FINAL DRAINAGE REPORT

for

PETERSON'S REPLAT

Prepared for:

Hannigan and Associates, Inc.
19360 Spring Valley Road
Monument, CO 80132

May 4, 2020
Revised October 10, 2022

Prepared by:

JPS ENGINEERING

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JPS Project No. 051903
PCD File No.: VR-226

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FINAL DRAINAGE REPORT
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DRAINAGE STATEMENT

Engineer's Statement:

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

COLORADO REGISTERED
29891
PROFESSIONAL ENGINEER

10/10/22

John P. Schwab, P.E. #29891

Developer's Statement:

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

By: 10 OCT 22

Printed Name: Brian Peterson, Owner — Date

17390 Shiloh Pines Drive, Monument, CO 80132

El Paso County's Statement

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

APPROVED
Engineering Department
11/02/2022 1:24:08 PM
dsdnijkamp
EPC Planning & Community
Development Department

Joshua Palmer, P.E. — Date

County Engineer / ECM Administrator

Conditions:

I. GENERAL LOCATION AND DESCRIPTION

A. Background

Peterson's Replat is a proposed rural residential minor subdivision located in the Palmer Lake area of northern El Paso County, Colorado. The replat will create one new residential lot northwest of the existing Lots 27 and 28, Block 1, Shiloh Pines Subdivision. The new 3.97-acre lot will be created from a portion of the existing 74.5-acre unplatted tract owned by Mr. Tom Puskas (El Paso County Assessor's Number 71000-00-413). The existing Lots 27 and 28, Shiloh Pines Subdivision, will be included in the replat, with side lot lines adjusted to provide a "flag-stem" access to the newly created lot.

The new lot will be created on the north side of the existing Lot 28, with a "flag-stem" extending along the side lot line of the replatted Lots 1 and 3 (former Lots 27 and 28) to provide access from the new Lot 2 to Shiloh Pines Drive. Access to each of the replatted lots will be provided by individual driveway connections to Shiloh Pines Drive.

B. Scope

This report will provide a summary of site drainage issues impacting the proposed residential development. The report will analyze upstream drainage patterns, site-specific developed drainage patterns, and impacts on downstream facilities. This report is based on the guidelines and criteria presented in the El Paso County Drainage Criteria Manual, and the report is intended to fulfill the requirements for a "Final Drainage Report" in support of the Final Plat process for this property.

C. Site Location and Description

Peterson's Replat is located in Sections 15 and 16, Township 11 South, Range 67 West of the 6th Principal Meridian. The site of the new lot is currently a vacant, forested area. The Shiloh Pines Subdivision is zoned RR-2.5 (rural residential; 2.5-acre minimum lot sizes). The Puskas property is currently zoned RR-5 (rural residential), allowing for 5-acre minimum lot sizes. The proposed replat will also include processing of a re-zoning of the replatted area within the Puskas parcel to RR-2.5, matching the zoning of the adjoining Shiloh Pines Subdivision to the south.

The proposed replat site is bordered by rural residential properties on all sides. The existing unplatted Puskas property (Zoned RR-5) adjoins the north and east boundaries of the property. The existing Shiloh Ranch Subdivision (Zoned RR-2.5) adjoins the south boundary of the property, and the existing Sundance Estates Subdivision (Zoned RR-2.5) adjoins the west boundary of the property.

The site is located within the Raspberry Mountain Drainage Basin, and the main channel of Monument Creek flows across the east side of the Puskas property. The terrain is rolling with average grades ranging from 2 to 6 percent. Ground elevations within the site range from approximately 7,030 above mean sea level at the southwest corner of the site down to approximately 6,980 at the eastern property boundary.

D. General Soil Conditions

According to the Custom Soil Resource Report for this site (see details in Appendix A) provided by the Natural Resources Conservation Service (NRCS), on-site soils are comprised of "Type 40-41: Kettle gravelly loamy sand." These soils are classified as hydrologic soils group "B" (moderate infiltration rate).

E. References

Abbott & Jacobsen Engineering Services, "Drainage Report for Shiloh Pines Subdivision," April 5, 1979.

City of Colorado Springs & El Paso County "Drainage Criteria Manual," revised October 12, 1994.

City of Colorado Springs & El Paso County "Drainage Criteria Manual, Volumes 1 and 2," revised May, 2014.

El Paso County "Engineering Criteria Manual," revised December 13, 2016.

FEMA, Flood Insurance Rate Map (FIRM) Number 08041C0257G, December 7, 2018.

II. DRAINAGE BASINS AND SUB-BASINS

A. Major Basin Description

The proposed development lies within the Raspberry Mountain Drainage Basin (FOM 05600) as classified by El Paso County. Drainage from this site flows easterly to existing natural drainage swales draining into the main channel of Monument Creek upstream of Monument Lake.

B. Floodplain Impacts

The main channel of Monument Creek flows southeasterly across the east side of the Puskas property, downstream of the proposed replat site. The 100-year floodplain limits in the vicinity of the site are shown in FEMA Flood Insurance Rate Map (FIRM) Number 08041C0257G, dated December 7, 2018, as depicted in Figure FP1 (Appendix C). According to the FEMA Flood Insurance Study (FIS), the 100-year flow in the main channel of Monument Creek at this location (Section CT) is calculated as approximately 13,944 cfs. The proposed replat area is not impacted by FEMA floodplain limits.

C. Sub-Basin Description

The existing drainage basins lying in and around the proposed development are depicted on Figure EX1 (Appendix C). The proposed replat property has been delineated as a single drainage basin (Basin A), flowing northeasterly towards the Monument Creek channel.
The site is impacted by an off-site area adjoining the property to the southwest (Basin OA2) which flows northeasterly into Basin A.

The balance of the Puskas property has been delineated as Basin OA1, which sheet flows into the Monument Creek channel.

Developed runoff in this minor subdivision will generally continue to follow historic paths.

III. DRAINAGE DESIGN CRITERIA

A. Development Criteria Reference

A report entitled "Drainage Report for Shiloh Pines Subdivision" by Abbott & Jacobsen Engineering Services" dated April 5, 1979 was found on file. This report generally identifies developed flows from the Shiloh Pines Subdivision as sheet flowing easterly to natural swales draining into Monument Creek and Monument Lake.

B. Hydrologic Criteria

The tributary drainage basins impacting this site are all less than 100 acres, so Rational Method Hydrology procedures were utilized for calculation of peak flows. Rational Method hydrologic calculations were based on the following assumptions:

• Design storm (minor)	5-year	
• Design storm (major)	100-year	
• Rainfall Intensities	El Paso County I-D-F Curve	
• Hydrologic soil type	B	
	C5	C100
• Runoff Coefficients - undeveloped:		
Existing meadow/forest areas	0.08	0.35
• Runoff Coefficients - developed:		
Existing / Proposed lot areas (2.5-acre lots)	0.170	0.417
Proposed lot area (4-acre lot)	0.152	0.403

(see composite runoff coefficient calculations in Appendix B)

Hydrologic calculations are enclosed in Appendix B, and peak design flows are identified on the drainage plan drawings.

IV. DRAINAGE PLANNING FOUR STEP PROCESS

El Paso County Drainage Criteria require drainage planning to include a Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls.
As stated in DCM Volume 2, the Four Step Process is applicable to all new and re-development projects with construction activities that disturb 1 acre or greater or that disturb less than 1 acre but are part of a larger common plan of development. The Four Step Process has been implemented as follows in the planning of this project:

Step 1: Employ Runoff Reduction Practices

- Minimize Impacts: The proposed rural residential subdivision is an inherently low impact development. The proposed 4-acre lot size for the newly created lot will minimize drainage impacts in comparison to higher density development alternatives.

Step 2: Stabilize Drainageways

- There are no major drainageways within the replat site. There is a significant vegetated buffer area between the replat site and the downstream drainage channel.
- Drainage basin fees will be paid at the time of recording of the subdivision plat, and these fees provide the applicable cost contribution towards regional drainage improvements.

Step 3: Provide Water Quality Capture Volume (WQCV)

- Water quality detention is not required based on the rural residential development proposed (5-acre minimum lot sizes).

Step 4: Consider Need for Industrial and Commercial BMPs

- No industrial or commercial land uses are proposed as part of this development.

V. GENERAL DRAINAGE RECOMMENDATIONS

The developed drainage plan for the site is to provide and maintain positive drainage away from structures and conform to the established drainage patterns for the overall site. JPS Engineering recommends that positive drainage be established and maintained away from all structures within the site in conformance with applicable building codes and geotechnical engineering recommendations.

Site grading and drainage improvements performed as a part of subdivision infrastructure development includes overlot grading and subdivision drainage improvements depicted on the subdivision construction drawings. Individual lot grading is the sole responsibility of the individual builders and property owners. Final grading of each home site should establish proper protective slopes and positive drainage in accordance with HUD guidelines and building codes. In general, main floor elevations for each home should be established a minimum of 2 feet above the top of curb of the adjoining street.

In general, we recommend a minimum of 6 inches clearance from the top of concrete foundation walls to adjacent finished site grades. Positive drainage slopes should be maintained away from all structures, with a minimum recommended slope of 5 percent for the first 10 feet away from buildings in landscaped areas, a minimum recommended slope of 2 percent for the first 10 feet away from buildings in paved areas, and a minimum slope of 1 percent for paved areas beyond buildings.

VI. DRAINAGE FACILITY DESIGN

A. General Concept

Development of the proposed subdivision replat will not require any public improvements, as access to the new lot will be provided by a private access drive connection to Shiloh Pines Drive. The general concept for management of developed storm runoff is to establish site grading to provide positive drainage away from the building pads and divert runoff to drainage swales following historic drainage patterns.

B. Specific Details

1. Existing Drainage Conditions

Historic drainage conditions are depicted on Figure EX1 (Appendix C). The proposed replatted home site is currently a vacant, forested area, and the balance of the replatted area is comprised of two existing 2.5-acre home sites. There are no existing drainage facilities within the property. There are no existing irrigation facilities, major utilities, or significant encumbrances impacting the site.

Drainage from the replat property (Basin A) sheet flows northeasterly to an existing drainage swale at the eastern subdivision boundary. Historic peak flows from Basin A are calculated as Q_5 = 3.8 cfs and Q_{100} = 18.9 cfs. Off-site drainage from Basin OA2 flows northeasterly into an existing drainage swale which flows east across Basin A. Historic peak flows from Basin OA2 are calculated as Q_5 = 0.9 cfs and Q_{100} = 6.6 cfs. Flows from Basins OA2 and A combine at Design Point #A1, with historic peak flows calculated as Q_5 = 4.6 cfs and Q_{100} = 24.9 cfs.

The balance of the Puskas property has been delineated as Basin OA1, which sheet flows to the Monument Creek channel. Flows from Basins OA2, A, and OA1 combine at Design Point #1, with historic peak flows calculated as Q_5 = 22.3 cfs and Q_{100} = 149.0 cfs.

2. Developed Drainage Conditions

The developed drainage basins and projected flows are shown on the Developed Drainage Plan (Figure D1, Appendix C).

Developed flows from Basin A will continue to sheet flow northeasterly to Design Point #A1, with developed peak flows calculated as Q_5 = 4.8 cfs and Q_{100} = 20.3 cfs. Off-site drainage from Basin OA2 will continue to combine with Basin A at Design Point #A1, with developed peak flows calculated as Q_5 = 5.6 cfs and Q_{100} = 26.4 cfs.

A proposed drainage easement has been delineated along the existing drainage swale flowing east in the southeast corner of Lot 2 (based on the channel hydraulic calculations in Appendix B).

Flows from Basins OA2, A, and OA1 will continue to combine at Design Point #1, with developed peak flows calculated as Q_5 = 23.6 cfs and Q_{100} = 151.5 cfs.

As previously noted, 100-year flows in the main channel of Monument Creek at this site are approximately 14,000 cfs, so the small increase in developed flow at Design Point #1 will be negligible in comparison to flows in the main channel of Monument Creek at this location.

C. Comparison of Developed to Historic Discharges

Based on the hydrologic calculations in Appendix B, the comparison of developed to historic discharges at key design points is summarized as follows:

Design Point	Historic Flow			Developed Flow			Comparison of Developed to Historic Flow
	Area (ac)	Q_5 (cfs)	Q_{100} (cfs)	Area (ac)	Q_5 (cfs)	Q_{100} (cfs)	
1	82.7	22.3	149.0	82.7	23.6	151.5	+1.3 cfs / +2.5 cfs (increase)

With proper site drainage and erosion control measures within the site, the proposed rural residential minor subdivision will not have any significant developed drainage impact.

D. On-Site Drainage Facility Design

Developed drainage basins and drainage patterns are depicted on the enclosed Developed Drainage Plan (Sheet D1). No public drainage improvements are required for this minor subdivision.

E. Analysis of Existing and Proposed Downstream Facilities

The proposed replat area will drain easterly to existing natural drainage swales flowing to Monument Creek. Development of this property as a rural residential subdivision will have no significant impact on downstream drainage facilities.

F. Anticipated Drainage Problems and Solutions

The drainage plan for this minor subdivision consists of maintaining positive drainage away from home sites, and conveying surface drainage through the site in general conformance with historic drainage patterns. The primary drainage problems anticipated within this type of development consist of maintenance of proper drainage patterns and erosion control.

Care will need to be taken to implement proper erosion control measures associated with the proposed driveways, home sites, and drainage swales. Proposed drainage facilities outside the public right-of-way will be owned and maintained by the individual lot owners unless otherwise noted.

VII. EROSION CONTROL / SEDIMENT CONTROL

Contractors and Owners will need to implement and maintain proper Best Management Practices (BMP's) for erosion and sediment control during and after construction. Erosion control measures should include installation of silt fence at the toe of disturbed areas, sediment control logs protecting drainage ditches, vehicle tracking control pads at access points, riprap protection at culvert outlets, and revegetation of disturbed areas. Cut slopes will need to be stabilized during excavation as necessary and vegetation will need to be re-established as soon as possible for stabilization of graded areas.

VIII. STORMWATER DETENTION AND WATER QUALITY

As previously stated, the proposed development will result in a minimal increase in developed flows based on the rural residential development plan, and the increase in flow will be negligible in comparison to flows in the main channel of Monument Creek. As such, there is no need for on-site stormwater detention based on the minimal developed drainage impact.

Water quality facilities are not required as this site meets exclusions listed in the revised El Paso County Engineering Criteria Manual (ECM). Section I.7.1.B.5 of the ECM identifies "Large Lot Single Family Sites" as excluded sites under the following definition: "A single-family residential lot, or agricultural zoned lands, greater than or equal to 2.5 acres in size per dwelling and having a total lot impervious area of less than 10 percent." The proposed subdivision replat will create a single new lot with a size of 4-acres, and the proposed impervious area has been calculated as 8.75 percent, which is below the "10 percent" threshold.

IX. COST ESTIMATE AND DRAINAGE FEES

The developer will finance all costs for proposed subdivision improvements, and there are no public facilities proposed as part of this subdivision replat.

The property is located entirely within the Raspberry Mountain Drainage Basin (FOM 05600), which has a 2022 drainage basin fee of $4,927 per impervious acre and no bridge fee. Applicable drainage basin fees are summarized as follows:

Newly replatted residential area (Proposed Lot 2) = 3.96 acres
Percent impervious = 8.75% (presumptive value for 4-acre lot)
Calculated Impervious area = 0.35 ac.
Adjusted Impervious area = (0.35 ac) * 75% = 0.2625 ac.
(includes 25% reduction on drainage fees for 2.5 to 5-acre lots)
Drainage Basin Fee = (0.2625 ac.) @ $4,927 ac. = <u>$1,293.34</u>

Bridge Fee = <u>$0</u>

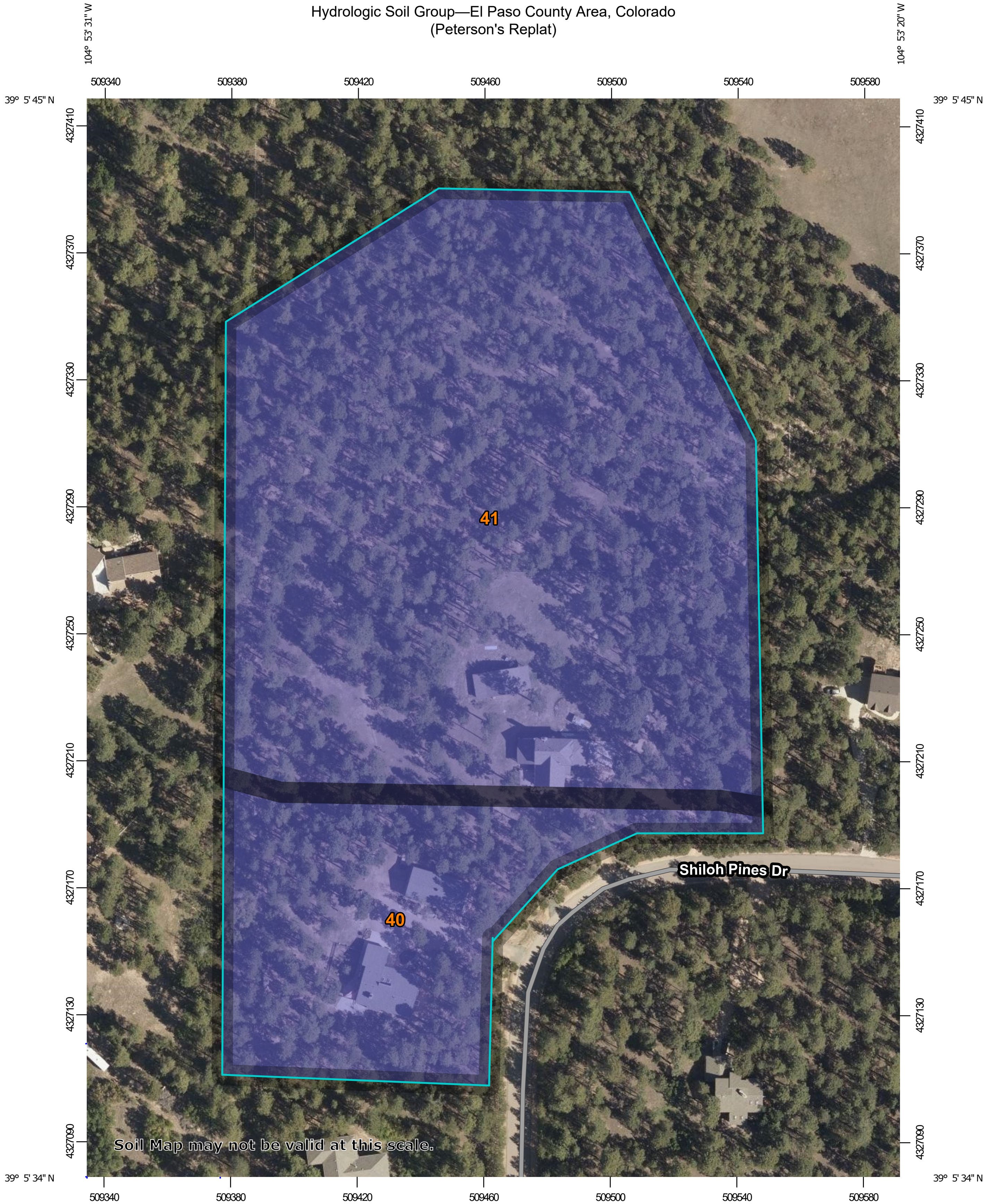
X. SUMMARY

Peterson's Replat is a proposed rural residential subdivision consisting of 3 lots on a 9-acre site, resulting in creation of one new 4-acre residential lot. Development of the proposed subdivision is anticipated to result in a negligible increase in developed runoff from the site, and erosion control best management practices will be implemented to mitigate developed drainage impacts. The proposed drainage patterns will remain consistent with historic conditions. Implementation and maintenance of proper erosion control measures will ensure that this subdivision replat has no significant adverse drainage impact on downstream properties or drainage facilities.

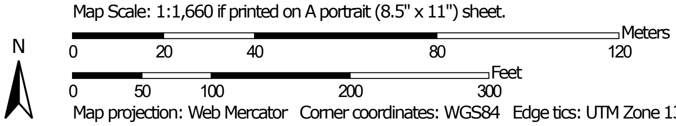
APPENDIX A

SOILS INFORMATION

Hydrologic Soil Group—El Paso County Area, Colorado
(Peterson's Replat)



Map Scale: 1:1,660 if printed on A portrait (8.5" 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

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

Soil Rating Lines

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

Soil Rating Points

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

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 17, Sep 13, 2019

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	B	2.3	24.1%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	B	7.2	75.9%
Totals for Area of Interest			**9.5**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

United States Department of Agriculture

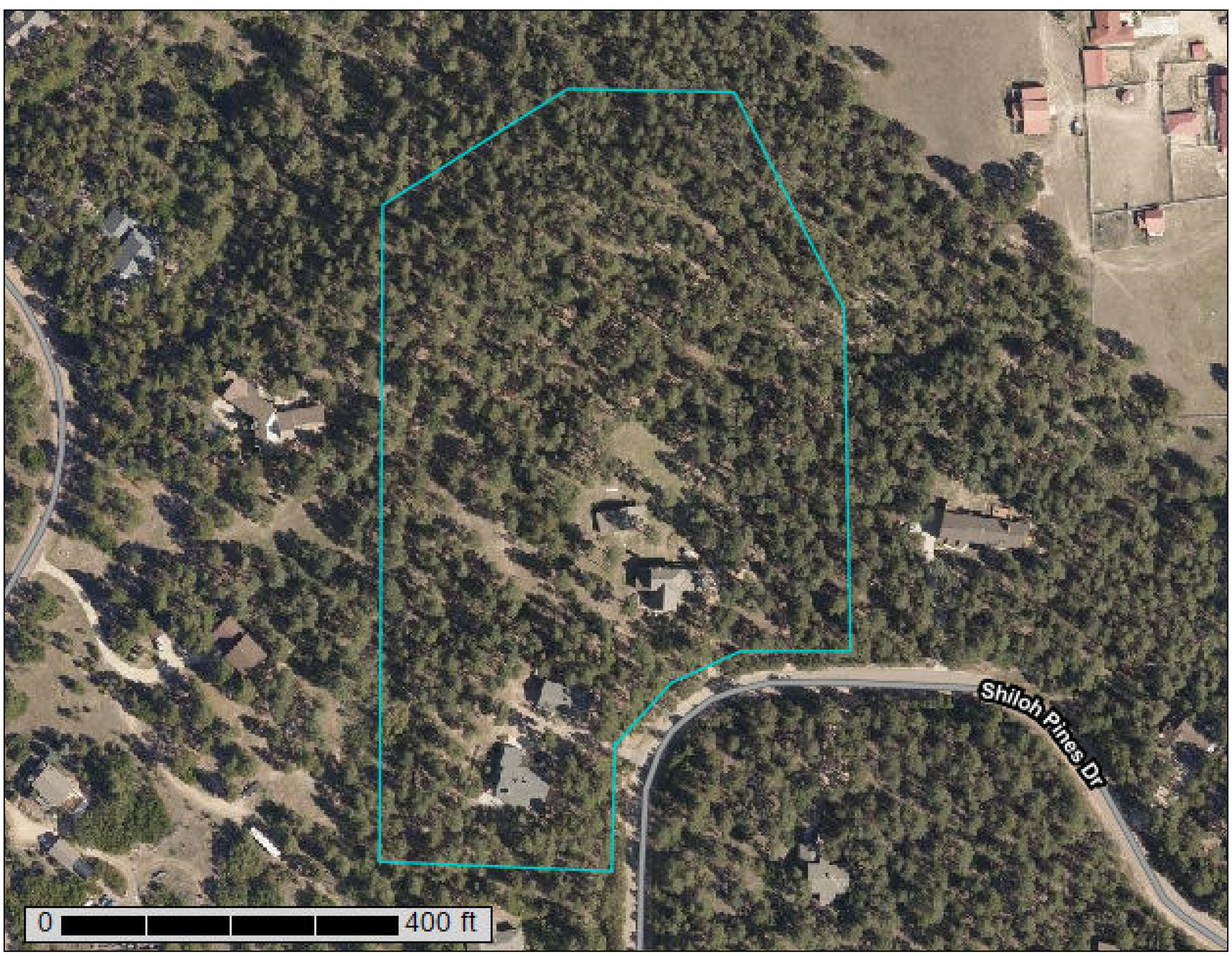
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

El Paso County Area, Colorado



February 20, 2020

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

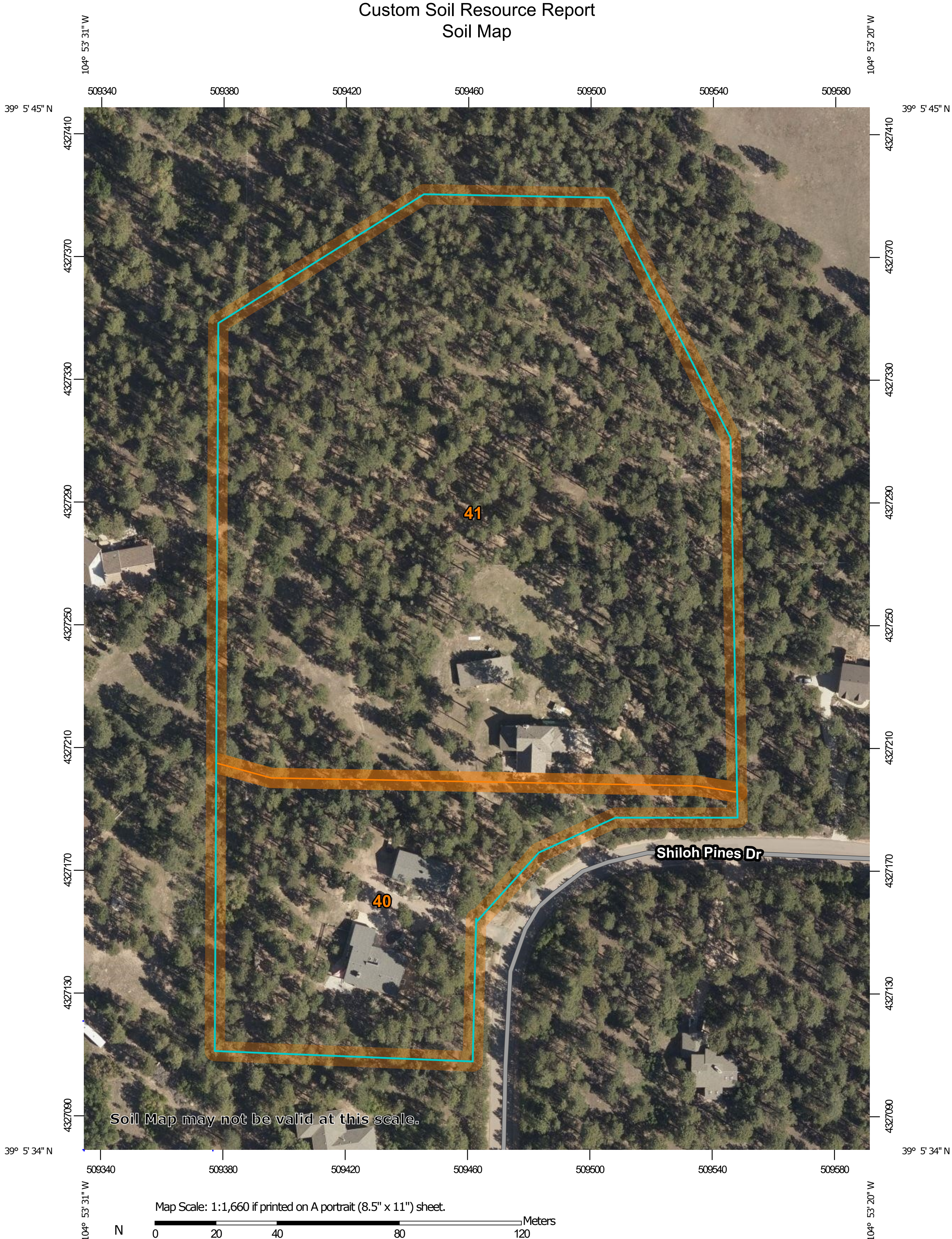
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:1,660 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 20, 40, 80, 120

Feet: 0, 50, 100, 200, 300

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 17, Sep 13, 2019

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	2.3	24.1%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	7.2	75.9%
Totals for Area of Interest		**9.5**	**100.0%**

Map Unit Descriptions

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

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

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

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

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

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

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

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

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

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

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

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

El Paso County Area, Colorado

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

Map Unit Setting

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

Map Unit Composition

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

Description of Kettle

Setting

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

Typical profile

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

Properties and qualities

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

Interpretive groups

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

Minor Components

Pleasant

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

Other soils

Percent of map unit:
Hydric soil rating: No

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

Map Unit Setting

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

Map Unit Composition

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

Description of Kettle

Setting

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

Typical profile

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

Properties and qualities

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

Interpretive groups

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

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:

Landform: Depressions
Hydric soil rating: Yes

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

APPENDIX B

DRAINAGE CALCULATIONS

Table 6-6. Runoff Coefficients for Rational Method

(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis-- Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

$$t_c = t_i + t_t \quad \text{(Eq. 6-7)}$$

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

t_t = travel time in the ditch, channel, gutter, storm sewer, etc. (min)

3.2.1 Overland (Initial) Flow Time

The overland flow time, t_i, may be calculated using Equation 6-8.

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

* For buried riprap, select C_v value based on type of vegetative cover.

The travel time is calculated by dividing the flow distance (in feet) by the velocity calculated using Equation 6-9 and converting units to minutes.

The time of concentration (t_c) is then the sum of the overland flow time (t_i) and the travel time (t_t) per Equation 6-7.

3.2.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (typically the first inlet in the system) in an urbanized catchment should not exceed the time of concentration calculated using Equation 6-10. The first design point is defined as the point where runoff first enters the storm sewer system.

$$t_c = \frac{L}{180} + 10 \qquad \text{(Eq. 6-10)}$$

Where:

t_c = maximum time of concentration at the first design point in an urban watershed (min)

L = waterway length (ft)

Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional "calibration" of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

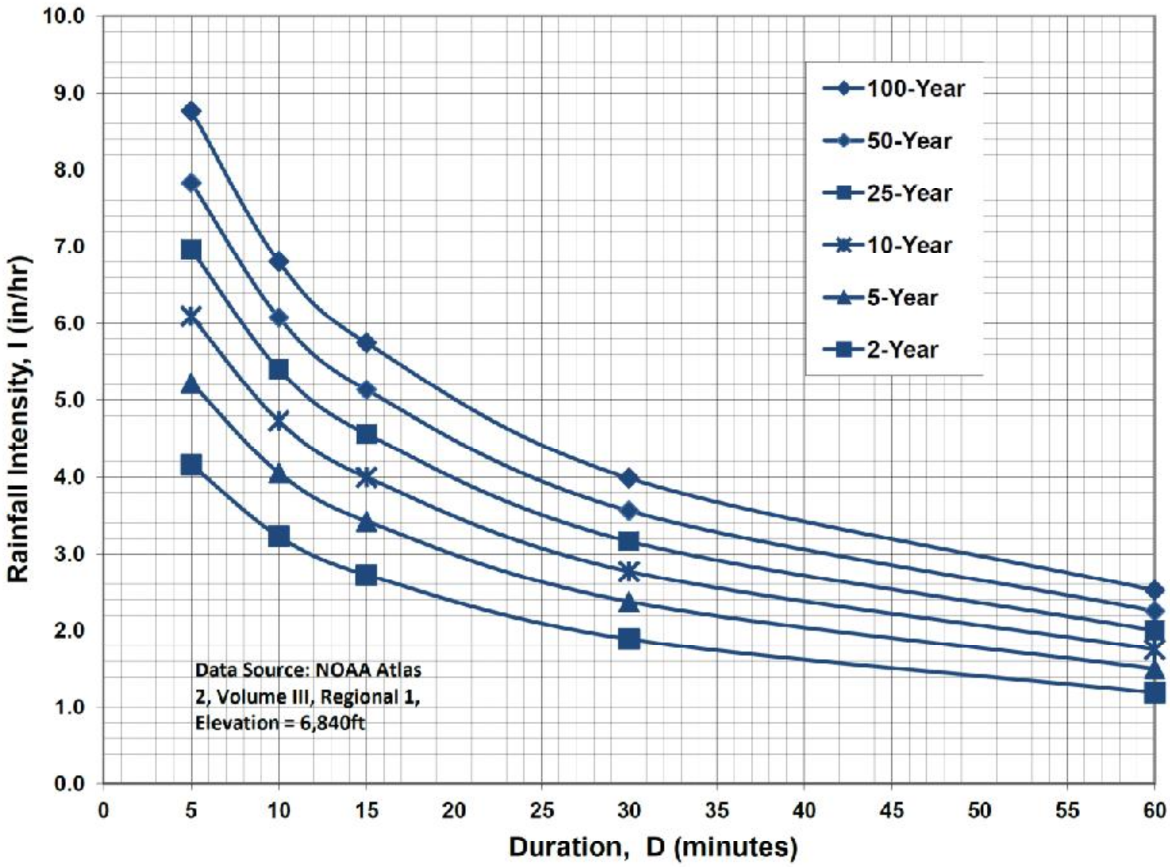
3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

3.2.5 Post-Development Time of Concentration

As Equation 6-8 indicates, the time of concentration is a function of the 5-year runoff coefficient for a drainage basin. Typically, higher levels of imperviousness (higher 5-year runoff coefficients) correspond to shorter times of concentration, and lower levels of imperviousness correspond to longer times of

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

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

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

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

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

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

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

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

PETERSON'S REPLAT
COMPOSITE RUNOFF COEFFICIENTS - TYPICAL RURAL RESIDENTIAL LOTS

DEVELOPED CONDITIONS

5-YEAR C VALUES

BASIN	TOTAL AREA (AC)	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
2.5-ACRE LOTS	2.50	11.00	BUILDING / PAVEMENT	0.90	89.00	MEADOW/FOREST	0.08				0.170
4-ACRE LOT	4.00	8.75	BUILDING / PAVEMENT	0.90	91.25	MEADOW/FOREST	0.08				0.152

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
2.5-ACRE LOTS	2.50	11.00	BUILDING / PAVEMENT	0.96	89.00	MEADOW/FOREST	0.35				0.417
4-ACRE LOT	4.00	8.75	BUILDING / PAVEMENT	0.96	91.25	MEADOW/FOREST	0.35				0.403

IMPERVIOUS AREAS

BASIN	TOTAL AREA (AC)	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
2.5-ACRE LOTS	2.50	11.00	BUILDING / PAVEMENT	100.00	89.00	MEADOW/FOREST	0				11.000
4-ACRE LOT	4.00	8.75	BUILDING / PAVEMENT	100	91.25	MEADOW/FOREST	0				8.750

PETERSON'S REPLAT
COMPOSITE RUNOFF COEFFICIENTS

HISTORIC CONDITIONS

5-YEAR C-VALUES

BASIN	TOTAL AREA (AC)	AREA (AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA2	3.20	3.20	MEADOW/FOREST	0.08							0.080
A	9.00	5.00	2.5-AC LOTS	0.170	4.00	MEADOW/FOREST	0.08				0.130
OA2,A	12.20										0.117
OA1	70.50	0.50	BUILDING / PAVEMENT	0.900	70.00	MEADOW/FOREST	0.08				0.086
OA2,A,OA1	82.70										0.090

100-YEAR C-VALUES

BASIN	TOTAL AREA (AC)	AREA (AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA2	3.20	3.20	MEADOW/FOREST	0.35							0.350
A	9.00	5.00	2.5-AC LOTS	0.417	4.00	MEADOW/FOREST	0.35				0.387
OA2,A	12.20										0.377
OA1	70.50	0.50	BUILDING / PAVEMENT	0.960	70.00	MEADOW/FOREST	0.35				0.354
OA2,A,OA1	82.70										0.358

DEVELOPED CONDITIONS

5-YEAR C-VALUES

BASIN	TOTAL AREA (AC)	AREA (AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA2	3.20	3.20	MEADOW/FOREST	0.08							0.080
A	9.00	5.00	2.5-AC LOTS	0.170	4.00	4-AC LOT	0.152				0.162
OA2,A	12.20										0.140
OA1	70.50	0.50	BUILDING / PAVEMENT	0.900	70.00	MEADOW/FOREST	0.08				0.086
OA2,A,OA1	82.70										0.094

100-YEAR C-VALUES

BASIN	TOTAL AREA (AC)	AREA (AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA2	3.20	3.20	MEADOW/FOREST	0.35							0.350
A	9.00	5.00	2.5-AC LOTS	0.417	4.00	4-AC LOT	0.403				0.411
OA2,A	12.20										0.395
OA1	70.50	0.50	BUILDING / PAVEMENT	0.960	70.00	MEADOW/FOREST	0.35				0.354
OA2,A,OA1	82.70										0.360

PETERSON'S REPLAT
RATIONAL METHOD

HISTORIC FLOWS

BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR(7)	C 100-YEAR (7)	Overland Flow LENGTH (FT)	Overland Flow SLOPE (FT/FT)	Overland Flow Tco (1) (MIN)	Channel flow CHANNEL LENGTH (FT)	Channel flow CONVEYANCE COEFFICIENT C	Channel flow SLOPE (FT/FT)	Channel flow SCS (2) VELOCITY (FT/S)	Channel flow Tt (3) (MIN)	TOTAL Tc (4) (MIN)	TOTAL Tc (4) (MIN)	INTENSITY (5) 5-YR (IN/HR)	INTENSITY (5) 100-YR (IN/HR)	PEAK FLOW Q5 (6) (CFS)	PEAK FLOW Q100 (6) (CFS)
OA2	OA2	3.20	0.080	0.350	100	0.04	11.8	620	15	0.042	3.07	3.4	15.1	15.1	3.51	5.89	0.90	6.60
A	A	9.00	0.130	0.387	100	0.020	14.1	880	15	0.055	3.52	4.2	18.3	18.3	3.23	5.41	3.77	18.86
OA2,A	A1	12.20	0.117	0.377									18.3	18.3	3.23	5.41	4.60	24.90
OA1		70.50	0.086	0.354			0.0	900	15	0.113	5.04	3.0						
OA2,A,OA1	1	82.70	0.090	0.358									21.2	21.2	3.00	5.03	22.32	149.04

DEVELOPED FLOWS

BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR(7)	C 100-YEAR (7)	Overland Flow LENGTH (FT)	Overland Flow SLOPE (FT/FT)	Overland Flow Tco (1) (MIN)	Channel flow CHANNEL LENGTH (FT)	Channel flow CONVEYANCE COEFFICIENT C	Channel flow SLOPE (FT/FT)	Channel flow SCS (2) VELOCITY (FT/S)	Channel flow Tt (3) (MIN)	TOTAL Tc (4) (MIN)	TOTAL Tc (4) (MIN)	INTENSITY (5) 5-YR (IN/HR)	INTENSITY (5) 100-YR (IN/HR)	PEAK FLOW Q5 (6) (CFS)	PEAK FLOW Q100 (6) (CFS)
OA2	OA2	3.20	0.080	0.350	100	0.04	11.8	620	15	0.042	3.07	3.4	15.1	15.1	3.51	5.89	0.90	6.60
A	A	9.00	0.162	0.411	100	0.020	13.6	880	15	0.055	3.52	4.2	17.8	17.8	3.26	5.48	4.76	20.27
OA2,A	A1	12.20	0.140	0.395									17.8	17.8	3.26	5.48	5.58	26.40
OA1		70.50	0.086	0.354			0.0	900	15	0.113	5.04	3.0						
OA2,A,OA1	1	82.70	0.094	0.360									20.8	20.8	3.03	5.09	23.57	151.53

1) OVERLAND FLOW Tco = (0.395*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))
2) SCS VELOCITY = C * ((SLOPE(FT/FT)^0.5)
C = 2.5 FOR HEAVY MEADOW
C = 5 FOR TILLAGE/FIELD
C = 7 FOR SHORT PASTURE AND LAWNS
C = 10 FOR NEARLY BARE GROUND
C = 15 FOR GRASSED WATERWAY
C = 20 FOR PAVED AREAS AND SHALLOW PAVED SWALES

3) MANNING'S CHANNEL TRAVEL TIME = L/V (WHEN CHANNEL VELOCITY IS KNOWN)
4) Tc = Tco + Tt
*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED
5) INTENSITY BASED ON I-D-F EQUATIONS IN CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL
I_5 = -1.5 * ln(Tc) + 7.583
I_{100} = -2.52 * ln(Tc) + 12.735
6) Q = CiA

PETERSON'S REPLAT
CHANNEL CALCULATIONS
DEVELOPED FLOWS

DRAINAGE CHANNELS

CHANNEL	SLOPE (%)	BOTTOM WIDTH (B, FT)	SIDE SLOPE (Z)	MIN. DEPTH (FT)	FRICTION FACTOR (n)	DP	Q100 FLOW (CFS)	Q100 DEPTH (FT)	Q100 VELOCITY (FT/S)	TOP WIDTH (FT)	PROPOSED EASEMENT WIDTH (FT)	CHANNEL LINING
A1	0.068	2	4	2.0	0.030	A1	26.4	0.7	7.5	7.8	**30**	GRASS

Hydraulic Analysis Report

Project Data

Project Title: Project - Peterson's Replat
Designer: JPS
Project Date: Sunday, October 9, 2022
Project Units: U.S. Customary Units
Notes:

Channel Analysis: Channel Analysis - Channel A1

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 4.0000 ft/ft
Channel Width: 2.0000 ft
Longitudinal Slope: 0.0680 ft/ft
Manning's n: 0.0300
Flow: 26.4000 cfs

Result Parameters

Depth: 0.7206 ft
Area of Flow: 3.5179 ft^2
Wetted Perimeter: 7.9419 ft
Hydraulic Radius: 0.4430 ft
Average Velocity: 7.5044 ft/s
Top Width: 7.7645 ft
Froude Number: 1.9647
Critical Depth: 1.0005 ft
Critical Velocity: 4.3963 ft/s
Critical Slope: 0.0161 ft/ft
Critical Top Width: 10.00 ft
Calculated Max Shear Stress: 3.0575 lb/ft^2
Calculated Avg Shear Stress: 1.8796 lb/ft^2

APPENDIX C

FIGURES

National Flood Hazard Layer FIRMette

FEMA

39°5'54.18"N

104°53'46.33"W

104°53'8.87"W

39°5'26.25"N

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

1:6,000

Legend

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

SPECIAL FLOOD HAZARD AREAS

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

OTHER AREAS OF FLOOD HAZARD

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

OTHER AREAS

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

GENERAL STRUCTURES

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

OTHER FEATURES

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

MAP PANELS

- Digital Data Available
- No Digital Data Available
- Unmapped

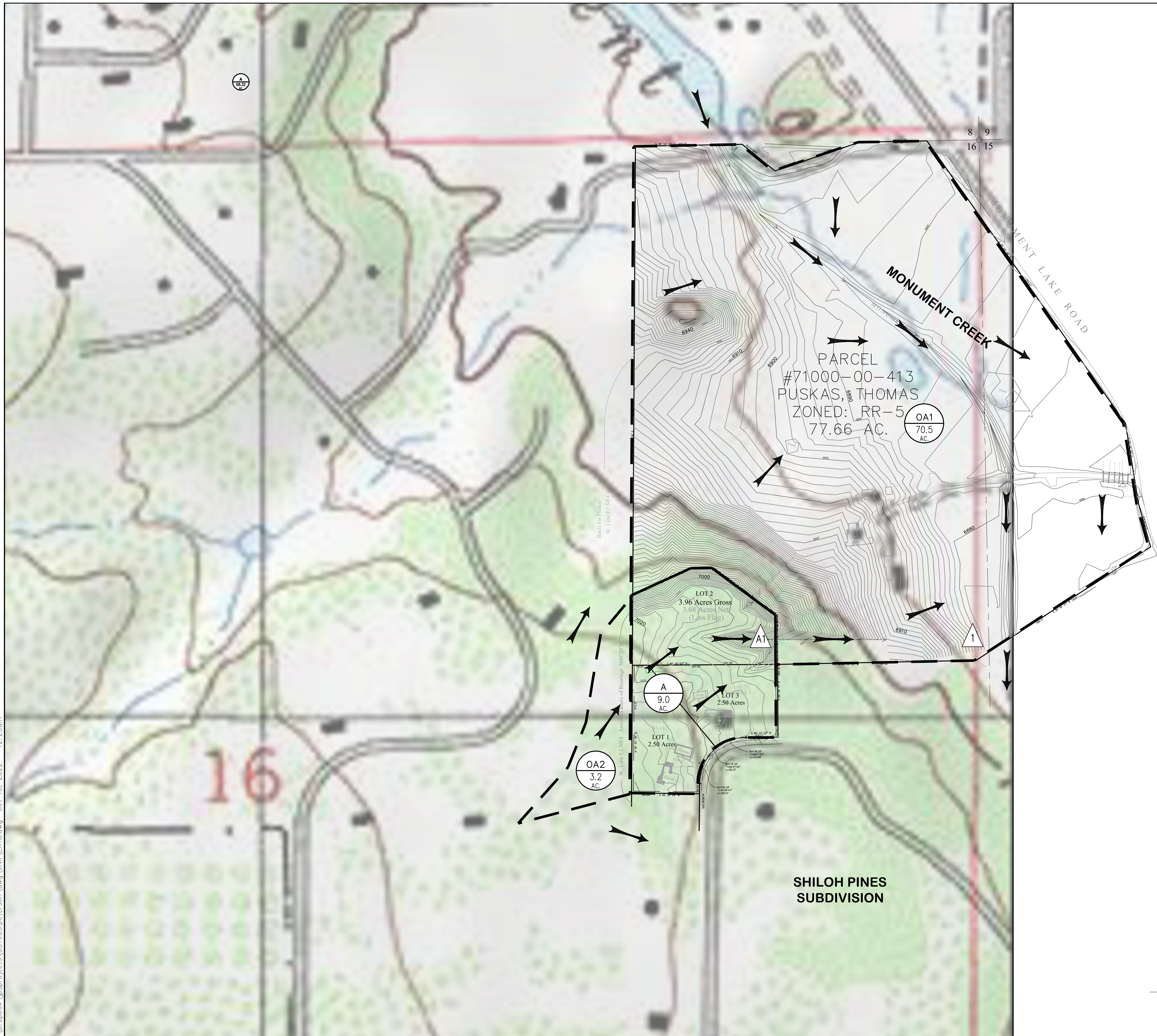
N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 2/20/2020 at 3:31:26 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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



HYDROLOGY SUMMARY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
A1	4.6	24.9
1	22.3	149.0

DRAINAGE LEGEND

- RIPRAP
- FLOW DIRECTION ARROW
- FLOWLINE
- DRAINAGE BASIN BOUNDARY
- DEVELOPED BASIN DESIGNATION (C14)
- DEVELOPED BASIN AREA (ACRES) (23.21 AC.)
- DESIGN POINT (1)
- Q_5 (cfs) (20.6)
- Q_{100}(cfs) (DEVELOPED FLOW) (50.3)

N

200 0 200 400

Original Scale: 1"=200'
Contour Interval = 40 ft.

JPS ENGINEERING
19 E. Willamette Ave.
Colorado Springs, CO 80903
PH: 719-477-9429
FAX: 719-471-0766

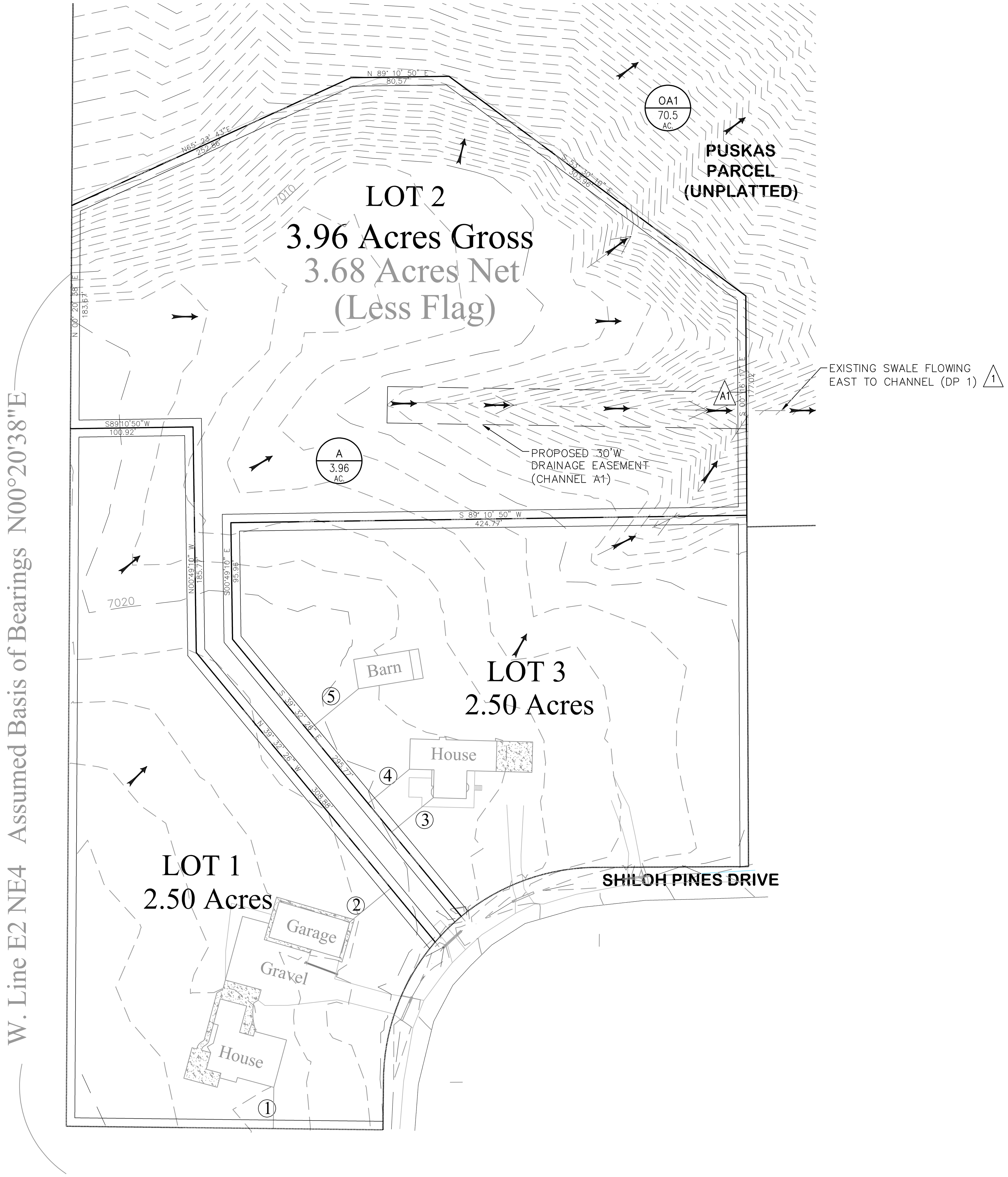
PETERSON'S REPLAT

HISTORIC DRAINAGE PLAN

No.	REVISION	BY	DATE

HORZ. SCALE:	1"=200'	DRAWN:	BJJ
VERT. SCALE:	N/A	DESIGNED:	JPS
SURVEYED:		CHECKED:	JPS
CREATED:	2/24/20	LAST MODIFIED:	10/8/22
PROJECT NO:	051903	MODIFIED BY:	JPS
SHEET:	EX1		

C:\Users\Owner\Dropbox\jpsprojects\051903.peterson\dwg\civil\EX1a.dwg Oct 10, 2022 - 12:25am



N

60' 0 60' 120'

ORIGINAL SCALE: 1"=60' (24"x36" SHEET)
CONTOUR INTERVAL: 2'

DRAINAGE LEGEND

- RIPRAP
- FLOW DIRECTION ARROW
- FLOWLINE
- MAJOR DRAINAGE BASIN BOUNDARY
- MINOR DRAINAGE BASIN BOUNDARY
- DESIGN POINT
- DEVELOPED BASIN DESIGNATION
- DEVELOPED BASIN AREA (ACRES)

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
A1	5.6	26.4
1	23.6	151.5

GENERAL DRAINAGE NOTES:

1. CONTRACTOR AND OWNER SHALL PROVIDE POSITIVE DRAINAGE AWAY FROM STRUCTURES AND ACCOUNT FOR POTENTIAL CROSS-LOT DRAINAGE IMPACTS WITHIN EACH LOT.

2. CONTRACTOR AND PROPERTY OWNER SHALL IMPLEMENT & MAINTAIN PROPER BEST MANAGEMENT PRACTICES FOR DRAINAGE AND EROSION CONTROL FOR PROTECTION OF DOWNSTREAM PROPERTIES.

JPS ENGINEERING
19 E. Willamette Ave.
Colorado Springs, CO 80903
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FAX: 719-471-0766
www.jpsengr.com

CALL UTILITY NOTIFICATION CENTER OF COLORADO
1-800-922-1987
CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

No.	REVISION	BY	DATE

PETERSON'S REPLAT

DEVELOPED DRAINAGE PLAN

HORZ. SCALE: 1"=60'	DRAWN: BJJ
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: HANNIGAN	CHECKED: JPS
CREATED: 2/24/20	LAST MODIFIED: 10/8/22
PROJECT NO: 051903	MODIFIED BY: BJJ
SHEET:	D1