# Final Drainage Report
## U-Haul at Falcon
## Falcon U-Haul Filing 1
## El Paso County, Colorado
## PCD File #s: PPR-22-56 & SF-22-40

Prepared for:
Amerco Real Estate Company
2727 N Central Avenue
Phoenix, AZ 85004

Prepared by:

Kiowa
Engineering Corporation
7175 West Jefferson Avenue, Suite 2200
Lakewood, Colorado 80235
Ph: (303)692-0369

Kiowa Project No. 21061

June 9, 2023

**TABLE OF CONTENTS**

## STATEMENTS AND APPROVALS

### ENGINEER'S STATEMENT:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the City/County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

Kiowa Engineering Corporation, 7175 West Jefferson Ave, Suite 2200, Lakewood, CO 80235

____________________________________ ____________________

Matthew W. Erichsen, P.E. (PE #36713) Date

For and on Behalf of Kiowa Engineering Corporation

### DEVELOPER'S STATEMENT:

I, the Developer, have read and will comply with all of the requirements specified in this drainage report and plan.

By: ____________________________________ ____________________

Amerco Real Estate Company Date

Print Name: ________________________________

Address: Amerco Real Estate Company
2727 North Central Ave
Phoenix, AZ 85004

### EL PASO COUNTY:

Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 & 2, El Paso County Engineering Criteria Manual, and Land Development Code, as amended.

____________________________________ ____________________

Date

El Paso County Engineer/ECM Administrator

## I. GENERAL LOCATION AND DESCRIPTION

The Falcon U-Haul Filing No. 1 property will be developed as a commercial development including two main buildings on the site for self storage, U-Box warehouse, showroom, vehicle sharing and retail area. The subject property is located along the south side of Rolling Thunder Way, west of Meridian Road and north of Tamlin Road in Falcon, Colorado. The site is located in the east half of Section 12, Township 13 South, Range 65 West of the 6th Principal Meridian, in El Paso County, Colorado. The site is bounded to the west by Falcon Highlands Filing No. 2, future Falcon Highlands Filing No. 3, to the south by Tamlin Road, east by Meridian Road and north by Rolling Thunder Way. The Unnamed West Tributary to Black Squirrel Creek No. 2 (West Tributary) is a drainageway along the west side of the property which includes a regulated FEMA Zone AE floodplain. The drainageway and floodplain is located outside the subject property. The property covers approximately 11.50 acres and is currently undeveloped. The property is planned to be developed in two phases. The northern portion which is described in this drainage report and the southern portion will be developed in the future. The southern portion is planned to be developed as mini self storage and RV storage. A vicinity map of the site is shown on Figure 1 included in the Appendix.

The existing vegetative cover within the development is in fair condition with grasses throughout the site. The existing ground slopes within the property range from 1 to 6 percent typical with areas of vertical slopes along the edges. Soils within the subject site are classified to be within Hydrologic Soil Group A as shown in the El Paso County Soils Survey, see Appendix for the Soil Map. Specifically the site includes Blakeland Fluvaquentic Haplaquolls soil. For the purposes of computing the existing and proposed hydrology for the site, Hydrologic Soil Group AB was used.

There are no active irrigation ditches or facilities within or adjacent to the site.

## II. MAJOR DRAINAGE BASINS AND SUBBASINS

The site lies within the Falcon drainage basin. The majority of the site drains by sheet flow southwest into the West Tributary near the south end of the property before flowing into Detention Pond WU. The property has been included in multiple drainage studies. The *Falcon Drainage Basin Planning Study (DBPS) (2015)* shows overall Falcon drainage basin and the West Tributary. The U-Haul site is located in Drainage Basin WT240 and the portion of the West Tributary adjacent to the site Element RWT240. The *DBPS* includes the stormwater detention values for Regional Pond WU and identifies improvements to the Pond.

The Bent Grass Development FDR, MDDP & DBPS Amendment provides the design of the improvements including water quality facilities. For the West Tributary, the *DBPS* indicates "Protect in Place" which is described as "There are several relatively pristine reaches of channel throughout the Falcon Watershed that are currently in a stable condition. Additionally, there are several reaches throughout the Falcon Watershed that have already been improved and appear to be stable. Preserving both of these reach conditions would not require a direct reach improvement cost. However, upstream detention improvements may be required depending on the location of the reach.". The DBPS does not identify any improvements to the West Tributary or include any improvements costs for it.

The Bent Grass Development includes an FDR and MDDP & DBPS Amendment (2021). The reports and associated construction plans show improvements to Detention Pond WU including water quality improvements. Those improvements have been completed. The design accounted for the future development of the U-Haul site as a commercial development.

The Falcon Highlands Market Place Filing No. 1 Preliminary and Final Drainage Report (2005) studied the area directly north of Pond WU including the U-Haul site. This study includes the runoff calculations for the area upstream tributary to the existing 42-inch storm sewer crossing under Rolling Thundery Way at the northeast corner of the property. The report describes the existing drainage channel downstream of the 42-inch pipe and the expectation the channel will be replaced with a pipe with the development of the subject property to convey the flows through the site to the West Tributary and Pond WU. The report identifies this public/private storm sewer system however it is not included in the DBPS and the DBPS schedule of improvement costs. This should be a reimbursable cost and as such a cost estimate is provided in the Appendix. Refer to the Drainage and Bridge Fees section. This report assumed a fully developed property for the subject site with runoff coefficients of $C_5$=0.90 and $C_{100}$=0.95.

The subject property is not located within a FEMA regulated floodplain. The West Tributary is located adjacent to the site and does include a Zone AE FEMA regulated floodplain based on Flood Insurance Rate Map 08041C0561G, effective dated December 7, 2018. A copy of the FIRM panel is provided in the Appendix.

## III. EXISTING DRAINAGE PATTERNS

The existing drainage patterns for the property include mainly sheet flow to the south where the flows will drain into the West Tributary which is connected to Regional Detention Pond WU. Following is a description of the existing drainage patterns, refer to the Drainage Plan – Existing Conditions for the basin locations and the Appendix for the runoff calculations.

Design Point 23: This Design Point is from the Falcon Highlands Market Place Filing No. 1 PDR and FDR. The DP includes the flows being conveyed through the existing 42-inch storm sewer under Rolling Thunder Way at the northeast corner of the property. The flow assumes a fully developed tributary area upstream of the DP including both the streets and properties.

Basin OS-1: The drainage basin is located along Rolling Thunder Way street section to the north of the site. The basin includes mainly paved area with the sidewalk and tree lawn. The runoff from the basin sheet flows to the south street curb line and drains into Basin EX-B in the subject site through the north driveway access.

Basin EX-A: The drainage basin is located at the northwest corner of the property. The runoff from the basin sheet flows southwest to the property line where it will continue west into the West Tributary.

Basin EX-B: The drainage basin includes most of the property. The runoff sheet flows south into the existing drainage swale downstream of the existing 42-inch storm sewer. The swale conveys the flows south off the property at future Tamlin Road where the flows continue into the West Tributary and then Pond WU. The existing 42-inch storm sewer described in DP 23 drains into this basin and is conveyed by the existing drainage swale.

Basin EX-C: The drainage basin is located at the northeast corner of the property. The runoff from the basin sheet flows east onto Meridian Road gutter where the flows will continue south to Tamlin Road.

Regional Detention Pond WU: Pond WU is located south of the site and is an in-line regional detention basin with stormwater quality facilities. The current design of the Pond and facilities is described in the Bent Grass MDDP/DBPS Amendment. The detention basin is designed to have an embankment on the upstream end across the West Tributary at future Tamlin Road. The embankment includes an 18-inch culvert at the upstream low point to capture and convey the minor flows from the West Tributary. Larger storm events will pond upstream of the embankment until reaching the spillway crest elevation at a depth of roughly 8.4-ft. The flows will then overtop the embankment and drain into Pond WU. To the east of this embankment are twin 18-inch storm sewer pipes which have an invert roughly 1.0-ft below the spillway crest. These pipes drain to a side "diversion" channel and it appears these flows are meant to provide moisture for the vegetation in this side channel. The DBPS indicates the future/proposed Tamlin Road crossing of the West Tributary will replace the existing 18-inch storm sewer with a 12'(W) x 6'(H) box culvert and removal of the existing embankment. Pond WU does not currently include a concrete trickle channel to convey flows. A concrete trickle channel in Pond WU will be constructed as part of this development. This development will also include a new forebay in Pond WU.

## IV. DRAINAGE DESIGN CRITERIA

Hydrologic and hydraulic calculations for the site were performed using the methods outlined in the *El Paso County Drainage Criteria Manual*. Topography for the site is presented on the Drainage Plan. The hydrologic calculations were made for the existing and proposed site conditions. The Drainage Plan presents the drainage patterns for the site, including the drainage basins. The peak flow rates for the drainage basins were estimated using the Rational Method. The 5-year (Minor Storm) and 100-year (Major Storm) recurrence intervals were determined. The one-hour rainfall depth was determined from Table 6-2 of the *Drainage Criteria Manual*. The peak flow data generated using the rational method was used to size inlets and storm sewers within the site. The drainage basin area, time of concentration, and rainfall intensity were determined for each of the drainage basins within the property. The onsite soils were assumed to be Hydrologic Soil Group AB, based on the *Soil Survey*.

The onsite hydraulic structures were sized using the methods outlined in the *El Paso County Drainage Criteria Manual*. The hydraulic capacities of the curb inlets were determined using the MHFD-Inlet spreadsheet developed by the MHFD. Colorado Department of Transportation (CDOT) Type R curb inlets, Type 13 valley inlets and Type C grated inlets will be used within the site. Storm sewer pipes were initially sized based on their full-flow capacity using the Manning's equation. The UDSewer program was then used to verify storm sewer pipe sizes and perform hydraulic grade line (HGL) and energy grade line (EGL) calculations for the 5-year and 100-year storm events. Hydraulic calculations are provided in the Appendix for the proposed inlet and pipe capacities.

The subject site is tributary to Regional Detention Pond WU which is located directly downstream of the site along Unnamed West Tributary to Black Squirrel Creek No. 2. Stormwater quality and detention for the property is provided in Detention Pond WU, so no on site water quality or detention improvements will be required.

## V. DRAINAGE FACILITY DESIGN

The drainage of the site will be accomplished through a combination of sheet flow, gutter flow and storm sewer flow. The site has been graded to convey runoff to low points on the site where drainage inlets, curb openings or pipes are located to capture the 100 year flow and direct it into a storm sewer which will discharge to the Detention Pond WU. The proposed drainage patterns for the site are shown on the Drainage Plan – Proposed Conditions (Exhibit B) provided in the map pocket at the end of this report. The hydrologic and hydraulic calculations are provided in the Appendix.

The on-site drainage system will include a couple storm sewer systems. The main system will be Storm Sewer System A (Storm A) which is located along the east side of the site conveying flows from discharged into the northeast corner of the site by an existing 42-inch RCP storm sewer. Storm A will also be used to convey on site runoff through the site and into Pond WU. A forebay with energy dissipator will constructed on the end of Storm A for energy dissipation, water quality and erosion protection. West Tributary is considered Waters of the State, for that reason Storm A has been extended past West Tributary to outfall directly to Pond WU. If Storm A connected to Tributary A, then the County requires water quality to be provided for the storm water runoff being discharging to Waters of the State, in this case Tributary A. Pond WU was designed to provide stormwater quality for the area tributary to Storm Sewer A.

The County requires a Four Step Process for selection of appropriate permanent BMPs for the site. In this development following are the steps taken to meet this process.

Step 1-Employ Runoff Reduction Practices: Runoff from a portion of the site along the west side will be routed through a grass lined swale before reaching the drainage inlets. The middle and east portions of the site have less opportunity to use Minimizing Directly Connected Impervious Areas (MDCIA) due to required vehicle turning movements and layout of the facilities. The site ultimately drains to Regional Detention Pond WU which includes a pervious bottom for stormwater infiltration and runoff reduction.

Step 2-Stabilize Drainageways: The West Tributary is located adjacent to the site to the west. The West Tributary was analyzed as part of the *DBPS* and the selected plan is to "Protect in Place" which is described as "There are several relatively pristine reaches of channel throughout the Falcon Watershed that are currently in a stable condition. Additionally, there are several reaches throughout the Falcon Watershed that have already been improved and appear to be stable. Preserving both of these reach conditions would not require a direct reach improvement cost. However, upstream detention improvements may be required depending on the location of the reach.". The DBPS does not identify any improvements to the West Tributary or include any improvements costs for it. The proposed development does not discharge developed flows into Tributary A until Pond WU which is stabilized.

Step 3-Provide Water Quality Capture Volume (WQCV): Regional Detention Pond WU is located downstream of the site and will provide the WQCV as shown in the Bent Grass Development MDDP & DBPS Amendment and the Falcon Highlands Market Place Filing No. 1 PDR/FDR.

Step 4-Consider Need for Industrial and Commercial BMPs: The potential pollutant sources for a commercial development like this one include: parked vehicles, deicing chemicals/snow storage, waste storage/disposal practices and landscapes (fertilizers, herbicides, pesticides, excessive irrigation). Some of the planned source control BMPs for the development include the following: No vehicle maintenance is allowed on the site. The property owner provides trash collection and full landscape maintenance for the development. The application of fertilizers, pesticides and other chemicals is planned to be done per manufacturer's recommendations. The owner will ensure proper use, storage and disposal of materials on site. Material and equipment necessary for spill cleanup will be kept on the site.

## A. PROPOSED DRAINAGE PATTERNS

Following is a description of the proposed condition drainage basins and the main storm sewer system which conveys flows through the site (Storm Sewer System A or Storm A).

<u>Drainage Basin A:</u> The basin is located along the northwest corner of the property. It includes pavement and landscape areas. The runoff from the basin will sheet flow southwest to the curb line or drain pan which will direct the flows to a curb opening in sump condition at the southwest corner of the paved lot. The flows will continue into Basin D in a grass lined swale. This basin drains to DP1, is 1.46 acres, 81.5% impervious, has a 5-yr flow of 4.5 cfs, and a 100-yr flow of 8.7 cfs.

<u>Drainage Basin B:</u> The basin is located in the north central portion of the site. It includes mainly pavement areas. The runoff from Basin OS-1 will enter this basin at the north end. The runoff from the basin will sheet flow south to a low point in the paved area between the buildings where a grated valley inlet in sump condition with 100-year capacity will be

located. A pipe will extend out of the inlet south and be routed to Storm A which drains to the Detention Pond WU. This basin drains to DP2, is 2.03 acres, 96.1% impervious, has a 5-yr flow of 8.7 cfs, and a 100-yr flow of 15.8 cfs.

Drainage Basin C: The basin is located in the northeast portion of the site. It includes pavement and landscape areas. The runoff from the basin will sheet flow to the proposed drain pan or curb line which will convey the flows to a low point and curb opening at the northeast corner of the paved area. A storm sewer flared end section will be located behind the curb opening to capture the 100-year flows and convey to Storm A. This basin drains to DP4, is 0.91 acres, 65.9% impervious, has a 5-yr flow of 1.9 cfs, and a 100-yr flow of 4.0 cfs.

Drainage Basin D: The basin is located to the west of Building B. It includes landscape area. The runoff from the basin will sheet flow to a swale which will drain the flows to a proposed 24" RCP FES. 100-year flows will be captured, then conveyed through storm sewer pipes to Storm A. This basin drains to DP1, is 0.16 acres, 2.0% impervious, has a 5-yr flow of 0.1 cfs, and a 100-yr flow of 0.4 cfs.

Drainage Basin E: The basin is located on the west side of the site and includes the roof of Building B. The runoff from the roof will drain to the west side where a gutter and downspouts will convey the flows down to the ground surface and into Basin D. This basin drains to DP1, is 0.39 acres, 90.0% impervious, has a 5-yr flow of 1.4 cfs, and a 100-yr flow of 2.6 cfs.

Drainage Basin F.1: The basin is located on the east side of the site and includes the north portion of the Building A roof. The runoff from the roof will drain to the east side where a gutter and downspouts will convey the flows down to the paved ground surface and into Basin C. This basin drains to DP4, is 0.28 acres, 90.0% impervious, has a 5-yr flow of 1.0 cfs, and a 100-yr flow of 1.8 cfs.

Drainage Basin F.2: The basin is located on the east side of the site and includes the north portion of the Building A roof. The runoff from the roof will drain to the east side where a gutter and downspouts will convey the flows down to the paved ground surface and into Basin G. This basin drains to DP5, is 0.59 acres, 90.0% impervious, has a 5-yr flow of 2.1 cfs, and a 100-yr flow of 3.9 cfs.

Drainage Basin G: The basin is located to the east of Building A. It includes paved and landscaped areas. The runoff from the basin will sheet flow to the gutter line which will convey the flows to a low point where a curb inlet will be located in sump condition with 100-year capacity. A pipe will convey the flows from the inlet to Storm A. This basin drains to DP5, is 0.59 acres, 58.6% impervious, has a 5-yr flow of 1.2 cfs, and a 100-yr flow of 2.4 cfs.

Drainage Basin H: The basin is located on the west side of the site and includes the Building A loading dock ramp. The runoff from the ramp will drain to a trench drain in sump condition and 100 year capacity. A storm sewer pipe will extend from the trench drain to the storm sewer from Basin D. This basin drains to DP1A, is 0.06 acres, 100.0% impervious, has a 5-yr flow of 0.3 cfs, and a 100-yr flow of 0.5 cfs.

Drainage Basin J: The basin is located to the south of Building A. It includes paved and landscaped areas. The runoff from the basin will sheet flow to the gutter line which will convey the flows to a low point where a curb inlet will be located in sump condition with 100-year capacity. A pipe will convey the flows from the inlet to Storm A. In the future, the area to the south, occupied by mostly drainage basins K and L, will be developed. This basin drains to DP26, is 0.65 acres, 39.4% impervious, has a 5-yr flow of 0.8 cfs, and a 100-yr flow of 2.3

cfs. In the future, developed stage, this basin is 75.8% impervious, has a 5-yr flow of 1.3 cfs, and a 100-yr flow of 2.6 cfs.

Drainage Basin K: The basin is located in the southwest portion of the site. It currently includes grassed areas and a paved access drive. The runoff from the basin will sheet flow to the south end of the site where a low point is located with a "temporary" storm sewer pipe to capture the flows and convey to Storm A. In the future, the area within the basin will be developed. Drainage Basin K-Dev assumes a developed percent impervious. The runoff from the developed basin will also connect to Storm A. This basin drains to DP28, is 3.17 acres, 21.0% impervious, has a 5-yr flow of 2.3 cfs, and a 100-yr flow of 8.6 cfs. In the future, developed stage, this basin is 85.0% impervious, has a 5-yr flow of 9.3 cfs and a 100-yr flow of 17.9 cfs.

Drainage Basin L: The basin is located in the southeast portion of the site. It currently includes grassed areas. The runoff from the basin will sheet flow to the east of the access drive and south end of the site where a low point is located with a "temporary" storm sewer pipe to capture the flows and convey to Storm A. In the future, the area within the basin will be developed. Drainage Basin L-Dev assumes a developed percent impervious. The runoff from the developed basin will also connect to Storm A. This basin drains to DP27, is 1.14 acres, 2.0% impervious, has a 5-yr flow of 0.4 cfs, and a 100-yr flow of 2.6 cfs. In the future, developed stage, this basin is 85.0% impervious, has a 5-yr flow of 3.5 cfs, and a 100-yr flow of 6.8 cfs.

Drainage Basin M: The basin is located in the northwestern corner of the site. It currently includes grassed areas. The runoff from this basin will sheet flow to the southwest and enter the west tributary. This basin is remaining undeveloped, and its flow patterns are not being modified. This basin is 0.08 acres, 2.0% impervious, has a 5-yr flow of 0.0 cfs, and a 100-yr flow of 0.03 cfs.

Storm Sewer System A (Storm A): The storm sewer system is located along the east side of the development. Storm A will connect to the existing 42-inch storm sewer which conveys off site flows onto the site from under Rolling Thunder Way at the northeast corner of the property. The on-site storm sewer will connect to Storm A which is designed to convey the 100-year storm through the site to Pond WU. Refer to previous discussion regarding Waters of the State and the West Tributary. A forebay will be located at the end of the storm sewer pipe to dissipate the flows, minimize erosion and provide pre-sedimentation for water quality. The County has required the construction of a concrete trickle channel from the end of the forebay through the detention basin to the outlet structure.

## B. STORMWATER QUALITY DESIGN

Storm water quality improvements for the site will be provided in the existing Detention Pond WU. The WQCV is provided in Pond WU and it accounted for the proposed development of the subject site. The original design of Pond WU was completed as part of the Falcon Highlands Filing No. 2 MDDP/PDR/FDR. Water quality improvements were made to Pond WU as part of Bent Grass Development MDDP & DBPS Amendment, FDR and Construction Plans.

## C. COST OF PROPOSED DRAINAGE FACILITIES

Table 2 presents a cost estimate for the construction of drainage improvements (public and private) for development. The subject development requires the construction of a 42-inch storm sewer through the property to convey off site public and private flows to the West

Tributary and Pond WU, a forebay into Pond WU, and a trickle channel through Pond WU. The cost associated with this storm sewer extension is not included in the DBPS as a reimbursable cost. The costs for this storm sewer extension has been broken out separately in Table 2.

### D. DRAINAGE AND BRIDGE FEES

The site lies within the Falcon Drainage Basin. The DBPS was completed in 2015. No drainage improvements were identified for the West Tributary adjacent to the site or for the storm sewer extension through the property. The 2023 drainage basin fee is $37,256 per impervious acre and the bridge fee is $5,118 per impervious acre. The Falcon U-Haul property encompasses 11.50 acres. Table 1 details the fees due as part of this development. Table 2 includes an opinion of cost for the storm sewer extension noted in the previous section.

## VI. CONCLUSIONS

The U-Haul at Falcon development will be a commercial development with two buildings and associated paved and landscaped areas on approximately 11.50 acres. The buildings and site will provide self storage, U-Box warehouse, showroom, vehicle sharing and retail area. This phase includes the development of the north side of the property. A future phase is planned to develop the south side of the property with self mini storage and RV storage. The on site drainage will be conveyed and captured by a combination of sheet flow, gutter flow, swale flow, inlets and storm sewers draining directly to Pond WU through Storm Sewer System A which includes on-site and off-site flows. The off-site storm sewer enters the site at the northeast corner which will be extended along the east side of the site to the south end outfalling into regional Pond WU, benefitting the upstream properties and the subject site by draining directly to Pond WU instead of the West Tributary which is Waters of the State. Regional Detention Pond WU provides stormwater quality and detention for the site. No onsite stormwater quality or detention will be required. Per the Bent Gradd MDDP and DBPS, Figure 3-6, included in the appendix, the site is within drainage basin WT240. Per this report, this basin will have a future peak 100-yr runoff of 160.3 cfs. In the proposed condition, it was concluded the peak 100-yr runoff will be 149.6 cfs. This area was planned to be "Service Commercial" which is considered to be 95% impervious. In the final proposed condition, the site will be 80.0% impervious. The runoff from the developed site is calculated to be less than what was planned as part of the Pond WU design. The Unnamed West Tributary to Black Squirrel Creek No. 2 (West Tributary) is located adjacent to the site on the west side and is described in the Falcon DBPS. Improvements to the Pond WU were made in the Bent Grass Development MDDP & DBPS Amendment.

## VII. REFERENCES


1) Falcon Highlands Market Place, Filing No. 1 Preliminary and Final Drainage Report, prepared by URS, dated December 22, 2005.

2) Market Place Filing No. 2, Final Drainage Letter, prepared by Springs Engineering, dated November 2008.

3) Falcon Drainage Basin Planning Study, Selected Plan Report, prepared by Matrix Design Group, dated September 2015.

4) Final Drainage Report, Bent Grass Residential Subdivision Filing No. 2, prepared by Galloway, dated March 2020.

5) MDDP and DBPS Amendment, Bent Grass Development, prepared by Galloway, dated September 2021.

6) Final Grading & Erosion Control Plans, Bent Grass Residential Filing No. 2, prepared by Galloway, dated 3/4/2021.

7) Falcon Highlands Filing No. 3 Preliminary Drainage Report, prepared by Atwell, LLC, dated March 24, 2022.

8) El Paso County, Colorado, Flood Insurance Study, prepared by the Federal Emergency Management Agency, dated December 7, 2018.

9) El Paso County Drainage Criteria Manual (Volumes 1 and 2) and Engineering Criteria Manual, current editions.

10) Urban Storm Drainage Criteria Manual (USDCM) Volumes 1, 2 and 3, Mile High Flood District, Current Editions

11) Soil Survey of El Paso County Area, Colorado, prepared by United States Department of Agriculture Soil Conservation Service.

## APPENDIX TABLE OF CONTENTS

## APPENDIX A

**Figure 1: Vicinity Map**

**Soils Map**

**FEMA Flood Insurance Rate Map**

**Table 1: Drainage Basin & Bridge Fee Calc**

**Table 2: Opinion of Cost – Drainage Facilities**

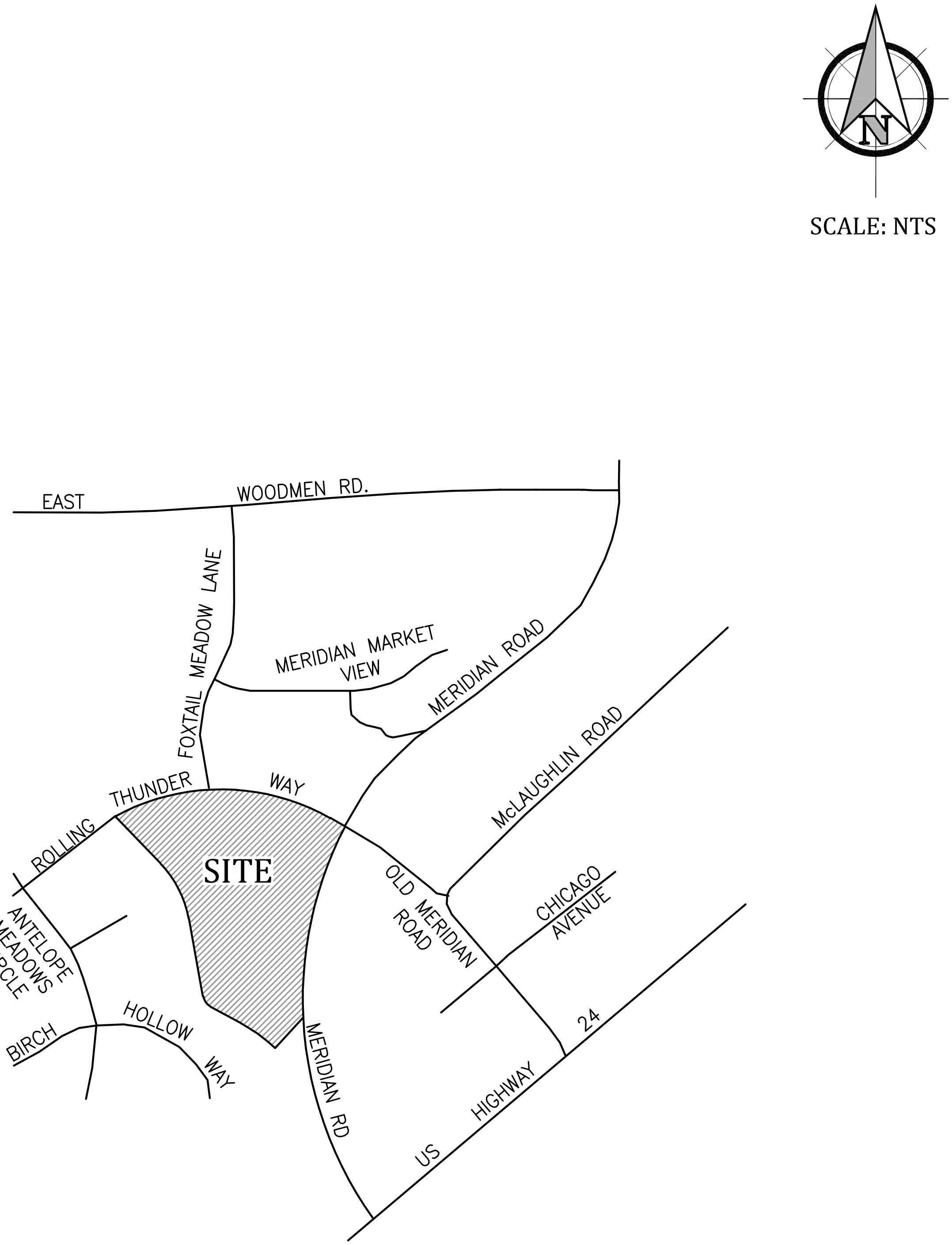
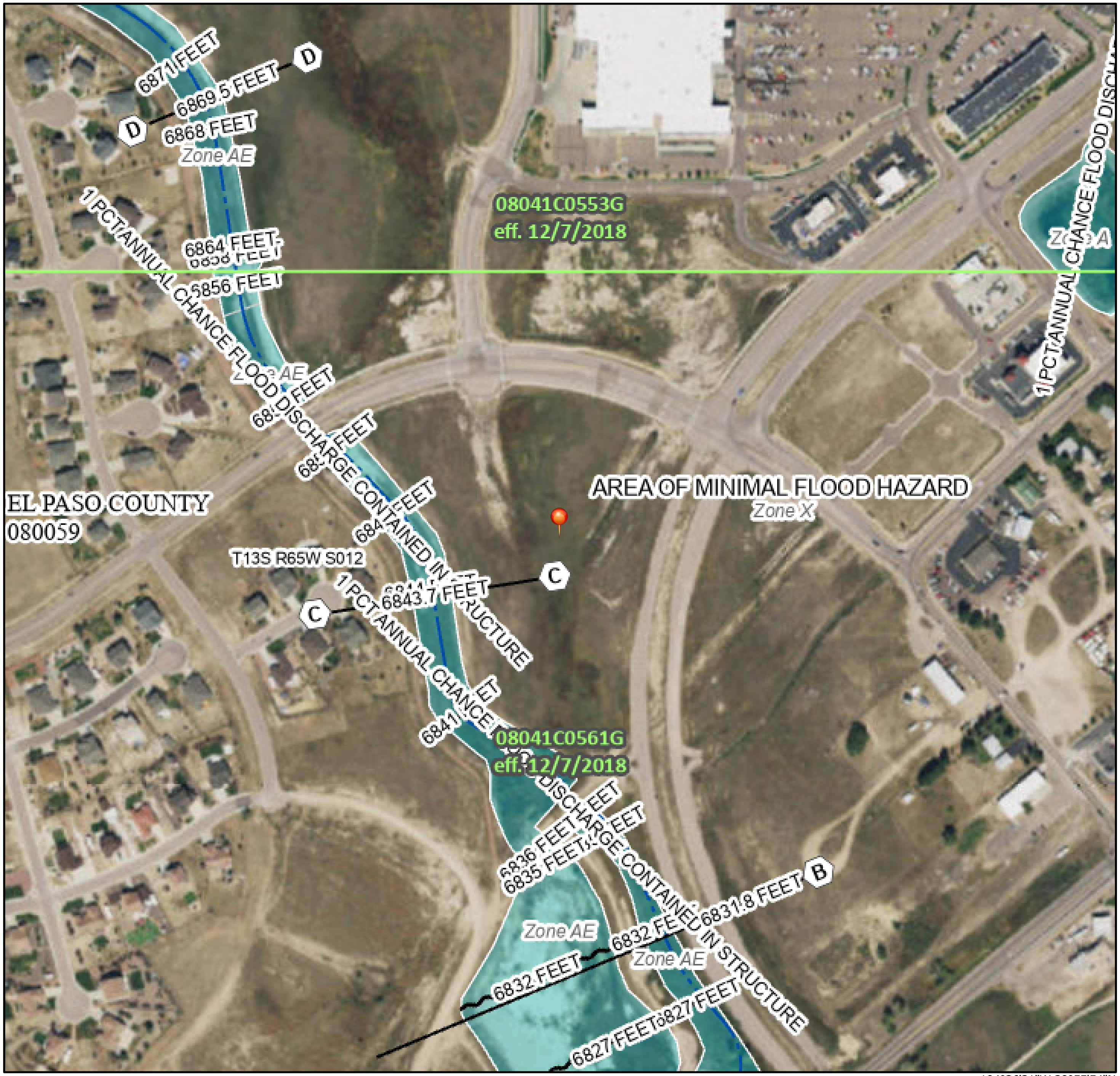



FIGURE 1
VICINITY MAP
U-HAUL FALCON

# National Flood Hazard Layer FIRMette

FEMA

104°37'9"W 38°56'22"N




0 250 500 1,000 1,500 2,000 Feet

1:6,000

104°36'31"W 38°55'54"N

*Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020*

## Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

| | |
|---|---|
| SPECIAL FLOOD HAZARD AREAS | Without Base Flood Elevation (BFE) *Zone A, V, A99* |
| | With BFE or Depth *Zone AE, AO, AH, VE, AR* |
| | Regulatory Floodway |
| OTHER AREAS OF FLOOD HAZARD | 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X* |
| | Future Conditions 1% Annual Chance Flood Hazard *Zone X* |
| | Area with Reduced Flood Risk due to Levee. See Notes. *Zone X* |
| | Area with Flood Risk due to Levee *Zone D* |
| OTHER AREAS | NO SCREEN Area of Minimal Flood Hazard *Zone X* |
| | Effective LOMRs |
| | Area of Undetermined Flood Hazard *Zone D* |
| GENERAL STRUCTURES | Channel, Culvert, or Storm Sewer |
| | Levee, Dike, or Floodwall |
| OTHER FEATURES | B 20.2 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation |
| | 8 Coastal Transect |
| | 513 Base Flood Elevation Line (BFE) |
| | Limit of Study |
| | Jurisdiction Boundary |
| | Coastal Transect Baseline |
| | Profile Baseline |
| | Hydrographic Feature |
| MAP PANELS | Digital Data Available |
| | No Digital Data Available |
| | Unmapped |

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 11/30/2021 at 11:28 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.


104° 37' 1" W
104° 36' 43" W
38° 56' 16" N
38° 55' 57" N
533200
533270
533340
533410
533480
533550
533620
4309940
4309870
4309800
4309730
4309660
4309590
4309520
4309450
4309380
19
9
Tamlin Rd
Soil Map may not be valid at this scale.
N
Map Scale: 1:2,820 if printed on A portrait (8.5" x 11") sheet.
Meters
0 40 80 160 240
Feet
0 100 200 400 600
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

## MAP LEGEND

**Area of Interest (AOI)**

- Area of Interest (AOI)

**Soils**

**Soil Rating Polygons**

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

**Soil Rating Lines**

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

**Soil Rating Points**

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

**Water Features**

- Streams and Canals

**Transportation**

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

**Background**

- Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 19, Aug 31, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 11, 2018—Oct 20, 2018

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

# Hydrologic Soil Group

| Map unit symbol | Map unit name | Rating | Acres in AOI | Percent of AOI |
|---|---|---|---|---|
| 9 | Blakeland-Fluvaquentic Haplaquolls | A | 21.2 | 97.0% |
| 19 | Columbine gravelly sandy loam, 0 to 3 percent slopes | A | 0.6 | 3.0% |
| **Totals for Area of Interest** | | | **21.9** | **100.0%** |

## Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

**Table 1: Impervious Area and Drainage & Bridge Fee Calculation**

**U-haul at Falcon**

| | | Current Development (North) | Future Area (South) | **Overall Property** |
|---|---|---|---|---|
| Area | | 7.23 ac | 4.27 ac | **11.50 ac** |
| Paved Area | 100% | 4.67 ac | 3.25 ac | **7.91 ac** |
| Landscape Area | 2% | 1.31 ac | 0.84 ac | **2.15 ac** |
| Building Roof Area | 90% | 1.26 ac | 0.18 ac | **1.44 ac** |
| | | | | |
| **Effective % Impervious** | | 80.5 % | 80.3 % | **80.4 %** |

| **Falcon Drainage Basin: Drainage Fee and Bridge Fee Calculations** | |
|---|---|
| Drainage Fee (per impervious acre) = $37,256 / ac | **Drainage Fee = $ 344,647** |
| Bridge Fee (per impervious acre) = $5,118 / ac | **Bridge Fee = $ 47,345** |

Kiowa Engineering Corporation

**Table 2: Engineer's Opinion of Cost - Proposed Drainage Facilities**

| Item | Quantity | Unit | Unit Price | Totals |
|---|---|---|---|---|
| **On-Site Drainage Facilities** | | | | |
| Inlet - 5' Type R Curb Depth < 5' | 1 | EA | $ 6,703 | $ 6,703.00 |
| Inlet - 5' Type R Curb 5' < Depth < 10' | 1 | EA | $ 8,715 | $ 8,715.00 |
| Inlet - Grated Type D Depth <5' | 1 | EA | $ 6,931 | $ 6,931.00 |
| 18" RCP Storm Sewer | 110 | LF | $ 76 | $ 8,360.00 |
| 24" RCP Storm Sewer | 770 | LF | $ 91 | $ 70,070.00 |
| 18" RCP FES | 1 | EA | $ 420 | $ 420.00 |
| 24" RCP FES | 1 | EA | $ 498 | $ 498.00 |
| Manhole - Storm Sewer - 4' Diameter | 1 | EA | $ 7,734 | $ 7,734.00 |
| Manhole - Storm Sewer - 5' Diameter | 1 | EA | $ 7,734 | $ 7,734.00 |
| Manhole - Storm Sewer - 6' Diameter | 1 | EA | $ 14,061 | $ 14,061.00 |
| | | | | |
| Subtotal (On-Site Drainage Facilities): | | | | $ 131,226.00 |
| Engineering (10%): | | | | $ 13,122.60 |
| Contingency (5%): | | | | $ 6,561.30 |
| Total | | | | $ 150,909.90 |
| **Storm Sewer Outfall Extension thru Property to Pond WU** | | | | |
| 42" RCP Storm Sewer | 369 | LF | $ 187 | $ 69,003.00 |
| 48" RCP Storm Sewer | 797 | LF | $ 228 | $ 181,716.00 |
| Manhole - Storm Sewer - 6' Diameter | 6 | EA | $ 14,061 | $ 84,366.00 |
| Forebay into Pond WU | 1 | LS | $ 55,000 | $ 55,000.00 |
| Trickle Channel in Pond WU | 740 | LF | $ 112 | $ 82,880.00 |
| | | | | $ - |
| | | | | |
| Subtotal (Storm Sewer Extension): | | | | $ 472,965.00 |
| Engineering (10%): | | | | $ 47,296.50 |
| Contingency (5%): | | | | $ 23,648.25 |
| Total (Storm Sewer Extension): | | | | $ 543,909.75 |
| Total (Overall): | | | | $ 694,819.65 |

# APPENDIX B

## Hydrologic Calculations

### Runoff Coef, Time of Concentration and Runoff Calcs

# U-Haul at Falcon

## Runoff Coeficient and Percent Impervious Calculation

| Basin / DP | Basin or DP Area (DP contributing basins) | | Soil Type | PV | Area 1 Land Use | | | LA | Area 2 Land Use | | | RO | Area 3 Land Use | | | US1 | Area 4 Land Use | | | Basin % Imperv | Basin Runoff Coef | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | % Imperv | Land Use Area | % Area | Comp Land Use % Imp | % Imperv | Land Use Area | % Area | Comp Land Use % Imp | % Imperv | Land Use Area | % Area | Comp Land Use % Imp | % Imperv | Land Use Area | % Area | Comp Land Use % Imp | | $C_5$ | $C_{100}$ |
| EX-A | 52,605 sf | 1.21ac | AB | 100% | - | 0% | 0% | 2% | 1.21ac | 100% | 2% | 90% | | 0% | 0% | 85% | | 0% | 0% | **2.0%** | **0.08** | **0.36** |
| EX-B | 450,432 sf | 10.34ac | AB | 100% | 0.06ac | 1% | 1% | 2% | 10.28ac | 99% | 2% | 90% | | 0% | 0% | 85% | | 0% | 0% | **2.6%** | **0.08** | **0.37** |
| EX-C | 5,167 sf | 0.12ac | AB | 100% | - | 0% | 0% | 2% | 0.12ac | 100% | 2% | 90% | | 0% | 0% | 85% | | 0% | 0% | **2.0%** | **0.08** | **0.36** |
| OS-1 | 14,267 sf | 0.33ac | AB | 100% | 0.33ac | 100% | 100% | 2% | | 0% | 0% | 90% | | 0% | 0% | 85% | | 0% | 0% | **100.0%** | **0.90** | **0.96** |
| DP 23 | Falcon High Mkt | 16.71ac | AB | 100% | - | 0% | 0% | 2% | | 0% | 0% | 90% | | 0% | 0% | 85% | 16.71ac | 100% | 85% | **85.0%** | **0.66** | **0.75** |
| | | | | | | | | | | | | | | | | | | | | | | |
| A | 63,770 sf | 1.46ac | AB | 100% | 1.19ac | 81% | 81% | 2% | 0.28ac | 19% | 0% | 90% | | 0% | 0% | 85% | | 0% | 0% | **81.5%** | **0.61** | **0.71** |
| B | 88,406 sf | 2.03ac | AB | 100% | 1.95ac | 96% | 96% | 2% | 0.08ac | 4% | 0% | 90% | | 0% | 0% | 85% | | 0% | 0% | **96.1%** | **0.83** | **0.89** |
| C | 39,564 sf | 0.91ac | AB | 100% | 0.59ac | 65% | 65% | 2% | 0.32ac | 35% | 1% | 90% | | 0% | 0% | 85% | | 0% | 0% | **65.9%** | **0.46** | **0.60** |
| D | 6,867 sf | 0.16ac | AB | 100% | - | 0% | 0% | 2% | 0.16ac | 100% | 2% | 90% | | 0% | 0% | 85% | | 0% | 0% | **2.0%** | **0.08** | **0.36** |
| E | 17,012 sf | 0.39ac | AB | 100% | - | 0% | 0% | 2% | | 0% | 0% | 90% | 0.39ac | 100% | 90% | 85% | | 0% | 0% | **90.0%** | **0.73** | **0.81** |
| F.1 | 12,132 sf | 0.28ac | AB | 100% | - | 0% | 0% | 2% | | 0% | 0% | 90% | 0.28ac | 100% | 90% | 85% | | 0% | 0% | **90.0%** | **0.73** | **0.81** |
| F.2 | 25,596 sf | 0.59ac | AB | 100% | - | 0% | 0% | 2% | | 0% | 0% | 90% | 0.59ac | 100% | 90% | 85% | | 0% | 0% | **90.0%** | **0.73** | **0.81** |
| G | 25,629 sf | 0.59ac | AB | 100% | 0.34ac | 58% | 58% | 2% | 0.25ac | 42% | 1% | 90% | | 0% | 0% | 85% | | 0% | 0% | **58.6%** | **0.40** | **0.56** |
| H | 2,688 sf | 0.06ac | AB | 100% | 0.06ac | 100% | 100% | 2% | | 0% | 0% | 90% | | 0% | 0% | 85% | | 0% | 0% | **100.0%** | **0.90** | **0.96** |
| J | 28,188 sf | 0.65ac | AB | 100% | 0.25ac | 38% | 38% | 2% | 0.40ac | 62% | 1% | 90% | | 0% | 0% | 85% | | 0% | 0% | **39.4%** | **0.29** | **0.49** |
| J-Dev | 28,188 sf | 0.65ac | AB | 100% | 0.49ac | 75% | 75% | 2% | 0.16ac | 25% | 0% | 90% | | 0% | 0% | 85% | | 0% | 0% | **75.8%** | **0.55** | **0.66** |
| K | 138,058 sf | 3.17ac | AB | 100% | 0.62ac | 19% | 19% | 2% | 2.55ac | 81% | 2% | 90% | | 0% | 0% | 85% | | 0% | 0% | **21.0%** | **0.20** | **0.44** |
| K-Dev | 138,058 sf | 3.17ac | AB | 100% | - | 0% | 0% | 2% | | 0% | 0% | 90% | | 0% | 0% | 85% | 3.17ac | 100% | 85% | **85.0%** | **0.66** | **0.75** |
| L | 49,551 sf | 1.14ac | AB | 100% | - | 0% | 0% | 2% | 1.14ac | 100% | 2% | 90% | | 0% | 0% | 85% | | 0% | 0% | **2.0%** | **0.08** | **0.36** |
| L-Dev | 49,551 sf | 1.14ac | AB | 100% | - | 0% | 0% | 2% | | 0% | 0% | 90% | | 0% | 0% | 85% | 1.14ac | 100% | 85% | **85.0%** | **0.66** | **0.75** |
| M | 3,651 sf | 0.08ac | AB | 100% | | 0% | 0% | 2% | 0.08ac | 100% | 2% | 90% | | 0% | 0% | 85% | | 0% | 0% | **2.0%** | **0.08** | **0.36** |
| | | | | | | | | | | | | | | | | | | | | | | |
| Property | 501,112 sf | 11.50ac | AB | 100% | 5.48ac | 48% | 48% | 2% | 5.41ac | 47% | 1% | 90% | 1.26ac | 11% | 10% | 85% | - | 0% | 0% | **58.4%** | **0.40** | **0.56** |
| Prop.-Dev | 501,112 sf | 11.50ac | AB | 100% | 4.38ac | 38% | 38% | 2% | 1.56ac | 14% | 0% | 90% | 1.26ac | 11% | 10% | 85% | 4.31ac | 37% | 32% | **80.0%** | **0.59** | **0.70** |
| | | | | | | | | | | | | | | | | | | | | | | |
| WT240-EX | 2,122,831 sf | 48.73ac | AB | 100% | 0.39ac | 1% | 1% | 2% | 31.63ac | 65% | 1% | 90% | | 0% | 0% | 85% | 16.71ac | 34% | 29% | **31.2%** | **0.25** | **0.47** |
| WT240-PRO | 2,122,831 sf | 48.73ac | AB | 100% | 5.48ac | 11% | 11% | 2% | 26.54ac | 54% | 1% | 90% | 1.26ac | 3% | 2% | 85% | 16.71ac | 34% | 29% | **43.8%** | **0.32** | **0.51** |
| WT240-DEV | 2,122,831 sf | 48.73ac | AB | 100% | 4.38ac | 9% | 9% | 2% | 23.34ac | 48% | 1% | 90% | 1.26ac | 3% | 2% | 85% | 21.02ac | 43% | 37% | **48.9%** | **0.34** | **0.52** |
| | | | | | | | | | | | | | | | | | | | | | | |
| North | 315,125 sf | 7.23ac | AB | 100% | 4.67ac | 64% | 64% | 2% | 1.31ac | 18% | 0% | 90% | 1.26ac | 17% | 16% | 85% | | 0% | 0% | **80.5%** | **0.60** | **0.70** |
| South | 185,987 sf | 4.27ac | AB | 100% | 3.25ac | 76% | 76% | 2% | 0.84ac | 20% | 0% | 90% | 0.18ac | 4% | 4% | 85% | | 0% | 0% | **80.3%** | **0.60** | **0.70** |

# U-Haul at Falcon
## Runoff Coeficient and Percent Impervious Calculation

| Basin Runoff Coefficient is based on % Imperviousness Calculation | | | | | | |
|---|---|---|---|---|---|---|
| **Runoff Coefficients and Percents Impervious** | | | | | | |
| **Hydrologic Soil Type:** | **AB** | **Runoff Coef Method** | | | %Imp | |
| Land Use | Abb | % | $C_5$ | $C_{10}$ | $C_{100}$ | Weighted |
| Commercial Area | CO | 95% | 0.81 | 0.83 | 0.88 | %Imp |
| Drives and Walks | DR | 100% | 0.90 | 0.92 | 0.96 | |
| Streets - Gravel (Packed) | GR | 80% | 0.59 | 0.63 | 0.70 | AB |
| Historic Flow Analysis | HI | 2% | 0.09 | 0.17 | 0.36 | CD |
| Lawns | LA | 2% | 0.08 | 0.17 | 0.36 | D |
| Off-site flow-Undeveloped | OF | 45% | 0.32 | 0.38 | 0.51 | |
| Streets - Paved | PV | 100% | 0.90 | 0.92 | 0.96 | |
| Roofs | RO | 90% | 0.73 | 0.75 | 0.81 | |
| User Input 1 | US1 | 85% | 0.66 | 0.69 | 0.75 | |

Based on Table 6-6: Runoff Coefficients for Rational Method from City of Colo Springs DCM

# U-Haul at Falcon
## Time of Concentration Calculation

| Sub-Basin Data | | | | Time of Concentration Estimate | | | | | | | | | | Min. Tc in Urban | | Final $t_c$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Initial/Overland Time ($t_i$) | | | Travel Time ($t_t$) | | | | | | Comp. | Tc Check (urban) | | |
| Basin / Design Point | Contributing Basins | Area | $C_5$ | Length | Slope | $t_i$ | Length | Slope | Land Type | Cv | Velocity | $t_t$ | $t_c$ | Total Length | $t_c$ Check | |
| EX-A | | 1.21ac | 0.08 | 150lf | 3.5% | 15.0 min. | 100lf | 2.6% | SP | 7 | 1.1ft/sec | 1.5min. | 16.5 min. | 250lf | 11.4 min. | **11.4 min.** |
| EX-B | | 10.34ac | 0.08 | 150lf | 1.3% | 20.9 min. | 940lf | 1.3% | SP | 7 | 0.8ft/sec | 19.6min. | 40.5 min. | 1090lf | 16.1 min. | **16.1 min.** |
| EX-C | | 0.12ac | 0.08 | 40lf | 1.0% | 11.8 min. | 150lf | 1.5% | SP | 7 | 0.9ft/sec | 2.9min. | 14.7 min. | 190lf | 11.1 min. | **11.1 min.** |
| OS-1 | | 0.33ac | 0.90 | 35lf | 2.0% | 1.8 min. | 160lf | 0.1% | PV | 20 | 0.6ft/sec | 4.2min. | 6.0 min. | 195lf | 11.1 min. | **6.0 min.** |
| DP 23 | | 16.71ac | | | | | | | | | | | | | | **10.5 min.** |
| - | | - | - | | | - | | | | | | | | | | |
| A | | 1.46ac | 0.61 | 40lf | 5.0% | 3.3 min. | 410lf | 2.0% | PV | 20 | 2.8ft/sec | 2.4min. | 5.7 min. | 450lf | 12.5 min. | **5.7 min.** |
| B | | 2.03ac | 0.83 | 60lf | 2.2% | 3.0 min. | 320lf | 2.2% | PV | 20 | 3.0ft/sec | 1.8min. | 5.0 min. | 380lf | 12.1 min. | **5.0 min.** |
| C | | 0.91ac | 0.46 | 60lf | 4.2% | 5.7 min. | 370lf | 1.7% | PV | 20 | 2.6ft/sec | 2.4min. | 8.0 min. | 430lf | 12.4 min. | **8.0 min.** |
| D | | 0.16ac | 0.08 | 20lf | 7.5% | 4.3 min. | 110lf | 1.0% | SP | 7 | 0.7ft/sec | 2.6min. | 6.9 min. | 130lf | 10.7 min. | **6.9 min.** |
| E | | 0.39ac | 0.73 | 60lf | 1.0% | 5.3 min. | 50lf | 1.0% | PV | 20 | 2.0ft/sec | 0.4min. | 5.7 min. | 110lf | 10.6 min. | **5.7 min.** |
| F.1 | | 0.28ac | 0.73 | 70lf | 1.0% | 5.7 min. | 60lf | 1.0% | PV | 20 | 2.0ft/sec | 0.5min. | 6.2 min. | 130lf | 10.7 min. | **6.2 min.** |
| F.2 | | 0.59ac | 0.73 | 70lf | 1.0% | 5.7 min. | 60lf | 1.0% | PV | 20 | 2.0ft/sec | 0.5min. | 6.2 min. | 130lf | 10.7 min. | **6.2 min.** |
| G | | 0.59ac | 0.40 | 35lf | 1.4% | 6.8 min. | 150lf | 0.8% | PV | 20 | 1.8ft/sec | 1.4min. | 8.2 min. | 185lf | 11.0 min. | **8.2 min.** |
| H | | 0.06ac | 0.90 | 25lf | 6.2% | 1.0 min. | 75lf | 1.0% | PV | 20 | 2.0ft/sec | 0.6min. | 5.0 min. | 100lf | 10.6 min. | **5.0 min.** |
| J | | 0.65ac | 0.29 | 50lf | 1.8% | 8.6 min. | 130lf | 1.3% | PV | 20 | 2.3ft/sec | 1.0min. | 9.5 min. | 180lf | 11.0 min. | **9.5 min.** |
| K | | 3.17ac | 0.20 | 40lf | 3.8% | 6.7 min. | 650lf | 1.4% | SP | 7 | 0.8ft/sec | 13.1min. | 19.7 min. | 690lf | 13.8 min. | **13.8 min.** |
| K-Dev | | 3.17ac | 0.66 | 40lf | 3.8% | 3.3 min. | 650lf | 1.4% | PV | 20 | 2.4ft/sec | 4.6min. | 7.9 min. | 690lf | 13.8 min. | **7.9 min.** |
| L | | 1.14ac | 0.08 | 70lf | 3.0% | 10.8 min. | 360lf | 2.2% | SP | 7 | 1.0ft/sec | 5.8min. | 16.6 min. | 430lf | 12.4 min. | **12.4 min.** |
| L-Dev | | 1.14ac | 0.66 | 70lf | 3.0% | 4.7 min. | 360lf | 2.2% | PV | 20 | 3.0ft/sec | 2.0min. | 6.7 min. | 430lf | 12.4 min. | **6.7 min.** |
| M | | 0.08ac | 0.08 | | | | 40lf | 5.0% | PV | 20 | 4.5ft/sec | 0.1min. | 5.0 min. | 40lf | 10.2 min. | **5.0 min.** |
| WT240-EX | | 48.73ac | 0.25 | | | - | 2500lf | 1.9% | PV | 20 | 2.8ft/sec | 15.1min. | 15.1 min. | 2500lf | 23.9 min. | **15.1 min.** |
| WT240-PRO | | 48.73ac | 0.32 | | | - | 2500lf | 1.9% | PV | 20 | 2.8ft/sec | 15.1min. | 15.1 min. | 2500lf | 23.9 min. | **15.1 min.** |
| WT240-DEV | | 48.73ac | 0.34 | | | - | 2500lf | 1.9% | PV | 20 | 2.8ft/sec | 15.1min. | 15.1 min. | 2500lf | 23.9 min. | **15.1 min.** |

Equations:

$t_i$ (Overland) = $0.395(1.1-C_5)L^{0.5}S^{-0.333}$

$C_5$ = Runoff coefficient for 5-year

L = Length of overland flow (ft)

S = Slope of flow path (ft/ft)

tc Check = (L/180)+10 (Developed Cond. Only)

L = Overall Length

Velocity (Travel Time) = $CvS^{0.5}$

Cv = Conveyance Coef (see table)

S = Watercourse slope (ft/ft)

**Table 6-7: Conveyance Coef (City CS DCM, Vol 1)**

| Type of Land Surface | Land Type | Cv |
|---|---|---|
| Grassed Waterway | GW | 15 |
| Heavy Meadow | HM | 2.5 |
| Nearly Bare Ground | NBG | 10 |
| Paved Area | PV | 20 |
| Riprap (Not Buried) | RR | 6.5 |
| Short Pasture/Lawns | SP | 7 |
| Tillage/Fields | TF | 5 |

# U-Haul at Falcon
## Runoff Calculation

**Design Storm: 5 Year**

| Design Point | Area Designation | Area | C | $T_c$ | C*A (acre) | i (in/hr) | Q | $T_c$ | Sum C*A | i (in/hr) | Q | Slope | Q | Q | Slope | Pipe Size | L (ft) | Vel (ft/s) | $T_t$ | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Direct Runoff** | | | | | | | **Total Runoff** | | | | **Street/Chan** | | **Pipe** | | | **Travel Time** | | | |
| | EX-A | 1.21ac | 0.08 | 11.4min | 0.10 | 3.9 | 0.4 cfs | | | - | - | | | | | | | | --- | |
| | EX-B | 10.34ac | 0.08 | 16.1min | 0.86 | 3.4 | 3.0 cfs | | | - | - | | | | | | | | --- | |
| | EX-C | 0.12ac | 0.08 | 11.1min | 0.01 | 4.0 | 0.0 cfs | | | - | - | | | | | | | | --- | |
| | OS-1 | 0.33ac | 0.90 | 6.0min | 0.29 | 4.9 | 1.4 cfs | | | - | - | 1.8% | 1.4 cfs | | | | 1125' | 2.6 | 7.2min | to E1 |
| | OS-1 | | | | | | | | | - | | 2.9% | 1.4 cfs | | | | 420' | 5.8 | 1.2min | to DP2 |
| *DP23 | | 16.71ac | | 10.5min | 9.86 | 4.1 | 40.0 cfs | Falcon Highlands Markt Place Flg 1 | | | | 0.7% | 40.0 cfs | | | | 980' | 4.3 | 3.8min | to E1 |
| E1 | 23, EX-B, OS-1 | 10.67ac | | | | | | 16.1min | 11.02 | 3.4 | 37.7 cfs | | | | | | | | --- | |
| | | | | | | | | | | - | - | | | | | | | | --- | |
| | A | 1.46ac | 0.61 | 5.7min | 0.90 | 5.0 | 4.5 cfs | | | - | - | 2.3% | 4.5 cfs | | | | 20' | 7.4 | 0.0min | to DP1 |
| | B | 2.03ac | 0.83 | 5.0min | 1.68 | 5.2 | 8.7 cfs | | | - | - | | | | | | | | --- | |
| | C | 0.91ac | 0.46 | 8.0min | 0.41 | 4.5 | 1.9 cfs | | | - | - | | | | | | | | --- | |
| | D | 0.16ac | 0.08 | 6.9min | 0.01 | 4.7 | 0.1 cfs | | | - | - | | | | | | | | --- | |
| | E | 0.39ac | 0.73 | 5.7min | 0.28 | 5.0 | 1.4 cfs | | | - | - | 2.3% | 1.4 cfs | | | | 30' | 5.3 | 0.1min | to DP1 |
| | F.1 | 0.28ac | 0.73 | 6.2min | 0.20 | 4.8 | 1.0 cfs | | | - | - | 1.7% | 1.0 cfs | | | | 95' | 4.3 | 0.4min | to DP4 |
| | F.2 | 0.59ac | 0.73 | 6.2min | 0.43 | 4.8 | 2.1 cfs | | | - | | 2.7% | 2.1 cfs | | | | 65' | 6.3 | 0.2min | to DP5 |
| | G | 0.59ac | 0.40 | 8.2min | 0.24 | 4.4 | 1.0 cfs | | | - | - | | | | | | | | --- | |
| | H | 0.06ac | 0.90 | 5.0min | 0.06 | 5.2 | 0.3 cfs | | | - | - | | | | | | | | --- | |
| | J | 0.65ac | 0.29 | 9.5min | 0.19 | 4.2 | 0.8 cfs | | | - | - | | | | | | | | --- | |
| | J-Dev | 0.65ac | 0.55 | 13.8min | 0.35 | 3.6 | 1.3 cfs | | | | | | | | | | | | | |
| | K | 3.17ac | 0.20 | 13.8min | 0.64 | 3.6 | 2.3 cfs | | | - | - | | | | | | | | --- | |
| | K-Dev | 3.17ac | 0.66 | 7.9min | 2.08 | 4.5 | 9.3 cfs | | | | | | | | | | | | --- | |
| | L | 1.14ac | 0.08 | 12.4min | 0.09 | 3.8 | 0.4 cfs | | | - | | | | | | | | | --- | |
| | L-Dev | 1.14ac | 0.66 | 6.7min | 0.75 | 4.7 | 3.5 cfs | | | | | | | | | | | | --- | |
| | M | 0.08ac | 0.08 | 5.0min | 0.01 | 5.2 | 0.0 cfs | | | | | | | | | | | | | |
| 1 | A, D, E | 2.01ac | | | | | | 6.9min | 1.19 | 4.7 | 5.6 cfs | | | | | | 195' | 4.6 | 0.7min | DP1A |
| 1A | H,DP1 | 2.07ac | | | | | | 7.6min | 1.25 | 4.5 | 5.7 cfs | | | | | | 260' | 4.7 | 0.9min | DP3 |
| 2 | OS-1, B | 2.36ac | | | | | | 7.2min | 1.97 | 4.6 | 9.1 cfs | | | 9.1 cfs | 0.6% | 18-in | 152' | 4.6 | 0.6min | S11 |
| 3 | DP1A, DP2 | 4.43ac | | | | | | 8.5min | 3.22 | 4.4 | 14.1 cfs | | | 14.1 cfs | 0.6% | 24-in | 171' | 5.6 | 0.5min | S13 |
| 4 | C, F.1 | 1.19ac | | | | | | 8.0min | 0.62 | 4.5 | 2.8 cfs | | | 2.8 cfs | 0.8% | 42-in | 123' | 9.1 | 0.2min | S15 |
| 5 | F.2, G | 1.18ac | | | | | | 8.2min | 0.66 | 4.4 | 2.9 cfs | | | | | | | | --- | |
| 6 | K, L | 4.31ac | | | | | | 13.8min | 0.73 | 3.6 | 2.7 cfs | | | | | | | | --- | |
| 24 | DP4, DP23 | 17.90ac | | | | | | 10.5min | 10.48 | 4.1 | 42.5 cfs | | | 42.5 cfs | 0.8% | 42-in | 123' | 9.1 | 0.2min | DP25 |
| 25 | DP5, DP24 | 19.07ac | | | | | | 10.7min | 11.14 | 4.0 | 44.8 cfs | | | 44.8 cfs | 0.8% | 42-in | 258' | 9.4 | 0.5min | DP26 |
| 26 | J, DP3, DP25 | 24.15ac | | | | | | 11.2min | 14.55 | 4.0 | 57.6 cfs | | | | | | 410' | 9 | 0.8min | DP27 |
| 26-Dev | J-Dev, DP3, DP25 | 24.15ac | | | | | | 11.2min | 14.71 | 4.0 | 58.3 cfs | | | | | | | | | DP27-Dev |
| 27 | L,DP26 | 25.29ac | | | | | | 11.9min | 14.64 | 3.9 | 56.6 cfs | | | | | | 150' | 9 | 0.3min | DP28 |
| 27-Dev | L-Dev,DP26 | 25.29ac | | | | | | 11.9min | 15.46 | 3.9 | 59.7 cfs | | | | | | 150' | 9 | 0.3min | DP28-Dev |
| 28 | K, DP27 | 28.46ac | | | | | | 12.2min | 15.28 | 3.8 | 58.5 cfs | | | | | | | | --- | |
| 28-Dev | K-Dev, DP27 | 28.46ac | | | | | | 12.2min | 17.54 | 3.8 | 67.1 cfs | | | | | | | | --- | |

Equations (taken from Fig 6-5, City of Colorado Springs DCM):

$i_2$=-1.19 ln($T_c$) + 6.035

$i_5$=-1.50 ln($T_c$) + 7.583

$i_{10}$=-1.75 ln($T_c$) + 8.847

$i_{100}$=-2.52 ln($T_c$) + 12.735

Q = CiA

Q = Peak Runoff Rate (cubic feet/second)

C = Runoff coef representing a ration of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.

i = average rainfall intensity in inches per hour

A = Drainage area in acres

## U-Haul at Falcon
### Runoff Calculation

**Design Storm: 100 Yr**

| | Direct Runoff | | | | | | | Total Runoff | | | | Street/Chan | | Pipe | | | Travel Time | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Design Point** | Area Designation | Area | C | $T_c$ | C*A (acre) | i (in/hr) | Q | $T_c$ | Sum C*A | i (in/hr) | Q | Slope | Q | Q | Slope | Pipe Size | L (ft) | Vel (ft/s) | $T_t$ | Remarks |
| | EX-A | 1.21ac | 0.36 | 11.4min | 0.44 | 6.6 | 2.9 cfs | | | - | - | | | | | | | | --- | |
| | EX-B | 10.34ac | 0.37 | 16.1min | 3.78 | 5.7 | 21.7 cfs | | | - | - | | | | | | | | --- | |
| | EX-C | 0.12ac | 0.36 | 11.1min | 0.04 | 6.7 | 0.3 cfs | | | - | - | | | | | | | | --- | |
| | OS-1 | 0.33ac | 0.96 | 6.0min | 0.31 | 8.2 | 2.6 cfs | | | - | - | 1.8% | 2.6 cfs | | | | 1125' | 2.6 | 7.2min | to E1 |
| | OS-1 | | | | | | | | | | | 2.9% | 2.6 cfs | | | | 420' | 5.8 | 1.2min | to DP2 |
| *DP23 | | 16.71ac | | 10.5min | 10.41 | 6.8 | 70.9 cfs | Falcon Highlands Markt Place Flg 1 | | | | 0.7% | 70.9 cfs | | | | 980' | 4.3 | 3.8min | to E1 |
| E1 | 23, EX-B, OS-1 | 10.67ac | | | | | | 16.1min | 14.51 | 5.7 | 83.3 cfs | | | | | | | | --- | |
| | | | | | | | | | | - | - | | | | | | | | --- | |
| | A | 1.46ac | 0.71 | 5.7min | 1.05 | 8.3 | 8.7 cfs | | | - | - | 2.3% | 8.7 cfs | | | | 20' | 7.4 | 0.0min | to DP1 |
| | B | 2.03ac | 0.89 | 5.0min | 1.82 | 8.7 | 15.8 cfs | | | - | - | | | | | | | | --- | |
| | C | 0.91ac | 0.60 | 8.0min | 0.54 | 7.5 | 4.0 cfs | | | - | - | | | | | | | | --- | |
| | D | 0.16ac | 0.36 | 6.9min | 0.06 | 7.9 | 0.4 cfs | | | - | - | | | | | | | | --- | |
| | E | 0.39ac | 0.81 | 5.7min | 0.32 | 8.3 | 2.6 cfs | | | - | - | 2.3% | 2.6 cfs | | | | 30' | 5.3 | 0.1min | to DP1 |
| | F.1 | 0.28ac | 0.81 | 6.2min | 0.23 | 8.1 | 1.8 cfs | | | - | - | 1.7% | 1.8 cfs | | | | 95' | 4.3 | 0.4min | to DP4 |
| | F.2 | 0.59ac | 0.81 | 6.2min | 0.48 | 8.1 | 3.9 cfs | | | | | 2.7% | 3.9 cfs | | | | 65' | 6.3 | 0.2min | to DP5 |
| | G | 0.59ac | 0.56 | 8.2min | 0.33 | 7.4 | 2.4 cfs | | | - | - | | | | | | | | --- | |
| | H | 0.06ac | 0.96 | 5.0min | 0.06 | 8.7 | 0.5 cfs | | | - | - | | | | | | | | --- | |
| | J | 0.65ac | 0.49 | 9.5min | 0.32 | 7.1 | 2.3 cfs | | | - | - | | | | | | | | --- | |
| | J-Dev | 0.65ac | 0.66 | 13.8min | 0.43 | 6.1 | 2.6 cfs | | | | | | | | | | | | | |
| | K | 3.17ac | 0.44 | 13.8min | 1.41 | 6.1 | 8.6 cfs | | | - | - | | | | | | | | --- | |
| | K-Dev | 3.17ac | 0.75 | 7.9min | 2.38 | 7.5 | 17.9 cfs | | | - | - | | | | | | | | --- | |
| | L | 1.14ac | 0.36 | 12.4min | 0.41 | 6.4 | 2.6 cfs | | | - | - | | | | | | | | --- | |
| | L-Dev | 1.14ac | 0.75 | 6.7min | 0.85 | 7.9 | 6.8 cfs | | | - | - | | | | | | | | --- | |
| | M | 0.08ac | 0.36 | 5.0min | 0.03 | 8.7 | 0.3 cfs | | | | | | | | | | | | | |
| | WT240-EX | 48.73ac | 0.47 | 15.1min | 23.03 | 5.9 | 135.7 cfs | | | | | | | | | | | | | |
| | WT240-PRO | 48.73ac | 0.51 | 15.1min | 24.63 | 5.9 | 145.1 cfs | | | | | | | | | | | | | |
| | WT240-DEV | 48.73ac | 0.52 | 15.1min | 25.39 | 5.9 | 149.6 cfs | | | | | | | | | | | | | |
| 1 | A, D, E | 2.01ac | | | | | | 6.9min | 1.42 | 7.9 | 11.2 cfs | | | | | | 195' | 4.6 | 0.7min | DP1A |
| 1A | H,DP1 | 2.07ac | | | | | | 7.6min | 1.48 | 7.6 | 11.3 cfs | | | | | | 260' | 4.7 | 0.9min | DP3 |
| 2 | OS-1, B | 2.36ac | | | | | | 7.2min | 2.13 | 7.8 | 16.5 cfs | | | 16.5 cfs | 0.6% | 18-in | 152' | 4.6 | 0.6min | S11 |
| 3 | DP1A, DP2 | 4.43ac | | | | | | 7.7min | 3.61 | 7.6 | 27.3 cfs | | | 27.3 cfs | 0.6% | 24-in | 171' | 5.6 | 0.5min | S13 |
| 4 | C, F.1 | 1.19ac | | | | | | 8.0min | 0.77 | 7.5 | 5.7 cfs | | | 5.7 cfs | 0.8% | 42-in | 123' | 9.1 | 0.2min | S15 |
| 5 | F.2, G | 1.18ac | | | | | | 8.2min | 0.80 | 7.4 | 6.0 cfs | | | | | | | | --- | |
| 6 | K, L | 4.31ac | | | | | | 13.8min | 1.82 | 6.1 | 11.1 cfs | | | | | | | | --- | |
| 24 | DP4, DP23 | 17.90ac | | | | | | 10.5min | 11.18 | 6.8 | 76.1 cfs | | | 76.1 cfs | 0.8% | 42-in | 123' | 9.1 | 0.2min | DP25 |
| 25 | DP5, DP24 | 19.07ac | | | | | | 10.7min | 11.98 | 6.8 | 80.9 cfs | | | 80.9 cfs | 0.8% | 42-in | 258' | 9.4 | 0.5min | DP26 |
| 26 | J, DP3, DP25 | 24.15ac | | | | | | 11.2min | 15.91 | 6.7 | 105.8 cfs | | | | | | 410' | 9 | 0.8min | DP27 |
| 26-Dev | J-Dev, DP3, DP25 | 24.15ac | | | | | | 11.2min | 16.02 | 6.7 | 106.5 cfs | | | | | | | | | DP27-Dev |
| 27 | L,DP26 | 25.29ac | | | | | | 11.9min | 16.32 | 6.5 | 105.8 cfs | | | | | | 150' | 9 | 0.3min | DP28 |
| 27-Dev | L-Dev,DP26 | 25.29ac | | | | | | 11.9min | 17.17 | 6.5 | 111.4 cfs | | | | | | 150' | 9 | 0.3min | DP28-Dev |
| 28 | K, DP27 | 28.46ac | | | | | | 12.2min | 17.73 | 6.4 | 113.9 cfs | | | | | | | | --- | |
| 28-Dev | K-Dev, DP27 | 28.46ac | | | | | | 12.2min | 19.55 | 6.4 | 125.7 cfs | | | | | | | | --- | |
| | | | | | | | | | | - | - | | | | | | | | --- | |

Equations (taken from Fig 6-5, City of Colorado Springs DCM):

$i_2$=-1.19 ln($T_c$) + 6.035
$i_5$=-1.50 ln($T_c$) + 7.583
$i_{10}$=-1.75 ln($T_c$) + 8.847
$i_{100}$=-2.52 ln($T_c$) + 12.735

Q = CiA
Q = Peak Runoff Rate (cubic feet/second)
C = Runoff coef representing a ration of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.
i = average rainfall intensity in inches per hour
A = Drainage area in acres

# APPENDIX B.1

## Supporting Tables and Figures

**Table 6-6. Runoff Coefficients for Rational Method**
(Source: UDFCD 2001)

| Land Use or Surface Characteristics | Percent Impervious | Runoff Coefficients | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2-year | | 5-year | | 10-year | | 25-year | | 50-year | | 100-year | |
| | | HSG A&B | HSG C&D | HSG A&B | HSG C&D | HSG A&B | HSG C&D | HSG A&B | HSG C&D | HSG A&B | HSG C&D | HSG A&B | HSG C&D |
| Business | | | | | | | | | | | | | |
| Commercial Areas | 95 | 0.79 | 0.80 | 0.81 | 0.82 | 0.83 | 0.84 | 0.85 | 0.87 | 0.87 | 0.88 | 0.88 | 0.89 |
| Neighborhood Areas | 70 | 0.45 | 0.49 | 0.49 | 0.53 | 0.53 | 0.57 | 0.58 | 0.62 | 0.60 | 0.65 | 0.62 | 0.68 |
| | | | | | | | | | | | | | |
| Residential | | | | | | | | | | | | | |
| 1/8 Acre or less | 65 | 0.41 | 0.45 | 0.45 | 0.49 | 0.49 | 0.54 | 0.54 | 0.59 | 0.57 | 0.62 | 0.59 | 0.65 |
| 1/4 Acre | 40 | 0.23 | 0.28 | 0.30 | 0.35 | 0.36 | 0.42 | 0.42 | 0.50 | 0.46 | 0.54 | 0.50 | 0.58 |
| 1/3 Acre | 30 | 0.18 | 0.22 | 0.25 | 0.30 | 0.32 | 0.38 | 0.39 | 0.47 | 0.43 | 0.52 | 0.47 | 0.57 |
| 1/2 Acre | 25 | 0.15 | 0.20 | 0.22 | 0.28 | 0.30 | 0.36 | 0.37 | 0.46 | 0.41 | 0.51 | 0.46 | 0.56 |
| 1 Acre | 20 | 0.12 | 0.17 | 0.20 | 0.26 | 0.27 | 0.34 | 0.35 | 0.44 | 0.40 | 0.50 | 0.44 | 0.55 |
| | | | | | | | | | | | | | |
| Industrial | | | | | | | | | | | | | |
| Light Areas | 80 | 0.57 | 0.60 | 0.59 | 0.63 | 0.63 | 0.66 | 0.66 | 0.70 | 0.68 | 0.72 | 0.70 | 0.74 |
| Heavy Areas | 90 | 0.71 | 0.73 | 0.73 | 0.75 | 0.75 | 0.77 | 0.78 | 0.80 | 0.80 | 0.82 | 0.81 | 0.83 |
| | | | | | | | | | | | | | |
| Parks and Cemeteries | 7 | 0.05 | 0.09 | 0.12 | 0.19 | 0.20 | 0.29 | 0.30 | 0.40 | 0.34 | 0.46 | 0.39 | 0.52 |
| Playgrounds | 13 | 0.07 | 0.13 | 0.16 | 0.23 | 0.24 | 0.31 | 0.32 | 0.42 | 0.37 | 0.48 | 0.41 | 0.54 |
| Railroad Yard Areas | 40 | 0.23 | 0.28 | 0.30 | 0.35 | 0.36 | 0.42 | 0.42 | 0.50 | 0.46 | 0.54 | 0.50 | 0.58 |
| | | | | | | | | | | | | | |
| Undeveloped Areas | | | | | | | | | | | | | |
| Historic Flow Analysis-- Greenbelts, Agriculture | 2 | 0.03 | 0.05 | 0.09 | 0.16 | 0.17 | 0.26 | 0.26 | 0.38 | 0.31 | 0.45 | 0.36 | 0.51 |
| Pasture/Meadow | 0 | 0.02 | 0.04 | 0.08 | 0.15 | 0.15 | 0.25 | 0.25 | 0.37 | 0.30 | 0.44 | 0.35 | 0.50 |
| Forest | 0 | 0.02 | 0.04 | 0.08 | 0.15 | 0.15 | 0.25 | 0.25 | 0.37 | 0.30 | 0.44 | 0.35 | 0.50 |
| Exposed Rock | 100 | 0.89 | 0.89 | 0.90 | 0.90 | 0.92 | 0.92 | 0.94 | 0.94 | 0.95 | 0.95 | 0.96 | 0.96 |
| Offsite Flow Analysis (when landuse is undefined) | 45 | 0.26 | 0.31 | 0.32 | 0.37 | 0.38 | 0.44 | 0.44 | 0.51 | 0.48 | 0.55 | 0.51 | 0.59 |
| | | | | | | | | | | | | | |
| Streets | | | | | | | | | | | | | |
| Paved | 100 | 0.89 | 0.89 | 0.90 | 0.90 | 0.92 | 0.92 | 0.94 | 0.94 | 0.95 | 0.95 | 0.96 | 0.96 |
| Gravel | 80 | 0.57 | 0.60 | 0.59 | 0.63 | 0.63 | 0.66 | 0.66 | 0.70 | 0.68 | 0.72 | 0.70 | 0.74 |
| | | | | | | | | | | | | | |
| Drive and Walks | 100 | 0.89 | 0.89 | 0.90 | 0.90 | 0.92 | 0.92 | 0.94 | 0.94 | 0.95 | 0.95 | 0.96 | 0.96 |
| Roofs | 90 | 0.71 | 0.73 | 0.73 | 0.75 | 0.75 | 0.77 | 0.78 | 0.80 | 0.80 | 0.82 | 0.81 | 0.83 |
| Lawns | 0 | 0.02 | 0.04 | 0.08 | 0.15 | 0.15 | 0.25 | 0.25 | 0.37 | 0.30 | 0.44 | 0.35 | 0.50 |

## 3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration ($t_c$) consists of an initial time or overland flow time ($t_i$) plus the travel time ($t_t$) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time ($t_i$) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion ($t_t$) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

For Colorado Springs and much of the Fountain Creek watershed, the 1-hour depths are fairly uniform and are summarized in Table 6-2. Depending on the location of the project, rainfall depths may be calculated using the described method and the NOAA Atlas maps shown in Figures 6-6 through 6-17.

**Table 6-2. Rainfall Depths for Colorado Springs**

| Return Period | 1-Hour Depth | 6-Hour Depth | 24-Hour Depth |
|---|---|---|---|
| 2 | 1.19 | 1.70 | 2.10 |
| 5 | 1.50 | 2.10 | 2.70 |
| 10 | 1.75 | 2.40 | 3.20 |
| 25 | 2.00 | 2.90 | 3.60 |
| 50 | 2.25 | 3.20 | 4.20 |
| 100 | 2.52 | 3.50 | 4.60 |

Where Z= 6,840 ft/100

These depths can be applied to the design storms or converted to intensities (inches/hour) for the Rational Method as described below. However, as the basin area increases, it is unlikely that the reported point rainfalls will occur uniformly over the entire basin. To account for this characteristic of rain storms an adjustment factor, the Depth Area Reduction Factor (DARF) is applied. This adjustment to rainfall depth and its effect on design storms is also described below. The UDFCD UD-Rain spreadsheet, available on UDFCD's website, also provides tools to calculate point rainfall depths and Intensity-Duration-Frequency curves[2] and should produce similar depth calculation results.

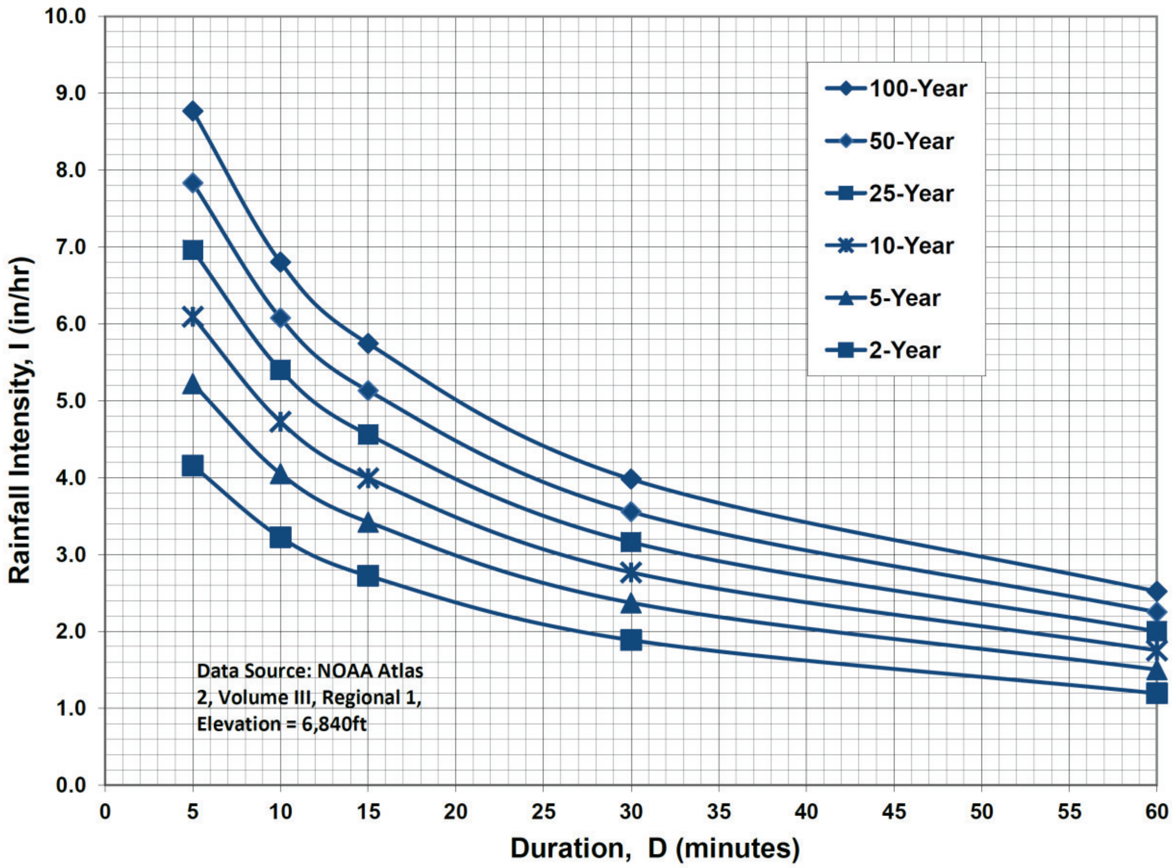
## 2.2 Design Storms

Design storms are used as input into rainfall/runoff models and provide a representation of the typical temporal distribution of rainfall events when the creation or routing of runoff hydrographs is required. It has long been observed that rainstorms in the Front Range of Colorado tend to occur as either short-duration, high-intensity, localized, convective thunderstorms (cloud bursts) or longer-duration, lower-intensity, broader, frontal (general) storms. The significance of these two types of events is primarily determined by the size of the drainage basin being studied. Thunderstorms can create high rates of runoff within a relatively small area, quickly, but their influence may not be significant very far downstream. Frontal storms may not create high rates of runoff within smaller drainage basins due to their lower intensity, but tend to produce larger flood flows that can be hazardous over a broader area and extend further downstream.

- **Thunderstorms**: Based on the extensive evaluation of rain storms completed in the Carlton study (Carlton 2011), it was determined that typical thunderstorms have a duration of about 2 hours. The study evaluated over 300,000 storm cells using gage-adjusted NEXRAD data, collected over a 14-year period (1994 to 2008). Storms lasting longer than 3 hours were rarely found. Therefore, the results of the Carlton study have been used to define the shorter duration design storms.

  To determine the temporal distribution of thunderstorms, 22 gage-adjusted NEXRAD storm cells were studied in detail. Through a process described in a technical memorandum prepared by the City of Colorado Springs (City of Colorado Springs 2012), the results of this analysis were interpreted and normalized to the 1-hour rainfall depth to create the distribution shown in Table 6-3 with a 5 minute time interval for drainage basins up to 1 square mile in size. This distribution represents the rainfall

**Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency**




**IDF Equations**

$I_{100} = -2.52 \ln(D) + 12.735$

$I_{50} = -2.25 \ln(D) + 11.375$

$I_{25} = -2.00 \ln(D) + 10.111$

$I_{10} = -1.75 \ln(D) + 8.847$

$I_5 = -1.50 \ln(D) + 7.583$

$I_2 = -1.19 \ln(D) + 6.035$

Note: Values calculated by equations may not precisely duplicate values read from figure.

**Table EDB-4. EDB component criteria**

| | **On-Site EDBs for Watersheds up to 1 Impervious Acre[1]** | **EDBs with Watersheds between 1 and 2 Impervious Acres[1]** | **EDBs with Watersheds up to 5 Impervious Acres** | **EDBs with Watersheds over 5 Impervious Acres** | **EDBs with Watersheds over 20 Impervious Acres** |
|---|---|---|---|---|---|
| Forebay Release and Configuration | EDBs should not be used for watersheds with less than 1 impervious acre. | Release 2% of the undetained 100-year peak discharge by way of a wall/notch configuration | Release 2% of the undetained 100-year peak discharge by way of a wall/notch configuration | Release 2% of the undetained 100-year peak discharge by way of a wall/notch configuration | Release 2% of the undetained 100-year peak discharge by way of a wall/notch or berm/pipe[2] configuration |
| Minimum Forebay Volume | | 1% of the WQCV | 2% of the WQCV | 3% of the WQCV | 3% of the WQCV |
| Maximum Forebay Depth | | 12 inches | 18 inches | 18 inches | 30 inches |
| Trickle Channel Capacity | | ≥ the maximum possible forebay outlet capacity | ≥ the maximum possible forebay outlet capacity | ≥ the maximum possible forebay outlet capacity | ≥ the maximum possible forebay outlet capacity |
| Micropool | | Area ≥ 10 $ft^2$ | Area ≥ 10 $ft^2$ | Area ≥ 10 $ft^2$ | Area ≥ 10 $ft^2$ |
| Initial Surcharge Volume | | Depth ≥ 4 inches | Depth ≥ 4 inches | Depth ≥ 4 in. Volume ≥ 0.3% WQCV | Depth ≥ 4 in. Volume ≥ 0.3% WQCV |

[1] EDBs are not recommended for sites with less than 2 impervious acres. Consider a sand filter or rain garden.

[2] Round up to the first standard pipe size (minimum 8 inches).

# APPENDIX C

## Hydraulic Calculations

### Inlet Summary and Capacity Calculations – UD-Inlet
### Pipe Sizing Calculations
### Forebay and Trickle Channel Calculations

*MHFD-Inlet, Version 5.01 (April 2021)*

# INLET MANAGEMENT

Worksheet Protected

| INLET NAME | Inlet 10 | Inlet 11 | Inlet 16 |
|---|---|---|---|
| Site Type (Urban or Rural) | URBAN | URBAN | URBAN |
| Inlet Application (Street or Area) | AREA | STREET | STREET |
| Hydraulic Condition | Swale | In Sump | In Sump |
| Inlet Type | CDOT Type C | CDOT/Denver 13 Valley Grate | CDOT/Denver 13 Combination |

## USER-DEFINED INPUT

**User-Defined Design Flows**

| | | | |
|---|---|---|---|
| Minor $Q_{Known}$ (cfs) | 5.9 | 9.5 | 3.1 |
| Major $Q_{Known}$ (cfs) | 11.8 | 17.1 | 6.2 |

**Bypass (Carry-Over) Flow from Upstream**

| | | | |
|---|---|---|---|
| Receive Bypass Flow from: | No Bypass Flow Received | No Bypass Flow Received | No Bypass Flow Received |
| Minor Bypass Flow Received, $Q_b$ (cfs) | 0.0 | 0.0 | 0.0 |
| Major Bypass Flow Received, $Q_b$ (cfs) | 0.0 | 0.0 | 0.0 |

**Watershed Characteristics**

| | | | |
|---|---|---|---|
| Subcatchment Area (acres) | | | |
| Percent Impervious | | | |
| NRCS Soil Type | | | |

**Watershed Profile**

| | | | |
|---|---|---|---|
| Overland Slope (ft/ft) | | | |
| Overland Length (ft) | | | |
| Channel Slope (ft/ft) | | | |
| Channel Length (ft) | | | |

**Minor Storm Rainfall Input**

| | | | |
|---|---|---|---|
| Design Storm Return Period, $T_r$ (years) | | | |
| One-Hour Precipitation, $P_1$ (inches) | | | |

**Major Storm Rainfall Input**

| | | | |
|---|---|---|---|
| Design Storm Return Period, $T_r$ (years) | | | |
| One-Hour Precipitation, $P_1$ (inches) | | | |

## CALCULATED OUTPUT

| | | | |
|---|---|---|---|
| **Minor Total Design Peak Flow, Q (cfs)** | **5.9** | **9.5** | **3.1** |
| **Major Total Design Peak Flow, Q (cfs)** | **11.8** | **17.1** | **6.2** |
| Minor Flow Bypassed Downstream, $Q_b$ (cfs) | 0.0 | N/A | N/A |
| Major Flow Bypassed Downstream, $Q_b$ (cfs) | 0.0 | N/A | N/A |

*MHFD-Inlet, Version 5.01 (April 2021)*

# INLET MANAGEMENT

Worksheet Protected

| | |
|---|---|
| **INLET NAME** | Inlet 17 |
| Site Type (Urban or Rural) | URBAN |
| Inlet Application (Street or Area) | STREET |
| Hydraulic Condition | In Sump |
| Inlet Type | CDOT/Denver 13 Combination |

## USER-DEFINED INPUT

**User-Defined Design Flows**

| | |
|---|---|
| Minor $Q_{Known}$ (cfs) | 17.3 |
| Major $Q_{Known}$ (cfs) | 32.5 |

**Bypass (Carry-Over) Flow from Upstream**

| | |
|---|---|
| Receive Bypass Flow from: | No Bypass Flow Received |
| Minor Bypass Flow Received, $Q_b$ (cfs) | 0.0 |
| Major Bypass Flow Received, $Q_b$ (cfs) | 0.0 |

**Watershed Characteristics**

| | |
|---|---|
| Subcatchment Area (acres) | |
| Percent Impervious | |
| NRCS Soil Type | |

**Watershed Profile**

| | |
|---|---|
| Overland Slope (ft/ft) | |
| Overland Length (ft) | |
| Channel Slope (ft/ft) | |
| Channel Length (ft) | |

**Minor Storm Rainfall Input**

| | |
|---|---|
| Design Storm Return Period, $T_r$ (years) | |
| One-Hour Precipitation, $P_1$ (inches) | |

**Major Storm Rainfall Input**

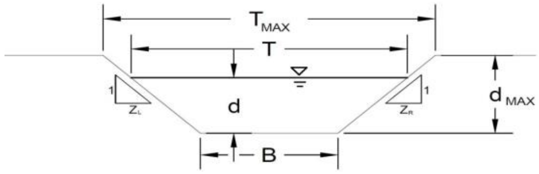
| | |
|---|---|
| Design Storm Return Period, $T_r$ (years) | |
| One-Hour Precipitation, $P_1$ (inches) | |

## CALCULATED OUTPUT

| | |
|---|---|
| **Minor Total Design Peak Flow, Q (cfs)** | **17.3** |
| **Major Total Design Peak Flow, Q (cfs)** | **32.5** |
| Minor Flow Bypassed Downstream, $Q_b$ (cfs) | N/A |
| Major Flow Bypassed Downstream, $Q_b$ (cfs) | N/A |

# AREA INLET IN A SWALE

**U-Haul Falcon**
**Inlet 10**




This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

## Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

| | | | |
|---|---|---|---|
| NRCS Vegetal Retardance (A, B, C, D, or E) | A, B, C, D, or E = | | |
| Manning's n (Leave cell D16 blank to manually enter an n value) | n = | 0.035 | |
| Channel Invert Slope | $S_O$ = | 0.0150 | ft/ft |
| Bottom Width | B = | 2.00 | ft |
| Left Side Slope | Z1 = | 4.00 | ft/ft |
| Right Side Sloe | Z2 = | 4.00 | ft/ft |

Check one of the following soil types:

| Soil Type: | Max. Velocity ($V_{MAX}$) | Max Froude No. ($F_{MAX}$) |
|---|---|---|
| Non-Cohesive | 5.0 fps | 0.60 |
| Cohesive | 7.0 fps | 0.80 |
| Paved | N/A | N/A |

Choose One:
- ○ Non-Cohesive
- ⦿ Cohesive
- ○ Paved

| | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| Maximum Allowable Top Width of Channel for Minor & Major Storm | $T_{MAX}$ = | **8.00** | **10.00** | **ft** |
| Maximum Allowable Water Depth in Channel for Minor & Major Storm | $d_{MAX}$ = | **0.55** | **1.00** | **ft** |

## Allowable Channel Capacity Based On Channel Geometry

| | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| MINOR STORM Allowable Capacity is based on Depth Criterion | $Q_{allow}$ = | **6.0** | **21.9** | **cfs** |
| MAJOR STORM Allowable Capacity is based on Depth Criterion | $d_{allow}$ = | **0.55** | **1.00** | **ft** |

## Water Depth in Channel Based On Design Peak Flow

| | | | | |
|---|---|---|---|---|
| Design Peak Flow | $Q_o$ = | **5.9** | **11.8** | **cfs** |
| Water Depth | d = | **0.54** | **0.76** | **ft** |

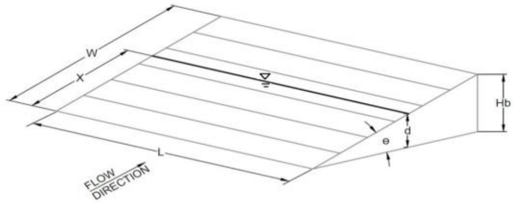
**Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'**
**Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'**

# AREA INLET IN A SWALE

**U-Haul Falcon**
**Inlet 10**

Inlet Design Information (Input)

Type of Inlet: CDOT Type C — Inlet Type = CDOT Type C



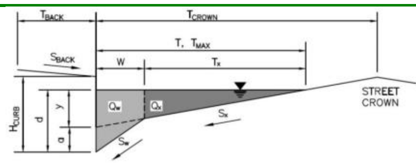

| | | | |
|---|---|---|---|
| Angle of Inclined Grate (must be <= 30 degrees) | $\theta$ = | 0.00 | degrees |
| Width of Grate | W = | 3.00 | ft |
| Length of Grate | L = | 3.00 | ft |
| Open Area Ratio | $A_{RATIO}$ = | 0.70 | |
| Height of Inclined Grate | $H_B$ = | 0.00 | ft |
| Clogging Factor | $C_f$ = | 0.50 | |
| Grate Discharge Coefficient | $C_d$ = | 0.96 | |
| Orifice Coefficient | $C_o$ = | 0.64 | |
| Weir Coefficient | $C_w$ = | 2.05 | |

| | | MINOR | MAJOR | |
|---|---|---|---|---|
| Water Depth at Inlet (for depressed inlets, 1 foot is added for depression) | d = | 0.54 | 0.76 | |
| Total Inlet Interception Capacity (assumes clogged condition) | **$Q_a$ =** | **7.4** | **12.1** | **cfs** |
| Bypassed Flow | **$Q_b$ =** | **0.0** | **0.0** | **cfs** |
| Capture Percentage = Qa/Qo | **C% =** | **100** | **100** | **%** |

# ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

**(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)**

**Project: U-Haul Falcon**
**Inlet ID: Inlet 11**




Gutter Geometry:

| | | | |
|---|---|---|---|
| Maximum Allowable Width for Spread Behind Curb | $T_{BACK}$ = | 20.0 | ft |
| Side Slope Behind Curb (leave blank for no conveyance credit behind curb) | $S_{BACK}$ = | 0.020 | ft/ft |
| Manning's Roughness Behind Curb (typically between 0.012 and 0.020) | $n_{BACK}$ = | 0.015 | |
| Height of Curb at Gutter Flow Line | $H_{CURB}$ = | 0.00 | inches |
| Distance from Curb Face to Street Crown | $T_{CROWN}$ = | 30.0 | ft |
| Gutter Width | W = | 2.00 | ft |
| Street Transverse Slope | $S_X$ = | 0.025 | ft/ft |
| Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft) | $S_W$ = | 0.040 | ft/ft |
| Street Longitudinal Slope - Enter 0 for sump condition | $S_O$ = | 0.000 | ft/ft |
| Manning's Roughness for Street Section (typically between 0.012 and 0.020) | $n_{STREET}$ = | 0.015 | |

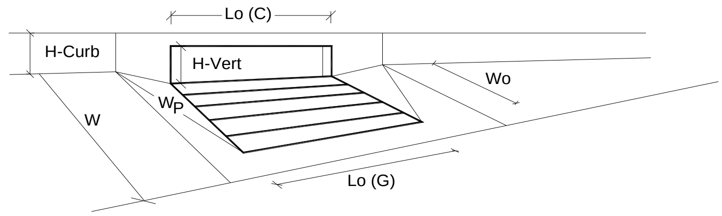
| | | | Minor Storm | Major Storm | |
|---|---|---|---|---|---|
| | Max. Allowable Spread for Minor & Major Storm | $T_{MAX}$ = | 15.0 | 20.0 | ft |
| **Warning 02** | Max. Allowable Depth at Gutter Flowline for Minor & Major Storm | $d_{MAX}$ = | 6.0 | 12.0 | inches |
| | Check boxes are not applicable in SUMP conditions | | ☐ | ☐ | |

MINOR STORM Allowable Capacity is based on Depth Criterion
MAJOR STORM Allowable Capacity is based on Depth Criterion

| | Minor Storm | Major Storm | |
|---|---|---|---|
| $Q_{allow}$ = | **SUMP** | **SUMP** | **cfs** |

# INLET IN A SUMP OR SAG LOCATION

*MHFD-Inlet, Version 5.01 (April 2021)*

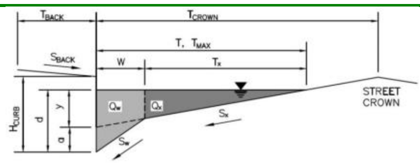



| | | MINOR | MAJOR | |
|---|---|---|---|---|
| **Design Information (Input)** CDOT/Denver 13 Valley Grate | | | | |
| Type of Inlet | Type = | CDOT/Denver 13 Valley Grate | | |
| Local Depression (additional to continuous gutter depression 'a' from above) | $a_{local}$ = | 2.00 | 2.00 | inches |
| Number of Unit Inlets (Grate or Curb Opening) | No = | 3 | 3 | |
| Water Depth at Flowline (outside of local depression) | Ponding Depth = | 8.0 | 10.3 | inches |
| **Grate Information** | | MINOR | MAJOR | ☑ Override Depths |
| Length of a Unit Grate | $L_o$ (G) = | 3.00 | 3.00 | feet |
| Width of a Unit Grate | $W_o$ = | 1.73 | 1.73 | feet |
| Area Opening Ratio for a Grate (typical values 0.15-0.90) | $A_{ratio}$ = | 0.43 | 0.43 | |
| Clogging Factor for a Single Grate (typical value 0.50 - 0.70) | $C_f$ (G) = | 0.50 | 0.50 | |
| Grate Weir Coefficient (typical value 2.15 - 3.60) | $C_w$ (G) = | 3.30 | 3.30 | |
| Grate Orifice Coefficient (typical value 0.60 - 0.80) | $C_o$ (G) = | 0.60 | 0.60 | |
| **Curb Opening Information** | | MINOR | MAJOR | |
| Length of a Unit Curb Opening | $L_o$ (C) = | N/A | N/A | feet |
| Height of Vertical Curb Opening in Inches | $H_{vert}$ = | N/A | N/A | inches |
| Height of Curb Orifice Throat in Inches | $H_{throat}$ = | N/A | N/A | inches |
| Angle of Throat (see USDCM Figure ST-5) | Theta = | N/A | N/A | degrees |
| Side Width for Depression Pan (typically the gutter width of 2 feet) | $W_p$ = | N/A | N/A | feet |
| Clogging Factor for a Single Curb Opening (typical value 0.10) | $C_f$ (C) = | N/A | N/A | |
| Curb Opening Weir Coefficient (typical value 2.3-3.7) | $C_w$ (C) = | N/A | N/A | |
| Curb Opening Orifice Coefficient (typical value 0.60 - 0.70) | $C_o$ (C) = | N/A | N/A | |
| **Low Head Performance Reduction (Calculated)** | | MINOR | MAJOR | |
| Depth for Grate Midwidth | $d_{Grate}$ = | 0.727 | 0.918 | ft |
| Depth for Curb Opening Weir Equation | $d_{Curb}$ = | N/A | N/A | ft |
| Combination Inlet Performance Reduction Factor for Long Inlets | $RF_{Combination}$ = | N/A | N/A | |
| Curb Opening Performance Reduction Factor for Long Inlets | $RF_{Curb}$ = | N/A | N/A | |
| Grated Inlet Performance Reduction Factor for Long Inlets | $RF_{Grate}$ = | 0.75 | 0.97 | |
| | | MINOR | MAJOR | |
| Total Inlet Interception Capacity (assumes clogged condition) | $Q_a$ = | **9.5** | **17.4** | **cfs** |
| **Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)** | $Q_{PEAK\ REQUIRED}$ = | 9.5 | 17.1 | cfs |

# ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

**(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)**

**Project: U-Haul Falcon**
**Inlet ID: Inlet 16**




Gutter Geometry:

| | | | |
|---|---|---|---|
| Maximum Allowable Width for Spread Behind Curb | $T_{BACK}$ = | 30.0 | ft |
| Side Slope Behind Curb (leave blank for no conveyance credit behind curb) | $S_{BACK}$ = | 0.020 | ft/ft |
| Manning's Roughness Behind Curb (typically between 0.012 and 0.020) | $n_{BACK}$ = | 0.015 | |
| Height of Curb at Gutter Flow Line | $H_{CURB}$ = | 6.00 | inches |
| Distance from Curb Face to Street Crown | $T_{CROWN}$ = | 60.0 | ft |
| Gutter Width | W = | 1.73 | ft |
| Street Transverse Slope | $S_X$ = | 0.020 | ft/ft |
| Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft) | $S_W$ = | 0.040 | ft/ft |
| Street Longitudinal Slope - Enter 0 for sump condition | $S_O$ = | 0.000 | ft/ft |
| Manning's Roughness for Street Section (typically between 0.012 and 0.020) | $n_{STREET}$ = | 0.015 | |

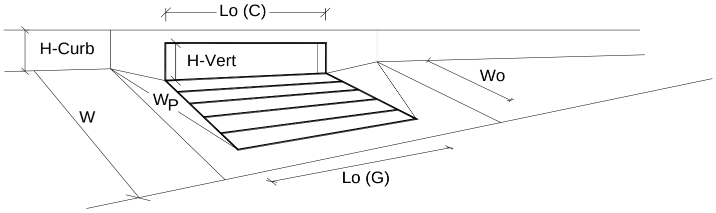
| | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| Max. Allowable Spread for Minor & Major Storm | $T_{MAX}$ = | 10.0 | 40.0 | ft |
| Max. Allowable Depth at Gutter Flowline for Minor & Major Storm | $d_{MAX}$ = | 6.0 | 12.0 | inches |
| Check boxes are not applicable in SUMP conditions | | ☐ | ☐ | |

MINOR STORM Allowable Capacity is based on Depth Criterion
MAJOR STORM Allowable Capacity is based on Depth Criterion

| | Minor Storm | Major Storm | |
|---|---|---|---|
| **$Q_{allow}$ =** | **SUMP** | **SUMP** | **cfs** |

# INLET IN A SUMP OR SAG LOCATION

*MHFD-Inlet, Version 5.01 (April 2021)*



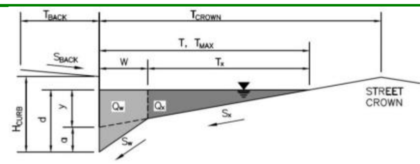

| | | MINOR | MAJOR | |
|---|---|---|---|---|
| Design Information (Input) | | MINOR | MAJOR | |
| Type of Inlet (CDOT/Denver 13 Combination) | Type = | CDOT/Denver 13 Combination | | |
| Local Depression (additional to continuous gutter depression 'a' from above) | $a_{local}$ = | 2.00 | 2.00 | inches |
| Number of Unit Inlets (Grate or Curb Opening) | No = | 1 | 1 | |
| Water Depth at Flowline (outside of local depression) | Ponding Depth = | 5.3 | 10.0 | inches |
| Grate Information | | MINOR | MAJOR | ☑ Override Depths |
| Length of a Unit Grate | $L_o$ (G) = | 3.00 | 3.00 | feet |
| Width of a Unit Grate | $W_o$ = | 1.73 | 1.73 | feet |
| Area Opening Ratio for a Grate (typical values 0.15-0.90) | $A_{ratio}$ = | 0.43 | 0.43 | |
| Clogging Factor for a Single Grate (typical value 0.50 - 0.70) | $C_f$ (G) = | 0.50 | 0.50 | |
| Grate Weir Coefficient (typical value 2.15 - 3.60) | $C_w$ (G) = | 3.30 | 3.30 | |
| Grate Orifice Coefficient (typical value 0.60 - 0.80) | $C_o$ (G) = | 0.60 | 0.60 | |
| Curb Opening Information | | MINOR | MAJOR | |
| Length of a Unit Curb Opening | $L_o$ (C) = | 3.00 | 3.00 | feet |
| Height of Vertical Curb Opening in Inches | $H_{vert}$ = | 6.50 | 6.50 | inches |
| Height of Curb Orifice Throat in Inches | $H_{throat}$ = | 5.25 | 5.25 | inches |
| Angle of Throat (see USDCM Figure ST-5) | Theta = | 0.00 | 0.00 | degrees |
| **Warning 1** Side Width for Depression Pan (typically the gutter width of 2 feet) | $W_p$ = | 1.00 | 1.00 | feet |
| Clogging Factor for a Single Curb Opening (typical value 0.10) | $C_f$ (C) = | 0.10 | 0.10 | |
| Curb Opening Weir Coefficient (typical value 2.3-3.7) | $C_w$ (C) = | 3.70 | 3.70 | |
| Curb Opening Orifice Coefficient (typical value 0.60 - 0.70) | $C_o$ (C) = | 0.66 | 0.66 | |
| Low Head Performance Reduction (Calculated) | | MINOR | MAJOR | |
| Depth for Grate Midwidth | $d_{Grate}$ = | 0.490 | 0.883 | ft |
| Depth for Curb Opening Weir Equation | $d_{Curb}$ = | 0.37 | 0.77 | ft |
| Combination Inlet Performance Reduction Factor for Long Inlets | $RF_{Combination}$ = | 0.83 | 1.00 | |
| Curb Opening Performance Reduction Factor for Long Inlets | $RF_{Curb}$ = | 1.00 | 1.00 | |
| Grated Inlet Performance Reduction Factor for Long Inlets | $RF_{Grate}$ = | 0.83 | 1.00 | |
| | | MINOR | MAJOR | |
| Total Inlet Interception Capacity (assumes clogged condition) | $\mathbf{Q_a}$ = | **3.2** | **8.4** | **cfs** |
| **Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)** | $Q_{PEAK\ REQUIRED}$ = | 3.1 | 6.2 | cfs |

**Warning 1: Dimension entered is not a typical dimension for inlet type specified.**

# ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

**(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)**

**Project: U-Haul Falcon**
**Inlet ID: Inlet 17**




Gutter Geometry:

| | | | |
|---|---|---|---|
| Maximum Allowable Width for Spread Behind Curb | $T_{BACK}$ = | 50.0 | ft |
| Side Slope Behind Curb (leave blank for no conveyance credit behind curb) | $S_{BACK}$ = | 0.020 | ft/ft |
| Manning's Roughness Behind Curb (typically between 0.012 and 0.020) | $n_{BACK}$ = | 0.015 | |
| Height of Curb at Gutter Flow Line | $H_{CURB}$ = | 6.00 | inches |
| Distance from Curb Face to Street Crown | $T_{CROWN}$ = | 50.0 | ft |
| Gutter Width | W = | 1.73 | ft |
| Street Transverse Slope | $S_X$ = | 0.020 | ft/ft |
| Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft) | $S_W$ = | 0.040 | ft/ft |
| Street Longitudinal Slope - Enter 0 for sump condition | $S_O$ = | 0.000 | ft/ft |
| Manning's Roughness for Street Section (typically between 0.012 and 0.020) | $n_{STREET}$ = | 0.015 | |

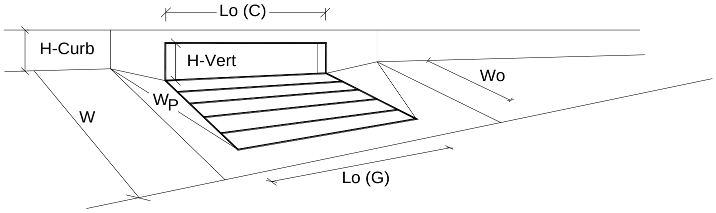
| | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| Max. Allowable Spread for Minor & Major Storm | $T_{MAX}$ = | 10.0 | 50.0 | ft |
| Max. Allowable Depth at Gutter Flowline for Minor & Major Storm | $d_{MAX}$ = | 6.0 | 12.0 | inches |
| Check boxes are not applicable in SUMP conditions | | ☐ | ☐ | |

MINOR STORM Allowable Capacity is based on Depth Criterion
MAJOR STORM Allowable Capacity is based on Depth Criterion

| | Minor Storm | Major Storm | |
|---|---|---|---|
| **$Q_{allow}$ =** | **SUMP** | **SUMP** | **cfs** |

# INLET IN A SUMP OR SAG LOCATION

*MHFD-Inlet, Version 5.01 (April 2021)*




| | | MINOR | MAJOR | |
|---|---|---|---|---|
| Design Information (Input) CDOT/Denver 13 Combination | | | | |
| Type of Inlet | Type = | CDOT/Denver 13 Combination | | |
| Local Depression (additional to continuous gutter depression 'a' from above) | $a_{local}$ = | 2.00 | 2.00 | inches |
| Number of Unit Inlets (Grate or Curb Opening) | No = | 3 | 3 | |
| Water Depth at Flowline (outside of local depression) | Ponding Depth = | 8.1 | 12.0 | inches |
| Grate Information | | MINOR | MAJOR | ☑ Override Depths |
| Length of a Unit Grate | $L_o$ (G) = | 3.00 | 3.00 | feet |
| Width of a Unit Grate | $W_o$ = | 1.73 | 1.73 | feet |
| Area Opening Ratio for a Grate (typical values 0.15-0.90) | $A_{ratio}$ = | 0.43 | 0.43 | |
| Clogging Factor for a Single Grate (typical value 0.50 - 0.70) | $C_f$ (G) = | 0.50 | 0.50 | |
| Grate Weir Coefficient (typical value 2.15 - 3.60) | $C_w$ (G) = | 3.30 | 3.30 | |
| Grate Orifice Coefficient (typical value 0.60 - 0.80) | $C_o$ (G) = | 0.60 | 0.60 | |
| Curb Opening Information | | MINOR | MAJOR | |
| Length of a Unit Curb Opening | $L_o$ (C) = | 3.00 | 3.00 | feet |
| Height of Vertical Curb Opening in Inches | $H_{vert}$ = | 6.50 | 6.50 | inches |
| Height of Curb Orifice Throat in Inches | $H_{throat}$ = | 5.25 | 5.25 | inches |
| Angle of Throat (see USDCM Figure ST-5) | Theta = | 0.00 | 0.00 | degrees |
| **Warning 1** Side Width for Depression Pan (typically the gutter width of 2 feet) | $W_p$ = | 1.00 | 1.00 | feet |
| Clogging Factor for a Single Curb Opening (typical value 0.10) | $C_f$ (C) = | 0.10 | 0.10 | |
| Curb Opening Weir Coefficient (typical value 2.3-3.7) | $C_w$ (C) = | 3.70 | 3.70 | |
| Curb Opening Orifice Coefficient (typical value 0.60 - 0.70) | $C_o$ (C) = | 0.66 | 0.66 | |
| Low Head Performance Reduction (Calculated) | | MINOR | MAJOR | |
| Depth for Grate Midwidth | $d_{Grate}$ = | 0.724 | 1.049 | ft |
| Depth for Curb Opening Weir Equation | $d_{Curb}$ = | 0.61 | 0.93 | ft |
| Combination Inlet Performance Reduction Factor for Long Inlets | $RF_{Combination}$ = | 0.76 | 1.00 | |
| Curb Opening Performance Reduction Factor for Long Inlets | $RF_{Curb}$ = | 1.00 | 1.00 | |
| Grated Inlet Performance Reduction Factor for Long Inlets | $RF_{Grate}$ = | 0.76 | 1.00 | |
| | | MINOR | MAJOR | |
| Total Inlet Interception Capacity (assumes clogged condition) | **$Q_a$ =** | **17.3** | **34.8** | **cfs** |
| **WARNING: Inlet Capacity less than Q Peak for Minor Storm** | $Q_{PEAK\ REQUIRED}$ = | 17.3 | 32.5 | cfs |

**Warning 1: Dimension entered is not a typical dimension for inlet type specified.**

# U-Haul at Falcon
## Pipe Diameter Calculations

| Pipe # | 5yr Flow | 100yr Flow (Design) | Contributing Flows | Manning 'n' | Pipe Slope | Calculated Pipe Diameter | **Pipe Diameter** | Minimum Slope of Pipe | Full Pipe Flow Velocity | **Mannings Pipe Capacity** | Capacity Check |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S10 | 5.6 cfs | 11.2 cfs | DP1 | 0.013 | **0.80%** | 19-inch | **24-inch** | 0.24% | 6.5 ft/sec | **20.3 cfs** | OK |
| S11 | 9.1 cfs | 16.5 cfs | DP2 | 0.013 | **0.60%** | 23-inch | **24-inch** | 0.53% | 5.6 ft/sec | **17.6 cfs** | OK |
| S12 | 5.7 cfs | 11.3 cfs | DP1A | 0.013 | **0.60%** | 20-inch | **24-inch** | 0.25% | 5.6 ft/sec | **17.6 cfs** | OK |
| S13 | 14.1 cfs | 27.3 cfs | DP3 | 0.013 | **0.60%** | 28-inch | **30-inch** | 0.44% | 6.5 ft/sec | **31.9 cfs** | OK |
| S15 | 2.8 cfs | 5.7 cfs | DP4 | 0.013 | **0.80%** | 15-inch | **18-inch** | 0.30% | 5.3 ft/sec | **9.4 cfs** | OK |
| S16 | 2.9 cfs | 6.0 cfs | DP5 | 0.013 | **0.75%** | 15-inch | **18-inch** | 0.32% | 5.2 ft/sec | **9.1 cfs** | OK |
| S17 | 0.8 cfs | 2.3 cfs | J | 0.013 | **0.80%** | 11-inch | **18-inch** | 0.05% | 5.3 ft/sec | **9.4 cfs** | OK |
| S20 | 42.5 cfs | 76.1 cfs | DP24 | 0.013 | **0.75%** | 40-inch | **42-inch** | 0.57% | 9.1 ft/sec | **87.4 cfs** | OK |
| S21 | 44.8 cfs | 80.9 cfs | DP25 | 0.013 | **0.81%** | 40-inch | **42-inch** | 0.65% | 9.4 ft/sec | **90.8 cfs** | OK |
| S22 | 57.6 cfs | 105.8 cfs | DP26 | 0.013 | **0.60%** | 47-inch | **48-inch** | 0.54% | 8.9 ft/sec | **111.6 cfs** | OK |
| S23 | 59.7 cfs | 111.4 cfs | DP27-Dev | 0.013 | **0.80%** | 46-inch | **48-inch** | 0.60% | 10.3 ft/sec | **128.8 cfs** | OK |
| S24 | 67.1 cfs | 125.7 cfs | DP28-Dev | 0.013 | **1.00%** | 46-inch | **48-inch** | 0.77% | 11.5 ft/sec | **144.0 cfs** | OK |
| S30 | 0.4 cfs | 2.6 cfs | L | 0.022 | **1.7%** | 12-inch | **18-inch** | 0.18% | 4.6 ft/sec | **8.1 cfs** | OK |
| S31 | 2.7 cfs | 11.1 cfs | DP6 | 0.013 | **1.5%** | 17-inch | **18-inch** | 1.12% | 7.3 ft/sec | **12.9 cfs** | OK |

Equations:

Pipe Dia=$((2.16Qn)/(S^{0.5}))^{0.375}$

Q = Discharge in cubic feet per second

n = Manning's roughness coefficient

RCP=0.013, CMP=0.024, HDPE (smooth)=0.012

S = Slope of the pipe

$R_h$ = Hydraulic Radius

Flow Velocity = $(1.49/n)R_h^{2/3} S^{1/2}$

Pipe Capacity = $(1.49/n)AR_h^{2/3} S^{1/2}$

A = Cross-sectional area of pipe

A=p $(D^2/4)$

D = Inside Diameter of Pipe

$R_h = A_w/W_p$

$A_w = p(d^2/4)$

$A_w$ = Water Cross Sectional Area

d = Water (Flow) Depth Within Pipe

$W_p$ = pd (For Capacity Calculation)

$W_p$=Wetted Perimeter of Pipe

| | |
|---|---|
| **Program:** UDSEWER Math Model Interface 2.1.1.4<br>**Run Date:** 9/7/2022 5:20:21 PM | **UDSewer Results Summary**<br><br>**Project Title:** U-Haul Falcon Main<br>**Project Description:** 100-yr |

# System Input Summary

### Rainfall Parameters

**Rainfall Return Period:** 100
**Rainfall Calculation Method:** Formula

**One Hour Depth (in):**
**Rainfall Constant "A":** 28.5
**Rainfall Constant "B":** 10
**Rainfall Constant "C":** 0.786

### Rational Method Constraints

**Minimum Urban Runoff Coeff.:** 0.20
**Maximum Rural Overland Len. (ft):** 500
**Maximum Urban Overland Len. (ft):** 300
**Used UDFCD Tc. Maximum:** Yes

### Sizer Constraints

**Minimum Sewer Size (in):** 18.00
**Maximum Depth to Rise Ratio:** 0.90
**Maximum Flow Velocity (fps):** 18.0
**Minimum Flow Velocity (fps):** 2.0

### Backwater Calculations:

**Tailwater Elevation (ft):** 6828.00

# Manhole Input Summary:

| | | Given Flow | | Sub Basin Information | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Element Name | Ground Elevation (ft) | Total Known Flow (cfs) | Local Contribution (cfs) | Drainage Area (Ac.) | Runoff Coefficient | 5yr Coefficient | Overland Length (ft) | Overland Slope (%) | Gutter Length (ft) | Gutter Velocity (fps) |
| OUTFALL 1 | 6832.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| S24A | 6840.00 | 127.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S24 | 6839.61 | 127.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| S23 | 6840.61 | 113.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| S22 | 6846.00 | 108.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| S21 | 6847.36 | 81.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| S16 | 6847.50 | 6.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| S20 | 6850.20 | 76.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| E1 | 6851.00 | 70.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| S15 | 6848.40 | 5.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| S13 | 6847.72 | 28.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| S11 | 6845.75 | 17.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| S12 | 6848.33 | 11.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| S10A | 6847.73 | 11.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| S10 | 6848.00 | 11.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| S17 | 6846.50 | 4.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| S30 | 6840.20 | 6.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| S31 | 6838.50 | 17.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

# Manhole Output Summary:

| | Local Contribution | | | | | Total Design Flow | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Element Name** | **Overland Time (min)** | **Gutter Time (min)** | **Basin Tc (min)** | **Intensity (in/hr)** | **Local Contrib (cfs)** | **Coeff. Area** | **Intensity (in/hr)** | **Manhole Tc (min)** | **Peak Flow (cfs)** | **Comment** |
| OUTFALL 1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| S24A | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 127.90 | |
| S24 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 127.90 | |
| S23 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 113.70 | |
| S22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 108.10 | |
| S21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 81.10 | |
| S16 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.20 | |
| S20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 76.20 | |
| E1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 70.90 | |
| S15 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.90 | Surface Water Present (Upstream) |
| S13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 28.00 | |
| S11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 17.10 | Surface Water Present (Upstream) |
| S12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 11.30 | |
| S10A | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 11.20 | |
| S10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 11.20 | |
| S17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.90 | |
| S30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.80 | |
| S31 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 17.90 | Surface Water Present (Upstream) |

# Sewer Input Summary:

| | | Elevation | | | Loss Coefficients | | | Given Dimensions | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Element Name | Sewer Length (ft) | Downstream Invert (ft) | Slope (%) | Upstream Invert (ft) | Mannings n | Bend Loss | Lateral Loss | Cross Section | Rise (ft or in) | Span (ft or in) |
| S24A | 116.42 | 6827.60 | 2.1 | 6830.00 | 0.013 | 0.03 | 1.00 | CIRCULAR | 48.00 in | 48.00 in |
| S24 | 121.78 | 6830.20 | 1.9 | 6832.50 | 0.013 | 0.14 | 1.00 | CIRCULAR | 48.00 in | 48.00 in |
| S23 | 121.14 | 6833.00 | 1.1 | 6834.30 | 0.013 | 0.05 | 0.25 | CIRCULAR | 48.00 in | 48.00 in |
| S22 | 438.12 | 6834.50 | 0.8 | 6837.90 | 0.015 | 0.30 | 0.30 | CIRCULAR | 48.00 in | 48.00 in |
| S21 | 237.58 | 6838.97 | 1.1 | 6841.58 | 0.013 | 0.05 | 0.25 | CIRCULAR | 42.00 in | 42.00 in |
| S16 | 13.00 | 6843.18 | 1.5 | 6843.38 | 0.013 | 1.00 | 0.00 | CIRCULAR | 18.00 in | 18.00 in |
| S20 | 123.08 | 6841.58 | 0.7 | 6842.50 | 0.013 | 0.05 | 0.25 | CIRCULAR | 42.00 in | 42.00 in |
| E1 | 7.67 | 6843.98 | 0.4 | 6844.01 | 0.013 | 0.14 | 0.26 | CIRCULAR | 42.00 in | 42.00 in |
| S15 | 22.00 | 6845.50 | 5.0 | 6846.60 | 0.013 | 0.29 | 0.00 | CIRCULAR | 18.00 in | 18.00 in |
| S13 | 119.34 | 6839.90 | 0.7 | 6840.70 | 0.013 | 0.82 | 0.00 | CIRCULAR | 30.00 in | 30.00 in |
| S11 | 186.45 | 6840.90 | 0.5 | 6841.90 | 0.013 | 0.26 | 0.00 | CIRCULAR | 24.00 in | 24.00 in |
| S12 | 259.38 | 6840.90 | 0.6 | 6842.50 | 0.013 | 0.18 | 0.29 | CIRCULAR | 24.00 in | 24.00 in |
| S10A | 73.14 | 6842.70 | 1.5 | 6843.80 | 0.013 | 0.05 | 1.00 | CIRCULAR | 24.00 in | 24.00 in |
| S10 | 131.43 | 6844.03 | 1.5 | 6846.00 | 0.013 | 1.00 | 1.00 | CIRCULAR | 24.00 in | 24.00 in |
| S17 | 10.00 | 6840.90 | 1.0 | 6841.00 | 0.013 | 1.00 | 0.00 | CIRCULAR | 18.00 in | 18.00 in |
| S30 | 20.00 | 6837.00 | 8.5 | 6838.70 | 0.015 | 1.00 | 0.00 | CIRCULAR | 18.00 in | 18.00 in |
| S31 | 42.20 | 6835.00 | 4.7 | 6837.00 | 0.015 | 0.44 | 0.00 | CIRCULAR | 18.00 in | 18.00 in |

# Sewer Flow Summary:

| | Full Flow Capacity | | Critical Flow | | Normal Flow | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Element Name | Flow (cfs) | Velocity (fps) | Depth (in) | Velocity (fps) | Depth (in) | Velocity (fps) | Froude Number | Flow Condition | Flow (cfs) | Surcharged Length (ft) | Comment |
| S24A | 206.79 | 16.46 | 40.66 | 11.27 | 27.31 | 17.32 | 2.24 | Supercritical | 127.90 | 0.00 | |
| S24 | 197.93 | 15.75 | 40.66 | 11.27 | 28.08 | 16.75 | 2.12 | Supercritical | 127.90 | 0.00 | |
| S23 | 149.19 | 11.87 | 38.63 | 10.49 | 31.36 | 13.07 | 1.52 | Pressurized | 113.70 | 121.14 | |
| S22 | 109.96 | 8.75 | 37.74 | 10.20 | 38.63 | 9.97 | 0.95 | Pressurized | 108.10 | 438.12 | |
| S21 | 105.80 | 11.00 | 33.74 | 9.79 | 27.56 | 12.12 | 1.51 | Pressurized | 81.10 | 237.58 | |
| S16 | 12.90 | 7.30 | 11.55 | 5.18 | 8.79 | 7.23 | 1.68 | Pressurized | 6.20 | 13.00 | |
| S20 | 87.21 | 9.06 | 32.77 | 9.46 | 30.40 | 10.22 | 1.17 | Pressurized | 76.20 | 123.08 | |
| E1 | 63.80 | 6.63 | 42.00 | 7.37 | 42.00 | 7.37 | 0.00 | Pressurized | 70.90 | 7.67 | |
| S15 | 23.55 | 13.33 | 11.25 | 5.08 | 6.14 | 11.09 | 3.19 | Pressurized | 5.90 | 22.00 | |
| S13 | 33.68 | 6.86 | 21.65 | 7.38 | 20.89 | 7.67 | 1.07 | Pressurized | 28.00 | 119.34 | |
| S11 | 16.61 | 5.29 | 24.00 | 5.44 | 24.00 | 5.44 | 0.00 | Pressurized | 17.10 | 186.45 | |
| S12 | 17.82 | 5.67 | 14.47 | 5.71 | 13.88 | 6.00 | 1.08 | Pressurized | 11.30 | 259.38 | |
| S10A | 27.78 | 8.84 | 14.41 | 5.69 | 10.60 | 8.37 | 1.80 | Pressurized | 11.20 | 73.14 | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S10 | 27.78 | 8.84 | 14.41 | 5.69 | 10.60 | 8.37 | 1.80 | Supercritical Jump | 11.20 | 62.39 | |
| S17 | 10.53 | 5.96 | 10.21 | 4.73 | 8.63 | 5.85 | 1.38 | Pressurized | 4.90 | 10.00 | |
| S30 | 26.61 | 15.06 | 12.11 | 5.38 | 6.20 | 12.60 | 3.61 | Supercritical Jump | 6.80 | 18.49 | |
| S31 | 19.87 | 11.25 | 17.40 | 10.23 | 13.36 | 12.73 | 2.17 | Pressurized | 17.90 | 42.20 | |

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

# Sewer Sizing Summary:

| | | | Existing | | Calculated | | Used | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Element Name** | **Peak Flow (cfs)** | **Cross Section** | **Rise** | **Span** | **Rise** | **Span** | **Rise** | **Span** | **Area (ft^2)** | **Comment** |
| S24A | 127.90 | CIRCULAR | 48.00 in | 48.00 in | 42.00 in | 42.00 in | 48.00 in | 48.00 in | 12.57 | |
| S24 | 127.90 | CIRCULAR | 48.00 in | 48.00 in | 42.00 in | 42.00 in | 48.00 in | 48.00 in | 12.57 | |
| S23 | 113.70 | CIRCULAR | 48.00 in | 48.00 in | 48.00 in | 48.00 in | 48.00 in | 48.00 in | 12.57 | |
| S22 | 108.10 | CIRCULAR | 48.00 in | 48.00 in | 48.00 in | 48.00 in | 48.00 in | 48.00 in | 12.57 | |
| S21 | 81.10 | CIRCULAR | 42.00 in | 42.00 in | 42.00 in | 42.00 in | 42.00 in | 42.00 in | 9.62 | |
| S16 | 6.20 | CIRCULAR | 18.00 in | 18.00 in | 18.00 in | 18.00 in | 18.00 in | 18.00 in | 1.77 | |
| S20 | 76.20 | CIRCULAR | 42.00 in | 42.00 in | 42.00 in | 42.00 in | 42.00 in | 42.00 in | 9.62 | |
| E1 | 70.90 | CIRCULAR | 42.00 in | 42.00 in | 48.00 in | 48.00 in | 42.00 in | 42.00 in | 9.62 | Existing height is smaller than the suggested height. Existing width is smaller than the suggested width. Exceeds max. Depth/Rise |
| S15 | 5.90 | CIRCULAR | 18.00 in | 18.00 in | 18.00 in | 18.00 in | 18.00 in | 18.00 in | 1.77 | |
| S13 | 28.00 | CIRCULAR | 30.00 in | 30.00 in | 30.00 in | 30.00 in | 30.00 in | 30.00 in | 4.91 | |
| S11 | 17.10 | CIRCULAR | 24.00 in | 24.00 in | 27.00 in | 27.00 in | 24.00 in | 24.00 in | 3.14 | Existing height is smaller than the suggested height. Existing width is smaller than the suggested width. Exceeds max. Depth/Rise |
| S12 | 11.30 | CIRCULAR | 24.00 in | 24.00 in | 21.00 in | 21.00 in | 24.00 in | 24.00 in | 3.14 | |
| S10A | 11.20 | CIRCULAR | 24.00 in | 24.00 in | 18.00 in | 18.00 in | 24.00 in | 24.00 in | 3.14 | |
| S10 | 11.20 | CIRCULAR | 24.00 in | 24.00 in | 18.00 in | 18.00 in | 24.00 in | 24.00 in | 3.14 | |
| S17 | 4.90 | CIRCULAR | 18.00 in | 18.00 in | 18.00 in | 18.00 in | 18.00 in | 18.00 in | 1.77 | |
| S30 | 6.80 | CIRCULAR | 18.00 in | 18.00 in | 18.00 in | 18.00 in | 18.00 in | 18.00 in | 1.77 | |
| S31 | 17.90 | CIRCULAR | 18.00 in | 18.00 in | 18.00 in | 18.00 in | 18.00 in | 18.00 in | 1.77 | |

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

# Grade Line Summary:

**Tailwater Elevation (ft):** 6828.00

| | Invert Elev. | | Downstream Manhole Losses | | HGL | | EGL | | |
|---|---|---|---|---|---|---|---|---|---|
| **Element Name** | **Downstream (ft)** | **Upstream (ft)** | **Bend Loss (ft)** | **Lateral Loss (ft)** | **Downstream (ft)** | **Upstream (ft)** | **Downstream (ft)** | **Friction Loss (ft)** | **Upstream (ft)** |
| S24A | 6827.60 | 6830.00 | 0.00 | 0.00 | 6829.88 | 6833.39 | 6834.54 | 0.82 | 6835.36 |
| S24 | 6830.20 | 6832.50 | 0.23 | 0.00 | 6833.61 | 6835.89 | 6836.89 | 0.96 | 6837.86 |
| S23 | 6833.00 | 6834.30 | 0.06 | 1.29 | 6837.94 | 6838.70 | 6839.21 | 0.75 | 6839.97 |
| S22 | 6834.50 | 6837.90 | 0.34 | 0.93 | 6840.09 | 6843.38 | 6841.24 | 3.29 | 6844.53 |
| S21 | 6838.97 | 6841.58 | 0.06 | 0.87 | 6844.35 | 6845.89 | 6845.45 | 1.54 | 6846.99 |
| S16 | 6843.18 | 6843.38 | 0.19 | 0.00 | 6846.99 | 6847.04 | 6847.18 | 0.05 | 6847.23 |
| S20 | 6841.58 | 6842.50 | 0.05 | 0.86 | 6846.92 | 6847.63 | 6847.90 | 0.70 | 6848.60 |
| E1 | 6843.98 | 6844.01 | 0.12 | 0.75 | 6848.63 | 6848.67 | 6849.47 | 0.04 | 6849.51 |
| S15 | 6845.50 | 6846.60 | 0.05 | 0.00 | 6848.48 | 6848.55 | 6848.65 | 0.07 | 6848.72 |
| S13 | 6839.90 | 6840.70 | 0.41 | 0.00 | 6844.44 | 6844.99 | 6844.94 | 0.55 | 6845.49 |
| S11 | 6840.90 | 6841.90 | 0.12 | 0.00 | 6845.15 | 6846.21 | 6845.61 | 1.06 | 6846.67 |
| S12 | 6840.90 | 6842.50 | 0.04 | 0.45 | 6845.78 | 6846.42 | 6845.98 | 0.64 | 6846.62 |
| S10A | 6842.70 | 6843.80 | 0.01 | 0.00 | 6846.44 | 6846.61 | 6846.63 | 0.18 | 6846.81 |
| S10 | 6844.03 | 6846.00 | 0.20 | 0.00 | 6846.81 | 6847.20 | 6847.01 | 0.69 | 6847.70 |
| S17 | 6840.90 | 6841.00 | 0.12 | 0.00 | 6844.53 | 6844.55 | 6844.65 | 0.02 | 6844.67 |
| S30 | 6837.00 | 6838.70 | 0.23 | 0.00 | 6839.97 | 6840.04 | 6840.20 | 0.10 | 6840.30 |
| S31 | 6835.00 | 6837.00 | 0.70 | 0.00 | 6836.97 | 6838.59 | 6838.56 | 1.62 | 6840.18 |

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

---

# Excavation Estimate:

The trench side slope is 1.0 ft/ft
The minimum trench width is 2.00 ft

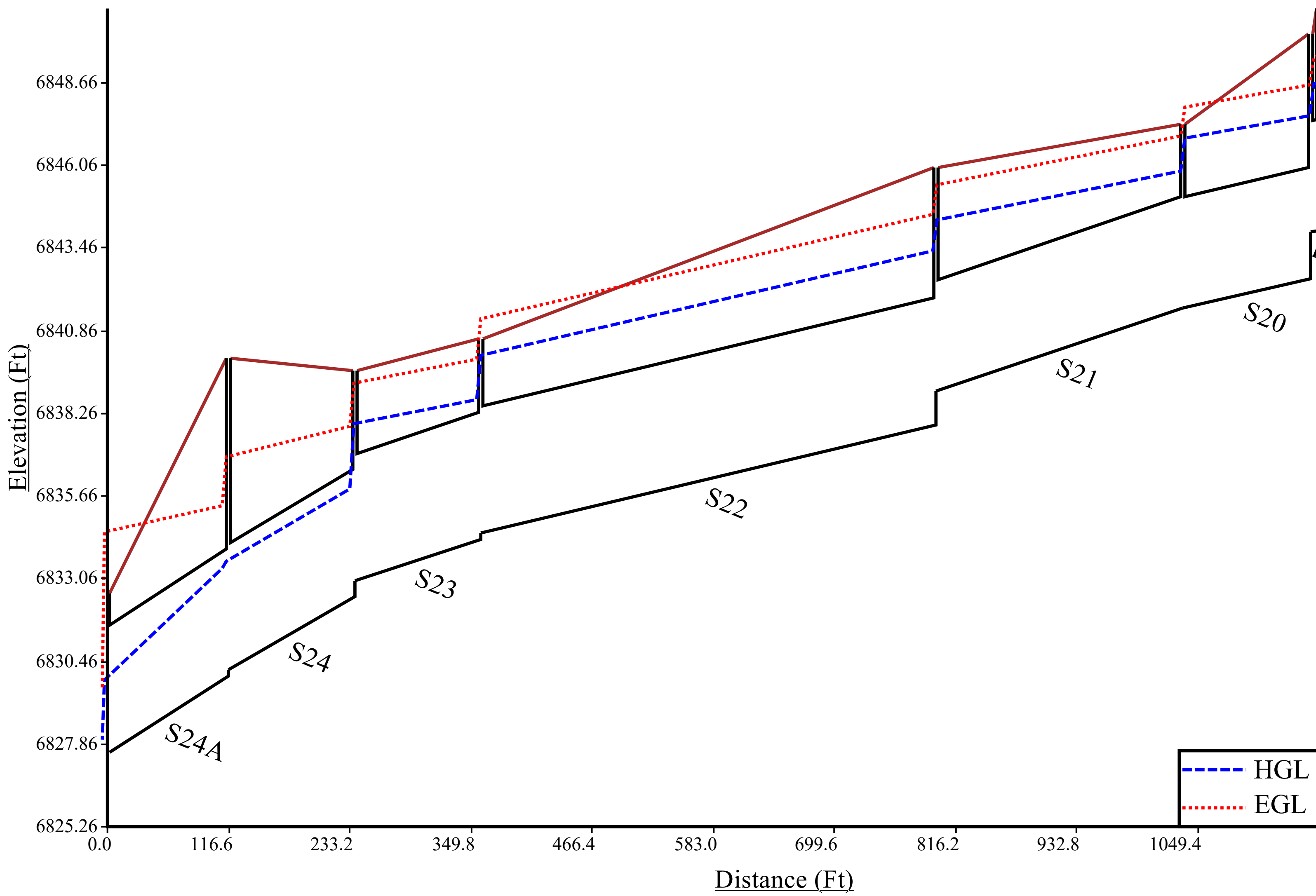
| | | | | | Downstream | | | Upstream | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Element Name** | **Length (ft)** | **Wall (in)** | **Bedding (in)** | **Bottom Width (ft)** | **Top Width (ft)** | **Trench Depth (ft)** | **Cover (ft)** | **Top Width (ft)** | **Trench Depth (ft)** | **Cover (ft)** | **Volume (cu. yd)** | **Comment** |
| S24A | 116.42 | 5.00 | 6.00 | 7.83 | 0.00 | 5.92 | 0.58 | 17.00 | 10.92 | 5.58 | 319.72 | Sewer Too Shallow |
| S24 | 121.78 | 5.00 | 6.00 | 7.83 | 16.60 | 10.72 | 5.38 | 11.22 | 8.03 | 2.69 | 380.90 | |
| S23 | 121.14 | 5.00 | 6.00 | 7.83 | 10.22 | 7.53 | 2.19 | 9.62 | 7.23 | 1.89 | 264.24 | Sewer Too Shallow |
| S22 | 438.12 | 5.00 | 6.00 | 7.83 | 9.22 | 7.03 | 1.69 | 13.20 | 9.02 | 3.68 | 1081.94 | Sewer Too Shallow |
| S21 | 237.58 | 4.50 | 6.00 | 7.25 | 11.57 | 7.91 | 3.16 | 9.06 | 6.66 | 1.91 | 488.63 | Sewer Too Shallow |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S16 | 13.00 | 2.50 | 4.00 | 4.92 | 7.86 | 4.72 | 2.47 | 7.75 | 4.67 | 2.42 | 12.12 | |
| S20 | 123.08 | 4.50 | 6.00 | 7.25 | 9.06 | 6.65 | 1.90 | 12.90 | 8.58 | 3.83 | 271.73 | Sewer Too Shallow |
| E1 | 7.67 | 4.50 | 6.00 | 7.25 | 9.94 | 7.10 | 2.35 | 11.48 | 7.87 | 3.12 | 16.30 | |
| S15 | 22.00 | 2.50 | 4.00 | 4.92 | 8.90 | 5.24 | 2.99 | 4.92 | 2.34 | 0.09 | 16.62 | Sewer Too Shallow |
| S13 | 119.34 | 3.50 | 6.00 | 6.08 | 10.70 | 6.89 | 3.31 | 12.54 | 7.81 | 4.23 | 232.49 | |
| S11 | 186.45 | 3.00 | 4.00 | 5.50 | 12.64 | 7.40 | 4.57 | 6.70 | 4.43 | 1.60 | 270.03 | Sewer Too Shallow |
| S12 | 259.38 | 3.00 | 4.00 | 5.50 | 12.64 | 7.40 | 4.57 | 10.66 | 6.41 | 3.58 | 458.21 | |
| S10A | 73.14 | 3.00 | 4.00 | 5.50 | 10.25 | 6.21 | 3.38 | 6.86 | 4.51 | 1.68 | 88.17 | Sewer Too Shallow |
| S10 | 131.43 | 3.00 | 4.00 | 5.50 | 6.40 | 4.28 | 1.45 | 5.50 | 2.58 | 0.00 | 92.44 | Sewer Too Shallow |
| S17 | 10.00 | 2.50 | 4.00 | 4.92 | 9.70 | 5.64 | 3.39 | 10.50 | 6.04 | 3.79 | 13.14 | |
| S30 | 20.00 | 2.50 | 4.00 | 4.92 | 6.72 | 4.15 | 1.90 | 4.92 | 2.04 | 0.00 | 11.58 | Sewer Too Shallow |
| S31 | 42.20 | 2.50 | 4.00 | 4.92 | 8.72 | 5.15 | 2.90 | 4.92 | 2.04 | 0.00 | 30.46 | Sewer Too Shallow |

**Total earth volume for sewer trenches** = 4049 cubic yards.

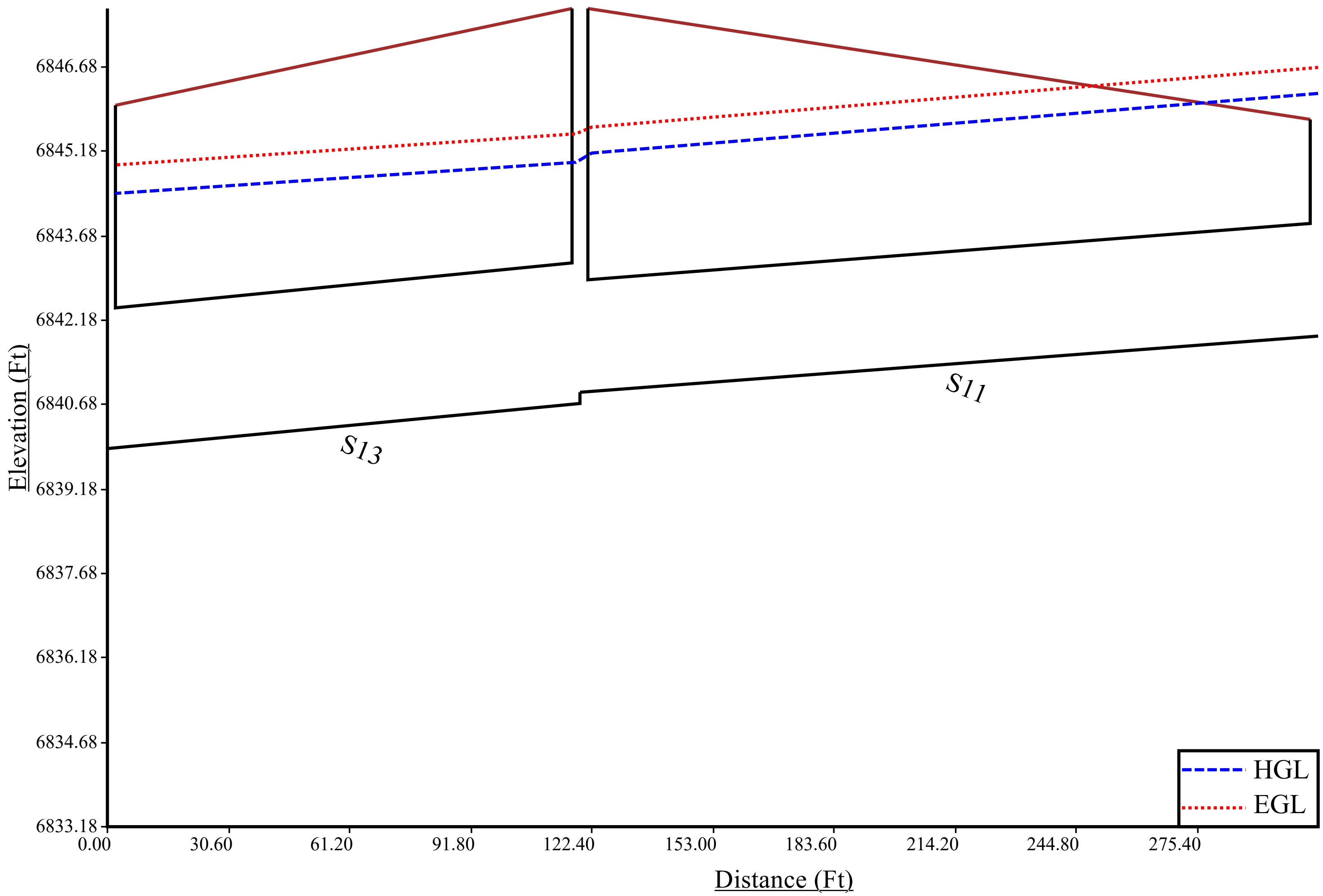
- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.
  - Six inches for pipes less than 60 inches.
  - Eight inches for all larger sizes.

# Storm A

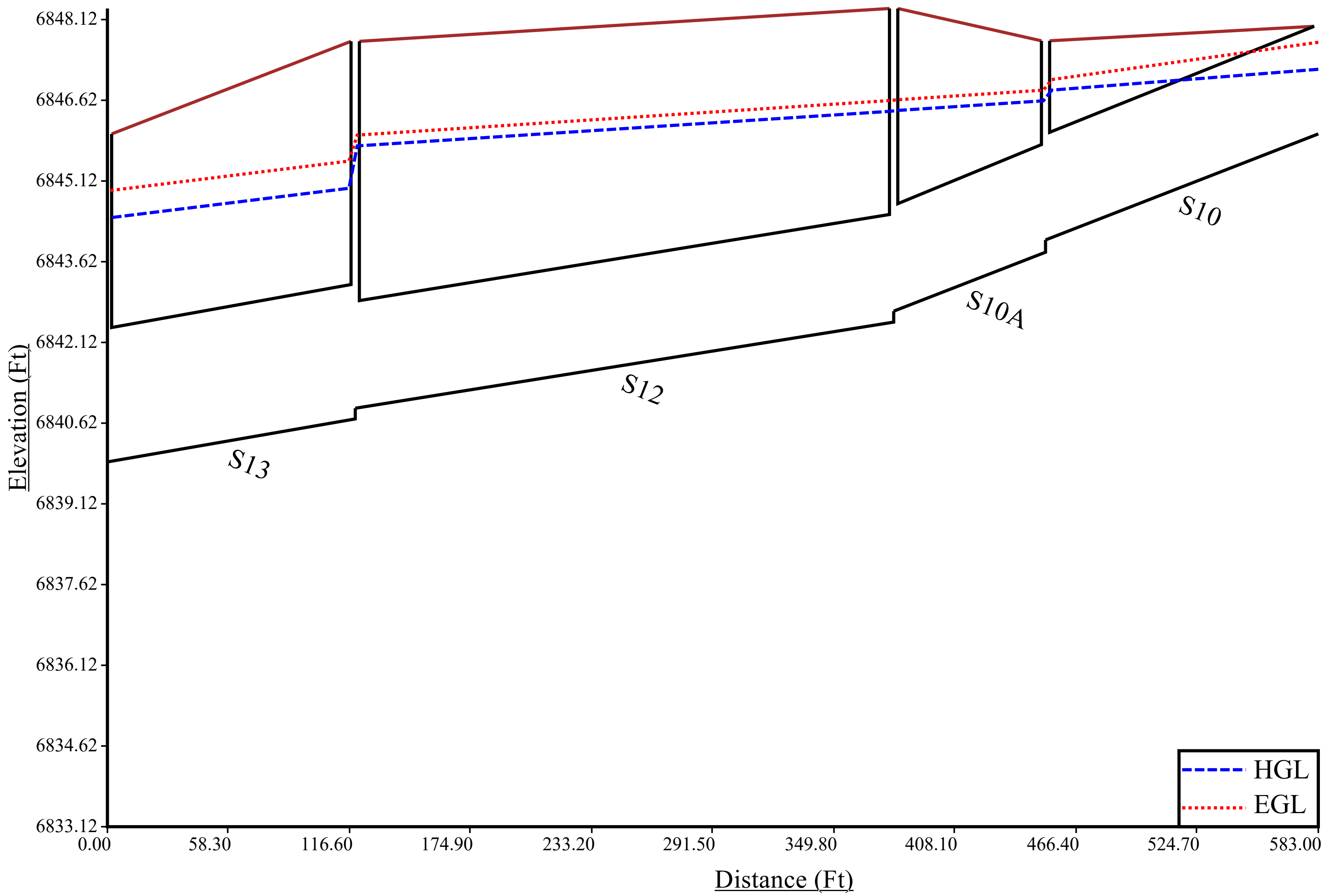


Elevation (Ft)
6848.66
6846.06
6843.46
6840.86
6838.26
6835.66
6833.06
6830.46
6827.86
6825.26
0.0
116.6
233.2
349.8
466.4
583.0
699.6
816.2
932.8
1049.4
Distance (Ft)
S24A
S24
S23
S22
S21
S20
E1
HGL
EGL

# Storm B


Elevation (Ft)
6846.68
6845.18
6843.68
6842.18
6840.68
6839.18
6837.68
6836.18
6834.68
6833.18
0.00
30.60
61.20
91.80
122.40
153.00
183.60
214.20
244.80
275.40
Distance (Ft)
S13
S11
HGL
EGL

# Storm C



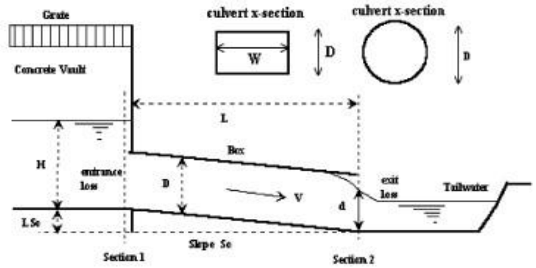
6848.12
6846.62
6845.12
6843.62
6842.12
6840.62
6839.12
6837.62
6836.12
6834.62
6833.12
Elevation (Ft)
S13
S12
S10A
S10
HGL
EGL
0.00
58.30
116.60
174.90
233.20
291.50
349.80
408.10
466.40
524.70
583.00
Distance (Ft)

# CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

*MHFD-Culvert, Version 4.00 (May 2020)*

**Project: U-Haul Falcon**

**ID: Pipe S10 (DP 1) (Q100=11.2cfs)**




Design Information (Input):

| | | | | |
|---|---|---|---|---|
| Circular Culvert: | Barrel Diameter in Inches | D = | 24 | inches |
| | Inlet Edge Type (Choose from pull-down list) | | Grooved Edge Projecting | |
| **OR:** | | | | |
| Box Culvert: | Barrel Height (Rise) in Feet | H (Rise) = | | ft |
| | Barrel Width (Span) in Feet | W (Span) = | | ft |
| | Inlet Edge Type (Choose from pull-down list) | | | |
| | Number of Barrels | # Barrels = | 1 | |
| | Inlet Elevation at Culvert Invert | Elev IN = | 100 | ft |
| | Outlet Elevation **OR** Slope | So = | 0.005 | ft/ft |
| | Culvert Length | L = | 150 | ft |
| | Manning's Roughness | n = | 0.012 | |
| | Bend Loss Coefficient | $K_b$ = | 0 | |
| | Exit Loss Coefficient | $K_x$ = | 1 | |

Design Information (calculated):

| | | |
|---|---|---|
| Entrance Loss Coefficient | $K_e$ = | 0.20 |
| Friction Loss Coefficient | $K_f$ = | 1.58 |
| Sum of All Loss Coefficients | $K_s$ = | 2.78 |
| Minimum Energy Condition Coefficient | $KE_{low}$ = | -0.0028 |
| Orifice Inlet Condition Coefficient | $C_d$ = | 0.67 |

Calculations of Culvert Capacity (output):

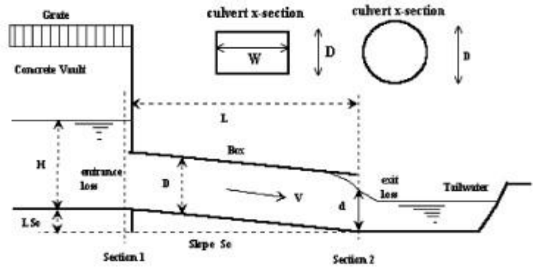
| Headwater Surface Elevation (ft) | Tailwater Surface Elevation (ft) | Inlet Control Equation Used | Inlet Control Flowrate (cfs) | Outlet Control Flowrate (cfs) | Controlling Culvert Flowrate (cfs) | Flow Control Used |
|---|---|---|---|---|---|---|
| 101.50 | 101.00 | Regression Eqn. | 8.64 | 10.70 | **8.64** | INLET |
| 101.60 | 101.00 | Regression Eqn. | 9.71 | 11.72 | **9.71** | INLET |
| 101.70 | 101.00 | Regression Eqn. | 10.74 | 12.66 | **10.74** | INLET |
| 101.80 | 101.00 | Regression Eqn. | 11.82 | 13.53 | **11.82** | INLET |
| 101.90 | 101.00 | Regression Eqn. | 12.91 | 14.35 | **12.91** | INLET |
| 102.00 | 101.00 | Regression Eqn. | 13.97 | 15.13 | **13.97** | INLET |
| 102.10 | 101.00 | Regression Eqn. | 15.01 | 15.87 | **15.01** | INLET |
| 102.20 | 101.00 | Regression Eqn. | 16.01 | 16.58 | **16.01** | INLET |
| 102.30 | 101.00 | Regression Eqn. | 16.94 | 17.25 | **16.94** | INLET |
| 102.40 | 101.00 | Regression Eqn. | 17.85 | 17.83 | **17.83** | OUTLET |
| 102.50 | 101.00 | Regression Eqn. | 18.71 | 18.40 | **18.40** | OUTLET |

Processing Time: **01.34 Seconds**

# CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

*MHFD-Culvert, Version 4.00 (May 2020)*

**Project:** **U-Haul Falcon**
**ID:** **Pipe S30 (Basin L) (Q100=2.6cfs)**




Design Information (Input):

| | | | | |
|---|---|---|---|---|
| Circular Culvert: | Barrel Diameter in Inches | D = | 18 | inches |
| | Inlet Edge Type (Choose from pull-down list) | | Square Edge Projecting | |
| **OR:** | | | | |
| Box Culvert: | Barrel Height (Rise) in Feet | H (Rise) = | | ft |
| | Barrel Width (Span) in Feet | W (Span) = | | ft |
| | Inlet Edge Type (Choose from pull-down list) | | | |
| | Number of Barrels | # Barrels = | 1 | |
| | Inlet Elevation at Culvert Invert | Elev IN = | 100 | ft |
| | Outlet Elevation **OR** Slope | So = | 0.005 | ft/ft |
| | Culvert Length | L = | 150 | ft |
| | Manning's Roughness | n = | 0.012 | |
| | Bend Loss Coefficient | $K_b$ = | 0 | |
| | Exit Loss Coefficient | $K_x$ = | 1 | |

Design Information (calculated):

| | | |
|---|---|---|
| Entrance Loss Coefficient | $K_e$ = | 0.20 |
| Friction Loss Coefficient | $K_f$ = | 2.32 |
| Sum of All Loss Coefficients | $K_s$ = | 3.52 |
| Minimum Energy Condition Coefficient | $KE_{low}$ = | 0.0981 |
| Orifice Inlet Condition Coefficient | $C_d$ = | 0.60 |

Calculations of Culvert Capacity (output):

| Headwater Surface Elevation (ft) | Tailwater Surface Elevation (ft) | Inlet Control Equation Used | Inlet Control Flowrate (cfs) | Outlet Control Flowrate (cfs) | Controlling Culvert Flowrate (cfs) | Flow Control Used |
|---|---|---|---|---|---|---|
| 101.50 | 101.00 | Regression Eqn. | 6.17 | 5.35 | **5.35** | OUTLET |
| 101.60 | 101.00 | Regression Eqn. | 6.73 | 5.86 | **5.86** | OUTLET |
| 101.70 | 101.00 | Regression Eqn. | 7.26 | 6.33 | **6.33** | OUTLET |
| 101.80 | 101.00 | Regression Eqn. | 7.81 | 6.77 | **6.77** | OUTLET |
| 101.90 | 101.00 | Regression Eqn. | 8.26 | 7.18 | **7.18** | OUTLET |
| 102.00 | 101.00 | Regression Eqn. | 8.73 | 7.56 | **7.56** | OUTLET |
| 102.10 | 101.00 | Regression Eqn. | 9.21 | 7.93 | **7.93** | OUTLET |
| 102.20 | 101.00 | Regression Eqn. | 9.61 | 8.29 | **8.29** | OUTLET |
| 102.30 | 101.00 | Regression Eqn. | 10.01 | 8.63 | **8.63** | OUTLET |
| 102.40 | 101.00 | Regression Eqn. | 10.41 | 8.95 | **8.95** | OUTLET |
| 102.50 | 101.00 | Regression Eqn. | 10.81 | 9.27 | **9.27** | OUTLET |

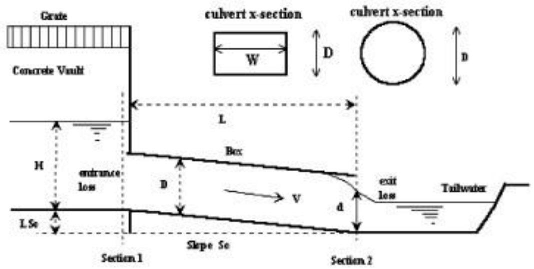
Processing Time: **01.52 Seconds**

# CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

*MHFD-Culvert, Version 4.00 (May 2020)*

**Project: U-Haul Falcon**

**ID: Pipe S31 (Basin K) (Q100=8.6cfs)**




Design Information (Input):

| | | | | |
|---|---|---|---|---|
| Circular Culvert: | Barrel Diameter in Inches | D = | 18 | inches |
| | Inlet Edge Type (Choose from pull-down list) | Square Edge Projecting | | |
| **OR:** | | | | |
| Box Culvert: | Barrel Height (Rise) in Feet | H (Rise) = | | ft |
| | Barrel Width (Span) in Feet | W (Span) = | | ft |
| | Inlet Edge Type (Choose from pull-down list) | | | |
| | Number of Barrels | # Barrels = | 1 | |
| | Inlet Elevation at Culvert Invert | Elev IN = | 100 | ft |
| | Outlet Elevation **OR** Slope | So = | 0.005 | ft/ft |
| | Culvert Length | L = | 150 | ft |
| | Manning's Roughness | n = | 0.012 | |
| | Bend Loss Coefficient | $K_b$ = | 0 | |
| | Exit Loss Coefficient | $K_x$ = | 1 | |

Design Information (calculated):

| | | |
|---|---|---|
| Entrance Loss Coefficient | $K_e$ = | 0.20 |
| Friction Loss Coefficient | $K_f$ = | 2.32 |
| Sum of All Loss Coefficients | $K_s$ = | 3.52 |
| Minimum Energy Condition Coefficient | $KE_{low}$ = | 0.0981 |
| Orifice Inlet Condition Coefficient | $C_d$ = | 0.60 |

Calculations of Culvert Capacity (output):

| Headwater Surface Elevation (ft) | Tailwater Surface Elevation (ft) | Inlet Control Equation Used | Inlet Control Flowrate (cfs) | Outlet Control Flowrate (cfs) | Controlling Culvert Flowrate (cfs) | Flow Control Used |
|---|---|---|---|---|---|---|
| 101.50 | 101.00 | Regression Eqn. | 6.17 | 5.35 | **5.35** | OUTLET |
| 101.60 | 101.00 | Regression Eqn. | 6.73 | 5.86 | **5.86** | OUTLET |
| 101.70 | 101.00 | Regression Eqn. | 7.26 | 6.33 | **6.33** | OUTLET |
| 101.80 | 101.00 | Regression Eqn. | 7.81 | 6.77 | **6.77** | OUTLET |
| 101.90 | 101.00 | Regression Eqn. | 8.26 | 7.18 | **7.18** | OUTLET |
| 102.00 | 101.00 | Regression Eqn. | 8.73 | 7.56 | **7.56** | OUTLET |
| 102.10 | 101.00 | Regression Eqn. | 9.21 | 7.93 | **7.93** | OUTLET |
| 102.20 | 101.00 | Regression Eqn. | 9.61 | 8.29 | **8.29** | OUTLET |
| 102.30 | 101.00 | Regression Eqn. | 10.01 | 8.63 | **8.63** | OUTLET |
| 102.40 | 101.00 | Regression Eqn. | 10.41 | 8.95 | **8.95** | OUTLET |
| 102.50 | 101.00 | Regression Eqn. | 10.81 | 9.27 | **9.27** | OUTLET |

Processing Time: **01.52 Seconds**

U-Haul at Falcon
Forebay and Trickle Channel Calculations

## Presedementation / Forebay Sizing

| Forebay | 100 Yr Flow | Detention WQCV | Total Req'd Forebay Vol 3.0% WQCV | Tributary Area | % Total Trib Area | Required Forebay Volume | Forebay Design Area | Forebay Design Depth | Forebay Design Volume | Discharge Design Flow 2.0% 100yr | Calc'd Open Width (1" min) | **Design Width** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 125.7cfs | 427,751cf | 12,833cf | 28.46ac | 1.2% | 158cf | 470sf | 2.00-ft | 940 cf | 2.51 cfs | 8.4-inch | **8.0-inch** |
| 2 | | | | 2284ac | 98.8% | 12,675cf | | | 0 cf | 0.00 cfs | #DIV/0! | |
| 3 | | | | | 0.0% | --- | | | --- | --- | --- | |
| Totals | | 427,751cf | 12,833cf | 2313ac | 100.0% | | | | | | | |

Opening Width Equation for Rectangular Opening

L = Q / $(CH^{1.5})$ x 12 + 0.2xHx12 (UD-BMP Spreadsheet -- EDB tab)

C = 3.0

## Trickle Channel Calculation

| Location | 100yr Flow | Req'd Flow 1.0% 100yr | Bottom Width | Flow Depth | Side Slope | Slope | Manning 'n' | Top Width | Flow Area | Wetted Perimeter | Hydraulic Radius | Flow Velocity | **Capacity** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 125.7cfs | 1.3cfs | 6.0 ft | 0.50 ft | 0.0:1 | 0.5% | 0.013 | 6.0 ft | 3.00 sf | 7.0 ft | 0.43 ft | 4.6 ft/sec | **13.8 cfs** |

Equations:

Area (A) = $b(d)+zd^2$
b = width
d = depth

Perimeter (P) = $b+2d*(1+z^2)^{0.5}$
z = side slope
Hydraulic Radius = A/P

Velocity = $(1.49/n)R_n^{2/3} S^{1/2}$
S = Slope of the channel
n = Manning's number
$R_n$ = Hydraulic Radius (Reynold's Number)

Flow = $(1.49/n)AR_n^{2/3} S^{1/2}$

# APPENDIX D

**Pages from Relevant Previous Studies**

**Falcon Highlands Market Place Flg No. 1 FDR**
**Market Place Flg No. 2 Final Drainage Letter**
**Bent Grass Development MDDP & DBPS Amendment**
**Falcon Drainage Basin Planning Study**

# FALCON HIGHLANDS
# MARKET PLACE FILING NO. 1
# PRELIMINARY AND
# FINAL DRAINAGE REPORT
# EL PASO COUNTY, COLORADO

**December 22, 2005**

PREPARED FOR:

Falcon Highlands Metropolitan District
24 N. Tejon St
Colorado Springs, CO 80903

And

Regency Centers
1873 South Bellaire St, Suite 600
Denver, CO 80222


PREPARED BY:

URS

9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
719.531.0001


URS PROJECT NO. 21711426

- Basin D-22 ( 1.28 acres) includes the west half of Foxtail Meadow Lane. The flow from this basin will cross Foxtail Meadow Lane to the proposed sump inlet (Design Point 21) in Rolling Thunder Way. The basin generates 4.1 cfs and 7.4 cfs for the 5-year and 100-year storms.

- Basin D-31 (00.32 acres) includes the north portion of Rolling Thunder Way between Foxtail Meadow Lane and the West Tributary Channel. The flow of this basin will be through curb and gutter to the existing sump inlet on Rolling Thunder Way at the channel. The flow from this basin was used in the design of the inlet in the Falcon Highlands MDDP/FDR. The inlet was designed for a flow of 2.2 cfs and 4.6 cfs for the 5-year and 100-year storms. The basin now produces 0.5 cfs and 1.2 cfs for the 5-year and 100-year storms. An on-grade inlet will intercept a portion of this flow prior to it reaching the existing sump inlet on Rolling Thunder Way at the West Tributary Channel. The flow-by from the inlet will continue as street flow to the existing inlet.

- Basin D-23 (12.92 acres) includes the proposed commercial development east of Foxtail Meadow Lane, south of Woodmen Road and north of Shopping Center Drive. Runoff from this basin is intercepted by an internal storm system, which will connect to the proposed storm system in Foxtail Meadow Lane by a 36" rcp stub at inlet DP-19. This basin produces 43.6 cfs and 82.0 cfs for the 5-year and 100-year storm.

- Basin D-24 (17.64 acres) consists of commercial development just south of Woodmen Road and west of the realigned Meridian Road. Runoff for this basin flows west/southwest, where it will cross under Meridian Road through the proposed 8x8 RCBC, which discharges directly into detention pond MN. Runoff from this basin is 74.1 cfs and 139.3 cfs for the 5-year and 100-year storms. A 48" rcp stub will connect the internal storm system from this basin, to the 8x8 box culvert at Meridian Road.

- Basin D-25 (4.10 acres) is a commercial development area east of Basin D-19, south of Basin D-24 and west of Meridian Road. Runoff flows south where it combines at design point 11, to pass through a 42" rcp stub under Rolling Thunder Way. Basin D-25 generates 15.8 cfs and 29.8 cfs for the 5-year and 100-year storms.

- Basin D-26 (1.42 acres) is the east half of Foxtail Meadow Lane and the north half of Rolling Thunder Way between Foxtail Meadow Lane and Meridian Road. A sump curb inlet at design point 21 will collect the runoff from this basin. Basin D-26 generates 4.3 cfs and 8.0 cfs for the 5-year and 100-year storms. Flowby from this inlet will overtop the crown and cross over to the sump inlet at design point 22 during the 100-year storm.

- Basin D-27 (0.86 acres) is the south half of Rolling Thunder Way between Foxtail Meadow Lane and Meridian Road. Runoff from this basin will be carried as gutter flow and intercepted by a sump curb inlet at design point 22. This basin generates 3.3 cfs and 6.3 cfs for the 5-year and 100-year storms.

- Basin D-28 (0.47 acres) is the south half of Rolling Thunder Way between Foxtail Meadow Lane and the West Tributary Channel. Curb and gutter conveys this flow to an existing sump inlet on Rolling Thunder Way at the West Tributary Channel. An at-grade inlet will be installed to intercept a portion of these flows. The flow-by will continue to the existing sump inlet in Rolling Thunder Way via curb and gutter. From the Falcon Highlands MDDP/FDR, the existing inlet was designed to intercept 4.8 cfs and 8.2 cfs for the 5-year and 100-year storms from this basin. Basin D-28 generates 1.7 cfs and 3.2 cfs for the 5-year and 100-year storms. The existing inlet is adequately sized for these flows.

U-Haul Site

- Basin D-29 (11.14 acres) is a proposed commercial development south of the proposed Rolling Thunder Way and between Meridian Road and the West Tributary Channel. Runoff in this basin flows towards the south and discharges directly into the West Tributary Channel upstream of Tamlin Road and detention pond WU. This basin generates 28.4 cfs and 53.4 cfs for the 5-year and 100-year storms.

- Basin D-30 (9.41 acres) consists of an undeveloped native area just east and south of the Falcon Highlands detention pond (Pond WU). Runoff from this basin combines with flows from design point 18 and the detention pond outlet and crosses under US Highway 24 through existing culverts at design point 25. Basin D-30 generates 12.1 cfs and 27.8 cfs for the 5-year and 100-year storms.

- Basin Offsite (13.96 acres) consists of an area north east of existing Meridian and McLaughlin Roads in the "Town of Falcon". The flow from this basin will be directed towards the intersection of SH 24 and Meridian Road, where it is then conveyed under an existing culvert under "old" Meridian Road. This flow will be directed towards the proposed structure at Design Point 17. The basin generates 16.4 cfs and 37.5 cfs for the 5-year and 100-year storms.

***Design Point Discussion***

- Design Point 1 ($Q_5$=7.1 cfs, $Q_{100}$=13.2 cfs) includes Basin D-1. This flow will be intercepted by a sump inlet, which connects directly to the 8x8 rcbc parallel to Meridian Road. This inlet will be included in the internal plans for the commercial development.

- Design Point 2 ($Q_5$=6.8 cfs, $Q_{100}$=12.6 cfs) includes Basin D-2. A 15' at-grade inlet, to keep flows from entering the Beckett at Woodmen Hills Filing No. 3 site, intercepts flow at this design point. This flow will be released directly into detention pond MN.

- Design Point 3 ($Q_5$=6.0 cfs, $Q_{100}$=11.1 cfs) contains Basin D-4. This design point is a 10' sump inlet, which intercepts the curb and gutter flow. This inlet will connect with design point DP-5 through an 18" rcp.

- Design Point 5 ($Q_5$=6.4 cfs, $Q_{100}$=11.7 cfs) contains Basin D-5. This design point is a 10' sump inlet, which intercepts curb and gutter flow along the east side of Meridian Road. The outflow at this point is 22.8 cfs, the combined intercepted flows from DP-3 and DP-5. This flow is released directly into detention pond MN through an 18" rcp.

- Design Point 6 ($Q_5$=9.4 cfs, $Q_{100}$=17.4 cfs) contains Basin D-7. A 15' on-grade inlet will intercept curb and gutter flow. This deisgn point will release through an 18" rcp into a temporary roadside ditch along the north side of Rolling Thunder Way.

- Design Point 7 ($Q_5$=40.8 cfs, $Q_{100}$=76.5 cfs) contains Basin D-16 and flow-by from Inlet DP-6. This design point collects curb and gutter flow along the east side of Meridian Road from the access point south to Rolling Thunder Way. An existing temporary culvert is located at this design point to intercept the street flow from D-7 and the sheet/channel flow from D-16 and convey the flow under the existing section of Rolling Thunder Way.

- Design Point 10 ($Q_5$=9.5 cfs, $Q_{100}$=17.5 cfs) contains Basin D-6. This design point collects the curb and gutter flow along the west side of Meridian Road, between the access point and Rolling Thunder Way. A 15' on-grade inlet will collect the majority of this flow just upstream of Rolling Thunder Way and will be piped to Design Point 21 via an 18" rcp. The by-pass flow will continue as curb and gutter flow west along Rolling Thunder Way, where the sump inlet at Design Point 21 will intercept it.

- Design Point 11 ($Q_5$=38.7 cfs, $Q_{100}$=71.4 cfs) contains Basins D-19 and D-25. This design point is a 42" rcp stub used to temporarily intercept the flow from these two basins. The stub will connect to the proposed sump inlet in Rolling Thunder Way at design point 21. Once these basins develop, an internal storm system will need to be designed to convey the developed flow.

- Design Point 13 ($Q_5$=9.4 cfs, $Q_{100}$=17.2 cfs) contains Basin D-12. This flow combines with the flow from the temporary culvert at design point 7. A temporary vegetated v-ditch conveys the flow to design point 17, until further development occurs.

- Design Point 14 ($Q_5$=9.2 cfs, $Q_{100}$=17.0 cfs) contains Basin D-11. This design point collects curb and gutter flow along the west side of Meridian Road between Rolling Thunder Way and the access point north of Highway 24. This flow will release directly into the water quality area of the West Tributary Channel.

- Design Point 15 ($Q_5$=10.6 cfs, $Q_{100}$=19.6 cfs) contains Basin D-15. This design point collects curb and gutter flow along the east side of Meridian Road between the access point north of Highway 24 to Highway 24. This flow is intercepted by a 20' sump inlet, which connects to the box culvert crossing under Meridian Road, just north of Highway 24.

- Design Point 16 ($Q_5$=11.7 cfs, $Q_{100}$=21.5 cfs) contains Basin D-14. This design point is a 25' sump inlet, which collects the street flow between an access drive and Highway 24. A 24" rcp will connect this inlet to the proposed box culvert under Meridian Road.

- Design Point 17 ($Q_5$=157.9 cfs, $Q_{100}$=300.6 cfs) combines flow from design points 7 and 13 and flow from Basin D-17 and Basin Offsite. A 12'(w) x 3' (h) reinforced concrete box will convey this flow under Meridian Road to the west, where the flow combines with the intercepted street flow from the sump inlets at design points 15 and 16.

- Design Point 18 ($Q_5$=181.2 cfs, $Q_{100}$=345.5 cfs) combines the culvert flow from design point 17 with the intercepted street flow from design points 15 and 16. At this location, a channel is graded to convey this flow to design point 25 at Highway 24, where the flow exits the Falcon Highlands development area under an existing bridge.

- Design Point 19 ($Q_5$=3.6 cfs, $Q_{100}$=6.7 cfs) is the street flow from Foxtail Meadow Lane between Woodmen Road and Shopping Center Drive. A 5' at-grade inlet intercepts 0.4 cfs for the 5 and 100-year storms. The remaining flow will continue as street flow to design point 21. The inlet flow combines with the flow from Basin D-23 and in conveyed through a 36" rcp storm system in Foxtail Meadow Lane and Rolling Thunder Way to the West Tributary Channel.

- Design Point 20 ($Q_5$=74.2 cfs, $Q_{100}$=136.9 cfs) contains Basin D-24. Currently, this flow will continue through natural drainage swales, but upon development, an internal storm system will connect to a proposed 42" rcp stub, which connects to the major storm system (8x8 box culverts) along the west side of Meridian Road.

- Design Point 21 ($Q_5$=10.2 cfs, $Q_{100}$=12.3 cfs) combines curb and gutter flow from Basins D-21 and D-26 with the street flow from design points 10 and 19. A 25' sump inlet will intercept this flow. The 100-year flow will overtop the crown and will be intercepted by the inlet at design point 22. The inlet will connect to the sump inlet at design point 22 through a 42" rcp.

- Design Point 22 ($Q_5$=3.3 cfs, $Q_{100}$=6.1 cfs) contains curb and gutter flow from Basin D-27 and 100-year overtopping flow from inlet DP-21. A 5' sump inlet intercepts the flow. A 42" rcp will continue to design point 23.

- Design Point 23 ($Q_5$=39.2 cfs, $Q_{100}$=72.2 cfs) combines the intercepted flows from design points 11, 21 and 22. A temporary 42" rcp stub will release the flow onto Basin D-29, where a temporary swale will continue to carry the flow until the channel matches existing ground. At this point, the flow will continue as sheet flow until it reaches the West Tributary Channel. Upon development of Basin D-29, an internal storm conveyance system will be designed to carry this flow, which will also release into the West Tributary Channel. The temporary stub and channel can be removed once the storm system is built.

- Design Point 25 ($Q_5$=221.91 cfs, $Q_{100}$=1479.1 cfs) combines Basin D-30 with flows from design points 14, 18 and detention pond WU. This is where the flow leaves the Falcon Highlands development via the existing bridge at Highway 24.

- Design Point 26 ($Q_5$=160.9 cfs, $Q_{100}$=788.5) combines the intercepted street flow of design points 2, 3 and 5 with the flow from design point 20 and pipe flow from off-site points MN1 and MN2. This flow is released directly into Pond MN through an 8x8 RCBC and two sets of 18" rcp's.

***Proposed Storm System Improvements***

All of the proposed inlets, pipes and ditches were analyzed using StormCad, Culvert Master and Flow Master programs. Calculations for the proposed culvert improvements can be found in Appendix I: Proposed Culvert Improvements.

The proposed systems will be sized to collect and convey the estimated 100-year runoff. The 8x8 RCBC's will convey flow from design points MN1 ($Q_{100}$=454.0 cfs) and MN2 ($Q_{100}$=363.1 cfs) to detention pond MN. The DBPS amendment also addresses this change from the approved Falcon Area DBPS. One 10-foot CDOT Type-R curb inlet in sump condition will be installed at DP-3 and at DP-5. An 18-inch rcp is used to connect the inlets at DP-3 and DP-5. The storm system discharges into detention pond MN with an estimated flow of 12.0 cfs for the 100-year storm.

A new 8x8 box culvert/trail crossing will be installed at station 32+50, paralleling the 8x8 storm system, and both will outfall into the detention pond east of Meridian Road. These culverts were previously designed in the CLOMR for the Middle Tributary of the Falcon Basin, prepared by URS Corporation in January 2005. This box will also serve as the conveyance system for the flow in the proposed overflow swale on top of the box storm drain system. Also, it will convey the minor surface flow not intercepted by the internal storm system in Basin D-24, which is approximately 15 cfs for the 5-year and 28 cfs for the 100-year storms.

One 10-foot CDOT Type-R curb inlet in sump conditions will be installed at DP-1. This inlet will release directly into the 8x8 RCBC along the west side of Meridian Road.

A 10-foot CDOT Type-R at-grade curb inlet will be constructed at DP-2. This inlet will intercept 4.5 cfs and 7.4 cfs for the 5 and 100-year storms. An 18" rcp will deliver these flows directly into detention pond MN.

DP-19 is a 5-foot at-grade CDOT Type-R curb inlet, which will intercept 0.4 cfs for the 5 and 100-year storms. A 36-inch rcp stub collects the flow Basin D-23 and connects to the back of the inlet. This combined flow (DP-19 and D-23) continues through a 36-inch rcp in Foxtail Meadow Lane and Rolling Thunder Way to the existing box culvert in the West Tributary Channel. This system releases approximately 49.2 cfs into the channel.

A storm drain system is designed for flows at Rolling Thunder Way. This system connects 2 sump inlets in Rolling Thunder Way. Design point 11 is a 42" rcp stub, which will be used to intercept the sheet flow from basins D-19 and D-25. Flow from design point 10 will be directed toward the sump inlet at design point 21. Design point 23 will be a temporary outlet point for the combined flows of design points 11, 21 and 22. This flow will be conveyed through a temporary vegetated channel, west to the West Tributary Channel, through Basin D-29 until development occurs in this area.

DP-15 and DP-16 are both 20' sump inlets (CDOT Type-R), which intercepts the street flow from Meridian Road just north of Highway 24. Both inlets connect to the proposed box culvert (DP-17) under Meridian Road, via 24-inch rcp's. The proposed drainage structure at DP-17 will be a 12-foot (W) by 3-foot (H) reinforced concrete box culvert. Using the criteria stated in the DCM, the maximum allowable HW/D for this structure is 1.2, which correlates to an elevation of 6815.40. Calculations for the new pipes have been provided in Appendix I.

### *Channel Improvements*

The overflow swale on the south side of Woodmen Road is designed to carry a flow of 605 cfs, in the event the major storm structure should fail. The swale is a 25-foot trapezoidal channel with a flow depth of 1.92 feet and a velocity of 8.6 feet per second (fps). This swale will release into the 8 x 8 trail box under Meridian Road and will be conveyed to detention pond MN.

The roadside ditch along Basin D-12 is located east of Meridian Road from the right-in access point south to Highway 24. The ditch will carry the 100-year storm (17.2 cfs) at a depth of 0.85 feet to DP-17. The velocity in this channel is 3.94 fps.

The temporary channel from DP-23 has a 100-year flow of 200 cfs from the proposed storm system. The channel will be trapezoidal with a 50-foot bottom and 4 to 1 side slopes. The velocity of the channel is 3.61 fps with a flow depth of 1.02 feet. This channel will be graded out to match existing grade. Upon development of Basin D-29, this channel will be removed and the flow will be intercepted by an internal storm system.

A temporary roadside will carry the intercepted flow from Design Point 6 to the temporary culvert under Rolling Thunder Way. The v-ditch channel will carry a flow of 17 cfs at a depth of 1.0 feet and a velocity of 3.8 ft/s.

## *DRAINAGE FACILITY DESIGN*

### *General Concept*

The area south of Woodmen Road, which includes the proposed Market Place site and Meridian Road, is either routed to detention pond WU in Falcon Highlands or detention pond MN, east of the realigned Meridian Road. Flow from each of these ponds continues south, crossing under US Highway 24 and Falcon Highway, until they combine at design point WX. Pond WU was designed as part of the Falcon Highlands MDDP/PDR/FDR for Filing 1 by URS dated January 21, 2005. Detention pond MN is approximately 14.0

acre-feet with a maximum water surface elevation of 6852.80. Discharge will be through 2- 8x4 RCBC, which will release into an existing channel to US Highway 24.

Detention pond WU and the West Tributary channel were designed in the MDDP/PDR/FDR for Falcon Highlands Filing No. 2. Each of these facilities were designed based on SCS HEC-1 flows. Both of these are located within the Falcon Basin West Tributary and all basins within the current development were accounted for in the MDDP/PDR/FDR design of these structures. The HEC-1 run for the West Tributary of the Falcon Basin is included in Appendix D.

Under existing conditions, there are 6 drainage basins, 5 of which contribute to the West Tributary Channel/Pond WU and the remaining basin flows towards McLaughlin Road. (See Figure 5:Existing Drainage Plan) Currently, there are no drainage structures within any of the 6 basins. Flow is conveyed through natural, vegetated swales and channels.

In the proposed conditions, 6 of the rational basins contribute to detention pond MN, with all the remaining basins releasing into the West Tributary Channel or detention pond WU. At design point MN1 and MN2, a major storm sewer system has been designed to intercept flows from the existing culverts at Woodmen Road and deliver it to Pond MN. This allows the proposed 8x8 RCBC under Meridian Road to serve as a trail crossing and to carry only the surface runoff not intercepted by the internal storm system from Basin D-24. An internal storm system is being designed, thereby decreasing the initial flows for the trail crossing at this location. Pond MN will also receive intercepted curb and gutter flow from Basins D-1, D-2, D-4 and D-5.

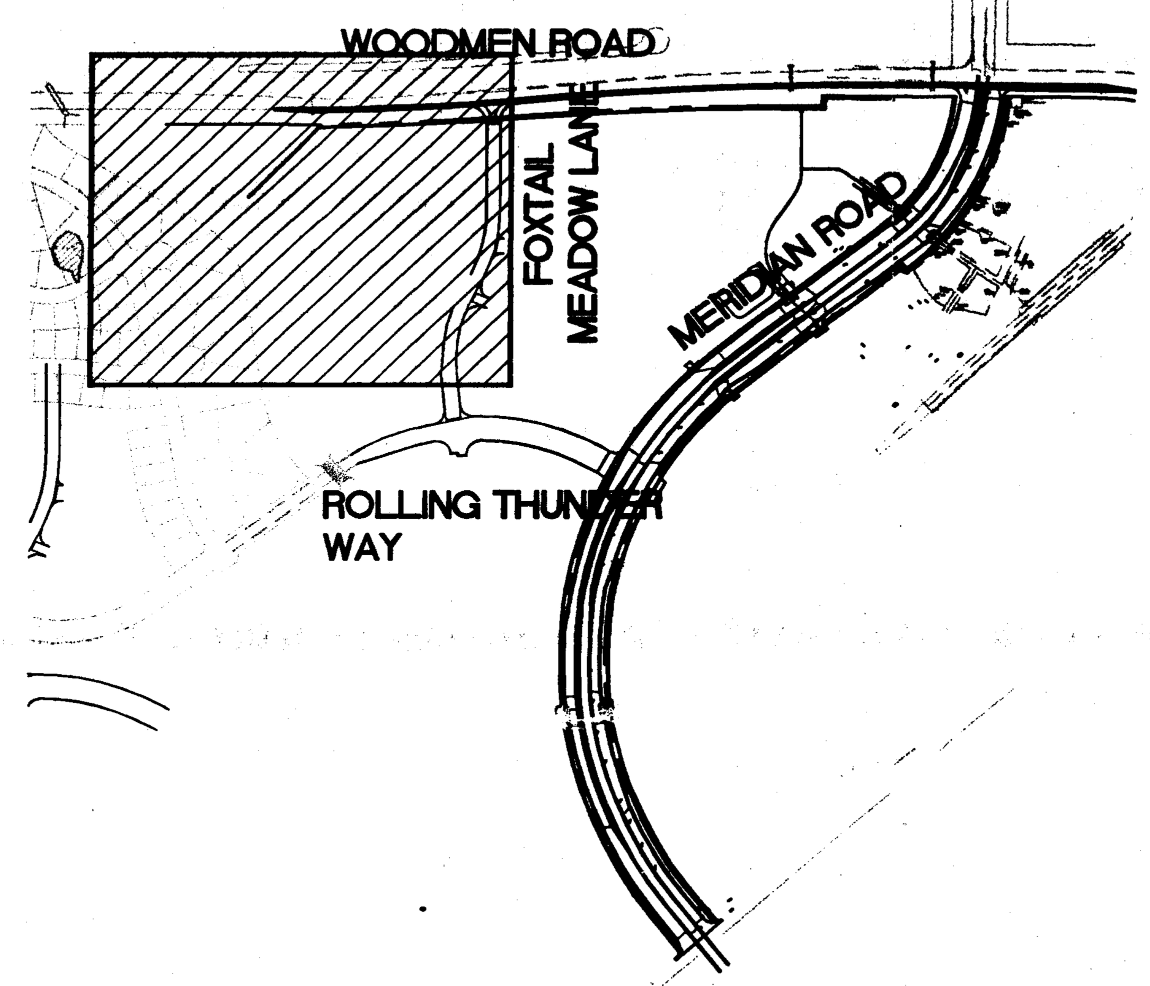
The remainder of Meridian Road will convey flow through curb and gutter, and minor storm systems, which eventually discharge into the West Tributary Channel at various locations. The future commercial and multi-family developments will be overlot graded so that they will drain towards the West Tributary Channel. Upon development of these areas, internal storm drain systems will need to be designed. These systems, will also release into the West Tributary Channel.

**Detention Pond MN**

The Falcon Basin DBPS provided the initial precipitation data, basin delineation, CN runoff coefficients and times of concentration. The original data was processed using HEC-1 software. For this report, the data was converted to the HEC-HMS software. Other than the incorrect input for Pond W, the existing HEC-HMS used the same data in the HEC-1 analysis. Only Basin D-23 changed for the proposed condition: it has been divided into 2 basins, 23A and 23B, due to the realignment of Meridian Road, and the CN value has changed from undeveloped (60) conditions to commercial (92).

It was determined that detention pond MN is approximately 14.0 acre-feet. The existing flows at this location are 63.8 cfs and 628.3 cfs for the 5-year and 100-year storms. The developed flows entering the pond are $Q_5$=94.4 cfs and $Q_{100}$=646.0 cfs (Design Point MO in the HEC-HMS analysis). With the current outlet design, Pond MN releases flows of 46.1 cfs (72% of existing) and 459.9 cfs (73% of existing) for the 5-year and 100-year storms. The current design of Pond MN differs from that in the Falcon DBPS because the location of the pond has moved. Prior, the pond was to be located on the west side of

# *DEVELOPED DRAINAGE PLAN – FALCON HIGHLANDS MARKET PLACE FILING NO. 1*




***KEY MAP***
*N.T.S.*

***LEGEND***

| | |
| --- | --- |
| D-25 / AREA / Q5 Q100 | BASIN DATA |
| 12 | DESIGN POINT |
| *HP* | ROAD HIGH POINT |
| *LP* | ROAD LOW POINT |
| 1.2% | ROAD GRADE |
| | BASIN BOUNDARY |
| | FLOW PATH |
| | EX. 10' CONTOUR |
| | EX. 2' CONTOUR |
| | PR 10' CONTOUR |
| | PR 2' CONTOUR |
| | WEST TRIBUTARY FLOODPLAIN (LOMR SUBMITTAL–AWAITING APPROVAL) |
| | MIDDLE TRIBUTARY FLOODPLAIN (CLOMR SUBMITTAL–APPROVED MAY 2005) |
| | EXISTING WETLANDS |

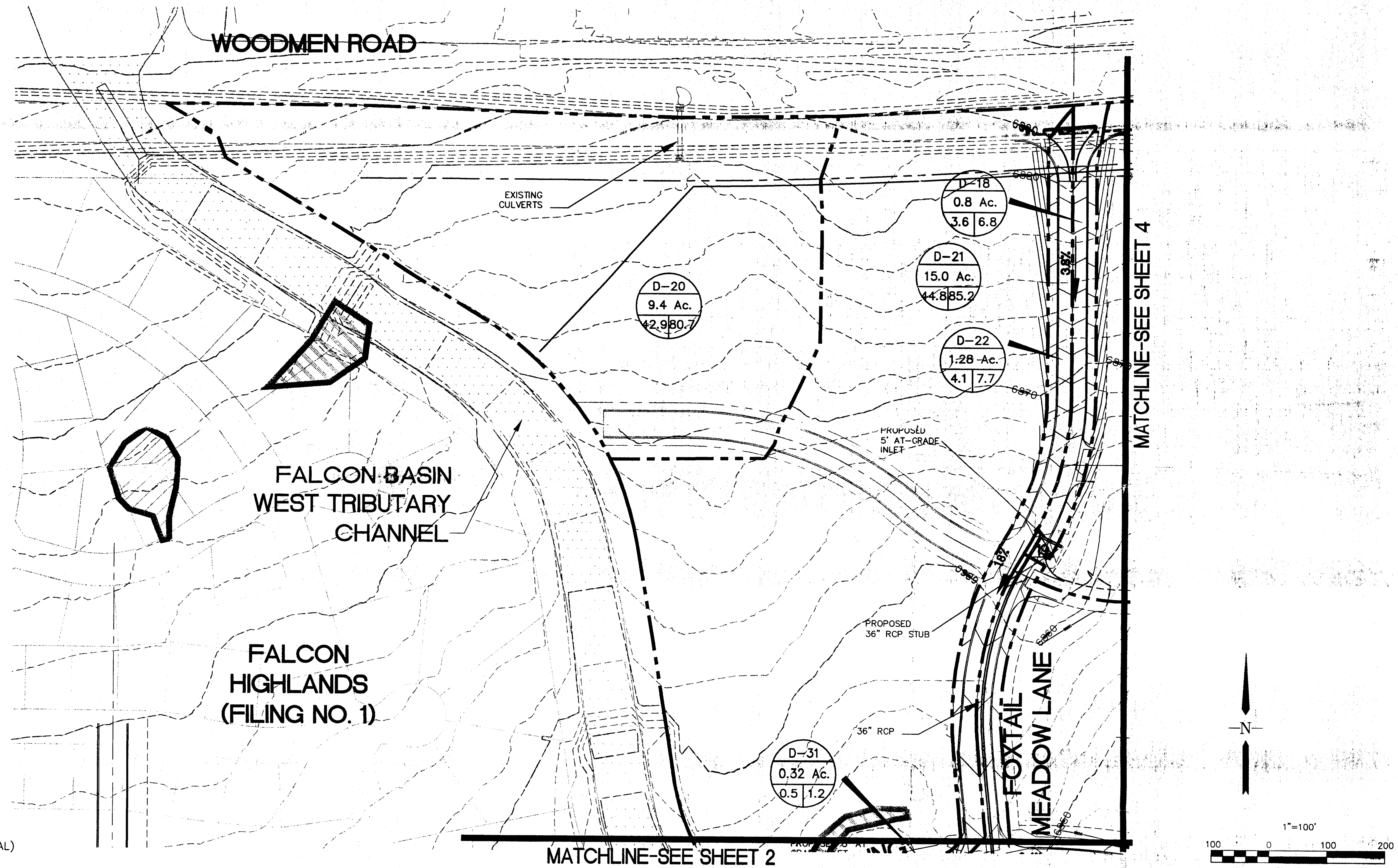



**FIGURE 6**

| REVISIONS: | | |
| --- | --- | --- |
| NO. | DESCRIPTION | DATE |

ENGINEER:
DESIGNED BY: CMS DATE: 8/9/05
DRAWN BY: CMS DATE: 8/9/05
CHECKED BY: XXX DATE: XX/XX/XX

48 HOURS BEFORE YOU DIG, CALL UTILITY LOCATORS
1-800-922-1987
(SEE COVER FOR LIST OF UTILITY CONTACTS)


**URS**
9960 FEDERAL DRIVE #300
COLORADO SPRINGS, COLORADO 80921
PHONE: (719) 531-0001
FAX: (719) 531-0007


PROJECT F.H. MARKET PLACE – PDR/FDR
SHEET TITLE DEVELOPED DRAINAGE PLAN
FROM ______ TO ______
JOB NO. 21711426 SHEET 1 OF 4

# DEVELOPED DRAINAGE PLAN – FALCON HIGHLANDS MARKET PLACE FILING NO. 1


**FIGURE 6**

| REVISIONS: | | |
|---|---|---|
| NO. | DESCRIPTION | DATE |

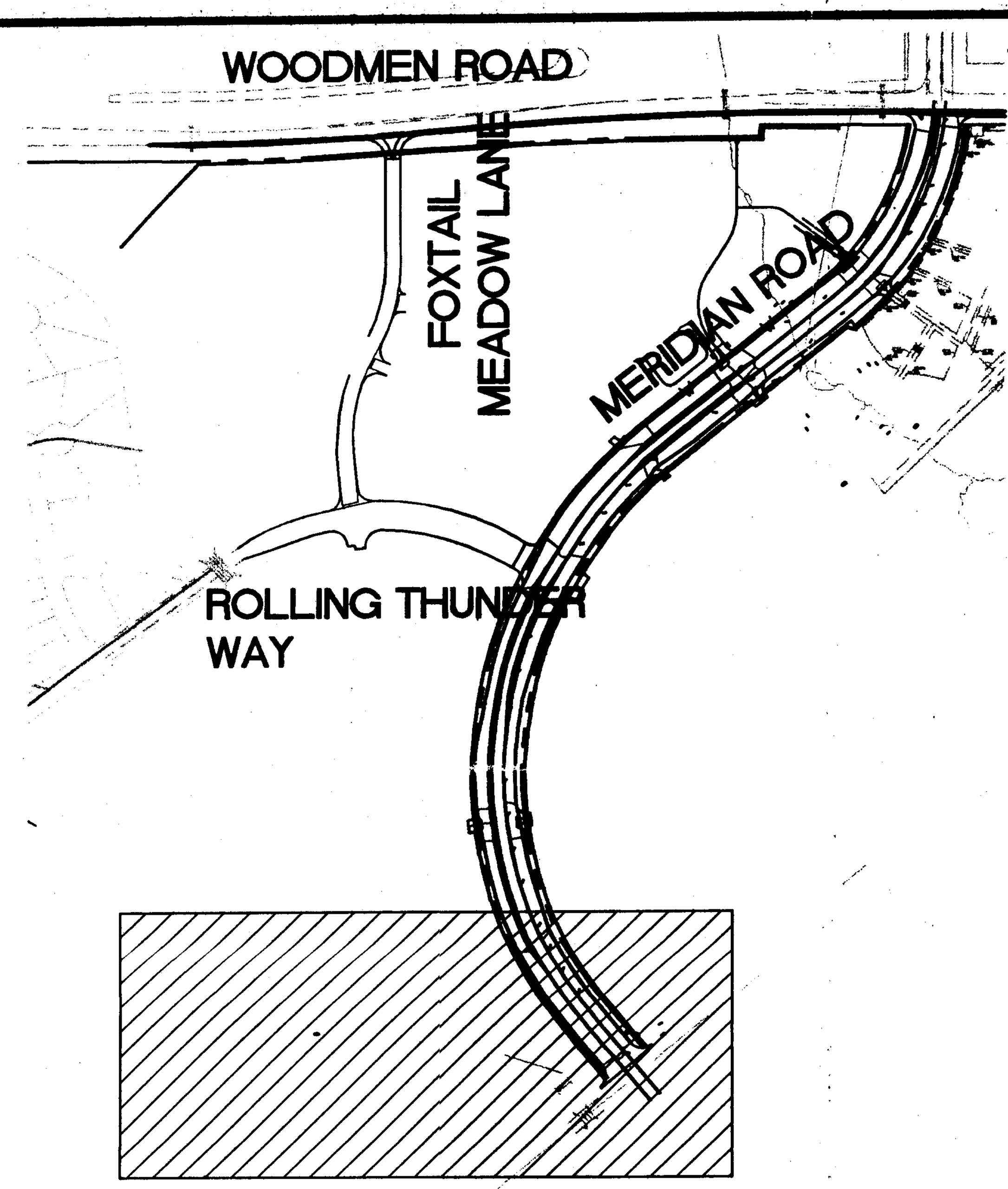
ENGINEER:
DESIGNED BY: CMS DATE: 8/9/05
DRAWN BY: CMS DATE: 8/9/05
CHECKED BY: XXX DATE: XX/XX/XX

48 HOURS BEFORE YOU DIG, CALL UTILITY LOCATORS
1-800-922-1987
(SEE COVER FOR LIST OF UTILITY CONTACTS)

URS
9960 FEDERAL DRIVE #300
COLORADO SPRINGS, COLORADO 80921
PHONE: (719) 531-0001
FAX: (719) 531-0007

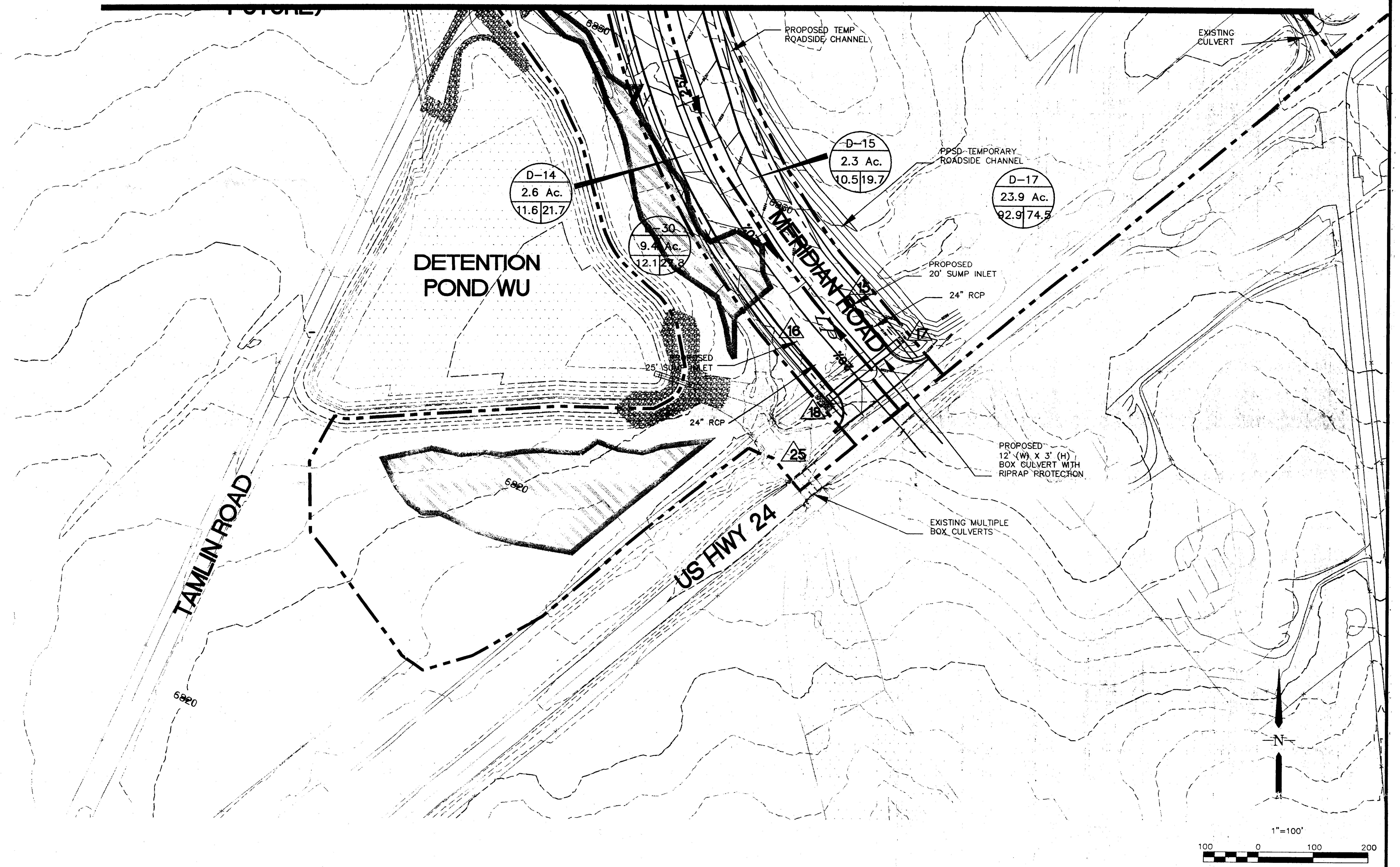
PROJECT F.H. MARKET PLACE – PDR/FDR
SHEET TITLE DEVELOPED DRAINAGE PLAN
FROM ______ TO ______
JOB NO. 21711426 SHEET 2 OF 4

# *DEVELOPED DRAINAGE PLAN – FALCON HIGHLANDS MARKET PLACE FILING NO. 1*




*KEY MAP*
*N.T.S.*

MATCHLINE-SEE SHEET 2




*LEGEND*

| | |
|---|---|
| D–25 / AREA / Q5 Q100 | BASIN DATA |
| 12 | DESIGN POINT |
| *HP* | ROAD HIGH POINT |
| *LP* | ROAD LOW POINT |
| 1.2% | ROAD GRADE |
| | BASIN BOUNDARY |
| | FLOW PATH |
| | EX. 10' CONTOUR |
| | EX. 2' CONTOUR |
| | PR 10' CONTOUR |
| | PR 2' CONTOUR |
| | WEST TRIBUTARY FLOODPLAIN (LOMR SUBMITTAL–AWAITING APPROVAL) |
| | MIDDLE TRIBUTARY FLOODPLAIN (CLOMR SUBMITTAL–APPROVED MAY 2005) |
| | EXISTING WETLANDS |

**FIGURE 6**

REVISIONS:

| NO. | DESCRIPTION | DATE |
|---|---|---|
| | | |

ENGINEER:
DESIGNED BY: CMS DATE: 8/9/05
DRAWN BY: CMS DATE: 8/9/05
CHECKED BY: XXX DATE: XX/XX/XX

48 HOURS BEFORE YOU DIG, CALL UTILITY LOCATORS
1-800-922-1987
(SEE COVER FOR LIST OF UTILITY CONTACTS)

**URS**
9960 FEDERAL DRIVE #300
COLORADO SPRINGS, COLORADO 80921
PHONE: (719) 531-0001
FAX: (719) 531-0007

PROJECT F.H. MARKET PLACE – PDR/FDR
SHEET TITLE DEVELOPED DRAINAGE PLAN
FROM ______ TO ______
JOB NO. 21711426
SHEET 3 OF 4

# DEVELOPED DRAINAGE PLAN – FALCON HIGHLANDS MARKET PLACE FILING NO. 1


**FIGURE 6**

| REVISIONS: | | |
|---|---|---|
| NO. | DESCRIPTION | DATE |

ENGINEER:
DESIGNED BY: CMS DATE: 8/9/05
DRAWN BY: CMS DATE: 8/9/05
CHECKED BY: XXX DATE: XX/XX/XX

48 HOURS BEFORE YOU DIG, CALL UTILITY LOCATORS
1-800-922-1987
(SEE COVER FOR LIST OF UTILITY CONTACTS)


URS
9960 FEDERAL DRIVE #300
COLORADO SPRINGS, COLORADO 80921
PHONE: (719) 531-0001
FAX: (719) 531-0007


PROJECT F.H. MARKET PLACE – PDR/FDR
SHEET TITLE DEVELOPED DRAINAGE PLAN
FROM ______ TO ______
JOB NO. 21711426 SHEET 4 OF 4

# MARKET PLACE FILING NO. 1- PDR & FDR - DEVELOPED CONDITIONS
## (RATIONAL METHOD  Q=CIA)

| BASIN | TOTAL FLOWS | | | | AREA | WEIGHTED | | OVERLAND | | | | CHANNEL | | | | Tc | INTENSITY | | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $Q_5$ | $Q_{100}$ | CA(equiv.) | | TOTAL | $C_5$ | $C_{100}$ | $C_5$ | Length | Slope | Tco | Length | Slope | Velocity | Tcc | TOTAL | $I_5$ | $I_{100}$ | |
| | (c.f.s.) | (c.f.s.) | 5 YR | 100 YR | (Ac) | | | | (ft) | (ft) | (min) | (ft) | (%) | (fps) | (min) | (min) | (in/hr) | (in/hr) | |
| D-1 | 7.0 | 13.2 | 1.38 | 1.45 | 1.53 | 0.90 | 0.95 | 0.90 | 5 | 2.0% | 0.7 | 536 | 3.0% | 3.5 | 2.6 | 5.0 | 5.1 | 9.1 | |
| D-2 | 6.7 | 12.6 | 1.31 | 1.39 | 1.46 | 0.90 | 0.95 | 0.90 | 5 | 2.0% | 0.7 | 624 | 3.0% | 3.5 | 3.0 | 5.0 | 5.1 | 9.1 | |
| D-4 | 5.9 | 11.1 | 1.16 | 1.23 | 1.29 | 0.90 | 0.95 | 0.90 | 5 | 2.0% | 0.7 | 344 | 1.0% | 2.0 | 2.9 | 5.0 | 5.1 | 9.1 | |
| D-5 | 6.2 | 11.7 | 1.22 | 1.29 | 1.36 | 0.90 | 0.95 | 0.90 | 5 | 2.0% | 0.7 | 336 | 1.0% | 2.0 | 2.8 | 5.0 | 5.1 | 9.1 | |
| D-6 | 9.5 | 17.8 | 2.02 | 2.13 | 2.24 | 0.90 | 0.95 | 0.90 | 5 | 2.0% | 0.7 | 925 | 1.6% | 2.5 | 6.1 | 6.8 | 4.7 | 8.4 | |
| D-7 | 9.4 | 17.6 | 1.96 | 2.07 | 2.18 | 0.90 | 0.95 | 0.90 | 5 | 2.0% | 0.7 | 867 | 1.6% | 2.5 | 5.7 | 6.4 | 4.8 | 8.5 | |
| D-11 | 9.2 | 17.3 | 1.96 | 2.07 | 2.18 | 0.90 | 0.95 | 0.90 | 5 | 2.0% | 0.7 | 928 | 1.6% | 2.5 | 6.1 | 6.8 | 4.7 | 8.3 | |
| D-12 | 9.3 | 17.5 | 1.94 | 2.04 | 2.15 | 0.90 | 0.95 | 0.90 | 5 | 2.0% | 0.7 | 848 | 1.6% | 2.5 | 5.6 | 6.3 | 4.8 | 8.5 | |
| D-14 | 11.6 | 21.7 | 2.36 | 2.49 | 2.62 | 0.90 | 0.95 | 0.90 | 5 | 2.0% | 0.7 | 873 | 2.0% | 2.8 | 5.1 | 5.8 | 4.9 | 8.7 | |
| D-15 | 10.5 | 19.7 | 2.09 | 2.20 | 2.32 | 0.90 | 0.95 | 0.90 | 5 | 2.0% | 0.7 | 797 | 2.0% | 2.8 | 4.7 | 5.4 | 5.0 | 8.9 | |
| D-16 | 40.2 | 75.6 | 7.88 | 8.32 | 8.76 | 0.90 | 0.95 | 0.90 | 10 | 2.0% | 0.9 | 647 | 2.0% | 2.8 | 3.8 | 5.0 | 5.1 | 9.1 | |
| D-17 | 92.9 | 174.5 | 21.50 | 22.70 | 23.89 | 0.90 | 0.95 | 0.90 | 10 | 2.0% | 0.9 | 1,315 | 2.0% | 2.8 | 7.7 | 8.7 | 4.3 | 7.7 | |
| D-18 | 3.6 | 6.8 | 0.72 | 0.76 | 0.81 | 0.90 | 0.95 | 0.90 | 35 | 2.0% | 1.8 | 760 | 2.8% | 3.3 | 3.8 | 5.5 | 5.0 | 8.8 | |
| D-19 | 27.6 | 51.8 | 5.40 | 5.70 | 6.00 | 0.90 | 0.95 | 0.90 | 25 | 2.0% | 1.5 | 425 | 2.0% | 2.8 | 2.5 | 5.0 | 5.1 | 9.1 | |
| D-20 | 42.9 | 80.7 | 8.43 | 8.90 | 9.37 | 0.90 | 0.95 | 0.90 | 145 | 5.5% | 2.6 | 475 | 2.5% | 3.2 | 2.5 | 5.1 | 5.1 | 9.1 | |
| D-21 | 44.8 | 85.2 | 11.12 | 11.87 | 15.03 | 0.74 | 0.79 | 0.90 | 140 | 6.8% | 2.4 | 1,385 | 2.0% | 2.8 | 8.1 | 10.5 | 4.0 | 7.2 | |
| D-22 | 4.1 | 7.7 | 1.15 | 1.22 | 1.28 | 0.90 | 0.95 | 0.25 | 35 | 2.0% | 7.5 | 1,305 | 2.8% | 3.3 | 6.6 | 14.0 | 3.6 | 6.3 | |
| D-23 | 43.6 | 82.0 | 11.63 | 12.27 | 12.92 | 0.90 | 0.95 | 0.90 | 25 | 5.3% | 1.1 | 2,100 | 2.4% | 3.1 | 11.4 | 12.5 | 3.8 | 6.7 | |
| D-24 | 74.1 | 139.2 | 15.88 | 16.76 | 17.64 | 0.90 | 0.95 | 0.90 | 105 | 5.7% | 2.2 | 1,030 | 3.3% | 3.6 | 4.7 | 6.9 | 4.7 | 8.3 | |
| D-25 | 15.8 | 29.8 | 3.69 | 3.90 | 4.10 | 0.90 | 0.95 | 0.25 | 25 | 2.9% | 5.6 | 550 | 2.0% | 2.8 | 3.2 | 8.8 | 4.3 | 7.6 | |
| D-26 | 4.3 | 8.0 | 1.28 | 1.35 | 1.42 | 0.90 | 0.95 | 0.25 | 35 | 2.0% | 7.5 | 1,735 | 2.8% | 3.3 | 8.7 | 16.2 | 3.3 | 5.9 | |
| D-27 | 3.3 | 6.3 | 0.77 | 0.82 | 0.86 | 0.90 | 0.95 | 0.25 | 25 | 2.0% | 6.3 | 440 | 2.4% | 3.1 | 2.3 | 8.7 | 4.3 | 7.7 | |
| D-28 | 1.7 | 3.2 | 0.42 | 0.45 | 0.47 | 0.90 | 0.95 | 0.25 | 25 | 2.0% | 6.3 | 360 | 0.6% | 1.5 | 3.9 | 10.2 | 4.1 | 7.2 | |
| D-29 | 28.4 | 53.4 | 10.03 | 10.58 | 11.14 | 0.90 | 0.95 | 0.25 | 230 | 3.5% | 16.0 | 955 | 1.5% | 2.4 | 6.6 | 22.5 | 2.8 | 5.0 | |
| D-30 | 12.1 | 27.8 | 3.29 | 4.23 | 9.41 | 0.35 | 0.45 | 0.25 | 60 | 10.0% | 5.8 | 1,020 | 1.4% | 2.3 | 7.3 | 13.0 | 3.7 | 6.6 | |
| D-31 | 0.5 | 1.2 | 0.11 | 0.14 | 0.32 | 0.35 | 0.45 | 0.25 | 10 | 2.0% | 4.0 | 285 | 0.6% | 1.5 | 3.1 | 7.1 | 4.6 | 8.2 | |
| OFFSITE | 16.4 | 37.5 | 4.89 | 6.28 | 13.96 | 0.35 | 0.45 | 0.25 | 20 | 2.0% | 5.7 | 1,370 | 1.2% | 2.2 | 10.4 | 16.1 | 3.4 | 6.0 | |
| Formula: | C*I*A | C*I*A | Q/I | Q/I | 156.71 | | | | | | *1 | | | *2 20 | *3 | Tco+Tcc | *4 1.5 | *6 2.67 | |

1* Tco = 1.87*(1.1-C5)*(L^0.5)*((S*100)^-0.33) (DCM page 5-11)
2* Vc = 20*S^0.5 (USDCM RO-4)
3* Tcc = 1/V*L/60
4* $I_5$ = (26.65*1.50)/(10+Tc)^0.76 (City Letter of 1/7/2003)
6* $I_{100}$ =(26.65*2.67)/(10+Tc)^0.76 (City Letter of 1/7/2003)

# MARKET PLACE FILING NO. 1- PDR & FDR - DEVELOPED CONDITIONS
# SURFACE ROUTING

| DESIGN POINT | CONTRIBUTING BASINS | CA(equivalent) CA(5) | CA(100) | Tc (min.) | INTENSITY I(5) (in/hr) | I(100) (in/hr) | TOTAL FLOWS Q(5) (cfs) | Q(100) (cfs) |
|---|---|---|---|---|---|---|---|---|
| 1 | D-1 | 1.38 | 1.45 | 5.0 | 5.2 | 9.1 | 7.1 | 13.2 |
| | | | | TRAVEL TIME | | | | |
| | | 1.38 | 1.45 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | | 2.9 | 0.0 | 5.0 |
| 2 | D-2 | 1.31 | 1.39 | 5.0 | 5.2 | 9.1 | 6.8 | 12.6 |
| | | | | TRAVEL TIME | | | | |
| | | 1.31 | 1.39 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | | 2.8 | 0.0 | 5.0 |
| 3 | D-4 | 1.16 | 1.23 | 5.0 | 5.2 | 9.1 | 6.0 | 11.1 |
| | | | | TRAVEL TIME | | | | |
| | | 1.16 | 1.23 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 83 | 3.3 | 0.4 | 5.4 |
| 5 | D-5 | 1.22 | 1.29 | 5.0 | 5.2 | 9.1 | 6.4 | 11.7 |
| | | | | TRAVEL TIME | | | | |
| | | 1.22 | 1.29 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | | 4.5 | 0.0 | 5.0 |
| 6 | D-7 | 1.96 | 2.07 | 6.4 | 4.8 | 8.4 | 9.4 | 17.4 |
| | | | | TRAVEL TIME | | | | |
| | | 1.96 | 2.07 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | | 4.5 | 0.0 | 6.4 |
| 7 | DP-6 (INLET) | 0.62 | 0.80 | 6.4 | 4.8 | 8.4 | 40.8 | 76.5 |
| | D-16 | 7.88 | 8.32 | TRAVEL TIME | | | | |
| | | 8.51 | 9.12 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 77 | 4.7 | 0.3 | 6.7 |
| 10 | D-6 | 2.02 | 2.13 | 6.8 | 4.7 | 8.2 | 9.5 | 17.5 |
| | | | | TRAVEL TIME | | | | |
| | | 2.02 | 2.13 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 83 | 5.8 | 0.2 | 7.0 |
| 11 | D-19 | 5.40 | 5.70 | 8.8 | 4.3 | 7.4 | 38.7 | 71.3 |
| | D-25 | 3.69 | 3.90 | TRAVEL TIME | | | | |
| | | 9.09 | 9.60 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | | 0.0 | 0.0 | 8.8 |
| 13 | D-12 | 1.94 | 2.04 | 6.3 | 4.8 | 8.4 | 9.4 | 17.2 |
| | | | | TRAVEL TIME | | | | |
| | | 1.94 | 2.04 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 98 | 6.1 | 0.3 | 6.5 |

DP 11: D19, D25 = 10.1 acres

Entrance to Ex. 42" RCP at NE corner site under Rolling Thunder

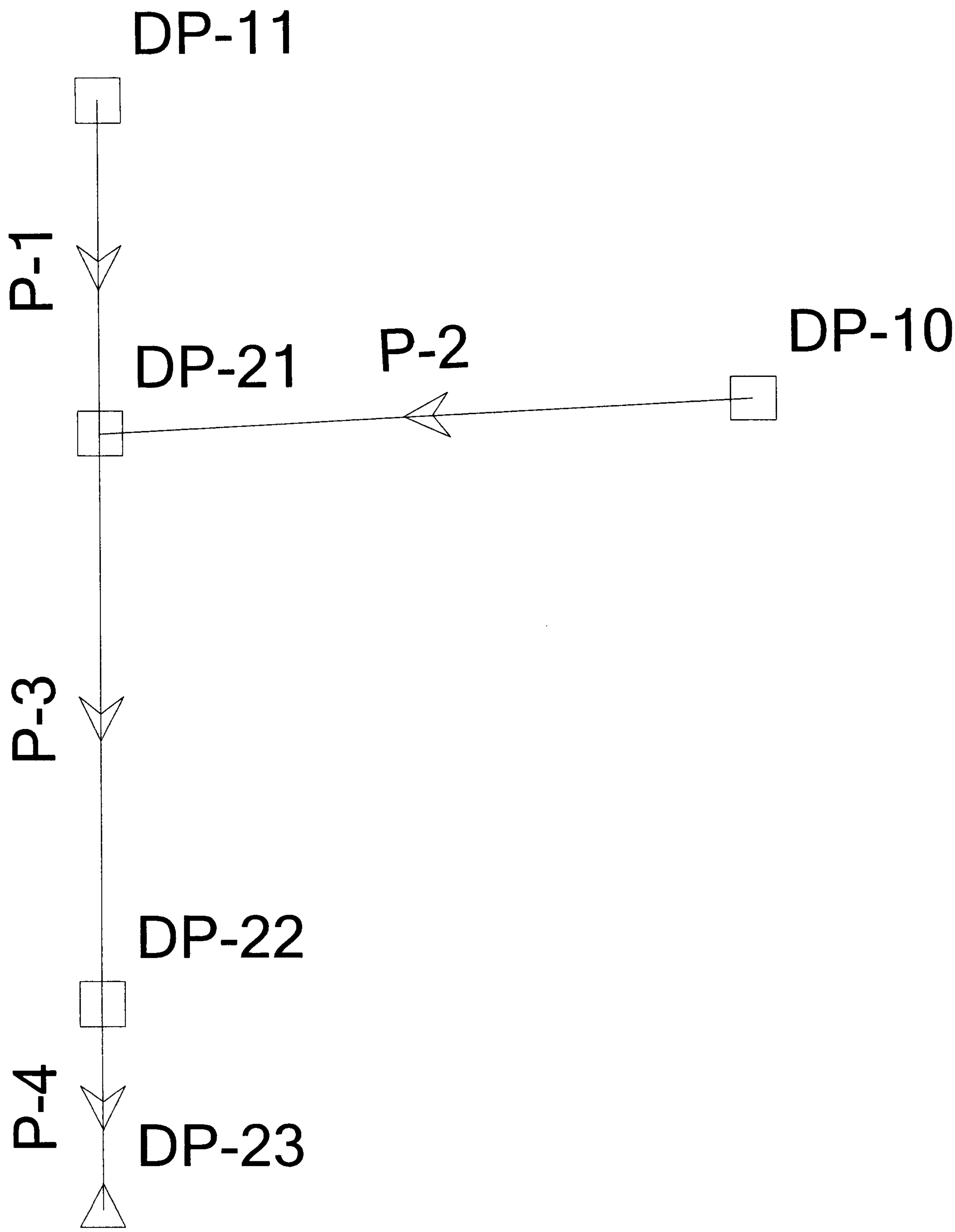
| DESIGN POINT | CONTRIBUTING BASINS | CA(equivalent) CA(5) | CA(100) | Tc (min.) | INTENSITY I(5) (in/hr) | I(100) (in/hr) | TOTAL FLOWS Q(5) (cfs) | Q(100) (cfs) |
|---|---|---|---|---|---|---|---|---|
| 14 | D-11 | 1.96 | 2.07 | 6.8 | 4.7 | 8.2 | 9.2 | 17.0 |
| | | | | TRAVEL TIME | | | | |
| | | 1.96 | 2.07 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | | 5.2 | 0.0 | 6.8 |
| 15 | D-15 | 2.09 | 2.20 | 5.4 | 5.1 | 8.9 | 10.6 | 19.6 |
| | | | | TRAVEL TIME | | | | |
| | | 2.09 | 2.20 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 347 | 2.0 | 2.9 | 8.3 |
| 16 | D-14 | 2.36 | 2.49 | 5.8 | 5.0 | 8.6 | 11.7 | 21.5 |
| | | | | TRAVEL TIME | | | | |
| | | 2.36 | 2.49 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 62 | 9.0 | 0.1 | 5.9 |
| 17 | DP-7 | 8.51 | 9.12 | 8.7 | 4.3 | 7.5 | 157.9 | 300.6 |
| | DP-13 | 1.94 | 2.04 | | | | | |
| | D-17 | 21.50 | 22.70 | | | | | |
| | OFFSITE | 4.89 | 6.28 | TRAVEL TIME | | | | |
| | | 36.83 | 40.14 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 36 | 1.5 | 0.4 | 9.1 |
| 18 | DP-17 | 36.83 | 40.14 | 5.9 | 4.9 | 8.6 | 181.2 | 345.5 |
| | DP-15 (INLET) | 0.00 | 0.07 | | | | | |
| | DP-16 (INLET) | 0.00 | 0.00 | TRAVEL TIME | | | | |
| | | 36.83 | 40.21 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 139 | 8.4 | 0.3 | 6.2 |
| 19 | D-18 | 0.72 | 0.76 | 5.5 | 5.0 | 8.8 | 3.6 | 6.7 |
| | | | | TRAVEL TIME | | | | |
| | | 0.72 | 0.76 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 62 | 9.0 | 0.1 | 5.7 |
| 20 | D-24 | 15.88 | 16.76 | 6.9 | 4.7 | 8.2 | 74.2 | 136.9 |
| | | | | TRAVEL TIME | | | | |
| | | 15.88 | 16.76 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 139 | 8.4 | 0.3 | 7.2 |
| 21 | D-26 | 1.28 | 1.35 | 16.2 | 3.2 | 5.7 | 10.2 | 12.3 |
| | DP-10 (INLET) | 0.64 ✓ | 0.82 ✓ | | | | | |
| | D-22 | 1.15 | 1.22 | | | | | |
| | DP-19 (INLET) | 0.06 ✓ | 0.04 ✓ | TRAVEL TIME | | | | |
| | | 3.13 ✓ | 2.17 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | 3.43 | | 139 | 8.4 | 0.3 | 16.5 |
| 22 | D-27 | 0.77 | 0.82 | 8.7 | 4.3 | 7.5 | 3.3 | 6.1 |
| | DP 21 (INLET) | 3.13 0.00 | 3.43 0.00 | TRAVEL TIME | | | | |
| | | 3.90 0.77 | 4.25 0.82 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 139 | 8.4 | 0.3 | 8.9 |

| DESIGN POINT | CONTRIBUTING BASINS | CA(equivalent) CA(5) | CA(100) | Tc (min.) | INTENSITY I(5) (in/hr) | I(100) (in/hr) | TOTAL FLOWS Q(5) (cfs) | Q(100) (cfs) |
|---|---|---|---|---|---|---|---|---|
| DP 23: D19, D25, D27, D26, D22, D6, D18 = 16.71 acres | | | | | | | | |
| 23 | DP-11 | 9.09 | 9.60 | 10.5 | 4.0 | 6.9 | 39.2 | 72.2 |
| | DP-22 (INLET) | 0.77 | 0.82 | | | | | |
| Ex. 42" RCP at NE corner site under Rolling Thunder draining into U-Haul site | | | | TRAVEL TIME | | | | |
| | | 9.86 | 10.41 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | 16.71 ac x 0.90=15.04 | 16.71 ac x 0.95=15.87 | | 139 | 8.4 | 0.3 | |
| 25 | DP-18 | 36.83 | 40.21 | 13.0 | 3.6 | 6.3 | 221.9 | 1479.1 |
| | POND WU | 19.44 | 188.25 | | | | | |
| | DP-14 | 1.96 | 2.07 | | | | | |
| | D-30 | 3.29 | 4.23 | | | | | |
| | | | | TRAVEL TIME | | | | |
| | | 61.53 | 234.76 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 83 | 5.8 | 0.2 | 13.3 |
| 26 | DP-3 (INLET) | 0.00 | 0.02 | 7.2 | 4.6 | 8.1 | 160.9 | 788.5 |
| | DP-5 (INLET) | 0.00 | 0.09 | | | | | |
| | DP-2 (INLET) | 0.29 | 0.41 | | | | | |
| | DP-20 | 15.88 | 16.76 | | | | | |
| | BECKETT PROP | 3.06 | 3.23 | | | | | |
| | DP-MN1 | 7.07 | 37.20 | | | | | |
| | DP-MN2 | 8.61 | 40.20 | TRAVEL TIME | | | | |
| | | 34.91 | 97.91 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | | 5.8 | 0.0 | 7.2 |
| 27 | D-31 | 0.11 | 0.14 | 7.1 | 4.6 | 8.1 | 0.5 | 1.2 |
| | | | | TRAVEL TIME | | | | |
| | | 0.11 | 0.14 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 139 | 8.4 | 0.3 | 7.3 |
| 28 | D-28 | 0.42 | 0.45 | 10.2 | 4.0 | 7.0 | 1.7 | 3.1 |
| | | | | TRAVEL TIME | | | | |
| | | 0.42 | 0.45 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 139 | 8.4 | 0.3 | 10.5 |

# MARKET PLACE FILING NO. 1- PDR & FDR - DEVELOPED CONDITIONS
## INLET CALCULATIONS

| | | | | | | | $Q_5$ | | | | | | $Q_{100}$ | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DP | Inlet size L(i) | INLET TYPE | CROSS SLOPE | STREET SLOPE | Q(5) | Q(100) | Qi | CA(eqv.) | FB | CA(eqv.) | DEPTH (max) | SPREAD | Qi | CA(eqv.) | FB | CA(eqv.) | DEPTH (max) | SPREAD |
| 2 | 15 | FLOW-BY | 2.0% | 0.5% | 7 | 13 | 5.3 | 1.02 | 2 | 0.29 | 0.42 | 16.9 | 8.8 | 0.97 | 4 | 0.41 | 0.51 | 21.2 |
| 3 | 10 | SUMP | 2.0% | SAG | 6 | 11 | 6.0 | 1.16 | 0 | 0.00 | 0.50 | | 10.9 | 1.20 | 0 | 0.02 | 0.50 | |
| 5 | 10 | SUMP | 2.0% | SAG | 6 | 12 | 6.4 | 1.22 | 0 | 0.00 | 0.50 | | 10.9 | 1.20 | 1 | 0.09 | 0.50 | |
| 6 | 15 | FLOW-BY | 2.0% | 1.0% | 9 | 17 | 6.4 | 1.34 | 3 | 0.62 | 0.42 | 16.7 | 10.7 | 1.27 | 7 | 0.80 | 0.51 | 21.0 |
| 10 | 15 | FLOW-BY | 2.0% | 1.0% | 9 | 17 | 6.5 | 1.37 | 3 | 0.64 | 0.42 | 16.8 | 10.7 | 1.31 | 7 | 0.82 | 0.51 | 21.1 |
| 13 | 20 | SUMP | 2.0% | SAG | 9 | 17 | 9.4 | 1.94 | 0 | 0.00 | 0.50 | | 17.2 | 2.04 | 0 | 0.00 | 0.50 | |
| 14 | 20 | SUMP | 2.0% | SAG | 9 | 17 | 9.2 | 1.96 | 0 | 0.00 | 0.50 | | 17.0 | 2.07 | 0 | 0.00 | 0.50 | |
| 15 | 20 | SUMP | 2.0% | SAG | 11 | 20 | 10.6 | 2.09 | 0 | 0.00 | 0.50 | | 18.9 | 2.14 | 1 | 0.07 | 0.50 | |
| 16 | 25 | SUMP | 2.0% | SAG | 12 | 22 | 11.7 | 2.36 | 0 | 0.00 | 0.50 | | 21.5 | 2.49 | 0 | 0.00 | 0.50 | |
| 19 | 5 | FLOW-BY | 2.0% | 2.8% | 1 | 1 | 0.4 | 0.09 | 0 | 0.06 | 0.19 | 5.3 | 0.4 | 0.05 | 0 | 0.04 | 0.19 | 5.4 |
| 21 | 25 | SUMP | 2.0% | SAG | 10 | 12 | 10.2 | 3.13 | 0 | 0.00 | 0.50 | | 12.3 | 2.17 | 0 | 0.00 | 0.50 | |
| 22 | 5 | SUMP | 2.0% | SAG | 3 | 6 | 3.3 | 0.77 | 0 | 0.00 | 0.50 | | 6.1 | 0.82 | 0 | 0.00 | 0.50 | |
| 27 | 5 | FLOW-BY | 2.0% | 0.6% | 1 | 1 | 0.4 | 0.08 | 0 | 0.03 | 0.21 | 6.2 | 0.8 | 0.10 | 0 | 0.05 | 0.25 | 8.4 |
| 28 | 10 | FLOW-BY | 2.0% | 0.6% | 2 | 3 | 1.4 | 0.35 | 0 | 0.08 | 0.28 | 9.7 | 2.3 | 0.33 | 1 | 0.12 | 0.33 | 12.2 |

**Scenario: 100-year**



# Calculation Results Summary

==================================================================

Scenario: 5-year

>>>> Info: DP-10 No bypass target specified. Bypass is assumed
to travel to DP-23.

>>>> Info: Subsurface Network Rooted by: DP-23
>>>> Info: Subsurface Analysis iterations: 2
>>>> Info: Convergence was achieved.

CALCULATION SUMMARY FOR SURFACE NETWORKS

| Label | Inlet Type | Inlet | Total Intercepted Flow (cfs) | Total Bypassed Flow (cfs) | Capture Efficiency (%) | Gutter Spread (ft) | Gutter Depth (ft) |
|---|---|---|---|---|---|---|---|
| DP-10 | Curb Inlet | Curb Type R 10' | 0.00 | 0.00 | 100.0 | 0.00 | 0.00 |
| DP-22 | Curb Inlet | Curb Type R 10' | 3.38 | 0.00 | 100.0 | 9.11 | 0.16 |
| DP-21 | Curb Inlet | Curb Type R 10' | 11.20 | 0.00 | 100.0 | 11.70 | 0.23 |
| DP-11 | Generic Inlet | Generic Default 100% | 70.74 | 0.00 | 100.0 | 0.00 | 0.00 |

CALCULATION SUMMARY FOR SUBSURFACE NETWORK WITH ROOT: DP-23

| Label | Number of Sections | Section Size | Section Shape | Length (ft) | Total System Flow (cfs) | Average Velocity (ft/s) | Hydraulic Grade Upstream (ft) | Hydraulic Grade Downstream (ft) |
|---|---|---|---|---|---|---|---|---|
| P-4 | 1 | 42 inch | Circular | 27.33 | 68.60 | 8.78 | 6,842.51 | 6,842.26 |
| P-3 | 1 | 42 inch | Circular | 94.00 | 66.24 | 8.61 | 6,843.24 | 6,842.65 |
| P-1 | 1 | 42 inch | Circular | 36.02 | 70.74 | 8.87 | 6,843.83 | 6,843.51 |
| P-2 | 1 | 18 inch | Circular | 188.17 | 0.00 | 0.00 | 6,847.13 | 6,843.24 |

| Label | Total System Flow (cfs) | Ground Elevation (ft) | Hydraulic Grade Line In (ft) | Hydraulic Grade Line Out (ft) |
|---|---|---|---|---|
| DP-23 | 68.53 | 6,842.00 | 6,839.66 | 6,839.66 |
| DP-22 | 68.60 | 6,846.23 | 6,842.51 | 6,842.51 |
| DP-21 | 66.24 | 6,846.47 | 6,843.24 | 6,843.24 |
| DP-11 | 70.74 | 6,846.00 | 6,843.83 | 6,843.83 |
| DP-10 | 0.00 | 6,850.88 | 6,847.13 | 6,847.13 |

==================================================================

Completed: 12/19/2005 12:20:11 PM

# Scenario: 5-year

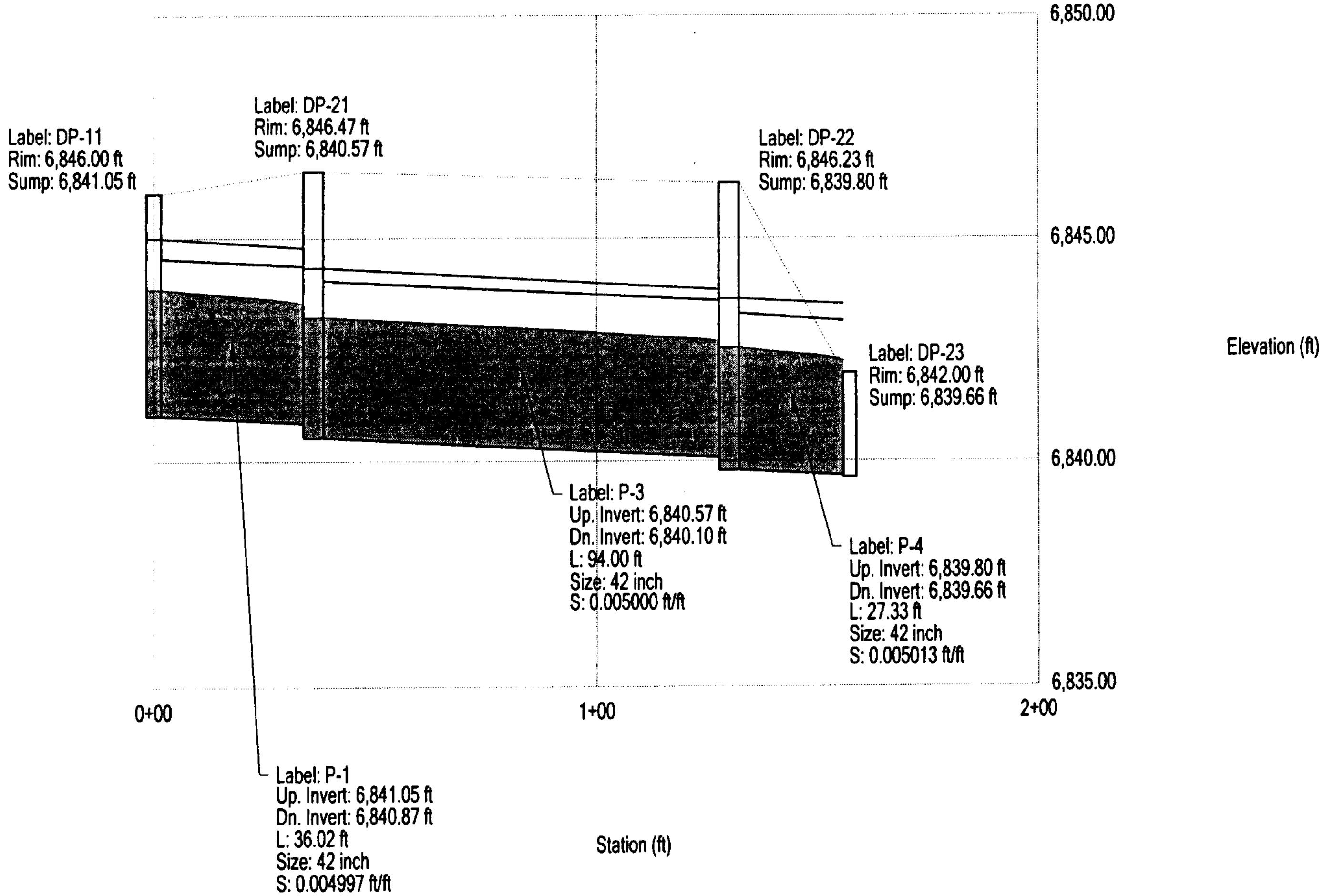
## combined

| Label | Up. Node | Dn. Node | L (ft) | Size | Up. Inlet Area (acres) | Up. Calc. Sys. CA (acres) | Up.Inlet Rat. Q (cfs) | System Rational Q (cfs) | Q Full (cfs) | Avg. v (ft/s) | Up. Gr Elev. (ft) | Up. HGL (ft) | Up. Invert (ft) | Dn. Gr. Elev. (ft) | Dn. HGL (ft) | Dn. Invert (ft) | S (ft/ft) | Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P-4 | DP-22 | DP-23 | 27.33 | 42 inch | 0.77 | 20.23 | 3.38 | 68.60 | 71.23 | 8.78 | 6,846.23 | 6,842.51 | 6,839.80 | 6,842.00 | 6,839.66 | 6,839.66 | 0.005013 | |
| P-1 | DP-11 | DP-21 | 36.02 | 42 inch | 16.17 | 16.17 | 70.74 | 70.74 | 71.12 | 8.87 | 6,846.00 | 6,843.83 | 6,841.05 | 6,846.47 | 6,843.24 | 6,840.87 | 0.004997 | |
| P-3 | DP-21 | DP-22 | 94.00 | 42 inch | 3.29 | 19.46 | 11.20 | 66.24 | 71.14 | 8.61 | 6,846.47 | 6,843.24 | 6,840.57 | 6,846.23 | 6,842.51 | 6,840.10 | 0.005000 | |
| P-2 | DP-10 | DP-21 | 188.17 | 18 inch | 0.00 | 0.00 | 0.00 | 0.00 | 16.35 | 0.00 | 6,850.88 | 6,847.13 | 6,847.13 | 6,846.47 | 6,843.24 | 6,842.57 | 0.024233 | |

## Profile
## Scenario: 5-year

# Profile: Rolling Thunder Way

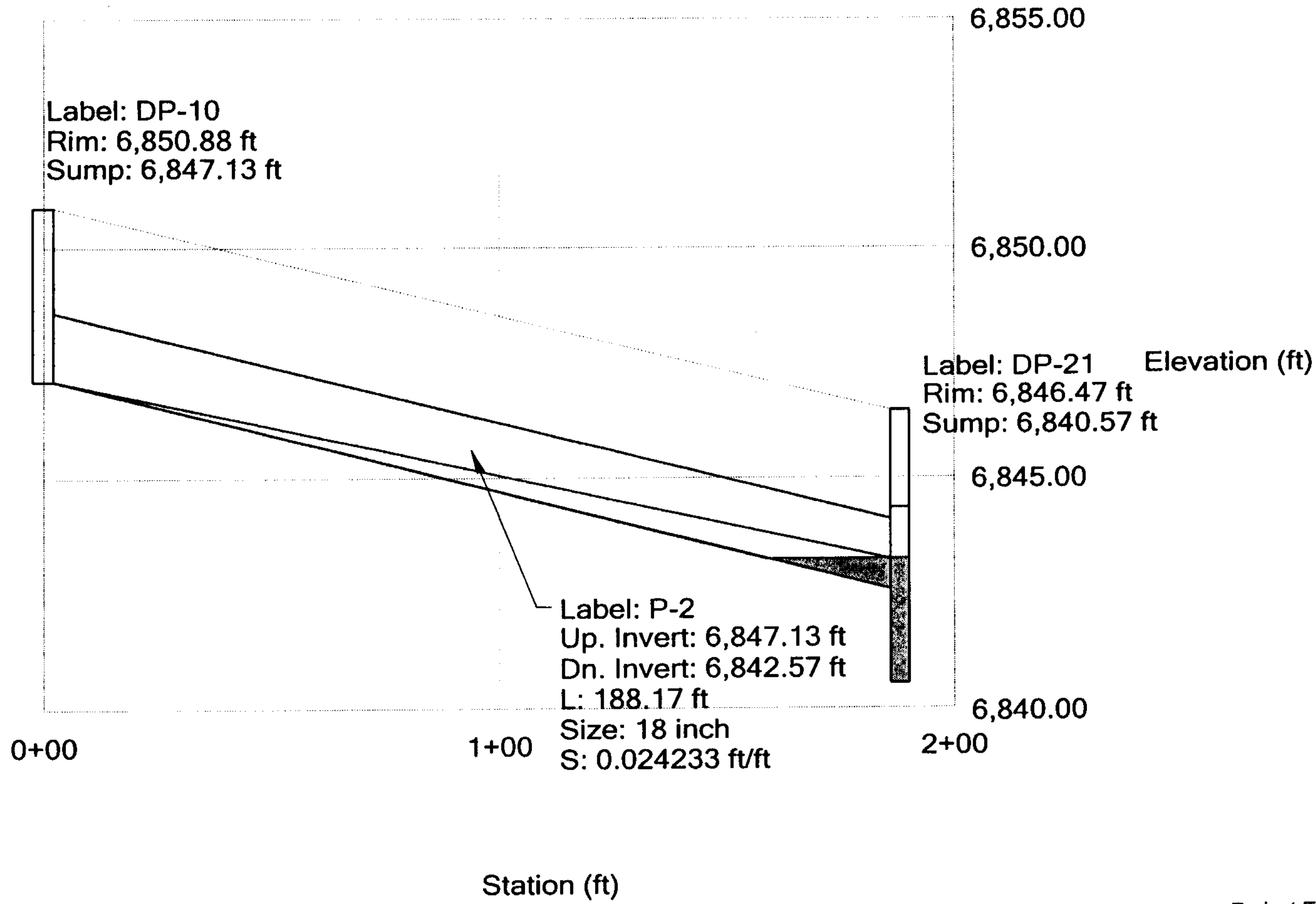
Scenario: 5-year



**Profile**
**Scenario: 5-year**

# Profile: Meridian Road Connection-DP 10

## Scenario: 5-year




Title: Rolling Thunder Way system
r:\...\market place-rolling thunder.stm
12/19/05 12:21:04 PM



Project Engineer: Charlene Sammons
StormCAD v5.5 [5.5005]

# Calculation Results Summary

================================================================
Scenario: 100-year

>>>> Info: DP-10 No bypass target specified. Bypass is assumed to travel to DP-23.

>>>> Info: Subsurface Network Rooted by: DP-23
>>>> Info: Subsurface Analysis iterations: 2
>>>> Info: Convergence was achieved.

CALCULATION SUMMARY FOR SURFACE NETWORKS

| Label | Inlet Type | Inlet | Total Intercepted Flow (cfs) | Total Bypassed Flow (cfs) | Capture Efficiency (%) | Gutter Spread (ft) | Gutter Depth (ft) |
|---|---|---|---|---|---|---|---|
| DP-10 | Curb Inlet | Curb Type R 10' | 7.66 | 10.44 | 42.3 | 18.61 | 0.50 |
| DP-22 | Curb Inlet | Curb Type R 10' | 6.41 | 0.00 | 100.0 | 15.86 | 0.32 |
| DP-21 | Curb Inlet | Curb Type R 10' | 15.61 | 0.00 | 100.0 | 14.60 | 0.29 |
| DP-11 | Generic Inlet | Generic Default 100% | 74.68 | 0.00 | 100.0 | 0.00 | 0.00 |

CALCULATION SUMMARY FOR SUBSURFACE NETWORK WITH ROOT: DP-23

| Label | Number of Sections | Section Size | Section Shape | Length (ft) | Total System Flow (cfs) | Average Velocity (ft/s) | Hydraulic Grade Upstream (ft) | Hydraulic Grade Downstream (ft) |
|---|---|---|---|---|---|---|---|---|
| P-4 | 1 | 42 inch | Circular | 27.33 | 83.82 | 9.65 | 6,842.89 | 6,842.52 |
| P-3 | 1 | 42 inch | Circular | 94.00 | 79.15 | 9.19 | 6,843.68 | 6,842.89 |
| P-1 | 1 | 42 inch | Circular | 36.02 | 74.68 | 8.89 | 6,843.95 | 6,843.68 |
| P-2 | 1 | 18 inch | Circular | 188.17 | 7.66 | 5.56 | 6,848.20 | 6,843.68 |

| Label | Total System Flow (cfs) | Ground Elevation (ft) | Hydraulic Grade Line In (ft) | Hydraulic Grade Line Out (ft) |
|---|---|---|---|---|
| DP-23 | 83.74 | 6,842.00 | 6,839.66 | 6,839.66 |
| DP-22 | 83.82 | 6,846.23 | 6,842.89 | 6,842.89 |
| DP-21 | 79.15 | 6,846.47 | 6,843.68 | 6,843.68 |
| DP-11 | 74.68 | 6,846.00 | 6,843.95 | 6,843.95 |
| DP-10 | 7.66 | 6,850.88 | 6,848.20 | 6,848.20 |

================================================================
Completed: 12/19/2005 12:19:10 PM

## Scenario: 100-year

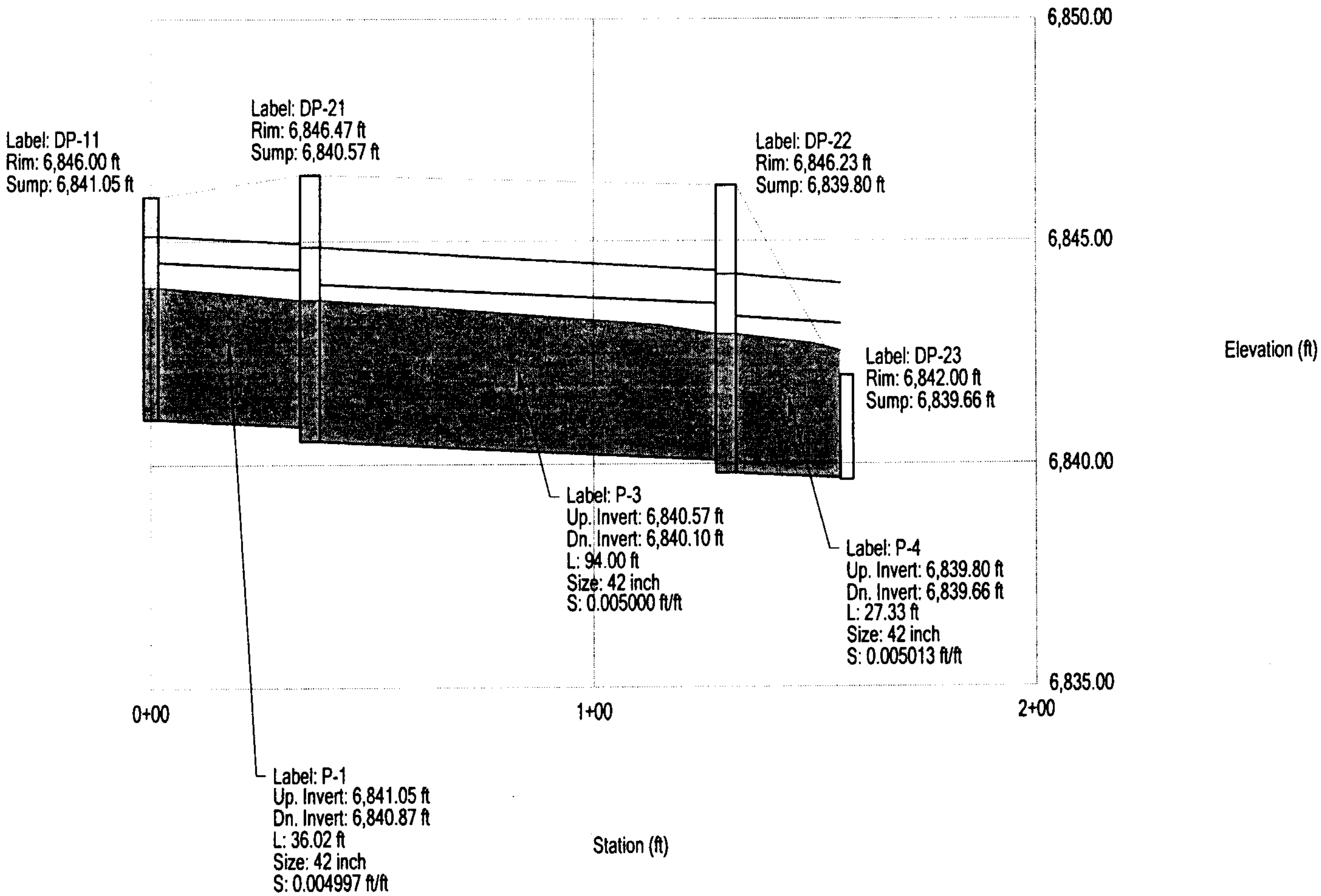
## combined

| Label | Up. Node | Dn. Node | L (ft) | Size | Up. Inlet Area (acres) | Up. Calc. Sys. CA (acres) | Up.Inlet Rat. Q (cfs) | System Rational Q (cfs) | Q Full (cfs) | Avg. v (ft/s) | Up. Gr Elev. (ft) | Up. HGL (ft) | Up. Invert (ft) | Dn. Gr. Elev. (ft) | Dn. HGL (ft) | Dn. Invert (ft) | S (ft/ft) | Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P-4 | DP-22 | DP-23 | 27.33 | 42 inch | 0.82 | 13.90 | 6.41 | 83.82 | 71.23 | 9.65 | 6,846.23 | 6,842.89 | 6,839.80 | 6,842.00 | 6,839.66 | 6,839.66 | 0.005013 | |
| P-1 | DP-11 | DP-21 | 36.02 | 42 inch | 9.60 | 9.60 | 74.68 | 74.68 | 71.12 | 8.89 | 6,846.00 | 6,843.95 | 6,841.05 | 6,846.47 | 6,843.68 | 6,840.87 | 0.004997 | |
| P-3 | DP-21 | DP-22 | 94.00 | 42 inch | 2.58 | 13.08 | 15.61 | 79.15 | 71.14 | 9.19 | 6,846.47 | 6,843.68 | 6,840.57 | 6,846.23 | 6,842.89 | 6,840.10 | 0.005000 | |
| P-2 | DP-10 | DP-21 | 188.17 | 18 inch | 2.13 | 0.90 | 18.10 | 7.66 | 16.35 | 5.56 | 6,850.88 | 6,848.20 | 6,847.13 | 6,846.47 | 6,843.68 | 6,842.57 | 0.024233 | |

**Profile**
**Scenario: 100-year**

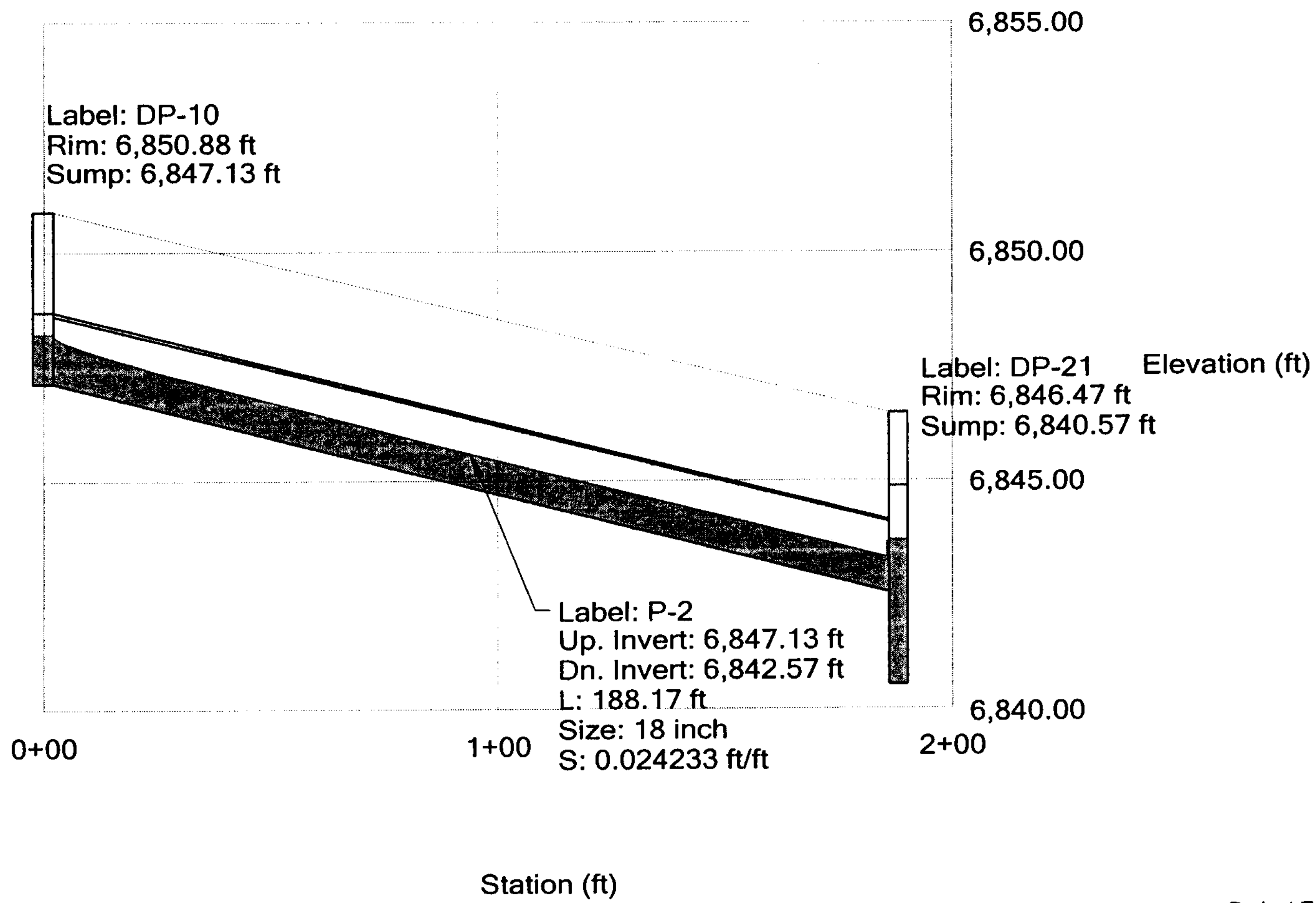
# Profile: Rolling Thunder Way

Scenario: 100-year



# Profile: Meridian Road Connection-DP 10

## Scenario: 100-year



NEW DOC

# Market Place Filing No. 2
# FINAL DRAINAGE LETTER
## El Paso County, Colorado
**November, 2008**

**Prepared for:**

**Phantom II Partners**
6255 Barrel Race Dr
Colorado Springs, Colorado 80923

**Prepared by:**


*Springs Engineering*
31 N Tejon Street
Suite 315
Colorado Springs, CO 80903
Phone: 719-227-7388


Project No. 078-08-018

VERSION # 1
DATE 12/1/08

proposed low point, DP-C. At this location a curb cut will be installed, along with a small riprap drainage swale to direct flows to a proposed Type C inlet. Flows from this basin are 2.7 cfs and 5.1 cfs for the 5 and 100-year events, respectively.

Basin D-25d is 0.26 acres. This basin consists of the majority of the proposed private roadway. Flow is conveyed through the curb and gutter to the south. At DP-D, on the south side of the roadway, prior to the Meridian Road intersection, a 5' Type R inlet will be installed. This basin generates 1.2 cfs for the 5-year storm and 2.2 cfs for the 100-year storm.

Basin D-25e is 1.49 acres and consists of the eastern portion of Lot 2, which is not currently being developed. This basin will have grading occur for grades to match into existing from the proposed private roadway. Flows in this basin will sheetflow down the proposed slope til meeting existing ground, at which time flows will continue to a proposed temporary channel along Meridian Road.

Basin D-25f is 0.05 acres and consists of the entrance of the private roadway from Meridian Road. This basin will sheetflow across the pavement to a proposed curb cut. A riprap rundown will convey this flow into the proposed channel along Meridian Road. Flows at this location are 0.2 and 0.4 cfs for the minor and major storms.

STORM SYSTEM:

There are two storm systems designed for this site. Design Point B is a 5' type R sump inlet which intercepts flow from Basin D-25b. It will cross under the proposed private roadway through an 18" rcp, which releases into the proposed channel.

DP-C is a type C inlet, which will intercept flow from Basin D-25c. Flows from this basin will be directed towards the inlet via a riprap swale from the curb cut located in the parking lot. Inlet DP-C will connect to a 5' type R inlet located in the private road. From this inlet, the system will release into the proposed temporary ditch. Both pipes in this system are 24" rcp. Riprap protection will be installed at the outlet of the pipe. Refer to the appendix for an analysis of both storm systems.

The temporary channel is designed to carry a flow of 13.1 cfs. The channel geometry consists of a trapezoidal ditch with a 5' bottom width, 4 to 1 side slopes, a channel slope of 1.0 % and a height of 2'. Based on these parameters, the channel will have a velocity of 2.61 ft/s and a flow depth of 8.0 inches. The velocity is well within the range allowed by the criteria manual for a natural channel, and there is 16 inches of freeboard for the channel. Design of this channel is included in the appendix.

From this location, Basin D25e and flow from the channel are all combined at DP-11, an existing culvert under Rolling Thunder Way. From this report, DP-11 has flows of 36.7 cfs and 67.7 cfs. The approved Market Place Filing No. 1 Report shows flows of 38.7 and 71.3 cfs. Based on the new analysis for this area, the developed flows at DP-11 are less than those previously assumed. Therefore there will be no adverse impacts to any of the downstream facilities from this area.

WATER QUALITY:

No water quality will be necessary for this site, as all flows are directed towards Pond WU which has a water quality facility.

POND WU DISCUSSION:

All previous drainage reports (including Falcon Highlands Market Place Filing No. 1 FDR) have shown storm runoff from Lot 7 to enter Pond WU. Based on the proposed conditions for the area, the construction of this project the outlet structure of the pond will need to be modified. Based on the entire build out of the Falcon Highlands development, a recommendation has been determined, which will allow the 5-year storm to release at a historic rate. This recommendation also enhances the 100-year release rate from the pond. The recommendation, to ensure the 5-year historic release rate is to cover on the of the two grate openings on top of the orifice pipes and to cover both of the 24" pipe openings in the headwall. This will leave all of the 12" pipes open and the second grate open. Based on these modifications, the historic rates will be met. See Table below for comparison of flows.

| Design Point | 5-Yr Historic | 5-Yr Proposed | 100-Yr Historic | 100-Year Proposed |
|---|---|---|---|---|
| WU | 148 | 141 | 1657 | 1132 |
| WV | 149 | 149 | 1650 | 1120 |

## EROSION CONTROL

During construction, best management practices for erosion control will be employed based on the City of Colorado Springs/El Paso County Drainage Criteria and Volume II (the Erosion Control Manual) and the erosion control plans. During construction, silt fencing, a temporary sediment basin and vehicle-tracking controls will be in place to minimize erosion from the site. Silt fencing will be placed along the south (downhill) side of the site. This will inhibit suspended sediment from leaving the site during construction. Silt fencing is to remain in place until vegetation is reestablished after completion of construction. The sediment basin will be graded in along the proposed temporary channel, downstream of all construction activities. Best erosion control practices will be utilized as deemed necessary by the Contractor, Engineer or County Inspector and are not limited to the measures described above.

## CONCLUSION

The proposed drainage design will be effective to control damage from design storm runoff. This Drainage Report for the Site is in accordance with Section 4.5 of the El Paso County Drainage Criteria manual.

If you have any questions or comments, please contact me at 719-227-7388.

Sincerely,
**Springs Engineering**

Charlene Sammons, P. E..
Project Engineer

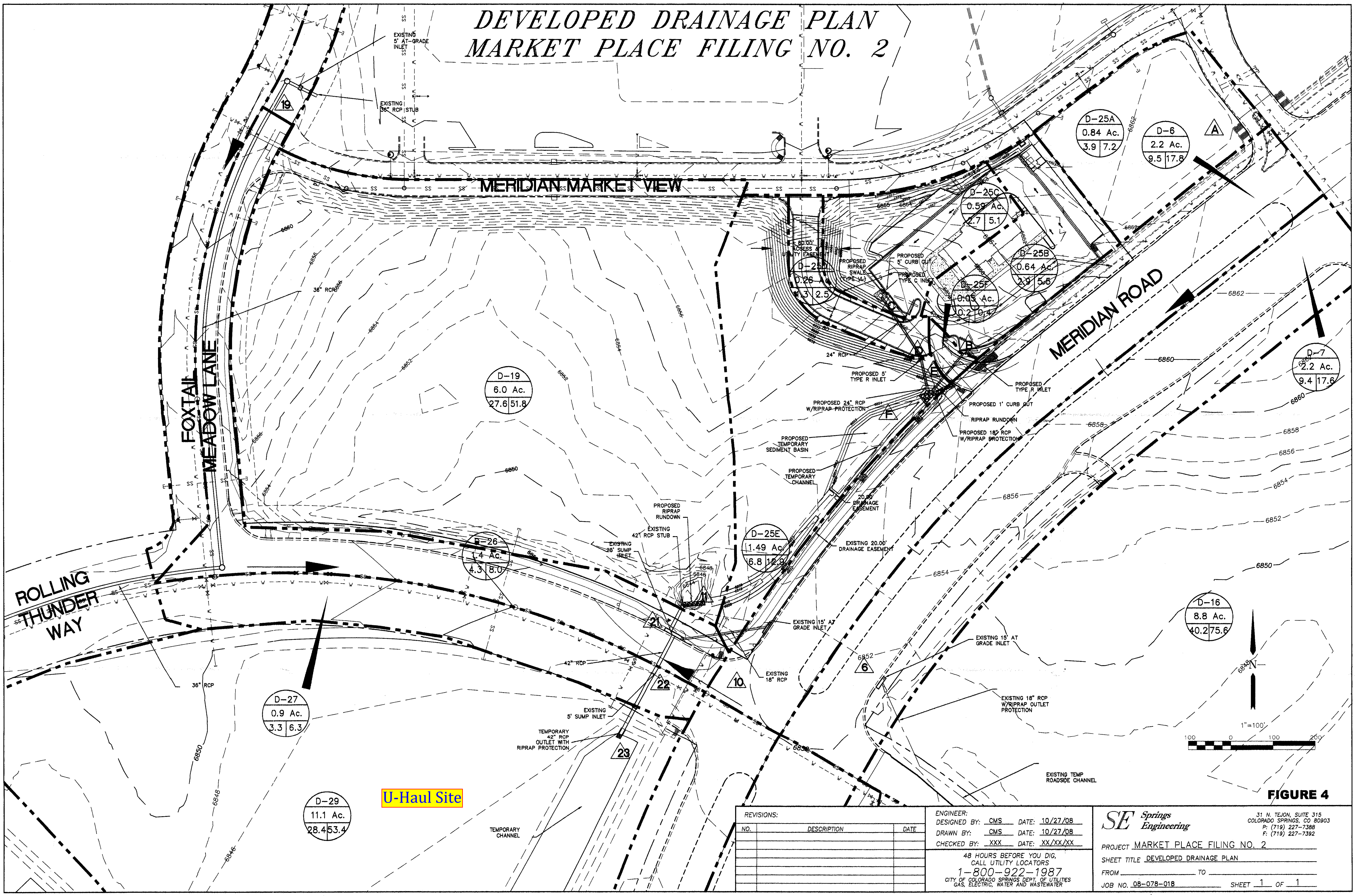

DEVELOPED DRAINAGE PLAN
MARKET PLACE FILING NO. 2
MERIDIAN MARKET VIEW
MERIDIAN ROAD
FOXTAIL MEADOW LANE
ROLLING THUNDER WAY
D-25A 0.84 Ac. 3.9 7.2
D-6 2.2 Ac. 9.5 17.8
D-25C 0.59 Ac. 2.7 5.1
D-25B 0.64 Ac. 2.9 5.6
D-25F 0.05 Ac. 0.2 0.4
D-25D 0.26 Ac. 1.3 2.5
D-7 2.2 Ac. 9.4 17.6
D-19 6.0 Ac. 27.6 51.8
D-26 1.4 Ac. 4.3 8.0
D-25E 1.49 Ac. 6.8 12.9
D-16 8.8 Ac. 40.2 75.6
D-27 0.9 Ac. 3.3 6.3
D-29 11.1 Ac. 28.4 53.4
U-Haul Site
EXISTING 5' AT-GRADE INLET
EXISTING 36" RCP STUB
36" RCP
24" RCP
PROPOSED 5' TYPE R INLET
PROPOSED 24" RCP W/RIPRAP PROTECTION
PROPOSED TEMPORARY SEDIMENT BASIN
PROPOSED TEMPORARY CHANNEL
PROPOSED RIPRAP RUNDOWN
EXISTING 42" RCP STUB
EXISTING 26' SUMP INLET
20.00' DRAINAGE EASEMENT
EXISTING 20.00' DRAINAGE EASEMENT
PROPOSED TYPE R INLET
PROPOSED 1' CURB CUT
RIPRAP RUNDOWN
PROPOSED 18" RCP W/RIPRAP PROTECTION
PROPOSED RIPRAP SWALE
PROPOSED 5' CURB CUT
PROPOSED TYPE C INLET
EXISTING 15' AT GRADE INLET
EXISTING 18" RCP
42" RCP
EXISTING 5' SUMP INLET
TEMPORARY 42" RCP OUTLET WITH RIPRAP PROTECTION
EXISTING 18" RCP W/RIPRAP OUTLET PROTECTION
EXISTING TEMP ROADSIDE CHANNEL
TEMPORARY CHANNEL
1"=100'
100 0 100 200
REVISIONS:
NO. DESCRIPTION DATE
ENGINEER:
DESIGNED BY: CMS DATE: 10/27/08
DRAWN BY: CMS DATE: 10/27/08
CHECKED BY: XXX DATE: XX/XX/XX
48 HOURS BEFORE YOU DIG, CALL UTILITY LOCATORS
1-800-922-1987
CITY OF COLORADO SPRINGS DEPT. OF UTILITIES GAS, ELECTRIC, WATER AND WASTEWATER
SE Springs Engineering
31 N. TEJON, SUITE 315 COLORADO SPRINGS, CO 80903
P: (719) 227-7388
F: (719) 227-7392
PROJECT MARKET PLACE FILING NO. 2
SHEET TITLE DEVELOPED DRAINAGE PLAN
FROM TO
JOB NO. 08-078-018 SHEET 1 OF 1

**FIGURE 4**

| DESIGN POINT | CONTRIBUTING BASINS | CA(equivalent) | | Tc | INTENSITY | | TOTAL FLOWS | |
|---|---|---|---|---|---|---|---|---|
| | | CA(5) | CA(100) | (min.) | I(5) (in/hr) | I(100) (in/hr) | Q(5) (cfs) | Q(100) (cfs) |
| 10 | D-6 | 2.02 | 2.13 | 6.8 | 4.7 | 8.2 | 9.5 | 17.5 |
| | | | | TRAVEL TIME | | | | |
| | | 2.02 | 2.13 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 83 | 5.8 | 0.2 | 7.0 |
| 11 | D-19 | 5.40 | 5.70 | 7.6 | 4.5 | 7.9 | 36.7 | 67.7 |
| | D-25e | 1.34 | 1.42 | | | | | |
| | DP-E | 1.38 | 1.46 | TRAVEL TIME | | | | |
| | Entrance to Ex. 42" RCP at NE corner site under Rolling Thunder | 8.13 | 8.58 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | | 0.0 | 0.0 | 7.6 |
| 13 | D-12 | 1.94 | 2.04 | 6.3 | 4.8 | 8.4 | 9.4 | 17.2 |
| | | | | TRAVEL TIME | | | | |
| | | 1.94 | 2.04 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 98 | 6.1 | 0.3 | 6.5 |
| 14 | D-11 | 1.96 | 2.07 | 6.8 | 4.7 | 8.2 | 9.2 | 17.0 |
| | | | | TRAVEL TIME | | | | |
| | | 1.96 | 2.07 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | | 5.2 | 0.0 | 6.8 |
| 15 | D-15 | 2.09 | 2.20 | 5.4 | 5.1 | 8.9 | 10.6 | 19.6 |
| | | | | TRAVEL TIME | | | | |
| | | 2.09 | 2.20 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 347 | 2.0 | 2.9 | 8.3 |
| 16 | D-14 | 2.36 | 2.49 | 5.8 | 5.0 | 8.6 | 11.7 | 21.5 |
| | | | | TRAVEL TIME | | | | |
| | | 2.36 | 2.49 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 62 | 9.0 | 0.1 | 5.9 |
| 17 | DP-7 | 8.51 | 9.12 | 8.7 | 4.3 | 7.5 | 157.9 | 300.6 |
| | DP-13 | 1.94 | 2.04 | | | | | |
| | D-17 | 21.50 | 22.70 | | | | | |
| | OFFSITE | 4.89 | 6.28 | TRAVEL TIME | | | | |
| | | 36.83 | 40.14 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 36 | 1.5 | 0.4 | 9.1 |
| 18 | DP-17 | 36.83 | 40.14 | 5.9 | 4.9 | 8.6 | 181.2 | 345.5 |
| | DP-15 (INLET) | 0.00 | 0.07 | | | | | |
| | DP-16 (INLET) | 0.00 | 0.00 | TRAVEL TIME | | | | |
| | | 36.83 | 40.21 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 139 | 8.4 | 0.3 | 6.2 |

| DESIGN POINT | CONTRIBUTING BASINS | CA(equivalent) CA(5) | CA(100) | Tc (min.) | INTENSITY I(5) (in/hr) | I(100) (in/hr) | TOTAL FLOWS Q(5) (cfs) | Q(100) (cfs) |
|---|---|---|---|---|---|---|---|---|
| 19 | D-18 | 0.72 | 0.76 | 5.5 | 5.0 | 8.8 | 3.6 | 6.7 |
| | | | | TRAVEL TIME | | | | |
| | | 0.72 | 0.76 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 62 | 9.0 | 0.1 | 5.7 |
| 21 | D-26 | 1.28 | 1.35 | 16.2 | 3.2 | 5.7 | 10.2 | 12.3 |
| | DP-10 (INLET) | 0.64 | 0.82 | | | | | |
| | D-22 | 1.15 | 1.22 | | | | | |
| | DP-19 (INLET) | 0.06 | 0.04 | TRAVEL TIME | | | | |
| | | 3.13 | 2.17 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 139 | 8.4 | 0.3 | 16.5 |
| 22 | D-27 | 0.77 | 0.82 | 8.7 | 4.3 | 7.5 | 3.3 | 6.1 |
| | DP 21 (INLET) | 0.00 | 0.00 | TRAVEL TIME | | | | |
| | | 0.77 | 0.82 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 139 | 8.4 | 0.3 | 8.9 |
| 23 | DP-11 | 8.13 | 8.58 | 10.5 | 4.0 | 6.9 | 35.3 | 65.1 |
| | DP-22 (INLET) | 0.77 | 0.82 | | | | | |
| | Ex. 42" RCP at NE corner site under Rolling Thunder draining into U-Haul site | | | TRAVEL TIME | | | | |
| | | 8.90 | 9.39 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 139 | 8.4 | 0.3 | 10.8 |
| 24 | D-29 | 10.03 | 10.58 | 22.5 | 2.7 | 4.8 | 51.7 | 95.4 |
| | DP-23 | 8.90 | 9.39 | | | | | |
| | Basin D-29 is U-Haul site. DP 24 is U-Haul site plus Ex. 42" RCP flows | | | TRAVEL TIME | | | | |
| | | 18.93 | 19.98 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 83 | 5.8 | 0.2 | 22.7 |
| 25 | DP-18 | 36.83 | 40.21 | 13.0 | 3.6 | 6.3 | 221.9 | 1479.1 |
| | POND WU | 19.44 | 188.25 | | | | | |
| | DP-14 | 1.96 | 2.07 | | | | | |
| | D-30 | 3.29 | 4.23 | | | | | |
| | | | | TRAVEL TIME | | | | |
| | | 61.53 | 234.76 | Type/flow | Length (ft) | Velocity (fps) | d. Time (min) | T. Time (min) |
| | | | | | 83 | 5.8 | 0.2 | 13.3 |

Galloway

# MDDP & DBPS AMENDMENT

## BENT GRASS DEVELOPMENT

El Paso County, Colorado

PREPARED FOR:
**Challenger Communities, LLC**
**8605 Explorer Dr., Suite 250**
**Colorado Springs, CO 80920**

PREPARED BY:
**Galloway & Company, Inc.**
**1155 Kelly Johnson Blvd., Suite 305**
**Colorado Springs, CO 80920**

DATE:
**January 2021**
**Revised: March 2021**
**Revised: April 2021**
**Revised: June 2021**
**Revised: August 2021**
**Revised: September 2021**

**PUDSP-20-005**

any new development and detention will be required for new development north of Bent Grass Meadows Drive. Also, in the future conditions scenario, Pond SR-4 and existing Pond MN from the Falcon DBPS will receive flows from the improved school site. The HEC-HMS has been updated and is included in Appendix B. As discussed previously, the “School Site” have been added as an additional Basin MT060a, which is routed to the regional detention facility SR-4.

Basin MT070, described in the Falcon DBPS, was analyzed to include the improvements made to the site within Basin MT070 and the effects it has on existing Pond MN.

From the analysis, Pond SR-4’s 100-yr. receiving flows increased from 1,000 cfs to 1072.8 cfs. Based on the increase in impervious area, Basin MT070’s Curve Number increased from 67 to 68. Subsequently, the 100-yr. receiving flows entering existing Pond MN decreased to 727.3 cfs from 850 cfs.

Release rates for SR-4 are 14.8 cfs for the 2-year storm and 700.3 cfs for the 100-year storm. Falcon DBPS has 2-year storm listed as 27 cfs and 100-year storm as 730 cfs. This gives a decrease of 12.2 cfs and 29.7 cfs for the 2 and 100-year events respectively.

Pond MN release rates 14.4 cfs for the 2-year storm and 691.7 cfs for the 100-year storm. The DBPS has release rates listed as 32 cfs for the 2-year storm and 820 cfs for the 100-year storm. This gives a decrease of 17.6 cfs and 128.3 cfs for the 2 and 100-year events respectively.

The West Tributary site does include the addition of proposed water quality ponds with the Bent Grass development, under the current scenario. Under future conditions, additional water quality facilities will be necessary for any other new developments. Existing Pond WU, further south in the West Tributary, near Highway 24, is a regional detention facility for areas (approximately 2,312 acres) just upstream of the pond, as well as providing water quality for the west side of the same Falcon Highlands area.

Pond WU release rates 45.9 for the 2-year storm and 921.2 cfs for the 100-year storm. The DBPS has release rates listed as 55 cfs for the 2-year storm and 1000 cfs for the 100-year storm. This gives a decrease of 9.1 cfs and 78.8 cfs for the 2 and 100-year events respectively.

# XI. Maintenance

The proposed channels are to be private facilities.  They will be maintained by the Bent Grass Metropolitan district. When completion of future DBPS construction improvements and upon the Board of County Commissioners acceptance the channels, Reaches RWT 204 & RWT210, will then be owned and maintained by El Paso County along with all drainage facilities within the public Right-of-Way.

# XII. Wetlands Mitigation

No wetlands are located on site.

# XIII. Floodplain Statement

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map number 08041C0553G, effective December 7, 2018, there is a floodplain in a portion of the project area. A copy of the FIRM Panel is included in Appendix A.

The portion of channel that has a floodplain designation is only the RWT210 and RWT204 portions of the channel.  It is unknown why the western channel, RWT202 is unmapped since it is the larger contributor

Pond WU downstream of site

# *STAGE - STORAGE - DISCHARGE TABLE (POND WU - OUTLET REVISIONS)*

per UDFCD UD-Detention Spreadsheet

| Elevation | Stage | Orifice Plate | Horiz Weir | Total Collection Capacity (WQCV & Weir) | Controlling Flowrate Culvert #1 (48") | Controlling Flowrate Culvert #2 (60") | Controlling Flowrate Culvert #3 (60") | Controlling Flowrate Culvert #4 (60") | Total Controlling Flowrate - Outlet Culverts | Spill Way | Total Outflow* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| [ft] | [ft] | [cfs] | [cfs] | [cfs] | [cfs] | [cfs] | [cfs] | [cfs] | [cfs] | [cfs] | [cfs] |
| 6816.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 6818.20 | 1.90 | 1.34 | 0.00 | 1.34 | 1.34 | 1.34 | 1.34 | 1.34 | 5.36 | 0.00 | 1.34 |
| 6819.00 | 2.70 | 2.18 | 0.00 | 2.18 | 2.18 | 2.18 | 2.18 | 2.18 | 8.72 | 0.00 | 2.18 |
| 6820.00 | 3.70 | 3.28 | 0.00 | 3.28 | 3.28 | 3.28 | 3.28 | 3.28 | 13.12 | 0.00 | 3.28 |
| 6821.00 | 4.70 | 4.53 | 0.00 | 4.53 | 4.53 | 4.53 | 4.53 | 4.53 | 18.12 | 0.00 | 4.53 |
| 6822.00 | 5.70 | 5.90 | 78.71 | 84.61 | 84.61 | 84.61 | 84.61 | 84.61 | 338.44 | 0.00 | 84.61 |
| 6823.00 | 6.70 | 6.91 | 544.70 | 551.61 | 116.75 | 134.68 | 153.58 | 150.75 | 555.76 | 0.00 | 551.61 |
| 6824.00 | 7.70 | 7.76 | 1233.69 | 1241.44 | 135.78 | 174.76 | 189.73 | 187.47 | 687.74 | 0.00 | 687.74 |
| 6825.00 | 8.70 | 8.51 | 2087.92 | 2096.43 | 152.52 | 207.28 | 220.03 | 218.07 | 797.90 | 0.00 | 797.90 |
| 6826.00 | 9.70 | 9.19 | 3080.00 | 3089.19 | 167.63 | 235.34 | 246.62 | 244.87 | 894.46 | 0.00 | 894.46 |
| 6827.00 | 10.70 | 9.83 | 4192.88 | 4202.71 | 181.43 | 260.37 | 270.62 | 269.03 | 981.45 | 0.00 | 981.45 |
| 6828.00 | 11.70 | 10.42 | 5414.65 | 5425.07 | 194.30 | 283.23 | 292.66 | 291.20 | 1061.39 | 0.00 | 1061.39 |
| 6829.00 | 12.70 | 10.98 | 6249.18 | 6260.16 | 206.36 | 304.32 | 313.16 | 311.78 | 1135.62 | 16.43 | 1152.05 |
| 6830.00 | 13.70 | 11.52 | 6659.12 | 6509.89 | 217.74 | 324.10 | 332.39 | 331.10 | 1205.33 | 148.29 | 1353.62 |
| 6830.20 | 13.90 | 11.62 | 6738.12 | 6509.99 | 219.95 | 327.91 | 336.10 | 334.82 | 1218.78 | 183.81 | 1402.59 |

** - Based on Spillway flow plus lesser flow of Total Collection Capacity (WQCV &Weir) or Total Controlling Flowrate - Outlet Culverts*

# FUTURE HMS MODEL - 100 YEAR STORM

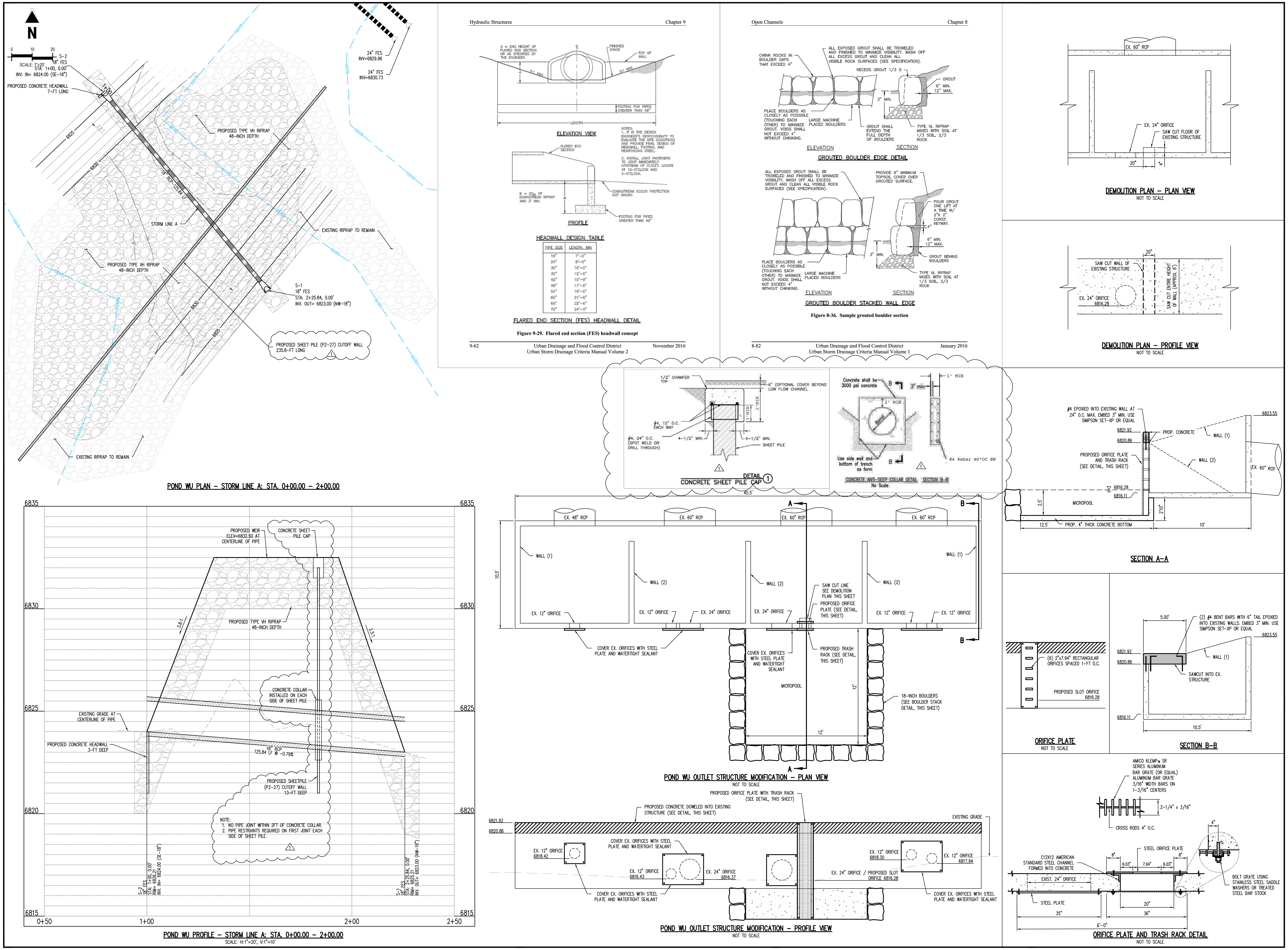
| Hydrologic Element | Drainage Area | Peak Discharge | Time of Peak | Volume |
|---|---|---|---|---|
| | (MI2) | (CFS) | | (AC-FT) |
| RWT150 | 0.14453 | 193.3 | 01Jan2011, 06:22 | 16.8 |
| WT150-REV | 0.13081 | 202.5 | 01Jan2011, 06:08 | 15 |
| Paint Brush Hills Pond B1 | 0.27534 | 235.6 | 01Jan2011, 06:29 | 31.8 |
| W34B2-REV | 0.09359 | 141.8 | 01Jan2011, 06:07 | 10.2 |
| Paint Brush Hills Pond B2 | 0.36893 | 234.3 | 01Jan2011, 06:43 | 38.9 |
| JWT150 | 0.36893 | 234.3 | 01Jan2011, 06:43 | 38.9 |
| RWT160 | 0.36893 | 234.2 | 01Jan2011, 06:49 | 38.8 |
| WT160-REV | 0.07348 | 109.9 | 01Jan2011, 06:06 | 7.5 |
| JWT160 | 0.44241 | 244.8 | 01Jan2011, 06:48 | 46.3 |
| RWT174 | 0.44241 | 244.7 | 01Jan2011, 06:56 | 46.2 |
| WT170-REV | 0.106015 | 85.2 | 01Jan2011, 06:19 | 9.2 |
| W34-CY-REV | 0.0465469 | 38.1 | 01Jan2011, 06:16 | 3.8 |
| JWT172 | 2.378328 | 981.9 | 01Jan2011, 06:56 | 199.7 |
| RWT176 | 2.378328 | 981.6 | 01Jan2011, 06:57 | 199.7 |
| Sub Regional Pond SR2 | 2.378328 | 972.9 | 01Jan2011, 07:01 | 194.8 |
| JWT174 | 2.378328 | 972.9 | 01Jan2011, 07:01 | 194.8 |
| RWT180 | 2.378328 | 972.1 | 01Jan2011, 07:10 | 194.2 |
| WT180-REV | 0.04094 | 29.3 | 01Jan2011, 06:19 | 3.2 |
| JWT180 | 2.419268 | 978 | 01Jan2011, 07:10 | 197.4 |
| RWT202 | 2.419268 | 977.7 | 01Jan2011, 07:16 | 197.1 |
| WT200-N | 0.191 | 121 | 01Jan2011, 06:29 | 16.5 |
| WT200-W | 0.068 | 64.4 | 01Jan2011, 06:13 | 5.9 |
| WT190 | 0.0574561 | 74.7 | 01Jan2011, 06:05 | 5 |
| The Meadows Pond #1 | 0.0574561 | 2.1 | 01Jan2011, 08:29 | 2.8 |
| JWT190 | 0.0574561 | 2.1 | 01Jan2011, 08:29 | 2.8 |
| RWT204 | 0.0574561 | 2.1 | 01Jan2011, 08:46 | 2.7 |
| 40 | 2.7357241 | 1029.1 | 01Jan2011, 07:15 | 222.1 |
| RWT206 | 2.7357241 | 1027.9 | 01Jan2011, 07:17 | 221.9 |
| BG | 0.184 | 255.6 | 01Jan2011, 06:17 | 24.7 |
| WT210-N | 0.074 | 77.5 | 01Jan2011, 06:17 | 7.8 |
| CC | 2.9937241 | 1075.3 | 01Jan2011, 07:16 | 254.4 |
| RWT210 | 2.9937241 | 1074.9 | 01Jan2011, 07:20 | 254.1 |
| WT210-S | 0.117 | 116.2 | 01Jan2011, 06:19 | 12.4 |
| JWT210 | 3.1107241 | 1093.7 | 01Jan2011, 07:20 | 266.5 |
| RWT232 | 3.1107241 | 1093.3 | 01Jan2011, 07:23 | 266.1 |
| WT220-S | 0.118 | 178.8 | 01Jan2011, 06:08 | 13.3 |
| JWT220 | 0.118 | 178.8 | 01Jan2011, 06:08 | 13.3 |
| RWT234 | 0.118 | 177.6 | 01Jan2011, 06:18 | 13.3 |
| JWT232 | 3.2287241 | 1107.7 | 01Jan2011, 07:23 | 279.4 |
| RWT236 | 3.2287241 | 1107.7 | 01Jan2011, 07:23 | 279.4 |
| WT230 | 0.19818 | 346.7 | 01Jan2011, 06:05 | 23.1 |
| JWT234 | 3.4269041 | 1125.3 | 01Jan2011, 07:23 | 302.4 |

West Trib adj
to U-Haul site

U-Haul is in this basin

# FUTURE HMS MODEL - 100 YEAR STORM

| Hydrologic Element | Drainage Area | Peak Discharge | Time of Peak | Volume |
|---|---|---|---|---|
| | (MI2) | (CFS) | | (AC-FT) |
| RWT240 | 3.4269041 | 1124.7 | 01Jan2011, 07:26 | 302.2 |
| WT240 | 0.0761461 | 160.3 | 01Jan2011, 06:01 | 9.1 |
| Regional Pond WU North | 3.5030502 | 1130.7 | 01Jan2011, 07:27 | 310.1 |
| Regional Pond WU Diversion | 3.5030502 | 1092 | 01Jan2011, 07:27 | 266.8 |
| Old Meridian | 0.03359 | 85 | 01Jan2011, 06:07 | 6.1 |
| RWT-OM | 0.03359 | 84.2 | 01Jan2011, 06:12 | 6.1 |
| Regional Pond WU South | 3.5366402 | 921.2 | 01Jan2011, 07:48 | 265.7 |
| RWT240_Diversion Reach | 0 | 38.7 | 01Jan2011, 07:32 | 43.1 |
| JWT240 | 3.5366402 | 959.8 | 01Jan2011, 07:48 | 308.8 |
| RWT250 | 3.5366402 | 959.5 | 01Jan2011, 07:49 | 308.7 |
| WT250 | 0.14695 | 291.4 | 01Jan2011, 06:02 | 17.1 |
| JWT250 | 3.6835902 | 971.8 | 01Jan2011, 07:49 | 325.8 |
| RWT260 | 3.6835902 | 971.4 | 01Jan2011, 07:59 | 324.8 |
| WT260 | 0.1388002 | 77.5 | 01Jan2011, 06:34 | 11.5 |
| JWT260 | 3.8223904 | 985.5 | 01Jan2011, 07:58 | 336.4 |
| RWT291 | 3.8223904 | 985.4 | 01Jan2011, 08:01 | 336.1 |
| WT270 | 0.0324738 | 57.1 | 01Jan2011, 06:04 | 3.6 |
| JWT270 | 0.0324738 | 57.1 | 01Jan2011, 06:04 | 3.6 |
| RWT292 | 0.0324738 | 56.9 | 01Jan2011, 06:08 | 3.5 |
| JWT292 | 3.8548642 | 988 | 01Jan2011, 08:01 | 339.7 |
| RWT295 | 3.8548642 | 987.9 | 01Jan2011, 08:02 | 339.6 |
| WT280 | 0.26695 | 251.8 | 01Jan2011, 06:12 | 22.3 |
| JWT280 | 0.26695 | 251.8 | 01Jan2011, 06:12 | 22.3 |
| RWT294 | 0.26695 | 251.2 | 01Jan2011, 06:15 | 22.2 |
| JWT294 | 4.1218142 | 1005.7 | 01Jan2011, 08:02 | 361.8 |
| RWT296 | 4.1218142 | 1005.3 | 01Jan2011, 08:07 | 361.1 |
| MT040 | 0.30842 | 455.2 | 01Jan2011, 06:11 | 38.1 |
| MT030 | 0.15663 | 228.6 | 01Jan2011, 06:05 | 15.1 |
| MT020 | 0.0902033 | 143.1 | 01Jan2011, 06:04 | 9 |
| JMT020 | 0.0902033 | 143.1 | 01Jan2011, 06:04 | 9 |
| RMT030 | 0.0902033 | 141.8 | 01Jan2011, 06:17 | 8.9 |
| JMT030 | 0.2468333 | 294.4 | 01Jan2011, 06:07 | 24 |
| RMT040 | 0.2468333 | 293 | 01Jan2011, 06:11 | 24 |
| Woodmen Hills Pond H | 0.5552533 | 751.7 | 01Jan2011, 06:11 | 61.7 |
| JMT040 | 0.5552533 | 751.7 | 01Jan2011, 06:11 | 61.7 |
| RMT050 | 0.5552533 | 745.8 | 01Jan2011, 06:14 | 61.7 |
| MT050 | 0.11861 | 109.7 | 01Jan2011, 06:18 | 11.4 |
| JMT050 | 0.6738633 | 851.9 | 01Jan2011, 06:14 | 73.1 |
| RMT062 | 0.6738633 | 849.2 | 01Jan2011, 06:16 | 73 |
| MT010 | 0.28989 | 139.9 | 01Jan2011, 06:24 | 17.7 |
| The Meadows Pond #2 | 0.28989 | 63.5 | 01Jan2011, 06:55 | 14.1 |
| JMT010 | 0.28989 | 63.5 | 01Jan2011, 06:55 | 14.1 |




**Galloway**

1155 Kelly Johnson Blvd., Suite 305
Colorado Springs, CO 80920
719.900.7220
GallowayUS.com

03/04/2021



CHALLENGER HOMES

FINAL GRADING & EROSION CONTROL PLANS
BENT GRASS RESIDENTIAL FILING NO. 2
FOR
CHALLENGER COMMUNITIES, LLC.

BENT GRASS MEADOWS DRIVE & MERIDIAN ROAD
FALCON, CO 80831 - EL PASO COUNTY

| # | Date | Issue / Description | Init. |
|---|---|---|---|
| 1 | 03/04/21 | CUT OFF WALL TO SHEET PILE | RGD |

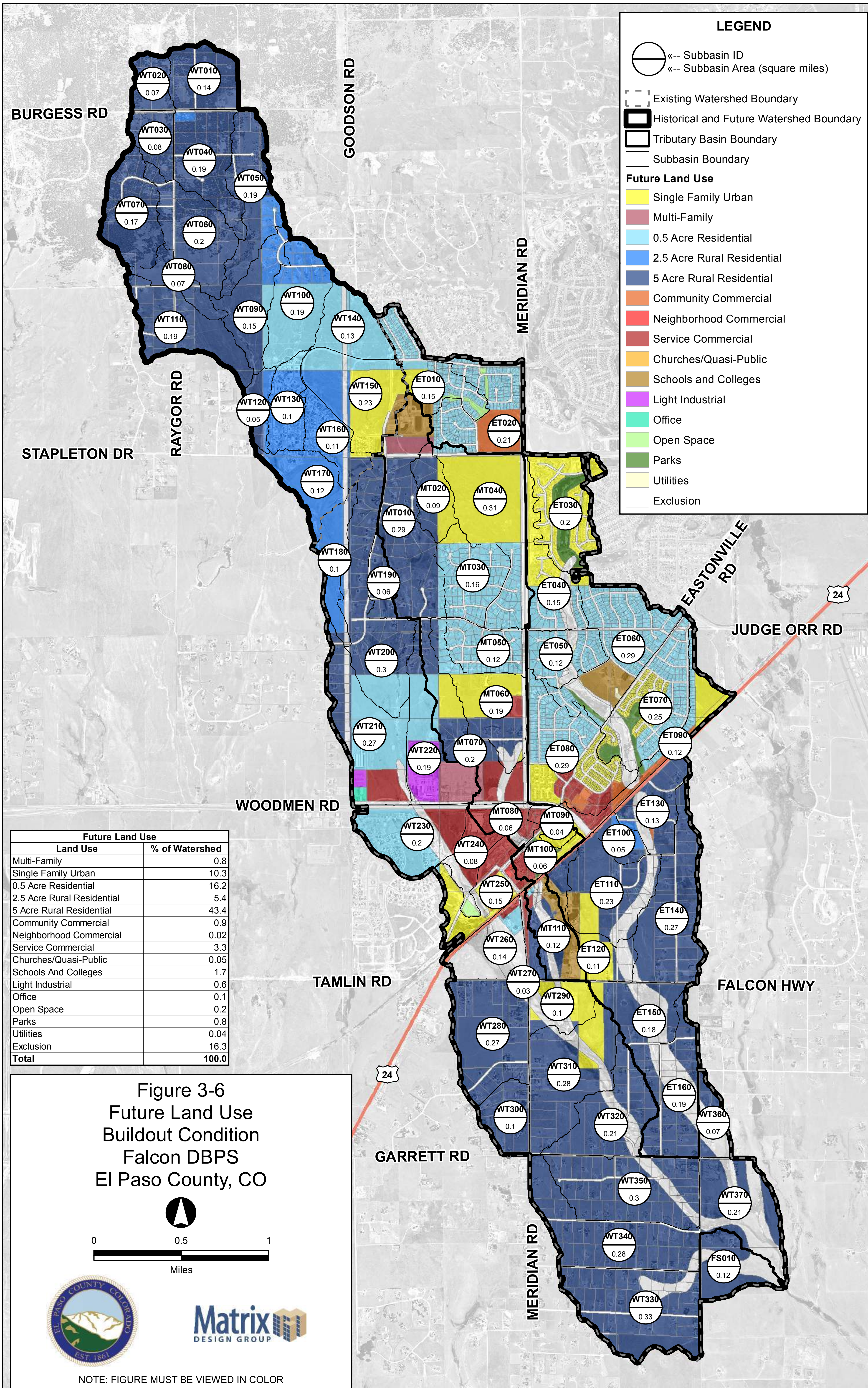
APPROVED
Engineering Department
03/08/2021 9:57:35 AM
dsdnijkamp
EPC Planning & Community Development Department

| | |
|---|---|
| Project No: | CLH000014.20 |
| Drawn By: | JDP |
| Checked By: | RGD |
| Date: | 3/4/2021 |

POND WU DETAILS

G6.06

Sheet 20 of 29




| Future Land Use | |
|---|---|
| Land Use | % of Watershed |
| Multi-Family | 0.8 |
| Single Family Urban | 10.3 |
| 0.5 Acre Residential | 16.2 |
| 2.5 Acre Rural Residential | 5.4 |
| 5 Acre Rural Residential | 43.4 |
| Community Commercial | 0.9 |
| Neighborhood Commercial | 0.02 |
| Service Commercial | 3.3 |
| Churches/Quasi-Public | 0.05 |
| Schools And Colleges | 1.7 |
| Light Industrial | 0.6 |
| Office | 0.1 |
| Open Space | 0.2 |
| Parks | 0.8 |
| Utilities | 0.04 |
| Exclusion | 16.3 |
| **Total** | **100.0** |

Figure 3-6
Future Land Use
Buildout Condition
Falcon DBPS
El Paso County, CO

FILE: G:\gis_projects\Falcon_Creek_DBPS\active\apps\20130617\Fig_3-6_landuse_future.mxd, 6/18/2013, ron_ramold

# FALCON DRAINAGE BASIN PLANNING STUDY

## SELECTED PLAN REPORT

**FINAL - SEPTEMBER 2015**

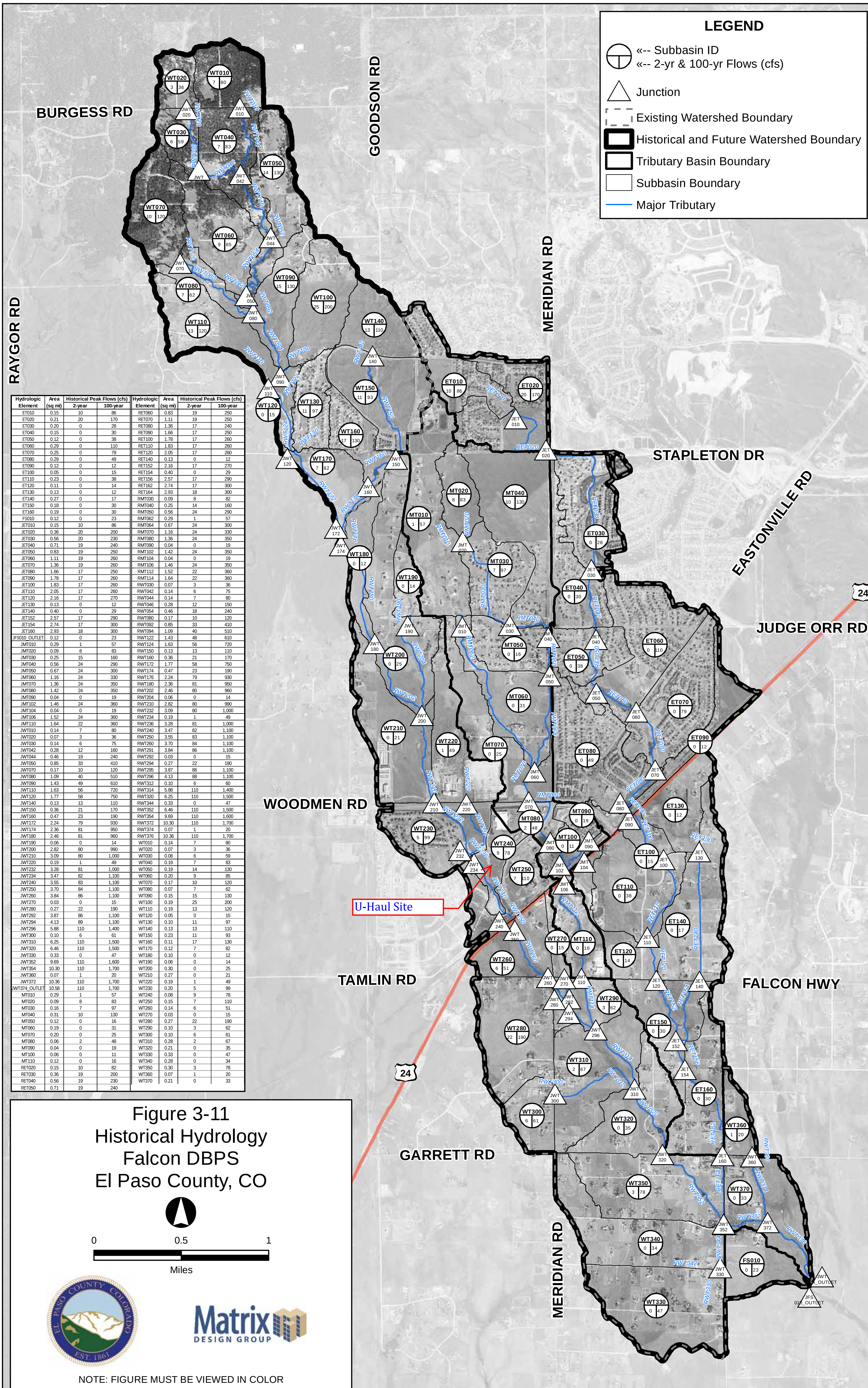
Prepared for:

El Paso County Public Services Department
3275 Akers Drive
Colorado Springs, CO 80922

Prepared By:

Matrix Design Group
2435 Research Parkway, Suite 300
Colorado Springs, CO 80920

Matrix Project No. 10.122.003



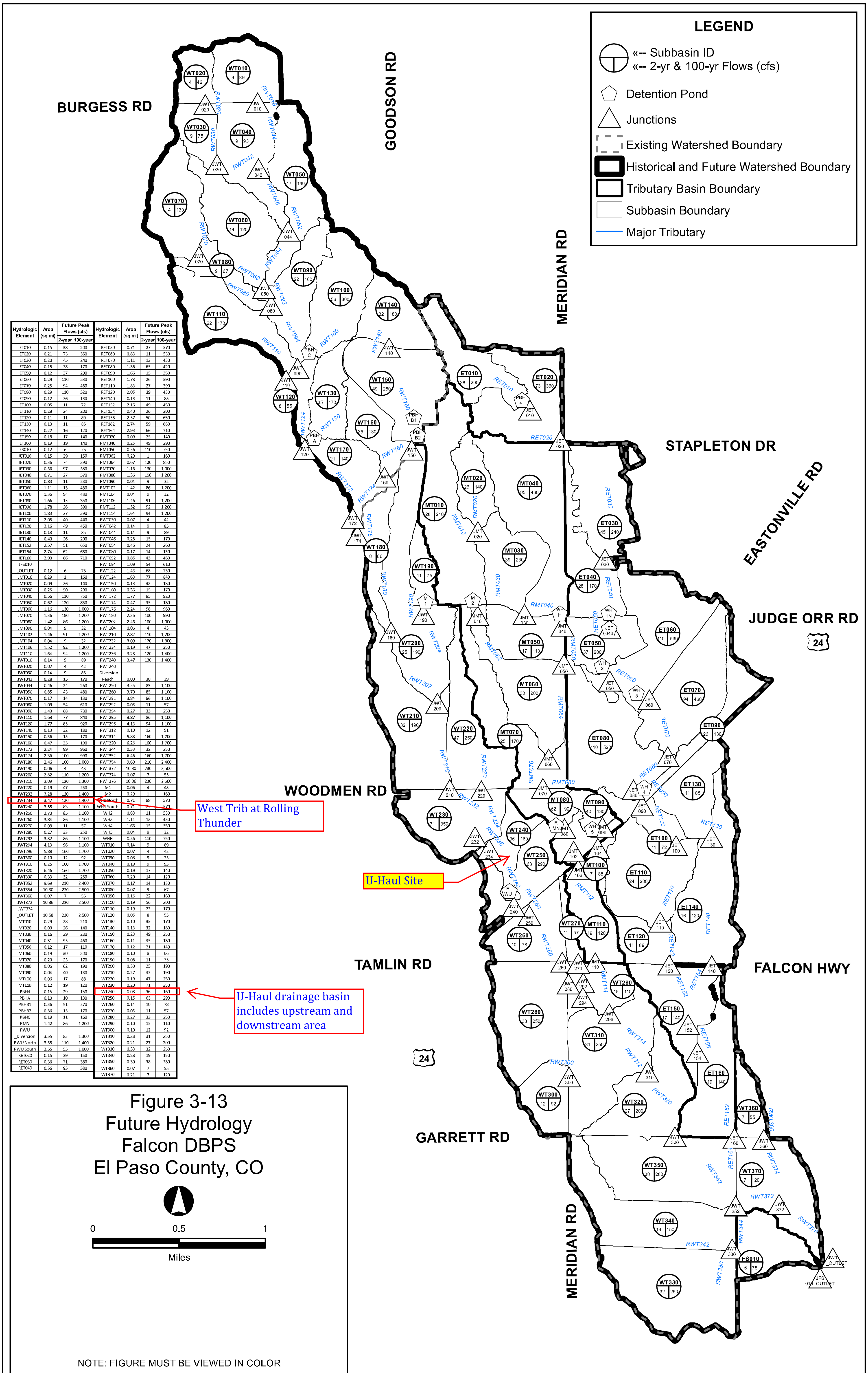

| Hydrologic Element | Area (sq mi) | Historical Peak Flows (cfs) | | Hydrologic Element | Area (sq mi) | Historical Peak Flows (cfs) | |
|---|---|---|---|---|---|---|---|
| | | 2-year | 100-year | | | 2-year | 100-year |
| ET010 | 0.15 | 10 | 86 | RET060 | 0.83 | 19 | 250 |
| ET020 | 0.21 | 20 | 170 | RET070 | 1.11 | 19 | 250 |
| ET030 | 0.20 | 0 | 28 | RET080 | 1.36 | 17 | 240 |
| ET040 | 0.15 | 0 | 30 | RET090 | 1.66 | 17 | 250 |
| ET050 | 0.12 | 0 | 38 | RET100 | 1.78 | 17 | 260 |
| ET060 | 0.29 | 0 | 110 | RET110 | 1.83 | 17 | 260 |
| ET070 | 0.25 | 0 | 79 | RET120 | 2.05 | 17 | 260 |
| ET080 | 0.29 | 0 | 49 | RET140 | 0.13 | 0 | 12 |
| ET090 | 0.12 | 0 | 12 | RET152 | 2.16 | 17 | 270 |
| ET100 | 0.05 | 0 | 15 | RET154 | 0.40 | 0 | 29 |
| ET110 | 0.23 | 0 | 38 | RET156 | 2.57 | 17 | 290 |
| ET120 | 0.11 | 0 | 14 | RET162 | 2.74 | 17 | 300 |
| ET130 | 0.13 | 0 | 12 | RET164 | 2.93 | 18 | 300 |
| ET140 | 0.27 | 0 | 17 | RMT030 | 0.09 | 8 | 82 |
| ET150 | 0.18 | 0 | 30 | RMT040 | 0.25 | 14 | 160 |
| ET160 | 0.19 | 0 | 30 | RMT050 | 0.56 | 24 | 290 |
| FS010 | 0.12 | 0 | 23 | RMT062 | 0.29 | 1 | 57 |
| JET010 | 0.15 | 10 | 86 | RMT064 | 0.67 | 24 | 300 |
| JET020 | 0.36 | 20 | 200 | RMT070 | 1.16 | 24 | 330 |
| JET030 | 0.56 | 20 | 230 | RMT080 | 1.36 | 24 | 350 |
| JET040 | 0.71 | 19 | 240 | RMT090 | 0.04 | 0 | 19 |
| JET050 | 0.83 | 19 | 250 | RMT102 | 1.42 | 24 | 350 |
| JET060 | 1.11 | 19 | 260 | RMT104 | 0.04 | 0 | 19 |
| JET070 | 1.36 | 19 | 260 | RMT106 | 1.46 | 24 | 350 |
| JET080 | 1.66 | 17 | 250 | RMT112 | 1.52 | 22 | 360 |
| JET090 | 1.78 | 17 | 260 | RMT114 | 1.64 | 22 | 360 |
| JET100 | 1.83 | 17 | 260 | RWT030 | 0.07 | 3 | 36 |
| JET110 | 2.05 | 17 | 260 | RWT042 | 0.14 | 6 | 75 |
| JET120 | 2.16 | 17 | 270 | RWT044 | 0.14 | 7 | 80 |
| JET130 | 0.13 | 0 | 12 | RWT046 | 0.28 | 12 | 150 |
| JET140 | 0.40 | 0 | 29 | RWT054 | 0.46 | 18 | 240 |
| JET152 | 2.57 | 17 | 290 | RWT080 | 0.17 | 10 | 120 |
| JET154 | 2.74 | 17 | 300 | RWT092 | 0.85 | 33 | 410 |
| JET160 | 2.93 | 18 | 300 | RWT094 | 1.09 | 40 | 510 |
| JFS010_OUTLET | 0.12 | 0 | 23 | RWT122 | 1.43 | 48 | 610 |
| JMT010 | 0.29 | 1 | 57 | RWT124 | 1.63 | 56 | 720 |
| JMT020 | 0.09 | 8 | 83 | RWT150 | 0.13 | 13 | 110 |
| JMT030 | 0.25 | 15 | 160 | RWT160 | 0.36 | 21 | 170 |
| JMT040 | 0.56 | 24 | 290 | RWT172 | 1.77 | 58 | 750 |
| JMT050 | 0.67 | 24 | 300 | RWT174 | 0.47 | 23 | 190 |
| JMT060 | 1.16 | 24 | 330 | RWT176 | 2.24 | 79 | 930 |
| JMT070 | 1.36 | 24 | 350 | RWT180 | 2.36 | 81 | 950 |
| JMT080 | 1.42 | 24 | 350 | RWT202 | 2.46 | 80 | 960 |
| JMT090 | 0.04 | 0 | 19 | RWT204 | 0.06 | 0 | 14 |
| JMT102 | 1.46 | 24 | 360 | RWT210 | 2.82 | 80 | 990 |
| JMT104 | 0.04 | 0 | 19 | RWT232 | 3.09 | 80 | 1,000 |
| JMT106 | 1.52 | 24 | 360 | RWT234 | 0.19 | 1 | 49 |
| JMT110 | 1.64 | 22 | 360 | RWT236 | 3.28 | 81 | 1,000 |
| JWT010 | 0.14 | 7 | 80 | RWT240 | 3.47 | 82 | 1,100 |
| JWT020 | 0.07 | 3 | 36 | RWT250 | 3.55 | 83 | 1,100 |
| JWT030 | 0.14 | 6 | 75 | RWT260 | 3.70 | 84 | 1,100 |
| JWT042 | 0.28 | 12 | 160 | RWT291 | 3.84 | 86 | 1,100 |
| JWT044 | 0.46 | 19 | 240 | RWT292 | 0.03 | 0 | 15 |
| JWT050 | 0.85 | 33 | 410 | RWT294 | 0.27 | 22 | 190 |
| JWT070 | 0.17 | 10 | 120 | RWT295 | 3.87 | 86 | 1,100 |
| JWT080 | 1.09 | 40 | 510 | RWT296 | 4.13 | 88 | 1,100 |
| JWT090 | 1.43 | 49 | 610 | RWT312 | 0.10 | 6 | 60 |
| JWT110 | 1.63 | 56 | 720 | RWT314 | 5.88 | 110 | 1,400 |
| JWT120 | 1.77 | 58 | 750 | RWT320 | 6.25 | 110 | 1,500 |
| JWT140 | 0.13 | 13 | 110 | RWT344 | 0.33 | 0 | 47 |
| JWT150 | 0.36 | 21 | 170 | RWT352 | 6.46 | 110 | 1,500 |
| JWT160 | 0.47 | 23 | 190 | RWT354 | 9.69 | 110 | 1,600 |
| JWT172 | 2.24 | 79 | 930 | RWT372 | 10.30 | 110 | 1,700 |
| JWT174 | 2.36 | 81 | 950 | RWT374 | 0.07 | 1 | 20 |
| JWT180 | 2.46 | 81 | 960 | RWT376 | 10.36 | 110 | 1,700 |
| JWT190 | 0.06 | 0 | 14 | WT010 | 0.14 | 7 | 80 |
| JWT200 | 2.82 | 80 | 990 | WT020 | 0.07 | 3 | 36 |
| JWT210 | 3.09 | 80 | 1,000 | WT030 | 0.08 | 6 | 59 |
| JWT220 | 0.19 | 1 | 49 | WT040 | 0.19 | 7 | 83 |
| JWT232 | 3.28 | 81 | 1,000 | WT050 | 0.19 | 14 | 130 |
| JWT234 | 3.47 | 82 | 1,100 | WT060 | 0.20 | 9 | 85 |
| JWT240 | 3.55 | 83 | 1,100 | WT070 | 0.17 | 10 | 120 |
| JWT250 | 3.70 | 84 | 1,100 | WT080 | 0.07 | 7 | 62 |
| JWT260 | 3.84 | 86 | 1,100 | WT090 | 0.15 | 15 | 130 |
| JWT270 | 0.03 | 0 | 15 | WT100 | 0.19 | 25 | 200 |
| JWT280 | 0.27 | 22 | 190 | WT110 | 0.19 | 13 | 120 |
| JWT292 | 3.87 | 86 | 1,100 | WT120 | 0.05 | 0 | 15 |
| JWT294 | 4.13 | 89 | 1,100 | WT130 | 0.10 | 11 | 97 |
| JWT296 | 5.88 | 110 | 1,400 | WT140 | 0.13 | 13 | 110 |
| JWT300 | 0.10 | 6 | 61 | WT150 | 0.23 | 11 | 93 |
| JWT310 | 6.25 | 110 | 1,500 | WT160 | 0.11 | 17 | 130 |
| JWT320 | 6.46 | 110 | 1,500 | WT170 | 0.12 | 7 | 82 |
| JWT330 | 0.33 | 0 | 47 | WT180 | 0.10 | 0 | 12 |
| JWT352 | 9.69 | 110 | 1,600 | WT190 | 0.06 | 0 | 14 |
| JWT354 | 10.30 | 110 | 1,700 | WT200 | 0.30 | 0 | 25 |
| JWT360 | 0.07 | 1 | 20 | WT210 | 0.27 | 0 | 21 |
| JWT372 | 10.36 | 110 | 1,700 | WT220 | 0.19 | 1 | 49 |
| JWT374_OUTLET | 10.58 | 110 | 1,700 | WT230 | 0.20 | 5 | 99 |
| MT010 | 0.29 | 1 | 57 | WT240 | 0.08 | 9 | 78 |
| MT020 | 0.09 | 8 | 83 | WT250 | 0.15 | 7 | 110 |
| MT030 | 0.16 | 7 | 97 | WT260 | 0.14 | 6 | 51 |
| MT040 | 0.31 | 10 | 130 | WT270 | 0.03 | 0 | 15 |
| MT050 | 0.12 | 0 | 16 | WT280 | 0.27 | 22 | 190 |
| MT060 | 0.19 | 0 | 31 | WT290 | 0.10 | 3 | 62 |
| MT070 | 0.20 | 0 | 25 | WT300 | 0.10 | 6 | 61 |
| MT080 | 0.06 | 2 | 48 | WT310 | 0.28 | 2 | 67 |
| MT090 | 0.04 | 0 | 19 | WT320 | 0.21 | 0 | 35 |
| MT100 | 0.06 | 0 | 11 | WT330 | 0.33 | 0 | 47 |
| MT110 | 0.12 | 0 | 16 | WT340 | 0.28 | 0 | 34 |
| RET020 | 0.15 | 10 | 82 | WT350 | 0.30 | 3 | 78 |
| RET030 | 0.36 | 19 | 200 | WT360 | 0.07 | 1 | 20 |
| RET040 | 0.56 | 19 | 230 | WT370 | 0.21 | 0 | 33 |
| RET050 | 0.71 | 19 | 240 | | | | |

# Figure 3-11
## Historical Hydrology
## Falcon DBPS
## El Paso County, CO

0 0.5 1
Miles

NOTE: FIGURE MUST BE VIEWED IN COLOR

FILE: G:\gis_projects\Falcon_Creek_DBPS\active\apps\20110613\hydrology_historical.mxd, 8/29/2011, wilson_wheeler




| Hydrologic Element | Area (sq mi) | Future Peak Flows (cfs) 2-year | Future Peak Flows (cfs) 100-year |
|---|---|---|---|
| ET010 | 0.15 | 38 | 200 |
| ET020 | 0.21 | 73 | 360 |
| ET030 | 0.20 | 45 | 240 |
| ET040 | 0.15 | 28 | 170 |
| ET050 | 0.12 | 37 | 200 |
| ET060 | 0.29 | 110 | 530 |
| ET070 | 0.25 | 94 | 460 |
| ET080 | 0.29 | 110 | 520 |
| ET090 | 0.12 | 26 | 130 |
| ET100 | 0.05 | 11 | 72 |
| ET110 | 0.23 | 24 | 200 |
| ET120 | 0.11 | 11 | 89 |
| ET130 | 0.13 | 11 | 85 |
| ET140 | 0.27 | 16 | 120 |
| ET150 | 0.18 | 17 | 140 |
| ET160 | 0.19 | 19 | 140 |
| FS010 | 0.12 | 6 | 75 |
| JET010 | 0.15 | 29 | 150 |
| JET020 | 0.36 | 74 | 390 |
| JET030 | 0.56 | 97 | 580 |
| JET040 | 0.71 | 27 | 570 |
| JET050 | 0.83 | 11 | 530 |
| JET060 | 1.11 | 13 | 430 |
| JET070 | 1.36 | 94 | 480 |
| JET080 | 1.66 | 15 | 350 |
| JET090 | 1.78 | 26 | 390 |
| JET100 | 1.83 | 27 | 390 |
| JET110 | 2.05 | 40 | 440 |
| JET120 | 2.16 | 49 | 450 |
| JET130 | 0.13 | 11 | 85 |
| JET140 | 0.40 | 26 | 200 |
| JET152 | 2.57 | 51 | 650 |
| JET154 | 2.74 | 62 | 680 |
| JET160 | 2.93 | 66 | 710 |
| JFS010_OUTLET | 0.12 | 6 | 75 |
| JMT010 | 0.29 | 1 | 160 |
| JMT020 | 0.09 | 26 | 140 |
| JMT030 | 0.25 | 50 | 290 |
| JMT040 | 0.56 | 110 | 750 |
| JMT050 | 0.67 | 120 | 850 |
| JMT060 | 1.16 | 130 | 1,000 |
| JMT070 | 1.36 | 150 | 1,200 |
| JMT080 | 1.42 | 86 | 1,200 |
| JMT090 | 0.04 | 9 | 32 |
| JMT102 | 1.46 | 91 | 1,200 |
| JMT104 | 0.04 | 9 | 32 |
| JMT106 | 1.52 | 92 | 1,200 |
| JMT110 | 1.64 | 94 | 1,200 |
| JWT010 | 0.14 | 9 | 89 |
| JWT020 | 0.07 | 4 | 42 |
| JWT030 | 0.14 | 9 | 85 |
| JWT042 | 0.28 | 15 | 170 |
| JWT044 | 0.46 | 24 | 260 |
| JWT050 | 0.85 | 43 | 480 |
| JWT070 | 0.17 | 14 | 130 |
| JWT080 | 1.09 | 54 | 610 |
| JWT090 | 1.43 | 68 | 730 |
| JWT110 | 1.63 | 77 | 840 |
| JWT120 | 1.77 | 85 | 920 |
| JWT140 | 0.13 | 32 | 180 |
| JWT150 | 0.36 | 15 | 170 |
| JWT160 | 0.47 | 35 | 190 |
| JWT172 | 2.24 | 99 | 960 |
| JWT174 | 2.36 | 100 | 990 |
| JWT180 | 2.46 | 100 | 1,000 |
| JWT190 | 0.06 | 4 | 43 |
| JWT200 | 2.82 | 110 | 1,200 |
| JWT210 | 3.09 | 120 | 1,300 |
| JWT220 | 0.19 | 47 | 250 |
| JWT232 | 3.28 | 120 | 1,400 |
| JWT234 | 3.47 | 130 | 1,400 |
| JWT240 | 3.55 | 83 | 1,100 |
| JWT250 | 3.70 | 85 | 1,100 |
| JWT260 | 3.84 | 86 | 1,100 |
| JWT270 | 0.03 | 11 | 57 |
| JWT280 | 0.27 | 33 | 250 |
| JWT292 | 3.87 | 86 | 1,100 |
| JWT294 | 4.13 | 96 | 1,100 |
| JWT296 | 5.88 | 160 | 1,700 |
| JWT300 | 0.10 | 12 | 92 |
| JWT310 | 6.25 | 160 | 1,700 |
| JWT320 | 6.46 | 160 | 1,700 |
| JWT330 | 0.33 | 32 | 250 |
| JWT352 | 9.69 | 210 | 2,400 |
| JWT354 | 10.30 | 230 | 2,500 |
| JWT360 | 0.07 | 7 | 55 |
| JWT372 | 10.36 | 230 | 2,500 |
| JWT374_OUTLET | 10.58 | 230 | 2,500 |
| MT010 | 0.29 | 28 | 210 |
| MT020 | 0.09 | 26 | 140 |
| MT030 | 0.16 | 39 | 230 |
| MT040 | 0.31 | 95 | 460 |
| MT050 | 0.12 | 17 | 110 |
| MT060 | 0.19 | 30 | 200 |
| MT070 | 0.20 | 25 | 170 |
| MT080 | 0.06 | 62 | 190 |
| MT090 | 0.04 | 40 | 130 |
| MT100 | 0.06 | 17 | 88 |
| MT110 | 0.12 | 19 | 120 |
| PBH4 | 0.15 | 29 | 150 |
| PBHA | 0.10 | 10 | 130 |
| PBHB1 | 0.36 | 51 | 270 |
| PBHB2 | 0.36 | 15 | 170 |
| PBHC | 0.19 | 11 | 160 |
| RMN | 1.42 | 86 | 1,200 |
| RWU_Diversion | 3.55 | 83 | 1,300 |
| RWU North | 3.55 | 110 | 1,400 |
| RWU South | 3.55 | 55 | 1,000 |
| RET020 | 0.15 | 29 | 150 |
| RET030 | 0.36 | 71 | 380 |
| RET040 | 0.56 | 95 | 580 |

| Hydrologic Element | Area (sq mi) | Future Peak Flows (cfs) 2-year | Future Peak Flows (cfs) 100-year |
|---|---|---|---|
| RET050 | 0.71 | 27 | 570 |
| RET060 | 0.83 | 11 | 530 |
| RET070 | 1.11 | 13 | 430 |
| RET080 | 1.36 | 65 | 420 |
| RET090 | 1.66 | 15 | 350 |
| RET100 | 1.78 | 26 | 390 |
| RET110 | 1.83 | 27 | 390 |
| RET120 | 2.05 | 39 | 430 |
| RET140 | 0.13 | 11 | 85 |
| RET152 | 2.16 | 49 | 450 |
| RET154 | 0.40 | 26 | 200 |
| RET156 | 2.57 | 50 | 650 |
| RET162 | 2.74 | 59 | 680 |
| RET164 | 2.93 | 66 | 710 |
| RMT030 | 0.09 | 25 | 140 |
| RMT040 | 0.25 | 49 | 290 |
| RMT050 | 0.56 | 110 | 750 |
| RMT062 | 0.29 | 1 | 160 |
| RMT064 | 0.67 | 120 | 850 |
| RMT070 | 1.16 | 130 | 1,000 |
| RMT080 | 1.36 | 150 | 1,200 |
| RMT090 | 0.04 | 9 | 32 |
| RMT102 | 1.42 | 86 | 1,200 |
| RMT104 | 0.04 | 9 | 32 |
| RMT106 | 1.46 | 91 | 1,200 |
| RMT112 | 1.52 | 92 | 1,200 |
| RMT114 | 1.64 | 94 | 1,200 |
| RWT030 | 0.07 | 4 | 42 |
| RWT042 | 0.14 | 9 | 85 |
| RWT044 | 0.14 | 9 | 89 |
| RWT046 | 0.28 | 15 | 170 |
| RWT054 | 0.46 | 24 | 260 |
| RWT080 | 0.17 | 14 | 130 |
| RWT092 | 0.85 | 43 | 480 |
| RWT094 | 1.09 | 54 | 610 |
| RWT122 | 1.43 | 68 | 730 |
| RWT124 | 1.63 | 77 | 840 |
| RWT150 | 0.13 | 32 | 180 |
| RWT160 | 0.36 | 15 | 170 |
| RWT172 | 1.77 | 85 | 920 |
| RWT174 | 0.47 | 35 | 180 |
| RWT176 | 2.24 | 98 | 960 |
| RWT180 | 2.36 | 100 | 990 |
| RWT202 | 2.46 | 100 | 1,000 |
| RWT204 | 0.06 | 4 | 43 |
| RWT210 | 2.82 | 110 | 1,200 |
| RWT232 | 3.09 | 120 | 1,300 |
| RWT234 | 0.19 | 47 | 250 |
| RWT236 | 3.28 | 120 | 1,400 |
| RWT240 | 3.47 | 130 | 1,400 |
| RWT240_Diversion Reach | 0.00 | 30 | 39 |
| RWT250 | 3.55 | 83 | 1,100 |
| RWT260 | 3.70 | 85 | 1,100 |
| RWT291 | 3.84 | 86 | 1,100 |
| RWT292 | 0.03 | 11 | 57 |
| RWT294 | 0.27 | 33 | 250 |
| RWT295 | 3.87 | 86 | 1,100 |
| RWT296 | 4.13 | 94 | 1,100 |
| RWT312 | 0.10 | 12 | 91 |
| RWT314 | 5.88 | 160 | 1,700 |
| RWT320 | 6.25 | 160 | 1,700 |
| RWT344 | 0.33 | 32 | 250 |
| RWT352 | 6.46 | 160 | 1,700 |
| RWT354 | 9.69 | 210 | 2,400 |
| RWT372 | 10.30 | 230 | 2,500 |
| RWT374 | 0.07 | 7 | 55 |
| RWT376 | 10.36 | 230 | 2,500 |
| M1 | 0.06 | 4 | 43 |
| M2 | 0.29 | 1 | 160 |
| WH1 North | 0.71 | 88 | 570 |
| WH1 South | 0.71 | 27 | 570 |
| WH2 | 0.83 | 11 | 530 |
| WH3 | 1.11 | 13 | 430 |
| WH4 | 1.66 | 15 | 350 |
| WH5 | 0.04 | 9 | 32 |
| WHH | 0.56 | 110 | 750 |
| WT010 | 0.14 | 9 | 89 |
| WT020 | 0.07 | 4 | 42 |
| WT030 | 0.08 | 9 | 75 |
| WT040 | 0.19 | 9 | 93 |
| WT050 | 0.19 | 17 | 140 |
| WT060 | 0.20 | 14 | 120 |
| WT070 | 0.17 | 14 | 130 |
| WT080 | 0.07 | 9 | 67 |
| WT090 | 0.15 | 22 | 160 |
| WT100 | 0.19 | 56 | 300 |
| WT110 | 0.19 | 22 | 170 |
| WT120 | 0.05 | 8 | 55 |
| WT130 | 0.10 | 35 | 170 |
| WT140 | 0.13 | 32 | 180 |
| WT150 | 0.23 | 49 | 250 |
| WT160 | 0.11 | 35 | 180 |
| WT170 | 0.12 | 21 | 140 |
| WT180 | 0.10 | 8 | 66 |
| WT190 | 0.06 | 11 | 75 |
| WT200 | 0.30 | 25 | 190 |
| WT210 | 0.27 | 32 | 190 |
| WT220 | 0.19 | 47 | 250 |
| WT230 | 0.20 | 71 | 350 |
| WT240 | 0.08 | 36 | 160 |
| WT250 | 0.15 | 63 | 290 |
| WT260 | 0.14 | 10 | 78 |
| WT270 | 0.03 | 11 | 57 |
| WT280 | 0.27 | 33 | 250 |
| WT290 | 0.10 | 15 | 110 |
| WT300 | 0.10 | 12 | 92 |
| WT310 | 0.28 | 31 | 250 |
| WT320 | 0.21 | 27 | 200 |
| WT330 | 0.33 | 32 | 250 |
| WT340 | 0.28 | 19 | 150 |
| WT350 | 0.30 | 38 | 280 |
| WT360 | 0.07 | 7 | 55 |
| WT370 | 0.21 | 7 | 120 |

Figure 3-13
Future Hydrology
Falcon DBPS
El Paso County, CO

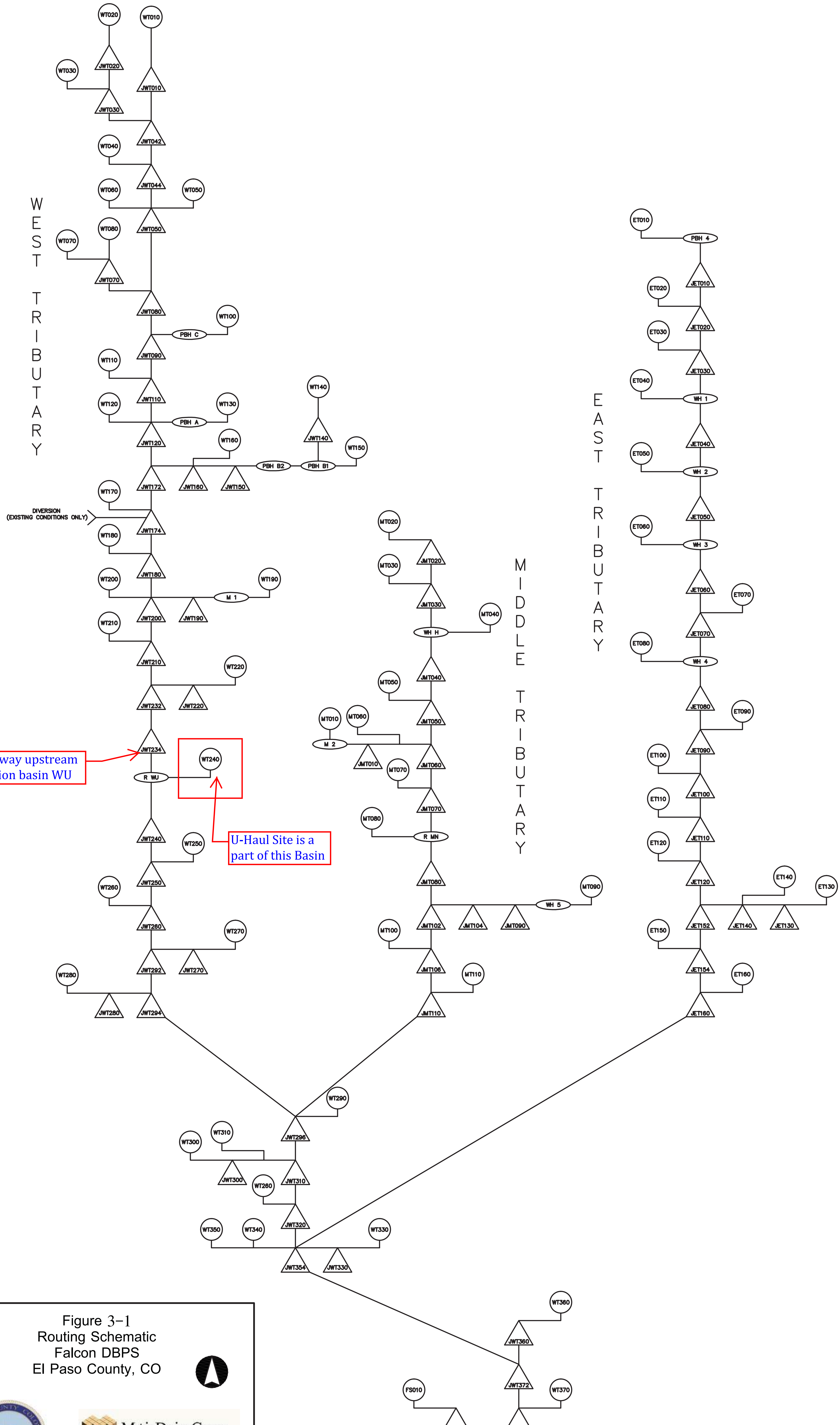



Figure 3-1
Routing Schematic
Falcon DBPS
El Paso County, CO

DRAWING NOT TO SCALE

**Bridge and Culvert Crossing Replacements**

The proposed size for crossing replacements includes the infrastructure necessary to provide the bridge or culvert with sufficient capacity to adhere to DCM criteria. Costs were estimated using a regression equation developed for this DBPS that was based on 2012 UDFCD master plan costs. Note that several crossings (e.g., WT 5-2, WT 4, WT 1, and MT 1) require such a large number of cells to comply with criteria that the proposed configurations are likely impractical. These locations may necessitate consideration of a more comprehensive capital improvement project including raising the roadway profile to achieve feasibility. The quantities and costs for all crossing replacements are provided in Table 6-11.

**Table 6-11. Crossing Replacement Cost Estimate**

| Crossing | Location | Q100 (cfs) | Proposed Size | Length | Total Cost |
|---|---|---|---|---|---|
| WT 14 | Burgess Rd. | 89 | 5’ | 66 | $ 31,585 |
| WT 13 | Pine Park Trl. | 89 | 5’ | 53 | $ 28,525 |
| Pond WU Inlet Structure | Tamlin Rd. | 1,110 | (8) 6’ x 12’ | 74 | $ 658,410 |
| WT 6 | Falcon Hwy. | 1,000 | (5) 6’ x 12’ | 43 | $ 249,775 |
| WT 5 | Meridian Rd. | 1,100 | 3’ | 43 | $ 8,651 |
| WT 5-2 | Meridian Rd. | 1,100 | (25) 3’ x 10’ | 43 | $ 718,121 |
| WT 4 | W. Condor Rd. | 1,500 | (11) 5’ x 12’ | 48 | $ 528,324 |
| WT 3 | Garrett Rd. | 1,500 | (3) 9’ x 12’ | 46 | $ 218,292 |
| WT 1 | Blaney Rd. | 2,200 | (16) 5’ x 12’ | 40 | $ 636,648 |
| MT 7 | Owl Ln. | 299 | (9) 2’ x 4’ | 58 | $ 207,465 |
| MT 6 | Woodmen Rd. | 840 | (3) 5’ | 200 | $ 166,177 |
| MT 6-2 | Woodmen Rd. | 840 | (3) 5’ | 220 | $ 181,365 |
| MT 5-1 | McLaughlin Rd. | 820 | (3) 7’ x 12’ | 48 | $ 191,098 |
| MT 2 | Swingline Rd. | 840 | (3) 8’ x 12’ | 83 | $ 343,147 |
| MT 1 | Falcon Hwy. | 860 | (11) 4’ x 12’ | 45 | $ 433,032 |
| ET 31 | Stapleton Dr. | 200 | (2) 4’ x 12’ | 302 | $ 525,026 |
| ET 19 | Eastonville Rd. | 530 | 7’ x 10’ | 39 | $ 63,340 |
| ET 13 | Pinto Pony Rd. | 300 | (2) 6’ x 8’ | 50 | $ 113,991 |
| ET 11 | Falcon Hwy. | 400 | (2) 6’ x 8’ | 40 | $ 84,348 |
| ET 10 | N. Condor Rd. | 590 | (3) 7’ x 10’ | 44 | $ 162,656 |
| ET 9 | Sunset Trl. | 490 | (2) 6’ x 8’ | 40 | $ 84,102 |
| ET 4 | Garrett Rd. | 640 | (2) 5’ x 8’ | 61 | $ 106,060 |
| | | | | Subtotal | $ 5,740,139 |
| | | | | Engineering/Construction Admin. (15%) | $ 861,021 |
| | | | | Contingency (20%) | $ 1,148,028 |
| | | | | **Total** | **$ 7,749,187** |

No crossing improvements were necessary at WT 10, WT 7-2, MT 4, or ET 30 since the hydraulic condition at these locations were within criteria as noted in Table 6-7. Crossings WT 7-1, MT 3, and ET 14 were not resized because they are CDOT structures. Crossing WT 11 was not resized because it is located under a private drive. Other crossings, including WT 9, ET 32, ET 26, and ET 15, were not resized because the degree of criteria exceedance was so minor that they did not warrant replacement.

### 6.3.5. Immediate Action Required

There are 6 locations where immediate action is required in order to preserve the existing reach conditions as shown in Figure 6-1. These locations are at points adjacent to pristine channel reaches, or Natural Channel Design reaches, where current erosion or deposition has been identified. If left unmitigated, the issues at these locations have the potential to propagate and worsen the existing condition, thereby necessitating additional reach improvement costs. These locations can be addressed by implementing the recommended reach alternative for the impaired reach at the sites that are identified while improvements for the remainder of the impaired reaches can be constructed at a later date.

### 6.3.6. Protect In Place

There are several relatively pristine reaches of channel throughout the Falcon Watershed that are currently in a stable condition. Additionally, there are several reaches throughout the Falcon Watershed that have already been improved and appear to be stable. Preserving both of these reach conditions would not require a direct reach improvement cost. However, upstream detention improvements may be required depending on the location of the reach.

### 6.3.7. Reach Phasing Priority

Reach construction should be phased so that planned upstream detention ponds are constructed prior to reach construction. This method of phasing protects the reach alternatives from being damaged as a result of higher than designed for flows being released into the reach. A phasing priority of 1 means the reach can be constructed. Higher phasing priority numbers indicate more upstream detention ponds should be built prior to construction of the reach in question. The phasing priority for each of the reaches is provided in Appendix D.

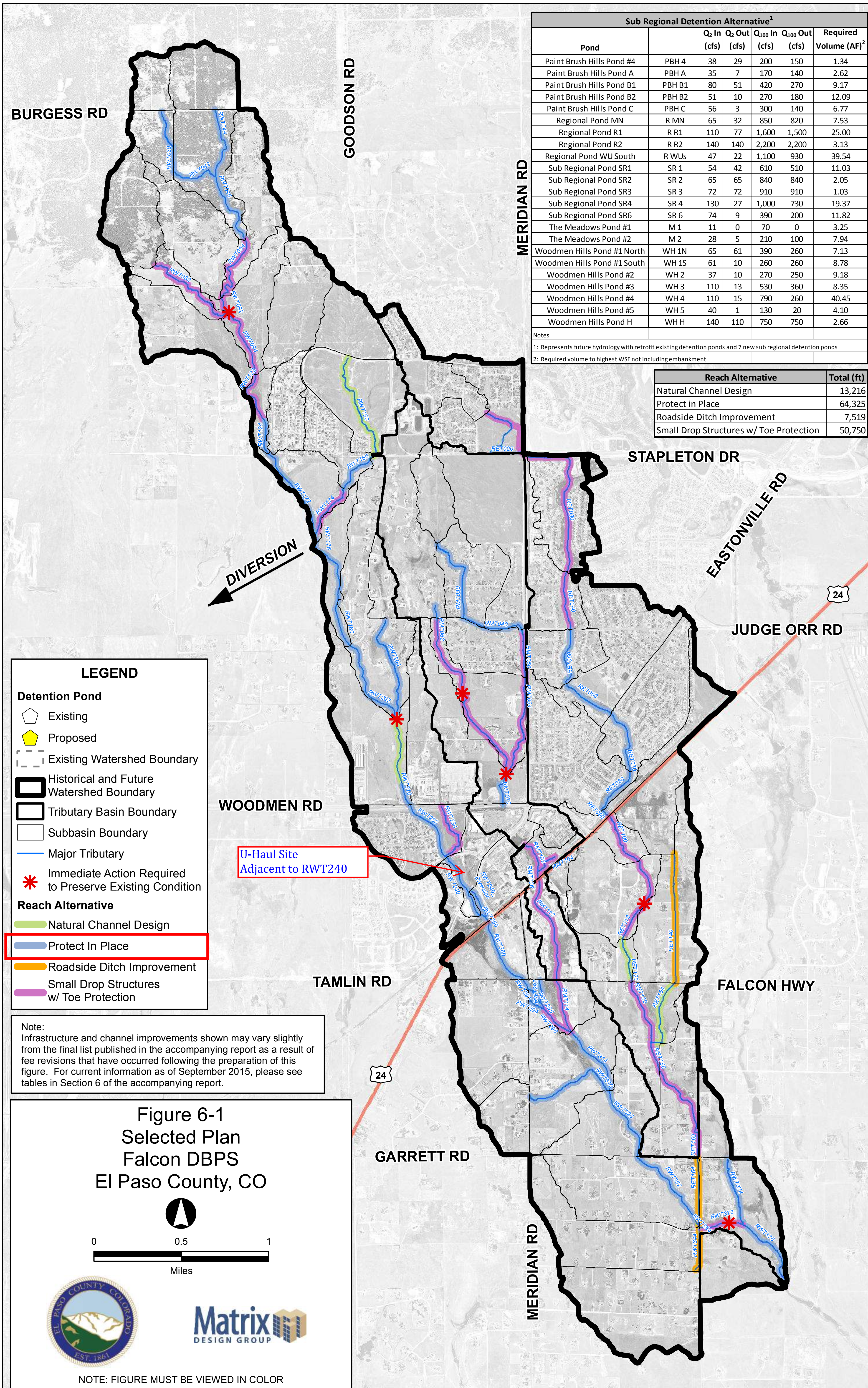
## 6.4. Cost Summary

Costs for all detention ponds, reach improvements, bridge and culvert replacements, and roadside ditches are summarized in Table 6-12.

**Table 6-12. Cost Summary**

| Alternative | Cost[1] |
|---|---|
| Detention Ponds | $ 6,822,546 |
| Roadside Ditches | $ 835,874 |
| Reaches[2] | $ 34,066,842 |
| Bridge & Culvert Crossings | $ 7,749,187 |
| **Total** | **$ 49,474,449** |

Notes:
[1]Includes all construction and additional costs
[2]Reaches includes both Natural Channel Design and Small Drop Structure reaches




| Sub Regional Detention Alternative[1] | | | | | | |
|---|---|---|---|---|---|---|
| Pond | | $Q_2$ In (cfs) | $Q_2$ Out (cfs) | $Q_{100}$ In (cfs) | $Q_{100}$ Out (cfs) | Required Volume (AF)[2] |
| Paint Brush Hills Pond #4 | PBH 4 | 38 | 29 | 200 | 150 | 1.34 |
| Paint Brush Hills Pond A | PBH A | 35 | 7 | 170 | 140 | 2.62 |
| Paint Brush Hills Pond B1 | PBH B1 | 80 | 51 | 420 | 270 | 9.17 |
| Paint Brush Hills Pond B2 | PBH B2 | 51 | 10 | 270 | 180 | 12.09 |
| Paint Brush Hills Pond C | PBH C | 56 | 3 | 300 | 140 | 6.77 |
| Regional Pond MN | R MN | 65 | 32 | 850 | 820 | 7.53 |
| Regional Pond R1 | R R1 | 110 | 77 | 1,600 | 1,500 | 25.00 |
| Regional Pond R2 | R R2 | 140 | 140 | 2,200 | 2,200 | 3.13 |
| Regional Pond WU South | R WUs | 47 | 22 | 1,100 | 930 | 39.54 |
| Sub Regional Pond SR1 | SR 1 | 54 | 42 | 610 | 510 | 11.03 |
| Sub Regional Pond SR2 | SR 2 | 65 | 65 | 840 | 840 | 2.05 |
| Sub Regional Pond SR3 | SR 3 | 72 | 72 | 910 | 910 | 1.03 |
| Sub Regional Pond SR4 | SR 4 | 130 | 27 | 1,000 | 730 | 19.37 |
| Sub Regional Pond SR6 | SR 6 | 74 | 9 | 390 | 200 | 11.82 |
| The Meadows Pond #1 | M 1 | 11 | 0 | 70 | 0 | 3.25 |
| The Meadows Pond #2 | M 2 | 28 | 5 | 210 | 100 | 7.94 |
| Woodmen Hills Pond #1 North | WH 1N | 65 | 61 | 390 | 260 | 7.13 |
| Woodmen Hills Pond #1 South | WH 1S | 61 | 10 | 260 | 260 | 8.78 |
| Woodmen Hills Pond #2 | WH 2 | 37 | 10 | 270 | 250 | 9.18 |
| Woodmen Hills Pond #3 | WH 3 | 110 | 13 | 530 | 360 | 8.35 |
| Woodmen Hills Pond #4 | WH 4 | 110 | 15 | 790 | 260 | 40.45 |
| Woodmen Hills Pond #5 | WH 5 | 40 | 1 | 130 | 20 | 4.10 |
| Woodmen Hills Pond H | WH H | 140 | 110 | 750 | 750 | 2.66 |

Notes
1: Represents future hydrology with retrofit existing detention ponds and 7 new sub regional detention ponds
2: Required volume to highest WSE not including embankment

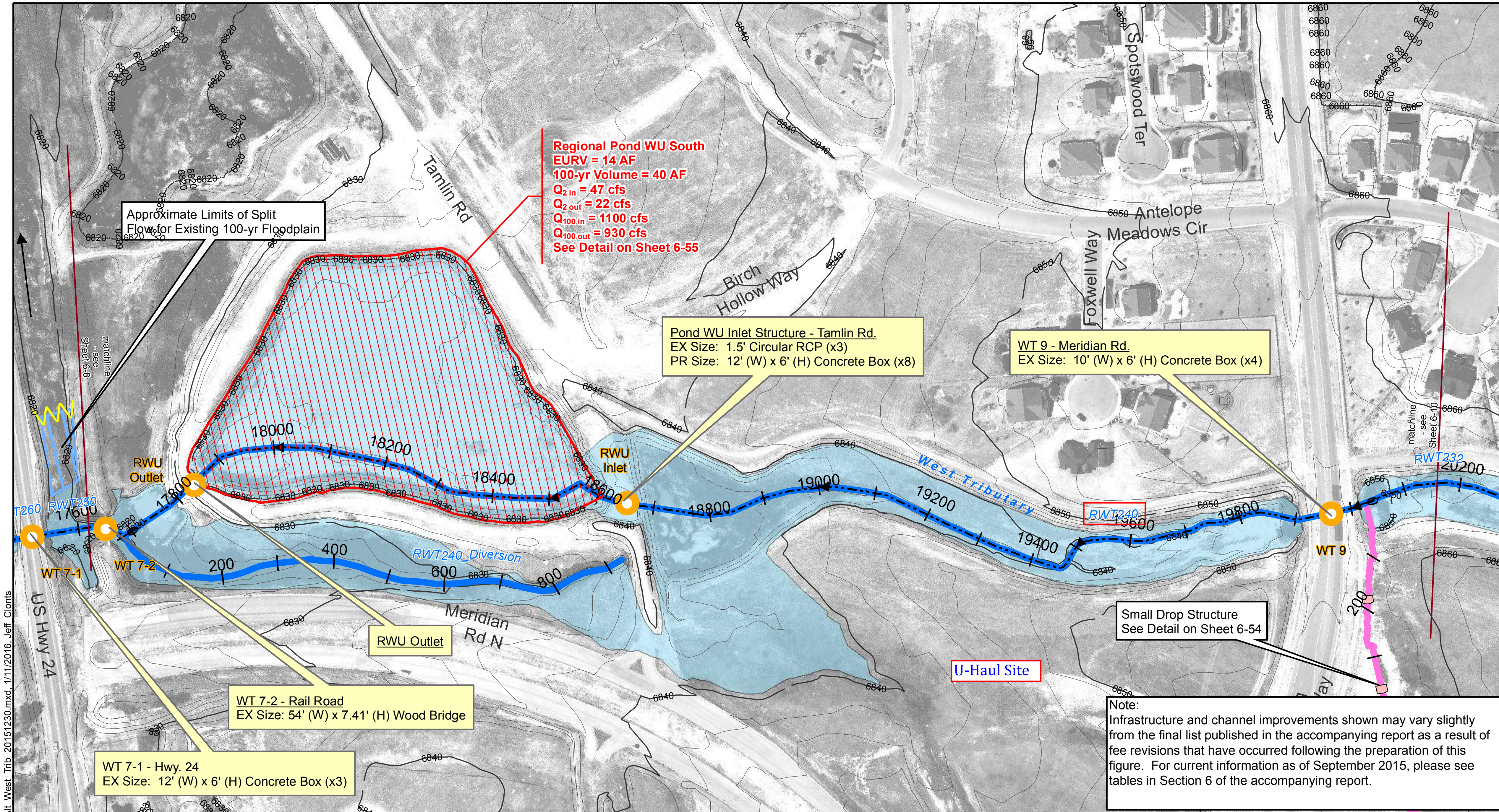
| Reach Alternative | Total (ft) |
|---|---|
| Natural Channel Design | 13,216 |
| Protect in Place | 64,325 |
| Roadside Ditch Improvement | 7,519 |
| Small Drop Structures w/ Toe Protection | 50,750 |

Note:
Infrastructure and channel improvements shown may vary slightly from the final list published in the accompanying report as a result of fee revisions that have occurred following the preparation of this figure. For current information as of September 2015, please see tables in Section 6 of the accompanying report.

Figure 6-1
Selected Plan
Falcon DBPS
El Paso County, CO

NOTE: FIGURE MUST BE VIEWED IN COLOR

# Sheet 6-9
## Falcon DBPS Conceptual Plan West Tributary El Paso County, CO



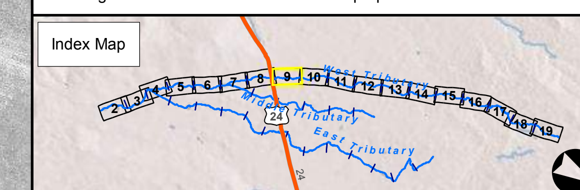

**Drainageway Crossing**
Stream Centerline
Existing Approximate 100-yr Floodplain*
Floodplain Study Limit

**Storm Sewer**
Inlet
Manhole
Pipe

**Reach Improvements**
Natural Channel Design
Protect In Place
Roadside Ditch Improvement
Small Drop Structures w/ Toe Protection
Existing Detention
Proposed Detention
Proposed Detention Grading
Small Drop Structure
Cross Vane
Immediate Action Required to Preserve Existing Condition

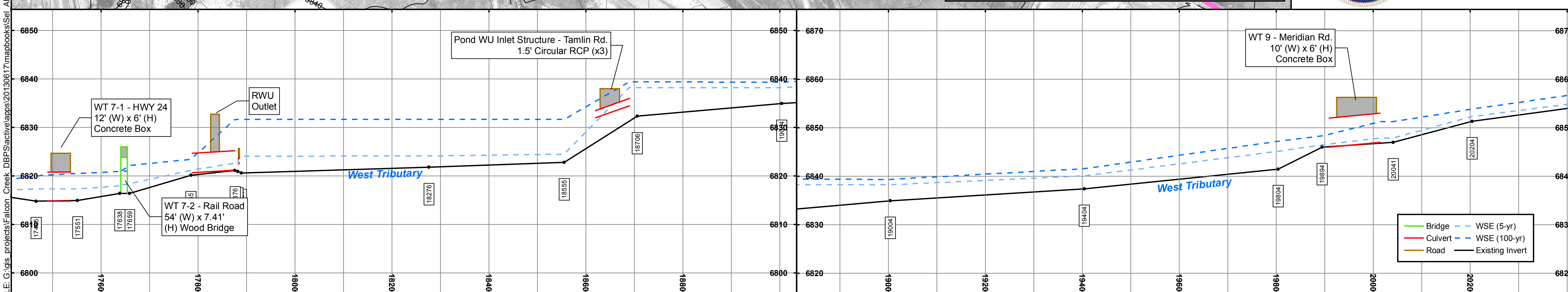
0 100 200 Feet

* These approximate 100-yr floodplain boundaries are for planning purposes only. This information is not intended to replace the information provided on the FEMA Flood Insurance Rate Maps for this area.
** These are conceptual design drawings and are subject to change. These drawings are not intended for construction purposes.




Note:
Infrastructure and channel improvements shown may vary slightly from the final list published in the accompanying report as a result of fee revisions that have occurred following the preparation of this figure. For current information as of September 2015, please see tables in Section 6 of the accompanying report.

MATRIX DESIGN GROUP




FILE: G:\gis_projects\Falcon Creek_DBPS\active\apps\20130617\mapbooks\Sel_Alt_West_Trib_20151230.mxd, 1/11/2016, Jeff_Clonts

## APPENDIX E

**Exhibit A: Drainage Plan – Existing Conditions**

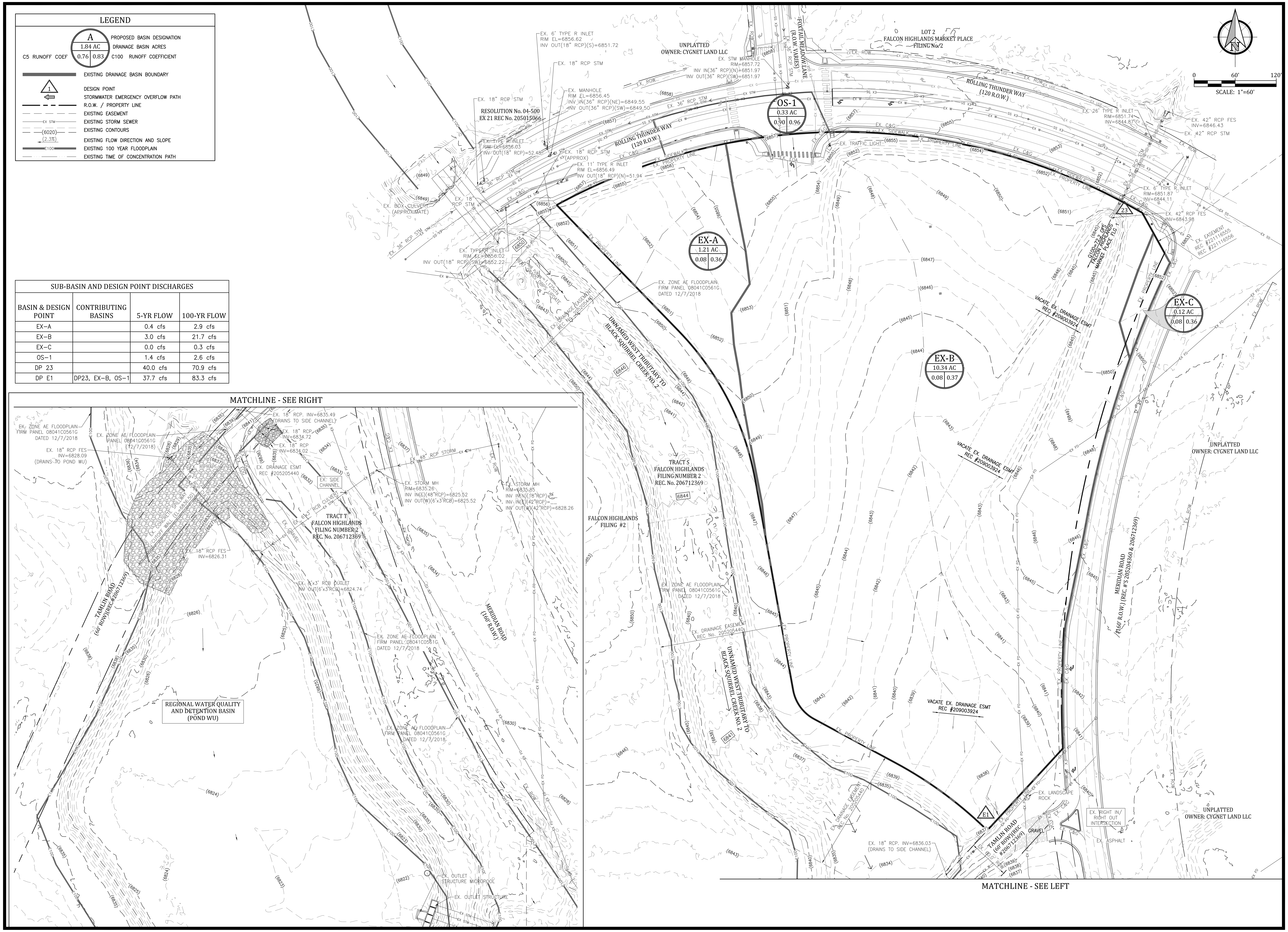
**Exhibit B: Drainage Plan – Proposed Conditions**

## LEGEND

| | |
|---|---|
| A | PROPOSED BASIN DESIGNATION |
| 1.84 AC | DRAINAGE BASIN ACRES |
| C5 RUNOFF COEF 0.76 / 0.83 C100 | RUNOFF COEFFICIENT |
| | EXISTING DRAINAGE BASIN BOUNDARY |
| 1 | DESIGN POINT |
| | STORMWATER EMERGENCY OVERFLOW PATH |
| | R.O.W. / PROPERTY LINE |
| | EXISTING EASEMENT |
| EX STM | EXISTING STORM SEWER |
| (6020) | EXISTING CONTOURS |
| 2.3% | EXISTING FLOW DIRECTION AND SLOPE |
| E100 | EXISTING 100 YEAR FLOODPLAIN |
| | EXISTING TIME OF CONCENTRATION PATH |

## SUB-BASIN AND DESIGN POINT DISCHARGES

| BASIN & DESIGN POINT | CONTRIBUTING BASINS | 5-YR FLOW | 100-YR FLOW |
|---|---|---|---|
| EX-A | | 0.4 cfs | 2.9 cfs |
| EX-B | | 3.0 cfs | 21.7 cfs |
| EX-C | | 0.0 cfs | 0.3 cfs |
| OS-1 | | 1.4 cfs | 2.6 cfs |
| DP 23 | | 40.0 cfs | 70.9 cfs |
| DP E1 | DP23, EX-B, OS-1 | 37.7 cfs | 83.3 cfs |




GENERAL NOTES:

REVISIONS:

| NO. | DATE | INITIALS | NOTES |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |

PROFESSIONAL SEAL:


Kiowa Engineering Corporation
7175 West Jefferson Avenue, Suite 2200
Lakewood, Colorado 80235
(303) 692-0369

AMERCO REAL ESTATE COMPANY
CONSTRUCTION DEPARTMENT
2727 NORTH CENTRAL AVENUE
PHOENIX, ARIZONA 85004
P: (602) 263-6502
F: (602) 277-1026


SITE ADDRESS:
U-HAUL at Falcon
Rolling Thunder Way
Falcon, CO 80831

SHEET CONTENTS:
DRAINAGE PLAN - EXISTING CONDITIONS

866077

| DRAWN: | JRD | A |
|---|---|---|
| CHECKED: | MWE | |
| DATE: | 6/9/23 | |

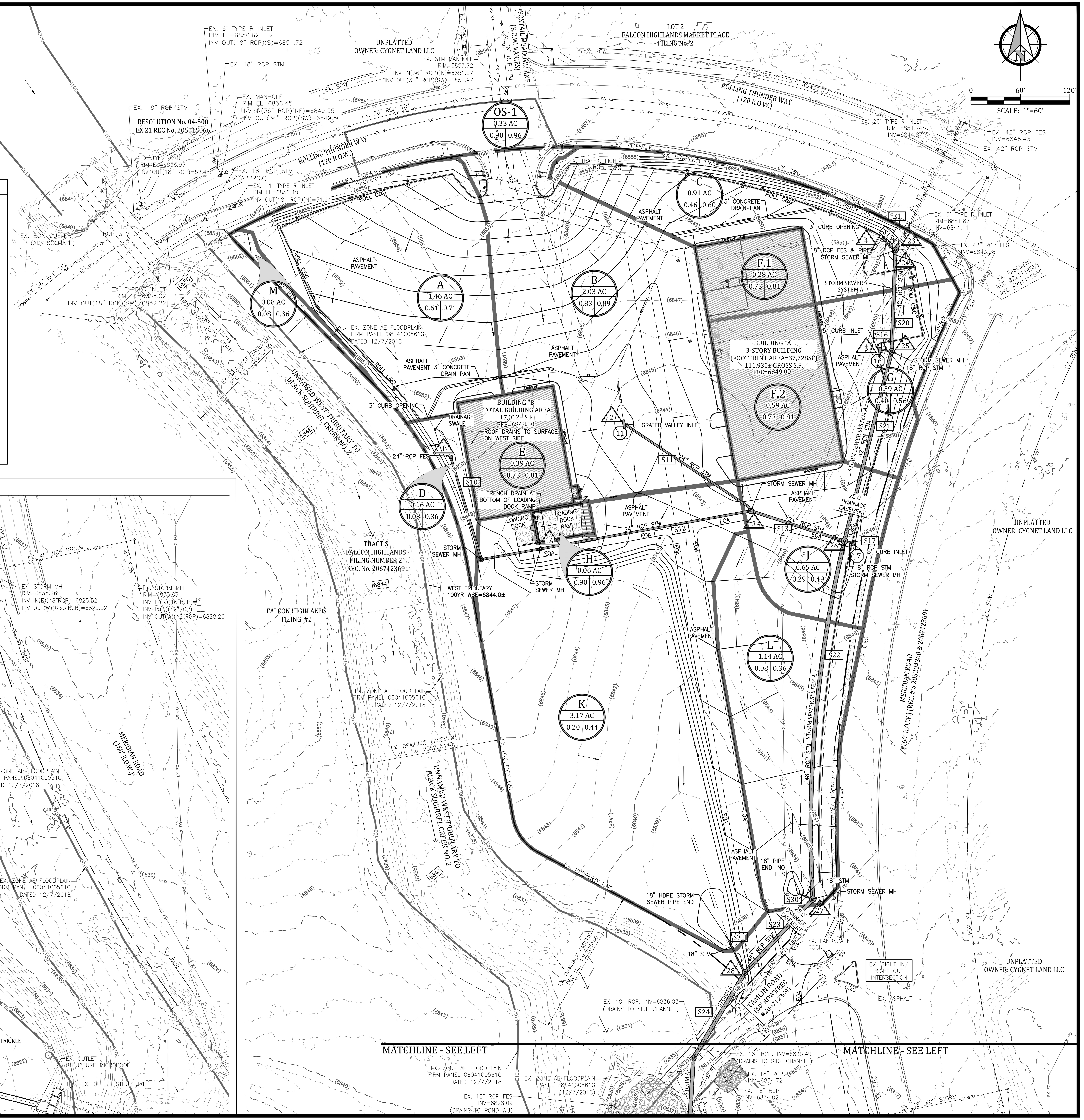
PCD File #
PPR-22-56 & SF-22-40

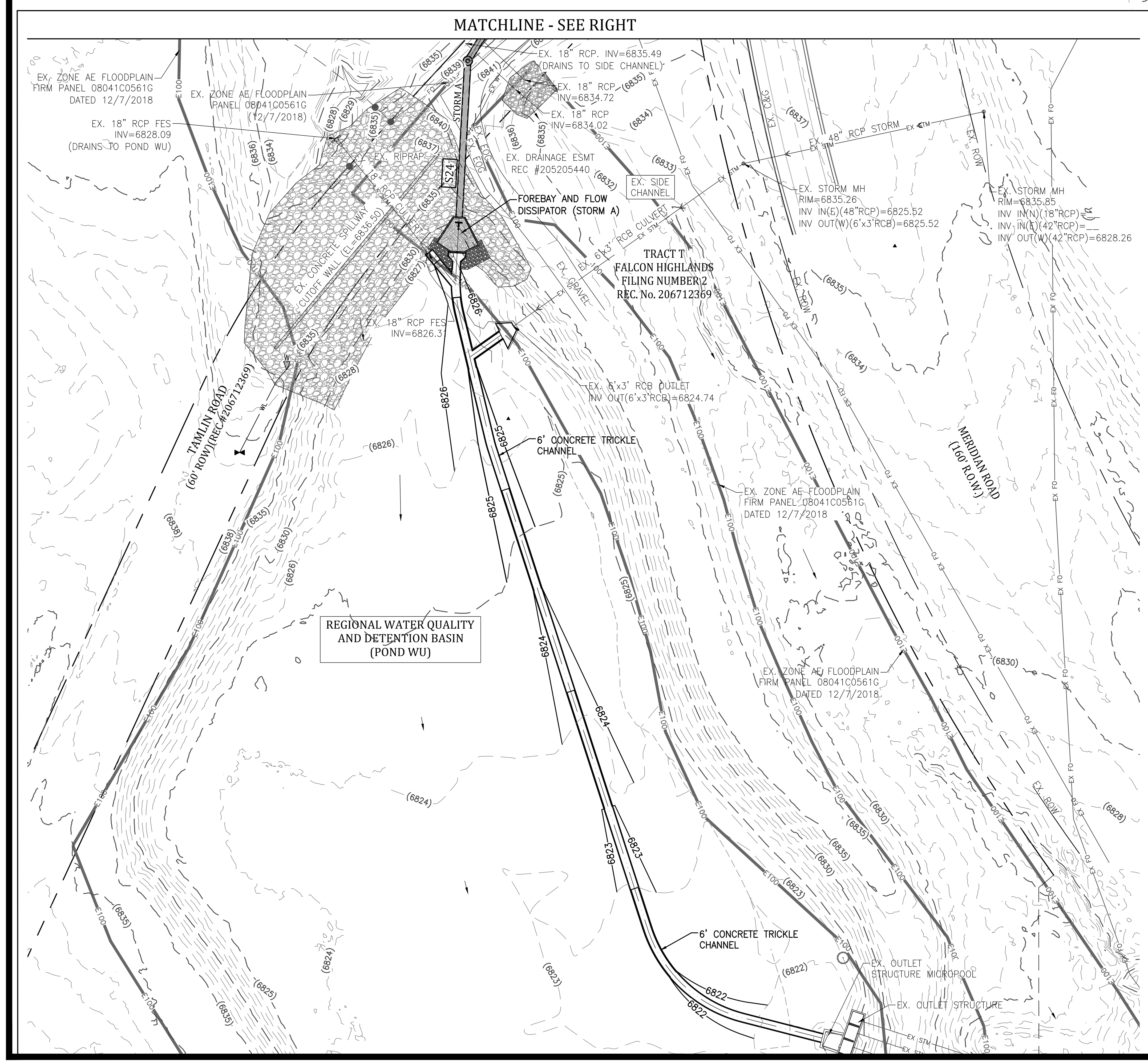
SUB-BASIN AND DESIGN POINT DISCHARGES

| BASIN & DESIGN POINT | CONTRIBUTING BASINS | 5-YR FLOW | 100-YR FLOW |
|---|---|---|---|
| OS-1 | | 1.4 cfs | 2.6 cfs |
| A | | 4.5 cfs | 8.7 cfs |
| B | | 8.7 cfs | 15.8 cfs |
| C | | 1.9 cfs | 4.0 cfs |
| D | | 0.1 cfs | 0.4 cfs |
| E | | 1.4 cfs | 2.6 cfs |
| F.1 | | 1.0 cfs | 1.8 cfs |
| F.2 | | 2.1 cfs | 3.9 cfs |
| G | | 1.2 cfs | 2.4 cfs |
| H | | 0.3 cfs | 0.5 cfs |
| J | | 0.8 cfs | 2.3 cfs |
| J-Dev | | 1.3 cfs | 2.6 cfs |
| K | | 2.3 cfs | 8.6 cfs |
| K-Dev | | 9.3 cfs | 17.9 cfs |
| L | | 0.4 cfs | 2.6 cfs |
| L-Dev | | 3.5 cfs | 6.8 cfs |
| M | | 0.0 cfs | 0.3 cfs |
| DP 1 | A, D, E | 5.6 cfs | 11.2 cfs |
| DP 1A | H, DP 1 | 5.7 cfs | 11.3 cfs |
| DP 2 | OS-1, B | 9.1 cfs | 16.5 cfs |
| DP 3 | DP 1A, DP 2 | 14.1 cfs | 27.3 cfs |
| DP 4 | C, F.1 | 2.8 cfs | 5.7 cfs |
| DP 5 | F.2, G | 3.9 cfs | 6.0 cfs |
| DP 6 | K, L | 2.7 cfs | 11.1 cfs |
| DP 23 | | 40.0 cfs | 70.9 cfs |
| DP 24 | DP 4, DP 23 | 42.5 cfs | 76.1 cfs |
| DP 25 | DP 5, DP 24 | 44.8 cfs | 80.9 cfs |
| DP 26 | J, DP 3, DP 25 | 57.6 cfs | 105.8 cfs |
| DP 26-Dev | J-Dev, DP3, DP25 | 58.3 cfs | 106.5 cfs |
| DP 27 | L, DP 26 | 56.6 cfs | 105.8 cfs |
| DP 27-Dev | L-Dev, DP 26 | 59.7 cfs | 111.4 cfs |
| DP 28 | K, DP 27 | 58.5 cfs | 113.9 cfs |
| DP 28-Dev | K-Dev, DP 27 | 67.1 cfs | 125.7 cfs |

LEGEND

- A — PROPOSED BASIN DESIGNATION
- 1.84 AC — DRAINAGE BASIN ACRES
- C5 RUNOFF COEF 0.76 | 0.83 C100 RUNOFF COEFFICIENT
- DIRECTIONAL FLOW ARROW
- DRAINAGE BASIN BOUNDARY
- (10) HYDRAULIC STRUCTURE IDENTIFIER
- S10 STORM SEWER IDENTIFIER
- DESIGN POINT
- STORMWATER EMERGENCY OVERFLOW PATH
- R.O.W. / PROPERTY LINE
- EXISTING EASEMENT
- EXISTING STORM SEWER
- EXISTING CONTOURS
- PROPOSED CONTOURS
- (2.3%) EXISTING FLOW DIRECTION AND SLOPE
- 2.3% PROPOSED FLOW DIRECTION AND SLOPE
- 4:1 PROPOSED SLOPE
- PROPOSED CURB AND GUTTER
- EXISTING 100 YEAR FLOODPLAIN
- TIME OF CONCENTRATION PATH
- PROPOSED STORM SEWER PIPE & MH
- PROPOSED STORM GRATED INLET
- PROPOSED STORM CURB INLET




GENERAL NOTES:

REVISIONS:

| NO. | DATE | INITIALS | NOTES |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |

PROFESSIONAL SEAL:

Kiowa Engineering Corporation
7175 West Jefferson Avenue, Suite 2200
Lakewood, Colorado 80235
(303) 692-0369

AMERCO REAL ESTATE COMPANY
CONSTRUCTION DEPARTMENT
2727 NORTH CENTRAL AVENUE
PHOENIX, ARIZONA 85004
P: (602) 263-6502
F: (602) 277-1026

SITE ADDRESS:
U-HAUL at Falcon
Rolling Thunder Way
Falcon, CO 80831

SHEET CONTENTS:
DRAINAGE PLAN - PROPOSED CONDITIONS

866077

DRAWN: JRD
CHECKED: MWE
DATE: 6/9/23
B

PCD File #
PPR-22-56 & SF-22-40