DRAINAGE LETTER REPORT

for

WETHERBEE OFFICE / WAREHOUSE BUILDING
LOT 22, CLAREMONT BUSINESS PARK FILING NO. 2

Prepared for:

T H E Properties, LLC
1950 Victor Place, Suite 110
Colorado Springs, CO 80915

October 4, 2018
Revised November 30, 2018

Prepared by:

JPS ENGINEERING

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JPS Project No. 081803
PPR-18-049

WETHERBEE OFFICE / WAREHOUSE BUILDING
LOT 22, CLAREMONT BUSINESS PARK FILING NO. 2
DRAINAGE REPORT STATEMENTS

Design Engineer's Statement:

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

COLORADO REGISTERED PROFESSIONAL ENGINEER JOHN P. SCHWAB 29891

John P. Schwab, Colorado P.E. No. 29891 — 1/2/19 Date

Owner/Developer's Statement:

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

1-7-19

Tony Wetherbee, Manager
T H E Properties LLC
1950 Victor Place #110
Colorado Springs, CO 80915

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.

Approved
by Elizabeth Nijkamp
El Paso County Planning and Community Development
on behalf of Jennifer Irvine, County Engineer, ECM Administrator
01/17/2019 1:51:32 PM

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

Conditions:

I. INTRODUCTION

A. Property Location and Description

Tony Wetherbee is planning construct a new office / warehouse building on a vacant commercial property described as Lot 22, Claremont Business Park Filing No. 2 in El Paso County, Colorado. The 0.5-acre lot (El Paso County Assessor's No. 54081-02-026) is located at 7302 Cole View. The property is zoned Commercial Service (CS).

Cole View is a paved private street along the south and west side of the property. Existing platted commercial / industrial lots adjoin the north and east sides of the property.

The site development plan consists of a proposed 5,000 square-foot office / warehouse building with associated parking and site improvements. Access will be provided by a new driveway connecting to Cole View on the south side of the lot. The proposed internal parking area will be paved with asphalt and concrete. Site development activities will include site grading, utilities, new warehouse building construction, parking lot paving, and site landscaping.

B. Scope

In support of the El Paso County Site Development Plan submittal for this project, this report is intended to meet the requirements of a site-specific "Letter Type" drainage report in accordance with El Paso County drainage criteria. This report will provide a summary of site drainage issues impacting the proposed development, including analysis of upstream drainage patterns, site-specific developed drainage patterns, and impacts on downstream facilities. This report is based on the guidelines and criteria presented in the City of Colorado Springs and El Paso County "Drainage Criteria Manual."

C. References

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

Matrix Design Group, Inc., "Final Drainage Report for Claremont Business Park Filing No. 2," revised November, 2006.

II. EXISTING / PROPOSED DRAINAGE CONDITIONS

According to the Natural Resources Conservation Services (NRCS) web soil survey, on-site soils are comprised of Blakeland loamy sand and Ellicott loamy coarse sand. These soils are classified as hydrologic soils group A. The existing site topography slopes downward to the southwest with grades of approximately 1-3 percent.

Drainage planning for this lot was previously addressed in the “Final Drainage Report for Claremont Business Park Filing No. 2” by Matrix Design Group, Inc. (Matrix) dated November, 2006. The subject property (Lot 22) was identified as part of Basin E5A in the subdivision drainage report, and drainage from these lots has been planned to sheet flow in a southwesterly direction to an existing storm sewer in Cole View along the west boundary of the site. The existing storm sewer system flows to the west from Cole View into the East Fork Sand Creek drainage channel. The subdivision drainage report assumed full commercial development within Basin E5A.

As shown on the enclosed Drainage Plan (Figure D1), Lot 22 has been delineated as two drainage basins (A1 and A2) flowing southwesterly across the site. The on-site development area (Basin A1) has been delineated as Sub-Basins A1.1-A1.4.

The existing private street of Cole View along the frontage of the property has been delineated as Basin A2. The existing private street was previously developed and no improvements to the existing street are proposed as part of this site development plan. As such, Basin A2 is excluded from WQCV requirements.

Recognizing that water quality improvements were not provided during initial development of this subdivision, El Paso County is requiring each lot to provide water quality mitigation as the lots develop. A private Rain Garden will be constructed at the southwest corner of Lot 22 to meet County water quality requirements.

Surface runoff from the developed site will follow the drainage patterns established in the subdivision drainage report, flowing towards the southwest corner of the site. The majority of the developed site (Lot 22) has been delineated as Sub-Basin A1.1. The proposed building pad will be graded with protective slopes to provide positive drainage away from the building. Curb and gutter will be installed along the outer perimeter of the new parking area. The curb, gutter, and drainage swales in the parking area will convey developed flows from the building area southwesterly to a private Type 16 private storm inlet (Inlet A1.1), which flows into the private Rain Garden at the southwest corner of the site. Developed peak flows from Sub-Basin A1.1 are calculated as $Q_5 = 0.8$ cfs and $Q_{100} = 1.5$ cfs. In the event of clogging of the private storm inlet in the southwest corner of the parking lot, overflows will drain directly into the Rain Garden, which would overflow into the existing storm sewer system in Cole View.

The southeast corner of the developed site (Lot 22) has been delineated as Sub-Basin A1.2, which sheet flows towards the south boundary of the site. Developed peak flows from Sub-Basin A1.2 are calculated as $Q_5 = 0.1$ cfs and $Q_{100} = 0.2$ cfs. A grated storm inlet will intercept surface drainage along the south boundary of the site, and 12-inch private storm Sewer A1.2 will convey these flows westerly to the Rain Garden.

The entry drive at the south end of the site has been delineated as Sub-Basin A1.3, which sheet flows southwesterly to a private storm inlet at the southwest corner of the entry drive, flowing directly into the Rain Garden. Developed peak flows from Sub-Basin A1.3 are calculated as $Q_5 = 0.06$ cfs and $Q_{100} = 0.1$ cfs. A 5’ Type R private storm inlet will intercept surface drainage from Sub-Basin A1.3, and convey these flows westerly into the Rain Garden.

The proposed building has been delineated as Sub-Basin A1.4, and roof drain downspouts from the building will be conveyed to an 8-inch PVC storm drain at the southwest corner of the building, flowing west into the Rain Garden. Developed peak flows from Sub-Basin A1.4 are calculated as Q_5 = 0.5 cfs and Q_{100} = 0.9 cfs.

Developed flows from Sub-Basins A1.1-A1.4 combine at Design Point A1, with developed peak flows calculated as Q_5 = 1.5 cfs and Q_{100} = 2.8 cfs.

The existing developed flows from off-site Basin A2 along Cole View are calculated as Q_5 = 0.6 cfs and Q_{100} = 1.1 cfs (Design Point A2).

As detailed in the subdivision drainage report, the total developed flows at the existing 15-foot Type R storm inlet in Cole View (identified as Design Point #12A in subdivision drainage report) have been calculated as Q_5 = 11.7 cfs and Q_{100} = 23.5 cfs.

The subdivision drainage report assumed full commercial development of this site, and the proposed site development plan is entirely consistent with the approved subdivision drainage plan.

Hydrologic calculations for the parcel are detailed in the attached spreadsheet (Appendix A), and peak flows are identified on Figure D1. The contractor will need to implement standard best management practices for erosion control during construction.

III. DRAINAGE PLANNING FOUR STEP PROCESS

El Paso County Drainage Criteria require drainage planning to include a Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls.

As stated in DCM Volume 2, the Four Step Process is applicable to all new and re-development projects with construction activities that disturb 1 acre or greater or that disturb less than 1 acre but are part of a larger common plan of development. The Four Step Process has been implemented as follows in the planning of this project:

<u>Step 1: Employ Runoff Reduction Practices</u>

- Minimize Directly Connected Impervious Areas (MDCIA): The proposed site development will include a Rain Garden at the southwest corner of Lot 22, which will have a grass-lined bottom to encourage stormwater infiltration, providing for the majority of the new site impervious area to drain across this pervious area.

Step 2: Stabilize Drainageways

- There are no major drainageways directly adjacent to this site. Routing flows through the on-site Rain Garden will minimize off-site impacts to existing downstream drainageways.

Step 3: Provide Water Quality Capture Volume (WQCV)

- Site drainage will be routed through the proposed Rain Garden (RG), which will capture and slowly release the WQCV over an extended release period.

Step 4: Consider Need for Industrial and Commercial BMPs

- On-site drainage will be routed through the private Rain Garden (RG) to minimize introduction of contaminants to the County's public drainage system.

IV. STORMWATER QUALITY

The proposed drainage and grading plan for this site includes a private Rain Garden (RG) at the southwest corner of Lot 22 to provide the required stormwater quality mitigation for the site in accordance with current El Paso County drainage criteria.

According to the calculations in Appendix A, the required Water Quality Capture Volume (WQCV) is 331 cubic feet, and the proposed Rain Garden provides a design volume of 574 cubic feet.

The Rain Garden will include an underdrain connected to an outlet structure, which will drain into the adjoining storm inlet along Cole View.

The proposed stormwater quality facilities will be privately owned and maintained by the property owner, and maintenance access is readily available from the existing street.

V. FLOODPLAIN IMPACTS

This site is located in vicinity of the limits of the FEMA 100-year floodplain boundaries for the East Fork Sand Creek channel according to the FEMA floodplain map for this area, FIRM Panel No. 08041C0752F dated March 17, 1997. As noted in the subdivision drainage report, "channel reconstruction has physically altered the floodplain from the heart of the property to immediately north of the site. A Letter of Map Revision (LOMR) has been prepared and submitted…" Following completion of the channel improvements during development of this subdivision, the 100-year floodplain limits do not impact these lots according to the currently approved LOMR, Case No. 06-08-B137P dated December 13, 2006. The current floodplain limits based on the approved LOMR are depicted on the enclosed Floodplain Map (Figure FLD-1, Appendix B).

VI. DRAINAGE BASIN FEES

This site is located within the Sand Creek Drainage Basin. No public drainage improvements are required for development of this site. Required drainage fees have been paid during the previous subdivision platting process (see "Final Drainage Report for Claremont Business Park Filing No. 2," which references an IGA with the Central Marksheffel Metropolitan District), so there are no applicable drainage fees required with the Site Development Plan.

VII. SUMMARY

The developed drainage patterns associated with the proposed Office / Warehouse Building on Lot 22, Claremont Business Park Filing No. 2 will remain consistent with the overall drainage plan for this commercial subdivision. The proposed Rain Garden at the southwest corner of Lot 22 will provide the required water quality mitigation for the site. Proper construction and maintenance of the proposed on-site drainage facilities, in conjunction with proper erosion control practices, will ensure that this developed site has no significant adverse drainage impact on downstream or surrounding areas.

APPENDIX A

DRAINAGE CALCULATIONS

Table 6-6. Runoff Coefficients for Rational Method

(Source: UDFCD 2001)

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

3.2 Time of Concentration

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

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

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

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

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

3.2.1 Overland (Initial) Flow Time

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

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

Where:

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

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

3.2.2 Travel Time

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

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

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

Table 6-7. Conveyance Coefficient, C_v

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

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

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

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

3.2.3 First Design Point Time of Concentration in Urban Catchments

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

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

Where:

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

L = waterway length (ft)

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

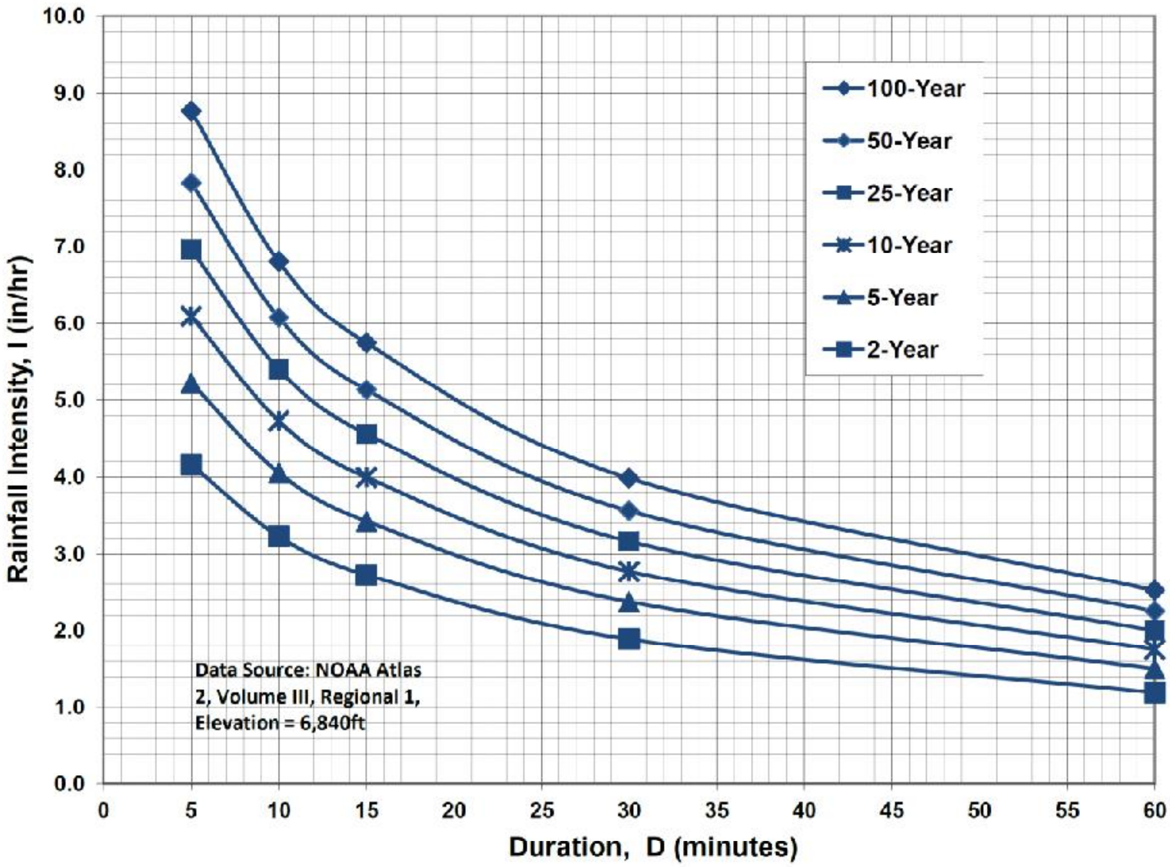
3.2.4 Minimum Time of Concentration

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

3.2.5 Post-Development Time of Concentration

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

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

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

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

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

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

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

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

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

WETHERBEE OFFICE / WAREHOUSE BUILDING - LOT 22, CLAREMONT BUSINESS PARK FILING NO. 2
RATIONAL METHOD

DEVELOPED FLOWS

			C		Overland Flow			Channel flow							INTENSITY [5]		PEAK FLOW	
BASIN	DESIGN POINT	AREA (AC)	5-YEAR	100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	Tco [1] (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS [2] VELOCITY (FT/S)	Tt [3] (MIN)	TOTAL Tc [4] (MIN)	TOTAL Tc [4] (MIN)	5-YR (IN/HR)	100-YR (IN/HR)	Q5 [6] (CFS)	Q100 [6] (CFS)
A1.1	A1.1	0.200	0.810	0.880	20	0.03	1.7	150	20	0.020	2.83	0.9	2.6	5.0	5.17	8.68	0.84	1.53
A1.2	A1.2	0.030	0.810	0.880	40	0.02	2.7			0.020		0.0	2.7	5.0	5.17	8.68	0.13	0.23
A1.3	A1.3	0.015	0.810	0.880	35	0.08	1.6					0.0	1.6	5.0	5.17	8.68	0.06	0.11
A1.4	A1.4	0.115	0.810	0.880	25	0.02	2.1	230	20	0.020	2.83	1.4	3.5	5.0	5.17	8.68	0.48	0.88
A1.1-A1.4	1	0.360	0.810	0.880									2.7	5.0	5.17	8.68	1.51	2.75
A2	A2	0.14	0.810	0.880	24	0.02	2.1	130	20	0.020	2.83	0.8	2.8	5.0	5.17	8.68	0.59	1.07
A1,A2	2	0.50	0.810	0.880									2.8	5.0	5.17	8.68	2.09	3.82

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

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

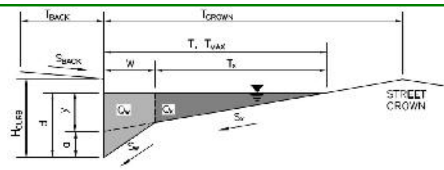
Version 4.05 Released March 2017

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

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

Project: **Wetherbee Office / Warehouse Building - Lot 22, Clarement BP F2 - Inlet A1.1**

Inlet ID: **Inlet A1.1**



Gutter Geometry (Enter data in the blue cells)

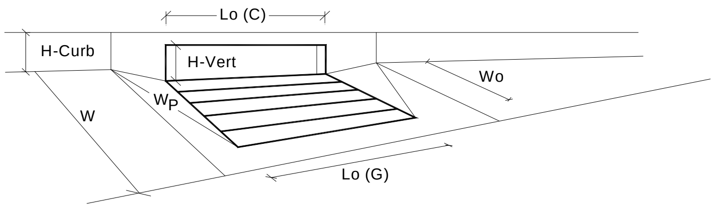
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	4.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	40.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.050	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} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	40.0	40.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (Denver No. 16 Combination)	Type =	Denver No. 16 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 =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	12.0	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
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.31	0.31	
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) =	3.60	3.60	
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 (see USDCM Figure ST-5)	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} =	0.523	1.023	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.83	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.94	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.94	1.00	

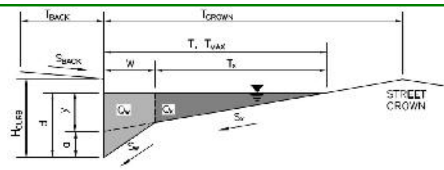
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**3.9**	**8.7**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	0.8	1.5	cfs

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

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

Project: Wetherbee Office / Warehouse Building - Lot 22, Clarement BP F2 - Inlet A1.2

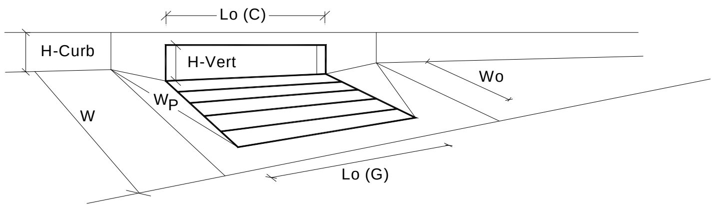
Inlet ID: Inlet A1.2



Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	4.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0		ft
Gutter Width	W =	3.00		ft
Street Transverse Slope	S_X =	0.050		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} =	0.020		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet — CDOT Type C Grate	Type =	CDOT Type C Grate		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	0.00	0.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	12.0	inches
Grate Information		MINOR	MAJOR	Override Depths
Length of a Unit Grate	L_o (G) =	2.92	2.92	feet
Width of a Unit Grate	W_o =	2.92	2.92	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.70	0.70	
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) =	2.41	2.41	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.67	0.67	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	N/A	N/A	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	N/A	N/A	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	N/A	N/A	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	N/A	N/A	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	N/A	N/A	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	N/A	N/A	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	N/A	N/A	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	N/A	N/A	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	0.379	0.879	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	N/A	N/A	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	N/A	N/A	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	0.95	1.00	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**2.0**	**7.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	0.1	0.2	cfs

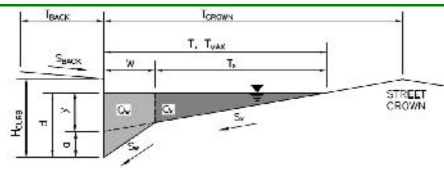
Version 4.05 Released March 2017

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

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

Project: **Wetherbee Office / Warehouse Building - Lot 22, Clarement BP F2 - Inlet A1.3**

Inlet ID: **Inlet A1.3**



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	4.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	24.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.050	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 =	0.080	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

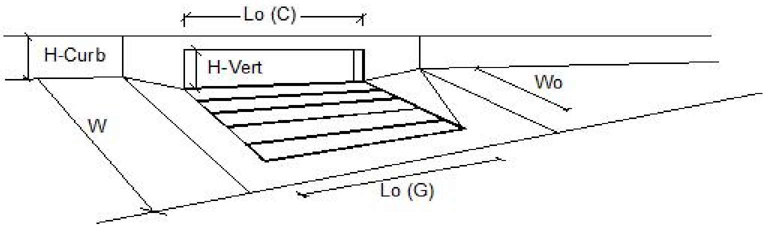
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	24.0	24.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**7.8**	**52.6**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.1**	**0.1**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**100**	**100**	**%**

Hydraulic Analysis Report

Project Data

Project Title: Wetherbee Office / Warehouse Building

Designer: JPS

Project Date: Monday, December 03, 2018

Project Units: U.S. Customary Units

Notes:

Channel Analysis: SD-A1.2

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.0000 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0130

Depth: 1.0000 ft

Result Parameters

Flow: 3.5628 cfs **>> Q100 = 0.2 CFS**

Area of Flow: 0.7854 ft^2

Wetted Perimeter: 3.1416 ft

Hydraulic Radius: 0.2500 ft

Average Velocity: 4.5363 ft/s

Top Width: 0.0000 ft

Froude Number: 0.0000

Critical Depth: 0.8057 ft

Critical Velocity: 5.2542 ft/s

Critical Slope: 0.0103 ft/ft

Critical Top Width: 0.79 ft

Calculated Max Shear Stress: 0.6240 lb/ft^2

Calculated Avg Shear Stress: 0.1560 lb/ft^2

Design Procedure Form: Rain Garden (RG)

UD-BMP (Version 3.06, November 2016)

Designer: JPS
Company: JPS
Date: October 3, 2018
Project: Lot 22, Claremont BP F2
Location: Lot 22, Claremont Business Park Filing No. 2 - 7302 Cole View

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of rain garden)	I_a = 78.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)	i = 0.780
C) Water Quality Capture Volume (WQCV) for a 12-hour Drain Time (WQCV= 0.8 * (0.91* i^3 - 1.19 * i^2 + 0.78 * i)	WQCV = 0.25 watershed inches
D) Contributing Watershed Area (including rain garden area)	Area = 15,682 sq ft
E) Water Quality Capture Volume (WQCV) Design Volume Vol = (WQCV / 12) * Area	V_{WQCV} = 331 cu ft
F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = ____ in
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume	$V_{WQCV\ OTHER}$ = ____ cu ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{WQCV\ USER}$ = ____ cu ft
2. Basin Geometry	
A) WQCV Depth (12-inch maximum)	D_{WQCV} = 12 in
B) Rain Garden Side Slopes (Z = 4 min., horiz. dist per unit vertical) (Use "0" if rain garden has vertical walls)	Z = 0.00 ft / ft
C) Mimimum Flat Surface Area	A_{Min} = 245 sq ft
D) Actual Flat Surface Area	A_{Actual} = 334 sq ft
E) Area at Design Depth (Top Surface Area)	A_{Top} = 814 sq ft
F) Rain Garden Total Volume (V_T= ((A_{Top} + A_{Actual}) / 2) * Depth)	V_T= 574 cu ft
3. Growing Media	Choose One (●) 18" Rain Garden Growing Media ( ) Other (Explain):
4. Underdrain System	
A) Are underdrains provided?	Choose One (●) YES ( ) NO
B) Underdrain system orifice diameter for 12 hour drain time	
i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice	y = 2.0 ft
ii) Volume to Drain in 12 Hours	Vol_{12} = 331 cu ft
iii) Orifice Diameter, 3/8" Minimum	D_O = 3/7 in

USE 7/16" ORIFICE

Design Procedure Form: Rain Garden (RG)

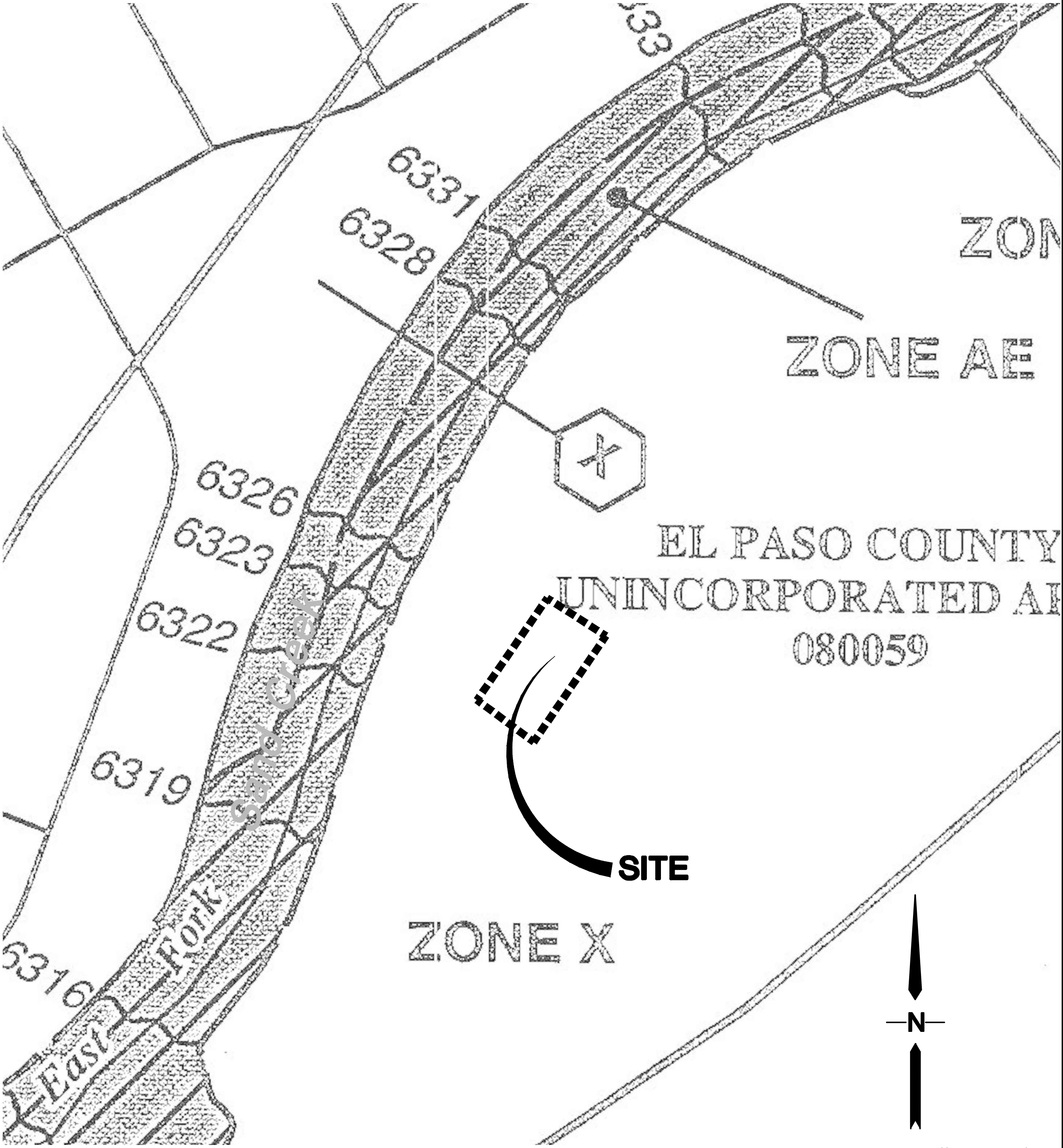
Designer: JPS
Company: JPS
Date: October 3, 2018
Project: Lot 22, Claremont BP F2
Location: Lot 22, Claremont Business Park Filing No. 2 - 7302 Cole View

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?	Choose One ○ YES ◉ NO
6. Inlet / Outlet Control A) Inlet Control	Choose One ○ Sheet Flow- No Energy Dissipation Required ◉ Concentrated Flow- Energy Dissipation Provided
7. Vegetation	Choose One ○ Seed (Plan for frequent weed control) ◉ Plantings ○ Sand Grown or Other High Infiltration Sod
8. Irrigation A) Will the rain garden be irrigated?	Choose One ○ YES ○ NO

Notes:

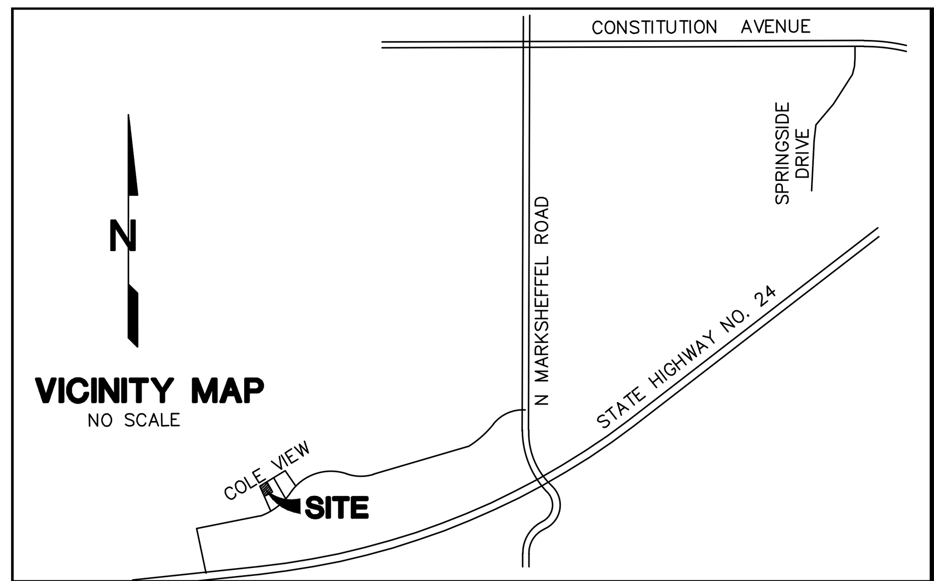
APPENDIX B

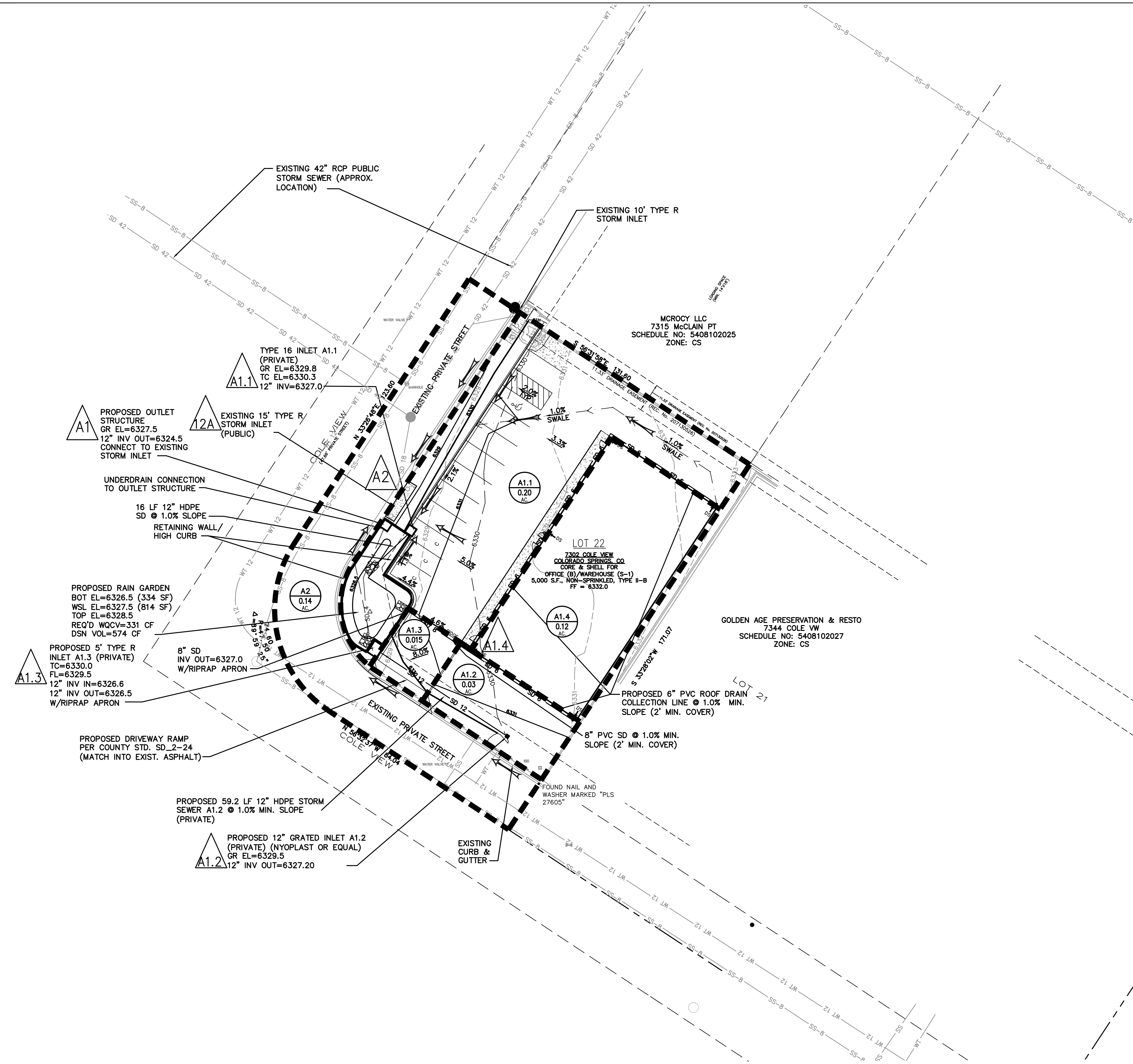
FIGURES



FIRM NO. 08041C0752F DATED 3/17/1997
REVISED BY LOMR CASE NO. 06-08-B137P DATED 12/13/2006

LOT 22 CLAREMONT BUSINESS PARK FILING NO. 2 WAREHOUSE BUILDING	JPS ENGINEERING	FLOODPLAIN MAP FIGURE FLD-1 JPS PROJ NO. 081803





IMPERVIOUS AREA CALCULATIONS:

TOTAL BASIN A1 AREA = 0.36 AC.

IMPERVIOUS AREAS:

SURFACE TYPE	AREA
PARKING PAVEMENT	6,480 SF
BUILDING (BOTH LOTS)	5,000 SF
SIDEWALK	500 SF
TOTAL	11,980 SF
	= 0.28 AC
	= 77.7% IMPERVIOUS

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
A1.1	0.8	1.5
A1.2	0.1	0.2
A1.3	0.06	0.1
A1.4	0.5	0.9
A1	1.5	2.8
A2	0.6	1.1
12A	11.7	23.5

BENCHMARK:
NGS BENCHMARK "R 76".
ELEVATION=6289.86 (NAVD-1988)

CLAREMONT-WETHERBEE

7302 COLE VIEW, COLORADO SPRINGS, COLORADO 80915

DEVELOPED DRAINAGE PLAN

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

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

No.	REVISION	BY	DATE

HORZ. SCALE:	1"=20'	DRAWN:	BJJ
VERT. SCALE:	N/A	DESIGNED:	JPS
SURVEYED:	COMPASS	CHECKED:	JPS
CREATED:	9/04/18	LAST MODIFIED:	12/03/18
PROJECT NO:	081803	MODIFIED BY:	BJJ
SHEET:	D1		