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# Final Drainage Report

## Freedom Springs

**Project No. 61090**

**November 8, 2018**

PCD File No.: PPR-18-040

# Final Drainage Report

for

**Freedom Springs**
Multifamily Residential Community

**Project No. 61090**

## November 8, 2018

prepared for

**Freedom Springs, LP**
444 S. Campbell Avenue
Springfield, MO 65806
417.720.1577

prepared by

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*61090-Freedom Springs-Final Drainage Report.odt*

# Statements and Acknowledgments

## Engineer's Statement

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

______________________________________________ ______________

David R. Gorman, P.E. Colorado No. 31672 Date
For and on Behalf of MVE, Inc.

## Developer's Statement

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

______________________________________________ ______________

Printed Name: Date
Title:
Freedom Springs, LP
444 S. Campbell Avenue
Springfield, MO 65806

## El Paso County

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.

______________________________________________ ______________

Jennifer Irvine, P.E., Date
County Engineer / ECM Administrator

# Contents

# Final Drainage Report

The purpose of this Final Drainage Report is to identify drainage patterns and quantities within and affecting the proposed Freedom Springs project located in Lot 2, Western Hills Filing No. 2. This project is the development of the existing platted lot having an area of approximately 3.87± Acres with a multi-family use. The report will "identify specific solutions to problems on-site and off-site resulting from the proposed project.[1] The report and included maps present results of hydrologic and drainage facilities analyses. The report will discuss the recommended drainage improvements to the site and identify drainage requirements relative to the proposed project. This report has been prepared and submitted in accordance with the requirements of the El Paso County land development approval process. An Appendix is included with this report with pertinent calculations and graphs used in the drainage analyses and design.

## 1 General Location and Description

### 1.1 Location

The proposed Freedom Springs site is located within the southeast one-quarter of Section 7, Township 14 South, Range 65 west of the 6th principal meridian in El Paso County, Colorado. The 3.87± acre site is situated on the north side of Western Drive, east of Hathaway Drive and west of Dale Road. The proposed site is platted as Lot 2, Western Hills Filing No. 2 in 1994. A **Vicinity Map** is included in the **Appendix**.

The unplatted property to the southwest of the site contains a manufacturing facility and is zoned M (Industrial). The property to the northwest of the site, platted as a portion of Aerospace Gardens, is zoned R-4 (Planned Development) and used as multi-family residential. A Multi-family residential property, zoned R-4, and platted as Lots 1 and 3, Block 1, Western Hills Subdivision and Lot 1 Western Hills Subdivision Filing No. 2 is adjacent to the site on the north. Western Drive, a paved public road with concrete curb and gutter in a 60 foot right-of-way, borders the site along the south. A golf course, platted as Lot 1, Cimarron Southeast Filing No. 2B is adjacent to Western Drive on the northeast. Vacant commercial lots, platted as Lot 1, Cimarron Southeast Filing No. 2C, is adjacent to the Western Drive on the southwestern side.

### 1.2 Description of Property

The Freedom Springs project contains 3.87± acres and is zoned R-4 (Planned Development), which is an obsolete county zone. The property contains no structures, but has a paved access road in and easement and various utilities with easements.

The site is covered with native prairie grasses and weeds in good condition. There are also sparse trees around the site. The existing site topography slopes to the south towards Western Drive with grades that range from 1% to 6% with isolated areas of up to 20%.

There are no major drainageways in the Freedom Springs site. All storm runoff flows south or southeast to Western Drive that collects the flows and conveys it to the northeast. There is no storm drain system in the Western Drive or or the surrounding area. The site is located in the Sand Creek

1 DCM

Major Drain Basin. The flows from the site continue northeast in Western Drive and eventually enters the East Fork of Sand Creek, continuing southwest.

According to the National Resource Conservation Service, the dominant soil in the immediate area of the Freedom Springs site is Blakeland loamy sand (map unit 8). The Blakeland loamy sand is typically deep and somewhat excessively drained. Permeability is rapid, surface runoff is slow, and the hazard of erosion is moderate. Blakeland loamy sand is classified as being part of Hydrologic Soil Group A.A portion of the **Soil Map** and data tables from the National Cooperative Soil Survey and relevant **Official Soil Series Descriptions (OSD)** are included in the **Appendix**.[2 3]

The current Flood Insurance Study of the region includes Flood Insurance Rate Maps (FIRMs), effective March 17, 1997. [4 5] The project site is included in Community Panel Number 08041C0754 F of the FIRMs for El Paso County, Colorado. No portion of the site lies within FEMA designated Special Flood Hazard Areas (SFHAs). An excerpt of the current **FEMA Flood Insurance Rate Maps** with the site delineated is included in the **Appendix**.

A new multi-family residential facility will be constructed on the site. The proposed building and parking area will be located on the western side if the site. The development will include a new building, parking lot, landscaping and recreational open area. Also, the east side of the site will be improved with a new Full Spectrum Sand Filter Basin (FS SFB) which will collect, detain and treat the flows from the new development.

# 2 Drainage Basins and Sub-Basins

## 2.1 Major Basin Descriptions

Freedom Springs site is located in the Sand Creek Major Drainage Basin (FOFO4000) on the east side of Colorado Springs, which contains properties in both City of Colorado Springs and unincorporated El Paso County jurisdictions. The basin is a studied basin with an approved and operative Drainage Basin Planning Study (DBPS). The Basin stretches for approximately 17 miles on the east side of Colorado Springs and drains from northeast to southwest into Fountain Creek at a point just north of the crossing of Interstate 25 and US Highway 85-87. The site is located in the southeastern portion of the Sand Creek Major Drainage Basin, in the East Fork sub-area and eventually drains into the East Fork of Sand Creek. A copy of a portion of the **"*Drainage Area Identification Study*" map**, showing the site location within the Basin is included in the **Appendix**. [6]

The Drainage Basin Planning Study for the Sand Creek Major Drainage Basin was completed in 1996 by Kiowa Engineering Corporation.[7] The site is contained within sub-basin 3, located just upstream of Design Point No. 3, as indicated in the 1996 report. There are not drainage improvements noted in the DBPS for the site.

A drainage report for Western Hills Subdivision was prepared in 1971 by G.L. Williams and Partners, LTD. No other drainage reports for this or any of the adjacent properties were available for review during the course of preparing this drainage report .

## 2.2 Sub-Basin Description

### 2.2.1 Existing Drainage Patterns (Off-Site)

Off-site drainage flows enter the north edge of the Freedom Springs property from two off-site drainage basins located north of the site. The hydrologic analyses used in the drainage design of the proposed subdivision considered the existing Land Use Conditions of the offsite sub-basins. The off-site drainage sub-basins are depicted on the included **Existing Drainage Basin Map**.

2 WSS
3 OSD
4 FIS
5 FIRM, Map No. 08041C0754 F
6 Drain. Area Ident. Study
7 1996 DBPS

Existing off-site sub-basin OS1 is located north of the western portion of the site (west of the existing paved access drive), and contains an existing multi-family residential development. The basin runoff flows south towards the site and enters exiting sub-basin A1 by way of the existing paved access drive. These flows continue to drain south towards Western Drive in the sub-basin A1, but remain mostly separated from sub-basin A1 runoff. The flows enter Western Drive and flow northeast in the street.

Existing off-site sub-basin OS2 is located north of the eastern portion of the site (west of the existing paved access drive). The sub-basin contains a part of the existing multi-family residential development, including the clubhouse and swimming pool area. The basin runoff flows southeast towards the site and enters exiting sub-basin B1 by overland sheet flow. These flows enter the site and join other flows generated in sub-basing B1 and continue to drain southeast towards Western Drive.

#### 2.2.2 Existing Drainage Patterns (On-Site)

The site is mostly undeveloped, except for the existing paved access drive that extends north from Western Drive to the existing multi-family development north of the site. The entire site drains from north to south and southeast to Western Drive. However, the existing paved drive conveys most of the offsite flows from existing off-site sub-basing OS1 to Western Drive. All off-site and on-site runoff reaches Western Drive and travels northeast in the existing concrete curb and gutter. There is no storm drain in Western Drive adjacent to the site, but two storm drain inlets located northeast of the site collect storm flows which drain into the pond adjacent to the south side of Western Drive. The existing drainage patterns for the site are described by two on-site basins. The drainage sub-basins are shown on the included **Existing Drainage Map**.

Existing sub-basin A1 is located on the western side of the site and contains open field (meadow) and paved access drive along the east side of the basin. Sub-basin A1 accepts the flows form off-site sub-basin OS1. These offsite flows travel south through the site, mostly contained in the paved drive, to Western Drive on the south. Storm runoff from sub-basin A1 also flows south to Western Drive and enters the street. Once in the street, all the flows from OS1 and A1 travel northeast in the street.

Existing sub-basin B1 contains the eastern portion of the property and contains grassed field (meadow) and trees. The basin accepts the sheet flow from off-site sub-basin OS2 on the north. The combined flows from drain toward Western Drive on the southeast, joining the flows from from OS1, A1, and other off-site flows in the street. The combined flows continue northeast in the street to an off-site inlet that drains into the existing pond located on the south side of Western Drive. These flows eventually reach the east fork of sand creek and continue to the southeast in the creek.

## 3 Drainage Design Criteria

### 3.1 Development Criteria Reference

This Final Drainage Report for Freedom Springs has been prepared according to the report guidelines presented in the latest edition of *El Paso County Drainage Criteria Manual* (DCM)[8]. The County has also adopted portions of the City of Colorado Springs Drainage Criteria Manual Volumes 1 and 2, especially concerning the calculation of rainfall runoff flow rates.[9] [10] The hydrologic analysis is based on a collection of data from the DCM, the NRCS Web Soil Survey[11], Existing topographic data and proposed site plan by by Land Development Consultants, Inc.

### 3.2 Hydrologic Criteria

For this Final Drainage Report, the Rational Method as described in the D*rainage Criteria Manual* has been used for all Storm Runoff calculations, as the development and all sub-basins are less than

8 DCM Section 4.3 and Section 4.4
9 CS DCM Vol 1
10 CS DCM Vol 2
11 WSS

130 acres in area. “Colorado Springs Rainfall Intensity Duration Frequency” curves, Figure 6-5 in the DCM, was used to obtain the design rainfall values; a copy is included in the **Appendix**. The “Overland (Initial) Flow Equation” (Eq. 6-8) in the DCM, and Manning's equation with estimated depths were used in time of concentration calculations. “Runoff Coefficients for Rational Method”, Table 6-6 in the DCM, was utilized as a guide in estimating runoff coefficient and Percent Impervious values; a copy is included in the **Appendix**. Peak runoff discharges were calculated for each drainage sub-basin for both the 5-year storm event and the 100-year storm event with the Rational Method formula, (Eq. 6-5) in the DCM.[12]

The Water Quality Control Volume procedure, Section 3.3 of the *Urban Drainage and Flood Control District Drainage Criteria Manual, Volume 3* (UDFCD) was used for water quality volume calculations with the aid of the worksheet “UD-BMP_v3.06” spreadsheet developed by the Urban Drainage and Flood Control District.[13] [14] Full Spectrum Detention utilizing the Excess Urban Runoff Volume (EURV) concept was sized and storm routing calculations were performed in accordance with *Urban Drainage and Flood Control District Drainage Criteria Manual, Volume 2 using* the aid of the detention design spreadsheet, “UD-Detention_v3.07”, developed by the Urban Drainage and Flood Control District. [15] [16]

# 4 Drainage Facility Design

## 4.1 General Concept

The intent of the drainage concept presented in this Final Drainage Report is to maintain the existing drainage patterns & quantities on the site. Major and minor storm flows will continue to be safely conveyed through the site and downstream. The runoff from all developed areas will drain to the proposed Full Spectrum Sand Filter Basin (FS SFB). A proposed private on-site storm drain system will collect the flow from the various developed on-site sub-basin and convey them to the proposed FS SFB. The developed flows will be detained and released to Western Drive at flow rates less than the calculated existing flow rates.

The existing and proposed drainage hydrologic conditions are described in more detail below. Input data and results for all calculations are included in the **Appendix**. Drainage maps for the hydrology are also included in the **Appendix**.

## 4.2 Specific Details

### 4.2.1 Existing Hydrologic Conditions

The off-site drainage area north of the western portion of the site, sub-basin OS1, contains the existing adjacent multi-family residential development known as Western Hills Apartments. The sub-basin is 2.84 acres in area and drains southerly towards the northeast corner of existing on-site sub-basin A1 at the paved access drive that extends from Western Drive. Basin OS1 generates peak storm runoff discharges of $Q_5$ = 4.7 cfs and $Q_{100}$ = 10.4 cfs (existing flows). These flows continue south through sub-basin A1 to Western Drive.

Existing off-site sub-basin OS2 is located north of the eastern portion of the site and also contains a portion of existing Western Hills Apartments. The sub-basin is 0.57 acres in area and drains southeasterly towards the northeast corner of the site with peak discharges of $Q_5$ = 1.1 cfs and $Q_{100}$ = 2.5 cfs (existing flows). These flows enter existing on-site sub-basin B1 and continue southeast towards Western Drive.

Existing on-site sub-basin A1 is 2.72 acres in area and comprises the western portion of the site, containing the existing paved access drive and open field area. The sub-basin accepts the offsite flows from sub-basin OS1 as described above. Sub-basin A1 produces peak discharges of $Q_5$ = 1.7 cfs and $Q_{100}$ = 7.2 cfs (existing flows) which drain southerly towards Western Drive. The combined

12 DCM
13 UDFCDV.3
14 UDFCD
15 UDFCD V.2
16 UDFCD

flow rate of the runoff from sub-basins OS1 and A1 are $Q_5$ = 6.2 cfs and $Q_{100}$ = 17.0 cfs (existing flows). These flows enter Western all along the street frontage, however concentrated flows, mostly from off-site sub-basin OS1, enter the street at the existing drive connection. The combined flows of continue northeast in the street.

Existing sub-basin B1 (1.16 acres) is comprised of the east side of the site, east of the existing paved access drive. The sub-basin accepts the off-site sheet flows from sub-basin OS2. Sub-basin B1 contains open field area and drains southeast towards Western Drive. The peak discharges generated by sub-basin B1 are $Q_5$ = 0.4 cfs and $Q_{100}$ = 2.8 cfs (existing flow), which joins with the off-site flows for combined peak discharges of $Q_5$ = 1.4 cfs and $Q_{100}$ = 5.0 cfs (existing flow). These flows enter Western Drive and are directed to the northeast in street.

The existing combined total flows entering Western Drive from the off-site and on-site basins are $Q_5$ = 7.6 cfs and $Q_{100}$ = 22.0 cfs (existing flow).

Western Drive an existing public 39 ft wide, paved street with concrete curb on both sides in a 60' right-of-way. The roadway drains to the northeast and does not contain a storm drain system adjacent to the site. However, there are two curb inlets located approximately 110 feet to the northeast of the site. The inlets drain street flows to the existing pond adjacent to the south side of the road.

The **Existing Drainage Map** depicts the existing topographic mapping, drainage basin delineations, drainage patterns, existing streets, drainage facilities, and runoff quantities with a data table including drainage areas and flow rates.

### 4.2.2 Proposed Hydrologic Conditions

The off-site drainage basin, OS1 (2.84 acres), will continue to drain south toward the site as in existing conditions. The discharges are $Q_5$ = 4.7 cfs and $Q_{100}$ = 10.4 cfs (proposed flow), which drain to the north edge of the site and into proposed sub-basins H1.

Proposed sub-basin H1 (0.45 acres) consists of the north edge of the site together with with the improved access drive to Western Drive. This sub-basin will accept the flows from off-site sub-basin OS1, which will continue south in the access drive to Western Drive as in existing conditions. Sub-basin H1 will produce runoff at peak flow rates of $Q_5$ = 1.6 cfs and $Q_{100}$ = 3.1 cfs (proposed flow), which drains to the access drive and then south towards Western Drive. The combined discharges of sub-basins OS1 and H1 are $Q_5$ = 5.7 cfs and $Q_{100}$ = 12.3 cfs (proposed flow). A proposed single Type 16 combination inlet at Design Point 4 (DP4) will collect the developed 100-year discharge from on-site sub-basin H1 of 3.1 cfs and allow the existing offsite flows from sub-basin OS1 to continue to flow by and reach Western Drive as in existing conditions. The collected flows will be carried to the proposed FS SFB located east of the access drive.

Proposed sub-basin A1 (0.63 acres) will consist of the paved parking area on the south side of the proposed building. The discharges generated by A1 are $Q_5$ = 2.7 cfs and $Q_{100}$ = 4.9 cfs (proposed flow), which drain southerly in the parking lot to a proposed double Type 16 combination inlet in sump condition at DP1. The collected storm runoff will be conveyed to the proposed FS SFB in the proposed private storm drain line.

Proposed sub-basin B1 (0.17 acres) is parking lot area located east of sub-basin A1. Sub-basin B1 drains to a proposed single Type 16 combination inlet in sump condition at DP2 with peak discharges of $Q_5$ = 0.7 cfs and $Q_{100}$ = 1.3 cfs (proposed flow). The inlet will collect up to the 100-year flows and the flows will be conveyed to the FS SFB in the storm drain system.

Proposed sub-basin C1 (0.11 acres) is comprised of the parking, drive and landscape area located north of sub-basin B1. The discharges from sub-basin C1 are $Q_5$ = 0.4 cfs and $Q_{100}$ = 0.8 cfs (proposed flows) which drain south to DP3, being the location of a proposed single Type 16 combination inlet on grade. The proposed inlet will collect flows of $Q_5$ = 0.3 cfs and $Q_{100}$ = 0.5 cfs and bypass flows of $Q_5$ = 0.1 cfs and $Q_{100}$ = 0.3 cfs to sub-basin H1.

Proposed sub-basin D1 (0.36 acres) consists of the proposed building footprint on the western side of the site. The sub-basin generates storm runoff peak discharges of $Q_5$ = 1.4 cfs and $Q_{100}$ = 2.6 cfs (proposed flows). Building roof drains will direct all flows to the underground drainage system and then to the FS SFB.

Proposed sub-basin E1 (0.17 acres) will consist of the recreation yard on the north side of the building. The discharges generated by E1 are $Q_5$ = 0.1 cfs and $Q_{100}$ = 0.5 cfs (proposed flow), which drain to a low point in the center of the basin (DP5). A proposed grated area inlet in sump condition will collect the flows which will be conveyed to the proposed FS SFB in the proposed private storm drain line.

Proposed sub-basin F1 (0.17 acres) is also part of the recreation yard on the north side of the building. Sub-basin F1 drains to a proposed area inlet in sump condition at DP6 with peak discharges of $Q_5$ = 0.3 cfs and $Q_{100}$ = 0.8 cfs (proposed flow). The inlet will collect up to the 100-year flows and the flows will be conveyed to the FS SFB in the storm drain system.

Proposed sub-basin G1 (0.58 acres) contains open landscape area and the proposed FS SFB located on the east side of the existing paved access drive at DP7. The discharges from sub-basin G1 are $Q_5$ = 0.2 cfs and $Q_{100}$ = 1.3 cfs (proposed flows) which drain south into the FS SFB at DP7. The pond also collects the flows from sub-basins A1, B1, C1, D1, E1, F1, G1 and H1. The combined peak discharges of all in-flowing basins are $Q_5$ = 7.2 cfs and $Q_{100}$ = 15.2 cfs (proposed flow). The proposed FS SFB will treat and detain the developed flows and release them to Western drive by way of a outlet pipe and County Standard curb opening with steel cover. The released flows are $Q_5$ = 0.2 cfs and $Q_{100}$ = 1.1 cfs (proposed flow).

Proposed sub-basin J1 (0.46 acres) is comprised of open yard and landscape area adjacent to Western Drive on the westerly side of the site. The proposed landscaping will consist of trees, shrubs in wood mulch, and non-irrigated native grass. The basin will drain south by sheet flow into Western Drive as this area does in the existing condition. Sub-basin J1 produces peak runoff discharges of $Q_5$ = 0.1 cfs and $Q_{100}$ = 1.1 cfs (proposed flows).

Proposed sub-basin M1 (0.13 acres) consists of narrow landscape area on the west edge of the site. The area drains westerly into the adjacent site and generates storm runoff peak discharges of $Q_5$ = 0.1 cfs and $Q_{100}$ = 0.4 cfs (proposed flows). Most of the area of this sub-basin historically drains into the site to the southeast. In the developed condition, this area will drain offsite to the west and then south to Western Drive. The area of this basin is minor, is landscaped pervious area, and results in runoff of negligible magnitude. The flows leaving the site from this basin will not present problems for the adjacent or downstream properties.

The off-site drainage basin, OS2 (0.57 acres), will continue to drain southeast toward the site as in existing conditions. The discharges are $Q_5$ = 1.1 cfs and $Q_{100}$ = 2.5 cfs (proposed flow), which drain onto the site into proposed sub-basins L1.

Proposed sub-basin L1 (0.45 acres) consists of open landscape area along the east edge of the site. Grading contours will remain the same as existing conditions. Sub-basin L1 will continue to accept the off-site flows from sub-basin OS2. The discharges generated by L1 are $Q_5$ = 0.1 cfs and $Q_{100}$ = 1.1 cfs (proposed flow), which drain to the southeast towards Western Drive. The combined flows of OS2 and L1 are $Q_5$ = 1.1 cfs and $Q_{100}$ = 3.3 cfs (proposed flow), which enter Western Drive along the street frontage by sheet flow.

Proposed sub-basin K1 (0.15 acres) is the south edge of the eastern portion of the site. This basin consist of the landscaped area between the proposed FS SFB and Western Drive which drains southwest into the street. Proposed peak runoff discharges from this basin are $Q_5$ = 0.1 cfs and $Q_{100}$ = 0.4 cfs (proposed flow).

The combined total developed flows entering Western Drive from the off-site and on-site basins are $Q_5$ = 4.7 cfs and $Q_{100}$ = 14.1 cfs (proposed flow). These flows represent a decrease of 2.9 cfs in the 5-year rainfall event and a decrease of 7.9 cfs in the 100-year event. The flows that enter Western Drive will continue to drain northeast in the the street to the existing inlets located northeast of the site.

#### 4.2.3 Proposed Drainage Facilities

The proposed on-site storm drain system will be owned and maintained by Freedom Springs. The pipe system will be 6", 12" and 18" HDPE material. The proposed inlets will be Type 16 combination inlets with concrete boxes and adjustable steel grate and curb openings. The area inlet will be PVC and non-traffic bearing located in landscaped areas. The proposed pipe system discharges into the Full Spectrum Sand Filter Basin, which is designed to detain the WQCV, EURV and 100-year developed runoff volumes. The proposed FS Sand Filter Basin has storage volume of 0.281 acre-feet. The facility is located in Type A soils and will be full-infiltration type. The EURV and 100-year flows will be regulated by a concrete outlet box with steel orifice plate and outlet pipe. The facility will have an emergency spillway with 6' bottom width discharging to Western Drive and protected by riprap lining.

### 4.3 Erosion Control

During future construction, best management practices (BMP's) for erosion control will be employed based on the previously referenced City of Colorado Springs Drainage Criteria Manual Volume 2 and the Erosion Control Plan to minimize erosion from the site. The BMP's will remain in place until the site is stabilized with the new hard surfacing or landscape seeding, planting and cover materials. Also, BMP's will be utilized as deemed necessary by the contractor, engineer, owner, or County inspector and are not limited to the measures described on the Erosion Control Plan.

### 4.4 Water Quality Enhancement Best Management Practices

The Full Spectrum Sand Filter Basin described above will provide storage for the WQCV, EURV and developed 100-year runoff volume for the site. A Grading and Erosion Control Plan for the construction of the site has been prepared in accordance with the provisions of the County's Engineering Criteria Manual. Placement of construction stormwater BMP's will as required by the plan will limit soil erosion and deposition by stormwater flowing over the site.

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. The parking lot contains landscape islands and the entire east side of the site will remain as pervious surface.

2) All drainage paths on the site are stabilized with pavement or appropriate landscape treatment. The Full Spectrum Sand Filter Basin will intercept flows from developed areas. Additionally, the pond outflow point will be stabilized with outlet protection.

3) The project contains no potentially hazardous uses. All developed areas drain into a proposed a WQCV BMP.

4) The site contains no storage of potentially harmful substances or use of potentially harmful substances. No Site Specific or Other Source Control BMP's are required.

The total area of the site is 3.87 acres. An existing paved access drive splits the lot into the east and west portions. All areas to be developed with impervious building or paved areas will be collected in the proposed storm drain inlets and directed to the proposed Full Spectrum Detention Sand Filter Basin (FSD SFB) on the west side of the site, except 0.08 acres of the existing paved access drive that is not possible to direct to the pond due to grade elevations. A total of 2.56 acres out of the 3.87 acres drains to the FSD SFB. Other areas of the site do not drain to the pond. Other than the 0.08 acres of existing paved area already discussed, these areas are unpaved pervious landscape areas of the site totaling 1.19 acres.

Call out that there will be a deviation request processed to allow for the landscape area to not receive SWCV treatment.

## 5 Opinion of Probable Cost for Drainage Facilities

There are no public drainage improvements associated with this project. Costs for the private non-reimbursable drainage improvements for this project are listed in the table below:

| **Freedom Springs Private Drainage Costs (Non-Reimbursable)** | | | | |
|---|---|---|---|---|
| **Item** | **Quantity** | **Unit** | **Unit Cost** | **Cost** |
| HDPE Storm Drain Pipe with Appurtenances | 1040 | LF | $45.00 | $46,800 |
| Type 16 Combination Inlets | 4 | EA | $3,800.00 | $15,200 |
| Sand Filter Basin (Full Spectrum) | 1 | EA | $10,500.00 | $10,500 |
| | | | | |
| **GRAND TOTAL** | | | | **$72,500.00** |

## 6 Drainage and Bridge Fees

The site is not being platted. No Drainage or Bridge Fees are due for this project.

## 7 Conclusion

This Final Drainage Report presents existing and proposed drainage conditions for the proposed Freedom Springs 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.

# References


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*City of Colorado Springs Drainage Criterial Manual, Volume 1*. City of Colorado Springs Engineering Division Staff, Matrix Desgin Group/Wright Water Engineers (Colorado Springs: , May 2014).

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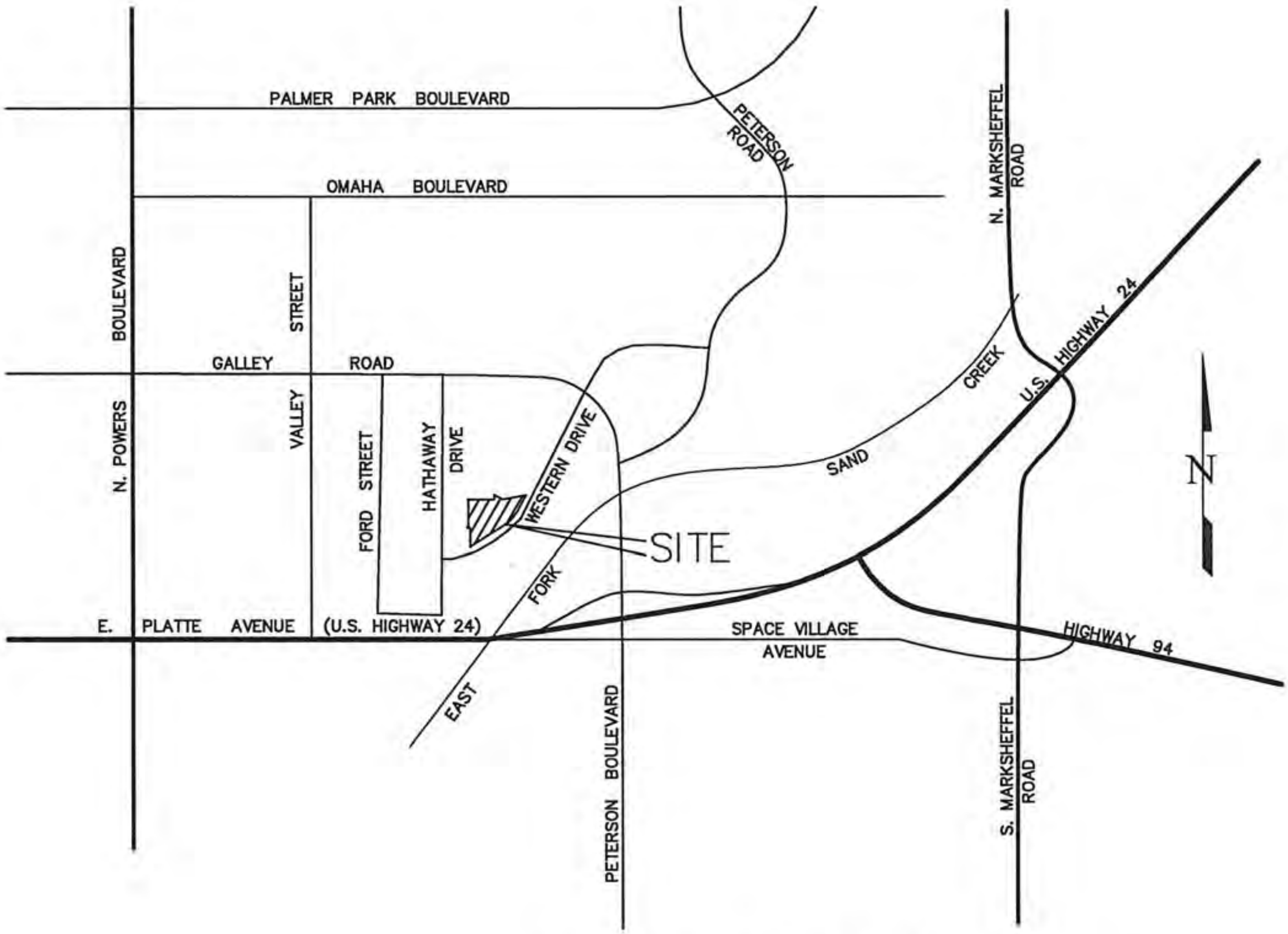
*Detention Design Spreadsheet*. Urban Drainage and Flood Control District ("http://www.udfcd.org/downloads/software/UD-Detention_v2.2.xls", accessed February 2017).

# Appendices

## 8 General Maps and Supporting Data

Vicinity Map
Portions of Flood Insurance Rate Map
Portion of Drainage Area Identification Study Map
NRCS Soil Map and Tables
SCS Soil Type Descriptions
Hydrologic Soil Group Map and Tables




# VICINITY MAP

NO SCALE


NATIONAL FLOOD INSURANCE PROGRAM

# FIRM
## FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

**PANEL 754 OF 1300**
(SEE MAP INDEX FOR PANELS NOT PRINTED)

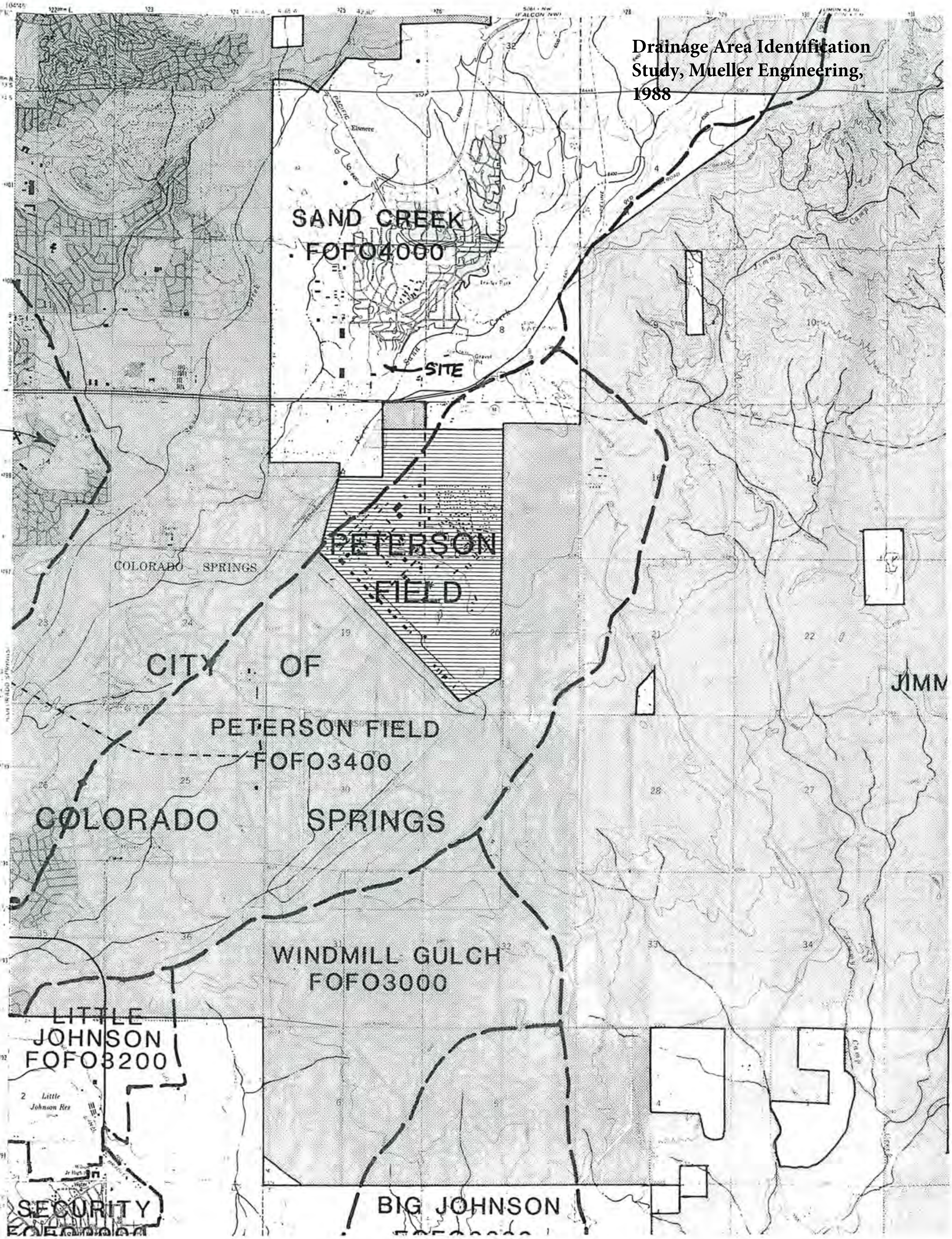
| CONTAINS: COMMUNITY | NUMBER | PANEL | SUFFIX |
| --- | --- | --- | --- |
| COLORADO SPRINGS, CITY OF | 080060 | 0754 | F |
| EL PASO COUNTY, UNINCORPORATED AREAS | 080059 | 0754 | F |

**MAP NUMBER 08041C0754 F**

**EFFECTIVE DATE: MARCH 17, 1997**

Federal Emergency Management Agency

Drainage Area Identification Study, Mueller Engineering, 1988



Soil Map—El Paso County Area, Colorado
(Freedom Springs)


Map Scale: 1:1,530 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 20, 40, 80, 120

N

Feet: 0, 50, 100, 200, 300

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

## MAP LEGEND

**Area of Interest (AOI)**
- Area of Interest (AOI)

**Soils**
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

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

**Water Features**
- Streams and Canals

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

**Background**
- Aerial Photography

## MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 15, Oct 10, 2017

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

Date(s) aerial images were photographed: Jun 3, 2014—Jun 17, 2014

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

# Map Unit Legend

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| 8 | Blakeland loamy sand, 1 to 9 percent slopes | 10.9 | 99.9% |
| 28 | Ellicott loamy coarse sand, 0 to 5 percent slopes | 0.0 | 0.1% |
| **Totals for Area of Interest** | | **10.9** | **100.0%** |

is severely eroded and blowouts have developed, the new seeding should be fertilized.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the main limitation for the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be necessary when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. In cropland areas, habitat favorable for ring-necked pheasant, mourning dove, and many nongame species can be developed by establishing areas for nesting and escape cover. For pheasant, the provision of undisturbed nesting cover is vital and should be included in plans for habitat development. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

This soil has good potential for use as homesites. Shallow excavation is severely limited because cut banks cave in. This sandy soil requires special management practices to reduce water erosion and soil blowing. Capability subclasses IIIe, irrigated, and IVe, nonirrigated.

**7—Bijou sandy loam, 3 to 8 percent slopes.** This deep, well drained soil is on flood plains, terraces, and uplands. It formed in sandy alluvium and eolian material derived from arkose deposits. Elevation ranges from 5,400 to 6,200 feet. The average annual precipitation is about 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 145 days.

Typically, the surface layer is brown sandy loam about 4 inches thick. The subsoil is brown or grayish brown sandy loam about 24 inches thick. The substratum is pale brown loamy coarse sand.

Included with this soil in mapping are small areas of Olney sandy loam, 3 to 5 percent slopes; Valent sand, 1 to 9 percent slopes; Vona sandy loam, 3 to 9 percent slopes; and Wigton loamy sand, 1 to 8 percent slopes.

Permeability of this Bijou soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Organic matter content of the surface layer is low. Surface runoff is slow, and the hazards of erosion and soil blowing are moderate.

Almost all areas of this soil are used for range.

This soil is suited to the production of native vegetation suitable for grazing. Because of the hazards of water erosion and soil blowing, the soil is not suited to nonirrigated crops.

Native vegetation is dominantly blue grama, sand dropseed, needleandthread, side-oats grama, and buckwheat.

Seeding is a suitable practice if the range has deteriorated. Seeding the native grasses is a good practice. If the range is severely eroded and blowouts have developed, the new seeding should be fertilized. Brush control and grazing management may be needed to improve the depleted range. Grazing should be managed so that enough forage is left standing to protect the soil from blowing, to increase infiltration of water, and to catch and hold snow.

Windbreaks and environmental plantings are generally suited to this soil. Soil blowing is the main limitation for the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, by properly managing livestock grazing, and by reseeding range where needed.

This soil has good potential for use as homesites. Shallow excavation is severely limited because cut banks cave in. This soil requires special management practices to reduce water erosion and soil blowing. Capability subclass VIe.

**8—Blakeland loamy sand, 1 to 9 percent slopes.** This deep, somewhat excessively drained soil formed in alluvial and eolian material derived from arkosic sedimentary rock on uplands. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 135 days.

Typically, the surface layer is dark grayish brown loamy sand about 11 inches thick. The substratum, to a depth of 27 inches, is brown loamy sand; it grades to pale brown sand that extends to a depth of 60 inches.

Included with this soil in mapping are small areas of Bresser sandy loam, 0 to 3 percent slopes; Bresser sandy loam, 3 to 5 percent slopes; Truckton sandy loam, 0 to 3 percent slopes; Truckton sandy loam, 3 to 9 percent slopes; and Stapleton sandy loam, 3 to 8 percent slopes. In some areas, mainly north of Colorado Springs in the Cottonwood Creek area, arkosic beds of sandstone and shale are at a depth of 0 to 40 inches.

Permeability of this Blakeland soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low to moderate. Organic matter content of the surface layer is medium. Surface runoff is slow, the hazard of erosion is moderate, and the hazard of soil blowing is severe.

Most areas of this soil are used for range, homesites, and wildlife habitat.

Native vegetation is dominantly western wheatgrass, side-oats grama, and needleandthread. This soil is best suited to deep-rooted grasses.

Proper range management is necessary to prevent excessive removal of plant cover from the soil. Interseeding improves the existing vegetation. Deferment of grazing in spring increases plant vigor and soil stability. Proper location of livestock watering facilities helps to control grazing.

Windbreaks and environmental plantings are fairly well suited to this soil. Blowing sand and low available water capacity are the main limitations for the establishment of trees and shrubs. The soil is so loose that trees need to be planted in shallow furrows and plant cover needs to be maintained between the rows. Supplemental irrigation may be needed to insure survival. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, and Siberian elm. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

This soil has good potential for urban development. Soil blowing is a hazard if protective vegetation is removed. Special erosion control practices must be provided to minimize soil losses. Capability subclass VIe.

**9—Blakeland complex, 1 to 9 percent slopes.** This complex is on uplands, mostly in the Falcon area. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the frost-free period is about 135 days.

This complex is about 60 percent Blakeland loamy sand, about 30 percent Fluvaquentic Haplaquolls, and 10 percent other soils.

Included with these soils in mapping are areas of Columbine gravelly sandy loam, 0 to 3 percent slopes, Ellicott loamy coarse sand, 0 to 5 percent slopes, and Ustic Torrifluvents, loamy.

The Blakeland soil is in the more sloping areas. It is deep and somewhat excessively drained. It formed in sandy alluvium and eolian material derived from arkosic sedimentary rock. Typically, the surface layer is dark grayish brown loamy sand about 11 inches thick. The substratum, to a depth of 27 inches, is brown loamy sand; it grades to pale brown sand that extends to a depth of 60 inches or more.

Permeability of the Blakeland soil is rapid. The effective rooting depth is more than 60 inches. The available water capacity is moderate to low. Surface runoff is slow, and the hazard of erosion is moderate.

The Fluvaquentic Haplaquolls are in swale areas. They are deep, poorly drained soils. They formed in alluvium derived from arkosic sedimentary rock. Typically, the surface layer is brown. The texture is variable throughout. The water table is at a depth of 0 to 3 feet.

The Blakeland soil is well suited to deep-rooted grasses. Native vegetation is dominantly western wheatgrass, side-oats grama, and needleandthread. Rangeland vegetation on the Fluvaquentic Haplaquolls is dominantly tall grasses, including sand bluestem, switchgrass, prairie cordgrass, little bluestem, and sand reedgrass. Cattails and bulrushes are common in the swampy areas.

Proper range management is needed to prevent excess removal of plant cover from these soils. It is also needed to maintain the productive grasses. Interseeding improves the existing vegetation. Deferment of grazing during the growing season increases plant vigor and soil stability, and it helps to maintain and improve range condition. Proper location of livestock watering facilities helps to control grazing of animals.

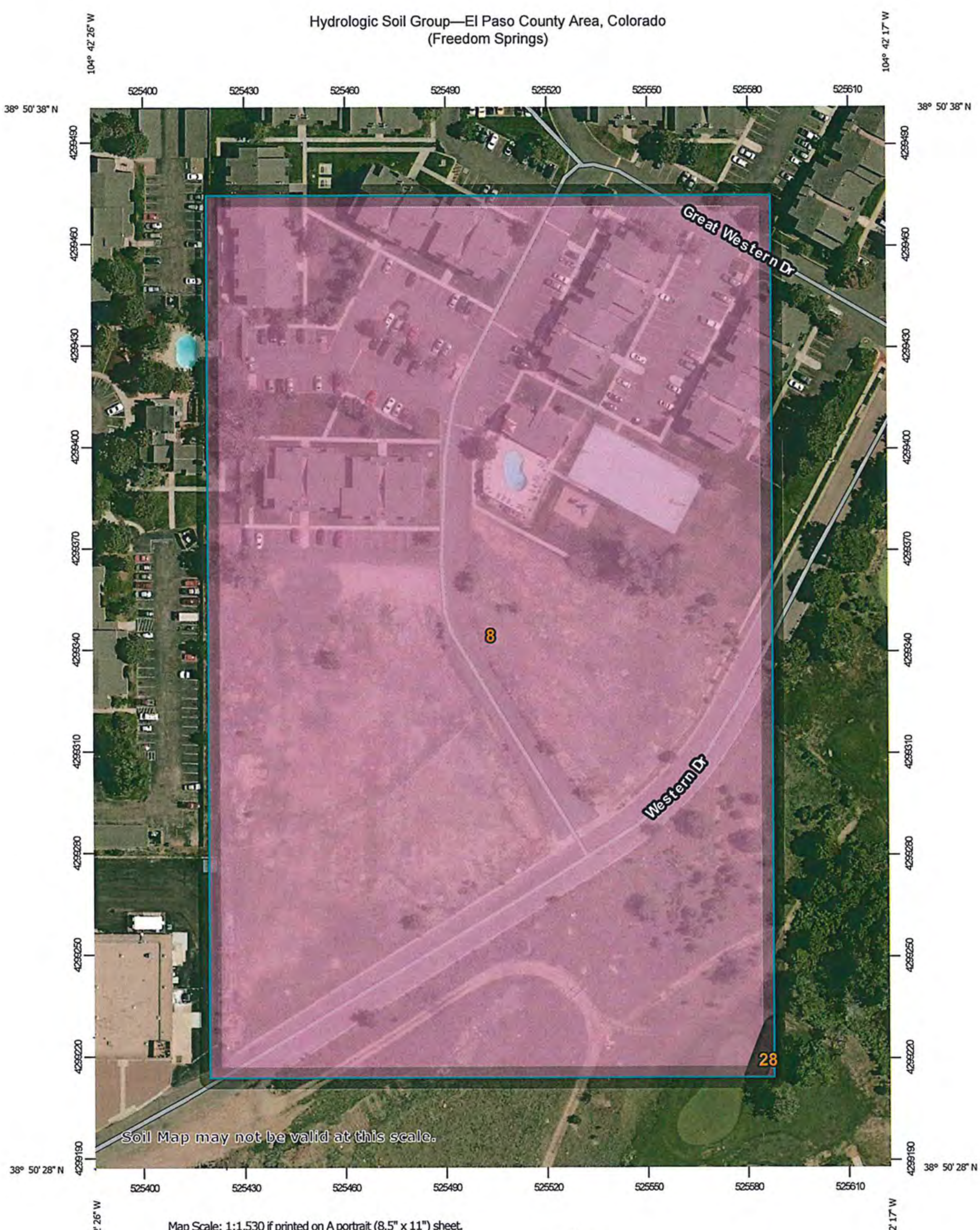
Windbreaks and environmental plantings are fairly well suited to these soils. Blowing sand and low available water capacity are the main limitations to the establishment of trees and shrubs. The soils are so loose that trees need to be planted in shallow furrows and plant cover needs to be maintained between the rows. Supplemental irrigation may be needed to insure survival. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, and Siberian elm. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

The Blakeland soil is well suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed. Wetland wildlife can be attracted to the Fluvaquentic Haplaquolls and the wetland habitat can be enhanced by several means. Shallow water developments can be created by digging or by blasting potholes to create open-water areas. Fencing to control livestock grazing is beneficial, and it allows wetland plants such as cattails, reed canarygrass, and rushes to grow. Control of unplanned burning and prevention of drainage that would remove water from the wetlands are good practices. Openland wildlife use the vegetation on these soils for nesting and escape cover. These shallow marsh areas are especially important for winter cover if natural vegetation is allowed to grow.

The Blakeland soil has good potential for homesites, roads, and streets. It needs to be protected from erosion when vegetation has been removed from building sites. The Fluvaquentic Haplaquolls have poor potential for homesites. Their main limitations for this use are the high water table and the hazard of flooding. Capability subclass VIe.

**10—Blendon sandy loam, 0 to 3 percent slopes.** This deep, well drained soil formed in sandy arkosic alluvium on alluvial fans and terraces. The average annual precipitation is about 15 inches, the mean annual air temperature is about 47 degrees F, and the average frost-free period is about 135 days.

# Hydrologic Soil Group—El Paso County Area, Colorado
(Freedom Springs)




Map Scale: 1:1,530 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 20, 40, 80, 120

Feet: 0, 50, 100, 200, 300

N

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

## MAP LEGEND

**Area of Interest (AOI)**

- Area of Interest (AOI)

**Soils**

**Soil Rating Polygons**

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

**Soil Rating Lines**

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

**Soil Rating Points**

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

**Water Features**

- Streams and Canals

**Transportation**

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

**Background**

- Aerial Photography

## MAP INFORMATION

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

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

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

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

Date(s) aerial images were photographed: Jun 3, 2014—Jun 17, 2014

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# Hydrologic Soil Group

| Map unit symbol | Map unit name | Rating | Acres in AOI | Percent of AOI |
|---|---|---|---|---|
| 8 | Blakeland loamy sand, 1 to 9 percent slopes | A | 10.9 | 99.9% |
| 28 | Ellicott loamy coarse sand, 0 to 5 percent slopes | A | 0.0 | 0.1% |
| **Totals for Area of Interest** | | | **10.9** | **100.0%** |

## Description

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

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

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

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

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

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

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

## Rating Options

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff: None Specified*

*Tie-break Rule:* Higher

# 9 Hydrologic Calculations

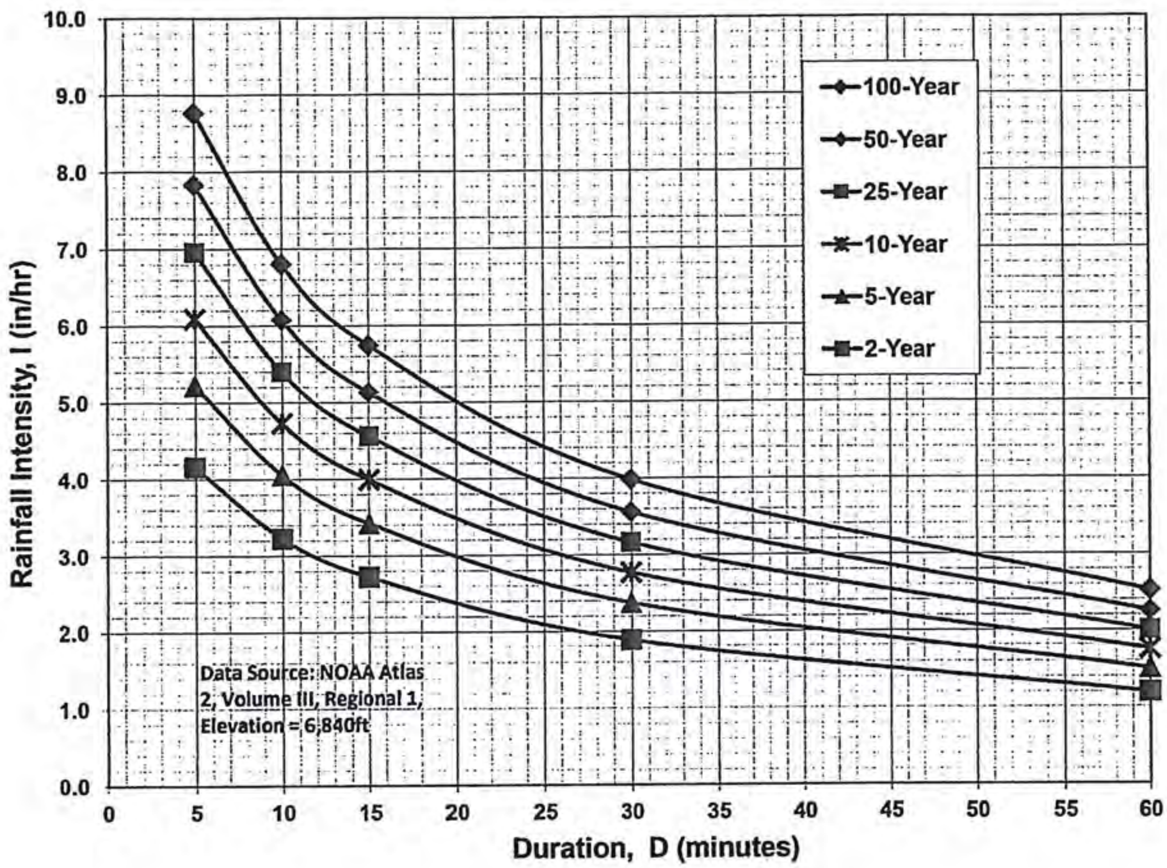
Runoff Coefficients and Percent Imperviousness Table 6-6
Colorado Springs Rainfall Intensity Duration Frequency Table 6-5
Hydrologic Calculations Summary Form SF-1 for Existing & Developed Conditions
Hydrologic Calculations Summary 5-yr Form SF-2 for Existing & Developed Conditions
Hydrologic Calculations Summary 100-yr Form SF-2 for Existing & Developed Conditions

# 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 | | | | | | | | | | | | | |
| EXIST. OFFSITE → | 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 |
| EXIST SITE & DEV. PART → | 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 | | | | | | | | | | | | | |
| DEV. → | 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 |
| EXIST → | 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 |
| DEV → | 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 |
| DEV → | 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 |

**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.

Job No.: **61090**
Project: **Freedom Springs**

Date: **3/22/18 10:03**
Calcs By: **TJW**
Checked By:

## Time of Concentration (Modified from Standard Form SF-1)

| Sub-Basin | Sub-Basin Data | | | | Overland | | | Shallow Channel | | | | Channelized | | | | $t_c$ Check | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Area (Acres) | $C_5$ | $C_{100}$/CN | % Imp. | $L_0$ (ft) | $S_0$ (%) | $t_i$ (min) | $L_{0t}$ (ft) | $S_{0t}$ (ft/ft) | $V_{0sc}$ (ft/s) | $t_t$ (min) | $L_{0c}$ (ft) | $S_{0c}$ (ft/ft) | $V_{0c}$ (ft/s) | $t_c$ (min) | L (min) | $t_{c,alt}$ (min) | $t_c$ (min) |
| OS1 | 2.84 | 0.45 | 0.59 | 65% | 95 | 1% | 11.4 | 125 | 0.010 | 2.0 | 1.0 | 360 | 0.019 | 3.0 | 2.0 | 580 | 13.2 | 13.2 |
| OS2 | 0.57 | 0.49 | 0.65 | 65% | 100 | 1% | 11.0 | 90 | 0.020 | 1.0 | 1.5 | 0 | 0.000 | 0.0 | 0.0 | 190 | 11.1 | 11.1 |
| EX A1 | 2.72 | 0.17 | 0.41 | 11% | 100 | 4% | 11.2 | 265 | 0.009 | 0.7 | 6.5 | 0 | 0.000 | 0.0 | 0.0 | 365 | 12.0 | 12.0 |
| EX B1 | 1.16 | 0.09 | 0.36 | 2% | 100 | 3% | 12.4 | 145 | 0.041 | 1.4 | 1.7 | 0 | 0.000 | 0.0 | 0.0 | 245 | 11.4 | 11.4 |
| A1 | 0.63 | 0.85 | 0.92 | 94% | 100 | 2% | 3.9 | 35 | 0.014 | 2.4 | 0.2 | 160 | 0.011 | 2.0 | 1.3 | 295 | 11.6 | 5.5 |
| B1 | 0.17 | 0.75 | 0.85 | 81% | 100 | 8% | 3.2 | 16 | 0.063 | 5.0 | 0.1 | 0 | 0.000 | 0.0 | 0.0 | 116 | 10.6 | 5.0 |
| C1 | 0.11 | 0.70 | 0.81 | 76% | 32 | 2% | 3.1 | 0 | 0.000 | 0.0 | 0.0 | 128 | 0.057 | 2.5 | 0.9 | 160 | 10.9 | 5.0 |
| D1 | 0.36 | 0.73 | 0.81 | 90% | 30 | 1% | 3.7 | 0 | 0.000 | 0.0 | 0.0 | 175 | 0.010 | 5.0 | 0.6 | 205 | 11.1 | 5.0 |
| E1 | 0.17 | 0.20 | 0.44 | 14% | 87 | 3% | 10.7 | 0 | 0.000 | 0.0 | 0.0 | 0 | 0.000 | 0.0 | 0.0 | 87 | 10.5 | 10.5 |
| F1 | 0.17 | 0.45 | 0.62 | 45% | 87 | 2% | 9.2 | 0 | 0.000 | 0.0 | 0.0 | 0 | 0.000 | 0.0 | 0.0 | 87 | 10.5 | 9.2 |
| G1 | 0.58 | 0.08 | 0.35 | 0% | 100 | 4% | 11.7 | 160 | 0.063 | 1.8 | 1.5 | 0 | 0.000 | 0.0 | 0.0 | 260 | 11.4 | 11.4 |
| H1 | 0.45 | 0.73 | 0.83 | 79% | 65 | 2% | 4.7 | 0 | 0.000 | 0.0 | 0.0 | 245 | 0.045 | 3.0 | 1.4 | 310 | 11.7 | 6.0 |
| J1 | 0.46 | 0.08 | 0.35 | 0% | 100 | 4% | 11.7 | 25 | 0.080 | 2.0 | 0.2 | 0 | 0.000 | 0.0 | 0.0 | 125 | 10.7 | 10.7 |
| K1 | 0.15 | 0.08 | 0.35 | 0% | 33 | 11% | 4.9 | 0 | 0.000 | 0.0 | 0.0 | 0 | 0.000 | 0.0 | 0.0 | 33 | 10.2 | 5.0 |
| L1 | 0.45 | 0.08 | 0.35 | 0% | 100 | 6% | 10.5 | 140 | 0.068 | 1.8 | 1.3 | 0 | 0.000 | 0.0 | 0.0 | 240 | 11.3 | 11.3 |
| M1 | 0.13 | 0.08 | 0.35 | 0% | 32 | 9% | 5.1 | 0 | 0.000 | 0.0 | 0.0 | 0 | 0.000 | 0.0 | 0.0 | 32 | 10.2 | 5.1 |

Job No.: 61090
Project: Freedom Springs
Design Storm: 5-Year Storm *(20% Probability)*
Jurisdiction: DCM

Date: 3/22/18 10:03
Calcs By: TJW
Checked By:

## Sub-Basin and Combined Flows (Modified from Standard Form SF-2)

| | | | | Direct Runoff | | | | Combined Runoff | | | | Streetflow | | | Pipe Flow | | | | | Travel Time | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DP | Sub-Basin | Area (Acres) | C5 | $t_c$ (min) | CA (Acres) | I5 (in/hr) | Q5 (cfs) | $t_c$ (min) | CA (Acres) | I5 (in/hr) | Q5 (cfs) | Slope (%) | Length (ft) | Q (cfs) | Q (cfs) | Slope (%) | Mnngs n | Length (ft) | $D_{Pipe}$ (in) | Length (ft) | $V_{Osc}$ (ft/s) | $t_t$ (min) |
| Offsite | | | | | | | | | | | | | | | | | | | | | | |
| | OS1 | 2.84 | 0.45 | 13.2 | 1.28 | 3.71 | 4.7 | | | | | | | | | | | | | | | |
| | OS2 | 0.57 | 0.49 | 11.1 | 0.28 | 3.98 | 1.1 | | | | | | | | | | | | | | | |
| Existing | | | | | | | | | | | | | | | | | | | | | | |
| | EX A1 | 2.72 | 0.17 | 12.0 | 0.45 | 3.85 | 1.7 | | | | | | | | | | | | | | | |
| | EX B1 | 1.16 | 0.09 | 11.4 | 0.11 | 3.94 | 0.4 | | | | | | | | | | | | | | | |
| OS1+EX A1 | OS1, EX A1 | 5.56 | 0.31 | | | | | 14.1 | 1.73 | 3.61 | 6.2 | | | | | | | | | | | |
| OS2+EX B1 | OS2, EX B1 | 1.72 | 0.21 | | | | | 11.4 | 0.36 | 3.94 | 1.4 | | | | | | | | | | | |
| Developed | | | | | | | | | | | | | | | | | | | | | | |
| DP1 | A1 | 0.63 | 0.85 | 5.5 | 0.54 | 5.02 | 2.7 | | | | | | | | | | | | | | | |
| DP2 | B1 | 0.17 | 0.75 | 5.0 | 0.13 | 5.17 | 0.7 | | | | | | | | | | | | | | | |
| DP3 | C1 | 0.11 | 0.70 | 5.0 | 0.08 | 5.17 | 0.4 | | | | | | | | | | | | | | | |
| | D1 | 0.36 | 0.73 | 5.0 | 0.27 | 5.17 | 1.4 | | | | | | | | | | | | | | | |
| DP5 | E1 | 0.17 | 0.20 | 10.5 | 0.03 | 4.06 | 0.1 | | | | | | | | | | | | | | | |
| DP6 | F1 | 0.17 | 0.45 | 9.2 | 0.08 | 4.25 | 0.3 | | | | | | | | | | | | | | | |
| | G1 | 0.58 | 0.08 | 11.4 | 0.05 | 3.93 | 0.2 | | | | | | | | | | | | | | | |
| | H1 | 0.45 | 0.73 | 6.0 | 0.33 | 4.89 | 1.6 | | | | | | | | | | | | | | | |
| | J1 | 0.46 | 0.08 | 10.7 | 0.04 | 4.03 | 0.1 | | | | | | | | | | | | | | | |
| | K1 | 0.15 | 0.08 | 5.0 | 0.01 | 5.17 | 0.1 | | | | | | | | | | | | | | | |
| | L1 | 0.45 | 0.08 | 11.3 | 0.04 | 3.94 | 0.1 | | | | | | | | | | | | | | | |
| | M1 | 0.13 | 0.08 | 5.1 | 0.01 | 5.14 | 0.1 | | | | | | | | | | | | | | | |
| OS2+L1 | OS2, L1 | 1.02 | 0.29 | | | | | 11.4 | 0.29 | 3.94 | 1.1 | | | | | | | | | | | |
| DP4 | OS1, H1 | 3.29 | 0.49 | | | | | 14.4 | 1.61 | 3.58 | 5.7 | | | | | | | | | | | |
| DP7 | A1-H1 | 2.65 | 0.56 | | | | | 6.2 | 1.49 | 4.84 | 7.2 | | | | | | | | | | | |

DCM: I = C1 * ln (tc) + C2
C1: 1.5
C1: 7.583

Job No.: 61090
Project: Freedom Springs
Design Storm: 100-Year Storm *(1% Probability)*
Jurisdiction: DCM

Date: 3/22/18 10:03
Calcs By: TJW
Checked By:

## Sub-Basin and Combined Flows (Modified from Standard Form SF-2)

| | | | | Direct Runoff | | | | Combined Runoff | | | | Streetflow | | | Pipe Flow | | | | | Travel Time | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DP | Sub-Basin | Area (Acres) | C100 | $t_c$ (min) | CA (Acres) | I100 (in/hr) | Q100 (cfs) | $t_c$ (min) | CA (Acres) | I100 (in/hr) | Q100 (cfs) | Slope (%) | Length (ft) | Q (cfs) | Q (cfs) | Slope (%) | Mnngs n | Length (ft) | $D_{Pipe}$ (in) | Length (ft) | $v_{Osc}$ (ft/s) | $t_t$ (min) |
| Offsite | | | | | | | | | | | | | | | | | | | | | | |
| | OS1 | 2.84 | 0.59 | 13.2 | 1.68 | 6.23 | 10.4 | | | | | | | | | | | | | | | |
| | OS2 | 0.57 | 0.65 | 11.1 | 0.37 | 6.68 | 2.5 | | | | | | | | | | | | | | | |
| Existing | | | | | | | | | | | | | | | | | | | | | | |
| | EX A1 | 2.72 | 0.41 | 12.0 | 1.12 | 6.47 | 7.2 | | | | | | | | | | | | | | | |
| | EX B1 | 1.16 | 0.36 | 11.4 | 0.42 | 6.61 | 2.8 | | | | | | | | | | | | | | | |
| OS1+EX A1 | OS1, EX A1 | 5.56 | 0.50 | | | | | 14.1 | 2.80 | 6.06 | 17.0 | | | | | | | | | | | |
| OS2+EX B1 | OS2, EX B1 | 1.72 | 0.44 | | | | | 11.4 | 0.75 | 6.61 | 5.0 | | | | | | | | | | | |
| Developed | | | | | | | | | | | | | | | | | | | | | | |
| DP1 | A1 | 0.63 | 0.92 | 5.5 | 0.58 | 8.43 | 4.9 | | | | | | | | | | | | | | | |
| DP2 | B1 | 0.17 | 0.85 | 5.0 | 0.15 | 8.68 | 1.3 | | | | | | | | | | | | | | | |
| DP3 | C1 | 0.11 | 0.81 | 5.0 | 0.09 | 8.68 | 0.8 | | | | | | | | | | | | | | | |
| | D1 | 0.36 | 0.81 | 5.0 | 0.30 | 8.68 | 2.6 | | | | | | | | | | | | | | | |
| DP5 | E1 | 0.17 | 0.44 | 10.5 | 0.07 | 6.81 | 0.5 | | | | | | | | | | | | | | | |
| DP6 | F1 | 0.17 | 0.62 | 9.2 | 0.11 | 7.14 | 0.8 | | | | | | | | | | | | | | | |
| | G1 | 0.58 | 0.35 | 11.4 | 0.20 | 6.59 | 1.3 | | | | | | | | | | | | | | | |
| | H1 | 0.45 | 0.83 | 6.0 | 0.37 | 8.21 | 3.1 | | | | | | | | | | | | | | | |
| | J1 | 0.46 | 0.35 | 10.7 | 0.16 | 6.76 | 1.1 | | | | | | | | | | | | | | | |
| | K1 | 0.15 | 0.35 | 5.0 | 0.05 | 8.68 | 0.4 | | | | | | | | | | | | | | | |
| | L1 | 0.45 | 0.35 | 11.3 | 0.16 | 6.62 | 1.1 | | | | | | | | | | | | | | | |
| | M1 | 0.13 | 0.35 | 5.1 | 0.05 | 8.63 | 0.4 | | | | | | | | | | | | | | | |
| OS2+L1 | OS2, L1 | 1.02 | 0.48 | | | | | 11.4 | 0.49 | 6.61 | 3.3 | | | | | | | | | | | |
| DP4 | OS1, H1 | 3.29 | 0.62 | | | | | 14.4 | 2.05 | 6.01 | 12.3 | | | | | | | | | | | |
| DP7 | A1-H1 | 2.65 | 0.71 | | | | | 6.2 | 1.87 | 8.13 | 15.2 | | | | | | | | | | | |

DCM: I = C1 * ln (tc) + C2
C1: 2.52
C1: 12.735

# Sub-Basin OS1 Runoff Calculations

| | | | |
|---|---|---|---|
| Job No.: | 61090 | Date: | 3/22/18 10:03 |
| Project: | Freedom Springs | Calcs by: | TJW |
| | | Checked by: | DRG |
| Jurisdiction | DCM | Soil Type | A |
| Runoff Coefficient | Surface Type | Urbanization | Urban |

## Basin Land Use Characteristics

| | Area | | Runoff Coefficient | | | | | | % |
|---|---|---|---|---|---|---|---|---|---|
| Surface | (SF) | (Acres) | C2 | C5 | C10 | C25 | C50 | C100 | Imperv. |
| 1/8 Acre or less | 123,800 | 2.84 | 0.41 | 0.45 | 0.49 | 0.54 | 0.57 | 0.59 | 65% |
| **Combined** | **123,800** | **2.84** | **0.41** | **0.45** | **0.49** | **0.54** | **0.57** | **0.59** | **65.0%** |
| | 123800 | | | | | | | | |

## Basin Travel Time

Shallow Channel Ground Cover Paved areas/shallow paved swales

$L_{max,Overland}$ 100 ft $C_v$ 20

| | L (ft) | $\Delta Z_0$ (ft) | $S_0$ (ft/ft) | v (ft/s) | t (min) | $t_{Alt}$ (min) | |
|---|---|---|---|---|---|---|---|
| Total | 580 | 9 | - | - | - | - | |
| Initial Time | 95 | 1 | 0.010 | - | 11.4 | 13.2 | DCM Eq. 6-8 |
| Shallow Channel | 125 | 1 | 0.010 | 2.0 | 1.0 | - | DCM Eq. 6-9 |
| Channelized | 360 | 7 | 0.019 | 3.0 | 2.0 | - | C&G |
| | | | | $t_c$ | **13.2 min.** | | |

## Rainfall Intensity & Runoff

| | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr |
|---|---|---|---|---|---|---|
| Intensity (in/hr) | 2.96 | 3.71 | 4.33 | 4.95 | 5.57 | 6.23 |
| Runoff (cfs) | 3.5 | **4.7** | 6.0 | 7.6 | 9.0 | **10.4** |
| Release Rates (cfs/ac) | - | - | - | - | - | - |
| Allowed Release (cfs) | 3.5 | **4.7** | 6.0 | 7.6 | 9.0 | **10.4** |

DCM: I = C1 * ln (tc) + C2

| | | | | | | |
|---|---|---|---|---|---|---|
| C1 | 1.19 | 1.5 | 1.75 | 2 | 2.25 | 2.52 |
| C2 | 6.035 | 7.583 | 8.847 | 10.111 | 11.375 | 12.735 |

## Notes

# Sub-Basin OS2 Runoff Calculations

| | | | | |
|---|---|---|---|---|
| Job No.: | 61090 | Date: | | 3/22/18 10:03 |
| Project: | Freedom Springs | Calcs by: | TJW | |
| | | Checked by: | DRG | |
| Jurisdiction | DCM | Soil Type | OS2 | |
| Runoff Coefficient | Surface Type | Urbanization | Urban | |

## Basin Land Use Characteristics

| Surface | Area (SF) | Area (Acres) | C2 | C5 | C10 | C25 | C50 | C100 | % Imperv. |
|---|---|---|---|---|---|---|---|---|---|
| 1/8 Acre or less | 24,712 | 0.57 | 0.45 | 0.49 | 0.54 | 0.59 | 0.62 | 0.65 | 65% |
| **Combined** | **24,712** | **0.57** | **0.45** | **0.49** | **0.54** | **0.59** | **0.62** | **0.65** | **65.0%** |
| | 24712 | | | | | | | | |

## Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ 100 ft    $C_v$ 7

| | L (ft) | $\Delta Z_0$ (ft) | $S_0$ (ft/ft) | v (ft/s) | t (min) | $t_{Alt}$ (min) | |
|---|---|---|---|---|---|---|---|
| Total | 190 | 3 | - | - | - | - | |
| Initial Time | 100 | 1 | 0.010 | - | 11.0 | 11.1 | DCM Eq. 6-8 |
| Shallow Channel | 90 | 2 | 0.020 | 1.0 | 1.5 | - | DCM Eq. 6-9 |
| Channelized | | | 0.000 | 0.0 | 0.0 | - | V-Ditch |
| | | | | $t_c$ | **11.1 min.** | | |

## Rainfall Intensity & Runoff

| | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr |
|---|---|---|---|---|---|---|
| **Intensity (in/hr)** | 3.18 | 3.98 | 4.64 | 5.31 | 5.97 | 6.68 |
| **Runoff (cfs)** | 0.8 | **1.1** | 1.4 | 1.8 | 2.1 | **2.5** |
| **Release Rates (cfs/ac)** | - | - | - | - | - | - |
| **Allowed Release (cfs)** | 0.8 | **1.1** | 1.4 | 1.8 | 2.1 | **2.5** |

DCM: I = C1 * ln (tc) + C2

| | | | | | | |
|---|---|---|---|---|---|---|
| C1 | 1.19 | 1.5 | 1.75 | 2 | 2.25 | 2.52 |
| C2 | 6.035 | 7.583 | 8.847 | 10.111 | 11.375 | 12.735 |

## Notes

# Sub-Basin EX A1 Runoff Calculations

| | | | | |
|---|---|---|---|---|
| Job No.: | 61090 | Date: | | 3/22/18 10:03 |
| Project: | Freedom Springs | Calcs by: | TJW | |
| | | Checked by: | DRG | |
| Jurisdiction | DCM | Soil Type | A | |
| Runoff Coefficient | Surface Type | Urbanization | Urban | |

## Basin Land Use Characteristics

| | Area | | Runoff Coefficient | | | | | | % |
|---|---|---|---|---|---|---|---|---|---|
| Surface | (SF) | (Acres) | C2 | C5 | C10 | C25 | C50 | C100 | Imperv. |
| Pasture/Meadow | 103,361 | 2.37 | 0.02 | 0.08 | 0.15 | 0.25 | 0.3 | 0.35 | 0% |
| Paved | 7,926 | 0.18 | 0.89 | 0.9 | 0.92 | 0.94 | 0.95 | 0.96 | 100% |
| Gravel | 7,102 | 0.16 | 0.57 | 0.59 | 0.63 | 0.66 | 0.68 | 0.7 | 80% |
| **Combined** | **118,389** | **2.72** | **0.11** | **0.17** | **0.23** | **0.32** | **0.37** | **0.41** | **11.5%** |
| | 118389 | | | | | | | | |

## Basin Travel Time

-

Shallow Channel Ground Cover Short Pasture/Lawns

$L_{max,Overland}$ 100 ft $C_v$ 7

| | L (ft) | $\Delta Z_0$ (ft) | $S_0$ (ft/ft) | v (ft/s) | t (min) | $t_{Alt}$ (min) | |
|---|---|---|---|---|---|---|---|
| Total | 365 | 6 | - | - | - | - | |
| Initial Time | 100 | 4 | 0.035 | - | 11.2 | 12.0 | DCM Eq. 6-8 |
| Shallow Channel | 265 | 3 | 0.009 | 0.7 | 6.5 | - | DCM Eq. 6-9 |
| Channelized | | | 0.000 | 0.0 | 0.0 | - | V-Ditch |
| | | | | $t_c$ | **12.0** | **min.** | |

## Rainfall Intensity & Runoff

| | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr |
|---|---|---|---|---|---|---|
| Intensity (in/hr) | 3.08 | 3.85 | 4.49 | 5.14 | 5.78 | 6.47 |
| Runoff (cfs) | 0.9 | **1.7** | 2.8 | 4.5 | 5.8 | **7.2** |
| Release Rates (cfs/ac) | - | - | - | - | - | - |
| Allowed Release (cfs) | 0.9 | **1.7** | 2.8 | 4.5 | 5.8 | **7.2** |
| DCM: $I = C1 * \ln(tc) + C2$ | | | | | | |
| C1 | 1.19 | 1.5 | 1.75 | 2 | 2.25 | 2.52 |
| C2 | 6.035 | 7.583 | 8.847 | 10.111 | 11.375 | 12.735 |

## Notes

# Sub-Basin EX B1 Runoff Calculations

| | | | |
|---|---|---|---|
| Job No.: | 61090 | Date: | 3/22/18 10:03 |
| Project: | Freedom Springs | Calcs by: | TJW |
| | | Checked by: | DRG |
| Jurisdiction | DCM | Soil Type | A |
| Runoff Coefficient | Surface Type | Urbanization | Urban |

## Basin Land Use Characteristics

| | Area | | Runoff Coefficient | | | | | | % |
|---|---|---|---|---|---|---|---|---|---|
| Surface | (SF) | (Acres) | C2 | C5 | C10 | C25 | C50 | C100 | Imperv. |
| Pasture/Meadow | 49,443 | 1.14 | 0.02 | 0.08 | 0.15 | 0.25 | 0.3 | 0.35 | 0% |
| Paved | 749 | 0.02 | 0.89 | 0.9 | 0.92 | 0.94 | 0.95 | 0.96 | 100% |
| Gravel | 214 | 0.00 | 0.57 | 0.59 | 0.63 | 0.66 | 0.68 | 0.7 | 80% |
| **Combined** | **50,406** | **1.16** | **0.04** | **0.09** | **0.16** | **0.26** | **0.31** | **0.36** | **1.8%** |
| | 50406 | | | | | | | | |

## Basin Travel Time

-

Shallow Channel Ground Cover Short Pasture/Lawns

$L_{max,Overland}$ 100 ft $C_v$ 7

| | L (ft) | $\Delta Z_0$ (ft) | $S_0$ (ft/ft) | v (ft/s) | t (min) | $t_{Alt}$ (min) | |
|---|---|---|---|---|---|---|---|
| Total | 245 | 9 | - | - | - | - | |
| Initial Time | 100 | 3 | 0.032 | - | 12.4 | 11.4 | DCM Eq. 6-8 |
| Shallow Channel | 145 | 6 | 0.041 | 1.4 | 1.7 | - | DCM Eq. 6-9 |
| Channelized | | | 0.000 | 0.0 | 0.0 | - | V-Ditch |
| | | | | $t_c$ | **11.4 min.** | | |

## Rainfall Intensity & Runoff

| | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr |
|---|---|---|---|---|---|---|
| Intensity (in/hr) | 3.14 | 3.94 | 4.59 | 5.25 | 5.91 | 6.61 |
| Runoff (cfs) | 0.1 | **0.4** | 0.9 | 1.6 | 2.1 | **2.8** |
| Release Rates (cfs/ac) | - | - | - | - | - | - |
| Allowed Release (cfs) | 0.1 | **0.4** | 0.9 | 1.6 | 2.1 | **2.8** |
| DCM: I = C1 * ln (tc) + C2 | | | | | | |
| C1 | 1.19 | 1.5 | 1.75 | 2 | 2.25 | 2.52 |
| C2 | 6.035 | 7.583 | 8.847 | 10.111 | 11.375 | 12.735 |

## Notes

# Combined Sub-Basin Runoff Calculations

Includes Basins OS1 EX A1

| | | | |
|---|---|---|---|
| Job No.: | **61090** | Date: | **3/22/18 10:03** |
| Project: | **Freedom Springs** | Calcs by: | **TJW** |
| | | Checked by: | **DRG** |
| Jurisdiction | **DCM** | Soil Type | **A** |
| Runoff Coefficient | **Surface Type** | Urbanization | **Urban** |

## Basin Land Use Characteristics

| | Area | | Runoff Coefficient | | | | | | % |
|---|---|---|---|---|---|---|---|---|---|
| **Surface** | **(SF)** | **(Acres)** | **C2** | **C5** | **C10** | **C25** | **C50** | **C100** | **Imperv.** |
| 1/8 Acre or less | 123,800 | 2.84 | 0.41 | 0.45 | 0.49 | 0.54 | 0.57 | 0.59 | 65% |
| Pasture/Meadow | 103,361 | 2.37 | 0.02 | 0.08 | 0.15 | 0.25 | 0.3 | 0.35 | 0% |
| Paved | 7,926 | 0.18 | 0.89 | 0.9 | 0.92 | 0.94 | 0.95 | 0.96 | 100% |
| Gravel | 7,102 | 0.16 | 0.57 | 0.59 | 0.63 | 0.66 | 0.68 | 0.7 | 80% |
| **Combined** | **242,189** | **5.56** | **0.26** | **0.31** | **0.36** | **0.43** | **0.47** | **0.50** | **38.8%** |

## Basin Travel Time

| | Sub-basin or Channel Type | Material Type | L (ft) | Elev. $\Delta Z_0$ (ft) | $Q_i$ (cfs) | Base or Dia (ft) | Sides z:1 (ft/ft) | v (ft/s) | t (min) |
|---|---|---|---|---|---|---|---|---|---|
| Furthest Reach | OS1 | - | 580 | 9 | - | - | - | - | 13.2 |
| Channelized-1 | V-Ditch | 1 | 296 | 12 | 10 | 1 | 2 | 5.5 | 0.9 |
| Channelized-2 | | | | | | 1 | | | |
| Channelized-3 | | | | | | | | | |
| Total | | | 876 | 21 | | | | | |

1 = Man-made, Smooth, Straight

**$t_c$ (min)** **14.1**

## Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

$Q_{Minor}$ (cfs) - 5-year Storm

$Q_{Major}$ (cfs) - 100-year Storm

## Rainfall Intensity & Runoff

| | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr |
|---|---|---|---|---|---|---|
| **Intensity (in/hr)** | 2.88 | 3.61 | 4.21 | 4.82 | 5.42 | 6.06 |
| **Site Runoff (cfs)** | 4.23 | **6.24** | 8.51 | 11.59 | 14.17 | **16.95** |
| **OffSite Runoff (cfs)** | - | **0.00** | - | - | - | **0.00** |
| **Release Rates (cfs/ac)** | - | - | - | - | - | - |
| **Allowed Release (cfs)** | - | **6.2** | - | - | - | **17.0** |

DCM: I = C1 * ln (tc) + C2

| | | | | | | |
|---|---|---|---|---|---|---|
| C1 | 1.19 | 1.5 | 1.75 | 2 | 2.25 | 2.52 |
| C2 | 6.035 | 7.583 | 8.847 | 10.111 | 11.375 | 12.735 |

## Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

# Combined Sub-Basin Runoff Calculations

Includes Basins OS2 EX B1

| | | | |
|---|---|---|---|
| Job No.: | **61090** | Date: | **3/22/18 10:03** |
| Project: | **Freedom Springs** | Calcs by: | **TJW** |
| | | Checked by: | **DRG** |
| Jurisdiction | **DCM** | Soil Type | **A** |
| Runoff Coefficient | **Surface Type** | Urbanization | **Urban** |

## Basin Land Use Characteristics

| | Area | | Runoff Coefficient | | | | | | % |
|---|---|---|---|---|---|---|---|---|---|
| **Surface** | **(SF)** | **(Acres)** | **C2** | **C5** | **C10** | **C25** | **C50** | **C100** | **Imperv.** |
| 1/8 Acre or less | 24,712 | 0.57 | 0.41 | 0.45 | 0.49 | 0.54 | 0.57 | 0.59 | 65% |
| Pasture/Meadow | 49,443 | 1.14 | 0.02 | 0.08 | 0.15 | 0.25 | 0.3 | 0.35 | 0% |
| Paved | 749 | 0.02 | 0.89 | 0.9 | 0.92 | 0.94 | 0.95 | 0.96 | 100% |
| Gravel | 214 | 0.00 | 0.57 | 0.59 | 0.63 | 0.66 | 0.68 | 0.7 | 80% |
| **Combined** | **75,118** | **1.72** | **0.16** | **0.21** | **0.27** | **0.35** | **0.40** | **0.44** | **22.6%** |

## Basin Travel Time

| | Sub-basin or Channel Type | Material Type | L (ft) | Elev. $\Delta Z_0$ (ft) | $Q_i$ (cfs) | Base or Dia (ft) | Sides z:1 (ft/ft) | v (ft/s) | t (min) |
|---|---|---|---|---|---|---|---|---|---|
| Furthest Reach | EX B1 | - | 245 | 9 | - | - | - | - | 11.4 |
| Channelized-1 | | | | | | 1 | | | |
| Channelized-2 | | | | | | 1 | | | |
| Channelized-3 | | | | | | | | | |
| Total | | | 245 | 9 | | | | | |

**$t_c$ (min)** **11.4**

## Rainfall Intensity & Runoff

| | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr |
|---|---|---|---|---|---|---|
| **Intensity (in/hr)** | 3.14 | 3.94 | 4.59 | 5.25 | 5.91 | 6.61 |
| **Site Runoff (cfs)** | 0.86 | **1.44** | 2.15 | 3.20 | 4.04 | **4.97** |
| **OffSite Runoff (cfs)** | - | **0.00** | - | - | - | **0.00** |
| **Release Rates (cfs/ac)** | - | - | - | - | - | - |
| **Allowed Release (cfs)** | - | **1.4** | - | - | - | **5.0** |

DCM: I = C1 * ln (tc) + C2

| | | | | | | |
|---|---|---|---|---|---|---|
| C1 | 1.19 | 1.5 | 1.75 | 2 | 2.25 | 2.52 |
| C2 | 6.035 | 7.583 | 8.847 | 10.111 | 11.375 | 12.735 |

## Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

# Sub-Basin A1 Runoff Calculations

| | | | | |
|---|---|---|---|---|
| Job No.: | 61090 | Date: | | 3/22/18 10:03 |
| Project: | Freedom Springs | Calcs by: | TJW | |
| | | Checked by: | DRG | |
| Jurisdiction | DCM | Soil Type | A | |
| Runoff Coefficient | Surface Type | Urbanization | Urban | |

## Basin Land Use Characteristics

| | Area | | Runoff Coefficient | | | | | | % |
|---|---|---|---|---|---|---|---|---|---|
| Surface | (SF) | (Acres) | C2 | C5 | C10 | C25 | C50 | C100 | Imperv. |
| Driveways & Walks | 25,793 | 0.59 | 0.89 | 0.9 | 0.92 | 0.94 | 0.95 | 0.96 | 100% |
| Lawns | 1,662 | 0.04 | 0.02 | 0.08 | 0.15 | 0.25 | 0.3 | 0.35 | 0% |
| **Combined** | **27,455** | **0.63** | **0.84** | **0.85** | **0.87** | **0.90** | **0.91** | **0.92** | **93.9%** |

## Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$ 100 ft     $C_v$ 20

| | L (ft) | $\Delta Z_0$ (ft) | $S_0$ (ft/ft) | v (ft/s) | t (min) | $t_{Alt}$ (min) | |
|---|---|---|---|---|---|---|---|
| Total | 295 | 4 | - | - | - | - | |
| Initial Time | 100 | 2 | 0.015 | - | 3.9 | 11.6 | DCM Eq. 6-8 |
| Shallow Channel | 35 | 1 | 0.014 | 2.4 | 0.2 | - | DCM Eq. 6-9 |
| Channelized | 160 | 2 | 0.011 | 2.0 | 1.3 | - | C&G |

$t_c$ **5.5 min.**

## Rainfall Intensity & Runoff

| | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr |
|---|---|---|---|---|---|---|
| **Intensity (in/hr)** | 4.00 | 5.02 | 5.86 | 6.69 | 7.53 | 8.43 |
| **Runoff (cfs)** | 2.1 | **2.7** | 3.2 | 3.8 | 4.3 | **4.9** |
| **Release Rates (cfs/ac)** | - | - | - | - | - | - |
| **Allowed Release (cfs)** | 2.1 | **2.7** | 3.2 | 3.8 | 4.3 | **4.9** |

DCM: I = C1 * ln (tc) + C2

| | | | | | | |
|---|---|---|---|---|---|---|
| C1 | 1.19 | 1.5 | 1.75 | 2 | 2.25 | 2.52 |
| C2 | 6.035 | 7.583 | 8.847 | 10.111 | 11.375 | 12.735 |

## Notes

# Sub-Basin B1 Runoff Calculations

2

| | | | |
|---|---|---|---|
| Job No.: | **61090** | Date: | **3/22/18 10:03** |
| Project: | **Freedom Springs** | Calcs by: | **TJW** |
| | | Checked by: | **DRG** |
| Jurisdiction | **DCM** | Soil Type | A |
| Runoff Coefficient | **Surface Type** | Urbanization | **Urban** |

## Basin Land Use Characteristics

| Surface | Area (SF) | Area (Acres) | Runoff Coefficient C2 | C5 | C10 | C25 | C50 | C100 | % Imperv. |
|---|---|---|---|---|---|---|---|---|---|
| Driveways & Walks | 6,096 | 0.14 | 0.89 | 0.9 | 0.92 | 0.94 | 0.95 | 0.96 | 100% |
| Lawns | 1,386 | 0.03 | 0.02 | 0.08 | 0.15 | 0.25 | 0.3 | 0.35 | 0% |
| **Combined** | **7,482** | **0.17** | **0.73** | **0.75** | **0.78** | **0.81** | **0.83** | **0.85** | **81.5%** |

## Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$ 100 ft    $C_v$ 20

| | L (ft) | $\Delta Z_0$ (ft) | $S_0$ (ft/ft) | v (ft/s) | t (min) | $t_{Alt}$ (min) | |
|---|---|---|---|---|---|---|---|
| Total | 116 | 9 | - | - | - | - | |
| Initial Time | 100 | 8 | 0.080 | - | 3.2 | 10.6 | DCM Eq. 6-8 |
| Shallow Channel | 16 | 1 | 0.063 | 5.0 | 0.1 | - | DCM Eq. 6-9 |
| Channelized | | | 0.000 | 0.0 | 0.0 | - | C&G |

$t_c$ **5.0 min.**

## Rainfall Intensity & Runoff

| | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr |
|---|---|---|---|---|---|---|
| **Intensity (in/hr)** | 4.12 | 5.17 | 6.03 | 6.89 | 7.75 | 8.68 |
| **Runoff (cfs)** | 0.5 | **0.7** | 0.8 | 1.0 | 1.1 | **1.3** |
| **Release Rates (cfs/ac)** | - | - | - | - | - | - |
| **Allowed Release (cfs)** | 0.5 | **0.7** | 0.8 | 1.0 | 1.1 | **1.3** |

DCM: I = C1 * ln (tc) + C2

| | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr |
|---|---|---|---|---|---|---|
| C1 | 1.19 | 1.5 | 1.75 | 2 | 2.25 | 2.52 |
| C2 | 6.035 | 7.583 | 8.847 | 10.111 | 11.375 | 12.735 |

## Notes

# Sub-Basin C1 Runoff Calculations

3

| | | | |
|---|---|---|---|
| Job No.: | 61090 | Date: | 3/22/18 10:03 |
| Project: | Freedom Springs | Calcs by: | TJW |
| | | Checked by: | DRG |
| Jurisdiction | DCM | Soil Type | A |
| Runoff Coefficient | Surface Type | Urbanization | Urban |

## Basin Land Use Characteristics

| | Area | | Runoff Coefficient | | | | | | % |
|---|---|---|---|---|---|---|---|---|---|
| Surface | (SF) | (Acres) | C2 | C5 | C10 | C25 | C50 | C100 | Imperv. |
| Driveways & Walks | 3,650 | 0.08 | 0.89 | 0.9 | 0.92 | 0.94 | 0.95 | 0.96 | 100% |
| Lawns | 1,169 | 0.03 | 0.02 | 0.08 | 0.15 | 0.25 | 0.3 | 0.35 | 0% |
| **Combined** | **4,819** | **0.11** | **0.68** | **0.70** | **0.73** | **0.77** | **0.79** | **0.81** | **75.7%** |

## Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$ 100 ft — $C_v$ 20

| | L (ft) | $\Delta Z_0$ (ft) | $S_0$ (ft/ft) | v (ft/s) | t (min) | $t_{Alt}$ (min) | |
|---|---|---|---|---|---|---|---|
| Total | 160 | 8 | - | - | - | - | |
| Initial Time | 32 | 1 | 0.022 | - | 3.1 | 10.9 | DCM Eq. 6-8 |
| Shallow Channel | | | 0.000 | 0.0 | 0.0 | - | DCM Eq. 6-9 |
| Channelized | 128 | 7 | 0.057 | 2.5 | 0.9 | - | C&G |
| | | | | $t_c$ | **5.0 min.** | | |

## Rainfall Intensity & Runoff

| | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr |
|---|---|---|---|---|---|---|
| **Intensity (in/hr)** | 4.12 | 5.17 | 6.03 | 6.89 | 7.75 | 8.68 |
| **Runoff (cfs)** | 0.3 | **0.4** | 0.5 | 0.6 | 0.7 | **0.8** |
| **Release Rates (cfs/ac)** | - | - | - | - | - | - |
| **Allowed Release (cfs)** | 0.3 | **0.4** | 0.5 | 0.6 | 0.7 | **0.8** |

DCM: I = C1 * ln (tc) + C2

| | | | | | | |
|---|---|---|---|---|---|---|
| C1 | 1.19 | 1.5 | 1.75 | 2 | 2.25 | 2.52 |
| C2 | 6.035 | 7.583 | 8.847 | 10.111 | 11.375 | 12.735 |

## Notes

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C1

# Sub-Basin D1 Runoff Calculations

| | | | |
|---|---|---|---|
| Job No.: | **61090** | Date: | **3/22/18 10:03** |
| Project: | **Freedom Springs** | Calcs by: | **TJW** |
| | | Checked by: | **DRG** |
| Jurisdiction | **DCM** | Soil Type | **A** |
| Runoff Coefficient | **Surface Type** | Urbanization | **Urban** |

## Basin Land Use Characteristics

| | Area | | Runoff Coefficient | | | | | | % |
|---|---|---|---|---|---|---|---|---|---|
| **Surface** | **(SF)** | **(Acres)** | **C2** | **C5** | **C10** | **C25** | **C50** | **C100** | **Imperv.** |
| Roofs | 15,888 | 0.36 | 0.71 | 0.73 | 0.75 | 0.78 | 0.8 | 0.81 | 90% |
| **Combined** | **15,888** | **0.36** | **0.71** | **0.73** | **0.75** | **0.78** | **0.80** | **0.81** | **90.0%** |

## Basin Travel Time

Shallow Channel Ground Cover Paved areas/shallow paved swales

$L_{max,Overland}$ 100 ft $C_v$ 20

| | L (ft) | $\Delta Z_0$ (ft) | $S_0$ (ft/ft) | v (ft/s) | t (min) | $t_{Alt}$ (min) | |
|---|---|---|---|---|---|---|---|
| Total | 205 | 2 | - | - | - | - | |
| Initial Time | 30 | 0 | 0.010 | - | 3.7 | 11.1 | DCM Eq. 6-8 |
| Shallow Channel | | | 0.000 | 0.0 | 0.0 | - | DCM Eq. 6-9 |
| Channelized | 175 | 2 | 0.010 | 5.0 | 0.6 | - | Pipe |
| | | | | $t_c$ | **5.0 min.** | | |

## Rainfall Intensity & Runoff

| | **2-Yr** | **5-Yr** | **10-Yr** | **25-Yr** | **50-Yr** | **100-Yr** |
|---|---|---|---|---|---|---|
| **Intensity (in/hr)** | 4.12 | 5.17 | 6.03 | 6.89 | 7.75 | 8.68 |
| **Runoff (cfs)** | 1.1 | **1.4** | 1.6 | 2.0 | 2.3 | **2.6** |
| **Release Rates (cfs/ac)** | - | - | - | - | - | - |
| **Allowed Release (cfs)** | 1.1 | **1.4** | 1.6 | 2.0 | 2.3 | **2.6** |
| DCM: I = C1 * ln (tc) + C2 | | | | | | |
| C1 | 1.19 | 1.5 | 1.75 | 2 | 2.25 | 2.52 |
| C2 | 6.035 | 7.583 | 8.847 | 10.111 | 11.375 | 12.735 |

## Notes

# Sub-Basin E1 Runoff Calculations

5

| | | | |
|---|---|---|---|
| Job No.: | 61090 | Date: | 3/22/18 10:03 |
| Project: | Freedom Springs | Calcs by: | TJW |
| | | Checked by: | DRG |
| Jurisdiction | DCM | Soil Type | A |
| Runoff Coefficient | Surface Type | Urbanization | Urban |

## Basin Land Use Characteristics

| | Area | | Runoff Coefficient | | | | | | % |
|---|---|---|---|---|---|---|---|---|---|
| Surface | (SF) | (Acres) | C2 | C5 | C10 | C25 | C50 | C100 | Imperv. |
| Driveways & Walks | 1,047 | 0.02 | 0.89 | 0.9 | 0.92 | 0.94 | 0.95 | 0.96 | 100% |
| Lawns | 6,356 | 0.15 | 0.02 | 0.08 | 0.15 | 0.25 | 0.3 | 0.35 | 0% |
| **Combined** | **7,403** | **0.17** | **0.14** | **0.20** | **0.26** | **0.35** | **0.39** | **0.44** | **14.1%** |

## Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ 100 ft  $C_v$ 7

| | L (ft) | $\Delta Z_0$ (ft) | $S_0$ (ft/ft) | v (ft/s) | t (min) | $t_{Alt}$ (min) | |
|---|---|---|---|---|---|---|---|
| Total | 87 | 3 | - | - | - | - | |
| Initial Time | 87 | 3 | 0.029 | - | 10.7 | 10.5 | DCM Eq. 6-8 |
| Shallow Channel | | | 0.000 | 0.0 | 0.0 | - | DCM Eq. 6-9 |
| Channelized | | | 0.000 | 0.0 | 0.0 | - | C&G |

$t_c$ **10.5 min.**

## Rainfall Intensity & Runoff

| | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr |
|---|---|---|---|---|---|---|
| **Intensity (in/hr)** | 3.24 | 4.06 | 4.73 | 5.41 | 6.09 | 6.81 |
| **Runoff (cfs)** | 0.1 | **0.1** | 0.2 | 0.3 | 0.4 | **0.5** |
| **Release Rates (cfs/ac)** | - | - | - | - | - | - |
| **Allowed Release (cfs)** | 0.1 | **0.1** | 0.2 | 0.3 | 0.4 | **0.5** |

DCM: I = C1 * ln (tc) + C2

| | | | | | | |
|---|---|---|---|---|---|---|
| C1 | 1.19 | 1.5 | 1.75 | 2 | 2.25 | 2.52 |
| C2 | 6.035 | 7.583 | 8.847 | 10.111 | 11.375 | 12.735 |

## Notes

# Sub-Basin F1 Runoff Calculations

6

| | | | |
|---|---|---|---|
| Job No.: | 61090 | Date: | 3/22/18 10:03 |
| Project: | Freedom Springs | Calcs by: | TJW |
| | | Checked by: | DRG |
| Jurisdiction | DCM | Soil Type | A |
| Runoff Coefficient | Surface Type | Urbanization | Urban |

## Basin Land Use Characteristics

| | Area | | Runoff Coefficient | | | | | | % |
|---|---|---|---|---|---|---|---|---|---|
| Surface | (SF) | (Acres) | C2 | C5 | C10 | C25 | C50 | C100 | Imperv. |
| Driveways & Walks | 3,305 | 0.08 | 0.89 | 0.9 | 0.92 | 0.94 | 0.95 | 0.96 | 100% |
| Lawns | 4,102 | 0.09 | 0.02 | 0.08 | 0.15 | 0.25 | 0.3 | 0.35 | 0% |
| **Combined** | **7,407** | **0.17** | **0.41** | **0.45** | **0.49** | **0.56** | **0.59** | **0.62** | **44.6%** |

## Basin Travel Time

Shallow Channel Ground Cover Short Pasture/Lawns

$L_{max,Overland}$ 100 ft $C_v$ 7

| | L (ft) | $\Delta Z_0$ (ft) | $S_0$ (ft/ft) | v (ft/s) | t (min) | $t_{Alt}$ (min) | |
|---|---|---|---|---|---|---|---|
| Total | 87 | 2 | - | - | - | - | |
| Initial Time | 87 | 2 | 0.017 | - | 9.2 | 10.5 | DCM Eq. 6-8 |
| Shallow Channel | | | 0.000 | 0.0 | 0.0 | - | DCM Eq. 6-9 |
| Channelized | | | 0.000 | 0.0 | 0.0 | - | C&G |

**$t_c$ 9.2 min.**

## Rainfall Intensity & Runoff

| | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr |
|---|---|---|---|---|---|---|
| **Intensity (in/hr)** | 3.39 | 4.25 | 4.96 | 5.67 | 6.38 | 7.14 |
| **Runoff (cfs)** | 0.2 | **0.3** | 0.4 | 0.5 | 0.6 | **0.8** |
| **Release Rates (cfs/ac)** | - | - | - | - | - | - |
| **Allowed Release (cfs)** | 0.2 | **0.3** | 0.4 | 0.5 | 0.6 | **0.8** |

DCM: I = C1 * ln (tc) + C2

| | | | | | | |
|---|---|---|---|---|---|---|
| C1 | 1.19 | 1.5 | 1.75 | 2 | 2.25 | 2.52 |
| C2 | 6.035 | 7.583 | 8.847 | 10.111 | 11.375 | 12.735 |

## Notes

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F1

# Sub-Basin G1 Runoff Calculations

| | | | | |
|---|---|---|---|---|
| Job No.: | 61090 | Date: | | 3/22/18 10:03 |
| Project: | Freedom Springs | Calcs by: | TJW | |
| | | Checked by: | DRG | |
| Jurisdiction | DCM | Soil Type | A | |
| Runoff Coefficient | Surface Type | Urbanization | Urban | |

## Basin Land Use Characteristics

| | Area | | Runoff Coefficient | | | | | | % |
|---|---|---|---|---|---|---|---|---|---|
| **Surface** | **(SF)** | **(Acres)** | **C2** | **C5** | **C10** | **C25** | **C50** | **C100** | **Imperv.** |
| Lawns | 25,376 | 0.58 | 0.02 | 0.08 | 0.15 | 0.25 | 0.3 | 0.35 | 0% |
| **Combined** | **25,376** | **0.58** | **0.02** | **0.08** | **0.15** | **0.25** | **0.30** | **0.35** | **0.0%** |

## Basin Travel Time

Shallow Channel Ground Cover Short Pasture/Lawns

$L_{max,Overland}$ 100 ft $C_v$ 7

| | L (ft) | $\Delta Z_0$ (ft) | $S_0$ (ft/ft) | v (ft/s) | t (min) | $t_{Alt}$ (min) | |
|---|---|---|---|---|---|---|---|
| Total | 260 | 14 | - | - | - | - | |
| Initial Time | 100 | 4 | 0.040 | - | 11.7 | 11.4 | DCM Eq. 6-8 |
| Shallow Channel | 160 | 10 | 0.063 | 1.8 | 1.5 | - | DCM Eq. 6-9 |
| Channelized | | | 0.000 | 0.0 | 0.0 | - | V-Ditch |

$t_c$ **11.4 min.**

## Rainfall Intensity & Runoff

| | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr |
|---|---|---|---|---|---|---|
| **Intensity (in/hr)** | 3.13 | 3.93 | 4.58 | 5.24 | 5.89 | 6.59 |
| **Runoff (cfs)** | 0.0 | **0.2** | 0.4 | 0.8 | 1.0 | **1.3** |
| **Release Rates (cfs/ac)** | - | - | - | - | - | - |
| **Allowed Release (cfs)** | 0.0 | **0.2** | 0.4 | 0.8 | 1.0 | **1.3** |

DCM: $I = C1 * \ln(tc) + C2$

| | | | | | | |
|---|---|---|---|---|---|---|
| C1 | 1.19 | 1.5 | 1.75 | 2 | 2.25 | 2.52 |
| C2 | 6.035 | 7.583 | 8.847 | 10.111 | 11.375 | 12.735 |

## Notes

# Sub-Basin H1 Runoff Calculations

| | | | |
|---|---|---|---|
| Job No.: | **61090** | Date: | **3/22/18 10:03** |
| Project: | **Freedom Springs** | Calcs by: | **TJW** |
| | | Checked by: | **DRG** |
| Jurisdiction | **DCM** | Soil Type | **A** |
| Runoff Coefficient | **Surface Type** | Urbanization | **Urban** |

## Basin Land Use Characteristics

| | Area | | Runoff Coefficient | | | | | | % |
|---|---|---|---|---|---|---|---|---|---|
| **Surface** | **(SF)** | **(Acres)** | **C2** | **C5** | **C10** | **C25** | **C50** | **C100** | **Imperv.** |
| Driveways & Walks | 15,473 | 0.36 | 0.89 | 0.9 | 0.92 | 0.94 | 0.95 | 0.96 | 100% |
| Lawns | 4,028 | 0.09 | 0.02 | 0.08 | 0.15 | 0.25 | 0.3 | 0.35 | 0% |
| **Combined** | **19,501** | **0.45** | **0.71** | **0.73** | **0.76** | **0.80** | **0.82** | **0.83** | **79.3%** |

## Basin Travel Time

Shallow Channel Ground Cover Paved areas/shallow paved swales

$L_{max,Overland}$ 100 ft $C_v$ 20

| | L (ft) | $\Delta Z_0$ (ft) | $S_0$ (ft/ft) | v (ft/s) | t (min) | $t_{Alt}$ (min) | |
|---|---|---|---|---|---|---|---|
| Total | 310 | 12 | - | - | - | - | |
| Initial Time | 65 | 1 | 0.015 | - | 4.7 | 11.7 | DCM Eq. 6-8 |
| Shallow Channel | | | 0.000 | 0.0 | 0.0 | - | DCM Eq. 6-9 |
| Channelized | 245 | 11 | 0.045 | 3.0 | 1.4 | - | C&G |
| | | | | $t_c$ | **6.0 min.** | | |

## Rainfall Intensity & Runoff

| | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr |
|---|---|---|---|---|---|---|
| **Intensity (in/hr)** | 3.90 | 4.89 | 5.71 | 6.52 | 7.34 | 8.21 |
| **Runoff (cfs)** | 1.2 | **1.6** | 1.9 | 2.3 | 2.7 | **3.1** |
| **Release Rates (cfs/ac)** | - | - | - | - | - | - |
| **Allowed Release (cfs)** | 1.2 | **1.6** | 1.9 | 2.3 | 2.7 | **3.1** |

DCM: I = C1 * ln (tc) + C2

| | | | | | | |
|---|---|---|---|---|---|---|
| C1 | 1.19 | 1.5 | 1.75 | 2 | 2.25 | 2.52 |
| C2 | 6.035 | 7.583 | 8.847 | 10.111 | 11.375 | 12.735 |

## Notes

# Sub-Basin J1 Runoff Calculations

| | | | |
|---|---|---|---|
| Job No.: | **61090** | Date: | **3/22/18 10:03** |
| Project: | **Freedom Springs** | Calcs by: | **TJW** |
| | | Checked by: | **DRG** |
| Jurisdiction | **DCM** | Soil Type | **A** |
| Runoff Coefficient | **Surface Type** | Urbanization | **Urban** |

## Basin Land Use Characteristics

| | Area | | Runoff Coefficient | | | | | | % |
|---|---|---|---|---|---|---|---|---|---|
| Surface | (SF) | (Acres) | C2 | C5 | C10 | C25 | C50 | C100 | Imperv. |
| Lawns | 20,091 | 0.46 | 0.02 | 0.08 | 0.15 | 0.25 | 0.3 | 0.35 | 0% |
| **Combined** | **20,091** | **0.46** | **0.02** | **0.08** | **0.15** | **0.25** | **0.30** | **0.35** | **0.0%** |

## Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ 100 ft  $C_v$ 7

| | L (ft) | $\Delta Z_0$ (ft) | $S_0$ (ft/ft) | v (ft/s) | t (min) | $t_{Alt}$ (min) | |
|---|---|---|---|---|---|---|---|
| Total | 125 | 6 | - | - | - | - | |
| Initial Time | 100 | 4 | 0.040 | - | 11.7 | 10.7 | DCM Eq. 6-8 |
| Shallow Channel | 25 | 2 | 0.080 | 2.0 | 0.2 | - | DCM Eq. 6-9 |
| Channelized | | | 0.000 | 0.0 | 0.0 | - | V-Ditch |

$t_c$ **10.7 min.**

## Rainfall Intensity & Runoff

| | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr |
|---|---|---|---|---|---|---|
| **Intensity (in/hr)** | 3.22 | 4.03 | 4.70 | 5.37 | 6.04 | 6.76 |
| **Runoff (cfs)** | 0.0 | **0.1** | 0.3 | 0.6 | 0.8 | **1.1** |
| **Release Rates (cfs/ac)** | - | - | - | - | - | - |
| **Allowed Release (cfs)** | 0.0 | **0.1** | 0.3 | 0.6 | 0.8 | **1.1** |

DCM: I = C1 * ln (tc) + C2

| | | | | | | |
|---|---|---|---|---|---|---|
| C1 | 1.19 | 1.5 | 1.75 | 2 | 2.25 | 2.52 |
| C2 | 6.035 | 7.583 | 8.847 | 10.111 | 11.375 | 12.735 |

## Notes

# Sub-Basin K1 Runoff Calculations

| | | | |
|---|---|---|---|
| Job No.: | 61090 | Date: | 3/22/18 10:03 |
| Project: | Freedom Springs | Calcs by: | TJW |
| | | Checked by: | DRG |
| Jurisdiction | DCM | Soil Type | A |
| Runoff Coefficient | Surface Type | Urbanization | Urban |

## Basin Land Use Characteristics

| | Area | | Runoff Coefficient | | | | | | % |
|---|---|---|---|---|---|---|---|---|---|
| Surface | (SF) | (Acres) | C2 | C5 | C10 | C25 | C50 | C100 | Imperv. |
| Lawns | 6,322 | 0.15 | 0.02 | 0.08 | 0.15 | 0.25 | 0.3 | 0.35 | 0% |
| **Combined** | **6,322** | **0.15** | **0.02** | **0.08** | **0.15** | **0.25** | **0.30** | **0.35** | **0.0%** |

## Basin Travel Time

Shallow Channel Ground Cover: Paved areas/shallow paved swales

$L_{max,Overland}$ 100 ft $C_v$ 20

| | L (ft) | $\Delta Z_0$ (ft) | $S_0$ (ft/ft) | v (ft/s) | t (min) | $t_{Alt}$ (min) | |
|---|---|---|---|---|---|---|---|
| Total | 33 | 4 | - | - | - | - | |
| Initial Time | 33 | 4 | 0.106 | - | 4.9 | 10.2 | DCM Eq. 6-8 |
| Shallow Channel | | | 0.000 | 0.0 | 0.0 | - | DCM Eq. 6-9 |
| Channelized | | | 0.000 | 0.0 | 0.0 | - | C&G |
| | | | | $t_c$ | **5.0 min.** | | |

## Rainfall Intensity & Runoff

| | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr |
|---|---|---|---|---|---|---|
| **Intensity (in/hr)** | 4.12 | 5.17 | 6.03 | 6.89 | 7.75 | 8.68 |
| **Runoff (cfs)** | 0.0 | **0.1** | 0.1 | 0.3 | 0.3 | **0.4** |
| **Release Rates (cfs/ac)** | - | - | - | - | - | - |
| **Allowed Release (cfs)** | 0.0 | **0.1** | 0.1 | 0.3 | 0.3 | **0.4** |
| DCM: $I = C1 * \ln(tc) + C2$ | | | | | | |
| C1 | 1.19 | 1.5 | 1.75 | 2 | 2.25 | 2.52 |
| C2 | 6.035 | 7.583 | 8.847 | 10.111 | 11.375 | 12.735 |

## Notes

# Sub-Basin L1 Runoff Calculations

| | | | |
|---|---|---|---|
| Job No.: | 61090 | Date: | 3/22/18 10:03 |
| Project: | Freedom Springs | Calcs by: | TJW |
| | | Checked by: | DRG |
| Jurisdiction | DCM | Soil Type | A |
| Runoff Coefficient | Surface Type | Urbanization | Urban |

## Basin Land Use Characteristics

| | Area | | Runoff Coefficient | | | | | | % |
|---|---|---|---|---|---|---|---|---|---|
| Surface | (SF) | (Acres) | C2 | C5 | C10 | C25 | C50 | C100 | Imperv. |
| Lawns | 19,790 | 0.45 | 0.02 | 0.08 | 0.15 | 0.25 | 0.3 | 0.35 | 0% |
| **Combined** | **19,790** | **0.45** | **0.02** | **0.08** | **0.15** | **0.25** | **0.30** | **0.35** | **0.0%** |

## Basin Travel Time

Shallow Channel Ground Cover Short Pasture/Lawns

$L_{max,Overland}$ 100 ft $C_v$ 7

| | L (ft) | $\Delta Z_0$ (ft) | $S_0$ (ft/ft) | v (ft/s) | t (min) | $t_{Alt}$ (min) | |
|---|---|---|---|---|---|---|---|
| Total | 240 | 15 | - | - | - | - | |
| Initial Time | 100 | 6 | 0.055 | - | 10.5 | 11.3 | DCM Eq. 6-8 |
| Shallow Channel | 140 | 10 | 0.068 | 1.8 | 1.3 | - | DCM Eq. 6-9 |
| Channelized | | | 0.000 | 0.0 | 0.0 | - | V-Ditch |

**$t_c$ 11.3 min.**

## Rainfall Intensity & Runoff

| | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr |
|---|---|---|---|---|---|---|
| **Intensity (in/hr)** | 3.15 | 3.94 | 4.60 | 5.26 | 5.91 | 6.62 |
| **Runoff (cfs)** | 0.0 | **0.1** | 0.3 | 0.6 | 0.8 | **1.1** |
| **Release Rates (cfs/ac)** | - | - | - | - | - | - |
| **Allowed Release (cfs)** | 0.0 | **0.1** | 0.3 | 0.6 | 0.8 | **1.1** |

DCM: I = C1 * ln (tc) + C2

| | | | | | | |
|---|---|---|---|---|---|---|
| C1 | 1.19 | 1.5 | 1.75 | 2 | 2.25 | 2.52 |
| C2 | 6.035 | 7.583 | 8.847 | 10.111 | 11.375 | 12.735 |

## Notes

# Sub-Basin M1 Runoff Calculations

| | | | |
|---|---|---|---|
| Job No.: | 61090 | Date: | 3/22/18 10:03 |
| Project: | Freedom Springs | Calcs by: | TJW |
| | | Checked by: | DRG |
| Jurisdiction | DCM | Soil Type | A |
| Runoff Coefficient | Surface Type | Urbanization | Urban |

## Basin Land Use Characteristics

| | Area | | Runoff Coefficient | | | | | | % |
|---|---|---|---|---|---|---|---|---|---|
| Surface | (SF) | (Acres) | C2 | C5 | C10 | C25 | C50 | C100 | Imperv. |
| Lawns | 5,771 | 0.13 | 0.02 | 0.08 | 0.15 | 0.25 | 0.3 | 0.35 | 0% |
| **Combined** | **5,771** | **0.13** | **0.02** | **0.08** | **0.15** | **0.25** | **0.30** | **0.35** | **0.0%** |

## Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ 100 ft    $C_v$ 7

| | L (ft) | $\Delta Z_0$ (ft) | $S_0$ (ft/ft) | v (ft/s) | t (min) | $t_{Alt}$ (min) | |
|---|---|---|---|---|---|---|---|
| Total | 32 | 3 | - | - | - | - | |
| Initial Time | 32 | 3 | 0.088 | - | 5.1 | 10.2 | DCM Eq. 6-8 |
| Shallow Channel | | | 0.000 | 0.0 | 0.0 | - | DCM Eq. 6-9 |
| Channelized | | | 0.000 | 0.0 | 0.0 | - | V-Ditch |

$t_c$ **5.1 min.**

## Rainfall Intensity & Runoff

| | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr |
|---|---|---|---|---|---|---|
| Intensity (in/hr) | 4.10 | 5.14 | 6.00 | 6.86 | 7.71 | 8.63 |
| Runoff (cfs) | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 |
| Release Rates (cfs/ac) | - | - | - | - | - | - |
| Allowed Release (cfs) | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 |

DCM: I = C1 * ln (tc) + C2

| | | | | | | |
|---|---|---|---|---|---|---|
| C1 | 1.19 | 1.5 | 1.75 | 2 | 2.25 | 2.52 |
| C2 | 6.035 | 7.583 | 8.847 | 10.111 | 11.375 | 12.735 |

## Notes

# Combined Sub-Basin Runoff Calculations

Includes Basins OS2 L1

| | | | |
|---|---|---|---|
| Job No.: | 61090 | Date: | 3/22/18 10:03 |
| Project: | Freedom Springs | Calcs by: | TJW |
| | | Checked by: | DRG |
| Jurisdiction | DCM | Soil Type | A |
| Runoff Coefficient | Surface Type | Urbanization | Urban |

## Basin Land Use Characteristics

| | Area | | Runoff Coefficient | | | | | | % |
|---|---|---|---|---|---|---|---|---|---|
| Surface | (SF) | (Acres) | C2 | C5 | C10 | C25 | C50 | C100 | Imperv. |
| 1/8 Acre or less | 24,712 | 0.57 | 0.41 | 0.45 | 0.49 | 0.54 | 0.57 | 0.59 | 65% |
| Lawns | 19,790 | 0.45 | 0.02 | 0.08 | 0.15 | 0.25 | 0.3 | 0.35 | 0% |
| **Combined** | **44,502** | **1.02** | **0.24** | **0.29** | **0.34** | **0.41** | **0.45** | **0.48** | **36.1%** |

## Basin Travel Time

| | Sub-basin or Channel Type | Material Type | L (ft) | Elev. $\Delta Z_0$ (ft) | $Q_i$ (cfs) | Base or Dia (ft) | Sides z:1 (ft/ft) | v (ft/s) | t (min) |
|---|---|---|---|---|---|---|---|---|---|
| Furthest Reach | OS2 | - | 190 | 3 | - | - | - | - | 11.1 |
| Channelized-1 | V-Ditch | 2 | 76 | 12 | 2 | 1 | 2 | 4.0 | 0.3 |
| Channelized-2 | | | | | | 1 | | | |
| Channelized-3 | | | | | | | | | |
| Total | | | 266 | 15 | | | | | |

2 = Natural, Winding, minimal vegetation/shallow grass

**$t_c$ (min)** **11.4**

## Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

$Q_{Minor}$ (cfs) - 5-year Storm

$Q_{Major}$ (cfs) - 100-year Storm

## Rainfall Intensity & Runoff

| | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr |
|---|---|---|---|---|---|---|
| **Intensity (in/hr)** | 3.14 | 3.94 | 4.59 | 5.25 | 5.90 | 6.61 |
| **Site Runoff (cfs)** | 0.76 | **1.15** | 1.59 | 2.20 | 2.71 | **3.26** |
| **OffSite Runoff (cfs)** | - | **0.00** | - | - | - | **0.00** |
| **Release Rates (cfs/ac)** | - | - | - | - | - | - |
| **Allowed Release (cfs)** | - | **1.1** | - | - | - | **3.3** |

DCM: I = C1 * ln (tc) + C2

| | | | | | | |
|---|---|---|---|---|---|---|
| C1 | 1.19 | 1.5 | 1.75 | 2 | 2.25 | 2.52 |
| C2 | 6.035 | 7.583 | 8.847 | 10.111 | 11.375 | 12.735 |

## Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

# Combined Sub-Basin Runoff Calculations

4

Includes Basins OS1 H1

| | | | |
|---|---|---|---|
| Job No.: | **61090** | Date: | **3/22/18 10:03** |
| Project: | **Freedom Springs** | Calcs by: | **TJW** |
| | | Checked by: | **DRG** |
| Jurisdiction | **DCM** | Soil Type | **A** |
| Runoff Coefficient | **Surface Type** | Urbanization | **Urban** |

## Basin Land Use Characteristics

| | Area | | Runoff Coefficient | | | | | | % |
|---|---|---|---|---|---|---|---|---|---|
| **Surface** | **(SF)** | **(Acres)** | **C2** | **C5** | **C10** | **C25** | **C50** | **C100** | **Imperv.** |
| 1/8 Acre or less | 123,800 | 2.84 | 0.41 | 0.45 | 0.49 | 0.54 | 0.57 | 0.59 | 65% |
| Driveways & Walks | 15,473 | 0.36 | 0.89 | 0.9 | 0.92 | 0.94 | 0.95 | 0.96 | 100% |
| Lawns | 4,028 | 0.09 | 0.02 | 0.08 | 0.15 | 0.25 | 0.3 | 0.35 | 0% |
| **Combined** | **143,301** | **3.29** | **0.45** | **0.49** | **0.53** | **0.58** | **0.60** | **0.62** | **67.0%** |

## Basin Travel Time

| | Sub-basin or Channel Type | Material Type | L (ft) | Elev. $\Delta Z_0$ (ft) | $Q_i$ (cfs) | Base or Dia (ft) | Sides z:1 (ft/ft) | v (ft/s) | t (min) |
|---|---|---|---|---|---|---|---|---|---|
| Furthest Reach | OS1 | - | 580 | 9 | - | - | - | - | 13.2 |
| Channelized-1 | C&G | Asphalt | 286 | 12 | 10 | 1 | 0 | 4.0 | 1.2 |
| Channelized-2 | | | | | | 1 | | | |
| Channelized-3 | | | | | | | | | |
| Total | | | 866 | 21 | | | | | |

**$t_c$ (min)** **14.4**

## Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

$Q_{Minor}$ (cfs) - 5-year Storm

$Q_{Major}$ (cfs) - 100-year Storm

## Rainfall Intensity & Runoff

| | **2-Yr** | **5-Yr** | **10-Yr** | **25-Yr** | **50-Yr** | **100-Yr** |
|---|---|---|---|---|---|---|
| **Intensity (in/hr)** | 2.86 | 3.58 | 4.18 | 4.77 | 5.37 | 6.01 |
| **Site Runoff (cfs)** | 4.24 | **5.75** | 7.24 | 9.03 | 10.66 | **12.32** |
| **OffSite Runoff (cfs)** | - | **0.00** | - | - | - | **0.00** |
| **Release Rates (cfs/ac)** | - | - | - | - | - | - |
| **Allowed Release (cfs)** | - | **5.7** | - | - | - | **12.3** |

DCM: I = C1 * ln (tc) + C2

| | | | | | | |
|---|---|---|---|---|---|---|
| C1 | 1.19 | 1.5 | 1.75 | 2 | 2.25 | 2.52 |
| C2 | 6.035 | 7.583 | 8.847 | 10.111 | 11.375 | 12.735 |

## Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

# Combined Sub-Basin Runoff Calculations

7

Includes Basins A1 B1 C1 D1 E1 F1 G1 H1

| | | | | |
|---|---|---|---|---|
| Job No.: | 61090 | Date: | | 3/22/18 10:03 |
| Project: | Freedom Springs | Calcs by: | TJW | |
| | | Checked by: | DRG | |
| Jurisdiction | DCM | Soil Type | A | |
| Runoff Coefficient | Surface Type | Urbanization | Urban | |

## Basin Land Use Characteristics

| | Area | | Runoff Coefficient | | | | | | % |
|---|---|---|---|---|---|---|---|---|---|
| Surface | (SF) | (Acres) | C2 | C5 | C10 | C25 | C50 | C100 | Imperv. |
| Roofs | 15,888 | 0.36 | 0.71 | 0.73 | 0.75 | 0.78 | 0.8 | 0.81 | 90% |
| Driveways & Walks | 55,364 | 1.27 | 0.89 | 0.9 | 0.92 | 0.94 | 0.95 | 0.96 | 100% |
| Lawns | 44,079 | 1.01 | 0.02 | 0.08 | 0.15 | 0.25 | 0.3 | 0.35 | 0% |
| **Combined** | **115,331** | **2.65** | **0.53** | **0.56** | **0.60** | **0.65** | **0.68** | **0.71** | **60.4%** |

## Basin Travel Time

| | Sub-basin or Channel Type | Material Type | L (ft) | Elev. $\Delta Z_0$ (ft) | $Q_i$ (cfs) | Base or Dia (ft) | Sides z:1 (ft/ft) | v (ft/s) | t (min) |
|---|---|---|---|---|---|---|---|---|---|
| Furthest Reach | A1 | - | 295 | 4 | - | - | - | - | 5.5 |
| Channelized-1 | Pipe | HDPE | 119 | 5 | 5 | 1 | 0 | 5.9 | 0.3 |
| Channelized-2 | Pipe | HDPE | 116 | 4 | 5 | 1 | 0 | 5.4 | 0.4 |
| Channelized-3 | | | | | | | | | |
| Total | | | 530 | 12 | | | | | |
| | | | | | | | | **$t_c$ (min)** | **6.2** |

## Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

$Q_{Minor}$ (cfs) - 5-year Storm

$Q_{Major}$ (cfs) - 100-year Storm

## Rainfall Intensity & Runoff

| | 2-Yr | 5-Yr | 10-Yr | 25-Yr | 50-Yr | 100-Yr |
|---|---|---|---|---|---|---|
| **Intensity (in/hr)** | 3.86 | 4.84 | 5.65 | 6.46 | 7.26 | 8.13 |
| **Site Runoff (cfs)** | 5.45 | **7.22** | 9.01 | 11.19 | 13.10 | **15.20** |
| **OffSite Runoff (cfs)** | - | **0.00** | - | - | - | **0.00** |
| **Release Rates (cfs/ac)** | - | - | - | - | - | - |
| **Allowed Release (cfs)** | - | **7.2** | - | - | - | **15.2** |

DCM: I = C1 * ln (tc) + C2

| | | | | | | |
|---|---|---|---|---|---|---|
| C1 | 1.19 | 1.5 | 1.75 | 2 | 2.25 | 2.52 |
| C2 | 6.035 | 7.583 | 8.847 | 10.111 | 11.375 | 12.735 |

## Notes

Runoff from Offsite basins have been assumed constant, despite additional times of concentration.

## 10 Hydraulic Calculations

Inlet Calculations
Storm Drain Pipe Calculations
Detention Pond Calculations

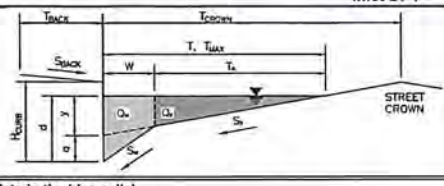
Version 4.05 Released March 2017

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

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

**Project:** Freedom Springs

**Inlet ID:** Inlet DP1




| Gutter Geometry (Enter data in the blue cells) | | | |
|---|---|---|---|
| Maximum Allowable Width for Spread Behind Curb | $T_{BACK}$ = | 0.0 | ft |
| Side Slope Behind Curb (leave blank for no conveyance credit behind curb) | $S_{BACK}$ = | 0.020 | ft/ft |
| Manning's Roughness Behind Curb (typically between 0.012 and 0.020) | $n_{BACK}$ = | 0.020 | |
| Height of Curb at Gutter Flow Line | $H_{CURB}$ = | 6.00 | inches |
| Distance from Curb Face to Street Crown | $T_{CROWN}$ = | 18.0 | ft |
| Gutter Width | W = | 2.00 | ft |
| Street Transverse Slope | $S_X$ = | 0.035 | ft/ft |
| Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft) | $S_W$ = | 0.083 | ft/ft |
| Street Longitudinal Slope - Enter 0 for sump condition | $S_O$ = | 0.000 | ft/ft |
| Manning's Roughness for Street Section (typically between 0.012 and 0.020) | $n_{STREET}$ = | 0.016 | |

| | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| Max. Allowable Spread for Minor & Major Storm | $T_{MAX}$ = | 9.0 | 18.0 | ft |
| Max. Allowable Depth at Gutter Flowline for Minor & Major Storm | $d_{MAX}$ = | 6.0 | 6.0 | inches |
| Check boxes are not applicable in SUMP conditions | | ☐ | ☐ | |

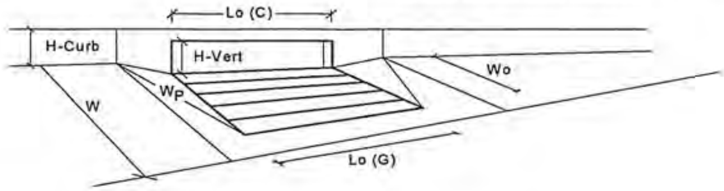
| Maximum Capacity for 1/2 Street based On Allowable Spread | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| Water Depth without Gutter Depression (Eq. ST-2) | y = | 3.78 | 7.56 | inches |
| Vertical Depth between Gutter Lip and Gutter Flowline (usually 2") | $d_C$ = | 2.0 | 2.0 | inches |
| Gutter Depression ($d_C$ - (W * $S_x$ * 12)) | a = | 1.15 | 1.15 | inches |
| Water Depth at Gutter Flowline | d = | 4.93 | 8.71 | inches |
| Allowable Spread for Discharge outside the Gutter Section W (T - W) | $T_X$ = | 7.0 | 16.0 | ft |
| Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7) | $E_O$ = | 0.556 | 0.296 | |
| Discharge outside the Gutter Section W, carried in Section $T_X$ | $Q_X$ = | 0.0 | 0.0 | cfs |
| Discharge within the Gutter Section W ($Q_T$ - $Q_X$) | $Q_W$ = | 0.0 | 0.0 | cfs |
| Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns) | $Q_{BACK}$ = | 0.0 | 0.0 | cfs |
| **Maximum Flow Based On Allowable Spread** | $Q_T$ = | SUMP | SUMP | cfs |
| Flow Velocity within the Gutter Section | V = | 0.0 | 0.0 | fps |
| V*d Product: Flow Velocity times Gutter Flowline Depth | V*d = | 0.0 | 0.0 | |

| Maximum Capacity for 1/2 Street based on Allowable Depth | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| Theoretical Water Spread | $T_{TH}$ = | 11.5 | 11.5 | ft |
| Theoretical Spread for Discharge outside the Gutter Section W (T - W) | $T_{X TH}$ = | 9.5 | 9.5 | ft |
| Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7) | $E_O$ = | 0.449 | 0.449 | |
| Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X TH}$ | $Q_{X TH}$ = | 0.0 | 0.0 | cfs |
| Actual Discharge outside the Gutter Section W, (limited by distance $T_{CROWN}$) | $Q_X$ = | 0.0 | 0.0 | cfs |
| Discharge within the Gutter Section W ($Q_d$ - $Q_X$) | $Q_W$ = | 0.0 | 0.0 | cfs |
| Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns) | $Q_{BACK}$ = | 0.0 | 0.0 | cfs |
| Total Discharge for Major & Minor Storm (Pre-Safety Factor) | Q = | 0.0 | 0.0 | cfs |
| Average Flow Velocity Within the Gutter Section | V = | 0.0 | 0.0 | fps |
| V*d Product: Flow Velocity Times Gutter Flowline Depth | V*d = | 0.0 | 0.0 | |
| Slope-Based Depth Safety Reduction Factor for Major & Minor (d ≥ 6") Storm | R = | SUMP | SUMP | |
| **Max Flow Based on Allowable Depth (Safety Factor Applied)** | $Q_d$ = | SUMP | SUMP | cfs |
| Resultant Flow Depth at Gutter Flowline (Safety Factor Applied) | d = | | | inches |
| Resultant Flow Depth at Street Crown (Safety Factor Applied) | $d_{CROWN}$ = | | | inches |

| | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| **MINOR STORM Allowable Capacity is based on Depth Criterion** | | | | |
| **MAJOR STORM Allowable Capacity is based on Depth Criterion** | $Q_{allow}$ = | SUMP | SUMP | cfs |

# INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017




| Design Information (Input) | Denver No. 16 Combination | | MINOR | MAJOR | |
|---|---|---|---|---|---|
| Type of Inlet | | Type = | Denver No. 16 Combination | | |
| Local Depression (additional to continuous gutter depression 'a' from above) | | $a_{local}$ = | 2.00 | 2.00 | inches |
| Number of Unit Inlets (Grate or Curb Opening) | | No = | 2 | 2 | |
| Water Depth at Flowline (outside of local depression) | | Ponding Depth = | 4.9 | 6.0 | inches |
| Grate Information | | | MINOR | MAJOR | Override Depths |
| Length of a Unit Grate | | $L_o$ (G) = | 3.00 | 3.00 | feet |
| Width of a Unit Grate | | $W_o$ = | 1.73 | 1.73 | feet |
| Area Opening Ratio for a Grate (typical values 0.15-0.90) | | $A_{ratio}$ = | 0.31 | 0.31 | |
| Clogging Factor for a Single Grate (typical value 0.50 - 0.70) | | $C_f$ (G) = | 0.50 | 0.50 | |
| Grate Weir Coefficient (typical value 2.15 - 3.60) | | $C_w$ (G) = | 3.60 | 3.60 | |
| Grate Orifice Coefficient (typical value 0.60 - 0.80) | | $C_o$ (G) = | 0.60 | 0.60 | |
| Curb Opening Information | | | MINOR | MAJOR | |
| Length of a Unit Curb Opening | | $L_o$ (C) = | 3.00 | 3.00 | feet |
| Height of Vertical Curb Opening in Inches | | $H_{vert}$ = | 6.50 | 6.50 | inches |
| Height of Curb Orifice Throat in Inches | | $H_{throat}$ = | 5.25 | 5.25 | inches |
| Angle of Throat (see USDCM Figure ST-5) | | Theta = | 0.00 | 0.00 | degrees |
| Warning 1 Side Width for Depression Pan (typically the gutter width of 2 feet) | | $W_p$ = | 1.00 | 1.00 | feet |
| Clogging Factor for a Single Curb Opening (typical value 0.10) | | $C_f$ (C) = | 0.10 | 0.10 | |
| Curb Opening Weir Coefficient (typical value 2.3-3.7) | | $C_w$ (C) = | 3.70 | 3.70 | |
| Curb Opening Orifice Coefficient (typical value 0.60 - 0.70) | | $C_o$ (C) = | 0.66 | 0.66 | |
| Low Head Performance Reduction (Calculated) | | | MINOR | MAJOR | |
| Depth for Grate Midwidth | | $d_{Grate}$ = | 0.434 | 0.523 | ft |
| Depth for Curb Opening Weir Equation | | $d_{Curb}$ = | 0.25 | 0.33 | ft |
| Combination Inlet Performance Reduction Factor for Long Inlets | | $RF_{Combination}$ = | 0.58 | 0.71 | |
| Curb Opening Performance Reduction Factor for Long Inlets | | $RF_{Curb}$ = | 1.00 | 1.00 | |
| Grated Inlet Performance Reduction Factor for Long Inlets | | $RF_{Grate}$ = | 0.58 | 0.71 | |
| | | | MINOR | MAJOR | |
| **Total Inlet Interception Capacity (assumes clogged condition)** | | $Q_a$ = | 3.6 | 6.2 | cfs |
| **Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)** | | $Q_{PEAK\ REQUIRED}$ = | 2.7 | 4.9 | cfs |

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

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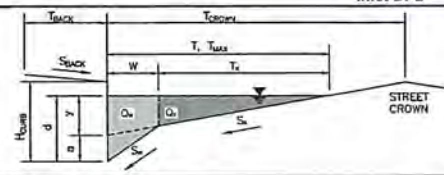
## ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project: Freedom Springs

Inlet ID: Inlet DP2

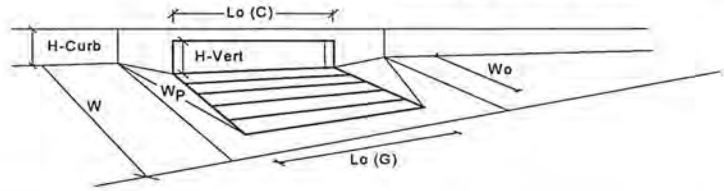



**Gutter Geometry (Enter data in the blue cells)**

| | | | | |
|---|---|---|---|---|
| Maximum Allowable Width for Spread Behind Curb | $T_{BACK}$ = | 0.0 | | ft |
| Side Slope Behind Curb (leave blank for no conveyance credit behind curb) | $S_{BACK}$ = | 0.020 | | ft/ft |
| Manning's Roughness Behind Curb (typically between 0.012 and 0.020) | $n_{BACK}$ = | 0.020 | | |
| Height of Curb at Gutter Flow Line | $H_{CURB}$ = | 6.00 | | inches |
| Distance from Curb Face to Street Crown | $T_{CROWN}$ = | 18.0 | | ft |
| Gutter Width | W = | 2.00 | | ft |
| Street Transverse Slope | $S_X$ = | 0.017 | | ft/ft |
| Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft) | $S_W$ = | 0.083 | | ft/ft |
| Street Longitudinal Slope - Enter 0 for sump condition | $S_O$ = | 0.000 | | ft/ft |
| Manning's Roughness for Street Section (typically between 0.012 and 0.020) | $n_{STREET}$ = | 0.016 | | |
| | | Minor Storm | Major Storm | |
| Max. Allowable Spread for Minor & Major Storm | $T_{MAX}$ = | 9.0 | 18.0 | ft |
| Max. Allowable Depth at Gutter Flowline for Minor & Major Storm | $d_{MAX}$ = | 6.0 | 6.0 | inches |
| Check boxes are not applicable in SUMP conditions | | ☐ | ☐ | |
| | | Minor Storm | Major Storm | |
| MINOR STORM Allowable Capacity is based on Depth Criterion<br>MAJOR STORM Allowable Capacity is based on Depth Criterion | $Q_{allow}$ = | SUMP | SUMP | cfs |

# INLET IN A SUMP OR SAG LOCATION

**Version 4.05 Released March 2017**




| Design Information (Input) — Denver No. 16 Combination | | MINOR | MAJOR | |
|---|---|---|---|---|
| Type of Inlet | Type = | Denver No. 16 Combination | | |
| Local Depression (additional to continuous gutter depression 'a' from above) | $a_{local}$ = | 2.00 | 2.00 | inches |
| Number of Unit Inlets (Grate or Curb Opening) | No = | 1 | 1 | |
| Water Depth at Flowline (outside of local depression) | Ponding Depth = | 3.4 | 5.3 | inches |
| **Grate Information** | | MINOR | MAJOR | ☐ Override Depths |
| Length of a Unit Grate | $L_o$ (G) = | 3.00 | 3.00 | feet |
| Width of a Unit Grate | $W_o$ = | 1.73 | 1.73 | feet |
| Area Opening Ratio for a Grate (typical values 0.15-0.90) | $A_{ratio}$ = | 0.31 | 0.31 | |
| Clogging Factor for a Single Grate (typical value 0.50 - 0.70) | $C_f$ (G) = | 0.50 | 0.50 | |
| Grate Weir Coefficient (typical value 2.15 - 3.60) | $C_w$ (G) = | 3.60 | 3.60 | |
| Grate Orifice Coefficient (typical value 0.60 - 0.80) | $C_o$ (G) = | 0.60 | 0.60 | |
| **Curb Opening Information** | | MINOR | MAJOR | |
| Length of a Unit Curb Opening | $L_o$ (C) = | 3.00 | 3.00 | feet |
| Height of Vertical Curb Opening in Inches | $H_{vert}$ = | 6.50 | 6.50 | inches |
| Height of Curb Orifice Throat in Inches | $H_{throat}$ = | 5.25 | 5.25 | inches |
| Angle of Throat (see USDCM Figure ST-5) | Theta = | 0.00 | 0.00 | degrees |
| Side Width for Depression Pan (typically the gutter width of 2 feet) | $W_p$ = | 2.00 | 2.00 | feet |
| Clogging Factor for a Single Curb Opening (typical value 0.10) | $C_f$ (C) = | 0.10 | 0.10 | |
| Curb Opening Weir Coefficient (typical value 2.3-3.7) | $C_w$ (C) = | 3.70 | 3.70 | |
| Curb Opening Orifice Coefficient (typical value 0.60 - 0.70) | $C_o$ (C) = | 0.66 | 0.66 | |

| Low Head Performance Reduction (Calculated) | | MINOR | MAJOR | |
|---|---|---|---|---|
| Depth for Grate Midwidth | $d_{Grate}$ = | 0.308 | 0.461 | ft |
| Depth for Curb Opening Weir Equation | $d_{Curb}$ = | 0.12 | 0.27 | ft |
| Combination Inlet Performance Reduction Factor for Long Inlets | $RF_{Combination}$ = | 0.53 | 0.82 | |
| Curb Opening Performance Reduction Factor for Long Inlets | $RF_{Curb}$ = | 1.00 | 1.00 | |
| Grated Inlet Performance Reduction Factor for Long Inlets | $RF_{Grate}$ = | 0.53 | 0.82 | |

| | | MINOR | MAJOR | |
|---|---|---|---|---|
| **Total Inlet Interception Capacity (assumes clogged condition)** | $Q_a$ = | 0.9 | 2.9 | cfs |
| Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK) | $Q_{PEAK\ REQUIRED}$ = | 0.7 | 1.3 | cfs |

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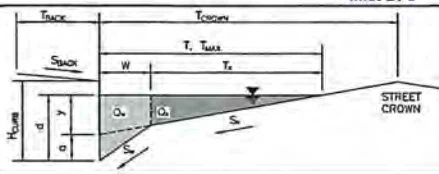
## ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project: Freedom Springs

Inlet ID: Inlet DP3




**Gutter Geometry (Enter data in the blue cells)**

| | | | |
|---|---|---|---|
| Maximum Allowable Width for Spread Behind Curb | $T_{BACK}$ = | 0.0 | ft |
| Side Slope Behind Curb (leave blank for no conveyance credit behind curb) | $S_{BACK}$ = | 0.020 | ft/ft |
| Manning's Roughness Behind Curb (typically between 0.012 and 0.020) | $n_{BACK}$ = | 0.020 | |
| Height of Curb at Gutter Flow Line | $H_{CURB}$ = | 6.00 | inches |
| Distance from Curb Face to Street Crown | $T_{CROWN}$ = | 18.0 | ft |
| Gutter Width | W = | 2.00 | ft |
| Street Transverse Slope | $S_X$ = | 0.063 | ft/ft |
| Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft) | $S_W$ = | 0.083 | ft/ft |
| Street Longitudinal Slope - Enter 0 for sump condition | $S_O$ = | 0.084 | ft/ft |
| Manning's Roughness for Street Section (typically between 0.012 and 0.020) | $n_{STREET}$ = | 0.016 | |

| | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| Max. Allowable Spread for Minor & Major Storm | $T_{MAX}$ = | 9.0 | 18.0 | ft |
| Max. Allowable Depth at Gutter Flowline for Minor & Major Storm | $d_{MAX}$ = | 6.0 | 6.0 | inches |
| Allow Flow Depth at Street Crown (leave blank for no) | | ☐ | ☐ | check = yes |

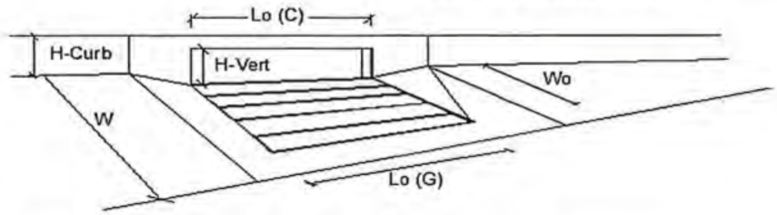
| | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| MINOR STORM Allowable Capacity is based on Depth Criterion | | | | |
| MAJOR STORM Allowable Capacity is based on Depth Criterion | $Q_{allow}$ = | 7.0 | 7.0 | cfs |

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

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

## INLET ON A CONTINUOUS GRADE

**Version 4.05 Released March 2017**




| Design Information (Input) | | MINOR | MAJOR | |
|---|---|---|---|---|
| Type of Inlet — Denver No. 16 Combination | Type = | Denver No. 16 Combination | | |
| Local Depression (additional to continuous gutter depression 'a') | $a_{LOCAL}$ = | 2.0 | 2.0 | inches |
| Total Number of Units in the Inlet (Grate or Curb Opening) | No = | 1 | 1 | |
| Length of a Single Unit Inlet (Grate or Curb Opening) | $L_o$ = | 3.00 | 3.00 | ft |
| Width of a Unit Grate (cannot be greater than W, Gutter Width) | $W_o$ = | 1.73 | 1.73 | ft |
| Clogging Factor for a Single Unit Grate (typical min. value = 0.5) | $C_f$-G = | 0.50 | 0.50 | |
| Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1) | $C_f$-C = | 0.10 | 0.10 | |
| **Street Hydraulics: OK - Q < Allowable Street Capacity'** | | MINOR | MAJOR | |
| **Total Inlet Interception Capacity** | Q = | 0.3 | 0.5 | cfs |
| **Total Inlet Carry-Over Flow (flow bypassing inlet)** | $Q_b$ = | 0.1 | 0.3 | cfs |
| **Capture Percentage = $Q_a/Q_o$ =** | C% = | 69 | 66 | % |

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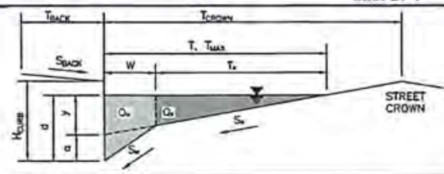
## ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

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

Project: Freedom Springs

Inlet ID: Inlet DP4




**Gutter Geometry (Enter data in the blue cells)**

| | | | |
|---|---|---|---|
| Maximum Allowable Width for Spread Behind Curb | $T_{BACK}$ = | 0.0 | ft |
| Side Slope Behind Curb (leave blank for no conveyance credit behind curb) | $S_{BACK}$ = | 0.020 | ft/ft |
| Manning's Roughness Behind Curb (typically between 0.012 and 0.020) | $n_{BACK}$ = | 0.020 | |
| Height of Curb at Gutter Flow Line | $H_{CURB}$ = | 6.00 | inches |
| Distance from Curb Face to Street Crown | $T_{CROWN}$ = | 16.0 | ft |
| Gutter Width | W = | 2.00 | ft |
| Street Transverse Slope | $S_X$ = | 0.020 | ft/ft |
| Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft) | $S_W$ = | 0.083 | ft/ft |
| Street Longitudinal Slope - Enter 0 for sump condition | $S_O$ = | 0.043 | ft/ft |
| Manning's Roughness for Street Section (typically between 0.012 and 0.020) | $n_{STREET}$ = | 0.016 | |

| | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| Max. Allowable Spread for Minor & Major Storm | $T_{MAX}$ = | 16.0 | 16.0 | ft |
| Max. Allowable Depth at Gutter Flowline for Minor & Major Storm | $d_{MAX}$ = | 6.0 | 6.0 | inches |
| Allow Flow Depth at Street Crown (leave blank for no) | | ☐ | ☐ | check = yes |

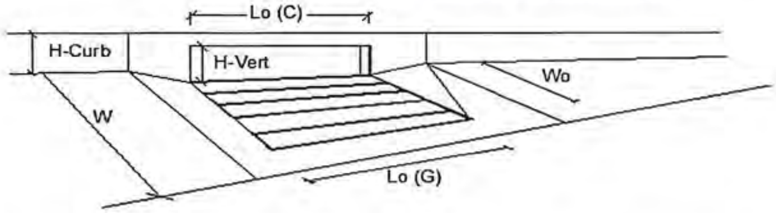
| | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| **MINOR STORM Allowable Capacity is based on Depth Criterion** | | | | |
| **MAJOR STORM Allowable Capacity is based on Depth Criterion** | $Q_{allow}$ = | 15.9 | 15.9 | cfs |

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

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

# INLET ON A CONTINUOUS GRADE

**Version 4.05 Released March 2017**




| Design Information (Input) | | | MINOR | MAJOR | |
|---|---|---|---|---|---|
| Type of Inlet | Denver No. 16 Combination | Type = | Denver No. 16 Combination | | |
| Local Depression (additional to continuous gutter depression 'a') | | $a_{LOCAL}$ = | 2.0 | 2.0 | inches |
| Total Number of Units in the Inlet (Grate or Curb Opening) | | No = | 1 | 1 | |
| Length of a Single Unit Inlet (Grate or Curb Opening) | | $L_o$ = | 3.00 | 3.00 | ft |
| Width of a Unit Grate (cannot be greater than W, Gutter Width) | | $W_o$ = | 1.73 | 1.73 | ft |
| Clogging Factor for a Single Unit Grate (typical min. value = 0.5) | | $C_f$-G = | 0.50 | 0.50 | |
| Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1) | | $C_f$-C = | 0.10 | 0.10 | |
| **Street Hydraulics: OK - Q < Allowable Street Capacity'** | | | MINOR | MAJOR | |
| **Total Inlet Interception Capacity** | | Q = | 2.3 | 3.1 | cfs |
| **Total Inlet Carry-Over Flow (flow bypassing inlet)** | | $Q_b$ = | 3.4 | 9.2 | cfs |
| **Capture Percentage = $Q_a/Q_o$ =** | | C% = | 40 | 25 | % |

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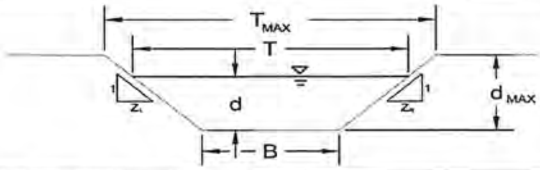
# AREA INLET IN A SWALE

**Freedom Springs**
**Inlet DP5**




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

For more information see Section 7.2.3 of the USDCM.

| | | | | |
|---|---|---|---|---|
| **Analysis of Trapezoidal Grass-Lined Channel Using SCS Method** | | | | |
| NRCS Vegetal Retardance (A, B, C, D, or E) | A, B, C, D or E | C | | |
| Manning's n (Leave cell D16 blank to manually enter an n value) | n = | see details below | | |
| Channel Invert Slope | $S_O$ = | 0.0200 | ft/ft | |
| Bottom Width | B = | 3.00 | ft | |
| Left Side Slope | Z1 = | 20.00 | ft/ft | |
| Right Side Slope | Z2 = | 20.00 | ft/ft | |

Check one of the following soil types:

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

Choose One:
- Non-Cohesive
- Cohesive
- Paved

| | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| Max. Allowable Top Width of Channel for Minor & Major Storm | $T_{MAX}$ = | 13.00 | 23.00 | feet |
| Max. Allowable Water Depth in Channel for Minor & Major Storm | $d_{MAX}$ = | 0.25 | 0.50 | feet |

| **Allowable Channel Capacity Based On Channel Geometry** | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| **MINOR STORM Allowable Capacity is based on Depth Criterion** | $Q_{allow}$ = | 0.3 | 1.4 | cfs |
| **MAJOR STORM Allowable Capacity is based on Depth Criterion** | $d_{allow}$ = | 0.25 | 0.50 | ft |

| **Water Depth in Channel Based On Design Peak Flow** | | | | |
|---|---|---|---|---|
| **Design Peak Flow** | $Q_o$ = | 0.1 | 0.5 | cfs |
| **Water Depth** | d = | 0.15 | 0.32 | feet |

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

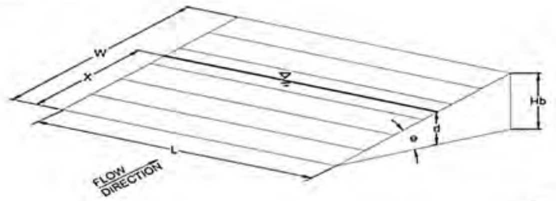
# AREA INLET IN A SWALE

**Freedom Springs**

**Inlet DP5**

**Inlet Design Information (Input)**

Type of Inlet: User-Defined — Inlet Type = User-Defined




| | | | |
|---|---|---|---|
| Angle of Inclined Grate (must be <= 30 degrees) | θ = | 0.00 | degrees |
| Width of Grate | W = | 1.00 | feet |
| Length of Grate | L = | 1.00 | feet |
| Open Area Ratio | $A_{RATIO}$ = | 0.70 | |
| Height of Inclined Grate | $H_B$ = | 0.00 | feet |
| Clogging Factor | $C_f$ = | 0.50 | |
| Grate Discharge Coefficient | $C_d$ = | N/A | |
| Orifice Coefficient | $C_o$ = | 0.64 | |
| Weir Coefficient | $C_w$ = | 2.05 | |

| | | MINOR | MAJOR | |
|---|---|---|---|---|
| Water Depth at Inlet (for depressed inlets, 1 foot is added for depression) | d = | 0.15 | 0.32 | |
| **Total Inlet Interception Capacity (assumes clogged condition)** | $Q_a$ = | 0.4 | 1.0 | cfs |
| | Bypassed Flow, $Q_b$ = | 0.0 | 0.0 | cfs |
| | Capture Percentage = $Q_a/Q_o$ = C% | 100 | 100 | % |

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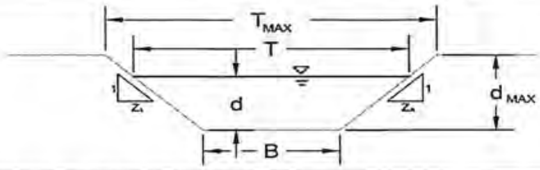
# AREA INLET IN A SWALE

**Freedom Springs**
**Inlet DP6**




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

For more information see Section 7.2.3 of the USDCM.

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

| | | | |
|---|---|---|---|
| NRCS Vegetal Retardance (A, B, C, D, or E) | A, B, C, D or E | C | |
| Manning's n (Leave cell D16 blank to manually enter an n value) | n = | see details below | |
| Channel Invert Slope | $S_O$ = | 0.0200 | ft/ft |
| Bottom Width | B = | 3.00 | ft |
| Left Side Slope | Z1 = | 20.00 | ft/ft |
| Right Side Slope | Z2 = | 20.00 | ft/ft |

Check one of the following soil types:

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

Choose One:
- (●) Non-Cohesive
- ( ) Cohesive
- ( ) Paved

| | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| Max. Allowable Top Width of Channel for Minor & Major Storm | $T_{MAX}$ = | 16.00 | 23.00 | feet |
| Max. Allowable Water Depth in Channel for Minor & Major Storm | $d_{MAX}$ = | 0.33 | 0.50 | feet |

**Allowable Channel Capacity Based On Channel Geometry**

| | | Minor Storm | Major Storm | |
|---|---|---|---|---|
| MINOR STORM Allowable Capacity is based on Top Width Criterion | $Q_{allow}$ = | 0.5 | 1.4 | cfs |
| MAJOR STORM Allowable Capacity is based on Depth Criterion | $d_{allow}$ = | 0.33 | 0.50 | ft |

**Water Depth in Channel Based On Design Peak Flow**

| | | | | |
|---|---|---|---|---|
| Design Peak Flow | $Q_o$ = | 0.3 | 0.8 | cfs |
| Water Depth | d = | 0.26 | 0.40 | feet |

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

Version 4.05 Released March 2017

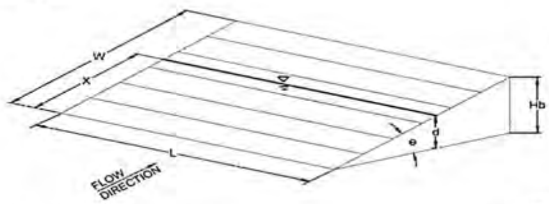
# AREA INLET IN A SWALE

**Freedom Springs**

**Inlet DP6**

**Inlet Design Information (Input)**

Type of Inlet: User-Defined — Inlet Type = User-Defined




| | | | |
|---|---|---|---|
| Angle of Inclined Grate (must be <= 30 degrees) | θ = | 0.00 | degrees |
| Width of Grate | W = | 1.00 | feet |
| Length of Grate | L = | 1.00 | feet |
| Open Area Ratio | $A_{RATIO}$ = | 0.70 | |
| Height of Inclined Grate | $H_B$ = | 0.00 | feet |
| Clogging Factor | $C_f$ = | 0.50 | |
| Grate Discharge Coefficient | $C_d$ = | N/A | |
| Orifice Coefficient | $C_o$ = | 0.64 | |
| Weir Coefficient | $C_w$ = | 2.05 | |

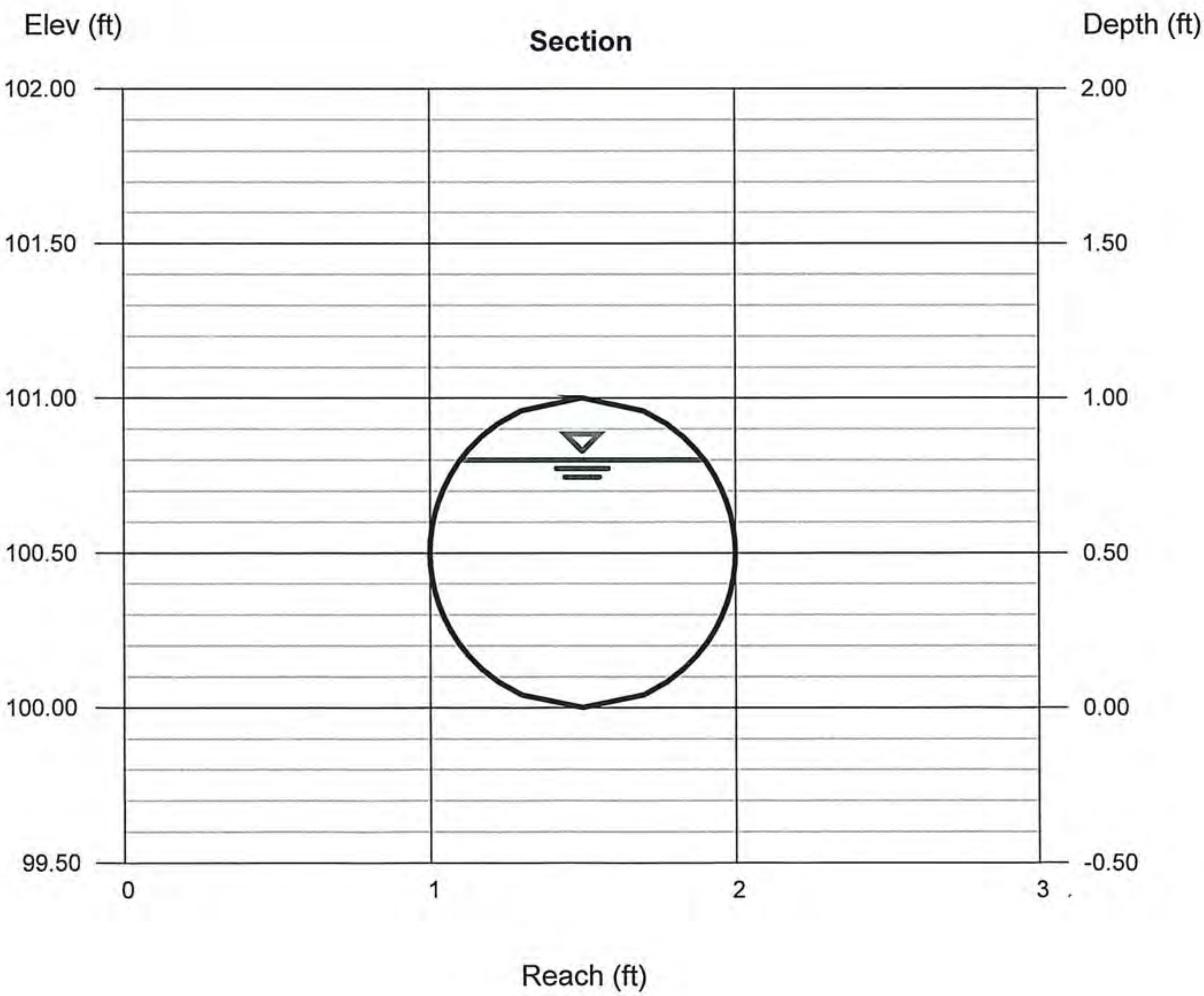
| | | MINOR | MAJOR | |
|---|---|---|---|---|
| Water Depth at Inlet (for depressed inlets, 1 foot is added for depression) | d = | 0.26 | 0.40 | |
| **Total Inlet Interception Capacity (assumes clogged condition)** | $Q_a$ = | 0.8 | 1.1 | cfs |
| | Bypassed Flow, $Q_b$ = | 0.0 | 0.0 | cfs |
| | Capture Percentage = $Q_a/Q_o$ = C% | 100 | 100 | % |

# Channel Report



## Pipe from DP1 inlet to MH1

| | | | |
|---|---|---|---|
| **Circular** | | **Highlighted** | |
| Diameter (ft) | = 1.00 | Depth (ft) | = 0.80 |
| | | Q (cfs) | = 4.900 |
| | | Area (sqft) | = 0.67 |
| Invert Elev (ft) | = 100.00 | Velocity (ft/s) | = 7.27 |
| Slope (%) | = 2.00 | Wetted Perim (ft) | = 2.22 |
| N-Value | = 0.013 | Crit Depth, Yc (ft) | = 0.92 |
| | | Top Width (ft) | = 0.80 |
| **Calculations** | | EGL (ft) | = 1.62 |
| Compute by: | Known Q | | |
| Known Q (cfs) | = 4.90 | | |



# Channel Report



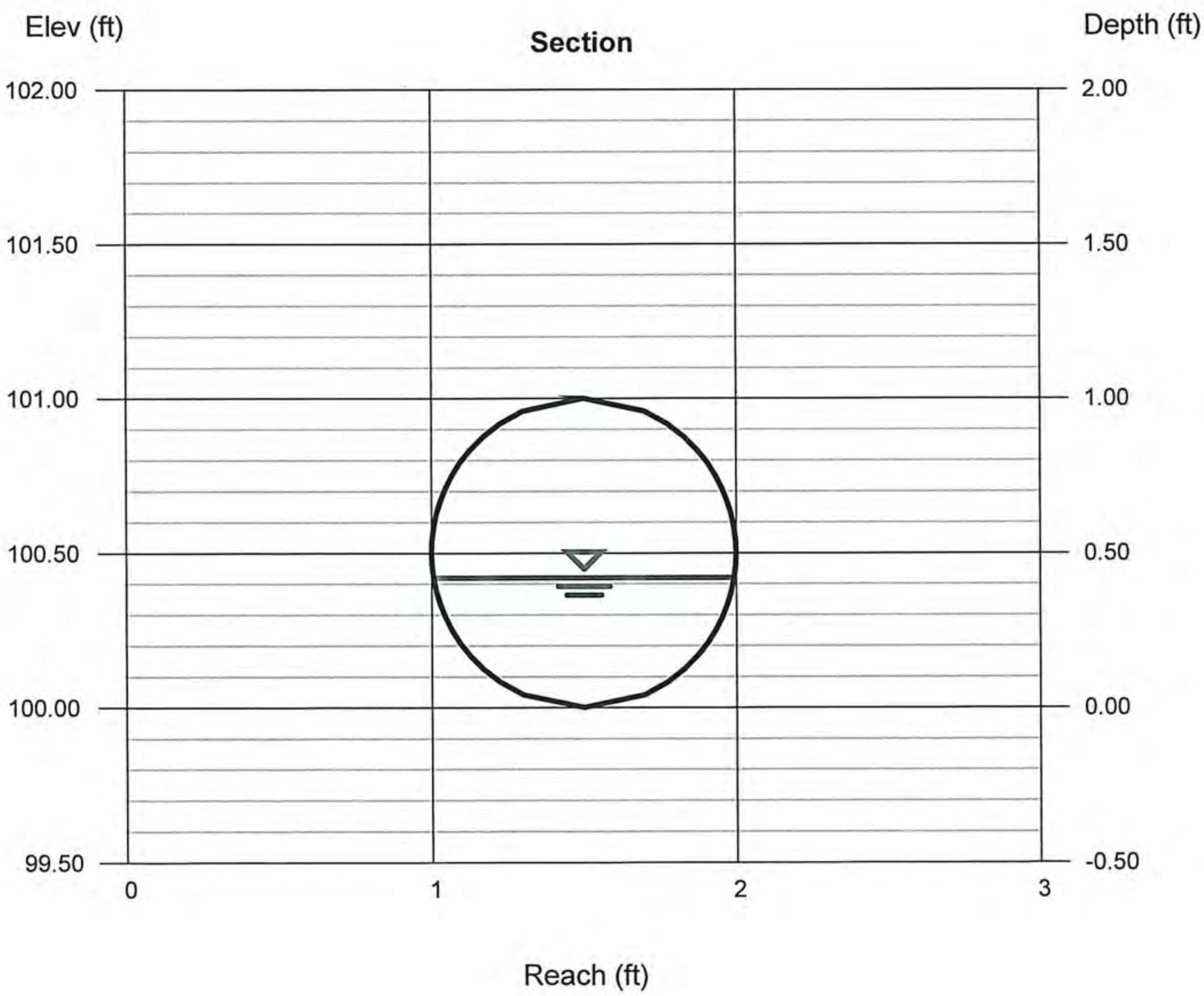
## Pipe from DP2 inlet to MH1

**Circular**
Diameter (ft) = 1.00

Invert Elev (ft) = 100.00
Slope (%) = 1.00
N-Value = 0.013

**Calculations**
Compute by: Known Q
Known Q (cfs) = 1.30

**Highlighted**
Depth (ft) = 0.42
Q (cfs) = 1.300
Area (sqft) = 0.32
Velocity (ft/s) = 4.12
Wetted Perim (ft) = 1.41
Crit Depth, Yc (ft) = 0.48
Top Width (ft) = 0.99
EGL (ft) = 0.68

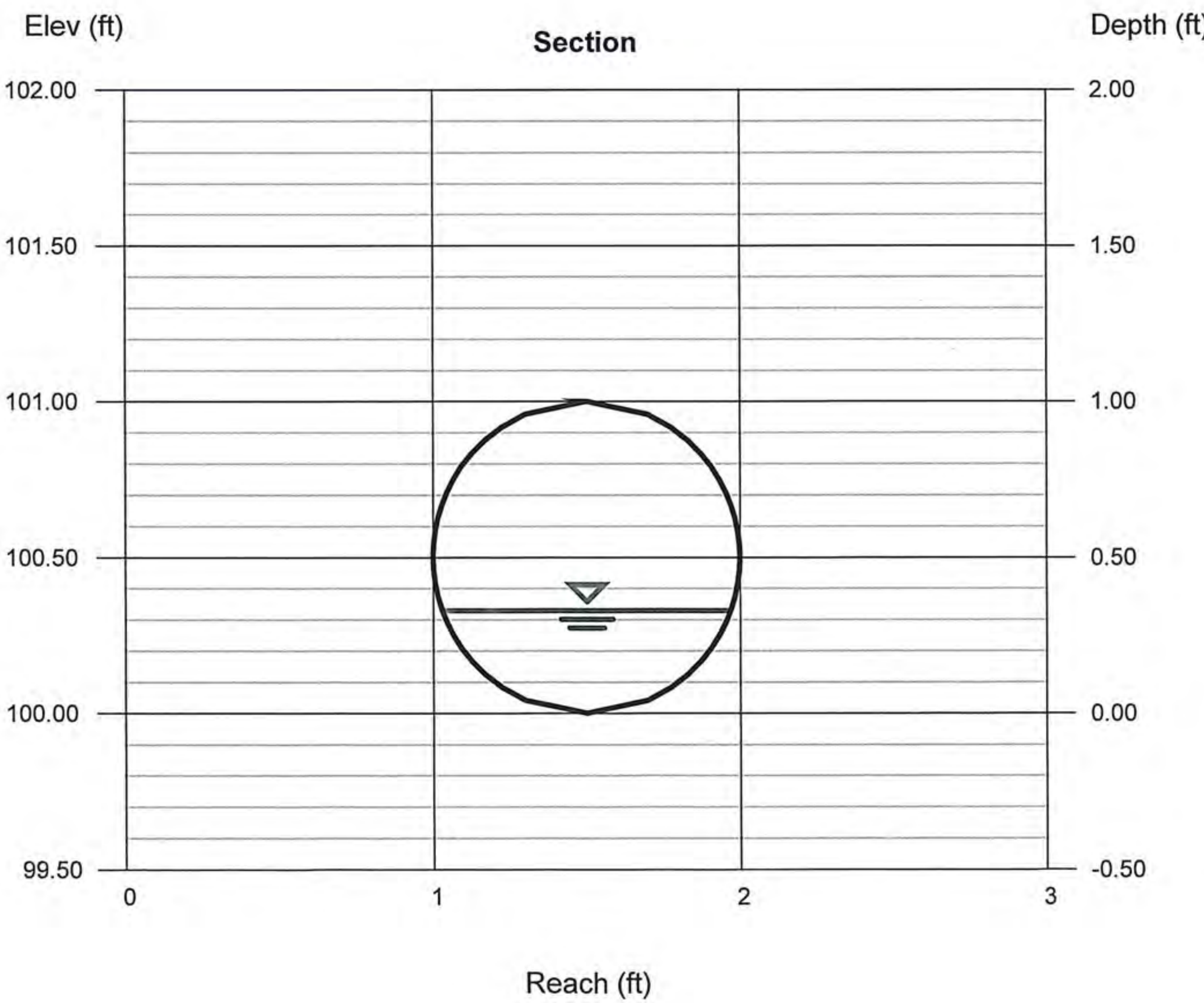


# Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Mar 7 2018

## Pipe from DP3 inlet to MH1

| | | | |
|---|---|---|---|
| **Circular** | | **Highlighted** | |
| Diameter (ft) | = 1.00 | Depth (ft) | = 0.33 |
| | | Q (cfs) | = 0.800 |
| | | Area (sqft) | = 0.23 |
| Invert Elev (ft) | = 100.00 | Velocity (ft/s) | = 3.53 |
| Slope (%) | = 1.00 | Wetted Perim (ft) | = 1.22 |
| N-Value | = 0.013 | Crit Depth, Yc (ft) | = 0.38 |
| | | Top Width (ft) | = 0.94 |
| **Calculations** | | EGL (ft) | = 0.52 |
| Compute by: | Known Q | | |
| Known Q (cfs) | = 0.80 | | |

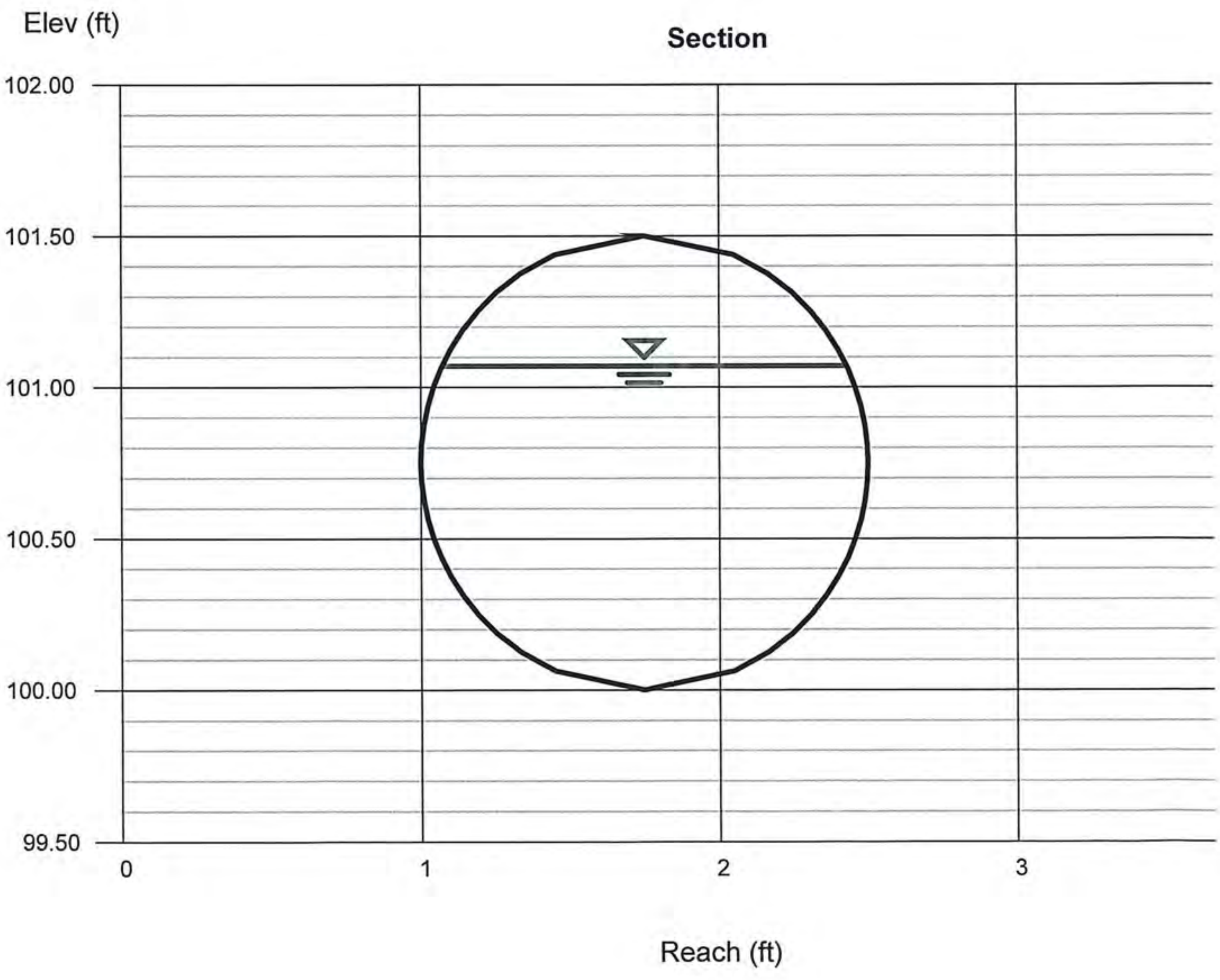


# Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Mar 7 2018

## Pipe from MH1 to Pond

| | | | |
|---|---|---|---|
| **Circular** | | **Highlighted** | |
| Diameter (ft) | = 1.50 | Depth (ft) | = 1.07 |
| | | Q (cfs) | = 12.70 |
| | | Area (sqft) | = 1.35 |
| Invert Elev (ft) | = 100.00 | Velocity (ft/s) | = 9.40 |
| Slope (%) | = 2.00 | Wetted Perim (ft) | = 3.02 |
| N-Value | = 0.013 | Crit Depth, Yc (ft) | = 1.34 |
| | | Top Width (ft) | = 1.35 |
| **Calculations** | | EGL (ft) | = 2.44 |
| Compute by: | Known Q | | |
| Known Q (cfs) | = 12.70 | | |



## Design Procedure Form: Sand Filter (SF)

UD-BMP (Version 3.06, November 2016)



**Designer:** TJW
**Company:** M.V.E., Inc.
**Date:** March 23, 2018
**Project:** Freedom Springs
**Location:** DP 7

| | |
|---|---|
| 1. Basin Storage Volume | |
| A) Effective Imperviousness of Tributary Area, $I_a$ (100% if all paved and roofed areas upstream of sand filter) | $I_a$ = 61.8 % |
| B) Tributary Area's Imperviousness Ratio ($i = I_a/100$) | i = 0.618 |
| C) Water Quality Capture Volume (WQCV) Based on 12-hour Drain Time WQCV= $0.8 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i)$ | WQCV = 0.19 watershed inches |
| D) Contributing Watershed Area (including sand filter area) | Area = 97,781 sq ft |
| E) Water Quality Capture Volume (WQCV) Design Volume $V_{WQCV}$ = WQCV / 12 * Area | $V_{WQCV}$ = 1,580 cu ft |
| F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm | $d_6$ = 0.42 in |
| G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume | $V_{WQCV\ OTHER}$ = 1,543 cu ft |
| H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired) | $V_{WQCV\ USER}$ = ______ cu ft |
| 2. Basin Geometry | |
| A) WQCV Depth | $D_{WQCV}$ = 2.5 ft |
| B) Sand Filter Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred). Use "0" if sand filter has vertical walls. | Z = 4.00 ft / ft |
| C) Minimum Filter Area (Flat Surface Area) | $A_{Min}$ = 755 sq ft |
| D) Actual Filter Area | $A_{Actual}$ = ______ sq ft |
| E) Volume Provided | $V_T$ = ______ cu ft |
| 3. Filter Material | Choose One<br>◉ 18" CDOT Class B or C Filter Material<br>○ Other (Explain): ______ |
| 4. Underdrain System | |
| A) Are underdrains provided? | Choose One<br>○ YES<br>◉ NO |
| B) Underdrain system orifice diameter for 12 hour drain time | |
| i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice | y = N/A ft |
| ii) Volume to Drain in 12 Hours | $Vol_{12}$ = N/A cu ft |
| iii) Orifice Diameter, 3/8" Minimum | $D_O$ = N/A in |

## Design Procedure Form: Sand Filter (SF)



| | |
|---|---|
| **Designer:** | **TJW** |
| **Company:** | **M.V.E., Inc.** |
| **Date:** | **March 23, 2018** |
| **Project:** | **Freedom Springs** |
| **Location:** | **DP 7** |

| | |
|---|---|
| 5. Impermeable Geomembrane Liner and Geotextile Separator Fabric<br>A) Is an impermeable liner provided due to proximity of structures or groundwater contamination? | Choose One<br>○ YES ◉ NO |
| 6-7. Inlet / Outlet Works<br>A) Describe the type of energy dissipation at inlet points and means of conveying flows in excess of the WQCV through the outlet | Outflows are small and will discharge to concrete channel to Western Drive<br>Emergency spillway lined with rip rap to Western Drive |

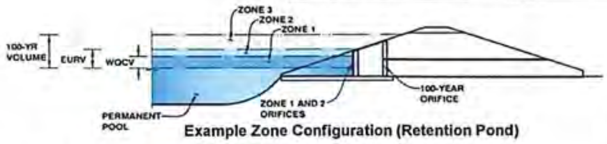
Notes:

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Freedom Springs

Basin ID: Full Spectrum Sand Filter Basin - DP7




**Example Zone Configuration (Retention Pond)**

**Required Volume Calculation**

| | | |
|---|---|---|
| Selected BMP Type = | SF | |
| Watershed Area = | 2.25 | acres |
| Watershed Length = | 430 | ft |
| Watershed Slope = | 0.036 | ft/ft |
| Watershed Imperviousness = | 61.80% | percent |
| Percentage Hydrologic Soil Group A = | 100.0% | percent |
| Percentage Hydrologic Soil Group B = | 0.0% | percent |
| Percentage Hydrologic Soil Groups C/D = | 0.0% | percent |
| Desired WQCV Drain Time = | 12.0 | hours |
| Location for 1-hr Rainfall Depths = | User Input | |
| Water Quality Capture Volume (WQCV) = | 0.036 | acre-feet |
| Excess Urban Runoff Volume (EURV) = | 0.170 | acre-feet |
| 2-yr Runoff Volume (P1 = 1.19 in.) = | 0.117 | acre-feet |
| 5-yr Runoff Volume (P1 = 1.5 in.) = | 0.152 | acre-feet |
| 10-yr Runoff Volume (P1 = 1.75 in.) = | 0.186 | acre-feet |
| 25-yr Runoff Volume (P1 = 2 in.) = | 0.226 | acre-feet |
| 50-yr Runoff Volume (P1 = 2.25 in.) = | 0.272 | acre-feet |
| 100-yr Runoff Volume (P1 = 2.52 in.) = | 0.326 | acre-feet |
| 500-yr Runoff Volume (P1 = 3.25 in.) = | 0.464 | acre-feet |
| Approximate 2-yr Detention Volume = | 0.110 | acre-feet |
| Approximate 5-yr Detention Volume = | 0.144 | acre-feet |
| Approximate 10-yr Detention Volume = | 0.174 | acre-feet |
| Approximate 25-yr Detention Volume = | 0.210 | acre-feet |
| Approximate 50-yr Detention Volume = | 0.232 | acre-feet |
| Approximate 100-yr Detention Volume = | 0.256 | acre-feet |

Optional User Override 1-hr Precipitation

| | |
|---|---|
| 1.19 | inches |
| 1.50 | inches |
| 1.75 | inches |
| 2.00 | inches |
| 2.25 | inches |
| 2.52 | inches |
| 3.25 | inches |

**Stage-Storage Calculation**

| | | |
|---|---|---|
| Zone 1 Volume (WQCV) = | 0.036 | acre-feet |
| Zone 2 Volume (EURV - Zone 1) = | 0.133 | acre-feet |
| Zone 3 Volume (100-year - Zones 1 & 2) = | 0.086 | acre-feet |
| Total Detention Basin Volume = | 0.256 | 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 | |

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 | -- | -- | -- | 3,208 | 0.074 | | |
| | -- | 0.25 | -- | -- | -- | 3,500 | 0.080 | 804 | 0.018 |
| WQCV=6301.46 | -- | 0.50 | -- | -- | -- | 3,818 | 0.088 | 1,715 | 0.039 |
| | -- | 0.75 | -- | -- | -- | 4,148 | 0.095 | 2,708 | 0.062 |
| | -- | 1.00 | -- | -- | -- | 4,505 | 0.103 | 3,786 | 0.087 |
| | -- | 1.25 | -- | -- | -- | 4,844 | 0.111 | 4,951 | 0.114 |
| | -- | 1.50 | -- | -- | -- | 5,214 | 0.120 | 6,204 | 0.142 |
| EURV=6302.71 | -- | 1.75 | -- | -- | -- | 5,596 | 0.128 | 7,552 | 0.173 |
| | -- | 2.00 | -- | -- | -- | 6,011 | 0.138 | 8,999 | 0.207 |
| | -- | 2.25 | -- | -- | -- | 6,396 | 0.147 | 10,609 | 0.244 |
| 100 YR=6303.34 | -- | 2.50 | -- | -- | -- | 6,817 | 0.156 | 12,261 | 0.281 |
| | -- | 2.75 | -- | -- | -- | 7,250 | 0.166 | 14,019 | 0.322 |
| | -- | 3.00 | -- | -- | -- | 7,715 | 0.177 | 15,890 | 0.365 |
| | -- | 3.25 | -- | -- | -- | 8,151 | 0.187 | 17,873 | 0.410 |
| | -- | 3.50 | -- | -- | -- | 8,622 | 0.198 | 19,970 | 0.458 |
| | -- | 3.75 | -- | -- | -- | 9,105 | 0.209 | 22,186 | 0.509 |
| | -- | 4.00 | -- | -- | -- | 9,631 | 0.221 | 24,528 | 0.563 |
| | -- | | -- | -- | -- | | | | |
| | -- | | -- | -- | -- | | | | |
| | -- | | -- | -- | -- | | | | |
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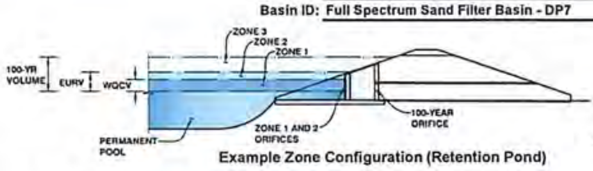
| | -- | | -- | -- | -- | | | | |
| | -- | | -- | -- | -- | | | | |

# Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

**Project:** Freedome Springs

**Basin ID:** Full Spectrum Sand Filter Basin - DP7




Example Zone Configuration (Retention Pond)

| | Stage (ft) | Zone Volume (ac-ft) | Outlet Type |
|---|---|---|---|
| Zone 1 (WQCV) | 0.46 | 0.036 | Filtration Media |
| Zone 2 (EURV) | 1.72 | 0.133 | Orifice Plate |
| Zone 3 (100-year) | 2.34 | 0.086 | Weir&Pipe (Restrict) |
| | | 0.256 | 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 = | 0.97 | inches |

**Calculated Parameters for Underdrain**

| | | |
|---|---|---|
| Underdrain Orifice Area = | 0.0 | $ft^2$ |
| Underdrain Orifice Centroid = | 0.04 | 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 = | 0.46 | ft (relative to basin bottom at Stage = 0 ft) |
| Depth at top of Zone using Orifice Plate = | 1.75 | ft (relative to basin bottom at Stage = 0 ft) |
| Orifice Plate: Orifice Vertical Spacing = | 5.00 | inches |
| Orifice Plate: Orifice Area per Row = | 2.94 | sq. inches (diameter = 1-15/16 inches) |

**Calculated Parameters for Plate**

| | | |
|---|---|---|
| WQ Orifice Area per Row = | 2.042E-02 | $ft^2$ |
| 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) | 0.46 | 0.89 | 1.32 | | | | | |
| Orifice Area (sq. inches) | 2.94 | 2.94 | 2.94 | | | | | |

| | 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 = | 1.75 | 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, $H_t$ = | 1.75 | N/A | feet |
| Over Flow Weir Slope Length = | 2.92 | N/A | feet |
| Grate Open Area / 100-yr Orifice Area = | 59.91 | 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 = | 18.00 | N/A | inches |
| Restrictor Plate Height Above Pipe Invert = | 2.10 | | inches |

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

| | Zone 3 Restrictor | Not Selected | |
|---|---|---|---|
| Outlet Orifice Area = | 0.12 | N/A | $ft^2$ |
| Outlet Orifice Centroid = | 0.10 | N/A | feet |
| Half-Central Angle of Restrictor Plate on Pipe = | 0.70 | N/A | radians |

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

| | | |
|---|---|---|
| Spillway Invert Stage= | 2.50 | ft (relative to basin bottom at Stage = 0 ft) |
| Spillway Crest Length = | 6.00 | feet |
| Spillway End Slopes = | 4.00 | H:V |
| Freeboard above Max Water Surface = | 1.00 | feet |

**Calculated Parameters for Spillway**

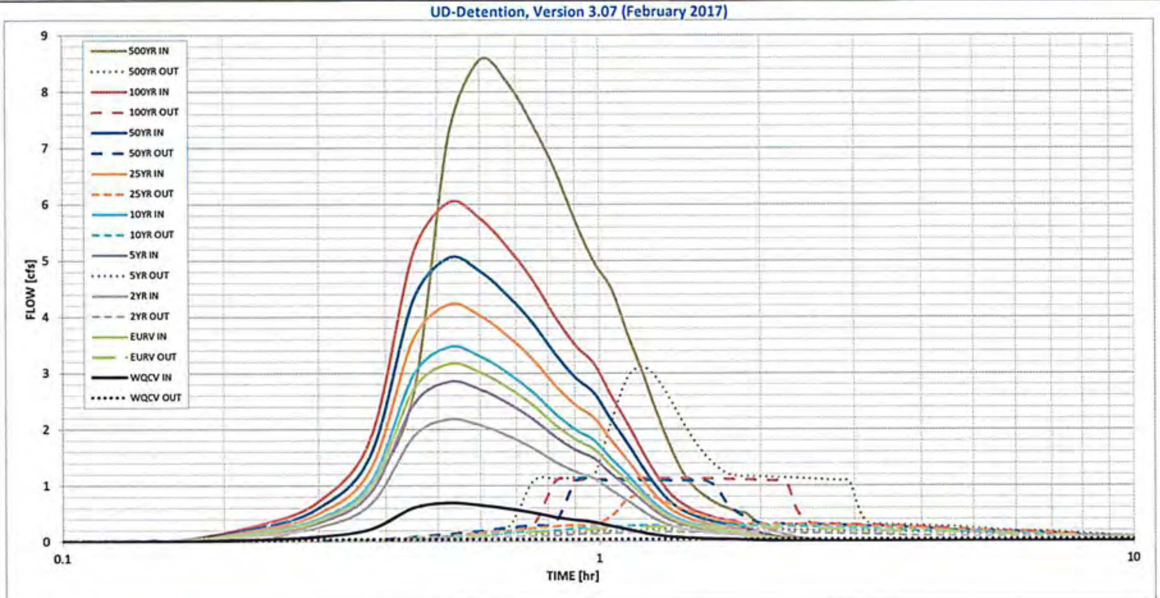
| | | |
|---|---|---|
| Spillway Design Flow Depth= | 0.42 | feet |
| Stage at Top of Freeboard = | 3.92 | feet |
| Basin Area at Top of Freeboard = | 0.22 | acres |

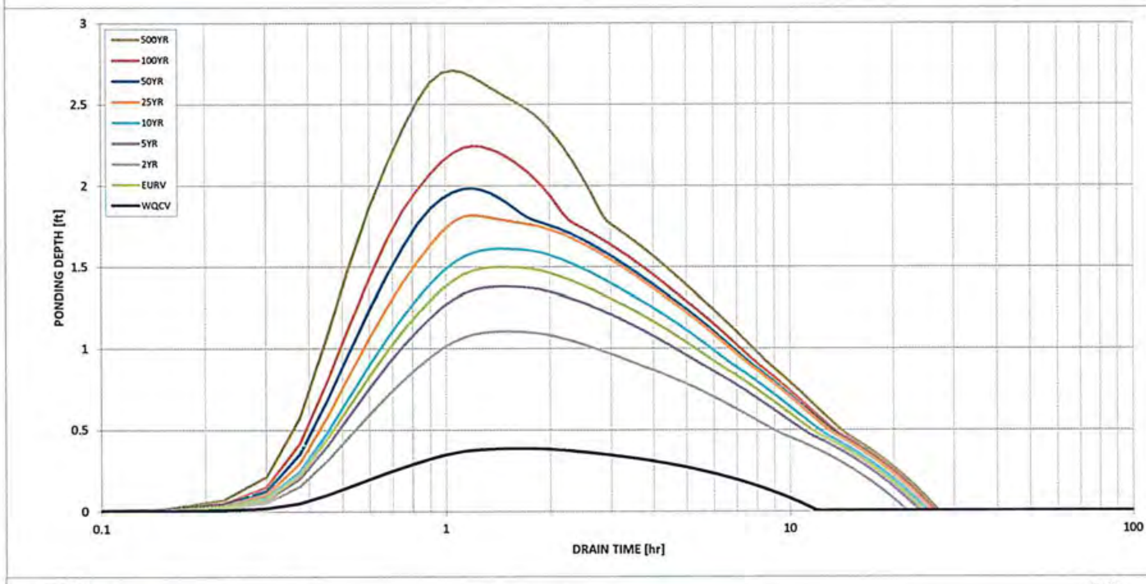
**Routed Hydrograph Results**

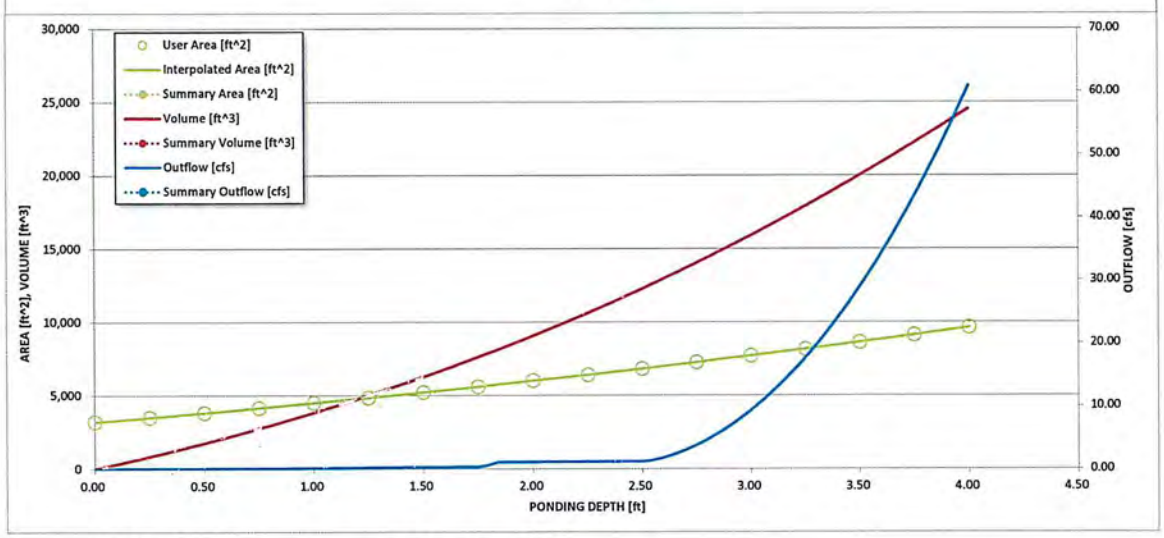
| Design Storm Return Period = | WQCV | EURV | 2 Year | 5 Year | 10 Year | 25 Year | 50 Year | 100 Year | 500 Year |
|---|---|---|---|---|---|---|---|---|---|
| One-Hour Rainfall Depth (in) = | 0.53 | 1.07 | 1.19 | 1.50 | 1.75 | 2.00 | 2.25 | 2.52 | 3.25 |
| Calculated Runoff Volume (acre-ft) = | 0.036 | 0.170 | 0.117 | 0.152 | 0.186 | 0.226 | 0.272 | 0.326 | 0.464 |
| OPTIONAL Override Runoff Volume (acre-ft) = | | | | | | | | | |
| Inflow Hydrograph Volume (acre-ft) = | 0.035 | 0.169 | 0.116 | 0.152 | 0.185 | 0.226 | 0.272 | 0.325 | 0.463 |
| Predevelopment Unit Peak Flow, q (cfs/acre) = | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.03 | 0.23 | 0.55 | 1.27 |
| Predevelopment Peak Q (cfs) = | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.5 | 1.2 | 2.9 |
| Peak Inflow Q (cfs) = | 0.7 | 3.2 | 2.2 | 2.8 | 3.5 | 4.2 | 5.1 | 6.0 | 8.6 |
| Peak Outflow Q (cfs) = | 0.0 | 0.3 | 0.2 | 0.2 | 0.3 | 0.8 | 1.1 | 1.1 | 3.1 |
| Ratio Peak Outflow to Predevelopment Q = | N/A | N/A | N/A | 17.5 | 9.3 | 11.8 | 2.1 | 0.9 | 1.1 |
| Structure Controlling Flow = | Filtration Media | Plate | Plate | Plate | Plate | Overflow Grate 1 | Outlet Plate 1 | Outlet Plate 1 | Spillway |
| Max Velocity through Grate 1 (fps) = | N/A | N/A | N/A | N/A | N/A | 0.1 | 0.1 | 0.1 | 0.1 |
| Max Velocity through Grate 2 (fps) = | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Time to Drain 97% of Inflow Volume (hours) = | 12 | 23 | 21 | 22 | 23 | 24 | 23 | 23 | 22 |
| Time to Drain 99% of Inflow Volume (hours) = | 12 | 24 | 22 | 23 | 25 | 25 | 25 | 25 | 26 |
| Maximum Ponding Depth (ft) = | 0.38 | 1.50 | 1.11 | 1.38 | 1.61 | 1.82 | 1.98 | 2.24 | 2.71 |
| Area at Maximum Ponding Depth (acres) = | 0.08 | 0.12 | 0.11 | 0.12 | 0.12 | 0.13 | 0.14 | 0.15 | 0.16 |
| Maximum Volume Stored (acre-ft) = | 0.030 | 0.144 | 0.098 | 0.128 | 0.157 | 0.182 | 0.205 | 0.242 | 0.314 |

# Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)



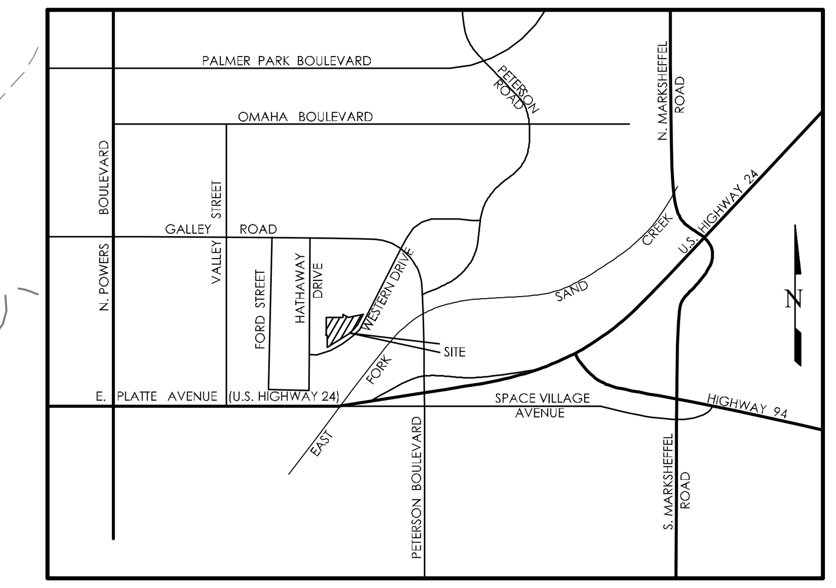




| S-A-V-D Chart Axis Override | X-axis | Left Y-Axis | Right Y-Axis |
|---|---|---|---|
| minimum bound | | | |
| maximum bound | | | |

## 11 Report Maps

Existing Condition Hydraulic Analysis Map (Map Pocket)
Proposed Condition Hydraulic Analysis Map (Map Pocket)


**VICINITY MAP**
NO SCALE

BENCHMARK

**LEGEND**

- PROPERTY LINE
- EASEMENT LINE
- LOT LINE
- BUILDING SETBACK LINE

EXISTING

- INDEX CONTOUR
- INTERMEDIATE CONTOUR
- BARBED WIRE FENCE
- TREE (EVERGREEN/DECID.)

PROPOSED

- INDEX CONTOUR
- INTERMEDIATE CONTOUR
- BASIN BOUNDARY
- GENERAL FLOW/DIRECTION
- SLOPE DIRECTION AND GRADE
- BASIN LABEL — AREA IN ACRES, PERCENT IMPERVIOUS
- POINT OF INTEREST

1" = 50' 1:600

REVISIONS

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

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

**EXISTING DRAINAGE SUMMARY TABLE**

| POINT OF INTEREST/BASIN(S) BASIN(S) | | AREA (AC) | RUNOFF Q5 (CFS) | Q100 (CFS) |
|---|---|---|---|---|
| | OS1 | 2.84 | 4.7 | 10.4 |
| | A1 | 2.72 | 1.7 | 7.2 |
| | OS2 | 0.57 | 1.1 | 2.5 |
| | B1 | 1.16 | 0.4 | 2.8 |
| | OS1+A1 | 5.56 | 6.2 | 17.0 |
| | OS2+B1 | 1.72 | 1.4 | 5.0 |
| | OS1,OS2,A1,B1 | 7.28 | 7.6 | 22.0 |

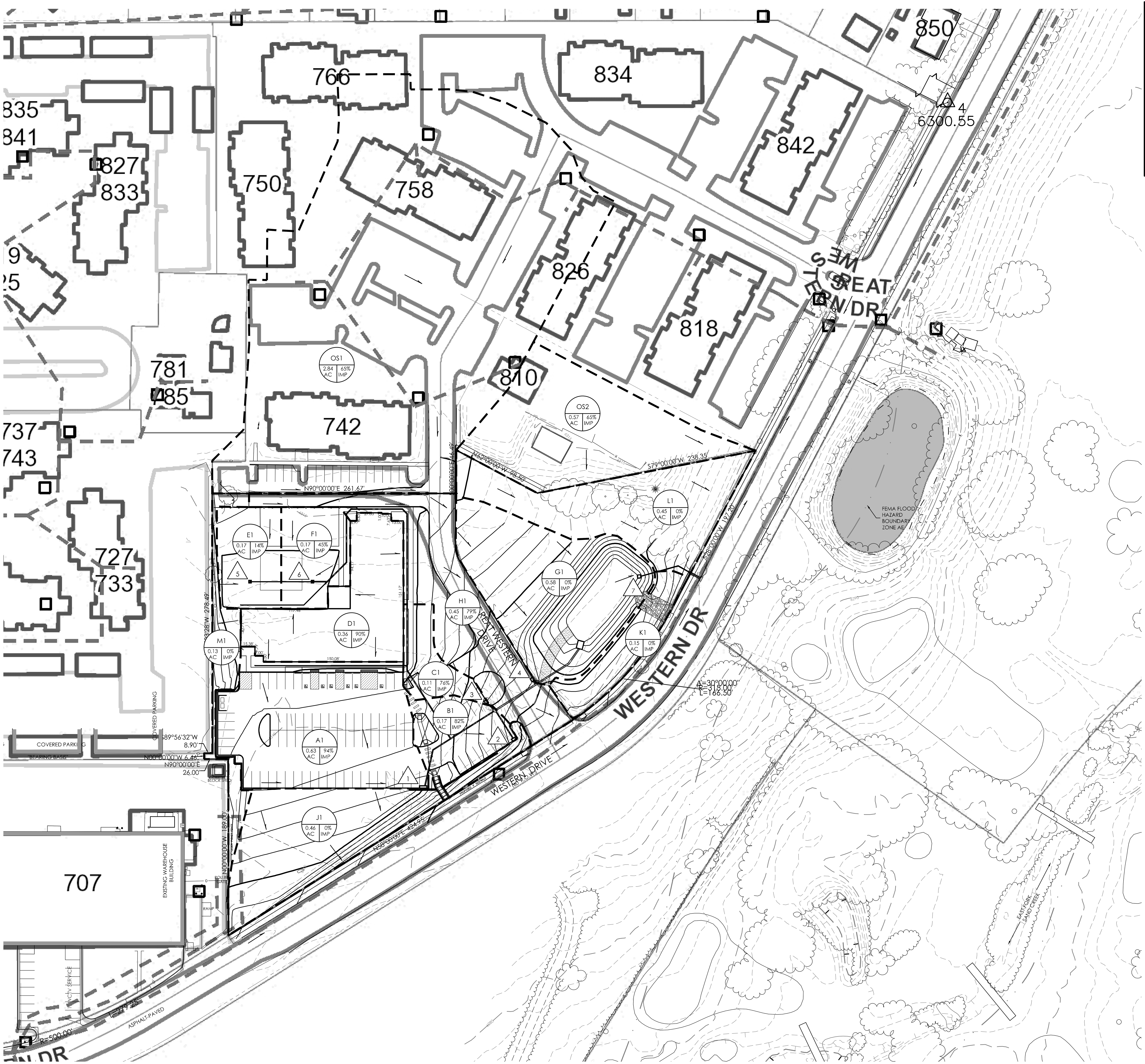
# FREEDOM SPRINGS
# 734 WESTERN DRIVE

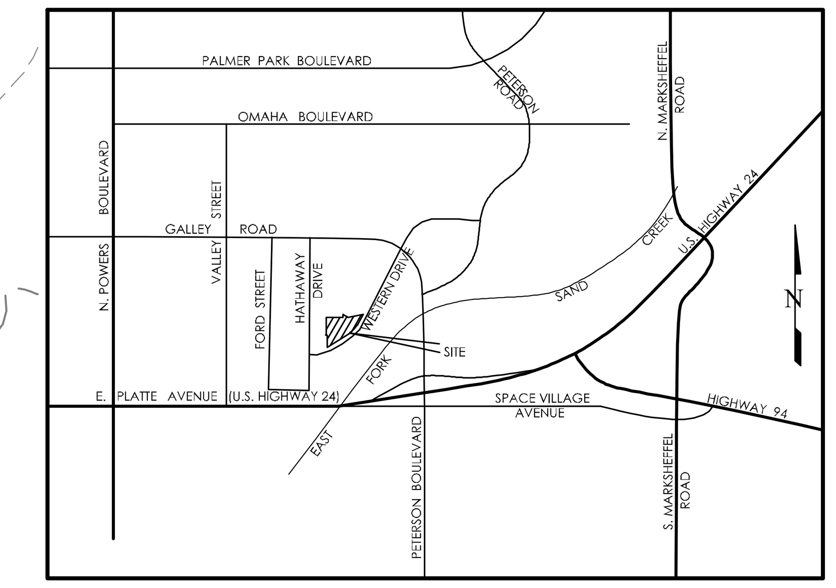
## Existing Drainage Map

MVE PROJECT 61090
MVE DRAWING Ex-Drain-Map

November 8, 2018

**SHEET** 1 **OF** 1




**VICINITY MAP**
NO SCALE

BENCHMARK

**LEGEND**

- PROPERTY LINE
- EASEMENT LINE
- LOT LINE
- BUILDING SETBACK LINE

**EXISTING**

- 5985 INDEX CONTOUR
- 84 INTERMEDIATE CONTOUR
- BARBED WIRE FENCE
- TREE (EVERGREEN/DECID.)

**PROPOSED**

- 5985 INDEX CONTOUR
- 84 INTERMEDIATE CONTOUR
- BASIN BOUNDARY
- $Q_5$ = 2 cfs, $Q_{100}$ = 7 cfs GENERAL FLOW/DIRECTION
- 1.5% SLOPE DIRECTION AND GRADE
- A1 1.0 AC 50% IMP BASIN LABEL AREA IN ACRES PERCENT IMPERVIOUS
- 1 POINT OF INTEREST

10 0 20 50 100
1" = 50' 1:600

**PROPOSED DRAINAGE SUMMARY TABLE**

| POINT OF INTEREST/BASIN(S) BASIN(S) | | AREA (AC) | RUNOFF Q5 (CFS) | RUNOFF Q100 (CFS) |
|---|---|---|---|---|
| | OS1 | 2.84 | 4.7 | 10.4 |
| | H1 | 0.45 | 1.6 | 3.1 |
| DP1 | A1 | 0.63 | 2.7 | 4.9 |
| DP2 | B1 | 0.17 | 0.7 | 1.3 |
| DP3 | C1 | 0.11 | 0.4 | 0.8 |
| DP4 | OS1,H1 | 3.29 | 5.7 | 12.3 |
| | D1 | 0.36 | 1.4 | 2.6 |
| DP5 | E1 | 0.17 | 0.1 | 0.5 |
| DP6 | F1 | 0.17 | 0.3 | 0.8 |
| | G1 | 0.58 | 0.2 | 1.3 |
| DP7 | A1,B1,C1,D1,E1,F1,G1,H1 | 2.65 | 7.2 | 15.2 |
| DP7 | POND OUTFLOW | 2.65 | 0.2 | 1.1 |
| | J1 | 0.46 | 0.1 | 1.1 |
| | K1 | 0.15 | 0.1 | 0.4 |
| | M1 | 0.13 | 0.1 | 0.4 |
| | OS2 | 0.57 | 1.1 | 2.5 |
| | L1 | 0.45 | 0.1 | 1.1 |
| | OS2,L1 | 1.02 | 1.1 | 3.3 |
| | OS1,H1,A1,B1,C1,D1, E1, F1,G1,H1,J1, K1, OS2,L1 | 7.11 | 4.7 | 14.4 |
| | | | | |
| | | | | |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REVISIONS

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

# FREEDOM SPRINGS
# 734 WESTERN DRIVE

## Proposed Drainage Map

MVE PROJECT 61090
MVE DRAWING Ex-Drain-Map

November 8, 2018

SHEET 1 OF 1