Architectural
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Engineers / Architects

Materials Testing
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FINAL DRAINAGE REPORT

Gunners Ridge Minor Subdivision
12172 Goodson Rd
El Paso County, Colorado

PREPARED FOR:

Drew Makings
9630 Arroya Lane
Colorado Springs, CO 80908

JOB NO. 192027

PCD File No. MS-23-003

June 7, 2023
June 28, 2023

SIGNATURE PAGE

ENGINEER'S STATEMENT

This report and plan for the drainage design of Gunners Ridge Minor Subdivision was prepared by me (or under my direct supervision) and is correct to the best of my knowledge and belief. Said report and plan has been prepared in accordance with the El Paso County Drainage Criteria Manuals Volumes 1 and 2 and is in conformity with the master plan of the drainage basin. I understand that El Paso County does not and will not assume liability for drainage facilities designed by others. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in the preparing this report.

Respectfully Submitted,

RMG – Rocky Mountain Group

David Walker, P.E.
Sr. Civil Project Manager

DEVELOPER'S STATEMENT

Drew Makings hereby certifies that the drainage facilities for Gunners Ridge Minor Subdivision shall be constructed according to the design presented in this report. I understand that El Paso County does not and will not assume liability for drainage facilities designed and/or certified by my engineer and that are submitted to El Paso County; and cannot, on behalf of Gunners Ridge Minor Subdivision, guarantee that final drainage design review will absolve Drew Makings and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the final plat does not imply approval of my engineer's drainage design.

Drew Makings
Name of Developer

Drew Makings (signature) 6/28/23
Authorized Signature Date

Drew Makings
Printed Name

Owner 719-482-6050
Title Phone

9630 Arroya, Lane, Colorado Springs, CO 80908
Address

EL PASO COUNTY STATEMENT

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

Joshua Palmer, P.E. Date
County Engineer / ECM Administrator

Conditions:

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I. PURPOSE

This report is a Final Drainage Report for Gunners Ridge Minor Subdivision for the development of single-family residences.

The purpose of this report is to identify on-site and off-site drainage patterns, assess stormwater conditions per delineated basin and sub-basins, demonstrate adequate design standards for storm water flow and release into the existing storm water system or right-of-way, and provide a narrative for any other drainage considerations related to the development of this parcel.

II. GENERAL LOCATION AND DESCRIPTION

A. LOCATION

The proposed development of Gunners Ridge Minor Subdivision is located at the address of 12172 Goodson Rd in El Paso County, Colorado. The parcel schedule number is 5214000014 and the legal description is currently a portion of special warranty deed recorded at reception no. 219050325 of the El Paso County Clerk and Recorder Office. The parcel is located in a portion of the Northeast Quarter of Section 14, Township 12 South, Range 65 West of the 6th Principal Meridian, County of El Paso, State of Colorado. The names and descriptions of surrounding platted developments can be seen on plan sets and appendix documents:

B. DESCRIPTION OF PROPERTY – EXISTING CONDITIONS

The project site is approximately 1,691,363 square feet (38.83 acres) and consists of undeveloped natural vegetation.

The existing percent imperviousness is approximately 0 percent on Gunners Ridge Minor Subdivision. The vegetation is grassy with shrub brush and a mix of evergreen trees

The existing topography consists of grades between 2.0 and 10.0 percent. Drainage patterns show the southern portion of the site slopes toward Goodson Road and the northern portion of the site slopes to the northeast. The roadside drainage flows toward the north along Goodson Road.

This site is not located within a streamside zone.

C. EXISTING SOILS

The soils indicative to the site are classified as Kettle gravelly loamy sand by the USDA Soil Conservation Service and are listed as NRCS (National Resources Conservation Service) Hydrologic Soil Group B. Group B soils have a moderate infiltration rate when thoroughly wet. These consist chiefly of deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission. The USDA Soil Map is provided in the Appendix.

D. EXISTING DRAINAGE

According to the "Final Drainage Report for Seclusion", by Classic Consulting Engineers & Surveyors LLC dated June 2007.

> "Off/on-site "P" discharges from the site in an existing 36" diameter galvanized corrugated metal culvert under Goodson Road. On-site "N" discharges from the site in an existing 18" diameter galvanized corrugated metal culver under Goodson Road. On-site "M" discharges from the site in an existing 30" diameter galvanized corrugated metal culvert under Goodson Road at the northeast corner of Basin M, near the access road for the electric substation."

The parcel is located in the El Paso County Upper Black Squirrel (CHBS 2000) drainage basin.

There are no known off-site flows that discharges on to the property. The runoff ultimately outfalls downstream into the Black Squirrel Creek. Site runoff will not adversely affect the downstream and surrounding developments.

The project site does not lie within a designated flood plain according to information published in the Federal Emergency Management Agency Floodplain Map No. 08041C0320G, dated December 7, 2018. The FEMA Floodplain map is provided in the Appendix showing it lies within Zone X, a minimal flood hazard area.

There are no known non-stormwater discharges that contribute to the storm water systems on site and downstream, both private and public.

E. DESCRIPTION OF PROPERTY – PROPOSED CONDITIONS

The proposed development consists of four lots with single-family residences.

There is one existing vehicle entry access point to the property. Lot #1 will have a driveway off Goodson Road from the existing access point. Lots #2, #3 and #4 will share a common driveway off Goodson Road from a new access point. There will be no public improvements.

The proposed development will require an approximate limits of disturbance of approximately 29,086 square feet or 0.67 acres which is 1.72 percent of the property. The limits of disturbance do not disturb the existing hillsides. The grading limits are kept within the setbacks wherever possible and the developed conditions remain consistent with the historical drainage pattern of the subdivision. A sub-basin delineation sheet for the proposed conditions is provided in the Appendix.

Water quality is not needed for this site per ECM I.7.1.B.5., since there is no roadway being proposed and the only disturbance on the site will be for the driveways.

III. DRAINAGE BASINS AND SUB-BASINS

A. EXISTING MAJOR DRAINAGE BASIN AND SUB-BASINS

The parcel is delineated into sub-basins according to the existing and proposed grading for existing and developed conditions. A drainage plan of the delineated basins for existing conditions can be found in the Appendix.

Basin E is the entirety of the parcel to be redeveloped representing existing conditions in four on-site basins. The Final Drainage Report for Seclusion, by Classic Consulting Engineers & Surveyors LLC dated June 2007 shows this property as portions of sub-basins P, N, and M.

Sub-basin E-1 (14.33 ac.; Q10 = 6.13 cfs, Q100 = 20.58 cfs) is the southerly portion of the property that consists of all natural vegetation. The basin flows east across the property to an existing 36" diameter galvanized corrugated metal culvert under Goodson Road, also known as Existing Point 1 (EP1). The flow travels north in the ROW ditch along Goodson Road. The Final Drainage Report for Seclusion, by Classic Consulting Engineers & Surveyors LLC dated June 2007 shows this as part of sub-basin P.

Sub-basin E-2 (7.47 ac.; Q10 = 3.20 cfs, Q100 = 10.73 cfs) is the easterly portion of the property that consists of natural vegetation. The basin flows east across the property to an existing 18" diameter galvanized corrugated metal culvert under Goodson Road, also known as Existing Point 2 (EP2). The flow travels north in the ROW ditch along Goodson Road. The Final Drainage Report for Seclusion, by Classic Consulting Engineers & Surveyors LLC dated June 2007 shows this as part of sub-basin N.

Sub-basin E-3 (15.31 ac.; Q10 = 6.55 cfs, Q100 = 22.00 cfs) is the northerly portion of the property that consists of natural vegetation. The basin flows east across the property and outlets into the Goodson Road ROW, also known as Existing Point 3 (EP3). The flow travels north in the ROW ditch along Goodson Road and ultimately goes to an existing 30" diameter galvanized corrugated metal culvert under the access road for the electric substation and then to an existing 30" diameter galvanized corrugated metal culvert under Goodson Road. The Final Drainage Report for Seclusion, by Classic Consulting Engineers & Surveyors LLC dated June 2007 shows this as part of sub-basin M.

Sub-basin E-4 (1.72 ac.; Q10 = 0.73 cfs, Q100 = 2.47 cfs) is the northwest corner of the property that consists of natural vegetation. The basin flows north across the property to exit the site, also known as Existing Point 4 (EP4). The flow travels northeast to the ROW ditch and ultimately goes to an existing 30" diameter galvanized corrugated metal culvert under the access road for the electric substation and then to an existing 30" diameter galvanized corrugated metal culvert under Goodson Road. The Final Drainage Report for Seclusion, by Classic Consulting Engineers & Surveyors LLC dated June 2007 shows this as part of sub-basin M.

Existing Point 1 (EP1) is the existing design point representing the existing 36" diameter galvanized corrugated metal culvert under Goodson Road. The Final Drainage Report for Seclusion, by Classic Consulting Engineers & Surveyors LLC dated June 2007 shows this as design point E-16.

Existing Point 2 (EP2) is the existing design point representing the existing 18" diameter galvanized corrugated metal culvert under Goodson Road. The Final Drainage Report for Seclusion, by Classic Consulting Engineers & Surveyors LLC dated June 2007 shows this as design point E-15.

Existing Point 3 (EP3) is the existing design point representing the location that flows exit the site into the Goodson Road ROW ditch.

Existing Point 4 (EP4) is the existing design point representing the location that flows exit the site at the northwest corner.

A. DEVELOPED MAJOR DRAINAGE BASIN AND SUB-BASINS

Basin D is the entirety of the platted parcel representing developed conditions and consists of several sub-basins. A Drainage Plan for developed conditions can be found in the Appendix.

Sub-basin D-1 (14.33 ac.; Q10 = 6.13 cfs, Q100 = 20.58 cfs) is the southerly portion of the property that consists of a single-family residence on lot #1 with a private driveway. The basin flows east across the property to an existing 36" diameter galvanized corrugated metal culvert under Goodson Road, also known as Design Point 1 (DP1).

Sub-basin D-2 (4.97 ac.; Q10 = 2.72 cfs, Q100 = 8.23 cfs) is the easterly portion of the property that includes lot #1 and consists of natural vegetation and half of the initial portion of the shared driveway to lots #2, #3, and #4. The basin flows east across the property to a proposed 18" diameter galvanized corrugated metal culvert at the driveway entrance, also known as Design Point 2 (DP2), to allow flow to keeps its natural path flowing north in the ROW ditch.

Sub-basin D-3 (15.31 ac.; Q10 = 6.82 cfs, Q100 = 21.57 cfs) is the northerly portion of the property that consists of three single-family residences on lots #2, #3, and #4 with part of the shared driveway. The basin flows east across the property and outlets into the Goodson Road ROW, also known as Design Point 3 (DP3). The flow travels north in the ROW ditch along Goodson Road and ultimately goes to an existing 30" diameter galvanized corrugated metal culvert under the access road for the electric substation and then to an existing 30" diameter galvanized corrugated metal culvert under Goodson Road

Sub-basin D-4 (1.72 ac.; Q10 = 0.85 cfs, Q100 = 2.85 cfs) is the northwest corner of the property that consists of natural vegetation. The basin flows north across the property to exit the site, also known as Design Point 4 (DP4). The flow travels northeast to the ROW ditch and ultimately goes to an existing 30" diameter galvanized corrugated metal culvert under the access road for the electric substation and then to an existing 30" diameter galvanized corrugated metal culvert under Goodson Road.

Sub-basin D-5 (2.50 ac.; Q10 = 1.71 cfs, Q100 = 4.74 cfs) is the easterly portion of the property that includes lot #2 and consists of natural vegetation and half of the initial portion of the shared driveway to lots #2, #3, and #4. The basin flows east across the property to an existing 18" diameter galvanized corrugated metal culvert under Goodson Road, also known as Design Point 5 (DP5). The flow travels north in the ROW ditch along Goodson Road.

Design Point 1 (DP1) is the existing design point representing the existing 36" diameter galvanized corrugated metal culvert under Goodson Road.

Design Point 2 (DP2) is the existing design point representing the proposed 18" diameter galvanized corrugated metal culvert under the proposed driveway entrance.

Design Point 3 (DP3) is the existing design point representing the location that flows exit the site into the Goodson Road ROW ditch.

Design Point 4 (DP4) is the existing design point representing the location that flows exit the site at the northwest corner.

Design Point 5 (DP5) is the existing design point representing the existing 18" diameter galvanized corrugated metal culvert under Goodson Road.

IV. DRAINAGE DESIGN CRITERIA

A. REGULATIONS

The hydrologic and hydraulic calculations and design of the site conform to the El Paso County Drainage Criteria Manuals I and II (October 2018), City of Colorado Springs Drainage Criteria Manuals I and II (May 2014), as well as the Mile High Flood District Drainage Criteria Manual (August 2018).

B. DEVELOPMENT CRITERIA REFERENCE AND CONSTRAINTS

The parcel falls within the Upper Black Squirrel (CHBS 2000) drainage basin. The runoff from this parcel will have no adverse effects on downstream infrastructure or facilities, streets, utilities, transit, or further development of adjacent lots. Relevant criteria for the calculations shown further include equations and design criteria for the rational method, volumes and runoff of various storms.

C. HYDROLOGICAL CRITERIA

The rational method was used to calculate the peak runoff of the delineated basin and sub-basins using the manuals referenced prior with the C, I and PI values from the Drainage Criteria Manual Volume I, Chapter 6 as well as the Colorado Springs designated IDF curve values. Specific calculations and tables are provided further with inputs including design rainfall, sub-basin acreage and percent imperviousness, runoff coefficients, one-hour rainfall depths, rainfall intensities, time of concentration, and peak discharge of various storm events. Weighted runoff coefficients were calculated for each basin and sub-basin due to the mix of impervious surfaces.

D. FOUR-STEP PROCESS

The selection of appropriate control measures is based on the characteristics of the site and potential pollutants. The Four-Step Process provides a method of going through the selection process. The proposed development has an approximate limit of disturbance of 29,086 square feet (0.67 acres), which is less than 1 acre, therefore the Four-Step Process is not required.

V. DRAINAGE INFRASTRUCTURE COSTS AND FEES

A. DRAINAGE AND BRIDGE FEES

The development falls within the Upper Black Squirrel (CHBS 2000) drainage basin which has a drainage basin fee of $0/acre and a bridge fee of $0/acre according to the El Paso County Drainage Basin 2023 fee schedule.

Any outstanding fees must be paid prior to new plat recordation.

VI. CONCLUSIONS

A. COMPLIANCE WITH STANDARDS

This Final Drainage Report is in conformance with the El Paso County Drainage Criteria Manual, Volumes 1 & 2, Colorado Springs Drainage Criteria Manual, Volumes 1 & 2, as well as the Mile High Flood District Drainage Criteria Manual. Grading practices for optimal drainage comply with the geotechnical investigative report and County standards. The development of Gunners Ridge Minor Subdivision is within compliance and standards and meets the requirements for the drainage design.

The overall change from the existing conditions to the developed conditions was an increase in the 10-year runoff by 1.62 cfs and an increase in the 100-year runoff by 2.19 cfs, which is negligible. There will be no improvements needed to the existing ROW ditch.

The proposed grading and drainage is within substantial conformance for the master drainage plan for the Subdivision and Drainage Basin. There is no impact on major drainage way planning studies within the larger drainage basin. Site runoff and storm drain appurtenances will not adversely affect the downstream and surrounding developments.

VII. REFERENCES

Colorado Springs Drainage Manual Volumes I & II (May 2014, Rev. January 2021)

El Paso County Drainage Criteria Manual Volumes I & II (October 2018)

Colorado Urban Drainage and Flood Control District Drainage Criteria Manual, Volume I (January 2016)

Colorado Urban Drainage and Flood Control District Drainage Criteria Manual, Volume III (April 2018)

Urban Storm Drainage Criteria Manual, Volume III (November, 2015)

FEMA Flood Map Service Center

United States Department of Agriculture National Resources Conservation Service

Final Drainage Report for Seclusion, dated June 2007, prepared by Classic Consulting Engineers & Surveyors LLC

VIII. APPENDICES

Appendix A – Vicinity Map

Vicinity Map

Appendix B – Hydrologic and Hydraulic Computations

Project Number: 192027 - Gunners Ridge Subdivion - Existing Conditions
Engineer: TPT
Date: 5/10/2023
Address: 12172 Goodson Rd

Sub-Basin:	E-1	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_c Duration:	30.72				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
1.959193	2.445429	2.853167	3.260905	3.668643	4.103880

Hydrologic Soil Type:	B

Land Use or Surface Characteristic	Square Feet	Acreage	$Coefficient_2$	$Coefficient_5$	$Coefficient_{10}$	$Coefficient_{25}$	$Coefficient_{50}$	$Coefficient_{100}$	2 Yr: C_i * A_i	5 Yr: C_i * A_i	10 Yr: C_i * A_i	25 Yr: C_i * A_i	50 Yr: C_i * A_i	100 Yr: C_i * A_i	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	0	0.00	0.71	0.73	0.75	0.78	0.80	0.81	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.080	0.150	0.250	0.300	0.350
Pavement	0	0.00	0.89	0.90	0.92	0.94	0.95	0.96	0.000	0.000	0.000	0.000	0.000	0.000						
Lawn	624133	14.33	0.02	0.08	0.15	0.25	0.30	0.35	0.287	1.146	2.149	3.582	4.298	5.015						
A_t:	624133	14.33																		

Coefficient (Table 6-6)

Q Peak Flow (cfs)					
2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
0.56	**2.80**	**6.13**	**11.68**	**15.77**	**20.58**

Sub-Basin:	E-2	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_c Duration:	27.91				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
2.073301	2.589261	3.020971	3.452682	3.884392	4.345519

Hydrologic Soil Type:	B

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	$Coefficient_2$	$Coefficient_5$	$Coefficient_{10}$	$Coefficient_{25}$	$Coefficient_{50}$	$Coefficient_{100}$	2 Yr: C_i * A_i	5 Yr: C_i * A_i	10 Yr: C_i * A_i	25 Yr: C_i * A_i	50 Yr: C_i * A_i	100 Yr: C_i * A_i	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	0	0.00	0.71	0.73	0.75	0.78	0.80	0.81	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.080	0.150	0.250	0.300	0.350
Pavement	0	0.00	0.89	0.90	0.92	0.94	0.95	0.96	0.000	0.000	0.000	0.000	0.000	0.000						
Lawn	325344	7.47	0.02	0.08	0.15	0.25	0.30	0.35	0.149	0.598	1.120	1.867	2.241	2.614						
A_t:	325344	7.47																		

Q Peak Flow (cfs)					
2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
0.29	**1.46**	**3.20**	**6.09**	**8.22**	**10.73**

Sub-Basin:	E-3	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_c Duration:	33.69				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
1.849673	2.307378	2.692107	3.076837	3.461567	3.871955

Hydrologic Soil Type:	B

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	$Coefficient_2$	$Coefficient_5$	$Coefficient_{10}$	$Coefficient_{25}$	$Coefficient_{50}$	$Coefficient_{100}$	2 Yr: C_i * A_i	5 Yr: C_i * A_i	10 Yr: C_i * A_i	25 Yr: C_i * A_i	50 Yr: C_i * A_i	100 Yr: C_i * A_i	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	0	0.00	0.71	0.73	0.75	0.78	0.80	0.81	0.000	0.000	0.000	0.000	0.000	0.000	**0.020**	**0.080**	**0.150**	**0.250**	**0.300**	**0.350**
Pavement	0	0.00	0.89	0.90	0.92	0.94	0.95	0.96	0.000	0.000	0.000	0.000	0.000	0.000						
Lawn	667120	15.31	0.02	0.08	0.15	0.25	0.30	0.35	0.306	1.225	2.297	3.829	4.594	5.360						
A_t:	667120	15.31																		

Q Peak Flow (cfs)					
2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
0.60	**3.00**	**6.55**	**12.49**	**16.86**	**22.00**

Sub-Basin:	E-4	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_c Duration:	23.79				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
2.263805	2.829393	3.301125	3.772857	4.244589	4.748940

Hydrologic Soil Type:	B

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	$Coefficient_2$	$Coefficient_5$	$Coefficient_{10}$	$Coefficient_{25}$	$Coefficient_{50}$	$Coefficient_{100}$	2 Yr: C_i * A_i	5 Yr: C_i * A_i	10 Yr: C_i * A_i	25 Yr: C_i * A_i	50 Yr: C_i * A_i	100 Yr: C_i * A_i	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	0	0.00	0.71	0.73	0.75	0.78	0.80	0.81	0.000	0.000	0.000	0.000	0.000	0.000	**0.020**	**0.080**	**0.150**	**0.250**	**0.300**	**0.350**
Pavement	0	0.00	0.89	0.90	0.92	0.94	0.95	0.96	0.000	0.000	0.000	0.000	0.000	0.000						
Lawn	74765	1.72	0.02	0.08	0.15	0.25	0.30	0.35	0.034	0.137	0.257	0.429	0.515	0.601						
A_t:	74765	1.72																		

Q Peak Flow (cfs)					
2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
0.07	**0.34**	**0.73**	**1.40**	**1.89**	**2.47**

Design Points

Design Point	Q_{10}	Q_{100}
E-1	6.13	20.58
E-2	3.20	10.73
E-3	6.55	22.00
E-4	0.73	2.47
Total Site	**16.62**	**55.77**

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}}$$ (Eq. 6-8)

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin:	E-1	
L (initial time):	300	ft
S (initial time):	0.034	ft/ft

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	0	0.00	0.73
Pavement	0	0.00	0.90
Lawn	624133	14.33	0.08
Total :	624133	14.33	

Composite Runoff Coefficient Calculation:

$C_c = (C_1A_1 + C_2A_2 + C_3A_3 + \ldots C_iA_i) / A_t$

C_c = 0.08

t_i = (0.395*(1.1-C_5)*sqrt(L))/(S^0.33)

t_i = **21.30** mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5}$$ (Eq. 6-9)

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

Conveyance Coeff.:	10	
Slope (travel time):	0.041	ft/ft
$V = C_v S_w^{0.5}$	2.02	ft/s
L (travel time):	1145	ft
$t_t = L/V =$	565.48	sec.
$t_t =$	**9.42**	min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = 30.72 min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: 30.72 min.

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}}$$ (Eq. 6-8)

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin:	E-2	
L (initial time):	300	ft
S (initial time):	0.042	ft/ft

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	0	0.00	0.73
Pavement	0	0.00	0.90
Lawn	325344	7.47	0.08
Total :	325344	7.47	

Composite Runoff Coefficient Calculation:

$C_c = (C_1A_1 + C_2A_2 + C_3A_3 + ...C_iA_i) / A_t$

C_c = 0.08

$t_i = (0.395*(1.1-C_5)*sqrt(L))/(S\text{^}0.33)$

t_i = 19.86 mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5}$$ (Eq. 6-9)

Where:

V = velocity (ft/s)
C_v = conveyance coefficient (from Table 6-7)
S_w = watercourse slope (ft/ft)

Conveyance Coeff.:	10	
Slope (travel time):	0.041	ft/ft
$V = C_v S_w^{0.5}$	2.02	ft/s
L (travel time):	927	ft
$t_t = L/V =$	457.81	sec.
t_t =	7.63	min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = 27.50 min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: 27.50 min.

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}}$$ (Eq. 6-8)

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft <u>maximum</u> for non-urban land uses, 100 ft <u>maximum</u> for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin:	E-3	
L (initial time):	300	ft
S (initial time):	0.03	ft/ft

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	0	0.00	0.73
Pavement	0	0.00	0.90
Lawn	667120	15.31	0.08
Total :	667120	15.31	

Composite Runoff Coefficient Calculation:

$C_c = (C_1A_1 + C_2A_2 + C_3A_3 + ...C_iA_i) / A_t$

C_c = 0.08

$t_i = (0.395*(1.1-C_5)*sqrt(L))/(S^{0.33})$

t_i = 22.20 mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5}$$ (Eq. 6-9)

Where:

V = velocity (ft/s)
C_v = conveyance coefficient (from Table 6-7)
S_w = watercourse slope (ft/ft)

Conveyance Coeff.:	10	
Slope (travel time):	0.034	ft/ft
$V = C_v S_w^{0.5}$	1.84	ft/s
L (travel time):	1271	ft
$t_t = L/V =$	689.30	sec.
$t_t =$	11.49	min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = 33.69 min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: 33.69 min.

Time of Concentration $\quad t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \qquad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft <u>maximum</u> for non-urban land uses, 100 ft <u>maximum</u> for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin:	E-4	
L (initial time):	300	ft
S (initial time):	0.033	ft/ft

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	0	0.00	0.73
Pavement	0	0.00	0.90
Lawn	74765	1.72	0.08
Total :	74765	1.72	

Composite Runoff Coefficient Calculation:

$C_c = (C_1A_1 + C_2A_2 + C_3A_3 + ...C_iA_i) / A_t$

C_c = 0.08

t_i = (0.395*(1.1-C_5)*sqrt(L))/(S^0.33)

t_i = **21.51** mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \qquad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)
C_v = conveyance coefficient (from Table 6-7)
S_w = watercourse slope (ft/ft)

Conveyance Coeff.:	10	
Slope (travel time):	0.04	ft/ft
$V = C_v S_w^{0.5}$	2.00	ft/s
L (travel time):	273	ft
$t_t = L/V =$	136.50	sec.
t_t =	2.28	min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = **23.79** min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: 23.79 min.

Project Number: 192027 - Gunners Ridge Subdivision - Developed Conditions
Engineer: TPT
Date: 5/10/2023
Address: 12172 Goodson Rd

Sub-Basin:	D-1	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_t Duration:	30.72				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
1.959193316	2.445428549	2.8531666	3.2609047	3.6686428	4.10388

Hydrologic Soil Type:	B

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	$Coefficient_2$	$Coefficient_5$	$Coefficient_{10}$	$Coefficient_{25}$	$Coefficient_{50}$	$Coefficient_{100}$	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	0	0.00	0.71	0.73	0.75	0.78	0.80	0.81	0.000	0.000	0.000	0.000	0.000	0.000	**0.020**	**0.080**	**0.150**	**0.250**	**0.300**	**0.350**
Pavement	0	0.00	0.89	0.90	0.92	0.94	0.95	0.96	0.000	0.000	0.000	0.000	0.000	0.000						
Lawn	624133	14.33	0.02	0.08	0.15	0.25	0.30	0.35	0.287	1.146	2.149	3.582	4.298	5.015						
A_t:	624133	14.33																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
0.56	**2.80**	**6.13**	**11.68**	**15.77**	**20.58**

Sub-Basin:	D-2	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_t Duration:	26.68				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
2.126998759	2.656948016	3.0999394	3.5429307	3.985922	4.4592327

Hydrologic Soil Type:	B

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	$Coefficient_2$	$Coefficient_5$	$Coefficient_{10}$	$Coefficient_{25}$	$Coefficient_{50}$	$Coefficient_{100}$	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	0	0.00	0.71	0.73	0.75	0.78	0.80	0.81	0.000	0.000	0.000	0.000	0.000	0.000	**0.050**	**0.109**	**0.177**	**0.274**	**0.323**	**0.371**
Pavement	7545	0.17	0.89	0.90	0.92	0.94	0.95	0.96	0.154	0.156	0.159	0.163	0.165	0.166						
Lawn	208895	4.80	0.02	0.08	0.15	0.25	0.30	0.35	0.096	0.384	0.719	1.199	1.439	1.678						
A_t:	216440	4.97																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
0.49	**1.32**	**2.72**	**4.44**	**5.88**	**8.23**

Sub-Basin:	D-3	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_t Duration:	33.35				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
1.861459226	2.322234318	2.70944	3.0966458	3.4838515	3.8969137

Hydrologic Soil Type:	B

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	$Coefficient_2$	$Coefficient_5$	$Coefficient_{10}$	$Coefficient_{25}$	$Coefficient_{50}$	$Coefficient_{100}$	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	0	0.00	0.71	0.73	0.75	0.78	0.80	0.81	0.000	0.000	0.000	0.000	0.000	0.000	**0.036**	**0.095**	**0.164**	**0.263**	**0.312**	**0.361**
Pavement	12411	0.28	0.89	0.90	0.92	0.94	0.95	0.96	0.254	0.256	0.262	0.268	0.271	0.274						
Lawn	654708	15.03	0.02	0.08	0.15	0.25	0.30	0.35	0.301	1.202	2.255	3.758	4.509	5.261						
A_t:	667119	15.31																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
1.09	**3.57**	**6.82**	**13.13**	**17.53**	**21.57**

Sub-Basin:	D-4	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_t Duration:	23.79				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
2.263804858	2.829392679	3.3011248	3.7728569	4.244589	4.7489397

Hydrologic Soil Type:	B

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	$Coefficient_2$	$Coefficient_5$	$Coefficient_{10}$	$Coefficient_{25}$	$Coefficient_{50}$	$Coefficient_{100}$	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	0	0.00	0.71	0.73	0.75	0.78	0.80	0.81	0.000	0.000	0.000	0.000	0.000	0.000	**0.020**	**0.080**	**0.150**	**0.250**	**0.300**	**0.350**
Pavement	0	0.00	0.89	0.90	0.92	0.94	0.95	0.96	0.000	0.000	0.000	0.000	0.000	0.000						
Lawn	74765	1.72	0.02	0.08	0.15	0.25	0.30	0.35	0.034	0.137	0.257	0.429	0.515	0.601						
A_t:	74765	1.72																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
0.07	**0.34**	**0.85**	**1.40**	**1.89**	**2.85**

Sub-Basin:	D-5	(IDF Curve Equations from Figure 6-5 of the DCM Volume 1)			
t_t Duration:	23.11				
I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}
2.298283186	2.872852755	3.3518282	3.8308037	4.3097791	4.8219526

Hydrologic Soil Type:	B

Coefficient (Table 6-6)

Land Use or Surface Characteristic	Square Feet	Acreage	$Coefficient_2$	$Coefficient_5$	$Coefficient_{10}$	$Coefficient_{25}$	$Coefficient_{50}$	$Coefficient_{100}$	2 Yr: $C_i * A_i$	5 Yr: $C_i * A_i$	10 Yr: $C_i * A_i$	25 Yr: $C_i * A_i$	50 Yr: $C_i * A_i$	100 Yr: $C_i * A_i$	2 Yr C_c	5 Yr C_c	10 Yr C_c	25 Yr C_c	50 Yr C_c	100 Yr C_c
Roof	0	0.00	0.71	0.73	0.75	0.78	0.80	0.81	0.000	0.000	0.000	0.000	0.000	0.000	**0.081**	**0.138**	**0.204**	**0.299**	**0.346**	**0.393**
Pavement	7689	0.18	0.89	0.90	0.92	0.94	0.95	0.96	0.157	0.159	0.162	0.166	0.168	0.169						
Lawn	101215	2.32	0.02	0.08	0.15	0.25	0.30	0.35	0.046	0.186	0.349	0.581	0.697	0.813						
A_t:	108904	2.50																		

Q Peak Flow (cfs)

2 Year Q	5 Year Q	10 Year Q	25 Year Q	50 Year Q	100 Year Q
0.40	**0.84**	**1.71**	**2.44**	**3.17**	**4.74**

Design Points

Design Point	Q_{10}	Q_{100}
D-1	6.13	20.58
D-2	2.72	8.23
D-3	6.82	21.57
D-4	0.85	2.85
D-5	1.71	4.74
Total Site	**18.24**	**57.96**

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}}$$ (Eq. 6-8)

Where:

- t_i = overland (initial) flow time (min)
- C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
- L = length of overland flow (300 ft <u>maximum</u> for non-urban land uses, 100 ft <u>maximum</u> for urban land uses)
- S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin:	D-1	
L (initial time):	300	ft
S (initial time):	0.034	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1A_1 + C_2A_2 + C_3A_3 + ...C_iA_i)/A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	0	0.00	0.73
Pavement	0	0.00	0.90
Lawn	624133	14.33	0.08
Total :	624133	14.33	

C_c = 0.08

$t_i = (0.395*(1.1-C_5)*sqrt(L))/(S^{\wedge}0.33)$

t_i = 21.30 mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5}$$ (Eq. 6-9)

Where:

- V = velocity (ft/s)
- C_v = conveyance coefficient (from Table 6-7)
- S_w = watercourse slope (ft/ft)

Conveyance Coeff.:	10	
Slope (travel time):	0.041	ft/ft
$V = C_v S_w^{0.5}$	2.02	ft/s
L (travel time):	1145	ft
$t_t = L/V$ =	565.48	sec.
t_t =	9.42	min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = 30.72 min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: 30.72 min.

Time of Concentration $\quad t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \qquad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin:	D-2	
L (initial time):	300	ft
S (initial time):	0.042	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1A_1 + C_2A_2 + C_3A_3 + ...C_iA_i)/A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	0	0.00	0.73
Pavement	7545	0.17	0.90
Lawn	208895	4.80	0.08
Total :	216440	4.97	

C_c = 0.11

$t_i = (0.395*(1.1-C_5)*sqrt(L))/(S\wedge 0.33)$

t_i = 19.31 mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \qquad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)
C_v = conveyance coefficient (from Table 6-7)
S_w = watercourse slope (ft/ft)

Conveyance Coeff.:	10	
Slope (travel time):	0.041	ft/ft
$V = C_v S_w^{0.5}$	2.02	ft/s
L (travel time):	896	ft
$t_t = L/V =$	442.50	sec.
t_t =	7.38	min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = 26.68 min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: 26.68 min.

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}}$$ (Eq. 6-8)

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft <u>maximum</u> for non-urban land uses, 100 ft <u>maximum</u> for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin:	D-3	
L (initial time):	300	ft
S (initial time):	0.03	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1A_1 + C_2A_2 + C_3A_3 + ...C_iA_i)/A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	0	0.00	0.73
Pavement	12411	0.28	0.90
Lawn	654708	15.03	0.08
Total :	667119	15.31	

C_c = 0.10

$t_i = (0.395*(1.1-C_5)*sqrt(L))/(S\text{^}0.33)$

t_i = **21.87** mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5}$$ (Eq. 6-9)

Where:

V = velocity (ft/s)
C_v = conveyance coefficient (from Table 6-7)
S_w = watercourse slope (ft/ft)

Conveyance Coeff.:	10	
Slope (travel time):	0.034	ft/ft
$V = C_v S_w^{0.5}$	1.84	ft/s
L (travel time):	1271	ft
$t_t = L/V$ =	689.30	sec.
t_t =	11.49	min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = **33.35** min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: 33.35 min.

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}}$$ (Eq. 6-8)

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft <u>maximum</u> for non-urban land uses, 100 ft <u>maximum</u> for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin:	D-4	
L (initial time):	300	ft
S (initial time):	0.033	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1A_1 + C_2A_2 + C_3A_3 + ...C_iA_i)/A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	0	0.00	0.73
Pavement	0	0.00	0.90
Lawn	74765	1.72	0.08
Total :	74765	1.72	

C_c = 0.08

t_i = (0.395*(1.1-C_5)*sqrt(L))/(S^0.33)

t_i = **21.51** mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5}$$ (Eq. 6-9)

Where:

V = velocity (ft/s)
C_v = conveyance coefficient (from Table 6-7)
S_w = watercourse slope (ft/ft)

Conveyance Coeff.:	10	
Slope (travel time):	0.04	ft/ft
$V = C_v S_w^{0.5}$	2.00	ft/s
L (travel time):	273	ft
$t_t = L/V =$	136.50	sec.
$t_t =$	2.28	min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = 23.79 min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

Final t_c: 23.79 min.

Time of Concentration $t_c = t_i + t_t$

3.2.1 - Overland (Initial) Flow Time

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \qquad \text{(Eq. 6-8)}$$

Where:

- t_i = overland (initial) flow time (min)
- C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
- L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
- S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

Sub-Basin:	D-5	
L (initial time):	300	ft
S (initial time):	0.033	ft/ft

Composite Runoff Coefficient Calculation:

$C_c = (C_1A_1 + C_2A_2 + C_3A_3 + ...C_iA_i) / A_t$

Land Use or Surface Characteristic	Square Feet	Acreage	C_5
Roof	0	0.00	0.73
Pavement	7689	0.18	0.90
Lawn	101215	2.32	0.08
Total :	108904	2.50	

C_c = 0.14

$t_i = (0.395*(1.1-C_5)*sqrt(L))/(S\text{^}0.33)$

t_i = 20.29 mins

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \qquad \text{(Eq. 6-9)}$$

Where:

- V = velocity (ft/s)
- C_v = conveyance coefficient (from Table 6-7)
- S_w = watercourse slope (ft/ft)

Conveyance Coeff.:	10	
Slope (travel time):	0.04	ft/ft
$V = C_v S_w^{0.5}$	2.00	ft/s
L (travel time):	338	ft
$t_t = L/V$ =	169.00	sec.
t_t =	2.82	min.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

$t_c = t_i + t_t$ = 23.11 min.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

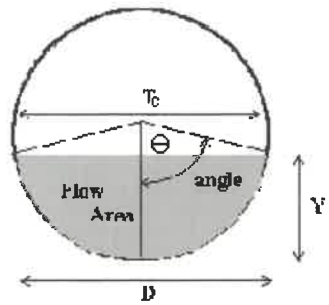
Final t_c: 23.11 min.

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Gunners Ridge Subdivision

Pipe ID: Proposed 18" CMP Culvert (Developed Conditions)



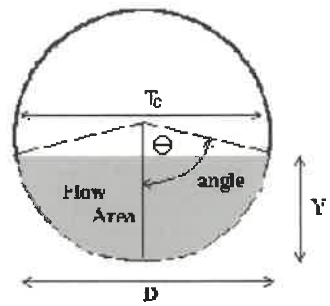
Design Information (Input)			
Pipe Invert Slope	So =	0.0150	ft/ft
Pipe Manning's n-value	n =	0.0120	
Pipe Diameter	D =	18.00	inches
Design discharge	Q =	7.57	cfs
Full-Flow Capacity (Calculated)			
Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	13.97	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.62	radians
Flow area	An =	0.94	sq ft
Top width	Tn =	1.50	ft
Wetted perimeter	Pn =	2.43	ft
Flow depth	Yn =	0.79	ft
Flow velocity	Vn =	8.07	fps
Discharge	Qn =	7.57	cfs
Percent of Full Flow	Flow =	54.2%	of full flow
Normal Depth Froude Number	Fr_n =	1.80	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.01	radians
Critical flow area	Ac =	1.34	sq ft
Critical top width	Tc =	1.36	ft
Critical flow depth	Yc =	1.07	ft
Critical flow velocity	Vc =	5.64	fps
Critical Depth Froude Number	Fr_c =	1.00	

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Gunners Ridge Subdivision

Pipe ID: Existing 18" CMP Culvert (Developed Conditions)



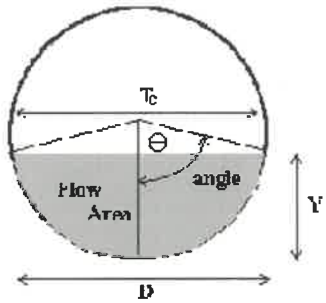
Design Information (Input)			
Pipe Invert Slope	So =	0.0150	ft/ft
Pipe Manning's n-value	n =	0.0120	
Pipe Diameter	D =	18.00	inches
Design discharge	Q =	11.60	cfs
Full-Flow Capacity (Calculated)			
Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	13.97	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.97	radians
Flow area	An =	1.31	sq ft
Top width	Tn =	1.38	ft
Wetted perimeter	Pn =	2.96	ft
Flow depth	Yn =	1.04	ft
Flow velocity	Vn =	8.84	fps
Discharge	Qn =	11.60	cfs
Percent of Full Flow	Flow =	83.0%	of full flow
Normal Depth Froude Number	Fr_n =	1.60	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.39	radians
Critical flow area	Ac =	1.62	sq ft
Critical top width	Tc =	1.03	ft
Critical flow depth	Yc =	1.30	ft
Critical flow velocity	Vc =	7.14	fps
Critical Depth Froude Number	Fr_c =	1.00	

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Gunners Ridge Subdivision

Pipe ID: Existing 30" CMP Culvert (Developed Conditions)



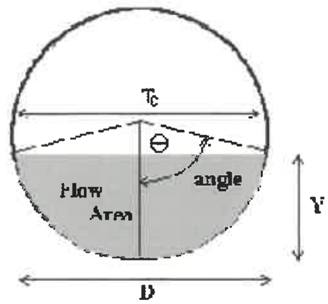
Design Information (Input)			
Pipe Invert Slope	So =	0.0150	ft/ft
Pipe Manning's n-value	n =	0.0120	
Pipe Diameter	D =	30.00	inches
Design discharge	Q =	25.18	cfs
Full-Flow Capacity (Calculated)			
Full-flow area	Af =	4.91	sq ft
Full-flow wetted perimeter	Pf =	7.85	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	54.57	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.53	radians
Flow area	An =	2.31	sq ft
Top width	Tn =	2.50	ft
Wetted perimeter	Pn =	3.81	ft
Flow depth	Yn =	1.19	ft
Flow velocity	Vn =	10.89	fps
Discharge	Qn =	25.18	cfs
Percent of Full Flow	Flow =	46.1%	of full flow
Normal Depth Froude Number	Fr_n =	2.00	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.95	radians
Critical flow area	Ac =	3.58	sq ft
Critical top width	Tc =	2.32	ft
Critical flow depth	Yc =	1.71	ft
Critical flow velocity	Vc =	7.04	fps
Critical Depth Froude Number	Fr_c =	1.00	

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Gunners Ridge Subdivision

Pipe ID: Existing 36" CMP Culvert (Developed Conditions)



Design Information (Input)			
Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0120	
Pipe Diameter	D =	36.00	inches
Design discharge	Q =	20.58	cfs
Full-Flow Capacity (Calculated)			
Full-flow area	Af =	7.07	sq ft
Full-flow wetted perimeter	Pf =	9.42	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	72.45	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.30	radians
Flow area	An =	2.33	sq ft
Top width	Tn =	2.89	ft
Wetted perimeter	Pn =	3.89	ft
Flow depth	Yn =	1.09	ft
Flow velocity	Vn =	8.83	fps
Discharge	Qn =	20.58	cfs
Percent of Full Flow	Flow =	28.4%	of full flow
Normal Depth Froude Number	Fr_n =	1.73	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.54	radians
Critical flow area	Ac =	3.40	sq ft
Critical top width	Tc =	3.00	ft
Critical flow depth	Yc =	1.46	ft
Critical flow velocity	Vc =	6.05	fps
Critical Depth Froude Number	Fr_c =	1.00	

Appendix C – FEMA Floodplain Map

National Flood Hazard Layer FIRMette

FEMA

104°37'53"W 39°0'43"N

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

1:6,000

104°37'15"W 39°0'16"N

Legend

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

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

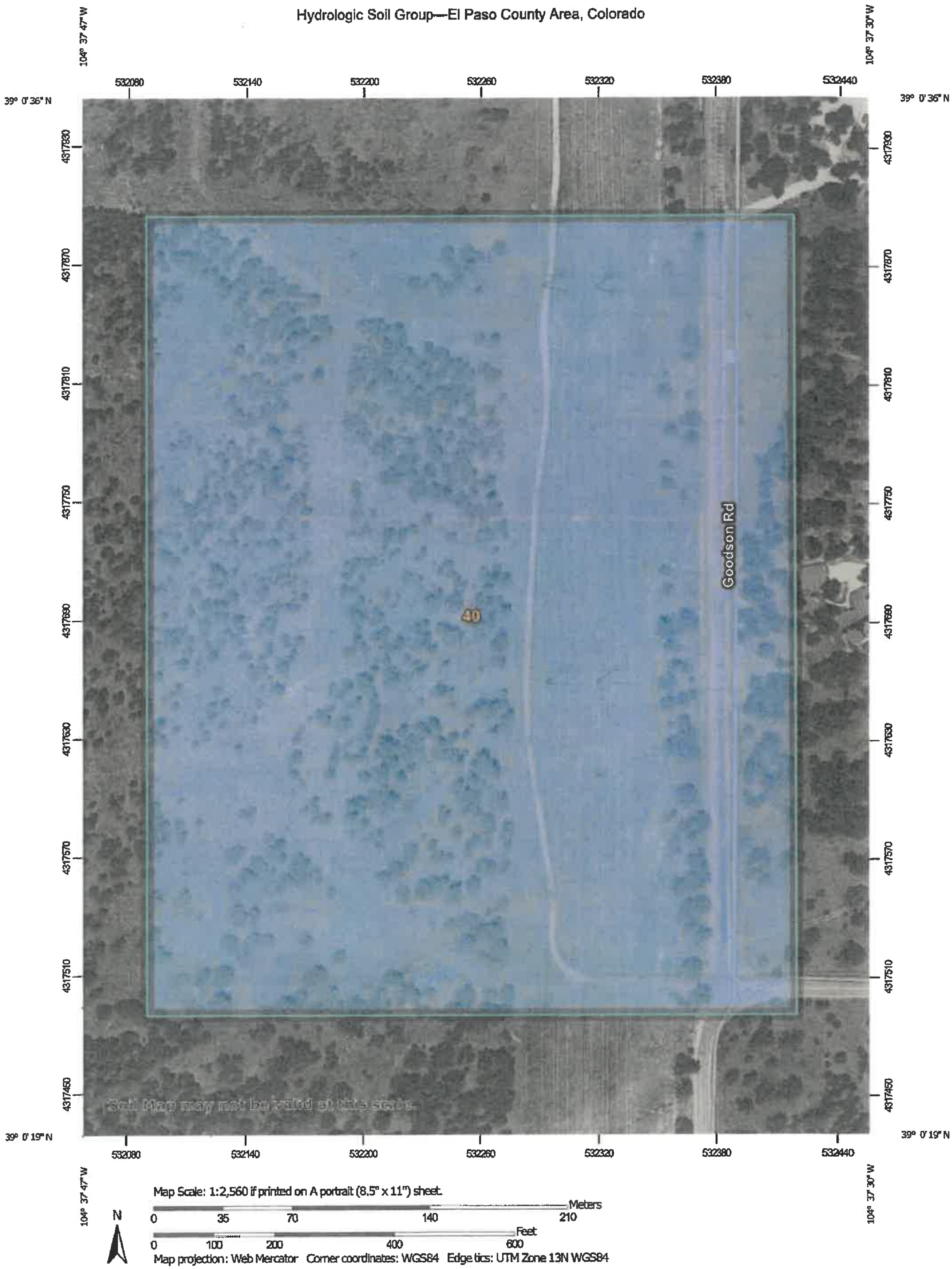
The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 2/21/2023 at 11:22 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

Appendix D – USDA Soils Survey Map


104° 37' 47" W
104° 37' 30" W
532080
532140
532200
532260
532320
532380
532440
39° 0' 36" N
39° 0' 19" N
4317930
4317870
4317810
4317750
4317690
4317630
4317570
4317510
4317450
Goodson Rd
40
Soil Map may not be valid at this scale.
Map Scale: 1:2,560 if printed on A portrait (8.5" x 11") sheet.
Meters
0 35 70 140 210
Feet
0 100 200 400 600
N
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 20, Sep 2, 2022

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

Date(s) aerial images were photographed: Jun 9, 2021—Jun 12, 2021

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.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	B	33.2	100.0%
Totals for Area of Interest			33.2	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

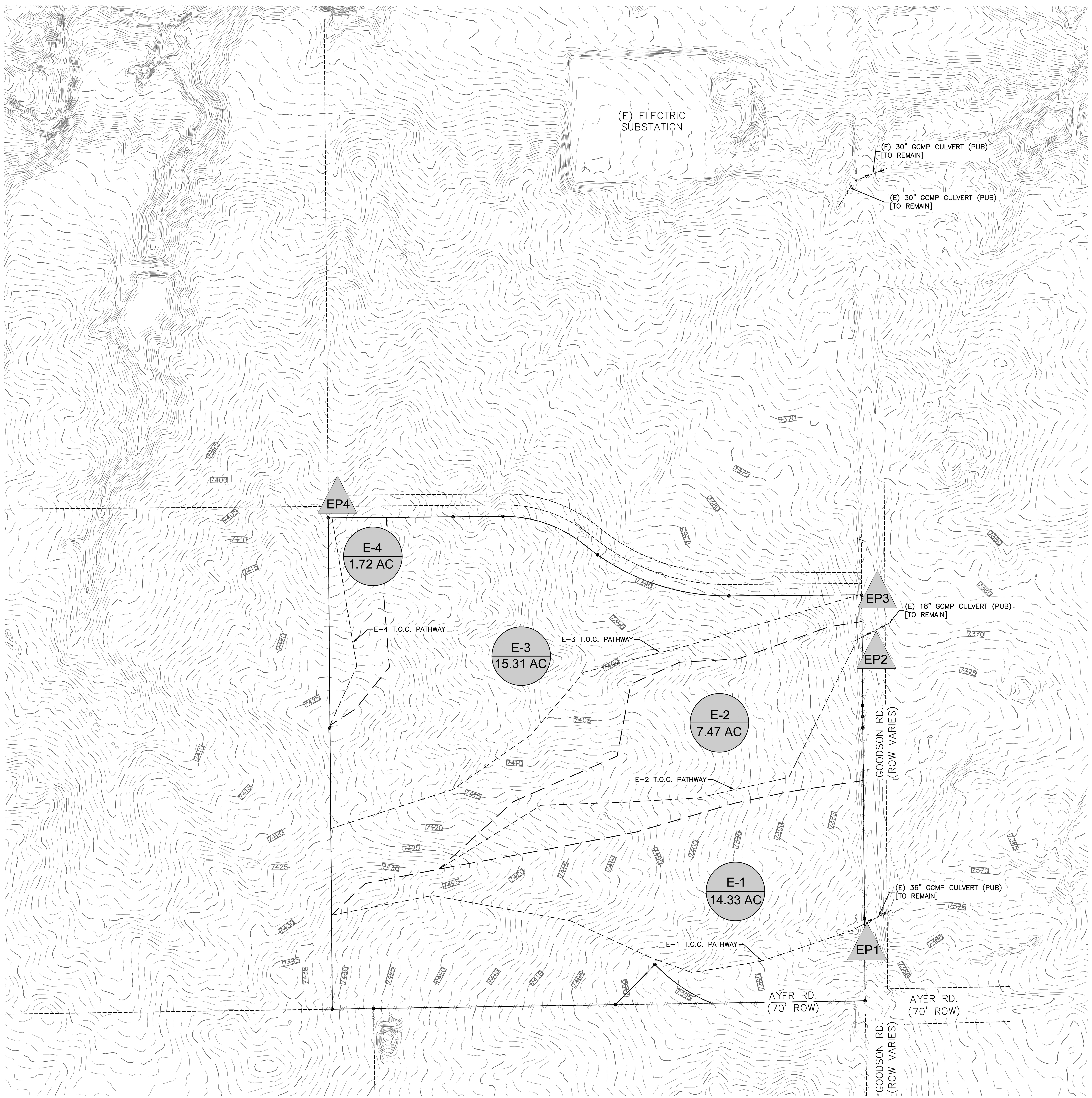
Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Appendix E – Drainage Maps



Graphic Scale

0 75 150 300

In Feet: 1" = 150'

LEGEND

- PROPERTY LINE
- EASEMENT LINE
- SETBACK LINE
- PROPERTY CORNER/MONUMENT, BENCHMARK OR TEMPORARY BENCHMARK
- EXISTING FENCE
- EXISTING MINOR CONTOUR
- EXISTING MAJOR CONTOUR
- TIME OF CONCENTRATION PATH
- BASIN DELINEATION
- PROPOSED MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- BASIN DESIGN POINT ID
- E-1 — BASIN IDENTIFIER
- X.XX AC — BASIN AREA

DESIGN POINT	FLOW (CFS)
EP1	Q_{10} = 6.13 Q_{100} = 20.58
EP2	Q_{10} = 3.20 Q_{100} = 10.73
EP3	Q_{10} = 6.55 Q_{100} = 22.00
EP4	Q_{10} = 0.73 Q_{100} = 2.47

BASIN SUMMARY

BASIN	Q10(CFS)	Q100 (CFS)	ACRES(AC)
E-1	6.13	20.58	14.33
E-2	3.20	10.73	7.47
E-3	6.55	22.00	15.31
E-4	0.73	2.47	1.72
TOTAL	16.62	55.77	38.83

RMG Engineers / Architects

Architecture Structural Geotechnical — Materials Testing Forensics Civil / Planning

SOUTHERN COLORADO OFFICE
2910 AUSTIN BLUFFS PKWY, SUITE 100, COLORADO SPRINGS, CO 80918

NOT FOR CONSTRUCTION

GUNNERS RIDGE SUBDIVISION

12172 GOODSON ROAD
EL PASO COUNTY, COLORADO

DREW MAKINGS

SHEET NAME: EXISTING SUB-BASIN ANALYSIS

PROJECT STATUS: FINAL DRAINAGE REPORT

ENG: DGW
DRAWN: TPT
CHECKED: TPT

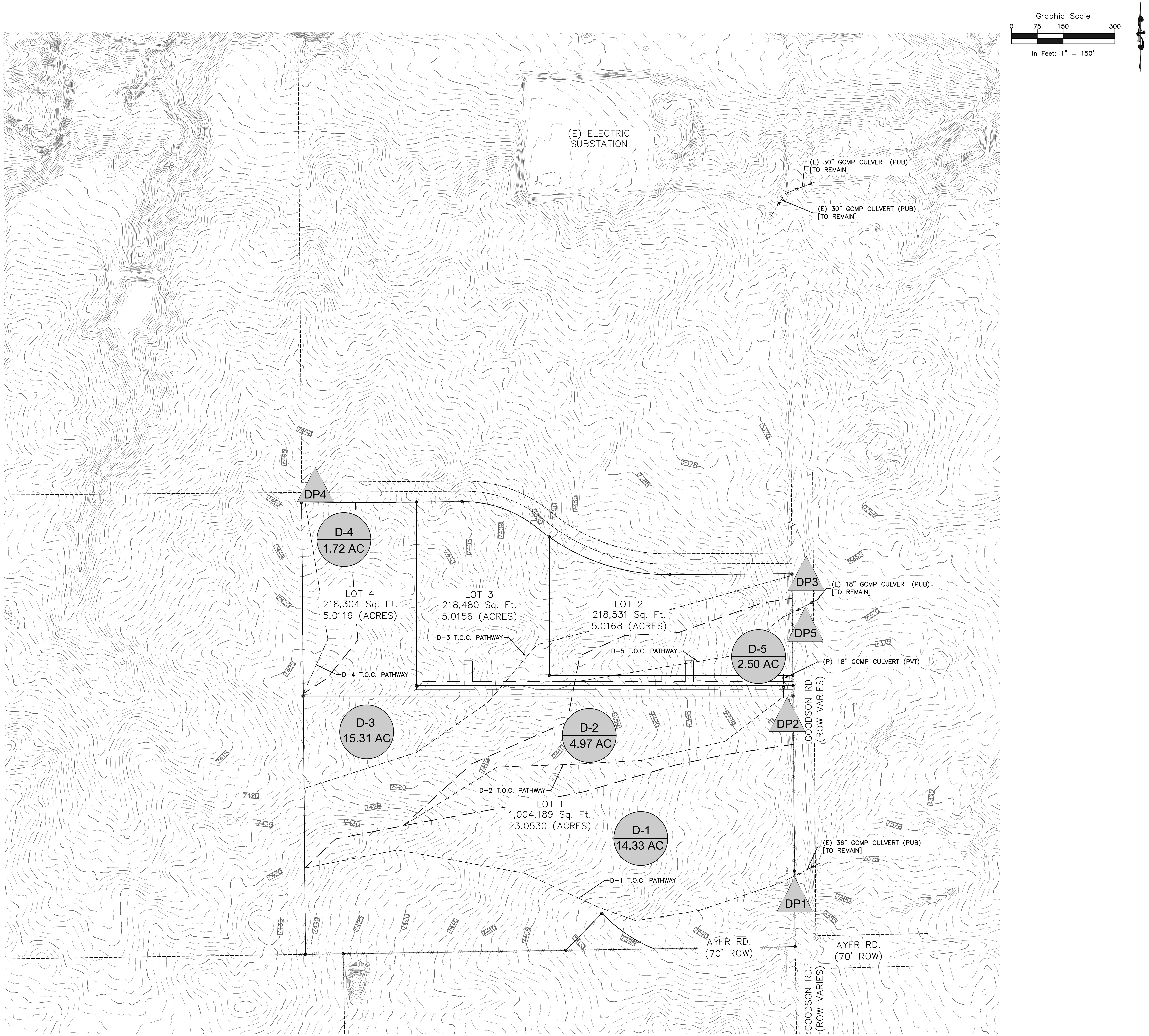
DATE: 06-28-2023

#	REVISION	DATE

JOB NO.: 192027

SHEET NO.: DR01

LAST SAVED: 7/20/2023 2:29:12 PM PATH: T:\Projects\Site Specific\2022\m-o\Makings, Drew-137891\12172 Goodson Rd-192027\Civil\Drawings\From RMG\Sheet Sets\Drainage Report Sub Basins\192027_Goodson Subdivision-Existing Sub Basin Analysis.dwg



Graphic Scale

0 75 150 300

In Feet: 1" = 150'

LEGEND

- PROPERTY LINE
- EASEMENT LINE
- SETBACK LINE
- PROPERTY CORNER/MONUMENT, BENCHMARK OR TEMPORARY BENCHMARK
- EXISTING FENCE
- EXISTING MINOR CONTOUR
- EXISTING MAJOR CONTOUR
- TIME OF CONCENTRATION PATH
- BASIN DELINEATION
- PROPOSED MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- BASIN DESIGN POINT ID
- D-1 BASIN IDENTIFIER
- X.XX AC BASIN AREA

DESIGN POINT	FLOW (CFS)
DP1	Q_{10} = 6.13 Q_{100} = 20.58
DP2	Q_{10} = 2.72 Q_{100} = 8.23
DP3	Q_{10} = 6.82 Q_{100} = 21.57
DP4	Q_{10} = 0.85 Q_{100} = 2.85
DP5	Q_{10} = 1.71 Q_{100} = 4.74

BASIN SUMMARY

BASIN	Q10(CFS)	Q100 (CFS)	ACRES(AC)
D-1	6.13	20.58	14.33
D-2	2.72	8.23	4.97
D-3	6.82	21.57	15.31
D-4	0.85	2.85	1.72
D-5	1.71	4.74	2.50
TOTAL	18.24	57.96	38.83

Architecture
Structural
Geotechnical

RMG

Materials Testing
Forensics
Civil / Planning

Engineers / Architects

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NOT FOR CONSTRUCTION

GUNNERS RIDGE SUBDIVISION

12172 GOODSON ROAD
EL PASO COUNTY, COLORADO

DREW MAKINGS

SHEET NAME
PROPOSED SUB-BASIN ANALYSIS

PROJECT STATUS
FINAL DRAINAGE REPORT

ENG: DGW
DRAWN: TPT
CHECKED: TPT

DATE
06-28-2023

#	REVISION	DATE

JOB NO.
192027

SHEET NO.
DR02