

**FINAL DRAINAGE REPORT FOR
FALCON ACRES
14655 DAVIS ROAD
PEYTON, COLORADO 80831**

January, 2023

Prepared For:

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DRAINAGE REPORT STATEMENT

Design Engineer's Statement

This 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 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.

L DUCETT, P.E. 32339

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.

Authorized Signature

Date

Printed Name, Title

Business Name

Address

El Paso County Approval:

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

Jennifer Irvine, P.E.

Date

County Engineer / ECM Administrator

Conditions:

Please update to
Joshua Palmer

Updated.

Purpose

The purpose of this Final Drainage Report is to identify and analyze the existing and proposed drainage patterns, determine proposed runoff quantities, size drainage structures to safely convey the developed runoff, and present solutions to drainage impacts on-site and off-site resulting from this development.

General Description

This Final Drainage Report is an analysis of the development of “FALCON ACRES” (AKA “NE4NE4, E2E2NW4NE4 Sec 4-14-64”) owned by Thousand Hills Land & Cattle Co., LLC. The site is located at 14655 Davis Road, Peyton, CO 80831 in Section 4, Township 14S, Range 64 West of the 6th Principal Meridian in El Paso County. The site is surrounded on all sides, except the north, by rural residential lots zoned RR-5. The lot to the north is zoned A-35. Davis Road borders the north boundary of the parcel and Curtis Road borders the east boundary. The site is currently unplatted.

The site is currently zoned RR-5 and does not currently have any significant structures as they were burned down in a fire since the initial approval of this final plat. There are two wells on this site which are intended to be reused.

Proposed is the subdivision of this unplatted lot into eight rural residential lots. A new public road (Peaceful Rain Way) extending south from Davis Road will provide access to the subdivision. Proposed gravel driveways will connect all lots to the new public road. Development of the subdivided lots is not included in this report. Grading associated with the proposed public road, driveways, and proposed drainage will be the only grading included in this report. Some grading can be expected when the individual lots are later developed.

The site lies within the upstream end of the Livestock Company Drainage Basin, which is tributary to the West Fork of Black Squirrel Creek.

Soils Condition

The soil for this project is composed of Type 97 “Truckton Loamy Sand” per the “Soils Survey of El Paso County Area, which is in Hydrologic Soil Group B with moderately rapid permeability, slow to medium surface runoff characteristics, moderate hazard of erosion, and 3 to 9 percent slopes.

Drainage Criteria

Hydrologic and Hydraulic calculations were performed using the El Paso County Storm Drainage Design Criteria Manual Volumes 1 & 2, latest editions. The Rational Method and the Soil Conservation Service Hydrograph Method were used to estimate storm water runoff.

Existing (Historic) Drainage Conditions

This site was previously studied in a report titled “Final Drainage Report for Falcon Acres Subdivision” dated June 25, 2007 by JPS Engineering. A drainage map for the existing conditions is included in the Appendix of this report. The site lies within the Livestock Company Drainage Basin. The existing topography is gently rolling with average grades ranging from 1 to 5 percent. The site is a rural ranch parcel and pasture/meadow area.

The existing drainage basins lying in and around the proposed development are depicted in the Appendix. The site is impacted by off-site drainage basins to the west, northwest, and southwest, which generally drain in an easterly direction across the site. Two existing sub-basins have been delineated within the site, each characterized by an existing depression as indicated by the hatched areas on the drainage maps. Overflows from the existing depressions within the site would tend to drain northeasterly towards the intersection of Davis Road and Curtis Road, where no culvert currently exists. The natural drainage patterns within the site will be impacted through development by site grading and concentration of runoff in subdivision streets. Developed runoff will generally continue to follow historic paths.

Basin OA1 contributes to DP OA1 and has an area of 207.64 acres consisting of mostly undeveloped land with localized depressions north of Davis Road. Runoff calculations for this basin were performed using the Soil Conservation Service Hydrograph Method due to the size of the basin. The basin was calculated to generate runoff amounts of Q10= 0.9 cfs and Q100= 21.6 cfs.

Basin OA2.1 contributes to DP OA2.1 and has an area of 469.43 acres consisting of mostly undeveloped land with localized depressions to the west of site. Runoff calculations for this basin were performed using the Soil Conservation Service Hydrograph Method due to the size of the basin. The basin was calculated to generate runoff amounts of Q10= 1.6 cfs and Q100= 39.3 cfs.

Basin OA2.2 contributes to DP OA2.2 and has an area of 14.49 acres consisting of undeveloped land draining onto the southwest corner of the site. Runoff calculations for this basin were performed using the Rational Method due to the small size of this offsite basin. The basin was calculated to generate runoff amounts of Q5= 2.5 cfs and Q100= 15.8 cfs.

Basin OA3 contributes to DP OA3 and has an area of 24.42 acres consisting of undeveloped land draining onto the southern area of Falcon Acres. Runoff calculations for this basin were performed using the Rational Method due to the smaller size of this offsite basin. The basin was calculated to generate runoff amounts of Q5= 4.2 cfs and Q100= 26.9 cfs.

Basin OB1 contributes to DP OB1 and has an area of 1.00 acres consisting of undeveloped land draining onto the southeast corner of the parcel. Runoff calculations for this basin were performed using the Rational Method due to the small size of this offsite basin. The basin was calculated to generate runoff amounts of Q5= 0.3 cfs and Q100= 1.9 cfs.

Basin A contributes to DP A and makes up a majority of the existing site. It has an area of 33.80 acres consisting of mostly undeveloped land on the eastern side of the parcel. There are a few remnants of structures that were destroyed in a fire several years ago. This entire basin drains to an existing depression near the center of the basin. Runoff calculations for this basin were performed using the Rational Method due to the smaller size of this basin. The basin was calculated to generate runoff amounts of Q5= 7.3 cfs and Q100= 47.9 cfs.

Basin B contributes to DP B and has an area of 15.48 acres consisting of mostly undeveloped similar to the land on the eastern side of the parcel. This basin drains to an existing depression near the center of the basin. Runoff calculations for this basin were performed using the Rational Method due to the smaller size of this basin. The basin was calculated to generate runoff amounts of $Q_5 = 2.9$ cfs and $Q_{100} = 18.8$ cfs.

Off-site flows from Basins OA1-OA3 combine with on-site drainage from Basin A, draining to the existing depression within Basin A on the west side of the parcel. The existing upstream basins have several stock ponds and retention areas. There is currently no culvert for drainage to cross the low point in Davis Road at the north boundary of the site. Based on the topography, overflows from Basin OA1 would overtop Davis Road and flow south into Basin A. Off-site flows from Basins OA1, OA2.1, OA2.2, and OA3 combine with on-site flows at the existing retention area within Basin A, with calculated historic peak flows of $Q_5 = 16.5$ cfs and $Q_{100} = 151.6$ cfs at Design Point A. The westerly retention area (Retention Area A) within the Falcon Acres site currently has a storage volume of approximately 91.6 acre-feet between the 6528 and 6536 contours. Overflows from this retention area would drain northeasterly to Basin B.

Off-site flows from Basin OB1 combine with on-site drainage from Basin B, draining to the existing depression within Basin B on the east side of the parcel. Off-site flows from Basin OB1 combine with on-site flows at the existing retention area within Basin B, with calculated historic peak flows of $Q_5 = 3.2$ cfs and $Q_{100} = 20.7$ cfs at Design Point B. The easterly retention area (Retention Area B) has a storage volume of approximately 6.9 acre-feet between the 6528 and 6530 contours. Overflows from Retention Area B would drain northeasterly towards the intersection of Curtis Road and Davis Road.

Based on the substantial retention volume within the site, no 100-year flows would be expected to reach Design Point 1 at the northeast corner of the site. In the unlikely event the existing retention ponds were completely full, overflows from Basin A would flow northeasterly, combining with flows from Basin B at Design Point 1, with calculated historic peak flows of $Q_5 = 19.7$ cfs and $Q_{100} = 172.3$ cfs. The calculated flows for off-site basins have incorporated an SCS runoff curve number of 50 based on the existence of numerous upstream retention areas which is consistent with the approved Final Drainage Report for Davis Ranch Subdivision, which is located a few miles east of this site. Historic overflows from the Falcon Acres site would tend to overtop Curtis Road and flow to an existing depression on the parcel at the southeast corner of Curtis Road and Davis Road.

Developed Drainage Conditions

A drainage map for the proposed condition is included in the appendix of this report. The offsite basins remain the same.

In the developed conditions, Basin A has been divided into Sub-basins A1 & A2 by the proposed public road within the site. Off-site flows from Basin OA2.1 and OA2.2 will combine with on-site drainage from Sub-basins A1 & A2, draining to a new culvert crossing at the low point of the proposed roadway profile. Developed peak flow at Design Point A1 are projected to be $Q_5 = 7.7$ cfs and $Q_{100} = 74.6$ cfs. Two Proposed 36" RCP culverts will cross the public road at Design Point A1.

Basin A1 contributes to DP A1 and has an area of 6.10 acres consisting mostly of proposed residential development and a small amount of gravel road in the northwestern corner of the site. This basin drains to the proposed 36" dual culverts that will cross beneath Peaceful Rain Way. Runoff calculations for this basin were performed using the Rational Method. The basin was calculated to generate runoff amounts of $Q_5 = 1.7$ cfs and $Q_{100} = 9.1$ cfs.

Basin A2 contributes to DP A2 and has an area of 6.24 acres consisting mostly of proposed residential development and a small amount of gravel road similar to Basin A1 in the southwestern corner of the site. This basin drains to DP A2 which will be the location of future 24" dual culverts that will cross beneath the future road Moonglow Heights to the west of Peaceful Rain Way. Runoff calculations for this basin were performed using the Rational Method. The basin was calculated to generate runoff amounts of $Q_5 = 1.9$ cfs and $Q_{100} = 10.4$ cfs.

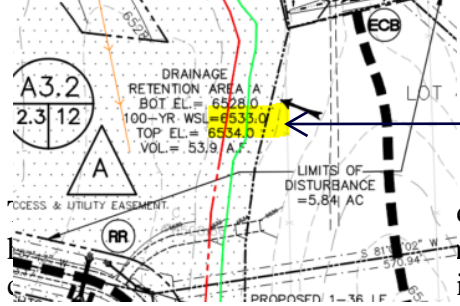
Given the lack of any existing drainage facility crossing the low point in Davis Road, a future 24-inch culvert is recommended at Design Point OA1. A 24" private driveway culvert will be installed across the private shared driveway (Satellite View) south of Design Point OA1. Dual 24" private driveway culverts will be constructed across Moonglow Heights as Design Point A3.1 to convey drainage across the retention area split by the new shared driveway. Possible driveway locations and grading have been provided for Lots 4, 7, & 8 extending to the edge of Retention Area A. The driveway for Lot 4 would require an 18" culvert as shown in the appendix.

Basin A3.1 contributes to DP A3.1 and has an area of 9.13 acres consisting mostly of proposed residential development and a small amount of gravel road in the southcentral area of the site. This basin drains to the proposed 24" dual culverts that will cross beneath Moonglow Heights east of Peaceful Rain Way. Runoff calculations for this basin were performed using the Rational Method. The basin was calculated to generate runoff amounts of $Q_5 = 2.0$ cfs and $Q_{100} = 10.6$ cfs.

Basin A3.2 contributes to DP A and has an area of 12.34 acres consisting of proposed residential development, a small amount of gravel road, and contains most of Retention Area A. It is located in the northcentral area of the site. This basin drains to Retention Area A in the center of the site. Runoff calculations for this basin were performed using the Rational Method. The basin was calculated to generate runoff amounts of $Q_5 = 3.5$ cfs and $Q_{100} = 19.2$ cfs.

Off-site flows from Basins OA1-OA3 will continue to combine with flows from Basins A1-A3 in the existing "Retention Area A" on the west side of the site. Off-site flows from Basins OA1, OA2.1, OA2.2, and OA3 will combine with on-site flows from Basins A1-A3.2 at the existing retention area within Basin A, with calculated developed peak flows of $Q_5 = 18.3$ cfs and $Q_{100} = 153.0$ cfs.

The retention area has a bottom elevation of 6528.0 and the existing saddle northeast of this area has an elevation of approximately 6536.0 which would be the natural overflow point from this area. Channel A3 is proposed to provide an overflow swale northeasterly from Retention Area A to Retention Area B. This channel will be excavated to an elevation of 6533.5, and a drainage easement will encompass ground elevations within Retention Area A up to the grade the grade of 6534.0 to preclude building anywhere within the retention area.



This paragraph contradicts the other engineering documents which shows 100-yr WSL of 6533 with 53.9 af. Update the text or the maps so they are consistent.

I submitted before I updated the plans which had the old WSL. The elevations in the text here are correct.

adopted criteria recommend the 24-hour 100-year volume for Design Point B. The available retention storage volume up to the 6532.0 contour level within Basin A is 25.28 acre-feet, which is approximately equal to the calculated 100-year storage volume recommendation of 2 times 11.73 acre-feet (based on a 24-hour retention volume with safety factor of 2.0 per Mile High Flood District recommendations. Overflow channels will be provided to safely convey overflows or to existing downstream swales.

Basin B contributes to DP B and has an area of 15.48 acres consisting of proposed residential development and contains all of Retention Area B. It is located on the eastern portion of the site. This basin drains to Retention Area B in the center of the basin. Runoff from the basin were performed using the Rational Method. The basin was calculated amounts of $Q_5 = 5.2$ cfs and $Q_{100} = 26.6$ cfs.

I added the text to the discussion of Retention Area A. Retention Area B will not have any drives or roads.

State that the proposed grading for the roadways and driveways has been subtracted from the pre-development volume of the retention ponds (John - I think that you told me on the phone that you had done this in the calcs, but I'm not seeing it written in the text).

Off-site flows from Basin OB1 will continue to combine with on-site drains draining to the existing "Retention Area B" on the east side of the site. Cretion Area OB1 will continue to combine with on-site flows at the existing retention area. Basin B, with calculated developed peak flows of $Q_5 = 5.5$ cfs and $Q_{100} = 28.5$ cfs at Design Point B.

Retention Area B has a bottom elevation of 6528.0 and the existing overflow swale to the northeast has an elevation of approximately 6530.0. A drainage easement will encompass ground elevations within Area B up to the grade of 6530 to preclude building within the retention area.

As detailed in the appendix, the calculated 100-year 24-hour retention volume for Design Point B is 0.31 acre-feet, which is below the available retention storage volume of 1.80 acre-feet at the 6528.0 contour.

As is the historic conditions, no 100-year flows would be expected to reach Design Point 1 based on the substantial retention volume within the site. In the unlikely event the existing retention ponds were completely full, overflows from off-site Basins OA1-OA3 & OB1 will combine with flows from on-site Basins A and B at Design Point 1, with developed peak flows of $Q_5 = 23.8$ cfs and $Q_{100} = 181.5$ cfs.

The proposed rural residential lot layout has been designed to maintain the two existing drainage retention areas, while providing an overflow channel to the northeast. Given the lack of any existing drainage facility crossing the low point on the south side of Davis Road and Curtis Road intersection, a culvert is recommended at this location. The proposed culvert is a 14" by 23" elliptical culvert sized to convey overflows only from the on-site retention areas (beyond 100-year flows).

The off-site parcel to the east also has an existing depression which serves as a drainage retention area. The proposed drainage approach of maintaining the existing drainage retention areas within the Falcon Acres parcel should maintain conditions that mimic pre-development hydrology downstream of the site.

Comparison of Developed to Historic Discharges

Based on the hydrologic calculations in the appendix, the total developed flow from the site will remain unchanged based on the existing retention volumes. If the existing retention volume were excluded from the analysis, the total developed flow would exceed historic flow from the site by

approximately 14%. The increase in developed flow will be mitigated by maintaining the existing on-site drainage retention areas.

The total developed storm runoff downstream of the proposed subdivision will be maintained at historic levels by routing flows through two existing retention ponds within the site. The retention volume has been sized to retain the calculated 24-hour, 100-year storm discharge from the developed basins within the site, as detailed in the appendix. Overflow swales will be provided to convey major storm discharges downstream following historic drainage patterns. Based on the drainage concept of protecting the existing on-site retention areas, the proposed development will have a negligible downstream drainag **Fixed.**

FSEDB

In an effort to protect receiving water and as part of the “four step process to minimize adverse impacts of urbanization” this site was analyzed in the following manner:

- Step 1: Employ Runoff Reduction Practices – All drainage from the proposed development will be routed to existing detention areas. By capturing these flows in the detention areas, the developed runoff will be detained and reduce the quantity of downstream runoff. Existing native prairie grasses in the retention areas are being retained that will act as natural grass buffers.
- Step 2: Stabilize Drainageways – There are no existing streams associated with this site, but the reduction of runoff from the site will help to stabilize downstream waterways. All drainageways proposed onsite are grass swales.
- Step 3: Provide Water Quality Capture Volume – The retention areas will be retained to capture and treat the runoff from the proposed development in the appropriate manner.
- Step 4: Consider Need for Industrial and Commercial BMPs – As this development will not include outdoor storage or the potential for the introduction of contaminants to the County’s MS4, since it is not an industrial or commercial site, no source controls are proposed or necessary.

Floodplain Statement

According to FEMA’s FIRM No. 08041CO785G (eff. 12/7/2018), the proposed development is within an area designated as Zone X, having minimal flood hazard.

Construction Cost Opinion

Private Drainage Facilities Improvements (Non-Reimbursable)

Description	Quantity	Unit Price	Cost
18” RCP Culvert	84 LF	\$70	\$5,880
24” RCP Culvert	116 LF	\$83	\$9,628
Total			\$15,508

Public Drainage Facilities Improvements

Description	Quantity	Unit Price	Cost
14"X23" RCP Culvert	68 LF	\$70	\$4,760
24" RCP Culvert	100 LF	\$83	\$8,300
36" RCP Culvert	132 LF	\$128	\$16,896
14"X23" FES	2 EA	\$138	\$276
36" FES	2 EA	\$216	\$432
<i>Subtotal</i>			<i>\$30,664</i>
<i>10% Contingency</i>			<i>\$3,066.40</i>
Total			\$33,730.40

Drainage Fee Update the drainage fee to include the 25% reduction for low density lots. See ECM Appendix L Section 3.10.2a

This site is located in the Livestock Company Drainage Basin. The site is 49.23 acres. The Drainage Criteria Manual 1 Addendum states that for single-family 5-acre lots, a reduction of 7% can be used. The combined Drainage Fees (2022) are due per acre.

Updated. Thank you.

Fee Type	% Imp.	Parcel Area (acre)	Imp. Area (acre)	Fee per Imp Acre	Mod %	Fee Cost
Drainage	7	49.23	3.45	\$19,552	100	\$67,454.40
Bridge	7	49.23	3.45	\$233	100	\$803.85
Total						\$68,258.25

Maintenance

The existing retention areas will be privately maintained by the lot owners and is accessible via private and public drives throughout the site. The retention areas should be inspected at least twice per year and debris removed as necessary. The proposed erosion control measures will be repaired and maintained by the property owners as required. The proposed private culverts will be privately maintained by the lot owners.

On-Site Drainage Facility Design

Developed sub-basins and proposed drainage improvements are depicted in the enclosed Drainage Plan (Sheet D1). In accordance with El Paso County standards, new roadways will be graded with a minimum longitudinal slope of one percent. On site-drainage facilities will consist of roadside ditches, grass-lined channels, and culverts. Hydraulic calculations for sizing of drainage facilities are enclosed in the appendix and design criteria is summarized as follows:

Culverts

The internal road system will be graded to drain roadside ditches to low points along the road profile, where culverts will convey developed flows into grass-lined channels following historic drainage paths. The culverts have been specified as reinforced concrete pipe (RCP) with a minimum diameter of 18-inches. Culvert sizes are based on El Paso County criteria. Riprap outlet protection will be provided at all culverts. Calculations are provided in the appendix.

Open Channels

I submitted the correspondence I've had with the State Engineer's office regarding water rights. A section discussing this has been added to the drainage report.

Drainage easements, including existing channels and existing depressions through the subdivision. Proposed channels convey 100-year flows, with a trapezoidal cross section, variable bottom width and depth, 4:1 maximum side slopes,

Add a subsection in the report for "Other Government Agency Requirements".

Provide a summary regarding the applicability of Senate Bill 15-212 and water rights. Are there requirements or determinations that have been provided by other government entities such as the Colorado State Engineer's office with regards to water rights?

MHFD provided the following information in the FAQ sheet section of their memorandum dated March 9, 2016 regarding SB 15-212:

How should retention facilities be handled?	Neither retention facilities nor constructed wetlands are protected under 37-92-602(8) CRS. These facilities expressly require a water right.
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What types of facilities require notification per SB-212?

BMPs		Water Quality Only	Flood Control Included
	Grass Buffers	Not Required	Not Required
	Grass Swales	Not Required	Not Required
	Bioretention (with or without an underdrain)	Not Required	Required
	Green Roof	Not Required	N/A
	Extended Detention Basin	Required	Required
	Sand Filter	Not Required	Required
	Permeable Pavement Systems	Not Required	Required
	Media Filter Drain	Not Required	Not Required
	Underground Detention Vaults	Required	Required
	Constructed Wetland Pond	N/A, SUBJECT TO WATER RIGHTS	
	Constructed Wetland Channel	N/A, SUBJECT TO WATER RIGHTS	

CSR 37-92-602(8) FAQ UDFCD 2015-08-26

	Retention Pond	N/A, SUBJECT TO WATER RIGHTS
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increase will be mitigated by maintaining two existing drainage retention areas within the site. Proposed flows, as detailed in this report, will follow existing drainage patterns and will be safely routed to those existing retention areas where water quality is also provided on-site.

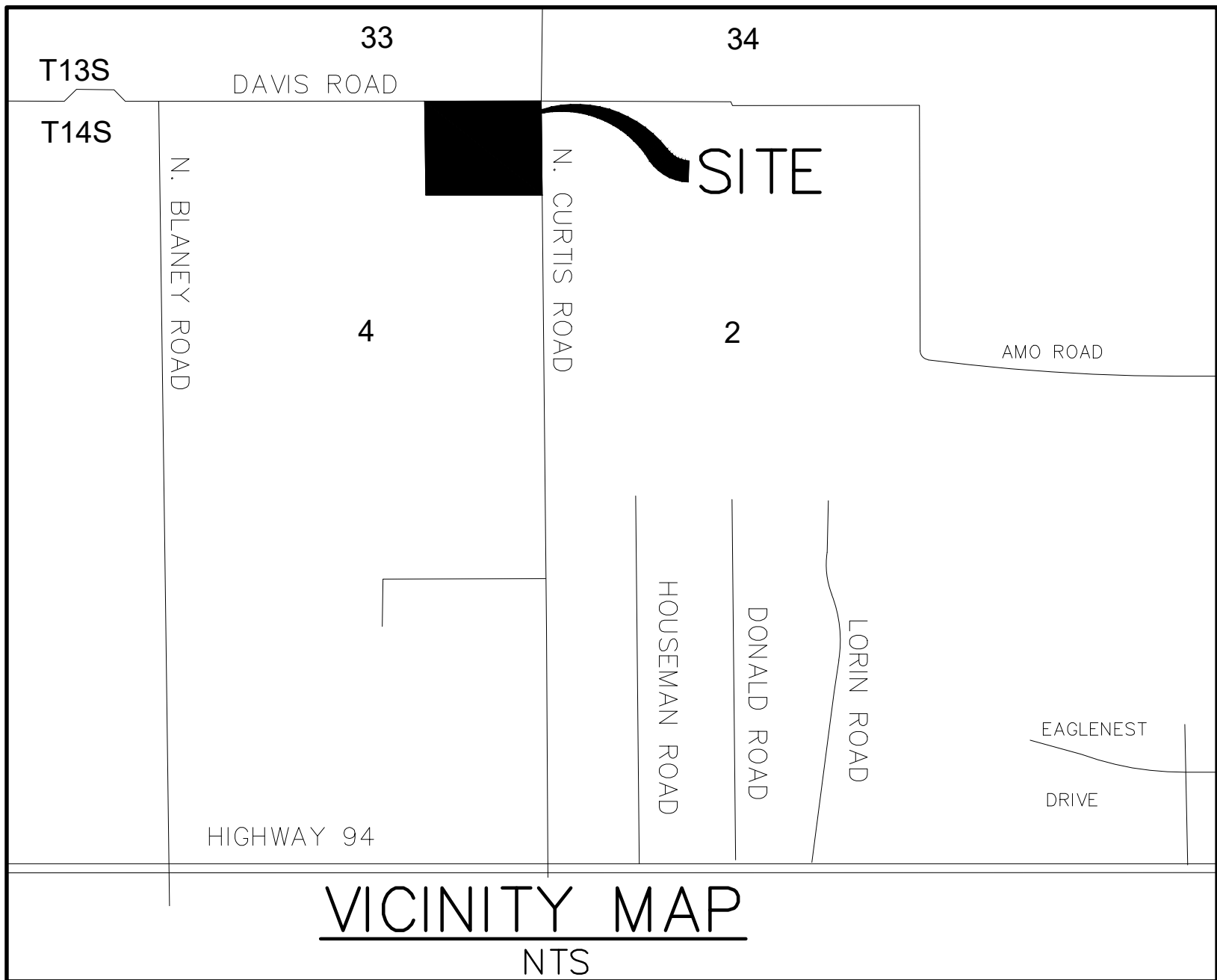
Maintenance of the retention areas, in conjunction with proper erosion control measures, will ensure that there will be no adverse drainage impacts from this development to downstream landowners or parcels. An Erosion Control Plan will be submitted separately.

References

- 1) *City of Colorado Springs/County of El Paso Drainage Criteria Manual, dated May 2014.*
- 2) *Soil survey of El Paso County Area, Colorado, Prepared by United States Department of Agriculture Soil Conservation Service, dated June 1981.*
- 3) *Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map Number 08041C0785G.*
- 4) *Mile High Flood District DCM*

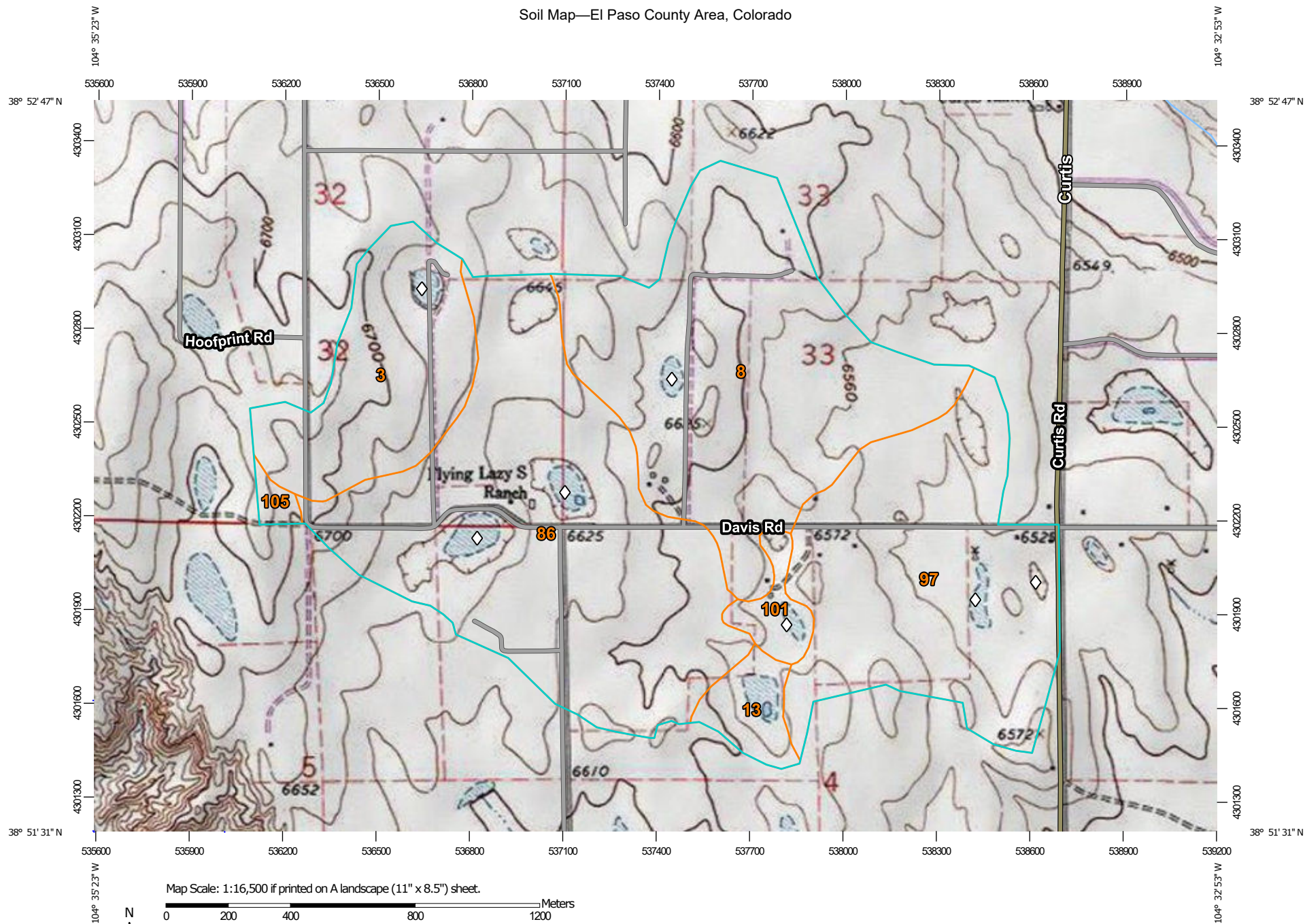
APPENDICES

VICINITY MAP



SOILS MAP

Soil Map—El Paso County Area, Colorado



Map Scale: 1:16,500 if printed on A landscape (11" x 8.5") sheet.

0 200 400 800 1200 Meters

0 500 1000 2000 3000 Feet

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



**Natural Resources
Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

5/28/2022
Page 1 of 3

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



Topographic Map



Aerial Photography

MAP INFORMATION

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

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 19, Aug 31, 2021

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

Date(s) aerial images were photographed: Sep 11, 2018—Oct 20, 2018

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
3	Ascalon sandy loam, 3 to 9 percent slopes	90.2	11.8%
8	Blakeland loamy sand, 1 to 9 percent slopes	214.3	28.0%
13	Bresser sandy loam, cool, 5 to 9 percent slopes	19.1	2.5%
86	Stoneham sandy loam, 3 to 8 percent slopes	249.6	32.6%
97	Truckton sandy loam, 3 to 9 percent slopes	174.3	22.8%
101	Ustic Torrifluvents, loamy	14.1	1.8%
105	Vona sandy loam, warm, 3 to 6 percent slopes	4.5	0.6%
Totals for Area of Interest		766.3	100.0%

El Paso County Area, Colorado

3—Ascalon sandy loam, 3 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2tlny

Elevation: 3,870 to 5,960 feet

Mean annual precipitation: 13 to 18 inches

Mean annual air temperature: 46 to 54 degrees F

Frost-free period: 95 to 155 days

Farmland classification: Not prime farmland

Map Unit Composition

Ascalon and similar soils: 85 percent

Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ascalon

Setting

Landform: Interfluves

Landform position (two-dimensional): Backslope

Landform position (three-dimensional): Side slope

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Wind-reworked alluvium and/or calcareous sandy eolian deposits

Typical profile

Ap - 0 to 6 inches: sandy loam

Bt1 - 6 to 12 inches: sandy clay loam

Bt2 - 12 to 19 inches: sandy clay loam

Bk1 - 19 to 35 inches: fine sandy loam

Bk2 - 35 to 80 inches: fine sandy loam

Properties and qualities

Slope: 3 to 9 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Well drained

Runoff class: Medium

Capacity of the most limiting layer to transmit water

(Ksat): Moderately high to high (0.60 to 5.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 10 percent

Maximum salinity: Nonsaline (0.1 to 1.9 mmhos/cm)

Sodium adsorption ratio, maximum: 1.0

Available water supply, 0 to 60 inches: Moderate (about 7.1 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

Minor Components

Olneft

Percent of map unit: 10 percent
Landform: Interfluves
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

Vona

Percent of map unit: 5 percent
Landform: Interfluves
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY024CO - Sandy Plains
Hydric soil rating: No

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 19, Aug 31, 2021

El Paso County Area, Colorado

8—Blakeland loamy sand, 1 to 9 percent slopes

Map Unit Setting

National map unit symbol: 369v

Elevation: 4,600 to 5,800 feet

Mean annual precipitation: 14 to 16 inches

Mean annual air temperature: 46 to 48 degrees F

Frost-free period: 125 to 145 days

Farmland classification: Not prime farmland

Map Unit Composition

Blakeland and similar soils: 98 percent

Minor components: 2 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Blakeland

Setting

Landform: Hills, flats

Landform position (three-dimensional): Side slope, talf

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Alluvium derived from sedimentary rock and/or
eolian deposits derived from sedimentary rock

Typical profile

A - 0 to 11 inches: loamy sand

AC - 11 to 27 inches: loamy sand

C - 27 to 60 inches: sand

Properties and qualities

Slope: 1 to 9 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Somewhat excessively drained

Runoff class: Low

Capacity of the most limiting layer to transmit water (Ksat): High to
very high (5.95 to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 5 percent

Available water supply, 0 to 60 inches: Low (about 4.5 inches)

Interpretive groups

Land capability classification (irrigated): 3e

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: A

Ecological site: R049XB210CO - Sandy Foothill

Hydric soil rating: No

Minor Components

Other soils

Percent of map unit: 1 percent

Hydric soil rating: No

Pleasant

Percent of map unit: 1 percent

Landform: Depressions

Hydric soil rating: Yes

Data Source Information

Soil Survey Area: El Paso County Area, Colorado

Survey Area Data: Version 19, Aug 31, 2021

El Paso County Area, Colorado

13—Bresser sandy loam, cool, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2tlpk

Elevation: 5,500 to 6,960 feet

Mean annual precipitation: 15 to 19 inches

Mean annual air temperature: 48 to 52 degrees F

Frost-free period: 100 to 130 days

Farmland classification: Not prime farmland

Map Unit Composition

Bresser, cool, and similar soils: 85 percent

Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bresser, Cool

Setting

Landform: Interfluves

Landform position (two-dimensional): Shoulder, backslope

Landform position (three-dimensional): Interfluve

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Tertiary aged alluvium derived from arkose

Typical profile

Ap - 0 to 5 inches: sandy loam

Bt1 - 5 to 8 inches: sandy loam

Bt2 - 8 to 27 inches: sandy clay loam

Bt3 - 27 to 36 inches: sandy loam

C - 36 to 80 inches: loamy coarse sand

Properties and qualities

Slope: 5 to 9 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Well drained

Runoff class: Medium

Capacity of the most limiting layer to transmit water

(Ksat): Moderately high to high (0.60 to 6.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 5 percent

Maximum salinity: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)

Available water supply, 0 to 60 inches: Low (about 5.4 inches)

Interpretive groups

Land capability classification (irrigated): 4e

Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Minor Components

Ascalon

Percent of map unit: 10 percent
Landform: Interfluves
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Truckton

Percent of map unit: 5 percent
Landform: Interfluves
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 19, Aug 31, 2021

El Paso County Area, Colorado

86—Stoneham sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 36b2

Elevation: 5,100 to 6,500 feet

Mean annual precipitation: 13 to 15 inches

Mean annual air temperature: 48 to 52 degrees F

Frost-free period: 135 to 155 days

Farmland classification: Not prime farmland

Map Unit Composition

Stoneham and similar soils: 95 percent

Minor components: 5 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Stoneham

Setting

Landform: Hills

Landform position (three-dimensional): Side slope

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Calcareous loamy alluvium

Typical profile

A - 0 to 4 inches: sandy loam

Bt - 4 to 8 inches: sandy clay loam

Btk - 8 to 11 inches: sandy clay loam

Ck - 11 to 60 inches: loam

Properties and qualities

Slope: 3 to 8 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Well drained

Runoff class: Medium

Capacity of the most limiting layer to transmit water

(Ksat): Moderately high to high (0.60 to 2.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 15 percent

Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)

Available water supply, 0 to 60 inches: High (about 9.5 inches)

Interpretive groups

Land capability classification (irrigated): 3e

Land capability classification (nonirrigated): 4e

Hydrologic Soil Group: B

Ecological site: R067BY024CO - Sandy Plains
Other vegetative classification: SANDY PLAINS (069AY026CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit: 4 percent
Hydric soil rating: No

Pleasant

Percent of map unit: 1 percent
Landform: Depressions
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 19, Aug 31, 2021

El Paso County Area, Colorado

97—Truckton sandy loam, 3 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2x0j2

Elevation: 5,300 to 6,850 feet

Mean annual precipitation: 14 to 19 inches

Mean annual air temperature: 48 to 52 degrees F

Frost-free period: 85 to 155 days

Farmland classification: Not prime farmland

Map Unit Composition

Truckton and similar soils: 85 percent

Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Truckton

Setting

Landform: Interfluves, hillslopes

Landform position (two-dimensional): Backslope

Landform position (three-dimensional): Side slope

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Re-worked alluvium derived from arkose

Typical profile

A - 0 to 4 inches: sandy loam

Bt1 - 4 to 12 inches: sandy loam

Bt2 - 12 to 19 inches: sandy loam

C - 19 to 80 inches: sandy loam

Properties and qualities

Slope: 3 to 9 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Well drained

Runoff class: Low

Capacity of the most limiting layer to transmit water (Ksat): High
(2.00 to 6.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 1 percent

Maximum salinity: Nonsaline (0.1 to 1.9 mmhos/cm)

Available water supply, 0 to 60 inches: Moderate (about 6.6 inches)

Interpretive groups

Land capability classification (irrigated): 6e

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: A
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Minor Components

Blakeland

Percent of map unit: 8 percent
Landform: Interfluves, hillslopes
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Bresser

Percent of map unit: 7 percent
Landform: Interfluves, low hills
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave, linear
Across-slope shape: Concave, linear
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 19, Aug 31, 2021

El Paso County Area, Colorado

101—Ustic Torrfluvents, loamy

Map Unit Setting

National map unit symbol: 3673

Elevation: 5,500 to 7,000 feet

Mean annual precipitation: 13 to 16 inches

Mean annual air temperature: 47 to 52 degrees F

Frost-free period: 125 to 155 days

Farmland classification: Not prime farmland

Map Unit Composition

Ustic torrfluvents and similar soils: 95 percent

Minor components: 5 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ustic Torrfluvents

Setting

Landform: Flood plains, stream terraces

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Sandy, clayey, stratified loamy

Typical profile

A - 0 to 6 inches: variable

C - 6 to 60 inches: stratified loamy sand to clay loam

Properties and qualities

Slope: 0 to 3 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Well drained

Runoff class: Low

Capacity of the most limiting layer to transmit water

(Ksat): Moderately high to high (0.20 to 2.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 10 percent

Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)

Available water supply, 0 to 60 inches: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): 2e

Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: B

Ecological site: R069XY037CO - Saline Overflow LRU's A and B

Other vegetative classification: OVERFLOW (069BY036CO)

Hydric soil rating: No

Minor Components

Other soils

Percent of map unit: 4 percent

Hydric soil rating: No

Pleasant

Percent of map unit: 1 percent

Landform: Depressions

Hydric soil rating: Yes

Data Source Information

Soil Survey Area: El Paso County Area, Colorado

Survey Area Data: Version 19, Aug 31, 2021

El Paso County Area, Colorado

105—Vona sandy loam, warm, 3 to 6 percent slopes

Map Unit Setting

National map unit symbol: 2t517

Elevation: 3,400 to 6,000 feet

Mean annual precipitation: 14 to 16 inches

Mean annual air temperature: 48 to 54 degrees F

Frost-free period: 130 to 170 days

Farmland classification: Not prime farmland

Map Unit Composition

Vona, warm, and similar soils: 85 percent

Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Vona, Warm

Setting

Landform: Sand sheets

Landform position (two-dimensional): Backslope

Landform position (three-dimensional): Head slope, side slope

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Eolian sands

Typical profile

A - 0 to 5 inches: sandy loam

Bt1 - 5 to 12 inches: sandy loam

Bt2 - 12 to 17 inches: sandy loam

Bk - 17 to 41 inches: sandy loam

BCK - 41 to 79 inches: loamy sand

Properties and qualities

Slope: 3 to 6 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Somewhat excessively drained

Runoff class: Very low

Capacity of the most limiting layer to transmit water (Ksat): High
(2.00 to 6.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 15 percent

Gypsum, maximum content: 2 percent

Maximum salinity: Nonsaline to very slightly saline (0.0 to 3.9 mmhos/cm)

Sodium adsorption ratio, maximum: 2.0

Available water supply, 0 to 60 inches: Moderate (about 7.2 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: R067BY024CO - Sandy Plains
Forage suitability group: Loamy, Dry (G067BW019CO)
Other vegetative classification: Sandy Plains #24
(067XY024CO_2), Loamy, Dry (G067BW019CO)
Hydric soil rating: No

Minor Components

Oldest, warm

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Summit, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY024CO - Sandy Plains
Other vegetative classification: Loamy, Dry (G067BW019CO)
Hydric soil rating: No

Valent, warm

Percent of map unit: 5 percent
Landform: Sand sheets
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R067BY015CO - Deep Sand
Other vegetative classification: Deep Sands #15 (067XY015CO_3),
Sandy, Dry (G067BW026CO)
Hydric soil rating: No

Otero, warm

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Head slope, side slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R067BY024CO - Sandy Plains
Other vegetative classification: SANDY PLAINS (067XY024CO_1),
Loamy, Dry (G067BW019CO)
Hydric soil rating: No

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 19, Aug 31, 2021

FEMA FLOODPLAIN MAP

National Flood Hazard Layer FIRMMette



104°33'38"W 38°52'7"N



0 250 500 1,000 1,500 2,000 Feet

1:6,000

104°33'1"W 38°51'39"N

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

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

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



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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on **8/1/2021 at 4:25 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

HYDROLOGIC CALCULATIONS

MEISMAN PROPERTY
(Area Runoff Coefficient Summary)

EXISTING CONDITIONS

		RESIDENTIAL (5 ACRE)			UNDEVELOPED			GRAVEL STREET			GRAVEL YARD			WEIGHTED	
BASIN	TOTAL AREA	AREA	C ₅	C ₁₀₀	AREA	C ₅	C ₁₀₀	AREA	C ₅	C ₁₀₀	AREA	C ₅	C ₁₀₀	C ₅	C ₁₀₀
	(Acres)	(Acres)			(Acres)			(Acres)			(Acres)				
OA1	207.64	0.00	0.12	0.39	207.64	0.09	0.36	0.00	0.59	0.70	0.00	0.30	0.50	0.09	0.36
OA2.1	469.43	0.00	0.12	0.39	469.43	0.09	0.36	0.00	0.59	0.70	0.00	0.30	0.50	0.09	0.36
OA2.2	14.49	0.00	0.12	0.39	14.49	0.09	0.36	0.00	0.59	0.70	0.00	0.30	0.50	0.09	0.36
OA3	24.42	0.00	0.12	0.39	24.42	0.09	0.36	0.00	0.59	0.70	0.00	0.30	0.50	0.09	0.36
OB1	1.00	0.00	0.12	0.39	1.00	0.09	0.36	0.00	0.59	0.70	0.00	0.30	0.50	0.09	0.36
A	33.80	0.00	0.12	0.39	33.80	0.09	0.36	0.00	0.59	0.70	0.00	0.30	0.50	0.09	0.36
B	15.48	0.00	0.12	0.39	15.48	0.09	0.36	0.00	0.59	0.70	0.00	0.30	0.50	0.09	0.36

DEVELOPED CONDITIONS

		RESIDENTIAL (5 ACRE)			UNDEVELOPED			GRAVEL STREET			GRAVEL YARD			WEIGHTED	
BASIN	TOTAL AREA	AREA	C ₅	C ₁₀₀	AREA	C ₅	C ₁₀₀	AREA	C ₅	C ₁₀₀	AREA	C ₅	C ₁₀₀	C ₅	C ₁₀₀
	(Acres)	(Acres)			(Acres)			(Acres)			(Acres)				
OA1	207.64	0.00	0.12	0.39	207.64	0.09	0.36	0.00	0.59	0.70	0.00	0.30	0.50	0.09	0.36
OA2.1	469.43	0.00	0.12	0.39	469.43	0.09	0.36	0.00	0.59	0.70	0.00	0.30	0.50	0.09	0.36
OA2.2	14.49	0.00	0.12	0.39	14.49	0.09	0.36	0.00	0.59	0.70	0.00	0.30	0.50	0.09	0.36
OA3	24.42	0.00	0.12	0.39	24.42	0.09	0.36	0.00	0.59	0.70	0.00	0.30	0.50	0.09	0.36
OB1	1.00	0.00	0.12	0.39	1.00	0.09	0.36	0.00	0.59	0.70	0.00	0.30	0.50	0.09	0.36
A1	6.10	4.93	0.12	0.39	0.75	0.09	0.36	0.42	0.59	0.70	0.00	0.30	0.50	0.11	0.36
A2	6.24	5.93	0.12	0.39	0.00	0.09	0.36	0.31	0.59	0.70	0.00	0.30	0.50	0.11	0.37
A3.1	9.13	8.75	0.12	0.39	0.00	0.09	0.36	0.38	0.59	0.70	0.00	0.30	0.50	0.12	0.37
A3.2	12.34	10.58	0.12	0.39	0.87	0.09	0.36	0.89	0.59	0.70	0.00	0.30	0.50	0.11	0.36
B	15.48	12.33	0.12	0.39	2.79	0.09	0.36	0.36	0.59	0.70	0.00	0.30	0.50	0.13	0.39

Calculated by: JF

Date: 11/14/202

Checked by: LD

MEISMAN PROPERTY AREA DRAINAGE SUMMARY

EXISTING CONDITIONS

		WEIGHTED		OVERLAND				STREET / CHANNEL FLOW				T_t	INTENSITY		TOTAL FLOWS	
BASIN	AREA TOTAL (Acres)	C_5	C_{100}	C_5	Length	Height	T_C	Length	Slope	Velocity	T_t	TOTAL	I_5	I_{100}	Q_5	Q_{100}
		<i>* For Calcs See Runoff Summary</i>			(ft)	(ft)	(min)	(ft)	(%)	(fps)	(min)	(min)	(in/hr)	(in/hr)	(c.f.s.)	(c.f.s.)
OA1	207.64	0.09	0.36	0.09	300	12.0	20.2	4540	1.5%	0.6	123.6	143.7	0.9	1.4	16.9	104.1
OA2.1	469.43	0.09	0.36	0.09	300	10.0	21.4	6860	2.1%	0.7	157.8	179.2	0.8	1.2	32.5	199.2
OA2.2	14.49	0.09	0.36	0.09	300	6.0	25.4	950	2.0%	0.7	22.4	47.8	1.9	3.0	2.5	15.8
OA3	24.42	0.09	0.36	0.09	300	20.0	17.0	900	1.0%	0.5	30.0	47.0	1.9	3.1	4.2	26.9
OBI	1.00	0.09	0.36	0.09	300	15.9	18.4	80	5.3%	1.2	1.2	19.5	3.1	5.2	0.3	1.9
A	33.80	0.09	0.36	0.09	300	13.5	19.4	650	3.2%	0.9	12.1	31.5	2.4	3.9	7.3	47.9
B	15.48	0.09	0.36	0.09	300	10.0	21.4	400	0.5%	0.4	18.9	40.3	2.1	3.4	2.9	18.8

DEVELOPED CONDITIONS

		WEIGHTED		OVERLAND				STREET / CHANNEL FLOW				T_t	INTENSITY		TOTAL FLOWS	
BASIN	AREA TOTAL (Acres)	C_5	C_{100}	C_5	Length	Height	T_C	Length	Slope	Velocity	T_t	TOTAL	I_5	I_{100}	Q_5	Q_{100}
		<i>* For Calcs See Runoff Summary</i>			(ft)	(ft)	(min)	(ft)	(%)	(fps)	(min)	(min)	(in/hr)	(in/hr)	(c.f.s.)	(c.f.s.)
OA1	207.64	0.09	0.36	0.09	300	12.0	20.2	4540	1.5%	0.6	123.6	143.7	0.9	1.4	16.9	104.1
OA2.1	469.43	0.09	0.36	0.09	300	10.0	21.4	6860	2.1%	0.7	157.8	179.2	0.8	1.2	32.5	199.2
OA2.2	14.49	0.09	0.36	0.09	300	6.0	25.4	950	2.0%	0.7	22.4	47.8	1.9	3.0	2.5	15.8
OA3	24.42	0.09	0.36	0.09	300	20.0	17.0	900	1.0%	0.5	30.0	47.0	1.9	3.1	4.2	26.9
OBI	1.00	0.09	0.36	0.09	300	15.9	18.4	80	5.3%	1.2	1.2	19.5	3.1	5.2	0.3	1.9
A1	6.10	0.11	0.36	0.11	300	10.0	21.1	425	1.2%	0.9	7.8	28.8	2.5	4.1	1.7	9.1
A2	6.24	0.11	0.37	0.11	300	13.5	18.9	490	3.7%	1.3	6.1	25.0	2.7	4.5	1.9	10.4
A3.1	9.13	0.12	0.37	0.12	300	6.0	24.8	730	0.7%	0.6	21.2	46.0	1.9	3.1	2.0	10.6
A3.2	12.34	0.11	0.36	0.11	30	4.0	4.2	1030	1.2%	0.8	22.7	26.9	2.6	4.3	3.5	19.2
B	15.48	0.13	0.39	0.13	10	1.0	2.6	700	0.5%	0.5	23.6	26.2	2.7	4.4	5.2	26.6

Note: Due to their size, flows from Basins OA1 & OA2.1 were determined using SCS method

Calculated by: JF

Date: 11/14/2022

Checked by: LD

EXISTING AND DEVELOPED CONDITIONS

Site: Falcon Acres

Basin: OA1

Basin Area: 207.64 ac

Method: Soil Conservation Service Hydrograph

HSG: A, good condition

CN= 50

Tc= 143.7 min

L= 86.22 min

P10-2= 2.3"

P100-2= 3.6"

S= 10.0"

la= 2.0"

Q10= 0.009"

Q100= 0.221"

D= 19.11 min

Tp= 95.78 min or 1.60 hr

Qp10= 0.88 cfs

Qp100= 21.62 cfs

EXISTING AND DEVELOPED CONDITIONS

Site: Falcon Acres
Basin: OA2.1
Basin Area: 469.43 ac
Method: Soil Conservation Service Hydrograph
HSG: A, good condition
CN= 50
Tc= 179.2 min
L= 107.52 min
P10-2= 2.3"
P100-2= 3.6"
S= 10.0"
la= 2.0"
Q10= 0.009"
Q100= 0.221"
D= 23.83 min
Tp= 119.44 min or 1.99 hr
Qp10= 1.60 cfs
Qp100= 39.33 cfs

HYDRAULIC CALCULATIONS

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: Falcon Acres **Location:** Channel A2-North **Need** 26.2 CFS
By: John Fornander **Date:** 1/7/2023
Chk By: **Date:** version 12-2004

Mannings Formula

$$Q = (1.486/n)AR_h^{2/3}S^{1/2}$$

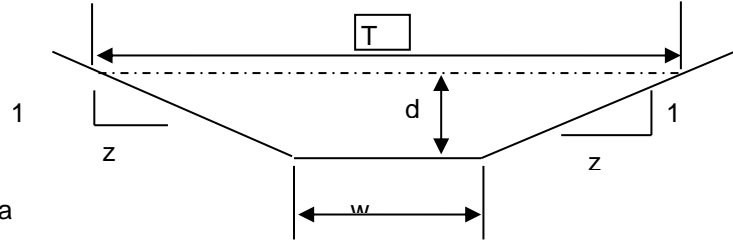
$$R = A/P$$

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$$V = (1.49/n)R_h^{2/3}S^{1/2}$$

$$Q = V \times A$$

INPUT

z (sideslope)= 4
z (sideslope)= 3
b (btm width, ft)= 0
d (depth, ft)= 1.6
S (slope, ft/ft) 0.005
n low = 0.03
n high = 0.03

Clear Data
Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity,				T =	Dm =
				Velocity, fps	Flow, cfs	fps	Flow, cfs		
1.6	8.96	11.66	0.77	2.93901969	26.3336	2.93902	26.3336		11.2
				Sc low =		Sc high =		0.800	
				Sc low =		Sc high =			
s _c = critical slope ft / ft									
T = top width of the stream				.7 Sc		1.3 Sc			
d _m = a/T = mean depth of flow				0.0104		0.0194			

s_c = critical slope ft / ft

T = top width of the stream

$d_m = a/T$ = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: Falcon Acres **Location:** Channel A2-South **Need** 26.2 CFS
By: John Fornander **Date:** 1/7/2023
Chk By: **Date:** version 12-2004

Mannings Formula

$$Q = (1.486/n)AR_h^{2/3}S^{1/2}$$

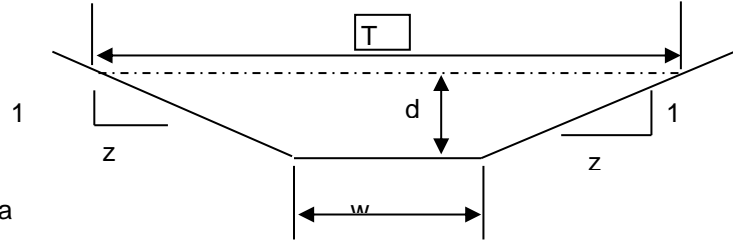
$$R = A/P$$

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$$V = (1.49/n)R_h^{2/3}S^{1/2}$$

$$Q = V \times A$$

INPUT

z (sideslope)= 6
z (sideslope)= 3
b (btm width, ft)= 0
d (depth, ft)= 1.1
S (slope, ft/ft) 0.034
n low = 0.03
n high = 0.03

Clear Data
Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity,		Velocity,		T =	9.9
				fps	Flow, cfs	fps	Flow, cfs		
1.1	5.45	10.17	0.54	6.02225166	32.7912	6.022252	32.7912	Dm =	0.550
				Sc low =	0.0166	Sc high =	0.0166		
s _c = critical slope ft / ft									
T = top width of the stream				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
d _m = a/T = mean depth of flow				0.0116	0.0215	0.0116	0.0215		

s_c = critical slope ft / ft

T = top width of the stream

$d_m = a/T$ = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: Falcon Acres **Location:** Overflow Channel A3 **Need** 153.0 CFS
By: John Fornander **Date:** 1/7/2023
Chk By: **Date:** **version** 12-2004

Mannings Formula

$$Q = (1.486/n)AR_h^{2/3}S^{1/2}$$

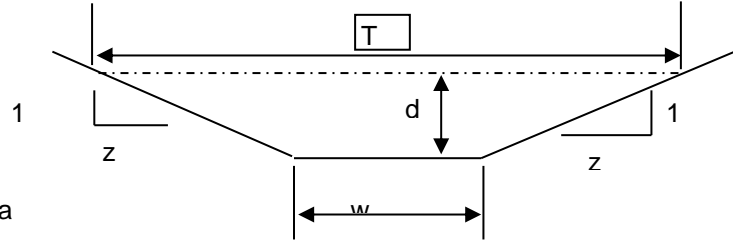
$$R = A/P$$

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$$V = (1.49/n)R_h^{2/3}S^{1/2}$$

$$Q = V \times A$$

INPUT

z (sideslope)= 4
z (sideslope)= 4
b (btm width, ft)= 4
d (depth, ft)= 2
S (slope, ft/ft) 0.0154
n low = 0.03
n high = 0.03

Clear Data
Entry Cells

Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Low N		High N		T =	Dm =
				Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
2	24.00	20.49	1.17	6.82976084	163.914	6.829761	163.914	20	1.200

Sc low = 0.0127 Sc high = 0.0127

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

.7 Sc	1.3 Sc	.7 Sc	1.3 Sc
0.0089	0.0166	0.0089	0.0166

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: Falcon Acres **Location:** Channel A4 **Need 1.6 CFS**
By: John Fornander **Date:** 1/7/2023
Chk By: **Date:** **version 12-2004**

Mannings Formula

$$Q = (1.486/n)AR_h^{2/3}S^{1/2}$$

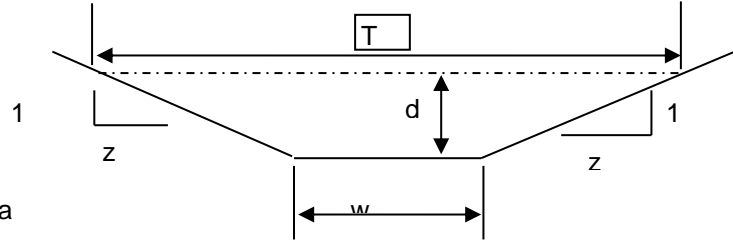
$$R = A/P$$

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$$V = (1.49/n)R_h^{2/3}S^{1/2}$$

$$Q = V \times A$$

INPUT

z (sideslope)= 6
z (sideslope)= 3
b (btm width, ft)= 0
d (depth, ft)= 0.5
S (slope, ft/ft) 0.034
n low = 0.03
n high = 0.03

Clear Data
Entry Cells

Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Low N		High N		
				Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs	
0.5	1.13	4.62	0.24	3.5601287	4.00514	3.560129	4.00514	T = 4.5
				Sc low = 0.0216		Sc high = 0.0216		Dm = 0.250
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc	
				0.0151	0.0280	0.0151	0.0280	

s_c = critical slope ft / ft

T = top width of the stream

$d_m = a/T$ = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: Falcon Acres **Location:** Channel A5 **Need 16.0 CFS**
By: John Fornander **Date:** 1/7/2023
Chk By: **Date:** **version 12-2004**

Mannings Formula

$$Q = (1.486/n)AR_h^{2/3}S^{1/2}$$

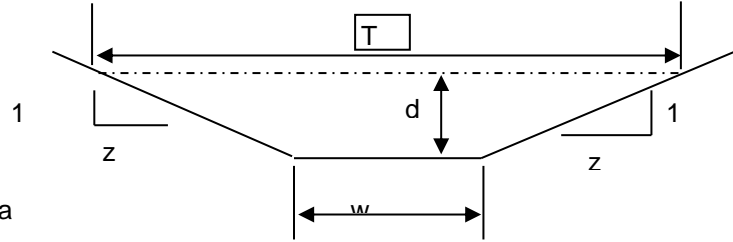
$$R = A/P$$

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$$V = (1.49/n)R_h^{2/3}S^{1/2}$$

$$Q = V \times A$$

INPUT

z (sideslope)= 6
z (sideslope)= 3
b (btm width, ft)= 0
d (depth, ft)= 1
S (slope, ft/ft) 0.034
n low = 0.03
n high = 0.03

Clear Data
Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1	4.50	9.25	0.49	5.65148263	25.4317	5.651483	25.4317	T =	9
				Sc low =		Sc high =		Dm =	0.500
				.7 Sc		.7 Sc			
				0.0120		0.0120			
				1.3 Sc		1.3 Sc			
				0.0222		0.0222			

s_c = critical slope ft / ft

T = top width of the stream

$d_m = a/T$ = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: Falcon Acres **Location:** Overflow Channel B **Need** 181.45 CFS
By: John Fornander **Date:** 1/7/2023
Chk By: **Date:** **version** 12-2004

Mannings Formula

$$Q = (1.486/n)AR_h^{2/3}S^{1/2}$$

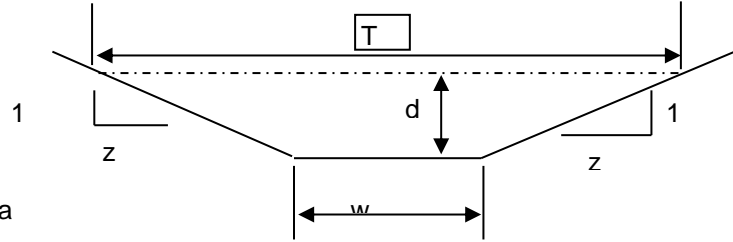
$$R = A/P$$

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$$V = (1.49/n)R_h^{2/3}S^{1/2}$$

$$Q = V \times A$$

INPUT

z (sideslope)= 4
z (sideslope)= 4
b (btm width, ft)= 4
d (depth, ft)= 2.2
S (slope, ft/ft) 0.013
n low = 0.03
n high = 0.03

Clear Data
Entry Cells

Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Low N		High N		T =	Dm =
				Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
2.2	28.16	22.14	1.27	6.62960466	186.69	6.629605	186.69	21.6	1.304
Sc low =				0.0124	Sc high =	0.0124			
.7 Sc				1.3 Sc	.7 Sc	1.3 Sc			
				0.0087	0.0161	0.0087	0.0161		

s_c = critical slope ft / ft

T = top width of the stream

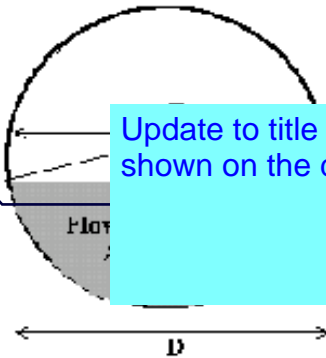
$d_m = a/T$ = mean depth of flow

Created by: Mike O'Shea

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

Project: **Blue cells are for user data entry**

Pipe ID: **Green cells are calculated values**



Updated.

Update to title to identify the corresponding culvert shown on the drainage map. Typical for all.

Design Information (Input)

Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	18.00	inches
Design discharge	Q =	4.00	cfs

Full-flow Capacity (Calculated)

Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	10.53	cfs

Calculation of Normal Flow Condition

Half Central Angle ($0 < \text{Theta} < 3.14$)	Theta =	1.42	radians
Flow area	An =	0.72	sq ft
Top width	Tn =	1.48	ft
Wetted perimeter	Pn =	2.14	ft
Flow depth	Yn =	0.64	ft
Flow velocity	Vn =	5.55	fps
Discharge	Qn =	4.00	cfs
Percent Full Flow	Flow =	38.0%	of full flow
Normal Depth Froude Number	Fr _n =	1.40	supercritical

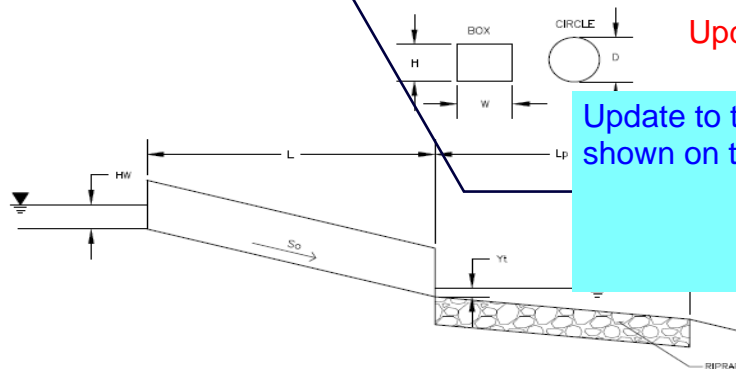
Calculation of Critical Flow Condition

Half Central Angle ($0 < \text{Theta-c} < 3.14$)	Theta-c =	1.59	radians
Critical flow area	Ac =	0.91	sq ft
Critical top width	Tc =	1.50	ft
Critical flow depth	Yc =	0.77	ft
Critical flow velocity	Vc =	4.41	fps
Critical Depth Froude Number	Fr _c =	1.00	

Determination of Culvert Headwater and Outlet Protection

Project: **Blue cells are for user data entry**

Basin ID: **Green cells are calculated values**



Updated.

Update to title to identify the corresponding culvert shown on the drainage map. Typical for all.

Choose One:

☐ Sandy

☒ Non-Sandy

Design Information (Input):

Design Discharge

Q = 4 cfs

Circular Culvert:

Barrel Diameter in Inches

D = 18 inches

Inlet Edge Type (Choose from pull-down list)

Grooved End Projection

OR

Box Culvert:

Barrel Height (Rise) in Feet

Height (Rise) = ft

Barrel Width (Span) in Feet

Width (Span) = ft

Inlet Edge Type (Choose from pull-down list)

Number of Barrels

No = 1

Inlet Elevation

Elev IN = 25.02 ft

Outlet Elevation **OR** Slope

Elev OUT = 24.85 ft

Culvert Length

L = 34 ft

Manning's Roughness

n = 0.013

Bend Loss Coefficient

k_b = 0

Exit Loss Coefficient

k_x = 1

Tailwater Surface Elevation

Elev Y_t = ft

Max Allowable Channel Velocity

V = 7 ft/s

Required Protection (Output):

Tailwater Surface Height

Y_t = 0.60 ft

Flow Area at Max Channel Velocity

A_t = 0.57 ft²

Culvert Cross Sectional Area Available

A = 1.77 ft²

Entrance Loss Coefficient

k_e = 0.20

Friction Loss Coefficient

k_f = 0.62

Sum of All Losses Coefficients

k_s = 1.82

Culvert Normal Depth

Y_n = 0.78 ft

Culvert Critical Depth

Y_c = 0.77 ft

Tailwater Depth for Design

d = 1.13 ft

Adjusted Diameter **OR** Adjusted Rise

D_a = - ft

Expansion Factor

1/(2*tan(Θ)) = 6.28

Flow/Diameter^{2.5} **OR** Flow/(Span * Rise^{1.5})

Q/D^{2.5} = 1.45 ft^{0.5}/s

Froude Number

Fr = 0.96

Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise

Y_t/D = 0.40

Inlet Control Headwater

HW_i = 1.09 ft

Outlet Control Headwater

HW_o = 1.11 ft

Design Headwater Elevation

HW = 26.13 ft

Headwater/Diameter **OR Headwater/Rise Ratio**

HW/D = 0.74

Minimum Theoretical Riprap Size

d₅₀ = 2 in

Nominal Riprap Size

d₅₀ = 6 in

UDFCD Riprap Type

Type = VL

Length of Protection

L_p = 5 ft

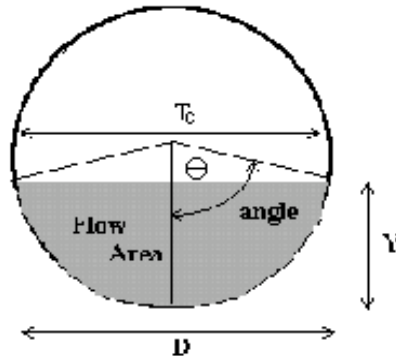
Width of Protection

T = 3 ft

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

Project: **Blue cells are for user data entry**

Pipe ID: **Green cells are calculated values**



Design Information (Input)

Pipe Invert Slope	So =	0.0076	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	36.00	inches
Design discharge	Q =	37.32	cfs

Full-flow Capacity (Calculated)

Full-flow area	Af =	7.07	sq ft
Full-flow wetted perimeter	Pf =	9.42	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	58.30	cfs

Calculation of Normal Flow Condition

Half Central Angle ($0 < \theta < 3.14$)	Theta =	1.73	radians
Flow area	An =	4.27	sq ft
Top width	Tn =	2.96	ft
Wetted perimeter	Pn =	5.20	ft
Flow depth	Yn =	1.74	ft
Flow velocity	Vn =	8.75	fps
Discharge	Qn =	37.32	cfs
Percent Full Flow	Flow =	64.0%	of full flow
Normal Depth Froude Number	Fr _n =	1.28	supercritical

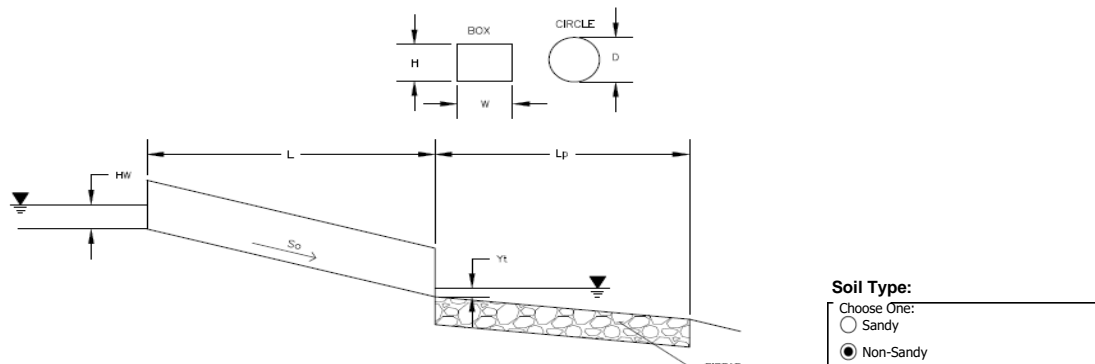
Calculation of Critical Flow Condition

Half Central Angle ($0 < \theta_c < 3.14$)	Theta-c =	1.90	radians
Critical flow area	Ac =	4.97	sq ft
Critical top width	Tc =	2.84	ft
Critical flow depth	Yc =	1.99	ft
Critical flow velocity	Vc =	7.51	fps
Critical Depth Froude Number	Fr _c =	1.00	

Determination of Culvert Headwater and Outlet Protection

Project: **Blue cells are for user data entry**

Basin ID: **Green cells are calculated values**



Supercritical Flow! Using D_a to calculate protection type.

Design Information (Input):

Design Discharge	Q = 74.63 cfs
Circular Culvert:	
Barrel Diameter in Inches	D = 36 inches
Inlet Edge Type (Choose from pull-down list)	Grooved End Projection
Box Culvert:	OR
Barrel Height (Rise) in Feet	Height (Rise) =
Barrel Width (Span) in Feet	Width (Span) =
Inlet Edge Type (Choose from pull-down list)	
Number of Barrels	No = 2
Inlet Elevation	Elev IN = 29 ft
Outlet Elevation OR Slope	Elev OUT = 28.5 ft
Culvert Length	L = 66 ft
Manning's Roughness	n = 0.013
Bend Loss Coefficient	$k_b = 0$
Exit Loss Coefficient	$k_x = 1$
Tailwater Surface Elevation	Elev $Y_t = $ ft
Max Allowable Channel Velocity	V = 7 ft/s

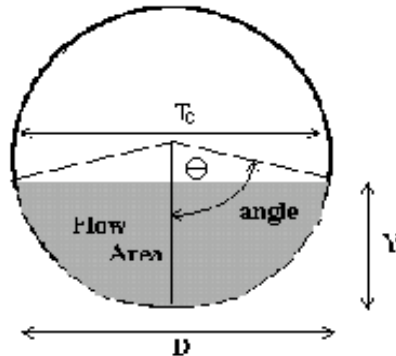
Required Protection (Output):

Tailwater Surface Height	$Y_t = 1.20$ ft
Flow Area at Max Channel Velocity	$A_t = 5.33$ ft ²
Culvert Cross Sectional Area Available	A = 7.07 ft ²
Entrance Loss Coefficient	$k_e = 0.20$
Friction Loss Coefficient	$k_f = 0.47$
Sum of All Losses Coefficients	$k_s = 1.67$ ft
Culvert Normal Depth	$Y_n = 1.75$ ft
Culvert Critical Depth	$Y_c = 1.99$ ft
Tailwater Depth for Design	d = 2.49 ft
Adjusted Diameter OR Adjusted Rise	$D_a = 2.37$ ft
Expansion Factor	$1/(2*\tan(\Theta)) = 6.36$
Flow/Diameter ^{2.5} OR Flow/(Span * Rise ^{1.5})	$Q/D^{2.5} = 2.39$ ft ^{0.5} /s
Froude Number	Fr = 1.28 Supercritical!
Tailwater/Adjusted Diameter OR Tailwater/Adjusted Rise	$Y_t/D = 0.51$
Inlet Control Headwater	$HW_i = 2.94$ ft
Outlet Control Headwater	$HW_o = 2.72$ ft
Design Headwater Elevation	HW = 31.94 ft
Headwater/Diameter OR Headwater/Rise Ratio	HW/D = 0.98
Minimum Theoretical Riprap Size	$d_{50} = 6$ in
Nominal Riprap Size	$d_{50} = 9$ in
UDFCD Riprap Type	Type = L
Length of Protection	$L_p = 10$ ft
Width of Protection	T = 5 ft

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

Project: **Blue cells are for user data entry**

Pipe ID: **Green cells are calculated values**



Design Information (Input)

Pipe Invert Slope	So =	0.0070	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	24.00	inches
Design discharge	Q =	18.75	cfs

Full-flow Capacity (Calculated)

Full-flow area	Af =	3.14	sq ft
Full-flow wetted perimeter	Pf =	6.28	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	18.98	cfs

Calculation of Normal Flow Condition

Half Central Angle ($0 < \theta < 3.14$)	Theta =	2.24	radians
Flow area	An =	2.72	sq ft
Top width	Tn =	1.57	ft
Wetted perimeter	Pn =	4.47	ft
Flow depth	Yn =	1.62	ft
Flow velocity	Vn =	6.89	fps
Discharge	Qn =	18.75	cfs
Percent Full Flow	Flow =	98.8%	of full flow
Normal Depth Froude Number	Fr _n =	0.92	subcritical

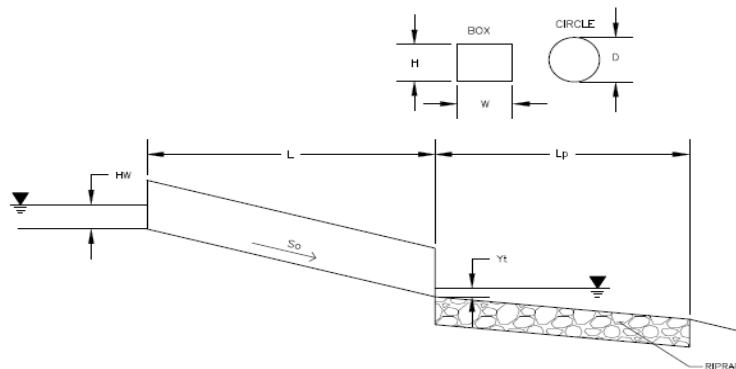
Calculation of Critical Flow Condition

Half Central Angle ($0 < \theta_c < 3.14$)	Theta-c =	2.16	radians
Critical flow area	Ac =	2.63	sq ft
Critical top width	Tc =	1.66	ft
Critical flow depth	Yc =	1.56	ft
Critical flow velocity	Vc =	7.14	fps
Critical Depth Froude Number	Fr _c =	1.00	

Determination of Culvert Headwater and Outlet Protection

Project: **Blue cells are for user data entry**

Basin ID: **Green cells are calculated values**



Soil Type:

Choose One:

- ☐ Sandy
☒ Non-Sandy

Design Information (Input):

Design Discharge

Q = 37.5 cfs

Circular Culvert:

Barrel Diameter in Inches

D = 24 inches

Inlet Edge Type (Choose from pull-down list)

Grooved End Projection

OR

Box Culvert:

Barrel Height (Rise) in Feet

Height (Rise) =

Barrel Width (Span) in Feet

Width (Span) =

Inlet Edge Type (Choose from pull-down list)

Number of Barrels

No = 2

Inlet Elevation

Elev IN = 28.1 ft

Outlet Elevation **OR** Slope

Elev OUT = 27.82 ft

Culvert Length

L = 40 ft

Manning's Roughness

n = 0.013

Bend Loss Coefficient

k_b = 0

Exit Loss Coefficient

k_x = 1

Tailwater Surface Elevation

Elev Y_t =

Max Allowable Channel Velocity

V = 7 ft/s

Required Protection (Output):

Tailwater Surface Height

Y_t = 0.80 ft

Flow Area at Max Channel Velocity

A_t = 2.68 ft²

Culvert Cross Sectional Area Available

A = 3.14 ft²

Entrance Loss Coefficient

k_e = 0.20

Friction Loss Coefficient

k_f = 0.49

Sum of All Losses Coefficients

k_s = 1.69

Culvert Normal Depth

Y_n = 1.62 ft

Culvert Critical Depth

Y_c = 1.56 ft

Tailwater Depth for Design

d = 1.78 ft

Adjusted Diameter **OR** Adjusted Rise

D_a = - ft

Expansion Factor

1/(2*tan(Θ)) = 4.13

Flow/Diameter^{2.5} **OR** Flow/(Span * Rise^{1.5})

Q/D^{2.5} = 3.31 ft^{0.5}/s

Froude Number

Fr = 0.92

Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise

Y_t/D = 0.40

Inlet Control Headwater

HW_i = 2.50 ft

Outlet Control Headwater

HW_o = 2.44 ft

Design Headwater Elevation

HW = 30.60 ft

Headwater/Diameter **OR Headwater/Rise Ratio**

HW/D = 1.25

Minimum Theoretical Riprap Size

d₅₀ = 5 in

Nominal Riprap Size

d₅₀ = 6 in

UDFCD Riprap Type

Type = VL

Length of Protection

L_p = 6 ft

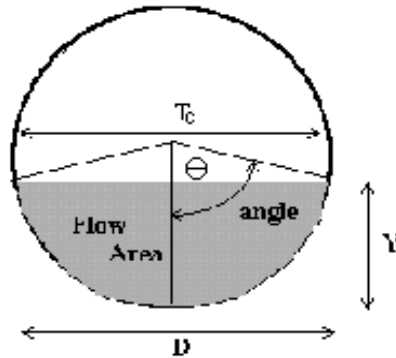
Width of Protection

T = 4 ft

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

Project: **Blue cells are for user data entry**

Pipe ID: **Green cells are calculated values**



Design Information (Input)

Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	18.00	inches
Design discharge	Q =	3.76	cfs

Full-flow Capacity (Calculated)

Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	10.53	cfs

Calculation of Normal Flow Condition

Half Central Angle ($0 < \text{Theta} < 3.14$)	Theta =	1.40	radians
Flow area	An =	0.69	sq ft
Top width	Tn =	1.48	ft
Wetted perimeter	Pn =	2.09	ft
Flow depth	Yn =	0.62	ft
Flow velocity	Vn =	5.46	fps
Discharge	Qn =	3.76	cfs
Percent Full Flow	Flow =	35.7%	of full flow
Normal Depth Froude Number	Fr _n =	1.41	supercritical

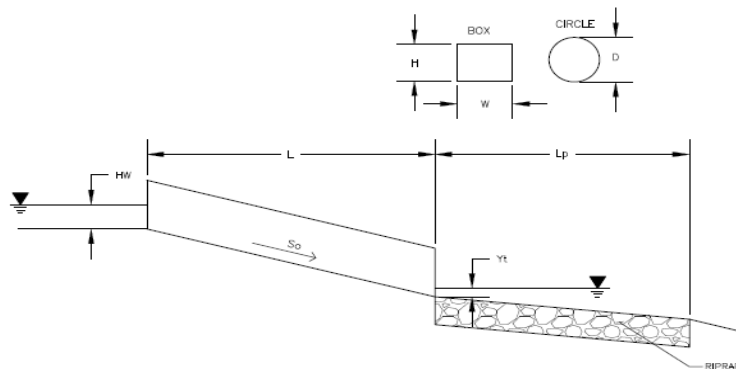
Calculation of Critical Flow Condition

Half Central Angle ($0 < \text{Theta-c} < 3.14$)	Theta-c =	1.56	radians
Critical flow area	Ac =	0.87	sq ft
Critical top width	Tc =	1.50	ft
Critical flow depth	Yc =	0.74	ft
Critical flow velocity	Vc =	4.32	fps
Critical Depth Froude Number	Fr _c =	1.00	

Determination of Culvert Headwater and Outlet Protection

Project: **Blue cells are for user data entry**

Basin ID: **Green cells are calculated values**



Soil Type:

Choose One:

- ☐ Sandy
☒ Non-Sandy

Design Information (Input):

Design Discharge

Q = 3.76 cfs

Circular Culvert:

Barrel Diameter in Inches

D = 18 inches

Inlet Edge Type (Choose from pull-down list)

Grooved End Projection

Box Culvert:

Barrel Height (Rise) in Feet

Height (Rise) = ft

Barrel Width (Span) in Feet

Width (Span) = ft

Inlet Edge Type (Choose from pull-down list)

Number of Barrels

No = 1

Inlet Elevation

Elev IN = 28 ft

Outlet Elevation **OR** Slope

Elev OUT = 27.82 ft

Culvert Length

L = 36 ft

Manning's Roughness

n = 0.013

Bend Loss Coefficient

k_b = 0

Exit Loss Coefficient

k_x = 1

Tailwater Surface Elevation

Elev Y_t = ft

Max Allowable Channel Velocity

V = 7 ft/s

Required Protection (Output):

Tailwater Surface Height

Y_t = 0.60 ft

Flow Area at Max Channel Velocity

A_t = 0.54 ft²

Culvert Cross Sectional Area Available

A = 1.77 ft²

Entrance Loss Coefficient

k_e = 0.20

Friction Loss Coefficient

k_f = 0.65

Sum of All Losses Coefficients

k_s = 1.85

Culvert Normal Depth

Y_n = 0.75 ft

Culvert Critical Depth

Y_c = 0.74 ft

Tailwater Depth for Design

d = 1.12 ft

Adjusted Diameter **OR** Adjusted Rise

D_a = - ft

Expansion Factor

1/(2*tan(Θ)) = 6.36

Flow/Diameter^{2.5} **OR** Flow/(Span * Rise^{1.5})

Q/D^{2.5} = 1.36 ft^{0.5}/s

Froude Number

Fr = 0.97

Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise

Y_t/D = 0.40

Inlet Control Headwater

HW_i = 1.06 ft

Outlet Control Headwater

HW_o = 1.07 ft

Design Headwater Elevation

HW = 29.07 ft

Headwater/Diameter **OR** Headwater/Rise Ratio

HW/D = 0.71

Minimum Theoretical Riprap Size

d₅₀ = 2 in

Nominal Riprap Size

d₅₀ = 6 in

UDFCD Riprap Type

Type = VL

Length of Protection

L_p = 5 ft

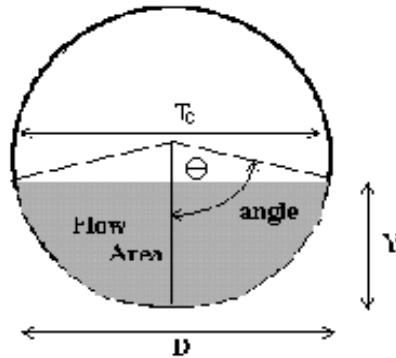
Width of Protection

T = 3 ft

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

Project: **Blue cells are for user data entry**

Pipe ID: **Green cells are calculated values**



Design Information (Input)

Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	18.00	inches
Design discharge	Q =	7.21	cfs

Full-flow Capacity (Calculated)

Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	10.53	cfs

Calculation of Normal Flow Condition

Half Central Angle ($0 < \theta < 3.14$)	Theta =	1.79	radians
Flow area	An =	1.12	sq ft
Top width	Tn =	1.46	ft
Wetted perimeter	Pn =	2.68	ft
Flow depth	Yn =	0.91	ft
Flow velocity	Vn =	6.42	fps
Discharge	Qn =	7.21	cfs
Percent Full Flow	Flow =	68.5%	of full flow
Normal Depth Froude Number	Fr _n =	1.29	supercritical

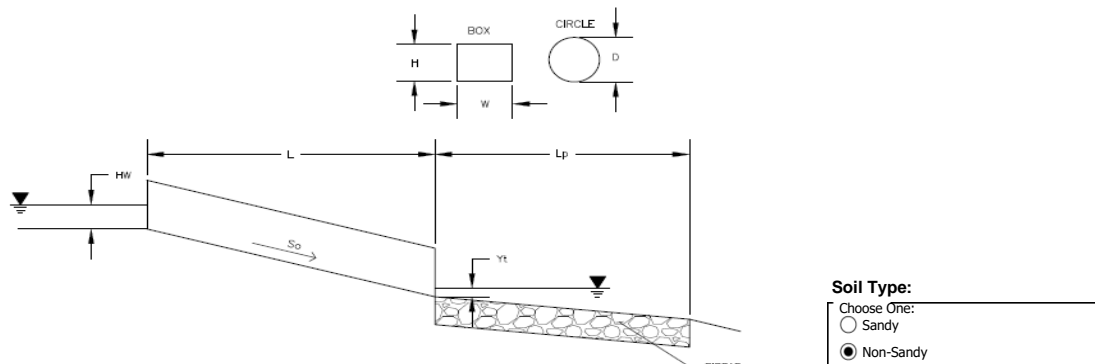
Calculation of Critical Flow Condition

Half Central Angle ($0 < \theta_c < 3.14$)	Theta-c =	1.97	radians
Critical flow area	Ac =	1.31	sq ft
Critical top width	Tc =	1.38	ft
Critical flow depth	Yc =	1.04	ft
Critical flow velocity	Vc =	5.52	fps
Critical Depth Froude Number	Fr _c =	1.00	

Determination of Culvert Headwater and Outlet Protection

Project: **Blue cells are for user data entry**

Basin ID: **Green cells are calculated values**



Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

Design Discharge	Q = 21.62 cfs
Circular Culvert:	
Barrel Diameter in Inches	D = 18 inches
Inlet Edge Type (Choose from pull-down list)	Grooved End Projection
Box Culvert:	OR
Barrel Height (Rise) in Feet	Height (Rise) =
Barrel Width (Span) in Feet	Width (Span) =
Inlet Edge Type (Choose from pull-down list)	
Number of Barrels	No = 3
Inlet Elevation	Elev IN = 29.99 ft
Outlet Elevation OR Slope	Elev OUT = 29.71 ft
Culvert Length	L = 28 ft
Manning's Roughness	n = 0.013
Bend Loss Coefficient	k _b = 0
Exit Loss Coefficient	k _x = 1
Tailwater Surface Elevation	Elev Y _t =
Max Allowable Channel Velocity	V = 7 ft/s

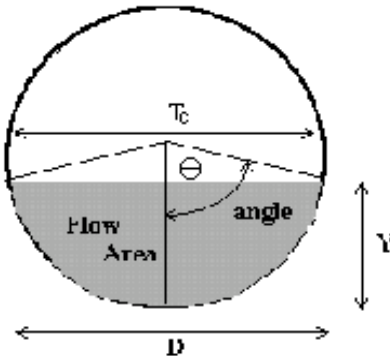
Required Protection (Output):

Tailwater Surface Height	Y _t = 0.60 ft
Flow Area at Max Channel Velocity	A _t = 1.03 ft ²
Culvert Cross Sectional Area Available	A = 1.77 ft ²
Entrance Loss Coefficient	k _e = 0.20
Friction Loss Coefficient	k _f = 0.51
Sum of All Losses Coefficients	k _s = 1.71
Culvert Normal Depth	Y _n = 0.91 ft
Culvert Critical Depth	Y _c = 1.04 ft
Tailwater Depth for Design	d = 1.27 ft
Adjusted Diameter OR Adjusted Rise	D _a = 1.21 ft
Expansion Factor	1/(2*tan(Θ)) = 6.13
Flow/Diameter ^{2.5} OR Flow/(Span * Rise ^{1.5})	Q/D ^{2.5} = 2.62 ft ^{0.5} /s
Froude Number	Fr = 1.29 Supercritical!
Tailwater/Adjusted Diameter OR Tailwater/Adjusted Rise	Y _t /D = 0.50
Inlet Control Headwater	HW _i = 1.56 ft
Outlet Control Headwater	HW _o = 1.43 ft
Design Headwater Elevation	HW = 31.55 ft
Headwater/Diameter OR Headwater/Rise Ratio	HW/D = 1.04
Minimum Theoretical Riprap Size	d ₅₀ = 3 in
Nominal Riprap Size	d ₅₀ = 6 in
UDFCD Riprap Type	Type = VL
Length of Protection	L_p = 5 ft
Width of Protection	T = 3 ft

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

Project: **Blue cells are for user data entry**

Pipe ID: **Green cells are calculated values**



Design Information (Input)

Pipe Invert Slope	So =	0.0050	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	24.00	inches
Design discharge	Q =	13.10	cfs

Full-flow Capacity (Calculated)

Full-flow area	Af =	3.14	sq ft
Full-flow wetted perimeter	Pf =	6.28	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	16.04	cfs

Calculation of Normal Flow Condition

Half Central Angle ($0 < \theta < 3.14$)	Theta =	1.95	radians
Flow area	An =	2.30	sq ft
Top width	Tn =	1.85	ft
Wetted perimeter	Pn =	3.91	ft
Flow depth	Yn =	1.37	ft
Flow velocity	Vn =	5.69	fps
Discharge	Qn =	13.10	cfs
Percent Full Flow	Flow =	81.7%	of full flow
Normal Depth Froude Number	Fr _n =	0.90	subcritical

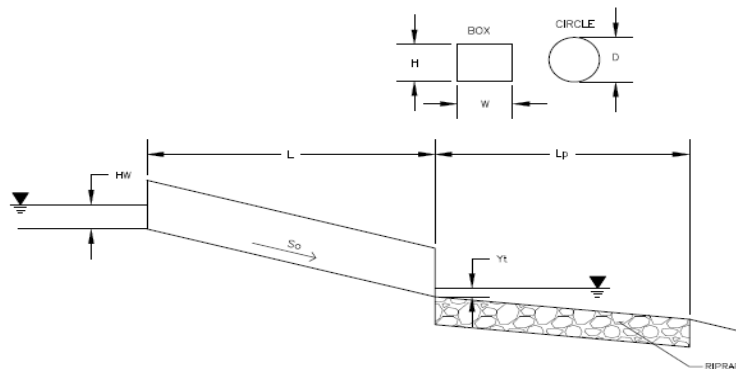
Calculation of Critical Flow Condition

Half Central Angle ($0 < \theta_c < 3.14$)	Theta-c =	1.88	radians
Critical flow area	Ac =	2.17	sq ft
Critical top width	Tc =	1.91	ft
Critical flow depth	Yc =	1.30	ft
Critical flow velocity	Vc =	6.05	fps
Critical Depth Froude Number	Fr _c =	1.00	

Determination of Culvert Headwater and Outlet Protection

Project: **Blue cells are for user data entry**

Basin ID: **Green cells are calculated values**



Soil Type:

Choose One:

- ☐ Sandy
☒ Non-Sandy

Design Information (Input):

Design Discharge

Q = 26.2 cfs

Circular Culvert:

Barrel Diameter in Inches

D = 24 inches

Inlet Edge Type (Choose from pull-down list)

Grooved End Projection

OR

Box Culvert:

Barrel Height (Rise) in Feet

Height (Rise) =

Barrel Width (Span) in Feet

Width (Span) =

Inlet Edge Type (Choose from pull-down list)

Number of Barrels

No = 2

Inlet Elevation

Elev IN = 31.33 ft

Outlet Elevation **OR** Slope

Elev OUT = 31.08 ft

Culvert Length

L = 50 ft

Manning's Roughness

n = 0.013

Bend Loss Coefficient

k_b = 0

Exit Loss Coefficient

k_x = 1

Tailwater Surface Elevation

Elev Y_t =

Max Allowable Channel Velocity

V = 7 ft/s

Required Protection (Output):

Tailwater Surface Height

Y_t = 0.80 ft

Flow Area at Max Channel Velocity

A_t = 1.87 ft²

Culvert Cross Sectional Area Available

A = 3.14 ft²

Entrance Loss Coefficient

k_e = 0.20

Friction Loss Coefficient

k_f = 0.62

Sum of All Losses Coefficients

k_s = 1.82

Culvert Normal Depth

Y_n = 1.37 ft

Culvert Critical Depth

Y_c = 1.30 ft

Tailwater Depth for Design

d = 1.65 ft

Adjusted Diameter **OR** Adjusted Rise

D_a = - ft

Expansion Factor

1/(2*tan(Θ)) = 5.34

Flow/Diameter^{2.5} **OR** Flow/(Span * Rise^{1.5})

Q/D^{2.5} = 2.32 ft^{0.5}/s

Froude Number

Fr = 0.90

Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise

Y_t/D = 0.40

Inlet Control Headwater

HW_i = 1.92 ft

Outlet Control Headwater

HW_o = 1.89 ft

Design Headwater Elevation

HW = 33.25 ft

Headwater/Diameter **OR Headwater/Rise Ratio**

HW/D = 0.96

Minimum Theoretical Riprap Size

d₅₀ = 4 in

Nominal Riprap Size

d₅₀ = 6 in

UDFCD Riprap Type

Type = VL

Length of Protection

L_p = 6 ft

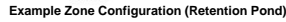
Width of Protection

T = 4 ft

FSEDB CALCULATIONS

MHFD-Detention, Version 4.04 (February 2021)

Basin ID:



Area > 1 sq.mi. for WQ Facility

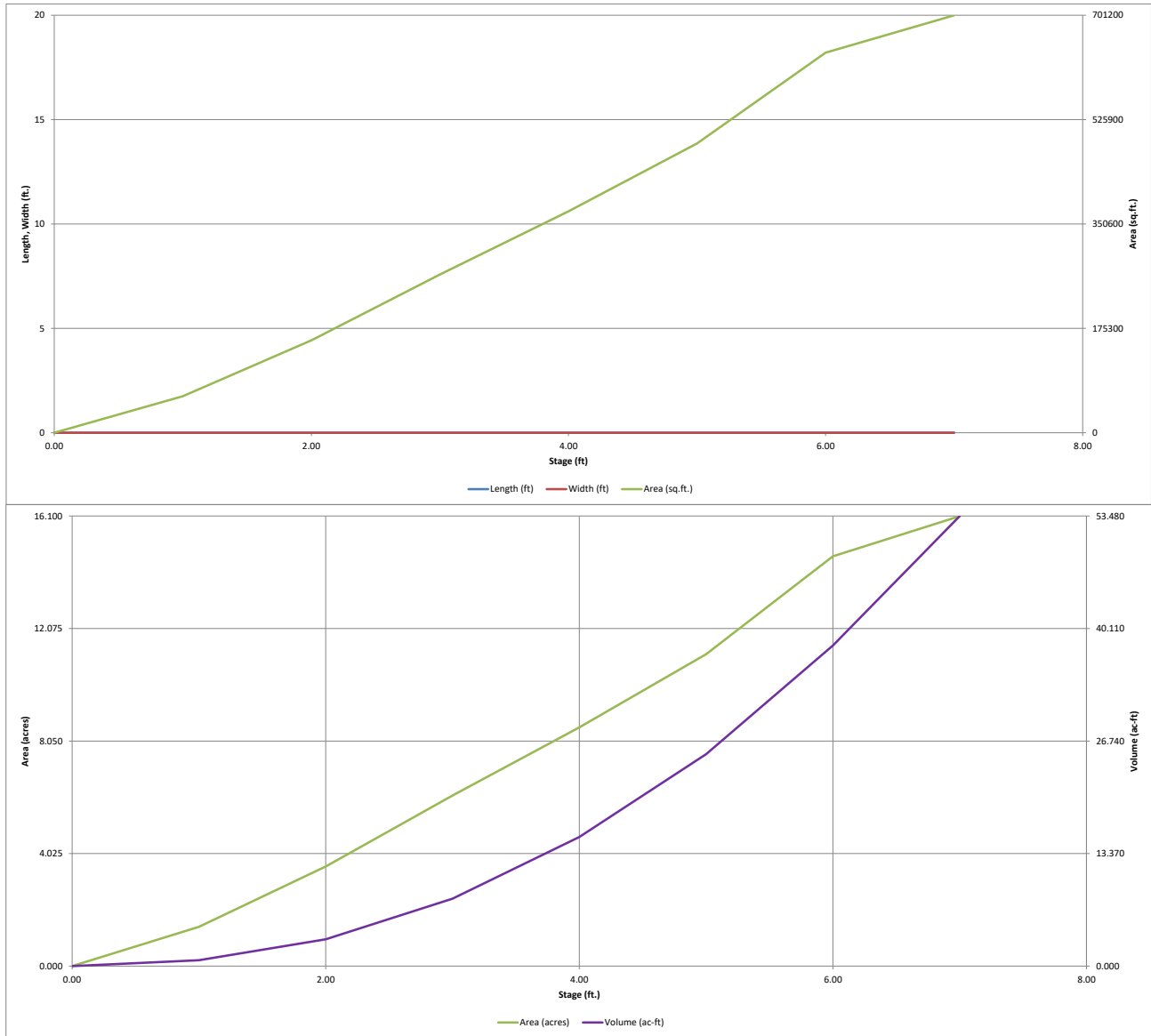
Water Quality Capture Volume (WQCV) =	1.082	acre-feet
Excess Urban Runoff Volume (EURV) =	1.146	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.921	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	5.107	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	12.535	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	31.934	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	44.501	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	66.413	acre-feet
500-yr Runoff Volume (P1 = 3 in.) =	94.184	acre-feet
Approximate 2-yr Detention Volume =	0.634	acre-feet
Approximate 5-yr Detention Volume =	1.044	acre-feet
Approximate 10-yr Detention Volume =	4.133	acre-feet
Approximate 25-yr Detention Volume =	6.398	acre-feet
Approximate 50-yr Detention Volume =	7.104	acre-feet
Approximate 100-yr Detention Volume =	11.732	acre-feet

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
culated Total Basin Volume (V_{TOTAL}) =	user	acre-feet

[illegible]

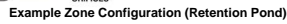
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



MHFD-Detention, Version 4.04 (February 2021)

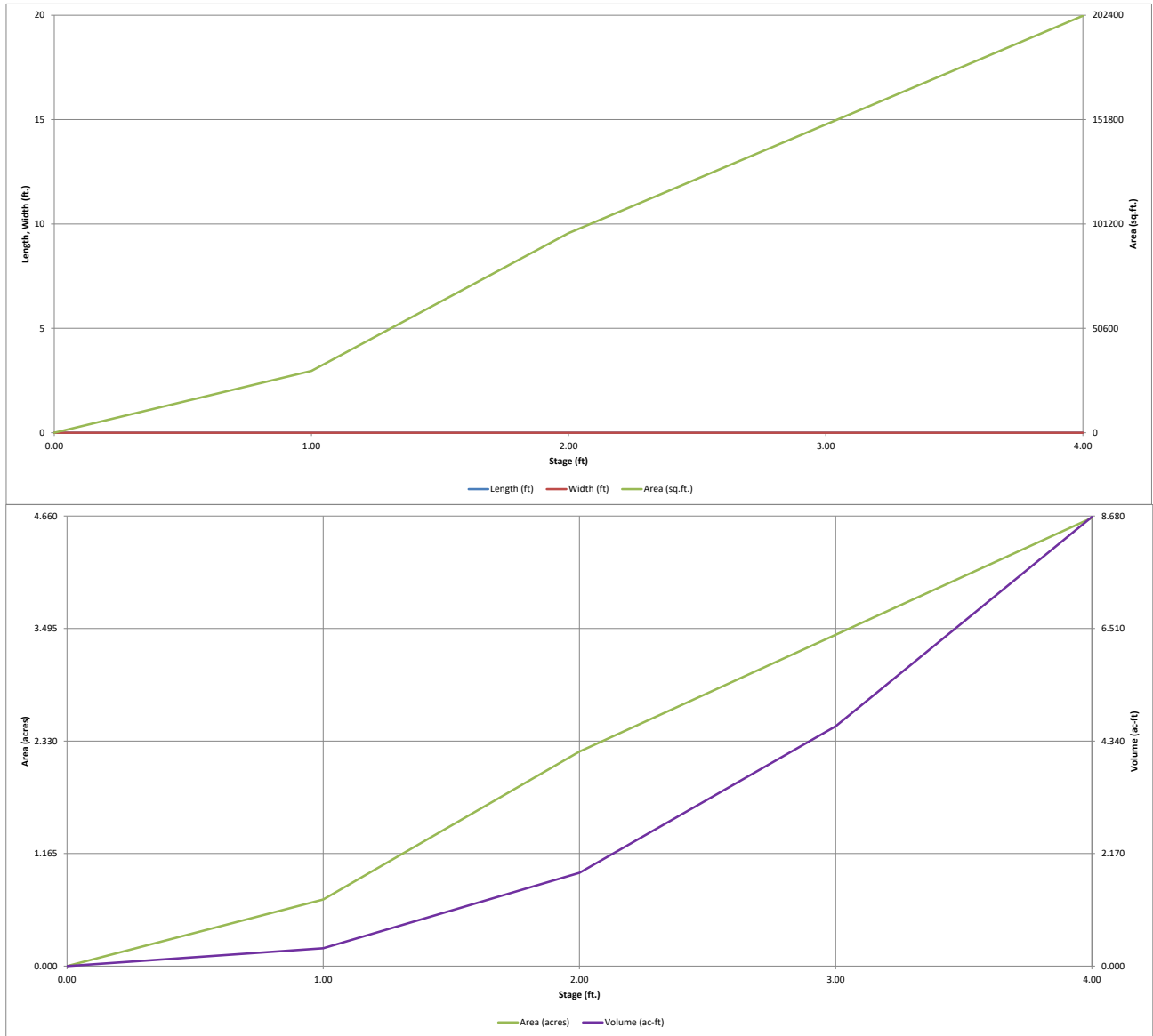
Basin ID:



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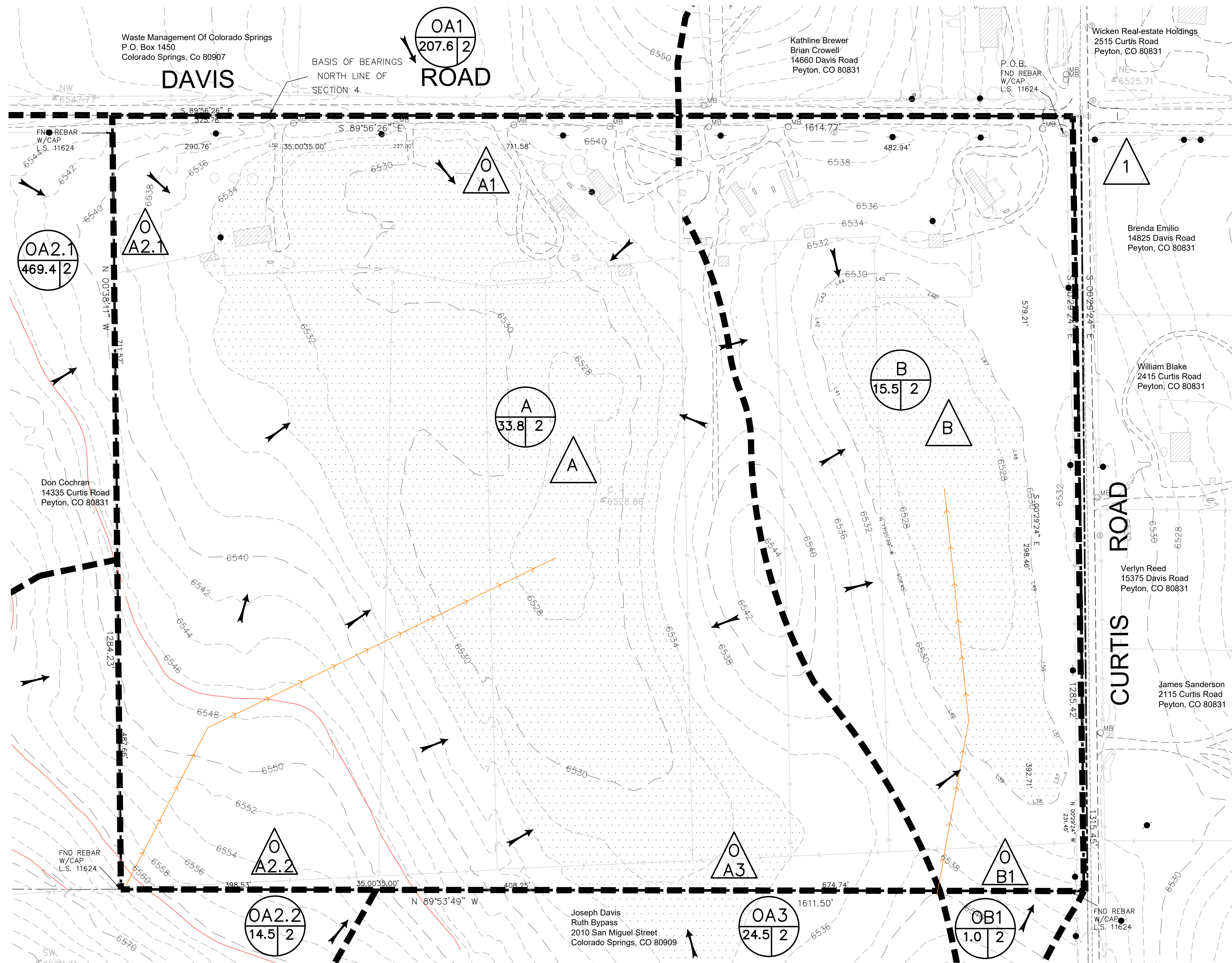
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



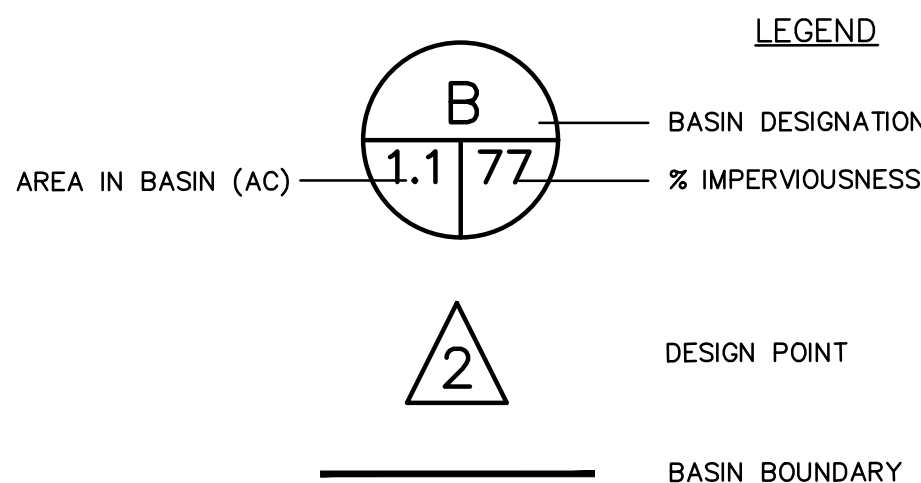
DRAINAGE MAPS

N:\jobs\2142.00\Drawings\Drawings\214200 GEC.dwg, 1/16/2023 1:45:57 PM, DWG To PDF.pcs

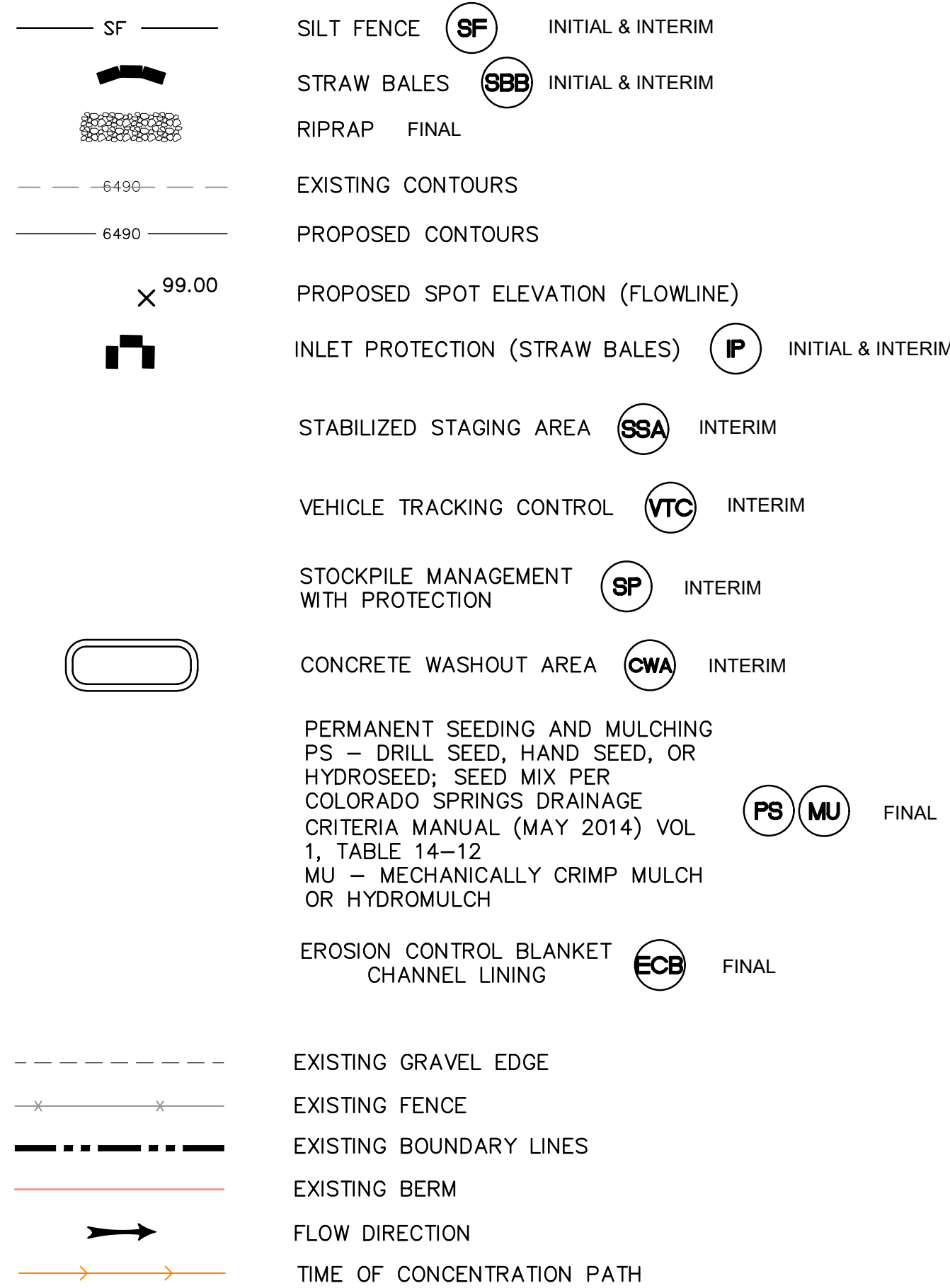


BENCHMARK

AN ALUMINUM CAP ON A 3" X 30" REBAR
35.00 FEET FROM TRUE CORNER LOCATION.
ELEV = 7386.46 (NAVD88)



GRADING & EROSION CONTROL LEGEND:



DRAINAGE SUMMARY

BASIN NAME	AREA (ACRES)	FLOW	
		5 YR (cfs)	100 YR (cfs)
OA1	207.6	0.9*	21.6
OA2.1	469.4	1.6*	39.3
OA2.2	14.5	2.5	15.8
OA3	24.4	4.2	26.9
OB1	1.0	0.3	1.9
A	33.8	7.3	47.9
B	15.5	2.9	18.8

*10 YEAR FLOW USED AS A CONSERVATIVE ESTIMATE FOR SCS HYDROGRAPH CALCULATIONS

DESIGN POINT SUMMARY

DP	CONTRIBUTING BASINS	AREA AC.	Q5 CFS	Q100 CFS
OA1	OA1	207.6	0.9*	21.6
OA2.1	OA2.1	469.4	1.6*	39.3
OA2.2	OA2.2	14.5	2.5	15.8
OA3	OA3	24.4	4.2	26.9
OB1	OB1	1.0	0.3	1.9
A	OA1, OA2.1, OA2.2, OA3, A	749.8	16.5	151.6
B	OB1, B	16.5	3.2	20.7
1	OA1, OA2.1, OA2.2, OA3, OB1, A, B	766.3	0	0

*10 YEAR FLOW USED AS A CONSERVATIVE ESTIMATE FOR SCS HYDROGRAPH CALCULATIONS

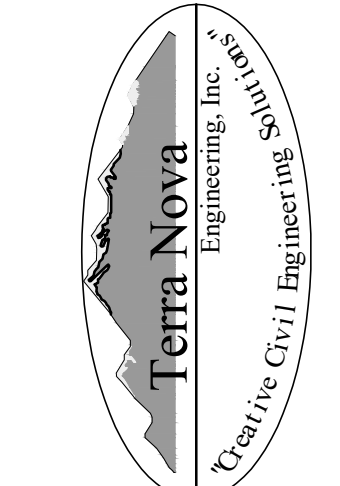
THIS DESIGN WAS PREPARED UNDER MY DIRECT SUPERVISION
FOR AND ON BEHALF OF TERRA NOVA ENGINEERING, INC.

L. DUCETT, P.E.
COLORADO P.E. NO. 32339

REVISIONS	NO.	DESCRIPTION	DATE

UNTIL SUCH TIME AS THESE
DRAWINGS ARE APPROVED
BY THE APPROPRIATE
REVIEWING AGENCIES,
THESE DRAWINGS ARE NOT
TO BE USED FOR ANY
PURPOSES DESIGNATED BY
THE WRITTEN AUTHORIZATION.

PREPARED FOR:
THOUSAND HILLS LAND & CATTLE CO
ATTN: RICHARD ELLIOTT
812 E MONUMENT STREET
COLORADO SPRINGS, CO 80903
(719) 238-4234



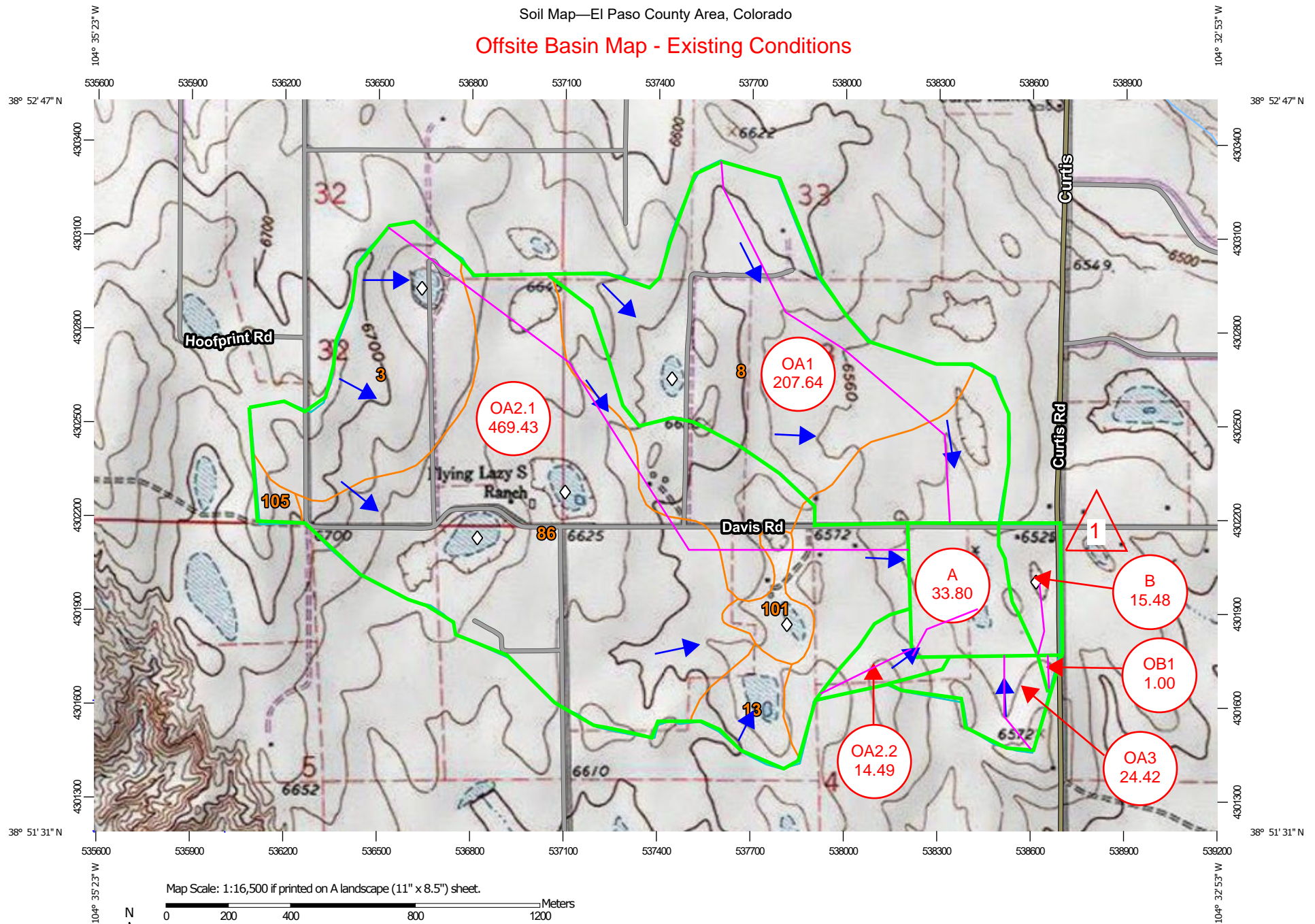
721 S. 23RD ST.
COLORADO SPRINGS, CO 80904
OFFICE: 719-635-6422
FAX: 719-635-6426
www.tneng.com

FALCON ACRES 14655 DAVIS ROAD	EXISTING DRAINAGE PLAN
----------------------------------	------------------------

DESIGNED BY JF
DRAWN BY JF
CHECKED BY LD
H-SCALE AS NOTED
V-SCALE AS NOTED
JOB NO. 2142.00
DATE ISSUED 1/1/23
SHEET NO. 1 OF 2

Soil Map—El Paso County Area, Colorado

Offsite Basin Map - Existing Conditions



Map Scale: 1:16,500 if printed on A landscape (11" x 8.5") sheet.



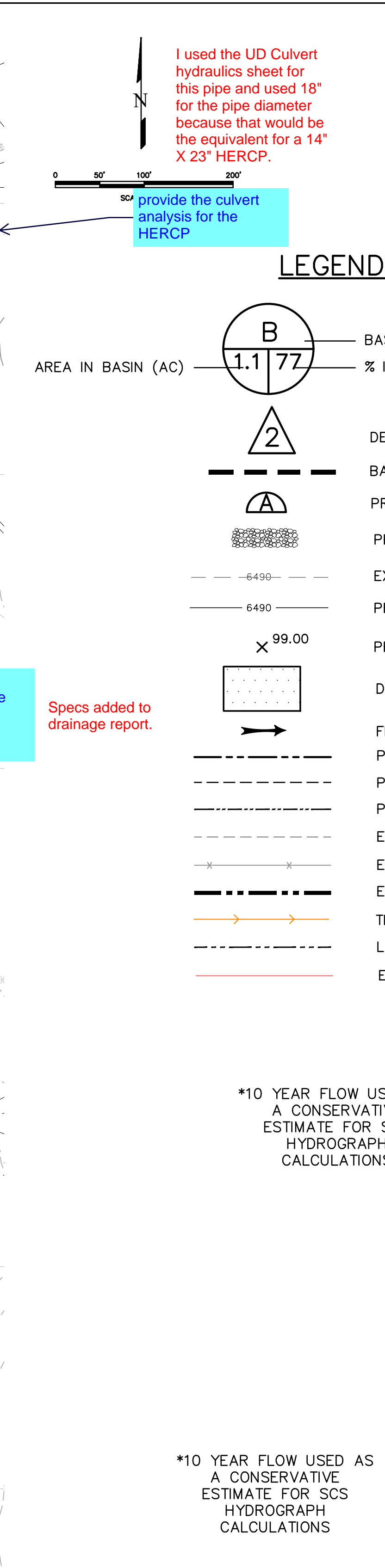
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84



**Natural Resources
Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

5/28/2022
Page 1 of 3



BENCHMARK

AN ALUMINUM CAP ON A $\frac{3}{4}$ " X 30" RE
35.00 FEET FROM TRUE CORNER LOC
ELEV = 7386.46 (NAVD88)

LEGEND:

- BASIN DESIGNATION
- % IMPERVIOUSNESS

DESIGN POINT

BASIN BOUNDARY

PROPOSED CHANNEL

PROPOSED RIPRAP

EXISTING CONTOURS

PROPOSED CONTOURS

PROPOSED SPOT ELEVATION (FLOWLINE)

DRAINAGE RETENTION AREAS

PROPOSED ROUND

PROPOSED BOUNDARY LINES
PROPOSED BOUNDARY LINES

PROPOSED GRAVEL EDGE

PROPOSED EASEMENT

EXISTING FENCE

EXISTING BOUNDARY LINES

TIME OF CONCENTRATION PAT

LIMITS OF CONSTRUCTION/DIS

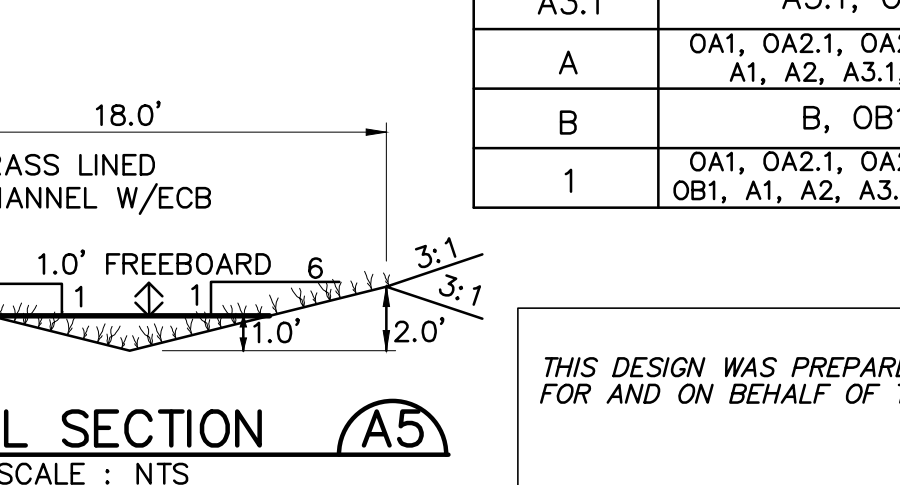
EXISTING BERM

BASIN NAME	AREA (ACRES)	FLOW	
		5 YR (cfs)	100 YR (cfs)
OA1	207.6	0.9*	21.6
OA2.1	469.4	1.6*	39.3
OA2.2	14.5	2.5	15.8
OA3	24.4	4.2	26.9
OB1	1.0	0.3	1.9
A1	6.1	1.7	9.1
A2	6.2	1.9	10.4
A3.1	9.1	2.0	10.6
A3.2	12.3	3.5	19.2
B	15.5	5.2	26.6

*10 YEAR FLOW USED AS
A CONSERVATIVE
ESTIMATE FOR SCS
HYDROGRAPH
CALCULATIONS

<u>DESIGN POINT SUMMARY</u>				
DP	CONTRIBUTING BASINS	AREA AC.	Q5 CFS	Q100 CFS
OA1	OA1	207.6	0.9*	21.6
OA2.1	OA2.1	469.4	1.6*	39.3
OA2.2	OA2.2	14.5	2.5	15.8
OA3	OA3	24.4	4.2	26.9
OB1	OB1	1.0	0.3	1.9
A1	A1, OA2.1, A2, OA2.2	496.2	7.7	74.6
A2	A2, OA2.2	20.7	4.4	26.2
A3.1	A3.1, OA3	33.56	6.2	37.5
A	OA1, OA2.1, OA2.2, OA3, A1, A2, A3.1, A3.2	749.8	18.3	153.0
B	B, OB1	16.5	5.5	28.5
1	OA1, OA2.1, OA2.2, OA3, OB1, A1, A2, A3.1, A3.2, B	766.3	0	0


*10 YEAR FLOW USED AS
A CONSERVATIVE
ESTIMATE FOR SCS
HYDROGRAPH
CALCULATIONS



Q CAP MIN = 25.4 CFS
SLOPE = 3.40%
n VALUE = 0.030
DEPTH = 2.00'
VELOCITY = 5.65 FT/S

THIS DESIGN WAS PREPARED UNDER MY DIRECT SUPERVISION
FOR AND ON BEHALF OF TERRA NOVA ENGINEERING, INC.

L DUCETT, P.E.
COLORADO P.E. NO. 32339

FALCON ACRES 14655 DAVIS ROAD	PROPOSED DRAINAGE PLAN	
721 S. 23RD ST COLORADO SPRINGS, CO 80904		
		
OFFICE: 719-635-6422 FAX: 719-635-6428 www.tnresinc.com		
DESIGNED BY JF		
DRAWN BY JF		
CHECKED BY LD		
H-SCALE	AS NOTED	
V-SCALE	AS NOTED	
JOB NO. 2142.00		
DATE ISSUED 1/1/23		
SHEET NO. 2 OF 2		