DRAINAGE LETTER

LOT 11, ROLLING THUNDER BUSINESS PARK

EL PASO COUNTY

April 2, 2021
Revised
September 24, 2021
Revised
December 24, 2021
Revised
May 27, 2022
Revised
June 14, 2022
Revised
August 1, 2022

Prepared for
Ruckus Development

County File No.: PPR-21-24

Oliver E. Watts, Consulting Engineer, Inc.
Colorado Springs, Colorado

OLIVER E. WATTS, PE-LS
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Celebrating over 43 years in business

August 1, 2022

El Paso County Planning and Community Development
2880 International Circle
Colorado Springs, CO 80910

ATTN: *Jennifer Irvine, P.E.*

Please update to new County Engineer "Joshua Palmer"

SUBJECT: Drainage Letter
Lot 11 Rolling Thunder Business Park

Transmitted herewith for your review and approval is the drainage plan and report for Lot 11 Rolling Thunder Business Park, in El Paso County. This report will accompany the Site Development Plan submittal for the Replat of Lot 11, Rolling Thunder Business Park. It has been revised per the review comments of July 24, 2021, November 16, 2021, April 8, 2022, July 25, 2022.

Please contact me if I may provide any further information.

Oliver E. Watts, Consulting Engineer, Inc.

BY: ______________________________
Oliver E. Watts, President

Encl:
- Drainage Report 4 pages
- Computations, 4 pages
- FEMA Panel No. 08041C0535 G
- SCS Soils Map and Interpretation Sheet
- Backup Information, 10 sheets
- Impervious Computation Sheet, Dwg 20-5509-03
- Drainage Plan, Historic, Dwg 20-5509-08
- Drainage Plan, Developed, Dwg 20-5509-04

1. ENGINEER'S STATEMENT:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the applicable 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.

Oliver E. Watts, Consulting Engineer, Inc.

Oliver E. Watts Colo. PE-LS No. 9853

2. OWNERS / DEVELOPER'S STATEMENT:

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

Ruckus Investments, LLC

By: ____________________
Jeffry Wesson
2041 Meadowbrook Parkway
Colorado Springs, CO 80951-4732
660-8990

3. EL PASO COUNTY:

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

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

Conditions:

4. LOCATION AND DESCRIPTION:

Lot 11 Rolling Thunder Business Park is located north of the intersection of Maltese Point and Rolling Thunder Way, and south of Woodmen Road, as shown on the enclosed site plan. It is a portion of the NE1/4 of Section 11, Township 13 South, Range 65 West of the 6^{th} P.M. in El Paso County, Colorado. The total size of the subdivision is 2.00 acres. We propose to construct two commercial buildings on the site.

5. FLOOD PLAIN STATEMENT:

This subdivision is not within the limits of a designated flood plain or flood hazard area, as identified on FEMA panel no. 08041C0535 G, dated December 7, 2018, a copy of which is enclosed for reference.

6. DESCRIPTION OF RUNOFF:

A: Existing Conditions:

As stated above, this Site is platted as Lot 11 in the Rolling Thunder Business Park in 2008. At that time a drainage report; Rolling Thunder Business Park Preliminary/Final Drainage Report was by Springs Engineering, submitted and approved by El Paso County on 10-16-08. This lot has been zoned for industrial or commercial uses since that time, and runoff was computed on that basis. The lot was rough graded and an erosion control pond, known as the “Fire House Pond” was constructed as shown on the enclosed existing conditions drainage plan, occupying approximately 3000 square feet to a depth of four feet. The historic runoff for the original ground range land condition is computed to be 0.3 cfs / 2.4 cfs) 5-year / 100- year runoffs). The outfall to the pond is a private 8 foot grated inlet and 24” RCP running westerly to a manhole, where a 30” RCP from the Lot 10 pond combines and runs south in a 36” RCP across Rolling Thunder Way.

Water quality storage exists on the “Southwest Pond” in lot 10, westerly of this lot, as shown on the drainage plan, and in the “Tank Pond” east of this site. These ponds are shown on the drainage plan for the Rolling Thunder Business Park enclosed in the backup material of this report. Therefore, a water quality pond is required for the development of this lot, since the disturbance is over 1-acre.

B: Proposed Conditions:

Those portions of the lot within the paved portions of Fire House View and Maltese Point will not be modified. The remainder of the lot (1.596 acre) will be developed as shown on the enclosed drainage plan, and runoff will be directed by the grading shown to a private water quality pond in the Southeast corner. The landscaped areas shown on the plan total 0.288 Ac., or 18.0% of Basin A, as shown on the enclosed impervious computation sheet. An impervious percentage of 82% was used for computation purposes, compared with the Springs Engineering report (attached), which used close to 100%.

There is no proposed storm sewer north side of the northern building. Unresolved.

A minor (private) storm sewer is provided along the north sides of the two main buildings to provide adequate drainage capacity and prevent winter ice problems. The existing pond has been relocated to allow for optimum use of the lot. A sand filter basin is proposed which requires a total bottom area of 713 square feet at a depth of two feet with 3:1 side slopes as shown on the enclosed SFB computation form. A pond bottom area of 751 square feet is provided as shown on the drainage plan, and the total pond storage is 2205 cubic feet, as shown in the computations. The total runoff from the lot will be 2.8 cfs / 5.8 CFS. The Springs Engineering report (attached) shows this to be part of Basins D-7 and D-8, which cannot be compared directly, but which used nearly 100%

impervious values. The Basin D-7 portion had flows of 4.6/8.7 cfs. A 6-foot curb outlet will discharge the 100 year runoff into the pond, a standard grated inlet at the two foot level will capture the 100-year runoff and an 18" HDPE will be routed to the existing grated inlet, which will end up being in the parking lot and will be capped. A 4-inch underdrain is provided with an orifice opening of 2-11/16".

Orifice size does not match UD-BMP Form Unresolved.

The existing RCP storm sewers described above are more than adequate to convey the 100-year runoff as shown in the enclosed computations.

7. FEES:

This Site is within the Sand Creek Drainage Basin. It has been previously platted; therefore fees are computed on the basis of a computed increase in impervious cover. The following is a summary of the computations reflected on the enclosed impervious area computation sheet:

Total developed area:	1.596 ac.	
Landscaped area:	0.288 ac.	18 %
Impervious area:	82 %	

Drainage Fees have been computed in accordance with the computations for the Rolling Thunder Business Park, which are enclosed in the attached back up material. The area involved is for basins D-3, D-7 and D-8 of that study, which used fees based on an assumed impervious ratio of 85%. Therefore, fees are not due for this (proposed) development plan.

FOUR STEP PROCESS

The following process has been followed to minimize adverse impacts of urbanization

Step1 Employ Runoff Reduction Practices – The extent of impervious materials is minimized consistent with the objectives of the facility. Modular block (Airpave pavers) is being used between the two buildings. Runoff is concentrated along curb and gutters to the outlet. Standard BMP's are provided as shown on the grading and erosion control plan; silt fence, vehicle tracking control, stockpile and staging area protection, and a concrete washout basin, as identified by the Erosion Control on the plan.

sand filter basin

Step 2 Stabilize Drainageways –The development of this project does not create Drainageways and is not anticipated to have any negative effects on downstream Drainageways. Slopes are minimized and storm water will outfall onto the proposed parking lot which will direct the flows to inlets and eventually the detention pond. Runoff across the asphalt pavement will be concentrated along curb, gutter, and dip slabs.

remove and adjust the following sentence to account for removal

Step 3 Provide Water Quality Capture Volume – The limit of disturbance for the proposed construction is 1.64 acres. There is a regional detention pond adjacent to the site on lots 9 and 10 (shown on the enclosed drainage plan). Therefore only water quality is required and necessary. A sand filter basin is proposed.

The adjacent lot only has a WQ pond. Please see notes below outfall from these WQ ponds.Statement will need to be corrected.

Step 4 Consider Need for Industrial and Commercial BMP's – This submittal provides a final grading and erosion control plans with BMP’s in place. The proposed project will use silt fence, a vehicle tracking control pad, and concrete washout area, reseeding and landscaping to mitigate the potential for erosion across the site. The proposed BMP’s are considered fully adequate.

8. SUMMARY

The proposed site will development is consistent with the previous approved drainage report for Rolling Thunder Business Park. There will be no adverse effects on downstream or surrounding properties.

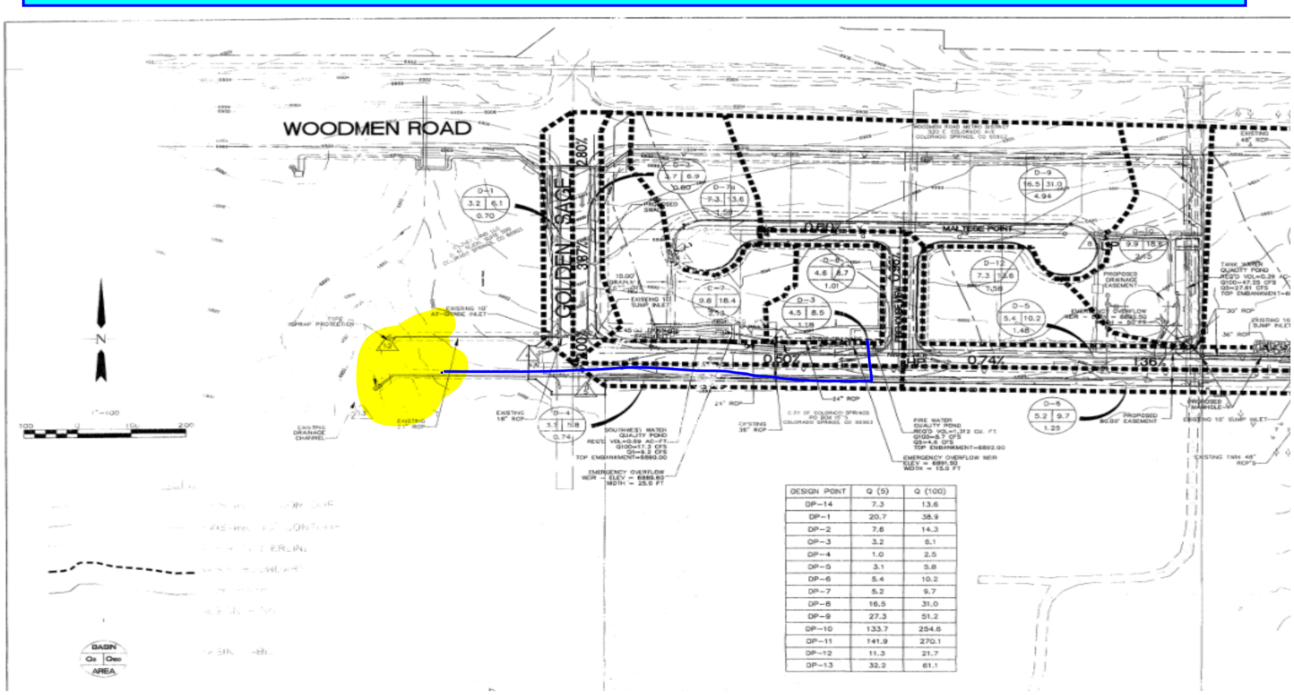
The drainage letter has been prepared in accordance with the current El Paso County Drainage Criteria Manuel. Supporting information and calculations are included in this report.

The resultant flows to the sand basin pond are within the capacity of the proposed 18-inch HDPE pipe.

For proposed drainage conditions a statement needs to be added to coincide with a suitable outfall determination and functionality.

Please Add
Discussion and analysis of existing and proposed downstream drainage facilities and their ability to convey developed runoff from the proposed development.

Since only WQ is being provided on site and the site flow are not being detained in a regional pond or on site detention pond a statement must be added that states that the proposed drainage improvements and facilities will adequately treat, and convey, and route runoff from the site to the East Fork Sand Creek drainage channel to the west of Golden Sage (shown below in yellow). Please state that the this is a suitable outfall for the generated site flows and is functioning properly.
Please refer to PCD File SF07019 FDR.



MAJOR BASIN	SUB BASIN	AREA		BASIN		Tc MIN	I in./hr.		SOIL GRP	DEV. TYPE	C		FLOW 5-ry qp -CFS-	FLOW 100-yr qp -CFS-	RETURN PERIOD -years-	
		PLANIM READ	ACRES	LENGTH -FT.-	HEIGHT -FT.-											
EXISTING	A	COGO	1.596	300	4	29	2.4	1.1	A	R/L	0.08	0.35	0.3	0.6	5	100
DEVELOPED	A	COGO	1.664	300	3	17.1			A	79	0.605	0.714				
				+130		+2.0										
						19.1	3.0	5.1					2.8	5.8	5	100
TSB POND	EL.	A-SF	V -	-CF-		V	=	1800	X1.664	2995 CF						
	74	353		-0-												
			626						d=2.74							
	75	899		626					V=	0.069	AF					
			899.5						3/8”	@	4”	1	ROW			
	76	1652		1901.5												
			2121		2995	@	76.51									
	77	2590		4022.5												

HYDROLOGICAL COMPUTATION – BASIC DATA
PROJ: FOLLLING THUNDER BUSINESS PARK F 1B BY:O.E. WATTS
RATIONAL METHOD DATE: 4/2/21 2/23/21 9/27/21, 5-27-22

OLIVER E. WATTS, CONSULTING ENGINEER, INC.
614 ELKTON DRIVE COLORADO SPRINGS, CO 80907

STREET AND STORM SEWER CALCULATIONS

STREET	LOCATION	DISTANCE -ft.-	ELEVATION & SLOPE	TOTAL RUNOFF -cfs- 5-yr./100-yr	STREET FLOW / CAPACITY -cfs- 5-yr./100-yr	PIPE FLOW -cfs-	TYPE PIPE, CATCH BASIN & SLOPE %
PARKING	OUTFALL		77.0	2.8/5.8	5.8		6' CURB OUTLET d=0.46'
		6	3:1				
	POIND		75.0				
	GRATE		TOP=77.0 INV=75.5		5.8	5.8	FB GRATE h=0.4' ok
		33.27	6.64%			5.8	18" HDPE
	EXIST. O/L		73.29				hi=0.16V2=0.17' < 0.4
POND ELEV	A-SF	V-CF	TOTAL V-CF				
75	751		0				
		944					
76	1137		944				
		1360					
77	1582		2303				

OLIVER E. WATTS, CONSULTING ENGINEER, INC.
614 ELKTON DRIVE COLORADO SPRINGS, CO 80907

Design Procedure Form: Sand Filter (SF)

Designer:	**Ollie Watts**
Company:	**Oliver E Watts Consulting Engineer, inc.**
Date:	**August 19, 2022**
Project:	**10659 Maltese Point**
Location:	**10659 Maltese Point**

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of sand filter)	I_a = 82.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)	i = 0.820
C) Water Quality Capture Volume (WQCV) Based on 12-hour Drain Time WOCV= $0.8 * (0.91* i^3 - 1.19 * i^2 + 0.78 * i)$	WQCV = 0.27 watershed inches
D) Contributing Watershed Area (including sand filter area)	Area = 69,540 sq ft
E) Water Quality Capture Volume (WQCV) Design Volume V_{WOCV} = WQCV / 12 * Area	V_{WOCV} = cu ft
F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = 0.40 in
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume	$V_{WOCV\ OTHER}$ = 1,471 cu ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{WOCV\ USER}$ = cu ft
2. Basin Geometry	
A) WQCV Depth	D_{WOCV} = 2.0 ft
B) Sand Filter Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred). Use "0" if sand filter has vertical walls.	Z = 3.00 ft / ft DIFFICULT TO MAINTAIN, INCREASE WHERE POSSIBLE
C) Minimum Filter Area (Flat Surface Area)	A_{Min} = 713 sq ft
D) Actual Filter Area	A_{Actual} = 751 sq ft
E) Volume Provided	V_T = 2303 cu ft
3. Filter Material	Choose One ● 18" CDOT Class B or C Filter Material ○ 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 = 1.0 ft
ii) Volume to Drain in 12 Hours	Vol_{12} = 1,471 cu ft
iii) Orifice Diameter, 3/8" Minimum	D_O = 1 in

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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 Works

A) Describe the type of energy dissipation at inlet points and means of conveying flows in excess of the WQCV through the outlet

Notes: Soil is Hydrologic Group A

National Flood Hazard Layer FIRMette

FEMA

38°56'37.30"N

104°38'6.82"W

104°37'29.37"W

38°56'9.32"N

Feet 1:6,000

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

Legend

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 1/22/2020 at 12:00:29 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.

OLIVER E. WATTS
CONSULTING ENGINEER, INC.
COLORADO SPRINGS

ROLLING THUNDER BUSINESS PARK
FILING NO. 1B
SOILS MAP
1"=2000'

TABLE 16.--SOIL AND WATER FEATURES

[Absence of an entry indicates the feature is not a concern. See "flooding" in Glossary for definition of terms as "rare," "brief," and "very brief." The symbol > means greater than]

Soil name and map symbol	Hydro-logic group	Flooding			Bedrock		Potential frost action
		Frequency	Duration	Months	Depth	Hardness	
					In		
Alamosa:							
1	C	Frequent	Brief	May-Jun	>60	---	High.
Ascalon:							
2, 3	B	None	---	---	>60	---	Moderate.
Badland:							
4	D	---	---	---	---	---	---
Bijou:							
5, 6, 7	B	None	---	---	>60	---	Low.
Blakeland:							
8	A	None	---	---	>60	---	Low.
[1]9:							
Blakeland part	A	None	---	---	>60	---	Low.
Fluvaquentic Haplaquolls part	D	Common	Very brief	Mar-Aug	>60	---	High.
Blendon:							
10	B	None	---	---	>60	---	Moderate.
Bresser:							
11, 12, 13	B	None	---	---	>60	---	Low.
Brussett:							
14, 15	B	None	---	---	>60	---	Moderate.
Chaseville:							
16, 17	A	None	---	---	>60	---	Low.
[1]18:							
Chaseville part	A	None	---	---	>60	---	Low.
Midway part	D	None	---	---	10-20	Rippable	Moderate.
Columbine:							
19	A	None to rare	---	---	>60	---	Low.
Connerton:							
[1]20:							
Connerton part	B	None	---	---	>60	---	High.
Rock outcrop part	D	---	---	---	---	---	---
Cruckton:							
21	B	None	---	---	>60	---	Moderate.
Cushman:							
22, 23	C	None	---	---	20-40	Rippable	Moderate.
[1]24:							
Cushman part	C	None	---	---	20-40	Rippable	Moderate.
Kutch part	C	None	---	---	20-40	Rippable	Moderate.
Elbeth:							
25, 26	B	None	---	---	>60	---	Moderate.
[1]27:							
Elbeth part	B	None	---	---	>60	---	Moderate.

See footnote at end of table.

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.

$$t_c = t_i + t_t$$ (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.

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}}$$ (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 <u>maximum</u> for non-urban land uses, 100 ft <u>maximum</u> 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).

$$V = C_v S_w^{0.5}$$ (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.

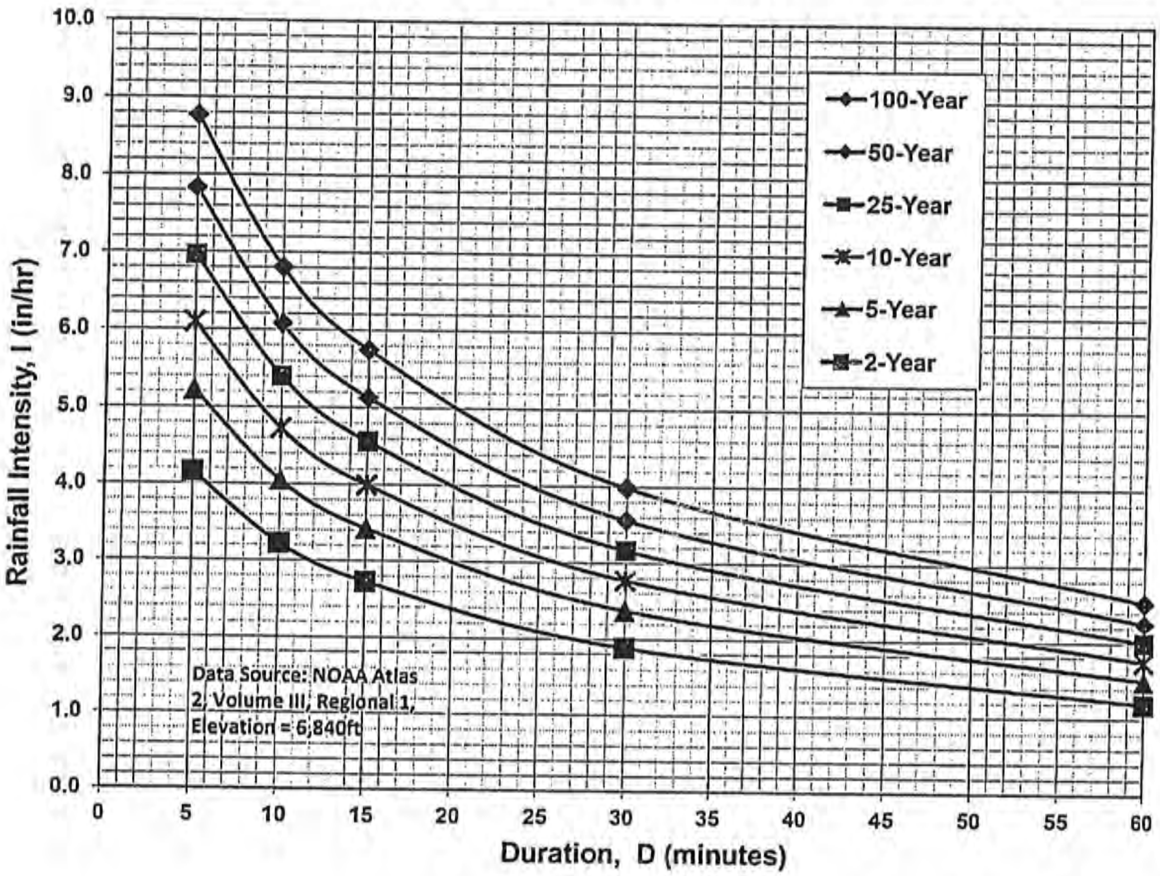
3.2.4 Minimum Time of Concentration

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

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

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

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

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

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

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

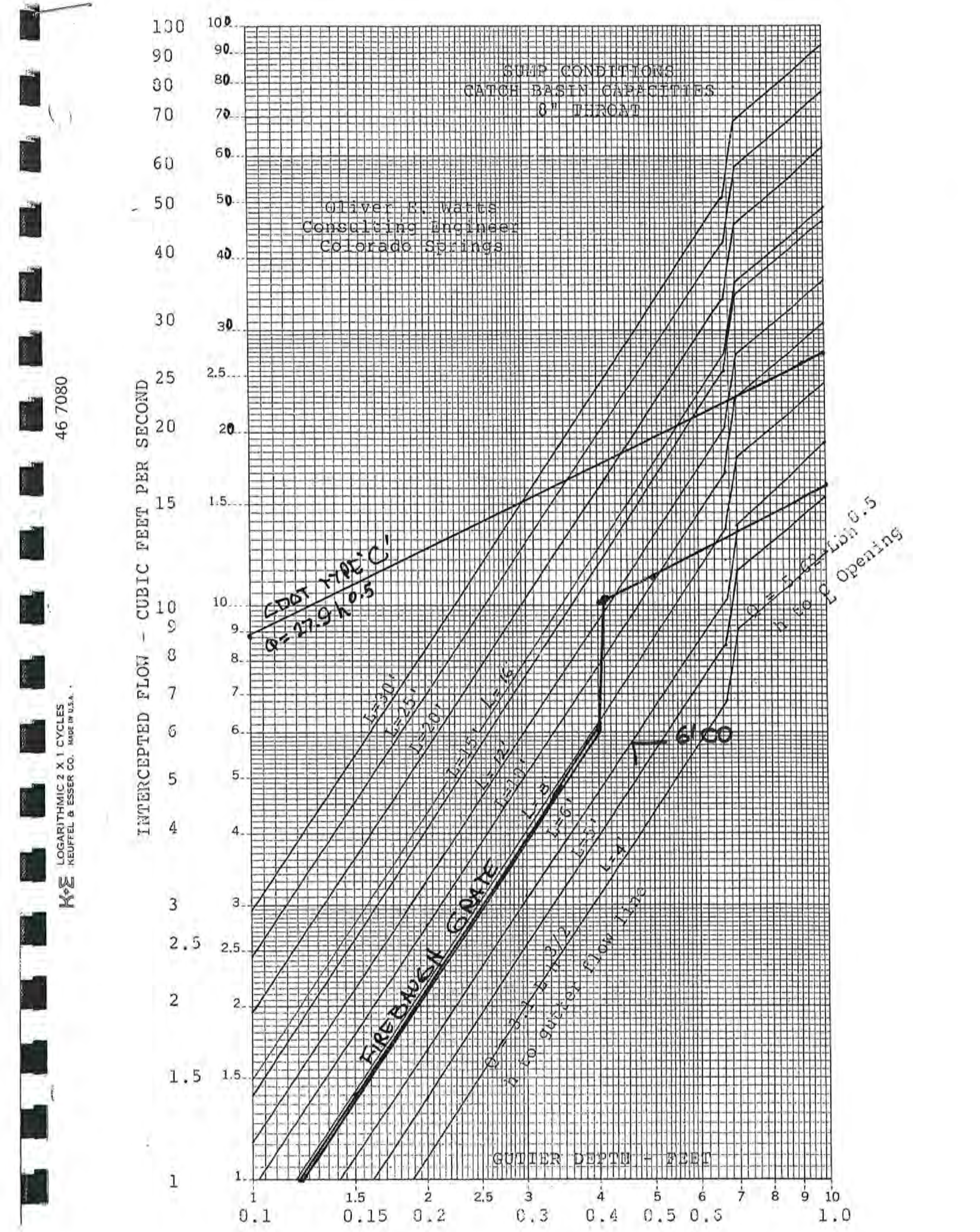
Note: Values calculated by equations may not precisely duplicate values read from figure.

$$Q=\frac{0.463}{n} D^{8/3} S^{\frac{1}{2}}$$

$$Q=KS^{\frac{1}{2}}$$

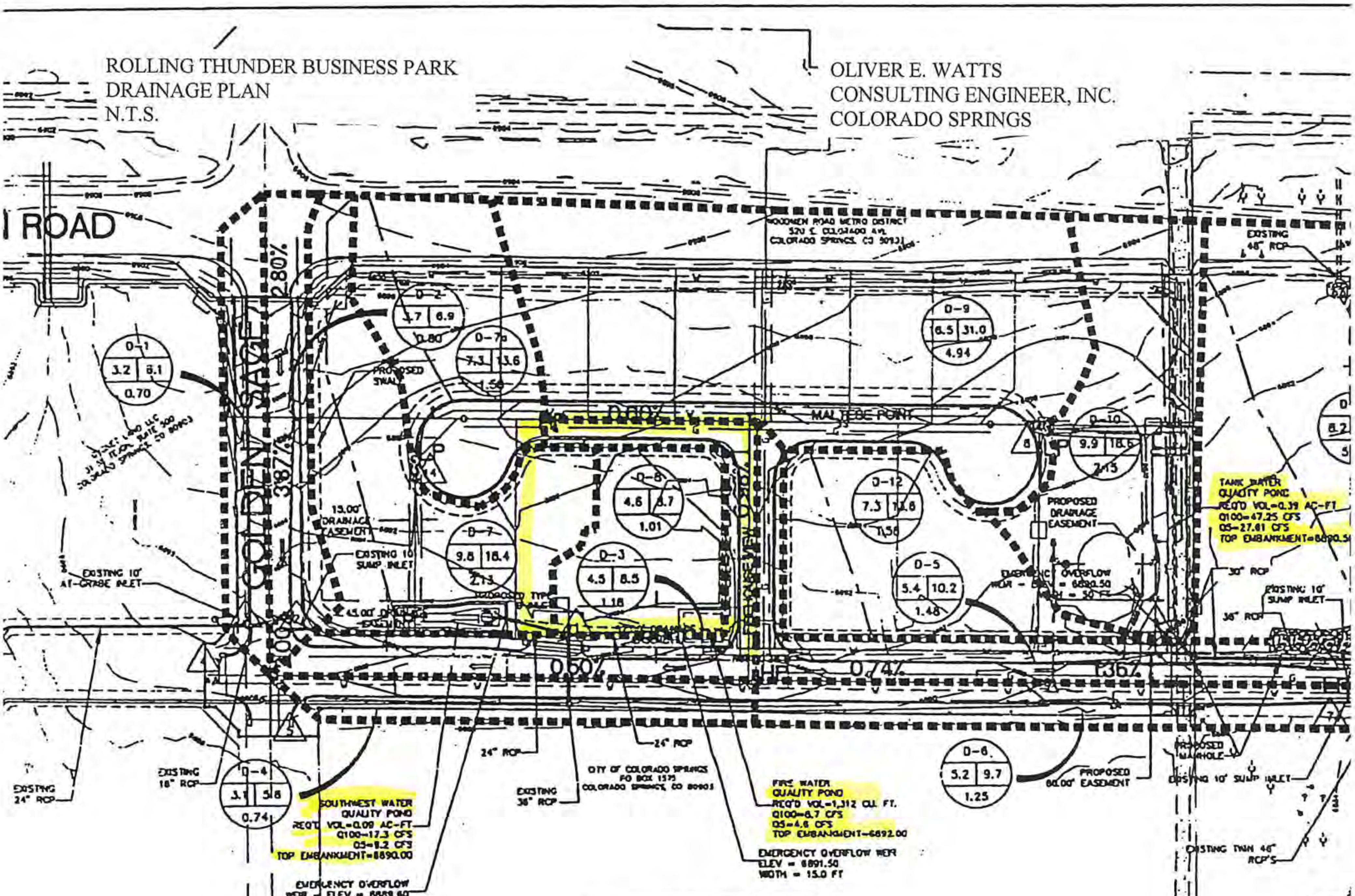
DIAMETER -IN.-	AREA -FT2-	D 8/3 -FT-	K			
			N=0.010	N=0.013	N=0.024	N=0.026
2	0.02182	0.008413	0.3895	---	---	---
4	0.08727	0.053420	2.4733	---	---	---
6	0.19630	0.157500	7.2922	5.609	---	---
8	0.34910	0.339200	15.7050	12.081	---	---
10	0.54540	0.615000	28.4745	21.903	---	---
12	0.78540	1.000000	46.3000	35.615	---	---
15	1.22720	1.813100	83.9465	64.574	---	---
18	1.76710	2.948300	136.5100	105.000	56.88	52.50
21	2.40530	4.447400	205.9100	158.400	85.80	79.20
24	3.14160	6.349600	293.9900	226.140	122.49	113.07
27	3.97610	8.692700	402.4700	309.590	167.70	154.79
30	4.90870	11.512600	533.0300	410.030	222.10	205.02
33	5.93960	14.844100	---	528.680	---	---
36	7.06860	18.720800	866.7700	666.700	361.20	333.30
39	8.29580	23.175100	---	825.400	---	---
42	9.62110	28.238900	---	1005.000	544.80	502.50
48	12.56640	40.317500	---	1436.000	777.80	718.00
54	15.90430	55.195000	---	1966.000	1065.00	983.00
60	19.63500	73.100400	---	2604.000	1410.00	1302.00
66	23.75830	94.254200	---	3357.000	1818.00	1678.00
72	28.27430	118.869400	---	4234.000	2293.00	2117.00
78	33.18310	147.152900	---	5241.000	2839.00	2620.00
84	38.48450	179.306000	---	6386.000	3459.00	3193.00
90	44.17860	215.524500	---	7676.000	4158.00	3838.00
96	50.26550	256.000000	---	9118.000	4939.00	4559.00
108	63.61730	350.466600	---	12480.000	6761.00	6140.00
120	78.53980	464.158900	---	16530.000	8954.00	8265.00

Oliver E. Watts
Consulting Engine
Colorado Springs


SUMP CONDITIONS
CATCH BASIN CAPACITIES
8" THROAT
Oliver E. Watts
Consulting Engineer
Colorado Springs
INTERCEPTED FLOW - CUBIC FEET PER SECOND
GUTTER DEPTH - FEET
CDOT TYPE 'C'
Q=27.9 h0.5
Q = 5.62 Lbh 0.5
h to ℄ Opening
Q = 3.1 L h 3/2
h to gutter flow line
FIREBAUGH GRATE
6' CO
L=30'
L=25'
L=20'
L=16'
L=15'
L=12'
L=10'
L=8'
L=6'
L=5'
L=4'
K+E LOGARITHMIC 2 X 1 CYCLES KEUFFEL & ESSER CO. MADE IN U.S.A.
46 7080

ROLLING THUNDER BUSINESS PARK
DRAINAGE PLAN
N.T.S.

OLIVER E. WATTS
CONSULTING ENGINEER, INC.
COLORADO SPRINGS

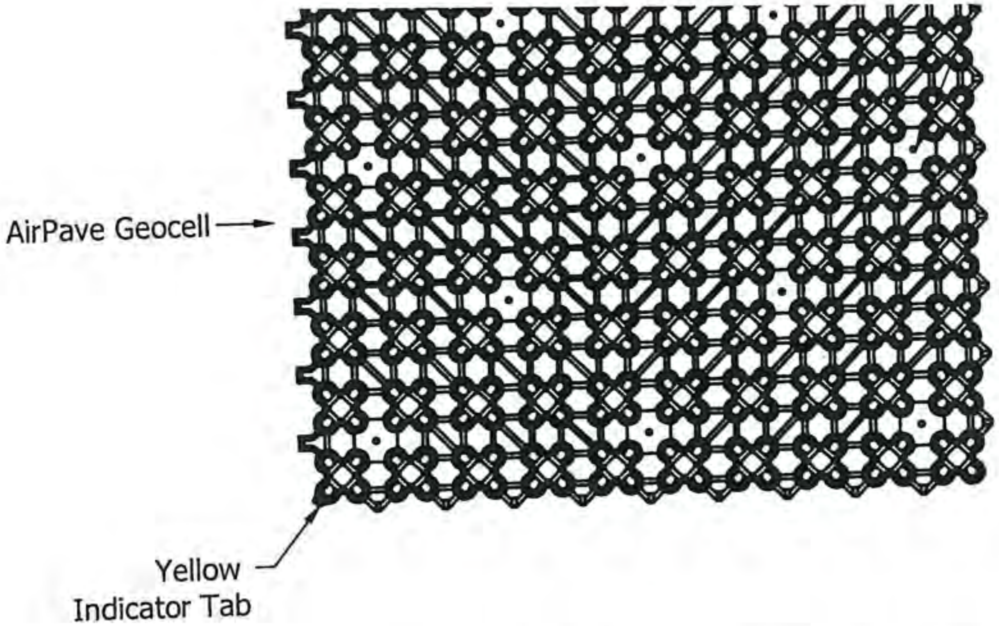


DESIGN POINT	Q (5)	Q (100)
DP-14	7.3	13.6
DP-1	20.7	38.9

ROLLING THUNDER BUSINESS PARK - FDR - DEVELOPED CONDITIONS
(RATIONAL METHOD Q=CIA)

BASIN	TOTAL FLOWS Q_2 (c.f.s.)	Q_5 (c.f.s.)	Q_{100} (c.f.s.)	CA(equiv.) 2 YR	5 YR	100 YR	AREA TOTAL (Ac)	WEIGHTED C_5	C_{100}	OVERLAND C_5	Length (ft)	Slope (ft)	Tco (min)	CHANNEL Length (ft)	Slope (%)	Velocity (fps)	Tcc (min)	Tc TOTAL (min)	INTENSITY I_2 (in/hr)	I_5 (in/hr)	I_{100} (in/hr)	COMMENTS
D-1	2.3	3.2	6.1	0.6	0.63	0.67	0.70	0.90	0.95	0.90	5	2.0%	0.7	500	3.5%	3.7	2.2	5.0	3.7	5.1	9.1	
D-2	2.7	3.7	6.9	0.7	0.72	0.76	0.80	0.90	0.95	0.90	5	2.0%	0.7	500	3.5%	3.7	2.2	5.0	3.7	5.1	9.1	
D-3	3.3	4.5	8.5	1.1	1.06	1.12	1.18	0.90	0.95	0.90	40	2.0%	1.9	715	0.7%	1.7	7.1	9.0	3.1	4.3	7.6	
D-4	2.2	3.1	5.8	0.7	0.67	0.71	0.74	0.90	0.95	0.90	5	2.0%	0.7	560	0.5%	1.4	6.6	7.3	3.3	4.6	8.2	
D-5	3.9	5.4	10.2	1.3	1.33	1.41	1.48	0.90	0.95	0.90	40	2.0%	1.9	1,000	1.0%	2.0	8.3	10.2	3.0	4.1	7.2	
D-6	3.8	5.2	9.7	1.1	1.12	1.19	1.25	0.90	0.95	0.90	5	2.0%	0.7	775	1.0%	2.0	6.5	7.1	3.4	4.6	8.2	
D-7	7.1	9.8	18.4	1.9	1.92	2.02	2.13	0.90	0.95	0.90	40	2.0%	1.9	515	3.1%	3.5	2.4	5.0	3.7	5.1	9.1	
D-7a	5.3	7.3	13.6	1.4	1.42	1.50	1.58	0.90	0.95	0.90	40	2.0%	1.9	285	4.3%	4.1	1.2	5.0	3.7	5.1	9.1	
D-8	3.4	4.6	8.7	0.9	0.91	0.96	1.01	0.90	0.95	0.90	5	2.0%	0.7	245	1.2%	2.2	1.8	5.0	3.7	5.1	9.1	
D-9	12.0	16.5	31.0	4.4	4.45	4.69	4.94	0.90	0.95	0.90	300	2.0%	5.2	715	0.6%	1.5	7.7	12.8	2.7	3.7	6.6	
D-10	7.2	9.9	18.6	1.9	1.94	2.04	2.15	0.90	0.95	0.90	60	2.0%	2.3	300	2.0%	2.8	1.8	5.0	3.7	5.1	9.1	
D-11	5.9	8.2	19.4	1.6	1.60	2.13	5.33	0.30	0.40	0.90	60	2.0%	2.3	500	2.8%	3.3	2.5	5.0	3.7	5.1	9.1	
D-12	5.3	7.3	13.6	1.4	1.42	1.50	1.58	0.90	0.95	0.90	10	2.0%	0.9	250	1.6%	2.5	1.6	5.0	3.7	5.1	9.1	
Offsite	68.8	94.7	194.5	32.5	32.50	37.50	50.00	0.65	0.75	0.35	100	2.0%	11.2	1,500	1.5%	2.4	10.2	21.4	2.1	2.9	5.2	
Formula:		C*I*A	C*I*A		Q/I	Q/I							*1			*2	*3	Tco+Tcc	*4	*5	*6	
							86.95									20			1.09	1.5	2.67	

1* $T_{co} = 1.87*(1.1-C5)*(L^{0.5})*((S*100)^{-0.33})$ (DCM page 5-11)
2* $V_c = 20*S^{0.5}$ (USDCM RO-4)
3* $T_{cc} = 1/V*L/60$
4* $I_2 = (26.65*1.09)/(10+T_c)^{0.76}$ (City Letter of 1/7/2003)
5* $I_5 = (26.65*1.50)/(10+T_c)^{0.76}$ (City Letter of 1/7/2003)
6* $I_{100} = (26.65*2.67)/(10+T_c)^{0.76}$ (City Letter of 1/7/2003)



Unit Panel Specifications:

Size:	32" x 32" x 1"
Weight:	3.1 lb
Strength:	233 psi (unfilled) 6747 psi (filled)
Resin:	100% Recycled (PIR) Copolymer with Impact Modifier "No Break" Polymer Material
Color:	Black (3% carbon black added for UV Protection)

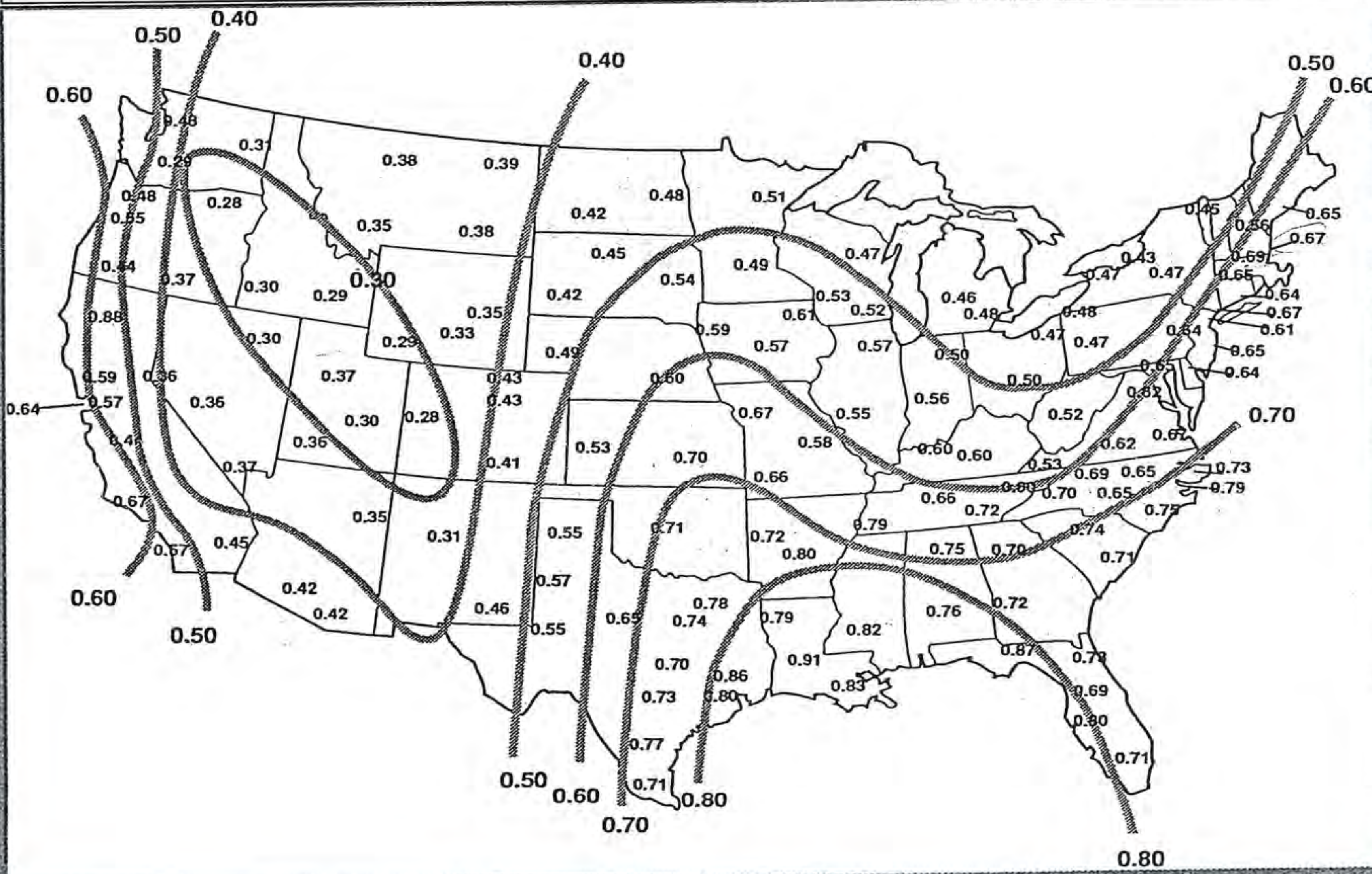
AirPave Cross Section
Typical

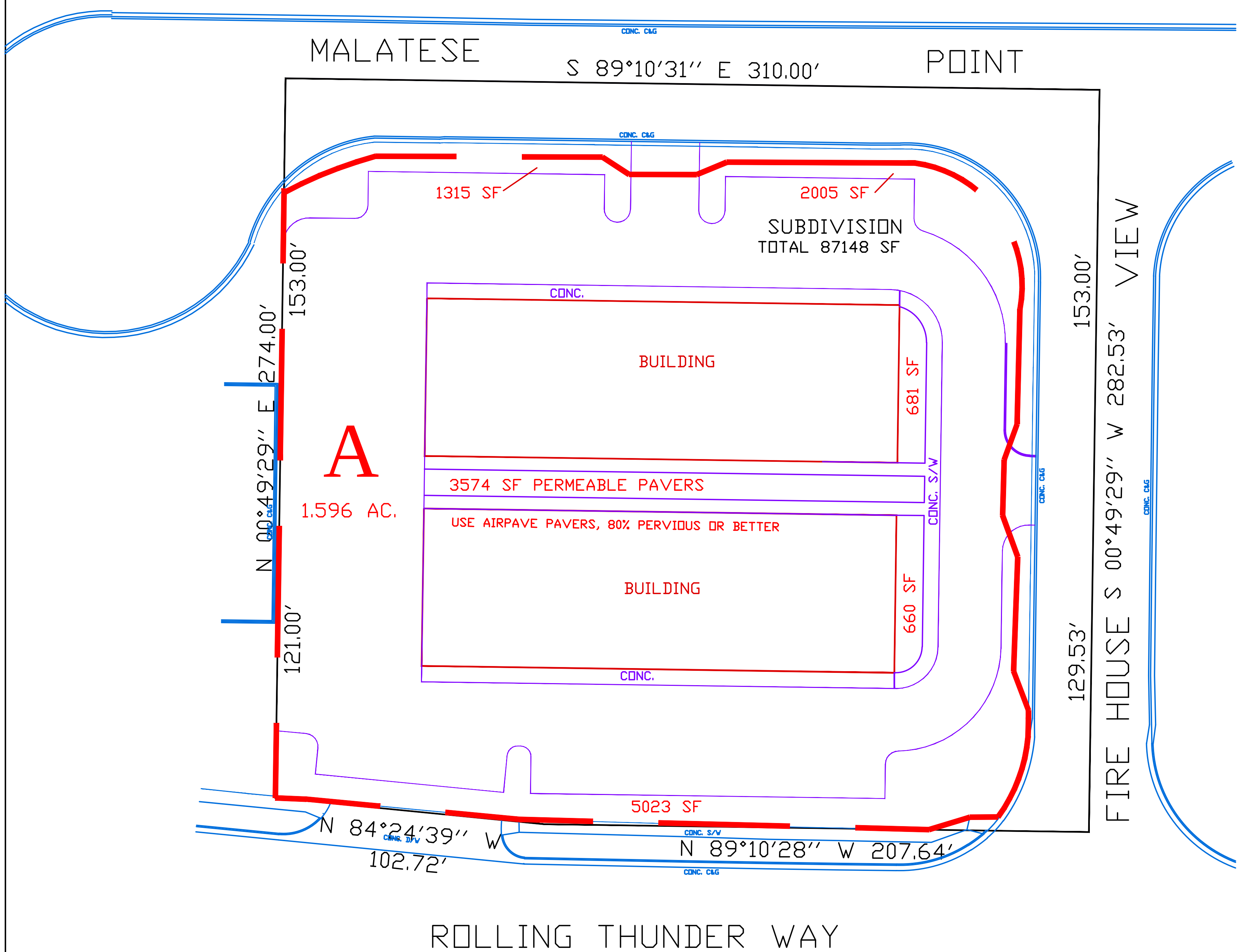
Scale 0.12:1

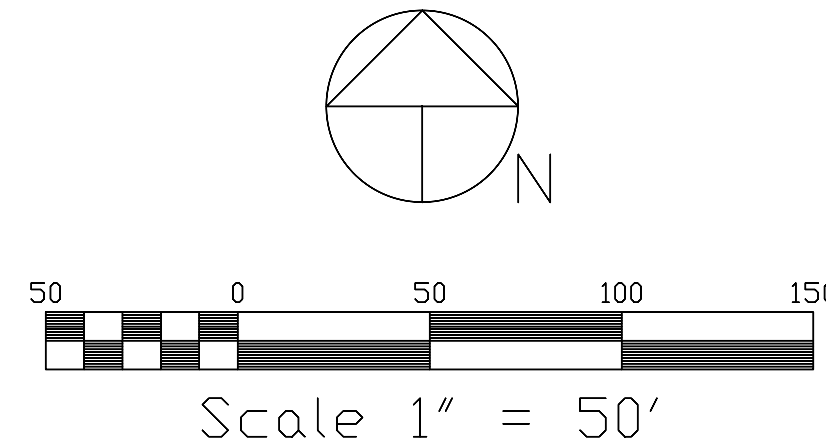
For AirPave Systems

Airfield Systems, LLC
8028 N May Ave, Suite 201
Oklahoma City, OK 73120
(405) 359-3375

Mean Annual Storm Precipitation Depths, P_6 (inches)







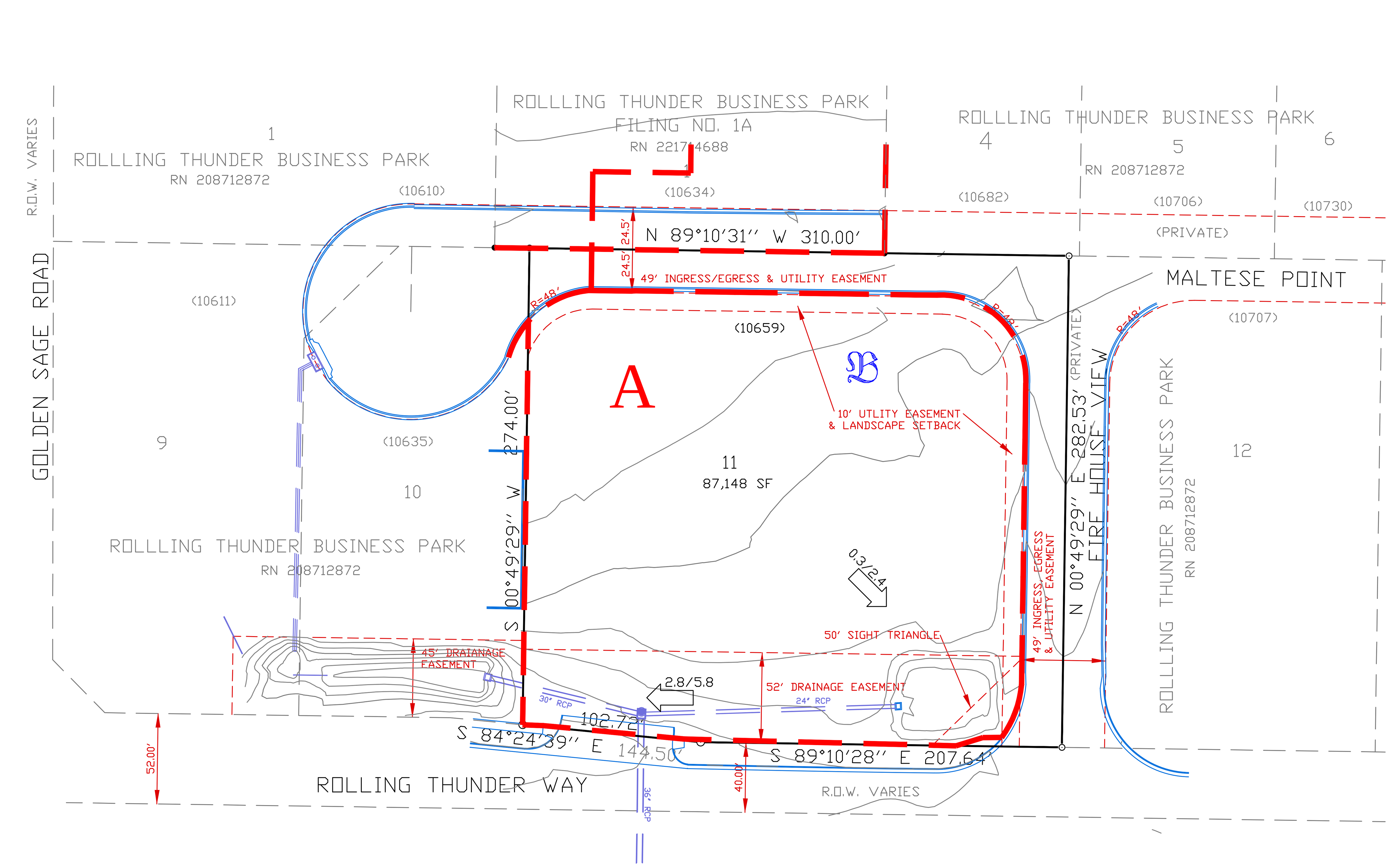
TOTAL LANDSCAPED AREA: 12,543 SF (0.2880 AC/) 18.0%
TOTAL IMPERVIOUS: 82.0%

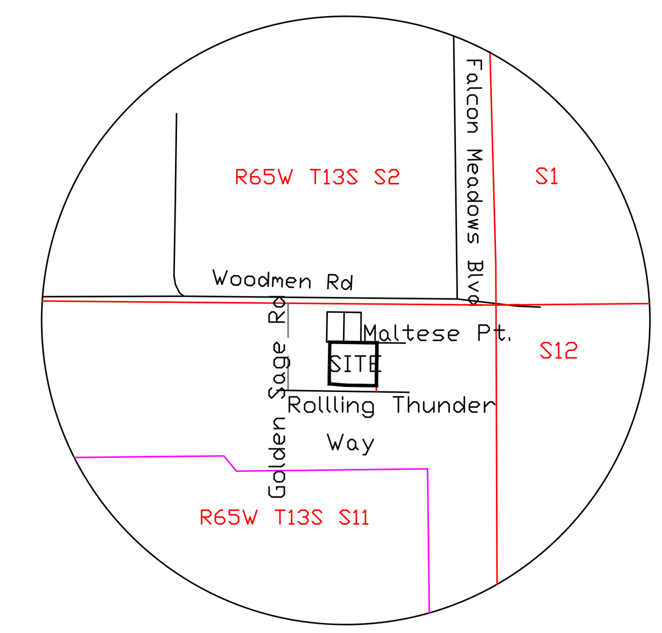
IMPERVIOUS COMPUTATIONS

DRAWN BY: O.E. WATTS DATE: 2-17-21 DWG. NO.: 20-5509-03	REVISIONS 6-14-22 OEW	OLIVER E. WATTS CONSULTING ENGINEER COLORADO SPRINGS	PROJECT 10659 MALTESE PT. LOT 11, ROLLILNG THUNDER BUSINESS PARK EL PASO COUNTY	SHT. NAME **SITE PLAN**	SHT. NO. 1 OF 1

ROLLING THUNDER BUSINESS PARK

EL PASO COUNTY, COLORADO





VICINITY MAP

1"=1000'

N

Scale 1" = 50'

LEGEND:

- FOUND #9853 WASHER ON PK NAIL
- FOUND #4 REBAR (NOT ACCEPTED)
- SET #9853 WASHER ON PK NAIL
- SET 2" AL. CAP, #9853 ON #5 REBAR

(10659) ADDRESS

LEGEND:

10.5/20.4	RUNOFF IN CFS 5-YEAR/100-YEAR
A	LIMIT OF DRAINAGE BASIN AND DESIGNATION
	EXISTING STORM SEWER AS LABELED
	PROPOSED STORM SEWER AS LABELED
B	LIMIT OF SOILS TYPE AND GROUP

DRAINAGE PLAN
HISTORIC CONDITIONS

PREPARED BY THE OFFICE OF:
OLIVER E. WATTS PE-LS
CONSULTING ENGINEER
614 ELKTON DRIVE
COLORADO SPRINGS, CO 80907
(719) 593-0173
olliewatts@aol.com
Celebrating over 42 years in business

DRAWN BY: O.E. WATTS	APPROVED BY:	REVISIONS	
DATE: 2-23-21	PROJ. NO.	12-24-21 REVISED PER COUNTY REVIEW COMMENTS	OEW
DWG. NO.: 20-5589-04	DWG.	5-31-22 REVISED PER COUNTY REVIEW COMMENTS	OEW
SURVEYED BY: OEW, ESW, 6-26-19,9-24-20		6-14-22 REVISED PER COUNTY REVIEW COMMENTS	OEW

OLIVER E. WATTS
CONSULTING ENGINEER
COLORADO SPRINGS

PROJECT
10659 MALTESE POINT
LOT 11, ROLLING THUNDER BUSINESS PARK
EL PASO COUNTY

SHT. NAME
DRAINAGE PLAN

SHT. NO. 1 OF 1