PRELIMINARY DRAINAGE REPORT
FOR
GRANDWOOD RANCH

Prepared for:
EL PASO COUNTY
Engineering Development Review Team
2880 International Circle
Colorado Springs, CO 80910

On Behalf of:
Grandwood Enterprises, LLC
270 Lodgepole Way
Monument, CO 80132

Prepared by:

Matrix
2435 Research Parkway, Suite 300
Colorado Springs, CO 80920
(719) 575-0100
fax (719) 572-0208

June 2020

Project No. 20.1105.004

PCD File No. SP195

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

_____ SEAL

Jesse Sullivan Date
Registered Professional Engineer
State of Colorado
No. 55600

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

GRANDWOOD ENTERPRISES, LLC
Business Name

By: _____ _____
Date

Title: _____

Address: 270 Lodgepole Way
Monument, CO 80132

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

_____ _____

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

Conditions:

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I. Introduction

The Grandwood Ranch subdivision is within El Paso County jurisdiction and is comprised of a total of 147 acres of 2.5-acre single-family residential (121 acres), open space (18 acres), and public right-of-way (5920 feet).

A. PURPOSE AND SCOPE OF STUDY

The purpose of this Preliminary Drainage Report is to identify and evaluate the offsite and onsite drainage patterns associated with the Grandwood Ranch development and to provide updated hydrologic and hydraulic analyses of this area to ensure compliance with the El Paso County Drainage Criteria Manual (DCM), as well as provide effective, safe routing to downstream outfalls. This report will include breach analysis of upstream offsite detention basins within the Timberview and Bent III subdivisions.

There are no previous applicable DBPS or MDDP reports covering the proposed development.

B. DBPS-RELATED INVESTIGATIONS

The proposed development is located within the Jackson Creek Drainage basin. No Drainage Basin Planning Study (DBPS) has been completed for this drainage basin.

C. STAKEHOLDER PROCESS

As there are no Drainage Basin Planning Studies to amend or otherwise modify, there is no required stakeholder process.

D. AGENCY JURISDICTIONS

This project is located within El Paso County and is subject to the design criteria set forth in the ***City of Colorado Springs & El Paso County Drainage Criteria Manual, Volumes I and II, dated May 2014 (DCM)*** as well as the ***El Paso County DCM, El Paso County Engineering Criteria Manual (ECM)*** and ***El Paso County Resolutions 15-042 and 19-245***.

E. GENERAL PROJECT DESCRIPTION

Grandwood Ranch extends from Higby Road on the south boundary north approximately ¼ mile to the north boundary. East to west the site is just under a mile (5136 feet) in length. The approximately 147-acre site is currently made up of sparsely grassed areas and areas of mature conifers/pine trees. The site slopes to the south with slopes from 2 percent up to in excess of 30 percent. The site is divided near the middle by a natural ridge with two locations with large and has two non-draining small basins along Higby Road on the downhill portion of the ridge dividing the site.

More specifically, the study area is located as follows:

1. General Location: The south half of the north half of Section 19, Township 11 South, Range 65 West of the 6th P.M. in the County of El Paso, State of Colorado.

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2. Surrounding Streets and Developments:

   a. North: The properties to the north are within several different developments. These developments from west to east include: Timberview Subdivision Filings No. 2 and 3, Mills Timber Subdivision, Arrowood I, and Bent Tree III at the northeast corner.

   b. East: This boundary of the development adjoints Bent Tree III for the entire length

   c. South: Higby Road: Undeveloped property for the majority of the length and Higby Estates Filing No. 2 for the east roughly 20% of the border.

   d. West: Fairplay Drive: Woodmoor Summit makes up the entire length of the west boundary

Refer to Appendix D for the Vicinity Map.

F. DATA SOURCES

Topographical information for the site was found using a combination of ***United States Geological Survey*** (USGS) LIDAR as well as field surveying. The ***Web Soil Survey*** created by the ***Natural Resources Conservation Service*** was utilized to investigate the existing general soil types within the site and the USGS **StreamStats** website was used to determine the overall drainage basins.

DBPS CONSIDERATIONS

There are no approved DBPS studies for this region.

EXISTING DRAINAGE STUDIES

There are two adjacent developments with drainage studies, however:

Final Drainage Report for Timberview Subdivision Phase II, by Premier Engineering Inc., June 5, 2001.

Final Drainage Report for Bent Tree Subdivision Filing No. 3, by RTW Professional Engineers and Consultants, Inc. March 1993.

Mills Timber Subdivision – Drainage Letter, by MVE, Inc. June 2002.

G. APPLICABLE CRITERIA AND STANDARDS

This report has been prepared in accordance to the criteria set forth in the City of Colorado Springs and El Paso County DCM, El Paso County Engineering Criteria Manual (ECM) and El Paso County Resolutions 15-042 and 19-245. In addition to the DCM, the ***Urban Storm Drainage Criteria Manuals, Volumes 1 through 3***, dated 2016 have been used to supplement the County's Criteria Manual.

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II. Project Characteristics

A. BASIN LOCATION AND FLOWS

As mentioned in Section I. E. 3., the Grandwood Ranch project is divided between two major drainage basins and one minor basin.

1. Jackson Creek:

Figure 1 - Project Vicinity: Jackson Creek Drainage Basin

a. West Basin: The 361-acre West Basin is made up of undeveloped land and 1 or 2-acre single family developments. Upstream of the proposed development this basin is divided into two other drainage basins. Runoff from the basin sheet flows off the residential lots and drains via grassed road ditches towards the site. The westernmost of the two basins drains into an existing detention pond in the Timberview development. This basin is conveyed through the proposed development area via a broad undefined drainage way and crosses Higby Road via a 15-inch culvert. The second basin drains to a large open area upstream of Minglewood Trail and discharges via a 30-inch crossroad pipe to a broad undefined drainage way running through the site. The flows are eventually discharged to a wetland area and from there conveyed across Higby Road via a 30-inch x 42-inch elliptical culvert.

Runoff from the second basin to the east, sheet flows off residential lots to several vegetated swales. The swales direct the runoff south and into the proposed development. A short section of Drainage Easement in the Mills Timber Subdivision exists just north of the property boundary. According to the Drainage Letter for Mills Timber Subdivision, the 100-foot wide section corresponds with a natural spring and associated pond. This pond does not appear to have any embankment, so breach analysis was not required. The narrower section of easement appears to be intended for one of the swales through the Mills Timber Subdivision, but, according to the 2018 LIDAR used in this report to identify the offsite basins, the drainage easement no longer appears to follow a defined swale. Once reaching the site, flows from this drainage area are

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directed south via natural swales. The offsite flows will be conveyed under the proposed roadway and will eventually discharge to the natural wetland on the south end of the project. As much as possible, the offsite and 2.5-acre lot runoff will not be allowed to mix with runoff from the proposed streets in order to reduce the detention requirements for the proposed development.

b. East Basin: The 266-acre East Basin is made up of undeveloped land and 1-acre plus single-family development. Much of the offsite portion of this basin is within the Bent Tree III subdivision. Bent Tree III is required to detain and discharge runoff from the development at rates as indicated in the Drainage Criteria governing in 1993 when the drainage report for the site was approved. Once reaching the site offsite flows in this basin are conveyed by grassed swales to a wetland area which discharges across Higby Road via a 48-inch CMP culvert.

c. Minor Central Basin

The Minor Central Basin is 6.4 acres. This basin is on the front side of the ridge dividing the Grandwood Ranch development. Flows in this basin sheet flow south towards Higby Road and into an existing 18-inch culvert crossing Higby Road. Some flow is captured in two low spots adjacent to Higby Road. There do not appear to be any culverts draining the two low spots. The soils in this area (described in the following section) are highly permeable and runoff to the low spots will infiltrate quickly. A site visit did not note any signs of ponding or wetland plants in these low points, so it is likely that the highly permeable soil removes runoff faster than it can accumulate. If the low areas did happen to fill up beyond the natural infiltration capacity, the surcharge would continue west along the Higby Road ditch to an existing culvert.

B. GEOLOGY

Soils can be classified in four different hydrologic groups, A, B, C, or D to help predict stormwater runoff rates. Hydrologic group "A" is characterized by deep, well-drained coarse-grained soils with a rapid infiltration rate when thoroughly wet and having a low runoff potential. Group "D" typically has a clay layer at or near to the surface, or a very shallow depth to impervious bedrock and has a very slow infiltration rate and a high runoff potential. See Soils Map; Appendix C. The following soil types are present in the development area:

Table 1.1 – NRCS Soil Survey for El Paso County

SOIL ID NUMBER	SOIL	HYDROLOGIC CLASSIFICATION	SATURATED CONDUCTIVITY (IN/HR)	PERCENT ON SITE
1	Alamosa loam, 1 to 3 percent slopes	D	1.28	6.4%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	B	13.04	57.5%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	3.97	20.9%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	B	13.04	15.2%

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Jackson Creek - Saturated Conductivity of Soils in the Grandwood Ranch Subdivision						
Soil Type	1	41	71	93	Total Area (Sq. Mi.)	Weighted Hydraulic conductivity in/hr
Area (Sq. Mi.)						
Grandwood Ranch	0.016	0.143	0.052	0.038	0.25	**10.39**
Conductivity						
um/s	9	92	28	92	From Soil Survey Report	
Inches/Hour	**1.28**	**13.04**	**3.97**	**13.04**		

Pre-project site conditions are undeveloped and ground cover consists of sparse natural vegetative land cover. Percolation rates determined at various bore locations throughout the site for the wastewater evaluation report indicated that one inch of water will infiltrate the soil over a period of 5 to 23 minutes depending on the bore location. This means the infiltration rate varied from 12 inches/hour to 2.6 inches/hour which correlates with the values shown in the table above. The higher infiltration rate (12 inches/hour) bore locations were near the low-lying areas of the site. This suggests that rainfall on the site will infiltrate at a higher rate than the DCM proscribed SCS curve numbers indicate and, therefore, the modeling in this report is conservative in its assumptions.

C. LAND USES

The site is currently zoned RR5 (min. 5-acre lot sizes) but is being rezoned to RR2.5 to allow the development to provide 48 single-family lots of at least 2.5 acres.

III. Hydrologic Analysis

A. MAJOR BASINS AND SUBBASINS

As mentioned in previous sections, the Grandwood Ranch development must be broken into two major basins and one minor basin to reflect areas within three general drainage paths through the site. These basins are all within the larger Jackson Creek Drainage Basin which is tributary to Fountain Creek.

Generally, under proposed conditions, offsite flows will be routed around or under the proposed roads. Culvert sizing for each lot will be provided so that drainage is maintained as the individual lots are developed. More channelized flow paths through the proposed lots have had drainage easements defined to maintain the drainage. Lots receiving these flows, but not currently possessing a defined flow path for a drainage easement to follow will require engineered site plans.

B. METHODOLOGY

The DCM requires SCS runoff method for drainage areas larger than 130 acres. Additionally, for these larger areas, two different storm durations must be considered (2-hour and 24-hour), and the more conservative of the two options will be utilized for design of infrastructure. In this case the 24-hour event was the more conservative.

The hypothetical rainfall depths for the 1-hour storm duration were derived using Table 2.1 of the DCM (shown below). These 1-hour rainfall depths were used to calculate the 2-hour design storm using Table 6-2 from the DCM which lists the "2-Hour Storm Distribution" (see Appendix B). This design storm is input to HEC-HMS via a time-series relationship. 24-hour storm events are modeled

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using a Type II storm distribution under the "Hypothetical Storm" option in HEC-HMS. Rainfall depths for this event were taken from Table 6-2 of the DCM.

Table 6-2. Rainfall Depths for Colorado Springs

Return Period	1-Hour Depth	6-Hour Depth	24-Hour Depth
2	1.19	1.70	2.10
5	1.50	2.10	2.70
10	1.75	2.40	3.20
25	2.00	2.90	3.60
50	2.25	3.20	4.20
100	2.52	3.50	4.60

Where Z= 6,840 ft/100

Water quality and storm detention for the proposed roads is modeled in UD-Detention. Detention ponds are placed throughout the site to balance the use of space with the need to treat and detain runoff from the proposed streets and, also, maintain the historic discharge from the property. Runoff Reduction calculations for street areas which were infeasible to detain were performed using the MHFD UD-BMP runoff reduction spreadsheet. Areas used for runoff reduction are illustrated in the appendices and are protected from development by either a drainage easement or road right of way.

Site permeability is based on Tables 5-4 through 5-6 of the DCM and/or Table 6-10 of the Colorado Springs DCM. The proposed site will have an estimated 11% impervious for the 2.5-acre lots, however, the runoff calculations are slightly more conservative and use the 12% impervious SCS curve number for 2-acre lots which is provided in the Colorado Springs DCM Table 6-10 and the NRCS SCS Method publication. Offsite areas upstream are modeled as approximately 1 or 2 acre lots.

Under proposed conditions, the portions of the development treated and detained within the proposed detention ponds is addressed in the HMS models by inputting an outflow hydrograph derived from the MHFD-Detention model of each proposed pond.

Existing detention ponds are modeled within HEC-HMS by stage-area relationship information and the model uses the discharge structure for the pond described in the associated historical drainage report. The modeling of surface runoff matched fairly closely with the original for the tributary undetained Q100 flow value (135.7 cfs vs 136.7 cfs), and, since the model included with this report allowed for roughly double the value indicated in the Bent Tree III FDR (129.0 cfs vs 51.2 cfs), the modeling is very conservative relative to the previous report.

C. BASIN HYDROLOGY

a. The ***undeveloped conditions*** for the site have been analyzed and are presented by design points (Table 3.2) and are described as follows:

1. West Basin:
   Under existing conditions, the developments directly north of Grandwood Ranch have several discharge points onto the proposed development. One of these is an existing

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detention pond for Timberview Subdivision Phase II (DP 1: Q_5 = 13.3 cfs, Q_{100} =29.1 cfs). The next development to the east, Timberview Subdivision Filing No. 3, provides a second discharge point at DP 2 with Q_{100} = 45.6 cfs. Additionally, a swale runs along the south boundary of Arrowwood Filing No. 1 and past Mills Timber Subdivision and discharges (Q_5 = 44.9 cfs, Q_{100} = 114.3 cfs) to this same basin at DP 3. These three areas combine at DP 3a discharging a combined Q_5 = 55.3 cfs and Q_{100} = 136.6 cfs onto the subject property. The total existing discharge from the adjacent and proposed developments at Higby Road (DP EX 2 & DP EX 3 combined) is approximately 67.0 cfs for the Q_5 event and 179.5 cfs for the Q_{100} event.

2. East Basin:
   This basin also has a significant drainage area upstream of the proposed development site. Flows from the Bent Tree Subdivision discharge to the Grandwood Ranch property. These flows include the discharge from the Bent Tree III detention pond as well as undetained flows from other portions of the subdivision. Offsite flows tributary to this sub-basin are approximately: Q_5 = 53.1 cfs, Q_{100} = 135.7 cfs. The existing detention pond reduces these flows to Q_5 = 44.8 cfs, Q_{100} = 129.0 cfs.

   Total discharge from the East Basin across Higby Road at DP EX-1 is approximately 47.2 cfs for the Q_5 event and 136.1 cfs for the Q_{100} event.

3. Minor Central Basin:
   Under existing conditions this basin has a total discharge of Q_5 = 2.5 cfs, Q_{100} = 10.0 cfs at DP EX-4. This basin is not affected by offsite flows.

Existing conditions consider all the on-site areas as undeveloped. Sub-basins and Design Points are summarized in the following tables:

Table 3.1
Grandwood Ranch
Existing Conditions Sub-Basin Summary Table

Area ID	Area (Acres)	Q5 (cfs)	Q100 (cfs)
EX-1A	82.1	10.4	26.8
EX-1B	8.0	1.7	5.2
EX-1C	5.8	2.3	6.0
EX-1D	24.7	9.6	24.5
EX-1E	37.0	13	33.2
EX-1F	52.7	16.6	42.7
EX-1G	62.5	20.9	53.2
EX-2A	14.36	5.7	14.6
EX-2B	34.14	0.6	5.8
EX-2C1	13.28	5.2	13.1
EX-2C2	33.24	0.2	3.9
EX-2C3	6.04	0.1	1.0
EX-2D	21.51	8.7	20.8

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Area ID	Area (Acres)	Q5 (cfs)	Q100 (cfs)
EX-2D1	14.40	11.2	19.3
EX-2D2	12.65	5.2	13.2
EX-2D3	16.40	6.2	15.9
EX-2E	12.37	5.3	13.4
EX-2F	19.74	6.3	16.1
EX-2G	12.42	4.5	11.5
EX-2H	31.60	11.5	29.2
EX-2I	13.29	4.8	12.3
EX-2J	48.38	16.5	42.0
EX-3	19.40	3.7	12.1
EX-3A	40.57	14.9	37.8
EX-4	8.2	5.2	13.2

Table 3.2
Grandwood Ranch
Existing Design Point Summary

Design Point	Sub-Basins	Total Area (ac.)	Q(5) (cfs)	Q(100) (cfs)
1	EX-3A	40.6	13.3	29.1
2	EX-2D1, EX-2D2, EX-2D	48.8	21.9	45.6
3	EX-2E, EX-2F, EX-2G, EX-2H, EX-2I, EX-2J	137.6	44.9	114.3
3a	EX-3A, EX-2D1, EX-2D2, EX-2D, EX-2E, EX-2F, EX-2G, EX-2H, EX-2I, EX-2J	227.0	55.3	136.6
4	Design Point 5, EX-1B, EX-1C	190.9	45.6	130.7
5	Design Point 6	177.0	44.9	128.9
6	EX-1D, EX-1E, EX-1F, EX-1G	177.0	53.1	135.7
EX-1	Design Point 4, EX-3	270.9	47.3	136.6
EX-2	EX-2A, EX-2B, Design Point 2, EX-2D3, Design Point 3, EX-2C1, EX-2C2, EX-2C3	303.9	56.4	145.5
EX-3	Design Point 1, EX-3	59.9	10.6	34.0
EX-4	EX-4	8.2	2.5	10

HEC-HMS outfall values for the Predevelopment Q_5 and Q_{100} storms are shown below:

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Q5 Runoff

Project: GWR 5 YR Final Simulation Run: EX - 5 YR 24HR

Start of Run: 01Jan2020, 00:00 Basin Model: EX GWR
End of Run: 02Jan2020, 00:05 Meteorologic Model: 24 HR 5 YR
Compute Time: 29Jun2020, 17:18:31 Control Specifications: GR Control

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Alphabetic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Basin EX-1B	0.0126	1.7	01Jan2020, 12:45	0.56
Basin EX-1C	0.0091	2.3	01Jan2020, 12:35	0.86
Basin EX-1D	0.0390	9.6	01Jan2020, 12:35	0.85
Basin EX-1E	0.0579	13.0	01Jan2020, 12:40	0.85
Basin EX-1F	0.0810	16.6	01Jan2020, 12:50	0.85
Basin EX-1G	0.0977	20.9	01Jan2020, 12:45	0.85
Design Point 4	0.2973	45.5	01Jan2020, 14:50	0.77
DP 3a	0.3169	55.3	01Jan2020, 14:15	0.91
EX-1A	0.1260	6.0	01Jan2020, 12:50	0.25
EX-2A	0.0220	5.7	01Jan2020, 12:30	0.86
EX-2B	0.0530	0.6	01Jan2020, 13:00	0.09
EX-2C1	0.0210	5.2	01Jan2020, 12:35	0.85
EX-2C2	0.0520	0.2	01Jan2020, 14:05	0.04
EX-2C3	0.0100	0.1	01Jan2020, 13:25	0.06
EX-2D	0.0340	8.7	01Jan2020, 12:45	0.99
EX-2D1	0.0225	11.2	01Jan2020, 12:35	1.76
EX-2D2	0.0198	5.2	01Jan2020, 12:30	0.86
EX-2D3	0.0256	6.2	01Jan2020, 12:35	0.85
EX-2E	0.0190	5.3	01Jan2020, 12:30	0.86
EX-2F	0.0310	6.3	01Jan2020, 12:50	0.85
EX-2G	0.0190	4.5	01Jan2020, 12:40	0.85
EX-2H	0.0490	11.5	01Jan2020, 12:40	0.85
EX-2I	0.0210	4.8	01Jan2020, 12:40	0.85
EX-2J	0.0760	16.5	01Jan2020, 12:45	0.85
EX-3	0.0302	3.7	01Jan2020, 12:45	0.51
EX-3A	0.0634	14.9	01Jan2020, 12:40	0.85
EX-4	0.0100	1.9	01Jan2020, 12:05	0.35
Junction EX-2D	0.0763	21.9	01Jan2020, 13:15	1.18
Reservoir OS-1	0.0634	13.3	01Jan2020, 12:55	0.85
Reservoir OS-5	0.2756	44.8	01Jan2020, 14:00	0.80
Route DP 1	0.0190	5.3	01Jan2020, 14:05	0.83
Route DP 2	0.0310	6.3	01Jan2020, 13:40	0.84
Route DP 3	0.0190	4.5	01Jan2020, 14:15	0.83
Route DP 5	0.0210	4.8	01Jan2020, 14:15	0.83
Route DP 6	0.0760	16.4	01Jan2020, 14:25	0.82
Route ex	0.0490	11.5	01Jan2020, 14:20	0.82
Route EX-1E	0.0579	13.0	01Jan2020, 13:30	0.84
Route EX-1F	0.0810	16.5	01Jan2020, 13:45	0.83
Route EX-1G	0.0977	20.9	01Jan2020, 13:40	0.84
Route EX-2A	0.0220	5.7	01Jan2020, 13:15	0.84
Route EX-2C1	0.0210	5.1	01Jan2020, 13:30	0.84
Route EX-2C2	0.0520	0.2	01Jan2020, 14:55	0.04
Route EX-2D1	0.0225	11.2	01Jan2020, 13:20	1.74
Route EX-2D2	0.0198	5.2	01Jan2020, 13:20	0.84
Route EX-2D3	0.0256	6.2	01Jan2020, 13:20	0.84
Route Res OS-1	0.0634	13.3	01Jan2020, 13:40	0.84
Route Res OS-5	0.2756	44.8	01Jan2020, 14:50	0.78
Route Upper Basin	0.2973	45.5	01Jan2020, 15:40	0.75
Route Upper Junction	0.3169	55.3	01Jan2020, 15:00	0.90
R-EX-1	0.4233	47.2	01Jan2020, 15:40	0.60
R-EX-2	0.4749	56.4	01Jan2020, 15:05	0.69
R-EX-3	0.0936	10.6	01Jan2020, 14:15	0.73
Sink EX-1	0.4233	47.2	01Jan2020, 15:35	0.60
Sink EX-2	0.4749	56.4	01Jan2020, 15:00	0.69
Sink EX-3	0.0936	10.6	01Jan2020, 14:10	0.73
Sink EX-4	0.0100	1.9	01Jan2020, 12:00	0.35
Upper Junction	0.2150	44.9	01Jan2020, 14:15	0.83

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Q100 Runoff

Project: GWR 100 YR Final Simulation Run: EX - 100 YR 24HR

Start of Run: 01Jan2020, 00:00 Basin Model: EX GWR
End of Run: 02Jan2020, 00:05 Meteorologic Model: 24 HR 100 YR
Compute Time: 30Jun2020, 15:15:04 Control Specifications: GR Control

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Alphabetic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Basin EX-1B	0.0126	5.2	01Jan2020, 12:40	1.51
Basin EX-1C	0.0091	6.0	01Jan2020, 12:30	2.06
Basin EX-1D	0.0390	24.5	01Jan2020, 12:35	2.06
Basin EX-1E	0.0579	33.2	01Jan2020, 12:40	2.05
Basin EX-1F	0.0810	42.2	01Jan2020, 12:50	2.05
Basin EX-1G	0.0977	53.2	01Jan2020, 12:45	2.05
Design Point 4	0.2973	130.1	01Jan2020, 14:40	1.87
DP 3a	0.3169	136.6	01Jan2020, 14:15	2.10
EX-1A	0.1260	26.8	01Jan2020, 12:50	0.89
EX-2A	0.0220	14.6	01Jan2020, 12:30	2.06
EX-2B	0.0530	5.8	01Jan2020, 12:50	0.50
EX-2C1	0.0210	13.1	01Jan2020, 12:35	2.06
EX-2C2	0.0520	3.9	01Jan2020, 12:50	0.38
EX-2C3	0.0100	1.0	01Jan2020, 12:40	0.43
EX-2D	0.0340	20.8	01Jan2020, 12:45	2.27
EX-2D1	0.0225	19.3	01Jan2020, 12:35	3.04
EX-2D2	0.0198	13.2	01Jan2020, 12:30	2.06
EX-2D3	0.0256	15.9	01Jan2020, 12:35	2.06
EX-2E	0.0190	13.4	01Jan2020, 12:30	2.06
EX-2F	0.0310	16.1	01Jan2020, 12:50	2.05
EX-2G	0.0190	11.5	01Jan2020, 12:35	2.06
EX-2H	0.0490	29.2	01Jan2020, 12:40	2.06
EX-2I	0.0210	12.3	01Jan2020, 12:40	2.05
EX-2J	0.0760	42.0	01Jan2020, 12:45	2.05
EX-3	0.0302	12.1	01Jan2020, 12:45	1.48
EX-3A	0.0634	37.8	01Jan2020, 12:40	2.06
EX-4	0.0100	7.5	01Jan2020, 12:05	1.19
Junction EX-2D	0.0763	45.6	01Jan2020, 13:15	2.42
Reservoir OS-1	0.0634	29.1	01Jan2020, 13:00	2.05
Reservoir OS-5	0.2756	128.3	01Jan2020, 13:50	1.91
Route DP 1	0.0190	13.4	01Jan2020, 14:05	2.00
Route DP 2	0.0310	16.0	01Jan2020, 13:35	2.02
Route DP 3	0.0190	11.5	01Jan2020, 14:10	2.00
Route DP 5	0.0210	12.3	01Jan2020, 14:15	1.99
Route DP 6	0.0760	41.9	01Jan2020, 14:25	1.99
Route ex	0.0490	29.2	01Jan2020, 14:20	1.99
Route EX-1E	0.0579	33.2	01Jan2020, 13:30	2.02
Route EX-1F	0.0810	42.1	01Jan2020, 13:40	2.01
Route EX-1G	0.0977	53.1	01Jan2020, 13:40	2.02
Route EX-2A	0.0220	14.6	01Jan2020, 13:15	2.03
Route EX-2C1	0.0210	13.0	01Jan2020, 13:30	2.02
Route EX-2C2	0.0520	3.9	01Jan2020, 13:40	0.37
Route EX-2D1	0.0225	19.3	01Jan2020, 13:20	3.01
Route EX-2D2	0.0198	13.2	01Jan2020, 13:20	2.03
Route EX-2D3	0.0256	15.8	01Jan2020, 13:20	2.03
Route Res OS-1	0.0634	29.1	01Jan2020, 13:50	2.02
Route Res OS-5	0.2756	128.3	01Jan2020, 14:40	1.88
Route Upper Basin	0.2973	130.1	01Jan2020, 15:30	1.84
Route Upper Junction	0.3169	136.6	01Jan2020, 15:00	2.07
R-EX-1	0.4233	136.1	01Jan2020, 15:30	1.55
R-EX-2	0.4749	145.5	01Jan2020, 15:00	1.67
R-EX-3	0.0936	34.0	01Jan2020, 13:45	1.84
Sink EX-1	0.4233	136.1	01Jan2020, 15:25	1.55
Sink EX-2	0.4749	145.5	01Jan2020, 14:55	1.67
Sink EX-3	0.0936	34.0	01Jan2020, 13:40	1.84
Sink EX-4	0.0100	7.5	01Jan2020, 12:00	1.19
Upper Junction	0.2150	114.3	01Jan2020, 14:15	1.99

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b. The ***fully developed conditions*** for the site are as follows:

Generally, runoff will sheet flow off of the various highpoints within each sub-basin. These flows will sheet flow towards natural swales and/or road ditches. More specific flow descriptions can be found in the Design Point description tables in the following sections. A feature of the drainage for most of these areas is that the peak runoff from the proposed development arrives at Higby Road earlier and its peak is thus mostly offset from the peak flows from upstream contributors of runoff. This reduces the affects of development on the overall peak discharge across Higby Road. To further reduce the effects of undetained development, the proposed detention ponds will over-detain as much as practical given the space available. This generally leads to a small decrease for the Q50 and Q100 events and neglibible increases for the higher probability storms within tolerances considered allowable by the MHFD-Detention spreadsheet parameters. Additional discussion regarding the offsetting of peak flows throughout the basins is available in Appendix A. Natural detention created by Higby Road also buffers increases in runoff from the proposed development.

- **West Basin:**
  Because of the very low density of the development (ECM I.7.1.B.5 - Large Lot Single-Family Development), the residential areas are only detained as necessary to prevent an increase in the total flow discharge from the property. The proposed streets, however, do require detention and this is provided for the majority of the proposed streets. However, it is impractical to detain flows from the two cul-de-sacs resulting in 0.55 acres of impervious streets undetained (0.28 AC in Sub-basin W-1 & 0.27 acres in Sub-basin W-7). Per ECM Section I.7.1.C.3 the UD-BMP Runoff Reduction calculation has been used to determine that the flows from these two cul-de-sacs are treated via infiltration of the entire WQ volume prior to entering the wetland tract. The flow path will be protected from development by a combination of road Right of Way and Drainage Easements designed to maintain the pervious footprint indicated in the UD-BMP runoff reduction spreadsheet. This spreadsheet can be found in the appendices. Sub-basins and Design Points within this major basin are summarized in Tables 3.3, 3.4, and 3.5 below:

Table 3.3a
Grandwood Ranch
West Basin
Proposed Conditions - Sub-basin Summary

Basin	Area	Q5	Q100
	acres	cfs	cfs
OS-1	40.6	14.9	37.8
OS-2A	14.4	5.7	14.6
OS-2B	6.4	5.5	14.0
OS-3A	21.5	5.5	14.0
OS-3B	16.4	11.0	26.4
OS-3C	12.7	5.2	13.2
OS-4A	12.7	6.2	15.9
OS-4B	12.4	5.3	13.4
OS-4C	19.7	6.3	16.1
OS-4D	12.4	4.5	11.5

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Table 3.3 b Grandwood Ranch West Basin Proposed Conditions - Sub-basin Summary			
OS-4E	31.6	11.5	29.2
OS-4F	13.3	4.8	12.3
OS-4G	48.4	16.5	42.0
OS-4H	13.3	5.2	13.1
W-1	19.3	7.0	17.4
W-2	3.1	0.2	1.2
W-3	7.3	3.0	7.6
W-4	3.9	1.3	3.3
W-5	9.3	2.1	5.4
W-6	1.8	0.8	2.1
W-7	16.4	6.3	15.8
W-8	2.5	1.0	2.7
W-9	2.0	0.7	1.7
D-1	10.8	6.7	15.1
D-2	8.2	4.5	9.5

Table 3.4
Grandwood Ranch
West Basin
Proposed Design Point Summary

Design Point	**Sub-Basins**	**Downstream Design Point**	**Total Area (ac.)**	**Q(5) (cfs)**	**Q(100) (cfs)**
1	OS-1	EX-3	40.6	13.3	29.1
2	OS-3A, OS-3B, OS-3C	C-2	48.8	14.4	36
3	OS-4B, OS-4C, OS-4D,OS-4E, OS-4F, OS-4G	C-2	137.6	44.9	114.3
C-1	OS-2A, OS-2B, W-3	C-3	33.2	9.5	23.9
C-2	W-4, Design Point 2, OS-4A, Design Point 3, OS-4H, W-5	C-3	225.9	53.6	135.1
C-3	W-8, Design Point C-1, Design Point C-2, W,6, W-7	EX-2	280.7	57.0	142.9
C-4	D-1	EX-2	12.8	6.7	15.1
C-5	D-1	EX-2	12.8	6.7	15.1
C-6	D-2	EX-2	6.4	4.5	9.5
C-7	W-9	EX-2	1.9	0.7	1.7
EX-2	W-2, Pond 1, Design Point C-3, Pond 2, W-9	N/A	305.0	54.6	143.2
EX-3	Design Point 1, W-1	N/A	59.9	11.2	35.7
Total West Basin Discharge Across Higby Road				65.8	178.9

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Table 3.5 **Grandwood Ranch** **West Basin** **Proposed Design Point Flow Description**	
Design Point	**Description**
1	Flows from this Design Point originate from the offsite detention basin located on Timberview Subdivision Phase II. These flows are conveyed onsite through overland flows through sub-basin W-1 and proceed to drain into culvert EX-3. Flow for this Design Point does not follow a defined channel through the site.
2	The flows at this point represent the offsite flows from a series of sub-basins concentrating at an existing drainage easement. These sub-basins are consistent between the pre- and post-development conditions. As the flows proceed onsite, there is some existing channelization on the boundary of sub-basins W-3 and W-4, towards culvert C-2, however the predominant flow mechanism is overland flow.
3	This Design Point captures the overland flows for a series of offsite sub-basins that are consistent between the pre- and post- development conditions. These flows travel overland to the culvert at Design Point C-2 and avoid the existing drainage easement.
C-1	This design point crosses the proposed east-west road. Flows follow the existing site topology and road embankment to concentrate at this location. Flows will be discharged into sub-basin W-8.
C-2	This design point is a culvert crossing the east-west road. Flows come from Design Points 2 and 3, across sub-basin W-4. Culvert C-2 discharges into sub-basin W-8 where flow proceeds as overland flow.
C-3	This design point captures the overland flows from the majority of the south-east area of the West Basin as well as the incoming flows from culverts C-1 and C-2 and conveys them across the north-south road and into sub-basin W-2 for discharge from the site.
C-4	This Design Point captures the overland flow from a section of sub-basin D-1 and the runoff from a section of the road for routing to Pond 1. The culvert passes these flows under a small section of road that does not require detention.
C-5	This Design Point captures the overland flow from sub-basin D-1 for transport under the east-west road to Pond 1.
C-6	This Design Point captures the overland flow from a section of sub-basin D-2 and the runoff from the east-west road for conveyance across a small section of roadway (0.27 ac.) that does not require detention.
C-7	This design point captures the overland flow from basin W-9 for passage through a culvert under the north-south road and into sub-basin W-2 for discharge from the site.

Drawings of these sub-basins and design points are illustrated in Drawing DR-02 in Appendix D.

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- **East Basin:**
  Because of the very low density of the development (ECM I.7.1.B.5 - Large Lot Single-Family Development), the residential areas are only detained as necessary to prevent an increase in the total flow discharge from the property. The proposed streets, however, do require detention. Per ECM Section I.7.1.C.3 the UD-BMP Runoff Reduction calculation has been used to determine that these flows are treated via infiltration of the entire WQ volume prior to entering the drainage tract. Sub-basins and Design Points within this major basin are summarized in Q_5 and Q_{100} HMS tables and Tables 3.6, 3.7, and 3.8 on the following pages:

Table 3.6
Grandwood Ranch
East Basin
Proposed Conditions - Sub-basin Summary

Basin	**Area**	Q5	Q100
	acres	cfs	cfs
OS-5	15.6	4.2	10.6
OS-6A	24.7	9.5	24.3
OS-6B	37.0	13.0	33.2
OS-6C	52.7	16.8	42.7
OS-6D	62.5	20.9	53.2
E-1	5.0	2.1	5.3
E-2	8.5	3.1	7.2
E-3	21.5	3.1	9.9
E-4A	8.0	2.8	7.2
E-4B	6.6	2.3	6.0
D-3	19.2	4.5	14.2
D-4A	4.4	1.3	3.4
D-4B	6.6	2.7	6.8

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Table 3.7
Grandwood Ranch
East Basin
Proposed Design Point Summary

Design Point	Sub-Basins	Downstream Design Point	Total Area (ac.)	Q(5) (cfs)	Q(100) (cfs)
4	OS-6A, OS-6B, OS-6C, OS-6D	5	177.0	44.9	128.8
5	Design Point 4 (Offsite reservoir)	C-10	177.0	53.1	135.7
C-8	E-1	EX-3	13.2	2.1	5.3
C-9	D-3	EX-3	19.2	4.5	14.2
C-10	OS-5, E-2	EX-3	22.5	7.3	17.8
C-11	Design Point 4, E-4A, E-4B	EX-3	191.0	45.7	130.9
C-12	D-4A, D-4B	EX-3	6.6	4.0	10.2
EX-1	E-1, Pond 3, Pond 4, E-3	N/A	270.9	49.5	140.6

Table 3.8
Grandwood Ranch
East Basin
Proposed Design Point Flow Description

Design Point	Description
4	This Design Point measures the outflow from the offsite detention basin in sub-basin OS-6A. Flows discharged from the reservoir travel overland onto the site to Design Point C-10.
5	The Design Point measures the incoming flow to the offsite reservoir on basin OS-6A. These flows are described in the Bent Tree III Drainage Report. Once detained in the offsite detention basin, their peak is attenuated, and the detention basin discharges to Design Point 4.
C-8	This Design Point measures the overland flow from sub-basin E-1 and into culvert C-8. This culvert directs flows across the road, around Pond 3, and into sub-basin E-3 for discharge off site.
C-9	This Design Point measures the overland flow from sub-basin D-3 and into the culvert. This flow is directed across the road where it flows into Pond 3.
C-10	This Design Point measures the overland flow from sub-basin E-2 and directs the flow across the road and into sub-basin E-3. Sub-basin E-2 includes a small section of road (0.41 ac.) that does not require detention and is discharged into sub-basin E-3.
C-11	This Design Point measures the flow from the offsite detention basin in Bent Tree III and overland flow from two onsite sub-basins. This flow is conducted through a culvert and into sub-basin E-3 for discharge from the site.
C-12	This design point describes a low point in the roadside swale in sub-basin D-4B Runoff will sheet flow from this sub-basin until it is captured in the roadside swale and directed to the 18-inch culvert.

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- **Minor Central Basin:**
  Under proposed conditions flows for this small basin towards the middle of the study area will sheet flow towards two low points near Higby Road. Sub-basins and Design Points within this major basin are summarized and described in Tables 3.9, 3.10, and 3.11 on the following pages:

Table 3.9 Grandwood Ranch Minor Central Basin Proposed Conditions - Sub-basin Summary			
Basin	**Area**	**Q5**	**Q100**
	(ac.)	**(cfs)**	**(cfs)**
W-10	8.2	3.6	12.7

Table 3.10 **Grandwood Ranch** **Minor Central Basin** **Proposed Design Point Summary**					
Design Point	**Sub-Basins**	**Downstream Design Point**	**Total Area (ac.)**	**Q5 (cfs)**	**Q100 (cfs)**
MHFD: UD Detention	Basin W-10	N/A	8.2	2.7	5.7

Note: The size and nature of this basin allowed analysis of the Natural detention created by the Higby Road Crossing within the MHFD UD-Detention spreadsheet. The analysis indicated that a restrictor plate would be required on the 18-inch crossroad culvert approximately 6 inches above the invert. This provides a maximum depth for the Q100 event that does not cause the road to surcharge.

c. Summary of Site Discharges

Table 3.11 Grand Wood Ranch Comparison of Site Discharges						
Design Point	Pre Development		Post Development		Ratio Pre vs Post	
	Q5	Q100	Q5	Q100	Q5	Q100
EX-1	47.3	136.6	49.5	140.6	1.05	1.03
EX-2	56.4	145.5	54.6	143.2	0.97	0.98
EX-3	10.6	34	11.2	35.7	1.06	1.05
EX-4 UD Detention Analysis	2.5	10	2.7	5.7	1.08	0.57

Note: UD-Detention Allows for a ratio up to 1.10 without highlighting the Ratio Cell Red.

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d. Detention

A summation of the proposed detention and water quality ponds is found below. These numbers are preliminary and will be finalized in the Final Drainage Report, as will the various pond outfall structures. UD-Detention spreadsheets for each detention pond can be found in Appendix A. Detention ponds will be privately owned and maintained by the HOA. Please note that significant over detention is provided.

Table 3.12
Pond Summary Table
Jackson Creek

Major Basin	Pond ID	Analysis Method	Contributing Basins	Approximate Detention Volumes			EX 5-YR	PR 5-YR	EX 100 YR	PR 100 YR
				WQCV	EURV	Q100				
				Ac.-Ft.	Ac.-Ft.	Ac.-Ft.	(CFS)	(CFS)	(CFS)	(CFS)
West	Pond 1	UD-Detention (EDB)	D-1	R:0.138 P:0.138	R:0.430 P:0.432	R:0.752 P:0.847	1.5	0.9	6.9	4.4
West	Pond 2	UD-Detention (EDB)	D-2	R:0.082 P:0.082	R:0.168 P:0.169	R:0.445 P:0.576	3.4	0.1	14.1	7.3
East	Pond 3	UD-Detention (EDB)	D-3	R:0.176 P:0.195	R:0.329 P:0.368	R:1.130 P:1.347	7.0	0.3	30.1	25.7
East	Pond 4	UD-Detention (EDB)	D-4	R:0.059 P:0.060	R:0.106 P:0.107	R:0.357 P:0.470	3.2	1.9	13.1	6.4

R: Required (as indicated in MHFD-Detention)
P: Provided

Emergency Overflows

Table 3.13
Emergency Overflow Weirs

Major Basin	Pond ID	Description of Emergency Overflow Weir
West	Pond 1	In the case of blockage, the emergency overflow weir will direct flows into the adjacent wetland area. From here flows will continue to follow historic paths.
West	Pond 2	In the case of blockage, the emergency overflow weir will direct flows into the adjacent wetland area. From here flows will continue to follow historic paths.
East	Pond 3	In the case of blockage, the emergency overflow weir will direct the surcharge into the adjacent Higby Road ditch. From here flows are directed into the adjacent wetland area. Flows will continue to follow historic paths.
East	Pond 4	In the case of blockage, the emergency overflow weir will direct flows into the adjacent wetland area. From here flows will continue to follow historic paths.

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Outfall Analysis

Outfall analysis will be completed with the Final Drainage report. The discharges will need to comply with the criteria indicated for erosive soils in Table 12-3 (shown below) of the DCM regarding Hydraulic Design Criteria for natural unlined channels.

Table 12-3. Hydraulic Design Criteria for Natural Unlined Channels

Design Parameter	Erosive Soils or Poor Vegetation	Erosion Resistant Soils and Vegetation
Maximum Low-flow Velocity (ft/sec)	3.5 ft/sec	5.0 ft/sec
Maximum 100-year Velocity (ft/sec)	5.0 ft/sec	7.0 ft/sec
Froude No., Low-flow	0.5	0.7
Froude No., 100-year	0.6	0.8
Maximum Tractive Force, 100-year	0.60 lb/sf	1.0 lb/sf

[1] Velocities, Froude numbers and tractive force values listed are average values for the cross section.
[2] "Erosion resistant" soils are those with 30% or greater clay content. Soils with less than 30% clay content shall be considered "erosive soils."

The Web Soil Survey for the site indicates that the Soils for the receiving swale are are classified as gravely or sandy loams which are erosive soils.

Further analysis will be completed with the Final Draiange Report.

Phasing:

Ponds will be constructed as required to provide treatment and detention for the proposed development.

Jurisdictional Dam Determination-On Site:

All proposed detention ponds have been specifically designed to be under the criteria for a jurisdictional Dam.

Analysis of Off-site Upstream Dams:

There are two existing detention ponds upstream of the proposed development:

<u>Timberview Subdivision Phase II:</u>

This detention pond is located near the northwest corner of the proposed development. This pond is briefly described in the FDR for Timberview Subdivision Phase II. Based on the anticipated discharge from the pond and the contours shown in the Phase II FDR drainage map the pond is estimated to detain water at a depth of approximately 3 feet and a volume of approximately 0.5 Acre-feet. Using these values in the Colorado Division of Water Resources "Estimation of Dam Breach Parameters Using the Froehlich 2008 Method", the peak discharge during a breach event is estimated to be approximately 73 cfs. This flow is small enough that downstream infrastructure, including driveway culverts will be able to handle the flow with little to no damage and no loss or

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endangerment of life is anticipated. Therefore, the embankment of this pond should be considered a "No Public Hazard" Dam (NPH)

Bent Tree Filing No. 3:

Detention for Bent Tree Filing No. 3 is provided in a detention pond just east of the proposed development. According to the FDR the Bent Tree Filing No. 3 the detention pond is anticipated to be approximately 10.07 feet deep (just over Jurisdictional Dam Criteria) with a volume of 3.8 Acre-Feet. Using these values in the Colorado Division of Water Resources "Estimation of Dam Breach Parameters Using the Froehlich 2008 Method", a peak discharge during a breach event is estimated to be approximately 807 cfs.

To accommodate this flow and minimize the hazard of the embankment, proposed lots (Lot 9) within the Grandwood Ranch development have been configured to allow the natural swale currently carrying the pond discharge to fall close to the lot lines. This swale will terminate just before the proposed roadway at an inlet or FES where normal flows will be captured and directed across the proposed road and back into natural drainage ways. The proposed roadway at this location will receive armoring to prevent failure in the case of an upstream dam breach. Lot 9 will have a designated "No Build" area at least 90 feet wide along the north property line to provide a clear conveyance and reduce the likelihood of damage to private property in the case of a breach. The above factors allow the offsite basin hazard classification to remain at "Low Hazard."

Correspondence with the State of Colorado Division of Water Resources regarding hazard classifications and steps take to minimize the hazard has been included in Appendix C.

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IV. Drainage Facilities

A worst-case roadside ditch capacity calculation is included in the appendix. More detailed Swale and roadside ditch capacities will be included in the FDR. Crossroad culvert sizing is summarized in the table below:

Cross Road Culvert Sizing

Mannings n	0.013	(renforced concrete)	Allowable Velocities in Culverts		
Min Diameter	18	inches	Min v	3	fps
			max V	18	fps

	Design Point	Peak Discharge (cfs)	Max Slope (%)	Culvert Diameter (ft)	Velocity (ft/s)	Stormwater Treatment	
West Basin	C-1	23.9	6	1.5	16.5	Bypass of Historic Flow	
	C-1	11.5	7.5	2	14.8	Treated Developed Flow	(Basin D-2)
	C-2	135.1	3.5	3	18	Bypass of Historic Flow	(2 culverts, 69 cfs each)
	C-3	142.9	135.1	3	18	Bypass of Historic Flow	(2 culverts, 72.8 cfs each)
	C-4	15.1	2	1.5	14.71	Treated Developed Flow	
	C-5	15.1	2	3	14.71	Treated Developed Flow	
	C-6	9.5	4.5	1.5	11.9	Treated Developed Flow	
	C-7	1.7	6.5	1.5	8.3	Bypass of Historic Flow	
East Basin	C-8	5.3	7	1.5	11.9	Bypass of Historic Flow	
	C-9	14.2	6.5	2	15	Treated Developed Flow	
	C-10	17.8	3.3	1.5	12.2	Bypass of Historic Flow	
	C-11	130.9	2.5	2.5	15	Bypass of Historic Flow	(2 culverts, 65.6 cfs each)
	C-12	10.2	10	1.5	14.75	Treated Developed Flow	

The preliminary plan for this development lays out several proposed drainage easements along areas of defined or concentrated flow. The proposed conditions Drawings DR-02 through DR-04 indicate where an engineered site plan will be required. This will require the consideration of these flows in the design of each lot and will allow the builder to choose the optimal solution to convey these flows through each lot.

V. STRUCTURE IMPROVEMENTS

Because all flows from Grandwood Ranch, which require treatment, are to be treated for water quality and detention onsite and the proposed project will not increase peak flows from the property, additional construction in any downstream Regional Detention Pond and/or improvements to the channel downstream will not be required.

Existing Infrastructure:
EX-1: 48-inch CMP
Condition Fair. Some rust in the bottom third of the culvert.
Improvement: None required

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	Minor Event	Major Event	
Flow	49.5	140.6	CFS
Velocity	4.81	10.49	Ft/s
PR Depth Over Higby	N/A	0.26	Ft
EX Depth Over Higby	N/A	0.23	Ft

EX-2: 30-inch by 42-inch Elliptical CMP
Condition: Fair. Minor rust in floor of culvert. Minor sediment accumulation in upstream end of pipe.
Improvement: Add 1-19-inch by 30-inch HERCP to reduce Q100 discharge across Higby Rd.

	Minor Event	Major Event	
Flow	56.4	143.2	CFS
Velocity (Existing 30"x 42")	17.01	20.47	Ft/s (Note: Improved over EX)
Velocity (Proposed 19"x 30")	N/A	10.78	Ft/s
PR Depth Over Higby	N/A	0.16	Ft
EX Depth Over Higby	N/A	0.22	Ft

EX-3: 15-inch CMP
Condition Fair. Some rust and sediment accumulation.
Improvement: Remove sediment

	Minor Event	Major Event	
Flow	11.2	35.7	CFS
Velocity	9.16	9.28	Ft/s
PR Depth Over Higby	N/A	0.12	Ft
EX Depth Over Higby	N/A	0.11	Ft

EX-4: 18-inch CMP
Condition Fair. Some rust and sediment accumulation.
Improvement: Remove sediment

	Minor Event	Major Event	
Flow	2.7	5.7	CFS
Velocity	3.89	5.01	Ft/s
PR Depth Over Higby	N/A	N/A	Ft
EX Depth Over Higby	N/A	N/A	Ft

VI. FLOODPLAINS

Per the ***Flood Insurance Rate Map (FIRM) 08041C 0279-G***, effective date December 7, 2018, published by the Federal Emergency Management Agency (FEMA), no portion of Grandwood Ranch (Waterview East) lies within any designated 100-year floodplain. This map can be found in Appendix C.

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VII. Environmental Evaluations

A. WETLAND IMPACTS

Wetlands and protected wildlife habitats within the project area will not be affected by the proposed development.

B. STORMWATER QUALITY

All on-site detention facilities shall be designed to accommodate water quality requirements. As the development of each parcel progresses, the detention guidelines outlined in this report are to be upheld.

Per Chapter 1, Section 4, of the El Paso County DCM, the DCM requires the UDFCD Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls.

Step 1: **Employ Runoff Reduction Practices**

- The low-density nature of this development and the fact that, with a minor exception along a retaining wall, none of the streets will have curb and gutter, means that most, if not all, runoff from impervious surfaces will sheet flow across pervious areas to grass lined swales.

Step 2: **Stabilize Drainageways.**

- The site is in the Jackson Creek Drainage Fee Basin. Drainage fees, to be paid by the relevant Grandwood Ranch developers at the time of platting, will help fund proposed channel improvements. Information on planned future improvements to the Jackson Creek channel was unavailable for this report.

Step 3: **Provide Water Quality Capture Volume**

- As required by the DCM, runoff from the proposed streets which is feasible to detain, is directed into proposed detention ponds. Each pond, or series of ponds, will be designed to meet the DCM standards for the release rates of Full Spectrum Detention Ponds for Water Quality Capture Volumes.

Step 4: **Consider Need for Industrial and Commercial BMPs**

- There are no commercial or industrial components of this development, therefore no BMPs of this nature are required. The Full Spectrum Detention BMP is provided for the proposed Development by the East Pond.

A. PERMITTING REQUIREMENTS

No additional permitting requirements are expected at this time.

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VIII. Selected Plan (Implementation of DBPS)

A. PLAN HYDROLOGY

The hydrology for the site has been provided above and complies with the DCM. There is no DBPS for the proposed development.

B. SYSTEM IMPROVEMENTS

No improvements to the existing system are anticipated.

C. SYSTEM PRIORITIES/PHASING

No phasing of the development beyond Filing No. 1 has been provided at this time. Once development of any portion of the site begins, the owner will be responsible for providing detention and water quality in accordance with this MDDP, before releasing downstream.

D. GOVERNMENTAL AGENCY REQUIREMENTS

There are no governmental agency requirements for this development.

E. MAINTENANCE REQUIREMENTS

Maintenance requirements for all stormwater quality and erosion control procedures will be outlined the Erosion Control and Storm Water Management Plans. The detention and water quality treatment ponds proposed in this report will be privately owned and maintained by the Grandwood Ranch Homeowners Association.

F. RECOMMENDATION FOR IMPLEMENTATION

It is recommended that any development of the site initiates the implementation of the detention and water quality procedures that have been detailed in this report. In doing so, the developed conditions will produce runoff comparable to that of predevelopment conditions, which will allow the site to continue to adhere to the DCM and protect downstream owners and facilities.

IX. Fee Development

A. UNDEVELOPED PLATTABLE LAND

The Grandwood Ranch Subdivision is made up entirely of undeveloped and unplatted land. Jackson Creek is included within the El Paso County Drainage Basin Fee program. The Drainage Fee will be calculated as part of the Final Drainage Report and must be paid at the time of plat recordation.

X. Construction Cost Opinion

Specific construction costs will be provided in an FDR for the development.

XI. References

1. ***El Paso County and City of Colorado Springs Drainage Criteria Manual, Volume 1 & 2***, El Paso County, May 2014
2. ***El Paso County Engineering Criteria Manual,*** El Paso County, Rev. December 2016
3. ***Web Soil Survey of El Paso County Area, Colorado. Unites States Department of Agriculture Soil Conservation Service***.

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4. ***Flood Insurance Rate Maps for El Paso County, Colorado and Incorporated Areas, Panel 279 of 1275, Federal Emergency Management Agency***, Effective Date December 7, 2018.
5. ***Urban Storm Drainage Criteria Manual, Vol. 1-3*** by Urban Drainage and Flood Control District (UDFCD), January 2016
6. ***Final Drainage Report for Timberview Subdivision Phase II***, by Premier Engineering Inc., June 5, 2001.
7. ***Final Drainage Report for Bent Tree Subdivision Filing No. 3,*** by RTW Professional Engineers and Consultants, Inc. March 1993.

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XII. Appendices

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APPENDIX A

HYDROLOGIC AND HYDRAULIC CALCULATIONS

SCS Composite Curve Number

Existing Conditions

Basin	Land Type	Area (AC)	CN	% I	Weighted CN	Weighted % I	Initial Abstraction, Ia
EX-1A	2 AC Residential	19.3	65	12	46.64	2.82	1.14
	Pinyon-Juniper-Good	62.8	41	0			
EX-1B	2 AC Residential	5.2	65	12	56.65	7.83	0.77
	Pinyon-Juniper-Good	2.8	41	0			
EX-1C	2 AC Residential	5.8	65	12			0.54
EX-1D	2 AC Residential	24.7	65	12			0.54
EX-1E	2 AC Residential	37.0	65	12			0.54
EX-1F	2 AC Residential	52.7	65	12			0.54
EX-1G	2 AC Residential	62.5	65	12			0.54
EX-2A	2 AC Residential	14.4	65	12			0.54
EX-2B	Woods, good	18.3	55	0	38.70	0.7	1.58
	Pinyon-Juniper-Good	13.8	41	0			
	2 AC Residential	2.1	65	12			
EX-2C1	2 AC Residential	13.3	65	12			0.54
EX-2C2	Woods, good	23.2	55	0	36.10	0	1.77
	Pinyon-Juniper-Good	10.1	41	0			
EX-2C3	Woods, good	3.0	55	0	37.50	0	1.67
	Pinyon-Juniper-Good	3.1	41	0			
EX-2D	2 AC Residential	20.4	65	12	66.74	16.64	0.50
	Road	1.1	98	100			
EX-2D1	2 AC Residential	14.4	65	12			0.54
EX-2D2	2 AC Residential	12.7	65	12			0.54
EX-2D3	2 AC Residential	16.4	65	12			0.54
EX-2E	2 AC Residential	12.4	65	12			0.54
EX-2F	2 AC Residential	19.7	65	12			0.54
EX-2G	2 AC Residential	12.4	65	12			0.54
EX-2H	2 AC Residential	31.6	65	12			0.54
EX-2I	2 AC Residential	13.3	65	12			0.54
EX-2J	2 AC Residential	48.4	65	12			0.54
EX-3	2 AC Residential	4.2	65	12	59.5	2.6	0.68
	Meadow	15.2	58	0			
EX-3A	2 AC Residential	40.6	65	12			0.54
EX-4	Woods, good	8.17	55	0			0.82

Lag Time Calculations

Existing Conditions

	Flow Lengths				Initial Flow				Channel Flow							
Basin	Initial	True Initial Length	Channel	True Channel Length	High Point	Low Point	Average	Initial	High Point	Low Point	Average	Velocity	Channel	Time of Concentration	Time of Concentration	Lag Time
	ft	ft	ft	ft	Elevation	Elevation	Slope	Tt (hr)	Elevation	Elevation	Slope	(ft/s)	Tt (hr)	Tc (hr)	Tc (min)	t lag (min)
EX-1A	2600.8	300	0	2301	7409	7269	0.05	1.2	7409	7269	0.07	4.3	0.1	1.4	83.8	50.3
EX-1B	1746.9	300	0	1447	7426	7323	0.06	1.2	7426	7323	0.08	4.6	0.1	1.3	77.4	46.4
EX-1C	1099.9	300	0	800	7401	7303	0.09	1.0	7401	7303	0.13	5.8	0.0	1.1	63.4	38.1
EX-1D	1334.2	300	0	1034	7432	7329	0.08	1.1	7432	7329	0.10	5.1	0.1	1.1	68.1	40.8
EX-1E	2105.6	300	0	1806	7484	7354	0.06	1.2	7484	7354	0.08	4.6	0.1	1.3	77.4	46.5
EX-1F	2718.3	300	0	2418	7505	7375	0.05	1.3	7505	7375	0.06	4.0	0.2	1.5	88.6	53.2
EX-1G	2446.8	300	0	2147	7506	7375	0.05	1.2	7506	7375	0.07	4.3	0.1	1.4	83.3	50.0
EX-2A	1451.2	300	0	1151	7409	7269	0.10	1.0	7409	7269	0.13	5.8	0.1	1.0	62.5	37.5
EX-2B	1720.2	300	0	1420	7264	7159	0.06	1.2	7264	7159	0.08	4.6	0.1	1.3	76.5	45.9
EX-2C1	1391.1	300	0	1091	7365	7258	0.08	1.1	7365	7258	0.10	5.1	0.1	1.1	68.5	41.1
EX-2C2	2561.1	300	0	2261	7350	7182	0.07	1.2	7350	7182	0.08	4.6	0.1	1.3	77.4	46.4
EX-2C3	882.9	300	0	583	7235	7156	0.09	1.0	7235	7156	0.14	6.0	0.0	1.0	62.7	37.6
EX-2D	2587.1	300	0	2287	7400	7248	0.06	1.2	7400	7248	0.07	4.3	0.1	1.4	81.2	48.7
EX-2D1	1285.8	300	0	986	7411	7316	0.07	1.1	7411	7316	0.10	5.1	0.1	1.2	69.1	41.4
EX-2D2	1192.4	300	0	892	7430	7317	0.10	1.0	7430	7317	0.13	5.8	0.0	1.0	62.1	37.3
EX-2D3	1794.6	300	0	1495	7429	7289	0.08	1.1	7429	7289	0.10	5.1	0.1	1.2	69.4	41.6
EX-2E	1338.1	300	0	1038	7410	7249	0.12	0.9	7410	7249	0.16	6.5	0.0	0.9	57.0	34.2
EX-2F	2590.9	300	0	2291	7379	7259	0.05	1.3	7379	7259	0.06	4.0	0.2	1.5	89.1	53.5
EX-2G	1700.5	300	0	1400	7432	7309	0.07	1.1	7432	7309	0.09	4.8	0.1	1.2	71.3	42.8
EX-2H	2113.0	300	0	1813	7477	7328	0.07	1.1	7477	7328	0.09	4.8	0.1	1.2	73.4	44.0
EX-2I	1793.7	300	0	1494	7425	7309	0.06	1.2	7425	7309	0.08	4.6	0.1	1.2	75.0	45.0
EX-2J	1636.1	300	0	1336	7466	7382	0.05	1.3	7466	7382	0.07	4.3	0.1	1.4	81.4	48.9
EX-3	1543.1	300	0	1243	7251	7171	0.05	1.3	7251	7171	0.07	4.3	0.1	1.3	81.0	48.6
EX-3A	2132.5	300	0	1832	7403	7251	0.07	1.1	7403	7251	0.09	4.8	0.1	1.2	73.2	43.9
EX-4	1094.6	300	0	795	7340	7244	0.09	1.0	7340	7244	0.13	5.8	0.0	1.1	63.8	38.3

Note: Maximum True Initial = 300 LF
Blue Shading indicates inputs to the spreadsheet
Unshaded indicates Calculations performed by the spreadsheet

Flowpath Routing

Exisiting Conditions

Routing calculations were completed through a combination of flow path calculations and known flow path lengths through sub-basins. These methods are noted below.

By Basin Path	Flow Path	Lag Time
EX-1A		
DP 4 to DP EX-1	EX-1A	50.3
EX-1D		
EX-1E	EX-1D	40.8
EX-1F	Flow Path 6	54.5
EX-1G	Flow Path 6	54.5
EX-2A	EX-2B	45.9
EX-2B		
EX-2C1	Flow Path 3	53.1
EX-2C2	Flow Path 4	50.1
EX-2C3		
EX-2D	EX-2B	45.9
EX-2D1	EX-2D	48.7
EX-2D2	EX-2D	48.7
EX-2D3	These basins match proposed basins and routing calculations	90.0
EX-2E		96.2
EX-2F		48.3
EX-2G		95.6
EX-2H		100.1
EX-2I		95.6
EX-2J		102.7
EX-3		
EX-3A	EX-3	48.6
EX-4		

By Path Length

		Flow Lengths				Initial Flow				Channel Flow							
Flow Path Number	Description	Initial	True Initial Length	Channel	True Channel Length	High Point	Low Point	Average	Initial	High Point	Low Point	Average	Velocity	Channel	Time of Concentration	Time of Concentration	Lag Time
		ft	ft	ft	ft	Elevation	Elevation	Slope	Tt (hr)	Elevation	Elevation	Slope	(ft/s)	Tt (hr)	Tc (hr)	Tc (min)	t lag (min)
1	Design Point 5 to Design Point 4	461	300	0	161	7323	7304	0.04	1.40	7323	7304	0.12	5.6	0.0	1.4	84.5	50.7
2	EX-1F/EX-1G to DP 6	1231.3	300	0	931	7375	7329	0.04	1.44	7375	7329	0.05	3.6	0.1	1.5	90.9	54.5
3	EX-2C1 to Culvert C-2	2198.7	300	0	1899	7258.61	7160	0.04	1.34	7259	7160	0.06	4.0	0.1	1.5	88.5	53.1
4	EX-2C2 to Culvert C-2	528.2	300	0	228	7182.147	7160	0.04	1.38	7182	7160	0.10	5.1	0.0	1.4	83.5	50.1
5	DP 3 to EX-2B	720	300	0	420	7298	7249.39	0.07	1.14	7298	7249	0.12	5.6	0.0	1.2	69.6	41.7
6	Junction of EX-1F/EX-1G to Reservoir OS-6	1231.3	300	0	931	7375	7329	0.04	1.44	7375	7329	0.05	3.6	0.1	1.5	90.9	54.5

Note: Maximum True Initial = 300 LF

SCS Composite Curve Number

Proposed Conditions

Basin	Land Type	Area (AC)	CN	% I	Weighted CN	Weighted % I	Inital Abstraction, Ia
W-1	2 ac Residential	18.9	65	12	65.6	13.6	0.52
	Road	0.4	98	100			
W-2	Wetland	0.3	86	0	45.4	0.0	1.20
	Pinyon-Juniper-Good	2.8	41	0			
W-3	2 ac Residential	7.3	65	12			0.54
W-4	2 ac Residential	3.9	65	12			0.54
W-5	2 ac Residential	9.3	65	12			0.54
W-6	2 ac Residential	1.8	65	12			0.54
W-7	2 ac Residential	16.1	65	12	65.5	13.4	0.53
	Road	0.3	98	100			
W-8	2 ac Residential	2.5	65	12			0.54
W-9	2 ac Residential	2.0	65	12			0.54
W-10	2 ac Residential	8.2	65	12			0.54
OS-1	2 ac Residential	40.6	65	12			0.54
OS-2A	2 ac Residential	14.4	65	12			0.54
OS-2B	2 ac Residential	6.4	65	12			0.54
OS-3A	2 ac Residential	14.4	65	12	65.0	12.0	0.54
	Road	0.0	98	100			
OS-3B	2 ac Residential	20.4	65	12	66.7	16.5	0.50
	Road	1.1	98	100			
OS-3C	2 ac Residential	12.7	65	12			0.54
OS-4A	2 ac Residential	16.4	65	12			0.54
OS-4B	2 ac Residential	12.4	65	12			0.54
OS-4C	2 ac Residential	19.7	65	12			0.54
OS-4D	2 ac Residential	12.4	65	12			0.54
OS-4E	2 ac Residential	31.6	65	12			0.54
OS-4F	2 ac Residential	13.3	65	12			0.54
OS-4G	2 ac Residential	48.4	65	12			0.54
OS-4H	2 ac Residential	13.3	65	12			0.54
D-1	Road	1.3	98	100	68.4	22.3	0.46
	Pinyon-Juniper-Good	0.3	41	0			
	2 ac Residential	9.2	65	12			
D-2	2 ac Residential	6.4	65	12	72.4	31.7	0.38
	Road	1.8	98	100			
D-3	Road	0.4	98	100	64.0	12.9	0.56
	2 ac Residential	18.4	65	12			
	Pinyon-Juniper-Good	1.4	41	0			

Basin	Land Type	Area (AC)	CN	% I	Weighted CN	Weighted % I	Inital Abstraction, Ia
D-4A	2 ac Residential	4.4	65	12			0.54
D-4B	2 ac Residential	6.6	65	12			0.54
E-1	Road	0.0	98	100	68.1	12.0	0.47
	2 ac Residential	5.0	65	12			
E-2	2 ac Residential	6.8	65	12	68.1	20.2	0.47
	Road	0.7	98	100			
E-3	Wetland	0.037	86	0	54.5	6.7	0.83
	Pinyon-Juniper-Good	9.4	41	0			
	2 ac Residential	12.0	65	12			
E-4A	2 ac Residential	8.0	65	12			0.54
E-4B	2 ac Residential	5.8	65	12			0.54
E-5A	2 ac Residential	8.0	65	12			0.54
E-5B	2 ac Residential	5.8	65	12			0.54
OS-5	2 ac Residential	15.6	65	12			0.54
OS-6A	2 ac Residential	24.7	65	12			0.54
OS-6B	2 ac Residential	37.0	65	12			0.54
OS-6C	2 ac Residential	52.7	65	12			0.54
OS-6D	2 ac Residential	62.5	65	12			0.54

Lag Time Calculations

Proposed Conditions - West and Central Basins

	Flow Lengths				Initial Flow				Channel Flow							
Basin	Initial	True Initial Length	Channel	True Channel Length	High Point	Low Point	Average	Initial	High Point	Low Point	Average	Velocity	Channel	Time of Concentration	Time of Concentration	Lag Time
	ft	ft	ft	ft	Elevation	Elevation	Slope	Tt (hr)	Elevation	Elevation	Slope	(ft/s)	Tt (hr)	Tc (hr)	Tc (min)	t lag (min)
W-1	1536.2	300	0	1236.2	7251	7172	0.051	1.270	7251	7172	0.07	4.3	0.1	1.4	81.0	48.6
W-2	279.0	279.0	207.3	207.3	7202	7169	0.117	0.862	7202	7156	0.23	7.7	0.0	0.9	52.2	31.3
W-3	490.2	300	0	190.2	7274	7205	0.141	0.849	7274	7205	0.37	9.8	0.0	0.9	51.3	30.8
W-4	525.6	300	0	225.6	7245	7221	0.046	1.330	7245	7221	0.11	5.4	0.0	1.3	80.5	48.3
W-5	1368.1	300	179.9	1248.0	7356	7276	0.058	1.206	7276	7272	0.01	1.6	0.2	1.4	85.3	51.2
W-6	723.5	300	0	423.5	7338	7261	0.107	0.949	7338	7261	0.19	7.0	0.0	1.0	57.9	34.8
W-7	1679.1	300	0	1379.1	7281	7186	0.056	1.223	7281	7186	0.07	4.3	0.1	1.3	78.8	47.3
W-8	584.0	300	0	284.0	7228	7169	0.100	0.972	7228	7169	0.21	7.4	0.0	1.0	59.0	35.4
W-9	503.4	300	0	203.4	7213	7186	0.053	1.256	7213	7186	0.14	6.0	0.0	1.3	75.9	45.6
W-10	1094.6	300	0	794.6	7340	7244	0.088	0.146	7340	7244	0.087703	1.2	0.2	0.3	19.9	11.9
D-1	1089.2	300	166.7	955.9	7287	7200	0.080	1.066	7200	7170	0.04	3.2	0.1	1.1	68.9	41.3
D-2	538.2	300	644.3	882.5	7262	7206	0.104	0.959	7206	7161	0.06	4.0	0.1	1.0	61.3	36.8
OS-1	2132.5	300	0	1832.5	7403	7251	0.071	1.115	7403	7251	0.09	4.8	0.1	1.2	73.2	43.9
OS-2A	1451.2	300	0	1151.2	7409	7269	0.096	0.987	7409	7269	0.13	5.8	0.1	1.0	62.5	37.5
OS-2B	300.0	300	0	0.0	7274	7238	0.121	0.902	7274	7238	0	0.0	0.0	0.9	54.1	32.5
OS-3A	1285.8	300	0	985.8	7411	7316	0.074	1.097	7411	7316	0.1	5.1	0.1	1.2	69.1	41.4
OS-3B	2587.1	300	0	2287.1	7400	7248	0.059	1.204	7400	7248	0.07	4.3	0.1	1.4	81.2	48.7
OS-3C	1192.4	300	0	892.4	7430	7317	0.095	0.993	7430	7317	0.13	5.8	0.0	1.0	62.1	37.3
OS-4A	1794.6	300	0	1494.6	7429	7289	0.078	1.075	7429	7289	0.1	5.1	0.1	1.2	69.4	41.6
OS-4B	1338.1	300	0	1038.1	7410	7249	0.120	0.905	7410	7249	0.16	6.5	0.0	0.9	57.0	34.2
OS-4C	1192.4	300	0	892.4	7430	7317	0.095	0.993	7430	7317	0.13	5.8	0.0	1.0	62.1	37.3
OS-4D	1700.5	300	0	1400.5	7432	7309	0.072	1.108	7432	7309	0.09	4.8	0.1	1.2	71.3	42.8
OS-4E	2113.0	300	0	1813.0	7477	7328	0.071	1.119	7477	7328	0.09	4.8	0.1	1.2	73.4	44.0
OS-4F	1793.7	300	0	1493.7	7425	7309	0.065	1.158	7425	7309	0.08	4.6	0.1	1.2	75.0	45.0
OS-4G	1636.1	300	0	1336.1	7466	7382	0.051	1.270	7466	7382	0.07	4.3	0.1	1.4	81.4	48.9
OS-4H	1391.1	300	0	1091	7365	7258	0.08	1.1	7365	7258	0.10	5.1	0.1	1.1	68.5	41.1

Note: Maximum True Initial = 300 LF

Blue Shading indicates inputs to the spreadsheet

Unshaded indicates Calculations performed by the spreadsheet

Lag Time Calculations

Proposed Conditions - East Basin

	Flow Lengths				Initial Flow				Channel Flow							
Basin	Initial	True Initial Length	Channel	True Channel Length	High Point	Low Point	Average	Initial	High Point	Low Point	Average	Velocity	Channel	Time of Concentration	Time of Concentration	Lag Time
	ft	ft	ft	ft	Elevation	Elevation	Slope	Tt (hr)	Elevation	Elevation	Slope	(ft/s)	Tt (hr)	Tc (hr)	Tc (min)	t lag (min)
E-1	632.6	300	1052.6	1385.133	7357	7302	0.087	1.0	7304	7270	0.03	2.8	0.1	1.2	70.0	42.0
E-2	613.8	300	0	313.823	7339	7300	0.063	1.2	7339	7300	0.13	5.8	0.0	1.2	71.1	42.7
E-3	1502.6	300	0	1202.637	7339	7300	0.026	1.7	7339	7300	0.04	3.2	0.1	1.8	106.6	64.0
E-4A	1746.9	300	0	1446.865	7426	7323	0.059	1.2	7426	7323	0.08	4.6	0.1	1.3	77.4	46.4
E-4B	1099.9	300	0	799.911	7401	7303	0.089	1.0	7401	7303	0.13	5.8	0.0	1.1	63.4	38.1
D-3	885.3	300	0	585.281	7299	7251	0.055	1.2	7299	7251	0.09	4.8	0.0	1.3	76.3	45.8
D-4A	1168.3	300	0	868.343	7339	7300	0.033	1.5	7339	7300	0.05	3.6	0.1	1.6	94.8	56.9
D-4B	1052.9	300	0	752.923	7394	7300	0.089	1.0	7394	7300	0.13	5.8	0.0	1.1	63.3	38.0
OS-5	3949.9	300	0	3649.897	7423	7308	0.029	1.6	7423	7308	0.04	3.2	0.3	1.9	114.5	68.7
OS-6A	1334.2	300	0	1034.166	7432	7329	0.077	1.1	7432	7329	0.10	5.1	0.1	1.1	68.1	40.8
OS-6B	2105.6	300	0	1805.604	7484	7354	0.062	1.2	7484	7354	0.08	4.6	0.1	1.3	77.4	46.5
OS-6C	2718.3	300	0	2418.312	7505	7375	0.048	1.3	7505	7375	0.06	4.0	0.2	1.5	88.6	53.2
OS-6D	2446.8	300	0	2146.783	7506	7375	0.054	1.2	7506	7375	0.07	4.3	0.1	1.4	83.3	50.0

Note: Maximum True Initial = 300 LF

Blue Shading indicates inputs to the spreadsheet

Unshaded indicates Calculations performed by the spreadsheet

Flowpath Routing

Exisiting Conditions

Routing calculations were completed through a combination of flow path calculations and known flow path lengths through sub-basins. These methods are noted below.

By Basin Path	Flow Path	Lag Time
OS-1		
OS-2A	Flow Path 6	43.9
OS-2B	W-3	30.8
OS-3A	W-4	48.3
OS-3B	W-4, Flow Path 5	90.0
OS-3C	OS-3A	46.4
OS-4A	OS-3A	46.4
OS-4B	W-4, Flow Path 4	96.2
OS-4C	W-4	48.3
OS-4D	W-4, Flow Path 1	95.6
OS-4E	W-4, Flow Path 3	100.1
OS-4F	W-4, Flow Path 1	95.6
OS-4G	W-4, Flow Path 2	102.7
OS-4H	W-4	48.3
OS-5	E-2, E-3	106.6
OS-6A		
OS-6B	OS-6A	40.8
OS-6C	Flow Path 7	54.5
OS-6D	Flow Path 7	54.5
W-1		
W-2		
W-3		
W-4		
W-5		
W-6	W-7	47.3
W-7		
W-8		
W-9	W-2	31.3
C-1		
E-1	D-3	45.8
E-2	E-3	64.0
E-3		
E-4A		
E-4B		
Pond 1	W-2	31.3
Pond 2	W-2	31.3
Pond 3	E-3	64.0
Pond 4	E-3	64.0

Flow Path

		Flow Lengths				Initial Flow				Channel Flow							
Flow Path Number	Description	Initial	True Initial Length	Channel	True Channel Length	High Point	Low Point	Average	Initial	High Point	Low Point	Average	Velocity	Channel	Time of Concentration	Time of Concentration	Lag Time
		ft	ft	ft	ft	Elevation	Elevation	Slope	Tt (hr)	Elevation	Elevation	Slope	(ft/s)	Tt (hr)	Tc (hr)	Tc (min)	t lag (min)
1	Junction of OS-3D/OS-3F to DP 3	1159.7	300	0	860	7310	7249	0.05	1.3	7310	7249	0.08	4.6	0.1	1.3	78.8	47.3
2	OS-4G to W-4	2891.0	300	0	2591	7382.02	7249	0.05	1.3	7382	7249	0.06	4.0	0.2	1.5	90.7	54.4
3	OS-4E to DP	1959.6	300	0	1660	7340	7249	0.05	1.3	7340	7249	0.06	4.0	0.1	1.4	86.4	51.8
4	OS-4B to W-4	981.1	300	0	681	7298	7249	0.05	1.3	7298	7249	0.08	4.6	0.0	1.3	79.8	47.9
5	DP 3 to W-4	720.0	300	0	420	7298	7249	0.07	1.1	7298	7249	0.12	5.6	0.0	1.2	69.6	41.7
6	OS-2A to Culvert 2	1483.1	300	0	1183	7274	7177	0.07	1.2	7274	7177	0.09	4.8	0.1	1.2	73.2	43.9
7	Junction of OS-6C/OS-6D to Reservoir OS-6	1231.3	300	0	931	7375	7329	0.04	1.4	7375	7329	0.05	3.6	0.1	1.5	90.9	54.5
8	Reservoir OS-6 to C-10	484.9	300	0	185	7332	7305	0.06	1.2	7332	7305	0.15	6.2	0.0	1.2	74.2	44.5
9	OS-6B to Reservoir OS-6	398.4	300	0	98	7353	7329	0.06	1.2	7353	7329	0.25	8.1	0.0	1.2	71.8	43.1

Note: Maximum True Initial = 300 LF

EXISTING CONDITIONS HEC-HMS BASIN LAYOUT

```
Basin: EX GWR
     Last Modified Date: 29 June 2020
     Last Modified Time: 22:51:30
     Version: 4.3
     Filepath Separator: \
     Unit System: English
     Missing Flow To Zero: No
     Enable Flow Ratio: No
     Compute Local Flow At Junctions: No

     Enable Sediment Routing: No

     Enable Quality Routing: No
End:

Junction: DP 3a
     Last Modified Date: 22 June 2020
     Last Modified Time: 19:07:54
     Canvas X: -104.82453425314438
     Canvas Y: 39.08138556559327
     From Canvas X: -104.82456536311055
     From Canvas Y: 39.0813864101259
     Downstream: Route Upper Junction
End:

Subbasin: EX-2C3
     Last Modified Date: 23 June 2020
     Last Modified Time: 14:57:33
     Canvas X: -104.82322693129225
     Canvas Y: 39.07472031764007
     From Canvas X: -104.82350166988653
     From Canvas Y: 39.077541668329665
     Area: 0.01
     Downstream: R-EX-2

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0
     Curve Number: 37.5
     Initial Abstraction: 1.67

     Transform: SCS
     Lag: 37.6
```

```
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: EX-2I
     Last Modified Date: 3 April 2020
     Last Modified Time: 16:12:29
     Canvas X: -104.81782596518133
     Canvas Y: 39.086409535460234
     From Canvas X: -104.81770300010537
     From Canvas Y: 39.08618912602626
     Area: 0.021
     Downstream: Route DP 5

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 45
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: EX-2H
     Last Modified Date: 3 April 2020
     Last Modified Time: 16:12:12
     Canvas X: -104.81772639141457
     Canvas Y: 39.08747995345288
     From Canvas X: -104.81819063264685
     From Canvas Y: 39.08727275389623
     Label X: -1.0
     Label Y: 0.0
     Area: 0.049
     Downstream: Route ex

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None
```

```
     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 44
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: EX-2J
     Last Modified Date: 2 April 2020
     Last Modified Time: 16:05:31
     Canvas X: -104.81768493964087
     Canvas Y: 39.08539446558829
     From Canvas X: -104.81768493964087
     From Canvas Y: 39.08539446558829
     Area: 0.076
     Downstream: Route DP 6

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 48.9
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: Upper Junction
     Description: Sub-basin divided using design points
     Last Modified Date: 23 June 2020
     Last Modified Time: 14:59:08
     Canvas X: -104.82158381307086
```

```
     Canvas Y: 39.0850581337859
     From Canvas X: -104.82149569765026
     From Canvas Y: 39.0849429539758
     Label X: -18.0
     Label Y: -20.0
     Downstream: DP 3a
End:

Subbasin: EX-2C2
     Last Modified Date: 10 April 2020
     Last Modified Time: 19:08:42
     Canvas X: -104.8230493378363
     Canvas Y: 39.07642647860602
     From Canvas X: -104.82375060430341
     From Canvas Y: 39.078363151905414
     Area: 0.052
     Downstream: Route EX-2C2

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0
     Curve Number: 36.1
     Initial Abstraction: 1.77

     Transform: SCS
     Lag: 46.4
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: EX-2C1
     Last Modified Date: 22 June 2020
     Last Modified Time: 19:15:34
     Canvas X: -104.8236882215212
     Canvas Y: 39.077674390196066
     From Canvas X: -104.8242733665789
     From Canvas Y: 39.07898548794765
     Area: 0.021
     Downstream: Route EX-2C1

     Canopy: None
     Allow Simultaneous Precip Et: No
```

```
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 41.1
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: Route EX-2C1
     Last Modified Date: 23 June 2020
     Last Modified Time: 21:33:35
     Canvas X: -104.82560757475201
     Canvas Y: 39.07534443843578
     From Canvas X: -104.82449545597765
     From Canvas Y: 39.07695292108636
     Downstream: R-EX-2

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 53.1
     Channel Loss: None
End:

Reach: Route DP 6
     Last Modified Date: 23 June 2020
     Last Modified Time: 14:59:06
     Canvas X: -104.82158381307086
     Canvas Y: 39.0850581337859
     From Canvas X: -104.81901636720333
     From Canvas Y: 39.0855274518477
     Downstream: Upper Junction

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 102.7
     Channel Loss: None
End:

Reach: Route DP 5
     Last Modified Date: 23 June 2020
```

```
     Last Modified Time: 14:59:04
     Canvas X: -104.82158381307086
     Canvas Y: 39.0850581337859
     From Canvas X: -104.81973414776844
     From Canvas Y: 39.085693093516575
     Downstream: Upper Junction

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 95.59
     Channel Loss: None
End:

Reach: Route EX-2C2
     Last Modified Date: 23 June 2020
     Last Modified Time: 21:33:35
     Canvas X: -104.82560757475201
     Canvas Y: 39.07534443843578
     From Canvas X: -104.82381045264754
     From Canvas Y: 39.07616643578142
     Downstream: R-EX-2

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 50.1
     Channel Loss: None
End:

Subbasin: EX-2E
     Last Modified Date: 3 April 2020
     Last Modified Time: 16:12:32
     Canvas X: -104.82228189124373
     Canvas Y: 39.08805250261174
     From Canvas X: -104.82248902319773
     From Canvas Y: 39.08772426550872
     Area: 0.019
     Downstream: Route DP 1

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54
```

```
     Transform: SCS
     Lag: 34.2
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: EX-2D
     Last Modified Date: 22 June 2020
     Last Modified Time: 19:07:18
     Canvas X: -104.82467977472965
     Canvas Y: 39.0853146483955
     From Canvas X: -104.82256126505573
     From Canvas Y: 39.083317512170844
     Area: 0.034
     Downstream: Junction EX-2D

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 16.64
     Curve Number: 66.74
     Initial Abstraction: 0.5

     Transform: SCS
     Lag: 48.7
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: Route Upper Junction
     Last Modified Date: 23 June 2020
     Last Modified Time: 21:33:35
     Canvas X: -104.82560757475201
     Canvas Y: 39.07534443843578
     From Canvas X: -104.82453425314438
     From Canvas Y: 39.08138556559327
     Downstream: R-EX-2

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 45.9
```

```
     Channel Loss: None
End:

Subbasin: EX-2G
     Last Modified Date: 2 April 2020
     Last Modified Time: 19:15:55
     Canvas X: -104.8189286826048
     Canvas Y: 39.087790017111175
     From Canvas X: -104.81896723262034
     From Canvas Y: 39.08772426550872
     Area: 0.019
     Downstream: Route DP 3

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 42.8
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: EX-2F
     Last Modified Date: 2 April 2020
     Last Modified Time: 16:05:01
     Canvas X: -104.82057461396079
     Canvas Y: 39.08770620504422
     From Canvas X: -104.82057461396079
     From Canvas Y: 39.08770620504422
     Area: 0.031
     Downstream: Route DP 2

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
```

```
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 53.5
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: EX-2A
     Description: Culvert at outlet. Max flow 29 cfs
     Last Modified Date: 25 June 2020
     Last Modified Time: 21:54:09
     Canvas X: -104.8289960363567
     Canvas Y: 39.083231977267154
     From Canvas X: -104.82572184634314
     From Canvas Y: 39.08447338189881
     Area: 0.022
     Downstream: Route EX-2A

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 37.5
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: Route DP 3
     Last Modified Date: 23 June 2020
     Last Modified Time: 14:58:52
     Canvas X: -104.82158381307086
     Canvas Y: 39.0850581337859
     From Canvas X: -104.81918395819433
     From Canvas Y: 39.08712827018024
     Downstream: Upper Junction
```

```
     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 95.59
     Channel Loss: None
End:

Reach: Route DP 2
     Last Modified Date: 23 June 2020
     Last Modified Time: 14:58:52
     Canvas X: -104.82158381307086
     Canvas Y: 39.0850581337859
     From Canvas X: -104.82056817382905
     From Canvas Y: 39.086834154708086
     Downstream: Upper Junction

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 48.3
     Channel Loss: None
End:

Reach: Route DP 1
     Last Modified Date: 23 June 2020
     Last Modified Time: 14:58:52
     Canvas X: -104.82158381307086
     Canvas Y: 39.0850581337859
     From Canvas X: -104.82193807142886
     From Canvas Y: 39.08644263441573
     Downstream: Upper Junction

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 96.18
     Channel Loss: None
End:

Subbasin: EX-2B
     Last Modified Date: 25 June 2020
     Last Modified Time: 21:27:40
     Canvas X: -104.82734972940409
     Canvas Y: 39.08265473562861
     From Canvas X: -104.82476464172467
     From Canvas Y: 39.08393156796382
     Label X: 5.0
     Label Y: 1.0
     Area: 0.053
     Downstream: R-EX-2
```

```
     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.73
     Curve Number: 38.7
     Initial Abstraction: 1.58

     Transform: SCS
     Lag: 45.9
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: Route ex
     Last Modified Date: 23 June 2020
     Last Modified Time: 14:58:52
     Canvas X: -104.82158381307086
     Canvas Y: 39.0850581337859
     From Canvas X: -104.82001658805
     From Canvas Y: 39.08583698630137
     Downstream: Upper Junction

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 100.14
     Channel Loss: None
End:

Subbasin: EX-2D3
     Last Modified Date: 22 June 2020
     Last Modified Time: 19:07:12
     Canvas X: -104.82327912947144
     Canvas Y: 39.08606044652
     From Canvas X: -104.82269415092439
     From Canvas Y: 39.085813561277924
     Area: 0.0256
     Downstream: Route EX-2D3

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None
```

```
     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 41.6
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: EX-2D2
     Last Modified Date: 22 June 2020
     Last Modified Time: 19:07:08
     Canvas X: -104.82564385523204
     Canvas Y: 39.08653339167213
     From Canvas X: -104.82406415758462
     From Canvas Y: 39.087132826950736
     Area: 0.0198
     Downstream: Route EX-2D2

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 37.3
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: EX-2D1
     Last Modified Date: 1 July 2020
     Last Modified Time: 18:22:21
     Canvas X: -104.82694256881825
     Canvas Y: 39.08583405875428
     From Canvas X: -104.82518045930776
```

```
     From Canvas Y: 39.086549305595454
     Area: 0.0225
     Downstream: Route EX-2D1

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 65
     Curve Number: 12
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 41.4
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: Route EX-2D2
     Last Modified Date: 22 June 2020
     Last Modified Time: 19:07:16
     Canvas X: -104.82512645260917
     Canvas Y: 39.082417395144546
     From Canvas X: -104.82513452968361
     From Canvas Y: 39.08471437185627
     Downstream: Junction EX-2D

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 48.7
     Channel Loss: None
End:

Reach: Route EX-2D1
     Last Modified Date: 22 June 2020
     Last Modified Time: 19:07:04
     Canvas X: -104.82512645260917
     Canvas Y: 39.082417395144546
     From Canvas X: -104.82589851800626
     From Canvas Y: 39.08491446403602
     Downstream: Junction EX-2D

     Route: Lag
     Initial Variable: Combined Inflow
```

```
     Lag: 48.7
     Channel Loss: None
End:

Reach: Route EX-2D3
     Last Modified Date: 22 June 2020
     Last Modified Time: 19:07:54
     Canvas X: -104.82453425314438
     Canvas Y: 39.08138556559327
     From Canvas X: -104.82424320997384
     From Canvas Y: 39.08249516768094
     Downstream: DP 3a

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 44.1
     Channel Loss: None
End:

Reservoir: R-EX-2
     Last Modified Date: 23 June 2020
     Last Modified Time: 22:23:07
     Canvas X: -104.82560757475201
     Canvas Y: 39.07534443843578
     From Canvas X: -104.82578006868228
     From Canvas Y: 39.07506441976396
     Label X: -70.0
     Label Y: -4.0
     Downstream: Sink EX-2

     Route: Controlled Outflow
     Routing Curve: Elevation-Area
     Initial Outflow Equals Inflow: Yes
     Elevation-Area Table: EX-2
     Adaptive Control: On
     Main Tailwater Condition: None
     Auxiliary Tailwater Condition: None

     Conduit: Culvert
     Conduit Outlet: Main
     Culvert Shape: Elliptical
     Chart Number: 29
     Scale Number: 2
     Solution Control: Automatic
     Rise: 2.5
     Span: 3.5
     Number Barrels: 1
     Culvert Length: 48.5
```

```
     Entrance Loss Coefficient: 0.2
     Exit Loss Coefficient: 1
     Top Manning's n: 0.02
     Inlet Invert Elevation: 7154.7
     Outlet Invert Elevation: 7149.5
     End Conduit:

     Spillway: Broad-Crested Spillway
     Spillway Outlet: Main
     Spillway Crest Length: 174.3
     Spillway Crest Elevation: 7162
     Spillway Coefficient: 2.6
     End Spillway:

     Evaporation Method: Zero Evaporation
     End Evaporation:
End:

Junction: Junction EX-2D
     Last Modified Date: 23 June 2020
     Last Modified Time: 14:58:43
     Canvas X: -104.82512645260917
     Canvas Y: 39.082417395144546
     From Canvas X: -104.82419101005316
     From Canvas Y: 39.08112001994197
     Label X: -92.0
     Label Y: -21.0
     Downstream: DP 3a
End:

Reach: Route EX-2A
     Last Modified Date: 23 June 2020
     Last Modified Time: 21:33:35
     Canvas X: -104.82560757475201
     Canvas Y: 39.07534443843578
     From Canvas X: -104.82826469371535
     From Canvas Y: 39.08135880318109
     Downstream: R-EX-2

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 45.9
     Channel Loss: None
End:

Sink: Sink EX-2
     Description: Existing culvert
     Last Modified Date: 23 June 2020
```

```
     Last Modified Time: 15:10:54
     Canvas X: -104.82605124012406
     Canvas Y: 39.07419777189607
     From Canvas X: -104.82853083687779
     From Canvas Y: 39.07687179389039
End:

Reach: Route EX-1G
     Last Modified Date: 1 July 2020
     Last Modified Time: 16:06:25
     Canvas X: -104.80410656292447
     Canvas Y: 39.08117099664817
     From Canvas X: -104.80288471191857
     From Canvas Y: 39.081030770530596
     Downstream: Reservoir OS-5

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 54.5
     Channel Loss: None
End:

Reach: Route EX-1F
     Last Modified Date: 1 July 2020
     Last Modified Time: 16:06:25
     Canvas X: -104.80410656292447
     Canvas Y: 39.08117099664817
     From Canvas X: -104.80313072206603
     From Canvas Y: 39.08183908958656
     Downstream: Reservoir OS-5

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 54.5
     Channel Loss: None
End:

Subbasin: Basin EX-1D
     Description: EX-1D
     Last Modified Date: 8 April 2020
     Last Modified Time: 14:31:23
     Canvas X: -104.80440202496102
     Canvas Y: 39.08418984968062
     From Canvas X: -104.80436077280338
     From Canvas Y: 39.0841937581409
     Area: 0.039
     Downstream: Reservoir OS-5
```

```
     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 40.8
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: Basin EX-1E
     Description: EX-1E
     Last Modified Date: 30 June 2020
     Last Modified Time: 20:49:18
     Canvas X: -104.80248779589795
     Canvas Y: 39.08343613094243
     From Canvas X: -104.8035524537474
     From Canvas Y: 39.083420583391714
     Area: 0.0579
     Downstream: Route EX-1E

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 46.5
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: Basin EX-1F
```

```
     Last Modified Date: 1 July 2020
     Last Modified Time: 17:40:23
     Canvas X: -104.80194199951546
     Canvas Y: 39.08239002120936
     From Canvas X: -104.80239269162362
     From Canvas Y: 39.08212024404081
     Area: 0.082
     Downstream: Route EX-1F

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 53.2
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: Basin EX-1G
     Last Modified Date: 8 April 2020
     Last Modified Time: 14:34:51
     Canvas X: -104.8020933100336
     Canvas Y: 39.08086500194017
     From Canvas X: -104.80197095994225
     From Canvas Y: 39.08085504899669
     Area: 0.0977
     Downstream: Route EX-1G

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54
```

```
     Transform: SCS
     Lag: 50
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reservoir: Reservoir OS-5
     Description: Reservoir is exisitng and will not be impacted by dev.
     Last Modified Date: 1 July 2020
     Last Modified Time: 16:06:25
     Canvas X: -104.80410656292447
     Canvas Y: 39.08117099664817
     From Canvas X: -104.80583683368818
     From Canvas Y: 39.08180394527978
     Downstream: Route Res OS-5

     Route: Controlled Outflow
     Routing Curve: Elevation-Area
     Initial Outflow Equals Inflow: Yes
     Elevation-Area Table: OS-5
     Adaptive Control: On
     Main Tailwater Condition: None
     Auxiliary Tailwater Condition: None

     Conduit: Orifice
     Conduit Outlet: Main
     Orifice Coefficient: 0.6
     Orifice Area: 0.545
     Centerline Elevation: 7324.42
     Number Barrels: 1
     End Conduit:

     Conduit: Orifice
     Conduit Outlet: Main
     Orifice Coefficient: 0.6
     Orifice Area: 7.06
     Centerline Elevation: 7331
     Number Barrels: 1
     End Conduit:

     Spillway: Broad-Crested Spillway
     Spillway Outlet: Main
     Spillway Crest Length: 20
     Spillway Crest Elevation: 7334
     Spillway Coefficient: 2.6
     End Spillway:
```

```
     Evaporation Method: Zero Evaporation
     End Evaporation:
End:

Reach: Route EX-1E
     Last Modified Date: 1 July 2020
     Last Modified Time: 16:06:25
     Canvas X: -104.80410656292447
     Canvas Y: 39.08117099664817
     From Canvas X: -104.80351247584771
     From Canvas Y: 39.082270446943426
     Downstream: Reservoir OS-5

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 50
     Channel Loss: None
End:

Reach: Route Res OS-5
     Last Modified Date: 1 July 2020
     Last Modified Time: 16:06:25
     Canvas X: -104.81193706159225
     Canvas Y: 39.07997834772512
     From Canvas X: -104.80410656292447
     From Canvas Y: 39.08117099664817
     Downstream: Design Point 4

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 50.7
     Channel Loss: None
End:

Subbasin: Basin EX-1B
     Description: EX-1B
     Last Modified Date: 8 April 2020
     Last Modified Time: 14:30:29
     Canvas X: -104.8106822864471
     Canvas Y: 39.081892742707595
     From Canvas X: -104.81026629613649
     From Canvas Y: 39.08118464386818
     Area: 0.0126
     Downstream: Design Point 4

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None
```

```
     Surface: None

     LossRate: SCS
     Percent Impervious Area: 7.83
     Curve Number: 56.65
     Initial Abstraction: 0.77

     Transform: SCS
     Lag: 46.4
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: Basin EX-1C
     Description: EX-1C
     Last Modified Date: 9 June 2020
     Last Modified Time: 18:26:35
     Canvas X: -104.80929853024664
     Canvas Y: 39.0802320526622
     From Canvas X: -104.80816187456509
     From Canvas Y: 39.07952068262567
     Area: 0.0091
     Downstream: Design Point 4

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 38.1
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: Design Point 4
     Last Modified Date: 23 June 2020
     Last Modified Time: 14:58:09
     Canvas X: -104.81193706159225
```

```
     Canvas Y: 39.07997834772512
     From Canvas X: -104.81161214714145
     From Canvas Y: 39.07932492247949
     Label X: -35.0
     Label Y: -25.0
     Downstream: Route Upper Basin
End:

Reach: Route Upper Basin
     Last Modified Date: 1 July 2020
     Last Modified Time: 16:11:04
     Canvas X: -104.81709394337855
     Canvas Y: 39.07731880753043
     From Canvas X: -104.81193706159225
     From Canvas Y: 39.07997834772512
     Downstream: R-EX-1

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 50.3
     Channel Loss: None
End:

Subbasin: EX-1A
     Last Modified Date: 25 June 2020
     Last Modified Time: 21:56:59
     Canvas X: -104.81501347968127
     Canvas Y: 39.08052242168436
     From Canvas X: -104.80709271634949
     From Canvas Y: 39.08411208955269
     Area: 0.126
     Downstream: R-EX-1

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 2.82
     Curve Number: 46.64
     Initial Abstraction: 1.14

     Transform: SCS
     Lag: 50.3
     Unitgraph Type: STANDARD
```

```
     Baseflow: None
End:

Reservoir: R-EX-1
     Last Modified Date: 1 July 2020
     Last Modified Time: 16:11:04
     Canvas X: -104.81709394337855
     Canvas Y: 39.07731880753043
     From Canvas X: -104.81718519301873
     From Canvas Y: 39.07731110636649
     Label X: -49.0
     Label Y: 18.0
     Downstream: Sink EX-1

     Route: Controlled Outflow
     Routing Curve: Elevation-Area
     Initial Outflow Equals Inflow: Yes
     Elevation-Area Table: EX-1
     Adaptive Control: On
     Main Tailwater Condition: None
     Auxiliary Tailwater Condition: None

     Conduit: Culvert
     Conduit Outlet: Main
     Culvert Shape: Circular
     Chart Number: 2
     Scale Number: 3
     Solution Control: Automatic
     Diameter: 4
     Number Barrels: 1
     Culvert Length: 48
     Entrance Loss Coefficient: 0.2
     Exit Loss Coefficient: 1
     Top Manning's n: 0.02
     Inlet Invert Elevation: 7235.6
     Outlet Invert Elevation: 7235.2
     End Conduit:

     Spillway: Broad-Crested Spillway
     Spillway Outlet: Main
     Spillway Crest Length: 71
     Spillway Crest Elevation: 7242
     Spillway Coefficient: 2.6
     End Spillway:

     Evaporation Method: Zero Evaporation
     End Evaporation:
End:
```

```
Sink: Sink EX-1
     Description: Existing culvert
     Last Modified Date: 25 June 2020
     Last Modified Time: 14:42:51
     Canvas X: -104.81727643777681
     Canvas Y: 39.07658114830191
     From Canvas X: -104.81738113287233
     From Canvas Y: 39.07830933434392
     Label X: -41.0
     Label Y: -25.0
End:

Reach: Route Res OS-1
     Last Modified Date: 24 June 2020
     Last Modified Time: 22:45:36
     Canvas X: -104.83061855649402
     Canvas Y: 39.075949444526486
     From Canvas X: -104.83067098109308
     From Canvas Y: 39.081798446858556
     Downstream: R-EX-3

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 48.6
     Channel Loss: None
End:

Subbasin: EX-3
     Last Modified Date: 25 June 2020
     Last Modified Time: 22:46:51
     Canvas X: -104.8292861506734
     Canvas Y: 39.08008888371974
     From Canvas X: -104.82989382670279
     From Canvas Y: 39.083728070852004
     Label X: -23.0
     Label Y: 15.0
     Area: 0.0302
     Downstream: R-EX-3

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 2.6
```

```
     Curve Number: 59.5
     Initial Abstraction: 0.68

     Transform: SCS
     Lag: 48.6
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reservoir: R-EX-3
     Last Modified Date: 24 June 2020
     Last Modified Time: 22:45:36
     Canvas X: -104.83061855649402
     Canvas Y: 39.075949444526486
     From Canvas X: -104.82961743401114
     From Canvas Y: 39.07605826977719
     Label X: 1.0
     Label Y: 0.0
     Downstream: Sink EX-3

     Route: Controlled Outflow
     Routing Curve: Elevation-Area
     Initial Outflow Equals Inflow: Yes
     Elevation-Area Table: EX-3
     Adaptive Control: On
     Main Tailwater Condition: None
     Auxiliary Tailwater Condition: None

     Conduit: Culvert
     Conduit Outlet: Main
     Culvert Shape: Circular
     Chart Number: 2
     Scale Number: 3
     Solution Control: Automatic
     Diameter: 1.25
     Number Barrels: 1
     Culvert Length: 43.1
     Entrance Loss Coefficient: 0.2
     Exit Loss Coefficient: 1
     Top Manning's n: 0.02
     Inlet Invert Elevation: 7168.6
     Outlet Invert Elevation: 7167.3
     End Conduit:

     Spillway: Broad-Crested Spillway
     Spillway Outlet: Main
     Spillway Crest Length: 234.06
```

```
     Spillway Crest Elevation: 7174
     Spillway Coefficient: 2.6
     End Spillway:

     Evaporation Method: Zero Evaporation
     End Evaporation:
End:

Subbasin: EX-3A
     Description: Same as PR Basin OS-1
     Last Modified Date: 6 April 2020
     Last Modified Time: 19:23:05
     Canvas X: -104.83121863681023
     Canvas Y: 39.085457782786904
     From Canvas X: -104.83134310401869
     From Canvas Y: 39.085457782786904
     Area: 0.0634
     Downstream: Reservoir OS-1

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 43.9
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reservoir: Reservoir OS-1
     Description: Same as in PR model
     Last Modified Date: 26 June 2020
     Last Modified Time: 17:10:30
     Canvas X: -104.83067098109308
     Canvas Y: 39.081798446858556
     From Canvas X: -104.83126842369361
     From Canvas Y: 39.08391438940216
     Label X: -110.0
     Label Y: -2.0
     Downstream: Route Res OS-1
```

```
     Route: Modified Puls
     Routing Curve: Storage-Outflow
     Initial Outflow: 0
     Storage-Outflow Table: EX OS-1
End:

Sink: Sink EX-3
     Description: Existing culvert
     Last Modified Date: 23 June 2020
     Last Modified Time: 15:10:58
     Canvas X: -104.83061838365983
     Canvas Y: 39.075059004677094
     From Canvas X: -104.8292671380857
     From Canvas Y: 39.078379458268486
     Label X: -36.0
     Label Y: -28.0
End:

Subbasin: EX-4
     Last Modified Date: 25 June 2020
     Last Modified Time: 21:56:40
     Canvas X: -104.82064189536449
     Canvas Y: 39.080518237967645
     From Canvas X: -104.82053670947764
     From Canvas Y: 39.08055329992993
     Area: 0.01
     Downstream: Sink EX-4

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 55
     Initial Abstraction: 0.82

     Transform: SCS
     Lag: 11.7
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Sink: Sink EX-4
```

```
     Last Modified Date: 24 June 2020
     Last Modified Time: 23:03:58
     Canvas X: -104.8206889917287
     Canvas Y: 39.07764871197136
     From Canvas X: -104.82204703883946
     From Canvas Y: 39.07744627004672
End:

Basin Layer Properties:
     Element Layer:
          Name: Icons
          Layer shown: Yes
     End Layer:
     Element Layer:
          Name: Subbasins
          Layer shown: No
     End Layer:
End:

Basin Spatial Properties:
     Coordinate System:
GEOGCS["GCS_WGS_1984",DATUM["WGS_1984",SPHEROID["WGS_84",6378137,298.257223563]],PR
IMEM["Greenwich",0],UNIT["Degree",0.017453292519943295]]
End:

Basin Schematic Properties:
     Last View N: 64.08265578047579
     Last View S: 14.082655780475783
     Last View W: -129.81009012756982
     Last View E: -79.81009012756984
     Maximum View N: 64.08265578047579
     Maximum View S: 14.082655780475783
     Maximum View W: -129.81009012756982
     Maximum View E: -79.81009012756984
     Extent Method: Elements
     Buffer: 0
     Draw Icons: Yes
     Draw Icon Labels: Name
     Draw Map Objects: No
     Draw Gridlines: No
     Draw Flow Direction: No
     Draw HillShade Layer: Yes
     Draw Elevation Layer: Yes
     Elevation Layer Color Palette: Default
     Ignore Elevation Color Ramp Scale: No
     Use Interpolated Color Ramp for Elevation Layer: Yes
     Color Ramp Opacity Level for Elevation Layer: 33.0
     Fix Element Locations: No
```

```
     Fix Hydrologic Order: No
End:
```

Project: GWR 100 YR Final Simulation Run: EX - 100 YR 24HR

Start of Run: 01Jan2020, 00:00 Basin Model: EX GWR
End of Run: 02Jan2020, 00:05 Meteorologic Model: 24 HR 100 YR
Compute Time: DATA CHANGED, RECOMPUTE Control Specifications:GR Control

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
DP 3a	0.3169	136.6	01Jan2020, 14:15	2.10
EX-2C3	0.0100	1.0	01Jan2020, 12:40	0.43
EX-2I	0.0210	12.3	01Jan2020, 12:40	2.05
EX-2H	0.0490	29.2	01Jan2020, 12:40	2.06
EX-2J	0.0760	42.0	01Jan2020, 12:45	2.05
Upper Junction	0.2150	114.3	01Jan2020, 14:15	1.99
EX-2C2	0.0520	3.9	01Jan2020, 12:50	0.38
EX-2C1	0.0210	13.1	01Jan2020, 12:35	2.06
Route EX-2C1	0.0210	13.0	01Jan2020, 13:30	2.02
Route DP 6	0.0760	41.9	01Jan2020, 14:25	1.99
Route DP 5	0.0210	12.3	01Jan2020, 14:15	1.99
Route EX-2C2	0.0520	3.9	01Jan2020, 13:40	0.37
EX-2E	0.0190	13.4	01Jan2020, 12:30	2.06
EX-2D	0.0340	20.8	01Jan2020, 12:45	2.27
Route Upper Junction	0.3169	136.6	01Jan2020, 15:00	2.07
EX-2G	0.0190	11.5	01Jan2020, 12:35	2.06
EX-2F	0.0310	16.1	01Jan2020, 12:50	2.05
EX-2A	0.0220	14.6	01Jan2020, 12:30	2.06
Route DP 3	0.0190	11.5	01Jan2020, 14:10	2.00
Route DP 2	0.0310	16.0	01Jan2020, 13:35	2.02
Route DP 1	0.0190	13.4	01Jan2020, 14:05	2.00
EX-2B	0.0530	5.8	01Jan2020, 12:50	0.50
Route ex	0.0490	29.2	01Jan2020, 14:20	1.99
EX-2D3	0.0256	15.9	01Jan2020, 12:35	2.06
EX-2D2	0.0198	13.2	01Jan2020, 12:30	2.06
EX-2D1	0.0225	19.3	01Jan2020, 12:35	3.04
Route EX-2D2	0.0198	13.2	01Jan2020, 13:20	2.03
Route EX-2D1	0.0225	19.3	01Jan2020, 13:20	3.01
Route EX-2D3	0.0256	15.8	01Jan2020, 13:20	2.03
R-EX-2	0.4749	145.5	01Jan2020, 15:00	1.67
Junction EX-2D	0.0763	45.6	01Jan2020, 13:15	2.42

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route EX-2A	0.0220	14.6	01Jan2020, 13:15	2.03
Sink EX-2	0.4749	145.5	01Jan2020, 14:55	1.67
Route EX-1G	0.0977	53.1	01Jan2020, 13:40	2.02
Route EX-1F	0.0820	42.6	01Jan2020, 13:40	2.01
Basin EX-1D	0.0390	24.5	01Jan2020, 12:35	2.06
Basin EX-1E	0.0579	33.2	01Jan2020, 12:40	2.05
Basin EX-1F	0.0820	42.7	01Jan2020, 12:50	2.05
Basin EX-1G	0.0977	53.2	01Jan2020, 12:45	2.05
Reservoir OS-5	0.2766	128.9	01Jan2020, 13:50	1.91
Route EX-1E	0.0579	33.2	01Jan2020, 13:30	2.02
Route Res OS-5	0.2766	128.9	01Jan2020, 14:40	1.88
Basin EX-1B	0.0126	5.2	01Jan2020, 12:40	1.51
Basin EX-1C	0.0091	6.0	01Jan2020, 12:30	2.06
Design Point 4	0.2983	130.7	01Jan2020, 14:40	1.87
Route Upper Basin	0.2983	130.7	01Jan2020, 15:30	1.84
EX-1A	0.1260	26.8	01Jan2020, 12:50	0.89
R-EX-1	0.4243	136.6	01Jan2020, 15:30	1.55
Sink EX-1	0.4243	136.6	01Jan2020, 15:25	1.55
Route Res OS-1	0.0634	29.1	01Jan2020, 13:50	2.02
EX-3	0.0302	12.1	01Jan2020, 12:45	1.48
R-EX-3	0.0936	34.0	01Jan2020, 13:45	1.84
EX-3A	0.0634	37.8	01Jan2020, 12:40	2.06
Reservoir OS-1	0.0634	29.1	01Jan2020, 13:00	2.05
Sink EX-3	0.0936	34.0	01Jan2020, 13:40	1.84
EX-4	0.0100	7.5	01Jan2020, 12:05	1.19
Sink EX-4	0.0100	7.5	01Jan2020, 12:00	1.19

Project: GWR 50 YR Final Simulation Run: EX - 50 YR 24HR

Start of Run: 01Jan2020, 00:00 Basin Model: EX GWR
End of Run: 02Jan2020, 00:05 Meteorologic Model: 24HR - 50YR
Compute Time: 01Jul2020, 11:44:12 Control Specifications: GR Control

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
DP 3a	0.3169	117.9	01Jan2020, 14:15	1.83
EX-2C3	0.0100	0.7	01Jan2020, 12:40	0.32
EX-2I	0.0210	10.6	01Jan2020, 12:40	1.78
EX-2H	0.0490	25.1	01Jan2020, 12:40	1.78
EX-2J	0.0760	36.1	01Jan2020, 12:45	1.78
Upper Junction	0.2150	98.2	01Jan2020, 14:15	1.73
EX-2C2	0.0520	2.6	01Jan2020, 12:55	0.28
EX-2C1	0.0210	11.3	01Jan2020, 12:35	1.78
Route EX-2C1	0.0210	11.2	01Jan2020, 13:30	1.75
Route DP 6	0.0760	36.0	01Jan2020, 14:25	1.72
Route DP 5	0.0210	10.6	01Jan2020, 14:15	1.72
Route EX-2C2	0.0520	2.6	01Jan2020, 13:45	0.27
EX-2E	0.0190	11.5	01Jan2020, 12:30	1.79
EX-2D	0.0340	18.0	01Jan2020, 12:45	1.98
Route Upper Junction	0.3169	117.9	01Jan2020, 15:00	1.80
EX-2G	0.0190	9.9	01Jan2020, 12:35	1.78
EX-2F	0.0310	13.8	01Jan2020, 12:50	1.77
EX-2A	0.0220	12.6	01Jan2020, 12:30	1.78
Route DP 3	0.0190	9.9	01Jan2020, 14:10	1.73
Route DP 2	0.0310	13.8	01Jan2020, 13:35	1.75
Route DP 1	0.0190	11.5	01Jan2020, 14:05	1.73
EX-2B	0.0530	4.2	01Jan2020, 12:50	0.39
Route ex	0.0490	25.1	01Jan2020, 14:20	1.72
EX-2D3	0.0256	13.6	01Jan2020, 12:35	1.78
EX-2D2	0.0198	11.4	01Jan2020, 12:30	1.78
EX-2D1	0.0225	17.6	01Jan2020, 12:35	2.76
Route EX-2D2	0.0198	11.3	01Jan2020, 13:20	1.76
Route EX-2D1	0.0225	17.6	01Jan2020, 13:20	2.74
Route EX-2D3	0.0256	13.6	01Jan2020, 13:20	1.76
R-EX-2	0.4749	125.5	01Jan2020, 15:00	1.44
Junction EX-2D	0.0763	40.3	01Jan2020, 13:15	2.15

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route EX-2A	0.0220	12.6	01Jan2020, 13:15	1.76
Sink EX-2	0.4749	125.5	01Jan2020, 14:55	1.44
Route EX-1G	0.0977	45.6	01Jan2020, 13:40	1.74
Route EX-1F	0.0820	36.6	01Jan2020, 13:40	1.74
Basin EX-1D	0.0390	21.1	01Jan2020, 12:35	1.78
Basin EX-1E	0.0579	28.5	01Jan2020, 12:40	1.78
Basin EX-1F	0.0820	36.7	01Jan2020, 12:50	1.77
Basin EX-1G	0.0977	45.7	01Jan2020, 12:45	1.77
Reservoir OS-5	0.2766	107.2	01Jan2020, 13:50	1.65
Route EX-1E	0.0579	28.5	01Jan2020, 13:30	1.75
Route Res OS-5	0.2766	107.2	01Jan2020, 14:40	1.62
Basin EX-1B	0.0126	4.3	01Jan2020, 12:40	1.28
Basin EX-1C	0.0091	5.1	01Jan2020, 12:30	1.78
Design Point 4	0.2983	108.8	01Jan2020, 14:40	1.61
Route Upper Basin	0.2983	108.8	01Jan2020, 15:30	1.58
EX-1A	0.1260	21.3	01Jan2020, 12:50	0.73
R-EX-1	0.4243	109.6	01Jan2020, 15:40	1.32
Sink EX-1	0.4243	109.6	01Jan2020, 15:35	1.32
Route Res OS-1	0.0634	25.5	01Jan2020, 13:50	1.75
EX-3	0.0302	10.1	01Jan2020, 12:45	1.25
R-EX-3	0.0936	29.7	01Jan2020, 13:45	1.58
EX-3A	0.0634	32.5	01Jan2020, 12:40	1.78
Reservoir OS-1	0.0634	25.5	01Jan2020, 13:00	1.78
Sink EX-3	0.0936	29.7	01Jan2020, 13:40	1.58
EX-4	0.0100	6.1	01Jan2020, 12:05	0.98
Sink EX-4	0.0100	6.1	01Jan2020, 12:00	0.98

Project: GWR 25 YR Final Simulation Run: EX - 25YR 24HR

Start of Run: 01Jan2020, 00:00 Basin Model: EX GWR
End of Run: 02Jan2020, 00:05 Meteorologic Model: 24HR - 25YR
Compute Time: 01Jul2020, 11:50:06 Control Specifications: GR Control

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
DP 3a	0.3169	91.2	01Jan2020, 14:15	1.44
EX-2C3	0.0100	0.3	01Jan2020, 12:45	0.19
EX-2I	0.0210	8.1	01Jan2020, 12:40	1.38
EX-2H	0.0490	19.2	01Jan2020, 12:40	1.38
EX-2J	0.0760	27.7	01Jan2020, 12:45	1.38
Upper Junction	0.2150	75.4	01Jan2020, 14:15	1.34
EX-2C2	0.0520	1.2	01Jan2020, 13:00	0.16
EX-2C1	0.0210	8.7	01Jan2020, 12:35	1.39
Route EX-2C1	0.0210	8.6	01Jan2020, 13:30	1.36
Route DP 6	0.0760	27.7	01Jan2020, 14:25	1.34
Route DP 5	0.0210	8.1	01Jan2020, 14:15	1.34
Route EX-2C2	0.0520	1.2	01Jan2020, 13:50	0.16
EX-2E	0.0190	8.8	01Jan2020, 12:30	1.39
EX-2D	0.0340	14.1	01Jan2020, 12:45	1.56
Route Upper Junction	0.3169	91.2	01Jan2020, 15:00	1.42
EX-2G	0.0190	7.6	01Jan2020, 12:35	1.39
EX-2F	0.0310	10.6	01Jan2020, 12:50	1.38
EX-2A	0.0220	9.6	01Jan2020, 12:30	1.39
Route DP 3	0.0190	7.6	01Jan2020, 14:10	1.34
Route DP 2	0.0310	10.6	01Jan2020, 13:35	1.36
Route DP 1	0.0190	8.8	01Jan2020, 14:05	1.35
EX-2B	0.0530	2.3	01Jan2020, 12:50	0.24
Route ex	0.0490	19.2	01Jan2020, 14:20	1.34
EX-2D3	0.0256	10.5	01Jan2020, 12:35	1.39
EX-2D2	0.0198	8.7	01Jan2020, 12:30	1.39
EX-2D1	0.0225	15.0	01Jan2020, 12:35	2.36
Route EX-2D2	0.0198	8.7	01Jan2020, 13:20	1.37
Route EX-2D1	0.0225	15.0	01Jan2020, 13:20	2.34
Route EX-2D3	0.0256	10.4	01Jan2020, 13:20	1.37
R-EX-2	0.4749	86.7	01Jan2020, 15:15	1.12
Junction EX-2D	0.0763	32.6	01Jan2020, 13:15	1.74

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route EX-2A	0.0220	9.6	01Jan2020, 13:15	1.37
Sink EX-2	0.4749	86.7	01Jan2020, 15:10	1.12
Route EX-1G	0.0977	35.0	01Jan2020, 13:40	1.36
Route EX-1F	0.0820	28.1	01Jan2020, 13:45	1.36
Basin EX-1D	0.0390	16.2	01Jan2020, 12:35	1.39
Basin EX-1E	0.0579	21.9	01Jan2020, 12:40	1.38
Basin EX-1F	0.0820	28.2	01Jan2020, 12:50	1.38
Basin EX-1G	0.0977	35.1	01Jan2020, 12:45	1.38
Reservoir OS-5	0.2766	71.0	01Jan2020, 14:00	1.28
Route EX-1E	0.0579	21.9	01Jan2020, 13:30	1.36
Route Res OS-5	0.2766	71.0	01Jan2020, 14:50	1.25
Basin EX-1B	0.0126	3.2	01Jan2020, 12:45	0.97
Basin EX-1C	0.0091	3.9	01Jan2020, 12:30	1.39
Design Point 4	0.2983	72.1	01Jan2020, 14:50	1.24
Route Upper Basin	0.2983	72.1	01Jan2020, 15:40	1.21
EX-1A	0.1260	14.1	01Jan2020, 12:50	0.51
R-EX-1	0.4243	74.9	01Jan2020, 15:45	1.00
Sink EX-1	0.4243	74.9	01Jan2020, 15:40	1.00
Route Res OS-1	0.0634	20.6	01Jan2020, 13:45	1.36
EX-3	0.0302	7.3	01Jan2020, 12:45	0.93
R-EX-3	0.0936	23.8	01Jan2020, 13:45	1.22
EX-3A	0.0634	24.9	01Jan2020, 12:40	1.39
Reservoir OS-1	0.0634	20.6	01Jan2020, 13:00	1.38
Sink EX-3	0.0936	23.8	01Jan2020, 13:40	1.22
EX-4	0.0100	4.2	01Jan2020, 12:05	0.70
Sink EX-4	0.0100	4.2	01Jan2020, 12:00	0.70

Project: GWR 10 YR Final Simulation Run: EX - 10-YR 24HR

Start of Run: 01Jan2020, 00:00 Basin Model: EX GWR
End of Run: 02Jan2020, 00:05 Meteorologic Model: 24 HR - 10-YR
Compute Time: 01Jul2020, 11:54:51 Control Specifications: GR Control

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
DP 3a	0.3169	74.6	01Jan2020, 14:15	1.20
EX-2C3	0.0100	0.2	01Jan2020, 12:50	0.12
EX-2I	0.0210	6.6	01Jan2020, 12:40	1.14
EX-2H	0.0490	15.6	01Jan2020, 12:40	1.14
EX-2J	0.0760	22.5	01Jan2020, 12:45	1.14
Upper Junction	0.2150	61.2	01Jan2020, 14:15	1.10
EX-2C2	0.0520	0.6	01Jan2020, 13:10	0.10
EX-2C1	0.0210	7.0	01Jan2020, 12:35	1.14
Route EX-2C1	0.0210	7.0	01Jan2020, 13:30	1.12
Route DP 6	0.0760	22.5	01Jan2020, 14:25	1.10
Route DP 5	0.0210	6.6	01Jan2020, 14:15	1.10
Route EX-2C2	0.0520	0.6	01Jan2020, 14:00	0.10
EX-2E	0.0190	7.2	01Jan2020, 12:30	1.14
EX-2D	0.0340	11.6	01Jan2020, 12:45	1.30
Route Upper Junction	0.3169	74.6	01Jan2020, 15:00	1.18
EX-2G	0.0190	6.2	01Jan2020, 12:40	1.14
EX-2F	0.0310	8.6	01Jan2020, 12:50	1.13
EX-2A	0.0220	7.8	01Jan2020, 12:30	1.14
Route DP 3	0.0190	6.2	01Jan2020, 14:15	1.10
Route DP 2	0.0310	8.6	01Jan2020, 13:35	1.12
Route DP 1	0.0190	7.2	01Jan2020, 14:05	1.11
EX-2B	0.0530	1.4	01Jan2020, 12:55	0.17
Route ex	0.0490	15.6	01Jan2020, 14:20	1.10
EX-2D3	0.0256	8.5	01Jan2020, 12:35	1.14
EX-2D2	0.0198	7.1	01Jan2020, 12:30	1.14
EX-2D1	0.0225	13.3	01Jan2020, 12:35	2.09
Route EX-2D2	0.0198	7.0	01Jan2020, 13:20	1.12
Route EX-2D1	0.0225	13.3	01Jan2020, 13:20	2.07
Route EX-2D3	0.0256	8.5	01Jan2020, 13:20	1.12
R-EX-2	0.4749	74.6	01Jan2020, 15:10	0.92
Junction EX-2D	0.0763	27.7	01Jan2020, 13:15	1.48

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route EX-2A	0.0220	7.8	01Jan2020, 13:15	1.13
Sink EX-2	0.4749	74.6	01Jan2020, 15:05	0.92
Route EX-1G	0.0977	28.5	01Jan2020, 13:40	1.12
Route EX-1F	0.0820	22.8	01Jan2020, 13:45	1.11
Basin EX-1D	0.0390	13.1	01Jan2020, 12:35	1.14
Basin EX-1E	0.0579	17.8	01Jan2020, 12:40	1.14
Basin EX-1F	0.0820	22.9	01Jan2020, 12:50	1.13
Basin EX-1G	0.0977	28.5	01Jan2020, 12:45	1.14
Reservoir OS-5	0.2766	58.6	01Jan2020, 14:00	1.06
Route EX-1E	0.0579	17.8	01Jan2020, 13:30	1.12
Route Res OS-5	0.2766	58.6	01Jan2020, 14:50	1.03
Basin EX-1B	0.0126	2.5	01Jan2020, 12:45	0.77
Basin EX-1C	0.0091	3.2	01Jan2020, 12:30	1.14
Design Point 4	0.2983	59.5	01Jan2020, 14:50	1.02
Route Upper Basin	0.2983	59.5	01Jan2020, 15:40	0.99
EX-1A	0.1260	10.1	01Jan2020, 12:50	0.38
R-EX-1	0.4243	61.7	01Jan2020, 15:45	0.81
Sink EX-1	0.4243	61.7	01Jan2020, 15:40	0.81
Route Res OS-1	0.0634	17.8	01Jan2020, 13:40	1.12
EX-3	0.0302	5.6	01Jan2020, 12:45	0.73
R-EX-3	0.0936	19.5	01Jan2020, 13:55	0.99
EX-3A	0.0634	20.3	01Jan2020, 12:40	1.14
Reservoir OS-1	0.0634	17.9	01Jan2020, 12:55	1.14
Sink EX-3	0.0936	19.5	01Jan2020, 13:50	0.99
EX-4	0.0100	3.1	01Jan2020, 12:05	0.53
Sink EX-4	0.0100	3.1	01Jan2020, 12:00	0.53

Project: GWR 5 YR Final Simulation Run: EX - 5 YR 24HR

Start of Run: 01Jan2020, 00:00 Basin Model: EX GWR
End of Run: 02Jan2020, 00:05 Meteorologic Model: 24 HR 5 YR
Compute Time: 01Jul2020, 13:51:17 Control Specifications: GR Control

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
DP 3a	0.3169	55.3	01Jan2020, 14:15	0.91
EX-2C3	0.0100	0.1	01Jan2020, 13:25	0.06
EX-2I	0.0210	4.8	01Jan2020, 12:40	0.85
EX-2H	0.0490	11.5	01Jan2020, 12:40	0.85
EX-2J	0.0760	16.5	01Jan2020, 12:45	0.85
Upper Junction	0.2150	44.9	01Jan2020, 14:15	0.83
EX-2C2	0.0520	0.2	01Jan2020, 14:05	0.04
EX-2C1	0.0210	5.2	01Jan2020, 12:35	0.85
Route EX-2C1	0.0210	5.1	01Jan2020, 13:30	0.84
Route DP 6	0.0760	16.4	01Jan2020, 14:25	0.82
Route DP 5	0.0210	4.8	01Jan2020, 14:15	0.83
Route EX-2C2	0.0520	0.2	01Jan2020, 14:55	0.04
EX-2E	0.0190	5.3	01Jan2020, 12:30	0.86
EX-2D	0.0340	8.7	01Jan2020, 12:45	0.99
Route Upper Junction	0.3169	55.3	01Jan2020, 15:00	0.90
EX-2G	0.0190	4.5	01Jan2020, 12:40	0.85
EX-2F	0.0310	6.3	01Jan2020, 12:50	0.85
EX-2A	0.0220	5.7	01Jan2020, 12:30	0.86
Route DP 3	0.0190	4.5	01Jan2020, 14:15	0.83
Route DP 2	0.0310	6.3	01Jan2020, 13:40	0.84
Route DP 1	0.0190	5.3	01Jan2020, 14:05	0.83
EX-2B	0.0530	0.6	01Jan2020, 13:00	0.09
Route ex	0.0490	11.5	01Jan2020, 14:20	0.82
EX-2D3	0.0256	6.2	01Jan2020, 12:35	0.85
EX-2D2	0.0198	5.2	01Jan2020, 12:30	0.86
EX-2D1	0.0225	11.2	01Jan2020, 12:35	1.76
Route EX-2D2	0.0198	5.2	01Jan2020, 13:20	0.84
Route EX-2D1	0.0225	11.2	01Jan2020, 13:20	1.74
Route EX-2D3	0.0256	6.2	01Jan2020, 13:20	0.84
R-EX-2	0.4749	56.4	01Jan2020, 15:05	0.69
Junction EX-2D	0.0763	21.9	01Jan2020, 13:15	1.18

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route EX-2A	0.0220	5.7	01Jan2020, 13:15	0.84
Sink EX-2	0.4749	56.4	01Jan2020, 15:00	0.69
Route EX-1G	0.0977	20.9	01Jan2020, 13:40	0.84
Route EX-1F	0.0820	16.7	01Jan2020, 13:45	0.83
Basin EX-1D	0.0390	9.6	01Jan2020, 12:35	0.85
Basin EX-1E	0.0579	13.0	01Jan2020, 12:40	0.85
Basin EX-1F	0.0820	16.8	01Jan2020, 12:50	0.85
Basin EX-1G	0.0977	20.9	01Jan2020, 12:45	0.85
Reservoir OS-5	0.2766	44.9	01Jan2020, 14:00	0.80
Route EX-1E	0.0579	13.0	01Jan2020, 13:30	0.84
Route Res OS-5	0.2766	44.9	01Jan2020, 14:50	0.78
Basin EX-1B	0.0126	1.7	01Jan2020, 12:45	0.56
Basin EX-1C	0.0091	2.3	01Jan2020, 12:35	0.86
Design Point 4	0.2983	45.6	01Jan2020, 14:50	0.77
Route Upper Basin	0.2983	45.6	01Jan2020, 15:40	0.75
EX-1A	0.1260	6.0	01Jan2020, 12:50	0.25
R-EX-1	0.4243	47.3	01Jan2020, 15:40	0.60
Sink EX-1	0.4243	47.3	01Jan2020, 15:35	0.60
Route Res OS-1	0.0634	13.3	01Jan2020, 13:40	0.84
EX-3	0.0302	3.7	01Jan2020, 12:45	0.51
R-EX-3	0.0936	10.6	01Jan2020, 14:15	0.73
EX-3A	0.0634	14.9	01Jan2020, 12:40	0.85
Reservoir OS-1	0.0634	13.3	01Jan2020, 12:55	0.85
Sink EX-3	0.0936	10.6	01Jan2020, 14:10	0.73
EX-4	0.0100	1.9	01Jan2020, 12:05	0.35
Sink EX-4	0.0100	1.9	01Jan2020, 12:00	0.35

Explanation of Peak Offsetting in the Grandwood Ranch HMS Model: *West Basin*

Using the Western Basin (EX-2) 100-year proposed conditions model, we can look at the peak offsetting found in the Grandwood Ranch sub-watersheds. The sub-basin discharging into culvert EX-2 is shown in Figure 1 on the following page. Each sub-section to be discussed is grouped by color for clarity.

The most upstream area, indicated in purple in Figure 1, yields a simple hydrograph shown in Figure 2. This hydrograph was taken at the model junction labeled "Upper Junction".

Figure 2. "Upper Junction" hydrograph (purple area).

The combined hydrograph peak, shown as a solid line, flows to the next junction point, "Junction C-2" (green). The flows from the "Upper Junction" hydrograph are indicated.

Figure 1. HEC-HMS model of Culvert EX-2 sub-watershed.

Figure 3. "Junction C-2" hydrograph (green area).

At this junction, we begin to see a combined hydrograph with multiple peaks. These peaks are caused by the lag times associated with the size of the sub-watershed.

From "Junction C-2", the flows move to "Junction C-3" (blue). This combined hydrograph is shown in Figure 4. As in Figure 3, the combined hydrograph from the previous junction, "Junction C-2", is noted. Additional flows into "Junction C-3" grow the first peak and leave the second, larger peak almost unaffected.

Figure 4. "Junction C-3" hydrograph (blue area)

This combined hydrograph moves to the culvert EX-2. The hydrograph for EX-2 is shown in Figure 5. Only a small amount of flow comes from the yellow area of the model. This flow, due to its proximity to the culvert, contributes to an increase in flows early in the model.

PROPOSED CONDITIONS WEST BASIN HEC-HMS BASIN LAYOUT

```
Basin: PR West Basin GWR
     Last Modified Date: 23 June 2020
     Last Modified Time: 21:06:18
     Version: 4.3
     Filepath Separator: \
     Unit System: English
     Missing Flow To Zero: No
     Enable Flow Ratio: No
     Compute Local Flow At Junctions: No

     Enable Sediment Routing: No

     Enable Quality Routing: No
End:

Reach: Route W-9
     Last Modified Date: 30 June 2020
     Last Modified Time: 14:31:19
     Canvas X: 3190830.1690315185
     Canvas Y: 1454218.4037954086
     From Canvas X: 3190941.0482914834
     From Canvas Y: 1454172.086088502
     Downstream: R-EX-2

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 31
     Channel Loss: None
End:

Reach: Route Pond 1
     Last Modified Date: 30 June 2020
     Last Modified Time: 14:31:19
     Canvas X: 3190830.1690315185
     Canvas Y: 1454218.4037954086
     From Canvas X: 3190788.6775098434
     From Canvas Y: 1454841.7546350043
     Downstream: R-EX-2

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 31
     Channel Loss: None
End:

Reach: Route Pond 2
     Last Modified Date: 30 June 2020
     Last Modified Time: 14:31:19
```

```
     Canvas X: 3190830.1690315185
     Canvas Y: 1454218.4037954086
     From Canvas X: 3191285.843830595
     From Canvas Y: 1454369.28601614
     Downstream: R-EX-2

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 31
     Channel Loss: None
End:

Subbasin: W-7
     Last Modified Date: 25 June 2020
     Last Modified Time: 22:00:54
     Canvas X: 3191588.062197299
     Canvas Y: 1454558.061469289
     From Canvas X: 3191726.0696871458
     From Canvas Y: 1454578.2102340478
     Label X: 0.0
     Label Y: -3.0
     Area: 0.027
     Downstream: Junction C-3

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 13.45
     Curve Number: 65.5
     Initial Abstraction: 0.53

     Transform: SCS
     Lag: 47.3
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: W-6
     Last Modified Date: 7 April 2020
     Last Modified Time: 17:50:28
     Canvas X: 3191787.2788931862
     Canvas Y: 1454806.7233097618
     From Canvas X: 3192492.046785609
```

```
     From Canvas Y: 1454929.1016958833
     Area: 0.003
     Downstream: Route W-6

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 35
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: W-8
     Description: Drainage Easement across lot
     Last Modified Date: 16 June 2020
     Last Modified Time: 22:12:19
     Canvas X: 3191046.9812794775
     Canvas Y: 1454826.8102695316
     From Canvas X: 3191390.648482099
     From Canvas Y: 1454613.8680979477
     Area: 0.00386
     Downstream: Junction C-3

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 35.4
     Unitgraph Type: STANDARD
```

```
     Baseflow: None
End:

Reach: Route to C-3
     Description: Combined junction C-1 and C-2 to Junction C-3
     Last Modified Date: 6 April 2020
     Last Modified Time: 22:00:34
     Canvas X: 3191125.8142608823
     Canvas Y: 1454636.8944506934
     From Canvas X: 3191740.132405288
     From Canvas Y: 1455102.301558766
     Downstream: Junction C-3

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 35.4
     Channel Loss: None
End:

Reach: Route OS-4A
     Last Modified Date: 8 April 2020
     Last Modified Time: 15:10:30
     Canvas X: 3191740.132405288
     Canvas Y: 1455102.301558766
     From Canvas X: 3191821.555858512
     From Canvas Y: 1455495.3148196193
     Downstream: Junction C-2

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 47.3
     Channel Loss: None
End:

Junction: Upper Junction
     Description: Combining design points into final basin flow
     Last Modified Date: 30 June 2020
     Last Modified Time: 16:34:05
     Canvas X: 3192064.58176487
     Canvas Y: 1455689.0141506763
     From Canvas X: 3192059.549422635
     From Canvas Y: 1455656.9537690468
     Label X: -110.0
     Label Y: 3.0
     Downstream: Route OS-3B
End:

Reach: Route W-5
```

```
     Last Modified Date: 6 April 2020
     Last Modified Time: 16:05:38
     Canvas X: 3191740.132405288
     Canvas Y: 1455102.301558766
     From Canvas X: 3192053.9995084023
     From Canvas Y: 1455254.1730524607
     Downstream: Junction C-2

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 48.3
     Channel Loss: None
End:

Reach: Route W-6
     Last Modified Date: 16 June 2020
     Last Modified Time: 22:40:46
     Canvas X: 3191125.8142608823
     Canvas Y: 1454636.8944506934
     From Canvas X: 3191596.658030947
     From Canvas Y: 1454785.3109359604
     Downstream: Junction C-3

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 47
     Channel Loss: None
End:

Reach: Route OS-3A
     Last Modified Date: 8 April 2020
     Last Modified Time: 20:02:16
     Canvas X: 3191620.2620947743
     Canvas Y: 1455576.2974092974
     From Canvas X: 3191610.741291508
     From Canvas Y: 1455715.037744202
     Downstream: Junction OS-3

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 46.4
     Channel Loss: None
End:

Junction: Junction C-1
     Last Modified Date: 6 April 2020
     Last Modified Time: 20:34:48
     Canvas X: 3191197.8710940355
```

```
     Canvas Y: 1455077.2244736233
     From Canvas X: 3191049.172513107
     From Canvas Y: 1455596.382345375
     Label X: -84.0
     Label Y: -3.0
     Downstream: Route C-1
End:

Subbasin: Basin OS-3C
     Last Modified Date: 1 July 2020
     Last Modified Time: 19:34:04
     Canvas X: 3191732.837927499
     Canvas Y: 1455795.0234726786
     From Canvas X: 3191732.837927499
     From Canvas Y: 1455795.0234726786
     Area: 0.0198
     Downstream: Route OS-3C

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 37.3
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: Route OS-3B
     Last Modified Date: 6 April 2020
     Last Modified Time: 22:18:54
     Canvas X: 3191740.132405288
     Canvas Y: 1455102.301558766
     From Canvas X: 3192064.58176487
     From Canvas Y: 1455689.0141506763
     Downstream: Junction C-2

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 47
```

```
     Channel Loss: None
End:

Reach: Route OS-3C
     Last Modified Date: 8 April 2020
     Last Modified Time: 20:02:16
     Canvas X: 3191620.2620947743
     Canvas Y: 1455576.2974092974
     From Canvas X: 3191701.8574730195
     From Canvas Y: 1455717.8851248743
     Downstream: Junction OS-3

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 46.4
     Channel Loss: None
End:

Subbasin: Basin OS-3B
     Last Modified Date: 16 June 2020
     Last Modified Time: 22:21:02
     Canvas X: 3191454.1353545357
     Canvas Y: 1455638.1584660518
     From Canvas X: 3191808.881599231
     From Canvas Y: 1455981.4348019836
     Label X: -51.0
     Label Y: 27.0
     Area: 0.034
     Downstream: Junction OS-3

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 16.5
     Curve Number: 66.7
     Initial Abstraction: 0.5

     Transform: SCS
     Lag: 34.2
     Unitgraph Type: STANDARD

     Baseflow: None
End:
```

```
Subbasin: Basin OS-3A
     Last Modified Date: 1 July 2020
     Last Modified Time: 19:33:42
     Canvas X: 3191585.114865458
     Canvas Y: 1455846.0172551244
     From Canvas X: 3191525.184704565
     From Canvas Y: 1455763.7332610039
     Area: 0.0225
     Downstream: Route OS-3A

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 41.4
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: Junction C-3
     Last Modified Date: 6 April 2020
     Last Modified Time: 18:40:14
     Canvas X: 3191125.8142608823
     Canvas Y: 1454636.8944506934
     From Canvas X: 3191239.226172219
     From Canvas Y: 1454613.8680979477
     Downstream: Route C-3
End:

Junction: Junction C-2
     Last Modified Date: 6 April 2020
     Last Modified Time: 16:05:38
     Canvas X: 3191740.132405288
     Canvas Y: 1455102.301558766
     From Canvas X: 3191601.3307882836
     From Canvas Y: 1454899.3142550313
     Downstream: Route to C-3
End:
```

```
Subbasin: Basin OS-4A
     Last Modified Date: 1 July 2020
     Last Modified Time: 19:34:28
     Canvas X: 3191816.144480269
     Canvas Y: 1455608.9537627215
     From Canvas X: 3191816.144480269
     From Canvas Y: 1455608.9537627215
     Area: 0.0256
     Downstream: Route OS-4A

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 41.6
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: OS-2B
     Description: Overland flow. Flows into basin W-3
     Last Modified Date: 18 June 2020
     Last Modified Time: 19:50:47
     Canvas X: 3191192.176332691
     Canvas Y: 1455473.0103870628
     From Canvas X: 3191079.159717601
     From Canvas Y: 1455778.8719525808
     Area: 0.0198
     Downstream: Route OS-2B

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12
     Curve Number: 65
```

```
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 34.2
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: OS-2A
     Description: Existing Basin on Timberview Filing 1. All flow routed to Culvert
11
     Last Modified Date: 1 July 2020
     Last Modified Time: 19:35:35
     Canvas X: 3191075.43372513
     Canvas Y: 1455652.395369413
     From Canvas X: 3190635.01570008
     From Canvas Y: 1456266.8411205618
     Area: 0.022
     Downstream: Route OS-2A

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 37.5
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: Route C-1
     Last Modified Date: 6 April 2020
     Last Modified Time: 22:00:20
     Canvas X: 3191125.8142608823
     Canvas Y: 1454636.8944506934
     From Canvas X: 3191197.8710940355
     From Canvas Y: 1455077.2244736233
     Downstream: Junction C-3
```

```
     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 35.4
     Channel Loss: None
End:

Reach: Route OS-4B
     Last Modified Date: 8 April 2020
     Last Modified Time: 15:11:14
     Canvas X: 3192064.58176487
     Canvas Y: 1455689.0141506763
     From Canvas X: 3192097.536148903
     From Canvas Y: 1455817.2918250756
     Downstream: Upper Junction

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 96.2
     Channel Loss: None
End:

Subbasin: Basin OS-4E
     Description: OS-3B
     Last Modified Date: 8 April 2020
     Last Modified Time: 15:13:01
     Canvas X: 3192707.2299209572
     Canvas Y: 1455857.660741784
     From Canvas X: 3193024.4086084175
     From Canvas Y: 1456017.9537466252
     Area: 0.049
     Downstream: Route OS-4E

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 44
     Unitgraph Type: STANDARD

     Baseflow: None
```

```
End:

Reach: Route Basin OS-3A
     Last Modified Date: 8 April 2020
     Last Modified Time: 20:02:16
     Canvas X: 3191740.132405288
     Canvas Y: 1455102.301558766
     From Canvas X: 3191620.2620947743
     From Canvas Y: 1455576.2974092974
     Downstream: Junction C-2

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 48
     Channel Loss: None
End:

Reach: Route OS-4C
     Last Modified Date: 8 April 2020
     Last Modified Time: 15:11:56
     Canvas X: 3192064.58176487
     Canvas Y: 1455689.0141506763
     From Canvas X: 3192259.8774961918
     From Canvas Y: 1455863.288540141
     Downstream: Upper Junction

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 48.3
     Channel Loss: None
End:

Subbasin: Basin OS-4D
     Description: OS-3B
     Last Modified Date: 8 April 2020
     Last Modified Time: 15:12:22
     Canvas X: 3192731.2547275363
     Canvas Y: 1455991.5132355825
     From Canvas X: 3192803.614351975
     From Canvas Y: 1456110.2858902286
     Area: 0.019
     Downstream: Route OS-4D

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None
```

```
     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 42.8
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: Route OS-2A
     Last Modified Date: 6 April 2020
     Last Modified Time: 20:34:48
     Canvas X: 3191197.8710940355
     Canvas Y: 1455077.2244736233
     From Canvas X: 3191121.592686727
     From Canvas Y: 1455311.9544209125
     Downstream: Junction C-1

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 63.2
     Channel Loss: None
End:

Subbasin: Basin OS-4C
     Description: OS-3B
     Last Modified Date: 8 April 2020
     Last Modified Time: 15:11:32
     Canvas X: 3192549.3526205793
     Canvas Y: 1456056.7234248691
     From Canvas X: 3192434.285777561
     From Canvas Y: 1456074.1559209926
     Area: 0.031
     Downstream: Route OS-4C

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
```

```
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 53.5
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: Route OS-4D
     Last Modified Date: 8 April 2020
     Last Modified Time: 15:12:43
     Canvas X: 3192064.58176487
     Canvas Y: 1455689.0141506763
     From Canvas X: 3192408.6358963293
     From Canvas Y: 1455885.1176635888
     Downstream: Upper Junction

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 95.6
     Channel Loss: None
End:

Reach: Route OS-2B
     Last Modified Date: 6 April 2020
     Last Modified Time: 21:56:42
     Canvas X: 3191197.8710940355
     Canvas Y: 1455077.2244736233
     From Canvas X: 3191198.059764327
     From Canvas Y: 1455243.1779213208
     Downstream: Junction C-1

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 31
     Channel Loss: None
End:

Subbasin: Basin OS-4B
     Description: OS-3B
     Last Modified Date: 8 April 2020
     Last Modified Time: 15:10:53
     Canvas X: 3192160.285761248
     Canvas Y: 1456065.2655668857
     From Canvas X: 3192165.318228803
     From Canvas Y: 1456058.0981568876
     Label X: 0.0
```

```
     Label Y: 1.0
     Area: 0.019
     Downstream: Route OS-4B

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 34.2
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: Route OS-4E
     Last Modified Date: 8 April 2020
     Last Modified Time: 15:13:32
     Canvas X: 3192064.58176487
     Canvas Y: 1455689.0141506763
     From Canvas X: 3192392.4562631445
     From Canvas Y: 1455779.412177375
     Downstream: Upper Junction

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 100.1
     Channel Loss: None
End:

Junction: Junction OS-3
     Last Modified Date: 8 April 2020
     Last Modified Time: 20:02:16
     Canvas X: 3191620.2620947743
     Canvas Y: 1455576.2974092974
     From Canvas X: 3191030.2304471615
     From Canvas Y: 1455857.6038960286
     Downstream: Route Basin OS-3A
End:

Reach: Route OS-4F
```

```
     Last Modified Date: 30 June 2020
     Last Modified Time: 16:34:09
     Canvas X: 3192064.58176487
     Canvas Y: 1455689.0141506763
     From Canvas X: 3192384.0746898083
     From Canvas Y: 1455708.2538620764
     Downstream: Upper Junction

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 95.6
     Channel Loss: None
End:

Subbasin: W-3
     Last Modified Date: 16 June 2020
     Last Modified Time: 22:25:18
     Canvas X: 3191274.205299845
     Canvas Y: 1455232.9233677052
     From Canvas X: 3191024.0629101307
     From Canvas Y: 1455607.9918769917
     Area: 0.01
     Downstream: Junction C-1

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 30.8
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: Basin OS-4H
     Last Modified Date: 1 July 2020
     Last Modified Time: 21:45:18
     Canvas X: 3192191.6069486425
     Canvas Y: 1455441.6891996684
     From Canvas X: 3192188.156768472
```

```
     From Canvas Y: 1455449.7392372065
     Area: 0.021
     Downstream: Route OS-4H

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 41.1
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: Route OS-4G
     Last Modified Date: 8 April 2020
     Last Modified Time: 15:14:46
     Canvas X: 3192064.58176487
     Canvas Y: 1455689.0141506763
     From Canvas X: 3192316.0300185457
     From Canvas Y: 1455651.1617253919
     Downstream: Upper Junction

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 102.7
     Channel Loss: None
End:

Reach: Route OS-4H
     Last Modified Date: 8 April 2020
     Last Modified Time: 15:15:37
     Canvas X: 3191740.132405288
     Canvas Y: 1455102.301558766
     From Canvas X: 3192057.7800570475
     From Canvas Y: 1455344.8782568125
     Downstream: Junction C-2

     Route: Lag
     Initial Variable: Combined Inflow
```

```
     Lag: 48
     Channel Loss: None
End:

Subbasin: W-5
     Description: All overland flow for watershed. Used to size swale DP 5-4
     Last Modified Date: 6 April 2020
     Last Modified Time: 21:51:01
     Canvas X: 3192181.679638902
     Canvas Y: 1455275.5631039173
     From Canvas X: 3192157.565279063
     From Canvas Y: 1455254.8641652972
     Label X: 1.0
     Label Y: 0.0
     Area: 0.01
     Downstream: Route W-5

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 51.2
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: Basin OS-4G
     Description: OS-3B
     Last Modified Date: 8 April 2020
     Last Modified Time: 15:14:25
     Canvas X: 3192660.319486171
     Canvas Y: 1455549.4286020491
     From Canvas X: 3193180.971808441
     From Canvas Y: 1455688.769582474
     Area: 0.076
     Downstream: Route OS-4G

     Canopy: None
     Allow Simultaneous Precip Et: No
```

```
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 48.9
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: Basin OS-4F
     Description: OS-3B
     Last Modified Date: 8 April 2020
     Last Modified Time: 15:13:48
     Canvas X: 3192736.0787815726
     Canvas Y: 1455736.1211514312
     From Canvas X: 3193108.7118699686
     From Canvas Y: 1455873.4338696809
     Area: 0.021
     Downstream: Route OS-4F

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 45
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: W-4
     Last Modified Date: 6 April 2020
     Last Modified Time: 21:51:06
```

```
     Canvas X: 3191593.657007475
     Canvas Y: 1455287.930643368
     From Canvas X: 3191663.9790399233
     From Canvas Y: 1455200.9491771364
     Label X: 0.0
     Label Y: 1.0
     Area: 0.006
     Downstream: Junction C-2

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 48.3
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: Route C-3
     Last Modified Date: 30 June 2020
     Last Modified Time: 14:31:19
     Canvas X: 3190830.1690315185
     Canvas Y: 1454218.4037954086
     From Canvas X: 3191125.8142608823
     From Canvas Y: 1454636.8944506934
     Downstream: R-EX-2

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 32
     Channel Loss: None
End:

Reservoir: Pond 2
     Last Modified Date: 26 June 2020
     Last Modified Time: 20:51:57
     Canvas X: 3191285.843830595
     Canvas Y: 1454369.28601614
     From Canvas X: 3191195.8916458623
```

```
     From Canvas Y: 1454392.14754045
     Label X: -6.0
     Label Y: -16.0
     Downstream: Route Pond 2

     Route: Specified Outflow
     Routing Curve: Elevation-Storage
     Initial Elevation: 0
     Elevation-Storage Table: Pond 2
     Outflow Gage Name: Pond 2 - Q50
End:

Reservoir: Pond 1
     Last Modified Date: 26 June 2020
     Last Modified Time: 20:51:50
     Canvas X: 3190788.6775098434
     Canvas Y: 1454841.7546350043
     From Canvas X: 3190512.093450769
     From Canvas Y: 1455477.2407319362
     Downstream: Route Pond 1

     Route: Specified Outflow
     Routing Curve: Elevation-Storage
     Initial Elevation: 0
     Elevation-Storage Table: Pond 1
     Outflow Gage Name: Pond 1 - Q50
End:

Reservoir: R-EX-2
     Description: Note: Outlet 1 is reduced in size from the existing condition to
represent a 3-5/8 inch depth restrictor plate installed on pipe to reduce flows for
Q5 event
     Last Modified Date: 30 June 2020
     Last Modified Time: 14:41:22
     Canvas X: 3190830.1690315185
     Canvas Y: 1454218.4037954086
     From Canvas X: 3190778.306968433
     From Canvas Y: 1454050.976266697
     Label X: -78.0
     Label Y: 71.0
     Downstream: Sink-2

     Route: Controlled Outflow
     Routing Curve: Elevation-Area
     Initial Outflow Equals Inflow: Yes
     Elevation-Area Table: EX-2
     Adaptive Control: On
     Main Tailwater Condition: None
```

```
     Auxiliary Tailwater Condition: None

     Conduit: Culvert
     Conduit Outlet: Main
     Culvert Shape: Elliptical
     Chart Number: 29
     Scale Number: 3
     Solution Control: Automatic
     Rise: 2.33
     Span: 3.5
     Diameter: 2.5
     Number Barrels: 1
     Culvert Length: 48.5
     Entrance Loss Coefficient: 0.2
     Exit Loss Coefficient: 1
     Top Manning's n: 0.02
     Inlet Invert Elevation: 7154.7
     Outlet Invert Elevation: 7149.5
     End Conduit:

     Conduit: Culvert
     Conduit Outlet: Main
     Culvert Shape: Elliptical
     Chart Number: 29
     Scale Number: 1
     Solution Control: Automatic
     Rise: 1.58
     Span: 2.5
     Diameter: 1.5
     Number Barrels: 1
     Culvert Length: 48.5
     Entrance Loss Coefficient: 0.2
     Exit Loss Coefficient: 1
     Top Manning's n: 0.02
     Inlet Invert Elevation: 7158.5
     Outlet Invert Elevation: 7151
     End Conduit:

     Spillway: Broad-Crested Spillway
     Spillway Outlet: Main
     Spillway Crest Length: 174.3
     Spillway Crest Elevation: 7162
     Spillway Coefficient: 2.6
     End Spillway:

     Evaporation Method: Zero Evaporation
     End Evaporation:
End:
```

```
Subbasin: W-2
     Last Modified Date: 23 June 2020
     Last Modified Time: 21:06:53
     Canvas X: 3190671.1056696735
     Canvas Y: 1454493.511435817
     From Canvas X: 3190858.8970014188
     From Canvas Y: 1454517.375669532
     Area: 0.005
     Downstream: R-EX-2

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 45.4
     Initial Abstraction: 1.2

     Transform: SCS
     Lag: 31
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: W-9
     Last Modified Date: 6 April 2020
     Last Modified Time: 23:21:10
     Canvas X: 3191400.0351217636
     Canvas Y: 1454154.673135822
     From Canvas X: 3191046.078595636
     From Canvas Y: 1454207.1248628749
     Area: 0.003
     Downstream: Route W-9

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12
     Curve Number: 65
```

```
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 46
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: D-2
     Last Modified Date: 25 June 2020
     Last Modified Time: 22:00:51
     Canvas X: 3191663.866892373
     Canvas Y: 1454378.4190795475
     From Canvas X: 3191628.3381642886
     From Canvas Y: 1454443.6292688341
     Area: 0.01
     Downstream: Pond 2

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 31.7
     Curve Number: 72.4
     Initial Abstraction: 0.38

     Transform: SCS
     Lag: 37
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: D-1
     Last Modified Date: 7 April 2020
     Last Modified Time: 17:50:40
     Canvas X: 3190762.221851185
     Canvas Y: 1455062.9875702623
     From Canvas X: 3190677.102419148
     From Canvas Y: 1455211.3929495476
     Area: 0.02
     Downstream: Pond 1

     Canopy: None
```

```
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 22.31
     Curve Number: 68.37
     Initial Abstraction: 0.46

     Transform: SCS
     Lag: 41.3
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Sink: Sink-2
     Description: Wetlands. Central drainage.
     Last Modified Date: 23 June 2020
     Last Modified Time: 21:07:21
     Canvas X: 3190748.0295129814
     Canvas Y: 1454016.9141293145
     From Canvas X: 3190880.4929359066
     From Canvas Y: 1454338.8286808033
     Label X: -28.0
     Label Y: -25.0
End:

Subbasin: W-1
     Last Modified Date: 30 June 2020
     Last Modified Time: 16:32:56
     Canvas X: 3190300.4924384844
     Canvas Y: 1454560.3114374725
     From Canvas X: 3190143.3967487137
     From Canvas Y: 1454903.4863893862
     Area: 0.0302
     Downstream: R-EX-3

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 13.6
     Curve Number: 65.6
```

```
     Initial Abstraction: 0.52

     Transform: SCS
     Lag: 48.6
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reservoir: R-EX-3
     Last Modified Date: 23 June 2020
     Last Modified Time: 21:32:34
     Canvas X: 3190274.944271556
     Canvas Y: 1454085.0384040799
     From Canvas X: 3190274.944271556
     From Canvas Y: 1454085.0384040799
     Downstream: Sink-3

     Route: Controlled Outflow
     Routing Curve: Elevation-Area
     Initial Outflow Equals Inflow: Yes
     Elevation-Area Table: EX-3
     Adaptive Control: On
     Main Tailwater Condition: None
     Auxiliary Tailwater Condition: None

     Conduit: Culvert
     Conduit Outlet: Main
     Culvert Shape: Circular
     Chart Number: 2
     Scale Number: 3
     Solution Control: Automatic
     Rise: 1.25
     Diameter: 1.25
     Number Barrels: 1
     Culvert Length: 43.1
     Entrance Loss Coefficient: 0.2
     Exit Loss Coefficient: 1
     Top Manning's n: 0.02
     Inlet Invert Elevation: 7168.6
     Outlet Invert Elevation: 7167.3
     End Conduit:

     Spillway: Broad-Crested Spillway
     Spillway Outlet: Main
     Spillway Crest Length: 237.06
     Spillway Crest Elevation: 7174
     Spillway Coefficient: 2.6
```

```
     End Spillway:

     Evaporation Method: Zero Evaporation
     End Evaporation:
End:

Subbasin: OS-1
     Description: Part of Timberview. Fully detained in sedimentation basin
     Last Modified Date: 26 June 2020
     Last Modified Time: 19:56:00
     Canvas X: 3189944.377164344
     Canvas Y: 1454944.7180917726
     From Canvas X: 3189604.487770659
     From Canvas Y: 1455611.2295709252
     Label X: -24.0
     Label Y: 15.0
     Area: 0.0634
     Downstream: Reservoir OS-1

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 43.9
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reservoir: Reservoir OS-1
     Description: All flows from OS-1 are collected by and detained by a
sedimentation pond on Timberview. Reservooir table are availabe in this report.
     Last Modified Date: 26 June 2020
     Last Modified Time: 19:55:52
     Canvas X: 3190016.0388309094
     Canvas Y: 1454678.4260555971
     From Canvas X: 3189388.7751533836
     From Canvas Y: 1455874.4720869225
     Downstream: Route OS-1
```

```
     Route: Modified Puls
     Routing Curve: Storage-Outflow
     Initial Outflow: 0
     Storage-Outflow Table: EX OS-1
End:

Reach: Route OS-1
     Last Modified Date: 26 June 2020
     Last Modified Time: 19:55:52
     Canvas X: 3190274.944271556
     Canvas Y: 1454085.0384040799
     From Canvas X: 3190016.0388309094
     From Canvas Y: 1454678.4260555971
     Downstream: R-EX-3

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 48.6
     Channel Loss: None
End:

Sink: Sink-3
     Description: West-most drainage - Culvert 3
     Last Modified Date: 23 June 2020
     Last Modified Time: 21:29:08
     Canvas X: 3190290.6604908723
     Canvas Y: 1453988.5970195946
     From Canvas X: 3190265.471714283
     From Canvas Y: 1454199.949087816
     Label X: -31.0
     Label Y: -20.0
End:

Subbasin: W-10
     Last Modified Date: 16 June 2020
     Last Modified Time: 22:56:37
     Canvas X: 3192674.484371266
     Canvas Y: 1454778.6071245822
     From Canvas X: 3192832.9140338055
     From Canvas Y: 1454753.0347040498
     Area: 0.01
     Downstream: Sink-4

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None
```

```
     LossRate: SCS
     Percent Impervious Area: 12
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 11.9
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Sink: Sink-4
     Description: EX culvert 4
     Last Modified Date: 25 March 2020
     Last Modified Time: 18:50:24
     Canvas X: 3192640.4035706962
     Canvas Y: 1454413.8496023817
     From Canvas X: 3192640.4035706962
     From Canvas Y: 1454413.8496023817
End:

Basin Layer Properties:
     Element Layer:
          Name: Icons
          Layer shown: Yes
     End Layer:
End:

Basin Spatial Properties:
End:

Basin Schematic Properties:
     Last View N: 1455607.9918769917
     Last View S: 1454940.6937600982
     Last View W: 3191024.0629101307
     Last View E: 3191102.8411600417
     Maximum View N: 1455607.9918769917
     Maximum View S: 1454940.6937600982
     Maximum View W: 3191024.0629101307
     Maximum View E: 3191102.8411600417
     Extent Method: Manual
     Buffer: 0
     Draw Icons: Yes
     Draw Icon Labels: Name
     Draw Map Objects: No
     Draw Gridlines: No
```

```
    Draw Flow Direction: No
    Draw HillShade Layer: Yes
    Draw Elevation Layer: Yes
    Elevation Layer Color Palette: Default
    Ignore Elevation Color Ramp Scale: No
    Use Interpolated Color Ramp for Elevation Layer: Yes
    Color Ramp Opacity Level for Elevation Layer: 33.0
    Fix Element Locations: No
    Fix Hydrologic Order: No
End:
```

Project: GWR 100 YR Final Simulation Run: PR West - 100 YR 24HR

Start of Run: 01Jan2020, 00:00 Basin Model: PR West Basin GWR
End of Run: 02Jan2020, 00:05 Meteorologic Model: 24 HR 100 YR
Compute Time: 01Jul2020, 15:45:26 Control Specifications: GR Control

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route W-9	0.00300	1.7	01Jan2020, 13:10	2.03
Route Pond 1	0.02000	4.1	01Jan2020, 02:10	0.94
Route Pond 2	0.01000	6.8	01Jan2020, 01:35	1.39
W-7	0.02700	15.8	01Jan2020, 12:40	2.12
W-6	0.00300	2.1	01Jan2020, 12:30	2.06
W-8	0.00386	2.7	01Jan2020, 12:30	2.06
Route to C-3	0.35390	135.1	01Jan2020, 15:35	1.98
Route OS-4A	0.02560	15.7	01Jan2020, 13:25	2.03
Upper Junction	0.21500	114.3	01Jan2020, 14:15	1.99
Route W-5	0.01000	5.3	01Jan2020, 13:35	2.02
Route W-6	0.00300	2.1	01Jan2020, 13:15	2.03
Route OS-3A	0.02250	13.9	01Jan2020, 13:20	2.03
Junction C-1	0.05180	23.9	01Jan2020, 13:25	2.04
Basin OS-3C	0.01980	13.2	01Jan2020, 12:30	2.06
Route OS-3B	0.21500	113.9	01Jan2020, 15:05	1.96
Route OS-3C	0.01980	13.1	01Jan2020, 13:15	2.03
Basin OS-3B	0.03400	26.4	01Jan2020, 12:25	2.28
Basin OS-3A	0.02250	14.0	01Jan2020, 12:35	2.06
Junction C-3	0.43956	142.9	01Jan2020, 15:35	2.00
Junction C-2	0.35390	135.1	01Jan2020, 15:00	2.01
Basin OS-4A	0.02560	15.9	01Jan2020, 12:35	2.06
OS-2B	0.01980	14.0	01Jan2020, 12:30	2.06
OS-2A	0.02200	14.6	01Jan2020, 12:30	2.06
Route C-1	0.05180	23.9	01Jan2020, 14:00	2.02
Route OS-4B	0.01900	13.4	01Jan2020, 14:05	2.00
Basin OS-4E	0.04900	29.2	01Jan2020, 12:40	2.06
Route Basin OS-3A	0.07630	36.0	01Jan2020, 14:00	2.11
Route OS-4C	0.03100	16.0	01Jan2020, 13:35	2.02
Basin OS-4D	0.01900	11.5	01Jan2020, 12:35	2.06
Route OS-2A	0.02200	14.6	01Jan2020, 13:35	2.02
Basin OS-4C	0.03100	16.1	01Jan2020, 12:50	2.05

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route OS-4D	0.01900	11.5	01Jan2020, 14:10	2.00
Route OS-2B	0.01980	13.9	01Jan2020, 13:00	2.04
Basin OS-4B	0.01900	13.4	01Jan2020, 12:30	2.06
Route OS-4E	0.04900	29.2	01Jan2020, 14:20	1.99
Junction OS-3	0.07630	36.2	01Jan2020, 13:15	2.14
Route OS-4F	0.02100	12.3	01Jan2020, 14:15	1.99
W-3	0.01000	7.6	01Jan2020, 12:25	2.07
Basin OS-4H	0.02100	13.1	01Jan2020, 12:35	2.06
Route OS-4G	0.07600	41.9	01Jan2020, 14:25	1.99
Route OS-4H	0.02100	13.0	01Jan2020, 13:25	2.03
W-5	0.01000	5.4	01Jan2020, 12:45	2.05
Basin OS-4G	0.07600	42.0	01Jan2020, 12:45	2.05
Basin OS-4F	0.02100	12.3	01Jan2020, 12:40	2.05
W-4	0.00600	3.3	01Jan2020, 12:45	2.05
Route C-3	0.43956	142.3	01Jan2020, 16:05	1.97
Pond 2	0.01000	6.8	01Jan2020, 01:05	1.39
Pond 1	0.02000	4.1	01Jan2020, 01:35	0.94
R-EX-2	0.47756	143.2	01Jan2020, 16:10	1.90
W-2	0.00500	1.2	01Jan2020, 12:30	0.74
W-9	0.00300	1.7	01Jan2020, 12:40	2.05
D-2	0.01000	9.5	01Jan2020, 12:30	2.94
D-1	0.02000	15.1	01Jan2020, 12:35	2.51
Sink-2	0.47756	143.2	01Jan2020, 16:05	1.90
W-1	0.03020	17.4	01Jan2020, 12:45	2.13
R-EX-3	0.09360	35.7	01Jan2020, 13:45	2.05
OS-1	0.06340	37.8	01Jan2020, 12:40	2.06
Reservoir OS-1	0.06340	29.1	01Jan2020, 13:00	2.05
Route OS-1	0.06340	29.1	01Jan2020, 13:50	2.02
Sink-3	0.09360	35.7	01Jan2020, 13:40	2.05
W-10	0.01000	13.1	01Jan2020, 12:05	2.08
Sink-4	0.01000	13.1	01Jan2020, 12:00	2.08

Project: GWR 50 YR Final Simulation Run: PR West - 50 YR 24HR

Start of Run: 01Jan2020, 00:00 Basin Model: PR West Basin GWR
End of Run: 02Jan2020, 00:05 Meteorologic Model: 24HR - 50YR
Compute Time: 01Jul2020, 15:34:59 Control Specifications: GR Control - PR

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route W-9	0.00300	1.5	01Jan2020, 13:10	1.76
Route Pond 1	0.02000	4.1	01Jan2020, 02:10	0.94
Route Pond 2	0.01000	6.8	01Jan2020, 01:35	1.39
W-7	0.02700	13.6	01Jan2020, 12:40	1.84
W-6	0.00300	1.8	01Jan2020, 12:30	1.79
W-8	0.00386	2.3	01Jan2020, 12:30	1.78
Route to C-3	0.35390	116.3	01Jan2020, 15:35	1.72
Route OS-4A	0.02560	13.5	01Jan2020, 13:25	1.75
Upper Junction	0.21500	98.2	01Jan2020, 14:15	1.73
Route W-5	0.01000	4.6	01Jan2020, 13:35	1.75
Route W-6	0.00300	1.8	01Jan2020, 13:15	1.76
Route OS-3A	0.02250	12.0	01Jan2020, 13:20	1.76
Junction C-1	0.05180	20.6	01Jan2020, 13:25	1.76
Basin OS-3C	0.01980	11.4	01Jan2020, 12:30	1.78
Route OS-3B	0.21500	97.9	01Jan2020, 15:05	1.70
Route OS-3C	0.01980	11.3	01Jan2020, 13:15	1.76
Basin OS-3B	0.03400	22.9	01Jan2020, 12:25	1.99
Basin OS-3A	0.02250	12.0	01Jan2020, 12:35	1.78
Junction C-3	0.43956	123.1	01Jan2020, 15:35	1.73
Junction C-2	0.35390	116.3	01Jan2020, 15:00	1.74
Basin OS-4A	0.02560	13.6	01Jan2020, 12:35	1.78
OS-2B	0.01980	12.0	01Jan2020, 12:30	1.79
OS-2A	0.02200	12.6	01Jan2020, 12:30	1.78
Route C-1	0.05180	20.6	01Jan2020, 14:00	1.74
Route OS-4B	0.01900	11.5	01Jan2020, 14:05	1.73
Basin OS-4E	0.04900	25.1	01Jan2020, 12:40	1.78
Route Basin OS-3A	0.07630	31.0	01Jan2020, 14:00	1.83
Route OS-4C	0.03100	13.8	01Jan2020, 13:35	1.75
Basin OS-4D	0.01900	9.9	01Jan2020, 12:35	1.78
Route OS-2A	0.02200	12.5	01Jan2020, 13:35	1.75
Basin OS-4C	0.03100	13.8	01Jan2020, 12:50	1.77

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route OS-4D	0.01900	9.9	01Jan2020, 14:10	1.73
Route OS-2B	0.01980	12.0	01Jan2020, 13:00	1.77
Basin OS-4B	0.01900	11.5	01Jan2020, 12:30	1.79
Route OS-4E	0.04900	25.1	01Jan2020, 14:20	1.72
Junction OS-3	0.07630	31.2	01Jan2020, 13:15	1.86
Route OS-4F	0.02100	10.6	01Jan2020, 14:15	1.72
W-3	0.01000	6.5	01Jan2020, 12:25	1.79
Basin OS-4H	0.02100	11.3	01Jan2020, 12:35	1.78
Route OS-4G	0.07600	36.0	01Jan2020, 14:25	1.72
Route OS-4H	0.02100	11.2	01Jan2020, 13:25	1.75
W-5	0.01000	4.6	01Jan2020, 12:45	1.77
Basin OS-4G	0.07600	36.1	01Jan2020, 12:45	1.78
Basin OS-4F	0.02100	10.6	01Jan2020, 12:40	1.78
W-4	0.00600	2.9	01Jan2020, 12:45	1.78
Route C-3	0.43956	122.5	01Jan2020, 16:05	1.71
Pond 2	0.01000	6.8	01Jan2020, 01:05	1.39
Pond 1	0.02000	4.1	01Jan2020, 01:35	0.94
R-EX-2	0.47756	112.2	01Jan2020, 16:25	1.66
W-2	0.00500	0.9	01Jan2020, 12:30	0.59
W-9	0.00300	1.5	01Jan2020, 12:40	1.78
D-2	0.01000	8.4	01Jan2020, 12:30	2.61
D-1	0.02000	13.2	01Jan2020, 12:35	2.21
Sink-2	0.47756	112.2	01Jan2020, 16:20	1.66
W-1	0.03020	15.0	01Jan2020, 12:45	1.85
R-EX-3	0.09360	31.3	01Jan2020, 13:45	1.78
OS-1	0.06340	32.5	01Jan2020, 12:40	1.78
Reservoir OS-1	0.06340	25.5	01Jan2020, 13:00	1.78
Route OS-1	0.06340	25.5	01Jan2020, 13:50	1.75
Sink-3	0.09360	31.3	01Jan2020, 13:40	1.78
W-10	0.01000	11.3	01Jan2020, 12:05	1.80
Sink-4	0.01000	11.3	01Jan2020, 12:00	1.80

Project: GWR 25 YR Final Simulation Run: PR West - 25 YR 24HR

Start of Run: 01Jan2020, 00:00 Basin Model: PR West Basin GWR
End of Run: 02Jan2020, 00:05 Meteorologic Model: 24HR - 25YR
Compute Time: 01Jul2020, 15:39:58 Control Specifications: GR Control - PR

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route W-9	0.00300	1.1	01Jan2020, 13:10	1.37
Route Pond 1	0.02000	3.9	01Jan2020, 02:05	0.78
Route Pond 2	0.01000	5.5	01Jan2020, 01:35	1.08
W-7	0.02700	10.5	01Jan2020, 12:40	1.44
W-6	0.00300	1.4	01Jan2020, 12:30	1.39
W-8	0.00386	1.8	01Jan2020, 12:30	1.39
Route to C-3	0.35390	89.6	01Jan2020, 15:35	1.34
Route OS-4A	0.02560	10.4	01Jan2020, 13:25	1.37
Upper Junction	0.21500	75.4	01Jan2020, 14:15	1.34
Route W-5	0.01000	3.5	01Jan2020, 13:35	1.36
Route W-6	0.00300	1.4	01Jan2020, 13:15	1.37
Route OS-3A	0.02250	9.2	01Jan2020, 13:20	1.37
Junction C-1	0.05180	15.8	01Jan2020, 13:25	1.37
Basin OS-3C	0.01980	8.7	01Jan2020, 12:30	1.39
Route OS-3B	0.21500	75.2	01Jan2020, 15:05	1.32
Route OS-3C	0.01980	8.7	01Jan2020, 13:15	1.37
Basin OS-3B	0.03400	17.8	01Jan2020, 12:30	1.57
Basin OS-3A	0.02250	9.2	01Jan2020, 12:35	1.39
Junction C-3	0.43956	94.9	01Jan2020, 15:35	1.35
Junction C-2	0.35390	89.6	01Jan2020, 15:00	1.35
Basin OS-4A	0.02560	10.5	01Jan2020, 12:35	1.39
OS-2B	0.01980	9.2	01Jan2020, 12:30	1.39
OS-2A	0.02200	9.6	01Jan2020, 12:30	1.39
Route C-1	0.05180	15.8	01Jan2020, 14:00	1.36
Route OS-4B	0.01900	8.8	01Jan2020, 14:05	1.35
Basin OS-4E	0.04900	19.2	01Jan2020, 12:40	1.38
Route Basin OS-3A	0.07630	23.9	01Jan2020, 14:00	1.43
Route OS-4C	0.03100	10.6	01Jan2020, 13:35	1.36
Basin OS-4D	0.01900	7.6	01Jan2020, 12:35	1.39
Route OS-2A	0.02200	9.6	01Jan2020, 13:35	1.36
Basin OS-4C	0.03100	10.6	01Jan2020, 12:50	1.38

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route OS-4D	0.01900	7.6	01Jan2020, 14:10	1.34
Route OS-2B	0.01980	9.2	01Jan2020, 13:00	1.38
Basin OS-4B	0.01900	8.8	01Jan2020, 12:30	1.39
Route OS-4E	0.04900	19.2	01Jan2020, 14:20	1.34
Junction OS-3	0.07630	24.1	01Jan2020, 13:15	1.46
Route OS-4F	0.02100	8.1	01Jan2020, 14:15	1.34
W-3	0.01000	5.0	01Jan2020, 12:25	1.39
Basin OS-4H	0.02100	8.7	01Jan2020, 12:35	1.39
Route OS-4G	0.07600	27.7	01Jan2020, 14:25	1.34
Route OS-4H	0.02100	8.6	01Jan2020, 13:25	1.37
W-5	0.01000	3.5	01Jan2020, 12:45	1.38
Basin OS-4G	0.07600	27.7	01Jan2020, 12:45	1.38
Basin OS-4F	0.02100	8.1	01Jan2020, 12:40	1.38
W-4	0.00600	2.2	01Jan2020, 12:45	1.38
Route C-3	0.43956	94.5	01Jan2020, 16:10	1.33
Pond 2	0.01000	5.5	01Jan2020, 01:05	1.09
Pond 1	0.02000	3.9	01Jan2020, 01:30	0.79
R-EX-2	0.47756	90.1	01Jan2020, 16:20	1.29
W-2	0.00500	0.6	01Jan2020, 12:30	0.39
W-9	0.00300	1.1	01Jan2020, 12:40	1.38
D-2	0.01000	6.8	01Jan2020, 12:30	2.12
D-1	0.02000	10.5	01Jan2020, 12:35	1.77
Sink-2	0.47756	90.1	01Jan2020, 16:15	1.29
W-1	0.03020	11.6	01Jan2020, 12:45	1.45
R-EX-3	0.09360	25.4	01Jan2020, 13:40	1.38
OS-1	0.06340	24.9	01Jan2020, 12:40	1.39
Reservoir OS-1	0.06340	20.6	01Jan2020, 13:00	1.38
Route OS-1	0.06340	20.6	01Jan2020, 13:45	1.36
Sink-3	0.09360	25.4	01Jan2020, 13:35	1.38
W-10	0.01000	8.7	01Jan2020, 12:05	1.40
Sink-4	0.01000	8.7	01Jan2020, 12:00	1.40

Project: GWR 10 YR Final Simulation Run: PR West - 10 YR 24HR

Start of Run: 01Jan2020, 00:00 Basin Model: PR West Basin GWR
End of Run: 02Jan2020, 00:05 Meteorologic Model: 24 HR - 10-YR
Compute Time: 01Jul2020, 15:38:41 Control Specifications: GR Control - PR

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route W-9	0.00300	0.9	01Jan2020, 13:10	1.13
Route Pond 1	0.02000	2.3	01Jan2020, 02:20	0.59
Route Pond 2	0.01000	1.9	01Jan2020, 01:55	0.65
W-7	0.02700	8.5	01Jan2020, 12:40	1.19
W-6	0.00300	1.1	01Jan2020, 12:30	1.14
W-8	0.00386	1.4	01Jan2020, 12:30	1.14
Route to C-3	0.35390	72.9	01Jan2020, 15:35	1.10
Route OS-4A	0.02560	8.4	01Jan2020, 13:25	1.12
Upper Junction	0.21500	61.2	01Jan2020, 14:15	1.10
Route W-5	0.01000	2.9	01Jan2020, 13:35	1.12
Route W-6	0.00300	1.1	01Jan2020, 13:15	1.13
Route OS-3A	0.02250	7.5	01Jan2020, 13:20	1.12
Junction C-1	0.05180	12.9	01Jan2020, 13:25	1.13
Basin OS-3C	0.01980	7.1	01Jan2020, 12:30	1.14
Route OS-3B	0.21500	61.1	01Jan2020, 15:05	1.08
Route OS-3C	0.01980	7.0	01Jan2020, 13:20	1.13
Basin OS-3B	0.03400	14.7	01Jan2020, 12:30	1.30
Basin OS-3A	0.02250	7.5	01Jan2020, 12:35	1.14
Junction C-3	0.43956	77.4	01Jan2020, 15:35	1.11
Junction C-2	0.35390	72.9	01Jan2020, 15:00	1.11
Basin OS-4A	0.02560	8.5	01Jan2020, 12:35	1.14
OS-2B	0.01980	7.5	01Jan2020, 12:30	1.14
OS-2A	0.02200	7.8	01Jan2020, 12:30	1.14
Route C-1	0.05180	12.9	01Jan2020, 14:00	1.12
Route OS-4B	0.01900	7.2	01Jan2020, 14:05	1.11
Basin OS-4E	0.04900	15.6	01Jan2020, 12:40	1.14
Route Basin OS-3A	0.07630	19.5	01Jan2020, 14:00	1.19
Route OS-4C	0.03100	8.6	01Jan2020, 13:35	1.12
Basin OS-4D	0.01900	6.2	01Jan2020, 12:40	1.14
Route OS-2A	0.02200	7.8	01Jan2020, 13:35	1.12
Basin OS-4C	0.03100	8.6	01Jan2020, 12:50	1.13

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route OS-4D	0.01900	6.2	01Jan2020, 14:15	1.10
Route OS-2B	0.01980	7.5	01Jan2020, 13:00	1.13
Basin OS-4B	0.01900	7.2	01Jan2020, 12:30	1.14
Route OS-4E	0.04900	15.6	01Jan2020, 14:20	1.10
Junction OS-3	0.07630	19.7	01Jan2020, 13:15	1.20
Route OS-4F	0.02100	6.6	01Jan2020, 14:15	1.10
W-3	0.01000	4.1	01Jan2020, 12:25	1.15
Basin OS-4H	0.02100	7.0	01Jan2020, 12:35	1.14
Route OS-4G	0.07600	22.5	01Jan2020, 14:25	1.10
Route OS-4H	0.02100	7.0	01Jan2020, 13:25	1.12
W-5	0.01000	2.9	01Jan2020, 12:45	1.14
Basin OS-4G	0.07600	22.5	01Jan2020, 12:45	1.14
Basin OS-4F	0.02100	6.6	01Jan2020, 12:40	1.14
W-4	0.00600	1.8	01Jan2020, 12:45	1.14
Route C-3	0.43956	77.0	01Jan2020, 16:10	1.09
Pond 2	0.01000	1.9	01Jan2020, 01:25	0.65
Pond 1	0.02000	2.3	01Jan2020, 01:50	0.59
R-EX-2	0.47756	75.1	01Jan2020, 16:15	1.05
W-2	0.00500	0.4	01Jan2020, 12:30	0.28
W-9	0.00300	0.9	01Jan2020, 12:40	1.14
D-2	0.01000	5.8	01Jan2020, 12:30	1.81
D-1	0.02000	8.7	01Jan2020, 12:35	1.49
Sink-2	0.47756	75.1	01Jan2020, 16:10	1.05
W-1	0.03020	9.5	01Jan2020, 12:45	1.20
R-EX-3	0.09360	21.8	01Jan2020, 13:40	1.14
OS-1	0.06340	20.3	01Jan2020, 12:40	1.14
Reservoir OS-1	0.06340	17.9	01Jan2020, 12:55	1.14
Route OS-1	0.06340	17.8	01Jan2020, 13:40	1.12
Sink-3	0.09360	21.8	01Jan2020, 13:35	1.14
W-10	0.01000	7.0	01Jan2020, 12:05	1.15
Sink-4	0.01000	7.0	01Jan2020, 12:00	1.15

Project: GWR 5 YR Final Simulation Run: PR West - 5 YR 24HR

Start of Run: 01Jan2020, 00:00 Basin Model: PR West Basin GWR
End of Run: 02Jan2020, 00:05 Meteorologic Model: 24 HR 5 YR
Compute Time: 01Jul2020, 15:36:49 Control Specifications: GR Control - PR

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route W-9	0.00300	0.7	01Jan2020, 13:10	0.84
Route Pond 1	0.02000	0.9	01Jan2020, 02:40	0.45
Route Pond 2	0.01000	0.1	01Jan2020, 02:20	0.40
W-7	0.02700	6.3	01Jan2020, 12:45	0.89
W-6	0.00300	0.8	01Jan2020, 12:30	0.86
W-8	0.00386	1.0	01Jan2020, 12:30	0.86
Route to C-3	0.35390	53.6	01Jan2020, 15:35	0.82
Route OS-4A	0.02560	6.2	01Jan2020, 13:25	0.84
Upper Junction	0.21500	44.9	01Jan2020, 14:15	0.83
Route W-5	0.01000	2.1	01Jan2020, 13:35	0.84
Route W-6	0.00300	0.8	01Jan2020, 13:15	0.84
Route OS-3A	0.02250	5.5	01Jan2020, 13:20	0.84
Junction C-1	0.05180	9.5	01Jan2020, 13:25	0.85
Basin OS-3C	0.01980	5.2	01Jan2020, 12:30	0.86
Route OS-3B	0.21500	44.8	01Jan2020, 15:05	0.81
Route OS-3C	0.01980	5.2	01Jan2020, 13:20	0.84
Basin OS-3B	0.03400	11.0	01Jan2020, 12:30	1.00
Basin OS-3A	0.02250	5.5	01Jan2020, 12:35	0.85
Junction C-3	0.43956	57.0	01Jan2020, 15:35	0.83
Junction C-2	0.35390	53.6	01Jan2020, 15:00	0.84
Basin OS-4A	0.02560	6.2	01Jan2020, 12:35	0.85
OS-2B	0.01980	5.5	01Jan2020, 12:30	0.86
OS-2A	0.02200	5.7	01Jan2020, 12:30	0.86
Route C-1	0.05180	9.5	01Jan2020, 14:00	0.84
Route OS-4B	0.01900	5.3	01Jan2020, 14:05	0.83
Basin OS-4E	0.04900	11.5	01Jan2020, 12:40	0.85
Route Basin OS-3A	0.07630	14.4	01Jan2020, 14:05	0.90
Route OS-4C	0.03100	6.3	01Jan2020, 13:40	0.84
Basin OS-4D	0.01900	4.5	01Jan2020, 12:40	0.85
Route OS-2A	0.02200	5.7	01Jan2020, 13:35	0.84
Basin OS-4C	0.03100	6.3	01Jan2020, 12:50	0.85

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route OS-4D	0.01900	4.5	01Jan2020, 14:15	0.83
Route OS-2B	0.01980	5.5	01Jan2020, 13:00	0.85
Basin OS-4B	0.01900	5.3	01Jan2020, 12:30	0.86
Route OS-4E	0.04900	11.5	01Jan2020, 14:20	0.82
Junction OS-3	0.07630	14.5	01Jan2020, 13:15	0.91
Route OS-4F	0.02100	4.8	01Jan2020, 14:15	0.83
W-3	0.01000	3.0	01Jan2020, 12:25	0.86
Basin OS-4H	0.02100	5.2	01Jan2020, 12:35	0.85
Route OS-4G	0.07600	16.4	01Jan2020, 14:25	0.82
Route OS-4H	0.02100	5.1	01Jan2020, 13:25	0.84
W-5	0.01000	2.1	01Jan2020, 12:45	0.85
Basin OS-4G	0.07600	16.5	01Jan2020, 12:45	0.85
Basin OS-4F	0.02100	4.8	01Jan2020, 12:40	0.85
W-4	0.00600	1.3	01Jan2020, 12:45	0.85
Route C-3	0.43956	56.8	01Jan2020, 16:10	0.82
Pond 2	0.01000	0.1	01Jan2020, 01:45	0.40
Pond 1	0.02000	0.9	01Jan2020, 02:05	0.45
R-EX-2	0.47756	54.6	01Jan2020, 16:20	0.79
W-2	0.00500	0.2	01Jan2020, 12:35	0.16
W-9	0.00300	0.7	01Jan2020, 12:40	0.85
D-2	0.01000	4.5	01Jan2020, 12:30	1.44
D-1	0.02000	6.7	01Jan2020, 12:35	1.15
Sink-2	0.47756	54.6	01Jan2020, 16:15	0.79
W-1	0.03020	7.0	01Jan2020, 12:45	0.90
R-EX-3	0.09360	11.2	01Jan2020, 14:15	0.85
OS-1	0.06340	14.9	01Jan2020, 12:40	0.85
Reservoir OS-1	0.06340	13.3	01Jan2020, 12:55	0.85
Route OS-1	0.06340	13.3	01Jan2020, 13:40	0.84
Sink-3	0.09360	11.2	01Jan2020, 14:10	0.85
W-10	0.01000	5.2	01Jan2020, 12:05	0.87
Sink-4	0.01000	5.2	01Jan2020, 12:00	0.87

PROPOSED CONDITIONS EAST BASIN HEC-HMS BASIN LAYOUT

```
Basin: PR East Basin GWR
     Last Modified Date: 29 June 2020
     Last Modified Time: 18:33:07
     Version: 4.3
     Filepath Separator: \
     Unit System: English
     Missing Flow To Zero: Yes
     Enable Flow Ratio: No
     Compute Local Flow At Junctions: No

     Enable Sediment Routing: No

     Enable Quality Routing: No
End:

Reach: Route OS-5
     Last Modified Date: 29 June 2020
     Last Modified Time: 21:03:25
     Canvas X: -861.7276411671855
     Canvas Y: 285.5041412301971
     From Canvas X: -1883.90357366932
     From Canvas Y: 2571.1693652962567
     Downstream: R-EX-1

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 106.6
     Channel Loss: None
End:

Subbasin: Basin OS-6C
     Description: OS-5C
     Last Modified Date: 1 July 2020
     Last Modified Time: 17:39:09
     Canvas X: 1882.53686692448
     Canvas Y: 2650.792490887343
     From Canvas X: 1862.9572697904414
     From Canvas Y: 2655.2453780700125
     Area: 0.082
     Downstream: Route OS-6C

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
```

```
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 53.2
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: Basin OS-6B
     Description: OS-5B
     Last Modified Date: 11 June 2020
     Last Modified Time: 22:02:51
     Canvas X: 1574.7803926437246
     Canvas Y: 2809.314217301934
     From Canvas X: 1597.8529604137002
     From Canvas Y: 2830.682053392856
     Area: 0.0579
     Downstream: Route OS-6B

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 46.5
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: Reservoir Route
     Last Modified Date: 29 June 2020
     Last Modified Time: 18:33:11
     Canvas X: 324.24823149222857
     Canvas Y: 1424.908662565677
     From Canvas X: 1336.12273862665
     From Canvas Y: 2299.4395669498244
     Downstream: C-10
```

```
     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 44.5
     Channel Loss: None
End:

Reach: Route OS-6B
     Last Modified Date: 30 June 2020
     Last Modified Time: 21:05:59
     Canvas X: 1336.12273862665
     Canvas Y: 2299.4395669498244
     From Canvas X: 1416.7680854049777
     From Canvas Y: 2520.167052110427
     Downstream: Reservoir OS-5

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 50
     Channel Loss: None
End:

Subbasin: Basin OS-6A
     Description: OS-5A
     Last Modified Date: 30 June 2020
     Last Modified Time: 21:16:19
     Canvas X: 1052.1566488115677
     Canvas Y: 2826.805162320692
     From Canvas X: 1044.252784950505
     From Canvas Y: 2822.884867822952
     Area: 0.0387
     Downstream: Reservoir OS-5

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 40.8
     Unitgraph Type: STANDARD
```

```
     Baseflow: None
End:

Subbasin: Basin E-4A
     Last Modified Date: 12 June 2020
     Last Modified Time: 15:39:13
     Canvas X: 715.0129745073164
     Canvas Y: 2323.649069557905
     From Canvas X: 676.6773862670857
     From Canvas Y: 2255.6209566399502
     Area: 0.0125
     Downstream: C-10

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 46.4
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: C-10
     Last Modified Date: 29 June 2020
     Last Modified Time: 16:20:17
     Canvas X: 324.24823149222857
     Canvas Y: 1424.908662565677
     From Canvas X: -84.11606967854232
     From Canvas Y: 1597.0236365676153
     Downstream: Route E-7
End:

Reach: Route OS-6C
     Last Modified Date: 29 June 2020
     Last Modified Time: 16:24:28
     Canvas X: 1336.12273862665
     Canvas Y: 2299.4395669498244
     From Canvas X: 1491.2771662334803
     From Canvas Y: 2451.188221151665
```

```
     Downstream: Reservoir OS-5

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 54.5
     Channel Loss: None
End:

Subbasin: Basin E-4B
     Last Modified Date: 25 June 2020
     Last Modified Time: 22:29:50
     Canvas X: 1165.3342353785638
     Canvas Y: 1932.9953623431986
     From Canvas X: 1312.564453923134
     From Canvas Y: 1483.4723744861783
     Label X: 3.0
     Label Y: -7.0
     Area: 0.0091
     Downstream: C-10

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 38.1
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: Route OS-6D
     Last Modified Date: 29 June 2020
     Last Modified Time: 16:24:28
     Canvas X: 1336.12273862665
     Canvas Y: 2299.4395669498244
     From Canvas X: 1594.6242279570024
     From Canvas Y: 2355.412855055983
     Downstream: Reservoir OS-5

     Route: Lag
```

```
     Initial Variable: Combined Inflow
     Lag: 54.5
     Channel Loss: None
End:

Reservoir: Reservoir OS-5
     Last Modified Date: 29 June 2020
     Last Modified Time: 18:33:11
     Canvas X: 1336.12273862665
     Canvas Y: 2299.4395669498244
     From Canvas X: 1258.6753881228692
     From Canvas Y: 2210.8058005854755
     Label X: 1.0
     Label Y: -7.0
     Downstream: Reservoir Route

     Route: Controlled Outflow
     Routing Curve: Elevation-Area
     Initial Outflow Equals Inflow: Yes
     Elevation-Area Table: OS-5
     Adaptive Control: On
     Main Tailwater Condition: None
     Auxiliary Tailwater Condition: None

     Conduit: Orifice
     Conduit Outlet: Main
     Orifice Coefficient: 0.6
     Orifice Area: 0.545
     Centerline Elevation: 7324.42
     Number Barrels: 1
     End Conduit:

     Conduit: Orifice
     Conduit Outlet: Main
     Orifice Coefficient: 0.6
     Orifice Area: 7.06
     Centerline Elevation: 7331
     Number Barrels: 1
     End Conduit:

     Spillway: Broad-Crested Spillway
     Spillway Outlet: Main
     Spillway Crest Length: 20
     Spillway Crest Elevation: 7334
     Spillway Coefficient: 2.6
     End Spillway:

     Evaporation Method: Zero Evaporation
```

```
     End Evaporation:
End:

Subbasin: Basin OS-6D
     Last Modified Date: 25 June 2020
     Last Modified Time: 22:29:42
     Canvas X: 1883.632123721196
     Canvas Y: 2418.0452279029837
     From Canvas X: 1874.6530481452974
     From Canvas Y: 2417.431218187936
     Area: 0.0977
     Downstream: Route OS-6D

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 50
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: Route E-7
     Last Modified Date: 29 June 2020
     Last Modified Time: 21:03:25
     Canvas X: -861.7276411671855
     Canvas Y: 285.5041412301971
     From Canvas X: 324.24823149222857
     From Canvas Y: 1424.908662565677
     Downstream: R-EX-1

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 64
     Channel Loss: None
End:

Subbasin: E-1
     Last Modified Date: 25 June 2020
```

```
     Last Modified Time: 22:22:08
     Canvas X: -1999.417346470526
     Canvas Y: 1455.897133923738
     From Canvas X: -2463.015010284649
     From Canvas Y: 2073.938937309651
     Label X: 0.0
     Label Y: 1.0
     Area: 0.0079
     Downstream: Pond 3

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12
     Curve Number: 68.1
     Initial Abstraction: 0.47

     Transform: SCS
     Lag: 42.0
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: Basin D-3
     Last Modified Date: 12 June 2020
     Last Modified Time: 15:38:21
     Canvas X: -1818.3597961754886
     Canvas Y: 1593.6807966465158
     From Canvas X: -1639.7683601942304
     From Canvas Y: 944.1038795993522
     Label X: 0.0
     Label Y: 1.0
     Area: 0.03
     Downstream: Pond 3

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.56
```

```
     Curve Number: 64
     Initial Abstraction: 0.6

     Transform: SCS
     Lag: 45.8
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reservoir: Pond 3
     Last Modified Date: 29 June 2020
     Last Modified Time: 23:01:04
     Canvas X: -1589.9080337438222
     Canvas Y: 1243.8534768484221
     From Canvas X: -1511.7339678911565
     From Canvas Y: 640.2004812966065
     Label X: 0.0
     Label Y: 1.0
     Downstream: R-EX-1

     Route: Specified Outflow
     Routing Curve: Elevation-Storage
     Initial Elevation: 0
     Elevation-Storage Table: Pond 3
     Outflow Gage Name: Pond 3 - Q100
End:

Subbasin: E-3
     Last Modified Date: 29 June 2020
     Last Modified Time: 16:25:38
     Canvas X: -850.7849400791165
     Canvas Y: 993.9331280597039
     From Canvas X: -1009.5588556422545
     From Canvas Y: 1006.5570737441426
     Area: 0.0336
     Downstream: R-EX-1

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 6.7
     Curve Number: 54.5
     Initial Abstraction: 0.83
```

```
     Transform: SCS
     Lag: 64
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: Basin D-4B
     Last Modified Date: 8 April 2020
     Last Modified Time: 14:57:45
     Canvas X: 77.17075639610812
     Canvas Y: 2378.1178945307097
     From Canvas X: 778.873522140379
     From Canvas Y: 773.7769864771967
     Area: 0.0103
     Downstream: Pond 4

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 38
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: Basin D-4A
     Last Modified Date: 8 April 2020
     Last Modified Time: 14:56:57
     Canvas X: -360.964130568138
     Canvas Y: 2409.983054835778
     From Canvas X: 18.080066194750998
     From Canvas Y: 2352.1395294091717
     Area: 0.0069
     Downstream: Pond 4

     Canopy: None
     Allow Simultaneous Precip Et: No
```

```
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 56.9
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reservoir: Pond 4
     Last Modified Date: 29 June 2020
     Last Modified Time: 20:59:36
     Canvas X: -260.0285318811434
     Canvas Y: 1875.104502058163
     From Canvas X: 539.8540713480625
     From Canvas Y: 1066.6296604004497
     Downstream: Route C-8

     Route: Specified Outflow
     Routing Curve: Elevation-Storage
     Initial Elevation: 0
     Elevation-Storage Table: Pond 4
     Outflow Gage Name: Pond 4 - Q100
End:

Reach: Route C-8
     Last Modified Date: 29 June 2020
     Last Modified Time: 21:03:25
     Canvas X: -861.7276411671855
     Canvas Y: 285.5041412301971
     From Canvas X: -260.0285318811434
     From Canvas Y: 1875.104502058163
     Downstream: R-EX-1

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 64
     Channel Loss: None
End:

Subbasin: E-2
```

```
     Last Modified Date: 29 June 2020
     Last Modified Time: 16:25:42
     Canvas X: -1197.4448419312953
     Canvas Y: 1642.9984762084644
     From Canvas X: -1372.9228943028534
     From Canvas Y: 2108.004315934082
     Area: 0.010
     Downstream: Route C-6

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 20.2
     Curve Number: 68.1
     Initial Abstraction: 0.47

     Transform: SCS
     Lag: 42.7
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: Route C-6
     Last Modified Date: 29 June 2020
     Last Modified Time: 21:03:25
     Canvas X: -861.7276411671855
     Canvas Y: 285.5041412301971
     From Canvas X: -1160.5661289682976
     From Canvas Y: 1491.7957530601734
     Downstream: R-EX-1

     Route: Lag
     Initial Variable: Combined Inflow
     Lag: 64
     Channel Loss: None
End:

Subbasin: Basin OS-5
     Last Modified Date: 8 April 2020
     Last Modified Time: 15:05:02
     Canvas X: -1910.9889810178615
     Canvas Y: 2730.049713289869
     From Canvas X: -1895.2586998774636
```

```
     From Canvas Y: 2743.89138359013
     Area: 0.0244
     Downstream: Route OS-5

     Canopy: None
     Allow Simultaneous Precip Et: No
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 12.0
     Curve Number: 65
     Initial Abstraction: 0.54

     Transform: SCS
     Lag: 68.7
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reservoir: R-EX-1
     Last Modified Date: 29 June 2020
     Last Modified Time: 21:44:46
     Canvas X: -861.7276411671855
     Canvas Y: 285.5041412301971
     From Canvas X: -616.7135794014512
     From Canvas Y: 410.34175233158203
     Downstream: Sink EX-1

     Route: Controlled Outflow
     Routing Curve: Elevation-Area
     Initial Outflow Equals Inflow: Yes
     Elevation-Area Table: EX-1
     Adaptive Control: On
     Main Tailwater Condition: None
     Auxiliary Tailwater Condition: None

     Conduit: Culvert
     Conduit Outlet: Main
     Culvert Shape: Circular
     Chart Number: 2
     Scale Number: 3
     Solution Control: Automatic
     Diameter: 4
     Number Barrels: 1
     Culvert Length: 48
```

```
     Entrance Loss Coefficient: 0.2
     Exit Loss Coefficient: 1
     Top Manning's n: 0.02
     Inlet Invert Elevation: 7235.6
     Outlet Invert Elevation: 7235.2
     End Conduit:

     Spillway: Broad-Crested Spillway
     Spillway Outlet: Main
     Spillway Crest Length: 71
     Spillway Crest Elevation: 7242
     Spillway Coefficient: 2.6
     End Spillway:

     Evaporation Method: Zero Evaporation
     End Evaporation:
End:

Sink: Sink EX-1
     Last Modified Date: 25 June 2020
     Last Modified Time: 14:58:26
     Canvas X: -890.526833152149
     Canvas Y: 101.46827435515797
     From Canvas X: -1043.6242342666856
     From Canvas Y: 370.67000608809485
     Label X: 3.0
     Label Y: -12.0
End:

Basin Layer Properties:
     Element Layer:
          Name: Icons
          Layer shown: Yes
     End Layer:
End:

Basin Spatial Properties:
End:

Basin Schematic Properties:
     Last View N: 3600.2886002886
     Last View S: 829.7258297258295
     Last View W: -1868.6868686868684
     Last View E: 1233.766233766235
     Maximum View N: 3600.2886002886
     Maximum View S: 829.7258297258295
     Maximum View W: -1868.6868686868684
     Maximum View E: 1233.766233766235
```

```
    Extent Method: Manual
    Buffer: 0
    Draw Icons: Yes
    Draw Icon Labels: Name
    Draw Map Objects: No
    Draw Gridlines: No
    Draw Flow Direction: No
    Draw HillShade Layer: Yes
    Draw Elevation Layer: Yes
    Elevation Layer Color Palette: Default
    Ignore Elevation Color Ramp Scale: No
    Use Interpolated Color Ramp for Elevation Layer: Yes
    Color Ramp Opacity Level for Elevation Layer: 33.0
    Fix Element Locations: No
    Fix Hydrologic Order: No
End:
```

Project: GWR 100 YR Final Simulation Run: PR East - 100 YR 24HR

Start of Run: 01Jan2020, 00:00 Basin Model: PR East Basin GWR
End of Run: 02Jan2020, 00:05 Meteorologic Model: 24 HR 100 YR
Compute Time: 01Jul2020, 11:43:09 Control Specifications: GR Control - PR

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route OS-5	0.0244	10.6	01Jan2020, 14:50	1.97
Basin OS-6C	0.0820	42.7	01Jan2020, 12:50	2.05
Basin OS-6B	0.0579	33.2	01Jan2020, 12:40	2.05
Reservoir Route	0.2763	128.7	01Jan2020, 14:30	1.89
Route OS-6B	0.0579	33.2	01Jan2020, 13:30	2.02
Basin OS-6A	0.0387	24.3	01Jan2020, 12:35	2.06
Basin E-4A	0.0125	7.2	01Jan2020, 12:40	2.05
C-10	0.2979	130.9	01Jan2020, 14:30	1.90
Route OS-6C	0.0820	42.6	01Jan2020, 13:40	2.01
Basin E-4B	0.0091	6.0	01Jan2020, 12:30	2.06
Route OS-6D	0.0977	53.1	01Jan2020, 13:40	2.02
Reservoir OS-5	0.2763	128.8	01Jan2020, 13:50	1.91
Basin OS-6D	0.0977	53.2	01Jan2020, 12:45	2.05
Route E-7	0.2979	130.8	01Jan2020, 15:35	1.85
E-1	0.0079	5.3	01Jan2020, 12:35	2.22
Basin D-3	0.0300	14.2	01Jan2020, 12:40	1.65
Pond 3	0.0379	25.8	01Jan2020, 01:05	1.28
E-3	0.0336	9.9	01Jan2020, 13:00	1.36
Basin D-4B	0.0103	6.8	01Jan2020, 12:30	2.06
Basin D-4A	0.0069	3.4	01Jan2020, 12:50	2.04
Pond 4	0.0172	6.4	01Jan2020, 01:15	1.10
Route C-8	0.0172	6.4	01Jan2020, 02:20	1.10
E-2	0.0100	7.2	01Jan2020, 12:35	2.44
Route C-6	0.0100	7.2	01Jan2020, 13:40	2.40
Basin OS-5	0.0244	10.6	01Jan2020, 13:05	2.04
R-EX-1	0.4210	140.6	01Jan2020, 15:40	1.75
Sink EX-1	0.4210	140.6	01Jan2020, 15:35	1.75

Project: GWR 50 YR Final Simulation Run: PR East - 50 YR 24HR

Start of Run: 01Jan2020, 00:00 Basin Model: PR East Basin GWR
End of Run: 02Jan2020, 00:05 Meteorologic Model: 24HR - 50YR
Compute Time: 01Jul2020, 11:46:16 Control Specifications: GR Control - PR

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route OS-5	0.0244	9.1	01Jan2020, 14:50	1.70
Basin OS-6C	0.0820	36.7	01Jan2020, 12:50	1.77
Basin OS-6B	0.0579	28.5	01Jan2020, 12:40	1.78
Reservoir Route	0.2763	107.0	01Jan2020, 14:35	1.62
Route OS-6B	0.0579	28.5	01Jan2020, 13:30	1.75
Basin OS-6A	0.0387	20.9	01Jan2020, 12:35	1.78
Basin E-4A	0.0125	6.2	01Jan2020, 12:40	1.78
C-10	0.2979	108.9	01Jan2020, 14:35	1.63
Route OS-6C	0.0820	36.6	01Jan2020, 13:40	1.74
Basin E-4B	0.0091	5.1	01Jan2020, 12:30	1.78
Route OS-6D	0.0977	45.6	01Jan2020, 13:40	1.74
Reservoir OS-5	0.2763	107.1	01Jan2020, 13:50	1.65
Basin OS-6D	0.0977	45.7	01Jan2020, 12:45	1.77
Route E-7	0.2979	108.6	01Jan2020, 15:40	1.59
E-1	0.0079	4.6	01Jan2020, 12:35	1.93
Basin D-3	0.0300	11.9	01Jan2020, 12:40	1.39
Pond 3	0.0379	21.0	01Jan2020, 01:05	0.94
E-3	0.0336	8.2	01Jan2020, 13:00	1.15
Basin D-4B	0.0103	5.8	01Jan2020, 12:30	1.78
Basin D-4A	0.0069	2.9	01Jan2020, 12:50	1.77
Pond 4	0.0172	5.8	01Jan2020, 01:10	0.84
Route C-8	0.0172	5.8	01Jan2020, 02:15	0.84
E-2	0.0100	6.3	01Jan2020, 12:35	2.14
Route C-6	0.0100	6.3	01Jan2020, 13:40	2.10
Basin OS-5	0.0244	9.1	01Jan2020, 13:05	1.76
R-EX-1	0.4210	115.7	01Jan2020, 15:45	1.48
Sink EX-1	0.4210	115.7	01Jan2020, 15:40	1.48

Project: GWR 25 YR Final Simulation Run: PR East - 25 YR 24HR

Start of Run: 01Jan2020, 00:00 Basin Model: PR East Basin GWR
End of Run: 02Jan2020, 00:05 Meteorologic Model: 24HR - 25YR
Compute Time: 01Jul2020, 11:52:07 Control Specifications: GR Control - PR

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route OS-5	0.0244	7.0	01Jan2020, 14:50	1.32
Basin OS-6C	0.0820	28.2	01Jan2020, 12:50	1.38
Basin OS-6B	0.0579	21.9	01Jan2020, 12:40	1.38
Reservoir Route	0.2763	70.9	01Jan2020, 14:45	1.25
Route OS-6B	0.0579	21.9	01Jan2020, 13:30	1.36
Basin OS-6A	0.0387	16.0	01Jan2020, 12:35	1.39
Basin E-4A	0.0125	4.7	01Jan2020, 12:40	1.38
C-10	0.2979	72.3	01Jan2020, 14:45	1.26
Route OS-6C	0.0820	28.1	01Jan2020, 13:45	1.36
Basin E-4B	0.0091	3.9	01Jan2020, 12:30	1.39
Route OS-6D	0.0977	35.0	01Jan2020, 13:40	1.36
Reservoir OS-5	0.2763	70.9	01Jan2020, 14:00	1.28
Basin OS-6D	0.0977	35.1	01Jan2020, 12:45	1.38
Route E-7	0.2979	72.2	01Jan2020, 15:50	1.22
E-1	0.0079	3.5	01Jan2020, 12:35	1.51
Basin D-3	0.0300	8.7	01Jan2020, 12:40	1.04
Pond 3	0.0379	14.2	01Jan2020, 01:10	0.69
E-3	0.0336	6.0	01Jan2020, 13:05	0.86
Basin D-4B	0.0103	4.5	01Jan2020, 12:30	1.39
Basin D-4A	0.0069	2.3	01Jan2020, 12:55	1.38
Pond 4	0.0172	5.4	01Jan2020, 01:05	0.66
Route C-8	0.0172	5.4	01Jan2020, 02:10	0.66
E-2	0.0100	4.9	01Jan2020, 12:35	1.70
Route C-6	0.0100	4.9	01Jan2020, 13:40	1.67
Basin OS-5	0.0244	7.0	01Jan2020, 13:05	1.37
R-EX-1	0.4210	77.8	01Jan2020, 15:50	1.14
Sink EX-1	0.4210	77.8	01Jan2020, 15:45	1.14

Project: GWR 10 YR Final Simulation Run: PR East - 10 YR 24HR

Start of Run: 01Jan2020, 00:00 Basin Model: PR East Basin GWR
End of Run: 02Jan2020, 00:05 Meteorologic Model: 24 HR - 10-YR
Compute Time: 01Jul2020, 11:56:17 Control Specifications: GR Control - PR

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route OS-5	0.0244	5.7	01Jan2020, 14:50	1.09
Basin OS-6C	0.0820	22.9	01Jan2020, 12:50	1.13
Basin OS-6B	0.0579	17.8	01Jan2020, 12:40	1.14
Reservoir Route	0.2763	58.5	01Jan2020, 14:45	1.03
Route OS-6B	0.0579	17.8	01Jan2020, 13:30	1.12
Basin OS-6A	0.0387	13.0	01Jan2020, 12:35	1.14
Basin E-4A	0.0125	3.8	01Jan2020, 12:40	1.14
C-10	0.2979	59.7	01Jan2020, 14:45	1.04
Route OS-6C	0.0820	22.8	01Jan2020, 13:45	1.11
Basin E-4B	0.0091	3.2	01Jan2020, 12:30	1.14
Route OS-6D	0.0977	28.5	01Jan2020, 13:40	1.12
Reservoir OS-5	0.2763	58.6	01Jan2020, 14:00	1.06
Basin OS-6D	0.0977	28.5	01Jan2020, 12:45	1.14
Route E-7	0.2979	59.6	01Jan2020, 15:50	1.00
E-1	0.0079	2.9	01Jan2020, 12:35	1.25
Basin D-3	0.0300	6.7	01Jan2020, 12:45	0.82
Pond 3	0.0379	3.6	01Jan2020, 01:50	0.34
E-3	0.0336	4.6	01Jan2020, 13:05	0.68
Basin D-4B	0.0103	3.6	01Jan2020, 12:30	1.14
Basin D-4A	0.0069	1.8	01Jan2020, 12:55	1.13
Pond 4	0.0172	3.4	01Jan2020, 00:55	0.40
Route C-8	0.0172	3.4	01Jan2020, 02:00	0.40
E-2	0.0100	4.1	01Jan2020, 12:35	1.43
Route C-6	0.0100	4.1	01Jan2020, 13:40	1.40
Basin OS-5	0.0244	5.7	01Jan2020, 13:05	1.13
R-EX-1	0.4210	64.8	01Jan2020, 15:50	0.91
Sink EX-1	0.4210	64.8	01Jan2020, 15:45	0.91

Project: GWR 5 YR Final Simulation Run: PR East - 5 YR 24HR

Start of Run: 01Jan2020, 00:00 Basin Model: PR East Basin GWR
End of Run: 02Jan2020, 00:05 Meteorologic Model: 24 HR 5 YR
Compute Time: 01Jul2020, 11:59:36 Control Specifications: GR Control - PR

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route OS-5	0.0244	4.1	01Jan2020, 14:55	0.81
Basin OS-6C	0.0820	16.8	01Jan2020, 12:50	0.85
Basin OS-6B	0.0579	13.0	01Jan2020, 12:40	0.85
Reservoir Route	0.2763	44.8	01Jan2020, 14:45	0.78
Route OS-6B	0.0579	13.0	01Jan2020, 13:30	0.84
Basin OS-6A	0.0387	9.5	01Jan2020, 12:35	0.85
Basin E-4A	0.0125	2.8	01Jan2020, 12:40	0.85
C-10	0.2979	45.7	01Jan2020, 14:45	0.79
Route OS-6C	0.0820	16.7	01Jan2020, 13:45	0.83
Basin E-4B	0.0091	2.3	01Jan2020, 12:35	0.86
Route OS-6D	0.0977	20.9	01Jan2020, 13:40	0.84
Reservoir OS-5	0.2763	44.9	01Jan2020, 14:00	0.80
Basin OS-6D	0.0977	20.9	01Jan2020, 12:45	0.85
Route E-7	0.2979	45.6	01Jan2020, 15:45	0.75
E-1	0.0079	2.1	01Jan2020, 12:35	0.94
Basin D-3	0.0300	4.5	01Jan2020, 12:45	0.57
Pond 3	0.0379	0.3	01Jan2020, 02:15	0.22
E-3	0.0336	3.1	01Jan2020, 13:05	0.49
Basin D-4B	0.0103	2.7	01Jan2020, 12:35	0.86
Basin D-4A	0.0069	1.3	01Jan2020, 12:55	0.85
Pond 4	0.0172	1.9	01Jan2020, 01:05	0.25
Route C-8	0.0172	1.9	01Jan2020, 02:10	0.25
E-2	0.0100	3.1	01Jan2020, 12:35	1.10
Route C-6	0.0100	3.1	01Jan2020, 13:40	1.08
Basin OS-5	0.0244	4.2	01Jan2020, 13:05	0.84
R-EX-1	0.4210	49.5	01Jan2020, 15:50	0.67
Sink EX-1	0.4210	49.5	01Jan2020, 15:45	0.67

Design Point	Q5		Ratio	Q10		Ratio	Q25		Ratio	Q50		Ratio	Q100		Ratio
	Pre-Dev (cfs)	Post-Dev (cfs)		Pre-Dev (cfs)	Post-Dev (cfs)		Pre-Dev (cfs)	Post-Dev (cfs)		Pre-Dev (cfs)	Post-Dev (cfs)		Pre-Dev (cfs)	Post-Dev (cfs)	
EX-1	47.3	49.5	1.0	61.7	64.8	1.1	74.9	77.8	1.0	109.6	115.7	1.1	136.6	140.6	1.0
EX-2	56.4	54.6	1.0	74.6	75.1	1.0	86.7	90.1	1.0	125.5	112.2	0.9	145.5	143.2	1.0
EX-3	10.6	11.2	1.1	19.5	21.8	1.1	23.8	25.4	1.1	29.7	31.3	1.1	34	35.7	1.1
EX-4 UD Detention Analysis	2.5	2.7	1.1	3.8	3.4	0.9	6.9	4.6	0.7	8.3	5.1	0.6	10	5.7	0.6

Note that the UD-Detention spreadsheet allows the ratio to reach 1.1 before highlighting the ratio cell red, therefore the developed flows match existing flows to a degree that is within the general expectations of the MHFD and complies with the DCM.

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.02 (February 2020)

Project: **Grandwood Ranch**

Basin ID: **Pond 1**

Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	8.04	acres
Watershed Length =	2,300	ft
Watershed Length to Centroid =	800	ft
Watershed Slope =	0.050	ft/ft
Watershed Imperviousness =	50.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

Note: L / W Ratio > 8

L / W Ratio = 15.1

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.138	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.430	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.409	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.584	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.738	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.945	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.113	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.325	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	1.758	acre-feet		inches
Approximate 2-yr Detention Volume =	0.324	acre-feet		
Approximate 5-yr Detention Volume =	0.444	acre-feet		
Approximate 10-yr Detention Volume =	0.589	acre-feet		
Approximate 25-yr Detention Volume =	0.644	acre-feet		
Approximate 50-yr Detention Volume =	0.674	acre-feet		
Approximate 100-yr Detention Volume =	0.752	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.138	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.292	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.322	acre-feet
Total Detention Basin Volume =	0.752	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	150	0.003		
7175	--	0.33	--	--	--	11,164	0.256	1,866	0.043
	--	1.33	--	--	--	13,109	0.301	14,003	0.321
	--	2.33	--	--	--	14,859	0.341	27,987	0.642
	--	3.33	--	--	--	16,519	0.379	43,676	1.003
7179	--	4.33	--	--	--	18,239	0.419	61,055	1.402

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.02 (February 2020)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.02 (February 2020)

Project: Grandwood Ranch

Basin ID: Pond 1

Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.70	0.138	Orifice Plate
Zone 2 (EURV)	1.69	0.292	Circular Orifice
Zone 3 (100-year)	2.65	0.322	Weir&Pipe (Restrict)
Total (all zones)		0.752	

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

			Calculated Parameters for Underdrain		
Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

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

			Calculated Parameters for Plate		
Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	9.375E-03	ft^2
Depth at top of Zone using Orifice Plate =	0.70	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	2.80	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	1.35	sq. inches (diameter = 1-5/16 inches)	Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.23	0.47					
Orifice Area (sq. inches)	1.35	1.35	1.35					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Circular	Not Selected		Calculated Parameters for Vertical Orifice	Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	0.70	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.06	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	1.69	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.14	N/A	feet
Vertical Orifice Diameter =	3.37	N/A	inches				

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

	Zone 3 Weir	Not Selected		Calculated Parameters for Overflow Weir	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.75	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	2.75	N/A	feet
Overflow Weir Front Edge Length =	6.00	N/A	feet	Overflow Weir Slope Length =	4.12	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	33.58	N/A	
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	17.32	N/A	ft^2
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area	Overflow Grate Open Area w/ Debris =	8.66	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

	Zone 3 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.52	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.29	N/A	feet
Restrictor Plate Height Above Pipe Invert =	6.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.23	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	3.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.32	feet
Spillway Crest Length =	25.00	feet	Stage at Top of Freeboard =	4.32	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.42	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.40	acre-ft

Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.138	0.430	0.409	0.584	0.738	0.945	1.113	1.325	1.758
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.409	0.584	0.738	0.945	1.113	1.325	1.758
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.5	1.5	2.3	4.3	5.3	6.9	9.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.07	0.18	0.28	0.53	0.66	0.85	1.20
Peak Inflow Q (cfs) =	N/A	N/A	4.3	6.2	7.7	10.6	12.5	14.8	19.4
Peak Outflow Q (cfs) =	0.1	0.4	0.4	0.9	2.3	3.9	4.1	4.4	11.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	1.0	0.9	0.8	0.6	1.2
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.0	0.1	0.2	0.2	0.2	0.2
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	47	48	48	46	43	42	40	37
Time to Drain 99% of Inflow Volume (hours) =	**41**	53	54	56	55	54	53	52	49
Maximum Ponding Depth (ft) =	0.69	1.69	1.43	1.87	2.04	2.23	2.49	2.91	3.20
Area at Maximum Ponding Depth (acres) =	0.27	0.32	0.30	0.32	0.33	0.34	0.35	0.36	0.37
Maximum Volume Stored (acre-ft) =	0.138	0.432	0.352	0.490	0.545	0.605	0.698	0.847	0.950

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.02 (February 2020)

Project: **Grandwood Ranch**

Basin ID: **Pond 2 (Lot 41)**

Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	8.48	acres
Watershed Length =	900	ft
Watershed Length to Centroid =	400	ft
Watershed Slope =	0.080	ft/ft
Watershed Imperviousness =	20.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

Steep Slope > 0.06 ft/ft

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.082	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.168	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.181	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.330	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.471	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.702	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.867	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.096	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	1.525	acre-feet		inches
Approximate 2-yr Detention Volume =	0.116	acre-feet		
Approximate 5-yr Detention Volume =	0.171	acre-feet		
Approximate 10-yr Detention Volume =	0.277	acre-feet		
Approximate 25-yr Detention Volume =	0.342	acre-feet		
Approximate 50-yr Detention Volume =	0.362	acre-feet		
Approximate 100-yr Detention Volume =	0.445	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.082	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.087	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.276	acre-feet
Total Detention Basin Volume =	0.445	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	150	0.003		
7161	--	0.33	--	--	--	2,500	0.057	437	0.010
	--	1.33	--	--	--	6,590	0.151	4,982	0.114
	--	2.33	--	--	--	7,794	0.179	12,174	0.279
	--	3.33	--	--	--	9,025	0.207	20,584	0.473
	--	4.33	--	--	--	10,372	0.238	30,282	0.695
	--	5.33	--	--	--	11,770	0.270	41,353	0.949
	--	6.33	--	--	--	13,000	0.298	53,738	1.234
	--	7.33	--	--	--	14,500	0.333	67,488	1.549
	--	8.33	--	--	--	16,000	0.367	82,738	1.899

20
15
10
5
0
16000
12000
8000
4000
0
0.00
2.50
5.00
7.50
10.00
Length, Width (ft.)
Area (sq.ft.)
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

0.380
0.285
0.190
0.095
0.000
1.900
1.425
0.950
0.475
0.000
0.00
2.50
5.00
7.50
10.00
Area (acres)
Volume (ac-ft)
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.02 (February 2020)

Project: Grandwood Ranch

Basin ID: Pond 2 (Lot 41)

Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.10	0.082	Orifice Plate
Zone 2 (EURV)	1.68	0.087	Circular Orifice
Zone 3 (100-year)	3.20	0.276	Weir&Pipe (Restrict)
Total (all zones)		0.445	

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

			Calculated Parameters for Underdrain		
Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

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

			Calculated Parameters for Plate		
Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	4.167E-03	ft^2
Depth at top of Zone using Orifice Plate =	1.10	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	4.40	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.60	sq. inches (diameter = 7/8 inch)	Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.37	0.73					
Orifice Area (sq. inches)	0.60	0.60	0.60					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Circular	Not Selected		Calculated Parameters for Vertical Orifice	Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	1.10	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.01	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	1.68	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.05	N/A	feet
Vertical Orifice Diameter =	1.27	N/A	inches				

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

	Zone 3 Weir	Not Selected		Calculated Parameters for Overflow Weir	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.50	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.50	N/A	feet
Overflow Weir Front Edge Length =	6.00	N/A	feet	Overflow Weir Slope Length =	4.12	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	22.72	N/A	
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	17.32	N/A	ft^2
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area	Overflow Grate Open Area w/ Debris =	8.66	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

	Zone 3 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.76	N/A	ft^2
Outlet Pipe Diameter =	24.00	N/A	inches	Outlet Orifice Centroid =	0.34	N/A	feet
Restrictor Plate Height Above Pipe Invert =	7.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	5.33	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.79	feet
Spillway Crest Length =	5.00	feet	Stage at Top of Freeboard =	7.12	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.33	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.48	acre-ft

Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.082	0.168	0.181	0.330	0.471	0.702	0.867	1.096	1.525
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.181	0.330	0.471	0.702	0.867	1.096	1.525
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.3	3.4	5.1	9.0	11.3	14.1	19.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.15	0.41	0.60	1.06	1.33	1.66	2.31
Peak Inflow Q (cfs) =	N/A	N/A	2.9	5.3	7.2	10.9	13.2	16.1	21.9
Peak Outflow Q (cfs) =	0.1	0.1	0.1	0.1	1.9	5.5	6.8	7.3	8.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.0	0.4	0.6	0.6	0.5	0.4
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.1	0.3	0.4	0.4	0.5
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	49	51	60	57	53	50	47	42
Time to Drain 99% of Inflow Volume (hours) =	**42**	54	56	68	67	65	63	60	57
Maximum Ponding Depth (ft) =	1.10	1.68	1.67	2.49	2.78	3.06	3.26	3.81	4.90
Area at Maximum Ponding Depth (acres) =	0.13	0.16	0.16	0.18	0.19	0.20	0.20	0.22	0.26
Maximum Volume Stored (acre-ft) =	0.082	0.169	0.166	0.308	0.363	0.416	0.456	0.576	0.836

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.02 (February 2020)

Project: **Grandwood Ranch**

Basin ID: **Pond 3 (Adjacent to Lot 1) (Includes Sub-basins E-1 and D-3)**

Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	25.10	acres
Watershed Length =	1,600	ft
Watershed Length to Centroid =	1,000	ft
Watershed Slope =	0.060	ft/ft
Watershed Imperviousness =	15.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.195	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.366	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.439	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.867	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	1.284	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	1.992	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	2.487	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	3.187	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	4.480	acre-feet		inches
Approximate 2-yr Detention Volume =	0.243	acre-feet		
Approximate 5-yr Detention Volume =	0.369	acre-feet		
Approximate 10-yr Detention Volume =	0.654	acre-feet		
Approximate 25-yr Detention Volume =	0.851	acre-feet		
Approximate 50-yr Detention Volume =	0.898	acre-feet		
Approximate 100-yr Detention Volume =	1.130	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.195	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.170	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.764	acre-feet
Total Detention Basin Volume =	1.130	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	150	0.003		
7243	--	0.33	--	--	--	1,581	0.036	286	0.007
	--	1.33	--	--	--	4,124	0.095	3,138	0.072
	--	2.33	--	--	--	6,376	0.146	8,388	0.193
	--	3.33	--	--	--	8,381	0.192	15,767	0.362
	--	4.33	--	--	--	10,256	0.235	25,085	0.576
	--	5.33	--	--	--	11,992	0.275	36,209	0.831
	--	6.33	--	--	--	13,741	0.315	49,076	1.127
	--	7.33	--	--	--	15,575	0.358	63,734	1.463
	--	8.33	--	--	--	17,637	0.405	80,340	1.844
7252	--	9.33	--	--	--	19,772	0.454	99,044	2.274

20
15
10
5
0
Length, Width (ft.)
20000
15000
10000
5000
0
Area (sq.ft.)
0.00
2.50
5.00
7.50
10.00
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

0.460
0.345
0.230
0.115
0.000
Area (acres)
2.280
1.710
1.140
0.570
0.000
Volume (ac-ft)
0.00
2.50
5.00
7.50
10.00
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.02 (February 2020)

Project: Grandwood Ranch

Basin ID: Pond 3 (Adjacent to Lot 1) (Includes Sub-basins E-1 and D-3)

Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.35	0.195	Orifice Plate
Zone 2 (EURV)	3.35	0.170	Rectangular Orifice
Zone 3 (100-year)	6.34	0.764	Weir&Pipe (Restrict)
Total (all zones)		1.130	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	2.35	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	0.99	sq. inches (diameter = 1-1/8 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	6.875E-03	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.78	1.57					
Orifice Area (sq. inches)	0.99	0.99	0.99					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	2.35	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	3.35	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Height =	2.00	N/A	inches
Vertical Orifice Width =	0.40		inches

Calculated Parameters for Vertical Orifice

	Zone 2 Rectangula	Not Selected	
Vertical Orifice Area =	0.01	N/A	ft^2
Vertical Orifice Centroid =	0.08	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	6.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	5.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	5.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	6.00	N/A	feet
Overflow Weir Slope Length =	5.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	8.48	N/A	
Overflow Grate Open Area w/o Debris =	17.50	N/A	ft^2
Overflow Grate Open Area w/ Debris =	8.75	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.30	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	36.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	12.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	2.06	N/A	ft^2
Outlet Orifice Centroid =	0.59	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.23	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	7.50	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	16.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.77	feet
Stage at Top of Freeboard =	9.27	feet
Basin Area at Top of Freeboard =	0.45	acres
Basin Volume at Top of Freeboard =	2.25	acre-ft

Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.195	0.366	0.439	0.867	1.284	1.992	2.487	3.187	4.480
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.439	0.867	1.284	1.992	2.487	3.187	4.480
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	2.9	8.1	12.3	21.6	27.2	34.5	48.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.12	0.32	0.49	0.86	1.08	1.38	1.92
Peak Inflow Q (cfs) =	N/A	N/A	5.8	11.4	15.7	25.2	31.0	38.0	52.0
Peak Outflow Q (cfs) =	0.1	0.2	0.2	0.3	3.6	14.2	21.0	25.7	39.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.0	0.3	0.7	0.8	0.7	0.8
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.2	0.8	1.2	1.5	1.5
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	48	53	69	74	69	67	63	58
Time to Drain 99% of Inflow Volume (hours) =	**41**	53	58	77	85	81	79	76	73
Maximum Ponding Depth (ft) =	2.35	3.36	3.56	5.29	6.18	6.47	6.61	7.01	7.88
Area at Maximum Ponding Depth (acres) =	0.15	0.19	0.20	0.27	0.31	0.32	0.33	0.34	0.38
Maximum Volume Stored (acre-ft) =	0.195	0.368	0.405	0.820	1.080	1.171	1.217	1.347	1.667

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.02 (February 2020)

Project: **Grandwood Ranch**

Basin ID: **Pond 4 (East)**

Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	8.53	acres
Watershed Length =	1,000	ft
Watershed Length to Centroid =	500	ft
Watershed Slope =	0.090	ft/ft
Watershed Imperviousness =	13.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

Steep Slope > 0.06 ft/ft

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.059	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.106	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.133	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.273	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.411	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.650	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.816	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.051	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	1.483	acre-feet		inches
Approximate 2-yr Detention Volume =	0.070	acre-feet		
Approximate 5-yr Detention Volume =	0.107	acre-feet		
Approximate 10-yr Detention Volume =	0.200	acre-feet		
Approximate 25-yr Detention Volume =	0.267	acre-feet		
Approximate 50-yr Detention Volume =	0.281	acre-feet		
Approximate 100-yr Detention Volume =	0.357	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.059	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.047	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.251	acre-feet
Total Detention Basin Volume =	0.357	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	150	0.003		
7295	--	0.33	--	--	--	150	0.003	50	0.001
	--	1.33	--	--	--	5,613	0.129	2,931	0.067
	--	2.33	--	--	--	8,538	0.196	10,006	0.230
	--	3.33	--	--	--	9,660	0.222	19,105	0.439
	--	4.33	--	--	--	10,870	0.250	29,370	0.674
	--	5.33	--	--	--	12,144	0.279	40,877	0.938

20
15
10
5
0
12400
9300
6200
3100
0
0.00
1.50
3.00
4.50
6.00
Length, Width (ft.)
Area (sq.ft.)
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

0.280
0.210
0.140
0.070
0.000
0.940
0.705
0.470
0.235
0.000
0.00
1.50
3.00
4.50
6.00
Area (acres)
Volume (ac-ft)
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.02 (February 2020)

Project: Grandwood Ranch

Basin ID: Pond 4 (East)

Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.27	0.059	Orifice Plate
Zone 2 (EURV)	1.62	0.047	Circular Orifice
Zone 3 (100-year)	2.96	0.251	Weir&Pipe (Restrict)
Total (all zones)		0.357	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	2.083E-03	ft^2
Depth at top of Zone using Orifice Plate =	1.27	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	5.10	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.30	sq. inches (diameter = 5/8 inch)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.42	0.85					
Orifice Area (sq. inches)	0.30	0.30	0.30					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	1.27	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	1.62	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	1.65	N/A	inches

Calculated Parameters for Vertical Orifice

	Zone 2 Circular	Not Selected	
Vertical Orifice Area =	0.01	N/A	ft^2
Vertical Orifice Centroid =	0.07	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.62	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	6.00	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	2.62	N/A	feet
Overflow Weir Slope Length =	4.12	N/A	feet
Grate Open Area / 100-yr Orifice Area =	24.85	N/A	
Overflow Grate Open Area w/o Debris =	17.32	N/A	ft^2
Overflow Grate Open Area w/ Debris =	8.66	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	7.50		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.70	N/A	ft^2
Outlet Orifice Centroid =	0.36	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.40	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.50	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.74	feet
Spillway Crest Length =	5.00	feet	Stage at Top of Freeboard =	5.24	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.28	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	0.91	acre-ft

Calculated Parameters for Spillway

Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.059	0.106	0.133	0.273	0.411	0.650	0.816	1.051	1.483
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.133	0.273	0.411	0.650	0.816	1.051	1.483
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.1	3.2	4.7	8.4	10.5	13.1	18.2
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.13	0.37	0.55	0.98	1.23	1.54	2.14
Peak Inflow Q (cfs) =	N/A	N/A	2.1	4.1	5.7	9.3	11.5	14.1	19.3
Peak Outflow Q (cfs) =	0.0	0.1	0.2	1.9	3.4	5.4	5.8	6.4	13.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.7	0.6	0.6	0.5	0.7
Structure Controlling Flow =	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	0.01	0.1	0.2	0.3	0.3	0.4	0.4
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	49	51	47	43	38	34	30	24
Time to Drain 99% of Inflow Volume (hours) =	**41**	52	55	53	51	49	47	45	42
Maximum Ponding Depth (ft) =	1.27	1.62	1.68	1.91	2.04	2.44	2.84	3.48	3.98
Area at Maximum Ponding Depth (acres) =	0.12	0.15	0.15	0.17	0.18	0.20	0.21	0.23	0.24
Maximum Volume Stored (acre-ft) =	0.060	0.107	0.116	0.152	0.176	0.249	0.331	0.470	0.586

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)

Cross Road Culvert Sizing

Mannings n 0.013 (renforced concrete)

Min D 18 inches

Allowable Velocities in Culverts

Min v 3 fps

max V 18 fps

	Design Point	Peak Discharge (cfs)	Max Slope (%)	Culvert Diameter (ft)	Velocity (ft/s)	Stormwater Treatment	
West Basin	C-1	23.9	6	1.5	16.5	Bypass of Historic Flow	
	C-1	11.5	7.5	2	14.8	Treated Developed Flow	(Basin D-2)
	C-2	135.1	3.5	3	18	Bypass of Historic Flow	(2 culverts,
	C-3	142.9	135.1	3	18	Bypass of Historic Flow	(2 culverts,
	C-4	15.1	2	1.5	14.71	Treated Developed Flow	
	C-5	15.1	2	3	14.71	Treated Developed Flow	
	C-6	9.5	4.5	1.5	11.9	Treated Developed Flow	
	C-7	1.7	6.5	1.5	8.3	Bypass of Historic Flow	
	C-8	5.3	7	1.5	11.9	Bypass of Historic Flow	
East Basin	C-9	14.2	6.5	2	15	Treated Developed Flow	
	C-10	17.8	3.3	1.5	12.2	Bypass of Historic Flow	
	C-11	130.9	2.5	2.5	15	Bypass of Historic Flow	(2 culverts,
	C-12	10.2	10	1.5	14.75	Treated Developed Flow	

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Jul 1 2020

Design Point C1

Circular

Diameter (ft)	=	1.50
Invert Elev (ft)	=	7208.12
Slope (%)	=	6.00
N-Value	=	0.013

Calculations

Compute by:		Known Q
Known Q (cfs)	=	23.90

Highlighted

Depth (ft)	=	1.15
Q (cfs)	=	23.90
Area (sqft)	=	1.46
Velocity (ft/s)	=	16.42
Wetted Perim (ft)	=	3.20
Crit Depth, Yc (ft)	=	1.49
Top Width (ft)	=	1.27
EGL (ft)	=	5.34

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Jul 1 2020

Culvert C-1

Circular

Diameter (ft)	=	3.00
Invert Elev (ft)	=	7192.98
Slope (%)	=	3.40
N-Value	=	0.013

Calculations

Compute by:		Known Q
Known Q (cfs)	=	71.45

Highlighted

Depth (ft)	=	1.65
Q (cfs)	=	71.45
Area (sqft)	=	4.00
Velocity (ft/s)	=	17.86
Wetted Perim (ft)	=	5.02
Crit Depth, Yc (ft)	=	2.68
Top Width (ft)	=	2.98
EGL (ft)	=	6.61

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Jul 1 2020

Design Point C-2 (2 Culverts)

Circular

Diameter (ft)	=	3.00
Invert Elev (ft)	=	7217.05
Slope (%)	=	3.50
N-Value	=	0.013

Calculations

Compute by:		Known Q
Known Q (cfs)	=	67.60

Highlighted

Depth (ft)	=	1.57
Q (cfs)	=	67.60
Area (sqft)	=	3.76
Velocity (ft/s)	=	18.00
Wetted Perim (ft)	=	4.86
Crit Depth, Yc (ft)	=	2.63
Top Width (ft)	=	3.00
EGL (ft)	=	6.61

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Apr 10 2020

Design Point C-4

Circular

Diameter (ft)	=	1.50
Invert Elev (ft)	=	7201.30
Slope (%)	=	5.00
N-Value	=	0.013

Calculations

Compute by:		Known Q
Known Q (cfs)	=	15.10

Highlighted

Depth (ft)	=	0.88
Q (cfs)	=	15.10
Area (sqft)	=	1.08
Velocity (ft/s)	=	13.94
Wetted Perim (ft)	=	2.62
Crit Depth, Yc (ft)	=	1.41
Top Width (ft)	=	1.48
EGL (ft)	=	3.90

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Apr 10 2020

Design Point C-5

Circular

Diameter (ft)	=	1.50
Invert Elev (ft)	=	7169.00
Slope (%)	=	5.00
N-Value	=	0.013

Calculations

Compute by:		Known Q
Known Q (cfs)	=	15.10

Highlighted

Depth (ft)	=	0.88
Q (cfs)	=	15.10
Area (sqft)	=	1.08
Velocity (ft/s)	=	13.94
Wetted Perim (ft)	=	2.62
Crit Depth, Yc (ft)	=	1.41
Top Width (ft)	=	1.48
EGL (ft)	=	3.90

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Jul 1 2020

Design Point C-6

Circular

Diameter (ft)	=	1.50
Invert Elev (ft)	=	7231.31
Slope (%)	=	4.50
N-Value	=	0.013

Calculations

Compute by:		Known Q
Known Q (cfs)	=	9.50

Highlighted

Depth (ft)	=	0.69
Q (cfs)	=	9.500
Area (sqft)	=	0.80
Velocity (ft/s)	=	11.90
Wetted Perim (ft)	=	2.24
Crit Depth, Yc (ft)	=	1.19
Top Width (ft)	=	1.50
EGL (ft)	=	2.89

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Jul 1 2020

Design Point C-7

Circular

Diameter (ft)	= 1.50
Invert Elev (ft)	= 7165.00
Slope (%)	= 6.50
N-Value	= 0.013

Calculations

Compute by:	Known Q
Known Q (cfs)	= 1.70

Highlighted

Depth (ft)	= 0.26
Q (cfs)	= 1.700
Area (sqft)	= 0.21
Velocity (ft/s)	= 8.27
Wetted Perim (ft)	= 1.29
Crit Depth, Yc (ft)	= 0.49
Top Width (ft)	= 1.14
EGL (ft)	= 1.32

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Jul 1 2020

Design Point C-8

Circular

Diameter (ft)	=	1.50
Invert Elev (ft)	=	7263.00
Slope (%)	=	7.00
N-Value	=	0.013

Calculations

Compute by:		Known Q
Known Q (cfs)	=	5.30

Highlighted

Depth (ft)	=	0.45
Q (cfs)	=	5.300
Area (sqft)	=	0.45
Velocity (ft/s)	=	11.87
Wetted Perim (ft)	=	1.74
Crit Depth, Yc (ft)	=	0.89
Top Width (ft)	=	1.38
EGL (ft)	=	2.64

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Jul 1 2020

Design Point C-10

Circular

Diameter (ft)	=	1.50
Invert Elev (ft)	=	7297.00
Slope (%)	=	3.30
N-Value	=	0.013

Calculations

Compute by:		Known Q
Known Q (cfs)	=	17.80

Highlighted

Depth (ft)	=	1.15
Q (cfs)	=	17.80
Area (sqft)	=	1.46
Velocity (ft/s)	=	12.23
Wetted Perim (ft)	=	3.20
Crit Depth, Yc (ft)	=	1.45
Top Width (ft)	=	1.27
EGL (ft)	=	3.48

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Jul 1 2020

Design Point C-11

Circular

Diameter (ft)	=	2.50
Invert Elev (ft)	=	7300.00
Slope (%)	=	2.50
N-Value	=	0.013

Calculations

Compute by:		Known Q
Known Q (cfs)	=	65.50

Highlighted

Depth (ft)	=	2.07
Q (cfs)	=	65.50
Area (sqft)	=	4.35
Velocity (ft/s)	=	15.05
Wetted Perim (ft)	=	5.73
Crit Depth, Yc (ft)	=	2.43
Top Width (ft)	=	1.88
EGL (ft)	=	5.59

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Friday, Apr 10 2020

Basin D-2 Storm Sewer - Max Slope

Circular

Diameter (ft)	=	2.00
Invert Elev (ft)	=	0.01
Slope (%)	=	7.50
N-Value	=	0.013

Calculations

Compute by:		Known Q
Known Q (cfs)	=	11.50

Highlighted

Depth (ft)	=	0.59
Q (cfs)	=	11.50
Area (sqft)	=	0.78
Velocity (ft/s)	=	14.80
Wetted Perim (ft)	=	2.30
Crit Depth, Yc (ft)	=	1.22
Top Width (ft)	=	1.83
EGL (ft)	=	3.99

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Friday, Apr 10 2020

Basin D-2 Storm Sewer - Min Slope

Circular

Diameter (ft)	=	2.00
Invert Elev (ft)	=	0.01
Slope (%)	=	0.50
N-Value	=	0.013

Calculations

Compute by:		Known Q
Known Q (cfs)	=	11.50

Highlighted

Depth (ft)	=	1.26
Q (cfs)	=	11.50
Area (sqft)	=	2.09
Velocity (ft/s)	=	5.51
Wetted Perim (ft)	=	3.67
Crit Depth, Yc (ft)	=	1.22
Top Width (ft)	=	1.93
EGL (ft)	=	1.73

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Apr 10 2020

Culvert Sizing-Timberview Breach Flow

Circular

Diameter (ft)	= 2.50
Invert Elev (ft)	= 1.00
Slope (%)	= 3.00
N-Value	= 0.013

Calculations

Compute by:	Known Q
Known Q (cfs)	= 73.00

Highlighted

Depth (ft)	= 2.12
Q (cfs)	= 73.00
Area (sqft)	= 4.45
Velocity (ft/s)	= 16.42
Wetted Perim (ft)	= 5.86
Crit Depth, Yc (ft)	= 2.45
Top Width (ft)	= 1.79
EGL (ft)	= 6.31

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Jul 1 2020

Basin D-3 Storm Sewer - Max Slope

Circular

Diameter (ft)	= 2.00
Invert Elev (ft)	= 0.01
Slope (%)	= 10.00
N-Value	= 0.013

Calculations

Compute by:	Known Q
Known Q (cfs)	= 14.20

Highlighted

Depth (ft)	= 0.61
Q (cfs)	= 14.20
Area (sqft)	= 0.82
Velocity (ft/s)	= 17.33
Wetted Perim (ft)	= 2.35
Crit Depth, Yc (ft)	= 1.36
Top Width (ft)	= 1.85
EGL (ft)	= 5.28

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Jul 1 2020

Basin D-3 Storm Sewer - Min Slope

Circular

Diameter (ft)	= 2.00
Invert Elev (ft)	= 0.01
Slope (%)	= 0.50
N-Value	= 0.013

Calculations

Compute by:	Known Q
Known Q (cfs)	= 14.20

Highlighted

Depth (ft)	= 1.47
Q (cfs)	= 14.20
Area (sqft)	= 2.48
Velocity (ft/s)	= 5.72
Wetted Perim (ft)	= 4.13
Crit Depth, Yc (ft)	= 1.36
Top Width (ft)	= 1.76
EGL (ft)	= 1.98

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Jul 1 2020

Basin D-4B , DP C-12 Storm Sewer - Max Slope

Circular

Diameter (ft)	= 1.50
Invert Elev (ft)	= 0.01
Slope (%)	= 10.00
N-Value	= 0.013

Calculations

Compute by:	Known Q
Known Q (cfs)	= 10.20

Highlighted

Depth (ft)	= 0.57
Q (cfs)	= 10.20
Area (sqft)	= 0.62
Velocity (ft/s)	= 16.51
Wetted Perim (ft)	= 1.99
Crit Depth, Yc (ft)	= 1.23
Top Width (ft)	= 1.46
EGL (ft)	= 4.81

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Jul 1 2020

Basin D-4B , DP C-12 Storm Sewer - Max Slope

Circular

Diameter (ft)	=	1.50
Invert Elev (ft)	=	0.01
Slope (%)	=	1.00
N-Value	=	0.013

Calculations

Compute by:		Known Q
Known Q (cfs)	=	10.20

Highlighted

Depth (ft)	=	1.20
Q (cfs)	=	10.20
Area (sqft)	=	1.52
Velocity (ft/s)	=	6.73
Wetted Perim (ft)	=	3.32
Crit Depth, Yc (ft)	=	1.23
Top Width (ft)	=	1.20
EGL (ft)	=	1.90

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Apr 8 2020

Swale from DP 4 to Culvert 1

Triangular

Side Slopes (z:1)	=	3.00, 3.00
Total Depth (ft)	=	4.00
Invert Elev (ft)	=	7226.00
Slope (%)	=	0.02
N-Value	=	0.025

Calculations

Compute by:		Known Q
Known Q (cfs)	=	42.20

Highlighted

Depth (ft)	=	3.47
Q (cfs)	=	42.20
Area (sqft)	=	36.12
Velocity (ft/s)	=	1.17
Wetted Perim (ft)	=	21.95
Crit Depth, Yc (ft)	=	1.66
Top Width (ft)	=	20.82
EGL (ft)	=	3.49

Hydraulic Analysis Report

Project Data

Project Title: Grandwood Ranch
Designer: Matrix Design Group
Project Date: Tuesday, March 31, 2020
Project Units: U.S. Customary Units
Notes: Worst Case Capacity. More detailed calculations, including armoring considerations will be included in FDR.

Channel Analysis: Channel Analysis

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0800 ft/ft
Manning's n: 0.0300
Flow: 20.0000 cfs

Result Parameters

Depth: 0.8581 ft
Area of Flow: 2.5772 ft^2
Wetted Perimeter: 6.2516 ft
Hydraulic Radius: 0.4122 ft
Average Velocity: 7.7603 ft/s
Top Width: 6.0067 ft
Froude Number: 2.0878
Critical Depth: 1.1567 ft
Critical Velocity: 4.2711 ft/s
Critical Slope: 0.0163 ft/ft
Critical Top Width: 8.27 ft
Calculated Max Shear Stress: 4.2837 lb/ft^2
Calculated Avg Shear Stress: 2.0579 lb/ft^2

Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Jul 1 2020

EX-1 HIGBY ROAD CULVERT

Invert Elev Dn (ft)	=	35.20
Pipe Length (ft)	=	44.00
Slope (%)	=	0.91
Invert Elev Up (ft)	=	35.60
Rise (in)	=	48.0
Shape	=	Circular
Span (in)	=	48.0
No. Barrels	=	1
n-Value	=	0.020
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Projecting
Coeff. K,M,c,Y,k	=	0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

Top Elevation (ft)	=	42.00
Top Width (ft)	=	25.00
Crest Width (ft)	=	71.00

Calculations

Qmin (cfs)	=	136.60
Qmax (cfs)	=	140.60
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	136.60
Qpipe (cfs)	=	113.26
Qovertop (cfs)	=	23.34
Veloc Dn (ft/s)	=	9.50
Veloc Up (ft/s)	=	10.47
HGL Dn (ft)	=	38.81
HGL Up (ft)	=	38.81
Hw Elev (ft)	=	42.23
Hw/D (ft)	=	1.66
Flow Regime	=	Inlet Control

Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Jul 2 2020

EX-1 HIGBY ROAD CULVERT-EX (Minor Event)

Invert Elev Dn (ft)	=	35.20
Pipe Length (ft)	=	44.00
Slope (%)	=	0.91
Invert Elev Up (ft)	=	35.60
Rise (in)	=	48.0
Shape	=	Circular
Span (in)	=	48.0
No. Barrels	=	1
n-Value	=	0.020
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Projecting
Coeff. K,M,c,Y,k	=	0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

Top Elevation (ft)	=	42.00
Top Width (ft)	=	25.00
Crest Width (ft)	=	71.00

Calculations

Qmin (cfs)	=	47.30
Qmax (cfs)	=	49.50
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	47.30
Qpipe (cfs)	=	47.30
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	4.63
Veloc Up (ft/s)	=	7.25
HGL Dn (ft)	=	38.23
HGL Up (ft)	=	37.66
Hw Elev (ft)	=	38.81
Hw/D (ft)	=	0.80
Flow Regime	=	Inlet Control

Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Jul 2 2020

EX-1 HIGBY ROAD CULVERT-PR

Invert Elev Dn (ft)	=	35.20
Pipe Length (ft)	=	44.00
Slope (%)	=	0.91
Invert Elev Up (ft)	=	35.60
Rise (in)	=	48.0
Shape	=	Circular
Span (in)	=	48.0
No. Barrels	=	1
n-Value	=	0.020
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Projecting
Coeff. K,M,c,Y,k	=	0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

Top Elevation (ft)	=	42.00
Top Width (ft)	=	25.00
Crest Width (ft)	=	71.00

Calculations

Qmin (cfs)	=	136.60
Qmax (cfs)	=	140.60
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	140.60
Qpipe (cfs)	=	113.54
Qovertop (cfs)	=	27.06
Veloc Dn (ft/s)	=	9.52
Veloc Up (ft/s)	=	10.49
HGL Dn (ft)	=	38.81
HGL Up (ft)	=	38.81
Hw Elev (ft)	=	42.26
Hw/D (ft)	=	1.66
Flow Regime	=	Inlet Control

Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Jul 2 2020

EX-1 HIGBY ROAD CULVERT-PR (Minor Event)

Invert Elev Dn (ft)	=	35.20
Pipe Length (ft)	=	44.00
Slope (%)	=	0.91
Invert Elev Up (ft)	=	35.60
Rise (in)	=	48.0
Shape	=	Circular
Span (in)	=	48.0
No. Barrels	=	1
n-Value	=	0.020
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Projecting
Coeff. K,M,c,Y,k	=	0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

Top Elevation (ft)	=	42.00
Top Width (ft)	=	25.00
Crest Width (ft)	=	71.00

Calculations

Qmin (cfs)	=	47.30
Qmax (cfs)	=	49.50
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	49.50
Qpipe (cfs)	=	49.50
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	4.81
Veloc Up (ft/s)	=	7.37
HGL Dn (ft)	=	38.25
HGL Up (ft)	=	37.71
Hw Elev (ft)	=	38.91
Hw/D (ft)	=	0.83
Flow Regime	=	Inlet Control

PR Culvert analysis at EX-2 (Reduces velocity on EX pipe by 0.23 ft/s)

Reach	River Sta		Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
				(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
a	-25	Culvert #1	PR-Q100	62.24	62.23	62.24	60.69	62.01	94.14	15.61	11.11	13.70	20.47
a	-25	Culvert #2	PR-Q100	62.24	62.23	64.06	62.24	62.01	33.44	15.61	11.11	10.78	10.78
a	-25	Culvert #1	PR-Q5	58.29	58.28	58.29	58.26	62.01	54.60		7.81	8.86	17.01
a	-25	Culvert #2	PR-Q5	58.29	58.28			62.01			7.81		

Flows

	River	Reach	RS	PR-Q100	PR-Q5
1	EX-2	a	0	143.2	54.6

Culverts

EX Culvert Analysis at EX-2

Reach	River Sta		Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
				(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
a	-25	Culvert #1	EX-Q100	62.53	62.53	62.53	60.86	62.01	96.43	49.07	11.39	14.03	20.70
a	-25	Culvert #1	EX-Q5	58.43	58.42	58.43	58.35	62.01	56.40		7.93	9.01	17.13

Flows

	River	Reach	RS	EX-Q100	EX-Q5
1	EX-2	a	0	145.5	56.4

Culvert

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Jun 11 2020

EX-3 (Proposed) Ditch Capacity for Eastward Overflow to EX-2

User-defined

Invert Elev (ft)	= 7173.32
Slope (%)	= 2.27
N-Value	= Composite

Calculations

Compute by:	Q vs Depth
No. Increments	= 24

Highlighted

Depth (ft)	= 0.68
Q (cfs)	= 8.321
Area (sqft)	= 2.44
Velocity (ft/s)	= 3.41
Wetted Perim (ft)	= 7.92
Crit Depth, Yc (ft)	= 0.68
Top Width (ft)	= 7.79
EGL (ft)	= 0.86

(Sta, El, n)-(Sta, El, n)...

(68.00, 7174.00)-(69.20, 7173.87, 0.030)-(71.08, 7173.32, 0.030)-(75.79, 7174.00, 0.030)

Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Jul 2 2020

EX-3-PR Minor

Invert Elev Dn (ft)	=	67.30
Pipe Length (ft)	=	43.20
Slope (%)	=	3.01
Invert Elev Up (ft)	=	68.60
Rise (in)	=	15.0
Shape	=	Circular
Span (in)	=	15.0
No. Barrels	=	1
n-Value	=	0.020
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Projecting
Coeff. K,M,c,Y,k	=	0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

Top Elevation (ft)	=	74.00
Top Width (ft)	=	25.00
Crest Width (ft)	=	237.60

Calculations

Qmin (cfs)	=	11.20
Qmax (cfs)	=	11.20
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	11.20
Qpipe (cfs)	=	11.20
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	9.16
Veloc Up (ft/s)	=	9.13
HGL Dn (ft)	=	68.53
HGL Up (ft)	=	71.46
Hw Elev (ft)	=	73.86
Hw/D (ft)	=	4.21
Flow Regime	=	Inlet Control

Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Jul 2 2020

EX-3

Invert Elev Dn (ft)	=	67.30
Pipe Length (ft)	=	43.20
Slope (%)	=	3.01
Invert Elev Up (ft)	=	68.60
Rise (in)	=	15.0
Shape	=	Circular
Span (in)	=	15.0
No. Barrels	=	1
n-Value	=	0.020
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Projecting
Coeff. K,M,c,Y,k	=	0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

Top Elevation (ft)	=	74.00
Top Width (ft)	=	25.00
Crest Width (ft)	=	237.60

Calculations

Qmin (cfs)	=	11.35
Qmax (cfs)	=	11.35
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	11.35
Qpipe (cfs)	=	11.35
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	9.28
Veloc Up (ft/s)	=	9.25
HGL Dn (ft)	=	68.53
HGL Up (ft)	=	71.54
Hw Elev (ft)	=	73.99
Hw/D (ft)	=	4.31
Flow Regime	=	Inlet Control

Weir Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Jul 2 2020

EX-3 Overtopping Flow

Trapezoidal Weir

Crest	=	Sharp
Bottom Length (ft)	=	237.60
Total Depth (ft)	=	1.00
Side Slope (z:1)	=	4.00

Calculations

Weir Coeff. Cw	=	3.10
Compute by:		Known Q
Known Q (cfs)	=	24.35

Highlighted

Depth (ft)	=	0.11
Q (cfs)	=	24.35
Area (sqft)	=	26.18
Velocity (ft/s)	=	0.93
Top Width (ft)	=	238.48

Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Jun 5 2020

EX-4

Invert Elev Dn (ft)	=	41.00
Pipe Length (ft)	=	48.00
Slope (%)	=	4.58
Invert Elev Up (ft)	=	43.20
Rise (in)	=	18.0
Shape	=	Circular
Span (in)	=	18.0
No. Barrels	=	1
n-Value	=	0.020
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Projecting
Coeff. K,M,c,Y,k	=	0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

Top Elevation (ft)	=	48.00
Top Width (ft)	=	25.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	1.30
Qmax (cfs)	=	1.30
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	1.30
Qpipe (cfs)	=	1.30
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	1.08
Veloc Up (ft/s)	=	3.14
HGL Dn (ft)	=	41.96
HGL Up (ft)	=	43.63
Hw Elev (ft)	=	43.77
Hw/D (ft)	=	0.38
Flow Regime	=	Inlet Control

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.02 (February 2020)

Project: **Grandwood Ranch**

Basin ID: **Sub-basin W-10 post-development and EX-4 Pre-development**

Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	8.20	acres
Watershed Length =	1,094	ft
Watershed Length to Centroid =	545	ft
Watershed Slope =	0.095	ft/ft
Watershed Imperviousness =	2.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

Steep Slope > 0.06 ft/

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.010	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.014	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.062	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.178	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.302	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.544	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.698	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.931	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	1.342	acre-feet		inches
Approximate 2-yr Detention Volume =	0.007	acre-feet		
Approximate 5-yr Detention Volume =	0.013	acre-feet		
Approximate 10-yr Detention Volume =	0.075	acre-feet		
Approximate 25-yr Detention Volume =	0.117	acre-feet		
Approximate 50-yr Detention Volume =	0.112	acre-feet		
Approximate 100-yr Detention Volume =	0.153	acre-feet		

Define Zones and Basin Geometry

Select Zone 1 Storage Volume (Required) =		acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =		acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	400	0.009		
7245	--	1.00	--	--	--	2,232	0.051	1,316	0.030
7246	--	2.00	--	--	--	4,356	0.100	4,610	0.106
7247	--	3.00	--	--	--	6,306	0.145	9,941	0.228
7248	--	4.00	--	--	--	9,355	0.215	17,771	0.408
7249	--	5.00	--	--	--	12,787	0.294	28,842	0.662
7250	--	6.00	--	--	--	16,178	0.371	43,325	0.995

20
15
10
5
0
Length, Width (ft.)
16400
12300
8200
4100
0
Area (sq.ft.)
0.00
1.50
3.00
4.50
6.00
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

0.380
0.285
0.190
0.095
0.000
Area (acres)
1.000
0.750
0.500
0.250
0.000
Volume (ac-ft)
0.00
1.50
3.00
4.50
6.00
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.02 (February 2020)

Project: Grandwood Ranch

Basin ID: Sub-basin W-10 post-development and EX-4 Pre-development

Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1	#N/A		Weir&Pipe (Restrict)
Zone 2			Not Utilized
Zone 3			
Total (all zones)			

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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

Invert of Lowest Orifice =	N/A	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	N/A	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

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

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =			inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

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

	Zone 1 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	0.00		ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00		feet
Overflow Weir Grate Slope =	0.00		H:V
Horiz. Length of Weir Sides =	1.00	N/A	feet
Overflow Grate Open Area % =	100%	N/A	%, grate open area/total area
Debris Clogging % =	0%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 1 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	0.00	N/A	feet
Overflow Weir Slope Length =	1.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	2.26	N/A	
Overflow Grate Open Area w/o Debris =	4.00	N/A	ft^2
Overflow Grate Open Area w/ Debris =	4.00	N/A	ft^2

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

	Zone 1 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	18.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 1 Restrictor	Not Selected	
Outlet Orifice Area =	1.77	N/A	ft^2
Outlet Orifice Centroid =	0.75	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	40.00	feet
Spillway End Slopes =	16.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.20	feet
Stage at Top of Freeboard =	5.20	feet
Basin Area at Top of Freeboard =	0.31	acres
Basin Volume at Top of Freeboard =	0.72	acre-ft

Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.010	0.014	0.062	0.178	0.302	0.544	0.698	0.931	1.342
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.062	0.178	0.302	0.544	0.698	0.931	1.342
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.0	2.8	4.3	7.5	9.4	11.8	16.5
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.12	0.35	0.52	0.92	1.15	1.44	2.01
Peak Inflow Q (cfs) =	N/A	N/A	1.0	2.8	4.3	7.5	9.4	11.8	16.5
Peak Outflow Q (cfs) =	0.7	1.1	0.9	2.5	3.8	6.9	8.3	10.0	12.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.9	0.9	0.9	0.9	0.8	0.8
Structure Controlling Flow =	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	0.26	0.38	0.22	0.6	0.9	1.7	2.1	2.5	3.2
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	1	1	2	2	2	2	2	2	2
Time to Drain 99% of Inflow Volume (hours) =	2	2	3	2	2	2	2	2	2
Maximum Ponding Depth (ft) =	0.51	0.63	0.46	0.82	1.04	1.45	1.70	2.14	3.00
Area at Maximum Ponding Depth (acres) =	0.03	0.04	0.03	0.04	0.05	0.07	0.08	0.11	0.14
Maximum Volume Stored (acre-ft) =	0.010	0.014	0.009	0.022	0.032	0.058	0.077	0.119	0.228

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)

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

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.02 (February 2020)

Project: **Grandwood Ranch**

Basin ID: **Sub-basin W-10 post-development and EX-4 Pre-development**

Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**		
Watershed Area =	8.20	acres	
Watershed Length =	1,094	ft	
Watershed Length to Centroid =	545	ft	
Watershed Slope =	0.095	ft/ft	**Steep Slope > 0.06 ft/**
Watershed Imperviousness =	12.00%	percent	
Percentage Hydrologic Soil Group A =	0.0%	percent	
Percentage Hydrologic Soil Group B =	100.0%	percent	
Percentage Hydrologic Soil Groups C/D =	0.0%	percent	
Target WQCV Drain Time =	40.0	hours	
Location for 1-hr Rainfall Depths =	User Input		

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.053	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.094	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.121	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.255	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.387	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.618	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.778	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.005	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	1.422	acre-feet		inches
Approximate 2-yr Detention Volume =	0.061	acre-feet		
Approximate 5-yr Detention Volume =	0.094	acre-feet		
Approximate 10-yr Detention Volume =	0.181	acre-feet		
Approximate 25-yr Detention Volume =	0.246	acre-feet		
Approximate 50-yr Detention Volume =	0.258	acre-feet		
Approximate 100-yr Detention Volume =	0.330	acre-feet		

Define Zones and Basin Geometry

Select Zone 1 Storage Volume (Required) =		acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =		acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	400	0.009		
7245	--	1.00	--	--	--	2,232	0.051	1,316	0.030
7246	--	2.00	--	--	--	4,356	0.100	4,610	0.106
7247	--	3.00	--	--	--	6,306	0.145	9,941	0.228
7248	--	4.00	--	--	--	9,355	0.215	17,771	0.408
7249	--	5.00	--	--	--	12,787	0.294	28,842	0.662
7250	--	6.00	--	--	--	16,178	0.371	43,325	0.995

20
15
10
5
0
Length, Width (ft.)
16400
12300
8200
4100
0
Area (sq.ft.)
0.00
1.50
3.00
4.50
6.00
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

0.380
0.285
0.190
0.095
0.000
Area (acres)
1.000
0.750
0.500
0.250
0.000
Volume (ac-ft)
0.00
1.50
3.00
4.50
6.00
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.02 (February 2020)

Project: Grandwood Ranch

Basin ID: Sub-basin W-10 post-development and EX-4 Pre-development

Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1	#N/A		Weir&Pipe (Restrict)
Zone 2			Not Utilized
Zone 3			
Total (all zones)			

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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

Invert of Lowest Orifice =	N/A	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	N/A	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

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

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =			inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

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

	Zone 1 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	0.00		ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00		feet
Overflow Weir Grate Slope =	0.00		H:V
Horiz. Length of Weir Sides =	1.00	N/A	feet
Overflow Grate Open Area % =	100%	N/A	%, grate open area/total area
Debris Clogging % =	0%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 1 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	0.00	N/A	feet
Overflow Weir Slope Length =	1.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	6.42	N/A	
Overflow Grate Open Area w/o Debris =	4.00	N/A	ft^2
Overflow Grate Open Area w/ Debris =	4.00	N/A	ft^2

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

	Zone 1 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	6.90		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 1 Restrictor	Not Selected	
Outlet Orifice Area =	0.62	N/A	ft^2
Outlet Orifice Centroid =	0.34	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.34	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	40.00	feet
Spillway End Slopes =	16.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.20	feet
Stage at Top of Freeboard =	5.20	feet
Basin Area at Top of Freeboard =	0.31	acres
Basin Volume at Top of Freeboard =	0.72	acre-ft

Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.053	0.094	0.121	0.255	0.387	0.618	0.778	1.005	1.422
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.121	0.255	0.387	0.618	0.778	1.005	1.422
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.0	2.8	4.3	7.5	9.4	11.8	16.5
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.12	0.35	0.52	0.92	1.15	1.44	2.01
Peak Inflow Q (cfs) =	N/A	N/A	1.8	3.6	5.1	8.3	10.3	12.7	17.4
Peak Outflow Q (cfs) =	2.8	3.6	1.6	2.7	3.4	4.6	5.1	5.7	15.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.0	0.8	0.6	0.5	0.5	0.9
Structure Controlling Flow =	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	0.77	0.93	0.40	0.7	0.9	1.2	1.3	1.4	1.5
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	1	1	2	2	2	2	3	3	3
Time to Drain 99% of Inflow Volume (hours) =	1	1	2	2	2	2	3	3	3
Maximum Ponding Depth (ft) =	1.38	1.88	0.64	1.16	1.65	2.70	3.26	3.99	4.17
Area at Maximum Ponding Depth (acres) =	0.07	0.09	0.04	0.06	0.08	0.13	0.16	0.21	0.23
Maximum Volume Stored (acre-ft) =	0.053	0.094	0.014	0.039	0.073	0.185	0.268	0.406	0.446

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)

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

Cross Road Culverts - Outfall Protection

	C-1		C-2		C-3		C-4		C-5		C-6		C-7		C-8		C-9		C-10		C-11	
Pipe Size (D)	18	Inches	36	Inches	42	Inches	36	Inches	36	Inches	18	Inches	18	Inches	18	Inches	24	Inches	18	Inches	30	Inches
Q	18	cfs	68	cfs	71.3	cfs	73	cfs	73	cfs	11.5	cfs	1.7	cfs	4.7	cfs	13.6	cfs	17.1	cfs	61	cfs
L	4.5	Feet	20	Feet	10.5	Feet	20	Feet	20	Feet	4.5	Feet	4.5	Feet	4.5	Feet	6	Feet	4.5	Feet	7.5	Feet
W	4.5	Feet	6	Feet	10.5	Feet	6	Feet	6	Feet	4.5	Feet	4.5	Feet	4.5	Feet	6	Feet	4.5	Feet	7.5	Feet
D	0	Feet	1.5	Feet	0	Feet	1.5	Feet	1.5	Feet	0	Feet	0	Feet	0	Feet	0	Feet	0	Feet	0	Feet
d_{50}	0.37	Feet	0.52	Feet	0.40	Feet	0.53	Feet	0.53	Feet	0.37	Feet	0.08	Feet	0.26	Feet	0.42	Feet	0.37	Feet	0.48	Feet
	4.40	Inches	6.29	Inches	4.85	Inches	6.38	Inches	6.38	Inches	4.46	Inches	0.91	Inches	3.16	Inches	5.02	Inches	4.44	Inches	5.81	Inches
Depth of Flow	1	Feet	1.89	Feet	2.4	Feet	2.0	Feet	2.0	Feet	0.7	Feet	0.5	Feet	0.4	Feet	0.7	Feet	1.0	Feet	1.9	Feet
Q/D^1.5	9.80		13.09		10.89		14.05		14.05		6.26		0.93		2.56		4.81		9.31		15.43	
Yt/D	0.667		0.630		0.671		0.66		0.66		0.453333333		0.346666667		0.286666667		0.33		0.633333333		0.772	
Rip Rap	Type L for 3 x Pipe Dia Downstream		Type L		Type L for 3 x Pipe Dia Downstream		Type L		Type L		Type L for 3 x Pipe Dia Downstream		Type L for 3 x Pipe Dia Downstream		Type L for 3 x Pipe Dia Downstream		Type L for 3 x Pipe Dia Downstream		Type L for 3 x Pipe Dia Downstream		Type L for 3 x Pipe Dia Downstream	
Length of Rock	4.5	Feet	20	Feet	10.5	Feet	20	Feet	20	Feet	4.5	Feet	4.5	Feet	4.5	Feet	6	Feet	4.5	Feet	7.5	Feet
Width of Rock	4.5	Feet	15.0	Feet	10.5	Feet	15.0	Feet	15.0	Feet	4.5	Feet	4.5	Feet	4.5	Feet	6.0	Feet	4.5	Feet	7.5	Feet

Use D_a instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for Q/D2.5 ≤ 6.0)

CLASSIFICATION AND GRADATION OF ORDINARY RIP RAP

Rip Rap Designation by Weight	% Smaller Than Given Size (inches)	Intermediate Rock Dimension	d50* (inches)
Type VL	70 – 100	12	6**
	50 – 70	9	
	35 – 50	6	
	2 - 10	2	
Type L	70 – 100	15	9**
	50 – 70	12	
	35 – 50	9	
	2 - 10	3	
Type M	70 – 100	21	12
	50 – 70	18	
	35 – 50	12	
	2 - 10	4	
Type H	70 – 100	30	18
	50 – 70	24	
	35 – 50	18	
	2 - 10	6	
Type VH	70 – 100	42	24
	50 – 70	33	
	35 – 50	24	
	2 - 10	9	

* d50 = Mean particle size
** Bury types VL and L with native top soil and revegetate to protect from vandalism.

PIPE SIZE OR BOX HEIGHT	D	W*	L
18" – 24"	1'–0"	4'	15'
30" – 36"	1'–6"	6'	20'
42" – 48"	2'–0"	7'	24'
54" – 60"	2'–6"	8'	28'
66" – 72"	3'–0"	9'	32'

* IF OUTLET PIPE IS A BOX CULVERT WITH A WIDTH GREATER THAN W, THEN W = CULVERT WIDTH

Figure 9-37. Low tailwater riprap basin

Note: This information is preliminary and will be updated with the FDR.

3.2.3 Rock Sizing for Riprap Apron and Low Tailwater Basin

Scour resulting from highly turbulent, rapidly decelerating flow is a common problem at conduit outlets. The following section summarizes the method for sizing riprap protection for both riprap aprons (Section 3.2.1) and low tailwater basins (Section 3.2.2).

Use Figure 9-38 to determine the required rock size for circular conduits and Figure 9-39 for rectangular conduits. Figure 9-38 is valid for $Q/D_c^{2.5}$ of 6.0 or less and Figure 9-39 is valid for $Q/WH^{1.5}$ of 8.0 or less. The parameters in these two figures are:

1. $Q/D^{1.5}$ or $Q/WH^{0.5}$ in which Q is the design discharge in cfs, D_c is the diameter of a circular conduit in feet, and W and H are the width and height of a rectangular conduit in feet.
2. Y_t/D_c or Y_t/H in which Y_t is the tailwater depth in feet, D_c is the diameter of a circular conduit in feet, and H is the height of a rectangular conduit in feet. In cases where Y_t is unknown or a hydraulic jump is suspected downstream of the outlet, use $Y_t/D_t = Y_t/H = 0.40$ when using Figures 9-38 and 9-39.
3. The riprap size requirements in Figures 9-38 and 9-39 are based on the non-dimensional parametric Equations 9-16 and 9-17 (Steven, Simons, and Watts 1971 and Smith 1975).

Circular culvert:

$$d_{50} = \frac{0.023Q}{Y_t^{1.2} D_c^{0.3}} \qquad \text{Equation 9-16}$$

Rectangular culvert:

$$d_{50} = \frac{0.014H^{0.5}Q}{Y_t W} \qquad \text{Equation 9-17}$$

3.2.2 Low Tailwater Basin

The design of low tailwater riprap basins is necessary when the receiving channel may have little or no flow or tailwater at time when the pipe or culvert is in operation. Figure 9-37 provides a plan and profile view of a typical low tailwater riprap basin.

By providing a low tailwater basin at the end of a storm drain conduit or culvert, the kinetic energy of the discharge dissipates under controlled conditions without causing scour at the channel bottom.

Low tailwater is defined as being equal to or less than ⅓ of the height of the storm drain, that is:

$$y_t \le \frac{D}{3} \quad \text{or} \quad y_t \le \frac{H}{3}$$

Where:

y_t = tailwater depth at design flow (feet)

D = diameter of circular pipe (feet)

H = height of rectangular pipe (feet)

Rock Size
The procedure for determining the required riprap size downstream of a conduit outlet is in Section 3.2.3.

After selecting the riprap size, the minimum thickness of the riprap layer, T, in feet, in the basin is defined as:

$$T = 2D_{50} \qquad \text{Equation 9-15}$$

Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018)

Designer:	**Jesse Sullivan**
Company:	**Matrix Design Group**
Date:	**June 24, 2020**
Project:	**Grandwood Ranch-Sub-basins E-3, W-1, and W7; Higby Road Improvements**
Location:	**El Paso County**

SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth	0.60	inches
Depth of Average Runoff Producing Storm, d_6 =	0.43	inches (for Watersheds Outside of the Denver Region, Figure 3-1 in USDCM Vol. 3)

Area Type	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA							
Area ID	W1	W7	E3	Higby North	Higby South							
Downstream Design Point ID	EX-3	EX-4	EX-1	EX-2	EX-2							
Downstream BMP Type	None	None	None	None	None							
DCIA (ft^2)	--	--	--	--	--							
UIA (ft^2)	12,197	11,761	17,860	6,789	3,919							
RPA (ft^2)	10,675	18,250	35,582	21,961	12,760							
SPA (ft^2)	--	--	--	--	--							
HSG A (%)	0%	0%	0%	0%	0%							
HSG B (%)	100%	100%	100%	100%	100%							
HSG C/D (%)	0%	0%	0%	0%	0%							
Average Slope of RPA (ft/ft)	0.054	0.026	0.050	0.060	0.092							
UIA:RPA Interface Width (ft)	25.00	25.00	14.00	15.00	15.00							

Note: This area includes the portions of Furrow Road adjacent to Higby Road which also are impractical to detain.

CALCULATED RUNOFF RESULTS

Area ID	W1	W7	E3	Higby North	Higby South							
UIA:RPA Area (ft^2)	22,872	30,011	53,442	28,750	16,679							
L / W Ratio	16.00	16.00	16.00	16.00	16.00							
UIA / Area	0.5333	0.3919	0.3342	0.2361	0.2350							
Runoff (in)	0.00	0.00	0.00	0.00	0.00							
Runoff (ft^3)	0	0	0	0	0							
Runoff Reduction (ft^3)	508	490	744	283	163							

CALCULATED WQCV RESULTS

Area ID	W1	W7	E3	Higby North	Higby South							
WQCV (ft^3)	508	490	744	283	163							
WQCV Reduction (ft^3)	508	490	744	283	163							
WQCV Reduction (%)	100%	100%	100%	100%	100%							
Untreated WQCV (ft^3)	0	0	0	0	0							

CALCULATED DESIGN POINT RESULTS (sums results from all columns with the same Downstream Design Point ID)

Downstream Design Point ID	EX-3	EX-4	EX-1	EX-2								
DCIA (ft^2)	0	0	0	0								
UIA (ft^2)	12,197	11,761	17,860	10,708								
RPA (ft^2)	10,675	18,250	35,582	34,721								
SPA (ft^2)	0	0	0	0								
Total Area (ft^2)	22,872	30,011	53,442	45,429								
Total Impervious Area (ft^2)	12,197	11,761	17,860	10,708								
WQCV (ft^3)	508	490	744	446								
WQCV Reduction (ft^3)	508	490	744	446								
WQCV Reduction (%)	100%	100%	100%	100%								
Untreated WQCV (ft^3)	0	0	0	0								

CALCULATED SITE RESULTS (sums results from all columns in worksheet)

Total Area (ft^2)	151,753
Total Impervious Area (ft^2)	52,526
WQCV (ft^3)	2,189
WQCV Reduction (ft^3)	2,189
WQCV Reduction (%)	100%
Untreated WQCV (ft^3)	0

N

GRAPHIC SCALE

150 0 75 150 300

(IN FEET)
1 inch = 150 ft.

SURFACE TYPES	
UNCONNECTED IMPERVIOUS AREA (UIA)	
RECEIVING PERVIOUS AREA (RPA)	
DIRECTLY CONNECTED IMPERVIOUS AREA (DCIA)	
SEPARATE PERVIOUS AREA (SPA)	

LEGEND

DESIGN POINT IDENTIFIER — L

BASIN IDENTIFICATION — BASIN

BASIN FLOWS — Q5 Q100

BASIN AREA — AREA

BASIN BOUNDARY

FLOW PATH

EXISTING CONTOURS — 5975

PROPOSED CONTOURS — 7050

BASIN E-3 UIA RUNOFF CONFIGURATION

Matrix
Excellence by Design
2435 Research Parkway, Suite 300
Colorado Springs, CO 80920
Phone 719-575-0100
Fax 719-575-0208

Jun 16, 2020 - 9:45am S:\20.1105.004 Grandwood Ranch\200 Drainage\201 Drainage Reports\PDR\DWG\EXHIBITS\20.1105-PR-UIA DRAINAGE EXHIBITS.dwg

N

GRAPHIC SCALE

150 0 75 150 300

(IN FEET)
1 inch = 150 ft.

SURFACE TYPES	
UNCONNECTED IMPERVIOUS AREA (UIA)	
RECEIVING PERVIOUS AREA (RPA)	
DIRECTLY CONNECTED IMPERVIOUS AREA (DCIA)	
SEPARATE PERVIOUS AREA (SPA)	

LEGEND

DESIGN POINT IDENTIFIER — L

BASIN IDENTIFICATION — BASIN

BASIN FLOWS — Q5 Q100

BASIN AREA — AREA

BASIN BOUNDARY

FLOW PATH

EXISTING CONTOURS — 5975

PROPOSED CONTOURS — 7050

Matrix
Excellence by Design

2435 Research Parkway, Suite 300
Colorado Springs, CO 80920
Phone 719-575-0100
Fax 719-575-0208

BASIN W-1 UIA RUNOFF CONFIGURATION

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N

GRAPHIC SCALE

150 0 75 150 300

(IN FEET)
1 inch = 150 ft.

SURFACE TYPES	
UNCONNECTED IMPERVIOUS AREA (UIA)	
RECEIVING PERVIOUS AREA (RPA)	
DIRECTLY CONNECTED IMPERVIOUS AREA (DCIA)	
SEPARATE PERVIOUS AREA (SPA)	

LEGEND

DESIGN POINT IDENTIFIER — L

BASIN IDENTIFICATION — BASIN

BASIN FLOWS — Q5 Q100

BASIN AREA — AREA

BASIN BOUNDARY

FLOW PATH

EXISTING CONTOURS — 5975

PROPOSED CONTOURS — 7050

BASIN W-7 UIA RUNOFF CONFIGURATION

Matrix
Excellence by Design
2435 Research Parkway, Suite 300
Colorado Springs, CO 80920
Phone 719-575-0100
Fax 719-575-0208

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N

GRAPHIC SCALE

150 0 75 150 300

(IN FEET)
1 inch = 150 ft.

SURFACE TYPES	
UNCONNECTED IMPERVIOUS AREA (UIA)	
RECEIVING PERVIOUS AREA (RPA)	
DIRECTLY CONNECTED IMPERVIOUS AREA (DCIA)	
SEPARATE PERVIOUS AREA (SPA)	

LEGEND

DESIGN POINT IDENTIFIER — L

BASIN IDENTIFICATION — BASIN

BASIN FLOWS — Q5 Q100

BASIN AREA — AREA

BASIN BOUNDARY

FLOW PATH

EXISTING CONTOURS — 5975

PROPOSED CONTOURS — 7050

HIGBY ROAD UIA RUNOFF CONFIGURATION

Matrix
Excellence by Design
2435 Research Parkway, Suite 300
Colorado Springs, CO 80920
Phone 719-575-0100
Fax 719-575-0208

Jun 24, 2020 - 1:28pm S:\20.1105.004 Grandwood Ranch\200 Drainage\201 Drainage Reports\PDR\DWG\EXHIBITS\20.1105-PR-UIA DRAINAGE EXHIBITS.dwg

APPENDIX B

STANDARD DESIGN CHARTS AND TABLES

El Paso County Drainage Basin Fees

Resolution No. 18-470

Basin Number	Receiving Waters	Year Studied	Drainage Basin Name	2019 Drainage Fee (per Impervious Acre)	2019 Bridge Fee (per Impervious Acre)
Drainage Basins with DBPS's:					
CHMS0200	Chico Creek	2013	Haegler Ranch	$10,324	$1,524
CHWS1200	Chico Creek	2001	Bennett Ranch	$11,558	$4,433
CHWS1400	Chico Creek	2013	Falcon	$29,622	$4,069
FOFO2000	Fountain Creek	2001	West Fork Jimmy Camp Creek	$12,564	$3,717
FOFO2600	Fountain Creek	1991*	Big Johnson / Crews Gulch	$18,350	$2,370
FOFO2800	Fountain Creek	1988*	Widefield	$18,350	$0
FOFO2900	Fountain Creek	1988*	Security	$18,350	$0
FOFO3000	Fountain Creek	1991*	Windmill Gulch	$18,350	$275
FOFO3100 / FOFO3200	Fountain Creek	1988*	Carson Street / Little Johnson	$11,192	$0
FOFO3400	Fountain Creek	1984*	Peterson Field	$13,235	$1,004
FOFO3600	Fountain Creek	1991*	Fisher's Canyon	$18,350	$0
FOFO4000	Fountain Creek	1996	Sand Creek	$18,940	$5,559
FOFO4200	Fountain Creek	1977	Spring Creek	$9,517	$0
FOFO4600	Fountain Creek	1984*	Southwest Area	$18,350	$0
FOFO4800	Fountain Creek	1991	Bear Creek	$18,350	$1,004
FOFO5400	Fountain Creek	1977	21st Street	$5,521	$0
FOFO5600	Fountain Creek	1964	19th Street	$3,611	$0
FOFO5800	Fountain Creek	1964	Camp Creek	$2,033	$0
FOMO0400	Monument Creek	1986*	Mesa	$9,598	$0
FOMO1000	Monument Creek	1981	Douglas Creek	$11,540	$255
FOMO1200	Monument Creek	1977	Templeton Gap	$11,847	$275
FOMO1400	Monument Creek	1976	Pope's Bluff	$3,676	$627
FOMO1600	Monument Creek	1976	South Rockrimmon	$4,314	$0
FOMO1800	Monument Creek	1973	North Rockrimmon	$5,521	$0
FOMO2000	Monument Creek	1971	Pulpit Rock	$6,085	$0
FOMO2200	Monument Creek	1994	Cottonwood Creek / S. Pine	$18,350	$1,004
FOMO2400	Monument Creek	1966	Dry Creek	$14,486	$524
FOMO3600	Monument Creek	1989*	Black Squirrel Creek	$8,331	$524
FOMO3700	Monument Creek	1987*	Middle Tributary	$15,312	$0
FOMO3800	Monument Creek	1987*	Monument Branch	$18,350	$0
FOMO4000	Monument Creek	1996	Smith Creek	$7,481	$1,004
FOMO4200	Monument Creek	1989*	Black Forest	$18,350	$500
FOMO5200	Monument Creek	1993*	Dirty Woman Creek	$18,350	$1,004
FOMO5300	Fountain Creek	1993*	Crystal Creek	$18,350	$1,004
Miscellaneous Drainage Basins: [1]					
CHBS0800	Chico Creek		Book Ranch	$17,217	$2,492
CHEC0400	Chico Creek		Upper East Chico	$9,380	$272
CHWS0200	Chico Creek		Telephone Exchange	$10,306	$241
CHWS0400	Chico Creek		Livestock Company	$16,976	$202
CHWS0600	Chico Creek		West Squirrel	$8,849	$3,672
CHWS0800	Chico Creek		Solberg Ranch	$18,350	$0
FOFO1200	Fountain Creek		Crooked Canyon	$5,540	$0
FOFO1400	Fountain Creek		Calhan Reservoir	$4,625	$270
FOFO1600	Fountain Creek		Sand Canyon	$3,342	$0
FOFO2000	Fountain Creek		Jimmy Camp Creek[3]	$18,350	$858
FOFO2200	Fountain Creek		Fort Carson	$14,486	$524
FOFO2700	Fountain Creek		West Little Johnson	$1,209	$0
FOFO3800	Fountain Creek		Stratton	$8,801	$394
FOFO5000	Fountain Creek		Midland	$14,486	$524
FOFO6000	Fountain Creek		Palmer Trail	$14,486	$524
FOFO6800	Fountain Creek		Black Canyon	$14,486	$524
FOMO4600	Monument Creek		Beaver Creek	$10,970	$0
FOMO3000	Monument Creek		Kettle Creek	$9,909	$0
FOMO3400	Monument Creek		Elkhorn	$1,665	$0
FOMO5000	Monument Creek		Monument Rock	$7,953	$0
FOMO5400	Monument Creek		Palmer Lake	$12,717	$0
FOMO5600	Monument Creek		Raspberry Mountain	$4,278	$0
PLPL0200	Monument Creek		Bald Mountain	$9,116	$0
Interim Drainage Basins: [2]					
FOFO1800	Fountain Creek		Little Fountain Creek	$2,346	$0
FOMO4400	Monument Creek		Jackson Creek	$7,263	$0
FOMO4800	Monument Creek		Teachout Creek	$5,044	$758

1. The miscellaneous drainage fee previous to September 1999 resolution was the average of all drainage fees for basins with Basin Planning Studies perform

2. Interim Drainage Fees are based upon draft Drainage Basin Planning Studies or the Drainage Basin Identification and Fee Estimation Report. (Best availabl

3. This is an interim fee and will be adjusted when a DBPS is completed. In addition to the Drainage Fee a surety in the amount of $7,285 per impervious acre sh the DBPS results in a fee greater than the current fee. Fees paid in excess of the future revised fee will be reimbursed. See Resolution 06-326 (9/14/06) and Res

EPC Stormwater Management *Jennifer Irvine, P.E.*

depths over the duration of the storm as a fraction of the 1-hour depth and is also shown in Figure 6-19. By applying the 1-hour depths shown in Table 6-2 to the values shown in Table 6-3, a short-duration project design storm can be developed for any return period storm from a 2-year up to 100-year frequency. By applying the appropriate 1-hour depth for other project locations, a project design storm can be created for any location.

Table 6-3. 2-Hour Design Storm Distribution, ≤ 1 mi^2

Time (minutes)	Fraction of 1-Hour Rainfall Depth	Time (minutes)	Fraction of 1-Hour Rainfall Depth
5	0.014	65	1.004
10	0.046	70	1.018
15	0.079	75	1.030
20	0.120	80	1.041
25	0.179	85	1.052
30	0.258	90	1.063
35	0.421	95	1.072
40	0.712	100	1.082
45	0.824	105	1.091
50	0.892	110	1.100
55	0.935	115	1.109
60	0.972	120	1.119

- **Frontal Storms**: The characteristics of longer-duration "frontal storms" (general) is less well understood than the shorter duration thunderstorms and should be studied further. However, some events of this nature have been observed, such as the April 1999 storm which produced flooding on Fountain Creek, showing that these types of events do occur and tend to produce hazardous flood flows. In addition, modeling of the Jimmy Camp Creek drainage basin using the 24-hour, Type II distribution shows that it produces results reasonably comparably to recorded flow data. Therefore, the NRCS 24-hour Type II distribution has replaced the Type IIa distribution as the standard, long-duration design storm. This distribution can be applied to drainage basins up to 10 square miles without a DARF correction and is shown in Table 6-4. This distribution is included as a standard storm option in the HEC-HMS program.

Table 6-6. Runoff Coefficients for Rational Method
(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis-- Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

Figure 6-25. Estimate of Average Concentrated Shallow Flow

Table 6-9. NRCS Curve Numbers for Pre-Development Thunderstorms Conditions (ARC I)

Fully Developed Urban Areas (vegetation established)[1]	Treatment	Hydrologic Condition	% I	Pre-Development CN			
				HSG A	HSG B	HSG C	HSG D
Open space (lawns, parks, golf courses, cemeteries, etc.):							
Poor condition (grass cover < 50%)	-----	-----	---	47	61	72	77
Fair condition (grass cover 50% to 75%)	-----	-----	---	29	48	61	69
Good condition (grass cover > 75%)	-----	-----	---	21	40	54	63
Impervious areas:							
Paved parking lots, roofs, driveways, etc. (excluding right-of-way	-----	-----	---	95	95	95	95
Streets and roads:							
Paved; curbs and storm sewers (excluding right-of-way)	-----	-----	---	95	95	95	95
Paved; open ditches (including right-of-way)	-----	-----	---	67	77	83	85
Gravel (including right-of-way)	-----	-----	---	57	70	77	81
Dirt (including right-of-way)	-----	-----	---	52	66	74	77
Western desert urban areas:							
Natural desert landscaping (pervious areas only)	-----	-----	---	42	58	70	75
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)	-----	-----	---	91	91	91	91
Developing Urban Areas[1]	**Treatment[2]**	**Hydrologic Condition[3]**	**% I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Newly graded areas (pervious areas only, no vegetation)	-----	-----	---	58	72	81	87
Cultivated Agricultural Lands[1]	**Treatment**	**Hydrologic Condition**	**% I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Fallow	Bare soil	-----	---	58	72	81	87
	Crop residue cover (CR)	Poor	---	57	70	79	85
		Good	---	54	67	75	79
Row crops	Straight row (SR)	Poor	---	52	64	75	81
		Good	---	46	60	70	77
	SR + CR	Poor	---	51	63	74	79
		Good	---	43	56	66	70
	Contoured (C)	Poor	---	49	61	69	75
		Good	---	44	56	66	72
	C + CR	Poor	---	48	60	67	74
		Good	---	43	54	64	70
	Contoured & terraced (C&T)	Poor	---	45	54	63	66
		Good	---	41	51	60	64
	C&T+ CR	Poor	---	44	53	61	64
		Good	---	40	49	58	63
Small grain	SR	Poor	---	44	57	69	75
		Good	---	42	56	67	74
	SR + CR	Poor	---	43	56	67	72
		Good	---	39	52	63	69
	C	Poor	---	42	54	66	70
		Good	---	40	53	64	69
	C + CR Poor	Poor	---	41	53	64	69
		Good	---	39	52	63	67
	C&T	Poor	---	40	52	61	66
		Good	---	38	49	60	64
	C&T+ CR	Poor	---	39	51	60	64
		Good	---	37	48	58	63
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	---	45	58	70	77
		Good	---	37	52	64	70
	C	Poor	---	43	56	67	70
		Good	---	34	48	60	67
	C&T	Poor	---	42	53	63	67
		Good	---	30	46	57	63

Table 6-9. (continued)

Other Agricultural Lands[1]	Treatment	Hydrologic Condition	% I	HSG A	HSG B	HSG C	HSG D
Pasture, grassland, or range—continuous forage for grazing[4]	-----	Poor	---	47	61	72	77
	-----	Fair	---	29	48	61	69
	-----	Good	---	21	40	54	63
Meadow—continuous grass, protected from grazing and generally mowed for hay	-----	-----	---	15	37	51	60
Brush—brush-weed-grass mixture with brush the major element[5]	-----	Poor	---	28	46	58	67
	-----	Fair	---	18	35	49	58
	-----	Good	---	15	28	44	53
Woods—grass combination (orchard or tree farm)[6]	-----	Poor	---	36	53	66	72
	-----	Fair	---	24	44	57	66
	-----	Good	---	17	37	52	61
Woods[7]	-----	Poor	---	26	45	58	67
	-----	Fair	---	19	39	53	61
	-----	Good	---	15	34	49	58
Farmsteads—buildings, lanes, driveways, and surrounding lots	-----	-----	---	38	54	66	72
Arid and Semi-arid Rangelands[1]	**Treatment**	**Hydrologic Condition[8]**	**% I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element	-----	Poor	---	-----	63	74	85
	-----	Fair	---	-----	51	64	77
	-----	Good	---	-----	41	54	70
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush	-----	Poor	---	-----	45	54	61
	-----	Fair	---	-----	28	36	42
	-----	Good	---	-----	15	23	28
Pinyon-juniper—pinyon, juniper, or both; grass understory	-----	Poor	---	-----	56	70	77
	-----	Fair	---	-----	37	53	63
	-----	Good	---	-----	23	40	51
Sagebrush with grass understory	-----	Poor	---	-----	46	63	70
	-----	Fair	---	-----	30	42	49
	-----	Good	---	-----	18	27	34
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus	-----	Poor	---	42	58	70	75
	-----	Fair	---	34	52	64	72
	-----	Good	---	29	47	61	69

1. Average runoff condition, and Ia = 0.1S.

2. Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

3. Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness. Poor: Factors impair infiltration and tend to increase runoff. Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

4. Poor: <50%) ground cover or heavily grazed with no mulch. Fair: 50 to 75% ground cover and not heavily grazed. Good: > 75% ground cover and lightly or only occasionally grazed.

5. Poor: <50% ground cover. Fair: 50 to 75% ground cover. Good: >75% ground cover.

6. CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

7. Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning. Fair: Woods are grazed but not burned, and some forest litter covers the soil. Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

8. Poor: <30% ground cover (litter, grass, and brush overstory). Fair: 30 to 70% ground cover. Good: > 70% ground cover.

Table 6-10. NRCS Curve Numbers for Frontal Storms & Thunderstorms for Developed Conditions (ARCII)

Fully Developed Urban Areas (vegetation established)[1]	Treatment	Hydrologic Condition	% I	Pre-Development CN			
				HSG A	HSG B	HSG C	HSG D
Open space (lawns, parks, golf courses, cemeteries, etc.):							
Poor condition (grass cover < 50%)	-----	-----	---	68	79	86	89
Fair condition (grass cover 50% to 75%)	-----	-----	---	49	69	79	84
Good condition (grass cover > 75%)	-----	-----	---	39	61	74	80
Impervious areas:							
Paved parking lots, roofs, driveways, etc. (excluding right-of-way	-----	-----	---	98	98	98	98
Streets and roads:							
Paved; curbs and storm sewers (excluding right-of-way)	-----	-----	---	98	98	98	98
Paved; open ditches (including right-of-way)	-----	-----	---	83	89	92	93
Gravel (including right-of-way)	-----	-----	---	76	85	89	91
Dirt (including right-of-way)	-----	-----	---	72	82	87	89
Western desert urban areas:							
Natural desert landscaping (pervious areas only)	-----	-----	---	63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)	-----	-----	---	96	96	96	96
Urban districts:							
Commercial and business	-----	-----	85	89	92	94	95
Industrial	-----	-----	72	81	88	91	93
Residential districts by average lot size:							
1/8 acre or less (town houses)	-----	-----	65	77	85	90	92
1/4 acre	-----	-----	38	61	75	83	87
1/3 acre	-----	-----	30	57	72	81	86
1/2 acre	-----	-----	25	54	70	80	85
1 acre	-----	-----	20	51	68	79	84
2 acres	-----	-----	12	46	65	77	82
Developing Urban Areas[1]	**Treatment[2]**	**Hydrologic Condition[3]**	**% I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Newly graded areas (pervious areas only, no vegetation)	-----	-----	---	77	86	91	94
Cultivated Agricultural Lands[1]	**Treatment**	**Hydrologic Condition**	**% I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Fallow	Bare soil	-----	---	77	86	91	94
	Crop residue cover (CR)	Poor	---	76	85	90	93
		Good	---	74	83	88	90
Row crops	Straight row (SR)	Poor	---	72	81	88	91
		Good	---	67	78	85	89
	SR + CR	Poor	---	71	80	87	90
		Good	---	64	75	82	85
	Contoured (C)	Poor	---	70	79	84	88
		Good	---	65	75	82	86
	C + CR	Poor	---	69	78	83	87
		Good	---	64	74	81	85
	Contoured & terraced (C&T)	Poor	---	66	74	80	82
		Good	---	62	71	78	81
	C&T+ CR	Poor	---	65	73	79	81
		Good	---	61	70	77	80
Small grain	SR	Poor	---	65	76	84	88
		Good	---	63	75	83	87
	SR + CR	Poor	---	64	75	83	86
		Good	---	60	72	80	84
	C	Poor	---	63	74	82	85
		Good	---	61	73	81	84
	C + CR Poor	Poor	---	62	73	81	84
		Good	---	60	72	80	83
	C&T	Poor	---	61	72	79	82
		Good	---	59	70	78	81
	C&T+ CR	Poor	---	60	71	78	81
		Good	---	58	69	77	80

Table 6-10. (continued)

Other Agricultural Lands[1]	Treatment	Hydrologic Condition	% I	HSG A	HSG B	HSG C	HSG D
Pasture, grassland, or range—continuous forage for grazing[4]	-----	Poor	---	68	79	86	89
	-----	Fair	---	49	69	79	84
	-----	Good	---	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay	-----	-----	---	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element[5]	-----	Poor	---	48	67	77	83
	-----	Fair	---	35	56	70	77
	-----	Good	---	30	48	65	73
Woods—grass combination (orchard or tree farm)[6]	-----	Poor	---	57	73	82	86
	-----	Fair	---	43	65	76	82
	-----	Good	---	32	58	72	79
Woods[7]	-----	Poor	---	45	66	77	83
	-----	Fair	---	36	60	73	79
	-----	Good	---	30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots	-----	-----	---	59	74	82	86
Arid and Semi-arid Rangelands[1]	**Treatment**	**Hydrologic Condition[8]**	**% I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element	-----	Poor	---	-----	80	87	93
	-----	Fair	---	-----	71	81	89
	-----	Good	---	-----	62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush	-----	Poor	---	-----	66	74	79
	-----	Fair	---	-----	48	57	63
	-----	Good	---	-----	30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory	-----	Poor	---	-----	75	85	89
	-----	Fair	---	-----	58	73	80
	-----	Good	---	-----	41	61	71
Sagebrush with grass understory	-----	Poor	---	-----	67	80	85
	-----	Fair	---	-----	51	63	70
	-----	Good	---	-----	35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus	-----	Poor	---	63	77	85	88
	-----	Fair	---	55	72	81	86
	-----	Good	---	49	68	79	84

: Ia = 0.1 S

2. Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

3. Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness. Poor: Factors impair infiltration and tend to increase runoff. Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

4. Poor: <50%) ground cover or heavily grazed with no mulch. Fair: 50 to 75% ground cover and not heavily grazed. Good: > 75% ground cover and lightly or only occasional

5. Poor: <50% ground cover. Fair: 50 to 75% ground cover. Good: >75% ground cover.

6. CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods

7. Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning. Fair: Woods are grazed but not burned, and some forest litter covers the soil. Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

8. Poor: <30% ground cover (litter, grass, and brush overstory). Fair: 30 to 70% ground cover. Good: > 70% ground cover.

4.6 Lag Time

While the NRCS curve numbers are used to calculate the volume of runoff and magnitude of losses, to transform the volume of runoff into a hydrograph using the NRCS dimensionless unit hydrograph, the lag time must be specified. The lag time is defined as the time from the centroid of the rainfall distribution of a storm to the peak discharge produced by the watershed. For this Manual, the lag time is defined as a fraction of the time of concentration (t_c) as shown in Equation 6-13.

$$t_{lag} = 0.6 \cdot t_c \qquad \text{(Eq. 6-13)}$$

TABLE 5-4
RUNOFF CURVE NUMBERS FOR HYDROLOGIC SOIL COVER COMPLEXES - RURAL CONDITIONS
(Antecedent Moisture Condition II, and Ia = 0.2 S)
(From: U.S. Dept. of Agriculture, Soil Conservation Service, 1977)

Land Use	Cover Treatment or Practice	Hydrologic Condition	Runoff Curve Number by Hydrologic Soil Group A	B	C	D
Fallow	Straight Row	----	77	86	91	94
Row Crops	Straight Row	Poor	72	81	88	91
	Straight Row	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	Contoured	Good	65	75	82	86
	Cont. & Terraced	Poor	66	74	80	82
	Cont. & Terraced	Good	62	71	78	81
Small Grain	Straight Row	Poor	65	76	84	88
	Straight Row	Good	63	75	83	87
	Contoured	Poor	63	74	82	85
	Contoured	Good	61	73	81	84
	Cont. & Terraced	Poor	61	72	79	82
	Cont. & Terraced	Good	59	70	78	81
Close-seeded legumes 1/ or rotation meadow	Straight Row	Poor	66	77	85	89
	Straight Row	Good	58	72	81	85
	Contoured	Poor	64	75	83	85
	Contoured	Good	55	69	78	83
	Cont. & Terraced	Poor	63	73	80	83
	Cont. & Terraced	Good	51	67	76	80
Pasture or range		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
	Contoured	Poor	47	67	81	88
	Contoured	Fair	25	59	75	83
	Contoured	Good	6	35	70	79
Meadow		Good	30	58	71	78
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		----	59	74	82	86
Roads (dirt) 2/		----	72	82	87	89
(hard surface) 2/		----	74	84	90	92

1/ Close-drilled or broadcast
2/ Including right-of-way

TABLE 5-5
RUNOFF CURVE NUMBERS FOR HYDROLOGIC SOIL COVER COMPLEXES - URBAN AND SUBURBAN CONDITIONS 1/
(Antecedent Moisture Condition II)
(From: U.S. Dept. of Agriculture, Soil Conservation Service, 1977)

Land Use		Hydrologic Soil Group A	B	C	D
Open spaces, lawns, parks, golf courses, cemeteries, etc.					
Good condition:	grass cover on 75% or more of the area	39*	61	74	80
Fair condition:	grass cover on 50% to 75% of the area	49*	69	79	84
Commercial and Business areas (85% Impervious)		89*	92	94	95
Industrial Districts 72% Impervious)		81*	88	91	93
Residential: 2/					
Acres per Dwelling Unit	Average % Impervious 3/				
1/8 acre or less	65	77*	85	90	92
1/4 acre	38	61*	75	83	87
1/3 acre	30	57*	72	81	86
1/2 acre	25	54*	70	80	85
1 acre	20	51*	68	79	84
Paved parking lots, roofs, driveways, etc.		98	98	98	98
Streets and Roads:					
paved with curbs and storm sewers		98	98	98	98
gravel		76*	85	89	91
dirt		72*	82	87	89

1/ For a more detailed description of agricultural land use curve numbers, refer to the National Engineering Handbook (U.S. Dept. of Agriculture, Soil Conservation Service, 1972).
2/ Curve numbers are computed assuming the runoff from the house and driveway is directed towards the street with a minimum of roof water directed to lawns where additional infiltration could occur.
3/ The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

* Not to be used wherever overlot grading or filling is to occur.

TABLE 5-6
RUNOFF CURVE NUMBERS FOR HYDROLOGIC SOIL COVER COMPLEXES - RURAL CONDITIONS
(Antecedent Moisture Condition III, and Ia = 0.2 S)
(From: U.S. Dept. of Agriculture, Soil Conservation Service, 1977)

NOTE: THIS TABLE TO BE USED FOR INFORMATION ONLY

Land Use	Cover Treatment or Practice	Hydrologic Condition	Runoff Curve Number by Hydrologic Soil Group A	B	C	D
Fallow	Straight Row	----	89	94	97	98
Row Crops	Straight Row	Poor	86	92	95	97
	Straight Row	Good	83	90	94	96
	Contoured	Poor	85	91	93	95
	Contoured	Good	82	88	92	94
	Cont. & Terraced	Poor	82	88	91	92
	Cont. & Terraced	Good	79	86	90	92
Small Grain	Straight Row	Poor	82	89	93	95
	Straight Row	Good	80	88	93	95
	Contoured	Poor	80	88	92	94
	Contoured	Good	78	87	92	93
	Cont. & Terraced	Poor	78	86	91	92
	Cont. & Terraced	Good	77	85	90	92
Close-seeded legumes 1/ or rotation meadow	Straight Row	Poor	82	89	94	96
	Straight Row	Good	76	86	92	94
	Contoured	Poor	81	88	93	94
	Contoured	Good	74	84	90	93
	Cont. & Terraced	Poor	80	87	91	93
	Cont. & Terraced	Good	70	83	89	91
Pasture or range		Poor	84	91	94	96
		Fair	69	84	91	93
		Good	59	78	88	91
	Contoured	Poor	67	83	92	95
	Contoured	Fair	64	77	88	93
	Contoured	Good	15	55	85	91
Meadow		Good	50	76	86	90
Woods		Poor	65	82	89	93
		Fair	56	78	87	91
		Good	43	74	85	89
Farmsteads		----	77	88	92	94
Roads (dirt) 2/		----	86	92	95	96
(hard surface) 2/		----	88	93	96	97

1/ Close-drilled or broadcast
2/ Including right-of-way

TABLE 5-7
RUNOFF CURVE NUMBERS FOR HYDROLOGIC SOIL COVER COMPLEXES - URBAN AND SUBURBAN CONDITIONS 1/
(Antecedent Moisture Condition III)
(From: U.S. Dept. of Agriculture, Soil Conservation Service, 1977)

NOTE: THIS TABLE TO BE USED FOR INFORMATION ONLY

Land Use		Hydrologic Soil Group A	B	C	D
Open spaces, lawns, parks, golf courses, cemeteries, etc.					
Good condition:	grass cover on 75% or more of the area	59*	78	88	91
Fair condition:	grass cover on 50% to 75% of the area	69*	84	91	93
Commercial and Business areas (85% Impervious)		96*	97	98	98
Industrial Districts 72% Impervious)		92*	95	97	98
Residential: 2/					
Acres per Dwelling Unit	Average % Impervious 3/				
1/8 acre or less	65	89*	94	96	97
1/4 acre	38	78*	88	93	95
1/3 acre	30	75*	86	92	94
1/2 acre	25	73*	85	91	94
1 acre	20	70*	84	91	93
Paved parking lots, roofs, driveways, etc.		99	99	99	99
Streets and Roads:					
paved with curbs and storm sewers		99	99	99	99
gravel		89*	94	96	97
dirt		86*	92	95	96

1/ For a more detailed description of agricultural land use curve numbers, refer to the National Engineering Handbook (U.S. Dept. of Agriculture, Soil Conservation Service, 1972).
2/ Curve numbers are computed assuming the runoff from the house and driveway is directed towards the street with a minimum of roof water directed to lawns where additional infiltration could occur.
3/ The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

* Not to be used wherever overlot grading or filling is to occur.

APPENDIX C

REPORT REFERENCES

Rothberg Tamburini Winsor

Proj. No.: GI-2030-CC File: ____ Pg.: ____ of: ____

Calcd: [illegible] Chkd: ____ Appvd: ____ Date: ____

Project: Bent Tree III - Drainage Report

Work: Detention Pond Section - Revised 4/21/93

Notes:
1. Elevations noted above datum of 7300'
2. See POND-2 output for storage area and outflows
3. See map of developed conditions for limits of pond in plan view
4. Details of emergency spillway, outlet works, energy dissipation, and inlet check structures will be addressed in the construction documents.

DISCHARGE PIPE - 36" Ø

$S_f = 0.009$, $L = 70'$, $n = 0.013$

$$Q_{CAP} = A\left(\frac{2g(H - S_f L)}{1 + K_e}\right)^{1/2} = 7.07\left[\frac{(64.4)(2.4 - .63)}{1.5}\right]^{1/2}$$

$$= 61.6 \text{ CFS} > 51.2 \text{ CFS} \quad \underline{OK}$$

1100 Stout Street/Suite 750/Denver, Colorado 80204-2064/(303) 825-5999/FAX (303) 825-0642

SUBDIVISION MAP
APPROXIMATE
SCALE: 1" = 2000'

VICINITY MAP

LEGEND

- BASIN BOUNDARY
- D / 10.8 — BASIN / AREA
- 2 — DESIGN POINT
- DIRECTION OF FLOW
- 100 YEAR FLOODPLAIN LIMIT
- DRAINAGE EASEMENT
- EXISTING CULVERT
- PROPOSED CULVERT
- 2/2 — 10 YR / 100 YEAR DESIGN FLOW

BENT+TREE

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ROTHBERG, TAMBURINI & WINSOR, INC.

Professional Engineers & Consultants — Denver, CO

BENT TREE SUBDIVISION – FILING NO. 3
FINAL DRAINAGE REPORT

DEVELOPED CONDITIONS

DESIGNED BY: SMB	DRAWN BY: RLH	CHECKED BY: KAT	SHEET NO. 2 OF 2
APPROVED BY:	DATE: MARCH, 1993	PROJECT NO.: GI-2030-CC	

APR 01, 1993 • 16:41:06

TREE

Reservoir Report

English

Reservoir No. 1 - Detention Pond / DP20

Pond Data

Pond storage is based on known values

Stage / Storage Table

Stage ft	Elevation ft	Contour area sqft	Incr. Storage cuft	Total storage cuft
0.00	7243.50	00	0	0
0.50	7244.00	00	0	575
1.50	7245.00	00	0	3,150
2.50	7246.00	00	0	12,600
6.50	7250.00	00	0	80,600

Culvert / Orifice Structures

		[A]	[B]	[C]	[D]
Rise in	=	0.0	0.0	0.0	0.0
Span in	=	0.0	0.0	0.0	0.0
No. Barrels	=	0	0	0	0
Invert El. ft	=	0.00	0.00	0.00	0.00
Length ft	=	0.0	0.0	0.0	0.0
Slope %	=	0.00	0.00	0.00	0.00
N-Value	=	.000	.000	.000	.000
Orif. Coeff.	=	0.00	0.00	0.00	0.00
Multi-Stage	=	——	No	No	No

Weir Structures

		[A]	[B]	[C]	[D]
Crest Len ft	=	0.0	0.0	0.0	0.0
Crest El. ft	=	0.00	0.00	0.00	0.00
Weir Coeff.	=	0.00	0.00	0.00	0.00
Eqn. Exp.	=	0.00	0.00	0.00	0.00
Multi-Stage	=	No	No	No	No

Tailwater Elevation = 0.00 ft

Note: All outflows have been analyzed under inlet and outlet control.

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	Clv D cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Discharge cfs
0.00	0	7243.50	—	—	—	—	—	—	—	—	0.00
0.50	575	7244.00	—	—	—	—	—	—	—	—	2.20
1.50	3,150	7245.00	—	—	—	—	—	—	—	—	9.00
2.50	12,600	7246.00	—	—	—	—	—	—	—	—	18.00
6.50	80,600	7250.00	—	—	—	—	—	—	—	—	50.00

TIMBERVIEW

FINAL DRAINAGE BASIN MAP
PROPOSED CONDITIONS

PHASE II

VICINITY MAP

SCALE · 1"= 100'

LEGEND

- PROPOSED BASIN BOUNDARY
- DIRECTION OF FLOW
- (7290) EXISTING CONTOUR
- DESIGN POINT
- PROPOSED CMP CULVERT
- BASELINE FOR HECRAS ANALYSIS
- E1 / 3 43 AC — SUB-BASIN DESIGNATION / AREA IN ACRES

Peak Flow Rate Summary Table

Proposed Conditions

Sub-basin	Design Point	Peak Flow Rate 5 Year cfs	Peak Flow Rate 100 Year cfs
OS 5		3 4	7 5
OS 6		1 4	3 1
OS 7		3 4	7 3
OS 8		2 2	4 8
OS 9		4 8	10 5
E 1		3 9	7 6
E 2		3.8	7 9
E 3		3 3	6 8
E 4		3 2	6 6
E 5		1 0	2.2
E 6		2 8	5 9
F 1		2 1	4 5
F 2		3 5	7 7
F 3		1 1	2 5
F 4		0 6	1 4
F 5		2 6	6 0
G 1		2 2	4 6
G 2		2 3	4 8
G 3		1 3	2 6
G 4		1 1	2 2
G 5		2 1	4 3
OS 10		1 0	2 2
I 1		1 0	2 0
J 1		2 6	6 0
	13	7 2	14 5
	14	14 0	28 8
	15	7 6	16 0
	16	10 5	22 5
	17	16 8	34 6
	18	16 7	38 1
	19	34.4	72 4
	20	19 3	31 9
	21	8 1	17 7
	22	10 4	23 0
	23	12 5	23 4
	24	3 0	6 9

TIMBERVIEW SUBDIVISION
PHASE II
FINAL DRAINAGE BASIN MAP
PROPOSED CONDITIONS

PREMIER ENGINEERING, INC.
Professional Civil Engineers
2110 Vickers Drive
Colorado Springs, CO 80918
(719) 598 6951
PremierEng@aol com

Jesse Sullivan

From: Hunyadi - DNR, John <john.hunyadi@state.co.us>
Sent: Tuesday, March 31, 2020 1:27 PM
To: Jesse Sullivan
Cc: Corey Petersen
Subject: Re: Grandwood Ranch: Existing Offsite Detention Embankments and Proposed Onsite Detention

Hi Jesse,

Sorry for not getting back to you sooner. I concur with your analyses and conclusions for the off-site detention ponds Bent Tree III (Low haz) and TImberview II (NPH). I agree with your initial discussions for the ones that will be part of the Grandwood Ranch and look forward to the submittal package when those become available.

I truly appreciate your efforts to work with the County and myself to plan the development with these dam safety concerns in mind!

Thank you .

John H.
John Hunyadi, PE
Dam Safety Engineer

COLORADO
Division of Water Resources
Department of Natural Resources

T: 719.227.5294 | C: 719.258.0859
4255 Sinton Road, Colorado Springs, CO 80907
john.hunyadi@state.co.us

On Tue, Mar 31, 2020 at 12:11 PM Jesse Sullivan <jesse_sullivan@matrixdesigngroup.com> wrote:

> John,
>
> Just checking in to see if you received the memo regarding the offsite detention upstream of the Grandwood Ranch subdivision. The file size may have been a bit large, so I wanted to confirm it made it through.
>
> If you received it and have any questions feel free to contact me.
>
> Thanks,

Matrix Design Group
2435 Research Parkway, Suite 300
Colorado Springs, CO 80920
Ph: (719) 575-0100

Date: March 26, 2020

To: John Hunyadi
Dam Safety Engineer
State of Colorado
4255 Sinton Road
Colorado Springs, CO 80919

From: Jesse Sullivan, P.E.

Subject: Existing Embankment Hazard Classification
Bent Tree III Detention Pond &
Timberview Phase II Detention Pond

Introduction:

We are providing a Hazard Classification for the two subject detention ponds in order to provide safe design for the proposed, downstream, Grandwood Ranch development. The two subject ponds are located just offsite of the proposed development. For the purposes of this memorandum the ponds are referred to as the Bent Tree III Pond and the Timberview II Pond.

Criteria:

The State of Colorado DWR publication "Guidelines for Hazard Classification" dated January 21, 2019 were utilized in determining the hazard classification for the two embankments. The study also utilized the state of Colorado DWR "Spreadsheet for Estimating Dam Breach Parameters Using the Froehlich Method" to estimate dam breach flows and designate "no-build" regions where necessary to maintain as minimal hazard from the existing embankments as possible.

Bent Tree III Pond (Existing & Offsite):

This existing detention pond is located in Lots 158 and 159 of the Bent Tree III subdivision just east of the proposed Grandwood Ranch development. The Grandwood Ranch lot lines have been adjusted so that the discharge of the pond and the potential breach flow will run just inside the north boundary of Lot 9 within the development within a designated "No-Build" area. Once passing through Lot 9, the breach flow will surcharge the proposed road and follow historic flow patterns to dissipate within an existing wetland. From this point waters will cross Higby Road via the existing culverts and eventually discharge to Jackson Creek.

Detention Basin Data:

Drainage Area:	162.9	Acres
Max Storage Depth:	8.1	Feet
Max Storage Volume:	3.7	Acre-Feet
Est. Breach Discharge Q:	807	CFS
Crest Width of Embankment:	8	Feet

Vertical Fall from Spillway to Exterior Toe of Embankment:	11	Feet
Exterior Embankment Slope:	2.5:1	Feet Horizontal : Feet Vertical
Interior Embankment Slope:	4:1	Feet Horizontal : Feet Vertical
Width of Breach Flow:	90	Feet
Dam Size Class:	Minor	

Hazard Classification:

Relevant Information:

- Breach flows will be conveyed through the adjacent residential, 2.5-acre, Lot 9 via a "No-Build" area centered on the natural flow path which the breach flow would be anticipated to follow.
- The downstream road will be armored at the location the breach flow is anticipated to cross.
    - The armoring should minimize damage to the road.
- Emergency access is provided for the lots possibly cut off from the primary road in the unlikely case of failure of both the armoring and the primary road.
- No developed lots across the road from the "No-Build" conveyance area.
- Downstream detention pond proposed for Grandwood Ranch has been located such that the direct Breach Flow should not impact the detention
    - It is possible that some dispersed waters could reach the detention.
    - Such flows will have lost much of the original energy from the Breach and are not anticipated to cause issues within the Grandwood Ranch detention pond.
    - The Grandwood Detention Pond does not utilize embankment and is thus not a failure risk.
    - No developed parcels downstream of the Grandwood Ranch Detention Pond.
- Past the Grandwood Ranch Detention Pond a natural, heavily vegetated water way will disperse the remaining energy of the breach.
- The above factors minimize the likelihood of loss of human life associated with a Breach.

Based on the above factors, this existing offsite detention pond is classified as "Low Hazard"

Timberview II Pond (Existing & Offsite):

This existing pond is located north of the northwestern corner of the proposed Grandwood Ranch development within Lots 47 and 48 of the Timberview Subdivision Phase II. the breach flow will surcharge the proposed road and follow historic flow patterns to dissipate within an existing wetland. From this point waters will cross Higby Road via the existing culverts and eventually discharge to Jackson Creek.

Detention Basin Data:

Drainage Area:	36	Acres
Max Depth:	3	Feet
Max Storage Volume:	0.5	Acre-Feet
Est. Breach Discharge Q:	73	CFS
Crest Width of Embankment:	50	Feet

Vertical Fall from Spillway to Exterior Toe of Embankment:	3	Feet
Exterior Embankment Slope:	4:1	Feet Horizontal : Feet Vertical
Interior Embankment Slope:	3:1	Feet Horizontal : Feet Vertical
Width of Breach Flow:	35	Feet
Dam Size Class:	Minor	

Hazard Classification:

Relevant Information:

- Very minimal Breach Flow of 73 CFS
- Driveway Culvert Sizing will accommodate 73 cfs discharge flow
- Natural Discharge Path will route around proposed roads
- No/minimal anticipated damage from Breach
    - Possibly minor erosion associated with Breach flow
- Broad, heavily vegetated drainage way receiving Breach flows
- Very Small detained volume of 0.5 Acre-Feet
- Due to very minor flows no loss of human life is anticipated
- Conveyance through driveways via 30" culvert.

Based on the above factors this embankment is classified as No Public Hazard (NPH). No or very minor damage is anticipated as a result of a breach and no loss of human life is anticipated either.

Grandwood Ranch Detention Ponds (Proposed & Onsite):

The Grandwood Ranch Subdivision will have several of its own detention ponds to provide treatment and detention for the roads associated with the proposed development. These ponds will all be below the jurisdictional dam criteria.

Detention Basin Data:

Drainage Area:	8.5-22.3	Acres
Max Storage Depth:	10	Feet
Max Storage Volume:	3.7	Acre-Feet
Max Breach Discharge Q:	317	CFS
Crest Width of Embankment:	8	Feet
Vertical Fall from Spillway to Exterior Toe of Embankment:	<7	Feet
Exterior Embankment Slope:	3:1	Feet Horizontal : Feet Vertical
Interior Embankment Slope:	3:1	Feet Horizontal : Feet Vertical
Dam Size Class:	Minor	

Hazard Classification:

The Grandwood Ranch ponds will all fall in either No Public Hazard or Low Hazard because they will all be located downhill of the developed areas. In the case of a breach flows from the ponds will

discharge to an undeveloped, heavily vegetated low-lying area where the velocities will decrease to below 7 ft/s. The low-lying areas then drain to Higby Road crossroad culverts, surcharge the paved road and from there channel flow through the undeveloped downstream areas towards Jackson Creek. Further information will be submitted on the proposed ponds (including the SDI sheet) after the design process has been completed.

ESTIMATION OF DAM BREACH PARAMETERS
USING THE FROEHLICH 2008 METHOD

PROJECT: **Timberview Subdivision Phase II Detention Pond Embankment**

BREACH INPUT PARAMETERS:

Select Failure Mode From Drop-Down Menu:	OVERTOPPING	
Height of water over base elevation of breach (H_w) =	3.0	Feet
Volume of water in the reservoir at the time of failure (V_w) =	0.5	Acre-Feet
Reservoir Surface Area at Hw (A_s) =	0.4	Acres
Height of breach (H_b) =	3.0	Feet
Failure Mode Factor (K_o) =	1.3	
Breach Side-Slope Ratio (Z_b) =	0.7	Z(H):1(V)
Dam Size Class:	Minor	Assumes Full Reservoir At Time of Breach.

CALCULATED BREACH CHARACTERISTICS:

Average Breach Width (B_{avg}) =	8.9	Feet
Bottom Width of Breach (B_b) =	6.8	Feet
Breach Formation Time (T_f) =	0.15	Hours
Storage Intensity (SI) =	0.2	Acre Feet/Foot
Predicted Peak Flow (Q_p) =	73	Cubic Feet per Second

RESULTS CHECK:

Average Breach Width Divided by Height of Breach (B_{avg}/H_b) =	2.96	If (B_{avg}/H_b) > 0.6, Full Breach Devlopment is Anticipated
Erosion Rate (ER), Calculated as (B_{avg}/T_f) =	59.2	
Erosion Rate Divided by Height of Water Over Base of Breach (ER/H_w) =	19.7	If 1.6 < (ER/H_w) < 21, Erosion Rate is Assumed Reasonable

Note: Storage volume of reservoir is outside the data set used to generate the emperical equations used in the Froehlich Method

Figure 1- Breach Variable Definition Sketch

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Mar 24 2020

Timberview Breach Flow into Grandwood drainage easement

User-defined

Invert Elev (ft)	=	7241.60
Slope (%)	=	5.00
N-Value	=	0.030

Calculations

Compute by:		Known Q
Known Q (cfs)	=	73.00

Highlighted

Depth (ft)	=	0.61
Q (cfs)	=	73.00
Area (sqft)	=	12.85
Velocity (ft/s)	=	5.68
Wetted Perim (ft)	=	33.85
Crit Depth, Yc (ft)	=	0.77
Top Width (ft)	=	33.82
EGL (ft)	=	1.11

(Sta, El, n)-(Sta, El, n)...

(0.00, 7242.94)-(31.80, 7241.60, 0.030)-(41.20, 7241.70, 0.030)-(48.60, 7241.95, 0.030)-(58.80, 7242.99, 0.030)

ESTIMATION OF DAM BREACH PARAMETERS
USING THE FROEHLICH 2008 METHOD

PROJECT: **Bent Tree III Detention Pond**

BREACH INPUT PARAMETERS:

Select Failure Mode From Drop-Down Menu:	OVERTOPPING	
Height of water over base elevation of breach (H_w) =	10.1	Feet
Volume of water in the reservoir at the time of failure (V_w) =	3.8	Acre-Feet
Reservoir Surface Area at Hw (A_s) =	1.0	Acres
Height of breach (H_b) =	10.1	Feet
Failure Mode Factor (K_o) =	1.3	
Breach Side-Slope Ratio (Z_b) =	0.7	Z(H):1(V)
Dam Size Class:	Minor	Assumes Full Reservoir At Time of Breach.

CALCULATED BREACH CHARACTERISTICS:

Average Breach Width (B_{avg}) =	18.0	Feet
Bottom Width of Breach (B_b) =	10.9	Feet
Breach Formation Time (T_f) =	0.12	Hours
Storage Intensity (SI) =	0.4	Acre Feet/Foot
Predicted Peak Flow (Q_p) =	807	Cubic Feet per Second

RESULTS CHECK:

Average Breach Width Divided by Height of Breach (B_{avg}/H_b) =	1.78	If (B_{avg}/H_b) > 0.6, Full Breach Devlopment is Anticipated
Erosion Rate (ER), Calculated as (B_{avg}/T_f) =	144.5	
Erosion Rate Divided by Height of Water Over Base of Breach (ER/H_w) =	14.3	If 1.6 < (ER/H_w) < 21, Erosion Rate is Assumed Reasonable

Note: Storage volume of reservoir is outside the data set used to generate the emperical equations used in the Froehlich Method

Figure 1- Breach Variable Definition Sketch

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Mar 23 2020

Bent Tree III Dam Breach - No Build Width in Lot 9 Based on Natural Flow Path

User-defined

Invert Elev (ft)	=	7306.00
Slope (%)	=	4.20
N-Value	=	0.040

Calculations

Compute by:		Known Q
Known Q (cfs)	=	807.00

Highlighted

Depth (ft)	=	1.92
Q (cfs)	=	807.00
Area (sqft)	=	99.72
Velocity (ft/s)	=	8.09
Wetted Perim (ft)	=	90.27
Crit Depth, Yc (ft)	=	2.21
Top Width (ft)	=	90.18
EGL (ft)	=	2.94

(Sta, El, n)-(Sta, El, n)...

(24.49, 7309.49)-(94.27, 7306.00, 0.040)-(100.80, 7306.00, 0.040)-(122.38, 7306.62, 0.040)-(145.10, 7307.85, 0.040)-(167.68, 7309.49, 0.040)

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Mar 24 2020

Bewnt Tree III - Downstream Road Crossing

User-defined

Invert Elev (ft)	=	7302.00
Slope (%)	=	2.00
N-Value	=	0.013

Calculations

Compute by:		Known Q
Known Q (cfs)	=	807.00

Highlighted

Depth (ft)	=	0.82
Q (cfs)	=	807.00
Area (sqft)	=	81.20
Velocity (ft/s)	=	9.94
Wetted Perim (ft)	=	165.56
Crit Depth, Yc (ft)	=	1.26
Top Width (ft)	=	165.54
EGL (ft)	=	2.36

(Sta, El, n)-(Sta, El, n)...

(0.00, 7304.00)-(89.00, 7302.15, 0.013)-(119.40, 7302.00, 0.013)-(169.40, 7302.29, 0.013)-(340.20, 7304.00, 0.013)

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Mar 24 2020

Bent Tree III Dam Breach -Wetland Flow

User-defined

Invert Elev (ft)	=	7242.00
Slope (%)	=	3.30
N-Value	=	0.048

Calculations

Compute by:		Known Q
Known Q (cfs)	=	807.00

Highlighted

Depth (ft)	=	3.24
Q (cfs)	=	807.00
Area (sqft)	=	99.92
Velocity (ft/s)	=	8.08
Wetted Perim (ft)	=	58.47
Crit Depth, Yc (ft)	=	3.36
Top Width (ft)	=	57.98
EGL (ft)	=	4.25

(Sta, El, n)-(Sta, El, n)...

(12.60, 7247.44)-(52.51, 7245.88, 0.040)-(91.95, 7245.60, 0.040)-(112.00, 7244.00, 0.050)-(122.00, 7242.00, 0.050)-(128.00, 7242.00, 0.050)-(136.00, 7242.96, 0.0
-(141.00, 7243.00, 0.050)-(159.00, 7246.00, 0.040)-(178.40, 7247.57, 0.040)

Figure 13-12b. Emergency Spillway Profile at Embankment

Figure 13-12c. Emergency Spillway Protection

ROAD EMBANKMENT PROTECTION CALCULATION
Q=807 CFS
LENGTH=167
UNIT FLOW RATE: 4.8 CFS/FT

=> TYPE M RIP RAP

Figure 13-12d. Riprap Types for Emergency Spillway Protection

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Mar 24 2020

Onsite Worst Case Dam Breach - Wetland Flow

User-defined

Invert Elev (ft)	=	7242.00
Slope (%)	=	3.30
N-Value	=	0.048

Calculations

Compute by:		Known Q
Known Q (cfs)	=	317.00

Highlighted

Depth (ft)	=	2.18
Q (cfs)	=	317.00
Area (sqft)	=	48.87
Velocity (ft/s)	=	6.49
Wetted Perim (ft)	=	38.70
Crit Depth, Yc (ft)	=	2.20
Top Width (ft)	=	38.34
EGL (ft)	=	2.83

(Sta, El, n)-(Sta, El, n)...

(12.60, 7247.44)-(52.51, 7245.88, 0.040)-(91.95, 7245.60, 0.040)-(112.00, 7244.00, 0.050)-(122.00, 7242.00, 0.050)-(128.00, 7242.00, 0.050)-(136.00, 7242.96, 0.0
-(141.00, 7243.00, 0.050)-(159.00, 7246.00, 0.040)-(178.40, 7247.57, 0.040)

REFERENCE DRAWINGS
Parcels
X-1105-EX SITE DESIGN
X-Title(Drainage)

NO.	DATE	DESCRIPTION	BY

REVISIONS

NAME: S:\20.1105.004 Grandwood Ranch\100 Dwg\106 Working\JTS Basins.dwg
PCP: Matrix.ctb
PLOT DATE: Thu Mar 26, 2020 1:46pm

BENCHMARK DATA(ELEV.)
(DATUM)
(DESCRIPTION/LOCATION)

VERTICAL BENCHMARK:

BASIS OF BEARING:

PREPARED UNDER MY DIRECT SUPERVISION, FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.

Matrix
2435 Research Parkway, Suite 300 Colorado Springs, CO 80920
Phone 719-575-0100
Fax 719-575-0208

Grandwood Ranch Subdivision

Potential Breach locations in Western Portion of Development

DESIGNED BY: JTS
DRAWN BY: JTS
CHECKED BY:
SCALE
HORIZ:
VERT:
DATE ISSUED: MARCH 2020
SHEET NO. 1 OF 2 SHEETS

REFERENCE DRAWINGS

X-1105-EX SITE DESIGN
X-Title(Drainage)

NO.	DATE	DESCRIPTION	BY

REVISIONS

NAME: S:\20.1105.004 Grandwood Ranch\100 Dwg\106 Working\JTS Basins.dwg
PCP: Matrix.ctb
PLOT DATE: Thu Mar 26, 2020 3:33pm

BENCHMARK DATA(ELEV.)
(DATUM)
(DESCRIPTION/LOCATION)

VERTICAL BENCHMARK:

BASIS OF BEARING:

PREPARED UNDER MY DIRECT SUPERVISION, FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.

Matrix
2435 Research Parkway, Suite 300 Colorado Springs, CO 80920
Phone 719-575-0100
Fax 719-575-0208

GRANDWOOD RANCH SUBDIVISION

Potential Breach locations in Eastern Portion of Development

DESIGNED BY: JTS	SCALE:	DATE ISSUED:	MARCH 2020
DRAWN BY: JTS	HORIZ:		
CHECKED BY:	VERT:	SHEET NO. OF	SHEETS

Vicinity Map

Grandwood Ranch Subdivision

El Paso County Drainage Basin Fees

Resolution No. 19-441

Basin Number	Receiving Waters	Year Studied	Drainage Basin Name	2020 Drainage Fee (per Impervious Acre)	2020 Bridge Fee (per Impervious Acre)
Drainage Basins with DBPS's:					
CHMS0200	Chico Creek	2013	Haegler Ranch	$10,737	$1,585
CHWS1200	Chico Creek	2001	Bennett Ranch	$12,020	$4,611
CHWS1400	Chico Creek	2013	Falcon	$30,807	$4,232
FOFO2000	Fountain Creek	2001	West Fork Jimmy Camp Creek	$13,066	$3,866
FOFO2600	Fountain Creek	1991*	Big Johnson / Crews Gulch	$19,084	$2,464
FOFO2800	Fountain Creek	1988*	Widefield	$19,084	$0
FOFO2900	Fountain Creek	1988*	Security	$19,084	$0
FOFO3000	Fountain Creek	1991*	Windmill Gulch	$19,084	$286
FOFO3100 / FOFO3200	Fountain Creek	1988*	Carson Street / Little Johnson	$11,640	$0
FOFO3400	Fountain Creek	1984*	Peterson Field	$13,764	$1,044
FOFO3600	Fountain Creek	1991*	Fisher's Canyon	$19,084	$0
FOFO4000	Fountain Creek	1996	Sand Creek	$19,698	$8,057
FOFO4200	Fountain Creek	1977	Spring Creek	$9,897	$0
FOFO4600	Fountain Creek	1984*	Southwest Area	$19,084	$0
FOFO4800	Fountain Creek	1991	Bear Creek	$19,084	$1,044
FOFO5400	Fountain Creek	1977	21st Street	$5,742	$0
FOFO5600	Fountain Creek	1964	19th Street	$3,756	$0
FOFO5800	Fountain Creek	1964	Camp Creek	$2,115	$0
FOMO0400	Monument Creek	1986*	Mesa	$9,982	$0
FOMO1000	Monument Creek	1981	Douglas Creek	$12,001	$265
FOMO1200	Monument Creek	1977	Templeton Gap	$12,320	$286
FOMO1400	Monument Creek	1976	Pope's Bluff	$3,823	$652
FOMO1600	Monument Creek	1976	South Rockrimmon	$4,486	$0
FOMO1800	Monument Creek	1973	North Rockrimmon	$5,742	$0
FOMO2000	Monument Creek	1971	Pulpit Rock	$6,328	$0
FOMO2200	Monument Creek	1994	Cottonwood Creek / S. Pine	$19,084	$1,044
FOMO2400	Monument Creek	1966	Dry Creek	$15,065	$545
FOMO3600	Monument Creek	1989*	Black Squirrel Creek	$8,664	$545
FOMO3700	Monument Creek	1987*	Middle Tributary	$15,925	$0
FOMO3800	Monument Creek	1987*	Monument Branch	$19,084	$0
FOMO4000	Monument Creek	1996	Smith Creek	$7,780	$1,044
FOMO4200	Monument Creek	1989*	Black Forest	$19,084	$520
FOMO5200	Monument Creek	1993*	Dirty Woman Creek	$19,084	$1,044
FOMO5300	Fountain Creek	1993*	Crystal Creek	$19,084	$1,044
Miscellaneous Drainage Basins: [1]					
CHBS0800	Chico Creek		Book Ranch	$17,906	$2,592
CHEC0400	Chico Creek		Upper East Chico	$9,755	$283
CHWS0200	Chico Creek		Telephone Exchange	$10,718	$251
CHWS0400	Chico Creek		Livestock Company	$17,655	$210
CHWS0600	Chico Creek		West Squirrel	$9,203	$3,819
CHWS0800	Chico Creek		Solberg Ranch	$19,084	$0
FOFO1200	Fountain Creek		Crooked Canyon	$5,761	$0
FOFO1400	Fountain Creek		Calhan Reservoir	$4,810	$280
FOFO1600	Fountain Creek		Sand Canyon	$3,475	$0
FOFO2000	Fountain Creek		Jimmy Camp Creek[3]	$19,084	$893
FOFO2200	Fountain Creek		Fort Carson	$15,065	$545
FOFO2700	Fountain Creek		West Little Johnson	$1,257	$0
FOFO3800	Fountain Creek		Stratton	$9,154	$409
FOFO5000	Fountain Creek		Midland	$15,065	$545
FOFO6000	Fountain Creek		Palmer Trail	$15,065	$545
FOFO6800	Fountain Creek		Black Canyon	$15,065	$545
FOMO4600	Monument Creek		Beaver Creek	$11,409	$0
FOMO3000	Monument Creek		Kettle Creek	$10,305	$0
FOMO3400	Monument Creek		Elkhorn	$1,731	$0
FOMO5000	Monument Creek		Monument Rock	$8,272	$0
FOMO5400	Monument Creek		Palmer Lake	$13,226	$0
FOMO5600	Monument Creek		Raspberry Mountain	$4,449	$0
PLPL0200	Monument Creek		Bald Mountain	$9,481	$0
Interim Drainage Basins: [2]					
FOFO1800	Fountain Creek		Little Fountain Creek	$2,440	$0
FOMO4400	Monument Creek		Jackson Creek	$7,554	$0
FOMO4800	Monument Creek		Teachout Creek	$5,245	$788

1. The miscellaneous drainage fee previous to September 1999 resolution was the average of all drainage fees for basins with Basin Planning Studies performed within the last 14 years.

2. Interim Drainage Fees are based upon draft Drainage Basin Planning Studies or the Drainage Basin Identification and Fee Estimation Report. (Best available information suitable for setting a fee.)

3. This is an interim fee and will be adjusted when a DBPS is completed. In addition to the Drainage Fee a surety in the amount of $7,285 per impervious acre shall be provided to secure payment of additional fees in the event that the DBPS results in a fee greater than the current fee. Fees paid in excess of the future revised fee will be reimbursed. See Resolution 06-326 (9/14/06) and Resolution 16-320 (9/07/16).

EPC Stormwater Management

Jennifer Irvine, P.E.

ARTICLES OF INCORPORATION
OF
THE GRANDWOOD RANCH HOMEOWNERS ASSOCIATION, INC.

The undersigned person acting as incorporator, registered agent, and person filing these Articles of Incorporation under the Colorado Revised Nonprofit Corporation Act (the "Nonprofit Act"), hereby signs and acknowledges the following Articles of Incorporation for the following Corporation:

ARTICLE I

Name

The name of this Corporation shall be THE GRANDWOOD RANCH HOMEOWNERS ASSOCIATION, INC.

ARTICLE II

Duration

The term of existence of this Corporation is perpetual.

ARTICLE III

Purposes

The business, objects and purposes for which the Corporation is formed are as follows:

1. To be and constitute the "Association" to which reference is made in the Declaration of Covenants, Conditions, Restrictions and Easements for Grandwood Ranch Subdivision, and any amendment or supplement thereto (hereinafter called the "Covenants" and the definitions and provisions thereof are incorporated herein by this reference as if set forth at length) which has been or will be recorded in the records of the Clerk and Recorder of the County of El Paso, Colorado, and to perform all obligations and duties of the Association and to exercise all rights and powers of the Association. The Covenants consist of beneficial property restrictions which are mutually enforceable by all Owners within the Subdivision. The Association's governing documents (hereinafter called the "Association Documents") shall consist of the Association's Covenants, these Articles of Incorporation, the Bylaws and the Rules. Any terms used in these Articles of Incorporation shall have the same meaning as set forth in the Covenants.

2. To provide an entity for the furtherance of the interests of all of the Owners, including the Declarant named in the Covenants, of Lots with the objectives of establishing and maintaining the Grandwood Ranch Subdivision (the "Subdivision"), as a project of substantial quality and value; enhancing and protecting its value, desirability and attractiveness; promoting the

health and welfare of the residents of said Subdivision and providing for any other purposes as set forth in the Covenants, including any maintenance, preservation, and architectural control of the Lots and any property owned by the Association within said Subdivision.

3. To perform any governmental requirements, including any requirements related to the Detention Basin Agreement, any water augmentation plan, or other planning or zoning requirements of El Paso County, to the extent applicable.

ARTICLE IV

Powers

In furtherance of its purposes, this Corporation shall have all of the powers conferred upon non-profit corporations by the statutes and common law of the State of Colorado in effect from time to time, shall have all rights and powers conferred upon owners' associations by Colorado laws and statutes as now or hereafter enacted, provided however, the Corporation, the Subdivision and the Owners shall not be subject to the Colorado Common Interest Ownership Act (C.R.S. §38-33.3-101 et seq. "CCIOA") as provided by C.R.S. §38-33.3-116. The Corporation shall have all of the powers necessary or desirable to perform the obligations and duties and exercise the rights and powers of the Association under the Covenants which shall include the following, which shall be subject to the limitations, requirements, restrictions and provisions of the Covenants and the Association's Bylaws:

(a) To fix, levy, collect and enforce payment by any lawful means, all charges, fines, other sums, or assessments pursuant to the terms of the Covenants, and by law and statute; to pay all expenses in connection therewith and all other expenses incident to the conduct of the business of the Association, including all licenses, taxes or governmental charges levied or imposed against the Association or its property, and including any expenses related to the Common Area, the Water Decree, the Development Plan and any other governmental requirements set forth in the Covenants;

(b) To acquire (by gift, purchase or otherwise), own, hold, improve, build upon, operate, maintain, convey, sell, lease, transfer, dedicate for public use or otherwise dispose of real or personal property in connection with the affairs of the Association;

(c) To borrow money, mortgage, pledge, deed in trust, or hypothecate any or all of its real or personal property as security for money borrowed or debts incurred;

(d) To dedicate, convey, sell or transfer all or any part of any common real or personal property owned by the Association;

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(e) To participate in mergers and consolidations with other non-profit corporations organized for the same purposes;

(f) To manage, control, operate, maintain, repair and improve any property owned by the Association;

(g) To enforce the covenants, restrictions and conditions contained in the Association Documents as provided therein and to have all rights, powers, duties, and interests of the Association under the Association Documents;

(h) To engage in activities which will foster, promote and advance the common interests of Owners of Lots, including the interest of the Declarant during its marketing of the Subdivision;

(i) To fulfill any obligations of the Association under the Water Decree, as described in Exhibit "C" to the Covenants, including the augmentation plan, and obligations under any Detention Basin Agreement and the Development Plan or any other governmental plan or requirements set forth in the Covenants;

(j) To enter into, make, perform or enforce contracts of every kind and description and to do all other acts necessary, appropriate or advisable in carrying out any purposes of this Association, with or in association with any person, firm, association, corporation or other entity or agency, public or private, subject to the requirements of the Covenants; and

(k) To adopt, alter and amend or repeal such Bylaws and Rules as may be necessary or desirable for the proper management of the affairs of the Association.

ARTICLE V

Non-Liability and Indemnity of Officers and Directors

1. No Officer or Director of the Corporation shall be personally liable to the Corporation or to its Members for monetary damages for breach of fiduciary duty as a Director to the fullest extent of the Nonprofit Act, including C.R.S. §7-128-402, or other law or statute. If the Nonprofit Act hereafter is amended to further eliminate or limit the liability of an Officer or Director, then such Officer or Director shall not be liable to the fullest extent permitted by the amended Nonprofit Act, in addition to the other provisions of these Articles of Incorporation. No Officer or Director shall be liable to any creditor of the Corporation, including as provided by C.R.S. §7-128-401(5).

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2. No Officer or Director of the Corporation shall be personally liable for any contract or claim against the Corporation nor for any injury to person or property arising out of a tort committed by such person unless such Officer or Director committed a criminal offense or committed a wanton and willful wrongful act or omission. The protections afforded by these Articles shall not restrict other common law and statutory protections and rights that such Officer or Director may have and shall not reduce or impair any insurance coverage of such persons.

3. Unless otherwise specifically provided herein, or in the Nonprofit Act, or the Covenants, no Officer or Director shall be held liable for actions taken or omissions made in the performance of his or her duties as an Officer or Director except for gross negligence or wanton and willful wrongful acts or omissions.

4. A Director or Officer is not liable as such to the Corporation or its Members for any action taken or omitted to be taken as a Director or Officer in the performance of the duties of such position in compliance with C.R.S. §7-128-401(2).

5. The Corporation may purchase and maintain insurance on behalf of any person who is or was a Director, Officer, employee, fiduciary, or agent of the Corporation against any liability asserted against or incurred by him or her in any such capacity or arising out of his or her status as such, whether or not the Corporation would have the power to indemnify him or her against such liability under the Nonprofit Act or the Covenants or otherwise.

6. Each Officer and Director of the Corporation, before, now or hereinafter serving in any such capacity, shall be indemnified by the Corporation against any and all claims and liabilities to which he or she has or shall become subject by reason of serving or having served in any such capacity, or by reason of any action alleged to have been taken, omitted, or neglected by him or her in any such capacity, to the fullest extent allowable by law and statute, including the Nonprofit Act. The right of indemnification herein provided shall not be exclusive of any rights to which any Director or Officer of the Corporation may otherwise be entitled by law or statute, provided however, this indemnification shall not reduce or impair any insurance coverage of the Corporation, nor any Officer, Director, or any other person described in this Article.

7. Notwithstanding any provision hereof, each Officer, Director, and committee person shall be considered to be volunteers under C.R.S. §13-21-115.5, 13-21-115.7 and 13-21-116 (and any related Colorado or Federal statutes) and individuals serving as Officers, Directors and/or committee members shall, to the fullest extent permitted by such statutes, be protected from personal liability and indemnified by the Association.

8. Any repeal or modification of any of the foregoing paragraphs shall not adversely affect any right or protection of a Director, Officer, nor any other person described in this Article existing on or before such repeal or modification.

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ARTICLE VI

Conflicts of Interest

No contract, transaction, or other financial relationship shall be void or voidable or be enjoined, set aside, or give rise to an award of damages or other sanctions in a proceeding by a Member of the Corporation or by or in the right of the Corporation, solely because of any conflicting interest so long as the contract, transaction, or other financial relationship complies with the Nonprofit Act, including C.R.S. §7-128-501. Common or interested Directors may be counted in determining the presence of a quorum at a meeting of the Board of Directors or of a committee which authorizes, approves or ratifies such contract or transaction.

ARTICLE VII

Membership

1. This Corporation shall be a membership corporation without certificates or shares of stock. As more fully provided in the Covenants and the Bylaws, every person or entity, who is a record owner of a fee or undivided fee interest in any Lot which is subject to the Covenants, including contract sellers, shall be a voting Member of the Corporation, but subject to the provisions of the Association Documents. The foregoing is not intended to include persons or entities who hold an interest merely as security for the performance of an obligation.

2. A membership in this Corporation and the share of a Member in the assets of this Corporation shall not be assigned, encumbered or transferred in any manner except as appurtenant to the transfer of title to the Lot to which the membership pertains; provided, however, that the rights of membership may be assigned to the holder of a mortgage, deed of trust or other security instrument on a Lot as further security for a loan secured by a lien on such Lot; foreclosure of a membership interest shall not be considered a purchase of such interest under C.R.S. §7-126-303.

3. A transfer of membership shall occur automatically upon the transfer of title to the Lot to which the membership pertains; provided however, that the Bylaws of this Corporation may contain reasonable provisions and requirements with respect to recording such transfers on the books and records of this Corporation.

4. Members shall have the right to purchase other Lots and to exercise the membership rights appurtenant thereto as provided in the Covenants.

5. This Corporation may suspend the voting rights of a Member for failure to comply with the Covenants, Bylaws or Rules of the Corporation or with any other obligations of the

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Owners of a Lot under the Covenants. All Members who are in good standing shall be entitled to vote on all matters, except any Members who are in default in any obligations to the Corporation, which default shall also subject them to the remedies set forth in the Covenants, or as provided by law or statute. Cumulative voting is prohibited.

6. The Bylaws may contain additional provisions setting forth the rights, privileges, duties and responsibilities of the Members; provided however, the provisions of these Articles of Incorporation and the Bylaws shall be subject to the covenants, terms and provisions of the Covenants which shall control in the event of any conflict, and the provisions of these Articles of Incorporation shall control over any conflicting provisions in the Bylaws.

ARTICLE VIII

Voting Rights

1. During the Period of Declarant Rights, the Declarant shall have all voting and other membership rights in the Association. During the Period of Declarant Rights, the Declarant or Persons appointed by the Declarant may appoint all Officers and members of the Board of Directors, and may remove all Officers and members of the Board of Directors which have been appointed by the Declarant. The Declarant may voluntarily surrender in writing the right to appoint and remove all or a portion of the Officers and members of the Board of Directors before termination of the Period of Declarant Rights; but, in that event, the Declarant may require, for the duration of the Period of Declarant Rights, that specified actions of the Association or Board of Directors, as described in a recorded instrument executed by the Declarant, be approved by the Declarant before they become effective.

2. After the termination of the Period of Declarant Rights, but subject to the provisions of the Covenants and Bylaws, each Lot shall have one (1) vote as set forth in the Covenants, and the affirmative vote of a majority of Members, present at any meeting in person or by proxy, shall be required for decisions and action by the Corporation, unless otherwise provided herein or in the Association's Covenants or Bylaws. If only one of the multiple Owners of a Lot is present at a meeting of the Corporation, such Owner is entitled to cast the vote allocated to that Lot. Alternatively, if more than one person holds an interest in a Lot, they may appoint one of their co-owners as proxy to cast the vote for that Lot. The vote for such Lot shall be cast as the Owners holding a majority interest in thereof agree, but in no event shall they cast more than one vote for that Lot on any one question. If such Owners of such Lot cannot agree as to the manner in which their vote shall be cast when called upon to vote, then they will be treated as having abstained; during any such period, each Owner shall retain all other rights and obligations of membership in the Corporation.

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3. The Bylaws may contain additional provisions regarding the voting rights of Members.

ARTICLE IX

Board of Directors

1. The business and affairs of the Corporation shall be conducted, managed and controlled by a Board of Directors. The initial Board of Directors shall consist of three (3) Directors, and thereafter the specific number shall be set forth as provided in the Bylaws of the Corporation. As set forth in the Covenants, the Declarant shall have the right to appoint the Board as set forth therein. Except for Directors appointed by the Declarant, Directors shall be Owners as defined in the Covenants and must be Members in good standing. The Declarant may, until January 1, 2040, appoint or remove any member of the Board of Directors of the Association. Following the termination of the Declarant's right to appoint the Board, the Owners shall elect the Board of Directors as provided in the Covenants, the Articles of Incorporation and the Bylaws.

2. The initial Board of Directors shall be appointed and removed by the Declarant and shall serve until their successors are duly elected and qualified.

3. Directors shall be elected, replaced and removed and vacancies of the Board of Directors shall be filled in the manner and for the terms as provided in these Articles of Incorporation and the Bylaws.

4. As set forth above, Directors shall have no liability to the Corporation or its Members for monetary damages for breach of any duty as a Director except as otherwise provided by law or statute. The Corporation shall indemnify its Directors and other persons pursuant to C.R.S. §7-22-101.5 and its Bylaws, but such indemnity shall not affect, impair, or reduce insurance coverage of its Directors and other persons.

ARTICLE X

Officers

The Board of Directors may appoint a President, one or more Vice-Presidents, a Secretary, a Treasurer and such other officers as the Board believes will be in the best interest of the Corporation. The Officers shall have such duties as may be prescribed in the Bylaws of the Corporation and shall serve at the pleasure of the Board of Directors.

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ARTICLE XI

Dissolution, Merger or Consolidation

The Corporation may be dissolved, merged or consolidated as provided by the Nonprofit Act but subject to the Covenants. Upon dissolution of the Corporation other than incident to a merger or consolidation, the assets of the Corporation shall be distributed and transferred as the Members may direct, subject to the requirements, limitations and other provisions of the Covenants. In such event, the assets may be granted, conveyed and assigned to any public agency, non-profit corporation, association, trust or other organization to be devoted to purposes similar to those for which this Corporation was created.

ARTICLE XII

Initial Registered Office, Agent and Address

The street address of the initial registered office of the Corporation shall be 270 Lodge Pole Way, Monument, CO 80132. The initial registered agent shall be Bill Herebic, whose street address is the same as the initial registered office and whose consent is shown by his signature of these Articles of Incorporation. The address of the Corporation's initial principal office is the same as its initial registered office.

ARTICLE XIII

Amendment

These Articles of Incorporation may be amended by the Members at a regular or special meeting, with a quorum present, by a vote of at least sixty-seven percent (67%) of the Members voting (one vote per Lot) who are present in person or by proxy, provided however, notwithstanding the foregoing, any amendment of these Articles of Incorporation shall require the prior written approval of the Declarant during the Period of Declarant Rights and furthermore, the Declarant reserves the following rights, until January 1, 2040 but without the vote of the Owners, to make amendments to these Articles of Incorporation: (i) as may be necessary or desirable to implement the Declarant's rights or privileges under the Association Documents or otherwise in the Declarant's sole discretion; (ii) to correct typographical errors or make clarifications in these Articles of Incorporation; or (iii) as may be approved in writing by Federal National Mortgage Association, Federal Home Loan Mortgage Corporation, Federal Housing Administration or Department of Veterans Affairs, so as to induce any of such lenders or secondary lending entity to make, purchase, sell, issue, or guarantee First Mortgages in the Subdivision, and each Owner, by accepting a deed, mortgage or other instrument affecting a Lot appoints Declarant as his or her attorney-in-fact for purposes of executing in said Owner's name and filing or recording any such

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amendments to these Articles of Incorporation, the Covenants and the Bylaws, and each deed, mortgage, trust deed, other evidence of obligation or other instrument affecting a Lot and the acceptance thereof shall be deemed to be a grant and acknowledgment of and a consent to the reservation of the power to the Declarant to make, execute and record any such amendments. The Secretary shall retain all ballots for at least one year after approval. Any legal action or other challenge to any amendment shall be barred if not filed in the El Paso County District Court within one (1) year of the date on which the amendment was approved. The Association's President is authorized to certify that the amendment has been duly approved; filing or recording of the ballots is not required. Upon such certification, the amendment shall be deemed to be duly adopted, fully valid and fully enforceable.

Notwithstanding the above, any provisions regarding the obligations of the Declarant, the Association and the Lot Owners with respect to the Development Plan or the Water Decree or the Detention Basin Agreement shall not be terminated except by written agreement of the Board of County Commissioners of El Paso County, Colorado, or except as otherwise provided in said documents.

ARTICLE XIV

Nonprofit Purposes

This Corporation is formed under the Nonprofit Act and not for pecuniary profit or financial gain. The Corporation is organized and operated to provide for the acquisition, construction, management, maintenance and care of property of the Subdivision as provided in the Association Documents.

ARTICLE XV

Incorporator and Filer

The incorporator of the Corporation and person filing this document is Bill Herebic, whose street address is 270 Lodge Pole Way, Monument, CO 80132.

ARTICLE XVI

Exemption from CCIOA

The Corporation and the Subdivision shall be exempt from the provisions of the CCIOA (C.R.S. §38-33.3-101, et seq.) pursuant to the provisions of C.R.S. §38-33.3-116 which exempt planned communities from the provisions of CCIOA if the annual common expense assessments do not exceed Five Hundred Dollars ($500.00) per year. Notwithstanding this exemption, this

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Corporation and the Subdivision are subject to the provisions of C.R.S. §§ 38-33.3-105, 38-33.3-106 and 38-33.3-107 of CCIOA.

IN WITNESS WHEREOF, for the purposes of forming this Corporation under the laws of the State of Colorado, the undersigned, constituting the Incorporator and Registered Agent of this Corporation and person filing this document and to whom notice may be delivered, has executed these Articles of Incorporation on the date shown below. The name and mailing address of the individual who caused this document to be delivered for filing, and to whom the Secretary of State may deliver notice if filing of this document is refused, is the above-named incorporator.

Dated: _____

_____
Bill Herebic
Address: 270 Lodge Pole Way
Monument, CO 80132

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FIRMETTE

39°5'44.21"N

104°50'38.03"W

39°3'38.39"N

104°48'14.54"W

USGS The National Map: Orthoimagery. Data refreshed October, 2017.

FLOOD HAZARD INFORMATION

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

SPECIAL FLOOD HAZARD AREAS

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

OTHER AREAS OF FLOOD HAZARD

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

OTHER AREAS

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

GENERAL STRUCTURES

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

OTHER FEATURES

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

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can beordered or obtained directly from the website.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Basemap information shown on this FIRM was provided in digital format by USDA, Farm Service Agency (FSA). This information was derived from NAIP, dated April 11, 2018.

This map was exported from FEMA's National Flood Hazard Layer (NFHL) on **3/8/2019 10:41:59 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. For additional information, please see the Flood Hazard Mapping Updates Overview Fact Sheet at https://www.fema.gov/media-library/assets/documents/118418

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

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.

SCALE

N

Map Projection:
GCS, Geodetic Reference System 1980;
Vertical Datum: NAVD88
For information about the specific vertical datum for elevation features, datum conversions, or vertical monuments used to create this map please see the Flood Insurance Study(FIS) Report for your community at https://msc.fema.gov

1 inch = 500 feet 1:6,000

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

0 50 100 200 300 400 Meters

FEMA

National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 279 OF 1275

Panel Contains:

COMMUNITY	NUMBER	PANEL
EL PASO COUNTY COLORADO	080059	0279
TOWN OF MONUMENT COLORADO	080064	0279

MAP NUMBER
08041C0279G
EFFECTIVE DATE
12/07/2018

USDA NRCS WEB SOIL SURVEY REPORT

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

El Paso County Area, Colorado

February 26, 2020

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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How Soil Surveys Are Made

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

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

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

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

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

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

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

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

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

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

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

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

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

Custom Soil Resource Report
Soil Map

Map Scale: 1:8,640 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 400 800 1600 2400

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 17, Sep 13, 2019

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

Date(s) aerial images were photographed: 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.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1	Alamosa loam, 1 to 3 percent slopes	10.1	6.4%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	91.6	57.5%
42	Kettle-Rock outcrop complex	0.0	0.0%
71	Pring coarse sandy loam, 3 to 8 percent slopes	33.4	20.9%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	24.2	15.2%
Totals for Area of Interest		**159.3**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

El Paso County Area, Colorado

1—Alamosa loam, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: 3670
Elevation: 7,200 to 7,700 feet
Farmland classification: Prime farmland if irrigated and reclaimed of excess salts and sodium

Map Unit Composition

Alamosa and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Alamosa

Setting

Landform: Flood plains, fans
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 6 inches: loam
Bt - 6 to 14 inches: clay loam
Btk - 14 to 33 inches: clay loam
Cg1 - 33 to 53 inches: sandy clay loam
Cg2 - 53 to 60 inches: sandy loam

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 12 to 18 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Very slightly saline to strongly saline (2.0 to 16.0 mmhos/cm)
Available water storage in profile: High (about 10.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: D
Ecological site: Mountain Meadow (R048AY241CO)
Hydric soil rating: Yes

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

41—Kettle gravelly loamy sand, 8 to 40 percent slopes

Map Unit Setting

National map unit symbol: 368h
Elevation: 7,000 to 7,700 feet
Farmland classification: Not prime farmland

Map Unit Composition

Kettle and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kettle

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium derived from arkose

Typical profile

E - 0 to 16 inches: gravelly loamy sand
Bt - 16 to 40 inches: gravelly sandy loam
C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 8 to 40 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:

Landform: Depressions
Hydric soil rating: Yes

42—Kettle-Rock outcrop complex

Map Unit Setting

National map unit symbol: 368j
Elevation: 6,800 to 7,700 feet
Frost-free period: 110 to 130 days
Farmland classification: Not prime farmland

Map Unit Composition

Kettle and similar soils: 60 percent
Rock outcrop: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kettle

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium derived from arkose

Typical profile

E - 0 to 16 inches: gravelly loamy sand
Bt - 16 to 40 inches: gravelly sandy loam
C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 8 to 40 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Hydric soil rating: No

Description of Rock Outcrop

Typical profile

R - 0 to 60 inches: unweathered bedrock

Properties and qualities

Slope: 8 to 60 percent
Depth to restrictive feature: 0 inches to lithic bedrock
Available water storage in profile: Very low (about 0.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

71—Pring coarse sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 369k
Elevation: 6,800 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Pring and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pring

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock

Typical profile

A - 0 to 14 inches: coarse sandy loam
C - 14 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained

Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 6.0 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: Loamy Park (R048AY222CO)
Hydric soil rating: No

Minor Components

Pleasant
Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Other soils
Percent of map unit:
Hydric soil rating: No

93—Tomah-Crowfoot complex, 8 to 15 percent slopes

Map Unit Setting
National map unit symbol: 36bb
Elevation: 7,300 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition
Tomah and similar soils: 50 percent
Crowfoot and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tomah

Setting
Landform: Alluvial fans, hills
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose and/or residuum weathered from arkose

Typical profile
A - 0 to 10 inches: loamy sand
E - 10 to 22 inches: coarse sand

C - 48 to 60 inches: coarse sand

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Description of Crowfoot

Setting

Landform: Alluvial fans, hills
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 12 inches: loamy sand
E - 12 to 23 inches: sand
Bt - 23 to 36 inches: sandy clay loam
C - 36 to 60 inches: coarse sand

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

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

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Physical Properties

Soil Physical Properties are measured or inferred from direct observations in the field or laboratory. Examples of soil physical properties include percent clay, organic matter, saturated hydraulic conductivity, available water capacity, and bulk density.

Saturated Hydraulic Conductivity (Ksat)

Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity is considered in the design of soil drainage systems and septic tank absorption fields.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

The numeric Ksat values have been grouped according to standard Ksat class limits.

Custom Soil Resource Report
Map—Saturated Hydraulic Conductivity (Ksat)

Map Scale: 1:8,640 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 400 800 1600 2400

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

<= 9.0000

> 9.0000 and <= 28.0000

> 28.0000 and <= 92.0000

Not rated or not available

Soil Rating Lines

<= 9.0000

> 9.0000 and <= 28.0000

> 28.0000 and <= 92.0000

Not rated or not available

Soil Rating Points

<= 9.0000

> 9.0000 and <= 28.0000

> 28.0000 and <= 92.0000

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)

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 17, Sep 13, 2019

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

Date(s) aerial images were photographed: 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.

Table—Saturated Hydraulic Conductivity (Ksat)

Map unit symbol	Map unit name	Rating (micrometers per second)	Acres in AOI	Percent of AOI
1	Alamosa loam, 1 to 3 percent slopes	9.0000	10.1	6.4%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	92.0000	91.6	57.5%
42	Kettle-Rock outcrop complex	92.0000	0.0	0.0%
71	Pring coarse sandy loam, 3 to 8 percent slopes	28.0000	33.4	20.9%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	92.0000	24.2	15.2%
Totals for Area of Interest			**159.3**	**100.0%**

Rating Options—Saturated Hydraulic Conductivity (Ksat)

Units of Measure: micrometers per second

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Fastest

Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Drainage Class

"Drainage class (natural)" refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized-excessively drained,

somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained. These classes are defined in the "Soil Survey Manual."

Map—Drainage Class

Map Scale: 1:8,640 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 400 800 1600 2400

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

Excessively drained

Somewhat excessively drained

Well drained

Moderately well drained

Somewhat poorly drained

Poorly drained

Very poorly drained

Subaqueous

Not rated or not available

Soil Rating Lines

Excessively drained

Somewhat excessively drained

Well drained

Moderately well drained

Somewhat poorly drained

Poorly drained

Very poorly drained

Subaqueous

Not rated or not available

Soil Rating Points

Excessively drained

Somewhat excessively drained

Well drained

Moderately well drained

Somewhat poorly drained

Poorly drained

Very poorly drained

Subaqueous

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 17, Sep 13, 2019

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

Date(s) aerial images were photographed: 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.

Table—Drainage Class

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Alamosa loam, 1 to 3 percent slopes	Poorly drained	10.1	6.4%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	Somewhat excessively drained	91.6	57.5%
42	Kettle-Rock outcrop complex	Somewhat excessively drained	0.0	0.0%
71	Pring coarse sandy loam, 3 to 8 percent slopes	Well drained	33.4	20.9%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	Well drained	24.2	15.2%
Totals for Area of Interest			**159.3**	**100.0%**

Rating Options—Drainage Class

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Hydrologic Soil Group

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.

Map Scale: 1:8,640 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 400 800 1600 2400

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 17, Sep 13, 2019

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

Date(s) aerial images were photographed: 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.

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Alamosa loam, 1 to 3 percent slopes	D	10.1	6.4%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	B	91.6	57.5%
42	Kettle-Rock outcrop complex	B	0.0	0.0%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	33.4	20.9%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	B	24.2	15.2%
Totals for Area of Interest			**159.3**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

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APPENDIX D

MAPS

Vicinity Map

Grandwood Ranch Subdivision

ASSESSOR

El Paso County
Colorado

N

December 30, 2019

SCALE OF FEET

0 100 200 400 600 800

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Sub Basins - West				
Sub-Basin	Area (mi2)	Area (Acres)	Q5 (cfs)	Q100 (cfs)
EX-2A	0.022	14.36	5.7	14.6
EX-2B	0.053	34.14	0.6	5.8
EX-2C1	0.021	13.28	5.2	13.1
EX-2C2	0.052	33.24	0.2	3.9
EX-2C3	0.01	6.04	0.1	1.0
EX-2D	0.034	21.51	8.7	20.8
EX-2D1	0.0225	14.40	11.2	19.3
EX-2D2	0.0198	12.65	5.2	13.2
EX-2D3	0.0256	16.40	6.2	15.9
EX-2E	0.019	12.37	5.3	13.4
EX-2F	0.031	19.74	6.3	16.1
EX-2G	0.019	12.42	4.5	11.5
EX-2H	0.049	31.60	11.5	29.2
EX-2I	0.021	13.29	4.8	12.3
EX-2J	0.076	48.38	16.5	42.0
EX-3	0.0302	19.40	3.7	12.1
EX-3A	0.0634	40.57	14.9	37.8

Sub Basins - East					
Sub-Basin	HMS Names	Area (mi2)	Area (Acres)	Q5 (cfs)	Q100 (cfs)
EX-1A	EX-1A	0.126	82.1	10.4	26.8
EX-1B	Basin EX-1B	0.0126	8.0	1.7	5.2
EX-1C	Basin EX-1C	0.0091	5.8	2.3	6.0
EX-1D	Basin EX-1D	0.039	24.7	9.6	24.5
EX-1E	Basin EX-1E	0.0579	37.0	13	33.2
EX-1F	Basin EX-1F	0.082	52.7	16.6	42.7
EX-1G	Basin EX-1G	0.0977	62.5	20.9	53.2

Sub Basins - Central				
Sub-Basin	Area (mi2)	Area (Acres)	Q5 (cfs)	Q100 (cfs)
EX-4	0.01	8.2	2.8	11.8

Design Point	Name in HMS	Sub-Basins	Downstream Design Point	Total Area (MI2)	Total Area (AC)	Q5 (cfs)	Q100 (cfs)
1	Reservoir OS-1	EX-3A	EX-3	0.0634	40.6	13.3	29.1
2	Junction EX-2D	EX-2D1, EX-2D2, EX-2D	3a	0.0763	48.8	21.9	45.6
3	Upper Junction	EX-2E, EX-2F, EX-2G, EX-2H, EX-2I, EX-2J	3a	0.215	137.6	44.9	114.3
3a	DP 3a	EX-3A, EX-2D1, EX-2D2, EX-2D, EX-2E, EX-2F, EX-2G, EX-2H, EX-2I, EX-2J	EX-2	0.3547	227.0	55.3	136.6
4	Design Point 4	Design Point 5, EX-1B, EX-1C	EX-1	0.2983	190.9	45.6	130.7
5	Reservoir OS-5	Design Point 6	4	0.2766	177.0	44.9	128.9
6	Inflow OS-5	EX-1D, EX-1E, EX-1F, EX-1G	5	0.2766	177.0	53.1	135.7
EX-1	Sink EX-1	Design Point 4, EX-3	15" CMP	0.4233	270.9	47.3	136.6
EX-2	Sink EX-2	EX-2A, EX-2B, Design Point 2, EX-2D3, Design Point 3, EX-2C1, EX-2C2, EX-2C3	Existing 30" x 42" CMP (Horizontal Elliptical)	0.4749	303.9	56.4	145.5
EX-3	Sink EX-3	Design Point 1, EX-3	Existing 48" CMP	0.0936	59.9	10.6	34.0

LEGEND

DESIGN POINT IDENTIFIER — 1

BASIN IDENTIFICATION — BASIN

BASIN FLOWS — Q5 Q100

BASIN AREA — AREA

BASIN BOUNDARY

FLOW PATH

EXISTING CONTOURS — 7310

N

GRAPHIC SCALE

250 0 125 250 500

(IN FEET)
1 inch = 250 ft.

EL PASO COUNTY, CO

PRELIMINARY DRAINAGE REPORT

GRANDWOOD RANCH
PRE DEVELOPMENT CONDITIONS

DESIGNED BY: TM/JTS
DRAWN BY: TM
CHECKED BY: JTS

SCALE: HORIZ 1" = 250' VERT N/A

DATE ISSUED: JUNE 2025

SHEET 1 OF 4

DRAWING No. DR-01

SEAL

PRELIMINARY
THIS DRAWING HAS NOT BEEN APPROVED BY GOVERNING AGENCIES AND IS SUBJECT TO CHANGE

FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 20.1105.004

PREPARED BY: Matrix Excellence by Design

SHEET KEY

No.	DATE	DESCRIPTION	BY
####	####	####	####
####	####	####	####
####	####	####	####
####	####	####	####
####	####	####	####
####	####	####	####

REVISIONS

COMPUTER FILE MANAGEMENT
FILE NAME:
CAD FILE:
PLOT DATE:
THIS DRAWING IS CURRENT AS OF PLOT DATE AND MAY BE SUBJECT TO CHANGE

REFERENCE DRAWINGS
X:\Projects\#### ####\
X:\1105-EX SITE RESIGN
HIGBY RACE DRIVE\CAD\

Sub Basins - West			
Sub-Basin	Area (Acres)	Q5 (cfs)	Q100 (cfs)
OS-1	40.6	14.9	37.8
OS-2A	14.4	5.7	14.6
OS-2B	6.4	5.5	14.0
Basin OS-3A	14.4	5.5	14.0
Basin OS-3B	21.5	11.0	26.4
Basin OS-3C	12.7	5.2	13.2
Basin OS-4A	16.4	6.2	15.9
Basin OS-4B	12.4	5.3	13.4
Basin OS-4C	19.7	6.3	16.1
Basin OS-4D	12.4	4.5	11.5
Basin OS-4E	31.6	11.5	29.2
Basin OS-4F	13.3	4.8	12.3
Basin OS-4G	48.4	16.5	42.0
Basin OS-4H	13.3	5.2	13.1
W-1	19.3	7.0	17.4
W-2	3.1	0.2	1.2
W-3	7.3	3.0	7.6
W-4	3.9	1.3	3.3
W-5	9.3	2.1	5.4
W-6	1.8	0.8	2.1
W-7	16.4	6.3	15.8
W-8	2.5	1.0	2.7
W-9	2.0	0.7	1.7
D-1	10.8	6.7	15.1
D-2	8.2	4.5	9.5

Sub Basins - East			
Sub-Basin	Area (Acres)	Q5 (cfs)	Q100 (cfs)
Basin OS-5	15.6	4.2	10.6
Basin OS-6A	24.7	9.5	24.3
Basin OS-6B	37.0	13.0	33.2
Basin OS-6C	52.7	16.8	42.7
Basin OS-6D	62.5	20.9	53.2
E-1	5.0	2.1	5.3
E-2	7.5	3.1	7.2
E-3	21.5	3.1	9.9
Basin E-4A	8.0	2.8	7.2
Basin E-4B	5.8	2.3	6.0
Basin D-3	20.1	4.5	14.2
Basin D-4A	4.4	1.3	3.4
Basin D-4B	6.6	2.7	6.8

Sub Basins - Central			
Sub-Basin	Area (Acres)	Q5 (cfs)	Q100 (cfs)
W-10	8.2	3.6	12.7

Design Point	Name in HMS	Sub-Basins	Downstream Design Point	Total Area (AC)	Q5	Q100
1	Reservoir OS-1	OS-1	EX-3	40.6	13.3	29.1
2	Route Basin OS-3A	OS-3A, OS-3B, OS-3C	C-2	48.8	14.4	36
3	Upper Junction	OS-4B, OS-4C, OS-4D,OS-4E, OS-4F, OS-4G	C-2	137.6	44.9	114.3
4	Reservoir OS-5	OS-6A, OS-6B, OS-6C, OS-6D	5	177.0	44.9	128.8
5	OS-5 inflow	Design Point 4 (Offsite reservoir)	C-10	177.0	53.1	135.7
C-1	Junction C-1	OS-2A, OS-2B, W-3	C-3	33.2	9.5	23.9
C-2	Junction C-2	W-4, Design Point 2, OS-4A, Design Point 3, OS-4H, W-5	C-3	225.9	53.6	135.1
C-3	Junction C-3	W-8, Design Point C-1, Design Point C-2, W,6, W-7	EX-2	280.7	57.0	142.9
C-4		D-1	EX-2	12.8	6.7	15.1
C-5		D-1	EX-2	12.8	6.7	15.1
C-6		D-2	EX-2	6.4	4.5	9.5
C-7		W-9	EX-2	1.9	0.7	1.7
C-8		E-1	EX-3	13.2	2.1	5.3
C-9		Basin D-3	EX-3	19.2	4.5	14.2
C-10		OS-5, E-2	EX-3	22.5	7.3	17.8
C-11	C-10	E-4A, E-4B, Design Point 4	EX-3	191.0	45.7	130.9
C-12	Pond 4	D-4A, D-4B	EX-1	6.6	4.0	10.2
EX-1	Sink-1	E-1A, Pond 3, C-10	Existing 48" CMP	270.9	49.5	140.6
EX-2	Sink-2	W-2, Pond 1, Design Point C-3, Pond 2, W-9	Existing 30" x 42" CMP Proposed 19" x 30" HERCP (Horizontal Elliptical)	305.0	54.6	143.2
EX-3	Sink-3	Design Point 1, W-1	15" CMP	59.9	11.2	35.7
EX-4	Sink-4	UD-Detention: W-4	Existing 18" CMP	8.2	2.7	5.7

LEGEND

DESIGN POINT IDENTIFIER — L

BASIN IDENTIFICATION — BASIN

BASIN FLOWS — Q5 Q100

BASIN AREA — AREA

BASIN BOUNDARY

FLOW PATH

EXISTING CONTOURS — 7280

PROPOSED CONTOURS — 7300

EL PASO COUNTY, CO

PRELIMINARY DRAINAGE REPORT

GRANDWOOD RANCH
POST DEVELOPMENT CONDITIONS

DESIGNED BY: JTS/TM
DRAWN BY: TM
CHECKED BY: JTS

SCALE: HORIZ 1" = 250' VERT N/A
DATE ISSUED: JUNE 2020
SHEET 2 OF 4
DRAWING No. DR02

PRELIMINARY
THIS DRAWING HAS NOT BEEN APPROVED BY GOVERNING AGENCIES AND IS SUBJECT TO CHANGE

FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 20.1105.004

PREPARED BY: Matrix Excellence by Design

SEAL

SHEET KEY

No.	DATE	DESCRIPTION	BY
###	###	###	###
###	###	###	###
###	###	###	###
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###	###	###	###
###	###	###	###
###	###	###	###

REVISIONS

COMPUTER FILE MANAGEMENT
FILE NAME: S:\20.1105.004 Grandwood Ranch\200 Drainage\201 Drainage Reports\PDR\DWG\DR02.dwg
CTB FILE:
PLOT DATE: July 1, 2020 4:10:47 PM
THIS DRAWING IS CURRENT AS OF PLOT DATE AND MAY BE SUBJECT TO CHANGE.

REFERENCE DRAWINGS
X-1105-KX_BTE1_EX(XR)
X-1105(Drainage)

Sub Basins - West			
Sub-Basin	Area (Acres)	Q5 (cfs)	Q100 (cfs)
OS-1	40.6	14.9	37.8
OS-2A	14.4	5.7	14.6
OS-2B	6.4	5.5	14.0
Basin OS-3A	14.4	5.5	14.0
Basin OS-3B	21.5	11.0	26.4
Basin OS-3C	12.7	5.2	13.2
Basin OS-4A	16.4	6.2	15.9
Basin OS-4B	12.4	5.3	13.4
Basin OS-4C	19.7	6.3	16.1
Basin OS-4D	12.4	4.5	11.5
Basin OS-4E	31.6	11.5	29.2
Basin OS-4F	13.3	4.8	12.3
Basin OS-4G	48.4	16.5	42.0
Basin OS-4H	13.3	5.2	13.1
W-1	19.3	7.0	17.4
W-2	3.1	0.2	1.2
W-3	7.3	3.0	7.6
W-4	3.9	1.3	3.3
W-5	9.3	2.1	5.4
W-6	1.8	0.8	2.1
W-7	16.4	6.3	15.8
W-8	2.5	1.0	2.7
W-9	2.0	0.7	1.7
D-1	10.8	6.7	15.1
D-2	8.2	4.5	9.5

Sub Basins - East			
Sub-Basin	Area (Acres)	Q5 (cfs)	Q100 (cfs)
Basin OS-5	15.6	4.2	10.6
Basin OS-6A	24.7	9.5	24.3
Basin OS-6B	37.0	13.0	33.2
Basin OS-6C	52.7	16.8	42.7
Basin OS-6D	62.5	20.9	53.2
E-1	5.0	2.1	5.3
E-2	7.5	3.1	7.2
E-3	21.5	3.1	9.9
Basin E-4A	8.0	2.8	7.2
Basin E-4B	5.8	2.3	6.0
Basin D-3	20.1	4.5	14.2
Basin D-4A	4.4	1.3	3.4
Basin D-4B	6.6	2.7	6.8

Sub Basins - Central			
Sub-Basin	Area (Acres)	Q5 (cfs)	Q100 (cfs)
W-10	8.2	3.6	12.7

Design Point	Name in HMS	Sub-Basins	Downstream Design Point	Total Area (AC)	Q5	Q100
1	Reservoir OS-1	OS-1	EX-3	40.6	13.3	29.1
2	Route Basin OS-3A	OS-3A, OS-3B, OS-3C	C-2	48.8	14.4	36
3	Upper Junction	OS-4B, OS-4C, OS-4D,OS-4E, OS-4F, OS-4G	C-2	137.6	44.9	114.3
4	Reservoir OS-5	OS-6A, OS-6B, OS-6C, OS-6D	5	177.0	44.9	128.8
5	OS-5 inflow	Design Point 4 (Offsite reservoir)	C-10	177.0	53.1	135.7
C-1	Junction C-1	OS-2A, OS-2B, W-3	C-3	33.2	9.5	23.9
C-2	Junction C-2	W-4, Design Point 2, OS-4A, Design Point 3, OS-4H, W-5	C-3	225.9	53.6	135.1
C-3	Junction C-3	W-8, Design Point C-1, Design Point C-2, W,6, W-7	EX-2	280.7	57.0	142.9
C-4		D-1	EX-2	12.8	6.7	15.1
C-5		D-1	EX-2	12.8	6.7	15.1
C-6		D-2	EX-2	6.4	4.5	9.5
C-7		W-9	EX-2	1.9	0.7	1.7
C-8		E-1	EX-3	13.2	2.1	5.3
C-9		Basin D-3	EX-3	19.2	4.5	14.2
C-10		OS-5, E-2	EX-3	22.5	7.3	17.8
C-11	C-10	E-4A, E-4B, Design Point 4	EX-3	191.0	45.7	130.9
C-12	Pond 4	D-4A, D-4B	EX-1	6.6	4.0	10.2
EX-1	Sink-1	E-1A, Pond 3, C-10	Existing 48" CMP	270.9	49.5	140.6
EX-2	Sink-2	W-2, Pond 1, Design Point C-3, Pond 2, W-9	Existing 30" x 42" CMP Proposed 19" x 30" HERCP (Horizontal Elliptical)	305.0	54.6	143.2
EX-3	Sink-3	Design Point 1, W-1	15" CMP	59.9	11.2	35.7
EX-4	Sink-4	UD-Detention: W-4	Existing 18" CMP	8.2	2.7	5.7

Cross Road Culvert Sizing

Mannings n 0.013 (renforced concrete)
Min D 18 inches

Allowable Velocities in Culverts
Min v 3 fps
max V 18 fps

*Dam breach flow used

	Design Point	Peak Discharge (cfs)	Max Slope (%)	Culvert Diameter (ft)	Velocity (ft/s)	Stormwater Treatment	
West Basin	C-1	23.9	6	1.5	16.5	Bypass of Historic Flow	
	C-1	11.5	7.5	2	14.8	Treated Developed Flow	(Basin D-2)
	C-2	135.1	3.5	3	18	Bypass of Historic Flow	(2 culverts, 69 cfs each)
	C-3	142.9	135.1	3	18	Bypass of Historic Flow	(2 culverts, 72.8 cfs each)
	C-4	15.1	2	1.5	14.71	Treated Developed Flow	
	C-5	15.1	2	3	14.71	Treated Developed Flow	
	C-6	9.5	4.5	1.5	11.9	Treated Developed Flow	
	C-7	1.7	6.5	1.5	8.3	Bypass of Historic Flow	
	C-8	5.3	7	1.5	11.9	Bypass of Historic Flow	
East Basin	C-9	14.2	6.5	2	15	Treated Developed Flow	
	C-10	17.8	3.3	1.5	12.2	Bypass of Historic Flow	
	C-11	130.9	2.5	2.5	15	Bypass of Historic Flow	(2 culverts, 65.6 cfs each)
	C-12	10.2	10	1.5	14.75	Treated Developed Flow	

GRAPHIC SCALE
100' 0' 100' 200'
(IN FEET)
1 inch = 100 ft.

LEGEND
DESIGN POINT IDENTIFIER — L
BASIN IDENTIFICATION — BASIN
BASIN FLOWS — Q5 Q100
BASIN AREA — AREA
BASIN BOUNDARY
FLOW PATH
EXISTING CONTOURS — 7280
PROPOSED CONTOURS — 7300

EL PASO COUNTY, CO

PRELIMINARY DRAINAGE REPORT

GRANDWOOD RANCH
POST DEVELOPMENT CONDITIONS

DESIGNED BY: ITS/TM
DRAWN BY: TM
CHECKED BY: JTS

SCALE: HORIZ 1" = 200' VERT N/A
DATE ISSUED: JUNE 2020
SHEET: 3 OF 4
DRAWING No. DR03

SEAL

PRELIMINARY
THIS DRAWING HAS NOT BEEN APPROVED BY GOVERNING AGENCIES AND IS SUBJECT TO CHANGE

FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 20.1105.004

PREPARED BY: Matrix Excellence by Design

SHEET KEY

No.	DATE	DESCRIPTION	BY
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REVISIONS

COMPUTER FILE MANAGEMENT
FILE NAME: S:\20.1105.004 Grandwood Ranch\200 Drainage\201 Drainage Reports\PDR\DWG\DR03-DR04.dwg
PLOT DATE: July 1, 2020 5:11:10 PM
THIS DRAWING IS CURRENT AS OF PLOT DATE AND MAY BE SUBJECT TO CHANGE

REFERENCE DRAWINGS
X:\100-AKA SITE FOLDER
X:\Files\Drainage\

Sub Basins - West			
Sub-Basin	Area (Acres)	Q5 (cfs)	Q100 (cfs)
OS-1	40.6	14.9	37.8
OS-2A	14.4	5.7	14.6
OS-2B	6.4	5.5	14.0
Basin OS-3A	14.4	5.5	14.0
Basin OS-3B	21.5	11.0	26.4
Basin OS-3C	12.7	5.2	13.2
Basin OS-4A	16.4	6.2	15.9
Basin OS-4B	12.4	5.3	13.4
Basin OS-4C	19.7	6.3	16.1
Basin OS-4D	12.4	4.5	11.5
Basin OS-4E	31.6	11.5	29.2
Basin OS-4F	13.3	4.8	12.3
Basin OS-4G	48.4	16.5	42.0
Basin OS-4H	13.3	5.2	13.1
W-1	19.3	7.0	17.4
W-2	3.1	0.2	1.2
W-3	7.3	3.0	7.6
W-4	3.9	1.3	3.3
W-5	9.3	2.1	5.4
W-6	1.8	0.8	2.1
W-7	16.4	6.3	15.8
W-8	2.5	1.0	2.7
W-9	2.0	0.7	1.7
D-1	10.8	6.7	15.1
D-2	8.2	4.5	9.5

Sub Basins - East			
Sub-Basin	Area (Acres)	Q5 (cfs)	Q100 (cfs)
Basin OS-5	15.6	4.2	10.6
Basin OS-6A	24.7	9.5	24.3
Basin OS-6B	37.0	13.0	33.2
Basin OS-6C	52.7	16.8	42.7
Basin OS-6D	62.5	20.9	53.2
E-1	5.0	2.1	5.3
E-2	7.5	3.1	7.2
E-3	21.5	3.1	9.9
Basin E-4A	8.0	2.8	7.2
Basin E-4B	5.8	2.3	6.0
Basin D-3	20.1	4.5	14.2
Basin D-4A	4.4	1.3	3.4
Basin D-4B	6.6	2.7	6.8

Sub Basins - Central			
Sub-Basin	Area (Acres)	Q5 (cfs)	Q100 (cfs)
W-10	8.2	3.6	12.7

Design Point	Name in HMS	Sub-Basins	Downstream Design Point	Total Area (AC)	Q5	Q100
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4	Reservoir OS-5	OS-6A, OS-6B, OS-6C, OS-6D	5	177.0	44.9	128.8
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C-1	Junction C-1	OS-2A, OS-2B, W-3	C-3	33.2	9.5	23.9
C-2	Junction C-2	W-4, Design Point 2, OS-4A, Design Point 3, OS-4H, W-5	C-3	225.9	53.6	135.1
C-3	Junction C-3	W-8, Design Point C-1, Design Point C-2, W,6, W-7	EX-2	280.7	57.0	142.9
C-4		D-1	EX-2	12.8	6.7	15.1
C-5		D-1	EX-2	12.8	6.7	15.1
C-6		D-2	EX-2	6.4	4.5	9.5
C-7		W-9	EX-2	1.9	0.7	1.7
C-8		E-1	EX-3	13.2	2.1	5.3
C-9		Basin D-3	EX-3	19.2	4.5	14.2
C-10		OS-5, E-2	EX-3	22.5	7.3	17.8
C-11	C-10	E-4A, E-4B, Design Point 4	EX-3	191.0	45.7	130.9
C-12	Pond 4	D-4A, D-4B	EX-1	6.6	4.0	10.2
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Cross Road Culvert Sizing

Mannings n 0.013 (renforced concrete)
Min D 18 inches

Allowable Velocities in Culverts
Min v 3 fps
max V 18 fps

*Dam breach flow used

	Design Point	Peak Discharge (cfs)	Max Slope (%)	Culvert Diameter (ft)	Velocity (ft/s)	Stormwater Treatment	
West Basin	C-1	23.9	6	1.5	16.5	Bypass of Historic Flow	
	C-1	11.5	7.5	2	14.8	Treated Developed Flow	(Basin D-2)
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	C-5	15.1	2	3	14.71	Treated Developed Flow	
	C-6	9.5	4.5	1.5	11.9	Treated Developed Flow	
	C-7	1.7	6.5	1.5	8.3	Bypass of Historic Flow	
	C-8	5.3	7	1.5	11.9	Bypass of Historic Flow	
East Basin	C-9	14.2	6.5	2	15	Treated Developed Flow	
	C-10	17.8	3.3	1.5	12.2	Bypass of Historic Flow	
	C-11	130.9	2.5	2.5	15	Bypass of Historic Flow	(2 culverts, 65.6 cfs each)
	C-12	10.2	10	1.5	14.75	Treated Developed Flow	

LEGEND

DESIGN POINT IDENTIFIER — L
BASIN IDENTIFICATION — BASIN
BASIN FLOWS — Q5 Q100
BASIN AREA — AREA
BASIN BOUNDARY
FLOW PATH
EXISTING CONTOURS
PROPOSED CONTOURS — 7300

EL PASO COUNTY, CO

PRELIMINARY DRAINAGE REPORT

GRANDWOOD RANCH
POST DEVELOPMENT CONDITIONS

DESIGNED BY: JTS/TM
DRAWN BY: TM
CHECKED BY: JTS
SCALE: HORIZ 1" = 100' VERT N/A
DATE ISSUED: JUNE 2020
SHEET 4 OF 4
DRAWING No. DR04

SEAL

PRELIMINARY
THIS DRAWING HAS NOT BEEN APPROVED BY GOVERNING AGENCIES AND IS SUBJECT TO CHANGE

FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 20.1105.004

PREPARED BY: Matrix Excellence by Design

SHEET KEY

No.	DATE	DESCRIPTION	BY
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REVISIONS

COMPUTER FILE MANAGEMENT
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PLOT DATE: July 1, 2020 5:05:07 PM
THIS DRAWING IS CURRENT AS OF PLOT DATE AND MAY BE SUBJECT TO CHANGE

REFERENCE DRAWINGS
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