Final

# PRELIMINARY DRAINAGE REPORT

**For**

# CIRCLE K at HIGHWAY 24 & MERIDIAN ROAD

Prepared for:
**EL PASO COUNTY**
**Engineering Development Review Team**
2880 International Circle
Colorado Springs, CO 80910

On Behalf of:
**Circle K Stores Inc.**
5500 S. Quebec Street, Suite 100
Greenwood Village, CO 80111

Prepared by:

Matrix Design Group
2435 Research Parkway, Suite 300
Colorado Springs, CO 80920
(719) 575-0100
fax (719) 572-0208

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Project No. 21.1207.037

PCD File No. VR-22-03

**Engineer's Statement:**

This report and plan for the drainage design of Circle K at Highway 24 & Meridian was prepared by me (or under my direct supervision) and is correct to the best of my knowledge and belief. Said report and plan has been prepared in accordance with the El Paso County Drainage Criteria Manual and is in conformity with the master plan of the drainage basin.

________________________________________________

Jesse Sullivan Date

Registered Professional Engineer

State of Colorado

No. 55600

**Developer's Statement:**

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

Circle K Stores Inc.

Business Name

By: ___________________________________ ____________

Zoe Pericak Date

Title: ____________________________________

Address: 5500 S Quebec St., Ste 100

Greenwood Village, CO 80111

**El Paso County:**

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

____________________________________ ________________________

County Engineer / ECM Administrator Date

Conditions:

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# I. Introduction

The Circle K development at Highway 24 & Meridian Road is within El Paso County jurisdiction and is comprised of a total of 7.79 acres of commercial zoning. The site is located within 3 miles of the City of Colorado Springs and is subject to future annexation.


**Figure 1 - Project Location**

# II. PURPOSE AND SCOPE OF STUDY

The purpose of this Preliminary Drainage Report (PDR) is to identify and evaluate the offsite and onsite drainage patterns associated with the Circle K development (7.79 acres) and to provide hydrologic and hydraulic analyses of this area to ensure compliance with the El Paso County Drainage Criteria Manual (DCM), as well as provide effective, safe routing to downstream outfalls.

# III. GENERAL LOCATION AND DESCRIPTION

The Circle K development is within Falcon in El Paso County, Colorado. An existing Circle K gas station is located at the northeast corner of the project site and will be demolished after construction is complete. The property boundary encompasses 7.79 acres split into 2 lots. The north lot is 4.56 acres while the south lot is 3.23 acres. A 60' tract splits the two lots and will be used for a private access road. The proposed Circle K site will located in the north lot southwest of the existing Circle K gas station. The south lot will be returned to undeveloped conditions after the demolition of the existing structures present on the site. The overall site is adjacent to the city of Colorado Springs on the southwest property line and is subject to future annexation efforts by Colorado Springs. The west portion of the site is bounded by the Meridian Road. The east portion of the site bounded by the Meridian Sol Drive (previously Meridian Sol Drive). The south is bounded by Swingline Road. The general topography of the area is flat with drainage sloping from the northwest to the southeast. More specifically, the study area is located as follows:

**A.** **General Location:** A portion of the SE ¼ of section 12, township 13 south, range 6 west of the 6th P.M. County of El Paso County, State of Colorado.

**B.** **Surrounding Streets and Developments:**

- **a.** **North:** Highway 24.
- **b.** **East:** Big O Tires, several undeveloped properties, Falcon Vista Sub 2 neighborhood, Meridian Sol Drive
- **c.** **South:** Farmland, undeveloped properties, Swingline Road
- **d.** **West:** Meridian Road, undeveloped properties

**C.** **Drainageways:** This site is located within the Falcon Drainage Basin and ultimately discharges into Chico Creek.

- **a.** **West Swale**: Proposed grading for the development of Meridian road shows a drainage swale to the east of the roadway. The swale continues down to Swingline Road where existing storm infrastructure collects the drainage. Current drainage patterns show flows from Highway 24 converging onto the proposed Circle K site and draining northwest to southeast. Opposite of the west swale.
- **b.** **East Swale:** An existing swale is located to the east of the Circle K property off of Meridian Sol Drive. Site imagery shows it is relatively flat with adjacent areas to the west of the swale consisting of farmland. An existing area inlet south of the project property collects flows.

**D.** **Irrigation Facilities**
No known functioning irrigation facilities are within the project area.

**E.** **Utilities and Encumbrances**

a) **Storm Sewer:** Existing inlets are present along Meridian Road to the south of the project site and along Meridian Sol Drive south of the project site. Two area inlets are present north of Swingline Road.

b) **Sanitary Sewer:** Sanitary sewer associated with the existing Circle K station at the northeast corner of the project is present and will remain in service during construction. Sanitary service for the residential housing located in the project site shall be removed prior to construction.

c) **Gas: E**xisting gas services associated with the existing Circle K station at the northeast corner of the project will remain in service during construction. Gas services for the residential housing located in the project site shall be removed prior to construction.

d) **Water: E**xisting water services associated with the existing Circle K station at the northeast corner of the project will remain in service during construction. Water services for the residential housing located in the project site shall be removed prior to construction.

e) **Electric: E**xisting electric services associated with the existing Circle K station at the northeast corner of the project will remain in service during construction. Electric services for the residential housing located in the project site shall be removed prior to construction. An existing overhead powerline is present in the middle of the site running north-south and will be rerouted prior to construction.

### F. Referenced Drainage Reports

This site is within the West Tributary area of the Falcon Drainage Basin Planning Study. This study looks at the future stormwater and infrastructure needs for the Falcon Watershed.

*"Falcon Drainage Basin Planning Study"*, completed by Matrix Design Group, Dated September 2015 (FDBPS-2015)

### G. Land Uses

Land uses for the proposed development will be commercial development and private roads.

## IV. SOIL CONDITIONS

Soils can be classified in four different hydrologic groups, A, B, C, or D to help predict stormwater runoff rates. Hydrologic group "A" is characterized by deep, well-drained coarse-grained soils with a rapid infiltration rate when thoroughly wet and having a low runoff potential. Group "D" typically has a clay layer at or near to the surface, or a very shallow depth to impervious bedrock and has a very slow infiltration rate and a high runoff potential. See Soils Map; Appendix C. Table 3.1 on the following page lists the soil types present in the development area:

***Table 3.1 – NRCS Soil Survey for El Paso County***

| ***SOIL ID NUMBER*** | ***SOIL*** | ***HYDROLOGIC CLASSIFICATION*** | ***PERMEABILITY*** | ***PERCENT ON SITE*** |
|---|---|---|---|---|
| 9 | Blakeland-Fluvaquentic Haplaquolls | A | Well Drained | 40.4% |
| 19 | Columbine Gravelly Sandy Loam, 0 to 3 percent slopes | A | Well Drained | 59.6% |

Predevelopment site conditions are undeveloped and ground cover consists of sparse natural vegetative land cover.

# V. Project Characteristics

## A. Major Basin Description

Chico Creek:

a. **Onsite Flows:** 7.79 Acres of commercial development are within the Falcon Drainage Basin. Under predevelopment conditions flows in the project area generally flow south. After north lot development, flows will generally sheet flow to adjacent streets, where they will be conveyed via gutter flow towards sump or at-grade inlets which will capture the flows. Flows will then be conveyed to the proposed North Detention Pond via storm sewer. South lot flows will remain in predevelopment conditions.

b. **Offsite Flows:**
Runoff from the adjacent Highway 24 and associated right of way will be bypassed around the site via existing swales. Undeveloped portions of the property will also be directed into these swales.

## B. Regulatory Floodplain

Per the ***Flood Insurance Rate Map (FIRM)*** 08041C0561-G, effective date December 7, 2018, published by the Federal Emergency Management Agency (FEMA), no portion of Circle K at Highway 24 & Meridian Road lies within any designated 100-year floodplain. This map can be found in Appendix C.

# VI. Drainage Design Criteria

## *A. Design References*

As required by El Paso County, Colorado, this report has been prepared in accordance to the criteria set forth in the ***El Paso County Drainage Criteria Manual Volume 1 & 2*** (Drainage Criteria Manual or DCM), the El Paso County Engineering Criteria Manual (ECM), and El Paso County Resolutions 15-042 and 19-245.

In addition to the DCM, the ***Urban Storm Drainage Criteria Manuals, Volumes 1-3*** (UDFCD), published by the Urban Drainage and Flood Control District, latest update, have been used to supplement the Drainage Criteria Manual for water quality capture volume (WQCV).

## *B. Design Frequency*

Design frequency is based on the DCM. The 100-year storm event was used as the major storm for the project, and the 5-year storm event was used as the minor storm.

## *C. Design Discharge*

### a. Method of Analysis

The hydrology for this project uses the Rational Method as recommended by the Drainage Criteria Manual for the minor and major storms for drainage basins less than 100-acres in size. The Rational Method uses the following equation: Q=C*i*A

Where:

Q = Maximum runoff rate in cubic feet per second (cfs)
C = Runoff coefficient
i = Average rainfall intensity (inches per hour)
A = Area of drainage sub-basin (acres)

### b. Runoff Coefficient

Rational Method coefficients from Table 6-6 of the Drainage Criteria Manual for developed land were utilized in the Rational Method calculations. See Appendix B for more information.

### c. Time of Concentration

The time of concentration consists of the initial time of overland flow and the travel time in a channel to the inlet or point of interest. A minimum time of concentrations of 5 minutes is utilized for urban areas.

### d. Rainfall Intensity

The hypothetical rainfall depths for the 1-hour storm duration were taken from Table 6-2 of the Drainage Criteria Manual. Table 5.1, below, lists the rainfall depth for the Major and Minor 1-hour storm events.

*Table 5.1 – Project Area 1-Hour Rainfall Depth*

| **Storm Recurrence Interval** | Rainfall Depth (inches) |
|---|---|
| **5-year** | 1.50 |
| **100-year** | 2.52 |

The rainfall intensity equation for the Rational Method was taken from Drainage Criteria Manual Volume 1 Figure 6-5.

### e. StormCAD Analysis

1. **Routing**
Storm CAD was utilized to analyze the routing of runoff through the proposed storm sewer system. The model was calibrated to match the values calculated in the Rational Method spreadsheet.

2. **HGL Profiles**
StormCAD was also used to determine the Hydraulic Grade Profiles for the major and minor storms. The standard method was used to calculate head loss in the system with K coefficients taken from Table 9-4 of the Colorado Springs DCM.

**Table 9-4. STORMCAD Standard Method Coefficients**

| Bend Loss | | |
|---|---|---|
| **Bend Angle** | **K Coefficient** | |
| 0° | 0.05 | |
| 22.5° | 0.10 | |
| 45° | 0.40 | |
| 60° | 0.64 | |
| 90° | 1.32 | |
| **LATERAL LOSS** | | |
| **One Lateral K Coefficient** | | |
| Bend Angle | Non-surcharged | Surcharged |
| 45° | 0.27 | 0.47 |
| 60° | 0.52 | 0.90 |
| 90° | 1.02 | 1.77 |
| **Two Laterals K Coefficient** | | |
| 45° | 0.96 | |
| 60° | 1.16 | |
| 90° | 1.52 | |

## VII. Drainage Basins and Sub-basins

**A.** The ***predevelopment conditions*** for the site have been analyzed and are presented by design points (Table 6.2) and are described as follows:

**a. Chico Creek:**
The studied area is within the West Tributary to Chico Creek. Flows from the majority of the site sheet flow in an easterly direction where they are captured by a broad swale which drains to the into an existing area inlet. A portion of onsite flows drain to the west and are captured by a broad swale which drains into an existing area inlet. Both swales capture roadside drainage.

Total discharge to Chico Creek basin is approximately 7.46 cfs for the $Q_5$ event and 23.31 cfs for the $Q_{100}$ event.

| Circle K - HWY 24 & Meridian | | | | |
|---|---|---|---|---|
| **Existing Sub Basin Summary** | | | | |
| **Design Point** | **Sub-Basins** | **Total Area (ac.)** | **Q(5) (cfs)** | **Q(100) (cfs)** |
| EX 01 | EX 01 | 1.68 | 1.52 | 4.09 |
| EX 02 | EX 02 | 3.93 | 1.29 | 6.40 |
| EX 03 | EX 03 | 0.09 | 0.10 | 0.29 |
| EX 04 | EX 04 | 1.88 | 3.95 | 8.70 |
| EX 05 | EX 05 | 0.43 | 1.34 | 2.69 |
| EX 06 | EX 06 | 3.16 | 1.43 | 5.78 |
| EX SITE NORTH | EX SITE NORTH | 8.01 | 6.14 | 17.89 |
| EX SITE OVERALL | EX SITE OVERALL | 11.18 | 7.46 | 23.31 |

**B.** The fully developed conditions for the site are as follows:

**a. Chico Creek:**

Under proposed conditions, developed flows for this basin will be directed to a proposed detention pond near the south boundary of the north lot. Offsite flows and flows for the south lot will continue under predeveloped conditions. Sub-basins and Design Points for this major basins are summarized in hydrology tables below and on the following pages.

| Circle K - HWY 24 & Meridian<br>Proposed Conditions<br>Sub-basin Summary | | | |
|---|---|---|---|
| **Basin** | **Area** | Q5 | Q100 |
| | acres | cfs | cfs |
| A | 1.00 | 3.3 | 6.2 |
| B | 0.77 | 2.2 | 4.3 |
| C | 0.33 | 1.1 | 2.1 |
| D | 0.36 | 1.0 | 2.1 |
| E | 0.22 | 0.7 | 1.4 |
| F | 0.03 | 0.2 | 0.3 |
| G | 0.14 | 0.7 | 1.2 |
| H | 0.12 | 0.6 | 1.0 |
| J | 0.73 | 0.3 | 1.5 |
| K | 1.88 | 2.1 | 5.4 |
| L | 1.68 | 0.9 | 2.9 |
| M | 0.09 | 0.4 | 0.8 |
| N | 0.43 | 2.0 | 3.6 |
| P | 0.23 | 0.1 | 0.7 |
| Q | 3.22 | 0.7 | 5.0 |

| Circle K - HWY 24 & Meridian | | | | |
|---|---|---|---|---|
| **Proposed Design Point Summary** | | | | |
| **Design Point** | **Sub-Basins** | **Total Area (ac.)** | **Q(5) (cfs)** | **Q(100) (cfs)** |
| DP A | Inlet at lowpoint of access road | 1.00 | 3.27 | 6.22 |
| DP A Inlet Flow | Inlet at lowpoint of access road, combined flow from DP B | 2.62 | 7.65 | 14.69 |
| DP B | Inlet at NW Corner of Pond, Sub Basin B | 0.77 | 2.16 | 4.27 |
| DP B Inlet Flow | Inlet at NW corner of Pond, B, C, D & G | 1.62 | 4.65 | 9.00 |
| DP C | Area inlets in middle of front parking | 0.33 | 1.09 | 2.08 |
| DP C Inlet Flow | Area inlets in middle of front parking, combined flow from DP D | 0.70 | 2.07 | 4.01 |
| DP D | Area inlets in eastern part of front parking | 0.36 | 1.05 | 2.06 |
| DP E | Car wash entrance flume, E & F | 0.25 | 0.71 | 1.39 |
| DP F | Car Wash Roof Drain | 0.03 | 0.16 | 0.28 |
| DP G | Fuel Canopy Roof Drainage | 0.14 | 0.67 | 1.20 |
| DP H | C-Store Roof Drain | 0.12 | 0.55 | 0.99 |
| DP J1 | Detention pond area | 0.73 | 0.32 | 1.54 |
| DP J2 | Sub-basins A, B, E, G & H1 | 3.72 | 7.52 | 15.38 |
| DP J3 | Pond Outlet Structure | 3.72 | 0.10 | 3.40 |
| DP K | Undeveloped land to NE | 1.88 | 2.12 | 5.43 |
| DP L | Offsite drainage to west of site | 1.68 | 0.91 | 2.87 |
| DP M | Offsite street drainage for West entrance | 0.09 | 0.43 | 0.77 |
| DP N | Offsite street drainage for East entrance, west part of Meridian Sol | 0.43 | 1.99 | 3.57 |
| DP P | Offsite drainage to the south of the Access road, offsite culvert outlets | 0.23 | 0.10 | 0.66 |
| DP Q1 | South Lot Drainage | 3.22 | 0.74 | 4.96 |
| DP Q2 | Combined flows into South Area K, J3, M, N, P, Q1 | 7.61 | 15.37 | 38.42 |
| DP Q3 | South Pond Outflow (Q1) | 3.22 | 0.10 | 1.40 |
| DP SITE | North and South Overall Drainage | 11.26 | 5.32 | 17.33 |

| DESIGN POINT DESCRIPTIONS | | |
|---|---|---|
| **Design Point** | **Description** | **Downstream Design Point** |
| DP A | - This design point is located at a private 5' Type R sump inlet on the north side of the private access road. It captures sheet flows from the access road, parts of the access entrances and sheet flows from paved portions of the commercial development. Flows from this inlet will be directed to the private detention pond via private 24" RCP storm drain. | J2 |
| DP A Inlet Flow | -This design point is the same as DP A but includes potential bypass flows from design points DP B, DP C, and DP D. | J2 |
| DP B | -This design point is located at a private 10' Type R sump inlet on the west side of the west entrance into the commercial development. It captures sheet flow from the northern area of the proposed site. Flows from this inlet will be directed to the private detention pond via private 18" RCP storm drain. | J2 |
| DP B Inlet Flow | -This design point is the same as DP B but includes by-pass flows from design points DP C & DP D and flows from DP G. | J2 |
| DP C | -This design point is located at a private triple valley inlet consisting of 3'x1.73' Denver No. 16 valley grates in the center of the front parking area. It captures sheet flows for the central area of the site. Flows from this inlet will be directed to the inlet at DP D via private 15" RCP storm drain. | B |
| DP C Inlet Flow | -This design point is the same as DP C but includes bypass flows from design point DP D. | B |
| DP D | This design point is located at a private triple valley inlet consisting of 3'x1.73' Denver No. 16 valley grates in the center of the east portion of the front parking area. It captures sheet flows for the northeast portion of the commercial site. Flows from this inlet will be directed to the inlet at DP B via private 15" and 18" RCP storm drain. | C |
| DP E | -This design point represents the private 5' wide concrete flume near the entrance to the onsite car wash. It captures sheet flows for the eastern paved portion of the site parking. It includes private roof drainage from the car wash building. Flows will be released into the private detention pond. | J2 |
| DP F | -This design point represents the private roof drainage from the car wash building. Flows will be directed to the private detention pond via private 6" PVC pipe. | J2 |
| DP G | -This design point represents the private roof drainage from the fuel canopy. Flows will be directed to the inlet at DP B via private 6" and 8" PVC pipe. | B |

| DESIGN POINT DESCRIPTIONS | | |
|---|---|---|
| **Design Point** | **Description** | **Downstream Design Point** |
| DP H | -This design point represents the private roof drainage from the convenience store building. Flows will be directed to the private detention pond via 6" PVC pipe. | J2 |
| DP J1 | -This design point represents the surface sheet flow from the detention pond area and the surrounding landscaping. | J2 |
| DP J2 | -This design point includes the combined inflow into the detention pond from design points DP A, DP B, DP E, DP G, DP H and DP J1. | J3 |
| DP K | -This design point includes the eastern sheet flows from the undeveloped area to the east of the proposed Circle K and road sheet flows draining to this area from Highway 24. A private 15" culvert and RCP storm drain will carry these flows across the proposed east entrance. | Q2 |
| DP L | -This design point includes the western sheet flows draining to the proposed west culvert. These offsite flows include northern portions of of offsite ROW green space, existing channel flows, flows from Highway 24 and flows from Meridian Road. A private 23"X14" culvert and RCP storm drain will carry these flows across the proposed west entrance. | Q2 |
| Detention Pond Discharge (J3) | -This design point is at the private discharge structure from the proposed private detention and water quality pond.<br>-Developed flows from the proposed improvements will be metered out by this private structure at predevelopment levels as determined by the UD-Detention modeling of the Full Spectrum Extended Detention Basin.<br>-Flows will discharge onto the south lot. Flows shall disperse across the south lot via riprap outfall projection and a proposed spreader swale. | Q2 |
| DP M | -This design point represents sheet flows from the proposed access road for the west entrance. | Q2 |
| DP N | -This design point represents offsite sheet flows from Meridian Sol Drive and the east entrance. These flows will be collected via riprap rundown into the existing west swale. | Q2 |
| DP P | -This design point represents sheet flows to the south of the proposed access road. | Q2 |
| DP Q1 | -This design point represents surface sheet flows for the south lot. | Q2 |
| DP Q2 | -This design point includes the combined inflow into the future south detention pond from design points DP J3, DP K, DP M, DP N, and DP P. | Q3 |

| DESIGN POINT DESCRIPTIONS | | |
|---|---|---|
| **Design Point** | **Description** | **Downstream Design Point** |
| Future South Detention Pond Discharge | -This design point represents the discharge structure for the future south detention pond (not for construction). Undeveloped flows for DP Q1 were used for approximate sizing of this future pond as determined by the UD-Detention modeling of the Full Spectrum Extended Detention Basin. | Existing Area Inlet |
| DP SITE | -This design point sums flows from the north and south lots (DP J3, DP K, DP L, DP M, DP N, DP P, and DP Q3) and gives a value to the overall site discharge. Both Q5 and Q100 flows are less than existing conditions. | Existing Area Inlets |

- Generally, flows will sheet flow off the commercial development towards adjacent storm infrastructure. After capture by inlets, the flows will be conveyed onwards towards the downstream detention basin via storm sewer. Undeveloped flows will continue historic conditions.

# VIII. Drainage Facility Design

## A. Inlet Capacity

In accordance with the DCM, this project will use Type R inlets. On-grade inlet capacities were determined utilizing UD-Inlet. The following Table 6.2 lists inlets by design point and corresponding capacity. Table 6.3 describes overflow routing for each sump inlet.

| Circle K at Highway 24 & Meridian Road INLET SUMMARY | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DESIGN POINT (#-Letter) or SUB-BASIN (Letter#) | SUB-BASINS | TOTAL AREA (AC) | INLET | | | Q(5) BYPASS FLOWS (cfs) | Q(5) TOTAL INFLOW | Q5 INLET CAPACITY | Q(100) BYPASS FLOWS (cfs) | Q(100) TOTAL INFLOW (cfs) | MAX INLET CAPACITY | NOTES: |
| | | | SIZE (Ft.) | TYPE | CONDITION | | | | | | | |
| DP A | A | 1.00 | 5 | R | SUMP | 0.0 | 3.27 | 5.4 | 0.0 | 6.22 | 9.2 | |
| DP B | B | 0.77 | 10 | R | SUMP | 0.0 | 2.16 | 2.5 | 0.0 | 4.27 | 6.1 | Inlet B Captures 100% of Bypass Flows From Inlets C & D |
| DP C | C | 0.33 | 3 | 16 | AT GRADE | 0.0 | 1.09 | 1.1 | 0.1 | 2.08 | 2.0 | Bypass flows to Inlet B |
| DP D | D | 0.36 | 3 | 16 | AT GRADE | 0.0 | 1.05 | 1.0 | 0.4 | 2.06 | 1.7 | Bypass flows to Inlet C |

| *Table 6.3 Overflow Routing Circle K at Highway 24 & Meridian Road* | |
|---|---|
| *Inlet* | *Overflow Routing Under Inlet Blockage Conditions* |
| A | In case of blockage of this inlet flows will surcharge the curb and gutter and flow directly into the North Detention pond. |

## B. Storm Sewer Capacities

Storm sewer capacities and HGL's were analyzed in StormCAD. Summary tables and HGL profiles for the Q5 and Q100 events can be found in Appendix A.

## C. Detention

Summary information for the North Detention Pond is listed below. Supporting UD-Detention spreadsheets for the Detention Pond can be found in Appendix A. The north Detention Pond will be privately owned and maintained.

| Table 6.5 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North Pond Summary Table | | | | | | | | | | | | |
| Major Basin | Pond ID | Analysis Method | Contributing Basins | Tributary Area | Imperviousness | Approximate Detention Volumes | | | EX | Proposed | EX | Proposed |
| | | | | | | WQCV | EURV | Q100 | 5 Year | 5 Year | 100 Year | 100 Year |
| | | | | Ac. | % | Ac.-Ft. | Ac.-Ft. | Ac.-Ft. | (CFS) | (CFS) | (CFS) | (CFS) |
| **Chico Creek** | Detention Pond | UD-Detention | A, B, C, D, E, F, G, H, J1 | 3.72 | 65.5 | 0.08 | 0.306 | 0.367 | 0.1 | **0.1** | 3.2 | **3.4** |

A future detention pond for the south lot was modeled to calculate overall site outflow for the north and south lots. Supporting UD-Detention spreadsheets for the future South Detention Pond can be found in Appendix A. The model is only preliminary and is not intended for construction.

## Emergency Overflows

| Table 6.6<br>Emergency Overflow Weirs | | |
|---|---|---|
| **Major Basin** | **Pond ID** | **Description of Emergency Overflow Weir** |
| **Chico Creek** | North Detention Pond | The emergency overflow weir for this pond will release emergency overflows across the proposed access road and into the south property. Flows will then follow historic patterns. |

## Outfall Analysis

### *North Detention Pond*

In order to assure a suitable outfall, we have completed Manning's channel flow analysis on the discharge from the proposed north detention pond. This outfall will discharge to the property to the south which will be rezoned for future commercial development. Using the FHWA Hydraulic Toolbox we have determined that the natural untouched vegetation is suitable for handling the outflow from the proposed north detention pond. The velocity of the anticipated Q100 discharge in the swale downstream off the 24" outfall was calculated to be 0.44 ft/s which is well below the maximum low-flow velocity and maximum 100-year velocity. Table 12-3 (below) of the DCM regarding Hydraulic Design Criteria for natural unlined channels.

**Table 12-3. Hydraulic Design Criteria for Natural Unlined Channels**

| Design Parameter | Erosive Soils or Poor Vegetation | Erosion Resistant Soils and Vegetation |
|---|---|---|
| Maximum Low-flow Velocity (ft/sec) | 3.5 ft/sec | 5.0 ft/sec |
| Maximum 100-year Velocity (ft/sec) | 5.0 ft/sec | 7.0 ft/sec |
| Froude No., Low-flow | 0.5 | 0.7 |
| Froude No., 100-year | 0.6 | 0.8 |
| Maximum Tractive Force, 100-year | 0.60 lb/sf | 1.0 lb/sf |

[1] Velocities, Froude numbers and tractive force values listed are average values for the cross section.
[2] "Erosion resistant" soils are those with 30% or greater clay content. Soils with less than 30% clay content shall be considered "erosive soils."

The Web Soil Survey for the site indicates that the Soils for the receiving swale are are class A sandy soils and likely resistant to erosive conditions.

*Future South Detention Pond*

For the future south detention pond, the outfall was modeled flowing into an existing area inlet located southeast of the south lot. From their an existing storm sewer network will convey the flows into an existing extended detention basin west of Meridian Road.

## IX. Environmental Evaluations

### A. WETLAND IMPACTS

There are no designated wetland or riparian areas on site, and no anticipated impacts.

### B. STORMWATER QUALITY

All on-site detention facilities shall be designed to accommodate water quality requirements. As the development of each parcel progresses, the detention guidelines outlined in this report are to be upheld. Per Chapter 4, Section 4.1, of the El Paso County DCM, Volume 2, the DCM requires a Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls.

**Step 1:** **Employ Runoff Reduction Practices**

- Site specific landscaping will be done on each lot to decrease the connectivity of impervious areas. Grass lined swales will be used where possible to allow infiltration.

**Step 2:** **Provide Water Quality Capture Volume**

- The Detention pond meets the DCM standards for the release rates of Full Spectrum Detention Ponds for Water Quality Capture Volumes.

**Step 3:** **Stabilize Drainageways.**

- Existing roadside swale existing along the east and western property boundaries for the entire site. The west swale collects flows from Meridian Road and portions of greenspace while the east swale collects flows from Meridian Sol Drive and portions of onsite undeveloped land. Both swales shall be maintained in current conditions where no development occurs. Proposed culverts shall be installed where the proposed private access road crosses each existing swale. Riprap protection and erosion control shall be installed at all culvert entrances and exits. Proposed sidewalk along the north portion of Meridian Sol Drive shall drain into the street while slopes facing west shall be installed with erosion control. Existing area inlets to the south of the property shall have erosion control measures installed during construction.

**Step 4:** **Consider Need for Industrial and Commercial BMPs**

- There are commercial components of this development, therefore special BMPs of this nature are required. Covering of fuel storage areas and spill containment & control will be required for this project. Please see the applicable underground fuel tank construction drawings for details and design information. The stormwater management plan developed for this site also includes potential sources of commercial pollution and a spill prevention and response plan. The Full Spectrum Detention BMP is provided for the proposed development by the detention pond.

### C. PERMITTING REQUIREMENTS

No additional permitting requirements are expected at this time.

### D. TREATMENT EXCLUSIONS

**a. Land Disturbance to Undeveloped**

Per Appendix I, Section 7.1.B.7, of the El Paso County DCM, Volume 2, the DCM allows the exclusion of sites with land disturbance resulting in undeveloped land that will remain undeveloped to remain untreated. DP L and DP K shall both be constructed back to undeveloped land and are not treated via the north detention pond. Both design points will flow downstream to existing swales via proposed culverts.

**b. Impractical Capture**

Per Appendix I, Section 7.1.C.1, of the El Paso County DCM, Volume 2, the DCM allows for areas less than 20%, and not to exceed 1 acre, of the applicable development site area to remain untreated if it is determined impractical to capture their flows. Both access driveways on the west and east sides into the proposed site are impractical to treat as they have been proposed to grade entrance flows away from the site so as to not take on offsite flows from Meridian Sol Drive and Meridian Road. The combined impervious area of both drive entrances does not exceed 20% of the site's applicable development area and does not exceed 1 acre.

## X. Erosion Control Plan

A grading and erosion control plan (GEC) for Circle K at Highway 24 & Meridian will be completed. The GEC incorporates check dams, silt fence, vehicle tracking control, inlet & outlet control, sedimentation basins and other best management practices (BMPs) identified in the DCM Volume 2. Please refer to the GEC for phasing and procedural information.

# XI. Drainage Fees

Impervious Area Calculations

| Land Use Type | % Impervious | Area (Acres) | Impervious Acres |
|---|---|---|---|
| **Falcon Drainage Basin** | | | |
| Commercial | 95% | 7.79 | 7.40 |
| Untouched/Green Space | 0% | 0 | 0 |
| | Total | 7.79 | 7.40 |

| **Circle K at Highway 24 & Meridian**<br>2022 Drainage and Bridge Fees for Falcon Drainage Basin | | | | | | |
|---|---|---|---|---|---|---|
| | Impervious Area (ac.) | Fee/ Imp. Acre | Fee Due | Reimbursable Const. Costs | Fee Due at Platting | Drainage Fee Credit |
| Chico Creek | | | | | | |
| Drainage Fee | 7.40 | $34,117.00 | $252,465.80 | $0.00 | $252,465.80 | $0.00 |
| Bridge Fee | 7.40 | $4,687 | $34,683.80 | $0.00 | $34,683.80 | $0.00 |
| *Overall Total* | | | | | ***$287,149.60*** | |

# XII. Construction Cost Opinion

| Engineer's Estimate of Probable Construction Costs | | | | |
|---|---|---|---|---|
| **Circle K at Highway 24 & Meridian** | | | | |
| **Public Non-Reimbursable** | | | | |
| **Item** | **Unit** | **Quantity** | **Unit Cost** | **Extension** |
| 15" RCP | LF | 302 | $58.00 | $17,516.00 |
| 18" RCP | LF | 218 | $70.00 | $15,260.00 |
| 24" RCP | LF | 85 | $83.00 | $7,055.00 |
| 23”X14” HERCP | LF | 97 | $85.00 | $8,245.00 |
| 15” FES | EA | 2 | $400.00 | $800.00 |
| 18" FES | EA | 1 | $420.00 | $420.00 |
| 24" FES | EA | 2 | $498.00 | $498.00 |
| 23”X14” FES | EA | 2 | $510.00 | $1,020.00 |
| TYPE II MANHOLE | EA | 1 | $7,082.00 | $7,082.00 |
| 5' TYPE R INLET | EA | 1 | $7,981.00 | $7,981.00 |
| 10' TYPE R INLET | EA | 1 | $10,898.00 | $10,898.00 |
| DENVER NO. 16 VALLEY GRATE | EA | 6 | $4,000.00 | $24,000.00 |
| DETENTION/WQ POND | EA | 2 | $86,000.00 | $172,000.00 |
| | | Sub Total | $272,775.00 | |
| | | 10% Contingency | $27,277.50 | |
| | | **TOTAL:** | | $300,052.50 |

Since the engineer has no control over the cost of labor, materials, equipment, or services furnished by others, or over the contractor's method of determining prices, or over the competitive bidding or market conditions, the opinion of probable construction costs provided herein are made on the basis of the engineer's experience and qualifications and represents the best judgment as an experienced and qualified professional familiar with the construction industry. The engineer cannot, and does not guarantee that proposals, bid or actual construction costs will not vary from the opinions of probable cost.

## XIII. Summary

The above report has demonstrated that the proposed Circle K at Highway 24 & Meridian development will comply with the governing DCM, ECM, and the El Paso County MS4 permit. There are no DBPS requirements affecting the site and no adverse effects on downstream infrastructure is anticipated. Therefore, we recommend approval of the proposed development.

## XIV. References

1. ***El Paso County Drainage Criteria Manual, Volume 1 & 2***, El Paso County, May 2014
2. ***El Paso County Engineering Criteria Manual,*** El Paso County, Rev. December 2016
3. ***Web Soil Survey of El Paso County Area, Colorado. Unites States Department of Agriculture Soil Conservation Service***.
4. ***Flood Insurance Rate Maps for El Paso County, Colorado and Incorporated Areas, Panel 561 of 1300, Federal Emergency Management Agency***, Effective Date December 7, 2018.
5. ***Urban Storm Drainage Criteria Manual, Vol. 1-3*** by Urban Drainage and Flood Control District (UDFCD), January 2016
6. ***Falcon Drainage Basin Planning Study,*** Matrix Design Group, September 2015
7. ***Stormwater Management Plan, Circle K at Highway 24 & Meridian Road,*** Matrix Design Group, Under review.
8. ***El Paso County Department of Public Services U.S. 24 and Meridian Road Improvement Plans*** **by HDR, August 2019.**

# XV. Appendices

# APPENDIX A

## HYDROLOGIC AND HYDRAULIC CALCULATIONS

Worksheet Protected

# Site-Level Low Impact Development (LID) Design Effective Impervious Calculator

## LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

| | | | |
|---|---|---|---|
| ***Design Storm: 1-Hour Rain Depth | WQCV Event | 0.60 | inches |
| ***Minor Storm: 1-Hour Rain Depth | 5-Year Event | 1.50 | inches |
| ***Major Storm: 1-Hour Rain Depth | 100-Year Event | 2.52 | inches |
| Optional User Defined Storm | CUHP | | |
| (CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm | 100-Year Event | 2.52 | |
| Max Intensity for Optional User Defined Storm | 2.51496 | | |

| | |
|---|---|
| **Designer:** | **Luke Bonner** |
| **Company:** | **Matrix Design Group** |
| **Date:** | **November 17, 2022** |
| **Project:** | **Circle K at Highway 24 & Meridian Road - Final Plat PDR** |
| **Location:** | **El Paso County, CO** |

**SITE INFORMATION (USER-INPUT)**

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sub-basin Identifier** | **J3** | | | | | | | | | | | | | |
| Receiving Pervious Area Soil Type | Loamy Sand | | | | | | | | | | | | | |
| Total Area (ac., Sum of DCIA, UIA, RPA, & SPA) | 11.255 | | | | | | | | | | | | | |
| Directly Connected Impervious Area (DCIA, acres) | 4.088 | | | | | | | | | | | | | |
| Unconnected Impervious Area (UIA, acres) | 0.000 | | | | | | | | | | | | | |
| Receiving Pervious Area (RPA, acres) | 0.000 | | | | | | | | | | | | | |
| Separate Pervious Area (SPA, acres) | 7.167 | | | | | | | | | | | | | |
| RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP) | V | C | C | C | C | C | C | C | C | C | C | C | C | |
| | | MISSING INPUT | MISSING INPUT | MISSING INPUT | MISSING INPUT | MISSING INPUT | MISSING INPUT | MISSING INPUT | MISSING INPUT | MISSING INPUT | MISSING INPUT | MISSING INPUT | MISSING INPUT | |

**CALCULATED RESULTS (OUTPUT)**

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Calculated Area (ac, check against input) | 11.255 | | | | | | | | | | | | | |
| Directly Connected Impervious Area (DCIA, %) | 36.3% | | | | | | | | | | | | | |
| Unconnected Impervious Area (UIA, %) | 0.0% | | | | | | | | | | | | | |
| Receiving Pervious Area (RPA, %) | 0.0% | | | | | | | | | | | | | |
| Separate Pervious Area (SPA, %) | 63.7% | | | | | | | | | | | | | |
| $A_R$ (RPA / UIA) | 0.000 | | | | | | | | | | | | | |
| $I_a$ Check | 1.000 | | | | | | | | | | | | | |
| f / I for WQCV Event: | 3.2 | | | | | | | | | | | | | |
| f / I for 5-Year Event: | 0.5 | | | | | | | | | | | | | |
| f / I for 100-Year Event: | 0.4 | | | | | | | | | | | | | |
| f / I for Optional User Defined Storm CUHP: | 0.39 | | | | | | | | | | | | | |
| IRF for WQCV Event: | 0.00 | | | | | | | | | | | | | |
| IRF for 5-Year Event: | 1.00 | | | | | | | | | | | | | |
| IRF for 100-Year Event: | 1.00 | | | | | | | | | | | | | |
| IRF for Optional User Defined Storm CUHP: | 1.00 | | | | | | | | | | | | | |
| Total Site Imperviousness: $I_{total}$ | 36.3% | | | | | | | | | | | | | |
| Effective Imperviousness for WQCV Event: | 36.3% | | | | | | | | | | | | | |
| Effective Imperviousness for 5-Year Event: | 36.3% | | | | | | | | | | | | | |
| Effective Imperviousness for 100-Year Event: | 36.3% | | | | | | | | | | | | | |
| Effective Imperviousness for Optional User Defined Storm CUHP: | 36.3% | | | | | | | | | | | | | |

**LID / EFFECTIVE IMPERVIOUSNESS CREDITS**

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WQCV Event CREDIT: Reduce Detention By: | N/A | | | | | | | | | | | | | N/A |
| This line only for 10-Year Event | N/A | | | | | | | | | | | | | N/A |
| 100-Year Event CREDIT**: Reduce Detention By: | 0.0% | | | | | | | | | | | | | N/A |
| User Defined CUHP CREDIT: Reduce Detention By: | 0.0% | | | | | | | | | | | | | |

| | |
|---|---|
| **Total Site Imperviousness:** | **36.3%** |
| **Total Site Effective Imperviousness for WQCV Event:** | **36.3%** |
| **Total Site Effective Imperviousness for 5-Year Event:** | **36.3%** |
| **Total Site Effective Imperviousness for 100-Year Event:** | **36.3%** |
| **Total Site Effective Imperviousness for Optional User Defined Storm CUHP:** | **36.3%** |

Notes:

* Use Green-Ampt average infiltration rate values from Table 3-3.

** Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.

*** Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

# Rational Method - Existing Conditions

| | |
|---|---|
| **Project Name:** | Circle K - HWY 24 & Meridian |
| **Project Location:** | Falcon, Colorado |
| **Designer** | LCB/JTS |
| **Notes:** | Existing Conditions |

Average Channel Velocity 5 ft/s
Average Slope for Initial Flow 0.04 ft/ft

Channel Flow Type Key

| | |
|---|---|
| Heavy Meadow | 2 |
| Tillage/Field | 3 |
| Short Pasture and Lawns | 4 |
| Nearly Bare Ground | 5 |
| Grassed Waterway | 6 |
| Paved Areas | 7 |

| | | Area | | Rational 'C' Values | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Major Basin / Sub-basin** | **Comments** | sf | acres | Surface Type 1 (Impervious) C5 | Surface Type 1 (Impervious) C100 | Area (SF) | Surface Type 2 (Undeveloped) C5 | Surface Type 2 (Undeveloped) C100 | Area | Composite C5 | Composite C100 |
| ***EX 01*** | ***West offsite drainage, south part of HWY 24, pervious area north of PR SITE*** | 72,996.4 | 1.68 | 0.90 | 0.96 | 22557.26 | 0.09 | 0.36 | 50439.15 | 0.34 | 0.55 |
| ***EX 02*** | ***Proposed site treated by WQ Pond, proposed comercial area, portion of access road*** | 171,386.7 | 3.93 | 0.90 | 0.96 | 9136.39 | 0.09 | 0.36 | 162250.28 | 0.13 | 0.39 |
| ***EX 03*** | ***West Entrance*** | 3,997.5 | 0.09 | 0.90 | 0.96 | 965.17 | 0.09 | 0.36 | 3032.36 | 0.29 | 0.50 |
| ***EX 04*** | ***Northeast area, south part of HWY 24, existing comercial building*** | 81,916.8 | 1.88 | 0.90 | 0.96 | 42958.11 | 0.09 | 0.36 | 38958.73 | 0.51 | 0.67 |
| ***EX 05*** | ***East Entrance, west part of Meridian Sol, proposed sidewalk*** | 18,712.0 | 0.43 | 0.90 | 0.96 | 12980.34 | 0.09 | 0.36 | 5731.65 | 0.65 | 0.78 |
| ***EX 06*** | ***South Lot 2 excluding proposed site embankment grading*** | 137,786.6 | 3.16 | 0.90 | 0.96 | 14753.02 | 0.09 | 0.36 | 123033.58 | 0.18 | 0.42 |
| ***EX SITE NORTH*** | ***EX 01-05*** | 349,009.4 | 8.01 | 0.90 | 0.96 | 88597.28 | 0.09 | 0.36 | 260412.16 | 0.30 | 0.51 |
| ***EX SITE OVERALL*** | ***EX 01-06*** | 486,796.0 | 11.18 | 0.90 | 0.96 | 103350.29 | 0.09 | 0.36 | 383445.74 | 0.26 | 0.49 |

| | Flow Lengths | | | | Initial Flow | | Channel Flow | | | | Tc | Rainfall Intensity & Rational Flow Rate | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Major Basin / Sub-basin** | Initial ft | True Initial Length ft | Channel ft | True Channel Length ft | Average Slope | Initial Tc (min) | Average (%) Slope | Channel Flow Type (See Key above) Ground Type | Velocity (ft/s) | Channel Tc (min) | Total (min) | i5 in/hr | Q5 cfs | i100 in/hr | Q100 cfs |
| ***EX 01*** | 350.00 | 300.00 | 500.00 | 300.00 | 0.020 | 20.30 | 2.000 | 4 | 1.0 | 5.1 | 25.4 | 2.7 | **1.5** | 4.5 | **4.1** |
| ***EX 02*** | 300.00 | 300.00 | 300.00 | 300.00 | 0.020 | 23.92 | 2.000 | 4 | 1.0 | 5.1 | 29.0 | 2.5 | **1.3** | 4.2 | **6.4** |
| ***EX 03*** | 40.00 | 40.00 | 75.00 | 300.00 | 0.020 | 7.36 | 2.000 | 4 | 1.0 | 5.1 | 12.4 | 3.8 | **0.1** | 6.3 | **0.3** |
| ***EX 04*** | 100.00 | 380.00 | 300.00 | 300.00 | 0.020 | 8.36 | 2.000 | 7 | 2.8 | 1.8 | 10.1 | 4.1 | **4.0** | 6.9 | **8.7** |
| ***EX 05*** | 50.00 | 50.00 | 450.00 | 300.00 | 0.020 | 4.53 | 2.000 | 7 | 2.8 | 1.8 | 6.3 | 4.8 | **1.3** | 8.1 | **2.7** |
| ***EX 06*** | 280.00 | 280.00 | 350.00 | 300.00 | 0.020 | 22.07 | 2.000 | 4 | 1.0 | 5.1 | 27.1 | 2.6 | **1.4** | 4.3 | **5.8** |
| ***EX SITE NORTH*** | 350.00 | 300.00 | 500.00 | 300.00 | 0.020 | 21.50 | 2.000 | 4 | 1.0 | 5.1 | 26.6 | 2.6 | **6.1** | 4.4 | **17.9** |
| ***EX SITE OVERALL*** | 350.00 | 300.00 | 500.00 | 300.00 | 0.020 | 22.40 | 2.000 | 4 | 1.0 | 5.1 | 27.4 | 2.5 | **7.5** | 4.3 | **23.3** |

# Rational Method - Proposed Conditions

| | |
|---|---|
| **Project Name:** | Circle K - HWY 24 & Meridian |
| **Project Location:** | Falcon, Colorado |
| **Designer** | LCB/JTS |
| **Notes:** | Circle K Proposed Conditions |

Average Channel Velocity 4.00 ft/s (If specific channel vel is used, this will be ignored)
Average Slope for Initial Flow 0.04 ft/ft (If Elevations are used, this will be ignored)

Channel Flow Type Key

| | |
|---|---|
| Heavy Meadow | 2 |
| Tillage/Field | 3 |
| Short Pasture and Lawns | 4 |
| Nearly Bare Ground | 5 |
| Grassed Waterway | 6 |
| Paved Areas | 7 |

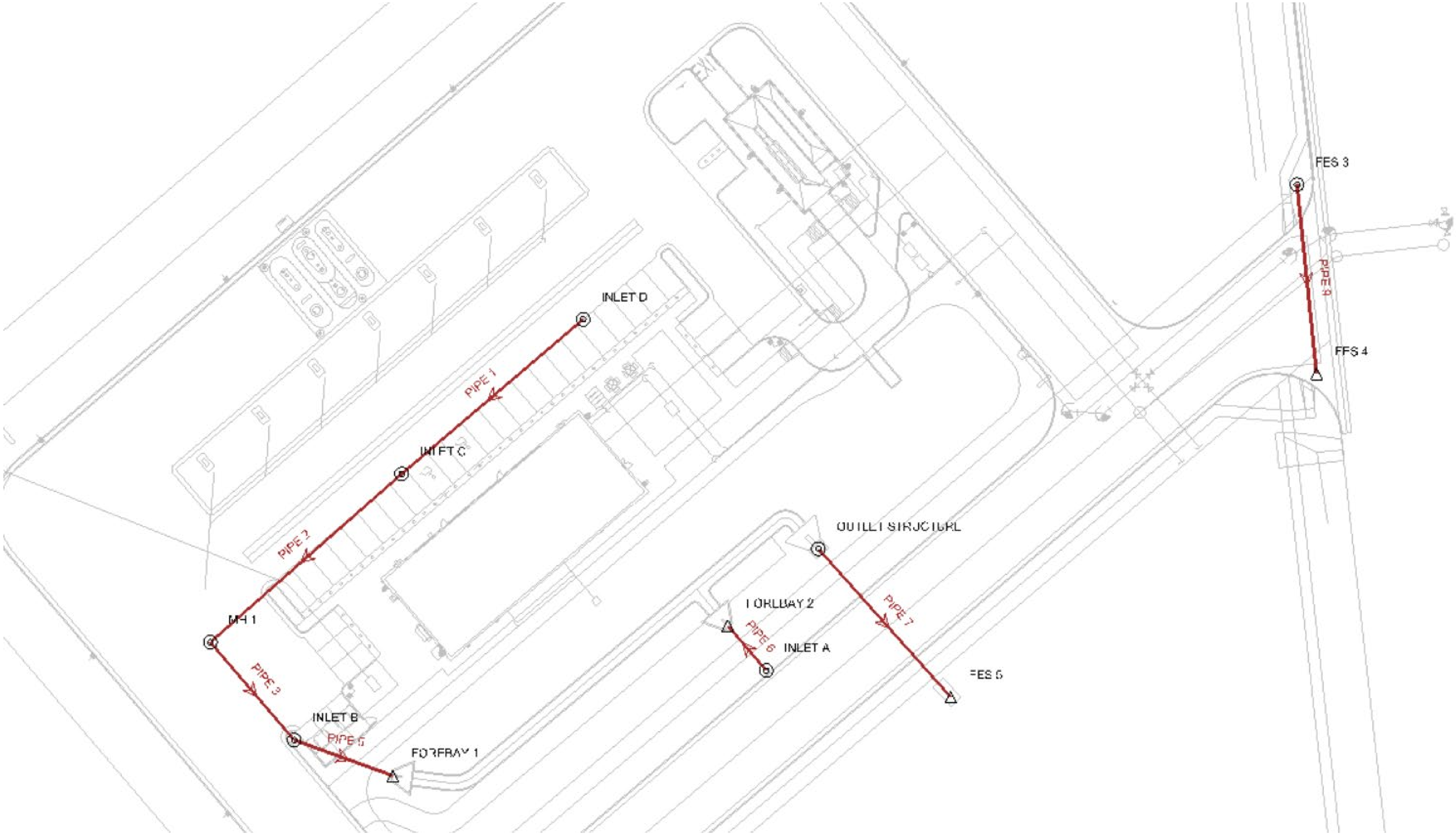
| | | Area | | Rational 'C' Values | | | | | | | | | Flow Lengths | | | | | | | | | | Tc | Rainfall Intensity & Rational Flow Rate | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sub-basin | Comments | | | Surface Type 1 Streets - Paved (100% Impervious) | | | Surface Type 2 Undeveloped-Historic Flow Analysis (2% Impervious) | | | Composite | | Percent Impervious | Initial | True Initial | Channel | True Channel | Average (decimal) | Initial | Average (%) | Channel Flow Type (See Key above) | Velocity | Channel | Total | i5 | Q5 | i100 | Q100 |
| | | sf | acres | C5 | C100 | Area (SF) | C5 | C100 | Area | C5 | C100 | | ft | Length ft | ft | Length ft | Slope | Tc (min) | Slope | Ground Type | (ft/s) | Tc (min) | (min) | in/hr | cfs | in/hr | cfs |
| *A* | *South Access road, internal west entrance, internal east entrance north adjacent to carwash* | 43748 | 1.00 | 0.90 | 0.96 | 35838.80 | 0.09 | 0.36 | 7909.38 | 0.75 | 0.85 | 82.28 | 100 | 100 | 500 | 500 | 0.02 | 5.45 | 1.50 | 7 | 2.45 | 3.40 | 8.84 | 4.29 | **3.3** | 7.21 | **6.2** |
| *B* | *West side of parcel, bypass from C and D* | 33696 | 0.77 | 0.90 | 0.96 | 24390.84 | 0.09 | 0.36 | 9304.86 | 0.68 | 0.79 | 72.94 | 120 | 100 | 180 | 200 | 0.01 | 8.35 | 1.00 | 7 | 2.00 | 1.67 | 10.02 | 4.10 | **2.2** | 6.89 | **4.3** |
| *C* | *Middle of fuel canopy and parking, central area inlet* | 14589 | 0.33 | 0.90 | 0.96 | 11878.55 | 0.09 | 0.36 | 2710.02 | 0.75 | 0.85 | 81.80 | 140 | 100 | 110 | 150 | 0.01 | 7.46 | 1.00 | 7 | 2.00 | 1.25 | 8.71 | 4.32 | **1.1** | 7.25 | **2.1** |
| *D* | *NE corner draining towards SW, NW area inlet at parking gutter* | 15880 | 0.36 | 0.90 | 0.96 | 11551.84 | 0.09 | 0.36 | 4328.52 | 0.68 | 0.80 | 73.29 | 100 | 100 | 225 | 225 | 0.01 | 7.57 | 1.00 | 7 | 2.00 | 1.88 | 9.44 | 4.19 | **1.0** | 7.04 | **2.1** |
| *E* | *Car Wash entrance and landscaping, east parking* | 9463 | 0.22 | 0.90 | 0.96 | 6574.49 | 0.09 | 0.36 | 2888.07 | 0.65 | 0.78 | 70.09 | 30 | 30 | 130 | 130 | 0.01 | 4.41 | 1.00 | 7 | 2.00 | 1.08 | 5.49 | 4.98 | **0.7** | 8.37 | **1.4** |
| *F* | *Car Wash Roof drainage* | 1458 | 0.03 | 0.90 | 0.96 | 1458.00 | 0.09 | 0.36 | 0.00 | 0.90 | 0.96 | 100.00 | 20 | 20 | 65 | 65 | 0.01 | 1.61 | 1.00 | 7 | 2.00 | 0.54 | 5.00 | 5.10 | **0.2** | 8.58 | **0.3** |
| *G* | *Fuel Canopy Roof Drainage* | 6312 | 0.14 | 0.90 | 0.96 | 6312.00 | 0.09 | 0.36 | 0.00 | 0.90 | 0.96 | 100.00 | 15 | 15 | 220 | 220 | 0.01 | 1.39 | 1.00 | 7 | 2.00 | 1.83 | 5.00 | 5.10 | **0.7** | 8.58 | **1.2** |
| *H* | *C-Store Roof Drainage* | 5200 | 0.12 | 0.90 | 0.96 | 5200.00 | 0.09 | 0.36 | 0.00 | 0.90 | 0.96 | 100.00 | 40 | 40 | 100 | 100 | 0.01 | 2.28 | 1.00 | 7 | 2.00 | 0.83 | 5.00 | 5.10 | **0.6** | 8.58 | **1.0** |
| *J* | *Detention pond* | 31797 | 0.73 | 0.90 | 0.96 | 1915.79 | 0.09 | 0.36 | 29881.69 | 0.14 | 0.40 | 7.90 | 60 | 60 | 210 | 210 | 0.01 | 13.40 | 1.00 | 4 | 0.70 | 5.00 | 18.40 | 3.14 | **0.3** | 5.28 | **1.5** |
| *K* | *Northeast area, south part of HWY 24* | 81917 | 1.88 | 0.90 | 0.96 | 28612.90 | 0.09 | 0.36 | 53303.94 | 0.37 | 0.57 | 36.23 | 75 | 75 | 375 | 375 | 0.01 | 11.33 | 1.00 | 4 | 0.70 | 8.93 | 20.26 | 2.99 | **2.1** | 5.03 | **5.4** |
| *L* | *Offsite drainage to north and west of site, roadway flows* | 72996 | 1.68 | 0.90 | 0.96 | 15235.61 | 0.09 | 0.36 | 57760.80 | 0.26 | 0.49 | 22.45 | 300 | 300 | 525 | 525 | 0.01 | 26.22 | 1.00 | 4 | 0.70 | 12.50 | 38.71 | 2.09 | **0.9** | 3.50 | **2.9** |
| *M* | *Offsite street drainage for West entrance* | 4050 | 0.09 | 0.90 | 0.96 | 4049.98 | 0.09 | 0.36 | 0.00 | 0.90 | 0.96 | 100.00 | 20 | 20 | 75 | 75 | 0.01 | 1.61 | 1.00 | 7 | 2.00 | 0.63 | 5.00 | 5.10 | **0.4** | 8.58 | **0.8** |
| *N* | *Offsite street drainage for East entrance, west part of Meridian Sol* | 18722 | 0.43 | 0.90 | 0.96 | 18721.61 | 0.09 | 0.36 | 0.00 | 0.90 | 0.96 | 100.00 | 20 | 20 | 50 | 50 | 0.01 | 1.61 | 1.00 | 7 | 2.00 | 0.42 | 5.00 | 5.10 | **2.0** | 8.58 | **3.6** |
| *P* | *Offsite drainage to the south of the Access road, offsite culvert outlets* | 10123 | 0.23 | 0.90 | 0.96 | 0.00 | 0.09 | 0.36 | 10123.38 | 0.09 | 0.36 | 2.00 | 20 | 20 | 20 | 20 | 0.02 | 6.45 | 2.00 | 4 | 0.99 | 0.34 | 6.78 | 4.69 | **0.1** | 7.88 | **0.7** |
| *Q* | *South Lot Drainage* | 140334 | 3.22 | 0.90 | 0.96 | 0.00 | 0.09 | 0.36 | 140333.94 | 0.09 | 0.36 | 2.00 | 260 | 260 | 275 | 275 | 0.02 | 23.27 | 2.00 | 4 | 0.99 | 4.63 | 27.89 | 2.52 | **0.7** | 4.24 | **5.0** |
| *DESIGN POINTS* | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *DP A* | *Inlet at lowpoint of access road* | 43748 | 1.00 | 0.90 | 0.96 | 35839 | 0.09 | 0.36 | 7909 | 0.75 | 0.85 | 82.28 | 100 | 100 | 500 | 500 | 0.02 | 5.45 | 1.5 | 7 | 2.45 | 3.40 | 8.84 | 4.29 | **3.3** | 7.21 | **6.2** |
| *DP A Inlet Flow* | *Inlet at lowpoint of access road, combined flow from DP B* | 114225 | 2.62 | 0.90 | 0.96 | 89972 | 0.09 | 0.36 | 24253 | 0.73 | 0.83 | 79.19 | 100 | 100 | 500 | 500 | 0.01 | 6.70 | 1.0 | 7 | 2.00 | 4.17 | 10.86 | 3.97 | **7.6** | 6.67 | **14.7** |
| *DP B* | *Inlet at NW Corner of Pond, Sub Basin B* | 33696 | 0.77 | 0.90 | 0.96 | 24391 | 0.09 | 0.36 | 9305 | 0.68 | 0.79 | 72.94 | 120 | 100 | 180 | 200 | 0.01 | 8.35 | 1.0 | 7 | 2.00 | 1.67 | 10.02 | 4.10 | **2.2** | 6.89 | **4.3** |
| *DP B Inlet Flow* | *Inlet at NW corner of Pond, B, C, D & G* | 70477 | 1.62 | 0.90 | 0.96 | 54133 | 0.09 | 0.36 | 16343 | 0.71 | 0.82 | 77.27 | 140 | 100 | 250 | 290 | 0.01 | 8.26 | 1.0 | 7 | 2.00 | 2.42 | 10.67 | 4.00 | **4.6** | 6.72 | **9.0** |
| *DP C* | *Area inlets in middle of front parking* | 14589 | 0.33 | 0.90 | 0.96 | 11879 | 0.09 | 0.36 | 2710 | 0.75 | 0.85 | 81.80 | 140 | 100 | 110 | 150 | 0.01 | 7.46 | 1.0 | 7 | 2.00 | 1.25 | 8.71 | 4.32 | **1.1** | 7.25 | **2.1** |
| *DP C Inlet Flow* | *Area inlets in middle of front parking, combined flow from DP D* | 30469 | 0.70 | 0.90 | 0.96 | 23430 | 0.09 | 0.36 | 7039 | 0.71 | 0.82 | 77.36 | 100 | 100 | 350 | 350 | 0.01 | 6.97 | 1.0 | 7 | 2.00 | 2.92 | 9.88 | 4.12 | **2.1** | 6.92 | **4.0** |
| *DP D* | *Area inlets in eastern part of front parking* | 15880 | 0.36 | 0.90 | 0.96 | 11552 | 0.09 | 0.36 | 4329 | 0.68 | 0.80 | 73.29 | 100 | 100 | 225 | 225 | 0.01 | 7.57 | 1.0 | 7 | 2.00 | 1.88 | 9.44 | 4.19 | **1.0** | 7.04 | **2.1** |
| *DP E* | *Car wash entrance flume, E & F* | 10921 | 0.25 | 0.90 | 0.96 | 8032 | 0.09 | 0.36 | 2888 | 0.69 | 0.80 | 74.08 | 140 | 100 | 110 | 150 | 0.01 | 8.82 | 1.0 | 7 | 2.00 | 1.25 | 10.07 | 4.09 | **0.7** | 6.87 | **1.4** |
| *DP F* | *Car Wash Roof Drain* | 1458 | 0.03 | 0.90 | 0.96 | 1458 | 0.09 | 0.36 | 0 | 0.90 | 0.96 | 100.00 | 20 | 20 | 65 | 65 | 0.01 | 1.61 | 1.0 | 7 | 2.00 | 0.54 | 5.00 | 5.10 | **0.2** | 8.58 | **0.3** |
| *DP G* | *Fuel Canopy Roof Drainage* | 6312 | 0.14 | 0.90 | 0.96 | 6312 | 0.09 | 0.36 | 0 | 0.90 | 0.96 | 100.00 | 15 | 15 | 220 | 220 | 0.01 | 1.39 | 1.0 | 7 | 2.00 | 1.83 | 5.00 | 5.10 | **0.7** | 8.58 | **1.2** |
| *DP H* | *C-Store Roof Drain* | 5200 | 0.12 | 0.90 | 0.96 | 5200 | 0.09 | 0.36 | 0 | 0.90 | 0.96 | 100.00 | 40 | 40 | 100 | 100 | 0.01 | 2.28 | 1.0 | 7 | 2.00 | 0.83 | 5.00 | 5.10 | **0.6** | 8.58 | **1.0** |
| *DP J1* | *Detention pond area* | 31797 | 0.73 | 0.90 | 0.96 | 1916 | 0.09 | 0.36 | 29882 | 0.14 | 0.40 | 7.90 | 60 | 60 | 210 | 210 | 0.01 | 13.40 | 1.0 | 4 | 0.70 | 5.00 | 18.40 | 3.14 | **0.3** | 5.28 | **1.5** |
| *DP J2* | *Sub-basins A, B, E, G & H1* | 162143 | 3.72 | 0.90 | 0.96 | 105120 | 0.09 | 0.36 | 57023 | 0.62 | 0.75 | 65.54 | 140 | 100 | 771 | 811 | 0.01 | 10.33 | 1.0 | 7 | 2.00 | 6.76 | 17.08 | 3.26 | **7.5** | 5.47 | **15.4** |
| *DP J3* | *Pond Outlet Structure* | 162143 | 3.72 | 0.90 | 0.96 | 105120 | 0.09 | 0.36 | 57023 | 0.62 | 0.75 | 65.54 | 140 | 100 | 771 | 811 | 0.01 | 10.33 | 1.0 | 7 | 2.00 | 6.76 | 17.08 | 3.26 | **0.1** | 5.47 | **3.4** |
| *DP K* | *Undeveloped land to NE* | 81917 | 1.88 | 0.90 | 0.96 | 28613 | 0.09 | 0.36 | 53304 | 0.37 | 0.57 | 36.23 | 75 | 75 | 375 | 375 | 0.01 | 11.33 | 1.0 | 4 | 0.70 | 8.93 | 20.26 | 2.99 | **2.1** | 5.03 | **5.4** |
| *DP L* | *Offsite drainage to west of site* | 72996 | 1.68 | 0.90 | 0.96 | 15236 | 0.09 | 0.36 | 57761 | 0.26 | 0.49 | 22.45 | 300 | 300 | 525 | 525 | 0.01 | 26.22 | 1.0 | 4 | 0.70 | 12.50 | 38.71 | 2.09 | **0.9** | 3.50 | **2.9** |
| *DP M* | *Offsite street drainage for West entrance* | 4050 | 0.09 | 0.90 | 0.96 | 4050 | 0.09 | 0.36 | 0 | 0.90 | 0.96 | 100.00 | 20 | 20 | 75 | 75 | 0.01 | 1.61 | 1.0 | 7 | 2.00 | 0.63 | 5.00 | 5.10 | **0.4** | 8.58 | **0.8** |
| *DP N* | *Offsite street drainage for East entrance, west part of Meridian Sol* | 18722 | 0.43 | 0.90 | 0.96 | 18722 | 0.09 | 0.36 | 0 | 0.90 | 0.96 | 100.00 | 20 | 20 | 50 | 50 | 0.01 | 1.61 | 1.0 | 7 | 2.00 | 0.42 | 5.00 | 5.10 | **2.0** | 8.58 | **3.6** |
| *DP P* | *Offsite drainage to the south of the Access road, offsite culvert outlets* | 10123 | 0.23 | 0.90 | 0.96 | 0 | 0.09 | 0.36 | 10123 | 0.09 | 0.36 | 2.00 | 20 | 20 | 20 | 20 | 0.02 | 6.45 | 2.0 | 4 | 0.99 | 0.34 | 6.78 | 4.69 | **0.1** | 7.88 | **0.7** |
| *DP Q1* | *South Lot Drainage* | 140334 | 3.22 | 0.90 | 0.96 | 0 | 0.09 | 0.36 | 140334 | 0.09 | 0.36 | 2.00 | 260 | 260 | 275 | 275 | 0.02 | 23.27 | 2.0 | 4 | 0.99 | 4.63 | 27.89 | 2.52 | **0.7** | 4.24 | **5.0** |
| *DP Q2* | *Combined flows into South Area K, J3, M, N, P, Q1* | 331322 | 7.61 | 0.90 | 0.96 | 123842 | 0.09 | 0.36 | 207480 | 0.39 | 0.58 | 38.63 | 260 | 260 | 275 | 275 | 0.02 | 0.02 | 2.0 | 4 | 0.99 | 4.63 | 5.00 | 5.10 | **15.4** | 8.58 | **38.4** |
| *DP Q3* | *South Pond Outflow (Q1)* | 140334 | 3.22 | 0.90 | 0.96 | 0 | 0.09 | 0.36 | 140334 | 0.09 | 0.36 | 2.00 | 260 | 260 | 275 | 275 | 0.02 | 23.27 | 2.0 | 4 | 0.99 | 4.63 | 27.89 | 2.52 | **0.1** | 4.24 | **1.4** |
| *DP SITE* | *North and South Overall Drainage* | 490285 | 11.26 | 0.90 | 0.96 | 171740 | 0.09 | 0.36 | 318545 | 0.37 | 0.57 | 36.33 | 300 | 300 | 525 | 525 | 0.01 | 22.64 | 1.0 | 4 | 0.70 | 12.50 | 35.14 | 2.21 | **5.3** | 3.71 | **17.3** |

## *Circle K at Highway 24 & Meridian Road*
## *INLET SUMMARY*

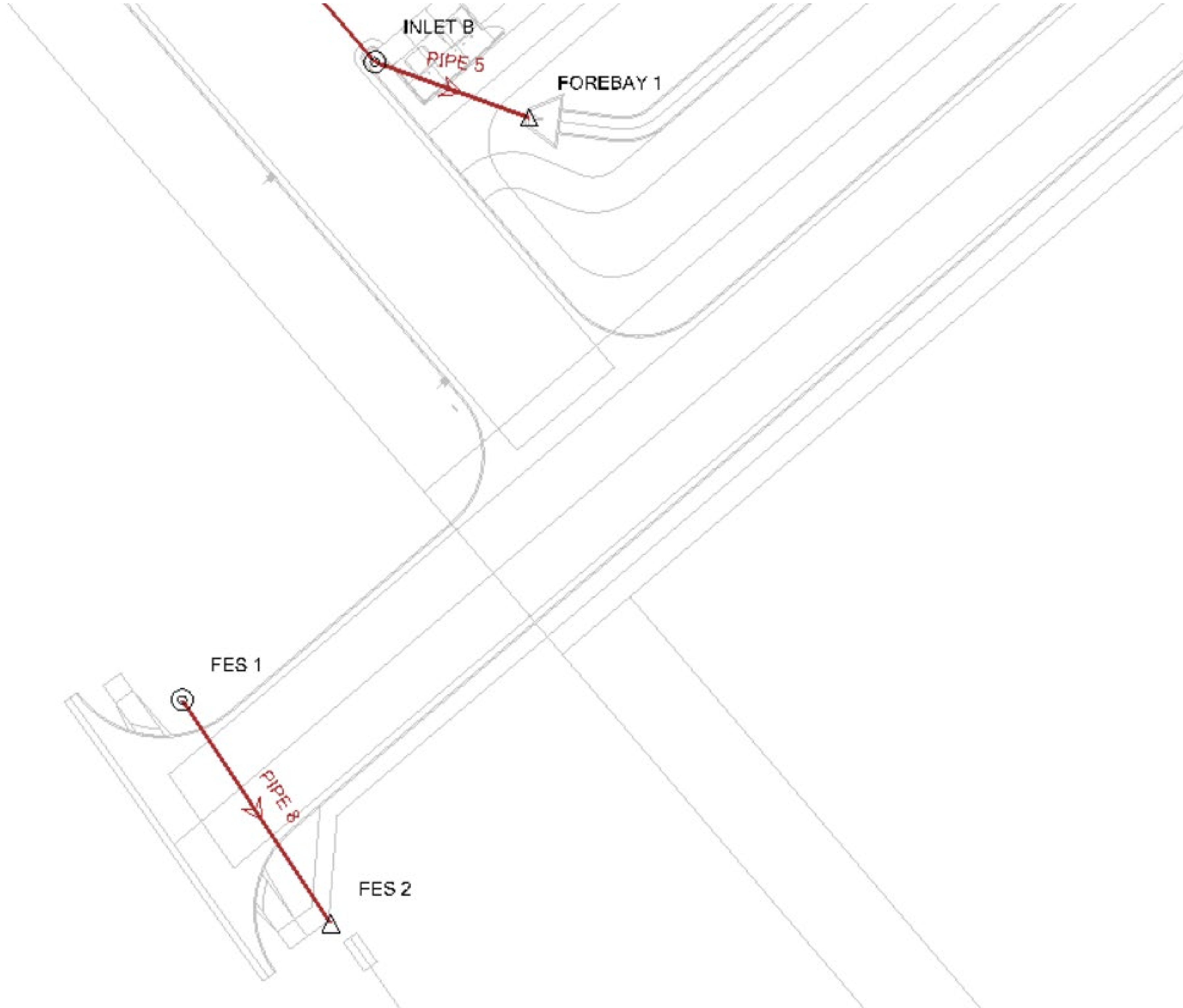
| DESIGN POINT (#-Letter) or SUB-BASIN (Letter#) | SUB-BASINS | TOTAL AREA (AC) | INLET | | | Q(5) BYPASS FLOWS (cfs) | Q(5) TOTAL INFLOW | Q5 INLET CAPACITY | Q(100) BYPASS FLOWS (cfs) | Q(100) TOTAL INFLOW (cfs) | MAX INLET CAPACITY | NOTES: |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | SIZE (Ft.) | TYPE | CONDITION | | | | | | | |
| **DP A** | A | 1.00 | 5 | R | **SUMP** | **0.0** | 3.27 | **5.4** | **0.0** | 6.22 | **9.2** | |
| **DP B** | B | 0.77 | 10 | R | **SUMP** | **0.0** | 2.16 | **2.5** | **0.0** | 4.27 | **6.1** | ***Inlet B Captures 100% of Bypass Flows From Inlets C & D*** |
| **DP C** | C | 0.33 | 3 | 16 | **AT GRADE** | **0.0** | 1.09 | **1.1** | **0.1** | 2.08 | **2.0** | ***Bypass flows to Inlet B*** |
| **DP D** | D | 0.36 | 3 | 16 | **AT GRADE** | **0.0** | 1.05 | **1.0** | **0.4** | 2.06 | **1.7** | ***Bypass flows to Inlet C*** |
| | | #N/A | | | | **#N/A** | #N/A | | **#N/A** | #N/A | | |
| | | #N/A | | | | **#N/A** | #N/A | | **#N/A** | #N/A | | |
| | | | | | | | | | | | | |
| | | #N/A | | | | **#N/A** | #N/A | | **#N/A** | #N/A | | |
| | | #N/A | | | | **#N/A** | #N/A | | **#N/A** | #N/A | | |
| | | #N/A | | | | **#N/A** | #N/A | | **#N/A** | #N/A | | |
| | | #N/A | | | | **#N/A** | #N/A | | **#N/A** | #N/A | | |
| | | #N/A | | | | **#N/A** | #N/A | | **#N/A** | #N/A | | |
| | | #N/A | | | | **#N/A** | #N/A | | **#N/A** | #N/A | | |
| | | #N/A | | | | **#N/A** | #N/A | | **#N/A** | #N/A | | |
| | | #N/A | | | | **#N/A** | #N/A | | **#N/A** | #N/A | | |
| | | #N/A | | | | **#N/A** | #N/A | | **#N/A** | #N/A | | |
| | | #N/A | | | | **#N/A** | #N/A | | **#N/A** | #N/A | | |
| | | #N/A | | | | **#N/A** | #N/A | | **#N/A** | #N/A | | |
| | | #N/A | | | | **#N/A** | #N/A | | **#N/A** | #N/A | | |
| | | #N/A | | | | **#N/A** | #N/A | | **#N/A** | #N/A | | |
| | | #N/A | | | | **#N/A** | #N/A | | **#N/A** | #N/A | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | #N/A | | R | | **#N/A** | #N/A | | **#N/A** | #N/A | | |

## Circle K at Highway 24 & Meridian Road
## INLET SUMMARY

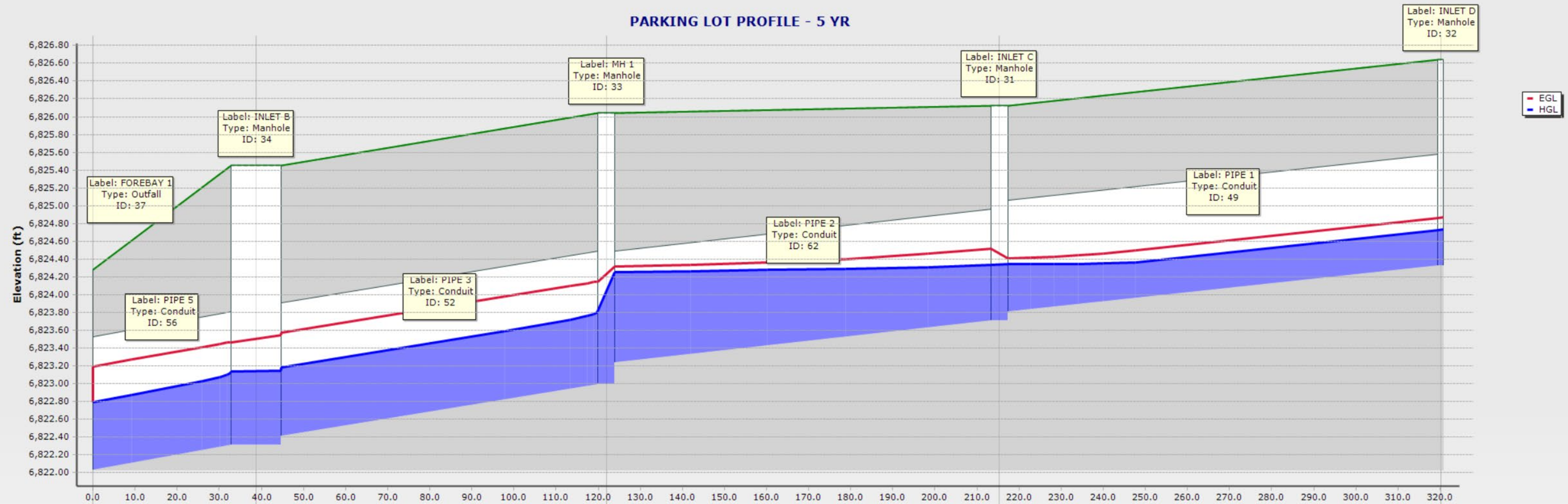
| DESIGN POINT (#-Letter) or SUB-BASIN (Letter#) | SUB-BASINS | TOTAL AREA (AC) | INLET | | | Q(5) BYPASS FLOWS (cfs) | Q(5) TOTAL INFLOW | Q5 INLET CAPACITY | Q(100) BYPASS FLOWS (cfs) | Q(100) TOTAL INFLOW (cfs) | MAX INLET CAPACITY | NOTES: |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | SIZE (Ft.) | TYPE | CONDITION | | | | | | | |
| DP A | A | 1.00 | 5 | R | SUMP | 0.0 | 3.27 | 5.4 | 0.0 | 6.22 | 9.2 | |
| DP B | B | 0.77 | 10 | R | SUMP | 0.0 | 2.16 | 2.5 | 0.0 | 4.27 | 6.1 | Inlet B Captures 100% of Bypass Flows From Inlets C & D |
| DP C | C | 0.33 | 3 | 16 | AT GRADE | 0.0 | 1.09 | 1.1 | 0.1 | 2.08 | 2.0 | Bypass flows to Inlet B |
| DP D | D | 0.36 | 3 | 16 | AT GRADE | 0.0 | 1.05 | 1.0 | 0.4 | 2.06 | 1.7 | Bypass flows to Inlet C |




STORMCAD LAYOUT – HIGHWAY 24 & MERIDIAN ROAD



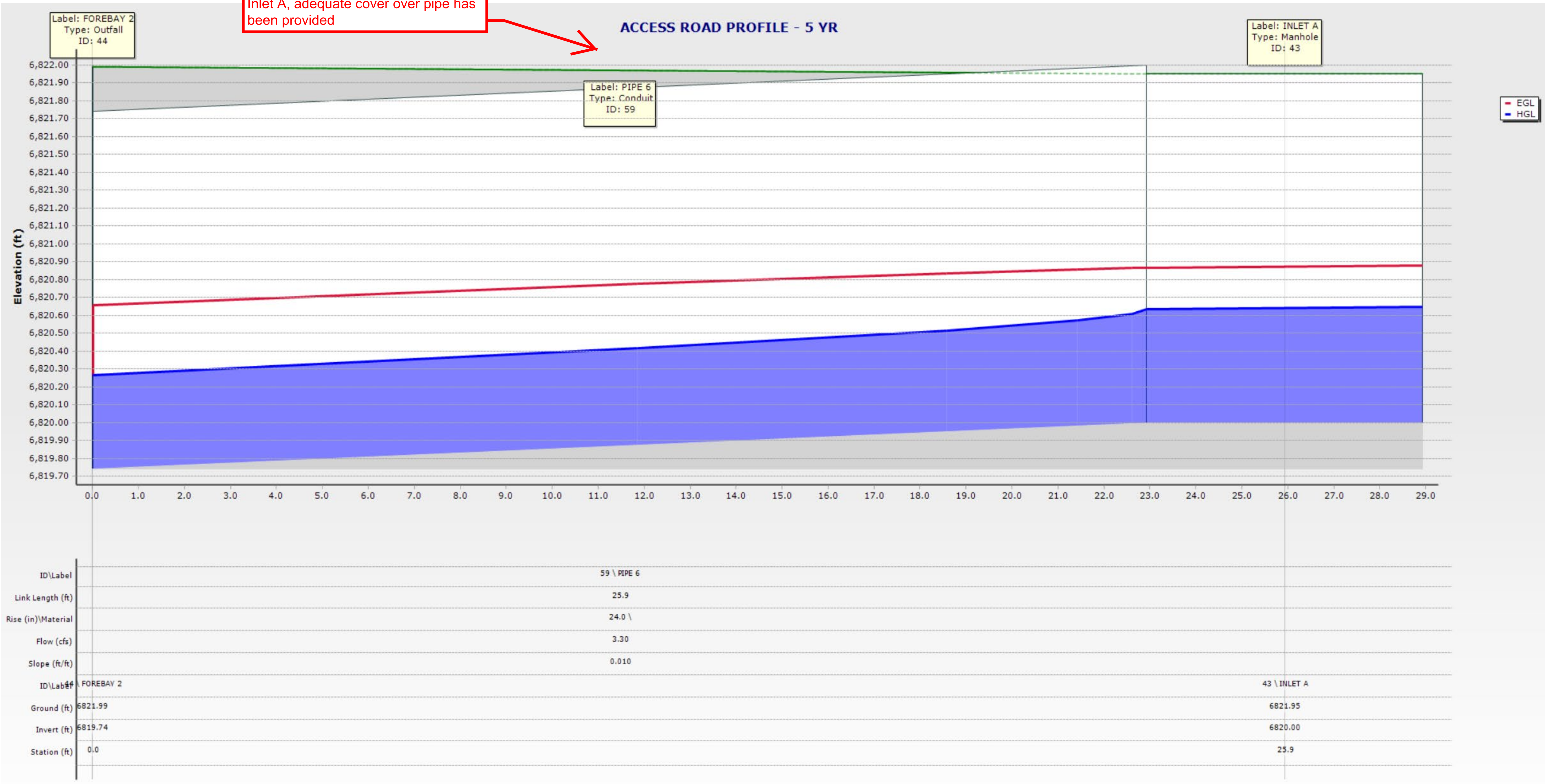

STORMCAD LAYOUT – HIGHWAY 24 & MERIDIAN ROAD

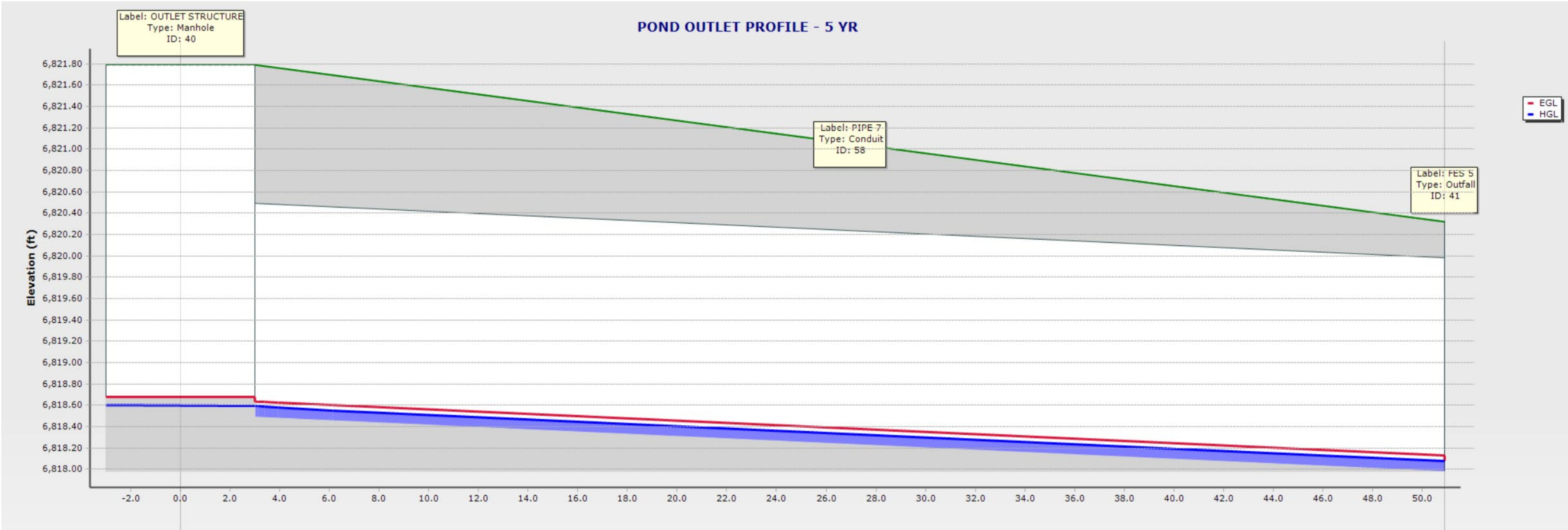



| ID\Label | 56 \ PIPE 5 | 52 \ PIPE 3 | 62 \ PIPE 2 | 49 \ PIPE 1 |
|---|---|---|---|---|
| Link Length (ft) | 38.8 | 83.2 | 93.4 | 104.8 |
| Rise (in)\Material | 18.0 \ | 18.0 \ | 15.0 \ | 15.0 \ |
| Flow (cfs) | 4.60 | 4.60 | 2.10 | 1.00 |
| Slope (ft/ft) | 0.007 | 0.007 | 0.005 | 0.005 |

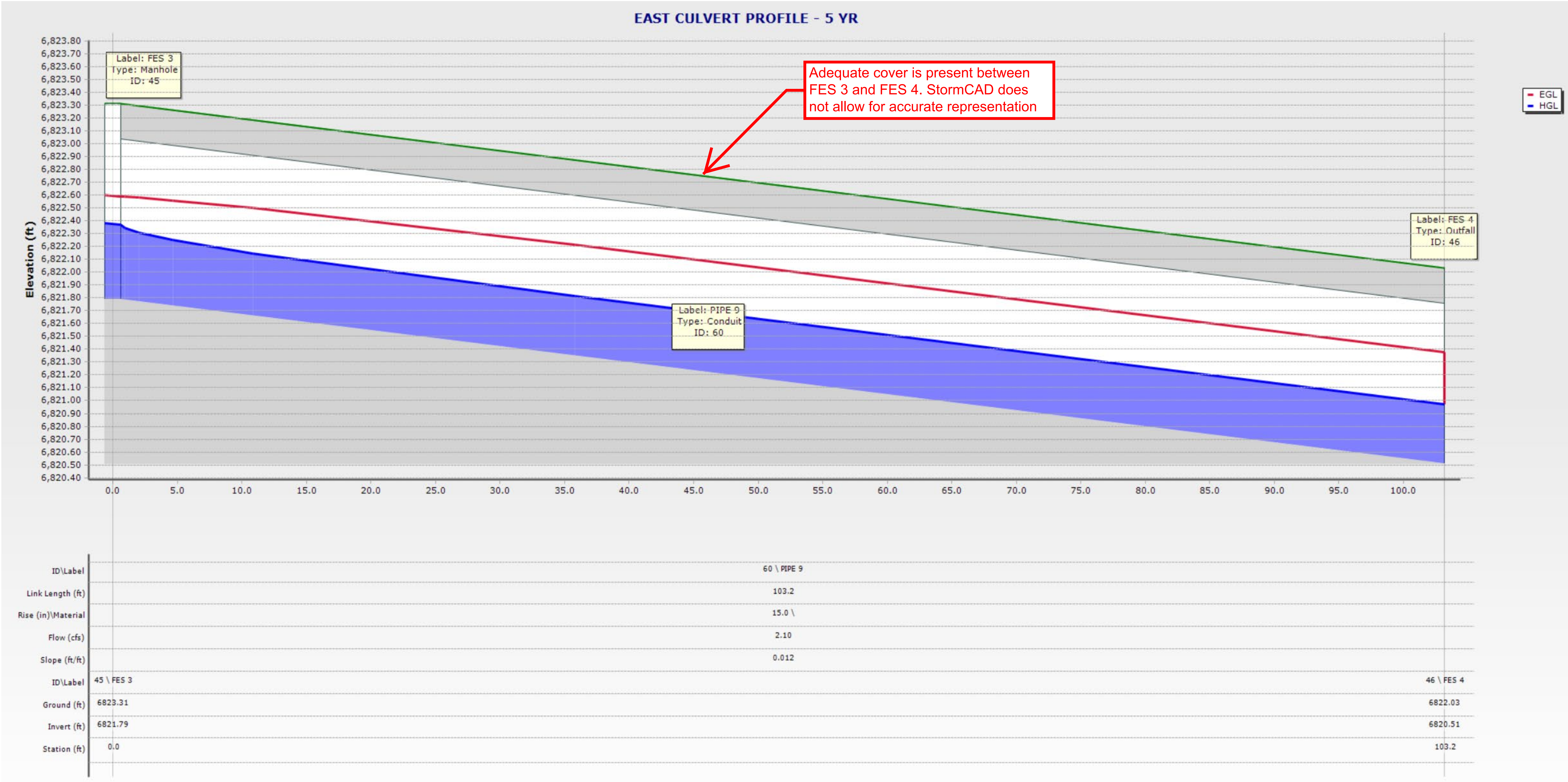
| ID\Label | 37 \ FOREBAY 1 | 34 \ INLET B | 33 \ MH 1 | 31 \ INLET C | 32 \ INLET D |
|---|---|---|---|---|---|
| Ground (ft) | 6824.28 | 6825.45 | 6826.04 | 6826.12 | 6826.64 |
| Invert (ft) | 6822.03 | 6822.31 | 6822.99 | 6823.71 | 6824.33 |
| Station (ft) | 0.0 | 38.8 | 122.0 | 215.3 | 320.1 |

Berm present between Forebay 2 and Inlet A, adequate cover over pipe has been provided



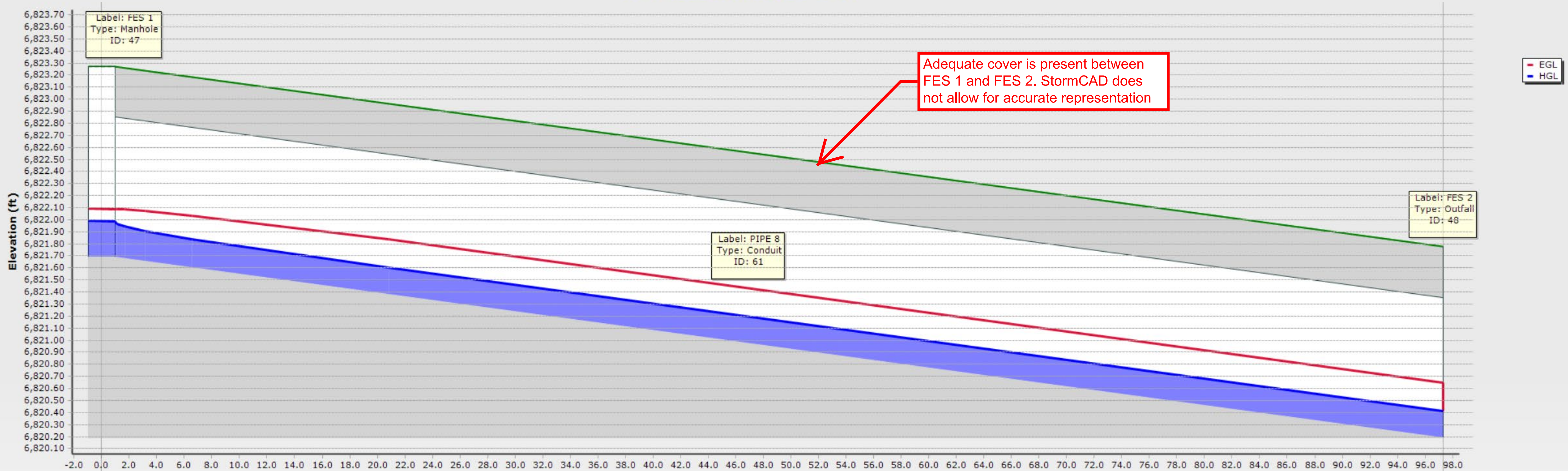



| | | | |
|---|---|---|---|
| ID\Label | | 58 \ PIPE 7 | |
| Link Length (ft) | | 50.9 | |
| Rise (in)\Material | | 24.0 \ | |
| Flow (cfs) | | 0.10 | |
| Slope (ft/ft) | | 0.010 | |
| ID\Label | 40 \ OUTLET STRUCTURE | | 41 \ FES 5 |
| Ground (ft) | 6821.79 | | 6820.32 |
| Invert (ft) | 6818.68 | | 6817.98 |
| Station (ft) | 0.0 | | 50.9 |



EAST CULVERT PROFILE - 5 YR
Label: FES 3
Type: Manhole
ID: 45
Adequate cover is present between FES 3 and FES 4. StormCAD does not allow for accurate representation
Label: FES 4
Type: Outfall
ID: 46
Label: PIPE 9
Type: Conduit
ID: 60
EGL
HGL
Elevation (ft)
6,823.80
6,823.70
6,823.60
6,823.50
6,823.40
6,823.30
6,823.20
6,823.10
6,823.00
6,822.90
6,822.80
6,822.70
6,822.60
6,822.50
6,822.40
6,822.30
6,822.20
6,822.10
6,822.00
6,821.90
6,821.80
6,821.70
6,821.60
6,821.50
6,821.40
6,821.30
6,821.20
6,821.10
6,821.00
6,820.90
6,820.80
6,820.70
6,820.60
6,820.50
6,820.40
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
85.0
90.0
95.0
100.0
ID\Label 60 \ PIPE 9
Link Length (ft) 103.2
Rise (in)\Material 15.0 \
Flow (cfs) 2.10
Slope (ft/ft) 0.012
ID\Label 45 \ FES 3 46 \ FES 4
Ground (ft) 6823.31 6822.03
Invert (ft) 6821.79 6820.51
Station (ft) 0.0 103.2

## WEST CULVERT PROFILE - 5 YR



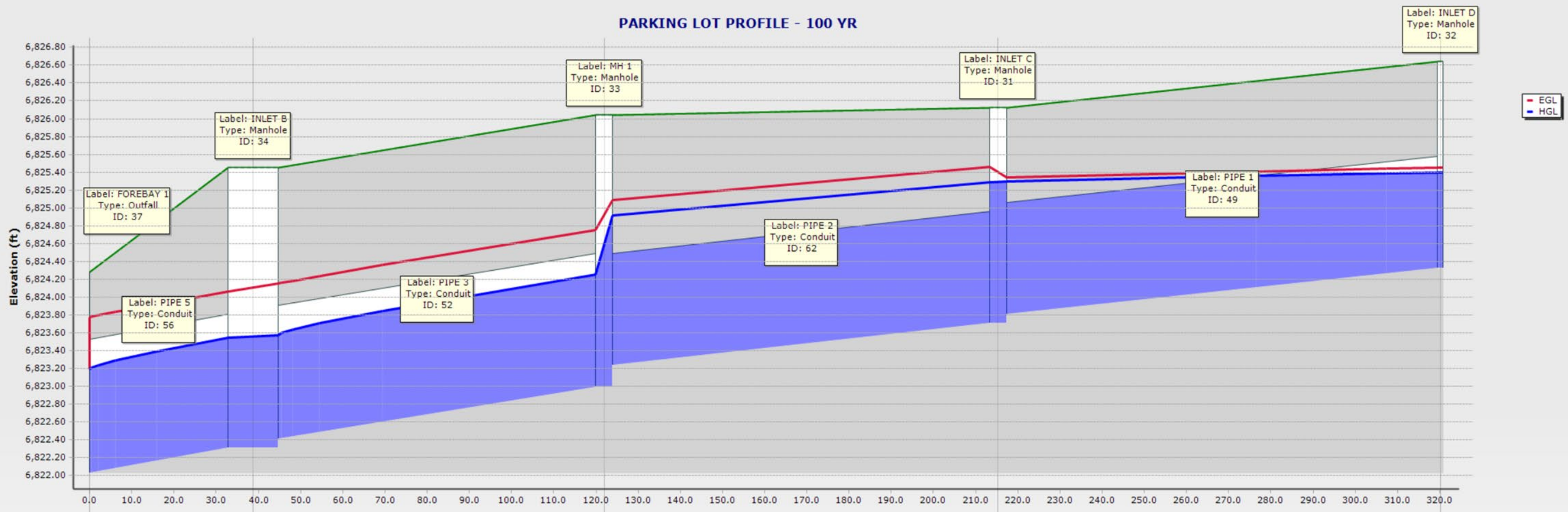

| | | |
|---|---|---|
| ID\Label | 61 \ PIPE 8 | |
| Link Length (ft) | 97.3 | |
| Rise (in)\Material | 14.0 \ | |
| Flow (cfs) | 0.90 | |
| Slope (ft/ft) | 0.015 | |
| ID\Label | 47 \ FES 1 | 48 \ FES 2 |
| Ground (ft) | 6823.27 | 6821.78 |
| Invert (ft) | 6821.69 | 6820.19 |
| Station (ft) | 0.0 | 97.3 |

## PIPE REPORT (5 YR)

| | ID | Label | Start Node | Invert (Start) (ft) | Stop Node | Invert (Stop) (ft) | Slope (Calculated) (ft/ft) | Diameter (in) | Manning's n | Flow (cfs) | Velocity (ft/s) | Hydraulic Grade Line (In) (ft) | Hydraulic Grade Line (Out) (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 49: PIPE 1 | 49 | PIPE 1 | INLET D | 6,824.33 | INLET C | 6,823.81 | 0.005 | 15.0 | 0.013 | 1.00 | 2.97 | 6,824.73 | 6,824.34 |
| 62: PIPE 2 | 62 | PIPE 2 | INLET C | 6,823.71 | MH 1 | 6,823.24 | 0.005 | 15.0 | 0.013 | 2.10 | 3.65 | 6,824.33 | 6,824.25 |
| 52: PIPE 3 | 52 | PIPE 3 | MH 1 | 6,822.99 | INLET B | 6,822.41 | 0.007 | 18.0 | 0.013 | 4.60 | 5.02 | 6,823.81 | 6,823.18 |
| 56: PIPE 5 | 56 | PIPE 5 | INLET B | 6,822.31 | FOREBAY 1 | 6,822.03 | 0.007 | 18.0 | 0.013 | 4.60 | 5.09 | 6,823.13 | 6,822.79 |
| 59: PIPE 6 | 59 | PIPE 6 | INLET A | 6,820.00 | FOREBAY 2 | 6,819.74 | 0.010 | 24.0 | 0.013 | 3.30 | 5.14 | 6,820.63 | 6,820.26 |
| 58: PIPE 7 | 58 | PIPE 7 | OUTLET STRUCTURE | 6,818.49 | FES 5 | 6,817.98 | 0.010 | 24.0 | 0.013 | 0.10 | 1.80 | 6,818.60 | 6,818.08 |
| 61: PIPE 8 | 61 | PIPE 8 | FES 1 | 6,821.69 | FES 2 | 6,820.19 | 0.015 | | 0.013 | 0.90 | 3.92 | 6,821.98 | 6,820.41 |
| 60: PIPE 9 | 60 | PIPE 9 | FES 3 | 6,821.79 | FES 4 | 6,820.51 | 0.012 | 15.0 | 0.013 | 2.10 | 5.08 | 6,822.37 | 6,820.97 |

## STRUCTURE REPORT (5 YR)

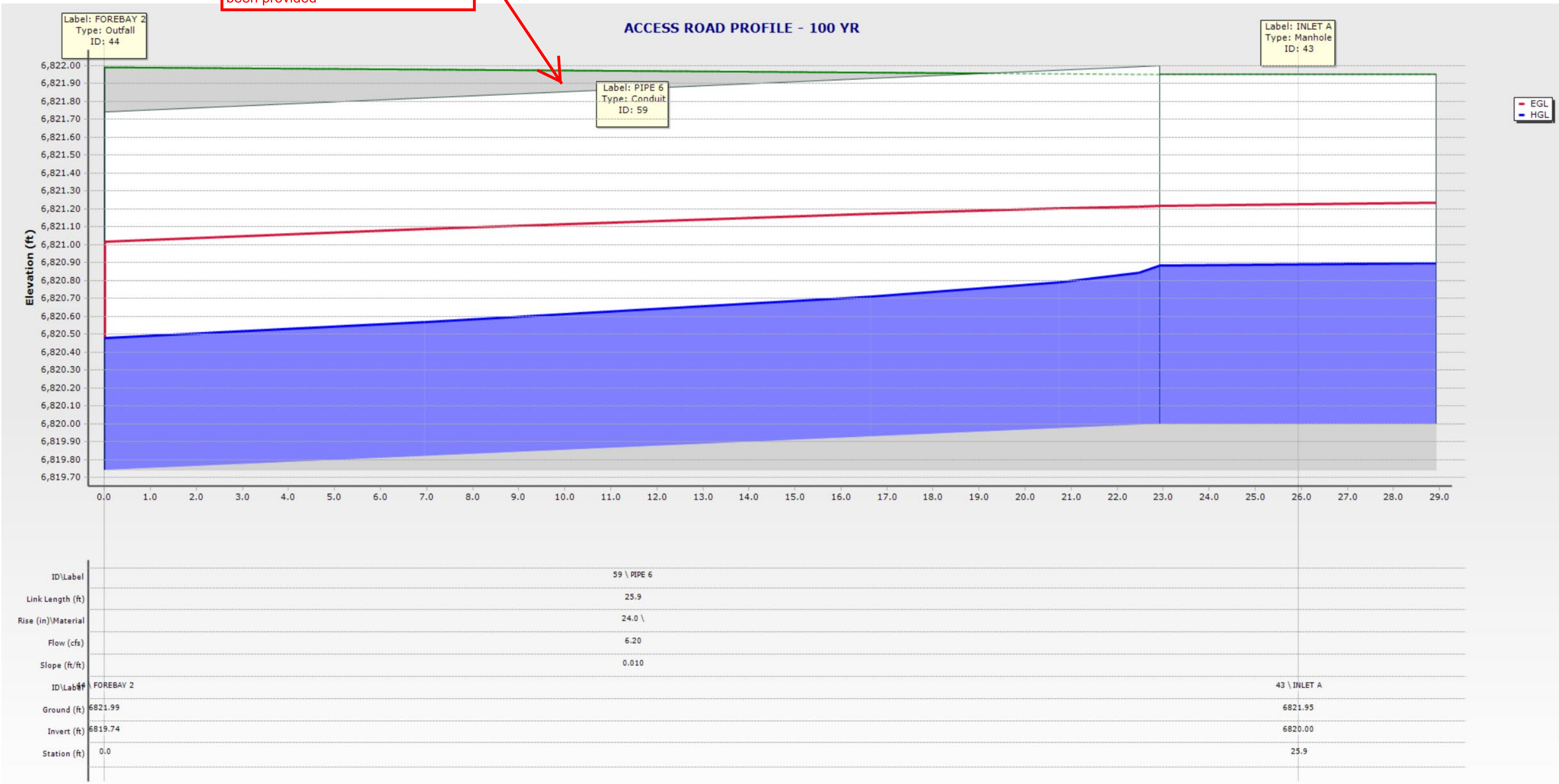
| | ID | Label | Elevation (Ground) (ft) | Elevation (Rim) (ft) | Depth (Out) (ft) | Hydraulic Grade Line (In) (ft) | Hydraulic Grade Line (Out) (ft) | Headloss Coefficient (Standard) | Flow (Total Out) (cfs) |
|---|---|---|---|---|---|---|---|---|---|
| 47: FES 1 | 47 | FES 1 | 6,823.27 | 6,823.27 | 0.29 | 6,821.99 | 6,821.98 | 0.050 | 0.90 |
| 45: FES 3 | 45 | FES 3 | 6,823.31 | 6,823.31 | 0.58 | 6,822.38 | 6,822.37 | 0.050 | 2.10 |
| 43: INLET A | 43 | INLET A | 6,821.95 | 6,821.95 | 0.64 | 6,820.65 | 6,820.63 | 0.050 | 3.30 |
| 34: INLET B | 34 | INLET B | 6,825.45 | 6,825.45 | 0.82 | 6,823.15 | 6,823.13 | 0.050 | 4.60 |
| 31: INLET C | 31 | INLET C | 6,826.12 | 6,826.12 | 0.62 | 6,824.34 | 6,824.33 | 0.050 | 2.10 |
| 32: INLET D | 32 | INLET D | 6,826.64 | 6,826.64 | 0.40 | 6,824.73 | 6,824.73 | 0.050 | 1.00 |
| 33: MH 1 | 33 | MH 1 | 6,826.04 | 6,826.04 | 0.82 | 6,824.25 | 6,823.81 | 1.320 | 4.60 |
| 40: OUTLET ST | 40 | OUTLET STRUCTURE | 6,821.79 | 6,821.79 | -0.08 | 6,818.60 | 6,818.60 | 0.050 | 0.10 |



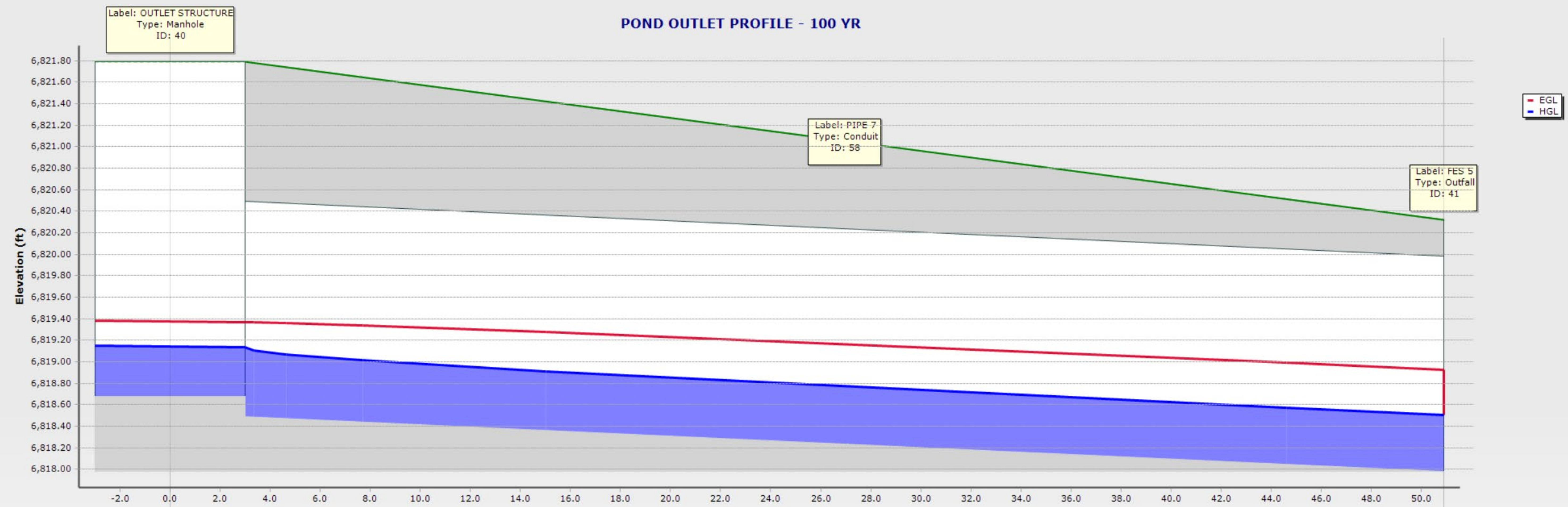

| ID\Label | 56 \ PIPE 5 | 52 \ PIPE 3 | 62 \ PIPE 2 | 49 \ PIPE 1 |
|---|---|---|---|---|
| Link Length (ft) | 38.8 | 83.2 | 93.4 | 104.8 |
| Rise (in)\Material | 18.0 \ | 18.0 \ | 15.0 \ | 15.0 \ |
| Flow (cfs) | 9.00 | 9.00 | 4.10 | 2.10 |
| Slope (ft/ft) | 0.007 | 0.007 | 0.005 | 0.005 |

| ID\Label | 37 \ FOREBAY 1 | 34 \ INLET B | 33 \ MH 1 | 31 \ INLET C | 32 \ INLET D |
|---|---|---|---|---|---|
| Ground (ft) | 6824.28 | 6825.45 | 6826.04 | 6826.12 | 6826.64 |
| Invert (ft) | 6822.03 | 6822.31 | 6822.99 | 6823.71 | 6824.33 |
| Station (ft) | 0.0 | 38.8 | 122.0 | 215.3 | 320.1 |

Berm present between Forebay 2 and Inlet A, adequate cover over pipe has been provided

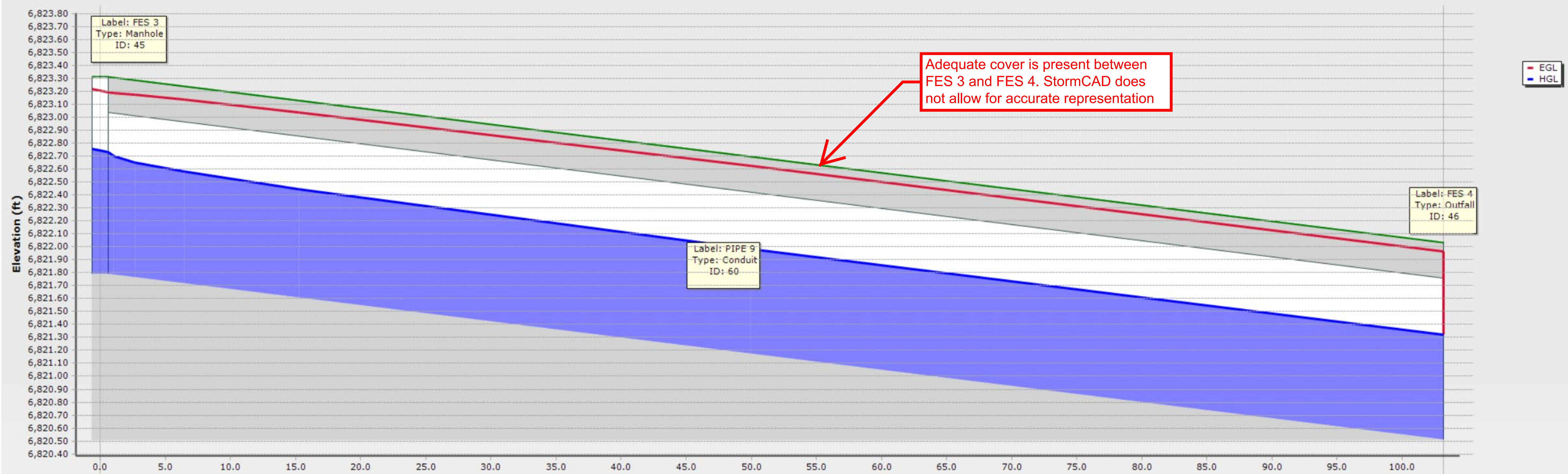


## POND OUTLET PROFILE - 100 YR



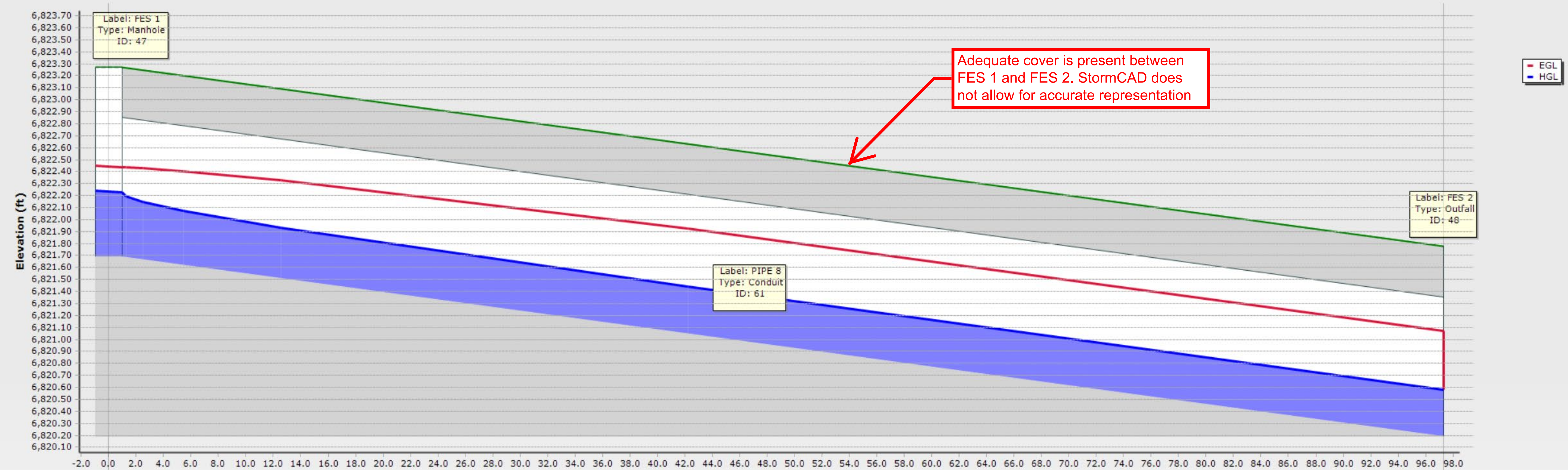

| | | |
|---|---|---|
| ID\Label | 58 \ PIPE 7 | |
| Link Length (ft) | 50.9 | |
| Rise (in)\Material | 24.0 \ | |
| Flow (cfs) | 3.40 | |
| Slope (ft/ft) | 0.010 | |
| ID\Label | 40 \ OUTLET STRUCTURE | 41 \ FES 5 |
| Ground (ft) | 6821.79 | 6820.32 |
| Invert (ft) | 6818.68 | 6817.98 |
| Station (ft) | 0.0 | 50.9 |

## EAST CULVERT PROFILE - 100 YR




| | | |
|---|---|---|
| ID\Label | 60 \ PIPE 9 | |
| Link Length (ft) | 103.2 | |
| Rise (in)\Material | 15.0 \ | |
| Flow (cfs) | 5.40 | |
| Slope (ft/ft) | 0.012 | |
| ID\Label | 45 \ FES 3 | 46 \ FES 4 |
| Ground (ft) | 6823.31 | 6822.03 |
| Invert (ft) | 6821.79 | 6820.51 |
| Station (ft) | 0.0 | 103.2 |

## WEST CULVERT PROFILE - 100 YR




| | | |
|---|---|---|
| ID\Label | 61 \ PIPE 8 | |
| Link Length (ft) | 97.3 | |
| Rise (in)\Material | 14.0 \ | |
| Flow (cfs) | 2.90 | |
| Slope (ft/ft) | 0.015 | |
| ID\Label | 47 \ FES 1 | 48 \ FES 2 |
| Ground (ft) | 6823.27 | 6821.78 |
| Invert (ft) | 6821.69 | 6820.19 |
| Station (ft) | 0.0 | 97.3 |

## PIPE REPORT (100 YR)

| | ID | Label | Start Node | Invert (Start) (ft) | Stop Node | Invert (Stop) (ft) | Slope (Calculated) (ft/ft) | Diameter (in) | Manning's n | Flow (cfs) | Velocity (ft/s) | Hydraulic Grade Line (In) (ft) | Hydraulic Grade Line (Out) (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 49: PIPE 1 | 49 | PIPE 1 | INLET D | 6,824.33 | INLET C | 6,823.81 | 0.005 | 15.0 | 0.013 | 2.10 | 3.63 | 6,825.40 | 6,825.30 |
| 62: PIPE 2 | 62 | PIPE 2 | INLET C | 6,823.71 | MH 1 | 6,823.24 | 0.005 | 15.0 | 0.013 | 4.10 | 3.34 | 6,825.29 | 6,824.91 |
| 52: PIPE 3 | 52 | PIPE 3 | MH 1 | 6,822.99 | INLET B | 6,822.41 | 0.007 | 18.0 | 0.013 | 9.00 | 5.65 | 6,824.26 | 6,823.57 |
| 56: PIPE 5 | 56 | PIPE 5 | INLET B | 6,822.31 | FOREBAY 1 | 6,822.03 | 0.007 | 18.0 | 0.013 | 9.00 | 5.76 | 6,823.55 | 6,823.19 |
| 59: PIPE 6 | 59 | PIPE 6 | INLET A | 6,820.00 | FOREBAY 2 | 6,819.74 | 0.010 | 24.0 | 0.013 | 6.20 | 6.15 | 6,820.88 | 6,820.48 |
| 58: PIPE 7 | 58 | PIPE 7 | OUTLET STRUCTURE | 6,818.49 | FES 5 | 6,817.98 | 0.010 | 24.0 | 0.013 | 3.40 | 5.19 | 6,819.13 | 6,818.50 |
| 61: PIPE 8 | 61 | PIPE 8 | FES 1 | 6,821.69 | FES 2 | 6,820.19 | 0.015 | | 0.013 | 2.90 | 5.60 | 6,822.23 | 6,820.58 |
| 60: PIPE 9 | 60 | PIPE 9 | FES 3 | 6,821.79 | FES 4 | 6,820.51 | 0.012 | 15.0 | 0.013 | 5.40 | 6.43 | 6,822.73 | 6,821.32 |

## STRUCTURE REPORT (100 YR)

| | ID | Label | Elevation (Ground) (ft) | Elevation (Rim) (ft) | Depth (Out) (ft) | Hydraulic Grade Line (In) (ft) | Hydraulic Grade Line (Out) (ft) | Headloss Coefficient (Standard) | Flow (Total Out) (cfs) |
|---|---|---|---|---|---|---|---|---|---|
| 47: FES 1 | 47 | FES 1 | 6,823.27 | 6,823.27 | 0.54 | 6,822.24 | 6,822.23 | 0.050 | 2.90 |
| 45: FES 3 | 45 | FES 3 | 6,823.31 | 6,823.31 | 0.94 | 6,822.75 | 6,822.73 | 0.050 | 5.40 |
| 43: INLET A | 43 | INLET A | 6,821.95 | 6,821.95 | 0.88 | 6,820.90 | 6,820.88 | 0.050 | 6.20 |
| 34: INLET B | 34 | INLET B | 6,825.45 | 6,825.45 | 1.24 | 6,823.57 | 6,823.55 | 0.050 | 9.00 |
| 31: INLET C | 31 | INLET C | 6,826.12 | 6,826.12 | 1.58 | 6,825.30 | 6,825.29 | 0.050 | 4.10 |
| 32: INLET D | 32 | INLET D | 6,826.64 | 6,826.64 | 1.07 | 6,825.40 | 6,825.40 | 0.050 | 2.10 |
| 33: MH 1 | 33 | MH 1 | 6,826.04 | 6,826.04 | 1.27 | 6,824.91 | 6,824.26 | 1.320 | 9.00 |
| 40: OUTLET ST | 40 | OUTLET STRUCTURE | 6,821.79 | 6,821.79 | 0.45 | 6,819.15 | 6,819.13 | 0.050 | 3.40 |

| Design Point | Total Water Quality Control Volume (Cu. Ft.) | Pond Name | Pond Drainage Area (Acres) | Pond Drainage Area Less Pond Footprint (Acres) | Forebay Location | Drainage area tributary to Forebay | Proportion of Total Drainage Area | Proportional WQCV Volume (Cu. Ft.) | Forebay Volume<br>2% of WQCV (Cu. Ft.) | Q100 to Forebay (cfs) | Forebay Outlet Sizing<br>2% of Q100 (cfs) | Forebay Slot Sizing (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DP A | 3463.591143 | Detention Pond | 3.73 | 3.263 | South | 1 | 0.31 | 1061.47 | 21 | 14.8 | 0.3 | 3.8 |

| | WQCV | | Pond Footprint | |
|---|---|---|---|---|
| Single Family EDB Pond | 0.080 | Acre-Ft | 0.47 | Acres |
| Percent of WQCV for Forebay | 2% | Between 2 and 5 impervious acres | | |
| Impervious Percentage | 65.43% | | | |
| | Impervious Acres | 2.4 | Acres | |

**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).

| Design Point | Total Water Quality Control Volume (Cu. Ft.) | Pond Name | Pond Drainage Area (Acres) | Pond Drainage Area Less Pond Footprint (Acres) | Forebay Location | Drainage area tributary to Forebay | Proportion of Total Drainage Area | Proportional WQCV Volume (Cu. Ft.) | Forebay Volume<br>2% of WQCV (Cu. Ft.) | Q100 to Forebay (cfs) | Forebay Outlet Sizing<br>2% of Q100 (cfs) | Forebay Slot Sizing (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DP B | 3463.591143 | Detention Pond | 3.73 | 3.263 | West | 1.63 | 0.50 | 1730.20 | 35 | 9.1 | 0.2 | 4.0 |

| | WQCV | | Pond Footprint | |
|---|---|---|---|---|
| Single Family EDB Pond | 0.080 | Acre-Ft | 0.47 | Acres |
| Percent of WQCV for Forebay | 2% | Between 2 and 5 impervious acres | | |
| Impervious Percentage | 65.43% | | | |
| | Impervious Acres | 2.4 | Acres | |

**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.

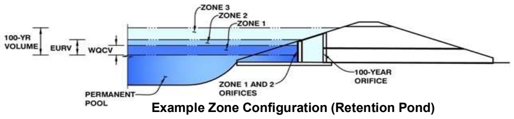
[2] Round up to the first standard pipe size (minimum 8 inches).

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.04 (February 2021)*

**Project: Circle K at Highway 24 & Meridian**

**Basin ID: North Detention/WQ Pond**




**Example Zone Configuration (Retention Pond)**

Watershed Information

| | | |
|---|---|---|
| Selected BMP Type = | **EDB** | |
| Watershed Area = | 3.73 | acres |
| Watershed Length = | 450 | ft |
| Watershed Length to Centroid = | 150 | ft |
| Watershed Slope = | 0.020 | ft/ft |
| Watershed Imperviousness = | 65.43% | percent |
| Percentage Hydrologic Soil Group A = | 100.0% | percent |
| Percentage Hydrologic Soil Group B = | 0.0% | percent |
| Percentage Hydrologic Soil Groups C/D = | 0.0% | percent |
| Target WQCV Drain Time = | 40.0 | hours |
| Location for 1-hr Rainfall Depths = | User Input | |

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

| | | | Optional User Overrides | |
|---|---|---|---|---|
| Water Quality Capture Volume (WQCV) = | 0.080 | acre-feet | | acre-feet |
| Excess Urban Runoff Volume (EURV) = | 0.303 | acre-feet | | acre-feet |
| 2-yr Runoff Volume (P1 = 1.19 in.) = | 0.205 | acre-feet | 1.19 | inches |
| 5-yr Runoff Volume (P1 = 1.5 in.) = | 0.269 | acre-feet | 1.50 | inches |
| 10-yr Runoff Volume (P1 = 1.75 in.) = | 0.320 | acre-feet | 1.75 | inches |
| 25-yr Runoff Volume (P1 = 2 in.) = | 0.387 | acre-feet | 2.00 | inches |
| 50-yr Runoff Volume (P1 = 2.25 in.) = | 0.452 | acre-feet | 2.25 | inches |
| 100-yr Runoff Volume (P1 = 2.52 in.) = | 0.531 | acre-feet | 2.52 | inches |
| 500-yr Runoff Volume (P1 = 3.55 in.) = | 0.824 | acre-feet | 3.55 | inches |
| Approximate 2-yr Detention Volume = | 0.197 | acre-feet | | |
| Approximate 5-yr Detention Volume = | 0.258 | acre-feet | | |
| Approximate 10-yr Detention Volume = | 0.311 | acre-feet | | |
| Approximate 25-yr Detention Volume = | 0.374 | acre-feet | | |
| Approximate 50-yr Detention Volume = | 0.412 | acre-feet | | |
| Approximate 100-yr Detention Volume = | 0.451 | acre-feet | | |

Define Zones and Basin Geometry

| | | |
|---|---|---|
| Zone 1 Volume (WQCV) = | 0.080 | acre-feet |
| Zone 2 Volume (EURV - Zone 1) = | 0.224 | acre-feet |
| Zone 3 Volume (100-year - Zones 1 & 2) = | 0.148 | acre-feet |
| Total Detention Basin Volume = | 0.451 | acre-feet |
| Initial Surcharge Volume (ISV) = | user | $ft^3$ |
| Initial Surcharge Depth (ISD) = | user | ft |
| Total Available Detention Depth ($H_{total}$) = | user | ft |
| Depth of Trickle Channel ($H_{TC}$) = | user | ft |
| Slope of Trickle Channel ($S_{TC}$) = | user | ft/ft |
| Slopes of Main Basin Sides ($S_{main}$) = | user | H:V |
| Basin Length-to-Width Ratio ($R_{L/W}$) = | user | |
| | | |
| Initial Surcharge Area ($A_{ISV}$) = | user | $ft^2$ |
| Surcharge Volume Length ($L_{ISV}$) = | user | ft |
| Surcharge Volume Width ($W_{ISV}$) = | user | ft |
| Depth of Basin Floor ($H_{FLOOR}$) = | user | ft |
| Length of Basin Floor ($L_{FLOOR}$) = | user | ft |
| Width of Basin Floor ($W_{FLOOR}$) = | user | ft |
| Area of Basin Floor ($A_{FLOOR}$) = | user | $ft^2$ |
| Volume of Basin Floor ($V_{FLOOR}$) = | user | $ft^3$ |
| Depth of Main Basin ($H_{MAIN}$) = | user | ft |
| Length of Main Basin ($L_{MAIN}$) = | user | ft |
| Width of Main Basin ($W_{MAIN}$) = | user | ft |
| Area of Main Basin ($A_{MAIN}$) = | user | $ft^2$ |
| Volume of Main Basin ($V_{MAIN}$) = | user | $ft^3$ |
| Calculated Total Basin Volume ($V_{total}$) = | **user** | acre-feet |

Depth Increement = 0.50 ft

| Stage - Storage Description | Stage (ft) | Optional Override Stage (ft) | Length (ft) | Width (ft) | Area ($ft^2$) | Optional Override Area ($ft^2$) | Area (acre) | Volume ($ft^3$) | Volume (ac-ft) |
|---|---|---|---|---|---|---|---|---|---|
| **Top of Micropool** | -- | 0.00 | -- | -- | -- | 104 | 0.002 | | |
| **6819.5** | -- | 0.50 | -- | -- | -- | 376 | 0.009 | 120 | 0.003 |
| | -- | 1.00 | -- | -- | -- | 1,157 | 0.027 | 503 | 0.012 |
| | -- | 1.50 | -- | -- | -- | 3,897 | 0.089 | 1,767 | 0.041 |
| | -- | 2.00 | -- | -- | -- | 6,935 | 0.159 | 4,475 | 0.103 |
| | -- | 2.50 | -- | -- | -- | 10,344 | 0.237 | 8,795 | 0.202 |
| | -- | 3.00 | -- | -- | -- | 12,769 | 0.293 | 14,573 | 0.335 |
| | -- | 3.50 | -- | -- | -- | 14,478 | 0.332 | 21,385 | 0.491 |
| | -- | 4.00 | -- | -- | -- | 15,956 | 0.366 | 28,993 | 0.666 |
| | -- | 4.50 | -- | -- | -- | 17,548 | 0.403 | 37,369 | 0.858 |
| | -- | 5.00 | -- | -- | -- | 20,596 | 0.473 | 46,905 | 1.077 |
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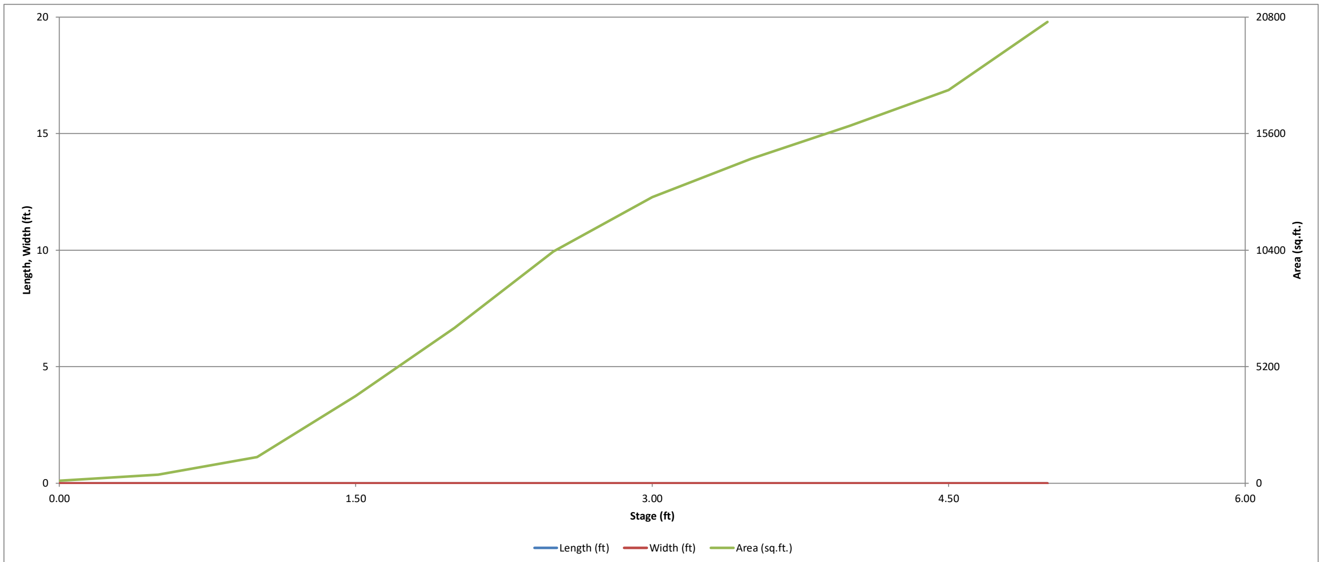
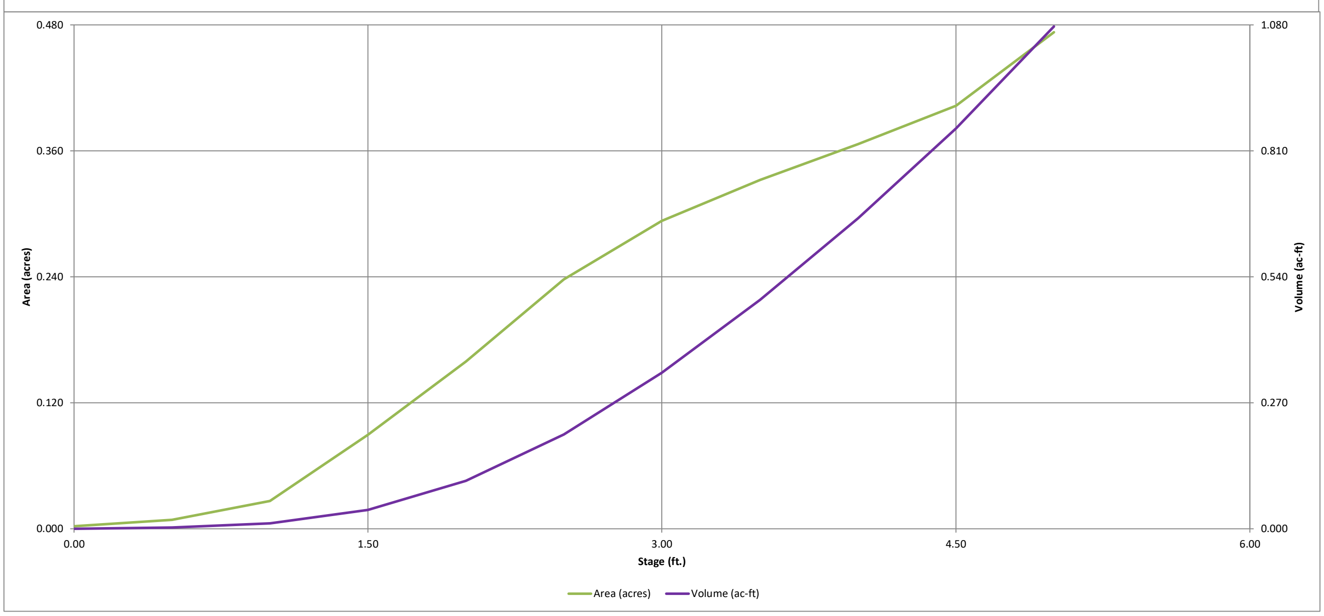
# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.04 (February 2021)*



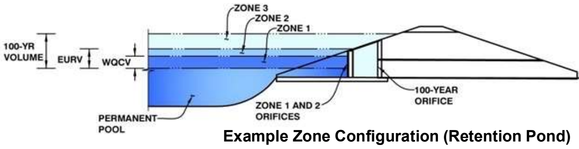



# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.04 (February 2021)*

**Project:** **Circle K at Highway 24 & Meridian**

**Basin ID:** **North Detention/WQ Pond**




**Example Zone Configuration (Retention Pond)**

| | Estimated Stage (ft) | Estimated Volume (ac-ft) | Outlet Type |
|---|---|---|---|
| Zone 1 (WQCV) | 1.85 | 0.080 | Orifice Plate |
| Zone 2 (EURV) | 2.90 | 0.224 | Circular Orifice |
| Zone 3 (100-year) | 3.38 | 0.148 | Weir&Pipe (Restrict) |
| Total (all zones) | | 0.451 | |

**User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)**

| | | |
|---|---|---|
| Underdrain Orifice Invert Depth = | N/A | ft (distance below the filtration media surface) |
| Underdrain Orifice Diameter = | N/A | inches |

**Calculated Parameters for Underdrain**

| | | |
|---|---|---|
| Underdrain Orifice Area = | N/A | $ft^2$ |
| Underdrain Orifice Centroid = | N/A | feet |

**User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)**

| | | |
|---|---|---|
| Invert of Lowest Orifice = | 0.00 | ft (relative to basin bottom at Stage = 0 ft) |
| Depth at top of Zone using Orifice Plate = | 1.85 | ft (relative to basin bottom at Stage = 0 ft) |
| Orifice Plate: Orifice Vertical Spacing = | 6.70 | inches |
| Orifice Plate: Orifice Area per Row = | 0.32 | sq. inches (diameter = 5/8 inch) |

**Calculated Parameters for Plate**

| | | |
|---|---|---|
| WQ Orifice Area per Row = | 2.188E-03 | $ft^2$ |
| Elliptical Half-Width = | N/A | feet |
| Elliptical Slot Centroid = | N/A | feet |
| Elliptical Slot Area = | N/A | $ft^2$ |

**User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)**

| | Row 1 (required) | Row 2 (optional) | Row 3 (optional) | Row 4 (optional) | Row 5 (optional) | Row 6 (optional) | Row 7 (optional) | Row 8 (optional) |
|---|---|---|---|---|---|---|---|---|
| Stage of Orifice Centroid (ft) | 0.00 | 0.62 | 1.23 | | | | | |
| Orifice Area (sq. inches) | 0.32 | 0.32 | 0.32 | | | | | |

| | Row 9 (optional) | Row 10 (optional) | Row 11 (optional) | Row 12 (optional) | Row 13 (optional) | Row 14 (optional) | Row 15 (optional) | Row 16 (optional) |
|---|---|---|---|---|---|---|---|---|
| Stage of Orifice Centroid (ft) | | | | | | | | |
| Orifice Area (sq. inches) | | | | | | | | |

**User Input: Vertical Orifice (Circular or Rectangular)**

| | Zone 2 Circular | Not Selected | |
|---|---|---|---|
| Invert of Vertical Orifice = | 1.72 | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Depth at top of Zone using Vertical Orifice = | 2.78 | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Vertical Orifice Diameter = | 1.25 | N/A | inches |

**Calculated Parameters for Vertical Orifice**

| | Zone 2 Circular | Not Selected | |
|---|---|---|---|
| Vertical Orifice Area = | 0.01 | N/A | $ft^2$ |
| Vertical Orifice Centroid = | 0.05 | N/A | feet |

**User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir (and No Outlet Pipe)**

| | Zone 3 Weir | Not Selected | |
|---|---|---|---|
| Overflow Weir Front Edge Height, Ho = | 2.90 | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Overflow Weir Front Edge Length = | 6.00 | N/A | feet |
| Overflow Weir Grate Slope = | 0.00 | N/A | H:V |
| Horiz. Length of Weir Sides = | 4.00 | N/A | feet |
| Overflow Grate Type = | Type C Grate | N/A | |
| Debris Clogging % = | 50% | N/A | % |

**Calculated Parameters for Overflow Weir**

| | Zone 3 Weir | Not Selected | |
|---|---|---|---|
| Height of Grate Upper Edge, $H_t$ = | 2.90 | N/A | feet |
| Overflow Weir Slope Length = | 4.00 | N/A | feet |
| Grate Open Area / 100-yr Orifice Area = | 37.34 | N/A | |
| Overflow Grate Open Area w/o Debris = | 16.70 | N/A | $ft^2$ |
| Overflow Grate Open Area w/ Debris = | 8.35 | N/A | $ft^2$ |

**User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)**

| | Zone 3 Restrictor | Not Selected | |
|---|---|---|---|
| Depth to Invert of Outlet Pipe = | 0.33 | N/A | ft (distance below basin bottom at Stage = 0 ft) |
| Outlet Pipe Diameter = | 24.00 | N/A | inches |
| Restrictor Plate Height Above Pipe Invert = | 4.80 | | inches |

**Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate**

| | Zone 3 Restrictor | Not Selected | |
|---|---|---|---|
| Outlet Orifice Area = | 0.45 | N/A | $ft^2$ |
| Outlet Orifice Centroid = | 0.24 | N/A | feet |
| Half-Central Angle of Restrictor Plate on Pipe = | 0.93 | N/A | radians |

**User Input: Emergency Spillway (Rectangular or Trapezoidal)**

| | | |
|---|---|---|
| Spillway Invert Stage= | 3.38 | ft (relative to basin bottom at Stage = 0 ft) |
| Spillway Crest Length = | 25.00 | feet |
| Spillway End Slopes = | 4.00 | H:V |
| Freeboard above Max Water Surface = | 1.00 | feet |

**Calculated Parameters for Spillway**

| | | |
|---|---|---|
| Spillway Design Flow Depth= | 0.28 | feet |
| Stage at Top of Freeboard = | 4.66 | feet |
| Basin Area at Top of Freeboard = | 0.43 | acres |
| Basin Volume at Top of Freeboard = | 0.92 | acre-ft |

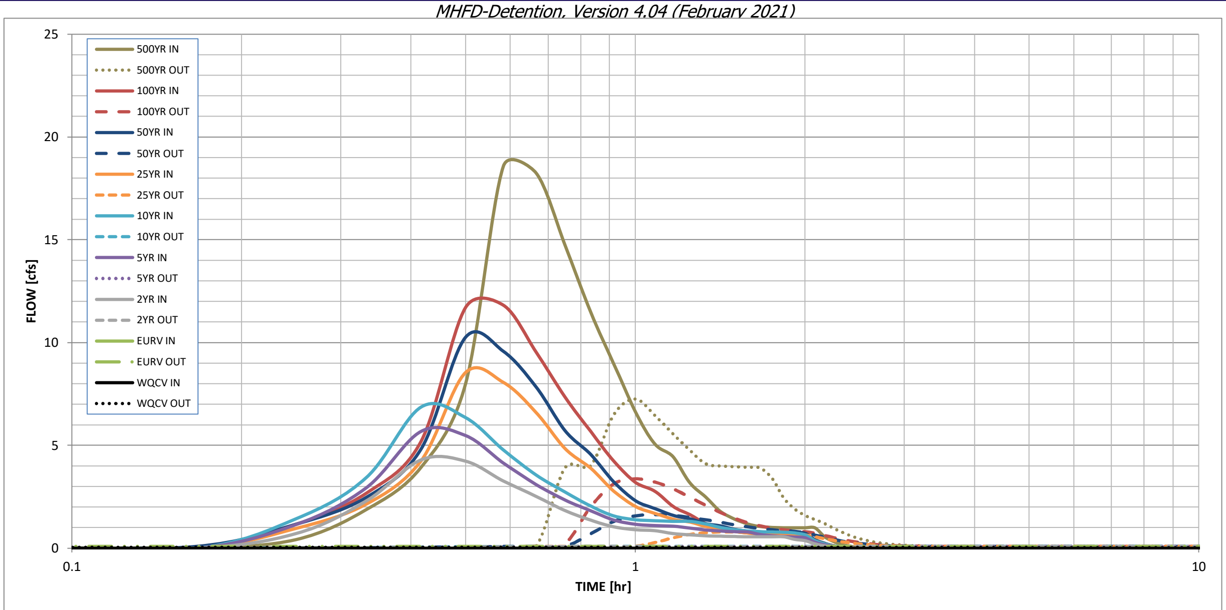
**Routed Hydrograph Results**

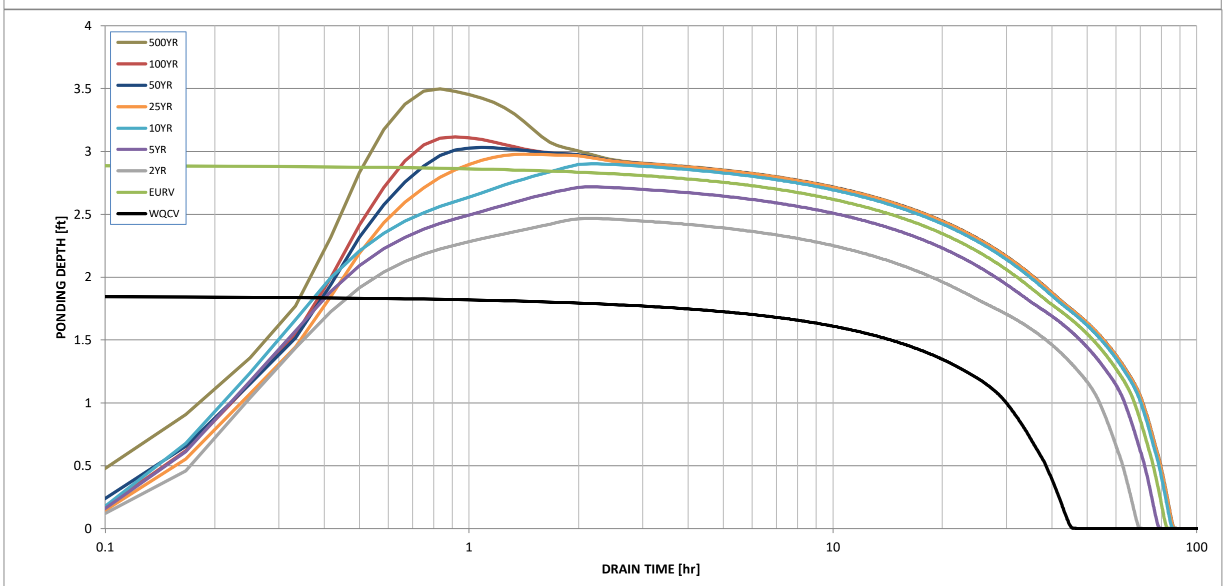
*The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).*

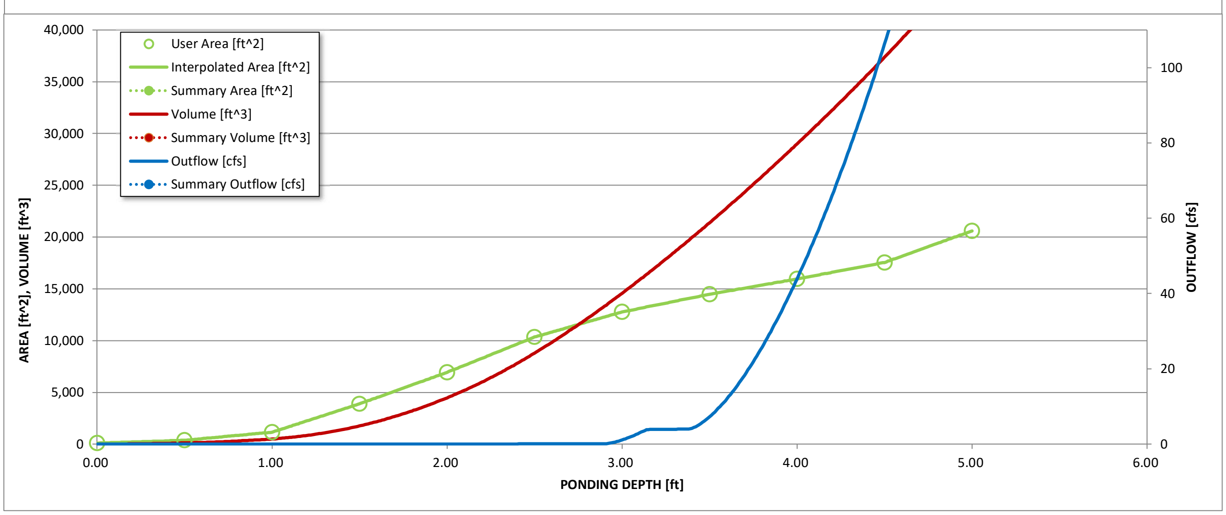
| Design Storm Return Period = | WQCV | EURV | 2 Year | 5 Year | 10 Year | 25 Year | 50 Year | 100 Year | 500 Year |
|---|---|---|---|---|---|---|---|---|---|
| One-Hour Rainfall Depth (in) = | N/A | N/A | 1.19 | 1.50 | 1.75 | 2.00 | 2.25 | 2.52 | 3.55 |
| CUHP Runoff Volume (acre-ft) = | 0.080 | 0.303 | 0.205 | 0.269 | 0.320 | 0.387 | 0.452 | 0.531 | 0.824 |
| Inflow Hydrograph Volume (acre-ft) = | N/A | N/A | 0.205 | 0.269 | 0.320 | 0.387 | 0.452 | 0.531 | 0.824 |
| CUHP Predevelopment Peak Q (cfs) = | N/A | N/A | 0.0 | 0.1 | 0.1 | 1.0 | 2.0 | 3.2 | 7.4 |
| OPTIONAL Override Predevelopment Peak Q (cfs) = | N/A | N/A | | | | | | | |
| Predevelopment Unit Peak Flow, q (cfs/acre) = | N/A | N/A | 0.01 | 0.02 | 0.03 | 0.27 | 0.52 | 0.85 | 1.98 |
| Peak Inflow Q (cfs) = | N/A | N/A | 4.3 | 5.7 | 6.9 | 8.5 | 10.3 | 11.8 | 18.6 |
| Peak Outflow Q (cfs) = | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.8 | 1.6 | 3.4 | 7.3 |
| Ratio Peak Outflow to Predevelopment Q = | N/A | N/A | N/A | 1.0 | 0.9 | 0.8 | 0.8 | 1.1 | 1.0 |
| Structure Controlling Flow = | Vertical Orifice 1 | Overflow Weir 1 | Vertical Orifice 1 | Vertical Orifice 1 | Overflow Weir 1 | Overflow Weir 1 | Overflow Weir 1 | Overflow Weir 1 | Spillway |
| Max Velocity through Grate 1 (fps) = | N/A | N/A | N/A | N/A | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 |
| Max Velocity through Grate 2 (fps) = | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Time to Drain 97% of Inflow Volume (hours) = | 39 | 69 | 58 | 66 | 72 | 71 | 70 | 68 | 63 |
| Time to Drain 99% of Inflow Volume (hours) = | **42** | 76 | 64 | 72 | 78 | 78 | 77 | 76 | 74 |
| Maximum Ponding Depth (ft) = | 1.85 | 2.90 | 2.47 | 2.72 | 2.90 | 2.98 | 3.03 | 3.12 | 3.50 |
| Area at Maximum Ponding Depth (acres) = | 0.14 | 0.28 | 0.23 | 0.26 | 0.28 | 0.29 | 0.30 | 0.30 | 0.33 |
| Maximum Volume Stored (acre-ft) = | 0.080 | 0.306 | 0.193 | 0.254 | 0.306 | 0.326 | 0.343 | 0.367 | 0.491 |

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.04 (February 2021)*



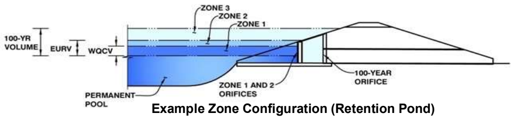

| S-A-V-D Chart Axis Override | X-axis | Left Y-Axis | Right Y-Axis |
|---|---|---|---|
| minimum bound | | | |
| maximum bound | | | |

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.04 (February 2021)*

**Project: Circle K at Highway 24 & Meridian South Detention**

**Basin ID: South Preliminary Pond Modeling (Not for Construction)**




**Example Zone Configuration (Retention Pond)**

Watershed Information

| | | | | |
|---|---|---|---|---|
| Selected BMP Type = | **EDB** | | | |
| Watershed Area = | 3.16 | acres | | |
| Watershed Length = | 400 | ft | | |
| Watershed Length to Centroid = | 300 | ft | | |
| Watershed Slope = | 0.020 | ft/ft | | |
| Watershed Imperviousness = | 100.00% | percent | | |
| Percentage Hydrologic Soil Group A = | 100.0% | percent | | |
| Percentage Hydrologic Soil Group B = | 0.0% | percent | | |
| Percentage Hydrologic Soil Groups C/D = | 0.0% | percent | | |
| Target WQCV Drain Time = | 40.0 | hours | | |
| Location for 1-hr Rainfall Depths = | User Input | | | |

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

| | | | Optional User Overrides | |
|---|---|---|---|---|
| Water Quality Capture Volume (WQCV) = | 0.132 | acre-feet | | acre-feet |
| Excess Urban Runoff Volume (EURV) = | 0.442 | acre-feet | | acre-feet |
| 2-yr Runoff Volume (P1 = 1.19 in.) = | 0.296 | acre-feet | 1.19 | inches |
| 5-yr Runoff Volume (P1 = 1.5 in.) = | 0.379 | acre-feet | 1.50 | inches |
| 10-yr Runoff Volume (P1 = 1.75 in.) = | 0.446 | acre-feet | 1.75 | inches |
| 25-yr Runoff Volume (P1 = 2 in.) = | 0.512 | acre-feet | 2.00 | inches |
| 50-yr Runoff Volume (P1 = 2.25 in.) = | 0.579 | acre-feet | 2.25 | inches |
| 100-yr Runoff Volume (P1 = 2.52 in.) = | 0.652 | acre-feet | 2.52 | inches |
| 500-yr Runoff Volume (P1 = 3.55 in.) = | 0.927 | acre-feet | 3.55 | inches |
| Approximate 2-yr Detention Volume = | 0.293 | acre-feet | | |
| Approximate 5-yr Detention Volume = | 0.379 | acre-feet | | |
| Approximate 10-yr Detention Volume = | 0.448 | acre-feet | | |
| Approximate 25-yr Detention Volume = | 0.525 | acre-feet | | |
| Approximate 50-yr Detention Volume = | 0.569 | acre-feet | | |
| Approximate 100-yr Detention Volume = | 0.605 | acre-feet | | |

Define Zones and Basin Geometry

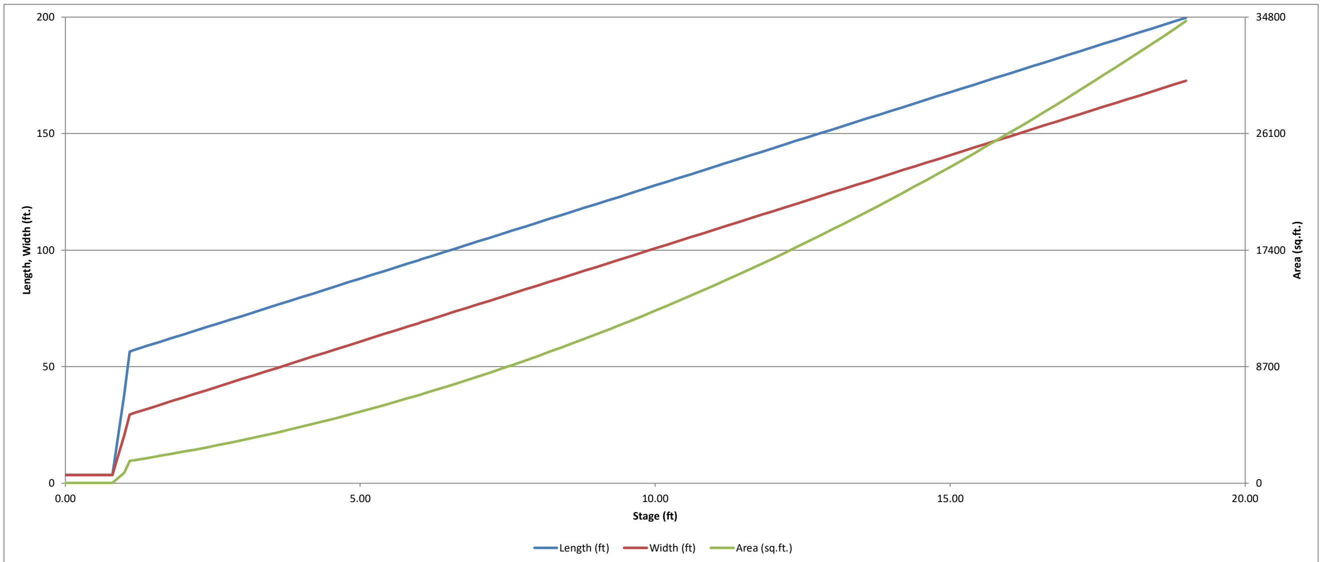
| | | |
|---|---|---|
| Zone 1 Volume (WQCV) = | 0.132 | acre-feet |
| Zone 2 Volume (EURV - Zone 1) = | 0.311 | acre-feet |
| Zone 3 Volume (100-year - Zones 1 & 2) = | 0.163 | acre-feet |
| Total Detention Basin Volume = | 0.605 | acre-feet |
| Initial Surcharge Volume (ISV) = | 4 | $ft^3$ |
| Initial Surcharge Depth (ISD) = | 0.33 | ft |
| Total Available Detention Depth ($H_{total}$) = | 7.00 | ft |
| Depth of Trickle Channel ($H_{TC}$) = | 0.50 | ft |
| Slope of Trickle Channel ($S_{TC}$) = | 0.005 | ft/ft |
| Slopes of Main Basin Sides ($S_{main}$) = | 4 | H:V |
| Basin Length-to-Width Ratio ($R_{L/W}$) = | 2 | |
| | | |
| Initial Surcharge Area ($A_{ISV}$) = | 12 | $ft^2$ |
| Surcharge Volume Length ($L_{ISV}$) = | 3.5 | ft |
| Surcharge Volume Width ($W_{ISV}$) = | 3.5 | ft |
| Depth of Basin Floor ($H_{FLOOR}$) = | 0.26 | ft |
| Length of Basin Floor ($L_{FLOOR}$) = | 56.5 | ft |
| Width of Basin Floor ($W_{FLOOR}$) = | 29.5 | ft |
| Area of Basin Floor ($A_{FLOOR}$) = | 1,666 | $ft^2$ |
| Volume of Basin Floor ($V_{FLOOR}$) = | 158 | $ft^3$ |
| Depth of Main Basin ($H_{MAIN}$) = | 5.91 | ft |
| Length of Main Basin ($L_{MAIN}$) = | 103.8 | ft |
| Width of Main Basin ($W_{MAIN}$) = | 76.8 | ft |
| Area of Main Basin ($A_{MAIN}$) = | 7,968 | $ft^2$ |
| Volume of Main Basin ($V_{MAIN}$) = | 26,158 | $ft^3$ |
| Calculated Total Basin Volume ($V_{total}$) = | **0.604** | acre-feet |

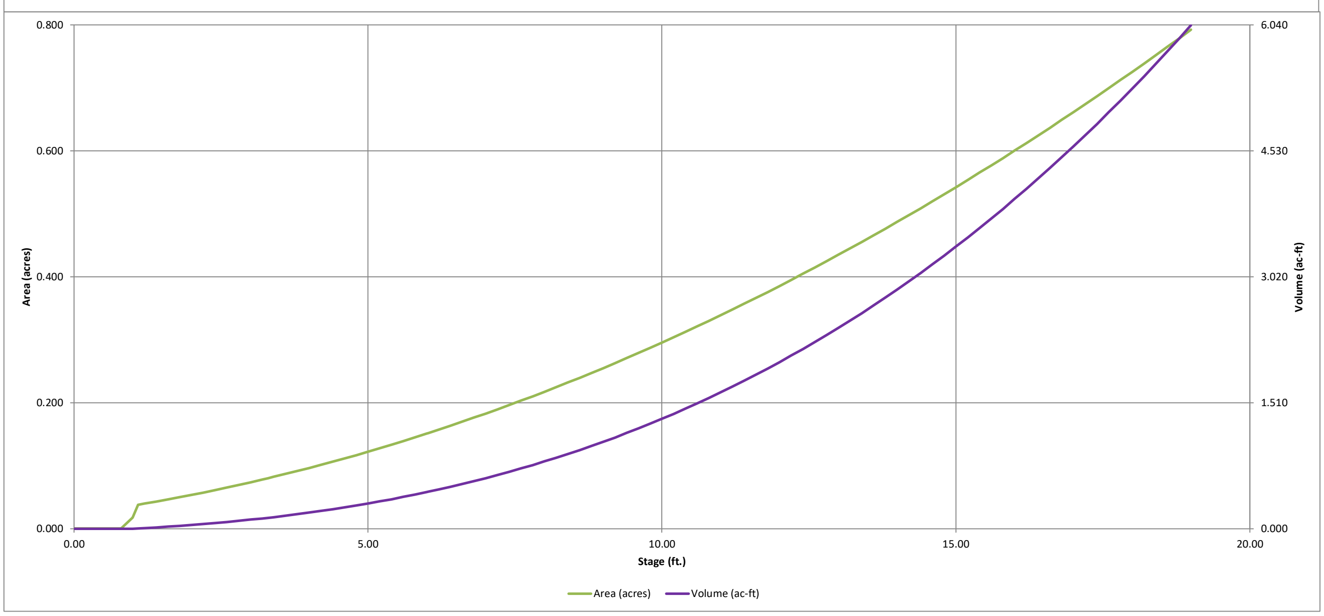
Depth Increment = 0.20 ft

| Stage - Storage Description | Stage (ft) | Optional Override Stage (ft) | Length (ft) | Width (ft) | Area ($ft^2$) | Optional Override Area ($ft^2$) | Area (acre) | Volume ($ft^3$) | Volume (ac-ft) |
|---|---|---|---|---|---|---|---|---|---|
| **Top of Micropool** | 0.00 | | 3.5 | 3.5 | 12 | | 0.000 | | |
| **ISV** | 0.33 | | 3.5 | 3.5 | 12 | | 0.000 | 4 | 0.000 |
| | 0.40 | | 3.5 | 3.5 | 12 | | 0.000 | 5 | 0.000 |
| | 0.60 | | 3.5 | 3.5 | 12 | | 0.000 | 7 | 0.000 |
| | 0.80 | | 3.5 | 3.5 | 12 | | 0.000 | 10 | 0.000 |
| | 1.00 | | 38.2 | 20.5 | 782 | | 0.018 | 61 | 0.001 |
| **Floor** | 1.09 | | 56.5 | 29.5 | 1,666 | | 0.038 | 169 | 0.004 |
| | 1.20 | | 57.4 | 30.4 | 1,743 | | 0.040 | 356 | 0.008 |
| | 1.40 | | 59.0 | 32.0 | 1,886 | | 0.043 | 719 | 0.017 |
| | 1.60 | | 60.6 | 33.6 | 2,034 | | 0.047 | 1,111 | 0.025 |
| | 1.80 | | 62.2 | 35.2 | 2,187 | | 0.050 | 1,533 | 0.035 |
| | 2.00 | | 63.8 | 36.8 | 2,345 | | 0.054 | 1,986 | 0.046 |
| | 2.20 | | 65.4 | 38.4 | 2,509 | | 0.058 | 2,471 | 0.057 |
| | 2.40 | | 67.0 | 40.0 | 2,677 | | 0.061 | 2,990 | 0.069 |
| | 2.60 | | 68.6 | 41.6 | 2,851 | | 0.065 | 3,543 | 0.081 |
| | 2.80 | | 70.2 | 43.2 | 3,030 | | 0.070 | 4,131 | 0.095 |
| | 3.00 | | 71.8 | 44.8 | 3,214 | | 0.074 | 4,755 | 0.109 |
| | 3.20 | | 73.4 | 46.4 | 3,403 | | 0.078 | 5,416 | 0.124 |
| **Zone 1 (WQCV)** | 3.30 | | 74.2 | 47.2 | 3,499 | | 0.080 | 5,762 | 0.132 |
| | 3.40 | | 75.0 | 48.0 | 3,597 | | 0.083 | 6,116 | 0.140 |
| | 3.60 | | 76.6 | 49.6 | 3,796 | | 0.087 | 6,856 | 0.157 |
| | 3.80 | | 78.2 | 51.2 | 4,001 | | 0.092 | 7,635 | 0.175 |
| | 4.00 | | 79.8 | 52.8 | 4,210 | | 0.097 | 8,456 | 0.194 |
| | 4.20 | | 81.4 | 54.4 | 4,425 | | 0.102 | 9,320 | 0.214 |
| | 4.40 | | 83.0 | 56.0 | 4,645 | | 0.107 | 10,227 | 0.235 |
| | 4.60 | | 84.6 | 57.6 | 4,870 | | 0.112 | 11,178 | 0.257 |
| | 4.80 | | 86.2 | 59.2 | 5,100 | | 0.117 | 12,175 | 0.280 |
| | 5.00 | | 87.8 | 60.8 | 5,335 | | 0.122 | 13,218 | 0.303 |
| | 5.20 | | 89.4 | 62.4 | 5,575 | | 0.128 | 14,309 | 0.328 |
| | 5.40 | | 91.0 | 64.0 | 5,821 | | 0.134 | 15,449 | 0.355 |
| | 5.60 | | 92.6 | 65.6 | 6,071 | | 0.139 | 16,638 | 0.382 |
| | 5.80 | | 94.2 | 67.2 | 6,327 | | 0.145 | 17,878 | 0.410 |
| | 6.00 | | 95.8 | 68.8 | 6,587 | | 0.151 | 19,169 | 0.440 |
| **Zone 2 (EURV)** | 6.02 | | 96.0 | 68.9 | 6,614 | | 0.152 | 19,301 | 0.443 |
| | 6.20 | | 97.4 | 70.4 | 6,853 | | 0.157 | 20,513 | 0.471 |
| | 6.40 | | 99.0 | 72.0 | 7,124 | | 0.164 | 21,911 | 0.503 |
| | 6.60 | | 100.6 | 73.6 | 7,400 | | 0.170 | 23,363 | 0.536 |
| | 6.80 | | 102.2 | 75.2 | 7,682 | | 0.176 | 24,871 | 0.571 |
| **Zone 3 (100-year)** | 7.00 | | 103.8 | 76.8 | 7,968 | | 0.183 | 26,436 | 0.607 |
| | 7.20 | | 105.4 | 78.4 | 8,259 | | 0.190 | 28,059 | 0.644 |
| | 7.40 | | 107.0 | 80.0 | 8,556 | | 0.196 | 29,740 | 0.683 |
| | 7.60 | | 108.6 | 81.6 | 8,858 | | 0.203 | 31,481 | 0.723 |
| | 7.80 | | 110.2 | 83.2 | 9,165 | | 0.210 | 33,284 | 0.764 |
| | 8.00 | | 111.8 | 84.8 | 9,476 | | 0.218 | 35,148 | 0.807 |
| | 8.20 | | 113.4 | 86.4 | 9,794 | | 0.225 | 37,074 | 0.851 |
| | 8.40 | | 115.0 | 88.0 | 10,116 | | 0.232 | 39,065 | 0.897 |
| | 8.60 | | 116.6 | 89.6 | 10,443 | | 0.240 | 41,121 | 0.944 |
| | 8.80 | | 118.2 | 91.2 | 10,775 | | 0.247 | 43,243 | 0.993 |
| | 9.00 | | 119.8 | 92.8 | 11,113 | | 0.255 | 45,432 | 1.043 |
| | 9.20 | | 121.4 | 94.4 | 11,456 | | 0.263 | 47,688 | 1.095 |
| | 9.40 | | 123.0 | 96.0 | 11,803 | | 0.271 | 50,014 | 1.148 |
| | 9.60 | | 124.6 | 97.6 | 12,156 | | 0.279 | 52,410 | 1.203 |
| | 9.80 | | 126.2 | 99.2 | 12,514 | | 0.287 | 54,877 | 1.260 |
| | 10.00 | | 127.8 | 100.8 | 12,877 | | 0.296 | 57,416 | 1.318 |
| | 10.20 | | 129.4 | 102.4 | 13,246 | | 0.304 | 60,028 | 1.378 |
| | 10.40 | | 131.0 | 104.0 | 13,619 | | 0.313 | 62,715 | 1.440 |
| | 10.60 | | 132.6 | 105.6 | 13,998 | | 0.321 | 65,476 | 1.503 |
| | 10.80 | | 134.2 | 107.2 | 14,381 | | 0.330 | 68,314 | 1.568 |
| | 11.00 | | 135.8 | 108.8 | 14,770 | | 0.339 | 71,229 | 1.635 |
| | 11.20 | | 137.4 | 110.4 | 15,164 | | 0.348 | 74,223 | 1.704 |
| | 11.40 | | 139.0 | 112.0 | 15,563 | | 0.357 | 77,295 | 1.774 |
| | 11.60 | | 140.6 | 113.6 | 15,967 | | 0.367 | 80,448 | 1.847 |
| | 11.80 | | 142.2 | 115.2 | 16,376 | | 0.376 | 83,682 | 1.921 |
| | 12.00 | | 143.8 | 116.8 | 16,790 | | 0.385 | 86,999 | 1.997 |
| | 12.20 | | 145.4 | 118.4 | 17,210 | | 0.395 | 90,399 | 2.075 |
| | 12.40 | | 147.0 | 120.0 | 17,635 | | 0.405 | 93,883 | 2.155 |
| | 12.60 | | 148.6 | 121.6 | 18,064 | | 0.415 | 97,453 | 2.237 |
| | 12.80 | | 150.2 | 123.2 | 18,499 | | 0.425 | 101,109 | 2.321 |
| | 13.00 | | 151.8 | 124.8 | 18,939 | | 0.435 | 104,853 | 2.407 |
| | 13.20 | | 153.4 | 126.4 | 19,384 | | 0.445 | 108,685 | 2.495 |
| | 13.40 | | 155.0 | 128.0 | 19,834 | | 0.455 | 112,607 | 2.585 |
| | 13.60 | | 156.6 | 129.6 | 20,290 | | 0.466 | 116,619 | 2.677 |
| | 13.80 | | 158.2 | 131.2 | 20,750 | | 0.476 | 120,723 | 2.771 |
| | 14.00 | | 159.8 | 132.8 | 21,216 | | 0.487 | 124,920 | 2.868 |
| | 14.20 | | 161.4 | 134.4 | 21,686 | | 0.498 | 129,210 | 2.966 |
| | 14.40 | | 163.0 | 136.0 | 22,162 | | 0.509 | 133,594 | 3.067 |
| | 14.60 | | 164.6 | 137.6 | 22,643 | | 0.520 | 138,075 | 3.170 |
| | 14.80 | | 166.2 | 139.2 | 23,129 | | 0.531 | 142,652 | 3.275 |
| | 15.00 | | 167.8 | 140.8 | 23,620 | | 0.542 | 147,327 | 3.382 |
| | 15.20 | | 169.4 | 142.4 | 24,116 | | 0.554 | 152,100 | 3.492 |
| | 15.40 | | 171.0 | 144.0 | 24,618 | | 0.565 | 156,973 | 3.604 |
| | 15.60 | | 172.6 | 145.6 | 25,124 | | 0.577 | 161,948 | 3.718 |
| | 15.80 | | 174.2 | 147.2 | 25,636 | | 0.589 | 167,023 | 3.834 |
| | 16.00 | | 175.8 | 148.8 | 26,153 | | 0.600 | 172,202 | 3.953 |
| | 16.20 | | 177.4 | 150.4 | 26,674 | | 0.612 | 177,485 | 4.074 |
| | 16.40 | | 179.0 | 152.0 | 27,201 | | 0.624 | 182,872 | 4.198 |
| | 16.60 | | 180.6 | 153.6 | 27,733 | | 0.637 | 188,366 | 4.324 |
| | 16.80 | | 182.2 | 155.2 | 28,271 | | 0.649 | 193,966 | 4.453 |
| | 17.00 | | 183.8 | 156.8 | 28,813 | | 0.661 | 199,674 | 4.584 |
| | 17.20 | | 185.4 | 158.4 | 29,360 | | 0.674 | 205,492 | 4.717 |
| | 17.40 | | 187.0 | 160.0 | 29,913 | | 0.687 | 211,419 | 4.854 |
| | 17.60 | | 188.6 | 161.6 | 30,471 | | 0.700 | 217,457 | 4.992 |
| | 17.80 | | 190.2 | 163.2 | 31,034 | | 0.712 | 223,607 | 5.133 |
| | 18.00 | | 191.8 | 164.8 | 31,602 | | 0.725 | 229,871 | 5.277 |
| | 18.20 | | 193.4 | 166.4 | 32,175 | | 0.739 | 236,248 | 5.424 |
| | 18.40 | | 195.0 | 168.0 | 32,753 | | 0.752 | 242,741 | 5.573 |
| | 18.60 | | 196.6 | 169.6 | 33,336 | | 0.765 | 249,350 | 5.724 |
| | 18.80 | | 198.2 | 171.2 | 33,924 | | 0.779 | 256,076 | 5.879 |
| | 19.00 | | 199.8 | 172.8 | 34,518 | | 0.792 | 262,920 | 6.036 |

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.04 (February 2021)*

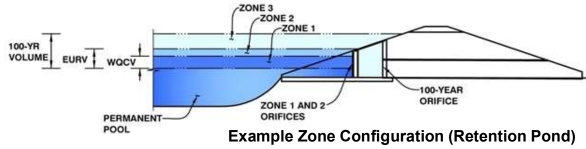


# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.04 (February 2021)*

**Project:** **Circle K at Highway 24 & Meridian South Detention**
**Basin ID:** **South Preliminary Pond Modeling (Not for Construction)**




**Example Zone Configuration (Retention Pond)**

| | Estimated Stage (ft) | Estimated Volume (ac-ft) | Outlet Type |
|---|---|---|---|
| Zone 1 (WQCV) | 3.30 | 0.132 | Orifice Plate |
| Zone 2 (EURV) | 6.02 | 0.311 | Circular Orifice |
| Zone 3 (100-year) | 7.00 | 0.163 | Weir&Pipe (Restrict) |
| Total (all zones) | | 0.605 | |

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

| | | |
|---|---|---|
| Underdrain Orifice Invert Depth = | N/A | ft (distance below the filtration media surface) |
| Underdrain Orifice Diameter = | N/A | inches |

Calculated Parameters for Underdrain

| | | |
|---|---|---|
| Underdrain Orifice Area = | N/A | $ft^2$ |
| Underdrain Orifice Centroid = | N/A | feet |

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

| | | |
|---|---|---|
| Invert of Lowest Orifice = | 0.00 | ft (relative to basin bottom at Stage = 0 ft) |
| Depth at top of Zone using Orifice Plate = | 3.30 | ft (relative to basin bottom at Stage = 0 ft) |
| Orifice Plate: Orifice Vertical Spacing = | N/A | inches |
| Orifice Plate: Orifice Area per Row = | N/A | inches |

Calculated Parameters for Plate

| | | |
|---|---|---|
| WQ Orifice Area per Row = | N/A | $ft^2$ |
| Elliptical Half-Width = | N/A | feet |
| Elliptical Slot Centroid = | N/A | feet |
| Elliptical Slot Area = | N/A | $ft^2$ |

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

| | Row 1 (required) | Row 2 (optional) | Row 3 (optional) | Row 4 (optional) | Row 5 (optional) | Row 6 (optional) | Row 7 (optional) | Row 8 (optional) |
|---|---|---|---|---|---|---|---|---|
| Stage of Orifice Centroid (ft) | 0.00 | 0.50 | 1.00 | 1.50 | 2.00 | 2.50 | 3.00 | |
| Orifice Area (sq. inches) | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.15 | |

| | Row 9 (optional) | Row 10 (optional) | Row 11 (optional) | Row 12 (optional) | Row 13 (optional) | Row 14 (optional) | Row 15 (optional) | Row 16 (optional) |
|---|---|---|---|---|---|---|---|---|
| Stage of Orifice Centroid (ft) | | | | | | | | |
| Orifice Area (sq. inches) | | | | | | | | |

User Input: Vertical Orifice (Circular or Rectangular)

| | Zone 2 Circular | Not Selected | |
|---|---|---|---|
| Invert of Vertical Orifice = | 3.30 | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Depth at top of Zone using Vertical Orifice = | 6.02 | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Vertical Orifice Diameter = | 0.10 | N/A | inches |

Calculated Parameters for Vertical Orifice

| | Zone 2 Circular | Not Selected | |
|---|---|---|---|
| Vertical Orifice Area = | 0.00 | N/A | $ft^2$ |
| Vertical Orifice Centroid = | 0.00 | N/A | feet |

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir (and No Outlet Pipe)

| | Zone 3 Weir | Not Selected | |
|---|---|---|---|
| Overflow Weir Front Edge Height, Ho = | 6.50 | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Overflow Weir Front Edge Length = | 4.00 | N/A | feet |
| Overflow Weir Grate Slope = | 0.00 | N/A | H:V |
| Horiz. Length of Weir Sides = | 4.00 | N/A | feet |
| Overflow Grate Type = | Type C Grate | N/A | |
| Debris Clogging % = | 50% | N/A | % |

Calculated Parameters for Overflow Weir

| | Zone 3 Weir | Not Selected | |
|---|---|---|---|
| Height of Grate Upper Edge, $H_t$ = | 6.50 | N/A | feet |
| Overflow Weir Slope Length = | 4.00 | N/A | feet |
| Grate Open Area / 100-yr Orifice Area = | 103.75 | N/A | |
| Overflow Grate Open Area w/o Debris = | 11.14 | N/A | $ft^2$ |
| Overflow Grate Open Area w/ Debris = | 5.57 | N/A | $ft^2$ |

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

| | Zone 3 Restrictor | Not Selected | |
|---|---|---|---|
| Depth to Invert of Outlet Pipe = | 0.25 | N/A | ft (distance below basin bottom at Stage = 0 ft) |
| Outlet Pipe Diameter = | 18.00 | N/A | inches |
| Restrictor Plate Height Above Pipe Invert = | 2.00 | | inches |

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

| | Zone 3 Restrictor | Not Selected | |
|---|---|---|---|
| Outlet Orifice Area = | 0.11 | N/A | $ft^2$ |
| Outlet Orifice Centroid = | 0.10 | N/A | feet |
| Half-Central Angle of Restrictor Plate on Pipe = | 0.68 | N/A | radians |

User Input: Emergency Spillway (Rectangular or Trapezoidal)

| | | |
|---|---|---|
| Spillway Invert Stage= | 7.00 | ft (relative to basin bottom at Stage = 0 ft) |
| Spillway Crest Length = | 4.00 | feet |
| Spillway End Slopes = | 4.00 | H:V |
| Freeboard above Max Water Surface = | 1.00 | feet |

Calculated Parameters for Spillway

| | | |
|---|---|---|
| Spillway Design Flow Depth= | 0.74 | feet |
| Stage at Top of Freeboard = | 8.74 | feet |
| Basin Area at Top of Freeboard = | 0.25 | acres |
| Basin Volume at Top of Freeboard = | 0.98 | acre-ft |

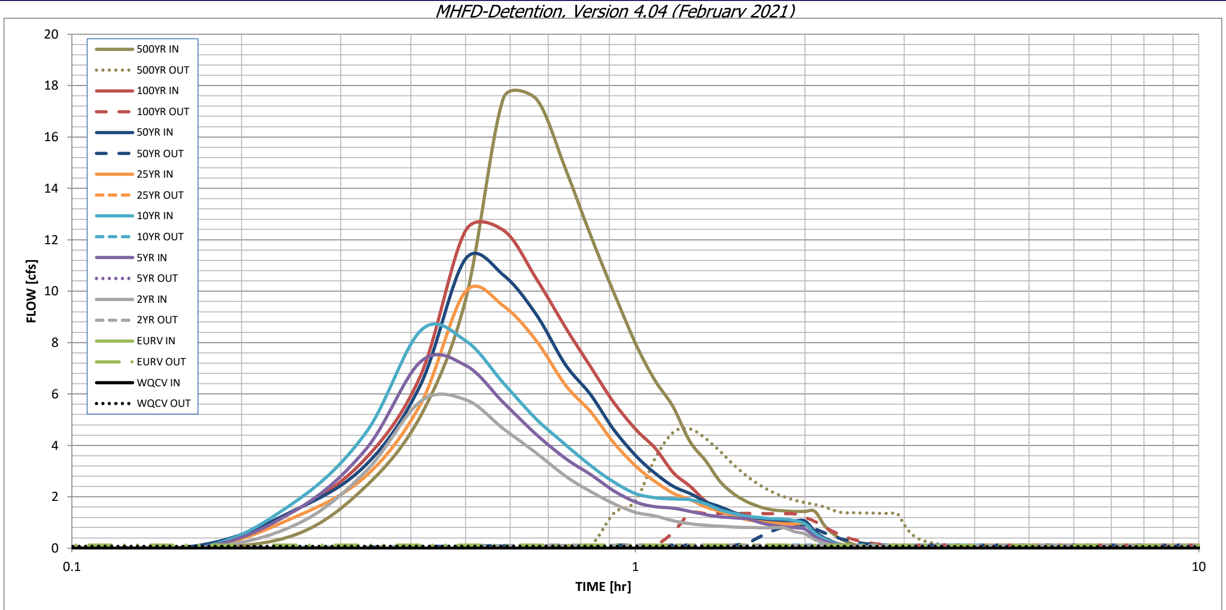
Routed Hydrograph Results

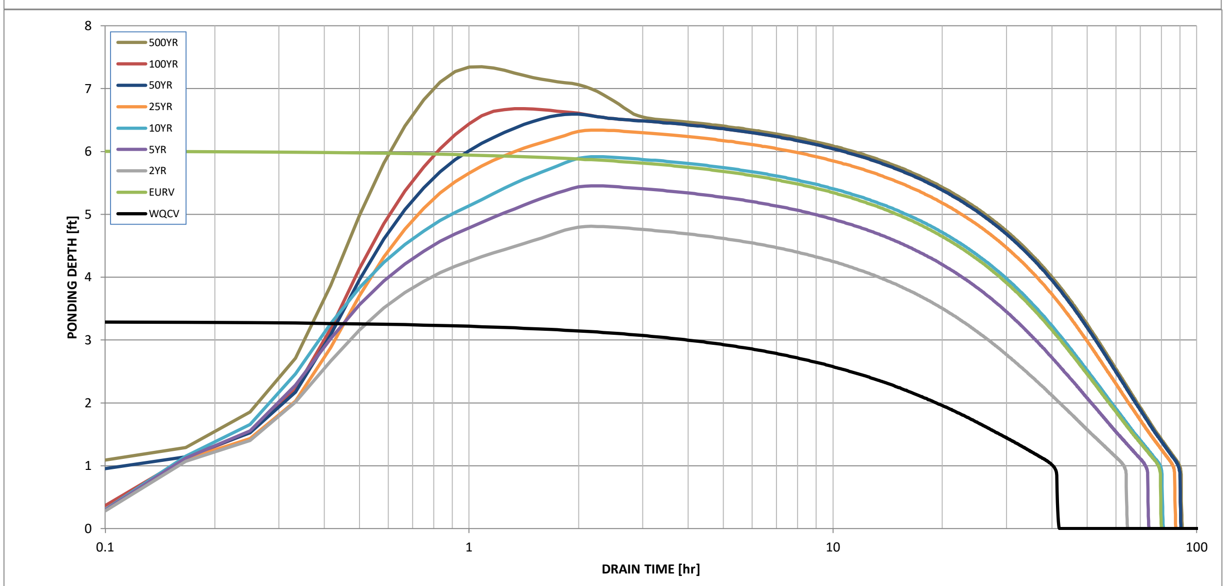
*The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).*

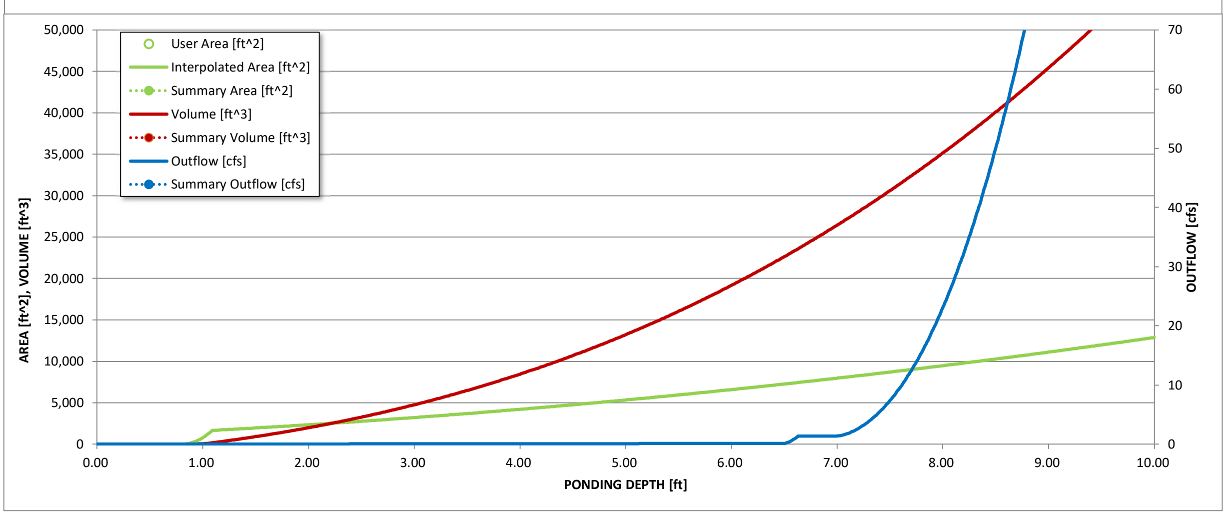
| Design Storm Return Period = | WQCV | EURV | 2 Year | 5 Year | 10 Year | 25 Year | 50 Year | 100 Year | 500 Year |
|---|---|---|---|---|---|---|---|---|---|
| One-Hour Rainfall Depth (in) = | N/A | N/A | 1.19 | 1.50 | 1.75 | 2.00 | 2.25 | 2.52 | 3.55 |
| CUHP Runoff Volume (acre-ft) = | 0.132 | 0.442 | 0.296 | 0.379 | 0.446 | 0.512 | 0.579 | 0.652 | 0.927 |
| Inflow Hydrograph Volume (acre-ft) = | N/A | N/A | 0.296 | 0.379 | 0.446 | 0.512 | 0.579 | 0.652 | 0.927 |
| CUHP Predevelopment Peak Q (cfs) = | N/A | N/A | 0.0 | 0.1 | 0.1 | 0.6 | 1.3 | 2.1 | 4.9 |
| OPTIONAL Override Predevelopment Peak Q (cfs) = | N/A | N/A | | | | | | | |
| Predevelopment Unit Peak Flow, q (cfs/acre) = | N/A | N/A | 0.01 | 0.02 | 0.02 | 0.20 | 0.40 | 0.65 | 1.54 |
| Peak Inflow Q (cfs) = | N/A | N/A | 5.8 | 7.3 | 8.5 | 10.0 | 11.3 | 12.4 | 17.5 |
| Peak Outflow Q (cfs) = | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.9 | 1.4 | 4.6 |
| Ratio Peak Outflow to Predevelopment Q = | N/A | N/A | N/A | 2.2 | 1.7 | 0.2 | 0.7 | 0.7 | 1.0 |
| Structure Controlling Flow = | Plate | Plate | Plate | Vertical Orifice 1 | Plate | Vertical Orifice 1 | Overflow Weir 1 | Outlet Plate 1 | Spillway |
| Max Velocity through Grate 1 (fps) = | N/A | N/A | N/A | N/A | N/A | N/A | 0.1 | 0.1 | 0.1 |
| Max Velocity through Grate 2 (fps) = | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Time to Drain 97% of Inflow Volume (hours) = | 38 | 71 | 58 | 66 | 72 | 77 | 79 | 78 | 75 |
| Time to Drain 99% of Inflow Volume (hours) = | **40** | 76 | 62 | 71 | 77 | 83 | 86 | 86 | 85 |
| Maximum Ponding Depth (ft) = | 3.30 | 6.02 | 4.81 | 5.45 | 5.92 | 6.34 | 6.60 | 6.68 | 7.35 |
| Area at Maximum Ponding Depth (acres) = | 0.08 | 0.15 | 0.12 | 0.14 | 0.15 | 0.16 | 0.17 | 0.17 | 0.19 |
| Maximum Volume Stored (acre-ft) = | 0.132 | 0.443 | 0.280 | 0.361 | 0.427 | 0.493 | 0.535 | 0.550 | 0.673 |

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.04 (February 2021)*




| S-A-V-D Chart Axis Override | X-axis | Left Y-Axis | Right Y-Axis |
|---|---|---|---|
| minimum bound | | | |
| maximum bound | | | |

**Figure 13-12b. Emergency Spillway Profile at Embankment**

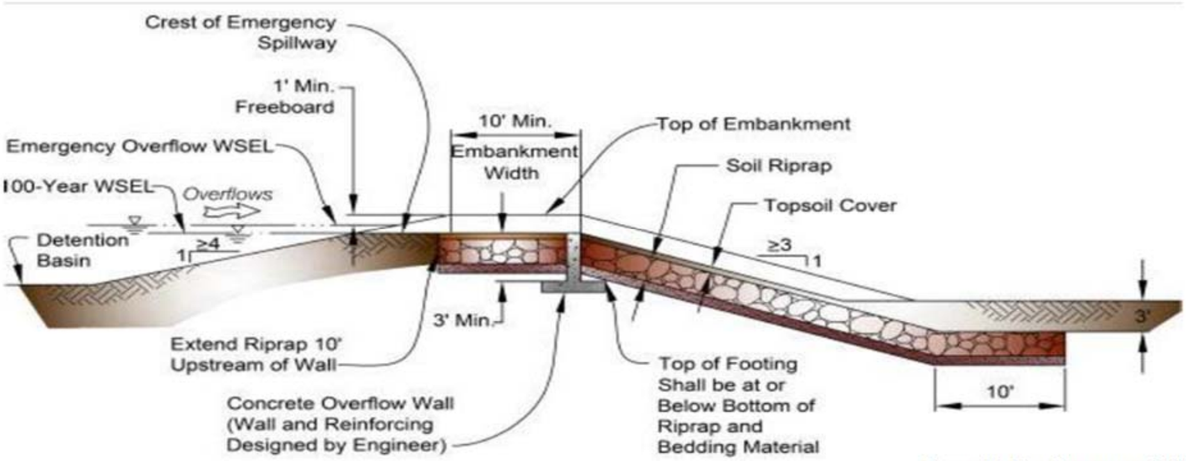
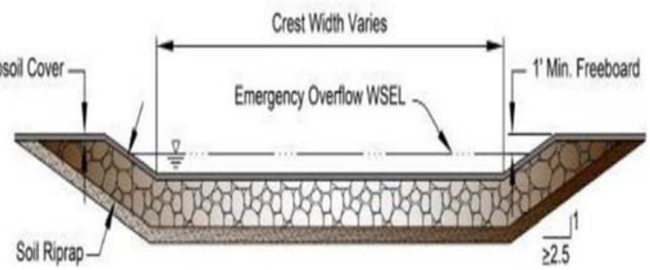



**Figure 13-12c. Emergency Spillway Protection**

North Pond: Side slopes: 4:1
Unit Discharge: 11.8 cfs / 30 ft
= 0.39 cfs/ft



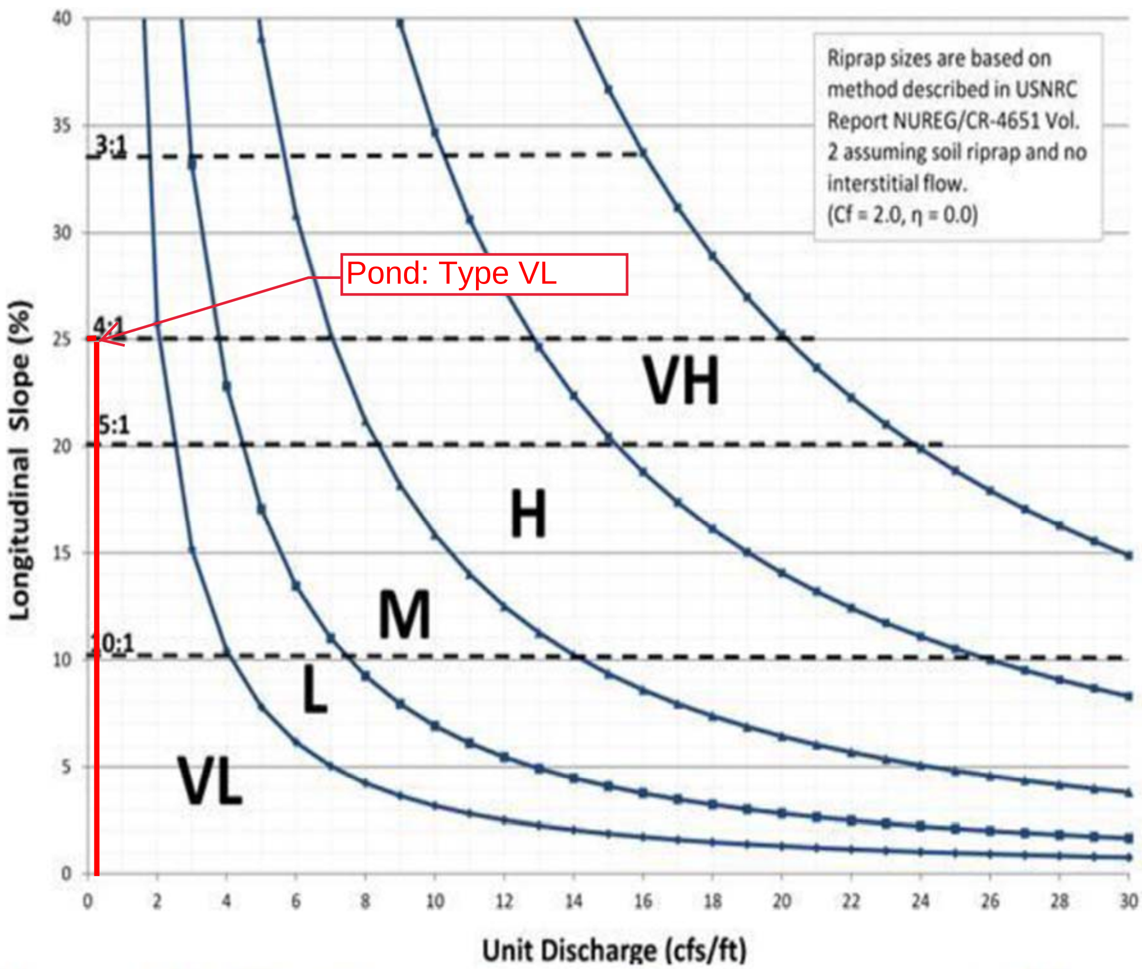
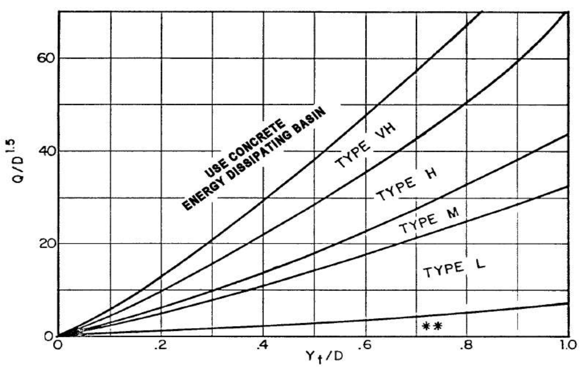




**Figure 13-12d. Riprap Types for Emergency Spillway Protection**

| | DP J3 | | DP K | | DP L | |
|---|---|---|---|---|---|---|
| Pipe Size (D) | 24 | Inches | 15 | Inches | 18 | Inches |
| Q | 3.3 | cfs | 5.6 | cfs | 2.9 | cfs |
| L | 6 | Feet | 3.75 | Feet | 4.5 | Feet |
| W | 6 | Feet | 3.75 | Feet | 4.5 | Feet |
| D | 0 | Feet | 0 | Feet | 0 | Feet |
| $d_{50}$ | 0.13 | Feet | 0.20 | Feet | 0.17 | Feet |
| | 1.52 | Inches | 2.42 | Inches | 2.07 | Inches |
| Depth of Flow | 0.55 | Feet | 0.65 | Feet | 0.4 | Feet |
| Q/D^1.5 | 1.17 | | 4.01 | | 1.58 | |
| Yt/D | 0.275 | | 0.520 | | 0.273 | |
| Rip Rap | Type L for 3 x Pipe Dia Downstream | | Type L for 3 x Pipe Dia Downstream | | Type L for 3 x Pipe Dia Downstream | |
| Length of Rock | 6 | Feet | 3.75 | Feet | 4.5 | Feet |
| Width of Rock | 6.0 | Feet | 3.8 | Feet | 4.5 | Feet |



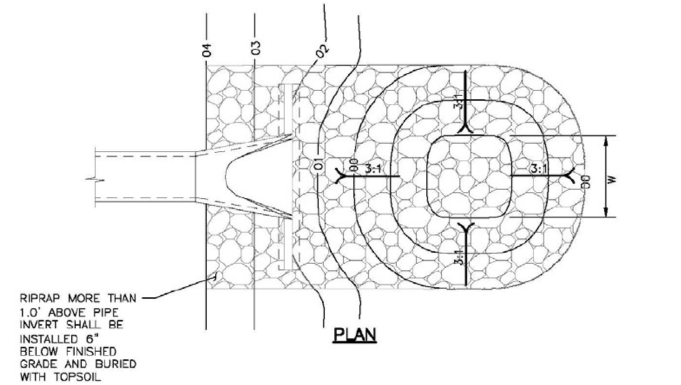

Use $D_a$ instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

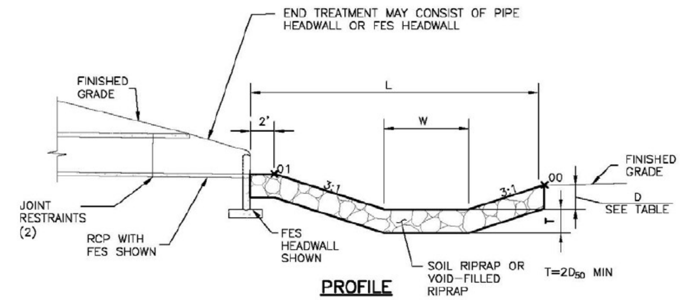
**CLASSIFICATION AND GRADATION OF ORDINARY RIP RAP**

| Rip Rap Designation by Weight | % Smaller Than Given Size (inches) | Intermediate Rock Dimension | d50* (inches) |
|---|---|---|---|
| Type VL | 70 – 100 | 12 | 6** |
| | 50 – 70 | 9 | |
| | 35 – 50 | 6 | |
| | 2 - 10 | 2 | |
| Type L | 70 – 100 | 15 | 9** |
| | 50 – 70 | 12 | |
| | 35 – 50 | 9 | |
| | 2 - 10 | 3 | |
| Type M | 70 – 100 | 21 | 12 |
| | 50 – 70 | 18 | |
| | 35 – 50 | 12 | |
| | 2 - 10 | 4 | |
| Type H | 70 – 100 | 30 | 18 |
| | 50 – 70 | 24 | |
| | 35 – 50 | 18 | |
| | 2 - 10 | 6 | |
| Type VH | 70 – 100 | 42 | 24 |
| | 50 – 70 | 33 | |
| | 35 – 50 | 24 | |
| | 2 - 10 | 9 | |

* d50 = Mean particle size

** Bury types VL and L with native top soil and revegetate to protect from vandalism.




| PIPE SIZE OR BOX HEIGHT | D | W* | L |
|---|---|---|---|
| 18" – 24" | 1'-0" | 4' | 15' |
| 30" – 36" | 1'-6" | 6' | 20' |
| 42" – 48" | 2'-0" | 7' | 24' |
| 54" – 60" | 2'-6" | 8' | 28' |
| 66" – 72" | 3'-0" | 9' | 32' |

* IF OUTLET PIPE IS A BOX CULVERT WITH A WIDTH GREATER THAN W, THEN W = CULVERT WIDTH

**Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for Q/D2.5 ≤ 6.0)**

# Channel Report



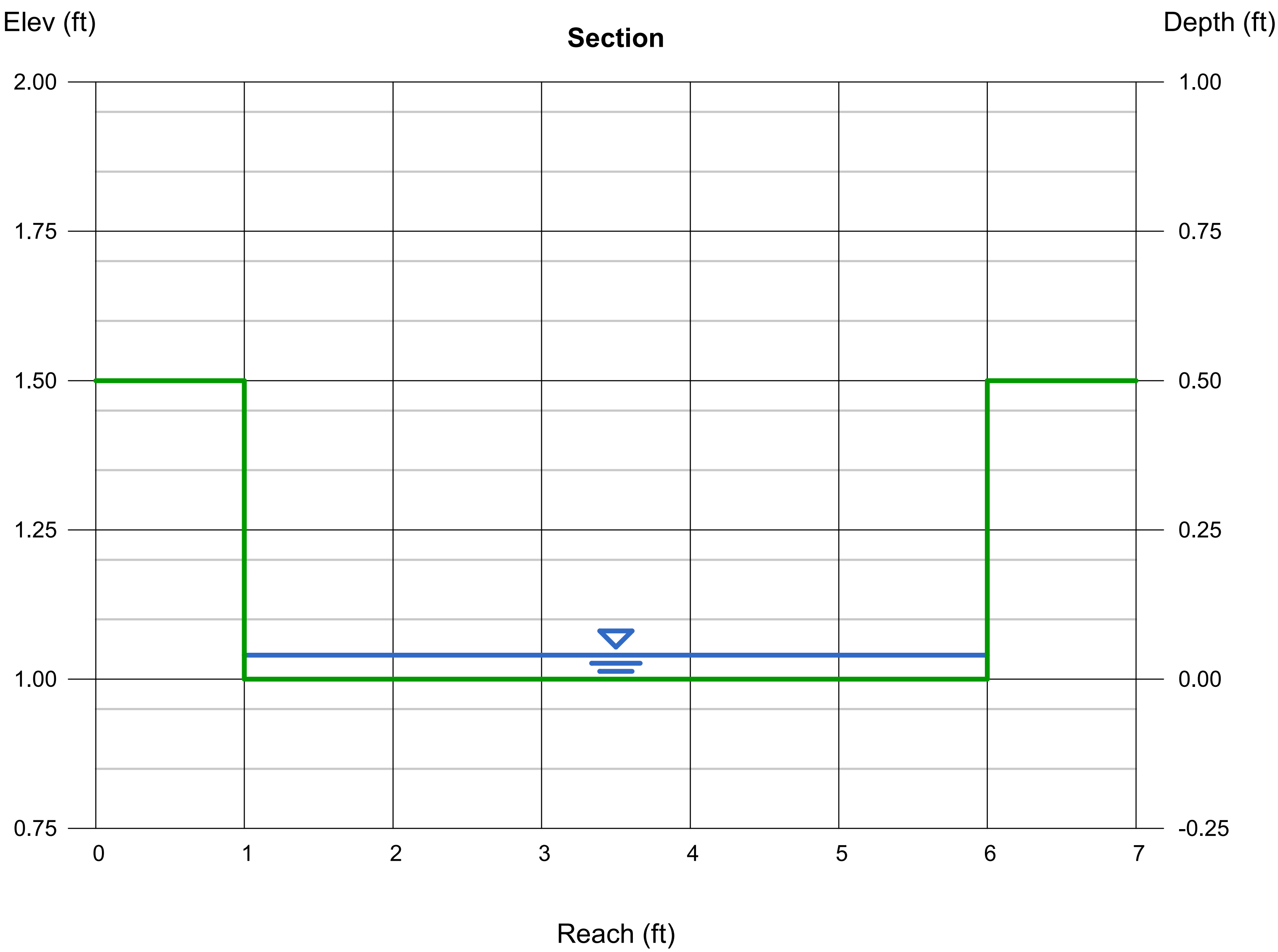
## BASIN E FLUME

**Rectangular**
Bottom Width (ft) = 5.00
Total Depth (ft) = 0.50

Invert Elev (ft) = 1.00
Slope (%) = 33.00
N-Value = 0.013

**Calculations**
Compute by: Known Q
Known Q (cfs) = 1.40

**Highlighted**
Depth (ft) = 0.04
Q (cfs) = 1.400
Area (sqft) = 0.20
Velocity (ft/s) = 7.00
Wetted Perim (ft) = 5.08
Crit Depth, Yc (ft) = 0.14
Top Width (ft) = 5.00
EGL (ft) = 0.80



# APPENDIX B

## STANDARD DESIGN CHARTS AND TABLES

# *El Paso County Drainage Basin Fees*

Resolution No. 21-468

| Basin Number | Receiving Waters | Year Studied | Drainage Basin Name | 2022 Drainage Fee (per Impervious Acre) | 2022 Bridge Fee (per Impervious Acre) |
|---|---|---|---|---|---|
| ***Drainage Basins with DBPS's:*** | | | | | |
| CHMS0200 | Chico Creek | 2013 | Haegler Ranch | $11,891 | $1,755 |
| CHWS1200 | Chico Creek | 2001 | Bennett Ranch | $13,312 | $5,106 |
| CHWS1400 | Chico Creek | 2013 | Falcon | $34,117 | $4,687 |
| FOFO2000 | Fountain Creek | 2001 | West Fork Jimmy Camp Creek | $14,470 | $4,281 |
| FOFO2600 | Fountain Creek | 1991* | Big Johnson / Crews Gulch | $21,134 | $2,729 |
| FOFO2800 | Fountain Creek | 1988* | Widefield | $21,134 | $0 |
| FOFO2900 | Fountain Creek | 1988* | Security | $21,134 | $0 |
| FOFO3000 | Fountain Creek | 1991* | Windmill Gulch | $21,134 | $317 |
| FOFO3100 / FOFO3200 | Fountain Creek | 1988* | Carson Street / Little Johnson | $12,891 | $0 |
| FOFO3400 | Fountain Creek | 1984* | Peterson Field | $15,243 | $1,156 |
| FOFO3600 | Fountain Creek | 1991* | Fisher's Canyon | $21,134 | $0 |
| FOFO4000 | Fountain Creek | 1996 | Sand Creek | $21,814 | $8,923 |
| FOFO4200 | Fountain Creek | 1977 | Spring Creek | $10,961 | $0 |
| FOFO4600 | Fountain Creek | 1984* | Southwest Area | $21,134 | $0 |
| FOFO4800 | Fountain Creek | 1991 | Bear Creek | $21,134 | $1,156 |
| FOFO5800 | Fountain Creek | 1964 | Camp Creek | $2,342 | $0 |
| FOMO1000 | Monument Creek | 1981 | Douglas Creek | $13,291 | $294 |
| FOMO1200 | Monument Creek | 1977 | Templeton Gap | $13,644 | $317 |
| FOMO2000 | Monument Creek | 1971 | Pulpit Rock | $7,008 | $0 |
| FOMO2200 | Monument Creek | 1994 | Cottonwood Creek / S. Pine | $21,134 | $1,156 |
| FOMO2400 | Monument Creek | 1966 | Dry Creek | $16,684 | $604 |
| FOMO3600 | Monument Creek | 1989* | Black Squirrel Creek | $9,595 | $604 |
| FOMO3700 | Monument Creek | 1987* | Middle Tributary | $17,636 | $0 |
| FOMO3800 | Monument Creek | 1987* | Monument Branch | $21,134 | $0 |
| FOMO4000 | Monument Creek | 1996 | Smith Creek | $8,616 | $1,156 |
| FOMO4200 | Monument Creek | 1989* | Black Forest | $21,134 | $575 |
| FOMO5200 | Monument Creek | 1993* | Dirty Woman Creek | $21,134 | $1,156 |
| FOMO5300 | Fountain Creek | 1993* | Crystal Creek | $21,134 | $1,156 |
| ***Miscellaneous Drainage Basins:*** [1] | | | | | |
| CHBS0800 | Chico Creek | | Book Ranch | $19,830 | $2,871 |
| CHEC0400 | Chico Creek | | Upper East Chico | $10,803 | $313 |
| CHWS0200 | Chico Creek | | Telephone Exchange | $11,870 | $278 |
| CHWS0400 | Chico Creek | | Livestock Company | $19,552 | $233 |
| CHWS0600 | Chico Creek | | West Squirrel | $10,192 | $4,229 |
| CHWS0800 | Chico Creek | | Solberg Ranch | $21,134 | $0 |
| FOFO1200 | Fountain Creek | | Crooked Canyon | $6,381 | $0 |
| FOFO1400 | Fountain Creek | | Calhan Reservoir | $5,327 | $310 |
| FOFO1600 | Fountain Creek | | Sand Canyon | $3,849 | $0 |
| FOFO2000 | Fountain Creek | | Jimmy Camp Creek[3] | $21,134 | $989 |
| FOFO2200 | Fountain Creek | | Fort Carson | $16,684 | $604 |
| FOFO2700 | Fountain Creek | | West Little Johnson | $1,392 | $0 |
| FOFO3800 | Fountain Creek | | Stratton | $10,137 | $453 |
| FOFO5000 | Fountain Creek | | Midland | $16,684 | $604 |
| FOFO6000 | Fountain Creek | | Palmer Trail | $16,684 | $604 |
| FOFO6800 | Fountain Creek | | Black Canyon | $16,684 | $604 |
| FOMO4600 | Monument Creek | | Beaver Creek | $12,635 | $0 |
| FOMO3000 | Monument Creek | | Kettle Creek | $11,413 | $0 |
| FOMO3400 | Monument Creek | | Elkhorn | $1,917 | $0 |
| FOMO5000 | Monument Creek | | Monument Rock | $9,160 | $0 |
| FOMO5400 | Monument Creek | | Palmer Lake | $14,647 | $0 |
| FOMO5600 | Monument Creek | | Raspberry Mountain | $4,927 | $0 |
| PLPL0200 | Monument Creek | | Bald Mountain | $10,500 | $0 |
| ***Interim Drainage Basins:*** [2] | | | | | |
| FOFO1800 | Fountain Creek | | Little Fountain Creek | $2,702 | $0 |
| FOMO4400 | Monument Creek | | Jackson Creek | $8,365 | $0 |
| FOMO4800 | Monument Creek | | Teachout Creek | $5,809 | $873 |

1. The miscellaneous drainage fee previous to September 1999 resolution was the average of all drainage fees for basins with Basin Planning Studies performed within the last 14 years.

2. Interim Drainage Fees are based upon draft Drainage Basin Planning Studies or the Drainage Basin Identification and Fee Estimation Report. (Best available information suitable for setting a fee.)

3. This is an interim fee and will be adjusted when a DBPS is completed. In addition to the Drainage Fee a surety in the amount of $7,285 per impervious acre shall be provided to secure payment of additional fees in the event that the DBPS results in a fee greater than the current fee. Fees paid in excess of the future revised fee will be reimbursed. See Resolution 06-326 (9/14/06) and Resolution 16-320 (9/07/16).

EPC Stormwater Management *Jennifer Irvine, P.E.*

depths over the duration of the storm as a fraction of the 1-hour depth and is also shown in Figure 6-19. By applying the 1-hour depths shown in Table 6-2 to the values shown in Table 6-3, a short-duration project design storm can be developed for any return period storm from a 2-year up to 100-year frequency. By applying the appropriate 1-hour depth for other project locations, a project design storm can be created for any location.

**Table 6-3. 2-Hour Design Storm Distribution, ≤ 1 mi$^2$**

| Time (minutes) | Fraction of 1-Hour Rainfall Depth | Time (minutes) | Fraction of 1-Hour Rainfall Depth |
|---|---|---|---|
| 5 | 0.014 | 65 | 1.004 |
| 10 | 0.046 | 70 | 1.018 |
| 15 | 0.079 | 75 | 1.030 |
| 20 | 0.120 | 80 | 1.041 |
| 25 | 0.179 | 85 | 1.052 |
| 30 | 0.258 | 90 | 1.063 |
| 35 | 0.421 | 95 | 1.072 |
| 40 | 0.712 | 100 | 1.082 |
| 45 | 0.824 | 105 | 1.091 |
| 50 | 0.892 | 110 | 1.100 |
| 55 | 0.935 | 115 | 1.109 |
| 60 | 0.972 | 120 | 1.119 |

- **Frontal Storms**: The characteristics of longer-duration "frontal storms" (general) is less well understood than the shorter duration thunderstorms and should be studied further. However, some events of this nature have been observed, such as the April 1999 storm which produced flooding on Fountain Creek, showing that these types of events do occur and tend to produce hazardous flood flows. In addition, modeling of the Jimmy Camp Creek drainage basin using the 24-hour, Type II distribution shows that it produces results reasonably comparably to recorded flow data. Therefore, the NRCS 24-hour Type II distribution has replaced the Type IIa distribution as the standard, long-duration design storm. This distribution can be applied to drainage basins up to 10 square miles without a DARF correction and is shown in Table 6-4. This distribution is included as a standard storm option in the HEC-HMS program.

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

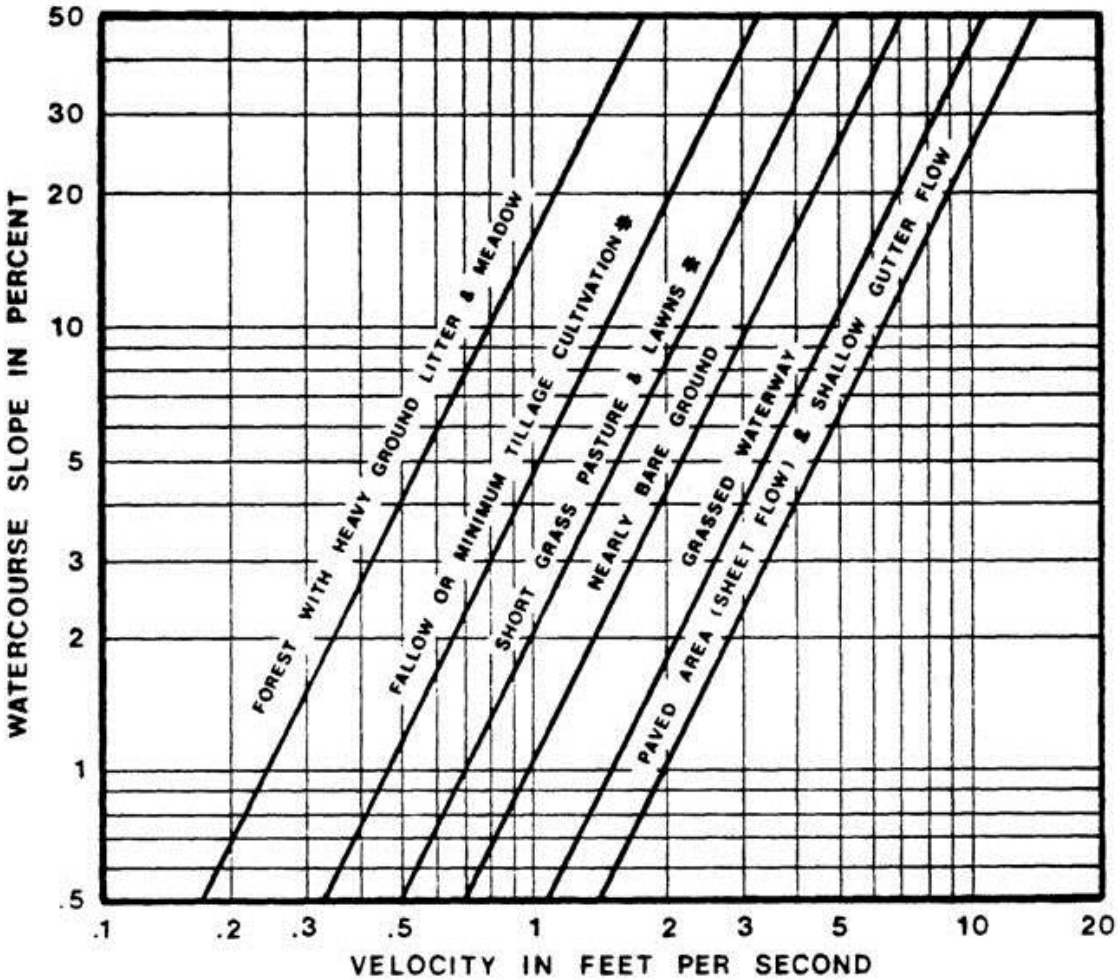
| Land Use or Surface Characteristics | Percent Impervious | Runoff Coefficients | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2-year | | 5-year | | 10-year | | 25-year | | 50-year | | 100-year | |
| | | HSG A&B | HSG C&D | HSG A&B | HSG C&D | HSG A&B | HSG C&D | 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.

**Figure 6-25. Estimate of Average Concentrated Shallow Flow**



# APPENDIX C

## REPORT REFERENCES

*FIRMETTE*

## NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

**Coastal Base Flood Elevations** shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242 or visit its website at http://www.ngs.noaa.gov/.

**Base Map** information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, City of Fountain, Bureau of Land Management, National Oceanic and Atmospheric Administration, United States Geological Survey, and Anderson Consulting Engineers, Inc. These data are current as of 2006.

This map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

**Corporate limits** shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

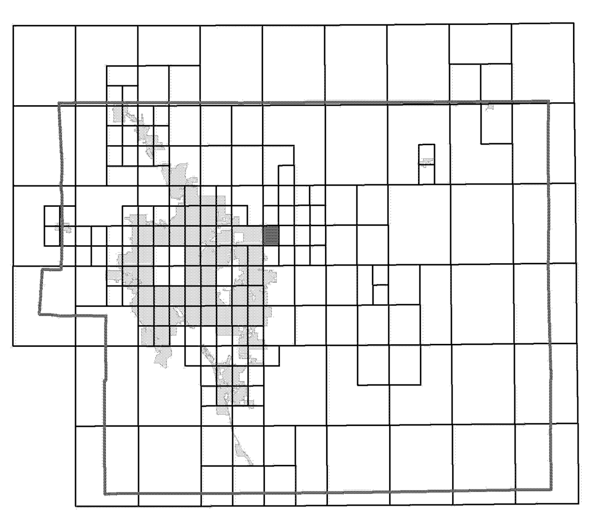
Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

**El Paso County Vertical Datum Offset Table**

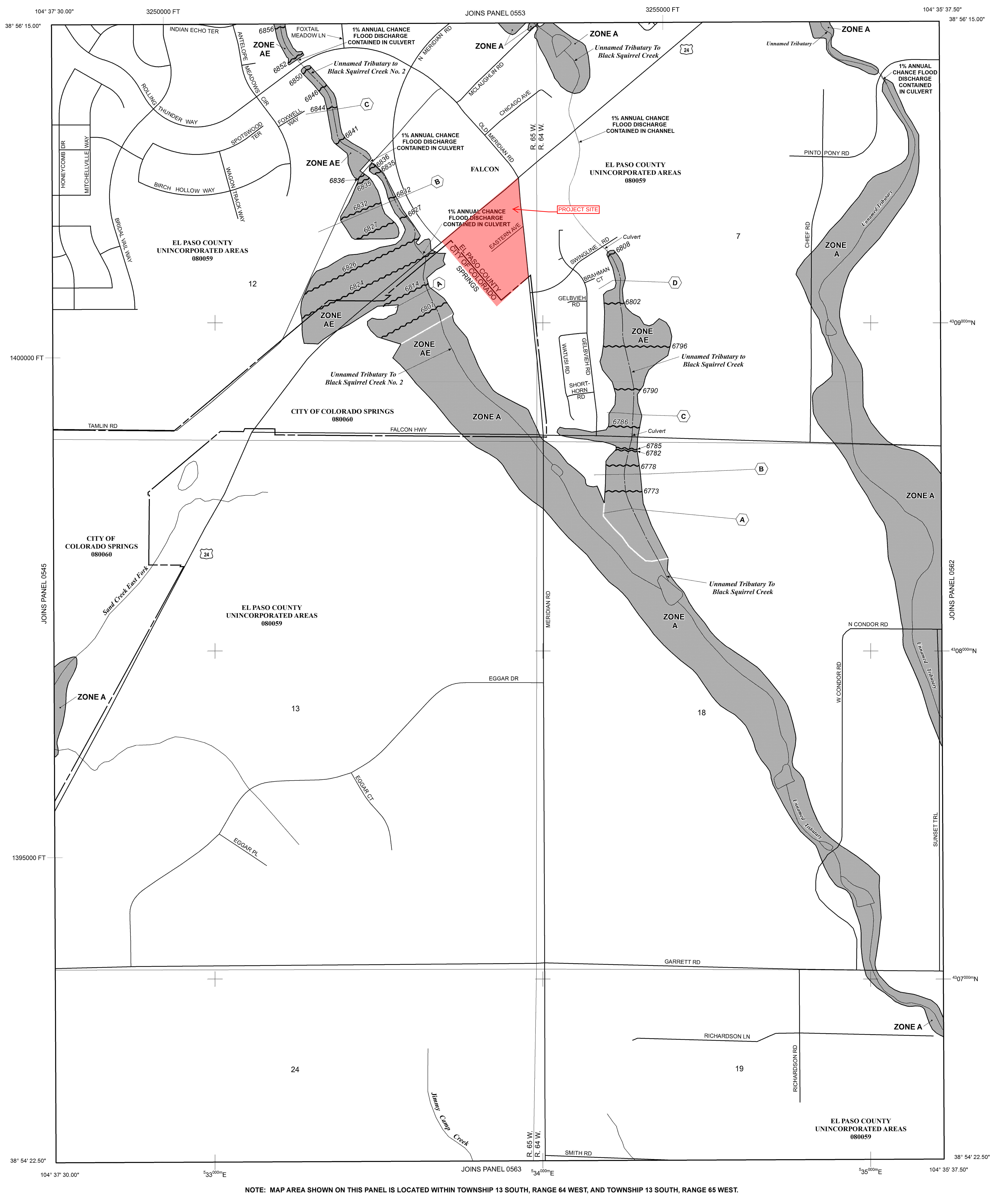
| Flooding Source | Vertical Datum Offset (ft) |
|---|---|
| REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION | |

**Panel Location Map**



This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWCB) and the Federal Emergency Management Agency (FEMA).

Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.




NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 13 SOUTH, RANGE 64 WEST, AND TOWNSHIP 13 SOUTH, RANGE 65 WEST.

## LEGEND

**SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD**

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

| | |
|---|---|
| ZONE A | No Base Flood Elevations determined. |
| ZONE AE | Base Flood Elevations determined. |
| ZONE AH | Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined. |
| ZONE AO | Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined. |
| ZONE AR | Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood. |
| ZONE A99 | Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined. |
| ZONE V | Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined. |
| ZONE VE | Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined. |

**FLOODWAY AREAS IN ZONE AE**

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

**OTHER FLOOD AREAS**

| | |
|---|---|
| ZONE X | Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood. |

**OTHER AREAS**

| | |
|---|---|
| ZONE X | Areas determined to be outside the 0.2% annual chance floodplain. |
| ZONE D | Areas in which flood hazards are undetermined, but possible. |

**COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS**

**OTHERWISE PROTECTED AREAS (OPAs)**

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary
Floodway boundary
Zone D Boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
513 — Base Flood Elevation line and value; elevation in feet*
(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A: Cross section line
23 - - - 23: Transect line
97° 07' 30.00", 32° 22' 30.00": Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000N: 1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 FT: 5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
DX5510: Bench mark (see explanation in Notes to Users section of this FIRM panel)
M1.5: River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
**MARCH 17, 1997**

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
**DECEMBER 7, 2018** - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

For community map revision history prior to countywide mapping, refer to the Community Map History Table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

**MAP SCALE 1" = 500'**

250 0 500 1000 FEET
150 0 150 300 METERS

NATIONAL FLOOD INSURANCE PROGRAM

**PANEL 0561G**

# FIRM
**FLOOD INSURANCE RATE MAP**

**EL PASO COUNTY, COLORADO AND INCORPORATED AREAS**

**PANEL 561 OF 1300**

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| COLORADO SPRINGS, CITY OF | 080060 | 0561 | G |
| EL PASO COUNTY | 080059 | 0561 | G |

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

**MAP NUMBER 08041C0561G**

**MAP REVISED DECEMBER 7, 2018**

**Federal Emergency Management Agency**

# *USDA NRCS WEB SOIL SURVEY REPORT*

# Soil Map


104° 36' 42" W
104° 36' 27" W
38° 56' 1" N
38° 55' 46" N
533680
533730
533780
533830
533880
533930
533980
4309480
4309430
4309380
4309330
4309280
4309230
4309180
4309130
4309080
4309030
24
Meridian Rd
19
9
Soil Map may not be valid at this scale.
Map Scale: 1:2,240 if printed on A portrait (8.5" x 11") sheet.
Meters
0 30 60 120 180
Feet
0 100 200 400 600
N
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 Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

**Special Point Features**

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

**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 18, Jun 5, 2020

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.

# Map Unit Legend

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| 9 | Blakeland-Fluvaquentic Haplaquolls | 4.9 | 40.4% |
| 19 | Columbine gravelly sandy loam, 0 to 3 percent slopes | 7.3 | 59.6% |
| **Totals for Area of Interest** | | **12.2** | **100.0%** |

# Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

# El Paso County Area, Colorado

## 9—Blakeland-Fluvaquentic Haplaquolls

### Map Unit Setting

*National map unit symbol:* 36b6
*Elevation:* 3,500 to 5,800 feet
*Mean annual precipitation:* 13 to 17 inches
*Mean annual air temperature:* 46 to 55 degrees F
*Frost-free period:* 110 to 165 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Blakeland and similar soils:* 60 percent
*Fluvaquentic haplaquolls and similar soils:* 38 percent
*Minor components:* 2 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Blakeland

#### Setting

*Landform:* Hills, flats
*Landform position (three-dimensional):* Side slope, talf
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Sandy alluvium derived from arkose and/or eolian deposits derived from arkose

#### Typical profile

*A - 0 to 11 inches:* loamy sand
*AC - 11 to 27 inches:* loamy sand
*C - 27 to 60 inches:* sand

#### Properties and qualities

*Slope:* 1 to 9 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Somewhat excessively drained
*Runoff class:* Low
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (5.95 to 19.98 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum content:* 5 percent
*Available water capacity:* Low (about 4.5 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 3e
*Land capability classification (nonirrigated):* 6e
*Hydrologic Soil Group:* A
*Ecological site:* R049XB210CO - Sandy Foothill
*Hydric soil rating:* No

### Description of Fluvaquentic Haplaquolls

**Setting**

*Landform:* Swales
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Alluvium

**Typical profile**

*H1 - 0 to 12 inches:* variable

**Properties and qualities**

*Slope:* 1 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Poorly drained
*Runoff class:* Very high
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.20 to 6.00 in/hr)
*Depth to water table:* About 0 to 24 inches
*Frequency of flooding:* Occasional
*Frequency of ponding:* None
*Maximum salinity:* Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)

**Interpretive groups**

*Land capability classification (irrigated):* 6w
*Land capability classification (nonirrigated):* 6w
*Hydrologic Soil Group:* D
*Hydric soil rating:* Yes

### Minor Components

**Other soils**

*Percent of map unit:* 1 percent
*Hydric soil rating:* No

**Pleasant**

*Percent of map unit:* 1 percent
*Landform:* Depressions
*Hydric soil rating:* Yes

## 19—Columbine gravelly sandy loam, 0 to 3 percent slopes

### Map Unit Setting

*National map unit symbol:* 367p
*Elevation:* 6,500 to 7,300 feet
*Mean annual precipitation:* 14 to 16 inches
*Mean annual air temperature:* 46 to 50 degrees F
*Frost-free period:* 125 to 145 days
*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Columbine and similar soils:* 97 percent
*Minor components:* 3 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Columbine**

**Setting**

*Landform:* Fans, flood plains, fan terraces
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Alluvium

**Typical profile**

*A - 0 to 14 inches:* gravelly sandy loam
*C - 14 to 60 inches:* very gravelly loamy sand

**Properties and qualities**

*Slope:* 0 to 3 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Well drained
*Runoff class:* Very low
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (5.95 to 19.98 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water capacity:* Very low (about 2.5 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 4e
*Land capability classification (nonirrigated):* 6e
*Hydrologic Soil Group:* A
*Ecological site:* R049XB215CO - Gravelly Foothill
*Hydric soil rating:* No

**Minor Components**

**Pleasant**

*Percent of map unit:* 1 percent
*Landform:* Depressions
*Hydric soil rating:* Yes

**Other soils**

*Percent of map unit:* 1 percent
*Hydric soil rating:* No

**Fluvaquentic haplaquolls**

*Percent of map unit:* 1 percent
*Landform:* Swales
*Hydric soil rating:* Yes

# Soil Information for All Uses

## Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

## Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

### Hydrologic Soil Group

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.

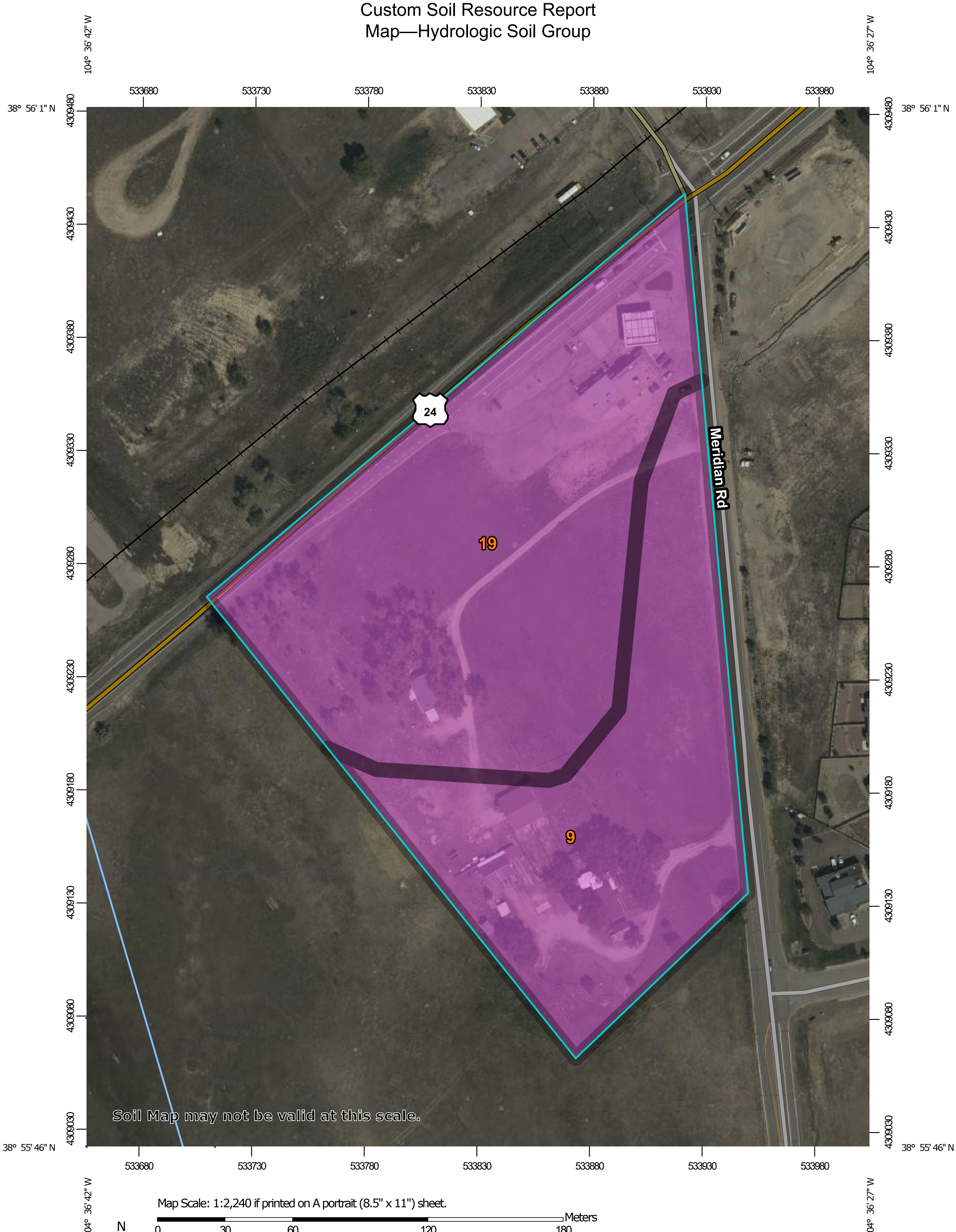
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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.

# Map—Hydrologic Soil Group




Map Scale: 1:2,240 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 30, 60, 120, 180

Feet: 0, 100, 200, 400, 600

N

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 18, Jun 5, 2020

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.

## Table—Hydrologic Soil Group

| Map unit symbol | Map unit name | Rating | Acres in AOI | Percent of AOI |
|---|---|---|---|---|
| 9 | Blakeland-Fluvaquentic Haplaquolls | A | 4.9 | 40.4% |
| 19 | Columbine gravelly sandy loam, 0 to 3 percent slopes | A | 7.3 | 59.6% |
| **Totals for Area of Interest** | | | **12.2** | **100.0%** |

## Rating Options—Hydrologic Soil Group

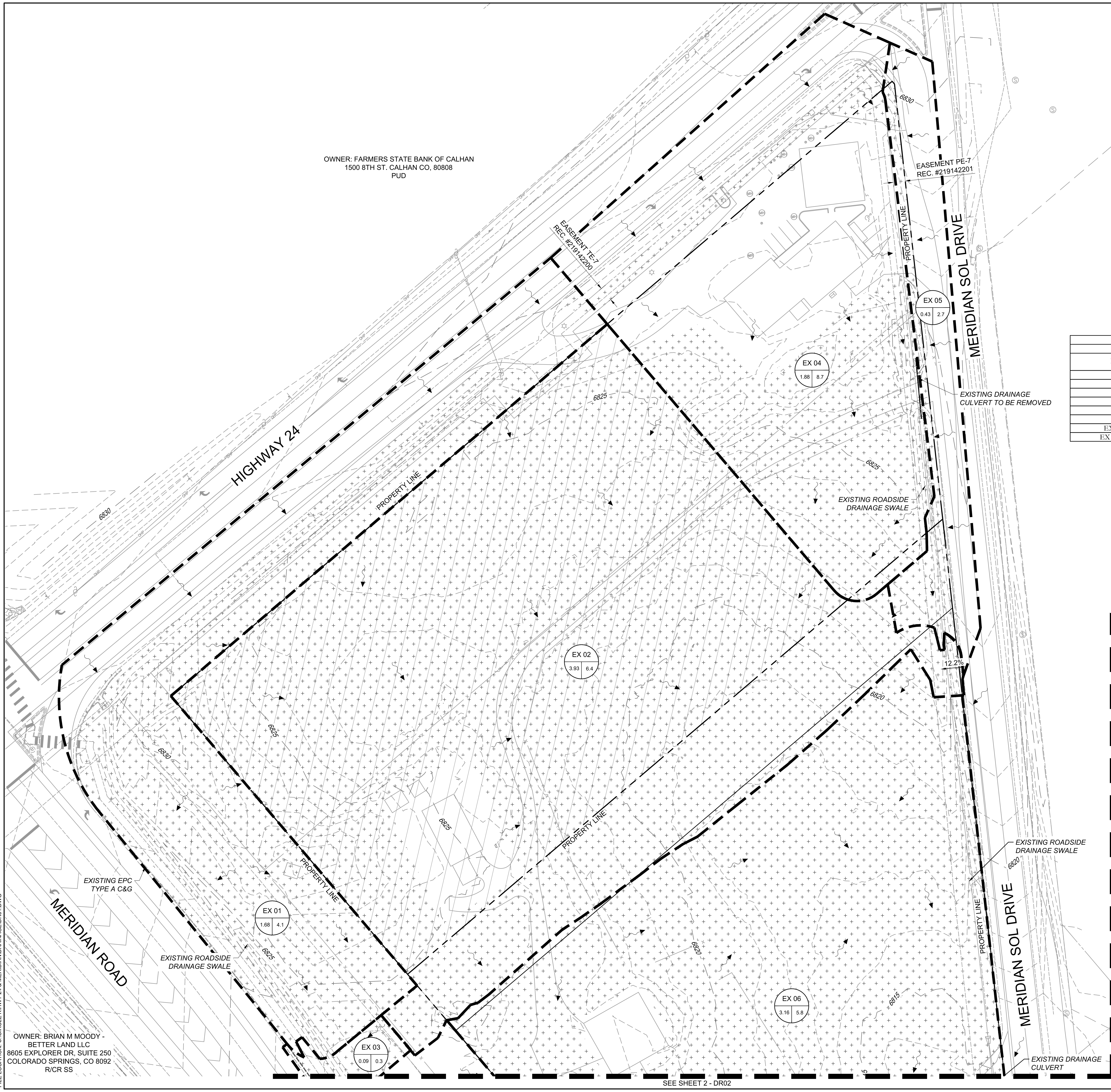
*Aggregation Method:* Dominant Condition

*Component Percent Cutoff: None Specified*

*Tie-break Rule:* Higher

# APPENDIX D

*MAPS*




FILE LOCATION: S:\CIRCLE K\HWY 24 & MERIDIAN\DRAINAGE\DR01.DWG

811 Know what's below. Call before you dig.

## LEGEND

- PROPERTY LINE
- DRAINAGE BASIN BOUNDARY
- FLOW DIRECTION
- PROPOSED SITE
- PERVIOUS AREAS

XXXX — BASIN ID
X.XX — BASIN AREA [AC]
X.X — 100-YR RUNOFF [CFS]

| Circle K - HWY 24 & Meridian<br>Existing Sub Basin Summary | | | | |
|---|---|---|---|---|
| **Design Point** | **Sub-Basins** | **Total Area (ac.)** | **Q(5) (cfs)** | **Q(100) (cfs)** |
| EX 01 | EX 01 | 1.68 | 1.52 | 4.09 |
| EX 02 | EX 02 | 3.93 | 1.29 | 6.40 |
| EX 03 | EX 03 | 0.09 | 0.10 | 0.29 |
| EX 04 | EX 04 | 1.88 | 3.95 | 8.70 |
| EX 05 | EX 05 | 0.43 | 1.34 | 2.69 |
| EX 06 | EX 06 | 3.16 | 1.43 | 5.78 |
| EX SITE NORTH | EX SITE NORTH | 8.01 | 6.14 | 17.89 |
| EX SITE OVERALL | EX SITE OVERALL | 11.18 | 7.46 | 23.31 |

N

GRAPHIC SCALE

40' 0' 40' 80'

( IN FEET )
1 inch = 40 ft.

SEE SHEET 2 - DR02

CONSULTANTS:

Matrix
Excellence by Design
2435 RESEARCH PARKWAY, SUITE 300 COLORADO SPRINGS, CO 80920
PHONE: (719) 575-0100

LAND DEVELOPMENT CONSULTANTS, LLC
950 S. CHERRY ST., SUITE 512
DENVER, CO 80246

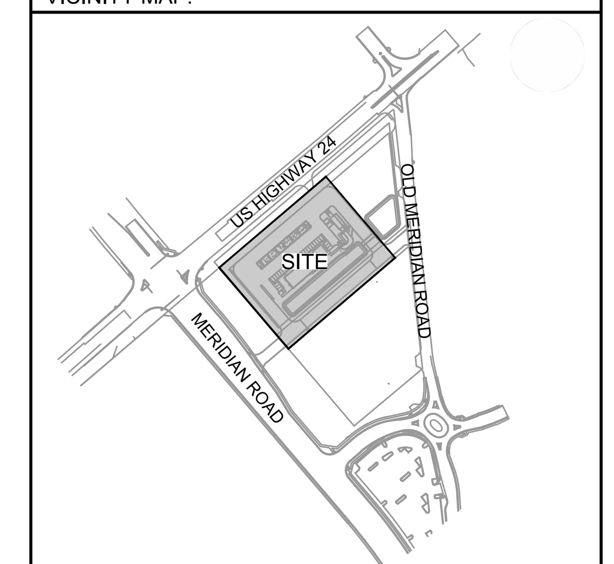
OWNER/DEVELOPER:

CIRCLE K
ROCKY MOUNTAINS DIVISION
5500 S QUEBEC STREET, SUITE 100
GREENWOOD VILLAGE, CO 80111
PHONE: (720) 758-6223

SEAL

FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC

VICINITY MAP:




PROJECT:

CIRCLE K STORES INC.

FINAL PLAT - OFFSITE PDR

HIGHWAY 24 & MERIDIAN ROAD
FALCON, CO

REVISION HISTORY:

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

DRAWING INFORMATION:

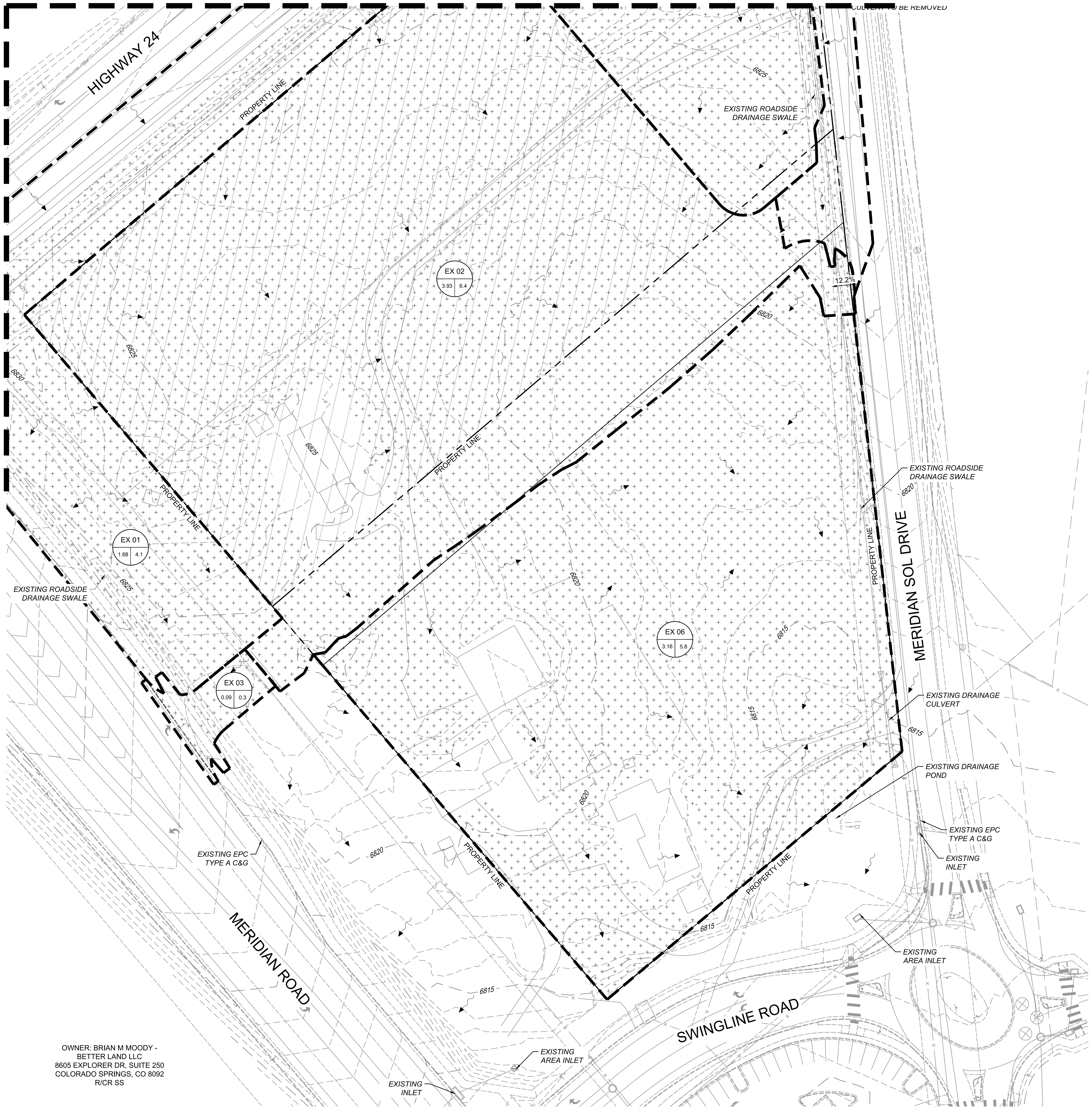
PROJECT NO: 21.1207.037
DRAWN BY: LCB
CHECKED BY: NMS
DESIGNED BY: NMS

SHEET TITLE:

# EXISTING DRAINAGE MAP

SHEET 1 OF 4
DR01

ISSUE DATE: NOVEMBER 2022




OWNER: BRIAN M MOODY -
BETTER LAND LLC
8605 EXPLORER DR, SUITE 250
COLORADO SPRINGS, CO 8092
R/CR SS

FILE LOCATION: S:\CIRCLE K\HWY 24 & MERIDIAN\DRAINAGE\DR01.DWG

Know what's **below**. **Call** before you dig.

## LEGEND

- PROPERTY LINE
- DRAINAGE BASIN BOUNDARY
- FLOW DIRECTION
- PROPOSED SITE
- PERVIOUS AREAS

XXXX — BASIN ID
X.XX — BASIN AREA [AC]
X.X — 100-YR RUNOFF [CFS]

| Circle K - HWY 24 & Meridian<br>Existing Sub Basin Summary | | | | |
|---|---|---|---|---|
| **Design Point** | **Sub-Basins** | **Total Area (ac.)** | **Q(5) (cfs)** | **Q(100) (cfs)** |
| EX 01 | EX 01 | 1.68 | 1.52 | 4.09 |
| EX 02 | EX 02 | 3.93 | 1.29 | 6.40 |
| EX 03 | EX 03 | 0.09 | 0.10 | 0.29 |
| EX 04 | EX 04 | 1.88 | 3.95 | 8.70 |
| EX 05 | EX 05 | 0.43 | 1.34 | 2.69 |
| EX 06 | EX 06 | 3.16 | 1.43 | 5.78 |
| EX SITE NORTH | EX SITE NORTH | 8.01 | 6.14 | 17.89 |
| EX SITE OVERALL | EX SITE OVERALL | 11.18 | 7.46 | 23.31 |

N

GRAPHIC SCALE
40' 0' 40' 80'
( IN FEET )
1 inch = 40 ft.

CONSULTANTS:

Matrix
Excellence by Design
2435 RESEARCH PARKWAY, SUITE 300 COLORADO SPRINGS, CO 80920
PHONE: (719) 575-0100

LAND DEVELOPMENT CONSULTANTS, LLC
950 S. CHERRY ST., SUITE 512
DENVER, CO 80246

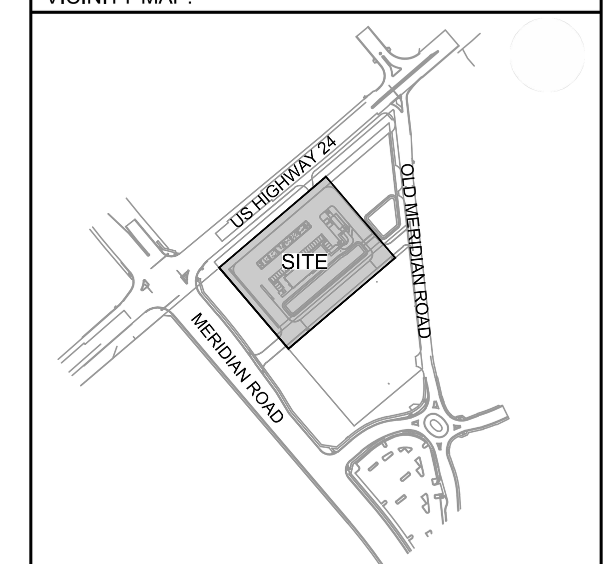
OWNER/DEVELOPER:

CIRCLE K
ROCKY MOUNTAINS DIVISION
5500 S QUEBEC STREET, SUITE 100
GREENWOOD VILLAGE, CO 80111
PHONE: (720) 758-6223

SEAL

FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC

VICINITY MAP:




PROJECT:

CIRCLE K STORES INC.

FINAL PLAT - OFFSITE PDR

HIGHWAY 24 & MERIDIAN ROAD
FALCON, CO

REVISION HISTORY:

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

DRAWING INFORMATION:

PROJECT NO: 21.1207.037
DRAWN BY: LCB
CHECKED BY: NMS
DESIGNED BY: NMS

SHEET TITLE:

# EXISTING DRAINAGE MAP



ISSUE DATE: NOVEMBER 2022


FILE LOCATION: S:\CIRCLE K\HWY 24 & MERIDIAN\DRAINAGE\DR01.DWG

## LEGEND

- PROPERTY LINE
- PERVIOUS AREAS
- DRAINAGE BASIN BOUNDARY
- PROPOSED SITE TREATED BY DETENTION POND
- FLOW DIRECTION
- DESIGN POINT
- BASIN ID
- BASIN AREA [AC]
- 100-YR RUNOFF [CFS]

811 Know what's below. Call before you dig.

## DRAINAGE NOTES

1. ALL STORM SEWER, STORM STRUCTURES, AND DRAINAGE INFRASTRUCTURE INCLUDED CURB CUTS, RIP RAP PADS, SWALES AND FLUMES TO BE PRIVATE UNLESS OTHERWISE NOTED.

**Circle K - HWY 24 & Meridian**
**Proposed Design Point Summary**

| Design Point | Sub-Basins | Total Area (ac.) | Q(5) (cfs) | Q(100) (cfs) |
|---|---|---|---|---|
| DP A | Inlet at lowpoint of access road | 1.00 | 3.27 | 6.22 |
| DP A Inlet Flow | Inlet at lowpoint of access road, combined flow from DP B | 2.62 | 7.65 | 14.69 |
| DP B | Inlet at NW Corner of Pond, Sub Basin B | 0.77 | 2.16 | 4.27 |
| DP B Inlet Flow | Inlet at NW corner of Pond, B, C, D & G | 1.62 | 4.65 | 9.00 |
| DP C | Area inlets in middle of front parking | 0.33 | 1.09 | 2.08 |
| DP C Inlet Flow | Area inlets in middle of front parking, combined flow from DP D | 0.70 | 2.07 | 4.01 |
| DP D | Area inlets in eastern part of front parking | 0.36 | 1.05 | 2.06 |
| DP E | Car wash entrance flume, E & F | 0.25 | 0.71 | 1.39 |
| DP F | Car Wash Roof Drain | 0.03 | 0.16 | 0.28 |
| DP G | Fuel Canopy Roof Drainage | 0.14 | 0.67 | 1.20 |
| DP H | C-Store Roof Drain | 0.12 | 0.55 | 0.99 |
| DP J1 | Detention pond area | 0.73 | 0.32 | 1.54 |
| DP J2 | Sub-basins A, B, E, G & H1 | 3.72 | 7.52 | 15.38 |
| DP J3 | Pond Outlet Structure | 3.72 | 0.10 | 3.40 |
| DP K | Undeveloped land to NE | 1.88 | 2.12 | 5.43 |
| DP L | Offsite drainage to west of site | 1.68 | 0.91 | 2.87 |
| DP M | Offsite street drainage for West entrance | 0.09 | 0.43 | 0.77 |
| DP N | Offsite street drainage for East entrance, west part of Meridian Sol | 0.43 | 1.99 | 3.57 |
| DP P | Offsite drainage to the south of the Access road, offsite culvert outlets | 0.23 | 0.10 | 0.66 |
| DP Q1 | South Lot Drainage | 3.22 | 0.74 | 4.96 |
| DP Q2 | Combined flows into South Area J3, P, N, Q1 | 7.61 | 15.37 | 38.42 |
| DP Q3 | South Pond Outflow (Q1) | 3.22 | 0.10 | 1.40 |
| DP SITE | North and South Overall Drainage | 11.26 | 5.32 | 17.33 |

Circle K - HWY 24 & Meridian
Proposed Conditions
Sub-basin Summary

| Basin | Area | Q5 | Q100 |
|---|---|---|---|
| | acres | cfs | cfs |
| A | 1.00 | 3.3 | 6.2 |
| B | 0.77 | 2.2 | 4.3 |
| C | 0.33 | 1.1 | 2.1 |
| D | 0.36 | 1.0 | 2.1 |
| E | 0.22 | 0.7 | 1.4 |
| F | 0.03 | 0.2 | 0.3 |
| G | 0.14 | 0.7 | 1.2 |
| H | 0.12 | 0.6 | 1.0 |
| J | 0.73 | 0.3 | 1.5 |
| K | 1.88 | 2.1 | 5.4 |
| L | 1.68 | 0.9 | 2.9 |
| M | 0.09 | 0.4 | 0.8 |
| N | 0.43 | 2.0 | 3.6 |
| P | 0.23 | 0.1 | 0.7 |
| Q | 3.22 | 0.7 | 5.0 |

N

GRAPHIC SCALE
40' 0' 40' 80'
( IN FEET )
1 inch = 40 ft.

CONSULTANTS:
Matrix
Excellence by Design
2435 RESEARCH PARKWAY, SUITE 300 COLORADO SPRINGS, CO 80920
PHONE: (719) 575-0100

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DENVER, CO 80246

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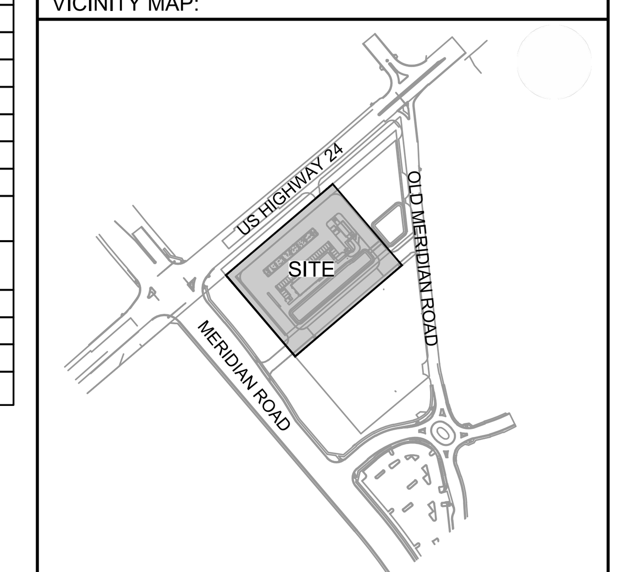
GREENWOOD VILLAGE, CO 80111
PHONE: (720) 758-6223

SEAL

FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC

VICINITY MAP:




PROJECT:
CIRCLE K STORES INC.

FINAL PLAT - OFFSITE PDR

HIGHWAY 24 & MERIDIAN ROAD
FALCON, CO

REVISION HISTORY:

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

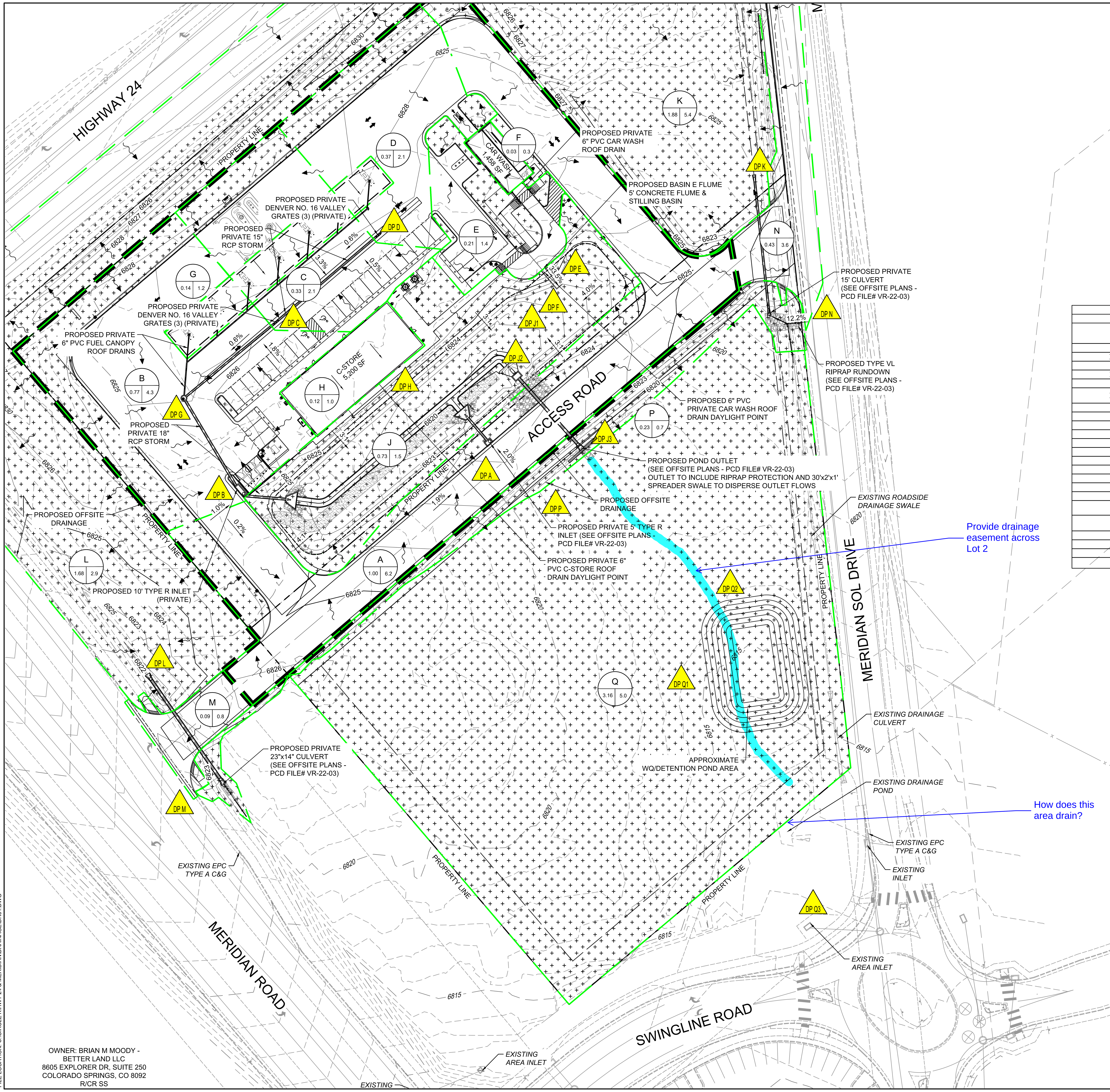
DRAWING INFORMATION:
PROJECT NO: 21.1207.037
DRAWN BY: LCB
CHECKED BY: NMS
DESIGNED BY: NMS

SHEET TITLE:

# PROPOSED DRAINAGE MAP

SHEET 3 OF 4
DR03

ISSUE DATE: NOVEMBER 2022




FILE LOCATION: S:\CIRCLE K\HWY 24 & MERIDIAN\DRAINAGE\DR01.DWG

## LEGEND

- PROPERTY LINE
- PERVIOUS AREAS
- DRAINAGE BASIN BOUNDARY
- PROPOSED SITE TREATED BY DETENTION POND
- FLOW DIRECTION
- DESIGN POINT
- BASIN ID / BASIN AREA [AC] / 100-YR RUNOFF [CFS]

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## DRAINAGE NOTES

1. ALL STORM SEWER, STORM STRUCTURES, AND DRAINAGE INFRASTRUCTURE INCLUDED CURB CUTS, RIP RAP PADS, SWALES AND FLUMES TO BE PRIVATE UNLESS OTHERWISE NOTED.

**Circle K - HWY 24 & Meridian**
**Proposed Design Point Summary**

| Design Point | Sub-Basins | Total Area (ac.) | Q(5) (cfs) | Q(100) (cfs) |
|---|---|---|---|---|
| DP A | Inlet at lowpoint of access road | 1.00 | 3.27 | 6.22 |
| DP A Inlet Flow | Inlet at lowpoint of access road, combined flow from DP B | 2.62 | 7.65 | 14.69 |
| DP B | Inlet at NW Corner of Pond, Sub Basin B | 0.77 | 2.16 | 4.27 |
| DP B Inlet Flow | Inlet at NW corner of Pond, B, C, D & G | 1.62 | 4.65 | 9.00 |
| DP C | Area inlets in middle of front parking | 0.33 | 1.09 | 2.08 |
| DP C Inlet Flow | Area inlets in middle of front parking, combined flow from DP D | 0.70 | 2.07 | 4.01 |
| DP D | Area inlets in eastern part of front parking | 0.36 | 1.05 | 2.06 |
| DP E | Car wash entrance flume, E & F | 0.25 | 0.71 | 1.39 |
| DP F | Car Wash Roof Drain | 0.03 | 0.16 | 0.28 |
| DP G | Fuel Canopy Roof Drainage | 0.14 | 0.67 | 1.20 |
| DP H | C-Store Roof Drain | 0.12 | 0.55 | 0.99 |
| DP J1 | Detention pond area | 0.73 | 0.32 | 1.54 |
| DP J2 | Sub-basins A, B, E, G & H1 | 3.72 | 7.52 | 15.38 |
| DP J3 | Pond Outlet Structure | 3.72 | 0.10 | 3.40 |
| DP K | Undeveloped land to NE | 1.88 | 2.12 | 5.43 |
| DP L | Offsite drainage to west of site | 1.68 | 0.91 | 2.87 |
| DP M | Offsite street drainage for West entrance | 0.09 | 0.43 | 0.77 |
| DP N | Offsite street drainage for East entrance, west part of Meridian Sol | 0.43 | 1.99 | 3.57 |
| DP P | Offsite drainage to the south of the Access road, offsite culvert outlets | 0.23 | 0.10 | 0.66 |
| DP Q1 | South Lot Drainage | 3.22 | 0.74 | 4.96 |
| DP Q2 | Combined flows into South Area J3, P, N, Q1 | 7.61 | 15.37 | 38.42 |
| DP Q3 | South Pond Outflow (Q1) | 3.22 | 0.10 | 1.40 |
| DP SITE | North and South Overall Drainage | 11.26 | 5.32 | 17.33 |

Circle K - HWY 24 & Meridian
Proposed Conditions
Sub-basin Summary

| Basin | Area | Q5 | Q100 |
|---|---|---|---|
| | acres | cfs | cfs |
| A | 1.00 | 3.3 | 6.2 |
| B | 0.77 | 2.2 | 4.3 |
| C | 0.33 | 1.1 | 2.1 |
| D | 0.36 | 1.0 | 2.1 |
| E | 0.22 | 0.7 | 1.4 |
| F | 0.03 | 0.2 | 0.3 |
| G | 0.14 | 0.7 | 1.2 |
| H | 0.12 | 0.6 | 1.0 |
| J | 0.73 | 0.3 | 1.5 |
| K | 1.88 | 2.1 | 5.4 |
| L | 1.68 | 0.9 | 2.9 |
| M | 0.09 | 0.4 | 0.8 |
| N | 0.43 | 2.0 | 3.6 |
| P | 0.23 | 0.1 | 0.7 |
| Q | 3.22 | 0.7 | 5.0 |

N

GRAPHIC SCALE
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( IN FEET )
1 inch = 40 ft.

CONSULTANTS:
Matrix
Excellence by Design
2435 RESEARCH PARKWAY, SUITE 300 COLORADO SPRINGS, CO 80920
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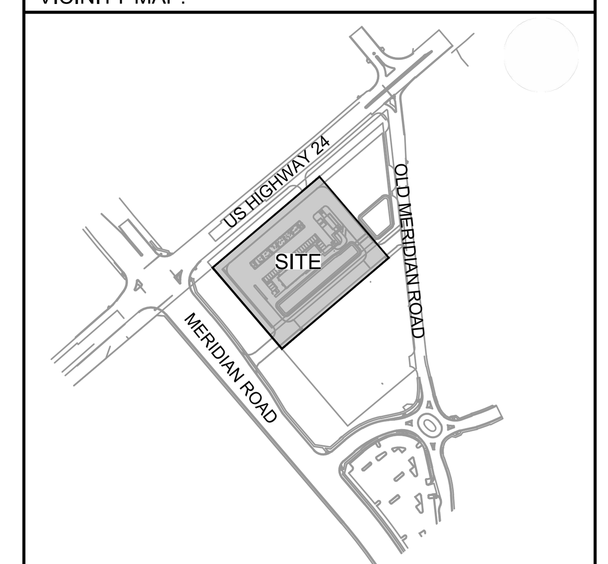
SEAL

FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC

VICINITY MAP:




PROJECT:
CIRCLE K STORES INC.
FINAL PLAT - OFFSITE PDR
HIGHWAY 24 & MERIDIAN ROAD
FALCON, CO

REVISION HISTORY:

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

DRAWING INFORMATION:
PROJECT NO: 21.1207.037
DRAWN BY: LCB
CHECKED BY: NMS
DESIGNED BY: NMS

SHEET TITLE:
# PROPOSED DRAINAGE MAP



ISSUE DATE: NOVEMBER 2022