

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

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

June 14, 2022

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

ATTN: *Jennifer Irvine, P.E.*

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, and April 8, 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., _____
County Engineer / ECM Administrator date

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 6th 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%.

The proposed storm sewer north of the northern building was removed on the plans

PLD

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

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

Runoff is concentrated along curb and gutter

Step1 Employ Runoff Reduction Practices – The extent of impervious materials is minimized consistent with the objectives of the facility. No curb and gutter or other items that might concentrate runoff are proposed. Standard BMP’s are provided as shown on the grading and erosion control plan; Vehicle tracking control, stockpile and staging area protection, and a concrete washout basin. Silt fence is not used as requested by the Airport, as it is considered a hazard to taxiing aircraft – instead drainage berms and swales are used as indicated by the finish topography and identified on the erosion control plan.

Silt fence is proposed, this Site is not part of the Airport

Step 1: Employ Runoff Reduction Practices

To reduce runoff peaks and volumes from urbanizing areas, employ a practice generally termed “minimizing directly connected impervious areas” (MDCIA). The principal behind MDCIA is twofold -- to reduce impervious areas and to route runoff from impervious surfaces over grassy areas to slow down runoff and promote infiltration. The benefits are less runoff, less stormwater pollution, and less cost for drainage infrastructure. There are several approaches to reduce the effective imperviousness of a development site:

Reduced Pavement Area

Sometimes, creative site layout can reduce the extent of paved areas including parking, thereby saving on initial capital cost of pavement and then saving on pavement maintenance, repair, and replacement over time.

This is just a guidance and shouldnt be included in the drainage report as most of it is not applicable

Grass Swales

The use of grass swales instead of storm sewers slows down runoff, promotes infiltration, and also reducing effective imperviousness. It also may reduce the size and cost of downstream storm sewers and detention.

Implementing these approaches on a new development site is discussed further in the DCM2 section titled Employing Runoff Reduction Techniques. This section provides a procedure for estimating a reduced imperviousness based on the use of grass buffers and swales. The latter three of the approaches for reducing imperviousness are structural BMPs and are described in detail in Section 4.2 of DCM2 (New Development BMP Fact sheets):

Grass Buffer.

Grass Swale.

Modular Block Porous Pavement (or Stabilized-Grass Porous Pavement).

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. Grass swales along the north and south sides of the building are minimized and slopes are minimized, and they 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 not be concentrated along the said swales.** **Runoff is concentrated along curb and gutter**

Step 2: Stabilize Drainageways

Drainageway, natural and manmade, erosion can be a major source of sediment and associated constituents, such as phosphorus. Natural Drainageways are often subject to bed and bank erosion when urbanizing areas increase the frequency, rate, and volume of runoff. Therefore, Drainageways are required to be stabilized. One of three basic methods of stabilization may be selected.

Constructed Grass, Riprap, or Concrete-Lined Channel

These methods of channel stabilization have been in practice for some time. The water quality benefit associated with these channels is the reduction of severe bed and bank erosion that can occur in the absence of a stabilized channel. On the other hand, the hard-lined low flow channels that are often used do not offer much in the way of water quality enhancement or wetland habitat. The use of riprap or concrete lined flood conveyance channels is not recommended, unless hydraulic or physical conditions require such an alternative. A grass lined channel is recommended along the north line of Basin A. **revise**

Step 3 Provide Water Quality Capture Volume – The limit of disturbance for the proposed construction is 2.292 acres, therefore water quality / water detention provisions are required and necessary. **Therefore the full spectrum detention pond is proposed.** **Only WQ is proposed**

Step 3: Provide Water Quality Capture Volume (WQCV)

All sites defined as "New Development and Significant Redevelopment" and all sites requiring stormwater quantity detention, as listed above in the Section I.7.1B, shall address stormwater quality by providing the WQCV. One or more of six types of water quality basins, each draining slowly to provide for long-term settling of sediment particles, may be selected. Information on selecting and configuring

This is just a guidance and shouldnt be included in the drainage report as most of it is not applicable

one or more of these WQCV facilities at a site is provided in the section providing Water Quality Capture Volume (WQCV). An Extended Detention Basin is recommended for this installation.

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 (dirt) berms, 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.

using silt
fence at
the site

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.

MAJOR BASIN	SUB BASIN	AREA		BASIN		T _c MIN	I in./hr.		SOIL GRP	DEV. TYPE	C		FLOW		RETURN PERIOD	
		PLANIM READ	ACRES	LENGTH -FT.-	HEIGHT -FT.-		5-ry qp -CFS-	100-yr qp -CFS-			-years-					
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														PAGE 1		
PROJ: FOLLING THUNDER BUSINESS PARK F 1B BY:O.E. WATTS							OLIVER E. WATTS, CONSULTING ENGINEER, INC.							OF		
RATIONAL METHOD DATE: 4/2/21 2/23/21 9/27/21, 5-27-22							614 ELKTON DRIVE COLORADO SPRINGS, CO 80907							4		

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				

STREET AND STORM SEWER CALCULATIONS
PROJECT: ROLLING THUNDER BUS. PK #1b
BY: O.E. WATTS **DATE: 2/23/21, 5-27-22**

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

Page:2
 Of
 Pages:4

Design Procedure Form: Sand Filter (SF)

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 2

Designer: Ollie Watts
Company: Oliver E Watts Consulting Engineer, inc.
Date: June 14, 2022
Project: 10659 Maltese Point
Location: 10659 Maltese Point

<p>1. Basin Storage Volume</p> <p>A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of sand filter)</p> <p>B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)</p> <p>C) Water Quality Capture Volume (WQCV) Based on 12-hour Drain Time $WQCV = 0.8 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i)$</p> <p>D) Contributing Watershed Area (including sand filter area)</p> <p>E) Water Quality Capture Volume (WQCV) Design Volume $V_{WQCV} = WQCV / 12 * Area$</p> <p>F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm</p> <p>G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume</p> <p>H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)</p>	<p>$I_a = 82.0$ %</p> <p>$i = 0.820$</p> <p>WQCV = 0.27 watershed inches</p> <p>Area = 69,540 sq ft</p> <p>$V_{WQCV} =$ cu ft</p> <p>$d_b = 0.40$ in</p> <p>$V_{WQCV \text{ OTHER}} = 1,471$ cu ft</p> <p>$V_{WQCV \text{ USER}} =$ cu ft</p>
<p>2. Basin Geometry</p> <p>A) WQCV Depth</p> <p>B) Sand Filter Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred). Use "0" if sand filter has vertical walls.</p> <p>C) Minimum Filter Area (Flat Surface Area)</p> <p>D) Actual Filter Area</p> <p>E) Volume Provided</p>	<p>PLDs have a max of 1ft WQCV depth. The PLD required filter area is >751SF</p> <p>$D_{WQCV} \geq 2.0$ ft</p> <p>$Z = 3.00$ ft / ft DIFFICULT TO MAINTAIN, INCREASE WHERE POSSIBLE</p> <p>$A_{Min} = 713$ sq ft</p> <p>$A_{Actual} = 751$ sq ft</p> <p>$V_T = 2205$ cu ft</p>
<p>3. Filter Material</p>	<p>Choose One</p> <p><input checked="" type="radio"/> 18" CDOT Class B or C Filter Material</p> <p><input type="radio"/> Other (Explain):</p> <p>_____</p> <p>_____</p>
<p>4. Underdrain System</p> <p>A) Are underdrains provided?</p> <p>B) Underdrain system orifice diameter for 12 hour drain time</p> <p>i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice</p> <p>ii) Volume to Drain in 12 Hours</p> <p>iii) Orifice Diameter, 3/8" Minimum</p>	<p>Choose One</p> <p><input checked="" type="radio"/> YES</p> <p><input type="radio"/> NO</p> <p>$y = 1.0$ ft</p> <p>$Vol_{12} = 1,471$ cu ft</p> <p>$D_o = 1$ in</p>

Design Procedure Form: Sand Filter (SF)

Sheet 2 of 2

Designer: Ollie Watts
Company: Oliver E Watts Consulting Engineer, inc.
Date: June 14, 2022
Project: 10659 Maltese Point
Location: 10659 Maltese Point

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



38°56'37.30"N



Legend

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

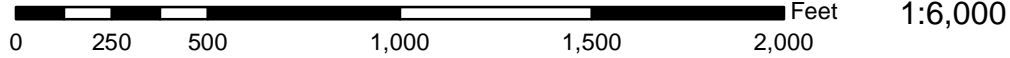
- | | | |
|------------------------------------|--|--|
| SPECIAL FLOOD HAZARD AREAS | | Without Base Flood Elevation (BFE)
<i>Zone A, V, A99</i> |
| | | With BFE or Depth <i>Zone AE, AO, AH, VE, AR</i> |
| | | Regulatory Floodway |
| OTHER AREAS OF FLOOD HAZARD | | 0.2% Annual Chance Flood Hazard, Areas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



38°56'9.32"N

104°37'29.37"W

USGS The National Map: Orthoimagery, Data refreshed April, 2019.

OLIVER E. WATTS
CONSULTING ENGINEER, INC.
COLORADO SPRINGS

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



EL PASO COUNTY AREA, COLORADO

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	
Alamosa: 1-----	C	Frequent-----	Brief-----	May-Jun	In >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.
19: 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.
118: Chaseville part	A	None-----	---	---	>60	---	Low.
Midway part----	D	None-----	---	---	10-20	Rippable	Moderate.
Columbine: 19-----	A	None to rare	---	---	>60	---	Low.
Connerton: 120: 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.
124: Cushman part----	C	None-----	---	---	20-40	Rippable	Moderate.
Kutch part----	C	None-----	---	---	20-40	Rippable	Moderate.
Elbeth: 25, 26-----	B	None-----	---	---	>60	---	Moderate.
127: 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	0.30	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_o) 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_o) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

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

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

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

3.2.1 Overland (Initial) Flow Time

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

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

Where:

t_i = overland (initial) flow time (min)

C_5 = runoff coefficient for 5-year frequency (see Table 6-6)

L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)

S = average basin slope (ft/ft)

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

3.2.2 Travel Time

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

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

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

Table 6-7. Conveyance Coefficient, C_v

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

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

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

The time of concentration (t_c) is then the sum of the overland flow time (t_o) 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.

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

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.

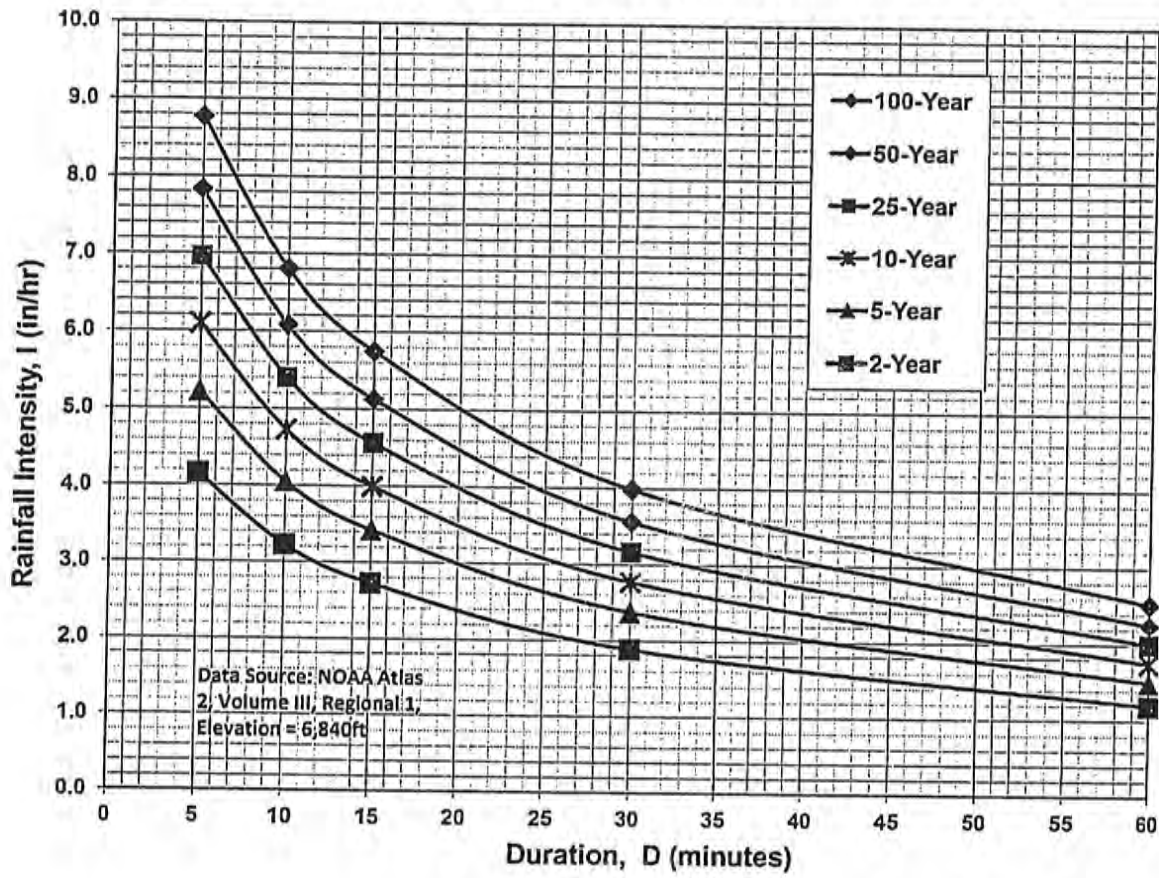
3.2.4 Minimum Time of Concentration

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

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

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

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

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

$$I_5 = -1.50 \ln(D) + 7.583$$

$$I_2 = -1.19 \ln(D) + 6.035$$

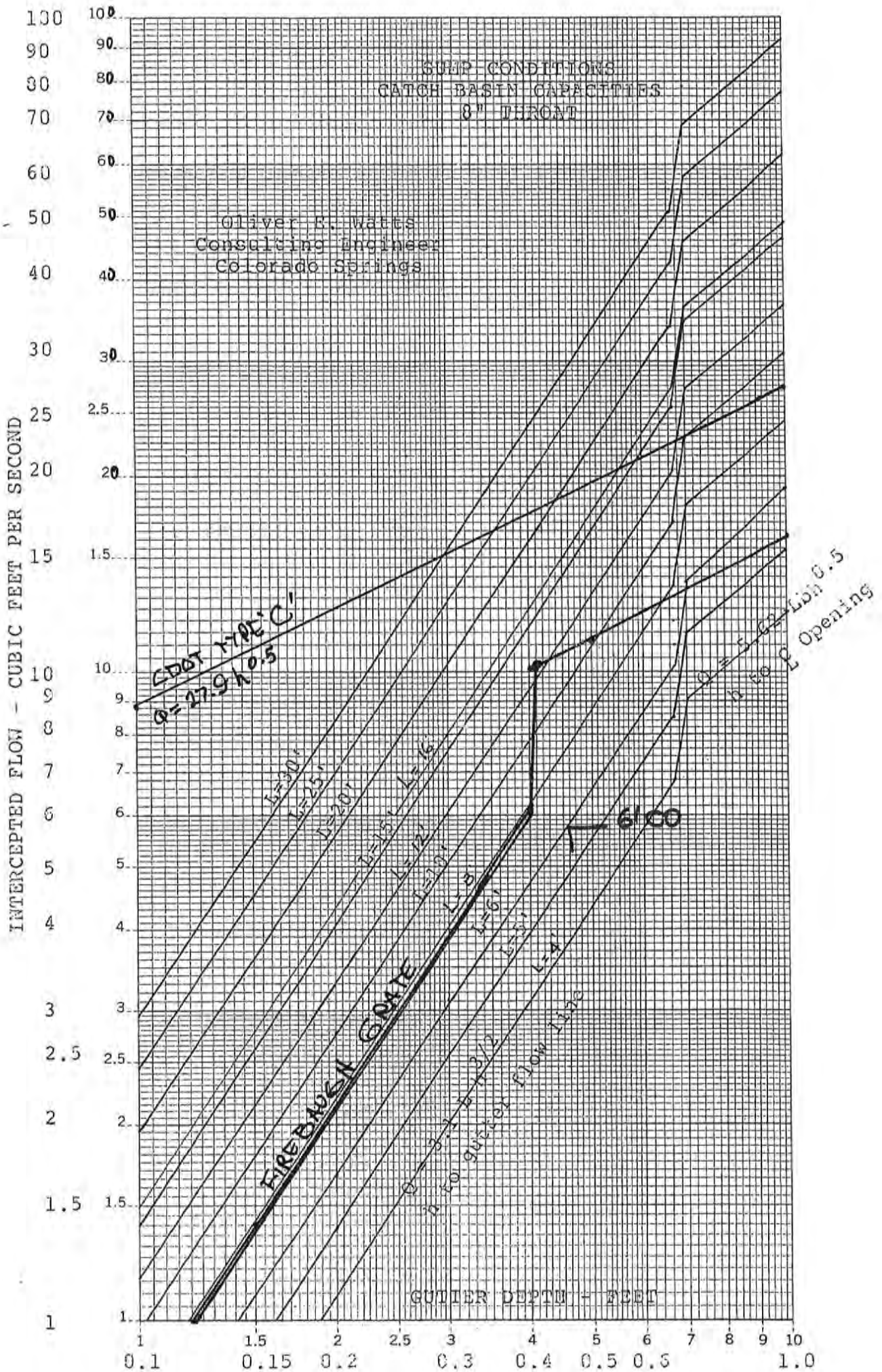
Note: Values calculated by equations may not precisely duplicate values read from figure.

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

$$Q = KS^{1/2}$$

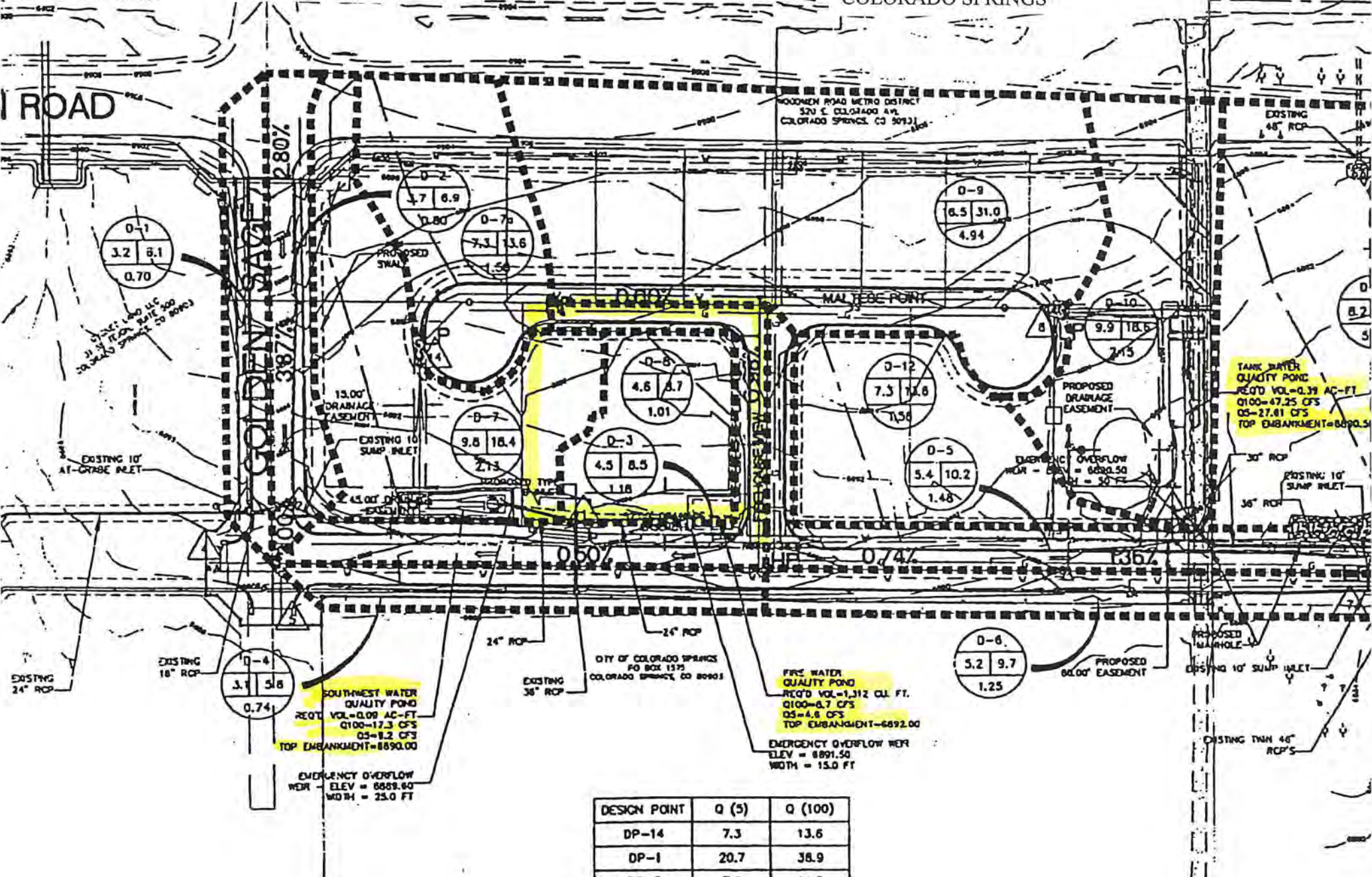
DIAMETER - IN. -	AREA - FT ² -	D 8/3 - FT -	K			
			N=0.010	N=0.013	N=0.024	N=0.026
2	0.02182	0.008413	0.3895	---	---	---
4	0.08727	0.053420	2.4733	---	---	---
6	0.19630	0.157500	7.2922	5.609	---	---
8	0.34910	0.339200	15.7050	12.081	---	---
10	0.54540	0.615000	28.4745	21.903	---	---
12	0.78540	1.000000	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 Engineer
 Colorado Springs



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

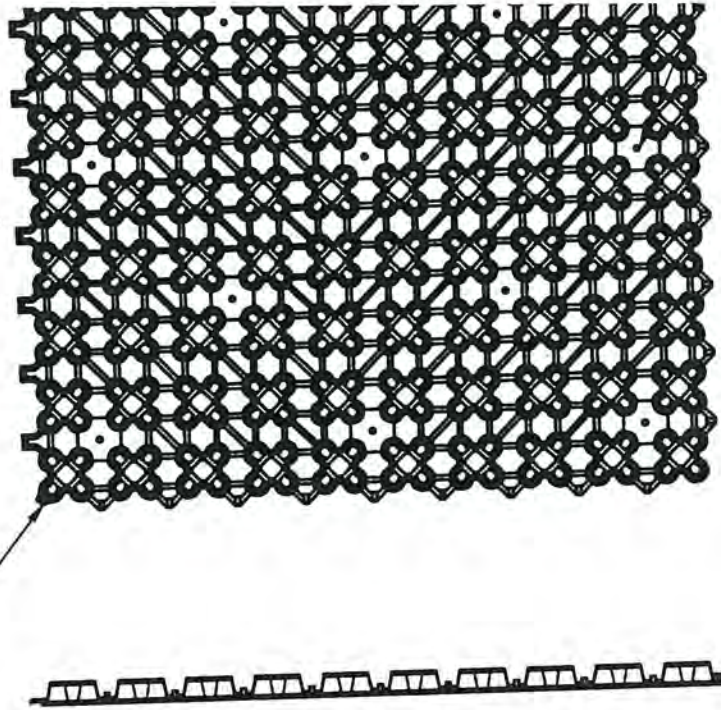
**ROLLING THUNDER BUSINESS PARK - FDR - DEVELOPED CONDITIONS
(RATIONAL METHOD Q=CIA)**

BASIN	TOTAL FLOWS						AREA TOTAL (Ac)	WEIGHTED			OVERLAND				CHANNEL				Tc TOTAL (min)	INTENSITY			COMMENTS
	Q2	Q5	Q100	2 YR	CA(equiv.)			Cs	C100	Cs	Length (ft)	Slope (ft)	Tco (min)	Length (ft)	Slope (%)	Velocity (fps)	Tcc (min)	Tc		I2	I5	I100	
	(c.f.s.)	(c.f.s.)	(c.f.s.)		5 YR	100 YR		(ft)	(ft)	(min)	(ft)	(%)	(fps)	(min)	(min)	(in/hr)	(in/hr)	(in/hr)					
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*1^A	C*1^A		Q/I	Q/I		86.95						*1		*2	*3	Tco+Tcc	*4	*5	*6			
															20				1.09	1.5	2.67		

- 1* $Tco = 1.87 * (1.1 - Cs) * (L^{0.5}) * ((S * 100)^{-0.33})$ (DCM page 5-11)
- 2* $Vc = 20 * S^{0.5}$ (USDCM RO-4)
- 3* $Tcc = 1/V * L/60$
- 4* $I2 = (26.65 * 1.09) / (10 + Tc)^{0.76}$ (City Letter of 1/7/2003)
- 5* $I5 = (26.65 * 1.50) / (10 + Tc)^{0.76}$ (City Letter of 1/7/2003)
- 6* $I100 = (26.65 * 2.67) / (10 + Tc)^{0.76}$ (City Letter of 1/7/2003)

AirPave Geocell →

Yellow
Indicator Tab



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)

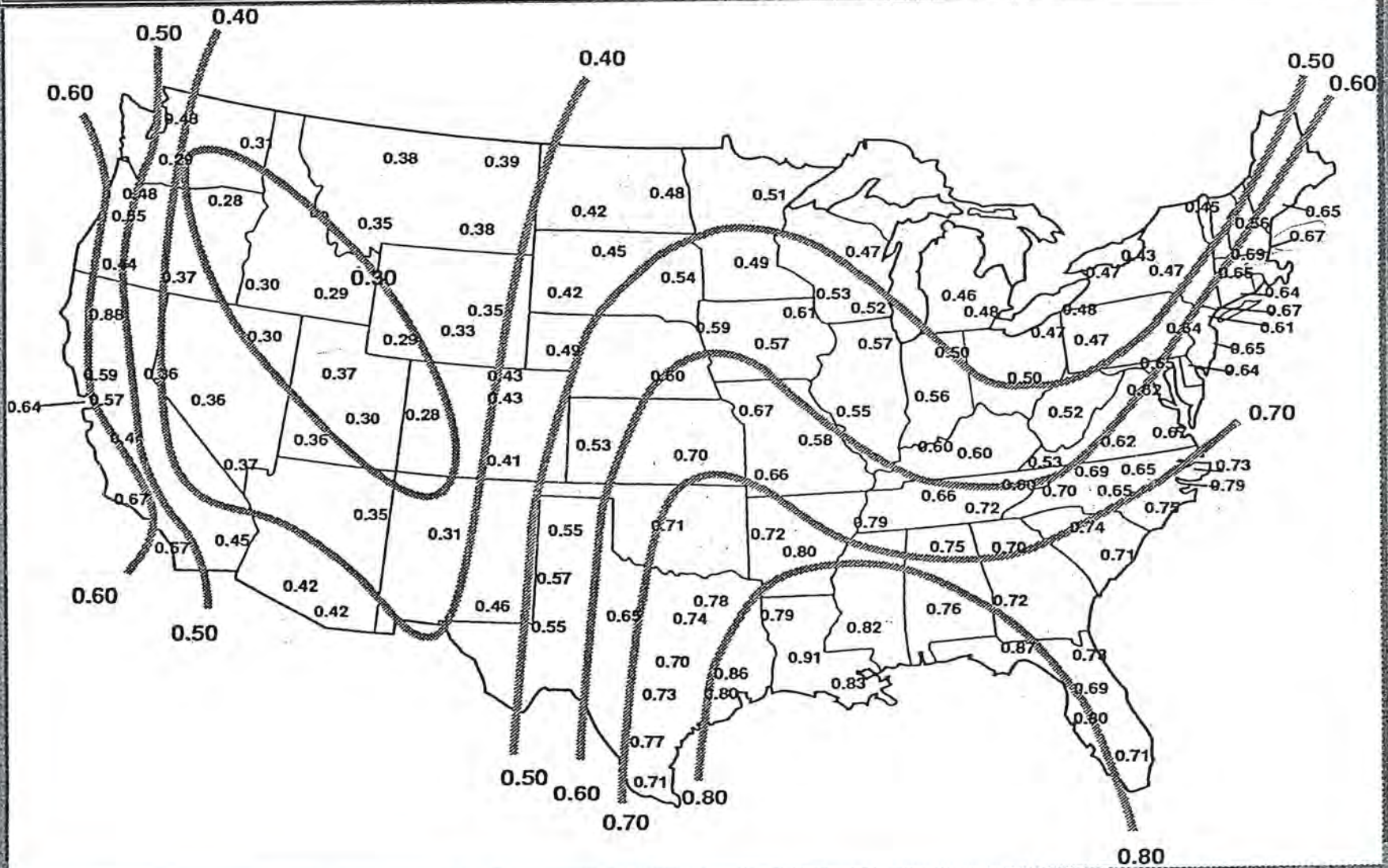
**AirPave Cross Section
Typical**

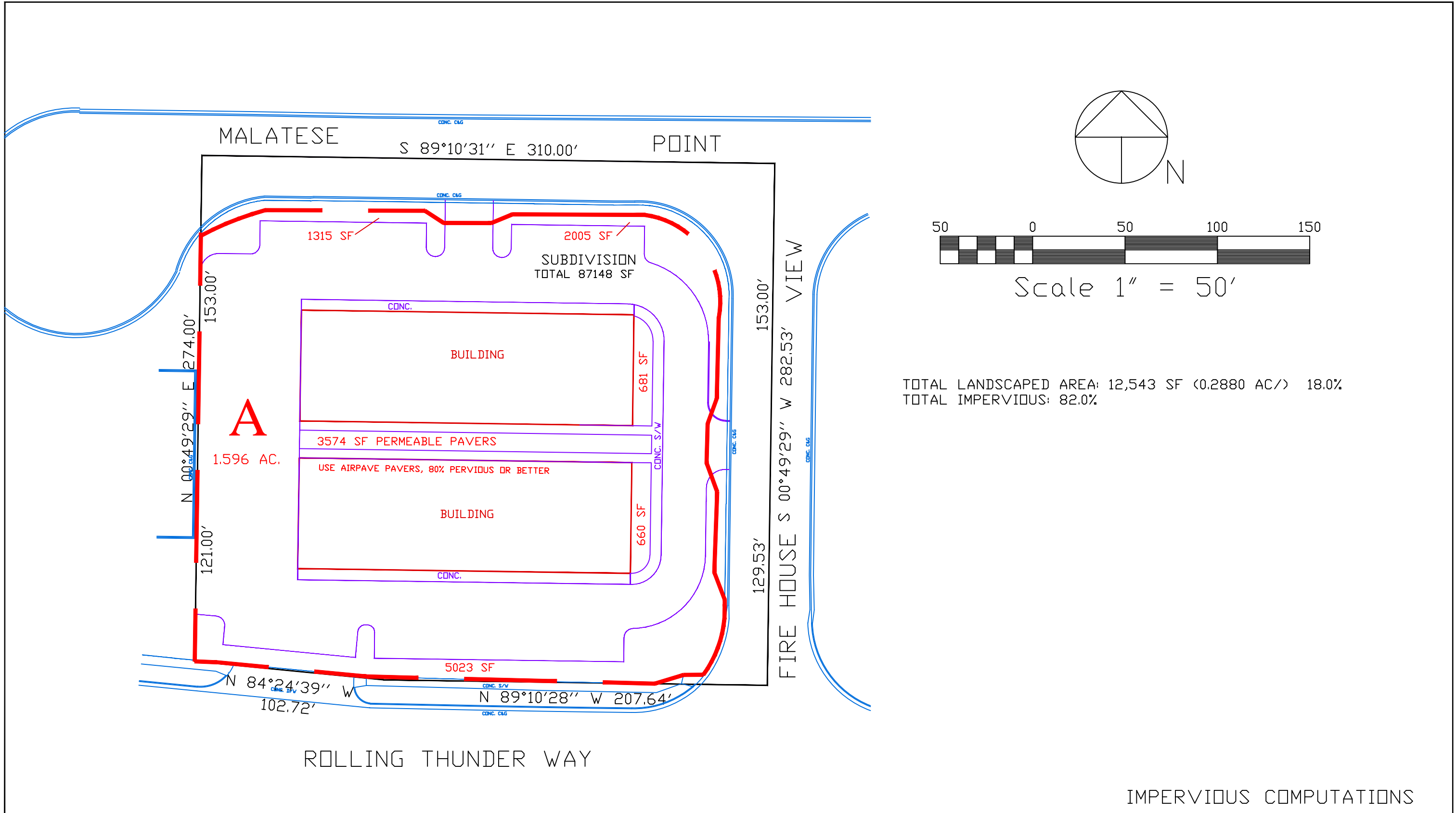
Scale 0.12:1

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)



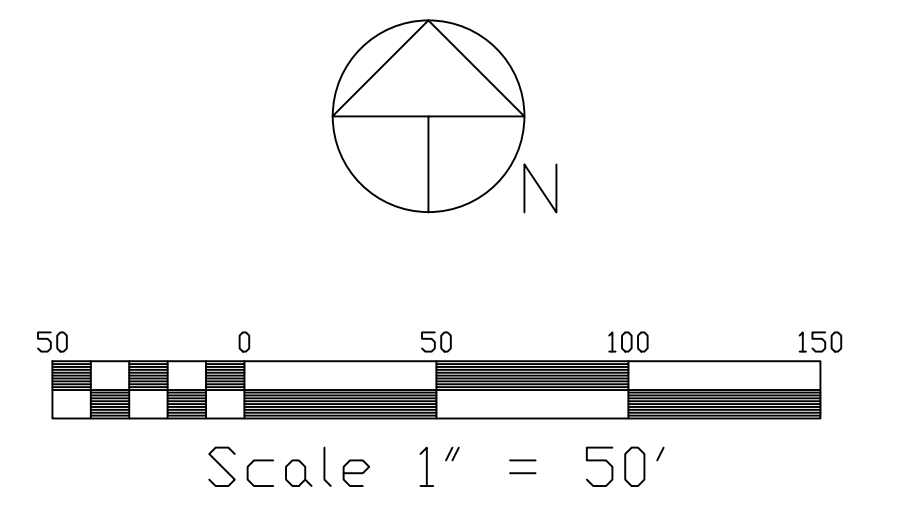
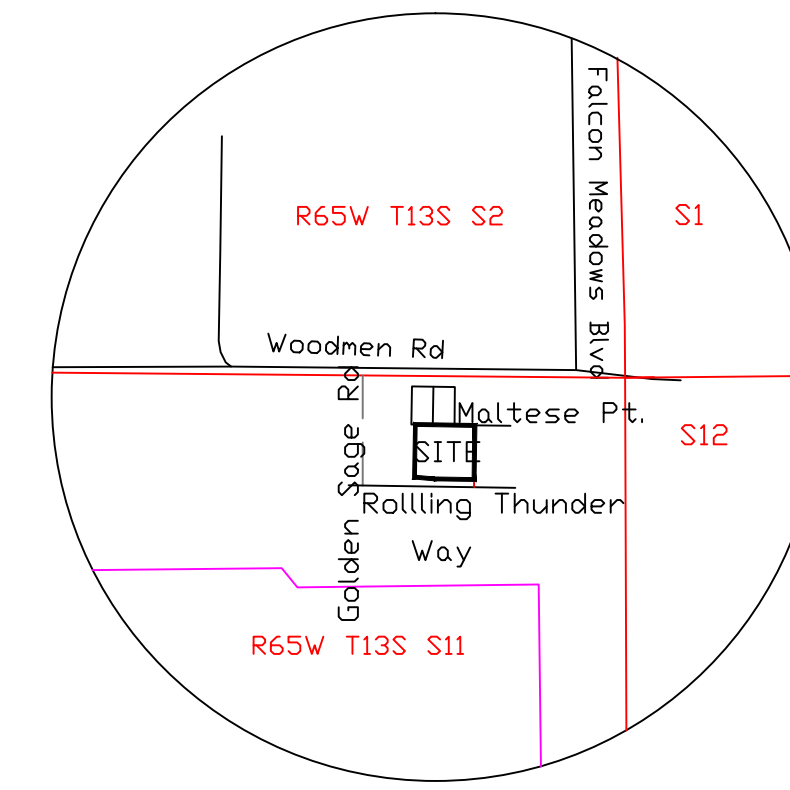
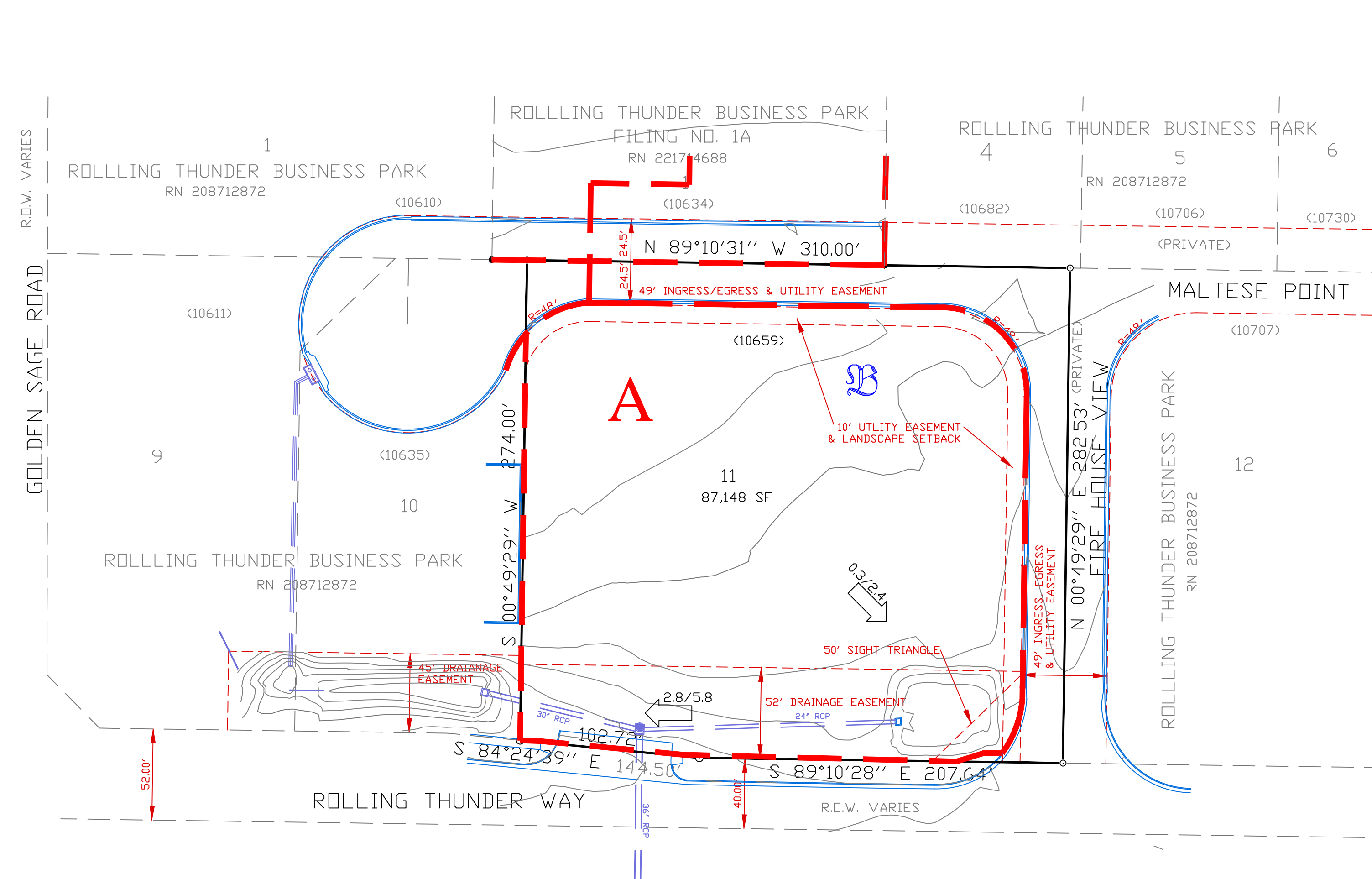


IMPERVIOUS COMPUTATIONS

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

ROLLING THUNDER BUSINESS PARK

EL PASO COUNTY, COLORADO

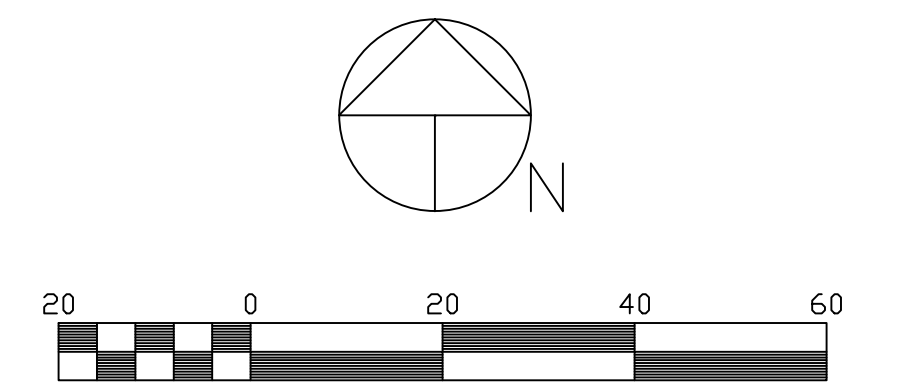
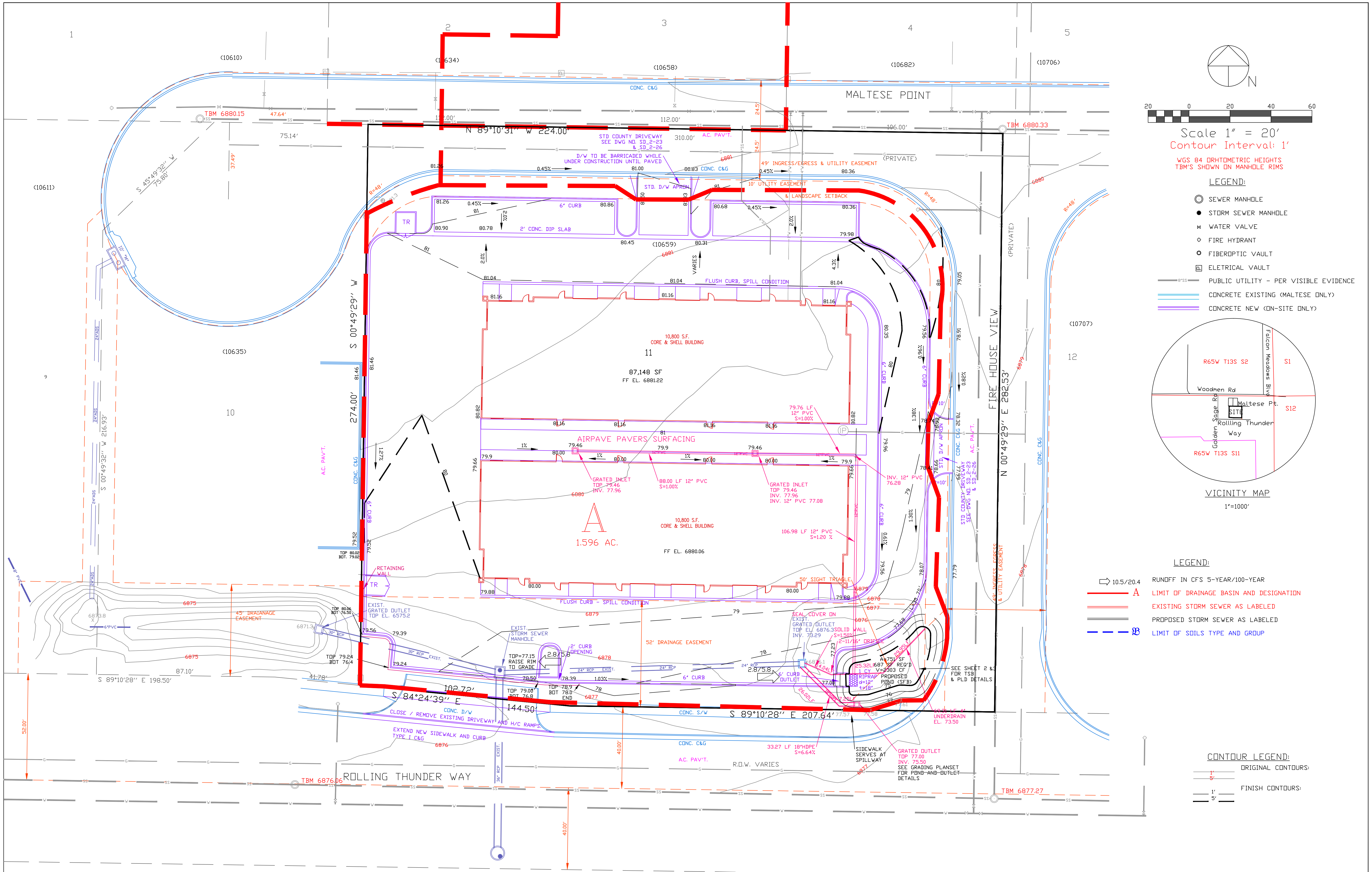


- LEGEND:**
- FOUND #9853 WASHER DN PK NAIL
 - ◊ FOUND #4 REBAR (NOT ACCEPTED)
 - SET #9853 WASHER DN PK NAIL
 - SET 2" AL. CAP, #9853 DN #5 REBAR
 - (10659) ADDRESS

- 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

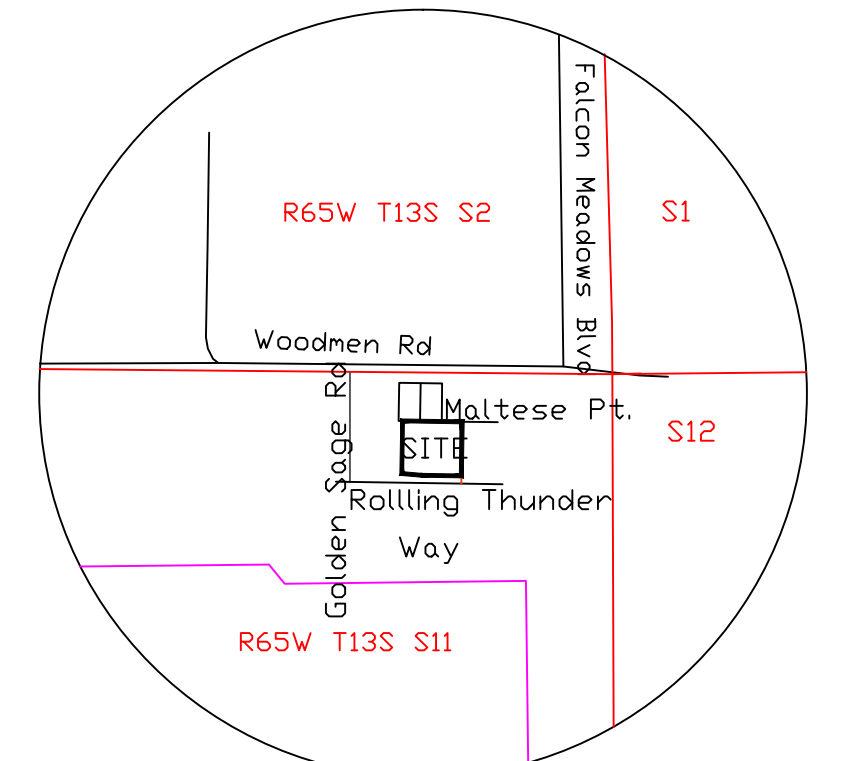
DRAINAGE PLAN HISTORIC CONDITIONS

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



Scale 1" = 20'
 Contour Interval: 1'
 WGS 84 ORTHOMETRIC HEIGHTS
 TBM'S SHOWN ON MANHOLE RIMS

- LEGEND:**
- SEWER MANHOLE
 - STORM SEWER MANHOLE
 - ✕ WATER VALVE
 - FIRE HYDRANT
 - FIBEROPTIC VAULT
 - ELECTRICAL VAULT
 - PUBLIC UTILITY - PER VISIBLE EVIDENCE
 - CONCRETE EXISTING (MALTESE ONLY)
 - CONCRETE NEW (ON-SITE ONLY)



VICINITY MAP
 1"=1000'

- LEGEND:**
- 10.5/20.4 RUNDFF 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

- CONTOUR LEGEND:**
- 1' ORIGINAL CONTOURS:
 - 5' ORIGINAL CONTOURS:
 - 1' FINISH CONTOURS:
 - 5' FINISH CONTOURS:

PCD FILE NO. PPR-21-024

DRAWN BY: D.E. WATTS DATE: 2-23-21 DWG. NO.: 20-5589-04 SURVEYED BY: DEW, ESW, 6-26-19, 9-24-20	APPROVED BY: PROJ. NO.: DWG.:	REVISIONS 12-24-21 REVISED PER COUNTY REVIEW COMMENTS DEW 5-31-22 REVISED PER COUNTY REVIEW COMMENTS DEW 6-14-22 REVISED PER COUNTY REVIEW COMMENTS DEW	OLIVER E. WATTS CONSULTING ENGINEER COLORADO SPRINGS	PROJECT 10659 MALTESE POINT LOT 11, ROLLING THUNDER BUSINESS PARK EL PASO COUNTY	SHEET NO. 1 OF 1
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DRAINAGE PLAN