

**Larimer County Road 27 (Buckhorn Road) along Buckhorn Creek
September 2013 Flood Recovery, Larimer County, Colorado**

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Larimer County Road 27 (LCR 27), also known as Buckhorn Road, crosses Buckhorn Creek numerous times in approximately 9.5 miles between Masonville, Colorado and the junction of LCR 27 and LCR 44H. For a lower reach approximately 8 miles upstream of Masonville, Buckhorn Creek exists as an alluvial system with a relatively extensive overbank component, and for a 1.5-mile upper reach, Buckhorn Creek becomes a confined channel with nearly no overbank as it travels through a stretch known as the Narrows. Prior to the September 2013 Flood, Buckhorn Creek was served along LCR 27 by multiple bridge and large culvert installations through these reaches. In the lower reach, one bridge was damaged, three large culvert installations were lost, and LCR 27 experienced minor to moderate damage in multiple locations during the flood. Through the Narrows, LCR 27 was damaged or destroyed in numerous locations and four large culvert installations were lost. Under the duress of a storm estimated to be between the 25- and 500-year event, undersized culverts, debris blockage, road overtopping and/or inundation, and embankment retreat were assumed to be the general mechanisms of failure. Through the majority of the Narrows, Buckhorn Creek and LCR 27 are adjacent and share the road embankment/channel bank. The September 2013 Flood demonstrated the insufficiency of the pre-flood road/creek system in enduring the hydraulic forces of large events, and efforts were channeled into (a) evaluating the existing condition hydrology of Buckhorn Creek for the selection of design discharges, (b) indirect evaluation of the September 2013 Flood hydrology, (c) repair of one existing bridge, and design of three new bridges and four new culvert crossings, (d) design of a new LCR 27 road/Buckhorn Creek alignment through the Narrows, (e) and design of erosion countermeasures for the system.

To this end, extensive iterations were completed to distance LCR 27 from Buckhorn Creek, whenever possible. By moving the county road from the over-encroached creek, infrastructure was designed to be robust, practical, constructible, and adhere to Larimer County roadway design standards, while restoring Buckhorn Creek habitat and geomorphology to a greater function. Through use of FEMA hydrology and post-flood LiDAR, ground survey from AVI, and field reconnaissance by ACE, three new bridges were designed in the lower portion of Buckhorn Creek that would capably convey flows up to and including the 25-year event. Through the Narrows, it was determined to be impractical to construct a system to convey flows within Buckhorn Creek and through new crossings in excess of the 5-year event, and therefore, four new crossings, and a new LCR 27/Buckhorn Creek alignment was designed to capably convey the 5-year event through the Narrows without inundation of the LCR 27 roadway. Throughout the entirety of Buckhorn Creek, erosion countermeasures were designed for the most severe hydraulics associated with events up to the 25-year. For constructability and cost-reduction concerns, the erosion countermeasures were designed to be constructed from rock blasted for the realignment of the proposed LCR 27/Buckhorn Creek system. The following tasks were completed for this project:

- Completion of an indirect hydrologic evaluation of the September 2013 Flood, and evaluation of other available indirect hydrologic studies;
- Evaluation of existing condition FEMA hydrology for selection of design discharges;
- Repair of an existing bridge, and design of three new bridge structures within the lower reach of Buckhorn Creek to pass the 25-year discharge;
- Design of four new culvert crossings and an alternative LCR 27/Buckhorn Creek alignment through the Narrows that would separate Buckhorn Creek and the county road to a greater extent, and pass the 5-year discharge without inundation of the LCR 27 roadway;
- Restoration of the Buckhorn Creek channel and overbank, wherever possible, and stabilization of the toe; replacement of vegetation lost during the flood with native species of shrubs, trees, willows, and grasses to enhance riparian habitat and promote bio-stabilization;
- Design of erosion countermeasures for the repaired bridge crossing, the new bridge and culvert crossings, and new LCR 27 road embankment/Buckhorn Creek channel bank through the Narrows.



The Narrows of Larimer County Road 27 and Buckhorn Creek – Post-flood (October 2013)



The Narrows of Larimer County Road 27 and Buckhorn Creek – Post-construction (July 2015)