WIDEFIELD WATER AND SANITATION DISTRICT

2 MG ROLLING HILLS TANK

SITE DEVELOPMENT PLAN FINAL DRAINAGE REPORT

May 2021

JDS Project Number 102.121

PCD Project Number: PPR-21-006

Prepared By:

CONSULTANTS, INC.

5540 TECH CENTER DR., SUITE 100 • COLORADO SPRINGS, CO • 80919 • (719) 227-0072

JDS-HYDRO CONSULTANTS, INC.

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.

Elizabeth Steffens, PE #53332 — 05/06/21 Date

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.

Lucas Hale — 5/11/2021
Widefield Water and Sanitation District
8495 Fontaine Blvd., Colorado Springs, CO 80925 — Date

El Paso County:

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

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

Conditions:

El Paso County **May 06, 2021**
Planning & Community Development
2880 International Circle, Suite 110
Colorado Springs, CO 80910-3127

RE: Widefield Water and Sanitation District
2 MG Potable Water Tank
SDP Submittal – Final Drainage Report
Address: TBD (Schedule 5500000385)

To Whom It May Concern:

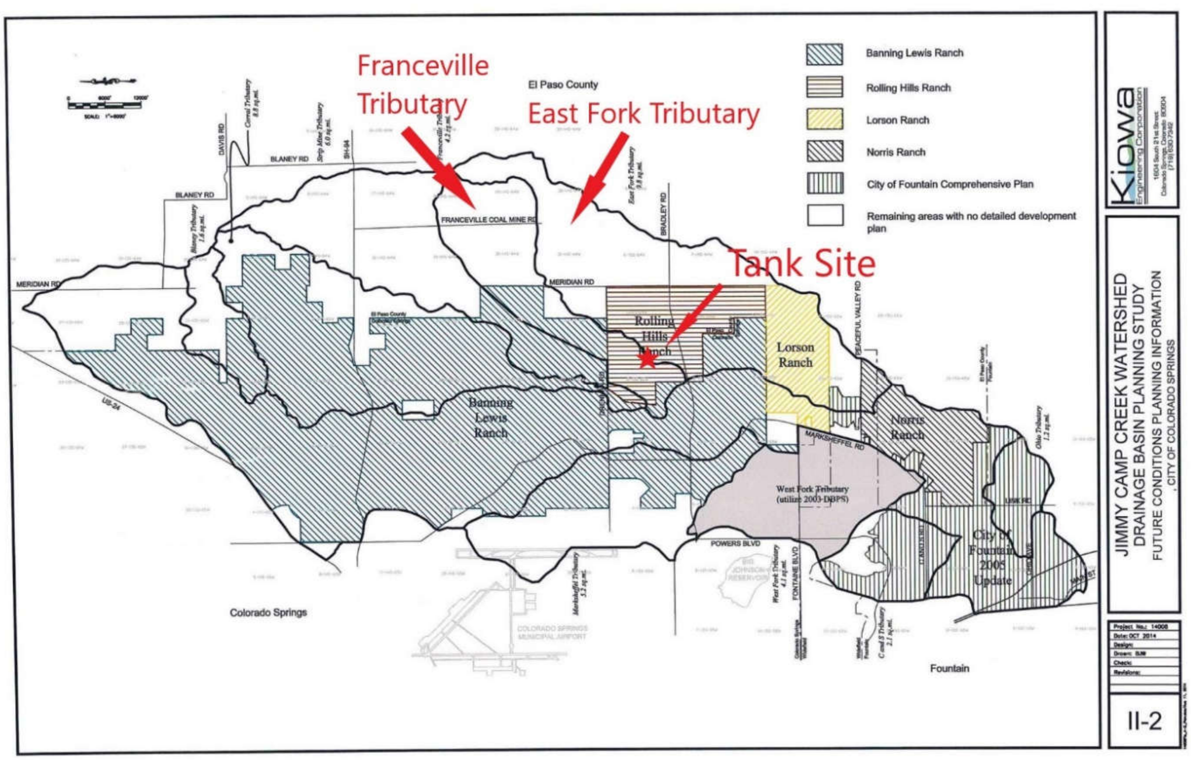
The purpose of this final drainage report is to satisfy requirements of the El Paso County Planning and Community Development division pertaining to the site development plan submittal for the project referenced above.

Property Description:

The intention of the applicant is to construct a storage tank to provide water service to areas within the existing Widefield Water and Sanitation District (WWSD) service area boundaries.

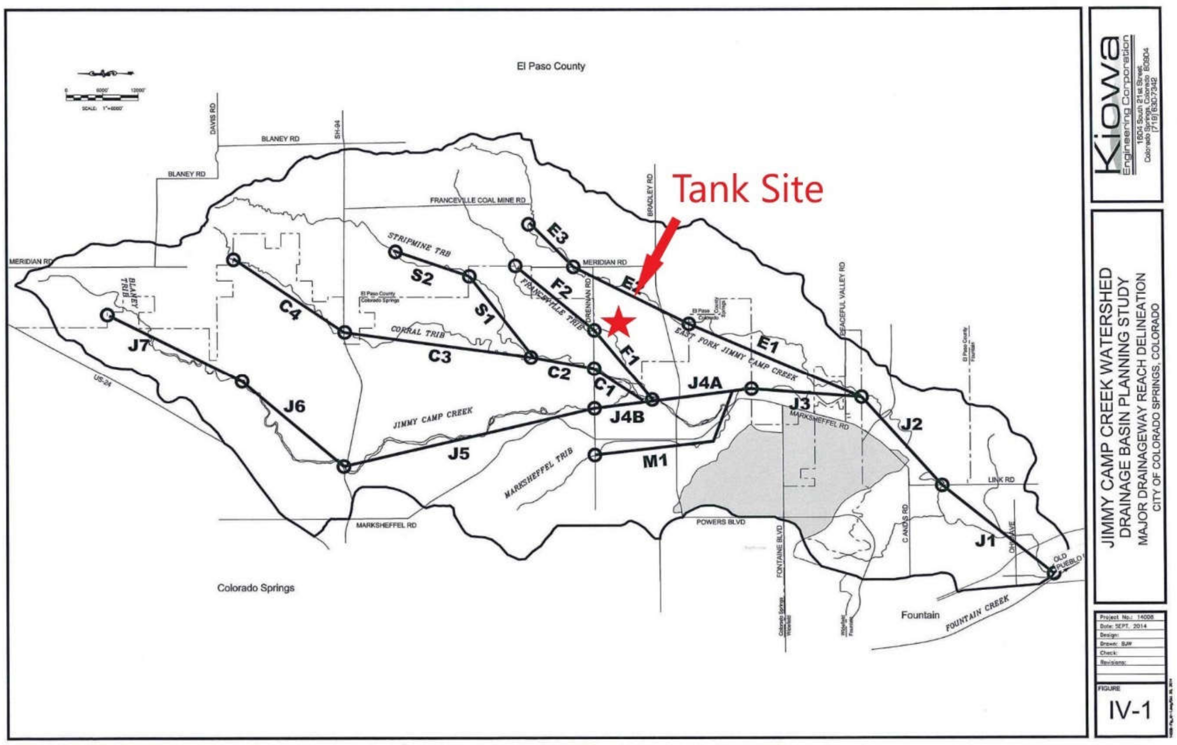
The site for Rolling Hills 2MG Tank is located in the Northwest 1/4 of Section 1, Township 15 South, Range 65 West of the 6th Principle Meridian, El Paso County, Colorado (El Paso County Parcel #: 5500000385). The subject facility is a proposed potable water tank and will be located on a 3.472 acre proposed site within the 802.42-acre overall parcel.

Figure 1 – Jimmy Camp Creek Drainage Basins



This project is located in the Jimmy Camp Creek Drainage Basin (FOFO2000) with Jimmy Camp Creek being the receiving water shed. A Drainage Basin Planning Study (DBPS) was prepared for this basin in 2015 by Kiowa Engineering Corporation. This study was authorized by the City of Colorado Springs, but due to the extensive regional implications of the study, input and review to the technical scope of the project was provided by the City of Fountain and El Paso County.

Figure 2 – Jimmy Camp Creek Tributaries



The site borders Drennan Road to the north and South Meridian Road to the east. The site for this project is used as grazing land for cattle and does not have an address. The address for the new facility will be determined and granted by the Pikes Peak Regional Building Department during their review of the building permit.

Soils

Soils for this project are delineated as Tassel fine sandy loam, 3 to 18 percent slopes (89) and are characterized as Hydrologic Soil Group D (high runoff potential when thoroughly wet). Soils were mapped using the NRCS Web Soil Survey. According to a geotechnical evaluation report by Vivid Engineering Group, dated 3/5/2020, site soils were comprised predominately of Piney Creek Alluvium deposits of mostly clayey and silty sand underlain by interbedded sandstone, claystone, and shale bedrock of the Pierre Shale Formation. A total of seven (7) exploratory borings within or near the general area to be occupied by the proposed tank were drilled to depths ranging from approximately 29 to 45 feet below the existing ground surface. The ground surface consists of gently rolling topography and was covered predominantly with grasses and yucca plants. A copy of NRCS Web Soil Survey is included in Appendix F.

Flood Plain Statement

The Floodplain Insurance Rate Map (FIRM) for El Paso County (map number 08041C0790G, dated December 7, 2018) was reviewed to determine any potential floodplain delineation. A copy of the relevant portion of this FIRM panel can be found in Appendix B. As shown, the proposed site lies within Zone X, defined as areas outside the 100-year floodplain. There is a FEMA floodplain zone AE on the parcel approximately 1400 feet the east of the site.

Drainage Criteria

This drainage analysis has been prepared in accordance with the current El Paso County Drainage Criteria Manual (Volumes 1 and 2). Volume 1 was established in 1991 with subsequent revisions in 1994. In 2002, the City of Colorado Springs Drainage Criteria Manual Volume 2 (DCMV2) was adopted as El Paso County's stormwater quality design criteria with Appendix I of the El Paso County's Engineering Criteria manual (ECM) to provide additions and revisions applicable to the County. In 2015, El Paso County adopted portions of the City of Colorado Springs Drainage Criteria Manual Volume 1 dated May 2014 including Chapter 6 and Section 3.2.1 of Chapter 13. In addition, the Urban Storm Drainage Criteria Manuals, Volumes 1-3 published by the Mile High Flood District (MHFD), formerly known as the Urban Drainage and Flood Control District, and dated November 2010 with subsequent updates were used to prepare this drainage report.

The Site is located within the Jimmy Camp Creek Drainage Basin (FOFO2000) with Jimmy Camp Creek being the receiving water shed. A Drainage Basin Planning Study (DBPS) was prepared for this basin in 2015 by Kiowa Engineering Corporation. A Master Development Drainage Plan for the Rolling Hills Ranch development will be prepared in the future. The proposed water storage tank will serve the future Rolling Hills Ranch development and will be owned and operated by WWSD.

Four Step Process

The Four Step Process for stormwater quality management listed below was utilized during planning for the proposed water tank site when applicable. Further details on how this was implemented for the proposed project is discussed throughout this drainage report.

Step 1: Employ Runoff Reduction Practices

Gravel driveway rather than a paved driveway is planned. Reduces runoff by disconnecting impervious area, eliminating "unnecessary" impervious area and encouraging infiltration into soils that are suitable.

Step 2: Stabilize Drainageways.

By implementing a sand filter basin the runoff from the water tank site will be reduced to pre-development conditions and therefore not anticipated to have negative effects on downstream drainageways. All drainageways proposed within the water tank site will be stabilized by revegetation with a native seed mix.

Step 3: Provide Water Quality Capture Volume (WQCV).

Sand filter basin is proposed to encourage infiltration of the WQCV.

Step 4: Consider Need for Industrial and Commercial BMPs

Spill containment and control for equipment fueling and maintenance and bulk storage will be implemented on the site. In addition, silt fence, sediment control logs, vehicle tracking control pad, concrete washout area, and mulching and reseeding will be used to mitigate the potential for erosion on the site. Further details will be provided in the site's stormwater management plan (SWMP).

Hydrologic Calculations

The hydrologic calculations were prepared following guidance from El Paso County Drainage Criteria Manual and resources from the MHFD (formerly known as UDFCD). The tank and access road easements are less than 100 acres, so the Rational Method is utilized as recommended in El Paso County Drainage Criteria Manual Volume 1. The Rational Method was used to determine estimated runoff peak discharges from storms between 2-year and 100-year storm recurrence intervals. Figure 6-5 IDF Curves are based on the rainfall depths for an elevation of 6,840 feet in the Colorado Springs area and were used for the hydrologic calculations. The 1-hr rainfall depths for each storm recurrence interval were obtained from Table 6-2 Rainfall Depths for Colorado Springs in the Drainage Criteria Manual Volume 1 Update.

Table 1 – 1-hr Rainfall Depths

1-hr rainfall depth, P1 (in)					
2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
1.19	1.50	1.75	2.00	2.25	2.52

Runoff coefficients were established based on Table 6-6 and Equation 6-6 of the El Paso County Drainage Criteria Manual Volume 1 Update. The percent impervious values for the site was calculated using the existing conditions for pre-development and proposed improvements for post-development. Time of concentration (Tc) for the basin for both historic and developed flows was calculated using Equations 6-7 through 6-9 of the El Paso County Drainage Criteria Manual Volume 1 Update. The El Paso Drainage Criteria Manual recommends limiting overland flow to a maximum of 300 feet in non-urban land uses. Calculations can be found in Appendix C.

Hydraulic Calculations

Hydraulic calculations were estimated using methods described in the El Paso County Drainage Criteria Manual and resources from the MHFD.

Drainage swale hydraulic calculations were performed using Manning's Equation to determine the drainage swale geometry needed to convey the developed runoff based on the site conditions. Calculations can be found in Appendix C.

Access to the tank site is provided from Drennan Rd. The proposed culvert is located near a high point and will convey flows from an approximately 0.99-acre area which includes 500 feet of gravel driveway and grassed drainage swale adjacent to the access road. Hydraulic calculations for the proposed culvert were prepared using HY-8. Based on the calculations and the City of Colorado Springs minimum culvert size requirement, a 15-inch CMP culvert is proposed for the temporary access road. Culvert calculations are provided in Appendix E.

Further discussion of the hydraulic calculations for the sand filter basin outlet works is included in the Sand Filter Basin section.

Existing Drainage Conditions

The developed land for the potable water tank will occur on the 3.472-acre easement, located at the high point of the surrounding area, and is not impacted from off-site flows. An access road from Drennan Rd. will serve the tank site. Historically, Subbasin A drains to the west and enters Franceville Tributary either by entering the roadside ditch along Drennan Road and flowing west or by overland flow. Subbasin B drains to the southeast and enters the Jimmy Camp East Tributary. The site is covered with native vegetation and includes grass and herbaceous species typical of vegetative assemblages in pastures routinely grazed by livestock. There are no existing drainage facilities (storm pipes, inlets, culverts, etc.) on the site.

The site evaluated for this study includes the 3.472-acre easement for the tank site and 1.24-acre easement for the access road. The drainage is subdivided into two basins (Subbasin A and B) for this evaluation. Drainage basin delineation is included in Appendix A.

Subbasin A

Runoff is conveyed via overland sheet flow at a slope of 4.9% resulting in a time of concentration (Tc) of 12.18 minutes to the northwest to a point identified as Design Point DP-EX-A. Table 2 – Pre-Development Runoff for Subbasin A provides the calculated runoff flows for the pre-development condition.

Table 2 – Pre-Development Runoff for Subbasin A

	10-year	100-year
Peak Flow, cfs	2.10	6.05

Subbasin B

Runoff is conveyed via overland sheet flow at a slope of 9.7% resulting in a time of concentration (Tc) of 10.57 minutes to the southeast to a point identified as Design Point DP-EX-B. Table 3 – Pre-Development Runoff for Subbasin B provides the calculated runoff flows for the pre-development condition.

Table 3 – Pre-Development Runoff for Subbasin B

	10-year	100-year
Peak Flow, cfs	1.26	3.63

Proposed Drainage Conditions

General Concept

Proposed drainage will generally remain the same as the existing drainage. The addition of the water tank will add 7,620 square feet of new impervious area based on the roof of the tank. The gravel access road up to the tank and 15 ft clear area around the tank will add 30,700 square feet.

The proposed drainage for the tank site has been divided into three subbasins (Subbasins A, B, & C). Subbasin A is generally unchanged and flows off-site via sheet flow to the west and into the Franceville Tributary drainage basin. Subbasin B is generally unchanged and flows off-site via sheet flow to the southeast and into the East Fork Tributary. Subbasin C (historically included in Subbasin A & B) is a new small subbasin and includes the tank access road and drainage swale, tank roof, and 15 ft gravel area around the tank. Flow from Subbasin C is discharged into the East Fork Tributary. Drainage in Subbasin C will be conveyed via drainage swale around the tank and continues in a vegetated drainage swale adjacent to the access road to a sand filter basin (SFB) located at a natural low point before discharging off-site and into the East Fork Tributary drainage basin. The proposed SFB will treat additional drainage produced from impervious areas that will be added to the site as a result of the tank construction including the tank roof and gravel areas. The SFB provides full spectrum detention and will be used to treat the Water Quality Capture Volume (WQCV) and detain the 100-yr flood event to pre-development release rates before leaving the site. The SFB is based on a drain time of 12 hours for the WQCV and 10-yr and 100-year release rate based on draining at 90% of predevelopment flows. Note that Colorado law requires 97% of the 5-year storm event to drain within 72 hours.

The SFB is included in the access road easement and language was included in the easement that the structure may only be abandoned when the future Rolling Hills Ranch Development agrees to accept and treat the developed runoff from the site. Subbasins A will generally not be changed and will drain into the undisturbed existing area to the northwest. Subbasin B will generally not be changed and will drain into the undisturbed existing area to the southeast. The natural division of drainage between Subbasin A and B will be shifted east to allow portions of the land previously included in Subbasin B to drain into the detention area created in Subbasin C.

Approximately 500 LF of the access road drains to the northwest and into the Drennan Rd. drainage ditch. The access road location was driven by grade restraints at the intersection of Drennan Rd and to limit excavation in the exposed sandstone. The drainage area for the access road culvert was designated Subbasin D. Prior to the proposed development, the Drennan Rd. roadside ditch only captured flow from the road north of the proposed access road. With the addition of the access road, drainage from approximately 500 LF of the access road and a small undeveloped area north of the proposed access road will flow into the proposed drainage swale adjacent to the access road. This additional flow will then be conveyed to the proposed access road culvert. The culvert was designed to convey flow for the post-development Subbasin D.

Developed drainage basin delineation is included in Appendix A.

Specific Design Details

Subbasin A & B

Subbasin A & B result in a reduction in post-development runoff due to the reduced size of the drainage area. Developed flows from Subbasin A & B are presented in Table 4 – Post-Development Runoff Estimates for Subbasin A & B below.

Table 4 – Post-Development Runoff for Subbasin A & B

	10-year	100-year
Subbasin A		
Post-Development Flow, cfs	1.62	3.63
	30% Decrease	
Subbasin B		
Post-Development Flow, cfs	1.04	3.63
	22% Decrease	

Subbasin C

Subbasin C is a new subbasin created due to the site improvements and was previously included within pre-development Subbasin A & B. Subbasin C is 1.76 acres and includes the access road easement and tank site easement. Subbasin C is located at a high point and is not impacted from off-site flows. Developed runoff is routed in drainage swales around the tank to a drainage swale located adjacent to the access road and into the proposed SFB at a natural low-point on the access road alignment. Drainage from the access road on the west side of the SFB is also conveyed in a drainage swale to the proposed SFB.

The calculated Tc is 14.66 minutes. Proposed developed flows are greater than pre-development flows due to the additional impervious area for the new gravel access road and water storage tank. Subbasin C generates the developed flow presented in Table 5 – Post-Development Runoff Estimates for Subbasin C below.

Table 5 - Post-Development Runoff Estimates for Subbasin C

	10-yr	100-yr
Post-Development, cfs (into SFB)	3.19	6.43
Post-Development, cfs (release rate out of SFB)	0.10	0.75

Subbasin D

Subbasin D is a new subbasin created due to the proposed site access road. Drainage from this subbasin flows to the access road culvert at the intersection of Drennan Rd. Flow from the culvert is conveyed west in the Drennan Rd. drainage ditch and contributes to the Franceville Tributary of Jimmy Camp Creek. Table 6 – Pre-Development Runoff for Drennan Rd. Drainage Ditch (@ Proposed Culvert Loc.) provides the calculated runoff flows for the pre-development condition.

Table 6 – Pre-Development Runoff for Drennan Rd. Drainage Ditch (@ Proposed Culvert Loc.)

	10-year	100-year
Post-Development Flow, cfs	0.34	0.99

For developed flows, the calculated Tc is 14.54 minutes. Proposed developed flows are greater than pre-development flows due to the additional impervious area for the new gravel access road and runoff from an additional area is being conveyed to the ditch where it previously would have continued southwest via overland flow to the Franceville Tributary of Jimmy Camp Creek. Subbasin D generates the developed flow presented in Table 7 – Post-Development Runoff Estimates for Subbasin D below.

Table 7 - Post-Development Runoff Estimates for Subbasin D

	10-yr	100-yr
Post-Development, cfs	1.32	3.22
	74% Increase	69% Increase

No improvements are proposed to the existing Drennan Rd. drainage ditch. The existing drainage ditch is irregular in shape with a channel depth of 1-ft, sideslopes of 10:1 and 8:1, and channel slope of 0.067 ft/ft. Hydraulic calculations were performed using Manning's Equation to determine the existing drainage swale geometry will convey the developed runoff based on the site conditions. The existing drainage ditch is adequate to convey developed flows. Based on the culvert calculations, if a storm event above the 100-yr event were to occur, overtopping of both the site access road and Drennan Rd. would likely occur.

Sand Filter Basin (SFB)

The SFB provides an 18-inch layer of filter material with an underdrain system that discharges into the proposed outlet structure. The SFB will allow for partial infiltration and the stormwater that does not infiltrate is collected and removed by the underdrain system. An orifice plate on the underdrain pipe is sized to drain the design volume in approximately 12 hours or more. The proposed outlet structure is comprised of a sloped inlet concrete box with circular orifice and overflow weir including an outlet pipe with circular orifice plate designed to constrict flow to no more than 90% of the pre-development release rate for the 100-yr event. The underdrain pipe with orifice plate discharges into the outlet structure. A 15-inch RCP outlet pipe discharges flows off-site and into the East Fork Tributary.

The SFB proposed for the site includes volumes, release rates, and components matching the design guidelines in the EPC DCM (Volumes I and II) and the ECM as well as guidance from USDCM. Due to the very small size of the drainage basin, a time step interval of 1-minute was used for the inflow hydrograph to more accurately represent the incoming flow. This caused the time of peak flow to occur sooner which is more realistic for a small drainage basin. This resulted in different stage and volume calculations for each zone than what was calculated using the simplified equations. Below is a list of the SFB's major characteristics:

Description (Zone)	*Depth*	*Volume*	*Release Rate*
WQCV	0.06 ft	0.003 acre-ft	0.005 cfs
EURV	0.18 ft	0.010 acre-ft	0.020 cfs
10-yr	0.37 ft	0.022 acre-ft	0.278 cfs
100-yr	0.54 ft	0.033 acre-ft	0.561 cfs

An emergency spillway with a crest length of 1 foot, 4:1 sideslopes, and minimum of 1-foot freeboard above the water surface when the emergency spillway is conveying the maximum design flow. Refer to the detention basin outlet structure design calculations in Appendix D for the outlet structure and spillway design.

A riprap basin is provided where the drainage swale discharges into the sand filter basin for energy dissipation and filtration. Construction details are provided in the drainage plans in Appendix A.

Water Quality Provisions and Maintenance

The proposed SFB provides water quality treatment for runoff produced on the Rolling Hills Tank Site. This water quality basin is designed to treat approximately 1.76 acres and provide 2,044 cubic feet of water quality storage (below the emergency spillway invert). The SFB will be private and maintained by the property owner. Access to be granted to the owner and El Paso County for access and maintenance of the private WQCV facility. A private maintenance agreement accompanies the submittal. The WQCV facility sizing calculations are included as an attachment of this report.

An access road on the north side of the SFB will provide maintenance access to the filter. Cleanouts will be installed on the underdrain pipes to provide access for inspection (by camera) immediately following construction to ensure that the underdrain pipe was not crushed during construction and to provide ongoing maintenance.

The runoff from a small portion of the site, designated as Subbasin D is not captured and is excluded in accordance with Appendix I of the Engineering Criteria Manual, section I.7.1.C.1. The area of land disturbance of subbasin D does not exceed 20% of the site and includes an area of 0.33 acre. Increased post-development flow in Subbasin D is due to the proposed gravel access road resulting in increased impervious area and channelized flow as well as additional drainage area that is being conveyed to the ditch where it previously would have continued southwest via overland flow to the Franceville Tributary of Jimmy Camp Creek.

Erosion Control

A Grading, Erosion, and Sediment Control Plan for the site was submitted with the site development plan. A temporary sediment basin will be constructed prior to the other site improvements in order to control stormwater flows off-site. Silt fence and erosion control socks will be used during construction to reduce sediment loading before site stabilization. Erosion control blanket and/or hydroseeding with tackifier will be installed at the end of the project to stabilize grass swales, sand filter basin slopes, and slopes 3:1 or steeper before vegetation is established. Further details are included on the Grading and Erosion Control (GEC) Plan.

Environmental Evaluations:

The project area, which encompasses the proposed tank site, waterline easement, and access road easement, was investigated by a qualified biologist on June 2, 2020 for the purpose of delineating all waterbodies and wetlands and identifying suitable habitat for federally listed threatened and endangered species.

No waters or wetlands were observed within the project area. Two shallow swales were observed but do not exhibit Ordinary High Water Marks (OHWM).

Drainage Fees

No significant drainage structures are planned for this project and therefore no reimbursement will be requested for additional development that occurs within the area of the study. It is anticipated that in the future, the area around the tank will be developed and at that time, a detailed drainage plan and associated infrastructure will be developed. If development occurs around the tank site, the drainage from the tank site will be redirected to storm sewers planned as part of the Rolling Hills Ranch development.

This site is within the Jimmy Camp Creek Drainage Basin. The El Paso County Drainage Basin Fees associated with the site will be paid when the developer plats the land.

Summary

Recommendations are made within this report concerning necessary improvements that will be required as a result of development of this property. The Rolling Hills Tank site is proposing to construct a sand filter basin that will detain developed flows and release at or below historic rates for the 10-yr and 100-yr storm events, as well as provide WQCV treatment. The sand filter basin will sufficiently mitigate the developed flows. The development of the proposed site does not significantly impact any downstream facility or property to an extent greater than that which currently exists due to historic conditions. Overall, proposed drainage characteristics will generally remain the same as existing, with the addition of a sand filter basin to address the developed flow from the site improvements and a driveway culvert along the Drennan Rd. drainage ditch to facilitate access to the site.

Respectfully,
JDS-Hydro Consultants, Inc.

Elizabeth Steffens, P.E.

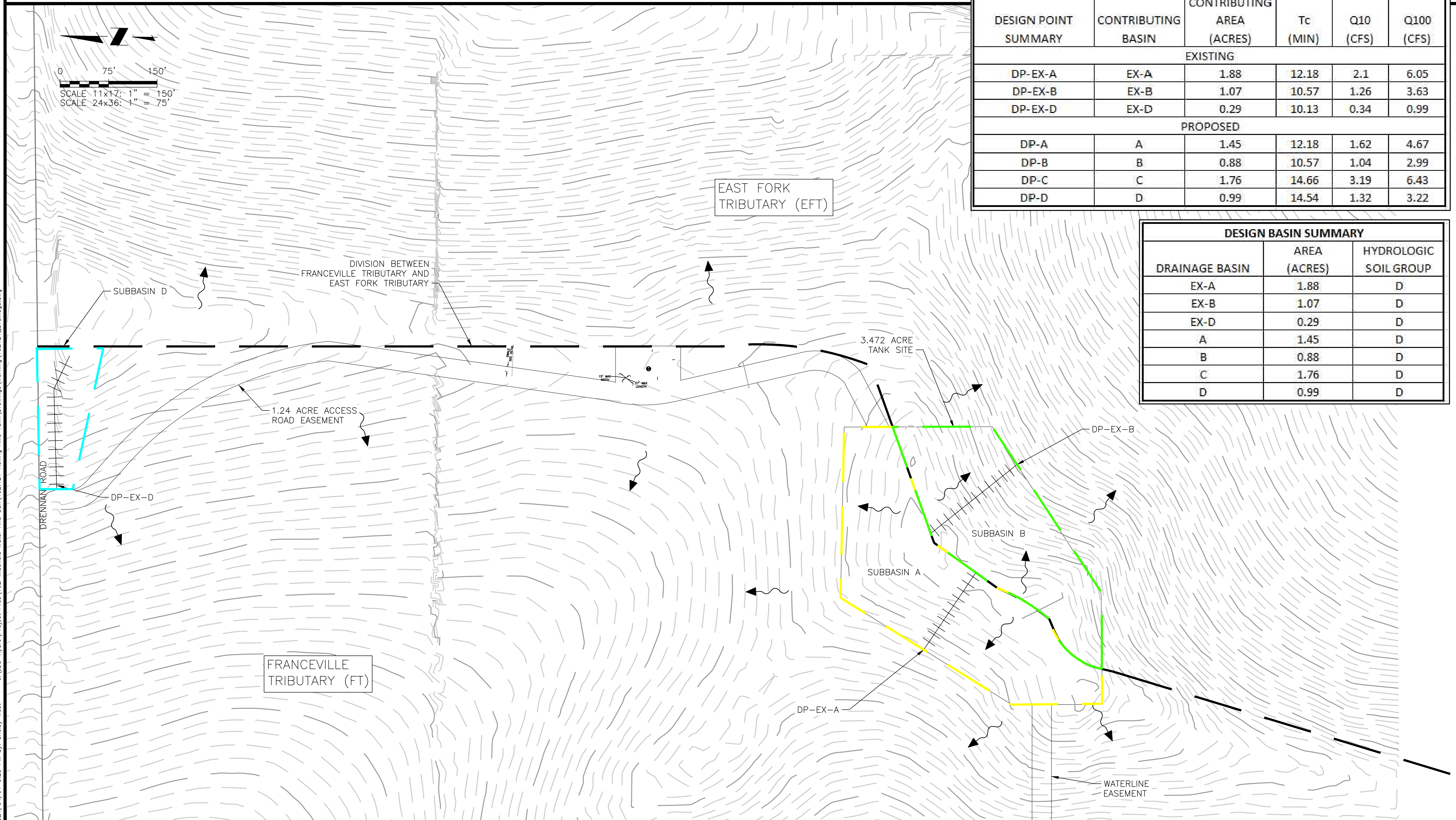
Enclosed

- *Appendix A – Drainage Plans*
- *Appendix B – FIRM Map*
- *Appendix C – Hydrologic Calculations*
- *Appendix D – Sand Filter Basin/Grass Swale Sizing Calculations*
- *Appendix E – Driveway Culvert Sizing Calculations*
- *Appendix F – Soils Map and Report*

Appendix A

LEGEND

- EX CONTOURS–MAJOR
- EX CONTOURS–MINOR
- PP CONTOURS–MAJOR
- PP CONTOURS–MINOR
- PP FENCE
- PP WATER LINE ALIGNMENT
- FLOW PATH
- PP FIRE HYDRANT
- PP WATER VALVE
- RIPRAP (FINAL)
- PRE–DEVELOPED FLOW DIRECTION
- DEVELOPED FLOW DIRECTION
- SUBBASIN A
- SUBBASIN B
- SUBBASIN C
- SUBBASIN D



DESIGN POINT SUMMARY

DESIGN POINT SUMMARY	CONTRIBUTING BASIN	CONTRIBUTING AREA (ACRES)	Tc (MIN)	Q10 (CFS)	Q100 (CFS)
EXISTING					
DP-EX-A	EX-A	1.88	12.18	2.1	6.05
DP-EX-B	EX-B	1.07	10.57	1.26	3.63
DP-EX-D	EX-D	0.29	10.13	0.34	0.99
PROPOSED					
DP-A	A	1.45	12.18	1.62	4.67
DP-B	B	0.88	10.57	1.04	2.99
DP-C	C	1.76	14.66	3.19	6.43
DP-D	D	0.99	14.54	1.32	3.22

DESIGN BASIN SUMMARY

DRAINAGE BASIN	AREA (ACRES)	HYDROLOGIC SOIL GROUP
EX-A	1.88	D
EX-B	1.07	D
EX-D	0.29	D
A	1.45	D
B	0.88	D
C	1.76	D
D	0.99	D

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COLORADO SPRINGS, COLORADO 80919
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WIDEFIELD WATER AND SANITATION DISTRICT

ROLLING HILLS 2MG POTABLE WATER TANK AND INLET PIPELINE

SITE DEVELOPMENT PLAN
EXISTING SITE DRAINAGE

REVISIONS

NO.	DESCRIPTION	BY	APP.	DATE
1				
2				
3				
4				
5				
6				
7				

EXHIBIT

Project No.: 102.121
Date: 07/30/20
Design: GJD
Drawn: SNW
Check: JPM

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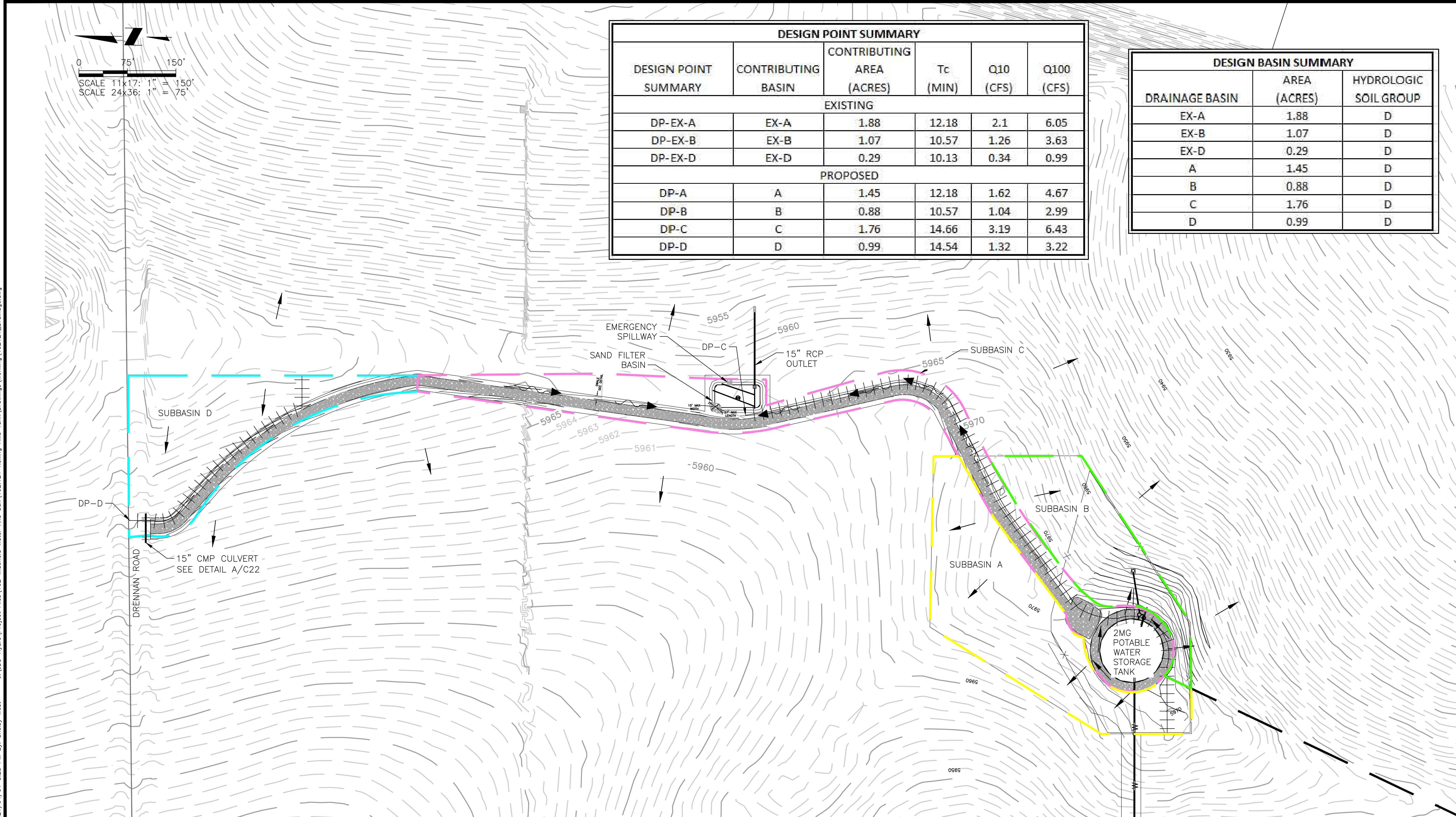
LEGEND

- EX CONTOURS–MAJOR
- EX CONTOURS–MINOR
- PP CONTOURS–MAJOR
- PP CONTOURS–MINOR
- PP FENCE
- PP WATER LINE ALIGNMENT
- FLOW LINE
- PP FIRE HYDRANT
- PP WATER VALVE
- RIPRAP (FINAL)
- PRE–DEVELOPED FLOW DIRECTION
- DEVELOPED FLOW DIRECTION
- SUBBASIN A
- SUBBASIN B
- SUBBASIN C
- SUBBASIN D
- GRAVEL ROAD
- RIPRAP



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DP-A	A	1.45	12.18	1.62	4.67
DP-B	B	0.88	10.57	1.04	2.99
DP-C	C	1.76	14.66	3.19	6.43
DP-D	D	0.99	14.54	1.32	3.22

DESIGN BASIN SUMMARY

DRAINAGE BASIN	AREA (ACRES)	HYDROLOGIC SOIL GROUP
EX-A	1.88	D
EX-B	1.07	D
EX-D	0.29	D
A	1.45	D
B	0.88	D
C	1.76	D
D	0.99	D

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5540 TECH CENTER DR., SUITE 100
COLORADO SPRINGS, COLORADO 80919
(719) 227-0072

WIDEFIELD WATER AND SANITATION DISTRICT

ROLLING HILLS 2MG POTABLE WATER TANK AND INLET PIPELINE

SITE DEVELOPMENT PLAN
PROPOSED SITE DRAINAGE

NO.	DESCRIPTION	BY	APP.	DATE
1				
2				
3				
4				
5				
6				
7				

REVISIONS

EXHIBIT

Project No.: 102.121
Date: 07/30/20
Design: GJD
Drawn: SNW
Check: JPM

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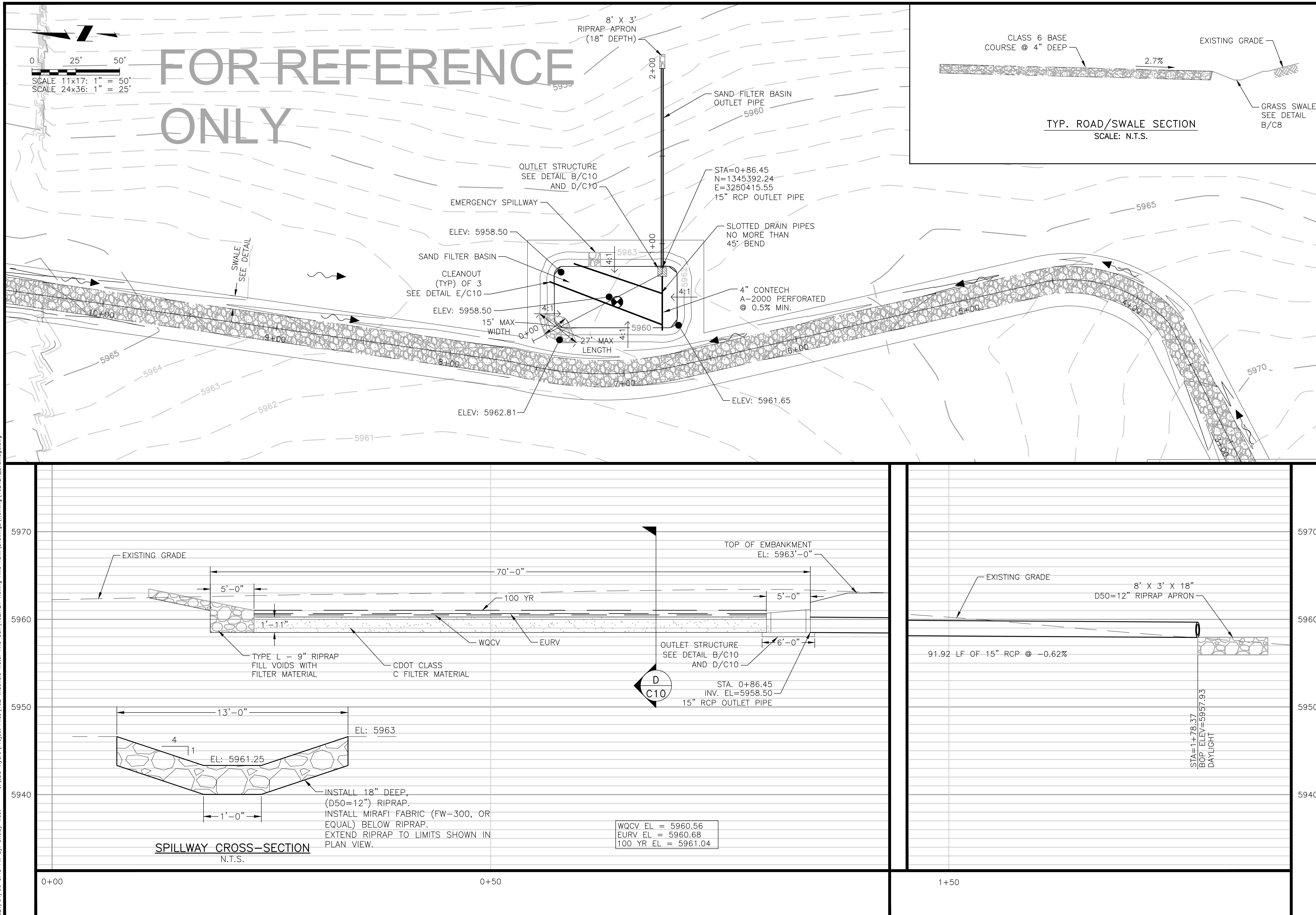

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COLORADO SPRINGS, COLORADO 80919
(719) 227-0072

WIDEFIELD WATER AND SANITATION DISTRICT

ROLLING HILLS 2MG POTABLE WATER TANK AND INLET PIPELINE

DRAINAGE BASIN PLAN & PROFILE

REVISIONS

NO.	DESCRIPTION	BY	APP.	DATE
1				
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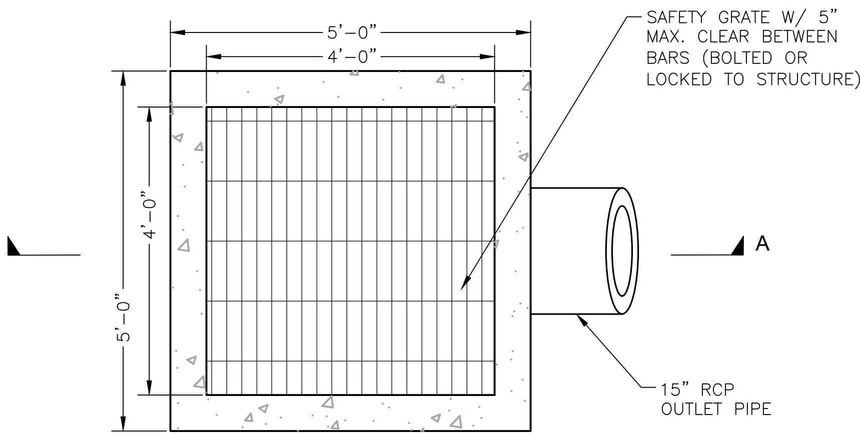
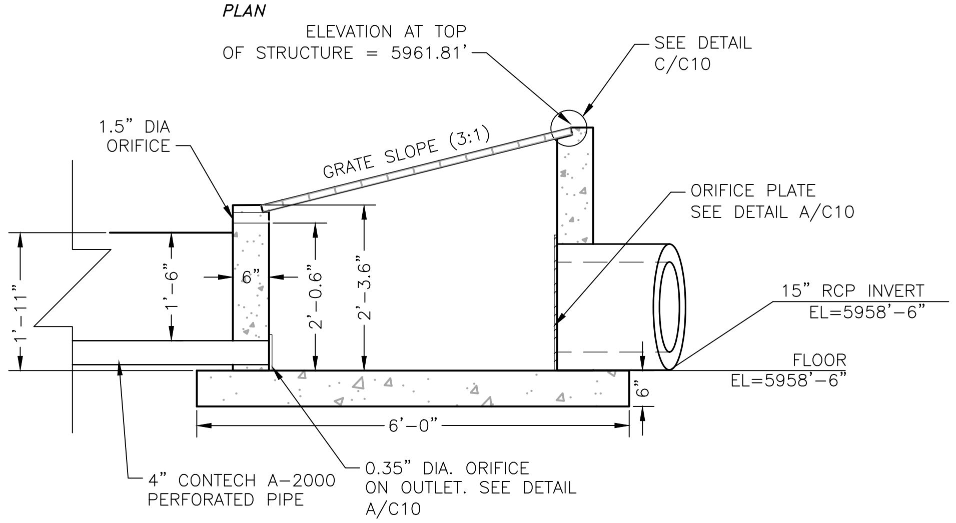
EXHIBIT

Project No.: 102.121
Date: 07/30/20
Design: GJD
Drawn: SNW
Check: JPM

SHEET ----OF

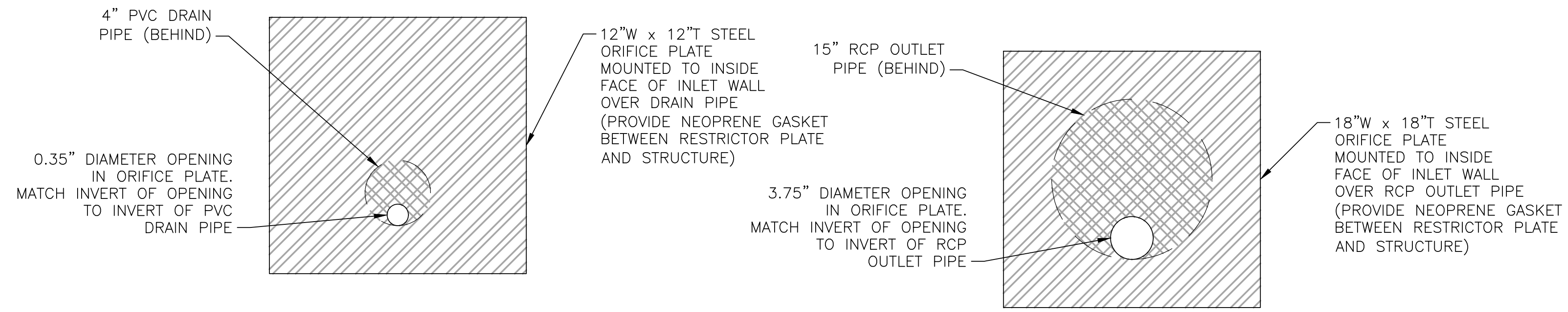


PLAN

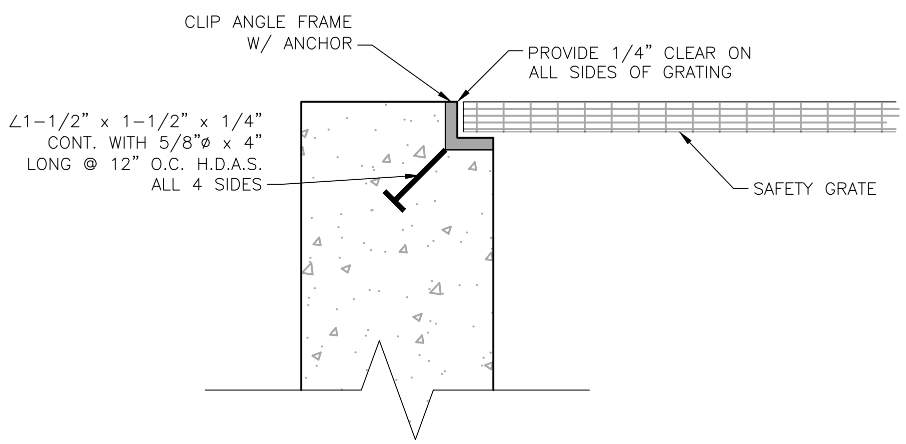


SECTION A

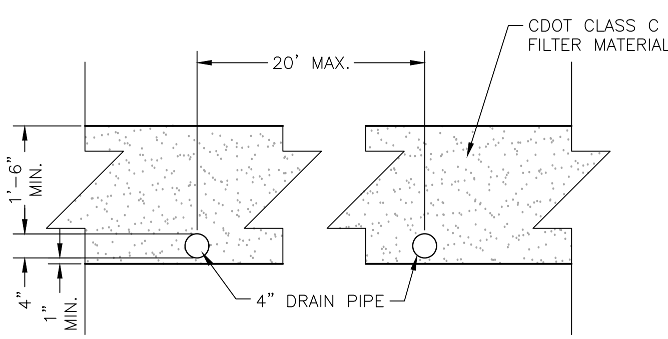
B / C10 OUTLET STRUCTURE
SCALE: 3/8" = 1'-0"



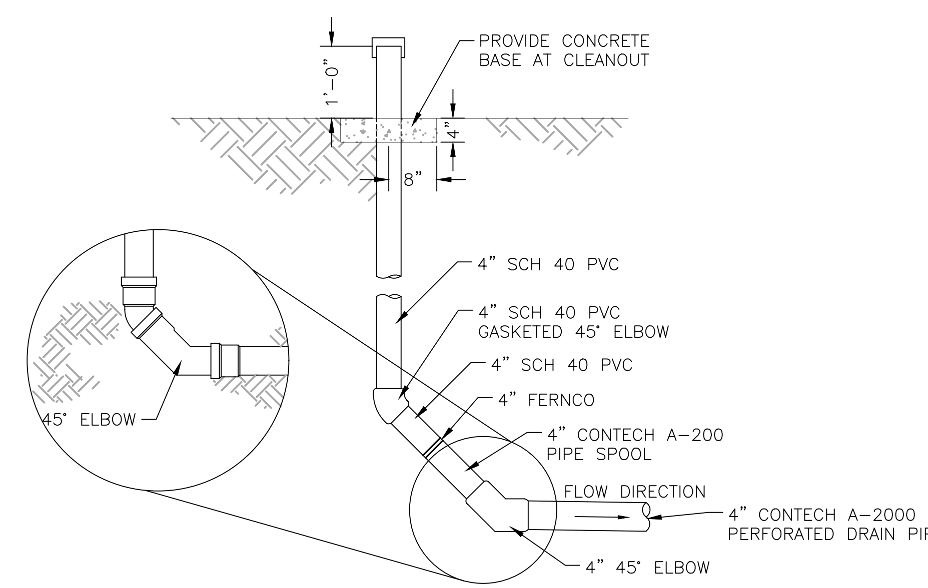
A / C10 ORIFICE PLATES
SCALE: N.T.S.



C / C10 GRATING DETAIL
SCALE: N.T.S.



D / C10 DRAINAGE BASIN SECTION (SEE SHEET C9)
SCALE: 3/8" = 1'-0"



E / C10 CLEANOUT
SCALE: N.T.S.

JDS-HYDRO CONSULTANTS, INC.
5540 TECH CENTER DR., SUITE 100
COLORADO SPRINGS, COLORADO 80919
(719) 227-0072

WIDEFIELD WATER AND SANITATION DISTRICT
ROLLING HILLS 2MG POTABLE WATER TANK
DRAINAGE BASIN CIVIL DETAILS

REVISIONS

NO.	DESCRIPTION	BY	APP.	DATE
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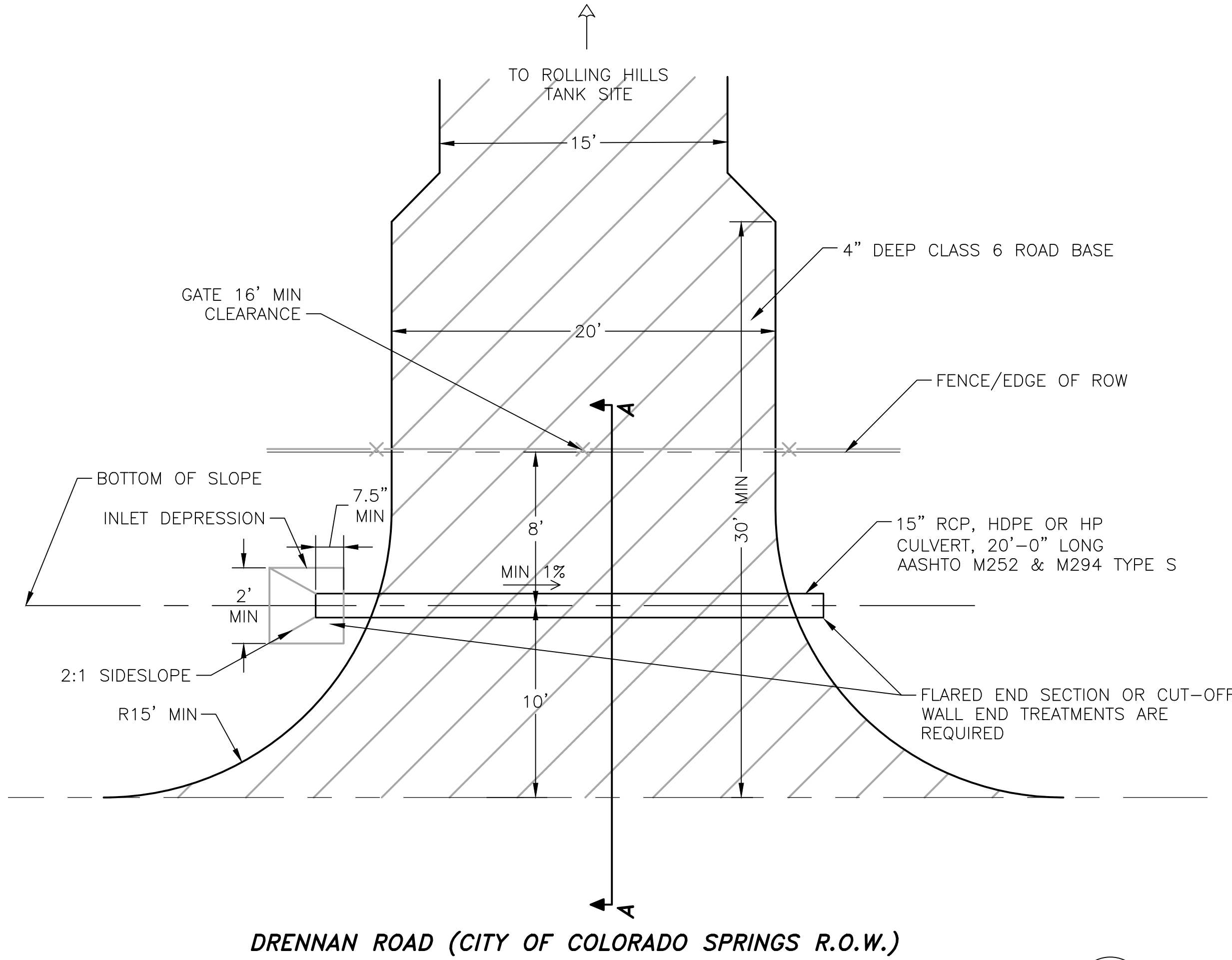
TO BID

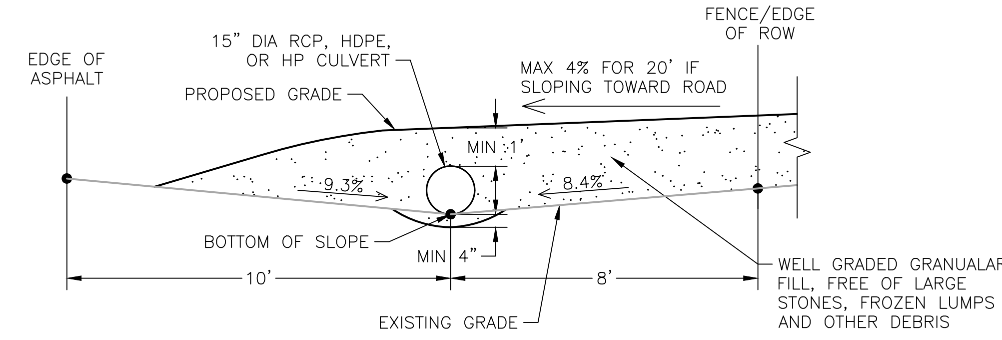
Project No.: 102.121
Date: 02/22/21
Design: GJD
Drawn: SNW
Check: JPM

C10
SHEET 13 OF 32

2021/04/06 3:29 PM By: Shelby West J:\JDS-Hydro\Project Files\102 Widefield Water And San\102.121 Rolling Hills Tank\Drawings\Working\102121_Civil Details.dwg



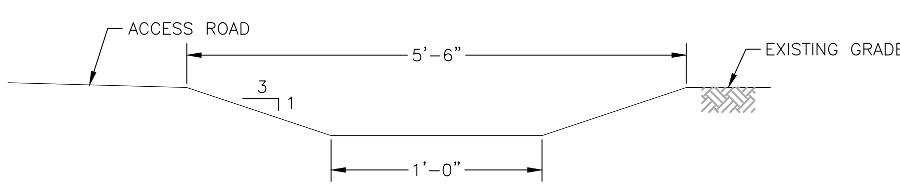
A / C8 DRIVEWAY ACCESS ROAD
SCALE: N.T.S.



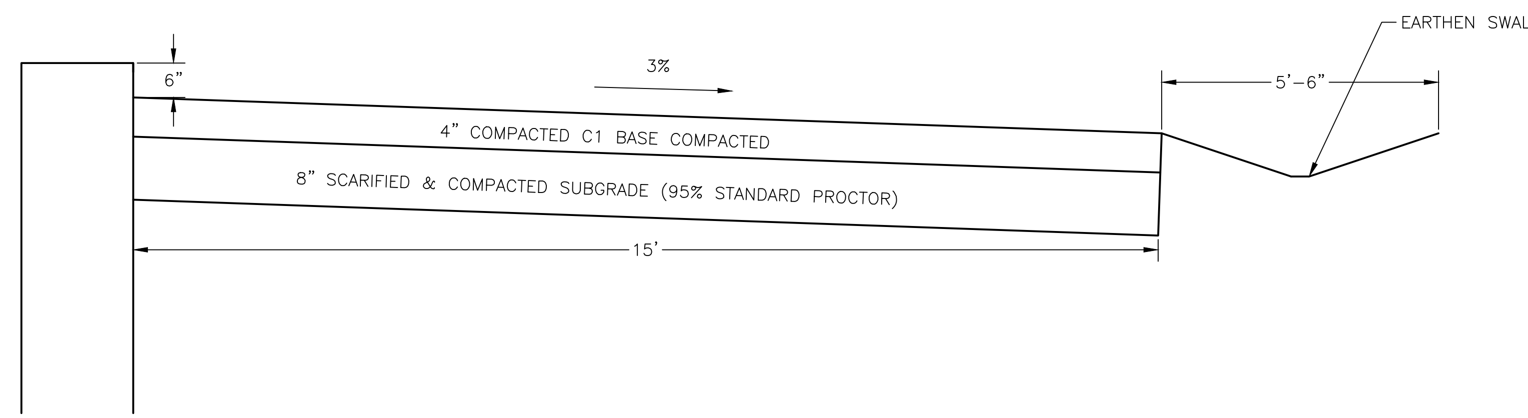
SECTION A–A
SCALE: N.T.S.

NOTES:

1. SURFACE TREATMENT OF DRIVEWAY TO BE CLASS 6 ROAD BASE AT 4" DEEP.
2. DRAIN PIPE TO BE 15" DIAMETER MINIMUM.
3. PIPE SLOPE TO BE CONSISTANT WITH FLOW LINE OF DITCH, MINIMUM OF 1%.
4. BACKFILL TO BE PLACED IN 6" LAYERS, DEPOSITED AND COMPACTED ON ALTERNATING SIDES OF THE PIPE.
5. MEASUREMENTS ARE APPROXIMATE AND SHOULD BE FIELD VERIFIED PRIOR TO COMMENCING CONSTRUCTION.



B / C8 TYPICAL GRASS SWALE SECTION
SCALE: N.T.S.



C / C8 TANK MAINTENANCE ROAD
SCALE: N.T.S.

JDS-HYDRO CONSULTANTS, INC.
5540 TECH CENTER DR., SUITE 100
COLORADO SPRINGS, COLORADO 80919
(719) 227-0072

WIDEFIELD WATER AND SANITATION DISTRICT
ROLLING HILLS 2MG POTABLE WATER TANK
ACCESS ROAD CIVIL DETAILS

REVISIONS

NO.	DESCRIPTION	BY	APP.	DATE
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TO BID

Project No.: 102.121
Date: 02/22/21
Design: GJD
Drawn: SNW
Check: JPM

C8
SHEET 11 OF 32

Appendix B

NOTE:
SEE FIRM 08041C07090G (12/07/08)
REVALIDATIONS PER FEMA.GOV

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

ZONE AE — Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

Floodway boundary

513 — Base Flood Elevation line and value; elevation in feet*

A — A Cross section line

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0790G

FIRM
FLOOD INSURANCE RATE MAP

EL PASO COUNTY,
COLORADO
AND INCORPORATED AREAS

PANEL 790 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0790	G
EL PASO COUNTY	080059	0790	G

Notice to User: The Map Number shown below should be used when placing map orders. The Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
08041C0790G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

JDS-HYDRO CONSULTANTS, INC.
5540 TECH CENTER DR., SUITE 100
COLORADO SPRINGS, COLORADO 80919
(719) 227-0072

WIDEFIELD WATER AND SANITATION DISTRICT

ROLLING HILLS 2MG POTABLE WATER TANK AND INLET PIPELINE

FEMA FLOODPLAIN MAP

REVISIONS

NO.	DESCRIPTION	BY	APP.	DATE
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80% DESIGN

Project No.: 102.121
Date: 08/07/20
Design: GJD
Drawn: SNW
Check: JPM

C3

SHEET 5 OF 34

Appendix C

DRAINAGE CALCULATIONS
Widefield Water and Sanitation District
Rolling Hills Tank
Pre-Development Runoff

1 - RUNOFF COEFFICIENT CALCULATION

Subbasin A (Franceville Tributary)

Undeveloped Area								
Surface Type	Area (SF)	Area (AC)	C5	C10	C100			
Undeveloped Land - Pasture/Meadow	81,893	1.88	0.15	0.25	0.50			

Subbasin B (East Fork Tributary)

Undeveloped Area								
Surface Type	Area (SF)	Area (AC)	C5	C10	C100			
Undeveloped Land - Pasture/Meadow	46,609	1.07	0.15	0.25	0.5			

Subbasin D - Drennan Rd. Ditch (@ Proposed Culvert Loc.)

Undeveloped Area								
Surface Type	Area (SF)	Area (AC)	C5	C10	C100			
Undeveloped Land - Pasture/Meadow	12,500	0.2869605	0.15	0.25	0.5			

2 -TIME OF CONCENTRATION CALCULATION

El Paso County Drainage Criteria Manual V1 Update (Eqn. 6-7, 6-8. 6-9)

Undeveloped

Subbasin A (Franceville Tributary)

Overland Flow Length (ft)based on Design Point DP-EX-A	144
C5	0.15
Land Slope ft/ft)	0.049
Ti (min)	12.18
Channelized Length (ft)	0.00
NRCS Conveyance Factor	20.00
Waterway Slope ft/ft)	0.02
Tt (min)	0.00
Tc (min)	12.18

Subbasin B (East Fork Tributary)

Overland Flow Length (ft)	170
C5	0.15
Land Slope ft/ft)	0.097
Ti (min)	10.57
Channelized Length (ft)	0.00
NRCS Conveyance Factor	20.00
Waterway Slope ft/ft)	0.02
Tt (min)	0.00
Tc (min)	10.57

Subbasin D - Drennan Rd. Ditch (@ Proposed Culvert Loc.)

Overland Flow Length (ft)	50
C5	0.15
Land Slope ft/ft)	0.02
Ti (min)	9.65
Channelized Length (ft)	150.00
NRCS Conveyance Factor	20.00
Waterway Slope ft/ft)	0.07
Tt (min)	0.48
Tc (min)	10.13

3 - HISTORICAL AND DEVELOPED FLOWRATE CALCULATIONS

Q = CiA, calculated I using Figure 6-5 of the El Paso County Drainage Criteria Manual V1 Update

10-Year Storm

Subbasin A

Undeveloped Drainage Basin 10-Year Storm				
Area (acres)	C10	i (in/hr)	Q (acre-in/h	Q (CFS)
1.88	0.2500	4.47	2.10	2.10

Subbasin B

Undeveloped Drainage Basin 10-Year Storm				
Area (acres)	C10	i (in/hr)	Q (acre-in/h	Q (CFS)
1.07	0.2500	4.72	1.26	1.26

Subbasin D - Drennan Rd. Ditch (@ Proposed Culvert Loc.)

Undeveloped Drainage Basin 10-Year Storm				
Area (acres)	C10	i (in/hr)	Q (acre-in/h	Q (CFS)
0.29	0.2500	4.79	0.34	0.34

100-Year Storm

Subbasin A

Undeveloped Drainage Basin 100-Year Storm				
Area (acres)	C100	i (in/hr)	Q (acre-in/h	Q (CFS)
1.88	0.5000	6.43	6.05	6.05

Subbasin B

Undeveloped Drainage Basin 100-Year Storm				
Area (acres)	C100	i (in/hr)	Q (acre-in/h	Q (CFS)
1.07	0.5000	6.79	3.63	3.63

Subbasin D - Drennan Rd. Ditch (@ Proposed Culvert Loc.)

Undeveloped Drainage Basin 10-Year Storm				
Area (acres)	C100	i (in/hr)	Q (acre-in/h	Q (CFS)
0.29	0.5000	6.90	0.99	0.99

DRAINAGE CALCULATIONS
Widefield Water and Sanitation District
Rolling Hills Tank

1 - RUNOFF COEFFICIENT CALCULATION

Subbasin A (Franceville Tributary)

Developed Area					
Surface Type	Area (SF)	Area (AC)	C5	C10	C100
Undeveloped Land - Pasture/Meadow	63,162	1.45	0.15	0.25	0.50

Subbasin B (East Fork Tributary)

Developed Area					
Surface Type	Area (SF)	Area (AC)	C5	C10	C100
Undeveloped Land - Pasture/Meadow	38,333	0.88	0.15	0.25	0.50

Subbasin C - Tank Site Improvements

Developed Area								
Surface Type	Area (SF)	Area (AC)	C5	C10	C100	Composite C5	Composite C10	Composite C100
Roof	7620	0.1749341	0.75	0.77	0.83	5715	5867	6325
Gravel Driveway	25,343	0.5817852	0.63	0.66	0.74	15966	16726	18753
Vegetated Swale	5,950	0.1365932	0.15	0.25	0.50	893	1488	2975
Undeveloped Land - Pasture/Meadow	37,753	0.8666875	0.15	0.25	0.50	5663	9438	18876
	76,666	1.76				0.37	0.44	0.61

Subbasin D - Drainage to Access Rd. Culvert

Developed Area								
Surface Type	Area (SF)	Area (AC)	C5	C10	C100	Composite C5	Composite C10	Composite C100
Gravel Driveway	7,320	0.1680441	0.63	0.66	0.74	4611.6	4831.2	5416.80
Vegetated Swale	2,440	0.0560147	0.15	0.25	0.50	366	610	1220.00
Undeveloped Land - Pasture Meadow	33,500	0.7690542	0.15	0.25	0.50	5025	8375	16750.00
	43,260	0.9931129				0.23	0.32	0.54

2 -TIME OF CONCENTRATION CALCULATION

El Paso County Drainage Criteria Manual V1 Update (Eqn. 6-7, 6-8. 6-9)

Developed

Subbasin A (Franceville Tributary)

Overland Flow Length (ft)based on Design Point DP-EX-A	144
C5	0.15
Land Slope ft/ft)	0.049
Ti (min)	12.18
Channelized Length (ft)	0.00
NRCS Conveyance Factor	20.00
Waterway Slope ft/ft)	0.02
Tt (min)	0.00
Tc (min)	12.18

Subbasin B (East Fork Tributary)

Overland Flow Length (ft)	170
C5	0.15
Land Slope ft/ft)	0.097
Ti (min)	10.57
Channelized Length (ft)	0.00
NRCS Conveyance Factor	20.00
Waterway Slope ft/ft)	0.02
Tt (min)	0.00
Tc (min)	10.57

Subbasin C - Tank Site Improvements

Overland Flow Length (ft)	50
C5	0.37
Land Slope ft/ft)	0.02
Ti (min)	7.43
Channelized Length (ft)	950.00
NRCS Conveyance Factor	20.00
Waterway Slope ft/ft)	0.01
Tt (min)	7.23
Tc (min)	14.66

Subbasin D - Drainage to Access Rd. Culvert

Overland Flow Length (ft)	120
C5	0.23
Land Slope ft/ft)	0.02
Ti (min)	13.67
Channelized Length (ft)	200.00
NRCS Conveyance Factor	20.00
Waterway Slope ft/ft)	0.04
Tt (min)	0.87
Tc (min)	14.54

3 - HISTORICAL AND DEVELOPED FLOWRATE CALCULATIONS

Q = CiA, calculated I using Figure 6-5 of the El Paso County Drainage Criteria Manual V1 Update

10-Year Storm

Subbasin A (Franceville Tributary)

Historic Drainage Basin 10-Year Storm						
Area (acres)		C10	i (in/hr)	Q (acre-in/hr)	Q (CFS)	
	1.88	0.2500	4.47	2.10		2.10
Developed Drainage Basin 10-Year Storm						
Area (acres)		C10	i (in/hr)	Q (acre-in/hr)	Q (CFS)	
	1.45	0.2500	4.47	1.62		1.62
Subbasin A Increase (CFS)						**-0.48**

-30% Runoff Reduction

Subbasin B (East Fork Tributary)

Historic Drainage Basin 10-Year Storm						
Area (acres)		C10	i (in/hr)	Q (acre-in/hr)	Q (CFS)	
	1.07	0.2500	4.72	1.26		1.26
Developed Drainage Basin 10-Year Storm						
Area (acres)		C10	i (in/hr)	Q (acre-in/hr)	Q (CFS)	
	0.88	0.2500	4.72	1.04		1.04
Subbasin B Increase (CFS)						**-0.22**

-22% Runoff Reduction

Subbasin C - Tank Site Improvements

Developed Drainage Basin 10-Year Storm						
Area (acres)		C10	i (in/hr)	Q (acre-in/hr)	Q (CFS)	
	1.76	0.4372	4.15	3.19		3.19

Subbasin D - Drainage to Access Rd. Culvert

Historic Drainage Basin 10-Year Storm						
Area (acres)		C10	i (in/hr)	Q (acre-in/hr)	Q (CFS)	
	0.29	0.25	4.79	0.34		0.34
Developed Drainage Basin 10-Year Storm						
Area (acres)		C10	i (in/hr)	Q (acre-in/hr)	Q (CFS)	
	0.99	0.3194	4.16	1.32		1.32
Subbasin D Increase (CFS)						0.98

74% Runoff Increase

100-Year Storm

Subbasin A (Franceville Tributary)

Historic Drainage Basin 100-Year Storm					
Area (acres)	C100	i (in/hr)	Q (acre-in/hr)	Q (CFS)	
1.88	0.5000	6.43	6.05		6.05
Developed Drainage Basin 100-Year Storm					
Area (acres)	C100	i (in/hr)	Q (acre-in/hr)	Q (CFS)	
1.45	0.5000	6.43	4.67		4.67
Subbasin A Increase (CFS)					**-1.38**

-30% Runoff Reduction

Subbasin B (East Fork Tributary)

Historic Drainage Basin 100-Year Storm					
Area (acres)	C100	i (in/hr)	Q (acre-in/hr)	Q (CFS)	
1.07	0.5000	6.79	3.63		3.63
Developed Drainage Basin 100-Year Storm					
Area (acres)	C100	i (in/hr)	Q (acre-in/hr)	Q (CFS)	
0.88	0.5000	6.79	2.99		2.99
Subbasin B Increase (CFS)					**-0.65**

-22% Runoff Reduction

Subbasin C - Tank Site Improvements

Developed Drainage Basin 100-Year Storm					
Area (acres)	C100	i (in/hr)	Q (acre-in/hr)	Q (CFS)	
1.76	0.6121	5.97	6.43		6.43

Subbasin D - Drainage to Access Rd. Culvert

Historic Drainage Basin 100-Year Storm					
Area (acres)	C100	i (in/hr)	Q (acre-in/hr)	Q (CFS)	
0.29	0.5	6.90	0.99		0.99
Developed Drainage Basin 100-Year Storm					
Area (acres)	C100	i (in/hr)	Q (acre-in/hr)	Q (CFS)	
0.99	0.54	5.99	3.22		3.22
Subbasin D Increase (CFS)					2.23

69% Runoff Increase

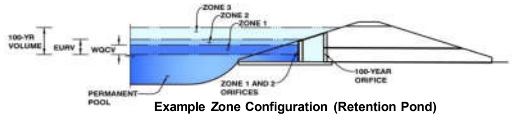
Appendix D

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.00 (December 2019)

Project: **Widefield Water and Sanitation District - Rolling Hills Tank**

Basin ID: **Subbasin C**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**SF**		**Note: L / W Ratio > 8**	
Watershed Area =	1.76	acres	**L / W Ratio = 13.04**	
Watershed Length =	1,000	ft		
Watershed Length to Centroid =	650	ft		
Watershed Slope =	0.012	ft/ft		
Watershed Imperviousness =	36.00%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	0.0%	percent		
Percentage Hydrologic Soil Groups C/D =	100.0%	percent		
Target WQCV Drain Time =	12.0	hours		
Location for 1-hr Rainfall Depths =	User Input			

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.020	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.058	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.075	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.116	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.151	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.195	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.233	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.280	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	0.376	acre-feet		inches
Approximate 2-yr Detention Volume =	0.051	acre-feet		
Approximate 5-yr Detention Volume =	0.081	acre-feet		
Approximate 10-yr Detention Volume =	0.093	acre-feet		
Approximate 25-yr Detention Volume =	0.103	acre-feet		
Approximate 50-yr Detention Volume =	0.108	acre-feet		
Approximate 100-yr Detention Volume =	0.128	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.020	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.039	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.070	acre-feet
Total Detention Basin Volume =	0.128	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	N/A	ft
Slope of Trickle Channel (S_{TC}) =	N/A	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
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 = 0.50 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	--	0.00	--	--	--	2,450	0.056		
	--	0.50	--	--	--	2,886	0.066	1,334	0.031
	--	1.00	--	--	--	3,354	0.077	2,894	0.066
	--	1.50	--	--	--	3,854	0.088	4,696	0.108
	--	2.00	--	--	--	4,386	0.101	6,756	0.155
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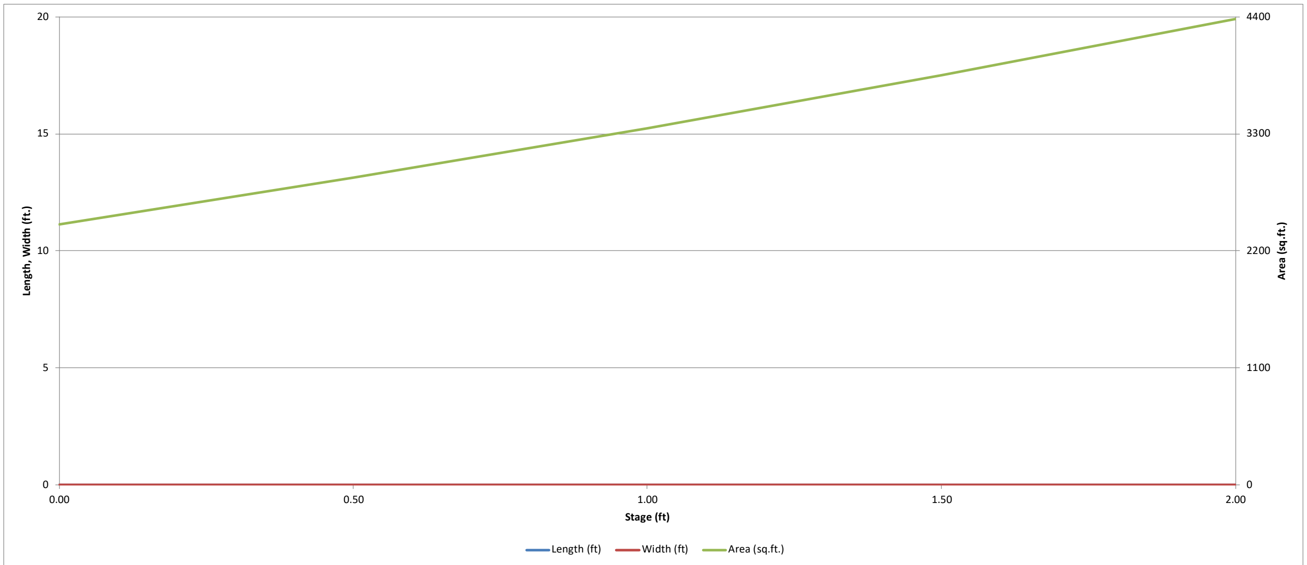
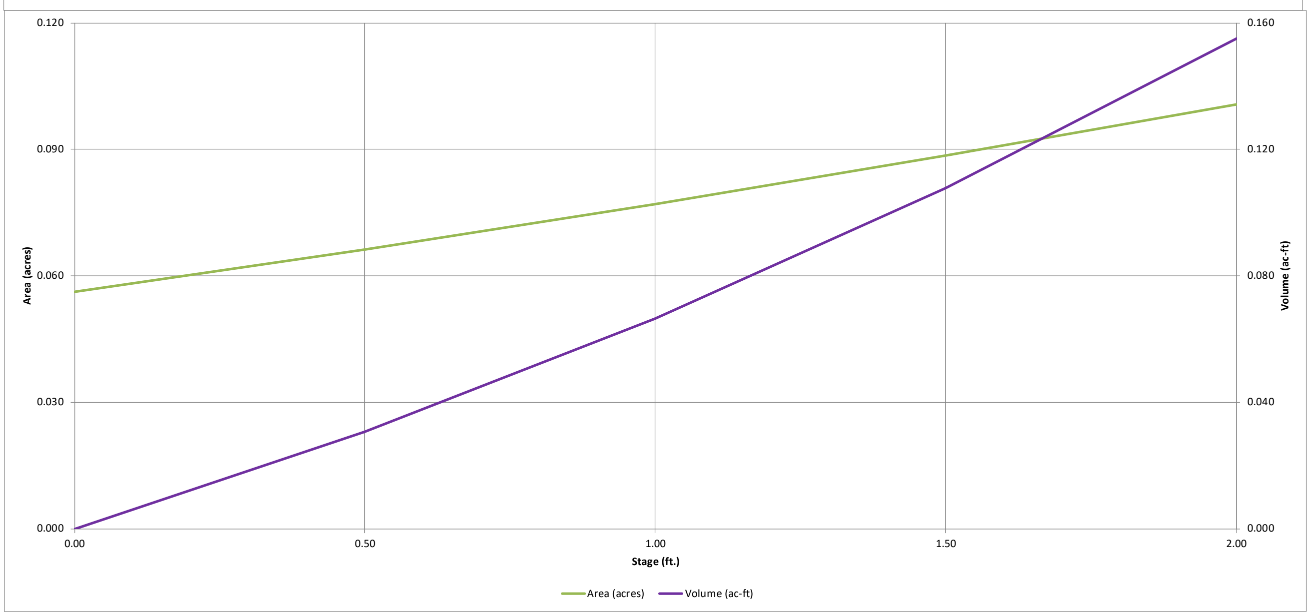
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.00 (December 2019)



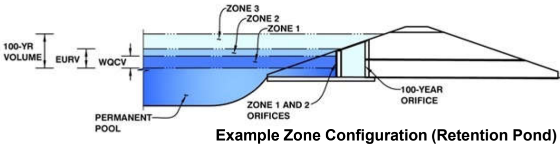


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)

Project: Widefield Water and Sanitation District - Rolling Hills Tank

Basin ID: Subbasin C



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.34	0.020	Filtration Media
Zone 2 (EURV)	0.90	0.039	Circular Orifice
Zone 3 (100-year)	1.73	0.070	Weir&Pipe (Circular)
Total (all zones)		0.128	

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

Underdrain Orifice Invert Depth =	1.83	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	0.35	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	0.0	ft^2
Underdrain Orifice Centroid =	0.01	feet

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

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

Calculated Parameters for Plate

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

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

	Row 1 (optional)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orifice Area (sq. inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	0.05	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	0.50	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	1.50	N/A	inches

Calculated Parameters for Vertical Orifice

	Zone 2 Circular	Not Selected	
Vertical Orifice Area =	0.01	N/A	ft^2
Vertical Orifice Centroid =	0.06	N/A	feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir (and No Outlet Pipe)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	0.30	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	3.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	0%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	1.63	N/A	feet
Overflow Weir Slope Length =	4.22	N/A	feet
Grate Open Area / 100-yr Orifice Area =	153.92	N/A	
Overflow Grate Open Area w/o Debris =	11.81	N/A	ft^2
Overflow Grate Open Area w/ Debris =	11.81	N/A	ft^2

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

	Zone 3 Circular	Not Selected	
Depth to Invert of Outlet Pipe =	1.92	N/A	ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =	3.75	N/A	inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Circular	Not Selected	
Outlet Orifice Area =	0.08	N/A	ft^2
Outlet Orifice Centroid =	0.16	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	0.75	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	1.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.36	feet
Stage at Top of Freeboard =	2.11	feet
Basin Area at Top of Freeboard =	0.10	acres
Basin Volume at Top of Freeboard =	0.16	acre-ft

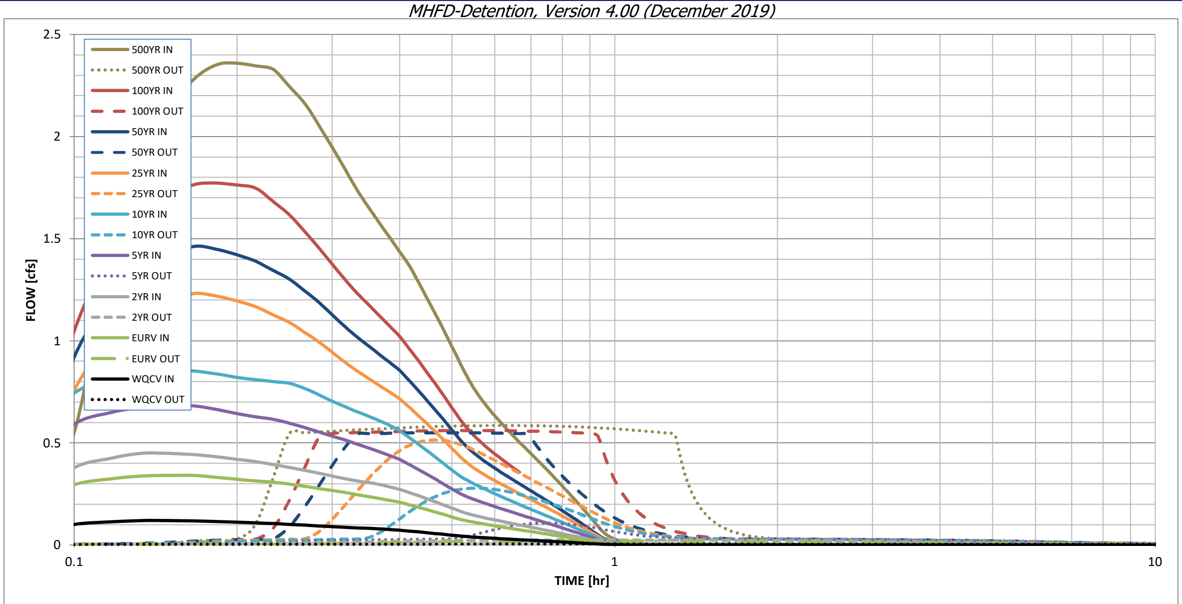
Routed Hydrograph Results

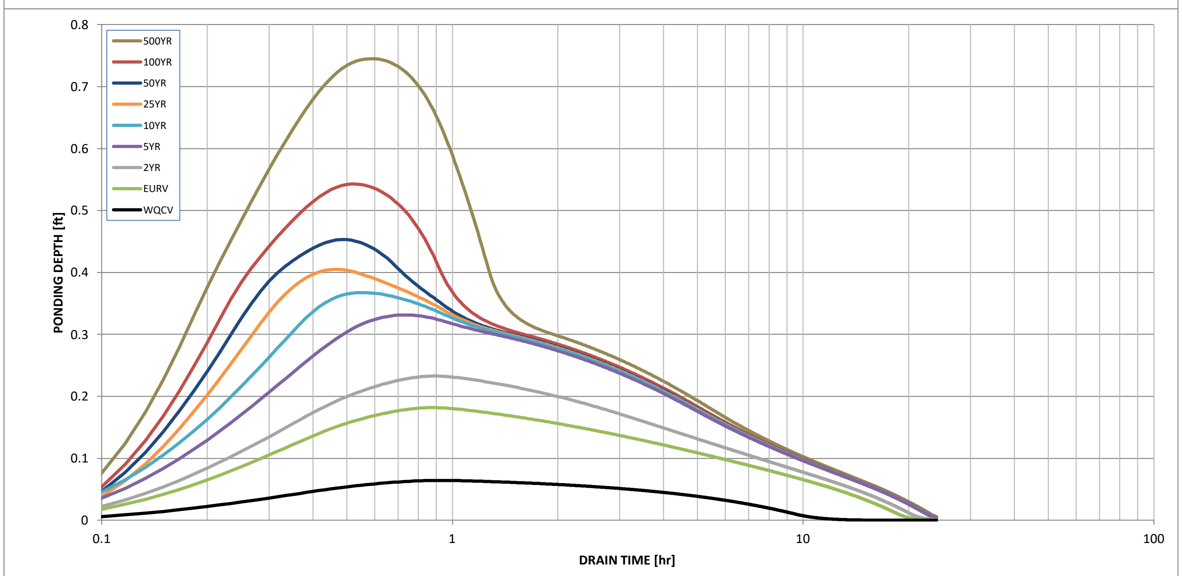
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

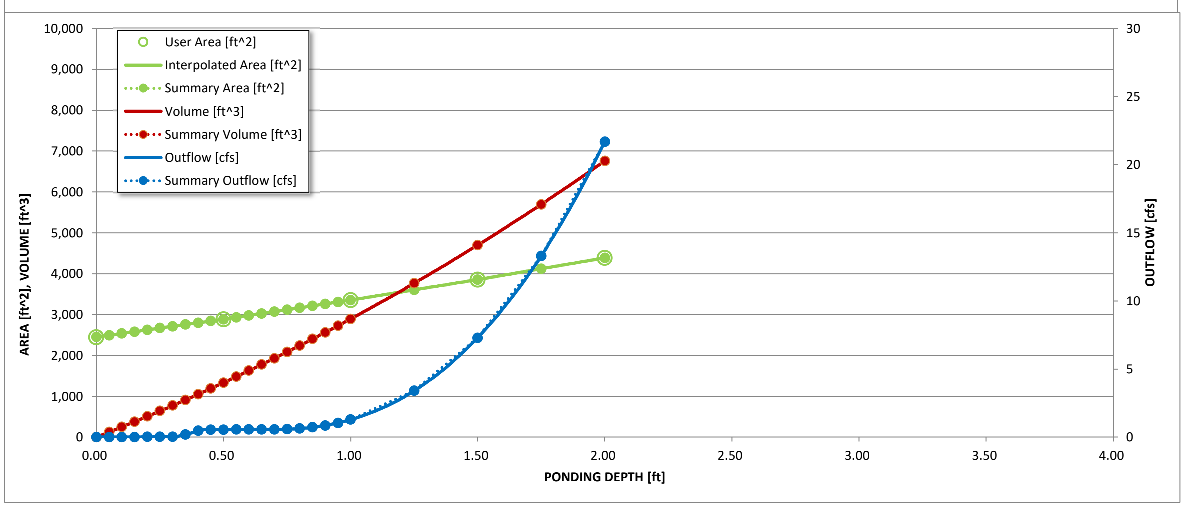
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.020	0.058	0.075	0.116	0.151	0.195	0.233	0.280	0.376
Inflow Hydrograph Volume (acre-ft) =	0.004	0.012	0.015	0.023	0.030	0.039	0.047	0.056	0.075
CUHP Predevelopment Peak Q (cfs) =	0.0	0.0	0.1	0.3	0.4	0.7	0.8	1.1	1.5
OPTIONAL Override Predevelopment Peak Q (cfs) =	0.0	0.0							
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.08	0.17	0.24	0.38	0.47	0.62	0.86
Peak Inflow Q (cfs) =	0.1	0.3	0.4	0.7	0.9	1.2	1.5	1.8	2.4
Peak Outflow Q (cfs) =	0.005	0.020	0.0	0.1	0.278	0.5	0.5	0.561	0.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.4	0.7	0.8	0.7	0.5	0.4
Structure Controlling Flow =	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.0	0.0	0.0	0.0	0.0	0.0
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	12	19	21	22	22	21	20	20	18
Time to Drain 99% of Inflow Volume (hours) =	**14**	21	22	24	24	23	23	23	23
Maximum Ponding Depth (ft) =	0.06	0.18	0.23	0.33	0.37	0.41	0.45	0.54	0.75
Area at Maximum Ponding Depth (acres) =	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07
Maximum Volume Stored (acre-ft) =	0.003	0.010	0.013	0.020	0.022	0.024	0.027	0.033	0.047

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

User-Defined Time Interval: 1.00 min

SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:01:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:02:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
0:03:00	0.01	0.02	0.02	0.03	0.04	0.03	0.04	0.03	0.05
0:04:00	0.02	0.06	0.08	0.12	0.15	0.08	0.09	0.10	0.15
0:05:00	0.06	0.20	0.23	0.41	0.54	0.22	0.30	0.34	0.55
0:06:00	0.10	0.30	0.38	0.59	0.74	0.76	0.92	1.05	1.44
0:07:00	0.11	0.32	0.42	0.65	0.81	1.00	1.19	1.42	1.91
0:08:00	0.12	0.34	0.45	0.67	0.84	1.13	1.35	1.60	2.14
0:09:00	0.12	0.34	0.45	0.68	0.86	1.19	1.41	1.71	2.28
0:10:00	0.12	0.34	0.44	0.68	0.85	1.23	1.46	1.76	2.35
0:11:00	0.12	0.33	0.43	0.66	0.84	1.22	1.45	1.77	2.36
0:12:00	0.11	0.32	0.42	0.64	0.82	1.19	1.42	1.76	2.35
0:13:00	0.11	0.31	0.41	0.63	0.81	1.17	1.39	1.75	2.33
0:14:00	0.11	0.31	0.39	0.62	0.80	1.13	1.34	1.68	2.25
0:15:00	0.10	0.30	0.38	0.60	0.79	1.09	1.30	1.62	2.17
0:16:00	0.10	0.29	0.37	0.58	0.77	1.04	1.25	1.54	2.06
0:17:00	0.09	0.28	0.35	0.55	0.74	1.00	1.19	1.46	1.95
0:18:00	0.09	0.27	0.34	0.53	0.70	0.94	1.13	1.38	1.84
0:19:00	0.09	0.26	0.32	0.52	0.68	0.90	1.07	1.30	1.74
0:20:00	0.08	0.25	0.31	0.49	0.65	0.85	1.02	1.24	1.66
0:21:00	0.08	0.24	0.31	0.48	0.63	0.82	0.98	1.18	1.58
0:22:00	0.08	0.23	0.30	0.46	0.61	0.78	0.93	1.12	1.51
0:23:00	0.08	0.22	0.28	0.44	0.59	0.75	0.89	1.07	1.44
0:24:00	0.07	0.21	0.27	0.42	0.56	0.72	0.85	1.02	1.37
0:25:00	0.07	0.20	0.26	0.39	0.53	0.67	0.80	0.96	1.29
0:26:00	0.06	0.18	0.24	0.37	0.49	0.63	0.76	0.90	1.21
0:27:00	0.06	0.17	0.23	0.35	0.46	0.59	0.71	0.84	1.13
0:28:00	0.06	0.16	0.21	0.32	0.43	0.55	0.66	0.79	1.05
0:29:00	0.05	0.15	0.20	0.30	0.40	0.51	0.61	0.73	0.97
0:30:00	0.05	0.14	0.18	0.27	0.37	0.47	0.56	0.67	0.90
0:31:00	0.04	0.13	0.17	0.25	0.34	0.44	0.52	0.62	0.82
0:32:00	0.04	0.12	0.15	0.24	0.32	0.40	0.48	0.57	0.76
0:33:00	0.04	0.11	0.15	0.22	0.30	0.38	0.45	0.53	0.71
0:34:00	0.04	0.11	0.14	0.21	0.28	0.35	0.42	0.50	0.67
0:35:00	0.03	0.10	0.13	0.20	0.27	0.33	0.40	0.47	0.63
0:36:00	0.03	0.09	0.12	0.19	0.25	0.32	0.38	0.45	0.60
0:37:00	0.03	0.09	0.12	0.18	0.24	0.30	0.36	0.42	0.56
0:38:00	0.03	0.08	0.11	0.17	0.22	0.28	0.34	0.40	0.53
0:39:00	0.03	0.08	0.10	0.16	0.21	0.27	0.32	0.38	0.50
0:40:00	0.03	0.07	0.10	0.15	0.20	0.25	0.30	0.36	0.47
0:41:00	0.02	0.07	0.09	0.14	0.19	0.24	0.28	0.34	0.45
0:42:00	0.02	0.07	0.09	0.13	0.17	0.22	0.27	0.32	0.42
0:43:00	0.02	0.06	0.08	0.12	0.16	0.21	0.25	0.30	0.39
0:44:00	0.02	0.06	0.08	0.12	0.15	0.20	0.23	0.28	0.37
0:45:00	0.02	0.05	0.07	0.11	0.14	0.18	0.22	0.26	0.34
0:46:00	0.02	0.05	0.07	0.10	0.13	0.17	0.20	0.24	0.31
0:47:00	0.02	0.05	0.06	0.09	0.12	0.16	0.18	0.22	0.29
0:48:00	0.01	0.04	0.06	0.08	0.11	0.14	0.17	0.20	0.26
0:49:00	0.01	0.04	0.05	0.08	0.10	0.13	0.15	0.18	0.24
0:50:00	0.01	0.03	0.05	0.07	0.09	0.12	0.14	0.16	0.21
0:51:00	0.01	0.03	0.04	0.06	0.08	0.10	0.12	0.14	0.19
0:52:00	0.01	0.03	0.04	0.05	0.07	0.09	0.11	0.13	0.16
0:53:00	0.01	0.02	0.03	0.05	0.06	0.08	0.09	0.11	0.14
0:54:00	0.01	0.02	0.03	0.04	0.05	0.07	0.08	0.09	0.11
0:55:00	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.09
0:56:00	0.00	0.01	0.02	0.03	0.03	0.04	0.05	0.05	0.07
0:57:00	0.00	0.01	0.01	0.02	0.03	0.03	0.03	0.04	0.05
0:58:00	0.00	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.04
0:59:00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03
1:00:00	0.00	0.01	0.01	0.01	0.02	0.01	0.02	0.02	0.02
1:01:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02
1:02:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1:03:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
1:04:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
1:05:00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.01
1:06:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1:07:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1:08:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1:09:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1:11:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1:12:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft²]	Area [acres]	Volume [ft³]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	2,450	0.056	0	0.000	0.000
	0.05	2,494	0.057	124	0.003	0.004
	0.10	2,537	0.058	249	0.006	0.007
	0.15	2,581	0.059	377	0.009	0.014
	0.20	2,624	0.060	507	0.012	0.022
	0.25	2,668	0.061	640	0.015	0.027
	0.30	2,712	0.062	774	0.018	0.030
	0.35	2,755	0.063	911	0.021	0.187
	0.40	2,799	0.064	1,050	0.024	0.483
	0.45	2,842	0.065	1,191	0.027	0.549
	0.50	2,886	0.066	1,334	0.031	0.556
	0.55	2,933	0.067	1,479	0.034	0.562
	0.60	2,980	0.068	1,627	0.037	0.568
	0.65	3,026	0.069	1,777	0.041	0.574
	0.70	3,073	0.071	1,930	0.044	0.580
	0.75	3,120	0.072	2,085	0.048	0.586
	0.80	3,167	0.073	2,242	0.051	0.630
	0.85	3,214	0.074	2,401	0.055	0.722
	0.90	3,260	0.075	2,563	0.059	0.861
	0.95	3,307	0.076	2,727	0.063	1.048
	1.00	3,354	0.077	2,894	0.066	1.289
	1.25	3,604	0.083	3,764	0.086	3.399
	1.50	3,854	0.088	4,696	0.108	7.292
	1.75	4,120	0.095	5,693	0.131	13.29
	2.00	4,386	0.101	6,756	0.155	21.68

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

GRASS SWALE CALCULATIONS
Widefield Water and Sanitation District
Rolling Hills Tank

Proposed Grass Swale (typ.), Subbasin C Open Channel Flow Evaluation

Manning's Formula

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

$Q=V*A$

Q=Discharge, cfs
R=Hydraulic Radius, A/P, ft
A=cross sectional area, ft^2
P=wetter perimeter, ft
S=slope of channel
n=Manning's roughness coefficient
z=sideslope
d=Depth, ft
b=Bottom Width, ft

n (grass)=	0.033	Mannings coeff
S=	0.01	in/in
b=	1.0	ft
d=	0.75	ft
z=	3.0	
z=	3.0	

					Solution to Manning's Equation	
Depth, ft	Area, ft^2	Wetted Perimeter, ft Perimeter	Hydraulic Radius, ft Radius, ft	Top Width Width, ft	Velocity ft/s	Flow cfs
0.75	2.44	5.74	0.42	5.50	2.79	6.79

GRASS SWALE CALCULATIONS
Widefield Water and Sanitation District
Rolling Hills Tank

Proposed Grass Swale (typ.), Subbasin D Open Channel Flow Evaluation

Manning's Formula

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

Q=V*A

Q=Discharge, cfs
R=Hydraulic Radius, A/P, ft
A=cross sectional area, ft^2
P=wetter perimeter, ft
S=slope of channel
n=Manning's roughness coefficient
z=sideslope
d=Depth, ft
b=Bottom Width, ft

n (grass)=	0.033	Mannings coeff
S=	0.02	in/in
b=	1.0	ft
d=	0.75	ft
z=	3.0	
z=	3.0	

					Solution to Manning's Equation	
Depth, ft	Area, ft^2	Wetted Perimeter, ft Perimeter	Hydraulic Radius, ft Radius, ft	Top Width Width, ft	Velocity ft/s	Flow cfs
0.75	2.44	5.74	0.42	5.50	3.60	8.77

GRASS SWALE CALCULATIONS
Widefield Water and Sanitation District
Rolling Hills Tank

Proposed Grass Swale (typ.), Existing Drennan Rd. Drainage Ditch

Open Channel Flow Evaluation

Manning's Formula

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

Q=V*A

Q=Discharge, cfs
R=Hydraulic Radius, A/P, ft
A=cross sectional area, ft^2
P=wetter perimeter, ft
S=slope of channel
n=Manning's roughness coefficient
z=sideslope
d=Depth, ft

n (grass)=	0.033	Mannings coeff
S=	0.067	in/in
d=	1.00	ft
z=	8.0	

Depth, ft	Area, ft^2	Wetted Perimeter, ft Perimeter	Hydraulic Radius, ft Radius, ft	Top Width Width, ft	Solution to Manning's Equation Velocity ft/s	Flow cfs
1.00	8.00	10.06	0.80	16.00	10.00	80.02

Appendix E

HY-8 Culvert Analysis Report

Project Notes

Project Title:

Designer:

Project Date: Monday, August 17, 2020

Notes:

Project Units: U.S. Customary Units

Outlet Control Option: Profiles

Exit Loss Option: Standard Method

Crossing Notes: Subbasin D - Drennan Rd.

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

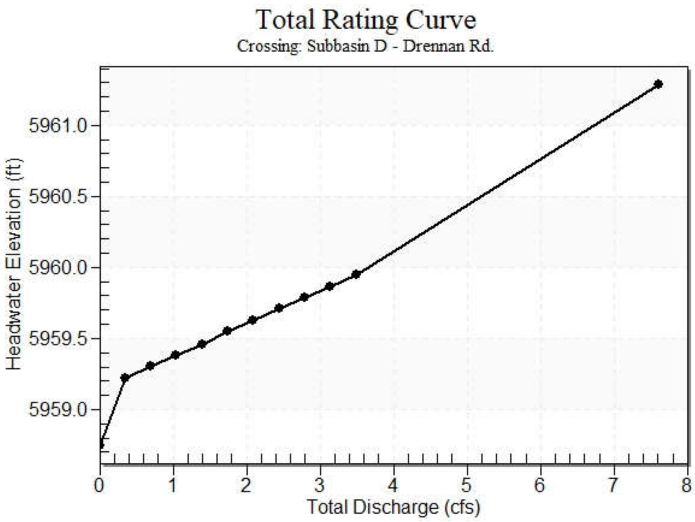
Design Flow: 1.4 cfs

Maximum Flow: 3.49 cfs

Table 1 - Summary of Culvert Flows at Crossing: Subbasin D - Drennan Rd.

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
5958.75	0.00	0.00	0.00	1
5959.22	0.35	0.35	0.00	1
5959.31	0.70	0.70	0.00	1
5959.38	1.05	1.05	0.00	1
5959.46	1.40	1.40	0.00	1
5959.55	1.75	1.75	0.00	1
5959.63	2.09	2.09	0.00	1
5959.71	2.44	2.44	0.00	1
5959.79	2.79	2.79	0.00	1
5959.86	3.14	3.14	0.00	1
5959.95	3.49	3.49	0.00	1
5961.25	7.12	7.12	0.00	Overtopping

Rating Curve Plot for Crossing: Subbasin D - Drennan Rd.



Culvert Notes: Culvert 1

Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5958.75	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
0.35	0.35	5959.22	0.466	0.0*	1-S2n	0.193	0.229	0.193	0.140	2.907	1.973
0.70	0.70	5959.31	0.558	0.0*	1-S2n	0.270	0.326	0.270	0.182	3.571	2.347
1.05	1.05	5959.38	0.635	0.0*	1-S2n	0.332	0.402	0.332	0.212	4.014	2.597
1.40	1.40	5959.46	0.707	0.0*	1-S2n	0.385	0.468	0.385	0.236	4.357	2.793
1.75	1.75	5959.55	0.797	0.0*	1-S2n	0.432	0.525	0.432	0.256	4.636	2.951
2.09	2.09	5959.63	0.880	0.0*	1-S2n	0.476	0.577	0.476	0.274	4.874	3.088
2.44	2.44	5959.71	0.958	0.077	1-S2n	0.518	0.625	0.518	0.291	5.081	3.210
2.79	2.79	5959.79	1.035	0.184	1-S2n	0.558	0.671	0.558	0.306	5.263	3.319
3.14	3.14	5959.86	1.114	0.297	1-S2n	0.597	0.713	0.597	0.320	5.426	3.418
3.49	3.49	5959.95	1.196	0.415	1-S2n	0.635	0.754	0.635	0.332	5.571	3.509

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

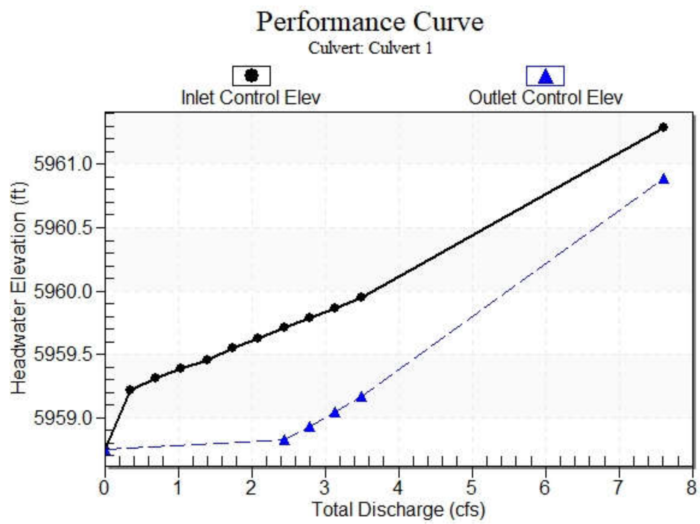
Inlet Elevation (invert): 5958.75 ft, Outlet Elevation (invert): 5958.00 ft

Culvert Length: 20.02 ft, Culvert Slope: 0.0375

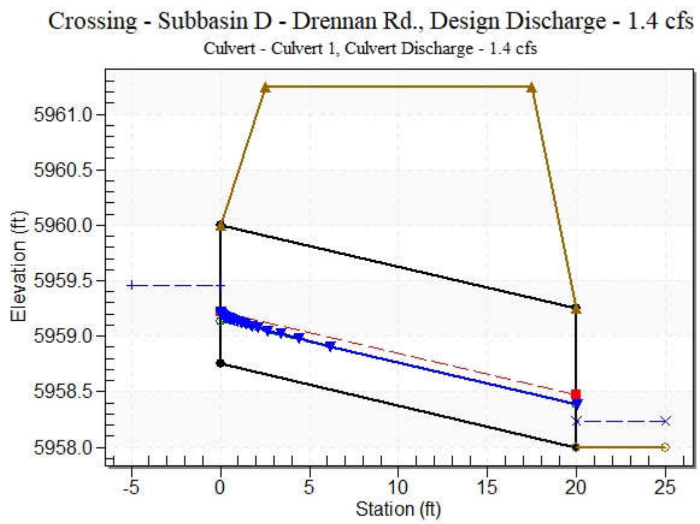
Inlet Throat Elevation: 5958.75 ft, Inlet Crest Elevation: 5959.06 ft

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5959.00 ft

Outlet Station: 20.00 ft

Outlet Elevation: 5958.00 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope

Inlet Depression: Yes

Table 3 - Downstream Channel Rating Curve (Crossing: Subbasin D - Drennan Rd.)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	5958.00	0.00	0.00	0.00	0.00
0.35	5958.14	0.14	1.97	0.59	1.31
0.70	5958.18	0.18	2.35	0.76	1.37
1.05	5958.21	0.21	2.60	0.88	1.41
1.40	5958.24	0.24	2.79	0.99	1.43
1.75	5958.26	0.26	2.95	1.07	1.45
2.09	5958.27	0.27	3.09	1.15	1.47
2.44	5958.29	0.29	3.21	1.22	1.48
2.79	5958.31	0.31	3.32	1.28	1.50
3.14	5958.32	0.32	3.42	1.34	1.51
3.49	5958.33	0.33	3.51	1.39	1.52

Tailwater Channel Data - Subbasin D - Drennan Rd.

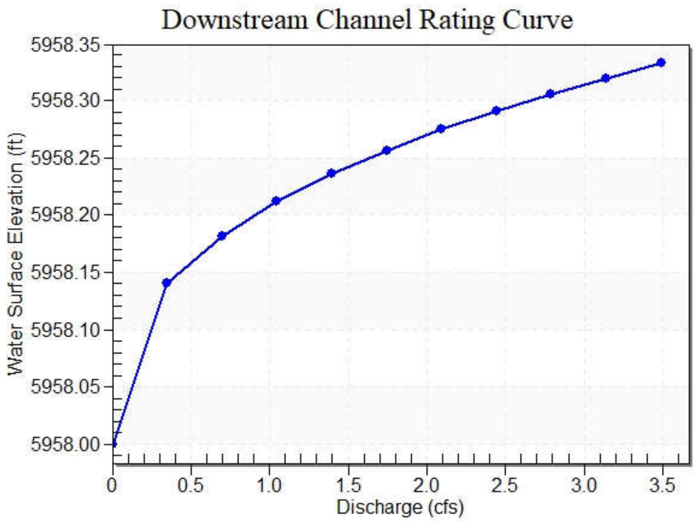
Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0670

User Defined Channel Cross-Section:

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	5959.00	0.0330
2	10.00	5958.00	0.0330
3	18.00	5959.00	0.0000

Tailwater Rating Curve Plot for Crossing: Subbasin D - Drennan Rd.



Roadway Data for Crossing: Subbasin D - Drennan Rd.

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 20.00 ft

Crest Elevation: 5961.25 ft

Roadway Surface: Gravel

Roadway Top Width: 15.00 ft

Appendix F

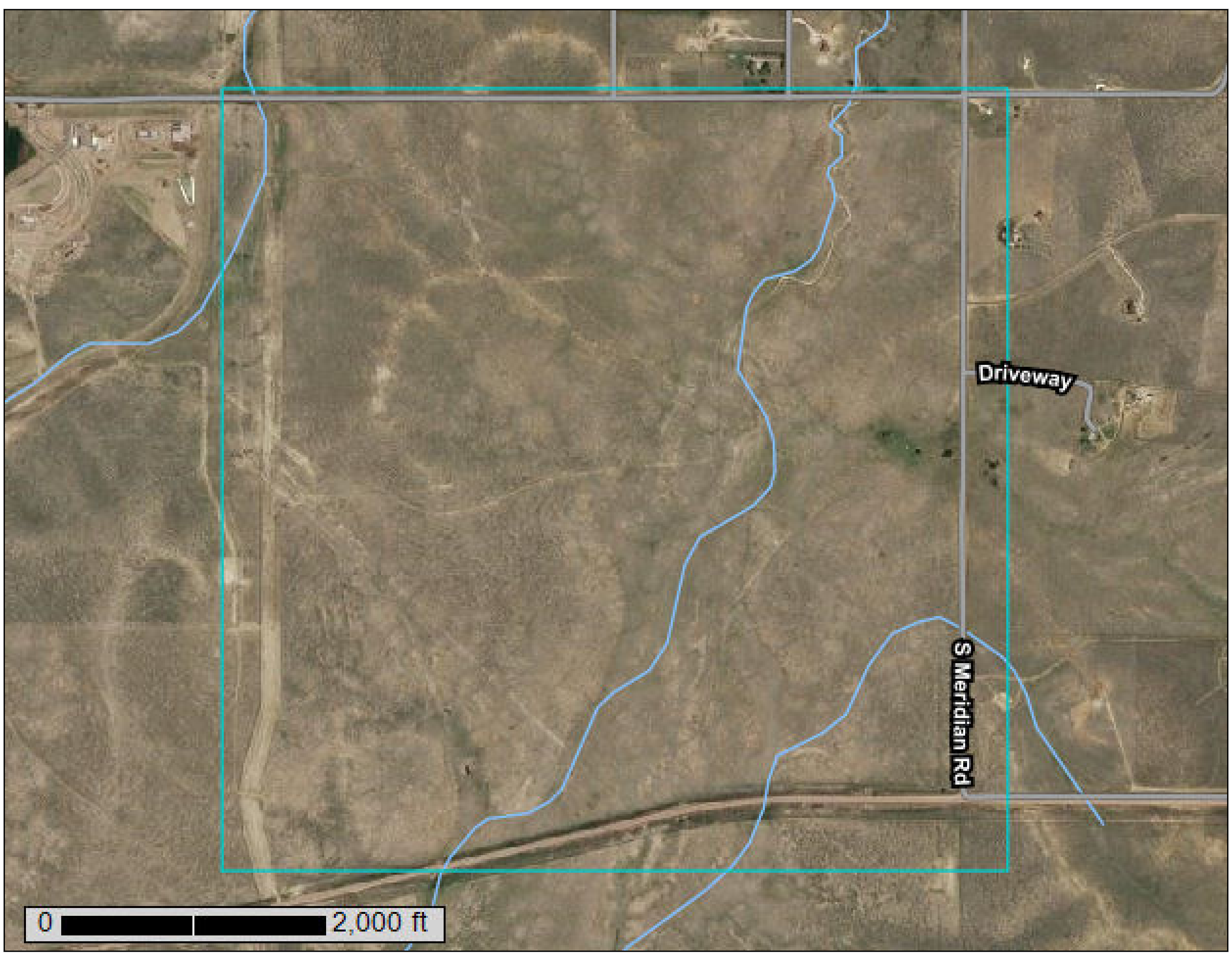
USDA United States Department of Agriculture

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 11, 2020

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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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

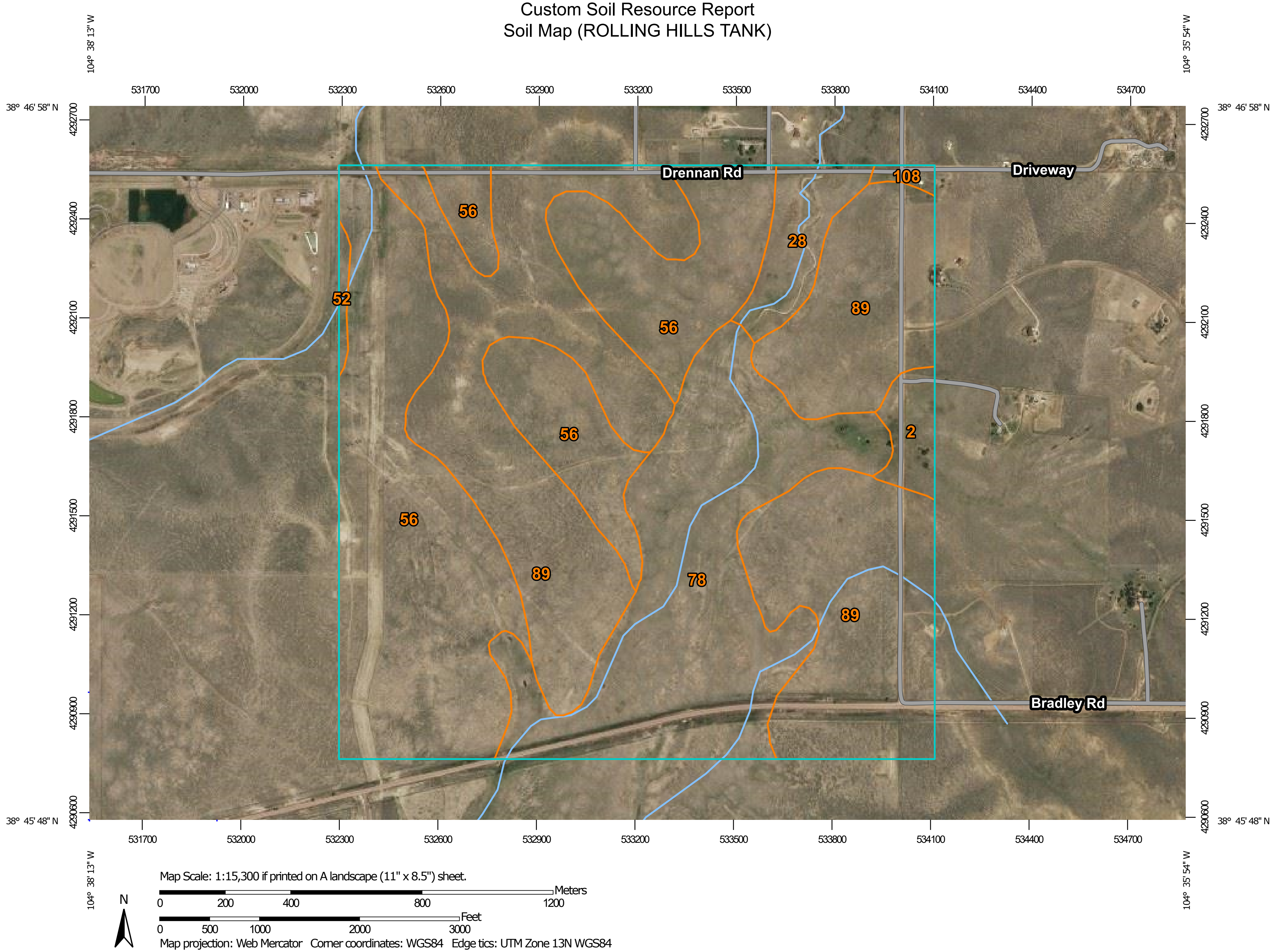
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

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

Soil Map (ROLLING HILLS TANK)



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.

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 17, Sep 13, 2019

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

Date(s) aerial images were photographed: Sep 8, 2018—May 26, 2019

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 (ROLLING HILLS TANK)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
2	Ascalon sandy loam, 1 to 3 percent slopes	13.3	1.6%
28	Ellicott loamy coarse sand, 0 to 5 percent slopes	25.0	3.1%
52	Manzanst clay loam, 0 to 3 percent slopes	2.9	0.4%
56	Nelson-Tassel fine sandy loams, 3 to 18 percent slopes	276.3	34.1%
78	Sampson loam, 0 to 3 percent slopes	164.9	20.4%
89	Tassel fine sandy loam, 3 to 18 percent slopes	324.7	40.1%
108	Wiley silt loam, 3 to 9 percent slopes	2.9	0.4%
Totals for Area of Interest		**810.1**	**100.0%**

Map Unit Descriptions (ROLLING HILLS TANK)

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

2—Ascalon sandy loam, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: 367q
Elevation: 5,500 to 6,500 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 47 to 50 degrees F
Frost-free period: 130 to 150 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Ascalon and similar soils: 98 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ascalon

Setting

Landform: Flats
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium and/or eolian deposits

Typical profile

A - 0 to 8 inches: sandy loam
Bt - 8 to 21 inches: sandy clay loam
BC - 21 to 27 inches: sandy loam
Ck1 - 27 to 48 inches: sandy loam
Ck2 - 48 to 60 inches: loamy sand

Properties and qualities

Slope: 1 to 3 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): 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 in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 7.1 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: Sandy Plains LRU's A & B (R069XY026CO)
Other vegetative classification: SANDY PLAINS (069BY026CO)
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

28—Ellicott loamy coarse sand, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: 3680
Elevation: 5,500 to 6,500 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 47 to 50 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Ellicott and similar soils: 97 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ellicott

Setting

Landform: Flood plains, stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium

Typical profile

A - 0 to 4 inches: loamy coarse sand
C - 4 to 60 inches: stratified coarse sand to sandy loam

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Very 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: Frequent
Frequency of ponding: None
Available water storage in profile: Low (about 4.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7w
Hydrologic Soil Group: A
Ecological site: Sandy Bottomland LRU's A & B (R069XY031CO)
Other vegetative classification: SANDY BOTTOMLAND (069AY031CO)
Hydric soil rating: No

Minor Components

Fluvaquentic haplaquoll

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

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

52—Manzanst clay loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2w4nr
Elevation: 4,060 to 6,660 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 130 to 170 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Manzanst and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Manzanst

Setting

Landform: Terraces, drainageways
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear, concave
Parent material: Clayey alluvium derived from shale

Typical profile

A - 0 to 3 inches: clay loam
Bt - 3 to 12 inches: clay

Btk - 12 to 37 inches: clay
Bk1 - 37 to 52 inches: clay
Bk2 - 52 to 79 inches: clay

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 3 percent
Salinity, maximum in profile: Slightly saline (4.0 to 7.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 10.0
Available water storage in profile: High (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: C
Ecological site: Saline Overflow (R067BY037CO)
Hydric soil rating: No

Minor Components

Ritoazul

Percent of map unit: 7 percent
Landform: Drainageways, interfluves
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Clayey Plains (R067BY042CO)
Hydric soil rating: No

Arvada

Percent of map unit: 6 percent
Landform: Drainageways, interfluves
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Salt Flat (R067BY033CO)
Hydric soil rating: No

Wiley

Percent of map unit: 2 percent
Landform: Interfluves
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Loamy Plains (R067BY002CO)
Hydric soil rating: No

56—Nelson-Tassel fine sandy loams, 3 to 18 percent slopes

Map Unit Setting

National map unit symbol: 3690
Elevation: 5,600 to 6,400 feet
Mean annual precipitation: 12 to 14 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

Nelson and similar soils: 55 percent
Tassel and similar soils: 40 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nelson

Setting

Landform: Hills
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Calcareous residuum weathered from interbedded sedimentary rock

Typical profile

A - 0 to 5 inches: fine sandy loam
Ck - 5 to 23 inches: fine sandy loam
Cr - 23 to 27 inches: weathered bedrock

Properties and qualities

Slope: 3 to 12 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 2.8 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B

Ecological site: Shaly Plains (R067BY045CO)
Other vegetative classification: SHALY PLAINS (069AY046CO)
Hydric soil rating: No

Description of Tassel

Setting

Landform: Hills
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Calcareous slope alluvium over residuum weathered from sandstone

Typical profile

A - 0 to 4 inches: fine sandy loam
C - 4 to 10 inches: fine sandy loam
Cr - 10 to 14 inches: weathered bedrock

Properties and qualities

Slope: 3 to 18 percent
Depth to restrictive feature: 6 to 20 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Available water storage in profile: Very low (about 1.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D
Ecological site: Shaly Plains (R067BY045CO)
Other vegetative classification: SHALY PLAINS (069AY046CO)
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

78—Sampson loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 369s
Elevation: 5,500 to 6,500 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 47 to 50 degrees F
Frost-free period: 135 to 155 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Sampson and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sampson

Setting

Landform: Depressions, alluvial fans, terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 15 inches: loam
Bt - 15 to 34 inches: clay loam
Bk - 34 to 60 inches: sandy clay loam

Properties and qualities

Slope: 0 to 3 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): 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 in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: B
Ecological site: Loamy Foothill (R049BY202CO)
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

89—Tassel fine sandy loam, 3 to 18 percent slopes

Map Unit Setting

National map unit symbol: 36b5
Elevation: 5,600 to 6,400 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 47 to 51 degrees F
Frost-free period: 135 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition

Tassel and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tassel

Setting

Landform: Hills
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Calcareous slope alluvium over residuum weathered from sandstone

Typical profile

A - 0 to 4 inches: fine sandy loam
C - 4 to 10 inches: sandy loam
Cr - 10 to 14 inches: weathered bedrock

Properties and qualities

Slope: 3 to 18 percent
Depth to restrictive feature: 6 to 20 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None

Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Available water storage in profile: Very low (about 1.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D
Ecological site: Sandy Plains (R067BY024CO)
Other vegetative classification: SANDY PLAINS (069AY026CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit: 5 percent
Hydric soil rating: No

108—Wiley silt loam, 3 to 9 percent slopes

Map Unit Setting

National map unit symbol: 367b
Elevation: 5,200 to 6,200 feet
Mean annual precipitation: 12 to 14 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

Wiley and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wiley

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Calcareous silty eolian deposits

Typical profile

A - 0 to 4 inches: silt loam
Bt - 4 to 16 inches: silt loam
Bk - 16 to 60 inches: silt loam

Properties and qualities

Slope: 3 to 9 percent
Depth to restrictive feature: More than 80 inches
Natural 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 in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.5 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Loamy Plains (R067BY002CO)
Other vegetative classification: LOAMY PLAINS (069AY006CO)
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

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