

Appendix Q

**Draft Location Hydraulic Study Report For the
State Route 32 Widening Between Fir Street and
Yosemite Drive at Dead Horse Slough and
South Fork Dead Horse Slough in the
City of Chico, California**

Draft

Location Hydraulic Study Report

**For the State Route 32 Widening
Between Fir Street and Yosemite Drive
At Dead Horse Slough and South Fork Dead Horse Slough
in the City of Chico, California**



Prepared for



**City of Chico
Department of Public Works**



Mark Thomas and Company, Inc

Prepared by



April 2006

Draft

Location Hydraulic Study Report

**For the State Route 32 Widening
Between Fir Street and Yosemite Drive
Over Dead Horse Slough and South Fork Dead Horse Slough
in the City of Chico, California**

Submitted to

**City of Chico
Department of Public Works
&
Mark Thomas and Company, Inc**

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.

Han-Bin Liang, Ph.D., P.E.
Registered Civil Engineer



April 2006

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1 General Discussion

1. Location:

The project location is in the City of Chico, Butte County, California. The Dead Horse Slough Bridge is located along State Route 32 (SR 32) approximately 530 ft east of the SR 32/Forest Avenue intersection. The South Fork Dead Horse Slough is located on SR 32 approximately 140 ft east of the SR 32/Bruce Road intersection. See *Figure 1* for the Project Location Map and *Figure 2* for the Project Vicinity Map.

2. Name of Streams:

- Dead Horse Slough
- South Fork Dead Horse Slough

3. Bridge Numbers:

12C-0135 Existing SR 32 Bridge at Dead Horse Slough

N/A Existing SR 32 8 ft x 6 ft Reinforced Concrete Box
Culvert (RCB) at South Fork Dead Horse Slough

4. Geographical References:

USGS Chico (complete) Quadrangle

Dead Horse Slough Bridge

Latitude: 39° 44' 32" N Longitude: 121° 48' 11" W

South Fork Dead Horse Slough RCB

Latitude: 39° 44' 23" N Longitude: 121° 47' 30" W

5. Description of Proposed Action:

The California Department of Transportation (Caltrans) and The City of Chico proposes to widen SR 32 from east of Fir Street to east of Yosemite Drive. The project extends through the Bruce Road/SR 32 intersection. The widening will generally occur to the north between Fir Street and Bruce Road, where existing right-of-way exists. Beginning just west of Bruce road and extending to Yosemite Drive, SR32 will be symmetrically widened. The scope is to prepare Caltrans PSR/PR and Environmental Document for the four-lane widening with a dirt/grassy median within the project limits. Major development projects are being planned for the area and the City needs planning complete to make sure developers know the ultimate geometry. The project is in the City's General Plan as a four-lane roadway and the Traffic Study has indicated that the ultimate Roadway will be a 4 lane facility. The project is anticipated for construction in 2008. The confluence of Dead Horse Slough with Little Chico Creek is approximately 0.2 mile downstream of the SR 32 crossing. The bridge widening and box culvert extension will be designed by Mark Thomas and Company, Inc. The SR 32 Bridge at Dead Horse Slough will be widened to the north 49 ft for a total bridge width of 81.5 feet. The SR 32 RCB at South Fork Dead Horse Slough will also be extended to accommodate the widened roadway.

6. Hydraulic Data: (Dead Horse Slough at SR 32 Bridge)

Base flood (Q_{100}):	1,900 cfs – based on hydrologic analysis per FEMA LOMR (2005) and Hignell & Hignell, Inc.'s <i>Proposed Husa Ranch Development Flood Mitigation Analysis</i> (February 2001), which was provided by the City of Chico.
Water surface elevation for base flood:	About 238.02 ft just upstream of the proposed bridge – based on hydraulic analysis by WRECO*.
Flood of record discharge:	Not available
Flood of record water surface elevation:	Not available
Tributary Watershed Area:	Approximately 5.2 square miles

* (See the *Draft Bridge Design Hydraulic Study for the State Route 32 Widening Between Fir Street and Yosemite Drive at Dead Horse Slough and South Fork Dead Horse Slough in the City of Chico, California*, (March 2006) for hydraulic analyses)

7. Hydraulic Data: (South Fork Dead Horse Slough at SR 32 RCB)

Base flood (Q_{100}):	470 cfs – based on a HEC-HMS hydrologic model by WRECO*.
Water surface elevation for base flood:	About 254.49 ft just upstream of the proposed culvert – based on hydraulic analysis by WRECO*.
Flood of record discharge:	Not available
Flood of record water surface elevation:	Not available
Tributary Watershed Area:	Approximately 0.9 square miles

* (See the *Draft Bridge Design Hydraulic Study for the State Route 32 Widening Between Fir Street and Yosemite Drive at Dead Horse Slough and South Fork Dead Horse Slough in the City of Chico, California*, (March 2006) for hydraulic analyses)

8. Map of Floodplain:

The FEMA *Flood Insurance Rate Map (FIRM) dated on April 20, 2000 for the Butte County, California and Incorporated Areas Map Number 06007C0510 Revised to Reflect LOMR Dated March 31, 2005* indicates that the 100-year flood inundates an area of about 0.2 acre, 50 feet upstream and 50 feet downstream of the project site. The width of the Dead Horse Slough 100-year floodplain is about 70 ft at the SR 32 Bridge. The *Appendix* shows the FEMA FIRM at the project site.

9. Base Flood (Q_{100}) Backwater Potential to:

Residences:	None
Other Buildings:	None
Crops:	None
Open area:	The Dead Horse Slough and South Fork Dead Horse Slough floodplain is comprised of open area.

The proposed action causes a less than significant increase in backwater potential when compared to the existing condition.

10. Traffic:

Average Daily Traffic (ADT) at Forest Avenue:	15,700
ADT at El Monte Avenue:	11,300
ADT at Bruce Road:	10,400
Year of ADT:	2004
Emergency Supply or Evacuation Route:	Yes. SR 32 may be used to leave Chico and travel towards Chester and the Lassen Volcanic National Park. Conversely, SR 32 may be used to leave Chester and Lassen Volcanic National Park and travel towards Chico, SR 99, and I-5.
Emergency Vehicle Access:	Yes.
Practicable Detour Route:	During construction of the bridge, there will be staged construction. A detour route is unnecessary.
School Bus or Mail Route:	Yes.

11. Approximate Value of Traffic Interruptions for Base Flood (Q_{100}):

None (SR 32 within the project limits is above the Q_{100})

12. Approximate Value of Base Flood (Q_{100}) Damages:

Roadway:	None
Property:	Low (open area adjacent to Dead Horse Slough and its South Fork)
Total:	Low (open area adjacent to Dead Horse Slough and its South Fork)

13. Drainage Pattern:

The topography of the project site is generally sloping from east to west. See *Figure 3* for the Watershed Map of Dead Horse Slough and its south fork.

2 Project Evaluation

1. The risk associated with implementation of the action.

As defined by FHWA, a significant encroachment is a highway encroachment and any direct support of likely base floodplain development that would involve one or more of the following construction or flood related impacts: 1) a significant potential for interruption or termination of a transportation facility which is needed for emergency vehicles or provides a community's only evacuation route; 2) a significant risk; or 3) a significant adverse impact on the natural and beneficial floodplain values.

Table 1 compares the existing and proposed water surface elevations for the 100-year and 50-year storms at the SR 32 Bridge over Dead Horse Slough.

Table 1. Bridge Water Surface Elevations for the Existing and Proposed Conditions (ft)

River Station	Distance to D/S RS	100-year			50-year		
		Existing	Proposed	Change	Existing	Proposed	Change
10882	90	237.85	238.05	0.20	237.19	237.37	0.18
10792	30	237.81	238.04	0.23	237.10	237.31	0.21
10762	118	237.72	237.96	0.24	237.01	237.24	0.23
10644	132	237.16	237.16	0.00	236.48	236.48	0.00
10512	250	236.63	236.63	0.00	235.95	235.95	0.00
10262	154	235.74	235.74	0.00	235.06	235.06	0.00
10108	32	235.36	235.36	0.00	234.67	234.67	0.00
10076	76	235.35	235.35	0.00	234.65	234.65	0.00
10000	0	235.12	235.12	0.00	234.43	234.43	0.00

Table 2 compares the existing and proposed flow velocities for the 100-year and 50-year storms at the SR 32 Bridge over Dead Horse Slough.

Table 2. Bridge Velocities for the Existing and Proposed Conditions (ft/s)

River Station	Distance to D/S RS	100-year			50-year		
		Existing	Proposed	Change	Existing	Proposed	Change
10882	90	7.69	7.36	-0.33	7.07	6.77	-0.30
10792	30	5.75	5.47	-0.28	5.37	5.10	-0.27
10762	118	5.74	5.45	-0.29	5.35	5.07	-0.28
10644	132	5.91	6.71	0.80	5.50	5.50	0.00
10512	250	6.51	6.51	0.00	6.08	6.08	0.00
10262	154	6.54	6.54	0.00	6.10	6.10	0.00
10108	32	5.94	5.95	0.01	5.48	5.48	0.00
10076	76	5.41	5.41	0.00	5.00	5.00	0.00
10000	0	5.69	5.69	0.00	5.28	5.28	0.00

Based on available information, this highway widening project will not have a significant impact on Dead Horse Slough and its floodplain encroachment downstream of the bridge. However, upstream of the bridge, there is an increase in backwater. The 100-year water surface elevation increases 0.24 ft and the 50-year water surface elevation increases 0.23 ft at the upstream face of the bridge. The highway widening will increase the head loss from additional piles, which results in a minor decrease in flow velocity and a less than significant increase in flood plain area.

Table 3 compares the existing and proposed water surface elevations for the 100-year and 50-year storms at the SR 32 RCB at South Fork Dead Horse Slough.

Table 3. RCB Water Surface Elevations for the Existing and Proposed Conditions (ft)

River Station	Distance to D/S RS	100-year			50-year		
		Existing	Proposed	Change	Existing	Proposed	Change
1725	48	254.25	254.48	0.23	253.84	254.06	0.22
1677	214	254.23	254.46	0.23	253.81	254.03	0.22
1463	118	254.26	254.49	0.23	253.84	254.07	0.23
1345	174	249.25	249.25	0.00	248.62	248.62	0.00
1171	171	248.98	248.98	0.00	248.15	248.15	0.00
1000	100	248.93	248.93	0.00	248.08	248.08	0.00
900	0	248.21	248.21	0.00	247.46	247.46	0.00

Table 4 compares the existing and proposed flow velocities for the 100-year and 50-year storms at the SR 32 RCB at South Fork Dead Horse Slough.

Table 4. RCB Velocities for the Existing and Proposed Conditions (ft/s)

River Station	Distance to D/S RS	100-year			50-year		
		Existing	Proposed	Change	Existing	Proposed	Change
1725	48	1.76	1.67	-0.09	1.8	1.71	-0.09
1677	214	2.03	1.91	-0.12	2.11	1.98	-0.13
1463	118	0.60	0.55	-0.05	0.63	0.59	-0.04
1345	174	2.85	2.85	0.00	3.39	3.39	0.00
1171	171	3.90	3.90	0.00	4.86	4.86	0.00
1000	100	2.65	2.65	0.00	3.04	3.04	0.00
900	0	6.34	6.34	0.00	5.95	5.95	0.00

Based on available information, this highway widening project will not have a significant impact on the South Fork Dead Horse Slough and its floodplain. In general, the proposed extension of the RCB will increase the water surface elevations. Downstream of the RCB, the water surface elevations are the same for the existing and proposed conditions. On the other hand, the increase in water surface elevation upstream of the RCB is insignificant. The slight increase in water surface elevation is due to energy losses from the longer RCB. This is explained in the Draft Design Hydraulic Study Report (April 2006). The flow regime upstream and downstream of the RCB is subcritical. However, the flow in the RCB is entirely supercritical.

The alignment of the SR 32 Bridge at Dead Horse Slough and South Fork Dead Horse Slough constitutes a transverse encroachment of the FEMA designated floodplain. No emergency vehicle access will be impacted.

2. The impacts on natural and beneficial floodplain values.

For this highway widening project, there is insignificant impacts to the natural and beneficial floodplain values, which will be mitigated. Natural and beneficial floodplain values shall include, but are not limited to: fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, aquaculture, forestry, natural moderation of floods, water quality maintenance, and groundwater recharge.

3. The support of probable incompatible floodplain development.

This highway widening project would not support any incompatible floodplain development. Portions of the project site are located in the fringe of the floodplain. The highway widening project responds to existing changes in travel that have exceeded the limited capacity of the existing facility. The proposed highway improvements would maintain local and regional access to existing commercial and industrial facilities, in addition to residential and agricultural homes, in the project vicinity, and would not create new access to developed or undeveloped lands.

4. The measures to minimize floodplain impacts associated with the action.

In the existing condition, the 100-year water surface elevation is contained in the reinforced concrete box culvert and the soffit of the bridge. The widening of the reinforced box culvert and bridge will not allow the 100-year flow to overtop the SR 32, and will provide ample freeboard.

5. The measures to restore and preserve the natural and beneficial floodplain values impacted by this action.

There are no identified significant impacts to the natural and beneficial floodplain values. No non-routine measures are required. All environmental impacts will be a result of construction activities and can be mitigated with standard measures such as revegetation, best management practices, and the requirements that are part of the project permit conditions.

The City of Chico and Caltrans will obtain, as necessary, permits or approvals from the US Army Corps of Engineers, (Federal Emergency Management Agency), California Department of Fish and Game, the US Fish and Wildlife Service, and the Regional Water Quality Control Board.

6. The practicability of alternatives to any significant encroachments.

As defined by FHWA, risk shall mean the consequences associated with the probability of flooding attributable to an encroachment. It shall include the potential for property loss and hazard to life during the service life of the bridge and roadway. The increase in risk associated with the highway widening project is negligible.

For this highway widening project, the risks associated with the action are not significant because, in the existing condition, the 100-year flood does not flood the project site adjacent to the Dead Horse Slough and its south fork. The project is primarily improving the existing traffic congestion by widening from two lanes to four lanes. The proposed improvements must cross these creeks and must also cross the flood zones. Any alternative that does not cross the associated flood zones would, therefore, be impracticable.

7. The practicability of alternatives to any longitudinal encroachments.

As defined by FHWA, a longitudinal encroachment is an action within the limits of the base floodplain that is longitudinal to the normal direction of the floodplain.

This highway widening project would not be considered a longitudinal encroachment to the 100-year floodplain. Therefore alternatives are not considered.

3 Summary

The SR 32 Widening Project will improve the existing traffic congestion by widening from two lanes to four lanes. Based on available information, this highway widening project will not have a significant impact on Dead Horse Slough and its floodplain encroachment downstream of the bridge. However, upstream of the bridge, there is a slight increase in backwater. The 100-year water surface elevation increases 0.24 ft and the 50-year water surface elevation increases 0.23 ft at the upstream face of the bridge. The highway widening creates more head losses through the bridge section because of the increased number of piles.

The proposed bridge will be able to contain the 100-year flow and not overtop. The water profile upstream of the bridge will be slightly increased. The water profile downstream of the bridge will not be affected by the proposed action because the downstream water surface is primarily controlled by the downstream floodplain elevation.

The highway widening project will not have a significant impact on the South Fork Dead Horse Slough and its floodplain. In general, the proposed lengthening of the RCB will slightly increase the water surface elevations upstream of the RCB. The water surface elevations downstream of the RCB are the same in the existing and proposed conditions. Upstream and downstream of the RCB, the flow regime is in subcritical. The flow regime in the RCB is entirely supercritical. No significant impacts to beneficial floodplain values are expected, nor does the project promote incompatible floodplain development.

4 References

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4. California Department of Transportation. February 1957. *Dead Horse Slough Bridge General Plan, Foundation Plan, Log of Test Borings, Pile Details, Structural Details*.
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12. Federal Highway Administration. March 1999. *HYDRAIN – Integrated Drainage Design Computer System, Version 6.1*. FHWA-IF-99-008
13. National Geographic Holdings, Inc. 2001. *California: Seamless USGS Topographic Maps on CD-ROM, Version 2.6.8*.
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15. United States Army Corps of Engineers. March 2000. *Hydrologic Modeling System HEC-HMS Technical Reference Manual*.
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SUMMARY OF FLOODPLAIN ENCROACHMENT

State Route: **32**
 Federal Project Number: **N/A**
 Bridge Number: **12C-0135**
 Roads: **Deer Creek Highway (aka SR 32), City of Chico, CA**
 Limits: **Post Mile 11.08**
 Floodplain Description: **100-year flood will be contained in Dead Horse Slough at the project site.**

	YES	NO
1. Is the proposed action a longitudinal encroachment of the base floodplain?		X
2. Are the risks associated with the implementation of the action significant?		X
3. Will the proposed action support probable incompatible floodplain development?		X
4. Are there significant impacts on the natural and beneficial floodplain values?		X
5. Routine construction procedures are required to minimize impacts on the floodplain. Are there special mitigation measures necessary to minimize the impacts or restore and preserve natural and beneficial floodplain values? If yes, explain.		X
6. Does the proposed action constitute a significant floodplain encroachment as defined in 23 CFR 650?		X
7. Is the Location Hydraulic Study that documents the above answers on file in the agency's office? If not, explain.	X	

Prepared By: _____

Signature – Dist. Hydraulic Engineer	Date
Signature – Dist. Environmental Branch Chief	Date
Signature – Dist. Project Engineer	Date

Concurrence: _____

Signature – FHWA	Date
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SUMMARY OF FLOODPLAIN ENCROACHMENT

State Route: **32**
 Federal Project Number: **N/A**
 Bridge Number: **N/A because RCB**
 Roads: **Deer Creek Highway (aka SR 32), City of Chico, CA**
 Limits: **Post Mile 11.73**
 Floodplain Description: **100-year flood will be contained in South Fork Dead Horse Slough at the project site.**

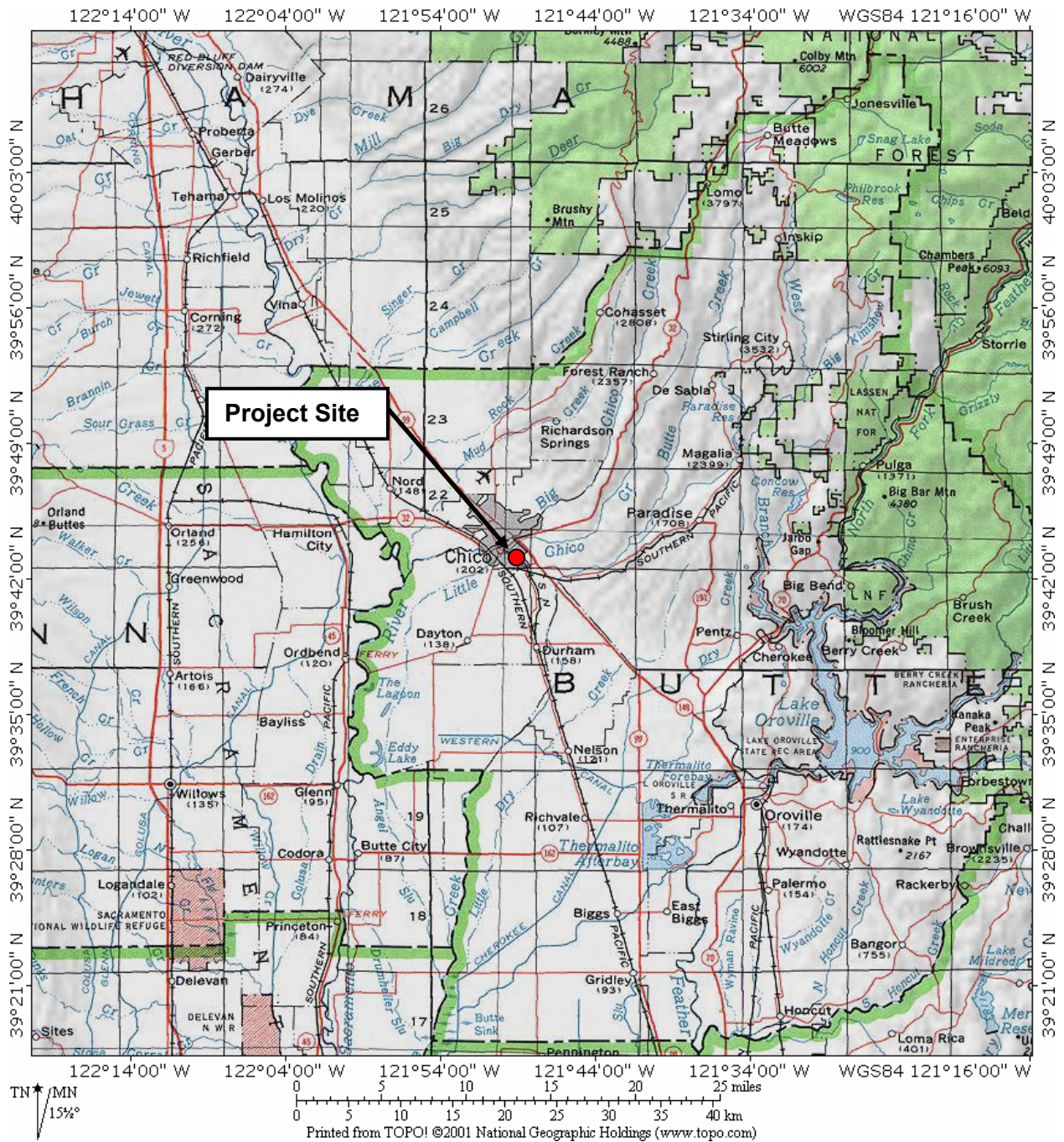
	YES	NO
1. Is the proposed action a longitudinal encroachment of the base floodplain?		X
2. Are the risks associated with the implementation of the action significant?		X
3. Will the proposed action support probable incompatible floodplain development?		X
4. Are there significant impacts on the natural and beneficial floodplain values?		X
5. Routine construction procedures are required to minimize impacts on the floodplain. Are there special mitigation measures necessary to minimize the impacts or restore and preserve natural and beneficial floodplain values? If yes, explain.		X
6. Does the proposed action constitute a significant floodplain encroachment as defined in 23 CFR 650?		X
7. Is the Location Hydraulic Study that documents the above answers on file in the agency's office? If not, explain.	X	

Prepared By: _____
 Signature – Dist. Hydraulic Engineer _____ Date _____

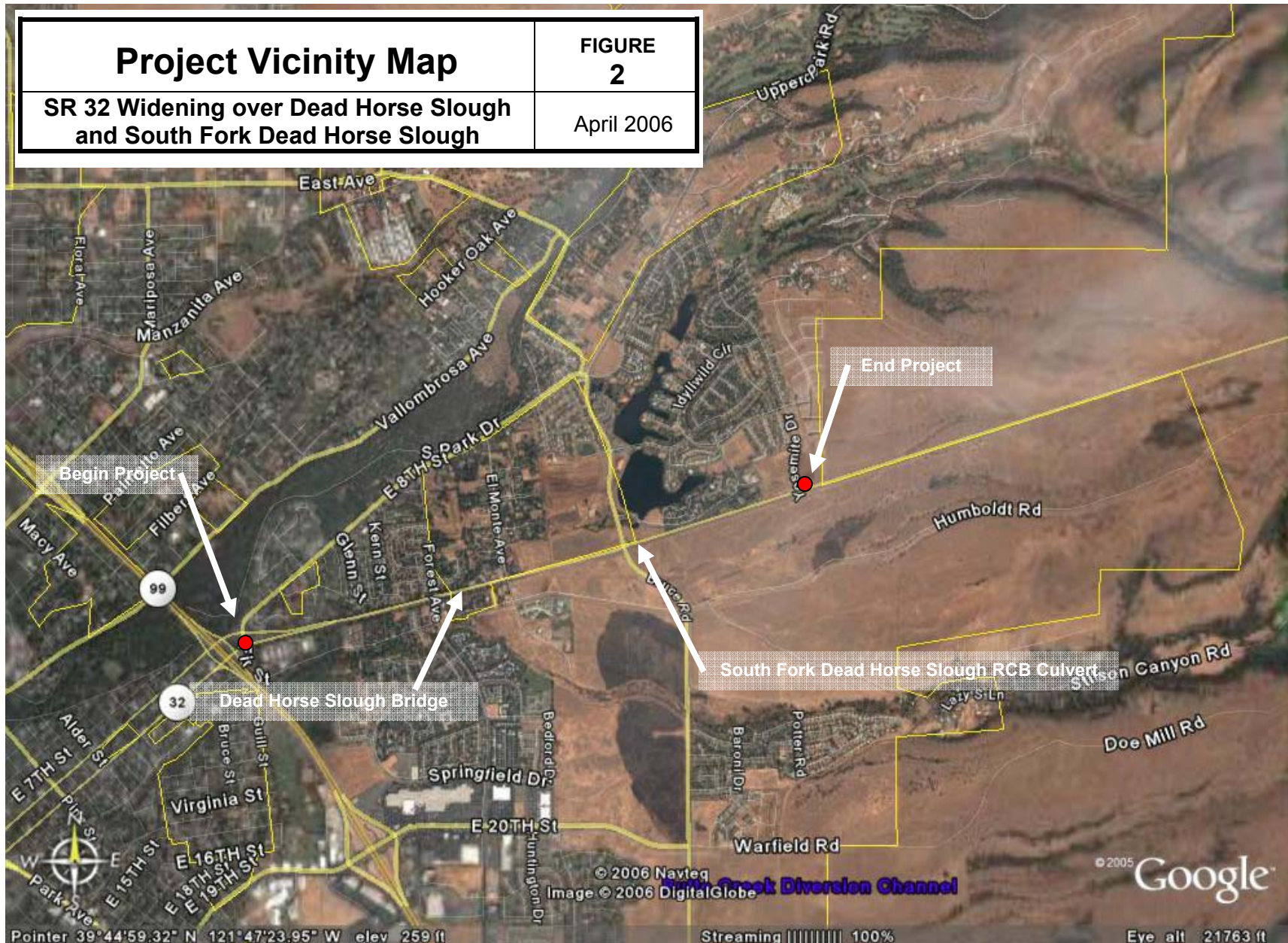
 Signature – Dist. Environmental Branch Chief _____ Date _____

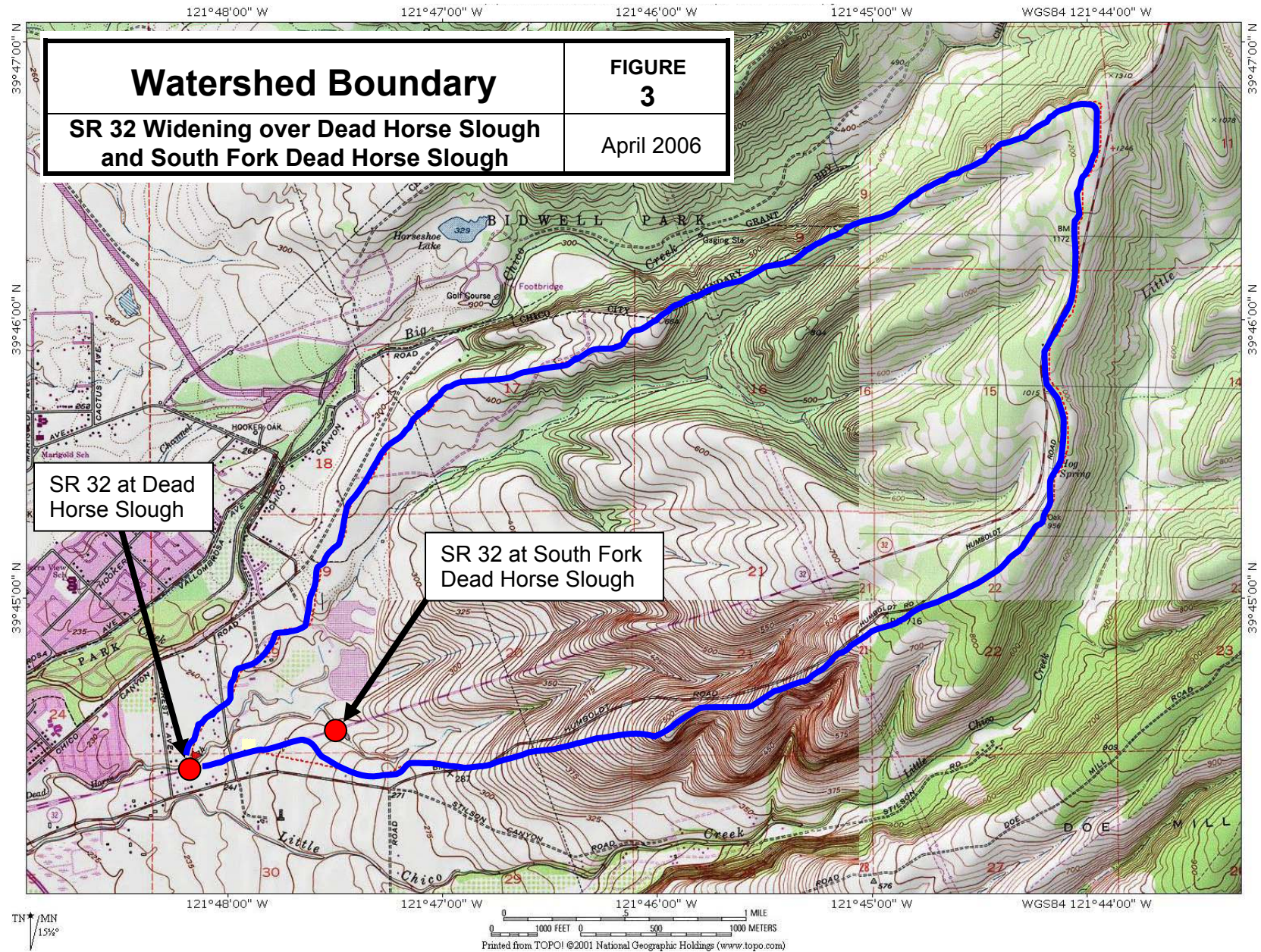
 Signature – Dist. Project Engineer _____ Date _____

Concurrence: _____
 Signature – FHWA _____ Date _____



Project Location Map	FIGURE 1
SR 32 Widening at Dead Horse Slough and South Fork Dead Horse Slough	April 2006





Appendix

Relevant Information to Support the Location Hydraulic Study

FEMA FIRM

(Per LOMR)

Flows From the City of Chico

(Per Borcalli & Associates Report)

12/09/2005 MON 11:00 FAX

001/000



Facsimile Transmittal

City of Chico

**P.O. Box 3420 / 411 Main Street
Chico, CA 95927 / 95928**

Date: 12-5-05

Number of Pages: 5 - including cover sheet

TO: Name: JEFF TUDD

Co.: WRECO

Fax No.: 925-941-0018

FROM: Name: TONY SANDERS
Dept.: Public Works, City of Chico
Phone: (530) 879-6900

MESSAGE:

ATTACHED ARE RELEVANT
PORTIONS OF ANALYSIS.
LET ME KNOW IF YOU NEED
ADDITIONAL INFORMATION

tsanders@ci.chico.ca.us
530-879-6952

12/05/2005 MON 11:58 FAX

002/000

HIGNELL & HIGNELL, INC.
Chico, CA

**PROPOSED HUSA RANCH DEVELOPMENT
FLOOD MITIGATION ANALYSIS**

February 26, 2001



12/03/2003 MON 11:05 PAA

003/003

CHANNEL CAPACITY ANALYSIS

B&A evaluated the 50-year (1,500 cfs) and 10-year (750 cfs) peak flow conditions in the vicinity of the Husa Ranch and El Monte Heights under existing conditions, to determine an approximate event or flow at which water flowed out-of-bank. It was determined the water flowed out-of-bank in both cases. The model was then run with a flow of 500 cfs. The 500 cfs was found to be totally contained within Dead Horse Slough. In summary, without attempting further refinement, the capacity of the channel is between 500 cfs and 750 cfs at this location along Dead Horse Slough, or less than a 10-year event under existing conditions.

With the encroachments proposed under this study being outside the established channel banks, the "out-of-bank" flow will be the same as for existing conditions.

with increased water surface elevation

12/09/2000 MON 11:05 PAA

0004/000

Proposed Conditions

Following consultation with H&H, B&A evaluated the extent to which encroachment into the floodplain could occur within the Husa Ranch property without creating an increase in flood level on property in El Monte Heights. The property between Bruce Road and the Husa Ranch property was modeled as being protected from the 100-year flood since the hydraulic effects of floodplain encroachment on the Husa Ranch would be most prominent on this property. Also, according to H&H, the owner of this property is willing to accept the construction of a levee or floodwall as part of the overall project to protect his property from flooding.

The results of this analysis show that encroachment into the floodplain along Dead Horse Slough can occur without adversely affecting property in El Monte Heights. However, the configuration of the encroachment is important, to avoid adverse impacts. After modeling various encroachment scenarios, B&A determined that encroachment could occur without adversely impacting downstream properties (Map 5). As shown on Map 5, encroachment to the south property line of the Husa Ranch and adjoining property can occur, however, the encroachment must taper back onto the Husa Ranch as it approaches El Monte Heights. Under this proposed condition, the flow split at El Monte Avenue is slightly less than existing conditions with 246 cfs flowing over El Monte Avenue (through El Monte Heights) and the remainder of flow through the channel and under the bridge at El Monte Avenue. Under this proposed condition, the water level is increased up to 0.5 to 0.6 foot in the vicinity of the east property line of the Husa Ranch. Water surface elevations, velocities, and flow depths for the proposed condition are shown on Map 5, Map 6, and Map 7, respectively. ?

The Bruce Road crossing was evaluated in the same manner as existing conditions and the water surface elevation increased slightly to ^{245.77} 245.85 feet msl at the upstream face of the bridge. The flow was still contained within the culverts under Bruce Road.

12/05/2005 MON 11:05 FAX

005/005

100-YEAR FLOODPLAIN ANALYSIS

Existing Conditions

The reach of Dead Horse Slough from El Monte Avenue to Bruce Road was modeled using FESWMS for the 100-year peak flow under existing conditions. The 100-year floodplain with water surface elevations is delineated on Map 1.

This analysis shows El Monte Heights, as well as the southern portion of the Husa Ranch property to flood under a 100-year event. A portion of the peak flow does not flow through the El Monte Avenue Bridge, but flows through El Monte Heights and over El Monte Avenue to the north and reenters Dead Horse Slough downstream. The exact location of where this split flow reenters Dead Horse Slough was not considered important since it should not have a significant backwater effect on the hydraulics of the upstream reach.

The neighbor
hood
would
be
to
know

Under existing conditions, the peak flow of 1,900 cfs is split with approximately 1,643 cfs flowing under the El Monte Avenue Bridge and approximately 257 cfs flowing through El Monte Heights and over El Monte Avenue north of the bridge. The output from the FESWMS model showing water surface elevations, velocities, and depth of flooding throughout the study reach are presented on Map 2, Map 3, and Map 4.

B&A calculated the head loss associated with the Bruce Road culverts and combined it with the FESWMS output to determine the existing flood elevation at the upstream face of Bruce Road. (These culverts could be modeled using FESWMS, however, it would require much greater time and effort to model without any gain in accuracy.) These calculations show the existing 100-year flood surface elevation at 245.77 feet above mean sea level (msl) with all the flow going through the culverts. The lowest elevation where the road could be overtopped is 246.0 feet msl near the intersection of Sunset Terrace Road and Bruce Road.

Sierra Sunrise

