Worksheet 3: Time of Concentration (T_c) or travel time (T_t)

Project	By	Date
MUNICIPAL SOLID WASTE LANDFILL FORT BLISS - TEXAS	DC	06/06/2014
Location	**Checked**	**Date**
WATERSHED #12		

Check one: ☐ Present ☑ Developed

Check one: ☑ T_c ☐ T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to Tc only)

	Segment ID		
1. Surface description (table 3-1)	12A		
2. Manning's roughness coefficient, n (table 3-1)	BARE		
3. Flow length, L (total L † 300 ft) ft	0.011		
4. Two-year 24-hour rainfall, P_2 in	30		
5. Land slope, s ft/ft	1.5		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t hr	0.20		
	0.004	+	= 0.004

Shallow concentrated flow

	Segment ID		
7. Surface description (paved or unpaved)	12B		
8. Flow length, L ft	UNPAVED		
9. Watercourse slope, s ft/ft	950		
10. Average velocity, V (figure 3-1) ft/s	0.0137		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t hr	1.82		
	0.145	+	= 0.145

Channel flow

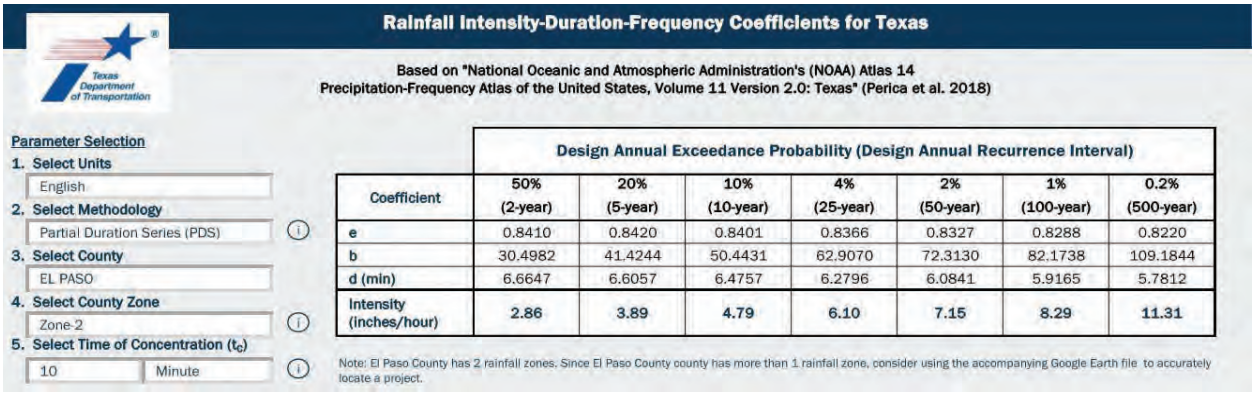
	Segment ID		
12. Cross sectional flow area, a ft^2	12C		
13. Wetted perimeter, p_w ft	33.00		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ft	37.25		
15 Channel slope, s ft/ft	0.89		
16. Manning's roughness coefficient, n	0.0077		
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V ft/s	0.022		
18. ~~Flow~~ length, L ft	5.50		
19. $T_t = \frac{L}{3600\ V}$ Compute T_t hr	400		
	0.020	+	= 0.020

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) Hr 0.169

Peak Discharge Using The Rational Method
25-Year Storm Event

:quation: Q = CIA

Total Watershed Peak Dischrge Runoff and Flow Velocity at Drainage Interceptors						
Watershed No.	**Area (A; acres)**	**Time of Concentration (hrs)**	**Time of Concentration (min)**	**Intensity (I; in/hr)**	**Coefficient (C)**	**Peak Flow (cfs)**
1	4.4	0.14	10	6.1	0.38	10.2
2	12.5	0.11	10	6.1	0.38	29.0
3	2.0	0.03	10	6.1	0.38	4.5
4	0.8	0.03	10	6.1	0.38	1.9
5	1.3	0.01	10	6.1	0.38	3.0
6	2.0	0.09	10	6.1	0.38	4.7
7	2.1	0.11	10	6.1	0.38	4.9
8	0.8	0.08	10	6.1	0.38	1.9
9	1.9	0.16	10	6.1	0.38	4.5
10	1.3	0.04	10	6.1	0.38	3.0
11	0.5	0.03	10	6.1	0.38	1.2
12	11.1	0.17	10.1	6.1	0.38	25.8
13	3.4	0.04	10	6.1	0.38	7.8
14	4.4	0.07	10	6.1	0.38	10.1
15	4.4	0.07	10	6.1	0.38	10.3
16	7.9	0.1	10	6.1	0.38	18.3
17	19.3	0.14	10	6.1	0.38	44.8
18	17.1	0.14	10	6.1	0.38	39.5
19	4.2	0.06	10	6.1	0.38	9.8
20	2.6	0.03	10	6.1	0.38	6.0
21	4.9	0.07	10	6.1	0.38	11.3



Rainfall Intensity-Duration-Frequency Coefficients for Texas

Based on "National Oceanic and Atmospheric Administration's (NOAA) Atlas 14
Precipitation-Frequency Atlas of the United States, Volume 11 Version 2.0: Texas" (Perica et al. 2018)

Parameter Selection

1. Select Units: English
2. Select Methodology: Partial Duration Series (PDS)
3. Select County: EL PASO
4. Select County Zone: Zone-2
5. Select Time of Concentration (t_c): 10 Minute

Coefficient	Design Annual Exceedance Probability (Design Annual Recurrence Interval)						
	50% (2-year)	20% (5-year)	10% (10-year)	4% (25-year)	2% (50-year)	1% (100-year)	0.2% (500-year)
e	0.8410	0.8420	0.8401	0.8366	0.8327	0.8288	0.8220
b	30.4982	41.4244	50.4431	62.9070	72.3130	82.1738	109.1844
d (min)	6.6647	6.6057	6.4757	6.2796	6.0841	5.9165	5.7812
Intensity (inches/hour)	**2.86**	**3.89**	**4.79**	**6.10**	**7.15**	**8.29**	**11.31**

Note: El Paso County has 2 rainfall zones. Since El Paso County county has more than 1 rainfall zone, consider using the accompanying Google Earth file to accurately locate a project.

* for Time of Concentration = 10 min.

Runoff Coefficient

Hydraulic Design Manual (TxDOT)

	Value
Relief (C_r)	0.08
Soil Infiltration (C_i)	0.07
Vegetal Cover (C_v)	0.12
Surface (C_s)	0.11
Coefficient (C= Cr + Ci + Cv + Cs)	0.38
Coefficient Ajustment Factor (C_f)	1.1

Diversion Swale Hydraulic Analysis
25-Year Storm Event

Diversion Swale	Contributing Watershed	Slope (ft/ft)	Manning Roughness, n	Side Slope 1 (z_1:1)	Side Slope 1 (z_1:1)	Depth (ft)	Area (ft2)	Wetted Perimeter (ft)	Hydraulic Radius (ft)	Average Velocity (ft/s)	Flow (cfs)
DS-1A	4	0.036	0.020	10.0	2.0	0.29	0.50	3.54	0.14	3.82	1.9
DS-1B	5	0.021	0.020	10.0	2.0	0.38	0.86	4.64	0.18	3.50	3.0
DS-1C	6	0.017	0.020	10.0	2.0	0.47	1.30	5.72	0.23	3.62	4.7
DS-1D	7	0.015	0.020	10.0	2.0	0.48	1.40	5.93	0.24	3.48	4.9
DS-1E	8	0.020	0.020	10.0	2.0	0.32	0.61	3.93	0.16	3.06	1.9
DS-1F	9	0.005	0.020	10.0	2.0	0.57	1.98	7.05	0.28	2.26	4.5
DS-2A	19	0.020	0.020	10.0	2.0	0.60	2.12	7.31	0.29	4.62	9.8
DS-3A	11	0.037	0.020	10.0	2.0	0.24	0.35	2.96	0.12	3.44	1.2
DS-3B	21	0.015	0.020	10.0	2.0	0.30	0.54	3.69	0.15	2.54	1.4
DS-4A	12	0.006	0.020	10.0	2.0	0.30	0.54	3.69	0.15	1.60	0.9
DS-4B	17	0.008	0.020	10.0	2.0	0.79	3.78	9.76	0.39	3.54	13.4
DS-4C/4D	14, 15 & 17	0.017	0.020	10.0	10.0	0.99	9.86	19.96	0.49	6.07	59.9
DS-SDA	14	0.005	0.020	10.0	2.0	0.78	3.65	9.58	0.38	2.77	10.1
DS-SDB	15	0.006	0.020	10.0	2.0	0.76	3.47	9.34	0.37	2.98	10.3

Perimeter Swale Hydraulic Analysis
25-Year Storm Event

Diversion Swale	Contributing Watershed	Slope (ft/ft)	Manning Roughness, n	Side Slope 1 (z_1:1)	Side Slope 1 (z_1:1)	Bottom Width (ft)	Depth (ft)	Area (ft2)	Wetted Perimeter (ft)	Hydraulic Radius (ft)	Average Velocity (ft/s)	Flow (cfs)
PS-1A	3 thru 5, 10 & 19	0.0070	0.026	4	4	20.00	0.41	8.87	23.38	0.38	2.51	22.3
PS-1B	10	0.0031	0.026	4	4	13.00	0.21	2.83	14.69	0.19	1.07	3.0
PS-2B	1, 6 thru 9	0.0041	0.026	4	4	70.00	0.25	17.97	72.09	0.25	1.45	26.1
PS-3A	2	0.0041	0.026	4	4	10.00	0.81	10.65	16.64	0.64	2.73	29.0
PS-4A	16 & 18	0.0024	0.026	4	4	60.00	0.52	32.47	64.31	0.50	1.78	57.8
PS-4B	16	0.0107	0.026	4	4	30.00	0.25	7.88	32.09	0.25	2.32	18.3
PS-5A	1, 12, 13, 17, 20 & 2	0.0056	0.026	4	4	50.00	0.62	32.40	55.09	0.59	3.01	97.5
PS-5B	11, 12, 20 & 21	0.0023	0.026	4	4	40.00	0.57	24.23	44.73	0.54	1.83	44.3
PS-5C	11, 20 & 21	0.0077	0.026	4	4	30.00	0.35	11.15	32.93	0.34	2.44	27.2

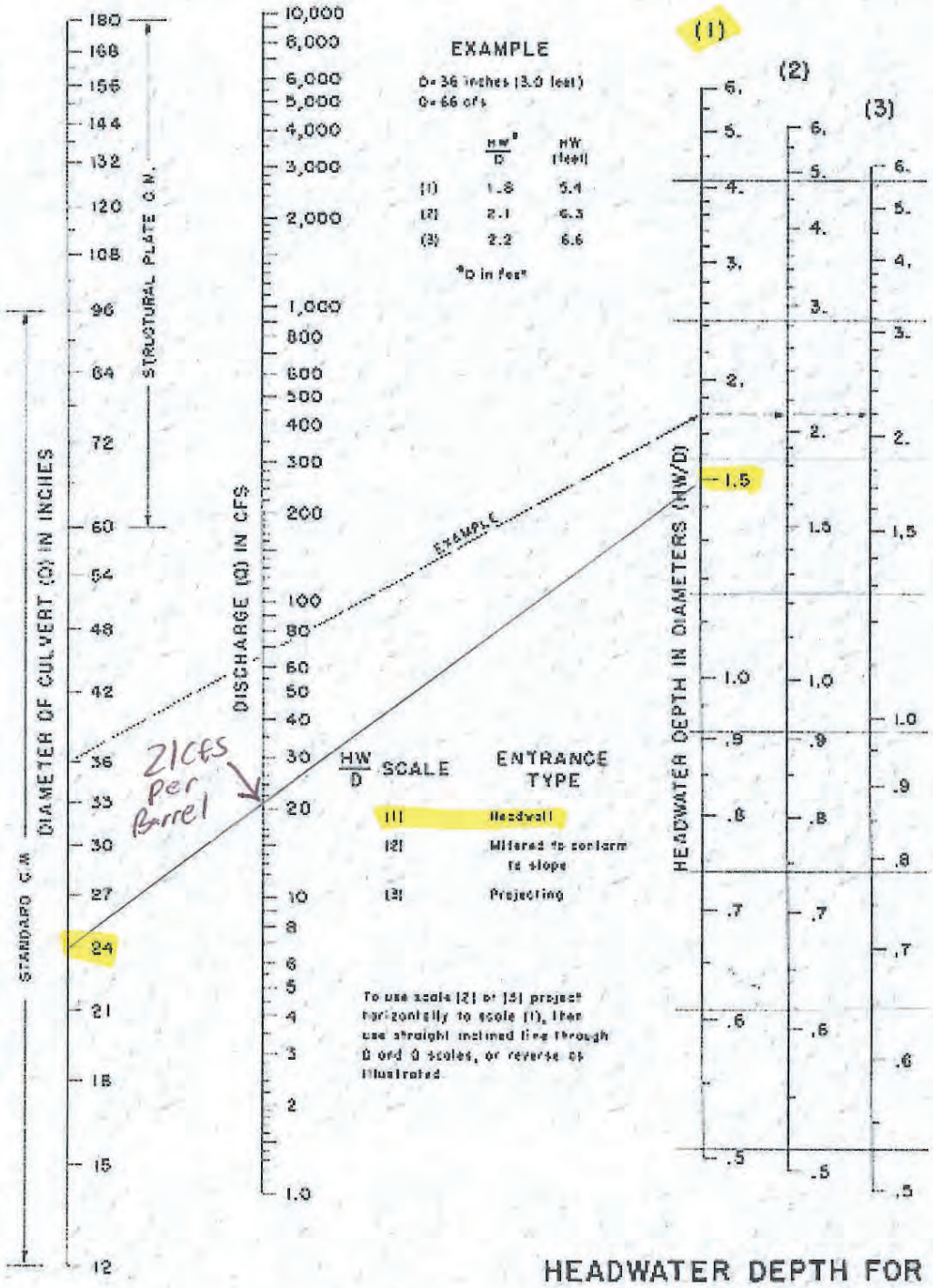
Downchute Hydraulic Analysis
25-Year Storm

Diversion Swale	Contributing Watershed	Slope (ft/ft)	Manning Roughness, n	Side Slope 1 (z_1:1)	Side Slope 1 (z_1:1)	Bottom Width (ft)	Depth (ft)	Area (ft2)	Wetted Perimeter (ft)	Hydraulic Radius (ft)	Average Velocity (ft/s)	Flow (cfs)
DC-1	4 & 5	0.25	0.033	1	1	12.00	0.09	1.09	12.25	0.09	4.49	4.9
DC-2	6 & 7	0.25	0.033	1	1	12.00	0.14	1.64	12.38	0.13	5.86	9.6
DC-3	8 & 9	0.25	0.033	1	1	12.00	0.11	1.27	12.30	0.10	4.97	6.3
DC-4	14 & 15	0.25	0.033	1	1	12.00	0.21	2.59	12.60	0.21	7.86	20.4

Go Back to Part II

Go to Chart 6

CHART 5



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

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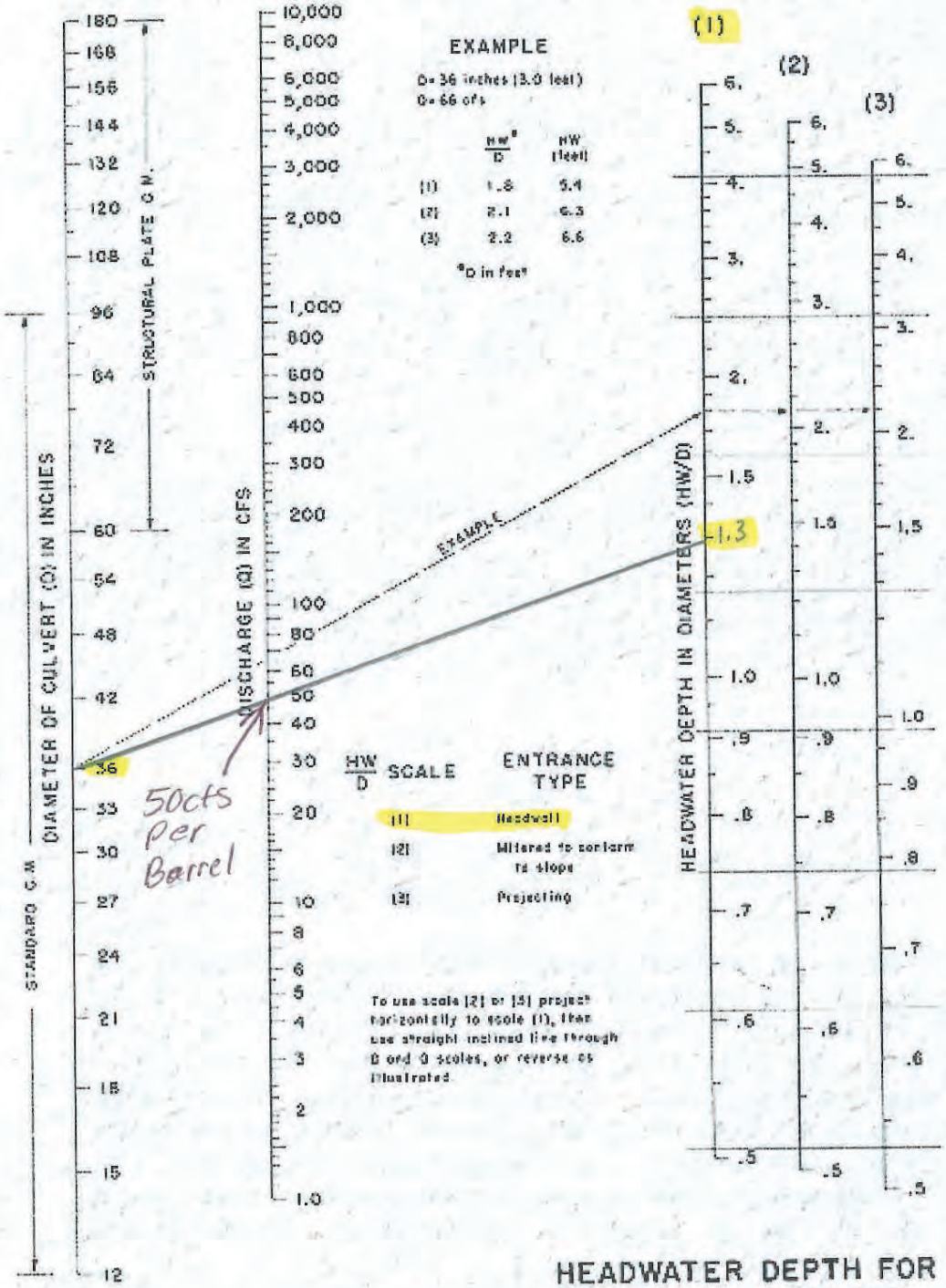
CHART 5



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