Memo

To:	Greg Toohey		
From:	Brett Sachtleben	**Email:**	greg.toohey@aecom.com
Phone:	301-820-3566	**Date:**	March 15, 2016
Ref:	E121-00-00 LOMR	**cc:**	
Subject:	E121-00-00 LOMR Hydrology		

This memorandum is intended to further explain Atkins' hydrologic analysis for the LOMR Application for E121-00-00. It should be noted that E121-00-00 (Vogel Creek) is a tributary to E100-00-00 (White Oak Bayou) and, as such, is included in the overall E100-00-00 hydrologic model. However, the limits of the LOMR only cover E121-00-00. As a result, only the hydrology of E121-00-00 will be discussed.

Please note that the hydrologic modeling (effective and LOMR) follows the methodology of the Harris County Flood Control District (HCFCD). HCFCD's "Hydrology & Hydraulics Guidance Manual (December 2009)" may be found online at https://www.hcfcd.org/technical-area/technical-document-library/.

1. Duplicate Effective Condition

The duplicate effective hydrologic model for the White Oak Bayou watershed was taken from the "*Corrected Effective LOMR Application for HCFCD Channel E100-00-00 (PBS&J-September 2010)".* This model was effective as of June 2014. The model contains two subbasins and one routing reach to reflect the hydrology of E121-00-00. Exhibit 1.1 displays the effective subbasins and nodes for the hydrologic model. The duplicate effective watershed parameters for E121-00-00 are documented in Table 1.1. Effective Modified Puls routing parameters for the single E121-00-00 routing reach are documented in Table 1.2. Table 1.3 documents the effective 10%, 2%, 1%, and 0.2% event node peak flows for E121-00-00. Note that that duplicate effective model uses HEC-HMS version 3.3.

2. Corrected Effective Condition

The duplicate effective hydrologic model was updated to create the corrected effective hydrologic model. The update did not include subbasin boundary modifications but only modifications of subbasin and routing parameters. Table 2.1 shows the subbasin parameters of the corrected effective hydrologic model. Because the subbasin boundaries were not modified for the E121-00-00 watershed the following parameters were not updated: drainage area, watershed length, length to centroid, watershed slope, development percentage, ponding percentage, or development affected by detention percentage. However, the parameters affected by hydraulic conditions were updated: channel slope, channel improvement percentage and channel conveyance percentage. The parameters that are highlighted (orange) in Table 2.1 were recalculated from the duplicate effective condition, The Channel Slope (S) and Channel Conveyance Percentage (DCC) were calculated using the corrected effective hydraulic model for E121-00-00 following the HCFCD hydrologic methodology. Corrected effective Modified Puls routing parameters for the single E121-00-00 routing reach were updated using the corrected effective hydraulic model for E121-00-00 (see Table 2.2).

Table 2.3 documents the corrected effective 10%, 2%, 1%, and 0.2% event node peak flows within the watershed. The corrected effective condition has 10% and 1% event peak flows at node E121a that are 20.9% and 19.4% lower than the effective condition, respectively. At the mouth of E121-00-00 10% and 1% event peak flows are 14.1% higher and 4.4% lower, respectively, than the effective condition. Note that the corrected effective condition uses HEC-HMS version 3.5.

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3. LOMR Condition

The corrected effective hydrologic model was updated to create the LOMR hydrologic model that reflects the E121-00-00 channel improvements. LOMR condition maintains the same subbasin boundaries as the corrected effective condition but includes updates Modified Puls routing parameters and subbasin parameters to reflect the E121-00-00 channel improvements. Table 3.1 shows the subbasin parameters of the LOMR condition hydrologic model. Because the E121-00-00 channel improvements lie within subbasin E121B, the Channel Slope (S), Channel Improvement Percentage (DCI) and Channel Conveyance Percentage (DCC) for only subbasin E121B were changed from the corrected effective condition. These parameters were calculated using the LOMR condition hydraulic model. LOMR condition Modified Puls routing parameters for the single E121-00-00 routing reach was also updated, as seen in Table 3.2.

Table 3.3 compares the LOMR and corrected effective 10%, 2%, 1%, and 0.2% event node peak flows within the E121-00-00 watershed. The 10% and 1% event peak flows at the mouth of E121-00-00 are increased by 12.7% and 11.1%, respectively, compared to the corrected effective condition.

Please note that the components of this LOMR submittal were included in the approved White Oak Bayou CLOMR submittal (Case No. 14-06-3864R). The CLOMR modeling proves that the peak flow increases induced by the E121-00-00 LOMR channel improvements do not induce adverse impacts to White Oak Bayou (E100-00-00) when all of the planned and constructed improvements within the White Oak Bayou watershed are considered.

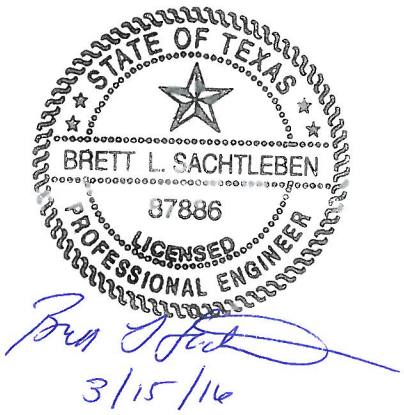

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TABLE 1.1
Clark Unit Hydrograph Parameters
E121-00-00 LOMR Application - Duplicate Effective Condition

Subbasin	Drainage Area (acres)	Drainage Area (mi^2) **DA**	Watershed Length (mi) **L**	Length to Centroid (mi) **Lca**	Channel Slope (ft/mi) **S**	Watershed Slope (ft/mi) **So**	D Value **D**	Development (Unadjusted) % **DLU**	Development (Minimum) % **DLU_Min**	Development (Adjusted) % **DLU_Det**	Channel Improvement % **DCI**	Channel Conveyance % **DCC**	Ponding % **DPP**	Development Affected by Detention % **DET**	Impervious %	Time of Concentration (HR.)	Storage Coefficient
E121A	2748.35	4.29	5.33	2.12	5.10	10.0	2.46	68.5	24.1	63.9	80.0	80	0	4.58	26.90	1.23	5.56
E121B	2398.20	3.75	3.49	1.67	5.50	10.0	2.46	66.6	29.0	64.4	100.0	70	0	2.18	21.90	0.77	4.78

TABLE 1.2
Storage-Outflow Relationship
E121-00-00 LOMR (Effective)

Time Step (min) = 15

Reach =	e1210000_0004_J					
HEC-HMS ANALYSIS POINT		HEC-RAS CROSS SECTION NO.		Volume	Q	Time Steps
UPSTREAM	DOWNSTREAM	UPSTREAM	DOWNSTREAM	(AC-FT)	(CFS)	(15-MIN)
e121a	e1210000_0012_J			0	0	
				34.90	200	
				58.70	400	
				97.40	800	
				196.10	1600	
				697.30	3142	
				1214.10	4118	
				1230.40	4573	
				1547.10	5500	
				2076.90	6900	
				3011.10	9266	
AVG. VEL. (ft/s)	-					10

Table 1.3
Node Peak Flows
Effective

HEC-HMS Node	C.E. HEC-HMS Node	Improvement Component	Location	*Effective*	
				10% Peak Flow (ft^3/s)	1% Peak Flow (ft^3/s)
				(1)	**(2)**
E121-00-00					
e121a		**5,200' U/S of C.I.**		1743	3030
e1210000_0012_J		**End CLOMR C.I.**		3059	4536

TABLE 2.1
Clark Unit Hydrograph Parameters
E121-00-00 LOMR Application - Corrected Effective Condition

Subbasin	Drainage Area (acres)	Drainage Area (mi^2) **DA**	Watershed Length (mi) **L**	Length to Centroid (mi) **Lca**	Channel Slope (ft/mi) **S**	Watershed Slope (ft/mi) **So**	D Value **D**	Development (Unadjusted) % **DLU**	Development (Minimum) % **DLU_Min**	Development (Adjusted) % **DLU_Det**	Channel Improvement % **DCI**	Channel Conveyance % **DCC**	Ponding % **DPP**	Development Affected by Detention % **DET**	Impervious %	Time of Concentration (HR.)	Storage Coefficient
E121A	2748.35	4.29	5.33	2.12	5.41	10.0	2.46	68.5	36.0	63.9	80	60	0	4.58	26.90	1.19	7.59
E121B	2398.20	3.75	3.49	1.67	4.61	10.0	2.46	66.6	29.0	64.4	80	70	0	2.18	21.90	1.00	4.89

- Values recalculated for the corrected effective condition.

TABLE 2.2
Storage-Outflow Relationship
E121-00-00 - Corrected Effective Condition
(E121-00-00)

Time Step (min) = 15

Reach =	e1210000_0012_R							
HEC-HMS ANALYSIS POINT		HEC-RAS CROSS SECTION NO.		Profile	Volume	Q	Time Steps	Average FW TRAVEL
UPSTREAM	DOWNSTREAM	UPSTREAM	DOWNSTREAM		(AC-FT)	(CFS)	(15-MIN)	TIME (HR)
e121a	e1210000_0012_J	14540	386	0%	0	0		
				5%	21.81	259	5	1.29
				10%	37.84	518	5	1.13
				20%	66.60	1036	4	0.95
				40%	131.12	2071	5	1.13
				60%	192.82	3107	6	1.58
				80%	248.77	4142	7	1.81
				100%	315.34	5178	8	1.93
				120%	447.44	6213	8	2.06
				180%	990.58	9320	10	2.45
AVG. VEL. (ft/s)	2.47					AVG	7	1.59

Table 2.3
Node Peak Flow Comparisons
Effective vs. Corrected Effective

HEC-HMS Node	C.E. HEC-HMS Node	Improvement Component	Location	*Effective*		*Corrected Effective*		*Comparison*	
				10% Peak Flow (ft^3/s)	1% Peak Flow (ft^3/s)	10% Peak Flow (ft^3/s)	1% Peak Flow (ft^3/s)	10% Peak Flow	1% Peak Flow
				(1)	**(2)**	**(3)**	**(4)**	**(1) - (3)**	**(2) - (4)**
E121-00-00									
e121a		**5,200' U/S of C.I.**		1743	3030	1378	2442	-20.9%	-19.4%
e1210000_0012_J		**End CLOMR C.I.**		3059	4536	2925	5177	-4.4%	14.1%

TABLE 3.1
Clark Unit Hydrograph Parameters
E121-00-00 LOMR Application - LOMR Condition

Subbasin	Drainage Area (acres)	Drainage Area (mi^2)	Watershed Length (mi)	Length to Centroid (mi)	Channel Slope (ft/mi)	Watershed Slope (ft/mi)	D Value	Development (Unadjusted) %	Development (Minimum) %	Development (Adjusted) %	Channel Improvement %	Channel Conveyance %	Ponding %	Development Affected by Detention %	Impervious %	Time of Concentration (HR.)	Storage Coefficient
E121A	2748.35	4.29	5.33	2.12	5.41	10.0	2.46	68.5	36.0	63.9	80	60	0	4.58	26.90	1.19	7.59
E121B	2398.20	3.75	3.49	1.67	7.16	10.0	2.46	66.6	17.6	64.4	100	100	0	2.18	21.90	0.67	2.91

- Values recalculated for the LOMR condition.

TABLE 3.2
Storage-Outflow Relationship
E121-00-00 LOMR (LOMR Condition)

Time Step (min) = 15

Reach =	e1210000_0012_R							
HEC-HMS ANALYSIS POINT		HEC-RAS CROSS SECTION NO.		Profile	Volume	Q	Time Steps	Average FW TRAVEL
UPSTREAM	DOWNSTREAM	UPSTREAM	DOWNSTREAM		(AC-FT)	(CFS)	(15-MIN)	TIME (HR)
e121a	e1210000_0012_J	14510	438	0%	0	0		
				5%	48.23	309	5	1.24
				10%	76.99	619	4	0.99
				20%	124.88	1238	3	0.81
				40%	204.77	2476	3	0.65
				60%	288.74	3713	2	0.59
				80%	369.80	4951	2	0.55
				100%	520.36	6189	2	0.62
				120%	834.60	7427	3	0.83
				180%	2045.41	11140	6	1.43
AVG. VEL. (ft/s)	4.56					AVG	4	0.86

Table 3.3
Node Peak Flow Comparisons
Corrected Effective vs. LOMR

HEC-HMS Node	C.E. HEC-HMS Node	Improvement Component	Location	*Corrected Effective*		*LOMR*		*Comparison*	
				10% Peak Flow (ft^3/s)	1% Peak Flow (ft^3/s)	10% Peak Flow (ft^3/s)	1% Peak Flow (ft^3/s)	10% Peak Flow	1% Peak Flow
				(1)	**(2)**	**(3)**	**(4)**	**(1) - (3)**	**(2) - (4)**
E121-00-00									
e121a		**5,200' U/S of C.I.**		1378	2442	1378	2442	-	-
e1210000_0012_J		**End CLOMR C.I.**		2925	5177	3250	5834	11.1%	12.7%

N

1 inch = 7,000 feet

E100A (3.11 mi²)
E132A (3.07 mi²)
E100B (1.75 mi²)
E100C (2.17 mi²)
E100D (2.89 mi²)
E100E (1.4 mi²)
E135A (2.41 mi²)
E141A (1.98 mi²)
E125A (2.4 mi²)
E141B (1.38 mi²)
E124A (1.56 mi²)
E122B (1.91 mi²)
E121A (4.29 mi²)
E121B (3.75 mi²)
E100H (2.59 mi²)
E100G (2.04 mi²)
E100G2 (0.93 mi²)
E117B (2.67 mi²)
E117A (5.23 mi²)
E117C (1.76 mi²)
E100I (2.97 mi²)
E100J (3.95 mi²)
E115A (5.84 mi²)
E115B (5.79 mi²)
E100K (3.43 mi²)
E100L (2.28 mi²)
E100M (3.37 mi²)
E100N (2.95 mi²)
E100O (1.83 mi²)
E100P (1.19 mi²)
E101A (3.45 mi²)
E101B (2.32 mi²)
E101C (4.31 mi²)
E101D (2.06 mi²)
E101E (2.59 mi²)
E101F (1.83 mi²)
E101G (2.65 mi²)
E101H (2.81 mi²)

e100a
e1000000_1210_J
e1000000_1203_J
e1000000_1167_J
e1000000_1105_J
e141a
e1000000_1056_J
e1000000_1045_J
e1000000_1056_J
e1000000_1045_J
e1000000_0941_J
e1000000_0936_J
e1000000_0876_J
e1000000_0872_W
e1000000_0773_J
e1000000_0771_J
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e1000000_0629_J
e1210000_0012_J
e1170000_0019_J
e1170000_0010_J
e1000000_0562_J
e1000000_0558_J
e1000000_0479_J
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e1000000_0357_J
e1000000_0282_J
e1000000_0168_J
e1000000_0002_J

E135-00-00
E200-00-00
E127-00-00
E141-00-00
E125-00-00
E124-00-00
E122-00-00
E121-00-00
E117-00-00
E115-04-00
E115-00-00
E116-05-00
E100-00-00
E101-00-00

Eldridge
FM 1960
Veterans Memorial
Montgomery
Little York
Gessner
Clay
Antoine
Hempstead Rd

249
290
45
59
610
10

Legend

- Streams
- HEC-HMS Nodes

HEC-HMS Subbasins

- White Oak Bayou Watershed
- E121-00-00 Watershed

0 2,500 5,000 10,000 Feet

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LOMR Application for E121-00-00

Exhibit 1.1
Subbasin Boundaries
(Effective)

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