

## APPENDIX F

# LOCATION HYDRAULIC STUDY

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**Location Hydraulic Study**  
Colorado State Highway 9  
Proposed Widening  
between  
Frisco and Breckenridge, Colorado

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The proposed widening of SH 9 between Frisco and Breckenridge will have a very minor impact on the floodplain of the Blue River. It appears the roadway template grading will only impinge on the 100-year floodplain in a few locations. The encroachments identified from the preliminary roadway plans are very minor from a hydraulic nature, and will likely raise the flood levels by amounts less than 0.2 feet in only three separate locations in the corridor. The Federal Emergency Management Agency's floodplain regulations limit such increases to no more than one foot, so the encroachments planned appear to be well within this requirement.

The National Flood Insurance Program (NFIP) maps have been used to determine the floodplain limits of the Blue River. In areas where the NFIP mapping lacks the detail required to evaluate the floodplain impacts, project topographic mapping was consulted to review probable floodplain extents. The Blue River, between Breckenridge and Dillon Reservoir, is a mountain river with a 100-year flow of 900 cubic feet per second (cfs). The elevation of the river varies from approximately 9,000 feet to 9,600 feet in the study area. Much of the river passes through dredge waste material from historic placer mining operations. In most areas, the river channel is quite well defined, but there are several locations where flood flows pass into parallel secondary channels. The flood flows are typically contained within the primary and secondary channels, and the floodplain varies in width from 30 to 100 feet. In one notable reach of the stream, between County Road 3 and the SH 9 crossing at station 284+00, the flood flows are not contained in the channel and spread 500 to 1,000 feet in width. Stream flows reach a substantial annual maximum as a result of snowmelt. Peak flood flows typically occur when substantial rainfall occurs simultaneously with the snowmelt runoff peak. Using the NFIP mapping and project topography, three minor direct encroachments into the floodplain have been identified.

The first encroachment is just downstream from the proposed Park Avenue Bridge. Grading of the roadway approach will encroach several feet horizontally into the overflow channel on the east side of the stream. The Flood Insurance Rate Map for Breckenridge, dated June 20, 2001, identifies this overflow channel as a Floodway, which would indicate that the easterly channel is the main channel of the river. From site visits,

this appears to be incorrect, as the main flow of the river now flows in the westerly channel. In any event, the roadway encroachment will most likely raise the flood elevation by an amount less than 0.2 feet.

Several alternatives to this minor longitudinal encroachment are possible and have been reviewed. The Park Avenue intersection improvements are critical to increasing the capacity of the roadway at the northerly limits of Breckenridge. The existing Park Avenue Bridge is to be retrofitted with a roundabout to increase the northbound capacity of the intersection. A second bridge is proposed to carry large volumes of southbound traffic over the Blue River, and onto Park Avenue, which will be redesignated as SH 9. To carry these large volumes, the proposed bridge crosses the river at a skewed angle and has a sweeping approach to allow moderate speeds.

The first alternative would be to alter the sweeping approach to the proposed bridge, and either tighten its radius or replace it with a T-intersection. This alternative would result in an unacceptable decreased capacity of the intersection. The second alternative would be to move the roundabout/bridge approach geometry to the east, away from the river. The horizontal alignment of the roadway is determined by four factors-the existing roadway alignment of SH 9, Park Avenue and Main Street; the necessary geometry of the proposed roundabout; the existing Summit County Judicial Building just west of the proposed bridge; and the steep hillside just east of the proposed roundabout. Shifting the roadway alignment to the east would result in a substantially increased cut into the steep hillside to the east, and an unfeasibly extensive retaining wall system. Given the extremely minor encroachment into the floodplain, and the problems with changing the geometry, the encroachment is judged to be the best alternative.

The second encroachment area is along the bike path near Valley Brook Road and Highlands Drive, approximately from station 124+00 to 128+00 and 134+00 to 136+00. In this area, the roadway is to be held above the river with a retaining wall. The retaining wall is proposed to minimize the impacts to the river. Again, these encroachments are very minor from a hydraulic perspective, and they will raise the flood elevation by an amount less than 0.2 feet. The bike path itself is not considered an encroachment. The alternative to this encroachment is to move the entire roadway geometry to the east. The intersection geometry of Highlands Drive precludes the feasible realignment of the SH 9 section to the east. As in the case of the Park Avenue encroachment, the minor nature of the proposed encroachment is judged to be the best alternative.

The final encroachment area is located at approximately station 294+00. This is the most minor of the three and is better described as a potential encroachment. With only preliminary design, it is difficult to determine if the roadway will actually encroach at this location. If it does, it will raise the flood elevation by an amount far less than 0.2 feet. The potential encroachment location is a small, low finger in the river channel about 400 feet north of the existing Gateway Drive intersection. The NFIP mapping does not show this finger, but project mapping shows it. The length of the potential encroachment is approximately 70 feet. The extent of the encroachment appears to be less than 5 feet. A possible alternative to eliminate this encroachment would be to

steepen the grading of the roadway embankment to pull the toe of the embankment out of the floodplain. Adjusting the alignment to the west, away from the river is also a possibility. In any case, the potential encroachment is very small and all efforts in final design will be undertaken to reduce or eliminate it.

The three bridges planned to cross the Blue River (South Park Avenue, North Park Avenue, and Station 284+00) could have an impact on the flood elevation of the river. However, it is CDOT policy to size bridges such that they do not increase flood elevation if the jurisdictional floodplain contains established Base Flood Elevations. The Blue River in Breckenridge has established Base Flood Elevations, so these bridges must be designed to maintain these existing flood elevations.

The direct encroachments discussed herein are very minor, and no indirect support is provided for additional base flood development. The floodplain risks associated with the implementation of the preferred alternative are quite small. The increased flood elevations are negligible, and are well within the NFIP guidelines for floodway encroachments. The impacts of these improvements on the natural and beneficial floodplain values are also quite small. It should be noted that the proposed highway expansion also includes the construction of multiple permanent water quality features to treat highway stormwater runoff flowing into the river. These water quality features are mandated by CDOT's new updated NPDES permit. Though the direct floodplain encroachments are small, the water quality features will have a demonstrable positive effect on the natural and beneficial floodplain values. Indirect support of incompatible floodplain development is not anticipated, as the Summit County and Breckenridge land development regulations prohibit construction within the regulatory floodplain.

In the design of the proposed improvements, many efforts have been undertaken to minimize the floodplain impacts. Chief among these are the selection of the preferred alternative with a reduced cross-section. This cross-section will provide the functional capacity for the highway, but will minimize the roadway footprint in critical areas through the use of barrier medians and retaining walls. Additionally, the permanent water quality treatment facilities mandated by CDOT's NPDES permit will improve the quality of the runoff from the highway.

The encroachments proposed are not significant. Aside from the alternatives discussed with each encroachment, no other practical alternatives exist which will eliminate these small encroachments. The proposed highway construction is consistent with all existing local, state and federal watershed and flood-plain management programs.

