HYDROLOGY/HYDRAULICS REPORT
EL DORADO COUNTY

CLAY STREET BRIDGE REPLACEMENT

Prepared by:
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JULY 14, 2009

REGISTERED PROFESSIONAL ENGINEER
JOSEPH W. DOMENICHELLI
C38068
Exp 3-31-11
CIVIL
STATE OF CALIFORNIA
7-14-09

HYDROLOGY/HYDRAULICS REPORT

Clay Street Bridge Replacement
El Dorado County, California

PROJECT LOCATION AND DESCRIPTION

Clay Street Bridge is located in El Dorado County near downtown Placerville. The existing bridge is a two-span concrete arch structure. Hangtown Creek flows under the north span of the bridge and the south span of the bridge serves as the outfall location for Cedar Ravine. Flow from Cedar Ravine joins Hangtown Creek directly downstream from the bridge.

The existing bridge has a total span of approximately 60'-0" with a maximum opening width of approximately 21'-0" over the Hangtown Creek channel. The bridge width is approximately 19'-0". It is supported on concrete wall abutments at the banks and there is a central pier that ties into the concrete channel wall on the upstream side of the bridge. The central pier also separates Hangtown Creek and Cedar Ravine flow. The bridge width is insufficient for traffic demands and does not meet freeboard requirements for the 50-yr or 100-yr flows.

There are existing utilities that run below or adjacent to the bridge. These utilities include sewer lines and manhole risers and a water line that is attached to the bridge on the west side. There are also multiple drain/culvert pipes and many unidentified pipes in the vicinity of the bridge. The in-channel utilities will be removed prior to bridge removal.

Figure 1 –Clay Street Bridge.

Figure 2 –Existing utilities downstream of Clay Street Bridge.

It is proposed to remove the existing bridge (including 8'x20' of concrete sill in channel) and replace it with a single span bridge that has a total open span length of 32'-0" and an overall width of 45'-6". The proposed bridge will have concrete barrier type 80SW (mod) with architectural treatment and barrier mounted iron railings. The bridge deck type has not been selected. It will either be a cast-in-place reinforced concrete slab with a depth of 2'-0" or a pre-cast pre-stressed slab with a depth of 1'-9". The City would like to minimize

removal of the existing 66" corrugated metal culvert for Cedar Ravine. However, the proposed bridge design will require the Cedar Ravine pipe outlet to be reconstructed and the embankment regraded.

HANGTOWN CREEK AND CEDAR RAVINE HYDROLOGY

A hydrologic analysis was completed to establish design flows for the 50-yr and 100-yr events for Hangtown Creek and Cedar Ravine. A computer model was developed to determine these flows using the Army Corps of Engineers' Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS version 3.0.1). The El Dorado County Drainage Manual was used in conjunction with the U.S. Department of Natural Resources Conservation Service (NRCS) to determine watershed conditions such as rainfall and soil data. Other watershed conditions such as channel storage potential, channel Manning's n-values and existing surface development were determined during a site visit. The City will require that flows from new developments within the watershed be mitigated to existing flow conditions so that peak flows in Hangtown Creek will not increase in the future. A flow verses frequency relationship for Hangtown Creek and Cedar Ravine are shown in the tables below. The combined flow for Hangtown Creek upstream of Clay Street and Cedar Ravine at Clay Street does not equal the flow at the confluence because the two stream hydrographs do not peak at the same time.

Table 1: Peak flow rates for the 50-yr event.

Location	Peak Flow Rate (cfs)
Hangtown Creek just upstream of Clay Street	2453
Cedar Ravine at Clay Street	381
Confluence of Hangtown Creek and Cedar Ravine	2782

Table 2: Peak flow rates for the 100-yr event.

Location	Peak Flow Rate (cfs)
Hangtown Creek just upstream of Clay Street	2852
Cedar Ravine at Clay Street	450
Confluence of Hangtown Creek and Cedar Ravine	3219

HANGTOWN CREEK HYDRAULICS

Existing Conditions Model

An existing conditions computer model was created for both Hangtown Creek and Cedar Ravine using the Army Corps of Engineers' Hydrologic Engineering Center River Analysis System (HEC-RAS version 3.1.3). Survey by Area West Engineers provided existing channel cross sections of Hangtown Creek both upstream and downstream of Clay Street. Manning's n-values for Hangtown Creek varied from 0.03 in the channel to 0.05 along the banks. A Manning's n-value of 0.014 was used for the concrete sill located in the channel on the downstream side of Clay Street Bridge.

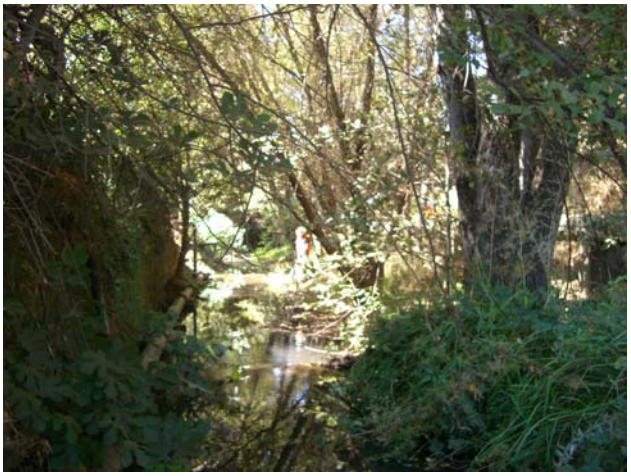


Figure 3 –Manning's n-values from 0.03-0.05 for HC.

Contraction and expansion coefficients of 0.3 and 0.5, respectively, were set in the vicinity of Clay Street Bridge and the Bedford Avenue Bridge downstream from Clay Street. The existing bridge geometry was entered into the model based on field measurements. Figure 4 and 5 show HEC-RAS cross-sections upstream and downstream of Clay Street Bridge. Figure 6 shows a profile through the existing bridge. The gray shaded areas represent blockage from structures such as the bridge deck/abutments. The top of existing bridge deck (not including railings) is at an elevation 1867.25 feet and the top soffit of the bridge arch is at an elevation of 1864.75 feet.

Figure 4 –Existing conditions cross section (upstream).

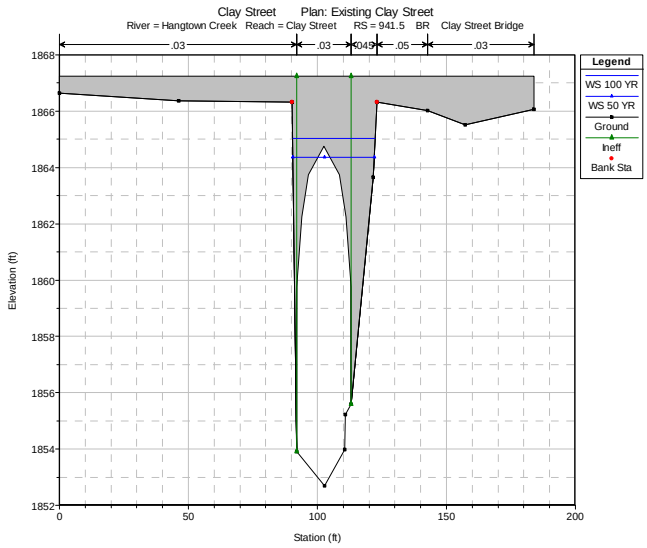
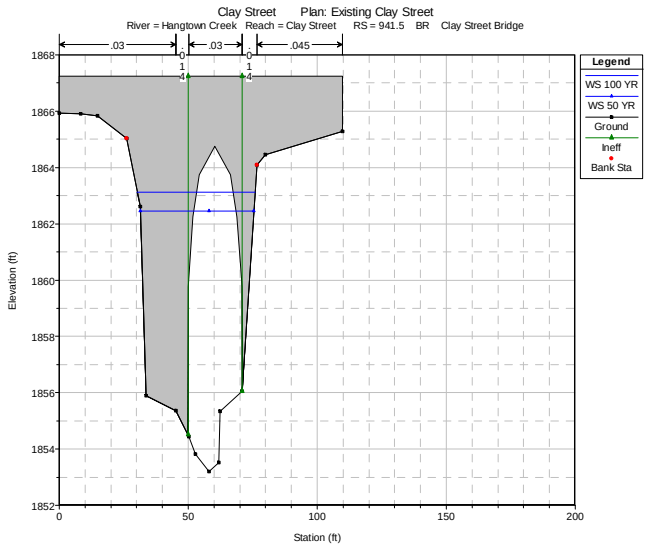


Figure 5 –Existing conditions cross section (downstream).



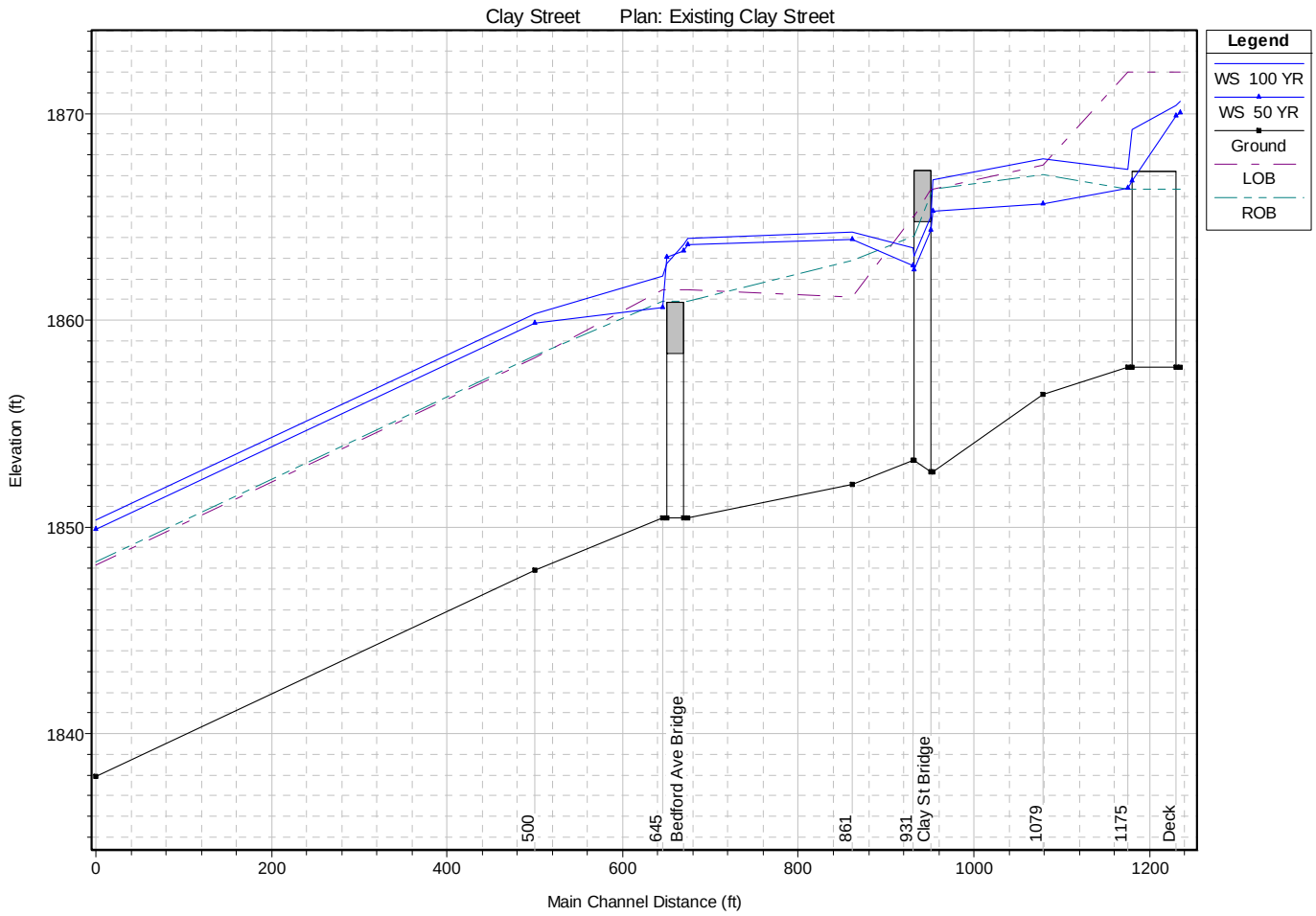


Figure 6 –Existing conditions 50-yr and 100-yr profile.

Approximately 249' upstream from Clay Street Bridge is a deck off of a building that spans over the channel. The deck is approximately 22' x 50' and it contains one pier that is one foot wide. Approximately 282' downstream of Clay Street Bridge is Bedford Avenue Bridge. This bridge is 19' wide with a 26' span. The existing model was run with the flows described previously. Results in the vicinity of Clay Street Bridge are presented in the following tables.

Table 3: 50-yr water surface elevations and velocities for the existing bridge.

Cross-section (River Sta)	Location Relative to Bridge	WSEL (feet)	Channel Velocity (fps)
1235	294' upstream	1870.0	7.2
Deck off of house			
1175	234' upstream	1866.4	13.9
1079	138' upstream	1865.5	10.6
953	12' upstream	1865.2	10.0
Clay Street Bridge			
931	11' downstream	1862.7	16.2
861	81' downstream	1863.9	7.2

Cross-section (River Sta)	Location Relative to Bridge	WSEL (feet)	Channel Velocity (fps)
674	268' downstream	1863.6	6.4
Bedford Ave Bridge			
645	297' downstream	1860.6	13.1
500	442' downstream	1859.9	10.6
0	942' downstream	1849.9	10.6

Table 4: 100-yr water surface elevations and velocities for the existing bridge.

Cross-section (River Sta)	Location Relative to Bridge	WSEL (feet)	Channel Velocity (fps)
1235	294' upstream	1870.6	6.8
Deck off of house			
1175	234' upstream	1867.3	13.9
1079	138' upstream	1867.7	8.2
953	12' upstream	1866.7	10.3
Clay Street Bridge			
931	11' downstream	1863.5	17.0
861	81' downstream	1864.3	7.7
674	268' downstream	1864.0	6.8
Bedford Ave Bridge			
645	297' downstream	1862.1	10.9
500	442' downstream	1860.3	10.8
0	942' downstream	1850.3	10.8

As seen in the profile and related tables the existing bridge will nearly overtop during the 100-yr flood event and will pass the 50-yr flow with no clearance to the soffit.

Proposed Conditions Model

The existing conditions model was modified to create the proposed conditions model. The proposed conditions model contains the new bridge geometry provided by Quincy Engineering, Inc. The proposed geometry was inserted into the model based on the provided plans shown in Appendix A. The alternative with the 2'-0" thick cast-in-place reinforced concrete slab was modeled for this analysis as hydraulically the most conservative alternative. If the alternative with the thicker slab meets clearance requirements then the other alternative will also meet clearance requirements. The proposed single span bridge will exceed the total width of the existing bridge by approximately 26'-6". Since the proposed bridge is much wider than the existing bridge, additional cross sections upstream and downstream from the bridge were created based on the topography provided by Quincy Engineering. The right side of the bridge was brought in 2 feet to account for debris that could potentially gather around the right side of the bridge abutment. Figure 7 and 8 show HEC-RAS cross-sections upstream and downstream of Clay Street Bridge. Figure 9 shows a profile through the new bridge. The top of the new bridge deck (not including the concrete barrier and hand railing) is at an elevation of 1868.57 feet and the bottom soffit of the bridge is at an elevation of 1866.57 feet.

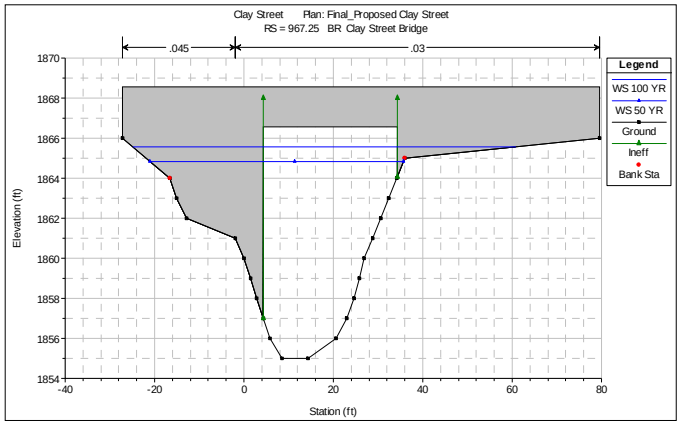


Figure 7 – Proposed conditions cross section (upstream).

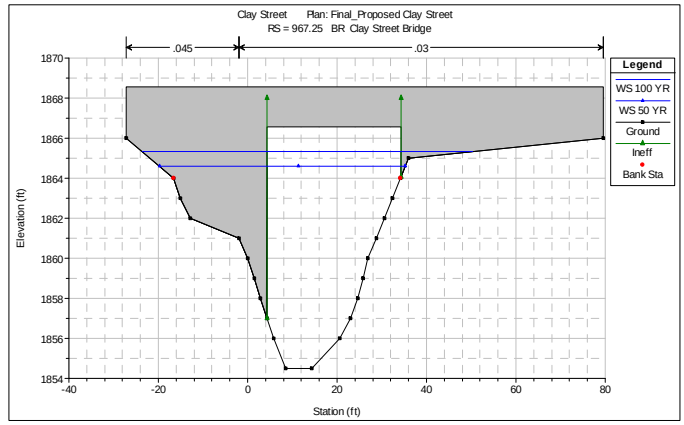


Figure 8 – Proposed conditions cross section (downstream).

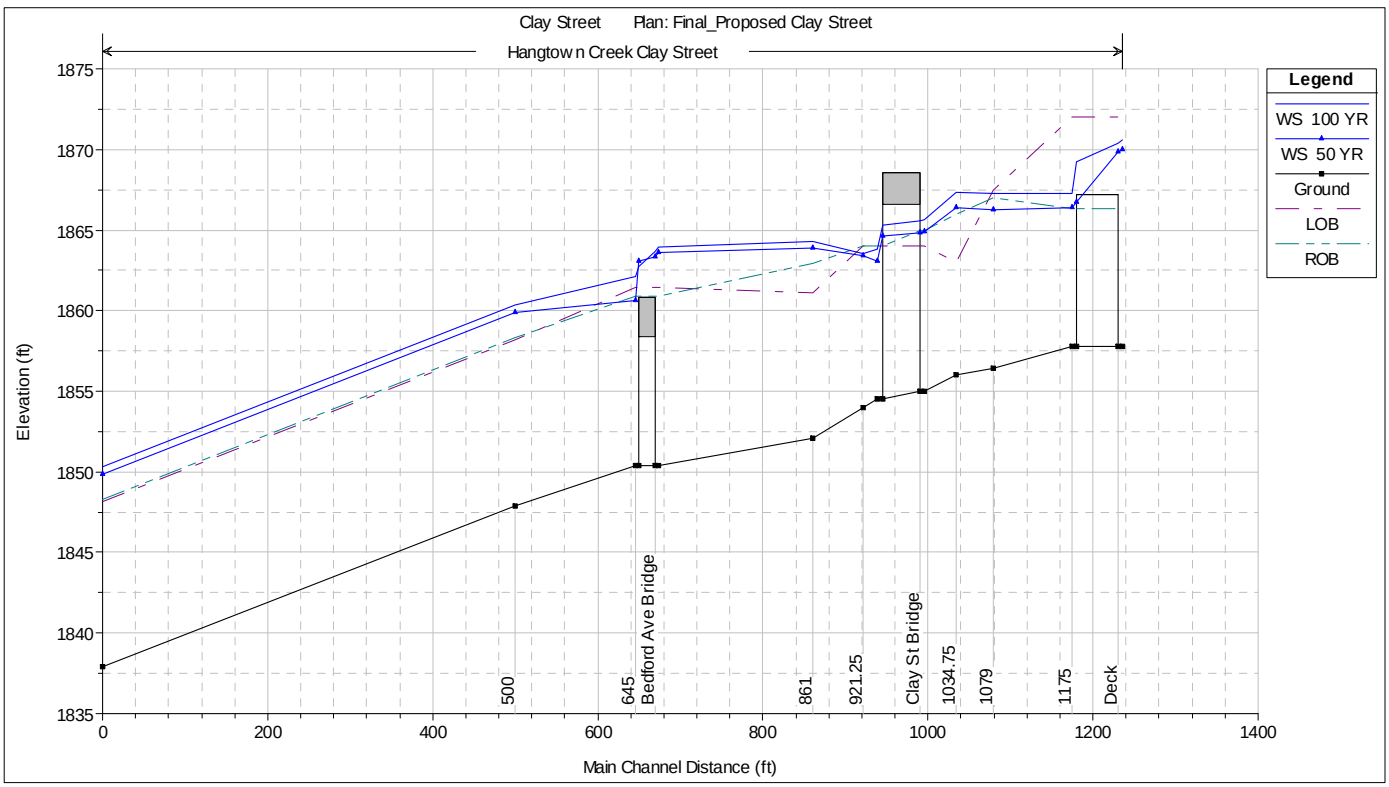


Figure 9 – Proposed conditions 50-yr and 100-yr profile.

The same flow rates as in the existing conditions model were run with the new bridge in place. Results in the vicinity of the new bridge are presented in the following tables.

Table 5: 50-yr water surface elevations and velocities for the proposed bridge.

Cross-section (River Sta)	Location Relative to Bridge	WSEL (feet)	Channel Velocity (fps)
1235	245' upstream	1870.0	6.7
Deck off of house			
1175	185' upstream	1866.4	13.8

Cross-section (River Sta)	Location Relative to Bridge	WSEL (feet)	Channel Velocity (fps)
1079	89' upstream	1866.3	9.2
1034.75	45' upstream	1866.4	7.6
995.25	5' upstream	1864.9	11.1
Clay Street Bridge			
939.25	5' downstream	1863.1	14.2
921.25	23’ downstream	1863.4	10.3
861	84' downstream	1863.9	7.2
674	271' downstream	1863.6	6.4
Bedford Ave Bridge			
645	300' downstream	1860.6	13.1
500	445' downstream	1859.9	10.6
0	945' downstream	1849.9	10.6

Table 6: 100-yr water surface elevations and velocities for the proposed bridge.

Cross-section (River Sta)	Location Relative to Bridge	WSEL (feet)	Channel Velocity (fps)
1235	245' upstream	1870.6	6.9
Deck off of house			
1175	185' upstream	1867.3	13.9
1079	89' upstream	1867.3	9.0
1034.75	45' upstream	1867.3	7.8
995.25	5' upstream	1865.6	11.8
Clay Street Bridge			
939.25	5' downstream	1863.9	14.6
921.25	23’ downstream	1863.5	11.7
861	84' downstream	1864.3	7.7
674	271' downstream	1864.0	6.8
Bedford Ave Bridge			
645	300' downstream	1862.1	10.9
500	445' downstream	1860.3	10.8
0	945' downstream	1850.3	10.8

Based on the results, the proposed bridge deck will have 1.73 feet of clearance between the deck soffit and the 50-yr water surface and can pass the 100-yr flow with 1.0 foot of clearance (shown in Table 7), therefore, exceeding clearance and freeboard requirements. It is important to note that freeboard was calculated from top of deck and clearance was calculated from soffit.

Table 7: Top of deck freeboard and soffit clearance for 50-yr and 100-yr events.

	100-yr Freeboard (ft)	50-yr Freeboard (ft)	100-yr Soffit Clearance (ft)	50-yr Soffit Clearance (ft)
Existing Conditions	0.5	2.0	0.0	0.0
Proposed Condition	3.0	3.73	1.0	1.73

Table 8 provides a comparison between existing conditions and the proposed bridge conditions water surfaces immediately upstream of the bridges and at cross section 861 downstream of the bridges. The models show no difference in water surface elevations downstream from the bridge. The models show that the upstream water surface elevations decrease with the new bridge. The models also show the velocities slowing down through the new bridge. Therefore, the new bridge will have no negative impacts to the Hangtown Creek floodplain.

Table 8: Comparison of water surface elevations and velocities for 50-yr and 100-yr events.

	100-year Event			50-yr Event		
	WSE Downstream of Bridge (ft)	WSE Upstream of Bridge (ft)	Velocity through Bridge (fps)	WSE Downstream of Bridge (ft)	WSE Upstream of Bridge (ft)	Velocity through Bridge (fps)
Existing Conditions	1864.3	1866.8	16.6	1863.9	1865.3	15.2
Proposed Condition	1864.3	1865.6	11.9	1863.9	1864.9	11.3
Difference	0.0	-1.2	-4.7	0.0	-0.4	-3.9

CEDAR RAVINE HYDRAULICS

Existing Conditions Model

An existing conditions computer model was created for Cedar Ravine using the Army Corps of Engineers' Hydrologic Engineering Center River Analysis System (HEC-RAS version 3.1.3). Survey by Area West Engineers provided cross sections upstream on Cedar Ravine. The modeled portion of Cedar Ravine consists of approximately 40 feet of open channel that flows into a 4' x 7.8' box culvert. The box culvert extends for about 234 feet and then it transitions into a 66" corrugated metal pipe that extends for approximately 286 feet where it outlets into Hangtown Creek. Due to limited survey, all lengths and dimensions were approximated during a site visit. A Manning's n-value of 0.025 was used for the open channel segment of Cedar Ravine. Manning's n-values of 0.017 and 0.024 were used for the box culvert segment and corrugated metal pipe segment, respectively. Cross sections and Manning's n-values downstream from the confluence of Hangtown Creek and Cedar Ravine remained the same as in the existing conditions model for Hangtown Creek.

Figure 10 –Manning's n-value of 0.025 for Cedar Ravine.

Figure 11 –Manning's n-value of 0.017 for box culvert.

The results show that Cedar Ravine cannot convey the 50-yr and 100-yr event flows through the culverts and some roadway flooding is anticipated during major storm events. Table 9 shows results for the culvert.

Table 9: Flow vs. capacity for Cedar Ravine culvert.

Location	Flow Rate (cfs)
Approximate flow conveyed in culvert	300
50-yr event flow	381
100-yr event flow	450

SCOUR ANALYSIS

A scour analysis of the Clay Street Bridge at Hangtown Creek was performed for the proposed bridge replacement (cast-in-place 2'-0" reinforced concrete slab). The other alternative was not analyzed because there should not be any significant difference in scour due to similar bridge alignment and dimensions. Evaluation of scour at the bridge is based on criteria and methodologies developed by the Federal Highways Administration, Hydraulic Circular No. 18 (HEC-18), *Evaluating Scour at Bridges* (February 1993). The analysis estimates scour potential that is based primarily on channel hydraulics, without consideration for streambed surface and subsurface conditions. It should be noted that the predictive scour equations were developed from laboratory tests using fine granular materials. The resulting values of estimated potential scour are typically conservative, especially in cases where the depth to scour resistant materials is shallower than the estimated scour depth.

Hydraulic Variables

Hydraulics variables such as channel flow, velocity and depth are adapted from the HEC-RAS Hydraulic Model for Hangtown Creek at the proposed Clay Street Bridge.

Soils Investigation

A preliminary foundation report was created by Taber. The report states that the stream channel contains bedrock that shows little erosion from flow and it appears to be scour resistant. Although the extent and depth of bedrock in the channel was not stated, the depth of scour resistant materials can be expected to be less than the calculated scour depths. When designing bridge foundations, depth to this scour resistant material should be accurately determined.

Long Term Aggradation and Degradation

Long term changes in streambeds may be either by aggradation (filling) or degradation (cutting) of the streambed over long periods of time. Long term changes differ from short term modifications in that changes are not apparent within the year, as is the case with local scour of the streambed at bridges. Generally, short term (local) changes result from bridge hydraulics, while long-term changes are associated with changes in the hydraulics of the stream itself. Thus, long-term changes are noticeable throughout the stream reach and not just at bridge locations.

Due to the presence of exposed bedrock along the channel bottom of Hangtown Creek, there are no significant signs of long-term aggradation or degradation. However, a value of 1 foot degradation has been assumed for conservative analysis.

Contraction and Pier Scour

There is no contraction scour due to the alignment of the new bridge and there is no pier scour because the new single span bridge does not have piers.

Local Abutment Scour

Local abutment scour occurs when the abutment obstructs the flow. In the case of the Clay Street Bridge the right and left abutment scour is fairly similar. The abutment scour was calculated using Froehlich's equation as described in HEC-18. The abutment scour was calculated for the worst case conditions using the channel capacity flow conditions.

$$\frac{Y_s}{Y_a} = 2.27 \times K_1 \times K_2 \times \left(\frac{a'}{Y_a}\right)^{0.43} \times Fr^{0.61} + 1$$

where:

K_1 = vertical wall

K_2 = angle coeff.

a' = Projection into Normal flow

Y_a = average depth of flow on the floodplain

Fr = Froude number of approach upstream of the abutment

$$Fr = \frac{Ve}{(g \times y_a)^{1/2}}$$

Ve = Average velocity in overbank

$g = 32.2$ ft/sec

Table 10 below shows the variables for the right and left abutment scour calculations and the total scour calculated.

Table 10. Variables for abutment scour calculations.

	Right Abutment	Left Abutment
K_1	1.0	1.0
K_2	1.0	1.0
a' (ft)	15.9	56.4
Fr	0.37	0.41
y_a (ft)	1.85	0.85
y_s (ft)	**7.6**	**7.7**

Total Scour Potential and Recommendations

The scour potential at the Clay Street Bridge at Hangtown Creek consists mostly of abutment scour. The maximum scour expected at the abutments is 7.6 feet for the right abutment and 7.7 feet for the left abutment. However, it is important to note that bedrock exists in this area and that abutment scour will only occur to the depth of bedrock. Rock protection is recommended at the abutments if foundation exposure is an issue. If rock protection is necessary, it should consist of standard Caltrans facing material with a minimum thickness of 1.8 feet for a width of 5 feet along each abutment.

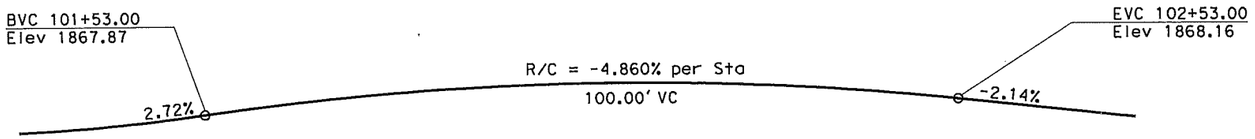
Significant scour is not anticipated at the confluence of Hangtown Creek and Cedar Ravine due to the proposed alignment of the new bridge and the outlet of Cedar Ravine. The proposed alignment of Cedar Ravine outlet will direct flow inline (parallel) with the flow of Hangtown Creek reducing cross bank flow and turbulence from that of the existing alignment. The existing rock channel bottom has not experienced significant sour downstream of the confluence, therefore the improved condition is not expected to show any measurable scour. If existing rock downstream from the culvert outlet is removed during construction it should be replaced in-kind or using Caltrans facing material as described above. The limits of the rock protection should extend approximately 20 feet downstream from the culvert outlet.

APPENDIX A - PROPOSED BRIDGE PLANS

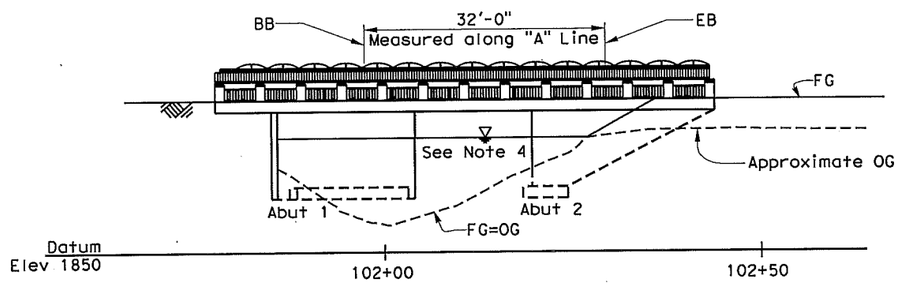
DIST.	COUNTY	ROUTE	POST MILES TOTAL PROJECT
03	PLA	CR	

QUINCY ENGINEERING, INC
3247 Ramos Circle
Sacramento, CA 95827 - 2501

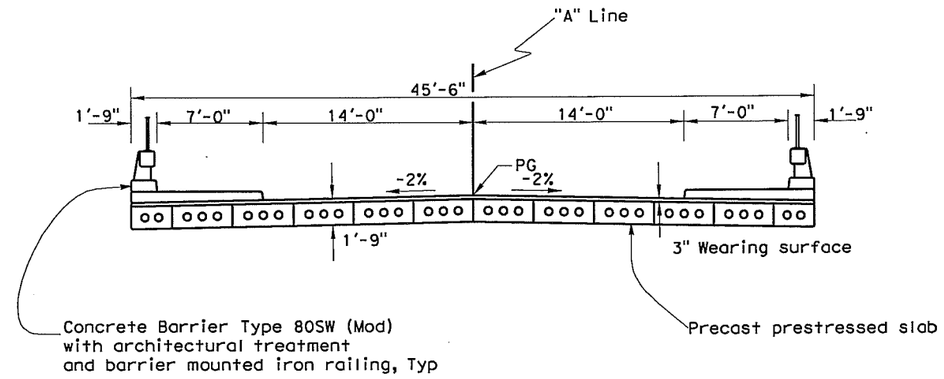
PREPARED FOR THE CITY OF PLACERVILLE



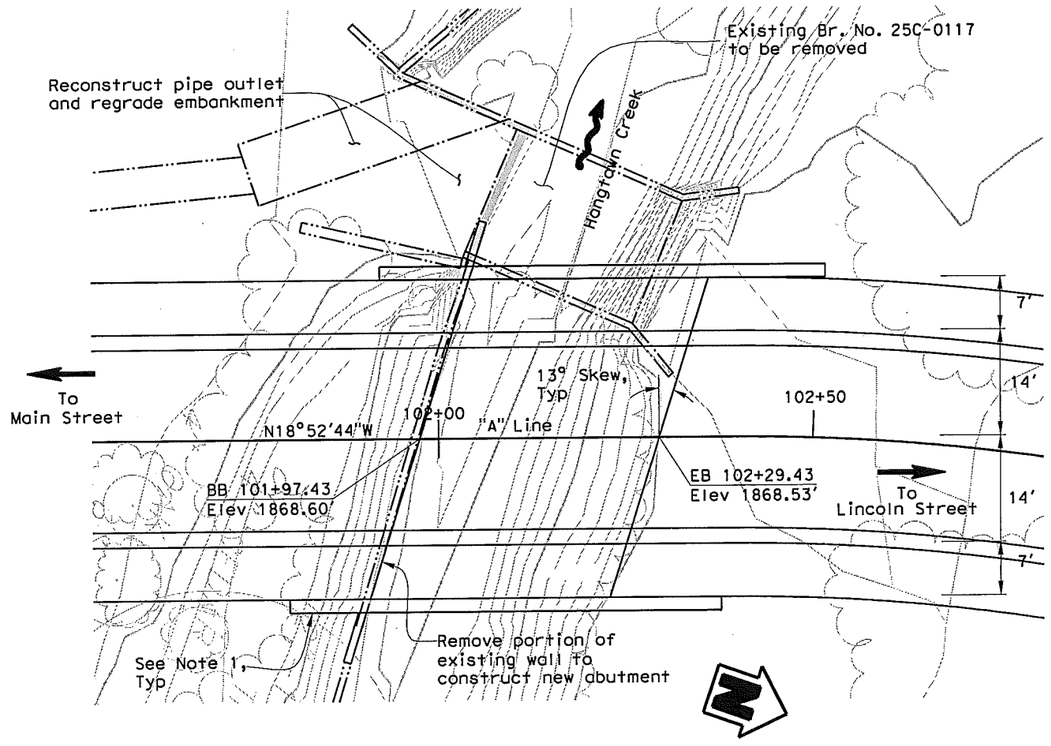
PROFILE GRADE
No Scale



ELEVATION
1"=10'



TYPICAL SECTION
1"=5'



PLAN
1"=10'

DATE OF ESTIMATE		6-22-09
BRIDGE REMOVAL	=	$30,000
STRUCTURE DEPTH	=	1.75 ft.
LENGTH	=	32.00 ft.
WIDTH	=	45.50 ft.
AREA	=	1456 sq. ft.
COST/ SQ. FT. INCLUDING 10% MOBILIZATION & 25% CONTINGENCY	=	$469.11
TOTAL COST	=	$685,000

LEGEND
Indicates Direction of Flow
Indicates Direction of Travel

Notes:

1. Concrete barrier Type 80SW (Mod) and barrier mounted iron railing, to extend beyond existing facilities.
2. Architectural treatment not shown for clarity.
3. Foundation assumed to be spread footing on bedrock.
4. Q50+2 Water surface elevation = 1865.98'

ALTERNATIVE 1

DESIGNED BY D. Nicolle	DATE 6/22/09	LELAND MASON PROJECT ENGINEER	PLANNING STUDY
DRAWN BY D. Nicolle	DATE 6/22/09		CLAY STREET BRIDGE
CHECKED BY L. Mason	DATE 6/22/09		BRIDGE NO. 25C-0117 / CU
APPROVED	DATE		SCALE: AS SHOWN / EA

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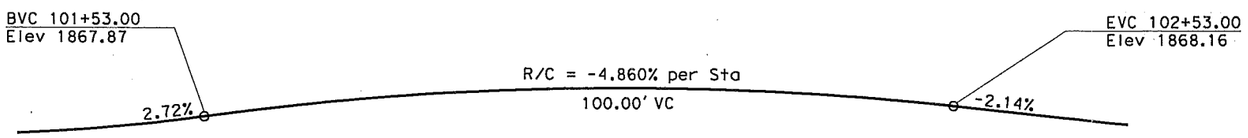
ADVANCE PLANNING STUDY SHEET (ENGLISH) (REV. 5/9/00)

DIST.	COUNTY	ROUTE	POST MILES TOTAL PROJECT
03	PLA	CR	

QUINCY ENGINEERING, INC
3247 Ramos Circle
Sacramento, CA 95827 - 2501

PREPARED FOR THE CITY OF PLACERVILLE



PROFILE GRADE
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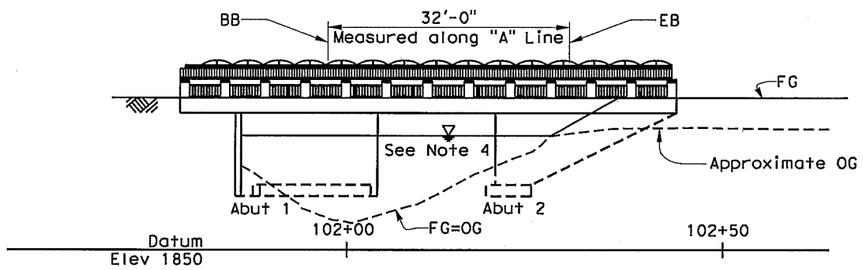
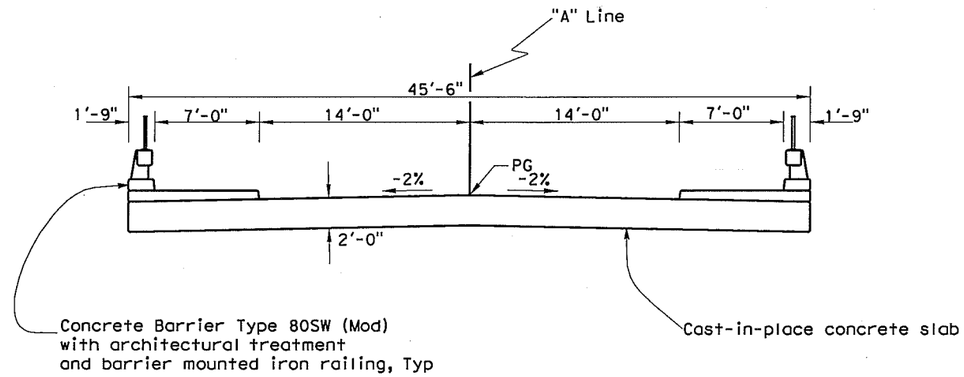
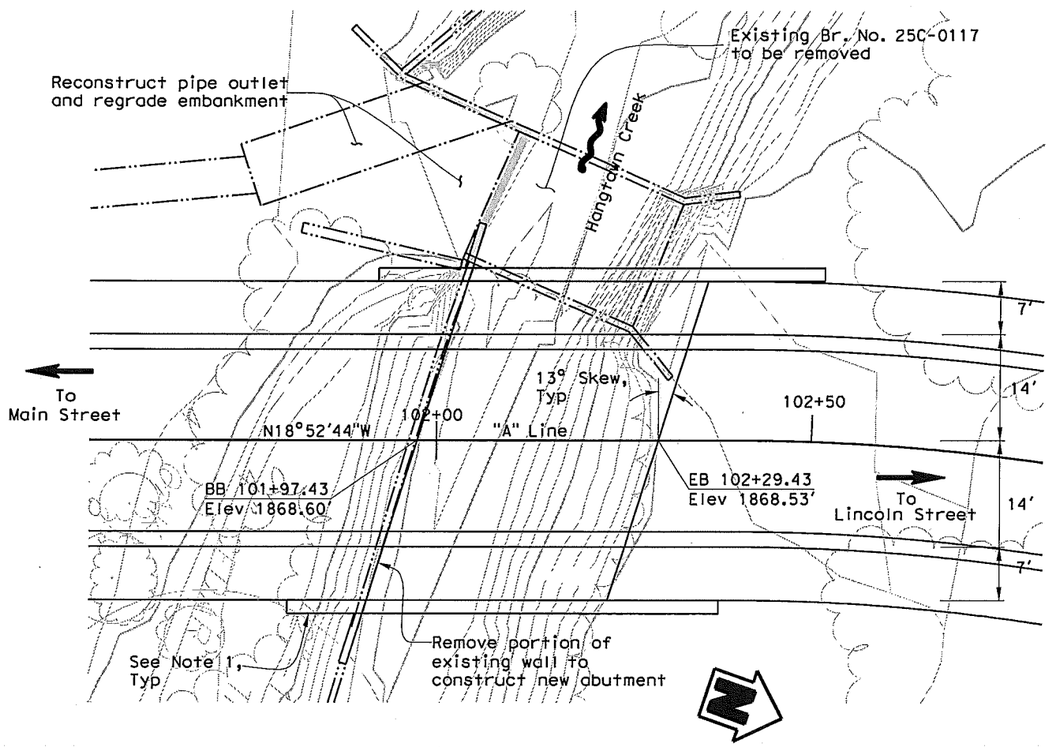


ELEVATION
1"=10'



TYPICAL SECTION
1"=5'



PLAN
1"=10'

DATE OF ESTIMATE		10-17-07
BRIDGE REMOVAL	=	$30,000
STRUCTURE DEPTH	=	2.0 ft.
LENGTH	=	32.00 ft.
WIDTH	=	45.50 ft.
AREA	=	1456 sq. ft.
COST/ SQ. FT. INCLUDING 10% MOBILIZATION & 25% CONTINGENCY	=	$457.55
TOTAL COST	=	$670,000

LEGEND
Indicates Direction of Flow
Indicates Direction of Travel

Notes:

1. Concrete barrier Type 80SW (Mod) and barrier mounted iron railing, to extend beyond existing facilities.
2. Architectural treatment not shown for clarity.
3. Foundation assumed to be spread footing on bedrock.
4. Q50+2 Water surface elevation = 1865.98'

ALTERNATIVE 2

DESIGNED BY D. Nicolle	DATE 6/22/09	LELAND MASON PROJECT ENGINEER	PLANNING STUDY
DRAWN BY D. Nicolle	DATE 6/22/09		CLAY STREET BRIDGE
CHECKED BY L. Mason	DATE 6/22/09		BRIDGE NO. 25C-0117 / CU
APPROVED	DATE		SCALE: AS SHOWN / EA

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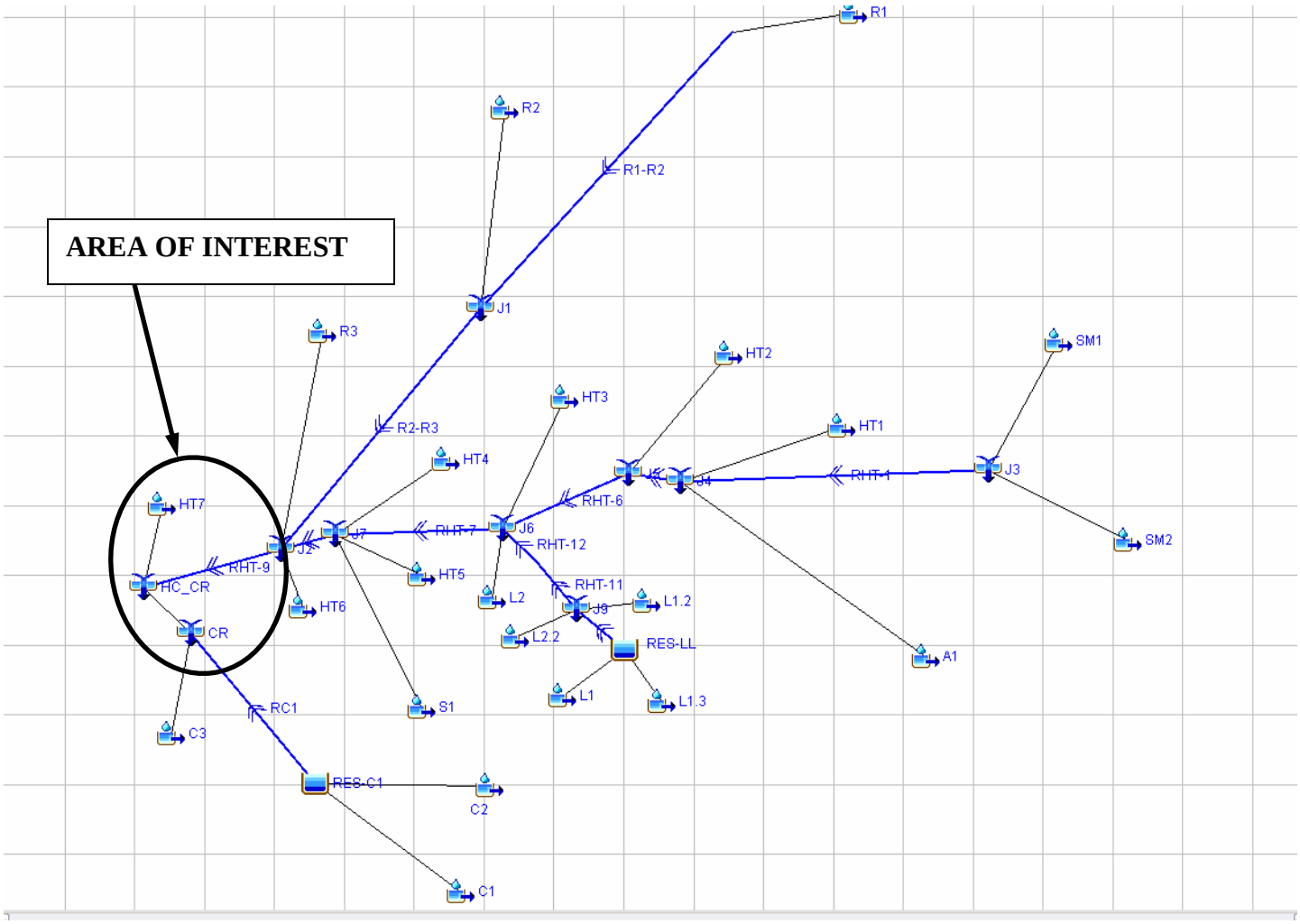
APPENDIX B - HEC-HMS OUTPUT

HEC-HMS SCHEMATIC FOR THE 50-YR AND 100-YR EVENTS



Project: Clay Street Brdg Simulation Run: Existing 50YR

Start of Run: 01Jan2006, 00:00 Basin Model: Existing
End of Run: 02Jan2006, 00:00 Meteorologic Model: GAGE 50YR
Compute Time: 15Nov2007, 08:45:30 Control Specifications: 1-day

Volume Units: AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
A1	0.5950	363.55	01Jan2006, 12:32	116.64
C1	0.4761	267.69	01Jan2006, 12:32	92.32
C2	0.0555	44.48	01Jan2006, 12:16	12.53
C3	0.3050	238.37	01Jan2006, 12:17	61.51
CR	0.8366	381.27	01Jan2006, 12:20	165.60
HC_CR	5.5396	2782.33	01Jan2006, 12:33	1023.52
HT1	0.2400	138.65	01Jan2006, 12:30	43.21
HT2	0.3160	208.84	01Jan2006, 12:21	57.82
HT3	0.1680	154.25	01Jan2006, 12:19	41.95
HT4	0.1010	104.94	01Jan2006, 12:18	29.34
HT5	0.0650	47.77	01Jan2006, 12:17	12.32
HT6	0.0750	63.96	01Jan2006, 12:16	16.59
HT7	0.0720	63.94	01Jan2006, 12:22	18.36
J1	1.3180	597.39	01Jan2006, 12:41	205.10
J2	4.6310	2396.34	01Jan2006, 12:32	841.32
J3	0.7660	522.51	01Jan2006, 12:24	155.57
J4	1.6010	1021.15	01Jan2006, 12:29	314.74
J5	1.9170	1205.27	01Jan2006, 12:28	372.31
J6	2.4650	1456.65	01Jan2006, 12:29	472.60
J7	2.8080	1595.69	01Jan2006, 12:30	527.30
J9	0.3100	108.74	01Jan2006, 12:31	45.37
L1	0.0500	21.69	01Jan2006, 12:25	6.36
L1.2	0.0960	50.38	01Jan2006, 12:15	12.75
L1.3	0.1360	65.88	01Jan2006, 12:28	20.01
L2	0.0700	60.10	01Jan2006, 12:10	13.73

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
L2.2	0.0280	34.11	01Jan2006, 12:04	6.67
R1	0.5340	239.58	01Jan2006, 12:38	81.67
R1-R2	0.5340	239.48	01Jan2006, 12:46	80.93
R2	0.7840	370.43	01Jan2006, 12:36	124.17
R2-R3	1.3180	597.16	01Jan2006, 12:46	203.84
R3	0.4300	331.91	01Jan2006, 12:22	94.13
RC1	0.5316	236.37	01Jan2006, 12:56	104.09
RES-C1	0.5316	236.44	01Jan2006, 12:48	104.81
RES-LL	0.1860	76.92	01Jan2006, 12:37	25.98
RHT-1	0.7660	522.20	01Jan2006, 12:28	154.89
RHT-10	0.1860	76.92	01Jan2006, 12:38	25.95
RHT-11	0.3100	108.73	01Jan2006, 12:32	45.35
RHT-12	0.3100	108.72	01Jan2006, 12:33	45.28
RHT-2	1.6010	1020.83	01Jan2006, 12:30	314.49
RHT-6	1.9170	1204.82	01Jan2006, 12:30	371.63
RHT-7	2.4650	1452.78	01Jan2006, 12:31	471.28
RHT-8	2.8080	1594.41	01Jan2006, 12:31	526.76
RHT-9	4.6310	2389.18	01Jan2006, 12:34	839.56
S1	0.1770	53.84	01Jan2006, 12:15	14.35
SM1	0.5850	380.84	01Jan2006, 12:26	113.84
SM2	0.1810	154.46	01Jan2006, 12:19	41.74

Project: Clay Street Brdg Simulation Run: Gage 100YR

Start of Run: 01Jan2006, 00:00 Basin Model: Existing
End of Run: 02Jan2006, 00:00 Meteorologic Model: Gage 100YR
Compute Time: 15Nov2007, 08:43:49 Control Specifications: 1-day

Volume Units: AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
A1	0.5950	418.01	01Jan2006, 12:31	133.73
C1	0.4761	308.36	01Jan2006, 12:32	105.87
C2	0.0555	50.90	01Jan2006, 12:16	14.27
C3	0.3050	276.06	01Jan2006, 12:16	71.79
CR	0.8366	450.13	01Jan2006, 12:42	191.07
HC_CR	5.5396	3219.30	01Jan2006, 12:33	1183.79
HT1	0.2400	160.91	01Jan2006, 12:29	49.95
HT2	0.3160	243.03	01Jan2006, 12:21	66.97
HT3	0.1680	174.17	01Jan2006, 12:18	47.52
HT4	0.1010	116.79	01Jan2006, 12:18	32.72
HT5	0.0650	55.56	01Jan2006, 12:17	14.39
HT6	0.0750	73.34	01Jan2006, 12:16	19.09
HT7	0.0720	71.83	01Jan2006, 12:22	20.90
J1	1.3180	703.50	01Jan2006, 12:40	240.59
J2	4.6310	2789.80	01Jan2006, 12:32	973.90
J3	0.7660	602.14	01Jan2006, 12:24	179.02
J4	1.6010	1176.67	01Jan2006, 12:29	361.91
J5	1.9170	1391.98	01Jan2006, 12:28	428.59
J6	2.4650	1686.46	01Jan2006, 12:28	545.03
J7	2.8080	1849.82	01Jan2006, 12:30	609.04
J9	0.3100	130.86	01Jan2006, 12:30	53.81
L1	0.0500	26.22	01Jan2006, 12:25	7.61
L1.2	0.0960	61.18	01Jan2006, 12:15	15.32
L1.3	0.1360	78.19	01Jan2006, 12:28	23.57
L2	0.0700	70.39	01Jan2006, 12:10	15.99

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
L2.2	0.0280	40.03	01Jan2006, 12:04	7.80
R1	0.5340	282.26	01Jan2006, 12:37	95.59
R1-R2	0.5340	282.14	01Jan2006, 12:46	94.74
R2	0.7840	434.69	01Jan2006, 12:36	145.85
R2-R3	1.3180	703.16	01Jan2006, 12:46	239.11
R3	0.4300	379.04	01Jan2006, 12:22	107.29
RC1	0.5316	330.37	01Jan2006, 12:43	119.28
RES-C1	0.5316	335.41	01Jan2006, 12:35	120.09
RES-LL	0.1860	92.06	01Jan2006, 12:37	30.71
RHT-1	0.7660	601.78	01Jan2006, 12:28	178.24
RHT-10	0.1860	92.04	01Jan2006, 12:38	30.68
RHT-11	0.3100	130.82	01Jan2006, 12:30	53.79
RHT-12	0.3100	130.81	01Jan2006, 12:32	53.71
RHT-2	1.6010	1176.32	01Jan2006, 12:30	361.62
RHT-6	1.9170	1391.44	01Jan2006, 12:30	427.81
RHT-7	2.4650	1682.13	01Jan2006, 12:31	543.49
RHT-8	2.8080	1848.20	01Jan2006, 12:31	608.41
RHT-9	4.6310	2780.51	01Jan2006, 12:34	971.82
S1	0.1770	70.99	01Jan2006, 12:15	18.43
SM1	0.5850	440.21	01Jan2006, 12:26	131.44
SM2	0.1810	176.62	01Jan2006, 12:19	47.57

APPENDIX C - HEC-RAS OUTPUT FOR HANGTOWN CREEK

HEC-RAS Plan: Existing River: Hangtown Creek Reach: Clay Street

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
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Clay Street	1235	100 YR	2852.00	1857.75	1870.61	1867.31	1871.22	0.002226	6.79	474.51	88.24	0.38
Clay Street	1235	50 YR	2453.00	1857.75	1870.02	1866.39	1870.61	0.002279	6.64	422.51	88.24	0.38
Clay Street	1190		Bridge									
Clay Street	1175	100 YR	2852.00	1857.75	1867.31	1867.31	1870.28	0.014654	13.89	208.62	38.96	0.94
Clay Street	1175	50 YR	2453.00	1857.75	1866.39	1866.39	1869.38	0.017418	13.89	176.61	30.69	1.01
Clay Street	1079	100 YR	2852.00	1856.40	1867.71		1868.75	0.005667	8.24	361.13	99.30	0.57
Clay Street	1079	50 YR	2453.00	1856.40	1865.53		1867.27	0.013011	10.57	232.09	45.18	0.82
Clay Street	953	100 YR	2852.00	1852.69	1866.70	1861.84	1868.36	0.001495	10.33	276.19	183.84	0.50
Clay Street	953	50 YR	2453.00	1852.69	1865.20	1861.03	1866.76	0.001656	10.03	244.66	32.05	0.52
Clay Street	941.5		Bridge									
Clay Street	931	100 YR	3219.00	1853.20	1863.49	1863.49	1867.99	0.004535	17.03	189.05	46.71	1.00
Clay Street	931	50 YR	2782.00	1853.20	1862.65	1862.65	1866.74	0.004686	16.22	171.52	44.32	1.00
Clay Street	861	100 YR	3219.00	1852.08	1864.26		1865.07	0.002850	7.66	479.25	112.40	0.46
Clay Street	861	50 YR	2782.00	1852.08	1863.89		1864.61	0.002649	7.17	438.25	107.15	0.44
Clay Street	674	100 YR	3219.00	1850.42	1863.98	1862.14	1864.56	0.002002	6.81	558.35	108.91	0.36
Clay Street	674	50 YR	2782.00	1850.42	1863.63	1859.44	1864.14	0.001829	6.38	520.12	108.91	0.34
Clay Street	659.5		Bridge									
Clay Street	645	100 YR	3219.00	1850.42	1862.14	1862.14	1863.74	0.005943	10.85	357.76	108.91	0.62
Clay Street	645	50 YR	2782.00	1850.42	1860.64	1859.44	1863.30	0.010464	13.10	214.22	81.01	0.81
Clay Street	500	100 YR	3219.00	1847.91	1860.32	1860.32	1861.87	0.007719	10.75	358.30	108.90	0.65
Clay Street	500	50 YR	2782.00	1847.91	1859.86	1859.86	1861.42	0.008063	10.59	308.77	103.30	0.66
Clay Street	0	100 YR	3219.00	1837.91	1850.32	1850.32	1851.87	0.007719	10.75	358.30	108.90	0.65
Clay Street	0	50 YR	2782.00	1837.91	1849.86	1849.86	1851.42	0.008063	10.59	308.77	103.30	0.66

HEC-RAS Plan: Final_Proposed River: Hangtown Creek Reach: Clay Street

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
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Clay Street	1235	100 YR	2852.00	1857.75	1870.60	1867.29	1871.22	0.002148	6.86	473.51	88.24	0.38
Clay Street	1235	50 YR	2453.00	1857.75	1870.01	1866.39	1870.60	0.002192	6.70	421.50	88.24	0.38
Clay Street	1190		Bridge									
Clay Street	1175	100 YR	2852.00	1857.75	1867.29	1867.29	1870.29	0.013875	13.92	208.12	38.85	0.94
Clay Street	1175	50 YR	2453.00	1857.75	1866.41	1866.41	1869.38	0.016189	13.84	177.23	30.87	1.00
Clay Street	1079	100 YR	2852.00	1856.40	1867.28		1868.53	0.007300	8.97	320.71	79.31	0.64
Clay Street	1079	50 YR	2453.00	1856.40	1866.29		1867.59	0.008831	9.18	267.32	48.57	0.69
Clay Street	1034.75	100 YR	2852.00	1856.00	1867.31	1863.82	1868.25	0.002764	7.78	366.62	112.58	0.48
Clay Street	1034.75	50 YR	2453.00	1856.00	1866.36	1863.24	1867.25	0.003062	7.55	324.79	90.13	0.49
Clay Street	995.25	100 YR	2852.00	1855.00	1865.61	1864.04	1867.76	0.003911	11.75	242.69	87.77	0.73
Clay Street	995.25	50 YR	2453.00	1855.00	1864.89	1863.33	1866.80	0.003954	11.10	220.98	57.06	0.72
Clay Street	967.25		Bridge									
Clay Street	939.25	100 YR	2852.00	1854.50	1863.85	1863.85	1867.17	0.008068	14.63	194.90	50.22	1.00
Clay Street	939.25	50 YR	2453.00	1854.50	1863.10	1863.10	1866.21	0.008266	14.15	173.37	47.75	1.01
Clay Street	921.25	100 YR	3219.00	1854.00	1863.53		1865.67	0.003878	11.73	274.49	46.64	0.74
Clay Street	921.25	50 YR	2782.00	1854.00	1863.41		1865.06	0.003046	10.29	270.36	46.27	0.65
Clay Street	861	100 YR	3219.00	1852.08	1864.26		1865.07	0.002850	7.66	479.25	112.40	0.46
Clay Street	861	50 YR	2782.00	1852.08	1863.89		1864.61	0.002649	7.17	438.25	107.15	0.44
Clay Street	674	100 YR	3219.00	1850.42	1863.98	1862.14	1864.56	0.002002	6.81	558.35	108.91	0.36
Clay Street	674	50 YR	2782.00	1850.42	1863.63	1859.44	1864.14	0.001829	6.38	520.12	108.91	0.34
Clay Street	659.5		Bridge									
Clay Street	645	100 YR	3219.00	1850.42	1862.14	1862.14	1863.74	0.005943	10.85	357.76	108.91	0.62
Clay Street	645	50 YR	2782.00	1850.42	1860.64	1859.44	1863.30	0.010464	13.10	214.22	81.01	0.81
Clay Street	500	100 YR	3219.00	1847.91	1860.32	1860.32	1861.87	0.007719	10.75	358.30	108.90	0.65
Clay Street	500	50 YR	2782.00	1847.91	1859.86	1859.86	1861.42	0.008063	10.59	308.77	103.30	0.66
Clay Street	0	100 YR	3219.00	1837.91	1850.32	1850.32	1851.87	0.007719	10.75	358.30	108.90	0.65
Clay Street	0	50 YR	2782.00	1837.91	1849.86	1849.86	1851.42	0.008063	10.59	308.77	103.30	0.66

APPENDIX D - HEC-RAS OUTPUT FOR CEDAR RAVINE

HEC-RAS Plan: Existing River: Cedar Ravine Reach: Cedar Ravine

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
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Cedar Ravine	1536	100YR	450.00	1870.16	1878.05	1875.34	1878.28	0.001029	4.40	129.87	50.18	0.29
Cedar Ravine	1536	50YR	381.00	1870.16	1876.38	1874.78	1877.16	0.004098	7.32	59.29	28.43	0.56
Cedar Ravine	1521		Bridge									
Cedar Ravine	1506	100YR	450.00	1869.16	1876.59		1876.94	0.001673	5.36	106.74	50.18	0.37
Cedar Ravine	1506	50YR	381.00	1869.16	1876.04		1876.48	0.002130	5.71	80.94	40.46	0.41
Cedar Ravine	1466	100YR	450.00	1868.66	1876.65	1873.40	1876.85	0.000939	4.07	137.11	50.18	0.27
Cedar Ravine	1466	50YR	381.00	1868.66	1876.13	1872.86	1876.36	0.001157	4.30	110.82	50.18	0.29
Cedar Ravine	1345.25		Culvert									
Cedar Ravine	1224.5	100YR	450.00	1864.17	1874.11	1870.09	1874.94	0.002390	7.29	61.74	7.83	0.46
Cedar Ravine	1224.5	50YR	381.00	1864.17	1873.10	1869.46	1873.88	0.002453	7.08	53.78	7.83	0.48
Cedar Ravine	1077.75		Culvert									
Cedar Ravine	931	100YR	450.00	1853.20	1863.42		1865.14	0.002918	10.51	42.84	46.53	0.66
Cedar Ravine	931	50YR	381.00	1853.20	1863.27		1864.55	0.002237	9.08	41.98	46.08	0.58
Cedar Ravine	861	100YR	450.00	1852.08	1864.26	1855.31	1864.28	0.000056	1.07	479.39	112.41	0.06
Cedar Ravine	861	50YR	381.00	1852.08	1863.89	1855.05	1863.90	0.000050	0.98	438.76	107.22	0.06