Deviation request to access Mesa Ridge Parkway is under consideration and will have a determination from the ECM Administrator by 10/26/2020.

MVE, INC.
ENGINEERS SURVEYORS
1903 lelaray street, suite 200
colorado springs, co 80909
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Final Drainage Report

Security Fire Station No. 4

Project No. 61134

September, 2020

PCD File No. PPR 2029

Final Drainage Report

for

Security Fire Station No. 4

Project No. 61134

September, 2020

prepared for

Security Fire Department
400 Security Boulevard
Security, CO 80911
719.392.3271

prepared by

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Colorado Springs, CO 80909
719.635.5736

61134-Security Fire Station 4-FDR.odt

Please provide page numbers in table of contents.

TABLE OF CONTENTS

APPENDIX

Certifications and Approvals

Engineer's Statement
The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report had been prepared according to the criteria established by El Paso County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omission on my part in preparation this report

Signature ______________________________ Seal
(Kenneth C. Harrison, P.E.)

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

____
(Business Name)

By: ____
(Signature) (Date)

Print Name and Title ____

Address: ____

El Paso County Engineer/ECM Administrator

El Paso County
Filed in accordance with ________ of the code of the El Paso County, dated ____ as amended.

For El Paso County Engineer

____
(Signature) *(Date)*

____
(Print name)

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

Flood Plain Statement

See Section V of this report

Jennifer Irvine, P.E.

I. Report Purpose

a. The purpose of this report is to evaluate the existing and developed drainage characteristics for the Security Fire Station #4 project site. This will include:

- The evaluation of offsite conditions both upstream and downstream of the project site.
- A description of the existing offsite and onsite drainage improvements.
- Recommendations regarding onsite drainage improvements.
- Evaluation of the capacity of offsite drainage improvements.
- Recommendations regarding detention and storm water quality.
- General recommendations regarding erosion control.

Please include the city, county, township, range, section, and 1/4 section.

II. General Description

The project site is a portion of an unplatted parcel located in the northeasterly corner of the Wayfarer Drive/ Mesa Ridge Parkway intersection.

Please include major drainage ways and existing facilities.

The project site is a 1.21-acre tract located approximately in the cente unplatted parcel. The northeasterly corner of the project site is locate approximately 650 feet west of the Wayfarer Drive/ Mesa Ridge Park intersection. The project site extends across the unplatted parcel from Drive to Mesa Ridge Parkway. Access to the site will be from both Wa Drive and Mesa Ridge Parkway. The subdivision that are located nea site included The Glen at Widefield Subdivision #2, The Glen at Wide Subdivision Filing No. 4 and The Glen at Widefield Subdivision Filing (*Appendix Exhibit 4*).

Please include a general description of the property to include: existing vegetation, general topography, general soil conditions, major drainage ways, irrigations facilities, and utilities and other encumbrances.

III. Design Criteria and Methodology

a. **Design Manuals**

Applicable excerpts from the following manuals are included in the Appendix of this report (*Exhibit 4, Appendix*)

- El Paso County Drainage Criteria Manual (EPCDCM), dated September 30, 1990, Revised July, 2019
- Colorado Springs Drainage Criteria Manuals, Volume 1 and 2, dated May, 2014
- Urban Drainage and Flood Control Manual, Volumes 2 and 3, dated August 2018
- CDOT Erosion Control Field Handbook, dated April 20, 2017

b. **Specific Criteria**

- Design storms

  The majority of the facilities are designed to accommodate the runoff from the 100-year storm event. This is necessary in order to facilitate the capture of the runoff from the 100-year storm event in the detention/ water quality pond.

The design storms are as follows:
Minor storm: 5 year
Major storm: 100 year

- Drainage Areas
  Areas for the offsite and onsite sub basins were estimated from available topographic mapping.

- Runoff Estimation
  Rational Method: This method was used to determine runoff estimates since the project site area is less than 130 acres (per criteria).

  Intensity-Duration-Frequency (IDF) curves were obtained from the CSDCM *(Appendix, Exhibit 5)*

- Onsite Storm Sewer and Inlets
  There are no existing storm sewer facilities located on the project site. All onsite storm sewer facilities will be privately owned and maintained. They will include pipes, inlets, cleanouts, flared end sections, concrete chases, etc.

c. Drainage swale and borrow ditch sizing

Offsite swales are evaluated with runoff from both the minor 5-year storm and the major 100-year storm events. All of the swales are located offsite south of the project site. These swales were constructed with the construction of Mesa Ridge Parkway and Powers Boulevard. Since runoff from the project does not have any impact on the existing swales, the swales were only evaluated for information purposes only. No improvements are proposed to these swales.

d. Culvert

- Headwater to Depth Ratio = 1.5 for the 5-year storm
- One lane open for the 100-year storm. Since this criteria typically produces substantial erosion at the outlet the allowable velocity in the culvert was limited to no greater than 10 fps.
- Riprap Erosion Control at the outlet
- Flared End Sections at both the entrance and the outlet to the culvert.

e. Detention/ Water Quality Pond

- Design Criteria: Urban Drainage Flood Control Manual (UDFCM)
- Type: Sand Filter Basin

f. Erosion control

The following facilities are anticipated to be required:

- Erosion Control Blankets
- Riprap aprons
- Silt fences
- Staked hay bales
- Erosion control fabric
- Erosion control logs

The locations of the above facilities will be shown on a Grading and Erosion Control Plan which is to be prepared for the Storm Water Management Permit Application and submitted under separate cover.

IV. EXISTING REPORTS, MAPPING AND INFORMATION

a. Mesa Ridge Phase 1 and 2 (*excerpts included in Exhibit4, Appendix)*

A portion of the Mesa Ridge Parkway Phases 1 and 2 is located along the south side of the project site.

Runoff from the Parkway sheet flows into the borrow ditch located along the north side of the highway. This borrow ditch only accommodates runoff from the north half of the Mesa Ridge Parkway right-of-way. A high point in the borrow ditch is located approximately 1000 feet east of the project site. At this point the flow is routed either east or west in the borrow ditch. The water flows in a westerly direction to a concrete channel and then eventually to a concrete box culvert located under Powers Boulevard. The location of these facilities are not shown either of the Drainage Maps.

The fire station proposes to construct an access to the building off of Mesa Ridge Parkway. The borrow ditch was evaluated in order to size the proposed culvert under the proposed driveway.

b. The Glen at Widefield Subdivision No. 4

The Glen at Widefield Subdivision No. 4 is located along the northerly side of Wayfarer Drive. The drainage plan shows all of the runoff from the minor storm event remains in the street and flows to the east to outfall into Mesa Ridge Parkway *(Exhibit 4, Appendix*). The stormwater does not outfall onto either the site or the unplatted parcel located along the east and the west sides of the project site. Analysis of the 100-year event in Wayfarer Drive is beyond the scope of this report.

c. **The Glen at Widefield Subdivision No. 2** The Glen at Widefield Subdivision No. 2 is located on the north and east side of the unplatted tract that is one either side of the project site. The drainage map indicates that no storm water runoff enters the project site but is directed to a detention pond located on the unplatted parcel immediately south of The Glen at Widefield Subdivision No. 2.

Please provide the date.

V. FEMA FLOODPLAIN

The project site is located in FEMA map # 08041CO956G (*Appendix, Exhibit 2).* The entire site is located outside the 100-year floodplain in Zone X which is an "Area of Minimal Disturbance" for which there are no special requirements for the construction of commercial or industrial structures.

VI. HYDROLOGIC SOILS INFORMATION

The hydrologic soils groups were obtained from the USDA National Resource Conservation Service website for soils types in El Paso County, Colorado (*Appendix, Exhibit 3*). The soils are identified as follows:

a. **Nelson-Tassel sandy loams** which have the following characteristics:
   - Well drained
   - Frequency of flooding: none
   - Frequency of ponding: none
   - Hydrologic Soil Group: B

b. **Stoneham Sandy Loams** which have the following characteristics:
   - Well drained
   - Frequency of flooding: none
   - Frequency of ponding: none
   - Hydrologic Soil Group: B

   - A detailed description of each of the type soil is included in Appendix Exhibit 3.

VII. EXISTING DRAINAGE CONDITIONS

ECM requires the design to be analyzed to the next suitable outfall. Please provide a narrative to include this.

a. **General Description**

All undeveloped runoff from Sub basins OS1, OS4, OS3, and onsite Sub basin A is collected by two (2) swales that route water in a westerly direction. Both swales are located along the northerly right-of-way for Mesa Ridge Parkway. Swale 1 is located south and inside the right-of-way. Swale 2 is located north and outside the right-of-way. The most northerly swale collects runoff from the Sub basins OS1, Sub basin A, OS3. The most southerly swale collects runoff from only the northerly ½ of the right of way of Mesa Ridge Parkway and routes it in a westerly direction.. Both swales intersect west of the site and enter a concrete channel which outfalls into a concrete box culvert under Powers Boulevard at DP5. This location is not indicate the size of the existing box culvert.

shown on the Existing Conditions Drainage Map. The water eventually passes under Powers Boulevard via a concrete box culvert at approximately 700 feet north of the Mesa Parkway intersection.

Hydraulic analysis and evaluation of all offsite drainage facilities is beyond the scope of this report. Hydraulic analysis of the swales was accomplished for only the immediate swale sections impacted by the installation of the two (2) culverts under the proposed driveway to the fire station building.

b. **Design Point 1, Runoff from OS1**
Undeveloped storm water runoff from OS1 (2.08 acres) sheet flows in a southerly direction to Swale 2 located north of the northerly right-of-way line for Mesa Ridge Parkway. The swale routes the water in a westerly direction to where it intersects with Swale1 located to the south of the northerly right-of-way line for Mesa Ridge Parkway. From here the combined swales are directed in a westerly direction to a concrete channel and a concrete box culvert under Powers Boulevard (DP5). The existing hydraulic characteristics of the swales will be maintained upon site development. Upon development a concrete culvert will be installed under the driveway to the fire station building approximately 15 feet west of DP1.

The hydrologic characteristics of the runoff from OS1 at DP1 for **both** the existing and developed conditions are as follows:

- Drainage Area = 2.08 acres
- Runoff Coefficients: 5 year = 0.09, 100 year = 0.36
- Time of Concentration: 17.0 minutes
- Runoff: 5 year = 0.4 cfs, 100 year = 2.4 cfs

c. **Design Point 2, Runoff from OS4**
Sub basin OS4 (1.0. acres) is comprised of the area north of the northerly right-of-way for Mesa Ridge Parkway and east of the project site. The sub basin is limited to the northerly portion of the Mesa Ridge Parkway right-of-way. Undeveloped runoff from OS4 is collected by Swale 1 and is routed in a westerly direction. This swale was designed and constructed to carry only the runoff from the right-of-way. Undeveloped runoff from adjacent property to the north does not enter the swale. The water in Swale 1 is routed in a westerly direction and joins Swale 2 located north of the northerly right-of-way line of Mesa Ridge Parkway. This location is not shown on the Existing Conditions Drainage Map. The water in the combined swales outfalls into an existing concrete channel and then is routed to an existing concrete box culvert under Powers Boulevard (DP5) This location is also not shown on the Existing Conditions Drainage Map.

As part of the site development, a concrete culvert is proposed located approximately 15 feet west of DP2 under the driveway that enters the fire station site. The culvert was sized based on the following hydrologic information. These conditions are for **both** the existing and developed conditions.

- Drainage Area = 1.0 acres
- Runoff Coefficients: 5 year = 0.09, 100 year = 0.36
- Time of Concentration: 17.0 minutes
- Rainfall intensity: 5 year = 3.3, 100 year = 5.6
- Runoff: 5 year = 0.4 cfs, 100 year = 2.4 cfs

d. **Design Point 3, Runoff from Sub basin A**
Sub basin A (1.21 acres) is comprised of the undeveloped area occupied by the project site. The water sheet flows in a southerly direction to Swale #2. Swale 2 routes the water in a westerly direction along the south side of Sub basin OS3. The purpose for evaluating this sub basin is to arrive at a design discharge for the existing undeveloped conditions.

- Drainage Area = 1.21 acres
- Runoff Coefficients: 5 year = 0.25, 100 year =0.48
- Time of Concentration: 17.0 minutes (Tc for OS1 controls)
- Rainfall intensity: 5 year = 3.3, 100 year = 5.6
- Runoff: 5 year = 0.5 cfs, 100 year = 4.2 cfs

e. **Design Point 4, Runoff from OS2**
Undeveloped storm water runoff from the north (OS2) is routed in an easterly direction in the southerly curb and gutter section along Wayfarer Drive. The water enters the Mesa Ridge Parkway intersection located approximately 650 feet east of the project site. Upon development, water from Wayfarer Drive will be prevented from entering the project site with the installation of a concrete pan and a high point constructed in the proposed driveway just south of the intersection with Wayfarer Drive.

f. **Design Point 5, Runoff from OS3**
Undeveloped runoff from the unplatted area (OS3) to the west of the site sheet flows in a southerly direction to a swale located north of the northerly right-of-way line for Mesa Ridge Parkway. The runoff combines with runoff from the easterly unplatted parcel (OS1) in Swale 2 and the undeveloped project area (Sub basin A) and is routed west in Swale #2.

a concrete pan is not indicated on the site plan or GEC plan. See comments provided on the GEC plan regarding the driveways and revise accordingly.

Please identify detention discharge and storage calculation method and Note ECM Appendix I Full Spectrum Detention (FSD) requirement.

- Please reference all criteria, master plans, and technical information used for report preparation and design.
- Please include discussion of previous drainage studies that influence or are influenced by the drainage design and how the studies affect drainage design for the site.
- Please state conformance with all previous studies.

VIII. DEVELOPED ONSITE DRAINAG

Criteria Summary

The hydrologic and hydraulic characteristics of the site and the proposed drainage improvements were evaluated in the following manner:

1. Design points (DP) were located where runoff data was required to size drainage improvements and/or locations where descriptions of drainage characteristics were necessary.
2. Areas were determined for the total area that contributes runoff to each design point.
3. Runoff coefficients and times of concentration were selected based on proposed land use. A minimum time of concentration of 5 minutes was selected in conformance with the El Paso County Drainage Criteria.
4. Estimation of the amounts of water at each Design Point was determined using the Rational Method.
5. The routing of the runoff from the 100-year storm event was discussed. The facilities were designed to intercept 100% of the runoff from the 100-year storm and discharge it into the proposed private full spectrum detention (FSD) pond.
6. The inlets were sized to intercept 80% to 90% of the surface runoff. Any bypass will be intercepted by downstream inlets and/or concrete chases. In order to be conservative, the pipes were sized for 100% of the 100-year runoff.
7. The inlets that are proposed are manufactured by Nyoplast. Examples of these units are included in *Exhibit 5, Appendix*.

Sub basin Summaries

a. **Design Point 1**

- Contributing Sub basin Description
  DP 1 collects runoff from ½ the street right-of-way of Wayfarer Drive (OS2lopement all of the water will remain in the street section with the construction of two (2) concrete cross pans and high points located in each of the two (2) driveways just south of the intersection with Wayfarer Drive. Data regarding the flow in Wayfarer Drive can be obtained from the Final Drainage Report prepared for The Glen at Widefield #2. Excerpts from this report are included in *Exhibit 4, Appendix*.

- Sub basin Characteristics
  The characteristics for the sub basin upstream of DP 1 were not evaluated since the runoff has no impact on the developed conditions of the Fire Station site.

- Stormwater Routing for Developed Conditions
  The runoff is collected by a proposed public concrete cross pan. The water is then is routed to DP 2 via the existing concrete curb and gutter section

along the southerly side of Wayfarer Drive. Evaluation of the hydrologic and hydraulic characteristics at this location is beyond the scope of this report this the runoff has no impact on the Fire Station site.

- Proposed Drainage Facilities
  A concrete cross pan is to be constructed at this location. The water will be prevented from entering the Fire Station site with the construction of a high point in the driveway south of the proposed cross pan.

b. **Design Point 2**

- Contributing Sub basin Description
  DP 2 collects runoff from ½ the street section of Wayfarer Drive located downstream of the proposed cross pan at DP1, onsite sub basin A (0.04 acres) (Q5 = 0.1 cfs, Q100 = 0.2 cfs), and onsite sub basin B (Q5 = neg cfs, Q100 = 0.1 cfs). DP2 is located at the upstream end of the proposed second concrete cross pan (located east of the DP1) located at the second driveway access to the fire station site. The total runoff amounts for both the 5-year and 100-year storms were not determined at this location since it will not have an impact on the project site.

- Stormwater Routing for Developed Conditions
  The runoff at DP2 is collected by a proposed concrete cross pan. Stormwater from Wayfarer Drive will remain in Wayfarer Drive with the construction of high points in the driveways and with the installation of concrete cross pans. The water is then routed along the southerly curb and gutter section in an easterly direction to the Mesa Ridge Parkway intersection. Evaluation of the hydrologic and hydraulic characteristics at this point is beyond the scope of this report. The runoff has no impact on the Fire Station site.

c. **Design Point 3**

- Contributing Sub basin Description
  DP 3 collects runoff from Sub basin D (0.08 acres). The Sub basin is a landscaped area. The discharges for the design flows were determined to be Q5 = negligible and Q100 = 0.3 cfs.

- Stormwater Routing for Developed Conditions
  The runoff sheet flows to a private inlet located in the middle of the landscaped area (DP3). The total runoff at DP3 is Q5 = neg cfs, Q100 = 0.3cfs. The water is then is routed to a cleanout at DP 4 via a proposed private pipe (STR 14).

- Proposed Drainage Facilities (Exhibit 8, Appendix, Calculation Sheet (CS) 1)

A private inlet is proposed at DP 3. The inlet is sized to intercept 100% of the runoff from Sub Basin D. The water is then routed to a cleanout at DP 4 via a private 12” HDPE (STR 14). The private pipe segment was sized for the 100-year storm since the driveway functions as a “dam” preventing a suitable outfall for the 100-year storm event. The hydrologic and hydraulic properties of STR 14 are as follows:

STR ID: 14
Design flows: 100 year = 0.3 cfs.
Size of pipe segment = 12 inches
Approximate slope: 1.0 %
Depth of flow: 100 year = 0.2 feet
Velocity: 100 year = 2.7 fps

- 100-year routing
  The runoff from the 100-year storm is contained within STR 14 and routed to DP 4 via a private 12” HDPE pipe (STR 14).

d. **Design Point 4**

- Contributing Sub basin Description
  A cleanout is proposed at DP 4. No additional runoff enters the storm sewer system at DP4. The design flow discharges at this Design Point were determined to be Q5 = neg and Q100 = 0.3 cfs.

- Stormwater Routing for Developed Conditions
  The 12” HDPE (STR 14) enters the cleanout from the west and exits the cleanout to the south via a 12” HDPE (STR 3) to DP 9. The pipe is located along the easterly side of the building from DP4 to DP9.

- Proposed Drainage Facilities (Exhibit 8, Appendix, CS 2)
  A private12” HDPE (STR 3) is sized for the 100-year storm since upstream facilities were all sized for the 100-year event. The hydrologic and hydraulic properties of the private STR 3 are as follows:

STR ID: 3
Design flows: 100 year = 0.3 cfs.
Size of pipe segment =12 inches HDPE
Approximate slope:1.0 %
Depth of flow: 100 year = 0.2 feet
Velocity: 100 year =_2.7 fps

- 100-year routing
  All water from the 100-year storm event is contained within STR 15.

e. **Design Point 5**

- Contributing Sub basin Description
  DP 5 is located at a cleanout at the northerly end of a concrete paved area between the building and the parking lot along the westerly side of the fire station (Sub basin J). Developed runoff from approximately one quarter of the roof is collected at DP5 and drops to the cleanout at DP5 and then is carried in a southerly direction via a 6" HDPE (STR 22). The design flow at this DP was not determined since it was runoff only from approximately ¼ of the roof.

- Stormwater Routing for Developed Conditions
  A 6" HDPE (STR 22) exists the cleanout at DP 5 and routes the water to the south to DP7.

- Proposed Drainage Facilities
  A 6" HDPE (STR 22) exits the cleanout at DP 5 and routes the water to the south to DP6

  The hydraulic characteristics of STR 22 was not determined since the pipe is only accommodating runoff from approximately ¼ of the roof.

- 100-year routing
  All water from the 100-year storm event is contained within STR 22

f. **Design Point** 6
DP 6 was eliminated from this analysis.

g. **Design Point** 7

- Contributing Sub basin Description
  Developed runoff from Sub basin I (0.09 acres, Q5 = 0.40 cfs and Q100 = 0.7 cfs enters a 6" HDPE pipe (STR22) and a 12" HDPE pipe (STR23) from roof downspouts at the northwest and southwest corners of the building. Facilities at DP7 include a 12" by 6" wye. A cleanout is located at the downstream end of STR 22. Design flows at DP7 were determined to be Q5 = 0.4 cfs and Q100 = 0.7 cfs.

- Stormwater Routing for Developed Conditions
  The runoff is routed in a southerly direction via private STR 23 to a proposed 12"- 45-degree bend (STR 24).

- Proposed Drainage Facilities (Exhibit 8, Appendix, CS3)
  STR 23 is sized for the 100-year storm in order to intercept all of the stormwater generated by the 100-year storm event and route it into the FSD

pond. The hydrologic and hydraulic properties of the private STR 23 are as follows:

STR ID: 23
Design flows: 100 year = 0.7 cfs.
Size of pipe segment = 12 inches
Approximate slope: 4.0%
Depth of flow: 100 year = 0.2 feet
Velocity: 100 year = 5.7 fps

- 100-year routing
  All of the runoff generated by the 100-year storm event is routed to the full spectrum detention (FSD) by the private underground storm sewer system.

h. Design Point 8

- Contributing Sub basin Description
  Stormwater runoff from Sub basins E (0.23 acres) and J (0.01 acres) is collected at DP 8. The areas consist of predominantly paved parking and a limited amount of landscaping. The discharges for the design flows at this Design Point were determined to be Q5 = 1.0 cfs and Q100 = 1.8 cfs.

- Stormwater Routing for Developed Conditions
  The majority of the runoff from these sub basins sheet flows to the in a southerly direction and is collected by the concrete curb and gutter section located along the westerly side of the parking lot. The water is collected by a private Nyoplast inlet at DP8. From here the water is routed in an easterly direction via private 12" HDPE pipe (STR 11) to DP21.

- Proposed Drainage Facilities (Exhibit 8, Appendix, CS 4)
  STR 11 (12" HDPE) is sized for the major portion of the 100-year storm in order to discharge all of the water generated by the 100-year storm event into the FSD pond. The hydrologic and hydraulic properties of private STR 11 are as follows. The hydraulic parameters for STR 11 are for 100% interception of the runoff from 100-year storm.

STR ID: 11
Design flows: 100 year = 1.8 cfs.
Size of pipe segment = 12" HDPE
Approximate slope: 10%
Depth of flow: 100 year = 0.2 feet
Velocity: 100 year = 10.3 fps

- 100-year routing
  All of the runoff generated by the 100-year storm event is routed downstream in the STR 11 with only a minimal amount of bypass on the surface.

i. **Design Point 9**

- Contributing Sub basin Description
  Developed stormwater runoff from Sub basins D (0.08 acres, Q5 = neg, Q100 = 0.3 cfs), F (0.03 acres, Q5 = 0.1 cfs, Q100 = 0.2 cfs) and H (0.09 acres, Q5 = 0.4 cfs, Q100 = 0.7 cfs), is collected at DP9 with a total design flow of Q5 = 0.5 cfs and Q100 = 1.2 cfs. This sub basins consist of the area to the north of the building and the easterly half of the fire station roof.

- Stormwater Routing for Developed Conditions
  The water from the roof surface drains to a downspouts located at DP 9 and the northeasterly corner of the building. The water enters the storm sewer system at downspouts located at the northeasterly corner of the building and at DP9. The water drains to the proposed 12" HDPE (STR3) located along the easterly side of the building. From here the water drains in a southerly direction to DP 17 via a 12" HDPE pipe (STR 17 and 18).

- Proposed Drainage Facilities (Exhibit 8, Appendix, CS 5 and CS 6)
  Private STR17 and STR18 were sized for the 100-year storm since upstream facilities were all sized for the 100-year event. The hydraulic parameters for STR 17 and STR 18 were determined based on 100% interception of the runoff from 100-year storm. It was assumed that the majority of the runoff from the 100-year could be intercepted with only a negligible amount of bypass that would occur at the inlets. Based on this assumption, the hydrologic and hydraulic properties of the private pipe segments are as follows:

  STR ID: 17 and 18
  Design flows: 100 year = 1.2 cfs.
  Size of pipe segment = 12 inches HDPE
  Assumed slope: 1.0% and 7.7%, respectively
  Depth of flow: 100 year = 0.2 feet and 0.2 feet, respectively
  Velocity: 100 year = 10.3 fps and 8.3 fps, respectively

- 100-year routing
  All of the runoff generated by the 100-year storm event is routed to the FSD pond via STR17 and STR18 and then STR19.

j. **Design Point 10**

- Contributing Sub basin Description

  Stormwater runoff from Sub basin O (0.02 acres) and any bypass from DP17 is collected at DP 10. The discharges at DP10 were determined to be Q5 = 0.1 cfs and Q100 = 0.2 cfs.

- Stormwater Routing for Developed Conditions

  Runoff from Sub basin O (Q5 = 0.1 cfs, Q100 = 0.2 cfs) sheet flows across the fire station's southerly parking area and driveway. The water is collected by the curb and gutter section located along the west side of the driveway. From DP 10 the water is routed to the FSD pond via a concrete swale (STR 27).

- Proposed Drainage Facilities (Exhibit 8, Appendix, CS 7)

  The concrete swale is sized for the 100-year storm event.
  The hydrologic and hydraulic properties of the private concrete swale are as follows:

  Structure ID: 27
  Design flows: 100 year = 0.2 cfs.
  Size of the concrete swale = 24" wide by 12" deep
  Assumed slope: 23%
  Depth of flow: 100-year = 0.1 feet
  Velocity: 100-year = 3.8 fps

k. Design Point 11

DP 11 is located at the FSD pond outfall structure. The description of the characteristics of the outfall structure for the FSD pond s included in section XI of this report. A Concentrated Inflow Structure is proposed at this location. This type facility is recommended as opposed to a concrete impact stilling basin due the small amount of flows entering the pond and the considerable savings between the two (2) type facilities.

l. Design Point 12

- Contributing Sub basin Description

  Runoff from OS1 (Q5 = 0.6 cfs, Q100 = 4.2 cfs) sheet flows from the north to the south and is collected by an existing swale (Swale 1). Stormwater runoff from Sub basin OS1 (2.08 acres) collects at DP 12 where a driveway culvert (STR 29) is proposed. The upstream boundary of OS1 is located at a high point in the swale approximately 1,000 feet east of the site. The water in Swale 1 passes under the proposed driveway via an 24 concrete culvert (STR29) and continues to flow in a westerly direction. Swale 1 combines with Swale 2 and continues to flow in a westerly direction to a concrete channel located upstream of a concrete box culvert under Powers Boulevard. Both of these facilities are not shown on either the Existing Conditions Drainage Plan or the Developed Conditions Drainage Plan.

- Proposed Drainage Facilities (Exhibit 8, Appendix, CS 8)

A 24" reinforced concrete pipe (CL IV) pipe is recommended at DP12. It is recommended to use a Class IV pipe to support the weight of the fire trucks. The Headwater to Depth ratio was determined by using the Headwater to Depth nomograph included in *Exhibit 5, Appendix*. The hydraulic properties of the culvert were determined based on the 100-year storm event and are as follows:

STR ID: 29 (Driveway culvert)
Design flows: 5 year = 0.6 cfs, 100 year = 4.2 cfs
Size of pipe segment = 24 inches, CL IV RCP
Headwater to Depth ratio = 0.5
Depth of flow at upstream culvert end = 0.8 ft
Control: inlet
Estimated culvert slope = 2.2%
Normal depth in culvert = 0.4 ft
Normal Velocity in Culvert = 7.1 fps

Riprap erosion protection is proposed at the outlet of the pipe from DP18 to DP15. The riprap is not only designed for the outlet at STR 29 but also for the emergency spillway from the FSD pond (STR31).

- 100-year routing

It is expected that the culvert will have sufficient capacity to accommodate the design flow from the 100-year storm. All of the water from the 100-year design storm will remain in the swale and be routed to the concrete box culvert under Powers Boulevard located west of the project site. Hydrologic and hydraulic analyses of the downstream facilities are beyond the scope of this report.

m. Design Point 13

- Contributing Sub basin Description

Runoff from OS4 (0.44 acres, Q5 = 0.9 cfs, Q100 = 2.9 cfs) sheet flows to Swale 2 from the area located between the northerly right-of-way line of Mesa Ridge Parkway and the northerly edge of pavement. No runoff from the pavement enters the swale since the paved section is super elevated to the south. The runoff enters Swale 2 and is directed in a westerly direction

The upstream boundary of OS4 is located at a high point in the swale approximately 1,000 feet east of the site. The water in Swale 2 passes under the proposed driveway via an 18-inch concrete culvert (STR30) and continues to flow in a westerly direction. Swale 2 combines with Swale 1 and continues to flow in a westerly direction to a concrete channel located upstream of a concrete box culvert under Powers Boulevard. Both of these facilities are not shown on either the Existing Conditions Drainage Plan or the Developed Conditions Drainage.

- Proposed Drainage Facilities for Developed Conditions (Exhibit 8, Appendix, CS 9)
  An 18" reinforced concrete pipe (CL IV) pipe is recommended at DP 13. The hydraulic properties of this culvert are as follows. The hydraulic properties of the culvert were determined based on the 100-year storm event and are as follows:

  STR ID: 30 (Driveway culvert)
  Design flows: 5 year = 0.9 cfs, 100 year = 2.9 cfs
  Size of pipe segment = 18 inches, CL IV RCP
  Headwater to Depth ratio = 0.6 (for 100 year event)
  Depth at upstream culvert end = 11 inches
  Control: inlet
  Estimated culvert slope = 2.0%
  Normal depth in culvert = 0.2 ft
  Normal Velocity in Culvert = 4.5 fps

- 100-year routing
  All of the runoff generated by the 100- year storm event is routed to the existing concrete channel upstream of the concrete box culvert under Powers Boulevard.

n. **Design Point 14**
Contributing Sub basin Description
DP 14 is located at the easterly end of the proposed driveway for the fire station. All runoff from the driveway intersection with Mesa Ridge Parkway runs off into Swale 2 which is located south of the northerly right of way line for Mesa Ridge Parkway.

o. **Design Point** 15
DP 15 is located in the existing swale at the westerly boundary of the project site. Runoff from Sub Basins M (0.17acres, Q5 = 0.2 cfs, Q100 = 0.7 cfs), N (0.03 acres Q5 =negligible, Q100 = 0.1 cfs), P (0.01 acres Q5 = negligible, Q100 = 0.1 cfs), and the FSD pond outfall combine with the flows at DP 12 to total the runoff amounts at DP 15 (Q5 = 2.9 cfs, Q100 = 8.1 cfs). It is highly problematic to route runoff from these sub basins to the FSD pond due to the existing and proposed topography. It is considered acceptable to not route this runoff to the FSD pond since the area of pavement (800 sf) to the total

area of sub basins M, N, and P (9,150 sf) is only 9%. As a result, the increase in runoff due to development is expected to be negligible.

It is recommended to line Swale 1 with riprap from DP18 to DP15. The swale was sized to accommodate the runoff from the sub basins as described above as well as the emergency overflow from the FSD pond (Q5 = 2.5 cfs, Q100 = 5.8 cfs). The hydraulic characteristics of Swale 1 is as follows (Exhibit 8, Appendix CS24;

- Design flows: Q5 = 2.9 cfs, Q100 = 8.1 cfs
- Approximate slope = 1.5 %
- Bottom Width = 2 feet
- Side slopes: 3 to 1
- Manning's Coefficient:
- Depth of flow = 0.5 feet
- Velocity = 4.8 fps

The water in this Swale 1 and 2 is routed to the existing downstream concrete ditch and concrete box culvert located under Powers Boulevard

p. Design Point 16

DP 16 is located at the outfall of the FSD pond (STR 28). The discharge from the FSD pond was determined using program provided by the Urban Drainage and Flood Control Manual. An emergency overflow (STR 31) is to be constructed from the top of the FSD pond bank to the outfall at Swale 1. This outfall is located near the downstream end of STR 29. The release rates for the pond are summarized in Section IX of this report.

All water from the 100-year storm event is routed in a westerly direction in swale 1 to the existing concrete channel and the concrete box culvert under Powers Boulevard (not shown).

q. Design Point 17

- Contributing Sub basin Description

  Stormwater runoff from Sub basins K (0.18 acres, Q5 = 0.7cfs, Q100 = 1.3 cfs) collect at DP 9. This area consists of predominantly paved parking and a limited amount of landscaping.

- Stormwater Routing for Developed Conditions

  The surface runoff from Sub basin K, sheet flows in a southeasterly direction across the concrete parking area to the concrete curb and gutter located along the southside of the parking area. The water is then routed in an easterly direction to a proposed private inlet (STR 6) located at DP 17. The underground water enters the inlet from the northeast via private a 12"

HDPE pipe (STR 18) and exits via a private 12” HDPE pipe (STR26). The water ultimately discharges into the FSD pond at DP 20.

- Proposed Drainage Facilities (Exhibit 8, Appendix, CS 10)
  STR 26 was sized for the 100-year storm since upstream facilities were all sized for the 100-year event. The hydrologic and hydraulic properties of the private pipe segment 26 are as follows:

  STR ID: 19
  Design flows: 100 year = 1.6 cfs.
  Size of pipe segment = 12 inches HDPE
  Assumed slope: 7.7%
  Depth of flow: 100 year = 0.2 feet
  Velocity: 100 year = 9.1 fps

- 100-year routing
  All of the runoff generated by the 100-year storm event is routed to the FSD pond by a private underground storm sewer system. The storm sewer (STR26) was designed to accommodate 100% of the runoff from the 100-year event. The inlet (STR6) was designed to accommodate 80% to 90% of the surface flow with the remaining surface flow to bypass to downstream concrete channel (STR27). The concrete channel outfalls into the FSD pond at DP 22.

r. **Design Point 18**
DP 18 is located at the downstream end of the proposed 18” culvert (STR 29) located at the swale crossing under the south driveway that accesses the fire station building. The description of the hydrologic and hydraulics characteristics pertaining to the structure were discussed in a previous section of this report.

s. **Design Point 19**
DP 19 is located at the downstream end of the proposed 18” culvert (STR 30) located at the swale crossing under the south driveway that accesses the fire station site. The description of the hydrologic and hydraulics characteristics pertaining to the structure were discussed in previous sections of this report.

t. **Design Point 20**
DP 20 is located at the FSD pond outlet of STR 18. The flow entering the pond is Q5 = 0.5 cfs and Q100 = 4.8 cfs from Sub basins D, E, J. K, H, and I. A concentrated inflow riprap basin is recommended at this location *(Exhibit 5, Appendix).*

u. **Design Point 22**
DP 22 is located at the outlet to STR 20 (Concrete chase). The flow entering the pond at this located is Q5 = 0.1 cfs and Q100 = 0.3 cfs from Sub Basin O. A concentrated inflow riprap basin is recommended at this location (*Exhibit 5, Appendix*).

v. **Drainage Sub basin G**
Runoff from Sub basin G (0.19 acres, Q5 = 0.1 cfs, Q100 = 0.6 cfs) sheet flows to the easterly property line. This area is to remain in a natural state. The runoff is to sheet flow onto undeveloped unplatted tract (OS 1). Stormwater runoff from this area will not have to be routed into the proposed FSD pond since no development is to occur in this sub basin.

w. **Drainage Sub basin L**
Sub basin L consists (0.13 acres) of the area occupied by the FSD pond. Runoff generated from this sub basin is Q5 = 0.1 cfs, Q100 = 0.4 cfs when the pond is empty. The runoff coefficients for this sub basin were C5 = 0.08, C100 = 0.35.

Please include narrative on missing Drainage Sub Basins

x. **Drainage Sub Basin M**
Runoff from Sub basin M (0.17 acres, Q5 = 0.2 cfs, Q100 = 0.7 cfs) sheet flows to the Swale 1 located north of the north right-of-way line for Mesa Ridge Parkway. Stormwater runoff from this area will not have to be routed into the proposed FSD pond since no development is to occur in this sub basin.

Paving is proposed in this location, stormwater quality capture volume must be addressed.

0.03 acres

y. **Drainage Sub Basin N**
Runoff from Sub basin N (0.0. acres, Q5 = negligible, Q100 = 0.1 cfs) sheet flows to the Swale 1 located north of the north right-of-way line for Mesa Ridge Parkway. Stormwater runoff from this area will not have to be routed into the proposed FSD pond since no development is to occur in this sub basin.

z. **Drainage Sub basin P**
Runoff from Sub basin P (0.01 acres, Q5 = negligible, Q100 = negligible) sheet flows to the westerly property line. This area is to remain in its natural state. The runoff is to sheet flow onto undeveloped unplatted tract (OS 3). Stormwater runoff from this area will not have to be routed into the proposed FSD pond since no development is to occur in this sub basin.

aa. Drainage Sub basin Q

Sub Basin Q (0.01 acres, Q5 = negligible, Q100 = 0,1 cfs) is comprised of the paved apron at the south end of the driveway. All of the runoff from this apron sheet flows into Swale 2 since there is no curb and gutter. Since the increase in impervious area is so minimal it is not necessary to accommodate this flow in the sizing of the FSD pond.

bb. Drainage Sub basin R

Runoff from Sub basin R (0.04 acres, Q5 = negligible, Q100 = 0.1 cfs) sheet flows to the westerly property line. This area is to remain in its natural state. The runoff is to sheet flow onto undeveloped unplatted tract (OS 3). Stormwater runoff from this area will not have to be routed into the proposed FSD pond since no development is to occur in this sub basin.

.

IX. FULL SPECTRUM DETENTION POND (EXHIBIT 7, APPENDIX)

The following elevations are based on a elevations of “0” at the bottom of the pond.

a. Design Flows

- Peak Inflow: Q5 year = 1.1 cfs, Q100 = 2.8 cfs
- Peak Outflow: Q5 year = 0.1 cfs, Q100 = 1.2 cfs
- Emergency Overflow = 2.5 cfs, Q100 = 5.8 cfs (based on Rational Method for site runoff with a time of concentration of 5 minutes)

b. Pond Characteristics

- Type: Sand Filter
- Water Quality Capture Volume (WQCV) = 0.015 acre-ft, elevation = 0.81 ft
- Excess Urban Runoff Volume (EURV) = 0.059 acre-ft, elevation = 2.19 ft
- 100-yer runoff volume = 0.167 acre- ft., elevation = 3.15 ft
- Media Surface elevations = 0.00 ft
- Spillway elevation = 3.5 ft
- Top of berm elevation = 5.0 ft

c. Outlet Structure

- Orifice size = 1 inch
- Number of rows = 3
- Overflow Weir Elevation = 2.5 ft
- Overflow Grate Size = approximately a 3’ by 3’
- Debris Clogging = 50%

d. Emergency Spillway

- Spillway Invert Elevation = 3.5 ft
- Spillway Crest length = 8.0 ft
- Spillway Side Slopes = 3 to 1
- Freeboard

e. Outfall Pipe (sized for 100 year event) (Exhibit 8, Appendix, CS 25)

- Size/ Type = 12” HDPE
- Design Discharge: Q5 year = 1.2 cfs
- Slope (assumed) = 5% max
- Depth of flow = 0.2 ft
- Velocity of flow = 7.1 fps

f. Outfall protection

A riprap lined swale from DP18 (downstream end of 24” RCP culvert, STR29) to DP15 (located on westerly property line where swale 1 exists the property)

X. EROSION CONTROL

Recommended erosion control measures are summarized in the Storm Water Management Permit Application that is being submitted under separate cover.

XI. STORMWATER MANAGEMENT PLAN (SWMP)

A **SWMP** has been completed and is being submitted under separate cover.

XII. DRAINAGE/ BRIDGE FEES

It is understood that there are no Drainage and/or Bridge Fees that are to be collected for this development.

> Please include: pending approval of the subdivision exemption.

XIII. OPINION OF PROBABLE COST FOR DRAINAGE FACILITIES

There are no public drainage improvements required for this project. The costs for the private drainage improvements is listed below:

Permanent Pond/BMP Construction (Grading)	203 CY at $20	= $ 4,060
Permanent Pond/BMP (Spillway)	1 EA at $2350	= $ 2,350
Permanent Pond/BMP (Outlet Structure)	1 EA at $2900	= $ 2,900
6" HDPE Pipe	106 LF at $18	= $ 1,908
12" HDPE Pipe	412 LF at $24	= $ 9,888
18" Sq. Area Inlet	3 EA at $2000	= $ 6,000
24" RCP	42 LF at $78	= $ 3,276
24" RCP F.E.S.	2 EA at $468	= $ 936
18" RCP	37 LF at $65	= $ 2,405
18" RCP F.E.S.	2 EA at $390	= $ 780
TOTAL		= $34,503

XIV. FOUR STEP PROCESS

The El Paso County Engineering Criteria Manual (Appendix I, Section I.7.2) requires the consideration of 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". The Four Step Process is incorporated in this project and the elements are discussed below.

1) Runoff Reduction Practices are employed in this project. Impervious surfaces have been reduced as much as practically possible. Significant areas of the site remain unpaved or landscaped pervious surfaces. Portions of the paved areas drain to pervious landscaped areas providing an element of Minimized Directly Connected Impervious Areas (MDCIA) by allowing runoff to pass through the pervious spaces before entering the proposed water quality BMP and leaving the site.

2) The developed areas of the site drain into the proposed the proposed Full Spectrum Sand Filter Basin with provision for the WQCV and EURV. The basin

will treat the WQCV and provide storm detention to include the 100-year rainfall event.
3) All drainage paths on the site which are susceptible to erosion are to be stabilized with pavement, appropriate landscape treatment or rip rap lining. The culvert outlets and pond outflow points will have rip rap protection.
4) The site will contain no potentially hazardous uses, no storage of potentially harmful substances or use of potentially harmful substances. No Site Specific or Other Source Control BMP's are required.

XV. **CONCLUSION**

This Final Drainage Report presents existing and proposed drainage conditions for the proposed Security Fire Station No. 4 project. The development will have negligible and inconsequential effects on the existing site drainage and drainage conditions downstream. Full Spectrum Detention and Water Quality treatment will be provided. A Permanent BMP Maintenance Agreement and Easement is being provided for this project. Also, an Operations and Maintenance Manual (O&M Manual) is being provided. The proposed project will not, with respect to stormwater runoff, negatively impact the adjacent properties and downstream properties.

APPENDIX

Exhibit 1: Location Map

Mesa Ridge Pkwy, Colorado Springs, CO 80925

mapquest

Mesa Ridge Pkwy, Colorado Springs, CO 80925

38.721245, -104.678850

Security Fire Station #4

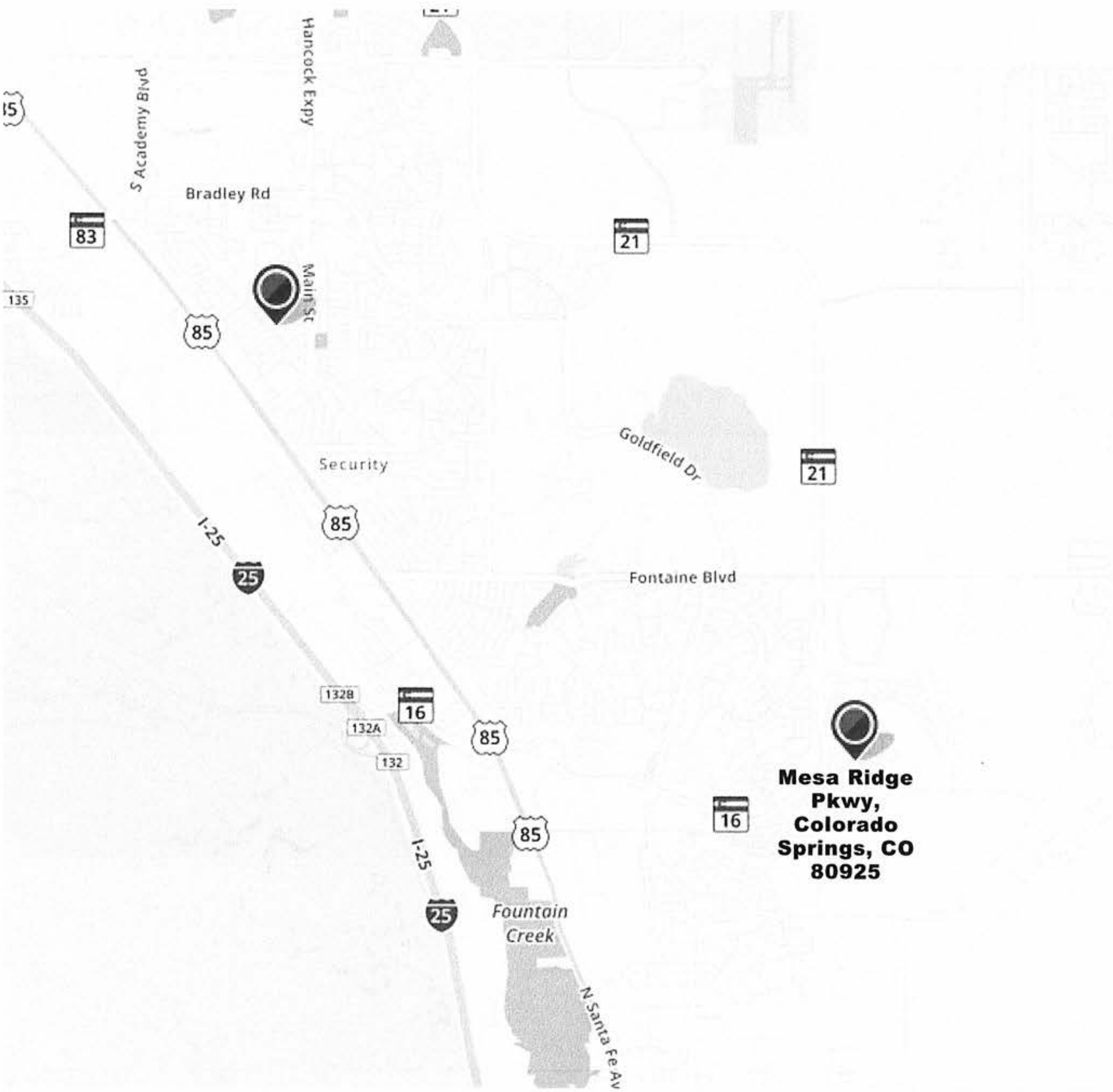
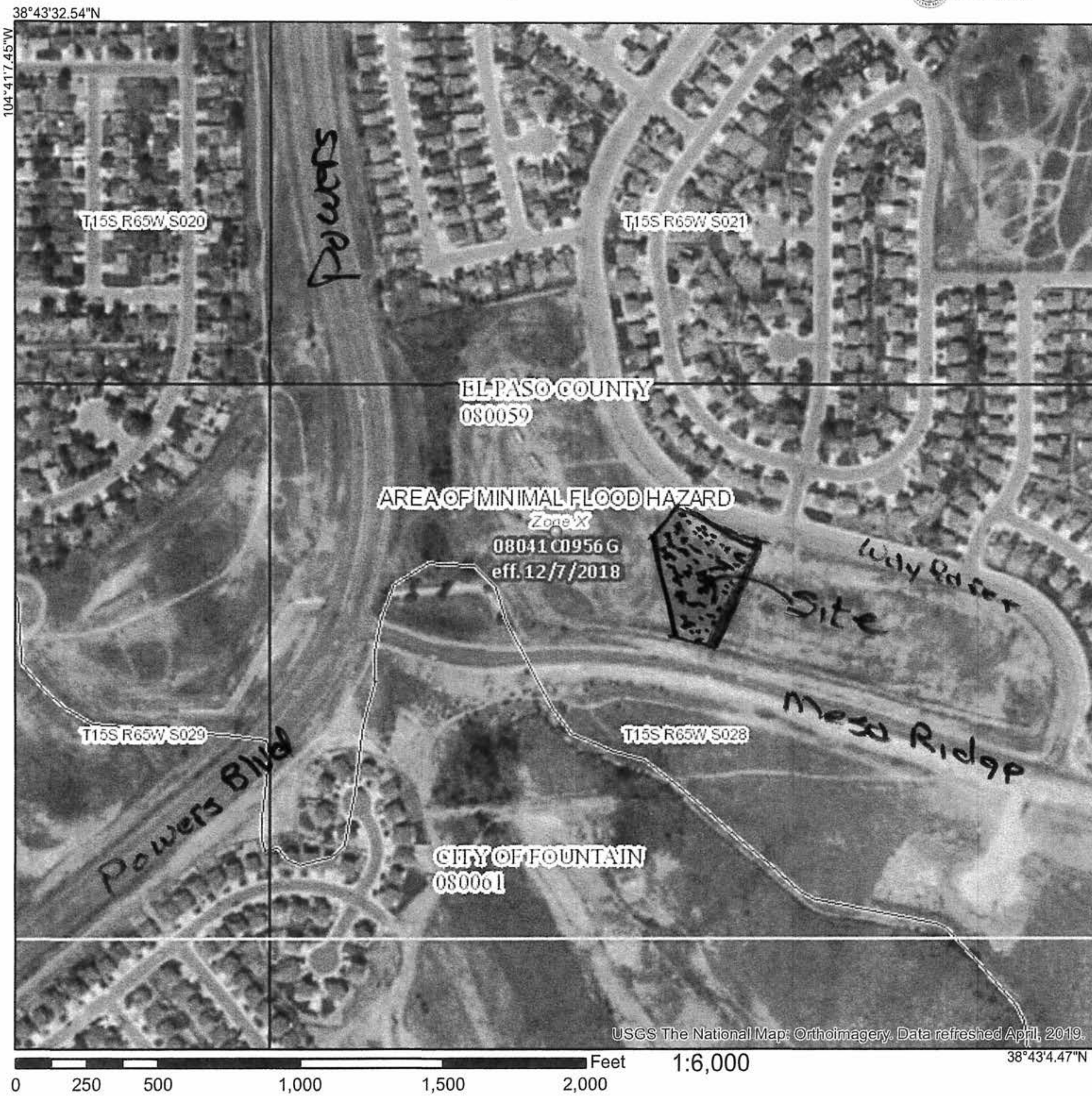


Exhibit 2: FEMA FIRM Map

National Flood Hazard Layer FIRMette

FEMA



Legend

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 9/11/2019 at 5:50:19 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

Exhibit 3: SCS Soils Map and Data

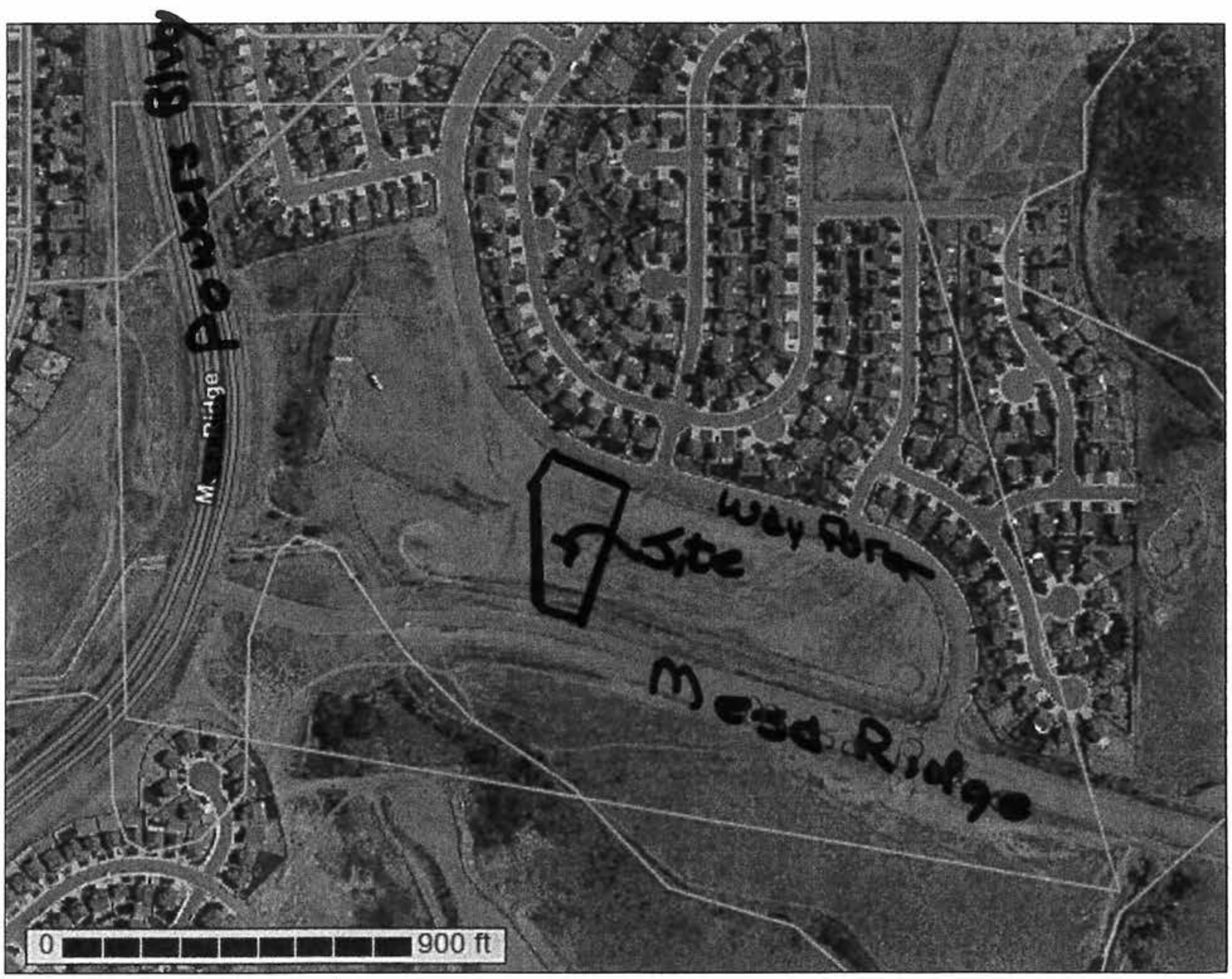
USDA United States Department of Agriculture

NRCS Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

El Paso County Area, Colorado



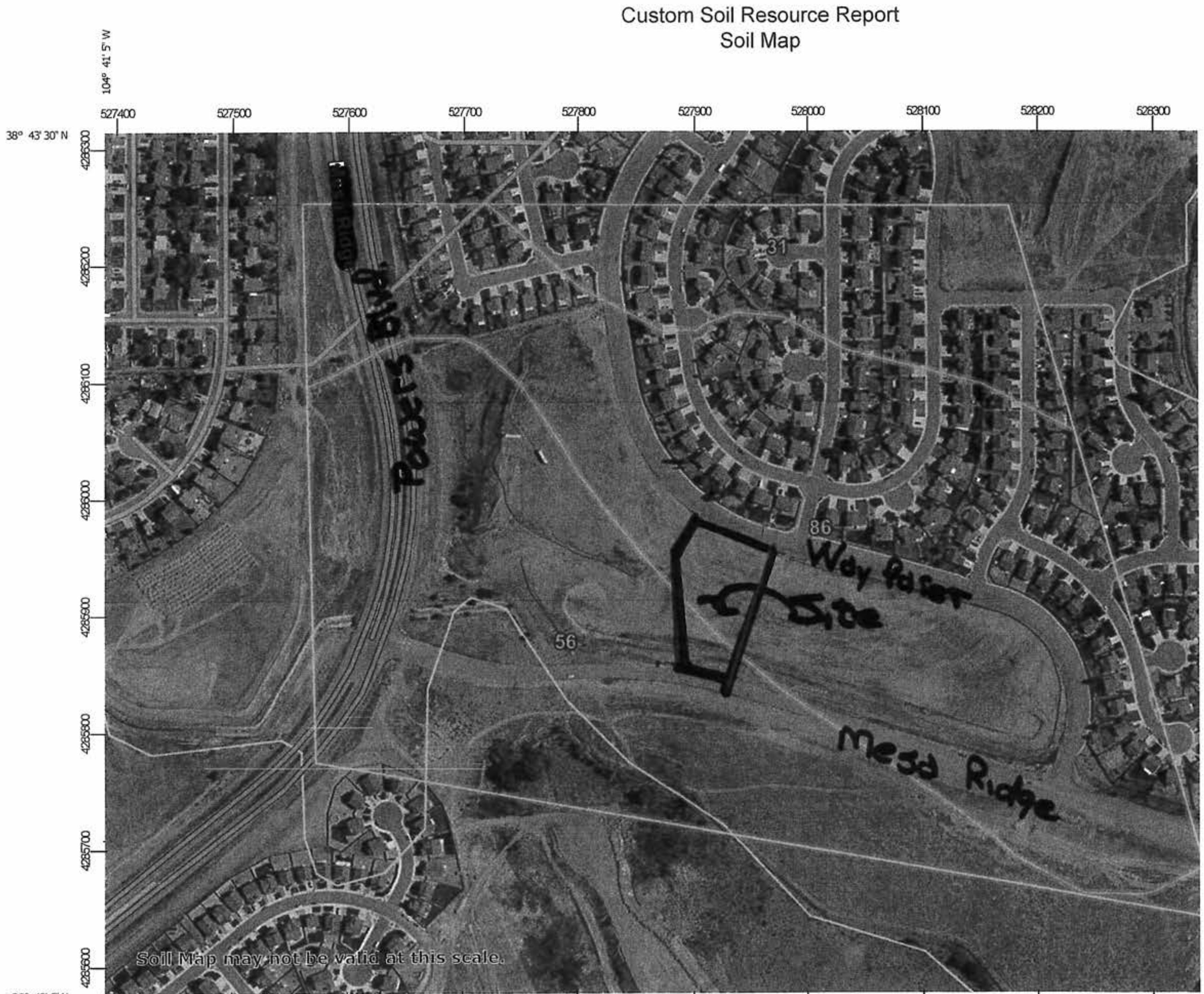
Scale: 1" = 500'±

September 11, 2019

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:5,210 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 250 500 1000 1500

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

Scale = NTS

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 INFORM

The soil surveys that comprise your A(
1:24,000.

Warning: Soil Map may not be valid at

Enlargement of maps beyond the scal
misunderstanding of the detail of mapp
line placement. The maps do not show
contrasting soils that could have been
scale.

Please rely on the bar scale on each m
measurements.

Source of Map: Natural Resources C
Web Soil Survey URL:
Coordinate System: Web Mercator (E

Maps from the Web Soil Survey are ba
projection, which preserves direction a
distance and area. A projection that pr
Albers equal-area conic projection, sh
accurate calculations of distance or ar

This product is generated from the US
of the version date(s) listed below.

Soil Survey Area: El Paso County Ar
Survey Area Data: Version 16, Sep 1

Soil map units are labeled (as space a
1:50,000 or larger.

Date(s) aerial images were photograph
17, 2014

The orthophoto or other base map on
compiled and digitized probably differs
imagery displayed on these maps. As
shifting of map unit boundaries may be

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
31	Fort Collins loam, 3 to 8 percent slopes	12.5	13.5%
56	Nelson-Tassel fine sandy loams, 3 to 18 percent slopes	33.8	36.4%
86	Stoneham sandy loam, 3 to 8 percent slopes	46.5	50.1%
Totals for Area of Interest		**92.9**	**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

31—Fort Collins loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 3684
Elevation: 5,200 to 6,500 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 48 to 52 degrees F
Farmland classification: Not prime farmland

Map Unit Composition

Fort collins and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fort Collins

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile

A - 0 to 9 inches: loam
Bt - 9 to 16 inches: clay loam
Bk - 16 to 21 inches: clay loam
Ck - 21 to 60 inches: loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 10.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Loamy Plains (R067BY002CO)
Other vegetative classification: LOAMY PLAINS (069AY006CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

56—Nelson-Tassel fine sandy loams, 3 to 18 percent slopes

Map Unit Setting

National map unit symbol: 3690
Elevation: 5,600 to 6,400 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 135 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition

Nelson and similar soils: 45 percent
Tassel and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nelson

Setting

Landform: Hills
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Calcareous residuum weathered from interbedded sedimentary rock

Typical profile

A - 0 to 5 inches: fine sandy loam
Ck - 5 to 23 inches: fine sandy loam
Cr - 23 to 27 inches: weathered bedrock

Properties and qualities

Slope: 3 to 12 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None

Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 2.8 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Shaly Plains (R067BY045CO)
Other vegetative classification: SHALY PLAINS (069AY046CO)
Hydric soil rating: No

Description of Tassel

Setting

Landform: Hills
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Calcareous slope alluvium over residuum weathered from sandstone

Typical profile

A - 0 to 4 inches: fine sandy loam
C - 4 to 10 inches: fine sandy loam
Cr - 10 to 14 inches: weathered bedrock

Properties and qualities

Slope: 3 to 18 percent
Depth to restrictive feature: 6 to 20 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Available water storage in profile: Very low (about 1.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D
Ecological site: Shaly Plains (R067BY045CO)
Other vegetative classification: SHALY PLAINS (069AY046CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:

Landform: Depressions
Hydric soil rating: Yes

86—Stoneham sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 36b2
Elevation: 5,100 to 6,500 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 135 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition

Stoneham and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Stoneham

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Calcareous loamy alluvium

Typical profile

A - 0 to 4 inches: sandy loam
Bt - 4 to 8 inches: sandy clay loam
Btk - 8 to 11 inches: sandy clay loam
Ck - 11 to 60 inches: loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 9.5 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e

Hydrologic Soil Group: B
Ecological site: Sandy Plains (R067BY024CO)
Other vegetative classification: SANDY PLAINS (069AY026CO)
Hydric soil rating: No

Minor Components

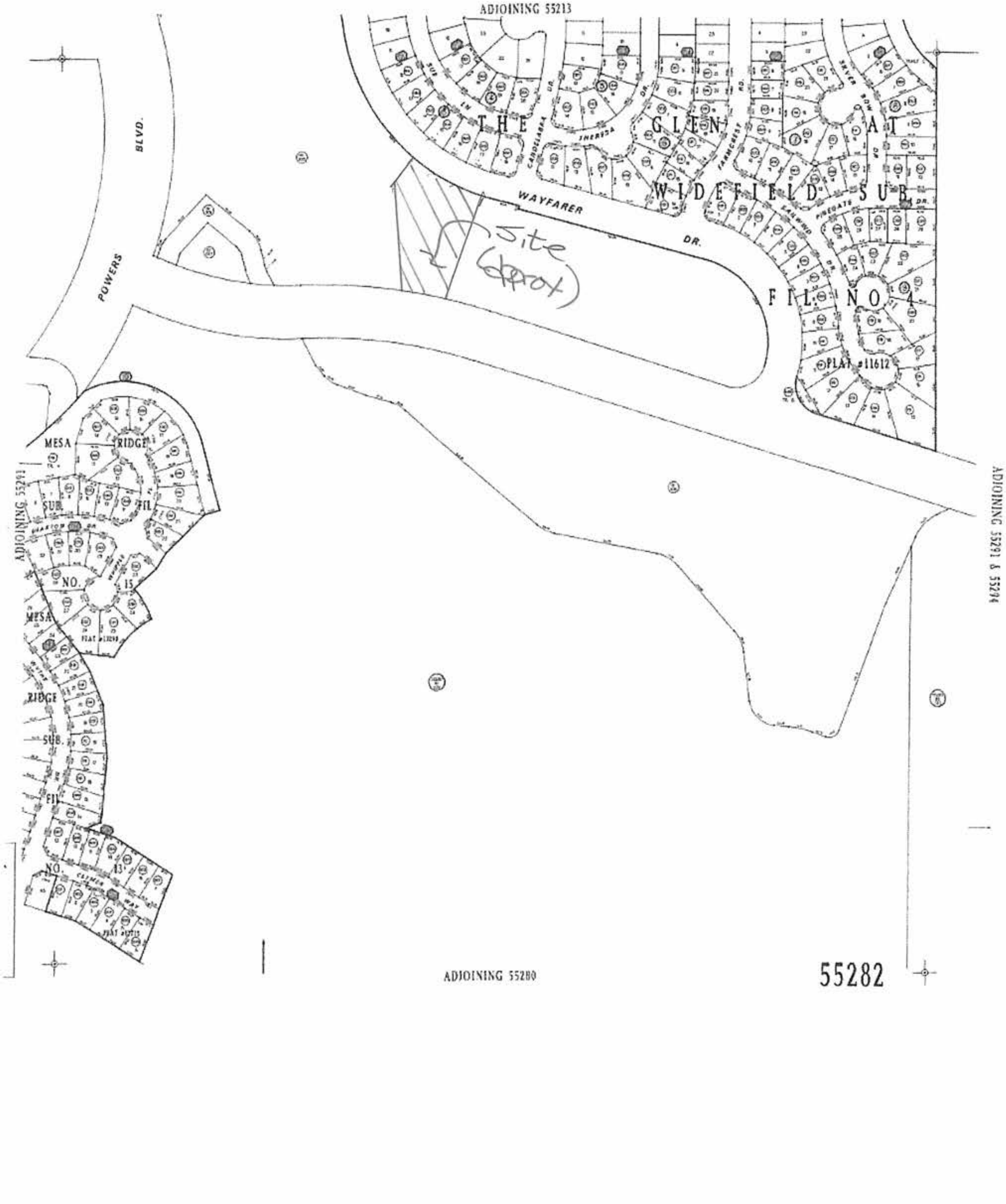
Other soils

Percent of map unit:
Hydric soil rating: No

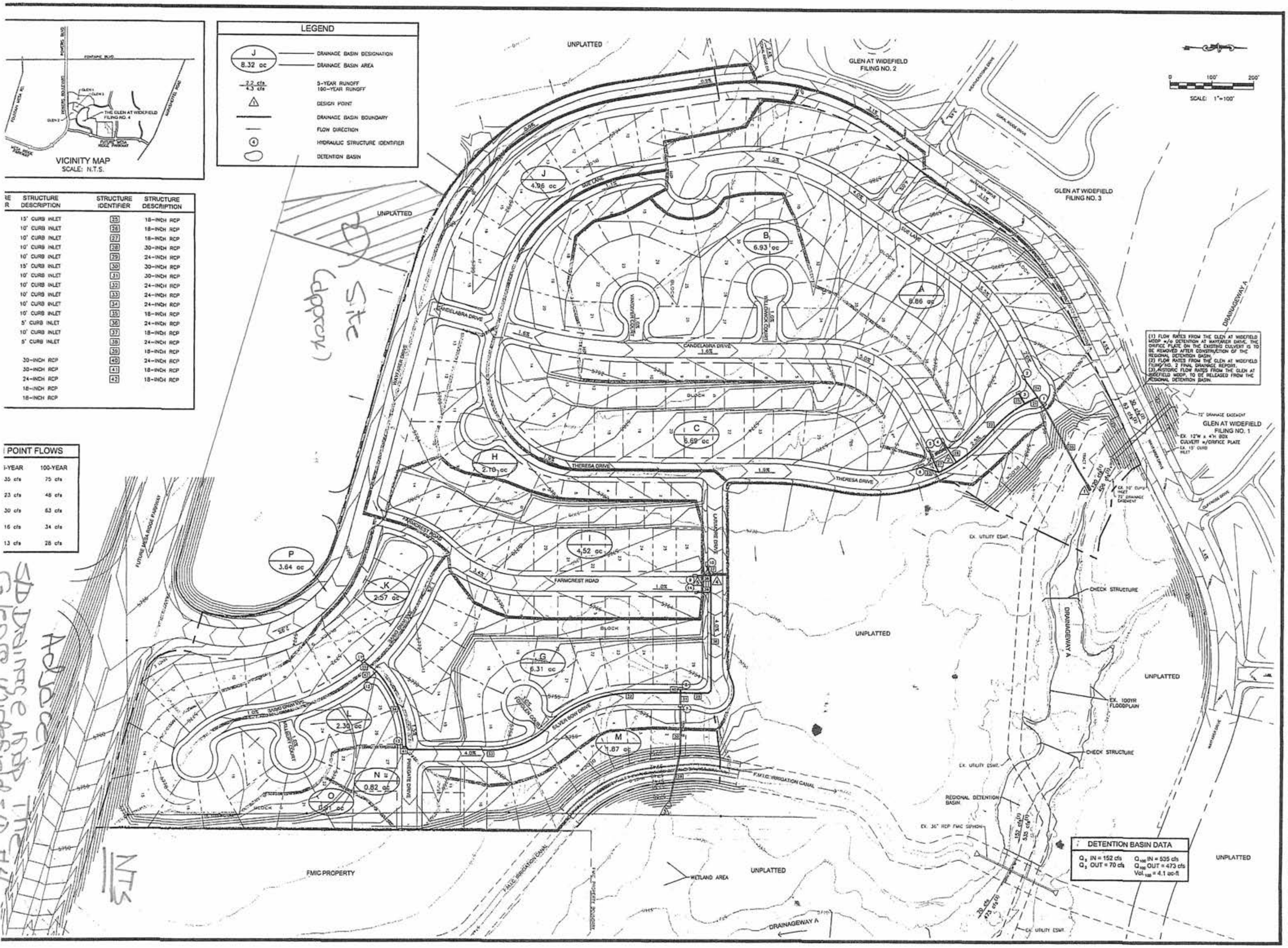
Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Exhibit 4: Existing Drainage Report Exhibits



Adjacent S/D Drainage Map for The Glen @ Widefield S/D #4 (NTS)



STRUCTURE DESCRIPTION	STRUCTURE IDENTIFIER	STRUCTURE DESCRIPTION
15' CURB INLET	25	18-INCH RCP
10' CURB INLET	26	18-INCH RCP
10' CURB INLET	27	18-INCH RCP
10' CURB INLET	28	30-INCH RCP
10' CURB INLET	29	24-INCH RCP
15' CURB INLET	30	30-INCH RCP
10' CURB INLET	31	30-INCH RCP
10' CURB INLET	32	24-INCH RCP
10' CURB INLET	33	24-INCH RCP
10' CURB INLET	34	24-INCH RCP
10' CURB INLET	35	18-INCH RCP
5' CURB INLET	36	24-INCH RCP
10' CURB INLET	37	18-INCH RCP
5' CURB INLET	38	24-INCH RCP
	39	18-INCH RCP
30-INCH RCP	40	24-INCH RCP
30-INCH RCP	41	18-INCH RCP
24-INCH RCP	42	18-INCH RCP
18-INCH RCP		
18-INCH RCP		

POINT FLOWS

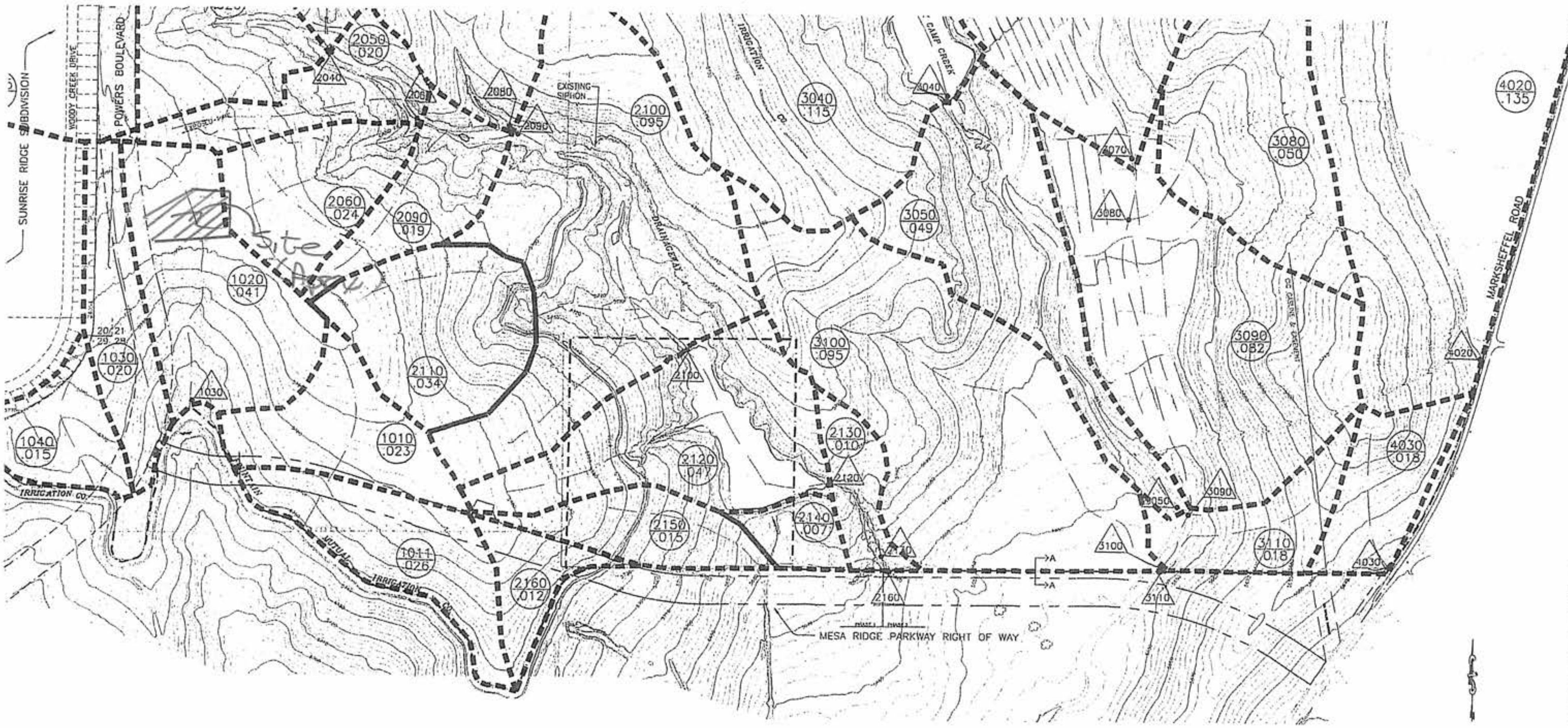
-YEAR	100-YEAR
35 cfs	75 cfs
23 cfs	48 cfs
30 cfs	63 cfs
16 cfs	34 cfs
13 cfs	28 cfs

GLEN AT WIDEFIELD FILING NO. 4

Kiowa Engineering Corporation

Project
Date:
Design:
Drawn:
Check:
Revision

EXHIBIT



FDR Drainage Map (Historic) for Mesa Ridge Parkway Phase I (NTS)

Site (Approx.)

NOTE:

1. THE MASTER DEVELOPMENT PLAN FOR THE GLEN AT WIDEFIELD WAS USED IN THE DETERMINATION OF FLOWS TO THE MESA RIDGE PARKWAY RIGHT OF WAY.

DESIGN POINT FLOWS (PROPOSED CONDITION WITH DETENTION)

DESIGN PT	5-YEAR	100-YEAR
1030	38 cfs	96 cfs
2130	187 cfs	615 cfs
2160	160 cfs	640 cfs
3110	766 cfs	3095 cfs
4030	20 cfs	44 cfs
DRAINAGEWAY A SECTION A-A		640 cfs

LEGEND

1011 / .015	SUB-BASIN NUMBER / SUB-BASIN SQUARE MILEAGE
1030	DESIGN POINT
— —	FLOWPATH
■ ■ ■ ■	SUB-BASIN BOUNDARY

VICINITY MAP
SCALE: N.T.S.

MESA RIDGE PARKWAY FINAL DESIGN
MDDP DRAINAGE PLAN
PHASE 1 DRAINAGE REPORT

Kiowa Engineering Corporation
1604 South 21st St
Colorado Springs, Colorado

Project No.: 0202
Date: March 7, 20
Design: MHH
Drawn: CAD
Check: AWMc
Revisions:

EXHIBIT 1

The Glen @ Widefield #2
FDR
NTS

Site Location

LEGEND

R / 10.24 ac / 7.9 cfs / 28.9 cfs	SUB-BASIN DESIGNATION SUB-BASIN AREA 5-YEAR SUB-BASIN RUNOFF 100-YEAR SUB-BASIN RUNOFF
2.2 cfs / 4.3 cfs	5-YEAR RUNOFF 100-YEAR RUNOFF
△	DESIGN POINT
	DRAINAGE BASIN BOUNDARY
④	HYDRAULIC STRUCTURE IDENTIFIER
	EXISTING LIMITS OF PRESERVATION AREA
	EXISTING LIMITS OF 100-YEAR FLOOD PLAIN
2.5%	PROPOSED STREET GRADE
	PROPOSED CHECK STRUCTURE

VICINITY MAP
SCALE: NOT TO SCALE

DESIGN POINT FLOWS

DESIGN POINT	5-YEAR FLOW	100-YEAR FLOW
1	15.2 cfs	31.9 cfs
2	29.8 cfs	62.6 cfs

HYDRAULIC STRUCTURE IDENTIFIER	HYDRAULIC STRUCTURE DESCRIPTION
1	5-FOOT TYPE R CURB INLET
1A	5-FOOT TYPE R CURB INLET
2	5-FOOT TYPE R CURB INLET
3	10-FOOT TYPE R CURB INLET
4	5-FOOT TYPE R CURB INLET
9	15-FOOT TYPE R CURB INLET
10	10-FOOT TYPE R CURB INLET
11	15-FOOT TYPE R CURB INLET
20	48-INCH RCP CULVERT w/FLARED END SECTIONS
22	12'x4' REINFORCED CONCRETE BOX CULVERT w/HEADWALL AND WINGWALL's

HYDRAULIC STRUCTURE IDENTIFIER	HYDRAULIC STRUCTURE DESCRIPTION
30	24-INCH RCP
30A	24-INCH RCP
30B	18-INCH RCP
31	18-INCH RCP
32	18-INCH RCP
33	18-INCH RCP
42	42-INCH RCP
45	18-INCH RCP
46	24-INCH RCP
47	24-INCH RCP w/F.E.S.
48	18-INCH RCP w/F.E.S.'s
49	18-INCH RCP w/F.E.S.

NOTE: A HIGHER STRENGTH CONCRETE MAY BE REQUIRED IN THE REINFORCED CONCRETE PIPES THAT ARE ABOVE THE MANUFACTURERS RECOMMENDED VELOCITY FOR THE STANDARD PIPE. THE FINAL CONSTRUCTION DRAWINGS WILL ADDRESS THE STRENGTH OF PIPE TO BE USED.

Kiowa Engineering Corporation

THE GLEN AT WIDEFIELD SUBDIVISION FILING NO. 2

Project N
Date: Sep
Design:
Drawn:
Check:
Revisions
Wayfarer
County Co
EXHIBIT

Exhibit 5: Charts and Tables

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

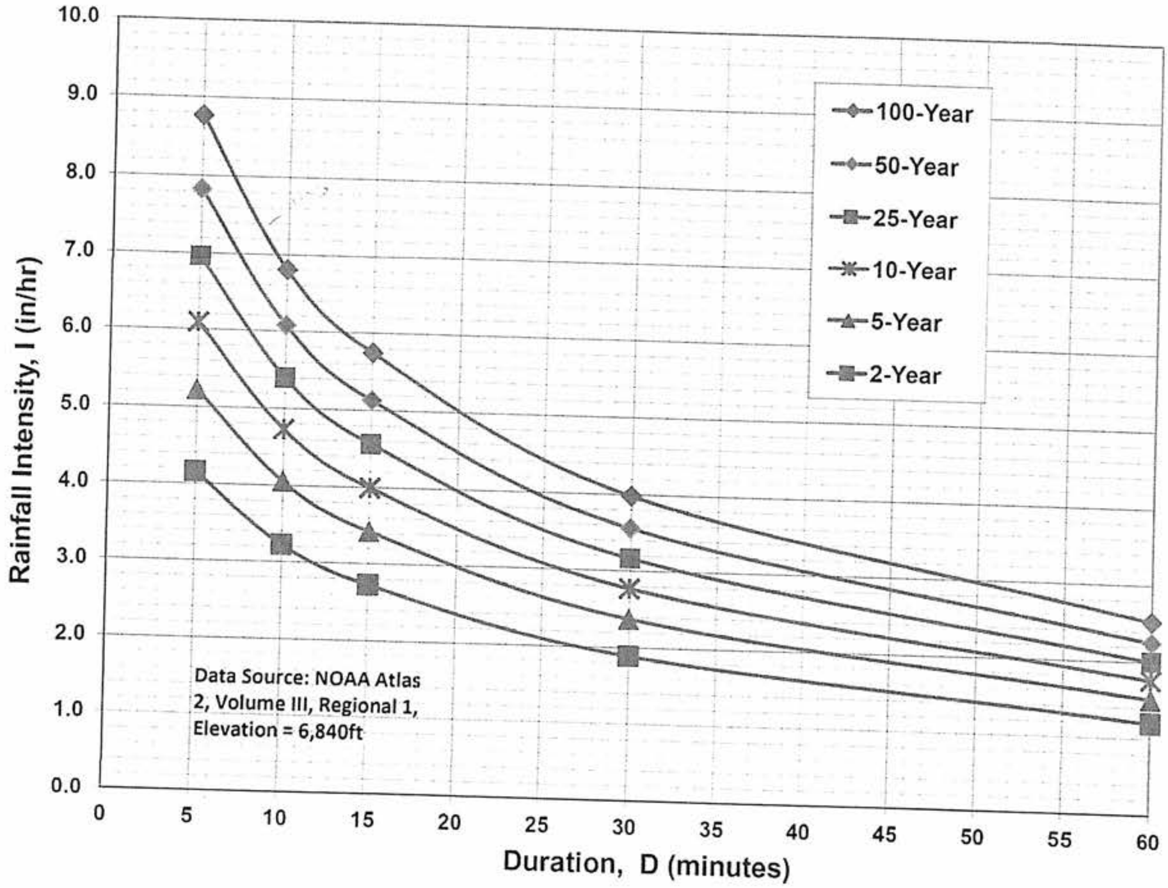
Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	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 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

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

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

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

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

$I_{5} = -1.50 \ln(D) + 7.583$

$I_{2} = -1.19 \ln(D) + 6.035$

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

$$t_c = t_i + t_t \quad \text{(Eq. 6-7)}$$

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

t_t = travel time in the ditch, channel, gutter, storm sewer, etc. (min)

3.2.1 Overland (Initial) Flow Time

The overland flow time, t_i, may be calculated using Equation 6-8.

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

* For buried riprap, select C_v value based on type of vegetative cover.

The travel time is calculated by dividing the flow distance (in feet) by the velocity calculated using Equation 6-9 and converting units to minutes.

The time of concentration (t_c) is then the sum of the overland flow time (t_i) and the travel time (t_t) per Equation 6-7.

3.2.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (typically the first inlet in the system) in an urbanized catchment should not exceed the time of concentration calculated using Equation 6-10. The first design point is defined as the point where runoff first enters the storm sewer system.

$$t_c = \frac{L}{180} + 10 \qquad \text{(Eq. 6-10)}$$

Where:

t_c = maximum time of concentration at the first design point in an urban watershed (min)

L = waterway length (ft)

Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional "calibration" of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

3.2.5 Post-Development Time of Concentration

As Equation 6-8 indicates, the time of concentration is a function of the 5-year runoff coefficient for a drainage basin. Typically, higher levels of imperviousness (higher 5-year runoff coefficients) correspond to shorter times of concentration, and lower levels of imperviousness correspond to longer times of

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

Table 6-2. Rainfall Depths for Colorado Springs

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

Where Z= 6,840 ft/100

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

2.2 Design Storms

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

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

  To determine the temporal distribution of thunderstorms, 22 gage-adjusted NEXRAD storm cells were studied in detail. Through a process described in a technical memorandum prepared by the City of Colorado Springs (City of Colorado Springs 2012), the results of this analysis were interpreted and normalized to the 1-hour rainfall depth to create the distribution shown in Table 6-3 with a 5 minute time interval for drainage basins up to 1 square mile in size. This distribution represents the rainfall trol were developed. These nomographs give headwater-discharge relationships for most conventional culverts flowing with inlet control through a range of headwater depths or discharges. An example of these nomographs is shown in *Figure 3.25*.

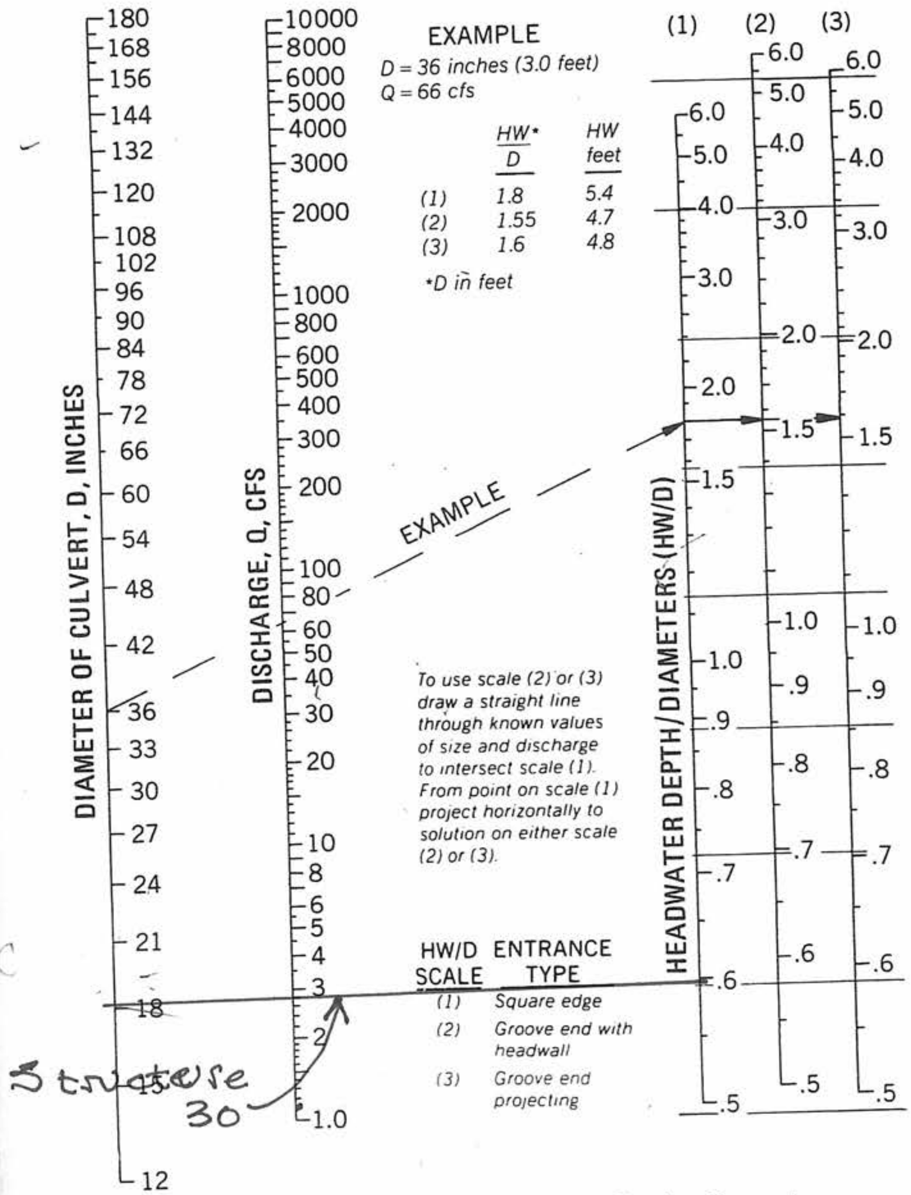
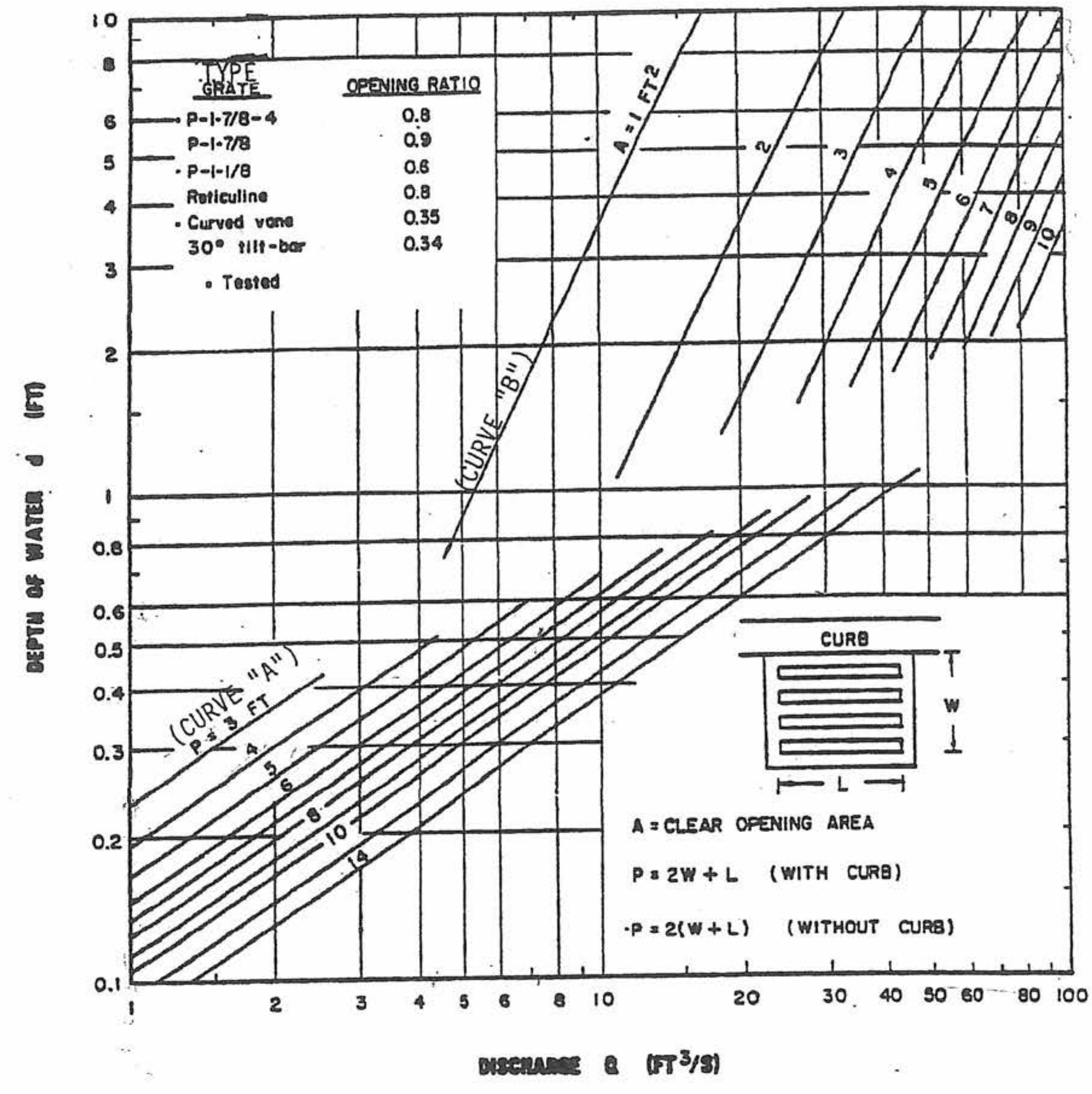


Figure 3.25. Headwater Depth for Circular Concrete Pipe Culverts with Inlet Control.



Reference: USDOT, March 1984
HEC NO. 12

NOTE: Use with effective P or A

9/30/90

HDR Infrastructure, Inc.
A Centerra Company

The City of Colorado Springs / El Paso County
Drainage Criteria Manual

Date OCT. 1987

Figure 7 - 6

Hydraulic Capacity of Grate Inlet in Sump

Heavy Duty

Nyloplast® Heavy Duty Drain Basins are used as a collection point typically where two or more drain lines converge. Basins can provide a transition between different sizes and types of pipe, and can also change the elevation or direction of the pipe. Drain Basins are also beneficial when faced with shallow pipe burial applications.

Watertight connection

Structures are shipped with rubber gaskets to insure a watertight connection. This prevents the soil infiltration that plagues precast structures and prevents long-term settlement around the basin.

Flexible resilient connection

The real world can be tough on underground structures. Soils consolidate unevenly and external loads can further complicate matters. Flexible connections allow minor movement to take place without compromising the structural or watertight integrity of the basin. Additionally, the need to wait for grout to set-up is totally eliminated. With Nyloplast, you can connect and backfill immediately.

Quick, easy and inexpensive installation

The product is lightweight and easily handled which translates into faster installation with less equipment and personnel, which results in a lower total cost.

Field Adjustments

Basins are easily adjustable in the field to meet final grade. Last minute trimming or extensions are easily made to insure proper positive drainage is achieved.

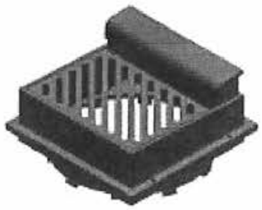
Not sure about final elevations or wondering how to connect unexpected laterals? Our **Inserta Tee® (http://www.insertatee.com/)** option (pictured right) allows field connections while still preserving the Nyloplast benefits of a resilient connection and watertight performance.

Nyloplast Grate Inlet Capacity Charts

–

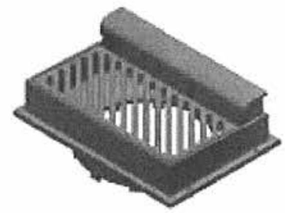
Heavy Duty Grates

Curb Inlet



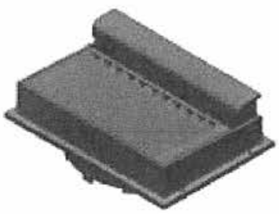
2x2 Diagonal

2x2 Standard



2x3

Diagonal



2x3 High Flow

2x3 Roll

Road & Highway (H20)

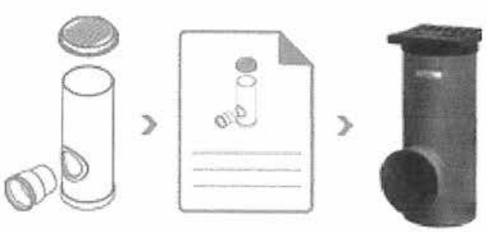
Heavy Duty Applications

- Subdivisions
- Primary and Secondary Roads
- Parking lots
- Interstates
- Heavy industrial and Commercial sites
- Inlet and Outlet stormwater control

**** (http://www.nyloplast-us.com/resources#drawings) CLICK HERE FOR DETAILS (http://www.nyloplast-us.com/resources#drawings) ** (http://www.nyloplast-us.com/resources#drawings)**

Have questions?

Need support?
Call us at (866) 888-8479
Send us a message



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Nyloplast
A division of ADS

Nyloplast Curb & Gutter Inlet Capacity Calculator - Co

EQUATIONS AND CALCULATIONS ARE BASED OFF USDOT/FHWA URBAN DESIGN MANUAL, HYDRAULIC ENGINEERING CIRCULAR NC
FHWA-NHI-10-009.

Curb & Gutter Design Inputs

Surface Type	Concrete pavement, broom finish
Mannings Coeffiecient for Street & Pavement Gutters	0.016
T (ft)	8.2
T_S (ft)	7.2
W (ft)	1
S_x (ft/ft)	0.020
S_W (ft/ft)	0.083
S_L (ft/ft)	0.010
a (in)	0.76
d (in)	2.73
Gutter Flow (cfs)	1.56
Gutter Flow (gpm)	698.39
Gutter Velocity (fps)	2.21

Output

Grate Style	Double 2'x3' Steel Bar MAG
Intercepted Flow (cfs)	1.404
Intercepted Flow (gpm)	630.30
Carryover Flow (cfs)	0.152
Carryover Flow (gpm)	68.087

DISCLAIMER: SAFETY FACTORS ARE NOT INCLUDED. ACTUAL CALCULATIONS SHOULD BE CARRIED OUT AND VERIFIED
ACCOUNT ALL LOCAL CONDITIONS. FAA RECOMMENDS USING A SAFETY FACTOR OF 1.25 FOR PAVED AREAS AND 2.0 FOR
RESPONSIBLE FOR MISUSE OF THIS TOOL.

Nyloplast
A division of ADS

Nyloplast Curb & Gutter

EQUATIONS AND CALCULATIONS ARE BASED OFF USDOT/FHWA URBAN DESIGN MAN

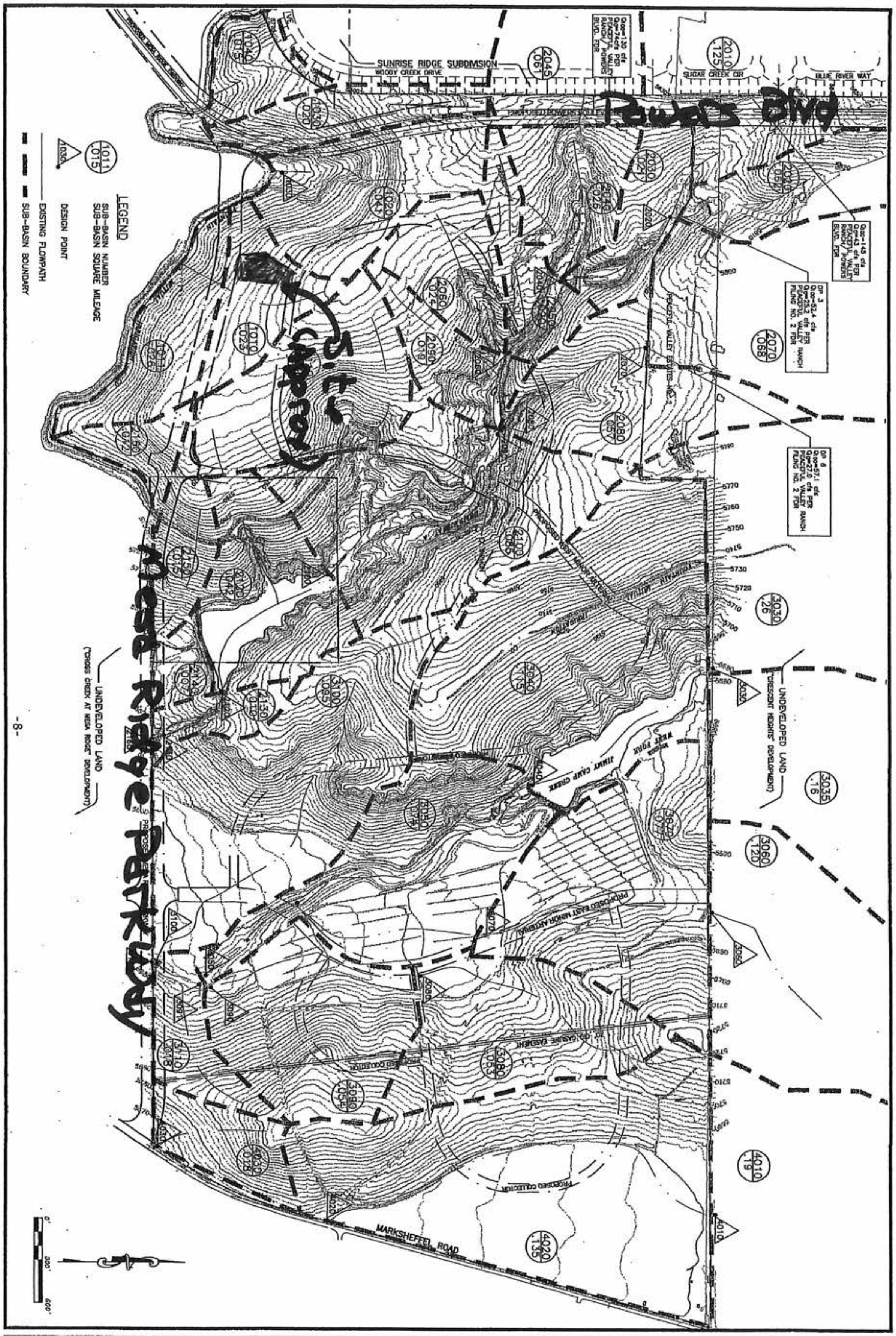
Curb &

Surface Type
Mannings Coeffiecient for Street & Pavement Gutters
T (ft)
S_x (ft/ft)
S_L (ft/ft)
h (in)
Gutter Flow (cfs)
Gutter Flow (gpm)
Gutter Velocity (fps)

Grate Style
Intercepted Flow (cfs)
Intercepted Flow (gpm)
Carryover Flow (cfs)
Carryover Flow (gpm)

DISCLAIMER: SAFETY FACTORS ARE NOT INCLUDED. ACTUAL CALCULATIONS
ALL LOCAL CONDITIONS. FAA RECOMMENDS USING A SAFETY FACTOR OF 1.
FOR MIS

Exhibit 6: West Fork Jimmy Camp Creek DBPS Exhibits



Project No:	9823
Date:	7/00
Design:	BMW
Drawn:	CAD
Check:	BMW
Revisions:	

FIG.3A

West Fork Jimmy Camp Creek
Drainage Basin Planning Study
HYDROLOGIC SUB-BASIN MAP
EL PASO COUNTY, COLORADO

Kiowa Engineering Corporation
1604 S. 21st Street
Colorado Springs, Colorado
80904
(719) 630-7342

El Paso County Drainage Basin Fees

Resolution No. 17-348

Basin Number	Receiving Waters	Year Studied	Drainage Basin Name	2018 Drainage Fee (per Impervious Acre)	2018 Bridge Fee (per Impervious Acre)
Drainage Basins with DBPS's:					
CHMS0200	Chico Creek	2013	Haegler Ranch	$9,676	$1,428
CHWS1200	Chico Creek	2001	Bennett Ranch	$10,832	$4,155
CHWS1400	Chico Creek	2013	Falcon	$27,762	$3,814
FOFO2000	Fountain Creek	2001	West Fork Jimmy Camp Creek	$11,775	$3,484
FOFO2600	Fountain Creek	1991*	Big Johnson / Crews Gulch	$17,197	$2,221
FOFO2800	Fountain Creek	1988*	Widefield	$17,197	$0
FOFO2900	Fountain Creek	1988*	Security	$17,197	$0
FOFO3000	Fountain Creek	1991*	Windmill Gulch	$17,197	$258
FOFO3100 / FOFO3200	Fountain Creek	1988*	Carson Street / Little Johnson	$10,490	$0
FOFO3400	Fountain Creek	1984*	Peterson Field	$12,404	$941
FOFO3600	Fountain Creek	1991*	Fisher's Canyon	$17,197	$0
FOFO4000	Fountain Creek	1996	Sand Creek	$17,197	$5,210
FOFO4200	Fountain Creek	1977	Spring Creek	$8,919	$0
FOFO4600	Fountain Creek	1984*	Southwest Area	$17,197	$0
FOFO4800	Fountain Creek	1991	Bear Creek	$17,197	$941
FOFO5400	Fountain Creek	1977	21st Street	$5,174	$0
FOFO5600	Fountain Creek	1964	19th Street	$3,385	$0
FOFO5800	Fountain Creek	1964	Camp Creek	$1,906	$0
FOMO0400	Monument Creek	1986*	Mesa	$8,995	$0
FOMO1000	Monument Creek	1981	Douglas Creek	$10,815	$239
FOMO1200	Monument Creek	1977	Templeton Gap	$11,103	$258
FOMO1400	Monument Creek	1976	Pope's Bluff	$3,445	$588
FOMO1600	Monument Creek	1976	South Rockrimmon	$4,043	$0
FOMO1800	Monument Creek	1973	North Rockrimmon	$5,174	$0
FOMO2000	Monument Creek	1971	Pulpit Rock	$5,703	$0
FOMO2200	Monument Creek	1994	Cottonwood Creek / S. Pine	$17,197	$941
FOMO2400	Monument Creek	1966	Dry Creek	$13,576	$492
FOMO3600	Monument Creek	1989*	Black Squirrel Creek	$7,808	$492
FOMO3700	Monument Creek	1987*	Middle Tributary	$14,351	$0
FOMO3800	Monument Creek	1987*	Monument Branch	$17,197	$0
FOMO4000	Monument Creek	1996	Smith Creek	$7,011	$941
FOMO4200	Monument Creek	1989*	Black Forest	$17,197	$468
FOMO5200	Monument Creek	1993*	Dirty Woman Creek	$17,197	$941
FOMO5300	Fountain Creek	1993*	Crystal Creek	$17,197	$941
Miscellaneous Drainage Basins: [1]					
CHBS0800	Chico Creek		Book Ranch	$16,136	$2,336
CHEC0400	Chico Creek		Upper East Chico	$8,791	$255
CHWS0200	Chico Creek		Telephone Exchange	$9,659	$226
CHWS0400	Chico Creek		Livestock Company	$15,910	$189
CHWS0600	Chico Creek		West Squirrel	$8,293	$3,442
CHWS0800	Chico Creek		Solberg Ranch	$17,197	$0
FOFO1200	Fountain Creek		Crooked Canyon	$5,192	$0
FOFO1400	Fountain Creek		Calhan Reservoir	$4,335	$253
FOFO1600	Fountain Creek		Sand Canyon	$3,132	$0
FOFO2000	Fountain Creek		Jimmy Camp Creek[3]	$17,197	$804
FOFO2200	Fountain Creek		Fort Carson	$13,576	$492
FOFO2700	Fountain Creek		West Little Johnson	$1,133	$0
FOFO3800	Fountain Creek		Stratton	$8,249	$369
FOFO5000	Fountain Creek		Midland	$13,576	$492
FOFO6000	Fountain Creek		Palmer Trail	$13,576	$492
FOFO6800	Fountain Creek		Black Canyon	$13,576	$492
FOMO4600	Monument Creek		Beaver Creek	$10,281	$0
FOMO3000	Monument Creek		Kettle Creek	$9,287	$0
FOMO3400	Monument Creek		Elkhorn	$1,560	$0
FOMO5000	Monument Creek		Monument Rock	$7,454	$0
FOMO5400	Monument Creek		Palmer Lake	$11,919	$0
FOMO5600	Monument Creek		Raspberry Mountain	$4,009	$0
PLPL0200	Monument Creek		Bald Mountain	$8,544	$0
Interim Drainage Basins: [2]					
FOFO1800	Fountain Creek		Little Fountain Creek	$2,199	$0
FOMO4400	Monument Creek		Jackson Creek	$6,807	$0
FOMO4800	Monument Creek		Teachout Creek	$4,727	$710

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.

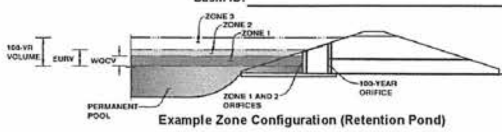
Exhibit 7: Detention Pond Charts and Tables

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project:

Basin ID:



Example Zone Configuration (Retention Pond)

Depth Increment = 0.25 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)
Media Surface	--	0.00	--	--	--	591	0.014		
BTM=5780.0	--	1.00	--	--	--	1,100	0.025	835	0.019
	--	2.00	--	--	--	1,679	0.039	2,218	0.051
	--	3.00	--	--	--	2,318	0.053	4,233	0.097
Spillway=5783.5	--	3.50	--	--	--	2,690	0.062	5,485	0.126
	--	4.00	--	--	--	3,095	0.071	6,932	0.159
Top Berm=5785.0	--	5.00	--	--	--	3,897	0.089	10,428	0.239
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Required Volume Calculation

			Optional User Override 1-hr Precipitation	
Selected BMP Type =	SF			
Watershed Area =	1.00	acres		
Watershed Length =	300	ft		
Watershed Slope =	0.023	ft/ft		
Watershed Imperviousness =	54.60%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	100.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Desired WQCV Drain Time =	12.0	hours		
Location for 1-hr Rainfall Depths =	User Input			
Water Quality Capture Volume (WQCV) =	0.015	acre-feet		
Excess Urban Runoff Volume (EURV) =	0.059	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.048	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.065	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.086	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.117	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.138	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.167	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.25 in.) =	0.233	acre-feet	3.25	inches
Approximate 2-yr Detention Volume =	0.045	acre-feet		
Approximate 5-yr Detention Volume =	0.061	acre-feet		
Approximate 10-yr Detention Volume =	0.080	acre-feet		
Approximate 25-yr Detention Volume =	0.087	acre-feet		
Approximate 50-yr Detention Volume =	0.090	acre-feet		
Approximate 100-yr Detention Volume =	0.100	acre-feet		

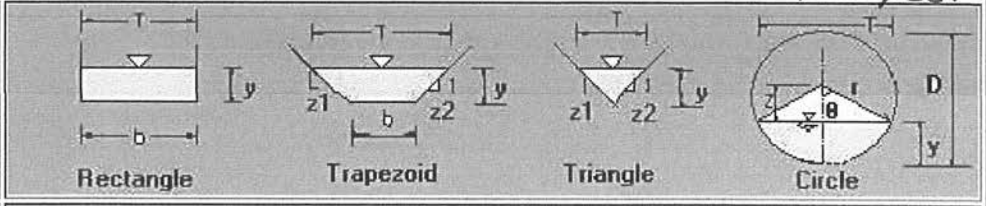
Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.015	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.044	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.041	acre-feet
Total Detention Basin Volume =	0.100	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	N/A	ft
Slope of Trickle Channel (S_{TC}) =	N/A	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

Q 5 25
STR (Outfall pipe from Detention Pond)
100year

The open channel flow calculator

Select Channel Type: Circle



Depth from Q | Select unit system: Feet(ft)

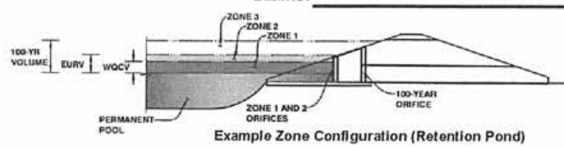
Channel slope: .05 ft/ft	Water depth(y): 0.2 ft	Radius (r) 1 ft
Flow velocity 7.1034 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge 1.2 ft^3/s	Input n value 0.012 or select n clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 1.3 ft	Flow area 0.17 ft^2	Top width(T) 1.21 ft
Specific energy 0.99 ft	Froude number 3.35	Flow status Supercritical flow
Critical depth 0.38 ft	Critical slope 0.0038 ft/ft	Velocity head 0.78 ft

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: ______________________

Basin ID: ______________________



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.81	0.015	Filtration Media
Zone 2 (EURV)	2.19	0.044	Orifice Plate
Zone 3 (100-year)	3.05	0.041	Weir&Pipe (Restrict)
		0.100	Total

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

Underdrain Orifice Invert Depth =	2.00	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	0.59	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	0.0	ft^2
Underdrain Orifice Centroid =	0.02	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 =	0.81	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	2.19	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	5.50	inches
Orifice Plate: Orifice Area per Row =	0.82	sq. inches (diameter = 1 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row =	5.694E-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)	0.81	1.27	1.73					
Orifice Area (sq. inches)	0.82	0.82	0.82					

	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)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.50	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	2.92	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	2.92	N/A	feet
Overflow Grate Open Area % =	81%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	2.50	N/A	feet
Over Flow Weir Slope Length =	2.92	N/A	feet
Grate Open Area / 100-yr Orifice Area =	61.76	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	6.91	N/A	ft^2
Overflow Grate Open Area w/ Debris =	3.45	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 =	2.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	12.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	2.40		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 =	0.12	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 =	3.50	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	8.00	feet
Spillway End Slopes =	3.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth =	0.23	feet
Stage at Top of Freeboard =	4.73	feet
Basin Area at Top of Freeboard =	0.08	acres

Routed Hydrograph Results

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) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.25
Calculated Runoff Volume (acre-ft) =	0.015	0.059	0.048	0.065	0.086	0.117	0.138	0.167	0.233
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.014	0.058	0.048	0.064	0.085	0.117	0.137	0.166	0.232
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.20	0.67	0.93	1.25	1.91
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.0	0.2	0.7	0.9	1.3	1.9
Peak Inflow Q (cfs) =	0.2	1.0	0.8	1.1	1.5	2.0	2.4	2.8	3.9
Peak Outflow Q (cfs) =	0.0	0.1	0.1	0.1	0.1	1.0	1.1	1.2	1.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	4.3	0.6	1.6	1.2	0.9	1.0
Structure Controlling Flow =	Filtration Media	Plate	Plate	Plate	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.1	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) =	12	23	22	24	25	25	24	23	22
Time to Drain 99% of Inflow Volume (hours) =	12	24	23	25	27	27	26	26	26
Maximum Ponding Depth (ft) =	0.67	1.94	1.71	2.09	2.50	2.60	2.67	2.95	3.58
Area at Maximum Ponding Depth (acres) =	0.02	0.04	0.03	0.04	0.05	0.05	0.05	0.05	0.06
Maximum Volume Stored (acre-ft) =	0.011	0.049	0.040	0.054	0.072	0.077	0.080	0.095	0.131

Outflow should be equal or less than the pre-development flow. Please revise.

Emergency Overflow Discharge Calcs

Developed Conditions

Sub basin ID	Area (acres)	"C"		C*A	
		5 year	100 year	5 year	100 year
D	0.08	0.12	0.39	0.01	0.03
E	0.23	0.83	0.91	0.19	0.21
F	0.03	0.90	0.96	0.03	0.03
H	0.09	0.90	0.96	0.08	0.09
I	0.09	0.90	0.96	0.08	0.09
J	0.01	0.12	0.39	0.00	0.00
K	0.18	0.73	0.83	0.13	0.15
L	0.13	0.08	0.35	0.01	0.05
N	0.03	0.08	0.35	0.00	0.01
O	0.02	0.49	0.66	0.01	0.01
subtotals	0.89			0.54	0.66
Composite "C"				0.61	0.75

Time of Concentration	5 minutes	
Rainfall Intensity (inches per hour)	5.20	8.70
Design Runoff for Emergency Swale (cfs)	2.5	5.8

Figure 13-12c. Emergency Spillway Protection

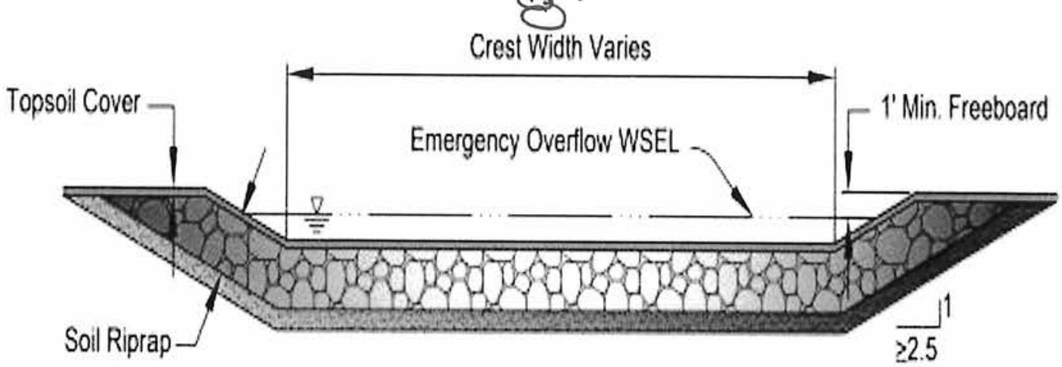
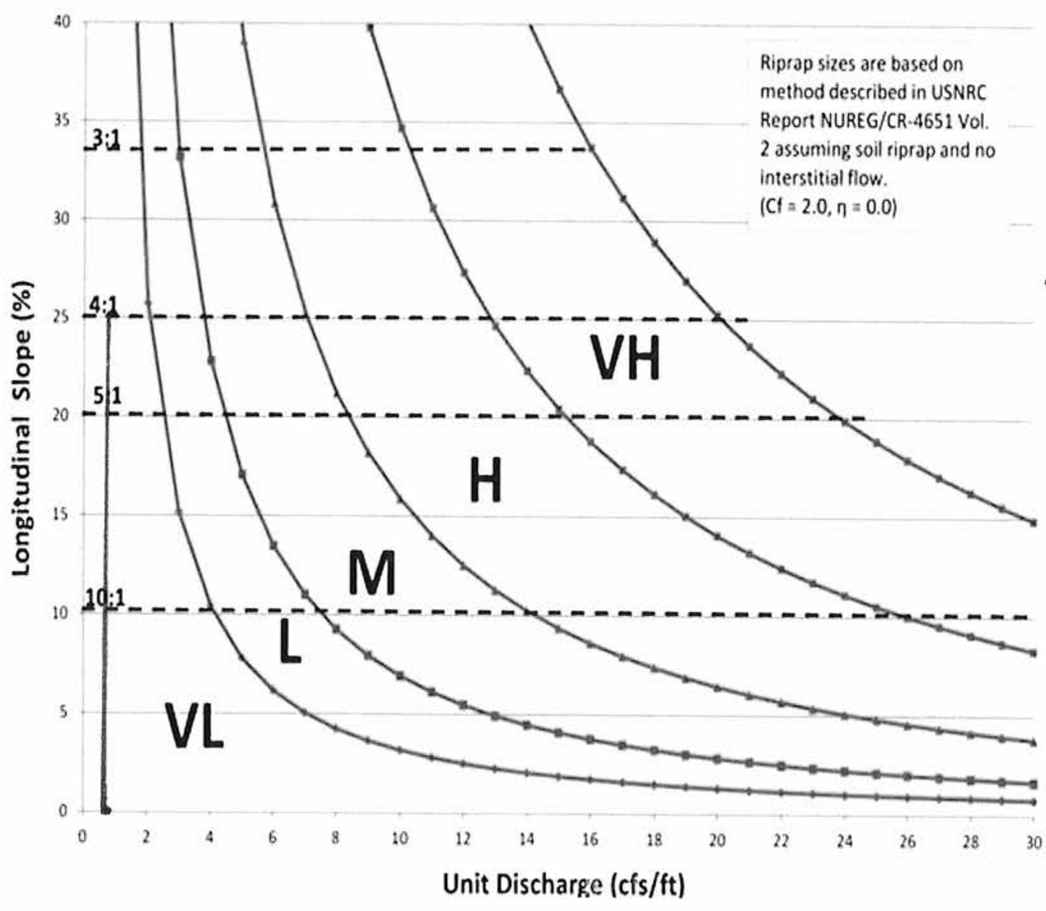


Figure 13-12d. Riprap Types for Emergency Spillway Protection



DOWNSLOPE = 4:1
100 YR INFLOW: 9 cfs.
UNIT DISCHARGE = 0.9 cfs/ft.
REQ = VL
USE = L

Exhibit 8: Calculations

SECURITY FIRE STATION #4
Runoff Coefficients Summary
(Existing Conditions)

		STREETS / DEVELOPED			*LANDSCAPED AREA*			*NATURAL*			*RUNOFF COEFFICIENT*	
BASIN	**TOTAL AREA** *(Acres)*	**AREA** *(Acres)*	C_5	C_{100}	**AREA** *(Acres)*	C_5	C_{100}	**AREA** *(Acres)*	C_5	C_{100}	C_5	C_{100}
A	1.21		0.90	0.96		0.12	0.39	1.21	0.09	0.36	***0.09***	***0.36***
OS1	2.08		0.90	0.96		0.12	0.39	2.08	0.09	0.36	***0.09***	***0.36***
OS4	0.44		0.90	0.96		0.12	0.39	0.44	0.09	0.36	***0.09***	***0.36***
OS2	NA		0.90	0.96		0.12	0.39		0.09	0.36	***#VALUE!***	***#VALUE!***
OS3	NA		0.90	0.96		0.12	0.39		0.09	0.36	***#VALUE!***	***#VALUE!***

SECURITY FIRE STATION #4
Area Drainage Summary
(Existing Conditions)

From Area Runoff Coefficient Summary				OVERLAND				STREET / CHANNEL FLOW				Time of Travel (T_t)		INTENSITY *		TOTAL FLOWS	
BASIN	AREA TOTAL	C_5	C_{100}	C_5	Length	Height	T_C	Length	Slope	Velocity	T_t	TOTAL	CHECK	I_5	I_{100}	Q_5	Q_{100}
	(Acres)	From DCM Table 5-1			(ft)	(ft)	(min)	(ft)	(%)	(fps)	(min)	(min)	(min)	(in/hr)	(in/hr)	(c.f.s.)	(c.f.s.)
A	1.21	0.09	0.36	0.09	150	4.9	15.1	400	3.3%	3.6	1.8	17.0	13.1	3.3	5.6	0.4	2.4
OS1	2.08	0.09	0.36	0.09	150	4.9	15.1	400	3.3%	3.6	1.8	17.0	13.1	3.3	5.6	0.6	4.2
OS4	0.44	0.09	0.36	0.09	150	4.9	15.1	400	3.3%	3.6	1.8	17.0	13.1	3.3	5.6	0.1	0.9
OS2	NA	#VALUE!	#VALUE!	#VALUE!			#VALUE!			0.0	#DIV/0!	#VALUE!	10.0	#VALUE!	#VALUE!	#VALUE!	#VALUE!
OS3	NA	#VALUE!	#VALUE!	#VALUE!			#VALUE!			0.0	#DIV/0!	#VALUE!	10.0	#VALUE!	#VALUE!	#VALUE!	#VALUE!

* Intensity equations assume a minimum travel time of 5 minutes.

3

Calculated by: Ken H
Date: 12/11/2019
Checked by: ______

Security Fire Station
DRAINAGE CALCULATIONS
(Area Runoff Coefficient Summary)

		PAVEMENT/ ROOF			*LANDSCAPED*			*NATURAL*			*RUNOFF COEFFICIENT*	
BASIN	**TOTAL AREA** *(Acres)*	**AREA** *(Acres)*	C_5	C_{100}	**AREA** *(Acres)*	C_5	C_{100}	**AREA** *(Acres)*	C_5	C_{100}	C_5	C_{100}
A	0.04	0.01	0.90	0.96	0.03	0.12	0.39	0.00	0.08	0.35	*0.32*	*0.53*
B	0.01	0.01	0.90	0.96	0.00	0.12	0.39	0.00	0.08	0.35	*0.90*	*0.96*
C	0.02	0.02	0.90	0.96	0.00	0.12	0.39	0.00	0.08	0.35	*0.90*	*0.96*
D	0.08	0.00	0.90	0.96	0.08	0.12	0.39	0.00	0.08	0.35	*0.12*	*0.39*
E	0.23	0.21	0.90	0.96	0.02	0.12	0.39	0.00	0.08	0.35	*0.83*	*0.91*
F	0.03	0.03	0.90	0.96	0.00	0.12	0.39	0.00	0.08	0.35	*0.90*	*0.96*
G	0.19	0.00	0.90	0.96	0.00	0.12	0.39	0.19	0.08	0.35	*0.08*	*0.35*
H	0.09	0.09	0.90	0.96	0.00	0.12	0.39	0.00	0.08	0.35	*0.90*	*0.96*
I	0.09	0.09	0.90	0.96	0.00	0.12	0.39	0.00	0.08	0.35	*0.90*	*0.96*
J	0.01	0.00	0.90	0.96	0.01	0.12	0.39	0.00	0.08	0.35	*0.12*	*0.39*
K	0.18	0.14	0.90	0.96	0.04	0.12	0.39	0.00	0.08	0.35	*0.73*	*0.83*
L	0.13	0.00	0.90	0.96	0.00	0.12	0.39	0.13	0.08	0.35	*0.08*	*0.35*
M	0.17	0.04	0.90	0.96	0.00	0.12	0.39	0.13	0.08	0.35	*0.27*	*0.49*
N	0.03	0.00	0.90	0.96	0.00	0.12	0.39	0.03	0.08	0.35	*0.08*	*0.35*
O	0.02	0.01	0.90	0.96	0.00	0.12	0.39	0.01	0.08	0.35	*0.49*	*0.66*
P	0.01	0.00	0.90	0.96	0.00	0.12	0.39	0.01	0.08	0.35	*0.08*	*0.35*
Q	0.01	0.01	0.90	0.96	0.00	0.12	0.39	0.00	0.08	0.35	*0.90*	*0.96*
R	0.04	0.00	0.90	0.96	0.00	0.12	0.39	0.04	0.08	0.35	*0.08*	*0.35*

Security Fire Station
FINAL DRAINAGE REPORT
Developed Onsite Conditions

From Area Runoff Coefficient Summary				Time of Travel (T_t)		INTENSITY *		TOTAL FLOWS	
BASIN	AREA TOTAL	C_5	C_{100}	TOTAL	CHECK	I_5	I_{100}	Q_5	Q_{100}
	(Acres)	From DCM Table 5-1		(min)	(min)	(in/hr)	(in/hr)	(c.f.s.)	(c.f.s.)
A	0.04	0.32	0.53	5.0	10.0	5.2	8.7	0.1	0.2
B	0.01	0.90	0.96	5.0	10.0	5.2	8.7	0.0	0.1
C	0.02	0.90	0.96	5.0	10.0	5.2	8.7	0.1	0.2
D	0.08	0.12	0.39	5.0	10.0	5.2	8.7	0.0	0.3
E	0.23	0.83	0.91	5.0	10.0	5.2	8.7	1.0	1.8
F	0.03	0.90	0.96	5.0	10.0	5.2	8.7	0.1	0.2
G	0.19	0.08	0.35	5.0	10.0	5.2	8.7	0.1	0.6
H	0.09	0.90	0.96	5.0	10.0	5.2	8.7	0.4	0.7
I	0.09	0.90	0.96	5.0	10.0	5.2	8.7	0.4	0.7
J	0.01	0.12	0.39	5.0	10.0	5.2	8.7	0.0	0.0
K	0.18	0.73	0.83	5.0	10.0	5.2	8.7	0.7	1.3
L	0.13	0.08	0.35	5.0	10.0	5.2	8.7	0.1	0.4
M	0.17	0.27	0.49	5.0	10.0	5.2	8.7	0.2	0.7
N	0.03	0.08	0.35	5.0	10.0	5.2	8.7	0.0	0.1
O	0.02	0.49	0.66	5.0	10.0	5.2	8.7	0.1	0.1
P	0.01	0.08	0.35	5.0	10.0	5.2	8.7	0.0	0.0
Q	0.01	0.90	0.96	5.0	10.0	5.2	8.7	0.0	0.1
R	0.04	0.08	0.35	5.0	10.0	5.2	8.7	0.0	0.1

Basin Summary

Existing/ Historic Conditions

Sub basin ID	Area	Time of Conc	Runoff Coefficient		Design Discharges	
	(Acres)	min.	5 year	100 year	5 year (cfs)	100 year (cfs)
OS1	2.06	17	0.09	0.36	0.60	4.20
OS4	0.44	17	0.09	0.36	0.10	0.90
A	1.21	17	0.09	0.36	0.40	2.40

Design Point Summary

Existing/ Historic Conditions

Design Point ID	Description	Contributing Sub Basins	Q5 (cfs)	Q100 (cfs)
1	SE corner of the site at Swale 1	OS1	0.6	4.2
2	SE corner of the site at Swale 2	OS4	0.1	0.9
3	Swale 1 project site outlet point on west PL	A, OS1	1	4.2
4	NW corner of site on Wayfayer Drive	OS2	NA	NA
5	Downstream facility locations	ID shown for info purposes only	NA	NA

Basin Summary

Developed Conditions

Sub basin ID	Area	Time of Conc	Runoff Coefficient		Design Discharges	
	(Acres)	min.	5 year	100 year	5 year (cfs)	100 year (cfs)
A	0.04	5	0.32	0.53	0.10	0.20
B	0.01	5	0.90	0.96	Negligible	0.10
C	0.02	5	0.90	0.96	0.10	0.20
D	0.08	5	0.12	0.39	Negligible	0.30
E	0.23	5	0.83	0.91	1.00	1.80
F	0.03	5	0.90	0.96	0.10	0.20
G	0.19	5	0.08	0.35	0.10	0.60
H	0.09	5	0.90	0.96	0.40	0.70
I	0.09	5	0.90	0.96	0.40	0.70
J	0.01	5	0.12	0.39	Negligible	Negligible
K	0.18	5	0.73	0.83	0.70	1.30
L	0.13	5	0.08	0.35	0.10	0.40
M	0.17	5	0.27	0.49	0.20	0.70
N	0.03	5	0.08	0.35	Negligible	0.10
O	0.02	5	0.49	0.66	0.10	0.20
P	0.01	5	0.08	0.35	Negligible	Negligible
Q	0.01	5	0.90	0.96	Negligible	0.10
R	0.04	5	0.08	0.35	Negligible	0.10

Design Point Summary

Surface Flow Developed Conditions

Design Point ID	Contributing sub Basin for surface flow	Description	Q5 (surface flow) (cfs)	Q100 (surface flow) (cfs)
1	OS2	Upstream end of proposed cross pan in Wayfarere Drive	NA	NA
2	OS2, A	Upstream end of proposed cross pan in Wayfarere Drive	NA	NA
3	D	Nyplast inlet	0	0.3
4	F	Nyplast inlet	0.1	0.2
5	NA	NW Roof downspout into storm sewer	neg	neg
6	NA	NOT USED	NA	NA
7	I	SW Roof downspout into storm sewer	0.4	0.7
8	E	Nyplast inlet	1	1.8
9	H	SE Roof downspout into storm sewer	0.4	0.7
10	O	Concrete Channel to FSD pond	0.1	0.2
11	see pond narrative	FSD pond outlet structure	see pond narrative	see pond narrative
12	OS1, G, N	Upstream end of 24" RCP culvert	0.7	3.1
13	OS4	Upstream end of 18" RCP culvert	0.1	0.9
14	NA	east end of drive apron onto Mesa Ridge Parkway	NA	NA
15	emergency overflow, OS4, G, N, M	Swale 1 outfal at west PL	2.9	8.1
16	see pond worksheet	FSD pond outfall of STR28	0.1	1.2
17	K	Nyplast inlet	0.7	1.3
18	OS1, G, N	Downstream end of 24" RCP culvert	0.7	3.1
19	OS4	west end of 18" RCP Driveway culvert	0.1	0.9
20	see pond worksheet	Outlet of STR 19	0.1	1.2
21	NA	Junction fitting	NA	NA
22	O	Outlet of STR 27	0.1	0.2

Structure and Pipe Summary

STR ID	Description
1	Nyplast inlet
2	Nyplast inlet
3	12" HDPE
4	fitting
5	fitting
6	Nyplast inlet
7	NOT USED
8	roof drain
9	NOT USED
10	12" HDPE
11	12" HDPE
12	NOT USED
13	12" HDPE
14	12" HDPE
15	NOT USED
16	NOT USED
17	12" HDPE
18	12" HDPE
19	12" HDPE
20	NOT USED
21	NOT USED
22	6" HDPE
23	12" HDPE

24	fitting
25	Nyplast inlet
26	12" HDPE
27	concrete chase
28	12" HDPE
29	24" CLIV RCP
30	18" CLIV RCP
31	riprap emergency spillway

Storm Sewer Summary

Developed Conditions

STR #	Design Q100 year cfs	size (HDPE) inches	slope %	Depth inches	Velocity fps	Calc Sht #
14	0.3	12	1.0	0.2	2.7	11
3	1.1	12	1.0	0.3	4.0	12
17	1.2	12	1.0	0.3	4.1	13
18	1.2	12	1.0	0.3	4.1	14
26	2.5	12	7.7	0.3	10.3	15
23	0.7	12	4.0	0.2	5.7	16
10	0.7	12	7.0	0.2	7.0	17
11	1.8	12	10.0	0.2	10.3	18
13	2.5	12	10.0	0.3	11.4	19
19	3.8	12	7.8	0.3	11.8	20
27	0.2	concrete chase	23.0	0.1	1.0	21
29	3.1	24" CL IV RCP	2.0	0.3	6.2	22
30	0.9	18" CL IV RCP	2.0	0.2	4.5	23

Notes

1 All storm sewer segments, inlets, manholes, cleanouts, and fittings are noted by a "STR" number.

2 The storm sewer segments were sized to accommodate 100% of the runoff from the 100-year storm for all contributing sub basins. Runoff quantities for the 5-year storm event are shown for information purposes only.

3 The inlets were sized to intercept 80% of the surface design flow with 20% bypass from upstream inlets.

4 The emergency spillway was sized based on the overall imperviousness of all of the contributing sub basins. This is not necessarilly reflected in the UDFC Worksheet

Storm Sewer Design Flows

Developed Conditions

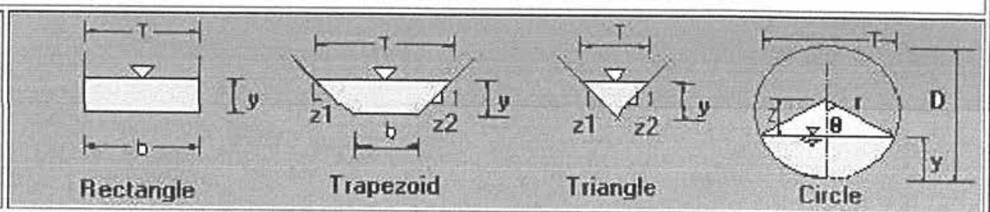
Structure #	Sub basin ID	Area	"C"		Runoff	
		(acres)	5 year	100 year	5 year	100 year
	A	0.04	0.32	0.53	0.1	0.2
	B	0.01	0.90	0.96	0.0	0.1
	C	0.02	0.90	0.96	0.1	0.2
	D	0.08	0.12	0.39	0.0	0.3
	E	0.23	0.83	0.91	1.0	1.8
	F	0.03	0.90	0.96	0.1	0.2
	G	0.19	0.08	0.35	0.1	0.6
	H	0.09	0.90	0.96	0.4	0.7
	I	0.09	0.90	0.96	0.4	0.7
	J	0.01	0.12	0.39	0.0	0.0
	K	0.18	0.73	0.83	0.7	1.3
	L	0.13	0.08	0.35	0.1	0.4
	M	0.17	0.27	0.49	0.2	0.7
	N	0.03	0.08	0.35	0.0	0.1
	O	0.02	0.49	0.66	0.1	0.2
	P	0.01	0.08	0.35	0.0	0.0
	Q	0.01	0.90	0.96	0.0	0.1
	R	0.01	0.08	0.35	0.0	0.1
	OS1	2.08	0.09	0.09	0.6	4.2
	OS4	0.44	0.09	0.09	0.1	0.9
14	D	0.08	0.12	0.39	0.0	0.3
	Subtotl STR 14	0.08			0.0	0.3
3	D	0.08	0.12	0.39	0.0	0.3
	F	0.03	0.90	0.96	0.1	0.2
	Subtotal STR3	0.27			0.1	1.1
18	D	0.08	0.12	0.39	0.0	0.3
	F	0.03	0.90	0.96	0.1	0.2
	H	0.09	0.90	0.96	0.4	0.7
	Subtotal STR18	0.2			0.5	1.2
26	D	0.08	0.12	0.39	0.0	0.3
	F	0.03	0.90	0.96	0.1	0.2
	H	0.09	0.90	0.96	0.4	0.7
	K	0.18	0.73	0.83	0.7	1.3
	Subtotal STR18	0.38			1.2	2.5
23	I	0.09	0.90	0.96	0.4	0.7
	Subtotal STR23	0.09			0.4	0.7
10	I	0.09	0.90	0.96	0.4	0.7
	Subtotal STR10	0.09			0.4	0.7
11	E	0.23	0.83	0.91	1.0	1.8

Structure #	Sub basin ID	Area	"C"		Runoff	
		(acres)	5 year	100 year	5 year	100 year
	J	0.01	0.12	0.39	0.0	0.0
	Subtotal STR11	0.24			1.0	1.8
13	I	0.09	0.90	0.96	0.4	0.7
	E	0.23	0.83	0.91	1.0	1.8
	J	0.01	0.12	0.39	0.0	0.0
	Subtotal STR11	0.33			1.4	2.5
26	D	0.08	0.12	0.39	0.0	0.3
	F	0.03	0.90	0.96	0.1	0.2
	H	0.09	0.90	0.96	0.4	0.7
	K	0.18	0.73	0.83	0.7	1.3
	Subtotal STR26	0.38			1.2	2.5
19	D	0.08	0.12	0.39	0.0	0.3
	F	0.03	0.90	0.96	0.1	0.2
	H	0.09	0.90	0.96	0.4	0.7
	K	0.18	0.73	0.83	0.7	1.3
	I	0.09	0.90	0.96	0.4	0.7
	E	0.23	0.83	0.91	1.0	1.8
	J	0.01	0.12	0.39	0.0	0.0
	Subtotal STR19	0.51			2.1	3.8
27	O	0.02	0.49	0.66	0.1	0.2
	Subtotal STR27	0.02			0.1	0.2
29	OS1	2.08	0.09	0.09	0.6	2.4
	G	0.19	0.08	0.35	0.1	0.6
	N	0.03	0.08	0.35	0.0	0.1
	Subtotal STR27	2.3			0.7	3.1
30	OS4	0.44	0.09	0.09	0.1	0.9
	Subtotal STR30	0.44			0.1	0.9
Swale 1 west of site	emergency overflow				2.5	5.8
	OS4	0.44	0.09	0.09	0.1	0.9
	G	0.19	0.08	0.35	0.1	0.6
	N	0.03	0.08	0.35	0.0	0.1
	M	0.17	0.27	0.49	0.2	0.7
	Subtotal Swale 1 west of site	0.83			2.9	8.1

CS I
STR 14
100 year

The open channel flow calculator

Select Channel Type: Circle

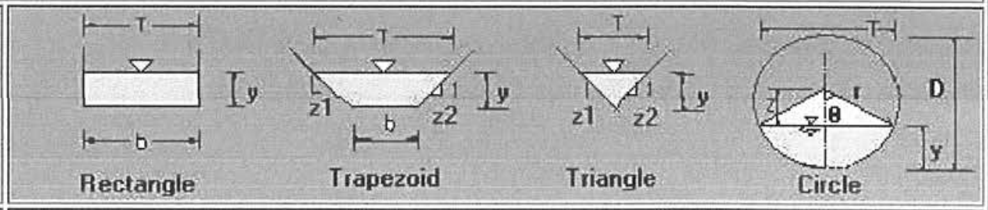


Depth from Q | Select unit system: Feet(ft)

Channel slope: .01 ft/ft	Water depth(y): 0.16 ft	Radius (r) 1 ft
Flow velocity 2.6689 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge 0.3 ft^3/s	Input n value 0.012 or select n clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 1.13 ft	Flow area 0.11 ft^2	Top width(T) 1.07 ft
Specific energy 0.27 ft	Froude number 1.45	Flow status Supercritical flow
Critical depth 0.19 ft	Critical slope 0.0042 ft/ft	Velocity head 0.11 ft

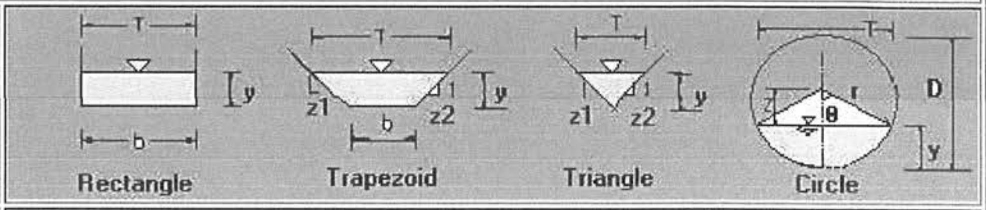
CS2
STR3
100 year

The open channel flow calculator

Select Channel Type: Circle		
Depth from Q	Select unit system: Feet(ft)	
Channel slope: .0 ft/ft	Water depth(y): 0.16 ft	Radius (r) 1 ft
Flow velocity 2.6689 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge 0.3 ft^3/s	Input n value 0.012 or select n clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 1.13 ft	Flow area 0.11 ft^2	Top width(T) 1.07 ft
Specific energy 0.27 ft	Froude number 1.45	Flow status Supercritical flow
Critical depth 0.19 ft	Critical slope 0.0042 ft/ft	Velocity head 0.11 ft

CS 3
STP 23
100 year

The open channel flow calculator

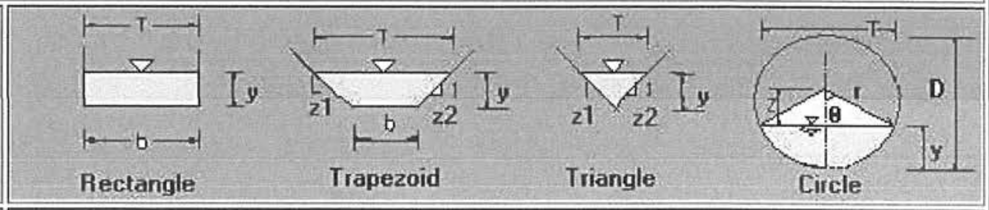
Select Channel Type: Circle	
Depth from Q	Select unit system: Feet(ft)

Channel slope: .04 ft/ft	Water depth(y): 0.17 ft	Radius (r) 1 ft
Flow velocity 5.6548 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge 0.7 ft^3/s	Input n value 0.012 or select n clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 1.19 ft	Flow area 0.13 ft^2	Top width(T) 1.12 ft
Specific energy 0.67 ft	Froude number 2.93	Flow status Supercritical flow
Critical depth 0.29 ft	Critical slope 0.004 ft/ft	Velocity head 0.5 ft

CS4
STR 11
100 year

The open channel flow calculator

Select Channel Type: Circle



Depth from Q | Select unit system: Feet(ft)

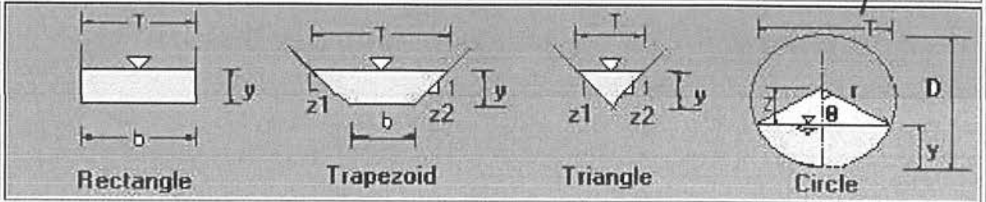
Channel slope: .10 ft/ft	Water depth(y): 0.21 ft	Radius (r) 1 ft
Flow velocity 10.3467 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge 1.8 ft^3/s	Input n value 0.012 or select n clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 1.33 ft	Flow area 0.18 ft^2	Top width(T) 1.24 ft
Specific energy 1.88 ft	Froude number 4.76	Flow status Supercritical flow
Critical depth 0.47 ft	Critical slope 0.0038 ft/ft	Velocity head 1.66 ft

CS5

SCR 17
100 yr

The open channel flow calculator

Select Channel Type: Circle



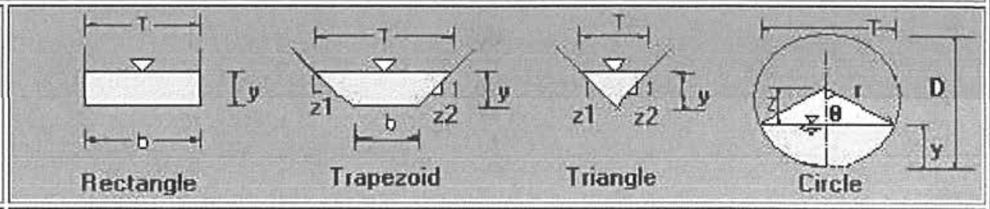
Depth from Q | Select unit system: Feet(ft)

Channel slope: .01 ft/ft	Water depth(y): 0.21 ft	Radius (r) 1 ft
Flow velocity 10.3467 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge 1.2 ft^3/s	Input n value 0.012 or select n clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 1.33 ft	Flow area 0.18 ft^2	Top width(T) 1.24 ft
Specific energy 1.88 ft	Froude number 4.76	Flow status Supercritical flow
Critical depth 0.47 ft	Critical slope 0.0038 ft/ft	Velocity head 1.66 ft

C 36
STD 18
100yr

The open channel flow calculator

Select Channel Type: Circle



Depth from Q

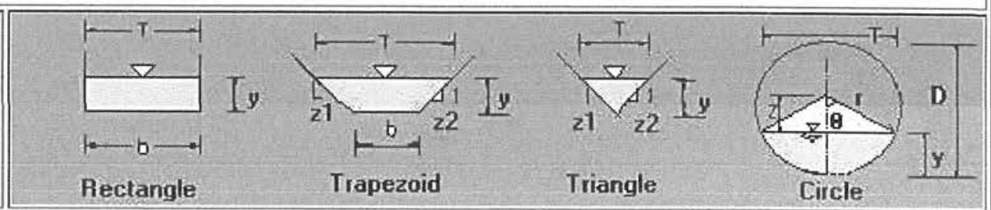
Select unit system: Feet(ft)

Channel slope: .077 ft/ft	Water depth(y): 0.19 ft	Radius (r) 1 ft
Flow velocity 8.2703 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge 1.2 ft^3/s	Input n value 0.012 or select n clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 1.24 ft	Flow area 0.15 ft^2	Top width(T) 1.16 ft
Specific energy 1.25 ft	Froude number 4.11	Flow status Supercritical flow
Critical depth 0.38 ft	Critical slope 0.0038 ft/ft	Velocity head 1.06 ft

CS 7
JTR 27
100 year

The open channel flow calculator

Select Channel Type: Rectangle



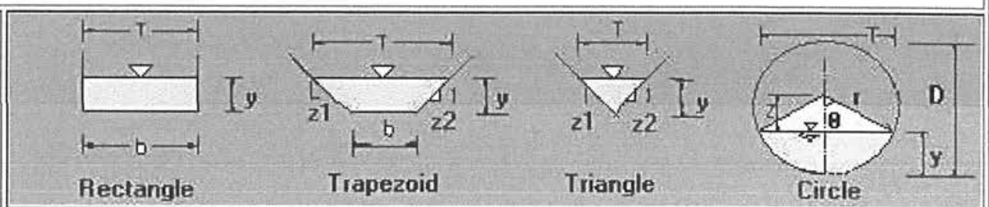
Depth from Q

Select unit system: Feet(ft)

Channel slope: 0.23 ft/ft	Water depth(y): 0.03 ft	Bottom W(b) 2 ft
Flow velocity 3.846154 ft/s	LeftSlope (Z1): 0 to 1 (H:V)	RightSlope (Z2): 0 to 1 (H:V)
Flow discharge .2 ft^3/s	Input n value .014 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 2.05 ft	Flow area 0.05 ft^2	Top width(T) 2 ft
Specific energy 0.26 ft	Froude number 4.2	Flow status Supercritical flow
Critical depth 0.07 ft	Critical slope 0.0069 ft/ft	Velocity head 0.23 ft

CS 8
STR 29
100 year

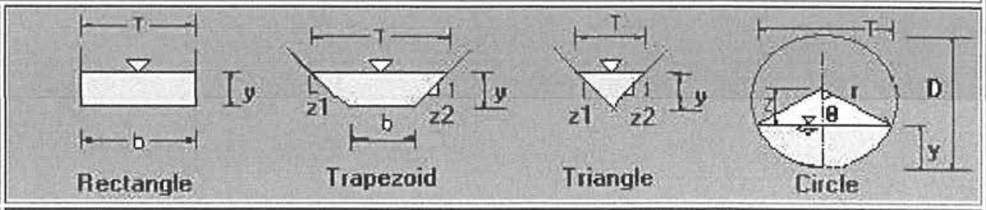
The open channel flow calculator

Select Channel Type: Circle	
Depth from Q	Select unit system: Feet(ft)

Channel slope: 0.022 ft/ft	Water depth(y): 0.38 ft	Radius (r) 2 ft
Flow velocity 7.0882 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge 4.2 ft^3/s	Input n value .012 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 2.49 ft	Flow area 0.6 ft^2	Top width(T) 2.34 ft
Specific energy 1.16 ft	Froude number 2.47	Flow status Supercritical flow
Critical depth 0.59 ft	Critical slope 0.0032 ft/ft	Velocity head 0.78 ft

CS9
STR 30
100 year

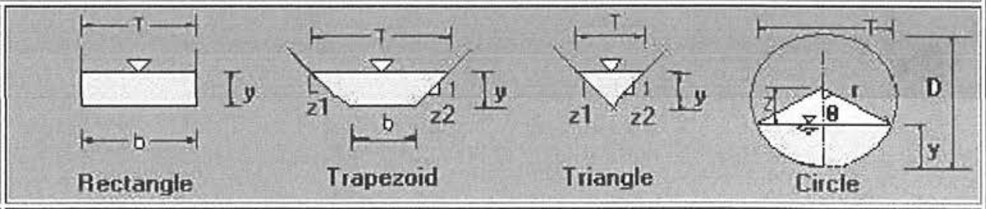
The open channel flow calculator



Select Channel Type: Circle		
Depth from Q	Select unit system: Feet(ft)	
Channel slope: 0.022 ft/ft	Water depth(y): 0.34 ft	Radius (r) 1.5 ft
Flow velocity 6.6064 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge 2.9 ft^3/s	Input n value .012 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 2.07 ft	Flow area 0.45 ft^2	Top width(T) 1.91 ft
Specific energy 1.02 ft	Froude number 2.41	Flow status Supercritical flow
Critical depth 0.53 ft	Critical slope 0.0034 ft/ft	Velocity head 0.68 ft

CS 10
STR 19
100 year

The open channel flow calculator

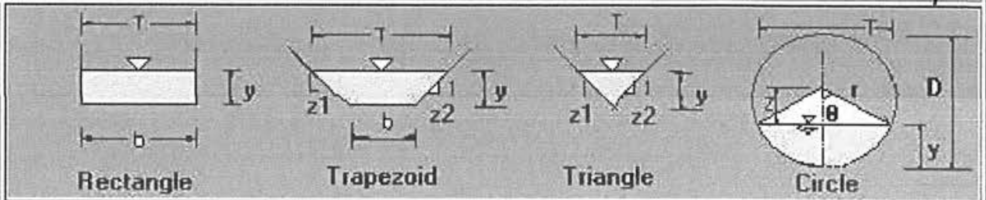
Select Channel Type: Circle		
Depth from Q	Select unit system: Feet(ft)	
Channel slope: 0.077 ft/ft	Water depth(y): 0.21 ft	Radius (r) 1 ft
Flow velocity 9.0792 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge 1.6 ft^3/s	Input n value .012 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 1.33 ft	Flow area 0.18 ft^2	Top width(T) 1.24 ft
Specific energy 1.49 ft	Froude number 4.18	Flow status Supercritical flow
Critical depth 0.44 ft	Critical slope 0.0037 ft/ft	Velocity head 1.28 ft

CS 11

STR 14
100 yr

The open channel flow calculator

Select Channel Type: Circle



Depth from Q

Select unit system: Feet(ft)

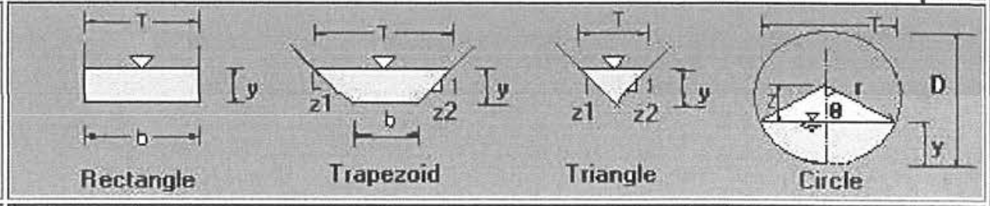
Channel slope: .01 ft/ft	Water depth(y): 0.16 ft	Radius (r) 1 ft
Flow velocity 2.6689 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge .3 ft^3/s	Input n value .012 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 1.13 ft	Flow area 0.11 ft^2	Top width(T) 1.07 ft
Specific energy 0.27 ft	Froude number 1.45	Flow status Supercritical flow
Critical depth 0.19 ft	Critical slope 0.0042 ft/ft	Velocity head 0.11 ft

CS 12

The open channel flow calculator

STR 3
100 yr

Select Channel Type: Circle



Depth from Q | Select unit system: Feet(ft)

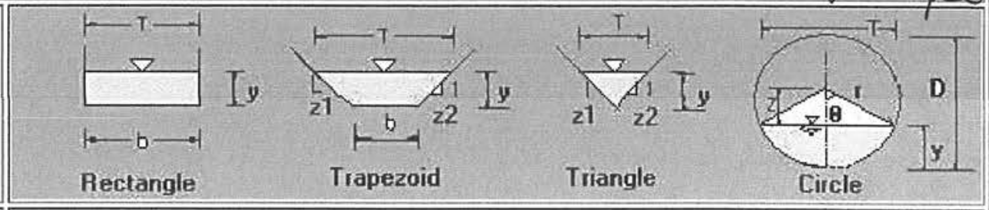
Channel slope: .01 ft/ft	Water depth(y): 0.29 ft	Radius (r) 1 ft
Flow velocity 3.9733 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge 1.1 ft^3/s	Input n value .012 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 1.57 ft	Flow area 0.29 ft^2	Top width(T) 1.41 ft
Specific energy 0.54 ft	Froude number 1.56	Flow status Supercritical flow
Critical depth 0.36 ft	Critical slope 0.0039 ft/ft	Velocity head 0.25 ft

CS 13

STR 17
100 year

The open channel flow calculator

Select Channel Type: Circle



Depth from Q

Select unit system: Feet(ft)

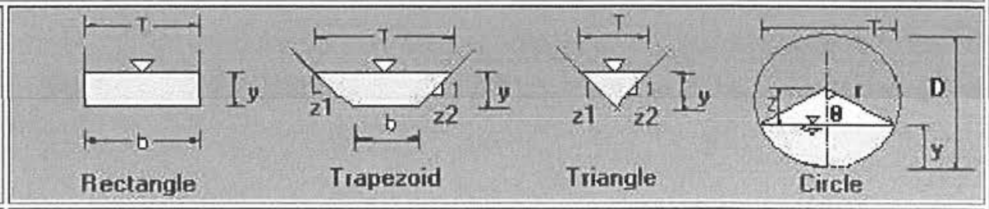
Channel slope: .01 ft/ft	Water depth(y): 0.3 ft	Radius (r) 1 ft
Flow velocity 4.0546 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge 1.2 ft^3/s	Input n value .012 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 1.6 ft	Flow area 0.3 ft^2	Top width(T) 1.43 ft
Specific energy 0.56 ft	Froude number 1.56	Flow status Supercritical flow
Critical depth 0.38 ft	Critical slope 0.0038 ft/ft	Velocity head 0.26 ft

CSV4

STR 18
100YR

The open channel flow calculator

Select Channel Type: Circle



Depth from Q | Select unit system: Feet(ft)

Channel slope: .01 ft/ft	Water depth(y): 0.3 ft	Radius (r) 1 ft
Flow velocity 4.0546 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge 1.2 ft^3/s	Input n value .012 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 1.6 ft	Flow area 0.3 ft^2	Top width(T) 1.43 ft
Specific energy 0.56 ft	Froude number 1.56	Flow status Supercritical flow
Critical depth 0.38 ft	Critical slope 0.0038 ft/ft	Velocity head 0.26 ft

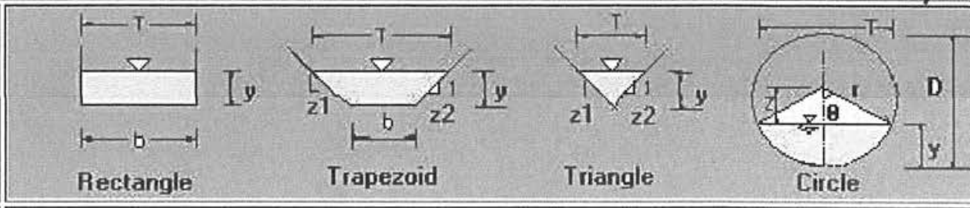
CS 15

STR 26

100 year

The open channel flow calculator

Select Channel Type: Circle



Depth from Q | Select unit system: Feet(ft)

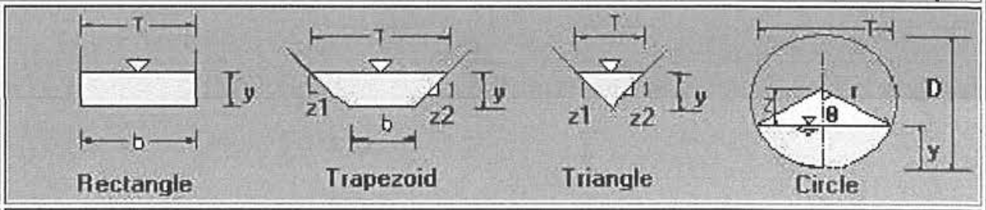
Channel slope: .077 ft/ft	Water depth(y): 0.26 ft	Radius (r) 1 ft
Flow velocity 10.3272 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge 2.5 ft^3/s	Input n value .012 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 1.49 ft	Flow area 0.24 ft^2	Top width(T) 1.35 ft
Specific energy 1.92 ft	Froude number 4.28	Flow status Supercritical flow
Critical depth 0.55 ft	Critical slope 0.0037 ft/ft	Velocity head 1.66 ft

CS16

STR 23
100 YR

The open channel flow calculator

Select Channel Type: Circle



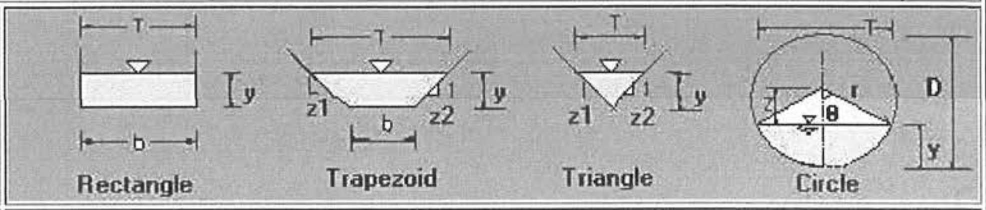
Depth from Q | Select unit system: Feet(ft)

Channel slope: .04 ft/ft	Water depth(y): 0.17 ft	Radius (r) 1 ft
Flow velocity 5.6548 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge .7 ft^3/s	Input n value 0.012 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 1.19 ft	Flow area 0.13 ft^2	Top width(T) 1.12 ft
Specific energy 0.67 ft	Froude number 2.93	Flow status Supercritical flow
Critical depth 0.29 ft	Critical slope 0.004 ft/ft	Velocity head 0.5 ft

CS 17

STR 10
100 year

The open channel flow calculator

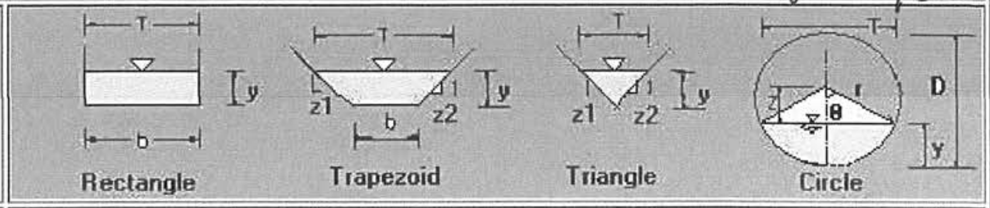
Select Channel Type: Circle	
Depth from Q	Select unit system: Feet(ft)

Channel slope: .07 ft/ft	Water depth(y): 0.15 ft	Radius (r) 1 ft
Flow velocity 6.9181 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge .7 ft^3/s	Input n value 0.012 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 1.11 ft	Flow area 0.11 ft^2	Top width(T) 1.06 ft
Specific energy 0.89 ft	Froude number 3.81	Flow status Supercritical flow
Critical depth 0.29 ft	Critical slope 0.004 ft/ft	Velocity head 0.74 ft

STR 11
100 year

The open channel flow calculator

Select Channel Type: Circle



Depth from Q | Select unit system: Feet(ft)

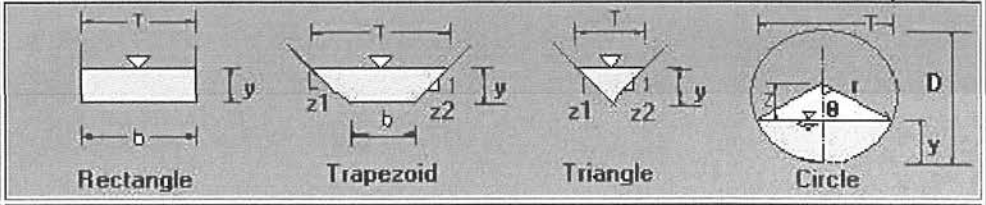
Channel slope: .1 ft/ft	Water depth(y): 0.21 ft	Radius (r) 1 ft
Flow velocity 10.3467 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge 1.8 ft^3/s	Input n value 0.012 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 1.33 ft	Flow area 0.18 ft^2	Top width(T) 1.24 ft
Specific energy 1.88 ft	Froude number 4.76	Flow status Supercritical flow
Critical depth 0.47 ft	Critical slope 0.0038 ft/ft	Velocity head 1.66 ft

CS19

The open channel flow calculator

STR 13
100 Year

Select Channel Type: Circle



Depth from Q

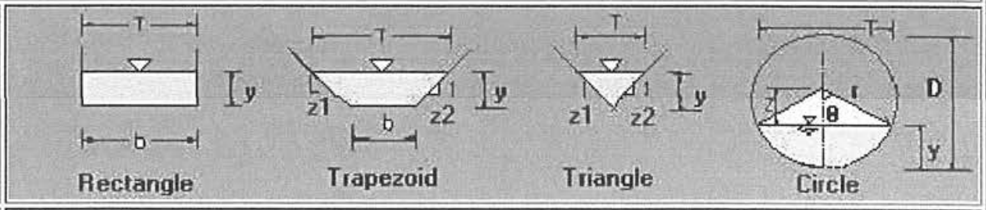
Select unit system: Feet(ft)

Channel slope: .1 ft/ft	Water depth(y): 0.25 ft	Radius (r) 1 ft
Flow velocity 11.3557 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge 2.5 ft^3/s	Input n value .012 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 1.44 ft	Flow area 0.23 ft^2	Top width(T) 1.32 ft
Specific energy 2.25 ft	Froude number 4.85	Flow status Supercritical flow
Critical depth 0.55 ft	Critical slope 0.0037 ft/ft	Velocity head 2 ft

C520
STR 19
100 year

The open channel flow calculator

Select Channel Type: Circle



Depth from Q | Select unit system: Feet(ft)

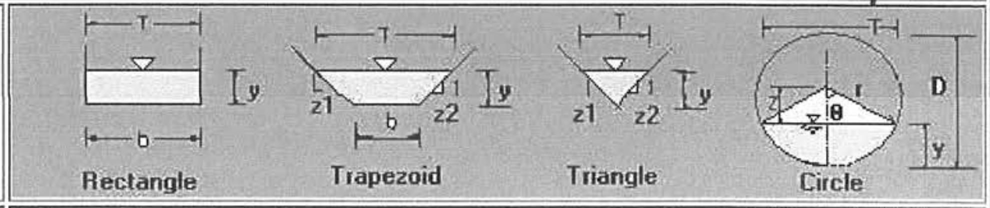
Channel slope: .078 ft/ft	Water depth(y): 0.32 ft	Radius (r) 1 ft
Flow velocity 11.767 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge 3.8 ft^3/s	Input n value .012 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 1.65 ft	Flow area 0.33 ft^2	Top width(T) 1.47 ft
Specific energy 2.47 ft	Froude number 4.39	Flow status Supercritical flow
Critical depth 0.69 ft	Critical slope 0.0038 ft/ft	Velocity head 2.15 ft

C521

The open channel flow calculator

STR 29
100 year

Select Channel Type: Rectangle



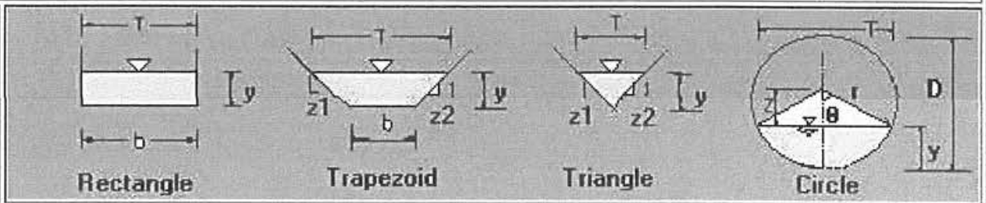
Depth from Q | Select unit system: Feet(ft)

Channel slope: .23 ft/ft	Water depth(y): 0.1 ft	Bottom W(b) 2 ft
Flow velocity 0.971817 ft/s	LeftSlope (Z1): 0 to 1 (H:V)	RightSlope (Z2): 0 to 1 (H:V)
Flow discharge 0.2 ft^3/s	Input n value 0.14 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 2.21 ft	Flow area 0.21 ft^2	Top width(T) 2 ft
Specific energy 0.12 ft	Froude number 0.53	Flow status Subcritical flow
Critical depth 0.07 ft	Critical slope 0.7338 ft/ft	Velocity head 0.01 ft

CS 22
STR 29
100 year

The open channel flow calculator

Select Channel Type: Circle



Depth from Q

Select unit system: Feet(ft)

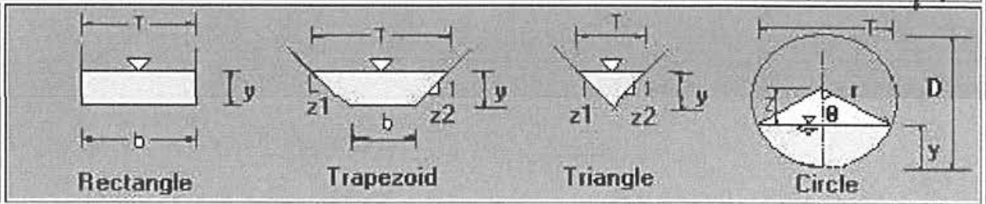
Channel slope: .02 ft/ft	Water depth(y): 0.33 ft	Radius (r) 2 ft
Flow velocity 6.2422 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge 3.1 ft^3/s	Input n value .012 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 2.34 ft	Flow area 0.5 ft^2	Top width(T) 2.21 ft
Specific energy 0.94 ft	Froude number 2.32	Flow status Supercritical flow
Critical depth 0.51 ft	Critical slope 0.0033 ft/ft	Velocity head 0.61 ft

CS 23

STR 30
100 YR

The open channel flow calculator

Select Channel Type: Circle



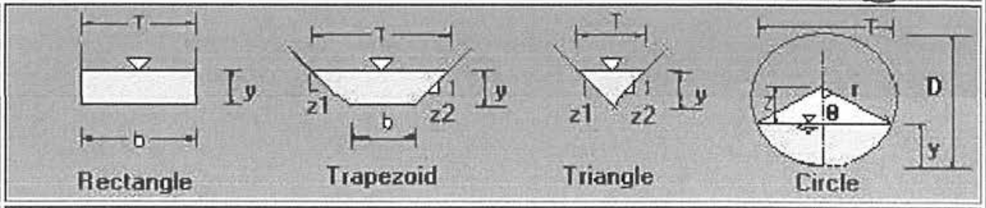
Depth from Q | Select unit system: Feet(ft)

Channel slope: .02 ft/ft	Water depth(y): 0.2 ft	Radius (r) 1.5 ft
Flow velocity 4.4732 ft/s	LeftSlope (Z1): to 1 (H:V)	RightSlope (Z2): to 1 (H:V)
Flow discharge .9 ft^3/s	Input n value .012 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 1.57 ft	Flow area 0.2 ft^2	Top width(T) 1.5 ft
Specific energy 0.51 ft	Froude number 2.14	Flow status Supercritical flow
Critical depth 0.29 ft	Critical slope 0.0039 ft/ft	Velocity head 0.31 ft

CS 24
100 year
Riprap channel
~~below down~~ in
swale I

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

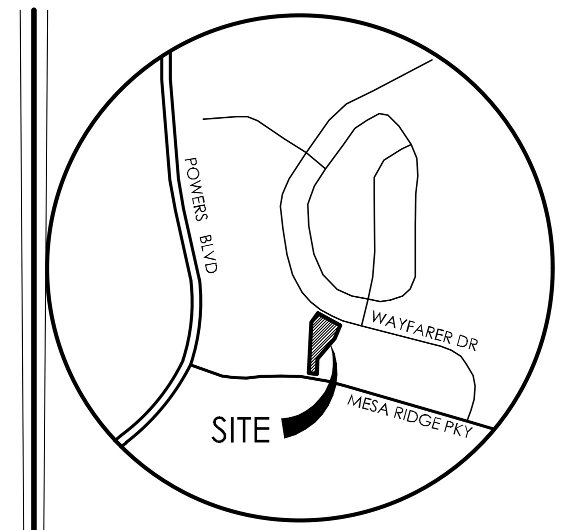
Channel slope: .015 ft/ft	Water depth(y): 0.49 ft	Bottom width(b) 2 ft
Flow velocity 4.832457 ft/s	LeftSlope (Z1): 3 to 1 (H:V)	RightSlope (Z2): 3 to 1 (H:V)
Flow discharge 8.1 ft^3/s	Input n value 0.018 or select n clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 5.07 ft	Flow area 1.68 ft^2	Top width(T) 4.91 ft
Specific energy 0.85 ft	Froude number 1.46	Flow status Supercritical flow
Critical depth 0.6 ft	Critical slope 0.0065 ft/ft	Velocity head 0.36 ft

Exhibit 10: Existing Drainage Conditions (map pocket)

LEGEND

EXISTING
INDEX CONTOUR
INTERMEDIATE CONTOUR

PROPOSED
INDEX CONTOUR
INTERMEDIATE CONTOUR
BASIN BOUNDARY
GENERAL FLOW/DIRECTION
SLOPE DIRECTION
BASIN LABEL
BASIN ID
BASIN AREA (AC.)
POINT OF INTEREST
DRAINAGE ITEM (SEE TABLE)



VICINITY MAP
NOT TO SCALE

BENCHMARK

1" = 30' 1:360

Design Point Summary

Existing/ Historic Conditions

Design Point ID	Description	Contributing Sub Basins	Q5 (cfs)	Q100 (cfs)
1	SE corner of the site at Swale 1	OS1	0.6	4.2
2	SE corner of the site at Swale 2	OS4	0.1	0.9
3	Swale 1 project site outlet point on west PL	A, OS1	1	4.2
4	NW corner of site on Wayfayer Drive	OS2	NA	NA
5	Downstream facility locations	ID shown for info purposes only	NA	NA

Basin Summary

Existing/ Historic Conditions

Sub basin ID	Area	Time of Conc	Runoff Coefficient		Design Discharges	
	(Acres)	min.	5 year	100 year	5 year (cfs)	100 year (cfs)
OS1	2.06	17	0.09	0.36	0.60	4.20
OS4	0.44	17	0.09	0.36	0.10	0.90
A	1.21	17	0.09	0.36	0.40	2.40

MVE, INC.
ENGINEERS, SURVEYORS
1903 lelaray street, suite 200 colorado springs co 80909 719.635.5736

REVISIONS

DESIGNED BY
DRAWN BY
CHECKED BY
AS-BUILTS BY
CHECKED BY

SECURITY FIRE
STATION NO. 4

DRAINAGE MAP

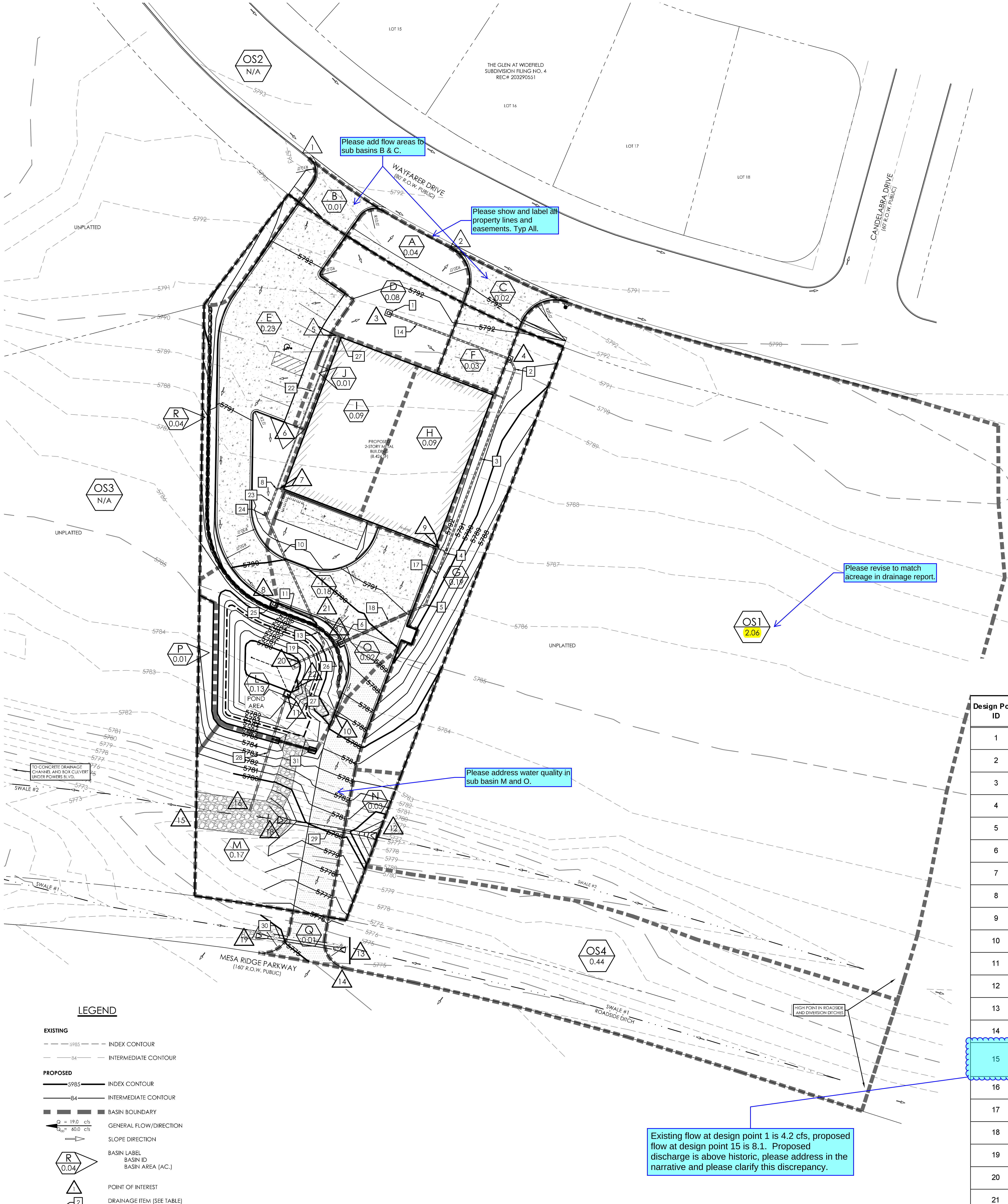
EXISTING

MVE PROJECT 61134
MVE DRAWING DRAIN-EX

SEPTEMBER 10, 2020

SHEET 1 OF 1

Exhibit 11: Developed Drainage Conditions (map pocket)



Structure and Pipe Summary

STR ID	Description
1	Nyplast inlet
2	Nyplast inlet
3	12" HDPE
4	fitting
5	fitting
6	Nyplast inlet
7	NOT USED
8	roof drain
9	NOT USED
10	12" HDPE
11	12" HDPE
12	NOT USED
13	12" HDPE
14	12" HDPE
15	NOT USED
16	NOT USED
17	12" HDPE
18	12" HDPE
19	12" HDPE
20	NOT USED
21	NOT USED
22	6" HDPE
23	12" HDPE
24	fitting
25	Nyplast inlet
26	12" HDPE
27	concrete chase
28	12" HDPE
29	24" CLIV RCP
30	18" CLIV RCP
31	riprap emergency spillway

Storm Sewer Design Flows

Developed Conditions

Structure #	Sub basin ID	Area (acres)	"C" 5 year	"C" 100 year	Runoff 5 year	Runoff 100 year
	A	0.04	0.32	0.53	0.1	0.2
	B	0.01	0.90	0.96	0.0	0.1
	C	0.02	0.90	0.96	0.1	0.2
	D	0.08	0.12	0.39	0.0	0.3
	E	0.23	0.83	0.91	1.0	1.8
	F	0.03	0.90	0.96	0.1	0.2
	G	0.19	0.08	0.35	0.1	0.6
	H	0.09	0.90	0.96	0.4	0.7
	I	0.09	0.90	0.96	0.4	0.7
	J	0.01	0.12	0.39	0.0	0.0
	K	0.18	0.73	0.83	0.7	1.3
	L	0.13	0.08	0.35	0.1	0.4
	M	0.17	0.27	0.49	0.2	0.7
	N	0.03	0.08	0.35	0.0	0.1
	O	0.02	0.49	0.66	0.1	0.2
	P	0.01	0.08	0.35	0.0	0.0
	Q	0.01	0.90	0.96	0.0	0.1
	R	0.01	0.08	0.35	0.0	0.1
	OS1	2.08	0.09	0.09	0.6	4.2
	OS4	0.44	0.09	0.09	0.1	0.9

14	D	0.08	0.12	0.39	0.0	0.3
	Subtotl STR 14	0.08			0.0	0.3
3	D	0.08	0.12	0.39	0.0	0.3
	F	0.03	0.90	0.96	0.1	0.2
	Subtotal STR3	0.27			0.1	1.1
18	D	0.08	0.12	0.39	0.0	0.3
	F	0.03	0.90	0.96	0.1	0.2
	H	0.09	0.90	0.96	0.4	0.7
	Subtotal STR18	0.2			0.5	1.2
26	D	0.08	0.12	0.39	0.0	0.3
	F	0.03	0.90	0.96	0.1	0.2
	H	0.09	0.90	0.96	0.4	0.7
	K	0.18	0.73	0.83	0.7	1.3
	Subtotal STR18	0.38			1.2	2.5
23	I	0.09	0.90	0.96	0.4	0.7
	Subtotal STR23	0.09			0.4	0.7
10	I	0.09	0.90	0.96	0.4	0.7
	Subtotal STR10	0.09			0.4	0.7
11	E	0.23	0.83	0.91	1.0	1.8
	J	0.01	0.12	0.39	0.0	0.0
	Subtotal STR11	0.24			1.0	1.8
13	I	0.09	0.90	0.96	0.4	0.7
	E	0.23	0.83	0.91	1.0	1.8
	J	0.01	0.12	0.39	0.0	0.0
	Subtotal STR11	0.33			1.4	2.5
26	D	0.08	0.12	0.39	0.0	0.3
	F	0.03	0.90	0.96	0.1	0.2
	H	0.09	0.90	0.96	0.4	0.7
	K	0.18	0.73	0.83	0.7	1.3
	Subtotal STR26	0.38			1.2	2.5
19	D	0.08	0.12	0.39	0.0	0.3
	F	0.03	0.90	0.96	0.1	0.2
	H	0.09	0.90	0.96	0.4	0.7
	K	0.18	0.73	0.83	0.7	1.3
	I	0.09	0.90	0.96	0.4	0.7
	E	0.23	0.83	0.91	1.0	1.8
	J	0.01	0.12	0.39	0.0	0.0
	Subtotal STR19	0.51			2.1	3.8
27	O	0.02	0.49	0.66	0.1	0.2
	Subtotal STR27	0.02			0.1	0.2
29	OS1	2.08	0.09	0.09	0.6	2.4
	G	0.19	0.08	0.35	0.1	0.6
	N	0.03	0.08	0.35	0.0	0.1
	Subtotal STR27	2.3			0.7	3.1
30	OS4	0.44	0.09	0.09	0.1	0.9
	Subtotal STR30	0.44			0.1	0.9
Swale 1 west of site	emergency overflow				2.5	5.8
	OS4	0.44	0.09	0.09	0.1	0.9
	G	0.19	0.08	0.35	0.1	0.6
	N	0.03	0.08	0.35	0.0	0.1
	M	0.17	0.27	0.49	0.2	0.7
	Subtotal Swale 1 west of site	0.83			2.9	8.1

Design Point Summary

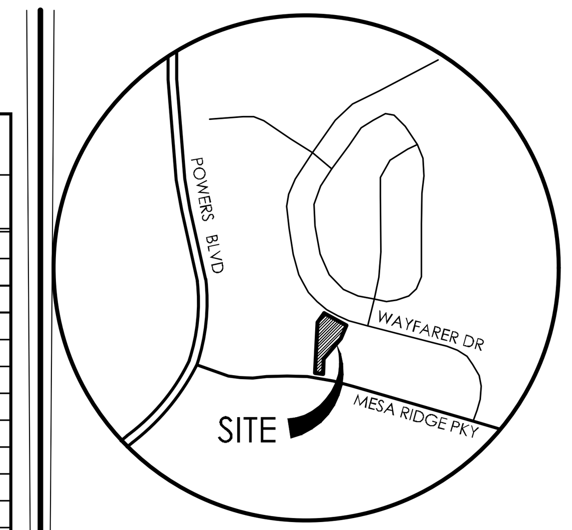
Surface Flow Developed Conditions

Design Point ID	Contributing sub Basin for surface flow	Description	Q5 (surface flow) (cfs)	Q100 (surface flow) (cfs)
1	OS2	Upstream end of proposed cross pan in Wayfarere Drive	NA	NA
2	OS2, A	Upstream end of proposed cross pan in Wayfarere Drive	NA	NA
3	D	Nyplast inlet	0	0.3
4	F	Nyplast inlet	0.1	0.2
5	NA	NW Roof downspout into storm sewer	neg	neg
6	NA	NOT USED	NA	NA
7	I	SW Roof downspout into storm sewer	0.4	0.7
8	E	Nyplast inlet	1	1.8
9	H	SE Roof downspout into storm sewer	0.4	0.7
10	O	Concrete Channel to FSD pond	0.1	0.2
11	see pond narrative	FSD pond outlet structure	see pond narrative	see pond narrative
12	OS1, G, N	Upstream end of 24" RCP culvert	0.7	3.1
13	OS4	Upstream end of 18" RCP culvert	0.1	0.9
14	NA	east end of drive apron onto Mesa Ridge Parkway	NA	NA
15	emergency overflow, OS4, G, N, M	Swale 1 outfal at west PL	2.9	8.1
16	see pond worksheet	FSD pond outfall of STR28	0.1	1.2
17	K	Nyplast inlet	0.7	1.3
18	OS1, G, N	Downstream end of 24" RCP culvert	0.7	3.1
19	OS4	west end of 18" RCP Driveway culvert	0.1	0.9
20	see pond worksheet	Outlet of STR 19	0.1	1.2
21	NA	Junction fitting	NA	NA
22	O	Outlet of STR 27	0.1	0.2

Basin Summary

Developed Conditions

Sub basin ID	Area (Acres)	Time of Conc min.	Runoff Coefficient 5 year	Runoff Coefficient 100 year	Design Discharges 5 year (cfs)	Design Discharges 100 year (cfs)
A	0.04	5	0.32	0.53	0.10	0.20
B	0.01	5	0.90	0.96	Negligible	0.10
C	0.02	5	0.90	0.96	0.10	0.20
D	0.08	5	0.12	0.39	Negligible	0.30
E	0.23	5	0.83	0.91	1.00	1.80
F	0.03	5	0.90	0.96	0.10	0.20
G	0.19	5	0.08	0.35	0.10	0.60
H	0.09	5	0.90	0.96	0.40	0.70
I	0.09	5	0.90	0.96	0.40	0.70
J	0.01	5	0.12	0.39	Negligible	Negligible
K	0.18	5	0.73	0.83	0.70	1.30
L	0.13	5	0.08	0.35	0.10	0.40
M	0.17	5	0.27	0.49	0.20	0.70
N	0.03	5	0.08	0.35	Negligible	0.10
O	0.02	5	0.49	0.66	0.10	0.20
P	0.01	5	0.08	0.35	Negligible	Negligible
Q	0.01	5	0.90	0.96	Negligible	0.10
R	0.04	5	0.08	0.35	Negligible	0.10



VICINITY MAP
NOT TO SCALE

BENCHMARK

1" = 30' 1:360

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REVISIONS

DESIGNED BY
DRAWN BY
CHECKED BY
AS-BUILTS BY
CHECKED BY

SECURITY FIRE STATION NO. 4

DRAINAGE MAP

PROPOSED

MVE PROJECT 61134
MVE DRAWING DRAIN-PP

SEPTEMBER 10, 2020

SHEET 1 OF 1