Preliminary Drainage Report

Grand Valley Estates Filing II

October 5, 2018
(Revised --------)

Prepared for:

Grand Valley Estates Development Co., LLC
PO Box 119
Fruita, CO 81521

Prepared by:

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Job No. 1129-004

FIGURES

APPENDIX

Engineer's Certification

I hereby certify that the Drainage Report for the design of **Grand Valley Estates Filing II** was prepared by me, or under my direct supervision, in accordance with the provisions of the Stormwater Management Manual (dated December 31, 2007 and issued April 2008) for the owners thereof. I understand that the **City of Fruita** does not and will not assume liability for drainage facilities designed by others.

Ivan D. Geer, P.E.
State of Colorado Reg. No. 35518

Developer's Certification

I, _____ hereby certify that the drainage facilities for the **Grand Valley Estates Filing II** shall be constructed according to the design presented in this report. I understand that the **City of Fruita** reviews drainage plans but cannot, on behalf of the **Grand Valley Estates Filing II**, guarantee that the preliminary drainage design review will absolve **Grand Valley Estates Development Co., LLC** and/or their successors and/or assigns of future liability for improper design.

_____ (Name of Developer)

_____ (Authorized Signature)

_____ (Date)

I. Introduction

A. Background

The purpose of this Drainage Report is to identify pre-development and post-development drainage conditions for the proposed Grand Valley Estates Filing II development (Filing II). This report identifies the following items with respect to the site:

- existing drainage patterns and issues
- developed drainage patterns
- potential drainage issues resulting from development
- solutions to the potential drainage issues
- design of the various elements of the storm drain system for the site
- stormwater water quality requirements
- post construction BMP's

B. Project Location

The proposed project is located at the southwest corner of Fremont Street and J 2/10 Road within the city limits of Fruita, CO. The project site is positioned within a single parcel (Parcel No. 2697-163-00-130) and has the current address of 1849 J 2/10 Road. In more legal terms, the project site is situated in the West ½ of the NW ¼ of the SW ¼ of the SE ¼ of Section 16, Township 1 North, Range 2 West of the Ute Meridian, Mesa County, Colorado. Refer to Figure 1 for the General Location Map.

Primary access to the project site will be from Fremont Street between J Road and J 2/10 Road. The current land use of the subject parcel is vacant land. Adjacent land uses include large lot residential/agricultural operations and high-density single family residential. Existing development in the vicinity of the proposed subdivision includes the Grand Valley Estates Filing I (Filing I) directly to the west across Fremont Street, the Cotton Woods Subdivision to the northwest, the Wildcat Ranch Subdivision to the southwest, and the Fruita Homefront Subdivision to the southeast. Fruita 8/9 School and Fruita Monument High School are also in close proximity of the site to the southwest.

C. Project Description

The project site is approximately 4.33 acres of vacant land. Currently, the project is proposing to be rezoned from RR to CR and subdividing the parcel into a total of 20 single family residential lots. Grand Valley Estates

previously had final plan approval under a proposed PD zone district in 2008 that included Filing(s) I, II and III. Filing I was finalized and constructed. Filing II was not finalized due to the economic downturn that then occurred. Filing III is still in the planning stages.

There are no existing structures located on the site. The project will include right-of-way (ROW) for streets and sidewalk, lots for single-family homes, and Homeowners' Association (HOA) tracts for access, open space, and utility corridors. There are no encumbrances anticipated for this project.

According to the NRCS web site, the soils present at the site consist entirely of Fruitland sandy clay loam (0-2% slopes). Fruitland sandy clay loam is classified as Hydrologic Soil Group B. Group B soils have higher infiltration rates than Groups C and D Soils. NRCS Soil information is included in the Appendix.

Existing vegetation at the proposed project site consists of desert shrubs, grasses, and various weeds/invasive species. Existing vegetation is in good condition (>70% cover). An existing 10' irrigation easement is located along the eastern and southern sides of the parcel within the project boundary. A Grand Valley Drainage District (GVDD) easement also spans the southern boundary of the parcel.

A pair of curb inlets were installed at the low point in Fremont Street during the construction of Filing I. This low point is located near the middle of the west boundary of the parcel. The inlet on the west side of the Fremont Street low point collects runoff from the right-of-way (ROW) and eastern section of Filing I. The inlet on the east side of the low point is anticipated to collect runoff from the Filing II project site and ROW. However, the east inlet is not currently in use as it has been covered and bolted with a metal plate. This has allowed the runoff generated from the Filing II parcel to flow across the Fremont Street ROW to the inlet on the west side of the low point. From there the runoff is routed through the Filing I storm drain system to the existing detention pond.

The proposed project site is located entirely within the 117 Major Drainage Basin. The 117 Major Drainage Basin drains south to the Colorado River, approximately 2 miles south of the site. A graphical representation of the project boundary shown within the major drainage basin is provided in Figure 2. There are no FEMA floodplains located within or adjacent to the project site. FEMA flood maps for the area are available in the Appendix.

D. Previous Investigations

The Preliminary Drainage Report for Grand Valley Estates was completed by High Country Engineering, Inc. in November 2005 and submitted to the City of Fruita in conjunction with the Grand Valley Estates Subdivision Preliminary/Final Plan. The project site for Grand Valley Estates Filing II is included in the original Preliminary Drainage Report by High Country Engineering, Inc. as an outlot for future development. All of the runoff generated from the Filing I and Filing II parcels were accounted for and routed to the detention pond that was installed during the construction of Filing I.

The Preliminary Drainage Report for Grand Valley Estates was completed before water quality requirements had been established for the City of Fruita. In order to provide water quality for the Filing II development, the existing detention pond for Filing I will have a retro-fitted outlet structure.

The Filing I Preliminary Drainage Report accounts for irrigation flows entering the detention pond and proposes that a permanent water surface elevation of 4524.00 ft will be utilized to store these irrigation flows. However, from inspection of the current state of the detention pond, it does not appear that any permanent water surface elevations are sustained there. The detention pond also has a veranda with picnic tables installed in it, furthering the notion that this pond is not used for any permanent water storage, irrigation or otherwise.

II. Drainage System Description

A. Existing Drainage Conditions

The existing topography at the site is relatively flat with several local depressions dispersed throughout the vacant parcel. Generally, the site slopes from east to west with typical grades between 0.5 and 2.0 percent. Runoff from the site naturally collects near the low point in the adjacent Fremont Street where a pair of existing curb inlets are positioned. Because the eastern inlet is covered by a steel plate, all runoff from the project parcel will be collected by the west inlet and carried through the existing storm system installed during the construction of Filing I.

An existing GVDD easement borders the north side of the southern property line where the Kettles Drain is piped from east to west. Existing private irrigation ditches are located just south of the southern property line spanning the parcel from east to west on the neighboring parcels to the south.

These private irrigation ditches are connected to the Kettles Drain system via tailpipe located near the southwest corner of the parcel. The GVDD Fremont Street Drain also spans the western boundary of the site from north to south along the Fremont Street ROW. The Fremont Street Drain and Kettles Drain converge at a GVDD manhole located near the southwest corner of the project parcel. From there, the Kettles Drain pipe continues west to the Filing I detention pond where it appears to connect with an existing irrigation/drainage structure located at the south end of the pond. Further investigation of this existing irrigation/drainage structure is needed to further verify routing of offsite flows.

All runoff leaving the proposed project site is routed through the existing storm drain system and detention pond that were installed with the construction of Filing I. From there, all runoff eventually flows to the Colorado River located approximately 2 miles south of the project site. An analysis summary of the existing drainage sub-basins for the project are shown below in Table 1. Refer to Figure 3 for a layout of the existing sub-basins and proposed project site.

Table 1: Existing Sub-Basins

Basin ID	Basin Area (acres)	CN	Existing Peak Flow Rates (cfs)	
			10-Year	100-Year
EX-01	4.329	67.0	0.89	1.66
EX-02	0.752	98.0	0.88	1.79
EX-03	2.257	78.0	1.46	3.51
EX-04	7.502	78.0	4.29	9.00
EX-OS1	0.592	70.0	0.25	0.50

B. Master Drainage Plan

No "Master Drainage Plan" is known to exist for the subject property.

C. Offsite Tributary Area

The Filing I Preliminary Drainage Report included several offsite tributary areas in the design. Further investigation of the current topography around the project site suggests that runoff from these previously identified offsite areas does not contribute to the project flows. Specifically, sub-basins EX-OS1 and EX-OS3 from the Filing I Preliminary Drainage Report are not included as offsite tributary areas for the analysis of Filing II.

D. Proposed Drainage System Description

The proposed project will include lot grading, mountable curb and gutter, and v-pans. Water quality requirements will be provided by routing flows through the existing detention pond and retro-fitting the pond outlet structure. Re-grading of the pond may also be necessary to provide the required detention volumes.

Typically, runoff will sheet flow to the curb and gutter sections of the proposed development where it will concentrate and be conveyed through the site to the existing low point in Fremont Street. From there, the existing storm drain system will convey these flows to the detention pond located in the southwest corner of Filing I.

Water quality for Filing II will be provided in the existing detention pond for Filing I by retro-fitting an outlet structure and possibly re-grading the pond. Preliminary analysis of the pond and tributary areas has been completed using the SWMM methods and equations. Required volumes for the detention pond are provided in Table 2 below. SWMM calculations are provided in the Appendix.

Table 2: Water Surface Elevation and Volume Summary

Event	WSEL	Volume (cubic ft)
Top of Pond	4,527.00	36,753
100-Year	4,524.68	18,584
WQCV	4,522.74	7,395
10-Year Storm	4,522.40	5,787
Bottom of Pond	4,521.00	0

Note: Table values as per emperical SWMM formulas.

Analysis of the existing and proposed subdivisions for Grand Valley Estates Filings I & II shows that the existing pond for Filing I will have enough volume to support both developments. Approximately 15.4 acres is tributary to the detention pond in the newly proposed conditions. This provides a required 100-year detention volume of 18,584 ft^3. This value is less than the calculated required 100-year volume in the Filing I Preliminary Drainage Report, and therefore the pond layout should adequately function with the addition of the Filing II flows. The retro-fitted pond outlet structure and release rates will be analyzed during final design.

E. Drainage Facility Maintenance

Ownership and maintenance of the existing and proposed drainage improvements within public ROW shall be by the City of Fruita.

Inspection of the drainage facility and associated BMP's shall be as per the City's stormwater pollution prevention Ordinance No. 3824 and Sections 403.10 and 1606.2 of the Stormwater Management Manual (SWMM).

The developed drainage for the site is to be designed to minimize maintenance. Anticipated maintenance is expected to include periodic (1-2 times per year and as needed after major storm events) clearing of debris from drains, trash racks, and the screening protecting the water quality outlet plate. Periodic sediment removal from the pond and outlet system may be required. The removal frequency will vary depending on the sediment removal loading through the system to the detention pond but it is unlikely sediment removal would be required more often than once every 5 to 10 years.

III. DRAINAGE ANALYSIS AND DESIGN CRITERIA

A. Regulations

The policy, design criteria, design constraints, methods of analysis, recommendations, and conclusions presented in this report are in conformance with standard engineering practice and the Stormwater Management Manual (date December 31, 2007 and issued April 2008).

B. Development Criteria

No drainage constraints were noted for this project.

C. Hydrologic Criteria

The hydrologic design criteria presented in this report are in conformance with standard engineering practice and the Stormwater Management Manual (date December 31, 2007 and issued April 2008), except as noted within the report.

D. Hydraulic Criteria

The hydraulic design criteria presented in this report are in conformance with standard engineering practice and the Stormwater Management Manual

(SWMM) (dated December 31, 2007 and issued April 2008), except as noted within the report.

E. Variance from Criteria

No variances from the SWMM are requested.

F. Calculation Methodology

Autodesk Storm and Sanitary Analysis 2018 was used to model the basin runoff and perform the routing hydraulics. The following modeling methods were used within the model: the US EPA SWMM, SCS Curve Number, Hydrodynamic, and Hazen-Williams. The Autodesk software and selected methods are all accepted by the regulatory and engineering community and within standard engineering practice.

G. Calculation and Modeling Results

Initial calculations show compliance with City of Fruita and SWMM requirements. Final design and analysis of proposed storm drain and detention system will be provided during final design.

IV. POST CONSTRUCTION STORMWATER MANAGEMENT

A. Stormwater Quality Control Measures

The pond is intended to be designed as an extended detention basin that will treat the WQCV and drain it within 40 hours (as per the formulas within the SWMM). The pond will be designed to detain the WQCV and to pass through any flows above that.

B. Stormwater Quality Calculations

The WQCV was determined based on the projected percent imperviousness of the completed project. The WQCV was determined using Section 1604.2 WQCV in the SWMM.

V. CONCLUSIONS

A. Compliance with Manual

The policy, design criteria, design constraints, methods of analysis, recommendations, and conclusions presented in this report are in

conformance with standard engineering practice and the Stormwater Management Manual (dated December 31, 2007 and issued April 2008).

B. Design Effectiveness

This design will be very effective for controlling runoff from this site and will provide stormwater quality measures.

C. Areas in Flood Hazard Zone

There are no areas within the proposed project site that are classified as Flood Hazard Zones. There are no floodplains within the project area.

D. Variances from Manual

No variances from the manual are requested for this project.

VI. REFERENCES

1. Stormwater Management Manual, WRC Engineering under the direction of Mesa County Colorado, March 27, 2006.

2. Stormwater Management Manual, Williams Engineering for the City of Grand Junction and Mesa County Colorado, May 1996.

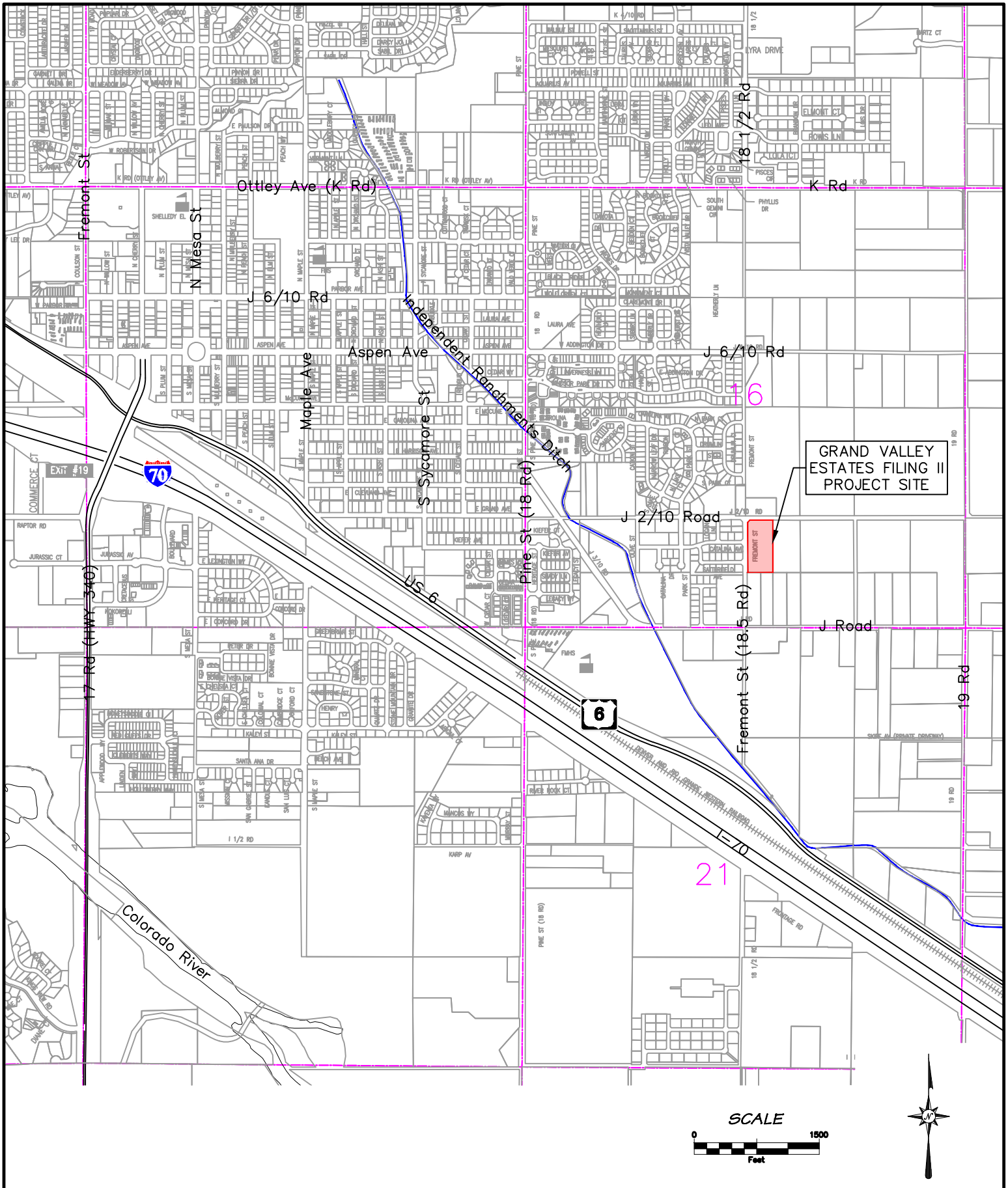
3. Mesa County Colorado GIS Website, . .

4. Natural Resources Conservation Service National Cooperative Soils Survey Website, http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx .

5. FEMA Flood Map Service Center website, https://msc.fema.gov/portal .

6. Drainage Criteria Manual, Urban Drainage and Flood Control District, Volumes 1, 2, & 3; Denver, Colorado 2001.

FIGURES



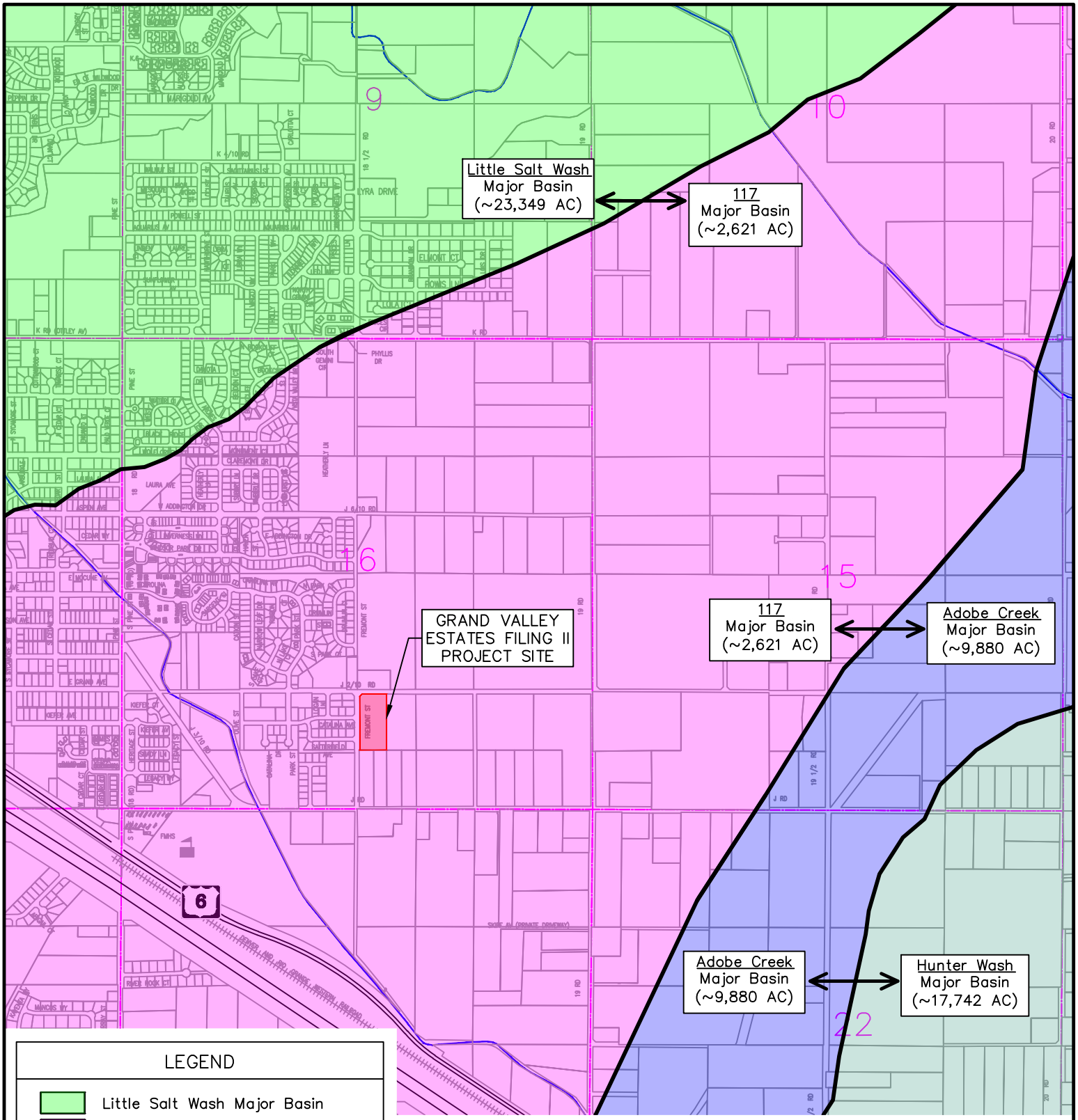
Grand Valley Estates Filing II

General Location Map

DATE: 02.Oct.2018

Figure 1

RIVER CITY CONSULTANTS



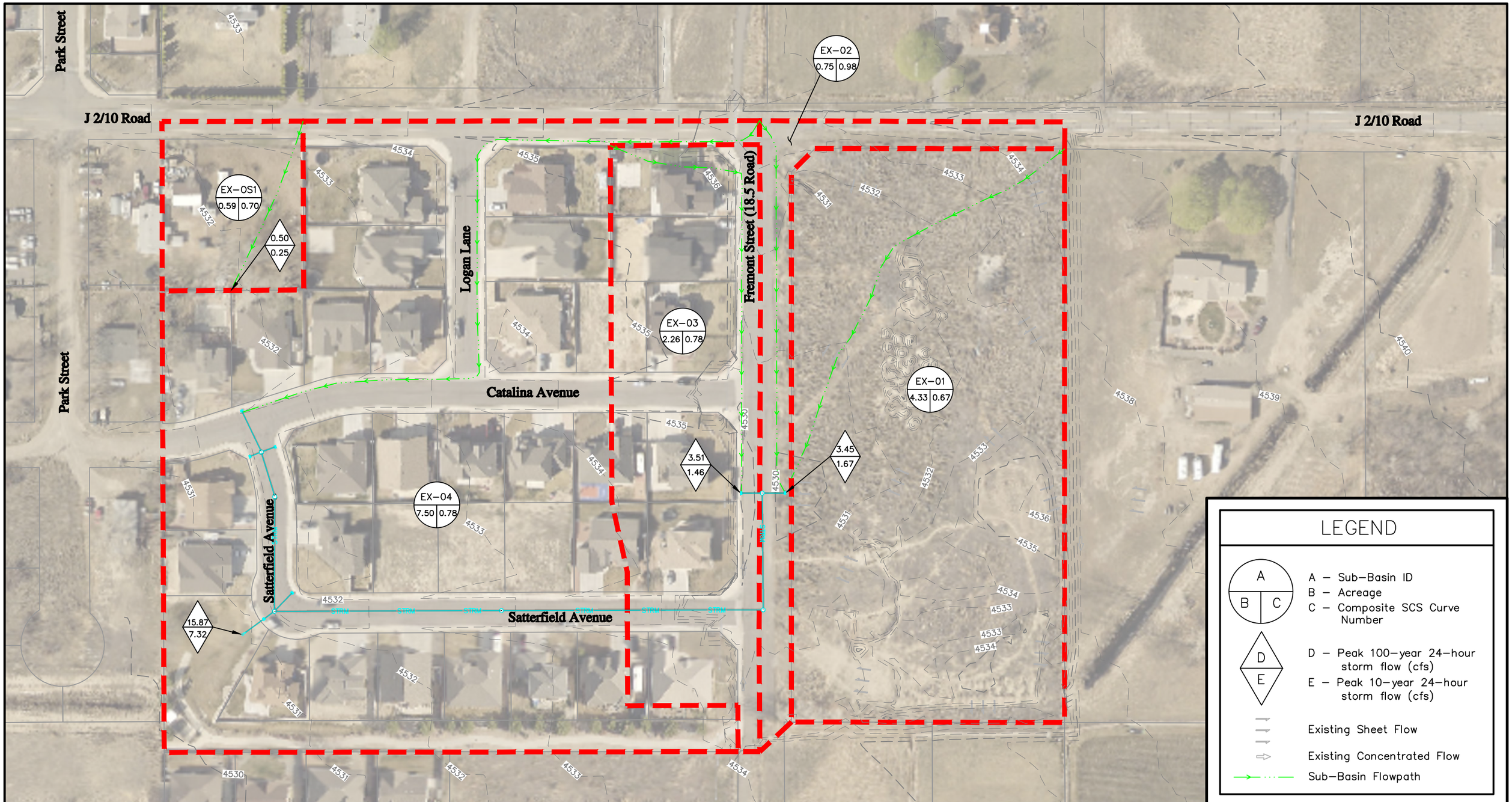
Grand Valley Estates FILING II

Major Basin & Floodplain Map

DATE: 02.Oct.2018

Figure 2

RIVER CITY CONSULTANTS



LEGEND

- A – Sub–Basin ID
- B – Acreage
- C – Composite SCS Curve Number
- D – Peak 100–year 24–hour storm flow (cfs)
- E – Peak 10–year 24–hour storm flow (cfs)
- Existing Sheet Flow
- Existing Concentrated Flow
- Sub–Basin Flowpath

UNCC
UTILITY NOTIFICATION CENTER OF COLORADO
800.922.1987
www.uncc.org
811 Know what's below. Call before you dig.

CALL 2 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

SCALE
0 100
Feet

CONTOUR INTERVAL = 1 FOOT

REVISIONS

NO.	DATE	DESCRIPTION	BY

S:\PROJECTS\1129 Daly\004 Grand Valley Estates F2\Design\DWG\03–Drainage\1129–004 EX Drainage.dwg [3 Existing Drainage Map] 10/5/2018

RIVER CITY CONSULTANTS
744 Horizon Court, Suite 110
Grand Junction, CO 81506
www.rccwest.com
Phone: 970.241.4722
Fax: 970.241.8841

PRELIMINARY

CLIENT NAME

Grand Valley Estates Filing II

Existing Drainage Map

DRAWN BY:	jmm		
CHECKED BY:	jwm	RCC PROJECT #: 1129–004	
HORZ SCALE:	1"=150'	DATE ISSUED: 03.Oct.2018	3
VERT SCALE:	N/A	ORIGINAL SHEET SIZE: 11 x 17	

APPENDIX A

Project Site Information

1. **FEMA Firm Panels**
2. **NRCS Web Soil Survey & K Factor Whole Soil**

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) Report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS Report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study Report for information on flood control structures for this jurisdiction.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study Report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study Report for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713- 3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was derived from NAIP color infrared orthophotography produced with a one meter ground resolution from photography dated 2003 or later.

Based on updated topographic information, this map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables for multiple streams in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on the map. Also, the road to floodplain relationships for unrevised streams may differ from what is shown on previous maps.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

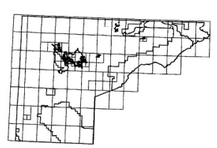
Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1- 877- FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov.

Mesa County Vertical Datum Offset Table

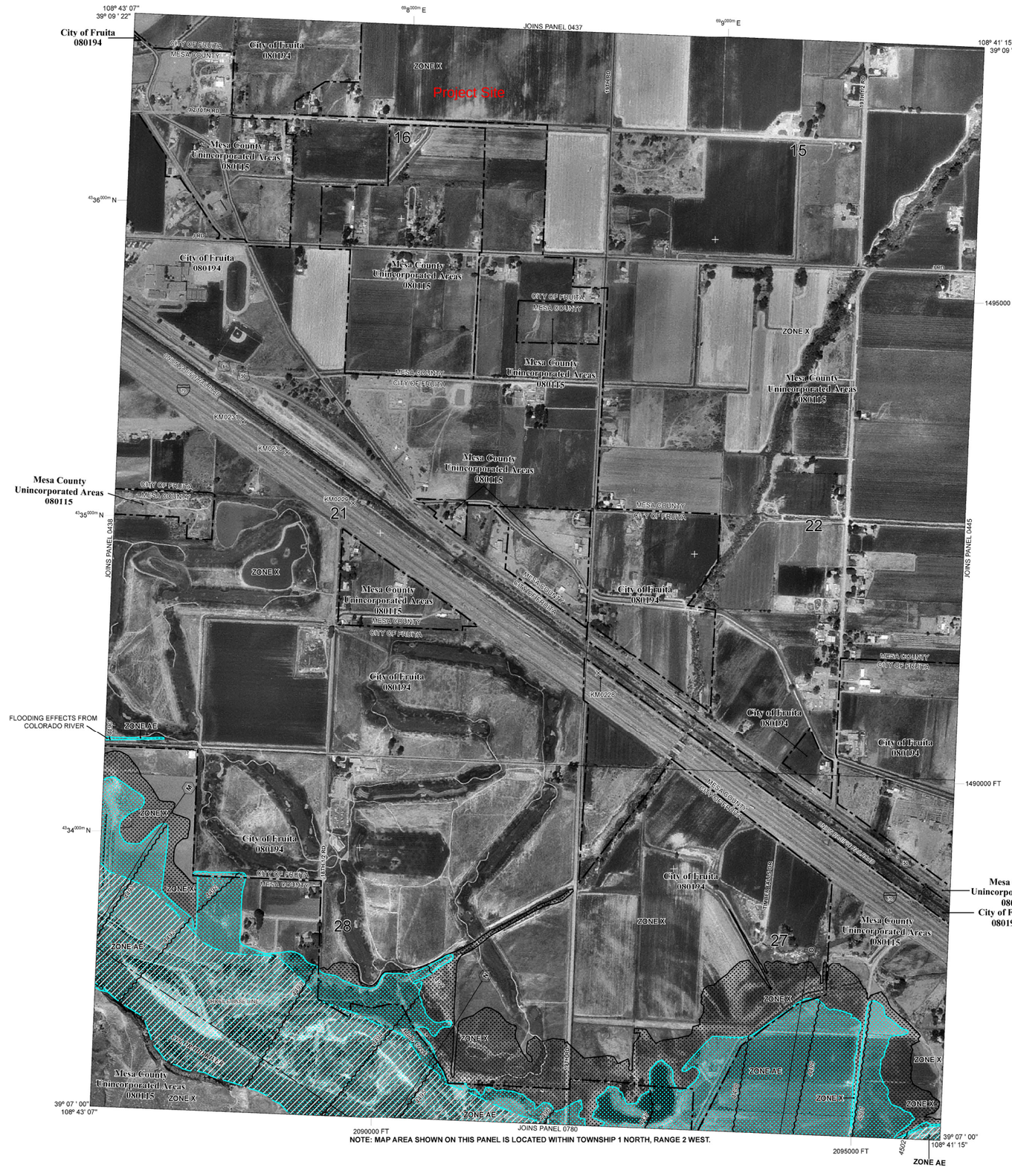
Flooding Source	Vertical Datum Offset (ft)	Flooding Source	Vertical Datum Offset (ft)
Colorado River	3.4		

Example: To convert Colorado River elevations to NAVD 88, 3.4 feet were added to the NGVD 29 elevations.



This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board and the Federal Emergency Management Agency (FEMA).

Additional Flood Hazard Information and resources are available from local communities and the Colorado Water Conservation Board.



NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 1 NORTH, RANGE 2 WEST.

LEGEND

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

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- 513 — Base Flood Elevation line and value; elevation in feet*
- (EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

- A — A — Cross section line
- 23 — 23 — Transect line
- 45° 02' 08", 93° 02' 12" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
- 4389000m N — 1000-meter Universal Transverse Mercator grid values, zone 12
- 3100000 FT — 5000-foot ticks: Colorado State Plane coordinate system, Central zone (FIPSZONE 0502), Lambert Conformal Conic projection
- DX5510 × — Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5 — River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
July 6, 2010

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in 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.

MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0439F

FIRM

FLOOD INSURANCE RATE MAP
MESA COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 439 OF 1725

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

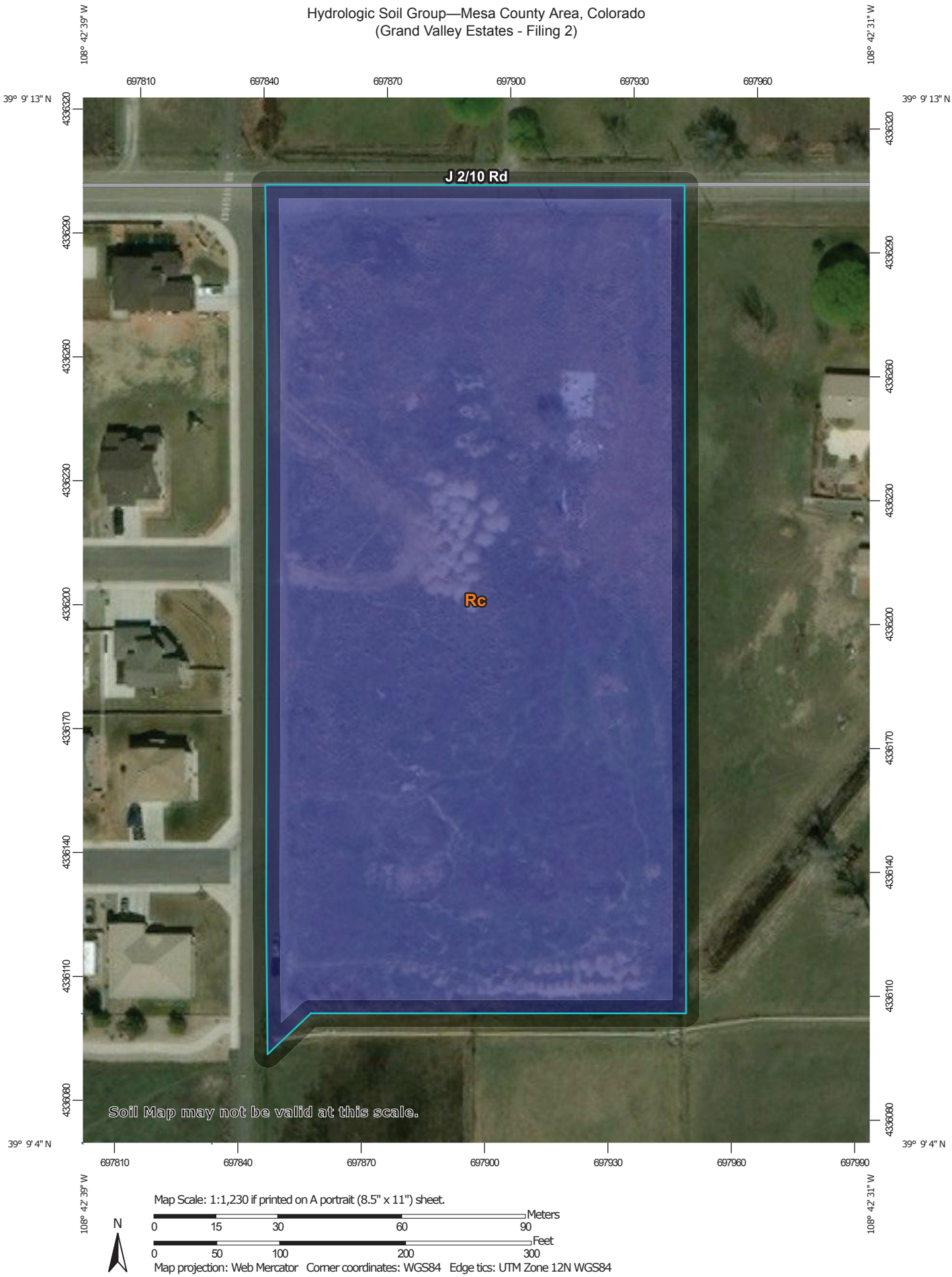
COMMUNITY	NUMBER	PANEL	SUFFIX
FRUITA, CITY OF	080194	0439	F
MESA COUNTY	080115	0439	F

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

MAP NUMBER
08077C0439F
EFFECTIVE DATE
JULY 6, 2010

Federal Emergency Management Agency

Hydrologic Soil Group—Mesa County Area, Colorado
(Grand Valley Estates - Filing 2)



Map Scale: 1:1,230 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 15 30 60 90

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N 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: Mesa County Area, Colorado
Survey Area Data: Version 9, Sep 10, 2018

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

Date(s) aerial images were photographed: Dec 31, 2009—Mar 2, 2017

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Rc	Fruitland sandy clay loam, 0 to 2 percent slopes	B	5.1	100.0%
Totals for Area of Interest			**5.1**	**100.0%**

Description

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

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

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

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

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

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

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

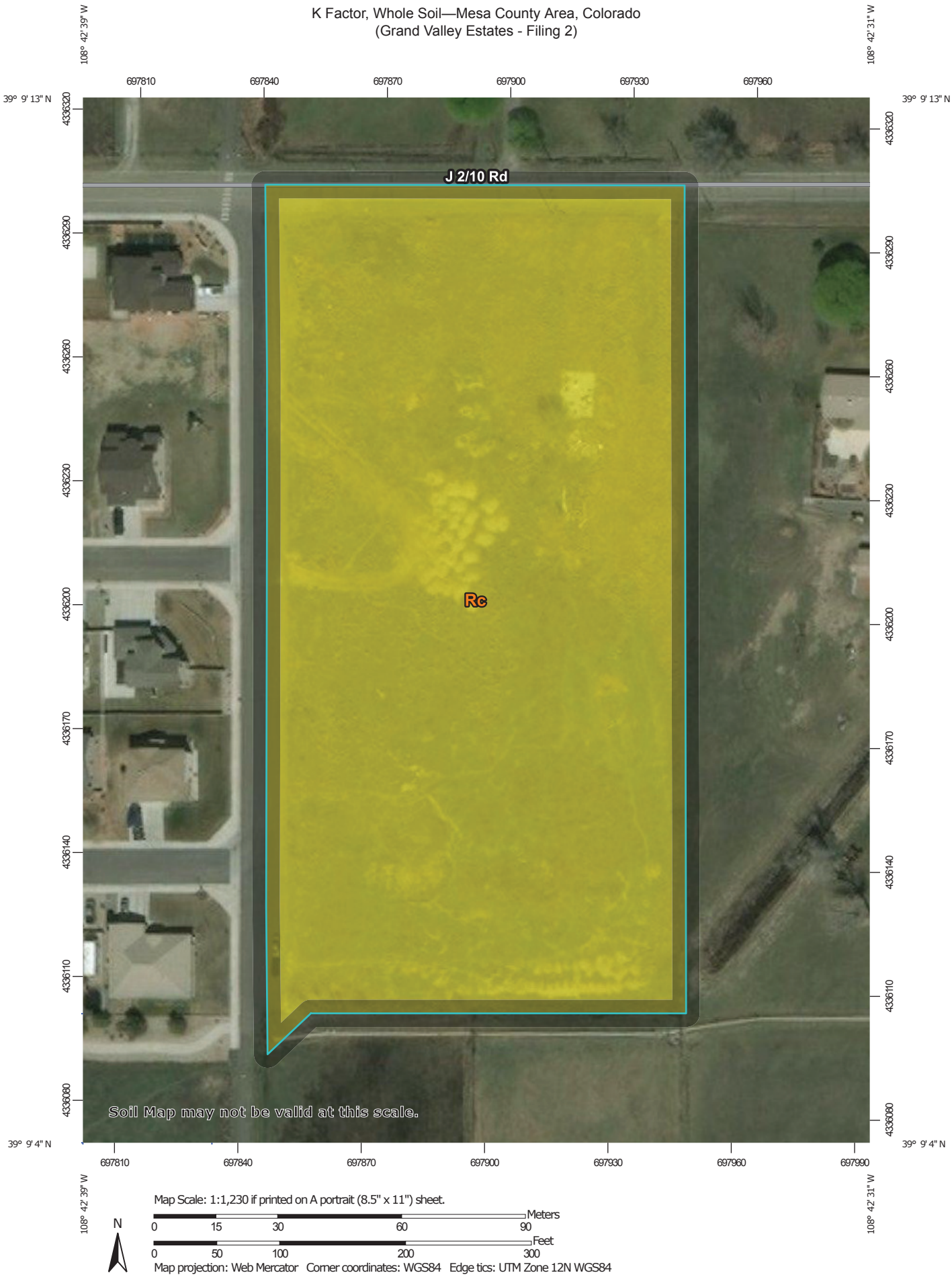
Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

K Factor, Whole Soil—Mesa County Area, Colorado
(Grand Valley Estates - Filing 2)



Map Scale: 1:1,230 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 15 30 60 90

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- .02
- .05
- .10
- .15
- .17
- .20
- .24
- .28
- .32
- .37
- .43
- .49
- .55
- .64
- Not rated or not available

Soil Rating Lines
- .02
- .05
- .10
- .15
- .17
- .20
- .24
- .28
- .32
- .37
- .43
- .49
- .55
- .64
- Not rated or not available

Soil Rating Points
- .02
- .05
- .10
- .15
- .17
- .20
- .24
- .28
- .32
- .37
- .43
- .49
- .55
- .64
- 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.

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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: Mesa County Area, Colorado
Survey Area Data: Version 9, Sep 10, 2018

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

Date(s) aerial images were photographed: Dec 31, 2009—Mar 2, 2017

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.

K Factor, Whole Soil

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Rc	Fruitland sandy clay loam, 0 to 2 percent slopes	.17	5.1	100.0%
Totals for Area of Interest			**5.1**	**100.0%**

Description

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity (Ksat). Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

"Erosion factor Kw (whole soil)" indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

APPENDIX B

SWMM Calculations

1. WQCV for Detention Pond

RIVERCITY CONSULTANTS
744 Horizon Drive
Grand Junction, CO 81506

Historic Flow Rates

100 Year 24 Hour Storm Historic Flow (whole site using Rational Method)

$I = (a * P_1) / (10 + T_C)^b$
$I = 2.02$

I = Average Rainfall Intensity (in/hr) (Section 604 SWMM)
a = Constant specific to Mesa County
a = 28.9
P_1 = Point rainfall value for 100 yr/1-hr (in) (Tbl 601 or 602 SWMM)
P_1 = 1.34
T_C = Time of Concentration (min)
$T_C = t_i + t_t$
T_C = 32.96 (10 min minimum)

t_i = Initial, inlet, or overland flow time (min)
$t_i = 1.8 * (1.1 - K) * L_o^{1/2} / S^{1/3}$
t_i = 29.63
K = Flow resistance Coefficent (unitless)
K = C_5 is the recommended K value
K = 0.15
L_o = Length of overland flow (ft; 300 max)
L_o = 300
S = average slope (%)
S = 1.0

t_t = Travel time in ditch, channel, gutter, pipe, etc. (min)
$t_t = L / V/60$ L = Length of flow (ft)
t_t = 3.33 L = 200
V = Velocity of flow (ft/s)
V = 1.0 (Figure 701 SWMM)

b = Constant specific to Mesa County
b = 0.786

$Q_{P\ H100} = C * I * A$
$Q_{P\ H100}$ = 12.41

Q_P = Peak Flow (cfs) (100 year Historical)
C = Rational Coefficent (see sheet 1)
C_{H100} = 0.41
I = Average Rainfall Intensity (in/hr) (Section 604 SWMM)
I = 2.02
A = Contibuting Area (acres)
A = 14.94

10 Year 24 Hour Storm Historic Flow (whole site using Rational Method)

$I = (a * P_1) / (10 + T_C)^b$

$I = 0.95$

I = Average Rainfall Intensity (in/hr) (Section 604 SWMM)

a = Constant specific to Mesa County

a = 28.9

P_1 = Point rainfall value for 10 yr/1-hr (in) (Tbl 601 or 602 SWMM)

P_1 = 0.63

T_C = Time of Concentration (min)

$T_C = t_i + t_t$

T_C = 32.96 (10 min minimum)

t_i = Initial, inlet, or overland flow time (min)

$t_i = 1.8 * (1.1 - K) * L_o^{1/2} / S^{1/3}$

t_i = 29.63

K = Flow resistance Coefficent (unitless)

K = C_5 is the recommended K value

K = 0.15

L_o = Length of overland flow (ft; 300 max)

L_o = 300

S = average slope (%)

S = 1.0

t_t = Travel time in ditch, channel, gutter, pipe, etc. (min)

$t_t = L / V/60$ L = Length of flow (ft)

t_t = 3.33 L = 200

V = Velocity of flow (ft/s)

V = 1 (Table 701 SWMM)

b = Constant specific to Mesa County

b = 0.786

$Q_{P\,H10} = C * I * A$

$Q_{P\,H10}$ = 3.27

Q_P = Peak Flow (cfs) (100 year Historical)

C = Rational Coefficent (see sheet 1)

C_{H10} = 0.23

I = Average Rainfall Intensity (in/hr) (Section 604 SWMM)

I = 0.95

A = Contibuting Area (acres)

A = 14.94

Grand Valley Estates Filing II

Preliminary Drainage Report

RIVERCITY CONSULTANTS
744 Horizon Ct
Grand Junction, CO 81506

Rational Coefficient Calculations

COMPOSITE RUNOFF COEFFICIENTS (whole site)

USING December 31, 2007 SWMM MANUAL (issued April 2008) (SECTION 700)

$C_{CD}=K_{CD}+(0.858*i^3-0.786*i^2+0.774*i+0.04)$

$C_A=K_A+(1.31*i^3-1.44*i^2+1.135*i-0.12)$

$C_B=(C_A+C_{CD})/2$

Where:

C_{CD}=Runoff coefficient for C and D soils

C_A=Runoff coefficients for A soils

C_B=Runoff coefficients for B soils

i=% impervious (asphalt, concrete, etc.) as a decimal

K_{CD}=Coefficient adjustment for C and D soils)

K_A=Coefficient adjustment for A soils)

ADJUSTMENT FACTORS FOR RUNOFF EQUATIONS
(FROM TABLE 707)

	2 YEAR	5 YEAR	10 YEAR	100 YEAR
K_{CD}	0	-0.10*i+0.11	-0.18*i+0.21	-0.39*i+0.46
K_A	0	-0.08*i+0.09	-0.14*i+0.17	-0.25*i+0.32

Historical Conditions

Impervious Area	
Area	Description
1.79	Impervious (asphalt, concrete, etc.)
14.94	Total area
0.12	Impervious (i) as decimal

2 Year Runoff Coefficients
C_{CD}= 0.12
C_A= 0.00
C_B= 0.06

5 Year Runoff Coefficients
C_{CD}= 0.22
C_A= 0.08
C_B= 0.15

100 Year Runoff Coefficients
C_{CD}= 0.54
C_A= 0.29
C_B= 0.41

Developed Conditions

Impervious Area	
Area	Description
5.68	Impervious (asphalt, concrete, etc.)
14.94	Total area
0.38	Impervious (i) as decimal (taken from SWMM Figure 703 for 2units/acre & 3,250 sqft homes)

2 Year Runoff Coefficients
C_{CD}= 0.27
C_A= 0.18
C_B= 0.22

5 Year Runoff Coefficients
C_{CD}= 0.34
C_A= 0.23
C_B= 0.29

100 Year Runoff Coefficients
C_{CD}= 0.58
C_A= 0.40
C_B= 0.49

Soil Type for project = TYPE **B**

HISTORICAL

$C_{2\ YEAR}$	$C_{5\ YEAR}$	$C_{10\ YEAR}$	$C_{100\ YEAR}$
0.06	0.15	0.23	0.41

DEVELOPED

$C_{2\ YEAR}$	$C_{5\ YEAR}$	$C_{10\ YEAR}$	$C_{100\ YEAR}$
0.22	0.29	0.35	0.49

Grand Valley Estates Filing II

Preliminary Drainage Report

RIVERCITY CONSULTANTS
744 Horizon Ct
Grand Junction, CO 81506

Detention Volume & Fee Calculations

Minimum Detention Volume

SWMM Table 1401:

Ultimate % Impervious	X_{100}	X_{10}
< 50%	0.42	0.26
≥ 50%	0.48	0.38

X_{100} = 0.42 Developed Basin Imperviousness (%) P = 38

X_{10} = 0.26 Tributary Area (Acres) A= 14.94

$K_{100}=(1.78P-0.002P^2-3.56)(X_{100}/900)=$ 0.03

$K_{10}=(0.95P-1.90)(X_{10}/1000)=$ 0.01

Assumed Depth= 5 ft

For 100-Year:

$V_{100}=K_{100}*A=$	**0.43** acre-feet	**18,584.03** ft^3	3716.806 ft^2

For 10-Year:

$V_{10}=K_{10}*A=$	**0.13** acre-feet	**5,786.79** ft^3

Allowable Release Rate:

SWMM Table 1402

	SOIL GROUP			
FREQUENCY	A	B	C	D
10-Year	0.05	0.09	0.12	0.12
100-Year	0.25	0.43	0.50	0.50

	cfs/Acre per Table 1402 SWMM	Release Rate
10-Year	0.09	**1.34 cfs**
100-Year	0.43	**6.42 cfs**

Drainage Fee

Drainage Fee = $B * (C100_d - C100_h) * A^{0.7}$

Drainage Fee = $5,170.31

B = 10,000 Fee Constant

C_D = 0.49 Developed Runoff Coefficient

C_H = 0.41 Historic Runoff Coefficient

A = 14.94 Area (acres)

Grand Valley Estates Filing II

Preliminary Drainage Report

RIVERCITY CONSULTANTS
744 Horizon Drive
Grand Junction, CO 81506

WATER QUALITY CAPTURE VOLUME (WQCV)

WQCV CALCULATIONS

Calculate WQCV:

WQCV = $k[a(0.91*i^3-1.19*i^2+0.78i)]$

k = $d_6/0.43$ where $d_6 = 0.28$

= 0.28/0.43

= 0.65

a = BMP Drain Time Coefficient (Assumed it is based on 40 hrs)

= 1.00

i = Watershed Imperviousness as a decimal

Description	Area (acres)	Imperviousness (decimal)	A*I
Basin D1	14.94	0.38	5.68
Total	14.94		

= [sum(area*impreviousness)]/total area

= 0.38

WQCV = $0.65[1.0(0.91*0.80^3-1.19*0.80^2+0.78*0.80)]$

= 0.1136 in

Calculate 120% WQCV:

120 % WQCV = 1.2*WQCV

= 0.1364 in

Calculate Required Storage Volume, SV:

SV = (120% WQCV/12)*Tributary Area

= **0.1698 acre-ft**

→ Multiply by 43,560 ft^2/acre **7,395 ft^3**

Grand Valley Estates Filing II
Preliminary Drainage Report

Water Quality Capture Volume (WQCV)

744 Horizon Drive
Grand Junction, CO 81506

Design Stage Storage

Contour Elevation	Contour Area (sq. ft)	**Depth (ft)**	**Cumulative Volume (cu. ft)**	**Contour Elevation**
4,521.00	3,526.39	0.00	0.00	4,521.00
4,522.00	4,282.93	1.00	3,904.66	4,522.00
4,523.00	5,111.43	2.00	8,601.84	4,523.00
4,524.00	6,011.88	3.00	14,163.50	4,524.00
4,525.00	6,984.27	4.00	20,661.58	4,525.00
4,526.00	8,028.62	5.00	28,168.03	4,526.00
4,527.00	9,140.65	6.00	36,752.67	4,527.00

Note: Volumes and elevations are taken from the Grand Valley Estates Filing I Preliminary Drainage Report. Updated survey and anlaysis of the detention pond will be provided during final design.

Water Quality Capture Volume		
	Elevation	Volume
EL low	4,522.00	3,904.66
WQCV Elevation	**4,522.74**	7,394.64
EL high	4,523.00	8,601.84

10-Year Detention Volume		
	Elevation	Volume
EL low	**4,522.00**	**3,904.66**
10-Yr Elevation	**4,522.40**	5,786.79
EL high	**4,523.00**	**8,601.84**

100-Year Detention Volume		
	Elevation	Volume
EL low	**4,524.00**	**14,163.50**
100-Yr Elevation	**4,524.68**	18,584.03
EL high	**4,525.00**	**20,661.58**

10-Year Detention Volume plus WQCV		
	Elevation	Volume
EL low	**4,523.00**	**8,601.84**
10-Yr + WQCV Elevation	**4,523.82**	13,181.44
EL high	**4,524.00**	**14,163.50**

Bottom of Pond
4,521.00

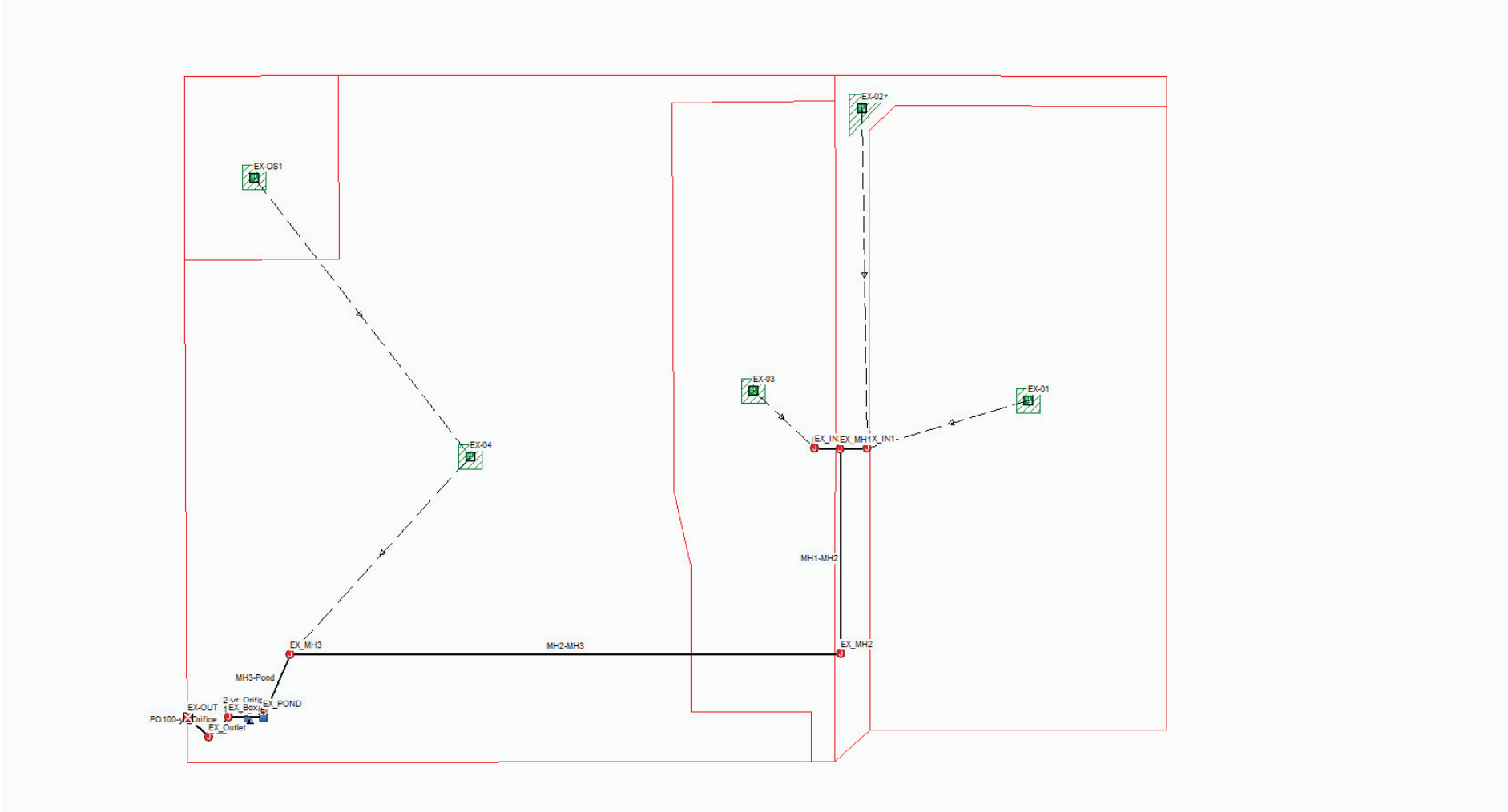
Note: 10 & 100 Yr WSEL were calculated from formulas & values in SWMM Section 1400

APPENDIX C

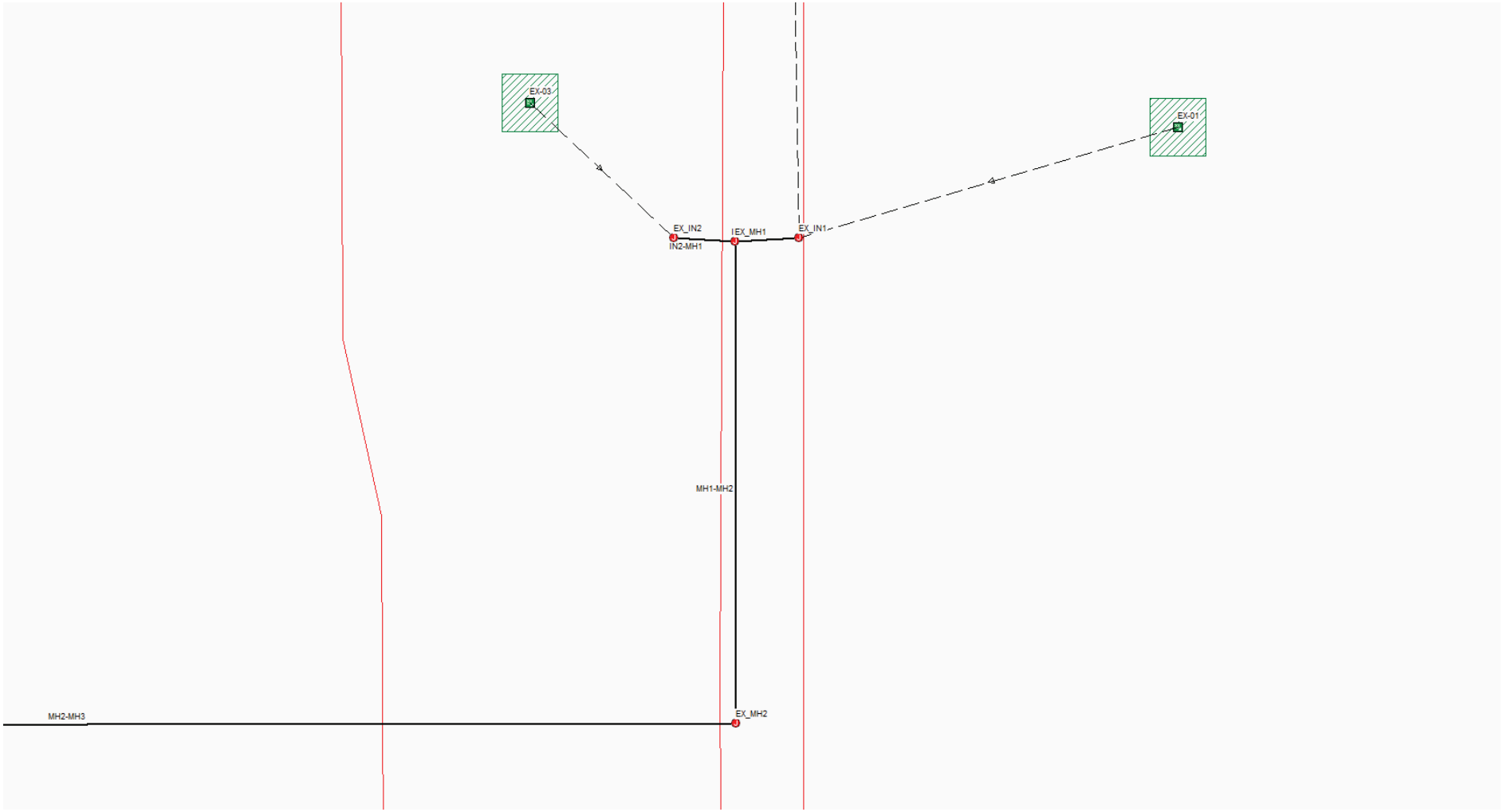
Hydrologic + Hydraulic Model Overview

1. SWMM Existing Model Overall View

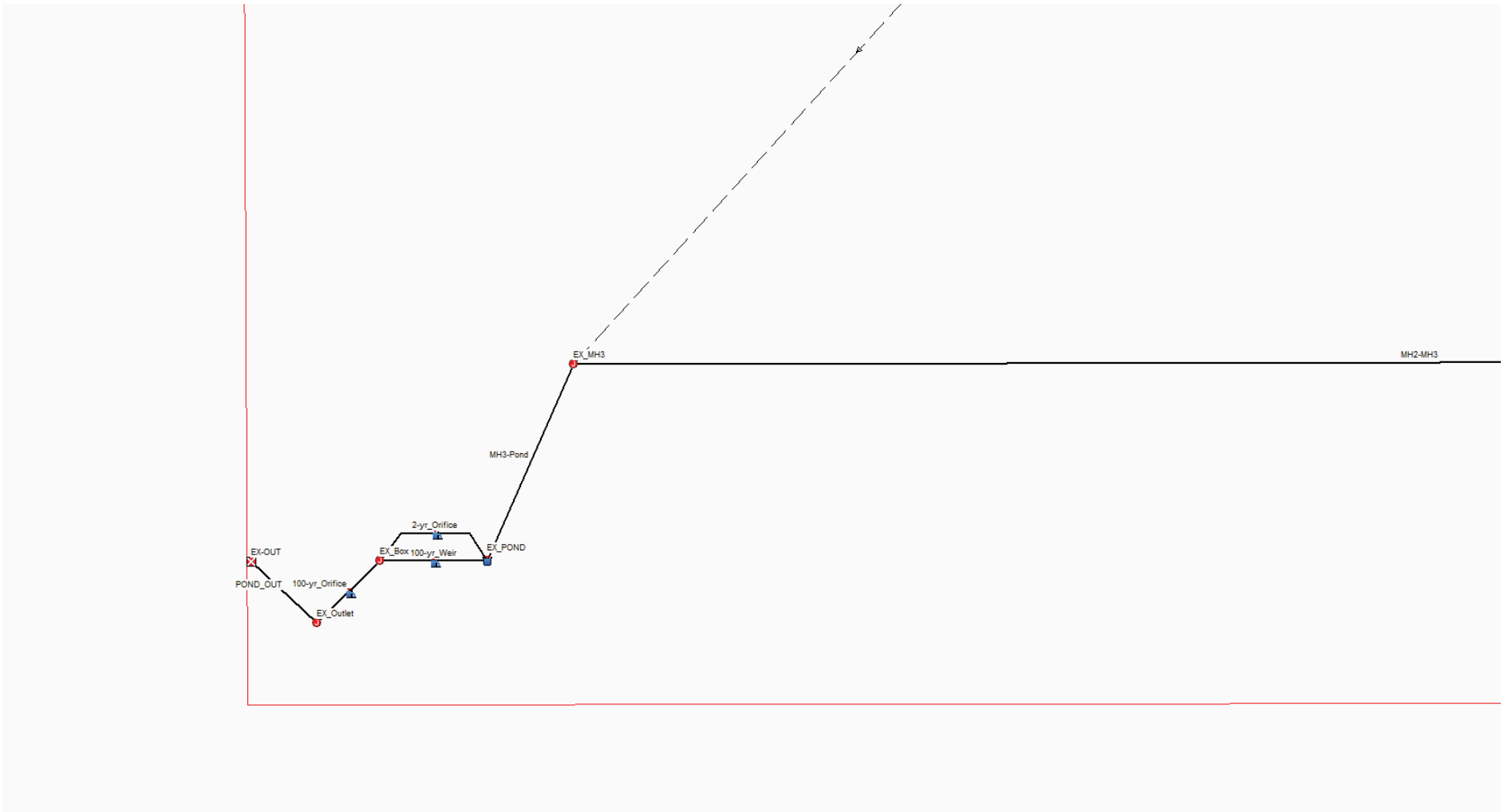
Grand Valley Estates Filing II
Existing Model Overview



Grand Valley Estates Filing II
Existing Model - East Zoom



Grand Valley Estates Filing II
Existing Model - West Zoom



APPENDIX D

Existing Minor & Major Storm Model Results

1. 2-year, 24-hour Existing Model Results
2. 10-year, 24-hour Existing Model Results
3. 100-year, 24-hour Existing Model Results

Grand Valley Estates Filing II
Existing Model 2-year 24-hour Results

****
Project Description
****
File Name ..... 1129-004 EX Model.SPF

****
Analysis Options
****
Flow Units ..... cfs
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method ..... SCS Curve Number
Link Routing Method ..... Hydrodynamic
Storage Node Exfiltration.. Horton, wetted area
Starting Date JUL-04-2017 00:00:00
Ending Date JUL-08-2017 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:00:30
Wet Time Step 00:00:30
Dry Time Step 01:00:00
Routing Time Step ..... 5.00 sec

****
Element Count
****
Number of rain gages 1
Number of subbasins 5
Number of nodes 9
Number of links 9
Number of pollutants 0
Number of land uses 0

****
Subbasin Summary
****

Subbasin ID	Total Area acres	Equiv. Width ft	Imperv. Area %	Average Slope %	Raingage
EX-01	4.33	1200.00	12.00	1.0000	-
EX-02	0.75	60.00	75.00	1.0000	-
EX-03	2.26	1200.00	38.00	1.2000	-
EX-04	7.50	1000.00	38.00	0.5000	-
EX-OS1	0.59	300.00	25.00	0.8000	-

****
Node Summary
****

Node ID	Element Type	Invert Elevation ft	Maximum Elev. ft	Ponded Area ft²	External Inflow
EX_Box	JUNCTION	4523.00	4529.72	0.00	
EX_IN1	JUNCTION	4525.34	4529.00	0.00	
EX_IN2	JUNCTION	4525.34	4529.00	0.00	
EX_MH1	JUNCTION	4525.14	4529.00	0.00	
EX_MH2	JUNCTION	4524.15	4528.00	0.00	
EX_MH3	JUNCTION	4521.40	4532.00	0.00	
EX_Outlet	JUNCTION	4523.00	4526.72	0.00	
EX-OUT	OUTFALL	4522.90	4524.40	0.00	
EX_POND	STORAGE	4521.00	4527.00	0.00	

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length ft	Slope %	Manning's Roughness
IN1-MH1	EX_IN1	EX_MH1	CONDUIT	20.0	1.0000	0.0110
IN2-MH1	EX_IN2	EX_MH1	CONDUIT	20.0	1.0000	0.0110
MH1-MH2	EX_MH1	EX_MH2	CONDUIT	197.8	0.5004	0.0110
MH2-MH3	EX_MH2	EX_MH3	CONDUIT	550.0	0.5000	0.0110
MH3-Pond	EX_MH3	EX_POND	CONDUIT	81.2	0.4927	0.0110
POND_OUT	EX_Outlet	EX-OUT	CONDUIT	10.0	1.0000	0.0110
100-yr_Orifice	EX_Box	EX_Outlet	ORIFICE			
2-yr_Orifice	EX_POND	EX_Box	ORIFICE			
100-yr_Weir	EX_POND	EX_Box	WEIR			

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter ft	Width ft	No. of Barrels	Cross Sectional Area ft²	Full Flow Hydraulic Radius ft	Design Flow Capacity cfs
IN1-MH1	CIRCULAR	1.50	1.50	1	1.77	0.38	12.41
IN2-MH1	CIRCULAR	1.50	1.50	1	1.77	0.38	12.41
MH1-MH2	CIRCULAR	1.50	1.50	1	1.77	0.38	8.78
MH2-MH3	CIRCULAR	1.50	1.50	1	1.77	0.38	8.78
MH3-Pond	CIRCULAR	1.50	1.50	1	1.77	0.38	8.71
POND_OUT	CIRCULAR	1.50	1.50	1	1.77	0.38	12.41

********** Runoff Quantity Continuity	Volume acre-ft	Depth inches
Total Precipitation	0.900	0.700
Evaporation Loss	0.000	0.000
Infiltration Loss	0.530	0.412
Surface Runoff	0.264	0.205
Final Surface Storage	0.107	0.083
Continuity Error (%)	0.000	

********** Flow Routing Continuity	Volume acre-ft	Volume Mgallons
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.264	0.086
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.000	0.000
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000

Final Stored Volume	0.263	0.086
Continuity Error (%)	0.176	

****
Composite Curve Number Computations Report
****

Subbasin EX-01

Soil/Surface Description	Area (acres)	Soil Group	CN
Brush, Poor	4.33	B	67.00
Composite Area & Weighted CN	4.33		67.00

Subbasin EX-02

Soil/Surface Description	Area (acres)	Soil Group	CN
Paved roads with curbs & sewers	0.75	B	98.00
Composite Area & Weighted CN	0.75		98.00

Subbasin EX-03

Soil/Surface Description	Area (acres)	Soil Group	CN
1/4 acre lots, 38% impervious	2.26	B	78.00
Composite Area & Weighted CN	2.26		78.00

Subbasin EX-04

Soil/Surface Description	Area (acres)	Soil Group	CN
1/4 acre lots, 38% impervious	7.50	B	78.00
Composite Area & Weighted CN	7.50		78.00

Subbasin EX-OS1

Soil/Surface Description	Area (acres)	Soil Group	CN
1/2 acre lots, 25% impervious	0.59	B	70.00
Composite Area & Weighted CN	0.59		70.00

****
EPA SWMM Time of Concentration Computations Report
****

Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

Where:

Tc = Time of Concentration (min)
L = Flow Length (ft)
n = Manning's Roughness
i = Rainfall Intensity (in/hr)
S = Slope (ft/ft)

Subbasin EX-01

Flow length (ft):	157.15
Pervious Manning's Roughness:	0.10000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (in/hr):	0.02917
Impervious Rainfall Intensity (in/hr):	0.02917
Slope (%):	1.00000
Computed TOC (minutes):	74.47

Subbasin EX-02

Flow length (ft):	545.97
Pervious Manning's Roughness:	0.10000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (in/hr):	0.02917
Impervious Rainfall Intensity (in/hr):	0.02917
Slope (%):	1.00000
Computed TOC (minutes):	73.88

Subbasin EX-03

Flow length (ft):	81.93
Pervious Manning's Roughness:	0.10000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (in/hr):	0.02917
Impervious Rainfall Intensity (in/hr):	0.02917
Slope (%):	1.20000
Computed TOC (minutes):	38.66

Subbasin EX-04

Flow length (ft):	326.71
Pervious Manning's Roughness:	0.10000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (in/hr):	0.02917
Impervious Rainfall Intensity (in/hr):	0.02917
Slope (%):	0.50000
Computed TOC (minutes):	115.27

Subbasin EX-OS1

Flow length (ft):	85.95
Pervious Manning's Roughness:	0.10000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (in/hr):	0.02917
Impervious Rainfall Intensity (in/hr):	0.02917
Slope (%):	0.80000

Computed TOC (minutes): 50.37

****
Subbasin Runoff Summary
****

Subbasin ID	Total Rainfall in	Total Runon in	Total Evap. in	Total Infil. in	Total Runoff in	Peak Runoff cfs	Runoff Coefficient	Time of Concentration days	Time of Concentration hh:mm:ss
EX-01	0.70	0.00	0.00	0.57	0.08	0.56	0.110	0	01:14:27
EX-02	0.70	0.00	0.00	0.05	0.56	0.45	0.806	0	01:13:53
EX-03	0.70	0.00	0.00	0.40	0.24	0.90	0.347	0	00:38:39
EX-04	0.70	0.01	0.00	0.35	0.25	2.59	0.348	0	01:55:16
EX-OS1	0.70	0.00	0.00	0.49	0.16	0.16	0.229	0	00:50:21

****
Node Depth Summary
****

Node ID	Average Depth Attained ft	Maximum Depth Attained ft	Maximum HGL Attained ft	Time of Max Occurrence days	Time of Max Occurrence hh:mm	Total Flooded Volume acre-in	Total Time Flooded minutes	Retention Time hh:mm:ss
EX_Box	0.00	0.00	4523.00	0	00:00	0	0	0:00:00
EX_IN1	0.01	0.38	4525.72	0	11:55	0	0	0:00:00
EX_IN2	0.01	0.37	4525.71	0	11:55	0	0	0:00:00
EX_MH1	0.02	0.50	4525.64	0	11:55	0	0	0:00:00
EX_MH2	0.02	0.46	4524.61	0	11:57	0	0	0:00:00
EX_MH3	1.26	1.45	4522.85	3	09:07	0	0	0:00:00
EX_Outlet	0.00	0.00	4523.00	0	00:00	0	0	0:00:00
EX-OUT	0.00	0.00	4522.90	0	00:00	0	0	0:00:00
EX_POND	1.63	1.85	4522.85	3	23:59	0	0	0:00:00

****
Node Flow Summary
****

Node ID	Element Type	Maximum Lateral Inflow cfs	Peak Inflow cfs	Time of Peak Inflow Occurrence days	Time of Peak Inflow Occurrence hh:mm	Maximum Flooding Overflow cfs	Time of Peak Flooding Occurrence days	Time of Peak Flooding Occurrence hh:mm
EX_Box	JUNCTION	0.00	0.00	0	00:00	0.00		
EX_IN1	JUNCTION	0.94	0.94	0	11:57	0.00		
EX_IN2	JUNCTION	0.90	0.90	0	11:55	0.00		
EX_MH1	JUNCTION	0.00	1.83	0	11:55	0.00		
EX_MH2	JUNCTION	0.00	1.82	0	11:55	0.00		
EX_MH3	JUNCTION	2.59	4.35	0	11:57	0.00		
EX_Outlet	JUNCTION	0.00	0.00	0	00:00	0.00		
EX-OUT	OUTFALL	0.00	0.00	0	00:00	0.00		
EX_POND	STORAGE	0.00	4.23	0	11:58	0.00		

****
Storage Node Summary
****

Storage Node ID	Maximum Ponded Volume 1000 ft³	Maximum Ponded Volume (%)	Time of Max Ponded Volume days	Time of Max Ponded Volume hh:mm	Average Ponded Volume 1000 ft³	Average Ponded Volume (%)	Maximum Storage Node Outflow cfs	Maximum Exfiltration Rate cfm	Time of Max. Exfiltration Rate hh:mm:ss	Total Exfiltrated Volume 1000 ft³
EX_POND	10.849	20	3	23:59	9.370	17	0.00	0.00	0:00:00	0.000

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow cfs	Peak Inflow cfs
EX-OUT	0.00	0.00	0.00
System	0.00	0.00	0.00

****
Link Flow Summary
****

Link ID	Element Type	Time of Peak Flow Occurrence days	Time of Peak Flow Occurrence hh:mm	Maximum Velocity Attained ft/sec	Length Factor	Peak Flow during Analysis cfs	Design Flow Capacity cfs	Ratio of Maximum /Design Flow	Ratio of Maximum Flow Depth	Total Time Surcharged minutes	Reported Condition
IN1-MH1	CONDUIT	0	11:58	2.24	3.49	0.94	12.41	0.08	0.29	0	Calculated
IN2-MH1	CONDUIT	0	11:55	2.17	3.49	0.90	12.41	0.07	0.29	0	Calculated
MH1-MH2	CONDUIT	0	11:55	3.84	1.00	1.82	8.78	0.21	0.31	0	Calculated
MH2-MH3	CONDUIT	0	11:57	2.21	1.00	1.76	8.78	0.20	0.50	0	Calculated
MH3-Pond	CONDUIT	0	11:58	3.33	1.00	4.23	8.71	0.49	0.98	0	Calculated
POND_OUT	CONDUIT	0	00:00	0.00	6.99	0.00	12.41	0.00	0.00	0	Calculated
100-yr_Orifice	ORIFICE	0	00:00			0.00			0.00		
2-yr_Orifice	ORIFICE	0	00:00			0.00			0.00		
100-yr_Weir	WEIR	0	00:00			0.00			0.00		

****
Flow Classification Summary
****

Link	--- Fraction of Time in Flow Class ---- Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change
IN1-MH1	0.00	0.01	0.00	0.99	0.00	0.00	0.00	0.32	0.0000
IN2-MH1	0.00	0.33	0.00	0.67	0.00	0.00	0.00	0.17	0.0000
MH1-MH2	0.00	0.00	0.00	0.95	0.05	0.00	0.00	0.32	0.0000
MH2-MH3	0.00	0.27	0.00	0.73	0.00	0.00	0.00	0.07	0.0000
MH3-Pond	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.03	0.0000
POND_OUT	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000

```
  ************************
  Highest Continuity Errors
  ************************
  Node EX_MH3 (5.00%)


  ***************************
  Time-Step Critical Elements
  ***************************
  None


  *******************************
  Highest Flow Instability Indexes
  *******************************
  All links are stable.


  ************************
  Routing Time Step Summary
  ************************
  Minimum Time Step           :     5.00 sec
  Average Time Step           :     5.00 sec
  Maximum Time Step           :     5.00 sec
  Percent in Steady State     :     0.00
  Average Iterations per Step :     2.00



  WARNING 108 : Surcharge elevation defined for Junction EX_MH3 is below junction maximum elevation. Assumed surcharge elevation equal to maximum
elevation.
  WARNING 002 : Max/rim elevation (depth) increased to account for connecting conduit height dimensions for Node EX_Box.

  Analysis began on:  Fri Oct 05 14:34:40 2018
  Analysis ended on:  Fri Oct 05 14:34:46 2018
  Total elapsed time: 00:00:06
```

Grand Valley Estates Filing II
Existing Model 10-year 24-hour Results

****
Project Description
****
File Name ..... 1129-004 EX Model.SPF

****
Analysis Options
****
Flow Units ..... cfs
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method ..... SCS Curve Number
Link Routing Method ..... Hydrodynamic
Storage Node Exfiltration.. Horton, wetted area
Starting Date JUL-04-2017 00:00:00
Ending Date JUL-08-2017 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:00:30
Wet Time Step 00:00:30
Dry Time Step 01:00:00
Routing Time Step ..... 5.00 sec

****
Element Count
****
Number of rain gages 1
Number of subbasins 5
Number of nodes 9
Number of links 9
Number of pollutants 0
Number of land uses 0

****
Subbasin Summary
****

Subbasin ID	Total Area acres	Equiv. Width ft	Imperv. Area %	Average Slope %	Raingage
EX-01	4.33	1200.00	12.00	1.0000	-
EX-02	0.75	60.00	75.00	1.0000	-
EX-03	2.26	1200.00	38.00	1.2000	-
EX-04	7.50	1000.00	38.00	0.5000	-
EX-OS1	0.59	300.00	25.00	0.8000	-

****
Node Summary
****

Node ID	Element Type	Invert Elevation ft	Maximum Elev. ft	Ponded Area ft²	External Inflow
EX_Box	JUNCTION	4523.00	4529.72	0.00	
EX_IN1	JUNCTION	4525.34	4529.00	0.00	
EX_IN2	JUNCTION	4525.34	4529.00	0.00	
EX_MH1	JUNCTION	4525.14	4529.00	0.00	
EX_MH2	JUNCTION	4524.15	4528.00	0.00	
EX_MH3	JUNCTION	4521.40	4532.00	0.00	
EX_Outlet	JUNCTION	4523.00	4526.72	0.00	
EX-OUT	OUTFALL	4522.90	4524.40	0.00	
EX_POND	STORAGE	4521.00	4527.00	0.00	

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length ft	Slope %	Manning's Roughness
IN1-MH1	EX_IN1	EX_MH1	CONDUIT	20.0	1.0000	0.0110
IN2-MH1	EX_IN2	EX_MH1	CONDUIT	20.0	1.0000	0.0110
MH1-MH2	EX_MH1	EX_MH2	CONDUIT	197.8	0.5004	0.0110
MH2-MH3	EX_MH2	EX_MH3	CONDUIT	550.0	0.5000	0.0110
MH3-Pond	EX_MH3	EX_POND	CONDUIT	81.2	0.4927	0.0110
POND_OUT	EX_Outlet	EX-OUT	CONDUIT	10.0	1.0000	0.0110
100-yr_Orifice	EX_Box	EX_Outlet	ORIFICE			
2-yr_Orifice	EX_POND	EX_Box	ORIFICE			
100-yr_Weir	EX_POND	EX_Box	WEIR			

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter ft	Width ft	No. of Barrels	Cross Sectional Area ft²	Full Flow Hydraulic Radius ft	Design Flow Capacity cfs
IN1-MH1	CIRCULAR	1.50	1.50	1	1.77	0.38	12.41
IN2-MH1	CIRCULAR	1.50	1.50	1	1.77	0.38	12.41
MH1-MH2	CIRCULAR	1.50	1.50	1	1.77	0.38	8.78
MH2-MH3	CIRCULAR	1.50	1.50	1	1.77	0.38	8.78
MH3-Pond	CIRCULAR	1.50	1.50	1	1.77	0.38	8.71
POND_OUT	CIRCULAR	1.50	1.50	1	1.77	0.38	12.41

********** Runoff Quantity Continuity	Volume acre-ft	Depth inches
Total Precipitation	1.440	1.120
Evaporation Loss	0.000	0.000
Infiltration Loss	0.808	0.628
Surface Runoff	0.504	0.392
Final Surface Storage	0.129	0.100
Continuity Error (%)	-0.002	

********** Flow Routing Continuity	Volume acre-ft	Volume Mgallons
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.504	0.164
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.002	0.001
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000

Final Stored Volume	0.500	0.163
Continuity Error (%)	0.342	

****
Composite Curve Number Computations Report
****

Subbasin EX-01

Soil/Surface Description	Area (acres)	Soil Group	CN
Brush, Poor	4.33	B	67.00
Composite Area & Weighted CN	4.33		67.00

Subbasin EX-02

Soil/Surface Description	Area (acres)	Soil Group	CN
Paved roads with curbs & sewers	0.75	B	98.00
Composite Area & Weighted CN	0.75		98.00

Subbasin EX-03

Soil/Surface Description	Area (acres)	Soil Group	CN
1/4 acre lots, 38% impervious	2.26	B	78.00
Composite Area & Weighted CN	2.26		78.00

Subbasin EX-04

Soil/Surface Description	Area (acres)	Soil Group	CN
1/4 acre lots, 38% impervious	7.50	B	78.00
Composite Area & Weighted CN	7.50		78.00

Subbasin EX-OS1

Soil/Surface Description	Area (acres)	Soil Group	CN
1/2 acre lots, 25% impervious	0.59	B	70.00
Composite Area & Weighted CN	0.59		70.00

****
EPA SWMM Time of Concentration Computations Report
****

Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

Where:

Tc = Time of Concentration (min)
L = Flow Length (ft)
n = Manning's Roughness
i = Rainfall Intensity (in/hr)
S = Slope (ft/ft)

Subbasin EX-01

Flow length (ft):	157.15
Pervious Manning's Roughness:	0.10000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (in/hr):	0.04667
Impervious Rainfall Intensity (in/hr):	0.04667
Slope (%):	1.00000
Computed TOC (minutes):	61.70

Subbasin EX-02

Flow length (ft):	545.97
Pervious Manning's Roughness:	0.10000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (in/hr):	0.04667
Impervious Rainfall Intensity (in/hr):	0.04667
Slope (%):	1.00000
Computed TOC (minutes):	61.22

Subbasin EX-03

Flow length (ft):	81.93
Pervious Manning's Roughness:	0.10000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (in/hr):	0.04667
Impervious Rainfall Intensity (in/hr):	0.04667
Slope (%):	1.20000
Computed TOC (minutes):	32.03

Subbasin EX-04

Flow length (ft):	326.71
Pervious Manning's Roughness:	0.10000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (in/hr):	0.04667
Impervious Rainfall Intensity (in/hr):	0.04667
Slope (%):	0.50000
Computed TOC (minutes):	95.51

Subbasin EX-OS1

Flow length (ft):	85.95
Pervious Manning's Roughness:	0.10000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (in/hr):	0.04667
Impervious Rainfall Intensity (in/hr):	0.04667
Slope (%):	0.80000

Computed TOC (minutes): 41.73

****
Subbasin Runoff Summary
****

Subbasin ID	Total Rainfall in	Total Runon in	Total Evap. in	Total Infil. in	Total Runoff in	Peak Runoff cfs	Runoff Coefficient	Time of Concentration days	Time of Concentration hh:mm:ss
EX-01	1.12	0.00	0.00	0.94	0.13	0.89	0.115	0	01:01:41
EX-02	1.12	0.00	0.00	0.05	0.98	0.88	0.876	0	01:01:12
EX-03	1.12	0.00	0.00	0.59	0.47	1.46	0.422	0	00:32:01
EX-04	1.12	0.02	0.00	0.50	0.49	4.29	0.430	0	01:35:30
EX-OS1	1.12	0.00	0.00	0.78	0.28	0.25	0.254	0	00:41:43

****
Node Depth Summary
****

Node ID	Average Depth Attained ft	Maximum Depth Attained ft	Maximum HGL Attained ft	Time of Max Occurrence days	Time of Max Occurrence hh:mm	Total Flooded Volume acre-in	Total Time Flooded minutes	Retention Time hh:mm:ss
EX_Box	0.00	0.01	4523.01	1	13:55	0	0	0:00:00
EX_IN1	0.02	0.56	4525.90	0	11:55	0	0	0:00:00
EX_IN2	0.01	0.53	4525.87	0	11:55	0	0	0:00:00
EX_MH1	0.02	0.67	4525.81	0	11:55	0	0	0:00:00
EX_MH2	0.02	0.61	4524.76	0	11:56	0	0	0:00:00
EX_MH3	2.24	2.60	4524.00	1	13:50	0	0	0:00:00
EX_Outlet	0.00	0.01	4523.01	1	13:56	0	0	0:00:00
EX-OUT	0.00	0.01	4522.91	1	13:56	0	0	0:00:00
EX_POND	2.62	3.00	4524.00	1	13:50	0	0	0:00:00

****
Node Flow Summary
****

Node ID	Element Type	Maximum Lateral Inflow cfs	Peak Inflow cfs	Time of Peak Inflow Occurrence days	Time of Peak Inflow Occurrence hh:mm	Maximum Flooding Overflow cfs	Time of Peak Flooding Occurrence days	Time of Peak Flooding Occurrence hh:mm
EX_Box	JUNCTION	0.00	0.00	1	13:50	0.00		
EX_IN1	JUNCTION	1.67	1.67	0	11:55	0.00		
EX_IN2	JUNCTION	1.46	1.46	0	11:55	0.00		
EX_MH1	JUNCTION	0.00	3.11	0	11:55	0.00		
EX_MH2	JUNCTION	0.00	3.09	0	11:55	0.00		
EX_MH3	JUNCTION	4.29	7.27	0	11:57	0.00		
EX_Outlet	JUNCTION	0.00	0.00	1	13:53	0.00		
EX-OUT	OUTFALL	0.00	0.00	1	13:56	0.00		
EX_POND	STORAGE	0.00	7.32	0	11:56	0.00		

****
Storage Node Summary
****

Storage Node ID	Maximum Ponded Volume 1000 ft³	Maximum Ponded Volume (%)	Time of Max Ponded Volume days	Time of Max Ponded Volume hh:mm	Average Ponded Volume 1000 ft³	Average Ponded Volume (%)	Maximum Storage Node Outflow cfs	Maximum Exfiltration Rate cfm	Time of Max. Exfiltration Rate hh:mm:ss	Total Exfiltrated Volume 1000 ft³
EX_POND	21.169	40	1	13:50	18.126	34	0.00	0.00	0:00:00	0.000

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow cfs	Peak Inflow cfs
EX-OUT	10.12	0.00	0.00
System	10.12	0.00	0.00

****
Link Flow Summary
****

Link ID	Element Type	Time of Peak Flow Occurrence days	Time of Peak Flow Occurrence hh:mm	Maximum Velocity Attained ft/sec	Length Factor	Peak Flow during Analysis cfs	Design Flow Capacity cfs	Ratio of Maximum /Design Flow	Ratio of Maximum Flow Depth	Total Time Surcharged minutes	Reported Condition
IN1-MH1	CONDUIT	0	11:55	2.49	3.49	1.66	12.41	0.13	0.41	0	Calculated
IN2-MH1	CONDUIT	0	11:55	2.26	3.49	1.45	12.41	0.12	0.40	0	Calculated
MH1-MH2	CONDUIT	0	11:55	4.36	1.00	3.09	8.78	0.35	0.42	0	Calculated
MH2-MH3	CONDUIT	0	11:56	2.27	1.00	3.00	8.78	0.34	0.70	0	Calculated
MH3-Pond	CONDUIT	0	11:56	4.15	1.00	7.32	8.71	0.84	1.00	5034	SURCHARGED
POND_OUT	CONDUIT	1	13:56	0.54	6.99	0.00	12.41	0.00	0.01	0	Calculated
100-yr_Orifice	ORIFICE	1	13:53			0.00			0.01		
2-yr_Orifice	ORIFICE	1	13:50			0.00			0.01		
100-yr_Weir	WEIR	0	00:00			0.00			0.00		

****
Flow Classification Summary
****

Link	--- Fraction of Time in Flow Class ---- Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change
IN1-MH1	0.00	0.01	0.00	0.99	0.00	0.00	0.00	0.32	0.0000
IN2-MH1	0.00	0.33	0.00	0.67	0.00	0.00	0.00	0.19	0.0000
MH1-MH2	0.00	0.00	0.00	0.88	0.12	0.00	0.00	0.34	0.0000
MH2-MH3	0.00	0.26	0.00	0.74	0.00	0.00	0.00	0.06	0.0000
MH3-Pond	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.03	0.0000
POND_OUT	0.33	0.00	0.00	0.67	0.00	0.00	0.00	0.38	0.0000

```
  ************************
  Highest Continuity Errors
  ************************
  Node EX_MH3 (2.79%)


  ***************************
  Time-Step Critical Elements
  ***************************
  None


  *******************************
  Highest Flow Instability Indexes
  *******************************
  All links are stable.


  ************************
  Routing Time Step Summary
  ************************
  Minimum Time Step           :     0.50 sec
  Average Time Step           :     4.99 sec
  Maximum Time Step           :     5.00 sec
  Percent in Steady State     :     0.00
  Average Iterations per Step :     2.00



  WARNING 108 : Surcharge elevation defined for Junction EX_MH3 is below junction maximum elevation. Assumed surcharge elevation equal to maximum
elevation.
  WARNING 002 : Max/rim elevation (depth) increased to account for connecting conduit height dimensions for Node EX_Box.

  Analysis began on:  Fri Oct 05 14:39:45 2018
  Analysis ended on:  Fri Oct 05 14:39:51 2018
  Total elapsed time: 00:00:06
```

Grand Valley Estates Filing II
Existing Model 100-year 24-hour Results

****
Project Description
****
File Name ..... 1129-004 EX Model.SPF

****
Analysis Options
****
Flow Units ..... cfs
Subbasin Hydrograph Method. EPA SWMM
Infiltration Method ..... SCS Curve Number
Link Routing Method ..... Hydrodynamic
Storage Node Exfiltration.. Horton, wetted area
Starting Date JUL-04-2017 00:00:00
Ending Date JUL-08-2017 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:00:30
Wet Time Step 00:00:30
Dry Time Step 01:00:00
Routing Time Step ..... 5.00 sec

****
Element Count
****
Number of rain gages 1
Number of subbasins 5
Number of nodes 9
Number of links 9
Number of pollutants 0
Number of land uses 0

****
Subbasin Summary
****

Subbasin ID	Total Area acres	Equiv. Width ft	Imperv. Area %	Average Slope %	Raingage
EX-01	4.33	1200.00	12.00	1.0000	-
EX-02	0.75	60.00	75.00	1.0000	-
EX-03	2.26	1200.00	38.00	1.2000	-
EX-04	7.50	1000.00	38.00	0.5000	-
EX-OS1	0.59	300.00	25.00	0.8000	-

****
Node Summary
****

Node ID	Element Type	Invert Elevation ft	Maximum Elev. ft	Ponded Area ft²	External Inflow
EX_Box	JUNCTION	4523.00	4529.72	0.00	
EX_IN1	JUNCTION	4525.34	4529.00	0.00	
EX_IN2	JUNCTION	4525.34	4529.00	0.00	
EX_MH1	JUNCTION	4525.14	4529.00	0.00	
EX_MH2	JUNCTION	4524.15	4528.00	0.00	
EX_MH3	JUNCTION	4521.40	4532.00	0.00	
EX_Outlet	JUNCTION	4523.00	4526.72	0.00	
EX-OUT	OUTFALL	4522.90	4524.40	0.00	
EX_POND	STORAGE	4521.00	4527.00	0.00	

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length ft	Slope %	Manning's Roughness
IN1-MH1	EX_IN1	EX_MH1	CONDUIT	20.0	1.0000	0.0110
IN2-MH1	EX_IN2	EX_MH1	CONDUIT	20.0	1.0000	0.0110
MH1-MH2	EX_MH1	EX_MH2	CONDUIT	197.8	0.5004	0.0110
MH2-MH3	EX_MH2	EX_MH3	CONDUIT	550.0	0.5000	0.0110
MH3-Pond	EX_MH3	EX_POND	CONDUIT	81.2	0.4927	0.0110
POND_OUT	EX_Outlet	EX-OUT	CONDUIT	10.0	1.0000	0.0110
100-yr_Orifice	EX_Box	EX_Outlet	ORIFICE			
2-yr_Orifice	EX_POND	EX_Box	ORIFICE			
100-yr_Weir	EX_POND	EX_Box	WEIR			

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter ft	Width ft	No. of Barrels	Cross Sectional Area ft²	Full Flow Hydraulic Radius ft	Design Flow Capacity cfs
IN1-MH1	CIRCULAR	1.50	1.50	1	1.77	0.38	12.41
IN2-MH1	CIRCULAR	1.50	1.50	1	1.77	0.38	12.41
MH1-MH2	CIRCULAR	1.50	1.50	1	1.77	0.38	8.78
MH2-MH3	CIRCULAR	1.50	1.50	1	1.77	0.38	8.78
MH3-Pond	CIRCULAR	1.50	1.50	1	1.77	0.38	8.71
POND_OUT	CIRCULAR	1.50	1.50	1	1.77	0.38	12.41

********** Runoff Quantity Continuity	Volume acre-ft	Depth inches
Total Precipitation	2.585	2.010
Evaporation Loss	0.000	0.000
Infiltration Loss	1.184	0.921
Surface Runoff	1.272	0.989
Final Surface Storage	0.129	0.100
Continuity Error (%)	-0.003	

********** Flow Routing Continuity	Volume acre-ft	Volume Mgallons
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	1.272	0.414
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.771	0.251
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000

Final Stored Volume	0.500	0.163
Continuity Error (%)	0.076	

****
Composite Curve Number Computations Report
****

Subbasin EX-01

Soil/Surface Description	Area (acres)	Soil Group	CN
Brush, Poor	4.33	B	67.00
Composite Area & Weighted CN	4.33		67.00

Subbasin EX-02

Soil/Surface Description	Area (acres)	Soil Group	CN
Paved roads with curbs & sewers	0.75	B	98.00
Composite Area & Weighted CN	0.75		98.00

Subbasin EX-03

Soil/Surface Description	Area (acres)	Soil Group	CN
1/4 acre lots, 38% impervious	2.26	B	78.00
Composite Area & Weighted CN	2.26		78.00

Subbasin EX-04

Soil/Surface Description	Area (acres)	Soil Group	CN
1/4 acre lots, 38% impervious	7.50	B	78.00
Composite Area & Weighted CN	7.50		78.00

Subbasin EX-OS1

Soil/Surface Description	Area (acres)	Soil Group	CN
1/2 acre lots, 25% impervious	0.59	B	70.00
Composite Area & Weighted CN	0.59		70.00

****
EPA SWMM Time of Concentration Computations Report
****

Tc = (0.94 * (L^0.6) * (n^0.6)) / ((i^0.4) * (S^0.3))

Where:

Tc = Time of Concentration (min)
L = Flow Length (ft)
n = Manning's Roughness
i = Rainfall Intensity (in/hr)
S = Slope (ft/ft)

Subbasin EX-01

Flow length (ft):	157.15
Pervious Manning's Roughness:	0.10000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (in/hr):	0.08375
Impervious Rainfall Intensity (in/hr):	0.08375
Slope (%):	1.00000
Computed TOC (minutes):	48.82

Subbasin EX-02

Flow length (ft):	545.97
Pervious Manning's Roughness:	0.10000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (in/hr):	0.08375
Impervious Rainfall Intensity (in/hr):	0.08375
Slope (%):	1.00000
Computed TOC (minutes):	48.44

Subbasin EX-03

Flow length (ft):	81.93
Pervious Manning's Roughness:	0.10000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (in/hr):	0.08375
Impervious Rainfall Intensity (in/hr):	0.08375
Slope (%):	1.20000
Computed TOC (minutes):	25.35

Subbasin EX-04

Flow length (ft):	326.71
Pervious Manning's Roughness:	0.10000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (in/hr):	0.08375
Impervious Rainfall Intensity (in/hr):	0.08375
Slope (%):	0.50000
Computed TOC (minutes):	75.58

Subbasin EX-OS1

Flow length (ft):	85.95
Pervious Manning's Roughness:	0.10000
Impervious Manning's Roughness:	0.01500
Pervious Rainfall Intensity (in/hr):	0.08375
Impervious Rainfall Intensity (in/hr):	0.08375
Slope (%):	0.80000

Computed TOC (minutes): 33.02

****
Subbasin Runoff Summary
****

Subbasin ID	Total Rainfall in	Total Runon in	Total Evap. in	Total Infil. in	Total Runoff in	Peak Runoff cfs	Runoff Coefficient	Time of Concentration days	Time of Concentration hh:mm:ss
EX-01	2.01	0.00	0.00	1.40	0.56	1.66	0.277	0	00:48:49
EX-02	2.01	0.00	0.00	0.05	1.87	1.79	0.929	0	00:48:26
EX-03	2.01	0.00	0.00	0.83	1.13	3.51	0.563	0	00:25:20
EX-04	2.01	0.06	0.00	0.74	1.19	9.00	0.572	0	01:15:34
EX-OS1	2.01	0.00	0.00	1.15	0.81	0.50	0.403	0	00:33:01

****
Node Depth Summary
****

Node ID	Average Depth Attained ft	Maximum Depth Attained ft	Maximum HGL Attained ft	Time of Max Occurrence days	Time of Max Occurrence hh:mm	Total Flooded Volume acre-in	Total Time Flooded minutes	Retention Time hh:mm:ss
EX_Box	0.07	0.80	4523.80	0	13:03	0	0	0:00:00
EX_IN1	0.03	3.73	4529.07	0	11:57	0	0	0:00:00
EX_IN2	0.02	3.74	4529.08	0	11:57	0	0	0:00:00
EX_MH1	0.04	3.86	4529.00	0	11:57	0	0	0:00:00
EX_MH2	0.05	3.96	4528.11	0	11:57	0	0	0:00:00
EX_MH3	2.37	4.76	4526.16	0	11:57	0	0	0:00:00
EX_Outlet	0.05	0.52	4523.52	0	13:03	0	0	0:00:00
EX-OUT	0.04	0.38	4523.28	0	13:03	0	0	0:00:00
EX_POND	2.75	3.67	4524.67	0	13:02	0	0	0:00:00

****
Node Flow Summary
****

Node ID	Element Type	Maximum Lateral Inflow cfs	Peak Inflow cfs	Time of Peak Inflow Occurrence days	Time of Peak Inflow Occurrence hh:mm	Maximum Flooding Overflow cfs	Time of Peak Flooding Occurrence days	Time of Peak Flooding Occurrence hh:mm
EX_Box	JUNCTION	0.00	1.77	0	13:02	0.00		
EX_IN1	JUNCTION	3.45	3.45	0	11:57	0.00		
EX_IN2	JUNCTION	3.51	3.51	0	11:57	0.00		
EX_MH1	JUNCTION	0.00	6.92	0	11:57	0.00		
EX_MH2	JUNCTION	0.00	6.93	0	11:57	0.00		
EX_MH3	JUNCTION	9.00	15.89	0	11:57	0.00		
EX_Outlet	JUNCTION	0.00	1.77	0	13:03	0.00		
EX-OUT	OUTFALL	0.00	1.77	0	13:03	0.00		
EX_POND	STORAGE	0.00	15.87	0	11:57	0.00		

****
Storage Node Summary
****

Storage Node ID	Maximum Ponded Volume 1000 ft³	Maximum Ponded Volume (%)	Time of Max Ponded Volume days	Time of Max Ponded Volume hh:mm	Average Ponded Volume 1000 ft³	Average Ponded Volume (%)	Maximum Storage Node Outflow cfs	Maximum Exfiltration Rate cfm	Time of Max. Exfiltration Rate hh:mm:ss	Total Exfiltrated Volume 1000 ft³
EX_POND	27.609	52	0	13:02	19.172	36	1.77	0.00	0:00:00	0.000

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow cfs	Peak Inflow cfs
EX-OUT	38.50	0.25	1.77
System	38.50	0.25	1.77

****
Link Flow Summary
****

Link ID	Element Type	Time of Peak Flow Occurrence days	Time of Peak Flow Occurrence hh:mm	Maximum Velocity Attained ft/sec	Length Factor	Peak Flow during Analysis cfs	Design Flow Capacity cfs	Ratio of Maximum /Design Flow	Ratio of Maximum Flow Depth	Total Time Surcharged minutes	Reported Condition
IN1-MH1	CONDUIT	0	11:57	2.63	3.49	3.43	12.41	0.28	1.00	3	SURCHARGED
IN2-MH1	CONDUIT	0	11:57	2.56	3.49	3.49	12.41	0.28	1.00	3	SURCHARGED
MH1-MH2	CONDUIT	0	11:57	4.81	1.00	6.93	8.78	0.79	1.00	4	SURCHARGED
MH2-MH3	CONDUIT	0	11:57	3.92	1.00	6.93	8.78	0.79	1.00	8	SURCHARGED
MH3-Pond	CONDUIT	0	11:57	8.98	1.00	15.87	8.71	1.82	1.00	5055	SURCHARGED
POND_OUT	CONDUIT	0	13:03	3.93	6.99	1.77	12.41	0.14	0.30	0	Calculated
100-yr_Orifice	ORIFICE	0	13:03			1.77			0.66		
2-yr_Orifice	ORIFICE	0	13:02			1.77			1.00		
100-yr_Weir	WEIR	0	00:00			0.00			0.00		

****
Flow Classification Summary
****

Link	--- Fraction of Time in Flow Class ---- Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change
IN1-MH1	0.00	0.01	0.00	0.99	0.00	0.00	0.00	0.35	0.0000
IN2-MH1	0.00	0.33	0.00	0.67	0.00	0.00	0.00	0.18	0.0000
MH1-MH2	0.00	0.00	0.00	0.82	0.18	0.00	0.00	0.34	0.0000
MH2-MH3	0.00	0.26	0.00	0.74	0.00	0.00	0.00	0.05	0.0000
MH3-Pond	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.03	0.0001
POND_OUT	0.13	0.00	0.00	0.58	0.29	0.00	0.00	0.69	0.0000

```
  ************************
  Highest Continuity Errors
  ************************
  Node EX_MH3 (1.07%)


  ***************************
  Time-Step Critical Elements
  ***************************
  None


  *******************************
  Highest Flow Instability Indexes
  *******************************
  All links are stable.


  ************************
  Routing Time Step Summary
  ************************
  Minimum Time Step           :     0.50 sec
  Average Time Step           :     5.00 sec
  Maximum Time Step           :     5.00 sec
  Percent in Steady State     :     0.00
  Average Iterations per Step :     2.01



  WARNING 108 : Surcharge elevation defined for Junction EX_MH3 is below junction maximum elevation. Assumed surcharge elevation equal to maximum
elevation.
  WARNING 002 : Max/rim elevation (depth) increased to account for connecting conduit height dimensions for Node EX_Box.

  Analysis began on:  Fri Oct 05 14:42:20 2018
  Analysis ended on:  Fri Oct 05 14:42:27 2018
  Total elapsed time: 00:00:07
```