Auburn to Cool Trail Crossing

Feasibility Study

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Tables and Figures

Acronyms and Abbreviations

ACT	Auburn to Cool Trail
APE	area of potential effects
bgs	below the ground surface
BLM	U.S. Bureau of Land Management
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
cfs	cubic feet per second
CHRIS	California Historical Resources Information System
CIP	Cast-in-Place
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
DBE	Design Basis Event
DFG	Department of Fish and Game
DPR	Department of Parks and Recreation
EIR/EIS	environmental impact report/environmental impact statement
ESA	Endangered Species Act
FR	Federal Register
FRP	Fiber Reinforced Polymer
Mw	Magnitude
NCIC	North Central Information Center
NEPA	National Environmental Policy Act
PCWA	Placer County Water Agency
PGA	peak ground acceleration
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
SR	State Route
SRA	State Recreation Area
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

Introduction

Background

The Auburn to Cool Trail (ACT) is a multi-use recreational trail connecting the communities of Auburn and Cool, which are separated by the north fork of the American River. The trail is located within the Auburn State Recreation Area (SRA), managed by the California Department of Parks and Recreation (DPR), and crosses the reach of the river that has been dewatered to allow construction of the Auburn Dam. Since the early phases of dam construction, normal river flows have been diverted through a bypass tunnel, thereby dewatering the channel.

Auburn SRA consists of 26,000 acres of federal lands administered by the U.S. Department of Interior, Bureau of Reclamation (Reclamation) for the Auburn Dam Project. DPR has managed the Auburn SRA since 1977 through a contract with Reclamation. Although the Auburn Dam remains a federally authorized project, its completion has never been funded. In the interim, Reclamation has maintained the tunnel and cofferdams that dewater the historical channel. In 1996, Reclamation officially approved use of the dewatered section of river as a trail crossing for public use. In granting this approval, Reclamation reserved the right to close the crossing at any time to meet the needs and purposes of the Auburn Dam Project and has done so to accommodate ongoing maintenance and construction activities. Presently, Reclamation and Placer County Water Agency (PCWA) are in the final phases of completing a new pump station in the dam construction area and are restoring the channel to its original course. The re-establishment of flow in the restored channel is scheduled for fall 2007 and will bifurcate the existing ACT, cutting off connection to the opposite sides of the channel.

The environmental impact report/environmental impact statement (EIR/EIS) developed for the pump station and channel restoration project identified the loss of the trail crossing as a significant and unavoidable impact on recreation resources. However, Reclamation (acting as the federal lead agency under the National Environmental Policy Act [NEPA]) did not determine that the trail loss required mitigation, and PCWA (acting as the local lead agency under the California Environmental Quality Act [CEQA]) did not have the full authority or responsibility to mitigate the loss of the trail. However, PCWA did commit to providing up to $500,000 toward construction of a crossing if the environmental review for such a project were completed and once the Pump Station project had received all necessary approvals. The California Resources Agency (and DPR) indicated $1 million has been made available for the planning, design and construction of a crossing. This included the completion of feasibility studies. This feasibility study is the part of the State commitment regarding the Auburn to Cool Trail. (Surface Water Resources, Inc. 2001; Montgomery Watson Harza 2006b; Bureau of Reclamation 1992, 2001, 2002, 2006.)

The fundamental decision and broad direction on the general type (new trail using existing bridge, seasonal bridge, permanent bridge) and location of the crossing will be made as part of the development of the new General Plan/Interim Resource Management Plan (GP/IRMP) currently being completed by DPR and Reclamation. This feasibility study will help inform that Plan and the decisions regarding the crossing options. Once the broad decision is made in the GP/IRMP, funding would need to be secured for the project, plans developed and project specific environmental analysis conducted. Reclamation will need to review and approve the crossing option.

Figure 1 provides an overview of the study area. The study area is bounded by the State Route (SR) 49 bridge to the north, the town of Cool to the east, Folsom Reservoir to the south, and the City of Auburn to the west. The figure also identifies the major roadways, and the trail system currently managed by DPR.

Feasibility Study Purpose and Scope

To fulfill their commitment, DPR has commissioned this feasibility study. This study will help DPR identify potential ACT crossings that could be further developed into constructible designs in the future. This study is not intended to be a decision document, but rather is an informational report that considers several factors that would affect the feasibility of a trail crossing. These factors are:

- biological resources,
- cultural resources,
- existing trail connections,
- geotechnical considerations,
- hydrology and hydraulics,
- scour,
- bridge types, and
- existing bridge types.

This document reports the results of the study that investigated potential trail connections to replace the function of the current ACT following the reestablishment of flow in the river. The study considered all current designated trail routes in the study area, as well as new or retrofitted permanent facilities and new seasonal facilities. It is the intent of this feasibility study to determine which alternatives should be considered for further design and analysis based on a number of key criteria and considerations. This feasibility study also identifies the estimated cost to design and construct each potential trail crossing.

The trail crossing will need to serve several types of trail users, including equestrians, pedestrians, and cyclists, that have become accustomed to the trail crossing since 1996. In addition, the study assumes the following: public river access and facilities will be provided at Oregon Bar and the Dam site as part of the Pump Station project; the PCWA pump station and river restoration project will be completed and operational; and Auburn Dam Project remains a federally authorized project which could be built in the future (i.e., the crossing must be compatible with possible dam structure and inundation scenarios).

Study Area Context and Management

The 26,000 acres of the Auburn SRA consist of the federal lands administered by Reclamation which were withdrawn or acquired for the Auburn Dam and Reservoir Project. DPR manages the public use, recreation and resources of these lands through a contract with Reclamation. Over the past decade, annual recreation use at Auburn SRA has been between 500,000 and 1 million visitors.

Sources of Information

The ACT crossing has been studied by others during preliminary phases of the Auburn Dam project and the PCWA pump station project. This feasibility study was initiated through the review of this existing information to determine how much additional data was needed to complete a comprehensive study to review potential crossing sites. Jones & Stokes and DPR worked with Reclamation and PCWA to collect previous report data, geographic information systems (GIS) databases (North Fork Associates 2007), and surveyed topography. Below are some of the key sources of information that served as a starting point for this feasibility study.

- PCWA Pump Station Phase II Design Drawings (Placer County Water Agency 2006).
- DPR ACT Trails Alternatives Cost Estimates (California Department of Parks and Recreation 2005a).
- Auburn Mountain Biking Trails Maps (Sowarwe-Werher 2005).
- Montgomery Watson Harza ACT Crossing Project Feasibility Study (Montgomery Watson Harza 2005a, 2006a).
- PCWA American River Pump Station EIR/EIS (Placer County Water Agency 2001).

Design Considerations

Recreation

Located approximately halfway between Sacramento and Lake Tahoe, Auburn SRA was designated as an SRA in 1979. The North Fork and Middle Fork American River have carved out more than 50 miles of canyons that support oak woodlands on the canyon rims and conifer forests near the water's edge. Auburn SRA provides recreational opportunities year-round and attracts many of its visitors from the greater Sacramento area. Offering a diverse array of cultural, natural, and scenic resources, Auburn SRA supports a significant number of recreational opportunities. Auburn SRA is a widely recognized destination for hiking, mountain bike riding, swimming, boating, fishing, camping, gold panning, off-highway motorcycle riding, and equestrian activities. Whitewater recreation is also very popular on the north and the middle forks of the river, with class II, III, IV, and V runs.

Recreation in the area has increased significantly in the last 10 years. Forty-six percent of Auburn SRA use occurs in the summer months, the most popular of which is July. Overall recreational use of the SRA falls off in the winter months, but increases again in spring. Additionally, based on the 1990 census, the population levels within a 150-mile radius have reached more than 10 million—designating this region as one of the fastest-growing areas in the country. Commensurate with this regional growth, increased demand on Auburn SRA is expected to continue.

When complete, the restoration of the North Fork American River through the dam site will allow for beneficial uses of the river, including recreation, fisheries, and other in-stream uses. As part of the Pump Station/River Restoration Project public access facilities are being provided at the Dam site and Oregon Bar.

Existing Trails and Connections

There are more than 100 miles of hiking, biking, and equestrian trails that wind through the steep American River canyons. The trail system within Auburn SRA supports some of the most popular recreation activities in the area including hiking, mountain biking and horseback riding. Per capita ownership of horses in the region is among the highest in the state. The most well known trail in the SRA is the Western States Trail (WST), which runs 100 miles from Lake Tahoe to Auburn and passes through the SRA. The WST is the location of renowned endurance events including the Tevis Cup endurance ride and the Western States Endurance Run, both of which attract entrants from around the world. Mountain biking use has increased in the region over the past several decades. The Cool Mountain Bike Race occurs within the SRA and is a popular event.

Within the 100 mile trail system are trails designated for separate uses (typically equestrian/pedestrian) and multi-use trails which serve all users. A common issue regarding trail use within the SRA is the conflict (both real problems and perceptions) between equestrians and mountain bikes. Other uses, but in particular mountain bikes, can startle horses. Aspects of these problems include line of sight on trails, trail widths, the speed of mountain bikes, "green" horses and trail etiquette. Some users promote developing more trails which separate users (particularly horses and bikes) and some promote developing more shared use trails (Flink 2001).

In addition to the WST, other popular trails within the SRA include: the Quarry Trail, the Lake Clementine Trail, the Foresthill Divide Loop, the Connector Trail, the Olmstead Loop, the Culvert Trail, the Stagecoach Trail and the Robie Point Firebreak Trail.

Major trail heads include: the Auburn Staging Area on Pleasant Avenue in the City of Auburn; the Confluence located at the old Foresthill Road bridge just above the confluence of the north and middle forks of the American River; the Quarry Trailhead along SR 49 just above the confluence; Foresthill Divide Loop Trailhead(s); and the Knickerbocker Flat trailhead located along SR 49 near the Town of Cool and the entrance to the Olmstead Loop.

The ACT provided a recreational link between Auburn and Cool. The ACT route is a multi-use trail used by pedestrians, equestrians, and mountain bicyclists; it is the only crossing in the SRA downstream of SR 49 for cyclists. Prior to the Pump Station construction activities, annual use of the ACT was estimated at approximately 2,500 to 3,500 users.

The shortest trail distance between Auburn and Cool follows the direct route across the Auburn Dam site. There are 3 miles of 30-foot-wide paved road and 2 miles of gravel road included in the ACT. Beginning at Maidu Drive, a road leads down to the official ACT starting point. Most cyclists prefer to use the paved road and pick up the trail at a later point. Halfway down the Canyon there are connections to the Pioneer Express Trail (to Rattlesnake Bar at Folsom Lake SRA).

The scenery from the trail includes small waterfalls, remnants of stone walls from the Gold Rush, views of large expanses of the lower foothills, and of course the American River. After crossing the riverbed, the trail goes up the hill to the south, winds up and past the old dam construction roads and site along Salt Creek, joins the Olmstead Loop Trail, and meets the paved road in Knickerbocker Flat, ending in the town of Cool near the Northside Fire Station.

As previously noted, the loss of the ACT was a key issue in the Pump Station EIR/EIS. A key concern regarding the issue was that failure to provide a crossing for the ACT, a multi-use trail, would displace mountain bike users onto the WST, which includes the No Hands Bridge (the WST is primarily an equestrian/pedestrian route), and other trails.

Geotechnical

Regional Geologic Setting

The study area is situated in the gently rolling topography that forms the western foothills of the Sierra Nevada. These foothills represent broad tilting of the Sierra Nevada resulting from uplift along the eastern escarpment where much steeper slopes prevail. The Sierra comprise a large, north-south elongated block of Mesozoic granitic terrane forming the backbone of California. Separating the Sierran crystalline basement rocks from the valley sediments is the northwest trending belt of metamorphosed volcanic rocks and sediments forming the western slopes of the Sierra Nevada. These rocks are distributed within three major fault-bounded lithologic terrane that extend along the length of the metamorphic belt. Rocks within these terranes have been isoclinally folded and metamorphosed on a regional scale and represent a "collage" of tectonically accreted blocks emplaced during convergent plate tectonism that occurred during the early Paleozoic and late Jurassic periods. Bedding, foliation and major structural features throughout the metamorphic belt normally trend northwest and dip steeply to the east (Borchardt et al. 1980; Cramer 1978). The site location relative to the regional geology is presented on Figure 2, "Regional Geology."

Regional Faulting and Seismicity

Major or active fault zones of California are generally distant from the study area and include (from west to east as identified by Jennings 1994):

- San Andreas fault zone (historical)—110 miles west,
- Rodgers Creek fault (historical)—90 miles west,
- Coast Ranges–Sierran block boundary zone (historical; blind rupture)—50 miles west, and
- Sierra Nevada frontal fault system (historical)—65 miles southeast.

Because of thee distances from the site, these faults would be expected to generate small to moderate ground shaking in the ACT project area during a major seismic event.

Historical seismicity data, as shown on Figure 3, "Regional Fault and Historic Seismicity," indicates that the majority of large Moment Magnitude (Mw) earthquakes have occurred along the distant faults to the west of the site. The Foothills Fault System traces trending through the project area typically generates earthquakes registering less than 4.9 Mw and occurring less frequently than earthquakes produced on the faults to the west (Bennett 1978) and is confirmed by similar investigations at area reservoirs (The Pacific Gas and Electric Company 1994).

Using the California Geological Survey's interactive website, the potential earthquake ground motion was estimated. A preliminary value of peak ground acceleration (PGA) in hard rock of 0.10g for the Design Basis Event (DBE) was estimated based on regional data. The DBE is defined having a 10% probability of occurrence in the next 50 years.

Regional Groundwater Conditions

The study area is located in canyon with shallow alluvium deposits forming the base of the canyon, and thin soils overlying bedrock forming the canyon slopes. Groundwater conditions in the alluvium along the river channel are expected be near the ground surface. Groundwater in the canyon slopes is expected to consist of fracture flow and perched groundwater near the soil-bedrock contact plane, with gradients toward the bottom of the canyon. Groundwater levels are expected to fluctuate seasonally during longer dry and wet cycles. The California Department of Water Resources Groundwater Data web page (2007) was reviewed for regional groundwater data. However, because this is a bedrock region, no wells with accompanying data were available for review in the Auburn area. Several studies in the project area performed by Kleinfelder have encountered perched and fracture-flow groundwater as high as 10 feet below the ground surface (bgs). Seeps were observed in excavations for the Auburn Dam at depths ranging from near the ground surface to well over 100 feet below the top of the excavation. Seeps were also observed in exposed bedrock along the river embankments within the project area.

Methodology

Previous Investigations

Numerous investigations have been performed for the proposed Auburn Dam, which is located within and north of the proposed bridge locations (Woodward-Clyde 1977a–d). In addition to studies performed for the dam, more recent investigations have been performed for PCWA’s pump station currently under construction and for a previous bridge alternatives location study within the Auburn Dam site. Several of these studies were available and reviewed as part of the geotechnical evaluation completed for this feasibility study.

Aerial Photograph Interpretation

Several aerial photographs of the project area were reviewed as part of this study. The photographs were reviewed to evaluate photolineaments in the project area that might represent faults or persistent discontinuities. The photographs were also used as a tool for mapping the different geologic units within the project area, including different weathering conditions of the bedrock and landslide deposits.

The review did not find any significant lineaments on or projecting toward the selected bridge locations. However, several prominent lineaments were identified on the slopes above the river trending 15 to 35 degrees northwest. Comparing these photolineaments with fault and geology maps of the area, they likely represent shear zones associated with the Maidu fault. In addition to the photolineaments, the aerial photographs provided indications of slope instability features and geologic contacts in the project area that are discussed below in Project Area Geology and presented on the Figure 2.

Geologic Mapping

Geologic mapping was performed for this study along an area that follows the American River from a point approximately 500 feet upstream of the lower diversion outlet at the Auburn Dam site to a distance about 1 mile downstream at Oregon Bar, as shown on Figure 2. Published geologic mapping has been performed in the project area by Wagner (1981) at a scale of a 1:250,000, Kohler (1984) at 1:48:000, and by Reclamation (1977, 1980) at 1:2,400. The Reclamation mapping extended from the north end of the project area (approximately 500 feet north of the lower diversion outlet) to a point about 1,500 feet downstream of the same diversion outlet. Where this map covered the project area it was used as a base map and modified/corrected during mapping performed for this evaluation. Downstream of this point Kohler was used as the base map and again, modified/corrected as necessary.

Naturally Occurring Asbestos

The study area is mapped by the California Geological Survey (CGS) (2006) as being both within an area more likely to contain naturally occurring asbestos (NOA)based on the presence of serpentine and ultramafic rocks and within a zone where faults and shears exist that may locally increase the relative likelihood for the presence of NOA. Mapping by Reclamation (1977) and Kohler (1984) both indicate the presence of serpentine and ultramafic rocks, as well as faults in the region and project area.

Project Area Geology and Structure

Based on mapping by Kleinfelder, and others the project area is underlain primarily by amphibolite, serpentine, and talcose serpentine. Granitic rocks were mapped adjacent to the west and southwest borders of the project area, and numerous small, hard, silica-rich dikes and quartz veins were observed within the project area.

The amphibolite was characterized by light grey and grey-green color, with mineral foliation generally following the regional trend of north-northwest and commonly forming a weakly defined schistose fabric. Larger, more persistent discontinuity type foliation was also common. This foliation also followed the regional trend and dipped steeply toward the southwest and northeast. The serpentine was typically more massive, and grey-green color. Shears within the serpentine resulted in a talc texture/mineralization with a moderately well defined north-northwest foliation.

For the purpose of this study, these rock units were not differentiated during mapping. The intent of this study was to identify areas of rock more suitable for foundation placement based on geologic engineering properties—including rock hardness, weathering, and discontinuities (Wyllie 2004). When a final bridge selection is chosen a site-specific geologic and geotechnical investigation should be performed during which detailed geologic and discontinuity mapping should be performed at that specific location.

Because the rock hardness could be correlated to the degree of weathering, the rocks along the project alignment were mapped based on degree of weathering forming two basic units: decomposed to highly weathered (map symbol bxd-h) and moderately weathered to slightly weathered (map symbol bxm-s). Fresh rock was not encountered during this investigation. Rocks mapped under the more weathered criteria were typically soft to moderately hard and very closely to closely fractured with abundant clay and silt infilling. The moderately to slightly weathered rock unit was typically hard to very hard with wide fracture spacing (greater than 2 feet). Discontinuity aperture width typically ranged from closed to 1 inch wide, with minor clay and silt infilling. It should be noted that exceptions do exist, with discontinuity aperture widths up to 6 inches wide being observed occasionally in this less weathered unit.

Other geologic units mapped within the project boundary included:

- Fill (map symbol ‘f’)—loose to dense silty sand, sandy gravel, and gravel with cobbles and small boulders. Located within the construction zone of the Auburn Dam site only.
- Talus (map symbol ‘t’)—loose gravel to boulder sized rock fragments forming mappable units on the down-slope sides of existing road excavations.
- Active Stream Deposits (map symbol ‘Qas’)—consisting of sand, gravel, and cobbles.
- Alluvium (map symbol ‘Qal’)—loose sand, gravel, cobbles, and boulders up to 24 inches across typically forming bars and embankments next to the active channels.
- Landslide deposits (map symbol ‘Qls’)—generally a heterogenous mix of clay, silt, sand and gravel to boulder size rock fragments exposed along the river embankments. Commonly mapped based on hummocky topography, visible headscarps, and distinct, sharp contact of reddish brown material described above lying unconformably over the bxm-s unit. In some instances a slide plane could be identified. Several bedrock slides were also mapped based on visible headscarps and identified failure planes exposed along the river embankment.

These geologic units are presented on the Project Boundary and Figures 4 through 6.

Five distinct discontinuity sets were identified at the different bridge locations during mapping performed for this study. The average orientation of data representative of these discontinuities is presented below.

- Set A—N23W, 75NE (foliation)
- Set B—N63W, 22SW
- Set C—N18E, 31SE
- Set D—N35E, 51NW
- Set E—N65E, 87SE

These five sets were found to represent two primary structural domains. Sets C and E appear to be confined to the west/north (same) side of the river at Oregon Bar and Upper Outlet Rapid locations. Sets B and D appear more often on the east/south (same) side of the river at the two aforementioned locations as well as at the Existing Crossing at Auburn Dam site. This data suggest there may be a structural control trending through and parallel to the channel in the project area which has resulted in discontinuity sets with different orientations on either side of it. Unlike the joint discontinuities, the foliation was uniform throughout the different bridge sites and sides of the river.

The kinematic stability of these discontinuities was evaluated relative to their orientation of the canyon slopes on which they are exposed. This analysis is discussed in detail in the Markland Kinematic Analysis, included in the complete Geotechnical Investigation Report located in Appendix A.

Hydrology and Hydraulics

This feasibility study did not develop a project-specific hydrology or hydraulic study. PCWA had already investigated the watershed hydrology and channel hydraulics for the design and operation of the pump station that is expected to be operational later this year. The existing hydraulic model is a one-dimensional HEC-RAS model (Placer County Water Agency 2001). The channel geometry in the model included the restored channel section design and up-to-date cross sections upstream and downstream of the pump station site that were surveyed following the New Year's Eve flood of January 2006 (Artic Slope Technical Services, Inc. 2006; Artic Slope Technical Services, Inc. and Bureau of Reclamation 2006; Placer County Water Agency 2006).

Flood flow and low-flow conditions were considered in the HEC-RAS model. Flood flows were used to determine minimum low chord (bottom of deck superstructure) heights. The 100-year flow, as reported in the PCWA HEC-RAS model, is 164,000 cubic feet per second (cfs). Depths calculated at each site varied upstream to downstream but typically were between 40 and 50 feet throughout the project reach.

Low flows were studied to determine expected channel widths and flow depths for seasonal crossings. The Pacific Gas and Electric Company (PG&E) regulates flows in the Middle Fork American River in concert with other PG&E power projects. Typical Middle Fork American River releases at the Oxbow Powerhouse are 150 to 1000 cfs. The North Fork Dam generally discharges at a rate of 30 cfs to 50 cfs in the summer months, however these flow are unregulated. These varied flows would be combined before reaching the new PCWA pump station that will be diverting up to 100 cfs. Given this information, the following low flows were considered:

120 cfs = 150 cfs (MF) + 30 cfs (NF)—60 cfs (pump station)

950 cfs = 1,000 cfs (MF) + 50 cfs (NF)—100 cfs (pump station)

MF = Middle Fork American River; NF = North Fork American River

Scour Analysis

A preliminary scour analysis was performed to determine the expected depth to which the river may erode the soil around a bridges support structure during a flood event. The 100-year flood water surface elevations, average channel velocities and shear stress were used to analyze the scour potential at a typical crossing location. The analysis was performed with HEC-RAS and considered the natural channel contraction and typical bridge pier geometric sizing. There were no available historical channel surveys to determine if a long-term trend for channel aggradation or degradation exists. However, the canyon is generally comprised of shallow bedrock capable of maintaining the channel thalweg near its current elevation over the life span of a potential bridge project.

This scour analysis assumed a homogeneous soil condition to the expected depth of weathered bedrock. It was determined that bridge piers may experience up to 12.8 feet of local scour. Bridge abutments were expected to be constructed above the 100-year water surface elevation and will not be subject to scour. The Preliminary Scour Analysis Report is located in Appendix B.

The predicted depth of local scour can be further refined when a bridge location is selected for construction and a complete geotechnical investigation is completed.

Concurrent Projects

Presently, Reclamation and PCWA are in the final phases of completing a new pump station in the proposed Auburn Dam construction area and restoration of the river channel to its original course. The pump station and related facilities will allow PCWA to convey water from the North Fork American River to the Auburn Ravine tunnel to meet the demands of its service area and mitigate safety concerns associated with the Auburn Dam construction bypass tunnel. Closure of the diversion tunnel and restoration of the dewatered portion of the American River at the proposed Auburn Dam construction site is scheduled for completion in fall 2007. These actions will allow public river recreation use on the reach from the Confluence to the Dam site. This portion of the river has been closed due to the danger of the diversion tunnel.

As part of the Pump Station project, public access facilities are being constructed to allow limited vehicle access into the canyon via Maidu Drive. The primary purpose of these facilities is to provide river access and take-out facilities for the restored river recreation use that will occur on this stretch of river. An entrance station would be constructed at the intersection of Maidu Drive and one of the primary paved construction roads down into the canyon. Just outside of this entrance station, a small paved parking area will be constructed to serve trail users when the entrance station is closed. Trail users currently park at this location, and the parking lot will formalize this use.

A paved parking lot for 53 vehicles, and a restroom, will be constructed at the old cement batch plant site approximately two-thirds of the way down into the canyon. This will be the primary parking area for vehicles. Two river-level turnaround drop-off/pick-up points with handicapped parking spaces will be constructed to provide access for river users picking up equipment—one at the existing construction road crossing in the proposed Auburn Dam site and one at Oregon Bar. Improvements will be made to existing construction roads that will be used as the routes to provide vehicle access to the parking area and turnaround areas. Because trail users in some locations currently use the access roads, parallel trail routes would be constructed as needed to prevent conflicts between vehicles and trail users. Gates and other barriers will be installed along these access routes and parking areas to prevent vehicular access from undesignated areas.

Environmental Constraints

Biological Resources

This section describes the results of the biological constraints analysis. It includes a discussion of study methodology, background information, and biological constraints.

Methodology

A Jones & Stokes biologist reviewed existing information to identify sensitive biological resources that could potentially occur in the proposed project area. The following information was reviewed:

- a California Natural Diversity Database (CNDDB) records search of the Wolf, Lake Combie, Colfax, Gold Hill, Auburn, Greenwood, Rocklin, Pilot Hill, and Coloma U.S. Geological Survey (USGS) 7.5-minute quadrangles (California Department of Fish and Game 2006);

- the U.S. Fish and Wildlife Service (USFWS) list of endangered, threatened, and proposed species for the Auburn 7.5-minute quadrangle obtained from the USFWS website (U.S. Fish and Wildlife Service 2007);
- the soil survey for Placer County, California (Western Part) (Rogers 1980);
- the soil survey for El Dorado Area, California (Rogers 1974);
- the California Native Plant Society's (CNPS's) 2007 online *Inventory of Rare and Endangered Plants of California* (California Native Plant Society 2007); and
- Jones & Stokes file information.

This information was used to develop lists of special-status species and other sensitive biological resources that could be present in the proposed project area.

Biological Communities

The study area is located in the Sierra Nevada foothills along the North Fork American River east of Auburn, California. Elevation ranges from approximately 500 to 700 feet above mean sea level. There are steep canyon walls along the edge of the river and dense vegetation on the slopes above. Five different biological communities are present within the study area: foothill pine/oak woodland, chaparral, annual grassland, riparian, and aquatic.

A large variety of wildlife species breed in oak woodland/foothill pine woodland habitat, although no species is completely dependent on it for breeding, feeding, or cover. Most species using this habitat breed during late winter and early spring (Mayer and Laudenslayer 1988). Oak woodland/foothill pine habitat provides foraging opportunities for a variety of bird species that feed on acorns, bark, and foliage insects. Primarily cavity-nesting birds (e.g., woodpeckers [Picidae family]) excavate nest holes in living and dead trees, which are subsequently used by other cavity-nesting species such as American kestrel (*Falco sparverius*), white-breasted nuthatch (*Sitta carolinensis*), and western bluebird (*Sialia mexicana*). Other species that may occur in this habitat include wild turkey (*Meleagris gallopavo*), oak titmouse (*Baeolophus inornatus*), and western gray squirrel (*Sciurus griseus*).

Mixed chaparral provides habitat for a variety of birds and mammals. Numerous rodents, deer, and other herbivores are common in chaparral communities. Rabbits and hares will eat twigs, evergreen leaves, and bark from chaparral in fall and winter when there is not an abundance of grasses. Shrubby vegetation provides mammals with cover and shade during hot weather and protection from wind in the winter. Chaparral provides seeds, fruits, insects, and protection from predators and the weather in addition to singing, roosting, and nesting sites for many species of birds (Mayer and Laudenslayer 1988). California quail (*Callipepla californica*), Bewick's wren (*Thryomanes bewickii*), wrentit (*Chamaea fasciata*), California thrasher (*Toxostoma redivivum*), black-tailed hare (*Lepus californicus*), brush mouse (*Peromyscus boylii*), dusky-footed woodrat

(*Neotoma fuscipes*), and black-tailed deer (*Odocoileus hemionus***)** are common in chaparral habitats.

Annual grasslands are used by many wildlife species for foraging. Some of these species also breed in annual grassland if special habitat features such as cliffs, caves, ponds, and woody plants are available for breeding, resting, and escape cover. Reptiles that breed in annual grassland habitats include western fence lizard (*Sceloporus occidentalis*), common garter snake (*Thamnophis sirtalis*), and western rattlesnake (*Crotalus tigris*). Grasslands provide foraging habitat for wide-ranging species such as red-tailed hawk (*Buteo jamaicensis*), turkey vulture (*Cathartes aura*), American kestrel, and northern harrier (*Circus cyaneus*). Mammals typically found in this habitat include California vole (*Microtus californicus*), western harvest mouse (*Reithrodontomys megalotis*), California ground squirrel (*Spermophilus beecheyi*), black-tailed hare, coyote (*Canis latrans*), and American badger (*Taxidea taxus*) (Mayer and Laudenslayer 1988). In addition, many species that nest or roost in adjacent woodlands may forage in grasslands, including western bluebird, western kingbird (*Tyrannus verticalis*), and some bat species.

Wildlife use of riparian habitat is dependent on the extent of emergent and submergent vegetation and adjacent streamside (riparian) vegetation. Creek and river channels with well-vegetated areas provide food, water, and migration and dispersal corridors, as well as escape, nesting, and thermal cover for many wildlife species (Mayer and Laudenslayer 1988). Wildlife species associated with stream and riparian habitats include western toad (*Bufo boreas*), California newt (*Taricha torosa*), black phoebe (*Sayornis nigricans*), Anna's hummingbird (*Calypte anna*), great egret (*Ardea alba*), belted kingfisher (*Ceryle alcyon*), raccoon (*Procyon lotor*), and striped skunk (*Mephitis mephitis*). In less-vegetated areas, aquatic species (e.g., fish, invertebrates, and amphibians) are found in the creek and river channels, and the banks of the channel are often used by species that require less cover, such as California ground squirrel, western fence lizard, gopher snake (*Pituophis melanoleucus*), and their predators (e.g., coyotes and raptors).

Special-Status Species

Special-status species are plants and animals that are legally protected under the California Endangered Species Act (CESA), the federal Endangered Species Act (ESA), or other regulations, as well as species considered sufficiently rare by the scientific community to qualify for such listing. For the purpose of this constraints analysis, special-status species include:

- species listed or proposed for listing as threatened or endangered under ESA (*50 Code of Federal Regulations [CFR] 17.12* [listed plants], *50 CFR 17.11* [listed animals], and various notices in the *Federal Register [FR]* [proposed species]);
- species that are candidates for possible future listing as threatened or endangered under ESA (*69 FR 24876*, May 11, 2005);

- species listed or proposed for listing by the State of California as threatened or endangered under CESA (*14 California Code of Regulations 670.5*);
- species that meet the definitions of rare or endangered under CEQA (State CEQA Guidelines Section 15380);
- plants listed as rare under the California Native Plant Protection Act (California Fish and Game Code Section 1900 *et seq*.);
- plants considered by CNPS to be “rare, threatened, or endangered in California” (Lists 1B and 2, California Native Plant Society 2005);
- plants listed by CNPS as plants about which more information is needed to determine their status, and plants of limited distribution (Lists 3 and 4, California Native Plant Society 2005), which may be included as special-status species on the basis of local significance or recent biological information;
- animal species of special concern to the California Department of Fish and Game (DFG) (Remsen 1978 [birds], Williams 1986 [mammals], and Jennings and Hayes 1994 [amphibians and reptiles]); and animals fully protected in California (California Fish and Game Code Sections 3511 [birds], 4700 [mammals], and 5050 [amphibians and reptiles]).

Special-Status Plants

Based on a review of existing information (including a search of the CNDDB [California Department of Fish and Game 2006] and species distribution and habitat requirements data [Bureau of Reclamation 1998; U.S. Fish and Wildlife Service 2007]), the following special-status plant species were identified as having the potential to occur in the proposed project area:

- Jepson’s onion (*Allium jepsonii*);
- Brandegee’s clarkia (*Clarkia biloba* ssp. *Brandegeae*);
- Butte County fritillary (*Fritillaria eastwoodiae*); and
- Oval-leaved viburnum *(Viburnum ellipticum)*.

The status and habitat requirements of each of these species are provided in Table 1. The occurrence of these species in the proposed project area cannot be definitively determined without conducting botanical surveys during the appropriate time of year. The occurrence of these species is likely to be localized and possibly avoidable during the bridge and connector trail design process.

Special-Status Wildlife

Based on a review of existing information (including a search of the CNDDB [California Department of Fish and Game 2006] species lists obtained from the USFWS, and species distribution and habitat requirements data), the following special-status wildlife species were identified as having the potential to occur in the proposed project area:

- California horned lizard (*Phrynosoma coronatum frontale*);
- California red-legged frog (*Rana aurora draytonii*);

- foothill yellow-legged frog (*Rana boylii*);
- northwestern pond turtle (*Clemmys marmorata marmorata*);
- Pacific fisher (*Martes pennanti pacifica*);
- tricolored blackbird (*Agelaius tricolor*); and
- valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*).

Non-special-status migratory birds, including raptors, also have the potential to nest on the project site. Although these species are not considered special-status wildlife species, their occupied nests and eggs are protected under California Fish and Game Code Section 3503 or 3503.5 and the Migratory Bird Treaty Act. The Migratory Bird Treaty Act and Section 3503.5 prohibit the take of migratory birds, nests, and young.

The status and habitat requirements of each of these species are provided in Table 1. The occurrence of these species in the proposed project area cannot be definitively determined without conducting a habitat-based site assessment. Depending on the results of the site assessment, focused surveys may need to be conducted for the species identified as likely to occur. However, based on this preliminary review, there are no substantial biological constraints in the study area.

Table 1. Special-Status Species Identified as having the Potential to Occur in the Project Area

Common and Scientific Name	Status[a] Fed/State	Geographic Distribution	Habitat Requirements	Potential Occurrence in Study Area[b]
SPECIAL STATUS WILDLIFE				
California black rail *Laterallus jamaicensis coturniculus*	–/T	Permanent resident in the San Francisco Bay and east-ward through the Delta into Sacramento and San Joaquin Counties; small populations in Marin, Santa Cruz, San Luis Obispo, Orange, Riverside, and Imperial Counties.	Tidal salt marshes associated with heavy growth of pickleweed; also occurs in brackish marshes or freshwater marshes at low elevations	No suitable habitat within the project area.
California horned lizard *Phrynosoma coronatum frontale*	–/SSC	Sacramento Valley, including foothills, south to southern California; Coast Ranges south of Sonoma County; below 4,000 feet in northern California.	Grasslands, brushlands, woodlands, and open coniferous forest with sandy or loose soil; requires abundant ant colonies for foraging	Potential habitat may be present within the project area.
California red-legged frog *Rana aurora draytoni*	T/SSC, P	Found along the coast and coastal mountain ranges of California from Marin County to San Diego County and in the Sierra Nevada from Tehema County to Fresno County.	Permanent and semipermanent aquatic habitats, such as creeks and cold-water ponds, with emergent and submergent vegetation. May estivate in rodent burrows or cracks during dry periods.	Suitable habitat may be present in tributaries near the project area.
Foothill yellow-legged frog *Rana boylii*	–/SSC, P	Occurs in the Klamath, Cascade, north Coast, south Coast, Transverse, and Sierra Nevada Ranges up to approximately 6,000 feet.	Creeks or rivers in woodland, forest, mixed chaparral, and wet meadow habitats with rock and gravel substrate and low overhanging vegetation along the edge. Usually found near riffles with rocks and sunny banks nearby.	Suitable habitat may be present. However, there are no recorded occurrences within 5 miles.
Northwestern pond turtle *Clemmys marmorata marmorata*	–/SSC	Occurs from the Oregon border of Del Norte and Siskiyou Counties south along the coast to San Francisco Bay, inland through the Sacramento Valley, and on the western slope of Sierra Nevada.	Occupies ponds, marshes, rivers, streams, and irrigation canals with muddy or rocky bottoms and with watercress, cattails, water lilies, or other aquatic vegetation in woodlands, grasslands, and open forests	Suitable habitat may be present. However, there are no recorded occurrences within 5 miles.
Pacific fisher *Martes pennanti pacifica*	–/SSC	Coastal mountains from Del Norte County to Sonoma Counties, east through the Cascades to Lassen County, and south in the Sierra Nevada to Kern County.	Late successional coniferous forests and montane riparian habitats	Suitable habitat may be present. However, there are no recorded occurrences within 5 miles.

Common and Scientific Name	Status[a] Fed/State	Geographic Distribution	Habitat Requirements	Potential Occurrence in Study Area[b]
Tricolored blackbird *Agelaius tricolor*	–/SSC	Permanent resident in the Central Valley from Butte County to Kern County. Breeds at scattered coastal locations from Marin County south to San Diego County; and at scattered locations in Lake, Sonoma, and Solano Counties. Rare nester in Siskiyou, Modoc, and Lassen Counties.	Nests in dense colonies in emergent marsh vegetation, such as tules and cattails, or upland sites with blackberries, nettles, thistles, and grainfields. Habitat must be large enough to support 50 pairs. Probably requires water at or near the nesting colony	Suitable habitat may be present. However, there are no recorded occurrences within 5 miles.
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	T/–	Stream side habitats below 3,000 feet throughout the Central Valley.	Riparian and oak savanna habitats with elderberry shrubs; elderberries are the host plant	Potential habitat may be present within the project area.
Vernal pool fairy shrimp *Branchinecta lynchi*	T/–	Central Valley, central and south Coast Ranges from Tehama County to Santa Barbara County. Isolated populations also in Riverside County.	Common in vernal pools; also found in sandstone rock outcrop pools	No suitable habitat within the project area.
White-tailed kite *Elanus leucurus*	–/FP	Lowland areas west of Sierra Nevada from the head of the Sacramento Valley south, including coastal valleys and foothills to western San Diego County at the Mexico border.	Low foothills or valley areas with valley or live oaks, riparian areas, and marshes near open grasslands for foraging	Unlikely to occur in project area.
SPECIAL STATUS PLANTS				
Jepson's onion *Allium jepsonii*	–/–/1B.2	Sierra Nevada foothills in Butte County; 1 disjunct population in Tuolumne County.	Serpentine or basalt outcrops in oak woodland and lower montane coniferous forest; 300–1,160 meters	May occur within the project area. Project is within elevation range and has the correct soil type.
Brandegee's clarkia *Clarkia biloba* ssp. *brandegeae*	–/–/1B	Northern Sierra Nevada foothills from Butte to El Dorado Counties.	Chaparral, cismontane woodland, often on roadcuts at 295–885 meters	May occur within the project area. Project is within elevation range and has the correct soil type
Butte County fritillary *Fritillaria eastwoodiae*	B/B/3	Sierra Nevada foothills, from Shasta to Yuba Counties.	Chaparral, cismontane woodland, openings in lower montane coniferous forest, sometimes on serpentine at 50–1,500 meter [Oak woodland, grassy openings in chaparral, and Ponderosa pine forest]	May occur within the project area. Project is within elevation range and has the correct soil type

Common and Scientific Name	Status[a] Fed/State	Geographic Distribution	Habitat Requirements	Potential Occurrence in Study Area[b]
Oval-leaved viburnum *Viburnum ellipticum*	–/–/2.3	Northwest California, San Francisco Bay Area, north and central Sierra Nevada foothills: Contra Costa, El Dorado, Fresno, Glenn, Humboldt, Mendocino, Napa, Placer, Shasta, Sonoma Counties; also Oregon, Washington.	Chaparral, cismontane woodland, and lower montane coniferous forest; 215–1400 meters	May occur within the project area. Project is within elevation range and has the correct soil type

[a] Status explanations:

Federal

E = listed as endangered under the federal Endangered Species Act.
T = listed as threatened under the federal Endangered Species Act.
PT = proposed for federal listing as threatened under the federal Endangered Species Act.
C = species for which USFWS has on file sufficient information on biological vulnerability and threat(s) to support issuance of a proposed rule to list, but issuance of the proposed rule is precluded.
SC = species of concern; species for which existing information indicates it may warrant listing but for which substantial biological information to support a proposed rule is lacking.
– = no listing.

State

E = listed as endangered under the California Endangered Species Act.
T = listed as threatened under the California Endangered Species Act.
FP = fully protected under the California Fish and Game Code.
SSC = species of special concern in California.
– = no listing.

[b] Potential Occurrence in the Study Area

High: Known occurrences of the species within the study area or California Natural Diversity Database, or other documents, records the occurrence of the species within a 10-mile radius of the study area. Suitable habitat is present within the study area.
Moderate: California Natural Diversity Database, or other documents, records the known occurrence of the species within a 10-mile radius of the study area. Poor quality suitable habitat is present within the study area.
Low: California Natural Diversity Database, or other documents, does not record the occurrence of the species within a 10-mile radius of the study area. Suitable habitat is present within the study area.

Cultural Resources

On March 12, 2007, a Jones & Stokes archaeologist conducted a records search at the North Central Information Center (NCIC) branch of the California Historical Resources Information System (CHRIS) at Sacramento State University. The records search included previous studies, previously recorded sites, Placer and El Dorado Historical Resource Index, and historic maps and General Land Office maps (GLOs). According to the records search, no cultural resources studies have been conducted within the study area. The records search indicated that the following cultural resources studies have been conducted directly adjacent to the study area:

- D. L. True and H. Crew. 1976. Archaeological Surveys Auburn-Folsom Knickerbocker Tract Part II. (6813).
- Peak & Associates, Inc. 1988. Cultural Resource Assessment of the Proposed Canyon Rim Estates, Placer County, CA. (5963 V.I).
- M. A. Peak. 2005. Determination of Eligibility and Effect for the Proposed Canyon Rim Estates Project, Placer County, California (5963, revised report).
- U.S. Department of the Interior, Bureau of Reclamation. 2001. An Archaeological Inventory of Placer County Pump Station/River Channel Restoration—American River Canyon/Auburn Dam Site, Placer and El Dorado Counties, California. (*In* NCIC Backlog).

The records search also indicated that no previously recorded cultural resources are located within or adjacent to the study area. This is typically the case for areas that have not been subjected to pedestrian archaeological surveys.

Overall, the area is highly sensitive for both prehistoric and historical resources. Native American groups have lived in the area for nearly 8,000 years as is evidenced by prehistoric and ethnographic Nisenan village sites throughout the American River canyon as well as other lesser prehistoric sites. The American River canyon also saw a high amount of activity during the gold rush era, as is evidenced by mining camps and multiple other historical sites associated with mining activities. It is recommended that a formal cultural resources study, including historic background research, Native American consultation, and a pedestrian archaeological survey, be conducted prior to any ground-disturbing activities.

The entire study area has to the potential for a proposed trail and crossing construction project to encounter cultural resources. Based on the design team's initial site visits there are several visible features located throughout the site including but not limited to; abandoned bridge foundations, abandoned bridge sections, abandoned flume sections, and abandoned mining operations. In addition, any proposed project in the Auburn Dam construction area will have the lowest potential to encounter cultural resources due to the extensive construction activities that has already occurred.

Bridge Design Characteristics

Bridge Types

The project team collected and reviewed information on several potential bridge types that could be implemented in a future design project. A large variety of types and technologies were considered from time-tested and trusted steel trusses and suspension alternatives to lightweight concrete and fiber reinforced polymer (FRP) spans. Each was considered for suitability in application, constructability, site access, cost, maintenance, and trail user safety. Following these simple criteria, the project team put forth the most feasible options for future consideration. The ACT crossing will require that any bridge selected for the project be able to provide a clear path of 12 feet to accommodate multiple users simultaneously. It should be noted that this criteria is less than the 15-foot width available on the No Hands Bridge. Described below are all the bridge types considered, both permanent and seasonal.

Permanent Bridge Types

As with any project that considers a bridge, several types, technologies, and materials are available and should be considered in the feasibility phase of the project. After the initial review of the study area, 8 bridge types were selected for consideration. These types had the potential to provide the necessary crossing and safely span the river.

Cast-in-Place (CIP) Reinforced or Pre-Stressed Concrete Box Girder

This type of bridge is the most commonly used structure type for highway bridges in California and for mid-range span lengths (80–250 feet). They are frequently the least expensive to build and always a prudent baseline against which to measure other bridge types. However, because of the difficulty in accessing the canyon, the need for construction of piers and multiple spans, and construction falsework a CIP box girder would be unlikely to be cost-effective for the ACT pedestrian bridge design. Due to expected costs, span requirements, and construction requirements this bridge type was not considered in the final feasibility analysis.

Precast Concrete I-Girder or Box Girder

Precast concrete girders are generally shipped in segments measuring up to 120 feet. This would require at least three spans when considering sites in the study area and therefore piers in the channel. The difficult construction access to the potential sites would limit the shipping length and increase the cost. Erection of these girders would require one or more large cranes either in the riverbed or on both sides of the river (or a temporary construction trestle). Due to expected cost and construction requirements this bridge type was not considered in the final feasibility analysis.

Steel Girder

Steel girder spans supporting concrete deck slabs are rarely cost competitive for highway or pedestrian bridges in California. In this situation, they share many of the same drawbacks as the aforementioned concrete bridge types. However, as noted above, the location and site constraints of these potential crossing locations provide circumstances under which steel girder spans may be more competitive. Steel girders can be shipped more easily in shorter lengths. To reduce the effective span lengths and therefore the overall structure depth, a strutted girder concept was developed and carried through the preliminary alternative stage.

Prefabricated Steel Truss

This type of structure is often the most economical choice for pedestrian/trail bridges. A typical example is shown in Figure 7. Numerous manufacturers readily detail and produce them in a variety of configurations. Typically, the manufacturer will provide the detailed design for the superstructure, with a local engineer specifying the design requirements and designing the substructure. A prefabricated steel truss would require multiple spans at the sites located in the study area. In addition to typically being an economical choice, these bridges have the advantage of low structure depth (below the deck), a small vertical surface area that limits wind and streamflow forces, relatively high stiffness (compared to cable-supported bridges), and a tendency to promote a feeling of safety for users since the truss also serves as the railing along the walkway. While these shipping pieces are relatively light, they are quite bulky and may be difficult to truck to the site on the recreation area's access roads. The structure can be provided with a variety of finishes, allowing the designer to blend the structure into the canyon setting. A preliminary prefabricated truss was considered at each of the alternative sites.

Steel or Concrete Arch

Arch bridges are often well-suited aesthetically to canyon crossings because they complement the shape of the canyon. For high-level crossings of steep-walled canyons, they can often be constructed without temporary falsework, providing them with a competitive advantage over other bridge types in such locations. However, arches tend to be rather expensive if other alternatives are feasible. In this case, because the canyon is somewhat V-shaped and the desired crossing elevation is near the river level, a deck arch (with the walking /riding surface above the arch) would require a much longer span than some other bridge types that could be set just above the elevation required to provide the needed freeboard for floodwaters. A through arch, in which the deck hangs from the arch, creates an odd aesthetic combination with the shape of the canyon. Due to expected cost, flood requirements, and aesthetics this bridge type was not considered in the final feasibility analysis.

Stress Ribbon

Stress ribbon bridges have the general form of the familiar old “swinging” suspension bridges occasionally found on trails even today, but make use of modern materials and technology. They consist of pre-cast concrete deck segments supported on cables spanning the river and post-tensioned for stiffness and continuity. Stress ribbon bridges have several very attractive features for sites such as the ones being considered in this study. These include: minimal structure depth (15 to 24 inches), resulting in a structure that easily blends into the background from a distance, the ability to clear-span the channel, minimal construction impacts (no need for falsework or large cranes within the river channel), segmental construction that employs relatively small precast concrete elements, and surprising stiffness because of the post-tensioning of the deck. While the stress ribbon bridge has certain aesthetic advantages over most other bridge types—a gently curving and nearly transparent form that blends well into a natural setting and mimics the shape of the valley below, its characteristic sag may be displeasing for some observers and unsettling to some users who may be more comfortable on a bridge with a more traditional flat or arched profile and a more rigid appearance. The structural challenge of the stress ribbon is the very large magnitude of lateral forces that must be resisted by the abutments. Typically this involves rock anchors and/or a massive concrete abutment. For longer spans, there is a trade-off between running grade (slope from the center of the bridge deck to the deck at the abutment or end) and abutment forces; in order to limit the running grade to acceptable levels, the sag must be minimized, but the lower the sag, the more lateral force must be resisted at the abutments, thus driving up the cost of the bridge. Competent rock near the surface is a key requirement for stress ribbon bridges; otherwise, the abutment costs become very high. The sites being considered generally have geotechnical characteristics favorable for the construction of a stress ribbon bridge. One down side of a stress ribbon bridge is that it is a relatively new structure type, with which most contractors are unfamiliar (although the basic elements—precast concrete, post-tensioning, rock anchors—are all separately fairly common). This may lead to cautious bidders and high prices. An example of a stress ribbon bridge is shown in Figure 8. A preliminary stress ribbon bridge was considered at each of the alternative sites.

Suspension (with or without Towers)

There is a long history of suspension bridges for trail crossings, both in California and worldwide. Traditional trail suspension bridges with spans of up to several hundred feet have been built using either steel or timber stiffening trusses. They have the advantage of being able to be constructed in remote locations using local materials and/or small structural elements that can be packed in by mule or flown in by helicopter and erected with light equipment. They can be rather economical. They also often have a “rustic” look that fits well into the backcountry. However, suspension bridges with timber trusses are prone to experiencing stiffness degradation as a result of loosening of the timber joints under repeated loadings. This can lead to an uncomfortable trip for users, especially equestrians. Even with a light steel stiffening truss, these bridges can be unpleasantly lively under equestrian loading because of the high ratio of live to dead load and limited inherent damping. One recent solution to this problem has been to use a composite stiffening truss with structural steel chords and timber web members (verticals and diagonals), eliminating the most troublesome wood-to-wood joints. Another relatively recent development for pedestrian bridges is to use a post-tensioned segmental concrete deck instead of a stiffening truss. In this configuration, the weight of the concrete deck combined with the post-tensioning of the deck (and in some cases, anchoring it to the abutments as in a stress ribbon) provides added stiffness with a much more streamlined horizontal form.

For the sites under consideration, a suspension bridge could be built with traditional towers and cable anchorages, or with no towers and the cables anchored directly to anchor blocks embedded in the walls of the canyon. The latter option would eliminate the cost of the towers and minimize the visual impact of the bridge. Like stress ribbon bridges, suspension bridges are relatively uncommon and are likely to result in cautious bids. Examples of suspension bridges are presented in Figures 9 and 10. A preliminary suspension bridge was considered at each of the alternative sites.

Cable-Stay (with a Superstructure of Steel or Concrete or with a Steel Stiffening Truss)

Cable-stayed bridges have become the most common long-span bridge type in the past few years. This has trickled down to pedestrian bridges as well, with some very notable signature pedestrian cable-stayed bridges having been built (the most notable being the Sundial Bridge in Redding). Cable-stayed bridges can be very economical for longer spans, but they are most efficient when they have span arrangements that roughly balance the suspended spans. A typical case would be a three-span bridge with the two side spans each being approximately one half as long as the main span. Aesthetically, cable-stayed bridges are more dominant than suspension bridges because they have taller towers and a larger number of “main” cables, often at various angles and spacing. A cable-stayed truss is a relatively cost-effective way to extend the effective range of the prefabricated truss beyond 250 feet to about 450 feet. To minimize cost, this requires a three-span bridge with side spans roughly equal in length to one half of the main span. In order to do this at the locations under consideration, both the towers would have to be in the river channel, partially negating the benefits of using a cable-stay bridge and making it less advantageous for the sites with shorter crossings, such as Oregon Bar. A rough cost estimate was developed for the longer span at the Lower Outlet Rapid site and it was determined this bridge type would not be cost competitive in the study area. Due to cost and the need for piers in the channel this bridge type was not considered in the final feasibility analysis.

Seasonal Bridge Types

Unlike bridge crossings that provide year round access, a seasonal alternative can provide a lower upfront capital cost solution for a trail crossing. These can be either temporary seasonal bridges, which are installed and removed annually, or permanent seasonal bridges, which may be unusable during certain seasons. However, with seasonal bridges, maintenance becomes a larger consideration over the life span of the bridge. During the initial site visits and preliminary investigation of bridges, four bridge types emerged as having potential for use in the study area.

Low-Level Bridge

This would consist of a multi-span steel or concrete bridge that would be only high enough to pass typical summer flows and rafters, and would be designed to withstand the full force of the design flood while submerged. This would consist of either a reinforced or pre-stressed concrete I-girder or box-girder bridge, or a steel girder trestle, designed to pass high flows with as little disturbance as possible. Railings would be designed to be removed or folded down to prevent debris buildup and damage under high flows. Figure 11 presents an example of this concept at the “Jim Jones” bridge across the lower American River downstream of Sunrise Boulevard near Fair Oaks, California. This scheme has several potential problems. First, being below the design high water surface elevation, the ends of the bridge would be subject to routine inundation, making them extremely prone to scour problems. Second, the low-level bridge presents a potential hazard for rafters during transitional flows. Third, annually it would be subject to flood damage and may have exceptionally high maintenance costs. Because of the risk associated with the bridge being a potential hazard at transitional flows and associated maintenance costs, this bridge type was not considered in the final feasibility analysis.

DPR Standard “Pipe Bridge”

Figure 12 illustrates the temporary pipe bridge concept. DPR currently has more than a dozen of these bridges in service that are installed each spring and removed each fall. According to DPR personnel, a crew of 10 can install or dismantle up to 300 feet of pipe bridge in 1 day using hand tools. These bridges are only 3 feet wide and therefore accommodate hikers and mountain bicyclists, but not equestrians, who would be accommodated via a nearby ford. Pipe bridges consist of 8-foot sections of wood-framed decking supported by steel pipes driven into the river channel. The vertical profile of the bridge can be adjusted by using longer pipes to accommodate rafters underneath, although the 8-foot spans are fairly narrow for boaters to navigate. DPR personnel report no problems on the Eel River, where a seasonal pipe bridge crosses a rafting run. Pipe bridges can be used only where water depths are approximately 3 feet or less. They do not require abutments of any sort (other than anchors for the cable railing), but rather start with a step up onto the bridge. The relative expense of this bridge type and the limited construction equipment requirements for installation give this bridge type a great advantage when considering feasible alternatives. It should be noted that additional investigation may be warranted to determine the ease of installation at any proposed location to verify pipes can be manually driven into the substrate. This bridge type was considered in the final feasibility analysis.

"Bailey" (Modular Steel Truss) Bridge

DPR also uses "Bailey" or modular bridges for temporary seasonal crossings at several locations. Like the pipe bridges, these are installed and removed each year. They can either be removed or installed as a unit using a crane, excavator, or backhoe, depending on size, or dismantled in sections using smaller equipment. They do, however, require construction of abutments, typically using concrete pipe in conjunction with modular retaining walls and backfill. These bridges can be designed to accommodate all trail users, as well as vehicles, but they require the annual installation of abutments as well. A suitable nearby area outside of the 100-year floodplain must be found for storage of the bridge materials.

A Bailey bridge may be appropriate at the Existing Crossing. However, the HEC-RAS modeling indicates a top water surface width of approximately 170 to 180 feet for a high summer flow of 1,000 cfs. This would require at least a two-span bridge and permanent or temporary substructure near the middle of the channel. Due to the competitive advantage of other similar bridge types this bridge type was not considered in the final feasibility analysis.

FRP Truss

An FRP bridge would be installed each spring and removed each fall (either as a unit or disassembled). Similar to a modular bridge, an FRP bridge can be designed for all trail users (or just mountain bikers and hikers) and can span up to about 100 feet. These bridges can be assembled on site with small tools or delivered in one piece. Their major advantage is that they are very light (about 4 tons for a 50-foot-by-8-foot bridge with timber decking) and not susceptible to corrosion or rot. Their span length is limited to about 80 feet for equestrian loading (because of vibration concerns) and 100 feet for pedestrians and cyclists only. Figure 13 shows an 80-foot FRP trail bridge in Redwood National Park, California. At the Existing Crossing site, it is likely that two intermediate piers would be required to span the restored channel. These would likely consist of stackable, modular concrete units placed and removed annually with a back-hoe, excavator, or small crane. This bridge type was considered in the final feasibility analysis.

Bridge Loading and Design Features

Design Loads and Design Guidance

All bridges considered in this study are subject to design loads and seismic loads as required by local jurisdictions and review agencies. Several references that provide relevant design guidance for the project area were reviewed and considered while assessing potential crossings. These references are listed below.

- Guide Specifications for Design of Pedestrian Bridges (American Association of State Highway and Transportation Officials 1997).
- AASHTO LRFD Bridge Design Specifications (American Association of State Highway and Transportation Officials 2004).
- Steel Construction Manual (American Institute of Steel Construction 2005).
- Bridge memos to Designers (California Department of Transportation 2006a).
- California Amendments, v3.06.01 to the AASHTO LRFD Bridge Design Specifications (California Department of Transportation 2006b).
- Highway Design Manual (California Department of Transportation 2006c).
- Seismic Design Criteria (California Department of Transportation 2006d).
- Bridge Plans fot the Auburn to Cool Trail Crossing Project (Montgomery Watson Harza 2005b).
- Preliminary Bridge Plans for the Auburn to Cool Trail Crossing Project (Montgomery Watson Harza 2005c).
- Stress Ribbon and Cable Supported Pedestrian Bridges (Straski 2005).

Streamflow

Any portion of a permanent structure within the 100-year floodplain is designed for streamflow forces associated with 100-year flood considering full scour. Footings on rock will be set below the maximum computed scour depth or protected from scour.

Seasonal bridges are designed to resist streamflow forces associated with the expected flows during the periods when the bridge is expected to be in place.

Freeboard

Freeboard is the distance between the top of the water surface and the low chord (soffit) of the bridge deck. For purposes of the feasibility analysis, permanent bridge alternatives were sited to provide 2 feet minimum freeboard above the 100-year water surface elevation. During final design, a detailed hydraulic analysis of the chosen site will be performed, at which time it will be determined if unusually large debris flows are expected. If so, a greater freeboard may be required.

Accessibility

Design for accessibility is per the *California State Parks Accessibility Guidelines (Accessibility Guidelines)* (California Department of Parks and recreation 2005b). The major consideration for preliminary bridge design is running grade. Because the crossing project is on a multi-use trail, it must meet the less-stringent guidelines for trails, rather than those for exterior routes of travel. The accessibility guidelines have four grade running criteria that must be met for trails:

- Trails may have a running slope of 5.00% or less for any distance.
- Trails may have a running slope between 5.10 and 8.33% for a distance of up to 200 feet between level landings.
- Trails may have a running slope between 8.34 and 10.00% for a distance of up to 30 feet between level landings.
- Trails may have a running slope between 10.10 and 12.00% for a distance of up to 10 feet between level landings.

Other accessibility considerations not expected to control the bridge design include cross slope, tread width, vertical and lateral clearance, surface details, and edge protection.

Safety Railing

For permanent bridge alternatives, railings will meet design requirements (loads, configuration, and height) for cyclists and meet accessibility requirements. Consideration will also be given to equestrian safety.

Alternatives Analysis Criteria and Development Process

There are several crossing location, bridge type, and trail connection possibilities when considering the ACT. This study reviewed available information, identified feasible crossing locations, reviewed potential bridge types, and created feasible combinations.

These alternatives were then analyzed to determine:

- their suitability in servicing the trail users,
- constructability within the confines of the canyon, and
- the estimated costs based on the best available information.

Based on the information provided in previous sections on design considerations and characteristics, the discussion below describes the criteria and the process applied for alternative development.

Study Area Use Constraints

The first step in this process was identifying DPR's need to maintain the ACT after the natural river course was restored and the existing crossing was removed. Through discussion with DPR and Reclamation, the project team determined that potential crossing alternatives must recognize the fact that the Auburn Dam one day may be constructed and the trail alignment should strongly consider locations that would not be affected by potential dam activities. Therefore, efforts to locate a new permanent bridge were focused in the area of the canyon from below the authorized Auburn Dam site downstream to the Folsom Reservoir pool limits. Only temporary seasonal bridge options were considered for the existing crossing location, which is within the dam site. The study area also includes sites upstream of the Auburn Dam site, where SR 49 and No Hands Bridge already span the river channel.

Geologic Considerations

With the area identified, the next logical step was to investigate the geologic aspect and determine where a crossing could be sited. The geologic formation of the canyon has a few competent rock formations surrounded by several less stable sections. Areas subject to slippage were quickly identified and eliminated from further consideration. Sites with apparent stability and suitable rock were reviewed more closely and ranked to determine preferred geologic locations for placement of approach trails and bridge abutments.

The preliminary geologic review of the project area focused on six potential sites that are shown in Figure 14:

- Existing Crossing at the Auburn Dam Site
- Tunnel Outlet
- Upper Outlet Rapid
- Lower Outlet Rapid
- Knickerbocker Canyon
- Oregon Bar

After further investigation, it was determined that the Existing Crossing (temporary seasonal bridge), the Upper Outlet Rapid Crossing, and Oregon Bar should be prioritized. These three sites are expected to require less mitigation of discontinuities, less grading for approaches and foundation pads, have shallower depths to bedrock, and less likely to be impacted by slope stability issues associated with the surrounding terrain.

Plan and profiles of these three final locations showing the geologic and structural conditions were presented on Figures 4 through 6.

Channel Geometry and Hydraulics

Suitable locations were investigated further to determine the expected flood flow characteristics. Using numerical hydraulic models that had been developed previously for the PCWA pump station design, the ACT project team was able to determine various flood flow water surface elevations, channel velocities, channel bank shear stress, and local scour potential. This information established the required height and length of proposed permanent bridge spans.

A low-flow analysis was also completed. Using historical flow information and expected operations of upstream PG&E facilities and PCWA's pump station, a seasonal (summertime) flow regime was determined. This information was included in additional hydraulic modeling runs to determine channel depth and width. These data helped to establish suitable locations for seasonal crossings (removable bridges and in-channel fords).

Bridge Type

Each location that showed the potential for geologically stable foundation material was paired with the bridge types described above. Each type was considered for its potential to span the river with or without piers, aesthetics, trail user stability, constructability, and potential cost. It was also recognized that nearly any bridge type could be fit to any location, but in an effort to develop a focused group of alternatives, the most likely bridge type was selected for each location that was analyzed. Given the available funding for a future design and construction project, multiple bridge types should be reviewed at the selected location.

Trail Connectivity

The ACT is a popular trail route that users have come to rely upon for recreation. Maintaining its connectivity is the driving force behind this entire project. While the current alignment serves the community, the location of this trail was not considered fixed when developing crossing alternatives. Based on available topography, trail alignments were considered to provide connectivity as close as possible to the current ACT. In some instances, these alternative routes would require substantial distances of new trail construction and potentially land acquisition. However, these connections will allow the DPR to maintain an ACT after the river corridor is restored.

Trail Design

All trail connections to the ACT crossing are expected to support the multiple trail users needs. For the purposes of this study, DPR directed the design team to assume that trail sections and crossing approaches would need to support a 60-inch tread width. Complete analysis of existing slope and cut-fill requirements and quantities were not developed for this study. It was determined that field layout and staking will be required and would be part of future design efforts. Instead, potential trail alignments were developed with the best available regional topographic data, selecting routes that appear to meet design criteria or will require the least amount of construction to meet the criteria.

Public Involvement

Through this process, our project team has coordinated with the public to ensure their concerns are available for the project teams' consideration. Through a public outreach program, the entire project team was able to meet with the public, hear comments and concerns firsthand, and provide immediate answers to specific questions. This interaction has shaped the feasibility study to focus on trail user needs as a priority. These needs, concerns, and comments that were considered by the project team have helped to determine potential bridge types, trail construction options, expanded use of the trail system and connections to other downstream points, seasonal crossing opportunities, and multi-use trail safety.

Summary of Comments Received for Auburn to Cool Feasibility Study Meeting

More than 100 people attended the March 27, 2007, meeting about the ACT crossing feasibility study. As part of that effort more than 60 comments were submitted to Jones & Stokes and DPR, each with different specific concerns.

Equestrians were the largest group in attendance at the meeting and submitted the greatest number of comments.

Although opinions differed as to which alternative crossing would be most favorable, the majority of the equestrians commenting expressed a strong dissatisfaction for use of SR 49 or the No Hands Bridge as a multi-use crossings. Overcrowding and safety risks between horses and cyclists were the greatest concern. Some mountain bike users expressed support for the concept of constructing a multi-use trail utilizing SR 49 or the "No Hands" bridge as a crossing option. Additionally, many people expressed that a "no build" alternative was not considered acceptable.

Of those comments that discussed a particular bridge type, most expressed the need for a permanent bridge as opposed to a seasonal bridge, noting recreational users are often more active in cool winter months to avoid intense summer heat. While there were various opinions as to which alternative is best, the most frequently preferred locations were a crossing at the Oregon Bar site, a crossing near the existing pump station site, and a crossing closest to where the current ACT crossing is located. Some comments noted that most horses could safely ford the river in 3 feet of water if reasonable footing is provided. The majority of comments said safety was of the utmost importance. Many comments reflected the desire for more signage with regard to trail etiquette, specifically pertaining to the way in which cyclists and equestrians should safely interact on the shared trails. Because the majority of the comments came from equestrians, a common thread from these users is the desire for trails separating use to avoid the potential for a horse to become surprised or uneasy by the rapid approach of cyclists, or by a swaying "unstable" bridge structure. Additional comments regarding public preference for crossing type and location have been received by DPR as part of the planning process for the new General Plan/Interim Resource Management Plan being developed for Auburn SRA.

Description of Alternatives

Utilizing the criteria described above, the design team was able to evaluate the project area and determine several feasible crossing locations. Based on the design team's preliminary recommendations (Appendix C) and through discussions with DPR, the field of possible crossings alternatives was reduced. The intent was to provide a focused range of feasible alternatives that would include permanent and seasonal crossings and the use of existing facilities where possible.

Four permanent crossings and two seasonal crossing alternatives are discussed below. These alternatives have the greatest potential to provide DPR with enough information to secure additional funding and move forward with a future project to design and construct the ACT crossing.

Permanent Crossings

Existing Facilities Considered

Two bridges in the project area cross the North Fork of the American River and have the potential to provide a multi-use ACT crossing, SR 49 and “No Hands Bridge” (Mountain Quarries Bridge).

State Route 49 Bridge

The SR 49 Bridge, shown in Figure 15, crossing over the North Fork American River provides a vehicular crossing just downstream of the confluence of the middle and north forks. Three alternatives were considered for use of the existing SR 49 Bridge for cyclists and pedestrians: (1) use existing shoulders, (2) widen existing bridge, and (3) construct an adjacent prefabricated truss supported from the existing bridge or on independent substructure.

Using the existing shoulders would require:

- re-striping to reduce lane widths to 12 feet and restore the original 4-foot shoulders,
- installing signage—either Class II bike lanes or Class III bike route signs and trail crossing signs,
- connecting trails under the side spans to allow cyclists to use the proper side of the road or providing improved at grade crossings, and
- adding bicycle-height railings to the existing concrete barriers on the bridge.

These improvements would be necessary to safely accommodate trail users adjacent to the vehicular traffic. Currently, trail users in the Auburn SRA access this crossing, though it is not a recognized DPR trail.

If the existing shoulder were not used the bridge would need to made wider, or a separate bridge would need to be constructed. Conceptual drawings were prepared for both the widening options and adjacent bridge are shown in Figure 16. The concrete bridge deck would be widened to the downstream side by 11 feet to provide a 10-foot clear Class I bike trail. The widening would be supported by a single steel plate girder matching the existing two and connected by cross bracing to the existing downstream girder. The plate girder would be supported either by a single, oval concrete column at each pier location and an extension of the existing abutments or by an extension of both the existing piers and abutments. It would also require:

- adding bicycle railing on the outside of the widened bridge and
- adding bicycle railing to the existing concrete barrier.

Widening would be difficult and expensive because:

- the flared ends of the existing bridge would significantly complicate the widening,
- staging areas are limited,
- steel girders tend to be very expensive in California and a project with only one is expected to be at the high end of the price range, and
- extending the existing piers would be complicated by the rounded noses on the existing piers.

Differential settlement is not expected to be a concern because the footings are on competent rock.

Building a new adjacent prefabricated steel truss would consist of constructing the truss with 10-foot clear width on an independent substructure (similar to the manner described for the widening) or on extensions of the existing substructure. The truss span could be set with deck near the bottom flange of the existing steel girders (below the existing bridge deck). For security reasons, however, it may be desirable to keep the trail bridge visible from the SR 49 Bridge deck, although even at the lower elevation, the bridge would be clearly visible from SR 49 north of the bridge. The new bridge alignment would provide 10 feet of clear space between the flared ends of the existing bridge, to improve visibility, and to discourage access between the two bridges.

Because the cost of the structural alternatives was determined to be too great, the use of the shoulder was the only alternative for the SR 49 Bridge that was carried forward.

This alternative would require the construction of 8.8 miles of trail and the addition of a bike lane to the SR 49 Bridge. The proposed trail alignment is shown in Figure 17.

No Hands Bridge

Historically, the No Hands Bridge, shown in Figure 18, was used as a railroad crossing that supported a special railroad line that connected the limestone quarry operation to the westbound Southern Pacific main line in Auburn, California. This crossing was the first concrete bridge of its kind in North America. The name *no hands* came from veteran equestrian rider, Ina Robinson, who would drop her reins to ride across the bridge at a time when no guardrails existed.

Using the No Hands Bridge as a multi-use crossing would require DPR to alter the current management practices for the bridge and allow cyclists to share the crossing with equestrian and pedestrian users that currently have access. While a trail system already exists, 8.3 miles of trails would need to be constructed to develop a multi-use trail available for all users including mountain bikes, maintaining the Western States Trail for equestrian and pedestrian use only. The proposed trail alignment is shown in Figure 17.

New Crossing Locations Considered

The review of the canyon geology in the vicinity of the current ACT was the first assessment completed to help determine potential river crossing sites. Through this process the Upper Outlet Rapid and Oregon Bar were identified as having the greatest potential to site a permanent facility.

Preliminary permanent bridge alignments were developed at the Upper Outlet Rapids and Oregon Bar sites. The length of the bridge alternatives at these two sites varies, but the Oregon Bar alternatives are substantially shorter than the Upper Outlet Rapids alternatives. At the Upper Outlet Rapids, the alternative spans range from 420 to 469 feet, while at the Oregon bar site, the alternative spans range from 280 to 290 feet. At each of these two sites, preliminary concepts were developed for each site.

All permanent bridge alternatives were developed based on providing a clear path of 12 feet to accommodate multiple users simultaneously. This is based on input from DPR as well as standards for multi-use (Class 1) paved trails, which call for a minimum width of 8 feet plus 2-foot shoulders, for a combined width of 12 feet. It should be noted that this is less than the 15-foot width of the No Hands Bridge.

Upper Outlet Rapid

Approximately 1,600 feet downstream of the existing ACT crossing, the river cascades through a mild rapid. This location, shown in Figure 19, lends itself to a possible crossing downstream of future dam construction and would benefit from several informal trails or abandoned access roads to ease trail construction. The distance to the current ACT is still minimal and considered a benefit. This was also the first location downstream of the Dam Site that had suitable rock formations on both banks.

A conceptual design was prepared to assess potential bridge alternatives for this site. The designs included four preliminary bridge alternatives with spans ranging from 420 to 469 feet. The four bridge types were considered because they each provide one or more key desirable features for this location:

- potential to clear span the 100-year floodplain,
- minimal visual impact,
- low construction cost,
- small permanent footprint, and
- ease of construction.

The four bridge alternatives at this site include: two suspension bridges, one stress ribbon bridge, and one steel truss bridge. Each bridge and its application to the site are described in further detail below.

Suspension Bridge

A traditional suspension bridge located at the upper outlet rapid would require a 414-foot main span and two 20-foot side spans. Because of the side spans' short length, they would not be suspended. The main span would require two towers extending 65 feet above the bridge deck. The towers would be supported by footings drilled or excavated to a depth below the calculated scour depth, approximately 10 to 15 feet below the channel thalweg. The deck would be stiffened by a lattice truss consisting of steel top and bottom chords and timber verticals and diagonals. The main cables would be anchored in concrete anchorages in the slopes above the ends of the bridge. Lateral sway bracing typically is required for these types of suspension bridges to limit movement attributable to both wind and equestrian use. Primarily because of concerns regarding stability of this type of bridge under equestrian loading, further feasibility analysis of this alternative was not performed. This alternative is shown in Figure 20 (UO-2).

Segmental Concrete Suspension Bridge

This alternative, while also a suspension design, would lack the recognizable towers that hold the main cables. Instead, the main cables would be anchored directly into the canyon walls above each end of the bridge deck. This would require a single clear span of 430 feet. In lieu of a stiffening truss a post tensioned segmental pre-cast concrete deck would be anchored to both abutments and provide lateral stability. It is anticipated that high-line construction techniques could be utilized and eliminate the need for a crane during construction. This alternative is shown in Figure 21 (UO-1).

The no-tower suspension bridge alternative would have the advantage of cost savings associated with avoiding construction of two towers as well as the benefit of the entire structure being out of the 100-year floodplain. Because of its shallow deck slab (less than 2 feet at the edges), lack of towers or stiffening trusses, and nearly invisible cables (it should be noted that in the accompanying two-dimensional line drawings, the main cables and hangers are substantially more dominant visually than they would be in the actual structure), this alternative would appear to spring gracefully from the canyon walls, simultaneously tied to and supported by them. Next to the stress ribbon alternative, the suspension bridge would have the least overall visual impact.

The suspension bridge, although requiring rock anchors at both the abutments and main cable anchorages, would require roughly the same total number of rock anchors as a comparable length stress ribbon bridge. This is because the overall horizontal forces resisted by the suspension bridge cable anchorages would be significantly less than those to be resisted by the stress ribbon bridge's combined abutment and cable anchorage, offsetting the additional number of rock anchors needed for the suspension bridge abutments.

One drawback of eliminating the towers is that there would be a substantial length of unsupported main cable—nearly 90 feet at the west end of the Upper Outlet Rapids bridge. This may require measures to mitigate potential aerodynamic instability of the cable under wind loads. This would require further investigation during final design of the bridge.

Stress Ribbon Bridge

Application of a stress ribbon design at this location will require a span of 460 feet, which would create a 9.5-foot sag at the mid-span of the bridge deck. This creates a 4.3% grade and meets accessibility standards. Anchoring this large span will require a series of rock anchors and associated costs. The large sag will also require the bridge abutments be placed at a higher elevation on the canyon walls to provide the bridge deck with the necessary freeboard. This alternative is shown in Figure 22 (UO-3).

Aesthetically, the stress ribbon bridge has the decided advantage of having the slightest profile and thus the least visual impact on the canyon. However, for some, the sag may be considered unattractive.

Construction of the stress ribbon bridge would be very similar to that of the segmental concrete suspension bridge alternative, with more substantial abutment work but no separate cable anchorages.

Concerns about excessive “liveliness” of stress ribbon bridges do not appear to be well-founded. Tests on and parametric studies done for existing bridges (Straski 2005) indicate that the combined stiffness provided by mass of the pre-cast segments and the post-tensioning of the entire system limit the potential from unpleasant movements, even in the presence of horses.

Steel Truss Bridge

A truss bridge at this location will require a total of three spans measuring 430 feet. The main span would measure 180 feet, with two side spans measuring 125 feet each. Figure 23 (UO-4) shows the proposed configuration. The main span truss would have an arched top chord to more efficiently carry the larger main span and to visually accentuate that span.

It is anticipated that the trusses would be fabricated off site by one of several manufacturers who specialize in these types of bridges. The bridge typically would be shipped in several pieces to be field-bolted together on site and placed by a large crane, or sometimes two. Consequently, this alternative would require site access to at least one side of the river by such a crane.

The superstructure would be supported on concrete abutments and piers. The piers could be prismatic or tapered and of oval, round, octagonal, or rectangular (with rounded ends) cross section. Piers would have to be founded below the calculated scour depth, approximate 10 to 15 feet below the channel thalweg, or anchored to competent bedrock.

While generally the most economical type of pedestrian bridge for medium length spans, a prefabricated truss span will be more expensive than typical at this site because of the access issues, the pier construction in the river channel, and the need for rock anchors at the abutments.

The Upper Outlet Rapid crossing would be approximately 1,600 feet downstream of the existing ACT crossing. The connection would require less than 1 mile of new trail to make the connections between the existing trail and the new bridge.

This connection would require only a short stretch of new trail on the west side to connect to the Oregon Bar Access road, and approximately 0.5 miles of new trail on the east side of the American River.

Oregon Bar

Approximately 4,800 feet downstream of the existing ACT crossing the river bends to the right at Oregon Bar (shown in Figure 24). This bar is formed on the inside of the river bend where the North Fork of the American River flows into the upper limits of the Folsom Reservoir pool. The best potential for a permanent crossing is to locate a bridge at the upper end of the bar where the shortest span and competent rock is evident. While this site is located at the furthest possible location downstream of the existing ACT crossing, it does increase the potential of connecting with the concurrent Oregon Bar River Access project and the Folsom Reservoir trail system.

An Advanced Planning Study (APS) was prepared to assess potential bridge alternatives for this site. The APS included four preliminary bridge alternatives with spans ranging from 280 to 290 feet. The four bridge types were considered because they each provide one or more key desirable features for this location:

- potential to clear span the 100-year floodplain,
- minimal visual impact,
- low construction cost,
- small permanent footprint, and
- ease of construction.

The four bridge alternatives at this site include: one strutted steel girder bridge, one suspension bridge, one stress ribbon bridge, and one steel truss bridge. Each bridge and its application to the site are described in further detail below.

Strutted Steel Girder Bridge

A strutted steel girder alternative was developed for the Oregon Bar site. This structure type would consist of a main span of approximately 130 feet, with two side spans of 80 feet. The superstructure would consist of two continuous steel I-shaped girders supporting a CIP reinforced concrete deck slab. The deck slab would be cast on stay-in-place steel forms between the girders. The steel girders would be supported by concrete abutments at each end and two Y-shaped concrete piers in the river channel. Further supporting the girders would be four diagonal steel struts radiating from each pier. These struts would effectively shorten the girder spans and allow a girder depth of only 3 feet. Because the deck slab would be cast between the girders, the overall structure depth would also be only 3 feet, presenting a clean, slender, gently arched horizontal line and limited visual obstruction. The combination of the struts and Y-shaped piers would resemble two trees growing from the riverbanks to support the superstructure. Railings would be mounted directly to the top flanges of the girders, which could be fabricated from unpainted weathering steel or painted steel. The railings would match the girders. The bridge profile would be set such that the base of the struts would be below the 100-year water surface elevation, but for flows beyond the 100-year event, the struts potentially would collect debris. This alternative is shown in Figure 25 (OB-1).

Piers would have to be founded below the calculated scour depth approximately 10–15 feet below the channel thalweg, or in founded in competent bedrock.

Because of the sloping slip planes in the rock slopes, it is anticipated that rock anchors will be required at the abutments to prevent failure of the rock below the footing.

As noted in the general description of bridges considered, steel girder bridges are seldom used in California and therefore typically are fairly expensive. With shipping pieces up to 65 feet long, transportation of the main girders and a crane to erect them into the canyon may be problematic and expensive.

An estimate of probable construction cost for the preliminary strutted girder alternative at Oregon Bar was determined using typical square foot cost data published by the California Department of Transportation (Caltrans). The published range of costs for steel bridges in California was adjusted for relevant bridge-specific considerations, such as the small size of the project, the access difficulties, the unique pier shape, and the construction of piers in the river channel, all of which tend to raise the cost.

Segmental Concrete Suspension Bridge

This alternative was developed as a variation of the segmental concrete suspension bridge concept investigated at the Upper Outlet Rapid site. In an effort to consider as many structural concepts as possible at multiple sites, each of these two variants was considered at only one of the sites, but could be applied at either. The major differences between the two would be in the horizontal geometry of the suspension cables, the resultant anchorage locations, and the method of connecting the hanger cables to the superstructure.

This alternative would consist of a single span of 280 feet suspended from two main cables anchored into the slopes above the ends of the bridge. The main cables would be curved both in a vertical plane and in a horizontal plane, providing an added degree of lateral stability. The main cables would be held away from the edge of deck by steel struts at mid-span and come together at the centerline of the bridge at the anchorages. In lieu of a stiffening truss, this alternative would employ a post-tensioned segmental pre-cast concrete deck anchored to both abutments. The combination of the post-tensioning, the mass of the concrete deck, and the anchorage to the abutments would provide the stiffness normally provided by a stiffening truss and sway cables. It is anticipated that, by using a high line, this bridge could be erected without the need for a large crane in the riverbed. This alternative is shown in Figure 26 (OB-2).

Because of the added complexity of using steel struts to hold the main cables away from the deck and the potential complications of having both main cables come to the same anchorage point, the segmental concrete suspension bridge alternative described for the Upper Outlet Rapid site is considered to be more feasible than this type for either site, so no additional analysis was performed of this alternative.

Stress Ribbon Bridge

A stress ribbon bridge alternative at this location would have a single span of 290 feet with approximately 6.0 feet of sag at the mid-span of the bridge deck. This would create a 4.3% grade, which would meet accessibility standards. Anchoring this large span would require a series of rock anchors and associated costs. The large sag would also require the bridge abutments be placed at a higher elevation on the canyon walls to provide the bridge deck with the necessary freeboard. This alternative is shown in Figure 27 (OB-3).

Aesthetically, the stress ribbon bridge has the decided advantage of having the slightest profile and thus the least visual impact on the canyon. However, for some, the sag may be considered unattractive.

Construction of the stress ribbon bridge would be very similar to that of the segmental concrete suspension bridge alternative, with more substantial abutment work but no separate cable anchorages.

Concerns about excessive “liveliness” of stress ribbon bridges do not appear to be well-founded. Tests on and parametric studies done for existing bridges (Straski 2005) indicate that the combined stiffness provided by mass of the precast segments and the post-tensioning of the entire system limit the potential from unpleasant movements, even in the presence of horses.

Steel Truss Bridge

A truss bridge at this location would have a main span of 130 feet and two side spans of 80 feet for a total length of 290 feet. The main span truss would have an arched top chord to more efficiently carry the larger main span and to visually accentuate that span. This alternative is shown in Figure 28 (OB-4).

It is anticipated that the trusses would be fabricated off site by one of several manufacturers who specialize in these types of bridges. The bridges typically would be shipped in several pieces to be field-bolted together on site and placed by a large crane, or sometimes two. Consequently, this alternative would require site access to at least one side of the river by such a crane. Both delivery of the bridge superstructure and crane access to erect it would be accomplished more easily at the Oregon Bar site because of the proximity to the existing road which will be improved during the Oregon Bar River Access project.

The superstructure would be supported on concrete abutments and piers. The piers could be prismatic or tapered and of oval, round, octagonal, or rectangular (with rounded ends) cross section. Piers would have to be founded below the calculated scour depth, approximately 10 to 15 feet below the channel thalweg, or anchored to competent bedrock.

While generally the most economical type of pedestrian bridge for medium length spans, a prefabricated truss span will be more expensive than typical at this site because of the pier construction in the river channel, and the need for rock anchors at the abutments.

As stated in the seasonal bridge alternative, approximately 2 miles of trail would need to be constructed for recreational use with the Oregon Bar crossing site. This trail may also require the purchase of lands or use easements. As presented later in the study, the permanent Oregon Bar Bridge would cost substantially less because of the length of the structure and geological features at the site.

Potential Seasonal Crossings

Seasonal crossings include both temporary bridge structures and low water fords. Seasonal bridge alternatives are generally lightweight and require either heavy equipment or hand crews to stabilize the abutments and install and remove the crossings each season. Two sites within the feasibility study area were identified as potentially suitable for installation of a seasonal crossing—the existing ACT crossing and Oregon Bar.

A bridge type to accommodate all trail users could be installed at each seasonal crossing. However, based on comments collected during the public involvement period, it was determined that a low-water ford would be preferable to separate the equestrian users and provide a safer crossing for all users. Although a ford crossing would be feasible at either location, a ford at Oregon Bar would provide fewer conflicts with boating traffic than one located at the current crossing site.

Existing Crossing

Fiber Reinforced Polymer Truss

At the Existing Crossing, preliminary topographic and hydraulic data indicate that the normal summer high water (associated with flows of 1,000 cfs) depth at the crossing would be a maximum of about 5.1 feet and average depth less than 3 feet over a surface width of about 180 feet. This would require a multi-span bridge. The preliminary topography suggests that a main span of 80 feet starting at the west abutment and two 50-foot spans to the east would clear-span the main low flow channel. Because of the light weight of the superstructure, the truss spans could be supported on simple pre-cast concrete members stacked and attached with high strength threaded rods. With weights of up to 6 tons these units would require an excavator or small crane to place on a graded bed. With the low summer flows, it is anticipate that the pier footings in the water would remain stable for the short life of the installation.

The FRP bridge was chosen over a Bailey bridge because it would be easier to install, require less maintenance, be less intrusive visually, and require less substantial temporary substructure. An FRP bridge could also be procured in any width from 3 feet to about 12 feet. Because a seasonal FRP bridge would be relatively short, it could be narrower than the 12 feet assumed for the permanent bridge alternatives, based on the assumption that other users would wait to cross when horses were on the bridge. An FRP bridge for bicycle and pedestrian use only could be less costly than one designed for equestrians as well. Savings could result from the use of longer spans, lighter decking materials and narrower width than feasible for equestrian use.

Based on the predicted water depths, a pipe bridge and equestrian ford at this location may be feasible as well, but subject to greater maintenance and user conflicts. A decision on a seasonal bridge type at this location should be based on updated topographic information at the site following completion of the river restoration project.

Oregon Bar

Pipe Bridge and Equestrian Ford

At Oregon Bar, the channel is very wide and appears to be suitable for a pipe bridge. However, the hydraulic modeling indicates that this area is within the influence of Folsom Reservoir. When Folsom Reservoir is full (water surface elevation 466 feet), all of Oregon Bar is inundated with Folsom Reservoir backwater, with depths of up to 14 feet and a flow width of more than 225 feet. Consequently, while Oregon Bar appears to be an excellent location for a pipe bridge and ford when reservoir levels are below about elevation 458 feet, in years when the reservoir fills, a pipe bridge would not be feasible while reservoir levels remain high.

When an armored ford is available, equestrians would generally prefer to use it than to cross a bridge. Limiting potential users of a seasonal bridge to hikers and cyclists would save money, ease installation, and separate equestrians from other trail users to increase safety.

Cost Estimation

Cost estimates for the preliminary alternatives were calculated based on square foot costs developed from a combination of recent, similar projects and from Caltrans' *Comparative Bridge Costs*, last updated in January 2007 (California Department of Transportation 2007). These square foot costs were qualitatively adjusted to account for factors that would result in project costs higher or lower than those represented by the historical square foot costs. Square foot costs were adjusted (generally upwards) to account for inflation, regional construction variation, the small size of the project, the relative difficulty in accessing the site, aesthetic and environmental sensitivity of the site, and foundation conditions. These costs include a 25 percent contingency and 10 percent for mobilization. Thirty percent of the construction cost was assumed for environmental studies, design engineering, construction engineering and construction management. Appendix D includes cost estimates developed for all of the preliminary alternatives considered.

Cost estimates for the alternatives taken to the feasibility level were calculated based on rough quantities developed from preliminary analyses. These analyses were used to determine approximate sizes of main structural elements of the bridge. Unit prices were then determined from historical cost data for each item to be estimated As with the estimates for the preliminary alternatives, these unit prices were adjusted to account for inflation, regional const variation, the small size of the project (or of the total quantity of an item), the relative difficulty in accessing the site, aesthetic and environmental sensitivity of the site, and foundation conditions. These costs also include a 25 percent contingency, 10 percent for mobilization and thirty percent for environmental studies, design engineering, construction engineering and construction management. Itemized estimated costs for each of the feasibility-level alternatives for an assumed construction year of 2007 can be found in Appendix D. Table 2 provides a summary of costs and narratives for several feasibility considerations.

Cost estimates for trail construction were based on the trail costs developed by DPR for the trail alternatives identified for addition of cyclist access to the No Hands Bridge (California Department of Parks and Recreation 2005a). Because trail construction costs can vary greatly given the required culverts, bridges, switchbacks and slope stabilizations, these costs were averaged to develop a single per linear foot cost of trail construction. For alternatives that included a new multi-use trail to accommodate pedestrians, cyclists, and equestrians the cost was increased by a factor of two to include additional signage, a 60-inch trail width and associated slope stabilization.

Summary of Findings

Throughout this process the design team was focused on developing a list of feasible solutions to maintain the ACT crossing and connectivity of the Auburn SRA trail system. Through the review of existing data, prior reports, and new investigations and analysis three basic solutions surfaced. The ACT crossing could be sited over existing facilities, a new permanent multi-use trail bridge, or a seasonal crossing. Any of these options will meet the needs of the trail users and connect the ACT across the North Fork of the American River.

Table 3 below provides a quick comparison and allows the reader to compare alternatives and their components.

Table 3. Summary of Feasibility Study Findings

Alternative	Permanent/Seasonal (P or S)	Bridge Type	Trails to be Constructed (feet)	Cost
1	P	SR 49	46,500	$1,989,000
2	P	No Hands	44,400	$1,831,000
Upper Outlet				
3	P	Suspension w/towers	3,700	$3,323,000
4	P	Suspension w/o towers	3,700	$4,103,000
5	P	Stress ribbon	3,700	$4,080,000
6	P	Steel truss	3,700	$3,470,000
Oregon Bar				
7	P	Steel girder	12,800	$3,196,000
8	P	Suspension w/o towers	12,800	$2,990,000
9	P	Stress ribbon	12,800	$2,700,000
10	P	Steel truss	12,800	$2,379,000
11	S	Pipe bridge and ford	12,800	$448,000
Existing Crossing				
12	S	FRP	500	$325,000

SR 49

This alternative requires the longest segments of newly constructed trail in order to separate cyclists from other users to maintain a high level of safety. However, the bridge is already in place and will greatly reduce the capital costs of project implementation over an alternative that provides a new bridge. Finally, this site is located in the inundation area if Auburn Dam were ever to be constructed, and the trail would have to be moved again.

No Hands Bridge

This alternative requires a substantial trail construction project to separate cyclists from other users along the approaches to the bridge. However, the bridge is already in place and will greatly reduce the capital costs of project implementation over an alternative that provides a new bridge. Finally, this site is located in the inundation area if Auburn Dam were ever to be constructed, and the trail would have to be moved again.

Bridge Type by Location	Drawing No.	Crossing Cost	Trail Cost	Subtotal Constr.	Eng. and Admin 30%	Total Project Cost	Aesthetics	Ease of Construction	Environmental Impacts	Geotechnical	Hydraulics/ Scour	Trail Connections	Maintenance	User Experience	Accessibility	Comments
EXISTING CROSSING (EC)																
FRP Seasonal Bridge (8' x 180': Spans 80'-50'-50')	EC-1	$224,000	$25,600	$249,600	$74,880	$324,480	X-truss gives appearance of permanence; precast substructure would not.	Requires backhoe or small crane to set substructure and trusses and level subgrade. Annual erection and dismantling; requires secure storage for trusses.	Annual re-grading of foundation areas and approach trails.	Restored gravel riverbed is anticipated to provide adequate bearing for temporary spread footings.	Susceptible to damage from unexpected high flows.	500' of new trail required. Minimal trail work; may require annual re-grading	Annual cost to erect and dismantle; intermittent decking replacement.	Narrow (8') bridge would be shared by all users; parallel ford may be feasible.	Could meet DPR trail accessibility guidelines.	1 span at 80 ft, 2 at 50'; temporary piers and abutments.
Seasonal Pipe Bridge (3' x 192': Spans 24 @ 8')	N/A	$49,000	$12,800	$61,800	$18,540	$80,340	Low level; small and unobtrusive; appears unsubstantial.	Water may be too deep. No heavy equipment. Annual erection and dismantling; requires secure storage.	Small diameter pipes driven into river bed and removed each year. Construction at an already disturbed site.	Restored gravel riverbed is anticipated to accommodate driving of support pipes.	Susceptible to damage from unexpected high flows.	500' of new trail required. Minimal trail work; may require annual re-grading	Annual cost to erect and dismantle; intermittent painting and decking replacement	Separates equestrians from mountain bikers and hikers; narrow (3') bridge.	Not wheel chair accessible due to steps, but could meet other DPR trail accessibility guidelines.	Subject to final topographic survey of restored river. At high summer flows (1000 cfs), water depth of 5.1 feet may be too deep for ford or bridge. No abutments required.
UPPER OUTLET RAPIDS (UOR)																
Strutted Girder (12' x 440': Spans 130'-180'-130')	N/A	$3,168,000	$240,000	$3,408,000	$1,022,400	$4,430,400	Low profile superstructure with Y-shaped piers and diagonal struts that would evoke a tree.	Difficult access to both ends, but west end near existing ATC trail. Difficult construction for river for piers. Large crane required to set girders.	Construction in river channel; may require temporary diversion of river. Piers will be permanent obstructions in channel.	Rock excavation required for abutments and piers. Piers expected to require cofferdam & seal course. Rock anchors or pin piles likely required at abutments due to adverse sloping fracture surfaces and at piers to its overturning.	Abutments set above 100-year flood. Pier scour depth could be substantial, depending on depth of competent rock. Bedrock may be very close to the surface within the channel and is not expected to erode.	3,700' of new trail required. Difficult trail connection on west end, easier on east.	Structural steel would either be weathering steel or require periodic painting.	15-ft between railings provides extra usable width to serve multiple use. Bike/pedestrian railings may seem unsubstantial for equestrians, but recessed deck and fillets would add to sense of safety.	Would meet DPR trail accessibility guidelines. Maximum running grade of 5.0%.	Probably not feasible without very large girders or more than two river piers. Longer spans would require deeper struts, higher profile and even longer spans. Expensive because of steel girders, small project size and difficult site access.
Suspension w/out Towers (12' x 430')	UO-1	$2,916,000	$240,000	$3,156,000	$946,800	$4,102,800	Low profile superstructure; no river piers; blends into background; sweeping catenary shape of cables complements arching deck and shape of canyon; lack of towers limits visual impact.	Existing roads on both ends of bridge; but steep slopes to west abutment. No construction in river. Secondary construction access roads required to construct anchorages.	No in-river construction minimizes impacts. Additional impacts for anchorages and construction access roads to them.	Rock excavation required for abutments and cable anchorages. Rock anchors required for moderate to large tension forces at abutments and cable anchorages.	Abutments set above 100-year flood. No impact on hydraulics and no scour issues for design flows.	3,700' of new trail required. Difficult trail connection on west end, easier on east.	Cables and connections may require cleaning to prevent debris buildup and corrosion. Repainting of railings.	12-ft deck width serves multiple use. Mass, extra overall width (to accommodate hanger connections), splayed main cables and post-tensioning of concrete deck to abutments provide stiffness, damping and resistance to lateral loads. Cables and hangers enhance sense of safety by enclosing trail on bridge.	Would meet DPR trail accessibility guidelines. Maximum running grade of 5.0%.	Precast segmental concrete with splayed main cables and no towers. Construction of superstructure assumed to use high-line.

Bridge Type by Location	Drawing No.	Crossing Cost	Trail Cost	Subtotal Constr.	Eng. and Admin 30%	Total Project Cost	Aesthetics	Ease of Construction	Environmental Impacts	Geotechnical	Hydraulics/ Scour	Trail Connections	Maintenance	User Experience	Accessibility	Comments
Suspension with Towers (12' x 454'; Spans 20'-414'-20')	UO-2	$2,316,000	$240,000	$2,556,000	$766,800	$3,322,800	Traditional "rustic" trail bridge; sweeping catenary shape of cables complements shape of canyon.	Existing roads on both ends of bridge; but steep slopes to west abutment. Tower construction at edges of main channel. Secondary construction access roads required to construct anchorages.	Tower construction in edge of channel. Additional impacts for anchorage construction access roads.	Rock excavation required for abutments, cable anchorages and towers. Towers could be supported on drilled shafts. Rock anchors required for large tension forces at cable anchorages.	Abutments set above 100-year flood. Tower piers would be in edge of channel and would be subject to scour, but would be set into bedrock.	3,700' of new trail required. Difficult trail connection on west end, easier on east.	Cables and connections may require cleaning to prevent debris buildup and corrosion. Repainting of railings.	12-ft deck width serves multiple use. Light timber and steel composite superstructure may be prone to large vertical and lateral displacements under equestrian loading. Cable sway bracing would probably be required to resist lateral loads. Stiffening truss, cables and hangers would enhance sense of safety by enclosing trail on bridge.	Would meet DPR trail accessibility guidelines. Maximum running grade of 5.0%.	Traditional cable suspension bridge with composite steel-timber stiffening truss.
Stress Ribbon (12' x 460')	UO-3	$2,898,000	$240,000	$3,138,000	$941,400	$4,079,400	Low profile superstructure; no river piers; blends into background; sag may be considered either attractive or unsettling.	Existing roads on both ends of bridge; but steep slopes to west abutment. No construction in river.	No in-river construction minimizes impacts.	Rock excavation required for abutments. Rock anchors required for large tension forces at abutments.	Abutments set above 100-year flood. No impact on hydraulics and no scour issues for design flows.	3,700' of new trail required. Difficult trail connection on west end, easier on east.	Minimal. Repainting of railings.	12-ft deck width serves multiple use. Bike/pedestrian railings may seem unsubstantial for equestrians.	Would meet DPR trail accessibility guidelines. Maximum running grade of 10.0% for 30 feet.	Near record span for stress ribbon.
Truss (12' x 440'; Spans 130'-180'-130')	UO-4	$2,429,000	$240,000	$2,669,000	$800,700	$3,469,700	Truss would create substantial visual impact on canyon due to large structure depth (up to 9 feet) and river piers. Careful design of piers and choice of paint color (or weathering steel) would help soften the view.	Difficult access to both ends, but west end near existing ATC trail. Difficult construction for river for piers. Large crane required to set trusses. Trusses may have to be shipped in fairly small sections.	Construction in river channel; may require temporary diversion of river. Piers will be permanent obstructions in channel.	Rock excavation required for abutments and piers. Piers expected to require cofferdam & seal course. Rock anchors or pin piles likely required at abutments due to adverse sloping fracture surfaces and at piers to its overturning.	Abutments set above 100-year flood. Pier scour depth up to 13', but possibly much less depending on depth of competent rock. Bedrock may be very close to the surface within the channel and is not expected to erode.	3,700' of new trail required. Difficult trail connection on west end, easier on east.	Structural steel would either be weathering steel or require periodic painting.	12-ft deck width serves multiple use. Half-through trusses provide substantial barrier for equestrians. Combination of truss and concrete deck provides stiffness and damping.	Would meet DPR trail accessibility guidelines. Maximum running grade of 5.0%.	

Bridge Type by Location	Drawing No.	Crossing Cost	Trail Cost	Subtotal Constr.	Eng. and Admin 30%	Total Project Cost	Aesthetics	Ease of Construction	Environmental Impacts	Geotechnical	Hydraulics/ Scour	Trail Connections	Maintenance	User Experience	Accessibility	Comments
OREGON BAR (OB)																
Strutted Girder (12' x 290'; Spans 80'-130'-80')	OB-1	$2,175,000	$283,200	$2,458,200	$737,460	$3,195,660	Low profile superstructure with Y-shaped piers and diagonal struts that would evoke a tree.	Existing road to Oregon Bar, several hundred feet downstream of crossing site; steep slopes at east abutment. Difficult construction for river for piers. Temporary river diversion or construction trestle may be necessary for access to east abutment. Large crane required to set girders. Girders would have to be shipped in fairly small sections.	Construction in river channel; may require temporary diversion of river. Piers will be permanent obstructions in channel.	Small area of rock excavation required for abutments; more substantial rock excavation for piers. Piers expected to require cofferdams and seal course.	Abutments set above 100-year flood. Pier scour depth up to 13', but possibly much less depending on depth of competent rock. Bedrock may be very close to the surface within the channel and is not expected to erode.	12,800' of new trail required. Short trail connection to existing trail on west end; very long trail connections along drainage on east.	Structural steel would either be weathering steel or require periodic painting.	15-ft between railings provides extra usable width to serve multiple use. Bike/pedestrian railings may seem unsubstantial for equestrians, but recessed deck and fillets would add to sense of safety.	Would meet DPR trail accessibility guidelines. Maximum running grade of 5.0%.	Square foot costs based on Caltrans Comparative Bridge Costs. Steel girders are traditionally very expensive in California; these would be at high end of range because of small project size and difficult site access.
Suspension (12' x 280')	OB-2	$2,016,000	$283,200	$2,299,200	$689,760	$2,988,960		Existing road to Oregon Bar, several hundred feet downstream of crossing site; steep slopes at east abutment. No permanent construction in river, but temporary river diversion or construction trestle and secondary access road may be necessary to provide construction access across river from west abutment to construct anchorages.	No in-river construction minimizes impacts. Additional impacts for anchorages and construction access roads to them.	Rock excavation required for abutments and cable anchorages. Rock anchors required for moderate to large tension forces at abutments and cable anchorages.	Abutments set above 100-year flood. No impact on hydraulics and no scour issues for design flows.	12,800' of new trail required. Short trail connection to existing trail on west end; very long trail connections along drainage on east.	Cables and connections may require cleaning to prevent debris buildup and corrosion. Repainting of railings.	12-ft deck width serves multiple use. Mass, extra overall width (to accommodate hanger connections), splayed main cables and post-tensioning of concrete deck to abutments provide stiffness, damping and resistance to lateral loads. Cables and hangers enhance sense of safety by enclosing trail on bridge.	Would meet DPR trail accessibility guidelines. Maximum running grade of 5.0%.	No tower; short span
Stress Ribbon (12' x 290')	OB-3	$1,793,000	$283,200	$2,076,200	$622,860	$2,699,060	Low profile superstructure; no river piers; blends into background; sag may be considered either attractive or unsettling.	Existing road to Oregon Bar, several hundred feet downstream of crossing site; steep slopes at east abutment. No permanent construction in river, but temporary river diversion or construction trestle may be necessary to provide construction access across river from west abutment.	No permanent in-river construction, but would potentially require temporary crossing.	Rock excavation required for abutments. Rock anchors required for large tension forces at abutments (but smaller than other stress ribbon alternatives because of shorter span).	Abutments set above 100-year flood. No impact on hydraulics and no scour issues for design flows.	12,800' of new trail required. Short trail connection to existing trail on west end; very long trail connections along drainage on east.	Minimal. Repainting of railings.	12-ft deck width serves multiple use. Bike/pedestrian railings may seem unsubstantial for equestrians.	Would meet DPR trail accessibility guidelines. Maximum running grade of 8.33%.	Based on very similar Rancho Santa Fe Bridges plans and bid prices.

Bridge Type by Location	Drawing No.	Crossing Cost	Trail Cost	Subtotal Constr.	Eng. and Admin 30%	Total Project Cost	Aesthetics	Ease of Construction	Environmental Impacts	Geotechnical	Hydraulics/ Scour	Trail Connections	Maintenance	User Experience	Accessibility	Comments
Truss (12' x 280': Spans 75'-130'-75')	OB-4	$1,546,000	$309,750	$1,855,750	$556,725	$2,412,475	Truss would create substantial visual impact on canyon due to large structure depth (up to 9 feet) and river piers. Careful design of piers and choice of paint color (or weathering steel) would help soften the view.	Existing road to Oregon Bar, several hundred feet downstream of crossing site; steep slopes at east abutment. Difficult construction for river for piers. Temporary river diversion or construction trestle may be necessary for access to east abutment. Large crane required to set trusses. Trusses may have to be shipped in fairly small sections.	Construction in river channel; may require temporary diversion of river. Piers will be permanent obstructions in channel.	Rock excavation required for abutments and piers. Piers expected to require cofferdam & seal course. Rock anchors or pin piles likely required at abutments due to adverse sloping fracture surfaces and at piers to its overturning.	Abutments set above 100-year flood. Pier scour depth up to 13', but possibly much less depending on depth of competent rock. Bedrock may be very close to the surface within the channel and is not expected to erode.	12,800' of new trail required. Short trail connection to existing trail on west end; very long trail connections along drainage on east.	Structural steel would either be weathering steel or require periodic painting.	12-ft deck width serves multiple use. Half-through trusses provide substantial barrier for equestrians. Combination of truss and concrete deck provides stiffness and damping.	Would meet DPR trail accessibility guidelines. Maximum running grade of 5.0%.	Uncertainty about quantities of rock excavation in riverbed and rock anchors at piers and abutments largely responsible for high cost.
Seasonal Pipe Bridge and Ford (3' x 224': Spans 28 @ 8')	N/A	$58,000	$286,400	$344,400	$103,320	$447,720	Low level; small and unobtrusive; appears unsubstantial.	Water may be too deep for bridge or ford. Bridge does not have to be designed for equestrian loading. No heavy equipment. Annual erection and dismantling; requires secure storage.	Small diameter pipes driven into river bed and removed each year. No permanent impacts.	Need to verify ability to drive pipes into riverbed.	Susceptible to damage from unexpected high flows.	12,800' of new trail required. Would open up connections between FLSRA and ASRA and provide access to the peninsula area.	Annual cost to erect and dismantle; intermittent painting and decking replacement.	Separates equestrians from mountain bikers and hikers; narrow (3') bridge.	Not wheel chair accessible due to steps, but could meet other DPR trail accessibility guidelines.	When Folsom Lake water surface is at Elev. 466, max water depth = 14.0 ft. Therefore, full reservoir could delay or prevent spring installation.
MQRR NO HANDS																
Convert to Multiple Use (15' x 482')	N/A	$–	$1,408,000	$1,408,000	$422,400	$1,830,400	No change to existing condition.	N/A	None directly associated with use of bridge.	N/A	N/A	44,400' of new trail mountain bike trail required to separate users where existing Western States Trail is not wide enough.	N/A	Would require revised management. Addition of mountain bikers may prompt desire to upgrade railings (with smaller openings, as users would more often find themselves closer to the railings) and improve drainage to eliminate persistent muddy conditions, better allowing full width of the bridge.	Existing surface does not meet DPR trail accessibility surface guidelines.	May consider upgrade of railing (not required from mountain bike use and not included in estimate) and drainage improvements.
STATE ROUTE 49 BRIDGE (SR49)																
Adjacent Prefab Truss (10' x 340': Spans 83'-174'-83')	AR-1	$1,564,000	$1,488,000	$3,052,000	$915,600	$3,967,600	Truss adjacent to existing steel plate girder span would be visually incompatible. Careful design of piers and choice of paint color could improve compatibility.	Little room for construction staging.	Permanent construction in river channel.	Rock excavation required at piers and abutments. Piers expected to require cofferdam & seal course.	Piers constructed in river channel, but adjacent to existing piers. Would not reduce flow area but could create local eddy problems between piers. Scour depths unknown at this time.	46,500' of new trail mountain bike trail required to separate users where existing Western States Trail is not wide enough.	Structural steel would either be weathering steel or require periodic painting.	Would provide separated mountain bike crossing protected from traffic.	Would meet DPR trail accessibility guidelines. Maximum running grade of 5.0%.	Through turss with 10-ft vertical clearance.

Bridge Type by Location	Drawing No.	Crossing Cost	Trail Cost	Subtotal Constr.	Eng. and Admin 30%	Total Project Cost	Aesthetics	Ease of Construction	Environmental Impacts	Geotechnical	Hydraulics/ Scour	Trail Connections	Maintenance	User Experience	Accessibility	Comments
Widen (10' x 350'; Spans 88'-174'-88')	AR-1	$1,733,000	$1,488,000	$3,221,000	$966,300	$4,187,300	Widening would match existing bridge and would have limited impact on aesthetics.	Widening existing piers would be problematic due to shape of existing piers and need to construct in river channel adjacent to existing piers. Little room for construction staging. Would require approval from and coordination with Caltrans.	Permanent construction in river channel.	Rock excavation required at piers and abutments. Piers expected to require cofferdam & seal course.	Piers constructed in river channel, but would be extensions of existing piers. Would not reduce flow area or add to scour. Scour depths unknown at this time.	46,500' of new trail mountain bike trail required to separate users where existing Western States Trail is not wide enough.	Maintenance would be consistent with and done in conjunction with existing bridge maintenance.	Would provide separated mountain bike crossing adjacent to, but protected from traffic.	Would meet DPR trail accessibility guidelines. Maximum running grade of 5.0%.	Single girder, widened concrete deck & bicycle railing added to existing barrier. Clear width, 10 ft; total deck widening, 11 ft.
Use existing (10' x 348'; Spans 87'-174'-87')	N/A	$42,000	$1,488,000	$1,530,000	$459,000	$1,989,000	N/A	Removal of existing handrail and addition of bicycle height railing to top of concrete barrier would require lane closures.	Higher railing may block views from some vehicles, but may improve views for some other vehicles.	N/A	N/A	46,500' of new trail mountain bike trail required to separate users where existing Western States Trail is not wide enough and for northbound bicyclists to cross under bridge to get to right side shoulder.	Minimal.	Would require off-road bicyclists to ride with heavy, but slow traffic for several hundred feet. Depending on design, could lead to wrong-way riding on bridge.	N/A	Add bicycle railing to existing barrier (2 sides x 350 ft); add signs and trail connections beneath bridge or marked bicycle crossings at grade.

Notes:

1 Costs are for comparison purposes only.

2 Costs include 10% mobilization and 25% contingency.

3 Costs are from Caltrans square foot cost data dated January 2007, or from individual comparable projects.

4 Cost basis is assumed construction year of 2007; Caltrans Cost Index assumed to be 450 (based on 1977=100) 2005 at 460 and 2006 at 423.

5 Comparable cost data from outside of Caltrans was normalized to Sacramento, CA based on Means 2006 geographical index of 109.4.

6 Rows in bold type correspond to developed alternatives with drawings (except for the No-hands and Use Exist SR 49 alternatives). Rows not bolded are extrapolated from developed ones.

7 Shaded rows represent alternatives that were carried to the feasibility level.

Upper Outlet Rapid

This series of alternatives requires the construction of the longer permanent bridge spans of any of the sites considered in the final feasibility analysis. This helps to make these alternatives the most expensive. The trail connections are relatively short and rely largely on the existing ACT on the east side and the Oregon Bar River Access road to the west side. This site provides a permanent facility that would be visible from the Auburn Dam site and would be unaffected by its construction or operation.

Oregon Bar

This series of alternatives requires the construction of the shortest permanent bridge spans of any of the sites considered in the final feasibility analysis. This helps to reduce the cost of these alternatives when considering a permanent bridge option. This site is also considered feasible for the use of a seasonal trail crossing through the construction of a temporary bridge and equestrian ford. This site can provide a crossing that will easily integrate into the other uses associated with the Oregon Bar River Access project.

Two potential drawbacks that require further consideration are the operation of Folsom Reservoir and land ownership on the east side of the canyon. A seasonal crossing in this location could be inundated by Folsom Reservoir operations and future dam raising projects. Trail connections on the east side of the river may require land or easement acquisition to make connections to the Olmstead loop.

Existing Crossing

This alternative may be the easiest to implement at this time. With current construction operations in the vicinity and the trail system already in place the capital costs are the lowest of any alternative considered. A temporary seasonal bridge is being considered for this location. However, this location would be located in the footprint or inundation area if Auburn Dam were ever to be constructed, and the trail would have to be moved again.

Costs

The feasibility study considered each alternative’s costs through design and construction. Operation and maintenance cost of each facility still needs thorough review by DPR staff and facilities managers to determine appropriate annual cost for each alternative. Permanent trail crossings will be subject to inspection and varying levels of repair and maintenance that would be dictated by the materials and finishes selected during the design process. Seasonal trail crossings will require the annual installation, removal, and winter storage of the bridge. In addition, seasonal crossings may include low water fords or permanent abutments that will require annual inspection and potentially repair following winter storm events.

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Appendix A

Engineering Geology and Geotechnical Investigation Report

ENGINEERING GEOLOGY AND GEOTECHNICAL INVESTIGATION REPORT
AUBURN TO COOL TRAIL BRIDGE
ALTERNATIVES LOCATION EVALUATION
EL DORADO AND PLACER COUNTIES, CALIFORNIA

May 1, 2007

This report may be used only by the client and only for the purposes stated, within a reasonable time from its issuance, but in no event later than 3 years from the date of the report. Land or facility use, on and off-site conditions, regulations, or other factors may change over time, and additional work may be required with the passage of time. Based on the intended use of the report, Kleinfelder may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party and client agrees to defend, indemnify, and hold harmless Kleinfelder from any claim or liability associated with such unauthorized use or non-compliance.

May 1, 2007
File: 80688

Mr. Steve Seville
Jones and Stokes
2600 V Street
Sacramento, California 95818

**Subject: Engineering Geology And Geotechnical Investigation Report
Auburn to Cool Trail Bridge Alternatives Location Evaluation
El Dorado and Placer Counties, California**

Dear Mr. Seville:

Kleinfelder is pleased to present the attached engineering geology and geotechnical investigation report for the Auburn to Cool Trail Bridge Alternatives Locations evaluation on the American River near Auburn, California. The purpose of our investigation was to identify potential locations for a permanent pedestrian and/or equestrian bridge in the area within and downstream of the Auburn Dam site and to identify associated preliminary geologic and geotechnical issues that might affect the project design.

Based on the results of our data research and mapping, it is our professional opinion that there are several locations within the project area that are suitable for construction of a bridge. However, the project design will need to consider rock and soil stability issues, the presence of naturally occurring asbestos, hard rock excavation conditions, erosion, and potential high groundwater conditions. Discussions of these conditions, and preliminary recommendations to mitigate them, are presented in the following report.

Recommendations provided herein are contingent on the provisions outlined in the ADDITIONAL SERVICES and LIMITATIONS sections of this report. The project Owner should become familiar with these provisions in order to assess further involvement by Kleinfelder and other potential impacts to the proposed project.

We appreciate the opportunity of providing our services for this project. If you have questions regarding this report or if we may be of further assistance, please contact the undersigned.

Sincerely,

KLEINFELDER, INC.

Byron C. Anderson, PG, CEG
Senior Engineering Geologist

Kenneth G. Sorensen, PE, GE
Senior Geotechnical Engineer

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1 INTRODUCTION

1.1. GENERAL

This report presents the results of our engineering geology and geotechnical investigation for the Auburn to Cool Trail Bridge Alternatives Evaluation located on the middle fork of the American River from the Highway 49 – American River Crossing to Oregon Bar (about 1 mile downstream of the Auburn Dam site). This report presents our findings, conclusions, and recommendations for three alternative, permanent bridge locations beginning at the existing crossing in the Auburn Dam site and continuing downstream along the American River about 1 mile to the upstream side of the Oregon Bar area.

This report is intended for use as a preliminary design document based on surface features and data collected during the investigation. This document should not be used as a final design document. A site-specific investigation should be performed for the final selected bridge location that includes oriented rock core data and site specific discontinuity and stability analysis in support of foundation and grading design. In addition, conclusions and recommendations presented herein are based on the provisions and requirements outlined in the ADDITIONAL SERVICES and LIMITATIONS sections of this report. Recommendations presented herein should not be extrapolated to other areas or used for other projects without our prior review.

1.2. PROPOSED PROJECT

This investigation is part of a larger project for the California Department of Parks and Recreation referred to as the Auburn to Cool Trail Crossing Project. The purpose of this project is to evaluate options for and eventually select a multi-use non-motorized trail crossing of the North Fork American River that will connect trails from the Auburn

Staging Area/Maidu Drive area in Auburn on the north side of the canyon to the Olmstead Trail Loop on the south side (Cool) of the Canyon. This evaluation is being performed in response to public interest in maintaining a crossing across the river channel once the river is restored to its historic channel in the Auburn Dam site. This restoration is currently under construction as part of the American River Pump Station Project located near the current diversion tunnel inlet at the upstream side of the Auburn Dam site. This study includes evaluation of a number of alternatives including using one of the existing Highway 49 or historic Quarry Railroad Bridges, or constructing a seasonal or permanent bridge. This investigation focuses on the later.

The proposed permanent bridges alternative will involve constructing a bridge above the 100 year flood zone of the American River that will be connected to a recreational trail as described above. Current designs being considered include a 3-span steel truss bridge with two center piers near the river and abutments or a single-span, stress ribbon with abutments near Oregon Bar location. A concrete suspension bridge is being considered for a location several hundred feet downstream of the diversion tunnel outlet. This investigation includes and evaluation of a third location at the existing crossing in the Auburn Dam site. However, at the request of the client a design was not considered for this location

The three permanent bridge locations evaluated for this study are shown on the attached Project Boundary and Engineering Geologic Map, Plate 1.

1.3. PURPOSE AND SCOPE OF SERVICES

The purpose of this investigation was to identify potential permanent bridge locations based on preliminary geologic, engineering geologic, and geotechnical data, and to identify geotechnical related issues that will need to be considered during a site-specific geologic and geotechnical investigation for the final bridge location.

The scope of our services was outlined in the project scope of work provided by Jones and Stokes dated July 31, 2006, and included the following:

1. Project Orientation and Site Visit

Initial meeting and site visit with the project team conducted to familiarize the contractor team with the project area.

2. Collect and Review Existing Data

Involved collecting and reviewing existing published data and data provided by the client within the project area. Provide a bibliography to the client all sources collected and reviewed. Data from this review process was utilized in mapping, analyses, and developing conclusions and recommendations. Mapping was performed between the existing crossing area and Oregon Bar, during which key engineering geologic and geotechnical data was collected and issues identified.

3. Prepare Existing Conditions and Background Memorandum

A memorandum was prepared summarizing data collected from Task 2 including issues identified during mapping, recommended alternative bridge locations, and method and criteria for bridge locations selection.

4. Public Workshop/Stakeholder Meetings #1

Assisted with the preparation and attended a Public Workshop during which information was presented to the public regarding the project and public comments were received. Provided a poster size engineering geologic map for display at the meeting that presented proposed permanent bridge locations relative to the engineering geologic setting.

5. Develop Preliminary Alternatives:

This task included preparation of this report presenting the findings, analyses, conclusions, and recommendations related to the preliminary engineering geologic and geotechnical aspects of the three bridge locations discussed above.

1.4. SITE DESCRIPTION

The project area evaluated for this study, as described above, included the area around the diversion tunnel outlet and extended downstream to Oregon Bar. The area around the diversion tunnel includes exposed, nearly flat to steeply dipping bedrock slopes excavated for the foundation of the Auburn Dam. The diversion tunnel itself, is located on the east side of the river channel, and consist of a concrete structure through which the waters of the American Rive flow. The river channel in the dam area is generally dry (due to the diversion tunnel), and consist of loose to compacted sands, gravels, cobbles and boulders. Adjacent to the diversion tunnel and spanning the entire river channel is the downstream earthen cofferdam. This cofferdam extends about 10 to 15 vertical feet above the downstream channel. Downstream from this dam is a natural river channel with gravel bars, exposed bedrock, and several rapids. The slopes of the river banks, beginning at the river channel, are generally very steeply dipping and expose hard gray to greenish gray bedrock that can extend less than 5 to 40 vertical feet above the channel. Above these bedrock exposures are more weathered, red colored bedrock, soil, and landslide deposits extending up to the top of canyon. In some cases landslide deposits extend over the less weathered bedrock and into the river channel. Vegetation in the channel consists of small shrubs and grasses with occasional willow trees. Minor grasses and small shrubs grow in the fractures of the harder rock exposed on the river bank slopes, while further up the slope pine and oak trees and native shrubs prevail.

2 GEOLOGIC SETTING

2.1. REGIONAL GEOLOGIC SETTING

The subject site is situated in the gently rolling topography that forms the western foothills of the Sierra Nevada Mountains. These foothills represent broad tilting of the Sierra Nevada resulting from uplift along the eastern Sierra Nevada escarpment where much steeper slopes prevail. The Sierras are comprised by a large, north-south elongated block of Mesozoic granitic terrane forming the backbone of California. Separating the Sierran crystalline basement rocks from the Valley sediments is the northwest trending belt of metamorphosed volcanic rocks and sediments forming the western slopes of the Sierra Nevada Mountains. These rocks are distributed within three major fault-bounded lithologic terranes that extend along the length of the metamorphic belt. Rocks within these terranes have been isoclinally folded and metamorphosed on a regional scale and represent a “collage” of tectonically accreted blocks emplaced during convergent plate tectonism that occurred during the Early Paleozoic and Late Jurassic. Bedding, foliation and major structural features throughout the metamorphic belt normally trend northwest and dip steeply to the east. The site location relative to the regional geology is presented on Plate 2.

2.2. REGIONAL FAULTING AND HISTORIC SEISMICITY

Major or active fault zones of California are generally distant from the Sacramento Valley as shown on the Regional Fault and Historic Seismicity Map, Plate 3 and include (from west to east as identified by Jennings, 1994):

- San Andreas Fault Zone (Historic) - 110± miles west
- Rodgers Creek Fault (Historic) - 90± miles west
- Coast Ranges-Sierran Block Boundary Zone (Historic; Blind Rupture) - 50± miles west
- Sierra Nevada Frontal Fault System (Historic) - 65± miles southeast

Because of these distances from the site, these faults would be expected to generate small to moderate ground shaking at one of the bridge locations during a major seismic event.

Historical seismicity data, as shown on Plate 3, indicates that the majority of large Moment Magnitude (Mw) earthquakes have occurred along these more distant faults to the west of the site. Historical earthquakes generated along the Foothills Fault System which has traces trending though the project area are typically less than 4.9 Mw, and occur less frequently than earthquakes produced on the faults to the west.

2.3. EARTHQUAKE GROUND MOTIONS

The potential ground motion has been estimated in the vicinity of the project site using the California Geological Survey's (CGS) website at: http://earthquake.usgs.gov/hazmaps/interactive/. This web page provides regional ground motions for an area by entering the latitude and longitude of a given location. These estimated values are calculated by the CGS utilizing the probabilistic seismic hazards analysis (PHSA) method. The PHSA approach is based on the characteristics of the historic earthquake and of the potential fault sources. This map indicates the site may be subjected to a peak horizontal ground acceleration (PGA) in hard rock conditions of about 0.10g for the Design Basis Event (DBE) which is defined as a 10% probability of occurrence in 50 years. It should be noted that this is a preliminary value based on regional data. A site specific seismic hazards analysis should be performed for the final bridge location.

2.4. REGIONAL GROUNDWATER CONDITIONS

The site is located in a canyon with shallow alluvium forming the base of the canyon and thin soil overlying bedrock forming the canyon slopes. Groundwater conditions in the alluvium along the river channel are expected to be near the ground surface. Groundwater in the canyon slopes is expected to consist of fracture flow and perched groundwater near the soil – bedrock contact, with gradients toward the bottom of the canyon. Groundwater levels area expected to fluctuate seasonally during longer dry and wet cycles. The Department of Water Resources Groundwater Data web page (2007) was reviewed for regional groundwater data. However, because this is a bedrock region, no wells with accompanying data were available for review in the

Auburn area. Several studies in the project area performed by Kleinfelder have encountered perched and fracture flow groundwater as high as 10 feet below the ground surface (bgs). Seeps were observed in excavations for the Auburn Dam at depths ranging from near the ground surface to well over 100 feet below the top of the excavation. Seeps were also observed in exposed bedrock along the river embankments within the project area.

2.5. AERIAL PHOTOGRAPH INTERPRETATION

Several aerial photographs of the project area were reviewed as part of this study. The photographs were reviewed to evaluate photolineaments in the project area that might represent faults or persistent discontinuities. The photographs were also used as a tool for mapping the different geologic units within the project area including different weathering conditions of the bedrock and landslide deposits.

The review did not find any significant lineaments on or projecting toward the selected bridge locations. However, several prominent lineaments were identified near the project area, on the slopes above the river trending 15 to 35 degrees northwest. Comparing these photolineaments with fault and geology maps of the area, they likely represent shear zones associated with the Maidu Fault. In addition to the photolineaments, the aerial photographs also provided indications of slope instability features and geologic contacts in the project area which are discussed below in Project Area Geology, Section 1.6, and presented on the Engineering Geology Map, Plate 5.

2.6. NATURALLY OCCURRING ASBESTOS

The project area is mapped by the CGS (2006) as being both within an area more likely to contain NOA based on the presence of serpentine and ultramafic rocks and within a zone where faults and shears exist that may locally increase the relative likelihood for the presence of NOA. Mapping by the USBR (1977) and Kohler (1984) both indicate the presence of serpentine and ultramafic rocks, as well as faults in the region and project area.

2.7. PROJECT AREA GEOLOGY AND STRUCTURE

Geologic mapping was performed for this study along an area that follows the American River from a point approximately 500 feet upstream of the lower diversion outlet at the Auburn Dam site to a distance about 1 mile downstream at the Oregon Bar, as shown on the Project Boundary and Engineering Geologic Map, Plate 1. Published geologic mapping has been performed in the project area by Wagner (1981) at a scale of a 1:250,000, Kohler (1984) at 1:48:000, and by the USBR (1977) at 1:2,400. The USBR mapping extended from the north end of the project area (approximately 500 feet north of the lower diversion outlet) to a point about 1,500 feet downstream of the same diversion outlet. Where this map covered the project area it was used as a base map and modified / corrected during mapping performed for this evaluation. Downstream of this point Kohler was used as the base map and again, modified / corrected as necessary. Based on mapping by Kleinfelder, and others the project area is underlain primarily by amphibolite, serpentine, and talcose serpentine. Granitic rocks were mapped adjacent to the west and southwest borders of the project area, and numerous small, hard, silica-rich dikes and quartz veins were observed within the project area.

The amphibolite was characterized by light grey and grey-green color, with mineral foliation generally following the regional trend of north-northwest and commonly forming a weakly defined schistose fabric. Larger, more persistent discontinuity type foliation was also common. This foliation also followed the regional trend and dipped steeply toward the southwest and northeast. The serpentine was typically more massive, and grey-green color. Shears within the serpentine resulted in a talc texture/mineralization with a moderately well defined north-northwest foliation.

For the purpose of this study, these rock units were not differentiated during mapping. The intent of this study was to identify areas of rock more suitable for foundation placement based on geologic engineering properties – including rock hardness, weathering, and discontinuities. When a final bridge selection is chosen a site-specific geologic and geotechnical investigation should be performed during which detailed geologic and discontinuity mapping should be performed at that specific location.

Because the rock hardness could be correlated to the degree of weathering, the rocks along the project alignment were mapped based on degree of weathering forming two basic units: decomposed to highly weathered (map symbol bx_{d-h}) and moderately weathered to slightly weathered (map symbol bx_{m-s}). Fresh rock was not encountered during this investigation. Rocks mapped under the more weathered criteria were typically soft to moderately hard and very closely to closely fractured with abundant clay and silt infilling. The moderately to slightly weathered rock unit was typically hard to very hard with wide fracture spacing (greater than 2 feet). Discontinuity aperture width typically ranged from closed to 1 inch wide, with minor clay and silt infilling. It should be noted that exceptions do exist, with discontinuity aperture widths up to 6 inches wide being observed occasionally in this less weathered unit.

Other geologic units mapped within the project boundary included:

- Fill (map symbol 'f')– loose to dense silty sand, sandy gravel, and gravel with cobbles and small boulders. Located within the construction zone of the Auburn Dam site only.
- Talus (map symbol 't') – loose gravel to boulder sized rock fragments forming mappable units on the down-slope sides of existing road excavations.
- Active Stream Deposits (map symbol 'Qas') - consisting of sand, gravel, and cobbles,
- Alluvium (map symbol 'Qal') – loose sand, gravel, cobbles, and boulders up to 24 inches across typically forming bars and embankments next to the active channels, and
- Landslide deposits (map symbol 'Qls') – Generally a heterogenous mix of clay, silt, sand and gravel to boulder size rock fragments exposed along the river embankments. Commonly mapped based on hummocky topography, visible headscarps, and distinct, sharp contact of reddish brown material described above lying unconformably over the bx_{m-s} unit. In some instances a slide plane could be identified. Several bedrock slides were also mapped based on visible headscarps and identified failure planes exposed along the river embankment.

These geologic units are presented on the Project Boundary and Engineering Geologic Map, Plate 1 and on the plan and profiles for the individual bridge alternatives, Plates 4 through 6.

Five distinct discontinuity sets were identified at the different bridge locations during mapping performed for this study. The average orientation of data representative of these discontinuities is presented below.

Set A – N23W, 75NE (foliation)
Set B – N63W, 22SW
Set C – N18E, 31SE
Set D – N35E, 51NW
Set E – N65E, 87SE

These five sets were found to represent two primary structural domains. Sets C and E appear to be confined to the west/north (same) side of the river at Oregon Bar and Upper Outlet Rapid locations. Sets B and D appear more often on the east/south (same) side of the river at the two aforementioned locations as well as at the Existing Crossing at Auburn Dam site. This data suggest there may be a structural control trending through and parallel to the channel in the project area which has resulted in discontinuity sets with different orientations on either side of it. Unlike the joint discontinuities, the foliation was uniform throughout the different bridge sites and sides of the river.

The kinematic stability of these discontinuities was evaluated relative to their orientation of the canyon slopes on which they are exposed. This analysis is discussed in detail in the Markland Kinematic Analysis, Section 2.9.5.

2.8. PROJECT AREA FAULTING

In the project vicinity, the Foothills Fault System (FFS), represented by the Wolf Creek – Maidu faults, is mapped in the project area. Historic seismicity (primarily low to moderate intensity events) aligns well with portions of this system and suggests that the system of faults is at least capable of generating small earthquakes at depth. Elevation surveys performed in the foothill region indicate ground deformation is occurring along some of the FFS traces at the present time. Ground rupture occurred during the 1975 Oroville earthquake along the northern extent of this fault (Cleveland Hill fault located 41± miles north). This rupture was studied by the California Geological Survey (formerly California Division of Mines and Geology) and was placed within an APEFZ and is thus still considered capable of ground-surface rupture. This earthquake also generated considerable interest in the age of movement along the Maidu East fault exposed in excavations made for the Auburn Dam that was under construction at the time of the earthquake. Mapping was performed in the dam site by the U.S. Bureau of Reclamation (1977) in response to this interest. There mapping identified a number of traces of the Maidu East Fault Zone trending through the right abutment of the dam site. Some of these traces were identified cutting the Mehrten Formation up to 5.5 meters. A study by the California Geological Survey (1980) to establish probable age relationships of movement along the fault concluded that there was no equivocal evidence for fault movement younger than early Pleistocene. This study also noted that there is a slight chance that small displacements along the Maidu East fault zone could have occurred during the late Pleistocene without being recorded in the available strata.

The other fault trace located near the site that is a part of the FFS is the Dewitt Fault, located approximately 3 miles north of the site. According to Jennings (2005) movement along this fault is considered late Quaternary. However, a study entitled "Characterization of Potential Earthquake Sources for the Rock Creek (Drum) Dam" by Pacific Gas and Electric (1994) found deformation of late Pleistocene-Holocene colluvium indicating displacement along the fault in the past 8,000 to 14,000 years. Additional data from this study suggested there may be possible deformation of even younger colluvium which dates movement along the fault at less than 4,000 years.

2.9. ANALYSES AND FINDINGS

2.9.1. Markland Kinematic Analysis

To evaluate the stability of the discontinuities at the three selected locations, and whether rock bolting or similar mitigation would be required, a Markland kinematic analysis was performed using discontinuity data representative of major joint sets and foliation observed at the sites. Where the stability of a rock cut is controlled by the structure of the rock mass, a Markland analysis can be used to estimate the kinematic potential for rock blocks to fail out of the existing or proposed slopes. The information required to perform an analysis are the design slope dip and dip direction, the orientation of the discontinuities within the rock mass, and the friction angle of the discontinuities.

A kinematically possible wedge failure is identified when a point defining the line of intersection of 2 planes falls within the area included between the great circle defining the slope face and a circle defined by the angle of friction ϕ. A planar failure is a specialized form of a wedge failure that follows the same criteria above and also must fall within ± 20° of the dip direction of the slope face.

Orientation data representative of the major discontinuities observed at the alternative bridge locations was plotted on stereonets using the computer programs Dips® Version 5.0 by Rocscience and ROCKPACK III by C. F. Watts (2001). Data was plotted as dip vectors which lend themselves to performing Markland analyses.

The Markland analysis does not consider a cohesion intercept when modeling the strength of discontinuities. This method also assumes that the discontinuities are continuous and through going with no “bridging” within the discontinuity. The effect of “bridging” would allow a tensional component (or cohesion intercept) of discontinuity strength. The Markland Analysis was performed as follows. When the dip of a discontinuity or the plunge of the line of intersection is greater than the friction angle, the factor of safety is less that 1.0. When the dip of a discontinuity or the plunge of the line of intersection is less than the friction angle, the factor of safety is greater than 1.0. In either case, the dip or plunge has to be less than the dip of the slope face, or the structure will not daylight the slope.

A basic rock discontinuity friction angle of 27 degrees was assumed based on the Rock Slopes Reference Manual (FHWA, 1998). This value represents the typical base friction angle value for slate type rock. Although slate was not observed at the bridge locations, the foliation commonly exhibited by the amphibolite and talc schist was assumed for the purposes of this evaluation to behave similar to a slate type rock.

A single data point (shown below in the stereo net plots as a triangle) representative of each of the major discontinuity sets observed at the different bridge crossings was used to perform a Markland kinematic evaluation of the rock mass. These points were plotted relative to great circles representing the aforementioned base friction angle and the orientation (dip direction and dip angle) of the steepest portion of the slope at the proposed bridge locations. Performing a Markland kinematic evaluation provided a preliminary “first screen” of the discontinuities and their stability relative to the current slope on which they were located. The results of these analyses should be used as a starting point for further, more detailed stability analyses and stability mitigation designs during the site specific geologic and geotechnical investigation. Figures 1 through 5 below show the stereo net plots for the east and west sides of the proposed bridge locations at Upper Outlet Rapids, and Existing Crossing at Auburn Dam (west only) and the north and south sides of the Oregon Bar Crossing.

Figures 1 and 2: Lower hemispherical plot of combined discontinuity data-Oregon Bar Bridge Location

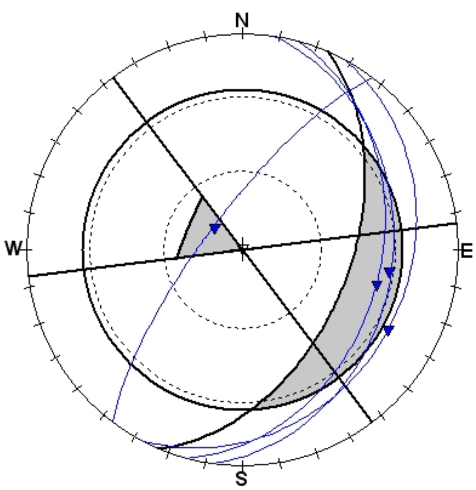


Figure 1: North Bank Oregon Bar

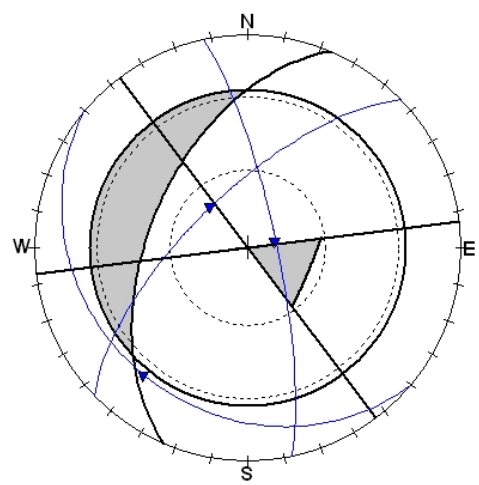


Figure 2: South Bank Oregon Bar

Figures 1 and 2 show the Markland Evaluation for the Oregon Bar Bridge location. The evaluation suggests that there are no adverse discontinuity planes or potential wedge or toppling failures relative to the existing slope at the south embankment. The stereo net plot for the north bank indicates there are two discontinuity sets that could result in block failures and toppling along the steeply dipping (foliation) discontinuity may also occur. Wedge failures (defined by the intersection of two great circles) appear to be just outside of the critical zone (shaded).

Figures 3 and 4: Lower hemispherical plot of combined discontinuity data- Upper Outlet Rapid Bridge Location

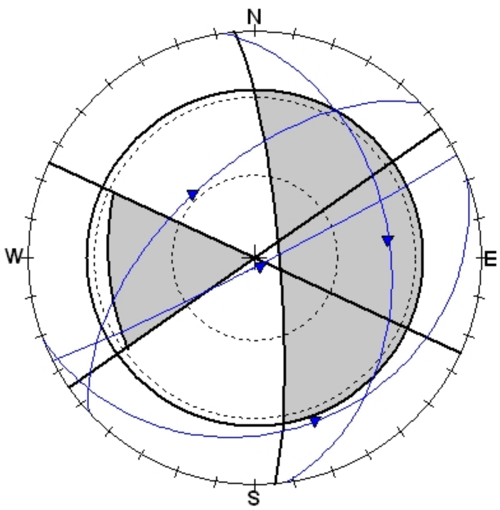


Figure 3: West Bank Upper Outlet Rapid

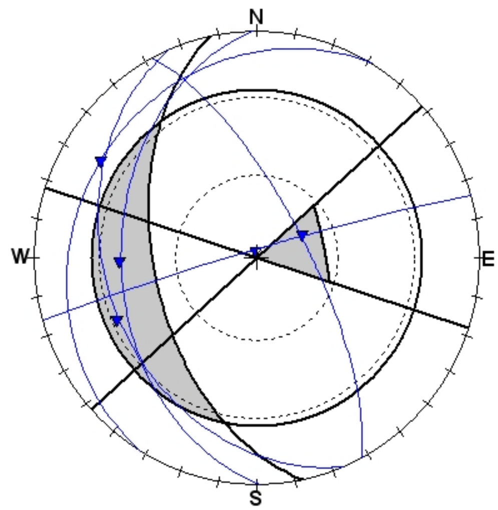


Figure 4: East Bank Upper Outlet Rapid

Figures 3 and 4 show the Markland Evaluation for the Upper Outlet Bridge location. The evaluation suggests that there are two adversely dipping discontinuity planes in the east slope and one adversely dipping discontinuity on the west slope of the bridge location. In addition, intersecting discontinuity planes form at least one potential wedge failure on both slopes with a second potential wedge failure identified on the boundary of the shaded critical area for the west slope. A potential toppling plane was identified on the east slope.

Figure 5: Lower hemispherical plot of combined discontinuity data- Existing Crossing at Auburn Dam Bridge Location

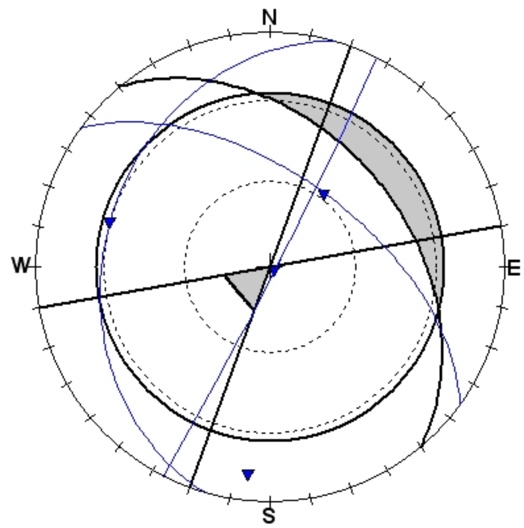


Figure 5 shows the Markland Evaluation for the Existing Crossing at Auburn Dam Bridge location. The evaluation suggests that there are no adverse discontinuity sets, wedge, or toppling failures on the west slope of this bridge location. The east side of the bridge location is composed entirely of fill of unknown depth, and as such, discontinuity data could not be obtained as part of this scope.

It should be reiterated that the results of the Markland evaluations discussed above are preliminary and for "screening" purposes only. The absence of adverse discontinuity conditions based on this evaluation does not preclude the potential for such conditions to be identified in a detailed site-specific study. In addition, a site specific study should evaluate current and proposed slope gradient stability utilizing site-specific shear strength data, additional discontinuity data, and groundwater conditions (particularly along discontinuities). Other stability evaluation methods such as limit equilibrium and sliding block analyses should also be considered for evaluating the existing and proposed excavations at the final bridge location.

2.9.2. Geologic Hazards

Based on review of available data and mapping performed for this investigation several geologic hazards were identified in the project area including the presence of Naturally

Occurring Asbestos and unstable slope conditions. Detailed discussions of these finding are presented below.

2.9.2.1. Naturally Occurring Asbestos

Asbestos is a term given to a group of naturally occurring, fibrous minerals that possess unique flexible yet heat resistant and high tensile strength properties. Asbestos was mined in the western Sierra Foothills and was commonly used as a heat insulator and in automotive brake linings until the mid-1970's when it was discovered to be harmful to humans if inhaled over long exposure periods. Asbestos minerals or naturally occurring asbestos (NOA) remain present in certain natural environments and, when disturbed, can become airborne.

Minerals known to contain asbestos-quality (i.e. asbestiform) fibers include ultramafic minerals of the amphibole group and phyllosilicates (Deer, 1975). Rock types associated with these minerals are accordingly known as amphibolites (i.e. >10% amphibole minerals) or serpentinites (i.e. >10% serpentine minerals), respectively. Both of these rock types are ultramafic rocks.

Mapping for this investigation confirmed that the project geology is consistent with the geologic and naturally occurring asbestos maps for the project area. The project area is underlain by amphibolite and serpentine rocks, both of which are composed primarily of NOA type minerals. In addition, macro-size NOA fibers were observed on rocks in the Auburn Dam site during mapping performed for this investigation.

2.9.2.2. Unstable Slopes

Several mechanisms of slope failure were identified and mapped in the project area. These include translational (with likely some rotational component) soil and decomposed rock landslides, debris flows, bedrock slides, and rock topples. The soil and decomposed rock landslides were identified through their characteristic red color and heterogeneous content contrasting with the light grey and green colors of the hard bedrock on which they overlaid. This feature in conjunction with hummocky topography that could be mapped up the canyon slope and, in some cases, head scarps at the top of the failures made these easily recognizable. Debris flow scars were observed in several locations with bedrock exposed at the base of the scar indicating mass wasting had occurred with the entire mass of upper weaker material sliding on the harder, more competent bedrock surface into and being carried away by the river (probably during high flow events). Bedrock slides were less prevalent, but were identified in several locations within the project area. These were identified where traceable bedrock units were clearly offset toward the river, and in one case, the failure plane between the failing and stable bedrock was exposed through a lateral exposure as a result of the upslope section of the slide having been completed removed and washed away. Evidence of rock topple failures were noted throughout the project area where the original locations of boulder sized rocks laying loose on or near the bottom of the channel could be identified higher on the slope.

These slope failures, with the exception of the rock toppling, appear to be associated with thick accumulations of colluvium and decomposed rock overlying less weathered material. Although not observed during this investigation, seepage likely was a controlling factor in the failure mechanism. Bedrock failures appear to be associated with adverse dip conditions of discontinuities and are probably most commonly associated with high water events. During these events the river may erode the toe of the rock slope, reducing the strength of slope. This condition, combined with increased water in the discontinuities reduces the strength of these surfaces resulting in movement of the blocks. Topples also likely occur during these high water events when the base of the rock mass is eroded away and the weight of the overhanging rocks exceed the underlying support. These conditions described above result in unstable slope conditions were observed immediately adjacent to the bridge locations selected during this investigation, and should be considered during the final investigation, particularly taking into consideration high flow events

2.9.3. Difficult Excavation Conditions

Bedrock exposed at the selected bridge locations consists primarily of hard to extremely hard rock in blocks ranging from less than 1 foot maximum dimension to over 10 feet maximum dimension. This hard rock will be difficult to excavate will standard earthmoving equipment.

2.9.4. Erosion

Erosion of the bedrock is expected to correlate well with the extent of weathering of the bedrock, with erosion of less weathered rock being minimal but increasing as the rock becomes more weathered. Decomposed rock and soil will likely erode at the highest rates. Similarly, fills developed for the bridge will be more susceptible to erosion forces and may require mitigative design. Bridge approaches are likely to encounter more weathered rock and soil conditions and will therefore, be more susceptible to erosion forces.

2.9.5. High Groundwater Conditions

Although there is not a recognizable groundwater level at the site, groundwater flow through the alluvium in the channel and through fracture flow near the bottom of the canyon does exist. Although the level or volume of water encountered will vary by season, there is moderate to high potential for groundwater to impact the project design – particularly where bridge abutments and piers are designed in or near the active channel.

2.9.6. Permanent Bridge Location Selection Criteria

Using the above geologic and engineering geologic criteria, areas within the project boundary were evaluated for potential permanent bridge crossing sites. Potential bridge sites were selected based on the absence of the Qls and bx_{d-h} units and where the bx_{m-s} unit was exposed for a considerable lateral and vertical distance. This methodology was based on the assumption that the greater the exposure of the bx_{m-s} unit, the less the construction cost would be compared to bridge locations sited on decomposed to highly weathered rock which would require larger excavations and mitigations to site the foundations on competent rock. Although adverse discontinuities were noted (and recorded) at the potential sites, this criteria was not utilized in the initial elimination process. A discussion of the discontinuities at each selected bridge site is presented below in Section 1.8. Based on this selection methodology five sites were chosen originally and were identified as:

- Existing Crossing at Auburn Dam
- Upper Outlet Rapid

- Lower Outlet Rapid
- Knickerbocker Canyon
- Oregon Bar

It should be noted that a sixth bridge location identified by Montgomery Watson Harza (2005) during a previous bridge alternatives location study was identified near the downstream cofferdam and was also considered during this evaluation. This list of six was reduced to three at the request of the California State Department of Parks and Recreation. Sites were eliminated by prioritizing them based on qualitatively evaluating the degree of anticipated geotechnical mitigation that would be required to construct at a specific site. The three final sites chosen included Oregon Bar, Upper Outlet Rapid, and Existing Crossing at Auburn Dam. These three sites were chosen over the other three potential locations because they will likely have the following conditions:

- Fewer and less persistent discontinuities,
- Require less grading for development of approaches and foundation pads,
- Greater exposure of more competent bedrock at target elevations likely resulting in smaller foundations, and
- Less likely to be impacted by landslides and other slope instability issues.

It should be noted that these are preliminary conclusions based on limited data. Verification of these conditions should be performed through site specific geologic and geotechnical investigations.

Plan and profiles of these three final locations showing the geologic and structural conditions are presented on Plates 4 through 6.

3 CONCLUSIONS AND RECOMMENDATIONS

Based on findings presented above in Section 2, three locations have been identified that are suitable for a bridge crossing location. However, there are a number of geologic and geotechnical issues identified that should be considered in the project design. These issues include, encountering naturally occurring asbestos during the grading operation, stability of the rock mass both under and surrounding the bridge abutments and approaches, slope stability of the more weathered rock and soil units, hard rock excavation conditions, erosion, and high groundwater in bridge foundation excavations in or near the current channel.

Foundation discussions below are based on preliminary designs provided by HDR for the Upper Outlet Rapid and Oregon Bar Crossings. These preliminary designs indicate a 3-span steel truss bridge with two center piers near the river and abutments on the sloping banks, or a stress ribbon bridge with abutments on the sloping banks is being considered for the Oregon Bar location. A single-span, precast concrete, suspension bridge is proposed for the Upper Outlet Rapid location. Plans were not provided for the Existing Crossing at Auburn Dam site, and therefore foundation recommendations for this crossing are not presented herein. Kleinfelder understands this site is the least likely of the three permanent bridge locations to be chosen due to its location within the Auburn Dam site.

3.1. NATURALLY OCURRING ASBESTOS

Based on the presence of NOA in the project area a NOA Fugitive Dust Mitigation Plan will need to be prepared and implemented for use during the grading operation of the project. This workplan will outline mitigative measures to be taken during the earthwork phase of the project as outlined by the California Air Resources Board's, Asbestos ATCM for Construction, Grading, Quarrying, and Surface Mining Operations, and Placer County's Rule 228 for Fugitive Dust. In general these will include dust suppression measures by the grading contractor, air monitoring, and geologic monitoring of the excavations by a qualified geologist.

3.2. ROCK EXCAVATABILITY AND OVERSIZED ROCK

Hard bedrock conditions exist at the selected bridge locations, as discussed above, in Section 2.9.2. Because of these hard rock conditions, specialized grading equipment should be anticipated for use in excavating foundation pads and approaches such as large excavators and or bulldozers, large model hoe-rams and/or blasting. Blasting has been utilized for grading of the Placer County Water Agency's pump station located upstream of the project area and within similar geologic material. Due to the larger block sized observed at the three bridge locations oversized material will be generated. Fills are not anticipated for any of the three bridge locations, however, disposal of these oversized rocks should be considered in the final design. It is recommended a grading contractor review the final bridge location to provide recommendations for suitable grading equipment and methods.

3.3. EROSION

Erosion of the harder rock masses is expected to be minimal. Rock bolting is recommended to secure blocks identified as having a potential to move per the Markland analysis detailed above and any subsequent site specific stability analyses. Excavations for the bridge foundations and approaches are likely to extend into less weathered rock and colluvium. These less resistant materials are likely to erode during the wet season and as such, the final design should include mitigative measures such as (but not limited to) erosion fabrics and netting, plantings, brow ditches, and shallow slope gradients, to minimize this erosion.

3.4. BRIDGE FOUNDATIONS

The currently proposed bridge alternatives at the Oregon Bar location includes a 3-span steel truss bridge with two center piers near the river and abutments on the sloping banks, or a stress ribbon bridge with abutments on the sloping banks. A single-span, precast concrete, suspension bridge is proposed for the Upper Outlet Rapid location. It is Kleinfelder's assumption that these designs were based on the foundation resting on moderately to slightly hard to extremely hard bedrock (bx_{m-s} unit).

Likely foundation alternatives for the proposed bridge include shallow spread footings, reinforced concrete cast-in-drilled-hole (CIDH) piles, and micropiles. Each of these foundation systems should bear in undisturbed bedrock. Due to the presence of adverse fracturing in the bx_{m-s} bedrock units observed along the slopes at the abutment locations, it may be necessary to install rock bolts to reinforce the rock mass beneath spread footings to achieve the required bearing capacity. Alternatively, CIDH piles cored into rock or micropiles drilled into rock could be used for support of the bridge foundations. The piles will need to extend below the potential failure plane at the abutment locations. Depending on scour potential and scour loading conditions, it may be necessary to anchor spread footings to the rock at the truss bridge pier locations. The proposed bridge design options also include rock anchors at and near the abutment locations for restraint of tension loads due to the bridge deck or suspension cables.

We have presented preliminary recommendations below for design of foundations and rock anchors for the two bridge sites presently being considered. Final design studies should include evaluation of the rock mass properties at each abutment location.

3.5. SPREAD FOUNDATIONS

3.5.1. Allowable Bearing Pressures

If spread footings are used for foundation support, they should be founded in undisturbed bedrock. For a typical bridge abutment foundation that is at least 2 feet wide and embedded at least 1 foot into bedrock, an allowable bearing pressure between about 2,500 to 4,000 psf appears possible. It may be necessary to reinforce the rock mass with rock anchors where adverse rock fracturing is present at the footing locations. Preliminary recommendations for rock anchor design are presented in the following sections of this report.

Considerations in the project design should be made to mitigate groundwater conditions encountered during construction. Groundwater levels, as discussed above in Section 2.9.4 may be encountered – particularly if construction is performed during or shortly after the wet season. The highest groundwater flows should be anticipated where foundations are constructed in the alluvium within the channel. Fracture flow through the bedrock fractures may also impact project design.

3.5.2. Estimated Settlements

Total settlement of an individual foundation will vary depending on the plan dimensions of the foundation, the actual load supported, and the design of any rock anchor reinforcement. Settlement is expected to be minimal provided foundations and rock anchors are properly designed and constructed.

3.5.3. Rock Anchors

Due to the nature and orientation of discontinuities observed in the rock mass at the bridge abutment locations, rock anchors may be needed to reinforce the individual rock blocks in order to provide support for a shallow foundation. In addition rock anchors may be used to resist tension forces from bridge deck or suspension cable anchor housings. Note that the recommendations presented below are based on the assumption that the bridge foundation will be located on the bx_{m-s} bedrock unit. Rock anchors described below may not be effective in the more weathered bedrock material and soils units, and should be evaluated for each of these different materials.

Rock anchors can be classified as either deadman or prestressed. Deadman anchors are defined as those anchors that are not loaded until the structure is loaded. Prestressed anchors are preloaded following installation of the anchor. Therefore, most of the initial strain of the prestressed anchor system is removed before the structural load is applied. This allows the full capacity of the anchor to be attained at very small deformations. Prestressed anchors also can be proof loaded to their design load at the time of installation.

There are two types of prestressed rock anchors including mechanical and grout bonded rock anchors. Mechanical rock anchors are suited for use in competent rock. Grout bonded rock anchors can be used in all rock conditions.

It appears that prestressed, grout bonded, rock anchors could be used for reinforcement of the rock mass beneath the bridge abutments at this site as well as any bridge deck or suspension cable anchorages. Where deflections are not critical, deadman, grout bonded, rock anchors could be used.

For a typical 4 to 6 inch diameter rock anchor, the anchor capacities typically range from about 25 to 50 kips. The rock anchor bond zones should extend beyond the lowest adverse joint set (theoretical failure plane dipping towards the river) beneath the bridge abutment or cable anchor foundations (see Table 2 below). The portion of the anchor above the potential failure plane should be unbonded. The rock anchor bond zones should be spaced a minimum of 5 feet center to center to minimize interaction effects between adjacent anchors.

Rock anchors should be designed in accordance with the procedures outlined in the Post-Tensioning Institute's "Recommendations for Prestressed Rock and Soil Anchors," 2004 edition. Based on the results of our preliminary field investigation and geologic mapping, the subsurface conditions expected to affect bridge foundation and rock anchor design at the Oregon Bar and Upper Outlet Rapids sites are presented below.

Location	Rock Type	Depth to potential failure plane (feet)	Allowable grout to rock bond stress (psi)*
Oregon Bar West Abutment	Serpentinite	15	150
Oregon Bar West Abutment	Serpentinite	15	150
Oregon Bar Piers 2 and 3	Serpentinite	Not applicable	150
Upper Outlet Rapids West Abutment	Serpentinite	5	150
Upper Outlet Rapids East Abutment	Serpentinite	35	150
Upper Outlet Rapids Piers 2 and 3	Serpentinite	Not applicable	150
Upper Outlet Rapids West Cable Anchor	Serpentinite	40	150
Upper Outlet Rapids East Cable Anchor	Serpentinite	40	150
*Post-Tensioning Institute, "Recommendations for Prestressed Rock and Soil Anchors," 2004 edition			

Properly constructed, prestressed or deadman anchors in undisturbed bedrock may be designed based on the grout-rock interface bond. The allowable tension capacity may be estimated based on the following equation:

$$P_{all} = \pi B L_b S$$

Where:

P_{all} = Allowable uplift capacity
B = Rock anchor diameter
L_b = Bond anchor length
S = Allowable average grout-rock bond resistance (includes Factor of Safety of 2)

Rock anchors designed according to the above equation are based on straight-sided anchors cored into bedrock with either a rotary or percussion drill. Since the rock mass is highly fractured, the actual grout volume required may be larger than the theoretical grout volume for the anchor shaft. However, if grout volumes are considerably in excess of the theoretical volume, grout may have been pumped into rock fractures or voids. The cause should be investigated and any suspect anchors should be rejected. In addition, the grout surface of the completed rock anchors should be observed for any evidence of subsidence after completion of the grouting operations. If subsidence occurs, the completed rock anchor should be abandoned and the cause investigated. It may be necessary to employ a 2 stage grouting process where grout takes are high. Initial grouting can be performed to seal rock factures around the anchor. Once the grout cures, the hole may be re-drilled and re-grouted and the anchor installed. Rock anchors are typically proof tested to 120 percent of their design load.

3.5.4. Micropiles

Micropiles could be used for foundation support in lieu of spread footings with rock anchors. The micropile should derive its capacity in undisturbed rock below the theoretical failure plane beneath the abutment foundations (see Table 2). Guidelines for design and construction of micropiles are presented in the Federal Highway Administration (FHWA) manual entitled “Micropile Design and Construction Guidelines,” Publication No. SA-97-070, dated June 2000. Micropiles can be installed in various diameters ranging from about 7⅝ to 15 inches and at any angle.

We have provided recommendations below for design and construction of 8-inch diameter micropiles. Depending on the bridge foundation loadings and the Contractor’s capabilities, larger diameter micropiles may be also be suitable for this project.

However, additional analysis and design recommendations will be required if alternative micropile sizes are to be considered.

3.5.5. Preliminary Micropile Axial Capacities

The following geotechnical design criteria and recommendations for micropile foundations are based in part on the current standards of practice described in the Federal Highway Administration (FHWA) manual entitled “Micropile Design and Construction Guidelines,” Publication No. SA-97-070, dated June 2000. We are recommending CASE 1, Type A or B micropiles for this project.

We recommend micropiles penetrate at least 5 feet into competent bedrock materials beneath the theoretical failure planes in the rock mass. The micropile bond length should be installed using Type A gravity grout placement or Type B pressure grout placement methods (FHWA, 2000).

If steel casing is used during drilling, it need not be left in place during grouting unless caving is an issue. Micropiles should be designed to develop their axial tension and compression capacity in side friction along the uncased bond zone. An allowable bond stress value of 150 psi should be used for design. A factor of safety of at least 2 was used in developing the allowable axial capacity. Therefore, the ultimate capacity may be taken as 2 times the allowable capacity. The axial capacity presented herein is based on estimated soil/rock strengths and not the structural capacity of the piles. The 33 percent increase allowed by the 1997 Uniform Building Code for evaluation of temporary wind and/or seismic loadings may be applied to the allowable axial capacities for design purposes. Structural capacity of the piles should be evaluated by the project Structural Engineer.

For preliminary design purposes, it is unnecessary to consider a group reduction factor for micropiles with a typical grouted diameter of 8 inches and typical minimum center to center spacing in the range of 3 times the grouted pile diameter, or greater. Note that the grouted diameter can be greater than the drilled diameter. If micropile spacing is less than 3 diameters center to center, a group reduction factor should be used for design. We recommend Kleinfelder provide the group reduction factor, if necessary, once the bridge site is selected and a design level geotechnical evaluation is performed.

3.5.6. Drilled Pier Foundations

Bridge piers could be supported on CIDH piles cored into the bedrock beneath the river bed sediments. Such a foundation system could also be used at the abutment locations. However, we expect this approach may not be practical due to the potential difficulties in drilling large diameter holes within the bedrock unit along with the site access constraints. Preliminary recommendations for CIDH pile design are presented below.

3.5.6.1. Axial Capacity of CIDH Piles

Piles should be designed to derive their capacity in side friction within the rock unit below the anticipated scour depth. An allowable side friction value of 5,000 psf may be used for preliminary design of CIDH Piles. The upper 1.5 pier diameters should be neglected when evaluating allowable axial capacities. Total, downward capacities estimated from the parameters provided above may be increased by 33 percent for short-term loads due to wind or seismic forces.

We anticipate pier holes will encounter groundwater. Therefore, caving of, or water intrusion into, the drilled pier excavations is likely. Use of casing, bentonite-based drilling fluid, and/or other drilling techniques may be required to minimize caving soil and/or water intrusion into the pier excavations. If water or drilling fluids are present in the pile excavations during concrete placement, concrete should be placed into the hole using tremie methods. Tremie concrete placement should be performed in accordance with ACI 304R. The tremie pipe should be rigid and remain below the surface of the in-place concrete at all times to maintain a seal between the water or slurry and the fresh concrete. The upper concrete seal layer will likely become contaminated with excess water and soil as the concrete is placed and should be removed to expose uncontaminated concrete during or immediately following completion of concrete placement. It has been our experience that the concrete seal layer may be on the order of 3 to 5 feet in thickness but will depend on the pile diameter and construction workmanship.

4 ADDITIONAL SERVICES

4.1. DESIGN LEVEL INVESTIGATION

This report provides preliminary geologic and geotechnical recommendations based on limited data. After a final location is chosen a design level investigation should be performed to further characterize the bedrock and discontinuity conditions and to further evaluate the foundation and rock bolt designs.

4.2. PLANS AND SPECIFICATIONS REVIEW

After preliminary foundations types are selected Kleinfelder should review the conceptual layouts and provide geologic and geotechnical input to further refine foundation selection. In addition, Kleinfelder should conduct a general review of final plans and specifications to evaluate that our earthwork and foundation recommendations have been properly interpreted and implemented during design. In the event Kleinfelder is not retained to perform this recommended review, we will assume no responsibility for misinterpretation of our recommendations.

4.3. CONSTRUCTION OBSERVATION AND TESTING

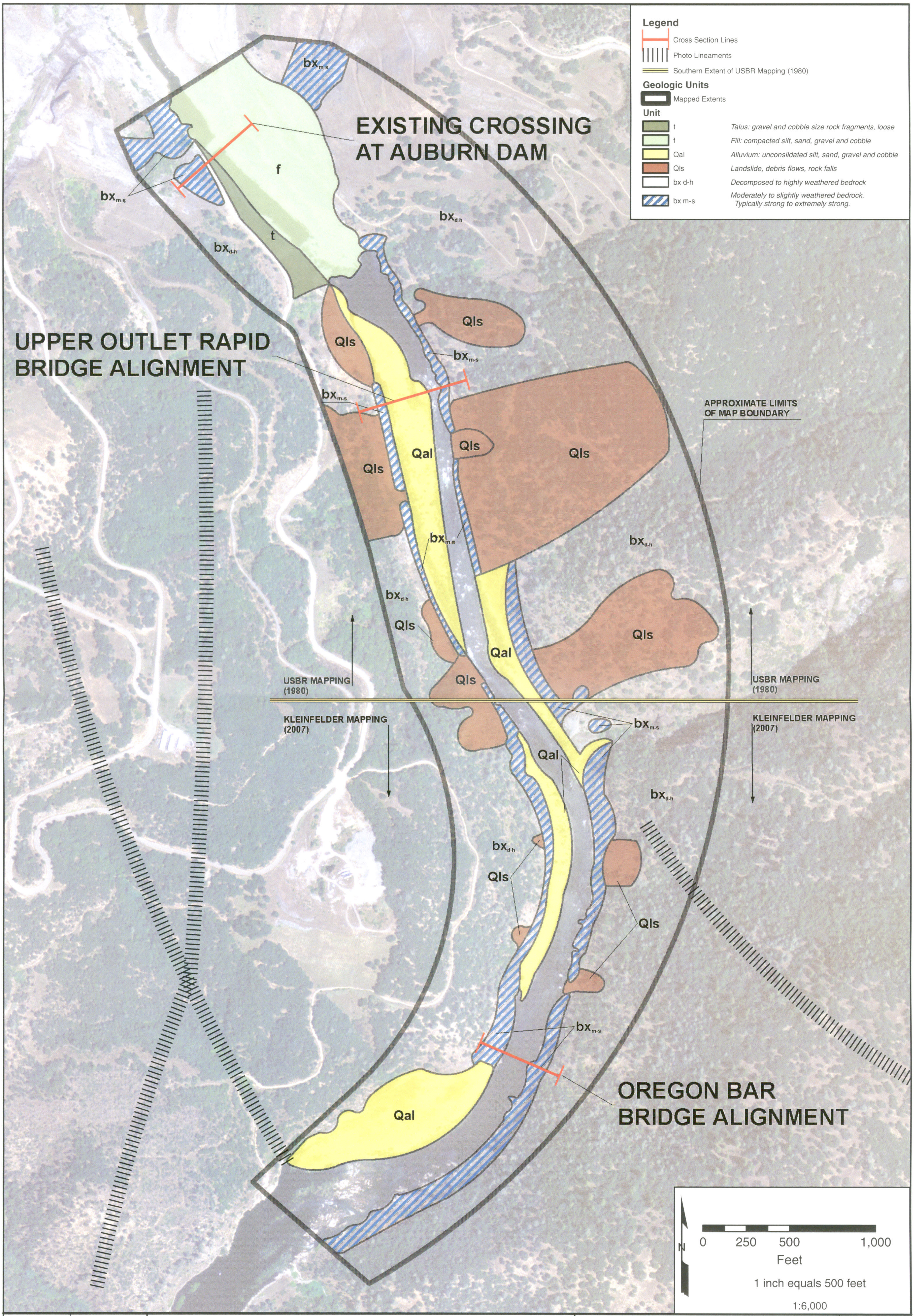
We recommend that all earthwork during construction be monitored by a representative from Kleinfelder, including site preparation, placement of all engineered fill and all foundation excavations. The purpose of these services would be to provide Kleinfelder the opportunity to observe the soil and rock conditions encountered during construction, evaluate the applicability of the recommendations presented in this report to the soil and rock conditions encountered, and recommend appropriate changes in design or construction procedures if conditions differ from those described herein.

5 LIMITATIONS

Recommendations contained in this report are based on our field observations and our present knowledge of the proposed construction. It is possible that soil and rock conditions could vary between or beyond the areas explored but laterally and at depth. If soil and/or rock conditions are encountered during construction, which differ from those described herein, we should be notified immediately in order that a review may be made and any supplemental recommendations provided. If the scope of the proposed construction, including the proposed loads or structural locations, changes from that described in this report, our recommendations should also be reviewed.

We have prepared this report in substantial accordance with the generally accepted engineering geology and geotechnical engineering practices as they exist in the site area at the time of our study. No warranty either express or implied is made. The recommendations provided in this report are based on the assumption that an adequate program of tests and observations will be conducted by Kleinfelder during the construction phase in order to evaluate compliance with our recommendations herein.

This report may be used only by the client and only for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both on site and off site) or other factors may change over time, and additional work may be required with the passage of time. Any party other than the client who wishes to use this report shall notify Kleinfelder of such intended use. Based on the intended use of the report, Kleinfelder may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party.



DATE DRAWN: 4/19/07	DATE REVISED: 5/1/2007	**PROJECT BOUNDARY AND ENGINEERING GEOLOGIC MAP**	KLEINFELDER	PLATE
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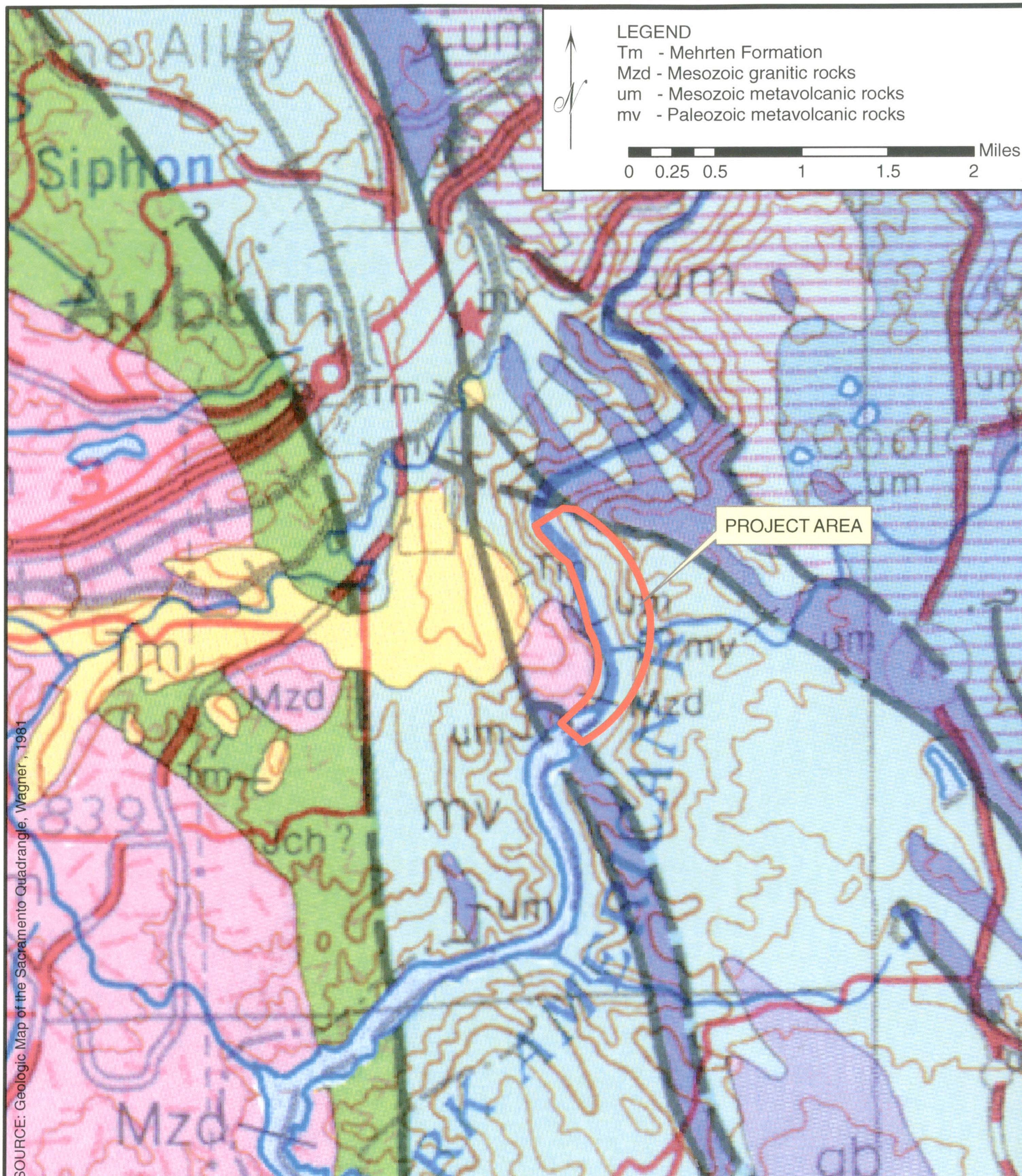
APPROVED BY:		PROJ NO. 80688-1 / FILE NAME: EngGeo.MXD		



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REGIONAL GEOLOGY
(Wagner, 1981)

COOL TO AUBURN BRIDGE TRAIL
ALTERNATIVE ANALYSIS
PLACER AND EL DORADO COUNTIES, CALIFORNIA

DRAFTED BY:	IPM
REVISED BY:	
CHECKED BY:	BA
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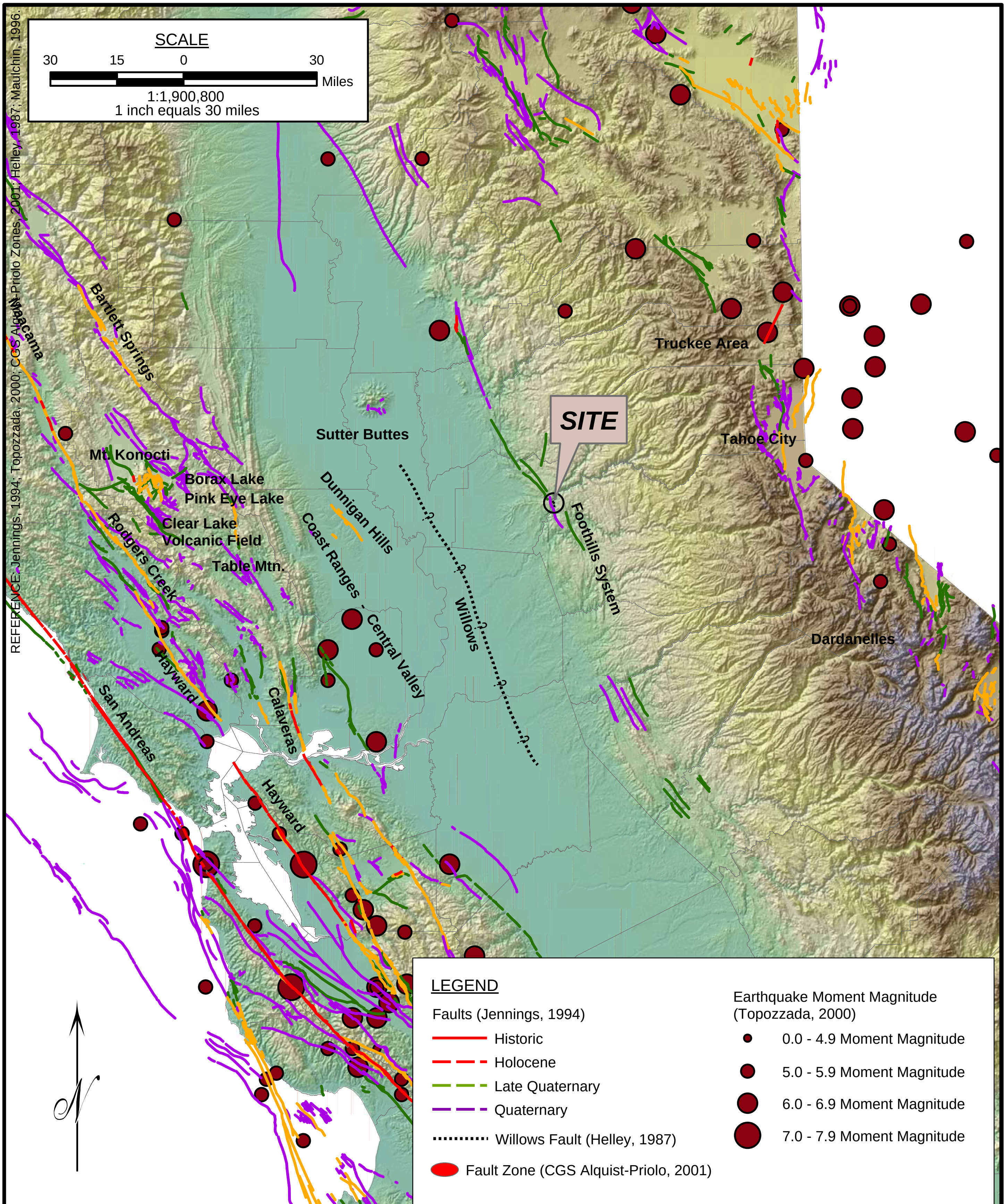

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Graphic By: D. Anderson
Date: 4/19/07

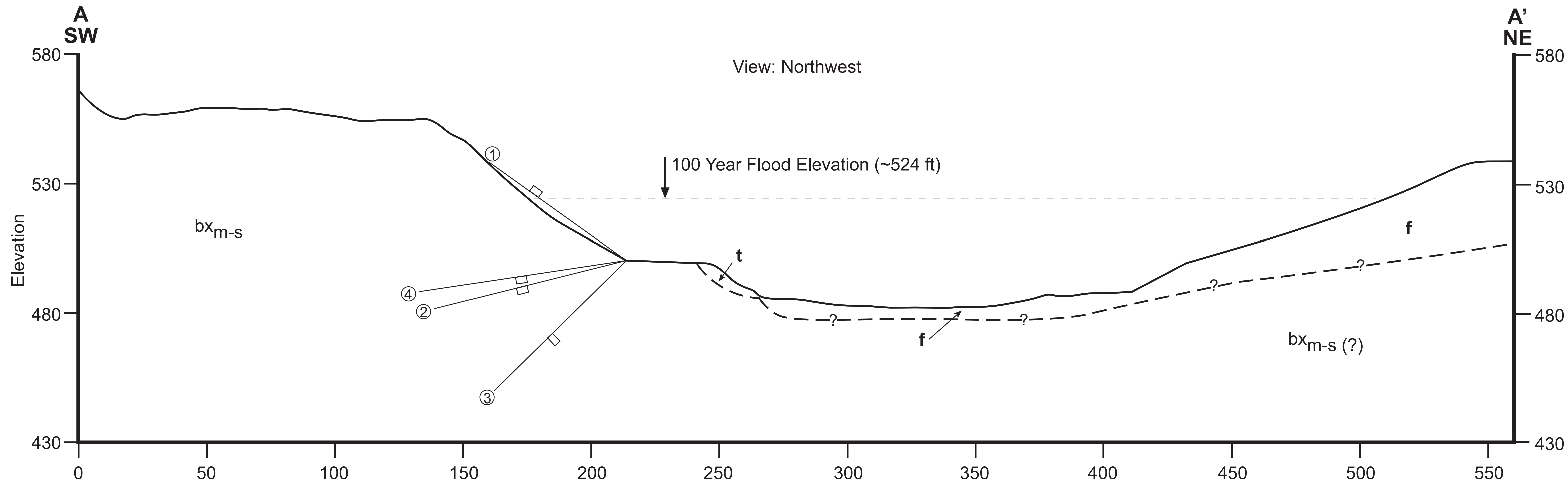
Project No: 60688
File Name: Seismic

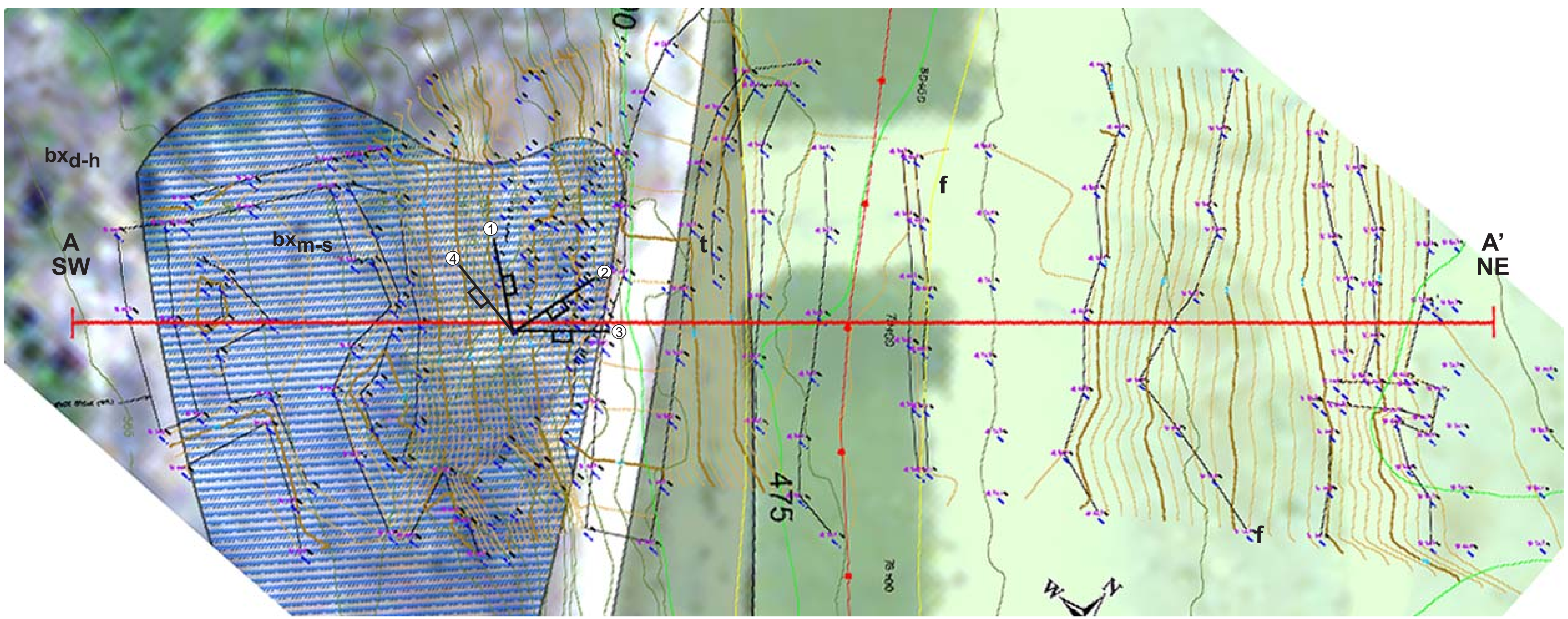
REGIONAL FAULT AND HISTORIC SEISMICITY MAP

EXISTING CROSSING BRIDGE ALTERNATIVE
COOL TO AUBURN TRAIL BRIDGE
ALTERNATIVE ANALYSIS
PLACER AND EL DORADO COUNTIES, CALIFORNIA

Plate

3





Note: Discontinuity lengths and locations shown schematically. Drawn showing apparent dip.

LEGEND

DiscontinuityOrientations

① - N53W 59NE
② - N15E 30NW
③ - N49E 88 SE
④ - N84W 12SW

t - talus
f - fill
bx_{m-s} - Moderately to slightly weathered bedrock
bx_{d-h} - Decomposed to Highly Weathered

SCALE (H&V)

0 50 100

KLEINFELDER

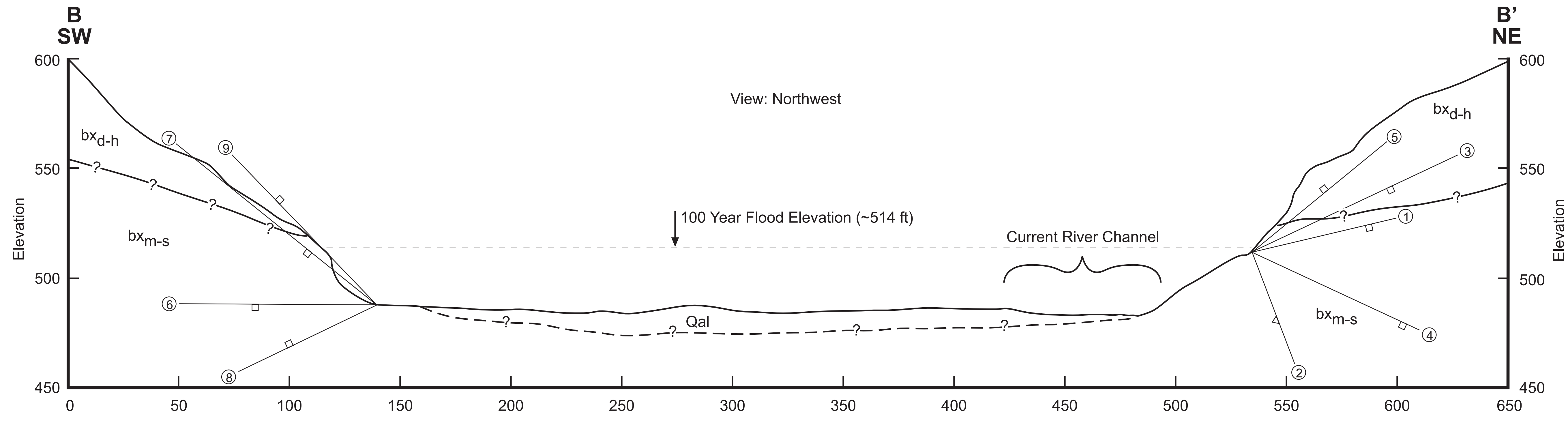
Project No. 80688
Filename: 80688xsecAA.fh11

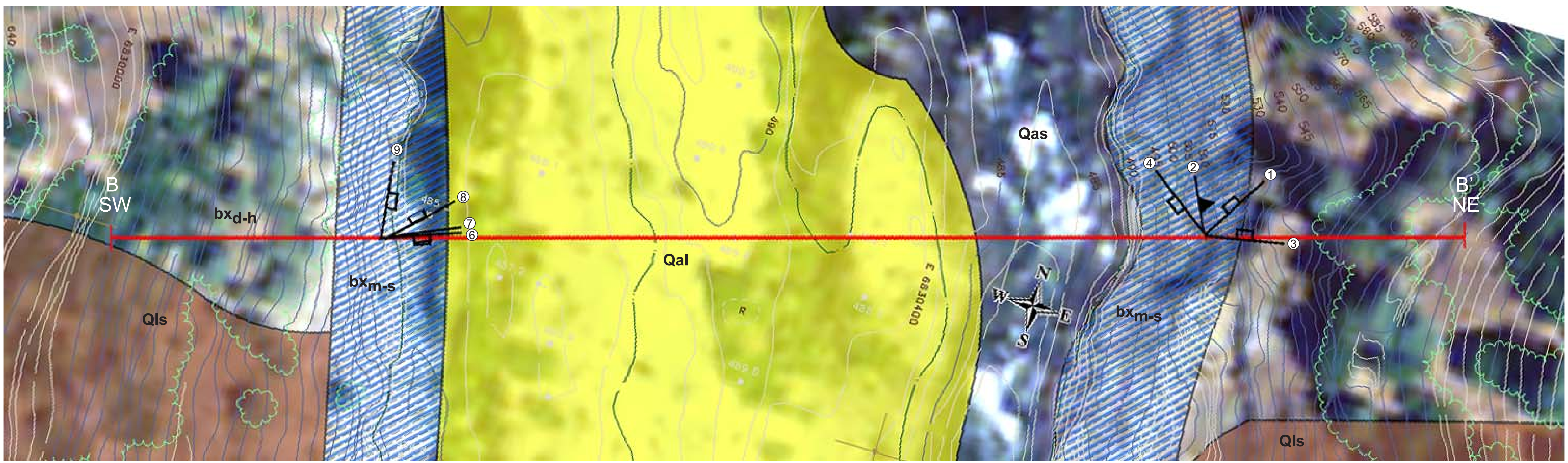
Graphic By: D. Anderson
Date: 4/18/07

CROSS SECTION A-A'

EXISTING CROSSING BRIDGE ALTERNATIVE
COOL TO AUBURN TRAIL BRIDGE
ALTERNATIVE ANALYSIS
PLACER AND ELDORADO COUNTIES, CALIFORNIA

PLATE
4





SCALE (H&V)

0 50 100

Note: Discontinuity lengths and locations shown schematically. Drawn showing apparent dip.

LEGEND

Discontinuity Orientations

① - N31E 19NW
② - N25W 72NE
③ - N79E 88NW
④ - N54W 32SW
⑤ - N2W 38SW
⑥ - N70E 24SE
⑦ - N66E 86SE
⑧ - N45E 58NW
⑨ - N7W 41NE

Qas - Active Stream Channel Deposits
Qal - Alluvium
Qls - Landslide
$bx_{d\text{-}h}$ - Decomposed to highly weathered bedrock
$bx_{m\text{-}s}$ - Moderately to slightly weathered bedrock

KLEINFELDER

Project No. 80688
Filename: 80688xsecBB.fh11

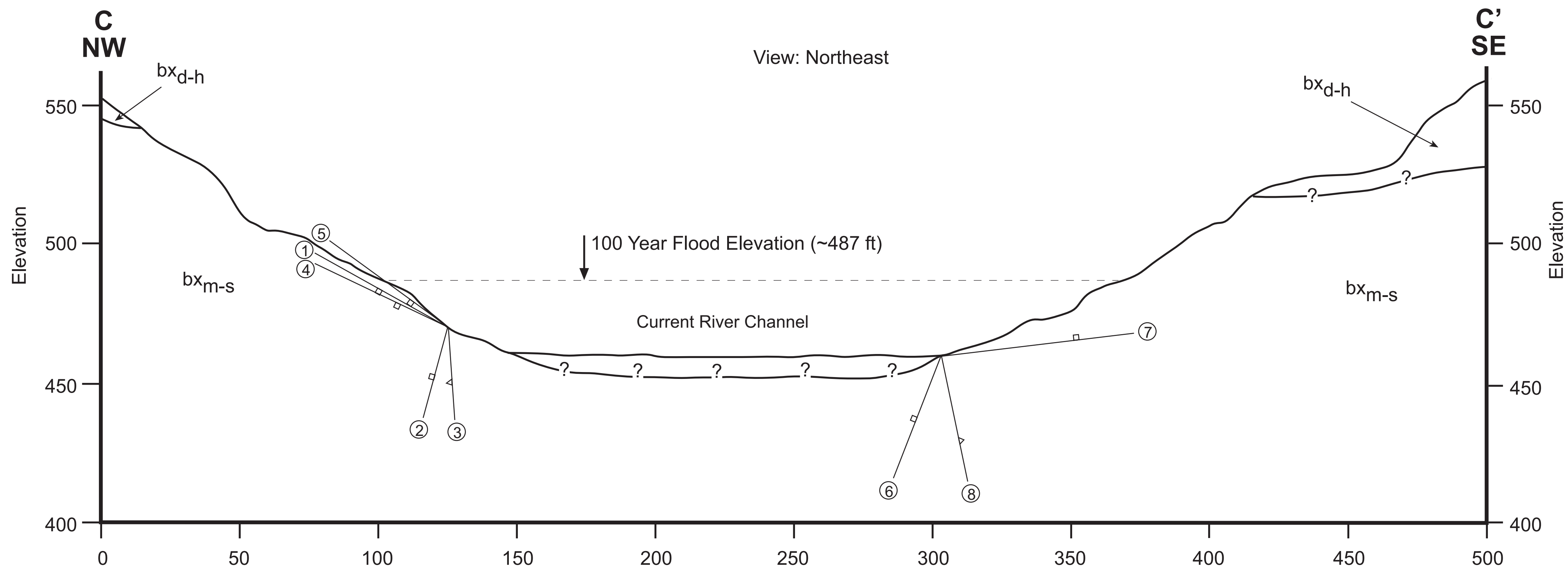
Graphic By: D. Anderson
Date: 4/18/07

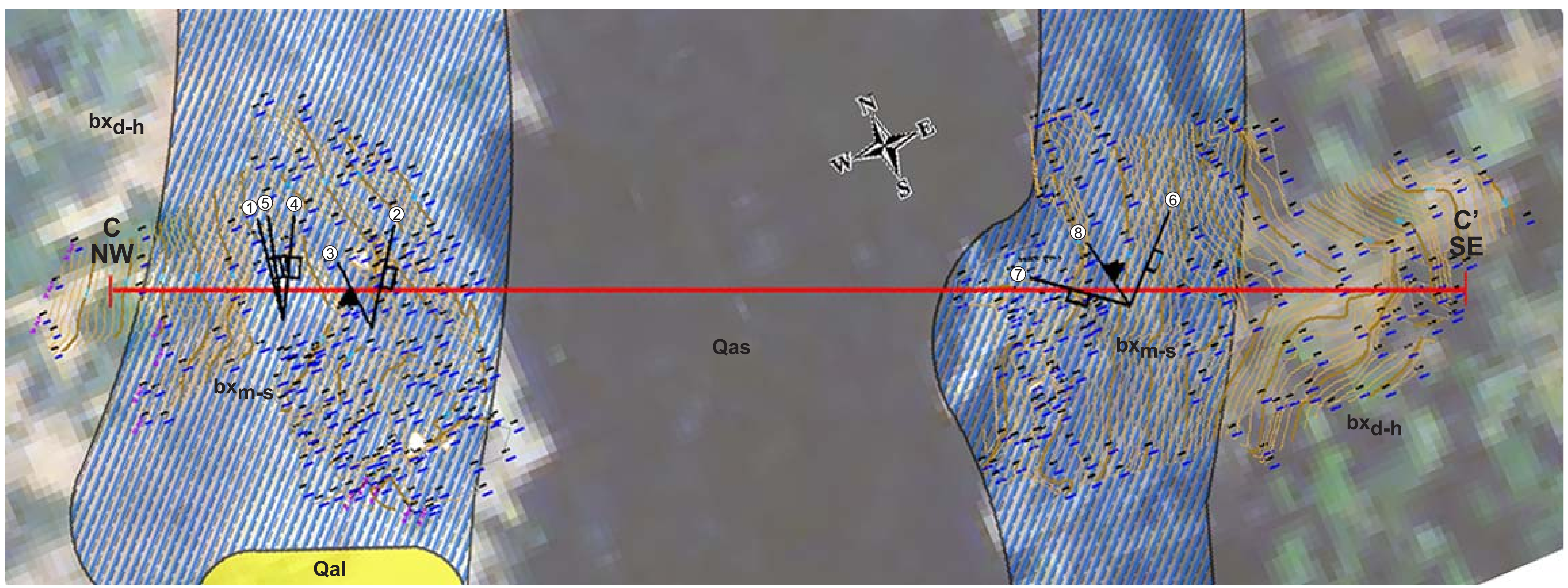
CROSS SECTION B-B'

UPPER OUTLET RAPID ALTERNATIVE
COOL TO AUBURN TRAIL BRIDGE
ALTERNATIVE ANALYSIS
PLACER AND ELDORADO COUNTIES, CALIFORNIA

PLATE

5





SCALE (H&V)

0 50 100

Note: Discontinunity lengths and locations shown schematically. Drawn showing apparent dip.

LEGEND

DiscontinunityOrientations

① - N9E 32SE
② - N36E 77NW
③ - N4W 90 (Foliation)
④ - N29E 24SE
⑤ - N15E 36SE
⑥ - N46E 69NW
⑦ - N51W 23SW
⑧ - N11W 80NE (Foliation)

Qas	- Active Stream Deposits
Qal	- Alluvium
bx_{d-h}	- Decomposed to highly weathered bedrock
bx_{m-s}	- Moderately to slightly weathered bedrock

KLEINFELDER

Graphic By: D. Anderson
Project No. 80688-1
Date: 4/18/07
Filename: 80688xsecCC.fh11

CROSS SECTION C-C’

OREGON BAR BRIDGE ALTERNATIVE
COOL TO AUBURN TRAIL BRIDGE
ALTERNATIVE ANALYSIS
PLACER AND EL DORADO COUNTIES, CALIFORNIA

PLATE
6

Appendix B

Scour Analysis for the Auburn to Cool Trail Crossing

AUBURN TO COOL TRAIL CROSSING

Scour Analysis for the Auburn to Cool Trail Crossing at the American River

Preliminary Report ***4/27/2007***

Written by: Elizabeth Baldi, EIT

Scour Analysis at Proposed Bridge Piers

Review existing data and HEC-RAS model

The effective HEC-RAS model for the American River was provided to HDR for this scour analysis.

Few changes were made to the existing HEC-RAS model to conduct this scour analysis. Two interpolated cross-sections were added to better model the proposed ground geometry at the Auburn to Cool Trail Crossing location. The bridge was added to the HEC-RAS model.

Grain-size distribution information was taken from the Sediment Transport Model within the provided HEC-RAS model. (D_{50} = 287 mm D_{90} = 415 mm)

Conduct Scour Analysis

A scour evaluation for the Auburn to Cool Trail Crossing has been conducted in accordance with the Federal Highway Administration Hydraulic Engineering Circular No. 18 (HEC-18), entitled Evaluating Scour at Bridges. This scour evaluation computes scour depths associated with the FEMA 100-Year Flood event at a peak discharge of 164,000 cfs.

HEC-RAS' Hydraulic Design –Bridge Scour tool was used to calculate contraction, abutment, and pier stem scour. Long-term channel degradation was not taken into account due to the lack of historical channel invert elevation data. If historical data had been available, an estimation of long-term channel degradation or possible aggregation would have been included in the total scour depth.

Contraction channel scour was calculated to be 5.84 feet. Although the bridge design does not significantly reduce the overall available channel width, natural contractions in the river occurring just upstream of the proposed bridge location can increase the channel scour.

Abutment scour was not necessary to calculate since the water surface elevation does not reach the abutments and the proposed design of the abutments are assumed not to contract the channel width.

One limitation of HEC-RAS' Scour analysis is that it assumes only one soil condition is present at the bridge. At the Auburn to Cool Trail Crossing location, weathered bedrock has been estimated to be at an elevation of 450'to 460'. For this analysis, it is assumed that the weathered bedrock does not erode, therefore, preventing the scour depth to travel deeper. If it is determined that the material can erode away easily, a more complex scour analysis may be needed. HEC-RAS calculated the pier stem scour depths to equal 27' at the west pier and 29' at the east pier assuming homogenous soil conditions matching those at the surface. Since the scour depth is limited to the weathered bedrock elevation, the scour depths are expected to be much less than these values. However, because of the uncertainty of the rock depth and characteristics, pier scour depths were conservatively reduced based only on the deepest estimated rock depth to a value of 7.0' for both piers.

Total scour depths at the pier locations are summarized in Table 1 below. In addition, a graphical representation of the scour depths (as calculated by HEC-RAS) in relation to the pier dimensions is shown in Appendix B.

Table 1 - Scour Condition 1 - Existing Soils - Total Pier Scour Depths

Scour Type	Scour Condition
Long-Term Channel Degradation	Unknown
Contraction (channel)	5.8 ft
Abutment	N/A
Pier Stem*	7.0 ft
Total Scour	12.8 ft + Long-Term Channel Degradation

N/A Not applicable. Since FEMA 100-Year water surface elevation did not reach abutments, abutment scour does not occur.

* Limited to determined bedrock location

Appendix C

Preliminary Alternative Screening Criteria and Alternative Recommendations

Jones & Stokes

Memorandum

Date: 11 April 2007

To: Jim Micheaels (DPR)

cc: Tony Powers (HDR), Byron Anderson (Kleinfelder)

From: Steve Seville (J&S)

Subject: **Preliminary Alternative Screening Criteria and Alternative Recommendations**

Jones & Stokes (J&S), HDR, and Kleinfelder are working with the State Department of Parks and Recreation (DPR) to prepare a feasibility study analyzing alternatives to maintain the Auburn To Cool (ATC) crossing of the north fork of the American River. The J&S team has reviewed the available data and investigated several potential trail crossings located between the Highway 49 Bridge and Oregon Bar. Through this process we have developed a list of design criteria to guide the assessment of potential alternatives and determine which alternatives should be further investigated in a feasibility study. The list below identifies the design criteria developed for evaluating the siting of a trail crossing in the canyon.

1. Geotechnical Considerations
2. Bridge Length Requirements
3. Length of Trail Connections
4. Conflicts with potential future Auburn Dam construction
5. Trail Use Requirement – Types of Use
6. Public Comment Consideration
7. Seasonal Access vs. Year-round Access
8. Construction Cost
9. Maintenance Cost
10. Safety and Security

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www.jonesandstokes.com

While this is not an exhaustive list, it does allow the design team to determine which alternatives, brought forth to date, need additional assessment in the feasibility study.

A total of eight trail crossing locations were identified in the project area. Two locations have existing bridges and six locations that would require a bridge crossing. The existing bridge locations are Hwy 49 Bridge and the Mountain Quarry or "No Hands" bridge. The existing bridges will be considered in the feasibility study. The six locations requiring a new trail crossing/bridge are:

- Existing ATC trail crossing (Auburn Dam Site)
- Diversion Tunnel Outlet (located just upstream of the Auburn Dam diversion tunnel outlet)
- Upper Outlet Rapids (about 900 feet downstream of the diversion tunnel outlet)
- Lower Outlet Rapids (about 1800 feet downstream of the diversion tunnel outlet)
- Knickerbocker Canyon (just upstream of the canyon, about 2800 feet downstream of the diversion tunnel outlet)
- Oregon Bar (at the upstream end of the gravel bar)

Geotechnical Considerations

Based on geotechnical considerations three site where eliminated and the feasibility study will focus on the Existing Crossing, Upper Outlet Crossing, and Oregon Bar. These locations will require less mitigation of discontinuities, require less grading for foundations, have shallower depths to competent bedrock, and are less likely to be impacted by slope stability issues. Hwy 49 and "No-Hands" bridges were not investigated for geotechnical stability since they are functional bridges.

Recommendations provided by Kleinfelder are included as Appendix A to this memorandum.

Conflicts with Potential Future Auburn Dam Construction

Based on concerns expressed by the US Bureau of Reclamation regarding conflicts between a permanent bridge and the potential future construction of Auburn Dam, further consideration of a permanent bridge at the Existing Crossing and the Diversion Tunnel Outlet sites will not be pursued. However, a seasonal bridge at the Existing Crossing site is considered acceptable.

Bridge Length Requirements

Sites are further reviewed to minimize the proposed bridge span and provide a safe crossing for trail users and State Park Ranger vehicles (H10 truck loading). The required length of the bridge is also impacted by the channel hydraulics. All permanent bridge alternatives will be analyzed for length assuming that the low chord of the deck will be a minimum of 2-feet higher than the 100-year flood flow elevation. This freeboard decision draws on best engineering judgment and guidance put forth in Caltrans *Memo to Designers 1-23*. Bridge length will also be impacted by the slope of the connecting trail and alignment of the bridge to accommodate these approaches. In addition, permanent bridge alternatives will meet Class 1 trail requirements for width.

Permanent bridge types will be selected to meet the span requirements of each location considered. Certain bridge types would require an in-channel pier to support the structure. Both clear span and pier supported bridge types will be considered in the feasibility analysis when considering length of the crossing and stability for the trail user. Cost and aesthetics will likely be more of a determining factor when considering a bridge type.

Temporary bridge crossings will be evaluated on length of required span in each location analyzed, maintenance, and ease of installation and storage.

Length of Trail Connections

While many trail systems exist within the canyon, not all are formalized and maintained by DPR. We are considering the length of most direct trail construction that will be required to provide safe and stable access for all trail users who will use the ATC trail crossing. To meet DPR standards, all trail connections will consider providing a 5-foot tread width, average slopes of 5% (with short reaches not exceeding 10%), and bench construction to provide a maximum 2% cross slope. The bench construction (cut/fill) may require additional trail design beyond the feasibility study as actual alignments are staked and investigated further. This feasibility study is considering trail alignment based on anecdotal knowledge of the existing formal and non-formal trails and roads, and the best available topography of the area.

Trail Use Requirements

Trail use is an important consideration moving forward into the feasibility study. Three main user groups wish to utilize the ATC: hikers, equestrians, and mountain bikers. Each alternative is considering providing access for all user groups. Equestrian user requirements are the most rigorous since the uncertainty in the movement of the horse can cause a bridge to sway and may create a dangerous situation for the rider, the horse, and other trail users. In some instances it may be appropriate to provide a low flow ford in the channel for equestrian use, or operational management of a bridge to restrict other trail users from entering the bridge while a horse is crossing. All trail users will be considered for each alternative analyzed to ensure the trail crossing is safe for all.

Public Comment Consideration

Through the community outreach facilitated by J&S, we have collected comments and concerns from the community and will compile these for review and comparison and consideration for each alternative in the feasibility study.

Seasonal Access vs. Year Around Access

In an effort to accommodate all trail users and recognizing that a majority of trail use occurs in the summer season, temporary crossings are being considered. While temporary crossings are located within the floodplain, they will allow the flexibility of maintaining the existing trail crossing location that is still under consideration for dam construction. Temporary bridge structures for seasonal crossings, may not have the capacity for equestrian users, so they will be considered in conjunction with equestrian in-channel fords.

Cost

Cost data will be based on the best available engineering estimate information and draw upon recognized industry standards, past DPR trail construction projects, and adjustments for difficult construction and location access.

Trail cost data provided by DPR will also be used to determine a single per linear foot cost for trail construction. DPR has completed a prior cost estimate for mountain bike trail construction to use No Hands Bridge as a potential crossing. These costs were generated in 2005, so they will be adjusted to 2007 costs. In addition, construction of multi-use trail is expected to more expensive, requiring a wide tread width. The multi-use trail cost will be based on the mountain bike trail cost, but increased by a factor of two.

These costs are included as Appendix B.

Recommendations

Based on our preliminary work, the J&S team recommends we move forward with the Feasibility Study focusing on the flowing alternatives:

1. Hwy 49 Bridge Trail Connection

2. No-Hands Bridge Trail Connection and Trail Use Management

3. Existing Trail Seasonal Crossing

4. Upper Outlet Permanent Bridge and Trail Connection

5. Oregon Bar Seasonal Crossing and Trail Connection

6. Oregon Bar Permanent Crossing and Trail Connection

HDR has developed some preliminary cross sections showing certain bridge types to be further considered in the feasibility study. These are included as Appendix C.

Appendix A

April 5, 2007
Project No.: 80688

Mr. Steven Seville
Jones and Stokes
2600 V Street
Sacramento, CA 95818

Subject: Interim Summary of Geologic Criteria for the Cool to Auburn Bridge Alternatives Evaluation Placer and El Dorado Counties, California

Dear Mr. Seville:

This letter provides a summary of Kleinfelder's geologic evaluation for permanent bridge locations crossing the North Fork of the American River near the Auburn Dam Site. This work was performed in accordance with Kleinfelder's contract agreement with Jones and Stokes as part of the Feasibility Evaluation for the Auburn to Cool Trail Crossing Project. Based on this agreement Kleinfelder was scoped with identifying potential bridge crossing areas from the existing crossing area within the Auburn Dam site to the downstream area identified as Oregon Bar.

Kleinfelder performed an initial reconnaissance of the project site during the project orientation meeting/field trip on January 17, 2007. Based on that initial visit, geologic criteria were established for identifying potential bridge locations. This criteria was utilized in subsequent mapping trips made on February 12 and 15, 2007 and included verifying geologic mapping of the area by the US Bureau of Reclamation (1977), mapping landslides, colluvium, and bedrock based on weathering criteria, and collecting discontinuity data at potential bridge locations. This cumulative geologic and geotechnical data was then evaluated from which six potential locations for permanent bridge crossings were identified. These locations have been identified as:

- Existing Crossing at the Auburn Dam Site
- Tunnel Outlet (identified previously by MWH study)
- Upper Outlet Rapid Crossing
- Lower Outlet Rapid Crossing
- Knickerbocker Canyon
- Oregon Bar

This list of six sites was reduced to the three final locations of Existing Crossing, Upper Outlet Rapid Crossing, and Oregon Bar. This process of reducing the six sites to three was performed by prioritizing the sites based on the degree of anticipated geotechnical mitigation that would be required to construct at a specific site. These three sites are preferred over the other three locations because of the following potential conditions:

- Require less mitigation of discontinuities,
- Require less grading for development of approaches and foundation pads,
- Shallower depths to competent bedrock likely requiring smaller foundations, and
- Sites are less likely to be impacted by slope stability issues.

It should be noted that these are preliminary conclusions based on limited data. Verification of these conditions should be performed through site specific geologic and geotechnical investigations.

We appreciate the opportunity to provide our services to you. Should you have questions or comments regarding the information provided herein please do not hesitate to call.

Sincerely,

KLEINFELDER WEST, INC.

Byron C. Anderson, PG, CEG
Senior Engineer Geologist

BCA:crt

Appendix B

Job No.		No.	

HDR Engineering, Inc.

Project	Auburn to Cool Trail Crossing	Computed	acp	Date	04/10/07
Subject	Feasibility Study Alternatives	Checked		Date	
Task	Comparative Cost Estimates (Square Foot Basis)	Sheet	1	Of	

Location	Drawing No.	Crossing L (ft)	Crossing W (ft)	Crossing A (ft^2)	Crossing SF Cost ($/SF)	Crossing Cost	Trail Connections L (ft)	Trail Connections Unit Cost ($/LF)	Trail Cost	Subtotal Construction	Engineering and Administration: Prelim. Eng 12%	Environ. 8%	CM 10%	Total Project Cost	Comments
Existing Crossing (1)															
FRP Seasonal Bridge	**EC-1**	180	8.0	1,440	$ 155	$ 224,000	400.00	64.00	$ 25,600	$ 249,600	$ 30,000	$ 20,000	$ 25,000	$ 325,000	1 span at 80 ft, 2 at 50'; temporary piers.
Stress Ribbon	N/A	**370**	**12.0**	**4,440**	**$ 525**	**$ 2,331,000**	**200.00**	**64.00**	**$ 12,800**	**$ 2,343,800**	**$ 281,300**	**$ 187,600**	**$ 234,400**	**$ 3,048,000**	No rock near surface at east abut; good rock at west end; good access.
Truss	N/A	**340**	**12.0**	**4,080**	**$ 450**	**$ 1,836,000**	**200.00**	**64.00**	**$ 12,800**	**$ 1,848,800**	**$ 221,900**	**$ 148,000**	**$ 184,900**	**$ 2,404,000**	Three-span - good access.
Seasonal Pipe Bridge	N/A	192	3.0	576	$ 85	$ 49,000	200.00	64.00	$ 12,800	$ 61,800	$ 7,500	$ 5,000	$ 6,200	$ 81,000	
Strutted Girder	N/A	360	12.0	4,320	$ 600	$ 2,592,000	200.00	64.00	$ 12,800	$ 2,604,800	$ 312,600	$ 208,400	$ 260,500	$ 3,387,000	Piers in fill.
Suspension with Towers	N/A	360	12.0	4,320	$ 425	$ 1,836,000	200.00	64.00	$ 12,800	$ 1,848,800	$ 221,900	$ 148,000	$ 184,900	$ 2,404,000	With towers and composite timber-steel stiffening truss.
Diversion Tunnel Outlet (2)															
Stress Ribbon	N/A	**335**	**12.0**	**4,020**	**$ 515**	**$ 2,071,000**	**600.00**	**64.00**	**$ 38,400**	**$ 2,109,400**	**$ 253,200**	**$ 168,800**	**$ 211,000**	**$ 2,743,000**	Difficult slope and foundation conditions at west abut; good access.
Suspension w/out Towers	N/A	**340**	**12.0**	**4,080**	**$ 565**	**$ 2,306,000**	**600.00**	**64.00**	**$ 38,400**	**$ 2,344,400**	**$ 281,400**	**$ 187,600**	**$ 234,500**	**$ 3,048,000**	Towerless segmental concrete with cables together at anchorages.
Strutted Girder	N/A	335	12.0	4,020	$ 600	$ 2,412,000	600.00	64.00	$ 38,400	$ 2,450,400	$ 294,100	$ 196,100	$ 245,100	$ 3,186,000	Piers in fill.
Truss	N/A	335	12.0	4,020	$ 450	$ 1,809,000	600.00	64.00	$ 38,400	$ 1,847,400	$ 221,700	$ 147,800	$ 184,800	$ 2,402,000	Three-span.
Upper Outlet Rapids (3)															
Seasonal Pipe Bridge	N/A	240	3.0	720	$ 85	$ 62,000	3950.00	64.00	$ 252,800	$ 314,800	$ 37,800	$ 25,200	$ 31,500	$ 410,000	
Strutted Girder	N/A	440	12.0	5,280	$ 600	$ 3,168,000	3750.00	64.00	$ 240,000	$ 3,408,000	$ 409,000	$ 272,700	$ 340,800	$ 4,431,000	Probably not feasible without very large girders.
Suspension w/out Towers	**UO-1**	**430**	**12.0**	**5,160**	**$ 565**	**$ 2,916,000**	**3750.00**	**64.00**	**$ 240,000**	**$ 3,156,000**	**$ 378,800**	**$ 252,500**	**$ 315,600**	**$ 4,103,000**	No tower; SF cost lower because of greater overall width for same loads.
Suspension with Towers	**UO-2**	**454**	**12.0**	**5,448**	**$ 425**	**$ 2,316,000**	**3750.00**	**64.00**	**$ 240,000**	**$ 2,556,000**	**$ 306,800**	**$ 204,500**	**$ 255,600**	**$ 3,323,000**	With towers and composite timber-steel stiffening truss.
Stress Ribbon	**UO-3**	**460**	**12.0**	**5,520**	**$ 525**	**$ 2,898,000**	**3750.00**	**64.00**	**$ 240,000**	**$ 3,138,000**	**$ 376,600**	**$ 251,100**	**$ 313,800**	**$ 4,080,000**	Near record span for stress ribbon + difficult access.
Truss	**UO-4**	**440**	**12.0**	**5,280**	**$ 460**	**$ 2,429,000**	**3750.00**	**64.00**	**$ 240,000**	**$ 2,669,000**	**$ 320,300**	**$ 213,600**	**$ 266,900**	**$ 3,470,000**	Three-span; difficult access; large cranes required.
Lower Outlet Rapids (4)															
Cable-stayed Truss	N/A	740	12.0	8,880	$ 550	$ 4,884,000	7150.00	64.00	$ 457,600	$ 5,341,600	$ 641,000	$ 427,400	$ 534,200	$ 6,945,000	Three-span; difficult access; large cranes required.
Stress Ribbon	N/A	760	12.0	9,120	$ 600	$ 5,472,000	7150.00	64.00	$ 457,600	$ 5,929,600	$ 711,600	$ 474,400	$ 593,000	$ 7,709,000	Record span; anchorage forces prohibitive to meet accessibility criteria.
Strutted Girder	N/A	740	12.0	8,880	$ 650	$ 5,772,000	7150.00	64.00	$ 457,600	$ 6,229,600	$ 747,600	$ 498,400	$ 623,000	$ 8,099,000	Probably not feasible without very large girders or four or more river piers.
Suspension with Towers	N/A	740	12.0	8,880	$ 650	$ 5,772,000	7150.00	64.00	$ 457,600	$ 6,229,600	$ 747,600	$ 498,400	$ 623,000	$ 8,099,000	Precast segmental concrete with towers.
Knickerbocker Canyon (5)															
Stress Ribbon	N/A	550	12.0	6,600	$ 575	$ 3,795,000	5350.00	64.00	$ 342,400	$ 4,137,400	$ 496,500	$ 331,000	$ 413,800	$ 5,379,000	Record span; anchorage forces prohibitive to meet accessibility criteria.
Strutted Girder	N/A	540	12.0	6,480	$ 650	$ 4,212,000	5350.00	64.00	$ 342,400	$ 4,554,400	$ 546,600	$ 364,400	$ 455,500	$ 5,921,000	Probably not feasible without very large girders or more than 2 river piers.
Suspension w/out Towers	N/A	540	12.0	6,480	$ 565	$ 3,662,000	5350.00	64.00	$ 342,400	$ 4,004,400	$ 480,600	$ 320,400	$ 400,500	$ 5,206,000	Segmental Concrete with cables spread at anchorages.
Truss	N/A	540	12.0	6,480	$ 500	$ 3,240,000	5350.00	64.00	$ 342,400	$ 3,582,400	$ 429,900	$ 286,600	$ 358,300	$ 4,658,000	Three-span; difficult access; large cranes required.
Oregon Bar (6)															
Strutted Girder	**OB-1**	**290**	**12.0**	**3,480**	**$ 625**	**$ 2,175,000**	**8850.00**	**32.00**	**$ 283,200**	**$ 2,458,200**	**$ 295,000**	**$ 196,700**	**$ 245,900**	**$ 3,196,000**	
Suspension w/out Towers	**OB-2**	**280**	**12.0**	**3,360**	**$ 600**	**$ 2,016,000**	**8850.00**	**32.00**	**$ 283,200**	**$ 2,299,200**	**$ 276,000**	**$ 184,000**	**$ 230,000**	**$ 2,990,000**	No tower; short span and steel struts; cables together at anchorages.
Stress Ribbon	**OB-3**	**290**	**12.0**	**3,480**	**$ 515**	**$ 1,793,000**	**8850.00**	**32.00**	**$ 283,200**	**$ 2,076,200**	**$ 249,200**	**$ 166,100**	**$ 207,700**	**$ 2,700,000**	Based on Rancho Santa Fe Bridges plans and bid prices.
Truss	**OB-4**	**280**	**12.0**	**3,360**	**$ 460**	**$ 1,546,000**	**8850.00**	**32.00**	**$ 283,200**	**$ 1,829,200**	**$ 219,600**	**$ 146,400**	**$ 183,000**	**$ 2,379,000**	Three-span.
Seasonal Pipe Bridge and Ford	N/A	224	3.0	672	$ 85	$ 58,000	8950.00	32.00	$ 286,400	$ 344,400	$ 41,400	$ 27,600	$ 34,500	$ 448,000	When Folsom Lake is at El 466, max water depth =14.0 ft.
No Hands Bridge															
Convert to Multiple Use	N/A	482	15.0	7,230	$ -	**$ -**	44000.00	32.00	**$ 1,408,000**	**$ 1,408,000**	$ 169,000	$ 112,700	$ 140,800	**$ 1,831,000**	Re-operation; improve drainage?
Hwy 49 Bridge															
Adjacent Prefab Truss	**AR-1**	**340**	**10.0**	**3,400**	**$ 460**	**$ 1,564,000**	**46500.00**	**32.00**	**$ 1,488,000**	**$ 3,052,000**	**$ 366,300**	**$ 244,200**	**$ 305,200**	**$ 3,968,000**	Little space for construction staging.
Widen	**AR-1**	**350**	**11.0**	**3,850**	**$ 450**	**$ 1,733,000**	**46500.00**	**32.00**	**$ 1,488,000**	**$ 3,221,000**	**$ 386,600**	**$ 257,700**	**$ 322,100**	**$ 4,188,000**	Single girder, widened concrete deck & bicycle railing.
Use existing	**N/A**	**350**	**2.0**	**700**	**$ 60**	**$ 42,000**	**46500.00**	**32.00**	**$ 1,488,000**	**$ 1,530,000**	**$ 183,600**	**$ 122,400**	**$ 153,000**	**$ 1,989,000**	Add bicycle railing to existing barrier (2 sides x 350 ft), sign and stripe.

Notes:

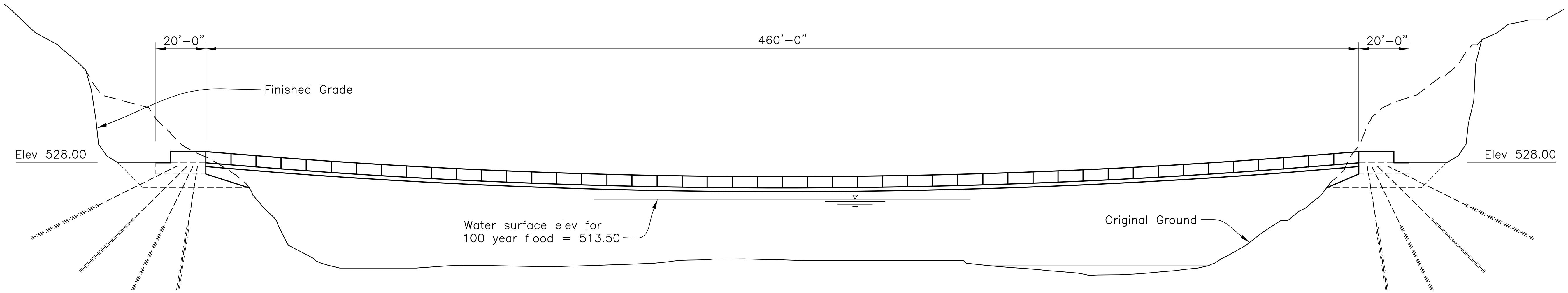
1. **Costs are for comparison purposes only.**
2. **Costs include 10% mobilization and 25% contingency.**
3. **Costs are from Caltrans square foot cost data dated January 2007, and/or from individual comparable projects.**
4. **Cost basis is assumed construction year of 2007; Caltrans Cost Index assumed to be 450 (based on 1977=100) 2005 at 460 and 2006 at 423.**
5. **Comparable cost data from outside of Caltrans was normalized to Sacramento, CA based on Means 2006 geographical index of 109.4.**
6. **Rows in bold type correspond to developed alternatives with drawings. Rows not bolded are extrapolated from developed ones.**
7. **SF costs for all new permanent bridges (except adjacent to SR 49) are normalized to a 12-ft clear bridge width to simplify comparisons (actual structure widths vary from approximately 13 ft to 17.5 ft).**

Location	Bridge Type	Drawing No.	Crossing Cost	Trail Cost	Subtotal Constr.	Eng. & Admin 30%	Total Project Cost	Aesthetics	Ease of Construction	Environ. Impacts	Geotechnical	Hydraulics/ Scour	Trail Connections	Maintenance	User Experience	Accessibility	Comments
Existing Crossing (EC)																	
Existing Crossing (EC)	**FRP Seasonal Bridge**	**EC-1**	**$ 224,000**	**$ 25,600**	**$ 249,600**	**$ 74,900**	**$ 325,000**	X-truss gives appearance of permanence; precast substructure would not.	Requires backhoe or small crane to set substructure and trusses and level subgrade. Annual erection and dismantling; requires secure storage for trusses.	Annual re-grading of foundation areas and approach trails.	Restored gravel riverbed is anticipated to provide adequate bearing for temporary spread footings.	Susceptible to damage from unexpected high flows.	XX' of new trail required. Minimal trail work; may require annual re-grading	Annual cost to erect and dismantle; intermittent decking replacement.	Narrow (8') bridge would be shared by all users; parallel ford may be feasible.	Could meet DPR trail accessibility guidelines.	1 span at 80 ft, 2 at 50'; temporary piers and abutments
	Seasonal Pipe Bridge	N/A	$ 49,000	$ 12,800	$ 61,800	$ 18,600	$ 81,000	Low level; small and unobtrusive; appears unsubstantial.	Water may be too deep. No heavy equipment. Annual erection and dismantling; requires secure storage.	Small diameter pipes driven into river bed and removed each year. Construction at an already disturbed site.	Restored gravel riverbed is anticipated to accommodate driving of support pipes.	Susceptible to damage from unexpected high flows.	XX' of new trail required. Minimal trail work; may require annual re-grading	Annual cost to erect and dismantle; intermittent painting and decking replacement	Separates equestrians from mountain bikers and hikers; narrow (3') bridge.	Not wheel chair accessible due to steps, but could meet other DPR trail accessibility guidelines.	Subject to final topographic survey of restored river. At high summer flows (1000 cfs), water depth of 5.1 feet may be too deep for ford or bridge. No abutments required.
Upper Outlet Rapids (UOR)																	
Upper Outlet Rapids (UOR)	Strutted Girder	N/A	$ 3,168,000	$ 240,000	$ 3,408,000	$ 1,022,400	$ 4,431,000	Low profile superstructure with Y-shaped piers and diagonal struts that would evoke a tree.	Difficult access to both ends, but west end near existing ATC trail. Difficult construction for river for piers. Large crane required to set girders.	Construction in river channel; may require temporary diversion of river. Piers will be permanent obstructions in channel.	Rock excavation required for abutments and piers. Piers expected to require cofferdam & seal course. Rock anchors or pin piles likely required at abutments due to adverse sloping fracture surfaces and at piers to its overturning.	Abutments set above 100-year flood. Pier scour depth could be substantial, depending on depth of competent rock. Bedrock may be very close to the surface within the channel and is not expected to erode.	XX' of new trail required. Difficult trail connection on west end, easier on east.	Structural steel would either be weathering steel or require periodic painting.	15-ft between railings provides extra usable width to serve multiple use. Bike/pedestrian railings may seem unsubstantial for equestrians, but recessed deck and fillets would add to sense of safety.	Would meet DPR trail accessibility guidelines. Maximum running grade o 5.0%.	Probably not feasible without very large girders or more than two river piers. Longer spans would require deeper struts, higher profile and even longer spans. Expensive because of steel girders, small project size and difficult site access.
	Suspension w/out Towers	**UO-1**	**$ 2,916,000**	**$ 240,000**	**$ 3,156,000**	**$ 946,800**	**$ 4,103,000**	Low profile superstructure; no river piers; blends into background; sweeping catenary shape of cables complements arching deck and shape of canyon; lack of towers limits visual impact.	Existing roads on both ends of bridge; but steep slopes to west abutment. No construction in river. Secondary construction access roads required to construct anchorages.	No in-river construction minimizes impacts. Additional impacts for anchorages and construction access roads to them.	Rock excavation required for abutments and cable anchorages. Rock anchors required for moderate to large tension forces at abutments and cable anchorages.	Abutments set above 100-year flood. No impact on hydraulics and no scour issues for design flows.	XX' of new trail required. Difficult trail connection on west end, easier on east.	Cables and connections may require cleaning to prevent debris buildup and corrosion. Repainting of railings.	12-ft deck width serves multiple use. Mass, extra overall width (to accommodate hanger connections), splayed main cables and post-tensioning of concrete deck to abutments provide stiffness, damping and resistance to lateral loads. Cables and hangers enha	Would meet DPR trail accessibility guidelines. Maximum running grade o 5.0%.	Precast segmental concrete with splayed main cables and no towers. Construction of superstructure assumed to use high-line.
	Suspension with Towers	**UO-2**	**$ 2,316,000**	**$ 240,000**	**$ 2,556,000**	**$ 766,800**	**$ 3,323,000**	Traditional "rustic" trail bridge; sweeping catenary shape of cables complements shape of canyon.	Existing roads on both ends of bridge; but steep slopes to west abutment. Tower construction at edges of main channel. Secondary construction access roads required to construct anchorages.	Tower construction in edge of channel. Additional impacts for anchorage construction access roads.	Rock excavation required for abutments, cable anchorages and towers. Towers could be supported on drilled shafts. Rock anchors required for large tension forces at cable anchorages.	Abutments set above 100-year flood. Tower piers would be in edge of channel and would be subject to scour, but would be set into bedrock.	XX' of new trail required. Difficult trail connection on west end, easier on east.	Cables and connections may require cleaning to prevent debris buildup and corrosion. Repainting of railings.	12-ft deck width serves multiple use. Light timber and steel composite superstructure may be prone to large vertical and lateral displacements under equestrian loading. Cable sway bracing would probably be required to resist lateral loads. Stiffening trus	Would meet DPR trail accessibility guidelines. Maximum running grade o 5.0%.	Traditional cable suspension bridge with composite steel-timber stiffening truss.
	Stress Ribbon	**UO-3**	**$ 2,898,000**	**$ 240,000**	**$ 3,138,000**	**$ 941,400**	**$ 4,080,000**	Low profile superstructure; no river piers; blends into background; sag may be considered either attractive or unsettling.	Existing roads on both ends of bridge; but steep slopes to west abutment. No construction in river.	No in-river construction minimizes impacts.	Rock excavation required for abutments. Rock anchors required for large tension forces at abutments .	Abutments set above 100-year flood. No impact on hydraulics and no scour issues for design flows.	XX' of new trail required. Difficult trail connection on west end, easier on east.	Minimal. Repainting of railings.	12-ft deck width serves multiple use. Bike/pedestrian railings may seem unsubstantial for equestrians.	Would meet DPR trail accessibility guidelines. Maximum running grade o 10.0% for 30 feet.	Near record span for stress ribbon.
	Truss	**UO-4**	**$ 2,429,000**	**$ 240,000**	**$ 2,669,000**	**$ 800,700**	**$ 3,470,000**	Truss would create substantial visual impact on canyon due to large structure depth (up to 9 feet) and river piers. Careful design of piers and choice of paint color (or weathering steel) would help soften the view.	Difficult access to both ends, but west end near existing ATC trail. Difficult construction for river for piers. Large crane required to set trusses. Trusses may have to be shipped in fairly small sections.	Construction in river channel; may require temporary diversion of river. Piers will be permanent obstructions in channel.	Rock excavation required for abutments and piers. Piers expected to require cofferdam & seal course. Rock anchors or pin piles likely required at abutments due to adverse sloping fracture surfaces and at piers to its overturning.	Abutments set above 100-year flood. Pier scour depth up to 13', but possibly much less depending on depth of competent rock. Bedrock may be very close to the surface within the channel and is not expected to erode.	XX' of new trail required. Difficult trail connection on west end, easier on east.	Structural steel would either be weathering steel or require periodic painting.	12-ft deck width serves multiple use. Half-through trusses provide substantial barrier for equestrians. Combination of truss and concrete deck provides stiffness and damping.	Would meet DPR trail accessibility guidelines. Maximum running grade o 5.0%.	
Lower Outlet Rapids (LOR)																	
Lower Outlet Rapids (LOR)	Cable-stayed Truss	N/A	$ 4,884,000	$ 457,600	$ 5,341,600	$ 1,602,500	$ 6,945,000	Truss, towers & cables would dominate canyon views due to large structure depth, tall towers/river piers and array of stay cables. Slender towers and weathering steel would help bridge blend in. Towers and cables would create gateway for bridge users.	Very difficult access to both ends. Difficult construction for river for piers. Large crane required to set trusses. Trusses may have to be shipped in fairly small sections.	Construction in river channel; may require temporary diversion of river. Piers will be permanent obstructions in channel.	Rock excavation required for abutments and piers. Piers expected to require cofferdam & seal course. Rock anchors or pin piles likely required at abutments due to adverse sloping fracture surfaces and at piers to its overturning.	Abutments set above 100-year flood. Pier scour depth up to 13', but possibly much less depending on depth of competent rock. Bedrock may be very close to the surface within the channel and is not expected to erode.	XX' of new trail required. Difficult, steep trail connection to west end from existing ATC trail; connection to east end may employ remnants of old roads.	Structural steel would either be weathering steel or require periodic painting. Cables and connections may require cleaning to prevent debris buildup and corrosion.	12-ft deck width serves multiple use. Half-through trusses provide substantial barrier for equestrians. Combination of truss and concrete deck provides stiffness and damping.	Would meet DPR trail accessibility guidelines. Maximum running grade o 5.0%.	Three-span; difficult access; large cranes required.
	Stress Ribbon	N/A	$ 5,472,000	$ 457,600	$ 5,929,600	$ 1,778,900	$ 7,709,000	Low profile superstructure; no river piers; blends into background; very large sag may be considered either attractive or unsettling.	Very difficult access to both ends. Once established, no construction activities are required in river.	No in-river construction minimizes impacts.	Rock excavation required for abutments. Rock anchors required for very large tension forces at abutments.	Abutments set above 100-year flood. No impact on hydraulics and no scour issues for design flows.	XX' of new trail required. Difficult, steep trail connection to west end from existing ATC trail; connection to east end may employ remnants of old roads.	Minimal. Repainting of railings.	12-ft deck width serves multiple use. Bike/pedestrian railings may seem unsubstantial for equestrians.	Would meet DPR trail accessibility guidelines. Maximum running grade o 12.0% for 10 feet, 10% for 30 feet and 8.33% for 200 feet.	Record span; anchorage forces prohibitive to meet accessibility criteria
	Strutted Girder	N/A	$ 5,772,000	$ 457,600	$ 6,229,600	$ 1,868,900	$ 8,099,000	Low profile superstructure with Y-shaped piers and diagonal struts that would evoke a tree.	Very difficult access to both ends. Difficult construction for river for piers. Large crane required to set girders. Girders would have to be shipped in fairly small sections.	Construction in river channel; may require temporary diversion of river. Piers will be permanent obstructions in channel.	Rock excavation required for abutments and piers. Piers expected to require cofferdam & seal course. Rock anchors or pin piles likely required at abutments due to adverse sloping fracture surfaces and at piers to its overturning.	Abutments set above 100-year flood. Pier scour depth up to 13', but possibly much less depending on depth of competent rock. Bedrock may be very close to the surface within the channel and is not expected to erode.	XX' of new trail required. Difficult, steep trail connection to west end from existing ATC trail; connection to east end may employ remnants of old roads.	Structural steel would either be weathering steel or require periodic painting.	15-ft between railings provides extra usable width to serve multiple use. Bike/pedestrian railings may seem unsubstantial for equestrians, but recessed deck and fillets would add to sense of safety.	Would meet DPR trail accessibility guidelines. Maximum running grade o 5.0%.	Probably not feasible without very large girders or more than two river piers. Longer spans would require deeper struts, higher profile and even longer spans. Expensive because of steel girders, small project size and difficult site access.
	Suspension	N/A	$ 5,772,000	$ 457,600	$ 6,229,600	$ 1,868,900	$ 8,099,000	Low profile superstructure; no river piers; blends into background; sweeping catenary shape of cables complements arching deck and shape of canyon; lack of towers limits visual impact.	Very difficult access to both ends. Once established, no construction activities are required in river. Secondary construction access roads required to construct anchorages.	No in-river construction minimizes impacts. Additional impacts for anchorages and construction access roads to them.	Rock excavation required for abutments and cable anchorages. Rock anchors required for moderate to large tension forces at abutments and cable anchorages.	Abutments set above 100-year flood. No impact on hydraulics and no scour issues for design flows.	XX' of new trail required. Difficult, steep trail connection to west end from existing ATC trail; connection to east end may employ remnants of old roads.	Cables and connections may require cleaning to prevent debris buildup and corrosion. Repainting of railings.	12-ft deck width serves multiple use. Mass, extra overall width (to accommodate hanger connections), splayed main cables and post-tensioning of concrete deck to abutments provide stiffness, damping and resistance to lateral loads. Cables and hangers enha	Would meet DPR trail accessibility guidelines. Maximum running grade o 5.0%.	Precast segmental bridge with towers.
Knickerbocker Canyon (KC)																	
Knickerbocker Canyon (KC)	Stress Ribbon	N/A	$ 3,795,000	$ 342,400	$ 4,137,400	$ 1,241,300	$ 5,379,000	Low profile superstructure; no river piers; blends into background; large sag may be considered either attractive or unsettling.	Very difficult access to both ends. Once established, no construction activities are required in river.	No construction in river. Relatively large abutment excavations. May have significant visual impacts on views of river canyon (but less than other alternatives because of slenderness of structure), while prov	Rock excavation required for abutments. Rock anchors required for very large tension forces at abutments.	Abutments set above 100-year flood. No impact on hydraulics and no scour issues for design flows.	XX' of new trail required. Difficult, steep and long trail connections at both ends.	Minimal. Repainting of railings.	12-ft deck width serves multiple use. Bike/pedestrian railings may seem unsubstantial for equestrians.	Would meet DPR trail accessibility guidelines. Maximum running grade o 10.0% for 30 feet.	Record span; anchorage forces prohibitive to meet accessibility criteria
	Strutted Girder	N/A	$ 4,212,000	$ 342,400	$ 4,554,400	$ 1,366,400	$ 5,921,000	Low profile superstructure with Y-shaped piers and diagonal struts that would evoke a tree.	Very difficult access to both ends. Difficult construction for river for piers. Large crane required to set girders. Girders would have to be shipped in fairly small sections.	Construction in river channel; may require temporary diversion of river. Piers will be permanent obstructions in channel. May have significant visual impacts on views of river canyon, while providing new views of Knickerbocker Canyon.	Rock excavation required for abutments and piers. Piers expected to require cofferdam & seal course. Rock anchors or pin piles likely required at abutments due to adverse sloping fracture surfaces and at piers to its overturning.	Abutments set above 100-year flood. Pier scour depth up to 13', but possibly much less depending on depth of competent rock. Bedrock may be very close to the surface within the channel and is not expected to erode.	XX' of new trail required. Difficult, steep and long trail connections at both ends.	Structural steel would either be weathering steel or require periodic painting.	15-ft between railings provides extra usable width to serve multiple use. Bike/pedestrian railings may seem unsubstantial for equestrians, but recessed deck and fillets would add to sense of safety.	Would meet DPR trail accessibility guidelines. Maximum running grade o 5.0%.	Probably not feasible without very large girders or more than two river piers. Longer spans would require deeper struts, higher profile and even longer spans. Expensive because of steel girders, small project size and difficult site access.
	Suspension	N/A	$ 3,662,000	$ 342,400	$ 4,004,400	$ 1,201,400	$ 5,206,000	Low profile superstructure; no river piers; blends into background; sweeping catenary shape of cables complements arching deck and shape of canyon; lack of towers limits visual impact.	Very difficult access to both ends. Once established, no construction activities are required in river. Secondary construction access roads required to construct anchorages.	No in-river construction minimizes impacts. May have significant visual impacts on views of canyon, while providing new views of Knickerbocker Canyon. Additional impacts for anchorages and construction access roads to them.	Rock excavation required for abutments and cable anchorages. Rock anchors required for moderate to large tension forces at abutments and cable anchorages.	Abutments set above 100-year flood. No impact on hydraulics and no scour issues for design flows.	XX' of new trail required. Difficult, steep and long trail connections at both ends.	Cables and connections may require cleaning to prevent debris buildup and corrosion. Repainting of railings.	12-ft deck width serves multiple use. Mass, extra overall width (to accommodate hanger connections), splayed main cables and post-tensioning of concrete deck to abutments provide stiffness, damping and resistance to lateral loads. Cables and hangers enha	Would meet DPR trail accessibility guidelines. Maximum running grade o 5.0%.	Precast segmental concrete without towers.
	Truss	N/A	$ 3,240,000	$ 342,400	$ 3,582,400	$ 1,074,800	$ 4,658,000	Truss would create substantial visual impact on canyon due to large structure depth (up to 9 feet) and river piers. Careful design of piers and choice of paint color (or weathering steel) would help soften the view.	Very difficult access to both ends. Difficult construction for river for piers. Large crane required to set trusses. Trusses may have to be shipped in fairly small sections.	Construction in river channel; may require temporary diversion of river. Piers will be permanent obstructions in channel. May have significant visua impacts on views of canyon, while providing new views of Knickerbocker Canyon.	Rock excavation required for abutments and piers. Piers expected to require cofferdam & seal course. Rock anchors or pin piles likely required at abutments due to adverse sloping fracture surfaces and at piers to its overturning.	Abutments set above 100-year flood. Pier scour depth up to 13', but possibly much less depending on depth of competent rock. Bedrock may be very close to the surface within the channel and is not expected to erode.	XX' of new trail required. Difficult, steep and long trail connections at both ends.	Structural steel would either be weathering steel or require periodic painting.	12-ft deck width serves multiple use. Half-through trusses provide substantial barrier for equestrians. Combination of truss and concrete deck provides stiffness and damping.	Would meet DPR trail accessibility guidelines. Maximum running grade o 5.0%.	Three-span; difficult access; large cranes required
Oregon Bar (OB)																	

Location	Bridge Type	Drawing No.	Crossing Cost	Trail Cost	Subtotal Constr.	Eng. & Admin 30%	Total Project Cost	Aesthetics	Ease of Construction	Environ. Impacts	Geotechnical	Hydraulics/ Scour	Trail Connections	Maintenance	User Experience	Accessibility	Comments
Oregon Bar (OB)	**Strutted Girder**	**OB-1**	**$ 2,175,000**	**$ 283,200**	**$ 2,458,200**	**$ 737,500**	**$ 3,196,000**	Low profile superstructure with Y-shaped piers and diagonal struts that would evoke a tree.	Existing road to Oregon Bar, several hundred feet downstream of crossing site; steep slopes at east abutment. Difficult construction for river for piers. Temporary river diversion or construction trestle may be necessary for access to east abutment. Large	Construction in river channel; may require temporary diversion of river. Piers will be permanent obstructions in channel.	Small area of rock excavation required for abutments; more substantial rock excavation for piers. Piers expected to require cofferdams and seal course.	Abutments set above 100-year flood. Pier scour depth up to 13', but possibly much less depending on depth of competent rock. Bedrock may be very close to the surface within the channel and is not expected to erode.	XX' of new trail required. Short trail connection to existing trail on west end; very long trail connections along drainage on east.	Structural steel would either be weathering steel or require periodic painting.	15-ft between railings provides extra usable width to serve multiple use. Bike/pedestrian railings may seem unsubstantial for equestrians, but recessed deck and fillets would add to sense of safety.	Would meet DPR trail accessibility guidelines. Maximum running grade o 5.0%.	Square foot costs based on Caltrans Comparative Bridge Costs. Steel girders are traditionally very expensive in California; these would be at high end of range because of small project size and difficult site access.
	Suspension	**OB-2**	**$ 2,016,000**	**$ 283,200**	**$ 2,299,200**	**$ 689,800**	**$ 2,989,000**	Low profile superstructure; no river piers; blends into background; sweeping catenary shape of cables complements arching deck and shape of canyon; lack of towers limits visual impact. Cables coming together at anchorages adds three-dimensional interest.	Existing road to Oregon Bar, several hundred feet downstream of crossing site; steep slopes at east abutment. No permanent construction in river, but temporary river diversion or construction trestle and secondary access road may be necessary to provide c	No in-river construction minimizes impacts. Additional impacts for anchorages and construction access roads to them.	Rock excavation required for abutments and cable anchorages. Rock anchors required for moderate to large tension forces at abutments and cable anchorages.	Abutments set above 100-year flood. No impact on hydraulics and no scour issues for design flows.	XX' of new trail required. Short trail connection to existing trail on west end; very long trail connections along drainage on east.	Cables and connections may require cleaning to prevent debris buildup and corrosion. Repainting of railings.	12-ft deck width serves multiple use. Mass, extra overall width (to accommodate hanger connections), splayed main cables and post-tensioning of concrete deck to abutments provide stiffness, damping and resistance to lateral loads. Cables and hangers enha	Would meet DPR trail accessibility guidelines. Maximum running grade o 5.0%.	No tower; short span
	Stress Ribbon	**OB-3**	**$ 1,793,000**	**$ 283,200**	**$ 2,076,200**	**$ 622,900**	**$ 2,700,000**	Low profile superstructure; no river piers; blends into background; sag may be considered either attractive or unsettling.	Existing road to Oregon Bar, several hundred feet downstream of crossing site; steep slopes at east abutment. No permanent construction in river, but temporary river diversion or construction trestle may be necessary to provide construction access across	No permanent in-river construction, but would potentially require temporary crossing.	Rock excavation required for abutments. Rock anchors required for large tension forces at abutments (but smaller than other stress ribbon alternatives because of shorter span).	Abutments set above 100-year flood. No impact on hydraulics and no scour issues for design flows.	XX' of new trail required. Short trail connection to existing trail on west end; very long trail connections along drainage on east.	Minimal. Repainting of railings.	12-ft deck width serves multiple use. Bike/pedestrian railings may seem unsubstantial for equestrians.	Would meet DPR trail accessibility guidelines. Maximum running grade o 8.33%.	Based on very similar Rancho Santa Fe Bridges plans and bid prices.
	Truss	**OB-4**	**$ 1,546,000**	**$ 283,200**	**$ 1,829,200**	**$ 548,800**	**$ 2,378,000**	Truss would create substantial visual impact on canyon due to large structure depth (up to 9 feet) and river piers. Careful design of piers and choice of paint color (or weathering steel) would help soften the view.	Existing road to Oregon Bar, several hundred feet downstream of crossing site; steep slopes at east abutment. Difficult construction for river for piers. Temporary river diversion or construction trestle may be necessary for access to east abutment. Large	Construction in river channel; may require temporary diversion of river. Piers will be permanent obstructions in channel.	Rock excavation required for abutments and piers. Piers expected to require cofferdam & seal course. Rock anchors or pin piles likely required at abutments due to adverse sloping fracture surfaces and at piers to its overturning.	Abutments set above 100-year flood. Pier scour depth up to 13', but possibly much less depending on depth of competent rock. Bedrock may be very close to the surface within the channel and is not expected to erode.	XX' of new trail required. Short trail connection to existing trail on west end; very long trail connections along drainage on east.	Structural steel would either be weathering steel or require periodic painting.	12-ft deck width serves multiple use. Half-through trusses provide substantial barrier for equestrians. Combination of truss and concrete deck provides stiffness and damping.	Would meet DPR trail accessibility guidelines. Maximum running grade o 5.0%.	Rock excavation in riverbed and rock anchors at piers and abutments largely responsible for high cost.
	Seasonal Pipe Bridge and Ford	**N/A**	**$ 58,000**	**$ 286,400**	**$ 344,400**	**$ 103,400**	**$ 448,000**	Low level; small and unobtrusive; appears unsubstantial.	Water may be too deep for bridge or ford. Bridge does not have to be designed for equestrian loading. No heavy equipment. Annual erection and dismantling; requires secure storage.	Small diameter pipes driven into river bed and removed each year. No permanent impacts.	Need to verify ability to drive pipes into riverbed.	Susceptible to damage from unexpected high flows.	XX' of new trail required. Would open up connections between FLSRA and ASRA and provide access to the peninsula area.	Annual cost to erect and dismantle; intermittent painting and decking replacement	Separates equestrians from mountain bikers and hikers; narrow (3') bridge.	Not wheel chair accessible due to steps, but could meet other DPR trail accessibility guidelines.	When Folsom Lake water surface is at Elev. 466, max water depth = 14.0 ft. Therefore, full reservoir could delay or prevent spring installation.
Mountain Quarries RR Bridge (MQRR) - "No Hands"																	
MQRR No Hands	**Convert to Multiple Use**	N/A	**$ -**	**$ 1,408,000**	**$ 1,408,000**	$ 422,400	**$ 1,831,000**	No change to existing condition.	N/A	None directly associated with use of bridge.	N/A	N/A	XX' of new trail mountain bike trail required to separate users where existing Western States Trail is not wide enough.	N/A	Would require revised management. Addition of mountain bikers may prompt desire to upgrade railings (with smaller openings, as users would more often find themselves closer to the railings) and improve drainage to eliminate persistent muddy conditions, be	Existing surface does not meet DPR trail accessibility surface guidelines.	May consider upgrade of railing (not required from mountain bike use and not included in estimate) and drainage improvements.
State Route 49 Bridge (SR49)																	
State Route 49 Bridge (SR49)	**Adjacent Prefab Truss**	**AR-1**	**$ 1,564,000**	**$ 1,488,000**	**$ 3,052,000**	**$ 915,600**	**$ 3,968,000**	Truss adjacent to existing steel plate girder span would be visually incompatible. Careful design of piers and choice of paint color could improve compatibility.	Little room for construction staging.	Permanent construction in river channel.	Rock excavation required at piers and abutments. Piers expected to require cofferdam & seal course.	Piers constructed in river channel, but adjacent to existing piers. Would not reduce flow area but could create local eddy problems between piers. Scour depths unknown at this time.	XX' of new trail mountain bike trail required to separate users where existing Western States Trail is not wide enough.	Structural steel would either be weathering steel or require periodic painting.	Would provide separated mountain bike crossing protected from traffic.	Would meet DPR trail accessibility guidelines. Maximum running grade o 5.0%.	
	Widen	**AR-1**	**$ 1,733,000**	**$ 1,488,000**	**$ 3,221,000**	**$ 966,300**	**$ 4,188,000**	Widening would match existing bridge and would have limited impact on aesthetics.	Widening existing piers would be problematic due to shape of existing piers and need to construct in river channel adjacent to existing piers. Little room for construction staging. Would require approval from and coordination with Caltrans.	Permanent construction in river channel.	Rock excavation required at piers and abutments. Piers expected to require cofferdam & seal course.	Piers constructed in river channel, but would be extensions of existing piers. Would not reduce flow area or add to scour. Scour depths unknown at this time.	XX' of new trail mountain bike trail required to separate users where existing Western States Trail is not wide enough.	Maintenance would be consistent with and done in conjunction with existing bridge maintenance.	Would provide separated mountain bike crossing adjacent to, but protected from traffic.	Would meet DPR trail accessibility guidelines. Maximum running grade o 5.0%.	Single girder, widened concrete deck & bicycle railing added to existing barrier.
	Use existing	**N/A**	$ 42,000	$ 1,488,000	$ 1,530,000	$ 459,000	$ 1,989,000	N/A	Removal of existing handrail and addition of bicycle height railing to top of concrete barrier would require lane closures.	Higher railing may block views from some vehicles, but may improve views for some other vehicles.	N/A	N/A	XX' of new trail mountain bike trail required to separate users where existing Western States Trail is not wide enough and for northbound bicyclists to cross under bridge to get to right side shoulder.	Minimal.	Would require off-road bicyclists to ride with heavy, but slow traffic for several hundred feet. Depending on design, could lead to wrong-way riding on bridge.	N/A	Add bicycle railing to existing barrier (2 sides x 350 ft); add signs and trail connections beneath bridge or marked bicycle crossings at grade.

Notes:
1. **Costs are for comparison purposes only.**
2. **Costs include 10% mobilization and 25% contingency.**
3. **Costs are from Caltrans square foot cost data dated January 2007, or from individual comparable projects.**
4. **Cost basis is assumed construction year of 2007; Caltrans Cost Index assumed to be 450 (based on 1977=100) 2005 at 460 and 2006 at 423.**
5. **Comparable cost data from outside of Caltrans was normalized to Sacramento, CA based on Means 2006 geographical index of 109.4.**
6. **Rows in bold type correspond to developed alternatives with drawings (except for the No-hands and Use Exist SR 49 alternatives). Rows not bolded are extrapolated from developed ones.**
7. **Shaded rows represent alternatives that were carried to the feasibility level.**

Appendix C



ELEVATION

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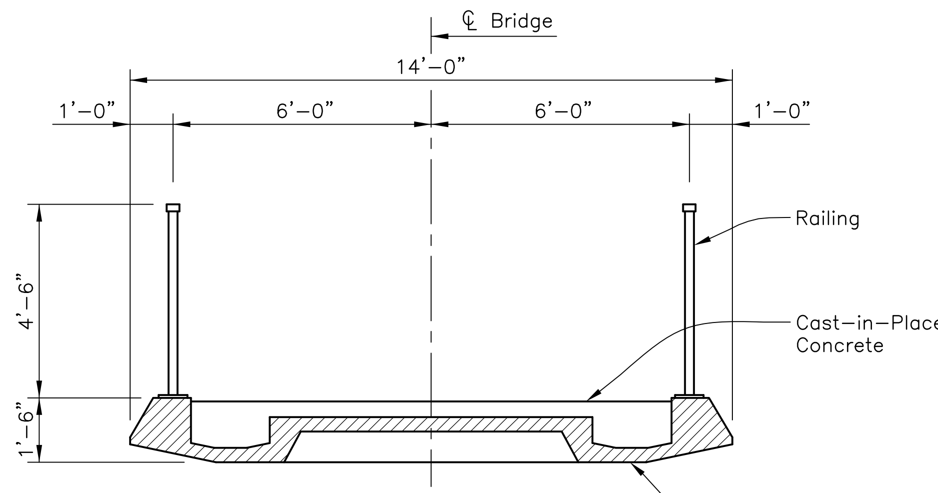

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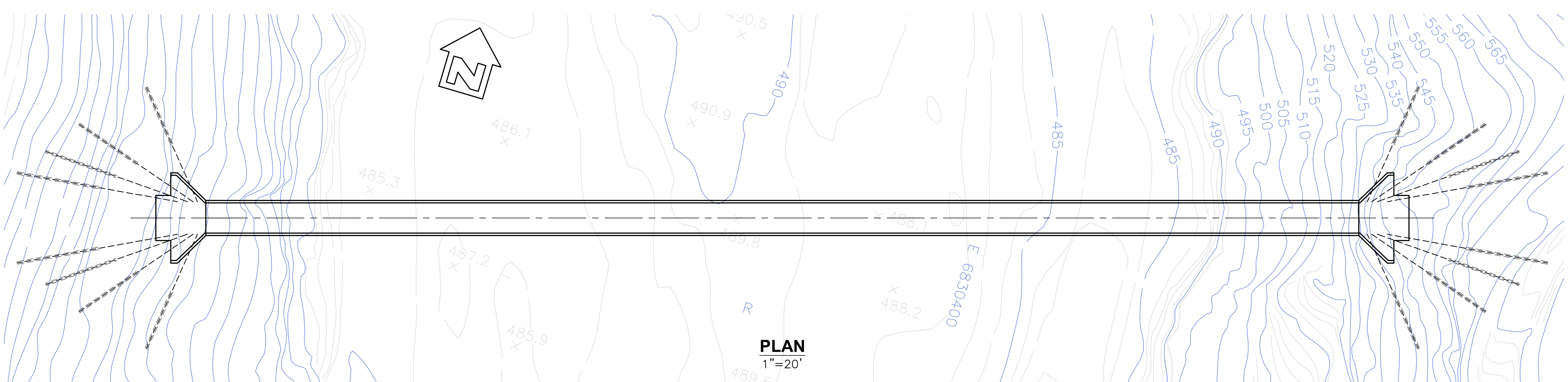


PLAN

1"=20'

CALIFORNIA STATE PARKS SINCE 1864

CALIFORNIA STATE FIRE MARSHAL- APPROVED

Approval of this plan does not authorize or approve any omission of deviation from applicable regulations. Final approval is subject to field inspection. One set of approved plans shall be available on the project site at all times.

Reviewed by Date

DPR ACCESS COMPLIANCE REVIEW
ACCESSIBILITY SECTION
CERTIFICATION #

Reviewed by Date

ACCESSIBILITY COMPLIANCE AND STATE FIRE MARSHAL SIGNED ORIGINALS ARE ON FILE AT THE DEPARTMENT OF PARKS AND RECREATION, NORTHERN SERVICE CENTER

DESIGNED:
DRAWN:
CHECKED:
DATE:

REVISIONS DATE

AUBURN TO COOL TRAIL CROSSING

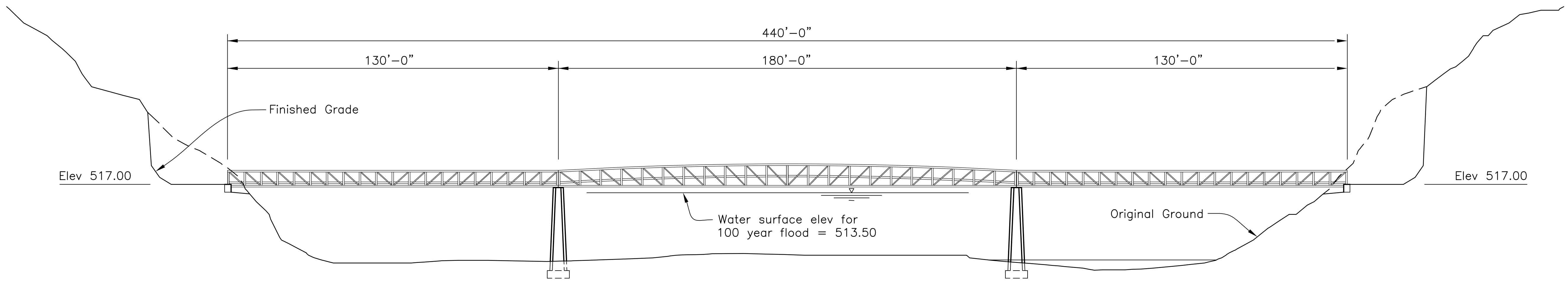
UPPER OUTLET RAPID - STRESS RIBBON BRIDGE

DRAWING NO.

SHEET NO.

OF

C:\PWworking\SAC\jvought\dms38593\Bridge Alt 3 Sress Ribbon.dwg, 4/19/2007 9:48:25 AM



ELEVATION
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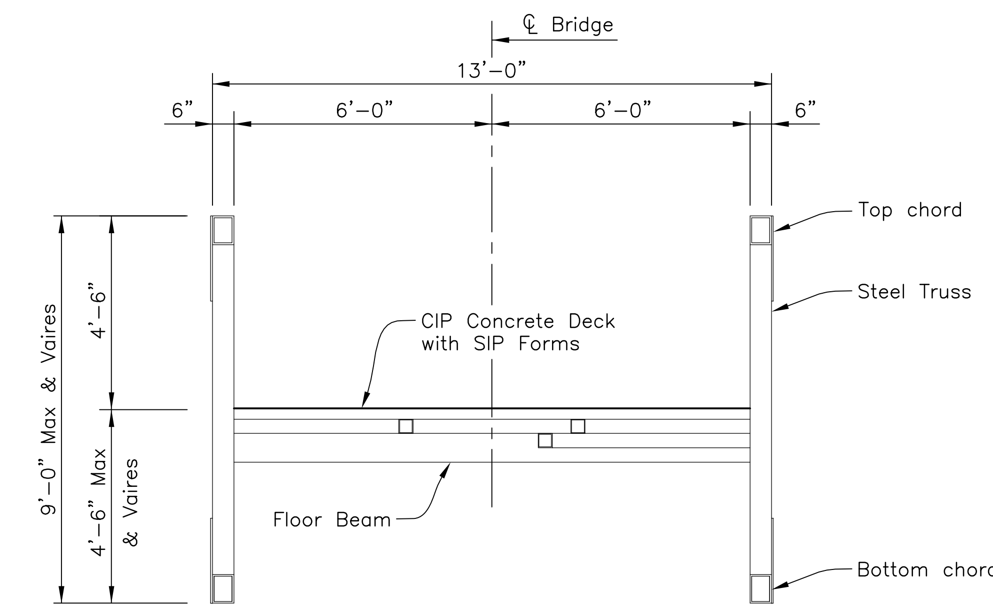
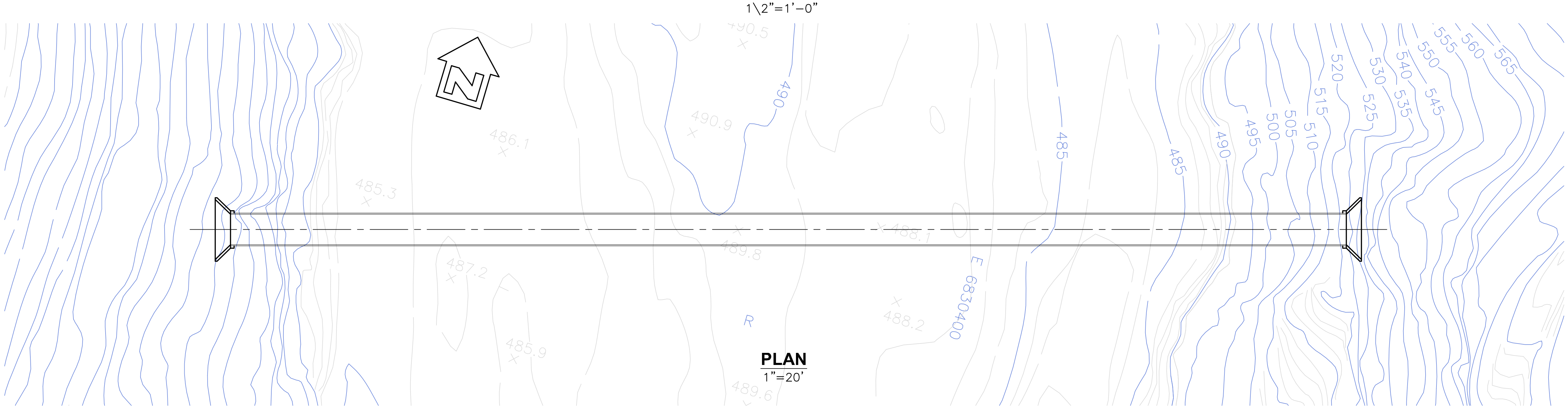


TYPICAL SECTION
1\2"=1'–0"



PLAN
1"=20'

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DATE:

REVISIONS
DATE

AUBURN TO COOL TRAIL CROSSING

UPPER OUTLET RAPID - STEEL TRUSS BRIDGE

DRAWING NO.

SHEET NO.
OF

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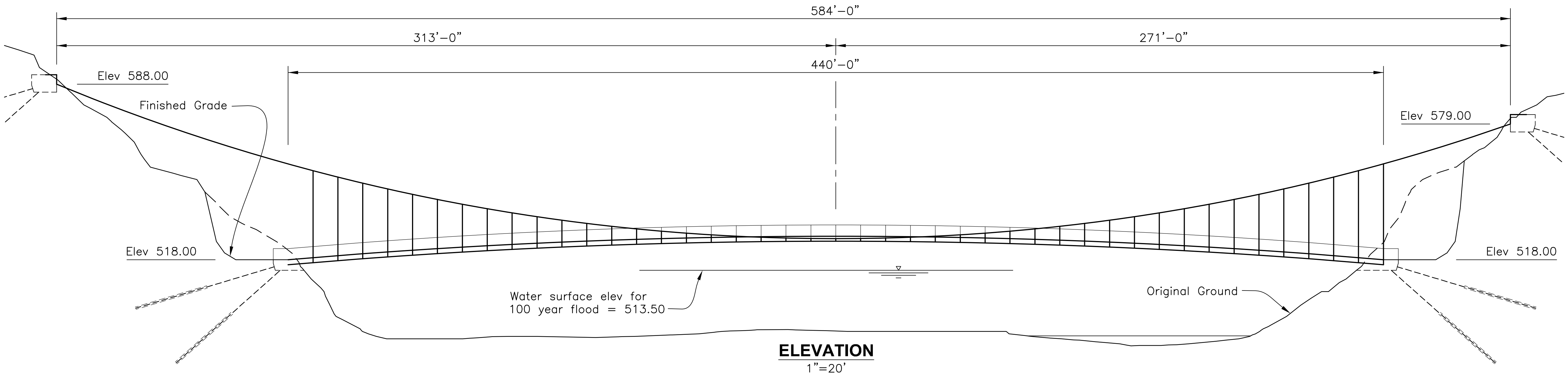

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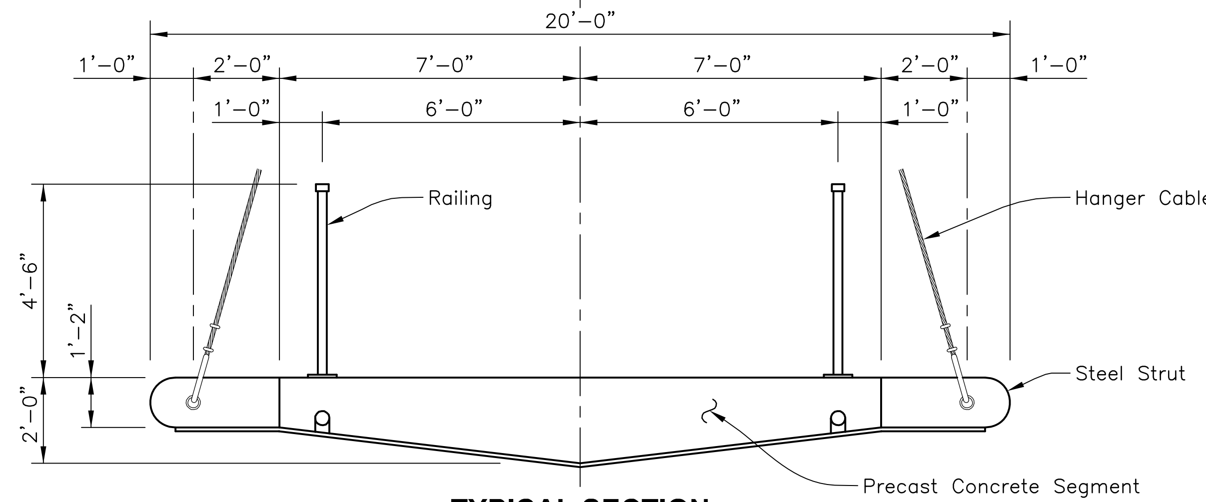
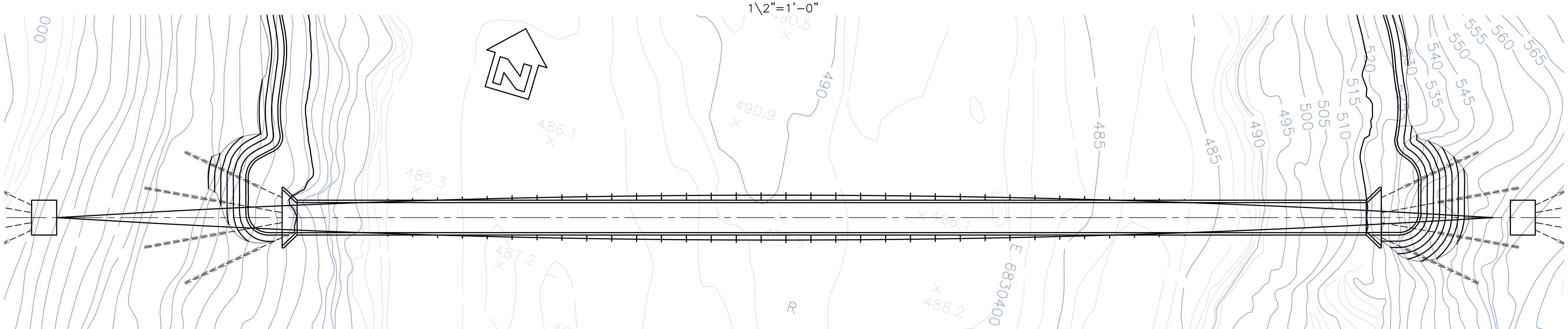


TYPICAL SECTION
1\2"=1'–0"



PLAN
1"=20'

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AUBURN TO COOL TRAIL CROSSING

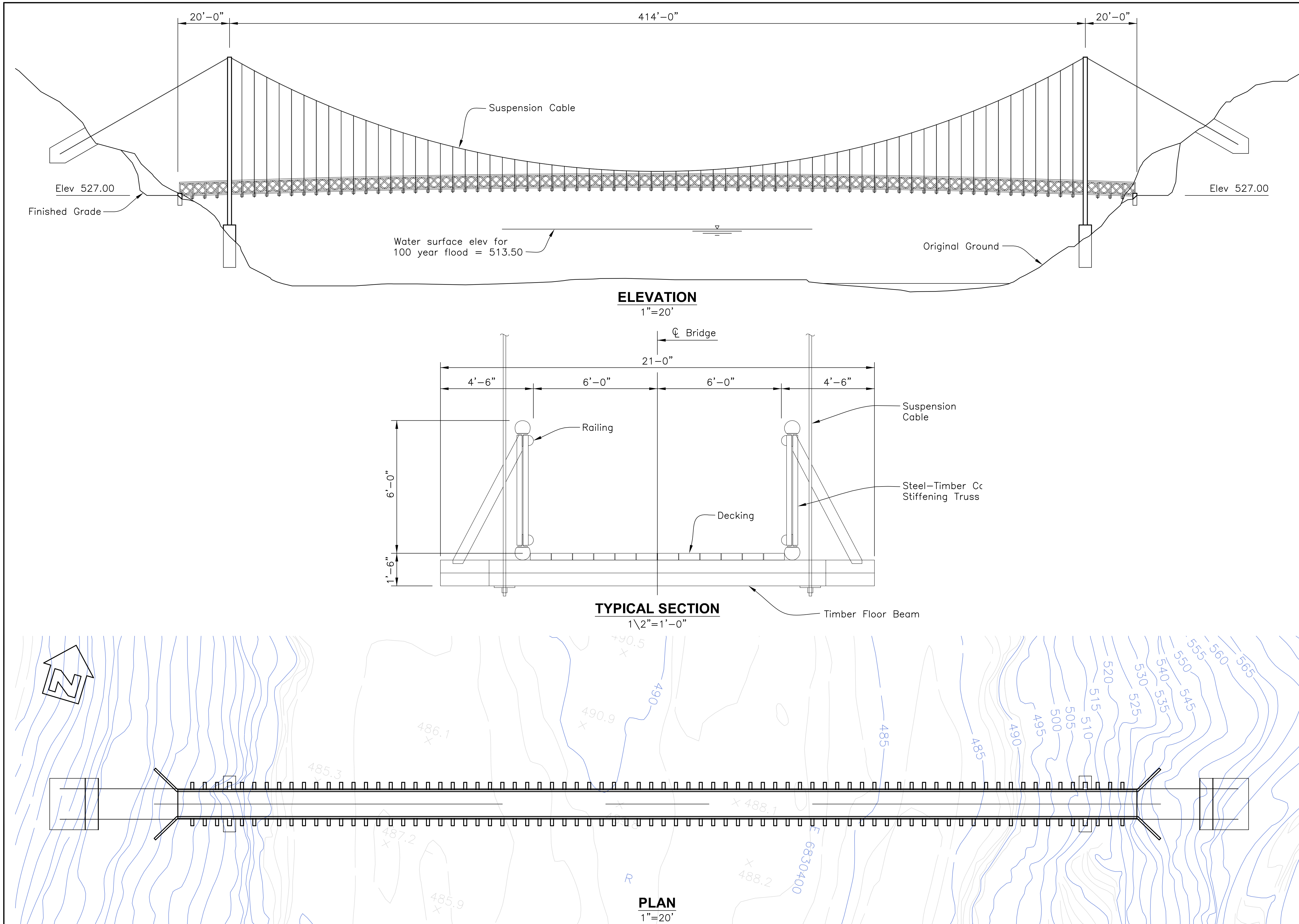
UPPER OUTLET RAPID - CONCRETE SUSPENSION BRIDGE

DRAWING NO.

SHEET NO.

OF

C:\PWworking\SAC\jvought\dms38593\Bridge Alt 3 Suspension Concrete.dwg, 4/19/2007 9:51:13 AM



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AUBURN TO COOL TRAIL CROSSING

UPPER OUTLET RAPID - TIMBER SUSPENSION BRIDGE

DRAWING NO.

SHEET NO.

OF

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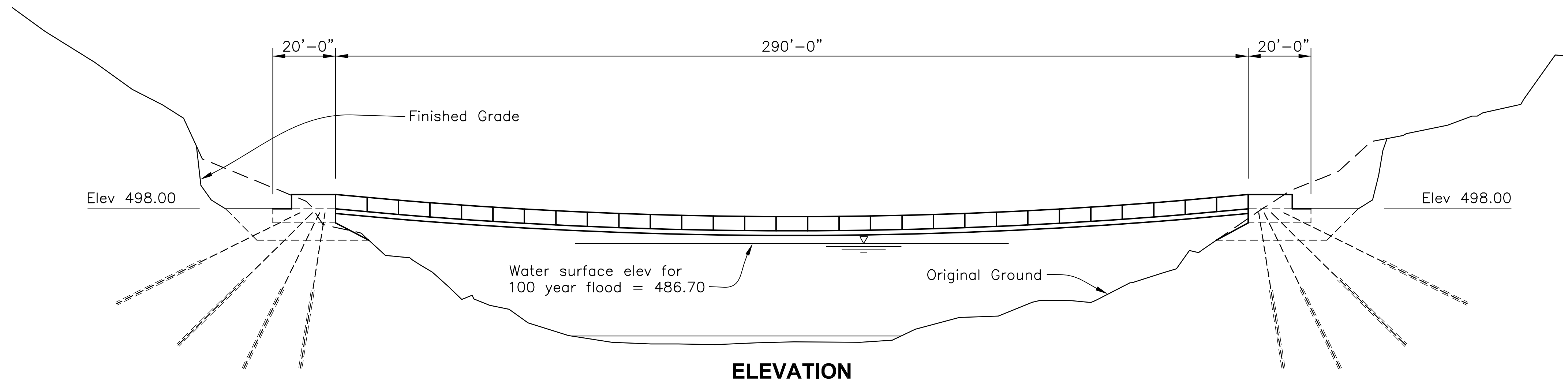

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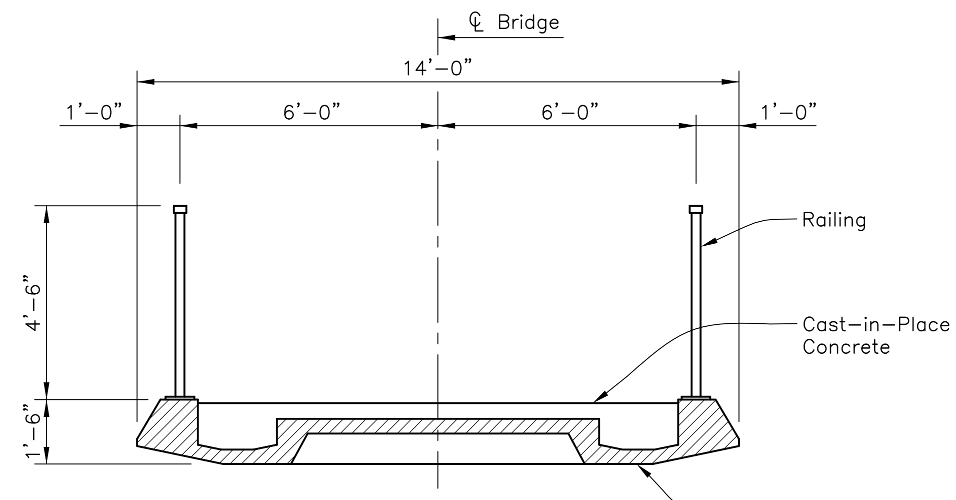

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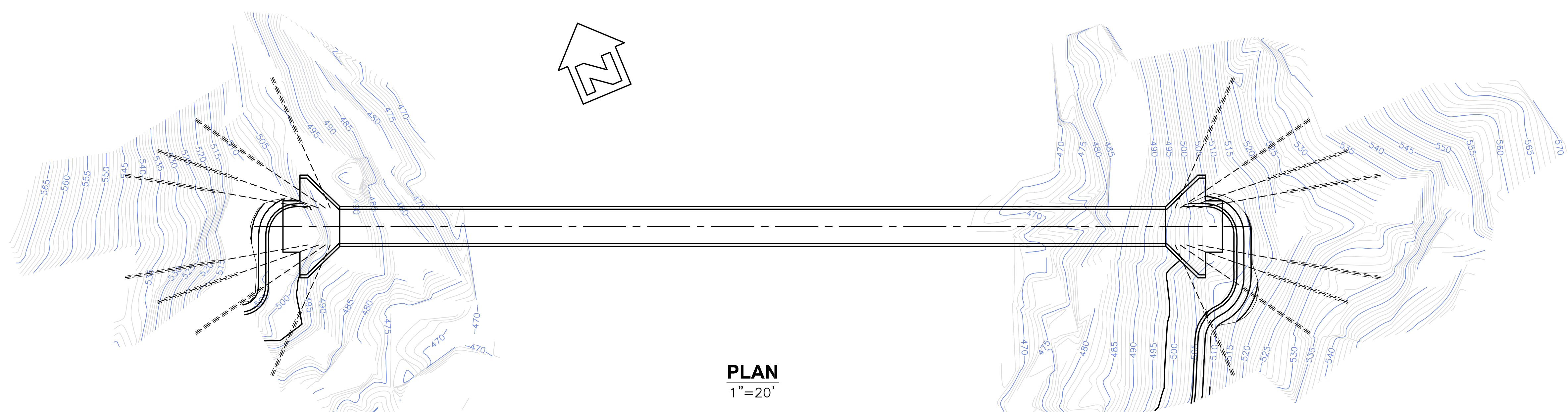

PLAN
1"=20'

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DATE:

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AUBURN TO COOL TRAIL CROSSING

OREGON BAR - STRESS RIBBON BRIDGE

DRAWING NO.

SHEET NO.

OF

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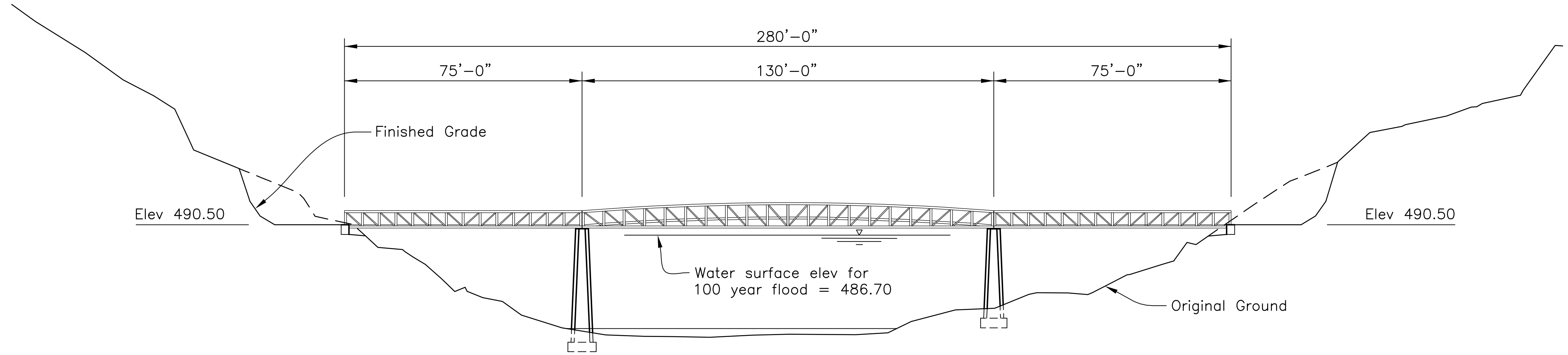
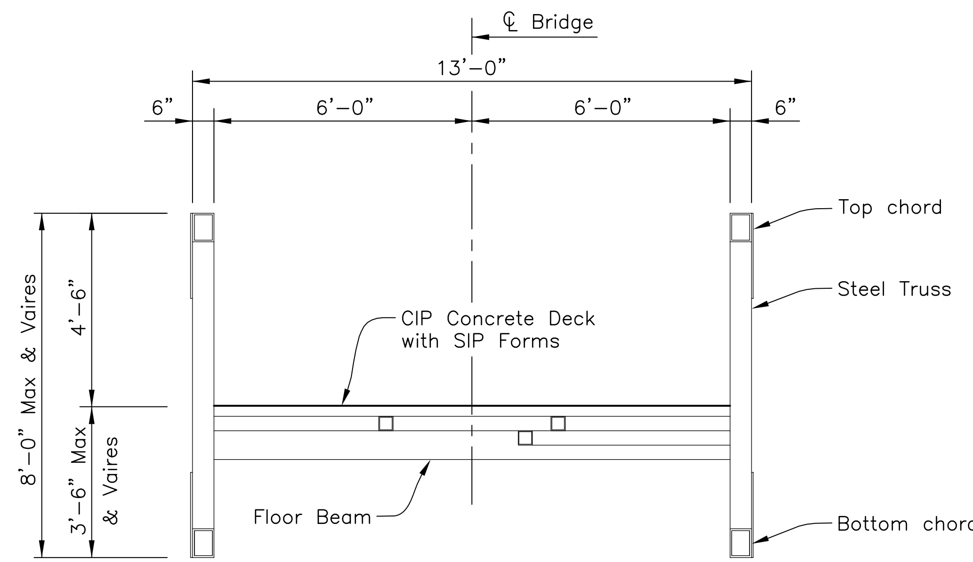


ELEVATION
1"=20'



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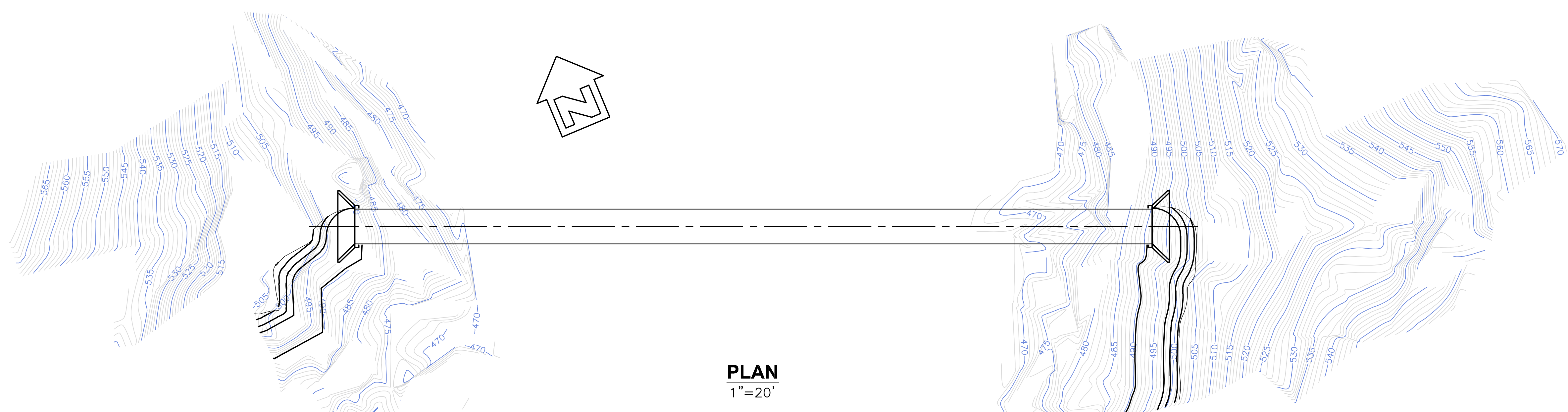
1\2"=1'–0"



PLAN
1"=20'

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AUBURN TO COOL TRAIL CROSSING

OREGON BAR - STEEL TRUSS BRIDGE

DRAWING NO.

SHEET NO.

OF

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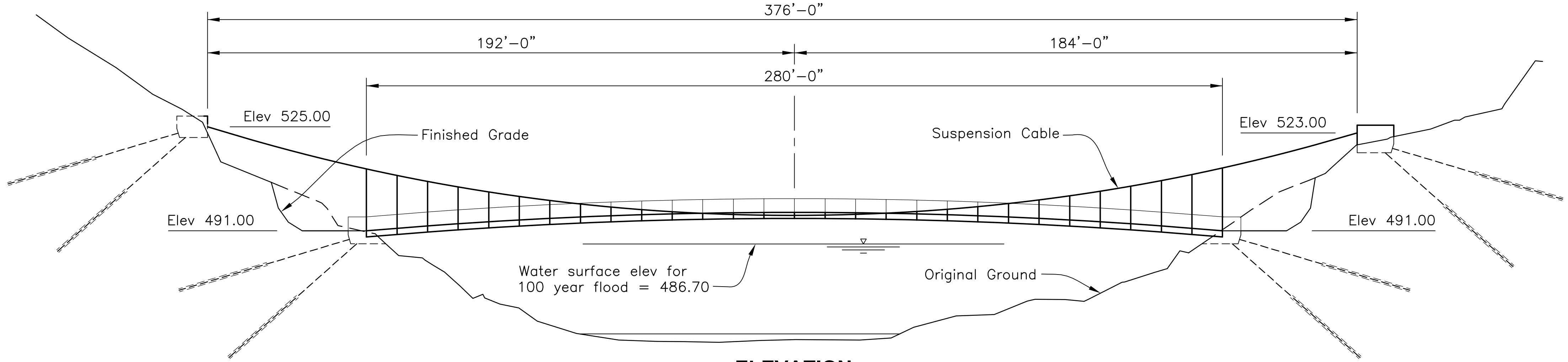

ELEVATION
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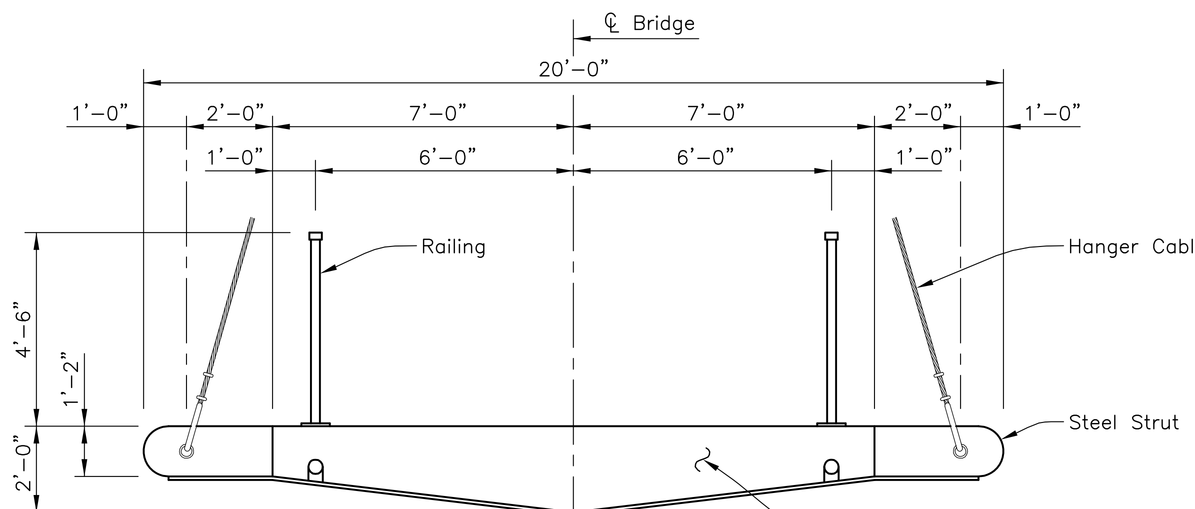

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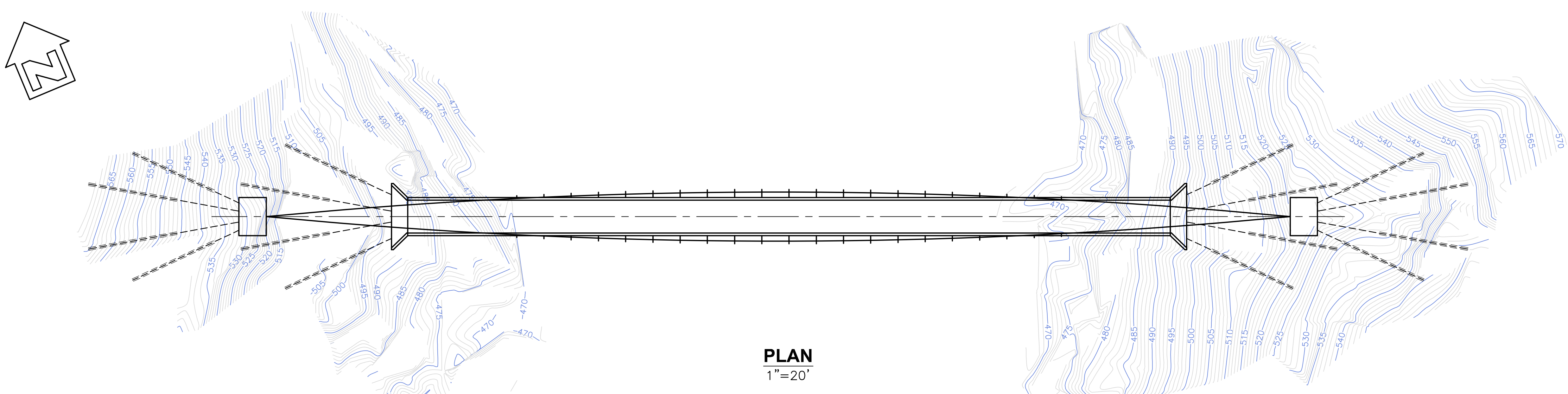
1\2"=1'–0"



PLAN
1"=20'

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AUBURN TO COOL TRAIL CROSSING

OREGON BAR - CONCRETE SUSPENSION BRIDGE

DRAWING NO.

SHEET NO.

OF

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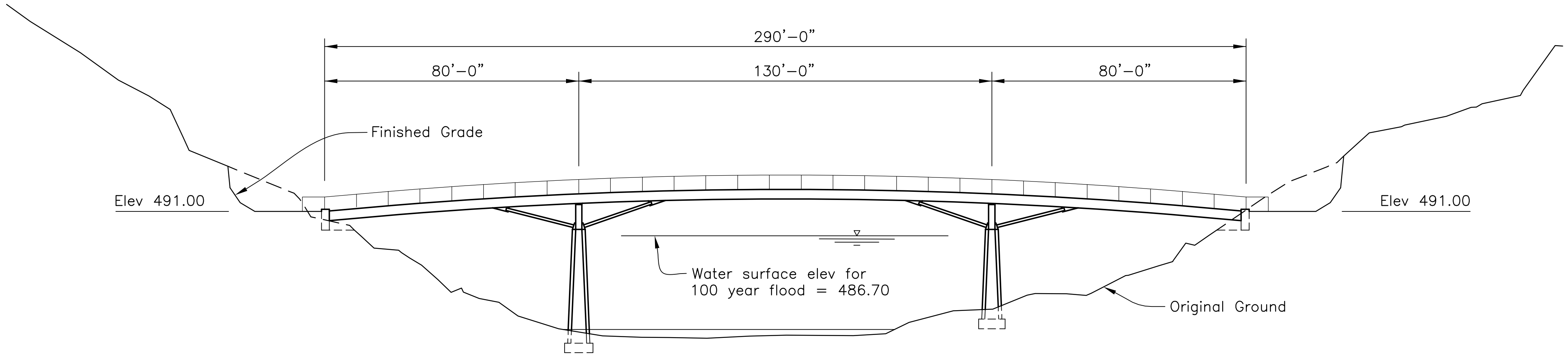
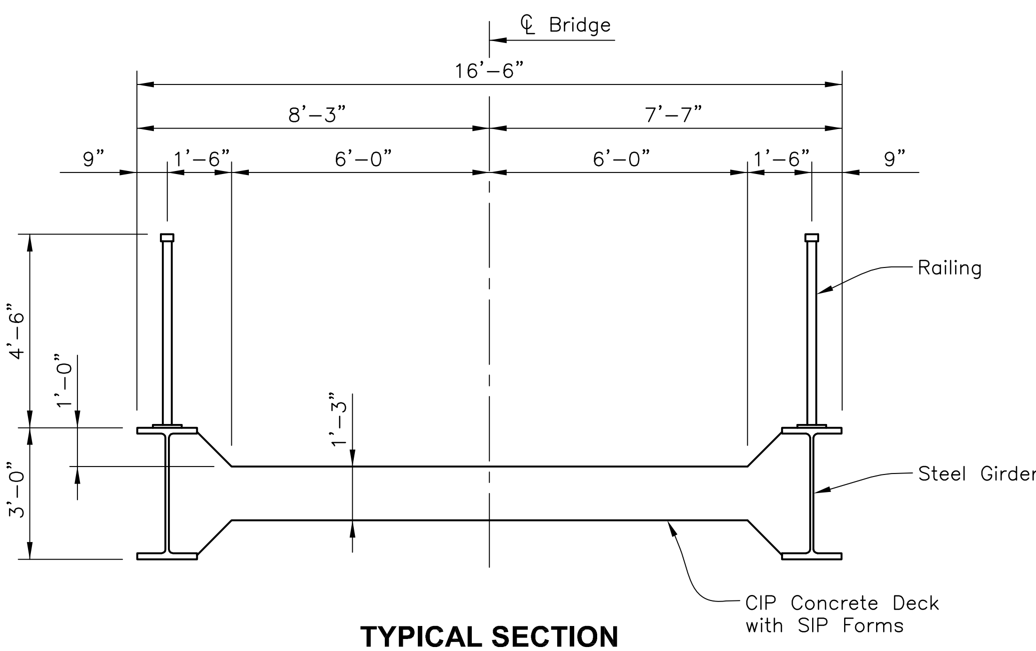


ELEVATION
1"=20'



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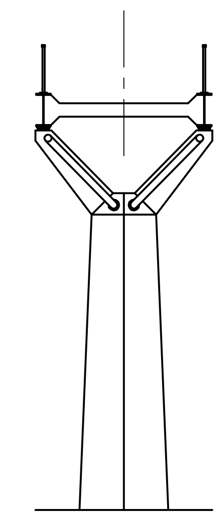
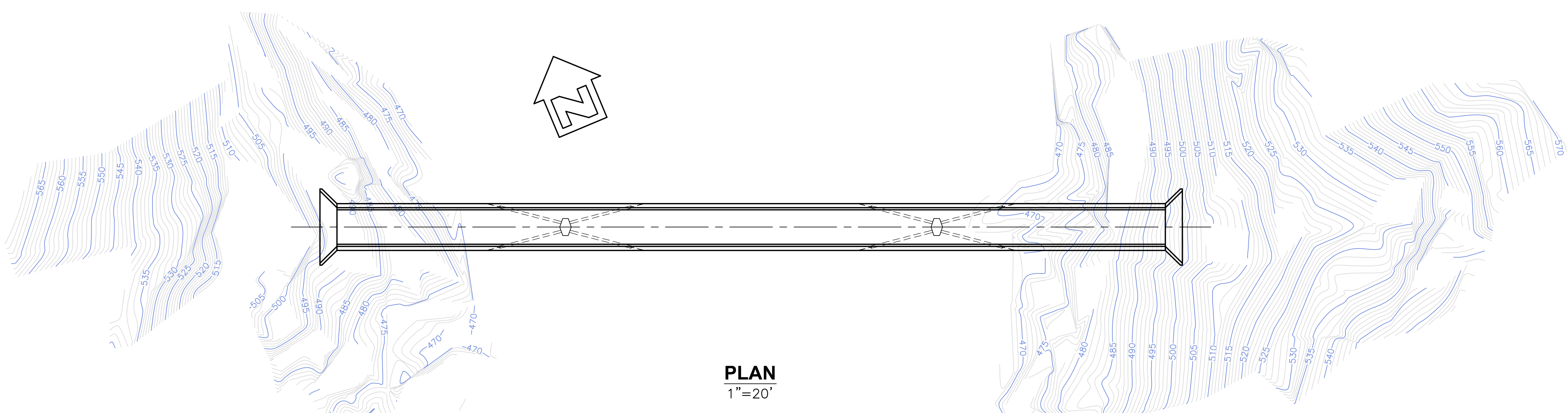


ELEVATION AT PIER
1\8"=1'–0"



PLAN
1"=20'

CALIFORNIA STATE FIRE MARSHAL- APPROVED

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DATE

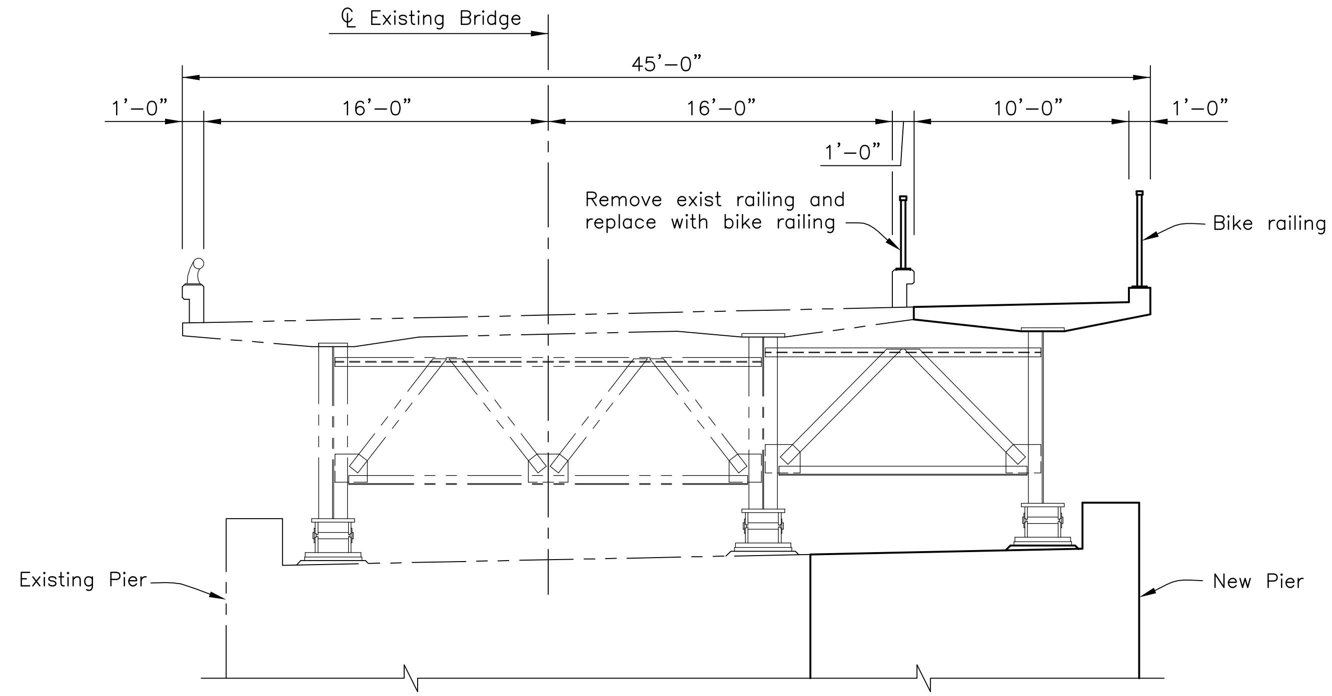
AUBURN TO COOL TRAIL CROSSING

OREGON BAR - STRUTTED GIRDER BRIDGE

DRAWING NO.

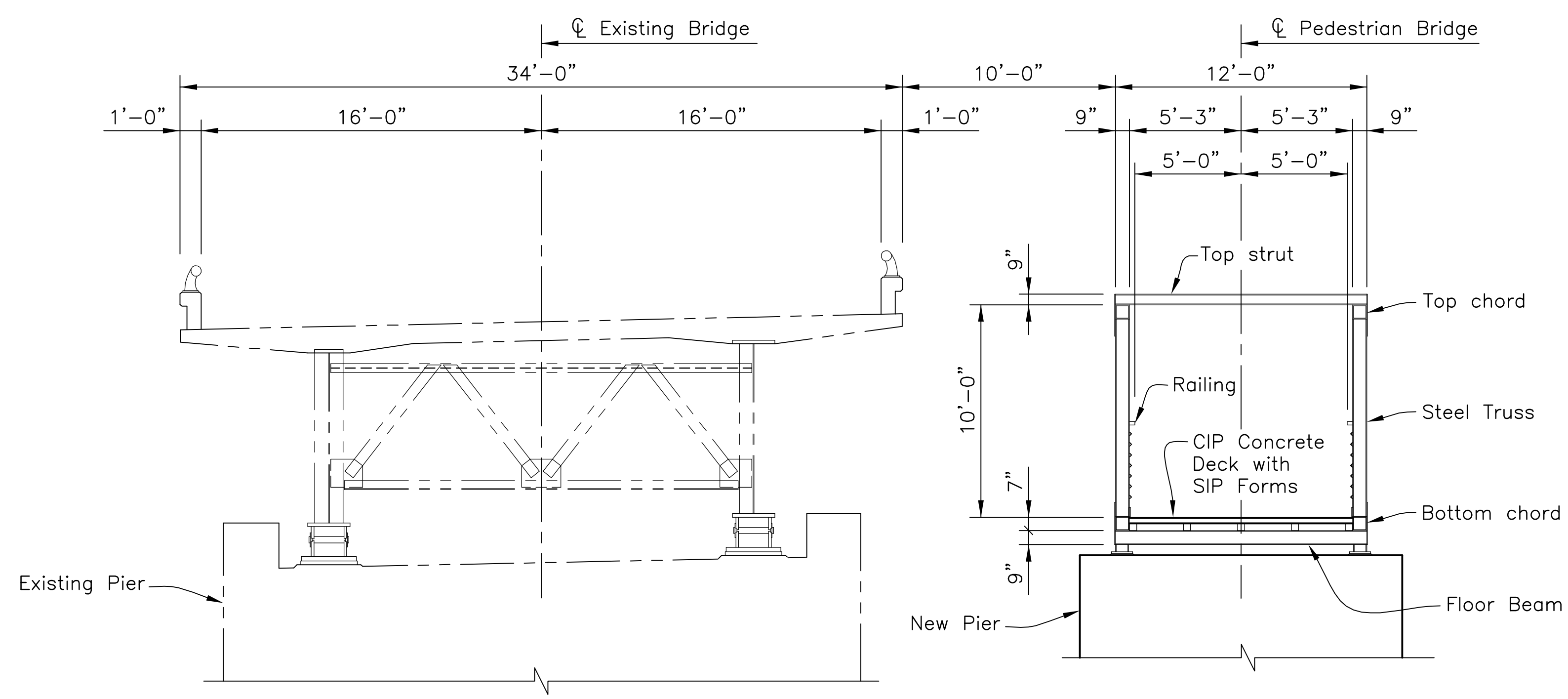
SHEET NO.
OF

C:\PWworking\SAC\jvought\dms38593\Bridge Alt 6 Strutted Girder.dwg, 4/19/2007 10:02:13 AM



TYPICAL SECTION - WIDENED FOR PEDESTRIAN CROSSING

1\4"=1'–0"



TYPICAL SECTION - WITH SEPARATE BRIDGE FOR PEDESTRIAN CROSSING

1\4"=1'–0"

CALIFORNIA STATE PARKS SINCE 1864

CALIFORNIA STATE FIRE MARSHAL- APPROVED

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DPR ACCESS COMPLIANCE REVIEW
ACCESSIBILITY SECTION

CERTIFICATION #

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DATE

AUBURN TO COOL TRAIL CROSSING

HIGHWAY 49 PEDESTRIAN CROSSING

DRAWING NO.

SHEET NO.

OF

C:\PWworking\SAC\jvought\dms38593\Bridge Alt X Hwy 49 Widen.dwg, 4/19/2007 10:03:27 AM

Appendix D

Auburn to Cool Trail Crossing Construction Costs

HDR

Auburn to Cool Trail Crossing

General Plan Estimates

Date: April 26, 2007

Construction Costs

	Bridge	Trail Connections	Total
Upper Outlet Rapids - Suspension	$2,914,000	$333,000	$3,247,000
Oregon Bar - Stress Ribbon	$1,787,000	$787,000	$2,574,000
Oregon Bar - Truss	$1,548,000	$787,000	$2,335,000
Highway 49 - Bikes on Shoulders	$118,000	$2,067,000	$2,185,000
Mountain Quarries RR Bridge - "No Hands"	$1,000	$1,956,000	$1,957,000
Existing Crossing - Seasonal FRP Truss	$224,000	$61,000	$285,000
Oregon Bar - Seasonal Pipe Bridge	$58,000	$429,000	$487,000

	GENERAL PLAN ESTIMATE	X	ADVANCE PLANNING ESTIMATE

RCVD BY:

IN EST:

OUT EST:

BRIDGE:	Auburn to Cool Trail Crossing - Upper Outlet Rapid	**BR. No.:**		**DISTRICT:**	03
TYPE:	Towerless Suspension Bridge w/ Stressed Precast Conc Deck			**RTE:**	N/A
CU:				**CO:**	ED/PLA
EA:				**PM:**	N/A
	LENGTH:	430.00	**WIDTH:** 12.00	**AREA (SF) =**	5,160

DESIGN SECTION:	HDR		
# OF STRUCTURES IN PROJECT :	01	**EST. NO.**	
PRICES BY :	ACP	**COST INDEX:**	450
QUANTITIES BY:	JV	**DATE:**	5/3/2007
QUANTITIES CHECKED BY:	ACP	**DATE:**	

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	STRUCTURE EXCAVATION (Bridge)	CY	1,735	$110.00	$190,850.00
2	STRUCTURE BACKFILL (Bridge)	CY	35	$350.00	$12,250.00
3	ROCK ANCHOR	EA	24	$12,500.00	$300,000.00
4	PRESTRESSING and SUSPENSION CABLES	LS	1	$175,000.00	$175,000.00
5	STRUCTURAL CONCRETE, BRIDGE	CY	244	$1,000.00	$244,000.00
6	CLASS C CONCRETE (Leveling Course)	CY	100	$325.00	$32,500.00
7	FURNISH PRECAST CONCRETE DECK UNIT	EA	44	$10,000.00	$440,000.00
8	ERECT PRECAST CONCRETE DECK UNIT	EA	44	$3,000.00	$132,000.00
9	BAR REINFORCING STEEL (Bridge)	LB	40,000	$1.50	$60,000.00
10	MISCELLANEOUS METAL (Bridge)	LB	42,000	$6.00	$252,000.00
11	ROCK ANCHOR WATER TIGHTNESS RE-TEST	EA	24	$2,500.00	$60,000.00
12	ROCK ANCHOR LIFT-OFF TEST	EA	24	$500.00	$12,000.00
13	ROCK ANCHOR LIFT-OFF RE-TEST	EA	24	$500.00	$12,000.00
14	METAL RAILING (54" painted steel)	LF	900	$175.00	$157,500.00
15	FURNISH BRIDGE DECK TREATMENT	GAL	20	$250.00	$4,950.00
16	TREAT BRIDGE DECK	SF	5,160	$2.50	$12,900.00
17					

SUBTOTAL	$2,097,950
MOBILIZATION (@ 10 %)	$233,106
SUBTOTAL BRIDGE ITEMS	$2,331,056
CONTINGENCIES (@ 25%)	$582,764
BRIDGE TOTAL COST	$2,913,819
COST PER SQ. FT.	$564.69
BRIDGE REMOVAL (CONTINGENCIES INCL.)	
WORK BY RAILROAD OR UTILITY FORCES	
GRAND TOTAL	$2,913,819
FOR BUDGET PURPOSES - SAY	**$2,914,000**

COMMENTS: SF cost calculated based on clear width of 12 ft (actual width = 17

ROUTING

1. DES SECTION
2. OFFICE OF BRIDGE DESIGN - NORTH
3. OFFICE OF BRIDGE DESIGN - CENTRAL
4. OFFICE OF BRIDGE DESIGN - SOUTH
5. OFFICE OF BRIDGE DESIGN - WEST
6. OFFICE OF BRIDGE DESIGN SOUTHERN CALIFORNIA

	GENERAL PLAN ESTIMATE	X	ADVANCE PLANNING ESTIMATE

RCVD BY:

IN EST:

OUT EST:

BRIDGE: Auburn to Cool Trail Crossing - Upper Outlet Rapid	**BR. No.:**	**DISTRICT:**	03
TYPE: Suspension Bridge -Trail Connections		**RTE:**	N/A
CU:		**CO:**	ED/PLA
EA:		**PM:**	N/A

LENGTH: 1.00 **WIDTH:** 5.00 **AREA (SF) =** 5

DESIGN SECTION:	HDR		
# OF STRUCTURES IN PROJECT :	01	**EST. NO.**	
PRICES BY :	ACP	**COST INDEX:**	450
QUANTITIES BY:	ACP	**DATE:**	4/26/2007
QUANTITIES CHECKED BY:		**DATE:**	

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	CONSTRUCT MULTI-USE TRAIL	LF	3,750	$64.00	$240,000.00
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					

SUBTOTAL	$240,000
MOBILIZATION (@ 10 %)	$26,667
SUBTOTAL TRAIL ITEMS	$266,667
CONTINGENCIES (@ 25%)	$66,667
TRAIL TOTAL COST	$333,333
COST PER SQ. FT.	$66,666.67
GRAND TOTAL	$333,333
FOR BUDGET PURPOSES - SAY	**$333,000**

ROUTING

1. DES SECTION
2. OFFICE OF BRIDGE DESIGN - NORTH
3. OFFICE OF BRIDGE DESIGN - CENTRAL
4. OFFICE OF BRIDGE DESIGN - SOUTH
5. OFFICE OF BRIDGE DESIGN - WEST
6. OFFICE OF BRIDGE DESIGN SOUTHERN CALIFORNIA

COMMENTS:

	GENERAL PLAN ESTIMATE	X	ADVANCE PLANNING ESTIMATE

RCVD BY:

IN EST:

OUT EST:

BRIDGE: Auburn to Cool Trail Crossing - Oregon Bar	**BR. No.:**	**DISTRICT:**	03
TYPE: Stress Ribbon		**RTE:**	N/A
CU:		**CO:**	ED/PLA
EA:		**PM:**	N/A
LENGTH: 290.00	**WIDTH:** 12.00	**AREA (SF) =**	3,480

DESIGN SECTION:	HDR		
# OF STRUCTURES IN PROJECT :	01	**EST. NO.**	
PRICES BY :	ACP	**COST INDEX:**	450
QUANTITIES BY:	JV	**DATE:**	4/29/2007
QUANTITIES CHECKED BY:	ACP	**DATE:**	

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	STRUCTURE EXCAVATION (Bridge)	CY	400	$100.00	$40,000.00
2	STRUCTURE BACKFILL (Bridge)	CY	80	$350.00	$28,000.00
3	ROCK ANCHOR	EA	22	$12,500.00	$275,000.00
4	PRESTRESSING	LS	1	$80,000.00	$80,000.00
5	STRUCTURAL CONCRETE, BRIDGE	CY	330	$1,000.00	$330,000.00
6	CLASS C CONCRETE (Leveling Course)	CY	100	$325.00	$32,500.00
7	FURNISH PRECAST CONCRETE DECK UNIT	EA	26	$7,500.00	$195,000.00
8	ERECT PRECAST CONCRETE DECK UNIT	EA	26	$3,000.00	$78,000.00
9	BAR REINFORCING STEEL (Bridge)	LB	88,000	$1.50	$132,000.00
10	MISCELLANEOUS METAL (Bridge)	LB	500	$7.00	$3,500.00
11	ROCK ANCHOR WATER TIGHTNESS RE-TEST	EA	22	$2,500.00	$55,000.00
12	ROCK ANCHOR LIFT-OFF TEST	EA	22	$500.00	$11,000.00
13	ROCK ANCHOR LIFT-OFF RE-TEST	EA	22	$500.00	$11,000.00
14	METAL RAILING (54" painted steel)	LF	650	$175.00	$113,750.00
15	FURNISH BRIDGE DECK TREATMENT	GAL	20	$250.00	$4,950.00
16	TREAT BRIDGE DECK	SF	3,480	$2.50	$8,700.00
17					

SUBTOTAL	$1,398,400
MOBILIZATION (@ 10 %)	$155,378
SUBTOTAL BRIDGE ITEMS	$1,553,778
CONTINGENCIES (@ 15%)	$233,067
BRIDGE TOTAL COST	$1,786,844
COST PER SQ. FT.	$513.46
BRIDGE REMOVAL (CONTINGENCIES INCL.)	
WORK BY RAILROAD OR UTILITY FORCES	
GRAND TOTAL	$1,786,844
FOR BUDGET PURPOSES - SAY	**$1,787,000**

ROUTING

1. DES SECTION
2. OFFICE OF BRIDGE DESIGN - NORTH
3. OFFICE OF BRIDGE DESIGN - CENTRAL
4. OFFICE OF BRIDGE DESIGN - SOUTH
5. OFFICE OF BRIDGE DESIGN - WEST
6. OFFICE OF BRIDGE DESIGN SOUTHERN CALIFORNIA

COMMENTS: 15% Contingency used because of quantities are based on plans for an existing bridge of very similar proportions, providing a hig level of confidence.

SF cost calculated based on clear width of 12 ft (actual width = 14

	GENERAL PLAN ESTIMATE	X	ADVANCE PLANNING ESTIMATE

RCVD BY:

IN EST:
OUT EST:

BRIDGE:	Auburn to Cool Trail Crossing - Oregon Bar	**BR. No.:**		**DISTRICT:**	03
TYPE:	Stress Ribbon - Trail Connections			**RTE:**	N/A
CU:				**CO:**	ED/PLA
EA:				**PM:**	N/A
	LENGTH:	1.00	**WIDTH:** 5.00	**AREA (SF) =**	5

DESIGN SECTION:	HDR		
# OF STRUCTURES IN PROJECT :	01	**EST. NO.**	
PRICES BY :	ACP	**COST INDEX:**	450
QUANTITIES BY:	ACP	**DATE:**	4/19/2007
QUANTITIES CHECKED BY:		**DATE:**	

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	CONSTRUCT MULTI-USE TRAIL	LF	8,850	$64.00	$566,400.00
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					

SUBTOTAL	$566,400
MOBILIZATION (@ 10 %)	$62,933
SUBTOTAL TRAIL ITEMS	$629,333
CONTINGENCIES (@ 25%)	$157,333
TRAIL TOTAL COST	$786,667
COST PER SQ. FT.	$157,333.33
GRAND TOTAL	$786,667
FOR BUDGET PURPOSES - SAY	**$787,000**

ROUTING

1. DES SECTION
2. OFFICE OF BRIDGE DESIGN - NORTH
3. OFFICE OF BRIDGE DESIGN - CENTRAL
4. OFFICE OF BRIDGE DESIGN - SOUTH
5. OFFICE OF BRIDGE DESIGN - WEST
6. OFFICE OF BRIDGE DESIGN SOUTHERN CALIFORNIA

COMMENTS:

	GENERAL PLAN ESTIMATE	X	ADVANCE PLANNING ESTIMATE

RCVD BY:

IN EST:

OUT EST:

BRIDGE: Auburn to Cool Trail Crossing - Oregon Bar		**BR. No.:**		**DISTRICT:**	03
TYPE:	Prefabricated Truss (3-span)			**RTE:**	N/A
CU:				**CO:**	ED/PLA
EA:				**PM:**	N/A
LENGTH:	280.00	**WIDTH:**	12.00	**AREA (SF) =**	3,360

DESIGN SECTION:	HDR		
# OF STRUCTURES IN PROJECT :	01	**EST. NO.**	
PRICES BY :	ACP	**COST INDEX:**	450
QUANTITIES BY:	ACP	**DATE:**	5/3/2007
QUANTITIES CHECKED BY:		**DATE:**	

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	STRUCTURE EXCAVATION (Type A)	CY	90	$575.00	$51,750.00
2	STRUCTURE EXCAVATION (Bridge)	CY	245	$100.00	$24,500.00
3	STRUCTURE BACKFILL (Bridge)	CY	75	$350.00	$26,250.00
4	ROCK ANCHOR	EA	16	$8,000.00	$128,000.00
5	STRUCTURAL CONCRETE, BRIDGE	CY	250	$1,000.00	$250,000.00
6	STRUCTURAL CONCRETE, BRIDGE FOOTING	CY	45	$450.00	$20,250.00
7	CLASS C CONCRETE (Leveling Course - Abutments)	CY	15	$325.00	$4,875.00
8	SEAL COURSE CONCRETE	CY	50	$575.00	$28,750.00
9	STRUCTURAL CONCRETE, BRIDGE DECK	CY	42	$450.00	$18,900.00
10	BAR REINFORCING STEEL (Bridge)	LB	102,000	$1.50	$153,000.00
11	FURNISH STRUCTURAL STEEL (Prefab Truss Main Span)	EA	1	$189,000.00	$189,000.00
12	FURNISH STRUCTURAL STEEL (Prefab Truss Side Span)	EA	2	$86,400.00	$172,800.00
13	MISCELLANEOUS METAL (Bridge)	LB	500	$7.00	$3,500.00
14					
15	ROCK ANCHOR LIFT-OFF TEST	EA	16	$500.00	$8,000.00
16					
17	ERECT STRUCTURAL STEEL (Prefabricated Truss Main Spar	EA	1	$15,000.00	$15,000.00
18	ERECT STRUCTURAL STEEL (Prefabricated Truss Main Spar	EA	2	$10,000.00	$20,000.00

SUBTOTAL	$1,114,575
MOBILIZATION (@ 10 %)	$123,842
SUBTOTAL BRIDGE ITEMS	$1,238,417
CONTINGENCIES (@ 25%)	$309,604
BRIDGE TOTAL COST	$1,548,021
COST PER SQ. FT.	$460.72
BRIDGE REMOVAL (CONTINGENCIES INCL.)	
WORK BY RAILROAD OR UTILITY FORCES	
GRAND TOTAL	$1,548,021
FOR BUDGET PURPOSES - SAY	**$1,548,000**

ROUTING

1. DES SECTION
2. OFFICE OF BRIDGE DESIGN - NORTH
3. OFFICE OF BRIDGE DESIGN - CENTRAL
4. OFFICE OF BRIDGE DESIGN - SOUTH
5. OFFICE OF BRIDGE DESIGN - WEST
6. OFFICE OF BRIDGE DESIGN SOUTHERN CALIFORNIA

COMMENTS:

	GENERAL PLAN ESTIMATE	X	ADVANCE PLANNING ESTIMATE

RCVD BY:

IN EST:

OUT EST:

BRIDGE: Auburn to Cool Trail Crossing - Oregon Bar **BR. No.:** **DISTRICT:** 03

TYPE: Prefabricated Truss (3-span) - Trail Connections **RTE:** N/A

CU: **CO:** ED/PLA

EA: **PM:** N/A

LENGTH: 1.00 **WIDTH:** 5.00 **AREA (SF) =** 5

DESIGN SECTION: HDR

 # OF STRUCTURES IN PROJECT : 01 **EST. NO.**

PRICES BY : ACP **COST INDEX:** 450

QUANTITIES BY: ACP **DATE:** 4/19/2007

QUANTITIES CHECKED BY: **DATE:**

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	CONSTRUCT MULTI-USE TRAIL	LF	8,850	$64.00	$566,400.00
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					

SUBTOTAL	$566,400
MOBILIZATION (@ 10 %)	$62,933
SUBTOTAL TRAIL ITEMS	$629,333
CONTINGENCIES (@ 25%)	$157,333
TRAIL TOTAL COST	$786,667
COST PER SQ. FT.	$157,333.33
GRAND TOTAL	$786,667
FOR BUDGET PURPOSES - SAY	**$787,000**

ROUTING

1. DES SECTION
2. OFFICE OF BRIDGE DESIGN - NORTH
3. OFFICE OF BRIDGE DESIGN - CENTRAL
4. OFFICE OF BRIDGE DESIGN - SOUTH
5. OFFICE OF BRIDGE DESIGN - WEST
6. OFFICE OF BRIDGE DESIGN SOUTHERN CALIFORNIA

COMMENTS:

	GENERAL PLAN ESTIMATE	X	ADVANCE PLANNING ESTIMATE

RCVD BY:

IN EST:

OUT EST:

BRIDGE:	ATC Trail Crossing - North Fork American River B	**BR. No.:**	19-35	**DISTRICT:**	03
TYPE:	Modification - Class 3 Bike Route on Shoulders			**RTE:**	49
CU:				**CO:**	ED/PLA
EA:				**PM:**	N/A
LENGTH:	348.16	**WIDTH:**	34.00	**AREA (SF) =**	11,837

DESIGN SECTION:	HDR		
# OF STRUCTURES IN PROJECT :	01	**EST. NO.**	
PRICES BY :	ACP	**COST INDEX:**	450
QUANTITIES BY:	ACP	**DATE:**	4/28/2007
QUANTITIES CHECKED BY:		**DATE:**	

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	TUBULAR BICYCLE RAILING (TYPE ??)	LF	700	$100.00	$70,000.00
2	ROADSIDE SIGN - ONE POST	EA	4	$400.00	$1,600.00
3	SALVAGE METAL BRIDGE RAILING	LF	700	$18.00	$12,600.00
4	6" THERMOPLASTIC TRAFFIC STRIPE	LF	700	$1.50	$1,050.00
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					

SUBTOTAL	$85,250
MOBILIZATION (@ 10 %)	$9,472
SUBTOTAL BRIDGE ITEMS	$94,722
CONTINGENCIES (@ 25%)	$23,681
BRIDGE TOTAL COST	$118,403
COST PER SQ. FT.	$10.00
BRIDGE REMOVAL (CONTINGENCIES INCL.)	
WORK BY RAILROAD OR UTILITY FORCES	
GRAND TOTAL	$118,403
FOR BUDGET PURPOSES - SAY	**$118,000**

ROUTING

1. DES SECTION
2. OFFICE OF BRIDGE DESIGN - NORTH
3. OFFICE OF BRIDGE DESIGN - CENTRAL
4. OFFICE OF BRIDGE DESIGN - SOUTH
5. OFFICE OF BRIDGE DESIGN - WEST
6. OFFICE OF BRIDGE DESIGN SOUTHERN CALIFORNIA

COMMENTS: Trail Xing and Bicyle signs

	GENERAL PLAN ESTIMATE	X	ADVANCE PLANNING ESTIMATE

RCVD BY:

IN EST:

OUT EST:

BRIDGE: ATC Trail Crossing - North Fork American River B **BR. No.:** 19-35 **DISTRICT:** 03

TYPE: Modification - Class 3 Bike Route on Shoulders - Trail Connections **RTE:** 49

CU: **CO:** ED/PLA

EA: **PM:** N/A

LENGTH: 1.00 **WIDTH:** 34.00 **AREA (SF) =** 34

DESIGN SECTION: HDR

 # OF STRUCTURES IN PROJECT : 01 **EST. NO.**

PRICES BY : ACP **COST INDEX:** 450

QUANTITIES BY: ACP **DATE:** 4/26/2007

QUANTITIES CHECKED BY: **DATE:**

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	CONSTRUCT MULTI-USE TRAIL	LF	46,500	$32.00	$1,488,000.00
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					

SUBTOTAL	$1,488,000
MOBILIZATION (@ 10 %)	$165,333
SUBTOTAL TRAIL ITEMS	$1,653,333
CONTINGENCIES (@ 25%)	$413,333
TRAIL TOTAL COST	$2,066,667
COST PER SQ. FT.	$60,784.31
GRAND TOTAL	$2,066,667
FOR BUDGET PURPOSES - SAY	**$2,067,000**

ROUTING

1. DES SECTION
2. OFFICE OF BRIDGE DESIGN - NORTH
3. OFFICE OF BRIDGE DESIGN - CENTRAL
4. OFFICE OF BRIDGE DESIGN - SOUTH
5. OFFICE OF BRIDGE DESIGN - WEST
6. OFFICE OF BRIDGE DESIGN SOUTHERN CALIFORNIA

COMMENTS:

[ ] GENERAL PLAN ESTIMATE   [X] ADVANCE PLANNING ESTIMATE

RCVD BY:

IN EST:

OUT EST:

BRIDGE: ATC Trail Crossing - Mountain Quarries Railroad B **BR. No.:**

DISTRICT: 03

TYPE: Re-operation

RTE: 49

CU:

CO: ED/PLA

EA:

PM: N/A

LENGTH: 482.00 **WIDTH:** 15.00 **AREA (SF) =** 7,230

DESIGN SECTION: HDR

 # OF STRUCTURES IN PROJECT : 01 **EST. NO.**

PRICES BY : ACP **COST INDEX:** 450

QUANTITIES BY: ACP **DATE:** 4/19/2007

QUANTITIES CHECKED BY: **DATE:**

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	ROADSIDE SIGN - ONE POST	EA	2	$400.00	$800.00
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					

SUBTOTAL	$800
MOBILIZATION (@ 10 %)	$89
SUBTOTAL BRIDGE ITEMS	$889
CONTINGENCIES (@ 25%)	$222
BRIDGE TOTAL COST	$1,111
COST PER SQ. FT.	$0.15
BRIDGE REMOVAL (CONTINGENCIES INCL.)	
WORK BY RAILROAD OR UTILITY FORCES	
GRAND TOTAL	$1,111
FOR BUDGET PURPOSES - SAY	**$1,000**

COMMENTS: Trail etiquette sign at each end.

ROUTING

1. DES SECTION
2. OFFICE OF BRIDGE DESIGN - NORTH
3. OFFICE OF BRIDGE DESIGN - CENTRAL
4. OFFICE OF BRIDGE DESIGN - SOUTH
5. OFFICE OF BRIDGE DESIGN - WEST
6. OFFICE OF BRIDGE DESIGN SOUTHERN CALIFORNIA

	GENERAL PLAN ESTIMATE	X	ADVANCE PLANNING ESTIMATE

RCVD BY:

IN EST:

OUT EST:

BRIDGE: ATC Trail Crossing - Mountain Quarries Railroad B **BR. No.:**

DISTRICT: 03

TYPE: Re-operation - Trail Connnections

RTE: 49

CU:

CO: ED/PLA

EA:

PM: N/A

LENGTH: 1.00 **WIDTH:** 5.00 **AREA (SF) =** 5

DESIGN SECTION: HDR

 # OF STRUCTURES IN PROJECT : 01 **EST. NO.**

PRICES BY : ACP **COST INDEX:** 450

QUANTITIES BY: ACP **DATE:** 4/19/2007

QUANTITIES CHECKED BY: **DATE:**

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	CONSTRUCT MULTI-USE TRAIL	LF	44,000	$32.00	$1,408,000.00
2	SIGNS	EA	2	$250.00	$500.00
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					

SUBTOTAL	$1,408,500
MOBILIZATION (@ 10 %)	$156,500
SUBTOTAL TRAIL ITEMS	$1,565,000
CONTINGENCIES (@ 25%)	$391,250
TRAIL TOTAL COST	$1,956,250
COST PER SQ. FT.	$391,250.00
GRAND TOTAL	$1,956,250
FOR BUDGET PURPOSES - SAY	**$1,956,000**

ROUTING

1. DES SECTION
2. OFFICE OF BRIDGE DESIGN - NORTH
3. OFFICE OF BRIDGE DESIGN - CENTRAL
4. OFFICE OF BRIDGE DESIGN - SOUTH
5. OFFICE OF BRIDGE DESIGN - WEST
6. OFFICE OF BRIDGE DESIGN SOUTHERN CALIFORNIA

COMMENTS:

[ ] GENERAL PLAN ESTIMATE	[X] ADVANCE PLANNING ESTIMATE

RCVD BY:

IN EST:

OUT EST:

BRIDGE: Auburn to Cool Trail Crossing - Existing Crossing **BR. No.:** **DISTRICT:** 03

TYPE: 3-span FRP Truss - Seasonal on precast "block" substructure **RTE:** N/A

CU: **CO:** ED/PLA

EA: **PM:** N/A

LENGTH: 180.00 **WIDTH:** 8.00 **AREA (SF) =** 1,440

DESIGN SECTION: HDR

 # OF STRUCTURES IN PROJECT : 01 **EST. NO.**

PRICES BY : ACP **COST INDEX:** 450

QUANTITIES BY: ACP **DATE:** 4/26/2007

QUANTITIES CHECKED BY: **DATE:**

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	STRUCTURE EXCAVATION (Bridge) - ANNUAL COST	CY	40	$50.00	$2,000.00
2	STRUCTURE BACKFILL (Bridge) - ANNUAL COST	CY	25	$100.00	$2,500.00
3	FURNISH PRECAST FOOTING	EA	4	$2,500.00	$10,000.00
4	FURNISH PRECAST PIER/ABUTMENT STEM	EA	8	$2,000.00	$16,000.00
5	INSTALL PRECAST SUBSTRUCTURE UNIT - ANNUAL CC	EA	12	$500.00	$6,000.00
6	BAR REINFORCING STEEL (Bridge)	LB	400	$1.50	$600.00
7					
8	FURNISH FRP TRUSS (50x8)	EA	2	$33,100.00	$66,200.00
9	FURNISH FRP TRUSS (80x8)	EA	1	$51,500.00	$51,500.00
10	ERECT FRP Truss (80'x8') - ANNUAL COST IS 1/2	EA	1	$2,500.00	$2,500.00
11	ERECT FRP Truss (50'x8') - ANNUAL COST IS 1/2	EA	2	$2,000.00	$4,000.00
12					
13					
14					
15					
16					
17					

SUBTOTAL	$161,300
MOBILIZATION (@ 10 %)	$17,922
SUBTOTAL BRIDGE ITEMS	$179,222
CONTINGENCIES (@ 25%)	$44,806
BRIDGE TOTAL COST	$224,028
COST PER SQ. FT.	$155.57
BRIDGE REMOVAL (CONTINGENCIES INCL.)	
WORK BY RAILROAD OR UTILITY FORCES	
GRAND TOTAL	$224,028
FOR BUDGET PURPOSES - SAY	**$224,000**

COMMENTS:

ROUTING

1. DES SECTION
2. OFFICE OF BRIDGE DESIGN - NORTH
3. OFFICE OF BRIDGE DESIGN - CENTRAL
4. OFFICE OF BRIDGE DESIGN - SOUTH
5. OFFICE OF BRIDGE DESIGN - WEST
6. OFFICE OF BRIDGE DESIGN SOUTHERN CALIFORNIA

[ ] GENERAL PLAN ESTIMATE	[X] ADVANCE PLANNING ESTIMATE

RCVD BY:

IN EST:
OUT EST:

BRIDGE: Auburn to Cool Trail Crossing - Existing Crossing	**BR. No.:**	**DISTRICT:**	03
TYPE: FRP Truss - Seasonal - Trail Connections		**RTE:**	N/A
CU:		**CO:**	ED/PLA
EA:		**PM:**	N/A

LENGTH: 1.00 **WIDTH:** 8.00 **AREA (SF) =** 8

DESIGN SECTION:	HDR		
# OF STRUCTURES IN PROJECT :	01	**EST. NO.**	
PRICES BY :	ACP	**COST INDEX:**	450
QUANTITIES BY:	ACP	**DATE:**	4/26/2007
QUANTITIES CHECKED BY:		**DATE:**	

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	CONSTRUCT MULTI-USE TRAIL	LF	400	$64.00	$25,600.00
2	CONSTRUCT LOW WATER EQUESTRIAN FORD	LF	180	$100.00	$18,000.00
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					

SUBTOTAL	$43,600
MOBILIZATION (@ 10 %)	$4,844
SUBTOTAL TRAIL ITEMS	$48,444
CONTINGENCIES (@ 25%)	$12,111
TRAIL TOTAL COST	$60,556
COST PER SQ. FT.	$7,569.44
GRAND TOTAL	$60,556
FOR BUDGET PURPOSES - SAY	**$61,000**

ROUTING

1. DES SECTION
2. OFFICE OF BRIDGE DESIGN - NORTH
3. OFFICE OF BRIDGE DESIGN - CENTRAL
4. OFFICE OF BRIDGE DESIGN - SOUTH
5. OFFICE OF BRIDGE DESIGN - WEST
6. OFFICE OF BRIDGE DESIGN SOUTHERN CALIFORNIA

COMMENTS:

	GENERAL PLAN ESTIMATE	X	ADVANCE PLANNING ESTIMATE

RCVD BY:

IN EST:
OUT EST:

BRIDGE:	Auburn to Cool Trail Crossing - Oregon Bar	**BR. No.:**		**DISTRICT:**	03
TYPE:	Pipe Bridge - Seasonal			**RTE:**	N/A
CU:				**CO:**	ED/PLA
EA:				**PM:**	N/A
LENGTH:	224.00	**WIDTH:**	3.00	**AREA (SF) =**	672

DESIGN SECTION:	HDR		
# OF STRUCTURES IN PROJECT :	01	**EST. NO.**	
PRICES BY :	ACP	**COST INDEX:**	450
QUANTITIES BY:	ACP	**DATE:**	4/19/2007
QUANTITIES CHECKED BY:		**DATE:**	

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	FURNISH 3' x 8' PIPE BRIDGE PANEL (Including Pipe)	EA	28	$1,400.00	$39,200.00
2	ERECT 3' x 8' PIPE BRIDGE PANEL	EA	28	$100.00	$2,800.00
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					

SUBTOTAL	$42,000
MOBILIZATION (@ 10 %)	$4,667
SUBTOTAL BRIDGE ITEMS	$46,667
CONTINGENCIES (@ 25%)	$11,667
BRIDGE TOTAL COST	$58,333
COST PER SQ. FT.	$86.81
BRIDGE REMOVAL (CONTINGENCIES INCL.)	
WORK BY RAILROAD OR UTILITY FORCES	
GRAND TOTAL	$58,333
FOR BUDGET PURPOSES - SAY	**$58,000**

ROUTING

1. DES SECTION
2. OFFICE OF BRIDGE DESIGN - NORTH
3. OFFICE OF BRIDGE DESIGN - CENTRAL
4. OFFICE OF BRIDGE DESIGN - SOUTH
5. OFFICE OF BRIDGE DESIGN - WEST
6. OFFICE OF BRIDGE DESIGN SOUTHERN CALIFORNIA

COMMENTS:

	GENERAL PLAN ESTIMATE	X	ADVANCE PLANNING ESTIMATE

RCVD BY:

IN EST:

OUT EST:

BRIDGE:	Auburn to Cool Trail Crossing - Oregon Bar	**BR. No.:**		**DISTRICT:**	03
TYPE:	Pipe Bridge - Seasonal - Trail Connections			**RTE:**	N/A
CU:				**CO:**	ED/PLA
EA:				**PM:**	N/A
LENGTH:	1.00	**WIDTH:**	5.00	**AREA (SF) =**	5

DESIGN SECTION:	HDR		
# OF STRUCTURES IN PROJECT :	01	**EST. NO.**	
PRICES BY :	ACP	**COST INDEX:**	450
QUANTITIES BY:	ACP	**DATE:**	4/19/2007
QUANTITIES CHECKED BY:		**DATE:**	

	CONTRACT ITEMS	UNIT	QUANTITY	PRICE	AMOUNT
1	CONSTRUCT MULTI-USE TRAIL	LF	8,950	$32.00	$286,400.00
2	CONSTRUCT LOW WATER EQUESTRIAN FORD	LF	225	$100.00	$22,500.00
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					

SUBTOTAL	$308,900
MOBILIZATION (@ 10 %)	$34,322
SUBTOTAL TRAIL ITEMS	$343,222
CONTINGENCIES (@ 25%)	$85,806
TRAIL TOTAL COST	$429,028
COST PER SQ. FT.	$85,805.56
GRAND TOTAL	$429,028
FOR BUDGET PURPOSES - SAY	**$429,000**

ROUTING

1. DES SECTION
2. OFFICE OF BRIDGE DESIGN - NORTH
3. OFFICE OF BRIDGE DESIGN - CENTRAL
4. OFFICE OF BRIDGE DESIGN - SOUTH
5. OFFICE OF BRIDGE DESIGN - WEST
6. OFFICE OF BRIDGE DESIGN SOUTHERN CALIFORNIA

COMMENTS: