FOR CONTRACT NO.: 01-262004

INFORMATION HANDOUT - PART 8

HYDRAULICS REPORTS

8-1. Final Hydraulic Report, Bridge Nos. 10-0129L/R, 10-0129G, 10-129F, 10-0165L/R, dated March 22, 2005.

8-2. Final Hydraulic Report, Bridge Nos. 10-0159L/R, dated September 15, 2005.

8-3. Final Hydraulic Report, Bridge Nos. 10-0305, 10-0174, 10-0174K, 10-0174S, dated June 30, 2009.

ROUTE: 01-MEN-101-R69.4/78.9

State of California Department of Transportation | Structure Hydraulics

DIVISION OF STRUCTURES
Final Hydraulic Report

Willits Bypass

Located in Mendocino County

JOB:

Bridge No. 10-0129 L/R 10-0129G 10-129F
Bridge No. 10-0165 L/R

New Bridges
Floodway Viaduct

LOCATION:

01-Men-101-KP 70.425

DATE:

March 22, 2005

WRITTEN BY:
Neal Alie

REVIEWED BY:
Steve Jaques

State of California Business, Transportation and Housing Agency

Memorandum

To: Gudmund Setberg
Office of Structure Design
Design Branch 2

Date: March 22, 2005

File: 01-Men-101-KP 70.425
EA 01-262001
Haehl Creek

From: **Department of Transportation**
Engineering Service Center
Office of Structure Maintenance and Investigations

Subject: Final Hydraulic Report for the Willits Bypass.

Attached for your records is the Final Hydraulic Report for the above referenced project. If you have any questions, please contact me at 227-0442.

Sincerely,

Neal Alie, P.E
Hydrology/Hydraulics Engineer

cc: Steve Jaques

General

The Office of Structure Design is proposing to build a new section of highway to improve traffic in the vicinity of the city of Willits by relocating the existing Route 101 to the east of it's current location through the flood plain of Little Lake Valley. The length of the bypass is approximately 14.8 km (9.0 mi) of which 2.6 km (1.6 mi) will be bridge structures. The project consists of the Haehl Creek IC at the south-end of the project and the Floodway Viaduct.

The Haehl Creek Interchange portion of the project consists of four new one- span structures that cross Haehl Creek; S101-W20 Connector, Br. No. 10-0129F is 8.2 m (26.9 ft) wide and 42.0 m (137.8 ft) long, Haehl Creek Bridge (Left), Br. No. 10-0129 is 12.7 m (41.7 ft) wide and 39.0 m (128.0 ft) long, Haehl Creek Bridge (Right), Br. No. 10-0129 is 12.7m (41.7 ft) wide and 49.0 m (160.8 ft) long and Haehl Creek, E20-N101 Connector Bridge, Br. No. 10-0129G is 8.2 m (26.9 ft) wide and 20.0 m (65.6 ft) long. The new structures being proposed are CIP/PS concrete box structures with a structure depth ranging from 1.2 to 1.9 m (3.9 to 6.2 ft) and supported on HP piles.

The Floodway Viaduct portion of the project will cross four creeks, Haehl, Baechtel, Broaduss and Mill/Willits Creek.The floodway Viaduct being proposed will be 12.7 m (41.7 ft) wide and is a CIP/PS concrete box structure with a structure depth of 2.4 m (7.9 ft) supported on driven piles or CISS/CIDH piles.

This report makes extensive reference to data and analysis found in (1) FEMA Flood Insurance Study 1988 (2) Willits Bypass Floodplain Study by the University of Davis, June 1995 (3) Hydraulic Study completed by the North Region Division of Design and Engineering Services, June 3, 1999, (4) General plans and profiles submitted by structures.

All elevations indicated in this report are referenced to the (Datum provided by Structure Design NAVD 88).

Drainage Basin

The City of Willits is located in the Center of Mendocino County, in the north coast region of California. The area around Willits is characterized by steep slopes with mountain streams that flow through the city into a broad flat valley area known as Little Lake Valley, which drains to the north via Outlet Creek. Haehl Creek is one of several tributaries to Outlet Creek. Haehl Creek is located northwest of Morris Reservoir and flows northward towards the city of Willits to it's confluence with

Baechtel Creek. Haehl Creek drains a watershed area of approximately 19.7 sqkm (7.6 sqmi). Baechtel Creek enters the city from the southwest and flows north towards Willits to its confluence with Haehl Creek and drains a watershed of approximately 22.9 sqkm (8.8 sqmi). Broaddus Creek enters the city from the west and flows northeasterly to its confluence with Haehl and Baechtel Creek and drains a watershed of 21.3 sqkm (8.2 sqmi). Mill creek (also known as Willits Creek) flows out of the hills to the west of Willits and through the city to the northeast. North of Willits, the creek joins with other creeks of Little Lake Valley to form Outlet Creek. Mill Creek drains a watershed of approximately 24.2 sqkm (9.3 sqmi). Davis Creek enters the city from the southeast and flows north towards Willits to it's confluence with Outlet Creek and drains a watershed of 36.8 sqkm (14.2 sqmi). There is a also a number of unknown tributaries that range from 5.9 sqkm (2.3 sqmi) to a half a square kilometer that drain into Outlet Creek. The eastern section of Willits is subject to flooding from the creeks flowing into Little Lake Valley. Flooding occurred in the years 1955, 1964 and 1974. In 1964 Little Lake Valley reached a water elevation of approximately 407.0 m.

The climate of the Willits area is west coast Mediterranean. Summers are usually warm and dry; winters are cool and wet. The mean annual precipitation is 1295.0 millimeters (51 inches). Approximately 82 percent of the total precipitation occurs in the period of November through March.

Discharge

The Watershed Modeling System, "WMS" program in conjunction with the National Flood Frequency Equation, "NFF" was used to calculate the 50-year and the 100-year discharges for all the contributing creeks. The table below summarizes the results:

	Drainage Area	Q 50	Q 100
Haehl Creek	*19.7 sqkm (7.6 sqmi)*	*59.5 cms (2100 cfs)*	*69.1 cms (2440 cfs)*
Baechtel Creek	*22.9 sqkm (8.8 sqmi)*	*67.1 cms (2360 cfs)*	*79.0 cms (2790 cfs)*
Broaddus Creek	*21.3 sqkm (8.2 sqmi)*	*63.1 cms (2228 cfs)*	*74.2 cms (2620 cfs)*
Mill/Willits Creek	*24.2 sqkm (9.3 sqmi)*	*70.2 cms (2479 cfs)*	*83.0 cms (2931 cfs)*

Stage, Velocity and Waterway

The U.S. Army Corps of Engineers Hydraulics Engineering Circular-River Analysis System (HEC-RAS) program was used to perform a one-dimensional hydraulic

analysis to calculate the water surface elevation and velocity for the Haehl Creek Structures and for the Floodway Viaduct structures.

The average velocity and stage for the 50-year and 100-year discharges at the upstream face of the new structures for the Haehl Creek bridges are given below. The results are based on a roughness coefficient of 0.035 and an average gradient given below for all the Haehl Creek Bridges.

Haehl Creek Structures

	10-0129F	10-0129L	10-0129R	10-0129G
50-Year Discharge	*59.5 cms (2100 cfs)*	*59.5 cms (2100 cfs)*	*59.5 cms (2100 cfs)*	*59.5 cms (2100 cfs)*
Water Surface Elev.	*443.6 m (1455.4 ft)*	*444.8 m (1459.3 ft)*	*445.2 m (1460.6 ft)*	*446.3 m (1464.2 ft)*
Available Freeboard	***5.1 m (16.7 ft)***	***5.2 m (17.1 ft)***	***5.7 m (18.7 ft)***	***0.89 m (2.9 ft)***
Average Velocity	*1.8 mps (5.9 fps)*	*2.7mps(8.9 ftps)*	*2.7 mps (8.9 ftps)*	*2.0 mps (6.6ftps)*
Slope	*0.006*	*0.007*	*0.007*	*0.005*
100-year Discharge	*69.1 cms (2440 cfs)*	*69.1 cms (2440 cfs)*	*69.10 cms (2440 cfs)*	*69.1 cms (2440 cfs)*
Water Surface Elev.	*443.8 m (1456.0 ft)*	*445.0 m (1460.0 ft)*	*445.4 m (1461.3 ft)*	*446.5 m (1464.9 ft)*
Available Freeboard	***4.9 m (16.1 ft)***	***5.1 m (16.7 ft)***	***5.5 m (18.0 ft)***	***0.70 m (2.3 ft)***
Average Velocity	*1.8 mps (5.9 fps)*	*2.0 mps (6.6 fps)*	*2.0 mps (6.6 fps)*	*2.1 mps (6.9 fps)*

There is more than adequate freeboard for both the 50-year and 100-year storm events for all the Haehl Creek Structures. There is more than adequate waterway for all the new structures below the 100-year water surface elevation. Bridge 10-0129G has the least amount of freeboard with 0.70 m (2.3 ft) below the 100-year flow, but that is still above the Structure Hydraulic standard of 50-year flow plus 0.60 m (2.0 ft).

The average velocity and the stage for the 50-year and 100-year discharges at the upstream face of the new structures for the Floodway Viaduct structures are given below. The results are based on a roughness coefficient of 0.035 and an average gradient given below for the viaduct structures.

Floodway Viaduct

	Hahel Creek (L)	Hahel Creek (R)
50-Year Discharge	*59.50 cms (2100 cfs)*	*59.50 cms (2100 cfs)*
Water Surface Elev.	*413.8 m (1357.6 ft)*	*413.8 m (1357.6 ft)*
Available Freeboard	***4.9 m (16.1 ft)***	***5.0 m (16.4 ft)***
Average Velocity	*1.3 mps (4.3 ftps)*	*1.3 mps (4.3 ftps)*
Slope	*0.001*	*0.001*
100-year Discharge	*69.1 cms (2440 cfs)*	*69.1 cms (2440 cfs)*
Water Surface Elev.	*414.0 m (1358.3 ft)*	*413.9 m (1357.9 ft)*
Available Freeboard	***4.7 m (15.4 ft)***	***4.9 m (16.0 ft)***
Average Velocity	*1.4 mps (4.6 fps)*	*1.4 mps (4.6 fps)*

	Baechtel Creek (L)	Baechtel Creek (R)
50-Year Discharge	*67.1 cms (2360 cfs)*	*67.1 cms (2360 cfs)*
Water Surface Elev.	*411.1 m (1348.8 ft)*	*411.1 m (1348.8 ft)*
Available Freeboard	***8.8 m (28.9 ft)***	***8.8 m (28.9 ft)***
Average Velocity	*2.2 mps (7.2 ftps)*	*2.2 mps (7.2 ftps)*
Slope	*0.002*	*0.002*
100-year Discharge	*79.0 cms (2790 cfs)*	*79.0 cms (2790 cfs)*
Water Surface Elev.	*411.4 m (1349.7 ft)*	*411.4 m (1349.7 ft)*
Available Freeboard	***8.5 m (27.9 ft)***	***8.5 m (27.9 ft)***
Average Velocity	*2.4 mps (7.9 fps)*	*2.4 mps (7.9 fps)*

	Broaddus Creek (L)	Broaddus Creek (R)
50-Year Discharge	*63.1 cms (2228 cfs)*	*63.1 cms (2228 cfs)*
Water Surface Elev.	*411.1 m (1348.8 ft)*	*410.8 m (1347.8)*
Available Freeboard	***9.7 m (31.8 ft)***	***9.5 m (31.2 ft)***
Average Velocity	*2.3 mps (7.5 ftps)*	*2.3 mps (7.5 ftps)*
Slope	*0.007*	*0.007*
100-year Discharge	*74.2 cms (2620 cfs)*	*74.2 cms (2620 cfs)*
Water Surface Elev.	*411.4 m (1349.7 ft)*	*411.2 m (1349.1 ft)*
Available Freeboard	***9.4 m (30.8 ft)***	***9.1 m (29.9 ft)***
Average Velocity	*2.4 mps (7.9 fps)*	*2.4 mps (7.9 fps)*

	Mill Creek (L)	Mill Creek (R)
50-Year Discharge	*70.2 cms (2479 cfs)*	*70.2 cms (2479 cfs)*
Water Surface Elev.	*411.1 m (1348.8 ft)*	*410.6 m (1347.1 ft)*
Available Freeboard	***6.6 m (21.7 ft)***	***7.2 m (23.6 ft)***
Average Velocity	*2.8 mps (9.2 ftps)*	*2.8 mps (9.2 ftps)*
Slope	*0.004*	*0.004*
100-year Discharge	*83.0 cms (2931 cfs)*	*83.0 cms (2931 cfs)*
Water Surface Elev.	*411.4 m (1349.7 ft)*	*410.8 m (1347.8 ft)*
Available Freeboard	***6.4 m (21.0 ft)***	***7.0 m (23.0 ft)***
Average Velocity	*3.1 mps (10.2 fps)*	*3.1 mps (10.2 fps)*

There is more than adequate freeboard and waterway for both the 50-year and 100-year storm events for the portion of the Floodway Viaduct Structure crossing the four creeks.

Streambed and Scour

The streambed at the Haehl Creek Interchange consists of an 8.0 m (26.2 ft) top layer of soft to stiff silty clay and a lower layer of highly fractured sandstone. The streambed for the Floodway Viaduct at the Haehl, Baechtel, Broaduss and Mill/Willits creek consists of a 20.0 m (65.6 ft) top layer of alluvium with soft clay and silt. The lower layer consists of fractured rock.

Haehl Creek Structures

The Haehl Creek Interchange Bridges are all one span structures and there are no local pier scour concerns. Structure Hydraulics does recommend that the abutment foundations should be designed assuming no ground support (lateral or vertical) as a result of soil loss due to possible degradation or lateral stream migration down to the current stream thalwag elevation. The approximate thalwag elevations at the proposed structures are given below.

	Thalwag, (Lowest elevation in channel)
10-0129F	*440.5 m (1445.2 ft)*
10-0129L	*438.5 m (1438.6 ft)*
10-0129R	*442.5 m (1451.8 ft)*
10-0129G	*443.7 m (1455.7 ft)*

Floodway Viaduct

The portion of the Floodway Viaduct crossing Haehl Creek and Mill Creek has no piers in the creek and Structure Hydraulics has no scour concerns. The potential local pier scour for all piers located within Baechtel and Broaddus Creeks was calculated to be 3.6 m (11.8 ft) based on a pier diameter of 1.5 m (5.0 ft). Structure Hydraulics recommends that all new foundations be placed below the anticipated scour elevation.

Structure Hydraulics recommends that the abutment foundations be designed assuming no ground support (lateral or vertical) as a result of soil loss due to possible degradation or lateral stream migration down to the current stream thalwag elevation. The approximate thalwag elevations at the creeks are given below.

	Thalwag, (Lowest elevation in channel)
Hahel Creek (L,R)	*408.5 m (1340.2 ft)*
Baechtel Creek (L, R)	*409.0 m (1341.9 ft)*
Broaddus Creek (L,R)	*407.5 m (1336.9 ft)*
Mill Creek (L, R)	*409.0 m (1341.9 m)*

Drift

A moderate amount of drift can be expected during a flood event.

Bank Protection

Rock slope protection will be designed by the District to protect the roadway approach fills, if required. The average velocity has been provided to assist the District hydraulic engineers in the design of bank protection if necessary. (See pages 3 and 4).

Haehl Creek Structures

HYDROLOGIC SUMMARY **10-0129F**			
Drainage Area: 19.7 sqkm			
	Design Flood	**Base Flood**	**Overtopping Flood/Flood of Record?**
Frequency	50-yr	100-yr	N/A
Discharge	59.5 cms (2100 cfs)	69.10 cms (2440 cfs)	N/A
Water Surface Elevation at Bridge	443.6 m (1455.4 ft)	443.8 m (1456.0 ft)	N/A
Flood plain data are based upon information available when the plans were prepared and are shown to meet federal requirements. The accuracy of said information is not warranted by the State and interested or affected parties should make their own investigation.			

HYDROLOGIC SUMMARY **10-0129 (Left)**			
Drainage Area: 19.7 sqkm			
	Design Flood	**Base Flood**	**Overtopping Flood/Flood of Record?**
Frequency	50-yr	100-yr	N/A
Discharge	59.50 cms (2100 cfs)	69.1 cms (2440 cfs)	N/A
Water Surface Elevation at Bridge	444.8 m (1459.3 ft)	445.0 m (1460.0 ft)	N/A
Flood plain data are based upon information available when the plans were prepared and are shown to meet federal requirements. The accuracy of said information is not warranted by the State and interested or affected parties should make their own investigation.			

HYDROLOGIC SUMMARY **10-0129 (Right)**			
Drainage Area: 19.7 sqkm			
	Design Flood	**Base Flood**	**Overtopping Flood/Flood of Record?**
Frequency	50-yr	100-yr	N/A
Discharge	59.5 cms (2100 cfs)	69.1 cms (2440 cfs)	N/A
Water Surface Elevation at Bridge	445.2 m (1460.6 ft)	445.4 m (1461.3 ft)	N/A
Flood plain data are based upon information available when the plans were prepared and are shown to meet federal requirements. The accuracy of said information is not warranted by the State and interested or affected parties should make their own investigation.			

HYDROLOGIC SUMMARY **10-0129G**			
Drainage Area: 19.7 sqkm			
	Design Flood	**Base Flood**	**Overtopping Flood/Flood of Record?**
Frequency	50-yr	100-yr	N/A
Discharge	59.5 cms (2100 cfs)	69.1 cms (2440 cfs)	N/A
Water Surface Elevation at Bridge	446.3 m (1464.2 ft)	446.5 m (1464.9 ft)	N/A
Flood plain data are based upon information available when the plans were prepared and are shown to meet federal requirements. The accuracy of said information is not warranted by the State and interested or affected parties should make their own investigation.			

Floodway Viaduct

HYDROLOGIC SUMMARY **Haehl Creek (Left)**			
Drainage Area: 19.7 sqkm			
	Design Flood	**Base Flood**	**Overtopping Flood/Flood of Record?**
Frequency	50-yr	100-yr	N/A
Discharge	59.5 cms (2100 cfs)	69.1 cms (2440 cfs)	N/A
Water Surface Elevation at Bridge	413.8 m (1357.6 ft)	414.0 m (1358.3 ft)	N/A
Flood plain data are based upon information available when the plans were prepared and are shown to meet federal requirements. The accuracy of said information is not warranted by the State and interested or affected parties should make their own investigation.			

HYDROLOGIC SUMMARY **Haehl Creek (Right)**			
Drainage Area: 19.7 sqkm			
	Design Flood	**Base Flood**	**Overtopping Flood/Flood of Record?**
Frequency	50-yr	100-yr	N/A
Discharge	59.5 cms (2100 cfs)	69.1 cms (2440 cfs)	N/A
Water Surface Elevation at Bridge	413.8 m (1357.6 ft)	413.9 m (1357.9 ft)	N/A
Flood plain data are based upon information available when the plans were prepared and are shown to meet federal requirements. The accuracy of said information is not warranted by the State and interested or affected parties should make their own investigation.			

HYDROLOGIC SUMMARY **Baechtel Creek (Left)**			
Drainage Area: 22.9 sqkm			
	Design Flood	**Base Flood**	**Overtopping Flood/Flood of Record?**
Frequency	50-yr	100-yr	N/A
Discharge	67.1 cms (2360 cfs)	79.0 cms (2790 cfs)	N/A
Water Surface Elevation at Bridge	411.1 m (1348.8 ft)	411.4 m (1349.7 ft)	N/A
Flood plain data are based upon information available when the plans were prepared and are shown to meet federal requirements. The accuracy of said information is not warranted by the State and interested or affected parties should make their own investigation.			

HYDROLOGIC SUMMARY **Baechtel Creek (Right)**			
Drainage Area: 22.9 sqkm			
	Design Flood	**Base Flood**	**Overtopping Flood/Flood of Record?**
Frequency	50-yr	100-yr	N/A
Discharge	67.1 cms (2360 cfs)	79.0 cms (2790 cfs)	N/A
Water Surface Elevation at Bridge	411.1 m (1348.8 ft)	411.4 m (1349.7 ft)	N/A
Flood plain data are based upon information available when the plans were prepared and are shown to meet federal requirements. The accuracy of said information is not warranted by the State and interested or affected parties should make their own investigation.			

HYDROLOGIC SUMMARY **Broaduss Creek (Left)**			
Drainage Area: 21.3 sqkm			
	Design Flood	**Base Flood**	**Overtopping Flood/Flood of Record?**
Frequency	50-yr	100-yr	N/A
Discharge	63.1 cms (2228 cfs)	74.2 cms (2620 cfs)	N/A
Water Surface Elevation at Bridge	411.1 m (1348.8 ft)	411.4 m (1349.7 ft)	N/A
Flood plain data are based upon information available when the plans were prepared and are shown to meet federal requirements. The accuracy of said information is not warranted by the State and interested or affected parties should make their own investigation.			

HYDROLOGIC SUMMARY **Broaduss Creek (Right)**			
Drainage Area: 21.3 sqkm			
	Design Flood	**Base Flood**	**Overtopping Flood/Flood of Record?**
Frequency	50-yr	100-yr	N/A
Discharge	63.1 cms (2228 cfs)	74.2 cms (2620 cfs)	N/A
Water Surface Elevation at Bridge	410.8 m (1347.8 ft)	411.2 m (1349.1 ft)	N/A
Flood plain data are based upon information available when the plans were prepared and are shown to meet federal requirements. The accuracy of said information is not warranted by the State and interested or affected parties should make their own investigation.			

HYDROLOGIC SUMMARY **Mill/Willits Creek (Left)**			
Drainage Area: 24.2 sqkm			
	Design Flood	**Base Flood**	**Overtopping Flood/Flood of Record?**
Frequency	50-yr	100-yr	N/A
Discharge	70.2 cms (2479 cfs)	83.0 cms (2931 cfs)	N/A
Water Surface Elevation at Bridge	411.6 m (1348.8 ft)	411.4 m (1349.7 ft)	N/A
Flood plain data are based upon information available when the plans were prepared and are shown to meet federal requirements. The accuracy of said information is not warranted by the State and interested or affected parties should make their own investigation.			

HYDROLOGIC SUMMARY **Mill/Willits Creek (Right)**			
Drainage Area: 24.2 sqkm			
	Design Flood	**Base Flood**	**Overtopping Flood/Flood of Record?**
Frequency	50-yr	100-yr	N/A
Discharge	70.2 cms (2479 cfs)	83.0 cms (2931 cfs)	N/A
Water Surface Elevation at Bridge	410.6 m (1347.1 ft)	410.8 m (1347.8 ft)	N/A
Flood plain data are based upon information available when the plans were prepared and are shown to meet federal requirements. The accuracy of said information is not warranted by the State and interested or affected parties should make their own investigation.			

This report has been prepared under my direction as the professional engineer in responsible charge of the work, in accordance with the provisions of the professional Engineers Act of the State of California.

REGISTERED CIVIL ENGINEER (SIGNATURE) _____

REGISTRATION NUMBER: C056398 DATE: 3/22/05

REGISTERED PROFESSIONAL ENGINEER
NEAL ALI
No. C056398
Exp. 6/05
CIVIL
STATE OF CALIFORNIA

Memorandum

To: Gudmund Setberg
Office of Bridge Design
Design Branch 2
Att: Marc Friedheim

Date: December 30, 2008

File: 01-MEN-101-KP70.425
Willits Bypass
Upp Creek Bridges
01-262001

From: **Department of Transportation**
Hydraulic Engineering Branch

Subject: Final Hydraulic Report

Attached for your records is the Final Hydraulic Report for the above referenced project. If you have any questions, please contact me at 227-0442.

Sincerely,

Neal Alie, P.E.
Hydrology/Hydraulics Engineer

cc: Steve Ng

DIVISION OF STRUCTURES
Final Hydraulic Report

Willits Bypass
Upp Creek Bridge's

Located in Mendocino County

JOB:

Bridge No. 10-0305 Bridge No. 10-0174
Bridge No. 10-0174K Bridge No. 10-0174S

LOCATION:

01-MEN-101-KP70.425

DATE:

December 30, 2008

WRITTEN BY:
Neal Alie

REVIEWED BY:
Steve Ng

General

The Office of Structure Design is proposing to build a new section of highway to improve traffic in the vicinity of the city of Willits by relocating the existing Route 101 to the east of it's current location through the flood plain of Little Lake Valley. Design is proposing to add four more bridges at the North end of the Willits Bypass Project. These new structures are in the vicinity of the Quail Meadows Interchange and will span Upp Creek. The district was originally planning to install box culverts but decided to construct four Bridges, Br. No. 10-0305, 10-0174K, 10-0174, and 10-0174S instead.

Br. No. 10-0305 is a single span 1.8 ft slab structure approximately 68.9 ft long and 57.4 ft wide. Br. No.10-0174K the SB Off-Ramp is a single span 4.6 ft CIP/RC Box Girder structure approximately 79.0 ft long and 27.0 ft wide. Br. No. 10-0174 the main line Rte 101 structure, is a single span 4.6 ft Prestressed CIP Box Girder structure approximately 102.0 ft long and 43.0 ft wide. Br. No. 10-0174S the NB On-Ramp, is a single span 4.9 ft CIP/RC Box Girder structure approximately 82.0 ft long and 26.9 ft long. All four bridges are supported on spread footings with piles.

This report makes extensive reference to data and analysis found in (1) FEMA Flood Insurance Study 1988 (2) Willits Bypass Floodplain Study by the University of Davis, June 1995 (3) Hydraulic Study completed by the North Region Division of Design and Engineering Services, June 3, 1999, (4) Final Hydraulic Report, Structures Hydraulics, February 22.2005, (5) Floodplain Evaluation Report, CH2MHILL, September 30, 2007 (6) General plans and profiles submitted by structures.

All elevations indicated in this report are referenced to the datum provided by Structure Design NAVD 88, September 17, 2008.

Drainage Basin

The City of Willits is located in the center of Mendocino County, in the north coast region of California. The area around Willits is characterized by steep slopes with mountain streams that flow through the city into a broad flat valley area known as Little Lake Valley, which drains to the north via Outlet Creek. Upp Creek enters the City of Willits from the North West and flows south until its confluence with Mill Creek approximately 2200 ft downstream from the existing State Route 101. Upp Creek drains a watershed area of approximately 2.6 square miles.

The climate of the Willits area is west coast Mediterranean. Summers are usually warm and dry; winters are cool and wet. The mean annual precipitation is 51 inches. Approximately 82 percent of the total precipitation occurs in the period of November through March.

Discharge

The Watershed Modeling System, "WMS" program in conjunction with the National Flood Frequency Equation, "NFF" was used to calculate a 50-year and 100-year discharges of **869.0 cfs** and **974.0 cfs** respectfully.

Stage, Velocity and Waterway

The Hydraulic Program (BrEase) was used to perform a one-dimensional hydraulic analysis to calculate the water surface elevation and velocity at the bridge locations. The average velocity and stage for the 50-year and 100-year discharges at the upstream face of the new structures for the Upp Creek bridges are given below.

Br. No. 10-0305 UPP Creek Bridge

50-Year Discharge	869.0 cfs
Velocity (50-year)	4.4 fps
WSEL (50-Year)	1338.6 ft
Minimum Soffit Elevation	1342.2 ft
Available Freeboard	**3.5 ft**
100-year Discharge	974.0 cfs
Velocity (100-year)	4.6 fps
WSEL (100-Year)	1338.8 ft
Available Freeboard	**3.3 ft**

The results are based on a roughness coefficient of 0.05 and an average gradient of 0.006. There is adequate freeboard for both the 50-year and 100-year storm events for this proposed structure.

Br. No. 10-0174K UPP Creek (SB Off-Ramp)

50-Year Discharge	869.0 cfs
Velocity (50-year)	5.1 fps
WSEL (50-Year)	1332.9 ft
Minimum Soffit Elevation	1344.2 ft
Available Freeboard	**11.3 ft**
100-year Discharge	974.0 cfs
Velocity (100-year)	5.3 fps
WSEL (100-Year)	1333.1 ft
Available Freeboard	**11.1 ft**

The results are based on a roughness coefficient of 0.05 and an average gradient of 0.004. There is adequate freeboard for both the 50-year and 100-year storm events for this proposed structure.

Br. No. 10-0174 UPP Creek Bridge (Mainline Rte 101)

50-Year Discharge	869.0 cfs
Velocity (50-year)	4.1 fps
WSEL (50-Year)	1333.2 ft
Minimum Soffit Elevation	1353.7 ft
Available Freeboard	**20.5 ft**
100-year Discharge	974.0 cfs
Velocity (100-year)	4.3 fps
WSEL (100-Year)	1333.5 ft
Available Freeboard	**20.1 ft**

The results are based on a roughness coefficient of 0.05 and an average gradient of 0.003. There is more than adequate freeboard for both the 50-year and 100-year storm events for this proposed structure.

Br. No. 10-0174S UPP Creek (NB On-Ramp)

50-Year Discharge	869.0 cfs
Velocity (50-year)	3.6 fps
WSEL (50-Year)	1335.7 ft
Minimum Soffit Elevation	1346.1 ft
Available Freeboard	**10.5 ft**
100-year Discharge	974.0 cfs
Velocity (100-year)	3.9 fps
WSEL (100-Year)	1336.1 ft
Available Freeboard	**10.0 ft**

The results are based on a roughness coefficient of 0.05 and an average gradient of 0.002. There is adequate freeboard for both the 50-year and 100-year storm events for this proposed structure.

Streambed and Scour

The 4 Upp Creek Structures being proposed are all one-span structures with no piers in the water. The only concern Structure Hydraulics may have is if there is future degradation and migration, which would cause the thalwag of the stream to move towards the abutments. The table below shows the thalwag elevations for each proposed structure.

	Thalwag, (lowest elevation in stream bank)
Br. No. 10-0305	1334.9 ft
Br. No. 10-0174K	1329.3 ft
Br. No. 10-0174 UPP	1328.1 ft
Br. No. 10-0174S	1328.1 ft

Structure Hydraulics recommends that all new foundations be designed assuming no ground support (lateral or vertical) as a result of soil loss due to possible scour or lateral stream migration to the thalwag elevations given above. The final unsupported elevation for the new foundations should be consulted with the Geotechnical Branch.

Drift

A moderate amount of drift can be expected during a flood event.

Bank Protection

The district if needed will design rock slope protection. Velocities have been provided on page 2, 3, and 4 for the proposed structures.

HYDROLOGIC SUMMARY (**Br. No. 10-0305**)			
Drainage Area: 2.64 sqmi			
	Design Flood	**Base Flood**	**Overtopping Flood/Flood of Record?**
Frequency	50-yr	100-yr	N/A
Discharge	869.0 cfs	974.0 cfs	N/A
Water Surface Elevation at Bridge	1338.6 ft	1338.8 ft	N/A
Flood plain data are based upon information available when the plans were prepared and are shown to meet federal requirements. The accuracy of said information is not warranted by the State and interested or affected parties should make their own investigation.			

HYDROLOGIC SUMMARY (**Br. No. 10-0174K UPP Creek (SB Off-Ramp)**			
Drainage Area: 2.64 sqmi			
	Design Flood	**Base Flood**	**Overtopping Flood/Flood of Record?**
Frequency	50-yr	100-yr	N/A
Discharge	869.0 cfs	974.0 cfs	N/A
Water Surface Elevation at Bridge	1332.9 ft	1333.1 ft	N/A
Flood plain data are based upon information available when the plans were prepared and are shown to meet federal requirements. The accuracy of said information is not warranted by the State and interested or affected parties should make their own investigation.			

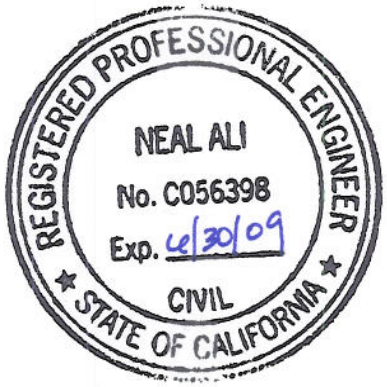
HYDROLOGIC SUMMARY **Br. No. 10-0174 UPP Creek Bridge (Mainline Rte 101)**			
Drainage Area: 2.64 sqmi			
	Design Flood	**Base Flood**	**Overtopping Flood/Flood of Record?**
Frequency	50-yr	100-yr	N/A
Discharge	869.0 cfs	974.0 cfs	N/A
Water Surface Elevation at Bridge	1333.2 ft	1333.5 ft	N/A
Flood plain data are based upon information available when the plans were prepared and are shown to meet federal requirements. The accuracy of said information is not warranted by the State and interested or affected parties should make their own investigation.			

HYDROLOGIC SUMMARY **Br. No. 10-0174S Upp Creek Bridge (NB on-Ramp)**			
Drainage Area: 2.64 sqmi			
	Design Flood	**Base Flood**	**Overtopping Flood/Flood of Record?**
Frequency	50-yr	100-yr	N/A
Discharge	869.0 cfs	974.0 cfs	N/A
Water Surface Elevation at Bridge	1335.7 ft	1336.1 ft	N/A
Flood plain data are based upon information available when the plans were prepared and are shown to meet federal requirements. The accuracy of said information is not warranted by the State and interested or affected parties should make their own investigation.			

This report has been prepared under my direction as the professional engineer in responsible charge of the work, in accordance with the provisions of the professional Engineers Act of the State of California.

REGISTERED CIVIL ENGINEER (SIGNATURE)

REGISTRATION NUMBER: C056398 DATE: 12-30-08



State of California Business, Transportation and Housing Agency

Memorandum

To: Gudmund Setberg
Office of Structure Design
Design Branch 2

Date: September 15, 2005

File: 01-Men-101-KP 70.425
EA 01-262001
Haehl Creek Bridges
10-0159 L/R

From: **Department of Transportation**
Engineering Service Center
Office of Structure Maintenance and Investigations

Subject: Final Hydraulic Report for the Willits Bypass.

Attached for your records is the Final Hydraulic Report for the above referenced project. If you have any questions, please contact me at 227-0442.

Sincerely,

Neal Alie, P.E
Hydrology/Hydraulics Engineer

cc: Steve Jaques

State of California Department of Transportation Structure Hydraulics

DIVISION OF STRUCTURES
Final Hydraulic Report

Willits Bypass

Located in Mendocino County

JOB:
Bridge No. 10-0159 L/R New Bridges

LOCATION:
01-Men-101-KP 70

DATE:
September 15, 2005

WRITTEN BY:
Neal Alie

REVIEWED BY:
Steve Jaques

General

The Office of Structure Design is proposing to build a new section of highway to improve traffic in the vicinity of the city of Willits by relocating the existing Route 101 to the east of it's current location through the flood plain of Little Lake Valley. The length of the bypass is approximately 14.8 km (9.0 mi) of which 2.6 km (1.6 mi) will be bridge structures. The project consists of the Haehl Creek IC at the south-end of the project, the Haehl Creek Bridges just beyond East Hill Road and south of the Floodway Viaduct and the Floodway Viaduct. This report addresses the Haehl Creek Bridges beyond East Hill Road and is a supplement to the Final Hydraulic Report completed February 2, 2005.

The left bridge is a CIP/PS single-span structure with a structural section of 2.2 m (7.2 ft) and is 80.0 m (262.5 ft) long and 12.6 m, (41.3 ft) wide. The right bridge is a CIP/PS two-span structure with a structural section of 1.4 m (4.6 ft) and is 95.0 m (311.7 ft) long and 11.7 m, (38.4 ft) wide.

This report makes extensive reference to data and analysis found in (1) FEMA Flood Insurance Study 1988 (2) Willits Bypass Floodplain Study by the University of Davis, June 1995 (3) Hydraulic Study completed by the North Region Division of Design and Engineering Services, June 3, 1999, (4) General plans and profiles submitted by structures.

All elevations indicated in this report are referenced to the datum provided by Structure Design NAVD 88.

Drainage Basin

The City of Willits is located in the center of Mendocino County, in the north coast region of California. The area around Willits is characterized by steep slopes with mountain streams that flow through the city into a broad flat valley area known as Little Lake Valley, which drains to the north via Outlet Creek. Haehl Creek is one of several tributaries to Outlet Creek. Haehl Creek is located northwest of Morris Reservoir and flows northward towards the city of Willits to it's confluence with Baechtel Creek. Haehl Creek drains a watershed area of approximately 19.7 sqkm (7.6 sqmi). Baechtel Creek enters the city from the southwest and flows north towards Willits to its confluence with Haehl Creek and drains a watershed of approximately 22.9 sqkm (8.8 sqmi). The eastern section of Willits is subject to flooding from the creeks flowing into Little Lake Valley. Flooding occurred in the years 1955, 1964 and 1974. In 1964 Little Lake Valley reached a water elevation of

approximately 407.0 m (1335.3 ft).

The climate of the Willits area is west coast Mediterranean. Summers are usually warm and dry; winters are cool and wet. The mean annual precipitation is 1295.0 millimeters (51 inches). Approximately 82 percent of the total precipitation occurs in the period of November through March.

Discharge

The Watershed Modeling System, "WMS" program in conjunction with the National Flood Frequency Equation, "NFF" was used to calculate the 50-year and the 100-year discharges for all the contributing creeks. The table below summarizes the results for Haehl Creek.

	Drainage Area	Q 50	Q 100
Haehl Creek	*19.7 sqkm (7.6 sqmi)*	*59.5 cms (2100 cfs)*	*69.1 cms (2440 cfs)*

Stage, Velocity and Waterway

The Hydraulic Program (BrEase) was used to perform a one-dimensional hydraulic analysis to calculate the water surface elevation and velocity at the bridge locations. The average velocity and stage for the 50-year and 100-year discharges at the upstream face of the new structures for the Haehl Creek bridges are given below. The results are based on a roughness coefficient of 0.035 and an average gradient of 0.004 for the Haehl Creek Bridges.

Haehl Creek Structures

	10-0159L	10-0159R
50-Year Discharge	*59.5 cms (2100 cfs)*	*59.5 cms (2100 cfs)*
Water Surface Elev.	*417.9 m (1371.1 ft)*	*417.4 m (1369.4 ft)*
Available Freeboard	***3.9 m (12.8 ft)***	***5.0 m (16.4 ft)***
Average Velocity	*2.17 mps (7.1 fps)*	*1.64 mps (5.4 ftps)*
100-year Discharge	*69.1 cms (2440 cfs)*	*69.1 cms (2440 cfs)*

Water Surface Elev.	*418.1 m (1371.7 ft)*	*417.5 m (1369.8 ft)*
Available Freeboard	***3.7 m (12.1 ft)***	***4.9 m (16.1 ft)***
Average Velocity	*2.18 mps (7.2 fps)*	*1.73 mps (5.7 fps)*

There is more than adequate freeboard for both the 50-year and 100-year storm events for the Haehl Creek Bridges. The waterway area of 62.5 sqm (672.7 sqft) for the left structure and 84.0 sqm (904.2 sqft) for the right structure is adequate for the 100-year water surface elevation.

Streambed and Scour

The Left Haehl Creek Bridge is a one span structure and there are no local pier scour concerns. Structure Hydraulics does recommend that the abutment foundations for both the left and right bridge should be designed assuming no ground support (lateral or vertical). as a result of soil loss due to possible degradation or lateral stream migration down to the current stream thalwag elevation of 414.3 m (1359.3 ft).

The potential local pier scour for the Right Haehl Creek Bridge was calculated to be 3.1 m (10.2 ft) at elevation 411.6 m, (1350.4 ft) for pier 2 assuming migration.

Structure Hydraulics recommends that all new foundations be placed below the anticipated scour elevation.

A moderate amount of drift can be expected during a flood event.

Bank Protection

Rock slope protection will be designed by the District to protect the roadway approach fills, if required. The average velocity has been provided to assist the District hydraulic engineers in the design of bank protection if necessary. (See pages 2 and 3).