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Preliminary / Final Drainage Report

Koinonia Ranch

Project No. 61148

September 5, 2023

PCD File No. SP-21-004

Preliminary / Final Drainage Report

for

Koinonia Ranch

Project No. 61148

September 5, 2023

prepared for

Koinonia Ranch, LLC
3647 Tuscanna Grove
Colorado Springs, CO 80920

prepared by

MVE, Inc.
1903 Lelaray Street, Suite 200
Colorado Springs, CO 80909
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Statements and Acknowledgments

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 R. Gorman, P.E. Colorado No. 31672 Date
For and on Behalf of MVE, Inc.

Developer's Statement

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

_____ _____

Sarah Bartels Date
Koinonia Ranch, LLC
3647 Tuscanna Grove
Colorado Springs, CO 80920

El Paso County

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

_____ _____

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

Conditions:

Contents

Preliminary / Final Drainage Report

The purpose of this Preliminary / Final Drainage Report is to identify drainage patterns and quantities within and affecting the proposed Koinonia Ranch site. The development project is a residential subdivision with six (6) 5.0± acre lots, and one (1) tract. The report will identify specific solutions to problems on-site and off-site resulting from the proposed project. The report and included maps present results of hydrologic and drainage facilities analyses. The report will discuss the recommended drainage improvements to the site and identify drainage requirements relative to the proposed project. This report has been prepared and submitted in accordance with the requirements of the El Paso County development approval process. An Appendix is included with this report with pertinent calculations and graphs used in the drainage analyses and design.

1 General Location and Description

1.1 Location

The proposed Koinonia Ranch site is located within the southeast one-quarter of the southwest one-quarter of Section 19, Township 12 South, Range 65 west of the 6th principal meridian in El Paso County, Colorado. The 39± acre site is situated north of Old Ranch Road. The site is generally west of Black Forest Road, north of Old Ranch Road. The site contains an existing single-family residential property using the address of 6170 Old Ranch Road. The El Paso County Assessor's Schedule Number for the site is 5219000059. The proposed site has never been platted. A **Vicinity Map** is included in the **Appendix**.

The south edge of the site is adjacent to an unplattted and undeveloped parcel zoned PUD (Planned Unit Development). Unplatted property zoned RR-5 and containing two single family residences is located adjacent to the east side of the site. Unplatted and undeveloped property zoned RR-5 is located adjacent to the west side of the site. The site is located in El Paso County's Cottonwood Creek Drainage Basin.

1.2 Description of Property

The Koinonia Ranch site 39± acres and is zoned RR-5 (Residential Rural (5 Acres)). The property is the location of a single-family residence with an existing unpaved driveway.

The site is covered with native grass and weeds in good condition, and coniferous trees. There is dense tree coverage on the northern portion of the site and sparse tree coverage on the southern portion of the site. The existing site topography slopes to the south towards Old Ranch Road with grades that range from 3% to 30%.

There are no major drainage ways in the Koinonia Ranch site. All storm runoff flows south to Old Ranch Road. An existing culvert discharges the flows south of Old Ranch Road. There is no storm drain system located within Old Ranch Road or the surrounding area. The site is located in the cottonwood creek major drain basin. The flows from the site flow south and eventually enter cottonwood creek, a tributary to Monument creek.

According to the National Resource Conservation Service, there are three (3) soil types in the Koinonia ranch site. Kettle gravelly loamy sand (map unit 40) makes up a portion of the soil in the center of the site where the existing structure is located. The soil is deep and somewhat excessively drained. Permeability

is moderately rapid, surface runoff is slow, and the hazard of erosion is slight to moderate. Kettle gravelly loamy sand is classified as being part of Hydrologic Soil Group B.

The second type is Kettle Gravelly Loamy Sand (map unit 41) which makes up the northern portion of the site. The soil is deep and somewhat excessively drained. Permeability is moderately rapid, surface runoff is slow, and the hazard of erosion is slight to moderate. Kettle gravelly loamy sand is classified as being part of Hydrologic Soil Group B.

The last soil type is Pring Coarse Sandy Loam (map unit 71) which makes up the southern side of the site. The soil is deep and well drained. Permeability is moderately rapid, surface runoff is slow, and the hazard of erosion is slight to moderate. Pring Coarse Sandy Loam is classified as being part of Hydrologic Soil Group B.

A portion of the Soil Map and data tables from the National Cooperative Soil Survey and relevant Official Soil Series Descriptions (OSD) are included in the **Appendix**.[1] [2]

There are no major drainage ways in the Koinonia Ranch site.

The current Flood Insurance Study of the region includes Flood Insurance Rate Maps (FIRM), effective on December 7, 2018.[3] The proposed subdivision is included in the Community Panel Numbered 08041C0527 G of the Flood Insurance Rate Maps for the El Paso County. No part of the site is shown to be included in a 100-year flood hazard area as determined by FEMA. A portion of the current FEMA Flood Insurance Rate Maps with the site delineated is included in the **Appendix**.

2 Drainage Basins and Sub-Basins

2.1 Major Basin Descriptions

The Koinonia Ranch site is located in the Cottonwood Creek Drainage Basin (FOMO2200) of the Fountain Creek Major Drainage Basin. The Cottonwood Creek Drainage Basin Covers an area of approximately 19 square miles and drains to Monument Creek. The *Cottonwood Creek Drainage Basin Planning Study* provides development recommendations and requirements for drainage development in the Cottonwood Creek Drainage Basin (DBPS).[4] The Cottonwood Creek Drainage Basin encompasses a part of the northeast portion of the City of Colorado Springs and extends to the north and east. The drainage basin and Cottonwood Creek drain southwest into Monument Creek. The Koinonia Ranch site is located north of Cottonwood Creek as it flows offsite towards Monument Creek . The site is located in sub-basin WR 050, upstream of Design Point 040 of the Drainage Basin Planning Study. No improvements are recommended on or near the project site. The proposed Koinonia Ranch project is in conformance with the DBPS.

2.2 Other Drainage Reports

The drainage report “Geist Subdivision” by Richards Land Surveying Company dated January 4, 1982[5] was reviewed in preparation of this Preliminary / Final Drainage Report.

2.3 Sub-Basin Description

The existing drainage patterns of the Koinonia Ranch project are described by five on-site drainage basins and five offsite basins. All of these sub-basins are previously undisturbed or developed to a degree as described below. All existing sub-basin delineations and data are depicted on the attached **Existing Drainage Map**.

1 WSS
2 OSD
3 FIRM
4 DBPS
5 DRGS

2.3.1 Existing Drainage Patterns (Off-Site)

Existing off site sub-basin EX-OSA1, containing pasture/meadow, is located to the west of the site. This sub-basin drains overland to the east onto the site. This flow enters the onsite sub-basin EX-A2 and continues through the site.

Existing off site sub-basin OSA2, containing pasture/meadow, is located to the west of the site just south of sub-basin EX-OS-A1. This sub-basin drains overland to the east into the site. This flow enters the onsite sub-basin A-5 and continues through the site.

Existing off site sub-basin EX-OS-A3, containing pasture/meadow, is located to the east of the site. This sub-basin drains overland to the west into the site. The flow enters the onsite sub-basin EX-A1 and continues through the site.

Existing off site sub-basin EX-OS-A4, containing pasture/meadow, is located to the west of the site just south of sub-basin EX-OS-A2. This sub-basin drains overland to the southeast into the site. The flow enters the onsite sub-basin EX-A1 and continues through the site.

Existing off site sub-basin EX-OS-B1, containing pasture/meadow, is located northwest of the site. This sub-basin drains overland to the southeast onto the site. The flow enters the onsite sub-basin EX-B1 and continues through the site.

2.3.2 Existing Drainage Patterns (On-Site)

The site generally drains to the south. The southeast portion of the site, drains towards the southeast corner of the site. The remaining potion of the site drains south towards the site's southern boundary.

Existing sub-basin EX-A1 is centrally located throughout the majority of the site. This sub-basin contains an existing single-family residence, gravel drive, and pasture/meadow areas. The flows generated by this sub-basin drain overland to the south and exit the site at design point 1 through an existing culvert. These flows continue south through the adjacent properties toward Cottonwood Creek. All flows from the site eventually enter Cottonwood Creek.

Existing sub-basin EX-A2, containing pasture/meadow, is located in the western portion of the site, just east of sub-basin EX-OS-A2. The sub-basin contains pasture/meadow. All flows from sub-basin EX-A2 drain overland and exit the site at the west property line into sub-basin EX-OS-A2.

Existing sub-basin EX-B1, containing pasture/meadow, is located in the northeastern portion of the site. All flows from sub-basin EX-B1 drain overland to the east into the adjacent site. These flows continue southeast through adjacent properties.

Existing sub-basin EX-C1, containing pasture/meadow, is located in the southeast portion of the site. All flows from sub-basin EX-C1 drain overland and exit the site through the east property line and continue south through adjacent properties into cottonwood creek.

Existing sub-basin EX-D1, containing pasture/meadow, is also located in the southeast portion of the site just south of sub-basin EX-C1. All flows from basin EX-D1 drain overland and exit the site through the east property line and continue south through adjacent properties into cottonwood creek.

3 Drainage Design Criteria

3.1 Development Criteria Reference

This Preliminary / Final Drainage Report for Koinonia Ranch has been prepared according to the report guidelines presented in the latest edition of *El Paso County Drainage Criteria Manual* (DCM)[6]. The County has also adopted portions of the City of Colorado Springs Drainage Criteria Manual Volumes 1 and 2, especially concerning the calculation of rainfall runoff flow rates.[7] [8] The hydrologic analysis is based on a collection of data from the DCM, the NRCS Web Soil Survey[9], and existing topographic data by Land Resource Associates.

6 DCM Section 4.3 and Section 4.4
7 CS DCM Vol 1
8 CS DCM Vol 2
9 WSS

3.2 Hydrologic Criteria

For this Preliminary / Final Drainage Report, the Rational Method as described in the D*rainage Criteria Manual* has been used for all Storm Runoff calculations, as the development and all sub-basins are less than 130 acres in area. "Colorado Springs Rainfall Intensity Duration Frequency" curves, Figure 6-5 in the DCM, was used to obtain the design rainfall values; a copy is included in the **Appendix**. The "Overland (Initial) Flow Equation" (Eq. 6-8) in the DCM, and Manning's equation with estimated depths were used in time of concentration calculations. "Runoff Coefficients for Rational Method", Table 6-6 in the DCM, was utilized as a guide in estimating runoff coefficient and Percent Impervious values; a copy is included in the **Appendix**. Peak runoff discharges were calculated for each drainage sub-basin for both the 5-year storm event and the 100-year storm event with the Rational Method formula, (Eq. 6-5) in the DCM.[10]

4 Drainage Facility Design

4.1 General Concept

The intent of the drainage concept presented in this Preliminary / Final Drainage Report is to allow for the development of the six (6) 5-acre lots, and one (1) tract while maintaining the existing drainage patterns on the site. The site will be in compliance with the County's Stormwater Management regulations without the need for permanent water quality treatment facilities. Major and minor storm flows will continue to be safely conveyed through the site and downstream.

The existing and proposed drainage hydrologic conditions are described in more detail below. Input data and results for all calculations are included in the **Appendix**. Drainage maps for the hydrology are also included in the **Appendix**.

4.2 Specific Details

4.2.1 Offsite Sub-basin Hydrologic Conditions

The off-site drainage area west of the site, sub-basin EX-OSA1, contains pasture/meadow. The sub-basin is 5.51 ± acres in area and drains easterly overland and into sub-basin EX-A5. Sub-basin EX-OSA1 generates peak storm runoff discharges of Q_5 = 2.1 cfs and Q_{100} = 15.2 cfs (existing flows) which drains overland into the site at sub-basin EX-A5. Once in the site, these flows continue to drain to the south to Existing Design Point 1 (EX-DP1).

Proposed offsite sub-basin OS-A1 is 3.17 ± acres, located west of the site and adjacent south of sub-basin OSB1, contains pasture/meadow. Offsite sub-basin EX-OSA1 is divided into OSA1 and OSA7 due to the creation of the gravel roadway. This sub-basin represents expected flows entering the east roadside ditch. Sub-basin OS-A1 will generate peak storm runoff discharges of Q_5 = 1.1 cfs and Q_{100} = 8.3 cfs (proposed flow) which drains overland to the southeast into proposed sub-basin A2.

Off-site sub-basin OSA2 is 12.08 ± acres in area located center west of the site and contains pasture/meadow with an existing gravel driveway. Sub-basin OSA2 produces peak discharges of Q_5 = 3.9 cfs and Q_{100} = 25.0 cfs which drain southeasterly overland into sub-basin EX-A5 (existing & proposed conditions). Once in the site, these flows continue to drain to the south to EX-DP2/DP2.

Off-site sub-basin OSA3, located east of the site is 3.97 ± acres in area. Sub-basin OSA3 contains a meadow/pasture area with an existing gravel driveway. Peak storm runoff rates are Q_5 = 2.7 cfs and Q_{100} = 11.7 cfs (existing flows) which drain westerly overland into sub-basin EX-A5/A2 (existing/proposed conditions). Once in the site, these flows continue to drain southwesterly to EX-DP2/DP1 (existing/proposed).

Offsite sub-basin OSA6, located west of the site just south of sub-basin OSA2, is 5.93 ± acres in area. Sub-basin OSA6 contains a meadow/pasture area with an existing gravel driveway. This sub-basin generates peak storm runoff rates of Q_5 = 2.2 cfs and Q_{100} = 12.9 cfs (existing flows) which drains easterly

10 DCM

overland into sub-basin EX-A5/A5 (existing/proposed conditions). These flows continue to drain to the south toward EX-DP2/DP2 (existing/proposed conditions).

Proposed offsite sub-basin OSA7 is 2.34 ± acres, located west of the site and adjacent south of sub-basin OSA1 which contains pasture/meadow. Offsite sub-basin EX-OSA1 is divided into OSA1 and OSA7 due to the creation of the gravel roadway. This sub-basin represents expected flows entering the west roadside ditch. Sub-basin OS-A7 will generate peak storm runoff discharges of Q_5 = 0.8 cfs and Q_{100} = 6.0 cfs (proposed flow) which drains overland to the southeast into proposed sub-basin A5.

Offsite sub-basin OSB1, located north of the site, is 1.67 ± acres in area and contains meadow/pasture. Sub-basin OSB1 generates peak storm runoff rates of Q_5 = 0.6 cfs and Q_{100} = 4.4 cfs (existing flows) which drains to the southeast into sub-basin EX-B2/B2 (existing/proposed conditions). These flows continue to drain southeasterly toward Design Points EXDP2/DP3 (existing/proposed conditions) before exiting the site.

4.2.2 Existing Hydrologic Conditions

Existing sub-basin EX-A4, located on the western portion of the site, is 0.96 ± acres in area. Sub-basin EX-A4 contains a meadow/pasture area. The sub-basin generates peak flows of Q_5 = 0.3 cfs and Q_{100} = 2.4 cfs (existing flow), which drains westerly overland and immediately exits the site into offsite sub-basin OSA2. This flow reenters the site at EX-A5 and combines with additional flows at Existing Design Point 1 (EX-DP1).

Existing sub-basin EX-A5, centrally located throughout most of the site, is 29.90 ± acres in area. This sub-basin contains an existing single-family residence, a gravel driveway, and meadow/pasture area. Peak storm runoff rates are Q_5 = 7.9 cfs and Q_{100} = 49.8 cfs (existing flows) which drains south toward Existing Design Point 1 (EX-DP1).

Existing sub-basin EX-B2, located in the northern portion of the site and immediate southeast of sub-basin EX-OSB1, is 5.70 ± acres in area. This sub-basin only contains meadow pasture. Peak storm runoff rates generated by this sub-basin are Q_5 = 1.7 cfs and Q_{100} = 12.3 cfs (existing flows) which drain southeasterly offsite. This flow combines with additional flows from OSB1 at Existing Design Point 2 (EX-DP2).

Existing sub-basin EX-C1, located in the southeast portion of the site and adjacent southeast of EX-A5, is 1.70 ± acres in area. This sub-basin only contains pasture/meadow. Peak storm runoff rates generated by this sub-basin are Q_5 = 0.6 cfs and Q_{100} = 4.1 cfs (existing flows) which drains southeast offsite. These flows continue draining south through adjacent properties to Cottonwood Creek.

Existing sub-basin EX-D1, located in the southeast portion of the site just south of sub-basin EX-C1, is 0.82 ± acres in area. This sub-basin only contains pasture/meadow. Peak storm runoff rates generated by this sub-basin are Q_5 = 0.3 cfs and Q_{100} = 1.9 cfs (existing flows) which drains southeast offsite. These flows continue draining south through adjacent properties to Cottonwood Creek.

Existing Design Point 1 (58.35 ± acres) contains offsite sub-basins: EX-OSA1, OS-A2, OSA3, OSA6, and on-site sub-basins: EX-A4 & EX-A5. The combined peak storm runoff rates flowing to EX-DP1 are Q_5 = 19.8 cfs and Q_{100} = 121.6 cfs (existing flows) which flow south through an existing culvert at Old Ranch Road and continues to flow south through adjacent properties to Cottonwood Creek.

Existing Design Point 2 (7.37 ± acres) contains offsite sub-basins OSB1 and on-site sub-basin EX-B2. The combined flows from sub-basin OSB1 and EX-B2 are Q_5 = 2.4 cfs and Q_{100} = 17.5 cfs (existing flows) which flow southeast offsite. These flows continue draining south through adjacent properties to Cottonwood Creek.

The **Existing Drainage Map** depicts the existing topographic mapping, drainage basin delineations, drainage patterns, existing drives, drainage facilities, and runoff quantities with a data table including drainage areas and flow rates.

4.2.3 Proposed Hydrologic Conditions

In proposed conditions, offsite sub-basin EX-OSA1 is split into two offsite sub-basins OSA1 and OSA7. This is to represent the expected flows to enter the respective roadside ditches. Additionally, several of the existing onsite sub-basins change names under proposed conditions to reflect changes for the

roadway ditches and are further described within each sub-basin description. To simulate proposed conditions for the new lots, a 5,000 SF house, 1000 SF gravel driveway, a 100 SF concrete parking area are simulated. The northern lot will require a longer gravel driveway of approximately 8,000 SF to connect to the proposed private roadway.

Proposed sub-basin A2 (14.14 ± acres), located on the north and eastern portion of the site, and contains two (2) proposed single-family residences, the gravel and paved portion for proposed Lot 1, and the east half of the proposed rural local gravel roadway. The building will be calculated for sub-basin C1. This also accounts for 8,000 SF gravel driveway for the northern-most lot, Lot 3. Sub-basin A2 will generate peak storm runoff discharges of Q_5 = 5.8 cfs and Q_{100} = 28.7 cfs (proposed flow) which drains south in the east roadside ditch along the private road to Design Point 1 (DP1).

The proposed sub-basin, A4 (0.96 ± acres), contains only pasture/meadow with no further development at this time. Proposed sub-basin A4 generates peak storm runoff discharges of Q_5 = 0.3 cfs and Q_{100} = 2.4 cfs (existing/proposed flows) which drains westerly overland and immediately exits the site into offsite sub-basin OSA2. This flow reenters the site at A5 and combines with additional flows at Design Point 2 (DP2).

Proposed sub-basin A5 (15.77 ± acres), located on the southwestern portion of the site, contains the existing single-family residence, two (2) proposed single-family residences, and the west half of the proposed rural local gravel roadway. Sub-basin A5 will generate peak storm runoff discharges of Q_5 = 6.9 cfs and Q_{100} = 35.9 cfs (proposed flow) which drains south in the west roadside ditch to Design Point 2 (DP2).

Proposed sub-basin, B2 (5.70 ± acres), located within the north portion of the site. This sub-basin contains a proposed single-family residence without a gravel driveway and pasture/meadow. The typical 3,000 SF gravel driveway for a single-family residence was accounted within sub-basin A2. Sub-basin B2 generates an existing peak storm runoff discharges of Q_5 = 1.7 cfs and Q_{100} = 12.3 cfs (existing flows) and a developed peak storm runoff discharges of Q_5 = 2.0 cfs and Q_{100} = 12.8 cfs (proposed flows), which represents an negligible increase of Q_5 = 0.3 cfs and Q_{100} = 0.5 cfs. These flows combine with additional flows from OSB1 at Design Point 3 (DP3) before draining offsite.

Proposed sub-basin C1 (1.70 ± acres), contains only the single-family residence without gravel and paved area. The gravel and paved area were calculated for sub-basin A2. Sub-basin C1 generates an existing peak storm runoff discharges of Q_5 = 0.6 cfs and Q_{100} = 4.1 cfs (existing flows) and a developed peak storm runoff discharges of Q_5 = 1.0 cfs and Q_{100} = 4.7 cfs (proposed flows), which represents an negligible increase of Q_5 = 0.4 cfs and Q_{100} = 0.6 cfs. These flows continue to drain southeast through adjacent properties eventually draining into Cottonwood Creek.

Existing/proposed sub-basin D1 (0.82 ± acres), will have no improvements at this time and will continue to drain from the site as in existing conditions. Basin D1 generates peak storm runoff discharges of Q_5 = 0.3 cfs and Q_{100} = 1.9 cfs (existing/proposed flows) which drains southeast offsite. These flows continue to drain southeast through adjacent properties eventually draining into Cottonwood Creek.

Proposed Design Point 1 (21.27 ± acres) contains OSA1, OSA3, and A2. These flows are captured within the east roadside ditch draining to the south. Design Point 1 has a developed peak storm runoff discharge of Q_5 = 8.7 cfs and Q_{100} = 43.5 cfs (proposed flows). These flows drain to the west under proposed Koinonia View through a proposed 18' x 54' Box culvert. Culvert sizing calculations are included in the **Appendix**.

Proposed Design Point 2 (58.35 ± acres), is the combined flows of all sub-basins except: OS-B1, B2, C1, and D1. In existing conditions, this design point has an existing peak storm runoff discharges of Q_5 = 19.8 cfs and Q_{100} = 121.6 cfs (existing flows) with a developed peak storm runoff discharge of Q_5 = 20.9 cfs and Q_{100} = 114.0 cfs (proposed flows). This results in a negligible difference of Q_5 = +1.1 cfs and Q_{100} = -7.6 cfs. These flows will drain into an existing 30” corrugated metal pipe culvert at DP3 then continue flowing south through adjacent properties toward Cottonwood Creek.

Proposed Design Point 3 (7.37 ± acres) contains offsite sub-basins OSB1 and on-site sub-basin B2. In existing conditions, this design point has an existing peak storm runoff discharges of Q_5 = 2.4 cfs and Q_{100} = 17.5 cfs (existing flows) with a developed peak storm runoff discharge of Q_5 = 2.8 cfs and Q_{100} = 18.4

cfs (existing flows). This results in a negligible increase of Q_5 = 0.4 cfs and Q_{100} = 0.9 cfs draining southeast into the east adjacent neighbor. These flows continue draining south through the adjacent properties, eventually draining into Cottonwood Creek.

4.3 Existing Old Ranch Road Culvert

The stormwater flows generated from the site generally drain to the south and exit the site through an existing 30" corrugated metal pipe (CMP) culvert. Said culvert runs through Old Ranch Road and is located west of the proposed roadway. The existing culvert is adequately sized to safely convey the entire 5 year storm event and will overtop by 6 inches during the 100 year storm event. The crest length for roadway culvert is 266 feet with the lowest elevation of 7266.2 feet. During the existing 100 year storm (Q_{total} = 121.6 cfs), the expected flows are $Q_{100yr\ culvert}$ = 32.7 cfs and $Q_{100yr\ roadway}$ = 88.9 cfs with a max headwater elevation of 7266.7 feet. In proposed conditions, (Q_{total} = 114.0 cfs), the expected flows are $Q_{100yr\ culvert}$ = 32.6 cfs and $Q_{100yr\ roadway}$ = 81.4 cfs with a max headwater elevation of 7266.7 feet. The proposed development will only increase flows at this location by Q_5 = 0.9 cfs and Q_{100} = 1.0 cfs. According to Table 6-1 in the DCM[11] cross flow with a depth of flow no more than 6 inches at the street shoulder is allowed in a local roadway with a roadside ditch during a major storm event. Cross flow depths do not reach depths greater than 6 inches at the street shoulder in either the existing or the proposed conditions. An HY-8 analysis of the proposed cross flow is included in the **Appendix**.

Outlet protection for this culvert is recommended due to the erosion concerns downstream. However, the placement of the existing culvert is difficult to install riprap due to the current size of the existing right-of-way. A drainage easement dedication from the property located south of the right-of-way will be required to properly install the riprap outlet protection. The size of the proposed riprap is to be a 7 foot wide by 17 feet in length with type L riprap.

4.4 Erosion Control

During future construction, best management practices (BMP's) for erosion control will be employed based on the previously referenced City of Colorado Springs Drainage Criteria Manual Volume 2 and the Erosion Control Plan for the site. During Construction, silt fencing, sediment control log, vehicle tracking control and concrete washout area will be in place to minimize erosion from the site. Silt Fencing will be placed along the southern and eastern sides of the disturbed areas. This will inhibit suspended sediment form leaving the site during construction. Vehicle tracking control will be placed at the access point in the private driveway connecting to Old Ranch Road. BMP's will be utilized as deemed necessary by the contractor, engineer, owner, or County inspector and are not limited to the measures described above.

4.5 Water Quality Enhancement Best Management Practices

The El Paso County Engineering Criteria Manual (Appendix I, Section I.7.2) requires the consideration of a "Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long term source controls". The Four Step Process is incorporated in this project and the elements are discussed below.

1) Runoff Reduction Practices are employed in this project. Impervious surfaces have been reduced as much as practically possible. There is only minimal concrete or other hard surfaces proposed. Minimized Directly Connected Impervious Areas (MDCIA) is employed on the project because runoff passes through a roadside ditch and an open space meadow area before leaving the site.

2) All drainage paths on the site are stabilized with appropriate landscape treatment. Rock check dams will be utilized in the ditch running along the roadway to reduce water velocities to promote stabilization. After the installation of the check dams the ditch will be seeded with native grasses. Ditch flow calculations and check dam spacing calculations are included in the **Appendix**.

3) The project contains no potentially hazardous uses. The site is exempted from the use of WQCV BMPs by ECM I.7.1.B.5 by virtue of the large lot rural residential nature of the site having percent

11 DCM

imperviousness of less than 10%. The runoff generated from the impervious areas of the gravel road will be treated for water quality by utilizing the runoff reduction standard. Stormwater runoff from the proposed roadway will be collected in the roadside ditches and will infiltrate into the ground, evaporate, or evapotranspire a quantity of water equal to at least 60% of what the calculated WQCV would be if all impervious area for the applicable development site discharged without infiltration. Runoff Reduction calculations are included in the appendix.

4) The rural residential development is not anticipated to contain storage of potentially harmful substances or use of potentially harmful substances. No site specific or other source control BMPs are required.

5 Drainage and Bridge Fees

The site is located within the Cottonwood Creek Drainage Basin of Fountain Creek, El Paso Basin Number FOMO2200, which was last studied in 1994. Fees associated with this basin are Drainage Fees of $23,078 per impervious acre and Bridge Fees of $1,262 per impervious acre. The percent Imperiousness of the 5-acre Rural Residential site is 7% in accordance with El Paso County Engineering Criteria Manual Appendix L Table 3-1. Also, reductions in the per acre Drainage Fee are allowed pursuant to El Paso County Resolution 99-383. A fee reduction in the of 25% for lots 2.5 acres or large is utilized for this project. The Koinonia Ranch site contains 39.079 acres. Drainage and Bridge Fees for the site are calculated below:

FEE CALCULATION (Cottonwood Creek 2023 Drainage and Bridge Fees)

Drainage Fee =	39.079 x $23,078/Imp. Ac x 0.07 Imp.	=	$ 63,131
Bridge Fee =	39.079 x $ 1,262/Imp. Ac x 0.07 Imp.	=	$ 3,452
	Subtotal	=	$ 66,583
	25% Drainage Fee Reduction	=	($15,783)
	Grand Total Fees	**=**	**$ 50,800**

6 Conclusion

This Preliminary / Final Drainage Report presents existing and proposed drainage conditions for the proposed Koinonia Ranch project. The development will have negligible and inconsequential effects on the existing site drainage and drainage conditions downstream. The site is exempted from the use of WQCV BMPs by ECM 1.7.1.B.5 by virtue of the large lot rural residential nature of the site having percent imperviousness of less than 10%. The entire site is consists of 5-acre single family residential lots which are excluded from Post Construction Stormwater Management requirements due to the low development density as 5-acre lots. The combined flows from the site at the existing culvert at Old Ranch Road are expected to increase by approximately 1.0 cfs during the 100yr storm event or an increase of about 2%. With such a negligible increase in stormwater flows from the site detention will not be necessary for the proposed development and will not be provided. The proposed project will not, with respect to stormwater runoff, negatively impact the adjacent properties and downstream properties.

References

NRCS Web Soil Survey. United States Department of Agriculture, Natural Resources Conservation Service ("http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx", accessed March, 2018).

NRCS Official Soil Series Descriptions. United States Department of Agriculture, Natural Resources Conservation Service ("http://soils.usda.gov/technical/classification/osd/index.html", accessed March, 2018).

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Drainage Report "Geist Subdivision". Richards Land Surveying Company (Colorado Springs: El Paso County, January 4, 1982).

NCSS Web Soil Survey. United States Department of Agriculture, Natural Resources Conservation Service ("http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx", accessed May, 2017).

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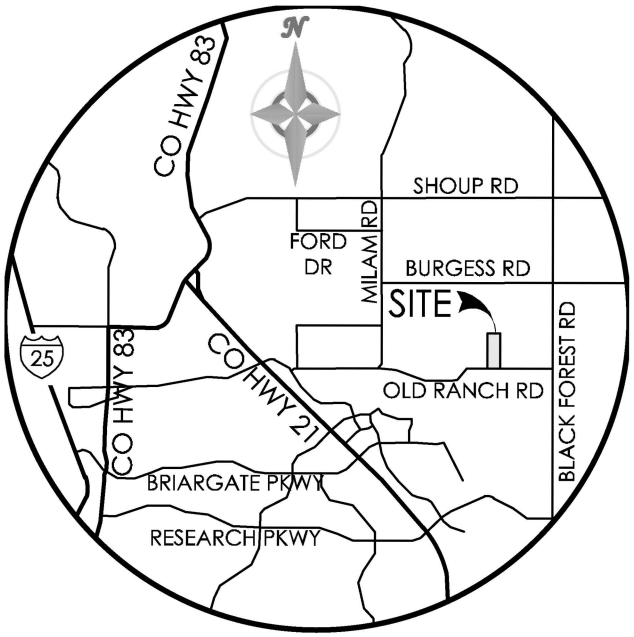
City of Colorado Springs/El Paso County Drainage Criteria Manual. City of Colorado Springs, Department of Public Works, Engineering Division; HDR Infrastructure, Inc.; El Paso County, Department of Public Works, Engineering Division (Colorado Springs: City of Colorado Springs, Revised November 1991).

City of Colorado Springs Drainage Criteria Manual Volume 1. City of Colorado Springs Engineering Division with Matrix Design Group and Wright Water Engineers (Colorado Springs, Colorado: , May 2014).

Appendices

7 General Maps and Supporting Data

Vicinity Map
Portions of Flood Insurance Rate Map
Portion of Drainage Area Identification Study Map
NRCS Soil Map and Tables
SCS Soil Type Descriptions
Hydrologic Soil Group Map and Tables



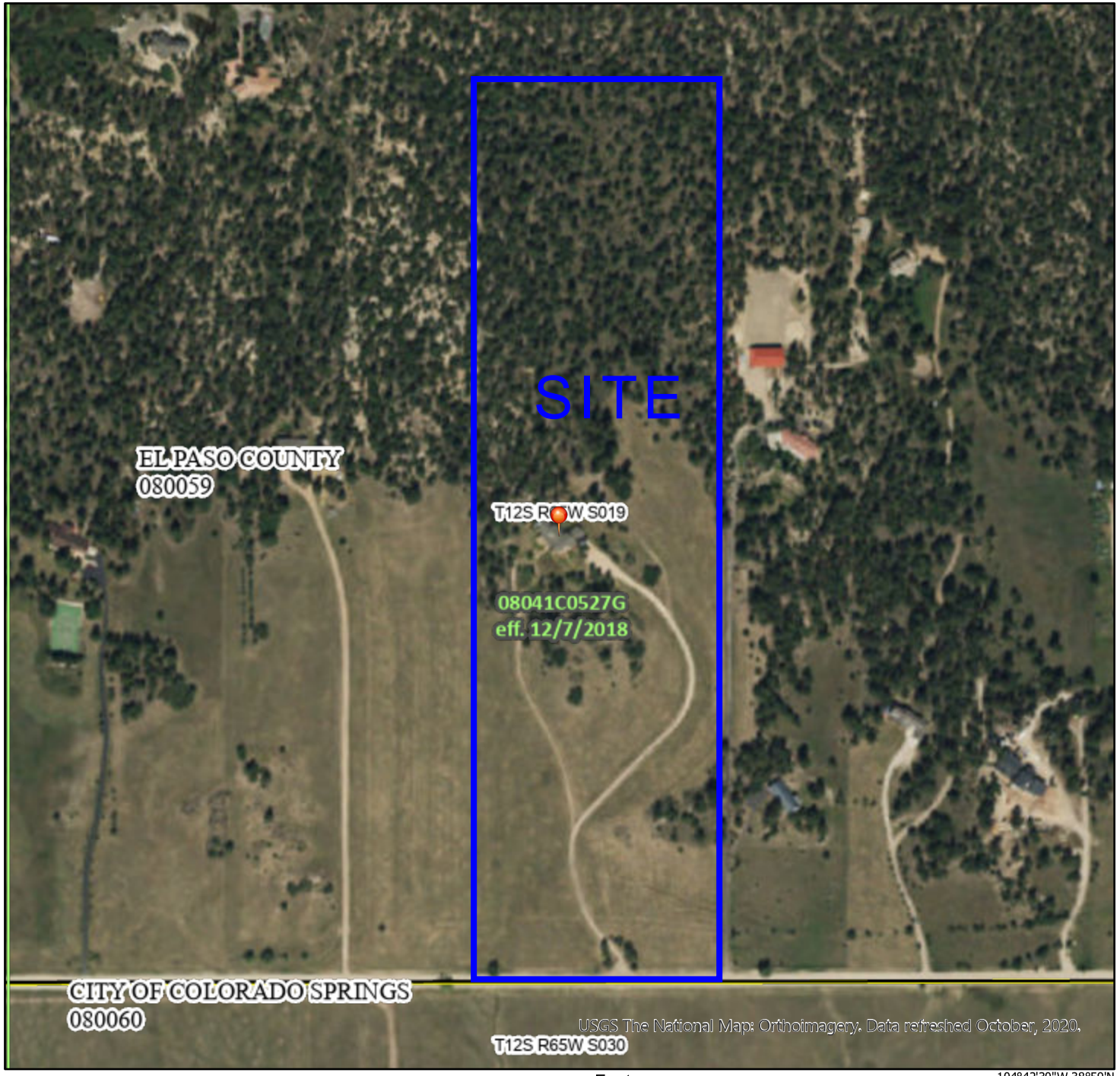
VICINITY MAP

NOT TO SCALE

National Flood Hazard Layer FIRMette

FEMA

104°43'8"W 38°59'28"N



104°42'30"W 38°59'N

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

1:6,000

Legend

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

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

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

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

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

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

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

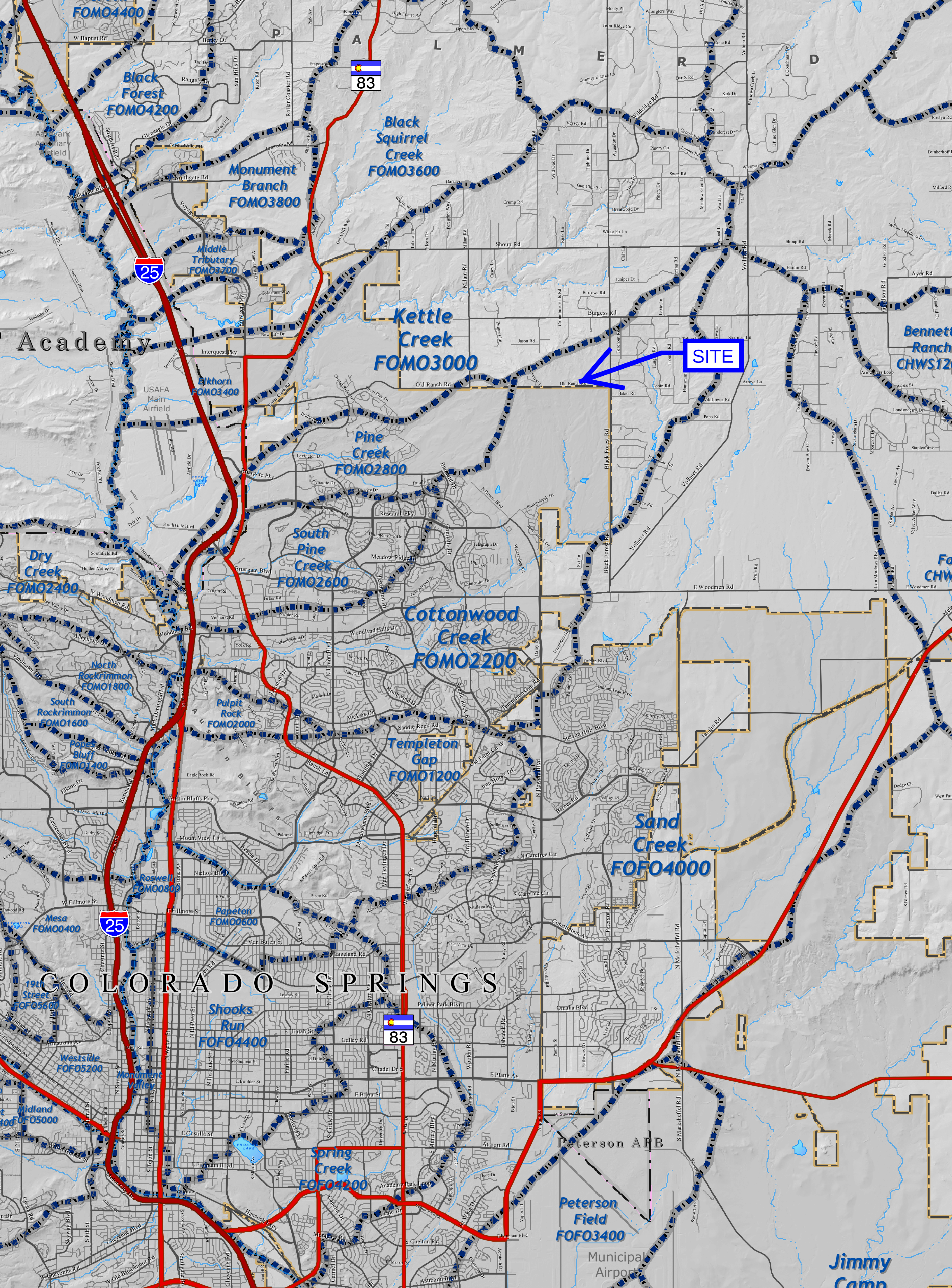
N

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

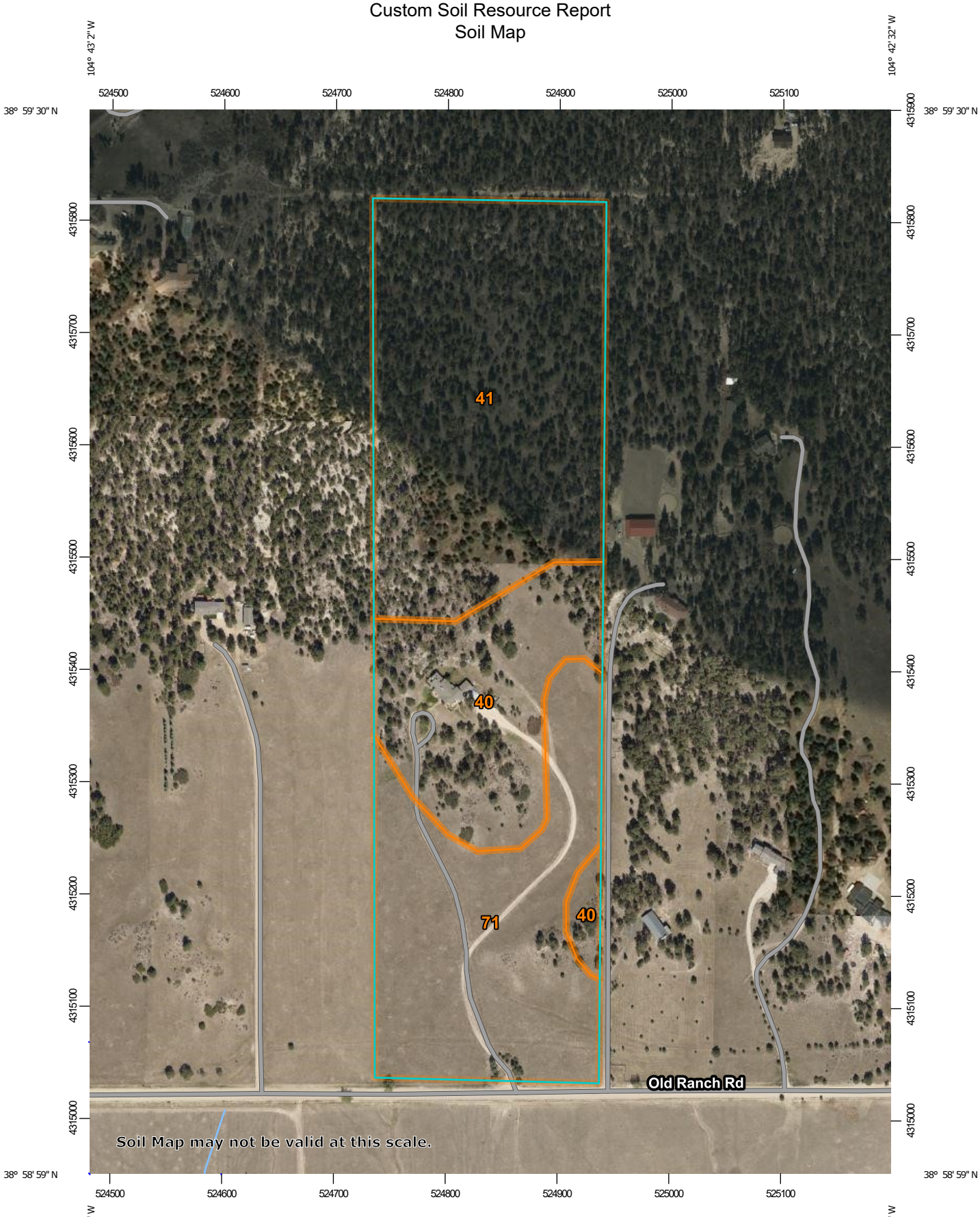
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 12/21/2020 at 12:51 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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


SITE
Black Forest FOMO4200
FOMO4400
Black Squirrel Creek FOMO3600
Monument Branch FOMO3800
Middle Tributary FOMO3700
Kettle Creek FOMO3000
Elkhorn FOMO3400
Pine Creek FOMO2800
South Pine Creek FOMO2600
Dry Creek FOMO2400
Cottonwood Creek FOMO2200
North Rockrimmon FOMO1800
South Rockrimmon FOMO1600
Pulpit Rock FOMO2000
Templeton Gap FOMO1200
Popes Bluff FOMO1400
Roswell FOMO0800
Sand Creek FOFO4000
Mesa FOMO0400
Papeton FOMO0600
19th Street FOFO5600
Shooks Run FOFO4400
Westside FOFO5200
Monument Valley
Midland FOFO5000
Spring Creek FOFO4200
Peterson Field FOFO3400
Bennett Ranch CHWS12
Jimmy Camp
Academy
USAFA Main Airfield
COLORADO SPRINGS
Peterson AFB
Municipal Airport
25
83
Old Ranch Rd
Shoup Rd
Burgess Rd
Black Forest Rd
Vollmer Rd
E Woodmen Rd
N Powers Blvd
E Platte Av
Marksheffel Rd

Custom Soil Resource Report
Soil Map



Map Scale: 1:4,620 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 200 400 800 1200

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

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

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 18, Jun 5, 2020

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

Date(s) aerial images were photographed: Aug 19, 2018—May 26, 2019

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	9.1	22.8%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	18.1	45.4%
71	Pring coarse sandy loam, 3 to 8 percent slopes	12.7	31.8%
Totals for Area of Interest		**39.8**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or

landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

El Paso County Area, Colorado

40—Kettle gravelly loamy sand, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 368g
Elevation: 7,000 to 7,700 feet
Farmland classification: Not prime farmland

Map Unit Composition

Kettle and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kettle

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium derived from arkose

Typical profile

E - 0 to 16 inches: gravelly loamy sand
Bt - 16 to 40 inches: gravelly sandy loam
C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

41—Kettle gravelly loamy sand, 8 to 40 percent slopes

Map Unit Setting

National map unit symbol: 368h
Elevation: 7,000 to 7,700 feet
Farmland classification: Not prime farmland

Map Unit Composition

Kettle and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kettle

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium derived from arkose

Typical profile

E - 0 to 16 inches: gravelly loamy sand
Bt - 16 to 40 inches: gravelly sandy loam
C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 8 to 40 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Other soils

Percent of map unit:
Hydric soil rating: No

71—Pring coarse sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 369k
Elevation: 6,800 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Pring and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pring

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock

Typical profile

A - 0 to 14 inches: coarse sandy loam
C - 14 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: R048AY222CO
Hydric soil rating: No

Minor Components

Pleasant

Percent of map unit:

Landform: Depressions
Hydric soil rating: Yes

Other soils

Percent of map unit:
Hydric soil rating: No

pricklypear occur. Ample amounts of litter and forage should be left on the soil because of the high hazard of soil blowing.

Windbreaks and environmental plantings are generally well suited to this soil. Summer fallow a year prior to planting and continued cultivation for weed control are needed to insure establishment and survival of plantings. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, Siberian peashrub, and American plum.

Depending on land use, this soil can produce habitat that is suitable for either rangeland wildlife, such as antelope, or for openland wildlife, such as pheasant, cottontail, and mourning dove. Availability of irrigation water largely determines the land use. Where no irrigation water is available, this soil is mainly used as rangeland, a use that favors rangeland wildlife. If this soil is used as rangeland, fences, livestock water developments, and proper livestock grazing use are practices that enhance habitat for rangeland wildlife. Production of crops such as wheat, corn, and alfalfa provides suitable habitat for openland wildlife, especially pheasant. Among the practices that increase openland wildlife populations are planting trees and shrubs and providing undisturbed nesting cover.

The main limitation of this soil for urban use is shrink-swell potential. Buildings and roads need to be designed to overcome this limitation. Roads need to be designed to minimize frost-heave damage. Capability subclasses IVe, nonirrigated, and IIe, irrigated.

40—Kettle gravelly loamy sand, 3 to 8 percent slopes. This deep, well drained soil formed in sandy arkosic deposits on uplands. Elevation ranges from 7,000 to 7,700 feet. The average annual precipitation is about 18 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 120 days.

Typically, the surface layer is gray gravelly loamy sand about 3 inches thick. The subsurface layer is light gray gravelly loamy sand about 13 inches thick. The subsoil is very pale brown gravelly sandy loam about 24 inches thick. It consists of a matrix of loamy coarse sand that has thin bands of coarse sandy loam or sandy clay loam. The substratum to a depth of 60 inches or more is light yellowish brown extremely gravelly loamy sand.

Included with this soil in mapping are small areas of Alamosa loam, 1 to 3 percent slopes; Elbeth sandy loam, 3 to 8 percent slopes; Pring coarse sandy loam, 3 to 8 percent slopes; Tomah-Crowfoot loamy sands, 3 to 8 percent slopes; and a few rock outcrops.

Permeability of this Kettle soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low to moderate. Surface runoff is slow, and the hazard of erosion is slight to moderate. A few gullies have formed in drainageways.

This soil is used for woodland, livestock grazing, wildlife habitat, recreation, and homesites.

This soil is suited to the production of ponderosa pine. It is capable of producing about 2,240 cubic feet or 4,900 board feet (International rule), of merchantable timber per acre from a fully stocked, even-aged stand of 80-year-old trees. The main limitation for the production or harvesting of timber is the low available water capacity. The low available water capacity also influences seedling survival, especially in areas where understory plants are plentiful. Erosion must be kept to a minimum when harvesting timber.

This soil has good potential for mule deer, tree squirrels, cottontail rabbit, and wild turkey. These animals obtain their food and shelter from pine trees, shrubs, and ground cover, which provide browse, forbs, fruit, and seeds. The presence of ponderosa pine and Gambel oak should encourage wild turkey populations; however, where water is not naturally present, wildlife watering facilities must be provided to attract and maintain wild turkey and other wildlife species. Livestock grazing management is vital on this soil if wildlife populations are to be maintained.

This soil has good potential for use as homesites. Plans for homesite development on this soil should provide for the preservation of as many trees as possible in order to maintain the esthetic value of the sites. During seasons of low precipitation, fire may become a hazard to homesites. This hazard can be minimized by installing firebreaks and reducing the amount of litter on the forest floor. Capability subclass VIe.

41—Kettle gravelly loamy sand, 8 to 40 percent slopes. This deep, well drained soil formed in sandy arkosic deposits on uplands. Elevation ranges from 7,000 to 7,700 feet. The average annual precipitation is about 18 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 120 days.

Typically, the surface layer is gray gravelly loamy sand about 3 inches thick. The subsurface layer is light gray gravelly loamy sand about 13 inches thick. The subsoil is very pale brown gravelly sandy loam about 24 inches thick. It consists of a matrix of loamy coarse sand that has thin bands of coarse sandy loam or sandy clay loam. The substratum to a depth of 60 inches or more is light yellowish brown extremely gravelly loamy sand.

Included with this soil in mapping are small areas of Elbeth sandy loam, 8 to 15 percent slopes; Pring coarse sandy loam, 8 to 15 percent slopes; Tomah-Crowfoot loamy sands, 8 to 15 percent slopes; and a few rock outcrops.

Permeability of this Kettle soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low to moderate. Surface runoff is medium, and the hazard of erosion is moderate. Some gullies have formed in drainageways.

The soil is used for woodland, livestock grazing, wildlife habitat, recreation, and homesites.

This soil is suited to the production of ponderosa pine. It is capable of producing 2,240 cubic feet, or 4,900 board

feet (International rule), of merchantable timber per acre from a fully stocked, even-aged stand of 80-year-old trees. The main limitation for this use is the moderate hazard of erosion. Measures must be taken to reduce erosion when harvesting timber, especially on the steeper slopes. The low to moderate available water capacity also influences seedling survival, especially in areas where understory plants are plentiful.

This soil has good potential for mule deer, tree squirrel, cottontail, and wild turkey. These animals obtain their food and shelter from pine trees, shrubs, and ground cover, which provide browse, forbs, fruit, and seeds. The presence of ponderosa pine and Gambel oak should encourage wild turkey populations; however, where water is not naturally present, wildlife watering facilities must be provided to attract and maintain wild turkey and other wildlife species. Livestock grazing management is vital on this soil if wildlife populations are to be maintained.

The moderately sloping to steep slopes limit the suitability of this soil for homesites. Special practices must be provided to minimize surface runoff and thus keep erosion to a minimum. This soil requires special site or building designs because of the slope. Deep cuts, to provide essentially level building sites, may expose bedrock. Access roads must be designed to provide adequate cut-slope grade, and drains must be used to control surface runoff and keep soil losses to a minimum. During seasons of low precipitation, fire may become a hazard to homesites. This hazard can be minimized by installing firebreaks and reducing the amount of litter on the forest floor. Capability subclass VIe.

42—Kettle-Rock outcrop complex. This gently rolling to very steep complex, is mostly on the side slopes of uplands. Slopes range from 8 to 60 percent. Elevation ranges from 6,800 to 7,700 feet. The average annual precipitation is about 18 inches, and average annual air temperature is about 43 degrees F.

The Kettle soil makes up about 60 percent of the complex, Rock outcrop about 20 percent, and other soils about 20 percent.

Included with this complex in mapping are areas of Peyton-Pring complex, 8 to 15 percent slopes; Elbeth sandy loam, 8 to 15 percent slopes; and Elbeth-Pring complex, 5 to 50 percent slopes.

The Kettle soil is deep and well drained. It formed in sandy arkosic deposits, mostly on the lower slopes of the complex. Slope is commonly less than 20 percent. Typically, the surface layer is gray, medium acid or slightly acid gravelly loamy sand about 3 inches thick. The subsurface layer is light gray, medium acid gravelly loamy sand about 13 inches thick. The subsoil is very pale brown, medium acid or slightly acid gravelly sandy loam about 24 inches thick. It consists of loamy coarse sand that has thin bands of coarse sandy loam or sandy clay loam. The substratum to a depth of 60 inches or more is light yellowish brown extremely gravelly loamy sand.

Permeability of the Kettle soil is rapid. Effective rooting depth is more than 60 inches. Available water capacity is low to moderate. Surface runoff is medium to rapid, and the hazard of erosion is slight to high. Soil slippage and deep gullies are common.

Rock outcrop is mostly in the form of vertical cliffs. Large stones are common on the lower slopes of this complex.

This complex is suited to the production of ponderosa pine. It is capable of producing 2,240 cubic feet, or 4,900 board feet (International rule), of merchantable timber per acre from a fully stocked, even-aged stand of 80-year-old trees. The main limitation of this complex for this use is the presence of Rock outcrop and the moderate hazard of erosion on the Kettle soil. Measures must be taken to minimize erosion when harvesting timber, especially on the steeper slopes. The low to moderate available water capacity also influences seedling survival, especially where understory plants are plentiful.

This complex has good potential for producing habitat for mule deer, tree squirrels, cottontail, and wild turkey. These animals obtain their food and shelter from pine trees, shrubs, and ground cover, which provide browse, forbs, fruit, and seeds. The presence of ponderosa pine and Gambel oak should encourage wild turkey populations; however, where water is not naturally present, wildlife watering facilities must be provided to attract and maintain wild turkey and other wildlife species. Livestock grazing management is vital on this soil if wildlife populations are to be maintained.

The moderate to very steep slopes limit the potential of this complex for homesites. Special practices must be provided to minimize surface runoff and thus keep erosion to a minimum. Special site or building designs are required because of the slope. Deep cuts, to provide essentially level building sites, can expose bedrock. The limitation of large stones on the soil surface can be overcome through the use of heavy equipment when preparing building sites. Access roads must be designed to provide adequate cut-slope grade, and drains must be used to control surface runoff and thus keep soil losses to a minimum. Deep cuts along the uphill side of the roads can expose the bedrock. Capability subclass VIIe.

43—Kim loam, 1 to 8 percent slopes. This deep, well drained soil formed in calcareous loamy sediment on fans and uplands. Elevation ranges from 5,300 to 5,600. The average annual precipitation is about 13 inches, the average annual temperature is about 49 degrees F, and the average frost-free period is about 145 days.

Typically, the surface layer is brown loam about 4 inches thick. The substratum is very pale brown loam to a depth of 60 inches or more.

Included with this soil in mapping are small areas of Fort Collins loam, 3 to 8 percent slopes; Midway clay loam, 3 to 25 percent slopes, and Wiley silt loam, 3 to 9 percent slopes.

Permeability of this Kim soil is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium, and the hazard of erosion is moderate.

Almost all areas of this soil are used as rangeland.

survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

These soils are suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

These soils have a good potential for homesites. The main limitations, especially on the Peyton soil, are low bearing strength and frost-action potential. Buildings and roads can be designed to overcome these limitations. Access roads should have adequate cut-slope grade and be provided with drains to control surface runoff and keep soil losses to a minimum. Capability subclass VIe.

69—Peyton-Pring complex, 8 to 15 percent slopes. These gently to moderately sloping soils are on valley side slopes and on uplands. Elevation ranges from 6,800 to 7,600 feet. The average annual precipitation is about 17 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 120 days.

The Peyton soil makes up about 40 percent of the complex, the Pring soil about 30 percent, and other soils about 30 percent.

Included with these soils in mapping are areas of Holderness loam, 8 to 15 percent slopes; Tomah-Crowfoot loamy sands, 8 to 15 percent slopes; Kettle gravelly loamy sand, 8 to 40 percent slopes; and a few areas of Rock outcrop.

The Peyton soil is commonly on the less sloping part of the landscape. It is deep, noncalcareous, and well drained. It formed in alluvium and residuum derived from weathered, arkosic, sedimentary rock. Typically, the surface layer is grayish brown sandy loam about 12 inches thick. The subsoil, about 23 inches thick, is pale brown sandy clay loam in the upper 13 inches and pale brown sandy loam in the lower 10 inches. The substratum is pale brown sandy loam to a depth of 60 inches or more.

Permeability of the Peyton soil is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium to rapid, and the hazard of erosion is moderate to high. Some gullies have developed along drainageways and livestock trails.

The Pring soil is deep, noncalcareous, and well drained. It formed in sandy sediment derived from weathered, arkosic, sedimentary rock. Typically, the surface layer is dark grayish brown coarse sandy loam about 4 inches thick. The substratum is dark grayish brown coarse sandy loam about 10 inches thick over pale brown gravelly sandy loam that extends to a depth of 60 inches or more.

Permeability of the Pring soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium to rapid, and the hazard of erosion is moderate to high. Some gullies have developed along drainageways and livestock trails.

The soils in this complex are used as rangeland, for wildlife habitat, and for homesites.

These soils are well suited to the production of native vegetation suitable for grazing. The dominant native species are mountain muhly, bluestem grasses, needleandthread, and blue grama. These soils are subject to invasion of Kentucky bluegrass and Gambel oak. Common forbs are hairy goldenrod, geranium, milkvetch, low larkspur, fringed sage, and buckwheat.

Properly locating livestock watering facilities helps to control grazing. Timely deferment of grazing is needed to protect the plant cover.

Windbreaks and environmental plantings generally are suited to these soils. Soil blowing is the main limitation to the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

These soils are well suited to wildlife habitat. They are best suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

These soils have good potential for use as homesites. The main limitations are steepness of slope, limited ability to support a load, and frost-action potential. Buildings and roads can be designed to overcome these limitations. These soils also require special site or building designs because of the slope. Access roads should have adequate cut-slope grade, and drains should be provided to control surface runoff and keep soil losses to a minimum. Capability subclass VIe.

70—Pits, gravel. Gravel pits are in nearly level to rolling areas. They are open excavations several feet deep and commonly 5 acres or less in size.

Gravel pits are very low in natural fertility and are highly susceptible to soil blowing. A cover of weeds or straw helps to control erosion.

Windbreaks and environmental plantings generally are not suited to these areas. Onsite investigation is needed to determine if plantings are feasible. Capability subclass VIIIs.

71—Pring coarse sandy loam, 3 to 8 percent slopes. This deep, noncalcareous, well drained soil formed in sandy sediment derived from arkosic sedimentary rock on valley side slopes and on uplands. Elevation ranges from 6,800 to 7,600 feet. The average annual precipitation is about 17 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 120 days.

Typically, the surface layer is dark grayish brown coarse sandy loam about 4 inches thick. The substratum is dark grayish brown coarse sandy loam about 10 inches thick over pale brown gravelly sandy loam that extends to a depth of 60 inches or more.

Included with this soil in mapping are small areas of Alamosa loam, 1 to 3 percent slopes, along drainageways; Cruckton sandy loam, 1 to 9 percent slopes; Peyton sandy loam, 1 to 5 percent slopes; Peyton sandy loam, 5 to 9 percent slopes; and Tomah-Crowfoot loamy sands, 3 to 8 percent slopes. In some places arkose beds of sandstone and shale are at a depth of 0 to 40 inches.

Permeability of this Pring soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the hazard of erosion is moderate.

Almost all areas of this soil are used as rangeland. Some areas previously cultivated have been reseeded to grass. This soil is also used for wildlife habitat and homesites.

This soil is well suited to the production of native vegetation suitable for grazing by cattle and sheep. Rangeland vegetation is mainly mountain muhly, little bluestem, needleandthread, Parry oatgrass, and junegrass.

Deferment of grazing in spring helps to maintain vigor and production of the cool-season bunchgrasses. Fencing and properly locating livestock watering facilities help to control grazing.

Windbreaks and environmental plantings generally are suited to this soil. The hazard of soil blowing is the main limitation to the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

This soil is well suited for use as homesites. Erosion control practices are needed to control soil blowing and water erosion on construction sites where the ground cover has been removed. Capability subclass IVe.

72—Pring coarse sandy loam, 8 to 15 percent slopes. This deep, noncalcareous, well drained soil formed in sandy sediment derived from arkosic sedimentary rock on valley side slopes and on uplands. Elevation ranges from 6,800 to 7,600 feet. The average annual precipitation is about 17 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 120 days.

Typically, the surface layer is dark grayish brown coarse sandy loam about 4 inches thick. The substratum is dark grayish brown coarse sandy loam about 10 inches thick over pale brown gravelly sandy loam that extends to a depth of 60 inches or more.

Included with this soil in mapping are small areas of Cruckton sandy loam, 1 to 9 percent slopes; Peyton sandy loam, 5 to 9 percent slopes; and Tomah-Crowfoot loamy sands, 8 to 15 percent slopes. Arkose beds of sandstone and shale are at a depth of 0 to 40 inches in some places.

Permeability of this Pring soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the hazard of erosion is moderate. Some gullies have developed along drainageways.

Almost all areas of this soil are used as rangeland. Some areas previously cultivated have been reseeded to grass. This soil is also used for wildlife habitat and as homesites.

This soil is well suited to the production of native vegetation suitable for grazing by cattle and sheep. The native vegetation is mainly mountain muhly, little bluestem, needleandthread, Parry oatgrass, and junegrass.

Deferment of grazing in spring helps to maintain the vigor and production of the cool-season bunchgrasses. Fencing and properly locating livestock watering facilities help to control grazing.

Windbreaks and environmental plantings generally are suited to this soil. The hazard of soil blowing is the main limitation to the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

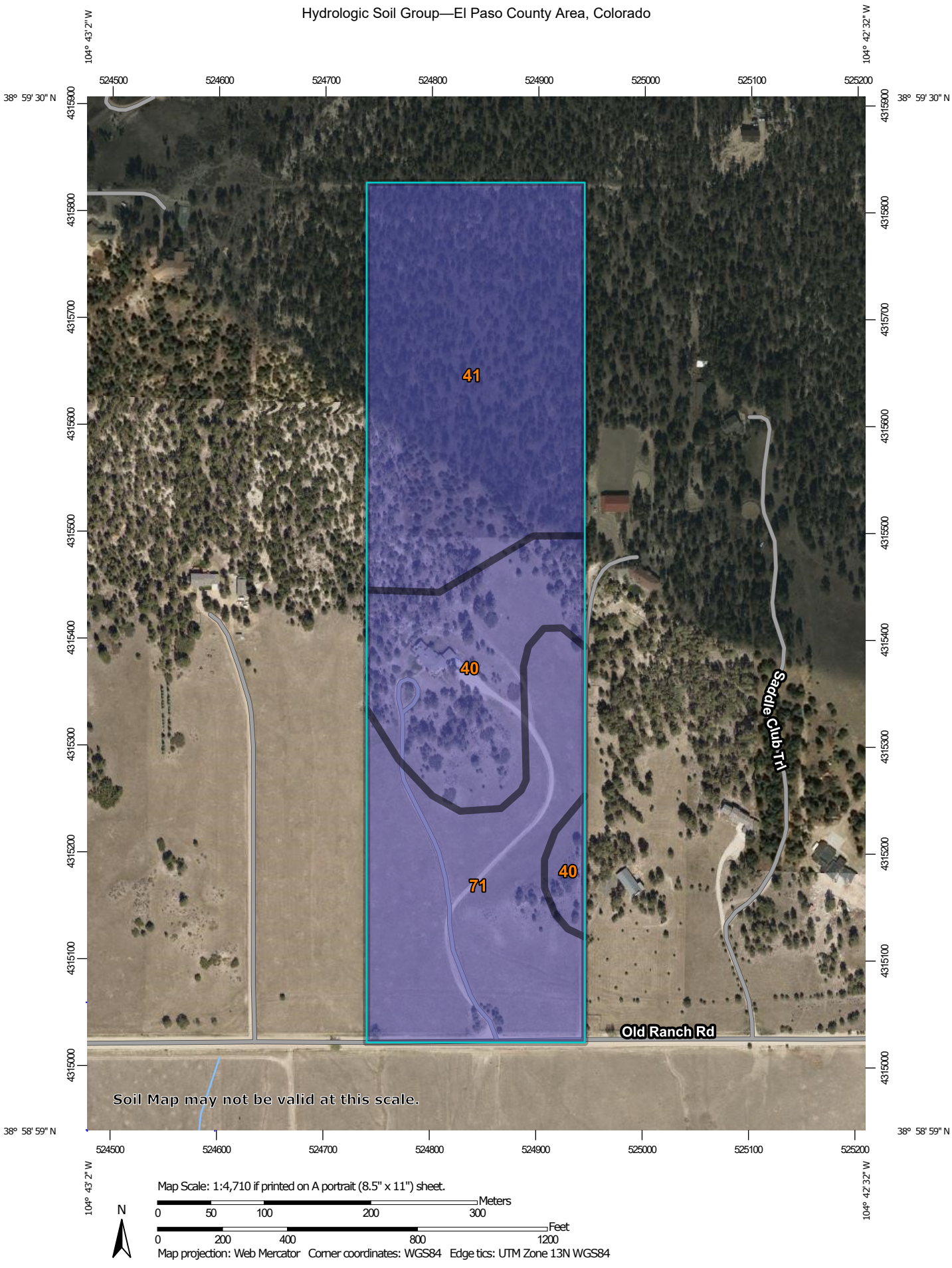
This soil is suited to habitat for openland and rangeland wildlife habitat. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

This soil has good potential for urban uses. The main limitation is slope. Special site or building designs are needed because of the slope. Access roads must have adequate cut-slope grade and be provided with drains to control surface runoff. Capability subclass VIe.

73—Razor clay loam, 3 to 9 percent slopes. This moderately deep, well drained, clayey soil formed in residuum derived from calcareous shale on uplands. Elevation ranges from 5,300 to 6,100 feet. The average annual precipitation is about 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 145 days.

Typically, the surface layer is light brownish gray clay loam about 3 inches thick. The subsoil is grayish brown heavy clay loam or clay about 15 inches thick. The substratum is grayish brown clay that grades to calcareous shale at a depth of about 31 inches. Visible lime is in the lower part of the subsoil and in the substratum.

Included with this soil in mapping are small areas of Midway clay loam, 3 to 25 percent slopes; Heldt clay loam, 0 to 3 percent slopes; and Stoneham sandy loam, 3 to 8 percent slopes.



Map Scale: 1:4,710 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 50 100 200 300

Feet
0 200 400 800 1200

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

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

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 18, Jun 5, 2020

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

Date(s) aerial images were photographed: Aug 19, 2018—May 26, 2019

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	B	9.3	22.7%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	B	18.3	44.6%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	13.3	32.6%
Totals for Area of Interest			**40.9**	**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

8 Hydrologic Calculations

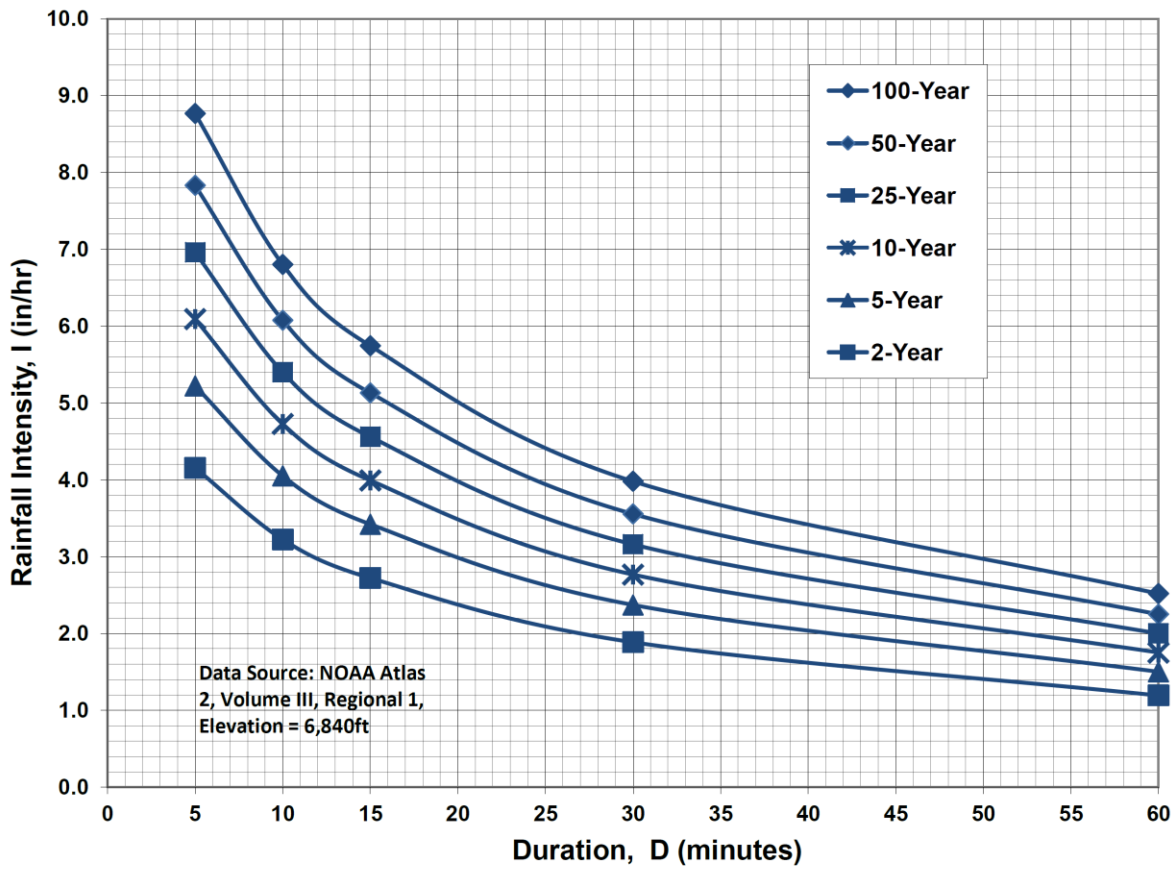
Runoff Coefficients and Percent Imperviousness Table 6-6
Colorado Springs Rainfall Intensity Duration Frequency Table 6-5
Hydrologic Calculations Summary Form SF-1 for Existing & Developed Conditions
Hydrologic Calculations Summary 5-yr Form SF-2 for Existing & Developed Conditions
Hydrologic Calculations Summary 100-yr Form SF-2 for Existing & Developed Conditions
Runoff Reduction Calculations
Runoff Reduction Map

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

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

$I_{100} = -2.52 \ln(D) + 12.735$

$I_{50} = -2.25 \ln(D) + 11.375$

$I_{25} = -2.00 \ln(D) + 10.111$

$I_{10} = -1.75 \ln(D) + 8.847$

$I_{5} = -1.50 \ln(D) + 7.583$

$I_{2} = -1.19 \ln(D) + 6.035$

Note: Values calculated by equations may not precisely duplicate values read from figure.

Job No.: **61148** Date: **09/07/2023 14:02**

Project: **Koinonia Ranch** Calcs By: **WCG, JO**

Checked By:

Time of Concentration (Modified from Standard Form SF-1)

Sub-Basin	Sub-Basin Data				Overland			Shallow Channel				Channelized				t_c Check		t_c
	Area (Acres)	C_5	C_{100}/CN	% Imp.	L_0 (ft)	S_0 (%)	t_i (min)	L_{0t} (ft)	S_{0t} (ft/ft)	v_{0sc} (ft/s)	t_t (min)	L_{0c} (ft)	S_{0c} (ft/ft)	v_{0c} (ft/s)	t_c (min)	L (min)	$t_{c,alt}$ (min)	(min)
OFFSITE																		
EX-OSA1	5.51	0.08	0.35	0%	95.5	29%	5.9	74.7	0.161	2.8	0.4	152.4	0.092	5.8	0.4	322.7	N/A	6.8
OSA1	3.17	0.08	0.35	0%	100.0	20%	6.9	113.7	0.220	3.3	0.6	152.4	0.105	5.3	0.5	366.1	N/A	7.9
OSA2	12.08	0.09	0.36	2%	100.0	8%	9.3	477.8	0.065	1.8	4.5	840.1	0.092	6.6	2.1	1417.9	N/A	15.9
OSA3	3.97	0.16	0.40	12%	100.0	9%	8.2	214.2	0.079	2.0	1.8	226.8	0.053	4.4	0.9	541.0	N/A	10.9
OSA6	5.93	0.11	0.37	4%	100.0	7%	9.4	597.5	0.069	1.8	5.4	122.0	0.061	4.8	0.4	819.5	N/A	15.3
OSA7	2.34	0.08	0.35	0%	100.0	14%	7.7	85.4	0.141	2.6	0.5	89.3	0.123	5.2	0.3	274.7	N/A	8.5
EXISTING ONSITE																		
EX-A4	0.96	0.08	0.35	0%	93.4	14%	7.5	66.2	0.091	2.1	0.5	110.8	0.045	2.8	0.7	270.4	N/A	8.6
EX-A5	29.90	0.10	0.36	2%	91.1	1%	16.8	119.3	0.067	1.8	1.1	2703.0	0.050	6.3	7.2	2913.3	N/A	25.1
EX-B2	5.70	0.08	0.35	0%	136.2	8%	11.0	128.0	0.094	2.1	1.0	408.6	0.054	4.5	1.5	672.8	N/A	13.5
EX-C1	1.70	0.08	0.35	0%	100.0	11%	8.3	90.6	0.099	2.2	0.7	171.9	0.052	3.4	0.8	362.5	N/A	9.9
EX-D1	0.82	0.08	0.35	0%	100.0	5%	10.8	90.6	0.072	1.9	0.8	65.6	0.061	3.0	0.4	256.2	N/A	12.0
PROPOSED ONSITE																		
A2	14.14	0.13	0.39	8%	100.0	10%	8.2	430.6	0.059	1.7	4.2	2304.3	0.050	5.5	7.0	2834.8	N/A	19.4
A4	0.96	0.08	0.35	0%	93.4	14%	7.5	66.2	0.091	2.1	0.5	110.8	0.045	2.8	0.7	270.4	N/A	8.6
A5	15.77	0.12	0.38	6%	100.0	8%	8.9	84.4	0.065	1.8	0.8	1707.9	0.052	5.9	4.9	1892.3	N/A	14.5
B2	5.70	0.10	0.36	2%	136.2	8%	10.8	128.0	0.094	2.1	1.0	408.6	0.054	4.6	1.5	672.8	N/A	13.3
C1	1.70	0.13	0.39	7%	100	11%	7.9	90.62	0.099	2.2	0.7	171.9	0.052	3.5	0.8	362.5	N/A	9.4
D1	0.82	0.08	0.35	0%	100	5%	10.8	90.59	0.072	1.9	0.8	65.64	0.061	3.0	0.4	256.2	N/A	12.0

Job No.: **61148**
Project: **Koinonia Ranch**
Design Storm: **5-Year Storm** *(20% Probability)*
Jurisdiction: **DCM**

Date: **09/07/2023 14:02**
Calcs By: **WCG, JO**
Checked By:

Sub-Basin and Combined Flows (Modified from Standard Form SF-2)

				Direct Runoff				Combined Runoff				Streetflow			Pipe Flow					Travel Time		
DP	Sub-Basin	Area (Acres)	C5	t_c (min)	CA (Acres)	I5 (in/hr)	Q5 (cfs)	t_c (min)	CA (Acres)	I5 (in/hr)	Q5 (cfs)	Slope (%)	Length (ft)	Q (cfs)	Q (cfs)	Slope (%)	Mnngs n	Length (ft)	D_{Pipe} (in)	Length (ft)	v_{0sc} (ft/s)	t_t (min)
OFFSITE SUB-BASINS																						
	EX-OSA1	5.51	0.08	6.8	0.44	4.7	2.1															
	OSA1	3.17	0.08	7.9	0.25	4.4	1.1															
	OSA2	12.08	0.09	15.9	1.13	3.3	3.7															
	OSA3	3.97	0.16	10.9	0.63	3.9	2.5															
	OSA6	5.93	0.11	15.3	0.64	3.4	2.2															
	OSA7	2.34	0.08	8.5	0.19	4.3	0.8															
	OSB1	1.67	0.08	8.0	0.13	4.4	0.6															
EXISTING ONSITE																					#####	#####
	EX-A4	0.96	0.08	8.6	0.08	4.3	0.3															
	EX-A5	29.90	0.10	25.1	2.86	2.6	7.5															
	EX-B2	5.70	0.08	13.5	0.46	3.6	1.6															
	EX-C1	1.70	0.08	9.9	0.14	4.1	0.6															
	EX-D1	0.82	0.08	12.0	0.07	3.8	0.2															
EX-DP1	EX-OSA1-6, EX-A4, EX-A5	58.35	0.10					16.1	5.78	3.3	19.0											
EX-DP2	EX-OSB1, EX-B2	7.37	0.08					10.7	0.59	3.9	2.3											
PROPOSED ONSITE																					#####	#####
	A2	14.14	0.13	19.4	1.86	3.0	5.6															
	A4	0.96	0.08	8.6	0.08	4.3	0.3															
	A5	15.77	0.12	14.5	1.95	3.5	6.7															
	B2	5.70	0.10	13.3	0.55	3.6	2.0															
	C1	1.70	0.13	9.4	0.23	4.2	1.0															
	D1	0.82	0.08	12.0	0.07	3.8	0.2															
DP1	OSA1, OSA3, A2	21.27	0.13					18.9	2.74	3.0	8.3											
DP2	DP1, OSA2, OSA6, OSA7, A4, A5	58.35	0.12					19.7	6.72	3.0	20.0											
DP3	OSB1, B2	7.37	0.09					9.9	0.68	4.08	2.8											

Rainfall Intensity: $I = (28.5 * P1) / (10 + tc)^{0.786}$
P1: 1.5

Job No.: **61148**
Project: **Koinonia Ranch**
Design Storm: **100-Year Storm** *(1% Probability)*
Jurisdiction: **DCM**

Date: **09/07/2023 14:02**
Calcs By: **WCG, JO**
Checked By:

Sub-Basin and Combined Flows (Modified from Standard Form SF-2)

DP	Sub-Basin	Area (Acres)	C100	Direct Runoff t_c (min)	Direct Runoff CA (Acres)	Direct Runoff I100 (in/hr)	Direct Runoff Q100 (cfs)	Combined Runoff t_c (min)	Combined Runoff CA (Acres)	Combined Runoff I100 (in/hr)	Combined Runoff Q100 (cfs)	Streetflow Slope (%)	Streetflow Length (ft)	Streetflow Q (cfs)	Pipe Flow Q (cfs)	Pipe Flow Slope (%)	Pipe Flow Mnngs n	Pipe Flow Length (ft)	Pipe Flow D_{Pipe} (in)	Travel Time Length (ft)	Travel Time v_{0sc} (ft/s)	Travel Time t_t (min)
OFFSITE SUB-BASINS																						
	EX-OSA1	5.51	0.35	6.8	1.93	7.9	15.2															
	OSA1	3.17	0.35	7.9	1.11	7.5	8.3															
	OSA2	12.08	0.36	15.9	4.34	5.8	25.0															
	OSA3	3.97	0.40	10.9	1.60	6.7	10.8															
	OSA6	5.93	0.37	15.3	2.19	5.9	12.9															
	OSA7	2.34	0.35	8.5	0.82	7.3	6.0															
	OSB1	1.67	0.35	8.0	0.58	7.5	4.4															
EXISTING ONSITE																					######	######
	EX-A4	0.96	0.35	8.6	0.33	7.3	2.4															
	EX-A5	29.90	0.36	25.1	10.79	4.6	49.8															
	EX-B2	5.70	0.35	13.5	2.00	6.2	12.3															
	EX-C1	1.70	0.35	9.9	0.60	7.0	4.1															
	EX-D1	0.82	0.35	12.0	0.29	6.5	1.9															
EX-DP1	EX-OSA1-6, EX-A4, EX-A5	58.35	0.36					16.1	21.19	5.7	121.6											
EX-DP2	EX-OSB1, EX-B2	7.37	0.35					10.7	2.58	6.8	17.4											
PROPOSED ONSITE																					######	######
	A2	14.14	0.39	19.4	5.45	5.3	28.7															
	A4	0.96	0.35	8.6	0.33	7.3	2.4															
	A5	15.77	0.38	14.5	5.99	6.0	35.9															
	B2	5.70	0.36	13.3	2.06	6.2	12.8															
	C1	1.70	0.39	9.4	0.66	7.1	4.7															
	D1	0.82	0.35	12.0	0.29	6.5	1.9															
DP1	OSA1, OSA3, A2	21.27	0.38					18.9	8.16	5.3	43.5											
DP2	DP1, OSA2, OSA6, OSA7, A4, A5	58.35	0.37					19.7	21.84	5.2	114.0											
DP3	OSB1, B2	7.37	0.36					9.9	2.65	6.96	18.4											

DCM: $I = C1 * \ln(tc) + C2$
C1: 2.52
C1: 12.735

Sub-Basin Ex-OSA1 Runoff Calculations

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	239,893	5.51	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**239,893**	**5.51**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**

239893

Basin Travel Time

-

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$: 300 ft C_v: 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	323	54	-	-	-	-	
Initial Time	96	28	0.293	-	5.9	N/A	DCM Eq. 6-8
Shallow Channel	75	12	0.161	2.8	0.4	-	DCM Eq. 6-9
Channelized	152	14	0.092	5.8	0.4	-	V-Ditch
				t_c	**6.8**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.76	4.71	5.50	6.28	7.07	7.91
Runoff (cfs)	0.4	**2.1**	4.5	8.6	11.7	**15.2**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.4	**2.1**	4.5	8.6	11.7	**15.2**

Notes

Sub-Basin OSA2 Runoff Calculations

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	512,497	11.77	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	13,610	0.31	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**526,107**	**12.08**	**0.03**	**0.09**	**0.16**	**0.26**	**0.31**	**0.36**	**2.1%**

526107

Basin Travel Time

-

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$: 300 ft C_v: 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	1,418	116	-	-	-	-	
Initial Time	100	8	0.075	-	9.3	N/A	DCM Eq. 6-8
Shallow Channel	478	31	0.065	1.8	4.5	-	DCM Eq. 6-9
Channelized	840	78	0.092	6.6	2.1	-	V-Ditch
				t_c	**15.9**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.74	3.43	4.00	4.57	5.15	5.76
Runoff (cfs)	1.1	**3.9**	7.9	14.4	19.3	**25.0**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.1	**3.9**	7.9	14.4	19.3	**25.0**

Notes

Sub-Basin OSA3 Runoff Calculations

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	146,150	3.36	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	26,770	0.61	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**172,920**	**3.97**	**0.11**	**0.16**	**0.22**	**0.31**	**0.36**	**0.40**	**12.4%**

172920

Basin Travel Time

-

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$: 300 ft C_v: 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	541	38	-	-	-	-	
Initial Time	100	9	0.090	-	8.2	N/A	DCM Eq. 6-8
Shallow Channel	214	17	0.079	2.0	1.8	-	DCM Eq. 6-9
Channelized	227	12	0.053	4.4	0.9	-	V-Ditch
				t_c	**10.9**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.19	4.00	4.67	5.33	6.00	6.71
Runoff (cfs)	1.3	**2.5**	4.2	6.6	8.5	**10.8**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.3	**2.5**	4.2	6.6	8.5	**10.8**

Notes

Sub-Basin OSA6 Runoff Calculations

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	244,075	5.60	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	14,320	0.33	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**258,395**	**5.93**	**0.05**	**0.11**	**0.18**	**0.27**	**0.32**	**0.37**	**4.4%**

258395

Basin Travel Time

-

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$: 300 ft C_v: 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	820	56	-	-	-	-	
Initial Time	100	7	0.070	-	9.4	N/A	DCM Eq. 6-8
Shallow Channel	597	41	0.069	1.8	5.4	-	DCM Eq. 6-9
Channelized	122	8	0.061	4.8	0.4	-	V-Ditch
				t_c	**15.3**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.79	3.49	4.08	4.66	5.24	5.87
Runoff (cfs)	0.8	**2.2**	4.3	7.5	10.0	**12.9**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.8	**2.2**	4.3	7.5	10.0	**12.9**

Notes

Sub-Basin OSB1 Runoff Calculations

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	72,721	1.67	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**72,721**	**1.67**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**

72721

Basin Travel Time

-

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$: 300 ft C_v: 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	347	44	-	-	-	-	
Initial Time	100	22	0.215	-	6.7	N/A	DCM Eq. 6-8
Shallow Channel	88	10	0.113	2.4	0.6	-	DCM Eq. 6-9
Channelized	159	12	0.076	4.0	0.7	-	V-Ditch
				t_c	**8.0**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.56	4.47	5.21	5.96	6.70	7.50
Runoff (cfs)	0.1	**0.6**	1.3	2.5	3.4	**4.4**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.1	**0.6**	1.3	2.5	3.4	**4.4**

Notes

Sub-Basin EX-A4 Runoff Calculations

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	41,638	0.96	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**41,638**	**0.96**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**

41638

Basin Travel Time

-

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$: 300 ft C_v: 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	270	24	-	-	-	-	
Initial Time	93	13	0.139	-	7.5	N/A	DCM Eq. 6-8
Shallow Channel	66	6	0.091	2.1	0.5	-	DCM Eq. 6-9
Channelized	111	5	0.045	2.8	0.7	-	V-Ditch
				t_c	**8.6**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.47	4.35	5.07	5.80	6.52	7.30
Runoff (cfs)	0.1	**0.3**	0.7	1.4	1.9	**2.4**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.1	**0.3**	0.7	1.4	1.9	**2.4**

Notes

Sub-Basin EX-A5 Runoff Calculations

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	1,265,252	29.05	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	30,428	0.70	0.57	0.59	0.63	0.66	0.68	0.7	80%
Roofs	4,265	0.10	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	2,631	0.06	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**1,302,576**	**29.90**	**0.04**	**0.10**	**0.16**	**0.26**	**0.31**	**0.36**	**2.4%**

1302576

Basin Travel Time

-

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$: 300 ft C_v: 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	2,913	145	-	-	-	-	
Initial Time	91	1	0.011	-	16.8	N/A	DCM Eq. 6-8
Shallow Channel	119	8	0.067	1.8	1.1	-	DCM Eq. 6-9
Channelized	2,703	136	0.050	6.3	7.2	-	V-Ditch
				t_c	**25.1**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.20	2.75	3.21	3.67	4.13	4.62
Runoff (cfs)	2.4	**7.9**	15.8	28.8	38.5	**49.8**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	2.4	**7.9**	15.8	28.8	38.5	**49.8**

Notes

Sub-Basin EX-B2 Runoff Calculations

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	248,302	5.70	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**248,302**	**5.70**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**

248302

Basin Travel Time

-

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$: 300 ft C_v: 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	673	45	-	-	-	-	
Initial Time	136	11	0.077	-	11.0	N/A	DCM Eq. 6-8
Shallow Channel	128	12	0.094	2.1	1.0	-	DCM Eq. 6-9
Channelized	409	22	0.054	4.5	1.5	-	V-Ditch
				t_c	**13.5**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.94	3.68	4.30	4.91	5.53	6.19
Runoff (cfs)	0.3	**1.7**	3.7	7.0	9.5	**12.3**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.3	**1.7**	3.7	7.0	9.5	**12.3**

Notes

Sub-Basin EX-C1 Runoff Calculations

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	74,145	1.70	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**74,145**	**1.70**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**

74145

Basin Travel Time

-

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$: 300 ft C_v: 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	363	29	-	-	-	-	
Initial Time	100	11	0.110	-	8.3	N/A	DCM Eq. 6-8
Shallow Channel	91	9	0.099	2.2	0.7	-	DCM Eq. 6-9
Channelized	172	9	0.052	3.4	0.8	-	V-Ditch
				t_c	**9.9 min.**		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.31	4.15	4.84	5.53	6.22	6.96
Runoff (cfs)	0.1	**0.6**	1.2	2.4	3.2	**4.1**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.1	**0.6**	1.2	2.4	3.2	**4.1**

Notes

Sub-Basin EX-D1 Runoff Calculations

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	35,623	0.82	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**35,623**	**0.82**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**

35623

-

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$: 300 ft C_v: 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	256	16	-	-	-	-	
Initial Time	100	5	0.050	-	10.8	N/A	DCM Eq. 6-8
Shallow Channel	91	7	0.072	1.9	0.8	-	DCM Eq. 6-9
Channelized	66	4	0.061	3.0	0.4	-	V-Ditch
				t_c	**12.0**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.08	3.86	4.50	5.14	5.78	6.47
Runoff (cfs)	0.1	**0.3**	0.6	1.1	1.4	**1.9**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.1	**0.3**	0.6	1.1	1.4	**1.9**

Notes

Combined Sub-Basin Runoff Calculations (EX-DP1)

Includes Basins EX-OSA1 OSA2 OSA3 OSA6 EX-A4 EX-A5

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	2,449,505	56.23	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	85,128	1.95	0.57	0.59	0.63	0.66	0.68	0.7	80%
Roofs	4,265	0.10	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	2,631	0.06	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**2,541,529**	**58.35**	**0.04**	**0.10**	**0.17**	**0.27**	**0.31**	**0.36**	**2.9%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	EX-OSA1	-	323	54	-	-	-	-	6.8
Channelized-1	V-Ditch	2	2,860	154	15.2	0	2	5.1	9.3
Channelized-2									
Channelized-3									
Total			3,183	208					

2 = Natural, Winding, minimal vegetation/shallow grass

t_c (min) **16.1**

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

Q_{Minor} (cfs) - 5-year Storm

Q_{Major} (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.73	3.42	3.99	4.56	5.13	5.74
Site Runoff (cfs)	6.45	**19.75**	39.07	70.57	94.02	**121.58**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**19.8**	-	-	-	**121.6**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Combined Sub-Basin Runoff Calculations (EX-DP2)

Includes Basins OSB1 EX-B2

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	321,023	7.37	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**321,023**	**7.37**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	OSB1	-	347	44	-	-	-	-	8.0
Channelized-1	V-Ditch	2	672	45	4	0	2	4.1	2.7
Channelized-2									
Channelized-3									
Total			1,019	89					

2 = Natural, Winding, minimal vegetation/shallow grass

t_c (min) **10.7**

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

Q_{Minor} (cfs) - 5-year Storm

Q_{Major} (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.21	4.02	4.70	5.37	6.04	6.76
Site Runoff (cfs)	0.47	**2.37**	5.19	9.89	13.35	**17.43**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**2.4**	-	-	-	**17.4**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Sub-Basin OSA1 Runoff Calculations (Created From EX-OSA1)

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	137,895	3.17	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**137,895**	**3.17**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**
	137895								

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$: 300 ft C_v: 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	366	61	-	-	-	-	
Initial Time	100	20	0.200	-	6.9	N/A	DCM Eq. 6-8
Shallow Channel	114	25	0.220	3.3	0.6	-	DCM Eq. 6-9
Channelized	152	16	0.105	5.3	0.5	-	V-Ditch
				t_c	**7.9**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.57	4.48	5.23	5.97	6.72	7.52
Runoff (cfs)	0.2	**1.1**	2.5	4.7	6.4	**8.3**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.2	**1.1**	2.5	4.7	6.4	**8.3**

Notes

Sub-Basin OSA7 Runoff Calculations (Created From EX-OSA1)

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	101,998	2.34	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**101,998**	**2.342**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**

101998

Basin Travel Time

-

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$: 300 ft C_v: 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	275	37	-	-	-	-	
Initial Time	100	14	0.140	-	7.7	N/A	DCM Eq. 6-8
Shallow Channel	85	12	0.141	2.6	0.5	-	DCM Eq. 6-9
Channelized	89	11	0.123	5.2	0.3	-	V-Ditch
				t_c	**8.5**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.48	4.37	5.09	5.82	6.55	7.33
Runoff (cfs)	0.2	**0.8**	1.8	3.4	4.6	**6.0**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.2	**0.8**	1.8	3.4	4.6	**6.0**

Notes

Proposed Sub-Basin A2 Runoff Calculations

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	557,792	12.81	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	46,057	1.06	0.57	0.59	0.63	0.66	0.68	0.7	80%
Roofs	10,000	0.23	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	2,000	0.05	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**615,849**	**14.14**	**0.08**	**0.13**	**0.20**	**0.29**	**0.34**	**0.39**	**7.8%**

615849

Basin Travel Time

-

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$: 300 ft C_v: 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	2,835	152	-	-	-	-	
Initial Time	100	10	0.100	-	8.2	N/A	DCM Eq. 6-8
Shallow Channel	431	26	0.059	1.7	4.2	-	DCM Eq. 6-9
Channelized	2,304	116	0.050	5.5	7.0	-	V-Ditch
				t_c	**19.4**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.50	3.13	3.66	4.18	4.70	5.26
Runoff (cfs)	2.7	**5.8**	10.2	17.2	22.5	**28.7**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	2.7	**5.8**	10.2	17.2	22.5	**28.7**

Notes

Proposed Sub-Basin A4 Runoff Calculations

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	41,638	0.96	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**41,638**	**0.96**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**

41638

-

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$: 300 ft C_v: 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	270	24	-	-	-	-	
Initial Time	93	13	0.139	-	7.5	N/A	DCM Eq. 6-8
Shallow Channel	66	6	0.091	2.1	0.5	-	DCM Eq. 6-9
Channelized	111	5	0.045	2.8	0.7	-	V-Ditch
				t_c	**8.6**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.47	4.35	5.07	5.80	6.52	7.30
Runoff (cfs)	0.1	**0.3**	0.7	1.4	1.9	**2.4**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.1	**0.3**	0.7	1.4	1.9	**2.4**

Notes

Proposed Sub-Basin A5 Runoff Calculations

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	633,176	14.54	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	10,000	0.23	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	3,631	0.08	0.89	0.9	0.92	0.94	0.95	0.96	100%
Gravel	39,920	0.92	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**686,727**	**15.77**	**0.07**	**0.12**	**0.19**	**0.29**	**0.33**	**0.38**	**6.5%**

686727

Basin Travel Time

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Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$: 300 ft C_v: 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	1,892	103	-	-	-	-	
Initial Time	100	8	0.080	-	8.9	N/A	DCM Eq. 6-8
Shallow Channel	84	6	0.065	1.8	0.8	-	DCM Eq. 6-9
Channelized	1,708	89	0.052	5.9	4.9	-	V-Ditch
				t_c	**14.5**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.85	3.57	4.16	4.76	5.35	5.99
Runoff (cfs)	3.0	**6.9**	12.5	21.4	28.1	**35.9**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	3.0	**6.9**	12.5	21.4	28.1	**35.9**

Notes

Proposed Sub-Basin B2 Runoff Calculations

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	242,302	5.56	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	5,000	0.11	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	1,000	0.02	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**248,302**	**5.70**	**0.04**	**0.10**	**0.17**	**0.26**	**0.31**	**0.36**	**2.2%**

248302

Basin Travel Time

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Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$: 300 ft C_v: 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	673	45	-	-	-	-	
Initial Time	136	11	0.077	-	10.8	N/A	DCM Eq. 6-8
Shallow Channel	128	12	0.094	2.1	1.0	-	DCM Eq. 6-9
Channelized	409	22	0.054	4.6	1.5	-	V-Ditch
				t_c	**13.3**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.96	3.71	4.32	4.94	5.56	6.22
Runoff (cfs)	0.6	**2.0**	4.1	7.4	9.9	**12.8**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.6	**2.0**	4.1	7.4	9.9	**12.8**

Notes

Proposed Sub-Basin C1 Runoff Calculations

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	68,145	1.56	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	5,000	0.11	0.71	0.73	0.75	0.78	0.8	0.81	90%
Paved	1,000	0.02	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**74,145**	**1.70**	**0.08**	**0.13**	**0.20**	**0.30**	**0.34**	**0.39**	**7.4%**

74145

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Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$: 300 ft C_v: 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	363	29	-	-	-	-	
Initial Time	100	11	0.110	-	7.9	N/A	DCM Eq. 6-8
Shallow Channel	91	9	0.099	2.2	0.7	-	DCM Eq. 6-9
Channelized	172	9	0.052	3.5	0.8	-	V-Ditch
				t_c	**9.4 min.**		

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.37	4.22	4.93	5.63	6.33	7.09
Runoff (cfs)	0.4	**1.0**	1.7	2.8	3.7	**4.7**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.4	**1.0**	1.7	2.8	3.7	**4.7**

Notes

Proposed Sub-Basin D1 Runoff Calculations

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	35,623	0.82	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**35,623**	**0.82**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**

35623

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Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$: 300 ft C_v: 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	256	16	-	-	-	-	
Initial Time	100	5	0.050	-	10.8	N/A	DCM Eq. 6-8
Shallow Channel	91	7	0.072	1.9	0.8	-	DCM Eq. 6-9
Channelized	66	4	0.061	3.0	0.4	-	V-Ditch
				t_c	**12.0**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.08	3.86	4.50	5.14	5.78	6.47
Runoff (cfs)	0.1	**0.3**	0.6	1.1	1.4	**1.9**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.1	**0.3**	0.6	1.1	1.4	**1.9**

Notes

Proposed Combined Sub-Basin Runoff Calculations (DP1)

Includes Basins OSA1 OSA3 A2

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	841,836	19.33	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	72,827	1.67	0.57	0.59	0.63	0.66	0.68	0.7	80%
Paved	2,000	0.05	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	10,000	0.23	0.71	0.73	0.75	0.78	0.8	0.81	90%
Combined	**926,664**	**21.27**	**0.07**	**0.13**	**0.20**	**0.29**	**0.34**	**0.38**	**7.5%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	OSA1	-	366	61	-	-	-	-	7.9
Channelized-1	V-Ditch	2	2,919	158	8	0	2	4.4	11.0
Channelized-2									
Channelized-3									
Total			3,285	219					

2 = Natural, Winding, minimal vegetation/shallow grass

t_c (min) **18.9**

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

Q_{Minor} (cfs) - 5-year Storm

Q_{Major} (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.54	3.17	3.70	4.23	4.76	5.33
Site Runoff (cfs)	3.92	**8.70**	15.43	26.06	34.11	**43.51**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**8.7**	-	-	-	**43.5**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Proposed Combined Sub-Basin Runoff Calculations (DP2)

Includes Basins DP1 OSA2 OSA6 OSA7 A4 A5

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	2,375,221	54.53	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	140,677	3.23	0.57	0.59	0.63	0.66	0.68	0.7	80%
Paved	5,631	0.13	0.89	0.9	0.92	0.94	0.95	0.96	100%
Roofs	20,000	0.46	0.71	0.73	0.75	0.78	0.8	0.81	90%
Combined	**2,541,529**	**58.35**	**0.06**	**0.12**	**0.18**	**0.28**	**0.33**	**0.37**	**5.4%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	DP1	-	3,285	219	-	-	-	-	18.9
Channelized-1	V-Ditch	2	239	5	44	0	2	4.7	0.9
Channelized-2									
Channelized-3									
Total			3,524	224					

2 = Natural, Winding, minimal vegetation/shallow grass

t_c (min) **19.7**

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

Q_{Minor} (cfs) - 5-year Storm

Q_{Major} (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.49	3.11	3.63	4.14	4.66	5.22
Site Runoff (cfs)	8.38	**20.89**	38.72	67.32	88.80	**113.96**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**20.9**	-	-	-	**114.0**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Proposed Combined Sub-Basin Runoff Calculations (DP3)

Includes Basins OSB1 B2

Job No.:	**61148**	Date:	**09/07/2023 14:02**
Project:	**Koinonia Ranch**	Calcs by:	**WCG, JO**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Non-Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	315,023	7.23	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	5,000	0.11	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	-	0.00	0.57	0.59	0.63	0.66	0.68	0.7	80%
Paved	1,000	0.02	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**321,023**	**7.37**	**0.03**	**0.09**	**0.16**	**0.26**	**0.31**	**0.36**	**1.7%**

Basin Travel Time

	Sub-basin or Channel Type	Material Type	L (ft)	Elev. ΔZ_0 (ft)	Q_i (cfs)	Base or Dia (ft)	Sides z:1 (ft/ft)	v (ft/s)	t (min)
Furthest Reach	OSB1	-	347	44	-	-	-	-	8.0
Channelized-1	V-Ditch	2	672	45	19	0	2	5.9	1.9
Channelized-2									
Channelized-3									
Total			1,019	89					

2 = Natural, Winding, minimal vegetation/shallow grass

t_c (min) **9.9**

Contributing Offsite Flows (Added to Runoff and Allowed Release, below.)

Contributing Basins/Areas

Q_{Minor} (cfs) - 5-year Storm

Q_{Major} (cfs) - 100-year Storm

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.31	4.15	4.84	5.53	6.22	6.96
Site Runoff (cfs)	0.82	**2.83**	5.76	10.61	14.20	**18.42**
OffSite Runoff (cfs)	-	**0.00**	-	-	-	**0.00**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	-	**2.8**	-	-	-	**18.4**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018)

Designer: TJW, JO
Company: MVE INC.
Date: August 16, 2023
Project: 61148-Koinonia Ranch
Location: SE corner of SW 1/4 of Section 19, Township 12 South, Range 65 West

SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth: 0.60 inches
Depth of Average Runoff Producing Storm, d_6 = 0.43 inches (for Watersheds Outside of the Denver Region, Figure 3-1 in USDCM Vol. 3)

Area Type	UIA:RPA	UIA:RPA										
Area ID	A5	A8										
Downstream Design Point ID	DP2	DP3										
Downstream BMP Type	None	None										
DCIA (ft^2)	--	--										
UIA (ft^2)	29,057	35,140										
RPA (ft^2)	14,991	14,071										
SPA (ft^2)	--	--										
HSG A (%)	0%	0%										
HSG B (%)	100%	100%										
HSG C/D (%)	0%	0%										
Average Slope of RPA (ft/ft)	0.250	0.250										
UIA:RPA Interface Width (ft)	1707.43	1752.69										

CALCULATED RUNOFF RESULTS

Area ID	A5	A8										
UIA:RPA Area (ft^2)	44,048	49,211										
L / W Ratio	0.06	0.06										
UIA / Area	0.6597	0.7141										
Runoff (in)	0.00	0.06										
Runoff (ft^3)	0	248										
Runoff Reduction (ft^3)	1211	1217										

CALCULATED WQCV RESULTS

Area ID	A5	A8										
WQCV (ft^3)	1211	1464										
WQCV Reduction (ft^3)	1211	1217										
WQCV Reduction (%)	100%	83%										
Untreated WQCV (ft^3)	0	248										

CALCULATED DESIGN POINT RESULTS (sums results from all columns with the same Downstream Design Point ID)

Downstream Design Point ID	DP2	DP3										
DCIA (ft^2)	0	0										
UIA (ft^2)	29,057	35,140										
RPA (ft^2)	14,991	14,071										
SPA (ft^2)	0	0										
Total Area (ft^2)	44,048	49,211										
Total Impervious Area (ft^2)	29,057	35,140										
WQCV (ft^3)	1,211	1,464										
WQCV Reduction (ft^3)	1,211	1,217										
WQCV Reduction (%)	100%	83%										
Untreated WQCV (ft^3)	0	248										

CALCULATED SITE RESULTS (sums results from all columns in worksheet)

Total Area (ft^2)	93,259
Total Impervious Area (ft^2)	64,197
WQCV (ft^3)	2,675
WQCV Reduction (ft^3)	2,427
WQCV Reduction (%)	91%
Untreated WQCV (ft^3)	248

Okay - Meets 60% WQCV Requirement for Runoff

LEGEND

PROPERTY LINE

EASEMENT LINE

EXISTING

5985 INDEX CONTOUR

84 INTERMEDIATE CONTOUR

PROPOSED

5985 INDEX CONTOUR

84 INTERMEDIATE CONTOUR

AREA BOUNDARY

AREA I.D.

SURFACE TYPES

UNCONNECTED IMPERVIOUS AREA (UIA)	
RECEIVING PERVIOUS AREA (RPA)	
EXCLUDED PER ECM I.7.1.B.5	

LOT 2

OVERHEAD UTILITY LINE

HOUSE DETAIL

OLD RANCH ROAD

30" CMP CULVERT (EXISTING)

(719) 635-5736

MONUMENT VALLEY ENGINEERS INC.

*** ENGINEERS *** SURVEYORS ***

1903 LELARAY ST., COLORADO SPRINGS, COLORADO 80909

BMP_AREA_I.D.

9 Hydraulic Calculations

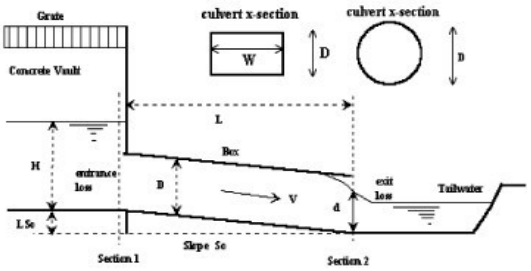
Culvert Calculations
Ditch Flow Calculations
HY-8 Calculations

CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **61148-Koinonia Ranch**

ID: **DP-1 Box Culvert**



Design Information (Input):

Circular Culvert: Barrel Diameter in Inches — D = [ ] inches

Inlet Edge Type (Choose from pull-down list)

OR:

Box Culvert: Barrel Height (Rise) in Feet — H (Rise) = 1.50 ft

Barrel Width (Span) in Feet — W (Span) = 4.50 ft

Inlet Edge Type (Choose from pull-down list) — Square Edge w/ 30-75 deg. Flared Wingwall

Number of Barrels	# Barrels =	1
Inlet Elevation at Culvert Invert	Elev IN =	7263.75 ft
Outlet Elevation **OR** Slope	Elev OUT =	7263.31 ft
Culvert Length	L =	87.4 ft
Manning's Roughness	n =	0.013
Bend Loss Coefficient	K_b =	0
Exit Loss Coefficient	K_x =	1

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.20
Friction Loss Coefficient	K_f =	0.92
Sum of All Loss Coefficients	K_s =	2.12
Minimum Energy Condition Coefficient	KE_{low} =	0.0493
Orifice Inlet Condition Coefficient	C_d =	0.62

Calculations of Culvert Capacity (output):

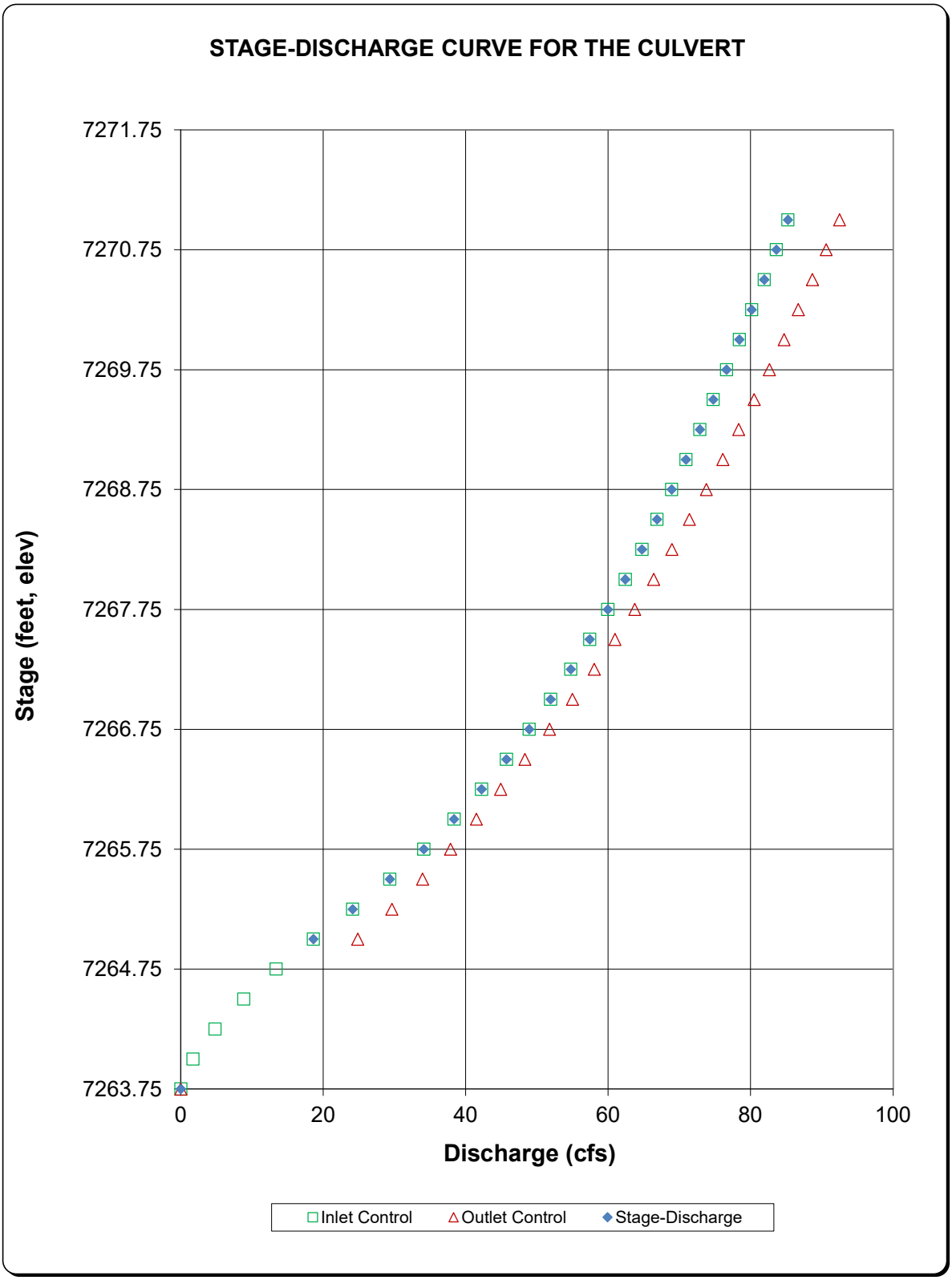
Backwater calculations required to obtain Outlet Control Flowrate when HWo < 0.75 * Culvert Ris

Headwater Surface Elevation (ft)	Tailwater Surface Elevation (ft)	Inlet Control Equation Used	Inlet Control Flowrate (cfs)	Outlet Control Flowrate (cfs)	Controlling Culvert Flowrate (cfs)	Flow Control Used
7263.75		No Flow (WS < inlet)	0.00	0.00	**0.00**	N/A
7264.00		Min. Energy. Eqn.	1.71	#N/A	#N/A	#N/A
7264.25		Min. Energy. Eqn.	4.81	#N/A	#N/A	#N/A
7264.50		Min. Energy. Eqn.	8.82	#N/A	#N/A	#N/A
7264.75		Regression Eqn.	13.37	#N/A	#N/A	#N/A
7265.00		Regression Eqn.	18.62	24.84	**18.62**	INLET
7265.25		Regression Eqn.	24.12	29.63	**24.12**	INLET
7265.50		Regression Eqn.	29.36	33.93	**29.36**	INLET
7265.75		Regression Eqn.	34.11	37.86	**34.11**	INLET
7266.00		Regression Eqn.	38.37	41.50	**38.37**	INLET
7266.25		Regression Eqn.	42.21	44.90	**42.21**	INLET
7266.50		Regression Eqn.	45.71	48.29	**45.71**	INLET
7266.75		Regression Eqn.	48.92	51.75	**48.92**	INLET
7267.00		Regression Eqn.	51.92	54.99	**51.92**	INLET
7267.25		Regression Eqn.	54.74	58.04	**54.74**	INLET
7267.50		Regression Eqn.	57.41	60.95	**57.41**	INLET
7267.75		Regression Eqn.	59.95	63.72	**59.95**	INLET
7268.00		Regression Eqn.	62.41	66.38	**62.41**	INLET
7268.25		Regression Eqn.	64.73	68.93	**64.73**	INLET
7268.50		Orifice Eqn.	66.86	71.39	**66.86**	INLET
7268.75		Orifice Eqn.	68.92	73.77	**68.92**	INLET
7269.00		Orifice Eqn.	70.91	76.08	**70.91**	INLET
7269.25		Orifice Eqn.	72.86	78.32	**72.86**	INLET
7269.50		Orifice Eqn.	74.75	80.50	**74.75**	INLET
7269.75		Orifice Eqn.	76.61	82.62	**76.61**	INLET
7270.00		Orifice Eqn.	78.41	84.68	**78.41**	INLET
7270.25		Orifice Eqn.	80.16	86.70	**80.16**	INLET
7270.50		Orifice Eqn.	81.91	88.67	**81.91**	INLET
7270.75		Orifice Eqn.	83.61	90.60	**83.61**	INLET
7271.00		Orifice Eqn.	85.23	92.48	**85.23**	INLET
				Processing Time:	**01.88 Seconds**	

CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

MHFD-Culvert, Version 4.00 (May 2020)

Project: 61148-Koinonia Ranch
ID: DP-1 Box Culvert

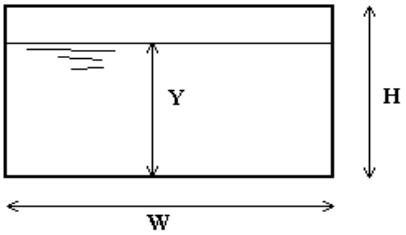


BOX CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: 61148-Koinonia Ranch

Box ID: DP1-Box Culvert



Design Information (Input)			
Box conduit invert slope	So =	0.0071	ft/ft
Box Manning's n-value	n =	0.0120	
Box Width	W =	4.50	ft
Box Height	H =	1.50	ft
Design discharge	Q =	43.50	cfs

Full-flow capacity (Calculated)			
Full-flow area	Af =	6.75	sq ft
Full-flow wetted perimeter	Pf =	12.00	ft
Full-flow capacity	Qf =	48.12	cfs

Calculations of Normal Flow Condition			
Normal flow depth (<H)	Yn =	1.12	ft
Flow area	An =	5.04	sq ft
Wetted perimeter	Pn =	6.74	ft
Flow velocity	Vn =	8.62	fps
Discharge	Qn =	43.50	cfs
Percent of Full Flow	Flow =	90.4%	of full flow
Normal Depth Froude Number	Fr_n =	1.44	supercritical

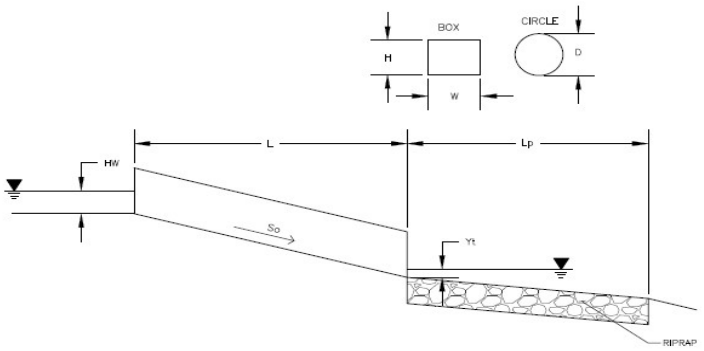
Calculation of Critical Flow Condition			
Critical flow depth	Yc =	1.43	ft
Critical flow area	Ac =	6.42	sq ft
Critical flow velocity	Vc =	6.78	fps
Critical Depth Froude Number	Fr_c =	1.00	

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: **61148-Koinonia Ranch**

ID: **DP-1 Box Culvert Outlet Protection**



Soil Type:

Choose One:
- (●) Sandy
- ( ) Non-Sandy

Supercritical Flow! Using Adjusted Rise to calculate protection type.

Design Information:

Design Discharge	Q =	43.5	cfs

Circular Culvert:

Barrel Diameter in Inches	D =		inches
Inlet Edge Type (Choose from pull-down list)			

OR:

Box Culvert:

		OR	
Barrel Height (Rise) in Feet	H (Rise) =	1.5	ft
Barrel Width (Span) in Feet	W (Span) =	4.5	ft
Inlet Edge Type (Choose from pull-down list)		Square Edge w/ 30-75 deg. Flared Wingwall	
Number of Barrels	# Barrels =	1	
Inlet Elevation	Elev IN =	7263.75	ft
Outlet Elevation **OR** Slope	Elev OUT =	7263.31	ft
Culvert Length	L =	87.4	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t,\ Elevation}$ =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Calculated Results:

Culvert Cross Sectional Area Available	A =	6.75	ft^2
Culvert Normal Depth	Y_n =	1.34	ft
Culvert Critical Depth	Y_c =	1.43	ft
Froude Number	Fr =	1.10	**Supercritical!**
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.92	
Sum of All Loss Coefficients	k_s =	2.12	ft

Headwater:

Inlet Control Headwater	HW_I =	2.59	ft
Outlet Control Headwater	HW_O =	2.39	ft
Design Headwater Elevation	**HW =**	**7266.34**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/H=**	**1.73**	**HW/H > 1.5!**

Outlet Protection:

Flow/(Span * Rise^1.5)	Q/WH^1.5 =	5.26	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	0.60	ft
Tailwater/Rise	Yt/H =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	1.60	
Flow Area at Max Channel Velocity	A_t =	8.70	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	-	ft
Length of Riprap Protection	**L_p =**	**15**	**ft**
Width of Riprap Protection at Downstream End	**T =**	**14**	**ft**
Adjusted Rise for Supercritical Flow	Ha =	1.42	ft
Minimum Theoretical Riprap Size	d_{50} min=	3	in
Nominal Riprap Size	d_{50} nominal=	6	in
MHFD Riprap Type	**Type =**	**VL**	

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

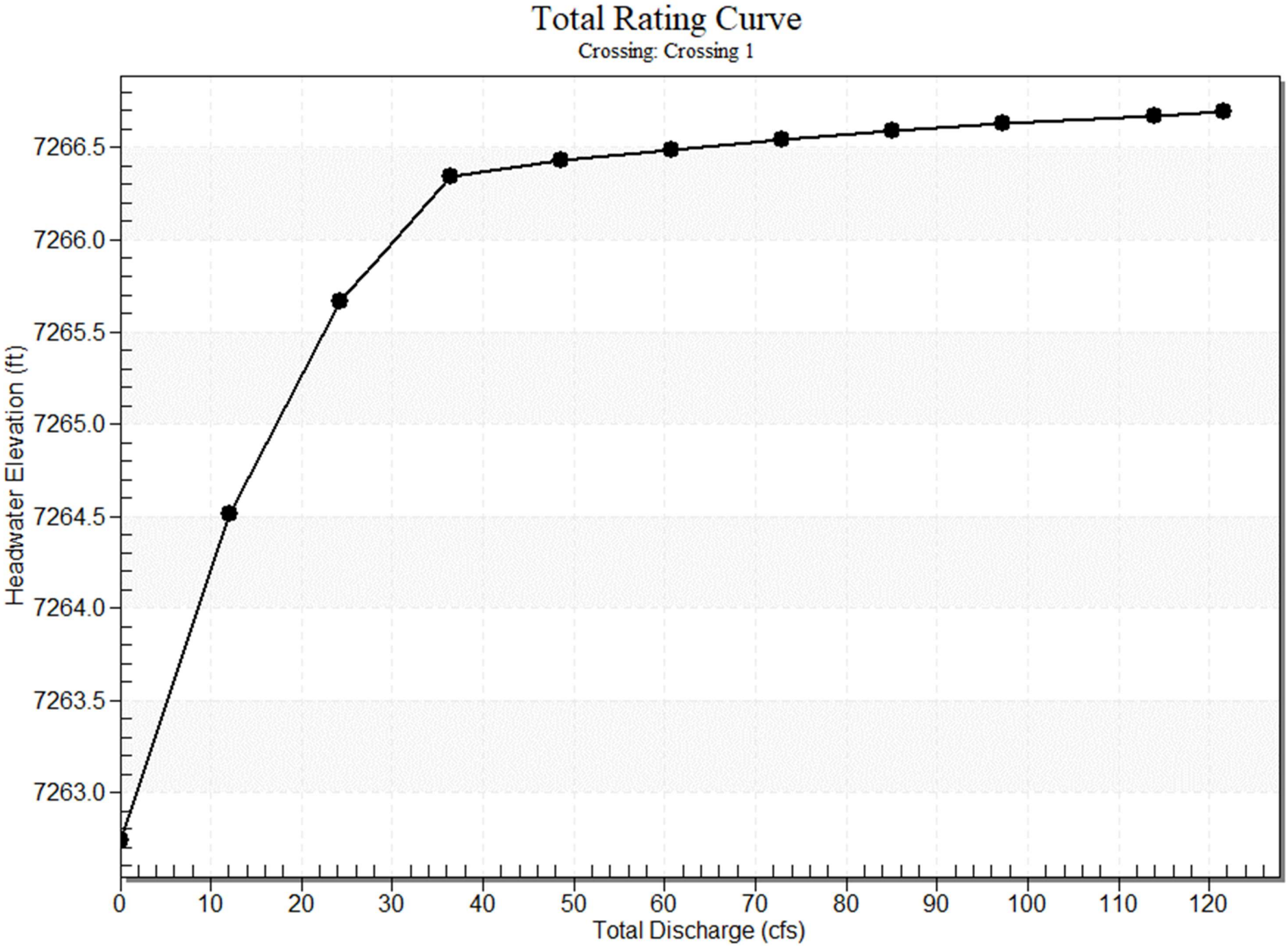
Design Flow: 114.00 cfs

Maximum Flow: 121.60 cfs

Table 1 - Summary of Culvert Flows at Crossing: Crossing 1

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7262.74	0.00	0.00	0.00	1
7264.51	12.16	12.16	0.00	1
7265.66	24.32	24.32	0.00	1
7266.34	36.48	30.11	6.28	17
7266.43	48.64	30.79	17.79	8
7266.49	60.80	31.26	29.44	6
7266.54	72.96	31.66	41.26	6
7266.59	85.12	31.98	53.09	5
7266.63	97.28	32.27	65.00	5
7266.67	114.00	32.60	81.38	4
7266.69	121.60	32.74	88.86	4
7266.17	28.76	28.76	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing 1



Culvert Data: Culvert 1

Table 1 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00 cfs	0.00 cfs	7262.74	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
12.16 cfs	12.16 cfs	7264.51	1.77	0.0*	6-FFc	0.93	1.17	1.17	0.78	5.39	4.97
24.32 cfs	24.32 cfs	7265.66	2.92	1.349	6-FFc	1.38	1.68	1.68	1.01	6.94	5.92
36.48 cfs	30.11 cfs	7266.34	3.60	2.222	6-FFc	1.58	1.87	1.87	1.18	7.65	6.55
48.64 cfs	30.79 cfs	7266.43	3.69	2.636	6-FFc	1.61	1.89	1.89	1.31	7.73	7.03
60.80 cfs	31.26 cfs	7266.49	3.75	2.707	6-FFc	1.62	1.90	1.90	1.43	7.79	7.44
72.96 cfs	31.66 cfs	7266.54	3.80	2.766	6-FFc	1.64	1.92	1.92	1.53	7.84	7.78
85.12 cfs	31.98 cfs	7266.59	3.85	2.816	6-FFc	1.65	1.93	1.93	1.62	7.88	8.09
97.28 cfs	32.27 cfs	7266.63	3.89	2.859	6-FFc	1.66	1.93	1.93	1.71	7.92	8.37
114.00 cfs	32.60 cfs	7266.67	3.93	2.910	6-FFc	1.67	1.94	1.94	1.81	7.96	8.70
121.60 cfs	32.74 cfs	7266.69	3.95	2.932	6-FFc	1.68	1.95	1.95	1.85	7.98	8.85

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

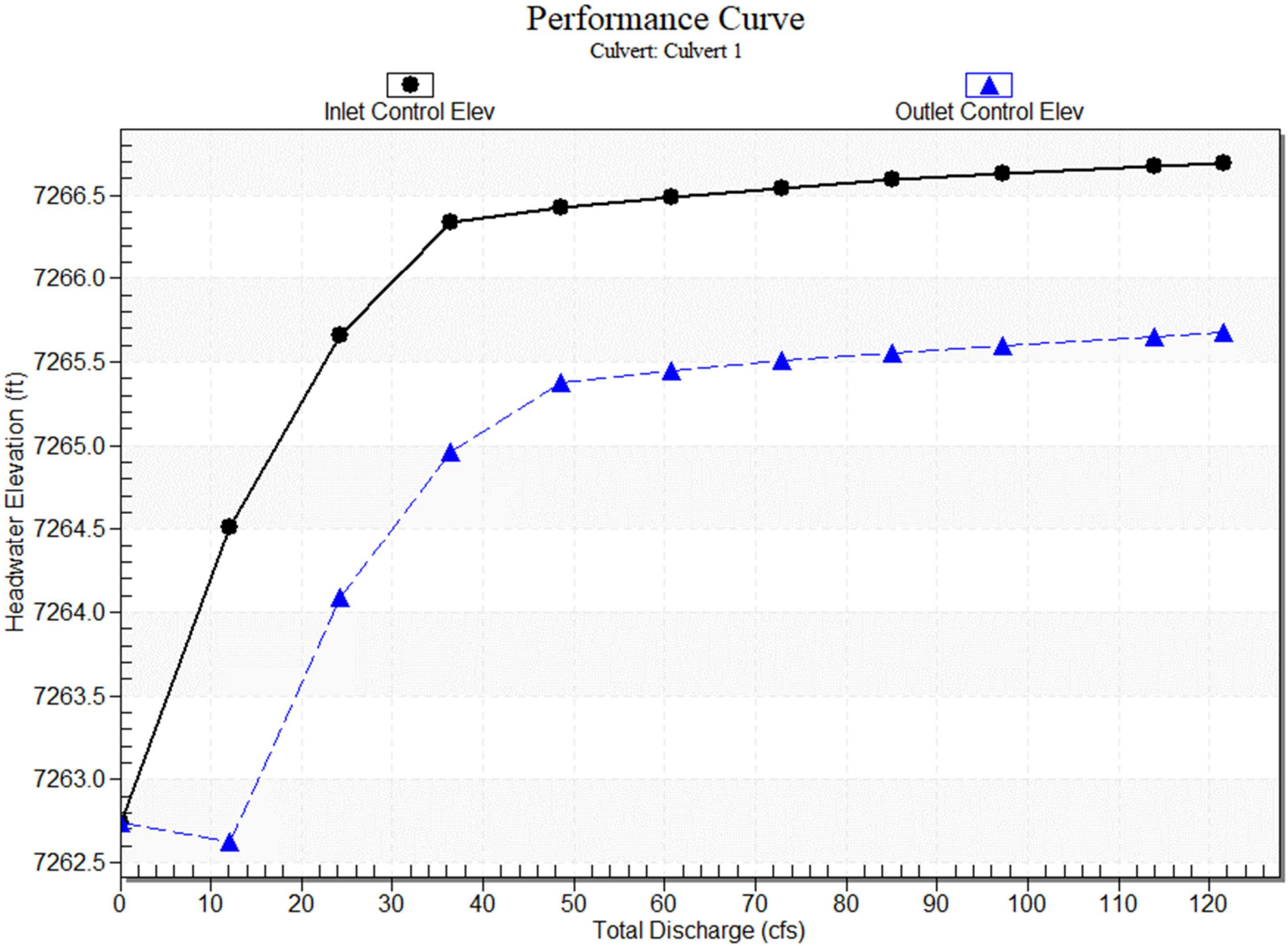
Inlet Elevation (invert): 7262.74 ft,

Outlet Elevation (invert): 7261.13 ft

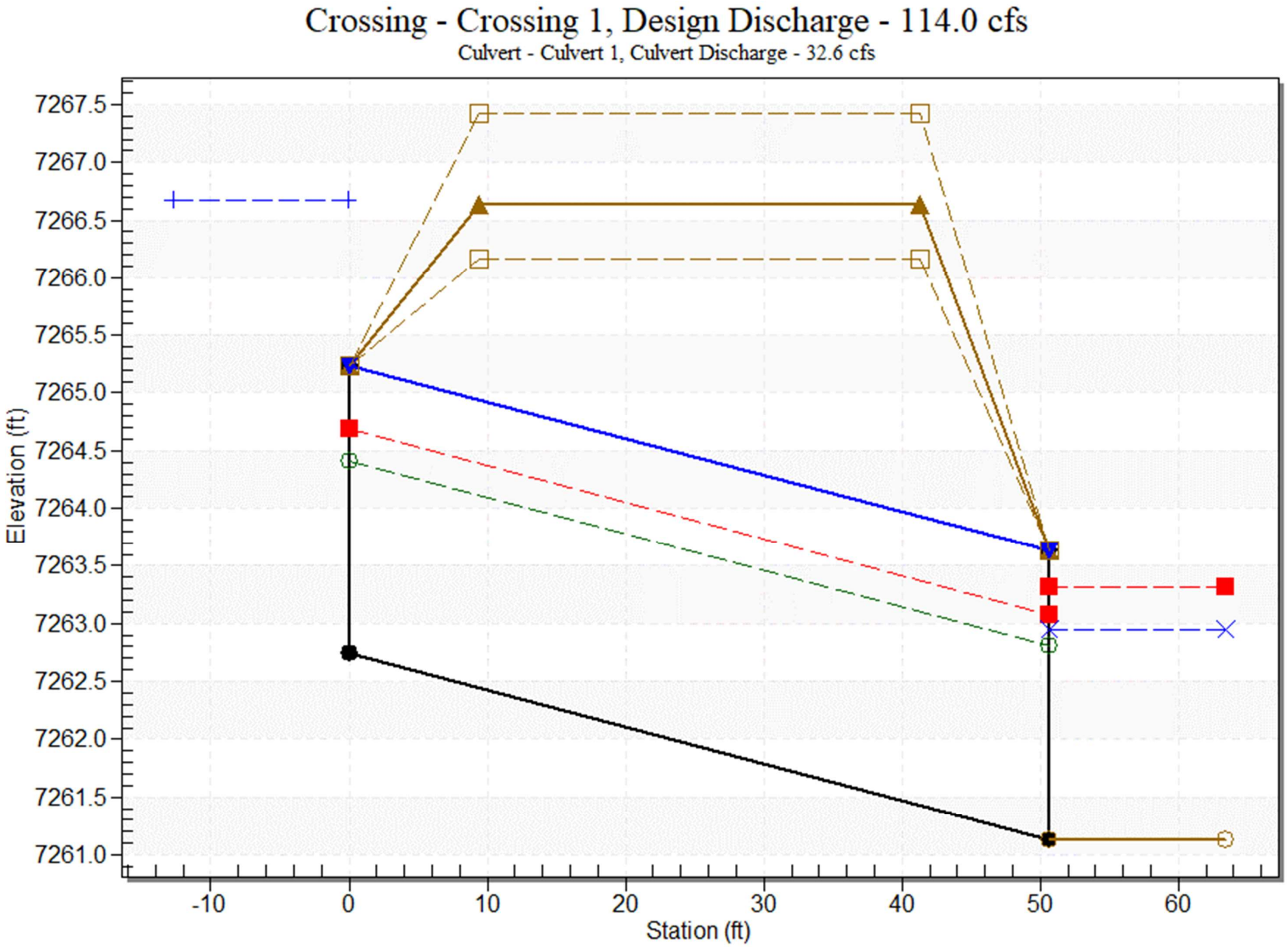
Culvert Length: 50.74 ft,

Culvert Slope: 0.0317

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7262.74 ft

Outlet Station: 50.71 ft

Outlet Elevation: 7261.13 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0230

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Tailwater Data for Crossing: Crossing 1

Table 2 - Downstream Channel Rating Curve (Crossing: Crossing 1)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	7261.13	0.00	0.00	0.00	0.00
12.16	7261.91	0.78	4.97	2.44	1.40
24.32	7262.14	1.01	5.92	3.16	1.46
36.48	7262.31	1.18	6.55	3.68	1.50
48.64	7262.44	1.31	7.03	4.10	1.53
60.80	7262.56	1.43	7.44	4.46	1.55
72.96	7262.66	1.53	7.78	4.78	1.57
85.12	7262.75	1.62	8.09	5.06	1.58
97.28	7262.84	1.71	8.37	5.32	1.60
114.00	7262.94	1.81	8.70	5.65	1.61
121.60	7262.98	1.85	8.85	5.78	1.62

Tailwater Channel Data - Crossing 1

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0350

Channel Invert Elevation: 7261.13 ft

Roadway Data for Crossing: Crossing 1

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section

Coord No.	Station (ft)	Elevation (ft)
0	0.00	7267.42
1	55.57	7266.77
2	92.65	7266.63
3	96.74	7266.62
4	133.93	7266.55
5	177.25	7266.30
6	218.97	7266.17
7	265.70	7266.37

Roadway Surface: Gravel

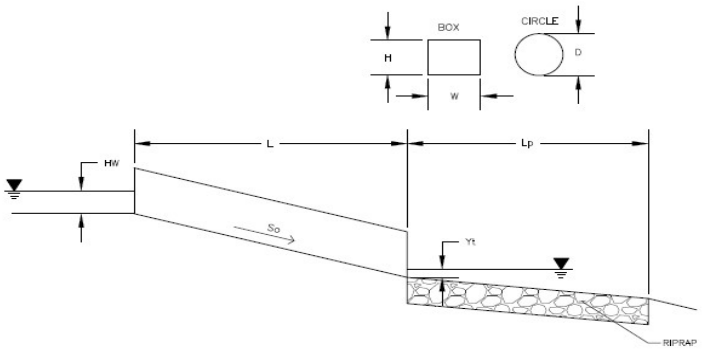
Roadway Top Width: 32.00 ft

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: **61148-Koinonia Ranch**

ID: **DP2-Existing Old Ranch Road 30" CMP Riprap Requirements**



Soil Type:
Choose One:
(•) Sandy
( ) Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:			
Design Discharge	Q =	32.6	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	30	inches
Inlet Edge Type (Choose from pull-down list)		Grooved Edge Projecting	
OR:			
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	H (Rise) =		ft
Barrel Width (Span) in Feet	W (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	# Barrels =	1	
Inlet Elevation	Elev IN =	7262.74	ft
Outlet Elevation **OR** Slope	Elev OUT =	7261.13	ft
Culvert Length	L =	50.7	ft
Manning's Roughness	n =	0.024	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t,\ Elevation}$ =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Calculated Results:			
Culvert Cross Sectional Area Available	A =	4.91	ft^2
Culvert Normal Depth	Y_n =	1.72	ft
Culvert Critical Depth	Y_c =	1.94	ft
Froude Number	Fr =	1.27	**Supercritical!**
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	1.58	
Sum of All Loss Coefficients	k_s =	2.78	ft
Headwater:			
Inlet Control Headwater	HW_I =	3.08	ft
Outlet Control Headwater	HW_O =	2.52	ft
Design Headwater Elevation	**HW =**	**7265.82**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.23**	
Outlet Protection:			
Flow/(Diameter^2.5)	Q/D^2.5 =	3.30	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	1.00	ft
Tailwater/Diameter	Yt/D =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	4.12	
Flow Area at Max Channel Velocity	A_t =	6.52	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	-	ft
Length of Riprap Protection	**L_p =**	**17**	**ft**
Width of Riprap Protection at Downstream End	**T =**	**7**	**ft**
Adjusted Diameter for Supercritical Flow	Da =	2.11	ft
Minimum Theoretical Riprap Size	d_{50} min=	7	in
Nominal Riprap Size	d_{50} nominal=	9	in
MHFD Riprap Type	**Type =**	**L**	

M.V.E., Inc.
Date: 09/7/2023
Project: 61148
Koinonia Ranch

Ditch Velocities & Erosion Protection

Ditch Data:		Permissible Velocities by Soil Type:		Permissible Velocities by Grass Linings:	
S. Slope H	4.0	40- Kettle gravelly loamy sand	3.5 fps	Grass-legume mixture (0-5%)	4.0 fps
S. Slope H	3.0	41- Kettle gravelly loamy sand	3.5 fps	Grass-legume mixture (5-10%)	3.0 fps
Manning's n	0.030	71 - Pring Coarse Sandy Loam	2.5 fps	> > >	

Sub-basin Designation	Road Name	Stations	Full Sub-Basin Area (Ac)	Full Sub-Basin Q_{100} (cfs)	Partial Sub-Basin Area (Ac)	Ditch Flow Q_{100} (cfs)	Max. Longit. Ditch Slope in Reach (ft/ft)	Ditch Flow Depth (ft)	Ditch Flow Area (ft^2)	**Ditch Flow Velocity (ft/sec)**	Permissible Velocity (ft/sec)	**Ditch Protection Required?**
A2	Koinonia Court	17+32.95E - 11+00.00E	21.27	43.5	17.03	34.8	0.051	1.2	4.6	**7.5**	4.0	**YES**
A5	Koinonia Court	17+32.95W - 11+00.00W	14.06	34.1	7.96	19.3	0.051	0.9	3.0	**6.4**	4.0	**YES**
A2	Koinonia Court	7+50.00E - 11+00.00E	N/A	N/A	N/A	N/A	N/A	N/A	3.0	**N/A**	N/A	**N/A**
A5	Koinonia Court	7+50.00w - 11+00.00W	14.06	34.1	10.01	24.3	0.040	1.1	3.9	**6.2**	4.0	**YES**
A2	Koinonia Court	3+00.00E - 7+50.00E	21.27	43.5	20.15	41.2	0.051	1.2	5.3	**7.8**	3.0	**YES**
A5	Koinonia Court	3+00.00W - 7+50.00W	14.06	34.1	13.85	33.6	0.051	1.1	4.5	**7.4**	3.0	**YES**
A2	Koinonia Court	1+59.00E - 3+00.00E	21.27	43.5	21.27	43.5	0.078	1.2	4.7	**9.2**	3.0	**YES**
A5	Koinonia Court	1+59.00W - 3+00.00W	14.06	34.1	14.06	34.1	0.078	1.1	3.9	**8.7**	3.0	**YES**

10 Report Maps

Existing Condition Hydraulic Analysis Map (Map Pocket)
Proposed Condition Hydraulic Analysis Map (Map Pocket)

LEGEND

- PROPERTY LINE
- EASEMENT LINE
- LOT LINE

EXISTING

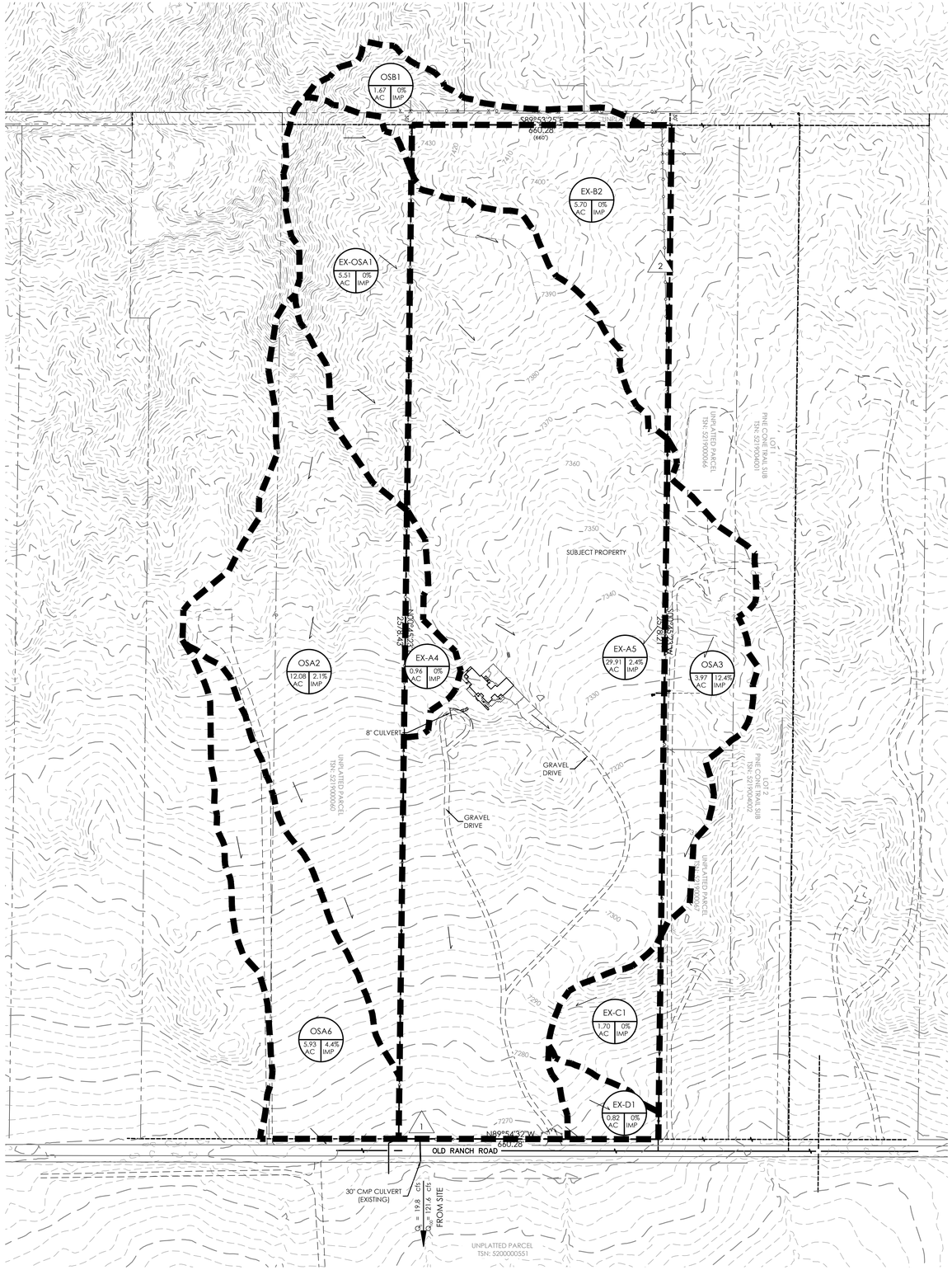
- 5985 INDEX CONTOUR
- 84 INTERMEDIATE CONTOUR

PROPOSED

- 5985 INDEX CONTOUR
- 84 INTERMEDIATE CONTOUR
- BASIN BOUNDARY
- Q = 19.0 cfs, Q_{100} = 60.0 cfs — GENERAL FLOW/DIRECTION
- 1.5% — SLOPE DIRECTION AND GRADE
- A1 | 1.0 AC | 50% IMP — BASIN LABEL, AREA IN ACRES, PERCENT IMPERVIOUS
- 1 — POINT OF INTEREST

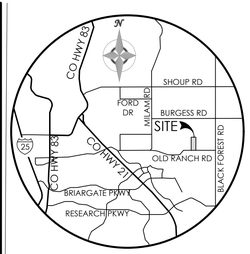
FLOODPLAIN STATEMENT

NO PORTION OF THE SUBJECT PROPERTY IS LOCATED WITHIN A FEMA DESIGNATED SPECIAL FLOOD HAZARD AREA (SFHA) AS INDICATED ON THE FLOOD INSURANCE RATE MAP (FIRM) FOR EL PASO COUNTY, COLORADO AND INCORPORATED AREAS - MAP NUMBER 08041C0527 G, EFFECTIVE DECEMBER 7, 2018.



EXISTING DRAINAGE SUMMARY TABLE

DESIGN POINT	INCLUDED BASIN(S)	AREA (AC)	Tc (MIN.)	RUNOFF Q5 (CFS)	RUNOFF Q100 (CFS)
	EX-OSA1	5.51	6.8	2.1	15.2
	OSA2	12.08	15.9	3.9	25.0
	OSA3	3.97	10.8	2.5	10.8
	OSA6	5.93	15.3	2.2	12.9
	OSB1	1.67	8.0	0.6	4.4
	EX-A4	0.96	8.6	0.3	2.4
	EX-A5	29.90	25.1	7.9	49.8
	EX-B2	5.70	13.5	1.7	12.3
	EX-C1	1.70	9.9	0.6	4.1
	EX-D1	0.82	12.0	0.3	1.9
EX-DP1	EX-OSA1, OSA2-6, EX-A4&5	58.35	16.1	19.8	121.6
EX-DP2	OSB1, EX-B2	7.37	10.7	2.4	17.4



VICINITY MAP

NOT TO SCALE

BENCHMARK

N

50 0 75 150 300

SCALE: 1"=150' 1:1800

MVE, INC.
ENGINEERS / SURVEYORS
1903 lelaray street, suite 200 colorado springs co 80909 719.635.5736

REVISIONS

DESIGNED BY
DRAWN BY
CHECKED BY
AS-BUILTS BY
CHECKED BY

KOINONIA RANCH

EXISTING DRAINAGE

MVE PROJECT 61148
MVE DRAWING EX-DRN

SEPTEMBER 7, 2023

SHEET 1 OF 1

LEGEND

PROPERTY LINE

EASEMENT LINE

LOT LINE

EXISTING

5985 INDEX CONTOUR

84 INTERMEDIATE CONTOUR

PROPOSED

5985 INDEX CONTOUR

84 INTERMEDIATE CONTOUR

BASIN BOUNDARY

Q_5 = 19.0 cfs, Q_{100} = 60.0 cfs — GENERAL FLOW/DIRECTION

1.0% — SLOPE DIRECTION AND GRADE

A1 — 1.0 AC, 50% IMP — BASIN LABEL, AREA IN ACRES, PERCENT IMPERVIOUS

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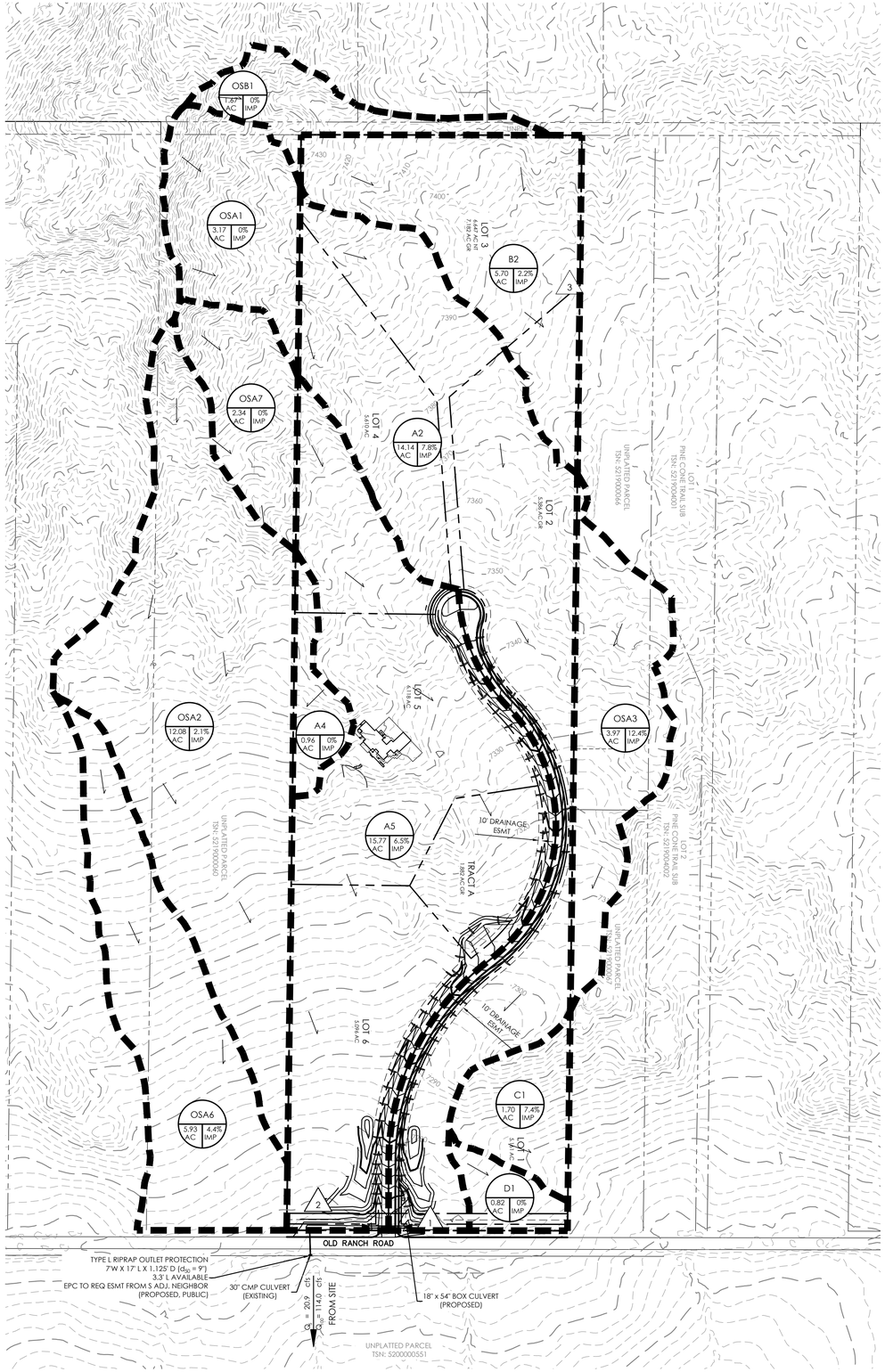
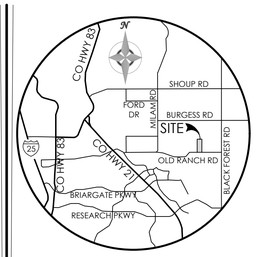
DEVELOPED DRAINAGE SUMMARY TABLE

DESIGN POINT	INCLUDED BASIN(S)	AREA (AC)	Tc (MIN.)	RUNOFF Q5 (CFS)	RUNOFF Q100 (CFS)
	OSA1	3.17	7.9	1.1	8.3
	OSA2	12.08	15.9	3.9	25.0
	OSA3	3.97	10.8	2.5	10.8
	OSA6	5.93	15.3	2.2	12.9
	OSA7	2.34	8.5	0.8	6.0
	OSB1	1.67	8.0	0.6	4.4
	A2	14.14	19.4	5.8	28.7
	A4	0.96	8.6	0.3	2.4
	A5	15.77	14.5	6.9	35.9
	B2	5.70	13.3	2.0	12.8
	C1	1.70	9.4	1.0	4.7
	D1	0.82	12.0	0.3	1.9
DP-1	OSA1, OSA3, A2	21.27	18.9	8.7	43.5
DP-2	DP-1, OSA2, OSA6, OSA7, A4, A5	58.35	19.7	20.9	114.0
DP-3	OSB1, B2	7.37	9.9	2.8	18.4





VICINITY MAP

NOT TO SCALE

BENCHMARK
x

50 0 75 150 300

SCALE: 1"=150' 1:1800

MVE, INC.
ENGINEERS / SURVEYORS
1903 lelaray street, suite 200 colorado springs co 80909 719.635.5736

REVISIONS

DESIGNED BY
DRAWN BY
CHECKED BY
AS-BUILTS BY
CHECKED BY

KOINONIA RANCH

PROPOSED DRAINAGE

MVE PROJECT 61148
MVE DRAWING PP-DRN

SEPTEMBER 5, 2023

SHEET 1 **OF** 1