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4.10 Floodplains

Governmental policy guides the actions for construction in or near floodplains. *Executive Order 11988, Floodplain Management*, requires federal agencies to avoid, to the extent possible long-term and short-term adverse impacts associated with the modification of floodplains and to avoid floodplain development wherever there is a practicable alternative. Federal agencies shall, *"take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains."* The agency shall further *"evaluate the potential effects of any actions it may take in a floodplain to ensure that its planning programs and budget requests reflect consideration of flood hazards and floodplain management and to prescribe procedures to implement the policies and requirements of this Order."*

The Federal Highway Administration's 23 CFR 650, Subpart A provides guidelines for floodplain and construction interaction, which included:

- Avoid longitudinal and significant encroachments, where practicable
- Minimize impacts of highway agency actions that adversely affect base floodplains
- Restore and preserve the natural and beneficial floodplain values that are adversely impacted by highway agency actions

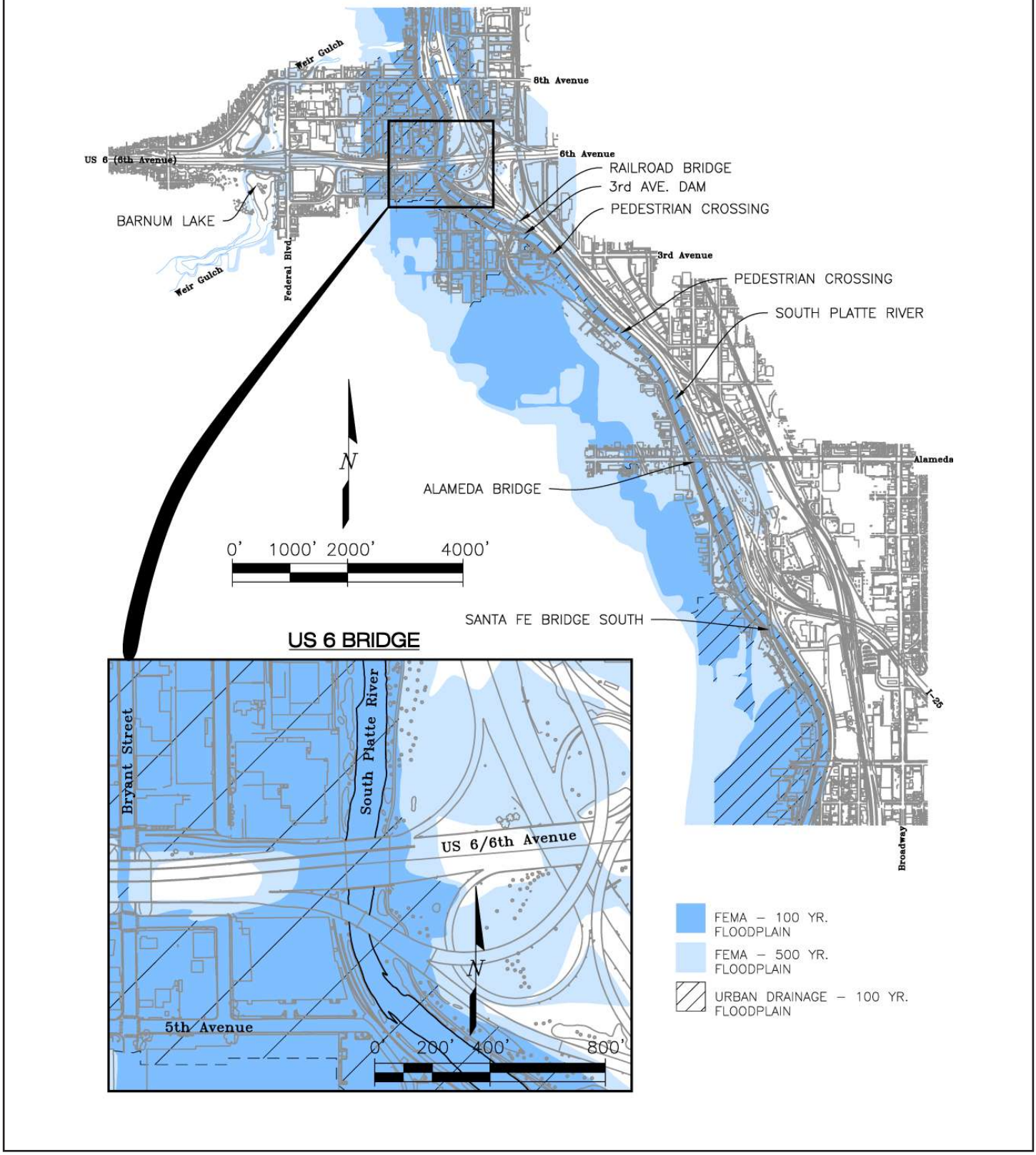
The base flood, which is defined as a flood that has a one percent or greater chance of occurrence in any given year (100-year flood) is the regulatory standard used by most federal and state agencies to administer floodplain management programs.

4.10.1 Current Conditions

4.10.1.1 FLOODPLAIN EXTENT

Floodplain and stormwater drainage studies have been completed for much of the project area. In 1990, the Federal Emergency Management Agency (FEMA) identified 100- and 500-year floodplains for the South Platte River, including those within the project area. More detailed floodplain information is available in FEMA's *Flood Insurance Study Volumes 1 and 2,* (FEMA, 1990).

The Urban Drainage and Flood Control District (UDFCD), in agreement with several city and county agencies, published a *Flood Hazard Area Delineation and a Major Drainageway Planning Study for the South Platte River* in 1985, which encompass the project area. In addition, in 1972, UDFCD published a major drainageway planning study for Weir Gulch, a small stormwater tributary to the South Platte River (Frasier & Gingery, 1972). This tributary flows under US 6, near Federal Boulevard prior to its confluence with the South Platte. These floodplains can be seen in **Figure 4.10-1**, which includes a digital schematic of FEMA flood insurance rate map, community panel numbers 0800460013C and 0014C and the UDFCD Flood Hazard Area Delineation.



Floodplains

4.10.1.2 SIGNIFICANT HISTORICAL FLOOD EVENTS

The South Platte River watershed, including the project corridor, has a long history of flooding. The river basin has flooded from large snowmelts in the mountains, storms covering large areas with continuous rainfall, as well as localized storms with high rainfall intensities. The majority of flooding in the project corridor is caused by summer thunderstorms that drop great amounts of rain in short time intervals, causing flash floods where the runoff exceeds the capacity of storm sewers and drainage channels.

There is a great detail of information available regarding the flooding history of the South Platte River and its tributaries; however, due to the size of the drainage basin, available information is not specific to localized areas of flooding. The following is a representative sample of the flooding history on the South Platte River including a range of flooding causes and results (Matrix Design Group, 2003):

- **May 1942 –** Heavy rains caused extensive damage along the South Platte River. The high water destroyed five bridges, including those at West Evans and West Mississippi.

- **June 16, 1965 –** The largest and most damaging natural disaster in the history of Denver occurred June 16 and 17, 1965, when a cloudburst dumped 15 inches of water on tributary basins near Larkspur. Flooding occurred throughout the South Platte River Basin with estimated damages of $500 million, of which $300 million occurred in the Denver area (FEMA, 1990). Since that time, Chatfield and Bear Creek dams have been constructed, greatly reducing the flood threat to Denver from precipitation over major sub-drainage basins.

- **July 7, 1967 –** A storm of cloudburst proportion caused damage from flooding in southwest and south Denver. Unofficial reports indicated rainfall of 2.0 inches in 30 minutes and more than 3.0 inches total from the storm. Streets and buildings were flooded by the heavy runoff. Hail in some areas contributed to flooding by blocking storm drains. Water reached a depth of 5 feet in the street.

- **June 8, 1969 –** Heavy rain flooded streets and underpasses throughout metro Denver. The heaviest amounts of rain fell in south Denver and Englewood, where unofficial totals of 5 to 6 inches were reported. Mud, debris, and hail carried by the heavy runoff clogged drains and increased the amount of flooding. Approximately 40 cars and a large truck were inundated at an underpass on I-25, and several more were inundated or buried in mud in other areas.

4.10.1.3 EXISTING CONDITIONS IN THE PROJECT CORRIDOR

The Valley Highway Project area is situated in the southern portion of the Denver metropolitan area along the South Platte River. The drainage basin near the project area is almost entirely developed with industrial, commercial, and residential uses. It has undergone a change of land use over the last decade. The industrial properties to the west of older established neighborhoods have been converted to shopping centers, restaurants, and commercial facilities to provide employment, retail shopping, and some recreational activities to the adjacent area.

The South Platte River in the project area is mostly channelized but some obstructions exist. The 3rd Avenue and US 6 bridges cause the 100-year water surface elevation of the river to increase. The US 6 bridge is overtopped by the 100-year flood, resulting in an almost 2-foot rise in the 100-year flood elevation. When combined with the west bank upstream of the bridge, extensive flooding occurs on the left bank from Vallejo Street to the US 6 bridge. The flooded area includes warehouses, retail stores, and small fabricating shops (Wright Water Engineers, 1985). Depth of flooding is generally less than 2 feet but may extend as much as 2400 feet wide (Wright Water Engineers, 1985). Currently, the Santa Fe Drive (south) and Alameda Avenue bridges do not affect the water surface elevation of the river.

There are some serious existing drainage concerns for I-25. As previously mentioned, the project corridor has been subject to both major and minor flooding events. The project corridor experiences heavy flooding at the underpass of Alameda Avenue and receives offsite runoff from the City and County of Denver. This area, I-25 under Alameda Avenue, is located at a lower elevation than the South Platte River, requiring a pump for stormwater discharge. City and County of Denver runoff has a varied effect on I-25, causing flooding from 4 inches of sheet flow in some places to as much as 20 feet of ponding in others. The Valley Highway intercepts the historic drainage path from the east, causing City and County of Denver runoff to combine with the runoff from the highway to make flooding locations worse. Overall, the highway drainage system is undersized, but the most substantial flooding occurs with the combined runoff of City and County of Denver and highway flows. **Table 4.10-1** contains a list of the most significant flooding problems in the project area.

No substantial flooding occurs within the project area along Weir Gulch. Channel improvements along Weir Gulch have been constructed from West Alameda Avenue to the confluence with the South Platte River. Improvements include the regrading of Barnum Lake and construction of an additional outlet culvert under west US 6 (U.S. Highway 6), designed to reduce the extent of 100- and 500-year flooding below Barnum Lake (FEMA, 1990). Additional floodplain and drainage details are provided in the *Water Resources Report* (FHU and Muller Engineering, 2005g).

Table 4.10-1 Existing Major Flooding Areas

Location	Flooding Extent on CDOT Roadways	Affected Structures/Land Use
US 6 near South Platte River	1 to 2 feet of river flow across US 6 bridge over the South Platte River	City and County of Denver roads, many building foundations
I-25 near 3rd Avenue	4.5 inches of ponding on I-25	City and County of Denver roads, railroad tracks, four (+/-) building foundations
I-25 near Ellsworth Avenue	4 inches of sheet flow across I-25	City and County of Denver roads, railroad tracks
I-25 near Bayaud Avenue	9 inches of sheet flow across I-25	City and County of Denver roads, railroad tracks, several building foundations
I-25 under Alameda Avenue	Up to 20 feet of ponding possible on I-25	City and County of Denver roads, railroad tracks, three (+/-) building foundations

Source: FHU and Muller Engineering, 2005g

4.10.2 Consequences of the Alternatives

4.10.2.1 No Action Alternative

The No Action Alternative would have no impact on the floodplain. It would not increase or reduce any volume of runoff on streets or in the river and it would not increase or reduce any volume of flow in the cross section in the river. The No Action Alternative would not raise or lower the base flood elevation. The locations identified in **Table 4.10-1** would remain flooded and continue to negatively impact traffic and the river. In short, there would be no additional adverse or beneficial impacts to existing floodplain conditions. However, with the expected increase in traffic, more vehicles would be inconvenienced by the existing flooding conditions and safety concerns would be compromised.

4.10.2.2 System Alternatives 1, 2, 3, and The Preferred Alternative

Construction of any of the system alternatives, which include System Alternatives 1, 2, 3, and the Preferred Alternative, would affect the floodplain, either through direct changes of the cross section of the river channel, which would affect the flow pattern of the rivers, or through indirect changes via increased impervious surfaces and additional water volume added to the floodplain.

Direct impacts to the floodplain are realized through the bridge replacements along the river or ramp encroachment within the floodplain. Each system alternative would replace three roadway bridges, including the Santa Fe Drive, Alameda Avenue, and US 6 and would add one new bicycle/pedestrian bridge near Bayaud Avenue. Bridge replacements would require temporary modifications in the floodplain to accommodate bridge demolition and construction of new structures. This could include river flow diversion, temporary embankment additions to provide access for construction, or excavations to facilitate construction. These impacts would be only temporary and the area would be restored upon construction completion.

The floodplain is currently affected by the US 6 bridge over the South Platte River. The low structure acts as a dam and raises the floodplain water surface elevation by approximately 2 feet. This backwater flows out of the river banks, flooding nearby areas. The floodplain crosses US 6 near Bryant Street and continues to flow overland until it gets back to the river to the north. All system alternatives include replacement of this bridge to provide a higher and potentially wider structure, providing the required freeboard above the base flood elevation. This would result in an overall drop in floodplain elevation because the raised bridge would no longer act as a dam and raise the floodplain elevation.

System Alternatives 1, 2, 3, and the Preferred Alternative reflect ramp configurations at Alameda that encroach on the eastern bank of the South Platte River and the associated floodplain and realign the southbound I-25 ramp to southbound Santa Fe encroaching on a portion of the overbank floodplain that extends beyond the river channel limits.

A localized floodplain impact could occur from roadway improvements near Alameda Avenue and Santa Fe Drive in System Alternative 2. Under this alternative, the Santa Fe Drive/Kalamath Street overpass of Alameda Avenue would cause runoff to be channelized along Alameda under Santa Fe/Kalamath, instead of allowing it to flow along its historic path southwesterly across Kalamath Street. The reduced flow area on Alameda Avenue would cause runoff to flow to a depth of approximately 2 feet under Santa Fe Drive/Kalamath Street, which is not

acceptable to the City and County of Denver. Additional inlets and storm sewer capacity would need to be added to the existing system in Alameda Avenue to mitigate this impact.

This project would provide additional highway lanes, resulting in increased impervious surface area within the drainage basins and increased runoff volumes into the South Platte River. System Alternative 3 would result in the greatest additional impervious drainage area (13 acres) to the project corridor. **Table 4.10-2** identifies the size of the drainage basin area for each system alternative.

Table 4.10-2 Drainage Basin Area

Location	No Action Alternative (Existing Conditions)	System Alternative 1	System Alternative 2	System Alternative 3	Preferred Alternative
US 6	51 acres	51 acres	51 acres	51 acres	51 acres
I-25	109 acres	115 acres	115 acres	116 acres	116 acres
Santa Fe Drive/ Kalamath Street	1144 acres	1145 acres	1144 acres	1150 acres	1145 acres
Total	**1304 acres**	**1311 acres**	**1310 acres**	**1317 acres**	**1312 acres**

Source: FHU and Muller Engineering, 2005g; 2006f

Often with new construction and redevelopment, detention ponds are used to detain runoff and release it at historic rates, so there is no increase in runoff. Detention ponds are not being considered for this project, although BMP ponds for water quality purposes are being proposed. This decision is supported by the fact that the additional runoff would be relatively small, the ponds would be located very close to the downstream drainageway (the South Platte River), and the detention might increase the overall peak to the river, resulting in a negative impact.

Several areas exist where historic localized flooding has occurred due to stormwater drainage within the project area. Ponding areas that reach a depth of 18 inches or more in the 100-year storm event have been identified as “Potential Ponding Areas” in the City and County of Denver 100% *Stormwater Drainage Master Plan* (Matrix Design Group, 2003). The storm sewer improvements implemented with the system alternatives would not worsen these ponding conditions and might, in fact, reduce localized flooding.

4.10.3 Mitigation Measures

In developing system alternatives for the Valley Highway Project, several measures were identified to help avoid, minimize, or mitigate potential adverse impacts to the floodplain. The system alternatives, including the Preferred Alternative, were designed to avoid direct and indirect support of floodplain development whenever practicable as required by *Executive Order 11988*. All system alternatives would avoid impacts to the river by keeping most improvements in the existing roadway location or, in the I-25 improvement area, by moving them to the east, away from the river, wherever possible. Impacts to the floodplain would be minimized by

reducing the overall number of storm sewer outfalls to the river. Mitigation would be provided for adverse floodplain impacts with implementation of permanent BMPs.

With the construction of any of the system alternatives, including the Preferred Alternative, there would be an overall reduction in the number of outfalls in the project area. The project would increase the amount of stormwater runoff, but consolidate it into fewer outfalls. On average, each outfall would therefore discharge more runoff into the river than under the No Action Alternative. Adequate outlet protection would be installed at the outfalls, as a BMP, to reduce erosion potential. Current UDFCD requirements for outfalls will be considered during final design in order to implement the most current outlet protection system. The fewer number of outfalls would result in fewer locations of continuous maintenance impact to the river and associated floodplain. Removing and constructing outfalls would temporarily disturb the river banks, but would provide fewer disturbances in river vegetation and a more aesthetically pleasing appearance for trail and river corridor users. The construction BMPs identified in CDOT's *Erosion Control and Stormwater Quality Guide* (CDOT, 2002e) would guide the specific BMPs used in final design and construction.

Under the any of the system alternatives including the Preferred Alternative, as much of the runoff in the "first flush" as possible would be conveyed from the post-construction onsite area through water quality ponds or other BMPs before discharging to the river, to mitigate sediment-laden runoff. The first flush is approximately equivalent to the 2-year storm. As runoff is collected in the water quality ponds, sediment would settle to the bottom and debris would be collected in the pond, leaving improved water quality to flow to the river. Runoff would be released from the ponds over approximately 40 hours. A more detailed discussion of the use of BMPs to enhance water quality from stormwater runoff is provided in **Section 4.9** *Water Resources*.

Under any of the system alternatives including the Preferred Alternative, demolition or/and construction of the bridges over the South Platte River would require mitigation. Three roadway bridges would be reconstructed and one new pedestrian bridge would be constructed. Bridge replacements would require some temporary modifications in the floodplain to facilitate the construction. These impacts would only be temporary and the area would be restored upon construction completion. In all cases, care would be taken to disturb the least amount of floodplain area. Construction BMPs, such as netting to collect bridge demolition debris and temporary sediment ponds, would be used to reduce temporary impacts. Construction BMPs identified in CDOT's *Erosion Control and Stormwater Quality Guide* (CDOT, 2002e) would guide the specific temporary and construction BMPs used in this area.

Reconstruction of the US 6 bridge could result in changes in the flow characteristics of the river, and local increase in velocity. The design for the new bridge would meet the requirements of FHWA's *Non-Regulatory Supplement Regarding 23 CFR 650 A, Location and Hydraulic Design of Encroachments on Flood Plains* (FHWA, 1992). Detailed modeling and bridge design are required to confirm the ultimate configuration. However, implementation of these improvements would result in improved public safety and a reduction in flooding in adjacent areas. Bridge design considerations would include streambed stability and protection against scour. Potential wetland impacts associated with the US 6 bridge are discussed in the **Section 4.11** *Wetlands*.

Construction of the Alameda ramps in System Alternatives 1, 2, 3, and the Preferred Alternative would encroach on the floodplain. To accommodate this encroachment, an equivalent volume

would be cut from the channel bank to maintain floodplain elevation. Similarly, the Santa Fe Drive ramps on the west side of I-25 would protrude into the floodplain. The ramps would not impact the main channel of the river, but only a portion of the overbank area. Final design will include a more detailed assessment of hydraulics and include design modifications, as appropriate, to mitigate these flood plain encroachments. Design refinements could include a longer bridge structure at Alameda over the river or the Alameda ramp could be realigned to the east, consist of a built on structure, or be integrated with the adjacent structures to reduce impact to the river. Additional flow capacity could be provided in the Santa Fe Drive area.

Common mitigation elements to the system alternatives, including the Preferred Alternative, are summarized in **Table 4.10-3**. US 6, Alameda Avenue, Broadway, SH 85, and Decatur water quality ponds (BMPs) would provide water quality enhancement for approximately 92 percent of the project area.

Table 4.10-3 Summary of Mitigation Measures for System Alternatives

	System Alternative 1	System Alternative 2	System Alternative 3	Preferred Alternative
US 6 Bridge Replacement	Temporary BMPs; Lower Floodplain Elevation; Permanent Erosion Protection			
Alameda Bridge Replacement	Temporary BMPs; Remains out of Floodplain			
Alameda Ramp Construction	Temporary BMPs; Provide Additional Volume in Channel Cross Section for Overall “No Rise” in Floodplain			
Santa Fe Drive/Kalamath Street Bridge Replacement	Temporary BMPs; Remains out of Floodplain			
Santa Fe Ramp Construction	Temporary BMPs; Additional Volume in overbank area overall “ no rise” in floodplain			
Overall Increased Imperviousness	Permanent BMPs for 100% Water Quality Capture Volume for 91% of Land; New Storm Sewers with Additional Capacity			
Storm Sewer Outfalls	Energy dissipation device or material protection; Reduced Number of Outfalls			

BMPs – Best Management Practices

Location-specific mitigation measures for the alternatives are described below.

I-25 Improvements

Floodplain mitigation efforts in this area would consist of providing water quality ponds and riprap protection. I-25 storm drainage improvements would consist of consolidating the existing storm sewer system and routing it to four water quality ponds and consolidating the existing number of outfalls in I-25 to only five. The ponds are located at the I-25 and US 6 interchange, Alameda and I-25, and Santa Fe/Kalamath and I-25. Specifics of the location and capacity of the ponds are provided in **Chapter 4.9** *Water Resources*.

The first flush of runoff from the I-25 – US 6 interchange and I-25 – 3rd Avenue Basins would be collected at their respective basin low areas and conveyed to the I-25 - US 6 interchange water

quality pond, before discharging to the South Platte River. Runoff in excess of the first flush would flow directly to the South Platte River.

All runoff from the I-25 – Alameda Basin would be collected and conveyed to BMPs. A small portion of area north of Alameda Avenue would be conveyed to a grassy swale BMP. The remainder would be conveyed either directly to the Alameda water quality pond or to the pump station near the Alameda Avenue overcrossing, where it would then be conveyed to the pond.

City and County of Denver and I-25 runoff collected in the existing 42-inch outfall would be intercepted by a proposed Broadway water quality pond, (located in the grassy area created by I-25, Santa Fe Drive/Kalamath Street, and northbound Santa Fe/Kalamath to southbound I-25 ramp) or by a proposed Santa Fe Drive/Kalamath Street water quality pond (located west of I-25 and north of Santa Fe Drive/Kalamath Street). The existing 42-inch outfall in this area has several smaller tributary pipes, which would be diverted to the SH 85 water quality pond, while the remaining runoff in the 42-inch pipe would be routed through the Broadway water quality pond, using the existing 42-inch outfall to the South Platte River as the pond outfall.

Currently, stormwater runoff from the City and County of Denver 3rd Avenue Basin collects in the area where 3rd Avenue meets I-25 near Raritan Way and floods the local area and the interstate. A small ponding area, with inlets and a 48-inch pipe, would provide drainage for the runoff from this basin to the river. This cross culvert would have adequate outlet protection to reduce erosion potential.

US 6 Improvements

Water quality ponds would be used to mitigate the additional area, imperviousness, and/or runoff in this area, while riprap protection would mitigate the increased flow velocity in the river due to the replaced US 6 bridge. Most of the runoff from US 6 would be collected by inlets and conveyed to the Decatur water quality ponds, located north and south of Decatur Street. From the Decatur water quality ponds, runoff would be conveyed to the South Platte River. Routing runoff from a small portion of US 6, near the river, through a BMP would be difficult, so it would flow directly to the river. More runoff from the project corridor would be routed through BMPs after the system alternatives than under the No Action Alternative.

Santa Fe Drive / Kalamath Street Improvements

Two types of BMPs would be used in this area - water quality ponds and energy dissipating outlet protection. Approximately 1.5 acres of land is tributary to the sump on Santa Fe Drive and Kalamath Street as they cross under the consolidated railroad line. A pump would be required to convey the runoff to the Santa Fe/Kalamath water quality pond, which would be drained by gravity to the river. Although storm sewer improvements would be made in this area, there may not be a reduction in the number of outfalls. However, two box culverts would be constructed with adequate outlet protection. The Ellsworth box culvert is located along the Ellsworth Avenue roadway alignment and would reduce existing flooding on local streets and I-25. To prohibit this flow from encroaching I-25, a small ponding area with inlets would collect and convey runoff to the box and to the river. The Alameda box culvert would convey City and County of Denver runoff under I-25 to reduce flooding on I-25 under Alameda Avenue and would have adequate outlet protection.

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