

# Drainage Report

## *Dillon/Eden and I-25 Interchange Improvements*

Pueblo, Colorado

SEH Project No. 103325-PUEBL

City of Pueblo Project No. 07-054 (DT0802)

CDOT Project No. HPP 0251-331 (16640)

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This report for the drainage design of Dillon Drive Improvements was prepared by me (or under my direct supervision) in accordance with the provisions of the City of Pueblo Storm Drainage Design Criteria and Construction Standards, and was designed to comply with the provisions thereof. I understand the Town of Pueblo does not and will not assume liability for the drainage facilities design.

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Exhibit 1 – Proposed Drainage Basin Maps

## Appendices

- Appendix A – Hydrologic Calculations
- Appendix B – Soils Report
- Appendix C – Inlet Sizing
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- Appendix E – Pipe Sizing – UD-Sewer Results
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- Appendix G – Preliminary Construction Plans
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# General Location and Description

## 1.1 Location

This Dillon Drive Overpass project is located in the Southwest ¼ of Section 1, Township 20 South, Range 65 West of the 6th Principal Meridian, near the City of Pueblo, Pueblo County, Colorado.

This project is located on Interstate-25 (I-25), approximately 1 mile north of Eagleridge Boulevard. This project is located approximately one-quarter mile to one-half mile west of Fountain Creek. Please refer to Figure 1 below for a vicinity map.

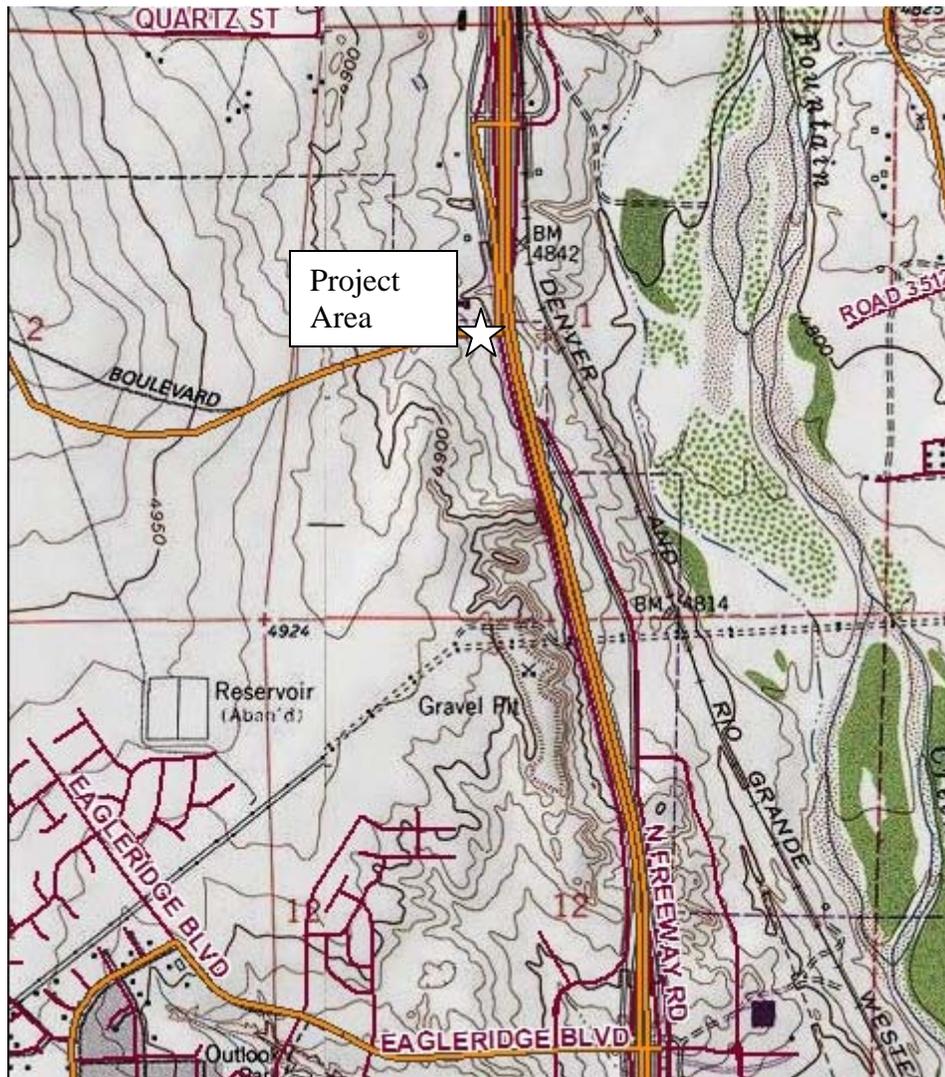


Figure 1, Vicinity Map

## **1.2 Description of Project**

The Dillon Drive overpass project will improve transportation by adding an overpass which connects to Dillon Drive, just north of Pueblo, CO. The project will consist of the following roadway modifications:

- Addition of the Dillon Drive Flyover;
- Addition of an off-ramp from I-25 northbound to Dillon Drive;
- Addition of an on-ramp from Dillon Drive to I-25 southbound;
- Addition of a ramp from the Dillon Drive northbound I-25 exit to the existing Eden exit ramp;
- Modification of the existing Dillon Drive to provide a 4-lane roadway that connects to the proposed bridge, which will taper down to connect to the existing 2-lane Dillon Drive;
- Modification of the existing frontage road running parallel to I-25 in order to connect the proposed bridge to the frontage road;
- Demolition of a portion of a dirt road running parallel to I-25 in order to provide area for the proposed on-ramp from Dillon Drive to I-25 southbound;
- Demolition of the off-ramp from I-25 northbound to Eden Street; and
- Demolition of the on-ramp from Eden Street to I-25 southbound

## **2.0 Drainage Basins**

Basins were identified in order to verify existing culvert capacities, as well as to size proposed drainage elements. These proposed drainage elements include roadway inlets, driveway culverts, roadside ditches, and water quality structures.

Existing and proposed basin maps can be seen in Exhibit One.

### **2.1 Major Basin Description**

The project is located in the West Fountain Creek Major Basin, per the Pueblo Stormwater Master Basin Planning Study (PSMBPS), completed in 2006.

The West Fountain Creek Basin adjoins the East Fountain Creek Basin on the east, the Central Pueblo Basin on the south, and the Wildhorse Dry Creek Basin on the West. The West Fountain Creek Basin is mostly developed except for its northerly portion. It includes a mix of commercial, residential, and industrial uses. The total area of the West Fountain Creek Basin is 4,200 acres. A few primary features in this basin are Fountain Creek, Mineral Palace Park, and the Pueblo Golf and Country Club. Additional features include State Highway No. 50 and I-25.

From the 2007 Pueblo Master Basin Planning Study, there are no major drainage improvements proposed for the Dillon Drive corridor.

## 2.2 Sub-Basin Description

The project area is located within West Fountain Creek sub-basin WF5-II (per the PSMBPS), which is 72 acres in size, and is 26% impervious. This basin is centered on Dillon Drive, and extends several hundred feet to the north and south of Dillon Drive.

Runoff that impacts the project area was analyzed in the current study. This area was divided into 9 sub-basins for the existing condition, and 16 basins for the proposed condition for detailed analysis.

In the existing condition, the flow pattern is generally from west to east by both sheet flow and concentrated ditch flow. Drainage flows toward I-25, and passes under the roadway through a group of culverts. After passing under I-25, runoff flows into Fountain Creek.

In the proposed condition, drainage patterns generally remain the same as existing. More detailed sub-basins were delineated for the proposed condition in order to size various proposed drainage elements.

## 3.0 Drainage Design Criteria

### 3.1 Regulations

This drainage report follows the requirements of the latest versions of the Colorado Department of Transportation (CDOT) Drainage Design Manual, the City of Pueblo Design Criteria (Criteria), and Volumes 1, 2 and 3 of the Urban Drainage and Flood Control District's (UDFCD) Urban Storm Drainage Criteria Manual (USDCM).

### 3.2 Hydrologic Criteria

Basins were delineated using contours provided from the City of Pueblo GIS department, provided to SEH in 2009, survey gathered as part of the design phase in 2009, and the most current proposed topography for the project.

Using the USDCM and the PSMBPS, the imperviousness of the basins was determined. For areas where survey data was available, the USDCM recommended impervious values were used. For areas outside of the available survey, the PSMBPS was used.

All basins delineated for the project were found to be less than 150 acres, so the rational method was used to calculate runoff for the project basins. The rational formula is as follows:

$$Q = CiA$$

Where:

Q = flows in cubic feet per second (cfs)

i = rainfall intensity (5 or 100 year)

A = basin size in acres

In order to find the rainfall intensity, the time of concentration was calculated as follows:

$$T_c = T_i + T_t$$

Where:

$T_c$  = time of concentration, minutes

$T_i$  = time of overland flow, minutes

$T_t$  = travel time of concentrated flow, minutes

And

$$T_i = \frac{1.8(1.1 - C_5)\sqrt{L}}{\sqrt[3]{S}}$$

$$T_t = \frac{L}{60V}$$

Where:

$T_i$  = time of overland flow, minutes

$C_5$  = 5-year runoff coefficient

$T_t$  = travel time of concentrated flow, minutes

$L$  = basin length, feet

$S$  = basin slope, feet/feet

$V$  = overland flow velocity, feet/second (ft/s)

Once the time of concentration is known from the above equation, it was checked against the following regional equation for urban areas:

$$T_c = \frac{L}{180} + 10$$

Where:

$T_c$  = time of concentration, minutes

$L$  = basin length, feet

The lesser of the two calculated time of concentration values was used to calculate peak flows (with a minimum time of concentration of 5 minutes for urban areas). Once the time of concentration was known, the rainfall intensity was found from the Time-Intensity-Frequency Curves found in the Pueblo Criteria. The 5- and 100-year storms were used for the minor and major runoff events, respectively, for this project. These design frequencies were chosen due to the fact that the City of Pueblo typically requires storm sewers to consider both the 5- and 100-year design storms for pipe sizing. All cross-culverts, however, will be sized to convey 100-year discharges.

A copy of all drainage calculations can be found in the Appendix A of this report.

A soils map is attached in Appendix B of the report. Various NRCS soils types exist on the project site, with the majority of soil types being hydrologic soil group C. The entire site was conservatively assumed to have Type C soils for hydrologic calculations.

### **3.3        *Hydraulic Criteria***

According to the CDOT Drainage Design Manual, the culvert capacities for the culverts crossing I-25 are to be designed to convey the 100-year storm event. Table 9.3 of the CDOT criteria was used to determine maximum headwater depths.

According to the Criteria, areas of Dillon Drive are not allowed to have any curb overtopping from the 5-year storm event. Additionally, the maximum depth for the 100-year runoff event is 12 inches at the flowline.

UDFCD spreadsheets were used to determine inlet capacity for the proposed CDOT Type “R” inlets located at the low point of Dillon Drive. See Appendix C for inlet capacity spreadsheets. Results indicate that a 10-foot Type R inlet on each side of the road will keep depths to less than 6 inches during the 100-year runoff event. Culvertmaster was used to calculate the culvert discharge capacity.

### **3.4        *Flood History***

Based on the PSMBPS, there are no major flooding problems associated with this project site and there are no records of flooding issues. However, in speaking with an adjacent landowner, City, and CDOT staff, there have been several drainage issues observed at the northwest corner of this interchange. Based on field inspection, it is believed that these issues are caused by improper grading, the poor condition of existing driveway cross-culverts, and poor culvert maintenance.

Conversations with CDOT staff have uncovered ponding issues along I-25 near Dillon Drive. This ponding may be partially due to improper grading along the roadside, leaving low points without positive drainage.

Staff from CDOT have also observed culvert capacity issues across I-25 in the project vicinity. A culvert has been reported overtopping in the project area, most specifically, the existing 6’x6’ box culvert near Drury Brothers Roofing, at Design Point 2, shown on Exhibit 1. Field inspection has revealed that the existing 6’x6’ culvert is almost completely clogged, with approximately 5 feet of sediment at the downstream end. This clogging is believed to be a cause of flooding in the area.

### 3.5 Existing Structures

There are three major cross drainage structures in the project area, as well as several small CMP culverts for local drainage. Please refer to Exhibit 1 for locations of all basins and design points.

The first cross-culvert that crosses I-25 is just south of Dillon Drive, and is an existing 4' high x 6' wide box. Design Point 4 is tributary to this culvert. A total of 71.76 acres are tributary to this culvert, and during the 100-year runoff event, a peak flow of approximately 169 cfs will be routed to this culvert. This culvert will be lengthened to the east as part of this project, to accommodate proposed fill slopes.

According to CDOT Headwater/Depth (Hw/D) criteria, for a culvert with a height of 36 to 60 inches, the maximum headwater depth is  $1.7 \times \text{Height}$ . For this culvert, this equates to a depth of 6.8 feet. From Culvertmaster, the capacity of this culvert, with a headwater to depth ratio (Hw/D) of 1.7, is 239 cfs.

However, survey mapping shows there is a maximum depth of 5 feet ( $\text{Hw/D} = 1.25$ ) at this culvert entrance. With a headwater of 5 feet, this culvert capacity is 176 cfs, greater than the 100-year runoff of 169 cfs. This report concludes that this culvert has sufficient capacity.

In the future, Dillon Drive may be improved to the west. Future improvements are unknown at this time, but it is assumed that additional lanes, curb, and gutter will be added. Since additional impervious area will be tributary to this culvert, additional flows may also be routed to Design Point 4. An increase in flows may cause capacity issues with this culvert.

One recommended solution to this problem may be to maintain existing flow patterns as much as possible in the future by ensuring that additional flows are not routed to this culvert. Another solution may be to berm up the area around this culvert entrance, to provide more head. With a CDOT maximum Hw/D ratio of 1.7, this culvert could pass approximately 239 cfs.

The second cross-drainage culvert is an existing 6'Hx6'W culvert crossing I-25 just north of the existing Dillon Drive intersection with the frontage road, at Design Point 2. Approximately 96.88 acres are tributary to this culvert, with a 100-year peak flow of approximately 178 cfs. Field inspection performed in 2005 has discovered that the exit of this culvert is nearly silted shut, only 1-2 feet of depth are available at the culvert exit. This is possibly one source of the flooding issue seen by CDOT mentioned above.

Based on CDOT criteria, for a culvert with a height of 60 to 84 inches, the maximum headwater is  $1.5D$ , which equates to a headwater of 9 feet for this culvert. Under a maximum headwater of 9 feet, this culvert can discharge approximately 406 cfs.

At the entrance to this culvert, there is approximately 14 feet of head available before the culvert is overtopped. Using Culvertmaster, the capacity of this culvert, under 14 feet of head, is approximately 597 cfs. This culvert has sufficient capacity to pass the 100-year runoff event (178 cfs), while meeting CDOT Hw/D criteria. An inspection of survey mapping shows that 14 feet of ponding at this location would not cause inundation of local structures or roadway.

At the very minimum, this culvert should be cleaned as a part of this project, and a regular maintenance program that includes cleaning should be undertaken in order to maintain discharge capacity.

The third cross-drainage culvert is an existing 6'Hx10'W box culvert just south of the Eden interchange, near the modular home sales building, at Design Point 1. A peak 100-year discharge of approximately 362 cfs is tributary to this culvert. This culvert will be extended to the east to accommodate proposed fill slopes.

According to CDOT criteria, the maximum allowable headwater over a 6' high culvert is 1.5H, or 9 feet. Using this maximum depth, the capacity of this culvert is 633 cfs. A headwater depth of 9 feet at this location will not cause inundation of local roadways. This culvert has sufficient capacity to pass current 100-year flows.

There are two 24" CMP culverts near Design Point 6. These culverts drain flows from basins F, G, and M. Approximately 17 cfs are routed to these culverts during the 100-year runoff event. With a headwater depth of 2 feet, these culverts can discharge 26.5 cfs, which is greater than the 100-year peak flow, and they will not cause flooding along I-25.

There is also an existing 24" culvert at Design Point 13 that drains flows from the I-25 median. This culvert will be lengthened to the east to accommodate proposed fill slopes. Tributary area to this culvert consists of a small amount of grassed median area.

A culvert crosses Dillon Drive approximately 800 feet west of I-25. This culvert is a double 40"H x 60"W, and Design Point 3 is tributary to this culvert. Its tributary drainage area is 29.6 acres. During the 100-year runoff event, a peak flow of approximately 62 cfs will be routed to this culvert. From the survey, there is approximately 4 feet of head available at this location. Based on a Culvertmaster calculation, with 4 feet of head, this culvert will pass approximately 181 cfs. Therefore, this culvert also has sufficient capacity.

There are also several existing driveway culverts along the I-25 frontage road. These culverts will be replaced as part of this project with dual 24" RCP culverts.

## 4.0 Drainage Facility Design

### 4.1 General Concept

In general, the existing drainage flows west to east toward I-25. Please refer to Exhibit 1 for a basin map showing design points. The proposed roadway improvements shall necessitate two roadway inlets on Dillon Drive at the low point (Design Points 7&8) and associated storm sewer, one water quality pond, roadside ditches, and driveway culverts. The existing culverts under I-25 have sufficient capacity, but will need to be extended as a part of this project in order to daylight through proposed fill slopes.

### 4.2 Drainage Plan Details

Refer to the proposed basins (see Exhibit 1) for a graphic depiction of the studied drainage area. The following is a more detailed description of the analyzed basins and the drainage system.

**Basin A (221.57 acres)** – Basin A is located north of Dillon Drive and west of I-25, and is tributary to Design Point 1, a 6'Hx10' W box culvert. The majority of this basin is undeveloped, with a percent impervious of 5%, and it slopes to the east at 3-5% slopes. Ground cover consists mainly of native grasses. There will be no improvements to this basin as a result of this project. During the 100-year runoff event, this basin produces approximately 362 cfs. The capacity of the box culvert at Design Point 1 is approximately 693 cfs, which is greater than the 100-year discharge of Basin A.

**Basin B (65.51 acres)** – Basin B contains a portion of existing Dillon Drive, as well as a roadside ditch, and is currently 10% impervious. There are no proposed elements in this basin. Water generally flows from west to east in this basin in the roadside ditch. Basin B has a 100-year peak flow of approximately 109 cfs. Flows will be intercepted by the existing channel between Wagner Rents and Drury Brothers Roofing and passed to Design Point 2, the existing 6'x6' box culvert. This culvert has sufficient capacity to discharge the 100-year runoff. The imperviousness of this basin will not change in the proposed condition.

**Basin C (29.55 acres)** – Basin C is located south of Dillon Drive. There are no proposed elements in this basin. Water generally flows from west to east, and ground cover consists of native grasses. Runoff is intercepted by the existing ditch and 2-40"Hx60" W culverts under Dillon Drive, which have sufficient capacity for the 100-year runoff event. This basin will not be altered in the proposed condition. It is currently 24% impervious.

**Basin D (71.76 acres)** – Basin D contains a small amount of commercial development, but is mostly undeveloped land. As a part of this project, a freeway on-ramp will be installed, and a new roadside ditch will be created along the proposed on-ramp in this basin. Water generally sheet flows from west to east along this basin, with a ditch at the eastern boundary. Basin D has a 100-year peak flow of approximately 142 cfs. This basin outlets to an existing 4'H x 6'W concrete box culvert. The existing culvert has the

capacity to pass the 100-year peak flow in the proposed condition. In the proposed condition, the percent impervious of this basin will increase slightly (to 13%) due to the construction of the proposed on-ramp.

**Basin E (3.16 acres)** – Basin E is located just south of the Eden interchange, and contains land between the existing frontage road and I-25. This basin gently slopes to the north, where an existing culvert discharges flows under I-25 at Eden (Design Point 5). Improvements in this basin consist of the demolition of the existing southbound on-ramp from Eden to I-25, which will decrease its imperviousness to 22%. Basin E has a 100-year flow of 11 cfs.

**Basin F (1.82 acres)** – Basin F is located in front of the Wagner Rents building, and contains a portion of the existing frontage road, as well as part of the southbound lanes of I-25. Water generally sheet flows from north to south in this basin, and collects in the roadside ditch between I-25 and the frontage road. It will be 56% impervious. Basin F has a 100-year peak flow of 7 cfs. This basin outlets to an existing 24” culvert (Design Point 6) which discharges to the 6’Hx6’W box culvert at Design Point 2. The existing culvert has the capacity to pass the 100-year peak flow in the proposed condition. Roadway improvements in Basin F consist of the reconstruction of a portion of the frontage road.

**Basin G (1.49 acres)** – Basin G contains a portion of the southbound lanes of I-25, just south of Basin F, and is 72% impervious. No improvements will occur in this basin. Water generally flows from south to north in this basin, and collects in the ditch along I-25. Basin G has a 100-year peak flow of 6 cfs. This basin outlets to an existing 24” culvert at Design Point 6. The existing culvert has the capacity to pass the 100-year peak flow in the proposed condition.

**Basin H (10.9 acres)** – Basin H is located at the southwest corner of I-25 and Dillon Drive, and it contains undeveloped land, including dirt stockpiles. This basin will contain a portion of the proposed on-ramp from Dillon Drive to I-25, a portion of the proposed overpass bridge, a water quality pond, and new roadside ditches. Once improvements are complete, this basin will be 8% impervious. Water generally sheet flows from west to east in this basin, collecting in proposed ditches. Basin H has a 100-year peak flow of approximately 32 cfs. This basin outlets to the existing 4’H x 6’W concrete box culvert at Design Point 4. The existing culvert has the capacity to pass the 100-year peak flow in the proposed condition.

**Basin I (0.89 acres)** – Basin I contains the southern half of the proposed Dillon Drive improvements west of I-25 (100% impervious). Water generally sheet flows across Dillon Drive and collects in the proposed curb and gutter on the south side of Dillon Drive. Runoff flows to a low point in Dillon Drive at Design Point 7. Flow at this design point shall be collected by a 10-foot CDOT Type “R” inlet, and shall be piped using a 24” Reinforced Concrete Pipe (RCP) to outfall to the roadside ditch along I-25 in Basin H. Basin I has a 100-year peak flow of approximately 8 cfs.

**Basin J (0.85 acres)** – Basin J contains the northern half of the proposed Dillon Drive improvements (100% impervious). Water generally sheet flows across Dillon Drive and collects in the proposed curb and gutter on the north side of Basin J, which flows to a low point in Dillon Drive at Design Point 8. Flow at this design point shall be collected by a 10-foot CDOT Type “R” inlet, and shall be piped using a 24” reinforced concrete pipe (RCP) to outfall to the roadside ditch along I-25 in Basin H. Basin J has a 100-year peak flow of 7 cfs.

**Basin K (4.69 acres)** – Basin K contains some commercial development, proposed roadside ditches along Dillon Drive, a portion of the proposed bridge, and a portion of the widened frontage road. It is located at the northwest corner of I-25 and Dillon Drive. Water generally sheet flows from west to east in this basin, collecting in the roadside ditches. It is 30% impervious. Basin K has a 100-year peak flow of approximately 16 cfs. This basin outlets to an existing 6’H x 6’W box culvert at Design Point 2. The existing culvert has the capacity to pass the 100-year peak flow in the proposed condition.

**Basin L (1.34 acres)** – Basin L contains a portion of existing I-25 and a proposed ditch. It is located south of the proposed flyover, on the northbound lanes of I-25. Water generally collects in the ditch through this basin, and is conveyed north underneath the proposed bridge to Design Point 9. Basin L has a 100-year peak flow of 6 cfs, and is 63% impervious.

**Basin M (1.04 acres)** – Basin M is located south of the proposed flyover, and contains a portion of existing southbound I-25 and a proposed ditch. Water generally collects in the ditch through this basin, and is conveyed north (underneath the proposed bridge) to Basin G, where it eventually outfalls to Design Point 2. Basin M has a 100-year peak flow of 4 cfs. It is 45% impervious.

**Basin N (3.67 acres)** – Basin N is located just north of Dillon Drive, and contains the area between the new northbound frontage road to Eden and I-25. It is 27% impervious. Water generally collects in the ditch along I-25 through this basin, and is conveyed to Design Point 11. At Design Point 11, flows are conveyed to the east, under the proposed northbound frontage road, via a 24” RCP. Basin N has a 100-year peak flow of approximately 16 cfs.

**Basin O (2.46 acres)** – Basin O contains a portion of existing northbound I-25, just south of the Eden interchange. Water generally flows from south to north in this basin, where it collects at Design Point 12, where a series of existing culverts eventually convey flow to Fountain Creek. Basin O is 46% impervious, and has a 100-year peak flow of 9 cfs. Improvements in this basin consist of a small portion of the new northbound frontage road from Dillon to Eden, including a small amount of grading.

**Basin P (1.15 acres)** – Basin P contains the northbound frontage road from Dillon to Eden. As a part of this project, the off-ramp from I-25 northbound to Eden will be demolished. Runoff will flow to the north along the frontage road curb and gutter to

Design Point 13. At the end of the retaining wall, a concrete rundown will be constructed to convey runoff from the roadside, down the proposed fill slope, to meet existing grade. The rundown will protect the fill slope from erosion. Basin P has a 100-year peak flow of 6 cfs. Based on the UDFCD inlet spreadsheets, the proposed roadway section has sufficient capacity to convey the 100-year runoff down the ramp without impeding traffic flow during a 100-year event.

### **4.3 Proposed Drainage Improvements**

**Storm Sewer** – A limited amount of storm sewer will be installed in Dillon Drive as a result of this project. This sewer will intercept flows at Design Points 7 and 8. Please refer to Exhibit 1 for a basin and design point map.

Discharge to Design Point 7 is 8 cfs, and the peak 100-year flow to Design Point 8 is 7 cfs. UD-Inlet, an inlet sizing spreadsheet from UDFCD, was used to size inlets. Results show that a 10-foot Type R inlet will be necessary at each location, in order to keep depth at the flowline to less than six inches.

Neo UD-Sewer, a sewer sizing program produced by the UDFCD, was used to size the proposed storm sewer. Based on results of UD-Sewer, a 24" RCP will have capacity to convey flows from the 100-year runoff event, with some excess capacity. See Appendix 5 for UD-Sewer output.

**Proposed Roadway Inlets** – Two roadway inlets will be provided on Dillon Drive, in a proposed roadway sump. Once improvements are completed, these inlets will intercept flows from Basins I and J. They have been sized such that the depth at the flowline will be less than 6-inches during the 100-year storm. No additional flow from future improvements to the west has been accounted for in sizing these inlets, since additional flow to these inlets may overwhelm the existing 4'Hx6'W culvert at Design Point 2. No future flows from the west should be routed to these inlets, since the detention pond has also not been sized for future flows. Instead, as Dillon Drive is improved to the west, flows should be discharged into the existing double 40"Hx60"W culvert under Dillon near Design Point 3, which will pass these flows to the 6'x6' culvert at Design Point 2. This will also effectively mimic the existing drainage patterns in the area.

**Drainage Channels** – Several roadside ditches will be included in this project. See Appendix D for ditch sizing calculations. All ditches were sized using Haestad Methods' Flowmaster program for the 100-year storm. All of the following ditches have triangular cross-sections.

- **Ditch One** – Ditch One is located west of I-25, near the proposed on-ramp. It conveys flows from Basin D to design point 4. The 100-year peak discharge is 169 cfs. It has 4:1 side slopes, a depth of 3.0 feet, and a slope of 0.75%. The velocity during the 100-year storm is less than 5 ft/s.

- **Ditch Two** – Ditch Two is located on the east shoulder of I-25, near the northbound off-ramp. It will convey flows from Basin L to the north, under the Dillon Drive overpass, where it will eventually outfall into an existing drainage channel. Ditch Two carries 6 cfs during the 100-year peak runoff event, with 6:1 side slopes. Due to its low discharge, and its slope of 0.25%, the 100-year velocity is 1.2 ft/s. The depth of flow during the 100-year runoff event is 0.9 feet.
- **Ditch Three** – Ditch Three is located on the west shoulder of I-25. It conveys flows from Basins M and G, a total of 10 cfs during the 100-year peak runoff event. Ditch Three has 6:1 side slopes, a longitudinal slope of 0.25%, and a 100-year depth of 1.1 feet. Both Ditch Two and Ditch Three are adjacent to I-25, which is very flat in this area. This accounts for the shallow longitudinal slopes on Ditches Two and Three.
- **Ditch Four** – Ditch Four is located south of Dillon Drive, and it conveys flows from the proposed 24” RCP in Dillon Drive, and flows from Basin H. The 100-year peak discharge for Ditch Four is 41 cfs. Ditch Four has a 2.0% longitudinal slope, with 4:1 side slopes. Flow will be 1.5 feet deep during the 100-year peak runoff event, with a velocity of 4.8 ft/s.
- **Ditch Five** – Ditch Five is located north of Dillon Drive, by the Drury Brothers roofing company. It conveys flows from Basin K, approximately 16 cfs during the 100-year peak runoff event. Ditch Five has a slope of 2.0%, 4:1 side slopes, and a depth of 1.02 feet, with a velocity of 3.8 ft/s. Ditch Five crosses under several driveways en route to Design Point K. Culverts will be used at these driveways, sized to pass the 100-year discharge. Assuming a headwater/depth ratio of 1.0, two 24” RCP culverts will be required at these driveway crossings in order to pass the 100-year discharge.
- **Ditch Six** – Ditch Six is located on the west side of I-25, north of Dillon Drive. It conveys flows to Design Point 6, estimated to be 17 cfs during the 100-year peak runoff event. It is 1.33 foot deep, with a slope of 0.25%, and 6:1 side slopes. Velocity during the 100-year runoff event is 1.6 ft/s.

**Channel Realignment** – The channel which receives flow from the existing 4’H x 6’W concrete box culvert (Design Point 4 – Channel One) will be realigned as a part of this project in order to allow for appropriate roadway fill slopes to the east of the proposed freeway offramp. The 100-year peak discharge at Design Point 4 is approximately 169 cfs.

Several options were considered for this channel realignment. One option included extending a new box culvert the entire length, which was cost prohibitive. A second option included extending the 4’H x 6’W box culvert to a new channel at an approximate 0.5% slope. Due to the high erodability of the soils in this area, it is imperative that velocities remain mild in order to limit erosion potential.

Since a 0.5% slope is flatter than the existing slope, provisions will be required to make up the excess grade. Currently, the channel slope is approximately 4%. Using a proposed channel slope of 0.5% will require a vertical drop of nearly 14 feet. One option is to install drop structures, but for an ephemeral stream such as this, drop structures were considered to be out of place and too costly for a stream that only receives storm runoff. Additionally, drop structures have a potential for failure if not designed and constructed correctly.

Instead, a steep section of box culvert will be installed at the end of this channel to allow the channel to drop safely without causing excessive erosion. This box culvert will contain roughness elements, which allow the culvert to achieve full flow, thereby decreasing flow velocities. Riprap will also be installed at the downstream end of this culvert for outlet protection.

The proposed channel will have a nine-foot bottom width, with 3:1 side slopes. With a peak discharge of 169 cfs, it will have a depth of 2.23 feet, and a velocity of 4.44 ft/s. This channel will have sufficient capacity for the 100-year peak runoff event, while remaining more stable than the existing channel. During lower flows, velocities will drop below 2.5 ft/s, which may cause sedimentation. However, due to the detention pond upstream of this channel, it is anticipated that most sediment will settle in the pond.

A second channel (Channel 2 on Exhibit 1) will also be relocated to accommodate proposed fill slopes. This channel is located at the discharge point of the existing 6'x6' box culvert at Design Point 2. The 100-year discharge to this channel is 178 cfs. Several options were considered for this channel, discussed below.

Like Channel 1, this channel will also be flatter than the existing channel, so it will contain a steep segment of paved channel in order to catch existing grade. Under option 1, Channel 2 will have a longitudinal slope of 0.25%, with 2.5:1 side slopes (maximum) and a flow depth of 2.95 feet. The 100-year velocity in Channel 2 will be 3.92 ft/sec. The side slopes are 2.5:1 in order to fit the channel in the allowable R.O.W. This is the preferred option, because it will provide a water quality benefit with reasonable costs.

Several other options were considered for this channel. The first included installing a box culvert for the length of the channel, but was considered too cost prohibitive, and may have required a large amount of maintenance, especially considering the silted condition of the existing box culvert. Additionally, the box culvert would not provide the water quality benefit that an open channel will.

A third option was the installation of retaining walls in order to flatten the channel side slopes. This scenario also was very cost prohibitive. Although the open channel will provide a water quality benefit, the cost for this option was considered excessive.

The selection option for Channel 2 will require routine maintenance in order to function properly. Due to the steep side slopes (2.5:1), maintenance responsibilities will need to be determined between the City of Pueblo and CDOT at the FIR meeting.

#### 4.4 *Water Quality*

The Colorado Discharge Permit System (CDPS) stormwater discharge permit issued to the Colorado Department of Transportation (CDOT) requires CDOT to implement a program to reduce the discharge of pollutants from areas of new highway development and significant redevelopment after construction is complete. Projects that fall under certain categories, for instance, projects that disturb one or more acres, or projects that require an Environmental Assessment, such as this project, are required to comply with requirements of the CDOT Municipal Separate Storm Sewer (MS4) permit.

The CDOT MS4 permit requires that construction and permanent Best Management Practices (BMP's) must be installed to reduce the discharge of pollutants to receiving water bodies, in accordance with the CDOT Drainage Design Manual. The Dillon Drive project provides 100% of the water quality control volume (WQCV) required for impervious surfaces in order meet the post-construction requirements. Construction BMP's are also provided in accordance with the CDOT Drainage Design Manual. Typically, BMP's are situated in series, to increase removal efficiencies.

Fountain Creek (located a half mile west of the project) has been found to have no Total Maximum Daily Load (TMDL) requirements according to both the EPA and CDPHE.

Following is a list and description of all temporary and permanent BMP's proposed for this project.

**Extended Detention Basin/Water Quality Pond** – The Extended Detention Basin (EDB)/water quality pond, located in Basin H, will treat runoff from all impervious areas for this project, a total of 4.33 acres. Since not all of the proposed impervious surfaces are tributary to the pond, and in order to be more cost-effective, the pond has been sized to treat runoff from all impervious surfaces. The pond volume will be approximately 30,000 cubic feet (cf). This pond shall both release and overflow (in events larger than the 100-year runoff event) to the existing 4'H x 6'W concrete box culvert at Design Point 4. The existing culvert has the capacity to pass the 100-year peak flow in the proposed condition.

This EDB also includes 100% of the WQCV for all impervious areas, 4.33 acres. With an imperviousness of 100%, this equates to a WQCV of 7861 cf.

**Sediment Basin** –A sediment basin will be installed directly upstream of the 6x6' box culvert in order to trap sediment before it enters the culvert, per an agreement between CDOT and the City of Pueblo Stormwater Department, dated October 30, 2009,. See Appendix F for a copy of this letter.

Basins B, C, F, G, K, and M are tributary to this pond, with a total drainage area of 104.09 acres, and a weighted percent impervious of 17%, equating to a total WQCV of 0.89 acre-feet. UDFCD criteria recommend that sediment forebays be sized for 3-5% of the WQCV, which equates to approximately 2,000 cf of forebay volume.

However, soil loss equations show that the total yearly sediment load to this culvert may be nearly 10,000 cf per year. A forebay volume of 2,000 cf would require very frequent maintenance. As a result, the forebay volume was increased to approximately 25% of the WQCV, or 10,000 CF. It is intended that the forebay will only require cleaning on an average of once per year.

**Grass Swale** – Grassed swales will be used as much as possible for runoff conveyance, especially in the roadside ditches and channels. All the roadside ditches are grass swales.

#### **4.5 Construction Best Management Practices**

At a minimum, the following construction Best Management Practices (BMPs) may be utilized during construction:

**Silt Fence:** A silt fence is made of a woven synthetic material. Its function is to trap sediment through sedimentation and filtering of runoff. Silt fence can be placed as a temporary barrier along the contour at the base of a slope of a disturbed area. They are of little if any use if placed at the top of the disturbed slope and are not intended for use as diversion barriers or as perimeter fencing. In addition, they are not to be used as checks within a swale or channel. Proper installation and maintenance is essential to ensure their performance.

**Sediment Control Log:** Sediment control logs, consisting of manufactured logs (wattles) made of straw, excelsior, or coconut fiber, can be placed parallel to the contour at the base of a hill slope as a sediment barrier. They are temporary in nature and may only perform for a period of weeks or months before they degrade. Proper installation and maintenance is essential to ensure their performance.

**Outlet Protection/Check Dams:** The outlets of slope drains, culverts, sediment traps and sediment basins must be protected from erosion and scour. Outlet protection should be provided where the velocity of flow will exceed the maximum permissible velocity of the material of the waterway into which discharge occurs. This may require the use of a riprap apron at the outlet location and/or other measures to keep the waterway from eroding. Check dams can be used along channels, ditches, or swales, and downstream of the outlets of temporary slope drains, culverts, sediment traps and sediment basins. Check dams reduce the velocity of concentrated flows and trap sediment. Although they do trap some sediment, they are not primary sediment trapping facilities and serve as temporary flow velocity reduction structures to reduce erosion. Check dams may be used under the following conditions:

- As temporary grade control facilities along waterways until final stabilization is established
- Along permanent swales that need protection prior to installation of a non-erodible lining

- Along temporary channels, ditches or swales that need protection where construction of a non-erodible lining is not practicable.

Check dams should be constructed of four- to six-inch angular rock mixed with sand to a maximum height of two-feet. The center of the top of the dam should be six-inches lower than the sides to reduce the chances of the flows eroding around the structure. Where multiple check dams are used, the top of the lower dam should be at the same topographical elevation as the toe of the upper dam. All of the rock and accumulated sediment should be removed, and the area seeded and mulched, or otherwise stabilized.

**Inlet Protection:** All storm sewer inlets which are made operable during construction and that are not connected to a storm sewer discharging to a sedimentation basin must be protected to minimize the amount of sediment that may enter them. The goal is to prevent sediment-laden runoff from entering the conveyance system without first being filtered or otherwise treated to remove sediment.

**Temporary Revegetation:** Temporary revegetation is required on all disturbed areas that are projected to have or have already experienced a period of exposure prior to final stabilization of one year or longer. All temporary seeding shall be protected with mulch. To provide temporary vegetative cover on disturbed areas that will not be paved, built upon, or fully landscaped within 12 months but will be completed within 24 months, plant an annual grass appropriate for the time of planting and mulch the planted areas.

**Surface Roughening:** Surface roughening consists of creating a series of grooves or furrows on the contour in all disturbed, graded areas to trap rainfall and reduce the formation of rill and gully erosion.

**Sediment Basin:** A sediment basin is an impoundment that captures sediment-laden runoff and releases it slowly, providing prolonged settling times to capture coarse and fine-grained particles. Often, sediment basins are located in proposed detention basins. Once construction is complete, the sediment basin must be cleaned out before the detention basin is brought on-line.

**Erosion Control Blanket:** Erosion Control Blanket (ECB) is a fibrous blanket of straw, jute, coconut, or excelsior material trenched in and staked down over prepared, seeded soil. The blanket reduces both wind and water erosion and helps to establish vegetation. Slopes steeper than 4:1 are typically protected with ECB.

**Concrete Washout Area:** A concrete washout area is a shallow excavation with a small perimeter berm to isolate concrete truck washout operations. Other options may also be considered, such as eco-pans (reusable steel washout containers), or kiddie pools, provided they are disposed of properly.

#### **4.6**      *Post Construction Water Quality*

Post construction water quality is required by CDOT to be addressed in all construction projects undertaken on CDOT right-of-way. Structural BMPs will be selected based on available land and non-structural BMPs are listed for inclusion in maintenance responsibilities.

The following BMPs will be used throughout the project area:

**Extended Detention Basin:** An extended detention basin (EDB) is a sedimentation basin designed to totally drain dry sometime after stormwater runoff ends. The EDB uses a much smaller outlet than a typical detention basin, which extends the basin emptying time to facilitate pollutant removal. The EDB drain time of 40 hours is typically used in order to remove a significant portion of fine particulate pollutants found in urban stormwater runoff. The basins are considered to be “dry” because they are designed not to have a significant permanent pool of water remaining between storm runoff events. An EDB can be used to enhance stormwater runoff quality and reduce peak stormwater runoff rates. Maintenance requirements include mowing, occasional mucking of the pond bottom, and cleaning of the outlet structure.

**Sediment Forebay:** Provides an opportunity for larger particles to settle out in an area that has a solid surface bottom to facilitate mechanical sediment removal. A rock berm or concrete-wall should be constructed between the forebay and the main EDB. The floor of the forebay should be concrete or grouted boulder lined to define sediment removal limits.

**Sheet Flow to Buffer:** This BMP is used to filter pollutants through the vegetation as stormwater runoff moves from adjacent surfaces (such as the roadway surface) to swales or natural drainageways. The buffer area should be densely vegetated with a mix of native plants and can only be used in areas where the slope from the edge of the asphalt to the swale is 4% or less for a minimum of 50 feet. Maintenance requirements include occasional mowing, litter control and periodic inspection for erosion and vegetation damage.

**Grass Swale** – A grass swale is a vegetated Drainageway with shallow slopes that collect and slowly convey runoff. Design of their longitudinal slope and cross-section size forces the flow to be slow and shallow, thereby facilitating sedimentation while limiting erosion. Maintenance requirements include mowing, and an occasional mucking of the swale bottom if sediment has accumulated.

**Seeding and Mulching:** Seeding and mulching consists of drill-seeding disturbed areas with grasses and crimping in straw mulch to provide immediate protection against raindrop and wind erosion and, as the grass cover becomes established, to provide long-term stabilization of exposed soils.

**Administrative BMPs:** These BMPs are non-structural in nature and are generally defined as “good housekeeping” or maintenance practices to help reduce TSS from

stormwater runoff. BMPs included in this category include street sweeping, mowing, training of maintenance personnel, and litter control.

## 5.0 Conclusions

The proposed drainage modifications presented in this report effectively maintain historic drainage patterns, and improve water quality for the proposed condition. The existing and proposed drainage elements have been sized to convey the 100-year peak runoff event within City of Pueblo and CDOT criteria. All drainage and water quality features designed in support of the proposed interchange improvements fully meet the CDOT and City of Pueblo design criteria requirements.