

Technical Memorandum -

DRAFT

Lamar EA Floodplain and Drainage Analysis Rough Draft

Introduction

This memorandum provides a discussion of drainage issues and potential impacts for the proposed U.S. 287 bypass of the City of Lamar, Colorado as part of the project's environmental assessment. Drainage impacts are divided into two categories: floodplain impacts and non-floodplain impacts. Floodplain impacts are those impacts that affect floodplains which have been designated as regulatory on mapping used by the Federal Emergency Management Agency (FEMA) flood insurance program. All other impacts are classified as non-floodplain impacts.

Numerous alternatives were considered as part of the Environmental Assessment process. These alternatives were screened based on factors that were not drainage related, and the preferred alternatives were selected. The drainage impacts were then evaluated for the preferred alternatives.

Floodplain Impacts

The project affects two floodplains designated as regulatory by FEMA. These are the Arkansas River and Willow Creek. Both floodplains are shown on the Flood Hazard Boundary Map (FBHM) for Unincorporated Prowers County as approximate. Therefore no existing hydraulic models were available for use in the hydraulic analysis. A detailed study for the Arkansas River was performed for the Flood Insurance Study for the City of Lamar, Colorado, Prowers County; however, the downstream limit of that study is approximately 3000 feet upstream of the crossing proposed by the project.

Arkansas River

The project proposes to create a new crossing of the Arkansas River. CDOT drainage criteria limit the increase in the 100-year water surface profile for a new bridge to 1 foot, compared to the existing condition. Therefore, the worst-case impacts of this crossing would result from a bridge opening that was sized to create a 1-foot increase in the 100-year water surface profile.

KM has performed a preliminary hydraulic analysis to based on a maximum allowable increase in the 100-year water surface profile of 1 foot. The impacts presented herein are based on this analysis. If the final design of the bridge results in a smaller increase in the water surface profile, the impacts would be less. The location of the proposed road/bridge crossing of the Arkansas River is based upon preliminary reviews of both river channel location and impacts to property owners. Final determination of the bridge site will require additional geotechnical investigations and final hydraulic analysis.

Hydrologic Analysis

The discharges for the Arkansas River were obtained from the previously mentioned Flood Insurance Study for the City of Lamar, Colorado, Prowers County. The estimated 100-year flood discharge is 40,000 cfs.

Hydraulic Analysis

The hydraulic analysis was performed by HEC-RAS. As mentioned previously, no existing hydraulic models were available for use in the hydraulic analysis. No survey data was available for the Arkansas River at the crossing location. For the preliminary analysis, the cross section at the downstream limit of the HEC-2 model for the Flood Insurance Study for the City of Lamar was assumed to represent a typical cross section through the project reach. This cross section, located 3000 feet upstream of the proposed crossing, was the nearest to the project site. This cross section was copied as necessary to extend the model sufficiently downstream of the site to allow modeling of flow expansion downstream of the bridge opening. The elevations of the copied cross sections were adjusted based on the general slope of the river, as obtained from USGS contour mapping.

Floodplain Impacts

The analysis showed that, for the existing condition, the floodplain at the site is approximately 6300 feet wide. The proposed bridge opening that produced a 1-foot increase in the 100-year water surface profile was 1400 feet. The increase in water surface elevation caused the floodplain width to increase to approximately 6500 feet in the immediate vicinity of the bridge. The water surface profile matched the existing condition approximately 5500 feet upstream of the proposed bridge. The area inundated by the 100-year flood discharge in this reach was 1200 acres for the existing condition, and 1235 acres for the proposed condition.

Existing condition velocities at the bridge site range from 1.6 feet per second in the overbanks to 6.6 feet per second in the main channel. For the proposed condition, the velocities increase to 5.3 feet per second in the overbanks to 8.1 feet per second in the main channel. These velocities are sufficiently low that no significant adverse effects would be anticipated.

Measures to Reduce Impacts

In the event that the impacts of an increase of 1 foot in the 100-year water surface profile are determined to be unacceptable, measures may be taken to reduce the impacts. Two options that

are available are: 1) reduce the backwater caused by the proposed crossing, and 2) purchase right-of-way or easements on affected properties.

The backwater caused by the proposed crossing could be reduced by 1) increasing the length of the bridge, thus reducing the losses through the opening, or 2) placement of relief bridges on the floodplain overbanks to reduce losses in the contraction and expansion regions upstream and downstream from the crossing.

In the event that specific properties are significantly affected by the backwater from the crossing, an additional possible solution would be to compensate the affected property owners by purchasing right-of-way or easements on affected properties.

Willow Creek

The preferred alternative proposes a new interchange with U.S. 50 east of the Lamar city limits. The proposed interchange will be located in an open field area between U.S. 50 and Parmenter Street. Through this area, Willow Creek flows through a channelized section along the south side of U.S. 50. The Lamar Canal parallels C.R. 9 and Parmenter Street and crosses under the Willow Creek channel via an inverted siphon. The existing bridge on the county bypass road will be removed, and new bridges will be constructed for the U.S. 287 mainline, ramps, and relocated U.S. 50.

Hydrologic Analysis

The discharges for Willow Creek were obtained from the previously mentioned Flood Insurance Study for the City of Lamar, Colorado, Prowers County. The estimated 100-year flood discharge for Willow Creek is 12,800 cfs.

Hydraulic Analysis

The hydraulic analysis was performed by HEC-RAS. As mentioned previously, no existing hydraulic models were available for use in the hydraulic analysis. Survey data was available for the Willow Creek main channel between its crossing with the Lamar Canal and its crossing with existing U.S. 50. The channel survey included data on the existing bridges crossing it through this reach. The extent of the survey on the south side of the channel was typically limited to within about 50 feet of the channel bank, except where the proposed U.S. 287 mainline is located. The survey did not include data on the existing levees, roads, and bridges upstream of the crossing with the Lamar Canal.

The terrain south of the existing channel is relatively uniform. This allowed the channel data to be extended to the south by extrapolating from the survey along U.S. 287 corridor. Approximate

cross section data for the existing levees, roads and bridges upstream of the Lamar Canal were generated by extrapolating from the closest survey data, supplemented by information from stereo pairs of aerial photographs.

While it is likely that some flow from Willow Creek overtops the levee of the Lamar Canal and is diverted to the canal, it appears that the amount would be small. This diversion has been considered negligible in this analysis. When additional survey information is available, this assumption should be verified.

Floodplain Impacts

The existing condition model showed that flood waters would overtop existing U.S. 50 upstream of the crossing with the Lamar Canal, when the discharge reached approximately 5,000 cfs. Field observations indicate that the height of the levee along the Lamar Canal is higher than the roadway surface of U.S. 50, therefore causing a backwater condition during flooding. At a discharge of 6,000 cfs, the water surface in Willow Creek would be approximately 1 foot over the top of existing U.S. 50. It was assumed that this would be the approximate maximum depth that could occur in the Willow Creek channel, since any additional flow would spill over existing U.S. 50. The flow that overtops the existing U.S. 50 would be transferred to the north side of that roadway, and would be lost from the existing Willow Creek channel. Therefore, the maximum existing condition discharge through the Willow Creek channel through the proposed interchange is approximately 6,000 cfs. For comparison, the 10-year flood discharge is 2,900 cfs and the 50-year flood discharge is 8,600 cfs.

The existing condition model further downstream at the county bypass road indicates that flows in excess of 3,000 cfs would overtop existing U.S. 50 and be transferred to the north side of that roadway. These flows would also be lost from the Willow Creek channel.

The existing Willow Creek "channel" between the Lamar Canal and the existing U.S. 50 bridge (1 mile downstream) has capacity for only about 1,500 cfs. Discharges in excess of 1,500 cfs cause flow to occur in the overbank areas to the south of the channel. This property could be significantly flooded before existing U.S. 50 is overtopped. This would include three residences located near the channel downstream of the proposed interchange.

Depending on the final profile grade of the proposed realignment of U.S. 50 the potential exists to reduce or prevent Willow Creek flood waters upstream of the Lamar Canal from overtopping the existing U.S. 50 roadway. However, any change that would prevent the overtopping upstream of the Lamar Canal would send additional flow down the Willow Creek channel on the south side of existing U.S. 50. This could potentially have an adverse impact on properties located downstream of the proposed interchange. Since flows in excess of 3,000 cfs overtop existing U.S. 50 in this area, most of the additional flow would be transferred to the north side of

that roadway. In order to transfer the additional flow, there would be a slight increase in the depth of overtopping, which would have the potential to increase flood damage to properties on the south side of existing U.S. 50 also.

The proposed location of the realigned U.S. 50 and the associated new interchange traverses through the overbank area south of the existing Willow Creek channel. This alignment results in a constriction to the southern floodplain area. The flood profile would attempt to respond to this constriction by raising its elevation; however, the overtopping of existing U.S. 50 would prevent any large increase in the flood profile elevation. Instead, additional flow would overtop existing U.S. 50 and the general effects would be similar to those described in the preceding paragraph.

Measures to Reduce Impacts

There are several possible ways to reduce the floodplain impacts on Willow Creek.

The project could be designed to maintain the same degree of overtopping of existing U.S. 50 as would occur for the existing condition. This would essentially constitute maintaining the current drainage pattern. Properties that are currently flooded would continue to be flooded to the same degree as would occur under existing conditions. This would require that a provision be made for flood flows in excess of 6,000 cfs to cross from the south side to the north side of the proposed U.S. 50 alignment upstream of the Lamar Canal without significantly increasing the 100-year flood profile. This could be accomplished by drainage structure under the proposed roadway. The waterway opening for such a structure would need to be relatively large to minimize hydraulic losses. For the 100-year flood, the structure would need to pass 6,800 cfs. Assuming a velocity of 4 feet per second to minimize hydraulic losses, a waterway opening of approximately 1,700 square feet would be required.

The foregoing concept would still require mitigation of the loss of overbank conveyance described previously. This could be accomplished by 1) widening the main channel of Willow Creek where it passes through the interchange, and 2) providing a relief channel downstream of the interchange. These measures would not be intended to eliminate existing flooding problems; only to prevent them from being worsened by the project

The channel widening through the interchange was modeled as a bench along the south side of the existing channel. At the channel, the bench would begin 3 feet above the flowline of the existing channel, then slope upward away from the channel at 2 percent for a distance of 135 feet from the centerline of the existing channel. The reason for starting the bench 3 feet above the existing channel bottom elevation is to maintain a low flow channel that will concentrate low flows to prevent excessive sediment deposition and stagnation. The 2 percent slope of the bench should provide sufficient drainage to facilitate drying of the area following a flood event, thus preventing health hazards. The model indicates that the channel widening could be discontinued

through the crossing of the Lamar Canal, thus avoiding the necessity of making modifications to the inverted siphon. The channel upstream of the siphon would need to be widened to provide sufficient capacity through the proposed bridge where U.S. 50 crosses Willow Creek, and the bridge where C.R. 9 upstream of the Lamar Canal crosses Willow Creek.

The relief channel downstream of the interchange was modeled as a trapezoidal channel with a 10-foot flat bottom. The flowline of this channel would also be approximately 3 feet above the existing Willow Creek channel. It would branch away from the existing Willow Creek channel on the down stream side of the proposed interchange and follow as close as possible along the east and north sides of the proposed ramps and realigned U.S. 50. Just prior to reaching the new north-south frontage road on the east side of the interchange, the channel would turn toward the north and follow along the west side of the frontage road to return to Willow Creek.

It is possible that another alternative could be developed that would reduce the existing flooding problems in this area by preventing flood waters from overtopping existing U.S. 50 and providing channel improvements similar to those described above, but large enough to reduce flood elevations and possibly protect the properties located along the channel. An important factor in determining the feasibility of such an alternative would be whether confining more of the flood waters on the south side of existing U.S. 50 would have unintended adverse impacts farther downstream. The information available at this time is not sufficient to make such a determination, but this alternative may be investigated during final design. If feasible, it would provide a benefit to the affected property owners. The cost of this alternative would exceed that of the one previously discussed, since longer bridges and more channel earthwork would be required. It is also likely that this alternative would require modification of the Lamar Canal inverted siphon crossing of Willow Creek, to allow for a widened channel section at that location.

Non-Floodplain Impacts

Markham Arroyo

The proposed roadway crosses the Markham Arroyo. A preliminary analysis was performed to estimate the size of a structure for this crossing.

Hydrologic Analysis

Hydrology for this crossing was performed using TM-1. Data for the analysis was obtained from USGS contour maps.

There are numerous canals that cross the watershed upstream of the proposed crossing. The irrigation companies that own the canals were contacted regarding the interaction of their canals

with storm runoff. The irrigation company superintendents indicated that during large storm events, they attempt to open all of their gates to release as much of the excess water as possible to the downstream side of the canal. When storm runoff exceeds the capacity of the canal gates to release it, it can overtop the canals in some locations and continue along the drainage path that existing prior to the canals. Given this information, the canals were assumed to have no effect on large storm events, such as the 50-year design storm for the Markham Arroyo crossing.

The discharges obtained for this crossing were:

50-year: 7,600 cfs - design discharge

100-year: 11,350 cfs - check discharge

Hydraulic Analysis

The new structure will be designed for a 50-year flood discharge. It is unlikely that the structure under the existing roadway was designed to this standard; therefore it is probable that the new structure will have greater capacity than the existing. The flooding impacts of the new structure are anticipated to be less severe than those of the existing structure.

Assuming a typical velocity range of 7 to 10 feet per second, the waterway opening required for the design discharge of 7,600 cfs would be approximately 760 to 1090 square feet.