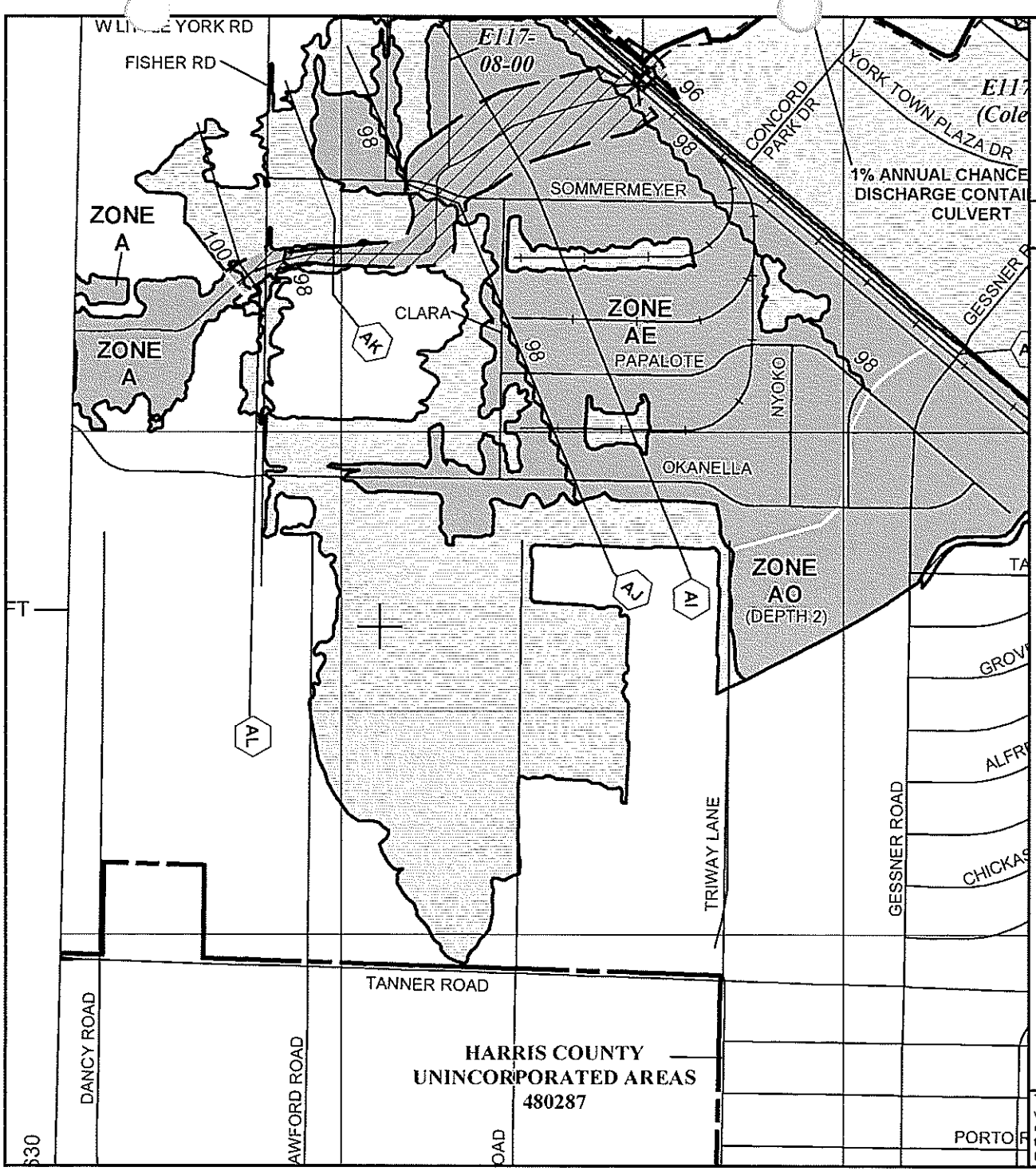
Appendix 1

Effective FEMA FIRMette 48201C0635M

Effective LOMA Case No. 20-06-2644A Determination Letter



MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

NFIP NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0635M

FIRM

FLOOD INSURANCE RATE MAP

HARRIS COUNTY, TEXAS AND INCORPORATED AREAS

PANEL 635 OF 1150

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
HARRIS COUNTY UNINCORPORATED AREAS	480287	0635	M
HOUSTON, CITY OF	480296	0635	M
JERSEY VILLAGE, CITY OF	480300	0635	M

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
48201C0635M

MAP REVISED
JUNE 9, 2014

Federal Emergency Management Agency

Federal Emergency Management Agency

Washington, D.C. 20472

LETTER OF MAP AMENDMENT
DETERMINATION DOCUMENT (REMOVAL)

COMMUNITY AND MAP PANEL INFORMATION		LEGAL PROPERTY DESCRIPTION
COMMUNITY	CITY OF HOUSTON, HARRIS COUNTY, TEXAS	Lot 18, and a portion of Lot 17, Block 4, Independence Gardens, as described in the General Warranty Deed recorded as Document No. 20110197277, in the Office of the County Clerk, Harris County, Texas The portion of property is more particularly described by the following metes and bounds:
	COMMUNITY NO.: 480296	
AFFECTED MAP PANEL	NUMBER: 48201C0635M	
	DATE: 6/9/2014	
FLOODING SOURCE: E117-00-00 (COLE CREEK)		APPROXIMATE LATITUDE & LONGITUDE OF PROPERTY:29.857915, -95.554676 SOURCE OF LAT & LONG: LOMA LOGIC DATUM: NAD 83

DETERMINATION

LOT	BLOCK/ SECTION	SUBDIVISION	STREET	OUTCOME WHAT IS REMOVED FROM THE SFHA	FLOOD ZONE	1% ANNUAL CHANCE FLOOD ELEVATION (NAVD 88)	LOWEST ADJACENT GRADE ELEVATION (NAVD 88)	LOWEST LOT ELEVATION (NAVD 88)
17	4	Independence Gardens	--	Portion of Property	X (shaded)	--	--	98.1 feet

Special Flood Hazard Area (SFHA) - The SFHA is an area that would be inundated by the flood having a 1-percent chance of being equaled or exceeded in any given year (base flood).

ADDITIONAL CONSIDERATIONS (Please refer to the appropriate section on Attachment 1 for the additional considerations listed below.)

LEGAL PROPERTY DESCRIPTION
PORTIONS REMAIN IN THE SFHA
STATE LOCAL CONSIDERATIONS

This document provides the Federal Emergency Management Agency's determination regarding a request for a Letter of Map Amendment for the property described above. Using the information submitted and the effective National Flood Insurance Program (NFIP) map, we have determined that the described portion(s) of the property(ies) is/are not located in the SFHA, an area inundated by the flood having a 1-percent chance of being equaled or exceeded in any given year (base flood). This document amends the effective NFIP map to remove the subject property from the SFHA located on the effective NFIP map; therefore, the Federal mandatory flood insurance requirement does not apply. However, the lender has the option to continue the flood insurance requirement to protect its financial risk on the loan. A Preferred Risk Policy (PRP) is available for buildings located outside the SFHA. Information about the PRP and how one can apply is enclosed.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Information eXchange (FMIX) toll free at (877) 336-2627 (877-FEMA MAP) or by letter addressed to the Federal Emergency Management Agency, Engineering Library, 3601 Eisenhower Ave Ste 500, Alexandria, VA 22304-6426.

Luis V. Rodriguez, P.E., Director
Engineering and Modeling Division
Federal Insurance and Mitigation Administration

Federal Emergency Management Agency
Washington, D.C. 20472

LETTER OF MAP AMENDMENT
DETERMINATION DOCUMENT (REMOVAL)

ATTACHMENT 1 (ADDITIONAL CONSIDERATIONS)

LEGAL PROPERTY DESCRIPTION (CONTINUED)

COMMENCING at the northeast corner of said 8.207 acre tract; THENCE, South 87°46'28" West, with the northerly line of said 8.207 acres, a distance of 420.49 feet to the POINT OF BEGINNING of the herein described tract; THENCE, over and across said 8.207 acres the following 3 calls; 1. South 00 Degrees 17 Minutes 19 Seconds East, a distance of 50.07 feet; 2. South 89 Degrees 53 Minutes 45 Seconds West, a distance of 49.64 feet; 3. North 00 Degrees 06 Minutes 55 Seconds West, a distance of 48.24 feet to a point in the northerly line said 8.207 acres; THENCE, North 87 Degrees 46 Minutes 28 Seconds East, with the northerly line of said 8.207 acres, a distance of 49.52 feet to the POINT OF BEGINNING

Please note: All Elevations in this Determination Document are referenced to the North American Vertical Datum of 1988 (2001 Adjustment).

PORTIONS OF THE PROPERTY REMAIN IN THE SFHA (This Additional Consideration applies to the preceding 1 Property.)

Portions of this property, but not the subject of the Determination/Comment document, may remain in the Special Flood Hazard Area. Therefore, any future construction or substantial improvement on the property remains subject to Federal, State/Commonwealth, and local regulations for floodplain management.

STATE AND LOCAL CONSIDERATIONS (This Additional Consideration applies to all properties in the LOMA DETERMINATION DOCUMENT (REMOVAL))

Please note that this document does not override or supersede any State or local procedural or substantive provisions which may apply to floodplain management requirements associated with amendments to State or local floodplain zoning ordinances, maps, or State or local procedures adopted under the National Flood Insurance Program.

This attachment provides additional information regarding this request. If you have any questions about this attachment, please contact the FEMA Map Information eXchange (FMIX) toll free at (877) 336-2627 (877-FEMA MAP) or by letter addressed to the Federal Emergency Management Agency, Engineering Library, 3601 Eisenhower Ave Ste 500, Alexandria, VA 22304-6426.

Luis V. Rodriguez, P.E., Director
Engineering and Modeling Division
Federal Insurance and Mitigation Administration

Appendix 2

1D/2D Floodplain Analysis

APPENDIX 2 – 1D-2D FLOODPLAIN ANALYSIS

PURPOSE

This detailed floodplain analysis is intended to serve as additional information to the Drainage and Detention Analysis for the Hawthorn Park Landfill. The basis of the drainage analysis is Method 2 for moderate drainage areas, utilizing the Small Watershed Hydrograph Method to determine the required size of the onsite detention basin. This detailed 1D-2D floodplain analysis is provided as supplemental information regarding the state of the existing flood hazards near the project site based on Atlas 14 rainfall data.

BACKGROUND

Effective Flood Insurance Rate Map (FIRM) Panel No. 48201C0635M, revised June 9, 2014, shows the northern portion of the Hawthorn Park Landfill (Hawthorn) detention basin and areas north of the tract to be in an overflow zone (Zone AO). The AO zone stems from the Cole Creek (E117-00-00) floodplain, and extends south to E117-07-00, which is not studied in detail. See Exhibit 4 – Effective FEMA Floodplain.

USA Waste of Texas Landfills, Inc. is aware that the Harris County Flood Control District (HCFCD) is in the process of revising floodplain modeling and mapping for a large portion of Harris County. It is our understanding that the re-mapping will account for increased Atlas 14 rainfall data, and will use unsteady 1D/2D modeling in HEC-RAS to integrate the various reaches into a single HEC-RAS model for each watershed.

Using a similar modeling approach, Jones|Carter has performed 1D/2D modeling of the streams near Hawthorn within the White Oak Bayou watershed to better understand the potential future regulatory floodplain near the site. The main streams included in this analysis are E117-07-00 and Cole Creek (E117-00-00). A portion of White Oak Bayou (E100-00-00) was also modeled completely in 2D.

HYDROLOGY

Most of the area of this detailed floodplain analysis resides within effective catchment E117A of the effective HEC-HMS model for the White Oak Bayou watershed. See Exhibit A2-1 – Effective White Oak Bayou Catchments. The E117A catchment and part of E117B were subdivided into 11 smaller drainage areas to perform updated hydrology calculations and to apply flows at appropriate locations in the stream network. The subdivided drainage areas are shown in Exhibit A2-2 – Drainage Area Map.

The subdivided drainage areas were analyzed for the 100-year and 500-year Atlas 14 storm events. For hydrology calculations, the proposed drainage areas use the Simple Canopy method, the Green and Ampt loss method, the HCFCD Site Runoff Curves to calculate peak flows, and the modified Clark Unit Hydrograph transform method to develop hydrographs. Each drainage area uses the Green and Ampt loss values and Simple Canopy values as found in the effective HEC-HMS model for White Oak Bayou.

A land-use dataset was developed using the Harris County parcels shapefile. The dataset classified each parcel's land use based on aerial imagery, taken in February 2019. Each land use classification was also given an impervious cover percentage. Using this dataset, each drainage area had a composite impervious cover calculated. See Table A2-1 – Impervious Cover Calculations.

Using the composite impervious cover calculations, peak flowrates were calculated for each drainage area using the HCFCD Site Runoff Curves, as described in section 3.3 of the HCFCD *Policy, Criteria, and Procedure Manual*. Peak flow calculations for the 100-year and 500-year storm events are found in Table A2-2 – Site Runoff Curve Calculations.

A time of concentration was calculated for each drainage area, using the methodology described *in Technical Release 55* (TR-55). Each drainage area calculates travel time for sheet flow, shallow concentrated flow, channel flow, and storm sewer flow. The sum of the travel times for each drainage area is the time of concentration that will be used in the Clark Unit Hydrograph transform method in HEC-HMS. See Table A2-3 – Time of Concentration Calculations.

The area (square miles), impervious cover (%), and time of concentration (hours) were entered for each subbasin into a HEC-HMS model to develop hydrographs. The model was run with arbitrary values set as the "R" storage coefficient. The storage coefficient was then iterated for each subbasin so that each subbasin produces a peak flow matching (within 1 cfs) the peak flow rate calculated using the Site Runoff Curves. This method is described in Section 3.7 of the HCFCD's PCPM. The resulting calibrated hydrographs were used as input data for the HEC-RAS model, discussed in the hydraulics portions of this appendix. A summary of the HEC-HMS inputs is included with the Site Runoff Curve calculations shown in Table A2-2.

HYDRAULICS

The floodplain near the Hawthorn Park Landfill was hydraulically analyzed using HEC-RAS (version 5.0.7). The effective model for Cole Creek (HCFCD Unit No. E117-00-00) was downloaded from the Harris County M3 system

in June 2019. Jones|Carter (JC) utilized the HCFCD's *HEC-RAS Unsteady Modeling Guidelines* and *Two-Dimensional Modeling Guidelines* for direction during the model set-up process. 2018 LiDAR for Harris County was downloaded from the Texas National Resources Information System (TNRIS). The elevation data was used for 2D cells and lateral structures, discussed in more detail later in this section.

For this analysis, the model was truncated at RS 17828, and all cross sections downstream were deleted from the model geometry. Then, the remaining effective cross sections had their left and right overbanks deleted from the cross-section data to leave only a main channel to be represented by the 1D geometry.

HCFCD Unit No. E117-07-00 does not have an effective HEC-RAS model, therefore JC acquired topographic survey data of the channel from the Hawthorn detention pond to the junction with Cole Creek (E117-00-00). Using the survey data, a new reach with 48 new cross sections (RS 31146 to RS 25612) were created for the 1D geometry on E117-07-00. The confluence of these streams was modeled via a storage area and lateral structure, as described in Section 4.7 of the HCFCD's *HEC-RAS Unsteady Modeling Guidelines*. Per the guidelines, the lateral structure weir coefficient at this confluence is set to a value of 5.0.

The LiDAR data was loaded into HEC-RAS to create a terrain (.hdf) file to be used in the model. Additionally, a land cover dataset for the project area was created for the project area, classifying land use per HCFCD's recommended 2D Manning's "n" values, as shown on Table 3.3.1 of the HCFCD *Two-Dimensional Modeling Guidelines*. This land cover dataset was loaded into the HEC-RAS model to determine the roughness of the 2D cells.

Three 2D areas (E117_North; E117_South; E117_Mid) were drawn in the overbank areas adjacent to the 1D reaches. The 2D areas are connected to the 1D reaches via lateral structures that allowing flow to spill out of the main channel into the overbanks and vice versa. The lateral structures are modeled as weirs, based on the terrain data that was created from 2018 TNRIS LiDAR for Harris County. The weir coefficient was set to a value of 0.5, representing water leaving a channel with a slight high bank, and not a true broad crested weir.

The Hawthorn detention basin was also reflected in the HEC-RAS Geometry, via a storage area (SA: "WMPond"). The storage area uses the underlying LiDAR data to calculate the storage in the existing detention basin. The existing detention outfall (10'x3' RCB) was modeled via a storage area connector in HEC-RAS, which required a second storage area downstream of our detention basin. This downstream storage area has minimal storage, and connects directly with the E117-07-00 1D network. Other areas of the maintenance berm around the detention basin were connected directly to the 2D overbank areas via storage area connectors.

The effective mapping shows a large overflow area from White Oak Bayou (HCFCD Unit No. E100-00-00) flowing south to E117-00-00. Rather than importing the effective White Oak Bayou 1D model data, the northern 2D mesh was extended north to include White Oak Bayou. Flows were put directly on the 2D mesh in the White Oak Bayou channel. The amount and location of overflow leaving White Oak Bayou and traveling south towards Cole Creek is based on the LiDAR elevation data that makes up the 2D cell data. See Exhibit A2-3 – Hydraulic Workmap.

The hydrographs developed in HEC-HMS were then assigned at various points in the 1D network as unsteady flow data. Table A2-4 shows a summary table of the HEC-HMS hydrograph inputs into the HEC-RAS geometry. The HEC-RAS model was run for the 100-year and 500-year Atlas 14 storm events to determine the existing conditions floodplain.

RESULTS

The resulting maximum ponding in the overbanks shown in the HEC-RAS model was exported for the 100-year and 500-year Atlas 14 storm events. These floodplains are shown on Exhibit A2-4 – 1D-2D Floodplain Results. The 100-year flood depths are shown in Exhibit A2-5 – 100-Year Floodplain Depths. These results show the existing flooding conditions near the Hawthorn Park Landfill based on Atlas 14 Rainfall criteria, and gives an approximation of expected future floodplain mapping.

The results of the modeling and mapping show large floodplain areas on either side of the E117-07-00 channel in the existing condition under Atlas 14 conditions. This is expanded floodplain from the effective FEMA FIRM (Panel No. 48201C0635M), as the E117-07-00 channel is not studied in the effective FIS. Much of the area mapped as Zone AO in the effective FIRM appears to be localized flooding from E117-07-00, although there is some overflow from Cole Creek that travels south towards E117-07-00.

Based on this analysis, none of the 100-year floodplain from Cole Creek (E117-00-00) reaches the north boundary of the Hawthorn Park Landfill, contrary to the effective mapping. Additionally, the large area of effective 500-year floodplain shown in the FEMA FIRM is greatly reduced based on the 1D-2D analysis. This is largely because the effective mapping was performed using 2001 Harris County LiDAR, prior to the filling of excavated areas which were present at that time. This area has since been filled, and would not be impacted by the riverine flooding studied in this analysis.

Hawthorn Park Drainage and Detention Analysis

Appendix 2 - Table 1 - Impervious Cover Calculation

Name	Impervious %	CC01	CC02	CC03	CC04	CC05	CC06	SF01	SF02	SF03_East	SF03_West	South_1	WM Pond
Area (acres)		419.95	400.69	133.30	363.74	334.79	758.61	212.85	168.78	126.32	206.61	416.25	253.38
Area (sqmi)		0.6562	0.6261	0.2083	0.5683	0.5231	1.1853	0.3326	0.2637	0.1974	0.3228	0.6504	0.3959
High Intensity	85%	207.8	167.2	49.2	180.4	256.9	578.7	134.2	73.4	30.3	69.0	240.3	19.0
Medium Intensity	65%	49.0	38.3	28.1	18.3	0.0	11.1	5.0	30.2	26.6	24.8	37.7	176.0
Low Intensity	40%	20.5	27.1	9.7	32.8	4.1	1.0	3.9	9.1	9.0	17.6	22.9	0.0
Water/Detention	100%	0.8	1.7	1.3	4.6	24.1	27.6	7.5	7.8	4.5	0.0	9.7	32.9
Pasture/Grassland	0%	33.4	49.4	7.9	41.3	7.8	51.4	18.2	13.2	0.0	64.1	18.3	0.0
Forest/Shrubs	0%	30.6	61.7	9.2	4.7	0.0	1.9	8.7	5.1	29.5	0.0	2.2	19.0
Road/ROW	75%	77.8	55.3	28.0	81.6	41.8	87.0	35.4	30.0	26.5	31.2	85.3	6.4
Impervious Cover (%)		**65.7%**	**55.2%**	**64.7%**	**67.1%**	**82.3%**	**78.1%**	**71.8%**	**68.7%**	**56.2%**	**50.9%**	**74.8%**	**66.4%**

Hawthorn Park Drainage and Detention Analysis

Appendix 2 - Table 2 - Site Runoff Curve Calculations

Revised "b" values for SRC

100-year		500-year	
0%	4.6	0%	6.8
10%	5.5	10%	8.1
20%	6.5	20%	9.5
30%	7.7	30%	11
40%	8.9	40%	12.6
85%	10.9	85%	15.1

Site Runoff Curve Calculations

DA Name	CC01	CC02	CC03	CC04	CC05	CC06	SF01	SF02	SF03_East	SF03_West	South_1	WM Pond
Area	419.95	400.69	133.30	363.74	334.79	758.61	212.85	168.78	126.32	206.61	416.25	253.38
%I	**65.7%**	**55.2%**	**64.7%**	**67.1%**	**82.3%**	**78.1%**	**71.8%**	**68.7%**	**56.2%**	**50.9%**	**74.8%**	**66.4%**
b_100	10.04	9.57	10.00	10.11	10.78	10.59	10.31	10.17	9.62	9.38	10.45	10.07
b_500	14.03	13.44	13.97	14.11	14.95	14.72	14.37	14.19	13.50	13.21	14.54	14.07
Q_100yr	1158	1064	468	1041	1040	1944	697	573	431	620	1196	781
Q_500yr	1617	1494	654	1453	1442	2701	971	799	605	872	1664	1090
TC	**1.77**	**1.11**	**2.23**	**0.94**	**1.74**	**0.98**	**1.94**	**0.70**	**0.63**	**2.17**	**2.27**	**2.74**
R_100yr	1.568	1.862	0.476	1.640	1.149	2.036	0.878	1.198	1.195	1.074	1.223	0.693
R_500yr	1.600	1.847	0.427	1.619	1.168	2.061	0.864	1.141	1.122	1.067	1.277	0.727

Appendix 2 - Table 3
Hawthorn Park Drainage & Detention Analysis
Formulas for Time of Concentration Calculation

November 2019

Equations:

Sheet Flow:	$T = (0.42 * (nL)^{0.8}) / (60 * P_2^{0.5} * S^{0.4})$
	T = travel time (hrs)
	n = Manning's roughness coefficient
	L = flow length (ft)
	P_2 = 2-year, 24-hour rainfall (in)
	S = land slope (ft/ft)
Sheet Flow Length:	$L = 100 * S^{.5} / n$
	L = flow length (ft)
	S = land slope (ft/ft)
	n = Manning's roughness coefficient
Shallow Concentrated Flow:	$T = (L / V) * (1 / 3600)$
	T = travel time (hrs)
	L = flow length (ft)
	$V_{unpaved} = 16.1345 * S^{0.5}$ (ft/s)
	$V_{paved} = 20.3282 * S^{0.5}$ (ft/s)
Lake Flow:	$V_w = (g * D_m)^{0.5}$
	V_w = wave velocity across the water (ft/s)
	g = gravity (32.2 ft/s^2)
	D_m = mean depth of lake (ft)
Manning's Equation:	$V = C_m / n * A * R^{2/3} * S_o^{1/2}$
	Cm = 1.486
	A = cross sectional area
	R = hydraulic radius = A / P_{wet}
	P_{wet} = wetted perimeter
	So = longitudinal slope
	n = Manning's roughness coefficient

References:

1. NCTCOG (2010). *iSWM Technical Manual: Hydrology.*
2. USDA, NRCS (1986). *Technical Release 55.*
3. USDA, NRCS (2010). *National Engineering Handbook.*

Hawthorn Park - Floodplain Analysis
Appendix 2 - Table 3
Time of Concentration Calculation

October 2019

CC01		***Pre-Project***
Sheet Flow	n	0.400
	L (ft)	20
	P_2 (in)	5.11
	S (ft/ft)	0.0070
	T (hrs)	0.12
Shallow Concentrated Flow	L (ft)	3355
	S (ft/ft)	0.0020
	V (ft/s)	0.72
	T (hrs)	1.29
		Unpaved
Channel Flow	L (ft)	4280
	S (ft/ft)	0.0024
	V (ft/s)	3.3
	T (hrs)	0.36
		Channel
Time of Conc.	T (hrs)	1.77
Time of Conc.	T (min)	106
Flowpath Length	L (ft)	7655

Hawthorn Park - Floodplain Analysis
Appendix 2 - Table 3
Time of Concentration Calculation

October 2019

CC02		***Pre-Project***
Sheet Flow	n	0.011
	L (ft)	100
	P_2 (in)	5.11
	S (ft/ft)	0.0100
	T (hrs)	0.02
Shallow Concentrated Flow	L (ft)	218
	S (ft/ft)	0.0025
	V (ft/s)	1.02
	T (hrs)	0.06
		Paved
Shallow Concentrated Flow	L (ft)	1385
	S (ft/ft)	0.0026
	V (ft/s)	0.82
	T (hrs)	0.47
		Unpaved
Lake Flow	L (ft)	2385
	Dm (ft)	1.0
	V (ft/s)	5.7
	T (hrs)	0.12
		Lake Flow
Storm Sewer	L (ft)	2953
	S (ft/ft)	0.0010
	V (ft/s)	6.0
	T (hrs)	0.14
		Storm Sewer
Channel Flow	L (ft)	3565
	S (ft/ft)	0.0040
	V (ft/s)	3.2
	T (hrs)	0.31
		Channel
Time of Conc.	T (hrs)	1.11
Time of Conc.	T (min)	67
Flowpath Length	L (ft)	10605

Hawthorn Park - Floodplain Analysis
Appendix 2 - Table 3
Time of Concentration Calculation

October 2019

CC03		***Pre-Project***
Sheet Flow	n	0.011
	L (ft)	100
	P_2 (in)	5.11
	S (ft/ft)	0.0050
	T (hrs)	0.03
Shallow Concentrated Flow	L (ft)	205
	S (ft/ft)	0.0030
	V (ft/s)	1.11
	T (hrs)	0.05
		Paved
Shallow Concentrated Flow	L (ft)	5570
	S (ft/ft)	0.0020
	V (ft/s)	0.72
	T (hrs)	2.14
		Unpaved
Channel Flow	L (ft)	85
	S (ft/ft)	0.0043
	V (ft/s)	2.8
	T (hrs)	0.01
		Channel
Time of Conc.	T (hrs)	2.23
Time of Conc.	T (min)	134
Flowpath Length	L (ft)	5960

Hawthorn Park - Floodplain Analysis
Appendix 2 - Table 3
Time of Concentration Calculation

October 2019

CC04		***Pre-Project***
Sheet Flow	n	0.011
	L (ft)	100
	P_2 (in)	5.11
	S (ft/ft)	0.0100
	T (hrs)	0.02
Shallow Concentrated Flow	L (ft)	1315
	S (ft/ft)	0.0020
	V (ft/s)	0.91
	T (hrs)	0.40
		Paved
Storm Sewer	L (ft)	2630
	S (ft/ft)	0.0010
	V (ft/s)	6.0
	T (hrs)	0.12
		Storm Sewer
Channel Flow	L (ft)	2155
	S (ft/ft)	0.0010
	V (ft/s)	1.5
	T (hrs)	0.40
		Channel
Time of Conc.	T (hrs)	0.94
Time of Conc.	T (min)	57
Flowpath Length	L (ft)	6200

Hawthorn Park - Floodplain Analysis
Appendix 2 - Table 3
Time of Concentration Calculation

October 2019

CC05		***Pre-Project***
Sheet Flow	n	0.011
	L (ft)	100
	P_2 (in)	5.11
	S (ft/ft)	0.0040
	T (hrs)	0.03
Shallow Concentrated Flow	L (ft)	3325
	S (ft/ft)	0.0017
	V (ft/s)	0.67
	T (hrs)	1.39
		Unpaved
Storm Sewer	L (ft)	745
	S (ft/ft)	0.0010
	V (ft/s)	6.0
	T (hrs)	0.03
		Storm Sewer
Channel Flow	L (ft)	1785
	S (ft/ft)	0.0020
	V (ft/s)	1.8
	T (hrs)	0.28
		Channel
Time of Conc.	T (hrs)	1.74
Time of Conc.	T (min)	104
Flowpath Length	L (ft)	5955

Hawthorn Park - Floodplain Analysis
Appendix 2 - Table 3
Time of Concentration Calculation

October 2019

CC06		***Pre-Project***
Sheet Flow	n	0.011
	L (ft)	100
	P_2 (in)	5.11
	S (ft/ft)	0.0150
	T (hrs)	0.02
Shallow Concentrated Flow	L (ft)	305
	S (ft/ft)	0.0025
	V (ft/s)	1.02
	T (hrs)	0.08
		Paved
Storm Sewer	L (ft)	3295
	S (ft/ft)	0.0010
	V (ft/s)	6.0
	T (hrs)	0.15
		Storm Sewer
Lake Flow	L (ft)	3255
	Dm (ft)	3.0
	V (ft/s)	9.8
	T (hrs)	0.09
		Lake Flow
Channel Flow	L (ft)	4350
	S (ft/ft)	0.0020
	V (ft/s)	1.9
	T (hrs)	0.64
		Channel
Time of Conc.	T (hrs)	0.98
Time of Conc.	T (min)	59
Flowpath Length	L (ft)	11305

Hawthorn Park - Floodplain Analysis
Appendix 2 - Table 3
Time of Concentration Calculation

October 2019

SF01		***Pre-Project***
Sheet Flow	n	0.150
	L (ft)	70
	P_2 (in)	5.11
	S (ft/ft)	0.0100
	T (hrs)	0.13
Shallow Concentrated Flow	L (ft)	3520
	S (ft/ft)	0.0015
	V (ft/s)	0.62
	T (hrs)	1.56
		Unpaved
Channel Flow	L (ft)	2025
	S (ft/ft)	0.0020
	V (ft/s)	2.3
	T (hrs)	0.25
		Channel
Time of Conc.	T (hrs)	1.94
Time of Conc.	T (min)	117
Flowpath Length	L (ft)	5615

Hawthorn Park - Floodplain Analysis
Appendix 2 - Table 3
Time of Concentration Calculation

October 2019

SF02		***Pre-Project***
Sheet Flow	n	0.410
	L (ft)	30
	P_2 (in)	5.11
	S (ft/ft)	0.0170
	T (hrs)	0.12
Shallow Concentrated Flow	L (ft)	750
	S (ft/ft)	0.0010
	V (ft/s)	0.51
	T (hrs)	0.41
		Unpaved
Storm Sewer	L (ft)	3215
	S (ft/ft)	0.0010
	V (ft/s)	6.0
	T (hrs)	0.15
		Storm Sewer
Channel Flow	L (ft)	130
	S (ft/ft)	0.0020
	V (ft/s)	1.4
	T (hrs)	0.03
		Channel
Time of Conc.	T (hrs)	0.70
Time of Conc.	T (min)	42
Flowpath Length	L (ft)	4125

Hawthorn Park - Floodplain Analysis
Appendix 2 - Table 3
Time of Concentration Calculation

October 2019

SF03_West		***Pre-Project***
Sheet Flow	n	0.150
	L (ft)	50
	P_2 (in)	5.11
	S (ft/ft)	0.0060
	T (hrs)	0.12
Shallow Concentrated Flow	L (ft)	1250
	S (ft/ft)	0.0018
	V (ft/s)	0.68
	T (hrs)	0.51
		Unpaved
Storm Sewer	L (ft)	2340
	S (ft/ft)	0.0010
	V (ft/s)	6.0
	T (hrs)	0.11
		Storm Sewer
Channel Flow	L (ft)	130
	S (ft/ft)	0.0050
	V (ft/s)	3.5
	T (hrs)	0.01
		Channel
Time of Conc.	T (hrs)	0.63
Time of Conc.	T (min)	38
Flowpath Length	L (ft)	3770

Hawthorn Park - Floodplain Analysis
Appendix 2 - Table 3
Time of Concentration Calculation

October 2019

SF03_West		***Pre-Project***
Sheet Flow	n	0.150
	L (ft)	70
	P_2 (in)	5.11
	S (ft/ft)	0.0100
	T (hrs)	0.13
Shallow Concentrated Flow	L (ft)	5930
	S (ft/ft)	0.0025
	V (ft/s)	0.81
	T (hrs)	2.04
		Unpaved
Time of Conc.	T (hrs)	2.17
Time of Conc.	T (min)	130
Flowpath Length	L (ft)	6000

Hawthorn Park - Floodplain Analysis
Appendix 2 - Table 3
Time of Concentration Calculation

October 2019

South_1		***Pre-Project***
Sheet Flow	n	0.150
	L (ft)	20
	P_2 (in)	5.11
	S (ft/ft)	0.0010
	T (hrs)	0.12
Shallow Concentrated Flow	L (ft)	6380
	S (ft/ft)	0.0030
	V (ft/s)	0.88
	T (hrs)	2.01
		Unpaved
Storm Sewer	L (ft)	3110
	S (ft/ft)	0.0010
	V (ft/s)	6.0
	T (hrs)	0.14
		Storm Sewer
Time of Conc.	T (hrs)	2.27
Time of Conc.	T (min)	136
Flowpath Length	L (ft)	9510

Hawthorn Park - Floodplain Analysis
Appendix 2 - Table 3
Time of Concentration Calculation

October 2019

WMPond		***Pre-Project***
Sheet Flow	n	0.011
	L (ft)	100
	P_2 (in)	5.11
	S (ft/ft)	0.0100
	T (hrs)	0.02
Shallow Concentrated Flow	L (ft)	390
	S (ft/ft)	0.0500
	V (ft/s)	3.61
	T (hrs)	0.03
		Unpaved
Shallow Concentrated Flow	L (ft)	4195
	S (ft/ft)	0.0030
	V (ft/s)	0.88
	T (hrs)	1.32
		Unpaved
Channel Flow	L (ft)	7390
	S (ft/ft)	0.0010
	V (ft/s)	1.5
	T (hrs)	1.37
		Channel
Time of Conc.	T (hrs)	2.74
Time of Conc.	T (min)	164
Flowpath Length	L (ft)	12075

Hawthorn Park Drainage and Detention Analysis
Appendix 2 - Table 4 - Summary of HEC-RAS Flow Inputs

HMS Element Name	Area (Ac.)	RAS Input Location	Reach
WM Pond	253.4	SA: WM Pond	Storage Area
CC06	758.6	36002	Cole Creek
CC05	334.8	33907 to 32734	Cole Creek
CC04	363.7	28684	Cole Creek
CC03	133.3	27267	Cole Creek
South_1	416.3	22615	Cole Creek
CC02	400.7	22223 to 19566	Cole Creek
CC01	420.0	18678	Cole Creek
SF03	332.9	SA: SF_US	Storage Area
SF02	168.8	29807	South Fork
SF01	212.9	27326	South Fork
2D Area Inflows			
E1000000_0905_J	N/A	WhiteOak_Inflow	2D Area
E100G1	N/A	E100G1_Inflow	2D Area
E124A	N/A	E124A_Inflow	2D Area