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:
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December 17, 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.

Charles K. Cothern, P.E. #24997

COLORADO REGISTERED PROFESSIONAL ENGINEER CHARLES K. COTHERN 24997 12/19/19

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.

Mule Deer Investors, LLC

By (signature): Heath A. Herber Date: 12/19/19

Title: Manager

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

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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, 70 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.

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 full spectrum detention ponds. Final design of these facilities is included in the appendix.

Detention Storage Criteria

Proposed Water quality will be incorporated into the full spectrum detention ponds. 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

No variances are being requested for this development.

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 road, Sika Deer Place. The basin includes half of the private road, along with the adjoining area which drains to the south towards the road. 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-1and 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 21 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 interconnected ponds for the development. The north pond will then release into the existing inlet in Akers Drive and continue through the existing storm system to the existing drainage channel to the west.

- Basin OS-1 (0.26 acres) is the southern most offsite basin. This flow is released into Basin D-21 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 (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 (1.83 acres) is along the north boundary of the site, along North Carefree and along Akers Drive, north of Fallow Lane. Runoff continues to a sump inlet on the west side of the west leg of Vineyard Circle. Flows for this basin are 3.47 cfs for the 5-year storm and 7.64 cfs for the 100-year storm.

- Basin D-6 (0.09 acres) is the east portion of Fallow Lane, from the high point in to the road, draining back to the east towards the site. Flows for this basin are 0.41 cfs for the 5-year storm and 0.74 cfs for the 100-year storm.

- Basin D-7 (0.07 acres) is the southwest half of Fallow Lane, flowing away from the site towards Akers Drive. Flows for this basin are 0.32 cfs for the 5-year storm and 0.57 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 a sump 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 (0.43 acres) is the area between the west leg of Vineyard Circle, Fallow Lane and Akers Drive. Runoff releases to a sump inlet on the west side of Vineyard Circle. Flows for this basin are 0.82 cfs for the 5-year storm and 1.80 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 (0.11 acres) is the north half of Running Deer Way. Flows for this basin are 0.50 cfs for the 5-year storm and 0.90 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 an at-grade 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 (1.70 acres) is the south portion of the site. Runoff is directed towards an at-grade inlet on the west half of Vineyard Circle. Flows for this basin are 3.35 cfs and 7.37 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 (0.21 acres) is northwest half of Fallow Lane. Flows are 0.41 cfs for the 5-year storm and 0.89 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 (0.09 acres) is the south half of Running Deer Way. Flows are 0.41 cfs and 0.74 cfs or 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 (0.12 acres) is the area between Fallow Land and Running Deer Way which flows towards Akers Drive. Flows are 0.27 cfs and 0.61 cfs for the minor and major storms, respectively.

- Basin D-20 (0.13 acres) is the area south of Running Deer Way, along the western boundary, which flows towards Akers Drive. Flows are 0.30 cfs for the minor storm and 0.66 cfs for them major storm.

- Basin D-21 (0.28 acres) is the area along the south boundary, which includes Sika Deer Place and the adjacent ROW area draining towards the private road. Flows are 0.64 cfs for the minor storm and 1.41 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 releases on site and will combine with Basin D-21.

- Design Point Y (Q_5=0.1, Q_{100}=0.6) consists of flow from Basin OS-2. Flow from this basin releases on site and will combine with Basin D-13. Flows enter the site as sheet flow and will be directed along the lot lines to the street by the plot plan of each individual lot.

- Design Point X (Q_5=0.4, Q_{100}=3.3) consists of flow from Basin OS-3. Flow from this basin releases on site and will combine with Basin D-2. Flows enter the site as sheet flow and will be directed along the lot lines to the street by the plot plan of each individual lot.

- Design Point W (Q_5=0.0, Q_{100}=0.2) consists of flow from Basin OS-4. Flow from this basin releases on site and will combine with Basin D-1. Flows enter the site as sheet flow and will be directed along the lot lines to the street by the plot plan of each individual lot.

- 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=4.6, Q_{100}=10.8) consists of flow from Basins D-8 and D-14 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. During the 5-year storm, ponding at this inlet will not overtop the curb and will spread less than 12 feet into the roadway. During the 100-year storm, ponding will not spread beyond the back of the sidewalk.

- Design Point V (Q_5=3.8, Q_{100}=8.6) 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=4.4, Q_{100}=9.9) 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. During the 5-year storm, ponding at this inlet will not overtop the curb and will spread less than 12 feet into the roadway. During the 100-year storm, ponding will not exceed the roadway crown.

- Design Point E (Q_5=2.0, Q_{100}=4.6) consists of flow from Basin D-12. 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 South Pond.

- Design Point F (Q_5=2.5, Q_{100}=6.0) 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 the east curb and gutter in Akers Drive and is conveyed south to an inlet just north of Running Deer Way where the flow combines with Design Point H.

- Design Point H (Q_5=1.1, Q_{100}=2.4) 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

This design point should include flow from design point G. Please revise accordingly.

Deer Way. Runoff is intercepted by an existing type R inlet in Akers Drive, north of the Running Deer Way intersection.

- Design Point I (Q_5=1.1, Q_{100}=2.7) consists of flow Basins D-11, D-17, D-20 and DP U. 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 U (Q_5=0.4, Q_{100}=1.3) consists of flow Basin D-21 and DP Z. This is the street flow from Sika Deer Place, along with the offsite flow from Basin OS-1. Flows continue along their existing path as gutter flow in the private road and release into Akers Drive where it is intercepted by an existing type R inlet.

- Design Point NP (Q_5=10.8, Q_{100}=27.1) combines basin D-10 with flows from DP A, DP B, DP C, and DP D. This is the flow being released into the North Pond.

- Design Point SP (Q_5=3.9, Q_{100}=9.3) combines basin D-16 with flows from DP E and 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.

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 account for approximately 8% (0.92 acres of 11.56) of the overall site area. The remaining 92% of the development area is treated through the proposed ponds.

In addition to the "on-site" basins described above and specifically addressed in the deviation request, there is an additional basin outside of the proposed developed area that is graded to tie into adjacent land uses that needs to be considered. This basin is D-21 and is located on the very southern end of the project outside of the proposed fencing that encloses the proposed residential development. This basin receives of site flow from the east (both historically Basin E-10 and as developed Basin D-21) and conveys storm flow to Akers Drive via the existing access road, Sika Drive. The only grading accruing in this basin is to tie grade from the proposed development at the fence line to the existing grade adjacent to Sika Drive. We have conservatively estimated the maximum disturbance to tie the proposed grade and expiating grade together would be 0.07 acres. This disturbance added to the other areas in Basins D-7, D-11, D-15 and D-17 thru D-20 that do not receive treatment would be less than one acre (0.92 + 0.07=0.99 acres meeting the requirements of the El Paso County MS-4 permit.

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 0.49 acres is proposed roadway, and 0.44 acres will be sloped areas at the back of lots along the exterior boundary, releasing into the existing Akers Drive.

DRAINAGE FACILITY DESIGN

General Concept

The Gardens at North Carefree is located in the Sand Creek Drainage Basin.

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 structure will connect to the existing inlet 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 south of Running Deer Way. The system will release into the South Pond

On-Site Water Quality

Water quality and detention for the proposed improvements will be provided by two interconnected ponds (labeled North and South) that function as a single facility. The South Pond drains to the North Pond. Flows will pass through an outlet structure in the North Pond to the existing storm system in Akers Drive through the existing Type R inlet on the northeast corner of Akers Drive and Running Deer Way. The 100-year release rate from the pond is 5.3 cfs, which is 90% of the predevelopment 100-year peak flow of 5.7 cfs. The basins releasing directly offsite have a combined flow of 6.1 cfs. The total combined 100-year flow (detained and undetained) to the existing storm system in Akers Drive will be 11.4 cfs. These flows are much less than the original flows which the existing storm system was designed for. 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 (see appendix in back of report). The existing storm system is adequate to handle the developed flows from the site.

The pond has been designed to provide water quality treatment and detention. The WQCV is treated by the proposed extended detention basin. Previous reports stated that on-site detention would not be necessary, but with updated criteria, the pond was designed to meet 5-year and 100-year detention requirements. Pond sizing calculations are provided in Appendix D. El Paso County has agreed to accept the 5-year storm release rate of 0.2 cfs (which exceeds the predevelopment release rate of 0.1 cfs) so that the pond will meet the 72 hour drain time required by the state.

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.

Temporary Sedimentation Basins

The North Pond and South Pond will serve 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

The WQCV is treated through an extended detention basin. The outlet structure has been designed with the UD-Detention 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 were designed to handle the proposed flows. Therefore, those downstream channel/facilities would not see any 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 x 6.84) + (1.0 x 2.66)+ (0 x 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
GRADING AND EROSION CONTROL				
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
SUBTOTAL GRADING & EROSION CONTROL				**$ 34,154**
DRAINAGE				
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
10' Type R Inlet	EA	$ 10,000.00	1	$ 10,000
15' Type R Inlet	EA	$ 15,000.00	1	$ 15,000
20' Type R Inlet	EA	$ 20,000.00	3	$ 60,000
Outlet Structure	EA	$ 10,000.00	1	$ 10,000
SUBTOTAL DRAINAGE				**$ 181,305**
SUBTOTAL DRAINAGE & GRADING/EROSION CONTROL				**$ 215,459**
ENGINEERING (10%)				$ 21,546
CONTINGENCY (25%)				$ 53,865
TOTAL				***$ 290,870***

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 Antelope Ridge" December 18, 1998. Prepared by URS Greiner Woodward Clyde

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.

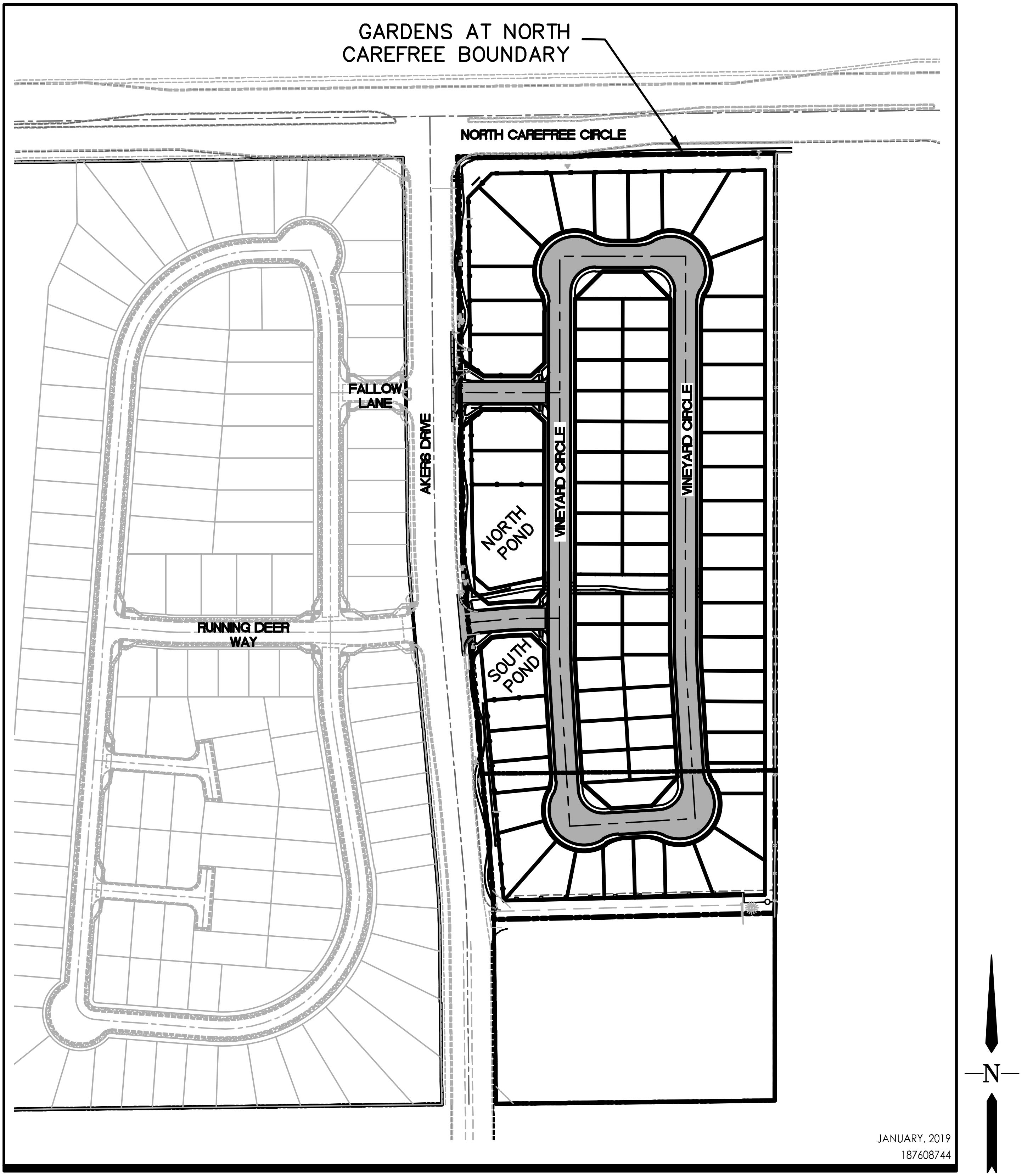
13. "Preliminary Drainage Report for Mule Deer Business Park" January 2005. Prepared by URS.

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



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Stantec

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

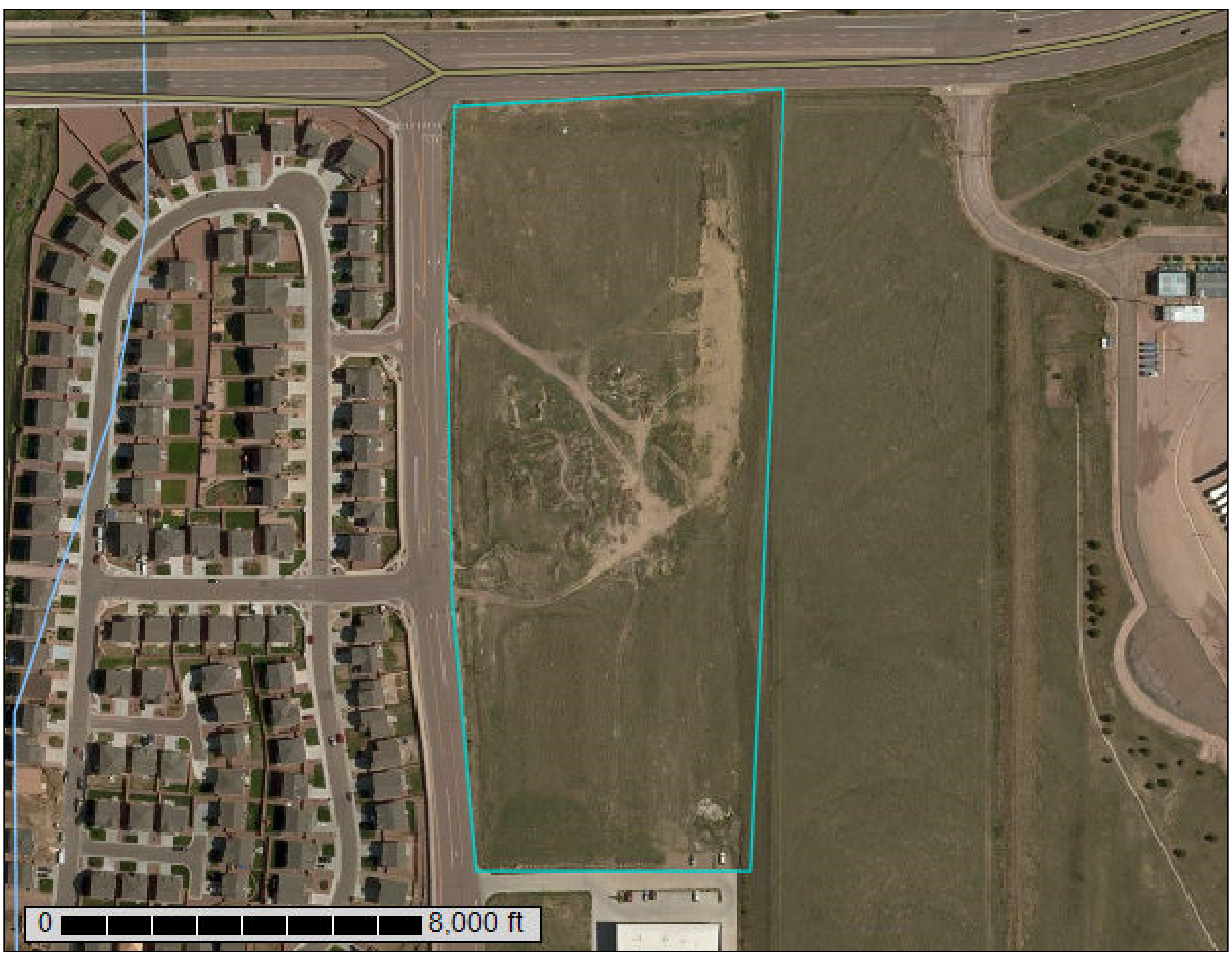
NRCS

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



June 8, 2017

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).

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.

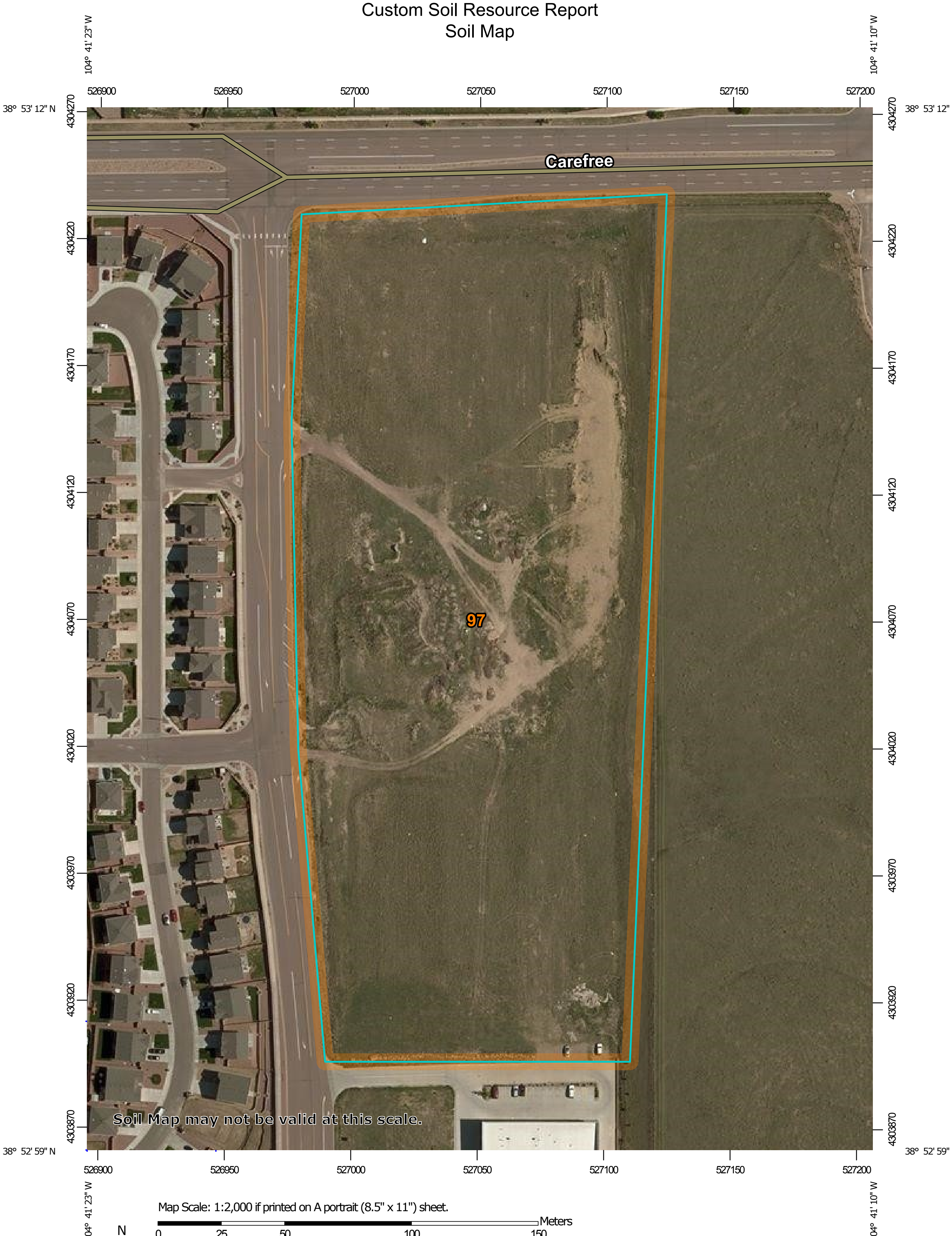
The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political 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

Soil Map

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

Soil Map



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

Meters: 0, 25, 50, 100, 150

Feet: 0, 50, 100, 200, 300

N

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

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 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%
Totals for Area of Interest		**11.5**	**100.0%**

Map Unit Descriptions

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

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

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

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

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

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

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

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

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

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

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

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

El Paso County Area, Colorado

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

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

Urban TOC $_{min}$ = 5 min
Rural TOC $_{min}$ = 10 min

	SUB-BASIN DATA			INITIAL/OVERLAND FLOW (t_i)			TRAVEL TIME (t_t)							TOTAL	Tc CHECK (Urbanized basins)				FINAL Tc (min)
										Type of Land Surface									
Basin ID	Description	C_5	Area (ac)	Length, L (ft)	Slope, s (ft/ft)	t_i (min) (1)	Length (ft)	S_w (ft/ft)	Code	Description	Convey Coef (C_v) (2)	Velocity (V) (ft/s) (3)	t_t Travel Time (min) (4)	$t_c = t_i + t_t$ (min)	Urban (Yes /No)	Length (ft)	$T_{c\ max}$ (min) (5)	$Tc_{max} > t_c$	
OS-1	Offsite Basin @ East Side	0.08	2.25	100	0.035	12.18	555	0.0455	4	Nearly bare ground	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	995	0.0171	4	Nearly bare ground	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	305	0.0295	4	Nearly bare ground	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	470	0.0319	4	Nearly bare ground	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	370	0.0270	4	Nearly bare ground	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	135	0.0296	4	Nearly bare ground	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	410	0.0366	4	Nearly bare ground	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	55	0.0545	4	Nearly bare ground	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	30	0.3333	4	Nearly bare ground	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	105	0.0381	4	Nearly bare ground	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*(1.1-C_5)*(L^0.5))/(S^0.33), from UDFCD Equation RO-3
(2) Cv from UDFCD Table RO-2
(3) Velocity from V = C_v*S_w^0.5, from UDFCD Equation RO-4
(4) t_t=L/60V
(5) t_i max = 10+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 — Created by: CMD — Date: 1/13/2017

Section: Existing Conditions — Checked by: CKC — Date:

Design Storm: 5-yr — P = 1.50 in

LOCATION	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
	AREA DESIGN	AREA (A) (AC)	RUNOFF COEFF (C)	t_c (MIN)	C.A. (AC)	I (IN / HR)	Q (CFS)	t_c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (INCHES)	LENGTH (FT)	VELOCITY (FPS)	t_t (MIN)	
(1)	(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	0.08	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 — Created by: CMD — Date: 1/13/2017
Section: Existing Conditions — Checked by: CKC — Date:
Design Storm: 100-yr — P = 2.52 in

LOCATION	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
	BASIN ID	AREA (A) (AC)	RUNOFF COEFF (C)	t_c (MIN)	C.A. (AC)	I (IN / HR)	Q (CFS)	t_c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (INCHES)	LENGTH (FT)	VELOCITY (FPS)	t_t (MIN)	
(1)	(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 cummulative 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	ONTRIBUTIN BASINS	C A (e q u i v a l e n t) CA(5)	CA(100)	Tc (min.)	I N T E N S I T Y I(5) (in/hr)	I(100) (in/hr)	T O T A L F L O W S Q(5) (cfs)	Q(100) (cfs)
Z	OS-1	0.18	0.79	16.5	3.2	5.6	0.6	4.4
				T R A V E L T I M E				
		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
				T R A V E L T I M E				
		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
				T R A V E L T I M E				
		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
				T R A V E L T I M E				
		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	0.13	0.56	18.9	3.0	5.2	1.2	9.4
	DP D	0.10	0.45	T R A V E L T I M E				
	DP Z	0.18	0.79					
		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	0.03	0.13	6.2	4.8	8.5	0.4	2.9
	DP B	0.05	0.21	T R A V E L T I M E				
		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
				T R A V E L T I M E				
		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	0.01	0.03	6.3	4.8	8.4	0.4	3.2
	DP E	0.08	0.34	T R A V E L T I M E				
		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	0.00	0.02	18.9	3.0	5.2	1.5	11.4
	DP C	0.41	1.79					
	DP G	0.09	0.37	T R A V E L T I M E				
		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
				T R A V E L T I M E				
		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

Runoff Coefficients (C-Values)

Project: Mule Deer Villas
Section: Proposed Conditions

Created by: CMD   Date: 6/9/2017
Checked by: CKC   Date:

Sub-Basin Data			Composite C		Existing			Sub Area (Gravel/Ballast)			Sub Area (Pervious)		
Basin ID	Description	Total Area (ac)	C_5	C_{100}	C_5	C_{100}	Area (ac)	C_5	C_{100}	Area (ac)	C_5	C_{100}	Area (ac)
OS-1	Offsite Basin @ East Side releases to D-20	0.26	0.08	0.35	0.08	0.35	4.09	0.35	0.58	0.00	0.18	0.52	0.00
OS-2	Offsite Basin @ East Side releases to D-13	0.27	0.08	0.35	0.08	0.35	4.09	0.35	0.58	0.00	0.18	0.52	0.00
OS-3	Offsite Basin @ East Side releases to D-2	1.63	0.08	0.35	0.08	0.35	4.09	0.35	0.58	0.00	0.18	0.52	0.00
OS-4	Offsite Basin @ East Side releases to D-1	0.07	0.08	0.35	0.08	0.35	4.09	0.35	0.58	0.00	0.18	0.52	0.00
D-1	East portion of Site btwn North half of Vineyard and East Boundary	1.24	0.45	0.59	0.08	0.35	1.23	0.35	0.58	0.00	0.18	0.52	0.00
D-2	East portion of Site btwn South half of Vineyard and East Boundary	0.99	0.45	0.59	0.90	0.95	0.86	0.35	0.58	0.00	0.18	0.52	0.00
D-3	South/Middle portion of Site inside of Vineyard Circle which drains to east	0.17	0.45	0.59	0.08	0.35	0.49	0.35	0.58	0.00	0.18	0.52	0.00
D-4	North/Middle portion of Site inside of Vineyard Circle which drains to east	0.21	0.45	0.59	0.08	0.35	0.72	0.35	0.58	0.00	0.18	0.52	0.00
D-5	North portion of site, along Carefree Circle	1.83	0.45	0.59	0.08	0.35	1.83	0.35	0.58	0.00	0.18	0.52	0.00
D-6	East Half of Fallow Lane which drains to Vineyard Circle	0.09	0.90	0.96	0.08	0.35	0.09	0.35	0.58	0.00	0.18	0.52	0.00
D-7	Southwest Half of Fallow Lane which drains to Akers	0.07	0.90	0.96	0.08	0.35	0.07	0.35	0.58	0.00	0.18	0.52	0.00
D-8	North/Middle portion of Site inside of Vineyard Circle which drains to west	1.90	0.45	0.59	0.08	0.35	1.13	0.35	0.58	0.00	0.18	0.52	0.00
D-9	Portion of site south of Fallow and btwn Akers and Vineyard	0.43	0.45	0.59	0.08	0.35	0.43	0.35	0.58	0.00	0.18	0.52	0.00
D-10	North Pond	0.33	0.32	0.51	0.08	0.35	0.20	0.35	0.58	0.00	0.18	0.52	0.00
D-11	North half of Running Deer Way	0.11	0.90	0.96	0.08	0.35	0.11	0.35	0.58	0.00	0.18	0.52	0.00
D-12	South/Middle portion of Site inside of Vineyard Circle which drains to west	0.93	0.45	0.59	0.08	0.35	0.64	0.35	0.58	0.00	0.18	0.52	0.00
D-13	Southern portion of site along Sika Deer Place and Akers	1.70	0.45	0.59	0.08	0.35	1.70	0.35	0.58	0.00	0.18	0.52	0.00
D-14	Along eastern Edge of Vineyard (West Side) opposite North Pond	0.64	0.45	0.59	0.08	0.35	0.32	0.35	0.58	0.00	0.18	0.52	0.00
D-15	Northwest Half of Fallow Lane which drains to Akers	0.21	0.45	0.59	0.08	0.35	0.22	0.35	0.58	0.00	0.18	0.52	0.00
D-16	South Pond	0.13	0.32	0.51	0.08	0.35	0.15	0.35	0.58	0.00	0.18	0.52	0.00
D-17	South half of of Running Deer Way	0.09	0.90	0.96	0.08	0.35	0.09	0.35	0.58	0.00	0.18	0.52	0.00
D-18	ROW north of Fallow which drains towards Akers	0.19	0.45	0.59	0.08	0.35	0.33	0.35	0.58	0.00	0.18	0.52	0.00
D-19	ROW btwn Fallow & Running Deer which drains towards Akers	0.12	0.45	0.59	0.08	0.35	0.12	0.35	0.58	0.00	0.18	0.52	0.00
D-20	ROW south of Running Deer which drains towards Akers	0.13	0.45	0.59	0.08	0.35	0.13	0.35	0.58	0.00	0.18	0.52	0.00
D-21	ROW along north edge of Sika Deer Place	0.28	0.45	0.59	0.08	0.35	0.28	0.35	0.58	0.00	0.18	0.52	0.00

Notes:
1. Runoff Coefficients (C-Values) determined by Runoff Coefficient Table 6-6 in Drainage Criteria Manual Vol 1

sf

Standard Form SF-1 . Time of Concentration

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

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

Urban TOC $_{min}$ = 5 min
Rural TOC $_{min}$ = 10 min

	Offsite Basin @ East Side releases to D-20			INITIAL/OVERLAND FLOW (t_i)			TRAVEL TIME (t_t)								Tc CHECK (Urbanized basins)				FINAL Tc (min)
									Type of Land Surface					TOTAL					
Basin ID	Description	C_5	Area (ac)	Length, L (ft)	Slope, s (ft/ft)	t_i (min) (1)	Length (ft)	S_w (ft/ft)	Code	Description	Convey Coef (C_v) (2)	Velocity (V) (ft/s) (3)	t_t Travel Time (min) (4)	$t_c = t_i + t_t$ (min)	Urban (Yes /No)	Length (ft)	$T_{c\ max}$ (min) (5)	$Tc_{max} > t_c$	
OS-1	Offsite Basin @ East Side releases to D-20	0.08	0.26	100	0.035	12.18	150	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	225	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	480	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	383	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	310	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	310	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	405	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	1.83	100	0.064	6.36	450	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	0.09	100	0.020	2.87	60	0.0250	6	Paved areas and shallow paved swales	20.00	3.16	0.32	3.19	YES	160.00	10.89	Check	5.0
D-7	Southwest Half of Fallow Lane which drains to Akers	0.90	0.07	5	0.029	0.57	80	0.0450	6	Paved areas and shallow paved swales	20.00	4.24	0.31	0.88	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	490	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	0.43	100	0.027	8.46	100	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	0.11	5	0.020	0.64	105	0.0600	6	Paved areas and shallow paved swales	20.00	4.90	0.36	1.00	YES	110.00	10.61	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	295	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	470	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	110	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	0.21	100	0.029	8.26	100	0.0450	6	Paved areas and shallow paved swales	20.00	4.24	0.39	8.65	YES	200.00	11.11	Check	8.7

	Offsite Basin @ East Side releases to D-20			INITIAL/OVERLAND FLOW (t_i)			TRAVEL TIME (t_t)								Tc CHECK (Urbanized basins)				FINAL Tc (min)
									Type of Land Surface					TOTAL					
Basin ID	Description	C_5	Area (ac)	Length, L (ft)	Slope, s (ft/ft)	t_i (min) (1)	Length (ft)	S_w (ft/ft)	Code	Description	Convey Coef (C_v) (2)	Velocity (V) (ft/s) (3)	t_t Travel Time (min) (4)	$t_c = t_i + t_t$ (min)	Urban (Yes /No)	Length (ft)	$T_{c\ max}$ (min) (5)	$Tc_{max} > t_c$	
D-16	South Pond	0.32	0.15	25	0.250	2.43			6	Paved areas and shallow paved swales	20.00	0.00	0.00	2.43	YES	25.00	10.14	Check	5.0
D-17	South half of of Running Deer Way	0.90	0.09	10	0.020	0.91	75	0.0600	6	Paved areas and shallow paved swales	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	6	Paved areas and shallow paved swales	20.00	2.83	1.68	5.88	YES	340.00	11.89	Check	5.9
D-19	ROW btwn Fallow & Running Deer which drains towards Akers	0.45	0.12	5	0.333	0.83			6	Paved areas and shallow paved swales	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	0.13	10	0.020	2.95	335	0.0236	6	Paved areas and shallow paved swales	20.00	3.07	1.82	4.77	YES	345.00	11.92	Check	5.0
D-21	ROW along north edge of Sika Deer Place	0.45	0.28	45	0.333	2.47	350	0.0236	6	Paved areas and shallow paved swales	20.00	3.07	1.90	4.37	YES	395.00	12.19	Check	5.0

Notes:
All Equations are from UDFCD Drainage Criteria Manual/Runoff
(1) t_i= (0.395*(1.1-C_5)*(L^0.5))/(S^0.33), from UDFCD Equation RO-3
(2) Cv from UDFCD Table RO-2
(3) Velocity from V = C_v*S_w^0.5, from UDFCD Equation RO-4
(4) t_t=L/60V
(5) t_i max = 10+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
Design Storm: 5-yr   P = 1.50 in

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

LOCATION	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
	AREA DESIGN	AREA (A) (AC)	RUNOFF COEFF (C)	t_c (MIN)	C.A. (AC)	I (IN / HR)	Q (CFS)	t_c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (INCHES)	LENGTH (FT)	VELOCITY (FPS)	t_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	1.83	0.45	9.08	0.82	4.21	3.47													
East Half of Fallow Lane which drains to Vineyard Circle	D-6	0.09	0.90	5.00	0.08	5.09	0.41													
Southwest Half of Fallow Lane which drains to Akers	D-7	0.07	0.90	5.00	0.06	5.09	0.32													
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	0.43	0.45	9.06	0.19	4.21	0.82													
North Pond	D-10	0.33	0.32	10.15	0.11	4.03	0.43													
North half of Running Deer Way	D-11	0.11	0.90	5.00	0.10	5.09	0.50													
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	1.70	0.45	8.17	0.77	4.38	3.35													
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	0.21	0.45	8.65	0.09	4.29	0.41													

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	0.32	5.00	0.04	5.09	0.21													
	South half of of Running Deer Way	D-17	0.09	0.90	5.00	0.08	5.09	0.41													
	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	0.12	0.45	5.00	0.05	5.09	0.27													
	ROW south of Running Deer which drains towards Akers	D-20	0.13	0.45	5.00	0.06	5.09	0.30													
	ROW along north edge of Sika Deer Place	D-21	0.28	0.45	5.00	0.13	5.09	0.64													

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	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
	BASIN ID	AREA (A) (AC)	RUNOFF COEFF (C)	t_c (MIN)	C.A. (AC)	I (IN / HR)	Q (CFS)	t_c (MIN)	SUM (C*A) (AC)	I (IN / HR)	Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	DESIGN FLOW (CFS)	SLOPE (%)	PIPE SIZE (INCHES)	LENGTH (FT)	VELOCITY (FPS)	t_t (MIN)	
(1)	(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	1.83	0.59	9.08	1.08	7.07	7.64													
East Half of Fallow Lane which drains to Vineyard Circle	D-6	0.09	0.96	5.00	0.09	8.55	0.74													
Southwest Half of Fallow Lane which drains to Akers	D-7	0.07	0.96	5.00	0.07	8.55	0.57													
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	0.43	0.59	9.06	0.25	7.08	1.80													
North Pond	D-10	0.33	0.51	10.15	0.17	6.78	1.14													
North half of Running Deer Way	D-11	0.11	0.96	5.00	0.11	8.55	0.90													
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	1.70	0.59	8.17	1.00	7.35	7.37													
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	0.21	0.59	8.65	0.12	7.20	0.89													

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

Project: Gardens at North Carefree - FDR | Created by: CMD | Date: 1/16/2019

Section: Proposed Conditions | Checked by: CKC | Date:

	South Pond	D-16	0.13	0.51	5.00	0.07	8.55	0.57													
	South half of of Running Deer Way	D-17	0.09	0.96	5.00	0.09	8.55	0.74													
	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	0.12	0.59	5.00	0.07	8.55	0.61													
	ROW south of Running Deer which drains towards Akers	D-20	0.13	0.59	5.00	0.08	8.55	0.66													
	ROW along north edge of Sika Deer Place	D-21	0.28	0.59	5.00	0.17	8.55	1.41													

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 cummulative 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	INTENSITY		TOTAL FLOWS	
		CA(5)	CA(100)	(min.)	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					
	DP W	0.01	0.03					
	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	4.6	10.8
	D-14	0.29	0.38					
	FB Inlet E	0.00	0.03	TRAVEL TIME				
		1.14	1.53	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				CHANNEL	34	2.5	0.2	10.3
V	D-5	0.82	1.08	9.1	4.2	7.4	3.8	8.6
	D-6	0.08	0.09					
		0.90	1.17	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				STREET	205	2.8	1.2	10.3
D	D-9	0.19	0.25	10.3	4.0	7.0	4.4	9.9
	DP V	0.90	1.17					
	FB Inlet F	0.00	0.00					
		1.10	1.42	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	6.4	4.8	8.4	2.0	4.6
				TRAVEL TIME				
		0.42	0.55	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				PIPE	34	2.5	0.2	6.6

DESIGN POINT	CONTRIBUTING BASINS	CA(equivalent)		Tc	INTENSITY		TOTAL FLOWS	
		CA(5)	CA(100)	(min.)	I(5) (in/hr)	I(100) (in/hr)	Q(5) (cfs)	Q(100) (cfs)
F	D-13	0.77	1.00	17.5	3.1	5.5	2.5	6.0
	DP Y	0.02	0.10	TRAVEL TIME				
		0.79	1.10	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
				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	0.09	0.12	5.0	5.2	9.1	1.1	2.4
	D-7	0.06	0.07	TRAVEL TIME				
	D-19	0.05	0.07					
		0.21	0.26	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					25	5.0	0.1	5.1
U	D-21	0.13	0.17	19.3	3.0	5.2	0.4	1.3
	DP Z	0.02	0.09	TRAVEL TIME				
		0.15	0.26	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
						5.0	0.0	19.3
I	D-11	0.10	0.11	19.3	3.0	5.2	1.1	2.7
	D-17	0.08	0.09					
	D-20	0.06	0.08					
	DP U	0.15	0.26	TRAVEL TIME				
		0.39	0.53	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
						5.0	0.0	19.3
NP	D-10	0.11	0.17	19.5	3.0	5.2	10.8	27.1
	DP A	1.14	1.91					
	DP B	0.17	0.22					
	DP C	1.14	1.53					
	DP D	1.10	1.42					
				TRAVEL TIME				
		3.66	5.25	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					80	4.0	0.3	19.9
SP	D-16	0.04	0.07	17.6	3.1	5.4	3.9	9.3
	DP E	0.42	0.55					
	DP F	0.79	1.10	TRAVEL TIME				
		1.25	1.71	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
						5.0	0.0	17.6

Per the narrative, design point H should also include design point G. Revise the design calculations accordingly.

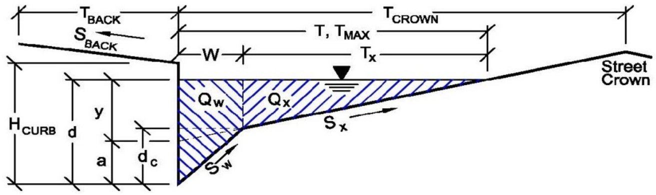
Appendix D: Inlet Calculations

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_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	8.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.92	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.52	1.52	inches
Water Depth at Gutter Flowline	d =	3.44	5.60	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	6.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.688	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	Q_T =	**SUMP**	**SUMP**	**cfs**
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	0.0	0.0	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**SUMP**	**SUMP**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

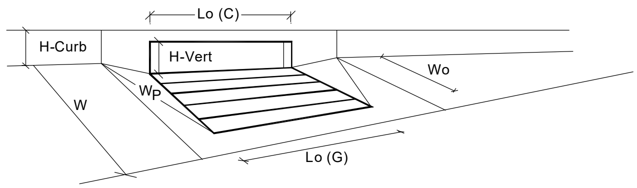
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

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 IN A SUMP OR SAG LOCATION

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



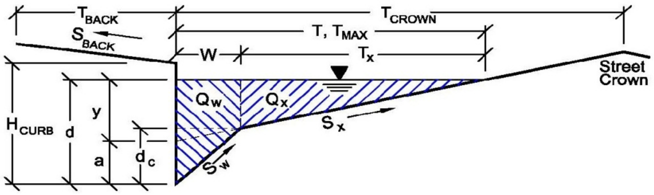
		MINOR	MAJOR	
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	3.4	5.6	inches
				☐ Override Depths
Grate Information		MINOR	MAJOR	
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_f (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	
Curb Opening Information		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_f (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	
Grate Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate Capacity as a Weir (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	N/A	N/A	cfs
Interception with Clogging	Q_{wa} =	N/A	N/A	cfs
Grate Capacity as a Orifice (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	N/A	N/A	cfs
Interception with Clogging	Q_{oa} =	N/A	N/A	cfs
Grate Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	N/A	N/A	cfs
Interception with Clogging	Q_{ma} =	N/A	N/A	cfs
Resulting Grate Capacity (assumes clogged condition)	Q_{Grate} =	**N/A**	**N/A**	**cfs**
Curb Opening Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.33	1.33	
Clogging Factor for Multiple Units	Clog =	0.03	0.03	
Curb Opening as a Weir (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	2.06	10.63	cfs
Interception with Clogging	Q_{wa} =	1.99	10.28	cfs
Curb Opening as an Orifice (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	30.08	37.75	cfs
Interception with Clogging	Q_{oa} =	29.08	36.50	cfs
Curb Opening Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	7.32	18.63	cfs
Interception with Clogging	Q_{ma} =	7.07	18.01	cfs
Resulting Curb Opening Capacity (assumes clogged condition)	Q_{Curb} =	**1.99**	**10.28**	**cfs**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	20.00	20.00	feet
Resultant Street Flow Spread (based on sheet *Q-Allow* geometry)	T =	8.0	17.0	ft
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.0	inches
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**2.0**	**10.3**	**cfs**
WARNING: Inlet Capacity less than Q Peak for Minor Storm	$Q_{PEAK\ REQUIRED}$ =	3.4	9.9	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 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_O =	0.000		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	8.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

		Minor Storm	Major Storm	
Maximum Capacity for 1/2 Street based On Allowable Spread				
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.92	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.52	1.52	inches
Water Depth at Gutter Flowline	d =	3.44	5.60	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	6.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.688	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**SUMP**	**SUMP**	**cfs**
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

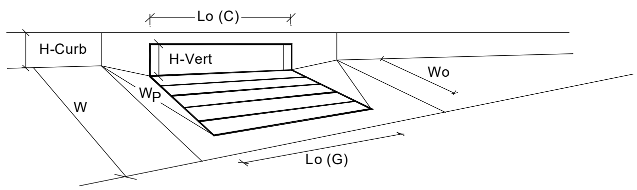
		Minor Storm	Major Storm	
Maximum Capacity for 1/2 Street based on Allowable Depth				
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	0.0	0.0	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**SUMP**	**SUMP**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

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

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 IN A SUMP OR SAG LOCATION

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



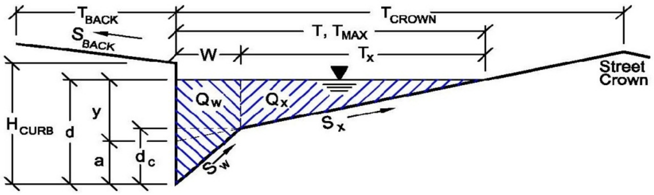
		MINOR	MAJOR	
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	3.4	5.6	inches
				☐ Override Depths
Grate Information		MINOR	MAJOR	
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_f (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	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	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_f (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	
Grate Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate Capacity as a Weir (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	N/A	N/A	cfs
Interception with Clogging	Q_{wa} =	N/A	N/A	cfs
Grate Capacity as a Orifice (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	N/A	N/A	cfs
Interception with Clogging	Q_{oa} =	N/A	N/A	cfs
Grate Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	N/A	N/A	cfs
Interception with Clogging	Q_{ma} =	N/A	N/A	cfs
Resulting Grate Capacity (assumes clogged condition)	Q_{Grate} =	**N/A**	**N/A**	**cfs**
Curb Opening Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.00	1.00	
Clogging Factor for Multiple Units	Clog =	0.10	0.10	
Curb Opening as a Weir (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	1.26	5.09	cfs
Interception with Clogging	Q_{wa} =	1.14	4.58	cfs
Curb Opening as an Orifice (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	7.52	9.44	cfs
Interception with Clogging	Q_{oa} =	6.77	8.49	cfs
Curb Opening Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	2.87	6.44	cfs
Interception with Clogging	Q_{ma} =	2.58	5.80	cfs
Resulting Curb Opening Capacity (assumes clogged condition)	Q_{Curb} =	**1.14**	**4.58**	**cfs**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	5.00	5.00	feet
Resultant Street Flow Spread (based on sheet *Q-Allow* geometry)	T =	8.0	17.0	ft
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.0	inches
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**1.1**	**4.6**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	0.9	2.0	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 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_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.88	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.52	1.52	inches
Water Depth at Gutter Flowline	d =	4.40	5.60	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	10.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.492	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**SUMP**	**SUMP**	**cfs**
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\ TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\ TH}$	$Q_{X\ TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	0.0	0.0	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**SUMP**	**SUMP**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

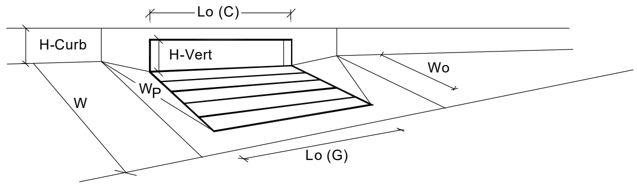
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

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 IN A SUMP OR SAG LOCATION

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



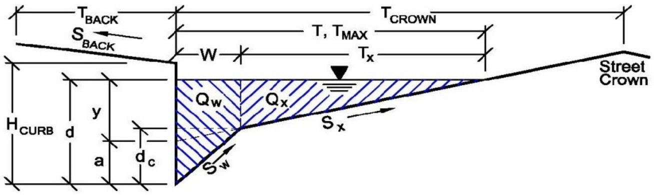
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4.4	5.8	inches ☐ Override Depths
Grate Information		MINOR	MAJOR	
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_f (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	
Curb Opening Information		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_f (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	
Grate Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate Capacity as a Weir (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	N/A	N/A	cfs
Interception with Clogging	Q_{wa} =	N/A	N/A	cfs
Grate Capacity as a Orifice (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	N/A	N/A	cfs
Interception with Clogging	Q_{oa} =	N/A	N/A	cfs
Grate Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	N/A	N/A	cfs
Interception with Clogging	Q_{ma} =	N/A	N/A	cfs
Resulting Grate Capacity (assumes clogged condition)	Q_{Grate} =	**N/A**	**N/A**	**cfs**
Curb Opening Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.33	1.33	
Clogging Factor for Multiple Units	Clog =	0.03	0.03	
Curb Opening as a Weir (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	5.11	11.73	cfs
Interception with Clogging	Q_{wa} =	4.94	11.34	cfs
Curb Opening as an Orifice (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	33.71	38.39	cfs
Interception with Clogging	Q_{oa} =	32.59	37.11	cfs
Curb Opening Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	12.20	19.74	cfs
Interception with Clogging	Q_{ma} =	11.80	19.08	cfs
Resulting Curb Opening Capacity (assumes clogged condition)	Q_{Curb} =	**4.94**	**11.34**	**cfs**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	20.00	20.00	feet
Resultant Street Flow Spread (based on sheet *Q-Allow* geometry)	T =	12.0	17.8	ft.>T-Crown
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.2	inches
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**4.9**	**11.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	4.6	10.8	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_O =	0.000		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	2.88	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.52	1.52	inches
Water Depth at Gutter Flowline	d =	4.40	5.60	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	10.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.492	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	Q_T =	**SUMP**	**SUMP**	**cfs**
Flow Velocity within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	0.0	0.0	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	0.0	0.0	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	0.0	0.0	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	0.0	0.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	0.0	0.0	cfs
Average Flow Velocity Within the Gutter Section	V =	0.0	0.0	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	0.0	0.0	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	SUMP	SUMP	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**SUMP**	**SUMP**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =			inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =			inches

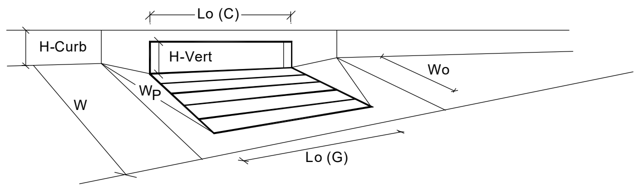
MINOR STORM Allowable Capacity is based on Depth Criterion		Minor Storm	Major Storm	
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

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 IN A SUMP OR SAG LOCATION

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



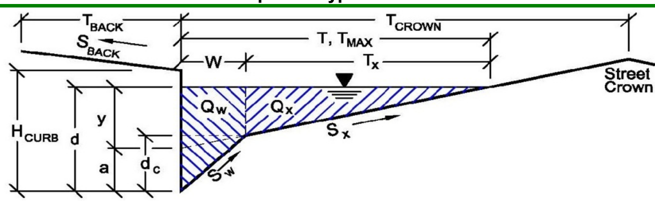
		MINOR	MAJOR	
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Inlet Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4.4	5.6	inches
			☐ Override Depths	
Grate Information		MINOR	MAJOR	
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_f (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	
Curb Opening Information		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_f (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	
Grate Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate Capacity as a Weir (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	N/A	N/A	cfs
Interception with Clogging	Q_{wa} =	N/A	N/A	cfs
Grate Capacity as a Orifice (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	N/A	N/A	cfs
Interception with Clogging	Q_{oa} =	N/A	N/A	cfs
Grate Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	N/A	N/A	cfs
Interception with Clogging	Q_{ma} =	N/A	N/A	cfs
Resulting Grate Capacity (assumes clogged condition)	Q_{Grate} =	**N/A**	**N/A**	**cfs**
Curb Opening Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.33	1.33	
Clogging Factor for Multiple Units	Clog =	0.03	0.03	
Curb Opening as a Weir (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	5.11	10.63	cfs
Interception with Clogging	Q_{wa} =	4.94	10.28	cfs
Curb Opening as an Orifice (based on UDFCD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	33.71	37.75	cfs
Interception with Clogging	Q_{oa} =	32.59	36.50	cfs
Curb Opening Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	12.20	18.63	cfs
Interception with Clogging	Q_{ma} =	11.80	18.01	cfs
Resulting Curb Opening Capacity (assumes clogged condition)	Q_{Curb} =	**4.94**	**10.28**	**cfs**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	20.00	20.00	feet
Resultant Street Flow Spread (based on sheet *Q-Allow* geometry)	T =	12.0	17.0	ft
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.0	inches
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**4.9**	**10.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	4.4	9.9	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} =	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_O =	0.052	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	8.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.92	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.52	1.52	inches
Water Depth at Gutter Flowline	d =	3.44	5.60	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	6.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.688	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	1.7	19.8	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	3.8	10.7	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**5.5**	**30.6**	**cfs**
Flow Velocity within the Gutter Section	V =	9.4	14.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.7	6.5	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	26.3	302.7	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	26.2	210.6	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	12.3	45.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	50.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	38.5	306.0	cfs
Average Flow Velocity Within the Gutter Section	V =	14.8	24.8	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	7.4	24.8	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	0.48	0.39	
Max Flow Based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**18.4**	**118.5**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	4.83	8.58	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	2.98	inches

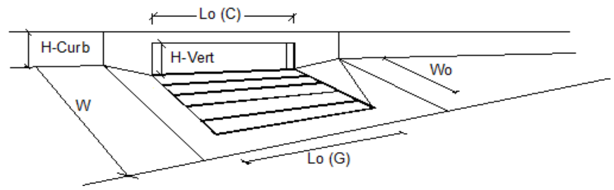
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**5.5**	**30.6**	**cfs**

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



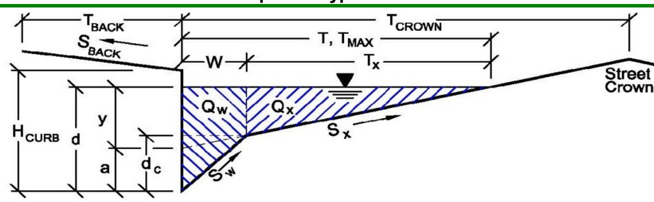
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	10.00	10.00	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_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	Q_o =	2.0	4.6	cfs
Water Spread Width	T =	4.3	7.3	ft
Water Depth at Flowline (outside of local depression)	d =	2.6	3.3	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.935	0.735	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.1	1.2	cfs
Discharge within the Gutter Section W	Q_w =	1.9	3.4	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.31	0.66	sq ft
Velocity within the Gutter Section W	V_W =	6.4	7.0	fps
Water Depth for Design Condition	d_{LOCAL} =	5.6	6.3	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	Q_a =	N/A	N/A	cfs
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	Q_b =	N/A	N/A	cfs
Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.196	0.158	ft/ft
Required Length L_T to Have 100% Interception	L_T =	7.12	12.00	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	7.12	10.00	ft
Interception Capacity	Q_i =	2.0	4.4	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.25	1.25	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	8.75	8.75	ft
Actual Interception Capacity	Q_a =	2.0	4.3	cfs
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	Q_b =	0.0	0.3	cfs
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**2.00**	**4.33**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.3**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100**	**94**	**%**

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



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_O =	0.052	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	8.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (Eq. ST-2)	y =	1.92	4.08	inches
Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.52	1.52	inches
Water Depth at Gutter Flowline	d =	3.44	5.60	inches
Allowable Spread for Discharge outside the Gutter Section W (T - W)	T_X =	6.0	15.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.688	0.350	
Discharge outside the Gutter Section W, carried in Section T_X	Q_X =	1.7	19.8	cfs
Discharge within the Gutter Section W (Q_T - Q_X)	Q_W =	3.8	10.7	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	Q_T =	**5.5**	**30.6**	**cfs**
Flow Velocity within the Gutter Section	V =	9.4	14.0	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	2.7	6.5	

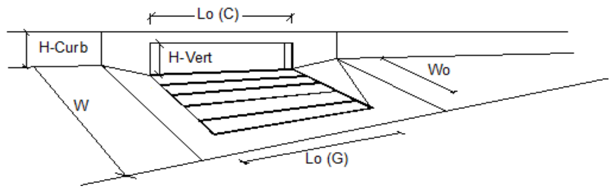
Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	18.7	43.7	ft
Theoretical Spread for Discharge outside the Gutter Section W (T - W)	$T_{X\,TH}$ =	16.7	41.7	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_O =	0.319	0.131	
Theoretical Discharge outside the Gutter Section W, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	26.3	302.7	cfs
Actual Discharge outside the Gutter Section W, (limited by distance T_{CROWN})	Q_X =	26.2	210.6	cfs
Discharge within the Gutter Section W (Q_d - Q_X)	Q_W =	12.3	45.5	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	50.0	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	38.5	306.0	cfs
Average Flow Velocity Within the Gutter Section	V =	14.8	24.8	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	7.4	24.8	
Slope-Based Depth Safety Reduction Factor for Major & Minor (d $\geq$ 6") Storm	R =	0.48	0.39	
Max Flow Based on Allowable Depth (Safety Factor Applied)	Q_d =	**18.4**	**118.5**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	4.83	8.58	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	2.98	inches

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	Q_{allow} =	**5.5**	**30.6**	**cfs**

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 F

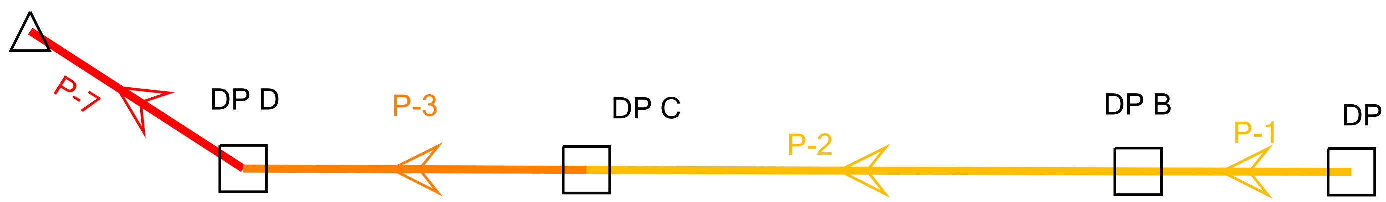


		MINOR	MAJOR	
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit 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_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	Q_o =	2.5	6.0	cfs
Water Spread Width	T =	5.1	8.4	ft
Water Depth at Flowline (outside of local depression)	d =	2.7	3.5	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.887	0.669	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.3	2.0	cfs
Discharge within the Gutter Section W	Q_w =	2.2	4.0	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.38	0.82	sq ft
Velocity within the Gutter Section W	V_W =	6.6	7.3	fps
Water Depth for Design Condition	d_{LOCAL} =	5.7	6.5	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	Q_a =	N/A	N/A	cfs
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	Q_b =	N/A	N/A	cfs
Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.187	0.146	ft/ft
Required Length L_T to Have 100% Interception	L_T =	8.15	14.28	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	8.15	14.28	ft
Interception Capacity	Q_i =	2.5	6.0	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.31	1.31	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.04	0.04	
Effective (Unclogged) Length	L_e =	13.03	13.03	ft
Actual Interception Capacity	Q_a =	2.5	6.0	cfs
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	Q_b =	0.0	0.0	cfs
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**2.50**	**6.00**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100**	**100**	**%**

Appendix E: StormCAD

Storm System 1

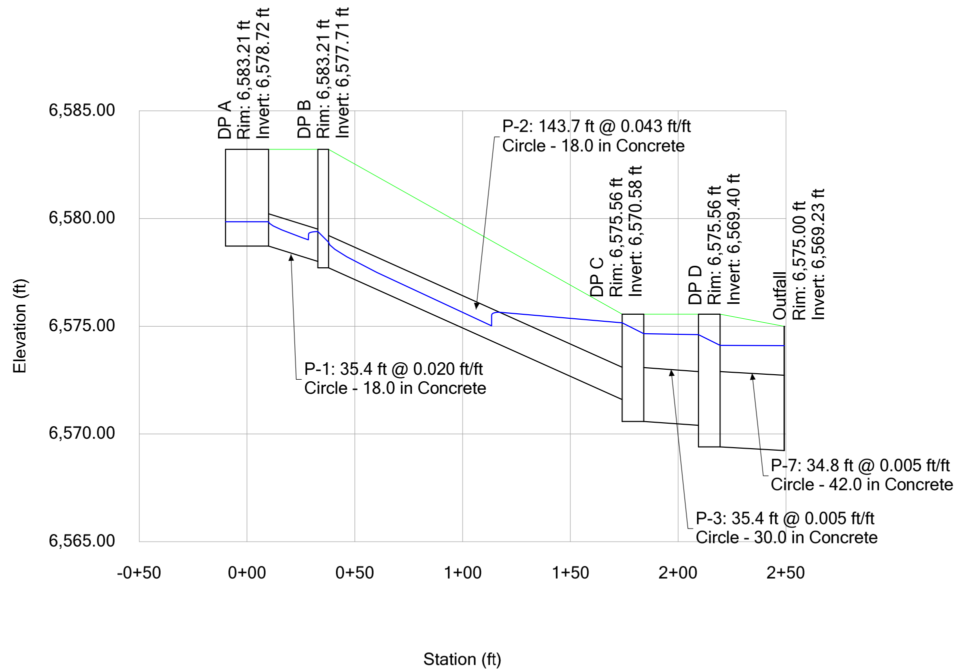
Scenario: 100-Year



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	21.66	9.5	11.86	6,583.21	6,578.90	6,577.71	4	6,575.56	6,575.16	6,571.60	2.46	4.30%
P-7	DP D	Outfall	34.8	42	70.32	20.78	2.16	6,575.56	6,574.11	6,569.40	2.66	6,575.00	6,574.10	6,569.23	2.27	0.50%
P-3	DP C	DP D	35.4	30	29.25	14.57	2.97	6,575.56	6,574.66	6,570.58	2.48	6,575.56	6,574.61	6,570.40	2.66	0.50%

Profile Report
Engineering Profile - DP A to Outfall (St Sys 1-Option.stsw)

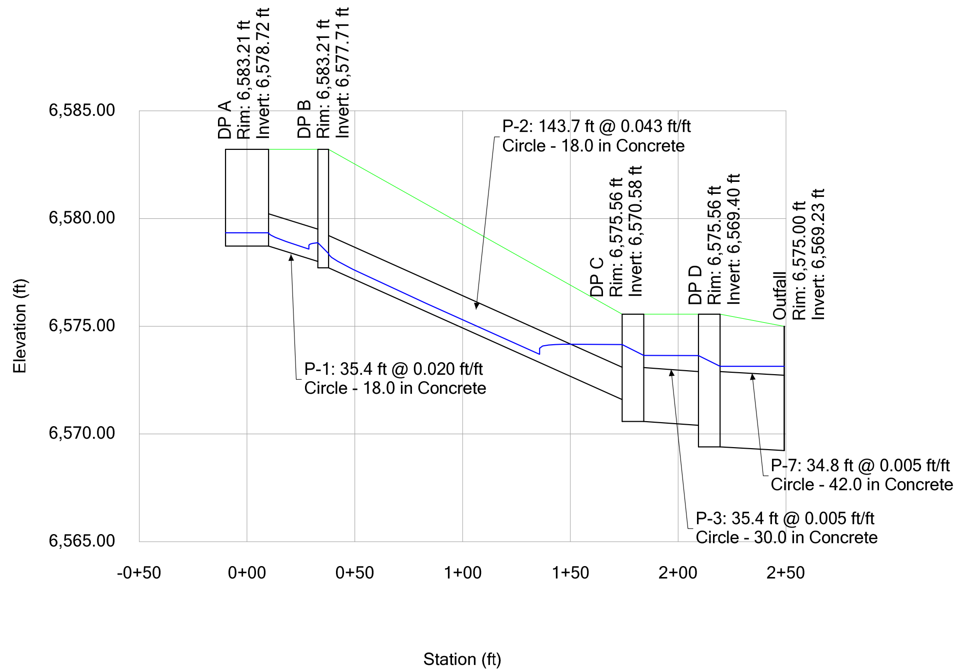


Storm System 1 - 5 Year

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	21.66	3.06	8.67	6,583.21	6,578.38	6,577.71	4	6,575.56	6,574.15	6,571.60	2.46	4.30%
P-7	DP D	Outfall	34.8	42	70.32	7.5	0.78	6,575.56	6,573.14	6,569.40	2.66	6,575.00	6,573.14	6,569.23	2.27	0.50%
P-3	DP C	DP D	35.4	30	29.25	5.04	1.03	6,575.56	6,573.65	6,570.58	2.48	6,575.56	6,573.64	6,570.40	2.66	0.50%

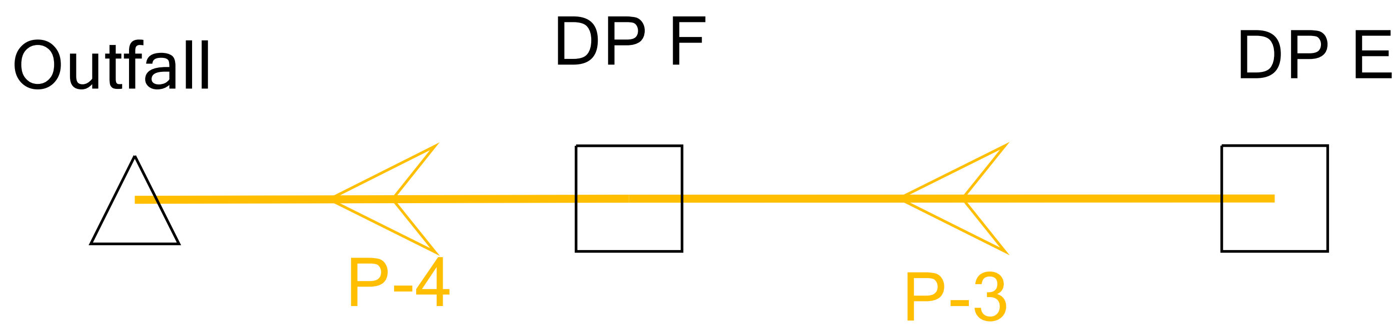
Profile Report

Engineering Profile - DP A to Outfall (St Sys 1-Option.stsw)



Storm System 2

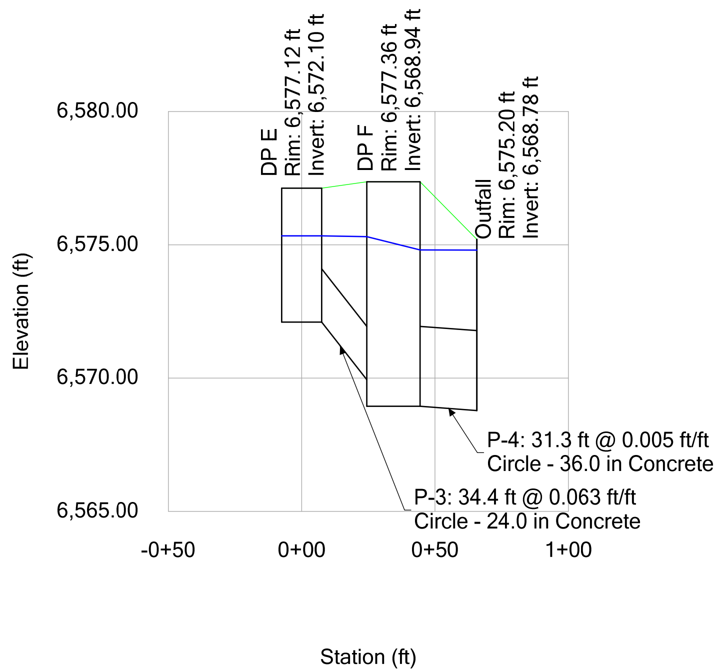
Scenario: 100-Year



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	3.65	0.52	6,577.36	6,574.00	6,568.94	5.42	6,575.20	6,574.00	6,568.78	3.42	0.50%
P-3	DP E	DP F	34.4	24	56.68	2.43	0.77	6,577.12	6,574.50	6,572.10	3.02	6,577.36	6,574.50	6,569.94	5.42	6.30%

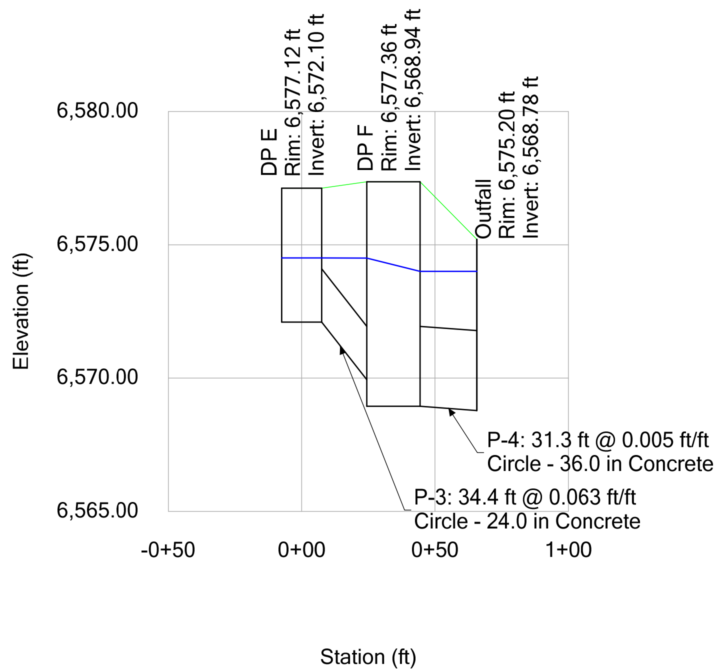
Profile Report
Engineering Profile - DP E to Outfall (St Sys 2-Option.stsw)



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	3.65	0.52	6,577.36	6,574.00	6,568.94	5.42	6,575.20	6,574.00	6,568.78	3.42	0.50%
P-3	DP E	DP F	34.4	24	56.68	2.43	0.77	6,577.12	6,574.50	6,572.10	3.02	6,577.36	6,574.50	6,569.94	5.42	6.30%

Profile Report
Engineering Profile - DP E to Outfall (St Sys 2-Option.stsw)



Appendix F: Detention & Water Quality Pond Calculations

Combined Pond

North Pond

Depth [ft]	Elevation [ft]	Updated Area [sf]	Volume* [cf]	Volume* [ac-ft]
0	6569	4,544	0	0
1	6570	5,494	4,964	0.114
2	6571	6,508	10,955	0.251
3	6572	7,592	18,070	0.415
4	6573	8,745	26,238	0.602
5	6574	9,968	35,595	0.817
5.5	6574.5	10,615	40,741	0.935
6	6575	11,261	46,209	1.061

South Pond

Depth [ft]	Elevation [ft]	Updated Area [sf]	Volume* [cf]	Volume* [ac-ft]
-1	6569	0	0	0
0	6570	1,646	0	0
1	6571	2,166	1,884	0.043
2	6572	2,753	4,338	0.100
3	6573	3,406	7,445	0.171
4	6574	4,122	11,209	0.257
4.5	6574.5	4,513	13,368	0.307
5	6575	4,904	15,722	0.361

Combined Pond
(Sum of North & South Ponds)

Depth [ft]	Elevation [ft]	Area [sf]	Volume** [cf]	Volume** [ac-ft]
0	6569	4,544	0	0.000
1	6570	7,140	4,964	0.114
2	6571	8,674	12,839	0.295
3	6572	10,345	22,408	0.514
4	6573	12,151	33,683	0.773
5	6574	14,090	46,804	1.074
5.5	6574.5	15,128	54,108	1.242
6	6575	16,165	61,931	1.422

* Volumes for North & South Ponds obtained from UD-Detention workbook for each pond separately

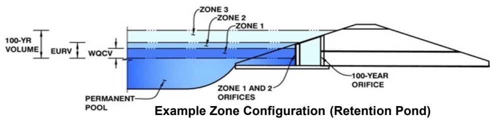
** Areas adjusted on UD-Detention workbook for the Combined Pond to approximate these volumes

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Gardens at North Carefree

Basin ID: Combined North & South Ponds



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	10.59	acres
Watershed Length =	825	ft
Watershed Slope =	0.019	ft/ft
Watershed Imperviousness =	65.00%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	0.224	acre-feet
Excess Urban Runoff Volume (EURV) =	0.854	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.587	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.767	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	0.934	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	1.131	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	1.349	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	1.603	acre-feet
500-yr Runoff Volume (P1 = 3.29 in.) =	2.286	acre-feet
Approximate 2-yr Detention Volume =	0.556	acre-feet
Approximate 5-yr Detention Volume =	0.727	acre-feet
Approximate 10-yr Detention Volume =	0.876	acre-feet
Approximate 25-yr Detention Volume =	1.054	acre-feet
Approximate 50-yr Detention Volume =	1.161	acre-feet
Approximate 100-yr Detention Volume =	1.273	acre-feet

Optional User Override 1-hr Precipitation

1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.29	inches

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.224	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.630	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.419	acre-feet
Total Detention Basin Volume =	1.273	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = 1 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	4,544	0.104		
6570	--	1.00	--	--	--	5,500	0.126	4,967	0.114
6571	--	2.00	--	--	--	9,900	0.227	12,623	0.290
6572	--	3.00	--	--	--	9,950	0.228	22,647	0.520
6573	--	4.00	--	--	--	12,151	0.279	33,697	0.774
6574	--	5.00	--	--	--	14,090	0.323	46,818	1.075
6574.5	--	5.50	--	--	--	15,128	0.347	54,122	1.242
6575	--	6.00	--	--	--	16,165	0.371	61,945	1.422
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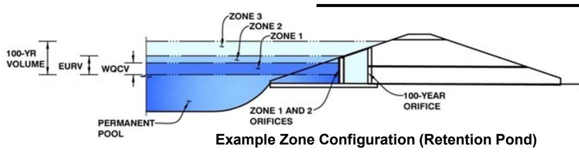
Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Gardens at North Carefree
Basin ID: Combined North & South Ponds



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.68	0.224	Orifice Plate
Zone 2 (EURV)	4.29	0.630	Orifice Plate
Zone 3 (100-year)	5.59	0.419	Weir&Pipe (Restrict)
		1.273	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^2
Underdrain Orifice Centroid =	N/A	feet

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	4.29	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

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

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.50	3.00					
Orifice Area (sq. inches)	2.41	1.11	1.11					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.30	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	4.00	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_t =	4.30	N/A	feet
Over Flow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	27.96	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	11.20	N/A	ft^2
Overflow Grate Open Area w/ Debris =	5.60	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.48	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 =	5.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.40	N/A	ft^2
Outlet Orifice Centroid =	0.25	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.11	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.60	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	30.00	feet
Spillway End Slopes =	3.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

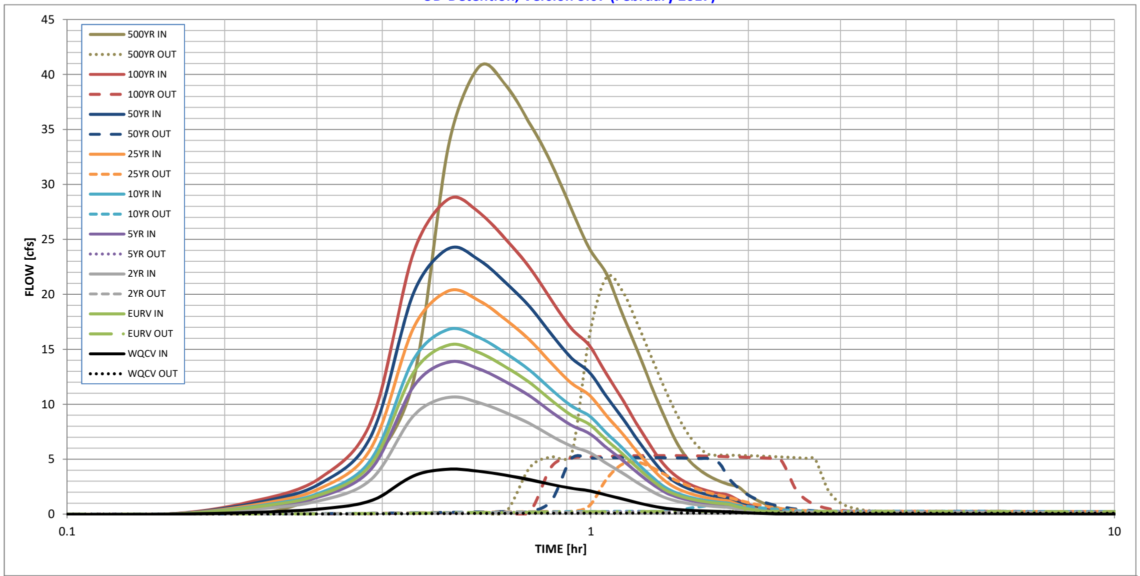
Spillway Design Flow Depth=	0.45	feet
Stage at Top of Freeboard =	7.05	feet
Basin Area at Top of Freeboard =	0.37	acres

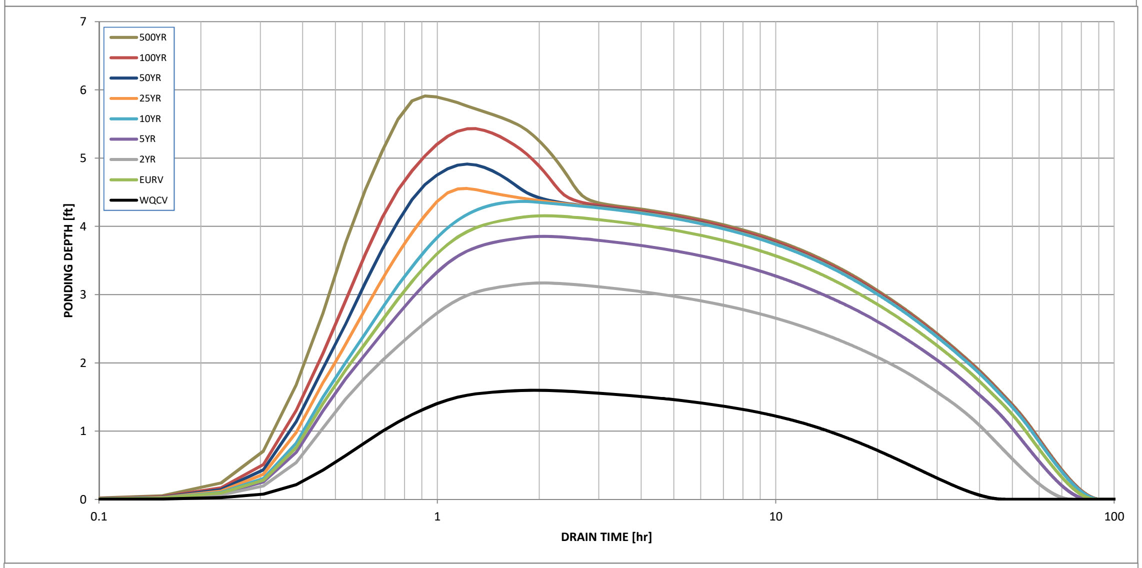
Routed Hydrograph Results

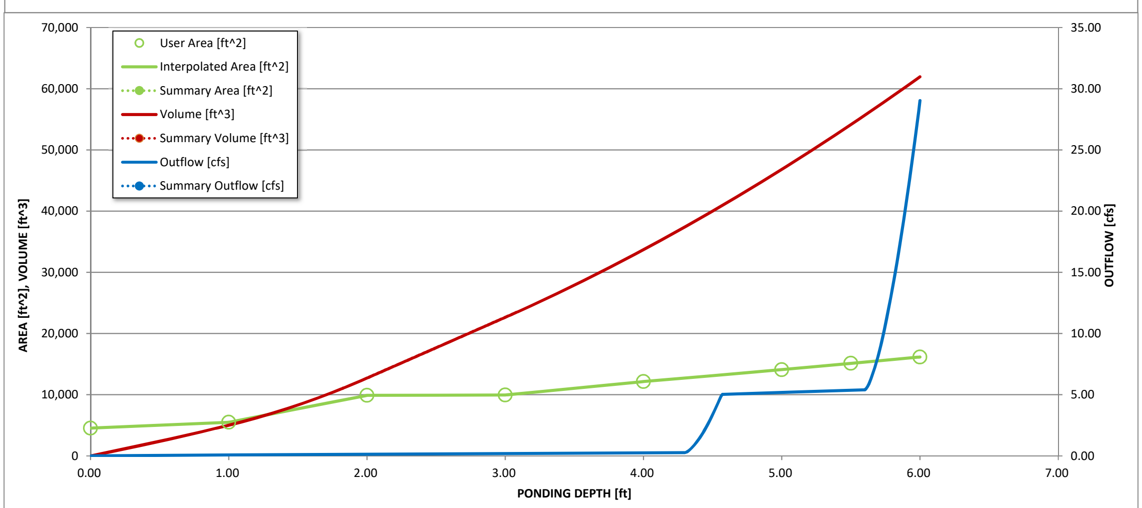
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.29
Calculated Runoff Volume (acre-ft) =	0.224	0.854	0.587	0.767	0.934	1.131	1.349	1.603	2.286
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.224	0.853	0.587	0.767	0.934	1.131	1.348	1.603	2.285
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.00	0.01	0.01	0.03	0.22	0.54	1.26
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.1	0.1	0.3	2.4	5.7	13.4
Peak Inflow Q (cfs) =	4.1	15.4	10.6	13.8	16.8	20.3	24.2	28.7	40.7
Peak Outflow Q (cfs) =	0.1	0.3	0.2	0.2	0.8	4.7	5.2	5.3	21.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	4.1	6.0	14.9	2.2	0.9	1.6
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.1	0.4	0.4	0.4	0.5
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) =	40	73	62	70	74	73	71	70	66
Time to Drain 99% of Inflow Volume (hours) =	**43**	79	68	76	81	80	80	79	77
Maximum Ponding Depth (ft) =	1.60	4.15	3.17	3.85	4.37	4.56	4.91	5.43	5.91
Area at Maximum Ponding Depth (acres) =	0.19	0.29	0.24	0.27	0.29	0.30	0.32	0.34	0.37
Maximum Volume Stored (acre-ft) =	0.207	0.816	0.559	0.732	0.877	0.934	1.046	1.218	1.389

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			

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

Time Interval	4.59 min
Hydrograph Constant	1.090

SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:04:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:09:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:13:46	0.19	0.68	0.47	0.61	0.74	0.89	1.05	1.24	1.74
0:18:22	0.49	1.83	1.27	1.65	2.00	2.41	2.86	3.38	4.77
0:22:57	1.27	4.70	3.26	4.23	5.13	6.18	7.34	8.68	12.25
0:27:32	3.50	12.92	8.97	11.64	14.10	16.98	20.15	23.84	33.62
0:32:08	4.10	15.39	10.63	13.84	16.82	20.32	24.18	28.69	40.71
0:36:43	3.90	14.70	10.14	13.22	16.07	19.42	23.12	27.45	39.01
0:41:19	3.55	13.38	9.23	12.03	14.63	17.68	21.05	24.99	35.50
0:45:54	3.15	11.97	8.24	10.76	13.09	15.84	18.87	22.41	31.90
0:50:29	2.70	10.35	7.11	9.30	11.33	13.72	16.36	19.46	27.76
0:55:05	2.36	9.01	6.20	8.10	9.86	11.93	14.22	16.91	24.15
0:59:40	2.13	8.17	5.62	7.34	8.94	10.82	12.90	15.33	21.88
1:04:16	1.74	6.76	4.63	6.07	7.40	8.98	10.72	12.76	18.26
1:08:51	1.41	5.53	3.78	4.96	6.06	7.37	8.81	10.51	15.07
1:13:26	1.06	4.28	2.91	3.83	4.70	5.73	6.87	8.21	11.84
1:18:02	0.78	3.20	2.16	2.86	3.52	4.31	5.19	6.23	9.05
1:22:37	0.57	2.31	1.57	2.07	2.54	3.13	3.78	4.56	6.68
1:27:13	0.45	1.79	1.21	1.60	1.96	2.40	2.89	3.47	5.05
1:31:48	0.37	1.47	1.00	1.32	1.61	1.97	2.37	2.84	4.10
1:36:23	0.31	1.25	0.85	1.12	1.37	1.67	2.00	2.40	3.46
1:40:59	0.28	1.09	0.74	0.98	1.20	1.46	1.75	2.10	3.02
1:45:34	0.25	0.98	0.67	0.88	1.08	1.31	1.57	1.88	2.71
1:50:10	0.23	0.91	0.62	0.81	0.99	1.21	1.45	1.73	2.49
1:54:45	0.17	0.66	0.45	0.60	0.73	0.89	1.06	1.27	1.84
1:59:20	0.12	0.49	0.33	0.44	0.53	0.65	0.78	0.93	1.34
2:03:56	0.09	0.36	0.24	0.32	0.39	0.48	0.57	0.68	0.99
2:08:31	0.07	0.26	0.18	0.24	0.29	0.35	0.42	0.51	0.73
2:13:07	0.05	0.19	0.13	0.17	0.21	0.25	0.31	0.37	0.53
2:17:42	0.03	0.13	0.09	0.12	0.15	0.18	0.22	0.26	0.38
2:22:17	0.02	0.10	0.06	0.09	0.11	0.13	0.16	0.19	0.28
2:26:53	0.01	0.06	0.04	0.06	0.07	0.09	0.11	0.13	0.19
2:31:28	0.01	0.04	0.02	0.03	0.04	0.05	0.07	0.08	0.12
2:36:04	0.00	0.02	0.01	0.02	0.02	0.03	0.03	0.04	0.07
2:40:39	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.02	0.03
2:45:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
2:49:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:54:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:59:01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:03:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:08:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:12:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:17:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:21:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:26:33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:31:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:35:44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:40:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:44:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:49:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:54:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:58:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:03:16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:07:52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:12:27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:17:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:21:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:26:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:30:49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:35:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:39:59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:44:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:49:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:53:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:58:21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:02:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:07:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:12:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:16:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:21:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:25:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:30:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Stormwater Detention and Infiltration Design Data Sheet

Workbook Protected   Worksheet Protected

Stormwater Facility Name: **Combined North & South Ponds - Gardens at North Carefree**

Facility Location & Jurisdiction: **NW Corner Akers Dr and Running Deer Way - El Paso County**

User Input: Watershed Characteristics

Watershed Slope =	0.019	ft/ft
Watershed Length =	825	ft
Watershed Area =	10.59	acres
Watershed Imperviousness =	65.0%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent

Location for 1-hr Rainfall Depths (use dropdown):

User Input

WQCV Treatment Method = Extended Detention

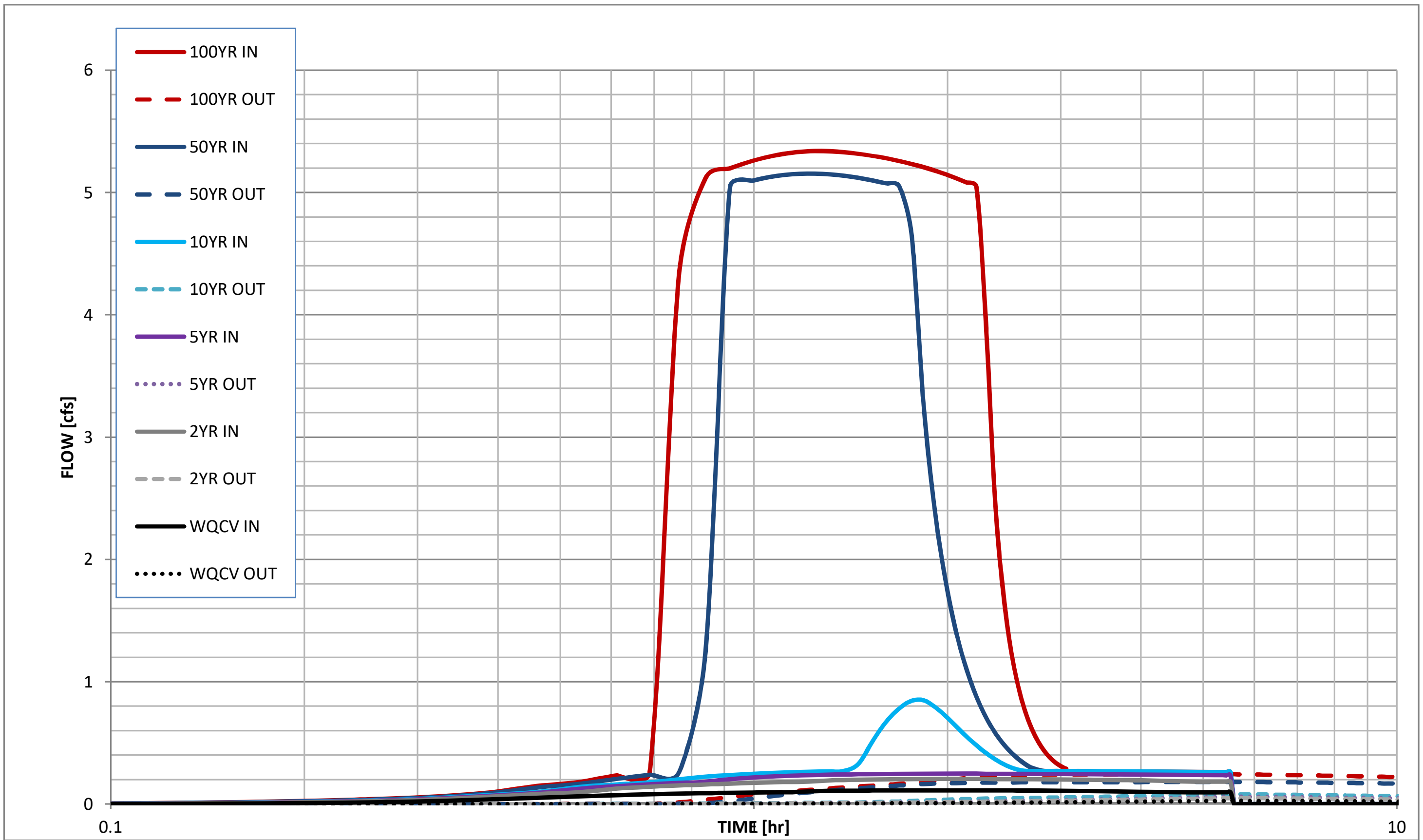
User Defined Stage [ft]	User Defined Area [ft^2]	User Defined Stage [ft]	User Defined Discharge [cfs]
0.00	4,544	0.00	0.00
1.00	5,500	1.00	0.08
2.00	9,900	2.00	0.14
3.00	9,950	3.00	0.19
4.00	12,151	4.00	0.26
5.00	14,090	5.00	5.19
5.50	15,128	5.50	5.36
6.00	16,165	6.00	29.03

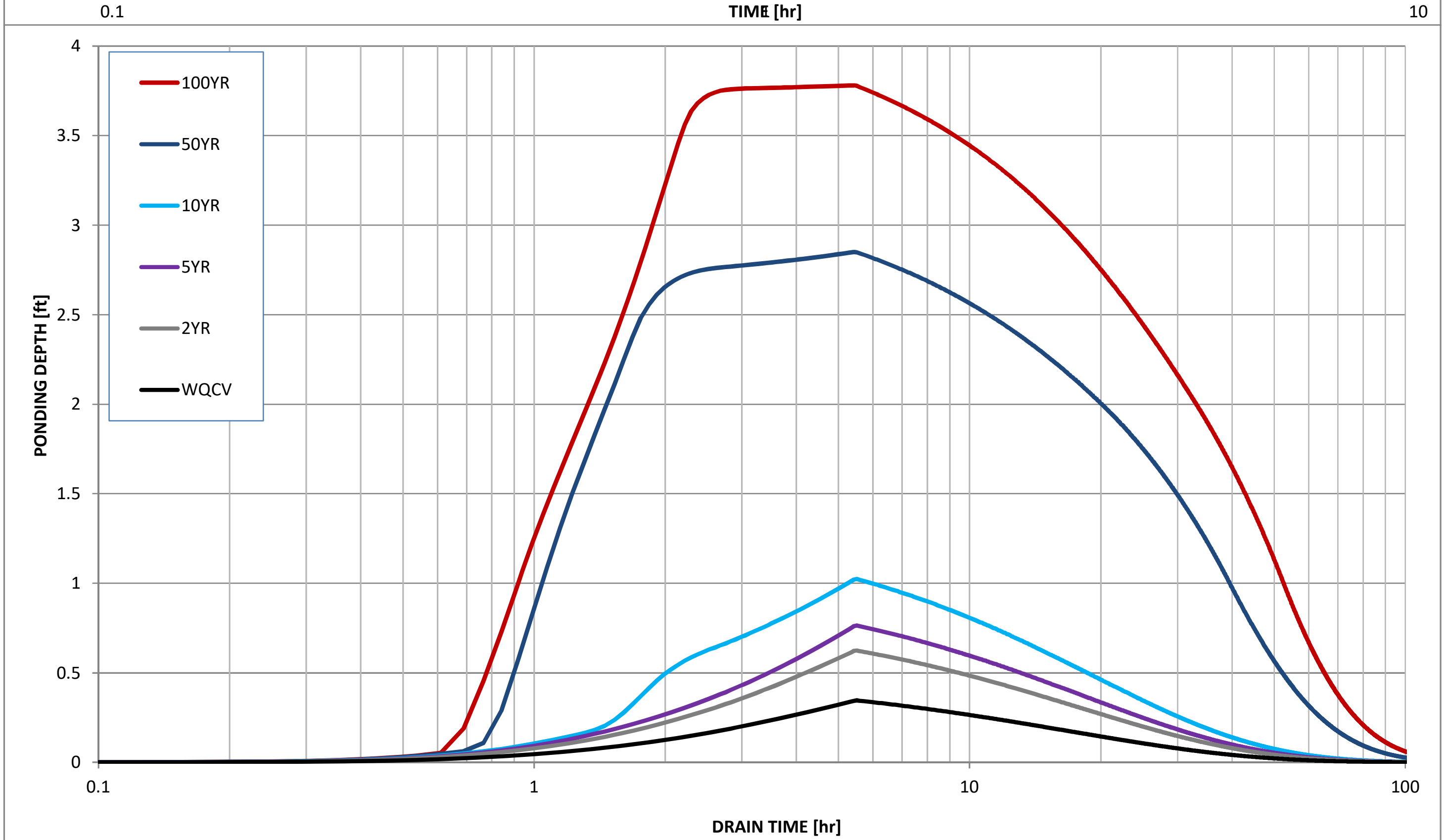
After completing and printing this worksheet to a pdf, go to:
https://maperture.digitaldataservices.com/gvh/?viewer=cswdif
create a new stormwater facility, and
attach the pdf of this worksheet to that record.

Routed Hydrograph Results

Design Storm Return Period =	WQCV	2 Year	5 Year	10 Year	50 Year	100 Year	
One-Hour Rainfall Depth =	0.53	1.19	1.50	1.75	2.25	2.52	in
Calculated Runoff Volume =	0.224	0.587	0.767	0.934	1.349	1.603	acre-ft
OPTIONAL Override Runoff Volume =							acre-ft
Inflow Hydrograph Volume =	0.044	0.081	0.100	0.139	0.549	0.797	acre-ft
Time to Drain 97% of Inflow Volume =	59.1	59.7	**60.0**	60.3	71.8	78.9	hours
Time to Drain 99% of Inflow Volume =	76.6	77.1	77.4	77.7	89.4	**96.5**	hours
Maximum Ponding Depth =	0.35	0.62	0.76	1.02	2.85	3.78	ft
Maximum Ponded Area =	0.11	0.12	0.12	0.13	0.23	**0.27**	acres
Maximum Volume Stored =	0.037	0.069	0.086	0.118	0.485	0.713	acre-ft

Stormwater Detention and Infiltration Design Data Sheet





North Pond Forebay

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.06, November 2016)

Designer:	**Charlene Durham**
Company:	**Stantec**
Date:	**October 16, 2019**
Project:	**Gardens at North Carefree**
Location:	**North Pond**

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 80.0 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.800

C) Contributing Watershed Area — Area = 7.190 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = ______ in

E) Design Concept (Select EURV when also designing for flood control)

Choose One
- (●) Water Quality Capture Volume (WQCV)
- ( ) Excess Urban Runoff Volume (EURV)

F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area)$) — V_{DESIGN} = 0.197 ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN}/0.43))$) — $V_{DESIGN\ OTHER}$ = ______ ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired) — $V_{DESIGN\ USER}$ = ______ ac-ft

I) Predominant Watershed NRCS Soil Group

Choose One
- ( ) A
- ( ) B
- ( ) C / D

WQCV selected. Soil group not required.

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = 1.68 * i^{1.28}$
For HSG B: $EURV_B = 1.36 * i^{1.08}$
For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$
— EURV = ______ ac-f t

2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.) — L : W = 1.5 : 1 **INCREASE FLOW PATH FOR 2:1 RATIO**

3. Basin Side Slopes

A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred) — Z = 4.00 ft / ft

4. Inlet

A) Describe means of providing energy dissipation at concentrated inflow locations: ______

Design Procedure Form: Extended Detention Basin (EDB)

Designer:	**Charlene Durham**
Company:	**Stantec**
Date:	**October 16, 2019**
Project:	**Gardens at North Carefree**
Location:	**North Pond**

5. Forebay

A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV) — V_{FMIN} = 0.006 ac-ft

B) Actual Forebay Volume — V_F = 0.009 ac-ft

C) Forebay Depth (D_F = 18 inch maximum) — D_F = 12.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge — Q_{100} = 25.80 cfs

ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$) — Q_F = 0.52 cfs

E) Forebay Discharge Design

Choose One
- ○ Berm With Pipe
- ◉ Wall with Rect. Notch
- ○ Wall with V-Notch Weir

(flow too small for berm w/ pipe)

F) Discharge Pipe Size (minimum 8-inches) — Calculated D_P = in

G) Rectangular Notch Width — Calculated W_N = 4.3 in

6. Trickle Channel

A) Type of Trickle Channel

Choose One
- ◉ Concrete
- ○ Soft Bottom

F) Slope of Trickle Channel — S = 0.0050 ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum) — D_M = 2.5 ft

B) Surface Area of Micropool (10 ft^2 minimum) — A_M = 10 sq ft

C) Outlet Type

Choose One
- ◉ Orifice Plate
- ○ Other (Describe):

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention) — $D_{orifice}$ = 1.25 inches

E) Total Outlet Area — A_{ot} = 3.60 square inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer:	**Charlene Durham**
Company:	**Stantec**
Date:	**October 16, 2019**
Project:	**Gardens at North Carefree**
Location:	**North Pond**

8. Initial Surcharge Volume		
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 4	in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = 25.7	cu ft
C) Initial Surcharge Provided Above Micropool	V_s= 3.3	cu ft
9. Trash Rack		
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 123	square inches
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.) Other (Y/N): N	*Aluminum Amico-Klemp SR Series with Cross Rods 2" O.C.*	
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =	
D) Total Water Quality Screen Area (based on screen type)	A_{total} = 173	sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 2.26	feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 55.12	inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 12.0	inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer:	**Charlene Durham**
Company:	**Stantec**
Date:	**October 16, 2019**
Project:	**Gardens at North Carefree**
Location:	**North Pond**

10. Overflow Embankment A) Describe embankment protection for 100-year and greater overtopping: B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	
11. Vegetation	Choose One ○ Irrigated ○ Not Irrigated
12. Access A) Describe Sediment Removal Procedures	

Notes:

South Pond Forebay

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.06, November 2016)

Designer:	**Charlene Durham**
Company:	**Stantec**
Date:	**October 16, 2019**
Project:	**Gardens at North Carefree**
Location:	**South Pond**

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a	I_a = 80.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i = 0.800
C) Contributing Watershed Area	Area = 3.400 ac
D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = ______ in
E) Design Concept (Select EURV when also designing for flood control)	Choose One ◉ Water Quality Capture Volume (WQCV) ○ Excess Urban Runoff Volume (EURV)
F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$)	V_{DESIGN}= 0.093 ac-ft
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6*(V_{DESIGN}/0.43))$)	$V_{DESIGN\ OTHER}$= ______ ac-ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{DESIGN\ USER}$= ______ ac-ft
I) Predominant Watershed NRCS Soil Group	Choose One ○ A ○ B ○ C / D **WQCV selected. Soil group not required.**
J) Excess Urban Runoff Volume (EURV) Design Volume For HSG A: $EURV_A = 1.68 * i^{1.28}$ For HSG B: $EURV_B = 1.36 * i^{1.08}$ For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$	EURV = ______ ac-f t
2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)	L : W = 1.0 : 1 **INCREASE FLOW PATH FOR 2:1 RATIO**
3. Basin Side Slopes	
A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z = 4.00 ft / ft
4. Inlet	
A) Describe means of providing energy dissipation at concentrated inflow locations:	

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Charlene Durham
Company: Stantec
Date: October 16, 2019
Project: Gardens at North Carefree
Location: South Pond

5. Forebay

A) Minimum Forebay Volume
(V_{FMIN} = 2% of the WQCV) — V_{FMIN} = 0.002 ac-ft

B) Actual Forebay Volume — V_F = 0.002 ac-ft

C) Forebay Depth
(D_F = 18 inch maximum) — D_F = 6.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge — Q_{100} = 16.60 cfs

ii) Forebay Discharge Design Flow
($Q_F = 0.02 * Q_{100}$) — Q_F = 0.33 cfs

E) Forebay Discharge Design

Choose One
- ○ Berm With Pipe
- ◉ Wall with Rect. Notch
- ○ Wall with V-Notch Weir

(flow too small for berm w/ pipe)

F) Discharge Pipe Size (minimum 8-inches) — Calculated D_P = ____ in

G) Rectangular Notch Width — Calculated W_N = 4.6 in

6. Trickle Channel

A) Type of Trickle Channel

Choose One
- ◉ Concrete
- ○ Soft Bottom

F) Slope of Trickle Channel — S = 0.0050 ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum) — D_M = 2.5 ft

B) Surface Area of Micropool (10 ft^2 minimum) — A_M = 10 sq ft

C) Outlet Type

Choose One
- ◉ Orifice Plate
- ○ Other (Describe):

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing
(Use UD-Detention) — $D_{orifice}$ = 0.50 inches

E) Total Outlet Area — A_{ot} = 1.50 square inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer:	**Charlene Durham**
Company:	**Stantec**
Date:	**October 16, 2019**
Project:	**Gardens at North Carefree**
Location:	**South Pond**

8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 4 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = cu ft
C) Initial Surcharge Provided Above Micropool	V_s= 3.3 cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 55 square inches
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.)	*S.S. Well Screen with 60% Open Area*
Other (Y/N): N	
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =
D) Total Water Quality Screen Area (based on screen type)	A_{total} = 92 sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 2.64 feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 59.68 inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 12.0 inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Charlene Durham
Company: Stantec
Date: October 16, 2019
Project: Gardens at North Carefree
Location: South Pond

10. Overflow Embankment A) Describe embankment protection for 100-year and greater overtopping: B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	
11. Vegetation	Choose One ○ Irrigated ○ Not Irrigated
12. Access A) Describe Sediment Removal Procedures	

Notes:

Excerpts from Previous Reports

Preliminary/Final Drainage Report
for
Mule Deer Crossing

El Paso County, Colorado
May 2005

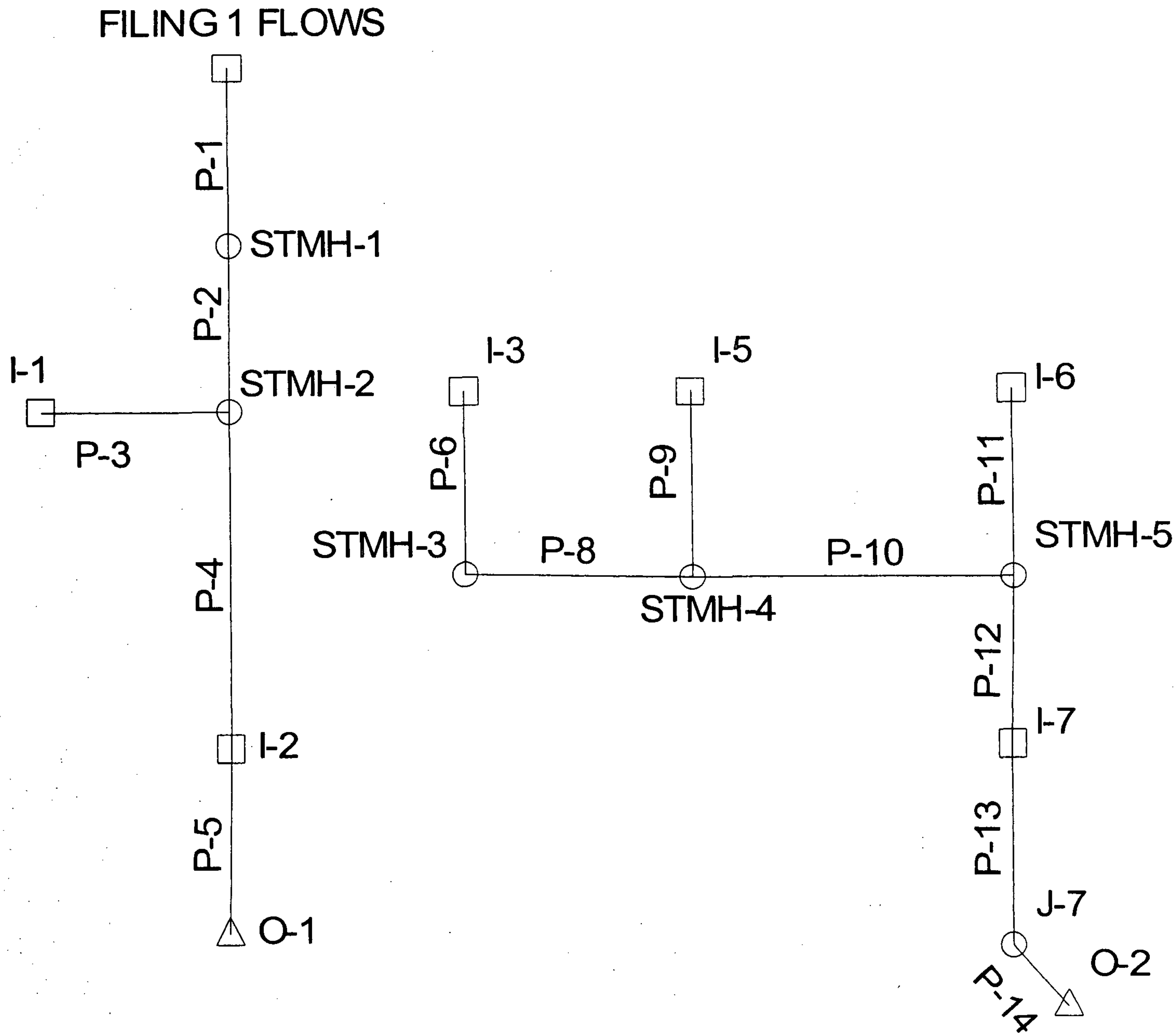
Prepared for:
MZT, LLC
520 E. Colorado Ave
Colorado Springs, CO 80903

Prepared by:

URS

9960 Federal Drive, Suite 300
Colorado Springs, CO 80921
URS Job No. 21711206

Scenario: 100-year

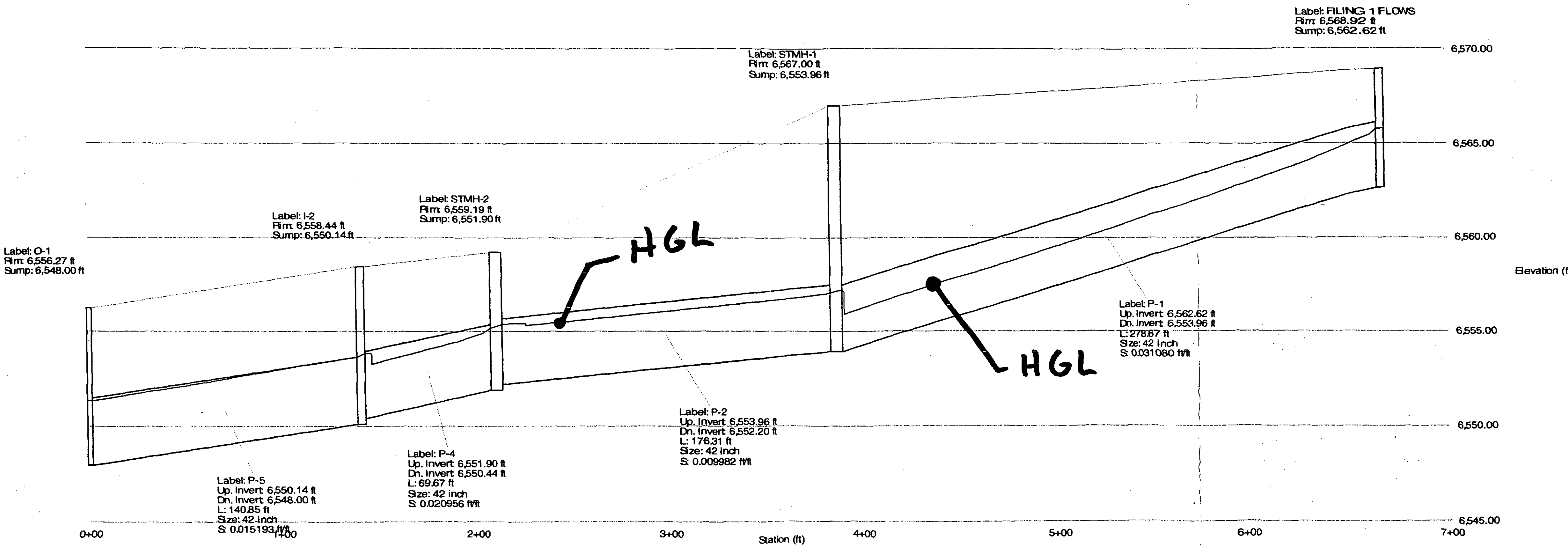


Scenario: 100-year

Combined Pipe\Node Report

Label	Upstream Node	Downstream Node	Length (ft)	Section Size	System Rational Flow (cfs)	Full Capacity (cfs)	Average Velocity (ft/s)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Constructed Slope (ft/ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-1	FILING 1 FLOW	STMH-1	278.67	42 inch	104.66	177.36	11.37	6,562.62	6,553.96	0.031080	6,565.74	6,557.23
P-2	STMH-1	STMH-2	176.31	42 inch	103.74	100.52	11.36	6,553.96	6,552.20	0.009982	6,557.07	6,555.41
P-3	I-1	STMH-2	6.67	24 inch	28.90	31.58	9.20	6,554.03	6,553.90	0.019490	6,557.30	6,557.20
P-4	STMH-2	I-2	69.67	42 inch	124.78	145.64	13.18	6,551.90	6,550.44	0.020956	6,555.18	6,553.86
P-5	I-2	O-1	140.85	42 inch	133.38	124.01	14.00	6,550.14	6,548.00	0.015193	6,553.64	6,551.33
P-6	I-3	STMH-3	4.67	24 inch	8.12	31.40	5.66	6,551.87	6,551.78	0.019272	6,552.88	6,552.64
P-9	I-5	STMH-4	4.67	12 inch	5.96	6.43	7.68	6,550.34	6,550.25	0.019272	6,551.29	6,551.23
P-8	STMH-3	STMH-4	123.16	24 inch	8.11	22.61	5.84	6,551.48	6,550.25	0.009987	6,552.49	6,551.08
P-10	STMH-4	STMH-5	112.41	24 inch	12.64	22.58	4.99	6,549.95	6,548.83	0.009964	6,551.23	6,551.15
P-11	I-6	STMH-5	4.67	24 inch	17.04	133.23	5.45	6,548.92	6,547.30	0.346895	6,550.86	6,550.84
P-12	STMH-5	I-7	24.67	30 inch	26.44	59.55	5.39	6,548.33	6,547.81	0.021078	6,550.80	6,550.70
P-13	I-7	J-7	149.02	30 inch	41.88	59.44	11.06	6,547.51	6,544.38	0.021004	6,549.68	6,545.95
P-14	J-7	O-2	14.72	30 inch	41.55	65.90	10.12	6,544.38	6,544.00	0.025815	6,546.54	6,545.79

Profile
Scenario: 100-year



Profile
Scenario: 100-year

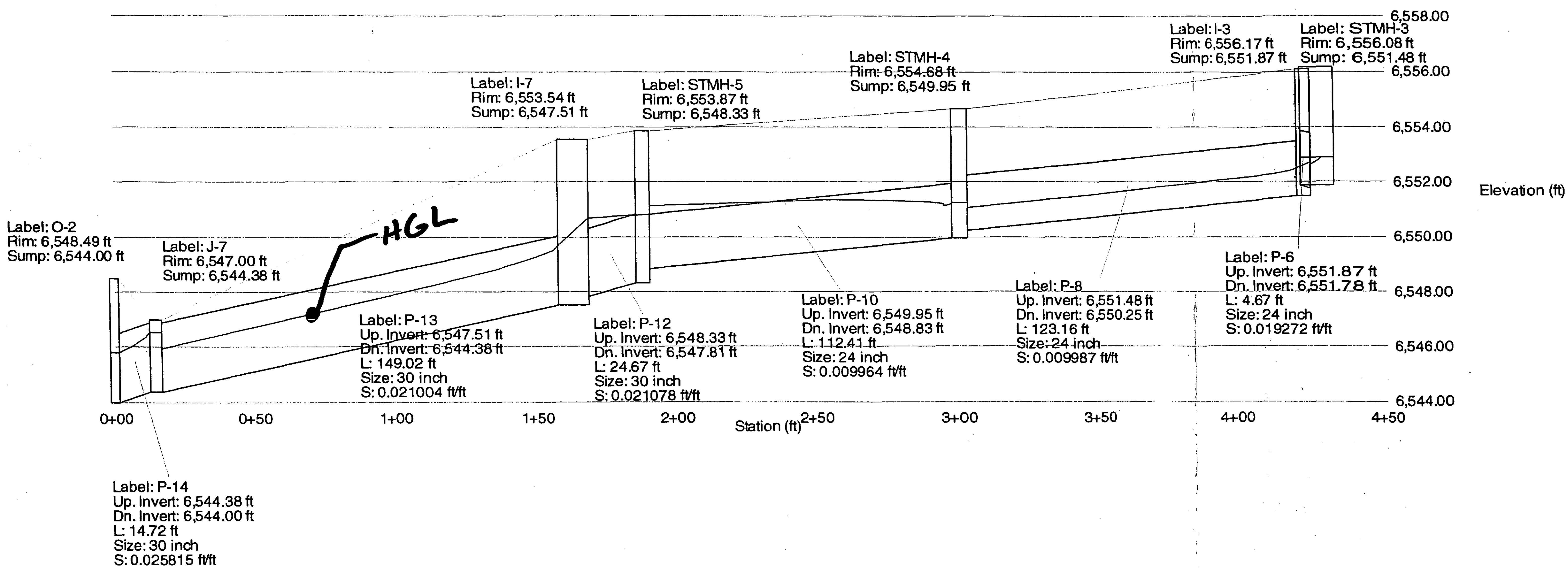
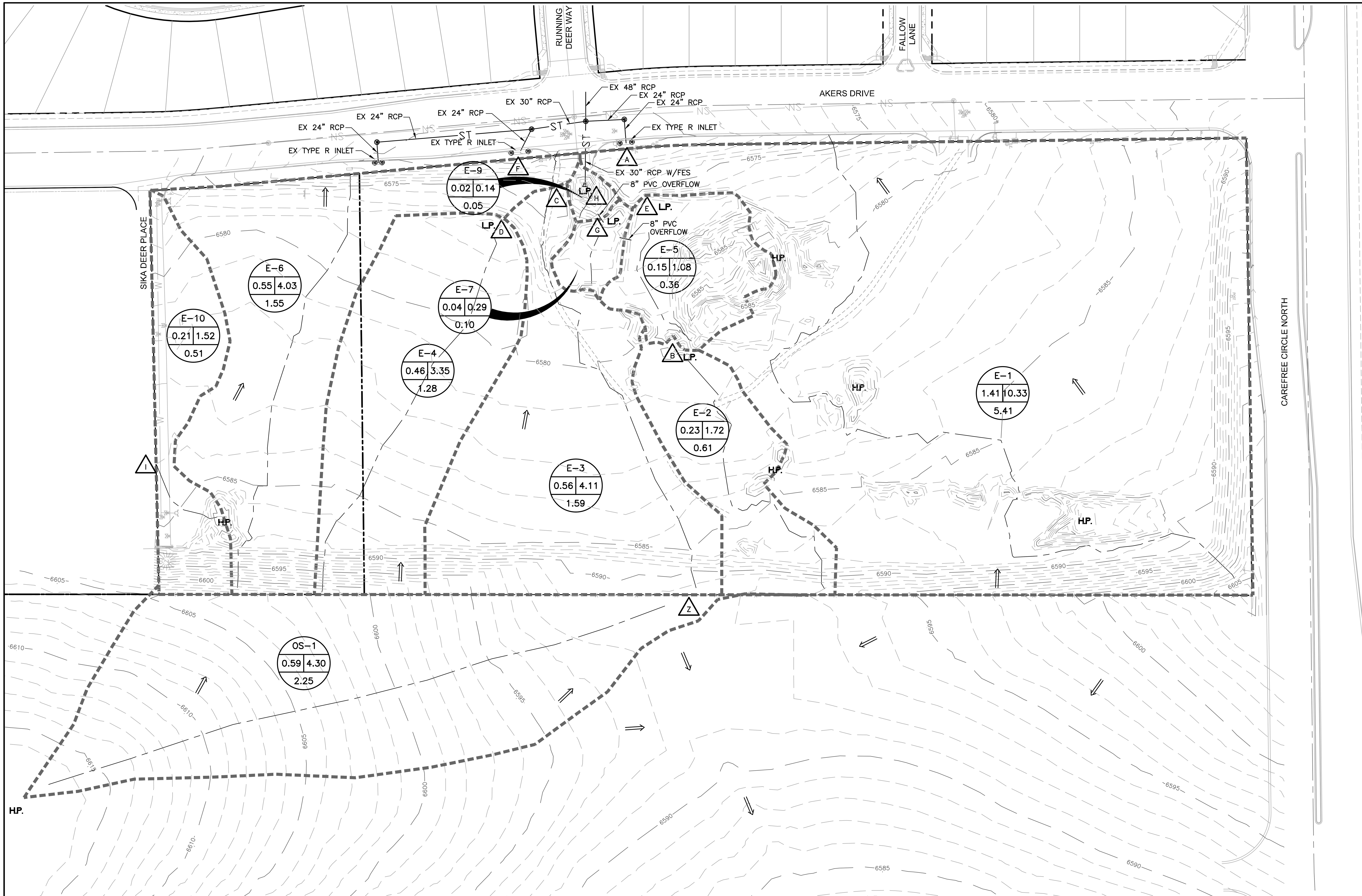


Figure 2: Existing Drainage Map



LEGEND

- EXISTING 1' CONTOUR
- EXISTING 5' CONTOUR
- PROPERTY BOUNDARY
- DRAINAGE BASIN BOUNDARY
- FLOW PATH
- DESIGN POINT
- BASIN LABEL (BASIN / Q_5 / Q_{100} / AREA)

1"=50'

50 0 50 100

DESIGN POINT SUMMARY

DESIGN POINT	Q_5	Q_{100}
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

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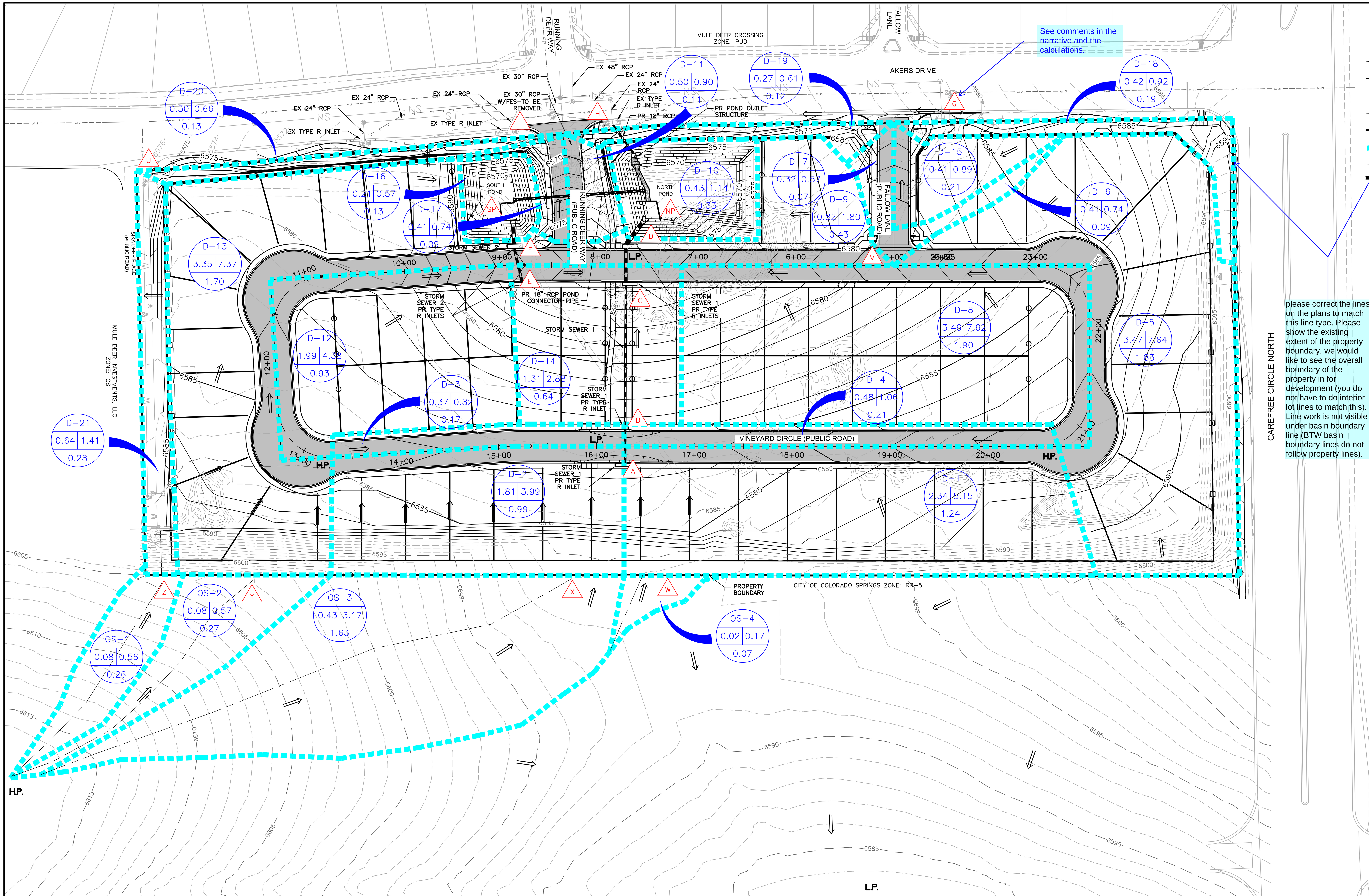
GARDENS AT NORTH CAREFREE
EXISTING DRAINAGE PLAN

Designer: CMS
Detailer: BG
Sheet Subset:
Structure Numbers

Project No./Code
187608744

Sheet Number 1 of 1

Figure 3: Proposed Drainage Map



LEGEND

- PROPOSED 1' CONTOUR
- PROPOSED 5' CONTOUR
- EXISTING 1' CONTOUR
- EXISTING 5' CONTOUR
- PROPERTY BOUNDARY
- DRAINAGE BASIN BOUNDARY
- FLOW PATH
- PR STORM PIPE
- DESIGN POINT
- BASIN LABEL (BASIN / Q_5 | Q_{100} / AREA)

1"=50'

0 50 100

DESIGN POINT SUMMARY

DESIGN POINT	Q_5	Q_{100}
A	3.4	9.9
B	0.9	2.0
C	4.6	10.8
D	4.4	9.9
E	2.0	4.6
F	2.5	6.0
G	0.4	1.0
H	1.1	2.4
I	1.1	2.7
U	0.4	1.3
Z	0.1	0.6
NP	10.8	27.1
SP	3.9	9.3
Y	0.1	0.6
X	0.4	3.3
W	0.0	0.2
V	3.8	8.6
Y	0.1	0.6

Computer File Information

Creation Date: 6-5-17 Initials: CMD

Last Modification Date: 12-17-2019 Initials: LML

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

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THE GARDENS AT NORTH CAREFREE
PROPOSED DRAINAGE PLAN

Designer: CMD
Detailer: BG
Sheet Subset:
Structure Numbers

Project No./Code
187608744

Sheet Number 1 of 1