Drainage Letter Report

1875 Main Street
Colorado Springs, Colorado
80911

Prepared for: Paul Faricy
360 San Marino Court
Colorado Springs, CO 80906

April 18, 2019

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

PCD File No. PPR198

Drainage Report Statements

1. **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 City/County for drainage reports and said report is in conformity with the master plan for the drainage basin. I accept responsibility for liability caused by negligent acts, errors or omissions on my part in preparing this report:

04-18-2019

Richard D. Lyon Colorado P.E. No. 53921

2. **Developer's Statement:**

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

Business Name

By: Paul M Fang

Title: Owner

Address: 360 San Marino Court

Colorado Springs, CO 80906

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

1.0 Existing Conditions

1.1 Existing Site

Lot 2 of the Elm Grove Villa Subdivision is located at the address of 1875 Main Street in Colorado Springs in El Paso County within the northern limits of the census-designated area of Security-Widefield. The 1.62 acre lot is located east of Main Street or the Hancock Expressway, south of Bradley Road, and west/southwest of Cable Lane. The parcel number is 6501312002 and is platted as Plat No. 6376 and zoned as CC CAD-O. The parcel is surrounded by commercial development to the west and multi-family residential development to the south. A vicinity map, survey maps with the legal description of the parcel and topography is provided in Appendix A. As part of the survey, setbacks and adjacent easements are shown.

The property contains an approximately 125 foot stretch of pavement as an access point on the east side of Main Street with a dirt trail to Cable Lane; the remaining majority of the vacant parcel contains field grasses and weeds. The site area is generally flat with a slope to the south at an average of about 3 percent. The topography consists of an on-site low point within the native grasses to the southeast of the lot surrounded by landscape walls and fencing.

The Owner plans to build 60 foot by 80 foot warehouse building with a concrete foundation and an asphalt paved parking and driving access area totaling approximately 0.35 acres. As such, a major development plan set and drainage letter are to be submitted to El Paso County. This drainage letter serves as an addendum to the previous Drainage Report developed by Weiss Consulting Engineers, Inc. in 1983 for the Elm Grove Villa Subdivision which includes sub-basin delineations for Lot 2 and other upstream properties. As part of this drainage letter, computations and delineations are updated to reflect current EPC and UDFCD standards and present hydrology and hydraulic analysis for Lot 2, specifically for the purposes of the major development application.

1.2 Existing Drainage Conditions

The drainage concept of Lot 2 consists of upstream off-site flow from the north and east in addition to the on-site flows that concentrate at the on-site low point. In general, the site slopes to the south/southeast to this low point delimited by landscape walls. The previous 1983 drainage report accounted for Lot 2 as upstream drainage basins A1 and A6 that would contribute to the detention volume of the Elm Grove Villa Subdivision. All other flows that were not to be detained or conveyed via outfall(s) currently flow south to an outfall at Fountain Creek.

According to a subsurface soil investigation report prepared by Entech Engineering, Inc. dated September 5, 2018, the existing soils consist of two types of soil. “Type 1A: a silty sand

fill/possible fill (SM), and Type 1: a native silty sand (SM). Bedrock was not encountered in the test borings which were drilled past 20 feet. The soil types were classified in accordance with the Unified Soil Classification System (USCS) using the laboratory testing results and the observations made during drilling." Additionally, "groundwater was encountered at 16.5 and 17.5 feet in the test borings subsequent to drilling."

Since development of the multi-family residences, landscape walls and finished grades have created a new basin within Lot 2 that does not flow to drainage facilities to the south and are instead contained on site.

The only known storm infrastructure within the lot is a storm sewer inlet to the northwest that currently catches storm flow from the west and north of its location. It is assumed that this storm sewer conveys due south within the drainage and utility easement.

As the parcel no longer has the means for conveyance off site, proper siting and sizing of the low point within vegetation to the south/southeast of the property is necessary to ensure excessive pooling does not take place. However, due to the development size not exceeding an acre, a formal detention facility such as a pond or rain garden is not proposed.

Since the previous drainage report was developed in 1983, County and state standards and criteria have changed. As part of this drainage letter, current criteria will be applied with updated basin and sub-basin delineations for existing conditions. The criteria used to analyze the existing drainage conditions is the rational method for the 5-year and 100-year storm event. The City of Colorado Springs and El Paso County Drainage Criteria Manual, Volumes 1 and 2, were used for hydrologic and hydraulic calculations. FEMA Floodplain maps are provided in Appendix A.

The existing drainage conditions of the lot are presented in the civil exhibit and calculations in the Appendix. The lot's existing paved area designated as Sub-basin E-1 is assumed to flow off-site or to the on-site storm inlet; this sub-basin has peak flows of Q_5 = 0.29 cfs, Q_{10} = 0.37 cfs, and Q_{100} = 0.88 cfs. Another sub-basin designated as Sub-basin E-2 flows off-site through the utility easement and has peak flows of Q_5 = 0.08 cfs, Q_{10} = 0.10 cfs, and Q_{100} = 0.36 cfs. The existing drainage designated as Sub-basin E-3 concentrates at the low point of the lot has peak flows of Q_5 = 0.12 cfs, Q_{10} = 0.16 cfs, and Q_{100} = 1.15 cfs.

2.0 Proposed Conditions

The site development plan includes a proposed RV parking structure of 4,800 square feet, approximately 0.35 ac. of asphalt pavement for parking and drive access, and landscaping around the paved areas with permanent stabilization and seeding for the regraded native grasses to the southeast of the parcel.

The developed drainage concept will be to provide positive drainage away from proposed structures and generally conform to historic drainage patterns. The development will have minimal impact to downstream facilities as the majority of the storm drainage will percolate in

a low elevation landscaped area on the southeast portion of the parcel, sized to handle the volume of storm water for a 100 year storm. Developed peak flows at Design Point #1 flow to the site low point and include on-site Sub-basins D-4, D-5, and off-site Sub-basin D-6 and are calculated as Q_5 = 0.97 cfs, Q_{10} = 1.23 cfs, and Q_{100} = 3.35 cfs. Developed peak flows at Design Point #2 flow to the storm catch basin and include on-site Sub-basins D-1 and D-2 and off-site Sub-basin D-3 and are calculated as Q_5 = 0.64 cfs, Q_{10} = 0.78 cfs, and Q_{100} = 1.58 cfs.

Sub-basin D-4 is delineated to represent the sheet flow that would enter the grass swale that outlets to Design Point #1. This sub-basin does not include any roof area as the architecture calls for a mono-sloped roof pitched toward the southwest. The roof slopes toward the southwest and a roof drain will outlet to the southeast to flow to Design Point #1. Sub-basin D-7 represents the area within the property limits that are outside of the block retaining walls that surround the southwest and southeast sides of the property. This area is pervious, there is no proposed disturbance of this area, and it will remain consistent with historical drainage patterns.

The storm water volume increases to DP1 are 0.85 cfs for a 5 year storm, 1.07 cfs for a 10 year storm, and 2.20 cfs for a 100 year storm from the existing drainage conditions. The storm water increases to DP2 are 0.35 cfs for a 5 year storm, 0.41 cfs for a 10 year storm, and 0.43 cfs for a 100 year storm from the existing drainage conditions. The increase to the low point of the lot is accounted for in bioretention calculations sized beyond a 100 year storm to adequately detain the storm water on site, allow drainage within 12 hours, and avoid excessive site ponding that would be detrimental to the development and neighboring properties. The development is less than one acre in disturbance and does not require detention or water quality capture, however, due to the site topography and general topography of the surrounding parcels, the grading and drainage design incorporates WQCV and bioretention sizing to ensure that storm water is properly conveyed and detained for percolation. The less than one-half of a cubic foot per second increase to the runoff to the storm inlet is minimal for storm system conveyance and it is unlikely that surcharging of the system would occur due to this increase.

As part of the construction process, proper erosion control measures will be required for development of the site including silt fencing along downstream limits of disturbance to minimize off-site transport of construction sediment. Other control measures such as rock socks along channelized flow areas, vehicle tracking pads, a concrete washout area, and erosion blankets are to be installed in appropriate areas. An erosion control plan is provided in the development plan set as a guide to proper control measure placement.

The Developed Drainage Plan includes the following notes for Builders and Property Owners:

1. Proposed site conditions shall not significantly vary from the conditions presented in this report. The degree to which variance from the proposed conditions allowed is at the discretion of the County. The most critical variable is the percent impervious of the site.
2. Individual builders shall provide positive drainage away from structures and account for potential cross-lot drainage impacts within the lot.

3. The builders and property owner shall implement and maintain erosion control best management practices/control measures for protection of downstream properties and facilities.
4. Recognizing the location of this subdivision adjacent to the storm inlets and developed downstream properties, the builders and property owner shall take extra care in providing and maintaining erosion control BMP's/control measures at downstream property boundaries.

3.0 Floodplain Impacts

According to the FEMA floodplain map for this area, El Paso County FIRM Panel No. 08041C0763G, dated December 7, 2018 (see Appendix A), the entire parcel falls into Zone X, an area of minimal flood hazard.

3.1 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 development of Lot 2:

Step 1: Employ Runoff Reduction Practices

The development plan consists of the minimal area of pavement for ease of access, turnarounds for large vehicles, the storage structure, and parking. The remainder of the parcel is to be permanently stabilized with grasses and vegetation to improve percolation and overall drainage.

Step 2: Stabilize Drainageways

A stabilized/constructed natural drainageway is to be implemented to convey stormwater from part of the developed area to the northwest of the structure. Rip-rap is to be implemented for energy dissipation and reduction of erosion to downstream landscape that leads to the property low point.

Step 3: Provide Water Quality Capture Volume

The development of the RV storage structure, parking lot, and further areas of disturbance for grading 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. However, due to the topography of the parcel and surrounding sites, a sized low point is to be constructed on site to act as a detention basin that accounts for 100-year storm flows and is adequate for water quality capture volume storage. Implementing

the aforementioned best management practices will maintain the historical drainage patterns and reduce erosion.

Step 4: Consider the Need for Industrial and Commercial BMPs

Since the lot is to be utilized as RV storage, there is no need for industrial or commercial BMPs. There will be no storage/handling areas or a need for permanent spill containment and control. The Client may request allowance for a sanitary manhole connection to wye into the proposed service for the building for emptying of RV sanitary tank(s). This has no bearing on drainage BMP selection and implementation.

4.0 Public Improvements / Drainage Basin Fee

No public drainage improvements are required or proposed for this project. According to El Paso County policies, drainage basin fees are due based on the impervious area projected for the new development but are not applicable with site development plans; therefore, no drainage fees are due.

5.0 Summary

The proposed drainage patterns for the lot will generally remain consistent with historic conditions with the exception of storm water capture on site which was accounted per the master drainage plan for the Elm Grove townhome complexes. The development results in a negligible increase of storm water volume to the existing storm inlet within the utility easement to the west and the low point on site is designed to detain 100 year storm volumes for a 12 hour period. The development will have negligible impact to downstream facilities. Should the proposed site plan for this lot vary significantly from the assumptions made in this Drainage Letter Report, a revised report with updated calculations shall be required. Additionally, should the proposed development vary and cause an increase in storm runoff volumes and result in significant impacts to downstream facilities, the proposed development shall be subject to detention and water quality requirements. Installation and maintenance of proper erosion control practices during and after construction will ensure that this developed site will not adversely affect downstream or surrounding areas.

Appendix A – FEMA Flood Insurance Study 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.

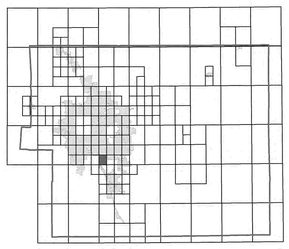
Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this 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

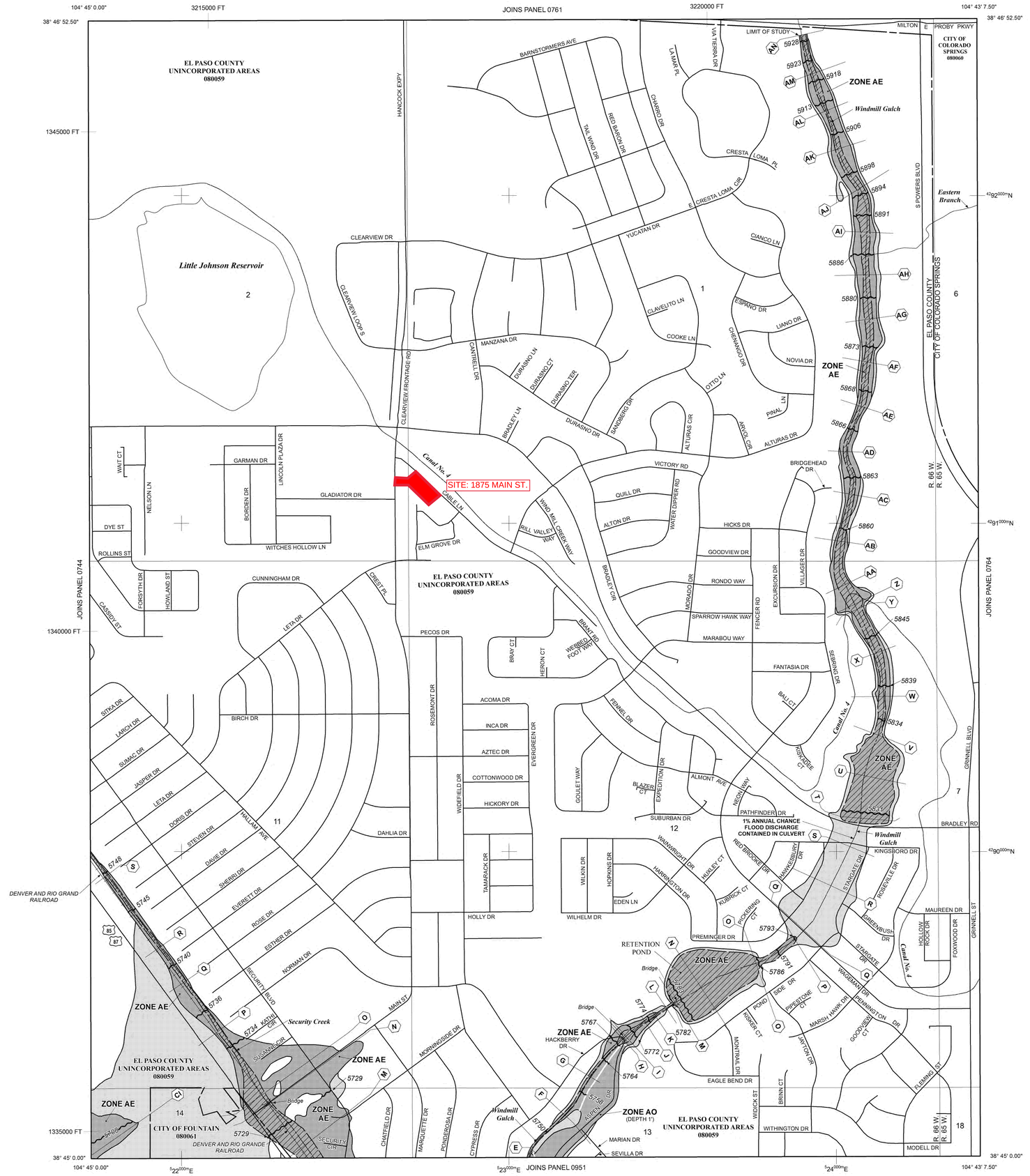
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

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 15 SOUTH, RANGE 65 WEST, AND TOWNSHIP 15 SOUTH, RANGE 66 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)
4275000mN — 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" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0763G

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 763 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0763	G
EL PASO COUNTY	080059	0763	G
FOUNTAIN, CITY OF	080061	0763	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
08041C0763G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

Appendix B – USGS Soils Map

Soil Map—El Paso County Area, Colorado
(1875 Main Street USGS Soil Survey Map)

Map Scale: 1:2,380 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 35 70 140 210

Feet: 0 100 200 400 600

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 3, 2014—Jun 17, 2014

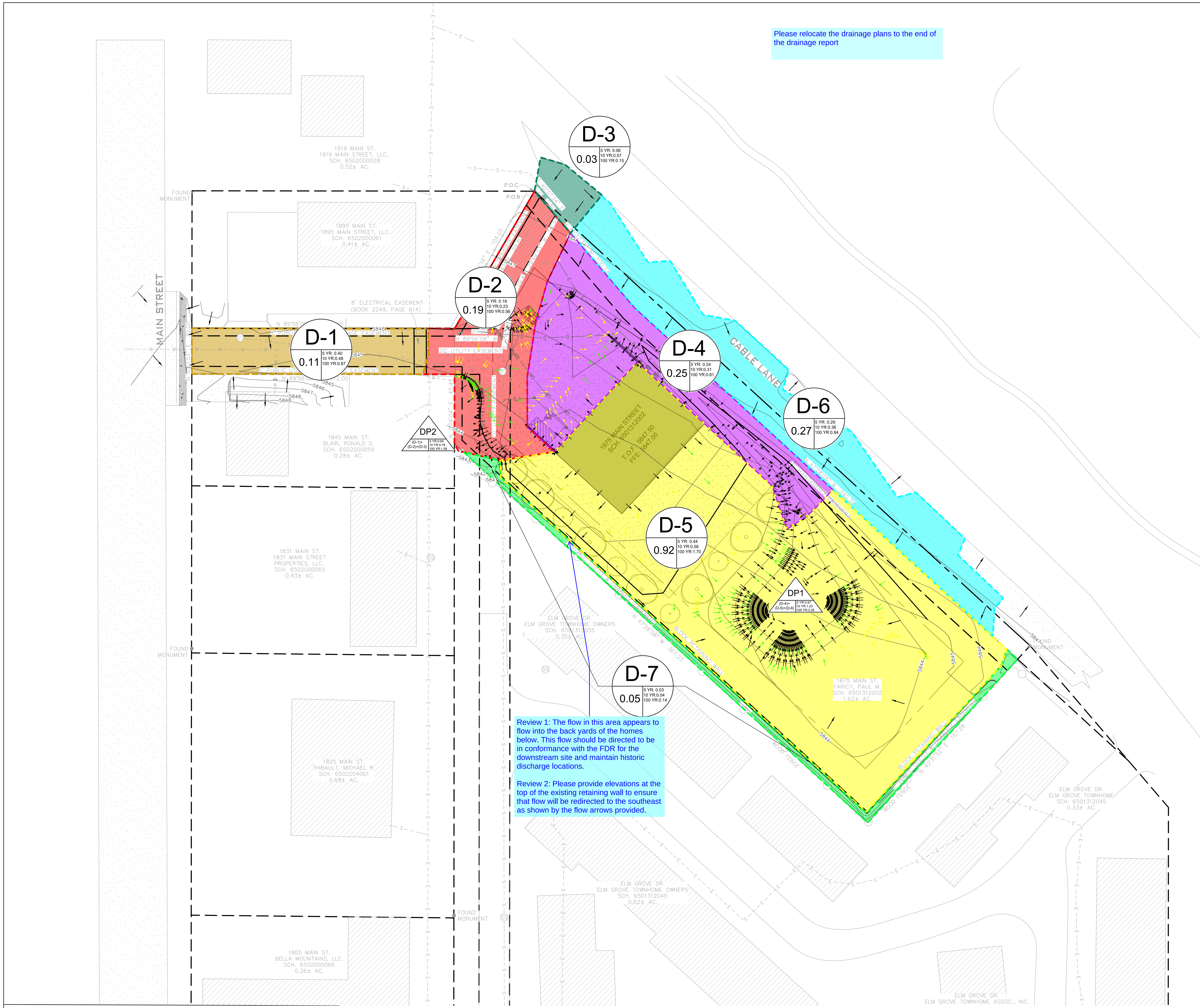
The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
8	Blakeland loamy sand, 1 to 9 percent slopes	24.4	100.0%
Totals for Area of Interest		**24.4**	**100.0%**

Appendix C – Sub-Basin Delineation Exhibits

Please relocate the drainage plans to the end of the drainage report



Review 1: The flow in this area appears to flow into the back yards of the homes below. This flow should be directed to be in conformance with the FDR for the downstream site and maintain historic discharge locations.

Review 2: Please provide elevations at the top of the existing retaining wall to ensure that flow will be redirected to the southeast as shown by the flow arrows provided.

SITE LEGEND

- EXISTING BUILDING FOOTPRINT
- NEW BUILDING FOOTPRINT
- PROPERTY LINE
- SETBACK LINE
- EASEMENT LINE
- LOT LINE
- (E) 6' HIGH CEDAR FENCE UNO
- PROPERTY CORNER/MONUMENT
- SPOT ELEVATION
- SWALE FLOW LINE
- FLOW DIRECTION
- PROPOSED MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- (E) MINOR CONTOUR
- (E) MAJOR CONTOUR

EX1 DEVELOPED SUB-BASIN DELINEATION EXHIBIT
1" = 30'-0"

0 15' 30' 60' 120'

N

ROCKY MOUNTAIN GROUP
RMG ARCHITECTS ENGINEERS
Geotechnical Materials Testing Civil, Planning
Architectural Structural Forensics
SOUTHERN COLORADO
2910 AUSTIN BLUFFS PARKWAY COLORADO SPRINGS, CO 80918
(719) 488-2145 · WWW.RMGENGINEERS.COM
SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

drawn by: RDL
job no.: 168544

REVISIONS
1 RESUBMITTAL 04.18.2019

DEVELOPED SUB-BASIN DELINEATION EXHIBIT

PCD FILE NO: PPR198

ECHO

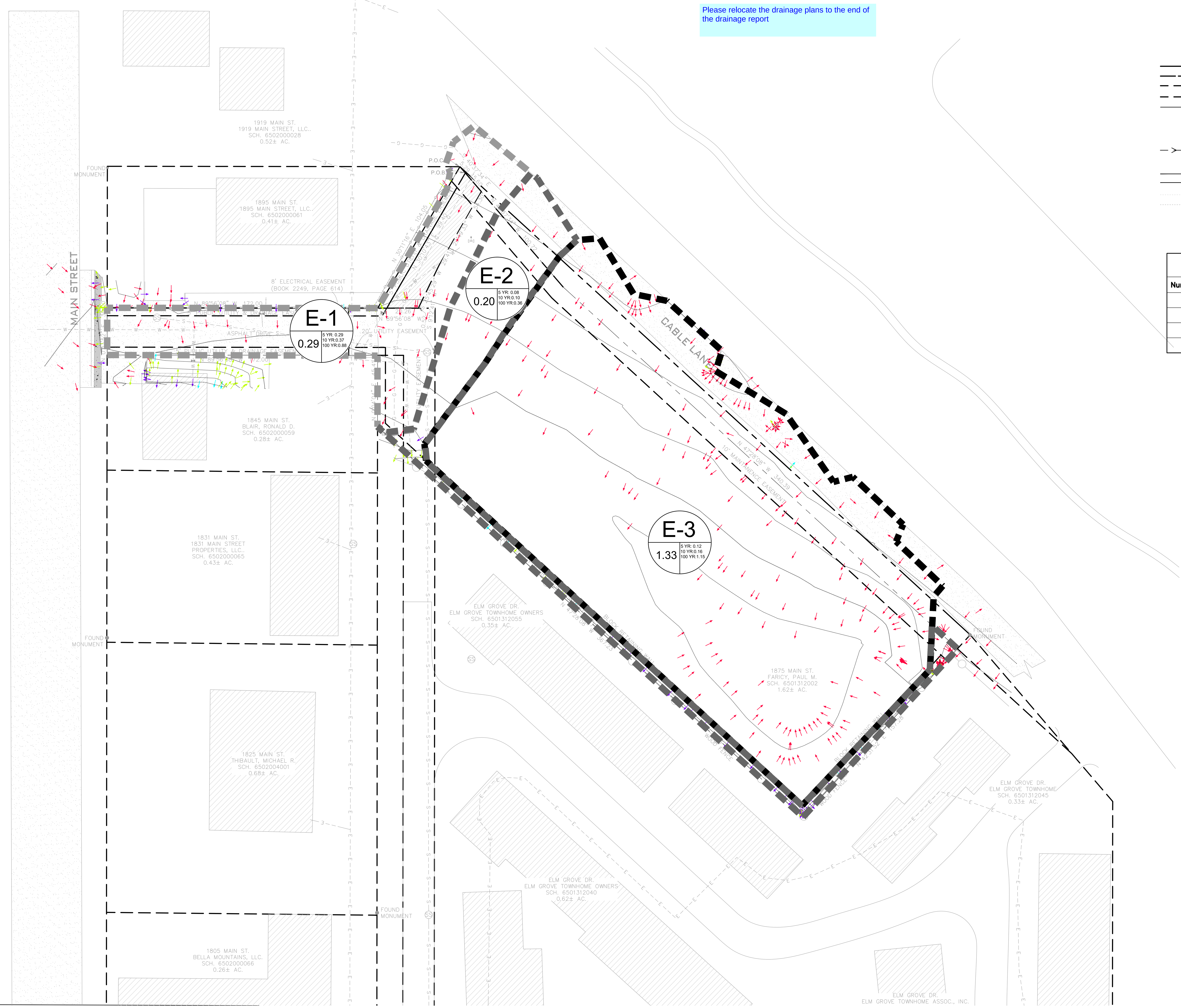
2018-016-FARICY REC BUILDING
1875 MAIN ST. COLORADO SPRINGS

date: 04.18.2019
phase: DEVELOPMENT PLAN
drawn by: SMS

Echo Architecture, LLC
Colorado Springs, CO 80903
www.echo-arch.com

EX1

Please relocate the drainage plans to the end of the drainage report



SITE LEGEND

- EXISTING BUILDING FOOTPRINT
- NEW BUILDING FOOTPRINT
- PROPERTY LINE
- SETBACK LINE
- EASEMENT LINE
- LOT LINE
- (E) 6' HIGH CEDAR FENCE UNO
- PROPERTY CORNER/MONUMENT
- SPOT ELEVATION
- SWALE FLOW LINE
- FLOW DIRECTION
- PROPOSED MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- (E) MINOR CONTOUR
- (E) MAJOR CONTOUR

Slope Arrows Table			
Number	Minimum Slope	Maximum Slope	Color
1	2.00%	10.00%	red
2	10.00%	25.00%	yellow-green
3	25.00%	33.33%	cyan
4	33.33%	100.00%	purple

EX2 EXISTING CONDITIONS SUB-BASIN DELINEATION EXHIBIT
1" = 30'-0"

0 15' 30' 60' 120'

N

ROCKY MOUNTAIN GROUP
Geotechnical
Materials, Testing
Civil, Planning
Architectural
Structural
Forensics
SOUTHERN COLORADO
2910 AUSTIN BLUFFS PARKWAY COLORADO SPRINGS, CO 80918
(719) 488-2145 ~ WWW. RMGENGINEERS.COM
SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

drawn by: RDL
job no.: 168544

REVISIONS
1 RESUBMITTAL 04.18.2019

EXISTING CONITIONS SUB-BASIN DELINEATION EXHIBIT

PCD FILE NO: PPR198

ECHO

2018-016-FARICY
REC BUILDING

1875 MAIN ST.
COLORADO SPRINGS

date: 04.18.2019
phase: DEVELOPMENT PLAN
drawn by: SMS

Echo Architecture, LLC
4 S Wahsatch Ave, #120
Colorado Springs, CO 80903
www.echo-arch.com
t 719.387.7836

EX2

Appendix D – Drainage Calculations

Calculation of Peak Runoff using Rational Method

Designer: Richard Lyon
Company: Rocky Mountain Group
Date: 4/1/2019
Project: 1875 Main Street
Location: Colorado Springs, CO

Version 2.00 released May 2017

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

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

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

Computed $t_c = t_i + t_t$

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

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

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) =	1.00	1.28	1.54	1.96	2.32	2.71	3.77
	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							Overland (Initial) Flow Time					Channelized (Travel) Flow Time							Time of Concentration			Rainfall Intensity, I (in/hr)							Peak Flow, Q (cfs)						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	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 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)	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
D-1	0.11	A	100.00	0.840	0.861	0.873	0.884	0.879	0.889	0.899	30.00	5846.00	5844.75	0.042	1.48	0.01	0.00	0.00	0.000	20	0.06	0.00	1.48	9.00	5.00	3.39	4.34	5.22	6.65	7.87	9.19	12.79	0.30	0.40	0.48	0.62	0.73	0.87	1.22
D-2	0.19	A	45.5	0.302	0.316	0.331	0.365	0.414	0.465	0.548	175.00	5848.30	5843.60	0.027	13.52	0.01	0.00	0.00	0.000	20	0.06	0.00	13.53	18.26	13.53	2.38	3.05	3.67	4.67	5.52	6.45	8.98	0.13	0.18	0.23	0.32	0.42	0.56	0.91
D-3 (OS)	0.03	A	66.2	0.491	0.509	0.525	0.556	0.590	0.626	0.681	40.00	5849.00	5848.20	0.020	5.37	0.01	0.00	0.00	0.000	20	0.06	0.00	5.37	14.75	5.37	3.32	4.26	5.12	6.52	7.72	9.02	12.54	0.04	0.06	0.07	0.10	0.12	0.15	0.23
D-4	0.25	A	40.0	0.255	0.267	0.282	0.316	0.367	0.422	0.512	40.00	5848.00	5846.63	0.034	6.33	250.00	5846.63	5842.00	0.019	15	2.04	2.04	8.37	21.30	8.37	2.89	3.70	4.45	5.67	6.71	7.84	10.90	0.18	0.24	0.31	0.44	0.61	0.81	1.37
D-5	0.92	A	30.2	0.18	0.19	0.20	0.23	0.28	0.35	0.45	240.00	5846.90	5841.75	0.021	19.85	0.01	0.00	0.00	0.000	20	0.06	0.00	19.85	20.87	19.85	1.97	2.53	3.04	3.87	4.58	5.35	7.44	0.32	0.44	0.56	0.82	1.20	1.70	3.08
D-6 (OS)	0.27	A	53.7	0.37	0.39	0.41	0.44	0.48	0.53	0.60	200.00	5848.00	5846.75	0.006	21.19	0.01	0.00	0.00	0.000	20	0.06	0.00	21.20	16.88	16.88	2.14	2.75	3.30	4.20	4.98	5.81	8.09	0.22	0.29	0.36	0.50	0.65	0.84	1.32
D-7 (OS)	0.05	A	24.0	0.13	0.14	0.15	0.18	0.23	0.30	0.41	20.00	5843.50	5841.00	0.125	3.37	0.01	0.00	0.00	0.000	20	0.06	0.00	3.37	21.92	5.00	3.39	4.34	5.22	6.65	7.87	9.19	12.79	0.02	0.03	0.04	0.06	0.10	0.14	0.28

Calculation of Peak Runoff using Rational Method

Designer: Richard Lyon
Company: Rocky Mountain Group
Date: 2/15/2019
Project: 1875 Main Street
Location: Colorado Springs, CO

Version 2.00 released May 2017

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

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

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

Computed $t_c = t_i + t_t$

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

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

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
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	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							Overland (Initial) Flow Time					Channelized (Travel) Flow Time							Time of Concentration			Rainfall Intensity, I (in/hr)							Peak Flow, Q (cfs)						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	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 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)	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
E-1	0.29	A	47.81	0.321	0.336	0.352	0.386	0.433	0.482	0.562	200.00	5849.00	5843.60	0.027	14.06	0.01	0.00	0.00	0.000	20	0.06	0.00	14.06	17.88	14.06	2.34	2.99	3.60	4.59	5.43	6.34	8.82	0.22	0.29	0.37	0.51	0.68	0.88	1.43
E-2	0.20	A	23.4	0.127	0.135	0.146	0.173	0.225	0.292	0.405	185.00	5848.73	5841.00	0.042	14.78	0.01	0.00	0.00	0.000	20	0.06	0.00	14.79	22.03	14.79	2.28	2.93	3.52	4.48	5.30	6.19	8.62	0.06	0.08	0.10	0.16	0.24	0.36	0.70
E-3	1.33	A	9.1	0.037	0.040	0.046	0.060	0.103	0.181	0.313	300.00	5848.33	5843.25	0.017	27.85	0.01	0.00	0.00	0.000	20	0.06	0.00	27.85	24.46	24.46	1.76	2.26	2.72	3.46	4.09	4.78	6.65	0.09	0.12	0.16	0.27	0.56	1.15	2.76

NOAA Atlas 14, Volume 8, Version 2
Location name: Colorado Springs, Colorado, USA*
Latitude: 38.7681°, Longitude: -104.738°
Elevation: 5854.46 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	**0.245** (0.202-0.301)	**0.295** (0.243-0.362)	**0.383** (0.314-0.471)	**0.461** (0.376-0.571)	**0.579** (0.458-0.754)	**0.676** (0.520-0.892)	**0.780** (0.577-1.06)	**0.891** (0.629-1.25)	**1.05** (0.708-1.51)	**1.18** (0.768-1.71)
10-min	**0.359** (0.296-0.440)	**0.432** (0.356-0.530)	**0.560** (0.460-0.690)	**0.675** (0.551-0.836)	**0.847** (0.671-1.10)	**0.990** (0.761-1.31)	**1.14** (0.845-1.55)	**1.31** (0.921-1.82)	**1.54** (1.04-2.21)	**1.72** (1.13-2.50)
15-min	**0.438** (0.361-0.537)	**0.527** (0.434-0.646)	**0.683** (0.561-0.841)	**0.824** (0.672-1.02)	**1.03** (0.818-1.35)	**1.21** (0.929-1.59)	**1.39** (1.03-1.89)	**1.59** (1.12-2.22)	**1.87** (1.26-2.69)	**2.10** (1.37-3.05)
30-min	**0.652** (0.538-0.799)	**0.783** (0.645-0.961)	**1.01** (0.833-1.25)	**1.22** (0.998-1.51)	**1.53** (1.22-2.00)	**1.79** (1.38-2.37)	**2.07** (1.53-2.81)	**2.37** (1.67-3.31)	**2.79** (1.88-4.01)	**3.12** (2.04-4.54)
60-min	**0.851** (0.702-1.04)	**0.999** (0.824-1.23)	**1.28** (1.05-1.57)	**1.54** (1.26-1.91)	**1.96** (1.56-2.57)	**2.32** (1.79-3.08)	**2.71** (2.01-3.70)	**3.14** (2.23-4.41)	**3.77** (2.56-5.45)	**4.29** (2.81-6.24)
2-hr	**1.05** (0.872-1.28)	**1.22** (1.01-1.48)	**1.54** (1.27-1.89)	**1.86** (1.53-2.29)	**2.38** (1.92-3.13)	**2.84** (2.21-3.76)	**3.35** (2.51-4.56)	**3.92** (2.80-5.49)	**4.76** (3.25-6.85)	**5.45** (3.60-7.88)
3-hr	**1.15** (0.959-1.40)	**1.31** (1.09-1.59)	**1.64** (1.36-2.00)	**1.99** (1.64-2.44)	**2.56** (2.09-3.38)	**3.09** (2.42-4.10)	**3.68** (2.78-5.00)	**4.35** (3.13-6.08)	**5.34** (3.68-7.68)	**6.18** (4.09-8.89)
6-hr	**1.31** (1.10-1.58)	**1.48** (1.24-1.78)	**1.84** (1.54-2.23)	**2.23** (1.85-2.71)	**2.89** (2.38-3.81)	**3.50** (2.78-4.63)	**4.20** (3.20-5.69)	**5.00** (3.63-6.96)	**6.19** (4.30-8.86)	**7.20** (4.81-10.3)
12-hr	**1.46** (1.23-1.75)	**1.67** (1.41-2.00)	**2.10** (1.76-2.52)	**2.54** (2.12-3.07)	**3.27** (2.70-4.25)	**3.93** (3.13-5.15)	**4.68** (3.58-6.28)	**5.52** (4.04-7.63)	**6.78** (4.74-9.62)	**7.83** (5.27-11.1)
24-hr	**1.63** (1.39-1.95)	**1.90** (1.61-2.26)	**2.41** (2.04-2.88)	**2.90** (2.44-3.49)	**3.69** (3.05-4.73)	**4.38** (3.51-5.66)	**5.15** (3.96-6.83)	**6.00** (4.41-8.19)	**7.24** (5.10-10.2)	**8.27** (5.62-11.7)
2-day	**1.86** (1.60-2.20)	**2.18** (1.87-2.58)	**2.77** (2.36-3.29)	**3.32** (2.82-3.97)	**4.17** (3.45-5.27)	**4.90** (3.94-6.26)	**5.69** (4.40-7.47)	**6.56** (4.85-8.86)	**7.80** (5.53-10.9)	**8.82** (6.04-12.4)
3-day	**2.03** (1.75-2.40)	**2.39** (2.05-2.82)	**3.03** (2.60-3.59)	**3.63** (3.08-4.31)	**4.53** (3.76-5.68)	**5.29** (4.26-6.72)	**6.11** (4.74-7.97)	**7.01** (5.20-9.41)	**8.28** (5.89-11.5)	**9.32** (6.42-13.0)
4-day	**2.18** (1.88-2.56)	**2.56** (2.20-3.01)	**3.24** (2.78-3.82)	**3.85** (3.29-4.57)	**4.79** (3.98-5.99)	**5.58** (4.51-7.06)	**6.43** (5.00-8.35)	**7.35** (5.47-9.84)	**8.65** (6.18-11.9)	**9.71** (6.71-13.5)
7-day	**2.56** (2.22-2.99)	**2.96** (2.57-3.47)	**3.69** (3.18-4.32)	**4.34** (3.73-5.12)	**5.33** (4.46-6.61)	**6.16** (5.01-7.74)	**7.06** (5.53-9.11)	**8.02** (6.01-10.7)	**9.39** (6.75-12.9)	**10.5** (7.31-14.5)
10-day	**2.89** (2.51-3.36)	**3.32** (2.88-3.86)	**4.08** (3.53-4.76)	**4.77** (4.11-5.60)	**5.80** (4.86-7.15)	**6.66** (5.43-8.32)	**7.58** (5.96-9.74)	**8.57** (6.45-11.4)	**9.98** (7.20-13.6)	**11.1** (7.76-15.3)
20-day	**3.77** (3.30-4.36)	**4.32** (3.78-5.00)	**5.26** (4.59-6.11)	**6.08** (5.27-7.09)	**7.26** (6.10-8.82)	**8.21** (6.73-10.1)	**9.20** (7.27-11.7)	**10.2** (7.74-13.4)	**11.7** (8.48-15.8)	**12.8** (9.03-17.6)
30-day	**4.50** (3.97-5.19)	**5.18** (4.55-5.97)	**6.29** (5.51-7.27)	**7.23** (6.29-8.40)	**8.54** (7.18-10.3)	**9.57** (7.85-11.7)	**10.6** (8.40-13.4)	**11.7** (8.86-15.2)	**13.1** (9.56-17.6)	**14.2** (10.1-19.4)
45-day	**5.45** (4.82-6.25)	**6.28** (5.54-7.21)	**7.61** (6.70-8.77)	**8.71** (7.62-10.1)	**10.2** (8.58-12.2)	**11.3** (9.31-13.7)	**12.4** (9.87-15.5)	**13.5** (10.3-17.4)	**15.0** (10.9-19.9)	**16.0** (11.4-21.8)
60-day	**6.27** (5.56-7.17)	**7.23** (6.41-8.28)	**8.76** (7.73-10.1)	**9.99** (8.76-11.5)	**11.6** (9.79-13.8)	**12.8** (10.6-15.5)	**14.0** (11.1-17.4)	**15.1** (11.5-19.4)	**16.6** (12.1-21.9)	**17.6** (12.6-23.8)

[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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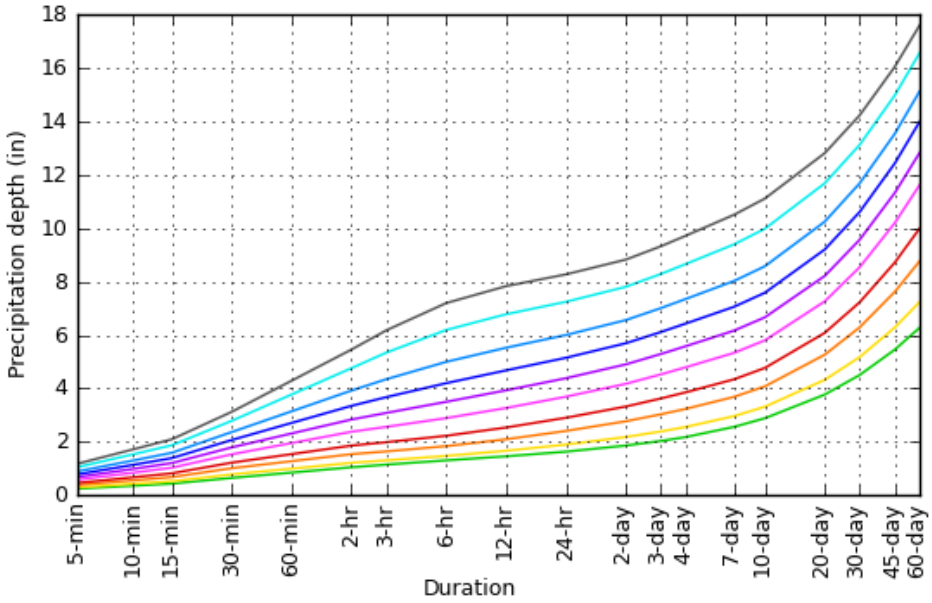
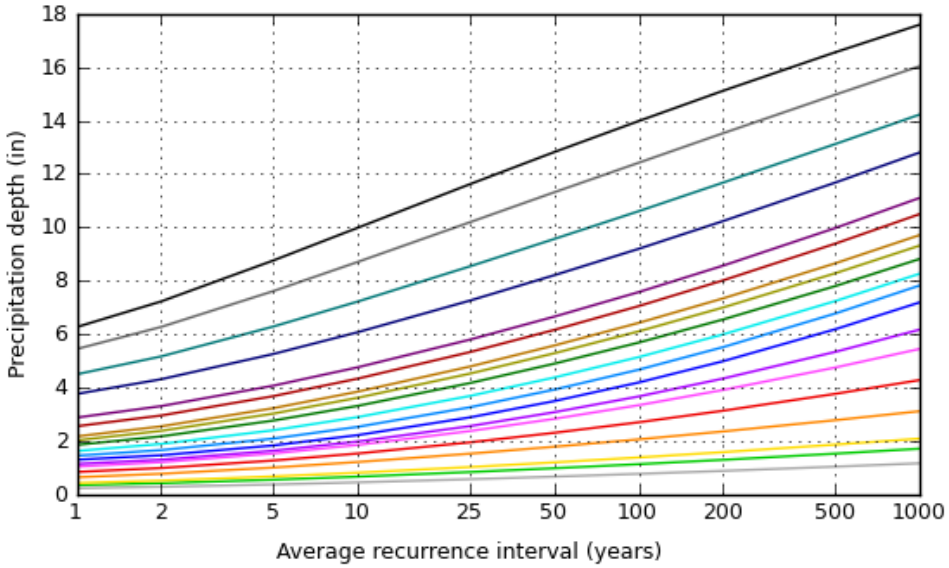
PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 38.7681°, Longitude: -104.7380°





NOAA Atlas 14, Volume 8, Version 2

Created (GMT): Fri Feb 15 15:08:49 2019

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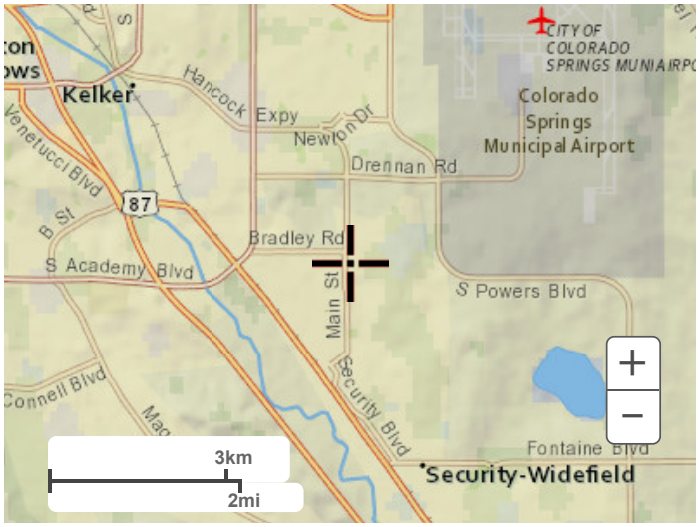
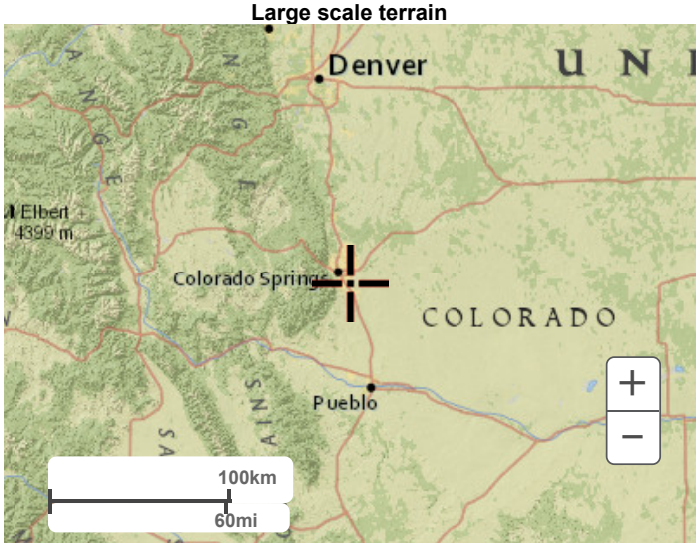
Maps & aerials

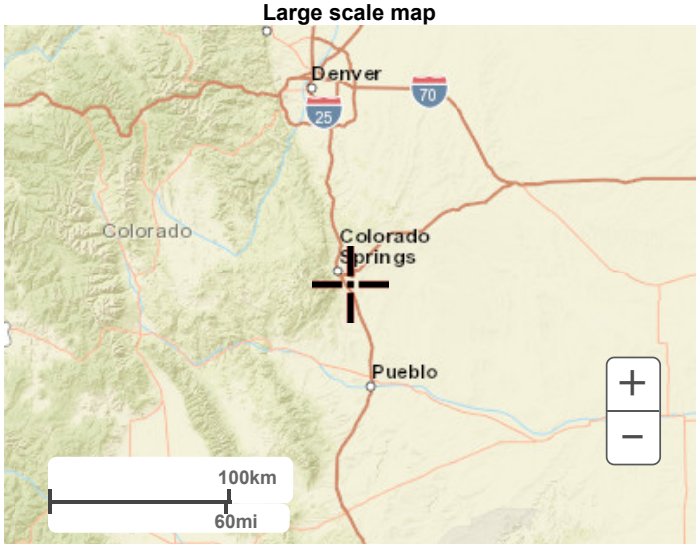
Small scale terrain



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

Detention and Water Quality BMP – Bioretention Area

The WQCV is calculated as a function of imperviousness and BMP drain time using Equation 3-1, and as shown in Figure 3-2 of the UDFCD Manuel, Volume 3:

$$WQCV = a(0.91I^3 - 1.19I^2 + 0.78I)$$ Equation 3-1

Where:

WQCV = Water Quality Capture Volume (watershed inches)

a = Coefficient corresponding to WQCV drain time (Table 3-2)

I = Imperviousness (%/100) (see Figures 3-3 through 3-5 [single family land use] and /or the *Runoff* chapter of Volume 1[other typical land uses])

Table 3-2. Drain Time Coefficients for WQCV Calculations

Drain Time (hrs)	Coefficient, a
12 hours	0.8
24 hours	0.9
40 hours	1.0

Sub-Basin ID	Total Area (ac)	Impervious Area (ac)	Impervious (%)
D-4	0.25	0.10	40.0%
D-5	0.92	0.28	30.2%
D-6 (OS)	0.27	0.14	53.7%
DESIGN POINT (2+3)	**1.44**	**0.52**	**36.30%**

$$WQCV = 0.80(0.91 * (0.3630)^3 - 1.19 * (0.3630)^2 + 0.78 * 0.3630) = 0.161\ watershed\ inches$$

Once the WQCV in watershed inches is found from Figure 3-2 or using Equation 3-1 and/or 3-2, the required BMP storage volume in acre-feet can be calculated as follows:

$$V = \left(\frac{\text{WQCV}}{12}\right) A \qquad \text{Equation 3-3}$$

Where:

V = required storage volume (acre-ft)

A = tributary catchment area upstream (acres)

WQCV = Water Quality Capture Volume (watershed inches)

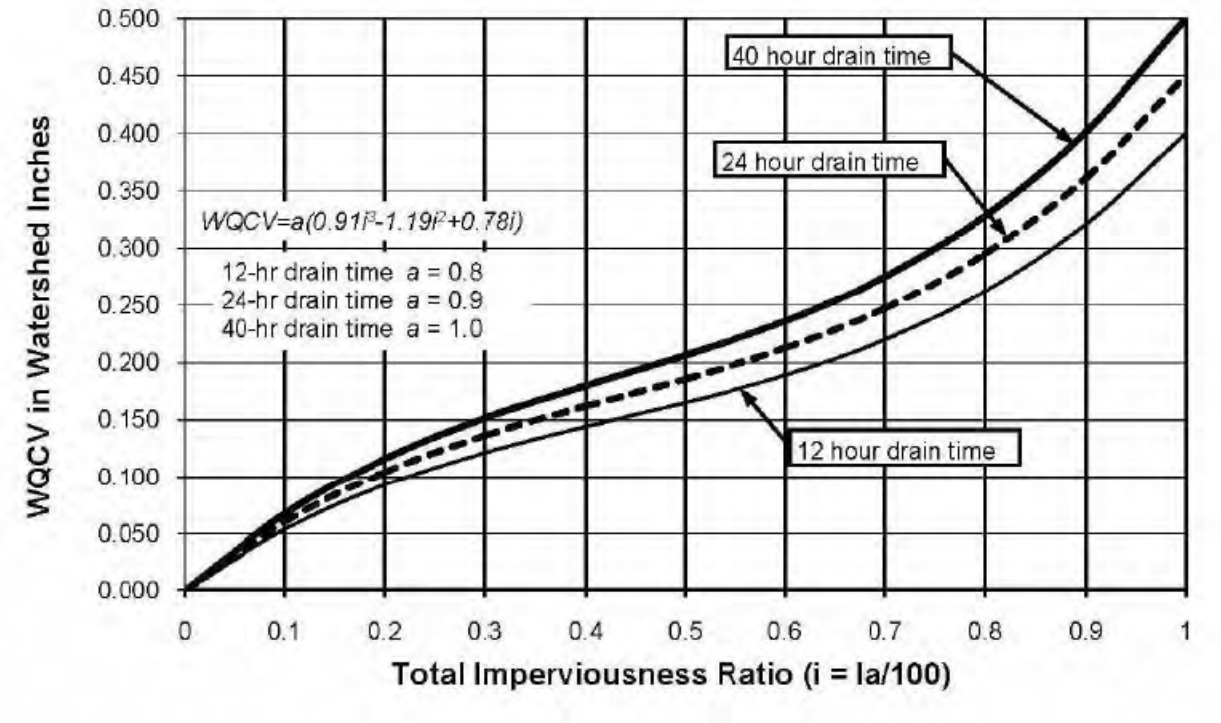


Figure 3-2. Water Quality Capture Volume (WQCV) Based on BMP Drain Time

$$V = \left(\frac{0.161\ in}{12\ \frac{in}{ft}}\right) * 1.44\ acres = \ 0.01932\ acre * ft$$

$$0.01932\ acre * ft\ * 43{,}560\ ft^2 = \ 841.58\ ft^3$$

Rounded to 845 ft³

Bioretention Area Calculation

2. **Basin Geometry:** A maximum WQCV ponding depth of 12 inches is recommended to maintain vegetation properly. Provide an inlet or other means of overflow at this elevation. Depending on the type of vegetation planted, a greater depth may be utilized to detain larger (more infrequent) events. The bottom surface of the rain garden, also referred to here as the filter area, should be flat. Sediment will reside on the filter area of the rain garden; therefore, if the filter area is too small, it may clog prematurely. Increasing the filter area will reduce clogging and decrease the frequency of maintenance. Equation B-2 provides a **minimum** filter area allowing for some of the volume to be stored beyond the area of the filter (i.e., above the sideslopes of the rain garden).

   Note that the total surcharge volume provided by the design must also equal or exceed the design volume. Use vertical walls or slope the sides of the basin to achieve the required volume. Use the rain garden growing medium described in design step 3 only on the filter area because this material is more erosive than typical site soils. Sideslopes should be no steeper than 4:1 (horizontal:vertical).

$$A \geq (2/3)\frac{V}{1\ \text{foot}}$$ Equation B-2

Where:

V= design volume (ft^3)

A = minimum filter area (flat surface area) (ft^2)

The one-foot dimension in this equation represents the maximum recommended WQCV depth in the rain garden. The actual design depth may differ; however, it is still appropriate to use a value of one foot when calculating the minimum filter area.

$$A \geq \left(\frac{2}{3}\right) * \left(\frac{845}{1.25}\right) = 450\ ft^2$$

The USCDM presents the following:

$$A_F = 0.02AI$$ Equation B-2

Where:

A_F= minimum (flat) filter area (ft^2)

A = area tributary to the rain garden (ft^2)

I = imperviousness of area tributary to the rain garden (percent expressed as a decimal)

$$A_F = 0.02 * (1.44 * 43{,}560) * 0.3630 = 455\ ft^2$$

The higher area is 455 ft^2. The bioretention area to be regraded in the existing low point of the site is approximately 2,700 ft^2 of 10 percent slope from elevation 5843 to 5842 and 1,700 ft^2 of 10 percent slope from elevation 5842 to elevation 5841.75. The design result is bioretention area of **4,400 ft^2** with a total volume of approximately **1,775 ft^3**. This is a 2.10 safety factor for the calculated bioretention area with a drain time of 12 hours.

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)

$$W = \frac{0.08\ cfs}{0.05} = 1.60\ ft\ minimum\ width$$

Design width of 2 ft. used. Safety factor of 1.25

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’

Appendix E – Weiss Consulting Engineering, Inc. Drainage Report (1983)

DRAINAGE REPORT

FOR

ELM GROVE VILLA

SECURITY, COLORADO

WEISS CONSULTING ENGINEERS, INC.
Professional Engineer and Land Surveyor

February 17, 1983

Mr. John Fisher
Land Use Administrator
County of El Paso
27 East Vermijo
Colorado Springs, Colorado 80903

Dear Mr. Fisher,

Transmitted herewith is a Drainage Report for Elm Grove Villa lying south of Bradley Road and east of Hancock Road at the north edge of Security, Colorado.

If you have any questions, please call me.

Sincerely,
WEISS CONSULTING ENGINEERS, INC.

G. J. Weiss PE-4124

1815 North Tejon • Colorado Springs, CO 80907 • (303) 634-0373

GENERAL

Elm Grove Villa lies in the Southwest quarter of Section 1 and the Southeast quarter of Section 2, Township 15 South, Range 66 West of the 6th P.M. in the Town of Security, Colorado. The site contains 5.225 acres and is planned for a townhouse development. The drainage from the site will flow south through Security and will eventually outfall into Fountain Creek.

A soils report for the site was prepared by Summerlee and Associates on July 19, 1973. The soils on the site consist of selty to clayey sands and very sandy clays. The SCS soil classification is Blakeland, and it falls in Hydrologic Group A.

Reference in made to a drainage report for Benchmark Subdivision, which was made for this site in a report dated February 13, 1973 by H. J. Kraettli and Sons.

METHOD OF RUNOFF COMPUTATION

The method of runoff computation utilized in this report is the S.C.S. method as outlined in the subdivision criteria manual for El Paso County and the areawide urban runoff control manual for P.P.A.C.G. The calculations are shown separately. The five year frequency, 24 hour duration storm was used in the calculations. The 100 year storm was also calculated.

EXTERIOR FLOWS

Basins A-1 through A-7 discharge flows into the site as shown on the drainage map for a total of 32.6 CFS for the 5 year flow and 57.9 CFS for the 100 year flow. This report assumes that drainage from the west side of Hancock will enter the site from Manzana Drive south, but that the east half of Hancock will have its drainage intercepted by the canal. It is also assumed that the developer north of the canal will make provisions for his own developed drainage and that it will not enter the site.

The two catchbasins in Main Street and their 24" C.M.P. outfall have a capacity of about 18 CFS and are undersized for the 5 year storm. The site east of the catchbasins is graded to permit an overflow around the buildings where it will sheet flow into Elm Grove Villa.

INTERIOR FLOWS

Basin B has a 5 year flow of 7.8 CFS and a 100 year flow of 20.8 CFS. The undeveloped flows for this site are 0.8 CFS and 6.5 CFS respectively. The difference between the 100 year flows

is 14.3 CFS, which must be detained on site. A detailed design of the detention facility will be designed upon acceptance of this report by the County Engineer. It is hoped that detention storage can be provided for more than that required for the Elm Grove Villa site.

DRAINAGE FACILITIES

This site is lower than the adjacent land on the west, north and east. Drainage from the west will enter the site through the existing 24" CMP and as an overflow. This will be carried through the site in the private street to the detention pond. Drainage from the north will flow into the site and be carried in the private streets and swales to the detention pond. It is planned that a swale or curb be constructed by the owner on the east side of this property to prevent it from entering the site.

Due to the low elevation of the site relative to the adjacent properties, it is essential that the developer and builder place the buildings on the site as high as possible above the private streets and swales to prevent any damage from flooding.

No detailed drainage cost can be prepared until the detention facility has been designed. The earthwork required to construct the detention pond can be done as part of the overall site grading. An outfall pipe must be constructed from the pond across Leta Drive. We would make a preliminary cost estimate for these facilities to be $6000.00

DRAINAGE REPORT STATEMENTS

ENGINEERS 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. This report was prepared in accordance with the El Paso County Subdivision Criteria Manual.

Gerald J. Weiss PE-4124

OWNERS STATEMENT

The developer has read and will comply with all of the requirements specified in this drainage report.

J.D.K. CONSTRUCTION, INC.
Developer

By John D. Kelly

Pres.
Title

EL PASO COUNTY

Approved By_____

Date_____

MAJOR BASIN	SUB BASIN	AREA Planim. Read. AC	AREA MILE	BASIN LENGTH	BASIN HEIGHT	Tc	K	SOIL GROUP	DEV. TYPE	CURVE NO.	FLOW Q 5 YR	FLOW Q 100	FLOW qp	Q cfs 5 YR	Q cfs 100
A	1	2.07	0.003228	900	32	0.09		A		90	1.62	2.55	1000	5.2	8.2
	2	2.59	0.00405	480	10	0.06		"		90	1.62	2.55	"	6.6	10.3
	3	3.51	0.00548	480	10	0.06		"		90	1.62	2.55	"	8.9	14.0
	4	1.10	0.00172	100	4	0.03		"		94	1.97	3.91	"	3.4	6.7
	5	1.85	0.00289	800	10	0.10		"		80	0.96	2.55	"	2.8	7.4
	6	0.97	0.00152	180	2	0.05		"		94	1.97	3.91	"	3.0	5.9
	7	0.88	0.00138	260	3	0.04		"		94	1.97	3.91	"	2.7	5.4
B		5.22	0.0082	700	5	0.10		"		80	0.96	2.55	"	7.8	20.8

HYDROLOGIC COMPUTATION – BASIC DATA

PROJ: ELM GROVE VILLA

By: DGweiss

Date: 2-16-83

WEISS CONSULTING ENGINEERS, INC.

DEVELOPED CONDITION 24 HR STORM

P = 2.6 5 YR 24 HR

P = 4.6 100 YR 24 HR

MAJOR BASIN	SUB BASIN	AREA Planim. Read.	AREA MILE	BASIN LENGTH	BASIN HEIGHT	Tc	K	SOIL GROUP	DEV. TYPE	CURVE NO.	FLOW Q 5-5	FLOW Q 100	FLOW qp	q_{ess} 5	q_{ess} 100
A	6	0.97	0.00152	180	2			A		55	0.10	0.79	1000	0.15	1.20
	7	0.88	0.00138	260	3			"		"	0.10	0.79	1000	0.14	1.10
B		5.22	0.0082	780	5			"		"	0.10	0.79	1000	0.82	6.5

HYDROLOGIC COMPUTATION – BASIC DATA

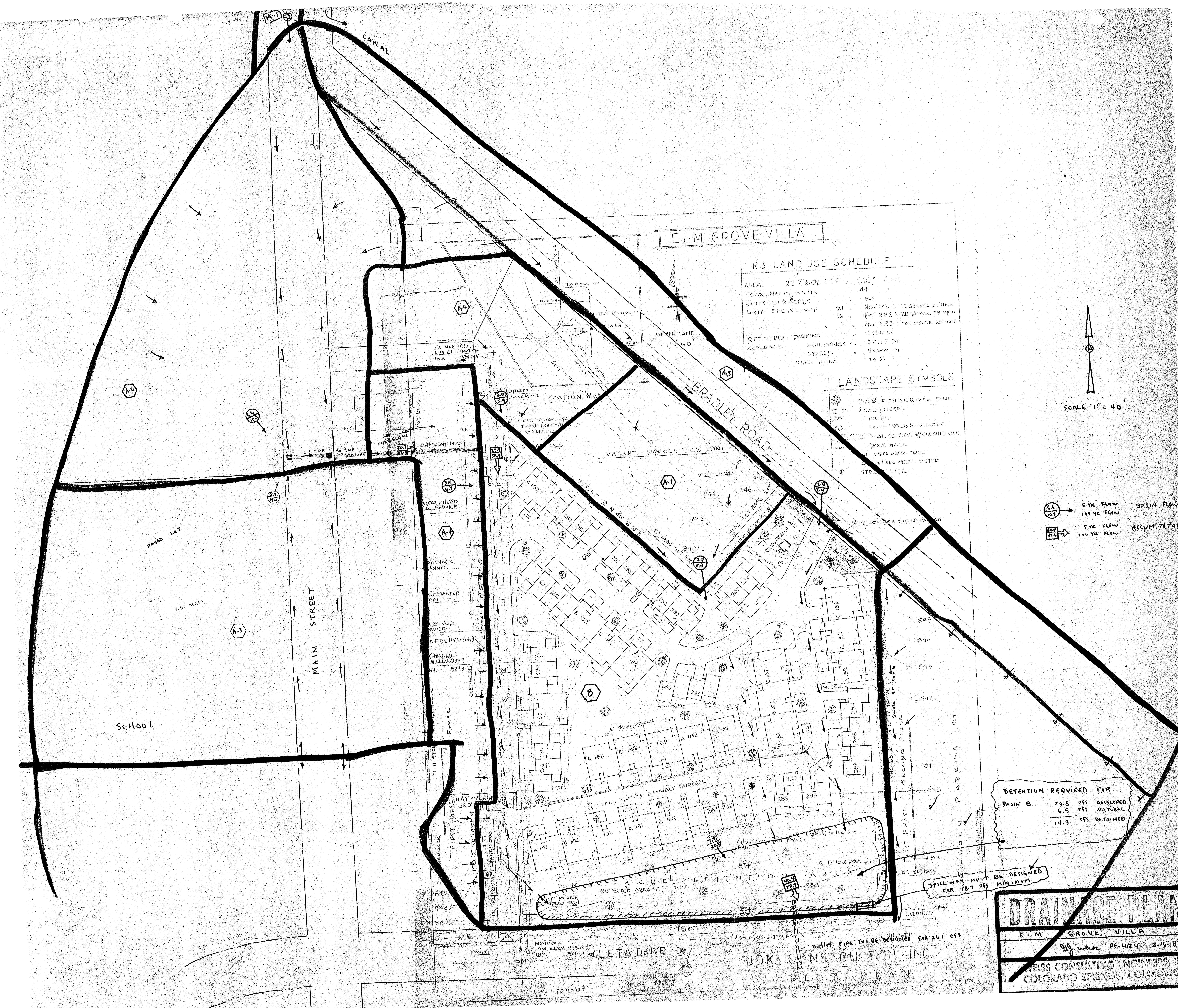
PROJ: ELM GROVE VILLA

By: [signature]

Date: 2/16/83

WEISS CONSULTING ENGINEERS, INC.

UNDEVELOPED CONDITION


DRAINAGE PLAN
ELM GROVE VILLA
D.J. Weiss PE-4124 2-16-8
WEISS CONSULTING ENGINEERS, I
COLORADO SPRINGS, COLORADO
JDK CONSTRUCTION, INC.
PLOT PLAN
ELM GROVE VILLA
R3 LAND USE SCHEDULE
AREA = 227,601 SF
TOTAL NO OF UNITS = 44
UNITS PER ACRES = 8.4
UNIT BREAKDOWN 21 = No. 182
16 = No. 282 2 CAR GARAGE 28' HIGH
7 = No. 283 1 CAR GARAGE 28' HIGH
OFF STREET PARKING = 11 SPACES
COVERAGE: BUILDINGS = 52115 SF
STREETS = 52600 SF
OPEN AREA = 53 %
LANDSCAPE SYMBOLS
5' to 6' PONDEROSA PINE
5 GAL FITZER
RIPRAP
100 TO 150 LB BOULDERS
5 GAL SCHRUBS W/CRUSHED ROCK
ROCK WALL
ALL OTHER AREAS TO BE ... W/SPRINKLER SYSTEM
STREET LITE
SCALE 1" = 40'
5 YR FLOW
100 YR FLOW
BASIN FLOW
ACCUM. TOTAL
CANAL
BRADLEY ROAD
MAIN STREET
LETA DRIVE
SCHOOL
PAVED LOT
VACANT LAND
VACANT PARCEL CZ ZONE
LOCATION MAP
SITE
A-1
A-2
A-3
A-4
A-5
A-7
B
24" CMP
24" CMP EXISTING
OVERFLOW
DRAIN PIPE
EX. MANHOLE RIM EL. 844.96 INV. 834.45
EX. OVERHEAD ELEC. SERVICE
DRAINAGE CHANNEL
EX. 8" WATER MAIN
EX. 8" VCP SEWER
EX. FIRE HYDRANT
EX. MANHOLE RIM ELEV 839.3 INV. 827.3
FIRST PHASE
SECOND PHASE
PARKING LOT
ALL STREETS ASPHALT SURFACE
6' WOOD SCREEN
ONE ACRE DETENTION AREA
NO BUILD AREA
RETAINING WALL
MANHOLE RIM ELEV. 833.12 INV. 821.93
CHURCH BLDG ACROSS STREET
DETENTION REQUIRED FOR
BASIN B 20.8 cfs DEVELOPED
6.5 cfs NATURAL
14.3 cfs DETAINED
SPILL WAY MUST BE DESIGNED FOR 78.7 cfs MINIMUM
outlet pipe to be designed for 26.1 cfs

Appendix F – Entech Engineering, Inc. SSI Report (2018)

ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907
PHONE (719) 531-5599
FAX (719) 531-5238

SUBSURFACE SOIL INVESTIGATION
60' X 80' WAREHOUSE BUILDING
1875 MAIN STREET
SECURITY, COLORADO

Prepared for:

Paul Faricy
4950 New Car Drive
Colorado Springs, Colorado 80923

September 5, 2018

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Reviewed by:

Daniel P. Stegman

Mark H. Hauschild, P.E.
Senior Engineer

DPS/ds

Encl.

Entech Job No. 181342
AA projects/2018/181342 ssi

Table of Contents

SUBSURFACE SOIL INVESTIGATION
60' X 80' WAREHOUSE BUILDING
1875 MAIN STREET
SECURITY, COLORADO

1.0 INTRODUCTION

Paul Faricy is planning the construction of a 60' X 80' warehouse building with associated site improvements located at 1875 Main Street in the northern portion of the Security area in El Paso County, Colorado. The approximate location of the site is shown on the Vicinity Location Map, Figure 1. The planned layout of the proposed development is shown on Figure 2, Test Boring Location Map.

This report describes the subsurface investigation conducted for the planned building and provides recommendations for foundation design and construction. The subsurface soil investigation included drilling test borings at two locations within the footprint of the planned building, collecting samples of soil, and conducting a geotechnical evaluation of the investigation findings. All drilling and subsurface investigation activities were performed by Entech Engineering, Inc. (Entech). The contents of this report, including the geotechnical evaluation and recommendations, are subject to the limitations and assumptions presented in Section 6.0.

2.0 PROJECT AND SITE DESCRIPTION

It is Entech Engineering, Inc. understanding that the project will consist of the construction of a 60' X 80' warehouse building and associated site improvements. The site is located at 1875 Main Street. The site is currently vacant. Vegetation on the site consists of field grasses and weeds. This site area is generally flat with a slight slope to the south. Retaining walls border the southwestern and southeastern boundaries of the site. The site is a flag lot to the east of Main Street, bordered by Cable Lane (closed) to the northeast, existing commercial development to the west, and existing multi-family residential development to the south. A canal exists to the northeast of the site across Cable Lane that flows in a southeasterly direction. Building loads are expected to be light to moderate.

3.0 SUBSURFACE EXPLORATIONS AND LABORATORY TESTING

The subsurface conditions were investigated by drilling two exploratory test borings in the footprint of the proposed building area. The borings were drilled to depths of 20 feet below ground surface (bgs) using a truck-mounted continuous flight auger-drilling rig supplied and operated by Entech Engineering, Inc. Boring Logs with descriptions of the subsurface conditions encountered during drilling and subsequent to drilling are presented in Appendix A. At the conclusion of drilling, observations of groundwater levels were made in each of the open borings. The approximate locations of the test borings are indicated on Figure 2.

Soil samples were obtained from the borings utilizing the Standard Penetration Test (ASTM D-1586) using a 2-inch O.D. split-barrel samplers. Results of the Standard Penetration Test (SPT) are included on the Test Boring Logs in terms of N-values expressed in blows per foot (bpf). Soil samples recovered from the borings were visually classified and recorded on the Test Boring Logs. The soil classifications were later verified utilizing laboratory testing and grouped by soil type. The soil type numbers are included on the Test Boring Logs. It should be understood that the soil descriptions shown on the Test Boring Logs may vary between boring location and sample depth. It should also be noted that the lines of stratigraphic separation

shown on the Test Boring Logs represent approximate boundaries between soil types and the actual stratigraphic transitions may be more gradual and vary with location. The Test Boring Logs are presented in Appendix A.

Moisture Content, ASTM D-2216, was obtained in the laboratory for all recovered samples. Grain-Size, ASTM D-422, and Atterberg Limits, ASTM D-4318, were determined for various samples for the purpose of classification and to obtain pertinent engineering characteristics. Sulfate testing was performed on selected samples to evaluate the soils corrosive characteristics. The Laboratory Test Results are included in Appendix B and summarized in Table 2.

4.0 SUBSURFACE CONDITIONS

Two soil types were encountered in the borings drilled for the subsurface investigation: Type 1A: a silty sand fill/possible fill (SM), and Type 1: a native silty sand (SM). Bedrock was not encountered in the test borings which were drilled to 20 feet. The soil types were classified in accordance with the Unified Soil Classification System (USCS) using the laboratory testing results and the observations made during drilling.

4.1 Soil and Rock

Soil Type 1A classified as a silty sand fill/possible fill (SM). The fill was encountered in Test Boring No. 1 at the existing ground surface and extending to depths of approximately 3 feet (bgs). Standard Penetration Testing conducted on the fill resulted in a SPT N-value of 3 blows per foot (bpf), indicating very loose states. Water content and grain size testing resulted in approximately 13 percent water content with 15 percent of the soil size particles passing the No. 200 sieve. Atterberg limits testing on the sand fill indicated that the soils are non-plastic. Sulfate testing resulted in 0.01 percent soluble sulfate by weight indicating, the fill exhibits a negligible potential for below grade concrete degradation.

Soil Type 1 classified as a native silty sand (SM). The native sand was encountered in both of the test borings at depths ranging from the existing ground surface to approximately 3 feet below ground surface (bgs) and extending to the depths explored (20 feet). Standard

Penetration Testing conduced on the sand resulted in SPT N-values of approximately 2 to 18 blows per foot (bpf), which indicated very loose to medium dense states. Moisture content and grain size testing resulted in moisture contents of 6 to 39 percent with approximately 13 to 14 percent of the soil size particles passing the No. 200 Sieve. Atterberg limits testing on samples of the sand indicated that the soils are non-plastic. Sulfate testing resulted in less than 0.01 percent soluble sulfate by weight, indicating the sand exhibits a negligible potential for below grade concrete degradation due to sulfate attack.

Additional descriptions and engineering properties of the soil encountered during drilling are included on the boring logs. Laboratory Testing Results are summarized on Table 1 and presented in Appendix B. It should be understood that the soil descriptions reported on the boring logs may vary between boring locations and sampling depths. Similarly, the lines of stratigraphic separation shown on the boring logs represent approximate boundaries between soil types and the actual transitions between types may be more gradual or variable.

4.2 Groundwater

Groundwater was encountered at 16.5 and 17.5 feet in the test borings subsequent to drilling. Groundwater should not affect the construction of the shallow foundation with slab-on-grade floors proposed for this site. Development of this and adjacent properties, as well as seasonal precipitation changes, and changes in runoff may affect groundwater elevations.

5.0 GEOTECHNICAL EVALUATION AND RECOMMENDATIONS

The following discussion is based on the subsurface conditions encountered in the borings drilled in the planned building footprint. If subsurface conditions different from those described herein are encountered during construction or if the project elements change from those described, Entech Engineering, Inc. should be notified so that the evaluation and recommendations presented can be reviewed and revised if necessary.

The soils encountered in the building site primarily consisted silty sand fill overlying native silty sand. Up to 3 feet of possible fill was encountered in Test Boring No. 1. Areas of deeper fill may be encountered on this site. The sand soils were encountered at very loose to medium dense states. Given the subsurface conditions encountered at the time of drilling and the site development as described, it is recommended that a shallow foundation bearing on a uniform bearing pad consisting of removed and recompacted site sand soils will be utilized. Existing fill should be completely penetrated or removed and recompacted according to the "Structural Fill" paragraph. Design considerations are discussed in the following sections.

To provide a uniform bearing pad and minimize differential settlements, the site soils should be overexcavated to the depth of 2 feet below footing grade, moisture-conditioned and recompacted. The overexcavation subgrade should be scarified to a minimum depth of 12 inches, be moisture-conditioned and compacted prior to the fill placement. The fill should be placed in maximum 6-inch thick completed lifts. Density tests should be performed to verify compaction with the first density test performed at the scarified overexcavation subgrade (anticipated at 2 feet below foundation and slab grades) and when each 12 to 18 inches of fill has been placed. Fill required for overexcavation or overlot grading should be approved by Entech Engineering and be compacted according to the "Structural Fill" paragraph. Any expansive soils in building areas should be removed to the depth of 3 feet and be replaced with non-expansive structural fill. Any uncontrolled fill in the building area should be completely penetrated or removed. On-site granular soils may be used as structural fill, as approved by Entech.

Groundwater was encountered at 16.5 and 17.5 feet in the test borings subsequent to drilling. Groundwater should not affect the construction of the shallow foundation with slab-on-grade floors proposed for this site. Development of this and adjacent properties, as well as seasonal precipitation changes, and changes in runoff may affect groundwater elevations.

5.1 Subgrade Improvements and Bearing Capacity

The structure can be supported with a shallow foundation resting on a layer of suitable on-site sand placed as structural fill. It is anticipated that a 2 feet thick layer of structural fill will be required depending on the conditions encountered at footing grade. Subgrade preparation and

placement of structural fill shall be according to the structural fill paragraphs. Any uncontrolled fill should be completely removed. Clays encountered at or within 3 feet of foundations or floor slabs should be penetrated or removed and replaced with structural fill. Any fill should be placed to the requirements of the "Structural Fill" paragraph. On-site granular sands may be used as structural fill pending approval by Entech. Any import material should be approved by Entech prior to hauling to the site.

Provided the above recommendations are followed, the proposed structure can be supported with shallow spread footing foundations placed on the uniform bearing pad of recompacted site sands. A maximum allowable bearing pressure of 2200 psf is recommended for foundation members bearing on the recompacted sands. Fill for final design, continuous spread footings are recommended to have a minimum width of 18 inches, and individual column footings for main support beams should have minimum plan dimensions of 24 inches on each side in order to avoid punching failure into the supporting subgrade soils. Exterior footings should extend a minimum of 30 inches below the adjacent exterior site grade for frost protection. Following the above subgrade preparation recommendations, and adhering to the recommended maximum allowable bearing pressure, it is expected to result in foundation design which should limit total and differential vertical movements to 1 and ½ inches, respectively.

Foundation excavations are recommended to extend at least 3 feet horizontally beyond the foundation wall limits (inside and outside) in order to provide adequate space for installation of drain materials (if necessary) and placement of controlled fill. All foundation excavation side slopes should be inclined at angles of $1^1/_2$ horizontal to 1 vertical or flatter, as necessary, to provide for excavation sidewall stability during construction or as required by OSHA regulations.

Entech should observe the overall foundation excavation subgrade and evaluate if the exposed conditions are consistent with those described in this report. Entech should also provide recommendations for overexcavation depth, if necessary, and the need for drain systems based on the excavation conditions observed at that time.

Foundation walls should be designed to resist lateral pressures generated by the soils on this site. An equivalent hydrostatic fluid pressure (in the active state) of 45 pcf is recommended for the granular site soils. It should be noted that these values apply to level backfill conditions. If

sloping backfill conditions exist, pressures will increase substantially depending on the conditions adjacent to the walls. Surcharge loading should also be considered in wall designs. Equivalent fluid pressures for sloping conditions should be determined on an individual basis.

5.2 Site Seismic Classification

Based on the subsurface conditions encountered at the site and in accordance with Section 1613 of the 2009 International Building Code (IBC), the site meets the conditions of a Site Class E.

5.3 On-Grade Floor Slabs

Floor slabs should be supported a minimum 2 feet thick layer of recompacted site soils/structural fill. Any uncontrolled fill should be completely removed and replaced with recompacted soils/structural fill. Clays encountered at or within 3 feet should be penetrated or replaced with structural fill. Backfill placed below floor slabs should be non-expansive and be compacted to a minimum of 95 percent of maximum Modified Proctor Dry Density (ASTM D-1557) per the structural fill paragraphs.

Grade supported floor slabs should be separated from other building structural components and utility penetrations to allow for possible future vertical movement unless they are designed as part of the foundation system. Interior partition walls should be constructed in such a manner so as not to transfer slab movement into the overlying floor(s) and/or roof members, should slab movement occur. Control joints in grade-supported slabs are recommended and should be placed according to ACI Guidelines.

5.4 Surface and Subsurface Drainage

Positive surface drainage must be maintained around the structure to minimize infiltration of surface water. A minimum gradient of 5 percent in the first 10 feet adjacent to foundation walls is recommended. A minimum gradient of 2 percent is recommended for paved areas. All grades should be directed away from the structure. All downspouts should be extended to discharge well beyond the backfill zone of the structure.

A subsurface perimeter drain is not required providing the slab is located above exterior grade, interior and exterior backfill is properly compacted, surface grading is maintained and irrigation is minimized. A subsurface perimeter drain is recommended for useable space below finished grade. A typical drain detail is shown in Figure 3. The drain should be provided with a free gravity outlet or be connected to a sewer underdrain. If such an outlet or connection is not available within a reasonable distance from the structure, a sump and pump system would be required.

To minimize infiltration of water into the foundation zone, vegetative plantings placed close to foundation walls should be limited to those species having low watering requirements and irrigated grass should not be located within 5 feet of the foundation. Similarly, sprinklers are not recommended to discharge water within 5 feet of foundations. Irrigation near foundations should be limited to the minimum amount sufficient to maintain vegetation. Application of more irrigation water than necessary can increase the potential for slab and foundation movement.

5.5 Concrete

Sulfate solubility testing was conducted on two selected soil samples to evaluate the potential for sulfate attack on concrete placed below surface grade. The test results indicated 0.01 to less than 0.01 percent soluble sulfate (by weight). The test results indicate the sulfate component of the in-place soil presents a negligible threat to concrete placed below site grade.

Type II cement is recommended for concrete at this site. To further avoid concrete degradation during construction it is recommended that concrete not be placed on frozen or wet ground. Care should be taken to prevent the accumulation or ponding of water in the foundation excavation prior to the placement of concrete. If standing water is present in the foundation excavation, it should be removed by ditching to sumps and pumping the water away from the foundation area prior to concrete placement. If concrete is placed during periods of cold temperatures, the concrete must be kept from freezing. This may require covering the concrete with insulated blankets and adding heat to prohibit freezing.

5.6 Foundation Excavation Observation

Subgrade preparation for building foundations should be observed by Entech Engineering prior to construction of the footings and floor slab in order to verify that (1) no anomalies are present, (2) materials of the proper bearing capacity have been encountered or placed, and (3) no soft, loose, uncontrolled fill material, expansive soil or debris are present in the foundation area prior to concrete placement or backfilling. Entech should make final recommendations for over-excavation, if required, and foundation drainage at the time of excavation observation, if necessary.

5.7 Structural Fill

Areas to receive fill should have all topsoil, organic material or debris removed. Fill must be properly benched. The fill receiving surface should be scarified to 8 to 12 inches deep and moisture conditioned to within ± 2 percent of its optimum moisture content and compacted to 95 percent of its maximum Modified Proctor Dry Density (ASTM D-1557) beneath footings or floor slabs prior to placing new fill. New fill beneath footings should be non-expansive and be placed in thin lifts not to exceed 6 inches after compaction while maintaining at least 95 percent of its maximum Modified Proctor Dry Density (ASTM D-1557). These materials should be placed at a moisture content conducive to compaction, usually ±2 percent of Proctor optimum moisture content. The placement and compaction of fill should be observed and tested by Entech Engineering, Inc. Imported soils should be approved by Entech Engineering, Inc. prior to being hauled to the site and on-site granular soils prior to placement.

Compacted, non-expansive granular soil, free of organics, debris and cobbles greater than 3-inches in diameter, is recommended for filling foundation components and for filling beneath floor slabs. All fill placed within the foundation area should be non-expansive and be compacted to a minimum of 95 percent of the soils maximum dry density as determined by the Modified Proctor Test (ASTM D-1557). Fill material placed beneath floor slabs should be compacted to a minimum of 95 percent of its maximum Modified Proctor Dry Density, ASTM D-1557. Fill material should be placed in horizontal lifts such that each finished lift has a compacted thickness of six inches or less. Fill should be placed at water contents conducive to

achieving adequate compaction, usually within ±2 percent of the optimum water content as determined by ASTM D-1557. Mechanical methods can be used for placement and compaction of fill; however, heavy equipment should be kept at distance from foundation walls and below slab infrastructure to avoid overstressing. No water flooding techniques of any type should be used for compaction or placement of foundation or floor slab fill material.

5.8 Utility Trench Backfill

Fill placed in utility trenches should be compacted to a minimum of 95 percent of its maximum dry density as determined by the Standard Proctor Test (ASTM D-698) for cohesive soils and 95 percent as determined by the Modified Proctor Test (ASTM D-1557) for cohesionless soils. Fill should be placed in horizontal lifts having a compacted thickness of six inches or less and at a water content conducive to adequate compaction, within ±2 percent of the optimum water content. Mechanical methods should be used for fill placement; however, heavy equipment should be kept at a distance from foundation walls. No water flooding techniques of any type should be used for compaction or placement of utility trench fill.

Trench backfill placement should be performed in accordance with City of Colorado Springs specifications. All excavation and excavation shoring/bracing should be performed in accordance with OSHA guidelines.

5.9 General Backfill

Any areas to receive fill outside the foundation limits should have all topsoil, organic material, and debris removed. Fill must be properly benched into existing slopes in order to be adequately compacted. The fill receiving surface should be scarified to a depth of 8-inches and moisture conditioned to ± 2 percent of the optimum water content, and compacted to a minimum of 95 percent of the ASTM D-1557 maximum dry density before the addition of new fill. Fill should be placed in thin lifts not to exceed 6 inches in thickness after compaction while maintaining at least 95 percent of the ASTM D-1557 maximum dry density. Fill material should be free of vegetation and other unsuitable material and shall not contain rocks or fragments greater than 3-inches. Topsoil and strippings should be segregated from all other fill sources on the site. Fill placement and compaction beneath and around foundations, in utility trenches,

beneath roadways or other structural features of the project should be observed and tested by Entech during construction.

5.10 Excavation Stability

Excavation sidewalls must be properly sloped, benched and/or otherwise supported in order to maintain stable conditions. All excavation openings and work completed therein shall conform to OSHA Standards as put forward in CFR 29, Part 1926.650-652, (Subpart P).

5.11 Winter Construction

In the event construction of the planned facility occurs during winter, foundations and subgrades should be protected from freezing conditions. Concrete should not be placed on frozen soil and once concrete has been placed, it should not be allowed to freeze. Similarly, once exposed, the foundation subgrade should not be allowed to freeze. During site grading and subgrade preparation, care should be taken to eliminate burial of snow, ice or frozen material within the planned construction area.

5.12 Construction Observations

It is recommended that Entech observe and document the following activities during construction of the building foundations.

- Excavated subgrades and subgrade preparation.
- Placement of drains (if installed).
- Placement/compaction of fill material for the foundation components or floor slab.
- Placement/compaction of utility bedding and trench backfill.

6.0 CLOSURE

The subsurface investigation, geotechnical evaluation and recommendations presented in this report are intended for use by Paul Faricy with application to the planned new warehouse building to be located at the 1875 Main Street, in the northern portion of the Security area of El Paso County, Colorado. In conducting the subsurface investigation, laboratory testing, engineering evaluation and reporting, Entech Engineering, Inc. endeavored to work in accordance with generally accepted professional geotechnical and geologic practices and principles consistent with the level of care and skill ordinarily exercised by members of the geotechnical profession currently practicing in same locality and under similar conditions. No other warranty, expressed or implied is made. During final design and/or construction, if conditions are encountered which appear different from those described in this report, Entech Engineering, Inc. requests that it be notified so that the evaluation and recommendations presented herein can be reviewed and modified as appropriate.

If there are any questions regarding the information provided herein or if Entech Engineering, Inc. can be of further assistance, please do not hesitate to contact us.

TABLE

TABLE 1

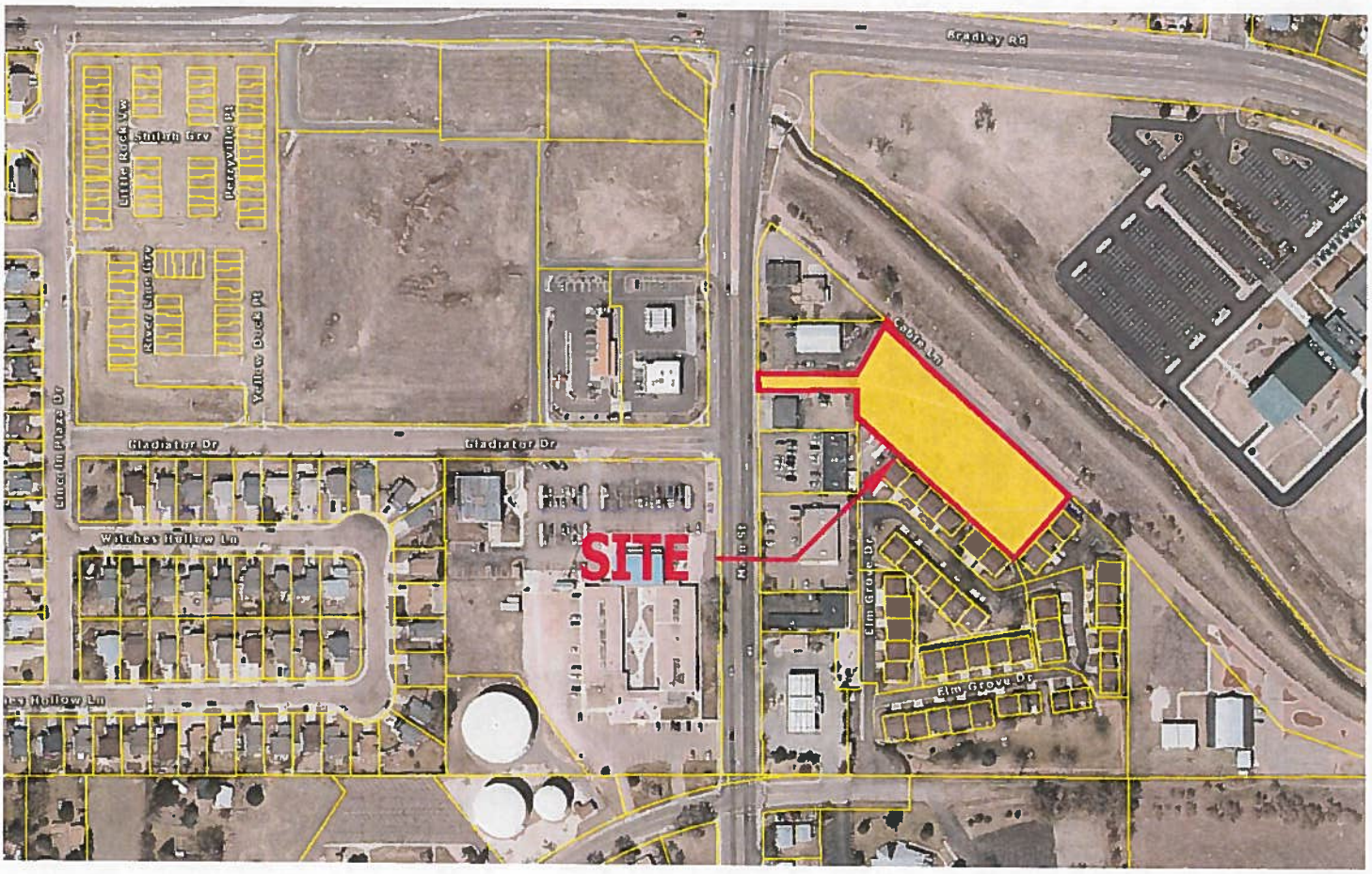
SUMMARY OF LABORATORY TEST RESULTS

CLIENT PAUL FARICY
PROJECT 1875 MAIN STREET
JOB NO. 181342

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	FHA SWELL (PSF)	SWELL/ CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1A	1	2-3			15.3	NV	NP	0.01			SM	FILL, SAND, SILTY
1	1	15			13.8						SM	SAND, SILTY
1	2	5			12.5	NV	NP	<0.01			SM	SAND, SILTY

FIGURES

N



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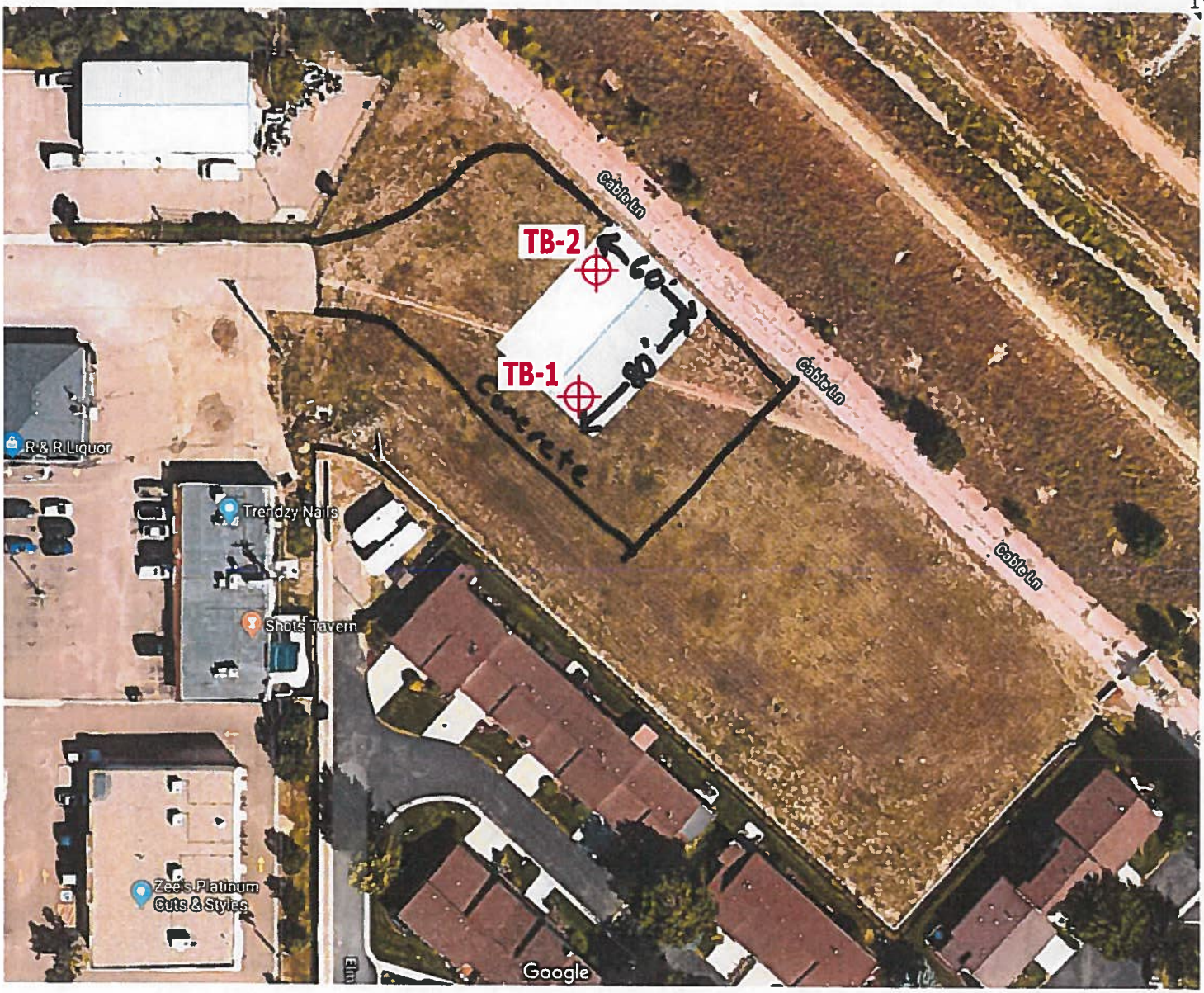
505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907 (719) 531-5599

VICINITY LOCATION MAP
1875 MAIN STREET
SECURITY, CO
FOR: PAUL FARICY

DRAWN BY:	DATE DRAWN:	DESIGNED BY:	CHECKED:
EK	8/29/18	KAH	KAH

JOB NO.: 181342
FIG. NO.: 1



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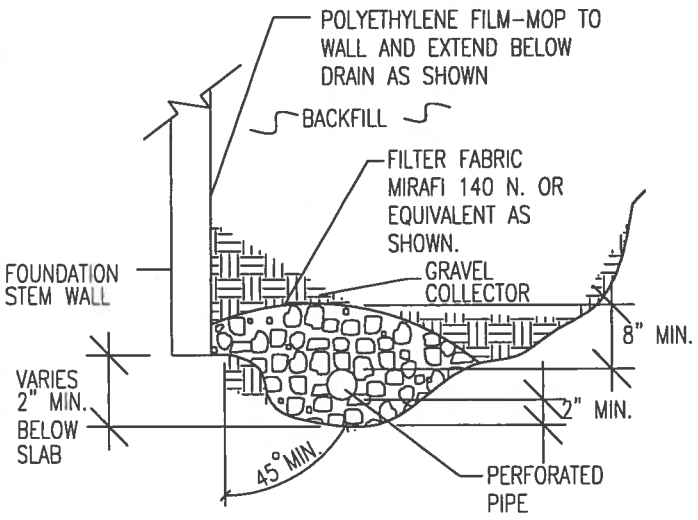
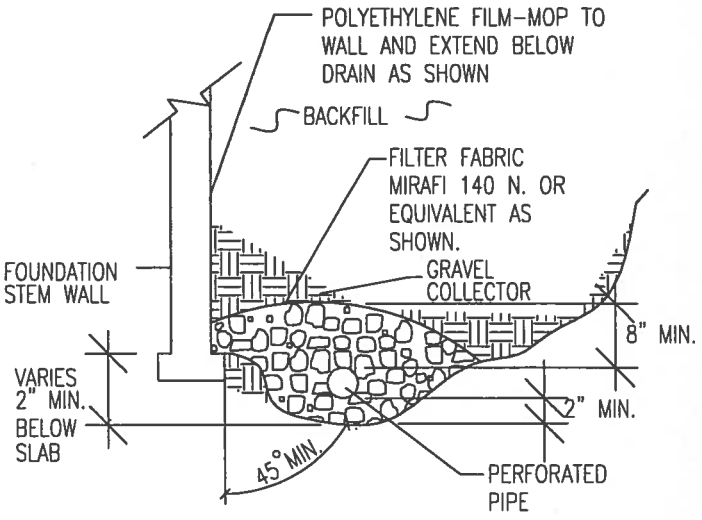
COLORADO SPRINGS, CO. 80907 (719) 531-5599

TEST BORING LOCATION MAP
1875 MAIN STREET
SECURITY, CO
FOR: PAUL FARICY

DRAWN BY:	DATE DRAWN:	DESIGNED BY:	CHECKED:
EK	8/29/18	KAH	KAH

JOB NO.: 181342
FIG. NO.: 2





NOTES:

–GRAVEL SIZE IS RELATED TO DIAMETER OF PIPE PERFORATIONS–85% GRAVEL GREATER THAN 2x PERFORATION DIAMETER.

–PIPE DIAMETER DEPENDS UPON EXPECTED SEEPAGE. 4–INCH DIAMETER IS MOST OFTEN USED.

–ALL PIPE SHALL BE PERFORATED PLASTIC. THE DISCHARGE PORTION OF THE PIPE SHOULD BE NON–PERFORATED PIPE.

–FLEXIBLE PIPE MAY BE USED UP TO 8 FEET IN DEPTH, IF SUCH PIPE IS DESIGNED TO WITHSTAND THE PRESSURES. RIGID PLASTIC PIPE WOULD OTHERWISE BE REQUIRED.

–MINIMUM GRADE FOR DRAIN PIPE TO BE 1% OR 3 INCHES OF FALL IN 25 FEET.

–DRAIN TO BE PROVIDED WITH A FREE GRAVITY OUTFALL, IF POSSIBLE. A SUMP AND PUMP MAY BE USED IF GRAVITY OUT FALL IS NOT AVAILABLE.

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PERIMETER DRAIN DETAIL

DRAWN:	DATE:	DESIGNED:	CHECKED:
	8/29/18	DS	

JOB NO.: 181342

FIG NO.: 3

APPENDIX A: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 8/21/2018
Job # 181342

REMARKS

WATER @ 17.5', 8/23/18

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	Description
			3	13.3	1A	POSS. FILL 0-3', SAND, SILTY, FINE TO MEDIUM GRAINED, BROWN, VERY LOOSE, MOIST
5			10	6.2	1	SAND, SILTY, FINE TO MEDIUM GRAINED, BROWN TO TAN, MEDIUM DENSE TO LOOSE, MOIST TO WET
10			5	6.1	1	
15			9	7.3	1	
20			18	19.1	1	

TEST BORING NO. 2
DATE DRILLED 8/21/2018
CLIENT PAUL FARICY
LOCATION 1875 MAIN STREET

REMARKS

WATER @ 16.5', 8/23/18

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	Description
			2	7.6	1	SAND, SILTY, FINE TO MEDIUM GRAINED, BROWN TO TAN, VERY LOOSE TO MEDIUM DENSE, MOIST TO WET
5			5	8.1	1	
10			4	10.2	1	
15			6	8.9	1	
20			16	16.2	1	

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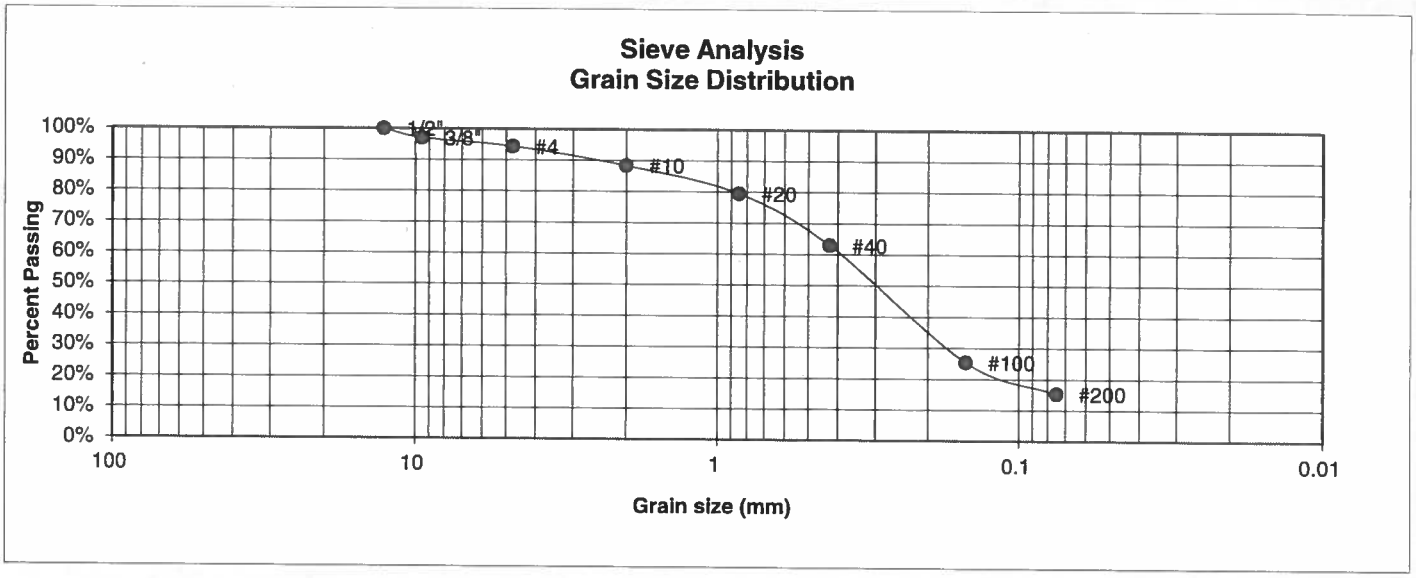
TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
			9/12/18

JOB NO.: 181342
FIG NO.: A- 1

APPENDIX B: Laboratory Testing Results

UNIFIED CLASSIFICATION	SM	CLIENT	PAUL FARICY
SOIL TYPE #	1A	PROJECT	1875 MAIN STREET
TEST BORING #	1	JOB NO.	181342
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	97.1%
4	94.4%
10	88.4%
20	79.5%
40	62.9%
100	25.4%
200	15.3%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

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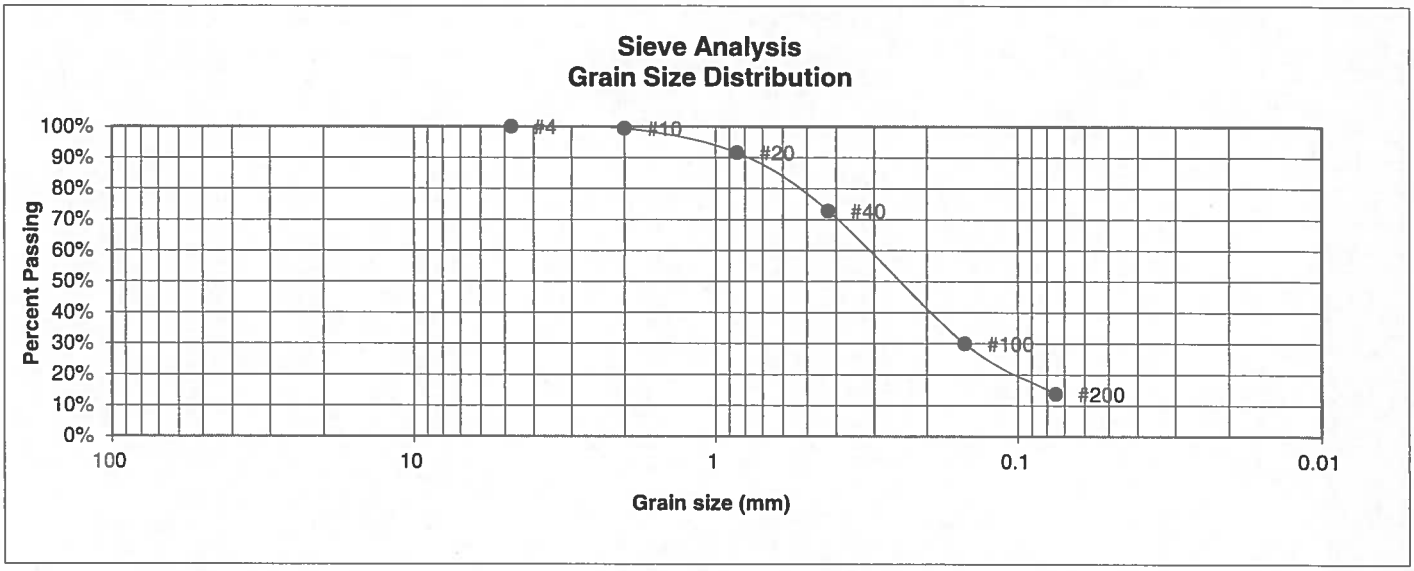
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		h	8/29/18

JOB NO.: 181342

FIG NO.: B-1

UNIFIED CLASSIFICATION	SM	CLIENT	PAUL FARICY
SOIL TYPE #	1	PROJECT	1875 MAIN STREET
TEST BORING #	1	JOB NO.	181342
DEPTH (FT)	15	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.4%
20	91.6%
40	72.8%
100	30.0%
200	13.8%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

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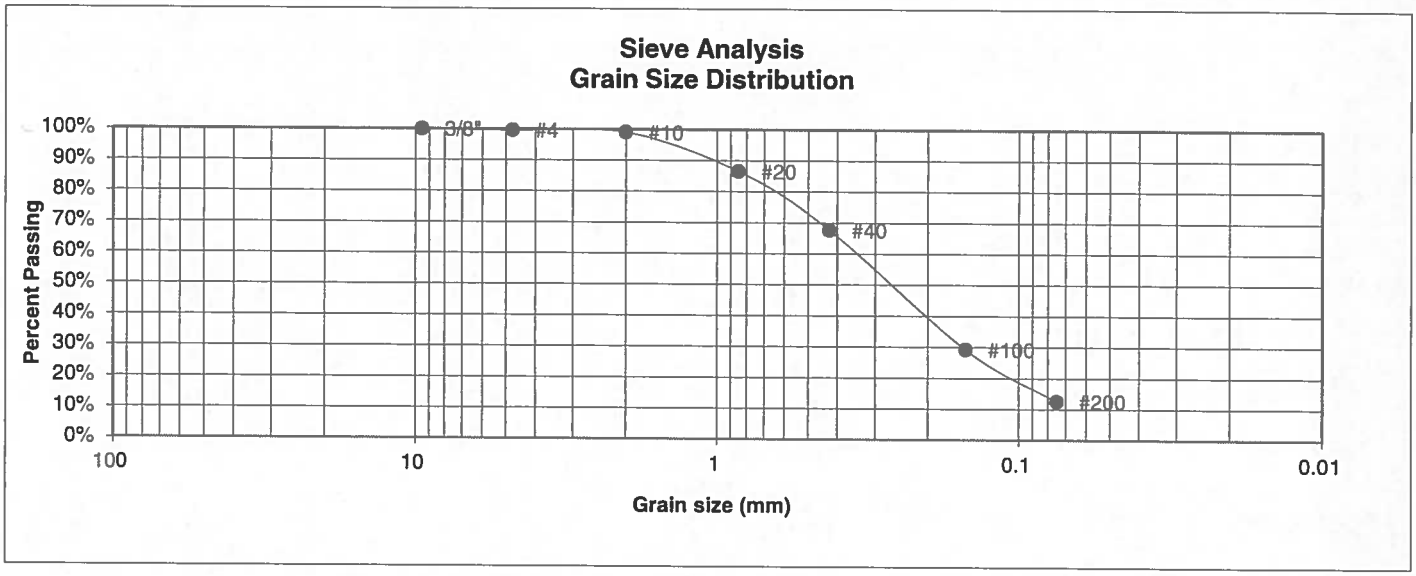
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE: 8/29/18

JOB NO.: 181342

FIG NO.: B-2

UNIFIED CLASSIFICATION	SM	CLIENT	PAUL FARICY
SOIL TYPE #	1	PROJECT	1875 MAIN STREET
TEST BORING #	2	JOB NO.	181342
DEPTH (FT)	5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.6%
10	99.0%
20	86.6%
40	67.7%
100	29.2%
200	12.5%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

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COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			8/29/18

JOB NO.: 181342

FIG NO.: B-3

CLIENT	PAUL FARICY	JOB NO.	181342
PROJECT	1875 MAIN STREET	DATE	8/27/2018
LOCATION	1875 MAIN STREET	TEST BY	BL

BORING NUMBER	DEPTH, (ft)	SOIL TYPE NUMBER	UNIFIED CLASSIFICATION	WATER SOLUBLE SULFATE, (wt%)
TB-1	2-3	1A	SM	0.01
TB-2	5	1	SM	<0.01

QC BLANK PASS

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LABORATORY TEST
SULFATE RESULTS

DRAWN:	DATE:	CHECKED:	DATE: 8/29/18

JOB NO.: 181342

FIG NO.: B-4

Markup Summary

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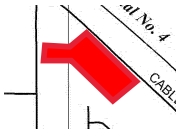

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Page Label: 17
Author: Daniel Torres
Date: 5/13/2019 6:41:05 PM
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Please relocate the drainage plans to the end of the drainage report

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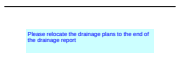

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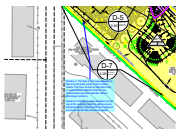

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Author: Daniel Torres
Date: 5/13/2019 6:56:06 PM
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Review 1: The flow in this area appears to flow into the back yards of the homes below. This flow should be directed to be in conformance with the FDR for the downstream site and maintain historic discharge locations.

Review 2: Please provide elevations at the top of the existing retaining wall to ensure that flow will be redirected to the southeast as shown by the flow arrows provided.