

**THE GARDENS AT NORTH  
CAREFREE  
FINAL DRAINAGE REPORT  
EL PASO COUNTY, COLORADO**

PROJECT NO. 187608744



Prepared for:  
MULE DEER INVESTMENTS, LLC  
2727 GLEN ARBOR DRIVE  
COLORADO SPRINGS, CO 80124

Prepared by:  
STANTEC CONSULTING, INC  
5725 MARK DABLING BLVD, SUITE 190  
COLORADO SPRINGS, CO 80919  
719.432.6880

January 21, 2019

**PCD File No: SF 195**

CERTIFICATIONS

**Design 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.

\_\_\_\_\_  
Charlene. M. Durham, P.E. #36727

Seal

**Owner/Developer's Statement:**

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

By (signature): \_\_\_\_\_

Date: \_\_\_\_\_

Title: \_\_\_\_\_

Address: \_\_\_\_\_  
2727 Glen Arbor Drive

\_\_\_\_\_ Colorado Springs, CO 80124

**El Paso County:**

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

\_\_\_\_\_  
Jennifer Irvine, P.E.,  
County Engineer / ECM Administrator

\_\_\_\_\_  
Date

Table of Contents

**PURPOSE .....5**

**GENERAL LOCATION & DESCRIPTION .....5**

    DESCRIPTION OF PROPERTY .....5

    CLIMATE .....5

    FLOODPLAIN STATEMENT .....5

    UTILITIES & OTHER ENCUMBRANCES .....6

**DRAINAGE DESIGN CRITERIA.....6**

    DEVELOPMENT CRITERIA REFERENCE .....6

    HYDROLOGIC CRITERIA .....6

        Rational Method .....6

        Storm Sewer Design .....6

        Detention Storage Criteria .....6

        Waivers/Deviations .....6

**DRAINAGE BASINS.....7**

    OFFSITE BASINS .....7

    EXISTING DRAINAGE ANALYSIS .....7

        Design Points .....8

    PROPOSED DRAINAGE ANALYSIS .....8

        Design Points .....10

        Deviations .....12

**DRAINAGE FACILITY DESIGN .....12**

    GENERAL CONCEPT .....12

    STORM SEWER SYSTEM .....12

    ON-SITE WATER QUALITY .....12

    FOUR STEP PROCESS .....13

*Reduce Runoff* .....13

*Treat & Release WQCV* .....13

*Stabilize Stream Channels* .....13

*Implement Source Controls* .....14

**DRAINAGE FEES, COST ESTIMATE & MAINTENANCE .....14**

    MAINTENANCE .....14

    DRAINAGE FEES .....14

    PROPOSED FACILITIES ESTIMATE .....15

**EROSION CONTROL .....15**

    GENERAL CONCEPT .....15

    SILT FENCE .....16

    EROSION BALES .....16

    VEHICLE TRACKING CONTROL .....16

    SEDIMENTATION POND .....16

**SUMMARY .....16**

**REFERENCE MATERIALS .....17**

## List of Figures

Figure 1: Vicinity Map .....	18
Figure 2: Existing Drainage Map .....	BACK POCKET
Figure 3: Proposed Drainage Map.....	BACK POCKET

## Appendix

Appendix A: NRCS Soil Report
Appendix B: Existing Hydrology Calculations
Appendix C: Proposed Hydrology Calculations
Appendix D: Inlet Calculations
Appendix E: StormCAD
Appendix F: Detention & Water Quality Pond Calculations

## PURPOSE

The purpose of this Final Drainage Report (FDR) is to identify and analyze on and offsite drainage patterns, locate and identify tributary and downstream drainage features and facilities that impact the proposed site. Runoff quantities and proposed facilities have been calculated using the City of Colorado Springs/El Paso County Drainage Criteria Manual (DCM) revised November 1991; and in accordance with El Paso County ordinance 15-042.

The Gardens at North Carefree is approximately 11.6 acres and is located within El Paso County.

## GENERAL LOCATION & DESCRIPTION

The Gardens at North Carefree is approximately 11.6 acres of single-family development. The site will include the construction of 3 public roads, 71 single family lots and 5 tracts. The project is bounded by North Carefree Circle to the north, Akers Drive to the west, Sika Deer Place to the south and open land to the east. The project is located in the eastern portion of Section 29, Township 13 South, Range 65 West.

The Gardens at North Carefree development site is located within the northern end of the Sand Creek Basin.

### ***Description of Property***

The project site is 11.6 acres of vegetation, consisting of short grasses and weeds. The average slope of the site is between 3 and 9%, generally sloping to the west.

The site is composed of a single soil type. From the NRCS report in Appendix A, the site falls into the following soil type:

97 – Truckton sandy loam (3-9%) – Type A Soil

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. Group A soil is defined by:

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.

### ***Climate***

The climate of the site is typical of a sub-humid to semiarid climate with mild summers and winters. The average temperature is 31 degrees F in the winter and 68.4 degrees in the summer. Total annual precipitation is 15.21 inches.

### ***Floodplain Statement***

The Flood Insurance Rate Map (FIRM No. 08041C0539-G dated 12/7/18) indicates that there is no floodplain in the vicinity of the proposed site.

## Utilities & Other Encumbrances

The site is currently undeveloped and there are no known utilities on site.

## DRAINAGE DESIGN CRITERIA

### Development Criteria Reference

Resolution No. 15-042, Adoption for portions of the El Paso County Drainage Criteria Manual (DCM), El Paso County Engineering Criteria Manual (ECM) and Urban Storm Drainage Criteria Manual (USDCM) by Urban Drainage & Flood Control District was used in preparation of this report. Additional preliminary and final drainage plans, master development drainage plans, and drainage basin planning studies used in the preparation of the report are listed in the References Section.

### Hydrologic Criteria

#### Rational Method

The rational method was used to determine onsite flows, as required by the current El Paso County Drainage Criteria Manual (DCM). Both the 5-year and 100-year storm events were considered in this analysis. Runoff coefficients appropriate to the existing and proposed land uses were selected for an SCS type "B" soil from Table 6-6 of the DCM even though the existing soil type is designated as a type "A" soil. The time of concentration was calculated per DCM requirements. Rational Method results are shown in the Appendix B & C. USDCM spreadsheets were used to design the detention and water quality pond features.

Full Spectrum Detention Ponds are required. Please update the text.

#### Storm Sewer Design

Storm Sewer systems have been designed to the 100-year storm and checked with the 5-year storm. Inlets are located at sump areas and intersections where street flow is larger than street capacity. UDFCD Inlet spreadsheet will be used to determine the size of all at-grade and sump inlets. Onsite flow captured within the storm system will be released into one of the two water quality facilities. Final design of these facilities is included in the appendix.

#### Detention Storage Criteria

The proposed Water quality facilities will not be designed as detention structures, as it was determined from previous studies that onsite detention was not necessary. This will be explained and addressed later in the report. Water quality requirements were determined from the UDFCD Volume 3 spreadsheet for an Extended Detention Basin.

Final storage volumes and outflows have been calculated and are included in the appendix.

#### Waivers/Deviations

No variances are being requested for this development.

Revise the narrative to indicate Full Spectrum Detention Ponds instead of water quality facilities/ponds.

A deviation has been requested and approved for El Paso County ECM\_Appendix I Section I.7.1.B: 1st Bullet; Providing Water Quality for Entire Development.

The deviation was for Basins D-7, D-11, D-15 and D-17 thru D-20, which drain into Akers Drive and are intercepted by existing inlets and will not reach an on-site water quality facility. These basins

Per the revised grading and construction drawings, the basins not reaching the ponds will change. See comment on the proposed drainage plan and update the narrative accordingly.

update accordingly. Note that a max of 1 acre may be excluded from water quality. See comment on the drainage plan.

account for approximately 8% (0.94 acres of 11.56) of the overall site area. The remaining 92% of the development area is treated through 1 of the 2 proposed ponds.

The topography of the site will not allow all areas within the site to drain to the proposed ponds. Of the area inside the development boundary that will not reach a facility only 0.19 acres is proposed roadway, and 0.75 acres will be sloped areas at the back of lots along the exterior boundary.

## DRAINAGE BASINS

### *Offsite Basins*

There is one off site basin contributing flows to the proposed development. It is located on the east side of the property along the southern half. The basin is 2.25 acres and is currently undeveloped. Flows from the basin are 0.59 cfs and 4.3 cfs for the minor and major storms. If this parcel develops, it will need to provide its own onsite water quality.

### *Existing Drainage Analysis*

Historic drainage analysis was determined by analyzing runoff quantities and patterns for the site. There are 9 existing basins for the proposed site.

- Basin E-1 (5.41 acres) is the top north half of the site between North Carefree Circle and Akers Drive. Flows are diverted through existing drainage swales to where they will release into Akers Drive. Flows for this basin are 1.41 cfs for the 5-year storm and 10.33 cfs for the 100-year storm.
- Basin E-2 (0.61 acres) is located south of Basin E-1. Existing drainage swales will divert this flow to an existing low point/detention area. Flows for this basin are 0.23 cfs for the 5-year storm and 1.72 cfs for the 100-year storm.
- Basin E-3 (1.59 acres) is south of Basin E-2. Flows are diverted to the west through existing drainage swales to an existing low point. Flows for this basin are 0.56 cfs for the 5-year storm and 4.11 cfs for the 100-year storm.
- Basin E-4 (1.28 acres) is south of Basin E-3. Existing drainage swales direct flows to the west to an existing low area. Flows for this basin are 0.46 cfs for the 5-year storm and 3.35 cfs for the 100-year storm.
- Basin E-5 (0.36 acres) is south of Basin E-1 and west of Basin E-2. Flows for this basin are 0.15 cfs for the 5-year storm and 1.08 cfs for the 100-year storm.
- Basin E-6 (1.55 acres) is south of Basin E-4. Existing drainage swales direct flows towards the west, where they will release into Akers Drive. Flows for this basin are 0.55 cfs for the 5-year storm and 4.03 cfs for the 100-year storm.
- Basin E-7 (0.10 acres) is south of Basin E-5 and west of Basin E-3. Flows for this basin are 0.04 cfs for the 5-year storm and 0.29 cfs for the 100-year storm.

- Basin E-9 (0.05 acres) is located between Basin E-7 and Akers Drive. This area is the low area/detention where an existing 30" rcp collects runoff. Flows for this basin are 0.02 cfs for the 5-year storm and 0.14 cfs for the 100-year storm.
- Basin E-10 (0.51 acres) is along the south boundary of the project, along the private driveway. Flows for this basin are 0.21 cfs for the 5-year storm and 1.52 cfs for the 100-year storm.

## Design Points

- Design Point Z ( $Q_5=0.6$ ,  $Q_{100}=4.4$ ) consists of flow from Basin OS-1. Flow from this basin release on site and combine with other onsite basins.
- Design Point A ( $Q_5=1.4$ ,  $Q_{100}=10.6$ ) consists of flow from Basin E-1. Flow from this basin is released directly into Akers Drive where it is intercepted by an existing Type R inlet.
- Design Point B ( $Q_5=0.2$ ,  $Q_{100}=1.8$ ) consists of flow from Basin E-2. It is a natural low point on the site. Flows will release from this location via an existing culvert and continue to DP E.
- Design Point D ( $Q_5=0.5$ ,  $Q_{100}=3.5$ ) consists of flow from Basin E-4. Flows will continue over existing ground to combine at DP C.
- Design Point C ( $Q_5=1.2$ ,  $Q_{100}=9.4$ ) consists of flow from Basins, OS-1 and E-3 and DP D. Flows will continue to the north where they will combine with other flows at DP H.
- Design Point E ( $Q_5=0.4$ ,  $Q_{100}=2.9$ ) consists of flow from Basin E-5 and DP B. This is a naturally occurring low spot on site. Flows will continue via an existing pipe to DP G.
- Design Point F ( $Q_5=0.6$ ,  $Q_{100}=4.2$ ) consists of flow from Basin E-6. These flows are released directly into Akers Drive where they are intercepted by an existing Type R inlet.
- Design Point G ( $Q_5=0.4$ ,  $Q_{100}=3.22$ ) consists of flow from Basin E-7 and DP E. This is a sump area which has an existing culvert for flows to continue to DP H.
- Design Point H ( $Q_5=1.5$ ,  $Q_{100}=11.4$ ) consists of flow from Basin E-9 and DP C and DP G. This is the final low point where flows are collected and via a 30" RCP, exit the site and combine with flows from Akers Drive and the Mule Deer development to the west.
- Design Point I ( $Q_5=0.2$ ,  $Q_{100}=1.6$ ) consists of flow from Basin E10. Flow will be collected in the curb and gutter of the existing driveway and flow west to Akers Drive.

## Proposed Drainage Analysis

The proposed development consists of 20 developed basins and the offsite basin has been divided into 4 separate basins, based on where flows enter onto developed site basins. The majority of the runoff from the site will be collected via inlets and pipes and diverted to one of two water quality ponds for the development. The ponds will then release into the existing inlets in Akers Drive and continue through the existing storm system to the existing drainage channel to the west

full spectrum detention ponds



Update the narrative and calculations of the proposed basins and design points as necessary per the comments made on the proposed drainage plan.

- Basin OS-1 (0.26 acres) is the southern most offsite basin. This flow is released into Basin D-20. Flows for this basin are 0.08 cfs for the 5-year storm and 0.56 cfs for the 100-year storm.
- Basin OS-2 (0.27 acres) is north of OS-1. Runoff is directed towards Basin D-13. Flows for this basin are 0.08 cfs for the 5-year storm and 0.57 cfs for the 100-year storm.
- Basin OS-3 (0.1.63 acres) is located between OS-2 and OS-4 along the south portion of the eastern boundary of the site. Runoff is directed towards Basin D-2. Flows for this basin are 0.43 cfs for the 5-year storm and 3.17 cfs for the 100-year storm.
- Basin OS-4 (0.07 acres) is the north of OS-3. Runoff is directed towards Basin D-1. Flows for this basin are 0.02 cfs for the 5-year storm and 0.17 cfs for the 100-year storm.
- Basin D-1 (1.24 acres) is the north half of the site along the east boundary to the east leg of Vineyard Circle. This flow is directed towards a sump inlet on the east side of Vineyard Circle. Flows for this basin are 2.34 cfs for the 5-year storm and 5.15 cfs for the 100-year storm.
- Basin D-2 (0.99 acres) is the south half of the site along the east boundary to the east leg of Vineyard Circle. Runoff is directed towards a sump inlet on the west side of Vineyard Circle. Flows for this basin are 1.81 cfs for the 5-year storm and 3.99 cfs for the 100-year storm.
- Basin D-3 (0.17 acres) is the southeast half of Vineyard Circle. Runoff is directed towards a sump inlet on the west side of the east leg of Vineyard Circle. Flows for this basin are 0.37 cfs for the 5-year storm and 0.82 cfs for the 100-year storm.
- Basin D-4 (0.21 acres) is the northeast half of Vineyard Circle. Runoff is directed towards a sump inlet on the west side of the east leg of Vineyard Circle. Flows for this basin are 0.48 cfs for the 5-year storm and 1.06 cfs for the 100-year storm.
- Basin D-5 (2.03 acres) is along the north boundary of the site, along North Carefree and along Akers Drive, north of Fallow Lane. Runoff continues to an at-grade inlet on the west side of the west leg of Vineyard Circle. Flows for this basin are 3.85 cfs for the 5-year storm and 8.47 cfs for the 100-year storm.
- Basin D-6 (0.08 acres) is the east half of Fallow Lane. Flows for this basin are 0.37 cfs for the 5-year storm and 0.66 cfs for the 100-year storm.
- Basin D-7 (0.04 acres) is the southwest half of Fallow Lane. Flows for this basin are 0.18 cfs for the 5-year storm and 0.33 cfs for the 100-year storm.
- Basin D-8 (1.90 acres) is the northwest half of the area inside of Vineyard Circle. Runoff is released into the east side of the west leg of Vineyard Circle to an at-grade inlet. Flows for this basin are 3.46 cfs for the 5-year storm and 7.62 cfs for the 100-year storm.
- Basin D-9 (0.52 acres) is the area between the west leg of Vineyard Circle, Fallow Lane and Akers Drive. Runoff releases to an at-grade inlet on the west side of Vineyard Circle. Flows for this basin are 0.99 cfs for the 5-year storm and 2.17 cfs for the 100-year storm.

- Basin D-10 (0.33 acres) is the North Pond area. Flows for this basin are 0.43 cfs for the 5-year storm and 1.14 cfs for the 100-year storm.
- Basin D-11 (0.07 acres) is the north half of Running Deer Way. Flows for this basin are 0.32 cfs for the 5-year storm and 0.57 cfs for the 100-year storm.
- Basin D-12 (0.93 acres) is the south half of the area in between the two legs of Vineyard Circle. Runoff will release to a sump inlet in the east side of Vineyard Circle. Flows for this basin are 1.99 cfs for the 5-year storm and 4.38 cfs for the 100-year storm.
- Basin D-13 (1.72 acres) is the south portion of the site. Runoff is directed towards a sump inlet on the west half of Vineyard Circle. Flows for this basin are 3.39 cfs and 7.46 cfs for the minor and major storms, respectively.
- Basin D-14 (0.64 acres) is the middle area on the west half of the area between the two legs of Vineyard Circle, across from Running Deer Way. Flows are 1.31 cfs for the 5-year storm and 2.88 cfs for the 100-year storm.
- Basin D-15 (0.04 acres) is northwest half of Fallow Lane. Flows are 0.09 cfs for the 5-year storm and 0.20 cfs for the 100-year storm.
- Basin D-16 (0.13 acres) is the South Pond area. Flows for this basin are 0.21 cfs for the minor storm and 0.57 cfs for the major storm.
- Basin D-17 (0.08 acres) is the south half of Running Deer Way. Flows are 0.37 cfs and 0.66 cfs for the minor and major storms respectively.
- Basin D-18 (0.19 acres) is the area north of Fallow Land and south of North Carefree which flows towards Akers Drive. Runoff for this basin is 0.42 cfs for the 5-year storm and 0.92 cfs for the 100-year storm.
- Basin D-19 (0.11 acres) is the area between Fallow Land and Running Deer Way which flows towards Akers Drive. Flows are 0.25 cfs and 0.55 cfs for the minor and major storms, respectively.
- Basin D-20 (0.41 acres) is the area south of Running Deer Way, along the western boundary, which flows towards Akers Drive. Flows are 0.88 cfs for the minor storm and 1.93 cfs for them major storm.

## Design Points

- Design Point Z ( $Q_5=0.1$ ,  $Q_{100}=0.6$ ) consists of flow from Basin OS-1. Flow from this basin release on site and will combine with Basin D-20.
- Design Point Y ( $Q_5=0.1$ ,  $Q_{100}=0.6$ ) consists of flow from Basin OS-2. Flow from this basin release on site and will combine with Basin D-13.
- Design Point X ( $Q_5=0.4$ ,  $Q_{100}=3.3$ ) consists of flow from Basin OS-3. Flow from this basin release on site and will combine with Basin D-2.

It appears that the majority of basin D-14 will now flow to design point C as opposed to design point E. Revise accordingly.

- Design Point W ( $Q_5=0.0$ ,  $Q_{100}=0.2$ ) consists of flow from Basin OS-4. Flow from this basin release on site and will combine with Basin D-1. Basin D-6 now flows towards Akers. See comment on drainage plan and revise accordingly.
- Design Point A ( $Q_5=3.4$ ,  $Q_{100}=9.9$ ) consists of flow from Basins D-1 and D-2 and Design Points DP W and DP X. A sump inlet will be installed on the east side of the east leg of Vineyard Circle to intercept this flow. This will connect with the storm system which will release into the North Pond.
- Design Point B ( $Q_5=0.9$ ,  $Q_{100}=2.0$ ) consists of flow from Basins D-3 and D-4. A sump inlet will be installed on west side of the east leg of Vineyard Circle to intercept the street flow. The inlet will connect with a storm system which releases into the North Pond.
- Design Point C ( $Q_5=3.5$ ,  $Q_{100}=8.1$ ) consists of flow from Basin D-8 and flow by from the at-grade inlet located at DP E. A sump inlet will be installed on the east side of the west leg of Vineyard Circle to intercept gutter flow. The inlet will be part of a storm system which releases into the North Pond.
- Design Point V ( $Q_5=4.2$ ,  $Q_{100}=9.4$ ) combines flow from Basins D-5 and D-6 at the Fallow Lane and Vineyard Circle intersection. Flows will continue as gutter flow to the south along Vineyard Circle.
- Design Point D ( $Q_5=4.9$ ,  $Q_{100}=11.0$ ) consists of flow from Basin D-9, design point DP V and flow-by from the at-grade inlet located at DP F. This sump inlet will intercept the flows from the west half of the west leg of Vineyard Circle. The inlet will connect to the system which will release into the North Pond.
- Design Point E ( $Q_5=3.2$ ,  $Q_{100}=7.4$ ) consists of flow from Basins D-12 and D-14. This is street flow at the east half of Vineyard Circle beginning at the southeast knuckle. Flows will be intercepted by an at-grade inlet on the east half of the west leg of Vineyard Circle. Flow-by from this inlet will continue as gutter flow in Vineyard Circle to DP C. The inlet will connect to the storm system which releases into the North Pond.
- Design Point F ( $Q_5=2.5$ ,  $Q_{100}=6.1$ ) consists of flow from Basin D-13, and design point DP Y. This is street flow at the west half of Vineyard Circle beginning at the southeast knuckle. Flows will be intercepted by an at-grade inlet on the west half of the west leg of Vineyard Circle, which releases directly into the South Pond. Flow-by from the inlet will continue as street flow to the sump inlet at DP D.
- Design Point G ( $Q_5=0.4$ ,  $Q_{100}=1.0$ ) consists of flow from Basin D-18. This is the street flow which has been released into Akers Drive north of Fallow Lane. Flow is intercepted by an existing type R inlet, north of the Fallow Lane Intersection.
- Design Point H ( $Q_5=0.3$ ,  $Q_{100}=0.6$ ) consists of flow from Basins D-7, D-15 and D-19. This is flow from Fallow Lane and street flow from Akers Drive, between Fallow Lane and Running Deer Way. Runoff is intercepted by an existing type R inlet in Akers Drive, north of the Running Deer Way intersection.

See previous comments regarding this matter and update accordingly.

- Design Point I ( $Q_5=0.9$ ,  $Q_{100}=2.0$ ) consists of flow Basins D-11, D-17 and D-20. This is the flow from Running Deer Way and the flow released onto Akers Drive from the site south of Running Deer Way. An existing type R inlet, south of the Running Deer Way intersection will intercept these flows.
- Design Point NP ( $Q_5=12.4$ ,  $Q_{100}=30.7$ ) combines basin D-10 with flows from DP A, DP B, DP C, DP D and DP E. This is the flow being released into the North Pond.
- Design Point SP ( $Q_5=2.6$ ,  $Q_{100}=6.4$ ) combines basin D-16 with flows from DP F. This is the flow being released into the South Pond.

### Deviations

A deviation has been requested and approved for El Paso County ECM\_Appendix I Section I.7.1.B: 1st Bullet; Providing Water Quality for Entire Development.

Basins D-7, D-11, D-15 and D-17 thru D-20 all release into Akers Drive and are intercepted by existing inlets and will not reach an on-site water quality facility. These basins account for approximately 8% (0.94 acres of 11.56) of the overall site area. The remaining 92% of the development area is treated through 1 of the 2 proposed ponds.

The topography of the site will not allow all areas within the site to drain to the proposed ponds. Of the area inside the development boundary that will not reach a facility only 0.19 acres is proposed roadway, and 0.75 acres will be sloped areas at the back of lots along the exterior boundary.

## DRAINAGE FACILITY DESIGN

### General Concept

The Gardens at North Carefree is located

Review 1 comment: Include excerpt from previously approved report where this flow was provided.  
Review 2: Previous submittal indicated 55 cfs now its 104 cfs. Please provide excerpt from previously approved report where this flow is provided

### Storm Sewer System

All development is anticipated to be urban and will include storm sewer and street inlets. Two storm sewers collect storm water runoff and convey the runoff to the proposed ponds prior to discharging into the existing storm system offsite. The WQ outlet structures will connect to the existing inlets via proposed concrete culverts.

Storm System 1 will connect the set of sump inlets on the east leg of Vineyard Circle with the set of sump inlets on the west leg of Vineyard Circle. This system will release into the North Pond.

Storm System 2 will connect an at-grade inlet on the west leg of Vineyard Circle, just north of Running Deer Way. The system will release into the South Pond

### On-Site Water Quality

There are two proposed water quality facilities on site that will provide water quality for the proposed improvements, as well as full-spectrum detention. Flows will pass through the outlet structures of one of the two proposed ponds. The existing storm system was designed to account for a 100-year flow of 104 cfs from this development. This flow is shown in the StormCAD 100-year table for System Rational Flow, Filing 1 Flow in the "PDR-FDR for Mule Deer Crossing" excerpt prepared by URS. The two

south

Update the narrative to include at grade inlet and new storm lines at design point E.

I assume that the flows from akers drive listed are just from this development. If so please add: "from this development."

ponds, based on the UDFCD pond spreadsheets, have 100-year release rate of 6.2 cfs (South Pond is 3.3 cfs and North Pond is 2.9 cfs). The basins releasing offsite have a combined flow of 4.7 cfs. Flows in Akers Drive and the two ponds have a total combined flow of 10.9 cfs being captured in the existing storm system. Pond sizing calculations are provided in Appendix D.

The two ponds have been designed to act as water quality features, as well as provide detention. Previous reports stated that on-site detention would not be necessary, but with updated criteria, ponds were designed per the Full-spectrum detention requirements.

The WQCV is treated through two proposed extended detention basins, North Pond and South Pond. There are no proposed major drainageways for the site that would need to be stabilized. Some site-specific source control BMPs that will be implemented include, but are not limited to, silt fencing placed around downstream areas of disturbance, construction vehicle tracking pads at the entrances, designated concrete truck washout basin, designated vehicle fueling areas, covered storage areas, spill containment and control, etc.

Please state that the total flow from this development is less than what the existing system was designed for and also state that the existing storm system is adequate for this sites developed flow.

### **Temporary Sedimentation Basins**

The 2 ponds (North Pond and South Pond) will work as temporary sedimentation ponds, until final construction is complete.

### **Four Step Process**

In accordance with the El Paso County Engineering Criteria Manual, Appendix I, this site has implemented the four-step process to minimize adverse impacts of urbanization and helps with the management of smaller, frequently occurring events. The four-step process includes reducing runoff volumes, treating and slowly releasing the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls.

### **Reduce Runoff**

In order to reduce runoff volume, the new impervious area for the site was minimized. Existing features will be preserved as all of the offsite basins which are undeveloped open space will continue to be so, and all developable areas will be required to release existing flows. Existing drainage paths have been maintained as much as possible to also help reduce overall impacts from the site.

### **Treat & Release WQCV**

Full spectrum detention ponds.

The WQCV is treated through 2 separate water quality ponds. The outlet structures for both ponds have been designed according to the FSD spreadsheet by UDFCD to ensure the release times of the facilities meet the requirements.

### **Stabilize Stream Channels**

There are no proposed major drainageways for the site that would need to be stabilized. Downstream of the project, all flows enter into existing storm systems, which are adequate to handle existing released flows, which will be the case as both ponds are designed to release less than existing flows. Therefore, those downstream channel/facilities would also, not see any increase or adverse effects to their functionality.

### ***Implement Source Controls***

Some site-specific source control BMPs that will be implemented include, but are not limited to, silt fencing placed around downstream areas of disturbance, construction vehicle tracking pads at the entrances, sediment ponds, designated concrete truck washout basin, designated vehicle fueling areas, covered storage areas, spill containment and control, etc.

## **DRAINAGE FEES, COST ESTIMATE & MAINTENANCE**

### ***Maintenance***

The ponds will be maintained by the Gardens at North Carefree Metropolitan District. Facilities located within the project boundary will be private facilities and will also be maintained by the district. All facilities located outside of the project boundary and within public right-of-way, will be maintained by the county. A BMP maintenance agreement and easement will be provided for the ponds, as well as an Operations and Maintenance manual. The remaining utilities (gas, phone, electric, cable, etc.) will be owned and maintained by their respective companies. Easements will be issued to ensure each entity is able to access and maintain their facilities.

### ***Drainage Fees***

The proposed development falls within the Sand Creek Basin. The entire development occupies approximately 11.6 acres. The project consists of 2.66 acres of right-of-way, 6.84 acres of residential lots, and tracts of open space of 2.10 acres. The following calculations for the imperviousness of this development have been computed as follows:

Average Residential lot size: 6.84 acres / 70 lots = 4257 sf

Average lot imperviousness = 2200 sf

Average Residential Imperviousness 2200/4257 = 51.68%

R.O.W. area 2.66 acres; imperviousness 100 %

Open Space area 2.10 acres; imperviousness 0%

Average imperviousness for developed area:

$(0.5168 \times 6.84) + (1.0 \times 2.66) + (0 \times 2.10) / (11.6) = 0.5340 = 53.40\%$ . The impervious area that the fees will be based on is 6.19 acres (11.6 x 53.40%)

Drainage fees in the Sand Creek Basin are \$18,940 and bridge fees are \$5,559. The calculated fees due will be as follows:

Drainage Fees: \$117,289 (6.19 x \$18,940)

Bridge Fees: \$34,410 (6.19 x \$5,559)

## Proposed Facilities Estimate

ITEM	UNITS	UNIT COST	QUANTITY	ITEM COST
<b>GRADING AND EROSION CONTROL</b>				
CURB BACKFILL	LF	\$ 4.00	4650	\$ 18,600
TEMPORARY SEEDING	AC	\$ 485.00	2.5	\$ 1,213
TEMPORARY MULCHING	AC	\$ 507.00	2.5	\$ 1,268
EROSION BALES	EA	\$ 21.00	120	\$ 2,520
INLET PROTECTION	EA	\$ 153.00	9	\$ 1,377
VEHICLE TRACKING CONTROL	EA	\$ 2,000.00	2	\$ 4,000
CONCRETE WASHOUT BASIN	EA	\$ 776.00	1	\$ 776
SILT FENCING	LF	\$ 4.00	1,100	\$ 4,400
<b>SUBTOTAL GRADING &amp; EROSION CONTROL</b>				<b>\$ 34,154</b>
<b>DRAINAGE</b>				
18" RCP	LF	\$ 95.00	180	\$ 17,100
24" RCP	LF	\$ 140.00	28	\$ 2,920
30" RCP	LF	\$ 175.00	151	\$ 26,425
36" RCP	LF	\$ 225.00	32	\$ 28,160
42" RCP	LF	\$ 250.00	35	\$ 7,200
5' Type R Inlet	EA	\$ 4,500.00	1	\$ 4,500
15' Type R Inlet	EA	\$ 15,000.00	4	\$ 60,000
20' Type R Inlet	EA	\$ 20,000.00	1	\$ 20,000
Outlet Structure	EA	\$ 10,000.00	2	\$ 20,000
<b>SUBTOTAL DRAINAGE</b>				<b>\$ 186,305</b>
<b>SUBTOTAL DRAINAGE &amp; GRADING/EROSION CONTROL</b>				<b>\$ 220,459</b>
ENGINEERING (10%)				\$ 22,046
CONTINGENCY (25%)				\$ 55,115
<b>TOTAL</b>				<b>\$ 248,020</b>

## EROSION CONTROL

### General Concept

During construction, best management practices for erosion control will be employed based on El Paso County criteria and the erosion control plan. The erosion control plan is included at the end of this report.

Ditches will be designed to meet El Paso County criteria for slope and velocity, keeping velocities below scouring levels.

During construction, best management practices (BMP) for erosion control will be employed based on El Paso County Criteria. BMP's will be utilized as deemed necessary by contractor and/or engineer and are not limited to measure shown on construction drawing set. The contractor shall minimize amount of area disturbed during all construction activities.

In general, the following shall be applied in developing the sequence of major activities:

- Install downslope and sideslope perimeter BMP's before the land disturbing activity occurs.
- Do not disturb an area until it is necessary for the construction activity to proceed.
- Cover or stabilize as soon as possible.
- Time the construction activities to reduce the impacts from seasonal climatic changes or weather events.

- The construction of filtration BMP's should wait until the end of the construction project when upstream drainage areas have been stabilized.
- Do not remove temporary perimeter controls until after all upstream areas are stabilized.

### ***Silt Fence***

Silt fence will be placed along downstream limits of disturbed areas. This will prevent suspended sediment from leaving the site during infrastructure construction. Silt fencing is to remain in place until vegetation is reestablished.

### ***Erosion Bales***

Erosion bales will be placed ten (10) feet from the inlet of all culverts and inlets during construction to prevent culverts from filling with sediment. Erosion bales will remain in place until vegetation is reestablished in graded roadside ditches. Erosion bale ditch checks will be used on slopes greater than 1% to reduce flow velocities until vegetation is reestablished.

### ***Vehicle Tracking Control***

This BMP is used to stabilize construction entrances, roads, parking areas and staging areas to prevent the tracking of sediment from the construction site. A vehicle tracking control (VTC) is to be used at all locations where vehicles exit the construction site onto public roads, loading and unloading areas, storage and staging areas, where construction trailers are to be located, any construction area that receives high vehicular traffic, construction roads and parking areas. VTC's should not be installed in areas where soils erode easily or are wet.

### ***Sedimentation Pond***

This BMP is used to detain runoff which has become laden with sediment long enough to allow the sediment to settle out. As the construction area is larger than 1 acre, a temporary sediment basin is required per Volume 2 of the Drainage Criteria Manual.

## **SUMMARY**

Development within the site is to be single family residential. The existing storm sewer will connect to the new water quality facilities, allowing flows to continue as they currently are.

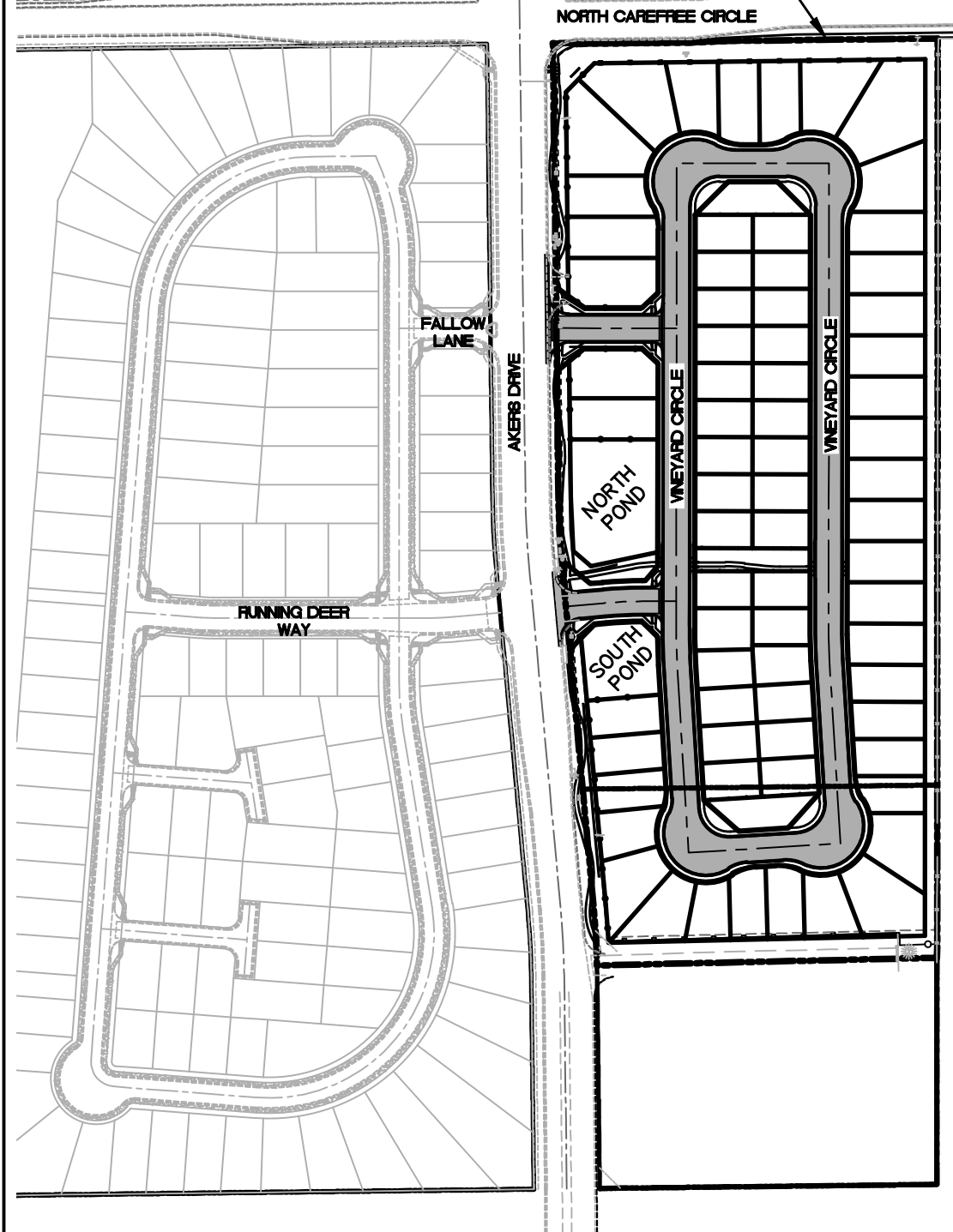


## REFERENCE MATERIALS

1. "City of Colorado Springs Drainage Criteria Manual Volume 1" May 2014.
2. Soils Survey of El Paso County Area, Natural Resources Conservation Services of Colorado.
3. Flood Insurance Rate Study for El Paso County, Colorado and Incorporated Areas. Federal Emergency Management Agency, Revised March 17, 1997.
4. "City of Colorado Springs Drainage Criteria Manual, Volume 2: Stormwater Quality Policies, Procedures and Best Management Practices (BMPs)" May 2014.
5. "Engineering Criteria Manual El Paso County" January 9, 2006, Revised December, 2016.
6. "Urban Storm Drainage Criteria Manual, Volume 1: Management, Hydrology & Hydraulics" Original September 1969, Updated January 2016.
7. "Urban Storm Drainage Criteria Manual, Volume 2: Structures, Storage & Recreation" Original September 1969, Updated January 2016.
8. "Urban Storm Drainage Criteria Manual, Volume 3: Stormwater Quality" Original September 1992, Updated November 2010.
9. "Sand Creek Drainage Basin Planning Study Preliminary Design Report", Kiowa Engineering Corporation.
10. "Master Development Drainage Plan for Hilltop Subdivision" Revised February 1998. Prepared by URS Greiner, Inc
11. Final Drainage Report and Erosion Control for Chateau at 
12. "Final Drainage Report for Mule Deer Filing 1, Lots 1 & 2 and Preliminary Drainage Report for Mule Deer Filing 1, Lots 3-46" January 2004. Prepared by URS.
13. "Preliminary Drainage Report for Mule Deer Business Park" January 2005. Prepared by URS.
14. "Final Drainage Report for Mule Deer Business Park" April 2005. Prepared by URS.
15. "Preliminary/Final Drainage Report for Mule Deer Crossing" May 2005. Prepared by URS.
16. "Final Drainage Report for Mule Deer Crossing" December 2005. Prepared by URS.

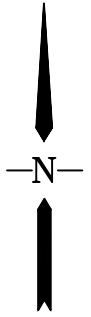
**Figure 1: Vicinity Map**

GARDENS AT NORTH CAREFREE BOUNDARY



V:\52876\ACTIVE\187608744\MULE DEER\REPORTS\DRAINAGE\EXHIBITS\FDR\FIG01-VMAP.DWG  
8/1/2019 2:44 PM

JANUARY, 2019  
187608744



5725 MARK DABLING BLVD, SUITE 190  
COLORADO SPRINGS, CO 80919  
www.stantec.com

Client/Project  
MULE DEER INVESTMENTS, LLC  
GARDENS AT NORTH CAREFREE

Figure No.  
1.0  
Title  
VICINITY MAP

## **Appendix A: NRCS Soil Report**



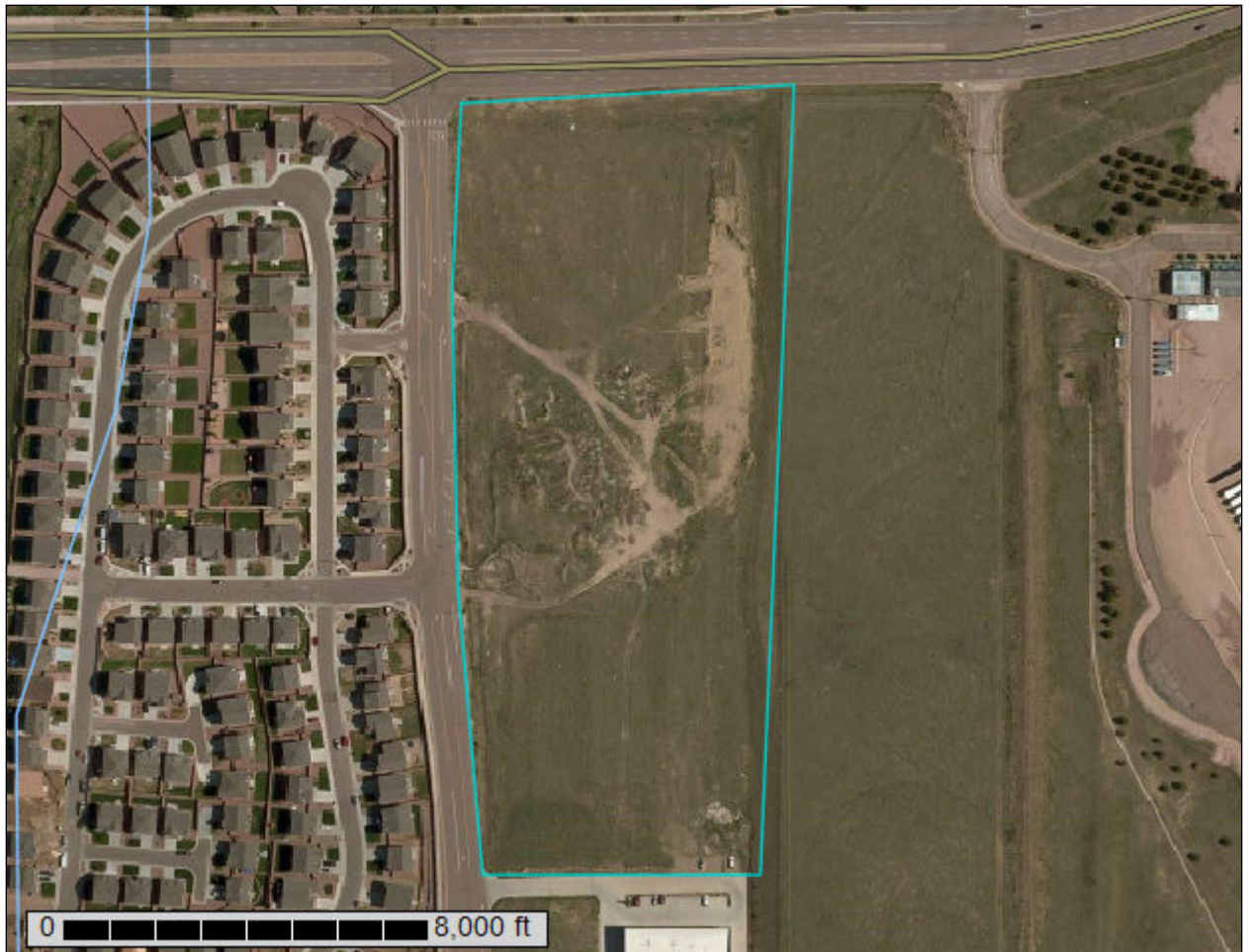
United States  
Department of  
Agriculture

**NRCS**

Natural  
Resources  
Conservation  
Service

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

# Custom Soil Resource Report for El Paso County Area, Colorado



# Preface

---

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (<http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/>) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (<https://offices.sc.egov.usda.gov/locator/app?agency=nrcs>) or your NRCS State Soil Scientist ([http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2\\_053951](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951)).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

# Contents

---

<b>Preface</b> .....	2
<b>Soil Map</b> .....	5
Soil Map.....	6
Legend.....	7
Map Unit Legend.....	8
Map Unit Descriptions.....	8
El Paso County Area, Colorado.....	10
97—Truckton sandy loam, 3 to 9 percent slopes.....	10
<b>References</b> .....	12



# Soil Map

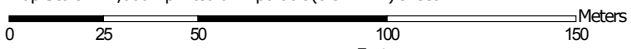
---

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

# Custom Soil Resource Report Soil Map














Map Scale: 1:2,000 if printed on A portrait (8.5" x 11") sheet.



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

## MAP LEGEND

<b>Area of Interest (AOI)</b>	 Area of Interest (AOI)	 Spoil Area
<b>Soils</b>	 Soil Map Unit Polygons	 Stony Spot
	 Soil Map Unit Lines	 Very Stony Spot
	 Soil Map Unit Points	 Wet Spot
<b>Special Point Features</b>	 Blowout	 Other
	 Borrow Pit	 Special Line Features
	 Clay Spot	<b>Water Features</b>
	 Closed Depression	 Streams and Canals
	 Gravel Pit	<b>Transportation</b>
	 Gravelly Spot	 Rails
	 Landfill	 Interstate Highways
	 Lava Flow	 US Routes
	 Marsh or swamp	 Major Roads
	 Mine or Quarry	 Local Roads
	 Miscellaneous Water	<b>Background</b>
	 Perennial Water	 Aerial Photography
	 Rock Outcrop	
	 Saline Spot	
	 Sandy Spot	
	 Severely Eroded Spot	
	 Sinkhole	
	 Slide or Slip	
	 Sodic Spot	

## 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 14, Sep 23, 2016

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

El Paso County Area, Colorado (CO625)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
97	Truckton sandy loam, 3 to 9 percent slopes	11.5	100.0%
<b>Totals for Area of Interest</b>		<b>11.5</b>	<b>100.0%</b>

## Map Unit Descriptions

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

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

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

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

## Custom Soil Resource Report

onsite investigation is needed to define and locate the soils and miscellaneous areas.

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

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

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

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

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

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

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

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

## El Paso County Area, Colorado

### 97—Truckton sandy loam, 3 to 9 percent slopes

#### Map Unit Setting

*National map unit symbol:* 36bg  
*Elevation:* 6,000 to 7,000 feet  
*Mean annual precipitation:* 14 to 16 inches  
*Mean annual air temperature:* 46 to 50 degrees F  
*Frost-free period:* 125 to 145 days  
*Farmland classification:* Not prime farmland

#### Map Unit Composition

*Truckton and similar soils:* 80 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Truckton

##### Setting

*Landform:* Hills  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Arkosic alluvium derived from sedimentary rock and/or arkosic residuum weathered from sedimentary rock

##### Typical profile

*A - 0 to 8 inches:* sandy loam  
*Bt - 8 to 24 inches:* sandy loam  
*C - 24 to 60 inches:* coarse sandy loam

##### Properties and qualities

*Slope:* 3 to 9 percent  
*Depth to restrictive feature:* More than 80 inches  
*Natural drainage class:* Well drained  
*Runoff class:* Low  
*Capacity of the most limiting layer to transmit water (Ksat):* High (1.98 to 6.00 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water storage in profile:* Low (about 5.7 inches)

##### Interpretive groups

*Land capability classification (irrigated):* 4e  
*Land capability classification (nonirrigated):* 6e  
*Hydrologic Soil Group:* A  
*Ecological site:* Sandy Foothill (R049BY210CO)  
*Hydric soil rating:* No

#### Minor Components

##### Pleasant

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

## Custom Soil Resource Report

### **Haplaquolls**

*Percent of map unit:*

*Landform:* Marshes

*Hydric soil rating:* Yes

### **Other soils**

*Percent of map unit:*

*Hydric soil rating:* No

## **Appendix B: Existing Hydrology Calculations**



**Standard Form SF-1 . Time of Concentration**

Project: Gardens at North Carefree  
 Section: Existing Conditions

Created by: CMD  
 Checked by: CKC

Date: 1/13/2017  
 Date:

Urban TOC<sub>min</sub> = 5 min  
 Rural TOC<sub>min</sub> = 10 min

Basin ID	SUB-BASIN DATA				INITIAL/OVERLAND FLOW (t <sub>i</sub> )							TRAVEL TIME (t <sub>t</sub> )							Tc CHECK (Urbanized basins)			FINAL Tc (min)
	Description	C <sub>s</sub>	Area (ac)	Length, L (ft)	Slope, s (ft/ft)	t <sub>i</sub> (min)	Type of Land Surface		Convey Coef (C <sub>c</sub> ) (2)	Velocity (V) (ft/s) (3)	t <sub>t</sub> Travel Time (min) (4)	TOTAL t <sub>c</sub> = t <sub>i</sub> + t <sub>t</sub> (min)	Urban (Yes/No)	Length (ft)	T <sub>c,max</sub> (min) (5)	T <sub>c,max</sub> > t <sub>c</sub>						
							Code	Description									S <sub>w</sub> (ft/ft)	Length (ft)				
OS-1	Offsite Basin @ East Side	0.08	2.25	100	0.035	12.18	0.0455	4	10.00	2.13	4.34	16.52	NO	655.00	13.64	Check	16.5					
E-1	North portion of site	0.08	5.41	45	0.333333	3.88	0.0171	4	10.00	1.31	12.68	16.57	NO	1040.00	15.78	Check	16.6					
E-2	South of E-1	0.08	0.61	30	0.33333	3.17	0.0295	4	10.00	1.72	2.96	6.13	NO	335.00	11.86	Check	6.1					
E-3	South of E-2	0.08	1.59	40	0.333333	3.66	0.0319	4	10.00	1.79	4.39	8.05	NO	510.00	12.83	Check	8.0					
E-4	South of E-3	0.08	1.28	50	0.333333	4.09	0.0270	4	10.00	1.64	3.75	7.85	NO	420.00	12.33	Check	7.8					
E-5	South of E-1 and West of E-2	0.08	0.36	5	0.5	1.13	0.0296	4	10.00	1.72	1.31	2.44	NO	140.00	10.78	Check	5.0					
E-6	South of E-4 and along Akers Dr	0.08	1.55	55	0.333333	4.29	0.0366	4	10.00	1.91	3.57	7.87	NO	465.00	12.58	Check	7.9					
E-7	South of E-5 and West of E-3	0.08	0.10	5	0.5	1.13	0.0545	4	10.00	2.34	0.39	1.52	NO	60.00	10.33	Check	5.0					
E-9	West of E-7	0.08	0.05	5	0.3333	1.29	0.3333	4	10.00	5.77	0.09	1.38	NO	35.00	10.19	Check	5.0					
E-10	South portion of Site along Private Driveway	0.08	0.51	15	0.5	1.96	0.0381	4	10.00	1.95	0.90	2.86	NO	120.00	10.67	Check	5.0					

Notes:

All Equations are from UDFCD Drainage Criteria Manual/Runoff

(1)  $t_i = (0.395 \cdot (1.1 - C_s) \cdot L^{0.5}) / (S^{0.33})$ , from UDFCD Equation RO-3

(2) Cv from UDFCD Table RO-2

(3) Velocity from  $V = C_c \cdot S_w^{0.5}$ , from UDFCD Equation RO-4

(4)  $t_t = L / 60V$

(5)  $t_{c,max} = 10 + L / 180$ , from UDFCD Eqn RO-5

Code	Description	Cv
1	Heavy meadow	2.5
2	Tillage/field	5
3	Short pasture and lawns	7
4	Nearly bare ground	10
5	Grassed waterway	15
6	Paved areas and shallow paved swales	20
*7	Riprap (not buried)	7.0

\* determined for the project based on UDFCD equations (E equation RO-4)

**Standard Form SF-2 . Storm Drainage System Design (Rational Method Procedure)**

Project: Gardens at North Carefree  
 Section: Existing Conditions

Created by: CMD Date: 1/13/2017  
 Checked by: CKC Date:

Design Storm: 5-yr P = 1.50 in

LOCATION	AREA DESIGN			DIRECT RUNOFF			TOTAL RUNOFF				STREET			PIPE			TRAVEL TIME			REMARKS	
	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)		(22)
(1)																					
Offsite Basin @ East Side	OS-1	2.25	0.08	16.52	0.18	3.25	0.59														
North portion of site	E-1	5.41	0.08	16.57	0.43	3.25	1.41														
South of E-1	E-2	0.61	0.08	6.13	0.05	4.81	0.23														
South of E-2	E-3	1.59	0.08	8.05	0.13	4.40	0.56														
South of E-3	E-4	1.28	0.08	7.85	0.10	4.44	0.46														
South of E-1 and West of E-2	E-5	0.36	0.08	5.00	0.03	5.09	0.15														
South of E-4 and along Akers Dr	E-6	1.55	0.08	7.87	0.12	4.43	0.55														
South of E-5 and West of E-3	E-7	0.10	0.08	5.00	0.01	5.09	0.04														
West of E-7	E-9	0.05	0.08	5.00	0.00	5.09	0.02														
South portion of Site along Private Driveway	E-10	0.51	0.08	5.00	0.04	5.09	0.21														

**Standard Form SF-2 . Storm Drainage System Design (Rational Method Procedure)**

Project: Gardens at North Carefree  
 Section: Existing Conditions

Created by: CMD Date: 1/13/2017  
 Checked by: CKC Date:

Design Storm: 100-yr P = 2.52 in

LOCATION	BASIN ID	DIRECT RUNOFF				TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS		
		AREA (A) (AC)	RUNOFF COEFF (C)	t <sub>d</sub> (MIN)	C.A. (AC)	I (IN / HR)	Q (CFS)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	SLOPE (%)	SLOPE (%)	DESIGN FLOW (CFS)	PIPE SLOPE (%)	PIPE SIZE (INCHES)	LENGTH (FT)	VELOCITY (FPS)		t <sub>t</sub> (MIN)	
	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
Offsite Basin @ East Side	OS-1	2.25	0.35	16.52	0.79	5.46	4.30													
North portion of site	E-1	5.41	0.35	16.57	1.89	5.45	10.33													
South of E-1	E-2	0.61	0.35	6.13	0.21	8.07	1.72													
South of E-2	E-3	1.59	0.35	8.05	0.56	7.39	4.11													
South of E-3	E-4	1.28	0.35	7.85	0.45	7.46	3.35													
South of E-1 and West of E-2	E-5	0.36	0.35	5.00	0.13	8.55	1.08													
South of E-4 and along Akers Dr	E-6	1.55	0.35	7.87	0.54	7.45	4.03													
South of E-5 and West of E-3	E-7	0.10	0.35	5.00	0.03	8.55	0.29													
West of E-7	E-9	0.05	0.35	5.00	0.02	8.55	0.14													
South portion of Site along Private Driveway	E-10	0.51	0.35	5.00	0.18	8.55	1.52													

All Equations follow UDFCD Rational Method

- (1) Basin Description linked to C-Value Sheet
- (2) Basin Design Point
- (3) Enter the Basin Name from C-Value Sheet
- (4) Basin Area linked to C-Value Sheet
- (5) Composite C linked to C-Value Sheet
- (6) Time of Concentration linked to SF-1 Sheet
- (7) = Column 4 x Column 5
- (8) = 28.5\*P/(10+Column 6)^0.786
- (9) = Column 7 x Column 8
- (10) = Column 6 + Column 21
- (11) Add the C.A. Values Column 7 to get the cumulative C.A. Values
- (12) = 28.5\*P/(10+Column 10)^0.786
- (13) Sum of Qs
- (14) Additional Street Longitudinal Slope
- (15) Additional Street Overland Flow
- (16) Additional Pipe Design Flow
- (17) Additional Pipe Slope
- (18) Additional Pipe Size
- (19) Additional Flow Length
- (20) Street or Pipe Velocity
- (21) = Column 15 OR Column 16 OR Column 20 / 60

## GARDENS AT NORTH CAREFREE SURFACE ROUTING

DESIGN POINT	CONTRIBUTING BASINS	CA (equivalent)		Tc (min.)	INTENSITY		TOTAL FLOWS		
		CA(5)	CA(100)		I(5) (in/hr)	I(100) (in/hr)	Q(5) (cfs)	Q(100) (cfs)	
Z	OS-1	0.18	0.79	16.5	3.2	5.6	0.6	4.4	
		TRAVEL TIME							
		0.18	0.79	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
			Channel	510	3.5	2.4	18.9		
A	E-1	0.43	1.89	16.6	3.2	5.6	1.4	10.6	
		TRAVEL TIME							
		0.43	1.89	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
					3.5	0.0	16.6		
B	E-2	0.05	0.21	6.1	4.9	8.5	0.2	1.8	
		TRAVEL TIME							
		0.05	0.21	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
			PIPE	25	4.4	0.1	6.2		
D	E-4	0.10	0.45	7.8	4.5	7.8	0.5	3.5	
		TRAVEL TIME							
		0.10	0.45	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
			CHANNEL	65	2.8	0.4	8.2		
C	E-3 DP D DP Z	0.13	0.56	18.9	3.0	5.2	1.2	9.4	
		0.10	0.45	TRAVEL TIME					
		0.18	0.79	TRAVEL TIME					
		0.41	1.79	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
				0	4.4	0.0	18.9		
E	E-5 DP B	0.03	0.13	6.2	4.8	8.5	0.4	2.9	
		0.05	0.21	TRAVEL TIME					
		0.08	0.34	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
			PIPE	15	5.0	0.1	6.3		
F	E-6	0.12	0.54	7.9	4.5	7.8	0.6	4.2	
		TRAVEL TIME							
		0.12	0.54	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
				270	4.4	1.0	8.9		
G	E-7 DP E	0.01	0.03	6.3	4.8	8.4	0.4	3.2	
		0.08	0.34	TRAVEL TIME					
		0.09	0.37	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
			PIPE	15	5.0	0.1	6.3		
H	D-9 DP C DP G	0.00	0.02	18.9	3.0	5.2	1.5	11.4	
		0.41	1.79	TRAVEL TIME					
		0.09	0.37	TRAVEL TIME					
		0.50	2.18	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
			PIPE	15	5.0	0.1	19.0		
I	E-10	0.04	0.18	5.0	5.2	9.1	0.2	1.6	
		TRAVEL TIME							
		0.04	0.18	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
			PIPE	15	5.0	0.1	5.1		

## Appendix C: Proposed Hydrology Calculations

**Standard Form SF-1 . Time of Concentration**

Project: Gardens at North Carefree - FDR  
 Section: Proposed Conditions

Urban TOC<sub>min</sub> = 5 min  
 Rural TOC<sub>min</sub> = 10 min

Created by: CMD  
 Checked by: CKC

Date: 1/16/2019  
 Date:

Basin ID	Description	INITIAL/OVERLAND FLOW (t)				TRAVEL TIME (t)						Tc CHECK (Urbanized basins)			FINAL Tc (min)			
		C <sub>5</sub>	Area (ac)	Length, L (ft)	Slope, s (ft/ft)	t <sub>i</sub> (min)	S <sub>w</sub> (ft/ft)	Type of Land Surface		Convey Coef (C <sub>v</sub> ) (2)	Velocity (V) (ft/s) (3)	t <sub>t</sub> Travel Time (min) (4)	TOTAL t <sub>c</sub> = t <sub>i</sub> + t <sub>t</sub> (min)	Urban (Yes/No)		Length (ft)	T <sub>c</sub> max (min) (5)	T <sub>c</sub> max > t <sub>c</sub>
								Code	Description									
OS-1	Offsite Basin @ East Side releases to D-20	0.08	0.26	100	0.035	12.18	0.0455	4	Nearly bare ground	10.00	2.13	1.17	13.35	YES	250.00	11.39	Check	13.4
OS-2	Offsite Basin @ East Side releases to D-13	0.08	0.27	100	0.035	12.18	0.0455	4	Nearly bare ground	10.00	2.13	1.76	13.94	YES	325.00	11.81	Check	13.9
OS-3	Offsite Basin @ East Side releases to D-2	0.08	1.63	100	0.035	12.18	0.0444	4	Nearly bare ground	10.00	2.11	3.80	15.98	YES	580.00	13.22	Check	16.0
OS-4	Offsite Basin @ East Side releases to D-1	0.08	0.07	86	0.040	10.81		4	Nearly bare ground	10.00	0.00	0.00	10.81	YES	86.00	10.48	Check	10.8
D-1	East portion of Site btwn North half of Vineyard and East Boundary	0.45	1.24	100	0.062	6.43	0.0132	6	Paved areas and shallow paved swales	20.00	2.30	2.78	9.21	YES	483.00	12.68	Check	9.2
D-2	East portion of Site btwn South half of Vineyard and East Boundary	0.45	0.99	100	0.060	6.50	0.0055	6	Paved areas and shallow paved swales	20.00	1.48	3.48	9.98	YES	410.00	12.28	Check	10.0
D-3	South/Middle portion of Site inside of Vineyard Circle which drains to east	0.45	0.17	6	0.020	2.29	0.0055	6	Paved areas and shallow paved swales	20.00	1.48	3.48	5.77	YES	316.00	11.76	Check	5.8
D-4	North/Middle portion of Site inside of Vineyard Circle which drains to east	0.45	0.21	5	0.020	2.09	0.0132	6	Paved areas and shallow paved swales	20.00	2.30	2.94	5.03	YES	410.00	12.28	Check	5.0
D-5	North portion of site, along Carefree Circle	0.45	2.03	100	0.064	6.36	0.0190	6	Paved areas and shallow paved swales	20.00	2.76	2.72	9.08	YES	550.00	13.06	Check	9.1
D-6	East Half of Fallow Lane which drains to Vineyard Circle	0.90	0.08	25	0.020	1.44	0.0200	6	Paved areas and shallow paved swales	20.00	2.83	0.24	1.67	YES	65.00	10.36	Check	5.0
D-7	Southwest Half of Fallow Lane which drains to Akers	0.90	0.04	5	0.020	0.64	0.0450	6	Paved areas and shallow paved swales	20.00	4.24	0.31	0.96	YES	85.00	10.47	Check	5.0
D-8	North/Middle portion of Site inside of Vineyard Circle which drains to west	0.45	1.90	58	0.020	7.11	0.0190	6	Paved areas and shallow paved swales	20.00	2.76	2.96	10.07	YES	548.00	13.04	Check	10.1
D-9	Portion of site south of Fallow and btwn Akers and Vineyard	0.45	0.52	100	0.027	8.46	0.0190	6	Paved areas and shallow paved swales	20.00	2.76	0.60	9.06	YES	200.00	11.11	Check	9.1
D-10	North Pond	0.32	0.33	100	0.027	10.15		6	Paved areas and shallow paved swales	20.00	0.00	0.00	10.15	YES	100.00	10.56	Check	10.1
D-11	North half of Running Deer Way	0.90	0.07	20	0.020	1.28	0.0600	6	Paved areas and shallow paved swales	20.00	4.90	0.36	1.64	YES	125.00	10.69	Check	5.0
D-12	South/Middle portion of Site inside of Vineyard Circle which drains to west	0.45	0.93	30	0.020	5.11	0.0380	6	Paved areas and shallow paved swales	20.00	3.90	1.26	6.37	YES	325.00	11.81	Check	6.4
D-13	Southern portion of site along Sika Deer Place and Akers	0.45	1.38	90	0.060	6.16	0.0380	6	Paved areas and shallow paved swales	20.00	3.90	2.01	8.17	YES	560.00	13.11	Check	8.2
D-14	Along eastern Edge of Vineyard (West Side) opposite North Pond	0.45	0.64	100	0.056	6.65	0.0190	6	Paved areas and shallow paved swales	20.00	2.76	0.67	7.31	YES	210.00	11.17	Check	7.3
D-15	Northwest Half of Fallow Lane which drains to Akers	0.45	0.04	25	0.020	4.67	0.0450	6	Paved areas and shallow paved swales	20.00	4.24	0.31	4.98	YES	105.00	10.58	Check	5.0

Basin ID	Offsite Basin @ East Side releases to D-20				INITIAL/OVERLAND FLOW				TRAVEL TIME (t <sub>t</sub> )					Tc CHECK (Urbanized basins)				FINAL Tc (min)	
	Description	C <sub>s</sub>	Area (ac)	Length, L (ft)	Slope, s (ft/ft)	t <sub>t</sub> (min)	Length (ft)	S <sub>w</sub> (ft/ft)	Type of Land Surface			t <sub>t</sub> Travel Time (min) (4)	TOTAL	Urban (Yes/No)	Length (ft)	T <sub>c</sub> max (min) (5)	T <sub>c</sub> max > t <sub>t</sub>		
									Code	Description	Convey Coef (C <sub>v</sub> ) (2)								Velocity (V) (ft/s) (3)
D-16	South Pond	0.32	0.15	25	0.250	2.43					20.00	0.00	0.00	2.43	YES	25.00	10.14	Check	5.0
D-17	South half of Running Deer Way	0.90	0.08	10	0.020	0.91	75	0.0600			20.00	4.90	0.26	1.16	YES	85.00	10.47	Check	5.0
D-18	ROW north of Fallow which drains towards Akers	0.45	0.19	55	0.091	4.20	285	0.0200			20.00	2.83	1.68	5.88	YES	340.00	11.89	Check	5.9
D-19	ROW bwn Fallow & Running Deer which drains towards Akers	0.45	0.11	5	0.333	0.83					20.00	0.00	0.00	0.83	YES	5.00	10.03	Check	5.0
D-20	ROW south of Running Deer which drains towards Akers	0.45	0.41	45	0.333	2.47	720	0.0236			20.00	3.07	3.90	6.38	YES	765.00	14.25	Check	6.4

Notes:

- All Equations are from UDFCD Drainage Criteria Manual/Runoff
- (1)  $t_t = (0.395 \cdot (L - C_s) \cdot (L + 0.5)) / (S \cdot 0.33)$ , from UDFCD Equation RO-3
- (2) Cv from UDFCD Table RO-2
- (3) Velocity from  $V = C_v \cdot S_w^{0.5}$ , from UDFCD Equation RO-4
- (4)  $t_t = L/60V$
- (5)  $t_t \text{ max} = 10 \cdot L/180$ , from UDFCD Eqn RO-5

UDFCD Table RO-2 Land Surface Coefficients

Code	Description	Cv
1	Heavy meadow	2.5
2	Tillage/field	5
3	Short pasture and lawns	7
4	Nearly bare ground	10
5	Grassed waterway	15
6	Paved areas and shallow paved swales	20
*7	Riprap (not buried)	7.0

\* determined for the project based on UDFCD equations (Equation RO-4)

**Standard Form SF-2 - Storm Drainage System Design (Rational Method Procedure)**

Project: Gardens at North Carefree - FDR  
 Section: Proposed Conditions

Created by: CMD Date: 1/16/2019  
 Checked by: CKC Date:

Design Storm: 5-yr P = 1.50 in

LOCATION	AREA DESIGN				DIRECT RUNOFF				TOTAL RUNOFF				STREET			PIPE			TRAVEL TIME			REMARKS
	AREA (A)	AREA (AC)	RUNOFF (C)	t (MIN)	CA (AC)	I (IN / HR)	Q (CFS)	t (MIN)	SUM (C+A)	I (IN / HR)	Q (CFS)	SLOPE (%)	SLOPE (%)	DESIGN FLOW (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (INCHES)	LENGTH (FT)	VELOCITY (FPS)	t (MIN)		
	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)		
Offsite Basin @ East Side releases to D-20	OS-1	0.26	0.08	13.35	0.02	3.59	0.08															
Offsite Basin @ East Side releases to D-13	OS-2	0.27	0.08	13.94	0.02	3.52	0.08															
Offsite Basin @ East Side releases to D-2	OS-3	1.63	0.08	15.98	0.13	3.30	0.43															
Offsite Basin @ East Side releases to D-1	OS-4	0.07	0.08	10.81	0.01	3.93	0.02															
East portion of Site btwn North half of Vineyard and East Boundary	D-1	1.24	0.45	9.21	0.56	4.19	2.34															
East portion of Site btwn South half of Vineyard and East Boundary	D-2	0.99	0.45	9.98	0.45	4.06	1.81															
South/Middle portion of Site inside of Vineyard Circle which drains to east	D-3	0.17	0.45	5.77	0.08	4.89	0.37															
North/Middle portion of Site inside of Vineyard Circle which drains to east	D-4	0.21	0.45	5.03	0.09	5.08	0.48															
North portion of site, along Carefree Circle	D-5	2.03	0.45	9.08	0.91	4.21	3.55															
East Half of Fallow Lane which drains to Vineyard Circle	D-6	0.08	0.90	5.00	0.07	5.09	0.37															
Southwest Half of Fallow Lane which drains to Akers	D-7	0.04	0.90	5.00	0.04	5.09	0.18															
North/Middle portion of Site inside of Vineyard Circle which drains to west	D-8	1.90	0.45	10.07	0.86	4.05	3.46															
Portion of site south of Fallow and btwn Akers and Vineyard	D-9	0.52	0.45	9.06	0.23	4.21	0.99															
North Pond	D-10	0.33	0.32	10.15	0.11	4.03	0.43															
North half of Running Deer Way	D-11	0.07	0.90	5.00	0.06	5.09	0.32															
South/Middle portion of Site inside of Vineyard Circle which drains to west	D-12	0.93	0.45	6.37	0.42	4.75	1.99															
Southern portion of site along Sika Deer Place and Akers	D-13	1.72	0.45	8.17	0.77	4.38	3.39															
Along eastern Edge of Vineyard (West Side) opposite North Pond	D-14	0.64	0.45	7.31	0.29	4.55	1.31															
Northwest Half of Fallow Lane which drains to Akers	D-15	0.04	0.45	5.00	0.02	5.09	0.09															



**Standard Form SF-2 . Storm Drainage System Design (Rational Method Procedure)**

Project: Gardens at North Carefree - FDR

Section: Proposed Conditions

Created by: CMD Date: 1/16/2019

Checked by: CKC Date:

	D-16	0.13	0.32	5.00	0.04	5.09	0.21													
South Pond	D-16	0.13	0.32	5.00	0.04	5.09	0.21													
South half of Running Deer Way	D-17	0.08	0.90	5.00	0.07	5.09	0.37													
ROW north of Fallow which drains towards Akers	D-18	0.19	0.45	5.88	0.09	4.86	0.42													
ROW btwn Fallow & Running Deer which drains towards Akers	D-19	0.11	0.45	5.00	0.05	5.09	0.25													
ROW south of Running Deer which drains towards Akers	D-20	0.41	0.45	6.38	0.18	4.75	0.88													

**Standard Form SF-2 - Storm Drainage System Design (Rational Method Procedure)**

Project: Gardens at North Carefree - FDR  
 Section: Proposed Conditions

Created by: CMD Date: 1/16/2019  
 Checked by: CKC Date:

Design Storm: 100-yr P = 2.52 in

LOCATION	BASIN ID	DIRECT RUNOFF				TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS		
		AREA (A) (AC)	RUNOFF COEFF (C)	t (MIN)	CA (AC)	I (IN / HR)	Q (CFS)	SUM (C+A) (AC)	I (IN / HR)	Q (CFS)	SLOPE (%)	STREET SLOPE (%)	DESIGN FLOW (CFS)	FLOW (CFS)	PIPE SIZE (INCHES)	LENGTH (FT)	VELOCITY (FPS)		t (MIN)	
	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
Offsite Basin @ East Side releases to D-20	OS-1	0.26	0.35	13.35	0.09	6.04	0.56													
Offsite Basin @ East Side releases to D-13	OS-2	0.27	0.35	13.94	0.10	5.92	0.57													
Offsite Basin @ East Side releases to D-2	OS-3	1.63	0.35	15.98	0.57	5.55	3.17													
Offsite Basin @ East Side releases to D-1	OS-4	0.07	0.35	10.81	0.03	6.61	0.17													
East portion of Site btwn North half of Vineyard and East Boundary	D-1	1.24	0.59	9.21	0.73	7.04	5.15													
East portion of Site btwn South half of Vineyard and East Boundary	D-2	0.99	0.59	9.98	0.58	6.82	3.99													
South/Middle portion of Site inside of Vineyard Circle which drains to east	D-3	0.17	0.59	5.77	0.10	8.22	0.82													
North/Middle portion of Site inside of Vineyard Circle which drains to east	D-4	0.21	0.59	5.03	0.12	8.54	1.06													
North portion of site, along Carefree Circle	D-5	2.03	0.59	9.08	1.20	7.07	8.47													
East Half of Fallow Lane which drains to Vineyard Circle	D-6	0.08	0.96	5.00	0.08	8.55	0.66													
Southwest Half of Fallow Lane which drains to Akers	D-7	0.04	0.96	5.00	0.04	8.55	0.33													
North/Middle portion of Site inside of Vineyard Circle which drains to west	D-8	1.90	0.59	10.07	1.12	6.80	7.62													
Portion of site south of Fallow and btwn Akers and Vineyard	D-9	0.52	0.59	9.06	0.31	7.08	2.17													
North Pond	D-10	0.33	0.51	10.15	0.17	6.78	1.14													
North half of Running Deer Way	D-11	0.07	0.96	5.00	0.07	8.55	0.57													
South/Middle portion of Site inside of Vineyard Circle which drains to west	D-12	0.93	0.59	6.37	0.55	7.98	4.38													
Southern portion of site along Sika Deer Place and Akers	D-13	1.72	0.59	8.17	1.01	7.35	7.46													
Along eastern Edge of Vineyard (West Side) opposite North Pond	D-14	0.64	0.59	7.31	0.38	7.64	2.88													
Northwest Half of Fallow Lane which drains to Akers	D-15	0.04	0.59	5.00	0.02	8.55	0.20													

**Standard Form SF-2 . Storm Drainage System Design (Rational Method Procedure)**

Project: Gardens at North Carefree - FDR

Section: Proposed Conditions

Created by: CMD Date: 1/16/2019

Checked by: CKC Date:

South Pond	D-16	0.13	0.51	5.00	0.07	8.55	0.57													
South half of Running Deer Way	D-17	0.08	0.96	5.00	0.08	8.55	0.66													
ROW north of Fallow which drains towards Akers	D-18	0.19	0.59	5.88	0.11	8.17	0.92													
ROW btwn Fallow & Running Deer which drains towards Akers	D-19	0.11	0.59	5.00	0.06	8.55	0.55													
ROW south of Running Deer which drains towards Akers	D-20	0.41	0.59	6.38	0.24	7.98	1.93													

All Equations follow UDFCD Rational Method

- (1) Basin Description linked to C-Value Sheet
- (2) Basin Design Point
- (3) Enter the Basin Name from C-Value Sheet
- (4) Basin Area linked to C-Value Sheet
- (5) Composite C linked to C-Value Sheet
- (6) Time of Concentration linked to SF-1 Sheet
- (7) =Column 4 x Column 5
- (8) =28.5^P/((10+Column 6)^0.786
- (9) =Column 7 x Column 8
- (10) =Column 6 + Column 21
- (11) Add the C.A. Values Column 7 to get the cumulative C.A. Values
- (12) =28.5^P/((10+Column 10)^0.786
- (13) Sum of Qs
- (14) Additional Street Longitudinal Slope
- (15) Additional Street Overland Flow
- (16) Additional Pipe Design Flow
- (17) Additional Pipe Slope
- (18) Additional Pipe Size
- (19) Additional Flow Length
- (20) Street or Pipe Velocity
- (21) =Column 15 OR Column 16 OR Column 20 / 60

## GARDENS AT NORTH CAREFREE - FDR SURFACE ROUTING

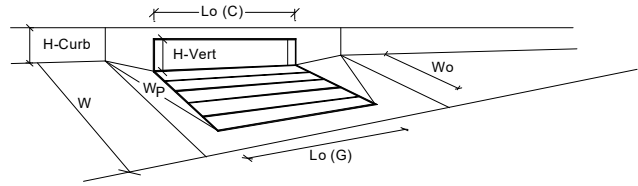
DESIGN POINT	CONTRIBUTING BASINS	CA (equivalent)		Tc (min.)	INTENSITY		TOTAL FLOWS		
		CA(5)	CA(100)		I(5) (in/hr)	I(100) (in/hr)	Q(5) (cfs)	Q(100) (cfs)	
Z	OS-1	0.02	0.09	13.4	3.6	6.2	0.1	0.6	
		TRAVEL TIME							
		0.02	0.09	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
			750	2.1	6.0	19.3			
Y	OS-2	0.02	0.10	13.9	3.5	6.1	0.1	0.6	
		TRAVEL TIME							
		0.02	0.10	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
			450	2.1	3.6	17.5			
X	OS-3	0.13	0.57	16.0	3.3	5.7	0.4	3.3	
		TRAVEL TIME							
		0.13	0.57	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
			115	2.1	0.9	16.9			
W	OS-4	0.01	0.03	10.8	3.9	6.8	0.0	0.2	
		TRAVEL TIME							
		0.01	0.03	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
			115	2.1	0.9	11.7			
A	D-1	0.56	0.73	19.3	3.0	5.2	3.4	9.9	
	D-2	0.45	0.58	TRAVEL TIME					
	DP W	0.01	0.03	TRAVEL TIME					
	DP X	0.13	0.57	TRAVEL TIME					
		1.14	1.91	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
			PIPE	34	2.5	0.2	19.5		
B	D-3	0.08	0.10	5.0	5.2	9.0	0.9	2.0	
	D-4	0.09	0.12	TRAVEL TIME					
		0.17	0.22	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
			PIPE	205	2.5	1.4	6.4		
C	D-8	0.86	1.12	10.1	4.0	7.1	3.5	8.1	
	FB Inlet E	0.00	0.03	TRAVEL TIME					
		0.86	1.15	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
			CHANNEL	34	2.5	0.2	10.3		
V	D-5	0.91	1.20	9.1	4.2	7.4	4.2	9.4	
	D-6	0.07	0.08	TRAVEL TIME					
		0.99	1.27	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
			STREET	205	2.8	1.2	10.3		
D	D-9	0.23	0.31	10.3	4.0	7.0	4.9	11.0	
	DP V	0.99	1.27	TRAVEL TIME					
	FB Inlet F	0.00	0.00	TRAVEL TIME					
		1.22	1.58	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
			PIPE	10	2.5	0.1	10.4		
E	D-12	0.42	0.55	7.3	4.6	8.0	3.2	7.4	
	D-14	0.29	0.38	TRAVEL TIME					
		0.71	0.93	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
			PIPE	34	2.5	0.2	7.5		

DESIGN POINT	CONTRIBUTING BASINS	CA (equivalent)		Tc (min.)	INTENSITY		TOTAL FLOWS		
		CA(5)	CA(100)		I(5) (in/hr)	I(100) (in/hr)	Q(5) (cfs)	Q(100) (cfs)	
F	D-13 DP Y	0.77	1.01	17.5	3.1	5.5	2.5	6.1	
		0.02	0.10	TRAVEL TIME					
		0.80	1.11	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
				PIPE	10	2.5	0.1	17.6	
G	D-18	0.09	0.11	5.9	4.9	8.6	0.4	1.0	
		0.09	0.11	TRAVEL TIME					
		0.09	0.11	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
					25	5.0	0.1	6.0	
H	D-15 D-7 D-19	0.02	0.02	5.0	5.2	9.1	0.3	0.6	
		0.04	0.04	TRAVEL TIME					
		0.05	0.06	TRAVEL TIME					
		0.05	0.06	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
			25	5.0	0.1	5.1			
I	D-11 D-17 D-20 DP Z	0.06	0.07	19.3	3.0	5.2	0.9	2.0	
		0.07	0.08	TRAVEL TIME					
		0.18	0.24	TRAVEL TIME					
		0.02	0.09	TRAVEL TIME					
		0.32	0.39	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
				5.0	0.0	19.3			
NP	D-10 DP A DP B DP C DP D DP E	0.11	0.17	19.5	3.0	5.2	12.4	30.7	
		1.14	1.91	TRAVEL TIME					
		0.17	0.22	TRAVEL TIME					
		0.86	1.15	TRAVEL TIME					
		1.22	1.58	TRAVEL TIME					
		0.71	0.93	TRAVEL TIME					
		4.20	5.96	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
					80	4.0	0.3	19.9	
SP	D-16 DP F	0.04	0.07	17.6	3.1	5.4	2.6	6.4	
		0.80	1.11	TRAVEL TIME					
		0.84	1.18	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)	
					5.0	0.0	17.6		

## Appendix D: Inlet Calculations

**INLET IN A SUMP OR SAG LOCATION**

Project = Gardens at North Carefree  
 Inlet ID = Proposed Type R Inlet - DP A



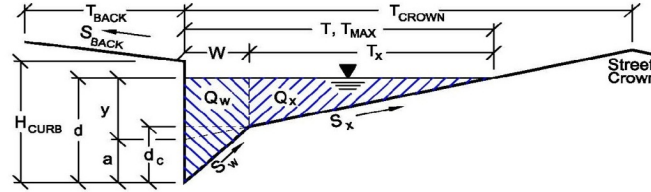
Design Information (Input)	MINOR		MAJOR	
	Type of Inlet	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	$a_{local}$ =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	$N_o$ =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	3.4	5.6	inches
<b>Grate Information</b>	<input type="checkbox"/> Override Depths			
Length of a Unit Grate	$L_o (G)$ =	N/A	N/A	feet
Width of a Unit Grate	$W_o$ =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	$A_{ratio}$ =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	$C_r (G)$ =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	$C_w (G)$ =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	$C_o (G)$ =	N/A	N/A	
<b>Curb Opening Information</b>	MINOR		MAJOR	
Length of a Unit Curb Opening	$L_o (C)$ =	20.00	20.00	feet
Height of Vertical Curb Opening in Inches	$H_{vert}$ =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	$H_{throat}$ =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	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)	$C_r (C)$ =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	$C_w (C)$ =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	$C_o (C)$ =	0.67	0.67	
<b>Total Inlet Interception Capacity (assumes clogged condition)</b>	MINOR		MAJOR	
	$Q_a$ =	2.0	10.3	cfs
<b>WARNING: Inlet Capacity less than Q Peak for Minor Storm</b>	$Q_{PEAK REQUIRED}$ =	3.4	9.9	cfs

Please show the complete inlet calculations as done in the first submittal.

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

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

Project: **Gardens at North Carefree**  
 Inlet ID: **Proposed Type R Inlet - DP A**



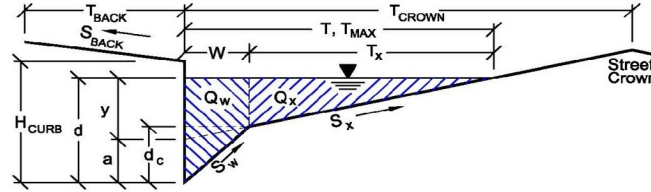
Gutter Geometry (Enter data in the blue cells)					
Maximum Allowable Width for Spread Behind Curb	$T_{BACK} = 10.0$ ft				
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	$S_{BACK} = 0.020$ ft/ft				
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	$n_{BACK} = 0.015$				
Height of Curb at Gutter Flow Line	$H_{CURB} = 6.00$ inches				
Distance from Curb Face to Street Crown	$T_{CROWN} = 17.0$ 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	$S_D = 0.000$ ft/ft				
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	$n_{STREET} = 0.013$				
Max. Allowable Spread for Minor & Major Storm	<table border="1" style="display: inline-table; border-collapse: collapse;"> <thead> <tr> <th style="padding: 2px;">Minor Storm</th> <th style="padding: 2px;">Major Storm</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; padding: 2px;"><math>T_{MAX} = 8.0</math></td> <td style="text-align: center; padding: 2px;"><math>17.0</math></td> </tr> </tbody> </table>	Minor Storm	Major Storm	$T_{MAX} = 8.0$	$17.0$
Minor Storm	Major Storm				
$T_{MAX} = 8.0$	$17.0$				
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	<table border="1" style="display: inline-table; border-collapse: collapse;"> <thead> <tr> <th style="padding: 2px;">Minor Storm</th> <th style="padding: 2px;">Major Storm</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; padding: 2px;"><math>d_{MAX} = 6.0</math></td> <td style="text-align: center; padding: 2px;"><math>12.0</math></td> </tr> </tbody> </table>	Minor Storm	Major Storm	$d_{MAX} = 6.0$	$12.0$
Minor Storm	Major Storm				
$d_{MAX} = 6.0$	$12.0$				
Allow Flow Depth at Street Crown (leave blank for no)	<input type="checkbox"/> <input type="checkbox"/> check = yes				
<b>MINOR STORM Allowable Capacity is based on Depth Criterion</b>					
<b>MAJOR STORM Allowable Capacity is based on Depth Criterion</b>					
Minor storm max. allowable capacity <b>GOOD</b> - greater than flow given on sheet 'Q-Peak'					
Major storm max. allowable capacity <b>GOOD</b> - greater than flow given on sheet 'Q-Peak'					
$Q_{allow} =$	<table border="1" style="display: inline-table; border-collapse: collapse;"> <thead> <tr> <th style="padding: 2px;">Minor Storm</th> <th style="padding: 2px;">Major Storm</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; padding: 2px;">SUMP</td> <td style="text-align: center; padding: 2px;">SUMP</td> </tr> </tbody> </table>	Minor Storm	Major Storm	SUMP	SUMP
Minor Storm	Major Storm				
SUMP	SUMP				



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

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

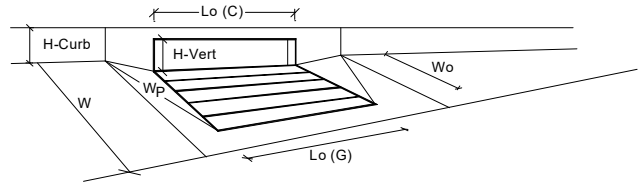
Project: **Gardens at North Carefree**  
 Inlet ID: **Proposed Type R Inlet - DP B**



Gutter Geometry (Enter data in the blue cells)							
Maximum Allowable Width for Spread Behind Curb	$T_{BACK} = 10.0$ ft						
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	$S_{BACK} = 0.020$ ft/ft						
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	$n_{BACK} = 0.015$						
Height of Curb at Gutter Flow Line	$H_{CURB} = 6.00$ inches						
Distance from Curb Face to Street Crown	$T_{CROWN} = 17.0$ 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	$S_D = 0.000$ ft/ft						
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	$n_{STREET} = 0.013$						
Max. Allowable Spread for Minor & Major Storm	<table border="1" style="display: inline-table; border-collapse: collapse;"> <thead> <tr> <th style="padding: 2px;">Minor Storm</th> <th style="padding: 2px;">Major Storm</th> <th style="padding: 2px;"></th> </tr> </thead> <tbody> <tr> <td style="text-align: center; padding: 2px;"><math>T_{MAX} = 8.0</math></td> <td style="text-align: center; padding: 2px;"><math>17.0</math></td> <td style="text-align: center; padding: 2px;">ft</td> </tr> </tbody> </table>	Minor Storm	Major Storm		$T_{MAX} = 8.0$	$17.0$	ft
Minor Storm	Major Storm						
$T_{MAX} = 8.0$	$17.0$	ft					
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	<table border="1" style="display: inline-table; border-collapse: collapse;"> <thead> <tr> <th style="padding: 2px;">Minor Storm</th> <th style="padding: 2px;">Major Storm</th> <th style="padding: 2px;"></th> </tr> </thead> <tbody> <tr> <td style="text-align: center; padding: 2px;"><math>d_{MAX} = 6.0</math></td> <td style="text-align: center; padding: 2px;"><math>12.0</math></td> <td style="text-align: center; padding: 2px;">inches</td> </tr> </tbody> </table>	Minor Storm	Major Storm		$d_{MAX} = 6.0$	$12.0$	inches
Minor Storm	Major Storm						
$d_{MAX} = 6.0$	$12.0$	inches					
Allow Flow Depth at Street Crown (leave blank for no)	<input type="checkbox"/> <input type="checkbox"/> check = yes						
<b>MINOR STORM Allowable Capacity is based on Depth Criterion</b>							
<b>MAJOR STORM Allowable Capacity is based on Depth Criterion</b>							
Minor storm max. allowable capacity <b>GOOD</b> - greater than flow given on sheet 'Q-Peak'							
Major storm max. allowable capacity <b>GOOD</b> - greater than flow given on sheet 'Q-Peak'							
$Q_{allow} =$	<table border="1" style="display: inline-table; border-collapse: collapse;"> <thead> <tr> <th style="padding: 2px;">Minor Storm</th> <th style="padding: 2px;">Major Storm</th> <th style="padding: 2px;"></th> </tr> </thead> <tbody> <tr> <td style="text-align: center; padding: 2px;">SUMP</td> <td style="text-align: center; padding: 2px;">SUMP</td> <td style="text-align: center; padding: 2px;">cfs</td> </tr> </tbody> </table>	Minor Storm	Major Storm		SUMP	SUMP	cfs
Minor Storm	Major Storm						
SUMP	SUMP	cfs					

**INLET IN A SUMP OR SAG LOCATION**

Project = Gardens at North Carefree  
 Inlet ID = Proposed Type R Inlet - DP B



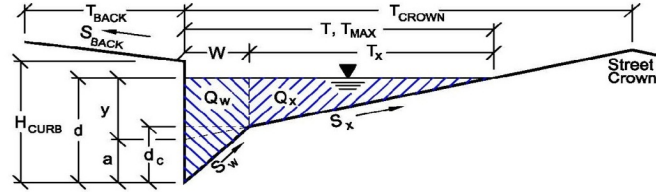
Design Information (Input)	MINOR	MAJOR	
Type of Inlet	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	1	1	
Water Depth at Flowline (outside of local depression)	3.4	5.6	inches
<b>Grate Information</b>	MINOR	MAJOR	<input type="checkbox"/> Override Depths
Length of a Unit Grate	N/A	N/A	feet
Width of a Unit Grate	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	N/A	N/A	
<b>Curb Opening Information</b>	MINOR	MAJOR	
Length of a Unit Curb Opening	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	0.67	0.67	
<b>Total Inlet Interception Capacity (assumes clogged condition)</b>	MINOR	MAJOR	
<b>Q<sub>a</sub></b>	1.1	4.6	cfs
<b>Q<sub>PEAK REQUIRED</sub></b>	0.9	2.0	cfs

Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)

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

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

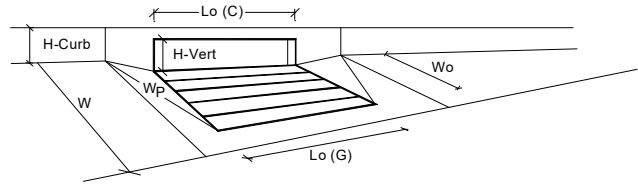
Project: **Gardens at North Carefree**  
 Inlet ID: **Proposed Type R Inlet - DP C**



Gutter Geometry (Enter data in the blue cells)							
Maximum Allowable Width for Spread Behind Curb	$T_{BACK} = 10.0$ ft						
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	$S_{BACK} = 0.020$ ft/ft						
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	$n_{BACK} = 0.015$						
Height of Curb at Gutter Flow Line	$H_{CURB} = 6.00$ inches						
Distance from Curb Face to Street Crown	$T_{CROWN} = 17.0$ 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	$S_D = 0.000$ ft/ft						
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	$n_{STREET} = 0.013$						
Max. Allowable Spread for Minor & Major Storm	<table border="1" style="display: inline-table; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">Minor Storm</th> <th style="text-align: center;">Major Storm</th> <th></th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">8.0</td> <td style="text-align: center;">17.0</td> <td>ft</td> </tr> </tbody> </table>	Minor Storm	Major Storm		8.0	17.0	ft
Minor Storm	Major Storm						
8.0	17.0	ft					
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	<table border="1" style="display: inline-table; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">Minor Storm</th> <th style="text-align: center;">Major Storm</th> <th></th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">6.0</td> <td style="text-align: center;">12.0</td> <td>inches</td> </tr> </tbody> </table>	Minor Storm	Major Storm		6.0	12.0	inches
Minor Storm	Major Storm						
6.0	12.0	inches					
Allow Flow Depth at Street Crown (leave blank for no)	<input type="checkbox"/> <input type="checkbox"/> check = yes						
<b>MINOR STORM Allowable Capacity is based on Depth Criterion</b>							
<b>MAJOR STORM Allowable Capacity is based on Depth Criterion</b>							
Minor storm max. allowable capacity <b>GOOD</b> - greater than flow given on sheet 'Q-Peak'							
Major storm max. allowable capacity <b>GOOD</b> - greater than flow given on sheet 'Q-Peak'							
$Q_{allow} =$	<table border="1" style="display: inline-table; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">Minor Storm</th> <th style="text-align: center;">Major Storm</th> <th></th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">SUMP</td> <td style="text-align: center;">SUMP</td> <td>cfs</td> </tr> </tbody> </table>	Minor Storm	Major Storm		SUMP	SUMP	cfs
Minor Storm	Major Storm						
SUMP	SUMP	cfs					

**INLET IN A SUMP OR SAG LOCATION**

Project = Gardens at North Carefree  
 Inlet ID = Proposed Type R Inlet - DP C

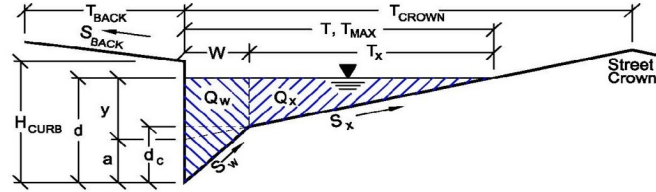


Design Information (Input)	MINOR		MAJOR		
Type of Inlet	CDOT Type R Curb Opening				
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	$a_{local}$ =	3.00	3.00		inches
Number of Unit Inlets (Grate or Curb Opening)	$N_o$ =	1	1		
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4.3	5.6		inches
<b>Grate Information</b>					<input type="checkbox"/> Override Depths
Length of a Unit Grate	$L_o (G)$ =	N/A	N/A		feet
Width of a Unit Grate	$W_o$ =	N/A	N/A		feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	$A_{ratio}$ =	N/A	N/A		
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	$C_r (G)$ =	N/A	N/A		
Grate Weir Coefficient (typical value 2.15 - 3.60)	$C_w (G)$ =	N/A	N/A		
Grate Orifice Coefficient (typical value 0.60 - 0.80)	$C_o (G)$ =	N/A	N/A		
<b>Curb Opening Information</b>					
Length of a Unit Curb Opening	$L_o (C)$ =	15.00	15.00		feet
Height of Vertical Curb Opening in Inches	$H_{vert}$ =	6.00	6.00		inches
Height of Curb Orifice Throat in Inches	$H_{throat}$ =	6.00	6.00		inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40		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)	$C_r (C)$ =	0.10	0.10		
Curb Opening Weir Coefficient (typical value 2.3-3.7)	$C_w (C)$ =	3.60	3.60		
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	$C_o (C)$ =	0.67	0.67		
<b>Total Inlet Interception Capacity (assumes clogged condition)</b>					
<b>WARNING: Inlet Capacity less than Q Peak for MAJOR Storm</b>	$Q_a$ =	3.6	8.1		cfs
	$Q_{PEAK REQUIRED}$ =	3.5	8.1		cfs

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

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

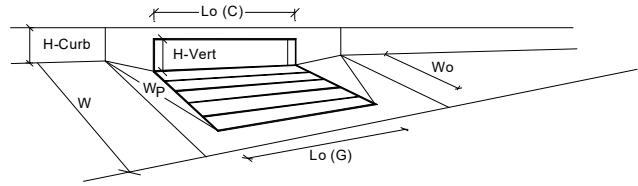
Project: **Gardens at North Carefree**  
 Inlet ID: **Proposed Type R Inlet - DP D**



Gutter Geometry (Enter data in the blue cells)							
Maximum Allowable Width for Spread Behind Curb	$T_{BACK} = 10.0$ ft						
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	$S_{BACK} = 0.020$ ft/ft						
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	$n_{BACK} = 0.015$						
Height of Curb at Gutter Flow Line	$H_{CURB} = 6.00$ inches						
Distance from Curb Face to Street Crown	$T_{CROWN} = 17.0$ 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	$S_D = 0.000$ ft/ft						
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	$n_{STREET} = 0.013$						
Max. Allowable Spread for Minor & Major Storm	<table border="1" style="display: inline-table; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">Minor Storm</th> <th style="text-align: center;">Major Storm</th> <th></th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">8.0</td> <td style="text-align: center;">17.0</td> <td style="text-align: right;">ft</td> </tr> </tbody> </table>	Minor Storm	Major Storm		8.0	17.0	ft
Minor Storm	Major Storm						
8.0	17.0	ft					
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	<table border="1" style="display: inline-table; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">Minor Storm</th> <th style="text-align: center;">Major Storm</th> <th></th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">6.0</td> <td style="text-align: center;">12.0</td> <td style="text-align: right;">inches</td> </tr> </tbody> </table>	Minor Storm	Major Storm		6.0	12.0	inches
Minor Storm	Major Storm						
6.0	12.0	inches					
Allow Flow Depth at Street Crown (leave blank for no)	<input type="checkbox"/> <input type="checkbox"/> check = yes						
<b>MINOR STORM Allowable Capacity is based on Depth Criterion</b>							
<b>MAJOR STORM Allowable Capacity is based on Depth Criterion</b>							
Minor storm max. allowable capacity <b>GOOD</b> - greater than flow given on sheet 'Q-Peak'							
Major storm max. allowable capacity <b>GOOD</b> - greater than flow given on sheet 'Q-Peak'							
$Q_{allow} =$	<table border="1" style="display: inline-table; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">Minor Storm</th> <th style="text-align: center;">Major Storm</th> <th></th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">SUMP</td> <td style="text-align: center;">SUMP</td> <td style="text-align: right;">cfs</td> </tr> </tbody> </table>	Minor Storm	Major Storm		SUMP	SUMP	cfs
Minor Storm	Major Storm						
SUMP	SUMP	cfs					

**INLET IN A SUMP OR SAG LOCATION**

Project = Gardens at North Carefree  
 Inlet ID = Proposed Type R Inlet - DP D

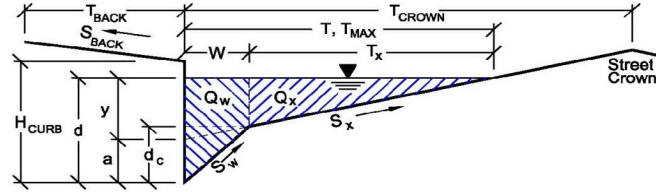


Design Information (Input)	MINOR		MAJOR	
	Type of Inlet	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	$a_{local}$ =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	$N_o$ =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4.7	6.3	inches
<b>Grate Information</b>				<input type="checkbox"/> Override Depths
Length of a Unit Grate	$L_o (G)$ =	N/A	N/A	feet
Width of a Unit Grate	$W_o$ =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	$A_{ratio}$ =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	$C_r (G)$ =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	$C_w (G)$ =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	$C_o (G)$ =	N/A	N/A	
<b>Curb Opening Information</b>				
Length of a Unit Curb Opening	$L_o (C)$ =	15.00	15.00	feet
Height of Vertical Curb Opening in Inches	$H_{vert}$ =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	$H_{throat}$ =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	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)	$C_r (C)$ =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	$C_w (C)$ =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	$C_o (C)$ =	0.67	0.67	
<b>Total Inlet Interception Capacity (assumes clogged condition)</b>	$Q_a$ =	4.9	11.1	cfs
<b>WARNING: Inlet Capacity less than Q Peak for Minor Storm</b>	$Q_{PEAK REQUIRED}$ =	4.9	11.0	cfs

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

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

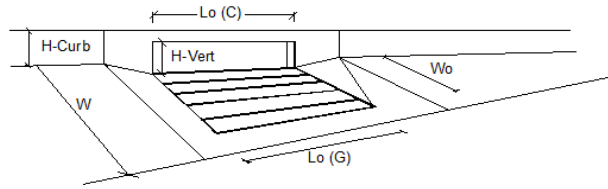
Project: **Gardens at North Carefree**  
 Inlet ID: **Proposed Type R Inlet - DP E**



Gutter Geometry (Enter data in the blue cells)							
Maximum Allowable Width for Spread Behind Curb	$T_{BACK} =$ <input style="width: 50px;" type="text" value="10.0"/> ft						
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	$S_{BACK} =$ <input style="width: 50px;" type="text" value="0.020"/> ft/ft						
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	$n_{BACK} =$ <input style="width: 50px;" type="text" value="0.015"/>						
Height of Curb at Gutter Flow Line	$H_{CURB} =$ <input style="width: 50px;" type="text" value="6.00"/> inches						
Distance from Curb Face to Street Crown	$T_{CROWN} =$ <input style="width: 50px;" type="text" value="17.0"/> ft						
Gutter Width	$W =$ <input style="width: 50px;" type="text" value="2.00"/> ft						
Street Transverse Slope	$S_x =$ <input style="width: 50px;" type="text" value="0.020"/> ft/ft						
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	$S_w =$ <input style="width: 50px;" type="text" value="0.083"/> ft/ft						
Street Longitudinal Slope - Enter 0 for sump condition	$S_o =$ <input style="width: 50px;" type="text" value="0.052"/> ft/ft						
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	$n_{STREET} =$ <input style="width: 50px;" type="text" value="0.013"/>						
Max. Allowable Spread for Minor & Major Storm	<table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="padding: 0 10px;">Minor Storm</th> <th style="padding: 0 10px;">Major Storm</th> <th></th> </tr> </thead> <tbody> <tr> <td style="text-align: center;"><input style="width: 50px;" type="text" value="8.0"/></td> <td style="text-align: center;"><input style="width: 50px;" type="text" value="17.0"/></td> <td style="text-align: right;">ft</td> </tr> </tbody> </table>	Minor Storm	Major Storm		<input style="width: 50px;" type="text" value="8.0"/>	<input style="width: 50px;" type="text" value="17.0"/>	ft
Minor Storm	Major Storm						
<input style="width: 50px;" type="text" value="8.0"/>	<input style="width: 50px;" type="text" value="17.0"/>	ft					
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	<table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="padding: 0 10px;">Minor Storm</th> <th style="padding: 0 10px;">Major Storm</th> <th></th> </tr> </thead> <tbody> <tr> <td style="text-align: center;"><input style="width: 50px;" type="text" value="6.0"/></td> <td style="text-align: center;"><input style="width: 50px;" type="text" value="12.0"/></td> <td style="text-align: right;">inches</td> </tr> </tbody> </table>	Minor Storm	Major Storm		<input style="width: 50px;" type="text" value="6.0"/>	<input style="width: 50px;" type="text" value="12.0"/>	inches
Minor Storm	Major Storm						
<input style="width: 50px;" type="text" value="6.0"/>	<input style="width: 50px;" type="text" value="12.0"/>	inches					
Allow Flow Depth at Street Crown (leave blank for no)	<table style="margin-left: auto; margin-right: auto;"> <tbody> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: right;">check = yes</td> </tr> </tbody> </table>	<input type="checkbox"/>	<input type="checkbox"/>	check = yes			
<input type="checkbox"/>	<input type="checkbox"/>	check = yes					
<b>MINOR STORM Allowable Capacity is based on Spread Criterion</b>	<table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="padding: 0 10px;">Minor Storm</th> <th style="padding: 0 10px;">Major Storm</th> <th></th> </tr> </thead> <tbody> <tr> <td style="text-align: center;"><input style="width: 50px;" type="text" value="5.5"/></td> <td style="text-align: center;"><input style="width: 50px;" type="text" value="30.6"/></td> <td style="text-align: right;">cfs</td> </tr> </tbody> </table>	Minor Storm	Major Storm		<input style="width: 50px;" type="text" value="5.5"/>	<input style="width: 50px;" type="text" value="30.6"/>	cfs
Minor Storm	Major Storm						
<input style="width: 50px;" type="text" value="5.5"/>	<input style="width: 50px;" type="text" value="30.6"/>	cfs					
<b>MAJOR STORM Allowable Capacity is based on Spread Criterion</b>							
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'							
Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'							

**INLET ON A CONTINUOUS GRADE**

Project: Gardens at North Carefree  
 Inlet ID: Proposed Type R Inlet - DP E



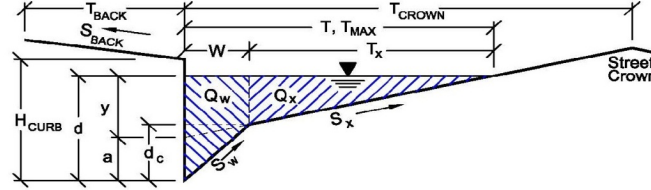
Design Information (Input)	MINOR		MAJOR		
Type of Inlet	Type = CDOT Type R Curb Opening				
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	$a_{LOCAL} =$	3.0	3.0		inches
Total Number of Units in the Inlet (Grate or Curb Opening)	$N_o =$	1	1		
Length of a Single Unit Inlet (Grate or Curb Opening)	$L_o =$	15.00	15.00		ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	$W_o =$	N/A	N/A		ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	$C_r-G =$	N/A	N/A		
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	$C_r-C =$	0.10	0.10		
<b>Street Hydraulics: OK - Q &lt; maximum allowable from sheet 'Q-Allow'</b>					
Total Inlet Interception Capacity	$Q =$	3.20	7.25		cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	$Q_b =$	0.0	0.2		cfs
Capture Percentage = $Q_c/Q_o =$	$C\% =$	100	98		%



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

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

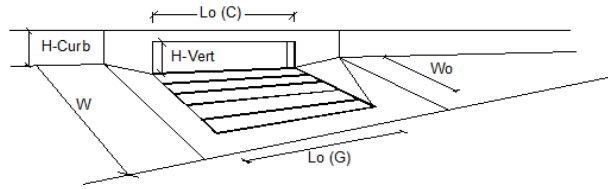
Project: **Gardens at North Carefree**  
 Inlet ID: **Proposed Type R Inlet - DP F**



<b>Gutter Geometry (Enter data in the blue cells)</b>							
Maximum Allowable Width for Spread Behind Curb	$T_{BACK} = 10.0$ ft						
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	$S_{BACK} = 0.020$ ft/ft						
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	$n_{BACK} = 0.015$						
Height of Curb at Gutter Flow Line	$H_{CURB} = 6.00$ inches						
Distance from Curb Face to Street Crown	$T_{CROWN} = 17.0$ 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	$S_D = 0.052$ ft/ft						
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	$n_{STREET} = 0.013$						
Max. Allowable Spread for Minor & Major Storm	<table style="margin-left: auto; margin-right: auto;"> <tr> <td style="text-align: center;">Minor Storm</td> <td style="text-align: center;">Major Storm</td> <td></td> </tr> <tr> <td style="text-align: center;"><math>T_{MAX} = 8.0</math></td> <td style="text-align: center;"><math>17.0</math></td> <td style="text-align: right;">ft</td> </tr> </table>	Minor Storm	Major Storm		$T_{MAX} = 8.0$	$17.0$	ft
Minor Storm	Major Storm						
$T_{MAX} = 8.0$	$17.0$	ft					
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	<table style="margin-left: auto; margin-right: auto;"> <tr> <td style="text-align: center;">Minor Storm</td> <td style="text-align: center;">Major Storm</td> <td></td> </tr> <tr> <td style="text-align: center;"><math>d_{MAX} = 6.0</math></td> <td style="text-align: center;"><math>12.0</math></td> <td style="text-align: right;">inches</td> </tr> </table>	Minor Storm	Major Storm		$d_{MAX} = 6.0$	$12.0$	inches
Minor Storm	Major Storm						
$d_{MAX} = 6.0$	$12.0$	inches					
Allow Flow Depth at Street Crown (leave blank for no)	<input type="checkbox"/> <input type="checkbox"/> check = yes						
<b>MINOR STORM Allowable Capacity is based on Spread Criterion</b>							
<b>MAJOR STORM Allowable Capacity is based on Spread Criterion</b>							
Minor storm max. allowable capacity <b>GOOD</b> - greater than flow given on sheet 'Q-Peak'							
Major storm max. allowable capacity <b>GOOD</b> - greater than flow given on sheet 'Q-Peak'							
	<table style="margin-left: auto; margin-right: auto;"> <tr> <td style="text-align: center;">Minor Storm</td> <td style="text-align: center;">Major Storm</td> <td></td> </tr> <tr> <td style="text-align: center;"><math>Q_{allow} = 5.5</math></td> <td style="text-align: center;"><math>30.6</math></td> <td style="text-align: right;">cfs</td> </tr> </table>	Minor Storm	Major Storm		$Q_{allow} = 5.5$	$30.6$	cfs
Minor Storm	Major Storm						
$Q_{allow} = 5.5$	$30.6$	cfs					

**INLET ON A CONTINUOUS GRADE**

Project: Gardens at North Carefree  
 Inlet ID: Proposed Type R Inlet - DP F

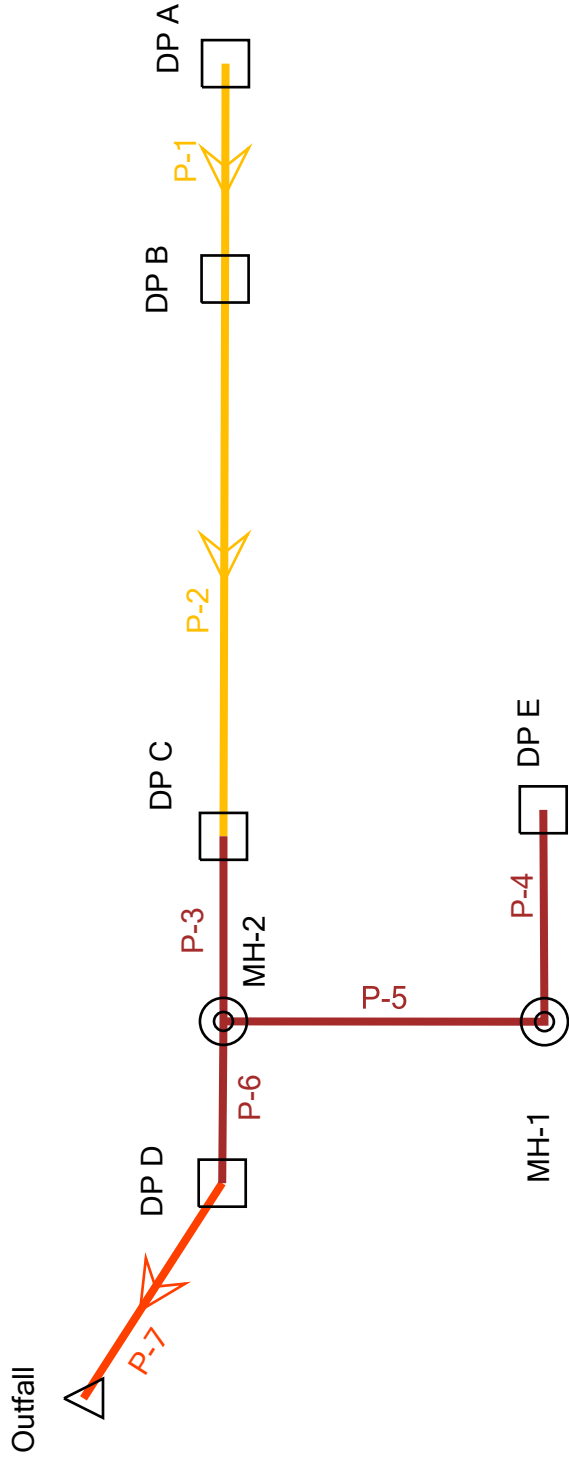


Design Information (Input)	MINOR		MAJOR		
Type of Inlet	Type = CDOT Type R Curb Opening				
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	$a_{LOCAL} =$	3.0	3.0		inches
Total Number of Units in the Inlet (Grate or Curb Opening)	$N_o =$	1	1		
Length of a Single Unit Inlet (Grate or Curb Opening)	$L_o =$	15.00	15.00		ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	$W_o =$	N/A	N/A		ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	$C_r-G =$	N/A	N/A		
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	$C_r-C =$	0.10	0.10		
<b>Street Hydraulics: OK - Q &lt; maximum allowable from sheet 'Q-Allow'</b>					
Total Inlet Interception Capacity	$Q =$	2.50	6.10		cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	$Q_b =$	0.0	0.0		cfs
Capture Percentage = $Q_c/Q_o =$	$C\% =$	100	100		%

## **Appendix E: StormCAD**

## Storm System 1

# Scenario: 5-Year



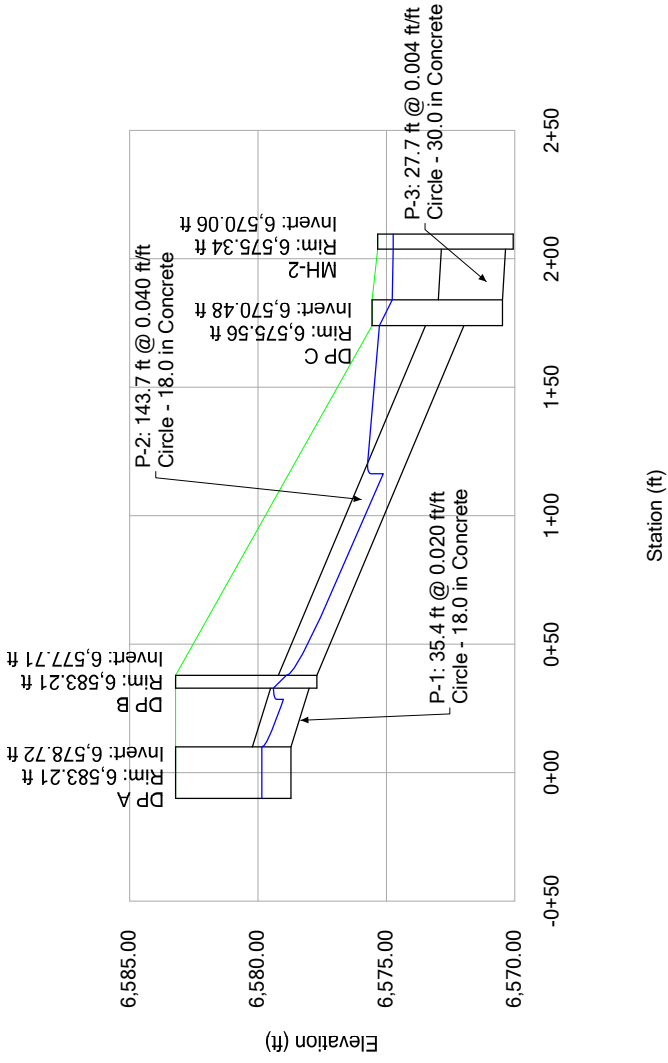
**Storm System 1 - 100 Year**

Label	Start Node	Stop Node	Length (Unified) (ft)	Diameter (in)	Capacity (Full Flow) (cfs)	System Rational Flow (cfs)	Velocity (ft/s)	Elevation Ground (Start) (ft)	Hydraulic Grade Line (In) (ft)	Invert (Start) (ft)	Cover (Start) (ft)	Elevation Ground (Stop) (ft)	Hydraulic Grade Line (Out) (ft)	Invert (Stop) (ft)	Cover (Stop) (ft)	Slope (Calculated) (ft/ft)
P-1	DP A	DP B	35.4	18	14.89	8.53	8.71	6,583.21	6,579.85	6,578.72	2.99	6,583.21	6,579.40	6,578.01	3.7	2.00%
P-2	DP B	DP C	143.7	18	20.98	9.51	11.58	6,583.21	6,578.90	6,577.71	4	6,575.56	6,575.27	6,571.98	2.08	4.00%
P-7	DP D	Outfall	34.8	42	68.22	25.6	2.66	6,575.56	6,574.22	6,568.71	3.35	6,575.00	6,574.20	6,568.55	2.95	0.50%
P-3	DP C	MH-2	27.7	30	27.01	14.56	2.97	6,575.56	6,574.77	6,570.48	2.58	6,575.34	6,574.74	6,570.36	2.48	0.40%
P-6	MH-2	DP D	7.7	30	33.12	18.63	3.8	6,575.34	6,574.74	6,570.06	2.78	6,575.56	6,574.72	6,570.01	3.05	0.70%
P-4	DP E	MH-1	27.7	24	30.4	6.09	1.94	6,577.12	6,574.80	6,572.50	2.62	6,576.90	6,574.78	6,572.00	2.9	1.80%
P-5	MH-1	MH-2	115	30	40.84	6.03	1.23	6,576.90	6,574.76	6,571.50	2.9	6,575.34	6,574.74	6,570.36	2.48	1.00%

Why is the flow different from what is shown on your design point calculations?

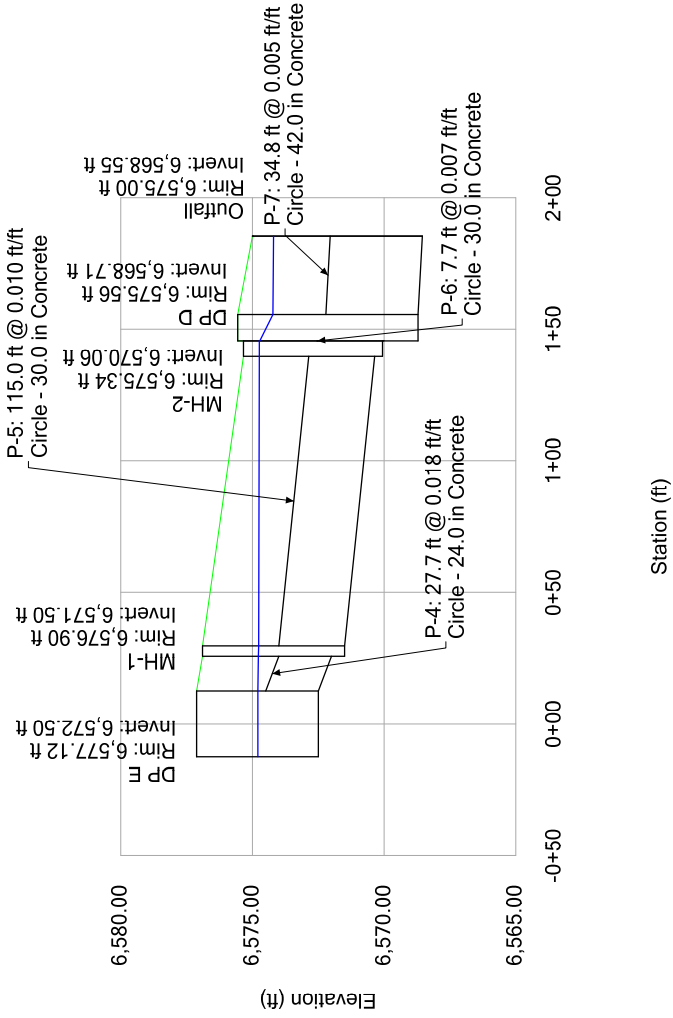
# Profile Report

## Engineering Profile - DP A to MH 2 (St Sys 1.stsw)



# Profile Report

## Engineering Profile - DP E to Outfall (St Sys 1.stsw)





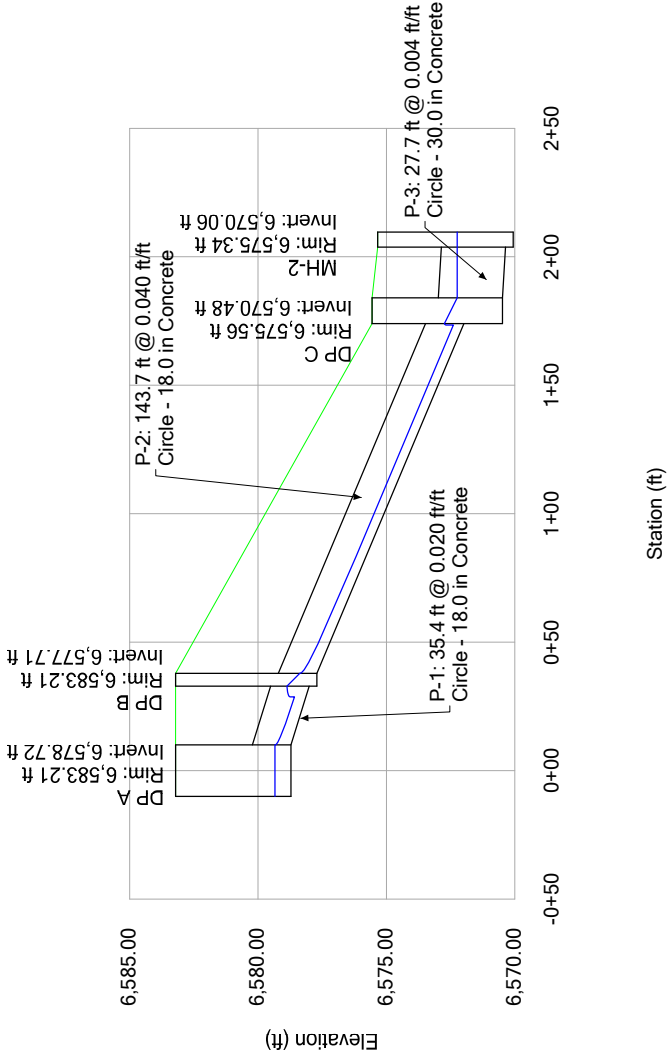
**Storm System 1 - 5 Year**

Label	Start Node	Stop Node	Length (Unified) (ft)	Diameter (in)	Capacity (Full Flow) (cfs)	System Rational Flow (cfs)	Velocity (ft/s)	Elevation Ground (Start) (ft)	Hydraulic Grade Line (In) (ft)	Invert (Start) (ft)	Cover (Start) (ft)	Elevation Ground (Stop) (ft)	Hydraulic Grade Line (Out) (ft)	Invert (Stop) (ft)	Cover (Stop) (ft)	Slope (Calculated) (ft/ft)
P-1	DP A	DP B	35.4	18	14.89	2.67	6.37	6,583.21	6,579.34	6,578.72	2.99	6,583.21	6,578.88	6,578.01	3.7	2.00%
P-2	DP B	DP C	143.7	18	20.98	3.06	8.47	6,583.21	6,578.38	6,577.71	4	6,575.56	6,572.74	6,571.98	2.08	4.00%
P-7	DP D	Outfall	34.8	42	68.22	9.49	4.99	6,575.56	6,571.74	6,568.71	3.35	6,575.00	6,571.74	6,568.55	2.95	0.50%
P-3	DP C	MH-2	27.7	30	27.01	5.04	4.21	6,575.56	6,572.24	6,570.48	2.58	6,575.34	6,572.24	6,570.36	2.48	0.40%
P-6	MH-2	DP D	7.7	30	33.12	6.67	5.28	6,575.34	6,572.24	6,570.06	2.78	6,575.56	6,572.24	6,570.01	3.05	0.007
P-4	DPE	MH-1	27.7	24	30.4	2.44	5.8	6,577.12	6,573.04	6,572.50	2.62	6,576.90	6,572.39	6,572.00	2.9	0.018
P-5	MH-1	MH-2	115	30	40.84	2.43	4.56	6,576.90	6,572.21	6,571.50	2.9	6,575.34	6,572.24	6,570.36	2.48	0.01

Why is the flow different from what is shown on your design point calculations?

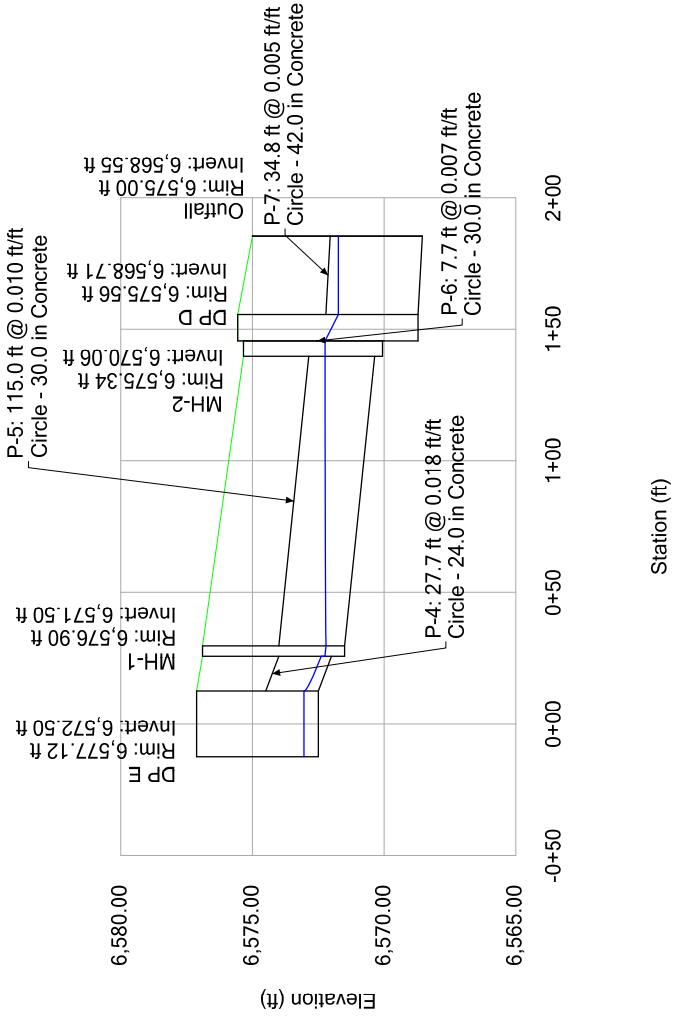
# Profile Report

## Engineering Profile - DP A to MH 2 (St Sys 1.stsw)



# Profile Report

## Engineering Profile - DP E to Outfall (St Sys 1.stsw)

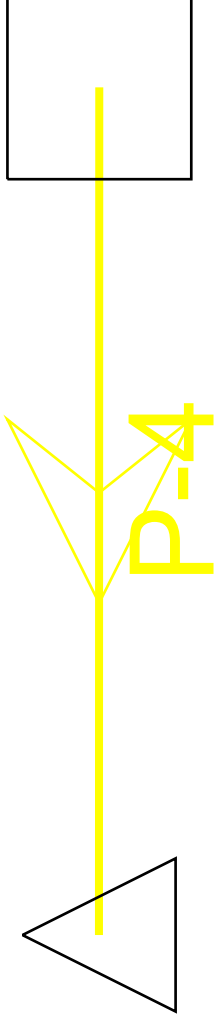


## Storm System 2

**Scenario: 5-Year**

# Outfall

# DP F



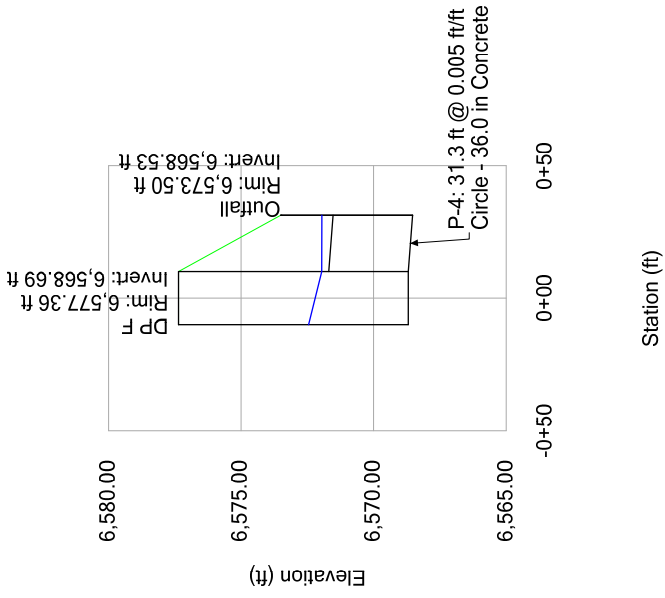
**Storm System 2 - 100 Year**

Label	Start Node	Stop Node	Length (Unified) (ft)	Diameter (in)	Capacity (Full Flow) (cfs)	System Rational Flow (cfs)	Velocity (ft/s)	Elevation Ground (Start) (ft)	Hydraulic Grade Line (In) (ft)	Invert (Start) (ft)	Cover (Start) (ft)	Elevation Ground (Stop) (ft)	Hydraulic Grade Line (Out) (ft)	Invert (Stop) (ft)	Cover (Stop) (ft)	Slope (Calculated) (ft/ft)
P-4	DP F	Outfall	31.3	36	47.7	5.15	0.73	6,577.36	6,571.95	6,568.69	5.67	6,573.50	6,571.95	6,568.53	1.97	0.50%

Why is the flow different from what is shown on your design point calculations?

# Profile Report

## Engineering Profile - DP F to Outfall (St Sys 2.stsw)



**Storm System 2 - 5 Year**

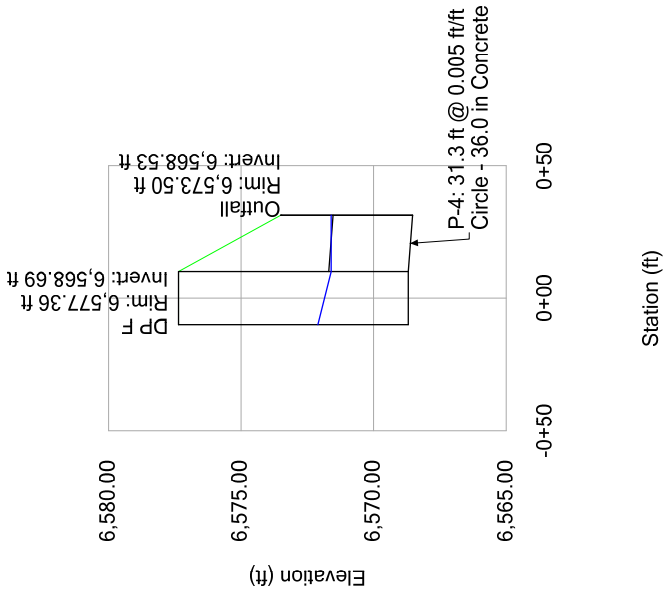
Label	Start Node	Stop Node	Length (Unified) (ft)	Diameter (in)	Capacity (Full Flow) (cfs)	System Rational Flow (cfs)	Velocity (ft/s)	Elevation Ground (Start) (ft)	Hydraulic Grade Line (In) (ft)	Invert (Start) (ft)	Cover (Start) (ft)	Elevation Ground (Stop) (ft)	Hydraulic Grade Line (Out) (ft)	Invert (Stop) (ft)	Cover (Stop) (ft)	Slope (Calculated) (ft/ft)
P-4	DP F	Outfall	31.3	36	47.7	1.95	3.31	6,577.36	6,571.60	6,568.69	5.67	6,573.50	6,571.60	6,568.53	1.97	0.50%

Why is the flow different from what is shown on your design point calculations?



# Profile Report

## Engineering Profile - DP F to Outfall (St Sys 2.stsw)



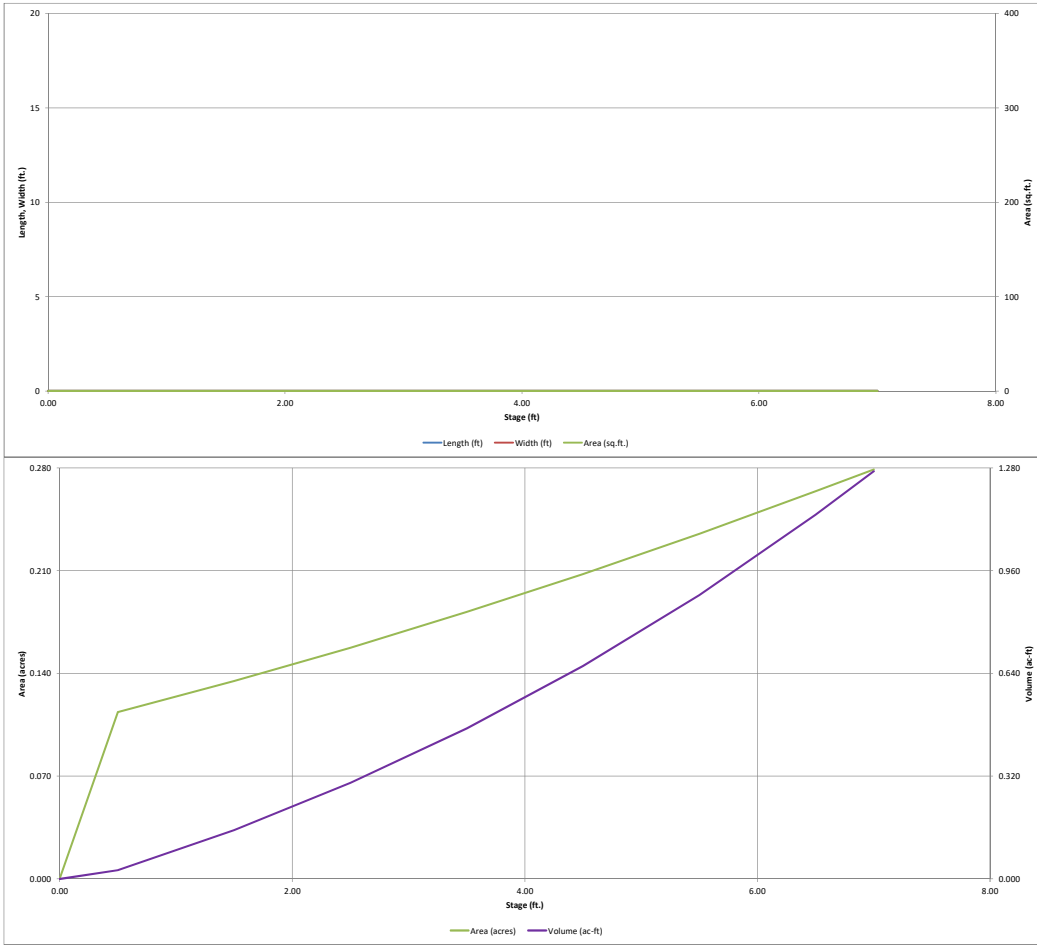
## **Appendix F: Detention & Water Quality Pond Calculations**

## North Pond



# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

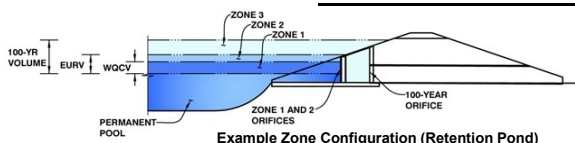


## Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Gardens at North Carefree

Basin ID: North Pond



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.59	0.164	Orifice Plate
Zone 2 (EURV)	4.35	0.466	Rectangular Orifice
Zone 3 (100-year)	5.57	0.268	Weir&Pipe (Restrict)
		0.899	Total

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area =  ft<sup>2</sup>  
Underdrain Orifice Centroid =  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 =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing =  inches  
Orifice Plate: Orifice Area per Row =  sq. inches (diameter = 1-1/4 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =  ft<sup>2</sup>  
Elliptical Half-Width =  feet  
Elliptical Slot Centroid =  feet  
Elliptical Slot Area =  ft<sup>2</sup>

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.70	1.40					
Orifice Area (sq. inches)	1.30	1.30	1.30					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	<input type="text" value="3.90"/>	<input type="text" value="N/A"/>	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	<input type="text" value="4.35"/>	<input type="text" value="N/A"/>	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Height =	<input type="text" value="2.00"/>	<input type="text" value="N/A"/>	inches
Vertical Orifice Width =	<input type="text" value="5.00"/>	<input type="text" value="N/A"/>	inches

Calculated Parameters for Vertical Orifice

	Zone 2 Rectangular	Not Selected	
Vertical Orifice Area =	<input type="text" value="0.07"/>	<input type="text" value="N/A"/>	ft <sup>2</sup>
Vertical Orifice Centroid =	<input type="text" value="0.08"/>	<input type="text" value="N/A"/>	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	<input type="text" value="5.25"/>	<input type="text" value="N/A"/>	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	<input type="text" value="4.00"/>	<input type="text" value="N/A"/>	feet
Overflow Weir Slope =	<input type="text" value="3.00"/>	<input type="text" value="N/A"/>	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	<input type="text" value="4.00"/>	<input type="text" value="N/A"/>	feet
Overflow Grate Open Area % =	<input type="text" value="70%"/>	<input type="text" value="N/A"/>	%, grate open area/total area
Debris Clogging % =	<input type="text" value="50%"/>	<input type="text" value="N/A"/>	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H <sub>1</sub> =	<input type="text" value="6.58"/>	<input type="text" value="N/A"/>	feet
Over Flow Weir Slope Length =	<input type="text" value="4.22"/>	<input type="text" value="N/A"/>	feet
Grate Open Area / 100-yr Orifice Area =	<input type="text" value="6.68"/>	<input type="text" value="N/A"/>	should be ≥ 4
Overflow Grate Open Area w/o Debris =	<input type="text" value="11.81"/>	<input type="text" value="N/A"/>	ft <sup>2</sup>
Overflow Grate Open Area w/ Debris =	<input type="text" value="5.90"/>	<input type="text" value="N/A"/>	ft <sup>2</sup>

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 =	<input type="text" value="2.50"/>	<input type="text" value="N/A"/>	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	<input type="text" value="18.00"/>	<input type="text" value="N/A"/>	inches
Restrictor Plate Height Above Pipe Invert =	<input type="text" value="18.00"/>	<input type="text" value="N/A"/>	inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	<input type="text" value="1.77"/>	<input type="text" value="N/A"/>	ft <sup>2</sup>
Outlet Orifice Centroid =	<input type="text" value="0.75"/>	<input type="text" value="N/A"/>	feet
Half-Central Angle of Restrictor Plate on Pipe =	<input type="text" value="3.14"/>	<input type="text" value="N/A"/>	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway

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

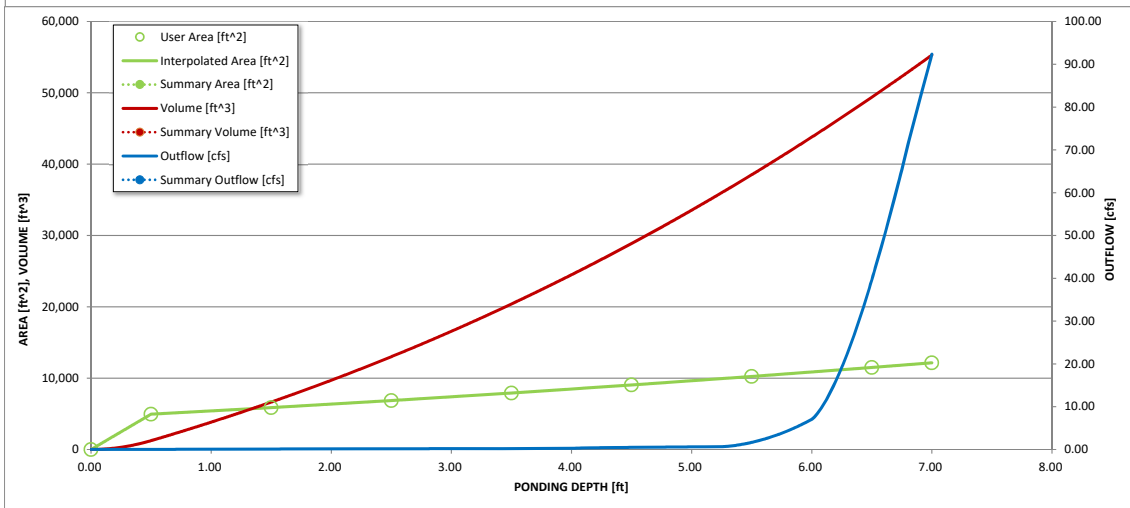
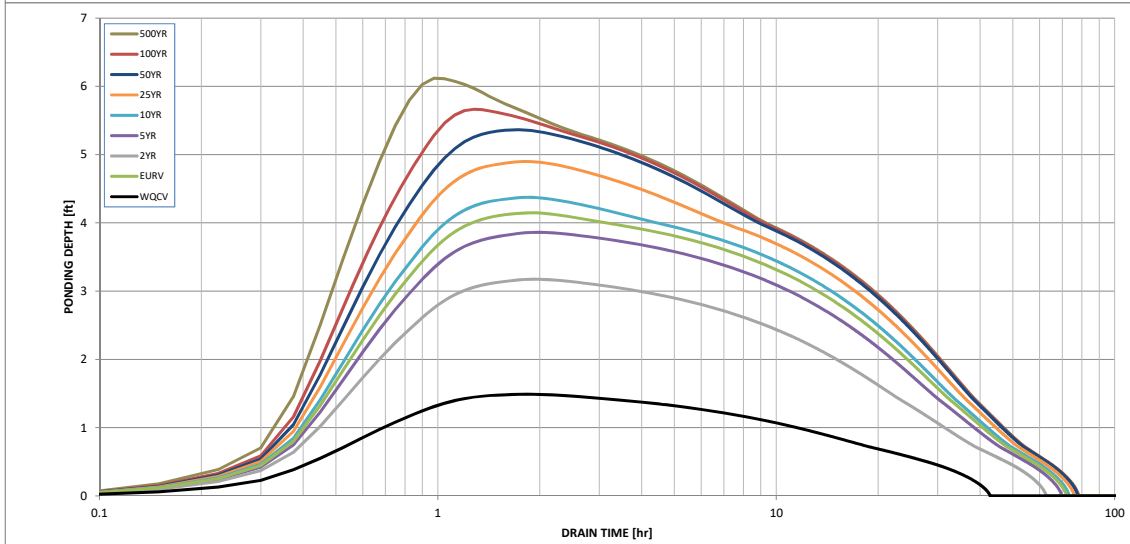
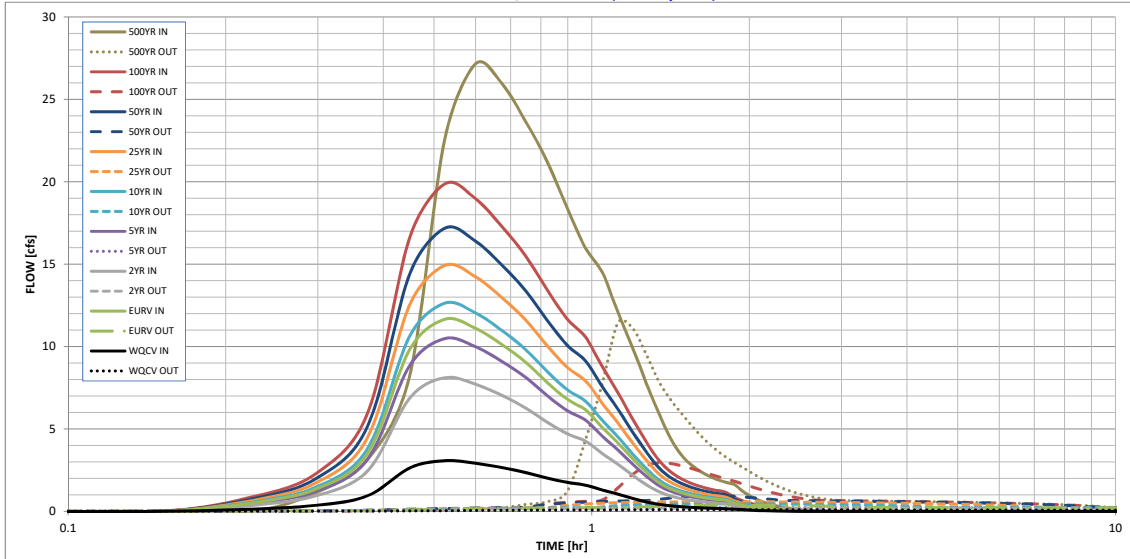
### Routed Hydrograph Results

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =									
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.29
Calculated Runoff Volume (acre-ft) =	0.164	0.630	0.436	0.567	0.683	0.809	0.933	1.081	1.482
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.163	0.630	0.436	0.566	0.684	0.809	0.933	1.081	1.482
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.00	0.01	0.01	0.03	0.23	0.55	1.30
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.0	0.1	0.2	1.4	3.3	7.8
Peak Inflow Q (cfs) =	3.1	11.7	8.1	10.5	12.6	14.9	17.2	19.9	27.1
Peak Outflow Q (cfs) =	0.1	0.4	0.2	0.2	0.5	0.6	1.0	2.9	11.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	6.5	5.5	3.1	0.7	0.9	1.5
Structure Controlling Flow =	Plate	Vertical Orifice 1	Plate	Plate	Vertical Orifice 1	Vertical Orifice 1	Overflow Grate 1	Overflow Grate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	0.0	0.2	0.7
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	61	54	60	62	63	63	62	57
Time to Drain 99% of Inflow Volume (hours) =	41	67	59	65	68	70	71	71	69
Maximum Ponding Depth (ft) =	1.49	4.15	3.17	3.86	4.37	4.90	5.37	5.67	6.12
Area at Maximum Ponding Depth (acres) =	0.13	0.20	0.17	0.19	0.20	0.22	0.23	0.24	0.25
Maximum Volume Stored (acre-ft) =	0.150	0.590	0.410	0.535	0.636	0.746	0.852	0.922	1.033

Adjust the design so that release is equal to less than pre-development.

# 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			





**Design Procedure Form: Extended Detention Basin (EDB)**

UD-BMP (Version 3.06, November 2016)

Sheet 1 of 4

**Designer:** Charlene Durham  
**Company:** Stantec  
**Date:** August 6, 2019  
**Project:** Gardens at North Carefree  
**Location:** North Pond

<p>1. Basin Storage Volume</p> <p>A) Effective Imperviousness of Tributary Area, <math>I_a</math></p> <p>B) Tributary Area's Imperviousness Ratio (<math>i = I_a / 100</math>)</p> <p>C) Contributing Watershed Area</p> <p>D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm</p> <p>E) Design Concept (Select EURV when also designing for flood control)</p> <p>F) Design Volume (WQCV) Based on 40-hour Drain Time (<math>V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area)</math>)</p> <p>G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume (<math>V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN} / 0.43))</math>)</p> <p>H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)</p> <p>I) Predominant Watershed NRCS Soil Group</p> <p>J) Excess Urban Runoff Volume (EURV) Design Volume                  For HSG A: <math>EURV_A = 1.68 * i^{1.28}</math>                  For HSG B: <math>EURV_B = 1.36 * i^{1.08}</math>                  For HSG C/D: <math>EURV_{C/D} = 1.20 * i^{1.08}</math> </p>	<p><math>I_a =</math> <u>80.0</u> %</p> <p><math>i =</math> <u>0.800</u></p> <p>Area = <u>5.990</u> ac</p> <p><math>d_6 =</math> _____ in</p> <p>Choose One</p> <p><input checked="" type="radio"/> Water Quality Capture Volume (WQCV)</p> <p><input type="radio"/> Excess Urban Runoff Volume (EURV)</p> <p><math>V_{DESIGN} =</math> <u>0.164</u> ac-ft</p> <p><math>V_{DESIGN\ OTHER} =</math> _____ ac-ft</p> <p><math>V_{DESIGN\ USER} =</math> _____ ac-ft</p> <p>Choose One</p> <p><input type="radio"/> A</p> <p><input type="radio"/> B</p> <p><input type="radio"/> C / D</p> <p><b>WQCV selected. Soil group not required.</b></p> <p>EURV = _____ ac-ft</p>
<p>2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)</p>	<p>L : W = <u>1.5</u> : 1 <b>INCREASE FLOW PATH FOR 2:1 RATIO</b></p>
<p>3. Basin Side Slopes</p> <p>A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)</p>	<p>Z = <u>4.00</u> ft / ft</p>
<p>4. Inlet</p> <p>A) Describe means of providing energy dissipation at concentrated inflow locations:</p>	<p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>

**Design Procedure Form: Extended Detention Basin (EDB)**

**Designer:** Charlene Durham  
**Company:** Stantec  
**Date:** August 6, 2019  
**Project:** Gardens at North Carefree  
**Location:** North Pond

<p>5. Forebay</p> <p>A) Minimum Forebay Volume (<math>V_{MIN} =</math> <u>2%</u> of the WQCV)</p> <p>B) Actual Forebay Volume</p> <p>C) Forebay Depth (<math>D_F =</math> <u>18</u> inch maximum)</p> <p>D) Forebay Discharge</p> <p style="padding-left: 20px;">i) Undetained 100-year Peak Discharge</p> <p style="padding-left: 20px;">ii) Forebay Discharge Design Flow (<math>Q_F = 0.02 * Q_{100}</math>)</p> <p>E) Forebay Discharge Design</p> <p>F) Discharge Pipe Size (minimum 8-inches)</p> <p>G) Rectangular Notch Width</p>	<p><math>V_{MIN} =</math> <u>0.003</u> ac-ft</p> <p><math>V_F =</math> <u>0.009</u> ac-ft</p> <p><math>D_F =</math> <u>12.0</u> in</p> <p><math>Q_{100} =</math> <u>25.80</u> cfs</p> <p><math>Q_F =</math> <u>0.52</u> cfs</p> <div style="border: 1px solid black; padding: 5px; display: inline-block; margin-bottom: 5px;">             Choose One  <input type="radio"/> Berm With Pipe  <input checked="" type="radio"/> Wall with Rect. Notch  <input type="radio"/> Wall with V-Notch Weir         </div> <p style="color: blue; font-size: small;">(flow too small for berm w/ pipe)</p> <p>Calculated <math>D_P =</math> <u>        </u> in</p> <p>Calculated <math>W_N =</math> <u>4.3</u> in</p>
<p>6. Trickle Channel</p> <p>A) Type of Trickle Channel</p> <p>F) Slope of Trickle Channel</p>	<div style="border: 1px solid black; padding: 5px; display: inline-block; margin-bottom: 5px;">             Choose One  <input checked="" type="radio"/> Concrete  <input type="radio"/> Soft Bottom         </div> <p><math>S =</math> <u>0.0050</u> ft / ft</p>
<p>7. Micropool and Outlet Structure</p> <p>A) Depth of Micropool (2.5-feet minimum)</p> <p>B) Surface Area of Micropool (10 ft<sup>2</sup> minimum)</p> <p>C) Outlet Type</p> <p>D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)</p> <p>E) Total Outlet Area</p>	<p><math>D_M =</math> <u>2.5</u> ft</p> <p><math>A_M =</math> <u>10</u> sq ft</p> <div style="border: 1px solid black; padding: 5px; display: inline-block; margin-bottom: 5px;">             Choose One  <input checked="" type="radio"/> Orifice Plate  <input type="radio"/> Other (Describe):         </div> <p>_____</p> <p>_____</p> <p><math>D_{orifice} =</math> <u>1.25</u> inches</p> <p><math>A_{ot} =</math> <u>3.60</u> square inches</p>

**Design Procedure Form: Extended Detention Basin (EDB)**

**Designer:** Charlene Durham  
**Company:** Stantec  
**Date:** August 6, 2019  
**Project:** Gardens at North Carefree  
**Location:** North Pond

<p>8. Initial Surcharge Volume</p> <p>A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)</p> <p>B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)</p> <p>C) Initial Surcharge Provided Above Micropool</p>	<p><math>D_{IS} = </math> <u>4</u> in</p> <p><math>V_{IS} = </math> <u>          </u> cu ft</p> <p><math>V_s = </math> <u>3.3</u> cu ft</p>
<p>9. Trash Rack</p> <p>A) Water Quality Screen Open Area: <math>A_t = A_{st} * 38.5 * (e^{-0.095D})</math></p> <p>B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.)</p> <p align="center">Other (Y/N): <u>N</u></p> <p>C) Ratio of Total Open Area to Total Area (only for type 'Other')</p> <p>D) Total Water Quality Screen Area (based on screen type)</p> <p>E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)</p> <p>F) Height of Water Quality Screen (<math>H_{TR}</math>)</p> <p>G) Width of Water Quality Screen Opening (<math>W_{opening}</math>) (Minimum of 12 inches is recommended)</p>	<p><math>A_t = </math> <u>123</u> square inches</p> <p><u>Aluminum Amico-Klemp SR Series with Cross Rods 2" O.C.</u></p> <hr/> <hr/> <p>User Ratio =</p> <p><math>A_{total} = </math> <u>173</u> sq. in.</p> <p><math>H = </math> <u>2.26</u> feet</p> <p><math>H_{TR} = </math> <u>55.12</u> inches</p> <p><math>W_{opening} = </math> <u>12.0</u> inches</p>

**Design Procedure Form: Extended Detention Basin (EDB)**

Designer: Charlene Durham  
Company: Stantec  
Date: August 6, 2019  
Project: Gardens at North Carefree  
Location: North Pond

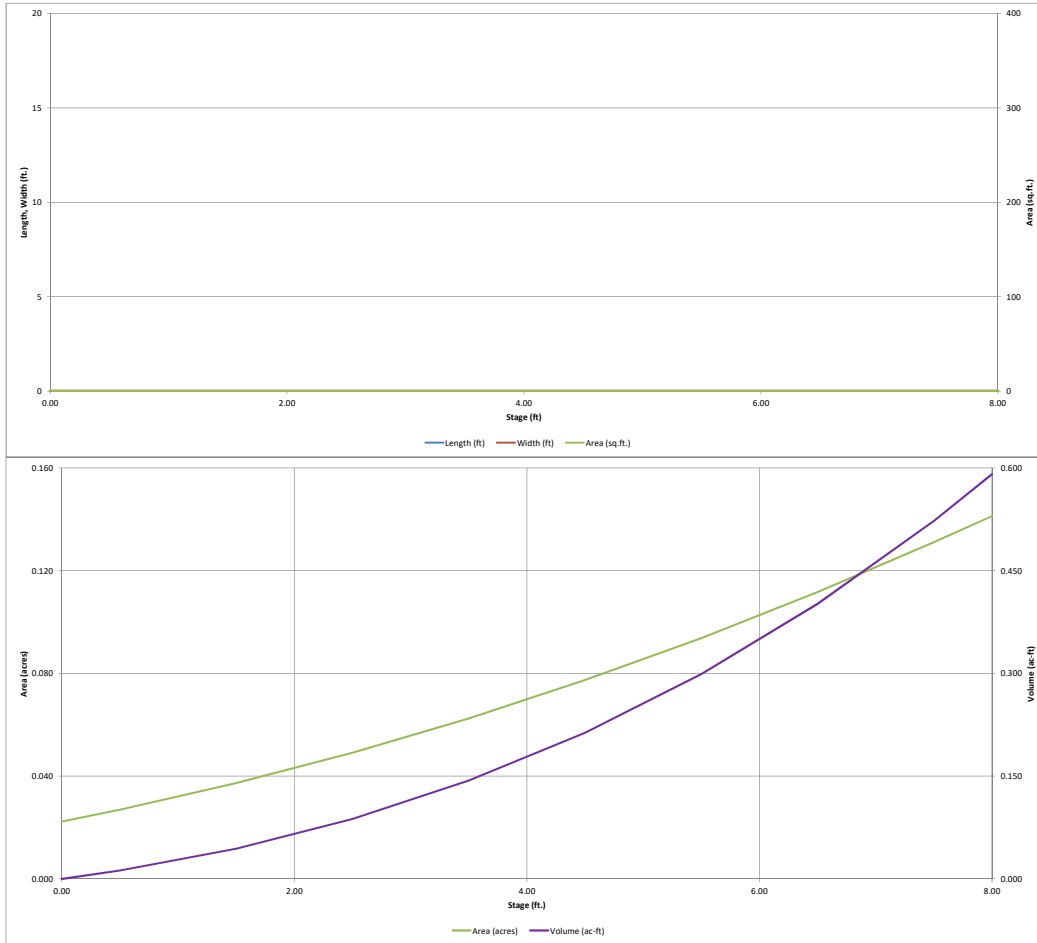
<p>10. Overflow Embankment</p> <p>A) Describe embankment protection for 100-year and greater overtopping:</p> <p>B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)</p>	<p>_____</p> <p>_____</p> <p>_____</p>
<p>11. Vegetation</p>	<p>Choose One</p> <p><input type="radio"/> Irrigated</p> <p><input type="radio"/> Not Irrigated</p>
<p>12. Access</p> <p>A) Describe Sediment Removal Procedures</p>	<p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>
<p>Notes: _____</p> <p>_____</p> <p>_____</p>	

## South Pond



# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

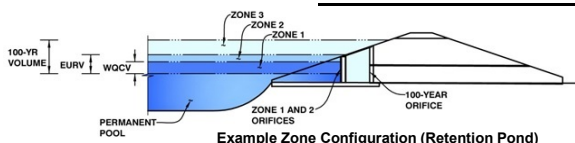
UD-Detention, Version 3.07 (February 2017)



## Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Gardens at North Carefree  
Basin ID: South Pond



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.27	0.076	Orifice Plate
Zone 2 (EURV)	5.45	0.217	Rectangular Orifice
Zone 3 (100-year)	6.66	0.125	Weir&Pipe (Restrict)
		0.419	Total

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft <sup>2</sup>
Underdrain Orifice Centroid =	N/A	feet

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	2.27	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	12.00	inches
Orifice Plate: Orifice Area per Row =	0.52	sq. inches (diameter = 13/16 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row =	3.601E-03	ft <sup>2</sup>
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft <sup>2</sup>

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.00	2.00					
Orifice Area (sq. inches)	0.52	0.52	0.52					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	5.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	5.45	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Height =	2.00	N/A	inches
Vertical Orifice Width =	4.00		inches

Calculated Parameters for Vertical Orifice

	Zone 2 Rectangular	Not Selected	
Vertical Orifice Area =	0.06	N/A	ft <sup>2</sup>
Vertical Orifice Centroid =	0.08	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.70	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	2.00	N/A	feet
Overflow Weir Slope =	3.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	2.00	N/A	feet
Overflow Grate Open Area % =	70%	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 <sub>1</sub> =	6.37	N/A	feet
Over Flow Weir Slope Length =	2.11	N/A	feet
Grate Open Area / 100-yr Orifice Area =	1.67	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	2.95	N/A	ft <sup>2</sup>
Overflow Grate Open Area w/ Debris =	1.48	N/A	ft <sup>2</sup>

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 =	2.50	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 =	18.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	1.77	N/A	ft <sup>2</sup>
Outlet Orifice Centroid =	0.75	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage =	6.70	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	25.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth =	0.27	feet
Stage at Top of Freeboard =	7.97	feet
Basin Area at Top of Freeboard =	0.14	acres

WQCV shall drain in 40hrs. Adjust design accordingly

### Routed Hydrograph Results

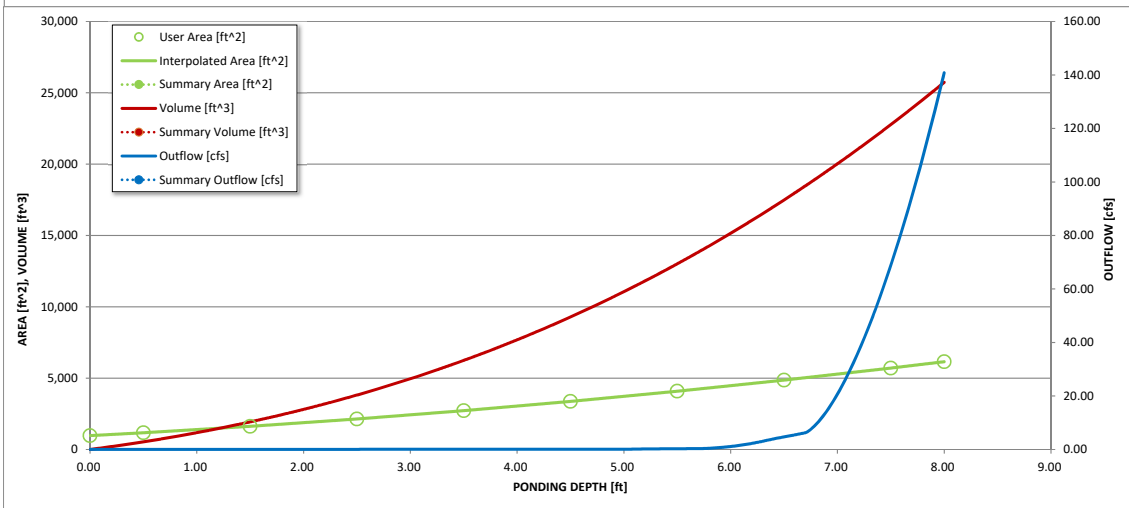
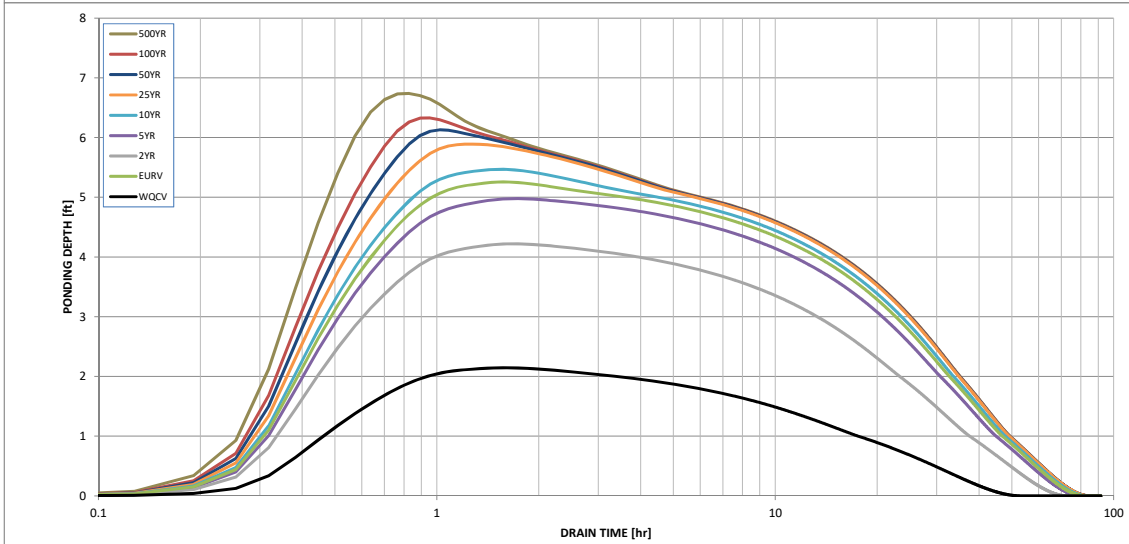
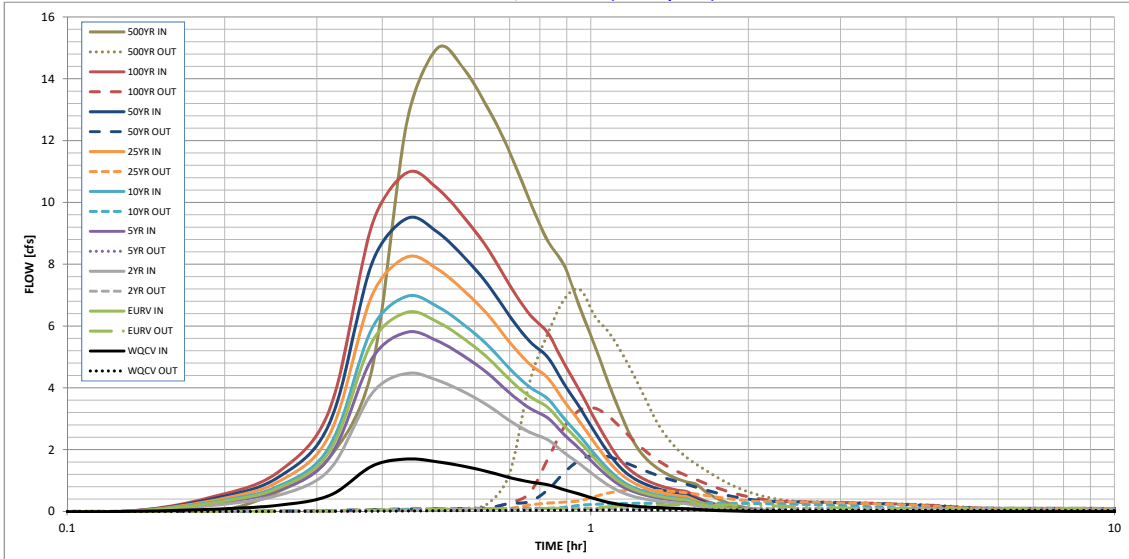
	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =									
One-Hour Rainfall Depth (in)	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.29
Calculated Runoff Volume (acre-ft)	0.076	0.294	0.203	0.264	0.318	0.377	0.434	0.503	0.690
OPTIONAL Override Runoff Volume (acre-ft)									
Inflow Hydrograph Volume (acre-ft)	0.076	0.294	0.203	0.264	0.318	0.377	0.434	0.503	0.690
Predevelopment Unit Peak Flow, q (cfs/acre)	0.00	0.00	0.00	0.01	0.02	0.04	0.29	0.70	1.60
Predevelopment Peak Q (cfs)	0.0	0.0	0.0	0.0	0.0	0.1	0.8	1.9	4.5
Peak Inflow Q (cfs)	1.7	6.4	4.5	5.8	7.0	8.2	9.5	11.0	15.0
Peak Outflow Q (cfs)	0.1	0.2	0.1	0.1	0.3	0.7	1.8	3.3	7.2
Ratio Peak Outflow to Predevelopment Q	N/A	N/A	N/A	4.9	5.6	6.2	2.3	1.7	1.6
Structure Controlling Flow	Plate	Vertical Orifice 1	Plate	Plate	Vertical Orifice 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Spillway
Max Velocity through Grate 1 (fps)	N/A	N/A	N/A	N/A	N/A	0.1	0.5	1.0	2.1
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)	43	63	57	62	63	62	61	59	54
Time to Drain 99% of Inflow Volume (hours)	47	71	64	70	72	72	71	70	67
Maximum Ponding Depth (ft)	2.15	5.26	4.22	4.98	5.47	5.89	6.13	6.33	6.74
Area at Maximum Ponding Depth (acres)	0.04	0.09	0.07	0.09	0.09	0.10	0.10	0.11	0.12
Maximum Volume Stored (acre-ft)	0.071	0.276	0.192	0.251	0.295	0.336	0.361	0.382	0.428

Adjust the design so that release is equal to less than pre-development.



# 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			



**Design Procedure Form: Extended Detention Basin (EDB)**

UD-BMP (Version 3.06, November 2016)

Sheet 1 of 4

**Designer:** Charlene Durham  
**Company:** Stantec  
**Date:** August 6, 2019  
**Project:** Gardens at North Carefree  
**Location:** South Pond

<p>1. Basin Storage Volume</p> <p>A) Effective Imperviousness of Tributary Area, <math>I_a</math></p> <p>B) Tributary Area's Imperviousness Ratio (<math>i = I_a / 100</math>)</p> <p>C) Contributing Watershed Area</p> <p>D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm</p> <p>E) Design Concept (Select EURV when also designing for flood control)</p> <p>F) Design Volume (WQCV) Based on 40-hour Drain Time (<math>V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area)</math>)</p> <p>G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume (<math>V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN} / 0.43))</math>)</p> <p>H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)</p> <p>I) Predominant Watershed NRCS Soil Group</p> <p>J) Excess Urban Runoff Volume (EURV) Design Volume                  For HSG A: <math>EURV_A = 1.68 * i^{1.28}</math>                  For HSG B: <math>EURV_B = 1.36 * i^{1.08}</math>                  For HSG C/D: <math>EURV_{C/D} = 1.20 * i^{1.08}</math> </p>	<p><math>I_a =</math> <u>80.0</u> %</p> <p><math>i =</math> <u>0.800</u></p> <p>Area = <u>2.790</u> ac</p> <p><math>d_6 =</math> _____ in</p> <p>Choose One</p> <p><input checked="" type="radio"/> Water Quality Capture Volume (WQCV)</p> <p><input type="radio"/> Excess Urban Runoff Volume (EURV)</p> <p><math>V_{DESIGN} =</math> <u>0.076</u> ac-ft</p> <p><math>V_{DESIGN\ OTHER} =</math> _____ ac-ft</p> <p><math>V_{DESIGN\ USER} =</math> _____ ac-ft</p> <p>Choose One</p> <p><input type="radio"/> A</p> <p><input type="radio"/> B</p> <p><input type="radio"/> C / D</p> <p>EURV = _____ ac-ft</p> <p><b>WQCV selected. Soil group not required.</b></p>
<p>2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)</p>	<p><math>L : W =</math> <u>1.0</u> : 1 <b>INCREASE FLOW PATH FOR 2:1 RATIO</b></p>
<p>3. Basin Side Slopes</p> <p>A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)</p>	<p><math>Z =</math> <u>4.00</u> ft / ft</p>
<p>4. Inlet</p> <p>A) Describe means of providing energy dissipation at concentrated inflow locations:</p>	<p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>

**Design Procedure Form: Extended Detention Basin (EDB)**

**Designer:** Charlene Durham  
**Company:** Stantec  
**Date:** August 6, 2019  
**Project:** Gardens at North Carefree  
**Location:** South Pond

<p>5. Forebay</p> <p>A) Minimum Forebay Volume (<math>V_{MIN} =</math> <u>2%</u> of the WQCV)</p> <p>B) Actual Forebay Volume</p> <p>C) Forebay Depth (<math>D_F =</math> <u>18</u> inch maximum)</p> <p>D) Forebay Discharge</p> <p style="margin-left: 40px;">i) Undetained 100-year Peak Discharge</p> <p style="margin-left: 40px;">ii) Forebay Discharge Design Flow (<math>Q_F = 0.02 * Q_{100}</math>)</p> <p>E) Forebay Discharge Design</p> <p>F) Discharge Pipe Size (minimum 8-inches)</p> <p>G) Rectangular Notch Width</p>	<p><math>V_{MIN} =</math> <u>0.002</u> ac-ft</p> <p><math>V_F =</math> <u>0.002</u> ac-ft</p> <p><math>D_F =</math> <u>6.0</u> in</p> <p><math>Q_{100} =</math> <u>16.60</u> cfs</p> <p><math>Q_F =</math> <u>0.33</u> cfs</p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>Choose One</p> <p><input type="radio"/> Berm With Pipe</p> <p><input checked="" type="radio"/> Wall with Rect. Notch</p> <p><input type="radio"/> Wall with V-Notch Weir</p> </div> <p style="margin-left: 150px; color: blue;">(flow too small for berm w/ pipe)</p> <p>Calculated <math>D_P =</math> <u>        </u> in</p> <p>Calculated <math>W_N =</math> <u>4.6</u> in</p>
<p>6. Trickle Channel</p> <p>A) Type of Trickle Channel</p> <p>F) Slope of Trickle Channel</p>	<div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>Choose One</p> <p><input checked="" type="radio"/> Concrete</p> <p><input type="radio"/> Soft Bottom</p> </div> <p><math>S =</math> <u>0.0050</u> ft / ft</p>
<p>7. Micropool and Outlet Structure</p> <p>A) Depth of Micropool (2.5-feet minimum)</p> <p>B) Surface Area of Micropool (10 ft<sup>2</sup> minimum)</p> <p>C) Outlet Type</p> <p>D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)</p> <p>E) Total Outlet Area</p>	<p><math>D_M =</math> <u>2.5</u> ft</p> <p><math>A_M =</math> <u>10</u> sq ft</p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>Choose One</p> <p><input checked="" type="radio"/> Orifice Plate</p> <p><input type="radio"/> Other (Describe):</p> </div> <hr style="border: 0; border-top: 1px solid black; margin: 5px 0;"/> <hr style="border: 0; border-top: 1px solid black; margin: 5px 0;"/> <hr style="border: 0; border-top: 1px solid black; margin: 5px 0;"/> <p><math>D_{orifice} =</math> <u>0.50</u> inches</p> <p><math>A_{ot} =</math> <u>1.50</u> square inches</p>

**Design Procedure Form: Extended Detention Basin (EDB)**

**Designer:** Charlene Durham  
**Company:** Stantec  
**Date:** August 6, 2019  
**Project:** Gardens at North Carefree  
**Location:** South Pond

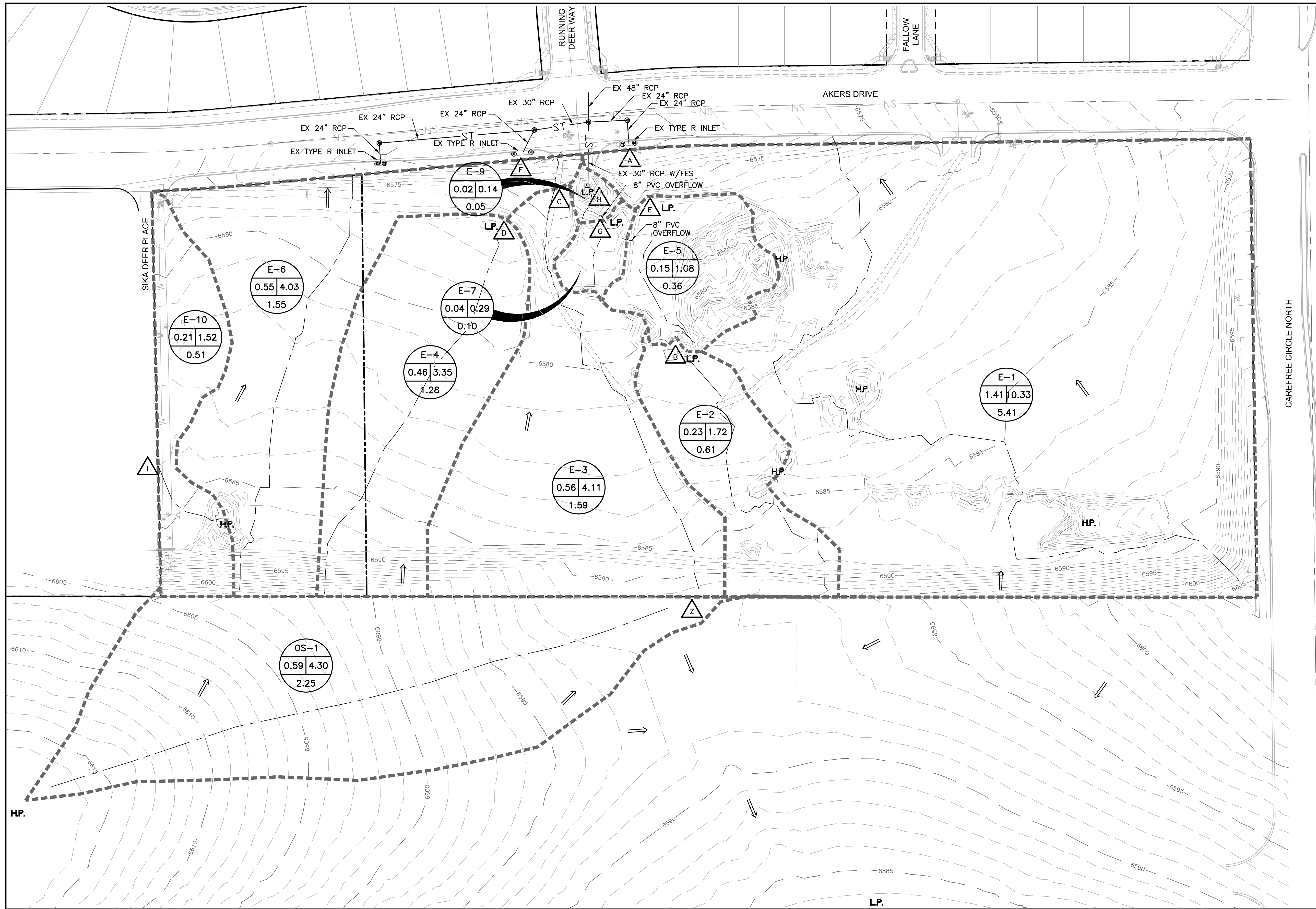
<p>8. Initial Surcharge Volume</p> <p>A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)</p> <p>B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)</p> <p>C) Initial Surcharge Provided Above Micropool</p>	<p><math>D_{IS} = </math> <u>4</u> in</p> <p><math>V_{IS} = </math> <u>          </u> cu ft</p> <p><math>V_s = </math> <u>3.3</u> cu ft</p>
<p>9. Trash Rack</p> <p>A) Water Quality Screen Open Area: <math>A_t = A_{st} * 38.5 * (e^{-0.095D})</math></p> <p>B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.)</p> <p style="padding-left: 40px;">Other (Y/N): <u>N</u></p> <p>C) Ratio of Total Open Area to Total Area (only for type 'Other')</p> <p>D) Total Water Quality Screen Area (based on screen type)</p> <p>E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)</p> <p>F) Height of Water Quality Screen (<math>H_{TR}</math>)</p> <p>G) Width of Water Quality Screen Opening (<math>W_{opening}</math>) (Minimum of 12 inches is recommended)</p>	<p><math>A_t = </math> <u>55</u> square inches</p> <p><u>S.S. Well Screen with 60% Open Area</u></p> <hr/> <hr/> <p>User Ratio =</p> <p><math>A_{total} = </math> <u>92</u> sq. in.</p> <p><math>H = </math> <u>2.64</u> feet</p> <p><math>H_{TR} = </math> <u>59.68</u> inches</p> <p><math>W_{opening} = </math> <u>12.0</u> inches</p>

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Charlene Durham  
Company: Stantec  
Date: August 6, 2019  
Project: Gardens at North Carefree  
Location: South Pond

<p>10. Overflow Embankment</p> <p>A) Describe embankment protection for 100-year and greater overtopping:</p> <p>B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)</p>	<p>_____</p> <p>_____</p> <p>_____</p>
<p>11. Vegetation</p>	<p>Choose One</p> <p><input type="radio"/> Irrigated</p> <p><input type="radio"/> Not Irrigated</p>
<p>12. Access</p> <p>A) Describe Sediment Removal Procedures</p>	<p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>
<p>Notes: _____</p> <p>_____</p> <p>_____</p>	

**Figure 2: Existing Drainage Map**



**LEGEND**

- EXISTING 1' CONTOUR
- EXISTING 5' CONTOUR
- PROPERTY BOUNDARY
- DRAINAGE BASIN BOUNDARY
- FLOW PATH
- DESIGN POINT
- BASIN LABEL

**DESIGN POINT SUMMARY**

DESIGN POINT	Q <sub>5</sub>	Q <sub>100</sub>
Z	0.6	4.4
A	1.4	10.6
B	0.2	1.8
C	1.2	9.4
D	0.5	3.5
E	0.4	2.9
F	0.6	4.2
G	0.4	3.2
H	1.5	11.4
I	0.2	1.6

**Computer File Information**

Creation Date: 6-5-17	Initials: CMD
Last Modification Date: 6-12-17	Initials: BG
Full Path & Drawing File Name: V:\52876\active\187608744-Mule Deer\Reports\Drainage\Exhibits\Ex Basin Exhibit.dwg	
Acad Ver. 2017	Scale: see plan Units: Feet

**Index of Revisions**


**Stantec**  
 Stantec Consulting Inc.  
 1110 Elton Drive  
 Suite B  
 Colorado Springs, CO 80907  
 Tel. (719) 432-6889  
 Fax. (719) 432-6889  
 www.stantec.com

**GARDENS AT NORTH CAREFREE  
EXISTING DRAINAGE PLAN**

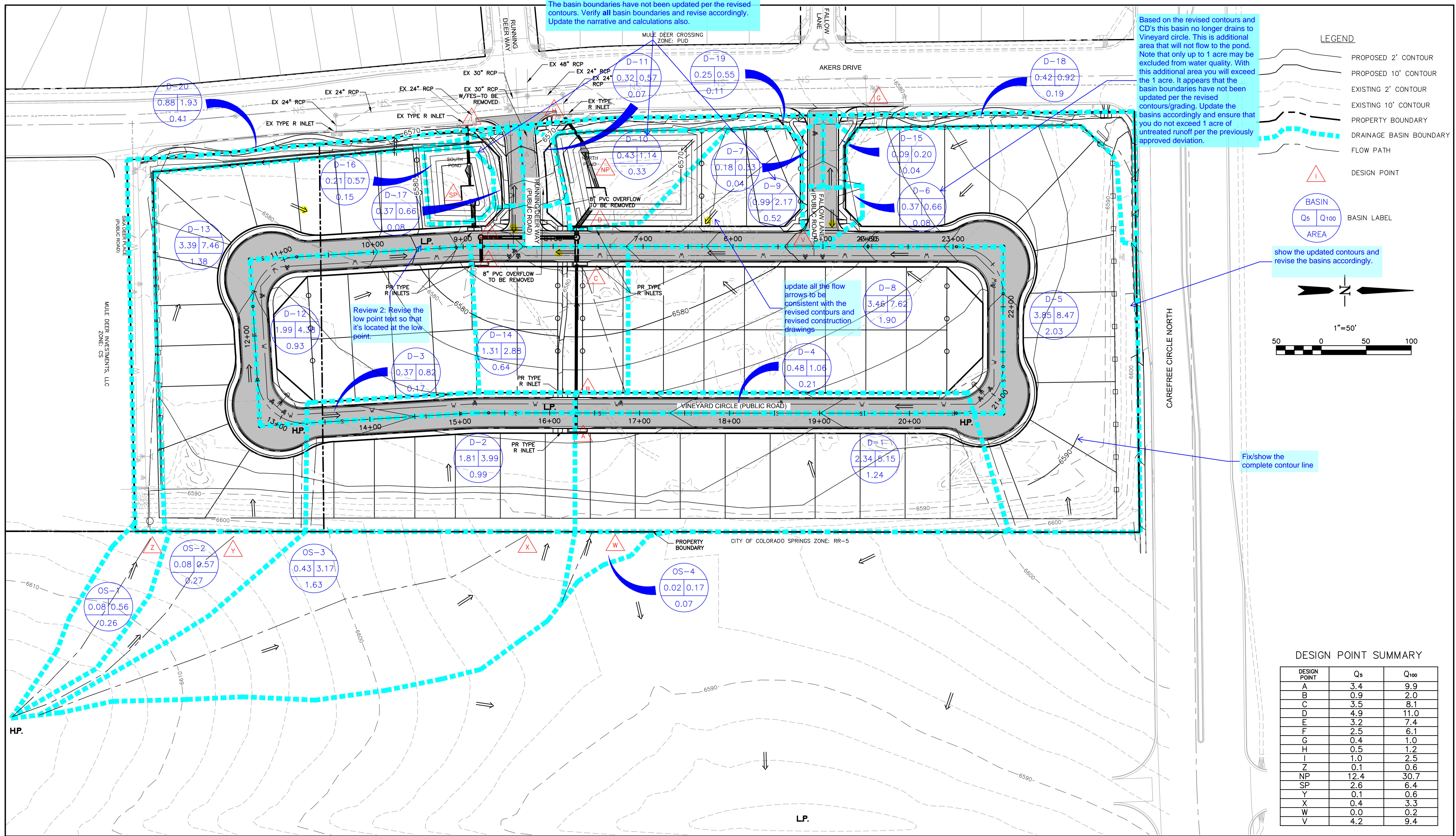
Designer: CMS	Structure Numbers
Detailer: BG	
Sheet Subset:	

**Project No./Code**  
187608744

Sheet Number 1 of 1



**Figure 3: Proposed Drainage Map**



Computer File Information

Creation Date: 6-5-17	Initials: CMD
Last Modification Date: 6-13-17	Initials: BG
Full Path & Drawing File Name: V:\52876\active\187608744-Mule Deer\Reports\Drainage\Exhibits\Pr Basin Exhibit.dwg	
Acad Ver. 2017	Scale: see plan Units: Feet

Index of Revisions

00		
00		
00		

**Stantec**  
Stantec Consulting Inc.  
1110 Elkton Drive  
Suite B  
Colorado Springs, CO 80907  
Tel. (719) 432-6889  
Fax.  
www.stantec.com

**THE GARDENS AT NORTH CAREFREE  
PROPOSED DRAINAGE PLAN**

Designer: CMD	Structure Numbers
Detailer: BG	
Sheet Subset:	

Project No./Code  
187608744

Sheet Number 1 of 1