FINAL DRAINAGE REPORT
FOR

Chick-fil-A Powers & Palmer Park

Portion of Lot 1, Block 1, Waldorf Subdivision
Located in the Southwest Quarter of the Southwest Quarter of Section 6, Township 14 South, Range 65 West of the 6th P.M.
City of Colorado Springs, County of El Paso, State of Colorado

EL PASO COUNTY, COLORADO

Prepared For:

Chick-fil-A, Inc.
5200 Buffington Road
Atlanta, GA 30349-2998
(303) 519-2732
Contact: Steve Schwartz

Prepared By:

MERRICK®

Merrick & Company
5970 Greenwood Plaza Blvd.
Greenwood Village, CO 80111
(303) 353-3926
Contact: Jon Killingsworth, P.E.
Phone: 303-353-3695
Project No. 65121141

January, 2025

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 of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report..

Jon Killingsworth P.E. No. xxxxxxx _______ Date Seal

Developer's Statement:

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

Business Name

By:________________________________

Title: ______________________________

Address: ___________________________

El Paso County Statement:

Filed in accordance with Section 51.1 of the El Paso Land Development Code as amended.

Director of Public Works Date

Conditions:

TABLE OF CONTENTS

A. GENERAL LOCATION AND DESCRIPTION

A. BACKGROUND/PURPOSE

This project is located in the southwest 1/4 of the southwest 1/4 of Section 6, Township 14 South, and Range 65 West of the 6th Principal Meridian. The property to be developed is located on a portion of Lot 1, Block 1 of the previously platted Waldorf Subdivision. The property is located at 5885 Palmer Park Blvd in the City of Colorado Springs, El Paso County, Colorado. The streets that border the project area are N Powers Blvd to the West, Palmer Park Blvd to the North and Omaha Blvd to the South. The site currently consists of a paved parking lot. See Appendix A for Vicinity Map of project area. This drainage report is intended to discuss water quality measures to be implemented that will satisfy all applicable standards and requirements.

The project site is located within the Waldorf Subdivision and is bordered by Lot 2, Block 1 to the north, a portion of Lot 1, Block 1 to the east, and Lot 3, Block 1 of the Waldorf Subdivision to the south.

B. EXISTING CONDITIONS

I. DESCRIPTION OF PROPERTY

The site has an area of 1.52 acres, with a total disturbance area of 1.54 acres, more or less. The site is fairly flat, with an average slope of approximately 2.0%, generally, from the northeast corner to the southwest corner of the site where it is collected in a trench drain and conveyed to a grass-lined drainage swale to the west. The site currently consists mainly of an asphaltic parking lot. Runoff flows to the south along the swale and into an existing storm inlet near the intersection of N Powers Blvd and Omaha Blvd where it is conveyed, ultimately, to Sand Creek. The soil type across the site consists of Blendon Sandy Loam at slopes of 0-3%. The soil present on the site is of Hydrologic Soil Group B. See Appendix D for the Custom Soils Resource Report for the site.

There are no known major or minor drainageways located adjacent to the development. Existing storm infrastructure captures and conveys peak storm runoff to Sand Creek located west of the Site.

There are no known existing irrigation canals or ditches on or near the proposed Site. Underground utilities shall not cause any encumbrance on the site development.

II. MAJOR DRAINAGE BASINS DESCRIPTION

The site is located within the Sand Creek Drainage Basin. Flows from the Sand Creek Drainage Basin outfall to Sand Creek which then flows to Fountain Creek. The drainage basin has an area of approximately 52.4 square miles. The site was previously studied as part of the previously approved Drainage Letter for Powers Plaza by Leigh Whitehead & Associates, January, 1984. This drainage letter was the most recent drainage letter obtained and the site has since been modified and developed by others. Drainage aspects described in this drainage letter are no longer applicable for the site.

The proposed improvements are not within a 100-year floodplain, FIRM #08041CO751G; effective 12/07/2018. See Appendix A for FEMA FIRM Floodplain maps.

There are no known existing irrigation canals, ditches or other obstructions which could influence or be influenced by local drainage on or near the proposed Site.

III. EXISTING SUB-BASINS DESCRIPTION

Storm runoff currently flows, generally, from northeast to southwest across an open parking lot to an existing trench drain located at the southwest corner of the site. Flows are then conveyed to the west to an existing grass lined swale. The swale runs north to south and flows are then captured in a storm inlet at the intersection of N Powers Blvd and Omaha Blvd. Flows are conveyed through the existing storm system which outfalls to Sand Creek and, ultimately, to Fountain Creek. Detailed, existing drainage patterns, routing, flows, etc are provided below.

Existing Basin 1 (EX1)
Existing Basin EX1 has an overall area of 67,153 square feet (1.54 ac) and sheet flows overland from the northeast corner of the site, generally, to the southwest to an existing trench drain at the southwest corner of the site. The 2-year maximum flow rate at a point hour rainfall depth (P_1) of 1.19 inches for this basin is 16.9 cfs and the 100-year maximum flow rate at a point hour rainfall depth (P_1) of 2.52 inches for this basin is 30.9 cfs (see Appendix B).

Existing Basin 2 (EX2)
Existing Basin EX2 has an overall area of 175,725 square feet (4.03 ac) and sheet flows overland from the northwest corner of the VASA Fitness, generally, to the southwest toward the project area (defined as EX1). Flows are directed from Basin EX2 to an existing trench drain at the southwest corner of the site. The 2-year maximum flow rate at a point hour rainfall depth (P_1) of 1.19 inches for this basin is 6.3 cfs and the 100-year maximum flow rate at a point hour rainfall depth (P_1) of 2.52 inches for this basin is 11.7 cfs (see Appendix B).

Existing drainage patterns shall be generally maintained with proposed construction. Flows will be ultimately conveyed to the existing grass lined drainage swale located west of the site along the eastern edge of N Powers Blvd.

C. PROPOSED CONDITIONS

The proposed Site will include a commercial drive-thru Chick-fil-A restaurant located at the southeast corner of the existing VASA Fitness Center parking lot. The proposed structure will be approximately 2,714 square feet more or less containing 0 interior seats and 50 exterior. The drive-thru entrance will be at the northern edge of the site and wrapping around to the south and along the western edge of the building containing two lanes, an order point canopy, and a meal delivery canopy attached to the building. There will be landscaping along the eastern edge of the site between the site and N Powers Blvd, as well as landscaping within the parking islands and throughout the site.

The Site will maintain the historic drainage patterns and convey peak storm runoff, generally, to one of two, proposed Type 13 Inlets where runoff will be conveyed to a stormwater quality structure at the southwest corner of the site and will then be conveyed to an existing drainage swale west of the site. Runoff shall be conveyed through the existing swale, captured in an existing storm inlet at the corner of N Powers Blvd and Omaha Blvd. and then conveyed to Sand Creek to the west and, ultimately, to Fountain Creek.

D. DRAINAGE DESIGN CRITERIA

A. REGULATIONS

Design standards and criteria presented in the *City of Colorado Springs Drainage Criteria Manual, Volumes 1-2,* by City of Colorado Springs, January 2021, the *Drainage Criteria Manual County of El Paso, Colorado Volume 1*, by El Paso County Colorado, June, 2021, and the *Urban Drainage Criteria Manual, Volumes 1-3,* by Urban Drainage and Flood Control District, Inc, updated 2024 were used in the development of this report and analysis presented herein.

B. DRAINAGE STUDIES, MASTER PLANS, and SITE CONSTRAINTS

No existing drainage studies were found to be relevant to the current site configuration.

C. HYDROLOGIC CRITERIA

2-year and 100-year storm event runoff was calculated using the Rational method. Percent imperviousness values are from Table 6-3 of the *MHFD Manual*.
Runoff coefficients are from Table 6-4 of the *MHFD Manual* using hydrologic soil group B. Times of concentration were based on land use imperviousness values as well as distance and slope of runoff travel. Runoff conveyance coefficients were determined using Table 6-2 from the *Criteria.*
Rainfall intensities (I) for the area are approximated by the equation:

$$I = -P1(\ln(tc)) + 12.735$$

P_1 represents the 1-hour design rainfall values in inches per Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency shown in the *City of Colorado Springs Drainage Criteria Manual*. T_c represents the time of concentration in minutes and consists of overland flow time plus travel time. Time of concentration is calculated as the sum of the overland flow time and travel time. Overland flow time is calculated over a maximum 300 foot distance using the FAA equation:

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

C_5 = basin composite runoff coefficient for the five-year storm event
L = length of overland flow in feet
S = slope of flow path in percent
T_i = travel time in minutes

Travel time is calculated as the flow time through a length of street gutter or channel by multiplying the average flow velocity by the travel length. The minimum time of concentration used for urbanized basins was 5 minutes.
All hydrological calculations, including a summary of the 2-year and 100-year storm event flows, are provided in Appendix B. Basin maps are also included in Appendix A.

D. HYDRAULIC CRITERIA

Hydraulic calculations in compliance with the Manual for street capacity, inlet calculations, pipe sizes, etc. will be included as part of the final drainage report. The Urban Drainage Inlet Sizing spreadsheet will be used to size proposed site inlets.

E. WATER QUALITY ENHANCEMENT

Water quality treatment will be provided via on-site stormwater quality structures. These shall be sized to remove a minimum of 80% of Total Suspended Solids (TSS) from the site runoff. Bypass runoff from offsite drainage shall not be treated.

F. FULL SPECTRUM DETENTION

Full spectrum detention is provided downstream in an existing regional detention facility. Water quality shall be provided on-site, and a reduction in flows from the site are anticipated with the proposed improvements.

E. FOUR STEP PROCESS

El Paso County has required the UDFCD Four Step Process be utilized for receiving waters protection since 2002. The goal of the Four Step Process is to reduce runoff volumes, treat the water quality capture volume of runoff, stabilize drainageways, and implement long-term source controls. For development projects with construction activities disturbing 1 acre or more, the Four Step Process must be implemented. Below is a description of all steps of the Four Step Process and how they were utilized in design.

A. STEP 1: EMPLOY RUNOFF REDUCTION PRACTICES

In order to reduce the runoff to the Sand Creek, LID strategies were implemented. LID techniques investigated and/or utilized include conserving existing features and minimizing impact to the overall site. Landscaping in lieu of the existing asphaltic parking lot along the western edge of the site provides a reduction of runoff between the site and the grass-lined swale conveying and treating runoff.

B. STEP 2: IMPLEMENT BMPS THAT PROVIDE A WATER QUALITY CAPTURE VOLUME WITH SLOW RELEASE

For our site, stormwater quality structures shall provide treatment and slow release of on-site flows. Currently, flows are unrestricted from the large impervious parking lot. Downstream conditions shall be improved overall from the development of this site.

C. STEP 3: STABILIZE DRAINAGEWAYS

Runoff flows directly offsite via underground storm piping to the south. Currently, the 100-year storm runoff is 11.7 cfs. The proposed 100-year storm runoff of 10.1 cfs will not impact downstream drainageways. We are providing an overall reduction in runoff from the site with the development of the site. No streams or drainageways are present on, or adjacent to, the site.

D. STEP 4: IMPLEMENT SITE SPECIFIC AND OTHER SOURCE CONTROL BMPS

Sites with specific needs, such as material storage or other site operations, require specific, source control BMPs be implemented on site, post-construction. For this site, contaminants from site activities are not anticipated. In addition, no hazardous materials or other outdoor storage will be done on-site. No site specific or other source control BMPs are proposed for this site.

F. DRAINAGE FACILITY DESIGN

A. HYDROLOGIC CALCULATIONS

The rational method was implemented in order to determine the runoff from each basin, as defined in the Basin Plan. The Site is comprised of 3 on-site drainage basins and 2 off-site drainage basins. The existing and proposed basins and design points are depicted on the associated drainage plan included in Appendix A. Below is a description of the drainage basins delineated for the proposed development.

Basin A1

Basin A1 has an overall area of 41,824 square feet (0.96 ac) and sheet flows overland from the northeast corner of the site, generally, to the west through a curb cut and curbline flow and be collected proposed 5’ Type 13 Inlet along the western edge of the Chick-fil-A drive-thru lane. The 2-year maximum flow rate at a point hour rainfall depth of 1.19 inches for this basin is 2.7 cfs and the 100-year maximum flow rate at a point hour rainfall depth of 2.52 inches for this basin is 6.2 cfs (see Appendix B).

Basin A2

Basin A2 has an overall area of 21,294 square feet (0.49 ac) and consists of the southerly portion of the site, a portion of the building roof, and landscaping to the south. Developed runoff from the basin will sheet flow overland where it will be conveyed via curb and gutter to the west and be collected in a 5' Type 13 Inlet along the southern edge of the Chick-fil-A drive-thru. The 2-year maximum flow rate at a point hour rainfall depth of 1.19 inches for this basin is 2.7 cfs and the 100-year maximum flow rate at a point hour rainfall depth of 2.52 inches for this basin is 6.2 cfs (see Appendix B).

Basin A3

Basin A3 has an overall area of 4,035 square feet (0.09 ac) and consists of the southwesterly portion of the site and consists of a pervious, landscaped area. Runoff from the basin will sheet flow directly off-site and into an existing grass-lined drainage swale where it will follow historic drainage patterns. The 2-year maximum flow rate at a point hour rainfall depth of 1.19 inches for this basin is 0.004 cfs and the 100-year maximum flow rate at a point hour rainfall depth of 2.52 inches for this basin is 0.3 cfs (see Appendix B).

Basin OS1

Basin OS1 has an overall area of 56,216 square feet (1.29 ac) and consists of a drainage area northeast of the site. Runoff from the existing offsite basin will sheet flow overland and into Basin A1. The 2-year maximum flow rate at a point hour rainfall depth of 1.19 inches for this basin is 5.4 cfs and the 100-year maximum flow rate at a point hour rainfall depth of 2.52 inches for this basin is 9.8 cfs (see Appendix B).

Basin OS2

Basin OS2 has an overall area of 29,169 square feet (0.67 ac) and consists of a drainage area east of the site. Runoff from the existing offsite basin will sheet flow overland and into Basin A2. The 2-year maximum flow rate at a point hour rainfall depth of 1.19 inches for this basin is 2.3 cfs and the 100-year maximum flow rate at a point hour rainfall depth of 2.52 inches for this basin is 5.1 cfs (see Appendix B).

Table 1: 2-Year Storm Runoff

	2-Year Direct Runoff						
Basin Name	Design Point	Area (ac)	Runoff Coeff	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)
EX1	1	1.54	0.79	5.0	1.22	5.17	6.3
EX2	1	4.03	0.81	5.0	3.27	5.17	16.9
A1	1	0.96	0.54	5.0	0.52	5.17	2.7
A2	2	0.49	0.75	5.0	0.37	5.17	1.9
A3	4	0.09	0.01	6.6	0.00	4.75	0.004
OS1	1	1.29	0.80	5.0	1.04	5.17	5.4
OS2	2	0.67	0.84	5.0	0.56	4.04	2.3
	1	Combined flows from A1 and OS1					
	1	2.25	0.69	5.7	1.55	3.89	6.0
	2	Combined flows from A2 and OS2					
	2	1.16	0.74	5.1	0.86	4.01	3.4
	3	Combined flows from DP1 and DP2 (Including Bypass Flow)					
	3	3.41	0.71	5.7	2.41	3.89	9.4
	3	Combined flows from DP1 and DP2 (On-site Flow for WQ)					
	3	1.45	0.61	5.0	0.88	4.04	3.6
	4	Combined flows from All Basins Discharging to EX Swale					
	4	3.50	0.69	5.7	2.41	3.89	9.4

Table 2: 100-Year Storm Runoff

	100-Year Direct Runoff						
Basin Name	Design Point	Area (ac)	Runoff Coeff	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)
EX1	1	1.54	0.87	5.0	1.35	8.68	11.7
EX2	1	4.03	0.88	5.0	3.56	8.68	30.9
A1	1	0.96	0.75	5.0	0.72	8.68	6.2
A2	2	0.49	0.85	5.0	0.42	8.68	3.6
A3	4	0.09	0.44	6.6	0.04	7.98	0.3
OS1	1	1.29	0.88	5.0	1.13	8.68	9.8
OS2	2	0.67	0.90	5.0	0.60	8.55	5.1
	1	Combined flows from A1 and OS1					
	1	2.25	0.82	5.7	1.85	8.24	15.2
	2	Combined flows from A2 and OS2					
	2	1.16	0.84	5.1	0.97	8.50	8.3
	3	Combined flows from DP1 and DP2 (Including Bypass Flow)					
	3	3.41	0.83	5.7	2.82	8.24	23.3
	3	Combined flows from DP1 and DP2 (On-site Flow for WQ)					
	3	1.45	0.78	5.0	1.13	8.55	9.7
	4	Combined flows from All Basins Discharging to EX Swale					
	4	3.50	0.82	5.7	2.86	8.24	23.6

Total runoff from new development entering the existing drainage swale is 10.0 cfs (sum of "Combined flows from DP1 and DP2 (On-site Flow for WQ)" and Basin A3). Existing runoff for the development area was 11.7 cfs. A net runoff reduction of 1.7 cfs is realized from the proposed development.

B. <u>HYDRAULIC CALCULATIONS</u>

Inlet Sizing Calculations

Storm runoff is captured in one of two 6' Type 13 Inlets in a sump condition on site and conveyed via storm system, ultimately, to an outfall at the southwest corner of the site. A 6' Type 13 Inlet , has a capture capacity of 6.6 cfs (adequate to convey the 100-year on-site flows of 6.2 from Basin A1 and 3.6 for Basin A2). Offsite flows shall bypass these two Type 13 inlets and flow overland to the existing grass lined swale to the west of the site, following historic conditions.

All on-site flow captured from impervious surfaces is collected in a common 96” Diameter ADS Barracuda Max S8 Hydrodynamic Separator providing an 80% removal of of TSS from the runoff flow prior to release into the existing system. The 96” ADS water quality basin structure has a capacity of 6.08 cfs and has been sized to handle the 2-year on-site runoff of 3.6 cfs.

In order to ensure there is no stormwater surcharge during the major storm event, the major storm hydraulic grade line elevations were determined for each storm conveyance pipeline to be installed. For the design of all pipelines on site, the pipes were sized to convey the 100-year storm event without being under pressure. The pipes installed on-site are oversized and the normal depth in the pipe is representative of the HGL for the stormwater flows. For the storm pipe from Design Point 1 to Design Point 3, the total flow conveyed in the pipe is consistent with the maximum flow entering the Type 13 Inlet of 6.6 cfs. The normal depth (HGL) is 7.4 inches in the 24-inch RCP pipe. For the storm pipe from Design Point 2 to Design Point 3, the total flow conveyed in the pipe is consistent with the maximum flow entering the Type 13 Inlet of 6.6 cfs. The normal depth (HGL) is 7.4 inches in the 24-inch RCP pipe. For the storm pipe from Design Point 3 to Design Point 4, the total flow conveyed in the pipe is consistent with the maximum flow entering the 2, Type 13 Inlet of 13.2 cfs. The normal depth (HGL) is 9.7 inches in the 30-inch RCP pipe. No storm pipe within the system is over 1/2 full in the 100-year storm event. It is not anticipated that any pipe will be surcharged in the 100-year storm event. For all storm sizing and HGL calculations, see Appendix B.

C. ENGINEERS OPINION OF PROBABLE CONSTRUCTION COSTS

Provided below is the engineers estimate of probable construction costs for the proposed stormwater conveyance and water quality features. All costs included are for private facilities and are non-reimbursable:

Engineers Opinion of Probable Construction Costs

Line Item Description	*Quantity*	*Unit*	*Unit Price*	*Line Item Cost*
Excavation (Pipe and Inlets Only)	270	CY	$10.75	$2,903
24-Inch RCP Pipe	252	LF	$80.00	$20,160
30-Inch RCP Pipe	40	LF	$120.00	$4,800
30-Inch Flared End Section	1	EA	$2,000.00	$2,000
Type 13 Inlet (6' Length)	2	EA	$7,500.00	$15,000
96” Diameter ADS Barracuda Max S8 Hydrodynamic Separator	1	EA	$35,000.00	$35,000
			Total	**$79,900**

Drainage basin fees for the property are anticipated to be $25,632. Bridge fees for the property are anticipated to be $10,484.

G. CONCLUSIONS

This Storm Drainage Report for the Chick-fil-A Powers and Palmer Park summarizes the anticipated runoff volumes for the proposed development for various storm events and describes the proposed infrastructure and water quality measures implemented prior to release into the existing storm system. It is the professional opinion of the engineer that the proposed improvements will not have any negative impacts on the existing site conditions or the storm drainage system's ability to convey flows from the site and will not adversely affect the downstream and surrounding developments. Report and findings presented herein are in general conformance with the Master Drainage Development Plan and all other relevant, previously approved studies/reports.

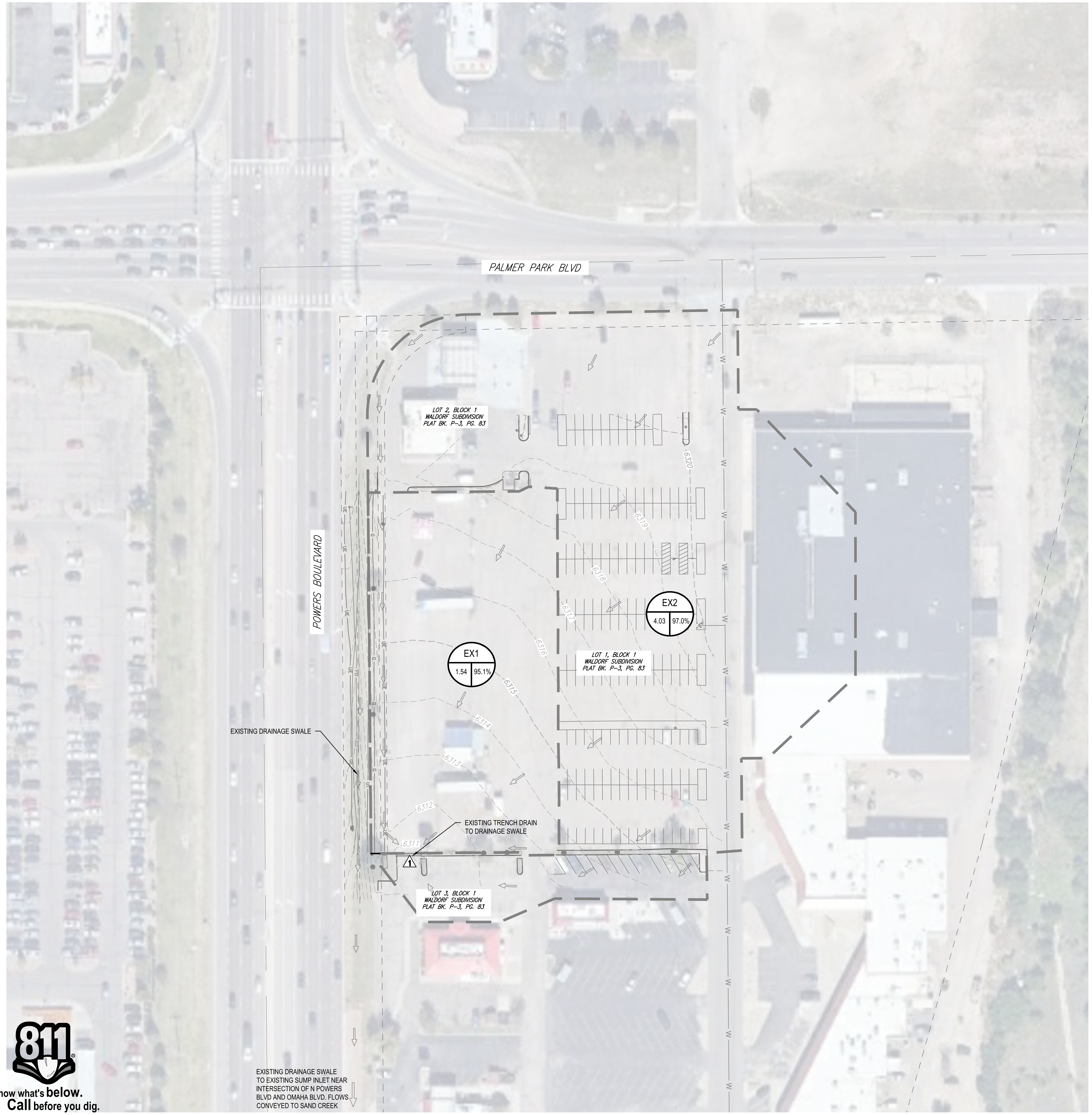
References:

Drainage Criteria Manual, County of El Paso, Colorado, Volumes 1-2, by El Paso County, June 2021

Urban Drainage Criteria Manual, Volumes 1-3, by Urban Drainage and Flood Control District, Inc, Updated March, 2024

City of Colorado Springs Drainage Criteria Manual, Volumes 1-2, by City of Colorado Springs, January 2021

Appendix A
(Maps)



LEGEND

- BASIN ID
- BASIN AREA (ACRES)
- IMPERVIOUSNESS
- A2 / 0.75 / 70.5%
- DESIGN POINT
- PROPOSED FLOW OF WATER
- EXISTING FLOW OF WATER
- PROPOSED STORM SEWER
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- EXISTING BASIN BOUNDARY
- PROPOSED MAJOR CONTOUR (4920)
- PROPOSED MINOR CONTOUR
- PROPOSED LIMITS OF DISTURBANCE

N

50' 0 25' 50' 100'

1" = 50' HOR.

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FOR AND AND ON-BEHALF OF
MERRICK AND COMPANY

SITE DEVELOPMENT PLAN

CHICK-FIL-A
POWERS & PALMER PARK

5885 PALMER PARK BLVD
COLORADO SPRINGS, CO 80915

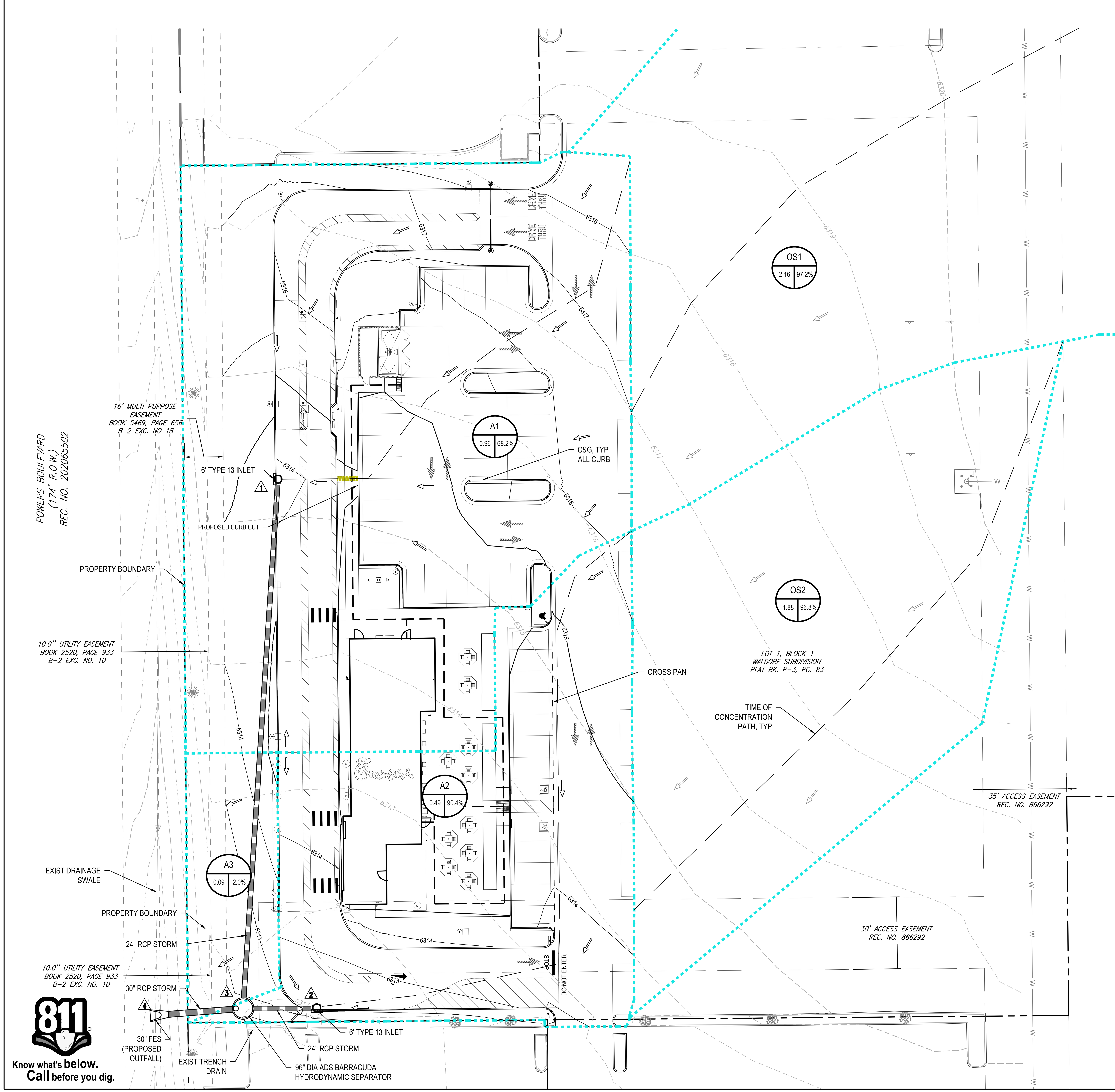
FSR#05934

BUILDING TYPE / SIZE:	P12 LS LRG
RELEASE:	vX.YY.MM

REVISION SCHEDULE

NO.	DATE	DESCRIPTION

CONSULTANT PROJECT #	
PRINTED FOR	
DATE	XX/XX/2024
DRAWN BY	KEA
SHEET	EXISTING DRAINAGE BASIN MAP
SHEET NUMBER	1



LEGEND

- BASIN ID / BASIN AREA (ACRES) / IMPERVIOUSNESS (example: A2, 0.75, 70.5%)
- DESIGN POINT
- PROPOSED FLOW OF WATER
- EXISTING FLOW OF WATER
- PROPOSED STORM SEWER
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- EXISTING BASIN BOUNDARY
- PROPOSED MAJOR CONTOUR (4920)
- PROPOSED MINOR CONTOUR
- PROPOSED LIMITS OF DISTURBANCE

NOTES:

1. ALL DIMENSIONS ARE FROM FLOWLINE UNLESS OTHERWISE NOTED.
2. REFER TO ARCHITECTURE PLANS FOR CANOPY INFORMATION.
3. REFER TO SIGNAGE PACKAGE FOR ALL SITE AND CHICK-FIL-A SIGN DETAILS.
4. ALL CURB ALONG CONCRETE DRIVE THROUGH TO BE MONOLITHICALLY POURED WITH DRIVE THROUGH.
5. STRIPING ON ASPHALT TO BE WHITE PAINT AND STRIPING ON CONCRETE TO BE YELLOW PAINT.

	100-Year Direct Runoff						
Basin Name	Design Point	Area (ac)	Runoff Coeff	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)
A1	1	0.96	0.75	5.0	0.72	8.68	6.2
A2	2	0.49	0.85	5.0	0.42	8.68	3.6
A3	4	0.09	0.44	6.6	0.04	7.98	0.3
OS1	1	1.29	0.88	5.0	1.13	8.68	9.8
OS2	2	0.67	0.90	5.0	0.60	8.55	5.1
	1	Combined flows from A1 and OS1					
	1	2.25	0.82	5.7	1.85	8.24	15.2
	2	Combined flows from A2 and OS2					
	2	1.16	0.84	5.1	0.97	8.50	8.3
	3	Combined flows from DP1 and DP2 (Including Bypass Flow)					
	3	3.41	0.83	5.7	2.82	8.24	23.3
	3	Combined flows from DP1 and DP2 (On-site Flow for WQ)					
	3	1.45	0.78	5.0	1.13	8.55	9.7
	4	Combined flows from All Basins Discharging to EX Swale					
	4	3.50	0.82	5.7	2.86	8.24	23.6

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CHICK-FIL-A
POWERS & PALMER PARK
SEC OF POWERS BLVD AND PALMER PARK BLVD COLORADO SPRINGS, CO 80915

CONSTRUCTION DOCUMENTS

FSR#05934

BUILDING TYPE / SIZE: P12 LS LRG
RELEASE: vX.YY.MM

REVISION SCHEDULE

NO.	DATE	DESCRIPTION

CONSULTANT PROJECT #
PRINTED FOR
DATE 01/31/2024
DRAWN BY CSS
SHEET PROPOSED DRAINAGE BASIN MAP
SHEET NUMBER
2

File Path: Q:\DEN\Projects\100810.00 CFA Powers & Palmer\DESIGN\Drainage\Basin Maps\100810 - PROPOSED BASIN MAP.dwg Last Saved By: CONNER.BURBA
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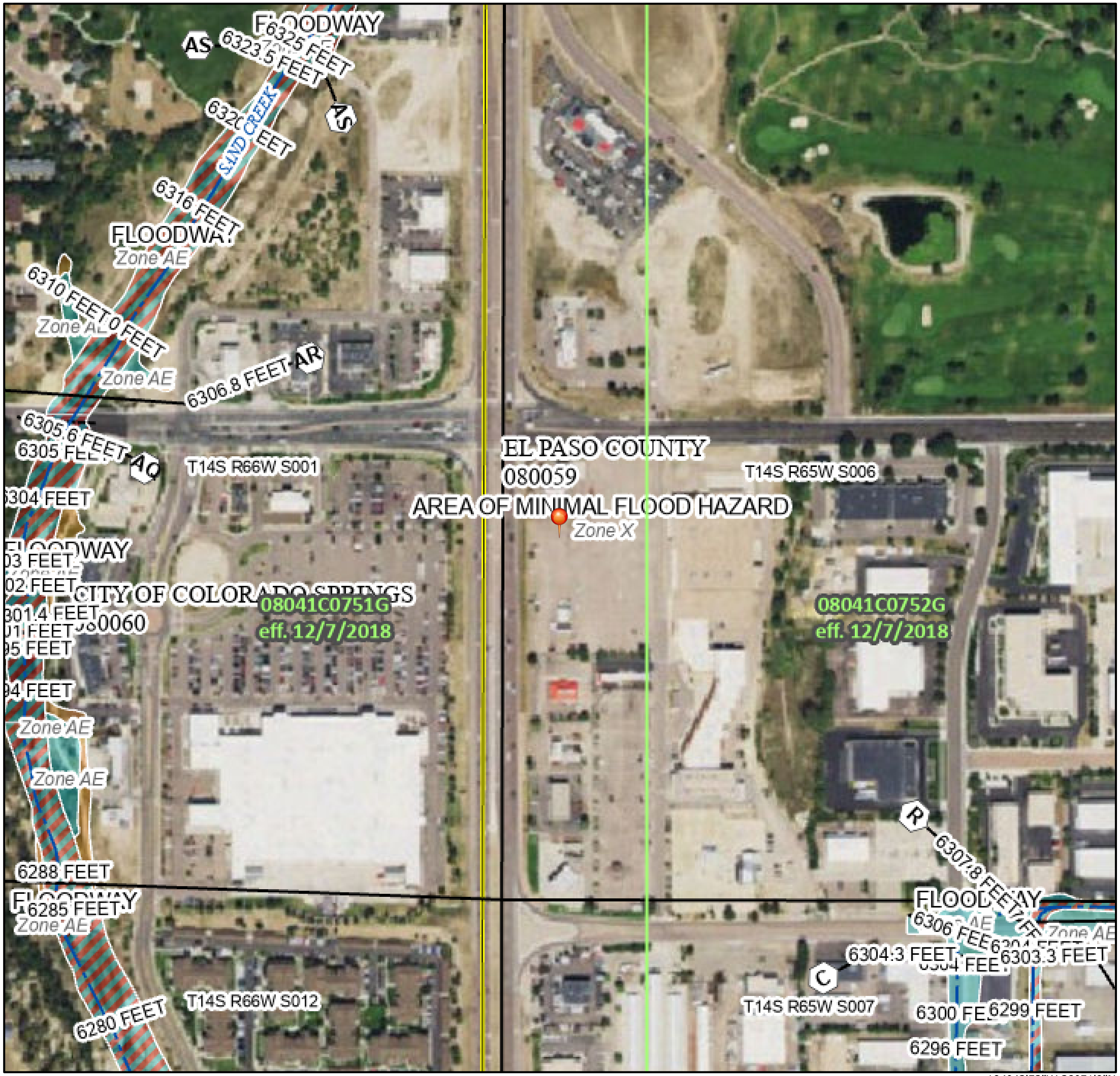
National Flood Hazard Layer FIRMette

FEMA

104°43'29"W 38°51'37"N



104°42'52"W 38°51'9"N

Feet

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

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

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

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A, V, A99*
	With BFE or Depth *Zone AE, AO, AH, VE, AR*
	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
	Area with Flood Risk due to Levee *Zone D*
OTHER AREAS	NO SCREEN Area of Minimal Flood Hazard *Zone X*
	Effective LOMRs
	Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Levee, Dike, or Floodwall
OTHER FEATURES	20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
	8 Coastal Transect
	513 Base Flood Elevation Line (BFE)
	Limit of Study
	Jurisdiction Boundary
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
MAP PANELS	Digital Data Available
	No Digital Data Available
	Unmapped

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 1/14/2025 at 9:38 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

Appendix B

(Hydrologic Calculations)

Merrick & Company
5970 Greenwood Plaza Blvd.
Greenwood Village, CO 80111
Ph: (303) 751-0741

Job Name: CFA - Powers and Palmer
Job Number: 100810
Date: 1/27/2025
By: C. Burba

CFA - Powers and Palmer

Existing Runoff Coefficient Calculations

Location: UDFCD
Municipality: UDFCD
Minor Design Storm: 2
Major Design Storm: 100
Soil Type: B

Runoff Coefficient (UDFCD Vol 1, Chp 6, Sec. 2.5.1)

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

Basin Design Data

	I (%) =	100%	90%	40%	40%	10%	25%	2%	2%			i (%)	Runoff Coeff's			
Basin Name	Design Point	A_{paved} (sf)	A_{Roof} (sf)	A_{Rock} (sf)	A_{gravel} (sf)	A_{plygnd} (sf)	$A_{art. turf}$ (sf)	$A_{lscape (B soil)}$ (sf)	$A_{lscape (C/D soil)}$ (sf)	A_{Total} (sf)	A_{Total} (ac)	Imp (%)	C2	C5	C10	C100
EX1	1	63,791						3,362		67,153	1.54	95.1%	0.79	0.81	0.83	0.87
EX2	1	142,430	31,131					2,164		175,725	4.03	97.0%	0.81	0.83	0.84	0.88
	TOTAL SITE	206,221	31,131	0	0	0	0	5,526	0	242,878	5.58	96.5%	0.81	0.83	0.84	0.88

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Job Name: CFA - Powers and Palmer
Job Number: 100810
Date: 1/27/2025
By: C. Burba

CFA - Powers and Palmer

Existing Time of Concentration Calculations

Location: UDFCD
Municipality: UDFCD
Minor Design Storm: 2
Major Design Storm: 100
Soil Type: B

$t_i=(0.395(1.1-C_5)(L_i\hat{}0.5))/(S_o\hat{}0.33)$
$t_t=L_t/(60V_t)$
Urban $t_c=(26-17i)+L_t/(60(14i+9)*(S_O\hat{}.5))$

Sub-Basin Data					Initial Overland Time (t_i)			Travel Time (t_t) t_t=Length/(Velocity x 60)						t_c Comp	tc Urbanized Check ON			t_c Final
Basin Name	Design Point	A_{Total} (ac)	i (%)	C5	Upper most Length (ft)	Slope (%)	t_i (min)	Length (ft)	Slope (%)	Type of Land Surface	C_v	Velocity (fps)	t_t (min)	Time of Conc $t_i + t_t = t_c$	L_t (ft)	S_O (%)	Urban t_c	Min t_c
EX1	1	1.54	95.1%	0.81	0	2.0%	0.0	760	1.6%	Paved areas & shallow paved swales	20	2.5	5.0	5.0	760.0	1.6%	14.3	5.0
EX2	1	4.03	97.0%	0.83	0	2.0%	0.0	390	2.0%	Paved areas & shallow paved swales	20	2.8	2.3	2.3	390.0	2.0%	11.5	5.0

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Job Name: CFA - Powers and Palmer
Job Number: 100810
Date: 1/27/2025
By: C. Burba

CFA - Powers and Palmer

Proposed Composite Runoff Coefficient Calculations

Location: UDFCD
Municipality: UDFCD
Minor Design Storm: 2
Major Design Storm: 100
Soil Type: B

Runoff Coefficient (UDFCD Vol 1, Chp 6, Sec. 2.5.1)

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

Basin Design Data

	I (%) =	100%	90%	40%	40%	10%	25%	2%	2%			i (%)	Runoff Coeff's			
Basin Name	Design Point	A_{paved} (sf)	A_{Roof} (sf)	A_{Rock} (sf)	A_{gravel} (sf)	A_{plygnd} (sf)	$A_{art. turf}$ (sf)	$A_{lscape (B soil)}$ (sf)	$A_{lscape (C/D soil)}$ (sf)	A_{Total} (sf)	A_{Total} (ac)	Imp (%)	C2	C5	C10	C100
A1	1	26,910	1,507					13,407		41,824	0.96	68.2%	0.54	0.57	0.61	0.75
A2	2	17,742	1,641					1,911		21,294	0.49	90.4%	0.75	0.77	0.79	0.85
A3	4							4,035		4,035	0.09	2.0%	0.01	0.01	0.07	0.44
OS1	1	45,094	10,040					1,082		56,216	1.29	96.3%	0.80	0.83	0.84	0.88
OS2	2	29,169								29,169	0.67	100.0%	0.84	0.86	0.87	0.90
	TOTAL SITE	118,915	13,188	0	0	0	0	20,435	0	152,538	3.50	86.0%	0.70	0.73	0.75	0.83

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Job Name: CFA - Powers and Palmer
Job Number: 100810
Date: 1/27/2025
By: C. Burba

CFA - Powers and Palmer

Proposed Time of Concentration Calculations

Location: UDFCD
Municipality: UDFCD
Minor Design Storm: 2
Major Design Storm: 100
Soil Type: B

$t_i=(0.395(1.1-C_5)(L_i\text{^}0.5))/(S_o\text{^}0.33)$

$t_t=L_t/(60V_t)$

Urban $t_c=(26-17i)+L_t/(60(14i+9)*(S_O\text{^}.5))$

Sub-Basin Data					Initial Overland Time (t_i)			Travel Time (t_t) t_t=Length/(Velocity x 60)						t_c Comp	tc Urbanized Check ON			t_c Final
Basin Name	Design Point	A_{Total} (ac)	i (%)	C5	Upper most Length (ft)	Slope (%)	t_i (min)	Length (ft)	Slope (%)	Type of Land Surface	C_v	Velocity (fps)	t_t (min)	Time of Conc $t_i + t_t = t_c$	L_t (ft)	S_O (%)	Urban t_c	Min t_c
A1	1	0.96	68.2%	0.57	20	4.0%	2.8	245	2.0%	Paved areas & shallow paved swales	20	2.8	1.4	4.2	265.0	2.1%	16.0	5.0
A2	2	0.49	90.4%	0.77	20	2.0%	2.1	270	2.5%	Paved areas & shallow paved swales	20	3.2	1.4	3.6	290.0	2.5%	12.1	5.0
A3	4	0.09	2.0%	0.01	20	3.0%	6.2	20	3.0%	Tillage/field	5	0.9	0.4	6.6	40.0	3.0%	26.1	6.6
OS1	1	1.29	96.3%	0.83	0	2.0%	0.0	390	1.6%	Paved areas & shallow paved swales	20	2.5	2.6	2.6	390.0	1.6%	11.9	5.0
OS2	2	0.67	100.0%	0.86	0	2.0%	0.0	560	2.0%	Paved areas & shallow paved swales	20	2.8	3.3	3.3	560.0	2.0%	11.9	5.0

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Job Name: CFA - Powers and Palmer
Job Number: 100810
Date: 1/27/2025
By: C. Burba

CFA - Powers and Palmer

Developed Storm Runoff Calculations

Design Storm : **100 Year**   Point Hour Rainfall (P_1) : **2.52**   I = -2.52 ln(D) +12.735

	100-Year Direct Runoff							Total Runoff				Inlets			Pipe					Pipe/Swale Travel Time				
Basin Name	Design Point	Area (ac)	Runoff Coeff	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Total tc (min)	ΣC*A (ac)	I (in/hr)	Q (cfs)	Inlet Type	Q intercepted	Q carryover (Qco)	Pipe Size (in) or equivalent	Pipe Material	Slope (%)	Pipe Flow (cfs)	Approx. Max Pipe Capacity (cfs)	Length (ft)	Velocity (fps)	tt (min)	Total Time (min)	Notes
A1	1	0.96	0.75	5.0	0.72	8.68	6.2																	
A2	2	0.49	0.85	5.0	0.42	8.68	3.6																	
A3	4	0.09	0.44	6.6	0.04	7.98	0.3																	
OS1	1	1.29	0.88	5.0	1.13	8.68	9.8																	
OS2	2	0.67	0.90	5.0	0.60	8.55	5.1																	
	1	Combined flows from A1 and OS1						5.00	1.85	8.53	15.8				24 in	RCP	0.5%	15.8	16.0	220.0	5.1	0.72	5.72	
	1	2.25	0.82	5.7	1.85	8.24	15.2																	
	2	Combined flows from A2 and OS2						5.00	1.02	8.53	8.7				24 in	RCP	0.5%	8.7	16.0	31.0	5.1	0.10	5.10	
	2	1.16	0.84	5.1	0.97	8.50	8.3																	
	3	Combined flows from DP1 and DP2 (Including Bypass Flow)						5.72	2.82	8.22	23.2				24 in	RCP	0.5%	23.2	16.0	0.0	5.1	0.00	5.72	
	3	3.41	0.83	5.7	2.82	8.24	23.3																	
	3	Combined flows from DP1 and DP2 (On-site Flow for WQ)						5.00	1.13	8.53	9.7				24 in	RCP	0.5%	9.7	16.0	0.0	5.1	0.00	5.00	
	3	1.45	0.78	5.0	1.13	8.55	9.7																	
	4	Combined flows from All Basins Discharging to EX Swale																						
	4	3.50	0.82	5.7	2.86	8.24	23.6																	

MERRICK & COMPANY
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5970 Greenwood Plaza Blvd.
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Ph: (303) 751-0741

Job Name: CFA - Powers and Palmer
Job Number: 100810
Date: 1/27/2025
By: C. Burba

CFA - Powers and Palmer

Developed Storm Runoff Calculations

Design Storm : **2 Year**

Point Hour Rainfall (P_1) : **1.19**

I = -1.50 ln(D) + 7.583

	2-Year Direct Runoff							Total Runoff				Inlets			Pipe					Pipe/Swale Travel Time				
Basin Name	Design Point	Area (ac)	Runoff Coeff	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Total tc (min)	ΣC*A (ac)	I (in/hr)	Q (cfs)	Inlet Type	Q intercepted	Q carryover (Qco)	Pipe Size (in) or equivalent	Pipe Material	Slope (%)	Pipe Flow (cfs)	Approx. Max Pipe Capacity (cfs)	Length (ft)	Velocity (fps)	tt (min)	Total Time (min)	Notes
EX1	1	1.54	0.79	5.0	1.22	5.17	6.3																	
EX2	1	4.03	0.81	5.0	3.27	5.17	16.9																	
A1	1	0.96	0.54	5.0	0.52	5.17	2.7																	
A2	2	0.49	0.75	5.0	0.37	5.17	1.9																	
A3	4	0.09	0.01	6.6	0.00	4.75	0.004																	
OS1	1	1.29	0.80	5.0	1.04	5.17	5.4																	
OS2	2	0.67	0.84	5.0	0.56	4.04	2.3																	
	1	Combined flows from A1 and OS1						5.00	1.55	4.03	6.3				24 in	RCP	0.5%	6.3	16.0	220.0	5.1	0.72	5.72	
	1	2.25	0.69	5.7	1.55	3.89	6.0																	
	2	Combined flows from A2 and OS2						5.00	0.93	4.03	3.7				24 in	RCP	0.5%	3.7	16.0	31.0	5.1	0.10	5.10	
	2	1.16	0.74	5.1	0.86	4.01	3.4																	
	3	Combined flows from DP1 and DP2 (Including Bypass Flow)						5.72	2.41	3.88	9.4				24 in	RCP	0.5%	9.4	16.0	0.0	5.1	0.00	5.72	
	3	3.41	0.71	5.7	2.41	3.89	9.4																	
	3	Combined flows from DP1 and DP2 (On-site Flow for WQ)						5.00	0.88	4.03	3.5				24 in	RCP	0.5%	3.5	16.0	0.0	5.1	0.00	5.00	
	3	1.45	0.61	5.0	0.88	4.04	3.6																	
	4	Combined flows from All Basins Discharging to EX Swale																						
	4	3.50	0.69	5.7	2.41	3.89	9.4																	

Appendix C
(Hydraulic Calculations)

Storm Pipe - DP 1 to DP3

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.020 ft/ft
Diameter	24.0 in
Discharge	6.60 cfs

Results

Normal Depth	7.4 in
Flow Area	0.8 ft²
Wetted Perimeter	2.4 ft
Hydraulic Radius	4.2 in
Top Width	1.85 ft
Critical Depth	10.9 in
Percent Full	30.8 %
Critical Slope	0.005 ft/ft
Velocity	8.02 ft/s
Velocity Head	1.00 ft
Specific Energy	1.62 ft
Froude Number	2.119
Maximum Discharge	34.41 cfs
Discharge Full	31.99 cfs
Slope Full	0.001 ft/ft
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	30.8 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	7.4 in
Critical Depth	10.9 in
Channel Slope	0.020 ft/ft
Critical Slope	0.005 ft/ft

Storm Pipe - DP 2 to DP 3

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.020 ft/ft
Diameter	24.0 in
Discharge	6.60 cfs

Results

Normal Depth	7.4 in
Flow Area	0.8 ft²
Wetted Perimeter	2.4 ft
Hydraulic Radius	4.2 in
Top Width	1.85 ft
Critical Depth	10.9 in
Percent Full	30.8 %
Critical Slope	0.005 ft/ft
Velocity	8.02 ft/s
Velocity Head	1.00 ft
Specific Energy	1.62 ft
Froude Number	2.119
Maximum Discharge	34.41 cfs
Discharge Full	31.99 cfs
Slope Full	0.001 ft/ft
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	30.8 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	7.4 in
Critical Depth	10.9 in
Channel Slope	0.020 ft/ft
Critical Slope	0.005 ft/ft

Storm Pipe - DP 3 to DP 4

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.020 ft/ft
Diameter	30.0 in
Discharge	13.20 cfs

Results

Normal Depth	9.7 in
Flow Area	1.4 ft²
Wetted Perimeter	3.0 ft
Hydraulic Radius	5.5 in
Top Width	2.34 ft
Critical Depth	14.7 in
Percent Full	32.4 %
Critical Slope	0.004 ft/ft
Velocity	9.57 ft/s
Velocity Head	1.42 ft
Specific Energy	2.23 ft
Froude Number	2.197
Maximum Discharge	62.40 cfs
Discharge Full	58.00 cfs
Slope Full	0.001 ft/ft
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

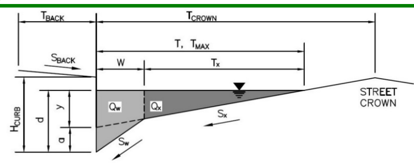
GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	32.4 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	9.7 in
Critical Depth	14.7 in
Channel Slope	0.020 ft/ft
Critical Slope	0.004 ft/ft

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Chick-fil-A Powers and Palmer
Inlet ID: Type 13 Inlet On-Site



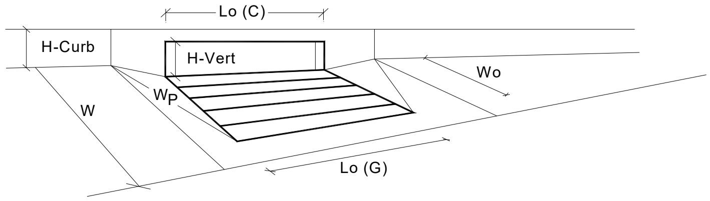
Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.014		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	25.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.020		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.014		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.5	25.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is not applicable to Sump Condition				
MAJOR STORM Allowable Capacity is not applicable to Sump Condition	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.03 (August 2023)



Design Information (Input)	CDOT/Denver 13 Combination	MINOR	MAJOR	
Type of Inlet	Type =	CDOT/Denver 13 Combination		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	2.00	2.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	2	2	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	4.5	6.0	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	3.00	3.00	feet
Width of a Unit Grate	W_o =	1.73	1.73	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.43	0.43	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	3.30	3.30	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.60	0.60	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	3.00	3.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.50	6.50	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	5.25	5.25	inches
Angle of Throat	Theta =	0.00	0.00	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.70	3.70	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.66	0.66	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.40	0.52	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.21	0.33	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.53	0.71	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	N/A	N/A	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.53	0.71	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**2.8**	**6.6**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	2.7	6.2	cfs

PRODUCT SPECIFICATIONS

- THE STORMWATER TREATMENT UNIT SHALL BE AN INLINE UNIT CAPABLE OF CONVEYING 100% OF THE DESIGN PEAK FLOW. IF PEAK FLOW RATES EXCEED MAXIMUM HYDRAULIC RATE, THE UNIT SHALL BE INSTALLED OFFLINE.
- THE BARRACUDA UNIT SHALL BE DESIGNED TO REMOVE AT LEAST 80% OF THE SUSPENDED SOLIDS ON AN ANNUAL AGGREGATE REMOVAL BASIS. SAID REMOVAL SHALL BE BASED ON FULL-SCALE THIRD PARTY TESTING USING OK-110 MEDIA GRADATION OR EQUIVALENT AND 300 mg/L INFLUENT CONCENTRATION. SAID FULL SCALE TESTING SHALL HAVE INCLUDED SEDIMENT CAPTURE BASED ON ACTUAL TOTAL MASS COLLECTED BY THE STORMWATER TREATMENT UNIT.

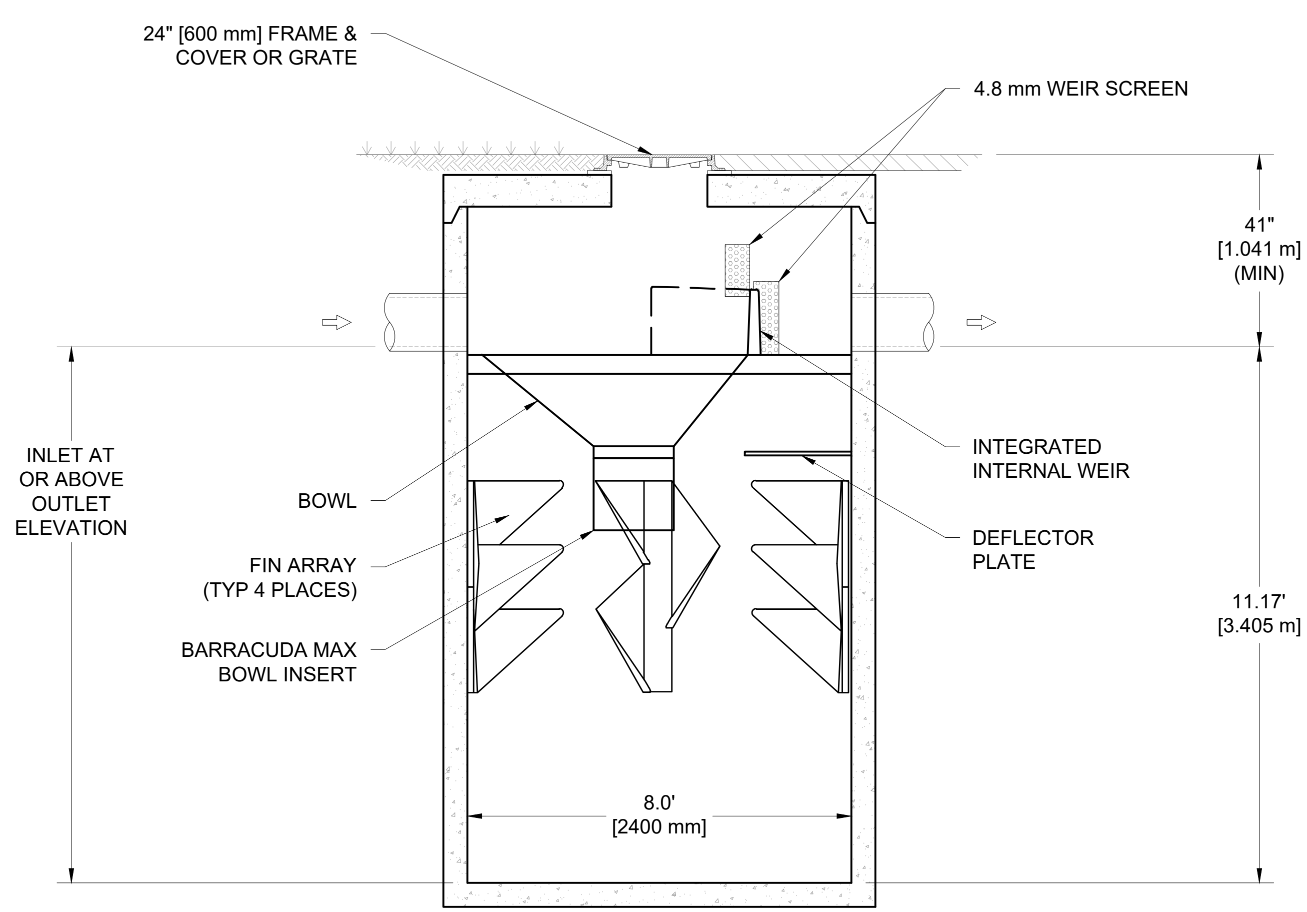
  -OR -

  THE BARRACUDA UNIT SHALL BE DESIGNED TO REMOVE AT LEAST 50% OF TSS USING A MEDIA MIX WITH d_{50}=75 MICRON AND 200 MG/L INFLUENT CONCENTRATION.

  -OR -

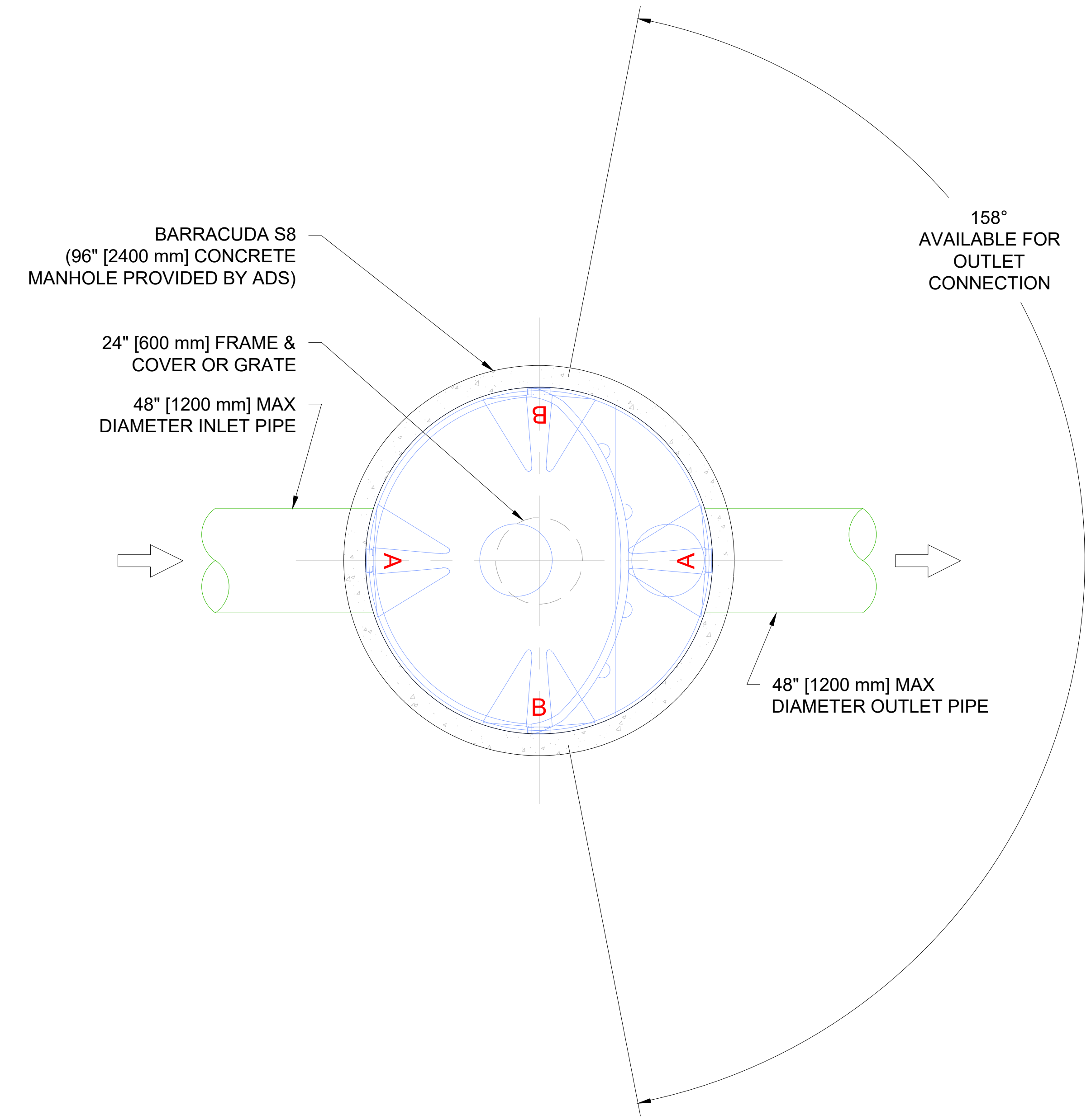
  THE BARRACUDA UNIT SHALL BE DESIGNED TO REMOVE AT LEAST 50% OF TSS PER CURRENT NJDEP/NJCAT HDS PROTOCOL .

BARRACUDA MAX S8		
	CFS	L/s
NJDEP (50% Removal)	6.08	172.2
OK-100 (80% Removal)	6.08	172.2



SECTION VIEW A-A

NOT TO SCALE



PLAN VIEW

NOT TO SCALE

NOTES:

- ENGINEER / CONTRACTOR TO CONFIRM PIPE MATERIALS AND APPLICABLE ADAPTERS
- CONTRACTOR IS RESPONSIBLE FOR MATERIAL AND LABOR TO BRING CASTINGS TO FINISHED GRADE
- CONTRATOR TO MEASURE HEIGHT OF STRUCTURE TO ENSURE THAT DEPTH OF EXCAVATION IS CORRECT.
- UNIT SHALL CONFORM TO HS20-44 LOAD RATINGS.
- CASQA CERTIFIED TRASH FULL CAPTURE SYSTEM

BARRACUDA MAX S8 WITH SCREEN
STANDARD DETAIL

DATE: 09/06/24	DRAWN: JLM
DRAWING #: 531-811	CHECKED: SMW

DATE	DRWN	CHKD	DESCRIPTION

Barracuda Max
Stormwater Separator

ADS

4640 TRUEMAN BLVD
HILLIARD, OH 43026

SHEET 1 OF 1

Appendix D
(Reference Documents)

United States Department of Agriculture

NRCS

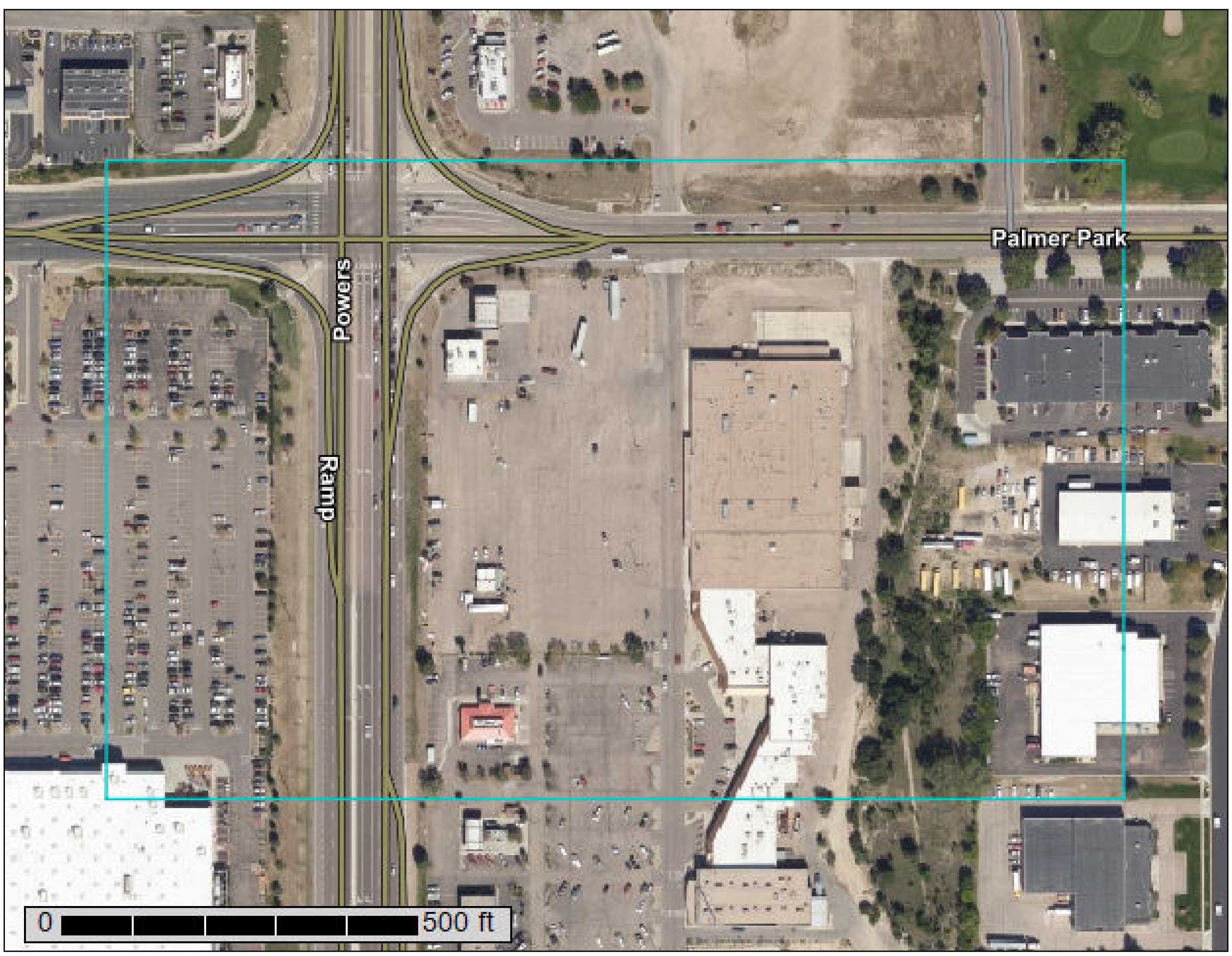
Natural Resources Conservation Service

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

Custom Soil Resource Report for

El Paso County Area, Colorado

CFA Powers and Palmer



January 14, 2025

Preface

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

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

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

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

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

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

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

Contents

How Soil Surveys Are Made

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

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

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

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

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

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

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

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

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

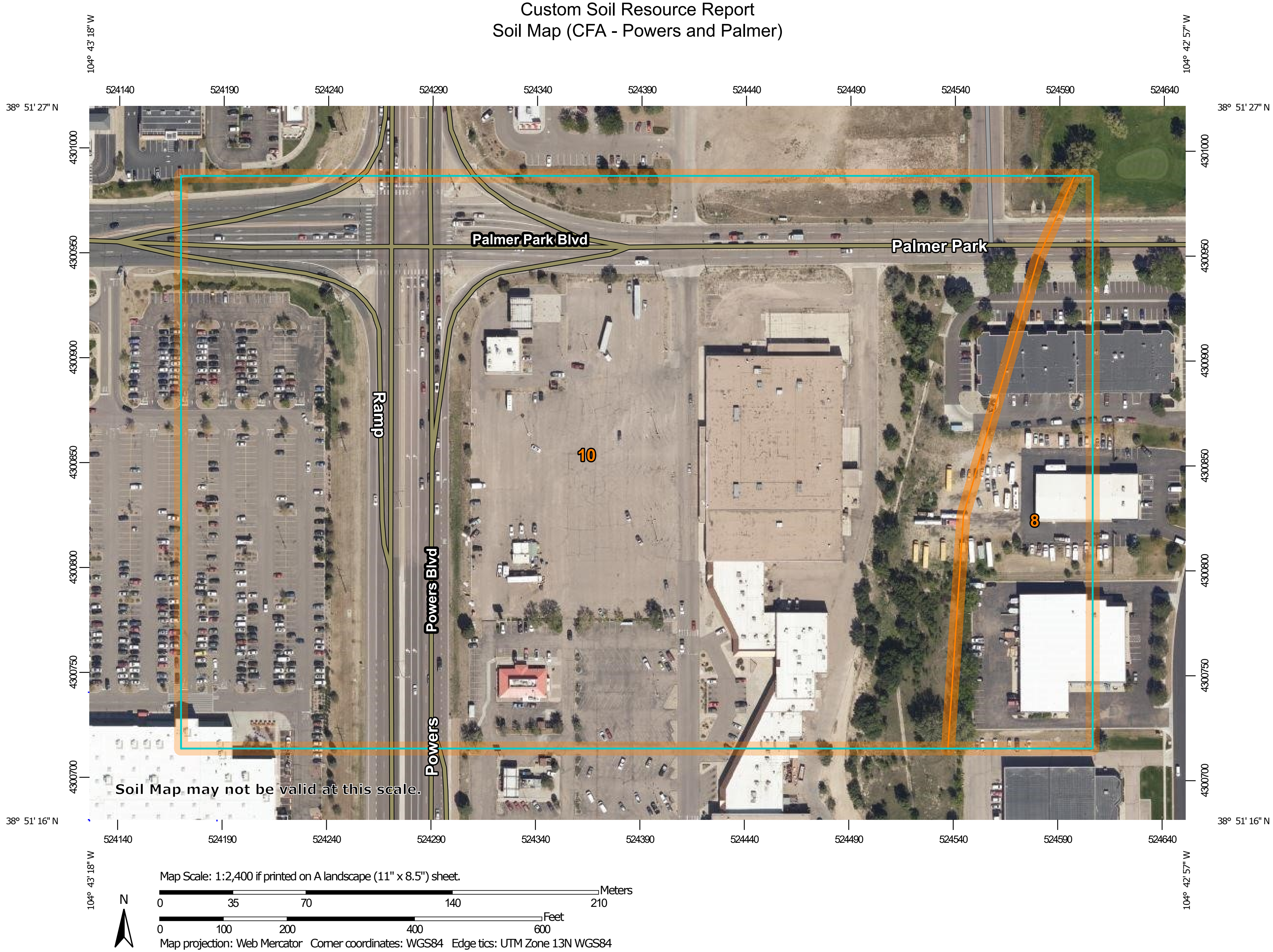
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree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

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

Soil Map

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

Custom Soil Resource Report
Soil Map (CFA - Powers and Palmer)



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 22, Sep 3, 2024

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

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

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

Map Unit Legend (CFA - Powers and Palmer)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
8	Blakeland loamy sand, 1 to 9 percent slopes	3.3	11.2%
10	Blendon sandy loam, 0 to 3 percent slopes	26.2	88.8%
Totals for Area of Interest		**29.6**	**100.0%**

Map Unit Descriptions (CFA - Powers and Palmer)

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

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

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

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

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

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

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

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

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

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

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

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

El Paso County Area, Colorado

8—Blakeland loamy sand, 1 to 9 percent slopes

Map Unit Setting

National map unit symbol: 369v
Elevation: 4,600 to 5,800 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Blakeland and similar soils: 98 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Blakeland

Setting

Landform: Flats, hills
Landform position (three-dimensional): Side slope, talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sedimentary rock and/or eolian deposits derived from sedimentary rock

Typical profile

A - 0 to 11 inches: loamy sand
AC - 11 to 27 inches: loamy sand
C - 27 to 60 inches: sand

Properties and qualities

Slope: 1 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Available water supply, 0 to 60 inches: Low (about 4.5 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit: 1 percent

Hydric soil rating: No

Pleasant

Percent of map unit: 1 percent
Landform: Depressions
Hydric soil rating: Yes

10—Blendon sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 3671
Elevation: 6,000 to 6,800 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Blendon and similar soils: 98 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Blendon

Setting

Landform: Alluvial fans, terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium derived from arkose

Typical profile

A - 0 to 10 inches: sandy loam
Bw - 10 to 36 inches: sandy loam
C - 36 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 2 percent
Available water supply, 0 to 60 inches: Moderate (about 6.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: B
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit: 1 percent
Hydric soil rating: No

Pleasant

Percent of map unit: 1 percent
Landform: Depressions
Hydric soil rating: Yes

Soil Information for All Uses

Soil Reports

The Soil Reports section includes various formatted tabular and narrative reports (tables) containing data for each selected soil map unit and each component of each unit. No aggregation of data has occurred as is done in reports in the Soil Properties and Qualities and Suitabilities and Limitations sections.

The reports contain soil interpretive information as well as basic soil properties and qualities. A description of each report (table) is included.

Soil Physical Properties

This folder contains a collection of tabular reports that present soil physical properties. The reports (tables) include all selected map units and components for each map unit. Soil physical properties are measured or inferred from direct observations in the field or laboratory. Examples of soil physical properties include percent clay, organic matter, saturated hydraulic conductivity, available water capacity, and bulk density.

Engineering Properties (CFA - Powers and Palmer)

This table gives the engineering classifications and the range of engineering properties for the layers of each soil in the survey area.

Hydrologic soil group is a group of soils having similar runoff potential under similar storm and cover conditions. The criteria for determining Hydrologic soil group is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Listing HSGs by soil map unit component and not by soil series is a new concept for the engineers. Past engineering references contained lists of HSGs by soil series. Soil series are continually being defined and redefined, and the list of soil series names changes so frequently as to make the task of maintaining a single national list virtually impossible. Therefore, the criteria is now used to calculate the HSG using the component soil properties and no such national series lists will be maintained. All such references are obsolete and their use should be discontinued. Soil properties that influence runoff potential are those that influence the minimum rate of infiltration for a bare soil after prolonged wetting and when not frozen. These properties are depth to a seasonal high water table, saturated hydraulic conductivity after prolonged wetting, and depth to a layer with a very slow water transmission rate. Changes in soil properties caused by land management or climate changes also cause the hydrologic soil group to change. The influence of ground cover is treated independently. There are four hydrologic soil groups, A, B, C, and D, and three dual groups, A/D, B/D, and C/D. In the dual groups, the first letter is for drained areas and the second letter is for undrained areas.

The four hydrologic soil groups are described in the following paragraphs:

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

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

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

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

Depth to the upper and lower boundaries of each layer is indicated.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly."

Classification of the soils is determined according to the Unified soil classification system (ASTM, 2005) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 2004).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to particle-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of particle-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Percentage of rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

References:

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

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

Absence of an entry indicates that the data were not estimated. The asterisk '*' denotes the representative texture; other possible textures follow the dash. The criteria for determining the hydrologic soil group for individual soil components is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Engineering Properties–El Paso County Area, Colorado														
Map unit symbol and soil name	**Pct. of map unit**	**Hydrologic group**	**Depth**	**USDA texture**	**Classification**		**Pct Fragments**		**Percentage passing sieve number—**				**Liquid limit**	**Plasticity index**
					Unified	**AASHTO**	**>10 inches**	**3-10 inches**	**4**	**10**	**40**	**200**		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
8—Blakeland loamy sand, 1 to 9 percent slopes														
Blakeland	98	A	0-11	Loamy sand	SM	A-1, A-2	0- 0- 0	0- 0- 0	95-98-100	90-95-100	40-50-60	15-23-30	—	NP
			11-27	Loamy sand	SM	A-1, A-2	0- 0- 0	0- 0- 0	95-98-100	90-95-100	40-50-60	15-23-30	—	NP
			27-60	Loamy sand, loamy coarse sand, sand	SM, SP-SM, SW-SM	A-1, A-2, A-3	0- 0- 0	0- 0- 0	95-98-100	80-90-100	35-48-60	5-15- 25	—	NP
10—Blendon sandy loam, 0 to 3 percent slopes														
Blendon	98	B	0-10	Sandy loam	SC, SC-SM	A-2-4, A-4	0- 0- 0	0- 0- 0	100-100-100	90-95-100	60-65-70	30-35-40	25-28-30	5-8 -10
			10-36	Sandy loam, fine sandy loam	CL, CL-ML, SC, SC-SM	A-2-4, A-4	0- 0- 0	0- 0- 0	85-93-100	80-90-100	50-68-85	25-40-55	25-28-30	5-8 -10
			36-60	Gravelly sandy loam	GM, SC-SM, SM	A-1-b, A-2	0- 0- 0	0- 0- 0	60-70-80	55-65-75	35-43-50	20-25-30	20-23-25	NP-3 -5

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