork Smith River Road
Site A - 15' MSE Wall
Seismic Analyis
250.00 lb/ft2
0
50
100
150
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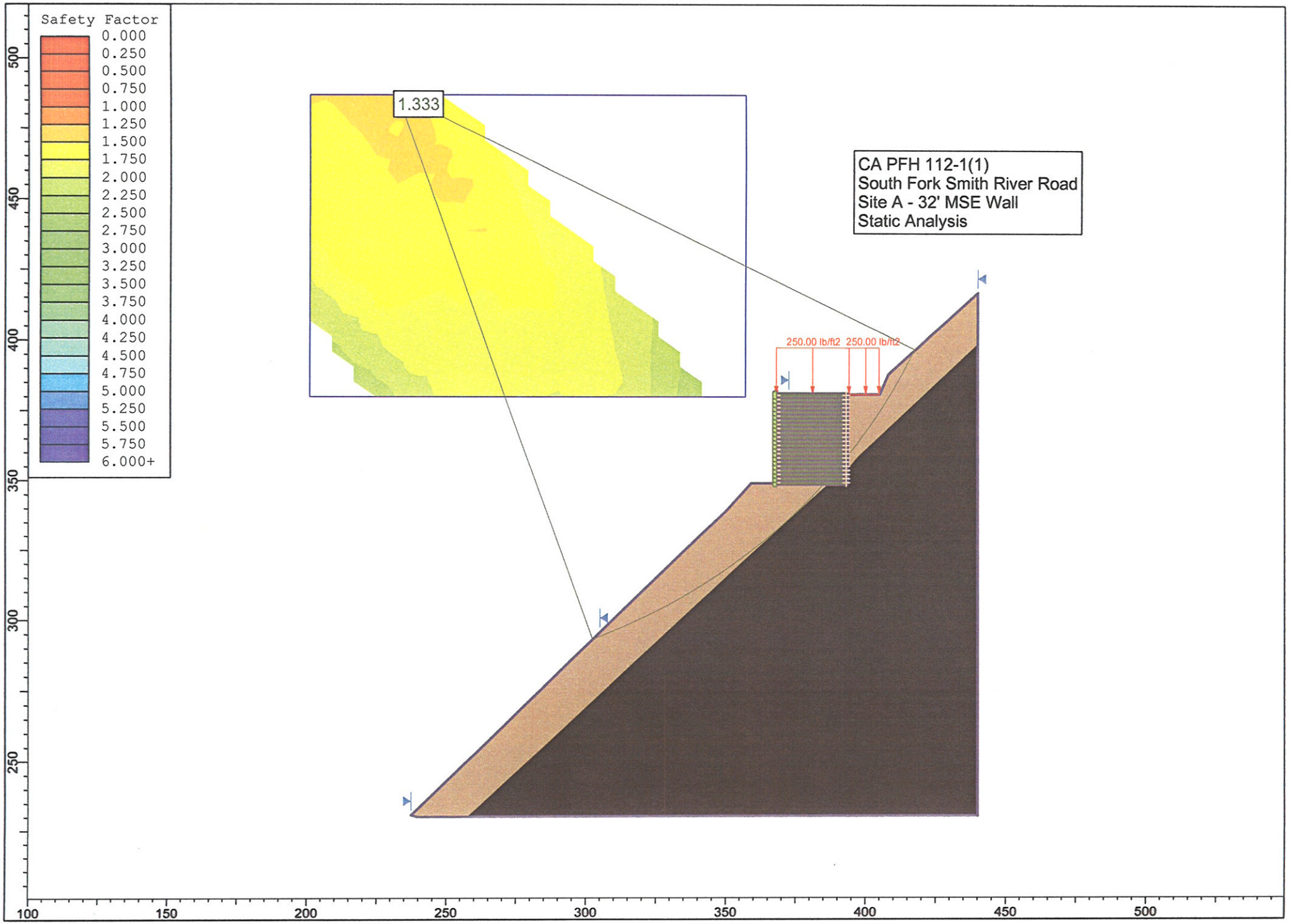
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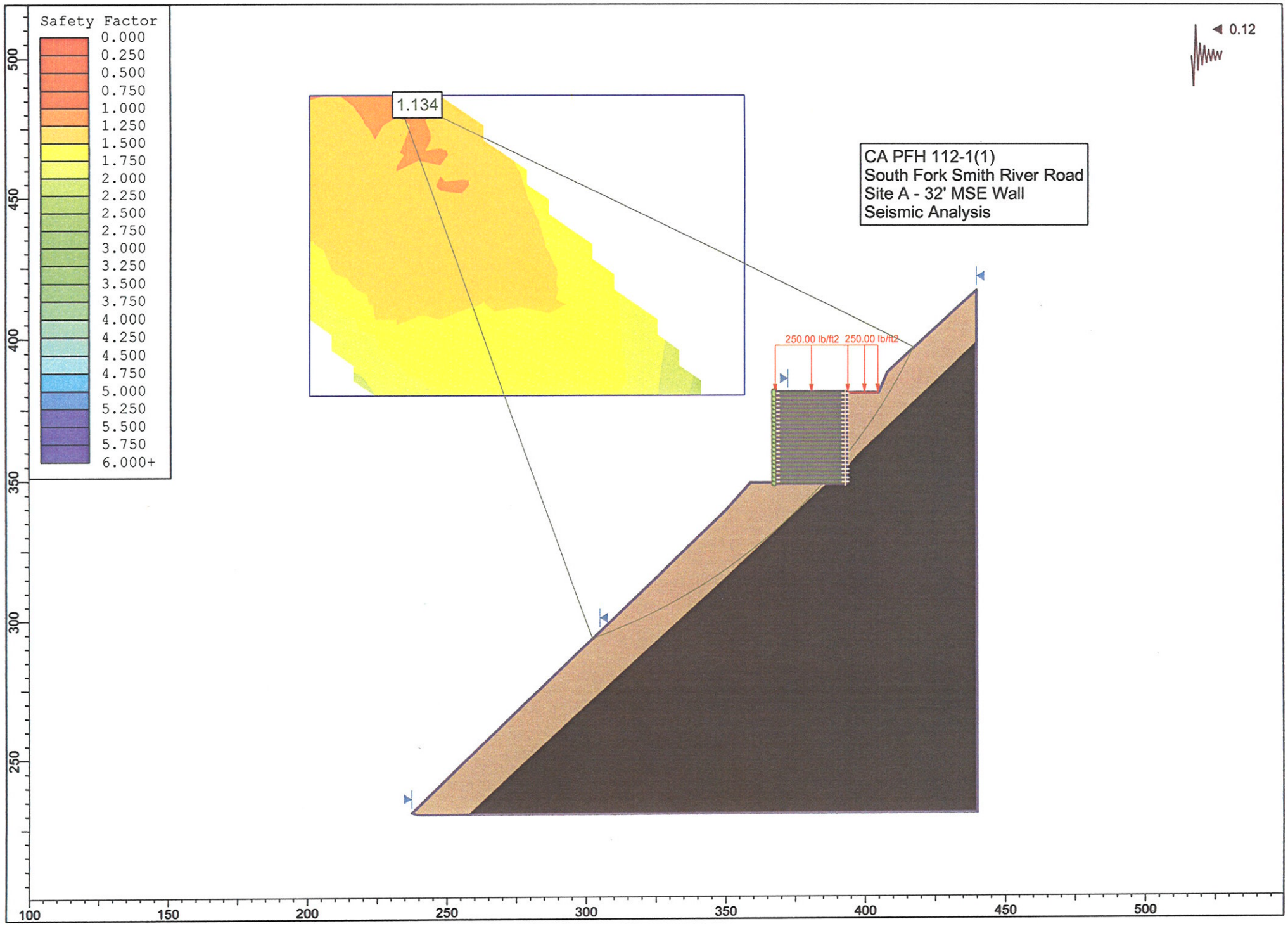
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
1.333
CA PFH 112-1(1)
South Fork Smith River Road
Site A - 32' MSE Wall
Static Analysis
250.00 lb/ft2
250.00 lb/ft2
500
450
400
350
300
250
100
150
200
250
300
350
400
450
500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3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
1.134
CA PFH 112-1(1)
South Fork Smith River Road
Site A - 32' MSE Wall
Seismic Analysis
250.00 lb/ft2
250.00 lb/ft2
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500
450
400
350
300
250
100
150
200
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400
450
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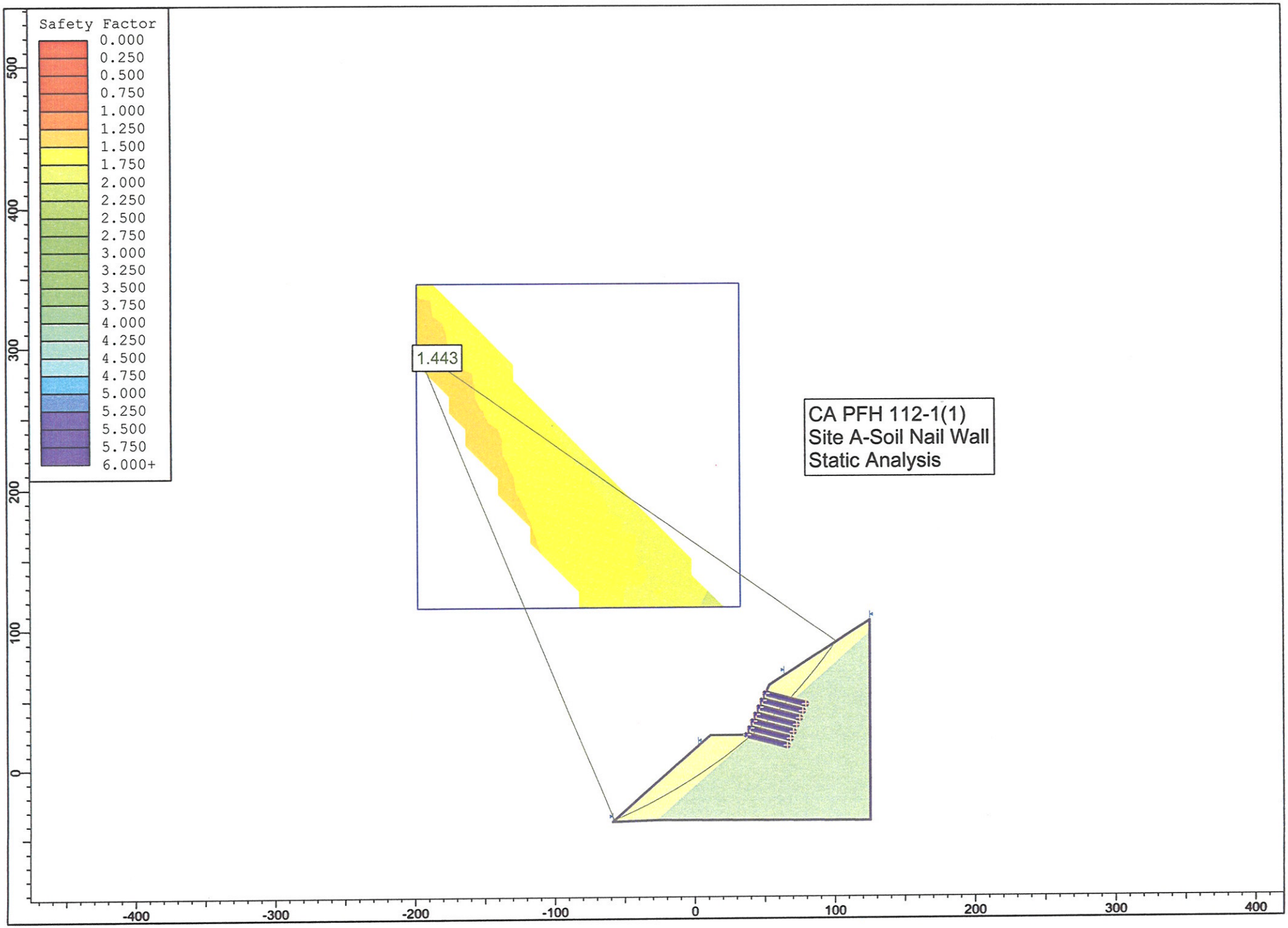
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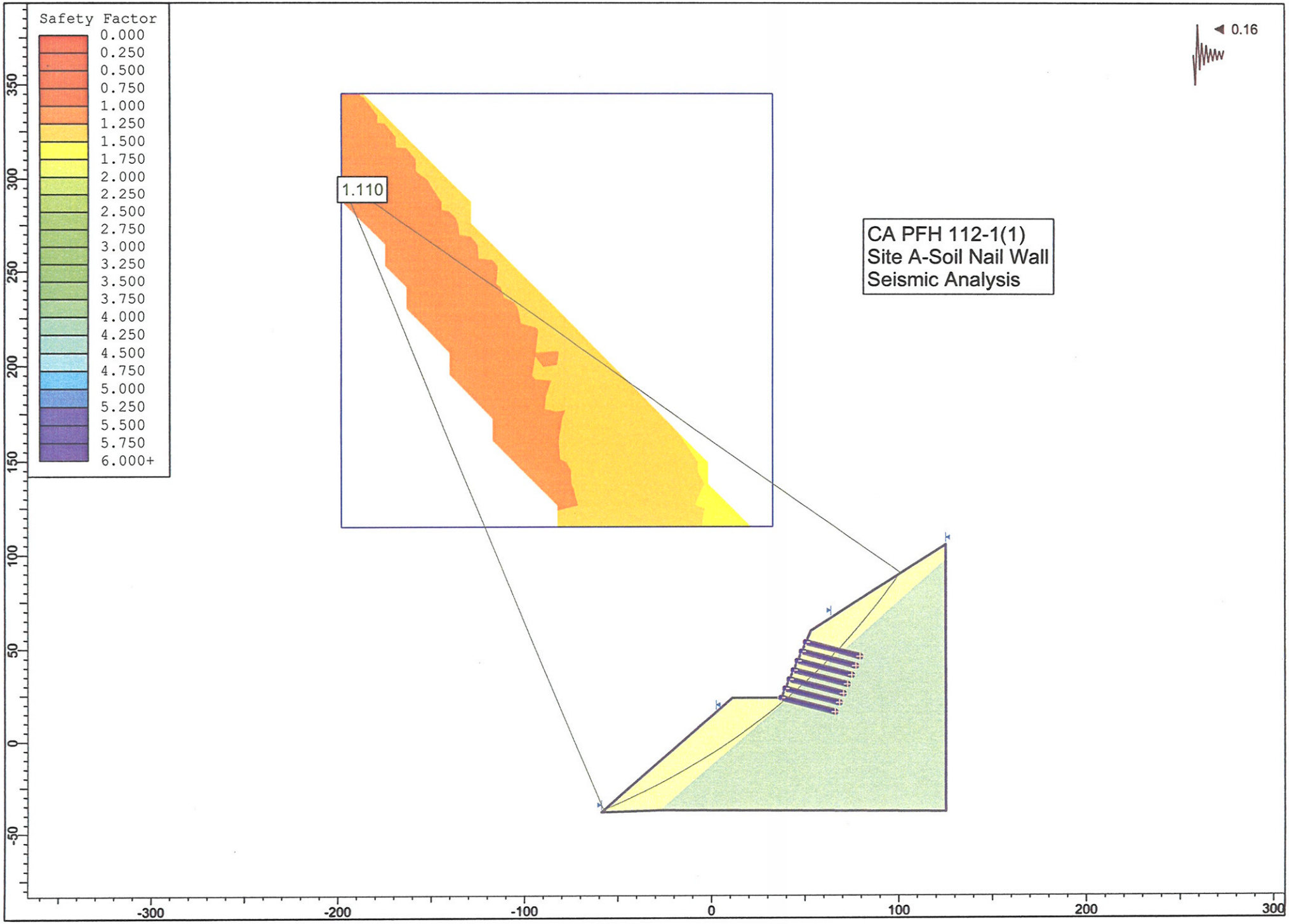
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
1.443
CA PFH 112-1(1)
Site A-Soil Nail Wall
Static Analysis
500
400
300
200
100
0
-400
-300
-200
-100
0
100
200
300
400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3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
1.110
0.16
CA PFH 112-1(1)
Site A-Soil Nail Wall
Seismic Analysis
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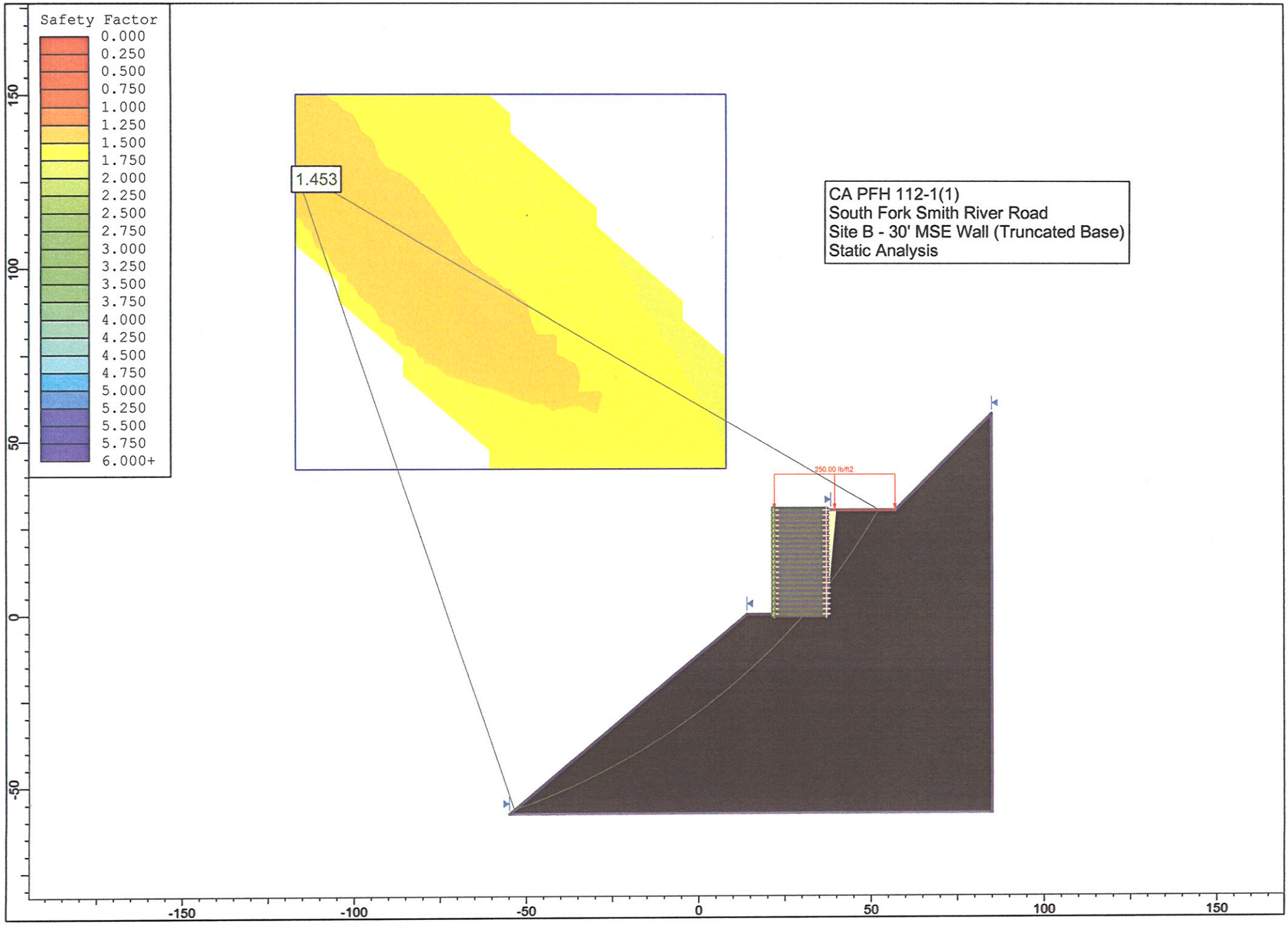
200
300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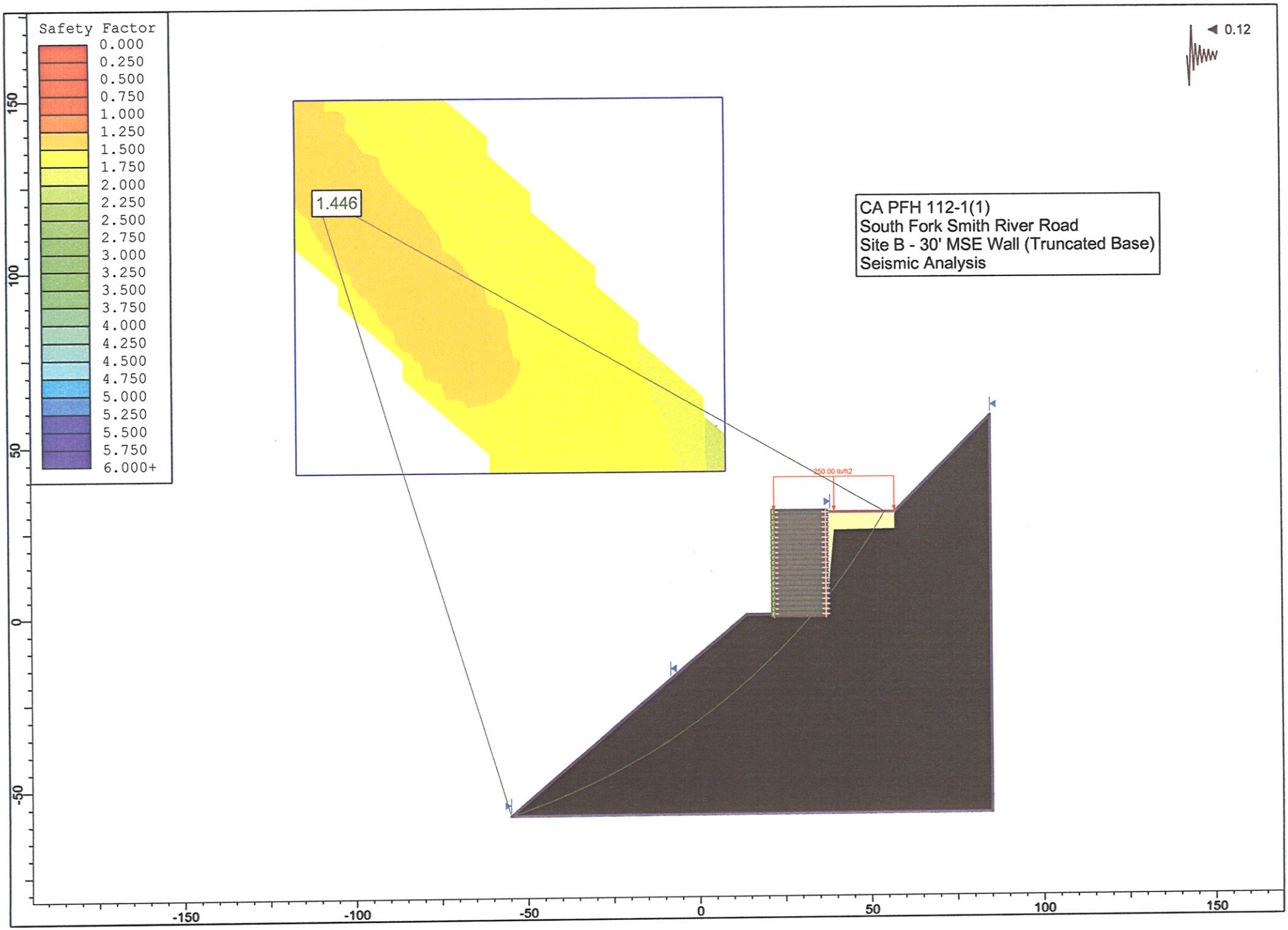
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
1.453
250.00 lb/ft2
CA PFH 112-1(1)
South Fork Smith River Road
Site B - 30' MSE Wall (Truncated Base)
Static Analysis
150
100
50
0
-50
-150
-100
-50
0
50
100
150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3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
1.446
250.00 lb/ft2
0.12
CA PFH 112-1(1)
South Fork Smith River Road
Site B - 30' MSE Wall (Truncated Base)
Seismic Analysis
150
100
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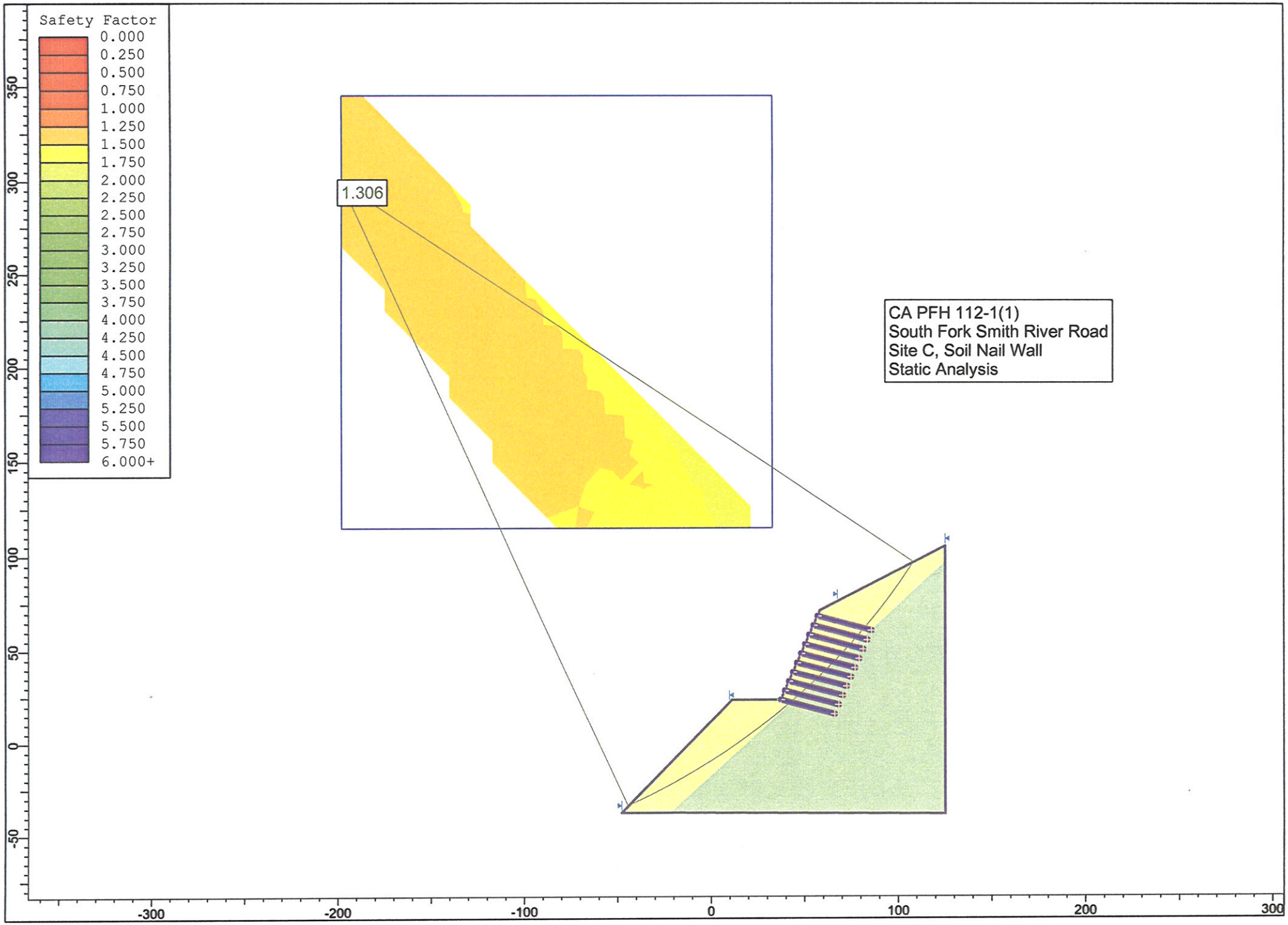
-150
-100
-50
0
50
100
150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3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
1.306
CA PFH 112-1(1)
South Fork Smith River Road
Site C, Soil Nail Wall
Static Analysis
350
300
250
200
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200
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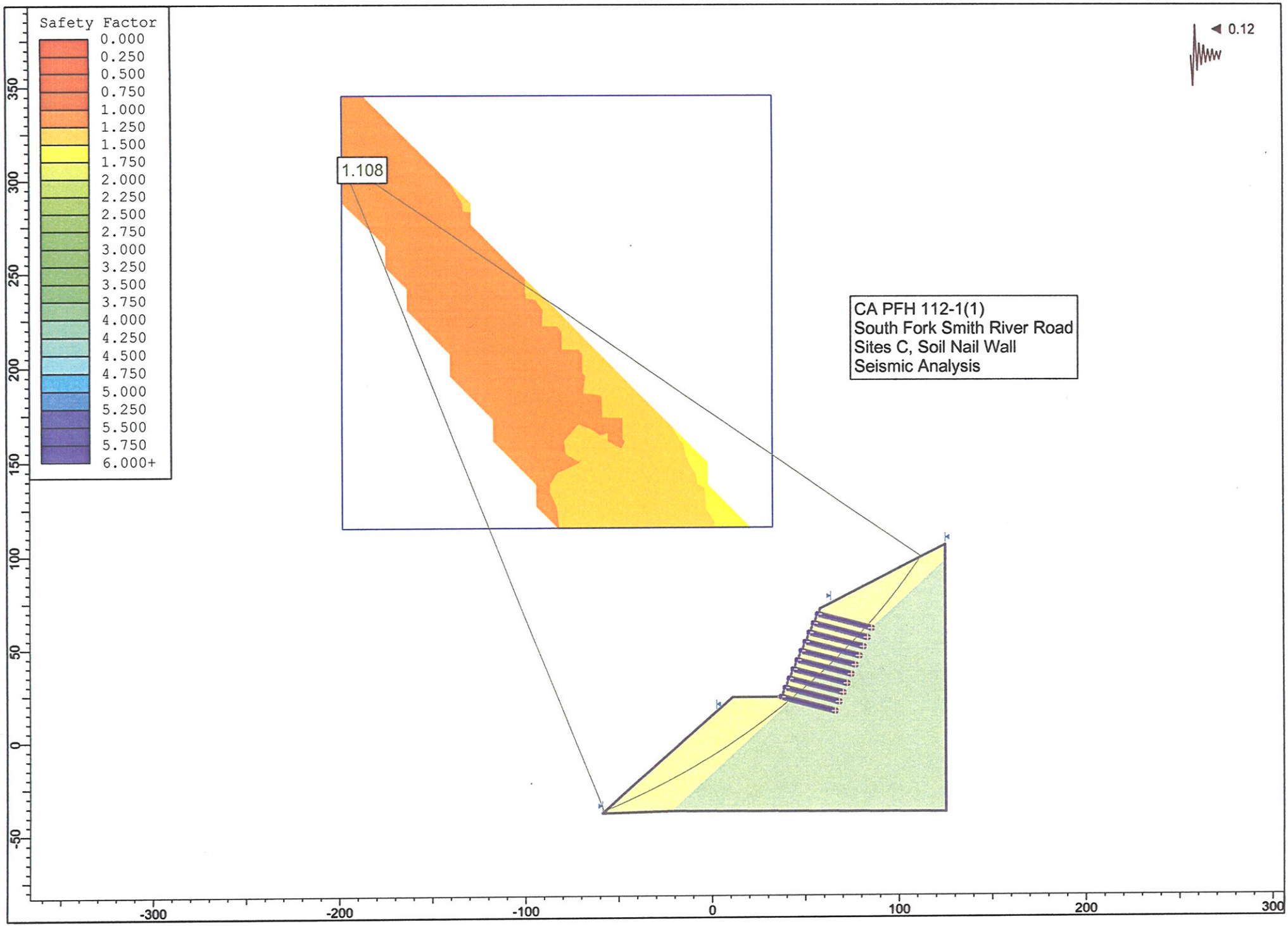
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3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
1.108
0.12
CA PFH 112-1(1)
South Fork Smith River Road
Sites C, Soil Nail Wall
Seismic Analysis
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300
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200
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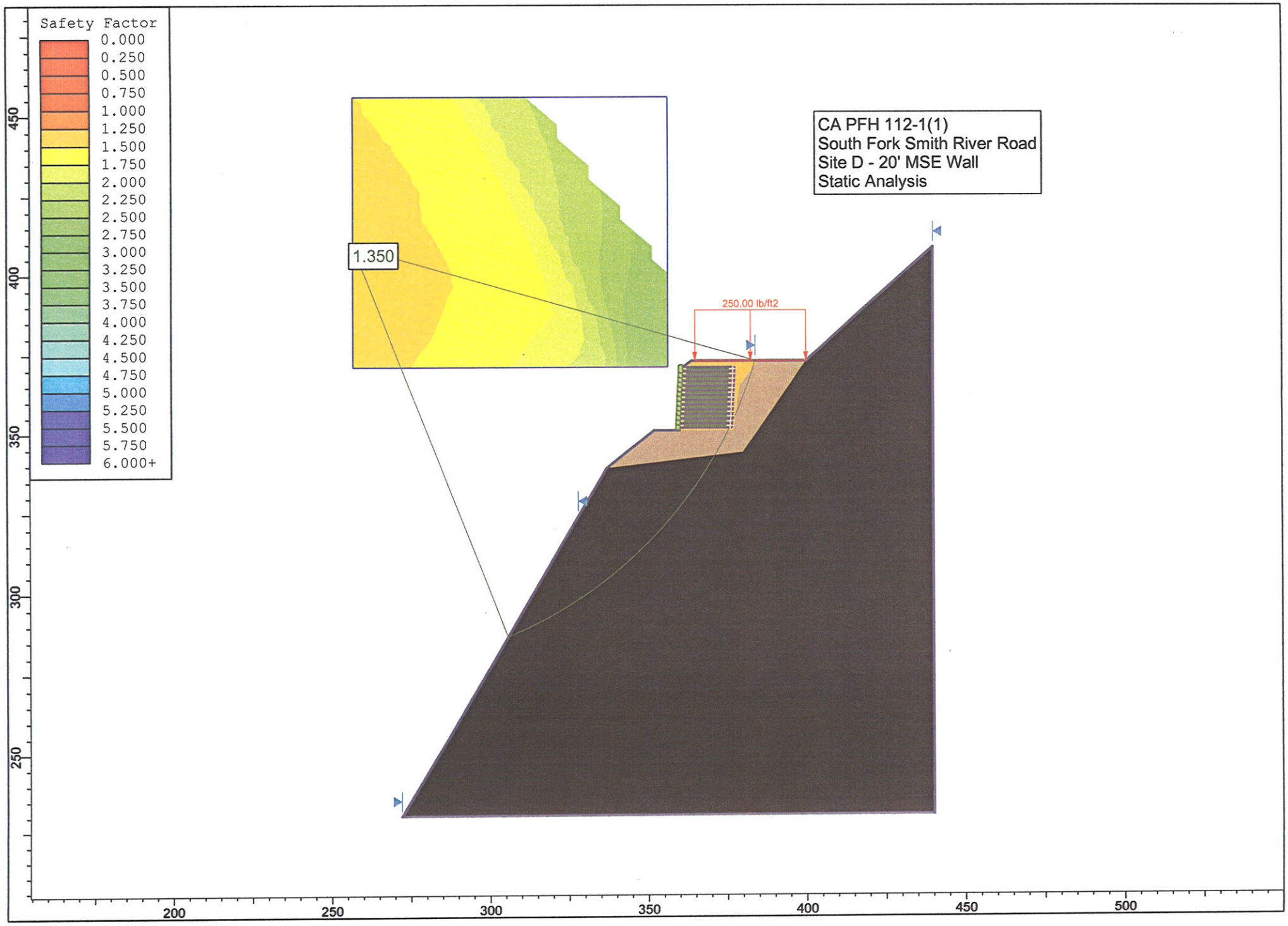
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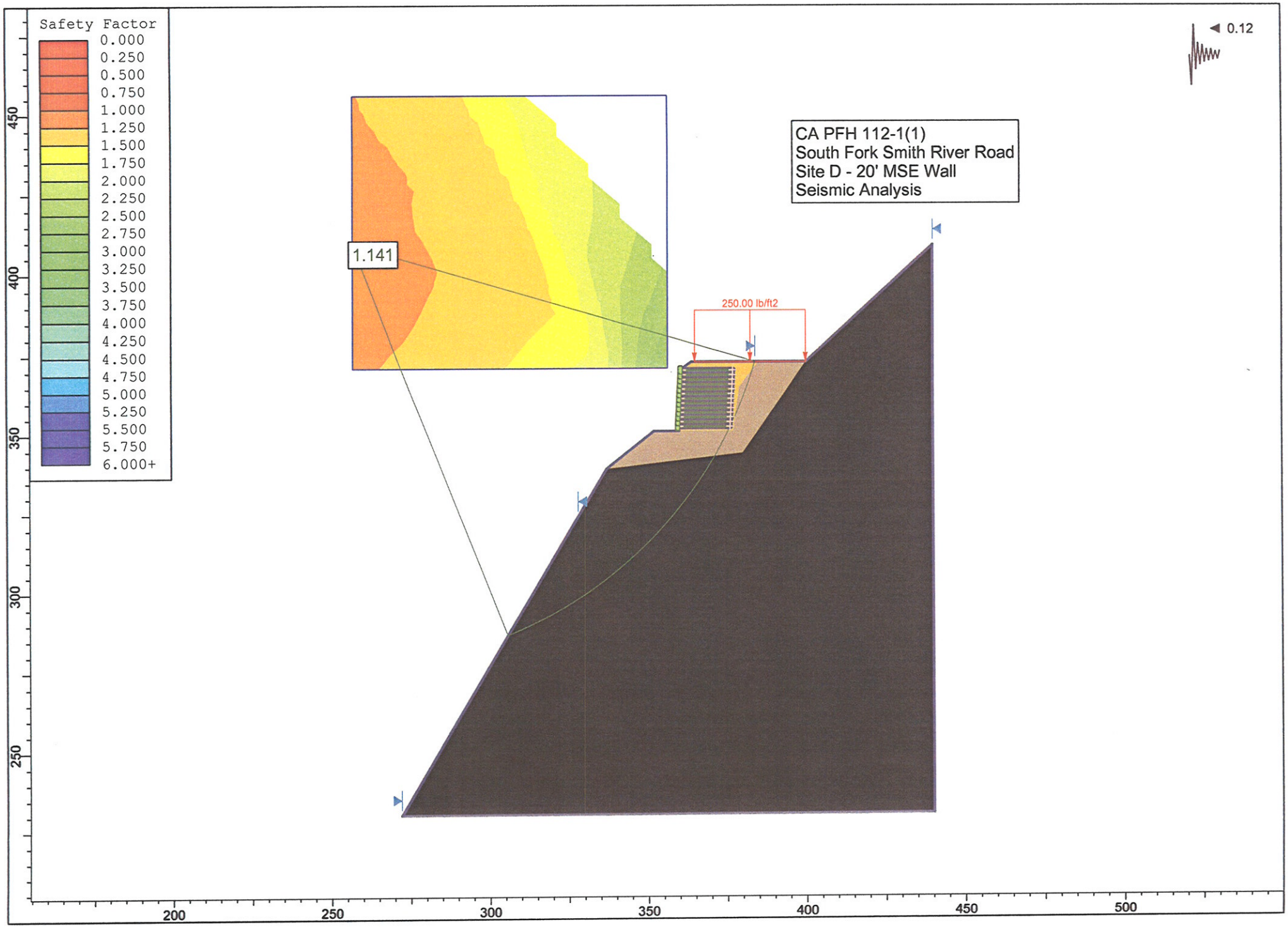
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
1.350
250.00 lb/ft2
CA PFH 112-1(1)
South Fork Smith River Road
Site D - 20' MSE Wall
Static Analysis
200
250
300
350
400
450
500
250
300
350
400
450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2.250
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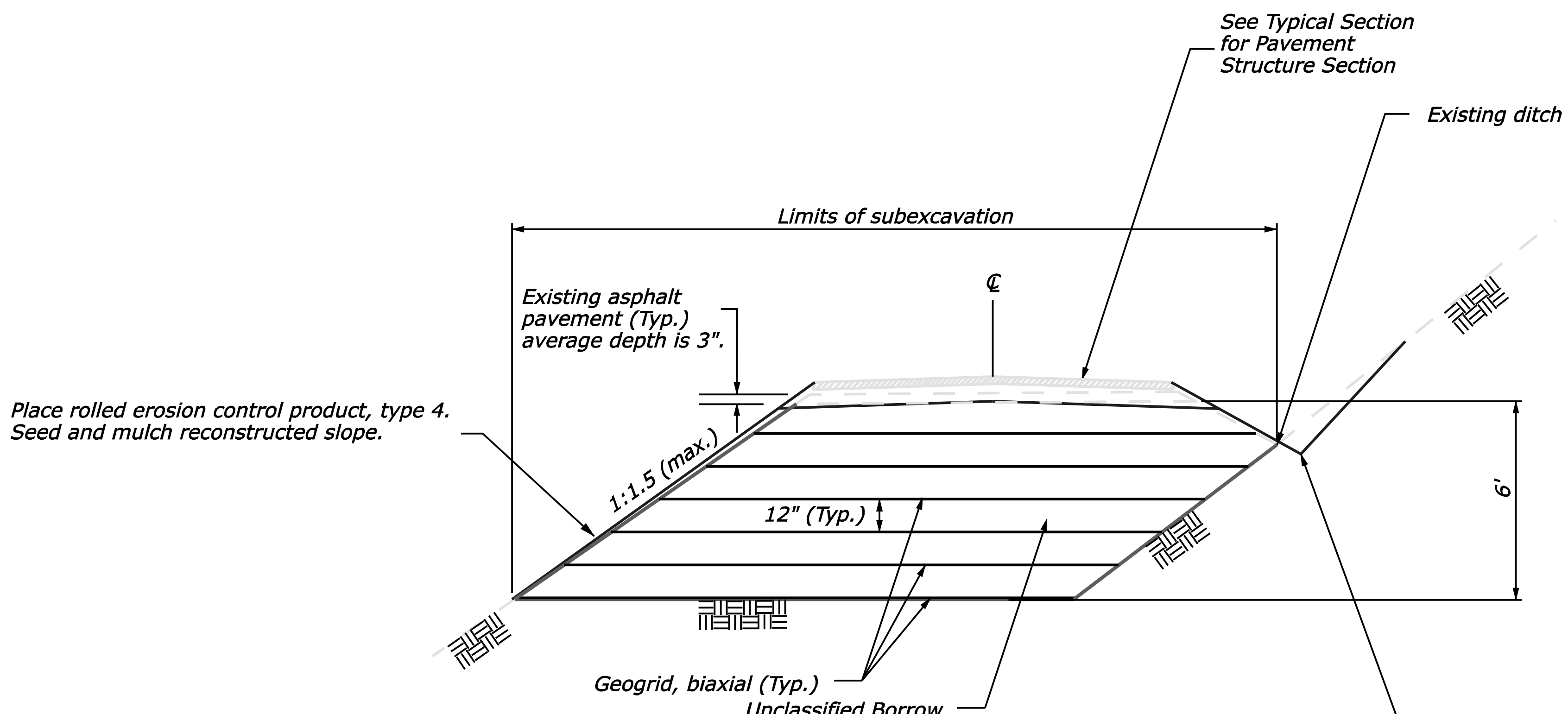
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
1.141
250.00 lb/ft2
0.12
CA PFH 112-1(1)
South Fork Smith River Road
Site D - 20' MSE Wall
Seismic Analysis
200
250
300
350
400
450
500

APPENDIX H – Miscellaneous Details

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
5	CA	PFH 112-1(1) S. FORK SMITH RIVER RD.	F1	F1

General Construction Notes:

1. *Remove existing asphalt pavement according to Section 203. Subexcavate according to Section 204.*
2. *Construct Deep Patch in 12" lifts.*
3. *Deep Patch limits are to be verified by CO. Deep patch to daylight on fill slopes where necessary.*
4. *Place Geogrid over each lift. Place Geogrid according to Subsection 207.05.*
5. *Immediately retrieve any construction material that has been transported downslope of the limits of excavation.*
6. *Maintain traffic according to Sections 108 and 156.*



DEEP PATCH
Site C
Sta. 518+26 to 519+00

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

U.S. CUSTOMARY DETAIL

DEEP PATCH DETAIL
Site C

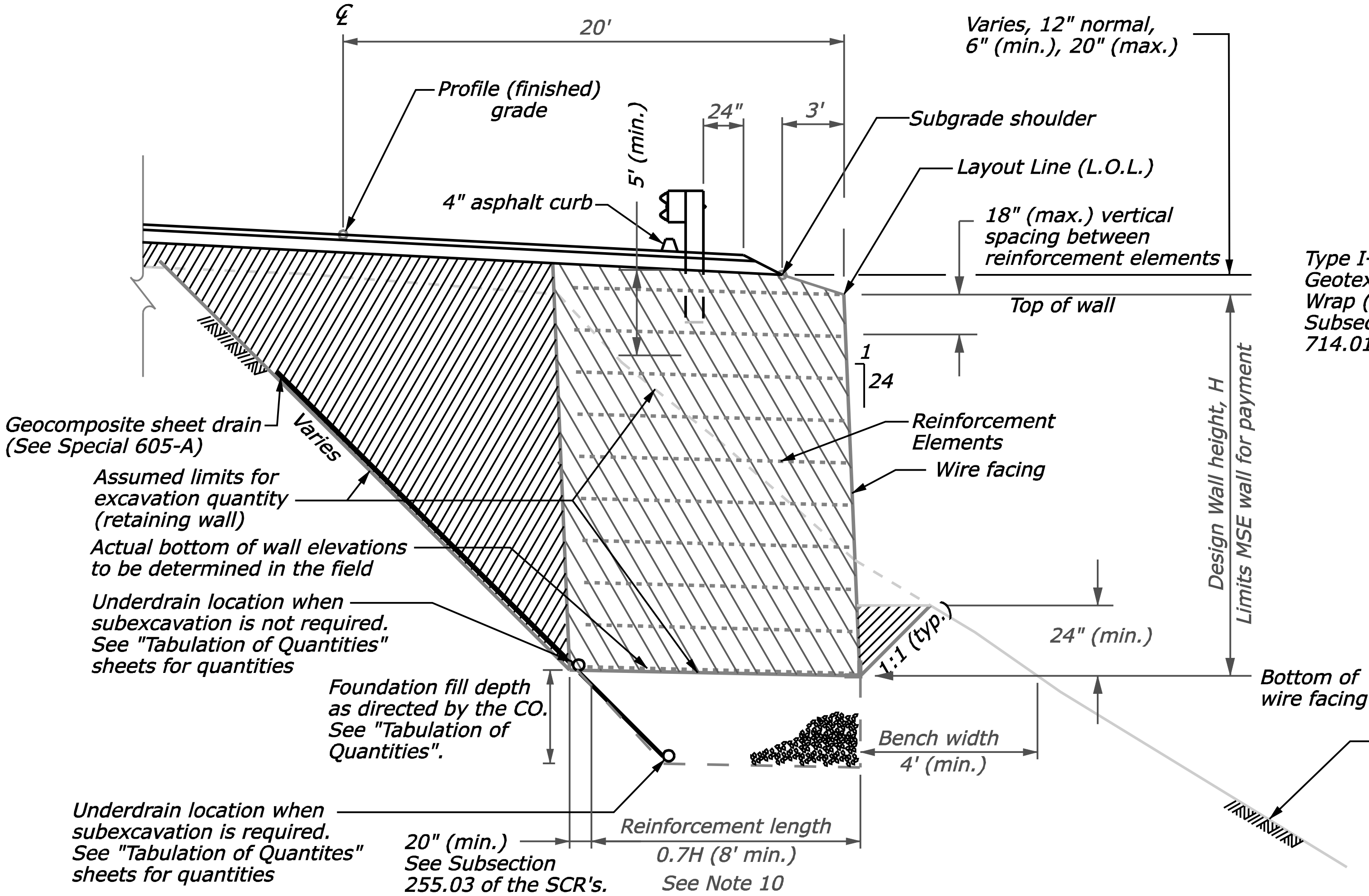
DETAIL APPROVED FOR USE

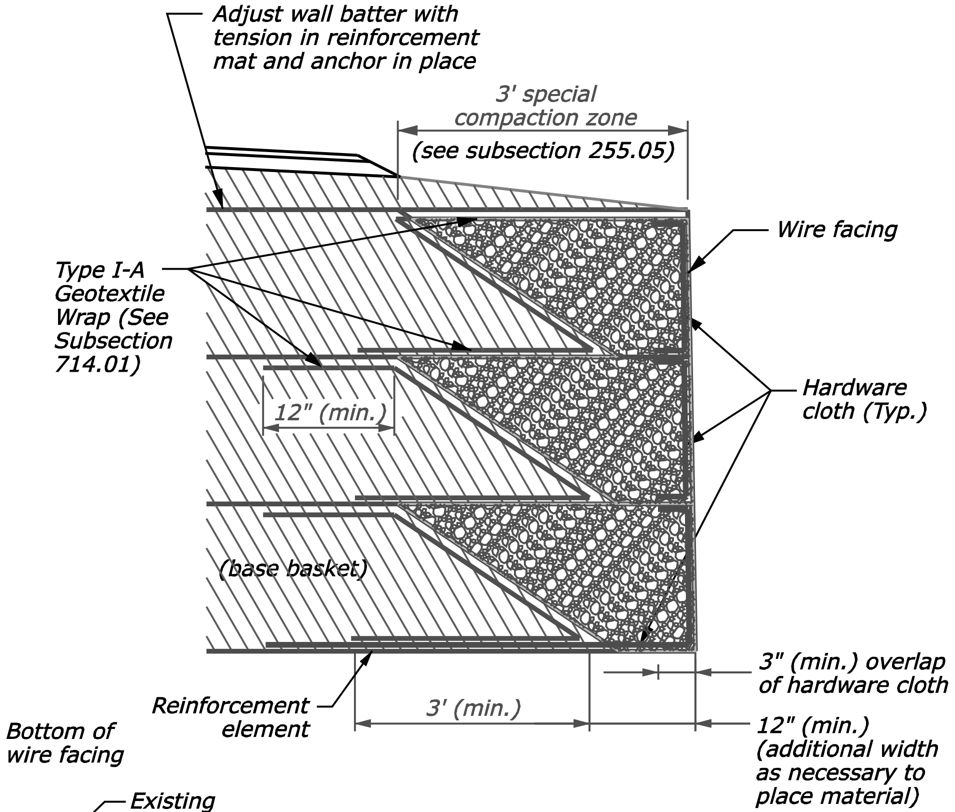
REVISED:

DETAIL
204-A

$$$$DATE$$$$ $TIME$ $$$$DGN$$$

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
5	CA	PFH 112-1(1) S. FORK SMITH RIVER RD.	G14	G16





MSE WALL FACING DETAIL

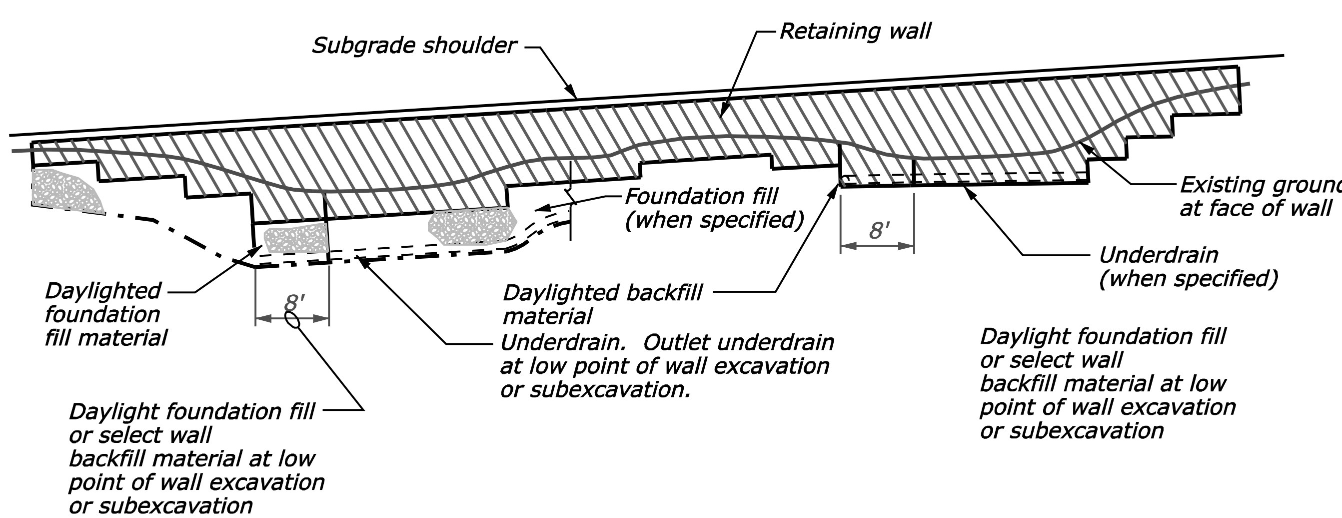
Wall Backfill | Select Wall Backfill | Foundation fill (when specified) | Wall facing fill

TYPICAL SECTION

NOTE:

1. Top of wall will be as shown on wall Layout Drawings. No steps will be allowed.
2. Survey MSE wall locations according to section 152 to acquire current terrain data. Prepare and submit for approval Preliminary Drawings according to 104.03. See subsection 255.03
3. Furnish select wall backfill consisting of soil meeting the requirements of Subsection 704.13(a).
4. Furnish wall backfill consisting of backfill soil meeting the requirements of subsection 704.13(b).
5. Furnish wall facing fill conforming to the requirements of subsection 704.13(c).
6. Design data:

   Unit weight of select wall backfill = 125 lb/ft3
   Equivalent fluid pressure (lateral) = 36 lb/ft3
   Ø = 34° for select wall backfill.
   Use the maximum cover dimension for all design calculations.
7. See Detail 255-51 for drainage details.
8. Install 5' (min.) width of hardware cloth and backing mat along horizontal leg, inside of the base basket. Place hardware cloth according to Subsection 255.04.
9. Terminate wire-face wall at the beginning and end of each lift with a return of the wall facing material (backing mat & hardware cloth) a minimum of 4' into the backfill. The returns shall not be measured for payment and are subsidiary to the MSE wall.
10. For truncated walls (Sites B and D) use a minimum reinforcement length of 0.5H or 8 feet, which ever is greater.



TYPICAL ELEVATION

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

U.S. CUSTOMARY DETAIL

MECHANICALLY STABILIZED EARTH WALL WELDED WIRE FACE

DETAIL APPROVED FOR USE

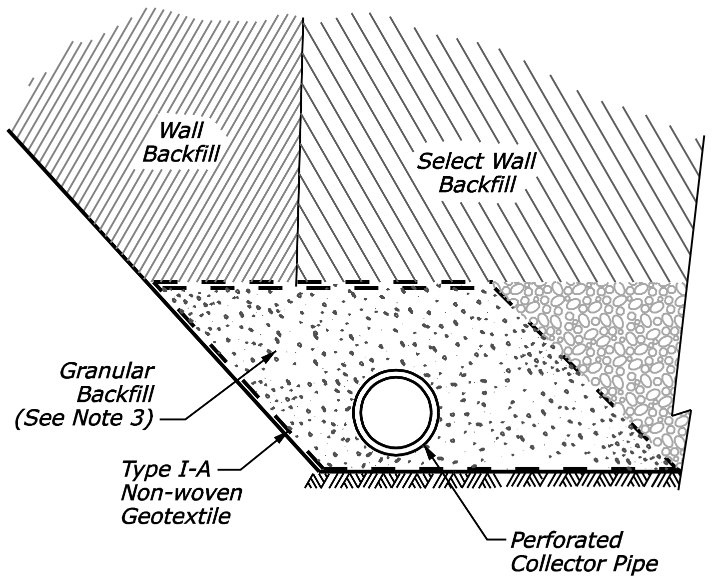
REVISED:

DETAIL C255-02

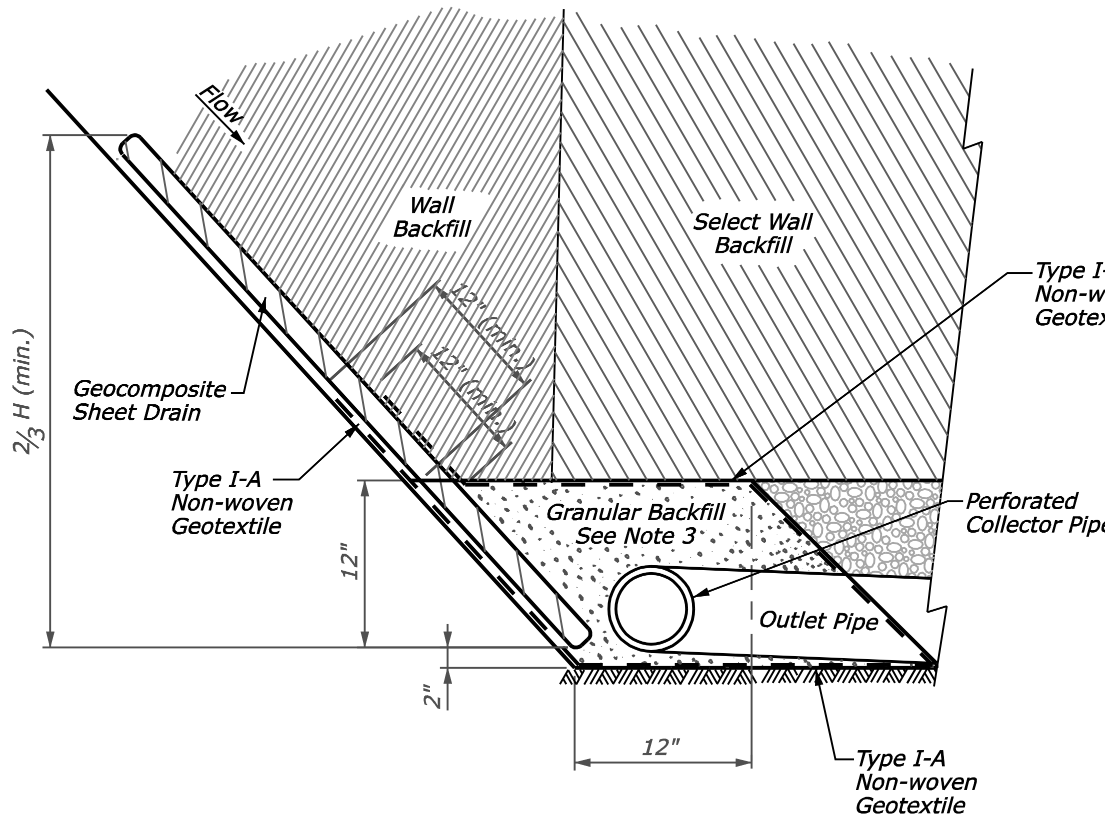
$$$$DGN$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$ $TIME$ $$$$DATE$$$$

NOTE:

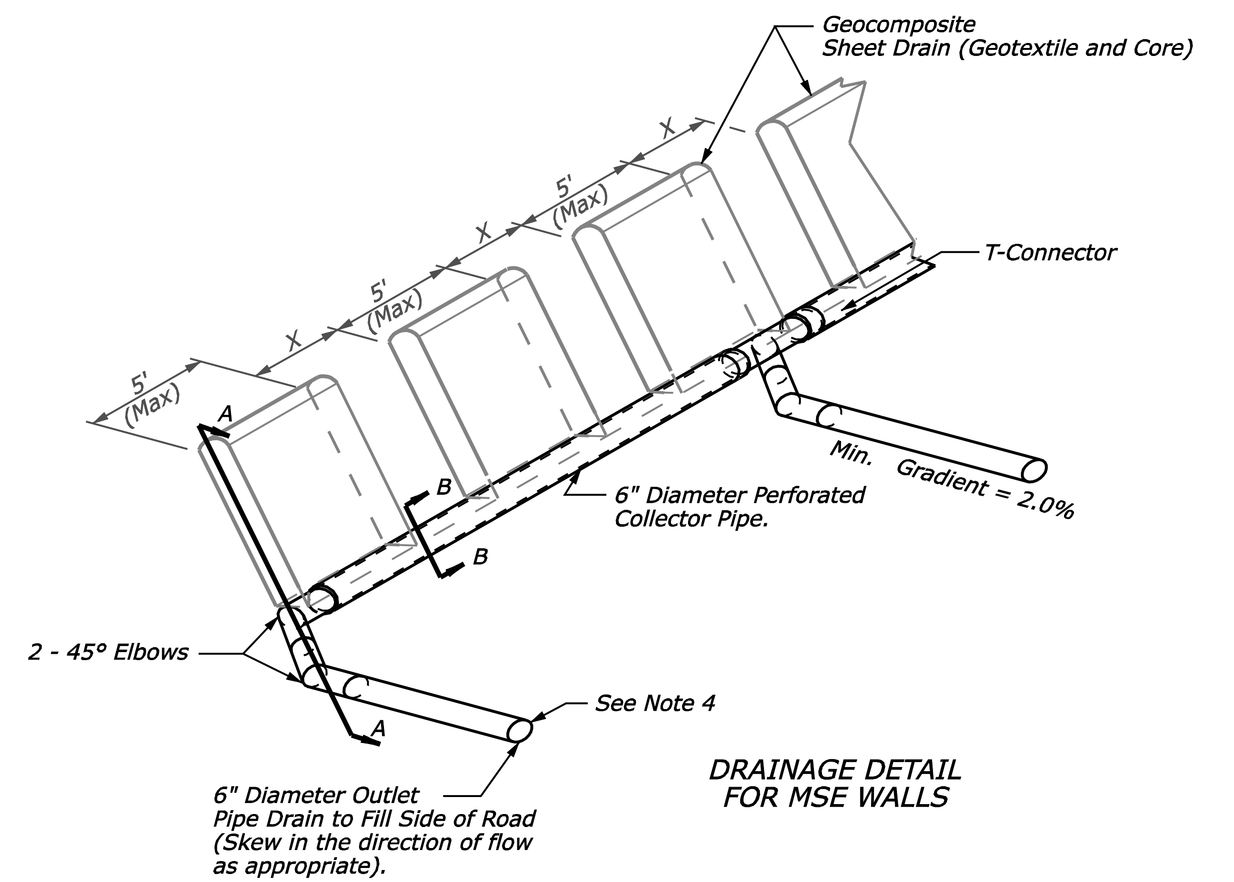
1. Outlet underdrains at low points of wall subexavation and at 50' (max) spacing.
2. Place Geocomposite Sheet Drains in 5' (Max.) wide strips with spacing X to achieve a 30% ± 5% coverage (Example; X = 11.5' for a 5' wide strip).
3. Furnish granular backfill meeting the requirements of subsection 703.03(a) .
4. Cover the end of the outlet pipe with screen according to Subsection 605.03. Hold the screen securely in place with standard coupling bands or by other approved means.
5. Mark the outlet of the underdrain with a delineator post or other suitable marker.
6. See Special C255-02 for MSE Wall Typical Section and Details.
7. Furnish Geocomposite Sheet Drain meeting the requirements of subsection 714.02(b)
8. Furnish Collector Pipe, Outlet Pipe, and Fittings meeting the requirements of Subsection 706.08(d).



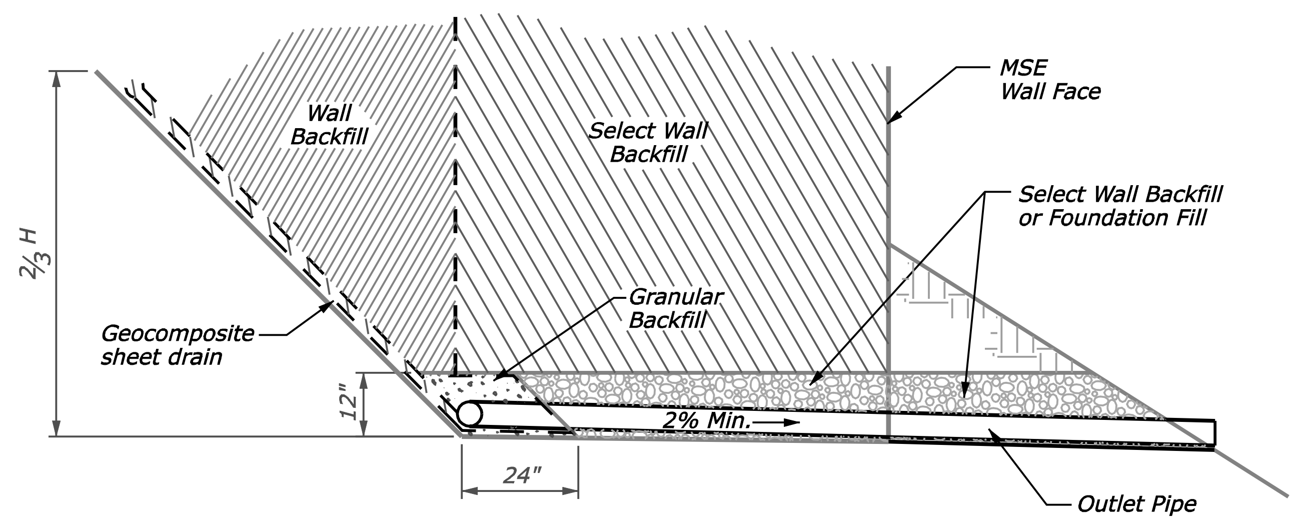
SECTION B-B



SECTION A-A



DRAINAGE DETAIL FOR MSE WALLS



GEOCOMPOSITE SHEET DRAIN FOR MSE WALLS

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

U.S. CUSTOMARY SPECIAL

MSE WALL DRAINAGE

08/2006

SPECIAL **255-51**

$$$$DATE$$$$ $TIME$ $$$$DGN$$$$

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
5	CA	PFH 112-1(1) S. FORK SMITH RIVER RD.	G16	G16

NOTE:

1. *Supply threaded, #8, grade 75 bolts with corrosion protection.*

2. *See plans for spot rock bolt areas. Lengths and quantities are estimated. Actual rock bolt locations are dependent upon the condition of the slope after scaling, slope rounding, and roadway excavation operations, and will be finalized during construction by the CO in consultation with FHWA geotechnical representative.*

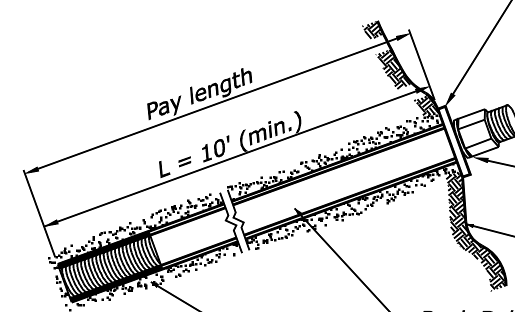
3. *Bearing plates shall be 8" x 8" x ½" thick mild steel thick mild steel.*

4. *Install rock reinforcement to a minimum depth of 10' or as directed by the CO.*

5. *Lock off load = Design load = 20 kips.*

6. *Remove bearing plates and end hardware after grout or resin has cured. Cut the bolt off flush with the ground surface.*

7. *See Section 260 of the Special Contract Requirements.*



TYPICAL ROCK BOLT

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

U.S. CUSTOMARY SPECIAL

ROCK BOLT

SPECIAL
260-A

$$$$DGN$$ $TIME$ $$$$DATE$$$$

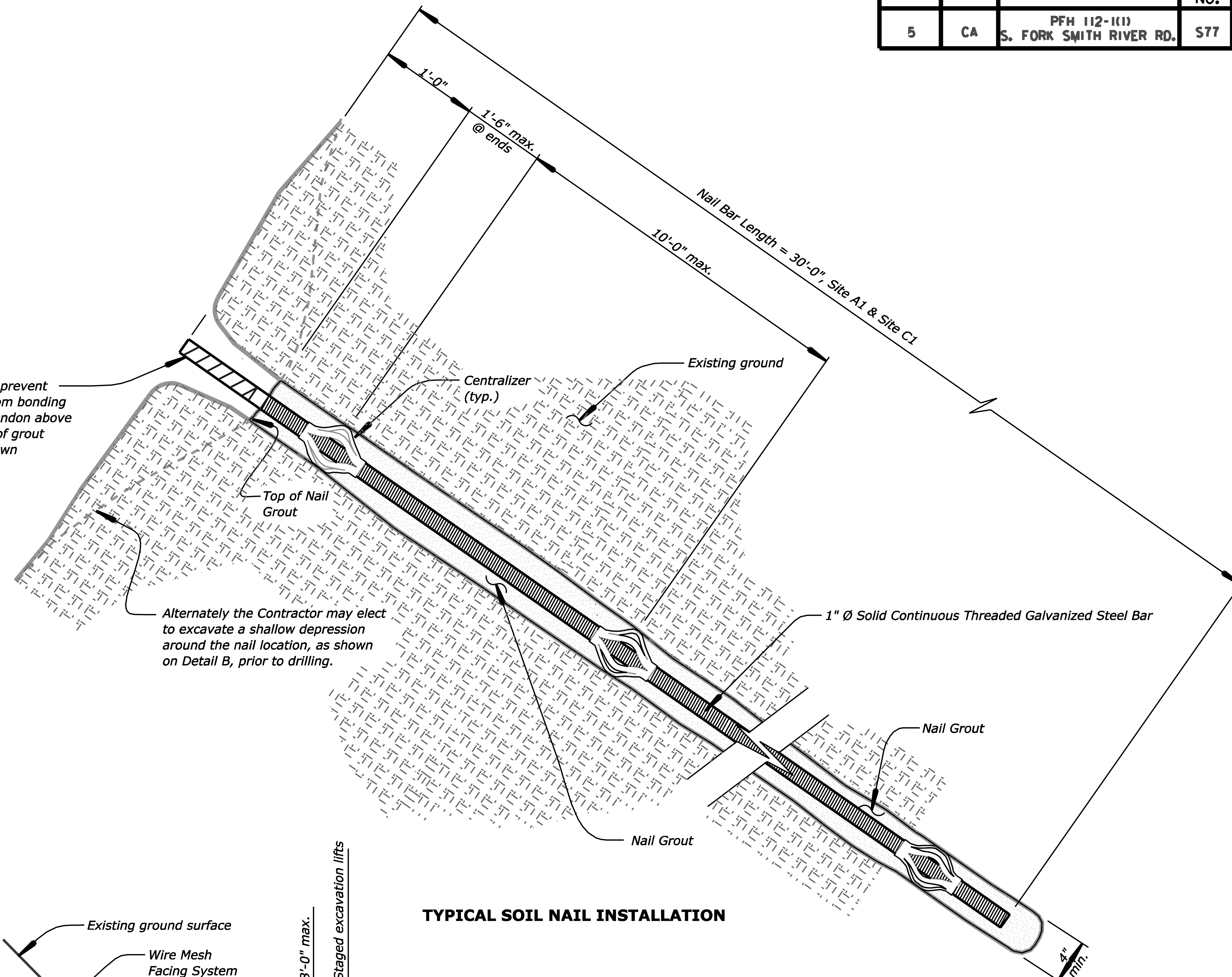
REGION	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
5	CA	PFH 112-1(1) S. FORK SMITH RIVER RD.	S77	S78

NOTE:

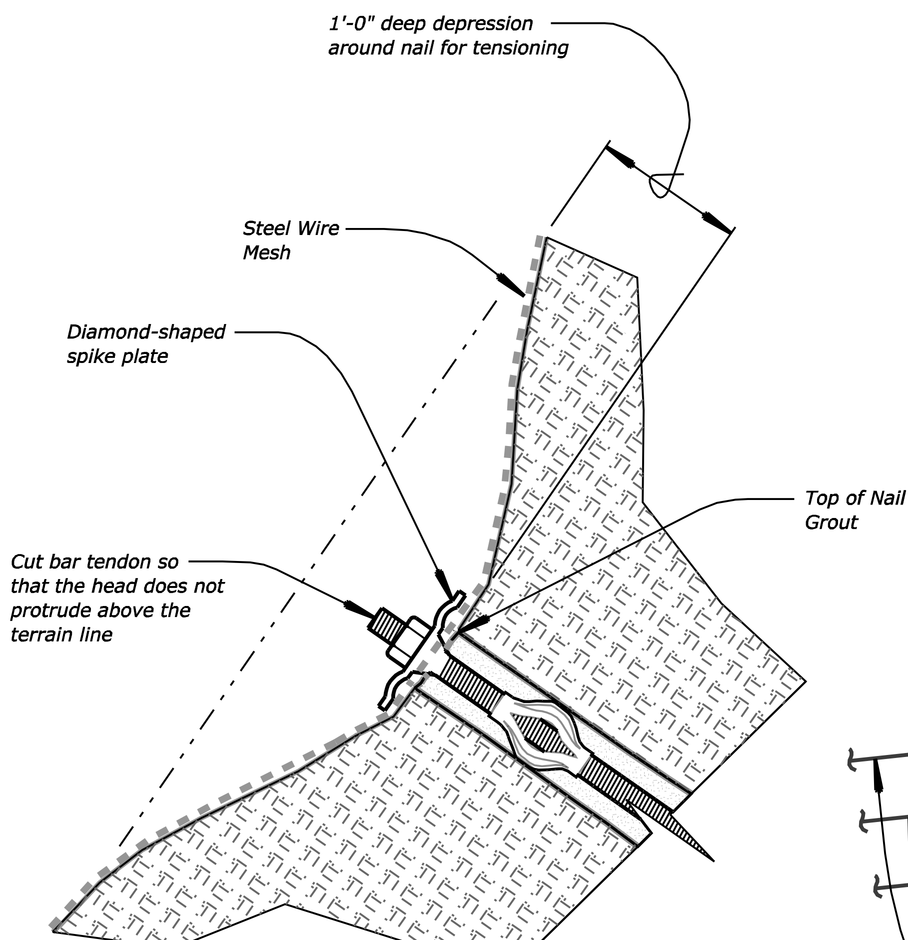
1. *Use grout with a minimum 28 day compressive strength of 3,000 psi.*
2. *Lock-off Load = 11 kips (pretensioned load).*
3. *The Contractor may develop a lock-off torque that corresponds to a 11 kips axial setting load. The lock-off load must be acceptable to the CO.*
4. *If depression is excavated prior to drilling, the Contractor may elect to install the nail with the head below the terrain line instead of cutting the bar.*

VERIFICATION TESTING NOTE:

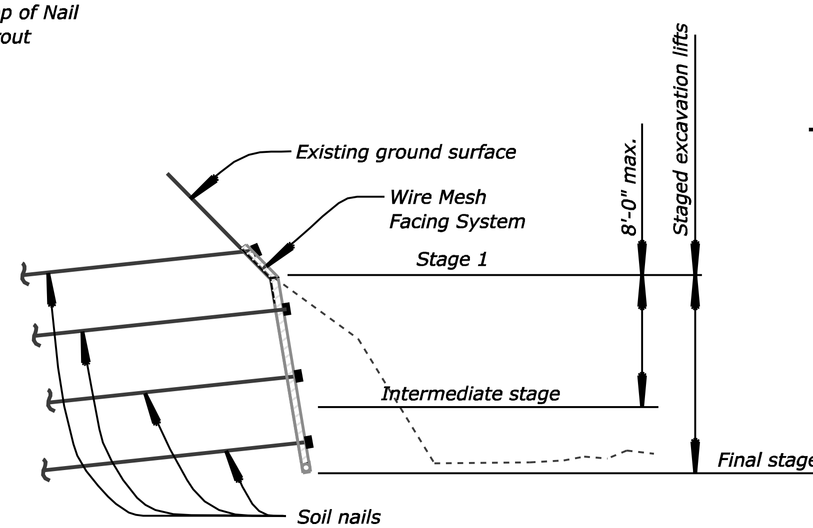
1. *See specifications for verification test nail requirements.*
2. *Required soil nail allowable pullout resistance Q_d = 1.1 kip/ft.*



TYPICAL SOIL NAIL INSTALLATION



DETAIL B
SOIL NAIL AFTER MESH INSTALLATION



STAGE EXCAVATION
SOIL NAIL WALL SECTION

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

SOUTH FORK SMITH RIVER ROAD

SIX RIVERS NATIONAL FOREST
DEL NORTE COUNTY, CALIFORNIA

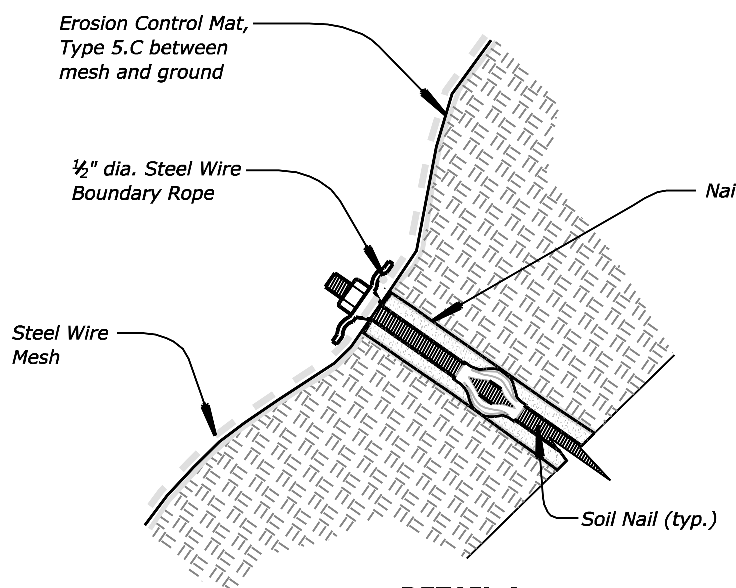
SOIL NAIL DETAILS

NO.	DATE	BY	REVISIONS	NO.	DATE	BY	REVISIONS

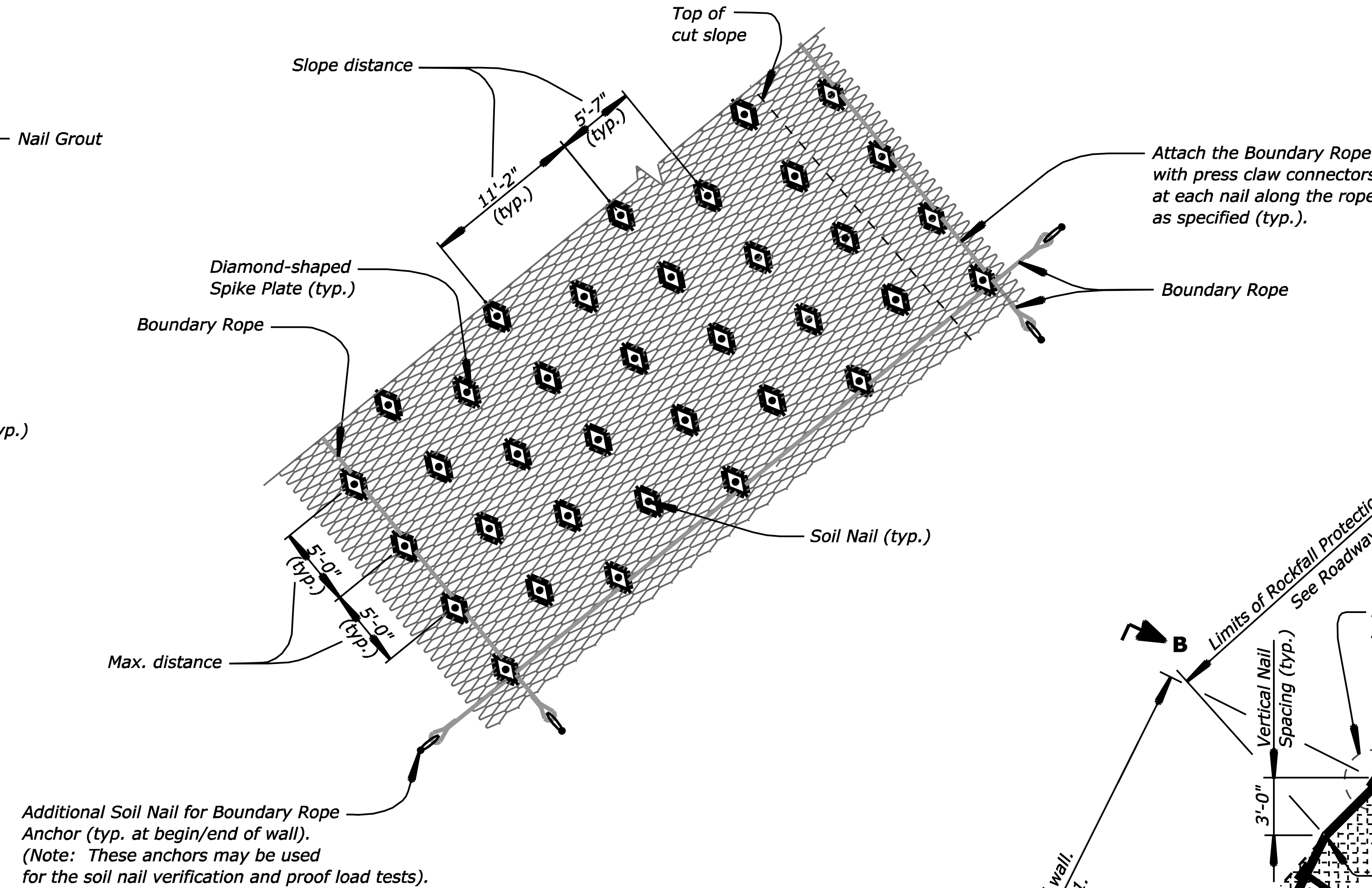
DESIGNED BY	DRAWN BY	CHECKED BY	SCALE	PROJECT TEAM LEADER	BRIDGE DRAWING	DATE	DRAWING NO.
V. JACOBSON	RICKY WIPF	K. EIKERMANN	NONE	SAMIR SIDHOM	6 of 7	JULY 2008	RG2822-F

$$$$$SYTIME$$$$$$ $$$$$DGNSPEC$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

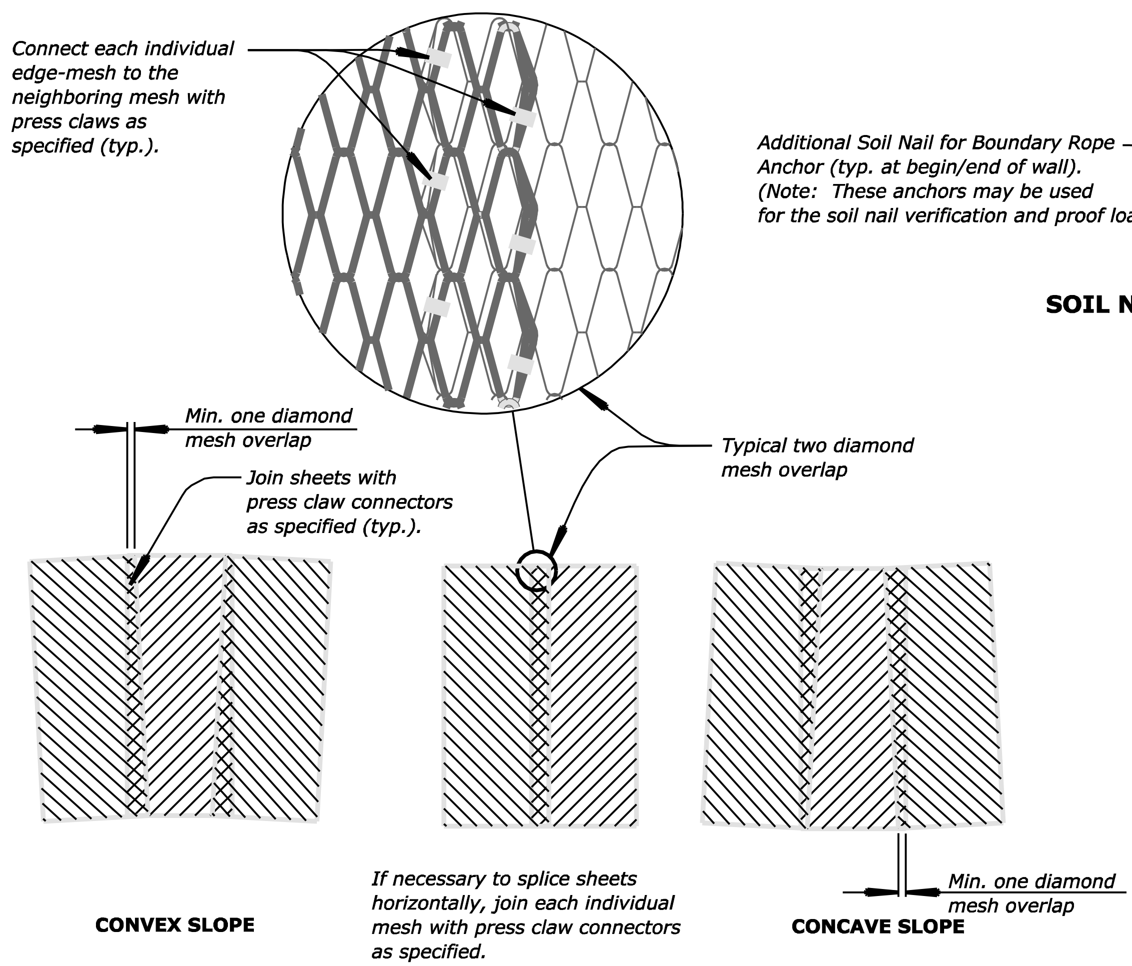
REGION	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
5	CA	PFH 112-1(1) S. FORK SMITH RIVER RD.	S78	S78



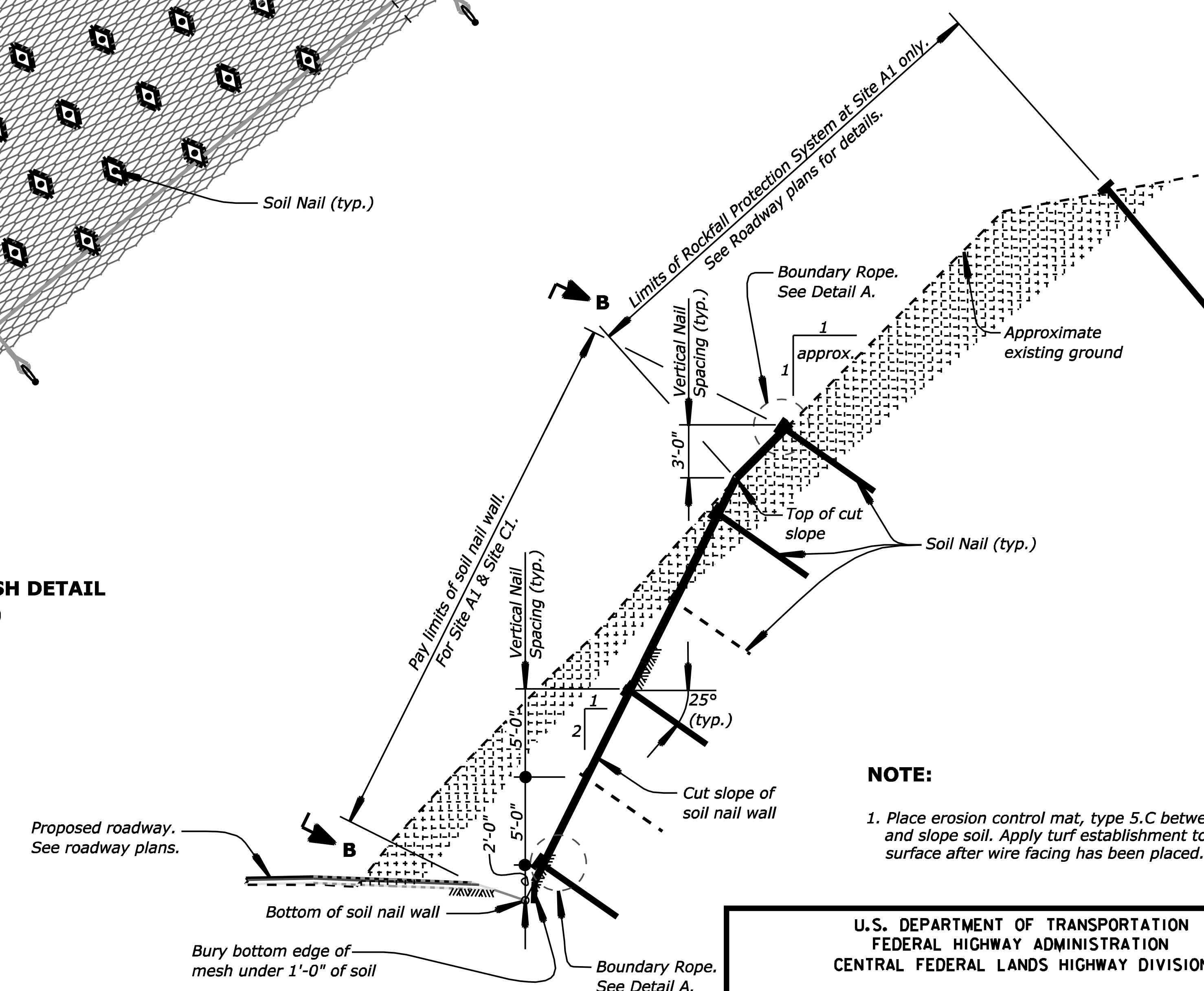
DETAIL A



SOIL NAIL WALL MESH DETAIL (VIEW B-B)



MESH SHEET SPLICING DETAILS



SOIL NAIL WALL WITH ROCK FALL PROTECTION TYPICAL SECTION

NOTE:

1. Place erosion control mat, type 5.C between mesh and slope soil. Apply turf establishment to ground surface after wire facing has been placed.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

SOUTH FORK SMITH RIVER ROAD

SIX RIVERS NATIONAL FOREST
DEL NORTE COUNTY, CALIFORNIA

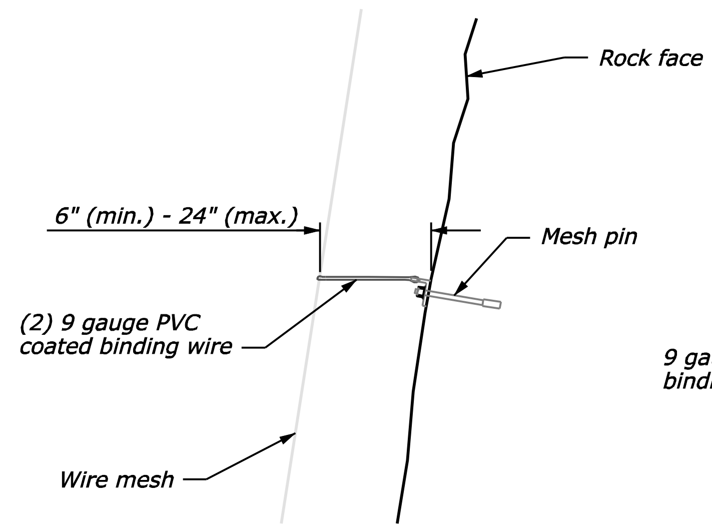
WIRE MESH FACING DETAILS

NO.	DATE	BY	REVISIONS	NO.	DATE	BY	REVISIONS

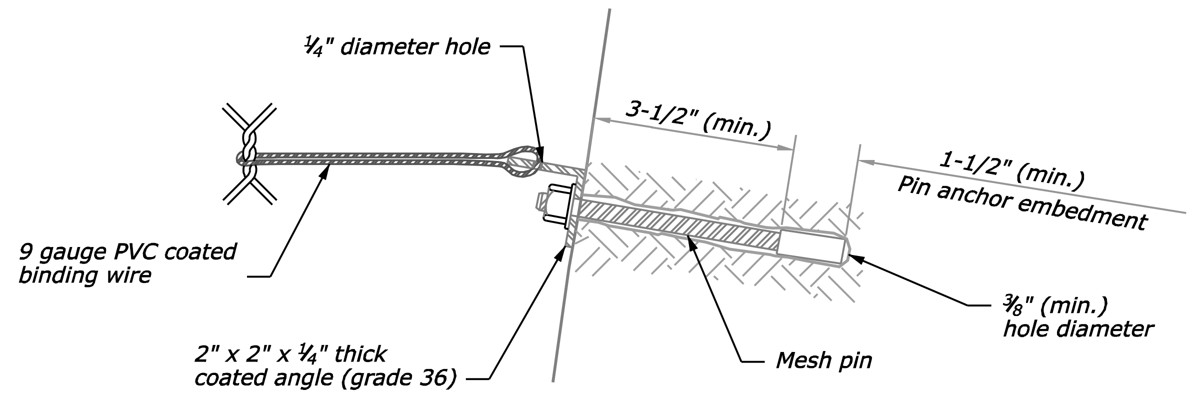
DESIGNED BY	DRAWN BY	CHECKED BY	SCALE	PROJECT TEAM LEADER	BRIDGE DRAWING	DATE	DRAWING NO.
V. JACOBSON	RICKY WIPF	K. EIKERMANN	NONE	SAMIR SIDHOM	7 of 7	JULY 2008	RG2822-G

$$$$$SYTIME$$$$$$ $$$$$DGNSPEC$$$

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
5	CA	PFH 112-1(1) S. FORK SMITH RIVER RD.	T48	T49



TYPICAL MESH PIN DETAIL ①



TYPICAL MESH PIN ATTACHMENT DETAIL

NOTE:

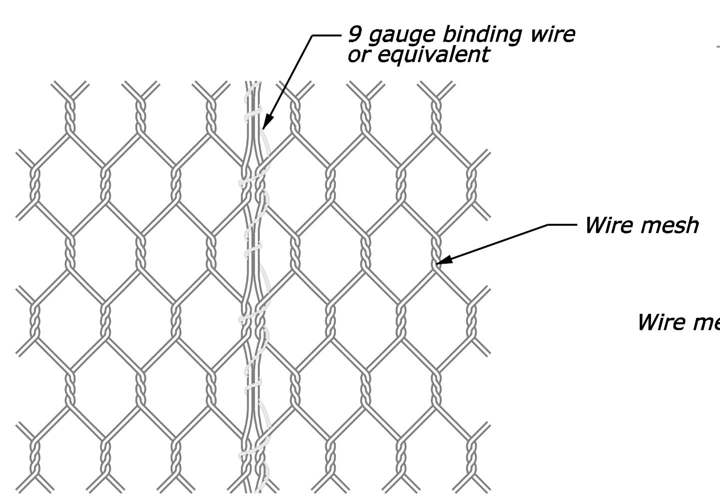
① Alternatively, mesh may be attached to rock reinforcement.

2. Locate rock dowels/bolts, if needed so that rock will not fall from the cut slope and impact the mesh at the point of attachment to the rock face.

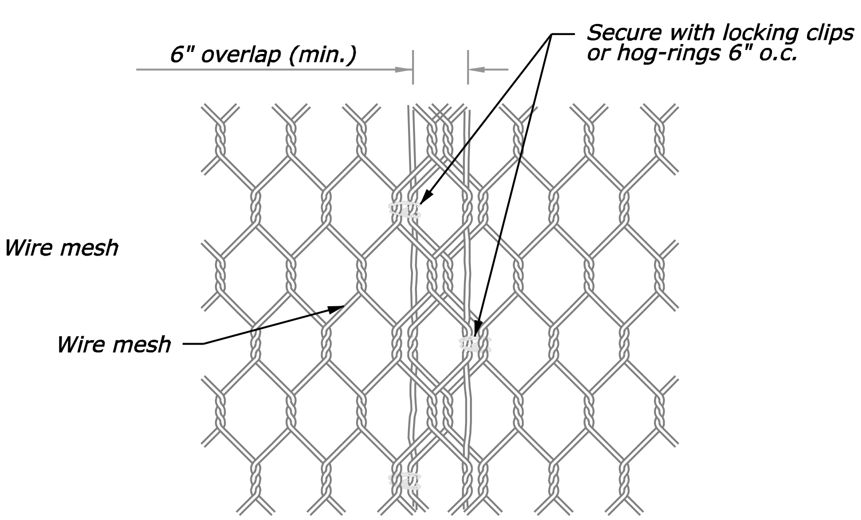
3. Overlap horizontal splices of draped mesh a minimum of 6" as shown. Place hog-rings at 6" intervals. If mesh is equal to or less than 20' in length, hog-rings may be placed at 8" intervals. Place spliced mesh on the outside of previously hanging mesh.

4. Use carbon steel mesh pins with electroplated zinc. Install mesh pins in competent bedrock to a minimum depth as shown. Install mesh pins perpendicular to the bedrock surface. Place mesh pins at a minimum vertical spacing of 10' where required.

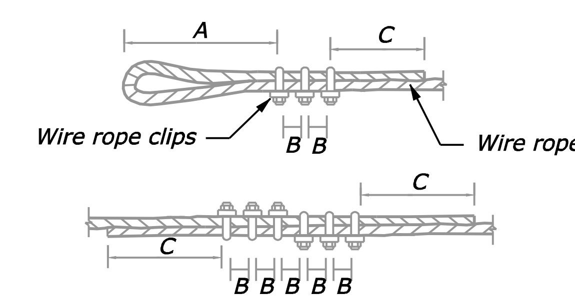
5. Install mesh pin plates in direct contact with competent bedrock.



OPTION 1: TYPICAL LACING DETAIL (DRAPED WIRE MESH)



OPTION 2: TYPICAL HOG-RING SPLICING DETAIL (DRAPED WIRE MESH)



SPLICING WIRE ROPE DETAIL AS RECOMMENDED BY THE MANUFACTURER

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

U.S. CUSTOMARY SPECIAL

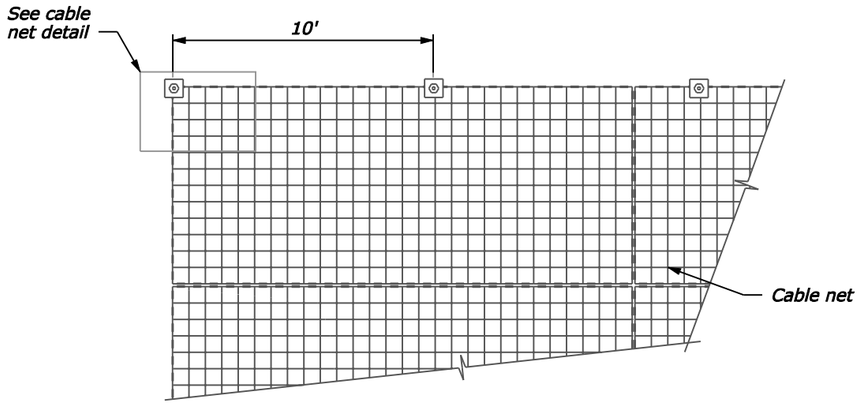
ROCKFALL PROTECTION SYSTEM

SHEET 1 OF 2

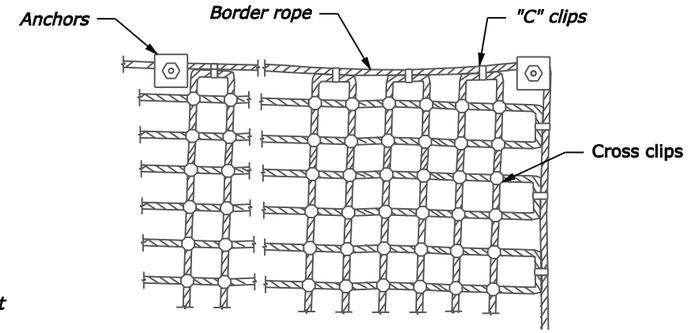
SPECIAL **651-A**

$$$$DATE$$$$ $TIME$ $$$$DGN$$

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
5	CA	PFH 112-1(1) S. FORK SMITH RIVER RD.	T49	T49



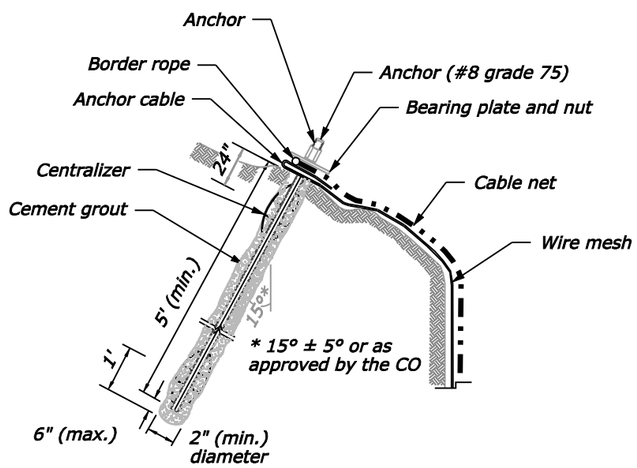
TYPICAL CABLE NET LAYOUT
Not to scale



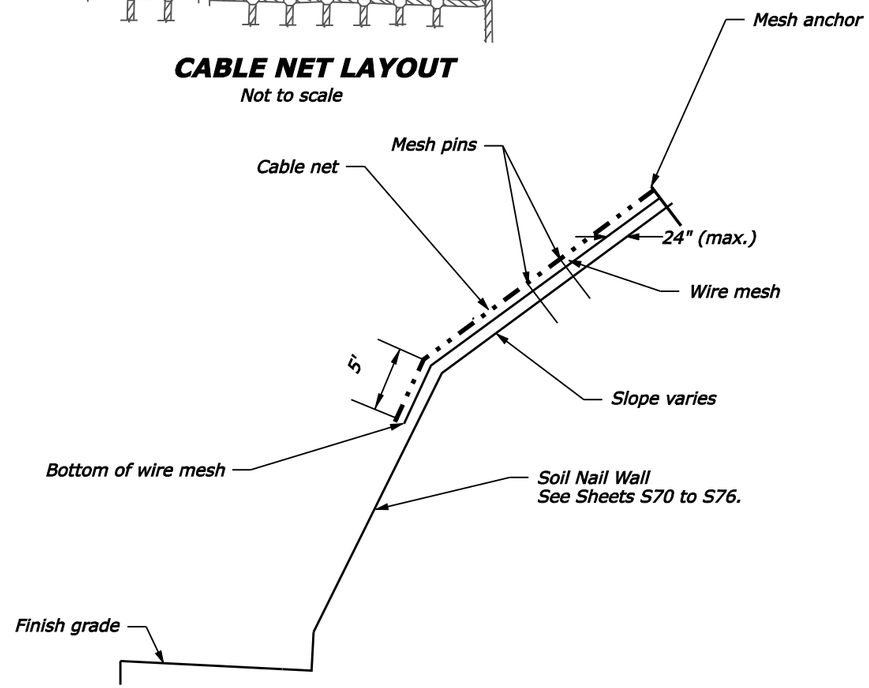
CABLE NET LAYOUT
Not to scale

NOTE:

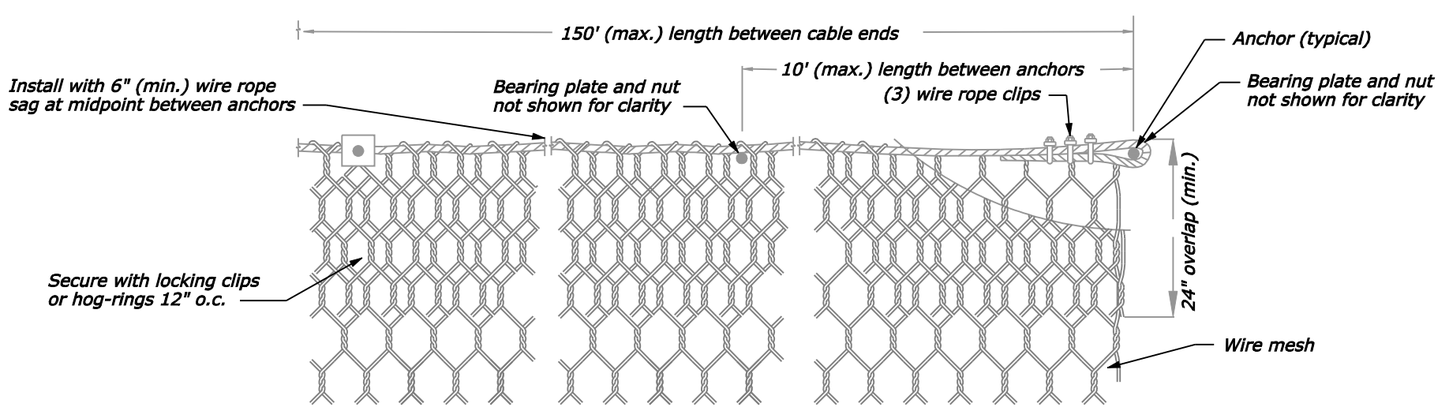
1. Configure anchor cable as shown. Do not loop cable around anchors and avoid "kinking" cable and other sharp bends.
2. Use epoxy coated #8 grade 75 threadbar anchors or wire rope anchors.
3. Anchors shall have a maximum test load of 10 kips and be torqued to a nominal lock off load.
4. Scale loose rock from the slope face and round slope crest prior to installation of anchored mesh.
5. Use 8" x 8" x 1" mild steel bearing plates with a rounded edge on the side in contact with mesh wire and/or cable wire. If square edges are used they must not cut, kink, or adversely affect wire mesh or cable wire.
6. Install mesh and cable net so that it is in direct contact with the slope at each anchor location.
7. Use ⅝" (min.) diameter galvanized anchor wire rope with a minimum breaking strength of 45 kips.
8. Place mesh anchors in a single row between 10' and 15' above the top of the disturbed slope.
9. Attach cable net panels to the anchors and each other as recommended by the cable net manufacturer.
10. Drape Rockfall Protection System 5' below the limits of the top of the soil nail wall.



TYPICAL ANCHOR DETAIL



TYPICAL ROCKFALL PROTECTION SYSTEM DETAIL



ANCHOR CABLE DETAIL

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

U.S. CUSTOMARY SPECIAL

ROCKFALL PROTECTION SYSTEM

SHEET 2 OF 2

SPECIAL
651-B

$$$$DATE$$$$ $TIME$ $$$$DGN$$$$

APPENDIX I – Special Contract Requirements

Section 204. - EXCAVATION AND EMBANKMENT

Construction Requirements

204.06 Roadway Excavation.

(a) General. Add the following:

Ultramafic rocks, specifically serpentinite, bearing naturally occurring asbestos were identified within the project limits. Refer to Subsection 107.01 and Appendix A for construction requirements.

(b) Rock cuts. Add the following:

Blasting will be required at the slide area on Site A. Provide a blasting plan to the CO for approval, at least 30 days prior to beginning the blasting work.

When blasting rock, use controlled blasting methods according to Subsection 205.08(c). Some hand drilling and shooting may be required when removing select outcrops in the rock cuts.

204.13 Sloping, Shaping, and Finishing

(a) Sloping. Add the following:

Selective slope rounding will be required at the slide area on Site A. Provide a slope rounding plan to the CO for approval, at least 30 days prior to beginning the slope rounding work.

Access to the top of the slide area is restricted to the existing slide chute and must be within the construction limits of this site. Alternate access routes may be considered. Submit alternate access routes to the CO for approval two weeks prior to commencing slope rounding operations at this site.

Prepare the cut crest by removing overburden materials to round the top of the slope per the typical section in the plans. Perform slope crest rounding using power equipment before the slope scaling is completed. Remove all material generated from rounding operations off of the slope.

Provide adequate protection in the areas being rounded to prevent damage to property and structures and utilities by falling rock from the rounding operations. The Contractor is also responsible for the protection of personnel from the danger inherent in rounding. Provide devices, measures, and procedures to protect the public and any adjacent facilities or structures from danger or damage caused by rounding. This plan must be in effect prior to commencing the rounding operations. Any injuries or damages caused by rounding are the responsibility of the Contractor.

Section 205. — ROCK BLASTING

Description

205.01 Delete the second and third paragraphs and substitute the following:

This project requires carefully planned and uniquely adapted blasting approaches to achieve engineered road cuts that are structurally sound and aesthetically pleasing. Use controlled blasting methods to properly utilize the natural geologic bedding planes and joint structure in a predicted and controlled manner to form the final cut slopes and to minimize back break beyond the trim line.

Controlled blasting consists of the controlled use of explosives and blasting accessories in carefully spaced and aligned drill holes to produce specific shear planes in the rock mass along the predetermined excavation back-slope. Controlled blasting techniques include pre-splitting, cushion blasting, and blasting methods using horizontal holes (all controlled blasting with horizontal holes shall be reviewed by the CO on a per-cut basis).

Production blasting consists of the main fragmentation blasting resulting from more widely spaced production holes. Detonate production holes in a controlled delay sequence to prevent escape of materials outside the construction limit and prevent damage to the natural environment outside the clearing limits from fly rock, operation of equipment, or other construction related causes in accordance with Subsection 107.02.

205.04 Blaster-in-Charge. Add the following:

Not less than two weeks prior to commencing drilling and blasting operations, submit the name and experience of the Blaster-in Charge with references. Blaster-in-charge shall have all required licensing required by the State and a minimum of 5 years experience in supervising the drilling, loading, and firing of charges for rock slope excavation.

205.05 Blasting Plans. Add the following after the first paragraph:

Formulate blast plans and approaches such that the final cut faces will blend with surrounding natural features of the landscape, such as rock outcrop, draws and slope of terrain. This includes slope warping, laying back draws, forming staggered ridges, and warping the top and/or the toe of the slope.

(a) General Blasting Plan. Add the following:

(6) Methods to be employed for traffic control and other public safety.

(7) Equipment intended to be used in or support of blasting operations.

(8) Method(s) of containment to prevent rock materials flying beyond the construction limits and contingency measures for unanticipated rock falls.

205.09 After Blast Report. Add the following to the first paragraph:

No additional drilling is allowed until the blast report is reviewed by the CO.

Payment

205.12 Delete the Subsection and substitute the following:

The accepted quantities will be paid at the contract price per unit of measurement for the Section 204 pay item listed in the bid schedule. Payment will be full compensation for the work prescribed in this Section. See Subsection 109.05.

Section 207. — EARTHWORK GEOTEXTILES

Delete the Section and substitute the following:

Description

207.01 This work consists of furnishing and placing a geotextile as a permeable separator, stabilizer, or permanent erosion control measure.

This work also consists of furnishing and placing a geogrid as a soil reinforcement element.

Geotextile types are designated as shown in Subsection 714.01.

Material

207.02 Conform to the following Subsection:

Geotextile	714.01
Geogrid	714.03

Construction Requirements

207.03 General. Submit test results to the CO verifying the proposed products meet the criteria as outlined in Section 714.

Where placing a geotextile on native ground, cut the trees and shrubs flush with the ground surface. Do not remove the topsoil and vegetation mat. Remove all sharp objects and large rocks. Fill depressions or holes with suitable material to provide a firm foundation.

Replace or repair all geotextile or geogrid that is torn, punctured, or muddy. Remove the damaged area and place a patch of the same type of geotextile or geogrid by overlapping 3 feet beyond the damaged area.

Furnish geogrid packaged in a sheathing or container suitable to protect the geogrid from damage due to ultraviolet light during storage and handling. Store, handle, protect, and haul all the materials in accordance with the manufacturer's specifications and as directed by the CO. Furnish geogrid that is visibly labeled with the name of the manufacturer, identification of the geogrid product, date of manufacture, lot number, length, width, and quantity.

207.04 Separation and Stabilization Applications. Where placing a geotextile on a subgrade, prepare the subgrade according to Subsections 204.13(c) and (d).

Place the geotextile smooth and free of tension, stress, or wrinkles. Fold or cut the geotextile to conform to curves. Overlap in the direction of construction. Overlap the geotextile a minimum of 2 feet at the ends and sides of adjoining sheets, or sew the geotextile joints according to the manufacturer's recommendations. Do not place longitudinal overlaps below anticipated wheel loads. Hold the geotextile in place with pins, staples, or piles of cover material.

End-dump the cover material onto the geotextile from the edge of the geo-textile or from previously placed cover material. Do not operate equipment directly on the geotextile. Spread the end-dumped pile of cover material maintaining a minimum lift thickness of 12 inches. Compact the cover material with rubber-tired or non-vibratory smooth drum rollers. Avoid sudden stops,

starts, or turns of the construction equipment. Fill all ruts from construction equipment with additional cover material. Do not regrade ruts with placement equipment.

Place subsequent lifts of cover material in the same manner. Vibratory compactors may be used for compacting subsequent lifts. If foundation failures occur, repair the damaged areas and revert to the use of non-vibratory compaction equipment.

207.05 Permanent Erosion Control Applications.

Place and anchor the geotextile on an approved smooth-graded surface. For slope or wave protection, place the long dimension of the geotextile down the slope. For stream bank protection, place the long dimension of the geotextile parallel to the centerline of the channel.

Overlap the geotextile a minimum of 12 inches at the ends and sides of adjoining sheets or sew the geotextile joints according to the manufacturer's recommendations. Overlap the uphill or upstream sheet over the downhill or downstream sheet. Offset end joints of adjacent sheets a minimum of 5 feet. Pins may be used to hold the geotextile sheets in place. Space pins along the overlaps at approximately 3-foot centers.

Place aggregate, slope protection, or riprap on the geotextile starting at the toe of the slope and proceed upward. Place riprap onto the geotextile from a height of less than 12 inches. Place slope protection rock or aggregate backfill onto the geotextile from a height less than 3 feet. In underwater applications, place the geotextile and cover material in the same day.

207.06 Soil Reinforcement Applications.

Place biaxial geogrid at the deep-patch location at Site C as shown on the plans, or as directed by the CO.

Install the geogrid reinforcement according to the manufacturer’s recommendations. Place the geogrid reinforcement at the elevations and to the extent shown on the plans. Place the geogrid reinforcement in continuous longitudinal strips such that the principle strength (highest strength) axis is perpendicular to the slope or wall face. If unable to complete the required length with a single continuous length of geogrid, a joint may be made with the CO’s approval. Only one joint per length of geogrid will be allowed. Construct this joint for the full width of the strip using a similar material, conforming to the requirements of Subsection 714.03(a), and following the manufacturer’s recommendations. Pull and hold taut joints in geogrid reinforcement during fill placement. Lay flat and pull taut the geogrid reinforcement prior to backfilling. After a layer of geogrid reinforcement has been placed, use suitable means, such as pins or small piles of soil, to hold the geogrid reinforcement in position until the subsequent layer of backfill can be placed. Do not operate track-mounted equipment on the geogrid reinforcement until at least 6 inches of soil has been placed over the geogrid. Keep equipment turning to a minimum to prevent displacement of embankment and damage to the geogrid reinforcement. If approved by the CO, rubber tired equipment may pass over the geogrid reinforcement at speeds less than 10 miles per hour. If during embankment placement waves, wrinkles, or slack develop in the geogrid, remove the embankment and pull geogrid taut to remove slack.

Place only that amount of geogrid reinforcement required for immediately pending work to prevent undue damage. During construction, the surface of the fill should be kept approximately horizontal. Place geogrid reinforcements within 3 inches of the design elevations and extend to the length as shown in the plans unless otherwise directed by the CO. Place and compact the embankment soils according to Subsections 204.10 and 204.11. Do not place sharp or angular

rock and rock larger than 4 inches in diameter within 6 inches of the geogrid reinforcement. After the specified soil layer has been placed, install the next layer of geogrid reinforcement. Repeat the process for each subsequent layer until final grade is reached.

207.07 Acceptance. Material for the geogrid will be evaluated under Subsections 106.02, 106.03, and 714.03.

Earthwork geotextile installation will be evaluated under Subsections 106.02 and 106.04.

Measurement

207.08 Material for the geogrid will be evaluated under Subsections 106.02, 106.03, and 714.03.

Payment

207.09 The accepted quantities will be paid at the contract price per unit of measurement for the Section 207 pay item listed in the bid schedule. Payment will be full compensation for the work prescribed in this Section. See Subsection 109.05.

Section 255. - MECHANICALLY STABILIZED EARTH WALLS

Delete the Section and substitute the following:

Description

255.01 This work consists of designing, furnishing, and constructing mechanically stabilized earth (MSE) walls with steel (mesh or strip) or geogrid reinforcement according to the details shown on the plans.

Materials

255.02 Conform to the following Section and Subsections:

Concrete leveling pad	601
Wall Stain	563
Foundation fill	704.01
Select wall backfill	704.13(a)
Wall backfill	704.13(b)
Wall facing fill	704.13(c)
Plastic pipe	706.08(d)
Geotextile	714.01
Geocomposite sheet drain	714.02(b)
Mechanically stabilized earth wall material	720.01

Construction Requirements

255.03 General. Survey the MSE wall locations according to Section 152 to acquire existing terrain data. Prepare and submit preliminary installation drawings for MSE walls according to Subsection 104.03. Drawings will include existing terrain cross-sections and elevations of MSE walls. Do not prepare design drawings for MSE walls or disturb the existing ground at wall locations until existing terrain data has been acquired, incorporated into the preliminary drawings, and the CO has approved the drawings. Once the CO has approved preliminary drawings, submit design drawings according to Subsection 255.03(a).

Perform the work under Section 209. Grade the foundation to a width equal to the length of reinforcing mesh or strips plus 20 inches. Bedrock and boulder excavation to obtain the necessary base width may be required. Excavate using equipment capable of removing the material while preventing material escape outside the construction limits. Excavate any loose, soft, or otherwise unsuitable material present at foundation grade and replace with foundation fill in horizontal layers that when compacted do not exceed 6 inches in depth. Compact the MSE wall foundation according to Subsection 204.11.

(a) Design of MSE Walls. Using the approved preliminary drawings, design all MSE wall components for a 75-year design service life according to the requirements of AASHTO Standard Specifications for Highway Bridges current at time of contract award and FHWA publication No. FHWA-NHI-00-043, “Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines” (2001). Other design methods will not be allowed. Design the MSE walls for:

(1) External stability including: sliding, overturning, bearing capacity, and eccentricity.
(2) Internal stability including: tensile stresses, pullout, facing connection, and sliding along reinforcement.
(3) Local stability including: bulging and maximum unreinforced height.
(4) Design the MSE wall to account for dead and live loads, seismic loads, horizontal loads from guardrails or barriers, hydrostatic loads, and other loads as appropriate.
(5) Design the MSE wall such that the toe is at a depth that no scouring or undermining will occur.

Use Table 255-1 for required factors of safety per AASHTO for MSE wall stability design:

Table 255-1
Required Factors of Safety

External Stability	**Static**	**Seismic (A > 0.09g)**
Base Sliding	1.5	1.1
Overturning	2.0	1.5
Bearing Capacity	2.5	1.5
Eccentricity	e < L/6	e < L/3
Internal Stability	**Static**	**Seismic (A > 0.09g)**
Tensile Stress:		
Steel Mesh (wire-faced walls)	0.55Fy	0.73Fy
Steel Mesh (concrete-faced walls)	0.48Fy	0.64Fy
Steel Strips	0.55Fy	0.73Fy
Geogrids	1.5	1.1
Pullout	1.5	1.1
Facing Connection (for concrete-faced walls)	1.5	1.1
Internal Sliding	1.5	1.1
A: Acceleration coefficient, e: Eccentricity, L: Reinforcement length, Fy: Yield strength of steel		

Table 255-2 lists available geotechnical report(s). General soil, rock strata descriptions, and indicated boundaries are based on engineering judgment and interpretation of available subsurface information, and may not reflect actual variation in subsurface conditions between borings and samples. The information has been prepared and is intended for Government design purposes. It is listed here for the purpose of providing intended users with access to the same information available to the Government.

Table 255-2
Available Geotechnical Reports

Title	Author	Date
Geotechnical Design Report- South Fork Smith River Road Report No. CA-FX-0112-08-01	Justin Henwood	August, 2008

Use soil parameters shown in Table 255-3 for the internal, external, and local stability of the MSE retaining walls:

Table 255-3
Soil Design Parameters

Material	**Friction Angle (degrees)**	**Cohesion (psf)**	**Unit Weight (pcf)**
Select Backfill	34	0	125
Wall Backfill	30	0	120
Foundation Soil	30	0	120

Use permanent retaining wall systems that have previously been successfully designed and constructed for a public highway agency in the United States, and that have performed in an acceptable manner. The following wire-faced retaining wall systems have been previously constructed on CFLHD projects. For all wire-faced wall systems, submit the required information listed in Subsection 255.03(b). For wire-faced systems not listed below and all concrete-faced wall systems, submit the required information listed in Subsections 255.03(b) and 255.03(c).

Hilfiker Retaining Wall
3900 Broadway
P.O. Box 2012, #E
Eureka, CA 95503
(800) 762-8962

SSL Retaining Walls
4740 Scotts Valley Dr.
Scotts Valley, CA 95066
(831) 430-9300

The Reinforced Earth Company
8614 Westwood Center Drive
Suite 1100
Vienna, VA 22182-2233
(703) 821-1175

Tensar Earth Technologies, Inc.
5883 Glenridge Dr., Suite 200
Atlanta, GA 30328
(800) 292-4459

T & B Structural Systems, Inc.
637 West Hurst Blvd.
Hurst, TX 76053
817-280-9858

(b) Design Submittal. Submit four (4) sets of drawings and supporting calculations according to Subsection 104.03. One set will be returned with any comments and requests for revisions or additional information. Allow 28 calendar days after received by the CO for review and

acceptance of the submittal. If revisions are required, make corrections and resubmit four (4) revised sets. If the drawings and calculations must be resubmitted, the time for review and acceptance starts over. Upon acceptance, furnish five (5) complete sets of the submittal to the CO. Do not order materials for MSE retaining walls before the CO approves the submittal.

A temporary traffic lane is required during construction of the MSE walls. In some cases, where MSE wall heights are substantial the width of the MSE wall is fixed because of temporary traffic requirements. Closely review the cross sections in these locations prior to conducting the design of these walls and determining reinforcement lengths.

To avoid having submittals returned with a request for more information, submittals should be organized in such a way to facilitate review for conformance with design standards and evaluation of design cases and loads. Include the following minimum information with the MSE wall submittals:

(1) Design calculations and information:

(a) Design calculations including an index page to the calculations. Submit design calculations on sheets approximately 8.5 by 11 inches in size with the project number, wall location, date of preparation, initials of designer and checker, and page number at the top of the page.
(b) Highway Innovative Technology Evaluation Center evaluation report (not required for wire-faced wall systems). Contact the following for copies of HITEC evaluation reports.

Highway Innovative Technology
Evaluation Center (HITEC)
1015 15th Street NW, Suite 600
Washington, DC 20005-2605
Phone: 202-842-0555
Fax: 202-789-5345
E-mail: hitec@cerf.org

(c) Design notes including an explanation of any symbols and computer programs used in the wall design.
(d) Summary of soil parameters, loading conditions considered, and factors of safety, including all partial reduction factors, if any.
(e) Summary of wall reinforcing elements used and their design properties.
(f) Demonstrate the compatibility of the effective aperture (the average opening created between the facing mat and backing mat) with the specified MSE wall facing fill.
(g) Provide a design analysis for each possible design situation.
(h) Specify the applied bearing pressure at wall foundation.
(i) Include one set of hand calculations for each unique design analysis if computer analysis other than MSEW per FHWA publication No. FHWA-NHI-00-043 is used.
(j) Special details, cross-sections, and quantities.
(k) A well-documented field construction manual describing in detail and with illustrations where necessary, the step-by-step construction process.

(2) Drawings:

(a) Submit design drawings on sheets approximately 11 by 17 inches in size with the project number, wall location, date of preparation, initials of designer, checker, and page number.

(b) A plan view of the wall identifying:

(1) Offset from the construction centerline to the face of the wall at its top and base at all changes in horizontal alignment.

(2) Limit of widest reinforcement.

(3) Centerline of any drainage structure or drainage pipes behind, passing through, or passing under the wall.

(4) Horizontal and vertical curve data affecting the wall. Match lines or other details to relate wall stationing to centerline stationing.

(c) An elevation view of the wall identifying:

(1) Elevation at the top of the wall, at all horizontal and vertical breaks, and at least every 15.0 feet along the wall.

(2) Elevations at the wall base or top of leveling pads.

(3) Distance along the face of the wall to all steps in the wall base or leveling pads.

(4) Length and type of reinforcement elements.

(5) Distance along the face of the wall to changes in the length of the reinforcement.

(6) Existing and final ground line along wall layout line.

(7) Existing ground line at a horizontal distance equal to the bench width away from the bottom of the wall. Refer to the MSE wall detail sheet.

(8) Listing of the summary of quantities.

(d) General notes for construction of wall.

(e) Wall Details:

(1) Typical section of wall.

(2) Wall batter.

(3) Details for constructing walls around drainage facilities entering, exiting, and within MSE wall envelope.

(4) Details for guardrail posts punching through the upper reinforcement layers.

(5) Details for terminating walls and adjacent slope construction.

(c) Supplemental Design Submittal. Submit the following additional information for wire-faced systems not listed at the end of Subsection 255.03(a) and all concrete-faced wall systems.

(1) Examples of successful projects (design, construction, and in-service performance with a public agency).

(2) Name, address, and telephone number of agency contact.

(3) Narrative descriptions and photos of example projects.

(4) Limitations and constraints of the system.

(5) Details of wall elements (procedures for field and laboratory evaluation including instrumentation and special requirements, if any).

(6) Material samples of reinforcing elements and connection devices.

(7) Construction control specifications showing material type, certifications, field-testing, acceptance/rejection criteria, and placement procedures.

(8) Typical unit costs, supported by data from actual projects.

(9) Laboratory and field-test results which support the system design criteria.

(10) Information substantiating all partial factors of safety used in establishing the reinforcement elements long-term design strength.

(11) Additional information requested by the CO.

(d) Temporary shoring. When required, design temporary shoring using one of the methods described in the AASHTO Standard Specifications for Highway Bridges current at time of contract award. Refer to Section 562 for temporary shoring construction requirements.

255.04 Wall Erection. Erect the wall according to the specifications, the design drawings approved by the CO, and manufacturer's recommendations. When requested, have an experienced field representative from the wall system manufacturer available during the first three days of wall erection and as otherwise requested by the CO.

Place reinforcement elements horizontally on compacted fill at elevations and dimensions shown on the approved design drawings. Orient reinforcement elements with the highest strength axis perpendicular to the wall alignment. Spliced reinforcement connections between shorter pieces of reinforcement will not be allowed unless approved by the CO. Prior to placing fill over reinforcement, place the next course of wall units, pull the reinforcement taut, and anchor the reinforcement.

(a) Wire-faced walls. Connect, tighten, and anchor soil reinforcement elements to the wall facing units before placing backfill. Design and construct the wire-faced wall and components to have the ability to compress up to 2 inches at each layer of reinforcement without creating outward bulging of the facing elements. Design and construct the wall and components to meet Table 255-5:

Table 255-5
Wire Faced Wall Construction Tolerances

Description	Requirement
Wall batter	Within 2.0 inches per 10.0 feet of wall height and 1% for the overall wall height
Wall height	Within 1.0 inch per 10.0 feet of wall height and a maximum of 4.0 inches
Horizontal and vertical alignment	Within 2.0 inches at any point in the wall when measured with a 10 foot straightedge
Separation of facing mat	Outside of facing mat within 1.5 inches from wall facing fill at all locations
Reinforcement elevation	Within 2.0 inches of the design elevation and within 2.0 inches above the corresponding connection elevation at the wall face. Do not place reinforcement below corresponding connection elevation.
Reinforcement inclination	Within 2% from horizontal

Include hardware cloth behind the wire face unless the D_{15} of the wall facing fill gradation is larger than the effective wire face opening. Place a Type I-A geotextile between the wall facing fill and select wall backfill. Terminate wire-face wall at the beginning and end of each lift with a return of the wall facing a minimum of 4 feet into the backfill.

255.05 Backfilling. Backfill the reinforced volume with select wall backfill in compacted lifts not to exceed 6 inches where hand compaction is used or in compacted lifts not to exceed 9 inches where heavy compaction equipment is used. Place, spread, and compact the select wall backfill over the reinforcement in a manner that prevents development of slack in the

reinforcement. Compact the select wall backfill according to Subsection 204.11. Ensure that no voids exist below the reinforcing elements. Where the stabilized volume supports spread footings for bridges or other structural loads, compact the top 5 feet to at least 100 percent of the maximum density according to AASHTO T-99 method C.

Use wall facing fill within 3.0 feet of the wall face. Place wall facing fill in compacted lifts not exceeding 12 inches and compact using hand operated equipment. Place wall facing fill in sequence with select wall backfill such that the top of the adjacent materials are within 18 inches of one another. Do not damage or disturb the facing or reinforcing elements. Do not operate equipment directly on top of the reinforcing elements. Remove and replace all damaged, misaligned, or distorted wall components.

Backfill and compact behind the reinforced volume with wall backfill according to Subsections 204.10 and 204.11. At the end of the day's operation, slope the last lift of fill away from the wall face to direct surface runoff away from the wall face. Do not allow surface runoff from adjacent areas to enter the wall construction area.

After completion of the wall, treat the exposed surfaces of the wire facing with an approved penetrating desert varnish stain. The treated surfaces' finished color, tint, and density will be as directed by the CO. Furnish materials and use application methods in accordance with Section 563.

255.06 Drainage. Subsurface drainage is required. Install the drainage system as shown in drawing "Special M605-A". The CO may require supplemental drainage when seepage is identified in the excavation.

255.07 Acceptance. Structure excavation will be evaluated under Section 209.

Select wall backfill, wall backfill, and wall facing fill will be evaluated under Subsection 704.13. Foundation fill will be evaluated under Subsection 704.01.

Material for mechanically stabilized earth walls, plastic pipe, geotextiles, and geocomposite sheet drains listed under Subsections 706.08, 714.01, 714.02 and 720.01 will be evaluated under Subsections 106.02 and 106.03.

Construction of mechanically stabilized earth wall will be evaluated under Subsections 106.02 and 106.04.

Survey work will be evaluated under Section 152.

Concrete leveling pad will be evaluated under Section 601.

Measurement

255.08 Measure mechanically stabilized earth walls by the square foot of front wall face. Structure excavation, select wall backfill, wall backfill, wall facing fill, temporary shoring, wall stain, drainage system, and returns at the ends of each lift will not be measured for payment and are considered incidental to the MSE walls.

Measure the foundation fill under Section 208.

Payment

255.09 The accepted quantities, measured as provided above, will be paid at the contract price per unit of measurement for the pay item listed below that is shown in the bid schedule. Payment will be full compensation for the work prescribed in this Section. See Subsection 109.05.

Payment at the unit bid price for the Section 255 pay items included in the bid schedule is full compensation for wall construction to a depth not exceeding 5 feet below the lowest elevation shown on the plans for each MSE wall structure. MSE wall construction includes structure excavation, structural backfill, wall elements, and all other costs associated with the wall installation. When the depth of the footing below the lowest elevation shown on the plans for each MSE wall exceeds 5 feet, either the Contractor or the CO may request an equitable price adjustment for the depth in excess of 5 feet. There will be no equitable adjustment when the depth of the footing does not exceed 5 feet below the elevation shown in the plans; however, all work constructed will be measured for payment.

Table 255-7
Sampling and Testing Requirements

Material or Product	Type of Acceptance (Subsection)	Property or Characteristic	Test Methods or Specifications	Sampling Frequency	Point of Sampling	Split Sample	Reporting Time
Backfill	Measure and tested for conformance (106.04)	Classification	AASHTO M145	1 per soil type	Source of material	Yes	Before using in work
		Gradation	AASHTO T27 & T11	1 per soil type	Source of material	Yes	Before using in work
		Moisture density	AASHTO T 180 Method D (1), or AASHTO T99, Method C (1)	1 per soil type	Source of material	Yes	Before using in work
		Compaction	AASHTO T 310 or other approved procedures	2 per lift	In place	---	Before using in work

(1) A minimum of five points per proctor.

Section 259. – SOIL NAIL RETAINING WALLS

Delete the Section and substitute the following:

Description

259.01 This work consists of constructing soil nail retaining walls.

Material

259.02 Conform to the following Section and Subsections:

Bolts and nuts	717.01(d)
Centralizers	722.02(f)
Grout	722.02(e)
Soil nails	722.04

(a) High Strength Wire Mesh. Wire mesh will be diamond shaped and of a woven construction. The mesh will be made with 0.118 inch diameter wire and the ends of the wire will be formed into a loop and twisted. The loops of the wire mesh will be fastened together to prevent unravelling of the mesh. The wire will be alloyed high strength carbon steel wire with a minimum tensile strength of 256,000 psi. The wire will be galvanized with a zinc/aluminum coating with a minimum weight of 0.655 oz/ft^2. The size of the wire mesh opening will be 3.25 inches by 5.5 inches, and the depth of the mesh will be 0.59 inches.

(b) Compression Claws. The compression claws will be 0.236 diameter carbon steel bar and galvanized with a minimum weight of 2.0 oz/ ft^2.

(c) Spike Plates. The spike plates will be made from 0.4 inch thick steel and galvanized with a minimum weight of 2.0 oz/ ft^2. The spike plate will be diamond shaped with a width of 7.5 inches and a length of 13 inches.

(d) Boundary Ropes. Boundary ropes will have a diameter of 0.5 inches and will be PVC coated with black pigmentation. The rope will be constructed of galvanized steel wire strands, common grade, type one coating, conforming to the requirements of ASTM A475 – Zinc Coated Steel Wire Strand. The rope will have a minimum breaking strength of 40,000 pounds.

(e) Color Coating. All components of the wire mesh system, such as the high strength wire mesh, compression claws, and spike plates will have a powder coating of black pigmentation. The pigmented powder will be applied using an electrostatic spray gun or equivalent process. The other exposed parts of the wire mesh system that have not been powder coated will have an applied coating of rubberized black paint for aesthetic purposes.

Construction Requirements

259.03 Qualifications. The Contractor or subcontractor must demonstrate satisfactory completion of at least 5 permanent soil nail-retaining wall projects during the past 3 years, totaling at least 10,000 square feet of wall face area and at least 500 permanent soil nails. Submit a brief description of each project including the owning agency's name, contact person, and current telephone number.

Provide a professional engineer with experience in constructing at least 3 soil nail-retaining walls over the past 5 years. Provide on-site supervisors and drill operators with experience installing permanent soil nails on at least 3 projects over the past 5 years. At least 30 days before starting soil nail work, identify the engineer, on-site supervisors, and drill operators assigned to the project and submit a summary of each individual's experience.

Geobrugg is a known supplier of the specified wire mesh facing system. Alternate wire mesh facing systems from various manufacturers may be proposed provided they meet the minimum material and corrosion requirements specified herein with the additional demonstrated capability of mesh and hardware to safely accept and distribute nail loads of at least 55 kips through the system. Use only alternate systems with components that comprise a proven system package by the manufacturer. Provide manufacturer's drawings and calculations, sealed by a registered engineer, demonstrating that any proposed alternate system is compatible with project objectives for internal and external stability of the slope during and after construction. Provide documented test data from the system supplier/manufacturer to verify a minimum of 5 years of demonstrated satisfactory performance of the proposed alternate slope stabilization system applications and capacities.

259.04 General. Survey according to Section 152 and verify the limits of the wall installation.

Provide a system supplier/manufacturer on-site technical representative to provide initial assistance and direction to the contractor as necessary to assure installation in accordance with system requirements. Assure that the technical assistance remains available to the contractor, as necessary, throughout the duration of construction of the soil nail walls. Conduct the installation of the steel wire mesh according to the manufacturer's recommendations with amendments, sequencing, and variations as noted and on the Plans.

259.05 Construction Plan. At least 30 days before starting soil nail-retaining wall work, submit the following according to Subsection 104.03:

(a) Start date and proposed retaining wall construction sequence. Include the proposed method of excavating to ensure wall and slope stability.

(b) Drilling methods and equipment. Include drill hole diameter to achieve the specified pullout resistance values and any variation of drill hole diameter or specific pullout resistance along the wall alignment.

(c) Nail grout mix design, placement procedures, and equipment. Include test results conducted according to AASHTO T 106 and supplied by a qualified testing lab verifying grout 3-day and 28-day compressive strengths. Previous test results for the same grout mix completed within one year of grouting are acceptable.

(d) Soil nail testing methods and equipment setup.

(e) Identification number and calibration test results for each test jack, pressure gauge, and load cell. Calibrate the test jack and pressure gauge as one unit. Submit results from calibration tests conducted by an independent testing laboratory within the previous 90 days.

(f) Ultimate strength of proposed soil nail tendons.

259.06 Excavation. Complete any clearing and excavation above the wall area according to Sections 201 and 204 before commencing wall excavation. Do not perform any of the wall excavation before beginning the wall construction. A work bench for the drilling equipment may be provided by placing material excavated from elsewhere on the project in front of the soil nail wall area.

Perform excavation for the wall in lifts concurrent with soil nail installation. Do not allow the exposed unsupported final excavation face cut height to exceed the estimated lift height of 8 feet or the short-term stand-up height of the ground, whichever is less. Excavate and form depressions of at least 12 inches in depth at each nail location. A stabilizing berm of soil may be left in place to contain the lift face during nail installation.

Do not excavate to the next lower lift or more than 100 feet along any given lift until nail installation, wire mesh placement, attachment of bearing plates and nuts, and nail testing have been completed and accepted in the current lift. Cure grout at least 72 hours or attain the specified 3-day compressive strength before excavating the next underlying lift.

259.07 Nail Installation.

(a) Storing and handling. Store and handle soil nail tendons in a manner that avoids damage or corrosion. Replace tendons exhibiting abrasions, cuts, weld splatter, corrosion, or pitting. Repair or replace any tendons exhibiting damage to the galvanization.

(b) Fabrication. Provide continuously threaded tendons to allow proper attachment of bearing plate and nut. Threading may be continuous spiral deformed ribbing provided by the bar deformations or may be cut into the reinforcing bar. Use the next larger bar size if threads are cut into the reinforcing bar.

Provide centralizers sized to position the tendon within 1 inch of the center of the drill hole. Position centralizers a maximum of 10 feet apart and within 18 inches from the top and bottom of the tendon. Use centralizers that do not impede the free flow of grout into the drill hole.

(c) Drilling. Drill holes for the soil nails at the locations and to the orientation shown on the plans. Select drilling equipment and methods suitable for the ground conditions. Do not use water, drilling mud, or other fluids for drilling or removing cuttings. If unstable ground is encountered, use cased drilling methods to support the circumference of the drill holes. Self-drilling tendons are not acceptable.

(d) Grouting. Insert the nail tendon into the hole and grout the drill hole within 2 hours of completing drilling. Inject the grout at the lowest point of each drill hole through a grout tube, casing, hollow-stem auger, or drill rods. Completely fill the drill hole in one continuous operation. To prevent voids, keep the outlet end of the grout conduit below the surface of the grout as the conduit is withdrawn. Cold joints in the grout column are only allowed at the top of the test bond length of proof-tested production nails.

Maintain the temporary unbonded length of proof test nails open for subsequent grouting. If the unbonded test length of production proof test nails cannot be satisfactorily grouted subsequent to testing, install a new nail in its place.

259.08 Nail Testing. Perform both verification and proof testing of designated test nails. Do not test any nail until the nail grout and shotcrete facing have cured for at least 72 hours and attained the specified 3-day compressive strength.

(a) Testing equipment. Furnish two dial gauges, dial gauge support, jack and pressure gauge, electronic load cell, and a reaction frame. The load cell is required for verification tests only.

Use pressure gauges graduated in no greater than 100-pound per square inch increments. Measure the nail head movement with a minimum of two dial gauges capable of measuring to 0.001 inch.

(b) Verification test. Perform verification tests on boundary rope anchors or at alternate locations as approved by the CO. Perform verification tests before installation of production nails to verify drilling and installation methods, nail pullout resistance, and design assumptions.

Provide verification test nails with both bonded and unbonded lengths. The minimum unbonded length is 3 feet and the minimum bonded length is 10 feet. Determine the maximum bonded length based on the verification nail bar grade and size to avoid exceeding the allowable bar structural load during testing. Provide larger bar sizes if required to safely accommodate the 10-foot minimum test bond length and testing to twice the allowable pullout resistance.

Use the following formula to determine the maximum bonded length:

$$L_{BV\max} = \frac{Cf_y A_s}{2Q_d}$$

where:

L_{BVmax}	=	Maximum verification test nail bonded length (feet)
C	=	0.9 for grades 60 and 75 bars and 0.8 for grade 150 bars
f_y	=	Bar yield or ultimate stress (pounds per square inch)
A_s	=	Bar steel area (square inches)
Q_d	=	Allowable pullout resistance (pounds per foot)

Determine the design test load by the following equation:

$$DTL = L_{BV} \times Q_d$$

where:

DTL	=	Design test load (pounds)
L_{BV}	=	As-built bonded test length (feet)
Q_d	=	Allowable pullout resistance (pounds per foot)

Perform tests by incrementally loading the verification test nails as indicated in Table 259-1. Measure and record soil nail movement at each load increment.

The alignment load is the minimum load required to align the testing apparatus and should not exceed 5 percent of the design test load. Set dial gauges to “zero” after applying the alignment load. Following application of the maximum load, reduce the load to the alignment load and record the permanent set.

Hold each load increment for at least 10 minutes. Monitor the verification test nail for creep at the 1.50 DTL load increment by measuring and recording nail movement at 1, 2, 3, 5, 6, 10, 20, 30, 50, and 60 minutes. Maintain the load during the creep test within 2 percent of the intended load by use of the load cell.

Table 259-1
Verification Test Load Schedule

Test Load Increment	Hold Time (minutes)
AL (0.05DTL max.)	1
0.25DTL	10
0.50DTL	10
0.75DTL	10
1.00DTL	10
1.25DTL	10
1.50DTL (creep test)	60
1.75DTL	10
2.00DTL (maximum load)	10
AL	1

Note: AL = Alignment load; DTL = Design test load.

(c) Proof testing of production nails. Perform proof tests on production nails at locations selected by the CO. Perform successful proof testing on 5 percent of the production nails in each nail row or a minimum of 1 per row.

Provide production proof test nails with both bonded and temporary unbonded lengths. The minimum temporary unbonded length is 3 feet. Determine the maximum bonded length based on the production nail bar grade and size to avoid exceeding the allowable bar structural load during testing. Provide a test nail bonded length of 10 feet or L_{BPmax}, whichever is less.

Use the following formula to determine the maximum bonded length:

$$L_{BP\max} = \frac{Cf_y A_s}{1.5Q_d}$$

where:

L_{BPmax} = Maximum proof test nail bonded length (feet)

C = 0.9 for grade 60 and 75 bars and 0.8 for grade 150 bars

f_y = Bar yield or ultimate stress (pounds per square inch)

A_s = Bar steel area (square inches)

Q_d = Allowable pullout resistance (pounds per foot)

Determine the design test load by the following equation:

$$DTL = L_{BP} \times Q_d$$

where:

DTL = Design test load (pounds)

L_{BP} = As-built bonded test length (feet)

Q_d = Allowable pullout resistance (pounds per foot)

Perform proof tests by incrementally loading the proof test nail to 150 percent of the design load as indicated in Table 259-2. Measure and record soil nail movement at each load increment.

Table 259-2
Proof Test Load Schedule

Test Load Increment	Hold Time (minutes)
AL (0.05DTL max.)	Until stable
0.25DTL	Until stable
0.50DTL	Until stable
0.75DTL	Until stable
1.00DTL	Until stable
1.25DTL	Until stable
1.50DTL (maximum load)	See below

Note: AL = Alignment load; DTL = Design test load.

The alignment load should be the minimum load required to align the testing apparatus and should not exceed 5 percent of the design test load. Set dial gauges to "zero" after the alignment load has been applied.

Perform either 10-minute or 60-minute creep tests at the maximum load. Start the creep period after the maximum test load is applied. Measure and record nail movement at 1, 2, 3, 5, 6, and 10 minutes. When the nail movement between 1 minute and 10 minutes exceeds 0.04 inches, maintain the maximum test load an additional 50 minutes, recording movement at 20, 30, 50, and 60 minutes. Maintain all load increments within 5 percent of the intended load.

259.10 Wall Construction. Install erosion control matting on slope face as required in Section 629 for the excavated lift. Lay the high strength wire mesh on the slope by unrolling along the excavated lift. Overlap adjacent mesh panels by a minimum of one mesh. Fasten the overlapped mesh panels with two compression clays at each mech. The compression claws are installed with one claw directly above the loop and one directly below the loop. Install the boundary ropes and fasten the wire mesh to the boundary ropes with compression claws. Fasten a minimum of one compression claw at each mesh. Tighten the boundary ropes and pull the system tight against the excavated slope. Place the spike plates onto the anchors. Using a hydraulic wrench, tighten the nuts and push the spike plates and wire mesh into the depressions around the nails in order to tension the anchored wire mesh to at least 11.0 kips.

259.13 Acceptance. Soil nail retaining wall material, construction, and services will be evaluated as follows:

Survey work will be evaluated under Section 152.

Material for the soil nails will be evaluated under Subsections 106.03 and 106.04.

Construction of soil nails and services will be evaluated under Subsections 106.02 and 106.04.

Installed soil nails will be evaluated based on the criteria in Table 259-5.

Table 259-5
Nail Acceptance Criteria

Type of Nail Test	Total Creep Movement	Total Movement at Maximum Load(2)	Pullout Failure?(3)
Verification	< 0.080 inches between 6 and 60 minutes(1)	>80%	No
Proof	< 0.040 inches between 1 and 10 minutes, or < 0.080 inches between 6 and 60 minutes(1)	>80%	No

(1) And the creep rate is linear or decreasing throughout the creep test load hold period.
(2) Percent of the theoretical elastic elongation of the test nail unbonded length.
(3) Pullout failure is defined as the inability to further increase the test load while there is continued pullout movement of the test nail. Record the pullout failure load as part of the test data.

If a verification test fails, propose alternate installation methods before installing additional verification test nails and install a replacement verification test nail.

If a proof test fails, replace some or all of the installed production nails between the failed proof test nail and the next proof test nail in the row, as directed. Alternatively, install additional proof test nails within this area to ensure that the acceptance criteria is being met within this area. Propose alternative methods before installing additional soil nails.

Measurement

259.14 Measure the Section 259 items listed in the bid schedule according to Subsection 109.02 and the following as applicable.

Measure soil nail retaining walls by the square yard of front wall face along the slope. Structure excavation, erosion control matting, wire mesh facing system, slope finishing, and all system appurtenances will not be measured and are considered incidental to the soil nail retaining walls.

Measure verification test nails by the each. Do not measure failed verification test nails or additional verification test nails installed to verify alternative nail installation methods proposed by the Contractor. . Grout, drill holes, and centralizers will not be measured and are considered incidental to the verification test nail

Measure production soil nails by the linear foot. Measure along bar centerline from the line of the wall excavation face to the tip of the nail. Grout, drill holes, and centralizers will not be measured and are considered incidental to the production soil nail.

Do not measure temporary stabilization berms.

Do not measure wall excavation.

Payment

259.15 The accepted quantities will be paid for at the contract unit price per unit of measurement for the Section 259 pay items listed in the bid schedule. Payment will be full compensation for the work prescribed in this Section. See Subsection 109.05.

Table 259-6
Sampling and Testing Requirements

Material or Product	Type of Acceptance (Subsection)	Characteristic	Category	Test Methods Specifications	Sampling Frequency	Point of Sampling	Split Sample	Reporting Time
Centralizers	Certification of compliance (106.03)	Quality & performance	—	Subsection 722.02(f)	Each shipment	Source	—	Before using in work
Soil nails	Certification of compliance (106.03)	Quality & performance	—	Subsection 722.04	Each shipment	Source	—	Before using in work
Galvanization	Certification of compliance (106.03)	Quality & performance	—	Subsection 722.04	Each shipment	Source	—	Before using in work
Grout mix design	Certification of compliance (106.03)	Quality & strength	—	Subsection 259.05	1 per source of material	—	—	30 days before beginning soil nail work

Table 259-6 (continued)
Sampling and Testing Requirements

Material or Product	Type of Acceptance (Subsection)	Characteristic	Category	Test Methods Specifications	Sampling Frequency	Point of Sampling	Split Sample	Reporting Time
Nail grout	Measured and tested for conformance (106.04)	Compressive strength	—	Subsection 722.02(e) AASHTO T 106	1 per mix design	Mixer	—	30 days before beginning soil nail work
Verification test nail	Measured and tested for conformance (106.04)	Performance	—	Subsection 259.08(b) Table 259-5	Each verification nail	Installation	—	—
Proof test nail	Measured and tested for conformance (106.04)	Performance	—	Subsection 259.08(c) Table 259-5	Each proof nail	Installation	—	—

Section 260. – ROCK BOLTS

Delete the Section and substitute the following:

260.01 Description

This work consists of furnishing and installing tensioned rock bolts at spot locations along the cut slope at Site A.

260.02 Material

Conform to the following Sections and Subsections:

Grout	722.02 (e)
Rock Bolts	722.03

Construction Requirements

260.03 Submittal. At least 21 days before the installation of rock bolts, submit the following information:

(a) Evidence that the foreman has a minimum of 1500 hours and the drill operator has a minimum of 1000 hours of satisfactory work in similar installation of tensioned rock bolts.
(b) All supporting engineering calculations for anchor bond length requirements, etc., as prepared by a licensed engineer for the typical ground conditions anticipated at the site. All design assumptions, factors of safety, installation requirements should be clearly described for evaluation by the CO.
(c) Proposed rock bolt, couplers, bearing plate, anchor unit, flat washer, and beveled washer specifications including manufacture's data sheets.
(d) Complete specifications and manufacturer's data sheets (as applicable) and proper placement procedures for polyester resin and/or cement grouts.
(e) Drilling methods and type of equipment, including procedures for tensioning bolts.
(f) Describe safety requirements of all drilling and bolt installation operations, including hazard protection related to falling rock and/or bolting materials and equipment.
(g) Complete procedural description of the installation of the bolt fixture. Describe the manner in which corrosion protection is ensured, how bolt installation and grouting will be conducted across open joints, etc., to achieve a fully grouted, well-protected installation.
(h) Description of test procedures to be employed to ensure bolt anchorage capacity is being achieved and applied tension levels are appropriate per design.
(i) Calibration data for equipment used to verify design loads. Submit results of calibration tests performed by an independent testing laboratory within the last 60 days.
(j) Anticipated schedule of bolt installation.

Allow 5 working days for acceptance or rejection. Do not begin work until submittals have been approved.

The CO may require modifications of any bolting plans or procedures during the duration of the project. Obtain approval from the CO for any modifications to the submitted bolting plans.

260.04 Rock Bolt. Utilize epoxy coated or galvanized bolts to maximize corrosion resistance.

260.05 Handling and Storage. Protect bolts from dirt, mud, water, and other harmful substances to avoid damage and corrosion. Do not use rock bolts that are heavily corroded, pitted, damaged due to welding, or show signs of abrasions, cuts, or nicks.

260.06 Installation. Complete scaling and slope rounding operations prior to rock bolt installation. Drill holes at locations and depths as recommended by the CO, in consultation with FHWA geotechnical representative. Drill holes to the diameter specified by the bolt and/or resin cartridge (if used) manufacturer, and to a depth of 12 inches beyond the end of the specified rock bolt, or as specified by the manufacturer. Clean holes of all drill cuttings, sludge, and debris before the rock bolt is inserted or grout is injected into the hole. Drill holes normal to the rock surface unless otherwise specified by the plans or the CO.

Be aware that special drilling and grouting procedures may be required within the rock mass to accommodate joint and fracture apertures in excess of 4 inches.

Couple sections together when standard, commercially available lengths are exceeded, and according to manufacturer's recommendations. Provide a center stop for connecting sections so that an equal length of thread connects each section. Provide couplings that equal the manufacturer's guaranteed ultimate strength for the rock bolt. Do not fabricate couplings in a manner that interferes with the flow of grout.

For cement grout anchored bolts, apply tension to the anchor bond section of the bolt installation after the time specified in Table 260-1. After tensioning, fully grout the remainder of the bolt to the prescribed finish at the collar of the hole. Remove nuts and bearing plates following full column grouting after the time specified in Table 260-1. Cut the bolt off flush with the ground surface.

Table 260-1
Grout Curing Time

Cement Type	**Curing Time (Days)**
I	5
II	5
III	3

For bolts anchored with polyester resin, use fast setting polyester resin cartridges in the distal anchorage zone and slow setting polyester resin cartridges in the pre-tensioned zone, with gel times consistent with rapid installation (per manufacturer's recommendations). Select cartridge diameters in accordance with the manufacturer's recommendations to ensure complete encapsulation of the rock bolt and satisfactory in-hole mixing. Break and mix resin cartridges by spinning the bolt as it is inserted into the drill hole according to the manufacturer's instructions. After tensioning and after the resin has cured, per the manufacturer's specifications, remove the bearing plate and end hardware. Cut the bolt off flush with the ground surface.

260.07 Tensioning. Once the anchorage zone has achieved the required bond strength, apply tension to the bolt with a calibrated torque wrench to 125 percent of the design load. As a proof test, demonstrate that this initial load can be maintained for a minimum of 10 minutes. Upon proof testing completion, lock all bolt installations off at the specified design load.

Tension polyester resin anchored bolts immediately after the fast-set resin in the distal anchorage zone has set up and before the slow-set resin in the pre-tensioned zone has set up. Tension cement grouted bolts after the anchorage length has been grouted and the grout has set up the recommended time, but before the pre-tensioned length is grouted. Tension mechanically anchored rock bolts immediately after insertion into the drill hole, according to the manufacturer's recommendations and the approved bolting plan. Fill the hole of mechanically anchored bolt installations with cement grout immediately following anchor set and bolt tensioning.

Allow the bolt to remain in place if:

(a) The bolt can be tensioned to 125% of the design load, and the load can be held for 10 minutes.
(b) The design load is maintained after final grouting has been accomplished.

Replace any bolt that does not meet (a) or (b) in a manner and in a location approved by the CO.

260.08 Acceptance. Material for rock bolts will be evaluated under Subsections 106.02 and 106.03.

Installation of rock bolts will be evaluated under Subsections 106.02 and 106.04.

At bolting completion, a written statement, countersigned by the bolting foreman, should be submitted certifying that:

(1) All bolting is complete to the satisfaction of the Contractor's engineer, all bolt heads have been finished according to the specifications, and all excess materials have been removed from the site and properly disposed of.
(2) All bolt installations achieved the required performance standards for bond capacity and pre-tensioning.

Measurement

260.09 Measure the Section 260 items listed in the bid schedule according to Subsection 109.02.

Payment

260.10 The accepted quantities will be paid at the contract price per unit of measurement for the Section 260 pay items listed in the bid schedule. Payment will be full compensation for the work prescribed in this Section. See Subsection 109.05.

Section 563. – PAINTING

Description

563.01 Add the following:

This work also consists of furnishing all materials, equipment and labor necessary for the application of penetrating desert varnish stain to all exposed surfaces of the MSE retaining walls.

Material

563.02 Add the following:

Furnish a desert varnish material that is an aqueous solution containing salts of iron and manganese, built in oxidizers and other trace elements including copper and zinc. Furnish a desert varnish stain that involves a stable, one-step component solution applied directly to the galvanized surfaces.

Provide a stain that has a projected life expectancy range from 50 to 100 years. Furnish a stain that develops full coloration within two weeks of application. Supply a stain where the final color of the stain is controlled or modified by custom blending of the basic ingredients, application techniques, dilution rate of the color concentrate with water or a combination of these methods.

Furnish a stain that contains chemical components that have no adverse reactions or effects on soils, plants, or animals. Furnish a stain that contains no corrosive by-products that are present once the stain has been applied; only nitrate fertilizer products are permitted to be present as soluble residues.

For information, the following stain systems have been previously used on CFLHD projects:

EONITE manufactured by:
Arizona Rain Sprinkling Co.
129 W. Elwood St.
Phoenix, Arizona 85041
Telephone, (602) 268-8100

PERMEON manufactured by:
Soil-Tech, Co.
5375 S. Cameron Dr., Suite L
Las Vegas, Nevada 89118
Telephone: (702) 873-2023

Alternate stain systems from various manufacturers may be proposed provided they meet the minimum material requirements specified herein.

Construction Requirements

563.03 Protection of Public, Property, and Workers. Add the following:

Comply with all applicable federal, state, and local regulations. Furnish material safety data sheets for all cleaning and staining products.

563.04 Protection of the Work. Add the following:

Cover and/or protect all adjacent surfaces outside the work, including vegetation, from receiving application of the stain.

563.08 Painting Galvanized Surfaces. Add the following:

Clean the welded wire face retaining wall surfaced to be stained, prior to the stain being applied, in accordance with the manufacturer's recommendations for the removal of all dirt, dust, efflorescence, scale or other foreign substances which could be detrimental to the stain penetration or color. At the time of application of stain, provide surfaces that are clean, completely dry, and free of frost or other foreign substances.

Apply the desert varnish stain in the presence of a manufacturer's representative in accordance with the manufacturer's recommendations.

Submit the name of the manufacturer of the desert varnish stain proposed for use, along with the manufacturer's specifications for mixing and application, to the CO for approval. The CO will select the desired color intensity of the stain. Furnish three, 1.0 foot square, preliminary samples of the galvanized materials equivalent to that used in the retaining wall. Vary the color intensity of the stain selected on each sample in increments normally used in actual field applications. Apply the stain using the same methods that will be used during actual field application. Allow four weeks for evaluation and approval of the stain. Do not acquire the materials to stain the surfaces until written approval of the final color selection has been given.

Adjustments to the final shade and tone will be made with aesthetic considerations, and final approval may require such adjustments. Approximate application rate per coat will be determined after evaluation and approval of the preliminary samples. Approximately two coats will be required.

Measurement and Payment

563.13 Add the following:

Do not measure wall stain for payment. See Subsection 255.08.

Section 623. – GENERAL LABOR

Description

623.01 Add the following:

This work also includes the removal of loose or potentially unstable rock and soil debris and vegetation on the slopes adjacent to the roadway within the limits shown on the plans, or as directed by the CO.

Construction Requirements

Add the following:

623.05 Slope Scaling. Stabilize or scale all loose rock and other unstable materials greater than 1 ft^3 in volume as directed by the CO. Remove and dispose of all spoil resulting from the scaling operation and all existing pre-scaling materials located between the slopes and the edge of the roadway.

Limits of scaling will extend to the crest and may be required up to an elevation of 250 ft higher than the existing roadway elevation. Scaling should be done by power equipment or by hand methods to remove potentially unstable boulders, blocks, and trees, thereby reducing the rockfall hazard and maintenance requirements following construction. Obtain approval of the CO for the use of power equipment for scaling operations.

Proceed with work according to the work plans and schedule submitted prior to the commencement of the work. Use concrete barriers where required to prevent safety hazards.

(a) Submittals. Six weeks prior to commencing rock slope scaling, submit the following to the CO for approval:

(1) Personnel qualifications. Submit evidence that the Foreman and scaling crew have at least two years of demonstrated experience in rock scaling in similar capacities.
(2) Slope scaling plan. Submit a detailed work plan for each rock slope to be scaled and slope crest overburden rounding. Include the following in the work plans:
- (a) Proposed construction sequence and schedule.
- (b) Types and quantities of machinery and tools to be utilized for scaling.
- (c) Number of scaling crews required for the project.
- (d) Rock and soil removal and disposal plan for materials generated from the scaling and slope crest preparation work.
- (e) Protection plan to be implemented to protect personnel, facilities, and other structures from damage caused by scaling activities. Include in the plan proposed traffic control as specified in Section 156.
- (f) Traffic interruptions and controls required.

(b) Scaling Crew Requirements. Provide scaling crews with one Foreman present at all times when scaling is performed. A scaling crew is defined as three qualified scalers, one of which could be the scaling Foreman. Provide qualified personnel if a crewmember must leave for any reason.

(c) Protection of Property. Provide adequate protection in the areas being scaled to prevent damage to property and structures and utilities by falling rock from the scaling operation. The Contractor is also responsible for the protection of personnel from the danger inherent in scaling.

Provide devices, measures, and procedures to protect the public and any adjacent facilities or structures from danger or damage caused by scaling. This plan must be in effect prior to commencing the scaling. Any injuries or damages caused by scaling are the responsibility of the Contractor.

(d) Sequencing. Begin slope scaling at the top of the cut slope and proceed downward towards the roadway. Perform slope crest rounding per Section 204 using power equipment before the slope scaling is completed. Remove all materials scaled off of the slopes.

623.06 Acceptance. Additional surveying services will be evaluated under Section 152. Hired technical services will be evaluated under Subsections 106.02 and 106.04

Measurement

623.07 Add the following:

Measure the slope scaling by the man-hour as ordered by the CO for slope scaling activities.

Removal and disposal of materials generated by scaling, including equipment needed, loading/unloading, and transporting material is incident to the work and will not be measured for payment.

Protection devices (such as barriers), measures, and procedures taken to protect adjacent property and structures from danger or damage and any repair required is incidental to the work and will not be measured for payment.

Payment

623.08 The accepted quantities will be paid at the contract price per unit of measurement for the Section 623 pay item listed in the bid schedule. Payment will be full compensation for the work prescribed in this section. See Subsection 109.05.

Section 651. – DRAPED ROCKFALL PROTECTION

Description

651.01 This Work consists of constructing wire mesh and cable net to restrain rock fall as designated on the Plans.

Material

651.02 Conform to the following Subsections and requirements:

Grout	725.22 (c)
Rock Bolt	260

(a) Wire Rope. Supply wire rope with a minimum of diameter of 5/8 inches. The rope should be manufactured from galvanized steel wire strand, common grade, type one coating, conforming to the requirements of ASTM A475 - Zinc Coated Steel Wire Strand with a minimum breaking strength as shown on the plans.

(b) Wire Rope Clips. Supply wire rope clips compatible with the cable sizes shown in the plans. The bases should be manufactured from drop forged carbon steel and the nuts will be of the heavy-duty hexagonal type. Galvanize all components in accordance with ASTM A153.

(c) Anchors. Conform to the requirements of Section 260, Rock Bolts, and Grade 75 for anchors. Supply epoxy coated bars for corrosion protection. Rope anchors may be used in lieu of thread bars per the mesh or netting manufactures recommendations. Supply epoxy coated bars for corrosion protection. Tension the bolts according to the requirements of Section 260, Rock Bolts.

(d) Nuts. Supply heavy duty nuts, conforming to the requirements of ASTM A325 Grade B. Nuts will develop an ultimate strength of not less than 125 percent of the minimum yield strength of the bar. Nuts will be epoxy coated for corrosion protection.

(e) Washers. Conform to the requirements of ASTM A325 for washers. Supply washers quenched and tempered to a Rockwell hardness of C38 to C45. The round center hole will be ¼ inch larger in diameter than the anchor to be used. Washers may be flat, beveled, or spherical seat washers as required, and will be placed between the plate and the nut. Washers will be epoxy coated for corrosion protection.

(f) Bearing Plates. Steel bearing plates will conform to ASTM A36. Bearing plates will be epoxy coated for corrosion protection.

(g) Grout. Non-shrink cement grout will be used for the anchors.

(h) Draped Wire Mesh. Supply wire mesh of the 8 x 10 double twist hexagonal netting type, zinc coated in accordance with ASTM A153. Apply a PVC coating to the wire mesh with a minimum film thickness of 15 mils. The color of the PVC coating will be black as approved by the CO. Wire used in the body of the mesh and lacing wire will be U.S. gauge 9 or equivalent in diameter, after coating. Alternatively, high tensile strength wire mesh may be substituted for the wire mesh/cable net system, as approved by the CO and provided that the submitted wire mesh has similar strength characteristics to the wire mesh/cable net system.

(i) Mesh Pins. Mesh pins are expansion anchors used to keep wire mesh within 2 feet of rock face to reduce the height distance which rock fall can occur.

(j) Cable Net. Supply cable netting with a minimum cable diameter of ¼ inch, zinc coated in accordance with ASTM A153. Apply a PVC coating to the wire mesh, with a minimum film thickness of 15 mils. The color of the PVC coating will be black as approved by the CO. The cable netting will have a maximum cable net opening of 8 inches. The cable net can be a horizontal square, diagonal, or ring net pattern. Attach cable net panels to the anchors and each other as recommended by the cable net manufacturer.

(k) Cable Net Hardware. Supply cable net hardware (clips or ties) that is compatible with the specified cable diameter. Galvanize all components in accordance with ASTM A153.

(l) Samples. One sample of the type of wire mesh, ground anchor, and hardware to be used will be submitted to the CO from the normal stock of the manufacturer. The samples will be submitted together with mill reports indicating tensile yield point and elongation results of the ground anchors, and the tensile and punching tests of the wire mesh at no additional expense to the Government.

The following certificates will be submitted to the CO at least two weeks prior to beginning work.

1. Certificates stating that samples for testing are from normal stock, which will be used in the work.

2. Manufacturer's certified test results of set time, shelf life, and compressive strength for each type of grout to be used.

3. The Contractor will furnish a certified report, not more than one year old, that the product to be supplied equals or exceeds these specifications.

Construction Requirements

651.03 General. Safety of the work will be the responsibility of the Contractor. The work will be performed in a manner to minimize hazards and exposure of the public, construction personnel, and equipment to hazardous and potentially hazardous conditions. Placement of the wire mesh will be scheduled so as to ensure safety.

651.04 Installation.

(a) Sloping and Scaling. The Contractor will round the slope crest and scale slope faces according to Sections 204 and 623, respectively.

(b) Anchors. The hole diameter for each anchor installation will be uniform for the entire length of the hole unless otherwise approved by the CO. The minimum hole diameter will be as shown on the Plans.

The drilling equipment will be capable of drilling a straight hole to the depths required, and will be equipped to inject air into the hole through the bit.

Holes will be drilled at the orientations and inclinations shown in the plans or as directed by the CO. Deviation from those orientations and inclinations will not exceed five degrees. The Contractor will use a measuring device to assure the required inclinations in the vertical plane.

(c) Clearing of the vegetation, brush and trees is required for the placement of mesh, cable net, and anchors. The clearing of the vegetation will be required on the slopes and brow to be meshed. The cleared material will be disposed of offsite or mulched for distribution on the project or on the seeded slopes.

(d) Each hole will be cleaned of all drill cuttings, sludge, and debris by means of compressed air introduced at the back of the hole prior to installation of the cement grout.

After the drill hole is cleaned, a sufficient amount of cement grout will be placed in the drill hole to fully encapsulate the anchor bar.

(e) Anchors will be spaced as shown on the plans. Ground conditions encountered as construction progresses may require the lengths of the anchors to be greater than the minimum length shown on the Plans. Where the varied lengths are to be utilized, the use of steel bolt couplings (or other approved methods as recommended by the manufacturer) will be permitted.

A minimum of two centralizers will be placed on each anchor to position the bar within 1 inch of center of the drill hole. The centralizers will be placed within 2.0 feet and 1.0 feet from the top and bottom of the drill hole, respectively. The centralizers will be attached securely to the anchor bar so they will not shift during handling or insertion into the drill hole.

(f) Draped mesh and cable netting will extend down the face to the height specified on the Plans and will be anchored to the top of the slope with anchors.

(g) Connect draped mesh to cable netting per manufacturer's recommendations.

(h) Wire rope will be connected to the end anchors as shown in the Plans. The ends of the wire rope will be secured with wire rope clips. The wire rope clips will be placed in the configuration and torqued as recommended by the manufacturer. The wire mesh will be folded around the anchorage cable and folded upon itself a minimum of 2.0 feet and secured using locking clips or hog rings.

(i) The wire mesh will be securely selvedge or bound so that the joints formed by tying the selvedges have minimum strength equal to that of the body of the mesh. Fasteners, ties, connectors, locking clips, or hog rings used for fastening edges will be spaced 6 inches apart or

less. Perimeter edges will be laced with binding wire by tightly looping through every mesh opening.

(j) Mesh pins will be installed to keep mesh within 2.0 feet of the rock cut face or as directed by the CO. Mesh pins will be installed per manufacture's recommendations for concrete applications as appropriate.

651.05 Acceptance. Draped rockfall protection material and construction will be evaluated as follows:

Material for the Draped rockfall protection will be evaluated under Subsections 106.03 and 106.04.

Construction of Draped rockfall protection will be evaluated under Subsections 106.02 and 106.04.

Measurement

651.06 Measure draped wire mesh by the square yard completed in place exclusive of the area of wire mesh used in any overlaps.

Measure the cable net by the square yard completed in place exclusive of the areas of cable net used in any overlaps.

Measure selective slope rounding under Section 204.

Measure the slope scaling under Section 623.

Payment

651.07 The accepted quantities, measured as provided above, will be paid at the contract price per unit of measurement for the Section 651 items listed in the bid schedule. Payments will be full compensation for the work prescribed in this Section. See Subsection 109.05.

Section 704. – SOIL

Add the following Subsection:

704.13 Wall fill soils.

(a) Select wall backfill. Furnish sound, durable, granular soil free from organic matter or other deleterious material (such as shale or other soft particles with poor durability). Conform to the following:

(1) Quality requirements.

(a) Gradation	Table 704-6
(b) Shear maximum angle of internal friction on the portion passing the No. 4 sieve, AASHTO T 236	34° min.

Note: Compact samples for AASHTO T 236 to 95 percent of the maximum density determined according to AASHTO T 99 method C.

(c) Sodium sulfate soundness loss (5 cycles)	15% max.
(d) Los Angeles abrasion, AASHTO T 96	50% max.
(e) Liquid limit, AASHTO T 89	30 max.
(f) Plastic index, AASHTO T 90	6 max.

(2) Electrochemical requirements

(a) Resistivity, AASHTO T 288	3000 Ω-cm min.
(b) pH, AASHTO T 289	5.0 to 10.0
(c) Sulfate content, AASHTO T 290	200 ppm max.
(d) Chloride content, AASHTO T 291	100 ppm max.

Notes:
(1) Tests for sulfate and chloride content are not required when pH is between 6.0 and 8.0 and the resistivity is greater than 5000 ohm centimeters.
(2) Electrochemical requirements are not applicable to geogrid-reinforced walls. Refer to Subsection 720.01(k) for durability design requirements.

Table 704-6

Select Wall Backfill Gradation

Sieve Size	**Percent by Mass Passing Designated Sieve (AASHTO T 27 and T 11)**
4 inch	100
3 inch	75 – 100
No. 4	30 – 75
No. 200	0 – 15

(b) Wall backfill. Furnish granular soil free from organic matter or other deleterious material (such as shale or other soft particles with poor durability) conforming to AASHTO soil classifications A-1, A-3, or A-2-4. Remove all rock particles and hard earth clods larger than 12 inches in the longest dimension.

(c) Wall facing fill. Furnish sound, durable, and pervious granular soil free from organic matter or other deleterious material (such as shale or other soft particles with poor durability) conforming to the following:

(1) Quality requirements.

(a) Gradation	Table 704-7
(b) Sodium sulfate soundness loss (5 cycles)	15% max.
(c) Los Angeles abrasion, AASHTO T 96	50% max.

Table 704-7
Wall Facing Fill

Sieve Size	**Percent by Mass Passing Designated Sieve (AASHTO T 27 and T 11)**
4 inch	100
2 inch	0 – 5

Section 713. — ROADSIDE IMPROVEMENT MATERIAL

713.18 Permanent Rolled Erosion Control Products.

(a) Type 5.C, permanent turf reinforcement mat. Add the following:

The reinforcement mat should be a homogeneous, three dimensional matrix composed of synthetic polymer fibers with a minimum open (void) space of 90% to facilitate infilling with hydraulically applied seed and mulch and development of vegetation within the matrix. Furnish a mat that will not unravel or separate when cut in the field.

Delete Table 713-4 and replace with the following table:

Table 713-4
Permanent Turf Reinforcement Mats

Properties[1]	Rolled Erosion Control Product Type			Test Method
	5.A	5.B	5.C	
Minimum tensile strength[2][3] (pounds per foot)	125	150	175	ASTM D4595
UV stability (minimum % tensile retention)	80	80	80	ASTM D 4355 (500-hour exposure)
Minimum thickness[2] (inches)	1/4	1/4	1/2	ASTM D 6525
Minimum permissible shear stress[4] (pounds per square foot)	6.0	8.0	10.0	ASTM D 6460 or other qualified independent test[5]

(1) For turf reinforcement mats containing degradable components, obtain all property values on the non-degradable portion of the matting alone.
(2) Minimum average roll values, machine direction only.
(3) Field conditions with high loading and high survivability requirements may warrant the use of turf reinforcement mats with tensile strengths of 3,000 pounds per foot or greater.
(4) Minimum shear stress the turf reinforcement mat (fully vegetated) can sustain without physical damage or excess erosion (>1/2-inch soil loss) during a 30-minute flow event in large-scale testing. These performance test values should be supported by periodic bench scale testing under similar test conditions and failure criteria using Erosion Control Technology Council Test Method #3.
(5) Other large-scale test methods determined acceptable by the CO.

Section 714. –GEOTEXTILE AND GEOCOMPOSITE DRAIN MATERIAL

714.01(a) Physical requirements. Add the following:

(7) Biaxial Geogrid Table 714-7

714.03 Geogrid. Furnish geogrid reinforcement with a regular network of integral connected polymer tensile elements having an aperture geometry and junction strength to sufficiently permit significant mechanical interlock with the surrounding soil or rock. Provide geogrid with a structure dimensionally stable and able to retain its geometry under manufacture, transport, installation, ultraviolet degradation, and all forms of chemical and biological degradation encountered in the soil being reinforced.

(a) Physical requirements. Provide geogrids composed of fibers or ribs that are at least 85% by weight polyethylene, polypropylene or polyester. Form a network of fibers that will retain dimensional stability. Calculate long-term tensile strength "T_{al}" and pullout capacity of geogrids according to FHWA publication No. FHWA-NHI-00-043, entitled "Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines." The long-term tensile strength "T_{al}" must take into account reduction factors "RF" for creep (RF_{CR}), durability (RF_D), and installation damage (RF_{ID}) as defined in FHWA-00-043. Conform to the physical requirements in Table 714-7.

Table 714-7
Geogrid Physical Requirements

Property	Test Method	Minimum Acceptable Values
		Biaxial Geogrid
Wide width tensile strength (ultimate), lb/ft	ASTM D 4595	1,100/1,100(1)
Aperture size, inches	----------	0.5/0.5(1)
Long Term Design Strength, lb/ft	GRI:GG4	500(2)

(1) Machine Direction/Cross Machine Direction
(2) Principle strength (highest strength) direction

Identify, store, and handle geogrid according to ASTM D 4873-88 and manufacturer's recommendations. Limit geogrid exposure to ultraviolet radiation to less than 10 days.

(b) Evaluation procedures. Geogrid will be evaluated under Subsection 106.03. Furnish to the CO three copies of a commercial certification that the geogrid supplied meets the respective index criteria, measured in full accordance with all test methods and standards set forth in these specifications. State on the commercial certification the name of the manufacturer, product name, style number, chemical composition of the filaments, ribs, or yarns, and other pertinent information to fully describe the geogrid. Attest the certification by a person having legal authority to bond the manufacturer. In case of dispute over validity of values, the CO can require the contractor to supply test data from an agency approved laboratory to support the certified values submitted. Also, include the calculation of the long term design strength, with assumed reduction factors.

When samples are required, remove a 3-foot long, full-width sample from beyond the first outer wrap of the roll. Label the sample with the lot and batch number, date of sampling, project number, item number, manufacturer, and product name.

Manufacturing Quality Control: The manufacturer is responsible for establishing and maintaining a quality control program to ensure compliance with the requirements of this specification.

Perform conformance testing as part of the manufacturing process, testing may vary for each type of product. Consider the Table 714-8 for applicable index tests as a minimum for an acceptable QA/QC program.

Table 714-8

Minimum Index Tests for QA/QC

Property	Test Method	Minimum Conformance Requirement
Specific Gravity (HDPE only)	ASTM D-1505	To be provided by the material supplier of specialty company
Wide Width Tensile	ASTM D-4595	
Melt Flow (HDPE and PP only)	ASTM D-1238	
Intrinsic Viscosity (PET only)	ASTM D-4603	
Carboxyl End Group (PET only)	ASTM D-2455	
Single Rib Tensile (geogrids)	GRI:GG1	

Section 720. – STRUCTURAL WALL AND STABILIZED EMBANKMENT MATERIAL

720.01 Mechanically-Stabilized Earth Wall Material. Add the following:

(k) Geogrid. Furnish geogrid reinforcement with a regular grid structure with apertures of sufficient size to allow interlocking with surrounding soil, rock, or earth. Manufacture geogrid using high-density polyethylene, polypropylene, or polyester. Calculate long-term tensile strength "T_{al}" and pullout capacity of geogrids according to FHWA publication No. FHWA-NHI-00-043, entitled "Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines." The long-term tensile strength "T_{al}" must take into account reduction factors "RF" for creep (RF_{CR}), durability (RF_D), and installation damage (RF_{ID}) as defined in FHWA-00-043.

Section 722. – ANCHOR MATERIAL

722.04 Soil Nails. Delete the second sentence and substitute the following:

Provide new, straight, continuous, threaded, undamaged, bare, galvanized bars.

Add the following:

(e) Galvanization. Apply galvanization according to ASTM A-153. Apply a minimum zinc coating of 2.0 oz/ft^2.

APPENDIX J – Photos

Existing Rock Creek Bridge

Existing Rock Creek Bridge

Rock Creek, Upstream

Existing Rock Creek Bridge

Location of Boring B-RC1

Core Samples from Boring B-RC1, 0-21.5’

Core Samples from Boring B-RC1, 21.5’-30.5’

Location of Boring B-RC2

Core Samples from Boring B-RC2, 0-10.5’

Core Samples from Boring B-RC2, 10.5’-21.5’

Core Samples from Boring B-RC2, 21.5-31.5’

Core Samples from Boring B-RC2, 31.5’-37.5’

Existing Boulder Creek Bridge

Existing Boulder Creek Bridge

Location of Boring B-BC1

Core Samples from Boring B-BC1, 0.0-15.0’

Core Samples from Boring B-BC1, 15.0’-25.0’

Core Samples from Boring B-BC1, 25.0’-38.0’

Core Samples from Boring B-BC1, 38.0’-47.4’

Existing Steven Memorial Bridge

Existing Steven Memorial Bridge

Existing Steven Memorial Bridge, Pier 1

Existing Steven Memorial Bridge, Pier 2

Location of Boring B-SM1

Core Samples from Boring B-SM1, 0.0-12.0’

Core Samples from Boring B-SM1, 12.0’-21.0’

Core Samples from Boring B-SM1, 21.0’-30.3’

Core Samples from Boring B-SM1, 30.3’-39.0’

Location of Boring B-SM2

Core Samples from Boring B-SM2, 0.0-10.0’

Core Samples from Boring B-SM2, 10.0’-20.0’

Core Samples from Boring B-SM2, 20.0’-30.0’

Location of Boring B-SM3

Core Samples from Boring B-SM3, 0.0-13.0’

Core Samples from Boring B-SM3, 13.0’-21.5’

Core Samples from Boring B-SM3, 21.5’-31.0’

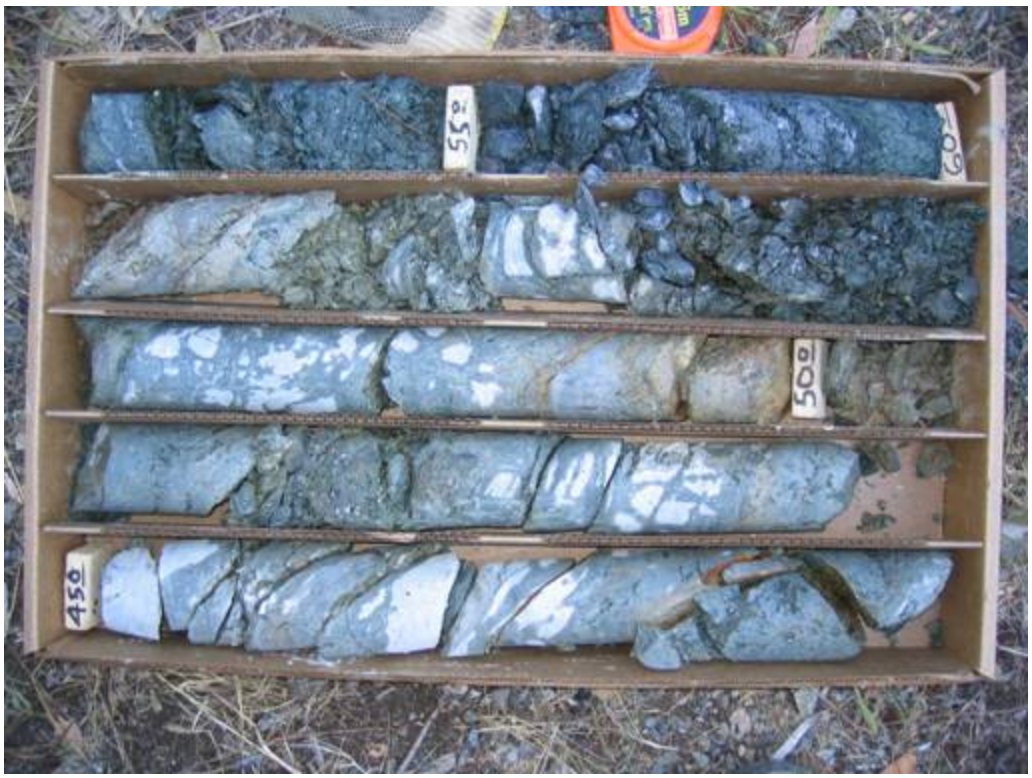
Location of Boring B-SM4

Core Samples from Boring B-SM4, 0.0-13.5’

Core Samples from Boring B-SM4, 13.5’-25.0’

Core Samples from Boring B-SM4, 25.0’-35.0’

Core Samples from Boring B-SM4, 35.0’-45.0’

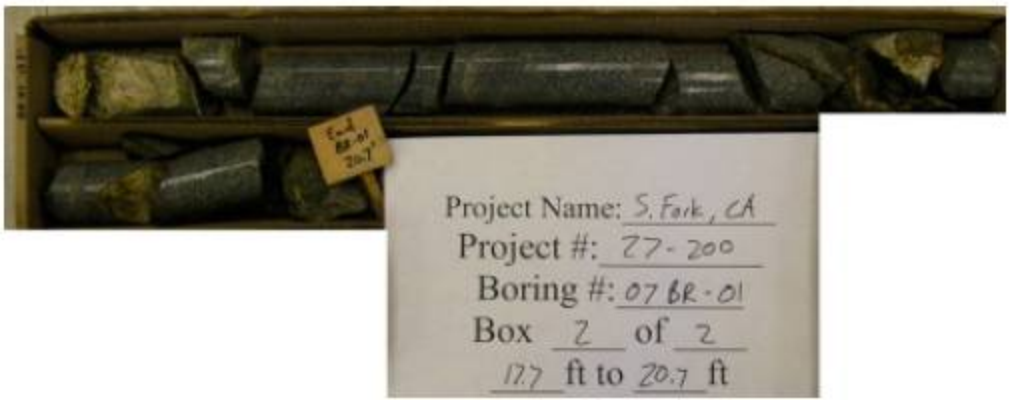


Core Samples from Boring B-SM4, 45.0’-60.0’

Core Samples from Boring B-SM4, 60.0'-70.0'

Location of Boring 07BR-01

Core Samples from Boring 07BR-01, 0.0-17.7’



Core Samples from Boring 07BR-01, 17.7’-20.7

Existing Hurdy Gurdy Creek Bridge

Existing Hurdy Gurdy Creek Bridge

Location of Boring B-HG1

Core Samples from Boring B-HG1, 0.0-19.0’

Core Samples from Boring B-HG1, 19.0’-34.0’

Location of Boring B-HG2

Core Samples from Boring B-HG2, 0.0-24.0’

Core Samples from Boring B-HG2, 24.0’-39.0’

Core Samples from Boring B-HG2, 39.0’-47.0’

Location of Boring B-HG3

Core Samples from Boring B-HG3, 0.0-18.5’

Core Samples from Boring B-HG3, 18.5’-30.5’

Location of Boring B-HG4

Core Samples from Boring B-HG4, 0.0-17.0’

Core Samples from Boring B-HG4, 17.0’-27.0’

Location of Boring B-HG5

Core Samples from Boring B-HG5, 0.0-15.0’

Core Samples from Boring B-HG5, 15.0’-21.0’

Location of Boring B-HG6

Core Samples from Boring B-HG6, 0.0-15.5’

Core Samples from Boring B-HG6, 20.5’-28.0’

Site A, looking up station

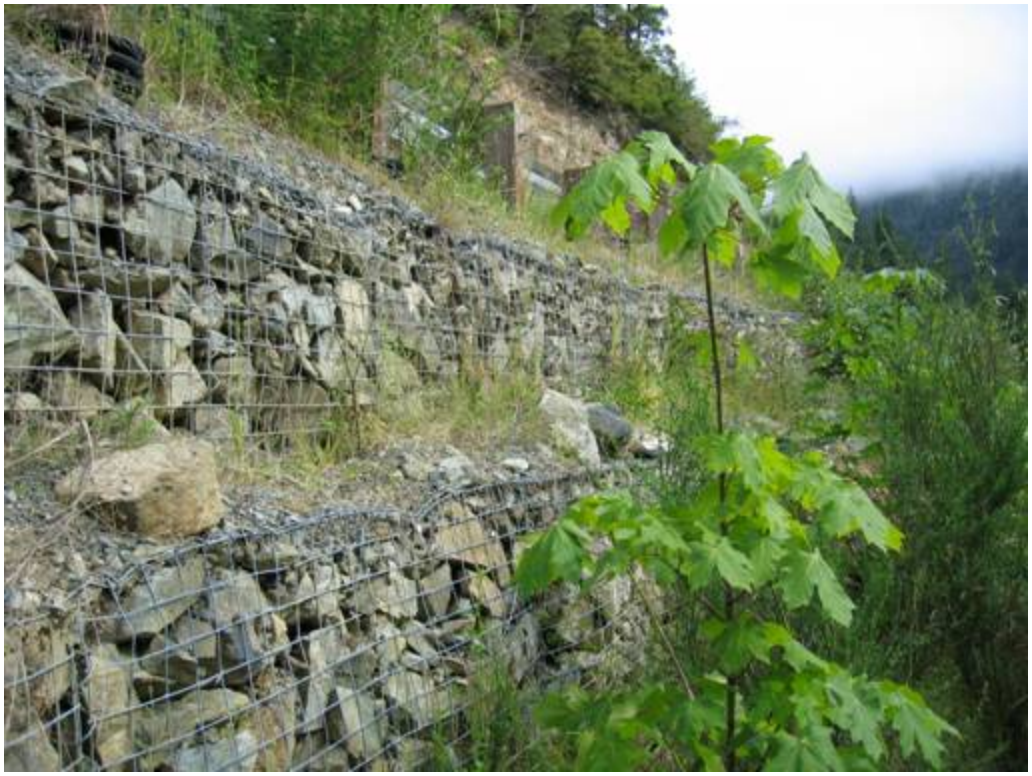
Site A, looking up station

Site A, looking down station

Site A, looking down station

Site A, looking down station

Site A, looking up station



Site A, existing gabion structure

Site A, looking down station

Core Samples from Boring B-A1, 0.0-13.0’

Core Samples from Boring B-A1, 13.0’-33.3’

Core Samples from Boring B-A1, 33.3’-40.0’

Location of Boring B-A2

Core Samples from Boring B-A2, 0.0-23.0’

Core Samples from Boring B-A2, 23.0’-39.0’

Core Samples from Boring B-A2, 39.0’-50.0’

Core Samples from Boring B-A2, 50.0’-52.5’

Core Samples from Boring SI-A1, 13.5’-27.0’

Core Samples from Boring SI-A1, 27.0’-37.0’

Core Samples from Boring SI-A1, 37.0’-48.7’

Core Samples from Boring SI-A1, 48.7’-62.0’

Core Samples from Boring SI-A1, 67.0’-70.0’

Location for Boring 07A-01

Core Samples from Boring 07A-01, 0.0-7.0’

Core Samples from Boring 07A-01, 7.7’-15.2’

Location of Boring 07A-02

Core Samples from Boring 07A-02, 0.0-4.0’

Core Samples from Boring 07A-02, 4.0’-9.8’

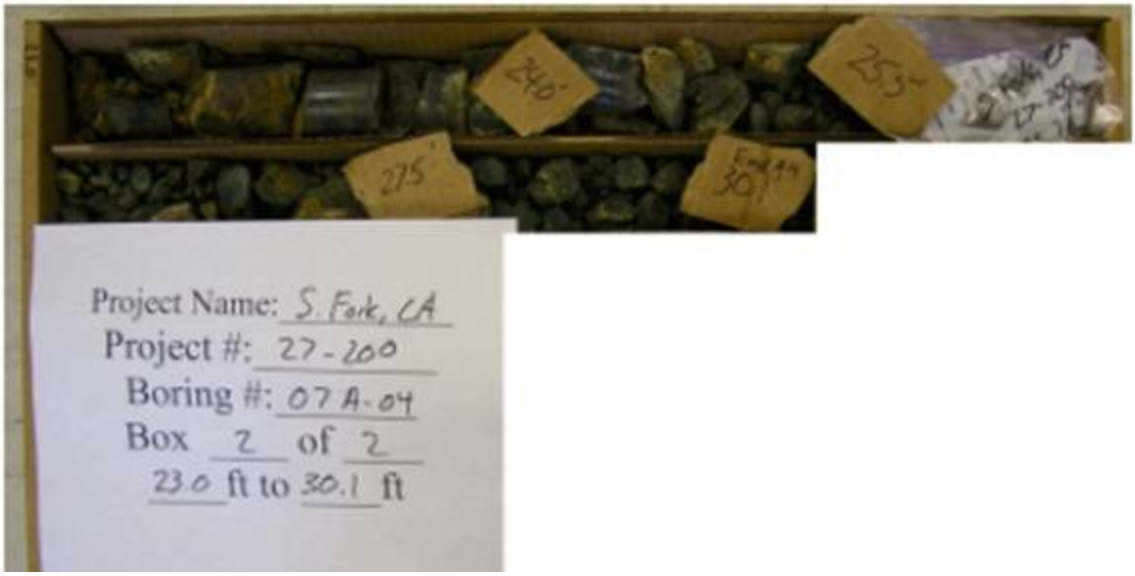
Location of Boring 07A-03

Core Samples from Boring 07A-03, 0.0-16.0’

Core Samples from Boring 07A-03, 16.0’-28.0’

Location of Boring 07A-04

Core Samples from Boring 07A-04, 0.0-23.0’



Core Samples from Boring 07A-04, 23.0’-30.1’

Site B, looking down station

Site B, looking up station

Site B, looking down station

Site B, looking up station

Core Samples from Boring B-B1, 2.0’-12.0’

Core Samples from Boring B-B1, 12.0’-17.0’

Location of Boring 07B-01

Core Samples from Boring 07B-01, 0.0-17.0’4

Core Samples from Boring 07B-01, 17.4’-25.4’

Location of Boring 07B-02

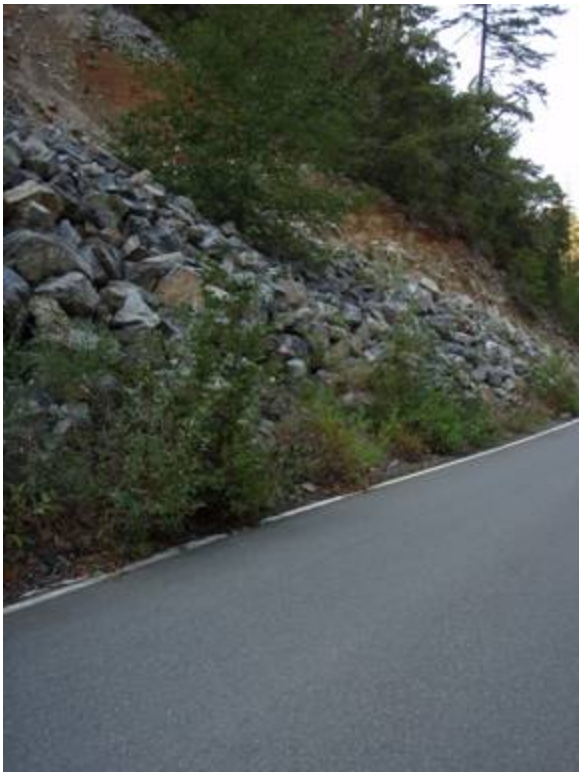
Core Samples from Boring 07B-02, 0.0-5.0’

Core Samples from Boring 07B-02, 5.0’-15.2’

Location of Boring 07B-03

Core Samples from Boring 07B-03, 0.0-9.0’

Core Samples from Boring 07B-03, 9.0’-15.2’



Site C, Existing Rock Buttress near Sta. 514+00

Site C, Existing MSE Wall near Sta. 514+00

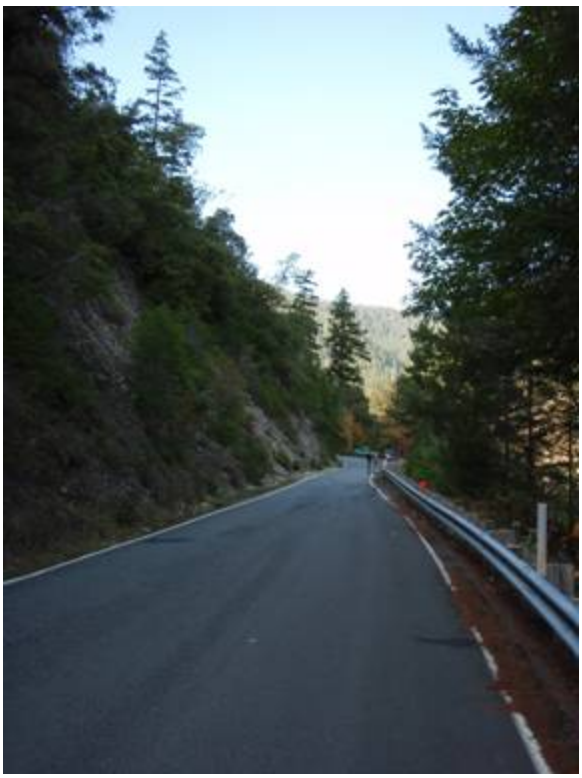
Site C, Sta. 521+00 looking down station

Site C, Existing Concrete Crib Wall near Sta. 521+00

Site C, Sta. 520+00 looking up station

Site C, Slope below road near Sta. 520+00

Site C, Sta. 523+00 looking up station



Site C, Sta. 523+00 looking down station

Site C, Sta. 527+00 looking up station

Site C, Sta. 530+00 looking down station

Location of Boring B-C1

Core Samples from Boring B-C1, 13.1’-22.0’

Core Samples from Boring B-C1, 22.0’-27.0’

Location of Boring B-C2

Core Samples from Boring B-C2, 4.5’-25.0’

Core Samples from Boring B-C2, 25.0’-28.5’

Location of Boring B-C3

Location of Boring B-C4

Core Samples from Boring B-C4, 18.5’-28.5’

Location of Boring B-C5

Core Samples from Boring B-C5, 0.7’-28.0’

Core Samples from Boring B-C5, 28.0’-46.2’

Core Samples from Boring B-C5, 46.2’-55.5’

Location of Boring B-C6

Core Samples from Boring B-C6, 5.1’-23.8’

Core Samples from Boring B-C6, 23.8’-45.3’

Core Samples from Boring B-C6, 45.3’-53.8’

Location of Boring B-C7

Core Samples from Boring B-C7, 1.0’-24.0’

Core Samples from Boring B-C7, 25.5’-39.0’

Core Samples from Boring B-C7, 39.0’-44.0’

Location of Boring P-C5

Location of Boring SI-C1

Core Samples from Boring SI-C1, 38.5’-46.6’

Core Samples from Boring SI-C1, 46.6’-50.0’

Core Samples from Boring SI-C2, 0.0-24.5’

Core Samples from Boring SI-C2, 24.5’-43.0’

Core Samples from Boring SI-C2, 43.0’-50.0’

Location of Boring SI-C3

Core Samples from Boring SI-C3, 0.0-20.5’

Core Samples from Boring SI-C3, 20.5’-32.0’

Core Samples from Boring SI-C3, 32.0’-39.0

Core Samples from Boring SI-C3, 39.0’-44.0’

Core Samples from Boring SI-C4, 0.0-25.5’

Core Samples from Boring SI-C4, 25.5’-38.0’

Core Samples from Boring SI-C4, 38.0’-52.5’

Location of Boring SI-C5

Core Samples from Boring SI-C5, 0.0-21.5’

Core Samples from Boring SI-C5, 21.5’-43.6’

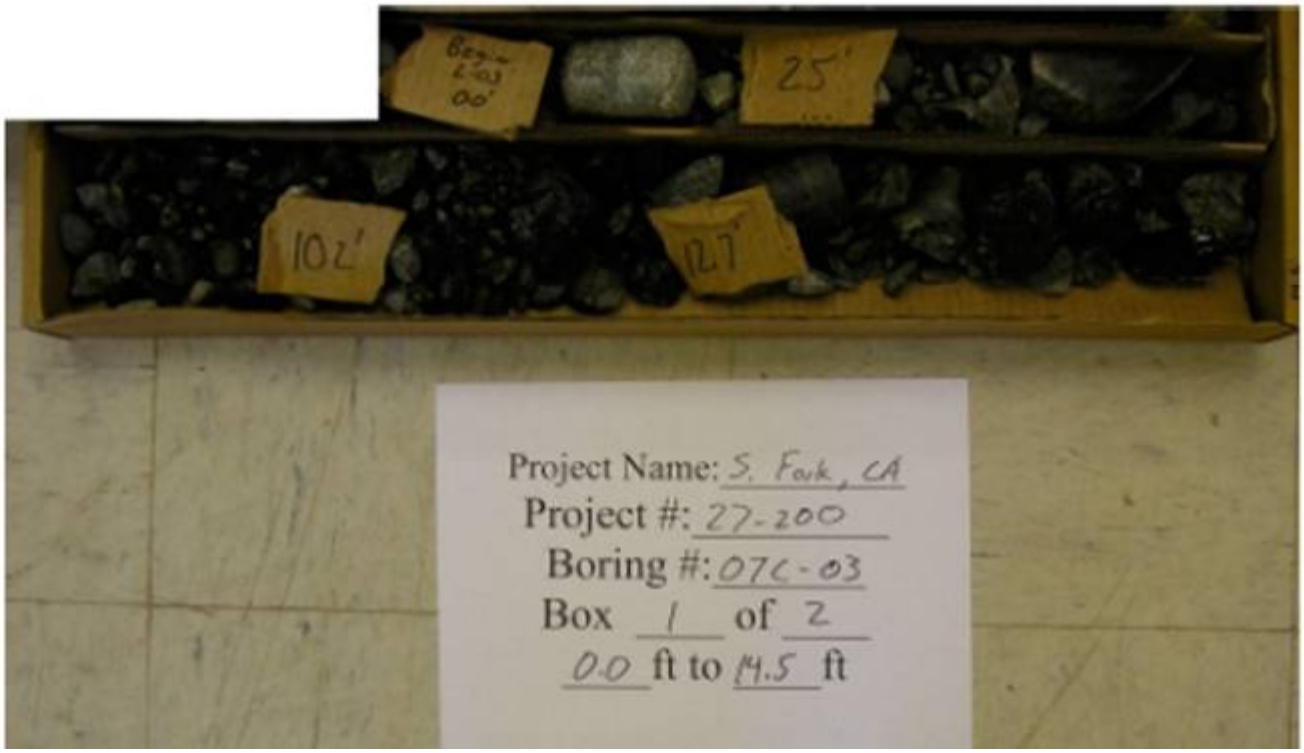
Core Samples from Boring SI-C5, 43.6’-52.5’

Location of Boring 07C-02

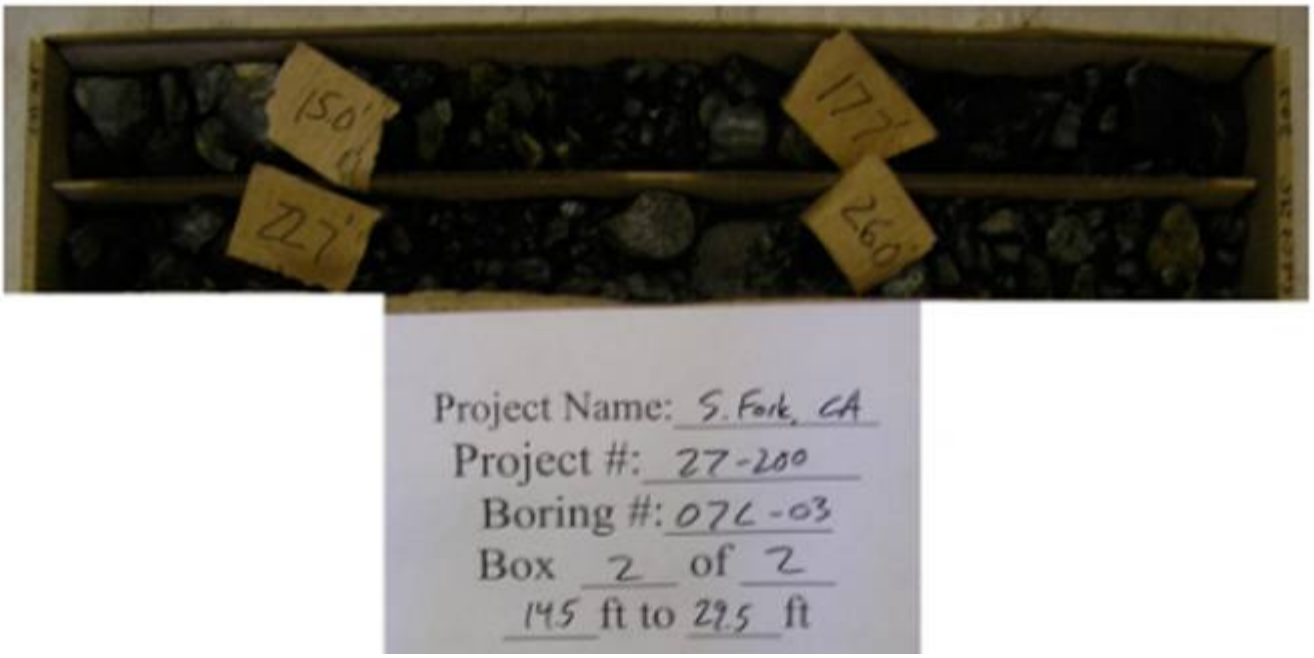
Core Samples from Boring 07C-02, 0.0-26.0’

Core Samples from Boring 07C-02, 26.0’-47.0’

Location of Boring 07C-03



Core Samples from Boring 07C-03, 0.0-14.5’



Core Samples from Boring 07C-03, 14.5’-29.5’

Location of Boring 07C-04

Core Samples from Boring 07C-04, 0.0-17.5’

Site D, looking down station

Site D, looking upstation

Site D, looking down station

Site D, looking upstation

Location of Boring B-D1

Core Samples from Boring B-D1, 0.0-8.5’

Core Samples from Boring B-D1, 8.5’-13.5’

Location of Boring B-D2

Core Samples from Boring B-D2, 0.0-18.5’

Core Samples from Boring B-D2, 18.5’-23.5’

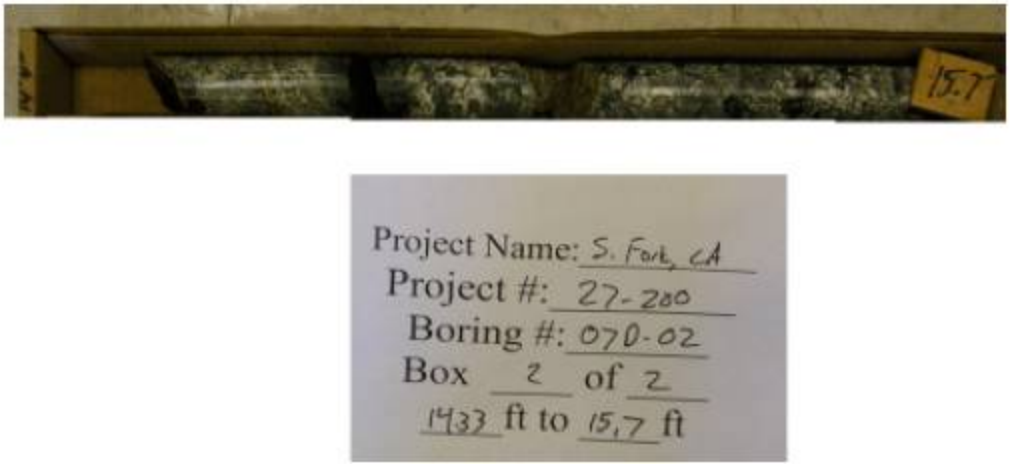
Location of Boring 07D-01

Core Samples from Boring 07D-01, 18.5’-21.6 ’

Core Samples from Boring 07D-01, 21.6'-28.0'

Location of Boring 07D-02

Core Samples from Boring 07D-02, 0.0-14.33’



Core Samples from Boring 07D-02, 14.33’-15.7’

Location of Boring 07D-03

Core Samples from Boring 07D-03, 0.0-7.7’

Core Samples from Boring 07D-03, 7.7’-10.2’