



**CONCEPTUAL DRAINAGE REPORT  
FOR  
GRAZING YAK SOLAR PROJECT  
EL PASO COUNTY, CO  
(WSE-O)**

**PREPARED FOR:**

GRAZING YAK SOLAR, LLC.  
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**PREPARED BY:**

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CORE PROJECT NUMBER: 18-082

OCTOBER 23, 2018  
*REVISED JANUARY 16, 2019*  
*REVISED FEBRUARY 11, 2019*

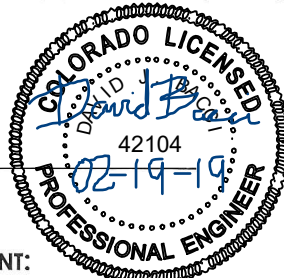
**PCD FILE NUMBER  
WSEO-18-002**



**APPROVAL BLOCKS**

**I. DESIGN ENGINEER'S STATEMENT:**

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



\_\_\_\_\_  
David Bacci, P.E. #42104

\_\_\_\_\_  
Date

**II. OWNER/DEVELOPER'S STATEMENT:**

I, the developer, have read and will comply with all the requirements specified in this Drainage Report and Plan.

\_\_\_\_\_  
Development Manager

**III. EL PASO COUNTY STATEMENT:**

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

\_\_\_\_\_  
Jennifer Irvine, PE  
County Engineer / ECM Administrator

\_\_\_\_\_  
Date

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DRAINAGE PLAN



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## **I. GENERAL LOCATION AND DESCRIPTION**

### **A. SITE LOCATION**

This Conceptual Drainage Report has been prepared on behalf of Grazing Yak Solar, LLC for the development of the proposed Grazing Yak Solar Project, referred to as "The Project". The Project would consist of a 35 megawatt (MW) utility scale photovoltaic solar facility and underground collection line that would encompass approximately 317 acres in El Paso County (EPC), Colorado. The solar array site, referred to as "The Site", is located to the east of the intersection of McQueen Road and Washington Road, approximately 4 miles southeast of the Town of Calhan on private, agricultural land. Rural residences and agricultural land surround the Site, as well as the Golden West Wind Energy Center located to the north, west, and south. The Site is located on 272-acres in Section 29, Township 12 South, Range 61 West of the 6<sup>th</sup> Principal Meridian, El Paso County, Colorado. A vicinity map for the site can be found in Appendix A.

### **B. DESCRIPTION OF PROPERTY**

The Site is flat to gently rolling, at elevations ranging from approximately 6,830 to 6,735 feet. The site has naturally occurring slopes ranging from 2 to 10 percent and is currently agricultural land. Surface runoff is to the north, south and east. Runoff from the northern portion of the site flows north overland through multiple conveyances. These flows continue north under Washington through a culvert and eventually into Horse Creek. Flows from the central portion of the site flow toward the drainage that bisects the site. Runoff travels east of the project through an unnamed drainage and eventually into Horse Creek. Flows from the southeast portion of the site flow southeast into an unnamed drainage and eventually into Horse Creek. The proposed improvements to the site consist of a 35 megawatt (MW) photovoltaic solar array, inverters, dirt and gravel access paths, and other necessary ancillary features. The soils vary throughout the site and include mainly Truckton sandy loam, (Hydrologic soil group A), Truckton-Bresser complex (Hydrologic soil group A), Bresser sandy loam (Hydrologic soil group B) and Ascalon sandy loam (Hydrologic soil group B). A soils map has been provided and can be found in Appendix A.

## **II. DRAINAGE BASINS AND SUB-BASINS**

### **A. MAJOR DRAINAGE BASINS**

The existing drainage patterns for the major basin will follow the historic patterns. Grazing Yak will drain north, east and south through drainageways and culverts and eventually discharging into Horse Creek. Horse Creek flows to the east and is part of the Arkansas River basin

The site falls within Zone X, as shown on the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) panels 08041C0650 G and 0841C0625 G. A copy of the FIRM maps can be found in Appendix A.

## **B. MINOR DRAINAGE BASINS**

Minor Drainage Basins for Grazing Yak Solar Project have been delineated per the preliminary layout of the solar arrays. Layout of the arrays and dirt and gravel access paths may change during the preliminary development of the site. The developed minor basins will include pole mounted solar arrays with native ground beneath and dirt and gravel access roads constructed of 12" re-compacted soil and Class 5 Gravel respectively. An Extended Detention Basin for the site will be designed to mitigate the increase in runoff. The EDB will be privately owned and maintained. Overall, the proposed drainage patterns for the sub-basins will follow the historic patterns prior to development. For sub-basins within the site, runoff will drain to the north, south and east.

Basin (A1) consists of dirt access paths, a portion of the solar array and offsite undeveloped land. Runoff generated in this basin will flow northeast toward the western property line of the project site. The runoff flows northeast, into the unnamed drainage bisecting the site. This runoff is conveyed through the site and eventually into Horse Creek.

Basin (A2) consists of dirt access paths, a portion of the solar array and offsite undeveloped land. Runoff generated in this basin will flow northeast toward the southern property line of the project site. The runoff flows east and northeast, into the unnamed drainage bisecting the site. This runoff is conveyed through the site and eventually into Horse Creek.

Basin (A3) consists of dirt access paths, a portion of the solar array and offsite undeveloped land. Runoff generated in this basin will flow north and east toward and existing stock pond located in the unnamed drainage within the project site. The runoff exits the stock pond into the unnamed drainage bisecting the site and travels northeast. This runoff leaves the site at the eastern boundary and eventually into Horse Creek.

Basin (A4) consists of gravel access paths, dirt access paths, and a portion of the solar array. Runoff generated in this basin will flow north and south into the unnamed drainage and an extended detention basin (EDB) respectively within the project site. The EDB will be sized to provide a 10% reduction in predevelopment flows generate by the increase in imperviousness for the total site. Runoff is discharged from the EDB into the unnamed drainage and conveyed to the eastern property line. This runoff leaves the site at the eastern boundary and eventually into Horse Creek.

Basin (B1) consists of dirt access paths and a portion of the solar array. Runoff generated in this basin will flow to the south east and eventually into Horse Creek. Flowrates or flow patterns within this basin will not be affected by this development.

Basin (B2) consists of dirt access paths and a portion of the solar array. Runoff generated in this basin will flow to the south east and eventually into Horse Creek. Flowrates or flow patterns within this basin will not be affected by this development.

Basin (C1) consists of dirt access paths and a portion of the solar array. Runoff generated in this basin flows will travel north through multiple conveyances towards the northern property line, under Washington road through a culvert and eventually into Horse Creek. Flowrates or flow patterns within this basin will not be affected by this development.

Basin (D1) consists of gravel access paths, a portion of the solar array and undeveloped land. The increase in imperviousness is being mitigated in the EDB located in basing A4. Runoff generated in this basin flows will travel north along the proposed site access road towards Washington Rd. Flows are conveyed under Washington road through a culvert and eventually into Horse Creek. Flowrates or flow patterns within this basin will not be affected by this development.

### **III. DRAINAGE DESIGN CRITERIA**

#### **A. REGULATIONS**

This Conceptual Drainage Report is in accordance with El Paso County Drainage Criteria Manual and the *Urban Drainage and Flood Control District (UDFCD) Storm Drainage Criteria Manual*. These manuals were used as a basis of design for the site. All applicable tables, figures, and charts from the referenced reports and criteria manuals used in the drainage design of the site can be found in Appendix B. The report will analyze the minor (5-year) and major (100-year) storm events.

#### **B. DRAINAGE STUDIES, MASTER PLANS, AND SITE CONSTRAINTS**

There are no previous drainage studies, master plans or site constraints for this development.

#### **C. HYDROLOGY**

All the basins within the site were less than 160 acres thus the Rational Method was used to determine the flow rates for various basins within the site. The sub-basins were delineated based on the existing topography for the project. Flow rates for each basin can be found in Appendix A. The impervious panels are going to be

pole mounted with the ground underneath them to remain vegetated. The main access from Washington Road to just south of the unnamed drainage will be constructed with Class 5 Gravel. The remaining site access paths will be constructed as recompacted dirt to promote infiltration back into the ground.

The intensity-frequency curves used in the Rational Method calculations were taken from the El Paso County Drainage Criteria Manual. All drainage facilities were analyzed and designed for both the minor (5-year) and major (100-year) storm events. Time of concentration calculations were used to determine the rainfall intensity. These calculations also can be found in Appendix A.

#### **D. HYDRAULICS**

Hydraulic calculations for the EDB sizing were based on UDFCD design spreadsheets. Street and inlet capacity will not be necessary for this development.

#### **E. WATER QUALITY ENHANCEMENT**

The Project will require gravel access paths to a small portion of the site for access year-round. The remaining access paths will be constructed of recompacted dirt. The Project will employ runoff reduction practices such as allowing sheet flow across grass buffers and minimizing the increased imperviousness to 2% total for the site post construction. The site consists of Type A & B soils, allowing for optimal infiltration throughout the site. The proposed water quality facility for the site was designed as an EDB which incorporates a structure that release flows for the water quality capture volume (WQCV), Excess Urban Runoff Volume (EURV), and the 100-year storm event. The preliminary design of this structure can be found in the Appendix. The EDB is located in an area with a NRCS Type A soil designation. The EDB is located to receive the sheet flow runoff from the basin with the increased imperviousness. The total area of increased imperviousness (approximately 2 acres of 270 acres) will create a minimal impact to the natural drainageway that stabilization beyond protection at the EDB outlet will not be necessary. The natural drainageway will be protected from sediment discharge, introduction of contaminants and other site operations during construction activities in conformance with El Paso County GEC requirements and MS4 permit.

### **IV. STORMWATER MANAGEMENT FACILITY DESIGN**

#### **A. STORMWATER CONVEYANCE FACILITIES**

The general concept for the drainage design is to maintain the historic drainage patterns and release rates. This approach reduces the impacts to existing channels and ultimately Horse Creek. No public infrastructure is proposed within this site.

#### **B. STORMWATER STORAGE FACILITIES**

Preliminary basin A4 EDB pond sizing calculations can be found in the Appendix. The EDB mitigates the increase of runoff generated by the gravel access road. Runoff

generated by the access roads will sheet flows into the EDB. The EDB will have an approximate volume of 1.4 acre-feet and release below historic runoff rates.

**C. WATER QUALITY ENHANCEMENT BEST MANAGEMENT PRACTICES**

Water quality measures have been included in the design of the proposed EDBs. The basin will be designed to incorporate a structure that release flows for the water quality capture volume (WQCV) and the 100-year storm event.

**D. FLOODPLAIN MODIFICATION**

There will be no modification to the floodplain.

**E. ADDITIONAL PERMITTING REQUIREMENTS**

No additional permitting will be required for this site.

**F. GENERAL**

All applicable tables, figures, and charts from the referenced reports and criteria manuals used in the drainage design of the site can be found in the Appendix. The site is not going to be platted at this time therefore no drainage fees are due.

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**REFERENCES**

- A. El Paso County Drainage Criteria Manual, Volumes 1 and 2.
- B. Drainage Criteria Manual, Volumes 1, 2, & 3, Urban Drainage and Flood Control District, June 2001, Revised June 2004.

## **APPENDIX**

### **HYDROLOGIC CALCULATIONS**

VICINITY MAP

FIRM MAP

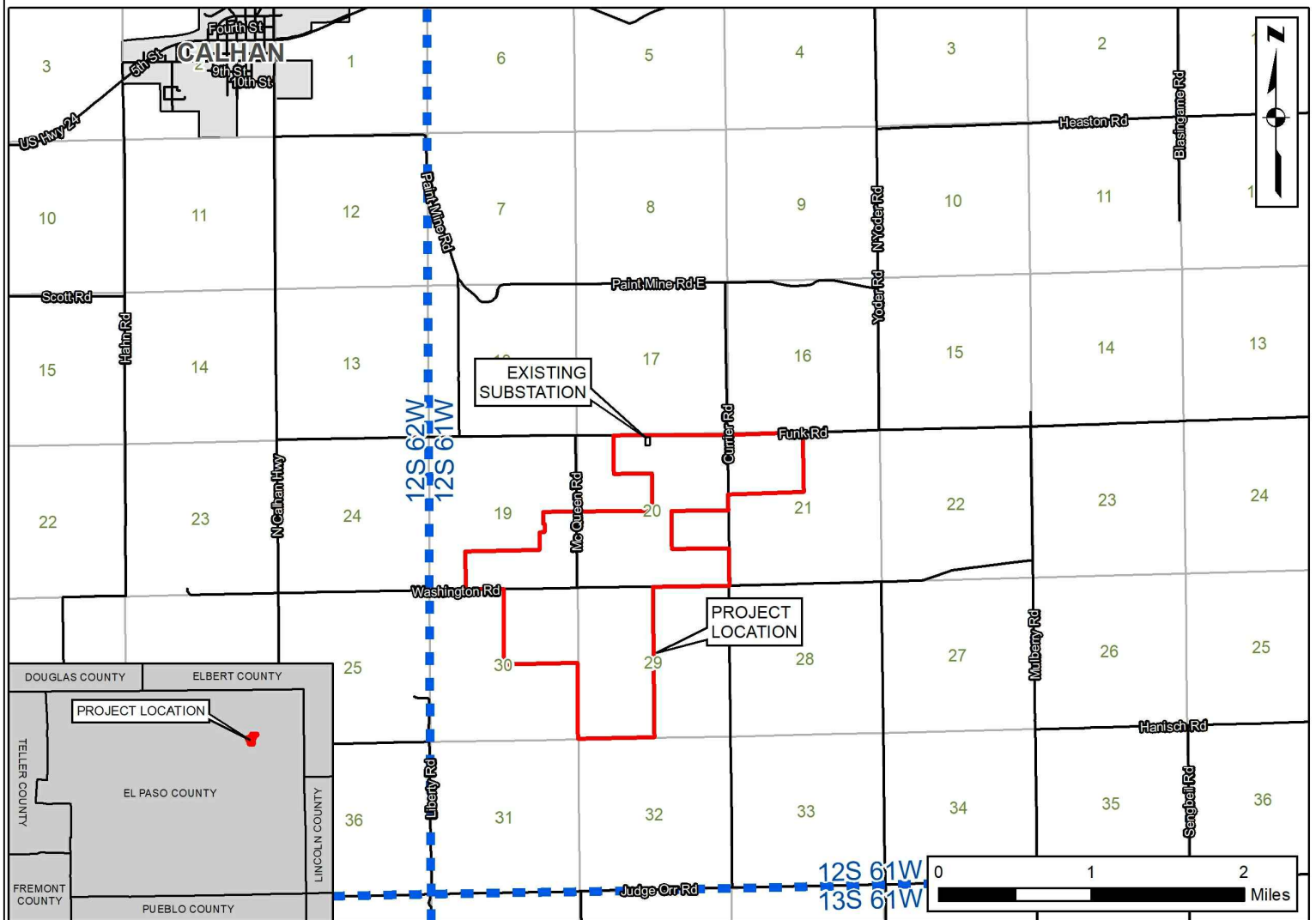
SOILS MAP

CIA CALCULATIONS

REFERENCE MATERIAL

PRELIMINARY DETENTION POND SIZING

DRAINAGE PLAN



PROJECT: GRAZING YAK SOLAR DR: D. BACCI  
 PRELIMINARY DRAINAGE REPORT DS: D. BACCI  
 DATE: 10/11/18 P.M. D. BACCI  
 SHEET 1 OF 1



CIVIL ENGINEERING  
 DEVELOPMENT CONSULTING  
 LAND SURVEYING  
 NATURAL RESOURCES  
 303.703.4444  
 1950 W. Littleton Blvd., Ste. 109  
 Littleton, CO 80120



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.

**Coastal Base Flood Elevations** shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). 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.

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.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, 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 (NAVD88)**. 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, MD 20910-3282

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 provided in digital format by El Paso County, Colorado Springs Utilities, and Anderson Consulting Engineers, Inc. These data are current as of 2006.

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. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

**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.

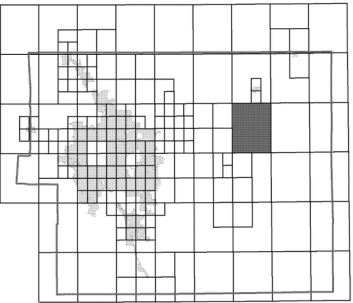
Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which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

Contact **FEMA Map Service Center (MSC)** via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 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 MSC 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/business/nfp>.

El Paso County Vertical Datum Offset Table	
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

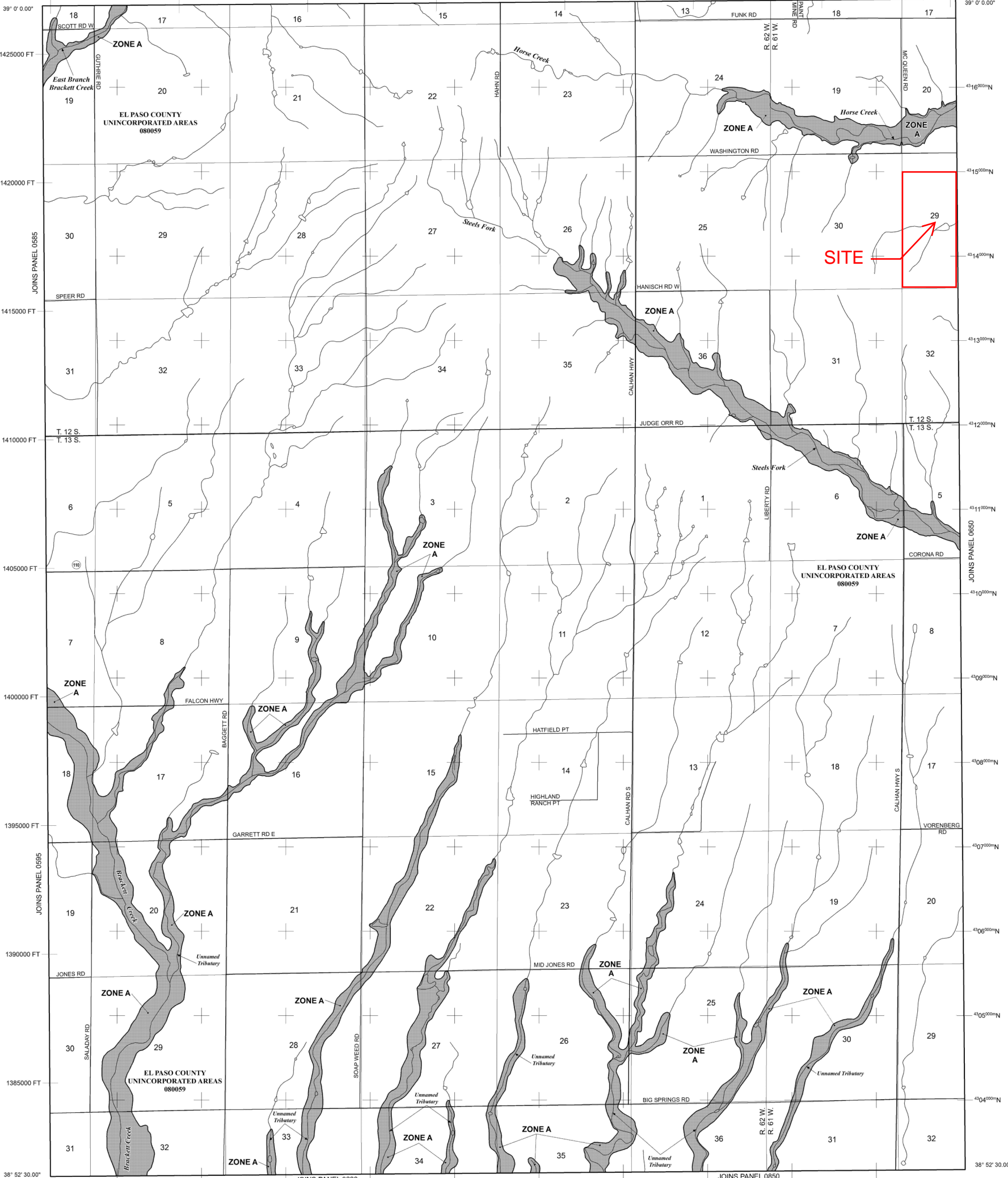
**Panel Location Map**



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



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



the 1% annual chance flood (100-year flood), also known as the **base flood**, is the flood that has a 1% chance of being equalled 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 Area 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.

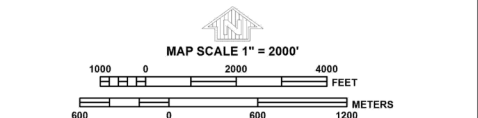
**OTHER AREAS**  
**ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.  
**ZONE D** Areas in which flood hazards are undetermined, but possible.

**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.

- 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.
- 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 (NAVD 88)
- Cross section line
- Transect line
- Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 1000-meter Universal Transverse Mercator grid ticks, zone 13
- 5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
- Bench mark (see explanation in Notes to Users section of this FIRM panel)
- River Mile
- MAP REPOSITORIES  
Refer to Map Repositories list on Map Index
- EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP  
MARCH 17, 1997
- EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL  
DECEMBER 7, 2018, to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

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.



**NFIP** **PANEL 0625G**

**FIRM**  
**FLOOD INSURANCE RATE MAP**  
**EL PASO COUNTY, COLORADO AND INCORPORATED AREAS**

**PANEL 625 OF 1300**  
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

**CONTAINS:**  

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080059	0625	G

Notes 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**  
**08041C0625G**  
**MAP REVISED**



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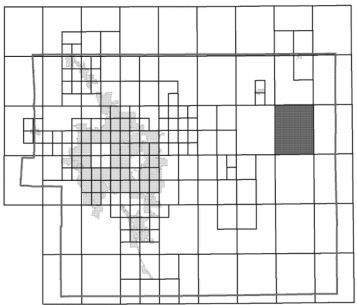
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Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

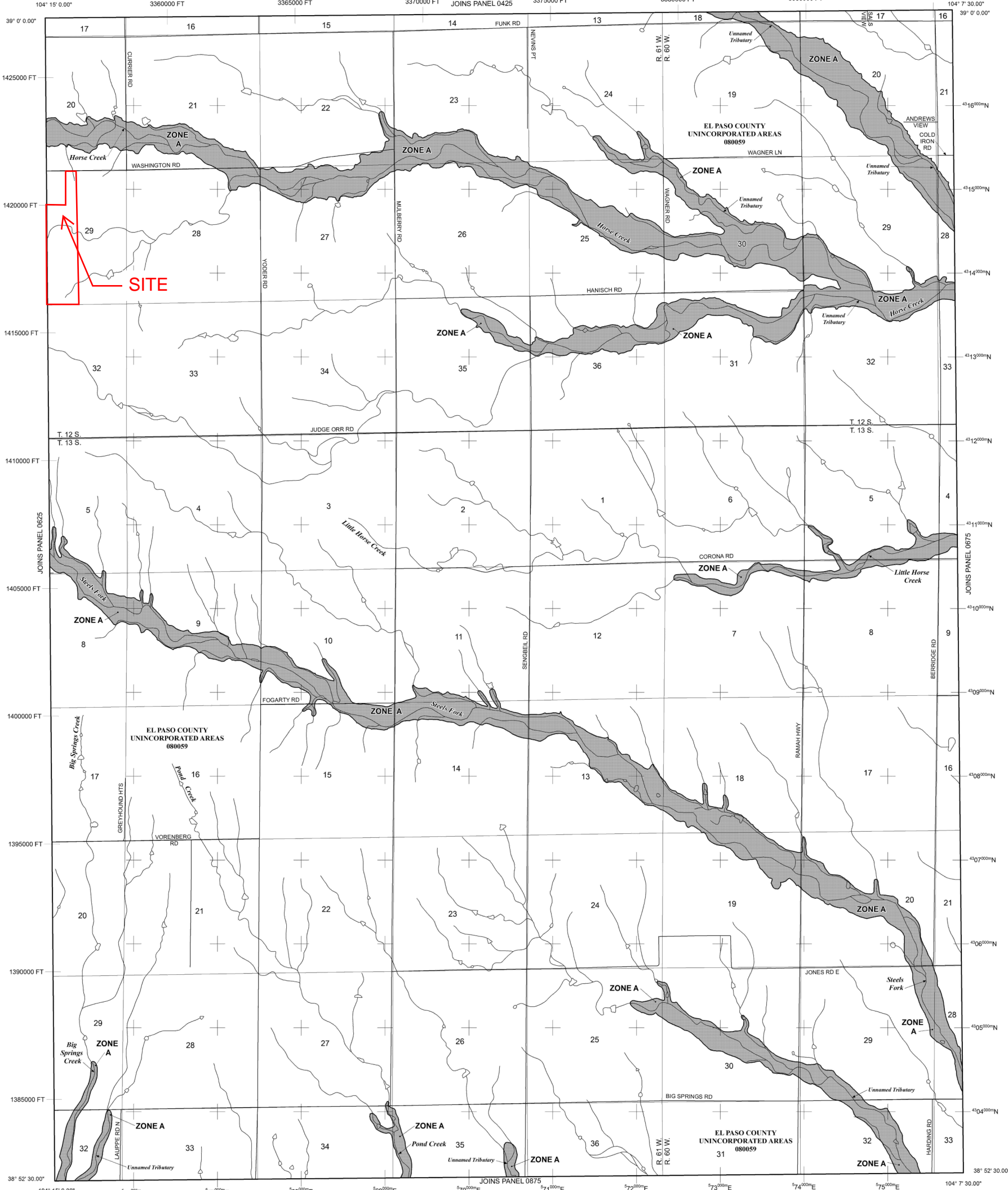
Panel Location Map



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



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



The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equalled 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 Area 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.

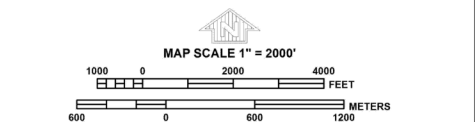
- Floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- Base Flood Elevation line and value; elevation in feet\* (EL 987)
- Base Flood Elevation value where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

\* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

- Cross section line
- Transect line
- Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 1000-meter Universal Transverse Mercator grid ticks, zone 13
- 5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
- Bench mark (see explanation in Notes to Users section of this FIRM panel)
- River Mile

**MAP REPOSITORIES**  
Refer to Map Repositories list on Map Index  
**EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP**  
MARCH 17, 1997  
**EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL**  
DECEMBER 7, 2016 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

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.



**NFIP** **PANEL 0650G**

**FIRM**  
**FLOOD INSURANCE RATE MAP**  
**EL PASO COUNTY, COLORADO AND INCORPORATED AREAS**

**PANEL 650 OF 1300**  
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

**CONTAINS:**  

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080059	0650	G

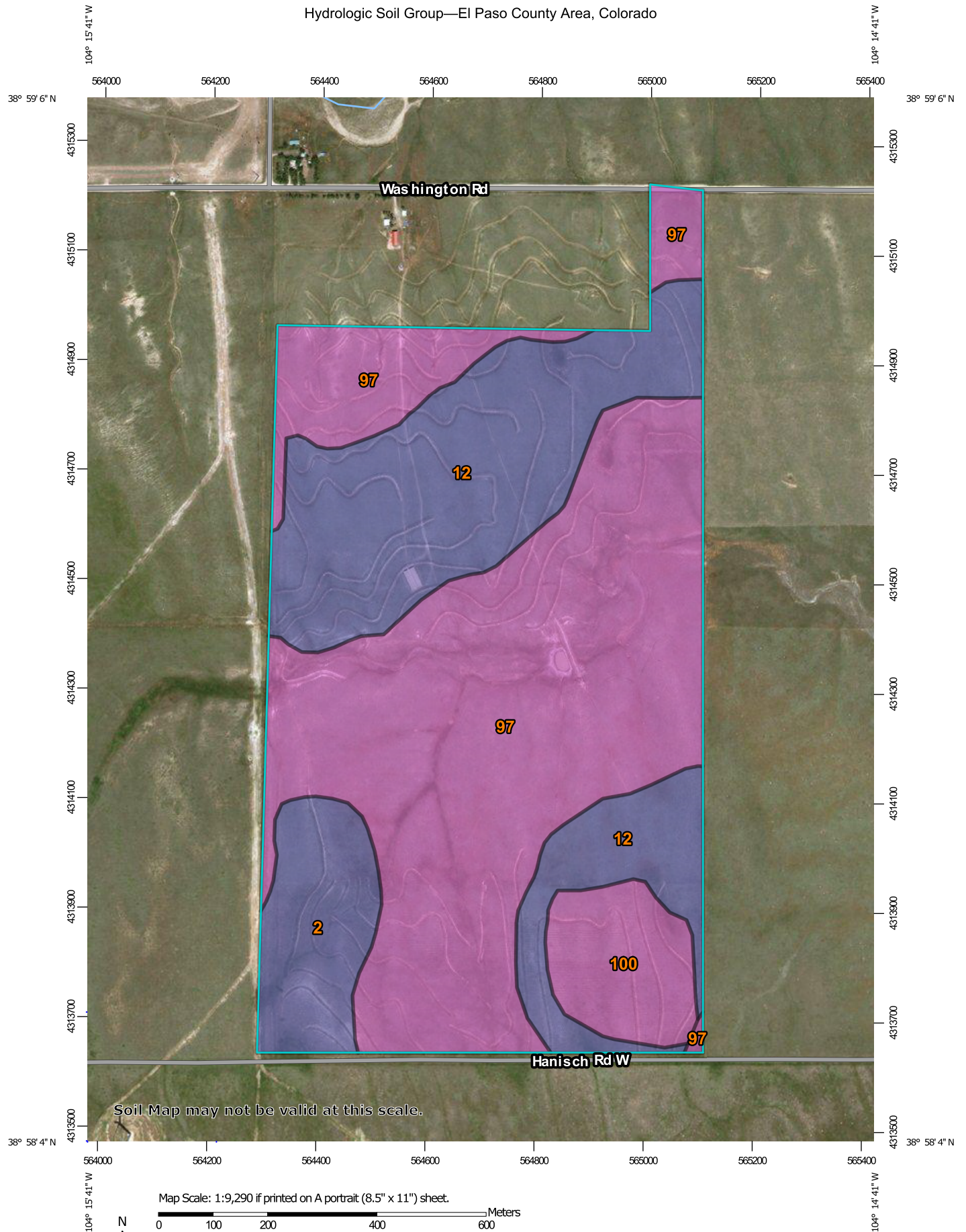
Notes to User: The Map Number shown below should be used when placing map orders. The Community Number shown above should be used on insurance applications for the subject community.

**MAP NUMBER**  
**08041C0650G**

**MAP REVISED**




# Hydrologic Soil Group—El Paso County Area, Colorado






## 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 15, Oct 10, 2017

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

Date(s) aerial images were photographed: May 22, 2016—Mar 9, 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
2	Ascalon sandy loam, 1 to 3 percent slopes	B	21.3	7.9%
12	Bresser sandy loam, cool, 3 to 5 percent slopes	B	79.4	29.6%
97	Truckton sandy loam, 3 to 9 percent slopes	A	150.7	56.2%
100	Truckton-Bresser complex, eroded	A	16.9	6.3%
<b>Totals for Area of Interest</b>			<b>268.3</b>	<b>100.0%</b>

## Description

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

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

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

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

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

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

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

## Rating Options

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff:* None Specified

*Tie-break Rule:* Higher

## Grazing Yak Solar

CORE Project #: 18-082

Prepared By: DJB

### COMPOSITE BASIN - WEIGHTED "C" CALCULATIONS

-REFERENCE UDFCD Vol.1 RUNOFF Table 6-3

	Residential							Lawns				
	Single Family			Multi-Unit				Clay Soil				
	0.25 acres	2.5 acres or larger	5 DU's/Ac 3,000 sf 2 story	(attached)	Roof	Streets: Paved	Gravel	2-7% Slope	>7% Slope		Historic	
% Imperv.	45.00%	12.00%	63.00%	75.00%	90.00%	100.00%	80.00%	2.00%	2.00%	2.00%		
											Total Area	Percent Impervious
BASIN	Area	Area	Area	Area	Area	Area	Area	Area	Area	Area		
A1										86.97	86.97	2.0%
A2										120.45	120.45	2.0%
A3										86.87	86.87	2.0%
A4							0.62			79.50	80.33	2.6%
Total A							0.62			373.79	374.62	2.13%
B1										3.82	3.82	2.0%
B2										5.60	5.60	2.0%
Total B										9.42	9.42	2.0%
C1										46.03	46.03	2.0%
Total C										46.03	46.03	2.0%
D1							0.53			5.07	5.56	9.4%
Total D							0.53			5.07	5.56	9.45%

## Grazing Yak Solar

CORE Project #: 18-082

Prepared By: DJB

### COMPOSITE DEVELOPED BASIN -WEIGHTED "C" CALCULATIONS

-REFERENCE UDFCD Vol.1 RUNOFF Table 6-4

$i$  = % imperviousness/100 expressed as a decimal

$C_A$  = Runoff coefficient for NRCS HSG A soils

$C_B$  = Runoff coefficient for NRCS HSG B soils

$C_{C/D}$  = Runoff coefficient for NRCS HSG C and D soils.

Natural Resource Conservation Service (NRCS)

Table 6-4. Runoff coefficient equations based on NRCS soil group and storm return period

NRCS Soil Group	Storm Return Period						
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
A	$C_A = 0.84i^{1.302}$	$C_A = 0.86i^{1.276}$	$C_A = 0.87i^{1.232}$	$C_A = 0.84i^{1.124}$	$C_A = 0.85i+0.025$	$C_A = 0.78i+0.110$	$C_A = 0.65i+0.254$
B	$C_B = 0.84i^{1.169}$	$C_B = 0.86i^{1.088}$	$C_B = 0.81i+0.057$	$C_B = 0.63i+0.249$	$C_B = 0.56i+0.328$	$C_B = 0.47i+0.426$	$C_B = 0.37i+0.536$
C/D	$C_{C/D} = 0.83i^{1.122}$	$C_{C/D} = 0.82i+0.035$	$C_{C/D} = 0.74i+0.132$	$C_{C/D} = 0.56i+0.319$	$C_{C/D} = 0.49i+0.393$	$C_{C/D} = 0.41i+0.484$	$C_{C/D} = 0.32i+0.588$

Basin ID	% Imperv.	$i$	Soil Type	Runoff Coefficients, C				Basin Area	Total Area	Weighted Runoff Coefficients, C			
				2-Year	5-Year	10-Year	100-Year			2-Year	5-Year	10-Year	100-Year
A1	2.0%	0.02	A	0.01	0.01	0.01	0.13	50.70	86.97	0.01	0.01	0.03	0.25
			B	0.01	0.01	0.07	0.44	36.27					
			C or D	0.01	0.05	0.15	0.49	0.00					
A2	2.0%	0.02	A	0.01	0.01	0.01	0.13	72.11	120.45	0.01	0.01	0.03	0.25
			B	0.01	0.01	0.07	0.44	48.34					
			C or D	0.01	0.05	0.15	0.49	0.00					
A3	2.0%	0.02	A	0.01	0.01	0.01	0.13	53.99	86.87	0.01	0.01	0.03	0.24
			B	0.01	0.01	0.07	0.44	32.88					
			C or D	0.01	0.05	0.15	0.49	0.00					
A4	2.6%	0.03	A	0.01	0.01	0.01	0.13	52.23	80.33	0.01	0.01	0.03	0.24
			B	0.01	0.02	0.08	0.44	28.10					
			C or D	0.01	0.06	0.15	0.49	0.00					
B1	2.0%	0.02	A	0.01	0.01	0.01	0.13	2.04	3.82	0.01	0.01	0.04	0.27
			B	0.01	0.01	0.07	0.44	1.78					
			C or D	0.01	0.05	0.15	0.49	0.00					
B2	2.0%	0.02	A	0.01	0.01	0.01	0.13	4.66	5.60	0.01	0.01	0.02	0.18
			B	0.01	0.01	0.07	0.44	0.94					
			C or D	0.01	0.05	0.15	0.49	0.00					
C1	2.0%	0.02	A	0.01	0.01	0.01	0.13	25.62	46.03	0.01	0.01	0.04	0.26
			B	0.01	0.01	0.07	0.44	20.41					
			C or D	0.01	0.05	0.15	0.49	0.00					
D1	9.4%	0.09	A	0.04	0.04	0.05	0.18	1.24	5.56	0.05	0.06	0.11	0.41
			B	0.05	0.07	0.13	0.47	4.32					
			C or D	0.06	0.11	0.20	0.52	0.00					



## Grazing Yak Solar

CORE Project #: 18-082

Prepared By: DJB

### TIME OF CONCENTRATION CALCULATIONS

-REFERENCE UDFCD Vol.1 Section 2.4

NRCS Conveyance factors, K -REFERENCE UDFCD Vol.1 RUNOFF Table 6-2

SF-2      Heavy Meadow      2.50      Short Grass Pasture & Lawns      7.00      Grassed Waterway      15.00  
                  Tillage/field      5.00      Nearly Bare Ground      10.00      Paved Area & Shallow Gutter      20.00

SUB-BASIN DATA			INITIAL / OVERLAND TIME			TRAVEL TIME T(t)					COMP. T(c)	T(c) CHECK (URBANIZED BASINS)		FINAL T(c)
DRAIN BASIN	AREA ac.	C(5)	Length ft.	Slope %	T(i) min	Length ft.	Slope %	Coeff.	Velocity fps	T(t) min.		% IMPER- VIOUS	USDCM Eq . 6-5	
A1	86.97	0.01	148	1.3	21.7	2623	2.4	5.00	0.8	54.7	76.4	2.0%		76.4
A2	120.45	0.01	300	1.7	28.8	3149	1.7	5.00	0.7	75.0	103.8	2.0%		103.8
A3	86.87	0.01	300	3.3	22.9	3203	2.4	5.00	0.8	66.7	89.6	2.0%		89.6
A4	80.33	0.01	300	3.7	22.2	3023	2.0	5.00	0.7	72.0	94.2	2.6%		94.2
B1	3.82	0.01	240	1.0	30.1	357	2.0	5.00	0.7	8.5	38.6	2.0%		38.6
B2	5.60	0.01	300	1.5	29.9	466	3.0	5.00	0.9	8.6	38.5	2.0%		38.5
C1	46.03	0.01	300	5.2	19.8	1517	1.6	5.00	0.6	42.1	61.9	2.0%		61.9
D1	5.56	0.06	529	0.9	45.5	1189	2.5	5.00	0.8	24.8	70.3	9.4%		70.3

## Grazing Yak Solar

CORE Project #: 18-082

Prepared By: DJB

### RATIONAL METHOD PEAK RUNOFF

#### 5-YR STORM

SF-3

Rainfall Depth-Duration-Frequency (1-hr) = **1.5**

-REFERENCE UDFCD Vol.1 EQ 5-1 & EQ 6-1

BASIN INFORMATION				DIRECT RUNOFF				TOTAL RUNOFF				REMARKS
DESIGN POINT	DRAIN BASIN	AREA ac.	5yr RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	SUM C x A	I in/hr	Q cfs	
1	A1	86.97	0.01	76.4	0.74	1.28	0.9					
2	A2	120.45	0.01	103.8	1.01	1.03	1.0					
3	A3	86.87	0.01	89.6	0.72	1.15	0.8					
4	A4	80.33	0.01	94.2	0.88	1.11	1.0					
5	B1	3.82	0.01	38.6	0.03	2.02	0.1					
6	B2	5.60	0.01	38.5	0.04	2.02	0.1					
7	C1	46.03	0.01	61.9	0.40	1.48	0.6					
8	D1	5.56	0.06	70.3	0.34	1.36	0.5					

## Grazing Yak Solar

CORE Project #: 18-082

Prepared By: DJB

### RATIONAL METHOD PEAK RUNOFF

#### 100-YR STORM

SF-3

Rainfall Depth-Duration-Frequency (1-hr) = **2.52**

-REFERENCE UDFCD Vol.1 EQ 5-1 & EQ 6-1

BASIN INFORMATON				DIRECT RUNOFF				TOTAL RUNOFF				REMARKS
DESIGN POINT	DRAIN BASIN	AREA ac.	100yr RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	SUM C x A	I in/hr	Q cfs	
1	A1	86.97	0.25	76.4	22.16	2.16	47.8					
2	A2	120.45	0.25	103.8	30.10	1.74	52.3					
3	A3	86.87	0.24	89.6	21.10	1.93	40.7					
4	A4	80.33	0.24	94.2	19.12	1.86	35.6					
5	B1	3.82	0.27	38.6	1.03	3.39	3.5					
6	B2	5.60	0.18	38.5	0.99	3.40	3.4					
7	C1	46.03	0.26	61.9	12.10	2.49	30.2					
8	D1	5.56	0.41	70.3	2.26	2.29	5.2					

For Colorado Springs and much of the Fountain Creek watershed, the 1-hour depths are fairly uniform and are summarized in Table 6-2. Depending on the location of the project, rainfall depths may be calculated using the described method and the NOAA Atlas maps shown in Figures 6-6 through 6-17.

**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  $Z = 6,840 \text{ ft}/100$

These depths can be applied to the design storms or converted to intensities (inches/hour) for the Rational Method as described below. However, as the basin area increases, it is unlikely that the reported point rainfalls will occur uniformly over the entire basin. To account for this characteristic of rain storms an adjustment factor, the Depth Area Reduction Factor (DARF) is applied. This adjustment to rainfall depth and its effect on design storms is also described below. The UDFCD UD-Rain spreadsheet, available on UDFCD's website, also provides tools to calculate point rainfall depths and Intensity-Duration-Frequency curves<sup>2</sup> and should produce similar depth calculation results.

## 2.2 Design Storms

Design storms are used as input into rainfall/runoff models and provide a representation of the typical temporal distribution of rainfall events when the creation or routing of runoff hydrographs is required. It has long been observed that rainstorms in the Front Range of Colorado tend to occur as either short-duration, high-intensity, localized, convective thunderstorms (cloud bursts) or longer-duration, lower-intensity, broader, frontal (general) storms. The significance of these two types of events is primarily determined by the size of the drainage basin being studied. Thunderstorms can create high rates of runoff within a relatively small area, quickly, but their influence may not be significant very far downstream. Frontal storms may not create high rates of runoff within smaller drainage basins due to their lower intensity, but tend to produce larger flood flows that can be hazardous over a broader area and extend further downstream.

- **Thunderstorms:** Based on the extensive evaluation of rain storms completed in the Carlton study (Carlton 2011), it was determined that typical thunderstorms have a duration of about 2 hours. The study evaluated over 300,000 storm cells using gage-adjusted NEXRAD data, collected over a 14-year period (1994 to 2008). Storms lasting longer than 3 hours were rarely found. Therefore, the results of the Carlton study have been used to define the shorter duration design storms.

To determine the temporal distribution of thunderstorms, 22 gage-adjusted NEXRAD storm cells were studied in detail. Through a process described in a technical memorandum prepared by the City of Colorado Springs (City of Colorado Springs 2012), the results of this analysis were interpreted and normalized to the 1-hour rainfall depth to create the distribution shown in Table 6-3 with a 5 minute time interval for drainage basins up to 1 square mile in size. This distribution represents the rainfall

**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.

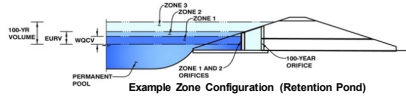
For urban areas, the time of concentration ( $t_c$ ) consists of an initial time or overland flow time ( $t_i$ ) plus the travel time ( $t_t$ ) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time ( $t_i$ ) 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.

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Grazing Yak

Basin ID: Detention Pond



## Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	85.89	acres
Watershed Length =	3,300	ft
Watershed Slope =	0.024	ft/ft
Watershed Imperviousness =	3.04%	percent
Percentage Hydrologic Soil Group A =	64.8%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	35.2%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	0.162	acre-feet
Excess Urban Runoff Volume (EURV) =	0.159	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.112	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.328	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	0.862	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	2.102	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	3.254	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	5.404	acre-feet
500-yr Runoff Volume (P1 = 0 in.) =	0.000	acre-feet
Approximate 2-yr Detention Volume =	0.103	acre-feet
Approximate 5-yr Detention Volume =	0.313	acre-feet
Approximate 10-yr Detention Volume =	0.486	acre-feet
Approximate 25-yr Detention Volume =	0.583	acre-feet
Approximate 50-yr Detention Volume =	0.719	acre-feet
Approximate 100-yr Detention Volume =	1.368	acre-feet

Optional User Override 1-hr Precipitation	1.19	inches
	1.50	inches
	1.75	inches
	2.00	inches
	2.25	inches
	2.52	inches

## Stage-Storage Calculation

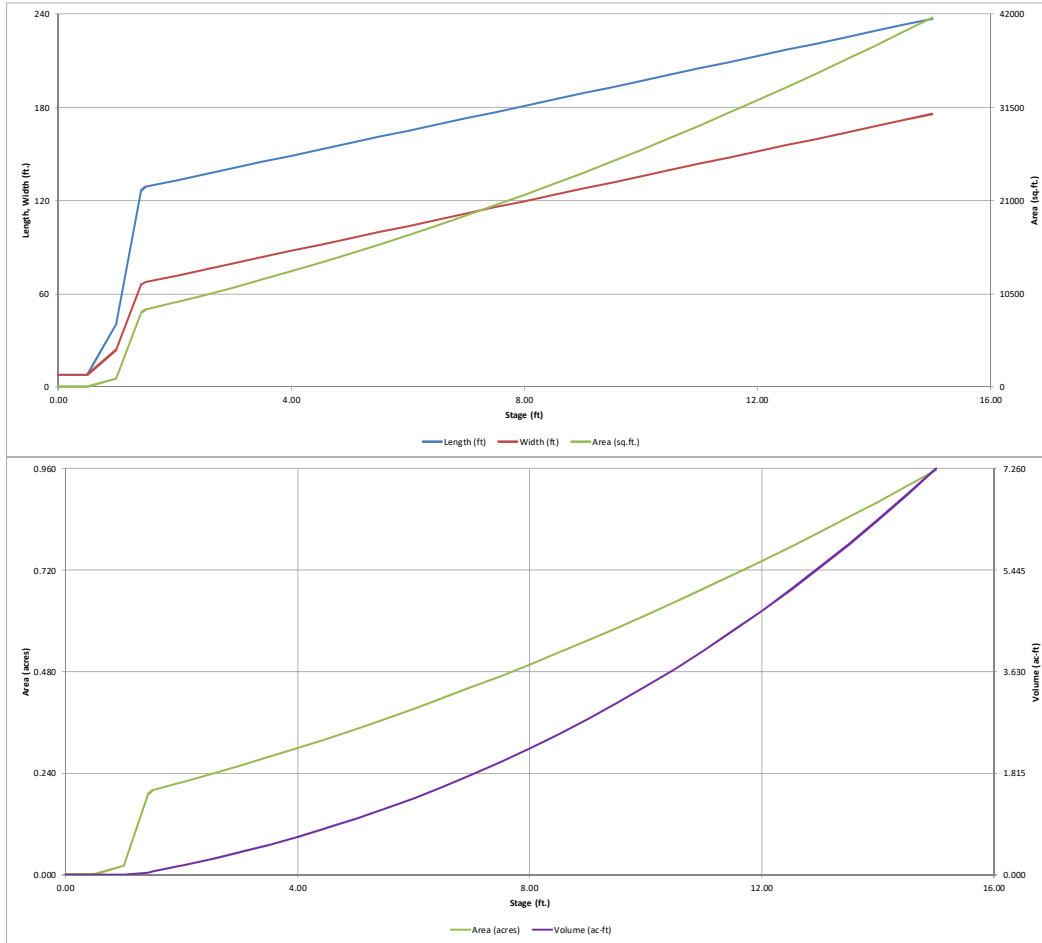
Zone 1 Volume (WQCV) =	0.162	acre-feet
Zone 2 Volume (100-year - Zone 1) =	1.206	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	1.368	acre-feet
Initial Surcharge Volume (SV) =	21	ft³
Initial Surcharge Depth (SD) =	0.33	ft
Total Available Detention Depth (H <sub>total</sub> ) =	6.00	ft
Depth of Trickle Channel (H <sub>TC</sub> ) =	0.50	ft
Slope of Trickle Channel (S <sub>TC</sub> ) =	0.005	ft/ft
Slopes of Main Basin Sides (S <sub>main</sub> ) =	4	H:V
Basin Length-to-Width Ratio (R <sub>L/W</sub> ) =	2	

Initial Surcharge Area (A <sub>SV</sub> ) =	64	ft²
Surcharge Volume Length (L <sub>SV</sub> ) =	8.0	ft
Surcharge Volume Width (W <sub>SV</sub> ) =	8.0	ft
Depth of Basin Floor (H <sub>floor</sub> ) =	0.59	ft
Length of Basin Floor (L <sub>floor</sub> ) =	128.3	ft
Width of Basin Floor (W <sub>floor</sub> ) =	67.0	ft
Area of Basin Floor (A <sub>floor</sub> ) =	8,589	ft²
Volume of Basin Floor (V <sub>floor</sub> ) =	1,846	ft³
Depth of Main Basin (H <sub>main</sub> ) =	4.58	ft
Length of Main Basin (L <sub>main</sub> ) =	164.9	ft
Width of Main Basin (W <sub>main</sub> ) =	103.6	ft
Area of Main Basin (A <sub>main</sub> ) =	17,086	ft²
Volume of Main Basin (V <sub>main</sub> ) =	57,697	ft³
Calculated Total Basin Volume (V <sub>total</sub> ) =	1.368	acre-feet

Depth Increment =	0.5								
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft²)	Optional Override Area (ft²)	Area (acre)	Volume (ft³)	Volume (ac-ft)
Top of Micropool	0.00		8.0	8.0	64		0.001		
ISV	0.33		8.0	8.0	64		0.001	21	0.000
	0.50		8.0	8.0	64		0.001	31	0.001
	1.00		40.7	24.0	976		0.022	123	0.003
Floor	1.42		126.3	66.0	8,339		0.191	1,827	0.042
	1.50		128.8	67.5	8,699		0.200	2,517	0.058
Zone 1 (WQCV)	1.99		132.8	71.5	9,501		0.218	7,065	0.162
	2.00		132.8	71.5	9,501		0.218	7,065	0.162
	2.50		136.9	75.6	10,351		0.238	12,126	0.278
	3.00		140.9	79.6	11,217		0.258	17,517	0.402
	3.50		144.9	83.6	12,115		0.278	23,349	0.536
	4.00		148.9	87.6	13,045		0.299	29,637	0.680
	4.50		152.9	91.6	14,007		0.322	36,399	0.836
	5.00		156.9	95.6	15,001		0.344	43,650	1.002
	5.50		160.9	99.6	16,028		0.368	51,406	1.180
Zone 2 (100-year)	6.00		164.9	103.6	17,086		0.392	59,683	1.370
	6.50		168.9	107.6	18,176		0.417	68,497	1.572
	7.00		172.9	111.6	19,298		0.443	77,864	1.788
	7.50		176.9	115.6	20,452		0.470	87,800	2.016
	8.00		180.9	119.6	21,638		0.497	98,321	2.257
	8.50		184.9	123.6	22,856		0.525	109,443	2.512
	9.00		188.9	127.6	24,106		0.553	121,182	2.782
	9.50		192.9	131.6	25,388		0.583	133,555	3.066
	10.00		196.9	135.6	26,702		0.613	146,576	3.365
	10.50		200.9	139.6	28,048		0.644	160,262	3.679
	11.00		204.9	143.6	29,426		0.676	174,629	4.009
	11.50		208.9	147.6	30,836		0.708	189,694	4.355
	12.00		212.9	151.6	32,278		0.741	205,471	4.717
	12.50		216.9	155.6	33,752		0.775	221,977	5.096
	13.00		220.9	159.6	35,259		0.809	239,229	5.492
	13.50		224.9	163.6	36,797		0.845	257,241	5.905
	14.00		228.9	167.6	38,367		0.881	276,031	6.337
	14.50		232.9	171.6	39,969		0.918	295,613	6.786
	15.00		236.9	175.6	41,603		0.955	316,005	7.254

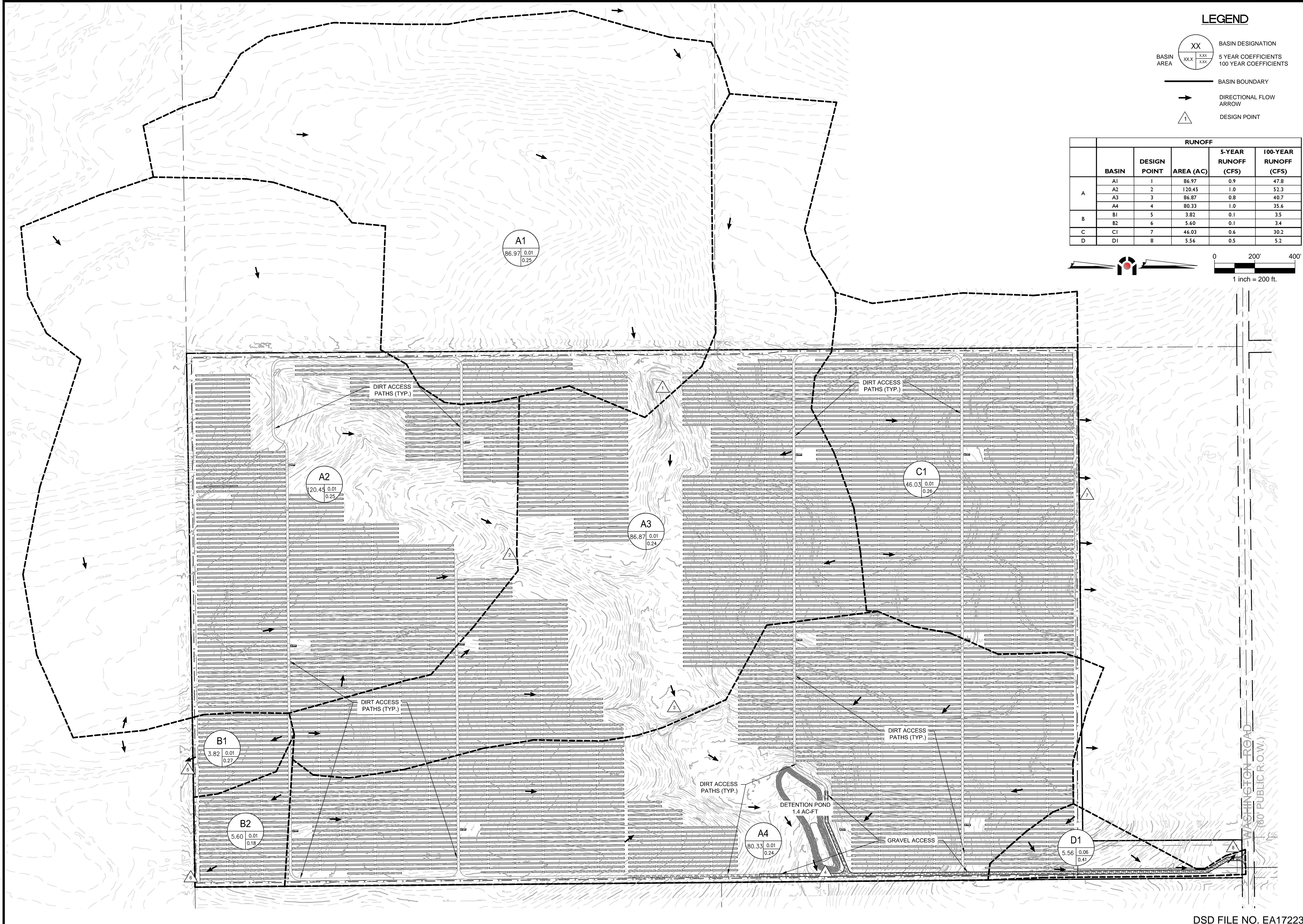
# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

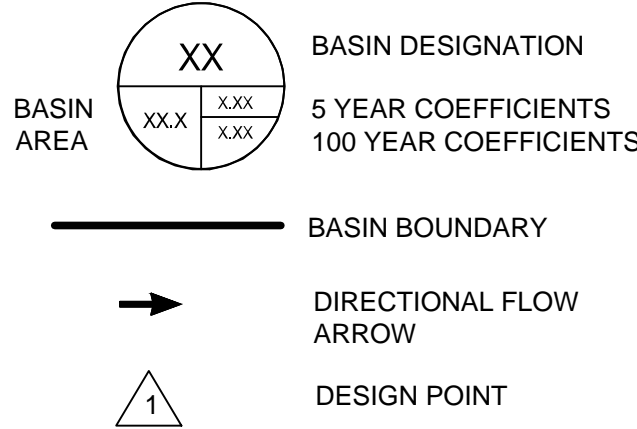




10/26/2018 11:05 AM - U:\CORE-2018\PROJECTS\18-082 GRAZING YAK SOLAR\ENGINEERING\CAD\DWG\01 SITE DETAIL.DWG



LEGEND



RUNOFF					
	BASIN	DESIGN POINT	AREA (AC)	5-YEAR RUNOFF (CFS)	100-YEAR RUNOFF (CFS)
A	A1	1	86.97	0.9	47.8
	A2	2	120.45	1.0	52.3
	A3	3	86.87	0.8	40.7
	A4	4	80.33	1.0	35.6
B	B1	5	3.82	0.1	3.5
	B2	6	5.60	0.1	3.4
C	C1	7	46.03	0.6	30.2
D	D1	8	5.56	0.5	5.2



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OF THE CLIENT. IT IS THE CLIENT'S RESPONSIBILITY TO OBTAIN  
THE LOCATION OF ALL UTILITIES PRIOR TO THE  
COMMENCEMENT OF ANY CONSTRUCTION ACTIVITIES.

#	REVISION DESCRIPTION	DATE	BY
1	1ST SUBMITTAL	10/11/18	DB

GRAZING YAK SOLAR  
EL PASO COUNTY, COLORADO  
WIND/SOLAR ENERGY OVERLAY PLAN  
DRAINAGE PLAN

DESIGNED BY: DB  
DRAWN BY: DB  
CHECKED BY: DB

JOB NO.  
18-082  
SHEET  
1 OF 1

DSD FILE NO. EA17223