

Case Study 11. Babcock Crossing Vented Ford

Location

Northeastern California. Plumas National Forest, Mount Hough Ranger District, at the Indian Creek crossing of Road 26N10, near Road 29N43 (Antelope Lake Road). The site is between Taylorsville, California and Antelope Lake, 14 miles northeast of Taylorsville.

Crossing Description

This ford was constructed in the 1960’s on a perennial stream below a reservoir. It was repaired after a major flood in 1982. Fish passage is a key issue. The structure has a 200-foot-long, 18-foot-wide concrete armored driving surface over four 32- by 44-inch corrugated metal pipe arch culverts. The culverts are set at stream level, with little elevation change between the inlet and outlet. The concrete slab is 6 inches thick and is protected at the inlet and outlet with gabions and grouted riprap.



Figure A64. Babcock crossing roadway has a slight vertical curve.

Setting

Sierra Nevada Section (M261-E). Elevation 4,480 feet. Within a granitic pluton in the northern Sierra Nevada and with dominantly decomposed granitic soils. Mid- to east-side forest area of mixed conifer, pine, and cottonwoods along creeks.

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Why Was This Structure Selected?

This design was chosen because of the large difference between normal flows and flood flows in response to reservoir releases (from Antelope Dam). Several similar vented fords were constructed during the 1970's since it was a popular design in that era.

Crossing Site History

The original crossing at this site was probably an unimproved ford. A 65-foot-long bridge was designed for this site in 1966 but was never built. This gabion, concrete, and culvert structure was designed and built in the late 1960's by the forest. Flooding in 1982 undermined the central part of the concrete slab, and significant repairs were required (figure A65). Since that date the structure has required little maintenance.



Figure A65. Downstream scour under the slab after the 1982 flood. The repair was to add a 5-foot-deep vertical concrete cutoff wall.

Road Management Objectives

This is a gravel-surfaced road maintained for passenger vehicles (maintenance level 3). It provides access to the Babcock Peak area and the east side of the forest and is not kept open in the winter. Use is a mix of occasional logging traffic during a timber sale, USDA Forest Service administrative traffic, and the general public. Traffic volume (average daily traffic is 50 vehicles) and type are such that occasional interruptions are acceptable. Also a longer but alternate route is available if necessary to access the area. Traffic interruptions lasting several days can occur up to two times per year after moderately large storm events (figure A66). When the reservoir water level is being lowered, traffic interruption can last several weeks.



Figure A66. Crossing during a flood event. It is clearly not passable at this time. Note the amount of energy and “scour power” where the flow drops several feet over the structure.

Stream Environment

Hydrology: This area has a snow-dominated precipitation regime, with severe runoff events often caused by rain-on-snow. Summer thunderstorms can be intense. The Indian Creek watershed drains approximately 85 square miles on the extreme northeast side of the forest. Indian Creek is a perennial stream controlled by Antelope Reservoir, several miles upstream. It has an estimated 100-year return flow of 4,500 cubic feet per second. Summer low flows are of the order of 5 to 10 cubic feet per second. Flood flows inundate the entire structure 2 to 4 feet deep. Flood-flow velocities were estimated at 7 to 9 feet per second.



Figure A67. Indian Creek looking upstream from the ford.

Channel Description: At this location, Indian Creek is a gravel-bed Rosgen C4 channel with stable banks 2 to 3 feet high. Channel width is approximately 30 feet above the structure and slope is between 1 and 2 percent. Riparian vegetation includes grasses, willow, cottonwood, alder, and pine trees. The channel is wider and shallower below the structure than above because of bank erosion when water overtops the ford.

Aquatic Organisms: This section of stream provides habitat for nonthreatened native fish, including rainbow trout and nongame species. The stream is a popular fishing and recreation area, and providing passage for fish is a key issue. The ford likely impedes fish passage but does not totally block it. At normal flow levels a beaver dam backwaters the pipes, and fish have been observed swimming through them. Movement for other aquatic organisms is at least partially blocked by the culverts.

Water Quality: Sediment delivery and movement in this area is a high concern, and this east side watershed produces a moderate amount of sediment in decomposed granite terrain. However the reservoir traps a high percentage of sediment so that water released below the reservoir is relatively high quality.

Structure Details

Structure: This structure is a 6-inch thick concrete slab roadway over four 32- by 44-inch corrugated metal pipes. It was originally constructed 130 feet long, but after the 1982 flood, an additional 70 feet of concrete surface was added (part on both ends) to protect the entire wetted perimeter of the crossing. Five-foot deep downstream cutoff walls were also added in 1982. This structure has a low vent area ratio, as can be seen in figure A68. Currently the structure is outlet controlled due to a downstream beaver dam.

Bank stabilization and approaches: After the 1982 event, one set of gabion baskets was placed below the outlet of the culvert pipes for scour protection and energy dissipation. Additional scour protection includes the 5-foot-deep concrete cutoff walls along both sides of the ford (as shown on the site sketch) that are tied into the concrete slab roadway. Grouted riprap was placed outside of the cutoff walls along the upstream and downstream edges of the structure. The ford slopes gently into the drainage at 3 to 5 percent on both approaches.

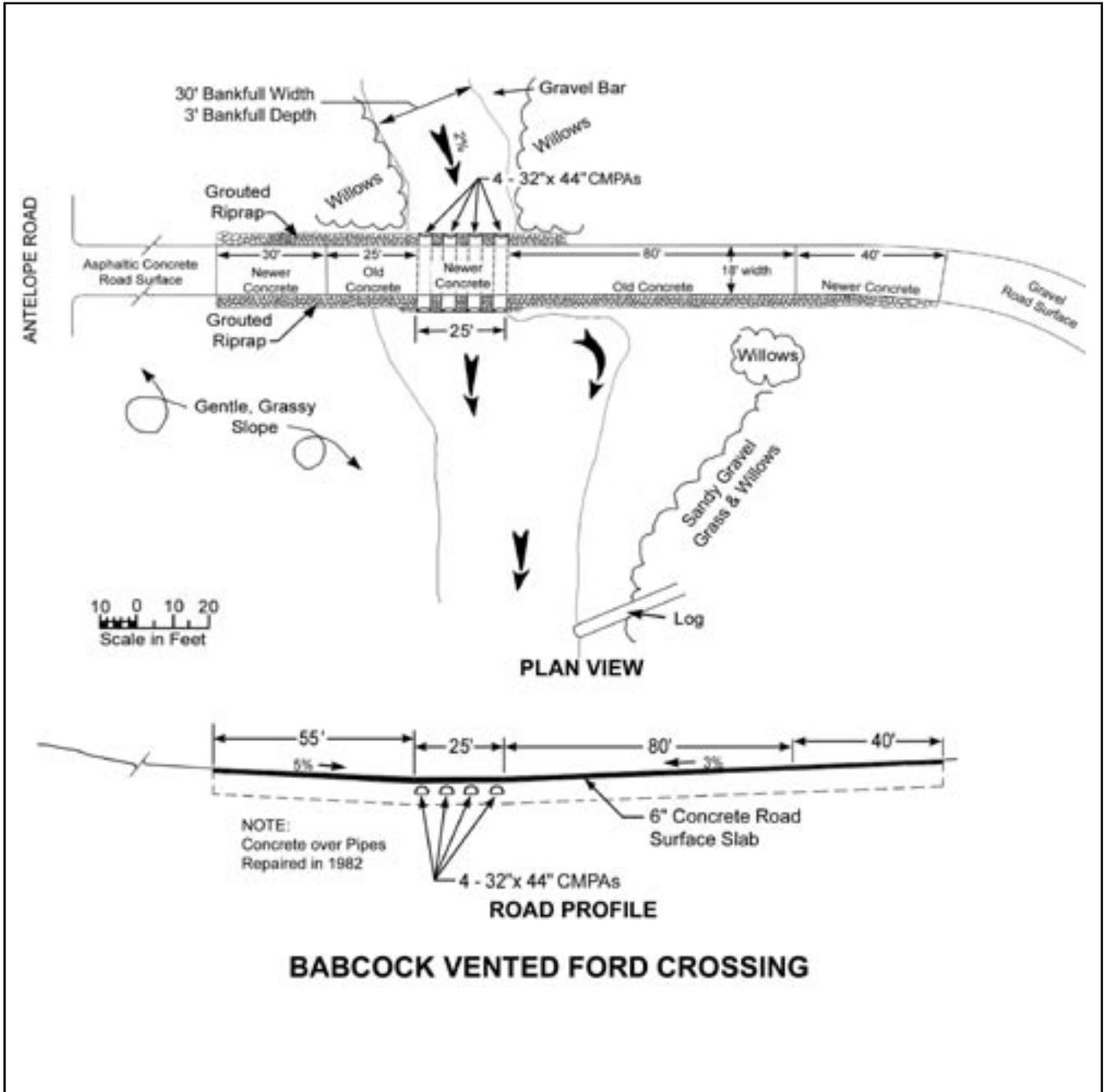


Figure A68. Site plan view and road cross-section sketch. Note the 5-foot deep concrete cutoff wall (dotted lines).

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Flood and Maintenance History

Cost: Initial construction cost is unknown. Repair costs in 1983 were \$48,700. This cost likely equaled or exceeded the initial cost of the structure.

Safety: The crossing is unsigned. However, the entire structure has a low profile, only 3 to 4 feet above the channel bottom, and there are gently sloping (1.5h:1v) grouted riprap shoulders along the edge of the roadway. The site is very open and on a nearly straight section of the road with good sight distance. Thus, safety issues are minimal. At one time road managers considered adding a guardrail, but decided against it because it would trap debris. Object markers and depth stakes could be added for additional safety.

A vented ford has existed at this site for about 30 years. The initial structure was a concrete slab roadway over the four 32- by 44-inch arch corrugated metal pipes. In 1982 the original ford was damaged and underwent significant repairs. Portions of the original upstream and downstream gabion slope protection were scoured away and the mid portion of the concrete slab over the culverts along the downstream edge was undermined, causing part of the slab to crack and settle (figure A65). Much of the roadway cross-section over the pipes was refilled, a new concrete slab was poured, cutoff walls were added, and rock riprap was replaced and grouted along the upstream and downstream edges of the roadway. Repairs in 1982 required a total of 103 cubic yards of concrete and nearly 200 cubic yards of grouted Class IV riprap.

Since that time the structure has endured two major storm events (in 1986 and 1997) with only minor downstream scour damage. Maintenance includes removing debris from the top of the structure and from the culverts. Slope protection with concrete and gabions along the margins of the roadway has been successful.

Summary and Recommendations

This structure has survived for over 30 years. Although an event in 1982 severely affected the structure and required significant repairs, there have been no significant problems since this event. Bank scouring during floods has caused local channel widening below the structure, but its extent is very limited. Increasing structure sag, and using larger culverts would likely decrease downstream erosion problems. Larger culverts would also decrease the potential for small-size debris to obstruct flow, as in figure A69. The 1982 repairs could have been avoided by constructing upstream and downstream concrete cutoff walls, several feet deep, for scour protection along the edges of the structure.



Figure A69. Small debris partially plugs the pipes.

Gordon Keller, geotechnical engineer on the Plumas National Forest, provided information and photos for this case study.

Similar Structures in Other Locations

The Ouachita National Forest in west central Arkansas has traditionally made frequent use of concrete vented fords with round concrete culverts on second- and third-order streams. The crossing on lower Harris Creek on the Ogden Ranger District is a good example (figure A70).



Figure A70. Lower Harris Creek concrete vented ford.

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Harris Creek is a moderately entrenched gravel- to cobble-bed stream with a drainage area of about 3 square miles. It is perennial, but flow can go very low in summer. It is habitat for the endangered leopard darter, among other weak-swimming fish. These fish need free passage to find deep pools with cool water during the summer heat, and to recolonize areas where local extirpations have occurred due to extreme low flows (Gagen and Rajput 2002). The Harris Creek vented ford is thought to be a complete passage barrier.



Figures A71a and A71b. Figure A71a. Harris Creek upstream of ford. Figure A71b. Downstream of ford.

Note the bank erosion and widened channel downstream of the structure (figure A71b). As figure A70 shows, the ford is nearly flat across the stream, and when it overtops flow can go around the ends of the structure, eroding the banks. The same type of turbulence shown in figure A66 at the Babcock crossing undoubtedly happens here during overflow, with similar results. Scour protection at this ford consists of a concrete splash apron (figure A72) and riprap. The riprap is placed in a trench just downstream of the apron.

The forest plans to replace this structure with a high vent-area ratio concrete box culvert that provides darter passage during low flows, like the crossings in case study 14.

Richard Standage, Jim Getchell, and Herb Mansbridge of the Ouachita National Forest provided the information for this example.



Figure A72. Concrete pipes outlet on splash apron with riprap downstream. Fillslope is also protected by concrete. Note erosion to side of fillslope concrete armor.

