STRUCTURE HYDRAULICS & HYDROLOGY
REVISED
FINAL HYDRAULIC REPORT

Horsethief Creek Bridge (Replace)

Located approximately 0.2 miles south of SR 173 on SR 138 over Horesethief Creek in San Bernardino County

JOB:
Bridge No. 54-0816 (Existing)
Bridge No. 54-1271 (Proposed)

LOCATION:
08-SBD-138-R24.11

Project No. 0800000324

WRITTEN BY:
Diane O'Brien

DATE:
September 23, 2013

REVIEWED BY:
Ronald McGaugh

DATE:
September 23, 2013

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Hydrology/Hydraulics Report

General

It is proposed to replace the Horsethief Creek Bridge (Bridge No. 54-0816) located on State Route 138 in San Bernardino County. The existing bridge was constructed in 1968 as a continuous three-span, reinforced concrete (RC) Box Girder with RC open-end diaphragm abutments and three-column bents, all on footings on piles. The span lengths are 54 feet, 148 feet, and 62 feet, for a total bridge length of 264 feet. The streambed is partially lined with rock rip rap.

Based on information provided by Structure Design, the existing bridge has exhibited signs of moderate to severe Alkali-Silica Reactivity. It is proposed to be replaced with a three-span PC/PS/PT Bulb T-Girder superstructure on 48-inch-diameter CIDH three-column bents in 60-inch-diameter casings. The abutment foundations are 36-inch-diameter CIDH piles in 48-inch-diameter casings. The new span lengths are 53'-0", 185'-0", and 53'-9". The bridge length and width are 291'-9" and 47'-6", respectively, with a substructure depth of 8'-8$^{3}/_{4}$" (minimum).

This report is based on the General Plan and Foundation Plan provided by Structure Design dated September 11, 2013. **All elevations indicated in this report are based on Vertical Datum NGVD 1929.**

Basin

At the bridge site, the Horsethief Creek watershed encompasses 13.8 square miles of predominately undeveloped land within the San Bernardino National Forest. The creek flows in an easterly direction through Summit Valley, which roughly bisects the basin. The basin is bounded by Cajon Pass on the west, Cleghorn Ridge on the south, and an unnamed ridge on the north. Approximately 2 miles downstream of the bridge, the creek flows into the West Fork of the Mojave River.

Based on land use data compiled by the Department of Water Resources, the watershed is comprised of approximately 97% shrub-brushland and rangeland, and less than 2% of developed land (i.e., residential, commercial, etc.). Elevations within the watershed range from 5,333 feet at Cleghorn Mountain and approximately 3,230 feet at the bridge site. Average annual precipitation ranges from approximately 39 inches along the Cleghorn Ridge on the south side of the basin to approximately 25 inches along the northern end of the basin.

Discharge

Horsethief Creek is an ungaged watershed. There is no information about a flood of record. The HEC-1 module within Watershed Modeling System (WMS) 8.4 was used to assist in the estimation of the 100-year and 50-year discharges at the bridge site. The Q100 and Q50 discharges are 10,000 cfs and 7,000 cfs, respectively.

Stage

HEC-RAS 4.1.0 was used to model the Q100 and Q50 discharges in the channel and through the bridge opening. The Manning's roughness coefficients used varied from 0.029 to 0.08, representing channel conditions ranging from sand bars to a heavy vegetated main channel.

The maximum water surface elevations for the Q100 and Q50 discharges are 3244.7 feet and 3243.0 feet, respectively. A minimum freeboard of 2 feet above the Q100 is recommended. This corresponds to a minimum soffit elevation of 3246.7 feet. The proposed bridge soffit will be more than 10 feet above this elevation.

The Horsethief Creek Q100 water surface elevation modeled with the proposed replacement bridge was compared to existing conditions. The Q100 water surface elevation will not be affected by the construction of the bridge replacement.

Overtopping Flood

At extremely high discharges Horsethief Creek will spread across its floodplain and overtop the highway north of the creek well before the water surface elevation can approach the bridge soffit elevation. Therefore it is not possible to calculate a discharge that will overtop the bridge.

Velocity

The velocities corresponding to the Q100 discharge were computed using HEC-RAS version 4.1.0. The flow regime approaching the bridge is subcritical although at other locations within the model flow is supercritical due to abrupt changes in flow area. During the 100-year flood event the velocity approaching the upstream face of the bridge is 11 fps.

Streambed

The streambed is composed of granitic sand and silt with larger cobbles and boulders. This material is scourable and subject to erosion. The As-Builts indicate that the creek was realigned, banks were constructed near Piers 2 and 3, and the banks were armored with rock slope protection. Inspections by Structure Maintenance & Investigations (SM&I) have indicated that the channel appears to be laterally and vertically stable. No signs of channel migration were discovered.
The bridge is on a relatively straight section of channel within a reverse curve between armored banks constructed at the same time as the existing bridge. Lateral migration within the bridge footprint is unlikely. In addition, the thalweg would have to move at least 30 feet in either direction to impact the pier foundations. **The existing rock slope protection must be replaced in kind to maintain this channel stability.**

Scour

The long-term degradation of the channel invert over the life of the new structure is estimated to be zero. There is no contraction scour. However, 2 feet of "degradation" of the ground surface at Pier 2 and Pier 3 due to potential erosion/undermining of the channel slopes is estimated. The local scour depth for the proposed 4-foot-diameter pier columns in 5-foot-diameter casings is estimated to be 10 feet. **Therefore, the total scour depth is 12 feet.**
The thalweg is approximately Elevation 3232 feet. The finish grade at Pier 2 is Elevation 3245 feet and at Pier 3 is Elevation 3250 feet. As stated above, lateral migration of the thalweg to either pier foundation is not likely. The local pier scour depth was subtracted from the finish grade elevation at each pier location after assuming 2 feet of degradation. **Therefore, the total scour is Elevation 3233 feet at Pier 2 and Elevation 3238 feet at Pier 3.**
Abutments 1 and 4 are outside the channel behind the RSP. It is recommended that 2 feet of general scour be accounted for in the pile design for the abutments.

Debris

Vegetation is dense within the channel, but there is no record of drift piling up at the piers. The proposed bridge will provide a waterway opening of 185 feet and well over 10 feet of freeboard above the 100-year water surface elevation. Therefore, problems from debris are not anticipated.

Bank Protection

As stated above, it is important that the bank protection be replaced in kind. A hydraulic engineer should review the design.

Demolition

The existing columns should be removed to a minimum of 6 feet below original ground, or below the bottom of the existing rock slope protection, whichever depth is greater.

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Summary Information for the Bridge Designer

Below is a summary of key design parameters based on the hydrologic and hydraulic analysis performed for this structure:

HYDROLOGIC AND HYDRAULIC SUMMARY Drainage Area: 13.8 mi^2		
Frequency	100-year	50-year
Discharge (cfs)	10,000	7,000
Water Surface Elevation (feet)	3244.7	3243.0
Velocity (fps)	11	
Minimum Soffit Elevation (feet)	3246.7	
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.		

Long Term Scour Depths

	Degradation (feet)	Contraction Scour Depth (feet)
Abutment 1	2	0
Pier 2	2	0
Pier 3	2	0
Abutment 4	2	0

Scour Data (Elevations and Depths)

	Long Term (Degradation and Contraction) Scour Elevation (feet)	Short Term (Local) Scour Depth (feet)
Abutment 1	3254	0
Pier 2	3243	10
Pier 3	3248	10
Abutment 4	3259	0

ALL CALCULATED ELEVATIONS IN THIS REPORT ARE BASED ON THE VERTICAL DATUM NGVD29.

References

1. Horsethief Creek Bridge (Replace) - Sheets 1-11, 14-20, 22-23, 27, 31-35 dated 09/11/13, Sheet 12 dated 09/16/13, Sheet 13, 26, 28, 30 dated 08/27/13, Sheet 21, 24- 25 dated 09/17/13 and Sheet 29 dated 09/18/13.

2. San Bernardino County Hydrology Manual, August 1986.

3. Caltrans Bridge Maintenance Records.

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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.

Diane K. O'B

REGISTERED CIVIL ENGINEER (SIGNATURE)

REGISTRATION NUMBER C 48483 DATE: June 30, 2014