EA 03-4E2801
Bridge Number 25-0005 R/L

# BRIDGE DESIGN HYDRAULIC STUDY

# For the US Route 50 Bridges
# Over Weber Creek
# El Dorado County, California

Prepared for:

**El Dorado County**
**Department of Public Works**

**Quincy Engineering, Inc.**

Prepared by:

WRECO

**August 2008**

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Submitted to:

**El Dorado County**
**Department of Public Works**

This report has been prepared by or under the supervision of the following Registered Engineer. The Registered Civil Engineer attests to the technical information contained herein and has judged the qualifications of any technical specialists providing engineering data upon which recommendations, conclusions, and decisions are based.

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**August 2008**

# TABLE OF CONTENTS

Page No.

**LIST OF TABLES**

**LIST OF PHOTOS**

**LIST OF FIGURES**

**APPENDICES**

# EXECUTIVE SUMMARY

This study presents the hydrologic and hydraulic assessment for the proposed United States Route 50 Bridges over Weber Creek in El Dorado County, California. The existing parallel bridge structures (Bridge Number 25-0005 R/L) are located approximately 0.65 kilometers northeast of the Missouri Flat Road Interchange in El Dorado County and are approximately 3.81 kilometers upstream of the confluence of Weber Creek with Hangtown Creek. The Project is needed to accommodate the proposed expansion of US Route 50 (US 50) between the Missouri Flat Road (MFRD) Interchange and the Forni Road Interchange.

This study only analyzes the hydraulics of the existing parallel bridges over Weber Creek and the proposed improvements. The study does not include an older County bridge, located approximately 20 meters upstream from the studied US 50 bridges. The County bridge is not included in the study, as no information is available for the bridge and it is outside of the Project scope.

US 50 is a major transportation corridor in El Dorado County from El Dorado Hills through the City of Placerville and to South Lake Tahoe. The Project proposes to widen the existing parallel bridges by approximately 5.8 m outward to become three lane bridges in both directions; this design will align with the proposed US Route 50 support lines. The expansion of the bridges will greatly improve the current operation of the existing two-lane bridges. This hydraulic analysis conforms to the Caltrans hydraulic standard design criteria for bridges, namely that they pass the 50-year flood flow with 0.61 m of freeboard and pass the 100-year flood flow with no freeboard.

The proposed bridges considered in this Design Hydraulic Study Report are four-span composite steel welded girders with reinforced concrete decks.

The water surface elevations and flow velocities in Tables E1 and E2 are at the modeled cross-sections at the upstream face of both the Eastbound and Westbound bridges over Weber Creek. The downstream controlling water surface elevation is based on the 100-year flood elevation, per the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS).

**Table E1. Hydraulic Summary at Upstream Face of the US Route 50 Eastbound Bridge**

| Design Flow Return Period | Design Flow ($m^3/s$) | Bridges Soffit Elevation (est.) (m) | Water Surface Elevation (m) | Velocity (m/s) |
|---|---|---|---|---|
| 100-year | 209 | 501.50 - 505.43 | 470.73 | 3.23 |
| 50-year | 176 | 501.50 - 505.43 | 470.39 | 3.03 |

**Table E2. Hydraulic Summary at Upstream Face of the US Route 50 Westbound Bridge**

| Design Flow Return Period | Design Flow ($m^3/s$) | Bridges Soffit Elevation (est.) (m) | Water Surface Elevation (m) | Velocity (m/s) |
|---|---|---|---|---|
| 100-year | 209 | 501.49 - 505.23 | 470.35 | 3.63 |
| 50-year | 176 | 501.49 - 505.23 | 470.00 | 3.43 |

The results of the modeled cross-sections show that the proposed bridge design meets the Caltrans hydraulic design criteria.

A total of six piers and four abutments will be constructed for both bridges. Scour analysis was performed only at Piers 3R (eastbound) and 3L (westbound), as these are the only piers that come into contact with the Weber Creek water surface. The scour analysis follows the Federal Highway Administration (FHWA) recommended methodology, as described in the HEC-18 Manual. Tables E3 and E4 summarize the estimated potential total scour depth at Pier 3R and Pier 3L during the 100-year event.

**Table E3. Potential Scour at Pier 3R (eastbound bridge)**

| Location | Long-term Bed Change | Contraction Scour (m) | Local Scour (m) | Total Scour Depth (m) |
|---|---|---|---|---|
|  | Negligible | 0.41 | 13.35 | N/A |

**Table E4. Potential Scour at Pier 3L (westbound bridge)**

| Location | Long-term Bed Change | Contraction Scour (m) | Local Scour (m) | Total Scour Depth (m) |
|---|---|---|---|---|
|  | Negligible | 1.94 | 13.73 | N/A |

The calculated total scour depths exceed the depth of erodible overburden, indicating that during the design event, the design flow will scour the soil to the elevation of bedrock. Because of this, it is recommended that the foundation of the bridges be embedded into bedrock to a sufficient depth in order to ensure structural stability.

# I. INTRODUCTION

**Background:** El Dorado County is proposing to widen US Route 50 between the Missouri Flat Road Interchange and the Forni Road Interchange. The widening Project is primarily designed to improve access between rural areas and the City of Placerville. There are two existing parallel bridges (Bridge No. 25-0005 R/L) that are located within this portion of US 50 that allow for travel over Weber Creek and will be widened as part of the US 50 expansion project. The widening of the bridges will be designed by Quincy Engineering, Inc.

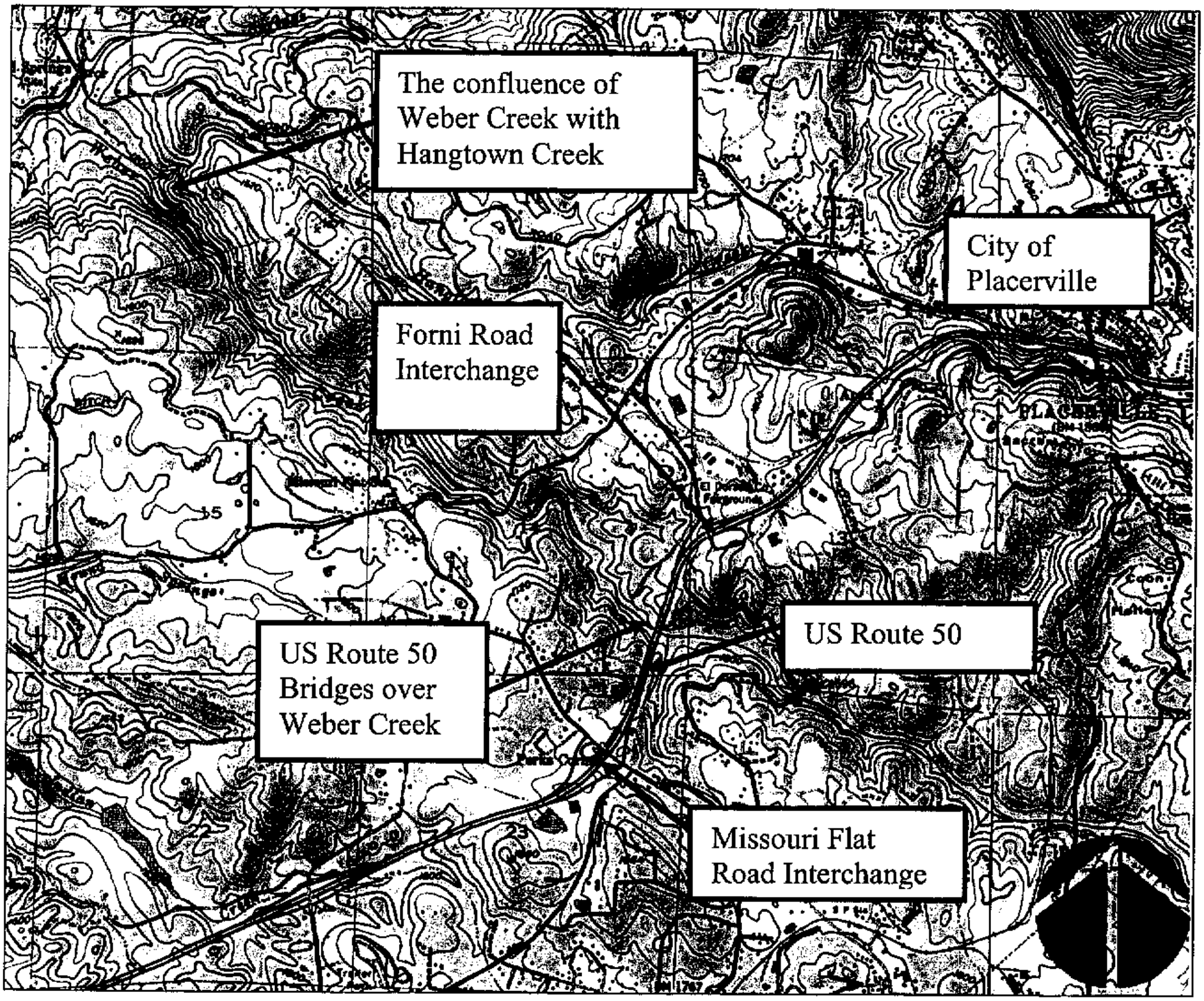
Weber Creek is tributary to the South Fork of the American River. The confluences of Weber Creek with Hangtown Creek and South Fork American River Creek are approximately 3.8 km and 21.8 km downstream (respectively) of the US 50 crossing. The Creek drains portions of the Towns of Diamond Springs, Tiger Lily, Newtown, Motor City, Camino, Pollock Pines, Five Mile Terrace and portions of the City of Placerville.

The purpose of this study is to provide hydrologic and hydraulic data for the design of US Route 50 Bridges over Weber Creek in El Dorado County.

**Project Location:** The Project location is approximately 4 km southwest, along US 50, from the City of Placerville, El Dorado County, California. The proposed bridges are located along US 50, approximately 0.7 km northeast of the Missouri Flat Road Interchange. See Figure 1 for the Project Location Map, Figure 2 for the Project Vicinity Map, and Photo 1 for the US Route 50 Bridges over Weber Creek.

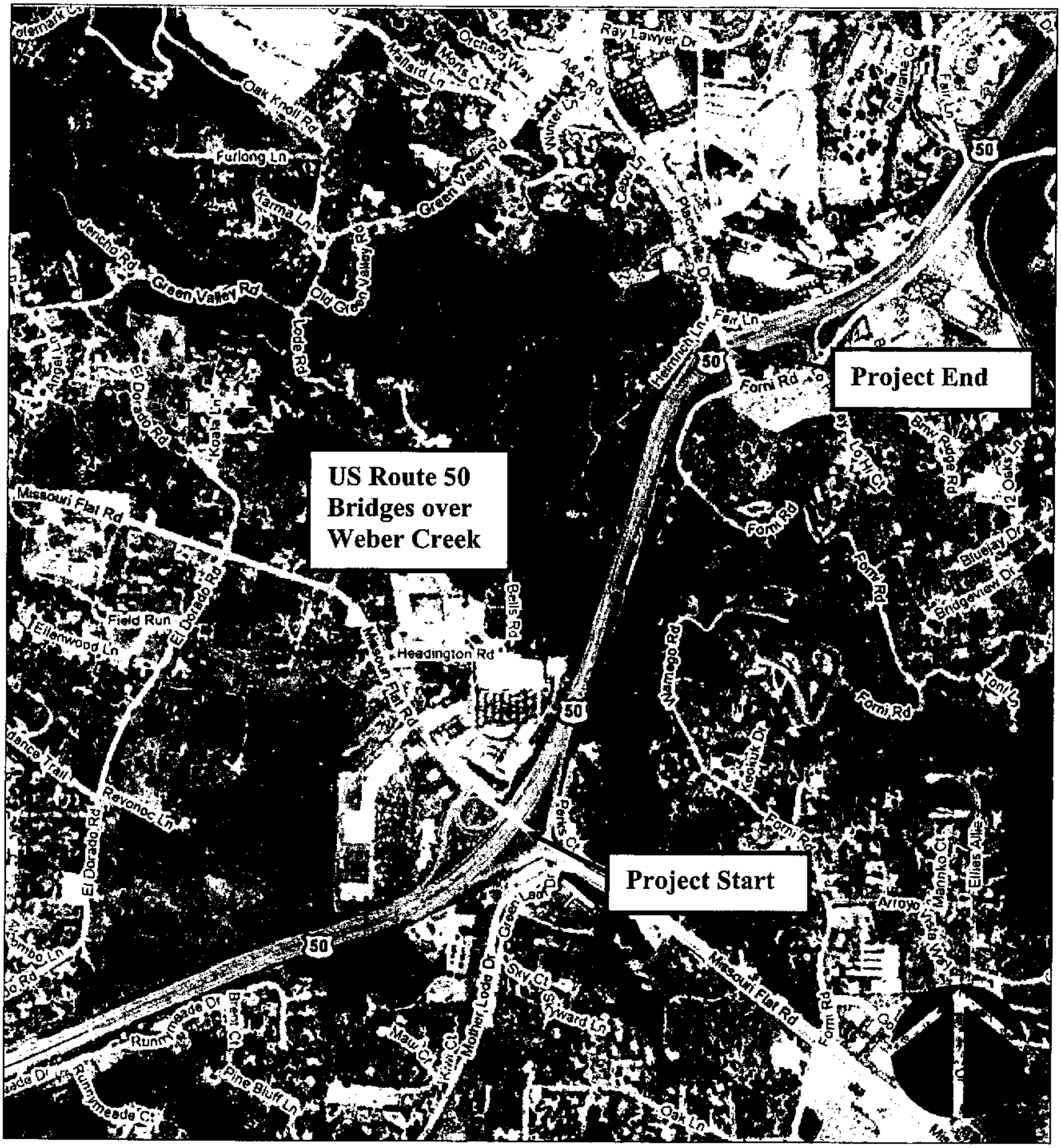
**Key Tasks:** The key tasks performed for the Project include: 1) a HEC-HMS hydrologic analysis of the watershed to determine design flows, 2) a hydraulic analysis to determine the water surface elevations and flow velocities at the Project site, and 3) a scour analysis to determine potential scour depths and countermeasures.

**Design Standards:** The design shall meet the standards set forth in the Cross Drainage chapter of the June 2006 *Caltrans Highway Design Manual* (Chapter 820, Index 821.3). The Design Storm Frequency for Bridges shall be a 50-year storm with a minimum 0.61 m freeboard and a 100-year storm with no freeboard.



Source: USGS TOPO

Figure 1. Project Location Map



Source: Google

Figure 2. Project Vicinity Map

# II. DESCRIPTION OF WATERSHED

**Geographic Location:** The Project is located in the Weber Creek Watershed (see Figure 3). Weber Creek begins approximately 27.9 kilometers upstream of the Project site and drains a segment of the western slopes of the Sierra foothills. The highest point in the watershed is at an elevation of 1,300 m and the elevation of the channel is approximately 465 m at the Project site.

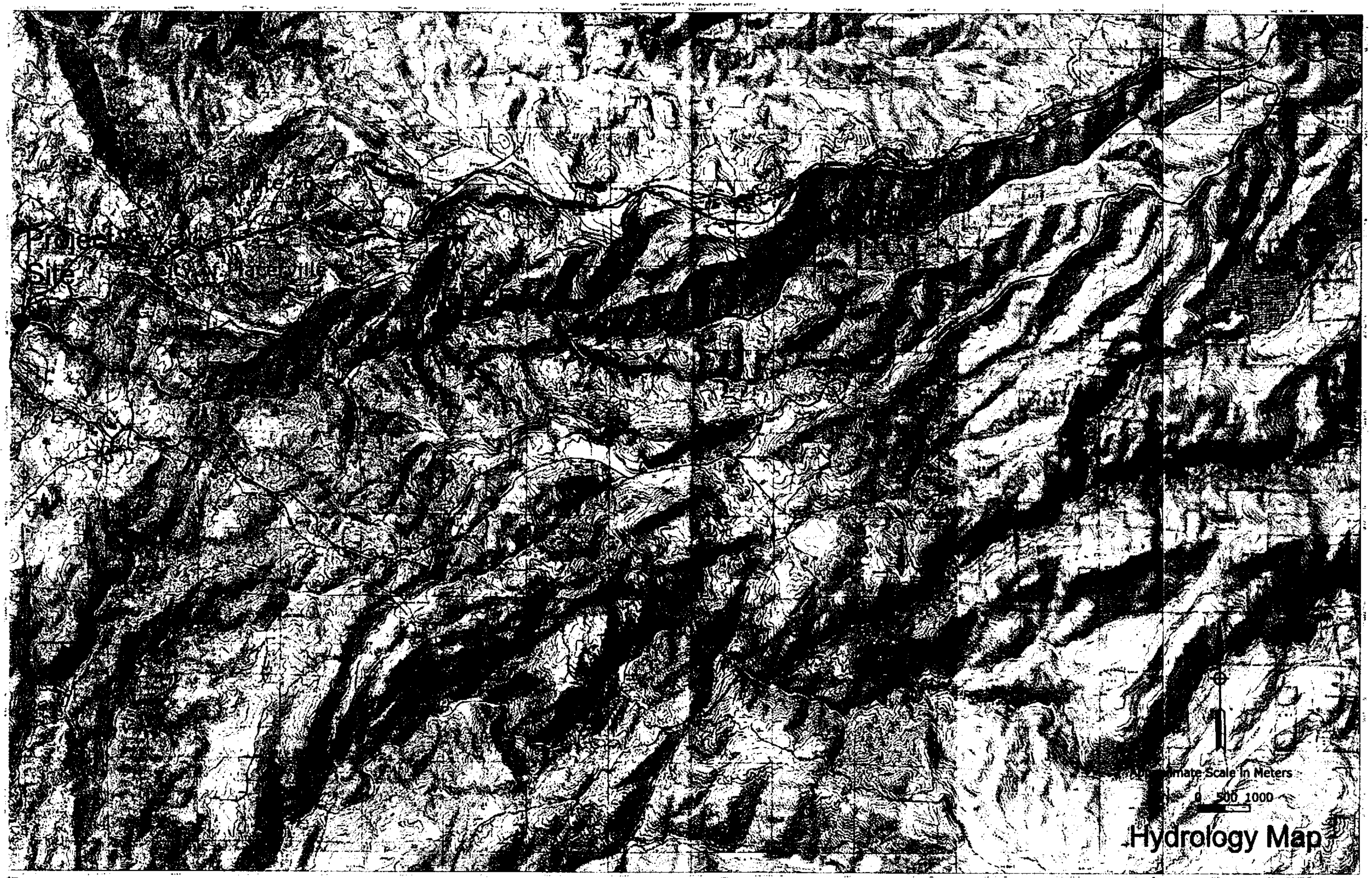
**Watershed Size:** The watershed area is approximately 89.7 square kilometers.

**Receiving Waters:** Weber Creek begins at the confluence of the North and South Weber Creeks and flows west, merging with the South Fork American River. The South Fork American River flows south to Folsom Lake which outfalls to the American River, joining the Sacramento River. The Sacramento River continues southwest into the San Francisco Bay and Pacific Ocean.

**Precipitation:** The mean annual precipitation at the Project site is approximately 850 mm based on *1961-1990 Average Annual Precipitation, California* map, using Prisms Climate Modeling System (Spatial Climate Analysis Service of Oregon State University) and the table of *California Annual Precipitation Summary* (Western Regional Climate Center).

**Land Use:** An examination of aerial satellite images from Google Earth shows the watershed of Weber Creek at and around the Project site as primarily open space, with some areas of agricultural, residential and commercial land uses.

**Vegetation:** The portion of Weber Creek upstream of the Project site is at a higher elevation watershed. The area is well covered with various grasses and chaparral vegetation.



Source: USGS TOPO

Figure 3. Watershed Boundary

# III. DESCRIPTION OF STREAM AND SITE

**Weber Creek:** At the Project site, Weber Creek occupies a well-defined channel with grassy side slopes. The total channel width under the bridges from Abutment 1 to Abutment 5 is confined to an approximately 170 m wide channel.

**Soil and Bed Material:** Taber Consultants, the geotechnical engineer for the Project, was responsible for the soil test borings. The *Log of Test Borings* (Taber Consultants) show the bed material at the crossing as brown clay to coarse gravel and cobble with fine to coarse sand and silt.

**Proposed Action:** The proposed action is to widen the existing bridges, adding a tertiary lane in both the eastern and western directions to conform the proposed widening Project along US 50.

**Existing Bridges:** A concise description of the existing US 50 Bridges over Weber Creek is shown below.

Type: Steel plate girder bridges
Pier Bents: Cast concrete piers
Abutments: Concrete Seat
Span: ~167.84 m (42.164 m, 41.758 m, 41.758 m and 42.164 m in direction of roadway)
Deck elev.: 504.20 – 508.14
Soffit elev.: 501.49 – 505.43

See Photo 1 for view of the bridges.

**Proposed Bridge 1 (Eastbound):**

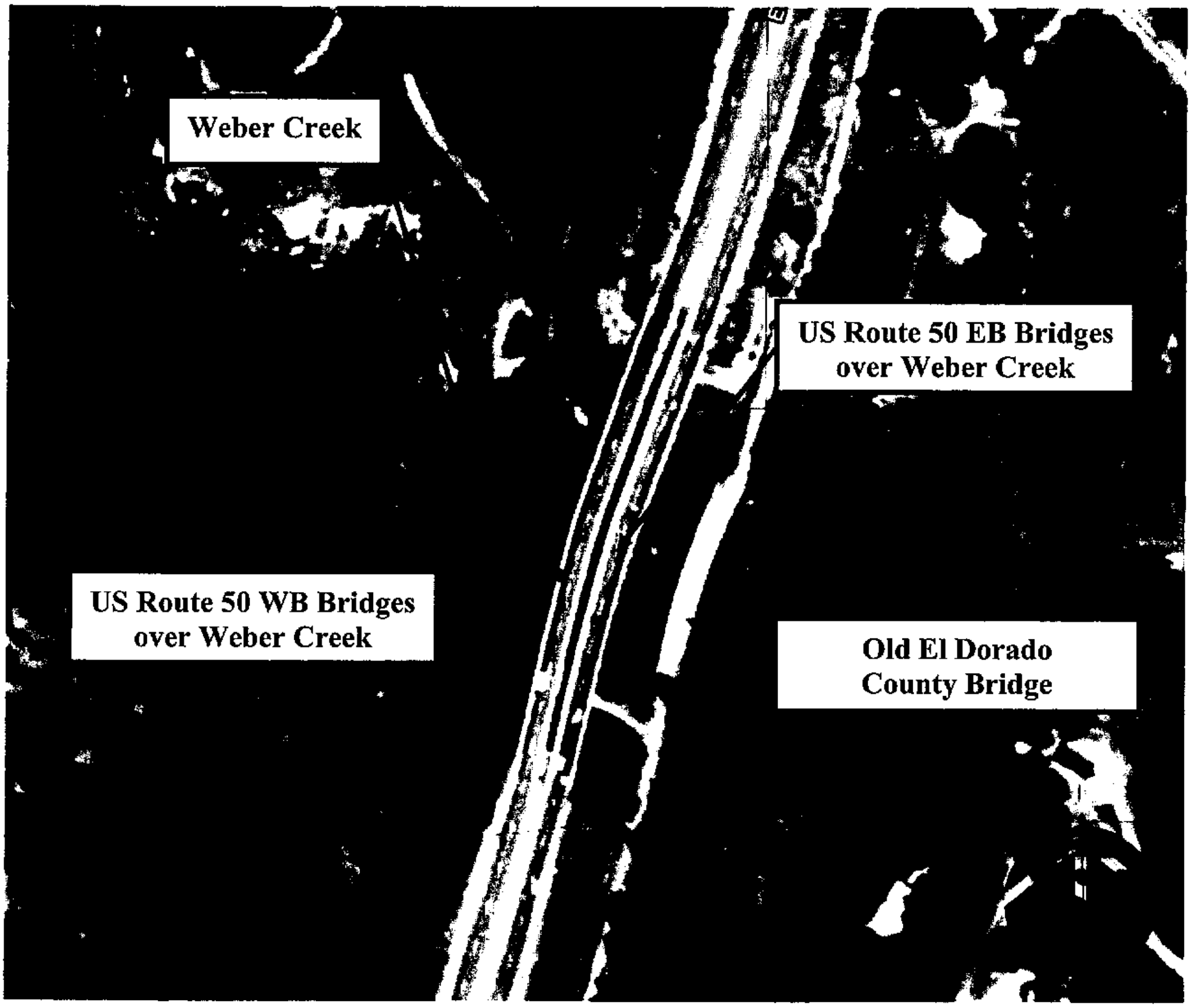
Type: Composite welded steel girders with reinforced concrete deck
Pier Bents: Cast concrete piers
Abutments: Concrete Seat
Span: ~167.84 m
Deck elev.: 504.20 – 508.14
Soffit elev.: 501.50 – 505.43

See Appendix D for a detailed schematic of the proposed Alternative Bridges.

**Proposed Bridge 2 (Westbound):**

Type: Composite welded steel girders with reinforced concrete deck
Pier Bents: Cast concrete piers
Abutments: Concrete Seat
Span: ~167.84 m
Deck elev.: 504.20 – 507.94
Soffit elev.: 501.49 – 505.23

See Appendix D for detailed schematic of the proposed Alternative Bridges.



Source: Google Earth

Photo 1. Aerial View of the US Route 50 Bridges over Weber Creek

# IV. HYDROLOGY

**Hydrologic Stability:** There have been no significant changes in basin hydrology in recent years. Most of the watershed is located primarily in a rural setting with open space.

**Hydrologic Analysis Tool:** Although Caltrans' *Highway Design Manual* indicates that the Rational Method is to be used for hydrologic calculations, the size of the watershed is 89.7 square kilometers. Watershed of this size can not be accurately modeled by the Rational Method. As such a hydrograph transform method was applied using the U.S. Army Corps of Engineers' HEC-HMS computer program (Version 3.1.0). The HEC-HMS hydrologic analysis of the Weber Creek watershed at the proposed bridges crossing included the use of the NRCS Transform Method with NRCS Curve Number loss calculations. The hydrologic model considered the limited future land use changes for this Project.

**Hydrologic Data** 24-hour storm hydrographs for the various storm frequencies were developed by HEC-HMS based on the NRCS Hypothetical Storm Type 1A. Return period rainfall depths (2-year, 5-year, 10-year, 25-year, 50-year, and 100-year) were obtained from the National Oceanic and Atmospheric Administration's Isopluvial maps (Appendix A). Table 1 and Figure 4 show the isopluvial data.

**Table 1. 24-Hour Storm Depth**

| Recurrence Interval (years) | Depth of Rainfall (mm) |
|---|---|
| 2 | 889 |
| 5 | 1219 |
| 10 | 1397 |
| 25 | 1651 |
| 50 | 1727 |
| 100 | 1905 |

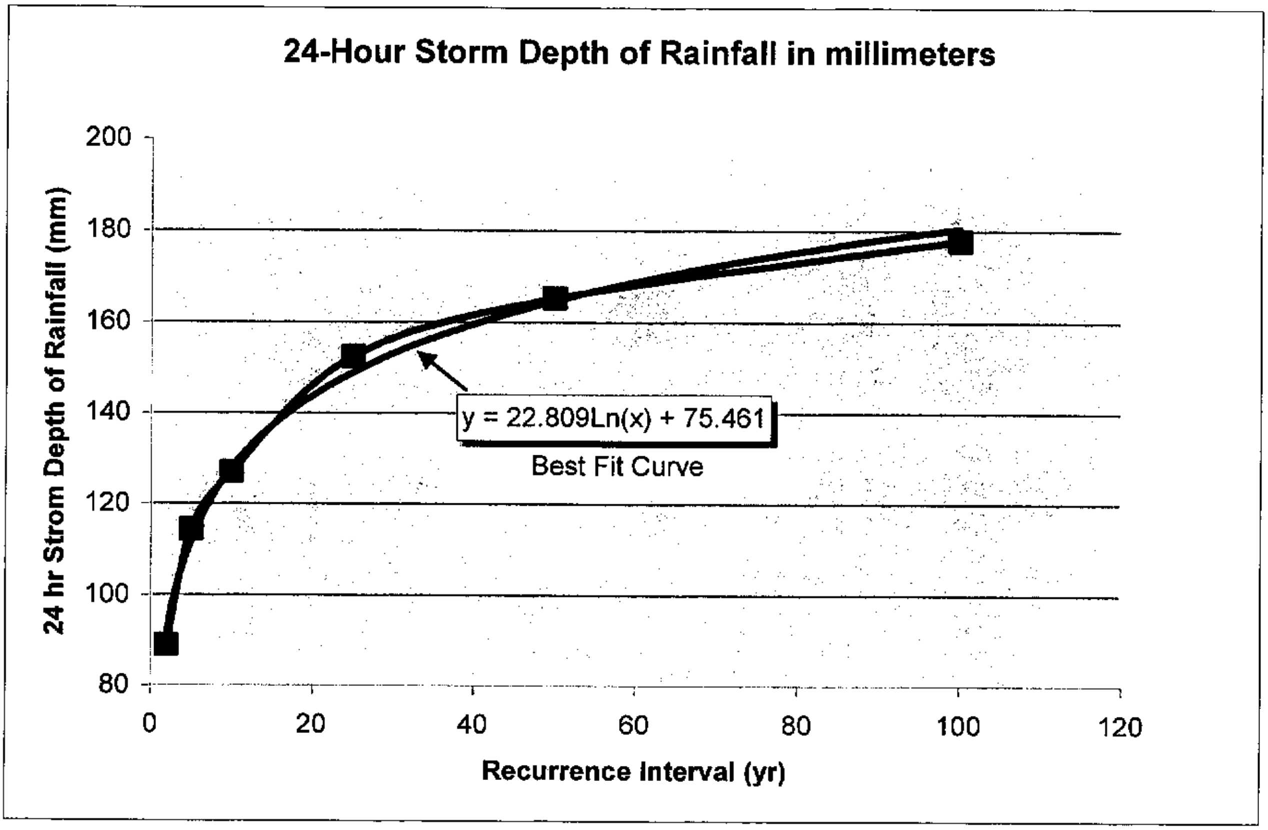


**Figure 4. Isopluvial Data**

**Curve Number** The NRCS runoff Curve Numbers are used to characterize the volume of rainfall that will be lost to infiltration, abstraction and transpiration. The Curve Numbers reflect the land use, vegetation, treatment, hydrologic condition, and antecedent soil condition. The Curve Number used in the hydrologic analysis of the Project watershed is based on the National Resource Conservation Service's *El Dorado County Soil Survey* (see Appendix A). The soil composition is a mixture of clayey silt and clayey sand with gravel. Based on the geologic descriptions of the various soils and study of the watershed, the SCS curve number was estimated as 3.7, representing contoured open space of hydrologic soil group C in fair hydrologic condition.

Based on the soil class and land use of the watershed, the initial abstraction is estimated at 5 mm of precipitation. The percentage impervious is estimated as 0.1%.

**Design Flows:** Based on the HEC-HMS hydrologic model of the Weber Creek watershed at US Route 50, the 24-hr design hydrographs are shown in Figure 5.

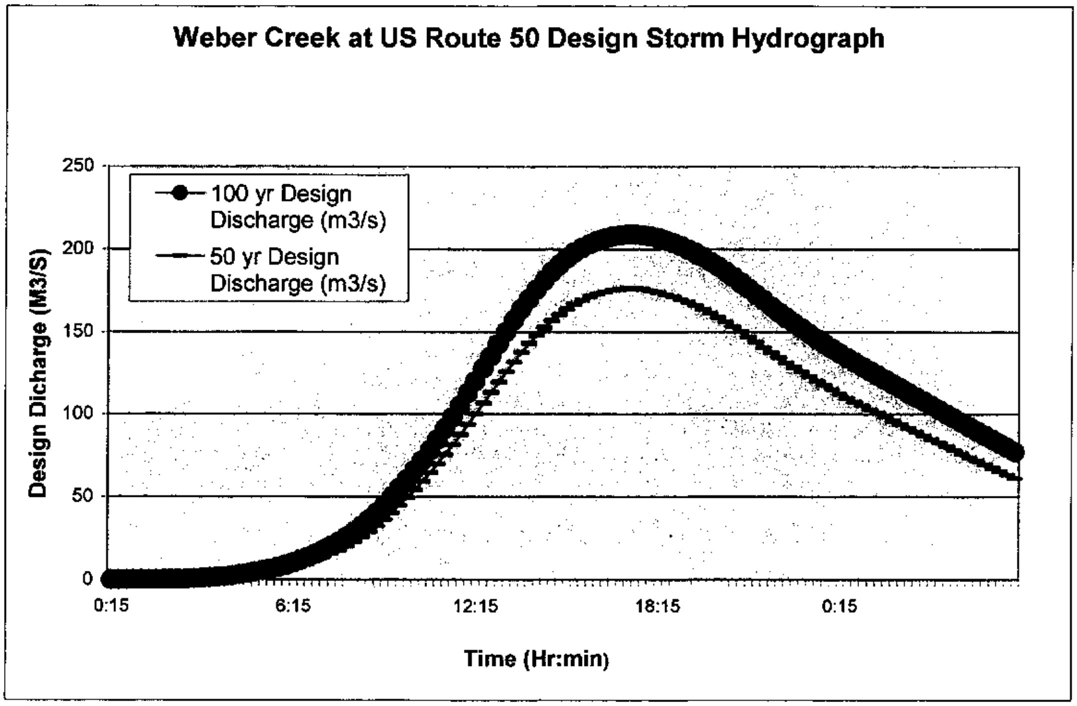


Figure 5. Design Storm Hydrograph

# V. HYDRAULIC ANALYSIS

**Design Tool:** The hydraulic analysis for Weber Creek involved a standard step backwater calculation using the U.S. Army Corps of Engineers' HEC-RAS computer program (Version 3.1.3) to provide flow characteristics.

**Cross-section Data:** A total of eleven cross-sections, distributed over an approximately 200 m reach of the Weber Creek were used in the hydraulic analyses (Figure 6 shows the location of cross sections) and cross-section data were obtained by using topographic survey data.

**Manning's 'n':** Manning's 'n' values are used in the hydraulic model to estimate energy losses in the flow due to friction. The Manning's 'n' value for the main channel was 0.04. For the left and right overbanks, a Manning's 'n' value of 0.075 was used. These Manning's 'n' values were selected to best describe the friction characteristics of the existing and proposed site under design storm conditions.

**Expansion and Contraction Coefficients:** Expansion and contraction coefficients used to represent the channel upstream and downstream of the bridges were 0.3 and 0.1, respectively. These values describe a creek with gradual transitions between cross-sections. The expansion and contraction coefficients used in the vicinity of the bridges were 0.5 and 0.3, respectively. These values were used because the abutments of the bridges are located within the channel bed.

**High Water Elevations:** The calculated water surface elevations for the peak discharge of the design storms for the proposed bridges are listed in Table 2.

**Table 2. Calculated Water Surface Elevations**

| | Soffit Elev. (m) | Existing Condition (m) | Proposed Condition (m) |
|---|---|---|---|
| Eastbound (Upstream Face) | | | |
| 100 year Storm Event | 501.50 - 505.43 | 470.68 | 470.73 |
| 50 year Storm Event | 501.50 - 505.43 | 470.35 | 470.39 |
| Westbound (Upstream Face) | | | |
| 100 year Storm Event | 501.49 - 505.23 | 470.35 | 470.35 |
| 50 year Storm Event | 501.49 - 505.23 | 470.00 | 470.00 |

The hydraulic analysis indicates that in the proposed condition the water surface elevations at the upstream face of the eastbound bridge will be slightly higher than the upstream face of the westbound bridge during both the 100-year and 50-year events. The Project topographic data indicates a slight reverse slope at the eastbound bridge , but the general trend of channel within the analyzed reach is to slope downstream at approximately 0.6%.

The proposed bridges allow for passage of the design flows under the soffit with minimal backwater impact. The bridges also meet the FHWA/Caltrans design criteria for passing the 100-year flood with no freeboard. Figure 7 shows the water surface profiles for the design storm events at the bridge site.

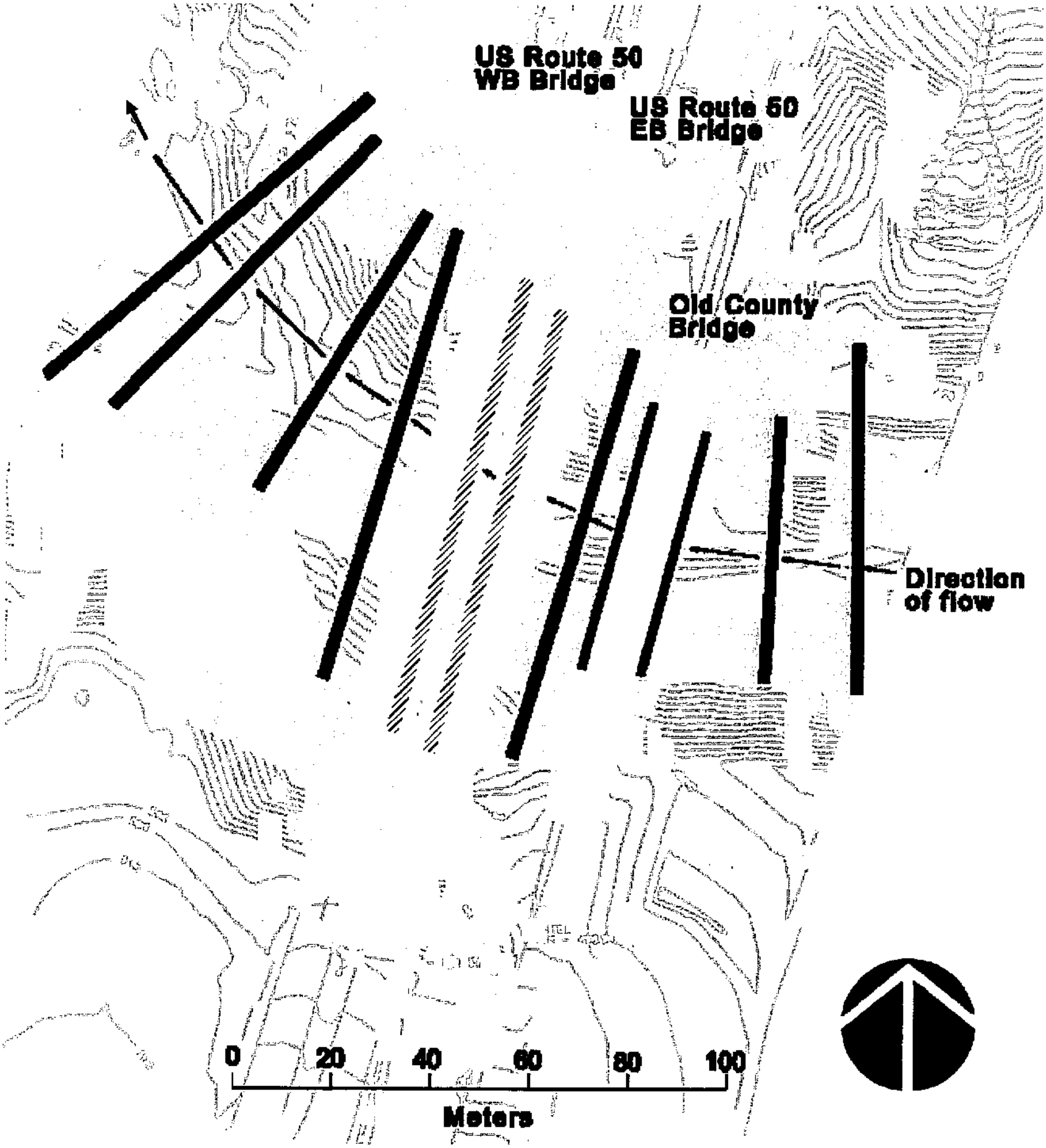


Figure 6. Cross-Section Locations

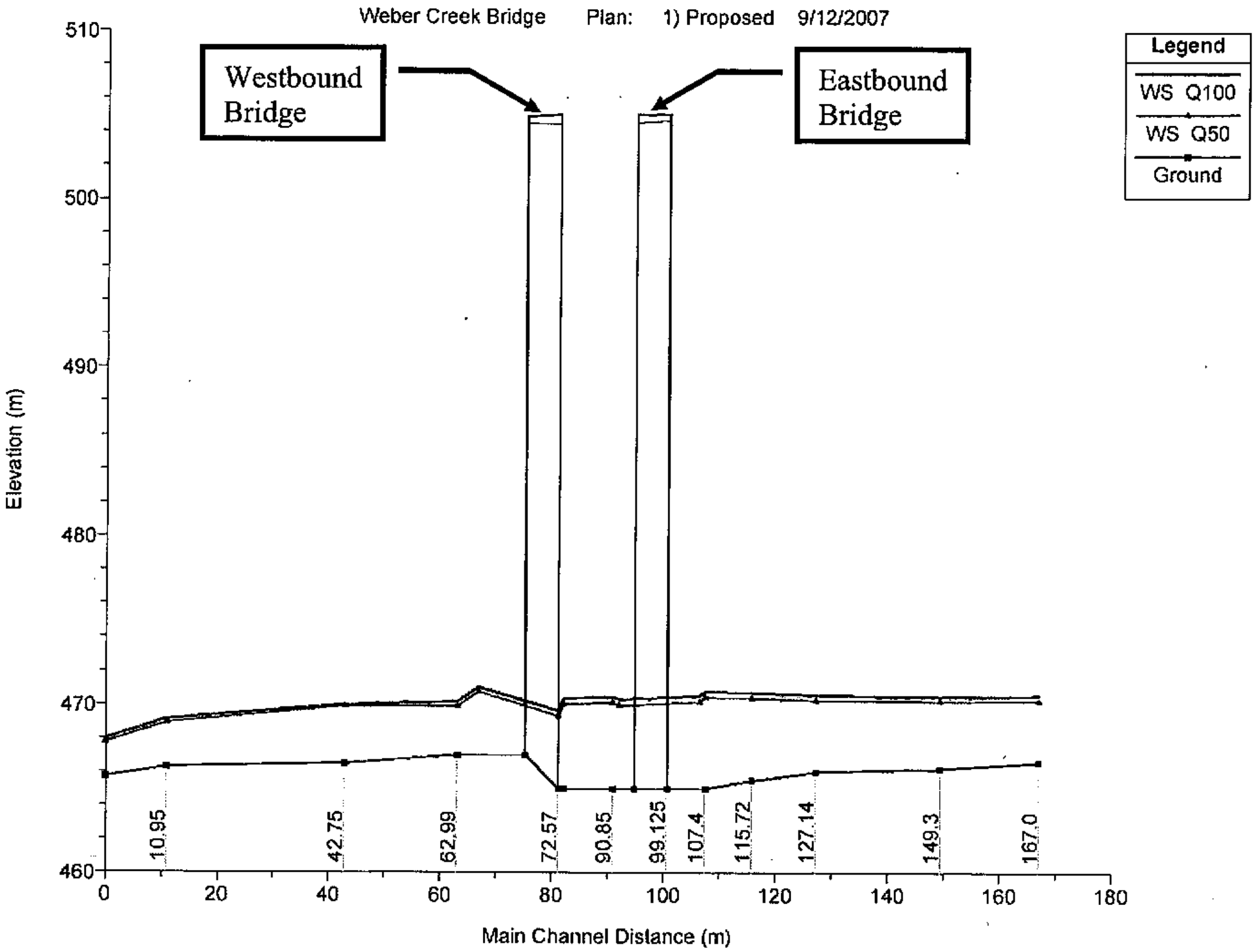


**Figure 7. Water Surface Profiles**

**Flow Velocities:** A comparison of the existing and proposed conditions at the upstream face of the eastbound and westbound bridges is shown in Table 3.

**Table 3. Flow Velocities in the Channel at the Upstream Face of the Bridges**

| | Design Flow ($m^3/s$) | Existing V(m/s) | Proposed V(m/s) |
|---|---|---|---|
| Eastbound | | | |
| 100 yr | 209 | 3.28 | 3.23 |
| 50 yr | 176 | 3.07 | 3.03 |
| Westbound | | | |
| 100 yr | 209 | 3.63 | 3.63 |
| 50 yr | 176 | 3.43 | 3.43 |

The small changes in velocity suggests that the overall change in flow characteristics during the design storm events will be negligible compared to the flow of the channel in its existing condition.

# VI. SCOUR ANALYSIS

**Design Methodology:** Local scour at the piers was evaluated using the methodology described in the Federal Highway Administration Manual HEC-18, *Evaluating Scour at Bridges (Fourth Edition)*. The minimum design criterion for bridge scour is the 100-year flood. The scour analysis is based on hydraulic data taken from the HEC-RAS (Version 3.1.3) analysis of the bridges site with a 4.9° skew angle.

**Foundation Plan:** The *Foundation Plan* was prepared by Quincy Engineering, Inc., (Appendix D). The Pier dimensions are similar for both the east and west bound bridges with a width of 2.15 m and a length of 4.35 m. Local scour analysis was performed only at Pier 3L and 3R as the other piers will not be immersed during the design storm events.

**Existing Channel Bed:** The bed material is brown clay to coarse gravel and cobble with fine to coarse sand and silt (described in Taber Consultant's Geotechnical Report). Eight logs of test borings were performed at the Project site: Information for boring 05-40 was obtained downstream of the existing eastbound bridge near the Abutment 5R. Information for 05-10 and 05-11 was obtained near Pier 2R and Pier 2L. Information for 05-09 and 05-08 was obtained near Pier 3R and 3L. Information for 05-06 and 05-07 was obtained near Pier 4R and Pier 4L. The results indicated that the channel bed is composed of about 1.83 m of soil on the top of bedrock. Soil in the bed channel is loose to medium dense, brown silty fine to coarse sand, with fine to coarse gravel and cobbles. The $D_{50}$ is estimated at 0.8 mm and $D_{95}$ at 2.0 mm. The estimates are based on matching the description of the top layer of soil from the Log of Test Borings (LOTB) with the American Association of State Highways Transportation Officials' (AASHTO) soil particle size distribution chart.

**Long-term Bed Change:** According to Quincy Engineering, Inc., the field observations did not indicate severe creek bed degradation. The long-term bed elevation change is assumed to be negligible.

**Contraction Scour:** Contraction scour occurs when the flow area of a stream is reduced significantly, either by a natural contraction or by a bridge. There is some contraction that will occur during the 100-year design event at the proposed bridge sites due to the proposed bridges structures.

The reduction in flow area is calculated by comparing the flow area at the upstream face of the bridge, shown on the HEC-RAS *Bridge Output Table* (Appendix B), to the flow area two stations upstream of the bridge, shown on the HEC-RAS *Summary Table* (Appendix B). For the eastbound portion of the proposed bridges, the flow area of Weber Creek will be reduced from 101.16 square meters to 78.87 square meters at the upstream face of the bridges. This corresponds to a 22% reduction in flow area in approximately 9.3 meters. Using the Live-Bed Contraction Scour Equation at the channel, the calculated contraction scour at the channel is 0.41 m.

For the westbound portion of the proposed bridges, the flow area of Weber Creek will be reduced from about 106.16 square meters to about 57.99 square meters at the upstream face of the bridges. This corresponds to a 45% reduction of flow area in approximately 9.7 meters. Using the Live-Bed Contraction Scour Equation at the channel, the calculated contraction scour at the channel is 1.94 m.

**Table 4. Summary of Hydraulic Data**

| | Eastbound Bridge | Westbound Bridge |
|---|---|---|
| Water Surface Elevation | 470.73 m | 470.35 m |
| Flow Velocity | 3.23 m/s | 3.63 m/s |

**Pier Scour:** The basic mechanism causing local scour at piers is the formation of vortices (known as horseshoe vortex) at their base. The horseshoe vortex results from the pileup of water on the upstream surface of the pier and subsequent acceleration of the flow around the base of the pier. The action of the vortex removes bed material from around the base of the pier. The Colorado State University (CSU) Equation was utilized to determine pier scour for Piers 3L and 3R.

The pier scour calculations were estimated by using the soil particle size estimates obtained from the LOTB and AASHTO with $D_{50}$ at 0.8 mm and $D_{95}$ at 2.0 mm. The pier widths obtained from the Foundation Plan were tripled for the design estimate, to simulate accumulation of debris. The estimated scour during the 100-year event is summarized in Table 5 for the upstream face of the eastbound bridge and Table 6 for the upstream face of the westbound bridge.

**Abutment Scour:** Scour occurs at abutments when the abutment and embankment obstruct the flow. The flow obstructed by the abutment and approach highway embankment forms a horizontal vortex starting at the upstream end of the abutment and running along the toe of the abutment, resulting in a vertical wake vortex at the downstream end of the abutment.

Since the 100-year water surface elevation does not reach the abutments, it is assumed that the long term abutment scour will be negligible.

**Total Scour:** Total scour is the sum of calculated local scour (pier and abutment scour), contraction scour, and long-term bed degradation. The total calculated scour depth for the piers of the proposed bridges is shown in Table 5 and Table 6. These estimated values assume that the scoured material is made up of erodible sediment. The detailed calculations for total scour are available in Appendix C. HEC-18 was used in performing the detailed calculations to estimate scour.

**Table 5. Summary of Scour at the Eastbound Bridge**

| Location | Long-term Bed Change | Contraction Scour | Local Scour | Total Scour Depth |
|---|---|---|---|---|
| Pier 3R | Negligible | 0.41 | 13.35 | N/A |

**Table 6. Summary of Scour at the Westbound Bridge**

| Location | Long-term Bed Change | Contraction Scour | Local Scour | Total Scour Depth |
|---|---|---|---|---|
| Pier 3L | Negligible | 1.94 | 13.73 | N/A |

While the abutment scour is assumed to be negligible, the potential for local scour and contraction scour should be considered in setting the pier foundation depths in and near the main channel of Weber Creek. The calculated scour depths exceed the 1.83 m depth of erodible overburden. This indicates that during the design event, the design flow will scour the soil to the elevation of bedrock.

It is recommended that the foundation of the bridges be embedded into bedrock to a sufficient depth in order to ensure structural stability.

Photo 2. Weber Creek Bed Channel (looking to Northwest)

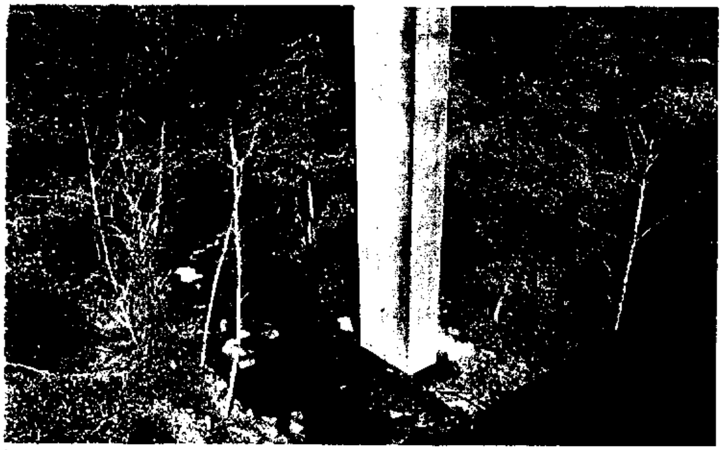


Photo 3. Weber Creek Bed Channel at Pier 3R

Photo 4. Weber Creek Bed Channel at Piers 2L and 2R

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# APPENDIX A

## Hydrologic Data

- NOAA ATLAS 2, Volume XI-Isopluvial Maps
- USDA NRCS Soil Survey at Project Site
- HMS Results

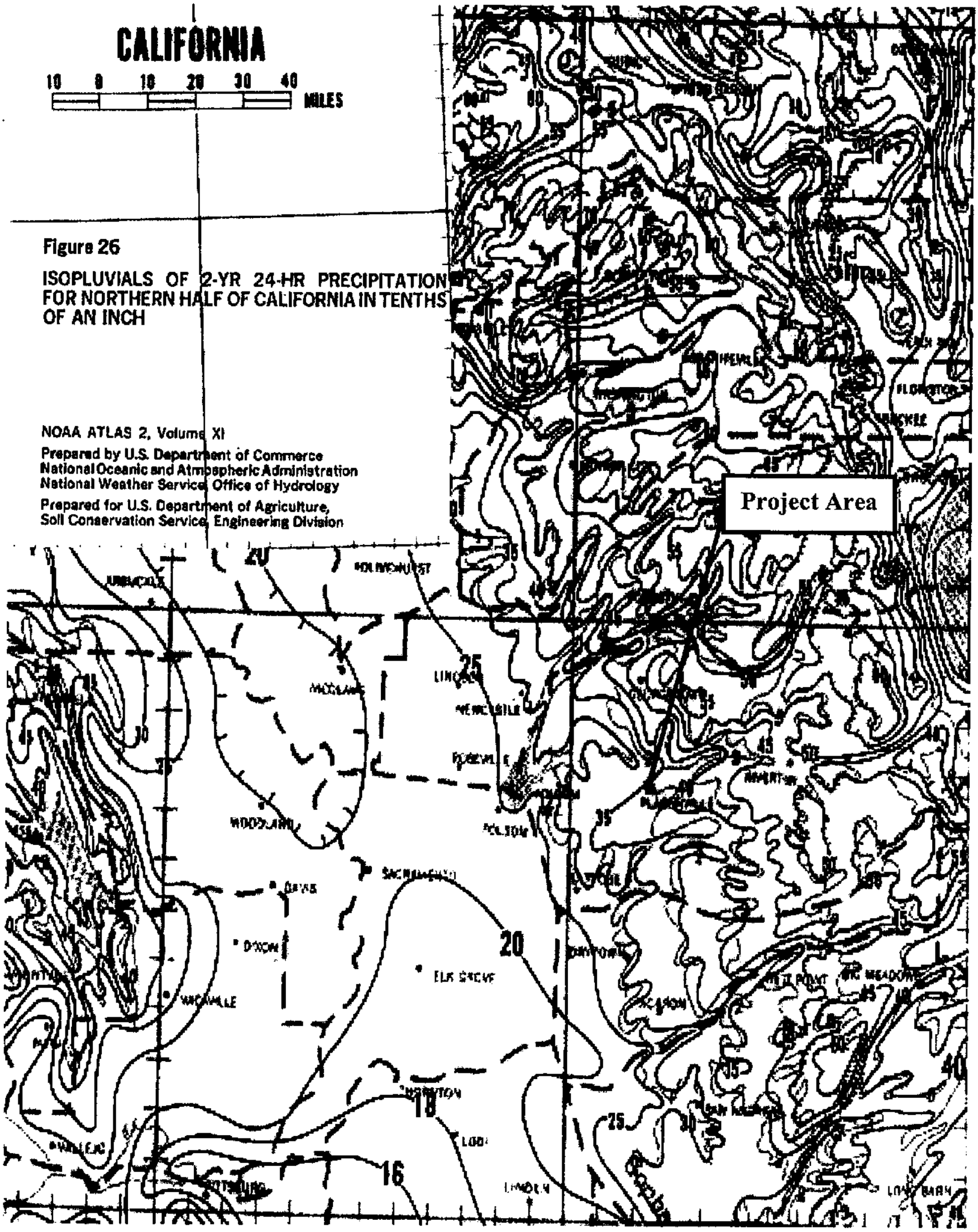


**Figure 26**

ISOPLUVIALS OF 2-YR 24-HR PRECIPITATION FOR NORTHERN HALF OF CALIFORNIA IN TENTHS OF AN INCH

NOAA ATLAS 2, Volume XI
Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology
Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

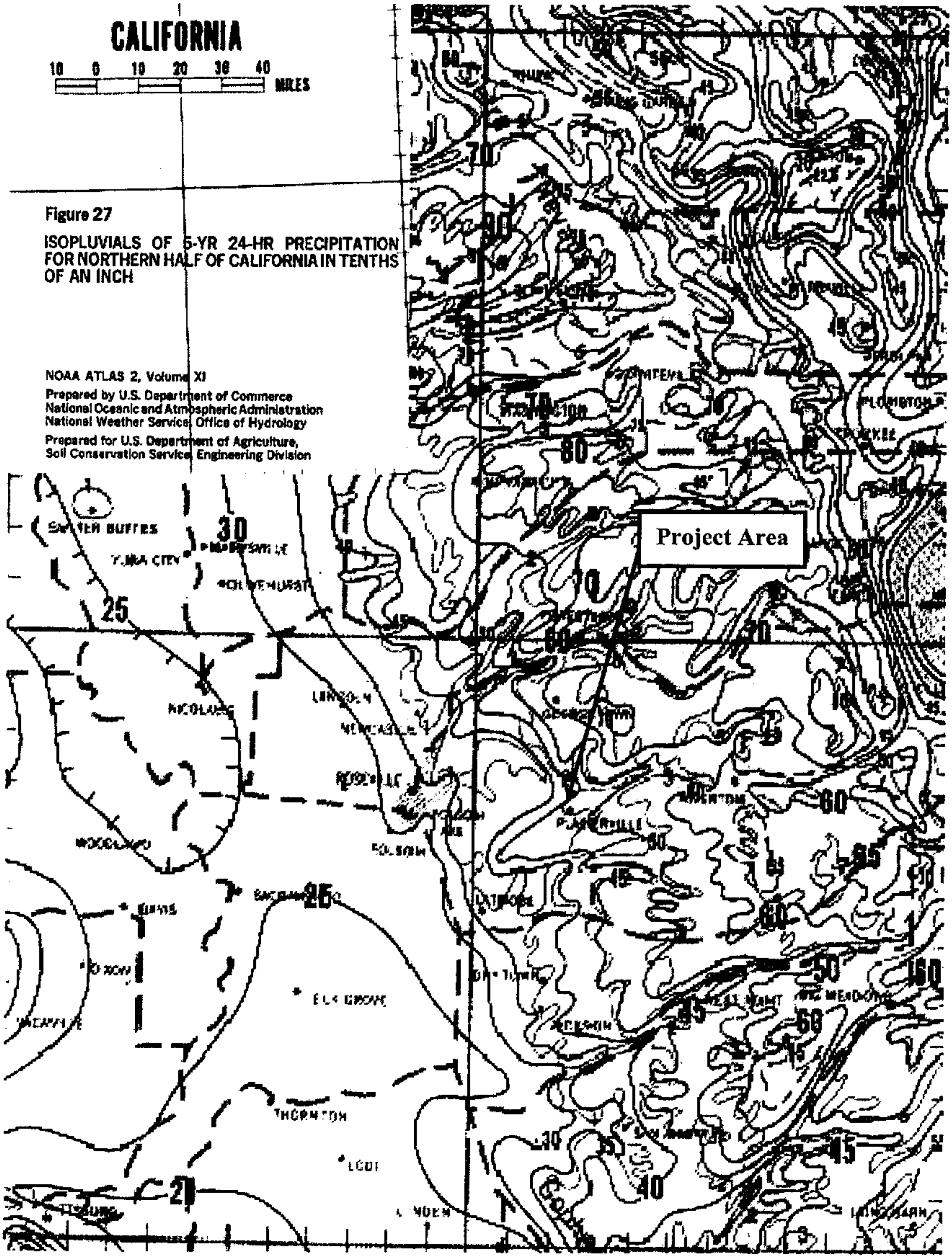


Figure 27

ISOPLUVIALS OF 5-YR 24-HR PRECIPITATION FOR NORTHERN HALF OF CALIFORNIA IN TENTHS OF AN INCH

NOAA ATLAS 2, Volume XI
Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology
Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

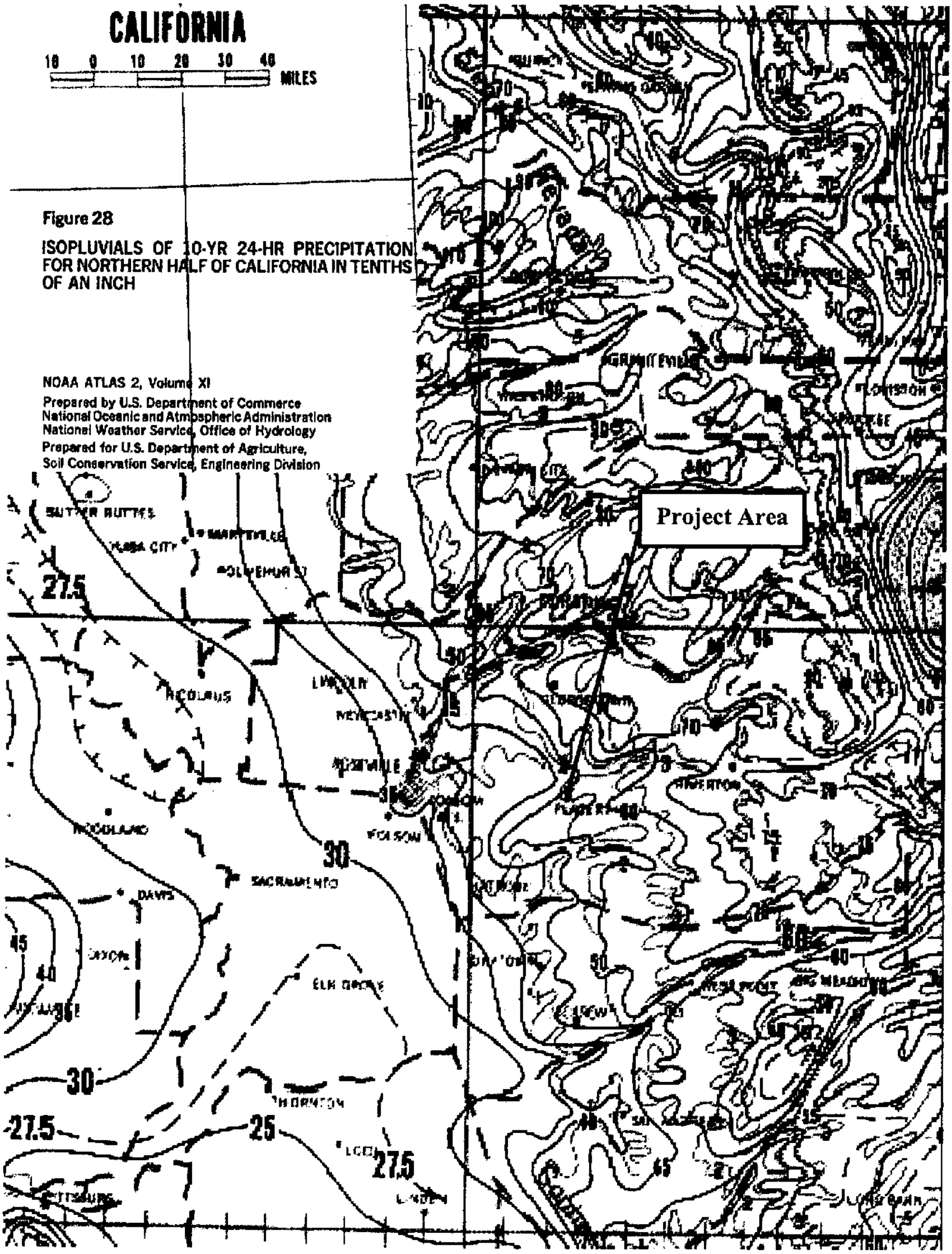


Figure 28

ISOPLUVIALS OF 10-YR 24-HR PRECIPITATION FOR NORTHERN HALF OF CALIFORNIA IN TENTHS OF AN INCH

NOAA ATLAS 2, Volume XI
Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology
Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

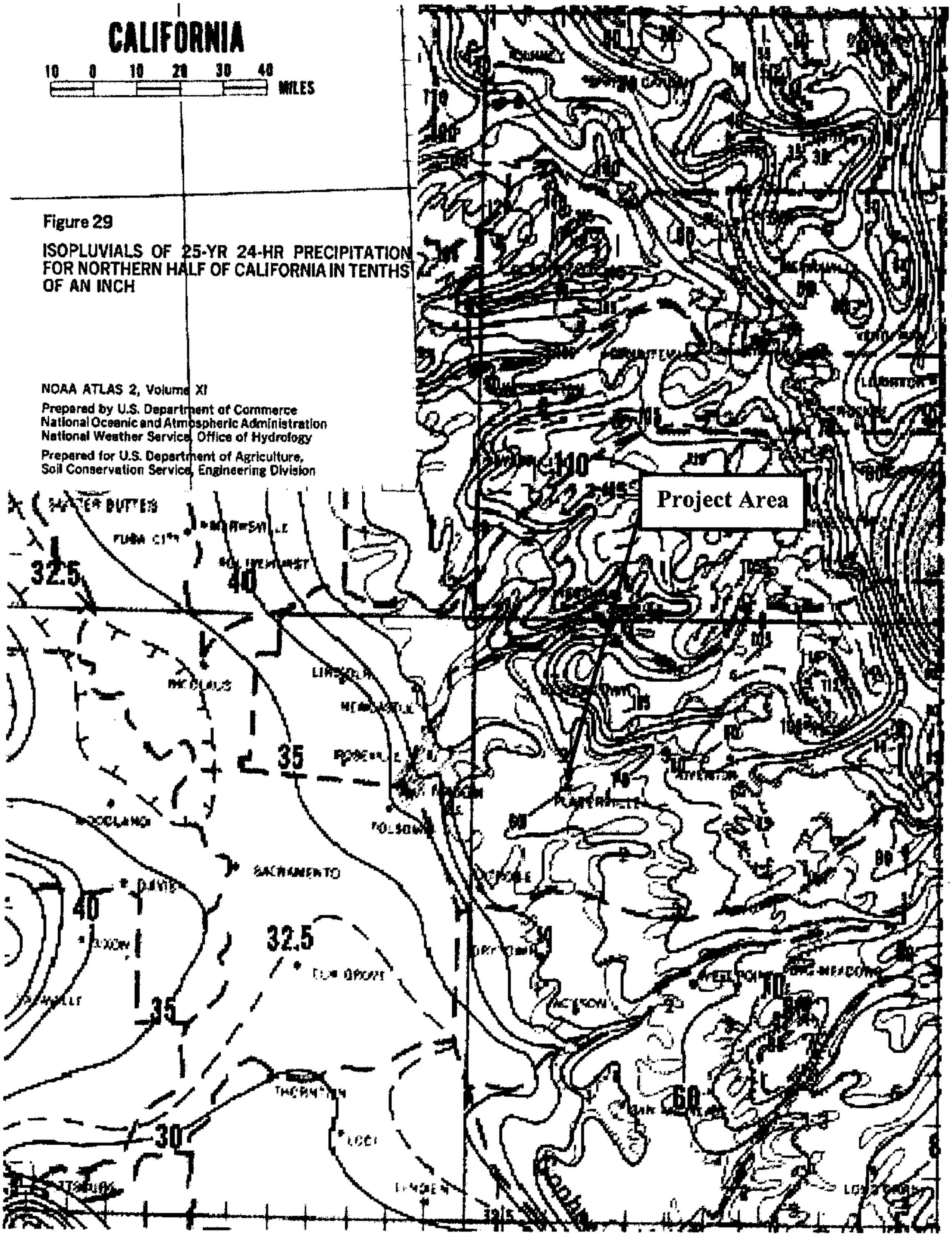


Figure 29

ISOPLUVIALS OF 25-YR 24-HR PRECIPITATION FOR NORTHERN HALF OF CALIFORNIA IN TENTHS OF AN INCH

NOAA ATLAS 2, Volume XI

Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology

Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

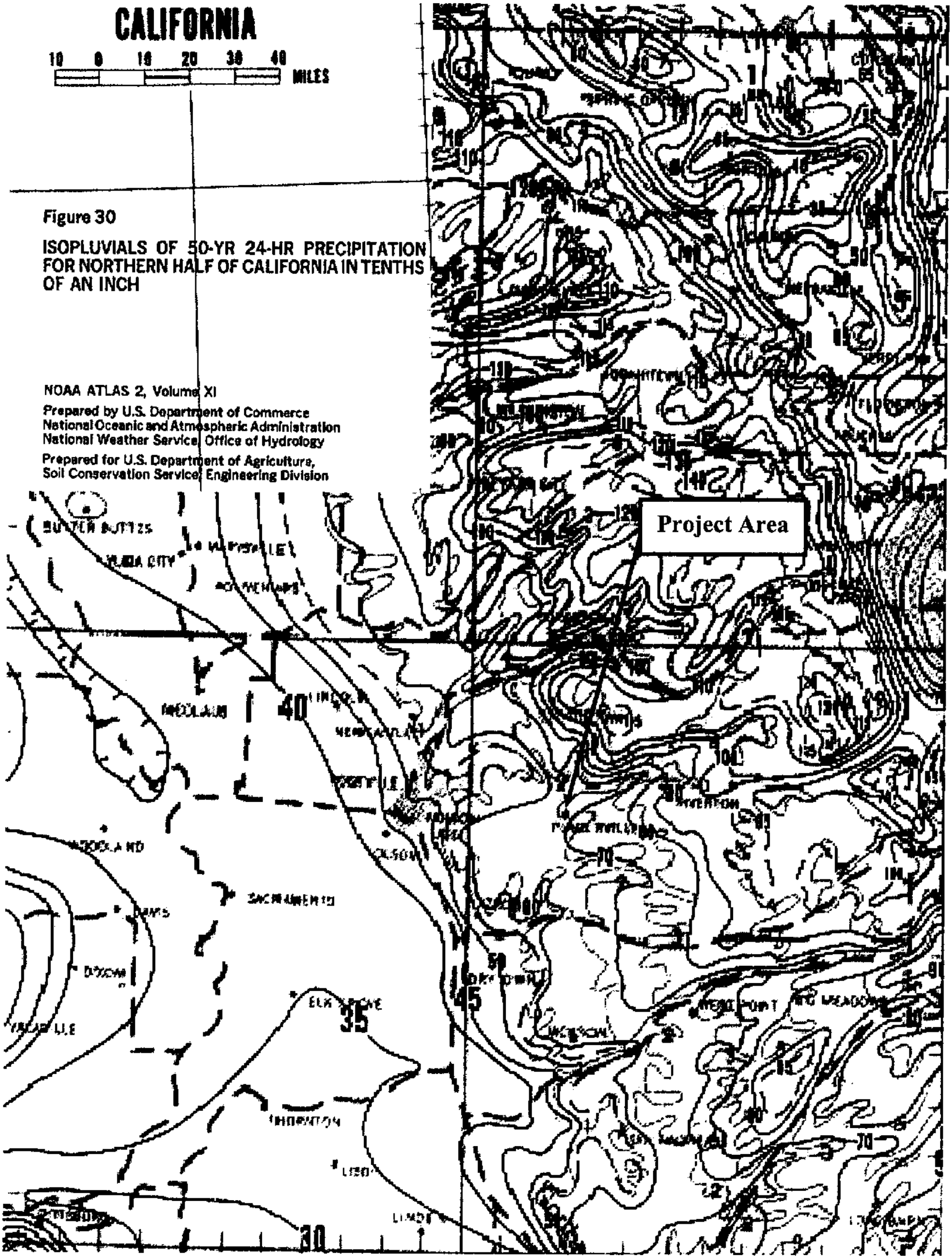


Figure 30

ISOPLUVIALS OF 50-YR 24-HR PRECIPITATION FOR NORTHERN HALF OF CALIFORNIA IN TENTHS OF AN INCH

NOAA ATLAS 2, Volume XI

Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology

Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

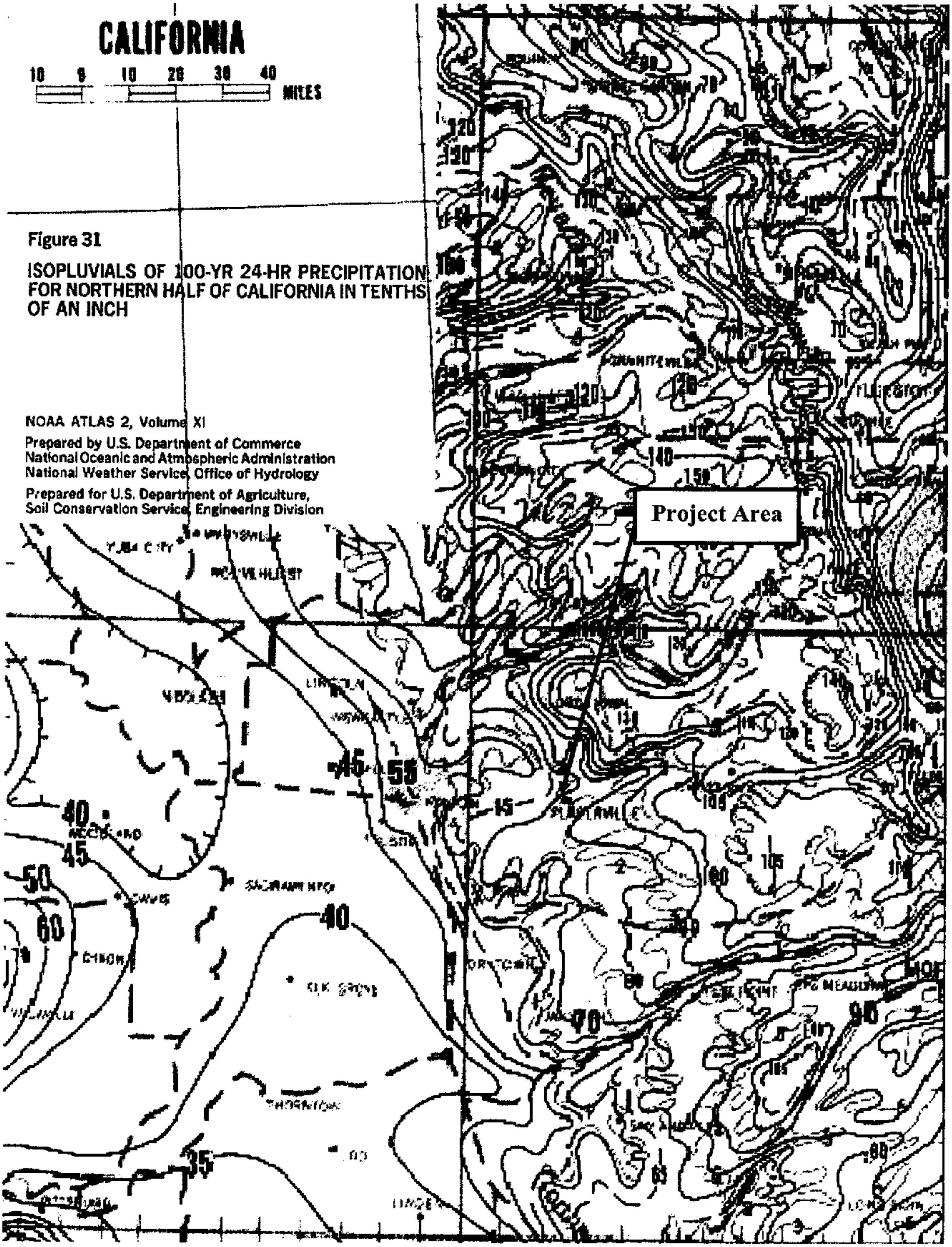


**Figure 31**

ISOPLUVIALS OF 100-YR 24-HR PRECIPITATION FOR NORTHERN HALF OF CALIFORNIA IN TENTHS OF AN INCH

NOAA ATLAS 2, Volume XI
Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology
Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

Hydrologic Soil Group–El Dorado Area, California

USDA **Natural Resources Conservation Service**

Web Soil Survey 2.0
National Cooperative Soil Survey

8/7/2007
Page 1 of 4

Hydrologic Soil Group–El Dorado Area, California

## MAP LEGEND

**Area of Interest (AOI)**
☐ Area of Interest (AOI)

**Soils**
Soil Map Units

**Soil Ratings**
☐ A
☐ A/D
■ B
☐ B/D
☐ C
▨ C/D
☐ D
Not rated or not available

**Political Features**
**Municipalities**
⊖ Cities
▨ Urban Areas

**Water Features**
■ Oceans
~ Streams and Canals

**Transportation**
Rails

**Roads**
Interstate Highways
US Routes
State Highways
Local Roads
Other Roads

## MAP INFORMATION

Original soil survey map sheets were prepared at publication scale. Viewing scale and printing scale, however, may vary from the original. Please rely on the bar scale on each map sheet for proper map measurements.

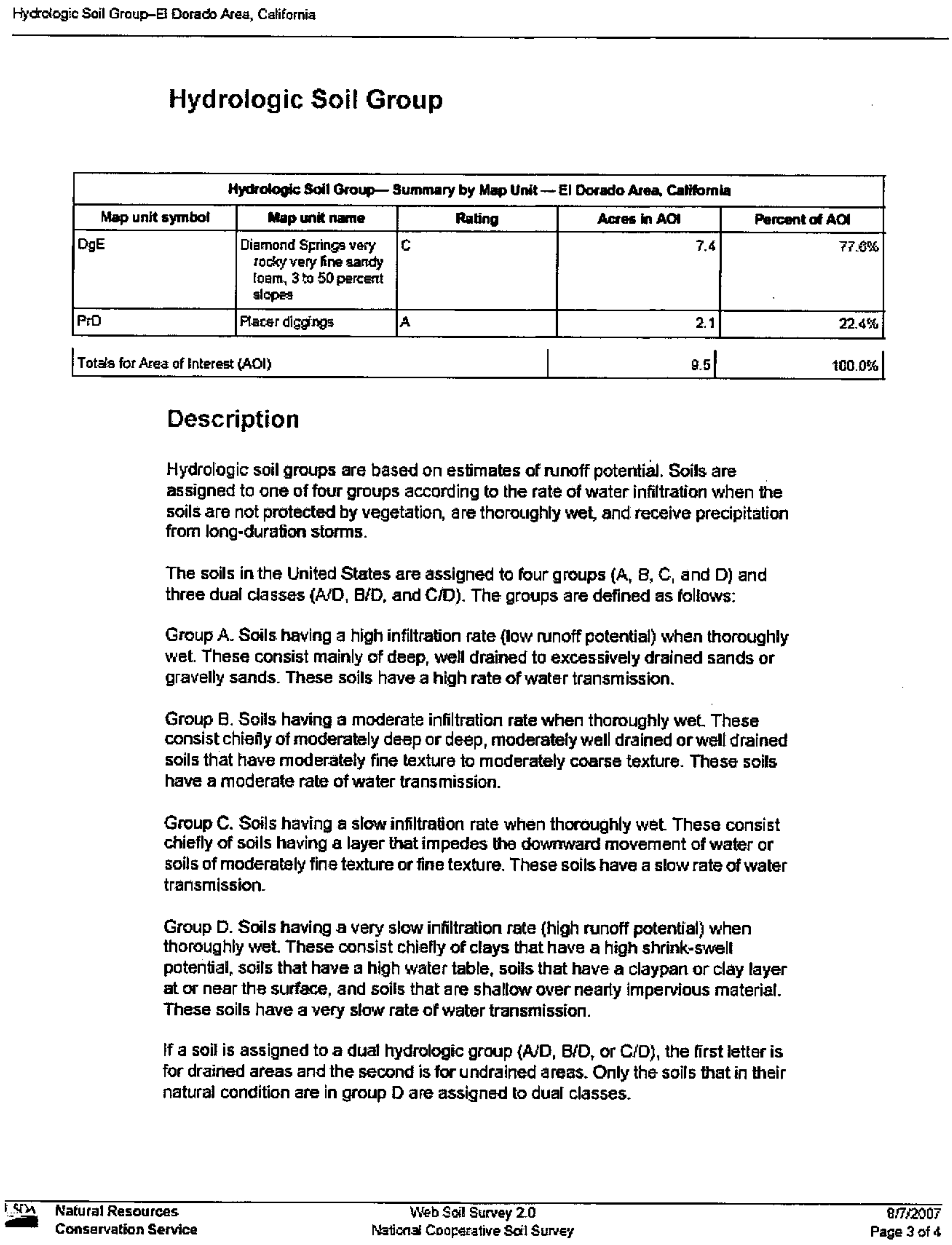
Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 10N

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Dorado Area, California
Survey Area Data: Version 3, Jan 4, 2007

Date(s) aerial images were photographed: 5/9/1993

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.



Hydrologic Soil Group–El Dorado Area, California

# Hydrologic Soil Group

| Hydrologic Soil Group— Summary by Map Unit — El Dorado Area, California | | | | |
|---|---|---|---|---|
| **Map unit symbol** | **Map unit name** | **Rating** | **Acres in AOI** | **Percent of AOI** |
| DgE | Diamond Springs very rocky very fine sandy loam, 3 to 50 percent slopes | C | 7.4 | 77.6% |
| PrD | Placer diggings | A | 2.1 | 22.4% |
| Totals for Area of Interest (AOI) | | | 9.5 | 100.0% |

## Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

USDA Natural Resources
Conservation Service

Web Soil Survey 2.0
National Cooperative Soil Survey

8/7/2007
Page 3 of 4

# HMS Results

| Time | 100 yr | 50 yr | Time | 100 yr | 50 yr | Time | 100 yr | 50 yr |
|---|---|---|---|---|---|---|---|---|
| 0:15 | 0 | 0 | 11:45 | 105.114 | 87.209 | 23:30 | 145.654 | 120.039 |
| 0:30 | 0 | 0 | 12:00 | 112.39 | 93.437 | 23:45 | 142.685 | 117.427 |
| 0:45 | 0.001 | 0.001 | 12:15 | 119.828 | 99.811 | 0:00 | 139.751 | 114.846 |
| 1:00 | 0.001 | 0.001 | 12:30 | 127.41 | 106.315 | 0:15 | 136.876 | 112.317 |
| 1:15 | 0.002 | 0.002 | 12:45 | 135.003 | 112.833 | 0:30 | 134.065 | 109.846 |
| 1:30 | 0.009 | 0.003 | 13:00 | 142.472 | 119.247 | 0:45 | 131.291 | 107.41 |
| 1:45 | 0.035 | 0.018 | 13:15 | 149.693 | 125.448 | 1:00 | 128.563 | 105.017 |
| 2:00 | 0.078 | 0.046 | 13:30 | 156.653 | 131.428 | 1:15 | 125.909 | 102.691 |
| 2:15 | 0.143 | 0.088 | 13:45 | 163.367 | 137.198 | 1:30 | 123.306 | 100.413 |
| 2:30 | 0.245 | 0.155 | 14:00 | 169.616 | 142.567 | 1:45 | 120.716 | 98.15 |
| 2:45 | 0.39 | 0.256 | 14:15 | 175.359 | 147.499 | 2:00 | 118.127 | 95.894 |
| 3:00 | 0.577 | 0.39 | 14:30 | 180.729 | 152.113 | 2:15 | 115.536 | 93.64 |
| 3:15 | 0.814 | 0.56 | 14:45 | 185.648 | 156.338 | 2:30 | 112.94 | 91.386 |
| 3:30 | 1.107 | 0.775 | 15:00 | 190.001 | 160.074 | 2:45 | 110.352 | 89.144 |
| 3:45 | 1.457 | 1.035 | 15:15 | 193.876 | 163.395 | 3:00 | 107.781 | 86.924 |
| 4:00 | 1.871 | 1.343 | 15:30 | 197.347 | 166.365 | 3:15 | 105.22 | 84.717 |
| 4:15 | 2.362 | 1.71 | 15:45 | 200.251 | 168.844 | 3:30 | 102.654 | 82.512 |
| 4:30 | 2.933 | 2.141 | 16:00 | 202.602 | 170.841 | 3:45 | 100.076 | 80.304 |
| 4:45 | 3.591 | 2.641 | 16:15 | 204.574 | 172.508 | 4:00 | 97.484 | 78.092 |
| 5:00 | 4.351 | 3.217 | 16:30 | 206.176 | 173.854 | 4:15 | 94.883 | 75.88 |
| 5:15 | 5.229 | 3.888 | 16:45 | 207.379 | 174.854 | 4:30 | 92.303 | 73.695 |
| 5:30 | 6.229 | 4.658 | 17:00 | 208.236 | 175.552 | 4:45 | 145.654 | 120.039 |
| 5:45 | 7.364 | 5.533 | 17:15 | 208.727 | 175.934 | 5:00 | 142.685 | 117.427 |
| 6:00 | 8.651 | 6.53 | 17:30 | 208.712 | 175.874 | 5:15 | 139.751 | 114.846 |
| 6:15 | 10.099 | 7.659 | 17:45 | 208.233 | 175.411 | 5:30 | 136.876 | 112.317 |
| 6:30 | 11.719 | 8.931 | 18:00 | 207.445 | 174.68 | 5:45 | 134.065 | 109.846 |
| 6:45 | 13.512 | 10.348 | 18:15 | 206.368 | 173.698 | 6:00 | 131.291 | 107.41 |
| 7:00 | 15.472 | 11.906 | 18:30 | 205.003 | 172.465 | 23:30 | 128.563 | 105.017 |
| 7:15 | 17.619 | 13.619 | 18:45 | 203.402 | 171.026 | 23:45 | 125.909 | 102.691 |
| 7:30 | 19.963 | 15.505 | 19:00 | 201.591 | 169.405 | 0:00 | 123.306 | 100.413 |
| 7:45 | 22.503 | 17.559 | 19:15 | 199.557 | 167.59 | 0:15 | 120.716 | 98.15 |
| 8:00 | 25.379 | 19.903 | 19:30 | 197.312 | 165.593 | 0:30 | 118.127 | 95.894 |
| 8:15 | 28.613 | 22.559 | 19:45 | 194.89 | 163.443 | 0:45 | 115.536 | 93.64 |
| 8:30 | 32.113 | 25.448 | 20:00 | 192.231 | 161.087 | 1:00 | 112.94 | 91.386 |
| 8:45 | 35.945 | 28.627 | 20:15 | 189.336 | 158.526 | 1:15 | 110.352 | 89.144 |
| 9:00 | 40.198 | 32.172 | 20:30 | 186.275 | 155.82 | 1:30 | 107.781 | 86.924 |
| 9:15 | 44.787 | 36.016 | 20:45 | 183.033 | 152.957 | 1:45 | 105.22 | 84.717 |
| 9:30 | 49.62 | 40.076 | 21:00 | 179.59 | 149.921 | 2:00 | 102.654 | 82.512 |
| 9:45 | 54.754 | 44.398 | 21:15 | 176.007 | 146.762 | 2:15 | 100.076 | 80.304 |
| 10:00 | 60.178 | 48.977 | 21:30 | 172.358 | 143.548 | 2:30 | 97.484 | 78.092 |
| 10:15 | 65.817 | 53.745 | 21:45 | 168.747 | 140.368 | 2:45 | 94.883 | 75.88 |
| 10:30 | 71.727 | 58.75 | 22:00 | 165.192 | 137.238 | 3:00 | 92.303 | 73.695 |
| 10:45 | 77.944 | 64.028 | 22:15 | 161.659 | 134.127 | 3:15 | 145.654 | 120.039 |
| 11:00 | 84.385 | 69.51 | 22:30 | 158.235 | 131.112 | 3:30 | 142.685 | 117.427 |

| Time | 100 yr | 50 yr | Time | 100 yr | 50 yr | Time | 100 yr | 50 yr |
|---|---|---|---|---|---|---|---|---|
| 11:15 | 91.022 | 75.167 | 22:45 | 154.973 | 128.241 | 3:45 | 139.751 | 114.846 |
| 11:30 | 97.95 | 81.082 | 23:00 | 151.806 | 125.453 | 4:00 | 136.876 | 112.317 |
| 11:45 | 105.114 | 87.209 | 23:15 | 148.692 | 122.712 | 4:15 | 134.065 | 109.846 |
| | | | | | | 4:30 | 131.291 | 107.41 |
| 4:45 | 89.757 | 71.548 | | | | | | |
| 5:00 | 87.223 | 69.422 | | | | | | |
| 5:15 | 84.687 | 67.304 | | | | | | |
| 5:30 | 82.148 | 65.191 | | | | | | |
| 5:45 | 79.61 | 63.088 | | | | | | |
| 6:00 | 77.077 | 60.998 | | | | | | |

# APPENDIX B

## HEC-RAS Hydraulic Analyses

- Existing Condition
- Proposed Condition
- Summary Table
- Bridge Output Tables
- Graphical Cross Sections

```
                         HEC-RAS Version 3.1.3 May 2005
                          U.S. Army Corp of Engineers
                         Hydrologic Engineering Center
                               609 Second Street
                               Davis, California

            X     X  XXXXXX   XXXX        XXXX     XX    XXXX
            X     X  X       X    X       X   X   X  X  X
            X     X  X       X            X   X  X    X X
            XXXXXXX  XXXX    X      XXX   XXXX   XXXXXX  XXXX
            X     X  X       X            X X    X    X      X
            X     X  X       X    X       X  X   X    X      X
            X     X  XXXXXX   XXXX        X   X  X    X XXXXX


PROJECT DATA
Project Title: Weber Creek Bridge
Project File : P0428new.prj
Run Date and Time: 8/25/2008 2:15:30 PM

Project in SI units



PLAN DATA

Plan Title: Plan 11
Plan File : g:\Projects\Y2004\P0428 US50 Missouri Fl\Calculations\HEC-
RAS\P0428new.p11

           Geometry Title: WEBER CREEK existing
           Geometry File : g:\Projects\Y2004\P0428 US50 Missouri
Fl\Calculations\HEC-RAS\P0428new.g02

           Flow Title    : WEBER CREEK DESIGN FLOWS
           Flow File     : g:\Projects\Y2004\P0428 US50 Missouri
Fl\Calculations\HEC-RAS\P0428new.f01

Plan Summary Information:
Number of:  Cross Sections =   11    Multiple Openings  =    0
            Culverts       =    0    Inline Structures  =    0
            Bridges        =    2    Lateral Structures =    0

Computational Information
    Water surface calculation tolerance  =  0.003
    Critical depth calculation tolerance =  0.003
    Maximum number of iterations         =  20
    Maximum difference tolerance         =  0.1
```

```
    Flow tolerance factor                  =  0.001

 Computation Options
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Mixed Flow



 FLOW DATA

 Flow Title: WEBER CREEK DESIGN FLOWS
 Flow File : g:\Projects\Y2004\P0428 US50 Missouri Fl\Calculations\HEC-
 RAS\P0428new.f01

 Flow Data (m3/s)

   River           Reach          RS                    Q100          Q50
   Weber Creek     1              167.0                  209          176


 Boundary Conditions

   River           Reach          Profile                      Upstream
 Downstream

   Weber Creek     1              Q100                      Normal S = 0.005
 Normal S = 0.03
   Weber Creek     1              Q50                       Normal S = 0.005
 Normal S = 0.03



 GEOMETRY DATA

 Geometry Title: WEBER CREEK existing
 Geometry File : g:\Projects\Y2004\P0428 US50 Missouri Fl\Calculations\HEC-
 RAS\P0428new.g02

 CROSS SECTION


 RIVER: Weber Creek
 REACH: 1                   RS: 167.0

 INPUT
 Description: 1+67.00
 Station Elevation Data    num=      10
      Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
```

```
   -21.6     480       -2 467.841    -1.5 467.531       0   466.6     6.5 467.459
    10.6     468     28.5     476      32   476.5      35     478    49.3     480

 Manning's n Values         num=       3
      Sta    n Val      Sta   n Val      Sta   n Val
    -21.6     .075     -1.5     .04      6.5    .075

 Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
           -1.5      6.5              17.7    17.7     17.7                .1        .3

 CROSS SECTION


 RIVER: Weber Creek
 REACH: 1                   RS: 149.3

 INPUT
 Description: 1+49.3
 Station Elevation Data     num=      11
      Sta     Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
      -18      480       -2 466.749     -1.7   466.5        0   466.2      4.9   466.5
        6  466.958      8.5     468       15     469     23.9   473.5     28.6   474.5
       36      480

 Manning's n Values         num=       3
      Sta    n Val      Sta   n Val      Sta   n Val
      -18     .075       -2     .04        6    .075

 Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
             -2        6             22.16   22.16    22.16                .1        .3

 CROSS SECTION


 RIVER: Weber Creek
 REACH: 1                   RS: 127.14

 INPUT
 Description: 1+27.14
 Station Elevation Data     num=       8
      Sta     Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
    -16.8      480       -2 467.667     -1.5  467.25        0     466      6.5   467.3
       10      468     21.2   468.5     34.1     480

 Manning's n Values         num=       3
      Sta    n Val      Sta   n Val      Sta   n Val
    -16.8     .075     -1.5     .04      6.5    .075

 Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
           -1.5      6.5             11.42   11.42    11.42                .1        .3

 CROSS SECTION
```

```
RIVER: Weber Creek
REACH: 1                   RS: 115.72

INPUT
Description:
Station Elevation Data     num=       9
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
   -16.6      480       -2  467.247     -1.5   466.81        0    465.5      6.5  467.048
     8.4    467.5     22.7      468     28.1    470.5       39      480

Manning's n Values         num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
   -16.6     .075     -1.5      .04      6.5     .075

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.    Expan.
          -1.5      6.5              8.32    8.32     8.32                  .1        .3

CROSS SECTION


RIVER: Weber Creek
REACH: 1                   RS: 107.4

INPUT
Description: 1+07.4
Station Elevation Data     num=      13
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     -45      489    -36.5      489    -28.6      485    -22.3      485       -2  466.794
       0      465        6  466.724      8.7    467.5     23.5      468     36.7      473
    45.2      483     49.6      485       54      485

Manning's n Values         num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
     -45     .075       -2      .04        6     .075

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.    Expan.
            -2        6             16.55   16.55    16.55                  .1        .3

BRIDGE


RIVER: Weber Creek
REACH: 1                   RS: 99.125

INPUT
Description: Eastbound US50
Distance from Upstream XS =    6.807
Deck/Roadway Width        =     5.87
Weir Coefficient          =     1.44
Upstream  Deck/Roadway Coordinates
```

```
   num=        2
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
  -77.05 508.144 505.434   90.08 504.205 501.495

Upstream Bridge Cross Section Data
Station Elevation Data    num=       13
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
     -45      489   -36.5      489   -28.6      485   -22.3      485      -2 466.794
       0      465       6  466.724     8.7    467.5    23.5      468    36.7      473
    45.2      483    49.6      485      54      485

Manning's n Values         num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
     -45     .075      -2      .04       6     .075

Bank Sta: Left    Right     Coeff Contr.    Expan.
            -2        6              .1        .3

Downstream  Deck/Roadway Coordinates
   num=        2
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
   -77.1 508.144 505.434   89.93 504.205 501.495

Downstream Bridge Cross Section Data
Station Elevation Data    num=        9
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
   -40.2    488.5   -14.2      480    -2.6    466.5      -2  466.154       0      465
       6  466.415    10.6    467.5    23.8      468    53.1      480

Manning's n Values         num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
   -40.2     .075      -2      .04       6     .075

Bank Sta: Left    Right     Coeff Contr.    Expan.
            -2        6              .1        .3

Upstream Embankment side slope                  =       0 horiz. to 1.0 vertical
Downstream Embankment side slope                =       0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =      .95
Elevation at which weir flow begins             =
Energy head used in spillway design             =
Spillway height used in design                  =
Weir crest shape                                = Broad Crested

Number of Piers =  3

Pier Data
Pier Station     Upstream=  -35.33    Downstream=  -35.39
Upstream      num=        2
   Width    Elev     Width    Elev
    6.45       0      6.45     506
Downstream      num=        2
```

```
    Width   Elev    Width   Elev
    6.45       0    6.45     506

Pier Data
Pier Station     Upstream=    6.42    Downstream=    6.37
Upstream     num=        2
    Width   Elev    Width   Elev
    6.45       0    6.45     506
Downstream     num=        2
    Width   Elev    Width   Elev
    6.45       0    6.45     506

Pier Data
Pier Station     Upstream=   48.18    Downstream=   48.13
Upstream     num=        2
    Width   Elev    Width   Elev
    6.45       0    6.45     506
Downstream     num=        2
    Width   Elev    Width   Elev
    6.45       0    6.45     506

Number of Bridge Coefficient Sets =  1

Low Flow Methods and Data
       Energy
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
       Energy Only

Additional Bridge Parameters
       Add Friction component to Momentum
       Do not add Weight component to Momentum
       Class B flow critical depth computations use critical depth
           inside the bridge at the upstream end
       Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION


RIVER: Weber Creek
REACH: 1                 RS: 90.85

INPUT
Description: 0+90.85
Station Elevation Data    num=       9
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   -40.2   488.5   -14.2     480    -2.6   466.5      -2 466.154       0     465
       6 466.415    10.6   467.5    23.8     468    53.1     480

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
```

```
   -40.2    .075       -2      .04        6    .075

 Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
             -2        6                8.7     8.7     8.7                .1        .3

 CROSS SECTION


 RIVER: Weber Creek
 REACH: 1                   RS: 82.15

 INPUT
 Description: 0+82.15
 Station Elevation Data     num=       10
      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
    -40.2    488.5    -14.7      480     -2.5    466.5       -2    466.2        0      465
        6  466.539     9.75    467.5     22.3      468    51.87      478     55.1      480

 Manning's n Values         num=        3
      Sta    n Val      Sta    n Val      Sta    n Val
    -40.2     .075       -2      .04        6     .075

 Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
             -2        6              19.16   19.16   19.16                .1        .3

 BRIDGE


 RIVER: Weber Creek
 REACH: 1                   RS: 72.57

 INPUT
 Description: Westbound US50
 Distance from Upstream XS =        1
 Deck/Roadway Width        =     5.87
 Weir Coefficient          =     1.44
 Upstream  Deck/Roadway Coordinates
     num=       2
      Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
    -74.6 507.944 505.234    92.7 504.196 501.486

 Upstream Bridge Cross Section Data
 Station Elevation Data     num=       10
      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
    -40.2    488.5    -14.7      480     -2.5    466.5       -2    466.2        0      465
        6  466.539     9.75    467.5     22.3      468    51.87      478     55.1      480

 Manning's n Values         num=        3
      Sta    n Val      Sta    n Val      Sta    n Val
    -40.2     .075       -2      .04        6     .075

 Bank Sta: Left    Right     Coeff Contr.    Expan.
```

```
          -2        6              .1        .3

Downstream  Deck/Roadway Coordinates
    num=       2
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
   -84.3 507.944 505.234    82.8 504.196 501.486

Downstream Bridge Cross Section Data
Station Elevation Data     num=      13
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     -50    489.5    -43.9    489.5    -17.2    482.5     -1.5  468.352       -1  467.901
       0      467      3.8    467.5        7  467.708     11.5      468     19.2    469.5
    29.7    472.5     42.8      474     50.8      480

Manning's n Values         num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
     -50     .075       -1      .04        7     .075

Bank Sta: Left    Right     Coeff Contr.   Expan.
            -1       7              .1        .3

Upstream Embankment side slope                 =       0 horiz. to 1.0 vertical
Downstream Embankment side slope               =       0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =      .95
Elevation at which weir flow begins            =
Energy head used in spillway design            =
Spillway height used in design                 =
Weir crest shape                               = Broad Crested

Number of Piers =  3

Pier Data
Pier Station     Upstream=  -32.76    Downstream=  -42.59
Upstream      num=        2
    Width   Elev     Width   Elev
    6.45       0     6.45     506
Downstream      num=        2
    Width   Elev     Width   Elev
    6.45       0     6.45     506

Pier Data
Pier Station     Upstream=        9    Downstream=    -.83
Upstream      num=        2
    Width   Elev     Width   Elev
    6.45       0     6.45     506
Downstream      num=        2
    Width   Elev     Width   Elev
    6.45       0     6.45     506

Pier Data
Pier Station     Upstream=   50.76    Downstream=   40.93
Upstream      num=        2
```

```
     Width    Elev     Width    Elev
     6.45        0     6.45      506
 Downstream      num=         2
     Width    Elev     Width    Elev
     6.45        0     6.45      506

 Number of Bridge Coefficient Sets =  1

 Low Flow Methods and Data
        Energy
 Selected Low Flow Methods = Highest Energy Answer

 High Flow Method
        Energy Only

 Additional Bridge Parameters
        Add Friction component to Momentum
        Do not add Weight component to Momentum
        Class B flow critical depth computations use critical depth
            inside the bridge at the upstream end
        Criteria to check for pressure flow = Upstream energy grade line

 CROSS SECTION


 RIVER: Weber Creek
 REACH: 1                  RS: 62.99

 INPUT
 Description: 0+62.99
 Station Elevation Data    num=      13
      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
      -50   489.5    -43.9   489.5    -17.2   482.5     -1.5 468.352       -1 467.901
        0     467      3.8   467.5        7 467.708     11.5     468     19.2   469.5
     29.7   472.5     42.8     474     50.8     480

 Manning's n Values        num=      3
      Sta   n Val      Sta   n Val      Sta   n Val
      -50    .075       -1     .04        7    .075

 Bank Sta: Left    Right     Lengths: Left Channel    Right        Coeff Contr.    Expan.
             -1        7             20.24    20.24    20.24                 .1        .3

 CROSS SECTION


 RIVER: Weber Creek
 REACH: 1                  RS: 42.75

 INPUT
 Description: 0+42.75
 Station Elevation Data    num=      11
```

```
      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
    -14.1      480       -2  468.415     -1.5  467.936        0    466.5        4    467.5
      6.5  467.712      9.9      468     23.4      469     36.1    472.5     44.5      474
     51.1      480

 Manning's n Values         num=        3
      Sta    n Val      Sta    n Val      Sta    n Val
    -14.1     .075     -1.5      .04      6.5     .075

 Bank Sta: Left    Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
           -1.5      6.5              31.8    31.8    31.8                .1       .3

 CROSS SECTION


 RIVER: Weber Creek
 REACH: 1                   RS: 10.95

 INPUT
 Description: 0+10.95
 Station Elevation Data     num=       13
      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
    -30.2      480       -5  466.763     -4.5    466.5       -4  466.478        0    466.3
        4  466.454      4.5  466.473        5  466.492      5.2    466.5      9.6      468
     19.5    468.5     29.2    470.5     45.4      480

 Manning's n Values         num=        3
      Sta    n Val      Sta    n Val      Sta    n Val
    -30.2     .075     -4.5      .04      4.5     .075

 Bank Sta: Left    Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
           -4.5      4.5             10.95   10.95   10.95                .1       .3

 CROSS SECTION


 RIVER: Weber Creek
 REACH: 1                   RS: 0

 INPUT
 Description: 0+00
 Station Elevation Data     num=       12
      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
    -35.7      480    -28.3      476    -24.4      475     -8.5    466.5       -6      466
        0    465.7      3.3      466      8.2    466.5     17.5    468.5     27.2      469
     33.1    470.5     50.3      480

 Manning's n Values         num=        3
      Sta    n Val      Sta    n Val      Sta    n Val
    -35.7     .075       -6      .04      3.3     .075

 Bank Sta: Left    Right     Coeff Contr.    Expan.
```

```
             -6      3.3              .1        .3


 SUMMARY OF MANNING'S N VALUES

 River:Weber Creek

       Reach              River Sta.        n1         n2         n3

  1                        167.0              .075        .04        .075
  1                        149.3              .075        .04        .075
  1                        127.14             .075        .04        .075
  1                        115.72             .075        .04        .075
  1                        107.4              .075        .04        .075
  1                        99.125         Bridge
  1                        90.85              .075        .04        .075
  1                        82.15              .075        .04        .075
  1                        72.57          Bridge
  1                        62.99              .075        .04        .075
  1                        42.75              .075        .04        .075
  1                        10.95              .075        .04        .075
  1                        0                  .075        .04        .075


 SUMMARY OF REACH LENGTHS

 River: Weber Creek

       Reach              River Sta.       Left     Channel     Right

  1                        167.0             17.7       17.7       17.7
  1                        149.3            22.16      22.16      22.16
  1                        127.14           11.42      11.42      11.42
  1                        115.72            8.32       8.32       8.32
  1                        107.4            16.55      16.55      16.55
  1                        99.125         Bridge
  1                        90.85              8.7        8.7        8.7
  1                        82.15            19.16      19.16      19.16
  1                        72.57          Bridge
  1                        62.99            20.24      20.24      20.24
  1                        42.75             31.8       31.8       31.8
  1                        10.95            10.95      10.95      10.95
  1                        0


 SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
 River: Weber Creek
```

```
     Reach              River Sta.     Contr.    Expan.

1                        167.0            .1         .3
1                        149.3            .1         .3
1                        127.14           .1         .3
1                        115.72           .1         .3
1                        107.4            .1         .3
1                        99.125   Bridge
1                        90.85            .1         .3
1                        82.15            .1         .3
1                        72.57    Bridge
1                        62.99            .1         .3
1                        42.75            .1         .3
1                        10.95            .1         .3
1                        0                .1         .3
```

```
                         HEC-RAS Version 3.1.3 May 2005
                          U.S. Army Corp of Engineers
                         Hydrologic Engineering Center
                               609 Second Street
                               Davis, California

            X     X  XXXXXX    XXXX        XXXX       XX      XXXX
            X     X  X        X    X       X   X     X  X    X
            X     X  X        X            X   X    X    X   X
            XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
            X     X  X        X            X  X     X    X        X
            X     X  X        X    X       X   X    X    X        X
            X     X  XXXXXX    XXXX        X    X   X    X   XXXXX



PROJECT DATA
Project Title: Weber Creek Bridge
Project File : P0428new.prj
Run Date and Time: 8/25/2008 2:25:06 PM

Project in SI units



PLAN DATA

Plan Title: Plan 12
Plan File : g:\Projects\Y2004\P0428 US50 Missouri Fl\Calculations\HEC-
RAS\P0428new.p12

           Geometry Title: WEBER CREEK PROPOSED
           Geometry File : g:\Projects\Y2004\P0428 US50 Missouri
Fl\Calculations\HEC-RAS\P0428new.g01

           Flow Title    : WEBER CREEK DESIGN FLOWS
           Flow File     : g:\Projects\Y2004\P0428 US50 Missouri
Fl\Calculations\HEC-RAS\P0428new.f01

Plan Summary Information:
Number of:  Cross Sections =   11    Multiple Openings  =    0
            Culverts       =    0    Inline Structures  =    0
            Bridges        =    2    Lateral Structures =    0

Computational Information
    Water surface calculation tolerance  =  0.003
    Critical depth calculation tolerance =  0.003
    Maximum number of iterations         =  20
    Maximum difference tolerance         =  0.1
```

```
    Flow tolerance factor                 =  0.001

  Computation Options
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Mixed Flow



  FLOW DATA

  Flow Title: WEBER CREEK DESIGN FLOWS
  Flow File : g:\Projects\Y2004\P0428 US50 Missouri Fl\Calculations\HEC-
  RAS\P0428new.f01

  Flow Data (m3/s)

    River          Reach           RS                    Q100             Q50
    Weber Creek    1               167.0                  209             176


  Boundary Conditions

    River          Reach           Profile                        Upstream
  Downstream

    Weber Creek    1               Q100                        Normal S = 0.005
  Normal S = 0.03
    Weber Creek    1               Q50                         Normal S = 0.005
  Normal S = 0.03



  GEOMETRY DATA

  Geometry Title: WEBER CREEK PROPOSED
  Geometry File : g:\Projects\Y2004\P0428 US50 Missouri Fl\Calculations\HEC-
  RAS\P0428new.g01

  CROSS SECTION


  RIVER: Weber Creek
  REACH: 1                  RS: 167.0

  INPUT
  Description: 1+67.00
  Station Elevation Data    num=      10
       Sta      Elev      Sta      Elev      Sta      Elev      Sta      Elev      Sta      Elev
```

```
   -21.6      480       -2 467.841    -1.5 467.531        0    466.6      6.5 467.459
    10.6      468     28.5     476      32   476.5       35      478     49.3     480

Manning's n Values        num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
   -21.6     .075     -1.5      .04      6.5     .075

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
          -1.5      6.5              17.7    17.7     17.7                .1        .3

CROSS SECTION


RIVER: Weber Creek
REACH: 1                  RS: 149.3

INPUT
Description: 1+49.3
Station Elevation Data    num=      11
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     -18      480       -2 466.749    -1.7    466.5        0    466.2      4.9    466.5
       6  466.958      8.5      468      15      469     23.9    473.5     28.6    474.5
      36      480

Manning's n Values        num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
     -18     .075       -2      .04        6     .075

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
            -2        6             22.16   22.16    22.16                .1        .3

CROSS SECTION


RIVER: Weber Creek
REACH: 1                  RS: 127.14

INPUT
Description: 1+27.14
Station Elevation Data    num=       8
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
   -16.8      480       -2 467.667    -1.5   467.25        0      466      6.5    467.3
      10      468     21.2    468.5    34.1      480

Manning's n Values        num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
   -16.8     .075     -1.5      .04      6.5     .075

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
          -1.5      6.5             11.42   11.42    11.42                .1        .3

CROSS SECTION
```

```
RIVER: Weber Creek
REACH: 1                    RS: 115.72

INPUT
Description:
Station Elevation Data    num=       9
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
   -16.6      480      -2  467.247    -1.5   466.81       0    465.5     6.5  467.048
     8.4    467.5    22.7      468    28.1    470.5      39      480

Manning's n Values        num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
   -16.6     .075    -1.5      .04     6.5     .075

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.    Expan.
          -1.5      6.5              8.32     8.32    8.32                 .1        .3

CROSS SECTION


RIVER: Weber Creek
REACH: 1                    RS: 107.4

INPUT
Description: 1+07.4
Station Elevation Data    num=      13
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
     -45      489   -36.5      489   -28.6      485   -22.3      485      -2  466.794
       0      465       6  466.724     8.7    467.5    23.5      468    36.7      473
    45.2      483    49.6      485      54      485

Manning's n Values        num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
     -45     .075      -2      .04       6     .075

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.    Expan.
            -2        6             16.55    16.55   16.55                 .1        .3

BRIDGE


RIVER: Weber Creek
REACH: 1                    RS: 99.125

INPUT
Description: Eastbound US50
Distance from Upstream XS =       1
Deck/Roadway Width        =    14.4
Weir Coefficient          =    1.44
Upstream  Deck/Roadway Coordinates
```

```
     -40.2    .075       -2      .04         6    .075

   Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
               -2        6                 8.7      8.7      8.7                .1        .3

   CROSS SECTION


   RIVER: Weber Creek
   REACH: 1                    RS: 82.15

   INPUT
   Description: 0+82.15
   Station Elevation Data    num=      10
        Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
      -40.2    488.5    -14.7      480     -2.5    466.5       -2    466.2        0      465
          6  466.539     9.75    467.5     22.3      468    51.87      478     55.1      480

   Manning's n Values        num=       3
        Sta    n Val      Sta    n Val      Sta    n Val
      -40.2     .075       -2      .04        6     .075

   Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
               -2        6               19.16    19.16    19.16                .1        .3

   BRIDGE


   RIVER: Weber Creek
   REACH: 1                    RS: 72.57

   INPUT
   Description: Westbound US50
   Distance from Upstream XS =        1
   Deck/Roadway Width        =     14.4
   Weir Coefficient          =     1.44
   Upstream  Deck/Roadway Coordinates
       num=       2
        Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
      -74.6 507.944 505.234    92.7 504.196 501.486

   Upstream Bridge Cross Section Data
   Station Elevation Data    num=      10
        Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
      -40.2    488.5    -14.7      480     -2.5    466.5       -2    466.2        0      465
          6  466.539     9.75    467.5     22.3      468    51.87      478     55.1      480

   Manning's n Values        num=       3
        Sta    n Val      Sta    n Val      Sta    n Val
      -40.2     .075       -2      .04        6     .075

   Bank Sta: Left    Right     Coeff Contr.    Expan.
```

```
               -2        6              .1        .3

 Downstream  Deck/Roadway Coordinates
     num=        2
      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
   -84.3 507.944 505.234     82.8 504.196 501.486

 Downstream Bridge Cross Section Data
 Station Elevation Data    num=       13
      Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
      -50   489.5   -43.9   489.5   -17.2   482.5    -1.5 468.352      -1 467.901
        0     467     3.8   467.5       7 467.708    11.5     468    19.2   469.5
     29.7   472.5    42.8     474    50.8     480

 Manning's n Values         num=        3
      Sta   n Val     Sta   n Val     Sta   n Val
      -50    .075      -1     .04       7    .075

 Bank Sta: Left   Right    Coeff Contr.   Expan.
             -1       7             .1        .3

 Upstream Embankment side slope              =        0 horiz. to 1.0 vertical
 Downstream Embankment side slope            =        0 horiz. to 1.0 vertical
 Maximum allowable submergence for weir flow =      .95
 Elevation at which weir flow begins         =
 Energy head used in spillway design         =
 Spillway height used in design              =
 Weir crest shape                            = Broad Crested

 Number of Piers =  3

 Pier Data
 Pier Station     Upstream=  -32.76    Downstream=  -42.59
 Upstream      num=         2
     Width   Elev    Width   Elev
     6.45       0    6.45     506
 Downstream        num=         2
     Width   Elev    Width   Elev
     6.45       0    6.45     506

 Pier Data
 Pier Station     Upstream=        9    Downstream=    -.83
 Upstream      num=         2
     Width   Elev    Width   Elev
     6.45       0    6.45     506
 Downstream        num=         2
     Width   Elev    Width   Elev
     6.45       0    6.45     506

 Pier Data
 Pier Station     Upstream=   50.76    Downstream=   40.93
 Upstream      num=         2
```

```
    Width   Elev    Width   Elev
    6.45       0    6.45     506
Downstream      num=        2
    Width   Elev    Width   Elev
    6.45       0    6.45     506

Number of Bridge Coefficient Sets =  1

Low Flow Methods and Data
       Energy
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
       Energy Only

Additional Bridge Parameters
       Add Friction component to Momentum
       Do not add Weight component to Momentum
       Class B flow critical depth computations use critical depth
           inside the bridge at the upstream end
       Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION


RIVER: Weber Creek
REACH: 1                 RS: 62.99

INPUT
Description: 0+62.99
Station Elevation Data    num=      13
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
     -50    489.5    -43.9    489.5    -17.2    482.5     -1.5  468.352       -1  467.901
       0      467      3.8    467.5        7  467.708     11.5      468     19.2    469.5
    29.7    472.5     42.8      474     50.8      480

Manning's n Values        num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
     -50     .075       -1      .04        7     .075

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.    Expan.
            -1        7             20.24   20.24    20.24                 .1        .3

CROSS SECTION


RIVER: Weber Creek
REACH: 1                 RS: 42.75

INPUT
Description: 0+42.75
Station Elevation Data    num=      11
```

```
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   -14.1     480      -2 468.415    -1.5 467.936       0   466.5       4   467.5
     6.5 467.712     9.9     468    23.4     469    36.1   472.5    44.5     474
    51.1     480

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   -14.1    .075    -1.5     .04     6.5    .075

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          -1.5     6.5             31.8    31.8    31.8                .1      .3

CROSS SECTION


RIVER: Weber Creek
REACH: 1                  RS: 10.95

INPUT
Description: 0+10.95
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   -30.2     480      -5 466.763    -4.5   466.5      -4 466.478       0   466.3
       4 466.454     4.5 466.473       5 466.492     5.2   466.5     9.6     468
    19.5   468.5    29.2   470.5    45.4     480

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   -30.2    .075    -4.5     .04     4.5    .075

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          -4.5     4.5            10.95   10.95   10.95                .1      .3

CROSS SECTION


RIVER: Weber Creek
REACH: 1                  RS: 0

INPUT
Description: 0+00
Station Elevation Data    num=      12
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   -35.7     480   -28.3     476   -24.4     475    -8.5   466.5      -6     466
       0   465.7     3.3     466     8.2   466.5    17.5   468.5    27.2     469
    33.1   470.5    50.3     480

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   -35.7    .075      -6     .04     3.3    .075

Bank Sta: Left    Right    Coeff Contr.   Expan.
```

```
          -6      3.3               .1        .3



SUMMARY OF MANNING'S N VALUES

River:Weber Creek

      Reach              River Sta.      n1         n2         n3

 1                        167.0            .075       .04       .075
 1                        149.3            .075       .04       .075
 1                        127.14           .075       .04       .075
 1                        115.72           .075       .04       .075
 1                        107.4            .075       .04       .075
 1                        99.125        Bridge
 1                        90.85            .075       .04       .075
 1                        82.15            .075       .04       .075
 1                        72.57         Bridge
 1                        62.99            .075       .04       .075
 1                        42.75            .075       .04       .075
 1                        10.95            .075       .04       .075
 1                        0                .075       .04       .075



SUMMARY OF REACH LENGTHS

River: Weber Creek

      Reach              River Sta.      Left     Channel     Right

 1                        167.0            17.7      17.7       17.7
 1                        149.3           22.16     22.16      22.16
 1                        127.14          11.42     11.42      11.42
 1                        115.72           8.32      8.32       8.32
 1                        107.4           16.55     16.55      16.55
 1                        99.125        Bridge
 1                        90.85             8.7       8.7        8.7
 1                        82.15           19.16     19.16      19.16
 1                        72.57         Bridge
 1                        62.99           20.24     20.24      20.24
 1                        42.75            31.8      31.8       31.8
 1                        10.95           10.95     10.95      10.95
 1                        0



SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: Weber Creek
```

```
     Reach              River Sta.     Contr.    Expan..

1                    167.0               .1         .3
1                    149.3               .1         .3
1                    127.14              .1         .3
1                    115.72              .1         .3
1                    107.4               .1         .3
1                    99.125   Bridge
1                    90.85               .1         .3
1                    82.15               .1         .3
1                    72.57    Bridge
1                    62.99               .1         .3
1                    42.75               .1         .3
1                    10.95               .1         .3
1                    0                   .1         .3
```

HEC-RAS Plan: Exist River: Weber Creek Reach: 1

| Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (m3/s) | (m) | (m) | (m) | (m) | (m/m) | (m/s) | (m2) | (m) | |
| 1 | 167.0 | Q100 | 209.00 | 466.60 | 470.53 | 470.53 | 471.85 | 0.010442 | 5.73 | 53.77 | 22.58 | 0.98 |
| 1 | 167.0 | Q50 | 176.00 | 466.60 | 470.20 | 470.20 | 471.41 | 0.010728 | 5.44 | 46.61 | 21.33 | 0.98 |
| | | | | | | | | | | | | |
| 1 | 149.3 | Q100 | 209.00 | 466.20 | 470.40 | 470.14 | 471.47 | 0.006897 | 5.13 | 61.44 | 24.16 | 0.82 |
| 1 | 149.3 | Q50 | 176.00 | 466.20 | 470.13 | 469.82 | 471.06 | 0.006404 | 4.72 | 55.21 | 23.33 | 0.78 |
| | | | | | | | | | | | | |
| 1 | 127.14 | Q100 | 209.00 | 466.00 | 470.49 | | 471.23 | 0.005936 | 4.51 | 74.33 | 28.82 | 0.73 |
| 1 | 127.14 | Q50 | 176.00 | 466.00 | 470.17 | | 470.85 | 0.006005 | 4.28 | 65.20 | 28.08 | 0.73 |
| | | | | | | | | | | | | |
| 1 | 115.72 | Q100 | 209.00 | 465.50 | 470.66 | | 471.08 | 0.003097 | 3.55 | 99.52 | 34.20 | 0.54 |
| 1 | 115.72 | Q50 | 176.00 | 465.50 | 470.33 | | 470.71 | 0.003041 | 3.33 | 88.29 | 33.26 | 0.53 |
| | | | | | | | | | | | | |
| 1 | 107.4 | Q100 | 209.00 | 465.00 | 470.68 | 469.40 | 471.04 | 0.002451 | 3.28 | 109.46 | 36.92 | 0.48 |
| 1 | 107.4 | Q50 | 176.00 | 465.00 | 470.35 | 469.15 | 470.67 | 0.002365 | 3.07 | 97.33 | 35.66 | 0.46 |
| | | | | | | | | | | | | |
| 1 | 99.125 | | Bridge | | | | | | | | | |
| | | | | | | | | | | | | |
| 1 | 90.85 | Q100 | 209.00 | 465.00 | 470.44 | | 470.84 | 0.002505 | 3.41 | 106.16 | 35.75 | 0.50 |
| 1 | 90.85 | Q50 | 176.00 | 465.00 | 470.09 | | 470.45 | 0.002456 | 3.21 | 93.84 | 34.60 | 0.49 |
| | | | | | | | | | | | | |
| 1 | 82.15 | Q100 | 209.00 | 465.00 | 470.35 | 469.31 | 470.81 | 0.002979 | 3.63 | 98.98 | 35.23 | 0.54 |
| 1 | 82.15 | Q50 | 176.00 | 465.00 | 470.00 | 469.04 | 470.42 | 0.002946 | 3.43 | 86.97 | 33.89 | 0.53 |
| | | | | | | | | | | | | |
| 1 | 72.57 | | Bridge | | | | | | | | | |
| | | | | | | | | | | | | |
| 1 | 62.99 | Q100 | 209.00 | 467.00 | 470.34 | 470.61 | 471.83 | 0.016040 | 6.27 | 51.37 | 25.85 | 1.17 |
| 1 | 62.99 | Q50 | 176.00 | 467.00 | 470.05 | 470.33 | 471.46 | 0.017193 | 6.05 | 43.93 | 24.49 | 1.19 |
| | | | | | | | | | | | | |
| 1 | 42.75 | Q100 | 209.00 | 466.50 | 469.94 | 470.33 | 471.46 | 0.019864 | 6.47 | 51.95 | 30.41 | 1.26 |
| 1 | 42.75 | Q50 | 176.00 | 466.50 | 469.83 | 470.08 | 471.06 | 0.016786 | 5.79 | 48.60 | 29.89 | 1.15 |
| | | | | | | | | | | | | |
| 1 | 10.95 | Q100 | 209.00 | 466.30 | 469.10 | 469.59 | 470.83 | 0.018440 | 6.58 | 49.96 | 31.84 | 1.28 |
| 1 | 10.95 | Q50 | 176.00 | 466.30 | 468.89 | 469.35 | 470.47 | 0.018105 | 6.19 | 43.64 | 30.47 | 1.25 |
| | | | | | | | | | | | | |
| 1 | 0 | Q100 | 209.00 | 465.70 | 467.93 | 468.50 | 470.47 | 0.038798 | 8.02 | 38.51 | 26.04 | 1.77 |
| 1 | 0 | Q50 | 176.00 | 465.70 | 467.72 | 468.43 | 470.11 | 0.041546 | 7.71 | 33.01 | 24.62 | 1.80 |

HEC-RAS Plan: Proposed River: Weber Creek Reach: 1

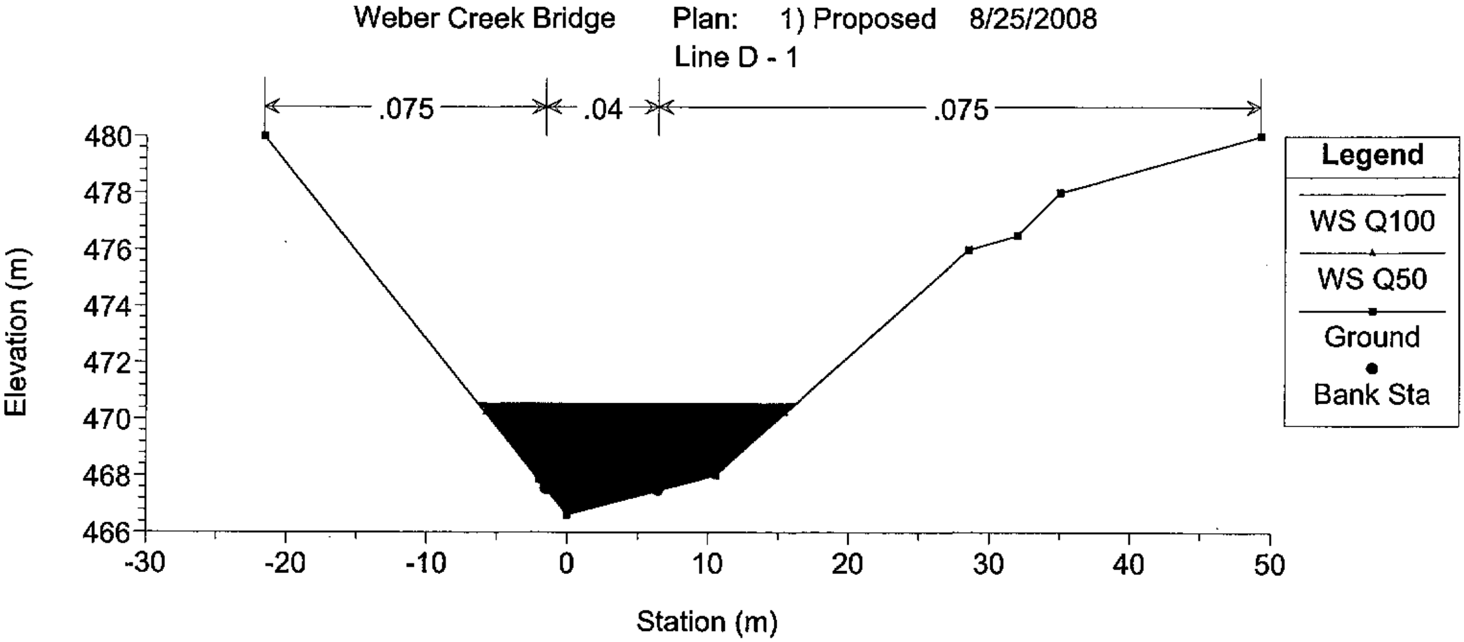
| Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  | (m3/s) | (m) | (m) | (m) | (m) | (m/m) | (m/s) | (m2) | (m) |  |
| 1 | 167.0 | Q100 | 209.00 | 466.60 | 470.53 | 470.53 | 471.85 | 0.010442 | 5.73 | 53.77 | 22.58 | 0.98 |
| 1 | 167.0 | Q50 | 176.00 | 466.60 | 470.20 | 470.20 | 471.41 | 0.010728 | 5.44 | 46.61 | 21.33 | 0.98 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 149.3 | Q100 | 209.00 | 466.20 | 470.45 | 470.14 | 471.48 | 0.006514 | 5.03 | 62.85 | 24.35 | 0.80 |
| 1 | 149.3 | Q50 | 176.00 | 466.20 | 470.18 | 469.82 | 471.07 | 0.006078 | 4.64 | 56.37 | 23.49 | 0.76 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 127.14 | Q100 | 209.00 | 466.00 | 470.55 |  | 471.25 | 0.005587 | 4.42 | 76.00 | 28.96 | 0.71 |
| 1 | 127.14 | Q50 | 176.00 | 466.00 | 470.22 |  | 470.87 | 0.005639 | 4.19 | 66.74 | 28.20 | 0.71 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 115.72 | Q100 | 209.00 | 465.50 | 470.71 |  | 471.12 | 0.002961 | 3.49 | 101.16 | 34.31 | 0.53 |
| 1 | 115.72 | Q50 | 176.00 | 465.50 | 470.37 |  | 470.74 | 0.002908 | 3.28 | 89.77 | 33.41 | 0.52 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 107.4 | Q100 | 209.00 | 465.00 | 470.73 | 469.40 | 471.08 | 0.002352 | 3.23 | 111.20 | 37.09 | 0.47 |
| 1 | 107.4 | Q50 | 176.00 | 465.00 | 470.39 | 469.15 | 470.70 | 0.002268 | 3.03 | 98.89 | 35.83 | 0.45 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 99.125 |  | Bridge |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 90.85 | Q100 | 209.00 | 465.00 | 470.44 |  | 470.84 | 0.002505 | 3.41 | 106.16 | 35.75 | 0.50 |
| 1 | 90.85 | Q50 | 176.00 | 465.00 | 470.09 |  | 470.45 | 0.002455 | 3.21 | 93.84 | 34.60 | 0.49 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 82.15 | Q100 | 209.00 | 465.00 | 470.35 | 469.31 | 470.81 | 0.002979 | 3.63 | 98.98 | 35.23 | 0.54 |
| 1 | 82.15 | Q50 | 176.00 | 465.00 | 470.00 | 469.04 | 470.42 | 0.002946 | 3.43 | 86.97 | 33.89 | 0.53 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 72.57 |  | Bridge |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 62.99 | Q100 | 209.00 | 467.00 | 470.15 | 470.61 | 471.94 | 0.020977 | 6.85 | 46.40 | 24.95 | 1.32 |
| 1 | 62.99 | Q50 | 176.00 | 467.00 | 469.87 | 470.33 | 471.58 | 0.022550 | 6.61 | 39.65 | 23.67 | 1.35 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 42.75 | Q100 | 209.00 | 466.50 | 469.97 | 470.33 | 471.44 | 0.019056 | 6.38 | 52.77 | 30.54 | 1.23 |
| 1 | 42.75 | Q50 | 176.00 | 466.50 | 469.88 | 470.08 | 471.04 | 0.015553 | 5.64 | 50.03 | 30.11 | 1.11 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 10.95 | Q100 | 209.00 | 466.30 | 469.10 | 469.59 | 470.83 | 0.018243 | 6.56 | 50.18 | 31.89 | 1.27 |
| 1 | 10.95 | Q50 | 176.00 | 466.30 | 468.90 | 469.35 | 470.47 | 0.017981 | 6.18 | 43.76 | 30.50 | 1.25 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 0 | Q100 | 209.00 | 465.70 | 467.93 | 468.50 | 470.46 | 0.038624 | 8.01 | 38.57 | 26.06 | 1.77 |
| 1 | 0 | Q50 | 176.00 | 465.70 | 467.72 | 468.43 | 470.10 | 0.041431 | 7.70 | 33.04 | 24.63 | 1.80 |

Plan: Proposed Eastbound Weber Creek 1 RS: 99.125 Profile: Q100

| | | | | |
|---|---|---|---|---|
| E.G. US. (m) | 471.08 | Element | Inside BR US | Inside BR DS |
| W.S. US. (m) | 470.73 | E.G. Elev (m) | 471.05 | 470.91 |
| Q Total (m3/s) | 209.00 | W.S. Elev (m) | 470.49 | 470.29 |
| Q Bridge (m3/s) | 209.00 | Crit W.S. (m) | 469.87 | 469.77 |
| Q Weir (m3/s) | | Max Chl Dpth (m) | 5.49 | 5.29 |
| Weir Sta Lft (m) | | Vel Total (m/s) | 2.65 | 2.74 |
| Weir Sta Rgt (m) | | Flow Area (m2) | 78.87 | 76.28 |
| Weir Submerg | | Froude # Chl | 0.61 | 0.65 |
| Weir Max Depth (m) | | Specif Force (m3) | 195.86 | 194.20 |
| Min El Weir Flow (m) | 505.08 | Hydr Depth (m) | 2.65 | 2.65 |
| Min El Prs (m) | 504.68 | W.P. Total (m) | 39.98 | 39.09 |
| Delta EG (m) | 0.24 | Conv. Total (m3/s) | 2203.7 | 2143.1 |
| Delta WS (m) | 0.29 | Top Width (m) | 29.75 | 28.80 |
| BR Open Area (m2) | 2167.70 | Frctn Loss (m) | 0.13 | 0.01 |
| BR Open Vel (m/s) | 2.74 | C & E Loss (m) | 0.01 | 0.07 |
| Coef of Q | | Shear Total (N/m2) | 174.00 | 182.03 |
| Br Sel Method | Energy only | Power Total (N/m s) | 461.08 | 498.73 |

Plan: Proposed Westbound Weber Creek 1 RS: 72.57 Profile: Q100

| | | | | |
|---|---|---|---|---|
| E.G. US. (m) | 470.81 | Element | Inside BR US | Inside BR DS |
| W.S. US. (m) | 470.35 | E.G. Elev (m) | 470.74 | 472.10 |
| Q Total (m3/s) | 209.00 | W.S. Elev (m) | 469.59 | 471.02 |
| Q Bridge (m3/s) | 209.00 | Crit W.S. (m) | 469.59 | 471.02 |
| Q Weir (m3/s) | | Max Chl Dpth (m) | 4.59 | 3.71 |
| Weir Sta Lft (m) | | Vel Total (m/s) | 3.60 | 4.02 |
| Weir Sta Rgt (m) | | Flow Area (m2) | 57.99 | 51.96 |
| Weir Submerg | | Froude # Chl | 0.86 | 1.00 |
| Weir Max Depth (m) | | Specif Force (m3) | 180.39 | 166.96 |
| Min El Weir Flow (m) | 505.04 | Hydr Depth (m) | 2.24 | 2.30 |
| Min El Prs (m) | 504.46 | W.P. Total (m) | 33.20 | 27.16 |
| Delta EG (m) | -1.14 | Conv. Total (m3/s) | 1882.2 | 1379.6 |
| Delta WS (m) | 0.21 | Top Width (m) | 25.85 | 22.55 |
| BR Open Area (m2) | 2151.54 | Frctn Loss (m) | | 0.24 |
| BR Open Vel (m/s) | 4.02 | C & E Loss (m) | | 0.02 |
| Coef of Q | | Shear Total (N/m2) | 211.16 | 430.57 |
| Br Sel Method | Energy only | Power Total (N/m s) | 761.05 | 1731.80 |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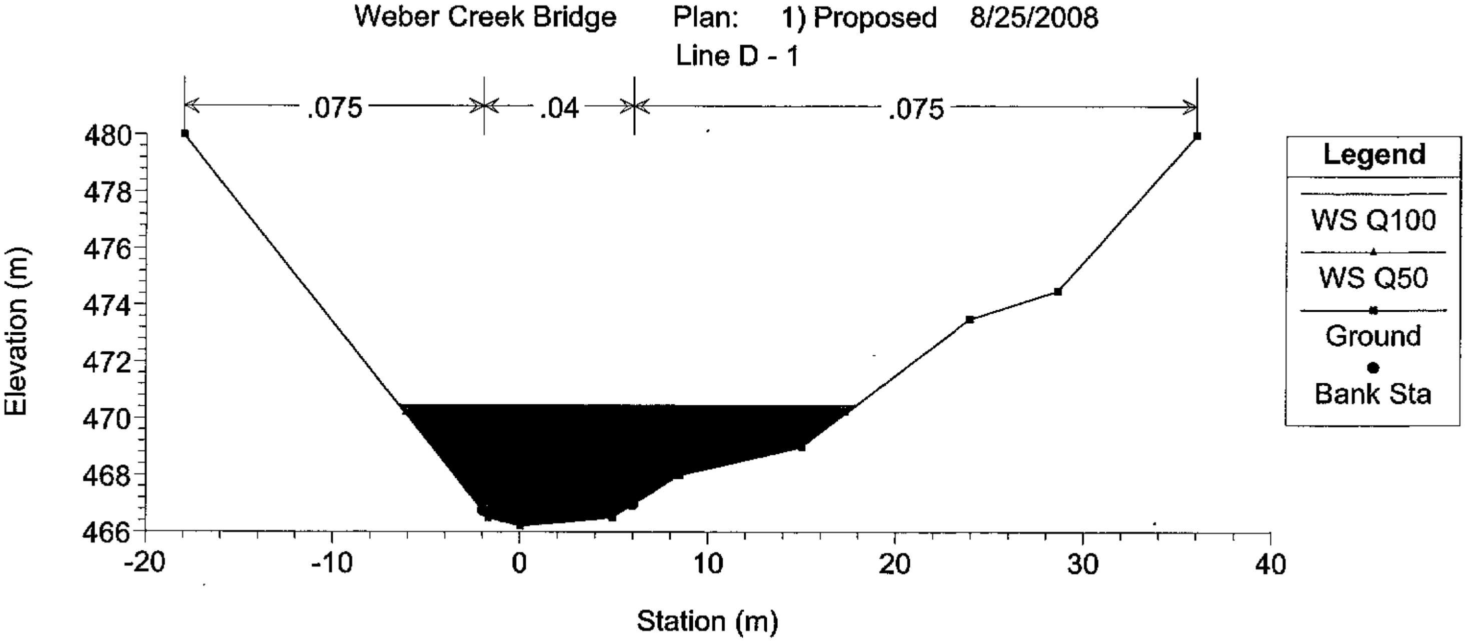
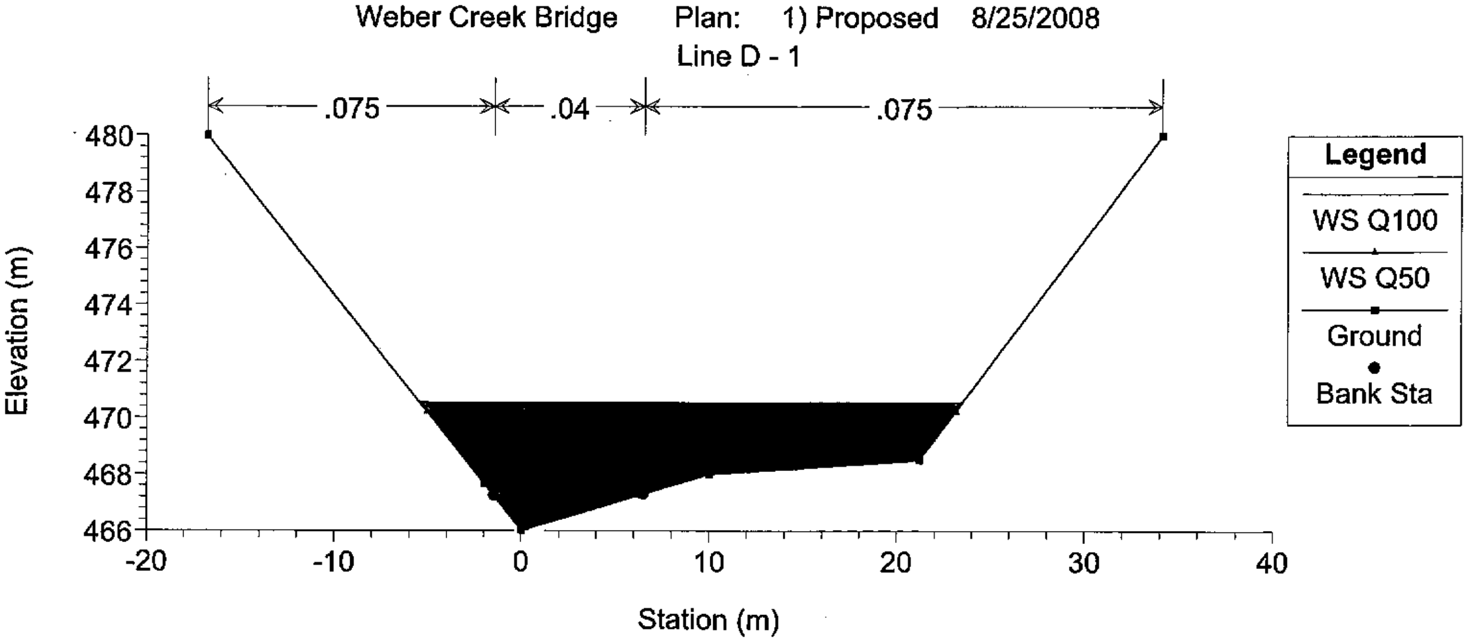
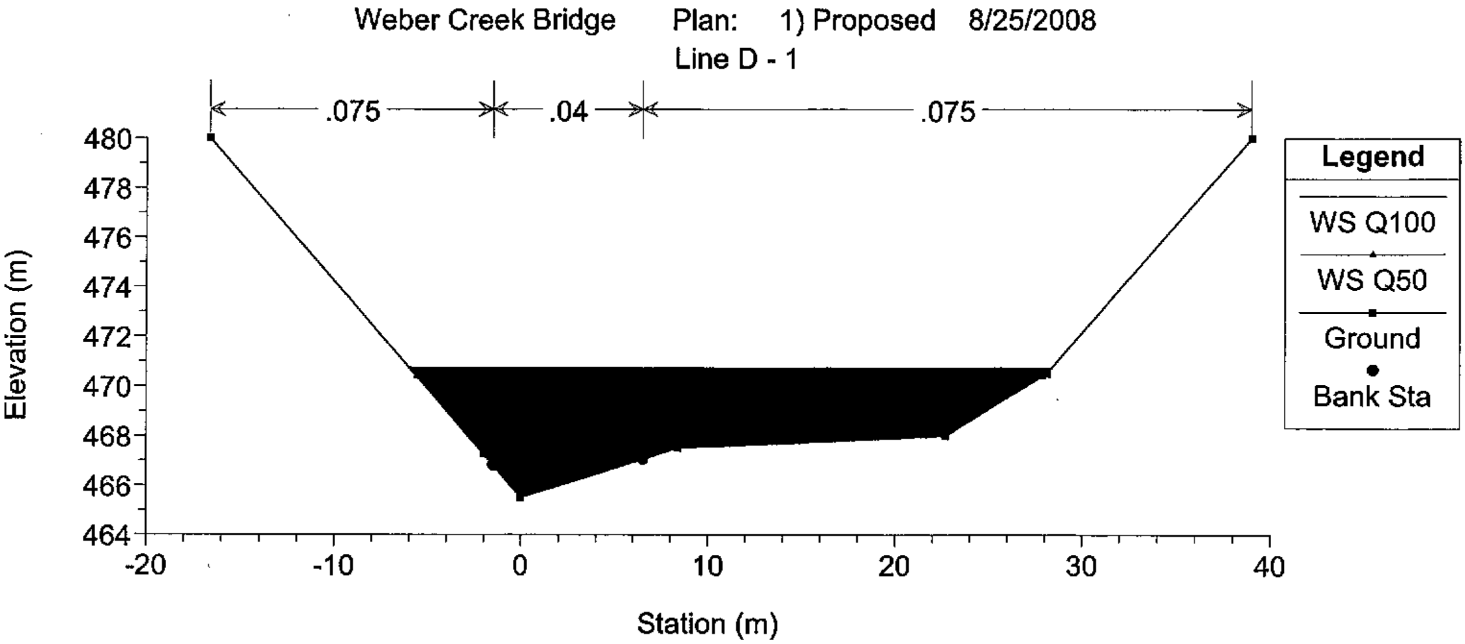
Line D - 1
.075
.04
.075
Elevation (m)
480
478
476
474
472
470
468
466
-30
-20
-10
0
10
20
30
40
50
Station (m)
Legend
WS Q100
WS Q50
Ground
Bank Sta


Weber Creek Bridge Plan: 1) Proposed 8/25/2008
Line D - 1
.075
.04
.075
Elevation (m)
480
478
476
474
472
470
468
466
-20
-10
0
10
20
30
40
Station (m)
Legend
WS Q100
WS Q50
Ground
Bank Sta


Weber Creek Bridge Plan: 1) Proposed 8/25/2008
Line D - 1
.075
.04
.075
Elevation (m)
480
478
476
474
472
470
468
466
-20
-10
0
10
20
30
40
Station (m)
Legend
WS Q100
WS Q50
Ground
Bank Sta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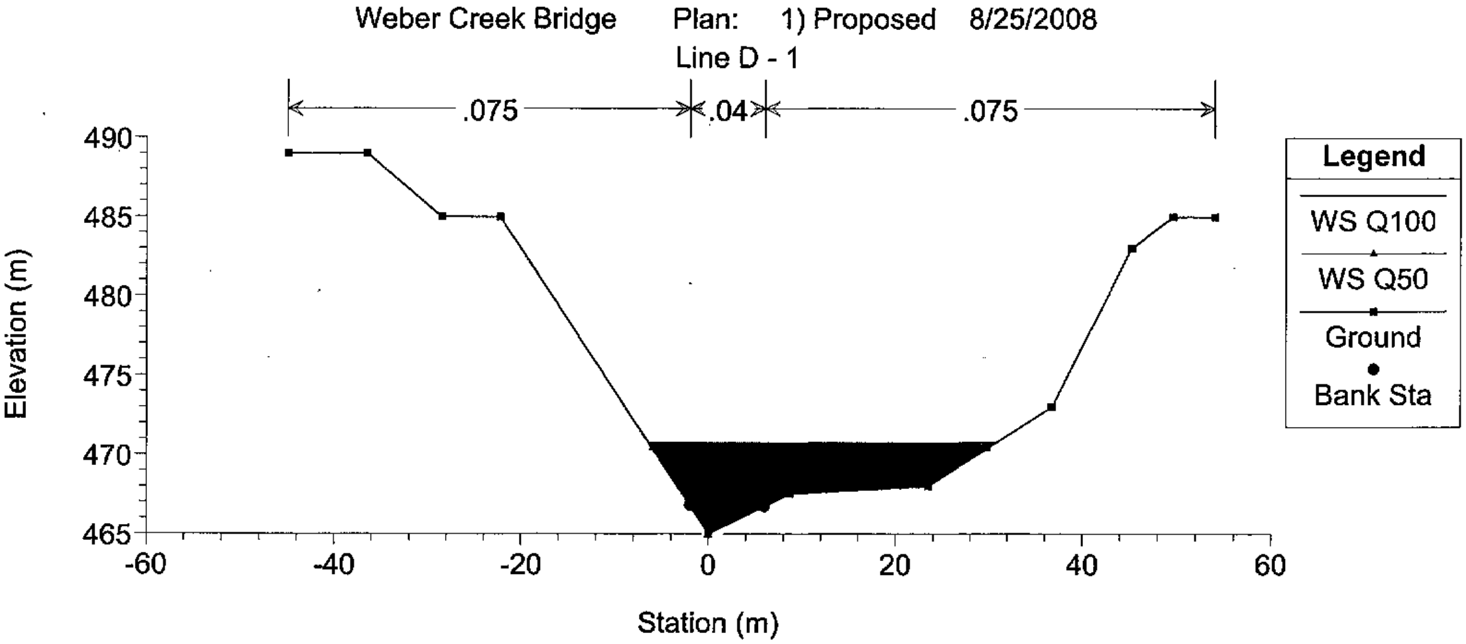
Line D - 1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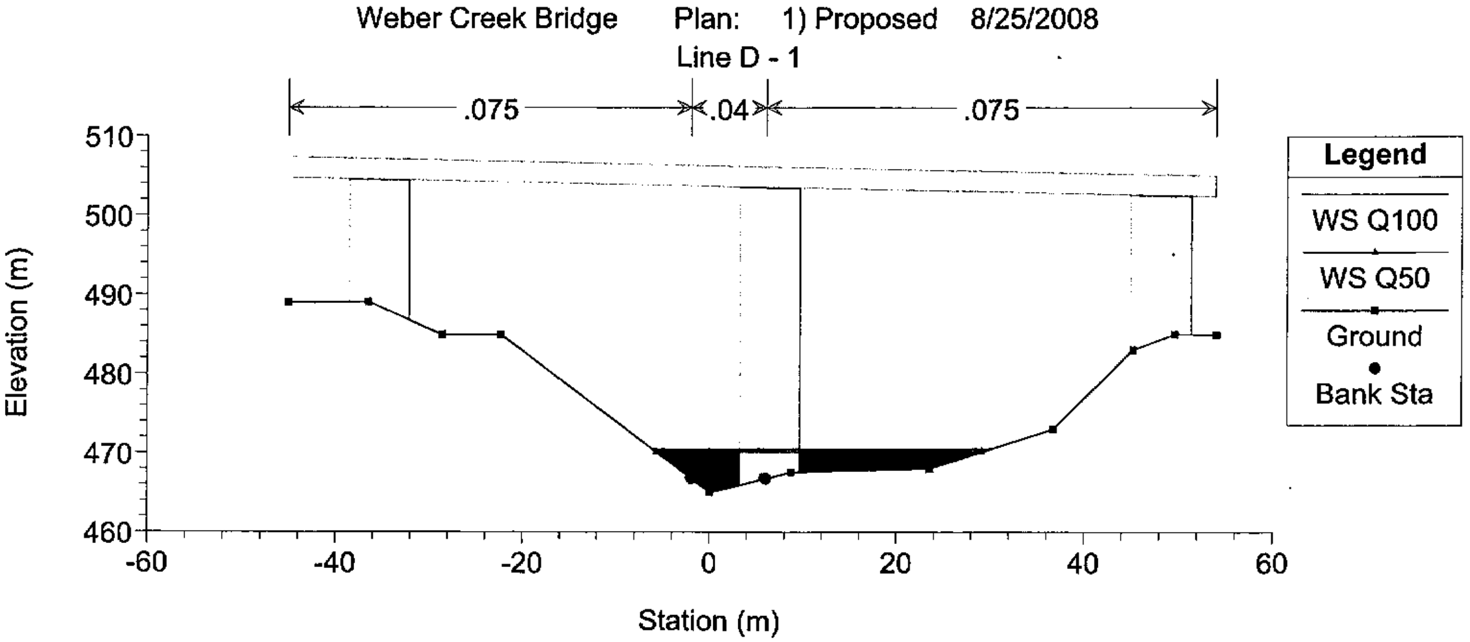
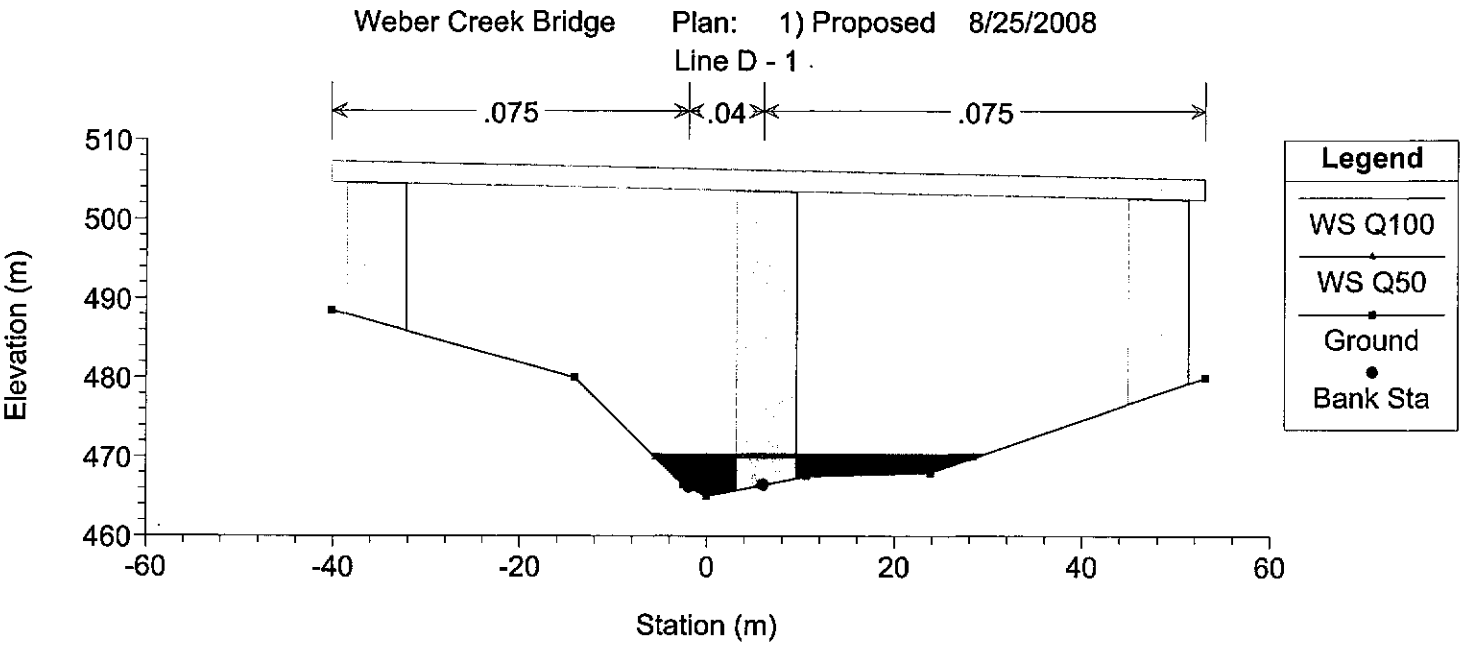
Line D - 1


Weber Creek Bridge Plan: 1) Proposed 8/25/2008
Line D - 1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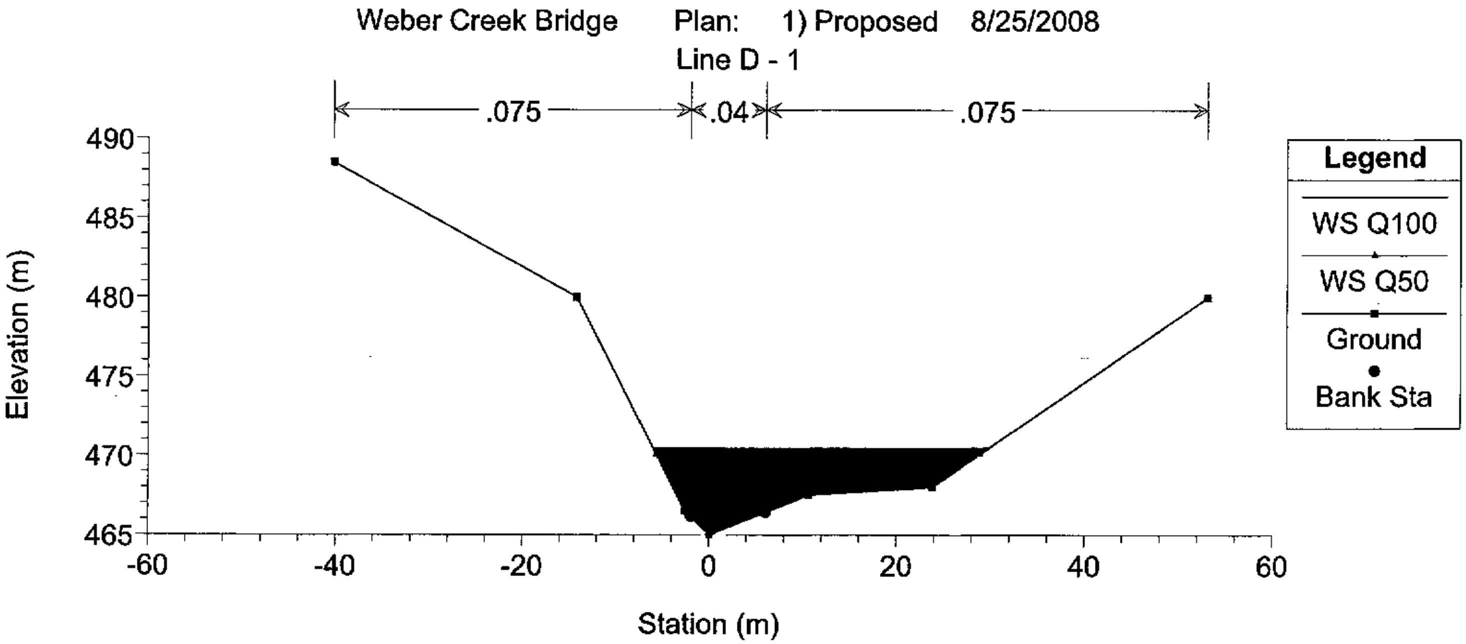
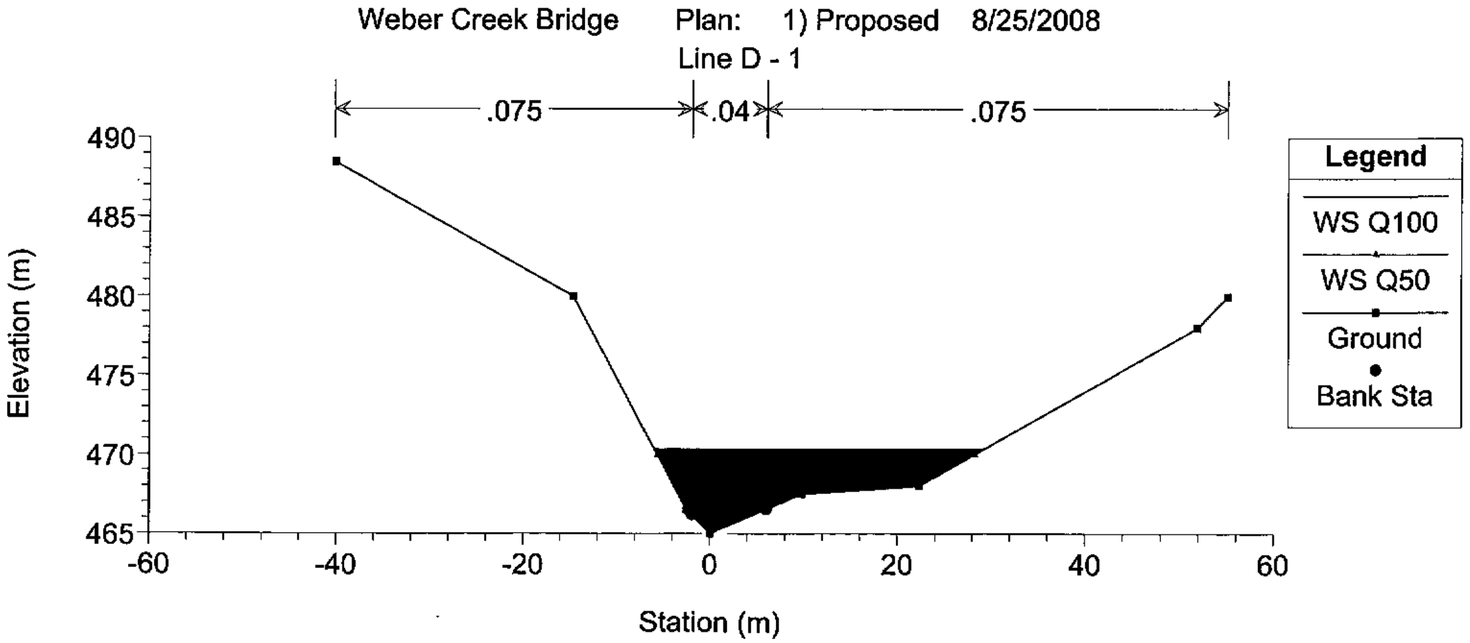
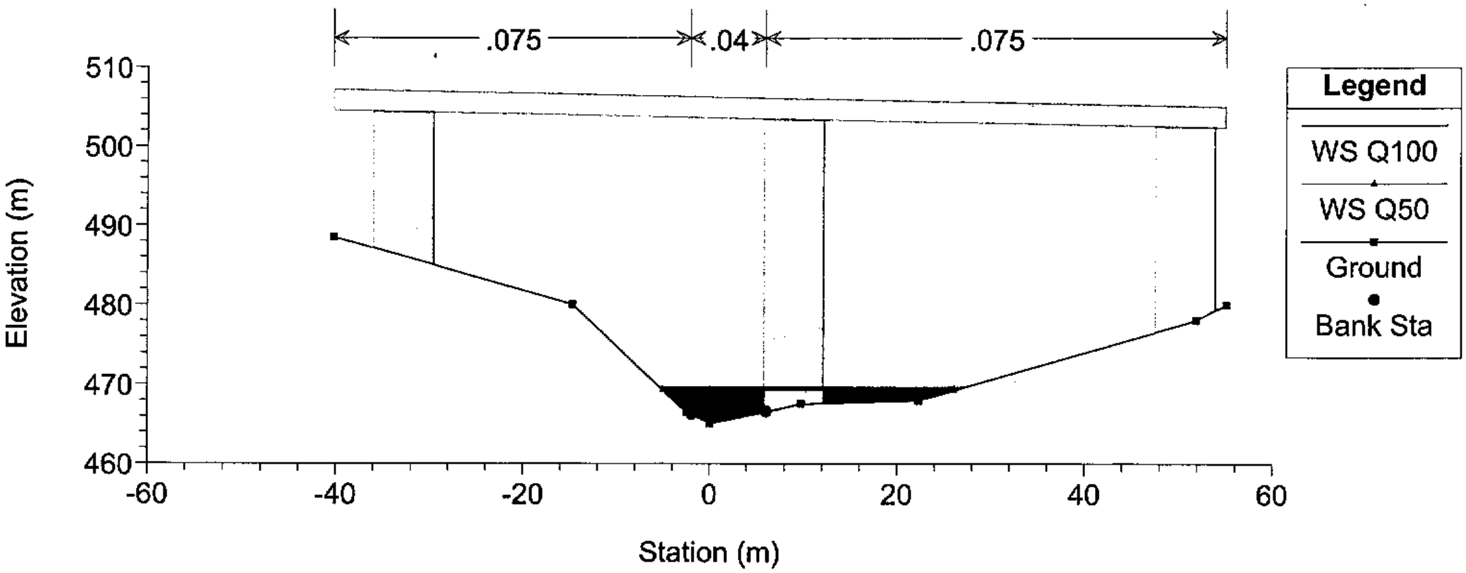
Line D - 1
.075
.04
.075
Elevation (m)
510
500
490
480
470
460
-60
-40
-20
0
20
40
60
Station (m)
Legend
WS Q100
WS Q50
Ground
Bank Sta

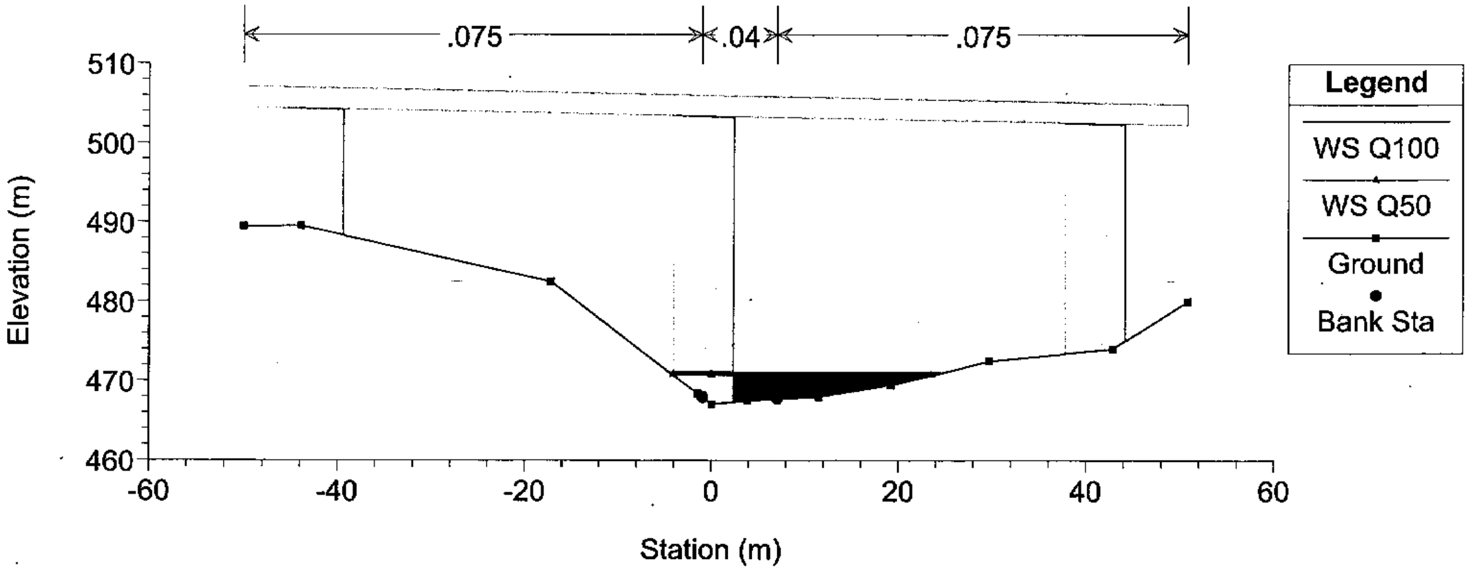

Weber Creek Bridge Plan: 1) Proposed 8/25/2008
Line D - 1
.075
.04
.075
Elevation (m)
490
485
480
475
470
465
-60
-40
-20
0
20
40
60
Station (m)
Legend
WS Q100
WS Q50
Ground
Bank Sta


Weber Creek Bridge Plan: 1) Proposed 8/25/2008
Line D - 1
.075
.04
.075
Elevation (m)
490
485
480
475
470
465
-60
-40
-20
0
20
40
60
Station (m)
Legend
WS Q100
WS Q50
Ground
Bank Sta



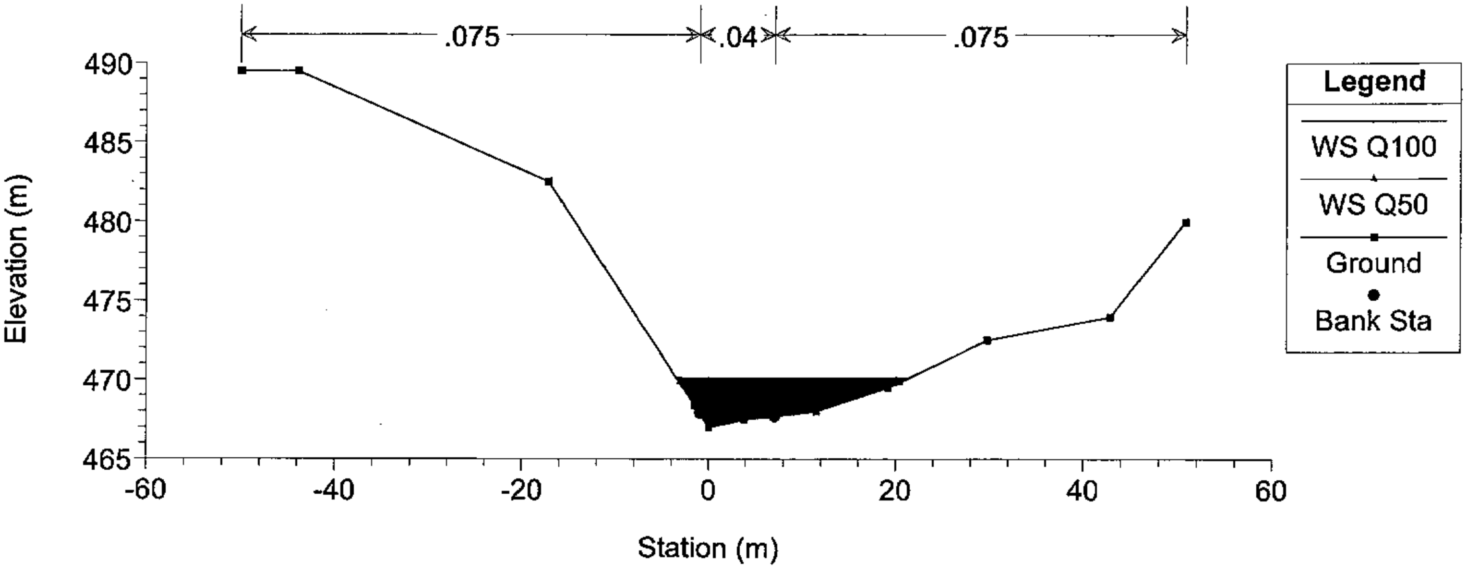
Weber Creek Bridge Plan: 1) Proposed 8/25/2008

Line D - 1



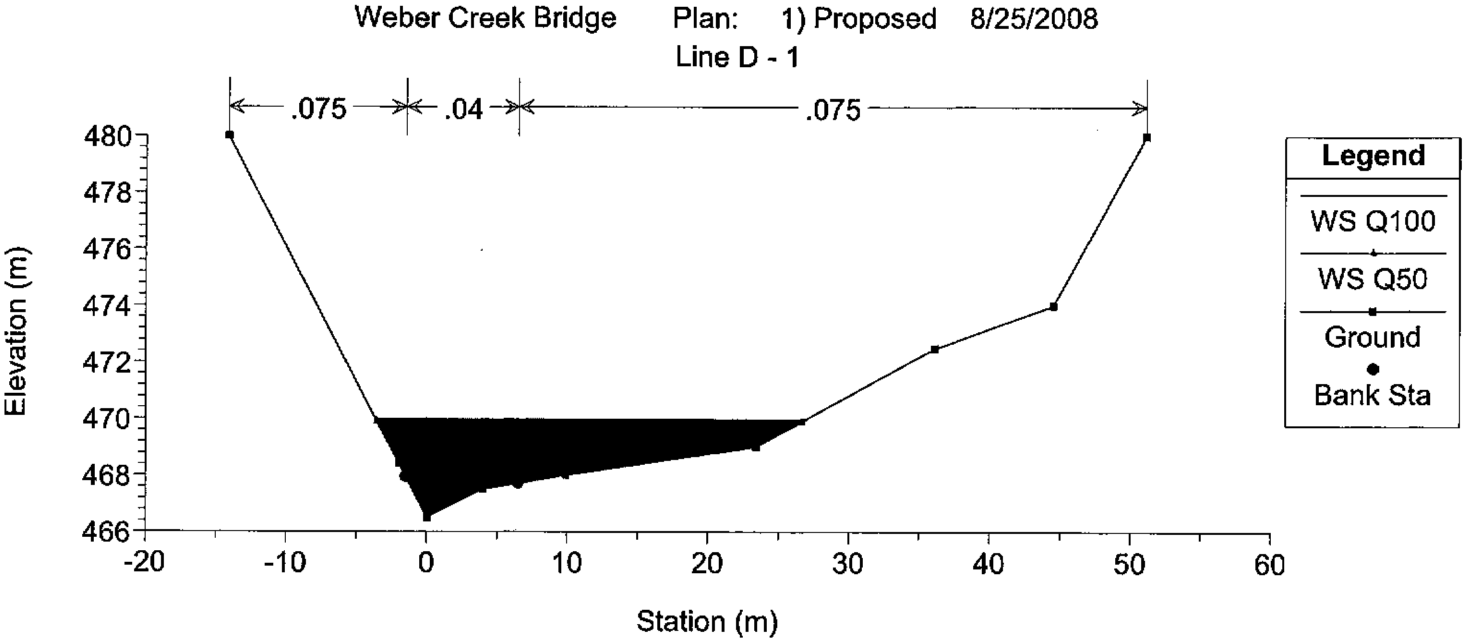
Weber Creek Bridge Plan: 1) Proposed 8/25/2008

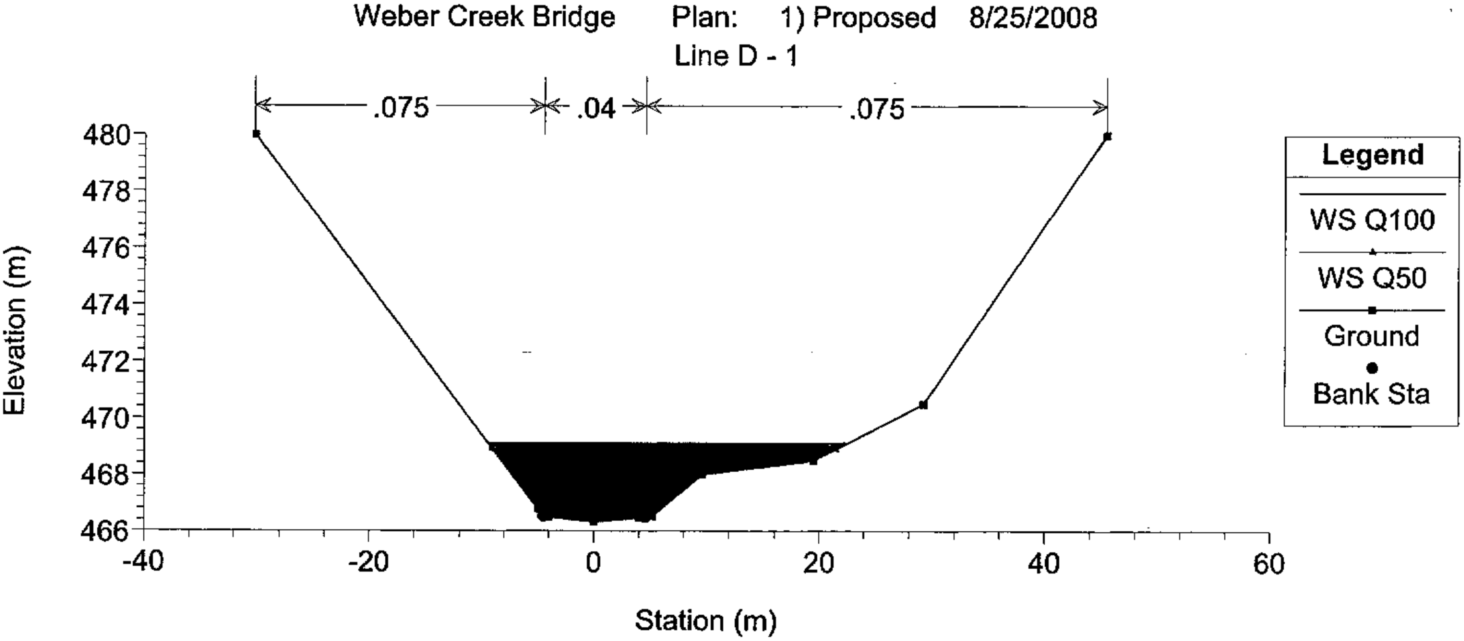
Line D - 1

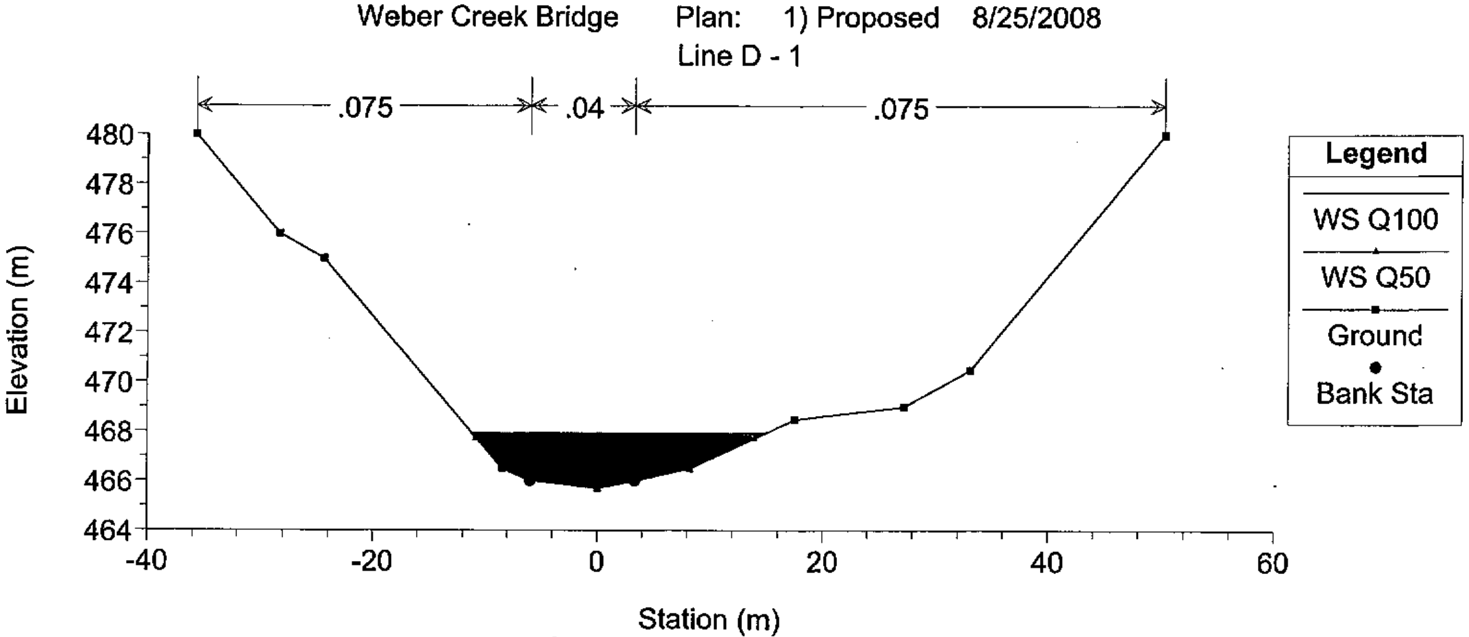


Weber Creek Bridge Plan: 1) Proposed 8/25/2008

Line D - 1


Weber Creek Bridge Plan: 1) Proposed 8/25/2008
Line D - 1


Weber Creek Bridge Plan: 1) Proposed 8/25/2008
Line D - 1


Weber Creek Bridge Plan: 1) Proposed 8/25/2008
Line D - 1

# APPENDIX C

## Scour Analysis Calculations

## ***HEC-RAS Scour Output***

Hydraulic Design Data – Pier 3R
Contraction Scour

| | Left | Channel | Right |
|---|---|---|---|
| Input Data | | | |
| Average Depth (m): | 1.95 | 4.46 | 2.60 |
| Approach Velocity (m/s): | 0.94 | 3.49 | 1.34 |
| Br Average Depth (m): | 1.85 | 4.86 | 2.25 |
| BR Opening Flow (m3/s): | 11.93 | 107.04 | 90.02 |
| BR Top WD (m): | 4.12 | 5.20 | 20.44 |
| Grain Size D50 (mm): | 0.80 | 0.80 | 0.80 |
| Approach Flow (m3/s): | 8.16 | 124.56 | 76.28 |
| Approach Top WD (m): | 4.47 | 8.00 | 21.84 |
| K1 Coefficient: | 0.690 | 0.690 | 0.690 |
| Results | | | |
| Scour Depth Ys (m): | 1.01 | 0.41 | 0.89 |
| Critical Velocity (m/s): | 0.64 | 0.74 | 0.67 |
| Equation: | Live | Live | Live |

Pier Scour
All piers have the same scour depth

| | |
|---|---|
| Input Data | |
| Pier Shape: | Round nose |
| Pier Width (m): | 6.45 |
| Grain Size D50 (mm): | 0.80000 |
| Depth Upstream (m): | 5.67 |
| Velocity Upstream (m/s): | 3.71 |
| K1 Nose Shape: | 1.00 |
| Pier Angle: | 10.00 |
| Pier Length (m): | 14.40 |
| K2 Angle Coef: | 1.33 |
| K3 Bed Cond Coef : | 1.10 |
| Grain Size D90 (mm): | 2.00000 |
| K4 Armouring Coef: | 1.00 |
| Set K1 value to 1.0 because angle > 5 degrees | |
| Results | |
| Scour Depth Ys (m): | 13.35 |
| Froude #: | 0.50 |
| Equation: | CSU equation |

Combined Scour Depths

Pier Scour + Contraction Scour (m):

| | |
|---|---|
| Left Bank: | 14.36 |
| Right Bank: | 14.24 |

Hydraulic Design Data – Pier 3L

Contraction Scour

| | Left | Channel | Right |
|---|---|---|---|
| Input Data | | | |
| Average Depth (m): | 2.29 | 4.77 | 2.48 |
| Approach Velocity (m/s): | 0.89 | 3.41 | 1.20 |
| Br Average Depth (m): | 1.80 | 3.89 | 1.48 |
| BR Opening Flow (m3/s): | 10.21 | 160.72 | 38.07 |
| BR Top WD (m): 3.29 | 7.78 | 14.78 | |
| Grain Size D50 (mm): | 0.80 | 0.80 | 0.80 |
| Approach Flow (m3/s): | 8.19 | 130.12 | 70.70 |
| Approach Top WD (m): | 3.99 | 8.00 | 23.77 |
| K1 Coefficient: | 0.690 | 0.690 | 0.690 |
| Results | | | |
| Scour Depth Ys (m): | 1.36 | 1.94 | 0.55 |
| Critical Velocity (m/s): | 0.66 | 0.74 | 0.67 |
| Equation: | Live | Live | Live |

Pier Scour

All piers have the same scour depth

| | |
|---|---|
| Input Data | |
| Pier Shape: | Round nose |
| Pier Width (m): | 6.45 |
| Grain Size D50 (mm): | 0.80000 |
| Depth Upstream (m): | 5.30 |
| Velocity Upstream (m/s): | 4.04 |
| K1 Nose Shape: | 1.00 |
| Pier Angle: | 10.00 |
| Pier Length (m): | 14.40 |
| K2 Angle Coef: | 1.33 |
| K3 Bed Cond Coef: | 1.10 |
| Grain Size D90 (mm): | 2.00000 |
| K4 Armouring Coef: | 1.00 |

Set K1 value to 1.0 because angle > 5 degrees

| | |
|---|---|
| Results | |
| Scour Depth Ys (m): | 13.73 |
| Froude #: | 0.56 |
| Equation: | CSU equation |

Combined Scour Depths

Pier Scour + Contraction Scour (m):

| | |
|---|---|
| Left Bank: | 15.09 |
| Right Bank: | 14.28 |

***<u>Local Pier Scour</u>*** – To determine pier scour, an equation based on the CSU equation is recommended within the HEC-18 manual for both live-bed and clear-water scour. The equation predicts maximum pier scour depths. The equation is:

$$\frac{Y_s}{Y_1} = 2.0\, K_1 K_2 K_3 K_4 \left(\frac{a}{Y_1}\right)^{0.65} Fr^{0.43}$$

where: $Y_s$ = Scour depth, m
$Y_1$ = Flow depth directly upstream of the pier, m
$K_1$ = Coefficient factor for pier nose shape (from HEC-18)
$K_2$ = Coefficient factor for angle of attack of flow (from HEC-18)
$K_3$ = Correction factor for bed condition (from HEC-18)
$K_4$ = Correction factor for armoring by bed material size (from HEC-18)
$a$ = Pier width, m
$V_1$ = Mean velocity of flow directly upstream of the pier
$Fr$ = Froude number directly upstream of the pier= $V_1/(gY_1)^{0.5}$

After using HEC-RAS to analyze the flow at the proposed US 50 Route Bridges over Weber Creek, the factors in the above equation were determined to be:

***Four -Span Replacement***

**Pier 3R**

$Y_1$ = 5.67 m (from HEC-RAS)
$K_1$ = 1.0 (for round nose pier shape) (from HEC-18)
$K_2$ = 1.33 (for angle of attack = 10 degrees) (from HEC-RAS)
$K_3$ = 1.1 (for clear-water scour) (from HEC-18)
$K_4$ = 1.0 (from HEC-18)
$a$ = 6.45 m
$Fr_1$ = 0.50 (from HEC-RAS)

The Pier scour, calculated using the CSU equation is:

$$\frac{Y_s}{5.67} = 2.0(1.0)(1.33)(1.1)(1.0)\left(\frac{6.45}{5.67}\right)^{0.65}(0.50)^{0.43}$$

$$\mathbf{Y_s = 13.35\ ft}$$

**Pier 3L**

$Y_1$ = 5.30 m (from HEC-RAS)
$K_1$ = 1.0 (for round nose pier shape) (from HEC-18)
$K_2$ = 1.33 (for angle of attack = 10 degrees) (from HEC-RAS)
$K_3$ = 1.1 (for clear-water scour) (from HEC-18)
$K_4$ = 1.0 (from HEC-18)
$a$ = 6.45 m
$Fr_1$ = 0.56 (from HEC-RAS)

The Pier scour, calculated using the CSU equation is:

$$\frac{Y_s}{5.30} = 2.0(1.0)(1.33)(1.1)(1.0)\left(\frac{6.45}{5.30}\right)^{0.65}(0.56)^{0.43}$$

$$\mathbf{Y_s = 13.73\ m}$$

***Clear-Water Contraction Scour*** - Contraction scour typically occurs where the bridges opening is smaller than the flow area of the upstream channel and/or flood plain. Clear-Water contraction scour occurs when there is little or no transport of bed material. Also use a Clear-Water Contraction Scour Equation if transported material is mostly suspended and will be washed through the contracted section reach. The Laursen's Clear-Water Contraction Scour Equation can be used:

$$y_2 = \left(\frac{K_U Q^2}{D_m^{2/3} W^2}\right)^{3/7}$$

where: $Y_2$ = Average equilibrium depth in the contracted section (after scour)
$D_m$ = $1.25xD_{50}$
$Q_1$ = Flow in the upstream channel transporting sediment
$Q$ = Flow in the contracted channel
$W$ = Bottom width of the contracted section (minus pier widths)
$K_U$ = Exponent: 0.025 SI units, 0.0077 English Units (from HEC-18)

***Live-Bed Contraction Scour*** - Contraction scour typically occurs where the bridges opening is smaller than the flow area of the upstream channel and/or flood plain. Live-bed contraction scour occurs when there is transport of bed material in the upstream reach into the bridges cross section. With live bed contraction scour, the area of the contracted section increases until, in the limit, the transport of sediment out of the contracted section equals the sediment transported in. The modified Laursen's Live-Bed Contraction Scour Equation can be used:

$$\frac{Y_2}{Y_1} = \left(\frac{Q_2}{Q_1}\right)^{6/7}\left(\frac{W_1}{W_2}\right)^{k_1}$$

$$Y_s = Y_2 - Y_o$$

where: $Y_2$ = Average depth in the contracted section (after scour)
$Y_1$ = Average depth in the upstream main channel
$Y_o$ = Existing depth in the contracted section
$Q_1$ = Flow in the upstream channel transporting sediment
$Q_2$ = Flow in the contracted channel
$W_1$ = Bottom width of the upstream main channel
$W_2$ = Bottom width of the contracted section (minus pier widths)

The critical velocity equation is applied to determine whether Clear Water Contraction Scour or Live Bed Contraction Scour is occurring. If the flow velocity at the site is greater than the critical velocity, based on the average particle size present at the site, then the Live Bed Contraction Scour equation is used to determine scour.

$$V_C = K_U y^{1/6} D^{1/3}$$

where: $V_C$ = Critical velocity above which bed material of size D and smaller will be transported, m/s (ft/s)

$y$ = Average depth of flow upstream of the bridges, m (from HEC-RAS)

$D$ = Particle size for $V_C$, m

$K_U$ = Exponent: 6.19 (from HEC-18)

***Four-Span Replacement***

**Pier 3R**

$y$ = 4.46 m (from HEC-RAS)

D = 0.0008 m

The Critical velocity is:

$$V_C = 6.19(4.46)^{1/6}(0.0008)^{1/3}$$

$$\mathbf{V_C = 0.74\ m/s}$$

After using HEC-RAS to analyze the flow at Pier 3R, it is determined that Live-Bed Contraction Scour is occurring. The factors for Laursen's Live-Bed Contraction Scour Equation were determined to be:

$Y_o$ = 4.86 m

$Y_1$ = 4.46 m

$Q_1$ = 124.56 m$^3$/s

$Q_2$ = 107.04 m$^3$/s

$W_1$ = 8.00 m

$W_2$ = 5.20 m

$K_1$ = 0.69

The live-bed contraction scour calculated using Laursen's Equation is:

$$\frac{Y_2}{4.46} = \left(\frac{107.04}{124.56}\right)^{6/7}\left(\frac{8.00}{5.20}\right)^{0.69}$$

$$Y_2 = 5.27\ m$$

$$Y_S = (5.27 - 4.86)\ m$$

$$\mathbf{Y_S = 0.41\ m}$$

**Pier 3L**

$y$ = 4.77 m (from HEC-RAS)
D = 0.0008 m

The Critical velocity is:

$$V_C = 6.19(4.77)^{1/6}(0.0008)^{1/3}$$

$$\mathbf{V_C = 0.74\ m/s}$$

After using HEC-RAS to analyze the flow at Pier 3R, it is determined that Live-Bed Contraction Scour is occurring. The factors for Laursen's Live-Bed Contraction Scour Equation were determined to be:

$Y_o$ = 3.89 m
$Y_1$ = 4.77 m
$Q_1$ = 130.12 $m^3/s$
$Q_2$ = 160.72 $m^3/s$
$W_1$ = 8.00 m
$W_2$ = 7.78 m
$K_1$ = 0.69

The live-bed contraction scour calculated using Laursen's Equation is:

$$\frac{Y_2}{4.77} = \left(\frac{160.72}{130.12}\right)^{6/7}\left(\frac{8.00}{7.78}\right)^{0.69}$$

$$Y_2 = 5.83\ m$$

$$Y_S = (5.83 - 3.89)\ m$$

$$\mathbf{Y_S = 1.94\ m}$$

***Long Term Bed Elevation Change*** (long-term scour) – Long-term bed elevation change is the trend of a reach of stream bed to degrade or aggrade. The purpose of the evaluation is to estimate the changes that will occur during the life of the structure. A long-term trend may change during the life of the bridges. These long-term changes are the result of modifications to the stream or watershed. Such changes may be a result of natural processes or human activities. The equation for evaluating long-term bed change is:

$$\Delta = \frac{E_1 - E_2}{A_1 - A_2}$$

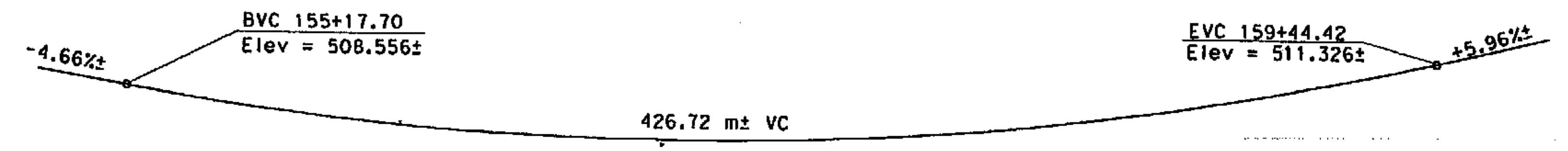
where: $\Delta$ = long-term bed elevation change per year (ft/yr)
$E_1$ = bed elevation in year *x (ft)*

$E_2$ = bed elevation in year $y$ *(ft)*
$A_1$ = year $x$
$A_2$ = year $y$

Field observations by Quincy Engineerin, Inc. did not indicate severe creek bed degradation. The long-term bed elevation change is assumed to be negligible.

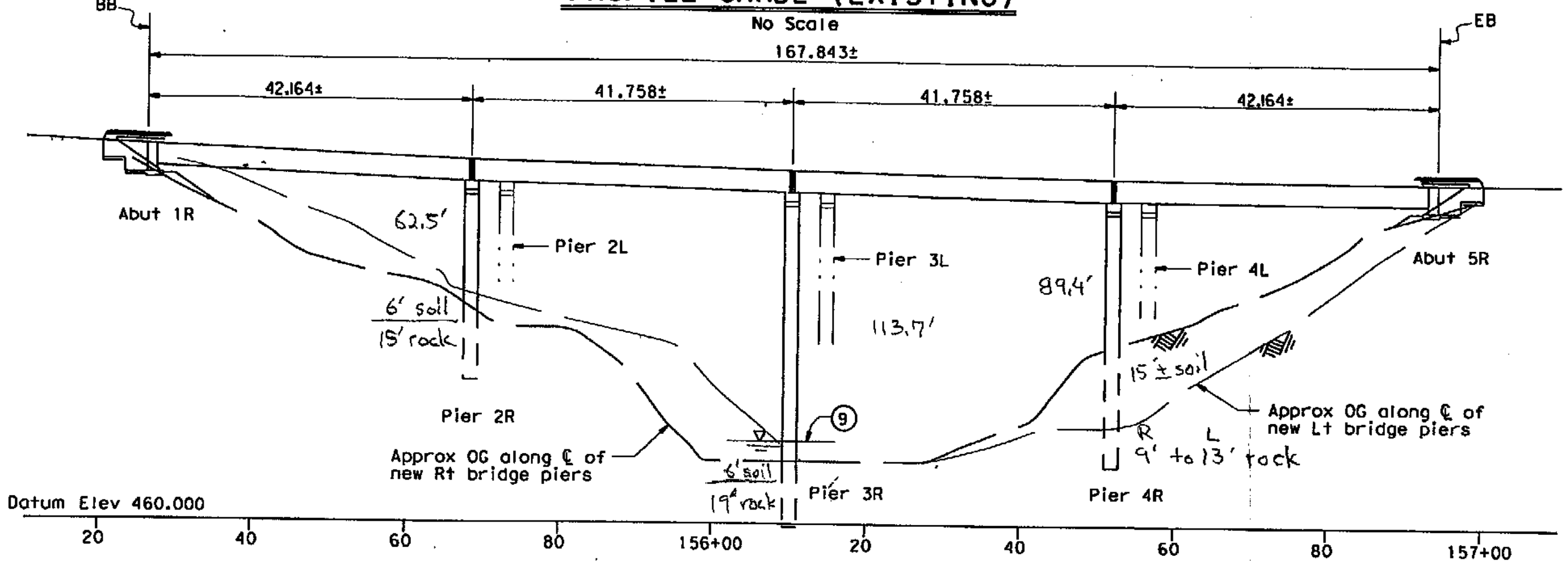
# APPENDIX D

## Draft Bridge Plans



## PROFILE GRADE (EXISTING)

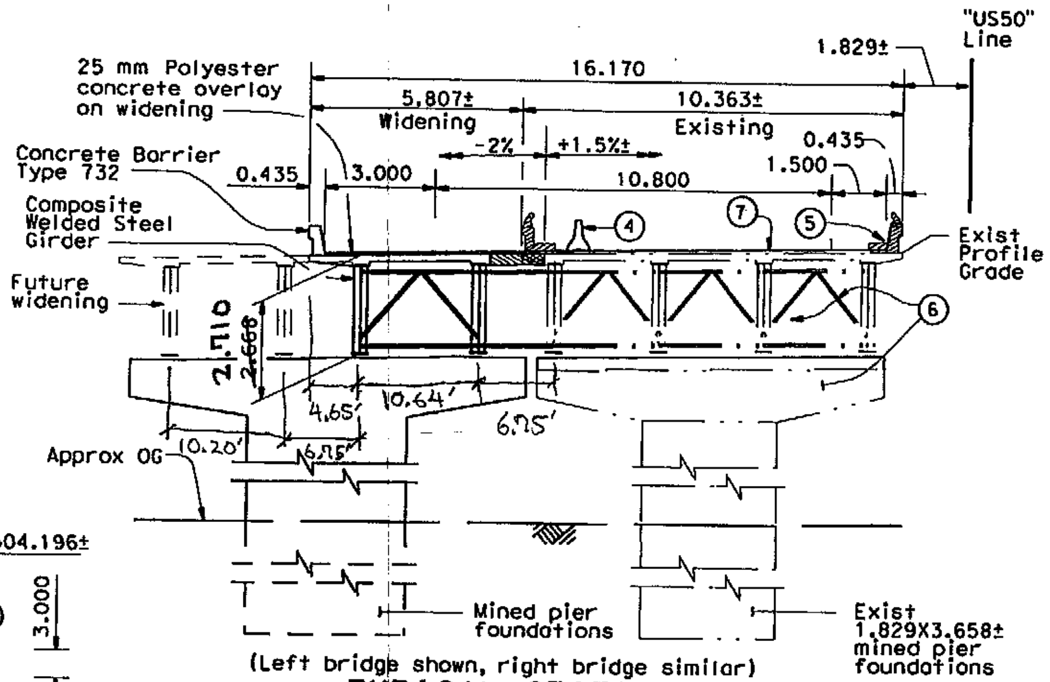
No Scale



(Right bridge shown, left bridge similar)

## ELEVATION

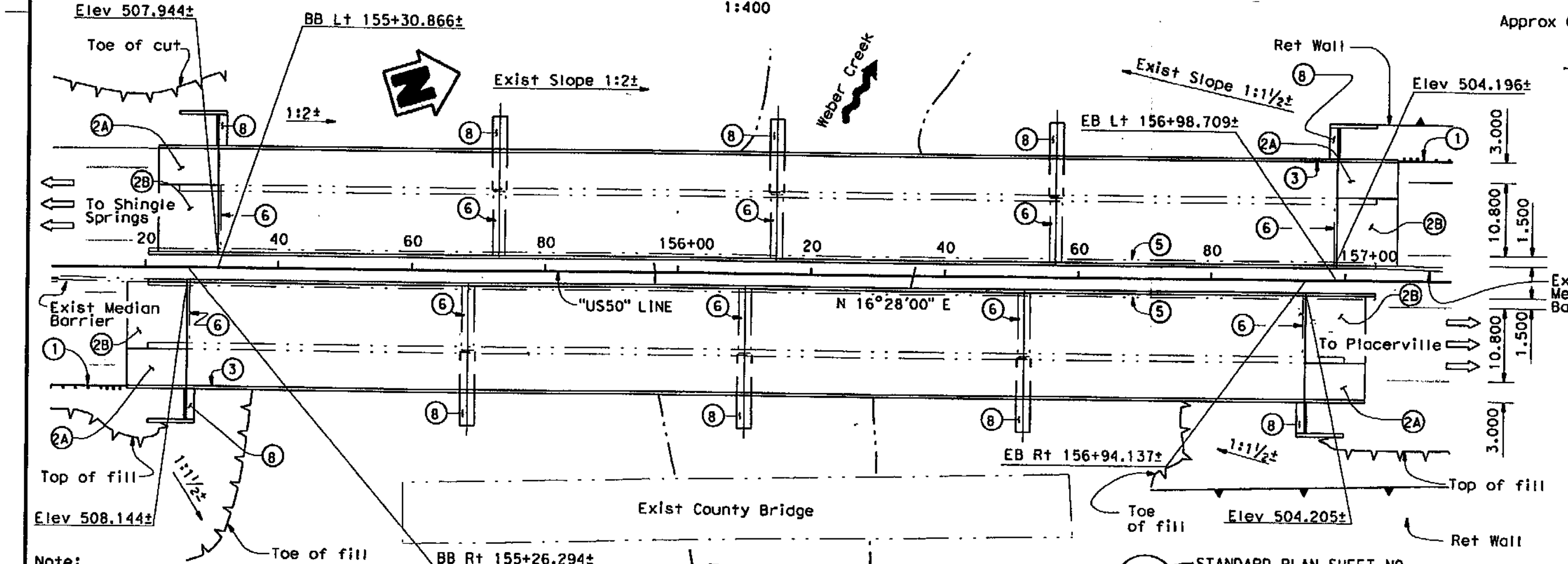
1:400



(Left bridge shown, right bridge similar)

## TYPICAL SECTION

1:100



## PLAN

1:400

Note:
The Contractor shall verify all controlling field dimensions before ordering or fabricating any material.

STANDARD PLAN SHEET NO.

DETAIL NO.

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

Notes:

① MBGR, "See Road Plans"
(2A) Structure Approach Type N (9S)
(2B) Structure Approach Type R (9S)
③ Paint Bridge Name and Number
④ Temporary Railing Type K, see "Phase 1 - Stage Construction"
⑤ Replace existing Type 2 Barrier with Concrete Barrier Type 732
⑥ Seismic Retrofit: Existing bent caps, cross frames, and abutments
⑦ Existing 3"AC overlay to be removed, 25 mm polyester concrete overlay rehab existing deck
⑧ Abutments and piers to be constructed for future ultimate width
⑨ For Hydrologic Summary, see "Index to Bridge Plans" sheet

— Indicates existing structure
▨ Indicates Bridge Removal (Portion)
▨ Indicates Closure Pour

MQ to
Ask Alan whether we want this on sheets.

| DIST | COUNTY | ROUTE | KILOMETER POST TOTAL PROJECT | SHEET No | TOTAL SHEETS |
|---|---|---|---|---|---|
| 03 | ED | 50 | 23.2/25.4 | | |

REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

Mario Quest
No. C41055
Exp. 3-31-07
CIVIL

Quincy Engineering, Inc.
3247 Ramos Circle
Sacramento, CA 95827

El Dorado County
2850 Fairlane Court
Placerville, CA 95667

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DESIGN OVERSIGHT | DESIGN | BY U. QUEST | CHECKED | LOAD FACTOR DESIGN | LIVE LOADING: HS20-44 AND ALTERNATIVE AND PERMIT DESIGN LOAD | | | | |
| | DETAILS | BY | CHECKED | LAYOUT | BY M. Quest | CHECKED | | | |
| SIGN OFF DATE | QUANTITIES | BY | CHECKED | SPECIFICATIONS | BY | PLANS AND SPECS COMPARED | | | |

DESIGN GENERAL PLAN SHEET (METRIC) (REV.3/1/99)

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 10 20 30 40 50 60 70 80 90 100

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

Mario Quest
PROJECT ENGINEER
Ask Alan

CU 03198
EA 370001 376001

BRIDGE NO.
25-05R/L
KILOMETER POST
25.2(R15.7)

PHASE 1

# WEBER CREEK BRIDGE (WIDEN)

# GENERAL PLAN

DISREGARD PRINTS BEARING EARLIER REVISION DATES

| REVISION DATES (PRELIMINARY STAGE ONLY) | | | SHEET | OF |
|---|---|---|---|---|
| 5/31/05 | 10/28/05 | | | |

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| DIST | COUNTY | ROUTE | KILOMETER POST TOTAL PROJECT | SHEET No | TOTAL |
|---|---|---|---|---|---|
| 03 | ED | 50 | 23.2/25.4 | | |

## 65% SUBMITTAL

REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

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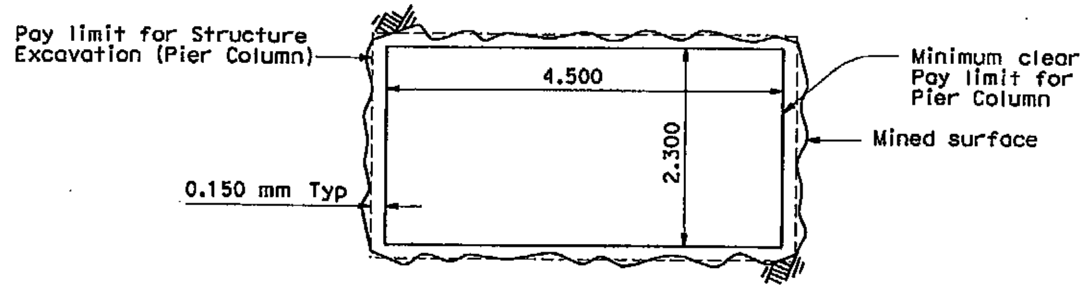
REGISTERED PROFESSIONAL ENGINEER
Mario Quest
No. C41055
Exp. 3-31-09
CIVIL
STATE OF CALIFORNIA

Caltrans Metric

Quincy Engineering, Inc.
3247 Ramos Circle
Sacramento, CA 95827

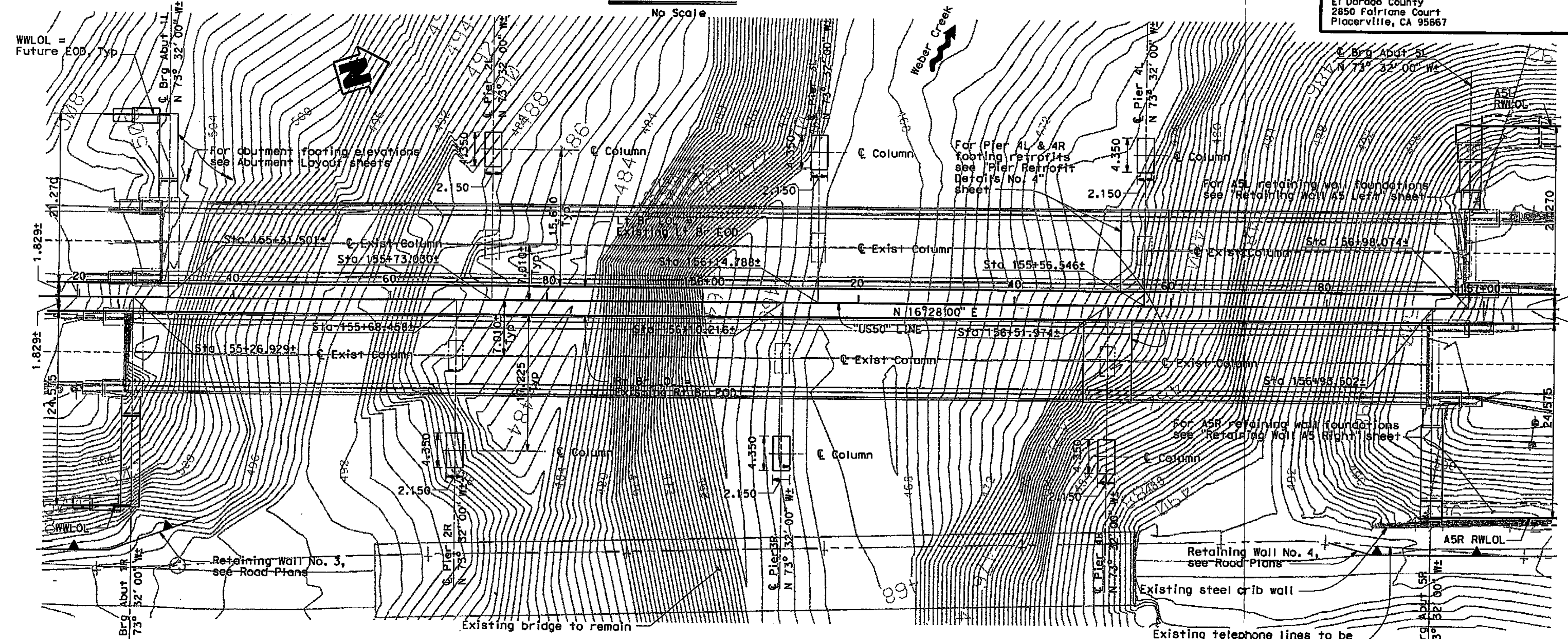
El Dorado County
2850 Fairlane Court
Placerville, CA 95667



Note: For location of Section C-C, see "Pier Details No. 1" sheet.

### SECTION C-C

No Scale



### PLAN

1:250

### BENCH MARK DATA

| No. | NORTHING | EASTING | ELEVATION | LINE | STATION | OFFSET | DESCRIPTION |
|---|---|---|---|---|---|---|---|
| PH13 | 617776.6815 | 2101425.9371 | 531.91 | US50 | 162+14.289 | 50.803 Lt | - |
| HV19 | 617418.4610 | 2101339.5830 | 510.24 | US50 | 158+53.081 | 92.109 Rt | - |
| WC4 | 617213.9969 | 2101214.4550 | 491.49 | US50 | 156+21.534 | 30.070 Rt | Pk Nail & Shinner |

Note:
The Contractor shall verify all controlling field dimensions before ordering or fabricating any material.

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

GEOTECHNICAL PROFESSIONAL APPROVAL DATE

DESIGN OVERSIGHT

SIGN OFF DATE

SCALE: | VERT.DATUM | HORZ.DATUM

PHOTOGRAMMETRY AS OF:

SURVEYED BY

FIELD CHECKED BY

ALIGNMENT TIES

DRAFTED BY

CHECKED BY

DESIGN BY M. Quest CHECKED

DETAILS BY J. Blond CHECKED

QUANTITIES BY CHECKED

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

Mario Quest
PROJECT ENGINEER

BRIDGE NO. 25-05R/L

KILOMETER POST 25.2(R15.7)

## WEBER CREEK BRIDGE (WIDEN)

## FOUNDATION PLAN

FOUNDATION PLAN SHEET (METRIC) (REV. 3/1/99)

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 10 20 30 40 50 60 70 80 90 100

CU 03198
EA 2E1701

DISREGARD PRINTS BEARING EARLIER REVISION DATES → 1/31/08

REVISION DATES (PRELIMINARY STAGE ONLY)

SHEET 4 OF 54

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# APPENDIX E

## Response to Comments

**PROJECT NAME: Missouri Flat I/C - Phase 1B**

**COMMENTS BY:**
**ADDRESSED BY: WRECO**

| **Submittal: Draft Bridge Design Hydraulic Study Report** | | **CODE** | **A** - Accept Comment (correct, add, clarify)<br>**B** - Will not incorporate<br>**C** - Resolution of comment in next submittal |
|---|---|---|---|
| Circulated by: Quincy Engineering | Date: 8/25/2008 | | |

| **Comment No.** | **Dwg or Page No.** | **Reviewer/ Entity** | **Reviewer's Comments** | **RESPONSE** | | | **Final Disposition** | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Response Code** | **By Whom/ Entity** | **Response Text** | **"√"** | **By Whom/ Entity** | **Date** |
| 1 | Title Sht | Eric Fredrickson | Include "Br. No. 25-0005 R/L" and "EA 03-4E2801" | A | WRECO | Bridge Number and EA are added to Title Sheet, see updated page. | | | |
| 2 | Title Sht | Eric Fredrickson | Revise Weber Creek Bridge Number to "25-0005 L/R" (two locations) | A | WRECO | Bridge Number is added to Title Sheet, see updated page. | | | |
| 3 | iii | Eric Fredrickson | 1st paragraph – Include "Br. No. 25-0005 R/L" in the description. | A | WRECO | Bridge Number is added to description, see Page iii. | | | |
| 4 | iii | Eric Fredrickson | Table E2 – Revise the Water Surface Elevation to match page 11, Table 2 information (both 50 and 100 year elevations). | A | WRECO | Table E2 is revised to match Table 2, see Table E2. | | | |
| 5 | 1 | Eric Fredrickson | Include "Br. No. 25-0005 R/L" in the description. | A | WRECO | Bridge Number is added to description, see Page 1. | | | |
| 6 | 6 | Eric Fredrickson | Proposed Bridge (1 and 2) – Revise "Appendix E" to "Appendix **D**" | A | WRECO | Statement is revised to read as "Appendix D," see Page 6. | | | |
| 7 | 13 | Eric Fredrickson | Verify Eastbound and Westbound bridge designations with respect to water profile. | A | WRECO | Designation of bridges is corrected with respect to water profile, see Page 13. | | | |
| 8 | 14 | Eric Fredrickson | Table 3 – Verify Eastbound and Westbound bridge information with respect to existing and | A | WRECO | Table is corrected to reflect velocities with respect to existing and proposed bridge | | | |

| **Submittal: Draft Bridge Design Hydraulic Study Report** | | **CODE** | **A** - Accept Comment (correct, add, clarify)<br>**B** - Will not incorporate<br>**C** - Resolution of comment in next submittal |
|---|---|---|---|
| Circulated by: Quincy Engineering | Date: 8/25/2008 | | |

| **Comment No.** | **Dwg or Page No.** | **Reviewer/ Entity** | **Reviewer's Comments** | **RESPONSE** | | | **Final Disposition** | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Response Code** | **By Whom/ Entity** | **Response Text** | **"√"** | **By Whom/ Entity** | **Date** |
| | | | proposed velocities. | | | results, see Table 3. | | | |
| 9 | 15 | Eric Fredrickson | Foundation Plan – Delete the reference to footing thickness, as it does not apply to this structure. | A | WRECO | Reference to footing thickness is deleted, see Page 15. | | | |
| 10 | 15 | Eric Fredrickson | Contraction Scour – Please explain how you calculated the reduction in the flow area. The area seems large. | A | WRECO | The reduction in flow area is calculated by examining the HEC-RAS output for the flow area at the upstream face of the bridges to the flow area two stations upstream of the bridges. | | | |
| 11 | App. C | Eric Fredrickson | Verify ALL. Text does not reflect this structure (Cohasset Road?), or this project (Abutment 2?, 3-span replacement?). Verify ALL scour calculations in the report. | A | WRECO | Text is corrected and scour calculations are verified to reflect Project bridges, see Appendix C. | | | |
| 12 | App. D | Eric Fredrickson | Revise title from "Advanced Planning Study" to "Draft Bridge Plans." | A | WRECO | Title is corrected to read as "Draft Bridge Plans," see Appendix D. | | | |
| 13 | App. D | Eric Fredrickson | Update General Plan and Foundation Plan sheets with current details. NOTE: The pier location for the right (EB) structure has moved upstream a couple of meters. May need to verify water surface elevations at this location. | A | QEI / WRECO | Details are updated, see Appendix D. | | | |