THE GARDENS AT NORTH CAREFREE
PRELIMINARY 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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PUDSP

August 3, 2018

PUD-18-004

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.

_____ Seal

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

Owner/Developer's Statement:

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

By (signature): _____ Date: _____

Title: _____

Address: 2727 Glen Arbor Drive

Colorado Springs, CO 80124

El Paso County:

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

_____ _____

Jennifer Irvine, P.E., Date

County Engineer / ECM Administrator

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GENERAL LOCATION & DESCRIPTION

The Gardens at North Carefree is approximately 11.6 acres of single family development. Site will include the construction of 3 public roads, 71 single family 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.

Design, phasing, responsibility and maintenance of any proposed improvements will be discussed in the final drainage report. Fees will be assessed and paid according to the current rates at the time of platting for each filing. All easements for utilities and drainage features will be provided with the final plat process.

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%.

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-F dated 3/17/99) 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 City of Colorado Springs 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

Make sure to indicate that detention facilities are full spectrum detention. Update the narrative throughout the report accordingly.

Rational Method

The rational method was used to determine onsite flows, as required by the current City of Colorado Springs 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 will be designed to the 100-year storm and checked with the 5-year storm. Inlets will be placed at sump areas and intersections where street flow is larger than street capacity. UDFCD Inlet spreadsheet will be used to determine the size of all at-grade and sump inlets. Onsite flow captured within the storm system will be released into one of the two water quality facilities. Final design of these facilities will be included in the Final Drainage Report for the development.

Detention Storage Criteria

This report addresses the preliminary design stage of the 2 detention/water quality features within the proposed development. Water quality requirements were determined from the UDFCD Volume 3 spreadsheet for an Extended Detention Basin.

Preliminary storage volumes and outflows have been calculated for both detention facilities. A copy of these designs has been included in the appendix. Final calculations will be completed at the time of final platting for these facilities.

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 on site water quality.

Existing Drainage Analysis

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

- Basin E-1 (5.41 acres) is the top north half of the site between North Carefree Circle and Akers Drive. Flows are diverted through existing drainage swales to where they will release into Akers Drive. Flows for this basin are 1.41 cfs for the 5-year storm and 10.33 cfs for the 100-year storm.

- Basin E-2 (0.61 acres) is located south of Basin E-1. Existing drainage swales will divert this flow to an existing low point/detention area. Flows for this basin are 0.23 cfs for the 5-year storm and 1.72 cfs for the 100-year storm.

- Basin E-3 (1.59 acres) is south of Basin E-2. Flows are diverted to the west through existing drainage swales to an existing low point. Flows for this basin are 0.56 cfs for the 5-year storm and 4.11 cfs for the 100-year storm.

- Basin E-4 (1.28 acres) is south of Basin E-3. Existing drainage swales direct flows to the west to an existing low area. Flows for this basin are 0.46 cfs for the 5-year storm and 3.35 cfs for the 100-year storm.

- Basin E-5 (0.36 acres) is south of Basin E-1 and west of Basin E-2. Flows for this basin are 0.15 cfs for the 5-year storm and 1.08 cfs for the 100-year storm.

- Basin E-6 (1.55 acres) is south of Basin E-4. Existing drainage swales direct flows towards the west, where they will release into Akers Drive. Flows for this basin are 0.55 cfs for the 5-year storm and 4.03 cfs for the 100-year storm.

- Basin E-7 (0.10 acres) is south of Basin E-5 and west of Basin E-3. Flows for this basin are 0.04 cfs for the 5-year storm and 0.29 cfs for the 100-year storm.

- Basin E-9 (0.05 acres) is located between Basin E-7 and Akers Drive. This area is the low area/detention where an existing 30” rcp collects runoff. Flows for this basin are 0.02 cfs for the 5-year storm and 0.14 cfs for the 100-year storm.

- Basin E-10 (0.51 acres) is along the south boundary of the project, along the private driveway. Flows for this basin are 0.21 cfs for the 5-year storm and 1.52 cfs for the 100-year storm.

Design Points

- Design Point Z (Q_5=0.6, Q_{100}=4.4) consists of flow from Basin OS-1. Flow from this basin release on site and combine with other on site 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 20 developed basins and the offsite basin has been divided into 4 separate basins, based on where flows enter onto developed site basins . The majority of the runoff from the site will be collected via inlets and pipes and diverted to one of two water quality ponds for the development. The ponds will then release into the existing inlets in Akers Drive and continue through the existing storm system to the existing drainage channel to the west.

- Basin OS-1 (0.26 acres) is the southern most offsite basin. This flow is released into Basin D-20 Flows for this basin are 0.08 cfs for the 5-year storm and 0.56 cfs for the 100-year storm.

- Basin OS-2 (0.27 acres) is north of OS-1. Runoff is directed towards Basin D-13. Flows for this basin are 0.08 cfs for the 5-year storm and 0.57 cfs for the 100-year storm.

- Basin OS-3 (0.1.63 acres) is located between OS-2 and OS-4 along the south portion of the eastern boundary of the site. Runoff is directed towards Basin D-2. Flows for this basin are 0.43 cfs for the 5-year storm and 3.17 cfs for the 100-year storm.

- Basin OS-4 (0.07 acres) is the north of OS-3. Runoff is directed towards Basin D-1. Flows for this basin are 0.02 cfs for the 5-year storm and 0.17 cfs for the 100-year storm.

- Basin D-1 (1.24 acres) is the north half of the site along the east boundary to the east leg of Vineyard Circle. This flow is directed towards a sump inlet on the east side of Vineyard Circle. Flows for this basin are 2.34 cfs for the 5-year storm and 5.15 cfs for the 100-year storm.

- Basin D-2 (0.99 acres) is the south half of the site along the east boundary to the east leg of Vineyard Circle. Runoff is directed towards a sump inlet on the west side of Vineyard Circle. Flows for this basin are 1.81 cfs for the 5-year storm and 3.99 cfs for the 100-year storm.

- Basin D-3 (0.17 acres) is the southeast half of Vineyard Circle. Runoff is directed towards a sump inlet on the west side of the east leg of Vineyard Circle. Flows for this basin are 0.37 cfs for the 5-year storm and 0.82 cfs for the 100-year storm.

- Basin D-4 (0.21 acres) is the northeast half of Vineyard Circle. Runoff is directed towards a sump inlet on the west side of the east leg of Vineyard Circle. Flows for this basin are 0.48 cfs for the 5-year storm and 1.06 cfs for the 100-year storm.

- Basin D-5 (1.72 acres) is along the north boundary of the site, along North Carefree and along Akers Drive, north of Fallow Lane. Runoff continues to an at-grade inlet on the west side of the west leg of Vineyard Circle. Flows for this basin are 3.26 cfs for the 5-year storm and 7.18 cfs for the 100-year storm.

- Basin D-6 (0.08 acres) is the east half of Fallow Lane. Flows for this basin are 0.37 cfs for the 5-year storm and 0.66 cfs for the 100-year storm.

- Basin D-7 (0.05 acres) is the southwest half of Fallow Lane. Flows for this basin are 0.23 cfs for the 5-year storm and 0.41 cfs for the 100-year storm.

- Basin D-8 (1.90 acres) is the northwest half of the area inside of Vineyard Circle. Runoff is released into the east side of the west leg of Vineyard Circle to an at-grade inlet. Flows for this basin are 3.46 cfs for the 5-year storm and 7.62 cfs for the 100-year storm.

- Basin D-9 (0.47 acres) is the area between the west leg of Vineyard Circle, Fallow Lane and Akers Drive. Runoff releases to an at-grade inlet on the west side of Vineyard Circle. Flows for this basin are 0.89 cfs for the 5-year storm and 1.96 cfs for the 100-year storm.

- Basin D-10 (0.37 acres) is the North Pond area. Flows for this basin are 0.48 cfs for the 5-year storm and 1.28 cfs for the 100-year storm.

- Basin D-11 (0.09 acres) is the north half of Running Deer Way. Flows for this basin are 0.41 cfs for the 5-year storm and 0.74 cfs for the 100-year storm.

- Basin D-12 (0.93 acres) is the south half of the area in between the two legs of Vineyard Circle. Runoff will release to a sump inlet in the east side of Vineyard Circle. Flows for this basin are 1.99 cfs for the 5-year storm and 4.38 cfs for the 100-year storm.

- Basin D-13 (1.42 acres) is the south portion of the site. Runoff is directed towards a sump inlet on the west half of Vineyard Circle. Flows for this basin are 2.80 cfs and 6.16 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 (0.07 acres) is northwest half of Fallow Lane. Flows are 0.16 cfs for the 5-year storm and 0.35 cfs for the 100-year storm.

- Basin D-16 (0.11 acres) is the South Pond area. Flows for this basin are 0.18 cfs for the minor storm and 0.48 cfs for the major storm.

- Basin D-17 (0.07 acres) is the south half of Running Deer Way. Flows are 0.32 cfs and 0.57 cfs or the minor and major storms respectively.

- Basin D-18 (0.64 acres) is the area north of Fallow Land and south of North Carefree which flows towards Akers Drive. Runoff for this basin is 1.40 cfs for the 5-year storm and 3.09 cfs for the 100-year storm.

- Basin D-19 (0.08 acres) is the area between Fallow Land and Running Deer Way which flows towards Akers Drive. Flows are 0.18 cfs and 0.40 cfs for the minor and major storms, respectively.

- Basin D-20 (0.64 acres) is the area south of Running Deer Way, along the western boundary, which flows towards Akers Drive. Flows are 1.37 cfs for the minor storm and 3.01 cfs for them major storm.

Design Points

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

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

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

- Design Point W (Q_5=0.0, Q_{100}=0.2) consists of flow from Basin OS-4. Flow from this basin release on site and will combine with Basin D-1.

- 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, at-grade inlet will be installed on west side of the east leg of Vineyard Circle to intercept the street flow. The inlet will connect with a storm system which releases into the North Pond.

- Design Point C (Q_5=3.5, Q_{100}=7.9) consists of flow from Basin D-8. 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 he the North Pond.

- Design Point V (Q_5=3.6, Q_{100}=8.0) 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=4.2, Q_{100}=9.6) consists of flow from Basin D-9 and design point DP V. This at-grade inlet will intercept the flows from the west half of the west leg of Vineyard Circle. The inlet will connect to the system which will release into the North Pond.

- Design Point E (Q_5=3.2, Q_{100}=7.4) consists of flow from Basins D-12 and D-14. This is street flow at the east half of Vineyard Circle beginning at the southeast knuckle. Flows will direct towards a sump inlet on the east half of the west leg of Vineyard Circle, which releases into the South Pond.

- Design Point F (Q_5=2.1, Q_{100}=5.1) consists of flow from Basin D-13 and design point DP Y. This is street flow at the west half of Vineyard Circle beginning at the southeast knuckle. Flows will direct towards a sump inlet on the west half of the west leg of Vineyard Circle, which releases into the South Pond.

- Design Point G (Q_5=1.4, Q_{100}=3.3) consists of flow from Basin D-18. This is the street flow which has been released into Akers Drive north of Fallow Lane. Flow is intercepted by an existing type R inlet, north of the Fallow Lane Intersection.

- Design Point H (Q_5=0.4, Q_{100}=0.8) consists of flow from Basins D-7, D-15 and D-19. This is flow from Fallow Lane and street flow from Akers Drive, between Fallow Lane and Running Deer Way. Runoff is intercepted by an existing type R inlet in Akers Drive, north of the Running Deer Way intersection.

- Design Point I (Q_5=1.3, Q_{100}=2.8) consists of flow Basins D-11, D-17 and D-20. This is the flow from Running Deer Way and the flow released onto Akers Drive from the site south of Running Deer Way. An existing type R inlet, south of the Running Deer Way intersection will intercept these flows.

Per the drainage plan Basin D6 flows are directed to Vineyard Circle. It appears that Basin D15 flows are directed to Akers Drive. Revise narrative.

- Design Point NP (Q_5=9.9, Q_{100}=24.8) 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=4.4, Q_{100}=10.4) 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 is being requested for El Paso County ECM_Appendix I Section I.7.1.B: 1st Bullet; Providing Water Quality for Entire Development.

Basins D-6, D-7, D-11 and D-17 thru D-20 all release into Akers Drive and are intercepted by existing inlets and will not reach an on-site water quality facility. These basins account for approximately 14% (1.64 ~~acres of 11.56) of the overall site area~~. The remaining 86% of the development area is treated through 1 of the 2 proposed water quality facilities.

Review 1: Partially resolved.
A deviation request is required since 100% of storm water is not captured in the detention pond. CDPS General Permit COR090000 (MS4 permit) Part I section E.4.iv.(A), page 29 of 63, may be used for justification of the deviation. Note that changes to the basins and grading will be required to comply with section E.4.iv.(A).
Review 2:
Per MS4 permit the exclusion is for max 20% but not to exceed 1 acre. It appears that basins D18 and D20 boundaries where not updated to reflect the revised grading. Make the changes and verify that it meets the MS4 exclusion above. Compliance

The topography of the site will not allow all areas within the site to drain to proposed water quality ponds. Of the area inside the development boundary that will not reach a facility only 0.19 acres is proposed roadway, 0.64 acres is developed lots, the remaining 0.81 acres will be sloped areas at the back of lots along the exterior boundary.

DRAINAGE FACILITY DESIGN

General Concept

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

Storm Sewer System

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

Final Plat submittals will include details concerning inlet location, storm sewer sizing and locations as part of the Final Drainage Report for each submittal.

On-Site Water Quality

There are two proposed water quality ponds on site that will provide water quality for the proposed improvements. Flows will pass through the outlet structures of one of the two proposed ponds. The existing storm system was designed to account for a 100-year flow of 55 cfs from this development. The two water quality ponds, based on the UDFCD pond spreadsheets, have a release rate of 33.5 cfs (South Pond is 6.0 cfs and North Pond is 27.5 cfs). The basins releasing offsite have a combined flow of 8.9 cfs. Flows in Akers Drive and the two ponds have a total combined flow of 42.4 cfs being captured in the existing storm system. The existing storm system will be analyzed with the developed flows at time of final platting. Preliminary pond sizing calculations are provided in Appendix D. Complete design details for the ponds will be included in the Final Drainage Report for the site. Such items to be finalized will be pond forebays, micropools, outlet configuration and emergency spillways. Also, at the time of final design, a geotechnical report may be required for the design of pond embankments.

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

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 and handle their own detention and water quality needs. 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 2 separate extended detention basins. The outlet structures for both ponds have been designed according to the FSD spreadsheet by UDFCD to ensure the release times of the facilities meet the requirements.

Stabilize Stream Channels

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

Implement Source Controls

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

Maintenance

The water quality ponds will be maintained by the Home Owners Association. Facilities located within the project boundary will be private facilities and will also be maintained by Home Owners Association. 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.

All easements will be provided as part of the Final Plat process.

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. "Sand Creek Drainage Basin Planning Study Preliminary Design Report", Kiowa Engineering Corporation.

3. Soils Survey of El Paso County Area, Natural Resources Conservation Services of Colorado.

4. Flood Insurance Rate Study for El Paso County, Colorado and Incorporated Areas. Federal Emergency Management Agency, Revised March 17, 1997.

5. "City of Colorado Springs Drainage Criteria Manual, Volume 2: Stormwater Quality Policies, Procedures and Best Management Practices (BMPs)" May 2014.

6. "Engineering Criteria Manual El Paso County" January 9, 2006, Revised December, 2016.

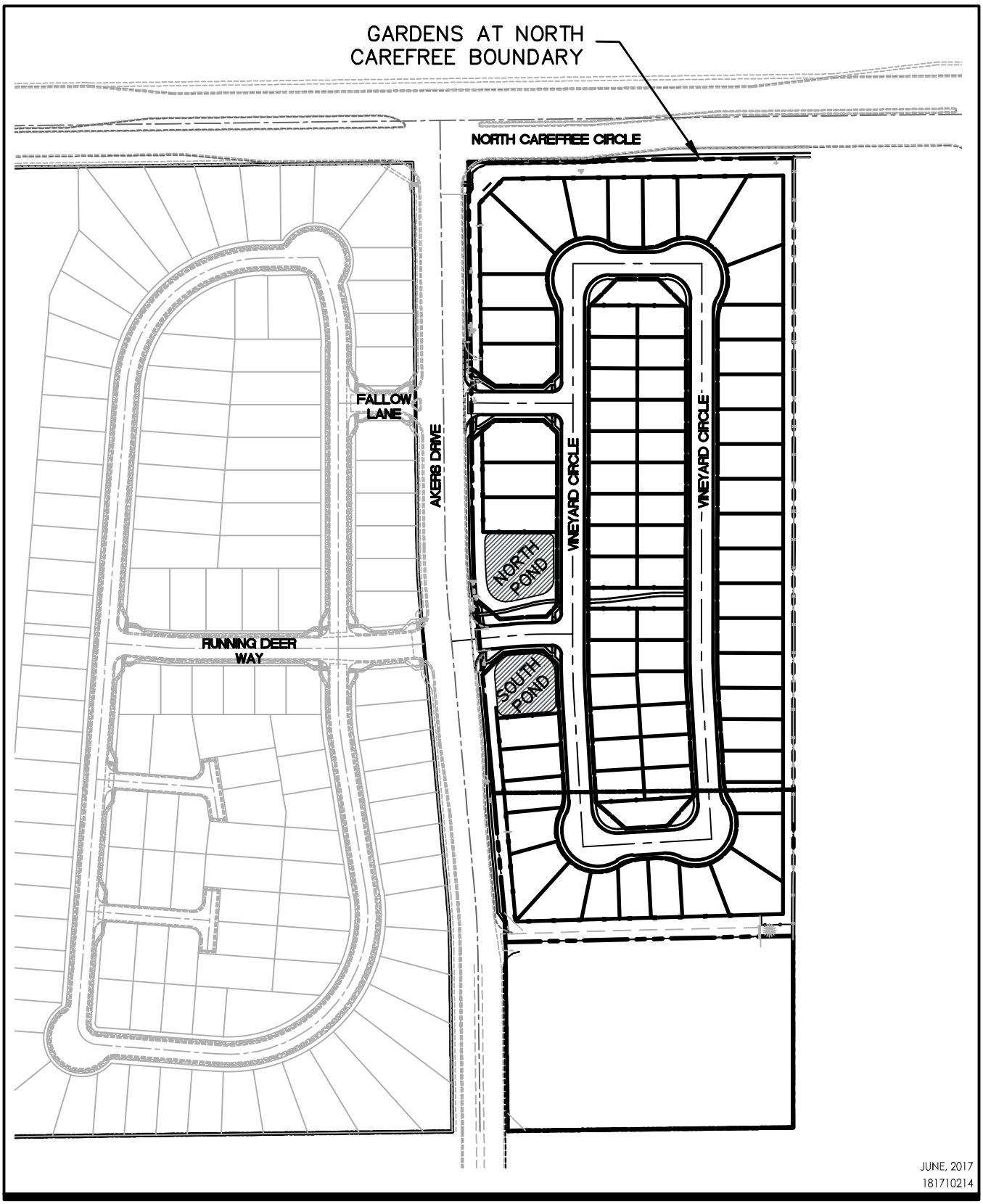
7. "Urban Storm Drainage Criteria Manual, Volume 1: Management, Hydrology & Hydraulics" Original September 1969, Updated January 2016.

8. "Urban Storm Drainage Criteria Manual, Volume 2: Structures, Storage & Recreation" Original September 1969, Updated January 2016.

9. "Urban Storm Drainage Criteria Manual, Volume 3: Stormwater Quality" Original September 1992, Updated November 2010.

10. "Final Drainage Report for Mule Deer Crossing" December 2005. Prepared by URS.

Figure 1: Vicinity Map



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JUNE, 2017
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Client/Project
MULE DEER INVESTMENTS, LLC
GARDENS AT NORTH CAREFREE

Figure No.
1.0

Title
VICINITY MAP

Appendix A: NRCS Soil Report

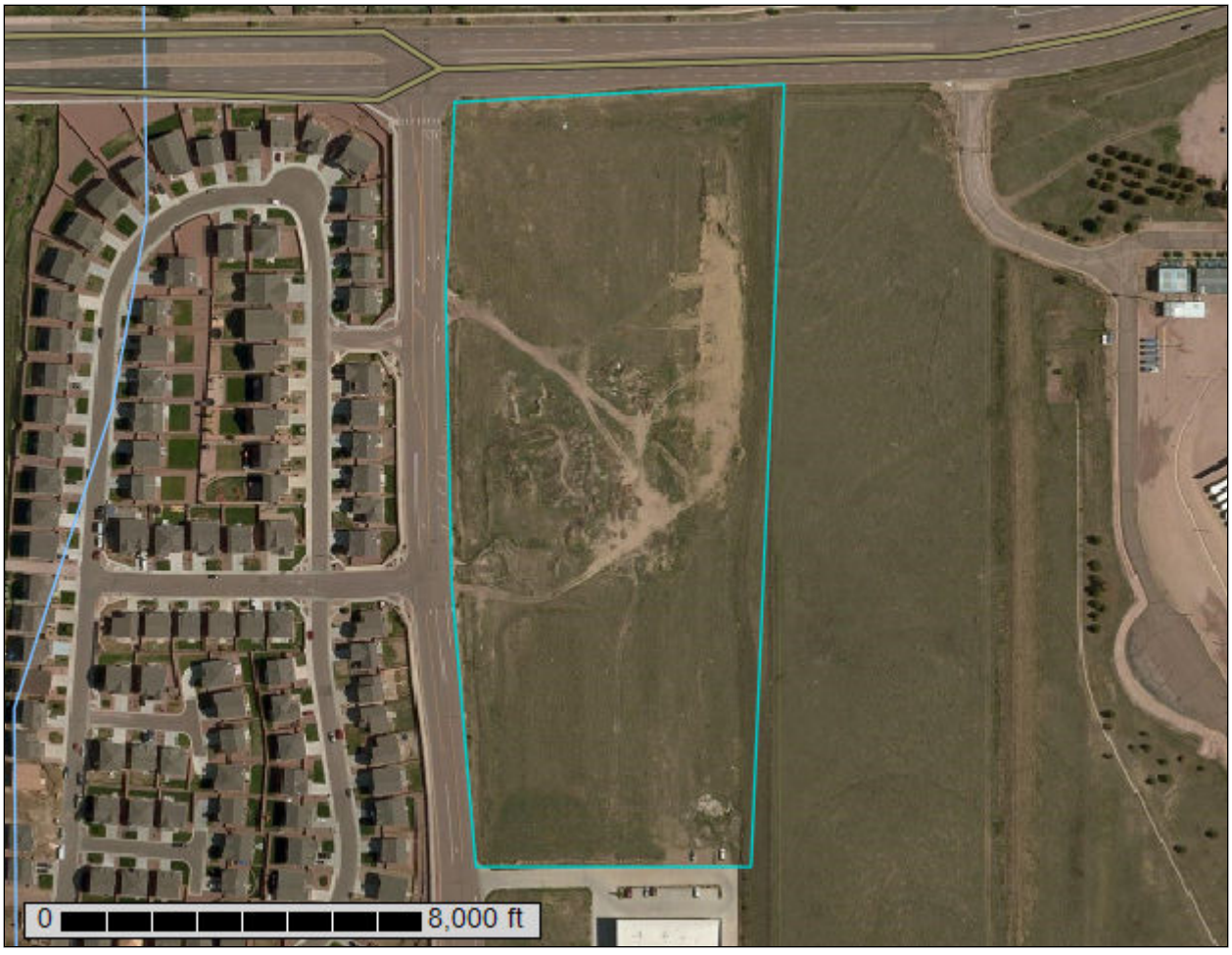
United States Department of Agriculture

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.

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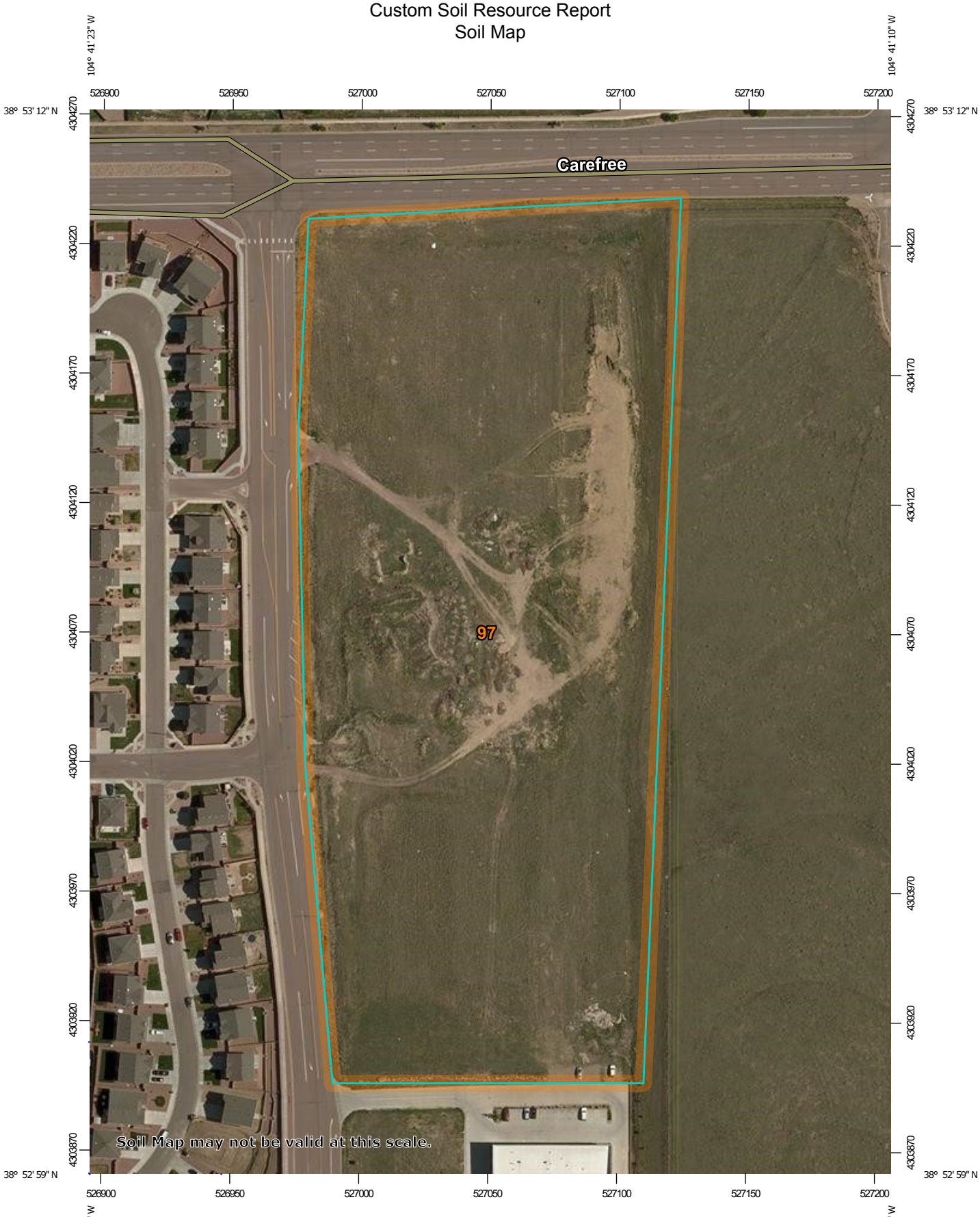
Contents

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.

Custom Soil Resource Report
Soil Map



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

N

Meters: 0 25 50 100 150

Feet: 0 50 100 200 300

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

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 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)								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	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
Section: Existing Conditions

Created by: CMD Date: 1/13/2017
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
Section: Existing Conditions

Created by: CMD Date: 1/13/2017
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	CA (equivalent) CA(5)	CA(100)	Tc (min.)	INTENSITY I(5) (in/hr)	I(100) (in/hr)	TOTAL FLOWS Q(5) (cfs)	Q(100) (cfs)
Z	OS-1	0.18	0.79	16.5	3.2	5.6	0.6	4.4
				TRAVEL TIME				
		0.18	0.79	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				Channel	510	3.5	2.4	18.9
A	E-1	0.43	1.89	16.6	3.2	5.6	1.4	10.6
				TRAVEL TIME				
		0.43	1.89	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
						3.5	0.0	16.6
B	E-2	0.05	0.21	6.1	4.9	8.5	0.2	1.8
				TRAVEL TIME				
		0.05	0.21	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				PIPE	25	4.4	0.1	6.2
D	E-4	0.10	0.45	7.8	4.5	7.8	0.5	3.5
				TRAVEL TIME				
		0.10	0.45	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				CHANNEL	65	2.8	0.4	8.2
C	E-3	0.13	0.56	18.9	3.0	5.2	1.2	9.4
	DP D	0.10	0.45	TRAVEL TIME				
	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	TRAVEL TIME				
		0.08	0.34	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				PIPE	15	5.0	0.1	6.3
F	E-6	0.12	0.54	7.9	4.5	7.8	0.6	4.2
				TRAVEL TIME				
		0.12	0.54	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					270	4.4	1.0	8.9
G	E-7	0.01	0.03	6.3	4.8	8.4	0.4	3.2
	DP E	0.08	0.34	TRAVEL TIME				
		0.09	0.37	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				PIPE	15	5.0	0.1	6.3
H	D-9	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	TRAVEL TIME				
		0.50	2.18	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				PIPE	15	5.0	0.1	19.0
I	E-10	0.04	0.18	5.0	5.2	9.1	0.2	1.6
				TRAVEL TIME				
		0.04	0.18	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				PIPE	15	5.0	0.1	5.1

Appendix C: Proposed Hydrology Calculations

Standard Form SF-1 . Time of Concentration

Project: Gardens at North Carefree
Section: Proposed Conditions

Created by: CMD Date: 7/31/2018
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	1.72	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	0.08	25	0.020	1.44	40	0.0200	6	Paved areas and shallow paved swales	20.00	2.83	0.24	1.67	YES	65.00	10.36	Check	5.0
D-7	Southwest Half of Fallow Lane which drains to Akers	0.90	0.05	5	0.020	0.64	80	0.0450	6	Paved areas and shallow paved swales	20.00	4.24	0.31	0.96	YES	85.00	10.47	Check	5.0
D-8	North/Middle portion of Site inside of Vineyard Circle which drains to west	0.45	1.90	58	0.020	7.11	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	0.47	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	0.37	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	0.09	20	0.020	1.28	105	0.0600	6	Paved areas and shallow paved swales	20.00	4.90	0.36	1.64	YES	125.00	10.69	Check	5.0
D-12	South/Middle portion of Site inside of Vineyard Circle which drains to west	0.45	0.93	30	0.020	5.11	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	0.07	25	0.020	4.67	80	0.0450	6	Paved areas and shallow paved swales	20.00	4.24	0.31	4.98	YES	105.00	10.58	Check	5.0

	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	0.07	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	0.64	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	0.08	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	0.64	45	0.333	2.47	720	0.0236	6	Paved areas and shallow paved swales	20.00	3.07	3.90	6.38	YES	765.00	14.25	Check	6.4

Notes:
All Equations are from UDFCD Drainage Criteria Manual/Runoff
(1) $t_i = (0.395*(1.1-C_5)*(L^0.5))/(S^0.33)$, 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: 7/31/2018

Section: Proposed 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)	
Offsite Basin @ East Side releases to D-20	(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	1.72	0.45	9.08	0.77	4.21	3.26													
East Half of Fallow Lane which drains to Vineyard Circle	D-6	0.08	0.90	5.00	0.07	5.09	0.37													
Southwest Half of Fallow Lane which drains to Akers	D-7	0.05	0.90	5.00	0.05	5.09	0.23													
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	0.47	0.45	9.06	0.21	4.21	0.89													
North Pond	D-10	0.37	0.32	10.15	0.12	4.03	0.48													
North half of Running Deer Way	D-11	0.09	0.90	5.00	0.08	5.09	0.41													
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	1.42	0.45	8.17	0.64	4.38	2.80													
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	0.07	0.45	5.00	0.03	5.09	0.16													

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

Project: Gardens at North Carefree — Created by: CMD — Date: 7/31/2018
Section: Proposed Conditions — Checked by: CKC — Date:

	South Pond	D-16	0.11	0.32	5.00	0.04	5.09	0.18													
	South half of of Running Deer Way	D-17	0.07	0.90	5.00	0.06	5.09	0.32													
	ROW north of Fallow which drains towards Akers	D-18	0.64	0.45	5.88	0.29	4.86	1.40													
	ROW btwn Fallow & Running Deer which drains towards Akers	D-19	0.08	0.45	5.00	0.04	5.09	0.18													
	ROW south of Running Deer which drains towards Akers	D-20	0.64	0.45	6.38	0.29	4.75	1.37													

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

Project: Gardens at North Carefree
Section: Proposed Conditions

Created by: CMD Date: 7/31/2018
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													
m	Offsite Basin @ East Side releases to D-13	OS-2	0.27	0.35	13.94	0.10	5.92	0.57													
m	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	1.72	0.59	9.08	1.01	7.07	7.18													
	East Half of Fallow Lane which drains to Vineyard Circle	D-6	0.08	0.96	5.00	0.08	8.55	0.66													
	Southwest Half of Fallow Lane which drains to Akers	D-7	0.05	0.96	5.00	0.05	8.55	0.41													
	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	0.47	0.59	9.06	0.28	7.08	1.96													
	North Pond	D-10	0.37	0.51	10.15	0.19	6.78	1.28													
	North half of Running Deer Way	D-11	0.09	0.96	5.00	0.09	8.55	0.74													
	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	1.42	0.59	8.17	0.84	7.35	6.16													
	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	0.07	0.59	5.00	0.04	8.55	0.35													

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

Project: Gardens at North Carefree — Created by: CMD — Date: 7/31/2018

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

	South Pond	D-16	0.11	0.51	5.00	0.06	8.55	0.48													
	South half of of Running Deer Way	D-17	0.07	0.96	5.00	0.07	8.55	0.57													
	ROW north of Fallow which drains towards Akers	D-18	0.64	0.59	5.88	0.38	8.17	3.09													
	ROW btwn Fallow & Running Deer which drains towards Akers	D-19	0.08	0.59	5.00	0.05	8.55	0.40													
	ROW south of Running Deer which drains towards Akers	D-20	0.64	0.59	6.38	0.38	7.98	3.01													

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	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	3.5	7.9
				TRAVEL TIME				
		0.86	1.12	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				CHANNEL	34	2.5	0.2	10.3
V	D-5	0.77	1.01	9.1	4.2	7.4	3.6	8.0
	D-6	0.07	0.08					
		0.85	1.09	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				STREET	205	2.8	1.2	10.3
D	D-9	0.21	0.28	10.3	4.0	7.0	4.2	9.6
	DP V	0.85	1.09					
		1.06	1.37	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				PIPE	10	2.5	0.1	10.4
E	D-12	0.42	0.55	7.3	4.6	8.0	3.2	7.4
	D-14	0.29	0.38	TRAVEL TIME				
		0.71	0.93	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				PIPE	34	2.5	0.2	7.5
F	D-13	0.64	0.84	17.5	3.1	5.5	2.1	5.1
	DP Y	0.02	0.10	TRAVEL TIME				
		0.66	0.93	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
				PIPE	10	2.5	0.1	17.6

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)
G	D-18	0.29	0.38	5.9	4.9	8.6	1.4	3.3
				TRAVEL TIME				
		0.29	0.38	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					25	5.0	0.1	6.0
H	D-15	0.03	0.04	5.0	5.2	9.1	0.4	0.8
	D-7	0.05	0.05	TRAVEL TIME				
	D-19	0.04	0.05					
		0.08	0.09	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					25	5.0	0.1	5.1
I	D-11	0.08	0.09	19.3	3.0	5.2	1.3	2.8
	D-17	0.06	0.07					
	D-20	0.29	0.38					
	DP Z	0.02	0.09	TRAVEL TIME				
		0.43	0.53	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
						5.0	0.0	19.3
NP	D-10	0.12	0.19	19.5	3.0	5.2	9.9	24.8
	DP A	1.14	1.91					
	DP B	0.17	0.22					
	DP C	0.86	1.12					
	DP D	1.06	1.37	TRAVEL TIME				
		3.34	4.82	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
					80	4.0	0.3	19.9
SP	D-16	0.04	0.06	17.6	3.1	5.4	4.4	10.4
	DP E	0.71	0.93					
	DP F	0.66	0.93	TRAVEL TIME				
		1.40	1.92	Type/flow	Length (ft)	Velocity (fps)	d. Time (min)	T. Time (min)
						5.0	0.0	17.6

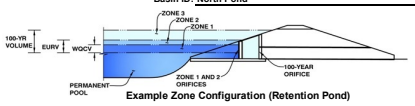
Appendix D: Water Quality Pond Calculations

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Gardens at North Carefree

Basin ID: North Pond



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	6.84	acres
Watershed Length =	570	ft
Watershed Slope =	0.022	ft/ft
Watershed Imperviousness =	80.00%	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) =	0.187	acre-feet
Excess Urban Runoff Volume (EURV) =	0.720	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.498	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.647	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	0.780	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	0.924	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	1.065	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	1.234	acre-feet
500-yr Runoff Volume (P1 = 3.29 in.) =	1.692	acre-feet
Approximate 2-yr Detention Volume =	0.472	acre-feet
Approximate 5-yr Detention Volume =	0.614	acre-feet
Approximate 10-yr Detention Volume =	0.733	acre-feet
Approximate 25-yr Detention Volume =	0.871	acre-feet
Approximate 50-yr Detention Volume =	0.952	acre-feet
Approximate 100-yr Detention Volume =	1.026	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) =	0.187	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.187	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

Total detention volume is less than 100-year volume.

Depth Increment = 0.5 ft

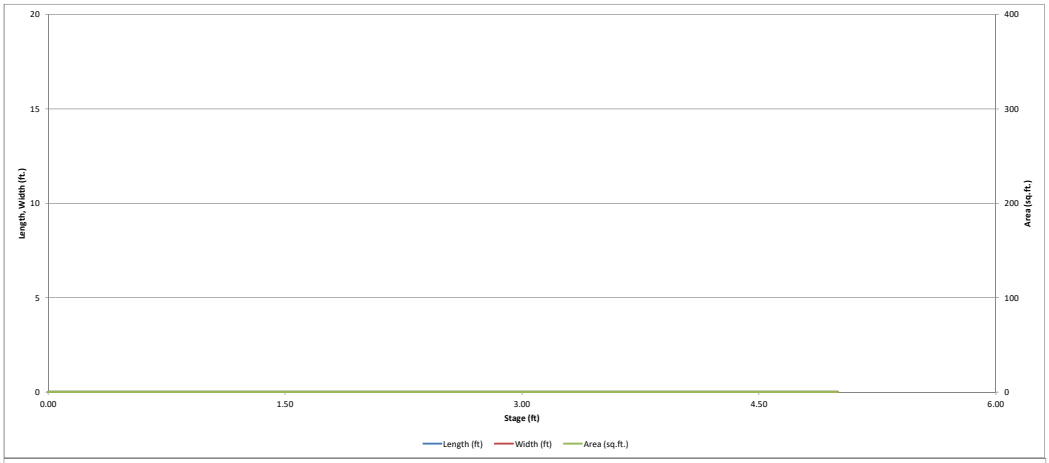
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	3,456	0.079		
	--	0.50	--	--	--	3,821	0.088	1,781	0.041
	--	1.00	--	--	--	4,204	0.097	3,784	0.087
	--	1.50	--	--	--	4,605	0.106	5,982	0.137
	--	2.00	--	--	--	5,024	0.115	8,385	0.192
	--	2.50	--	--	--	5,461	0.125	11,056	0.254
	--	3.00	--	--	--	5,915	0.136	13,900	0.319
	--	3.50	--	--	--	6,388	0.147	16,976	0.390
	--	4.00	--	--	--	6,878	0.158	20,292	0.466
	--	4.50	--	--	--	7,386	0.170	23,858	0.548
	--	5.00	--	--	--	7,912	0.182	27,683	0.636

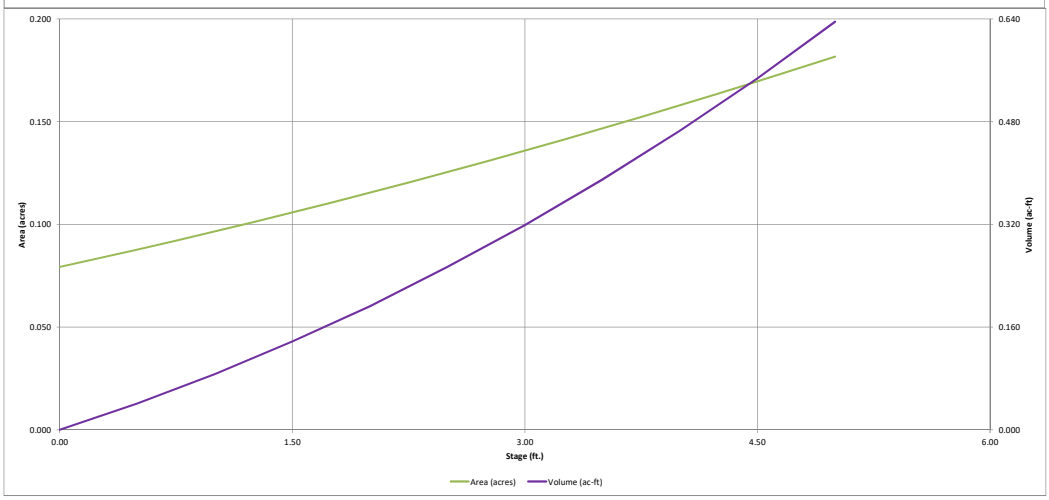
Review 1: Since improvements downstream has not been fully constructed provide Full Spectrum Detention (FSD) per current criteria. Update the narrative accordingly.

Review 2: Un-Resolved

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



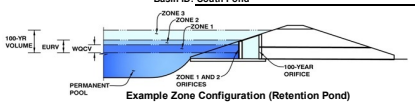


DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Gardens at North Carefree

Basin ID: South Pond



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	3.14	acres
Watershed Length =	605	ft
Watershed Slope =	0.030	ft/ft
Watershed Imperviousness =	80.00%	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) =	0.086	acre-feet
Excess Urban Runoff Volume (EURV) =	0.330	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.229	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.297	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	0.358	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	0.424	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	0.489	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	0.567	acre-feet
500-yr Runoff Volume (P1 = 3.29 in.) =	0.777	acre-feet
Approximate 2-yr Detention Volume =	0.217	acre-feet
Approximate 5-yr Detention Volume =	0.282	acre-feet
Approximate 10-yr Detention Volume =	0.337	acre-feet
Approximate 25-yr Detention Volume =	0.400	acre-feet
Approximate 50-yr Detention Volume =	0.437	acre-feet
Approximate 100-yr Detention Volume =	0.471	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

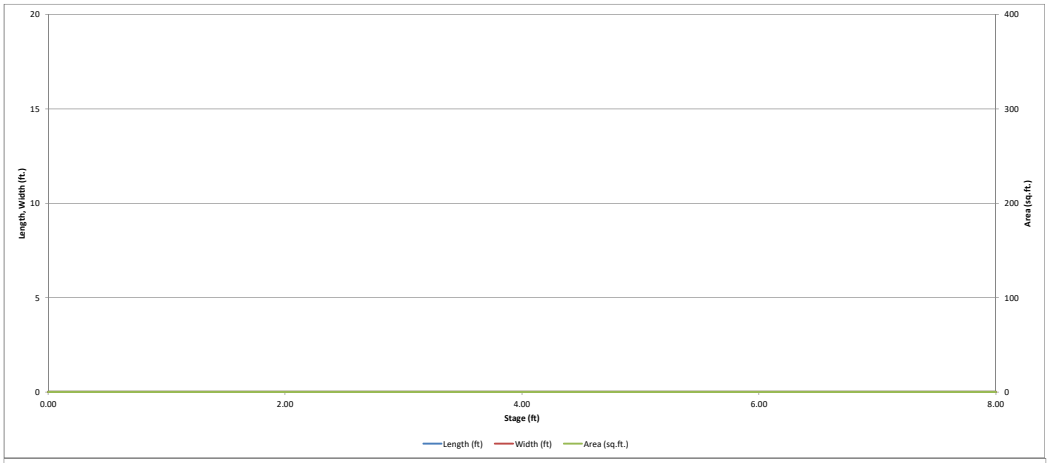
Zone 1 Volume (WQCV) =	0.086	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.244	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.141	acre-feet
Total Detention Basin Volume =	0.471	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (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

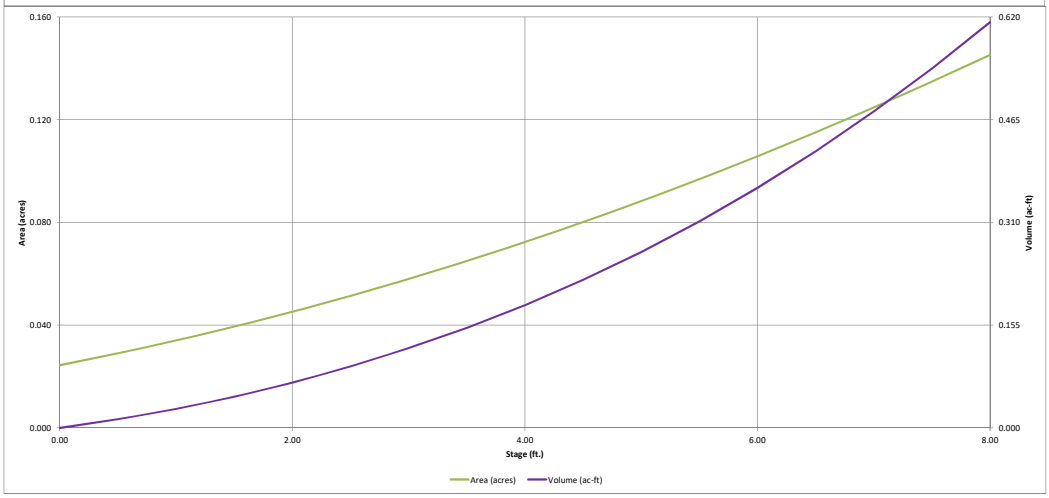
Depth Increment = 0.5 ft

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	--	--	--	1,062	0.024		
	--	0.50	--	--	--	1,262	0.029	569	0.013
	--	1.00	--	--	--	1,480	0.034	1,252	0.029
	--	1.50	--	--	--	1,715	0.039	2,049	0.047
	--	2.00	--	--	--	1,968	0.045	2,967	0.068
	--	2.50	--	--	--	2,237	0.051	4,038	0.093
	--	3.00	--	--	--	2,524	0.058	5,228	0.120
	--	3.50	--	--	--	2,828	0.065	6,566	0.151
	--	4.00	--	--	--	3,149	0.072	8,060	0.185
	--	4.50	--	--	--	3,488	0.080	9,719	0.223
	--	5.00	--	--	--	3,843	0.088	11,552	0.265
	--	5.50	--	--	--	4,216	0.097	13,567	0.311
	--	6.00	--	--	--	4,605	0.106	15,772	0.362
	--	6.50	--	--	--	5,010	0.115	18,176	0.417
	--	7.00	--	--	--	5,431	0.125	20,786	0.477
	--	7.50	--	--	--	5,870	0.135	23,611	0.542
	--	8.00	--	--	--	6,324	0.145	26,660	0.612

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)





Appendix E: Deviation Request

Procedures Manual

Procedure # R-FM-051-07

Page 1 of 6

Subject: DEVIATION REVIEW AND DECISION FORM

Date Issued: 12/31/07
Revision Issued: N/A
Rescinded: N/A

1.1. PURPOSE

The purpose of this resource is to provide a form for documenting the findings and decision by the ECM Administrator concerning a deviation request.

1.2. BACKGROUND

A deviation is a critical aspect of the review process and needs to be documented to ensure that the deviations granted are applied to a specific development application in conformance with the criteria for approval and that the action is documented as such requests can point to potential needed revisions to the ECM.

1.3. APPLICABLE STATUTES AND REGULATIONS

Section 5.9 of the ECM establishes a mechanism whereby an engineering design standard can be modified when if strictly adhered to, would cause unnecessary hardship or unsafe design because of topographical or other conditions particular to the site, and that a departure may be made without destroying the intent of such provision.

1.4. APPLICABILITY

All provisions of the ECM are subject to deviation by the ECM Administrator provided that one of the following conditions is met:

- The ECM standard is inapplicable to a particular situation.
- Topography, right-of-way, or other geographical conditions or impediments impose an undue hardship on the applicant, and an equivalent alternative that can accomplish the same design objective is available and does not compromise public safety or accessibility.
- A change to a standard is required to address a specific design or construction problem, and if not modified, the standard will impose an undue hardship on the applicant with little or no material benefit to the public.

1.5. TECHNICAL GUIDANCE

The review shall ensure all criteria for approval are adequately considered and that justification for the deviation is properly documented.

1.6. RELATED PROCEDURES

1.6.1. Governing Procedures

P-AR-063-07 Deviation

1.6.2. Other Related Procedures

P-AR-012-07 Administrative Relief

1.7. RESOURCE

Attached is the Deviation Review and Decision Form that is used by the applicant/engineer for requesting and justifying a deviation. The form is reviewed by the ECM Administrator and approved or denied. The form is used to document the review and decision concerning a requested deviation. The request and decision concerning each deviation from a specific section of the ECM shall be recorded on a separate form.

Development Services Department
2880 International Circle
Colorado Springs, Colorado 80910

Phone: 719.520.6300
Fax: 719.520.6695
Website www.elpasoco.com

DEVIATION REVIEW AND DECISION FORM

Procedure # R-FM-051-07
Issue Date: 12/31/07
Revision Issued: 00/00/00
DSD FILE NO.:

General Property Information:

Address of Subject Property (Street Number/Name):
Tax Schedule ID(s) #: 5500000135
Legal Description of Property: _See attached

Subdivision or Project Name: Gardens at
North Carefree PUD Plan

Section of ECM from Which Deviation is Sought: _Appendix I Section I.7.1.B
Specific Criteria from Which a Deviation is Sought: _1st Bullet; Providing Water Quality for Entire Development

Proposed Nature and Extent of Deviation: Approximately 1.64 acres of 11.89 acres of the area inside the development boundary will not reach a proposed on-site water quality facility. Of the area inside the development boundary that will not reach a facility only 0.19 acres is proposed roadway, 0.64 acres is developed lots, the remaining 0.81 acres will be sloped areas at back of lots along exterior boundary.

Applicant Information:

Applicant: _Mule Deer Investments Email Address: _HHerber@me.com
Applicant is: __X__ Owner __ Consultant _____ Contractor
Mailing Address: __2727 Glen Arbor Drive State: CO Postal Code: 80920
Telephone Number: _719-331-0083 Fax Number: _719-227-7392

Engineer Information:

Engineer: _Charlene Durham, P.E. Email Address: charlenedurham@stantec.com
Company Name: _Stantec Consulting Services
Mailing Address: 5725 Mark Dabling Blvd, Suite 190 State: _CO Postal Code: 80919
Registration Number: _36727 State of Registration: _CO
Telephone Number: _719-227-7388 _ Fax Number: _719-227-7392

Explanation of Request (Attached diagrams, figures, and other documentation to clarify request):

Section of ECM from Which Deviation is Sought: _Appendix I Section I.7.1.B
Specific Criteria from Which a Deviation is Sought: _1st Bullet, Providing Water Quality for Entire Development

Proposed Nature and Extent of Deviation: Approximately 1.64 acres of 11.89 acres of the area inside the development boundary will not reach a proposed on-site water quality facility. Of the area inside the development boundary that will not reach a facility only 0.19 acres is proposed roadway, 0.64 acres is developed lots, the remaining 0.81 acres will be sloped areas at back of lots along exterior boundary.

Reason for the Requested Deviation: _ The topography of the site will not allow all areas to drain to proposed water quality facilites.

Comparison of Proposed Deviation to ECM Standard: _ The areas of the site that do not drain to water quality ponds will be accommodated in the discharge of the detention ponds for developed to historic discharge. Open space/buffer areas do not require detention or water quality. __

Applicable Regional or National Standards used as Basis: _

Application Consideration:

CHECK IF APPLICATION MEETS CRITERIA FOR CONSIDERATION	**JUSTIFICATION**
☐ The ECM standard is inapplicable to a particular situation.	
X Topography, right-of-way, or other geographical conditions or impediments impose an undue hardship on the applicant, and an equivalent alternative that can accomplish the same design objective is available and does not compromise public safety or accessibility.	The topography of the site does not allow all areas to be conveyed to water quality (site is higher that adjacent Akers Drive).
☐ A change to a standard is required to address a specific design or construction problem, and if not modified, the standard will impose an undue hardship on the applicant with little or no material benefit to the public.	

If at least one of the criteria listed above is not met, this application for deviation cannot be considered.

Criteria for Approval:

PLEASE EXPLAIN HOW EACH OF THE FOLLOWING CRITERIA HAVE BEEN SATISFIED BY THIS REQUEST

The request for a deviation is not based exclusively on financial considerations.	This request has little or no relationship to financial considerations.
The deviation will achieve the intended result with a	Open space, and buffering parcels will provide water quality inherent to natural infiltration of storm water into the ground.

comparable or superior design and quality of improvement.

The deviation will not adversely affect safety or operations. There will be no negative effects related to safety or operations.

The deviation will not adversely affect maintenance and its associated cost.

The deviation will not adversely affect aesthetic appearance.

Owner, Applicant and Engineer Declaration:

To the best of my knowledge, the information on this application and all additional or supplemental documentation is true, factual and complete. I am fully aware that any misrepresentation of any information on this application may be grounds for denial. I have familiarized myself with the rules, regulations and procedures with respect to preparing and filing this application. I also understand that an incorrect submittal will be cause to have the project removed from the agenda of the Planning Commission, Board of County Commissioners and/or Board of Adjustment or delay review, and that any approval of this application is based on the representations made in the application and may be revoked on any breach of representation or condition(s) of approval.

Myle Beer Investment LLC
by Heath A. Herles Mgr — 10/8/2018
Signature of owner (or authorized representative) — Date

Date

Charlene Durham — 10/9/2018
Signature of Engineer — Date

COLORADO REGISTERED
CHARLENE M. DURHAM
36727
PROFESSIONAL ENGINEER

Date

This request has been determined to have met the criteria for approval. A deviation from Section _____ of ECM is hereby granted based on the justification provided. Comments:

Additional comments or information are attached.

DENIED by the ECM Administrator

Date

This request has been determined not to have met criteria for approval. A deviation from Section _____of ECM is hereby denied. Comments:

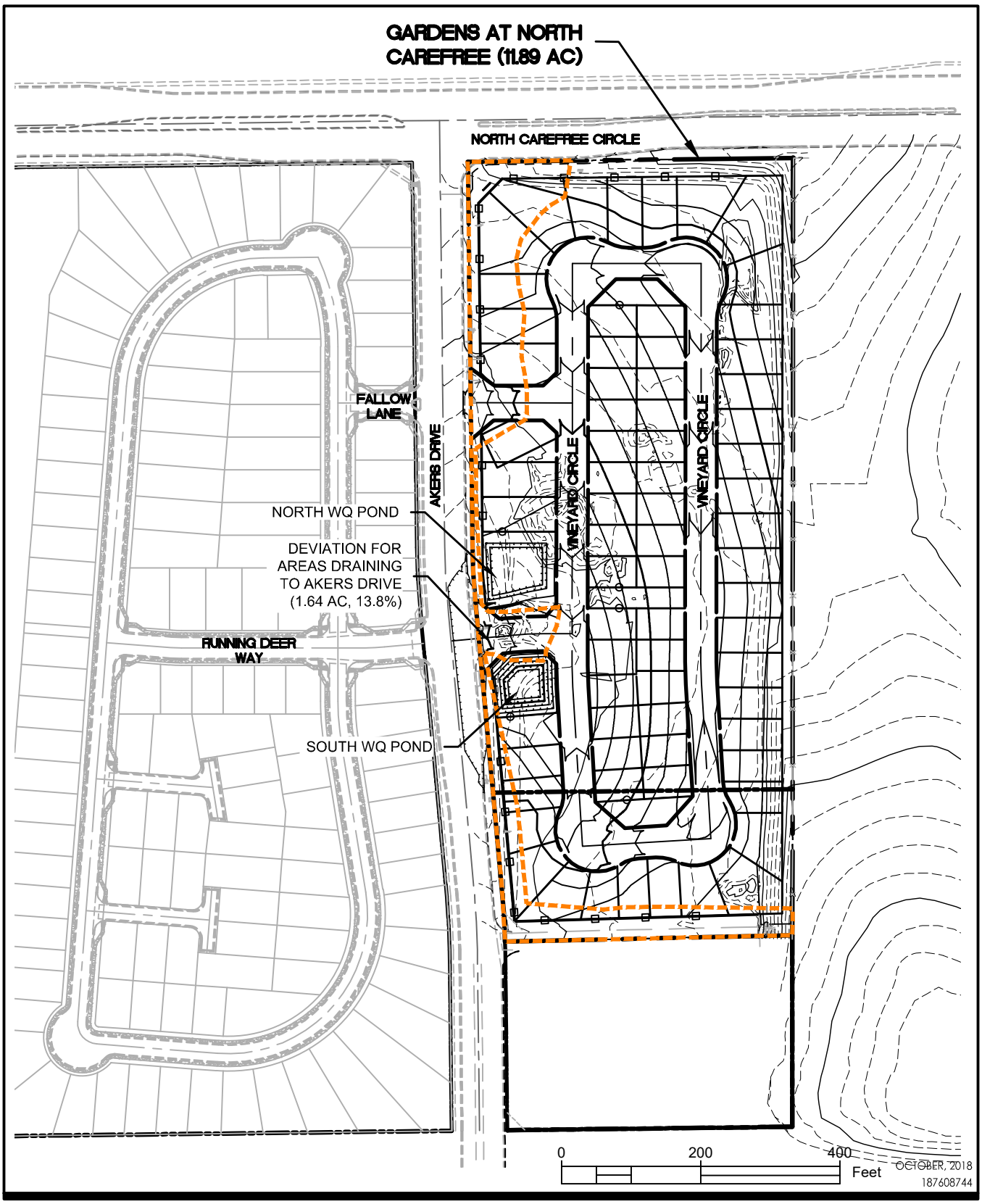
_____

_____

_____

_____

____ Additional comments or information are attached.



V:\52876\ACTIVE\187608744-MULE DEER\REPORTS\DRAINAGE\EXHIBITS\DEVIATION EXHIBIT.DWG
10/11/2018 4:36 PM

Stantec

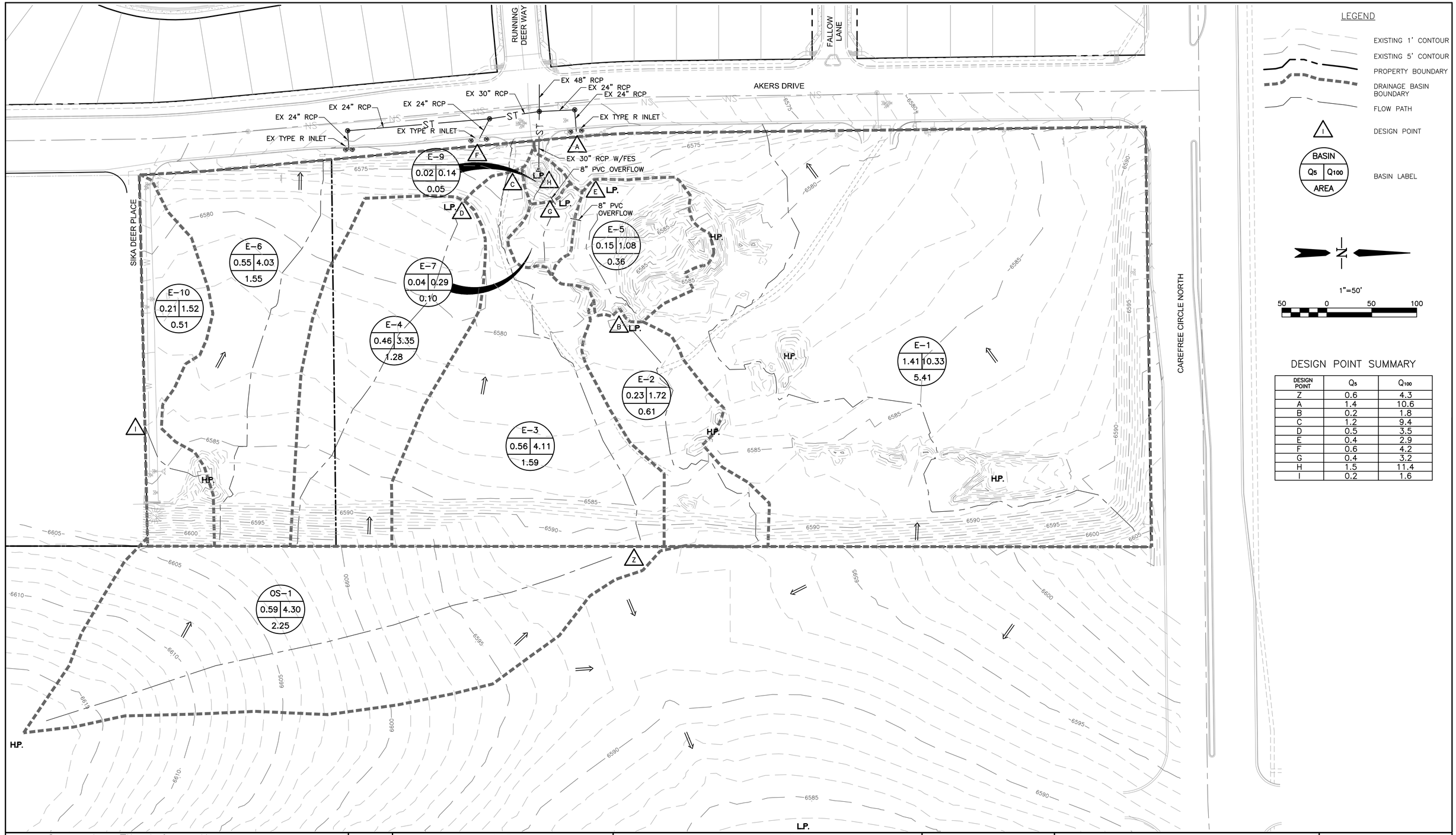
5725 MARK DABLING BLVD, SUITE 190
COLORADO SPRINGS, CO 80919
www.stantec.com

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

Figure No.
1.0

Title
VICINITY MAP

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)

DESIGN POINT SUMMARY

DESIGN POINT	Q_5	Q_{100}
Z	0.6	4.3
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

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Last Modification Date: 6-12-17	Initials: BG
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Acad Ver. 2017 Scale: see plan	Units: Feet

Index of Revisions

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Stantec Consulting Inc.
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Fax.
www.stantec.com

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

It appears that the sub-basin boundaries where not updated to reflect the revised grading.

MULE DEER CROSSING ZONE: PUD

RUNNING DEER WAY

FALLOW LANE

AKERS DRIVE

SIKA DEER PLACE (PUBLIC ROAD)

MULE DEER INVESTMENTS, LLC ZONE: CS

RUNNING DEER WAY (PUBLIC ROAD)

FALLOW LANE (PUBLIC ROAD)

CAREFREE CIRCLE NORTH

VINEYARD CIRCLE (PUBLIC ROAD)

PROPERTY BOUNDARY

CITY OF COLORADO SPRINGS ZONE: RR-5

BASIN	Q_5	Q_{100}	AREA
D-20	1.37	3.01	0.64
D-11	0.41	0.74	0.09
D-19	0.18	0.40	0.08
D-10	0.48	1.28	0.37
D-7	0.23	0.14	0.05
D-9	0.89	1.96	0.47
D-15	0.16	0.35	0.07
D-18	1.40	3.09	0.64
D-6	0.37	0.66	0.08
D-16	0.18	0.48	0.11
D-17	0.32	0.57	0.07
D-13	2.80	6.16	1.42
D-12	1.99	4.38	0.93
D-14	1.31	2.88	0.64
D-3	0.37	0.82	0.17
D-8	3.46	7.62	1.90
D-5	3.26	7.18	1.72
D-4	0.48	1.06	0.21
D-2	1.81	3.99	0.99
D-1	2.34	5.15	1.24
OS-1	0.08	0.56	0.26
OS-2	0.08	0.57	0.27
OS-3	0.43	3.17	1.63
OS-4	0.02	0.17	0.07

EX 48" RCP
EX 24" RCP
EX 30" RCP
EX TYPE R INLET
EX 24" RCP
EX 24" RCP
EX TYPE R INLET
EX 24" RCP
EX TYPE R INLET
EX 30" RCP W/FES-TO BE REMOVED
SOUTH POND
NORTH POND
8" PVC OVERFLOW TO BE REMOVED
8" PVC OVERFLOW TO BE REMOVED
9,801 SF
19,849 SF
PR TYPE R INLETS
PR TYPE R INLETS
PR TYPE R INLET
PR TYPE R INLET
LP.
LP.
HP.
HP.
LP.
H.P.

LEGEND

- PROPOSED 2' CONTOUR
- PROPOSED 10' CONTOUR
- EXISTING 2' CONTOUR
- EXISTING 10' CONTOUR
- PROPERTY BOUNDARY
- DRAINAGE BASIN BOUNDARY
- FLOW PATH
- DESIGN POINT
- BASIN (Q5 | Q100 | AREA) BASIN LABEL

1"=50'

50 0 50 100

DESIGN POINT SUMMARY

DESIGN POINT	Q_5	Q_{100}
A	3.4	9.9
B	0.9	2.0
C	3.5	7.9
D	4.2	9.6
E	3.2	7.9
F	2.1	5.1
G	1.4	3.3
H	0.4	0.8
I	1.3	2.8
Z	0.1	0.6
NP	9.9	24.8
SP	4.4	10.4
Y	0.1	0.6
X	0.4	3.3
W	0.0	0.2
V	3.6	8.0

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

Index of Revisions

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www.stantec.com

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