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# **CENTRAL WATER TREATMENT PLANT IMPROVEMENTS FINAL DRAINAGE REPORT**

AT

**SW ¼ SECTION 11, TOWNSHIP 11 SOUTH, RANGE 67 WEST OF THE 6<sup>TH</sup> P.M.  
COUNTY OF EL PASO, COLORADO**

FOR

**WOODMOOR WATER AND SANITATION DISTRICT NO. 1  
1845 WOODMOOR DRIVE  
MONUMENT, CO 80132**



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**JVA, Inc.  
Consulting Engineers**  
1319 Spruce Street  
Boulder, CO 80302  
(303) 444-1951

JVA Inc. Project No. 1051.1c

December 11, 2020



**JVA, Incorporated**  
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Boulder, CO 80302  
303.444.1951  
info@jvajva.com

Nov. 23, 2020

[www.jvajva.com](http://www.jvajva.com)

EPC PCD  
County Engineer/ECM Administrator  
El Paso County Planning & Community Development  
Colorado Springs, CO 80910

RE: Final Drainage Report  
WWSD Treatment Plant Improvements  
JVA No. 1051.5e

Dear EPC PCD,

The following *Final Drainage Report* and attached drainage maps have been prepared for the above referenced project. The stormwater report and drainage maps have been produced in accordance with "The City of Colorado Springs/El Paso County Drainage Criteria Manual" recommendations.

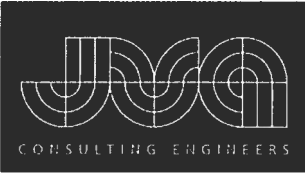
It is our understanding that the information provided herein meets all requirements of the County of El Paso.

Please contact us if you have any questions regarding this submission.

Sincerely,  
JVA, Inc.

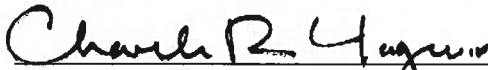
A handwritten signature in black ink, appearing to read "Ken Clifford", is written over a horizontal line.

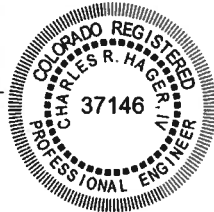
Kenneth J. Clifford, P.E.  
Professional Engineer



**Design Engineer's Statement:**

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the applicable master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.


  
Charles R. Hager, P.E. # 37146



12/11/2020  
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.

  
Jessie Shaffer, District Manager  
Woodmoor Water Sanitation District No. 1  
1845 Woodmoor Dr, Monument, CO 80132

12-22-20  
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.  
County Engineer / ECM Administrator

\_\_\_\_\_  
Date

Conditions:

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FIGURE 1 – HISTORIC DRAINAGE MAP

FIGURE 2 – DRAINAGE MAP

# FINAL DRAINAGE REPORT

## CENTRAL WATER TREATMENT PLANT

### IMPROVEMENTS

#### GENERAL LOCATION AND DESCRIPTION

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##### LOCATION

Woodmoor Water and Sanitation District No. 1 (WWSD) proposes to develop a new water pre-treatment plant facility, the Central Water Treatment Plant, in unincorporated El Paso County, Colorado. The facility is located on Lot 2, Patriot Place Subdivision - A in the Southwest ¼ Section 11 of Township 11 North, Range 67 West of the 6<sup>th</sup> Principal Meridian in Unincorporated El Paso County, State of Colorado. The project site is located west of the intersection of Deer Creek Road and Woodmoor Drive and northwest of the Lewis-Palmer Middle School. A vicinity map is included in Appendix A.

The site currently drains in a southwest direction to Crystal Creek. Historic runoff also flows south off the property to the riprap drainage ditch owned by Lewis-Palmer School District No. 38. The riprap ditch collects runoff which is eventually conveyed to Crystal Creek. The property is bound by Deer Creek Road to the northeast, Palen LLC owns the property to the north, Monument Hill Self Storage LLC to the west, Lewis-Palmer School District No. 38 to the south and southeast, and the Redner Family Trust to the northeast across Deer Creek Road.

##### DESCRIPTION OF PROPERTY

The WWSD property is currently 2.08 acres that houses the Central Water Treatment Plant. The WWSD property line will be adjusted to include 0.24 acres that Lewis-Palmer School District No. 38 is annexing. The total acreage of the proposed property will then be 2.32 acres. Although the property will increase in acreage only 0.36 acres of the property will be disturbed for the proposed building addition and improvements. In addition to the existing Water Treatment Plant building, the property includes a gravel access road to the structure with the remnant of the property being undisturbed open space with various trees and shrubs. The majority of the property has slopes steeper than 10 percent with an exception of the gravel lot adjacent to the structure and the open space near the Deer Creek Road.

The U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS) mapping of the area indicates that the soils are predominately Pring coarse sand loam, 3 to 8 percent slopes. These soils within the site area are classified as hydrological soil group B. Soils in this group have a moderate infiltration rate when thoroughly wet and therefore have moderate runoff potential. A Soils Map is provided in Appendix A.

There are no irrigation facilities on site. Water utilities are found within the property including pipes, hydrant, and water valve.

## DRAINAGE BASINS AND SUB-BASINS

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### MAJOR DRAINAGE BASIN DESCRIPTION

The property will drain to Crystal Creek which is then conveyed to Monument Creek. This is part of the Fountain Creek Watershed which drains to the Arkansas River.

The Property is located within Zone X as defined by the Federal Emergency Management Agency (FEMA). Zone X is defined as: *Area of Minimal Flood Hazard*. The site is located within FEMA Flood Insurance Rate Map (FIRM) number 08041C0276G, revised December, 7, 2018. A portion of the FEMA FIRM is included in Appendix A for reference.

The floodplain as part of Crystal Creek is shown in the FEMA Flood Insurance Rate Map (FIRM). The increased imperviousness will produce an additional 1.01 cfs in the developed condition. This runoff will be conveyed in the proposed swale which will mimic the historic, natural swale pattern. It is not anticipated that the development will have any impact on the Crystal Creek floodplain because of the small increase in runoff and it follows the historic flow pattern.

### SUB-BASIN DESCRIPTION

The historic major basin H is made up of 3 sub-basins, H1, H2, and H3. The imperviousness of basin H is 14.7% in the existing condition. These historic sub-basins include off-site and on-site runoff that drain to one design point and therefore are part of the same sub-basin.

Sub-basin H1 is 0.38 acres and is made up of landscape and gravel from the access road and lot surrounding the building. Runoff from the basin sheetflows to the southwest and then stays to the west of the building before entering Crystal Creek. Sub-basin H1 produces 1.28 cfs in the 100-year storm.

Sub-basin H2 is 1.26 acres and is made up of the existing Central Water Treatment Plant. In addition to the building, the basin also includes an asphalt from the public ROW, steep grades of landscape and the majority of the gravel access road servicing the existing treatment plant. Sub-basin H2 includes an existing swale that conveys flows to Crystal Creek. Runoff from the sub-basin will drain toward the existing building, combine within the swale, and then wrap around the east side of the existing building before flowing to Crystal Creek. Sub-basin H2 produces 3.86 cfs in the 100-year storm.

Sub-basin H3 is 0.47 acres and includes asphalt paving and landscape. Runoff sheetflows south to the riprap drainage ditch which then is conveyed to drainage structure. Flows will then continue to the southwest and terminate in Crystal Creek. Sub-basin H3 produces 1.12 cfs in the 100-year storm.

## DRAINAGE DESIGN CRITERIA

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### DEVELOPMENT CRITERIA REFERENCE

The proposed storm drainage facilities for the project are designed to comply with the “The City of Colorado Springs/El Paso County Drainage Criteria Manual, as revised in November 1991 and October 1994 with County adopted Chapter 6 and Section 3.2.1 of Chapter 13 of the City of Colorado Springs/El Paso County Drainage Criteria Manual as revised in May 2014.

## HYDROLOGIC METHOD AND DESIGN STORM FREQUENCIES

Design storm recurrence intervals for this project are consistent with The City of Colorado Springs/El Paso County Drainage Criteria Manual: the minor storm will be the 5-year event and the major storm will be the 100-year event.

The Rational Method ( $Q=CIA$ ) was used to determine the storm runoff ( $Q$ ) from the site, with composite runoff coefficients ( $C$ ) and contributing areas ( $A$ ) given for design points in sub-basins. Intensities ( $I$ ) were determined using NOAA Time-Intensity-Frequency Tables for the site located in Unincorporated El Paso County, Colorado and a calculated Time of Concentration ( $t_c$ ). Runoff coefficients were calculated based on Table 6-3 of the UDFCD Runoff chapter. Post-development Time of Concentration calculations for each sub-basin, corresponding rainfall intensities, and composite runoff coefficients for each sub-basin are provided in Appendix B.

The runoff calculations were based on NOAA Point Precipitation Frequency Estimates Tables set in the location of the site in unincorporated El Paso County and are listed in Table 1 below.

Return Period	One Hour Depth (in).
5-year	1.20
100-year	2.52

The proposed development will not disrupt historic drainage patterns and will not be disturbing more than an acre (.36 acres) for the new addition. Because of these considerations, there will not be any detention or water quality facilities proposed.

## DRAINAGE FACILITY DESIGN

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### GENERAL CONCEPT

The boundary and drainage pattern for the proposed basin will remain unchanged from the historic major basin, H. Offsite flows that are not within the WWSD property will continue to flow in historic patterns, entering and exiting the property until ending at Crystal Creek. There will be one developed swale to mimic the existing natural swale that conveys runoff to Crystal Creek. See “Developed Drainage Map” in Figure 2.

### SPECIFIC DETAILS

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The drainage facilities for the development of the WWSD pre-treatment plant will include a proposed swale to convey flows in their historic pattern. The proposed major basin boundary will include five sub-basins, A1, A2, A3, A4, and S1. The following is a description of the sub-basins:

A1 is 0.38 acres and includes existing and proposed asphalt paving, a portion of the gravel access road, and landscaping. There will be a change in imperviousness from 21.0% to 22.2%. Runoff

from the basin continues to sheetflow to the southwest and then stay west of the building before entering Crystal Creek. Sub-basin A1 will produce 1.29 cfs in the 100-year storm.

A2 is 0.24 acres and includes the existing WWSO water treatment plant and adjacent landscaping. There will be no proposed development within the sub-basin and no change in imperviousness and will have 1.18 cfs in runoff in the 100-year storm.

A3 is 0.37 acres and includes asphalt paving from existing public ROW, landscaping, and asphalt paving from the proposed parking lot for the pre-treatment plant. There will be a change in imperviousness from 10.3% to 10.8% in the developed condition. Runoff will continue to sheetflow south to the riprap drainage ditch which will then be conveyed to the drainage structure. Flows will then continue to the southwest and terminate in Crystal Creek. Sub-basin A3 produces 1.13 cfs in the 100-year storm.

A4 is 0.32 acres and includes existing landscaping that will not be disturbed. Flows will continue to flow to Crystal Creek. There will be no change in imperviousness. The basin will generate 0.97 cfs in runoff.

S1 is 0.70 acres of which 0.36 acres will be disturbed. The sub-basin will include the proposed pre-treatment plant building, sidewalk, asphalt parking lot, landscaping and a portion of the existing asphalt and gravel roads. The sub-basin will have an imperviousness of 18.6%. Runoff will sheetflow into the proposed swale where it will then be conveyed to the southwest and then terminate at Crystal Creek.

Sub-basins A2, A4, and S1 are a conglomerate of the historic sub-basin H2. The change in impervious from existing to proposed will be 14.2% to 21.1%. Overall, the entire major basin will have a change in imperviousness of 14.7% to 19.4% and a change in runoff from 6.26 cfs to 7.27 cfs from the historic to proposed condition, respectively.

The swale has also been analyzed to assure that the runoff does not overtop. The maximum depth during the 100-year storm with 2.7 cfs of runoff in the swale with 2:1 slopes is approximately 6.7 inches. The velocity of the runoff is expected to be 4.3 ft/s. This will not top the swale which has a total depth close to 2 feet. Riprap will be provided at the end of the swale to prevent erosion to the existing channel. See swale calculations in Appendix B.

The proposed WWSO pre-treatment plant has been designed in accordance with The City of Colorado Springs/El Paso County Drainage Criteria Manual. The area of disturbance will be less than one acre with 0.36 acres being disturbed. The total increase in impervious area on the parcel is 5,785 square feet. Historic drainage patterns will be maintained and will have minimal increase in runoff from historic to proposed, 6.26 cfs to 7.27 cfs, respectively. It is determined that the drainage impact from the development of the WWSO property will not adversely affect downstream properties.



## REFERENCES

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1. City of Colorado Springs/County of El Paso Drainage Criteria Manual, October 1991.
2. “Urban Storm Drainage Criteria Manual,” Urban Drainage and Flood Control District, updated March 2017.
3. Web Soil Survey, Natural Resources Conservation Service, United State Department of Agriculture, Online at <http://websoilsurvey.nrcs.usda.gov>, accessed May 15, 2020.

# **APPENDIX A – MAPPING AND FLOODPLAIN INFORMATION**

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87

Base Camp Rd

Deer Creek Rd

Emigrant Trail E

Woodmoor Dr

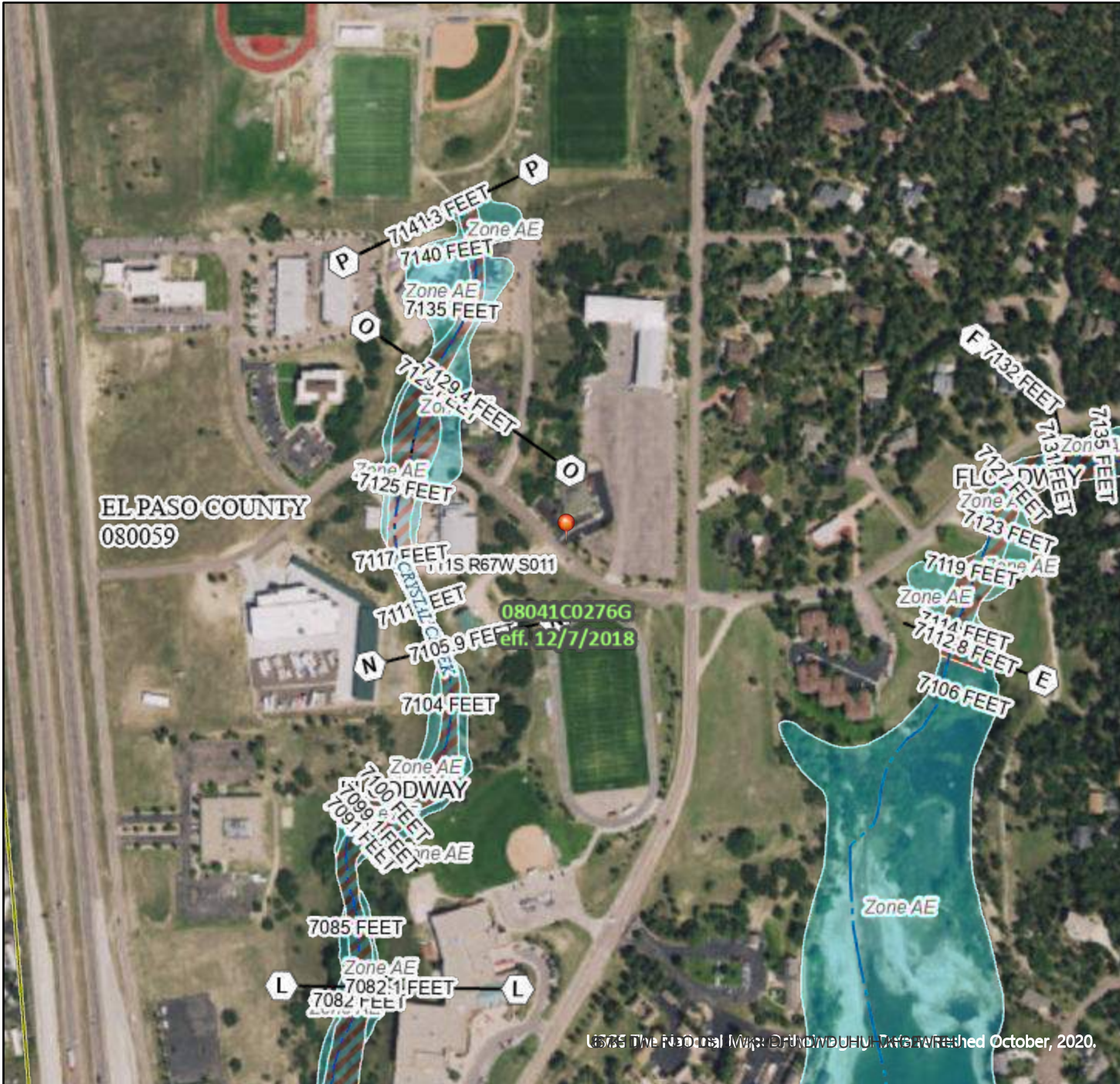
Burnin

Proposed Site

Mountain Hill Rd

Google arth

© 2020 Google



4) 688 85(8) 88888

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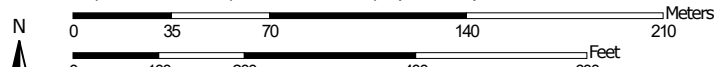
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U.H.K.O.D.W.R.U.S.U.S.R.V.H

USGS The National Map: Orthoimagery Data Refreshed October, 2020.

Hydrologic Soil Group—El Paso County Area, Colorado



Map Scale: 1:2,690 if printed on A landscape (11" x 8.5") sheet.



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
- Water Features**
  - Streams and Canals
- Transportation**
  - Rails
  - Interstate Highways
  - US Routes
  - Major Roads
  - Local Roads
- Background**
  - Aerial Photography
- Other**
  - C
  - C/D
  - D
  - Not rated or not available

### 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 18, Jun 5, 2020

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

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

## Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	B	0.3	0.9%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	30.3	90.3%
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	B	2.9	8.7%
<b>Totals for Area of Interest</b>			<b>33.5</b>	<b>100.0%</b>

## 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 B – CALCULATIONS

---



**JVA Incorporated**  
 1319 Spruce Street  
 Boulder, CO 80302  
 Ph: (303) 444 1951

**JVA Office:**  
 Boulder

Version 2020\_XT: 9/8/2020

**Project Information:**

Job Name: Woodmoor  
 Job Number: 1051.5c  
 Date: 12/10/2020  
 Designed by: SAH  
 Municipality : UDFCD  
 Soil Type: B

**Runoff Calculations:**

Minor Design Storm: 5 year  
 Major Design Storm: 100 year

**Detention Calculations:**

Minor Storm Detention: N/A year plus 0 % WQCV  
 Major Storm Detention: N/A year plus 0 % WQCV  
 Detention Volume by: N/A Enter WQCV : 0 cf  
 (GB, PP, PLD, SFB, EDB, etc.)

**Allowable Release Rates (if applicable):**

Max release rate 1 cfs / acre? No Site Area: 0.00 acres

Enter Offsite flows to bypass site (these will be added to the allowable release rates)

Qminor = 0.00 cfs (bypass flows) **Qminor allow = ENTER VALUE cfs**  
 Q100 = 0.00 cfs (bypass flows) **Qmajor allow = ENTER VALUE cfs**

**Rainfall Data Information:**

Enter City, Town, or County:

Frequency of Design Event	One Hour Point Rainfall P1	
2 yr	0.90	in
5 yr	1.20	in
10 yr	1.46	in
100 yr	2.52	in

Do you need to Calc P1? No

**Runoff Coefficient Calculations:**

Use MHFD Equations? Yes

**Intensity Duration Values:**

I-D-F Calculate



**JVA Incorporated**  
 1319 Spruce Street  
 Boulder, CO 80302  
 Ph: (303) 444 1951

Job Name: Woodmoor  
 Job Number: 1051.5c  
 Date: 12/10/20  
 By: SAH

**Woodmoor**

**Historic Runoff Coefficient & Time of Concentration Calculations**

Location: 0  
 Minor Design Storm: 5  
 Major Design Storm: 100  
 Soil Type: B

Basin Design Data														Initial Overland Time (t)			Travel Time (t <sub>t</sub> ) t <sub>t</sub> =Length/(Velocity x 60)						t <sub>c</sub> Comp	tc Urbanized Check ON		t <sub>c</sub> Final					
Basin Name	Design Point	A <sub>paved streets</sub> (sf)	A <sub>drives/conv</sub> (sf)	A <sub>roof</sub> (sf)	A <sub>gravel</sub> (sf)	A <sub>plygnd</sub> (sf)	A <sub>art. turf</sub> (sf)	A <sub>lscapc (B soil)</sub> (sf)	A <sub>lscapc (C/D soil)</sub> (sf)	A <sub>Total</sub> (sf)	A <sub>Total</sub> (ac)	Imp (%)	C2	C5	C10	C100	Upper most Length (ft)	Slope (%)	t <sub>t</sub> (min)	Length (ft)	Slope (%)	Type of Land Surface	K	Velocity (fps)	t <sub>t</sub> (min)	Time of Conc t <sub>t</sub> + t <sub>c</sub> = t <sub>c</sub>	Total Length (ft)	t <sub>c</sub> =(L/180)+10 (min.)	Min t <sub>c</sub>		
H1	1	228		7,655				8,560		16,443	0.38	21.0%	0.14	0.16	0.23	0.52	173	9.3%	10.8	230	8.8%	Paved areas & shallow paved swales	20	5.9	0.6	11.5	403	12.2	11.5		
H2	2	390		4,677	5,731			44,054		54,853	1.26	14.2%	0.09	0.10	0.17	0.49	220	10.8%	12.3	233	6.8%	Short Pasture and lawns	7	1.8	2.1	14.4	453	12.5	12.5		
H3	3	1,353							14,683	16,037	0.37	10.3%	0.06	0.07	0.14	0.47	137	6.9%	11.6	137	7.6%	Short Pasture and lawns	7	1.9	1.2	12.8	274	11.5	11.5		
										0	0.00																				
										0	0.00																				
TOTAL SITE		1,971	0	4,677	13,386	0	0	52,615	14,683	87,332	2.00	14.7%	0.09	0.11	0.18	0.50															

I = (28.5 P1) / ((10 + TC) 0.786)

Basin Name	Design Point	Time of Conc (tc)	Runoff Coeff's				Rainfall Intensities (in/hr)				Area		Flow Rates (cfs)			
			C2	C5	C10	C100	2	5	10	100	A <sub>Total</sub> (sf)	A <sub>Total</sub> (ac)	Q2	Q5	Q10	Q100
H1	1	11.5	0.14	0.16	0.23	0.52	2.30	3.07	3.73	6.44	16,443	0.38	0.12	0.18	0.32	1.28
H2	2	12.5	0.09	0.10	0.17	0.49	2.22	2.96	3.60	6.21	54,853	1.26	0.24	0.38	0.78	3.86
H3	3	11.5	0.06	0.07	0.14	0.47	2.30	3.07	3.73	6.44	16,037	0.37	0.05	0.08	0.19	1.12
0	0										0	0.00				
0	0										0	0.00				
TOTAL SITE											87,332	2.00	0.41	0.65	1.29	6.26



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Job Name: Woodmoor  
 Job Number: 1051.5c  
 Date: 12/10/20  
 By: SAH

## Woodmoor Composite Runoff Coefficient Calculations

Location: 0  
 Minor Design Storm: 5  
 Major Design Storm: 100  
 Soil Type: B

CA 100yr = 0.78i + 0.11  
 CB 100yr = 0.47i + 0.426  
 CC/D 100yr = 0.41i + 0.484

Basin Design Data																
	I (%) =	100%	90%	90%	40%	25%	25%	2%	2%			I (%)	Runoff Coeff's			
Basin Name	Design Point	A <sub>paved streets</sub> (sf)	A <sub>drives/c onc</sub> (sf)	A <sub>roof</sub> (sf)	A <sub>gravel</sub> (sf)	A <sub>plygnd</sub> (sf)	A <sub>art. turf</sub> (sf)	A <sub>iscape (B soil)</sub> (sf)	A <sub>iscape (C/D soil)</sub> (sf)	A <sub>Total</sub> (sf)	A <sub>Total</sub> (ac)	Imp (%)	C2	C5	C10	C100
A1	1	557			7,325			8,560		16,443	0.38	22.2%	0.14	0.17	0.24	0.53
A2	2			4,677	3,520			2,414		10,611	0.24	53.4%	0.40	0.43	0.49	0.68
A3	3	1,434						14,602		16,037	0.37	10.8%	0.06	0.08	0.14	0.48
A4	4							13,875		13,875	0.32	2.0%	0.01	0.01	0.07	0.44
S1	5	3,233	509	868	1,724			24,032		30,366	0.70	18.6%	0.12	0.14	0.21	0.51
TOTAL SITE		5,225	509	5,545	12,569	0	0	63,484	0	87,332	2.00	19.4%	0.12	0.14	0.21	0.52
To Swale	6	3,233	509	5,545	5,244	0	0	40,321	0	54,852	1.26	21.1%				



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Job Name: Woodmoor  
 Job Number: 1051.5c  
 Date: 12/10/20  
 By: SAH

## Woodmoor

### Time of Concentration Calculations

Location: 0  
 Minor Design Storm: 5  
 Major Design Storm: 100  
 Soil Type: B

Sub-Basin Data				Initial Overland Time ( $t_i$ )			Travel Time ( $t_t$ ) $t_t = \text{Length} / (\text{Velocity} \times 60)$						$t_c$ Comp	tc Urbanized Check ON		$t_c$ Final
Basin Name	Design Point	$A_{\text{Total}}$ (ac)	C5	Upper most Length (ft)	Slope (%)	$t_i$ (min)	Length (ft)	Slope (%)	Type of Land Surface	$C_v$	Velocity (fps)	$t_t$ (min)	Time of Conc $t_i + t_t = t_c$	Total Length (ft)	$t_c = (L/180) + 10$ (min)	Min $t_c$
A1	1	0.38	0.17	173	9.3%	10.7	230	8.8%	Paved areas & shallow paved swales	20	5.9	0.6	11.4	403	12.2	11.4
A2	2	0.24	0.43	106	3.2%	8.5	90	13.6%	Grassed waterway	15	5.5	0.3	8.8	196	11.1	8.8
A3	3	0.37	0.08	137	6.9%	11.5	137	7.6%	Short Pasture and lawns	7	1.9	1.2	12.7	274	11.5	11.5
A4	4	0.32	0.01	106	13.1%	8.7	128	9.9%	Nearly bare ground	10	3.1	0.7	9.4	234	11.3	9.4
S1	5	0.70	0.14	55	8.1%	6.5	393	9.1%	Paved areas & shallow paved swales	20	6.0	1.1	7.6	448	12.5	7.6



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Job Name: Woodmoor  
 Job Number: 1051.5c  
 Date: 12/10/20  
 By: SAH

**Woodmoor**

**Developed Storm Runoff Calculations**

Design Storm : **100 Year**

Point Hour Rainfall (P<sub>1</sub>) : **2.52**

$I = (28.5 P_1) / ((10 + TC)^{0.786})$

Basin Name	Design Point	Area (ac)	Runoff Coeff	Direct Runoff				Total Runoff				Inlets				Pipe			Pipe/Swale Travel Time			Total Time (min)	Notes	
				tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Total tc (min)	ΣC*A (ac)	I (in/hr)	Q (cfs)	Inlet Type	Q intercepted	Q carryover	Q bypass	Pipe Size (in) or equivalent	Pipe Material	Slope (%)	Pipe Flow (cfs)	Max Pipe Capacity (cfs)	Length (ft)			Velocity (fps)
A1	1	0.38	0.53	11.40	0.20	6.46	1.29	11.40	0.20	6.46	1.29													
A2	2	0.24	0.68	8.80	0.16	7.15	1.18	8.80	0.16	7.16	1.18													
A3	3	0.37	0.48	11.50	0.18	6.44	1.13	11.50	0.18	6.44	1.13													
A4	4	0.32	0.44	9.40	0.14	6.98	0.97	9.40	0.14	6.98	0.97													
S1	5	0.70	0.51	7.60	0.36	7.53	2.69	7.60	0.36	7.54	2.70													



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Job Name: Woodmoor  
 Job Number: 1051.5c  
 Date: 12/10/20  
 By: SAH

**Woodmoor**

**Developed Storm Runoff Calculations**

Design Storm : **5 Year**

Point Hour Rainfall (P<sub>1</sub>) : **1.20**

$I = (28.5 P_1) / ((10 + TC)^{0.786})$

Basin Name	Design Point	Area (ac)	Runoff Coeff	Direct Runoff				Total Runoff				Inlets			Pipe			Pipe/Swale Travel Time			Notes			
				tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Total tc (min)	ΣC*A (ac)	I (in/hr)	Q (cfs)	Inlet Type	Q intercepted	Q carryover	Q bypass	Pipe Size (in) or equivalent	Pipe Material	Slope (%)	Pipe Flow (cfs)	Max Pipe Capacity (cfs)		Length (ft)	Velocity (fps)	tt (min)
A1	1	0.38	0.17	11.40	0.06	3.07	0.19	11.40	0.06	3.08	0.19													
A2	2	0.24	0.43	8.80	0.11	3.40	0.36	8.80	0.11	3.41	0.36													
A3	3	0.37	0.08	11.50	0.03	3.06	0.09	11.50	0.03	3.07	0.09													
A4	4	0.32	0.01	9.40	0.00	3.32	0.01	9.40	0.00	3.33	0.01													
S1	5	0.70	0.14	7.60	0.10	3.58	0.34	7.60	0.10	3.59	0.34													

## Triangular Swale

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

---

Input Data	
Roughness Coefficient	0.050
Channel Slope	0.136 ft/ft
Left Side Slope	2.000 H:V
Right Side Slope	2.000 H:V
Discharge	2.70 cfs

---

Results	
Normal Depth	6.7 in
Flow Area	0.6 ft <sup>2</sup>
Wetted Perimeter	2.5 ft
Hydraulic Radius	3.0 in
Top Width	2.23 ft
Critical Depth	7.8 in
Critical Slope	0.062 ft/ft
Velocity	4.34 ft/s
Velocity Head	0.29 ft
Specific Energy	0.85 ft
Froude Number	1.449
Flow Type	Supercritical

---

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

---

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	6.7 in
Critical Depth	7.8 in
Channel Slope	0.136 ft/ft
Critical Slope	0.062 ft/ft



# Channel Report

## Triangular Swale

### Triangular

Side Slopes (z:1) = 2.00, 2.00  
Total Depth (ft) = 2.00

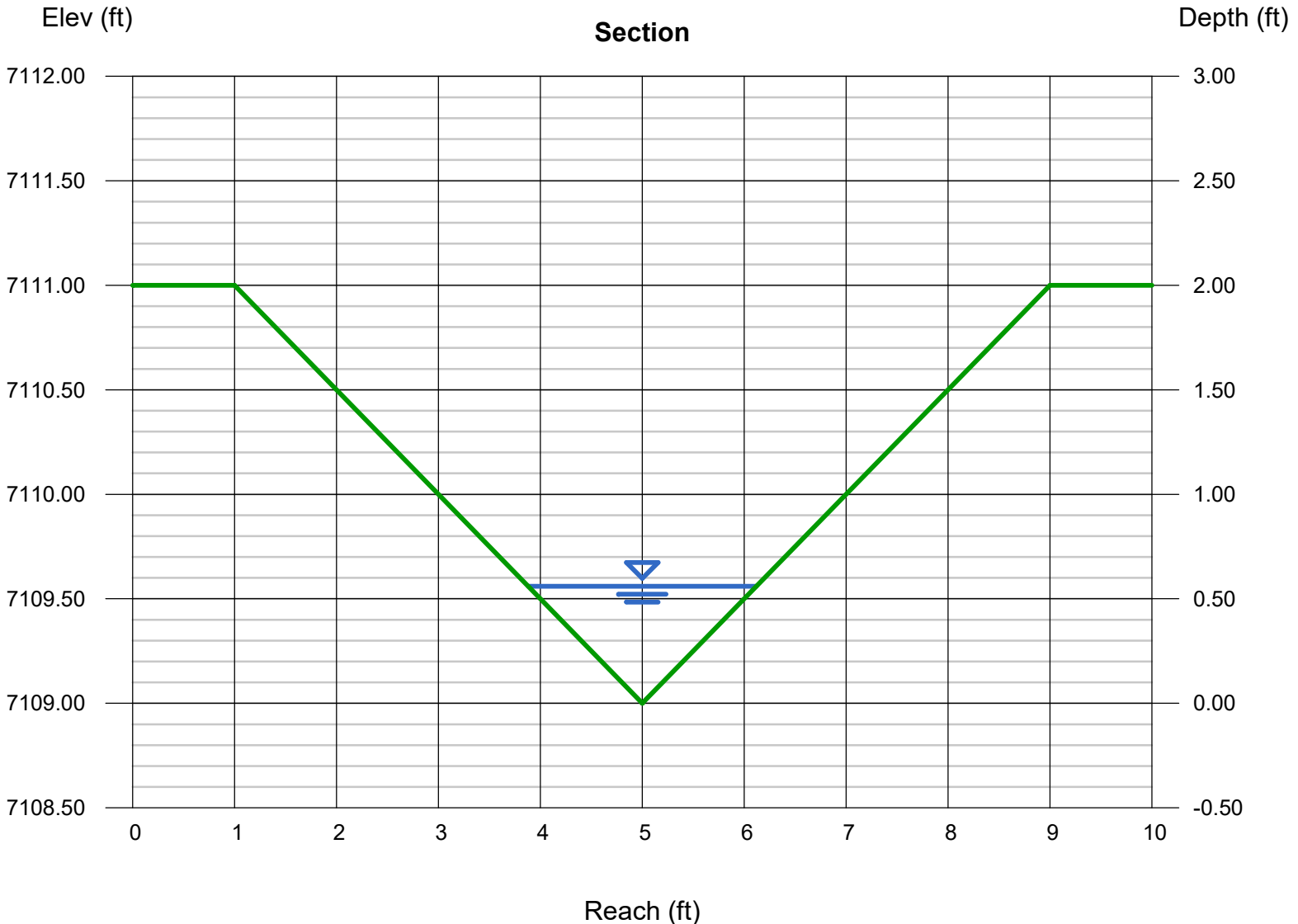
Invert Elev (ft) = 7109.00  
Slope (%) = 13.60  
N-Value = 0.050

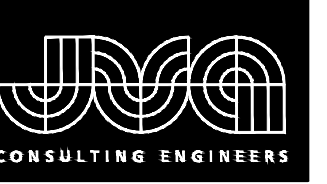
### Calculations

Compute by: Known Q  
Known Q (cfs) = 2.70

### Highlighted

Depth (ft) = 0.56  
Q (cfs) = 2.700  
Area (sqft) = 0.63  
Velocity (ft/s) = 4.30  
Wetted Perim (ft) = 2.50  
Crit Depth, Yc (ft) = 0.65  
Top Width (ft) = 2.24  
EGL (ft) = 0.85

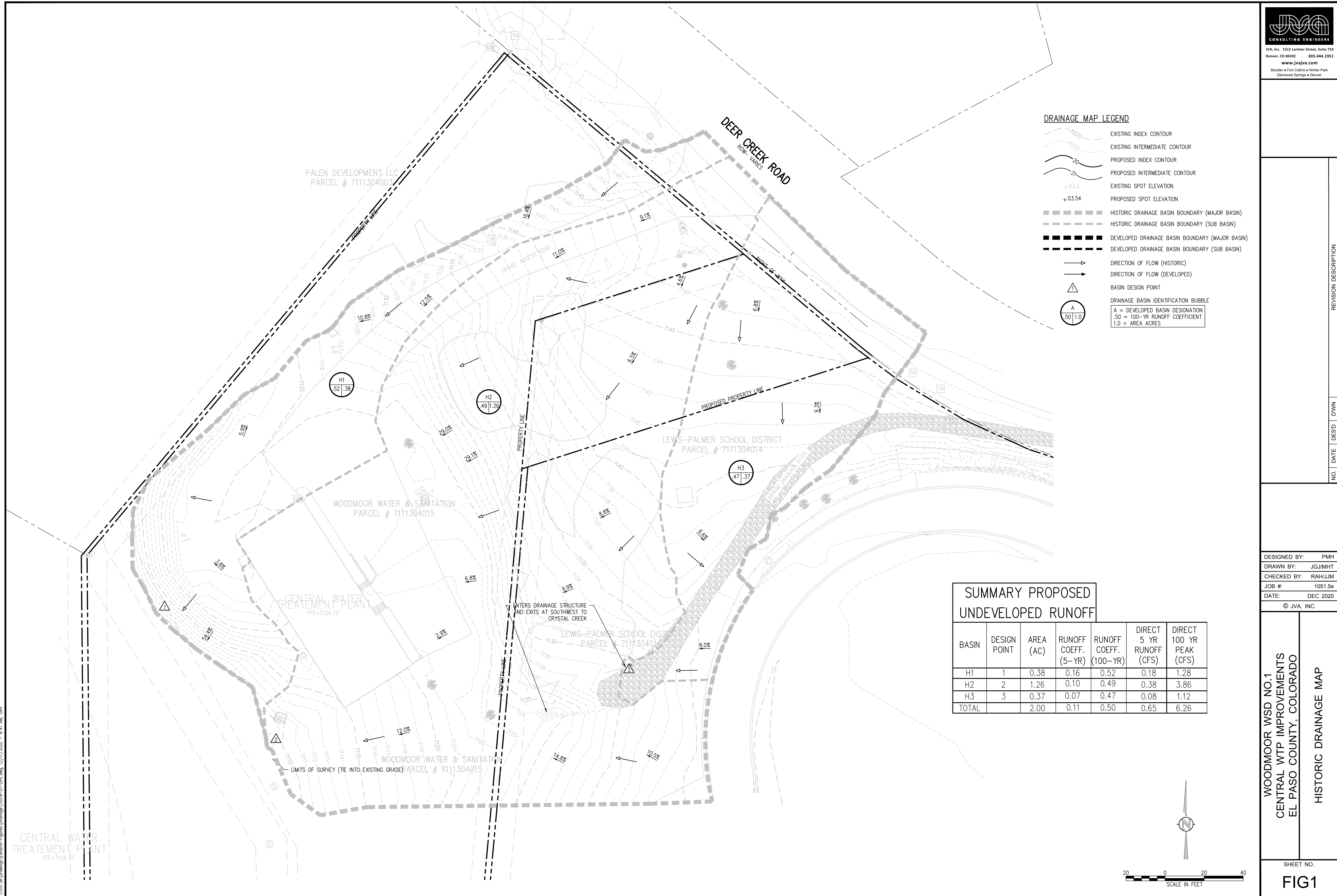




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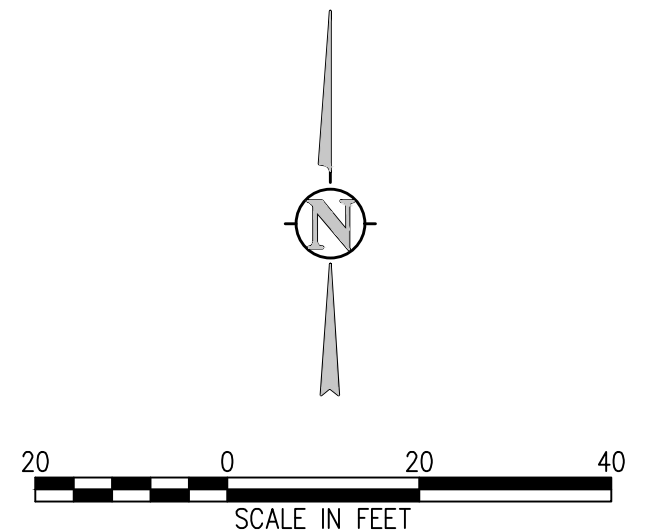
**DRAINAGE MAP LEGEND**

- EXISTING INDEX CONTOUR
  - EXISTING INTERMEDIATE CONTOUR
  - PROPOSED INDEX CONTOUR
  - PROPOSED INTERMEDIATE CONTOUR
  - EXISTING SPOT ELEVATION
  - PROPOSED SPOT ELEVATION
  - HISTORIC DRAINAGE BASIN BOUNDARY (MAJOR BASIN)
  - HISTORIC DRAINAGE BASIN BOUNDARY (SUB BASIN)
  - DEVELOPED DRAINAGE BASIN BOUNDARY (MAJOR BASIN)
  - DEVELOPED DRAINAGE BASIN BOUNDARY (SUB BASIN)
  - DIRECTION OF FLOW (HISTORIC)
  - DIRECTION OF FLOW (DEVELOPED)
  - BASIN DESIGN POINT
  - DRAINAGE BASIN IDENTIFICATION BUBBLE
- A = DEVELOPED BASIN DESIGNATION  
 .50 = 100-YR RUNOFF COEFFICIENT  
 1.0 = AREA ACRES



**SUMMARY PROPOSED UNDEVELOPED RUNOFF**

BASIN	DESIGN POINT	AREA (AC)	RUNOFF COEFF. (5-YR)	RUNOFF COEFF. (100-YR)	DIRECT 5 YR RUNOFF (CFS)	DIRECT 100 YR PEAK (CFS)
H1	1	0.38	0.16	0.52	0.18	1.28
H2	2	1.26	0.10	0.49	0.38	3.86
H3	3	0.37	0.07	0.47	0.08	1.12
TOTAL		2.00	0.11	0.50	0.65	6.26



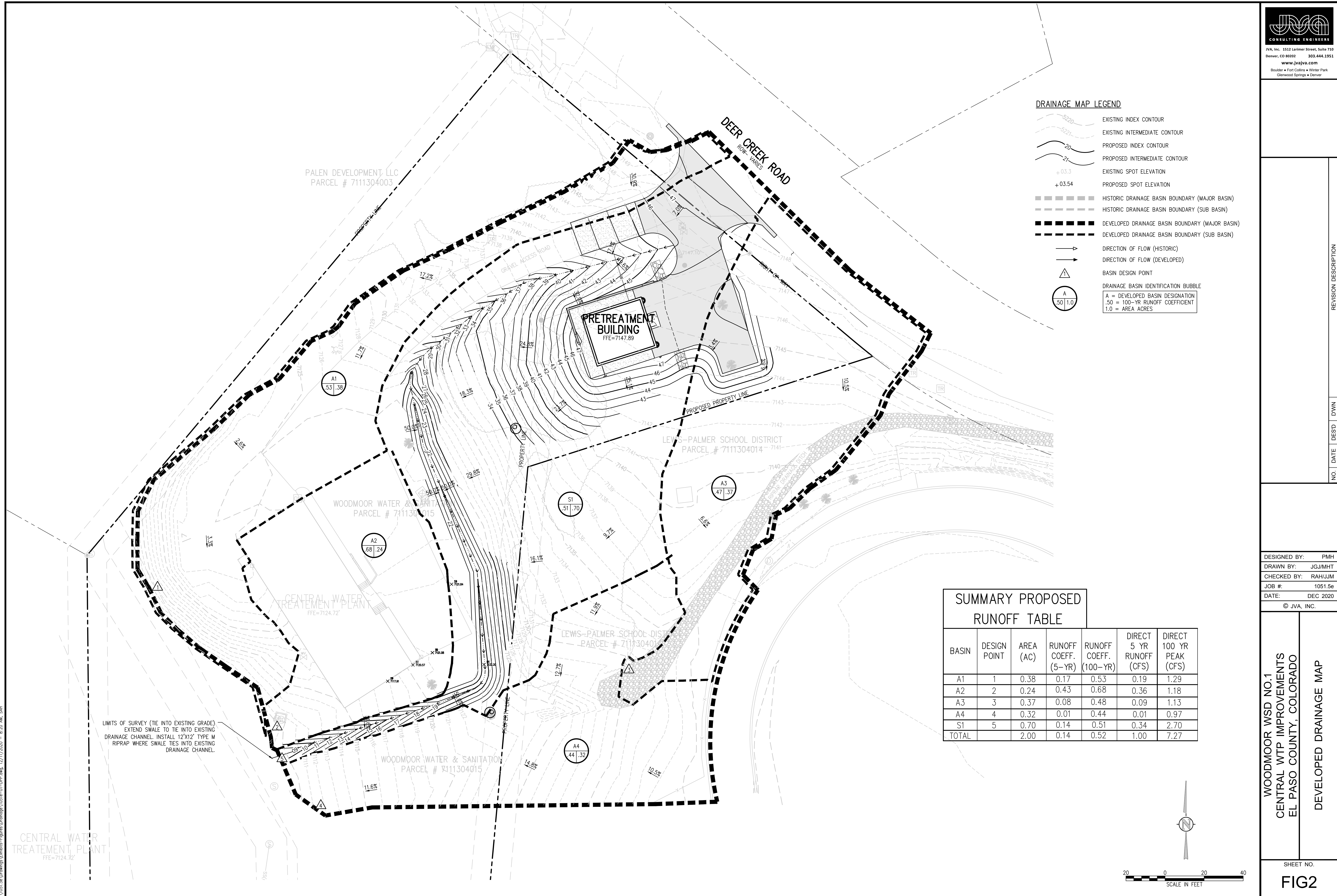
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CENTRAL WATER TREATMENT PLANT  
 FFE=7124.72

DESIGNED BY: PMH DRAWN BY: JGJMHT CHECKED BY: RAH/JJM JOB #: 1051.5e DATE: DEC 2020 © JVA, INC.	REVISION DESCRIPTION NO. DATE DESD DWN
WOODMOOR WSD NO.1 CENTRAL WTP IMPROVEMENTS EL PASO COUNTY, COLORADO	HISTORIC DRAINAGE MAP
SHEET NO. <b>FIG1</b>	

**DRAINAGE MAP LEGEND**

- EXISTING INDEX CONTOUR
  - EXISTING INTERMEDIATE CONTOUR
  - PROPOSED INDEX CONTOUR
  - PROPOSED INTERMEDIATE CONTOUR
  - EXISTING SPOT ELEVATION
  - PROPOSED SPOT ELEVATION
  - HISTORIC DRAINAGE BASIN BOUNDARY (MAJOR BASIN)
  - HISTORIC DRAINAGE BASIN BOUNDARY (SUB BASIN)
  - DEVELOPED DRAINAGE BASIN BOUNDARY (MAJOR BASIN)
  - DEVELOPED DRAINAGE BASIN BOUNDARY (SUB BASIN)
  - DIRECTION OF FLOW (HISTORIC)
  - DIRECTION OF FLOW (DEVELOPED)
  - BASIN DESIGN POINT
  - DRAINAGE BASIN IDENTIFICATION BUBBLE
- A = DEVELOPED BASIN DESIGNATION  
 .50 = 100-YR RUNOFF COEFFICIENT  
 1.0 = AREA ACRES



**SUMMARY PROPOSED RUNOFF TABLE**

BASIN	DESIGN POINT	AREA (AC)	RUNOFF COEFF. (5-YR)	RUNOFF COEFF. (100-YR)	DIRECT 5 YR RUNOFF (CFS)	DIRECT 100 YR PEAK (CFS)
A1	1	0.38	0.17	0.53	0.19	1.29
A2	2	0.24	0.43	0.68	0.36	1.18
A3	3	0.37	0.08	0.48	0.09	1.13
A4	4	0.32	0.01	0.44	0.01	0.97
S1	5	0.70	0.14	0.51	0.34	2.70
<b>TOTAL</b>		<b>2.00</b>	<b>0.14</b>	<b>0.52</b>	<b>1.00</b>	<b>7.27</b>

LIMITS OF SURVEY (TIE INTO EXISTING GRADE)  
 EXTEND SWALE TO TIE INTO EXISTING DRAINAGE CHANNEL. INSTALL 12"X12" TYPE M RIPRAP WHERE SWALE TIES INTO EXISTING DRAINAGE CHANNEL.

CENTRAL WATER TREATMENT PLANT  
 FFE=7124.72

NO.	DATE	DES'D	DWN	REVISION DESCRIPTION

DESIGNED BY: PMH  
 DRAWN BY: JGJMHT  
 CHECKED BY: RAH/JJM  
 JOB #: 1051.5e  
 DATE: DEC 2020  
 © JVA, INC.

WOODMOOR WSD NO.1  
 CENTRAL WTP IMPROVEMENTS  
 EL PASO COUNTY, COLORADO  
 DEVELOPED DRAINAGE MAP

SHEET NO.  
**FIG2**

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