APPENDIX III-2A

TABLES

TABLE III-2A-1.1

Pre-Development - Time of Concentration Calculations

for Pre-Development HEC-HMS Model Input

Date:	8/18/20
By:	EWT
Chkd:	CGD
Apprvd:	CGD

NRCS TR-55 Travel Time for sheet flow, shallow concentrated flow, and open channel flow calculations[1]; National Engineering Handbook for Travel time through bodies of water[2]

Basin	Calc. Point	Area (AC)	Area (sqmi)	Sheet				Shallow Concentrated			Downchute			Ditch - Grass-Lined			Pond			Calculated Tc (min)	Applicable Tc (min) [3]
				Length (ft)	Slope (ft/ft)	n	T_1 (min)	Length (ft)	Slope (ft/ft)	T_2 (min)	Length (ft)	Velocity (fps)	T_3 (min)	Length (ft)	Velocity (fps)	T_4 (min)	Length (ft)	Velocity (fps)	T_5 (min)		
A	1	9.1	0.0142	300	0.03	0.24	23.4	528	0.035	2.9	0	25	0.0	383	1.5	4.3	0	14.5	0.0	30.5	30.5
B	2	15.3	0.0239	300	0.03	0.24	23.4	348	0.04	1.8	0	25	0.0	1049	2	8.7	0	14.5	0.0	33.9	33.9
C	3	13.8	0.0216	300	0.02	0.011	2.3	195	0.015	1.6	0	25	0.0	534	2.5	3.6	0	14.5	0.0	7.5	10.0
D	4	32.2	0.0503	300	0.03	0.24	23.4	194	0.03	1.2	78	25	0.1	3470	2.5	23.1	0	14.5	0.0	47.7	47.7
E	5	25.4	0.0397	300	0.03	0.24	23.4	427	0.035	2.4	0	25	0.0	1870	2	15.6	0	14.5	0.0	41.3	41.3
F	6	42.2	0.0659	300	0.03	0.24	23.4	199	0.03	1.2	93	25	0.1	3378	2.5	22.5	0	14.5	0.0	47.1	47.1
G	7	20.2	0.0316	300	0.03	0.24	23.4	184	0.03	1.1	75	25	0.1	1399	1.75	13.3	0	14.5	0.0	37.8	37.8
H	9	19.3	0.0302	300	0.03	0.24	23.4	470	0.03	2.8	0	25	0.0	1125	2.75	6.8	0	14.5	0.0	33.0	33.0
I	10	27.4	0.0428	300	0.03	0.24	23.4	466	0.03	2.8	0	25	0.0	0	1.5	0.0	0	14.5	0.0	26.2	26.2
DET	CP-1	43.1	0.0673	0	0.01	0.24	0.0	0	0.01	0.0	0	25	0.0	0	1	0.0	2253	14.5	2.6	2.6	10.0
OFF1	CP-2	5.4	0.0084	300	0.015	0.011	2.6	140	0.02	1.0	0	25	0.0	0	1	0.0	0	14.5	0.0	3.6	10.0
ON1	CP-3	1.0	0.0016	97	0.02	0.24	11.1	0	0.01	0.0	0	25	0.0	0	1	0.0	0	14.5	0.0	11.1	11.1
ON2	CP-4	0.2	0.0003	93	0.035	0.24	8.6	0	0.01	0.0	0	25	0.0	0	1	0.0	0	14.5	0.0	8.6	10.0
ON3	CP-5	0.8	0.0013	140	0.02	0.24	14.9	0	0.01	0.0	0	25	0.0	0	1	0.0	0	14.5	0.0	14.9	14.9
ON4	CP-6	1.1	0.0017	138	0.015	0.24	16.6	0	0.01	0.0	0	25	0.0	0	1	0.0	0	14.5	0.0	16.6	16.6
ON5	CP-7	3.5	0.0055	220	0.05	0.24	14.9	0	0.01	0.0	0	25	0.0	0	1	0.0	0	14.5	0.0	14.9	14.9
ON6	CP-8	1.2	0.0019	206	0.05	0.011	1.2	0	0.01	0.0	0	25	0.0	0	1	0.0	0	14.5	0.0	1.2	10.0
ON7	CP-9	0.8	0.0013	178	0.05	0.011	1.1	0	0.01	0.0	0	25	0.0	0	1	0.0	0	14.5	0.0	1.1	10.0

Notes:

1 Sheet Flow equation (eq. 3-3, TR-55): $tsheet = \frac{0.007\,(NL)^{0.8}}{(P2)^{0.5}S^{0.4}}$, where Tt = travel time (hr), P2 = 2-year, 24-hour rainfall (in), S = slope (ft/ft), N = Manning's roughness coefficient, L = flow length (ft)

Shallow concentrated equation (TR-55): $V = 16.1345\sqrt{S}$ for unpaved surface, where V = average velocity (ft/s), S = slope (ft/ft)

Travel Time Equation (eq. 3-1, TR-55): $Tt = \frac{L}{3600\,V}$, where Tt = travel time (hr), L = flow length (ft), V = average velocity (ft/s), 3600 = conversion factor from seconds to hours

2 Travel time through bodies of water (eq. 15-11, Part 630, National Engineering Handbook): $Vw = \sqrt{gDm}$ for Vw = wave velocity (ft/s), g = 32.2 (ft/s²), Dm = mean depth (ft)

3 Minimum time of concentration used for computation of rainfall intensity is 10 minutes. If the time of concentration computed for the drainage area is less than 10 minutes, then 10 minutes should be adopted for rainfall intensity computations. (Texas Department of Transportation, Hydraulic Design Manual, Section 12: Rational Method)

4 See Figure **III-2A-1** for Pre-Development Overall Drainage Conditions

TABLE III-2A-1.2

Pre-Development - Reach Time Calculations

for Pre-Development HEC-HMS Model Input

Date:	8/18/20
By:	EWT
Chkd:	CGD
Apprvd:	CGD

NRCS TR-55 Travel Time for sheet flow, shallow concentrated flow, and open channel flow calculations[1]; National Engineering Handbook for Travel time through bodies of water[2]

Upstream Calculation Point	Downstream Calculation Point	Reach	Sheet				Shallow Concentrated			Downchute			Ditch - Grass-Lined			Pond			Lag Time (min)
			Length (ft)	Slope (ft/ft)	Sheet Flow, n	T_1 (min)	Length (ft)	Slope (ft/ft)	T_2 (min)	Length (ft)	Velocity (fps)	T_3 (min)	Length (ft)	Velocity (fps)	T_4 (min)	Length (ft)	Velocity (fps)	T5 (min)	
1	2	R(1-2)	0	0.01	0.24	0.0	0	0.01	0.0	0	25	0.0	1278	2	10.7	0	14.5	0.0	10.7
2	3	R(2-3)	0	0.01	0.24	0.0	0	0.01	0.0	0	25	0.0	1428	2.5	9.5	0	14.5	0.0	9.5
3	4	R(3-4)	0	0.01	0.24	0.0	0	0.01	0.0	0	25	0.0	1789	2.5	11.9	0	14.5	0.0	11.9
4 (8)	9	R(8-9)	0	0.01	0.24	0.0	0	0.01	0.0	0	25	0.0	2075	2.75	12.6	0	14.5	0.0	12.6
5	6	R(5-6)	0	0.01	0.24	0.0	0	0.01	0.0	0	25	0.0	3370	2.5	22.5	0	14.5	0.0	22.5
6 (8)	9	R(8-9)	0	0.01	0.24	0.0	0	0.03	0.0	0	25	0.0	2075	2.75	12.6	0	14.5	0.0	12.6
7 (8)	9	R(8-9)	0	0.01	0.24	0.0	0	0.03	0.0	0	25	0.0	2075	2.75	12.6	0	14.5	0.0	12.6
9	POND																		
10	POND																		
CP-1	N/A																		
CP-2	N/A																		
CP-3	1	R(CP-3)	139	0.02	0.24	14.9	0	0.01	0.0	0	25	0.0	383	1.5	4.3	0	14.5	0.0	19.1
CP-4	3	R(CP-4)	90	0.035	0.24	8.4	493	0.03	2.9	0	25	0.0	0	1	0.0	0	14.5	0.0	11.3
CP-5	5	R(CP-5)	49	0.04	0.24	4.9	0	0.01	0.0	0	25	0.0	1566	2	13.1	0	14.5	0.0	17.9
CP-6	5	R(CP-6)	0	0.01	0.24	0.0	0	0.01	0.0	0	25	0.0	302	1	5.0	0	14.5	0.0	5.0
CP-7	7	R(CP-7)	30	0.05	0.24	3.0	0	0.01	0.0	0	25	0.0	1399	1.75	13.3	0	14.5	0.0	16.3
CP-8	7	R(CP-8)	18	0.05	0.011	0.2	0	0.01	0.0	0	25	0.0	2372	1.75	22.6	0	14.5	0.0	22.8
CP-9	10	R(CP-9)	32	0.05	0.011	0.3	0	0.01	0.0	0	25	0.0	2338	1.5	26.0	0	14.5	0.0	26.2

Notes:

1 Sheet Flow equation (eq. 3-3, TR-55): $tsheet = \frac{0.007\ (NL)^{0.8}}{(P2)^{0.5} S^{0.4}}$, where Tt = travel time (hr), P2 = 2-year, 24-hour rainfall (in), S = slope (ft/ft), N = Manning's roughness coefficient, L = flow length (ft)

Shallow concentrated equation (TR-55): $V = 16.1345\sqrt{S}$ for unpaved surface, where V = average velocity (ft/s), S = slope (ft/ft)

Travel Time Equation (eq. 3-1, TR-55): $Tt = \frac{L}{3600\ V}$, where Tt = travel time (hr), L = flow length (ft), V = average velocity (ft/s), 3600 = conversion factor from seconds to hours

2 Travel time through bodies of water (eq. 15-11, Part 630, National Engineering Handbook): $Vw = \sqrt{gDm}$ for Vw = wave velocity (ft/s), g = 32.2 (ft/s^2), Dm = mean depth (ft)

TABLE III-2A-1.3

Pre-Development - Runoff Coefficient, C, Calculations

for Pre-Development HEC-HMS Model Input

Date:	8/18/20
By:	EWT
Chkd:	CGD
Apprvd:	CGD

Basin	Total Area (AC)	Unimproved		Top Slope		Side Slope		Industrial		Ditch		Pave/ROW		Pond		Composite C
		C	Area	C	Area	C	Area	C	Area	C	Area	C	Area	C	Area	
A	9.1	0.20	1.8	0.30	4.0	0.70	1.6	0.60	0.0	0.60	1.7	0.90	0.0	0.95	0	0.41
B	15.3	0.20	0.7	0.30	8.1	0.70	4.4	0.60	0.8	0.60	1.3	0.90	0.0	0.95	0	0.45
C	13.8	0.20	0.7	0.30	0.0	0.70	0	0.60	12.0	0.60	0.2	0.90	0.9	0.95	0	0.60
D	32.2	0.20	3.2	0.30	15.9	0.70	5.3	0.60	1.6	0.60	6.0	0.90	0.0	0.95	0.2	0.43
E	25.4	0.20	2.4	0.30	12.0	0.70	5.3	0.60	0.0	0.60	3.9	0.90	1.8	0.95	0.0	0.46
F	42.2	0.20	0.0	0.30	19.5	0.70	6.3	0.60	10.1	0.60	5.6	0.90	0.7	0.95	0	0.48
G	20.2	0.20	1.80	0.30	13.6	0.70	2.6	0.60	0.0	0.60	1.2	0.90	1.0	0.95	0	0.39
H	19.3	0.20	6.00	0.30	6.2	0.70	4.4	0.60	0.1	0.60	2.2	0.90	0.4	0.95	0	0.41
I	27.4	0.20	3.2	0.30	20.8	0.70	0	0.60	0.0	0.60	3.0	0.90	0.4	0.95	0	0.33
DET	43.1	0.20	0	0.30	0	0.70	0	0.60	0.0	0.60	0.0	0.90	1.0	0.95	42.1	0.95
Off1	5.4	0.20	0.0	0.30	0	0.70	0	0.60	5.4	0.60	0	0.90	0.0	0.95	0	0.60
On1	1.0	0.20	1.0	0.30	0	0.70	0	0.60	0.0	0.60	0	0.90	0.0	0.95	0	0.20
On2	0.2	0.20	0	0.30	0	0.70	0	0.60	0.2	0.60	0	0.90	0.0	0.95	0	0.60
On3	0.8	0.20	0.7	0.30	0	0.70	0	0.60	0.0	0.60	0	0.90	0.1	0.95	0	0.29
On4	1.1	0.20	0.2	0.30	0	0.70	0	0.60	0.1	0.60	0	0.90	0.8	0.95	0	0.75
On5	3.5	0.20	2.7	0.30	0	0.70	0	0.60	0.6	0.60	0	0.90	0.2	0.95	0	0.31
On6	1.2	0.20	0	0.30	0	0.70	0	0.60	1.2	0.60	0	0.90	0.0	0.95	0	0.60
On7	0.8	0.20	0	0.30	0	0.70	0	0.60	0.8	0.60	0	0.90	0.0	0.95	0	0.60

TABLE III-2A-1.4

Pre-Development - Curve Number, CN

for Pre-Development HEC-HMS Model Input

Date:	8/18/20
By:	EWT
Chkd:	CGD
Apprvd:	CGD

Basin	Total Area (AC)	Impervious Area (AC)	Impervious %	Landfill Final Cover and Other Open Areas		Developed Areas (unpaved)		Paved Areas		Area of Minimum Infiltration (Pond)		Composite CN
				CN	Area	CN	Area	CN	Area	CN	Area	
A	9.1	0.0	0%	85	7.4	92	1.7	98	0.0	98	0.0	86.3
B	15.3	0.0	0%	85	13.2	92	2.1	98	0.0	98	0.0	86.0
C	13.8	0.9	7%	85	0.7	92	12.2	98	0.9	98	0.0	92.0
D	32.2	0.2	1%	85	24.4	92	7.6	98	0.0	98	0.2	86.7
E	25.4	1.8	7%	85	19.7	92	3.9	98	1.8	98	0.0	87.0
F	42.2	0.7	2%	85	25.8	92	15.7	98	0.7	98	0.0	87.8
G	20.2	1.0	5%	85	18.0	92	1.2	98	1.0	98	0.0	86.1
H	19.3	0.4	2%	85	16.6	92	2.3	98	0.4	98	0.0	86.1
I	27.4	0.4	1%	85	24.0	92	3.0	98	0.4	98	0.0	86.0
DET	43.1	43.1	100%	85	0.0	92	0.0	98	1.0	98	42.1	98.0
Off1	5.4	0.0	0%	85	0.0	92	5.4	98	0.0	98	0.0	92.0
On1	1.0	0.0	0%	85	1.0	92	0.0	98	0.0	98	0.0	85.0
On2	0.2	0.0	0%	85	0.0	92	0.2	98	0.0	98	0.0	92.0
On3	0.8	0.1	13%	85	0.7	92	0.0	98	0.1	98	0.0	86.6
On4	1.1	0.8	73%	85	0.2	92	0.1	98	0.8	98	0.0	95.1
On5	3.5	0.2	6%	85	2.7	92	0.6	98	0.2	98	0.0	86.9
On6	1.2	0.0	0%	85	0.0	92	1.2	98	0.0	98	0.0	92.0
On7	0.8	0.0	0%	85	0.0	92	0.8	98	0.0	98	0.0	92.0

TABLE III-2A-1.5

Pre-Development - Rational Method Calculations

for Pre-Development HEC-HMS Model Input

Date:	8/18/20
By:	EWT
Chkd:	CGD
Aprvd:	CGD

$Q = I \times (CA)$

Where: C = watershed coefficient

A = area (acres)

I = rainfall intensity (inches per hour)

Atlas 14 Methodology: Storm precipitation intensity (inches/hour) data taken from NOAA Atlas 14, Volume 5, Version 2 for Location: Houston, Texas, USA, Latitude 29.8531°, Longitude -95.5602° (accessed June 5, 2020). Atlas 14 intensities are interpolated from NOAA PFDS tabulated data for project site per TxDOT Hydraulic Manual.

Basin	Calc. Point	Area (AC)	Area (sqmi)	TC (min)	Atlas 14 I_{25} (in/hr)	Atlas 14 I_{100} (in/hr)	Runoff Coefficient, C	Q_{25} = CIA (cfs)	Q_{100} = CIA (cfs)
A	1	9.1	0.0142	30.5	5.53	6.81	0.41	20.6	25.4
B	2	15.3	0.0239	33.9	5.33	6.57	0.45	36.7	45.2
C	3	13.8	0.0216	10.0	9.47	11.80	0.60	78.4	97.7
D	4	32.2	0.0503	47.7	4.50	5.58	0.43	62.3	77.3
E	5	25.4	0.0397	41.3	4.89	6.04	0.46	57.1	70.6
F	6	42.2	0.0659	47.1	4.54	5.62	0.48	92	113.8
G	7	20.2	0.0316	37.8	5.09	6.29	0.39	40.1	49.6
H	9	19.3	0.0302	33.0	5.38	6.64	0.41	42.6	52.5
I	10	27.4	0.0428	26.2	6.15	7.60	0.33	55.6	68.7
DET	CP-1	43.1	0.0673	10.0	9.47	11.80	0.95	387.7	483.2
OFF1	CP-2	5.4	0.0084	10.0	9.47	11.80	0.60	30.7	38.2
ON1	CP-3	1.0	0.0016	11.1	9.12	11.36	0.20	1.8	2.3
ON2	CP-4	0.2	0.0003	10.0	9.47	11.80	0.60	1.1	1.4
ON3	CP-5	0.8	0.0013	14.9	7.93	9.84	0.29	1.8	2.3
ON4	CP-6	1.1	0.0017	16.6	7.65	9.49	0.75	6.3	7.8
ON5	CP-7	3.5	0.0055	14.9	7.93	9.84	0.31	8.6	10.7
ON6	CP-8	1.2	0.0019	10.0	9.47	11.80	0.60	6.8	8.5
ON7	CP-9	0.8	0.0013	10.0	9.47	11.80	0.60	4.5	5.7

Notes: 1. See Pre-Development Time of Concentration Calculations spreadsheet for TC (min) calculations.

2. See Pre-Development Runoff Coefficient spreadsheet for C calculations.

TABLE III-2A-1.6

Pre-Development Summary of HEC-HMS Model Inputs

Date:	9/2/20
By:	EWT
Chkd:	CGD
Apprvd:	CGD

Basin Input					Transform Input		Loss Input - SCS Curve Number			*Iterative Input*	25-Year Peak Flow (cfs)		*Iterative Input*	100-Year Peak Flow (cfs)	
Basin	Calc. Point	Area (AC)	Area (sqmi)	Tc (min)	Tt (hr) = Tc (min) / 60min/hr	Reach - Lag (MIN)	Curve Number	Initial Abstractio	% Imp	Storage Coefficient, R	HEC-HMS Output	Rational Method	Storage Coefficient, R	HEC-HMS Output	Rational Method
A	1	9.1	0.0142	30.5	0.51	10.7	86.3	0.32	0%	1.645	20.6	20.6	2.312	25.4	25.4
B	2	15.3	0.0239	33.9	0.57	9.5	86.0	0.33	0%	1.48	36.7	36.7	2.105	45.2	45.2
C	3	13.8	0.0216	10.0	0.17	11.9	92.0	0.17	7%	0.329	78.4	78.4	0.493	97.7	97.7
D	4	32.2	0.0503	47.7	0.80	12.6	86.7	0.31	1%	2.067	62.3	62.3	2.853	77.3	77.3
E	5	25.4	0.0397	41.3	0.69	22.5	87.0	0.30	7%	1.665	57.1	57.1	2.325	70.6	70.6
F	6	42.2	0.0659	47.1	0.79	12.6	87.8	0.28	2%	1.737	92	92.0	2.424	113.8	113.8
G	7	20.2	0.0316	37.8	0.63	12.6	86.1	0.32	5%	2.01	40.1	40.1	2.78	49.6	49.6
H	9	19.3	0.0302	33.0	0.55	0.0	86.1	0.32	2%	1.705	42.6	42.6	2.395	52.5	52.5
I	10	27.4	0.0428	26.2	0.44	0.0	86.0	0.33	1%	1.95	55.6	55.6	2.705	68.7	68.7
DET	CP-1	43.1	0.0673	10.0	0.17		98.0	0.04	100%	0.0168	384.9	387.7	0.1483	483.2	483.2
OFF1	CP-2	5.4	0.0084	10.0	0.17		92.0	0.17	0%	0.323	30.7	30.7	0.486	38.2	38.2
ON1	CP-3	1	0.0016	11.1	0.19	19.1	85.0	0.35	0%	2.4	1.8	1.8	3.06	2.3	2.3
ON2	CP-4	0.2	0.0003	10.0	0.17	11.3	92.0	0.17	0%	0.35	1.1	1.1	0.43	1.4	1.4
ON3	CP-5	0.8	0.0013	14.9	0.25	17.9	86.6	0.31	13%	1.82	1.8	1.8	2.35	2.3	2.3
ON4	CP-6	1.1	0.0017	16.6	0.28	5.0	95.1	0.10	73%	0.3	6.3	6.3	0.48	7.8	7.8
ON5	CP-7	3.5	0.0055	14.9	0.25	16.3	86.9	0.30	6%	1.5	8.6	8.6	2.07	10.7	10.7
ON6	CP-8	1.2	0.0019	10.0	0.17	22.8	92.0	0.17	0%	0.34	6.8	6.8	0.5	8.5	8.5
ON7	CP-9	0.8	0.0013	10.0	0.17	26.2	92.0	0.17	0%	0.362	4.5	4.5	0.53	5.7	5.7

Hawthorn_Pre_Dev model - v. 2020_0902

TABLE III-2A-1.7

Pre-Development Summary of HEC-HMS Outputs

Date:	9/2/20
By:	EWT
Chkd:	CGD
Apprvd:	CGD

Calculation Point	Subbasins	Q25	Q100
1	A, ON1	22.3	27.6
2	A, B, ON1	58.6	72.5
3	A, B, C, ON1, ON2	104.3	138.5
4	A, B, C, D, ON1, ON2	162.5	212.6
5	E, ON3, ON4	62.8	78.4
6	E, F, ON3, ON4	152.8	190.7
7	G, ON5, ON6	54.8	68.1
8	A, B, C, D, E, F, G, ON1, ON2, ON3, ON4, ON5, ON6	363.1	464.7
9	A, B, C, D, E, F, G, H, ON1, ON2, ON3, ON4, ON5, ON6	402.6	514.1
10	I, ON7	60.1	74.3
Pond (Inflow)	A, B, C, D, E, F, G, H, I, DET, ON1, ON2, ON3, ON4, ON5, ON6, ON7	558.1	712.6
CP-1 Outfall	A, B, C, D, E, F, G, H, I, DET, ON1, ON2, ON3, ON4, ON5, ON6, ON7	151.2	174.9
CP-2 Offsite	OFF1	30.7	38.2
CP-3 Onsite	ON1	1.8	2.3
CP-4 Onsite	ON2	1.1	1.4
CP-5 Onsite	ON3	1.8	2.3
CP-6 Onsite	ON4	6.3	7.8
CP-7 Onsite	ON5	8.6	10.7
CP-8 Onsite	ON6	6.8	8.5
CP-9 Onsite	ON7	4.5	5.7
CP-10 NORTH	A, B, C, D, E, F, G, H, ON1, ON2, ON3, ON4, ON5, ON6	402.6	514.1
CP-11 EAST	I, ON7	60.1	74.3
CP-12	-	0.0	0.0

Hawthorn_Pre_Dev model - v. 2020_0902

TABLE III-2A-2.1

Post-Development - Time of Concentration Calculations

for Post-Development HEC-HMS Model Input

Date:	9/3/20
By:	EWT
Chkd:	CGD
Apprvd:	CGD

NRCS TR-55 Travel Time for sheet flow, shallow concentrated flow, and open channel flow calculations[1]; National Engineering Handbook for Travel time through bodies of water[2]

Basin	Calc. Point	Area (AC)	Area (sqmi)	Sheet				Shallow Concentrated			Channel - Add-On Berm			Channel - Downchute			Channel - Grass-Lined Ditch			Channel - Concrete-Lined Ditch			Pond			Calculated Tc (min)	Applicable Tc (min)[3]
				Length (ft)	Slope (ft/ft)	n	T_1 (min)	Length (ft)	Slope (ft/ft)	T_2 (min)	Length (ft)	Velocity (fps)	T_3 (min)	Length (ft)	Velocity (fps)	T_3 (min)	Length (ft)	Velocity (fps)	T_4 (min)	Length (ft)	Velocity (fps)	T_4 (min)	Length (ft)	Velocity (fps)	T_5 (min)		
A	1	32.6	0.0509	300	0.04	0.24	20.8	200	0.25	0.4	1850	4.3	7.2	192	32	0.1	864	1.5	9.6	0	5	0.0	0	14.5	0.0	38.1	38.1
B	2	22.8	0.0356	300	0.04	0.24	20.8	10	0.25	0.0	460	3.6	2.1	384	32	0.2	400	1.75	3.8	0	5	0.0	0	14.5	0.0	27.0	27.0
C	3	38.7	0.0605	300	0.04	0.24	20.8	54	0.25	0.1	1106	3.9	4.7	288	32	0.2	1900	3.0	10.6	0	5	0.0	0	14.5	0.0	36.4	36.4
D	4	11.2	0.0175	60	0.015	0.24	8.5	0	0.25	0.0	0	2.0	0.0	0	32	0.0	1450	1.00	24.2	0	5	0.0	0	14.5	0.0	32.7	32.7
E	5	34.0	0.0531	145	0.04	0.24	11.6	77	0.25	0.2	944	3.8	4.1	288	32	0.2	1790	1.5	19.9	0	5	0.0	0	14.5	0.0	36.0	36.0
F	6	37.5	0.0586	300	0.04	0.24	20.8	83	0.25	0.2	723	4.5	2.7	288	32	0.2	0	2.5	0.0	1425	5.5	4.3	0	14.5	0.0	28.2	28.2
G	7	6.0	0.0094	134	0.035	0.24	11.5	0	0.25	0.0	0	2	0.0	0	32	0.0	645	4.0	2.7	531	6.5	1.4	0	14.5	0.0	15.6	15.6
H	8	16.3	0.0255	100	0.04	0.24	8.7	0	0.25	0.0	644	3.9	2.8	480	32	0.3	335	2.0	2.8	0	5	0.0	0	14.5	0.0	14.4	14.4
I	9	11.2	0.0175	100	0.04	0.24	8.7	54	0.25	0.1	1740	4.3	6.7	0	32	0.0	568	2.0	4.7	0	5	0.0	0	14.5	0.0	20.2	20.2
DET	CP-1	43.1	0.0673	0	0.01	0.24	0.0	0	0.01	0.0	0	2	0.0	0	32	0.0	0	1.0	0.0	0	5	0.0	2253	14.5	2.6	2.6	10.0
OFF1	CP-2	0.0	0.0000																								
ON1	CP-3	1.0	0.0016	97	0.02	0.24	11.1	0	0.01	0.0	0	2	0.0	0	32	0.0	0	1.0	0.0	0	5	0.0	0	14.5	0.0	11.1	11.1
ON2	CP-4	0.2	0.0003	120	0.035	0.24	10.6	0	0.01	0.0	0	2	0.0	0	32	0.0	0	1.0	0.0	0	5	0.0	0	14.5	0.0	10.6	10.6
ON3	CP-5	0.8	0.0013	140	0.02	0.24	14.9	0	0.01	0.0	0	2	0.0	0	32	0.0	0	1.0	0.0	0	5	0.0	0	14.5	0.0	14.9	14.9
ON4	CP-6	1.1	0.0017	138	0.015	0.24	16.6	0	0.01	0.0	0	2	0.0	0	32	0.0	0	1.0	0.0	0	5	0.0	0	14.5	0.0	16.6	16.6
ON5	CP-7	3.5	0.0055	220	0.05	0.24	14.9	0	0.01	0.0	0	2	0.0	0	32	0.0	0	1.0	0.0	0	5	0.0	0	14.5	0.0	14.9	14.9
ON6	CP-8	1.2	0.0019	206	0.05	0.011	1.2	0	0.01	0.0	0	2	0.0	0	32	0.0	0	1.0	0.0	0	5	0.0	0	14.5	0.0	1.2	10.0
ON7	CP-9	0.8	0.0013	178	0.05	0.011	1.1	0	0.01	0.0	0	2	0.0	0	32	0.0	0	1.0	0.0	0	5	0.0	0	14.5	0.0	1.1	10.0

Notes:

1 Sheet Flow equation (eq. 3-3, TR-55): $tsheet = \frac{0.007\,(NL)^{0.8}}{(P2)^{0.5}S^{0.4}}$, where Tt = travel time (hr), P2 = 2-year, 24-hour rainfall (in), S = slope (ft/ft), N = Manning's roughness coefficient, L = flow length (ft)

Shallow concentrated equation (TR-55): $V = 16.1345\sqrt{S}$ for unpaved surface, where V = average velocity (ft/s), S = slope (ft/ft)

Travel Time Equation (eq. 3-1, TR-55): $Tt = \frac{L}{3600\,V}$, where Tt = travel time (hr), L = flow length (ft), V = average velocity (ft/s), 3600 = conversion factor from seconds to hours

2 Travel time through bodies of water (eq. 15-11, Part 630, National Engineering Handbook): $Vw = \sqrt{gDm}$ for Vw = wave velocity (ft/s), g = 32.2 (ft/s²), Dm = mean depth (ft)

3 Minimum time of concentration used for computation of rainfall intensity is 10 minutes. If the time of concentration computed for the drainage area is less than 10 minutes, then 10 minutes should be adopted for rainfall intensity computations. (Texas Department of Transportation, Hydraulic Design Manual, Section 12: Rational Method)

4 See Figure **III-2A-2** for Post-Development Overall Drainage Conditions

TABLE III-2A-2.2

Post-Development - Reach Time Calculations

for Post-Development HEC-HMS Model Input

Date:	8/18/20
By:	EWT
Chkd:	CGD
Apprvd:	CGD

Upstream Calculation Point	Downstream Calculation Point	Reach	Sheet				Shallow Concentrated			Channel - Grass			Channel - Concrete			Pond			Lag Time (min)
			Length (ft)	Slope (ft/ft)	Sheet Flow, n	T_1 (min)	Length (ft)	Slope (ft/ft)	T_2 (min)	Length (ft)	Velocity (fps)	T_4 (min)	Length (ft)	Velocity (fps)	T_4 (min)	Length (ft)	Velocity (fps)	T5 (min)	
1	2	R(1-2)	0	0.01	0.24	0.0	0	0.01	0.0	1342	1.75	12.8	0	4	0.0	0	14.5	0.0	12.8
2	3	R(2-3)	0	0.01	0.24	0.0	0	0.01	0.0	2974	3.0	16.5	0	4	0.0	0	14.5	0.0	16.5
3	POND																		
4	5	R(4-5)	0	0.01	0.24	0.0	0	0.01	0.0	2990	1.5	33.2	0	5	0.0	0	14.5	0.0	33.2
5	6	R(5-6)	0	0.01	0.24	0.0	0	0.01	0.0	223	2.0	1.9	1507	5.5	4.6	0	14.5	0.0	6.4
6	7	R(6-7)	0	0.01	0.24	0.0	0	0.01	0.0	645	4.0	2.7	922	6.5	2.4	0	14.5	0.0	5.1
7	POND																		
8	POND																		
9	POND																		
CP-1	--																		
CP-2	--																		
CP-3	1	R(CP-3)	90	0.02	0.24	10.5	0	0.01	0.0	0	1.8	0.0	0	4	0.0	0	14.5	0.0	10.5
CP-4	2	R(CP-4)	49	0.035	0.24	5.2	0	0.01	0.0	310	1.75	3.0	0	4	0.0	0	14.5	0.0	8.1
CP-5	4	R(CP-5)	49	0.04	0.24	4.9	0	0.01	0.0	1492	1.0	24.9	0	4	0.0	0	14.5	0.0	29.8
CP-6	4	R(CP-6)	40	0.015	0.24	6.2	0	0.01	0.0	0	2.5	0.0	0	4	0.0	0	14.5	0.0	6.2
CP-7	6	R(CP-7)	66	0.05	0.24	5.7	0	0.01	0.0	0	2.5	0.0	819	5.5	2.5	0	14.5	0.0	8.2
CP-8	7	R(CP-8)	27	0.05	0.011	0.2	0	0.01	0.0	645	4	2.7	702	6.5	1.8	0	14.5	0.0	4.7
CP-9	7	R(CP-9)	27	0.05	0.011	0.2	0	0.01	0.0	645	4	2.7	480	6.5	1.2	0	14.5	0.0	4.2

Notes:

1 Sheet Flow equation (eq. 3-3, TR-55): $tsheet = \frac{0.007\,(NL)^{0.8}}{(P2)^{0.5}S^{0.4}}$, where Tt = travel time (hr), P2 = 2-year, 24-hour rainfall (in), S = slope (ft/ft), N = Manning's roughness coefficient, L = flow length (ft)

Shallow concentrated equation (TR-55): $V = 16.1345\sqrt{S}$ for unpaved surface, where V = average velocity (ft/s), S = slope (ft/ft)

Travel Time Equation (eq. 3-1, TR-55): $Tt = \frac{L}{3600\,V}$, where Tt = travel time (hr), L = flow length (ft), V = average velocity (ft/s), 3600 = conversion factor from seconds to hours

2 Travel time through bodies of water (eq. 15-11, Part 630, National Engineering Handbook): $Vw = \sqrt{gDm}$ for Vw = wave velocity (ft/s), g = 32.2 (ft/s^2), Dm = mean depth (ft)

TABLE III-2A-2.3

Post-Development - Runoff Coefficient, C, Calculations

for Post-Development HEC-HMS Model Input

Date:	9/3/20
By:	EWT
Chkd:	CGD
Apprvd:	CGD

Basin	Total Area (AC)	Unimproved		Top Slope		Side Slope		Industrial		Ditch		Pave/ROW		Pond		Composite C
		C	Area	C	Area	C	Area	C	Area	C	Area	C	Area	C	Area	
A	32.6	0.20	0.1	0.30	11.0	0.70	19.0	0.60	0.0	0.60	2.5	0.90	0.0	0.95	0.0	0.56
B	22.8	0.20	1.9	0.30	7.3	0.70	11.0	0.60	0.0	0.60	2.6	0.90	0.0	0.95	0.0	0.52
C	38.7	0.20	0.0	0.30	9.4	0.70	22.4	0.60	0.0	0.60	6.9	0.90	0.0	0.95	0.0	0.59
D	11.2	0.20	1.8	0.30	0.0	0.70	3.7	0.60	0.0	0.60	4.6	0.90	1.1	0.95	0.0	0.60
E	34.0	0.20	1.4	0.30	2.6	0.70	22.0	0.60	0.7	0.60	7.2	0.90	0.1	0.95	0.0	0.63
F	37.5	0.20	0.0	0.30	12.4	0.70	22.2	0.60	0.0	0.60	2.9	0.90	0.0	0.95	0.0	0.56
G	6.0	0.20	0.3	0.30	1.2	0.70	0.8	0.60	0.0	0.60	3.0	0.90	0.7	0.95	0.0	0.57
H	16.3	0.20	0.0	0.30	3.1	0.70	12.1	0.60	0.0	0.60	1.1	0.90	0.0	0.95	0.0	0.62
I	11.2	0.20	0.0	0.30	3.2	0.70	6.7	0.60	0.0	0.60	1.3	0.90	0.0	0.95	0.0	0.57
DET	43.1	0.20	0.0	0.30	0.0	0.70	0.0	0.60	0.0	0.60	0.0	0.90	1.0	0.95	42.1	0.95
Off1	0.0	0.20	0.0	0.30	0.0	0.70	0.0	0.60	0.0	0.60	0.0	0.90	0.0	0.95	0.0	0.00
On1	1.0	0.20	1.0	0.30	0.0	0.70	0.0	0.60	0.0	0.60	0.0	0.90	0.0	0.95	0.0	0.20
On2	0.2	0.20	0.0	0.30	0.0	0.70	0.0	0.60	0.2	0.60	0.0	0.90	0.0	0.95	0.0	0.60
On3	0.8	0.20	0.7	0.30	0.0	0.70	0.0	0.60	0.0	0.60	0.0	0.90	0.1	0.95	0.0	0.29
On4	1.1	0.20	0.2	0.30	0.0	0.70	0.0	0.60	0.1	0.60	0.0	0.90	0.8	0.95	0.0	0.75
On5	3.5	0.20	2.7	0.30	0.0	0.70	0.0	0.60	0.6	0.60	0.0	0.90	0.2	0.95	0.0	0.31
On6	1.2	0.20	0.00	0.30	0.0	0.70	0.0	0.60	1.2	0.60	0.0	0.90	0.0	0.95	0.0	0.60
On7	0.8	0.20	0.00	0.30	0.0	0.70	0.0	0.60	0.8	0.60	0.0	0.90	0.0	0.95	0.0	0.60

TABLE III-2A-2.4

Post-Development - Curve Number, CN

for Post-Development HEC-HMS Model Input

Date:	9/3/20
By:	EWT
Chkd:	CGD
Apprvd:	CGD

Basin	Total Area (AC)	Impervious Area (AC)	Impervious %	Landfill Final Cover and Other Open Areas		Developed Areas (unpaved)		Paved Areas		Area of Minimum Infiltration (Pond)		Composite CN
				CN	Area	CN	Area	CN	Area	CN	Area	
A	32.6	0.0	0%	85	30.1	92	2.5	98	0.0	98	0.0	85.5
B	22.8	0.0	0%	85	20.2	92	2.6	98	0.0	98	0.0	85.8
C	38.7	0.0	0%	85	31.8	92	6.9	98	0.0	98	0.0	86.2
D	11.2	1.1	10%	85	5.5	92	4.6	98	1.1	98	0.0	89.2
E	34.0	0.1	0%	85	26.0	92	7.9	98	0.1	98	0.0	86.7
F	37.5	0.0	0%	85	34.6	92	2.9	98	0.0	98	0.0	85.5
G	6.0	0.7	12%	85	2.3	92	3.0	98	0.7	98	0.0	90.0
H	16.3	0.0	0%	85	15.2	92	1.1	98	0.0	98	0.0	85.5
I	11.2	0.0	0%	85	9.9	92	1.3	98	0.0	98	0.0	85.8
DET	43.1	43.1	100%	85	0.0	92	0.0	98	1.0	98	42.1	98.0
Off1	0.0											
On1	1.0	0.0	0%	85	1.0	92	0.0	98	0.0	98	0.0	85.0
On2	0.2	0.0	0%	85	0.0	92	0.2	98	0.0	98	0.0	92.0
On3	0.8	0.1	13%	85	0.7	92	0.0	98	0.1	98	0.0	86.6
On4	1.1	0.8	73%	85	0.2	92	0.1	98	0.8	98	0.0	95.1
On5	3.5	0.2	6%	85	2.7	92	0.6	98	0.2	98	0.0	86.9
On6	1.2	0.0	0%	85	0.0	92	1.2	98	0.0	98	0.0	92.0
On7	0.8	0.0	0%	85	0.0	92	0.8	98	0.0	98	0.0	92.0

TABLE III-2A-2.5

Post-Development - Rational Method Calculations

for Post-Development HEC-HMS Model Input

Date:	9/3/20
By:	EWT
Chkd:	CGD
Aprvd:	CGD

$Q = I \times (CA)$

Where: C = watershed coefficient

A = area (acres)

I = rainfall intensity (inches per hour)

Atlas 14 Methodology: Storm precipitation intensity (inches/hour) data taken from NOAA Atlas 14, Volume 5, Version 2 for Location: Houston, Texas, USA, Latitude 29.8531°, Longitude -95.5602° (accessed June 5, 2020). Atlas 14 intensities are interpolated from NOAA PFDS tabulated data for project site per TxDOT Hydraulic Manual.

Basin	Calc. Point	Area (AC)	Area (sqmi)	TC (min)	Atlas 14 I_{25} (in/hr)	Atlas 14 I_{100} (in/hr)	Runoff Coefficient, C	Q_{25} = CIA (cfs)	Q_{100} = CIA (cfs)
A	1	32.6	0.0509	38.1	5.08	6.27	0.56	92.7	114.5
B	2	22.8	0.0356	27.0	6.03	7.44	0.52	71.5	88.2
C	3	38.7	0.0605	36.4	5.18	6.39	0.59	118.3	145.9
D	4	11.2	0.0175	32.7	5.40	6.66	0.60	36.3	44.8
E	5	34	0.0531	36.0	5.20	6.42	0.63	111.4	137.5
F	6	37.5	0.0586	28.2	5.84	7.20	0.56	122.6	151.2
G	7	6	0.0094	15.6	7.81	9.68	0.57	26.7	33.1
H	8	16.3	0.0255	14.4	8.09	10.04	0.62	81.8	101.5
I	9	11.2	0.0175	20.2	7.09	8.78	0.57	45.3	56.1
DET	CP-1	43.1	0.0673	10.0	9.47	11.80	0.95	387.7	483.2
OFF1	CP-2	0	0.0000					0	0
ON1	CP-3	1.0	0.0016	11.1	9.12	11.36	0.20	1.8	2.3
ON2	CP-4	0.2	0.0003	10.6	9.28	11.56	0.60	1.1	1.4
ON3	CP-5	0.8	0.0013	14.9	7.93	9.84	0.29	1.8	2.3
ON4	CP-6	1.1	0.0017	16.6	7.65	9.49	0.75	6.3	7.8
ON5	CP-7	3.5	0.0055	14.9	7.93	9.84	0.31	8.6	10.7
ON6	CP-8	1.2	0.0019	10.0	9.47	11.80	0.60	6.8	8.5
ON7	CP-9	0.8	0.0013	10.0	9.47	11.80	0.60	4.5	5.7

Notes: 1. See Post-Development Time of Concentration Calculations spreadsheet for TC (min) calculations.

2. See Post-Development Runoff Coefficient spreadsheet for C coefficient calculations.

TABLE III-2A-2.6

Post-Development Summary of HEC-HMS Model Inputs

Date:	9/3/20
By:	EWT
Chkd:	CGD
Apprvd:	CGD

Basin Input				Transform Input		Loss Input			*Iterative Input*	25-Year Peak Flow (cfs)		*Iterative Input*	100-Year Peak Flow (cfs)	
Basin	Area (AC)	Area (sqmi)	Tc (min)	Tt (hr) = Tc (min) / 60min/hr	Reach - Lag (MIN)	Curve Number	Initial Abstraction	% Imp	Storage Coefficient, R	HEC-HMS Output	Rational Method	Storage Coefficient, R	HEC-HMS Output	Rational Method
A	32.6	0.0509	38.1	0.64	12.8	85.5	0.34	0%	1.082	92.7	92.7	1.58	114.5	114.5
B	22.8	0.0356	27.0	0.45	16.5	85.8	0.33	0%	0.942	71.5	71.5	1.379	88.2	88.2
C	38.7	0.0605	36.4	0.61		86.2	0.32	0%	0.971	118.3	118.3	1.418	145.9	145.9
D	11.2	0.0175	32.7	0.55	33.2	89.2	0.24	10%	0.934	36.3	36.3	1.337	44.8	44.8
E	34	0.0531	36.0	0.60	6.4	86.7	0.31	0%	0.855	111.4	111.4	1.267	137.5	137.5
F	37.5	0.0586	28.2	0.47	5.1	85.5	0.34	0%	0.866	122.6	122.6	1.281	151.2	151.2
G	6	0.0094	15.6	0.26		90.0	0.22	12%	0.54	26.7	26.7	0.789	33.1	33.1
H	16.3	0.0255	14.4	0.24		85.5	0.34	0%	0.374	81.8	81.8	0.597	101.5	101.5
I	11.2	0.0175	20.2	0.34		85.8	0.33	0%	0.594	45.3	45.3	0.888	56.1	56.1
DET	43.1	0.0673	10.0	0.17		98.0	0.04	100%	0.0167	384.9	387.7	0.1483	483.2	483.2
OFF1	0	0												
ON1	1	0.0016	11.1	0.19	10.5	85.0	0.35	0%	2.4	1.8	1.8	3.06	2.3	2.3
ON2	0.2	0.0003	10.6	0.18	8.1	92.0	0.17	0%	0.35	1.1	1.1	0.43	1.4	1.4
ON3	0.8	0.0013	14.9	0.25	29.8	86.6	0.31	13%	1.82	1.8	1.8	2.35	2.3	2.3
ON4	1.1	0.0017	16.6	0.28	6.2	95.1	0.10	73%	0.3	6.3	6.3	0.48	7.8	7.8
ON5	3.5	0.0055	14.9	0.25	8.2	86.9	0.30	6%	1.5	8.6	8.6	2.07	10.7	10.7
ON6	1.2	0.0019	10.0	0.17	4.7	92.0	0.17	0%	0.34	6.8	6.8	0.5	8.5	8.5
ON7	0.8	0.0013	10.0	0.17	4.2	92.0	0.17	0%	0.362	4.5	4.5	0.53	5.7	5.7

Hawthorn_Post_Dev model - v. 2020_0903

TABLE III-2A-2.7

Post-Development Summary of HEC-HMS Outputs

Date:	9/8/20
By:	EWT
Chkd:	CGD
Apprvd:	CGD

Calculation Point	Subbasins	Q25	Q100
1	A, ON1	94.5	116.8
2	A, B, ON1, ON2	159.1	199.6
3	A, B, C, ON1, ON2	262.5	333.0
4	D, ON3, ON4	42.8	53.4
5	D, E, ON3, ON4	137.8	176.3
6	D, E, F, ON3, ON4, ON5	256.6	323.6
7	D, E, F, G, ON3, ON4, ON5, ON6, ON7	282.1	357.3
8	H	81.8	101.5
9	I	45.3	56.1
10	H, I	126.2	156.1
Pond (Inflow)	A, B, C, D, E, F, G, H, I, DET, ON1, ON2, ON3, ON4, ON5, ON6, ON7	736.3	968.9
CP-1 Outfall	A, B, C, D, E, F, G, H, I, DET, ON1, ON2, ON3, ON4, ON5, ON6, ON7	141.8	169.8
CP-2 Offsite	OFF1	0	0
CP-3 Onsite	ON1	1.8	2.3
CP-4 Onsite	ON2	1.1	1.4
CP-5 Onsite	ON3	1.8	2.3
CP-6 Onsite	ON4	6.3	7.8
CP-7 Onsite	ON5	8.6	10.7
CP-8 Onsite	ON6	6.8	8.5
CP-9 Onsite	ON7	4.5	5.7
CP-10 NORTH	A, B, C, ON1, ON2	262.5	333.0
*CP-11 EAST	H, I	126.2	156.1
CP-12 SOUTH	D, E, F, G, ON3, ON4, ON5, ON6, ON7	282.1	357.3

Hawthorn_Post_Dev model - v. 2020_0903

TABLE III-2A-3

Ditch - Peak Flow Calculations

for Ditch Sizing and Design (HEC-RAS Model Input)

Date:	10/16/20
By:	EWT
Chkd:	CGD
Apprvd:	CGD

Reference **Figure III-2A-4** for Perimeter Ditch drainage areas, flow change locations, and ditch stationing.

HEC-HMS Drainage Basins	Calculation Point	Portion of Basins (AC)	Total Subbasin Acreage	Portion of Basins (%)	Total Basin Flow (cfs)		Segment Flow (cfs) (% of Basin x Flow)		HEC-RAS Reach ID	HEC-RAS Reach Station	Cumulative Flow (cfs)	
					Q25	Q100	Q25	Q100			Q25	Q100
A, ON1	1A	1.7	33.6	5.1%	94.5	116.8	4.8	6.0	North	59+58.3	4.8	6.0
A, ON1	1	32.6	33.6	97.0%	94.5	116.8	91.7	113.3	North	51+75	91.7	113.3
B, ON2	2A	4.8	23.0	20.9%	64.6	82.8	13.5	17.3	North	43+70	105.2	130.6
B, ON2	2	23.0	23.0	100.0%	64.6	82.8	64.6	82.8	North	33+40	156.3	196.1
C	3A	3.5	38.7	9.0%	103.4	133.4	9.3	12.0	North	29+90	165.6	208.1
C	3	38.7	38.7	100.0%	103.4	133.4	103.4	133.4	North	19+00	259.7	329.5
D, ON3, ON4	4A	5.7	13.1	43.5%	42.8	53.4	18.6	23.2	South	77+65.5	18.6	23.2
D, ON3, ON4	4	13.1	13.1	100.0%	42.8	53.4	42.8	53.4	South	71+35	42.8	53.4
E	5A	5.5	34.0	16.2%	95.0	122.9	15.4	19.9	South	62+00	58.2	73.3
E	5	34.0	34.0	100.0%	95.0	122.9	95.0	122.9	South	50+00	137.8	176.3
F, ON5	6A	0.7	41.0	1.7%	118.8	147.3	2.0	2.5	South	32+25	139.8	178.8
F, ON5	6	41.0	41.0	100.0%	118.8	147.3	118.8	147.3	South	28+65	256.6	323.6
G, ON6, ON7	7	8.0	8.0	100.0%	25.5	33.7	25.5	33.7	South	14+70	282.1	357.3
H	8A	1.1	16.3	6.7%	81.8	101.5	5.5	6.8	East-N	9+44.2	5.5	6.8
H	8	16.3	16.3	100.0%	81.8	101.5	81.8	101.5	East-N	3+00.0	81.8	101.5
H, I	10	27.5	27.5	100.0%	126.2	156.1	126.2	156.1	East-N	0+20.6	126.2	156.1
I	9A	1.0	11.2	8.9%	45.3	56.1	4.0	5.0	East-S	11+47.4	4.0	5.0
I	9	11.2	11.2	100.0%	45.3	56.1	45.3	56.1	East-S	5+46.5	45.3	56.1
H, I	10	27.5	27.5	100.0%	126.2	156.1	126.2	156.1	East-S	0+17.7	126.2	156.1

Note: Full (100%) calculation point flows are from HEC-HMS model output. See Table **III-2A-2.7** for a summary of HEC-HMS results.

TABLE III-2A-4

Downchute - Peak Flow Calculations
for Downchute Sizing and Design

Date:	9/8/20
By:	EWT
Chkd:	CGD
Apprvd:	CGD

Structure	Time of Concentration[1] (min)	I_{25} (in/hr)	C	Top Slope Area (acres)	Total Area (acres)	Q_{25} (cfs)
DC1	28.5	5.79	0.55	11.1	29.0	92.4
DC2	23.2	6.62	0.53	7.3	17.3	60.7
DC3	25.8	6.22	0.57	9.4	28.6	101.4
DC4	16.1	7.73	0.65	2.6	20.4	102.5
DC5	23.8	6.53	0.55	12.4	32.2	115.6
DC6	11.7	8.94	0.62	3.1	14.7	81.5
DC7	15.5	7.82	0.56	3.3	9.3	40.7

Rational Method, Q (cfs) = C I A, where:

C, runoff coefficient = 0.3 for top slope areas; 0.7 for sideslope areas
I, rainfall intensity (in/hr) = Atlas-14 value (using TC as storm Duration)
A, area (acre) = See Table; delineated in **Figure III-2A-3**

[1] The Time of Concentration, TC (min) is from **Table III-2A-2.1** for each respective downchute. The total value, in minutes, was obtained by totaling the top slope travel time (sheet/shallow concentrated flow), add-on berm travel time, and downchute travel time to the bottom of the downchute.

Structure	*Corresponding Basin*
DC1	*A*
DC2	*B*
DC3	*C*
DC4	*E*
DC5	*F*
DC6	*H*
DC7	*I*

Basin from Table III-2A-2.1

TABLE III-2A-5

Add-on Berm - Peak Flow Calculations

for Add-On Berm Sizing and Design

Date:	9/8/20
By:	EWT
Chkd:	CGD
Apprvd:	CGD

Drainage Area	Top Slope Distance	TC[1] (min)	I_{25} (in/hr)	C	Top Slope Area (acres)	Total Area (acres)	Q_{25} (cfs)
T1	280	19.7	7.17	0.35	1.4	1.6	4.0
T2	300	20.8	7.00	0.35	1.3	1.5	3.7
T3	300	20.8	7.00	0.34	3	3.3	7.9
T4	300	20.8	7.00	0.33	4.3	4.6	10.6
T5	300	20.8	7.00	0.47	2.6	4.6	15.1
T6	300	20.8	7.00	0.31	2.8	2.9	6.3
T7	200	15.1	7.88	0.34	2.5	2.8	7.5
T8	200	15.1	7.88	0.51	1.7	3.6	14.5
T9	300	20.8	7.00	0.4	6.7	8.9	24.9
T10	300	20.8	7.00	0.57	1.7	5.4	21.5
T11	145	11.6	8.97	0.55	1.1	2.9	14.3
T12	100	10.0	9.47	0.37	0.9	1.1	3.9
T13	100	10.0	9.47	0.4	0.6	0.8	3.0
T14[2]	300	20.8	7.00	0.42	6.3	9	26.5
T15	200	15.1	7.88	0.34	2.5	2.8	7.5
T16	200	15.1	7.88	0.34	2.9	3.2	8.6
T17	160	12.6	8.65	0.6	0.6	2.5	13.0
T18	200	15.1	7.88	0.56	0.9	2.5	11.0
T19	200	15.1	7.88	0.37	1.4	1.7	5.0
T20	200	15.1	7.88	0.37	0.9	1.1	3.2
T21	100	10.0	9.47	0.61	0.9	3.8	22.0
T22	100	10.0	9.47	0.45	1.6	2.6	11.1
T23	100	10.0	9.47	0.52	0.8	1.8	8.9

[1] The Time of Concentration, TC (min) is from calculating the sheet flow travel time using the NRCS TR-55 method for each Add-On Berm drainage area using the topslope travel distance, top slope of 4%, and n value of 0.24. See Table **III-2A-2.1** notes for more details. The minimum TC (min) used in the Rational Method calculations is 10-minutes, per the TxDOT Hydraulic Design Manual.

[2] The design of the add-on berms is constant. The worst-case scenario, which is for delineated add-on berm area T14 (highest estimated peak flow), is simulated using HydraFlow Express (based on Manning's Equation normal depth flow). See Appendix III-2A-2.

TABLE III-2A-5 (cont.)

Drainage Area	Area (acres)	C	Q_{25} (cfs)	Drainage Area	Area (acres)	C	Q_{25} (cfs)
S1	3.5	0.7	23.2	S24	3.2	0.7	21.2
S2	3.4	0.7	22.5	S25	1.5	0.7	9.9
S3	0.9	0.7	6.0	S26	1.4	0.7	9.3
S4	1.1	0.7	7.3	S27	1.8	0.7	11.9
S5	1.3	0.7	8.6	S28	2	0.7	13.3
S6	1.5	0.7	9.9	S29	2.1	0.7	13.9
S7	1.4	0.7	9.3	S30	3	0.7	19.9
S8	1.6	0.7	10.6	S31	2.8	0.7	18.6
S9	1.8	0.7	11.9	S32	2.5	0.7	16.6
S10	2	0.7	13.3	S33	2.2	0.7	14.6
S11	0.9	0.7	6.0	S34	2.2	0.7	14.6
S12	0.6	0.7	4.0	S35	1.9	0.7	12.6
S13	0.4	0.7	2.7	S36	1.2	0.7	8.0
S14	0.8	0.7	5.3	S37	1.2	0.7	8.0
S15	2.4	0.7	15.9	S38	0.8	0.7	5.3
S16	2.6	0.7	17.2	S39	1	0.7	6.6
S17	2.8	0.7	18.6	S40	0.7	0.7	4.6
S18	2.1	0.7	13.9	S41	0.7	0.7	4.6
S19	2.3	0.7	15.2	S42	1.9	0.7	12.6
S20	2.5	0.7	16.6	S43	2.1	0.7	13.9
S22	2.3	0.7	15.2	S44	2.3	0.7	15.2
S23	2.76	0.7	18.3				

C, runoff coefficient = 0.3 for top slope areas; 0.7 for sideslope areas
I, rainfall intensity (in/hr) = Atlas-14 value (using TC[3] as storm Duration)
A, area (acre) = See Table; delineated in **Figure III-2A-3**

[2] The design of the add-on berms is constant. The worst-case scenario, which is for delineated add-on berm area T14 (highest estimated peak flow, see page 1 of this table), is simulated using HydraFlow Express (based on Manning's Equation normal depth flow). See Appendix III-2A-2.

[3] A Time of Concentration, TC (min) of 10 minutes is used for all add-on berm with sideslope-only contributing areas, the minimum time of concentration to use in Rational Method calculations per TxDOT's Hydraulic Design Manual. The Atlas-14 25-year intensity is 9.47 in/hr for a 10-minute storm, local to the Hawthorn Park RDF project area.

TABLE III-2A-6
Riprap Sizing Calculations
for Ditch Lining

Date:	11/10/20
By:	EWT
Chkd:	CGD
Apprvd:	CGD

				25-YR [4]				COMPUTED	FHWA RIPRAP SELECTION [2]		
REACH	LOCATION	DOWNSTREAM	UPSTREAM	FLOW DEPTH	WS TOP WIDTH	DESIGN FLOW	VELOCITY	D_{50} [1]	D_{50}	THICKNESS	RIPRAP
NAME	DESCRIPTION	STA	STA	(FT)	(FT)	(CFS)	(FPS)	(IN)	(IN)	(IN)	TYPE
North	Upstream of Discharge	-0+88.5	-0+73.5	3.37	45.2	259.7	2.2	0.204	6.50	12.00	CLASS I
North	Downstream of Concrete	0+08.4	0+18.4	3.22	24.9	259.7	4.37	1.500	6.50	12.00	CLASS I
South	Upstream of Discharge	-1+16.6	-1+07.8	2.96	47.11	282.1	3.02	0.465	6.50	12.00	CLASS I
South	Downstream of Concrete	-1+07.8	-0+86.0	2.97	45.38	282.1	3.14	0.64	6.50	12.00	CLASS I
South	Downstream of Concrete	5+45.0	5+65.0	3.33	34.96	282.1	3.39	0.747	6.50	12.00	CLASS I
South	Downstream of Culvert	70+09.5	70+15.0	2.84	32.70	42.8	0.68	0.014	6.50	12.00	CLASS I
South	Upstream of Culvert	71+20.0	71+25.5	2.92	31.91	42.8	0.71	0.013	6.50	12.00	CLASS I
East[3]	Upstream of Discharge	-0+87.3	-0+72.3	1.77	16.94	126.2	6.2	3.193	6.50	12.00	CLASS I
East[3]	Erosion Control	-0+72.3	0+00.0	1.98	17.78	126.2	5.41	2.208	6.50	12.00	CLASS I
East[3]	Erosion Control	0+00.0	0+01.5	2.03	20.51	126.2	4.69	1.535	6.50	12.00	CLASS I
East-N	Erosion Control	0+01.5	0+11.1	2.03	20.50	126.2	4.69	9.636	12.50	24.00	CLASS III
East-N	Erosion Control	0+11.1	0+20.6	1.48	14.64	81.8	5.67	13.996	15.50	30.00	CLASS IV
East-S	Erosion Control	0+01.5	0+11.7	2.03	20.50	126.2	4.69	9.636	12.50	24.00	CLASS III
East-S	Erosion Control	0+11.7	0+17.7	1.96	16.92	45.3	2.1	1.178	6.50	12.00	CLASS I
East-S	Downstream of Culvert	0+80.0	0+85.0	2.38	19.35	45.3	1.76	0.159	6.50	12.00	CLASS I
East-S	Upstream of Culvert	1+25.0	1+30.0	2.31	20.37	45.3	1.27	0.057	6.50	12.00	CLASS I

NOTES:

[1] RIPRAP CALCULATED D_{50} SIZING FROM HYDRAULIC TOOLBOX RIPRAP ANALYSIS OUTPUT **(APP. III-2A-4)**.

2 RIPRAP SELECTION SIZING USING RIPRAP CLASSES PROVIDED BY THE FEDERAL HIGHWAY ADMINISTRATION (FHWA). ALTERNATIVE RIPRAP SIZING AND THICKNESSES MAY BE USED IF THE SELECTION, AT MINIMUM, SATISFIES THE COMPUTED D_{50} SIZING.

[3] COMBINED FLOWS FOR EAST-N AND EAST-S AT STATIONING -0+87.3 TO 0+1.5.

[4] 25-YR RIPRAP DESIGN INPUTS TAKEN FROM HEC-RAS RESULTS. SEE HEC-RAS OUTPUT **(APP. III-2A-3)**.

DOWNCHUTE CROSSINGS SHOULD BE LINED WITH CLASS II OR EQUIVALENT (D_{50} = 9.5 IN) TYPE RIPRAP, WITH MINIMUM 18 IN THICKNESS.