Drainage Report

17115 Goshawk Road
Colorado Springs, CO 80908
El Paso County

Prepared for: Mr. Arvin Loudermilk
17115 Goshawk Road
Colorado Springs, CO 80908

April 5, 2019

Prepared by
Richard Lyon, P.E.
Rocky Mountain Group
2910 Austin Bluffs Parkway | Colorado Springs, CO 80918

PCD File No. MS192

Drainage Report Statements

1. **Engineer's Statement:**

This report and plan for the preliminary drainage design of the Loudermilk Minor Subdivision was prepared by me (or under my direct supervision) in accordance with the provisions of El Paso County Drainage Design and Technical Criteria for the owners thereof. I understand that El Paso County does not and will not assume liability for drainage facilities designed by other :

53921

Richard D. Lyon　　　Colorado P.E. No.

COLORADO LICENSED
RICHARD D. LYON
53921
04-05-2019
PROFESSIONAL ENGINEER

2. **Developer's Statement:**

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

Loudermilk Living Trust
Business Name

By: Cheryl Loudermilk

Title: Trustee

Address: 17115 E. Goshawk Road

Colorado Springs, CO 80908

Cheryl Loudermilk

3. EL PASO COUNTY:

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

____ ____________

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

Conditions:

Table of Contents

Appendices

I. General Location and Description

A. Location

The project addresses of 17115 Goshawk Road East and 0 Goshawk Road East are located in Colorado Springs in El Paso County, Colorado. The township, range, and section code is S23 T11S R65W includes the two parcels owned by Loudermilk Living Trust and are schedule numbers 5123000014 and 5123000013, as shown in Appendix A. The parcels are approximately a half of a mile north of Hodgen Road, 1.25 miles west of North Meridian Road, and within 3.5 miles of the northern county border. The parcels are a quarter of a mile northwest of the West Kiowa Creek and are divided at an easement for overhead electric lines running north and south. Drainage and utilities easements are shown on the survey plat provided in the Appendix A. The property and the subdivisions in the vicinity flow to the Kiowa Creek watershed and are nearest the Kiowa Creek Watershed 1-N-10 Reservoir. The nearby platted developments include sections of Sec. 23-11-65 and Meridian Ranch to the east.

B. Description of Property

The properties are approximately 19.87 acres with 17115 Goshawk Road East accounting for 15.96 acres and 0 Goshawk Road East accounting for 4.04 acres. The vast majority of the parcels consist of vegetation, shrubbery, and fields. Existing development currently consists of a single family residence with various detached structures including a garage, two sheds, and a pool building currently under construction at 17115 Goshawk Road East. There is no existing or proposed development on the east parcel. A vicinity map, survey maps with the legal description of the parcel and topography is provided in Appendix A.

The developed property contains an existing 990 lineal foot gravel driveway from Goshawk Road East which terminates to the existing shed. The existing structures and their approximate roof areas are as follows: single family residence of 4,445 square feet; pool building additions of 2,612 square feet; detached garage of 1,632 square feet; shed 1 of 1,618 square feet; shed 2 of 584 square feet; and a barn of 2,024 square feet.

The Owners plan to build a single-family residence following the subdivision of the west parcel into a separate lot. As such, a minor subdivision is required by El Paso County prior to obtaining a building permit.

The general ground cover consists of tall grasses and weeds with landscaping around the existing single family residence. Deciduous trees and vegetation are denser near the western portion of the property. The general topography consists of natural flat areas nearing 1 percent slope to areas of drainage ways at 25 percent slopes from north to south. Field areas make up about two-thirds of the parcel and are generally within 10 percent slope. The other third of the parcel consists of sloped landscape to depressions that convey storm water to the West Kiowa Creek and are generally sloped from 10 to 25 percent. The overall elevation difference from the highest point in the northwest corner of the property to the lowest point about 400 feet east of the southwest property corner is about 36 feet.

The soil conditions are described in a Geology and Soils Report prepared by RMG-Rocky Mountain Group and are described as well-draining to high-draining sandy loam soils. Additionally, a USDA soil survey map is provided in Appendix C for reference.

The properties consists of some major drainage ways that ultimately drain to the West Kiowa Creek drainage way. The on-site major drainage ways consist of elevation depressions that flow from north to south. The existing development contains a gravel roadway that crosses through a drainage way and a stand pipe connected to a culvert pipe is currently installed for conveyance. A culvert pipe is proposed to replace the stand pipe for the proposed minor subdivision. There are no known irrigation facilities or utilities and other encumbrances in respect to drainage patterns on the site.

Further sections will refer to the two parcels as a combined 19.87 acre property as it was analyzed in engineering exhibits and calculations.

II. Existing and Proposed Drainage Basins and Subbasins

A. Major Basin Description

The parcel falls within the southeast region of FEMA Floodplain Map Number 08041C0310G dated December 7, 2018 showing a designation of Zone X, an area of minimal flood hazard. The map is provided in Appendix B. The major basin that the parcel falls within sheet flows from the north to the south to the West Kiowa Creek drainage way. There are no identified nearby irrigation facilities or other obstruction which could influence or be included by the local drainage.

B. Existing Subbasin Descriptions

The existing subbasins are delineated according to major drainage ways as determined by the natural topography of the land and any drainage infrastructure. The Loudermilk parcel plus the additional 4.04 acre parcel to the east (schedule no. 5123000013) was delineated into five subbasins and are described as follows:

Subbasin EX-1 is the 5.87 acre subbasin consisting of the area north of the gravel roadway to the existing single-family residence that flows into the existing stand pipe and culvert under the gravel roadway that is to be replaced with an 18” CMP culvert pipe. The subbasin contains impervious area due to existing gravel roadways, a single-family residence with addition, and various hardscape and detached buildings. The vast majority of the subbasin consists of tall grasses and weeds with dense deciduous trees and vegetation. This subbasin ultimately flows to the West Kiowa Creek and is added to Subbasin EX-2 for a final point of concentration at the southern property line.

Subbasin EX-2 is the 4.78 acre subbasin that consists of the west side of the parcel, the outlet of the standpipe and outlet drainage infrastructure, and the south side of the gravel roadway. As with most of the property, the vast majority of this subbasin consists of tall grasses and weeds. This sub-basin, in combination with Subbasin EX-1, provides a storm water volume within a drainage way to the south of the property which ultimately reaches the West Kiowa Creek. There is an existing 18" CMP culvert at the driveway entrance to the property off of Goshawk Road and Design Point #2 refers to the portion of Subbasin EX-2 that flows through this culvert.

Subbasin EX-3 is the 3.85 acre subbasin consisting of some detached structures and gravel roadway. The subbasin flows south through a drainage way in the form of an elevation depression that ultimately flows to the West Kiowa Creek. The survey limits do not show if this delineation meets with Subbasins EX-1 and EX-2 and so it was delineated as its own subbasin.

Subbasin EX-4 is the 3.47 acre subbasin that consists entirely of tall grasses and weeds that flows to the southeast property corner. This major drainage way includes part of the 4.04 acre parcel also owned by the Loudermilk Living Trust to the east. The subbasin ultimately flows to the West Kiowa Creek.

Subbasin EX-5 is the 1.83 acre subbasin to the northeast of the property which includes the 4.04 acre parcel also owned by the Loudermilk Living Trust. The drainage way flows south east to the West Kiowa Creek. The survey limits do not show if this delineation meets with Subbasin EX-4 and so it was delineated as its own subbasin.

Off-site Flow: The property address 17215 Goshawk Road E. to the north of the Loudermilk Living Trust parcel general flows through the property and consists of tall grasses, shrubs, and nearly full vegetative cover with approximately a third of the property consisting of trees. This off-site sheet flow has sufficient grass/vegetative buffer prior to entering the property. Areas to the north of 17215 Goshawk Road E. sheet flows to the east into the electrical easement and toward the creek. Properties to the west of Goshawk Road E. flow to the west roadside ditch and due south toward the creek. Offsite (OS) subbasins are depicted in the subbasin delineation exhibits.

C. Proposed Subbasin Descriptions

The proposed subbasins are within the proposed minor subdivision parcel as well as the existing property limits and are delineated according to major drainage ways as determined by the natural topography of the land and any drainage infrastructure. The post-development conditions are shown with the new minor subdivision parcel lines and the subbasins are delineated for proposed conditions. The rest of the parcel is delineated accordingly.

Development Subbasin 1 is the 3.75 acre subbasin consisting of the proposed house with a concrete driveway turnaround and a gravel driveway. The proposed single-family home will

Please see comments on drainage plan.

require an on-site wastewater treatment system and grading will be proposed via a grading and drainage plan to convey flow to the drainage way consistent with Subbasin EX-1 which flows to a new 18” CMP culvert pipe under the existing gravel driveway to the existing single-family residence. As with all drainage ways within the minor subdivision parcels, the flow ultimately goes to the West Kiowa Creek.

Development Subbasin 2 is the 1.36 acre subbasin consisting of the northwest corner of the new minor subdivision parcel that flows south to Subbasin EX-2. Sheet flow will go over the driveway and an 18” CMP culvert will be installed at Goshawk Road. The flow ultimately goes to the West Kiowa Creek.

Subbasin EX-1 is reduced to a 3.42 acre subbasin in order to delineate between the subdivide dparcels. The flow patterns remain the same as historical conditions.

Subbasin EX-2 is reduced to a 2.17 acre subbasin in order to delineate between the subdivided parcels. The flow pattern remains the same as historical conditions.

Subbasin EX-3 is slightly reduced a to 3.81 acre subbasin in order to delineate between the subdivided parcels with some of the development basin delineated to include some of the northern portion. The flow pattern remains the same as historical conditions.

Subbasin EX-4 is the 3.47 acre subbasin that consists entirely of tall grasses and weeds that flows to the southeast property corner. This major drainage way includes part of the 4.04 acre parcel also owned by the Loudermilk Living Trust to the east. The subbasin ultimately flows to the West Kiowa Creek.

Subbasin EX-5 is the 1.83 acre subbasin to the northeast of the property which includes the 4.04 acre parcel also owned by the Loudermilk Living Trust. The drainage way flows south east to the West Kiowa Creek. The survey limits do the show if this delineation meets with Subbasin EX-4 and so it was delineated as its own subbasin.

Offsite drainage patterns upstream are not expected to adversely affect development on the new minor subdivision parcel. Engineered grading plans can properly convey the upstream flow away from the building structure and septic area to the historic point of concentration as needed. Downstream drainage patterns will be not changed due to development within the new minor subdivision parcel. Upstream off-site flow also includes no impervious area with the exception of Goshawk Road Subbasin OS-2.

III. Drainage Design Criteria

A. Development Criteria Reference

Colorado Urban Drainage and Flood Control District Drainage Criteria Manual, Volume I (January 2016)

Colorado Urban Drainage and Flood Control District Drainage Criteria Manual, Volume III (April 2018)

Urban Storm Drainage Criteria Manual, Volume III (November, 2015)

No previous PDR, DBPSs, or master plan drainage reports/studies have been developed for this area. As such, a drainage study in the format of a Preliminary and Final Drainage Report is presented for the application of a minor subdivision in order to demonstrate the hydrological and hydraulic conditions for the existing and post-development conditions within the subdivision.

B. Hydrologic Criteria

The design rainfall is according to NOAA Rainfall Data provided in Appendix E. The data for the one-hour rainfall depths were used for inputs in the UD-Rational Method calculator for storms 2 through 500. The rational method tabulations and any drainage infrastructure calculations are provided in Appendix E.

The flows in cubic feet per second (cfs) for a 5-year, 10-year, and 100-year storm event per subbasin and design points are summarized in the following table for the existing and post-development conditions:

Existing Conditions Flows

Subbasin Name	5-Year	10-Year	100-Year
EX-1	0.35	0.48	4.02
EX-2	0.31	0.43	3.35
DP1: OS-1 + EX-1	0.49	0.67	6.79
EX-3	0.30	0.41	2.90
EX-4	0.04	0.06	1.76
EX-5	0.02	0.03	0.97

OS-1	0.14	0.20	6.06
OS-2	0.35	0.46	2.19
OS-4	0.00	0.00	0.05
OS-5	0.08	0.12	3.60

The total storm water flow from the parcel plus offsite upstream sheet flow to the West Kiowa Creek watershed is 1.59 cfs for a 5-year storm event, 2.19 cfs for a 10-year storm event, and 24.90 cfs for a 100-year storm event. The Loudermilk Parcel accounts for 1.02 cfs for a 5-year storm event, 1.41 cfs for a 10-year storm event, and 13.00 cfs for a 100-year storm event.

Please include DP3 in the post-developed flows table.

Post-Developed Conditions Flows

Subbasin Name	5-Year	10-Year	100-Year
DV-1	0.25	0.35	2.75
DV-2	0.17	0.23	1.33
EX-1	0.43	0.57	2.47
DP1: DV-2 + EX-1 (culvert inlet)	0.33	0.63	3.42
EX-2	0.22	0.30	2.44
DP2: DV-1 (DW entry culvert)	0.83	1.13	8.23
EX-3	0.30	0.41	2.89
EX-4	0.04	0.06	1.76
EX-5	0.02	0.03	0.97
OS-1	0.14	0.20	6.06
OS-2	0.35	0.46	2.19
OS-4	0.00	0.00	0.05
OS-5	0.08	0.12	3.60

Design Point 2 doesn't match what is on the drainage plan/calculations. Per the drainage plan, DP2 consists of OS2, DV2, and EX2. Revise the text and flows accordingly.

Design point 1 doesn't match what is on the drainage plan/calculations. Per the drainage plan DP1 consists of OS1, DV1, and EX1. Revise the text and flows accordingly.

The total storm water flow from the parcel plus offsite sheet flow from the upstream property to the West Kiowa Creek watershed is 2.00 cfs for a 5-year storm event, 2.73 cfs for a 10-year storm event, and 26.51 cfs for a 100-year storm event.

The Loudermilk Minor Subdivision accounts for 1.43 cfs for a 5-year storm event, 1.95 cfs for a 10-year storm event, and 14.61 cfs for a 100-year storm event.

For the entire assessed area (including offsite drainage), these are increases of 0.41 cfs for a 5-year storm event, 0.54 cfs for a 10-year storm event, and 1.61 cfs for a 100-year storm event. These are very minimal increases in storm flow to the West Kiowa Creek watershed. The greatest point of interest is the inlet of the proposed culvert pipe that crosses the existing gravel road and ensuring that the culvert pipe is sized properly for the post-development conditions (DP1).

Please show and label on the drainage plan

IV. Drainage Facility Design

A. General Concept

The general concept of the drainage across this parcel and within the drainage basin as a whole is to convey storm water sheet flow to the south and southeast to the West Kiowa Creek. The proposed minor subdivision will remain consistent with historical drainage patterns by implementing 18” CMP culvert pipes and eliminating channelized storm water flow via level spreaders of 14’ length and varied widths per the engineering calculations provided in Appendix D. The proposed development will also reduce erosion and sediment runoff by implementing energy dissipation at the outlet of channelized storm flow outlets via rip-rap of D_{50} = 6” and improve infiltration via plantings and landscaping of the proposed development. Culvert, level spreader, and rip-rap sizing calculations are included in the Appendix.

B. Specific Details

The hydrologic and hydraulic details are provided in the previous section. The post-development flow increase is 1.41 cfs for a 100-year storm event which is a minimal increase to the downstream properties and watershed. As stated previously, the proposed culvert pipe to replace the stand pipe and daylighted pipe under the existing gravel driveway will be analyzed to prevent standing water at the point of concentration or inlet of the culvert pipe. Rip-rap for energy dissipation and a level spreader will be designed at the outlet to eliminate channelized flow.

The proposed single-family residence will require grading and drainage plan(s) to show sheet flow from upstream areas away from structure foundations, away from the septic field, and to continue the historical drainage pattern to the proposed culvert pipe.

The proposed plan will not require any regular maintenance. It is recommended that the owner(s) inspect their respective culvert pipes to clear debris once a year and after major rainfall events such as 100-year storms or greater. Observing any soil settling that may alter the flowline grade of culvert pipes is also recommended to prevent backflow conditions.

C. Four-Step Process

The selection of appropriate BMPs is based on the characteristics of the site and potential pollutants. The Four-Step Process provides a method of going through the selection process. The following applies the four-step process to the preliminary development plan for the Loudermilk Minor Subdivision:

Step 1: Employ Runoff Reduction Practices

The preliminary development plan calls for the use of compacted gravel for the driveway off of Goshawk Road E. with the minimal amount of concrete pavement for the driveway apron at the entrance drive. The use of gravel provides reduced impervious area compared to a rigid pavement. Grass buffers are sufficient for the location of the build and drainage pattern with greater than 1:1 impervious (roof) to pervious grass landscape area. Additionally, grass swales will be graded to convey storm water toward the West Kiowa Creek.

Step 2: Stabilize Drainageways

A stabilized/constructed natural drainageway is to be implemented to convey stormwater from the developed area to the south side of the property. Engineered rip-rap and level spreaders are to be implemented for energy dissipation and reduction of erosion to downstream landscape.

Step 3: Provide Water Quality Capture Volume

The development of the minor subdivision will not require more than one acre of disturbance. BMPs such as porous pavement detention, porous landscape detention, extended detention basins, sand filter extended detention basins, constructed wetland basins, or a retention pond are unnecessary for a development of this size with adequate pervious landscaping downstream of the proposed development. Implementing the aforementioned best management practices will maintain the historical drainage patterns and reduce erosion. The flow chart (Figure I-1. BMP Requirements Flowchart for New Development and Redevelopment Sites – For Selecting Post-Construction BMPs in Compliance with El Paso County's Stormwater NPDES Permit) from the El Paso County Engineering Criteria Manual indicates that a rural area development with less than one acre of disturbance with site tributary waters not classified as high risk does not require additional BMPs and methods for permanent sediment control is the main focus.

Step 4: Consider the Need for Industrial and Commercial BMPs

As this is not an industrial or commercial site, the need for specialized BMPs is not required. There will be no storage/handling areas or a need for permanent spill containment and control.

V. Drawings

A. General Location Map

See Appendix A.

B. Drainage Plan

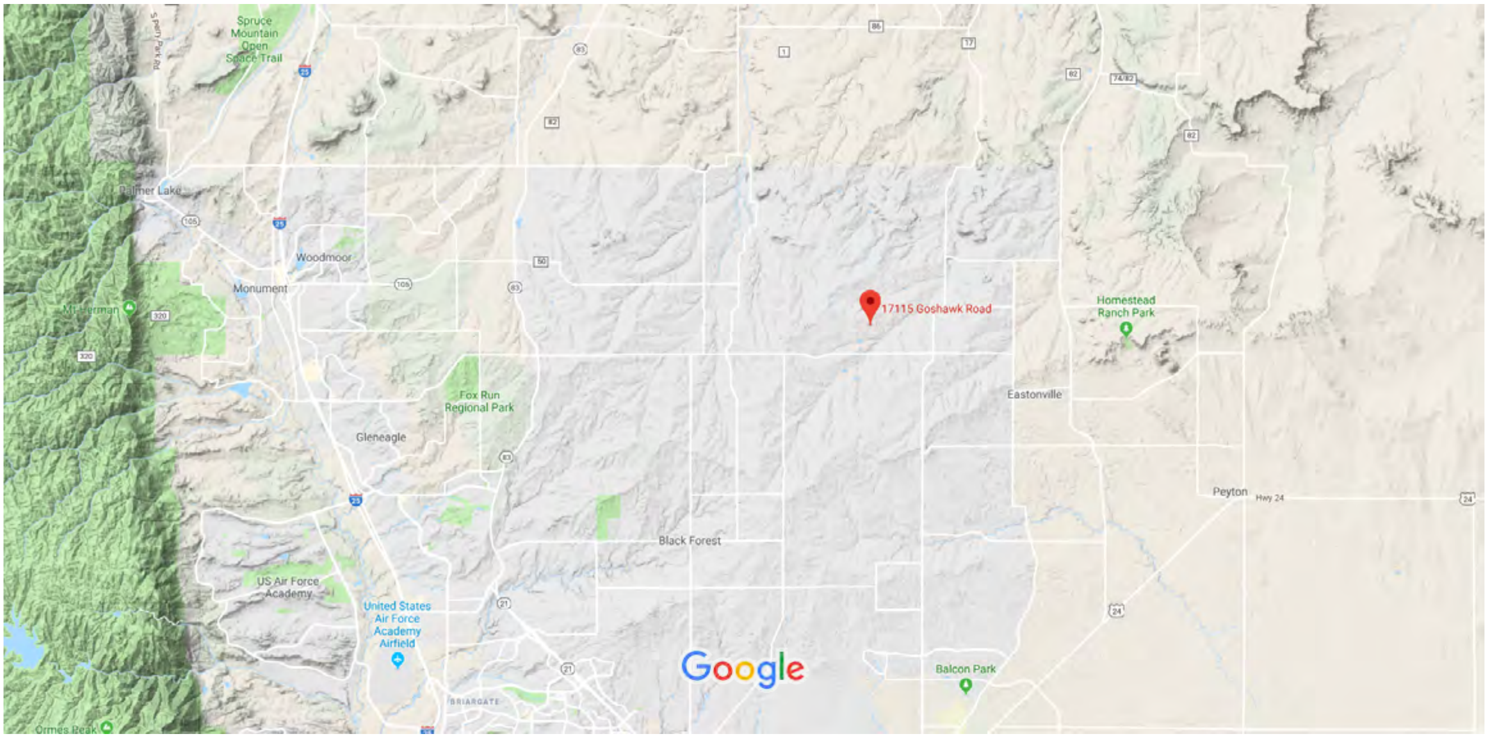
See Attached Exhibits in Appendix D.

Appendix A – General Location Map, Assessor Maps, and Survey & Plat Maps

Google Maps

17115 Goshawk Rd

Vicinity Map



Map data ©2019 Google 2 mi

17115 Goshawk Rd

Colorado Springs, CO 80908

You visited 2 months ago

39HC+QH Black Forest, Colorado

El Paso County Assessor's Office

17115 GOSHAWK RD E

SCHEDULE: 5123000014

OWNER: LOUDERMILK LIVING TRUST

N
W E
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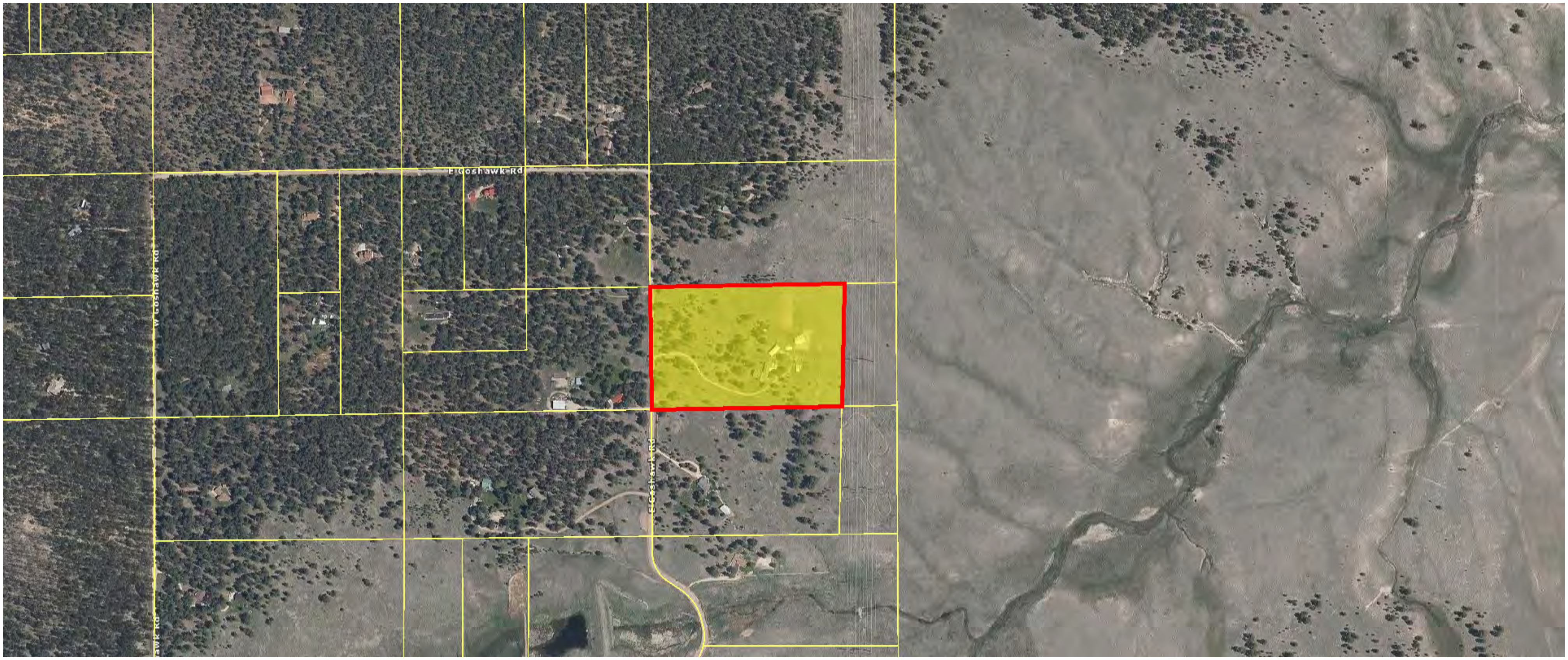

El Paso County Assessor's Office

0 GOSHAWK RD E

SCHEDULE: 5123000013

OWNER: LOUDERMILK LIVING TRUST

N
W E
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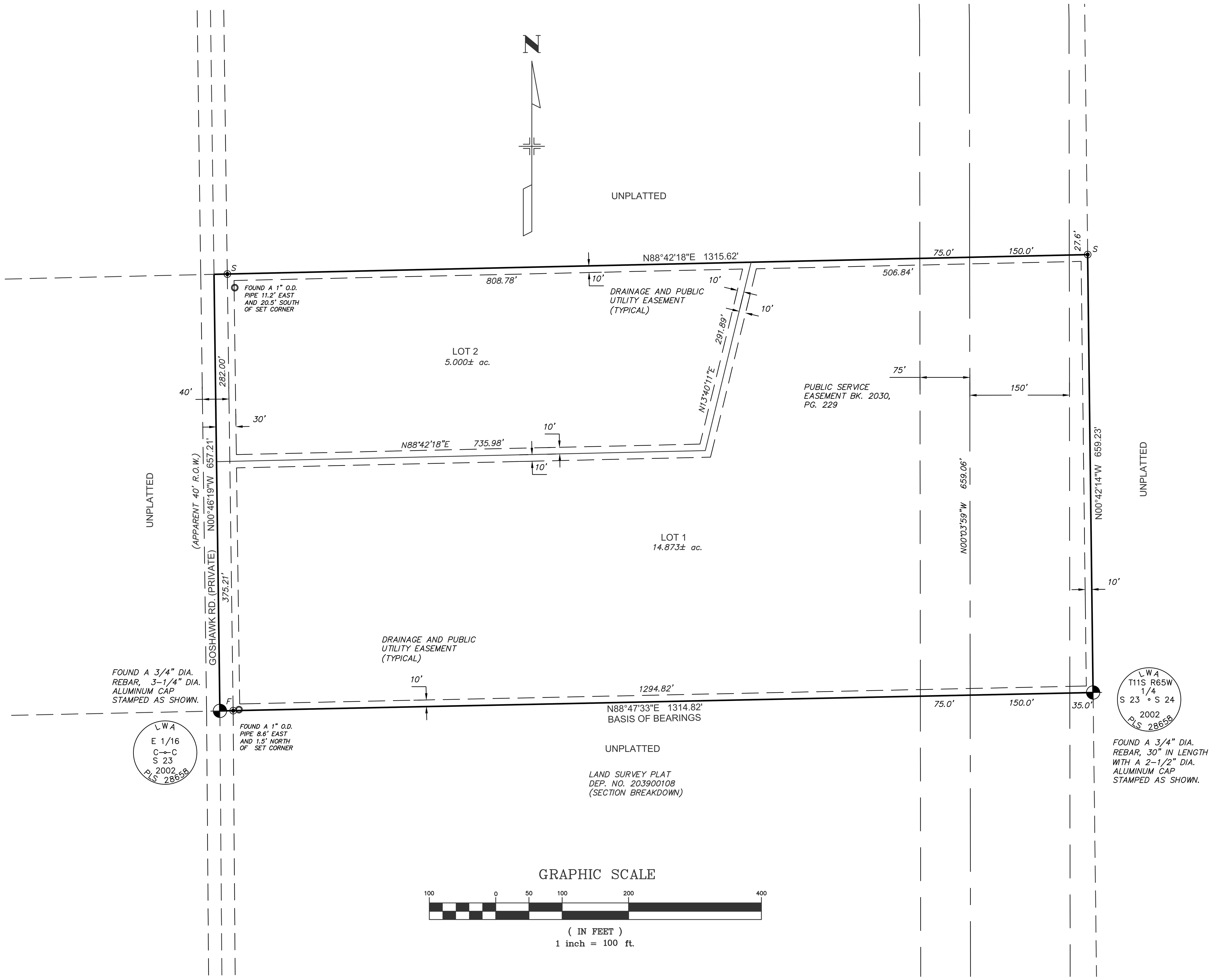
LOUDERMILK SUBDIVISION FILING NO. 1

IN THE NORTHEAST QUARTER OF SECTION 23, T11S, R65W, 6th P.M.
EL PASO COUNTY, COLORADO



BE IT KNOWN BY THESE PRESENTS:

THE LOUDERMILK LIVING TRUST, ____________________, MANAGER, IS THE OWNER OF THE FOLLOWING DESCRIBED TRACT OF LAND, TO WIT:

THE SOUTH HALF OF THE SOUTHEAST QUARTER OF THE NORTHEAST QUARTER SECTION 23, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6th PM., EL PASO COUNTY, COLORADO.

CONTAINING 19.873 ACRES, MORE OR LESS.

EASEMENTS:

SIDE AND REAR LOT LINES ARE HEREBY PLATTED WITH A TEN (10) FOOT EASEMENT FOR DRAINAGE AND PUBLIC UTILITIES ONLY; THE FRONT LOT LINES ARE HEREBY PLATTED WITH A THIRTY (30) FOOT EASEMENT FOR DRAINAGE AND PUBLIC UTILITIES ONLY, WITH THE SOLE RESPONSIBILITY FOR MAINTENANCE BEING VESTED WITH THE PROPERTY OWNERS.

OWNERS CERTIFICATE:

THE LOUDERMILK LIVING TRUST, ____________________, MANAGER, BEING THE OWNER, MORTGAGEES, BENEFICIARIES OF DEEDS OF TRUST AND HOLDERS OF OTHER INTERESTS IN THE LAND DESCRIBED HEREIN, HAVE LAID OUT, SUBDIVIDED AND PLATTED SAID LANDS INTO LOTS AND EASEMENTS AS SHOWN HEREON UNDER THE NAME AND SUBDIVISION OF LOUDERMILK SUBDIVISION FILING NO. 1. ALL PUBLIC IMPROVEMENTS SO PLATTED ARE HEREBY DEDICATED TO PUBLIC USE AND SAID OWNER DOES HEREBY COVENANT AND AGREE THAT THE PUBLIC IMPROVEMENTS WILL BE CONSTRUCTED TO EL PASO COUNTY STANDARDS AND THAT PROPER DRAINAGE AND EROSION CONTROL FOR THE SAME WILL BE PROVIDED AT SAID OWNER'S EXPENSE, ALL TO THE SATISFACTION OF THE BOARD OF COUNTY COMMISSIONERS OF EL PASO COUNTY, COLORADO. UPON ACCEPTANCE BY RESOLUTION, ALL PUBLIC IMPROVEMENTS SO DEDICATED WILL BECOME MATTERS OF MAINTENANCE BY EL PASO COUNTY, COLORADO. THE UTILITY EASEMENTS SHOWN HEREON ARE HEREBY DEDICATED FOR PUBLIC UTILITIES, COMMUNICATION SYSTEMS AND OTHER PURPOSES AS SHOWN HEREON. THE ENTITIES RESPONSIBLE FOR PROVIDING THE SERVICES FOR WHICH THE EASEMENTS ARE ESTABLISHED ARE HEREBY GRANTED THE PERPETUAL RIGHT OF INGRESS AND EGRESS FROM AND TO ADJACENT PROPERTIES FOR INSTALLATION, MAINTENANCE AND REPLACEMENT OF UTILITY LINES AND RELATED FACILITIES.

IN WITNESS WHEREOF:

THE AFOREMENTIONED THE LOUDERMILK LIVING TRUST, ____________________, MANAGER, HAS EXECUTED THIS INSTRUMENT THIS ______ DAY OF____________ 2019.

____
THE LOUDERMILK LIVING TRUST
____________________, MANAGER

NOTARIAL:

STATE OF COLORADO)
COUNTY OF EL PASO) SS

THE FOREGOING INSTRUMENT WAS ACKNOWLEDGED BEFORE ME THIS ________ DAY OF __________ 2019 BY ____________________, MANAGER
THE LOUDERMILK LIVING TRUST

MY COMMISSION EXPIRES: ____________________ ______________________________
NOTARY PUBLIC

BOARD OF COUNTY COMMISSIONERS CERTIFICATE:

THIS PLAT FOR LOUDERMILK SUBDIVISION FILING NO. 1 WAS APPROVED FOR FILING BY THE EL PASO COUNTY, COLORADO BOARD OF COUNTY COMMISSIONERS ON THIS ______ DAY OF ______________, OF 2019, SUBJECT TO ANY NOTES SPECIFIED HEREON AND ANY CONDITIONS INCLUDED IN THE RESOLUTION OF APPROVAL. THE DEDICATIONS OF LAND TO THE PUBLIC, STREETS, TRACTS AND EASEMENTS ARE ACCEPTED, BUT PUBLIC IMPROVEMENTS THEREON WILL NOT BECOME THE MAINTENANCE RESPONSIBILITY OF EL PASO COUNTY UNTIL PRELIMINARY ACCEPTANCE OF THE PUBLIC IMPROVEMENTS IN ACCORDANCE WITH THE REQUIREMENTS OF THE LAND DEVELOPMENT CODE AND ENGINEERING CRITERIA MANUAL, AND THE SUBDIVISION IMPROVEMENTS AGREEMENT.

____
PRESIDENT, BOARD OF COUNTY COMMISSIONERS DATE

____
DIRECTOR, COUNTY PLANNING AND COMMUNITY DEVELOPMENT DATE

____
COUNTY ASSESSOR DATE

NOTES:

THE PROPERTY IS SUBJECT TO AN APPARENT TWENTY (20) FOOT RIGHT OF WAY FOR GOSHAWK ROAD. THE ROAD IS POSTED AS PRIVATE AND MAINTENANCE IS THE RESPONSIBILITY OF THE HOMEOWNERS ASSOCIATION.

THE BASIS OF BEARINGS FOR THIS SURVEY IS THE SOUTH LINE OF THE SOUTHEAST QUARTER OF THE NORTHEAST QUARTER OF SECTION 23, N88°47'33"E – 1314.82'. THE DIRECTION IS BASED ON THE LAND SURVEY PLAT BY LEIGH WHITEHEAD AND ASSOCIATES, 7/2/2003, DEPOSIT NUMBER 203900108, AND THE LINE IS MONUMENTED AS SHOWN.

UNITS OF MEASURE ARE U.S. SURVEY FEET

FOUND ALIQUOT CORNER AS NOTED

FOUND MONUMENT AS NOTED

FOUND / SET A 5/8" DIAMETER REBAR, 18" IN LENGTH, WITH A 1-1/2" DIAMETER ALUMINUM CAP "LWA PLS 28658"

RESEARCH FOR RECORDED RIGHTS OF WAY AND EASEMENTS WAS DONE BY ____________.

THIS SURVEY DOES NOT CONSTITUTE A TITLE SEARCH BY LWA LAND SURVEYING, INC. OR KEVIN M. O'LEARY.

SURVEYOR'S CERTIFICATION:

I, KEVIN M. O'LEARY, A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF COLORADO, DO HEREBY CERTIFY THAT THIS PLAT TRULY AND CORRECTLY REPRESENTS THE RESULTS OF A SURVEY MADE ON THE DATE OF THE SURVEY, BY ME OR UNDER MY DIRECT SUPERVISION AND THAT ALL MONUMENTS EXIST AS SHOWN HEREON; THAT MATHEMATICAL CLOSURE ERRORS ARE LESS THAN 1:10,000; AND THAT SAID PLAT HAS BEEN PREPARED IN FULL COMPLIANCE WITH ALL APPLICABLE LAWS OF THE STATE OF COLORADO DEALING WITH MONUMENTS, SUBDIVISION, OR SURVEYING OF LAND AND ALL APPLICABLE PROVISIONS OF THE EL PASO COUNTY LAND DEVELOPMENT CODE.

I ATTEST THE ABOVE ON THIS ___ DAY OF ____________, 2019.

______________________________ ______________
KEVIN M. O'LEARY DATE
COLORADO REGISTERED PLS #28658
FOR AND ON BEHALF OF
LWA LAND SURVEYING, INC.

RECORDING:

STATE OF COLORADO)
COUNTY OF EL PASO) SS

I HEREBY CERTIFY THAT THIS INSTRUMENT WAS FILED FOR RECORD AT MY OFFICE AT _____ O'CLOCK ___ M., THIS _____ DAY OF ______________, 2019, AND IS DULY RECORDED AT RECEPTION NO. ______________ OF THE RECORDS OF EL PASO COUNTY, COLORADO.

CHUCK BROERMAN
BY: ______________________
COUNTY CLERK AND RECORDER

FEE: ______________
SURCHARGE: ______________

FEES:

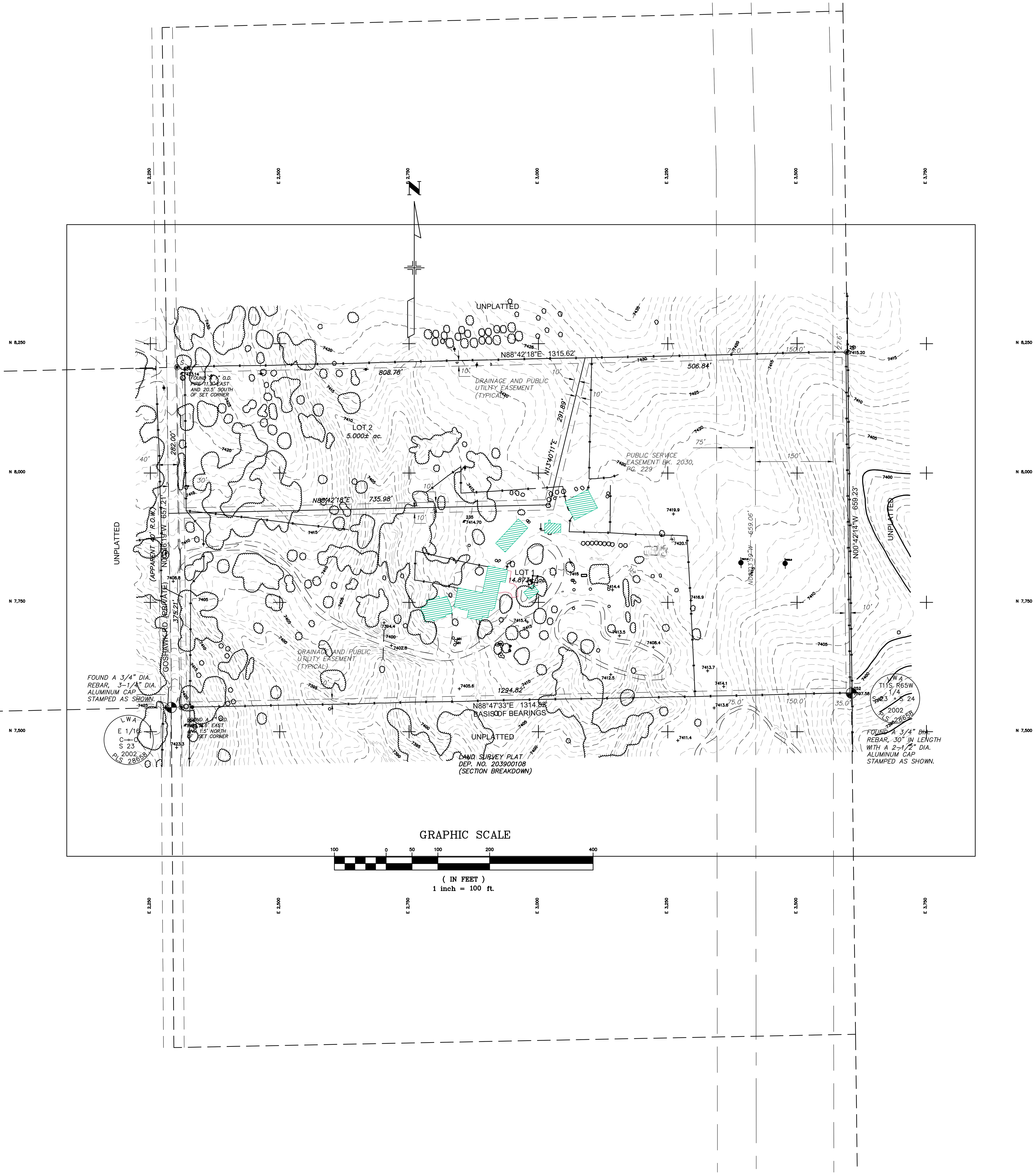
DRAINAGE FEES: ______________
BRIDGE FEES: ______________
SCHOOL FEES: ______________
PARK FEES: ______________

"NOTICE: ACCORDING TO COLORADO LAW YOU MUST COMMENCE ANY LEGAL ACTION BASED UPON ANY DEFECT IN THIS SURVEY WITHIN THREE YEARS AFTER YOU FIRST DISCOVER SUCH DEFECT. IN NO EVENT MAY ANY ACTION BASED UPON ANY DEFECT IN THIS SURVEY BE COMMENCED MORE THAN TEN YEARS FROM THE DATE OF THE CERTIFICATION SHOWN HEREON."

SF-19-___

PREPARED BY
LWA LAND SURVEYING, INC.
953 EAST FILLMORE STREET
COLORADO SPRINGS, COLORADO 80907
Phone (719) 636-5179

SILVERADO RANCH
DECEMBER 19, 2018
PROJECT 18072
SHEET 1 OF 1



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DATE OF PHOTOGRAPHY: 11-21-2018

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MAP AND AUTOCAD FILE MADE IN AMERICA
BY LANDMARK MAPPING, LTD.
1650 NORTH GILL DRIVE, PUEBLO WEST, COLORADO, 81007
PHONE: (303) 922-2417
LANDMARK MAPPING PROJECT NUMBER: LM1814

- FIRE
- LPOLE
- MANHOLE
- SIGN
- UPOLE
- FENCE
- MISC
- TOWER
- PILE
- CULVERT
- ROCK
- IRRIGATION
- MAILBOX
- TREE
- TRAFFIC
- RIP-RAP
- POLE-ANCHOR

17115 GOSHAWK ROAD EAST
THE SOUTH HALF OF THE SOUTHEAST QUARTER OF THE
NORTHEAST QUARTER SECTION 23, TOWNSHIP 11 SOUTH, RANGE 65
WEST OF THE 6th PM.

THE PROPERTY IS SUBJECT TO AN APPARENT TWENTY (20) FOOT RIGHT OF WAY FOR GOSHAWK ROAD. THE ROAD IS POSTED AS PRIVATE AND MAINTENANCE IS THE RESPONSIBILITY OF THE HOMEOWNERS ASSOCIATION.

THE BASIS OF BEARINGS FOR THIS SURVEY IS THE SOUTH LINE OF THE SOUTHEAST QUARTER OF THE NORTHEAST QUARTER OF SECTION 23, N88°47'33"E – 1314.82'. THE DIRECTION IS BASED ON THE LAND SURVEY PLAT BY LEIGH WHITEHEAD AND ASSOCIATES, 7/2/2003, DEPOSIT NUMBER 203900108, AND THE LINE IS MONUMENTED AS SHOWN.

UNITS OF MEASURE ARE U.S. SURVEY FEET

FOUND ALIQUOT CORNER AS NOTED

FOUND MONUMENT AS NOTED

FOUND / SET A 5/8" DIAMETER REBAR, 18" IN LENGTH, WITH A 1-1/2" DIAMETER ALUMINUM CAP "LWA PLS 28658"

RESEARCH FOR RECORDED RIGHTS OF WAY AND EASEMENTS WAS DONE BY ____________.

THIS SURVEY DOES NOT CONSTITUTE A TITLE SEARCH BY LWA LAND SURVEYING, INC. OR KEVIN M. O'LEARY.

Appendix B – FEMA Floodplain Map

NOTES TO USERS

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

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

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

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

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, City of Fountain, Bureau of Land Management, National Oceanic and Atmospheric Administration, United States Geological Survey, and Anderson Consulting Engineers, Inc. These data are current as of 2006.

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

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

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

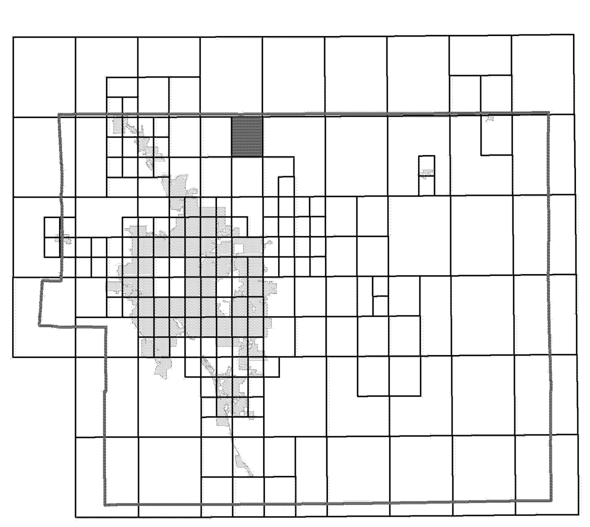
Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

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

El Paso County Vertical Datum Offset Table

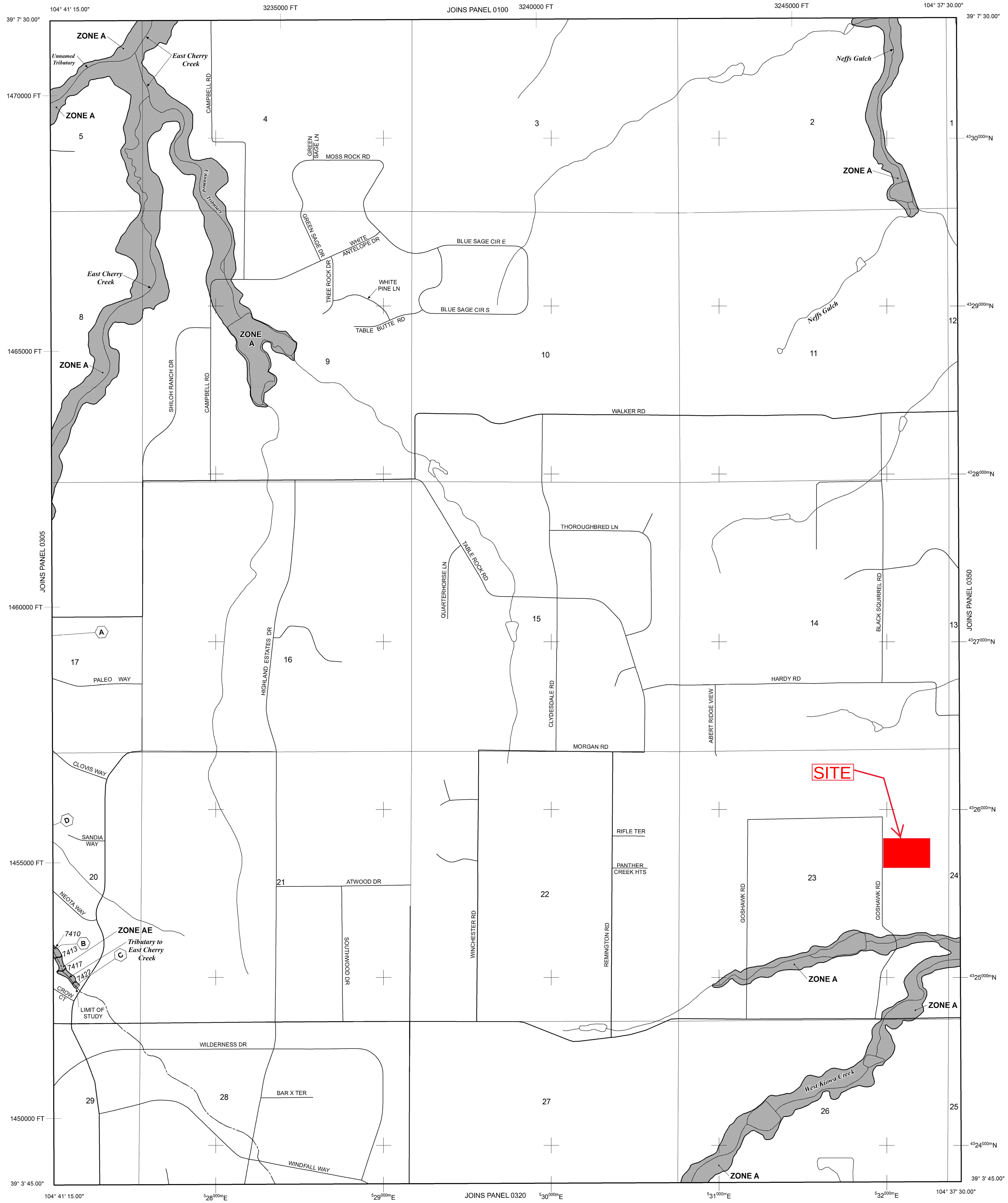
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

Panel Location Map



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

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



NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 11 SOUTH, RANGE 65 WEST.

LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

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

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

A — A	Cross section line
23 - - - 23	Transect line
97° 07' 30.00" 32° 22' 30.00"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 FT	5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
MARCH 17, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
DECEMBER 7, 2018 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

For community map revision history prior to countywide mapping, refer to the Community Map History Table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0310G

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

PANEL 310 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080059	0310	G

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

MAP NUMBER
08041C0310G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

Appendix C – USDA Soils Maps

Map Scale: 1:4,380 if printed on B landscape (17" x 11") sheet.

Meters: 0, 50, 100, 200, 300

Feet: 0, 200, 400, 800, 1200

N

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 16, Sep 10, 2018

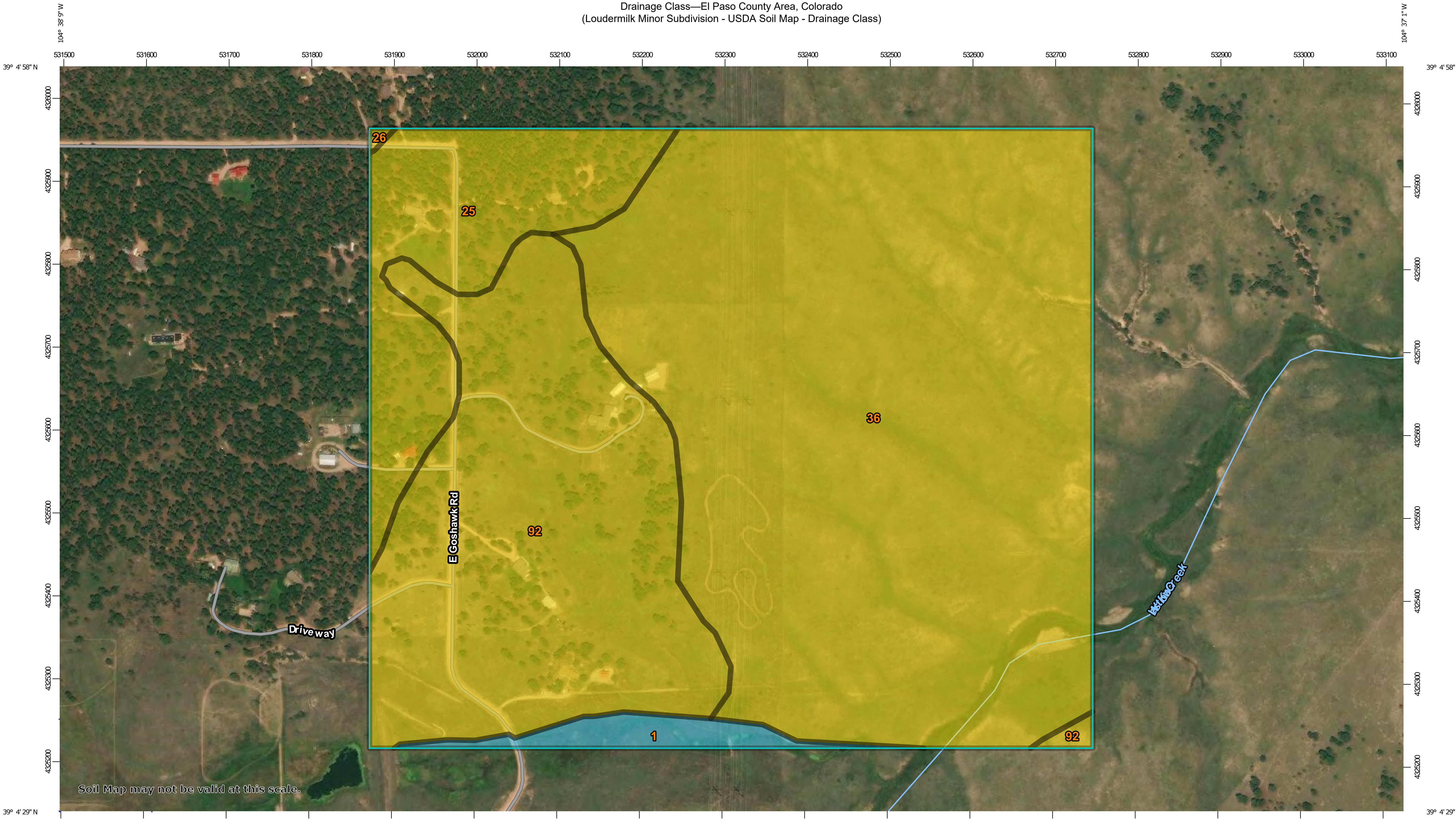
Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 7, 2016—Aug 17, 2017

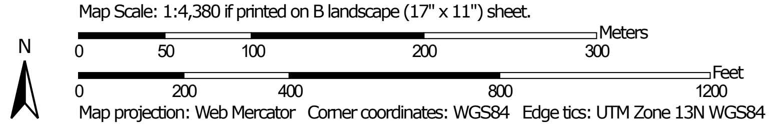
The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1	Alamosa loam, 1 to 3 percent slopes	3.3	2.0%
25	Elbeth sandy loam, 3 to 8 percent slopes	18.0	11.1%
26	Elbeth sandy loam, 8 to 15 percent slopes	0.1	0.1%
36	Holderness loam, 8 to 15 percent slopes	96.2	59.3%
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	44.6	27.5%
Totals for Area of Interest		**162.2**	**100.0%**



Map Scale: 1:4,380 if printed on B landscape (17" x 11") sheet.



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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- Excessively drained
- Somewhat excessively drained
- Well drained
- Moderately well drained
- Somewhat poorly drained
- Poorly drained
- Very poorly drained
- Subaqueous
- Not rated or not available

Soil Rating Lines

- Excessively drained
- Somewhat excessively drained
- Well drained
- Moderately well drained
- Somewhat poorly drained
- Poorly drained
- Very poorly drained
- Subaqueous
- Not rated or not available

Soil Rating Points

- Excessively drained
- Somewhat excessively drained
- Well drained
- Moderately well drained
- Somewhat poorly drained
- Poorly drained
- Very poorly drained
- Subaqueous
- Not rated or not available

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 16, Sep 10, 2018

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

Date(s) aerial images were photographed: Jun 7, 2016—Aug 17, 2017

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

Drainage Class

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Alamosa loam, 1 to 3 percent slopes	Poorly drained	3.3	2.0%
25	Elbeth sandy loam, 3 to 8 percent slopes	Well drained	18.0	11.1%
26	Elbeth sandy loam, 8 to 15 percent slopes	Well drained	0.1	0.1%
36	Holderness loam, 8 to 15 percent slopes	Well drained	96.2	59.3%
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	Well drained	44.6	27.5%
Totals for Area of Interest			**162.2**	**100.0%**

Description

"Drainage class (natural)" refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized-excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained. These classes are defined in the "Soil Survey Manual."

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Appendix D – Hydrologic and Hydraulic Calculations

NOAA Atlas 14, Volume 8, Version 2
Location name: Colorado Springs, Colorado, USA*
Latitude: 39.0794°, Longitude: -104.6285°
Elevation: 7417.11 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.241 (0.189-0.308)	0.292 (0.228-0.373)	0.379 (0.296-0.487)	0.457 (0.354-0.589)	0.570 (0.431-0.767)	0.663 (0.488-0.901)	0.760 (0.541-1.06)	0.863 (0.590-1.23)	1.01 (0.663-1.48)	1.12 (0.718-1.66)
10-min	0.353 (0.276-0.451)	0.427 (0.334-0.547)	0.556 (0.433-0.713)	0.669 (0.519-0.862)	0.835 (0.630-1.12)	0.970 (0.715-1.32)	1.11 (0.793-1.55)	1.26 (0.865-1.81)	1.48 (0.971-2.16)	1.64 (1.05-2.43)
15-min	0.430 (0.337-0.550)	0.521 (0.408-0.667)	0.678 (0.529-0.870)	0.816 (0.633-1.05)	1.02 (0.769-1.37)	1.18 (0.872-1.61)	1.36 (0.967-1.89)	1.54 (1.05-2.20)	1.80 (1.18-2.64)	2.00 (1.28-2.97)
30-min	0.610 (0.478-0.781)	0.739 (0.579-0.947)	0.961 (0.750-1.23)	1.16 (0.897-1.49)	1.44 (1.09-1.93)	1.67 (1.23-2.27)	1.91 (1.36-2.66)	2.17 (1.48-3.10)	2.52 (1.66-3.70)	2.81 (1.80-4.15)
60-min	0.773 (0.606-0.989)	0.928 (0.726-1.19)	1.20 (0.938-1.54)	1.45 (1.12-1.87)	1.82 (1.38-2.45)	2.12 (1.57-2.90)	2.45 (1.75-3.42)	2.80 (1.92-4.01)	3.30 (2.17-4.84)	3.70 (2.37-5.47)
2-hr	0.935 (0.739-1.19)	1.12 (0.881-1.42)	1.44 (1.13-1.83)	1.74 (1.36-2.22)	2.19 (1.68-2.95)	2.58 (1.92-3.49)	2.99 (2.15-4.15)	3.44 (2.38-4.89)	4.07 (2.71-5.95)	4.59 (2.96-6.75)
3-hr	1.02 (0.810-1.29)	1.21 (0.957-1.52)	1.55 (1.23-1.97)	1.88 (1.48-2.39)	2.38 (1.84-3.20)	2.82 (2.12-3.81)	3.29 (2.39-4.56)	3.81 (2.66-5.42)	4.56 (3.06-6.65)	5.17 (3.36-7.58)
6-hr	1.18 (0.946-1.48)	1.39 (1.11-1.73)	1.77 (1.41-2.22)	2.14 (1.70-2.70)	2.73 (2.13-3.65)	3.25 (2.47-4.38)	3.82 (2.80-5.27)	4.45 (3.14-6.30)	5.38 (3.64-7.80)	6.14 (4.03-8.94)
12-hr	1.38 (1.11-1.71)	1.61 (1.30-1.99)	2.05 (1.64-2.54)	2.47 (1.97-3.08)	3.14 (2.48-4.16)	3.73 (2.85-4.98)	4.38 (3.24-5.99)	5.10 (3.62-7.16)	6.15 (4.20-8.86)	7.01 (4.64-10.1)
24-hr	1.61 (1.31-1.98)	1.89 (1.53-2.32)	2.40 (1.94-2.95)	2.88 (2.32-3.56)	3.63 (2.87-4.74)	4.28 (3.29-5.64)	4.98 (3.71-6.74)	5.75 (4.12-8.00)	6.87 (4.74-9.81)	7.78 (5.20-11.2)
2-day	1.88 (1.54-2.28)	2.22 (1.82-2.69)	2.83 (2.31-3.44)	3.38 (2.74-4.14)	4.22 (3.35-5.43)	4.92 (3.81-6.40)	5.67 (4.25-7.57)	6.48 (4.67-8.91)	7.63 (5.30-10.8)	8.56 (5.78-12.2)
3-day	2.06 (1.70-2.48)	2.44 (2.01-2.94)	3.11 (2.55-3.77)	3.71 (3.03-4.51)	4.61 (3.67-5.89)	5.35 (4.16-6.92)	6.15 (4.63-8.16)	7.00 (5.07-9.56)	8.19 (5.72-11.5)	9.15 (6.22-13.0)
4-day	2.21 (1.83-2.66)	2.61 (2.16-3.14)	3.32 (2.73-4.00)	3.95 (3.23-4.78)	4.88 (3.90-6.20)	5.66 (4.41-7.28)	6.48 (4.89-8.57)	7.36 (5.35-10.0)	8.60 (6.03-12.1)	9.59 (6.54-13.6)
7-day	2.62 (2.18-3.12)	3.04 (2.52-3.62)	3.77 (3.12-4.51)	4.43 (3.65-5.33)	5.42 (4.36-6.83)	6.24 (4.90-7.97)	7.11 (5.41-9.34)	8.05 (5.90-10.9)	9.37 (6.62-13.1)	10.4 (7.17-14.7)
10-day	2.98 (2.49-3.54)	3.43 (2.86-4.07)	4.22 (3.51-5.02)	4.92 (4.07-5.88)	5.96 (4.81-7.46)	6.81 (5.38-8.66)	7.72 (5.91-10.1)	8.70 (6.40-11.7)	10.1 (7.15-14.0)	11.2 (7.71-15.7)
20-day	4.02 (3.38-4.72)	4.64 (3.90-5.45)	5.67 (4.76-6.68)	6.56 (5.47-7.76)	7.81 (6.33-9.61)	8.80 (6.98-11.0)	9.82 (7.56-12.6)	10.9 (8.06-14.5)	12.3 (8.81-16.9)	13.4 (9.37-18.8)
30-day	4.84 (4.10-5.65)	5.60 (4.74-6.54)	6.85 (5.77-8.02)	7.88 (6.60-9.27)	9.29 (7.55-11.3)	10.4 (8.27-12.9)	11.5 (8.86-14.7)	12.6 (9.36-16.6)	14.0 (10.1-19.1)	15.1 (10.6-21.1)
45-day	5.84 (4.96-6.77)	6.75 (5.73-7.83)	8.21 (6.95-9.56)	9.40 (7.92-11.0)	11.0 (8.94-13.2)	12.2 (9.72-15.0)	13.3 (10.3-16.9)	14.5 (10.8-18.9)	15.9 (11.5-21.5)	17.0 (12.0-23.5)
60-day	6.65 (5.68-7.68)	7.67 (6.54-8.86)	9.28 (7.88-10.8)	10.6 (8.93-12.3)	12.2 (10.00-14.7)	13.5 (10.8-16.5)	14.7 (11.4-18.5)	15.8 (11.9-20.6)	17.3 (12.5-23.3)	18.3 (13.0-25.3)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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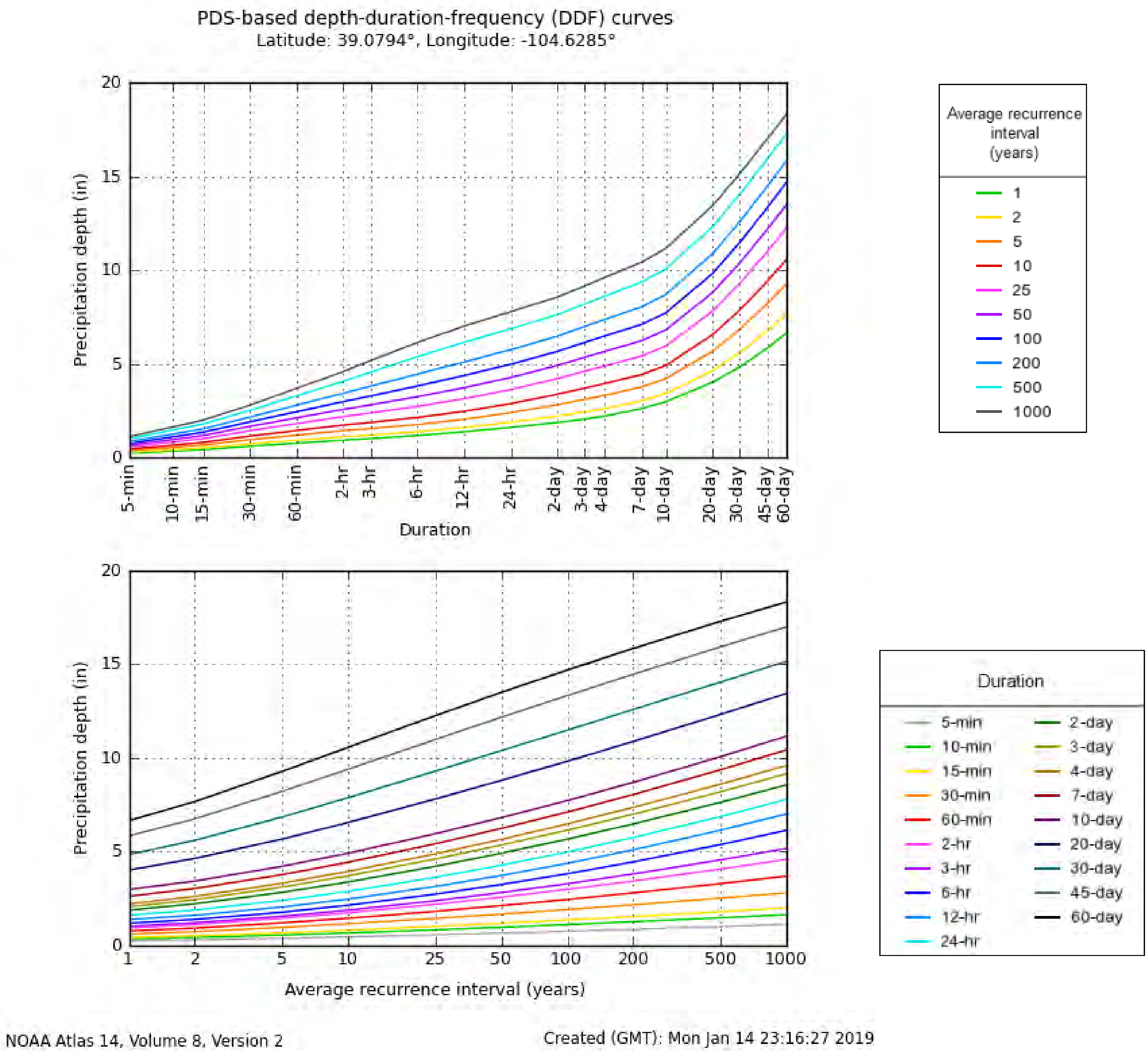
PF graphical



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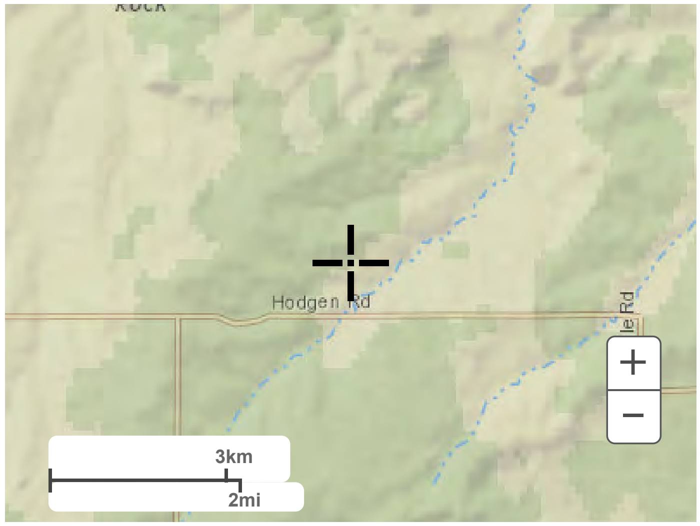
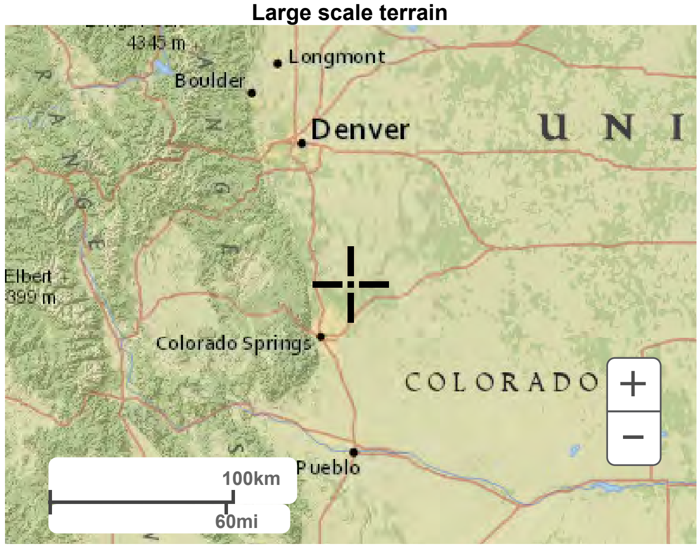
Maps & aerials

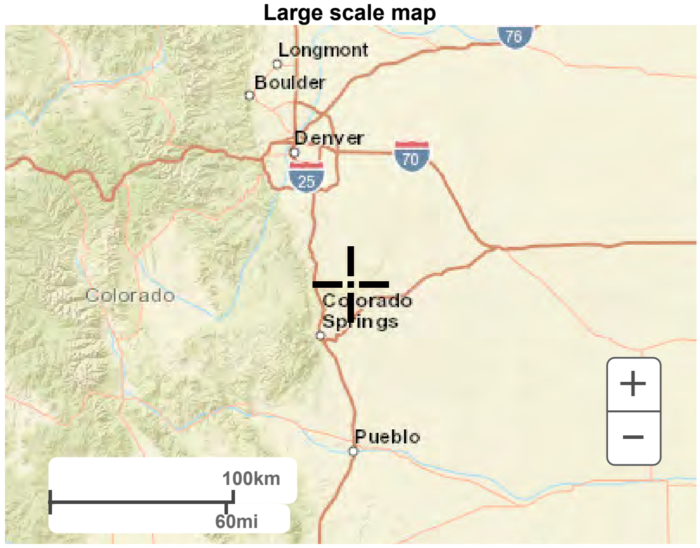
Small scale terrain



Large scale terrain



Large scale map



Large scale aerial

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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Calculation of Peak Runoff using Rational Method

Designer: Richard Lyon
Company: Rocky Mountain Group
Date: 4/5/2019
Project: Loudermilk Minor Subdivision
Location: Goshawk Road

Version 2.00 released May 2017

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$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_i^{0.33}}$$

$$t_t = \frac{L_t}{60K\sqrt{S_t}} = \frac{L_t}{60V_t}$$

$$\text{Computed } t_c = t_i + t_t$$

$$\text{Regional } t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$$

$t_{minimum} = 5$ (urban)
$t_{minimum} = 10$ (non-urban)

$$\text{Selected } t_c = \max\{t_{minimum}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$$

Select UDFCD location for NOAA Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained from the NOAA website (click this link)

	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
1-hour rainfall depth, P1 (in) =	0.93	1.20	1.45	1.82	2.12	2.45	3.30

	a	b	c
Rainfall Intensity Equation Coefficients =	28.50	10.00	0.786

$$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$$

$$Q(cfs) = CIA$$

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
EX-1	5.87	A	7.1	0.03	0.03	0.03	0.05	0.09	0.17	0.30
EX-2	4.78	A	7.6	0.03	0.03	0.04	0.05	0.09	0.17	0.30
EX-3	3.85	A	8.6	0.03	0.04	0.04	0.06	0.10	0.18	0.31
EX-4	3.47	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
EX-5	1.83	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
OS-1	11.25	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
OS-2	2.02	A	14.2	0.07	0.07	0.08	0.10	0.15	0.22	0.35
OS-4	0.06	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
OS-5	6.42	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27

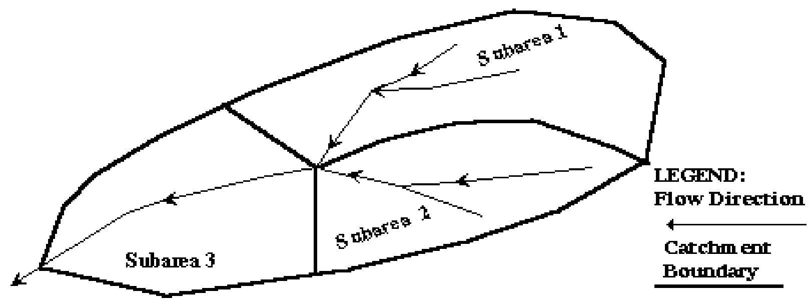
Subcatchment Name	Overland (Initial) Flow Time: Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)	Overland Flow Time t_i (min)	Channelized (Travel) Flow Time: Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)
EX-1	500.00	7428.00	7404.00	0.048	25.75	200.00	7404.00	7395.00	0.045	5	1.06	3.14
EX-2	500.00	7430.00	7403.00	0.054	24.71	200.00	7403.00	7395.00	0.040	5	1.00	3.33
EX-3	500.00	7428.00	7413.00	0.030	29.85	100.00	7413.00	7404.00	0.090	5	1.50	1.11
EX-4	500.00	7430.00	7412.00	0.036	28.95	255.00	7412.00	7398.00	0.055	5	1.17	3.63
EX-5	500.00	7430.00	7398.00	0.064	23.94	100.00	7398.00	7394.00	0.040	5	1.00	1.67
OS-1	500.00	7450.00	7418.00	0.064	23.94	50.00	7418.00	7416.00	0.040	5	1.00	0.83
OS-2	250.00	7450.00	7434.00	0.064	15.91	450.00	7434.00	7424.00	0.022	15	2.24	3.35
OS-4	50.00	7434.00	7430.00	0.080	7.03	0.00	0.01	0.01	0.000	2.5	0.01	0.00
OS-5	500.00	7450.00	7414.00	0.072	23.03	0.00	0.01	0.01	0.000	2.5	0.01	0.00

Subcatchment Name	Time of Concentration: Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	Rainfall Intensity, I (in/hr) 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	Peak Flow, Q (cfs) 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
EX-1	28.90	26.36	26.36	1.57	2.03	2.45	3.08	3.59	4.14	5.58	0.25	0.35	0.48	0.82	1.80	4.02	9.82
EX-2	28.05	26.36	26.36	1.57	2.03	2.45	3.08	3.59	4.14	5.58	0.22	0.31	0.43	0.72	1.54	3.35	8.09
EX-3	30.96	25.08	25.08	1.61	2.09	2.52	3.17	3.69	4.26	5.74	0.21	0.30	0.41	0.68	1.40	2.90	6.84
EX-4	32.57	27.61	27.61	1.53	1.98	2.39	3.00	3.49	4.03	5.43	0.03	0.04	0.06	0.11	0.51	1.76	5.03
EX-5	25.61	26.56	25.61	1.60	2.06	2.49	3.13	3.64	4.21	5.67	0.02	0.02	0.03	0.06	0.28	0.97	2.77
OS-1	24.77	26.11	24.77	1.63	2.10	2.54	3.19	3.71	4.29	5.78	0.09	0.14	0.20	0.39	1.76	6.06	17.36
OS-2	19.27	28.16	19.27	1.86	2.41	2.91	3.65	4.25	4.91	6.62	0.25	0.35	0.46	0.73	1.26	2.19	4.62
OS-4	7.03	25.66	10.00	2.51	3.25	3.92	4.92	5.74	6.63	8.93	0.00	0.00	0.00	0.00	0.01	0.05	0.14
OS-5	23.03	25.66	23.03	1.69	2.19	2.64	3.32	3.87	4.47	6.02	0.06	0.08	0.12	0.23	1.04	3.60	10.31

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: Richard Lyon
Company: Rocky Mountain Group
Date: 4/5/2019
Project: Loudermilk Minor Subdivision
Location: Goshawk Road



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Subcatchment Name
Post-Dev

See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
ROOF	0.21	A	90.0	0.73	0.75	0.77	0.79	0.79	0.81	0.83
CONCRETE	0.06	A	90.0	0.73	0.75	0.77	0.79	0.79	0.81	0.83
WOOD	0.01	A	90.0	0.73	0.75	0.77	0.79	0.79	0.81	0.83
GRAVEL	0.07	A	80.0	0.63	0.65	0.66	0.69	0.71	0.73	0.77
FIELD/SOIL	5.51	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
Total Area (ac)	**5.87**		**Area-Weighted C**	**0.05**	**0.05**	**0.05**	**0.06**	**0.09**	**0.17**	**0.30**
			Area-Weighted Override C	**0.05**	**0.05**	**0.05**	**0.06**	**0.09**	**0.17**	**0.30**

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: Richard Lyon
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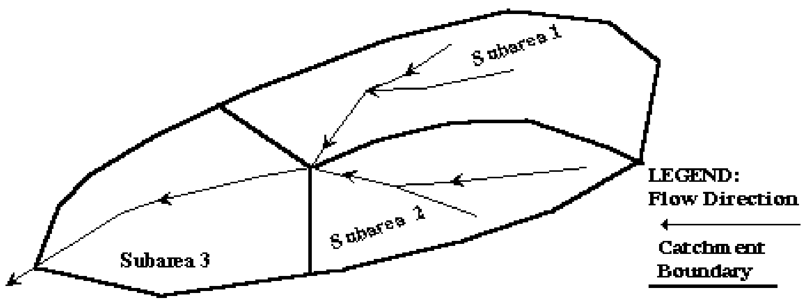

Subcatchment Name
Post-Dev

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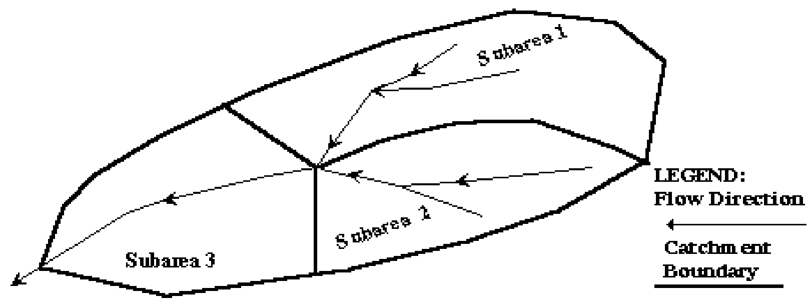
See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
GRAVEL	0.34	A	80.0	0.63	0.65	0.66	0.69	0.71	0.73	0.77
FIELD/SOIL	4.45	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
Total Area (ac)	4.78		Area-Weighted C	0.05	0.05	0.05	0.06	0.09	0.17	0.30
			Area-Weighted Override C	0.05	0.05	0.05	0.06	0.09	0.17	0.30

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: Richard Lyon
Company: Rocky Mountain Group
Date: 4/5/2019
Project: Loudermilk Minor Subdivision
Location: Goshawk Road



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Subcatchment Name
Post-Dev

See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
ROOF	0.03	A	90.0	0.73	0.75	0.77	0.79	0.79	0.81	0.83
CONCRETE	0.02	A	90.0	0.73	0.75	0.77	0.79	0.79	0.81	0.83
WOOD	0.001	A	90.0	0.73	0.75	0.77	0.79	0.79	0.81	0.83
GRAVEL	0.27	A	80.0	0.63	0.65	0.66	0.69	0.71	0.73	0.77
FIELD/SOIL	3.54	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
Total Area (ac)	**3.85**		**Area-Weighted C**	**0.06**	**0.06**	**0.06**	**0.07**	**0.10**	**0.18**	**0.31**
			Area-Weighted Override C	**0.06**	**0.06**	**0.06**	**0.07**	**0.10**	**0.18**	**0.31**

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: Richard Lyon
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Date: 4/5/2019
Project: Loudermilk Minor Subdivision
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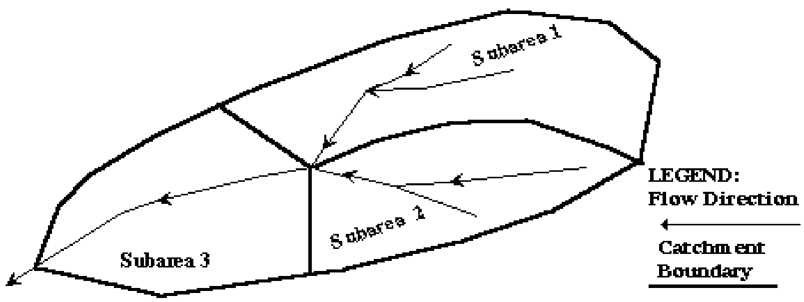

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Subcatchment Name
Post-Dev

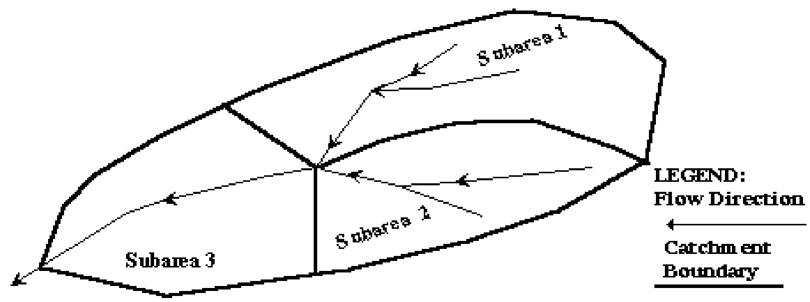
See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
FIELD/SOIL	3.47	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
Total Area (ac)	3.47		Area-Weighted C	0.01	0.01	0.01	0.01	0.04	0.13	0.27
			Area-Weighted Override C	0.01	0.01	0.01	0.01	0.04	0.13	0.27

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: Richard Lyon
Company: Rocky Mountain Group
Date: 4/5/2019
Project: Loudermilk Minor Subdivision
Location: Goshawk Road



Subcatchment Name
Post-Dev

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See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
FIELD/SOIL	1.83	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
Total Area (ac)	1.83		Area-Weighted C	0.01	0.01	0.01	0.01	0.04	0.13	0.27
			Area-Weighted Override C	0.01	0.01	0.01	0.01	0.04	0.13	0.27

Calculation of Peak Runoff using Rational Method

Designer: Richard Lyon
Company: Rocky Mountain Group
Date: 4/5/2019
Project: Loudermilk Minor Subdivision
Location: Goshawk Road

Version 2.00 released May 2017

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$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_i^{0.33}}$$

$$t_t = \frac{L_t}{60K\sqrt{S_t}} = \frac{L_t}{60V_t}$$

$$\text{Computed } t_c = t_i + t_t$$

$$\text{Regional } t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$$

$t_{minimum}$ = 5 (urban)
$t_{minimum}$ = 10 (non-urban)

$$\text{Selected } t_c = \max\{t_{minimum}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$$

Select UDFCD location for NOAA Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained from the NOAA website (click this link)

	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
1-hour rainfall depth, P1 (in) =	0.93	1.20	1.45	1.82	2.12	2.45	3.30

	a	b	c
Rainfall Intensity Equation Coefficients =	28.50	10.00	0.786

$$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$$

$$Q(cfs) = CIA$$

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
EX-1	2.17	A	15.9	0.08	0.08	0.09	0.11	0.16	0.23	0.36
EX-2	3.42	A	7.2	0.03	0.03	0.03	0.05	0.09	0.17	0.30
EX-3	3.81	A	8.7	0.03	0.04	0.04	0.06	0.10	0.18	0.31
EX-4	3.47	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
EX-5	1.83	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
DV-2	1.36	A	11.2	0.05	0.05	0.06	0.08	0.12	0.20	0.33
DV-1	3.75	A	7.5	0.03	0.03	0.04	0.05	0.09	0.17	0.30

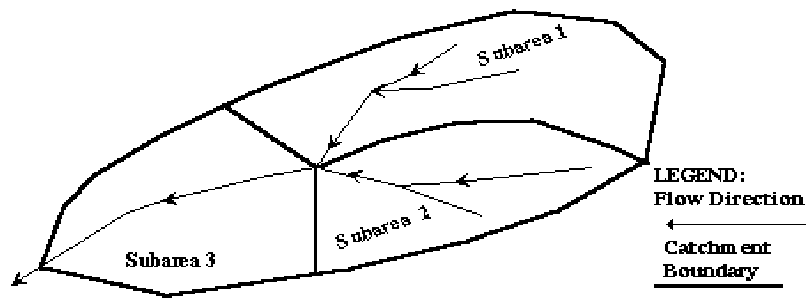
Subcatchment Name	Overland (Initial) Flow Time: Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)	Overland Flow Time t_i (min)	Channelized (Travel) Flow Time: Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)
EX-1	220.00	7401.00	7395.00	0.027	19.58	0.00	0.00	0.00	1.000	5	5.00	0.00
EX-2	500.00	7412.00	7392.00	0.040	27.34	0.00	0.00	0.00	1.000	5	5.00	0.00
EX-3	500.00	7428.00	7413.00	0.030	29.83	100.00	7413.00	7404.00	0.090	5	1.50	1.11
EX-4	500.00	7430.00	7412.00	0.036	28.95	255.00	7412.00	7398.00	0.055	5	1.17	3.63
EX-5	500.00	7430.00	7398.00	0.064	23.94	100.00	7398.00	7394.00	0.040	5	1.00	1.67
DV-2	300.00	7428.00	7412.00	0.053	18.85	0.00	0.00	0.00	1.000	5	5.00	0.00
DV-1	500.00	7430.00	7401.00	0.058	24.15	0.00	0.00	0.00	1.000	5	5.00	0.00

Subcatchment Name	Time of Concentration: Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	Rainfall Intensity, I (in/hr) 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	Peak Flow, Q (cfs) 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
EX-1	19.58	23.30	19.58	1.85	2.39	2.88	3.62	4.22	4.87	6.56	0.31	0.43	0.57	0.88	1.47	2.47	5.07
EX-2	27.34	24.78	24.78	1.63	2.10	2.54	3.19	3.71	4.29	5.78	0.15	0.22	0.30	0.50	1.10	2.44	5.94
EX-3	30.94	25.06	25.06	1.61	2.09	2.52	3.17	3.69	4.26	5.74	0.21	0.30	0.41	0.69	1.39	2.89	6.78
EX-4	32.57	27.61	27.61	1.53	1.98	2.39	3.00	3.49	4.03	5.43	0.03	0.04	0.06	0.11	0.51	1.76	5.03
EX-5	25.61	26.56	25.61	1.60	2.06	2.49	3.13	3.64	4.21	5.67	0.02	0.02	0.03	0.06	0.28	0.97	2.77
DV-2	18.85	24.10	18.85	1.88	2.43	2.94	3.69	4.30	4.97	6.69	0.12	0.17	0.23	0.38	0.70	1.33	2.96
DV-1	24.15	24.73	24.15	1.65	2.13	2.58	3.23	3.77	4.35	5.86	0.18	0.25	0.35	0.58	1.26	2.75	6.64

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: Richard Lyon
Company: Rocky Mountain Group
Date: 4/5/2019
Project: Loudermilk Minor Subdivision
Location: Goshawk Road



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Subcatchment Name
Post-Dev

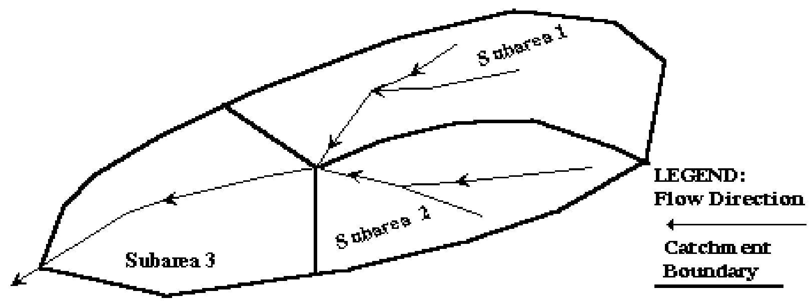
See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
ROOF	0.11	A	90.0	0.73	0.75	0.77	0.79	0.79	0.81	0.83
CONCRETE	0.04	A	90.0	0.73	0.75	0.77	0.79	0.79	0.81	0.83
WOOD	0.01	A	90.0	0.73	0.75	0.77	0.79	0.79	0.81	0.83
GRAVEL	0.14	A	80.0	0.63	0.65	0.66	0.69	0.71	0.73	0.77
FIELD/SOIL	3.45	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
Total Area (ac)	**3.75**		**Area-Weighted C**	**0.06**	**0.06**	**0.06**	**0.07**	**0.10**	**0.18**	**0.31**
			Area-Weighted Override C	**0.06**	**0.06**	**0.06**	**0.07**	**0.10**	**0.18**	**0.31**

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: Richard Lyon
Company: Rocky Mountain Group
Date: 4/5/2019
Project: Loudermilk Minor Subdivision
Location: Goshawk Road



Subcatchment Name
Post-Dev

Cells of this color are for required user-input
Cells of this color are for optional override values
Cells of this color are for calculated results based on overrides

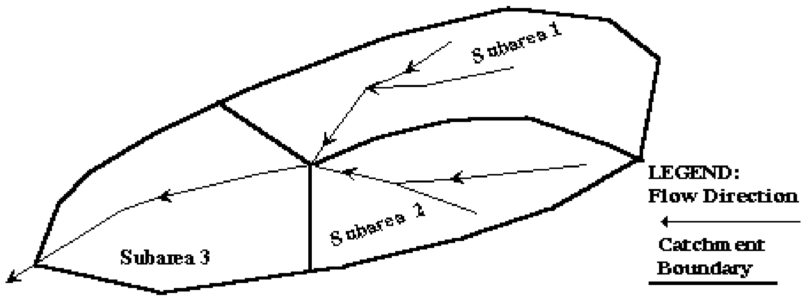
See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
GRAVEL	0.16	A	80.0	0.63	0.65	0.66	0.69	0.71	0.73	0.77
FIELD/SOIL	1.20	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
Total Area (ac)	1.36		Area-Weighted C	0.08	0.08	0.08	0.09	0.12	0.20	0.33
			Area-Weighted Override C	0.08	0.08	0.08	0.09	0.12	0.20	0.33

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: Richard Lyon
Company: Rocky Mountain Group
Date: 4/5/2019
Project: Loudermilk Minor Subdivision
Location: Goshawk Road



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Subcatchment Name
Post-Dev

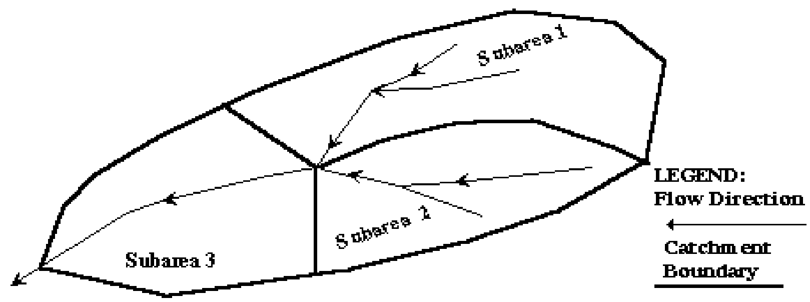
See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
ROOF	0.21	A	90.0	0.73	0.75	0.77	0.79	0.79	0.81	0.83
CONCRETE	0.06	A	90.0	0.73	0.75	0.77	0.79	0.79	0.81	0.83
WOOD	0.01	A	90.0	0.73	0.75	0.77	0.79	0.79	0.81	0.83
GRAVEL	0.07	A	80.0	0.63	0.65	0.66	0.69	0.71	0.73	0.77
FIELD/SOIL	1.81	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
Total Area (ac)	2.17		Area-Weighted C	0.12	0.12	0.13	0.13	0.16	0.23	0.36
			Area-Weighted Override C	0.12	0.12	0.13	0.13	0.16	0.23	0.36

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: Richard Lyon
Company: Rocky Mountain Group
Date: 4/5/2019
Project: Loudermilk Minor Subdivision
Location: Goshawk Road



Subcatchment Name
Post-Dev

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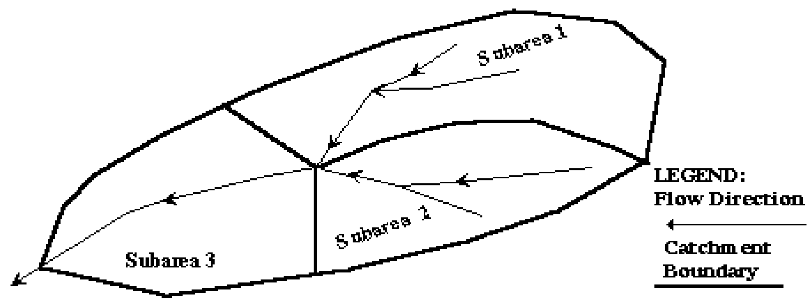
See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
GRAVEL	0.23	A	80.0	0.63	0.65	0.66	0.69	0.71	0.73	0.77
FIELD/SOIL	3.19	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
Total Area (ac)	**3.42**		**Area-Weighted C**	**0.05**	**0.05**	**0.05**	**0.06**	**0.09**	**0.17**	**0.30**
			Area-Weighted Override C	**0.05**	**0.05**	**0.05**	**0.06**	**0.09**	**0.17**	**0.30**

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: Richard Lyon
Company: Rocky Mountain Group
Date: 4/5/2019
Project: Loudermilk Minor Subdivision
Location: Goshawk Road



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Subcatchment Name
Post-Dev

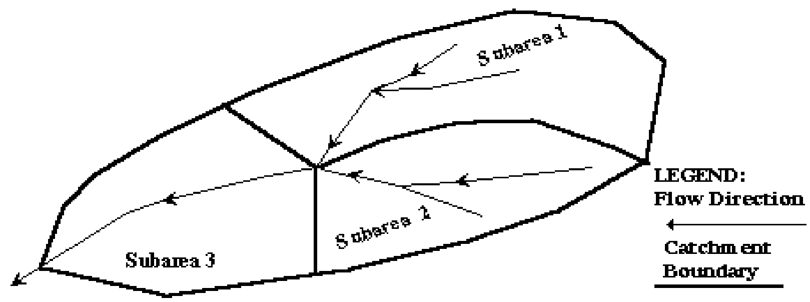
See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
ROOF	0.03	A	90.0	0.73	0.75	0.77	0.79	0.79	0.81	0.83
CONCRETE	0.02	A	90.0	0.73	0.75	0.77	0.79	0.79	0.81	0.83
WOOD	0.001	A	90.0	0.73	0.75	0.77	0.79	0.79	0.81	0.83
GRAVEL	0.27	A	80.0	0.63	0.65	0.66	0.69	0.71	0.73	0.77
FIELD/SOIL	3.49	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
Total Area (ac)	**3.81**		**Area-Weighted C**	**0.06**	**0.06**	**0.06**	**0.07**	**0.10**	**0.18**	**0.31**
			Area-Weighted Override C	**0.06**	**0.06**	**0.06**	**0.07**	**0.10**	**0.18**	**0.31**

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: Richard Lyon
Company: Rocky Mountain Group
Date: 4/5/2019
Project: Loudermilk Minor Subdivision
Location: Goshawk Road



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Subcatchment Name
Post-Dev

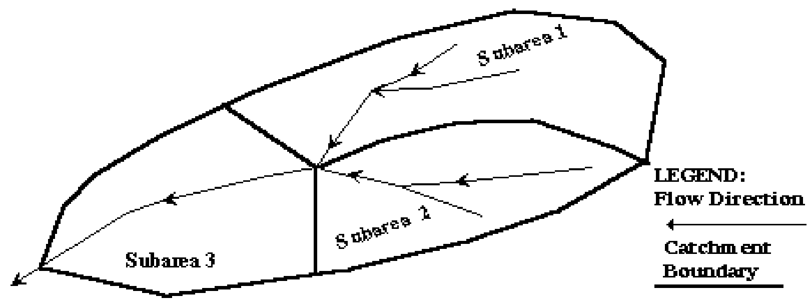
See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
FIELD/SOIL	3.47	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27
Total Area (ac)	**3.47**		**Area-Weighted C**	**0.01**	**0.01**	**0.01**	**0.01**	**0.04**	**0.13**	**0.27**
			Area-Weighted Override C	**0.01**	**0.01**	**0.01**	**0.01**	**0.04**	**0.13**	**0.27**

Area-Weighted Runoff Coefficient Calculations

Version 2.00 released May 2017

Designer: Richard Lyon
Company: Rocky Mountain Group
Date: 1/15/2019
Project: Loudermilk Minor Subdivision
Location: Goshawk Road



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Subcatchment Name
Post-Dev

See sheet "Design Info" for imperviousness-based runoff coefficient values.

Sub-Area ID	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
FIELD/SOIL	1.83	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27

Total Area (ac)	1.83		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
		Area-Weighted C	0.01	0.01	0.01	0.01	0.04	0.13	0.27
		Area-Weighted Override C	0.01	0.01	0.01	0.01	0.04	0.13	0.27

Calculation of Peak Runoff using Rational Method

Designer: Richard Lyon
Company: Rocky Mountain Group
Date: 4/5/2019
Project: Loudermilk Minor Subdivision
Location: Goshawk Road

Version 2.00 released May 2017

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$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_i^{0.33}}$$

$$t_t = \frac{L_t}{60K\sqrt{S_t}} = \frac{L_t}{60V_t}$$

$$\text{Computed } t_c = t_i + t_t$$

$$\text{Regional } t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$$

$t_{minimum} = 5$ (urban)
$t_{minimum} = 10$ (non-urban)

$$\text{Selected } t_c = \max\{t_{minimum}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$$

Select UDFCD location for NOAA Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained from the NOAA website (click this link)

	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
1-hour rainfall depth, P1 (in) =	0.93	1.20	1.45	1.82	2.12	2.45	3.30

	a	b	c
Rainfall Intensity Equation Coefficients =	28.50	10.00	0.786

$$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$$

$$Q(cfs) = CIA$$

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
DP1	18.42	A	3.9	0.01	0.01	0.02	0.02	0.06	0.14	0.28
DP2	2.41	A	13.9	0.06	0.07	0.08	0.10	0.14	0.22	0.34
DP3	2.95	A	2.0	0.01	0.01	0.01	0.01	0.04	0.13	0.27

Subcatchment Name	Overland (Initial) Flow Time: Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)	Overland Flow Time t_i (min)
DP1	500.00	7450.00	7416.00	0.068	23.30
DP2	500.00	7450.00	7434.00	0.032	28.34
DP3	500.00	7450.00	7415.00	0.070	23.24

Subcatchment Name	Channelized (Travel) Flow Time: Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)
DP1	500.00	7416.00	7395.00	0.042	5	1.02	8.13
DP2	500.00	7434.00	7410.00	0.048	15	3.29	2.54
DP3	450.00	7415.00	7414.00	0.002	5	0.24	31.82

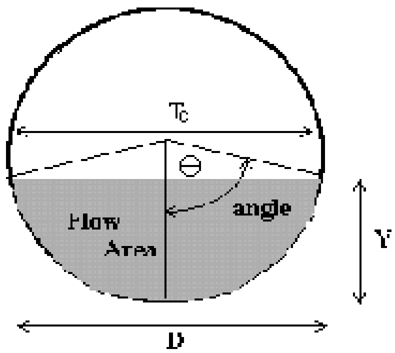
Subcatchment Name	Time of Concentration: Computed t_c (min)	Regional t_c (min)	Selected t_c (min)
DP1	31.43	29.61	29.61
DP2	30.88	27.11	27.11
DP3	55.06	42.80	42.80

Subcatchment Name	Rainfall Intensity, I (in/hr) 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
DP1	1.47	1.90	2.29	2.88	3.35	3.87	5.22
DP2	1.54	2.00	2.41	3.03	3.53	4.08	5.49
DP3	1.17	1.51	1.83	2.30	2.67	3.09	4.16

Subcatchment Name	Peak Flow, Q (cfs) 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
DP1	0.33	0.47	0.67	1.21	3.58	10.00	26.81
DP2	0.24	0.33	0.45	0.70	1.22	2.15	4.55
DP3	0.02	0.03	0.04	0.07	0.33	1.15	3.28

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

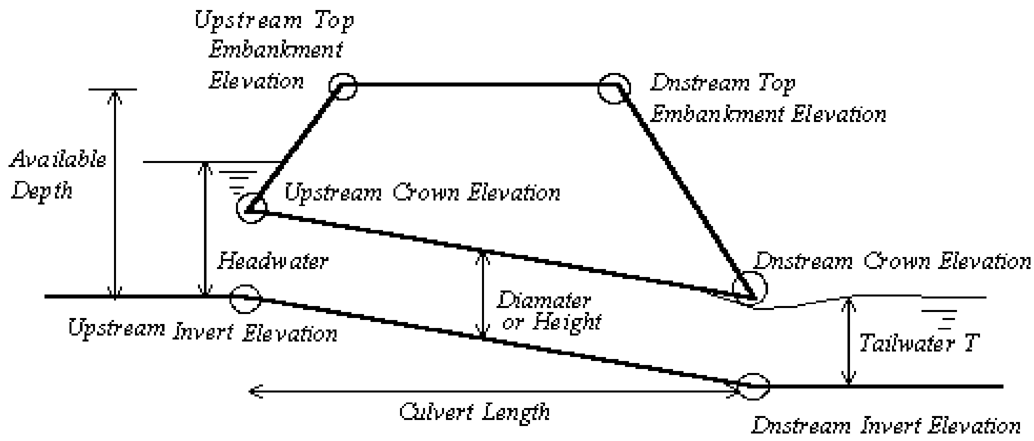
Project: **Loudermilk Minor Subdivision**
Pipe ID: **Proposed 18" CMP Culvert Pipe (DP1)**



Design Information (Input)			
Pipe Invert Slope	So =	0.0267	ft/ft
Pipe Manning's n-value	n =	0.0150	
Pipe Diameter	D =	18.00	inches
Design discharge	**Q =**	**10.00**	**cfs**
Full-flow Capacity (Calculated)			
Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	14.92	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.77	radians
Flow area	An =	1.11	sq ft
Top width	Tn =	1.47	ft
Wetted perimeter	Pn =	2.66	ft
Flow depth	Yn =	0.90	ft
Flow velocity	Vn =	9.05	fps
Discharge	Qn =	10.00	cfs
Percent Full Flow	Flow =	67.0%	of full flow
Normal Depth Froude Number	Fr_n =	1.84	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.25	radians
Critical flow area	Ac =	1.54	sq ft
Critical top width	Tc =	1.17	ft
Critical flow depth	Yc =	1.22	ft
Critical flow velocity	Vc =	6.50	fps
Critical Depth Froude Number	Fr_c =	1.00	

Vertical Profile for the Culvert

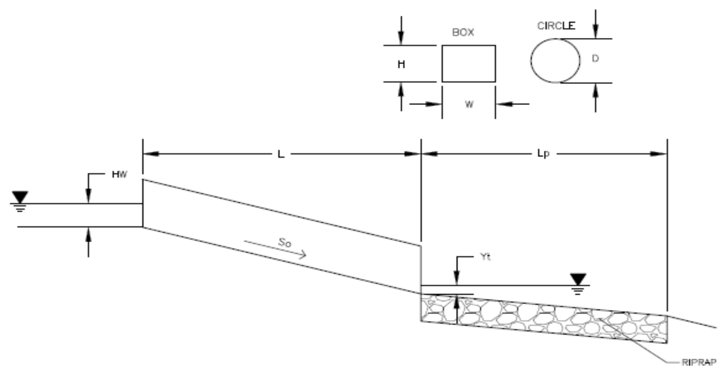
Project = **Loudermilk Minor Subdivision**
Box ID = **Proposed 18" CMP Culvert Pipe (DP1)**



Culvert Information (Input)			
Barrel Diameter or Height	D or H =	18.00	inches
Barrel Length	L =	56.00	ft
Barrel Invert Slope	So =	0.0267	ft/ft
Downstream Invert Elevation	EDI =	7393.50	ft
Downstream Top Embankment Elevation	EDT =	7402.00	ft
Upstream Top Embankment Elevation	EUT =	7402.00	ft
Design Headwater Depth (not elev.)	Hw =	6.00	ft
Tailwater Depth (not elev.)	Yt =	7.50	ft
Culvert Hydraulics (Calculated)			
Available Headwater Depth	HW-a =	7.00	ft
Design Hw/D ratio	Hw/D =	4.00	
Culvert Vertical Profile			
Upstream Invert Elevation	EUI =	7395.00	ft
Upstream Crown Elevation	EUC =	7396.50	ft
Upstream Soil Cover Depth	Upsoil =	5.50	ft
Downstream Invert Elevation	EDI =	7393.50	ft
Downstream Crown Elevation	EDC =	7395.00	ft
Downstream Soil Cover Depth	Dnsoil =	7.00	ft

Determination of Culvert Headwater and Outlet Protection

Project: Loudermilk Minor Subdivision
Basin ID: DP1



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

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

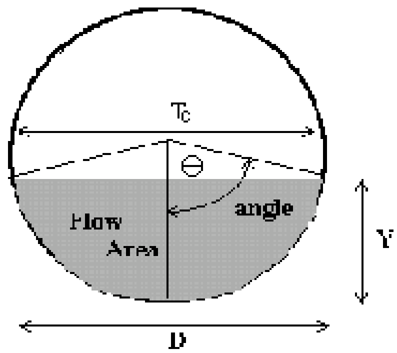
Design Discharge	Q =	10	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	18	inches
Inlet Edge Type (Choose from pull-down list)		Grooved End with Headwall	
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	Height (Rise) =		ft
Barrel Width (Span) in Feet	Width (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	No =	1	
Inlet Elevation	Elev IN =	7395	ft
Outlet Elevation **OR** Slope	Elev OUT =	7393.5	ft
Culvert Length	L =	56	ft
Manning's Roughness	n =	0.015	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	Elev Y_t =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.60	ft
Flow Area at Max Channel Velocity	A_t =	2.00	ft^2
Culvert Cross Sectional Area Available	A =	1.77	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	1.35	
Sum of All Losses Coefficients	k_s =	2.55	ft
Culvert Normal Depth	Y_n =	0.90	ft
Culvert Critical Depth	Y_c =	1.22	ft
Tailwater Depth for Design	d =	1.36	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	1.20	ft
Expansion Factor	1/(2*tan(Θ)) =	5.25	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	3.63	$ft^{0.5}/s$
Froude Number	Fr =	1.84	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.50	
Inlet Control Headwater	HW_I =	2.00	ft
Outlet Control Headwater	HW_O =	1.13	
Design Headwater Elevation	**HW =**	**7,397.00**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.34**	
Minimum Theoretical Riprap Size	d_{50} =	5	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	**VL**	
Length of Protection	**L_p =**	**10**	**ft**
Width of Protection	**T =**	**4**	**ft**

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

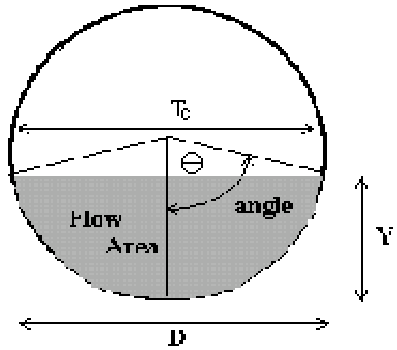
Project: **Loudermilk Minor Subdivision**
Pipe ID: **Existing Driveway Entrance Culvert Pipe (DP2)**



Design Information (Input)			
Pipe Invert Slope	So =	0.0200	ft/ft
Pipe Manning's n-value	n =	0.0150	
Pipe Diameter	D =	18.00	inches
Design discharge	**Q =**	**0.45**	**cfs**
Full-flow Capacity (Calculated)			
Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	12.91	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	0.73	radians
Flow area	An =	0.13	sq ft
Top width	Tn =	1.00	ft
Wetted perimeter	Pn =	1.10	ft
Flow depth	Yn =	0.19	ft
Flow velocity	Vn =	3.42	fps
Discharge	Qn =	0.45	cfs
Percent Full Flow	Flow =	3.5%	of full flow
Normal Depth Froude Number	Fr_n =	1.66	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	0.84	radians
Critical flow area	Ac =	0.19	sq ft
Critical top width	Tc =	1.11	ft
Critical flow depth	Yc =	0.25	ft
Critical flow velocity	Vc =	2.35	fps
Critical Depth Froude Number	Fr_c =	1.00	

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

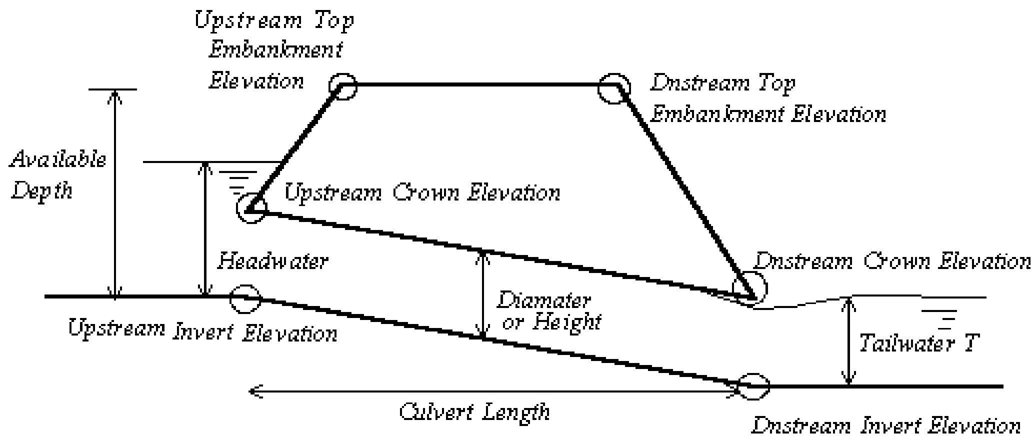
Project: **Loudermilk Minor Subdivision**
Pipe ID: **Proposed Culvert Pipe (DP3)**



Design Information (Input)			
Pipe Invert Slope	So =	0.0200	ft/ft
Pipe Manning's n-value	n =	0.0150	
Pipe Diameter	D =	18.00	inches
Design discharge	**Q =**	**0.05**	**cfs**
Full-flow Capacity (Calculated)			
Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	12.91	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	0.43	radians
Flow area	An =	0.03	sq ft
Top width	Tn =	0.62	ft
Wetted perimeter	Pn =	0.64	ft
Flow depth	Yn =	0.07	ft
Flow velocity	Vn =	1.76	fps
Discharge	Qn =	0.05	cfs
Percent Full Flow	Flow =	0.4%	of full flow
Normal Depth Froude Number	Fr_n =	1.45	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	0.47	radians
Critical flow area	Ac =	0.04	sq ft
Critical top width	Tc =	0.68	ft
Critical flow depth	Yc =	0.08	ft
Critical flow velocity	Vc =	1.33	fps
Critical Depth Froude Number	Fr_c =	1.00	

Vertical Profile for the Culvert

Project = Loudermilk Minor Subdivision
Box ID = Proposed 18" CMP Culvert Pipe (DP3)

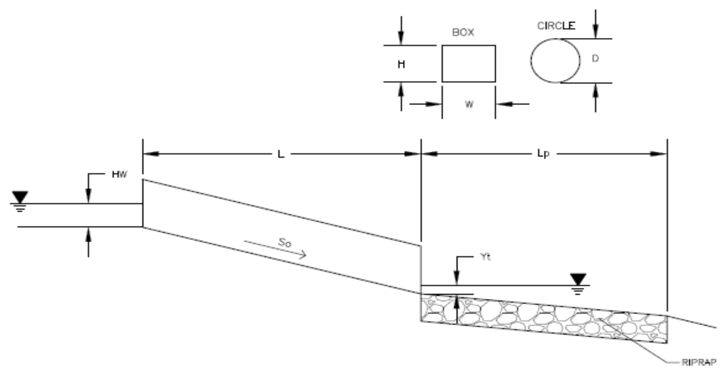


Culvert Information (Input)			
Barrel Diameter or Height	D or H =	18.00	inches
Barrel Length	L =	30.00	ft
Barrel Invert Slope	So =	0.0200	ft/ft
Downstream Invert Elevation	EDI =	7414.00	ft
Downstream Top Embankment Elevation	EDT =	7416.00	ft
Upstream Top Embankment Elevation	EUT =	7415.72	ft
Design Headwater Depth (not elev.)	Hw =	2.00	ft
Tailwater Depth (not elev.)	Yt =	2.80	ft
Culvert Hydraulics (Calculated)			
Available Headwater Depth	HW-a =	1.12	ft
Design Hw/D ratio	Hw/D =	1.33	
Culvert Vertical Profile			
Upstream Invert Elevation	EUI =	7414.60	ft
Upstream Crown Elevation	EUC =	7416.10	ft
Upstream Soil Cover Depth	Upsoil =	-0.38	ft
Downstream Invert Elevation	EDI =	7414.00	ft
Downstream Crown Elevation	EDC =	7415.50	ft
Downstream Soil Cover Depth	Dnsoil =	0.22	ft

Determination of Culvert Headwater and Outlet Protection

Project: **Loudermilk Minor Subdivision**

Basin ID: **DP3**



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

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

Design Discharge	Q =	1.15	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	18	inches
Inlet Edge Type (Choose from pull-down list)		Grooved End with Headwall	
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	Height (Rise) =		ft
Barrel Width (Span) in Feet	Width (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	No =	1	
Inlet Elevation	Elev IN =	7414	ft
Outlet Elevation **OR** Slope	Elev OUT =	7413.4	ft
Culvert Length	L =	30	ft
Manning's Roughness	n =	0.015	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	Elev Y_t =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.60	ft
Flow Area at Max Channel Velocity	A_t =	0.23	ft^2
Culvert Cross Sectional Area Available	A =	1.77	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.72	
Sum of All Losses Coefficients	k_s =	1.92	ft
Culvert Normal Depth	Y_n =	0.30	ft
Culvert Critical Depth	Y_c =	0.40	ft
Tailwater Depth for Design	d =	0.95	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	0.90	ft
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	0.42	$ft^{0.5}/s$
Froude Number	Fr =	1.73	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.67	
Inlet Control Headwater	HW_I =	0.54	ft
Outlet Control Headwater	HW_O =	0.36	ft
Design Headwater Elevation	**HW =**	**7,414.54**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**0.36**	
Minimum Theoretical Riprap Size	d_{50} =	1	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	**VL**	
Length of Protection	**L_p =**	**5**	**ft**
Width of Protection	**T =**	**3**	**ft**

Level Spreader Calculation

Design Procedure and Criteria

The following steps outline the grass buffer design procedure and criteria. Figure GB-1 is a schematic of the facility and its components:

1. **Design Discharge**: Use the hydrologic procedures described in the *Runoff* chapter of Volume 1 to determine the 2-year peak flow rate (Q_2) of the area draining to the grass buffer.

2. **Minimum Width:** The width (W), normal to flow of the buffer, is typically the same as the contributing basin (see Figure GB-1). An exception to this is where flows become concentrated. Concentrated flows require a level spreader to distribute flows evenly across the width of the buffer. The minimum width should be:

$$W = \frac{Q_2}{0.05} \qquad \text{Equation GB-1}$$

   Where:

   W = width of buffer (ft)

   Q_2 = 2-year peak runoff (cfs)

To be conservative, the Q5 is used per calcs:

Culvert Pipe for DP1:

$$W = \frac{0.43\ cfs}{0.05} = 8.6\ ft\ minimum\ width$$

Design width of 10 ft. used. Safety factor of 1.16.

Culvert Pipe for DP2:

$$W = \frac{0.33\ cfs}{0.05} = 6.6\ ft\ minimum\ width$$

Design width of 7 ft. used. Safety factor of 1.06.

Culvert Pipe for DP3:

$$W = \frac{0.03\ cfs}{0.05} = 0.6\ ft\ minimum\ width$$

Design width of 2 ft. used. Safety factor of 3.33.

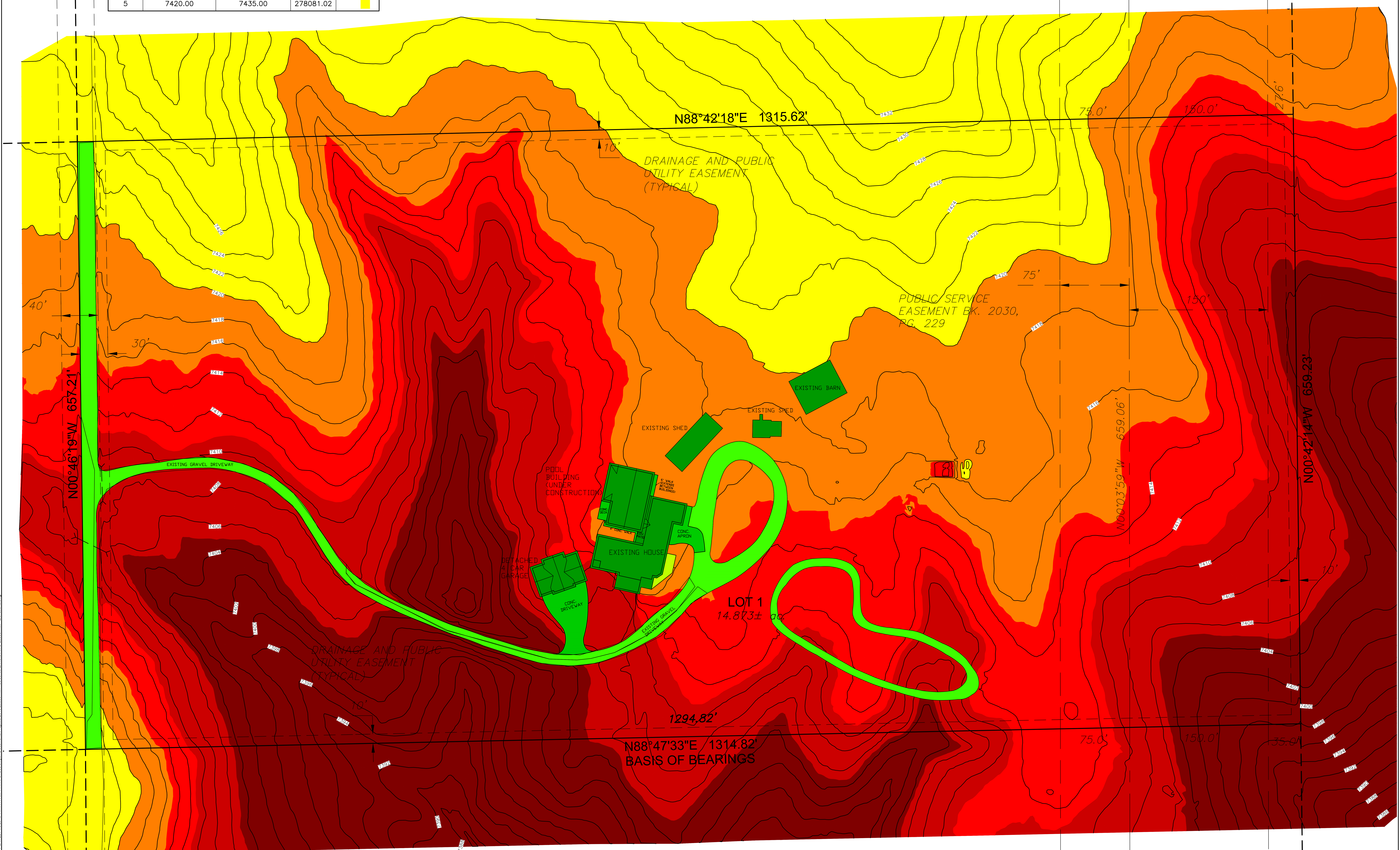
3. **Length:** The recommended length (L), the distance along the sheet flow direction, should be a minimum of 14 feet. This value is based on the findings of Barrett et al. 2004 in *Stormwater Pollutant Removal in Roadside Vegetated Strips* and is appropriate for buffers with greater than 80% vegetative cover and slopes up to 10%. The study found that pollutant removal continues throughout a length of 14 feet. Beyond this length, a point of diminishing returns in pollutant reduction was found. It is important to note that shorter lengths or slightly steeper slopes will also provide some level of removal where site constraints dictate the geometry of the buffer.

Design length = 14 ft for each.

Appendix E – Elevation Exhibit, Subbasin Exhibits

Elevations Table

Number	Minimum Elevation	Maximum Elevation	Area	Color
1	7385.00	7405.00	263738.01	
2	7405.00	7411.00	253743.72	
3	7411.00	7415.00	222732.83	
4	7415.00	7420.00	308359.72	
5	7420.00	7435.00	278081.02	



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17115 GOSHAWK ROAD
COLORADO SPRINGS, CO

ARVIN AND CHERYL LOUDERMILK

SHEET NAME
ELEVATIONS EXHIBIT

PROJECT STATUS
APPLICATION SUBMITTAL

ENG: RDL
DRAWN: RDL
CHECKED: RDL

DATE
04/05/19

#	REVISION	DATE
	SUBD APP	01/14/19
	SUBD APP 2	01/17/19
	CNTY REV. 1	04/05/19
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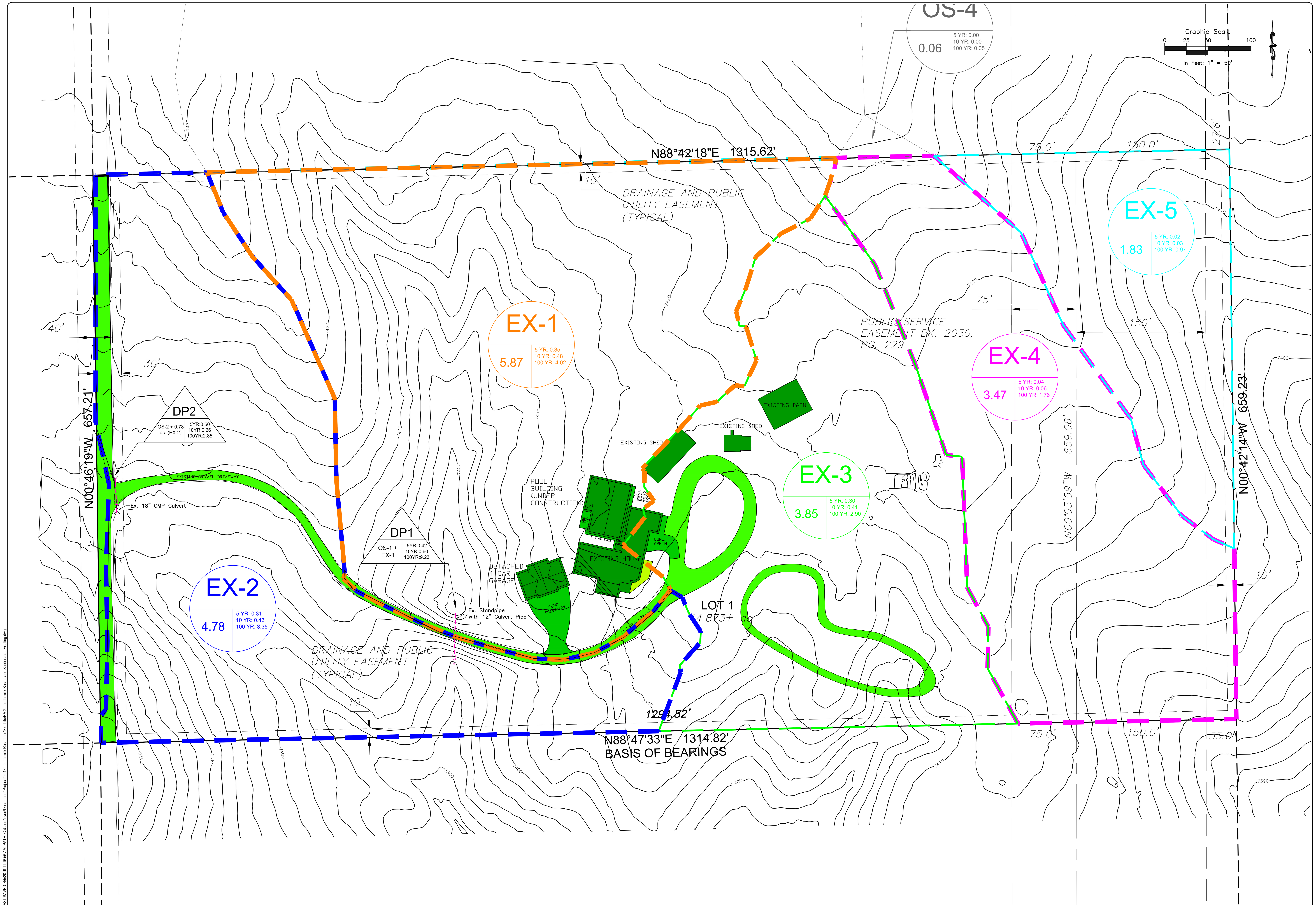
JOB NO.
167392

SHEET NO.
EXHIBIT 01
of 05



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SHEET NAME
EXISTING SUBBASINS

PROJECT STATUS
APPLICATION SUBMITTAL

ENG: RDL
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DATE
04/05/19

#	REVISION	DATE
	SUBD APP	01/14/19
	SUBD APP 2	01/17/19
	CNTY REV. 1	04/05/19
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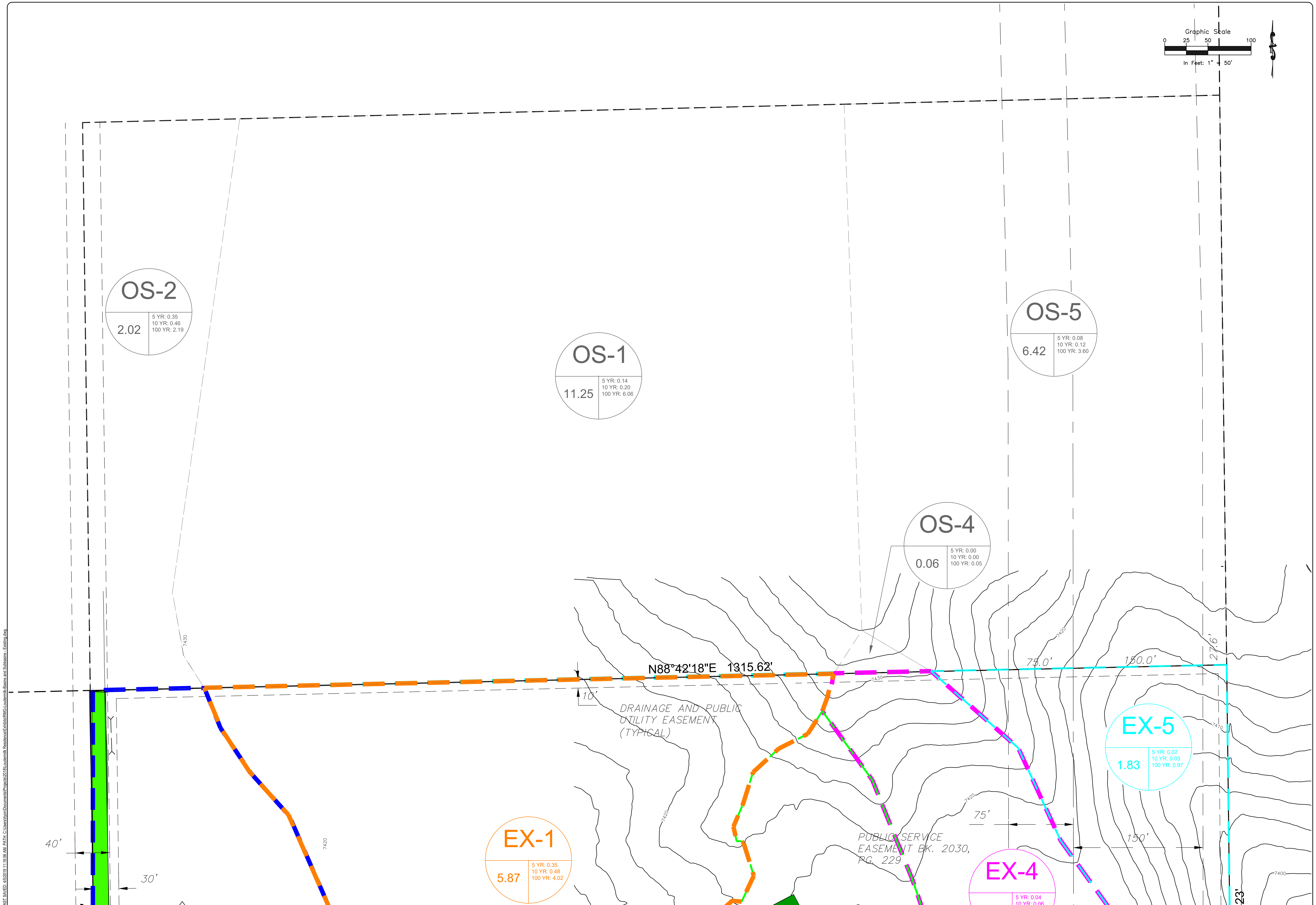
JOB NO.
167392

SHEET NO.
EXHIBIT 02
of 05



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SHEET NAME
EXISTING OFFSITE SUBBASINS

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APPLICATION SUBMITTAL

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CHECKED:	RDL

DATE
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#	REVISION	DATE
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	SUBD APP 2	01/17/19
	CNTY REV. 1	04/05/19
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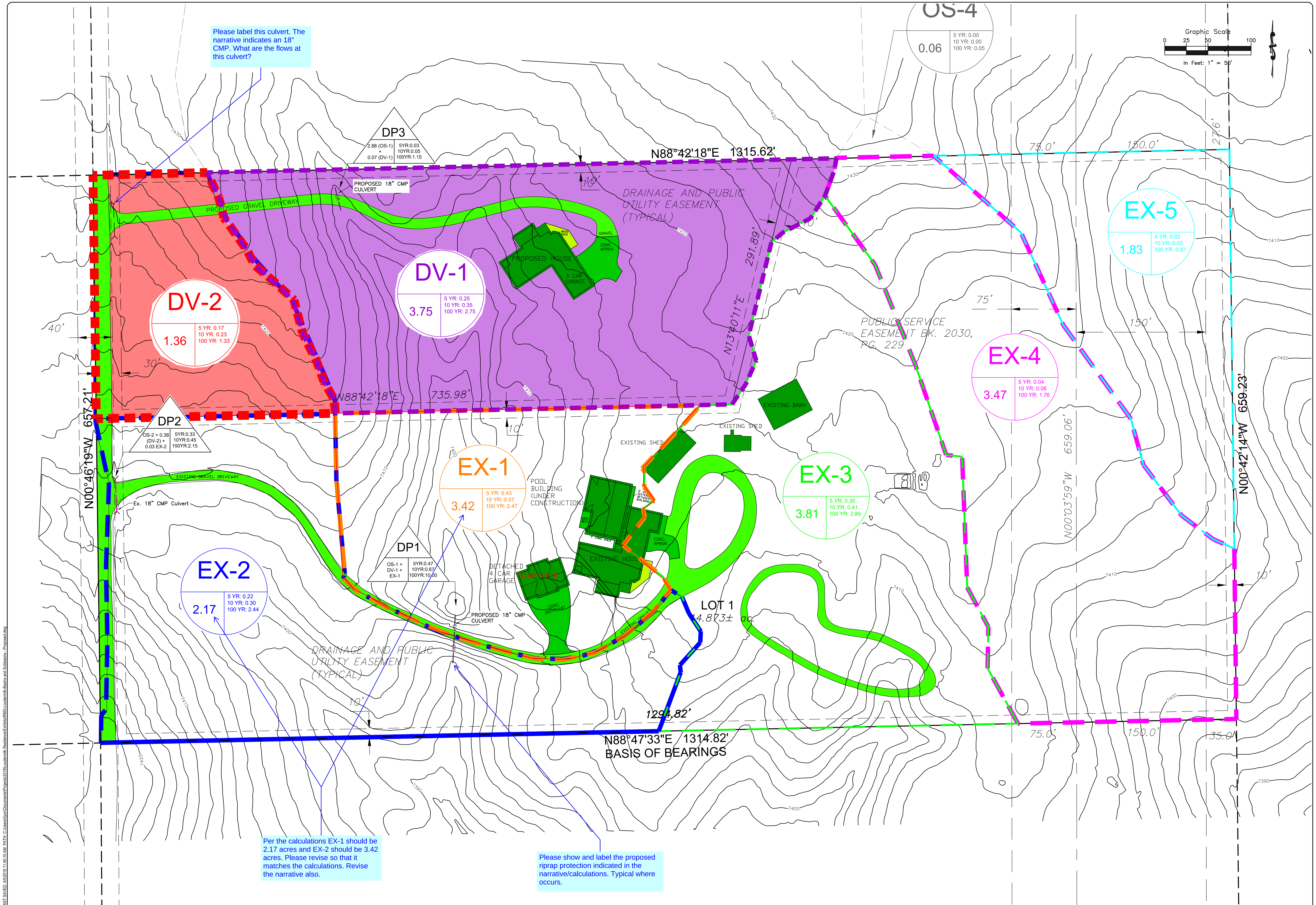
JOB NO.
167392

SHEET NO.
EXHIBIT 03
of 05



Please label this culvert. The narrative indicates an 18" CMP. What are the flows at this culvert?

Per the calculations EX-1 should be 2.17 acres and EX-2 should be 3.42 acres. Please revise so that it matches the calculations. Revise the narrative also.

Please show and label the proposed riprap protection indicated in the narrative/calculations. Typical where occurs.

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SHEET NAME
PROPOSED SUBBASINS

PROJECT STATUS
APPLICATION SUBMITTAL

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DRAWN: RDL
CHECKED: RDL

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#	REVISION	DATE
	SUBD APP	01/14/19
	SUBD APP 2	01/17/19
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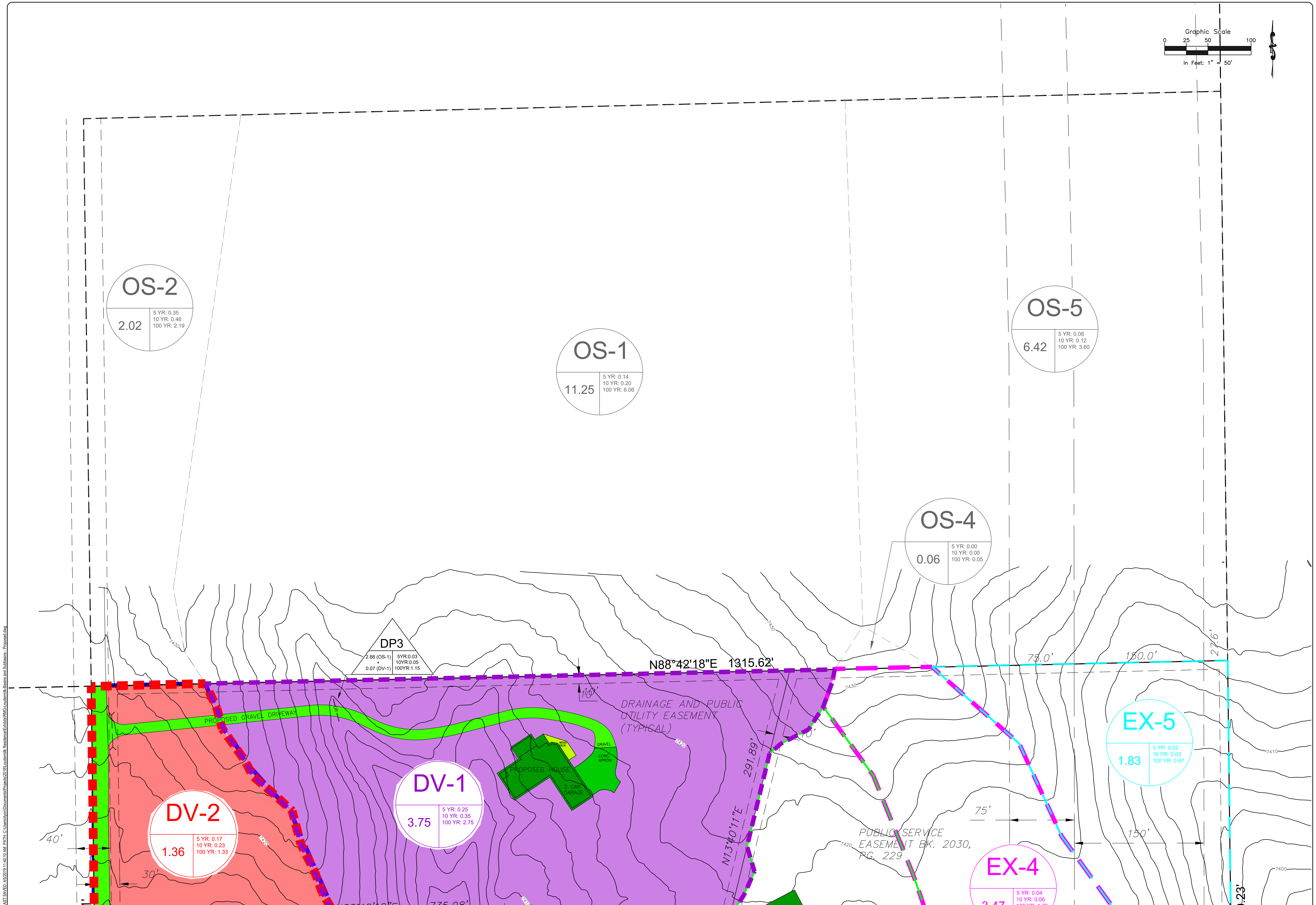
EXHIBIT 04
of 05



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SHEET NAME: PROPOSED OFFSITE SUBBASINS

PROJECT STATUS: APPLICATION SUBMITTAL

ENG:	RDL
DRAWN:	RDL
CHECKED:	RDL

DATE 04/05/19

#	REVISION	DATE
	SUBD APP	01/14/19
	SUBD APP 2	01/17/19
	CNTY REV. 1	04/05/19

JOB NO: 167392

SHEET NO. EXHIBIT 05 of 05

Markup Summary

Daniel Torres (19)

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s remain the

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a 2.17 ac
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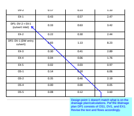
2.17



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Author: Daniel Torres
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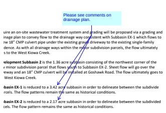
Design point 1 doesn't match what is on the drainage plan/calculations. Per the drainage plan DP1 consists of OS1, DV1, and EX1. Revise the text and flows accordingly.



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Author: Daniel Torres
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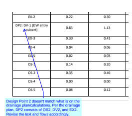
Please see comments on drainage plan.



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Design Point 2 doesn't match what is on the drainage plan/calculations. Per the drainage plan, DP2 consists of OS2, DV2, and EX2. Revise the text and flows accordingly.

EX-1
DP1: DV-2 + EX-1
(culvert inlet)
EX-2

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Author: Daniel Torres
Date: 5/3/2019 9:10:54 AM
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DP1: DV-2 + EX-1
(culvert inlet)

0.33

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Author: Daniel Torres
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0.33

0.63

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3.42

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Date: 5/3/2019 9:11:00 AM
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EX-2
DP2: DV-1 (DW entry culvert)
EX-3

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Author: Daniel Torres
Date: 5/3/2019 9:11:01 AM
Color:

DP2: DV-1 (DW entry culvert)

1.13

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Author: Daniel Torres
Date: 5/3/2019 9:11:02 AM
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1.13

0.83

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Author: Daniel Torres
Date: 5/3/2019 9:11:02 AM
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0.83

8.23

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Author: Daniel Torres
Date: 5/3/2019 9:11:04 AM
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8.23

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n sheet flow to the West Kiowa
r a 10-year storm event, and
ounts for 1.02 cfs for a 5-year
or a 100-year storm event.

Please include DP3 in the post-developed flows table.

r	100-Year
	2.75

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Author: Daniel Torres
Date: 5/3/2019 9:11:05 AM
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Please include DP3 in the post-developed flows table.

---

d culvert pipe that crosses the existing
ed properly for the post-development

Please show and label on the drainage plan

cel and within the drainage basin as a whole
d southeast to the West Kiowa Creek. The
with historical drainage patterns by
g channelized storm water flow via level
ngineering calculations provided in Appendix
ion and sediment runoff by implementing
m flow outlets via rip-rap of D_{50} = 6" and
f the proposed development. Culvert, level
d in the Appendix.

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Author: Daniel Torres
Date: 5/3/2019 9:11:06 AM
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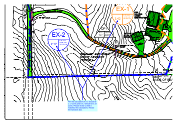
Please show and label on the drainage plan



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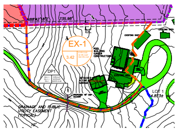
Per the calculations EX-1 should be 2.17 acres and EX-2 should be 3.42 acres. Please revise so that it matches the calculations. Revise the narrative also.



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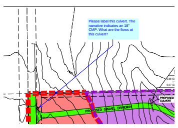
94,483.88 sf



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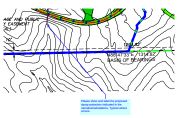
Please label this culvert. The narrative indicates an 18" CMP. What are the flows at this culvert?



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Please show and label the proposed riprap protection indicated in the narrative/calculations. Typical where occurs.