



**PAVING AND DRAINAGE IMPROVEMENTS
NEED AREA N-2016T-0004:
SHEPHERD DRIVE AND DURHAM DRIVE
INTERSTATE 610 TO WASHINGTON AVENUE
FINAL PRE-ENGINEERING REPORT**

January 2018

Prepared by:





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SHEPHERD DRIVE AND DURHAM DRIVE FROM
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PRE-ENGINEERING REPORT**

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Candidate Project	N-2016T-0004: Shepherd Drive and Durham Drive
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1.0 SUMMARY OF CANDIDATE PROJECT

Name of the Project:	N-2016T-0004: Shepherd Drive and Durham Drive
Project Limits:	Interstate 610 to Washington Avenue
Description and Scope:	Reconstruct Shepherd Drive and Durham Drive between Interstate 610 and Washington Avenue with a 3-lane configuration with bicycle lanes and improved pedestrian facilities. Construct a minimum 6-foot sidewalk along both sides of each roadway. Upgrade storm sewers between Interstate 610 and Washington Avenue to meet current City of Houston requirements and some segments of Shepherd Drive with 10-foot shared pedestrian/bicycle off-street path. Install 10-inch, 15-inch, 30-inch, and 36-inch sanitary sewers to allow for abandonment of the existing Durham Lift Station and North Shepherd Lift Station.
Type:	Principal Thoroughfare (P-4-60 and P-4-70)
Council District:	Council District C
Key Map Number:	452 P, R, U, V, Y, and Z; 492 C, D, G, and H
Super Neighborhood:	Washington Avenue Coalition/ Memorial Park/ Greater Heights
Project Cost:	
South Project:	\$39,700,684 (Between North of W 11 th St and Washington Ave)
South Project Sub-Project 1	\$17,843,992 (Between Interstate 10 and Washington Ave)
South Project Sub-Project 2	\$21,545,050 (Between North of W 11 th St and Interstate 10)
North Project	\$59,199,302 (Between Interstate 610 and North of W 11 th St)
North Project Sub-Project 1	\$22,396,877 (Between South of W 18 th St and North of W 11 th St)
North Project Sub-Project 2	\$7,106,103 (Between Interstate 610 and South of W 18 th St)

2.0 SUMMARY OF THE NEED AREA

The project along Shepherd Drive and Durham Drive is located approximately five (5) miles northwest of downtown Houston in Harris County, Texas. The project is located in Council District C with limits from Washington Avenue to Interstate 610. The project includes approximately 16,450 feet along Shepherd Drive and 16,540 feet along Durham Drive. Shepherd Drive and Durham Drive are classified as Principal Thoroughfares with four (4) lanes in 60 feet of right-of-way (P-4-60) in the current Major Thoroughfare and Freeway Plan. The project area lies in the Super Neighborhood of Washington Avenue Coalition/Memorial Park/ Greater Heights. The relevant Key Map pages are 452 P, R, U, V, Y, and Z; 492 C, D, G, and H. GIMS block map number are 5257B, 5258 B, D, 5259D, 5357A, 5358A, C and 5359 C. Exhibit E1 shows the project location within the City of Houston, and Exhibit E2 shows the limits of the project.



3.0 STATEMENT OF PROBLEM

The existing Shepherd Drive and Durham Drive roadway sections consists of an existing asphalt overlay over concrete pavement with concrete curb and gutter. The pavement conditions were observed to be generally in fair to poor condition. Potholes, pavement settlement, and broken curbs are prevalent through the project area.

Gunda Corporation, LLC (GUNDA) gathered information on utilities, paving, right-of-way, and property ownership for the project area after reviewing the existing information from public and private utility sectors. The information provided in this report is the best available information at this time and is provided without the benefit of a boundary and topographic survey. The information is taken from existing record drawings, the City of Houston GIMS database, Harris County Appraisal District (HCAD), and City-provided information. All cost data is in 2018 dollars and is based on unit pricing provided by the City. Based on the gathered information, the following are the brief descriptions of the findings.

A. Right-of-Way

The existing right-of-way along Shepherd Drive between Interstate 610 and Washington Avenue varies between 50 and 300 feet. The existing right-of-way along Durham Drive between Interstate 610 and Washington Avenue varies between 60 and 145 feet. Table 1 lists existing rights-of-way along Shepherd Drive and Durham Drive.

Table 1: Rights-of-Way Widths

Cross Street	Right-of-Way Width (feet)	
	Shepherd Drive	Durham Drive
Interstate 610 Westbound Service Road	95	85
Interstate 610 Eastbound Service Road	70	70-110
West 28 th Street	70	70-72
West 27 th Street	70	70
West 26 th Street	70	70
West 25 th Street	70	75
West 24 th Street	75	70
West 23 rd Street	70	75
West 22 nd Street	72	70
West 21 st Street	62-70	70-75
West 20 th Street	75	65-70
West 19 th Street	70	70
West 18 th Street	70	70-90
West 17 th Street	70	70-90
West 16 th Street	68	65-68
West 15 th Street	70-72	65



Table 1: Rights-of-Way Widths

Cross Street	Right-of-Way Width (feet)	
	Shepherd Drive	Durham Drive
West 14 th Street	68-70	60-65
West 13 th Street	80	60
West 12 th Street	75	60-62
West 11 th Street	72	65
West 10 th Street	72-78	62-65
West 8 th Street	78-110	60-150
West 7 th Street / UPRR	150-170	60-65
West 6 th Street	70-85	65
White Oak Bayou	85	65-110
Darling Street	65-85	58-60
Larkin Street	55	62-65
Cornish Street	85	85
Interstate 10 North Feeder	60	60
Interstate 10 South Feeder	55-60	55
Nolda Street	55	55
Inker Street	58	58
Eigel Street	60	60
Maxie Street	60	60
Eli Street	60	65
UPRR	60-65	65
Allen Street	65	60
Schuler Street	65	60
Nett Street	60	70
Center Street	60-62	62-65
Washington Avenue	60	65-60

B. Pedestrian Circulation and Bikeway System

Pedestrian traffic within the study area is significant. The pedestrian facilities throughout the study area need significant improvements. The sidewalks generally are in poor condition along both Shepherd Drive and Durham Drive. Sidewalks are damaged and obstructed with large amounts of vegetation and low branch crossings in some areas. Likewise, pedestrian ramps and some bus shelters are in poor condition and do not meet ADA requirements for safe utilization.

C. Traffic



Within the project limits of Washington Avenue to Interstate 610, the Shepherd-Durham one-way pair is currently a 4- lanes in each northbound (Shepherd) and southbound (Durham) directions. The speed limit is 30 miles per hour for Shepherd-Durham pair. It is important to note that at the outset of this investigation the COH directed GUNDA to continue the 3-lanes with dedicated bicycle facility that is recommended and is currently under design along Shepherd-Durham between Dickson and Washington.

D. Drainage

All of the storm sewer systems serving Project Area NT03-3 are at least 85 years old, which is significantly older than the average design age of a storm sewer system. Currently, there are storm sewer improvements under construction along Shepherd Drive from Westheimer Road to Buffalo Bayou. The results of the analysis indicate that storm sewer system W0495 does not have adequate capacity to convey the design flows. The storm sewer system W0530 is partially under capacity. The City of Houston Comprehensive Drainage Plan proposes storm sewer improvements along some segments of this system. The storm sewer system W0448 has sufficient capacity to convey the design flows.

The extreme event overland flow drainage area for storm sewer systems W0495 and W0530 is 84 acres and 21 acres respectively. The extreme event overland flow drainage area for W0488 is same as its design drainage area (1 acre).

E. Public Utilities

Water

15 major complaints and 312 minor complaints related to water were received within the study area. Minor complaints include discoloration, odor, taste, and repair service line. The major complaints received involved major line repairs..

Sanitary Sewers:

Along Durham Drive there were three (3) reports of odor, seven (7) reports of sanitary sewer overflows, and 44 reports of stoppages. Along Shepherd Drive there were three (3) reports of odor three (3) reports of sanitary sewer overflows, and 16 reports of stoppages. These complaints are located throughout the need area with recurrent complaints within the 800 and 1200 blocks of Shepherd Drive. Also these complains are located throughout the need are with recurrent complaints within the 700 and 1100 blocks of Durham Drive.

F. Private Utilities

CenterPoint Energy (electric) owns and maintains aerial lines and poles along both sides of the Shepherd Drive right-of-way and Durham Drive right-of-way. CenterPoint Energy (gas) owns and maintains gas lines crossing and along both rights-of-way of Shepherd Drive. AT&T owns and maintains aerials lines mounted on the CenterPoint Energy poles. AT&T underground



facilities that lie within Shepherd Drive right-of-way. TV Max/Wavevision owns and maintains aerial lines mounted on the CenterPoint Energy poles crossing Shepherd Drive at Washington Avenue. Phonoscope owns and maintains aerial lines mounted on the CenterPoint Energy poles which cross Shepherd Drive. Comcast owns and maintains aerial lines mounted on the CenterPoint Energy poles within the Shepherd Drive right-of-way.

G. Interagency Coordination

GUNDA coordinated with the City's Inter-Agency Coordination Group (IACG) to identify other City, METRO, TxDOT, or Railroad facility projects that could impact the final design of the proposed roadway and utility improvements.

H. Tree Impacts

The majority of the project corridor does not contain large, established trees. Love Elementary School located along the east right-of-way of Shepherd Drive between West 13th Street and West 12th Street does have large established trees that require protection and preservation. These trees are part of the character of the school and provide vital shade to the playgrounds on the school grounds.

4.0 CANDIDATE PROJECT

A. Recommended Traffic Improvements

As mentioned above COH directed GUNDA to continue the 3-lanes with dedicated bicycle facility that is recommended and is currently under design along Shepherd-Durham between Dickson and Washington for this project which is Washington to Interstate 610. This goes along with the desire to continue the north-south on-street bicycle facility planned north of Buffalo Bayou trail via other off- and on-street bicycle facilities to the north all the way to Interstate 610.

GUNDA recommends replacing the all the traffic signals at the major intersections along Shepherd Drive/Durham Drive Washington Avenue to Interstate 610 with the proposed lane configurations. Dedicated left turn lanes are provided at some signalized intersections, as well as bringing facilities up to ADA compliance, as appropriate.

B. Recommended Paving

GUNDA recommends replacing the existing pavements with concrete following the standards of City of Houston for major thoroughfares. Per the City *Infrastructure Design Manual* (dated July 1, 2016), the minimum pavement section includes 11-inch reinforced concrete pavement with 8-inch minimum lime stabilized subgrade. The pavement design must be verified during Final Design after the geotechnical investigation is completed.



GUNDA recommends replacing the pedestrian facilities along Shepherd Drive and Durham Drive. Sidewalks, bus shelters, ramps, and pedestrian signalization needs to meet ADA requirements for safe utilization.

Between Interstate 610 and Washington Avenue, GUNDA recommends improvements to Shepherd Drive and Durham Drive that follow the descriptions for Alternative 2 described in Section B.4.B.

C. Recommended Pedestrian Improvements

GUNDA recommends construction of minimum 6-foot sidewalks along the east and west rights-of-way of Shepherd Drive and Durham Drive.

D. Recommended Drainage Improvements

The existing drainage systems W0530, W0495 and W0448 will be combined into one (1) drainage system W0530 that will drain along Shepherd Drive from Washington Avenue south to outfall into Buffalo Bayou (HCFCD Unit W100-00-00). The existing drainage systems will continue to drain the areas that lie outside of the Shepherd Drive drainage area. The land used to size the storm sewer systems was kept as existing conditions for all areas, as the area is currently fully developed. The proposed drainage area map, peak flow, and pipe sizes are presented in Appendix F.

A 12.39 ac-ft detention is required to mitigate the increase impervious cover. The inline detention is recommended.

E. Wastewater Improvements

The City recommends the installation of new 10-inch, 15-inch, 18-inch, 30-inch, and 36-inch gravity sanitary sewers along Durham Drive, West 7th Street, and Shepherd Drive to allow for the abandonment of the Durham Lift Station and the North Shepherd Lift Station.

An alternative exhibit shown after the recommendation is in case the Durham improvement happens first. The 36-inch line is implemented along Durham.

F. Water Improvements

The City recommends the replacement of existing 12-inch waterline along Shepherd, 8-inch line along Durham, and 8-inch along 16th Street and 18th Street, and the replacement of existing 6-inch with 8-inch along 23rd Street, replacement of 8-inch along 14th Street and connecting to 12-inch on Durham.



G. Total Project Costs for the Recommended Project

Table 3 and 4 summarize the project costs of construction for the recommended improvements. In addition, in later sections of this report there are recommendations to break-up the entire project into north and south project, and each project is break down into two sub-projects based on constructability issues and also manageable construction costs.

Table 3: South Project Costs for Recommended Improvements

	Alternative 2
Paving	\$12,548,443.16
Storm Sewer	\$5,112,665.25
Water	\$657,267.60
Wastewater	\$3,067,059.60
Contingencies (30%)	\$6,415,630.68
Construction Management (15%)	\$3,207,815.34
Engineering Fee (17%)	\$5,560,213.26
Design Management (15%)	\$834,031.99
Land Acquisition (HCAD x3)	\$2,297,557.51
Grand Total	\$39,700,684.39

The CPPS for the recommended improvements is 64.90 with a benefitted population of 45,957.

Table 4: North Project Costs for Recommended Improvements

	Alternative 2
Paving	\$18,043,077.64
Storm Sewer	\$12,740,319.90
Water	\$2,267,520.64
Wastewater	\$594,000.00
Contingencies (30%)	\$10,093,475.45
Construction Management (15%)	\$5,046,737.73
Engineering Fee (17%)	\$8,747,678.73
Design Management (15%)	\$1,312,151.81
Land Acquisition (HCAD x3)	\$354,340.00
Grand Total	\$59,199,301.89

The CPPS for the recommended improvements is 68.16 with a benefitted population of 45,957.

FORMS



South Project



**FY 2016 Candidate Projects (\$ Thousands)
Street & Traffic Control Program - Thoroughfares**

Candidate Project Summary Information			
Need Area:	N-2016T-0004	Alternative No.:	2
Name:	Shepherd Drive and Durham Drive	Council District:	C
Limits:	W 11th St to Washington Ave (South Project)	Key Map No.:	452 Y and Z; 492 C, D, G, and H
Type:	Principal Thoroughfare	Super Neighborhood:	Washington Avenue Coalition/ Memorial Park/ Greater Heights
WBS No.:	(To be assigned by the City)	Total No. of Sub-projects:	2
Description:	Project provides for the ROW acquisition, design and construction of a 3-lane configuration with bicycle lanes and improved pedestrian facilities		
Justification:			

Implementation - Estimated Cost and Duration				
	City Funds	Other Entities Funds	Total	Duration
Total Project Cost	\$ 39,701	\$ -	\$ 39,701	
Acquisition	\$ 2,298	\$ -	\$ 2,298	12 Months
Design	\$ 6,394	\$ -	\$ 6,394	24 Months
Construction	\$ 24,593	\$ -	\$ 24,593	36 Months
Contingency	\$ 6,416	\$ -	\$ 6,416	NA
Private Utility Reloc.	\$ -	\$ -	\$ -	Months
Warranty	\$ -	\$ -	\$ -	12 Months

Candidate Project Priority Scores			Other Entities & Jurisdictions Coordination	
Infrastructure Categories	Benefit Scores (Total Maximum 100)		Entities	Coordination For
	Maximum	Actual		
Streets	75	17.66	TxDOT <input type="checkbox"/>	Unit W100-00-00 & Unit E100-00-00
			Metro <input checked="" type="checkbox"/>	
Drainage System	15	15.00	HCFCD <input checked="" type="checkbox"/>	
			Gulf Coast Railroad District <input type="checkbox"/>	
Water	5	4.44	Union Pacific Rail Road <input type="checkbox"/>	
			Harris County <input type="checkbox"/>	
Wastewater	5	1.00	Fort Bend County <input type="checkbox"/>	
			Private Utilities <input type="checkbox"/>	
Total	100	38.1	(Name of Private Utility)	
Service Area Benefit score:		38.1	Municipalities <input type="checkbox"/>	
Benefitted Population:		45,957	(Name of municipality)	
Rebuild Houston Funds:		\$ 33,187	(Name of municipality)	
Candidate Project Priority Score:		64.9	Other <input type="checkbox"/>	
Candidate Project Priority Rank No.:		(To be assigned by the City)	Other <input type="checkbox"/>	

Sequencing Requirements (SR) and Other Considerations	
SR:	
Permits:	
Other:	

Maintenance - Estimated Cost and Frequency (By the City)				
Asset Categories	Estimated Asset Life	Maintenance Items	Cost	Schedule/Frequency
Streets	40-years	Street Sweeping	\$ -	4 Times Annually
		Overlay	\$ -	N/A
		Pot Hole Patch	\$ -	As needed - typically starts year 25
		Panel Repair	\$ -	As needed
Storm Drainage	50-years	Point Repair	\$ -	
			\$ -	
Water	50-years	Point Repair	\$ -	
			\$ -	
Wastewater	50-years	Point Repair	\$ -	
			\$ -	

**Major Thoroughfare and Collectors (No Change in Classification) Candidate
Project Priority Score Determination**

N-2016T-0004 - Shepherd Drive and Durham Drive: North of W 11 th St to Washington Avenue (South); Alternative 2 with inline detention; 3-Lane roadways with concrete curb and gutter, left turn lanes at signalized intersections, bicycle lanes, 6-foot sidewalks, traffic signals, and underground utilities (wastewater and stormwater improvements).

Infrastructure Category	Weight	Criteria	Project Parameter	Point Range	Measurement or Calculation	Points
Streets	75%	Pavement Condition	Avg. PCI = 70.57	0-60	0.6x(100-PCI)	17.66
		Intersection Level of Service	Existing LOS: D-F; Proposed LOS C-D	0-15	F to C or better = 15; E to C or better = 10; D to C or better = 5	0.00
Drainage System	15%	Extreme Event Level of Service	Improve to convey extreme event	0-5	No improvements = 0; Partial Improvements = 3; Conveys extreme event = 5	5.00
		Design Level of Service	Improve to convey design event	0-10	No improvements = 0; Partial Improvements = 5; Conveys extreme event = 10	10.00
Water	5%	WIRP Rank (1045 total Area)	116	0-5	Replace since 2000 = 0; ((Total WIRP Areas-WIRP Rank)/Total WIRP Areas) x 5	4.44
Wastewater	5%	SSO	3 SSO	0-2	No SSO = 0; SSO = 1; Repeat SSO = 2	0.00
		Point Repairs	PR = 1	0-2	PR<5 = 0; PR 5-10 = 1; PR >10 = 2	0.00
		Age of Pipe	30+ years	0-1	30 years or less = 0; More than 30 years = 1; Agreed order = 1	1.00
					Service Area Benefit Factor	38.10

Benefitted Population 35% Current ADT + 65 Future ADT = Current METRO Ridership 45,956.95

Current ADT	41,432	35% Current ADT	14,501.20
Future ADT	44,335	65% Future ADT	28,817.75
Current METRO	2,638	Current METRO	2,638.00

Candidate Project Priority Score = Service Benefit Factor x1.23 miles

= 38.10 x1.23 miles

Candidate Project Priority Score = 64.90

Benefitted Population

City Rebuild Houston Funds

45,957

\$33,186.84

Pre-Engineering Services Contracts

Total Project Cost Estimate Breakdown (FY18 Dollars)

Need No.: N-2016T-0004 - Shepherd Drive and Durham Drive: W 11th St to Washington

Alt 2: 3-lane with Bicycle Lane (Inline Detention)

1	410 (Summarized based on FY 18 List of Unit Prices)	\$21,385,435.61
1.1	Total Unit Price, Paving Items	\$12,548,443.16
1.2	Total Unit Price, Storm Sewer Items	\$5,112,665.25
1.3	Total Unit Price, Water Items	\$657,267.60
1.4	Total Unit Price, Wastewater Items	\$3,067,059.60
2	Contingency (30% of 410)	\$6,415,630.68
3	Construction Management (15% of 410)	\$3,207,815.34
4	Engineering Fee Estimate (20% of Sum of 410 and Contingency)	\$5,560,213.26
5	Design Management (15% of Engineering Fee Estimate)	\$834,031.99
6	Land Acquisition (Engineer's Best Estimate)	\$2,297,557.51
	Total Project Cost	\$39,700,684.39

Note: General Items are prorated in Paving, Storm, Water & Wastewater items.

Pre-Engineering Services Contracts

COH Rebuild Funds

Need No.: N-2016T-0004 - Shepherd Drive and Durham Drive: W 11th St to Washington

Alt 2: 3-lane with Bicycle Lane (Inline Detention)

1	410 (Summarized based on FY 18 List of Unit Prices)	\$17,661,108.41
	1.1 Total Unit Price, Paving Items	\$12,548,443.16
	1.2 Total Unit Price, Storm Sewer Items	\$5,112,665.25
2	Contingency (30% of 410)	\$5,298,332.52
3	Construction Management (15% of 410)	\$2,649,166.26
4	Engineering Fee Estimate (20% of Sum of 410 and Contingency)	\$4,591,888.19
5	Design Management (15% of Engineering Fee Estimate)	\$688,783.23
6	Land Acquisition (Engineer's Best Estimate)	\$2,297,557.51
	Total Project Cost	\$33,186,836.12

Note: General Items are prorated in Paving & Storm items.

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: South Project Shepherd and Durham between Washington Ave and W 11th St, including W 11th St
ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

**BID FORM
PART B**

Document 00410B Note 1

BID FORM - PART B

1.0 TOTAL BID PRICE HAS BEEN CALCULATED BY BIDDER, USING THE FOLLOWING COMPONENT PRICES AND

A. STIPULATED PRICE \$ N/A
 (Total Bid Price; minus Base Unit Prices, Extra Unit Process, Cash Allowance and All Alternates, if any)

B. BASE UNIT PRICE TABLE:

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - PAVING ITEMS							
1	222101	02221	Remove and Dispose of Existing Pavement and Curb -Assumes all concrete pavement thicknesses with or without asphalt overlay	SY	50,310	\$6.00	\$301,860.00
2	222102	02221	Remove and Dispose of Existing Driveways and Sidewalks	SY	8,960	\$5.00	\$44,802.00
3	275106	02751	11" Reinforced Concrete Pavement (Complete in Place)	SY	49,970	\$70.00	\$3,497,900.00
4	233601	02336	Lime stabilized subgrade (6" thick)	SY	490	\$3.00	\$1,470.00
5	233602	02336	Lime stabilized subgrade (8" thick)	SY	54,970	\$4.00	\$219,880.00
6	233603	02336	Lime (6, 7% By Weight)	Ton	1,100	\$164.00	\$180,400.00
7	277101	02771	6" Concrete Curb	LF	21,760	\$4.00	\$87,040.00
8	275201	02752	Expansion Joint	LF	5,660	\$8.00	\$45,280.00
9	275401	02754	6" Concrete for Driveways	SF	44,240	\$8.00	\$353,920.00
10	277501	02775	4-1/2" Concrete for Sidewalks	SF	130,570	\$7.00	\$913,990.00
11	292201	02922	Sodding	SY	3,630	\$5.00	\$18,150.00
12	289301	02893	Traffic Signal/Intersection	EA	7	\$325,000.00	\$2,275,000.00
13	-	-	Railroad Crossing	EA	2	\$1,000,000.00	\$2,000,000.00
14	231501	02315	Roadway Excavation	CY	3,260	\$16.00	\$52,160.00
15	-	-	Pedestrian Bridge	LF	400	\$110.00	\$44,000.00
16	1601001	-	Street Light Removal	EA	67	\$272.00	\$18,224.00
17	1601002	-	Street Light Installation (includes conduit and Temporary Lighting during Construction)	LF	10,881	\$32.00	\$348,192.00
			Ancillary items (10%)				\$1,005,407.60
			SubTotal of Paving				\$11,407,675.60
			General Items (10% of Paving Subtotal)				\$1,140,767.56
TOTAL - PAVING ITEMS							\$12,548,443.16

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - STORM SEWER ITEMS							
1	222103	02221	Remove Storm Sewer Pipe (All Types)	LF	10,490	\$20.00	\$209,800.00
2	222105	02221	Remove Inlets (All Types)	EA	140	\$370.00	\$51,800.00
3	222106	02221	Remove Manholes (All Types, All Depths)	EA	40	\$390.00	\$15,600.00
4	263301	02633	Curb Inlets (All Types)	EA	110	\$2,910.00	\$320,100.00
5	208201	02082	Manholes (For 42" Dia. Pipe and Smaller) (All Types)	EA	24	\$3,470.00	\$83,280.00
6	208202	02082	Manholes (For 48" to 72" Dia. Pipe) (All Types)	EA	15	\$6,340.00	\$95,100.00
Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
			00410B-4 Description 12-06-2017				

Bidders Initials []

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: South Project Shepherd and Durham between Washington Ave and W 11th St, including W 11th St

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

7	208203	02082	Manholes (For 78" Dia. Pipe and Larger) (All Types)	EA	10	\$16,500.00	\$165,000.00
8	263101	02631	24-inch RCP	LF	5,310	\$115.00	\$610,650.00
9	263102	02631	30-inch RCP	LF	1,380	\$150.00	\$207,000.00
10	263103	02631	36-inch RCP	LF	930	\$180.00	\$167,400.00
11	263104	02631	42-inch RCP	LF	830	\$215.00	\$178,450.00
12	263105	02631	48-inch RCP	LF	50	\$250.00	\$12,500.00
13	263106	02631	54-inch RCP	LF	0	\$270.00	\$0.00
14	263107	02631	60-inch RCP	LF	0	\$350.00	\$0.00
15	263108	02631	66-inch RCP	LF	0	\$360.00	\$0.00
16	263109	02631	72-inch RCP	LF	130	\$485.00	\$63,050.00
17	263113	02631	96-inch RCP	LF	0	\$730.00	\$0.00
18	263123	02631	4x2 RCB	LF	2,500	\$250.00	\$625,000.00
19	263126	02631	5x3 RCB	LF	750	\$300.00	\$225,000.00
20	263128	02631	5X5 RCB	LF	0	\$350.00	\$0.00
21	263129	02631	6x3 RCB	LF	0	\$350.00	\$0.00
22	263130	02631	6x4 RCB	LF	0	\$445.00	\$0.00
23	263132	02631	6X6 RCB	LF	0	\$480.00	\$0.00
24	263134	02631	7X5 RCB	LF	500	\$580.00	\$290,000.00
25	263137	02631	8x4 RCB	LF	0	\$580.00	\$0.00
26	263147	02631	10X5 RCB	LF	1,270	\$850.00	\$1,079,500.00
27	263152	02631	10X10 RCB	LF	0	\$1,300.00	\$0.00
28	263161	02631	12x10 RCB	LF	0	\$1,335.00	\$0.00
29	226001	02260	Trench Safety System	LF	13,660	\$2.00	\$27,320.00
30	231504	02315	Fill Existing Ditch	CY	0	\$6.00	\$0.00
			Ancillary items (10%)				\$221,327.50
			SubTotal of Storm Sewer				\$4,647,877.50
			General Items (10% of Storm Sewer Subtotal)				\$464,787.75
TOTAL UNIT PRICES - STORM SEWER ITEMS							\$5,112,665.25

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - WASTEWATER							
1	222108	02221	Remove Existing Sanitary Sewer Manhole (All Types)	EA	0	\$800.00	\$0.00
2	222201	02221	Abandon and Fill Existing Sanitary Sewer Manhole (All Types)	EA	4	\$1,000.00	\$4,000.00
3	222109	02221	Remove Existing Sanitary Sewer Pipe (All Types)	LF	0	\$20.00	\$0.00
4	222202	02222	Abandon and Fill Existing Sanitary Sewer Pipe (All Sizes)	LF	1,039	\$20.00	\$20,780.00
5	-	02222	Abandon Existing Sanitary Sewer Lift Station	EA	2	\$100,000.00	\$200,000.00
6	253103	02531	10" PVC	LF	383	\$160.00	\$61,280.00
7	253105	02531	15" PVC	LF	394	\$230.00	\$90,620.00
8	253108	02531	30" PVC	LF	593	\$480.00	\$284,640.00
9	253109	02531	36" PVC	LF	2,649	\$590.00	\$1,562,910.00
10	253401	02534	Service Leads (Assume 6" Lead)	LF	0	\$120.00	\$0.00
11	208204	02082	Sanitary Sewer Manholes (4' diameter)	EA	4	\$4,200.00	\$16,800.00
12	208204	02082	Sanitary Sewer Manholes (5'-8' diameter)	EA	11	\$7,500.00	\$82,500.00

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: South Project Shepherd and Durham between Washington Ave and W 11th St, including W 11th St

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

			Ancillary Items (20%)				\$464,706.00
			SubTotal of Wastewater				\$2,788,236.00
			General Items (10% of Wastewater Subtotal)				\$278,823.60
TOTAL UNIT PRICES - WASTEWATER							\$3,067,059.60

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - WATER							
1	252001	02520	Remove and Salvage Fire Hydrants	EA	9	\$400.00	\$3,600.00
2	222107	02221	Remove Existing Water Line (All Types)	LF	2,700	\$16.00	\$43,200.00
3	251601	02516	Cut, Plug, and Abandon Existing Water Line (All Types)	EA	0	\$910.00	\$0.00
4	251102	02511	8" Water Line	LF	0	\$100.00	\$0.00
5	251104	02511	12" Water Line	LF	2,700	\$140.00	\$378,000.00
6	252002	02520	Fire Hydrant Assembly	EA	9	\$5,400.00	\$48,600.00
7	251201	02512	¾-1" Long Side	EA	0	\$1,500.00	\$0.00
8	251202	02512	¾-1" Short Side	EA	1	\$830.00	\$830.00
9	251203	02512	1½-2" Long Side	EA	3	\$2,500.00	\$7,500.00
10	251204	02512	1½-2" Short Side	EA	9	\$1,800.00	\$16,200.00
		-	Ancillary items (20%)				\$99,586.00
			SubTotal				\$597,516.00
		-	General Items (10% of Water SubTotal)				\$59,751.60
TOTAL UNIT PRICES - WATER							\$657,267.60

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - DETENTION							
1		-	Excavation (Detention Pond) (Dry)	AC-FT			
2		-	Excavation (Detention Pond) (Wet)	AC-FT			
3		-	Regional Detention	AC-FT		\$44,796.00	\$0.00
TOTAL UNIT PRICES - DETENTION							\$0.00

TOTAL BASE UNIT PRICE:

\$21,385,435.61

Note:

1. This is not a Standard Document 00410B (Form 410). The Form 410 was modified for the purpose of planning level cost estimates for Pre-Engineering Studies.
2. The "Item Reference No." shall be designated for each item listed. The numbers serve as reference and will be used for the future cost updates.

South Project

Sub-Project 1



**Major Thoroughfare and Collectors (No Change in Classification) Candidate
Project Priority Score Determination**

N-2016T-0004 - Shepherd Drive and Durham Drive: Interstate 10 to Washington Avenue (South Project Sub-Project 1); Alternative 2 with inline detention; 3-Lane roadways with concrete curb and gutter, left turn lanes at signalized intersections, bicycle lanes, 6-foot sidewalks, traffic signals, and underground utilities (wastewater and stormwater improvements).

Infrastructure Category	Weight	Criteria	Project Parameter	Point Range	Measurement or Calculation	Points
Streets	75%	Pavement Condition	Avg. PCI = 75.86	0-60	0.6x(100-PCI)	14.48
		Intersection Level of Service	Existing LOS: D-F; Proposed LOS C-D	0-15	F to C or better = 15; E to C or better = 10; D to C or better = 5	0.00
Drainage System	15%	Extreme Event Level of Service	Improve to convey extreme event	0-5	No improvements = 0; Partial Improvements = 3; Conveys extreme event = 5	5.00
		Design Level of Service	Improve to convey design event	0-10	No improvements = 0; Partial Improvements = 5; Conveys extreme event = 10	10.00
Water	5%	WIRP Rank (1045 total Area)	116	0-5	Replace since 2000 = 0; ((Total WIRP Areas-WIRP Rank)/Total WIRP Areas) x 5	4.44
Wastewater	5%	SSO	3 SSO	0-2	No SSO = 0; SSO = 1; Repeat SSO = 2	0.00
		Point Repairs	PR = 1	0-2	PR<5 = 0; PR 5-10 = 1; PR >10 = 2	0.00
		Age of Pipe	30+ years	0-1	30 years or less = 0; More than 30 years = 1; Agreed order = 1	1.00
					Service Area Benefit Factor	34.93

Benefitted Population 35% Current ADT + 65 Future ADT = Current METRO Ridership 45,956.95

Current ADT	41,432	35% Current ADT	14,501.20
Future ADT	44,335	65% Future ADT	28,817.75
Current METRO	2,638	Current METRO	2,638.00

Candidate Project Priority Score = Service Benefit Factor
= 34.93

Benefitted Population

City Rebuild Houston Funds
45,957

\$17,843.99

Candidate Project Priority Score = 89.96

Pre-Engineering Services Contracts

Total Project Cost Estimate Breakdown (FY18 Dollars)

Need No.: N-2016T-0004 - Shepherd Drive and Durham Drive: Interstate 10 to Washington
Alt 2: 3-lane with Bicycle Lane (Inline Detention)

1	410 (Summarized based on FY 18 List of Unit Prices)	\$8,888,755.98
	1.1 Total Unit Price, Paving Items	\$7,092,084.18
	1.2 Total Unit Price, Storm Sewer Items	\$1,796,671.80
	1.3 Total Unit Price, Water Items	\$0.00
	1.4 Total Unit Price, Wastewater Items	\$0.00
2	Contingency (30% of 410)	\$2,666,626.79
3	Construction Management (15% of 410)	\$1,333,313.40
4	Engineering Fee Estimate (20% of Sum of 410 and Contingency)	\$2,311,076.55
5	Design Management (15% of Engineering Fee Estimate)	\$346,661.48
6	Land Acquisition (Engineer's Best Estimate)	\$2,297,557.51
	Total Project Cost	\$17,843,991.71

Note: General Items are prorated in Paving, Storm, Water & Wastewater items.

Pre-Engineering Services Contracts

COH Rebuild Funds

Need No.: N-2016T-0004 - Shepherd Drive and Durham Drive: Interstate 10 to Washington
Alt 2: 3-lane with Bicycle Lane (Inline Detention)

1	410 (Summarized based on FY 18 List of Unit Prices)	\$8,888,755.98
	1.1 Total Unit Price, Paving Items	\$7,092,084.18
	1.2 Total Unit Price, Storm Sewer Items	\$1,796,671.80
2	Contingency (30% of 410)	\$2,666,626.79
3	Construction Management (15% of 410)	\$1,333,313.40
4	Engineering Fee Estimate (20% of Sum of 410 and Contingency)	\$2,311,076.55
5	Design Management (15% of Engineering Fee Estimate)	\$346,661.48
6	Land Acquisition (Engineer's Best Estimate)	\$2,297,557.51
	Total Project Cost	\$17,843,991.71

Note: General Items are prorated in Paving & Storm items.

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between Interstate 10 and Washington Avenue (South Project Sub-Project 1)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

Document 00410B ^{Note 1}

BID FORM - PART B

1.0 TOTAL BID PRICE HAS BEEN CALCULATED BY BIDDER, USING THE FOLLOWING COMPONENT PRICES AND

A. STIPULATED PRICE

\$ N/A

(Total Bid Price; minus Base Unit Prices, Extra Unit Process, Cash Allowance and All Alternates, if any)

B. BASE UNIT PRICE TABLE:

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - PAVING ITEMS							
1	222101	02221	Remove and Dispose of Existing Pavement and Curb -Assumes all concrete pavement thicknesses with or without asphalt overlay	SY	18,650	\$6.00	\$111,900.00
2	222102	02221	Remove and Dispose of Existing Driveways and Sidewalks	SY	4,187	\$5.00	\$20,933.50
3	275106	02751	11" Reinforced Concrete Pavement (Complete in Place)	SY	18,590	\$70.00	\$1,301,300.00
4	233601	02336	Lime stabilized subgrade (6" thick)	SY	260	\$3.00	\$780.00
5	233602	02336	Lime stabilized subgrade (8" thick)	SY	20,440	\$4.00	\$81,760.00
6	233603	02336	Lime (6, 7% By Weight)	Ton	410	\$160.00	\$65,600.00
7	277101	02771	6" Concrete Curb	LF	8,460	\$4.00	\$33,840.00
8	275201	02752	Expansion Joint	LF	2,130	\$8.00	\$17,040.00
9	275401	02754	6" Concrete for Driveways	SF	23,200	\$8.00	\$185,600.00
10	277501	02775	4-1/2" Concrete for Sidewalks	SF	50,740	\$7.00	\$355,180.00
11	292201	02922	Sodding	SY	1,410	\$5.00	\$7,050.00
12	289301	02893	Traffic Signal/Intersection	EA	5	\$300,000.00	\$1,500,000.00
13	-	-	Railroad Crossing	EA	2	\$1,000,000.00	\$2,000,000.00
14	231501	02315	Roadway Excavation	CY	1,210	\$15.00	\$18,150.00
15	-	-	Pedestrian Bridge	LF	400	\$110.00	\$44,000.00
16	1601001	-	Street Light Removal	EA	47	\$272.00	\$12,784.00
17	1601002	-	Street Light Installation (includes conduit and Temporary Lighting during Construction)	LF	3,620	\$32.00	\$115,840.00
			Ancillary items (10%)				\$575,591.75
			SubTotal of Paving				\$6,447,349.25
			General Items (10% of Paving Subtotal)				\$644,734.93
TOTAL - PAVING ITEMS							\$7,092,084.18

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - STORM SEWER ITEMS							
1	222103	02221	Remove Storm Sewer Pipe (All Types)	LF	4,573	\$20.00	\$91,460.00
2	222105	02221	Remove Inlets (All Types)	EA	80	\$370.00	\$29,600.00
3	222106	02221	Remove Manholes (All Types, All Depths)	EA	22	\$390.00	\$8,580.00
4	263301	02633	Curb Inlets (All Types)	EA	70	\$2,910.00	\$203,700.00
5	208201	02082	Manholes (For 42" Dia. Pipe and Smaller) (All Types)	EA	14	\$3,470.00	\$48,580.00
6	208202	02082	Manholes (For 48" to 72" Dia. Pipe) (All Types)	EA	10	\$6,340.00	\$63,400.00

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between Interstate 10 and Washington Avenue (South Project Sub-Project 1)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
7	208203	02082	Manholes (For 78" Dia. Pipe and Larger) (All Types)	EA	0	\$16,500.00	\$0.00
8	263101	02631	24-inch RCP	LF	3,010	\$115.00	\$346,150.00
9	263102	02631	30-inch RCP	LF	880	\$150.00	\$132,000.00
10	263103	02631	36-inch RCP	LF	790	\$180.00	\$142,200.00
11	263104	02631	42-inch RCP	LF	230	\$215.00	\$49,450.00
12	263105	02631	48-inch RCP	LF	0	\$250.00	\$0.00
13	263106	02631	54-inch RCP	LF	0	\$270.00	\$0.00
14	263107	02631	60-inch RCP	LF	0	\$350.00	\$0.00
15	263108	02631	66-inch RCP	LF	0	\$360.00	\$0.00
16	263109	02631	72-inch RCP	LF	0	\$485.00	\$0.00
17	263113	02631	96-inch RCP	LF	0	\$730.00	\$0.00
18	263123	02631	4x2 RCB	LF	810	\$250.00	\$202,500.00
19	263126	02631	5x3 RCB	LF	750	\$300.00	\$225,000.00
20	263128	02631	5X5 RCB	LF	0	\$350.00	\$0.00
21	263129	02631	6x3 RCB	LF	0	\$350.00	\$0.00
22	263130	02631	6x4 RCB	LF	0	\$445.00	\$0.00
23	263132	02631	6X6 RCB	LF	0	\$480.00	\$0.00
24	263134	02631	7X5 RCB	LF	0	\$580.00	\$0.00
25	263137	02631	8x4 RCB	LF	0	\$580.00	\$0.00
26	263147	02631	10X5 RCB	LF	0	\$850.00	\$0.00
27	263152	02631	10X10 RCB	LF	0	\$1,300.00	\$0.00
28	263161	02631	12x10 RCB	LF	0	\$1,335.00	\$0.00
29	226001	02260	Trench Safety System	LF	6,470	\$2.00	\$12,940.00
30	231504	02315	Fill Existing Ditch	CY	0	\$6.00	\$0.00
			Ancillary items (10%)				\$77,778.00
			SubTotal of Storm Sewer				\$1,633,338.00
			General Items (10% of Storm Sewer Subtotal)				\$163,333.80
TOTAL UNIT PRICES - STORM SEWER ITEMS							\$1,796,671.80

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - WASTEWATER							
1	222108	02221	Remove Existing Sanitary Sewer Manhole (All Types)	EA		\$800.00	\$0.00
2	222201	02221	Abandon and Fill Existing Sanitary Sewer Manhole (All Types)	EA		\$1,000.00	\$0.00
3	222109	02221	Remove Existing Sanitary Sewer Pipe (All Types)	LF		\$20.00	\$0.00
4	222202	02222	Abandon and Fill Existing Sanitary Sewer Pipe (All Sizes)	LF		\$20.00	\$0.00
5	222205	02222	Abandon Existing Sanitary Sewer Lift Station	EA		\$100,000.00	\$0.00
6	253103	02531	10" PVC	LF		\$160.00	\$0.00
7	253105	02531	15" PVC	LF		\$230.00	\$0.00
8	253108	02531	30" PVC	LF		\$480.00	\$0.00
9	253109	02531	36" PVC	LF		\$590.00	\$0.00
10	253401	02534	Service Leads (Assume 6" Lead)	LF		\$120.00	\$0.00
11	208204	02082	Sanitary Sewer Manholes (4' diameter)	EA		\$4,200.00	\$0.00
12	208204	02082	Sanitary Sewer Manholes (5'-8' diameter)	EA		\$7,500.00	\$0.00
			Ancillary Items (20%)				\$0.00

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between Interstate 10 and Washington Avenue (South Project Sub-Project 1)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

			SubTotal of Wastewater				\$0.00
			General Items (10% of Wastewater Subtotal)				\$0.00
TOTAL UNIT PRICES - WASTEWATER							\$0.00

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - WATER							
1	252001	02520	Remove and Salvage Fire Hydrants	EA		\$400.00	\$0.00
2	222107	02221	Remove Existing Water Line (All Types)	LF		\$16.00	\$0.00
3	251601	02516	Cut, Plug, and Abandon Existing Water Line (All Types)	EA		\$910.00	\$0.00
4	251102	02511	8" Water Line	LF		\$100.00	\$0.00
5	251104	02511	12" Water Line	LF		\$140.00	\$0.00
6	252002	02520	Fire Hydrant Assembly	EA		\$5,400.00	\$0.00
7	251201	02512	¾-1" Long Side	EA		\$1,500.00	\$0.00
8	251202	02512	¾-1" Short Side	EA		\$830.00	\$0.00
9	251203	02512	1½-2" Long Side	EA		\$2,500.00	\$0.00
10	251204	02512	1½-2" Short Side	EA		\$1,800.00	\$0.00
		-	Ancillary items (20%)				\$0.00
			SubTotal				\$0.00
		-	General Items (10% of Water SubTotal)				\$0.00
TOTAL UNIT PRICES - WATER							\$0.00

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - DETENTION							
1		-	Excavation (Detention Pond) (Dry)	AC-FT			
2		-	Excavation (Detention Pond) (Wet)	AC-FT			
3		-	Regional Detention	AC-FT		\$44,796.00	\$0.00
TOTAL UNIT PRICES - DETENTION							\$0.00

TOTAL BASE UNIT PRICE:

\$8,888,755.98

Note:

1. This is not a Standard Document 00410B (Form 410). The Form 410 was modified for the purpose of planning level cost estimates for Pre-Engineering Studies.
2. The "Item Reference No." shall be designated for each item listed. The numbers serve as reference and will be used for the future cost updates.

South Project

Sub-Project 2



**Major Thoroughfare and Collectors (No Change in Classification) Candidate
Project Priority Score Determination**

N-2016T-0004 - Shepherd Drive and Durham Drive: North of West 11th Street to Interstate 10 (South Project Sub-Project 2); Alternative 2 with inline detention; 3-Lane roadways with concrete curb and gutter, left turn lanes at signalized intersections, bicycle lanes, 6-foot sidewalks, traffic signals, and underground utilities (wastewater and stormwater improvements).

Infrastructure Category	Weight	Criteria	Project Parameter	Point Range	Measurement or Calculation	Points
Streets	75%	Pavement Condition	Avg. PCI = 65.74	0-60	0.6x(100-PCI)	20.56
		Intersection Level of Service	Existing LOS: D-F; Proposed LOS C-D	0-15	F to C or better = 15; E to C or better = 10; D to C or better = 5	0.00
Drainage System	15%	Extreme Event Level of Service	Improve to convey extreme event	0-5	No improvements = 0; Partial Improvements = 3; Conveys extreme event = 5	5.00
		Design Level of Service	Improve to convey design event	0-10	No improvements = 0; Partial Improvements = 5; Conveys extreme event = 10	10.00
Water	5%	WIRP Rank (1045 total Area)	116	0-5	Replace since 2000 = 0; ((Total WIRP Areas-WIRP Rank)/Total WIRP Areas) x 5	4.44
Wastewater	5%	SSO	3 SSO	0-2	No SSO = 0; SSO = 1; Repeat SSO = 2	0.00
		Point Repairs	PR = 0	0-2	PR<5 = 0; PR 5-10 = 1; PR >10 = 2	0.00
		Age of Pipe	30+ years	0-1	30 years or less = 0; More than 30 years = 1; Agreed order = 1	1.00
					Service Area Benefit Factor	41.00

Benefitted Population 35% Current ADT + 65 Future ADT = Current METRO Ridership 45,956.95

Current ADT	41,432	35% Current ADT	14,501.20
Future ADT	44,335	65% Future ADT	28,817.75
Current METRO	2,638	Current METRO	2,638.00

Candidate Project Priority Score = Service Benefit Factor
= 41.00

Benefitted Population

City Rebuild Houston Funds
45,957

\$15,031.20

Candidate Project Priority Score = 125.36
--

Pre-Engineering Services Contracts

Total Project Cost Estimate Breakdown (FY18 Dollars)

Need No.: N-2016T-0004 - Shepherd Drive and Durham Drive: West 11th to Interstate 10
 Alt 2: 3-lane with Bicycle Lane (Inline Detention)

1	410 (Summarized based on FY 18 List of Unit Prices)	\$12,318,496.19
1.1	Total Unit Price, Paving Items	\$5,240,372.39
1.2	Total Unit Price, Storm Sewer Items	\$3,353,796.60
1.3	Total Unit Price, Water Items	\$657,267.60
1.4	Total Unit Price, Wastewater Items	\$3,067,059.60
2	Contingency (30% of 410)	\$3,695,548.86
3	Construction Management (15% of 410)	\$1,847,774.43
4	Engineering Fee Estimate (20% of Sum of 410 and Contingency)	\$3,202,809.01
5	Design Management (15% of Engineering Fee Estimate)	\$480,421.35
6	Land Acquisition (Engineer's Best Estimate)	\$0.00
	Total Project Cost	\$21,545,049.84

Note: General Items are prorated in Paving, Storm, Water & Wastewater items.

Pre-Engineering Services Contracts

COH Rebuild Funds

Need No.: N-2016T-0004 - Shepherd Drive and Durham Drive: West 11th to Interstate 10

Alt 2: 3-lane with Bicycle Lane (Inline Detention)

1	410 (Summarized based on FY 18 List of Unit Prices)	\$8,594,168.99
	1.1 Total Unit Price, Paving Items	\$5,240,372.39
	1.2 Total Unit Price, Storm Sewer Items	\$3,353,796.60
2	Contingency (30% of 410)	\$2,578,250.70
3	Construction Management (15% of 410)	\$1,289,125.35
4	Engineering Fee Estimate (20% of Sum of 410 and Contingency)	\$2,234,483.94
5	Design Management (15% of Engineering Fee Estimate)	\$335,172.59
6	Land Acquisition (Engineer's Best Estimate)	\$0.00
	Total Project Cost	\$15,031,201.56

Note: General Items are prorated in Paving & Storm items.

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between West 11th and Interstate 10 (South Project Sub-Project 2)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

Document 00410B ^{Note 1}

BID FORM - PART B

1.0 TOTAL BID PRICE HAS BEEN CALCULATED BY BIDDER, USING THE FOLLOWING COMPONENT PRICES AND

A. STIPULATED PRICE

\$ N/A

(Total Bid Price; minus Base Unit Prices, Extra Unit Process, Cash Allowance and All Alternates, if any)

B. BASE UNIT PRICE TABLE:

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - PAVING ITEMS							
1	222101	02221	Remove and Dispose of Existing Pavement and Curb -Assumes all concrete pavement thicknesses with or without asphalt overlay	SY	31,660	\$6.00	\$189,960.00
2	222102	02221	Remove and Dispose of Existing Driveways and Sidewalks	SY	4,774	\$5.00	\$23,869.00
3	275106	02751	11" Reinforced Concrete Pavement (Complete in Place)	SY	31,390	\$70.00	\$2,197,300.00
4	233601	02336	Lime stabilized subgrade (6" thick)	SY	230	\$3.00	\$690.00
5	233602	02336	Lime stabilized subgrade (8" thick)	SY	34,530	\$4.00	\$138,120.00
6	233603	02336	Lime (6, 7% By Weight)	Ton	690	\$164.00	\$113,160.00
7	277101	02771	6" Concrete Curb	LF	13,310	\$4.00	\$53,240.00
8	275201	02752	Expansion Joint	LF	3,570	\$8.00	\$28,560.00
9	275401	02754	6" Concrete for Driveways	SF	21,040	\$8.00	\$168,320.00
10	277501	02775	4-1/2" Concrete for Sidewalks	SF	79,840	\$7.00	\$558,880.00
11	292201	02922	Sodding	SY	2,220	\$5.00	\$11,100.00
12	289301	02893	Traffic Signal/Intersection	EA	2	\$325,000.00	\$650,000.00
13	-	-	Railroad Crossing	EA	0	\$1,000,000.00	\$0.00
14	231501	02315	Roadway Excavation	CY	2,050	\$16.00	\$32,800.00
15	-	-	Pedestrian Bridge	LF	0	\$110.00	\$0.00
16	1601001	-	Street Light Removal	EA	20	\$272.00	\$5,440.00
17	1601002	-	Street Light Installation (includes conduit and Temporary Lighting during Construction)	LF	5,481	\$32.00	\$175,392.00
			Ancillary items (10%)				\$417,143.90
			SubTotal of Paving				\$4,763,974.90
			General Items (10% of Paving Subtotal)				\$476,397.49
TOTAL - PAVING ITEMS							\$5,240,372.39
Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - STORM SEWER ITEMS							
1	222103	02221	Remove Storm Sewer Pipe (All Types)	LF	5,910	\$20.00	\$118,200.00
2	222105	02221	Remove Inlets (All Types)	EA	60	\$370.00	\$22,200.00
3	222106	02221	Remove Manholes (All Types, All Depths)	EA	21	\$390.00	\$8,190.00
4	263301	02633	Curb Inlets (All Types)	EA	40	\$2,910.00	\$116,400.00
5	208201	02082	Manholes (For 42" Dia. Pipe and Smaller) (All Types)	EA	10	\$3,470.00	\$34,700.00

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between West 11th and Interstate 10 (South Project Sub-Project 2)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price <small>(this column controls)</small>	Total in Figures
6	208202	02082	Manholes (For 48" to 72" Dia. Pipe) (All Types)	EA	10	\$6,340.00	\$63,400.00
7	208203	02082	Manholes (For 78" Dia. Pipe and Larger) (All Types)	EA	10	\$16,500.00	\$165,000.00
8	263101	02631	24-inch RCP	LF	2,300	\$115.00	\$264,500.00
9	263102	02631	30-inch RCP	LF	500	\$150.00	\$75,000.00
10	263103	02631	36-inch RCP	LF	140	\$180.00	\$25,200.00
11	263104	02631	42-inch RCP	LF	600	\$215.00	\$129,000.00
12	263105	02631	48-inch RCP	LF	50	\$250.00	\$12,500.00
13	263106	02631	54-inch RCP	LF	0	\$270.00	\$0.00
14	263107	02631	60-inch RCP	LF	0	\$350.00	\$0.00
15	263108	02631	66-inch RCP	LF	0	\$360.00	\$0.00
16	263109	02631	72-inch RCP	LF	130	\$485.00	\$63,050.00
17	263113	02631	96-inch RCP	LF	0	\$730.00	\$0.00
18	263123	02631	4x2 RCB	LF	1,690	\$250.00	\$422,500.00
19	263126	02631	5x3 RCB	LF	0	\$300.00	\$0.00
20	263128	02631	5X5 RCB	LF	0	\$350.00	\$0.00
21	263129	02631	6x3 RCB	LF	0	\$350.00	\$0.00
22	263130	02631	6x4 RCB	LF	0	\$445.00	\$0.00
23	263132	02631	6X6 RCB	LF	0	\$480.00	\$0.00
24	263134	02631	7X5 RCB	LF	500	\$580.00	\$290,000.00
25	263137	02631	8x4 RCB	LF	0	\$580.00	\$0.00
26	263147	02631	10X5 RCB	LF	1,270	\$850.00	\$1,079,500.00
27	263152	02631	10X10 RCB	LF	0	\$1,300.00	\$0.00
28	263161	02631	12x10 RCB	LF	0	\$1,335.00	\$0.00
29	226001	02260	Trench Safety System	LF	7,190	\$2.00	\$14,380.00
30	231504	02315	Fill Existing Ditch	CY	0	\$6.00	\$0.00
			Ancillary items (10%)				\$145,186.00
			SubTotal of Storm Sewer				\$3,048,906.00
			General Items (10% of Storm Sewer Subtotal)				\$304,890.60
TOTAL UNIT PRICES - STORM SEWER ITEMS							\$3,353,796.60

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price <small>(this column controls)</small>	Total in Figures
UNIT PRICES - WASTEWATER							
1	222108	02221	Remove Existing Sanitary Sewer Manhole (All Types)	EA	0	\$800.00	\$0.00
2	222201	02221	Abandon and Fill Existing Sanitary Sewer Manhole (All Types)	EA	4	\$1,000.00	\$4,000.00
3	222109	02221	Remove Existing Sanitary Sewer Pipe (All Types)	LF	0	\$20.00	\$0.00
4	222202	02222	Abandon and Fill Existing Sanitary Sewer Pipe (All Sizes)	LF	1,039	\$20.00	\$20,780.00
5	-	02222	Abandon Existing Sanitary Sewer Lift Station	EA	2	\$100,000.00	\$200,000.00
6	253103	02531	10" PVC	LF	383	\$160.00	\$61,280.00
7	253105	02531	15" PVC	LF	394	\$230.00	\$90,620.00
8	253108	02531	30" PVC	LF	593	\$480.00	\$284,640.00
9	253109	02531	36" PVC	LF	2,649	\$590.00	\$1,562,910.00
10	253401	02534	Service Leads (Assume 6" Lead)	LF	0	\$120.00	\$0.00
11	208204	02082	Sanitary Sewer Manholes (4' diameter)	EA	4	\$4,200.00	\$16,800.00

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between West 11th and Interstate 10 (South Project Sub-Project 2)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

12	208204	02082	Sanitary Sewer Manholes (5'-8' diameter)	EA	11	\$7,500.00	\$82,500.00
			Ancillary Items (20%)				\$464,706.00
			SubTotal of Wastewater				\$2,788,236.00
			General Items (10% of Wastewater Subtotal)				\$278,823.60
TOTAL UNIT PRICES - WASTEWATER							\$3,067,059.60

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - WATER							
1	252001	02520	Remove and Salvage Fire Hydrants	EA	9	\$400.00	\$3,600.00
2	222107	02221	Remove Existing Water Line (All Types)	LF	2,700	\$16.00	\$43,200.00
3	251601	02516	Cut, Plug, and Abandon Existing Water Line (All Types)	EA		\$910.00	\$0.00
4	251102	02511	8" Water Line	LF		\$100.00	\$0.00
5	251104	02511	12" Water Line	LF	2,700	\$140.00	\$378,000.00
6	252002	02520	Fire Hydrant Assembly	EA	9	\$5,400.00	\$48,600.00
7	251201	02512	¾-1" Long Side	EA		\$1,500.00	\$0.00
8	251202	02512	¾-1" Short Side	EA	1	\$830.00	\$830.00
9	251203	02512	1½-2" Long Side	EA	3	\$2,500.00	\$7,500.00
10	251204	02512	1½-2" Short Side	EA	9	\$1,800.00	\$16,200.00
			Ancillary items (20%)				\$99,586.00
			SubTotal				\$597,516.00
			General Items (10% of Water SubTotal)				\$59,751.60
TOTAL UNIT PRICES - WATER							\$657,267.60

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - DETENTION							
1		-	Excavation (Detention Pond) (Dry)	AC-FT			
2		-	Excavation (Detention Pond) (Wet)	AC-FT			
3		-	Regional Detention	AC-FT		\$44,796.00	\$0.00
TOTAL UNIT PRICES - DETENTION							\$0.00

TOTAL BASE UNIT PRICE:

\$12,318,496.19

Note:

1. This is not a Standard Document 00410B (Form 410). The Form 410 was modified for the purpose of planning level cost estimates for Pre-Engineering Studies.
2. The "Item Reference No." shall be designated for each item listed. The numbers serve as reference and will be used for the future cost updates.

North Project



**FY 2016 Candidate Projects (\$ Thousands)
Street & Traffic Control Program - Thoroughfares**

Candidate Project Summary Information			
Need Area:	N-2016T-0004	Alternative No.:	2
Name:	Shepherd Drive and Durham Drive	Council District:	C
Limits:	Interstate 610 to W 11th St (North Project)	Key Map No.:	452 P, R, U, V, Y, and Z
Type:	Principal Thoroughfare	Super Neighborhood:	Greater Heights
WBS No.:	(To be assigned by the City)	Total No. of Sub-projects:	2
Description:	Project provides for the ROW acquisition, design and construction of a 3-lane configuration with bicycle lanes and improved pedestrian facilities		
Justification:			

Implementation - Estimated Cost and Duration				
	City Funds	Other Entities Funds	Total	Duration
Total Project Cost	\$ 59,199	\$ -	\$ 59,199	
Acquisition	\$ 354	\$ -	\$ 354	12 Months
Design	\$ 10,060	\$ -	\$ 10,060	24 Months
Construction	\$ 38,692	\$ -	\$ 38,692	36 Months
Contingency	\$ 10,093	\$ -	\$ 10,093	NA
Private Utility Reloc.	\$ -	\$ -	\$ -	Months
Warranty	\$ -	\$ -	\$ -	12 Months

Candidate Project Priority Scores			Other Entities & Jurisdictions Coordination	
Infrastructure Categories	Benefit Scores (Total Maximum 100)		Entities	Coordination For
	Maximum	Actual		
Streets	75	20.99	TxDOT <input type="checkbox"/>	Unit W100-00-00 & Unit E100-00-00
			Metro <input checked="" type="checkbox"/>	
Drainage System	15	15.00	HCFC <input checked="" type="checkbox"/>	
			Gulf Coast Railroad District <input type="checkbox"/>	
Water	5	4.44	Union Pacific Rail Road <input type="checkbox"/>	
			Harris County <input type="checkbox"/>	
Wastewater	5	1.00	Fort Bend County <input type="checkbox"/>	
			Private Utilities <input type="checkbox"/>	
Total	100	41.43	(Name of Private Utility)	
Service Area Benefit score:		41.43	Municipalities <input type="checkbox"/>	
Benefitted Population:		45,957	(Name of municipality)	
Rebuild Houston Funds:		\$ 54,195	(Name of municipality)	
Candidate Project Priority Score:		68.16	Other <input type="checkbox"/>	
Candidate Project Priority Rank No.:		(To be assigned by the City)	Other <input type="checkbox"/>	

Sequencing Requirements (SR) and Other Considerations	
SR:	
Permits:	
Other:	

Maintenance - Estimated Cost and Frequency (By the City)				
Asset Categories	Estimated Asset Life	Maintenance Items	Cost	Schedule/Frequency
Streets	40-years	Street Sweeping	\$ -	4 Times Annually
		Overlay	\$ -	N/A
		Pot Hole Patch	\$ -	As needed - typically starts year 25
		Panel Repair	\$ -	As needed
Storm Drainage	50-years	Point Repair	\$ -	
			\$ -	
Water	50-years	Point Repair	\$ -	
			\$ -	
Wastewater	50-years	Point Repair	\$ -	
			\$ -	

**Major Thoroughfare and Collectors (No Change in Classification) Candidate
Project Priority Score Determination**

N-2016T-0004 - Shepherd Drive and Durham Drive: Interstate 610 to North of West 11th Street (North); Alternative 2 with inline detention; 3-Lane roadways with concrete curb and gutter, left turn lanes at signalized intersections, bicycle lanes, 6-foot sidewalks, traffic signals, and underground utilities (wastewater and stormwater improvements).

Infrastructure Category	Weight	Criteria	Project Parameter	Point Range	Measurement or Calculation	Points
Streets	75%	Pavement Condition	Avg. PCI = 65.02	0-60	0.6x(100-PCI)	20.99
		Intersection Level of Service	Existing LOS: D-F; Proposed LOS C-D	0-15	F to C or better = 15; E to C or better = 10; D to C or better = 5	0.00
Drainage System	15%	Extreme Event Level of Service	Improve to convey extreme event	0-5	No improvements = 0; Partial Improvements = 3; Conveys extreme event = 5	5.00
		Design Level of Service	Improve to convey design event	0-10	No improvements = 0; Partial Improvements = 5; Conveys extreme event = 10	10.00
Water	5%	WIRP Rank (1045 total Area)	116	0-5	Replace since 2000 = 0; ((Total WIRP Areas-WIRP Rank)/Total WIRP Areas) x 5	4.44
Wastewater	5%	SSO	3 SSO	0-2	No SSO = 0; SSO = 1; Repeat SSO = 2	0.00
		Point Repairs	PR = 1	0-2	PR<5 = 0; PR 5-10 = 1; PR >10 = 2	0.00
		Age of Pipe	30+ years	0-1	30 years or less = 0; More than 30 years = 1; Agreed order = 1	1.00
					Service Area Benefit Factor	41.43

Benefitted Population 35% Current ADT + 65 Future ADT = Current METRO Ridership 45,956.95

Current ADT	41,432	35% Current ADT	14,501.20
Future ADT	44,335	65% Future ADT	28,817.75
Current METRO	2,638	Current METRO	2,638.00

Candidate Project Priority Score = Service Benefit Factor x1.94 miles
= 41.43 x1.94 miles

Benefitted Population

City Rebuild Houston Funds
45,957

\$54,194.50

Candidate Project Priority Score = 68.16

Pre-Engineering Services Contracts

Total Project Cost Estimate Breakdown (FY18 Dollars)

Need No.: N-2016T-0004 - Shepherd Drive and Durham Drive: Interstate 610 to West 11th
Alt 2: 3-lane with Bicycle Lane (Inline Detention)

1	410 (Summarized based on FY 18 List of Unit Prices)	\$33,644,918.18
1.1	Total Unit Price, Paving Items	\$18,043,077.64
1.2	Total Unit Price, Storm Sewer Items	\$12,740,319.90
1.3	Total Unit Price, Water Items	\$2,267,520.64
1.4	Total Unit Price, Wastewater Items	\$594,000.00
2	Contingency (30% of 410)	\$10,093,475.45
3	Construction Management (15% of 410)	\$5,046,737.73
4	Engineering Fee Estimate (20% of Sum of 410 and Contingency)	\$8,747,678.73
5	Design Management (15% of Engineering Fee Estimate)	\$1,312,151.81
6	Land Acquisition (Engineer's Best Estimate)	\$354,340.00
	Total Project Cost	\$59,199,301.89

Note: General Items are prorated in Paving, Storm, Water & Wastewater items.

Pre-Engineering Services Contracts

COH Rebuild Funds

Need No.: N-2016T-0004 - Shepherd Drive and Durham Drive: Interstate 610 to West 11th
Alt 2: 3-lane with Bicycle Lane (Inline Detention)

1	410 (Summarized based on FY 18 List of Unit Prices)	\$30,783,397.54
	1.1 Total Unit Price, Paving Items	\$18,043,077.64
	1.2 Total Unit Price, Storm Sewer Items	\$12,740,319.90
2	Contingency (30% of 410)	\$9,235,019.26
3	Construction Management (15% of 410)	\$4,617,509.63
4	Engineering Fee Estimate (20% of Sum of 410 and Contingency)	\$8,003,683.36
5	Design Management (15% of Engineering Fee Estimate)	\$1,200,552.50
6	Land Acquisition (Engineer's Best Estimate)	\$354,340.00
	Total Project Cost	\$54,194,502.29

Note: General Items are prorated in Paving & Storm items.

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: North Project Shepherd and Durham between North of W 11th St and Interstate 610

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

Document 00410B Note 1

BID FORM - PART B

1.0 TOTAL BID PRICE HAS BEEN CALCULATED BY BIDDER, USING THE FOLLOWING COMPONENT PRICES AND

A. STIPULATED PRICE

\$ N/A

(Total Bid Price; minus Base Unit Prices, Extra Unit Process, Cash Allowance and All Alternates, if any)

B. BASE UNIT PRICE TABLE:

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - PAVING ITEMS							
1	222101	02221	Remove and Dispose of Existing Pavement and Curb -Assumes all concrete pavement thicknesses with or without asphalt overlay	SY	106,370	\$6.00	\$638,220.00
2	222102	02221	Remove and Dispose of Existing Driveways and Sidewalks	SY	14,127	\$5.00	\$70,633.50
3	275106	02751	11" Reinforced Concrete Pavement (Complete in Place)	SY	104,160	\$70.00	\$7,291,200.00
4	233601	02336	Lime stabilized subgrade (6" thick)	SY	530	\$3.00	\$1,590.00
5	233602	02336	Lime stabilized subgrade (8" thick)	SY	114,580	\$4.00	\$458,320.00
6	233603	02336	Lime (6, 7% By Weight)	Ton	2,290	\$164.00	\$375,560.00
7	277101	02771	6" Concrete Curb	LF	47,490	\$4.00	\$189,960.00
8	275201	02752	Expansion Joint	LF	11,720	\$8.00	\$93,760.00
9	275401	02754	6" Concrete for Driveways	SF	47,680	\$8.00	\$381,440.00
10	277501	02775	4-1/2" Concrete for Sidewalks	SF	284,940	\$7.00	\$1,994,580.00
11	292201	02922	Sodding	SY	7,920	\$5.00	\$39,600.00
12	289301	02893	Traffic Signal/Intersection	EA	8	\$325,000.00	\$2,600,000.00
13	-	-	Railroad Crossing	EA	0	\$1,000,000.00	\$0.00
14	231501	02315	Roadway Excavation	CY	6,790	\$16.00	\$108,640.00
15	-	-	Pedestrian Bridge	LF	400	\$110.00	\$44,000.00
16	1601001	-	Street Light Removal	EA	170	\$272.00	\$46,240.00
17	1601002	-	Street Light Installation (includes conduit and Temporary Lighting during Construction)	LF	19,865	\$32.00	\$635,680.00
			Ancillary Items (10%)				\$1,433,374.35
			SubTotal of Paving				\$16,402,797.85
			General Items (10% of Paving Subtotal)				\$1,640,279.79
TOTAL - PAVING ITEMS							\$18,043,077.64

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - STORM SEWER ITEMS							
1	222103	02221	Remove Storm Sewer Pipe (All Types)	LF	11,220	\$20.00	\$224,400.00
2	222105	02221	Remove Inlets (All Types)	EA	160	\$370.00	\$59,200.00
3	222106	02221	Remove Manholes (All Types, All Depths)	EA	40	\$390.00	\$15,600.00
4	263301	02633	Curb Inlets (All Types)	EA	140	\$2,910.00	\$407,400.00
5	208201	02082	Manholes (For 42" Dia. Pipe and Smaller) (All Types)	EA	10	\$3,470.00	\$34,700.00
6	208202	02082	Manholes (For 48" to 72" Dia. Pipe) (All Types)	EA	5	\$6,340.00	\$31,700.00
Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
			00410B-13 Description 12-06-2017				

Bidders Initials []

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: North Project Shepherd and Durham between North of W 11th St and Interstate 610

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

7	208203	02082	Manholes (For 78" Dia. Pipe and Larger) (All Types)	EA	20	\$16,500.00	\$330,000.00
8	263101	02631	24-inch RCP	LF	5,300	\$115.00	\$609,500.00
9	263102	02631	30-inch RCP	LF	370	\$150.00	\$55,500.00
10	263103	02631	36-inch RCP	LF	370	\$180.00	\$66,600.00
11	263104	02631	42-inch RCP	LF	2,220	\$215.00	\$477,300.00
12	263105	02631	48-inch RCP	LF	850	\$250.00	\$212,500.00
13	263106	02631	54-inch RCP	LF	260	\$270.00	\$70,200.00
14	263107	02631	60-inch RCP	LF	940	\$350.00	\$329,000.00
15	263108	02631	66-inch RCP	LF	270	\$360.00	\$97,200.00
16	263109	02631	72-inch RCP	LF	0	\$485.00	\$0.00
17	263113	02631	96-inch RCP	LF	790	\$730.00	\$576,700.00
18	263123	02631	4x2 RCB	LF	0	\$250.00	\$0.00
19	263126	02631	5x3 RCB	LF	0	\$300.00	\$0.00
20	263128	02631	5X5 RCB	LF	1,410	\$350.00	\$493,500.00
21	263129	02631	6x3 RCB	LF	370	\$350.00	\$129,500.00
22	263130	02631	6x4 RCB	LF	3,160	\$445.00	\$1,406,200.00
23	263132	02631	6X6 RCB	LF	370	\$480.00	\$177,600.00
24	263134	02631	7X5 RCB	LF	0	\$580.00	\$0.00
25	263137	02631	8x4 RCB	LF	370	\$580.00	\$214,600.00
26	263147	02631	10X5 RCB	LF	0	\$850.00	\$0.00
27	263152	02631	10X10 RCB	LF	2,960	\$1,300.00	\$3,848,000.00
28	263161	02631	12x10 RCB	LF	840	\$1,335.00	\$1,121,400.00
29	226001	02260	Trench Safety System	LF	20,840	\$2.00	\$41,680.00
30	231504	02315	Fill Existing Ditch	CY	100	\$6.00	\$600.00
			Ancillary Items (10%)				\$551,529.00
			SubTotal of Storm Sewer				\$11,582,109.00
			General Items (10% of Storm Sewer Subtotal)				\$1,158,210.90
TOTAL UNIT PRICES - STORM SEWER ITEMS							\$12,740,319.90

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - WASTEWATER							
1	222108	02221	Remove Existing Sanitary Sewer Manhole (All Types)	EA		\$800.00	\$0.00
2	222201	02221	Abandon and Fill Existing Sanitary Sewer Manhole (All Types)	EA		\$1,000.00	\$0.00
3	222109	02221	Remove Existing Sanitary Sewer Pipe (All Types)	LF		\$20.00	\$0.00
4	222202	02222	Abandon and Fill Existing Sanitary Sewer Pipe (All Sizes)	LF		\$20.00	\$0.00
5	-	02222	Abandon Existing Sanitary Sewer Lift Station	EA		\$100,000.00	\$0.00
6	253103	02531	10" PVC	LF		\$160.00	\$0.00
7	253105	02531	15" PVC	LF		\$230.00	\$0.00
8	253108	02531	30" PVC	LF		\$480.00	\$0.00
9	253109	02531	36" PVC	LF	750	\$590.00	\$442,500.00
10	253401	02534	Service Leads (Assume 6" Lead)	LF		\$120.00	\$0.00
11	208204	02082	Sanitary Sewer Manholes (4' diameter)	EA		\$4,200.00	\$0.00
12	208204	02082	Sanitary Sewer Manholes (5'-8' diameter)	EA	1	\$7,500.00	\$7,500.00

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: North Project Shepherd and Durham between North of W 11th St and Interstate 610

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

			Ancillary Items (20%)			\$90,000.00
			SubTotal of Wastewater			\$540,000.00
			General Items (10% of Wastewater Subtotal)			\$54,000.00
TOTAL UNIT PRICES - WASTEWATER						\$594,000.00

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price <small>(this column controls)</small>	Total in Figures
UNIT PRICES - WATER							
1	252001	02520	Remove and Salvage Fire Hydrants	EA	33	\$400.00	\$13,294.67
2	222107	02221	Remove Existing Water Line (All Types)	LF	9,971	\$16.00	\$159,536.00
3	251601	02516	Cut, Plug, and Abandon Existing Water Line (All Types)	EA	0	\$910.00	\$0.00
4	251102	02511	8" Water Line	LF	6,271	\$100.00	\$627,100.00
5	251104	02511	12" Water Line	LF	3,700	\$140.00	\$518,000.00
6	252002	02520	Fire Hydrant Assembly	EA	33	\$5,400.00	\$179,478.00
7	251201	02512	¾-1" Long Side	EA	20	\$1,500.00	\$30,000.00
8	251202	02512	¾-1" Short Side	EA	37	\$830.00	\$30,710.00
9	251203	02512	1½-2" Long Side	EA	43	\$2,500.00	\$107,500.00
10	251204	02512	1½-2" Short Side	EA	29	\$1,800.00	\$52,200.00
		-	Ancillary items (20%)				\$343,563.73
			SubTotal				\$2,061,382.40
		-	General Items (10% of Water SubTotal)				\$206,138.24
TOTAL UNIT PRICES - WATER							\$2,267,520.64

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price <small>(this column controls)</small>	Total in Figures
UNIT PRICES - DETENTION							
1		-	Excavation (Detention Pond) (Dry)	AC-FT			
2		-	Excavation (Detention Pond) (Wet)	AC-FT			
3		-	Regional Detention	AC-FT		\$44,796.00	\$0.00
TOTAL UNIT PRICES - DETENTION							\$0.00

TOTAL BASE UNIT PRICE:

\$33,644,918.18

Note:

1. This is not a Standard Document 00410B (Form 410). The Form 410 was modified for the purpose of planning level cost estimates for Pre-Engineering Studies.
2. The "Item Reference No." shall be designated for each item listed. The numbers serve as reference and will be used for the future cost updates.

North Project

Sub-Project 1



**Major Thoroughfare and Collectors (No Change in Classification) Candidate
Project Priority Score Determination**

N-2016T-0004 - Shepherd Drive and Durham Drive:South of West 18th Street to North of West 11th Street (North Sub-Project 1); Alternative 2 with inline detention; 3-Lane roadways with concrete curb and gutter, left turn lanes at signalized intersections, bicycle lanes, 6-foot sidewalks, traffic signals, and underground utilities (wastewater and stormwater improvements).

Infrastructure Category	Weight	Criteria	Project Parameter	Point Range	Measurement or Calculation	Points
Streets	75%	Pavement Condition	Avg. PCI = 61.78	0-60	0.6x(100-PCI)	22.93
		Intersection Level of Service	Existing LOS: D-F; Proposed LOS C-D	0-15	F to C or better = 15; E to C or better = 10; D to C or better = 5	0.00
Drainage System	15%	Extreme Event Level of Service	Improve to convey extreme event	0-5	No improvements = 0; Partial Improvements = 3; Conveys extreme event = 5	5.00
		Design Level of Service	Improve to convey design event	0-10	No improvements = 0; Partial Improvements = 5; Conveys extreme event = 10	10.00
Water	5%	WIRP Rank (1045 total Area)	116	0-5	Replace since 2000 = 0; ((Total WIRP Areas-WIRP Rank)/Total WIRP Areas) x 5	4.44
Wastewater	5%	SSO	3 SSO	0-2	No SSO = 0; SSO = 1; Repeat SSO = 2	0.00
		Point Repairs	PR = 1	0-2	PR<5 = 0; PR 5-10 = 1; PR >10 = 2	0.00
		Age of Pipe	30+ years	0-1	30 years or less = 0; More than 30 years = 1; Agreed order = 1	1.00
					Service Area Benefit Factor	43.38

Benefitted Population 35% Current ADT + 65 Future ADT = Current METRO Ridership 45,956.95

Current ADT	41,432	35% Current ADT	14,501.20
Future ADT	44,335	65% Future ADT	28,817.75
Current METRO	2,638	Current METRO	2,638.00

Candidate Project Priority Score = Service Benefit Factor
= 43.38

Benefitted Population

City Rebuild Houston Funds
45,957

\$20,965.64

Candidate Project Priority Score = 95.08

Pre-Engineering Services Contracts

Total Project Cost Estimate Breakdown (FY18 Dollars)

Need No.: N-2016T-0004 - Shepherd Drive and Durham Drive: West 18th to West 11th

Alt 2: 3-lane with Bicycle Lane (Inline Detention)

1	410 (Summarized based on FY 18 List of Unit Prices)	\$12,602,937.16
1.1	Total Unit Price, Paving Items	\$7,367,145.39
1.2	Total Unit Price, Storm Sewer Items	\$4,417,477.13
1.3	Total Unit Price, Water Items	\$224,314.64
1.4	Total Unit Price, Wastewater Items	\$594,000.00
2	Contingency (30% of 410)	\$3,780,881.15
3	Construction Management (15% of 410)	\$1,890,440.57
4	Engineering Fee Estimate (20% of Sum of 410 and Contingency)	\$3,276,763.66
5	Design Management (15% of Engineering Fee Estimate)	\$491,514.55
6	Land Acquisition (Engineer's Best Estimate)	\$354,340.00
	Total Project Cost	\$22,396,877.09

Note: General Items are prorated in Paving, Storm, Water & Wastewater items.

Pre-Engineering Services Contracts

COH Rebuild Funds

Need No.: N-2016T-0004 - Shepherd Drive and Durham Drive: West 18th to West 11th

Alt 2: 3-lane with Bicycle Lane (Inline Detention)

1	410 (Summarized based on FY 18 List of Unit Prices)	\$11,784,622.52
	1.1 Total Unit Price, Paving Items	\$7,367,145.39
	1.2 Total Unit Price, Storm Sewer Items	\$4,417,477.13
2	Contingency (30% of 410)	\$3,535,386.76
3	Construction Management (15% of 410)	\$1,767,693.38
4	Engineering Fee Estimate (20% of Sum of 410 and Contingency)	\$3,064,001.85
5	Design Management (15% of Engineering Fee Estimate)	\$459,600.28
6	Land Acquisition (Engineer's Best Estimate)	\$354,340.00
	Total Project Cost	\$20,965,644.78

Note: General Items are prorated in Paving & Storm items.

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between West 18th Street and West 11th Street (North Project Sub-Project 1)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

Document 00410B ^{Note 1}

BID FORM - PART B

1.0 TOTAL BID PRICE HAS BEEN CALCULATED BY BIDDER, USING THE FOLLOWING COMPONENT PRICES AND

A. STIPULATED PRICE

\$ N/A

(Total Bid Price; minus Base Unit Prices, Extra Unit Process, Cash Allowance and All Alternates, if any)

B. BASE UNIT PRICE TABLE:

Item No.	Item Reference No. ^{Note 2}	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - PAVING ITEMS							
1	222101	02221	Remove and Dispose of Existing Pavement and Curb -Assumes all concrete pavement thicknesses with or without asphalt overlay	SY	46,730	\$6.00	\$280,380.00
2	222102	02221	Remove and Dispose of Existing Driveways and Sidewalks	SY	6,218	\$5.00	\$31,089.00
3	275106	02751	11" Reinforced Concrete Pavement (Complete in Place)	SY	45,780	\$70.00	\$3,204,600.00
4	233601	02336	Lime stabilized subgrade (6" thick)	SY	240	\$3.00	\$720.00
5	233602	02336	Lime stabilized subgrade (8" thick)	SY	50,350	\$4.00	\$201,400.00
6	233603	02336	Lime (6, 7% By Weight)	Ton	1,010	\$164.00	\$165,640.00
7	277101	02771	6" Concrete Curb	LF	21,780	\$4.00	\$87,120.00
8	275201	02752	Expansion Joint	LF	5,150	\$8.00	\$41,200.00
9	275401	02754	6" Concrete for Driveways	SF	21,600	\$8.00	\$172,800.00
10	277501	02775	4-1/2" Concrete for Sidewalks	SF	130,680	\$7.00	\$914,760.00
11	292201	02922	Sodding	SY	3,630	\$5.00	\$18,150.00
12	289301	02893	Traffic Signal/Intersection	EA	2	\$325,000.00	\$650,000.00
13	-	-	Railroad Crossing	EA	0	\$1,000,000.00	\$0.00
14	231501	02315	Roadway Excavation	CY	2,980	\$16.00	\$47,680.00
15	-	-	Pedestrian Bridge	LF	0	\$110.00	\$0.00
16	1601001	-	Street Light Removal	EA	85	\$272.00	\$23,120.00
17	1601002	-	Street Light Installation (includes conduit and Temporary Lighting during Construction)	LF	8,590	\$32.00	\$274,880.00
			Ancillary items (10%)				\$583,865.90
			SubTotal of Paving				\$6,697,404.90
			General Items (10% of Paving Subtotal)				\$669,740.49
TOTAL - PAVING ITEMS							\$7,367,145.39
Item No.	Item Reference No. ^{Note 2}	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - STORM SEWER ITEMS							
1	222103	02221	Remove Storm Sewer Pipe (All Types)	LF	5,580	\$20.00	\$111,600.00
2	222105	02221	Remove Inlets (All Types)	EA	73	\$370.00	\$27,010.00
3	222106	02221	Remove Manholes (All Types, All Depths)	EA	19	\$390.00	\$7,410.00
4	263301	02633	Curb Inlets (All Types)	EA	73	\$2,910.00	\$212,430.00
5	208201	02082	Manholes (For 42" Dia. Pipe and Smaller) (All Types)	EA	2	\$3,470.00	\$6,940.00
6	208202	02082	Manholes (For 48" to 72" Dia. Pipe) (All Types)	EA	5	\$6,340.00	\$31,700.00

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between West 18th Street and West 11th Street (North Project Sub-Project 1) **BID FORM**

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention **PART B**

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
7	208203	02082	Manholes (For 78" Dia. Pipe and Larger) (All Types)	EA	20	\$16,500.00	\$330,000.00
8	263101	02631	24-inch RCP	LF	2,150	\$115.00	\$247,250.00
9	263102	02631	30-inch RCP	LF	0	\$150.00	\$0.00
10	263103	02631	36-inch RCP	LF	0	\$180.00	\$0.00
11	263104	02631	42-inch RCP	LF	1	\$215.00	\$186.12
12	263105	02631	48-inch RCP	LF	850	\$250.00	\$212,500.00
13	263106	02631	54-inch RCP	LF	260	\$270.00	\$70,200.00
14	263107	02631	60-inch RCP	LF	247	\$350.00	\$86,450.00
15	263108	02631	66-inch RCP	LF	269	\$360.00	\$96,840.00
16	263109	02631	72-inch RCP	LF	0	\$485.00	\$0.00
17	263113	02631	96-inch RCP	LF	790	\$730.00	\$576,699.41
18	263123	02631	4x2 RCB	LF	0	\$250.00	\$0.00
19	263126	02631	5x3 RCB	LF	0	\$300.00	\$0.00
20	263128	02631	5X5 RCB	LF	1,410	\$350.00	\$493,500.00
21	263129	02631	6x3 RCB	LF	0	\$350.00	\$0.00
22	263130	02631	6x4 RCB	LF	0	\$445.00	\$0.00
23	263132	02631	6X6 RCB	LF	370	\$480.00	\$177,600.00
24	263134	02631	7X5 RCB	LF	0	\$580.00	\$0.00
25	263137	02631	8x4 RCB	LF	0	\$580.00	\$0.00
26	263147	02631	10X5 RCB	LF	0	\$850.00	\$0.00
27	263152	02631	10X10 RCB	LF	0	\$1,300.00	\$0.00
28	263161	02631	12x10 RCB	LF	840	\$1,335.00	\$1,121,400.00
29	226001	02260	Trench Safety System	LF	7,170	\$2.00	\$14,340.00
30	231504	02315	Fill Existing Ditch	CY	100	\$6.00	\$600.00
			Ancillary Items (10%)				\$191,232.78
			SubTotal of Storm Sewer				\$4,015,888.31
			General Items (10% of Storm Sewer Subtotal)				\$401,588.83
TOTAL UNIT PRICES - STORM SEWER ITEMS							\$4,417,477.13

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - WASTEWATER							
1	222108	02221	Remove Existing Sanitary Sewer Manhole (All Types)	EA		\$800.00	\$0.00
2	222201	02221	Abandon and Fill Existing Sanitary Sewer Manhole (All Types)	EA		\$1,000.00	\$0.00
3	222109	02221	Remove Existing Sanitary Sewer Pipe (All Types)	LF		\$20.00	\$0.00
4	222202	02222	Abandon and Fill Existing Sanitary Sewer Pipe (All Sizes)	LF		\$20.00	\$0.00
5	222205	02222	Abandon Existing Sanitary Sewer Lift Station	EA		\$100,000.00	\$0.00
6	253103	02531	10" PVC	LF		\$160.00	\$0.00
7	253105	02531	15" PVC	LF		\$230.00	\$0.00
8	253108	02531	30" PVC	LF		\$480.00	\$0.00
9	253109	02531	36" PVC	LF	750	\$590.00	\$442,500.00
10	253401	02534	Service Leads (Assume 6" Lead)	LF		\$120.00	\$0.00
11	208204	02082	Sanitary Sewer Manholes (4' diameter)	EA		\$4,200.00	\$0.00
12	208204	02082	Sanitary Sewer Manholes (5'-8' diameter)	EA	1	\$7,500.00	\$7,500.00
			Ancillary Items (20%)				\$90,000.00

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between West 18th Street and West 11th Street (North Project Sub-Project 1)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

			SubTotal of Wastewater				\$540,000.00
			General Items (10% of Wastewater Subtotal)				\$54,000.00
TOTAL UNIT PRICES - WASTEWATER							\$594,000.00

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price <small>(this column controls)</small>	Total in Figures
UNIT PRICES - WATER							
1	252001	02520	Remove and Salvage Fire Hydrants	EA	4	\$400.00	\$1,481.33
2	222107	02221	Remove Existing Water Line (All Types)	LF	1,111	\$16.00	\$17,776.00
3	251601	02516	Cut, Plug, and Abandon Existing Water Line (All Types)	EA		\$910.00	\$0.00
4	251102	02511	8" Water Line	LF	1,111	\$100.00	\$111,100.00
5	251104	02511	12" Water Line	LF		\$140.00	\$0.00
6	252002	02520	Fire Hydrant Assembly	EA	4	\$5,400.00	\$19,998.00
7	251201	02512	¾-1" Long Side	EA	4	\$1,500.00	\$6,000.00
8	251202	02512	¾-1" Short Side	EA	6	\$830.00	\$4,980.00
9	251203	02512	1½-2" Long Side	EA	2	\$2,500.00	\$5,000.00
10	251204	02512	1½-2" Short Side	EA	2	\$1,800.00	\$3,600.00
		-	Ancillary items (20%)				\$33,987.07
			SubTotal				\$203,922.40
		-	General Items (10% of Water SubTotal)				\$20,392.24
TOTAL UNIT PRICES - WATER							\$224,314.64

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price <small>(this column controls)</small>	Total in Figures
UNIT PRICES - DETENTION							
1		-	Excavation (Detention Pond) (Dry)	AC-FT			
2		-	Excavation (Detention Pond) (Wet)	AC-FT			
3		-	Regional Detention	AC-FT		\$44,796.00	\$0.00
TOTAL UNIT PRICES - DETENTION							\$0.00

TOTAL BASE UNIT PRICE:

\$12,602,937.16

Note:

1. This is not a Standard Document 00410B (Form 410). The Form 410 was modified for the purpose of planning level cost estimates for Pre-Engineering Studies.
2. The "Item Reference No." shall be designated for each item listed. The numbers serve as reference and will be used for the future cost updates.

North Project

Sub-Project 2



**Major Thoroughfare and Collectors (No Change in Classification) Candidate
Project Priority Score Determination**

N-2016T-0004 - Shepherd Drive and Durham Drive: Interstate 610 to South of West 18th Street (Sub-Project 4); Alternative 2 with inline detention; 3-Lane roadways with concrete curb and gutter, left turn lanes at signalized intersections, bicycle lanes, 6-foot sidewalks, traffic signals, and underground utilities (wastewater and stormwater improvements).

Infrastructure Category	Weight	Criteria	Project Parameter	Point Range	Measurement or Calculation	Points
Streets	75%	Pavement Condition	Avg. PCI = 66.44	0-60	0.6x(100-PCI)	20.14
		Intersection Level of Service	Existing LOS: D-F; Proposed LOS C-D	0-15	F to C or better = 15; E to C or better = 10; D to C or better = 5	0.00
Drainage System	15%	Extreme Event Level of Service	Improve to convey extreme event	0-5	No improvements = 0; Partial Improvements = 3; Conveys extreme event = 5	5.00
		Design Level of Service	Improve to convey design event	0-10	No improvements = 0; Partial Improvements = 5; Conveys extreme event = 10	10.00
Water	5%	WIRP Rank (1045 total Area)	116	0-5	Replace since 2000 = 0; ((Total WIRP Areas-WIRP Rank)/Total WIRP Areas) x 5	4.44
Wastewater	5%	SSO	3 SSO	0-2	No SSO = 0; SSO = 1; Repeat SSO = 2	0.00
		Point Repairs	PR = 0	0-2	PR<5 = 0; PR 5-10 = 1; PR >10 = 2	0.00
		Age of Pipe	30+ years	0-1	30 years or less = 0; More than 30 years = 1; Agreed order = 1	1.00
					Service Area Benefit Factor	40.58

Benefitted Population 35% Current ADT + 65 Future ADT = Current METRO Ridership 45,956.95

Current ADT	41,432	35% Current ADT	14,501.20
Future ADT	44,335	65% Future ADT	28,817.75
Current METRO	2,638	Current METRO	2,638.00

Candidate Project Priority Score =	Service Benefit Factor	x 1.10 mile	Benefitted Population
=	40.58	x 1.10 mile	City Rebuild Houston Funds
			45,957
			\$33,532.54

Candidate Project Priority Score =	61.18
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Pre-Engineering Services Contracts

Total Project Cost Estimate Breakdown (FY18 Dollars)

Need No.: N-2016T-0004 - Shepherd Drive and Durham Drive: Interstate 610 to West 18th
Alt 2: 3-lane with Bicycle Lane (Inline Detention)

1	410 (Summarized based on FY 18 List of Unit Prices)	\$21,215,610.48
1.1	Total Unit Price, Paving Items	\$10,667,595.35
1.2	Total Unit Price, Storm Sewer Items	\$8,504,809.13
1.3	Total Unit Price, Water Items	\$2,043,206.00
1.4	Total Unit Price, Wastewater Items	\$0.00
2	Contingency (30% of 410)	\$6,364,683.14
3	Construction Management (15% of 410)	\$3,182,341.57
4	Engineering Fee Estimate (20% of Sum of 410 and Contingency)	\$5,516,058.72
5	Design Management (15% of Engineering Fee Estimate)	\$827,408.81
6	Land Acquisition (Engineer's Best Estimate)	\$0.00
	Total Project Cost	\$37,106,102.73

Note: General Items are prorated in Paving, Storm, Water & Wastewater items.

Pre-Engineering Services Contracts

COH Rebuild Funds

Need No.: N-2016T-0004 - Shepherd Drive and Durham Drive: Interstate 610 to West 18th
Alt 2: 3-lane with Bicycle Lane (Inline Detention)

1	410 (Summarized based on FY 18 List of Unit Prices)	\$19,172,404.48
	1.1 Total Unit Price, Paving Items	\$10,667,595.35
	1.2 Total Unit Price, Storm Sewer Items	\$8,504,809.13
2	Contingency (30% of 410)	\$5,751,721.34
3	Construction Management (15% of 410)	\$2,875,860.67
4	Engineering Fee Estimate (20% of Sum of 410 and Contingency)	\$4,984,825.16
5	Design Management (15% of Engineering Fee Estimate)	\$747,723.77
6	Land Acquisition (Engineer's Best Estimate)	\$0.00
	Total Project Cost	\$33,532,535.43

Note: General Items are prorated in Paving & Storm items.

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between Interstate 610 and West 18th Street (North Project Sub-Project 2)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

Document 00410B Note 1

BID FORM - PART B

1.0 TOTAL BID PRICE HAS BEEN CALCULATED BY BIDDER, USING THE FOLLOWING COMPONENT PRICES AND

A. STIPULATED PRICE

\$ N/A

(Total Bid Price; minus Base Unit Prices, Extra Unit Process, Cash Allowance and All Alternates, if any)

B. BASE UNIT PRICE TABLE:

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - PAVING ITEMS							
1	222101	02221	Remove and Dispose of Existing Pavement and Curb -Assumes all concrete pavement thicknesses with or without asphalt overlay	SY	59,640	\$6.00	\$357,840.00
2	222102	02221	Remove and Dispose of Existing Driveways and Sidewalks	SY	7,909	\$5.00	\$39,544.50
3	275106	02751	11" Reinforced Concrete Pavement (Complete in Place)	SY	58,390	\$70.00	\$4,087,300.00
4	233601	02336	Lime stabilized subgrade (6" thick)	SY	7,310	\$3.00	\$21,930.00
5	233602	02336	Lime stabilized subgrade (8" thick)	SY	64,220	\$4.00	\$256,880.00
6	233603	02336	Lime (6, 7% By Weight)	Ton	1,390	\$164.00	\$227,960.00
7	277101	02771	6" Concrete Curb	LF	25,710	\$4.00	\$102,840.00
8	275201	02752	Expansion Joint	LF	6,570	\$8.00	\$52,560.00
9	275401	02754	6" Concrete for Driveways	SF	26,080	\$8.00	\$208,640.00
10	277501	02775	4-1/2" Concrete for Sidewalks	SF	154,260	\$7.00	\$1,079,820.00
11	292201	02922	Sodding	SY	3,760	\$5.00	\$18,800.00
12	289301	02893	Traffic Signal/Intersection	EA	6	\$325,000.00	\$1,950,000.00
13	-	-	Railroad Crossing	EA	0	\$1,000,000.00	\$0.00
14	231501	02315	Roadway Excavation	CY	3,810	\$16.00	\$60,960.00
15	-	-	Pedestrian Bridge	LF	0	\$110.00	\$0.00
16	1601001	-	Street Light Removal	EA	85	\$272.00	\$23,120.00
17	1601002	-	Street Light Installation (includes conduit and Temporary Lighting during Construction)	LF	11,275	\$32.00	\$360,800.00
			Ancillary items (10%)				\$848,819.45
			SubTotal of Paving				\$9,697,813.95
			General Items (10% of Paving Subtotal)				\$969,781.40
TOTAL - PAVING ITEMS							\$10,667,595.35

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - STORM SEWER ITEMS							
1	222103	02221	Remove Storm Sewer Pipe (All Types)	LF	5,640	\$20.00	\$112,800.00
2	222105	02221	Remove Inlets (All Types)	EA	90	\$370.00	\$33,300.00
3	222106	02221	Remove Manholes (All Types, All Depths)	EA	16	\$390.00	\$6,240.00
4	263301	02633	Curb Inlets (All Types)	EA	60	\$2,910.00	\$174,600.00
5	208201	02082	Manholes (For 42" Dia. Pipe and Smaller) (All Types)	EA	10	\$3,470.00	\$34,700.00

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between Interstate 610 and West 18th Street (North Project Sub-Project 2)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
6	208202	02082	Manholes (For 48" to 72" Dia. Pipe) (All Types)	EA	1	\$6,340.00	\$6,340.00
7	208203	02082	Manholes (For 78" Dia. Pipe and Larger) (All Types)	EA	10	\$16,500.00	\$165,000.00
8	263101	02631	24-inch RCP	LF	3,151	\$115.00	\$362,365.00
9	263102	02631	30-inch RCP	LF	370	\$150.00	\$55,500.00
10	263103	02631	36-inch RCP	LF	370	\$180.00	\$66,600.00
11	263104	02631	42-inch RCP	LF	2,221	\$215.00	\$477,486.12
12	263105	02631	48-inch RCP	LF	0	\$250.00	\$0.00
13	263106	02631	54-inch RCP	LF	0	\$270.00	\$0.00
14	263107	02631	60-inch RCP	LF	694	\$350.00	\$242,900.00
15	263108	02631	66-inch RCP	LF	0	\$360.00	\$0.00
16	263109	02631	72-inch RCP	LF	0	\$485.00	\$0.00
17	263113	02631	96-inch RCP	LF	0	\$730.00	\$0.00
18	263123	02631	4x2 RCB	LF	0	\$250.00	\$0.00
19	263126	02631	5x3 RCB	LF	0	\$300.00	\$0.00
20	263128	02631	5X5 RCB	LF	0	\$350.00	\$0.00
21	263129	02631	6x3 RCB	LF	370	\$350.00	\$129,500.00
22	263130	02631	6x4 RCB	LF	3,160	\$445.00	\$1,406,200.00
23	263132	02631	6X6 RCB	LF	0	\$480.00	\$0.00
24	263134	02631	7X5 RCB	LF	0	\$580.00	\$0.00
25	263137	02631	8x4 RCB	LF	370	\$580.00	\$214,600.00
26	263147	02631	10X5 RCB	LF	0	\$850.00	\$0.00
27	263152	02631	10X10 RCB	LF	2,960	\$1,300.00	\$3,848,000.00
28	263161	02631	12x10 RCB	LF	0	\$1,335.00	\$0.00
29	226001	02260	Trench Safety System	LF	13,670	\$2.00	\$27,340.00
30	231504	02315	Fill Existing Ditch	CY	0	\$6.00	\$0.00
			Ancillary items (10%)				\$368,173.56
			SubTotal of Storm Sewer				\$7,731,644.68
			General Items (10% of Storm Sewer Subtotal)				\$773,164.47
TOTAL UNIT PRICES - STORM SEWER ITEMS							\$8,504,809.13

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - WASTEWATER							
1	222108	02221	Remove Existing Sanitary Sewer Manhole (All Types)	EA		\$800.00	\$0.00
2	222201	02221	Abandon and Fill Existing Sanitary Sewer Manhole (All Types)	EA		\$1,000.00	\$0.00
3	222109	02221	Remove Existing Sanitary Sewer Pipe (All Types)	LF		\$20.00	\$0.00
4	222202	02222	Abandon and Fill Existing Sanitary Sewer Pipe (All Sizes)	LF		\$20.00	\$0.00
5	222205	02222	Abandon Existing Sanitary Sewer Lift Station	EA		\$100,000.00	\$0.00
6	253103	02531	10" PVC	LF		\$160.00	\$0.00
7	253105	02531	15" PVC	LF		\$230.00	\$0.00
8	253108	02531	30" PVC	LF		\$480.00	\$0.00
9	253109	02531	36" PVC	LF		\$590.00	\$0.00
10	253401	02534	Service Leads (Assume 6" Lead)	LF		\$120.00	\$0.00
11	208204	02082	Sanitary Sewer Manholes (4' diameter)	EA		\$4,200.00	\$0.00

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between Interstate 610 and West 18th Street (North Project Sub-Project 2)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

12	208204	02082	Sanitary Sewer Manholes (5'-8' diameter)	EA		\$7,500.00	\$0.00
			Ancillary Items (20%)				\$0.00
			SubTotal of Wastewater				\$0.00
			General Items (10% of Wastewater Subtotal)				\$0.00
TOTAL UNIT PRICES - WASTEWATER							\$0.00

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - WATER							
1	252001	02520	Remove and Salvage Fire Hydrants	EA	30	\$400.00	\$11,813.33
2	222107	02221	Remove Existing Water Line (All Types)	LF	8,860	\$16.00	\$141,760.00
3	251601	02516	Cut, Plug, and Abandon Existing Water Line (All Types)	EA		\$910.00	\$0.00
4	251102	02511	8" Water Line	LF	5,160	\$100.00	\$516,000.00
5	251104	02511	12" Water Line	LF	3,700	\$140.00	\$518,000.00
6	252002	02520	Fire Hydrant Assembly	EA	30	\$5,400.00	\$159,480.00
7	251201	02512	¾-1" Long Side	EA	16	\$1,500.00	\$24,000.00
8	251202	02512	¾-1" Short Side	EA	31	\$830.00	\$25,730.00
9	251203	02512	1½-2" Long Side	EA	41	\$2,500.00	\$102,500.00
10	251204	02512	1½-2" Short Side	EA	27	\$1,800.00	\$48,600.00
		-	Ancillary items (20%)				\$309,576.67
			SubTotal				\$1,857,460.00
		-	General Items (10% of Water SubTotal)				\$185,746.00
TOTAL UNIT PRICES - WATER							\$2,043,206.00

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - DETENTION							
1		-	Excavation (Detention Pond) (Dry)	AC-FT			
2		-	Excavation (Detention Pond) (Wet)	AC-FT			
3		-	Regional Detention	AC-FT		\$44,796.00	\$0.00
TOTAL UNIT PRICES - DETENTION							\$0.00

TOTAL BASE UNIT PRICE:

\$21,215,610.48

Note:

1. This is not a Standard Document 00410B (Form 410). The Form 410 was modified for the purpose of planning level cost estimates for Pre-Engineering Studies.
2. The "Item Reference No." shall be designated for each item listed. The numbers serve as reference and will be used for the future cost updates.

EXHIBITS

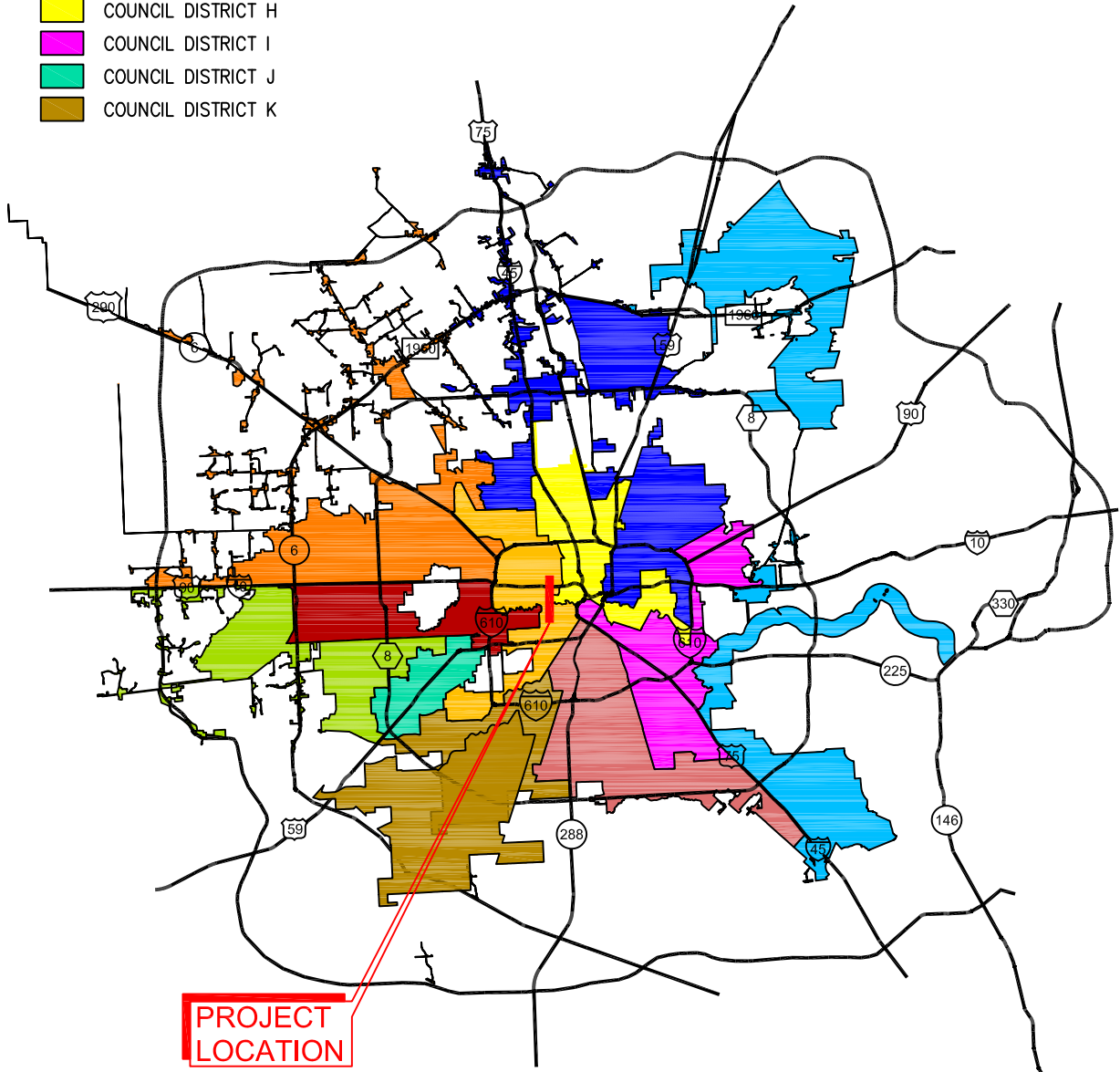


Exhibit E1
Project Vicinity Map



LEGEND

- COUNCIL DISTRICT A
- COUNCIL DISTRICT B
- COUNCIL DISTRICT C
- COUNCIL DISTRICT D
- COUNCIL DISTRICT E
- COUNCIL DISTRICT F
- COUNCIL DISTRICT G
- COUNCIL DISTRICT H
- COUNCIL DISTRICT I
- COUNCIL DISTRICT J
- COUNCIL DISTRICT K



KEY MAP: 452Y,452Z,492C,492D,492G,492H,492L&492 M
GIMS BLOCK: 5257B;5258B,D;5259D,5357A;5358A,C;5359C

GUNDA CORPORATION
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PROJECT NAME:
CITY OF HOUSTON
NT03-SHEPHERD DRIVE
AND DURHAM DRIVE
 INTERSTATE 610 TO
 WASHINGTON AVE

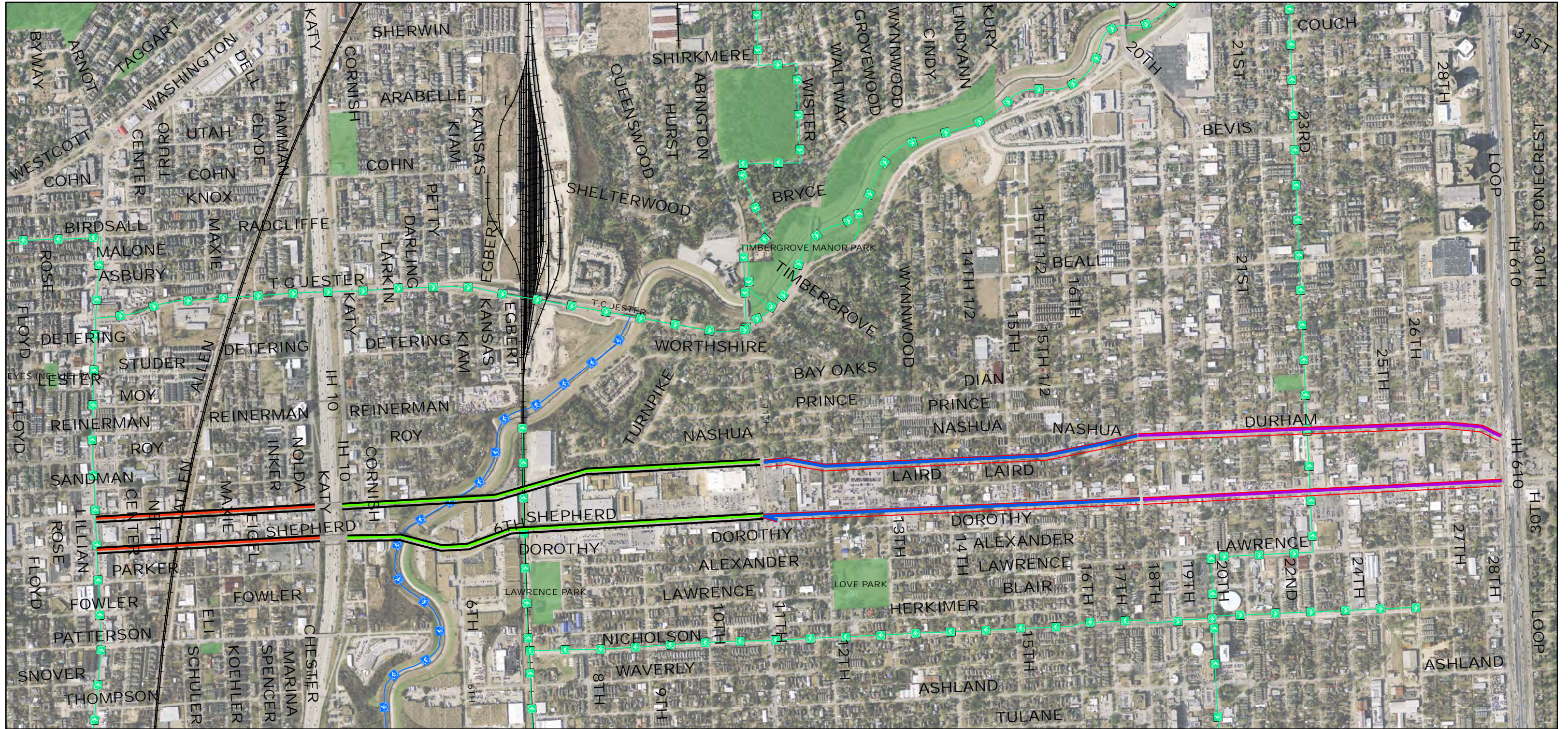
SHEET TITLE:
PROJECT
VICINITY MAP

GUNDA PROJ NO: 14013-23	SHEET NO: EXHIBIT E1
DATE: OCT, 2017	

Exhibit E2 Overall Layout

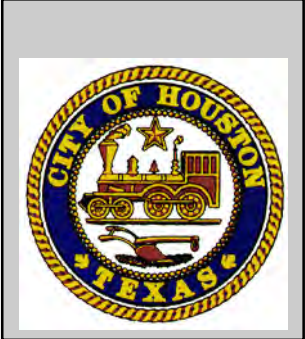


Shepherd Drive and Durham Drive Pre-Engineering for Street and Paving Improvements (Interstate 610 to Washington Avenue)





**SHEPHERD DRIVE AND
DURHAM DRIVE
(N-2016T-0004)**

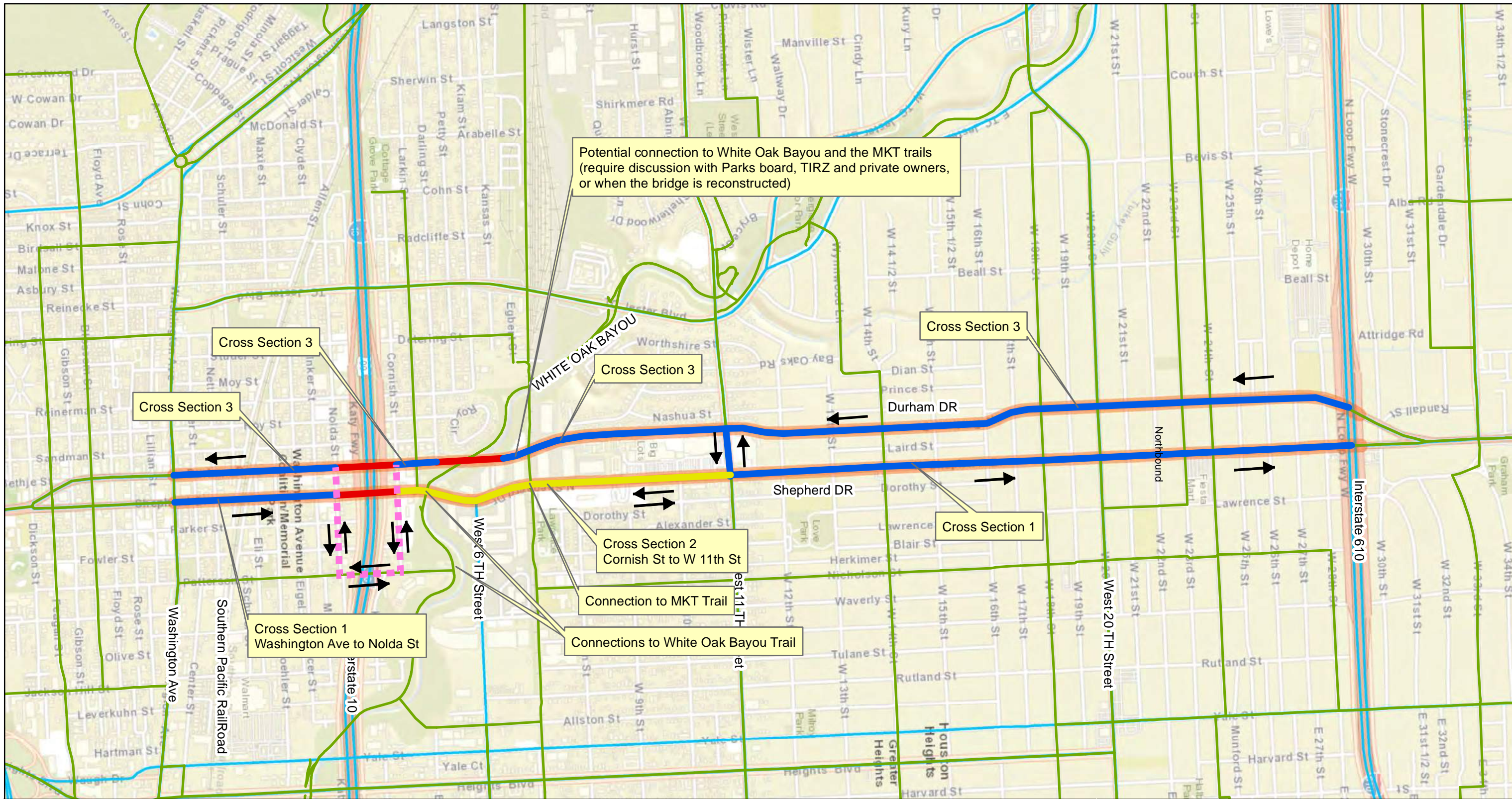
OVERALL LAYOUT



Legend

 South Project	 Bikeway
 South Project: Sub-Project 1 (Interstate 10 to Washington Ave)	 Railroad
 South Project: Sub-Project 2 (W 11 St to Interstate 10)	 Planned Bikeway
 North Project	 Park
 North Project: Sub-Project 1 (W 18 St to W 11 St)	
 North Project: Sub-Project 2 (Interstate 610 to W 18 St)	

 N
 1 inch = 1,083 feet



Potential connection to White Oak Bayou and the MKT trails (require discussion with Parks board, TIRZ and private owners, or when the bridge is reconstructed)

Cross Section 3

Cross Section 3

Cross Section 3

Cross Section 3

Cross Section 2
Cornish St to W 11th St

Cross Section 1

Cross Section 1
Washington Ave to Nolda St

Connection to MKT Trail

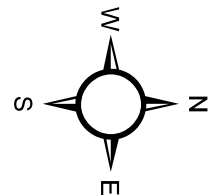
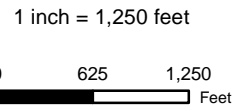
Connections to White Oak Bayou Trail

Basemap Source: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

Legend

- █ Low-Comfort Bicycle Facility Shared On-Street Due to Existing Bridge Configuration
- █ Off-Street Bi-Directional Bike Path
- █ On-Street One-Way Bike Lane
- █ Proposed Bi-Directional Detour Shared On-Street Bike Route

- ➔ Proposed Bicycle Route Direction of Travel
- █ Bike Plan Recommendations
- █ Study Corridors
- █ Major Thoroughfares



SHEPHERD DRIVE AND DURHAM DRIVE BETWEEN WASHINGTON AVENUE AND IH-610



WBS NO. 320100-0010-3
Exhibit 5
Proposed Bicycle Routes

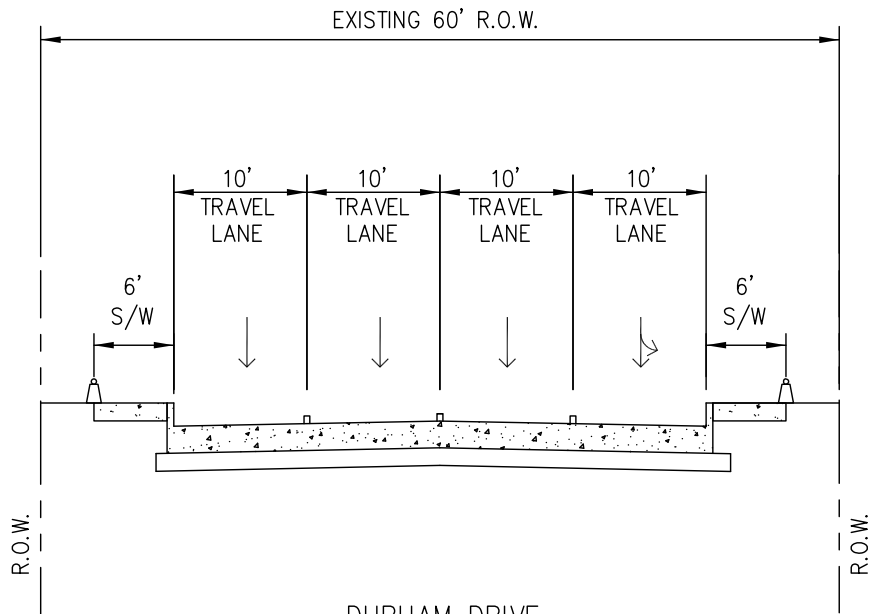
Jul, 2017

Exhibit E3
Typical Cross Sections

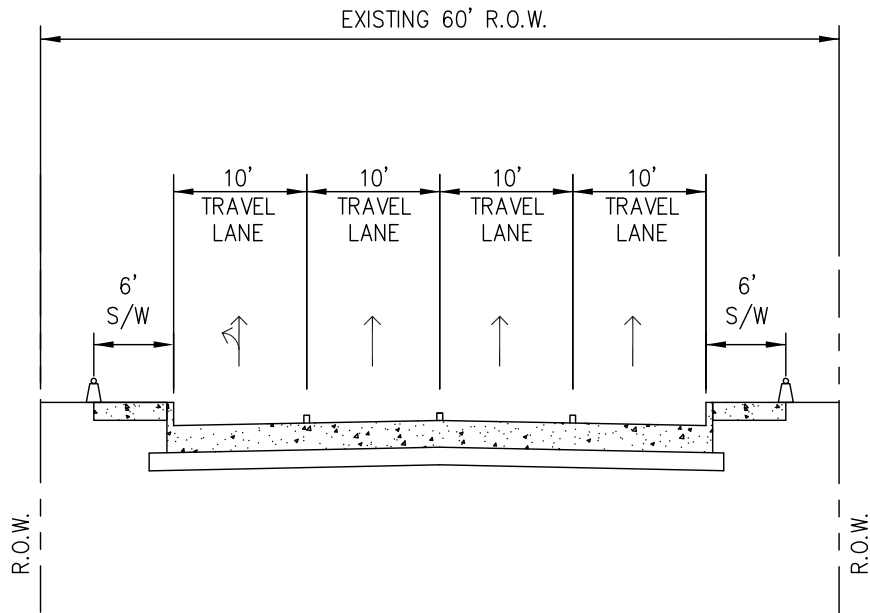


Existing Cross Sections





DURHAM DRIVE
OVER INTERSTATE 10
N.T.S.



SHEPHERD DRIVE
OVER INTERSTATE 10
N.T.S.

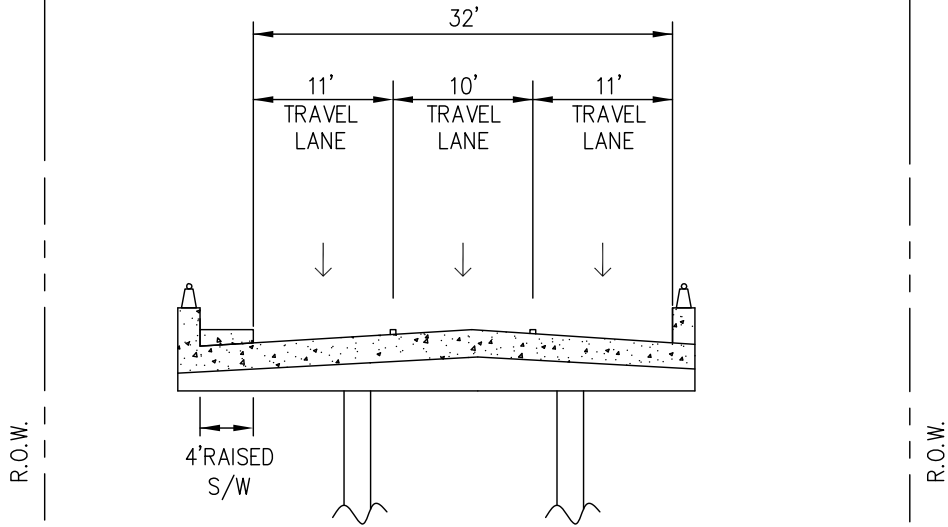
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 Engineers, Planners & Managers
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 Houston, Texas 77036
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 TBPE Registration Number: F-3531

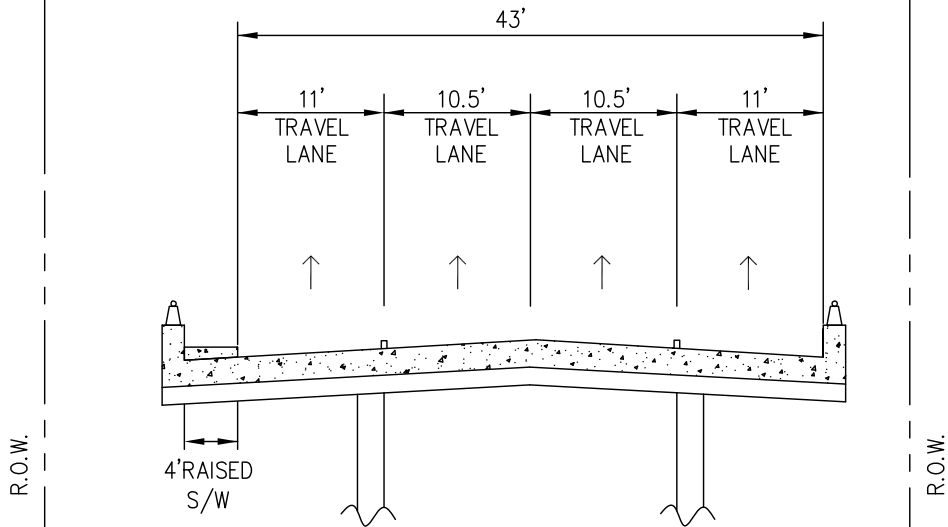
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GUNDA PROJ NO: 14013-23		SHEET NO: EXHIBIT 3	
DATE: OCT, 2017			

EXISTING 60' R.O.W. (TYPICAL)



DURHAM DRIVE
WEST 9TH STREET
TO WHITE OAK BAYOU
N.T.S.

EXISTING 60' R.O.W. (TYPICAL)



SHEPHERD DRIVE
WEST 9TH STREET
TO WHITE OAK BAYOU
N.T.S.

G GUNDA CORPORATION
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PROJECT NAME:

CITY OF HOUSTON

NT03-SHEPHERD DRIVE
AND DURHAM DRIVE

INTERSTATE 610 TO
WASHINGTON AVE

SHEET TITLE:

EXISTING CROSS
SECTIONS

14013-23

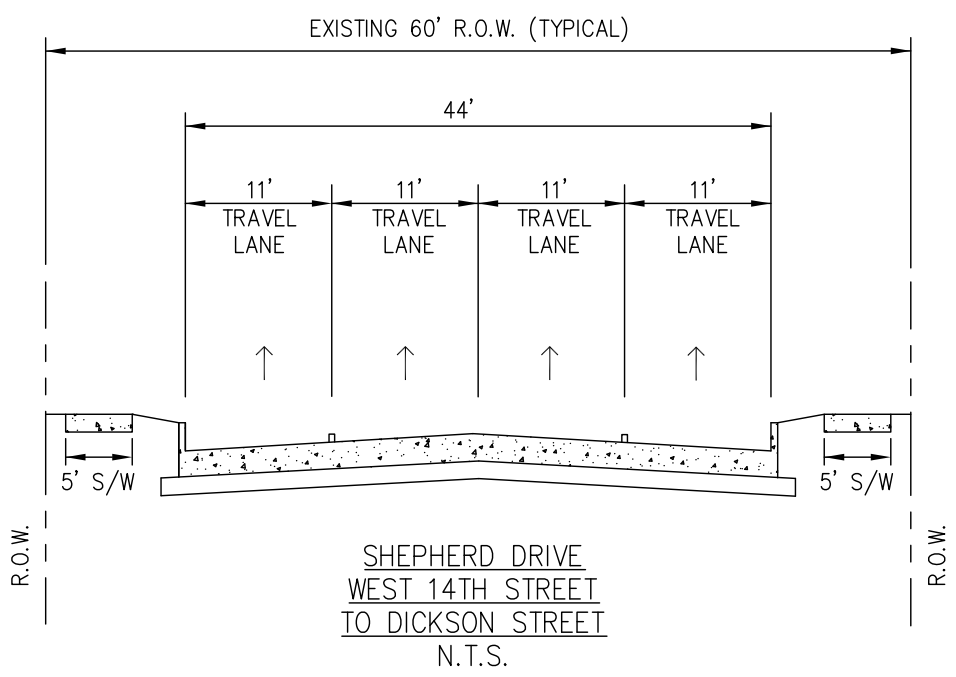
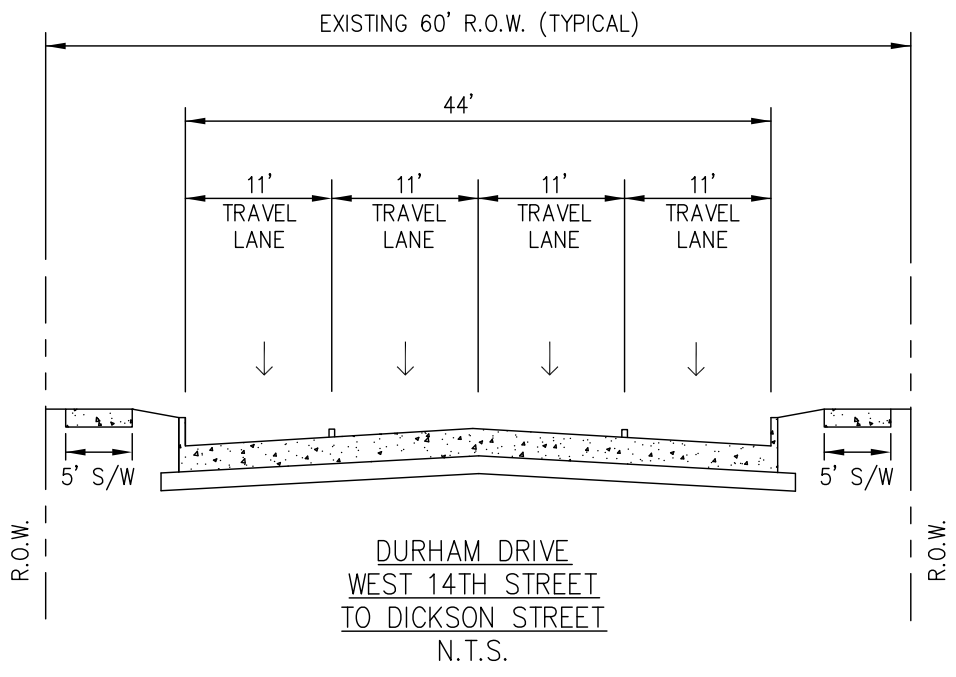
GUNDA PROJ NO:
14013-23

SHEET NO:

EXHIBIT 3

DATE:
OCT, 2017

GUNDA CORPORATION
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PROJECT NAME:
 CITY OF HOUSTON
 NT03-SHEPHERD DRIVE
 AND DURHAM DRIVE
 INTERSTATE 610 TO
 WASHINGTON AVE

SHEET TITLE:
EXISTING CROSS SECTIONS

14013-23

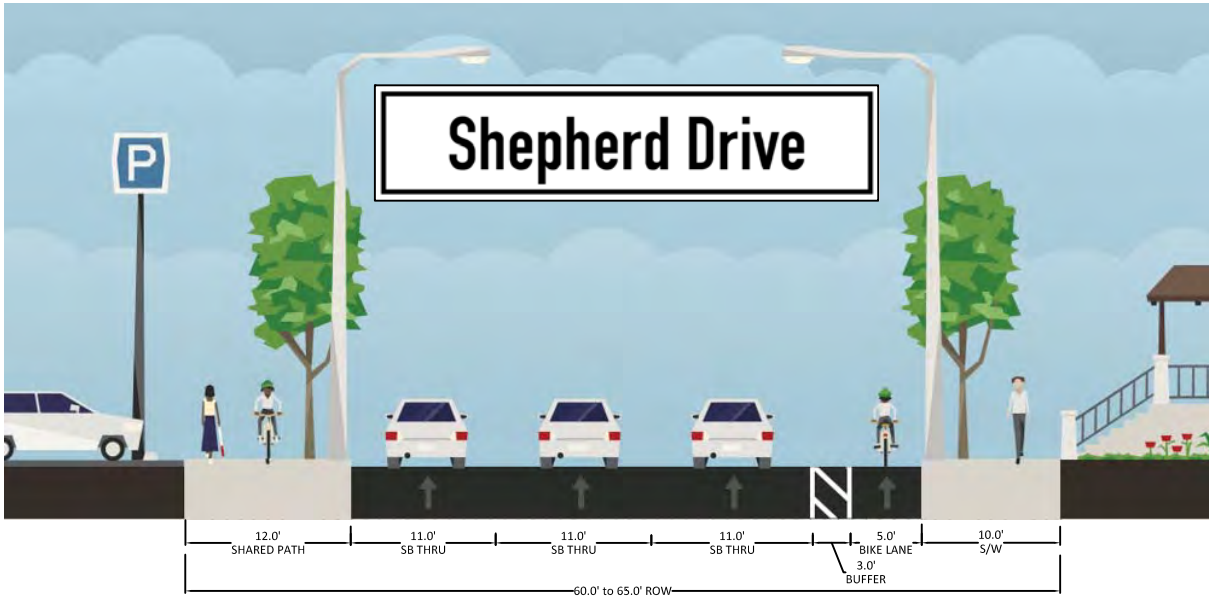
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DATE: OCT, 2017	

Proposed Cross Sections



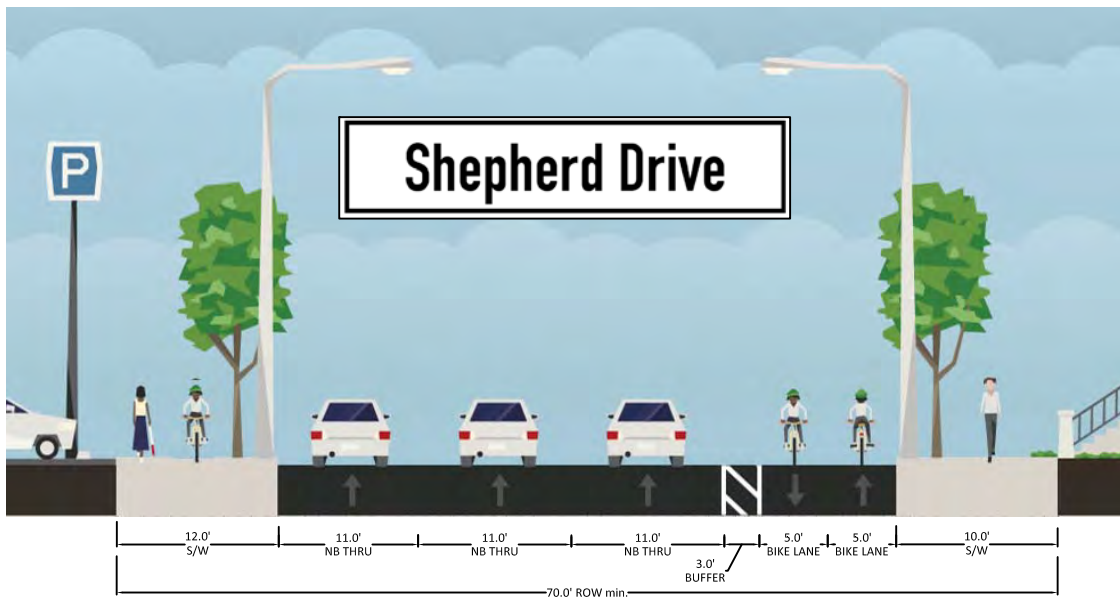
Cross Section 1

Shepherd Drive, Washington Ave to 900' North of Market Trail and W 11th Street to Interstate 610



Cross Section 2

Shepherd Drive, 900' North of Market Trail to W 11th Street



GUNDA CORPORATION
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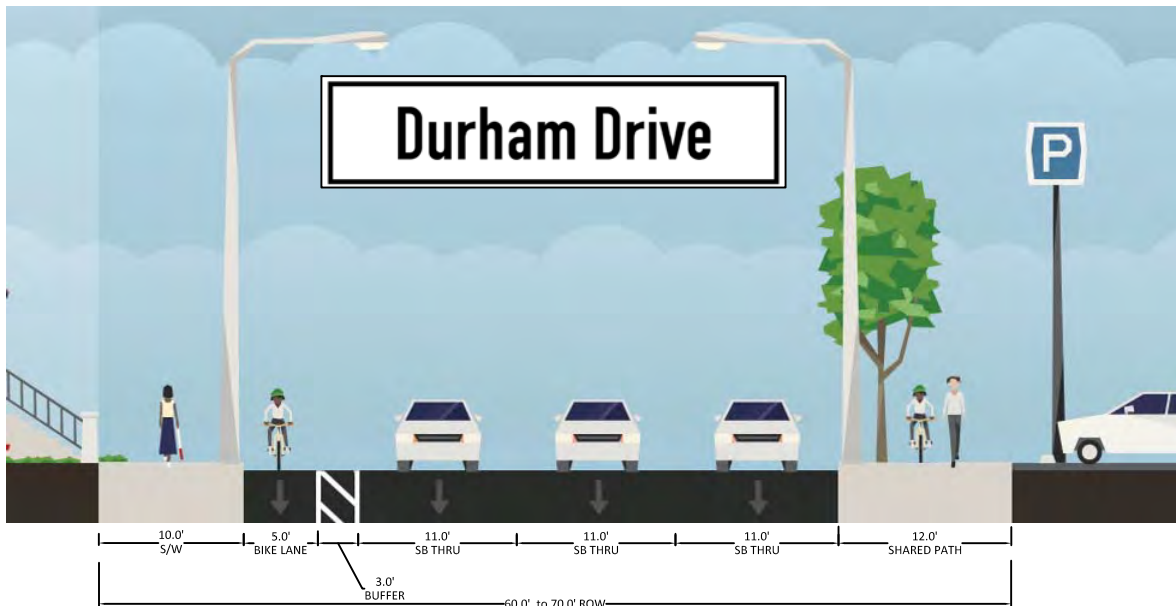
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CITY OF HOUSTON
N-2016T-0004
SHEPHERD DRIVE AND
DURHAM DRIVE
INTERSTATE 610 TO
WASHINGTON AVENUE

SHEET TITLE:
PROPOSED CROSS SECTIONS

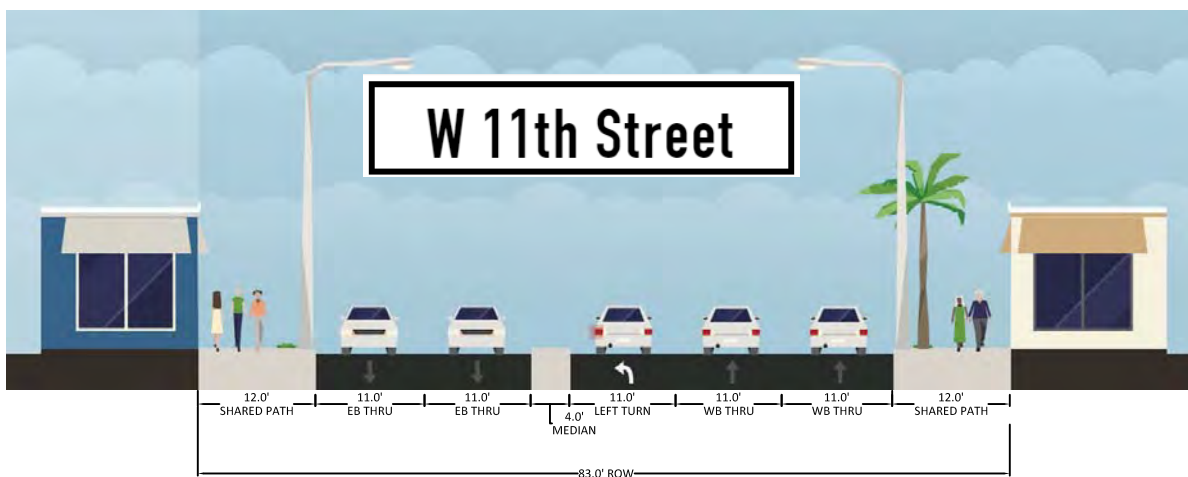
GUNDA PROJ NO: 14013-23	SHEET NO: EXHIBIT E3
DATE: OCT, 2017	

Cross Section 3 Durham Drive

Washington Avenue to Nolda Street,
Cornish Street to Darling Street,
and Market Trail to Interstate 610



Cross Section 4



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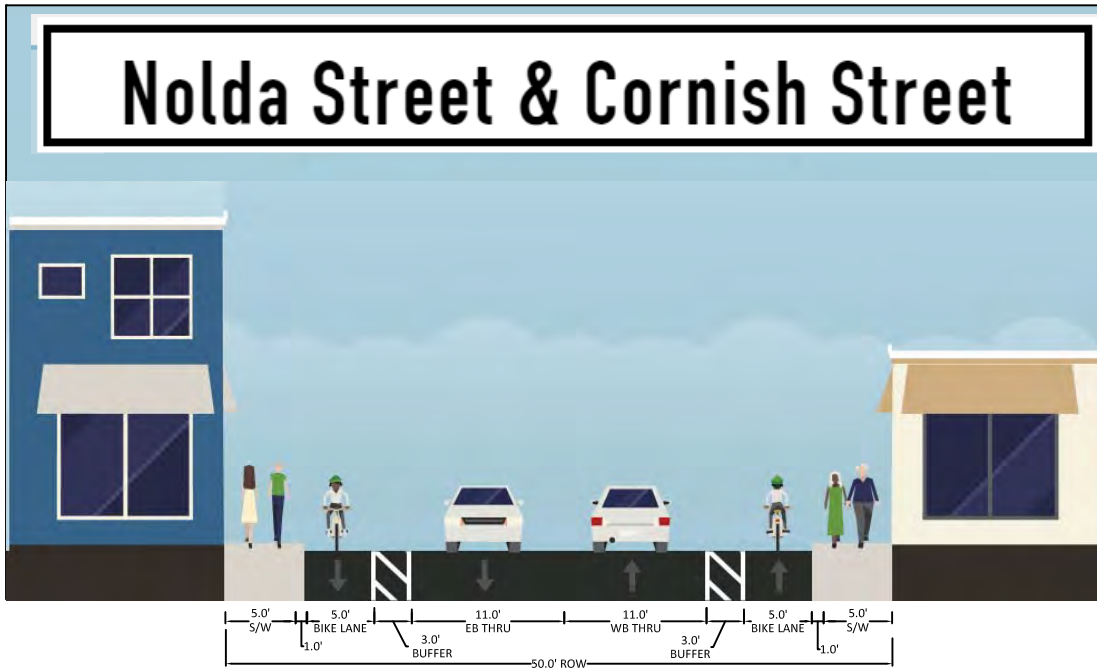


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**CITY OF HOUSTON
N-2016T-0004
SHEPHERD DRIVE AND
DURHAM DRIVE**
**INTERSTATE 610 TO
WASHINGTON AVENUE**

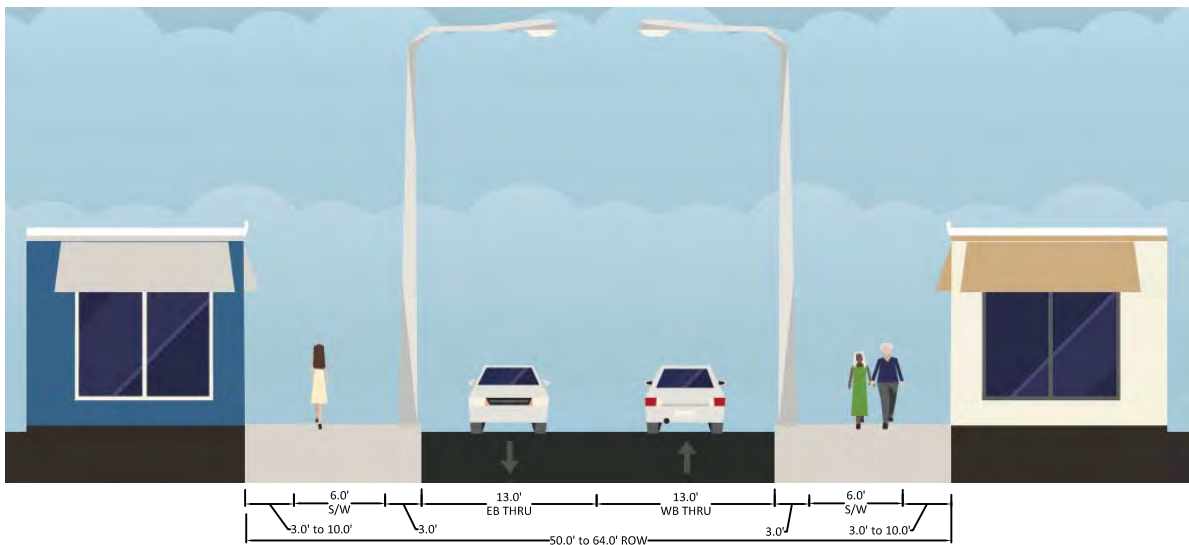
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**PROPOSED CROSS
SECTIONS**

GUNDA PROJ NO: 14013-23	SHEET NO: EXHIBIT E3
DATE: OCT, 2017	

Cross Section 5



Cross Section 6 Local Cross Streets with Storm Sewer Improvements



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PROJECT NAME:
**CITY OF HOUSTON
N-2016T-0004
SHEPHERD DRIVE AND
DURHAM DRIVE**

**INTERSTATE 610 TO
WASHINGTON AVENUE**

SHEET TITLE:
**PROPOSED CROSS
SECTIONS**

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DATE: OCT, 2017	

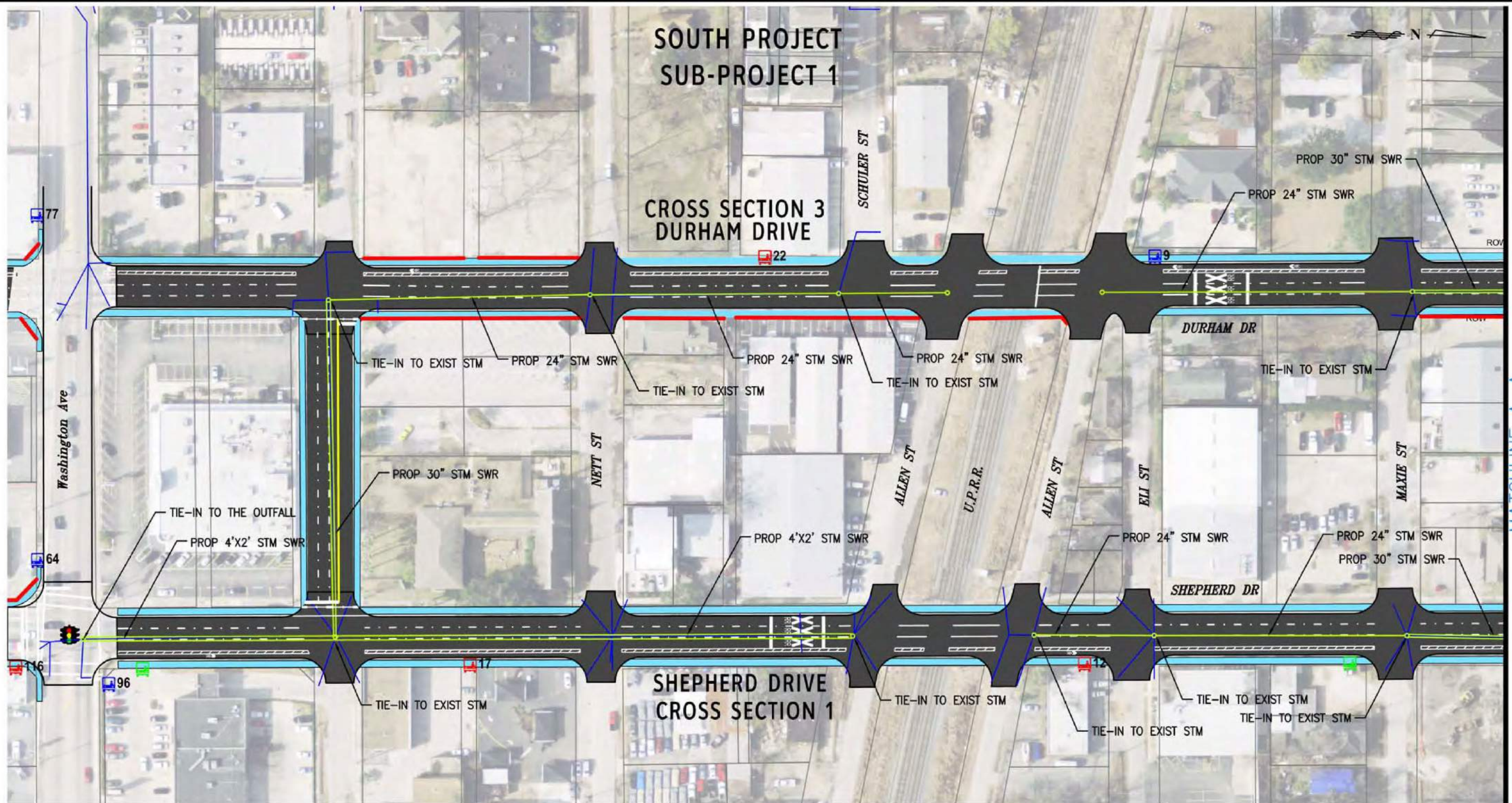
Exhibit E4
Candidate Project Layout



SOUTH PROJECT SUB-PROJECT 1

CROSS SECTION 3 DURHAM DRIVE

SHEPHERD DRIVE CROSS SECTION 1

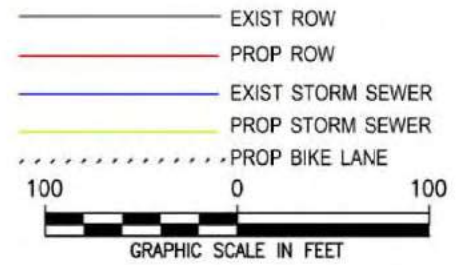


MATCHLINE A-A

LEGEND

- EXIST PAVEMENT
- PROP PAVEMENT
- PROP SIDEWALK
- PROP BUFFER / MEDIAN

- EXIST BUS STOP (TO REMAIN)
- EXIST BUS STOP (TO BE CONSOLIDATED / RELOCATED)
- PROP BUS STOP
- TRAFFIC SIGNAL



PROJECT NAME:
**CITY OF HOUSTON
PRE-ENGINEERING WO#12D
NT-03
SHEPHERD DRIVE
& DURHAM DRIVE
WASHINGTON AVENUE TO
INTERSTATE HIGHWAY 610**

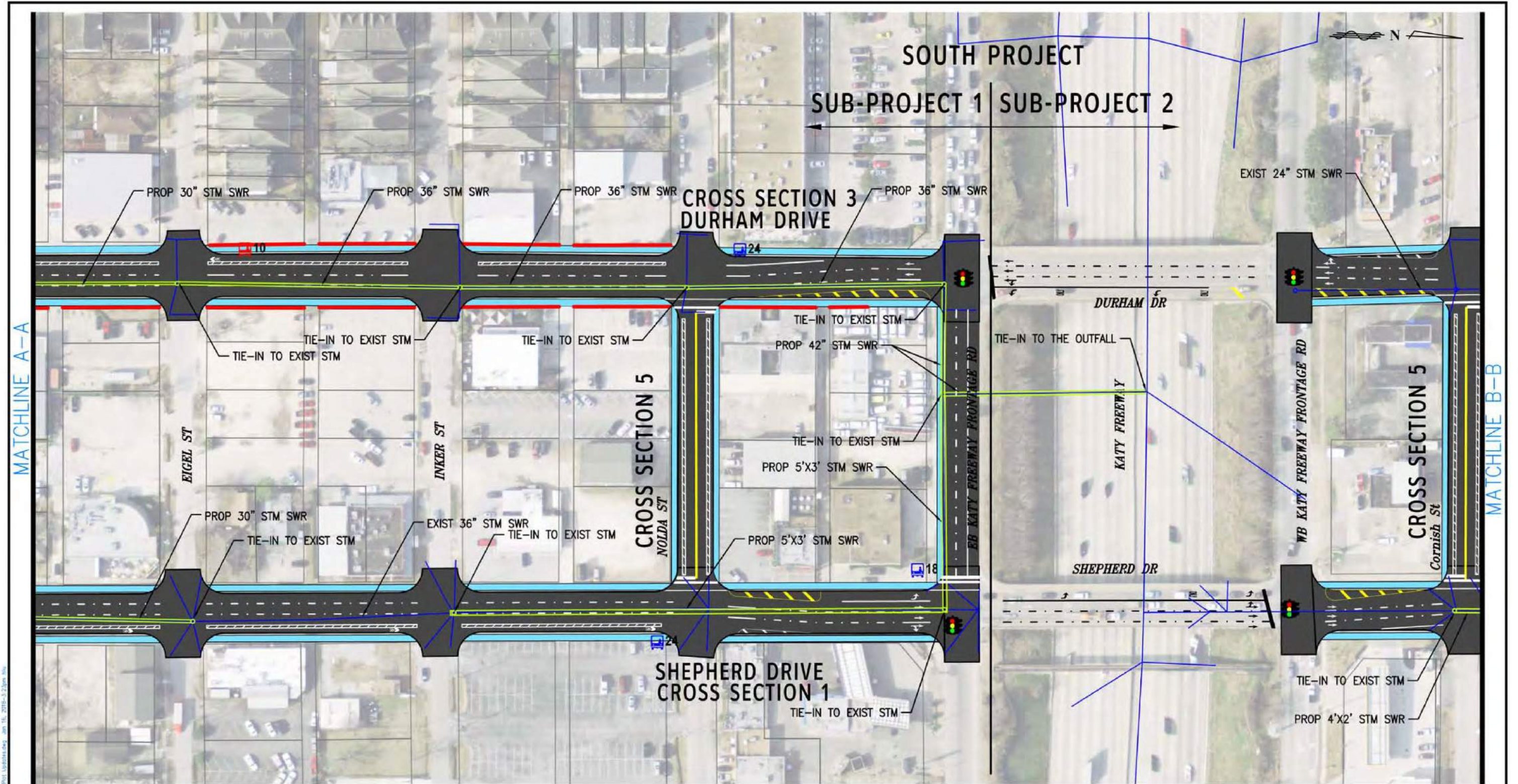
SHEET TITLE:
**CANDIDATE
PROJECT LAYOUT
PAVING & DRAINAGE**
SHEET 1 OF 12

GUNDA PROJ. NO.
14013-23

DATE:
OCT 2017

SHEET NO.
EXHIBIT E4

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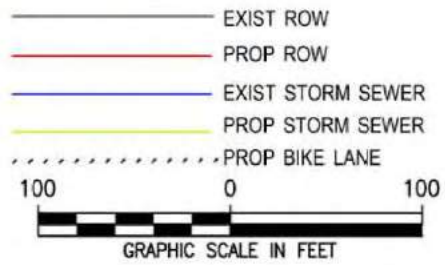


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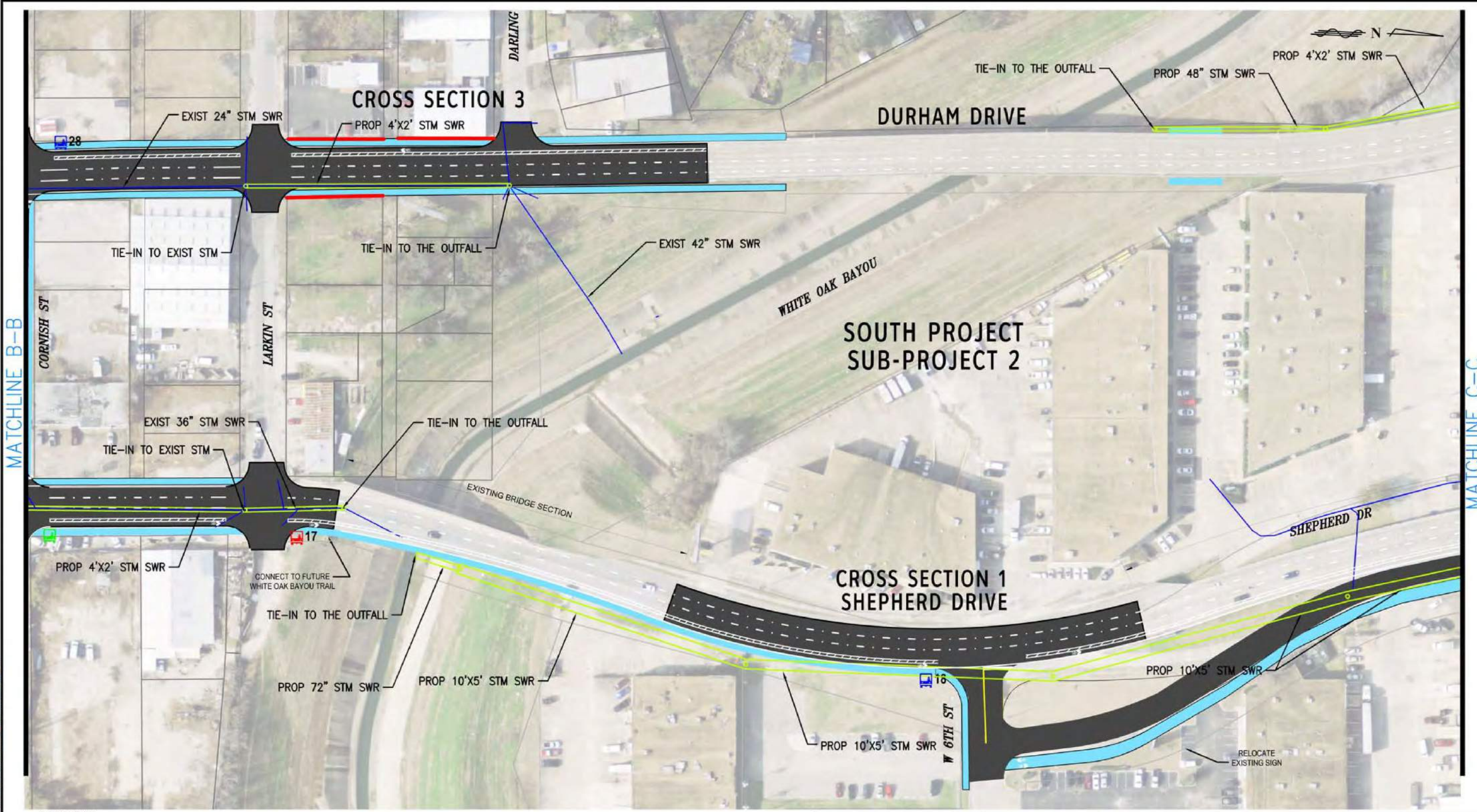
LEGEND

- EXIST PAVEMENT
- PROP PAVEMENT
- PROP SIDEWALK
- PROP BUFFER / MEDIAN

- EXIST BUS STOP (TO REMAIN)
- EXIST BUS STOP (TO BE CONSOLIDATED / RELOCATED)
- PROP BUS STOP
- TRAFFIC SIGNAL



 GUNDA CORPORATION <small>Engineers, Planners & Managers 6161 Savoy, Suite 500 Houston, Texas 77058 713.541.3530 • www.gundacorp.com T&E Registration Number: F-3531</small>		PROJECT NAME:	CITY OF HOUSTON PRE-ENGINEERING WO#12D NT-03 SHEPHERD DRIVE & DURHAM DRIVE	SHEET TITLE:	CANDIDATE PROJECT LAYOUT PAVING & DRAINAGE
		WASHINGTON AVENUE TO INTERSTATE HIGHWAY 610	SHEET 2 OF 12		
		GUNDA PROJ. NO.	14013-23	SHEET NO.	EXHIBIT E4
		DATE:	OCT 2017		

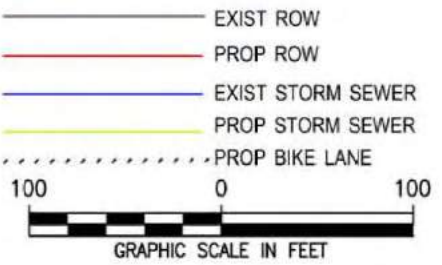


MATCHLINE B-B

MATCHLINE C-C

LEGEND

- | | | |
|----------------------|---|-------------------|
| EXIST PAVEMENT | EXIST BUS STOP (TO REMAIN) | EXIST ROW |
| PROP PAVEMENT | EXIST BUS STOP (TO BE CONSOLIDATED / RELOCATED) | PROP ROW |
| PROP SIDEWALK | PROP BUS STOP | EXIST STORM SEWER |
| PROP BUFFER / MEDIAN | TRAFFIC SIGNAL | PROP STORM SEWER |
| | | PROP BIKE LANE |

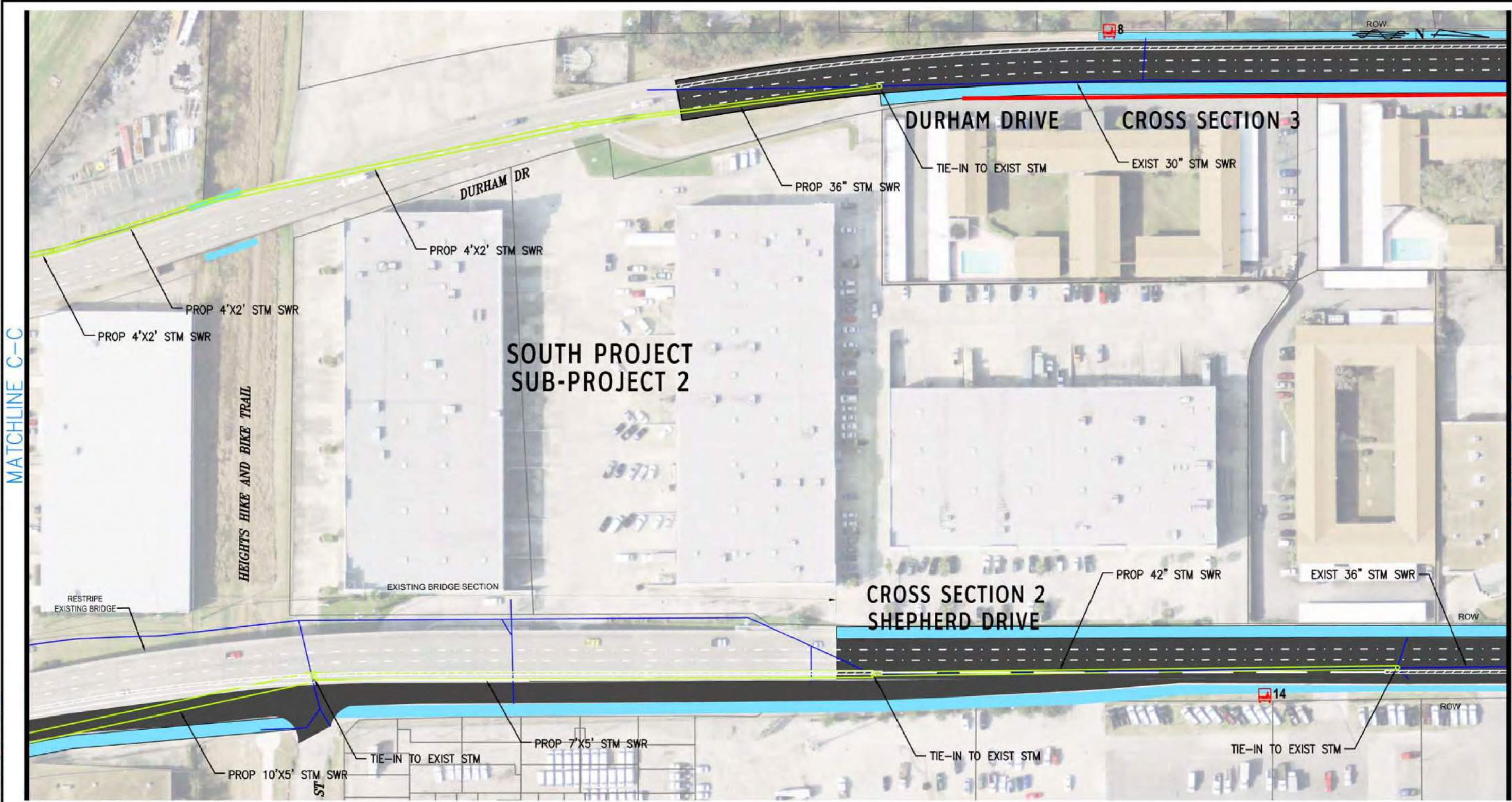


PROJECT NAME:
**CITY OF HOUSTON
 PRE-ENGINEERING WO#12D
 NT-03
 SHEPHERD DRIVE
 & DURHAM DRIVE
 WASHINGTON AVENUE TO
 INTERSTATE HIGHWAY 610**

SHEET TITLE:
**CANDIDATE
 PROJECT LAYOUT
 PAVING & DRAINAGE**
 SHEET 3 OF 12

GUNDA PROJ. NO. 14013-23	SHEET NO. EXHIBIT E4
DATE: OCT 2017	

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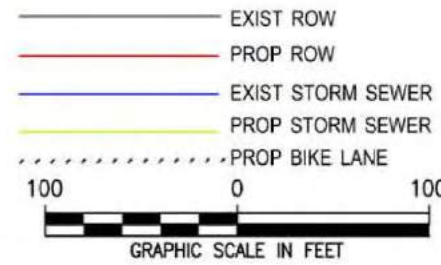
MATCHLINE C-C

MATCHLINE D-D

LEGEND

- EXIST PAVEMENT
- PROP PAVEMENT
- PROP SIDEWALK
- PROP BUFFER / MEDIAN

- EXIST BUS STOP (TO REMAIN)
- EXIST BUS STOP (TO BE CONSOLIDATED / RELOCATED)
- PROP BUS STOP
- TRAFFIC SIGNAL




PROJECT NAME:
**CITY OF HOUSTON
 PRE-ENGINEERING WO#12D
 NT-03
 SHEPHERD DRIVE
 & DURHAM DRIVE
 WASHINGTON AVENUE TO
 INTERSTATE HIGHWAY 610**

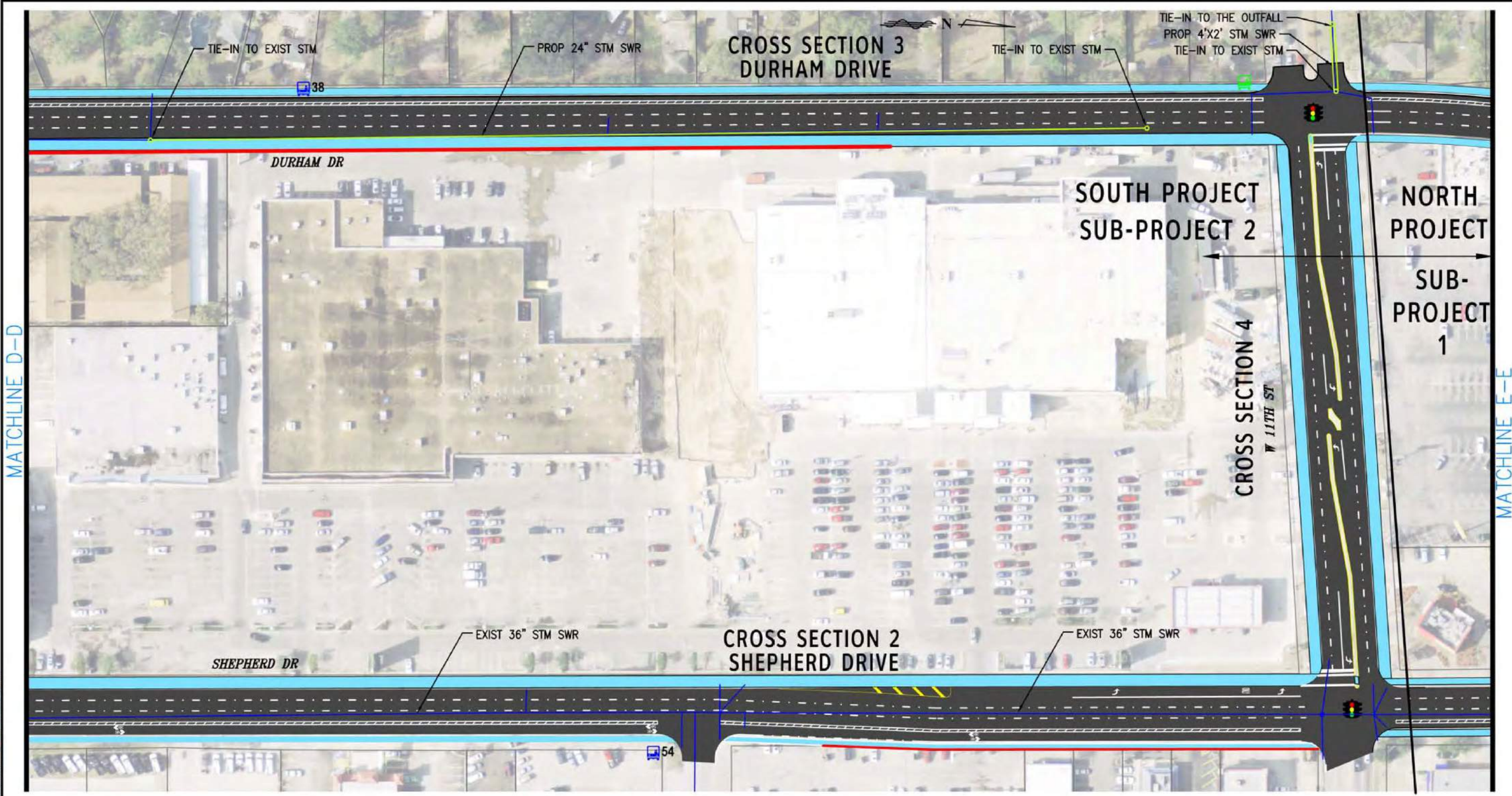
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**CANDIDATE
 PROJECT LAYOUT
 PAVING & DRAINAGE**
 SHEET 4 OF 12

GUNDA PROJ. NO.
14013-23

DATE:
OCT 2017

SHEET NO.
EXHIBIT E4

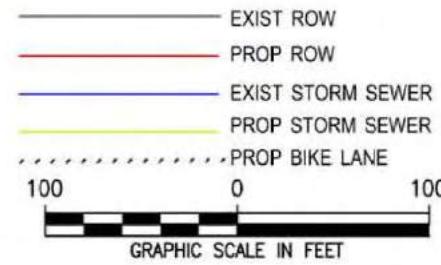
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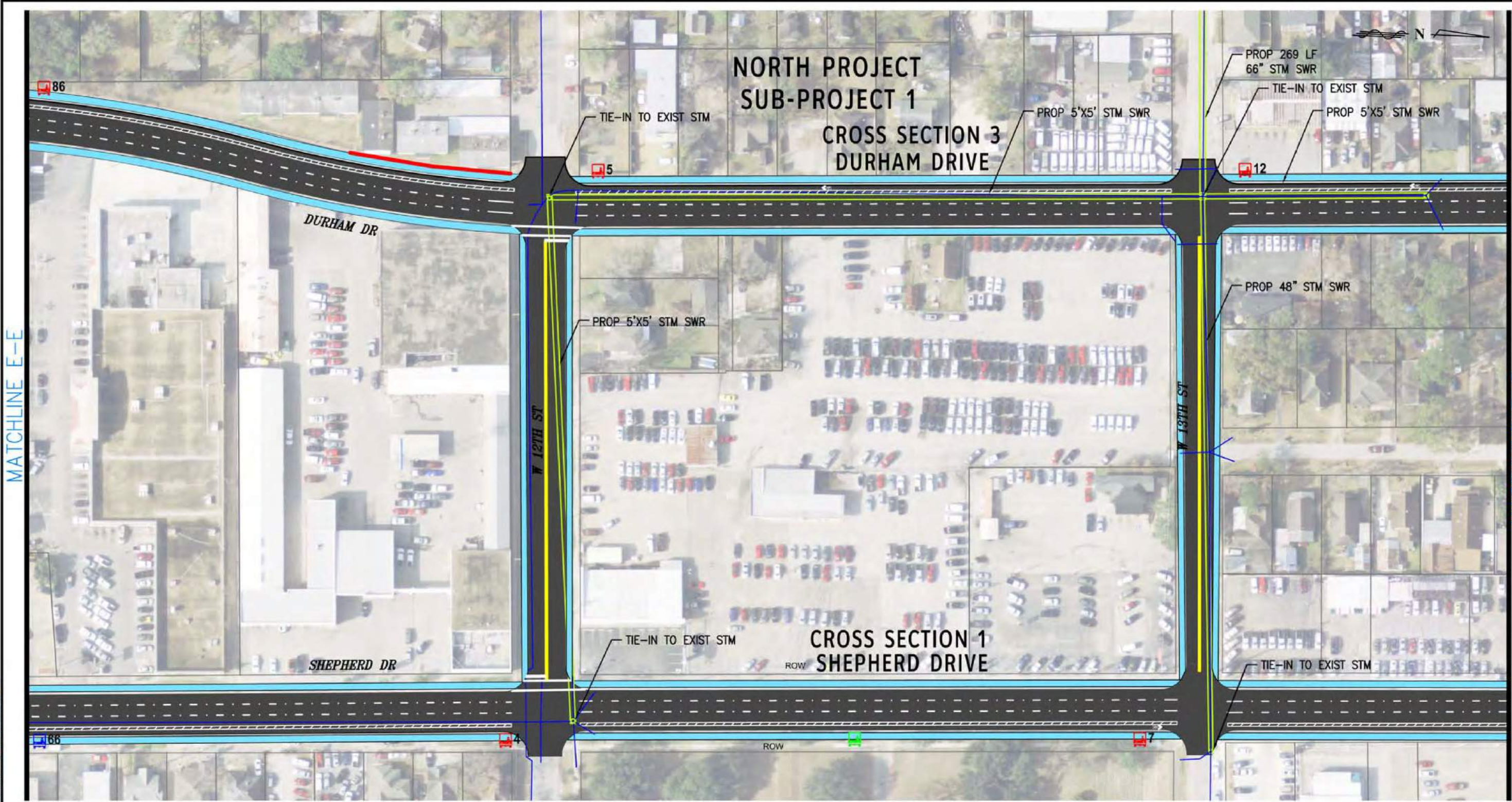
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-  PROP SIDEWALK
-  PROP BUFFER / MEDIAN

-  EXIST BUS STOP (TO REMAIN)
-  EXIST BUS STOP (TO BE CONSOLIDATED / RELOCATED)
-  PROP BUS STOP
-  TRAFFIC SIGNAL



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 <p>GUNDA CORPORATION Engineers, Planners & Managers 4161 Savoy, Suite 500 Houston, Texas 77056 713.541.3530 • www.gundacorp.com TSP# Registration Number: F-3531</p>		<p>PROJECT NAME: CITY OF HOUSTON PRE-ENGINEERING WO#12D NT-03 SHEPHERD DRIVE & DURHAM DRIVE WASHINGTON AVENUE TO INTERSTATE HIGHWAY 610</p>	<p>SHEET TITLE: CANDIDATE PROJECT LAYOUT PAVING & DRAINAGE SHEET 5 OF 12</p>
		<p>GUNDA PROJ. NO. 14013-23</p> <p>DATE: OCT 2017</p>	<p>SHEET NO. EXHIBIT E4</p>



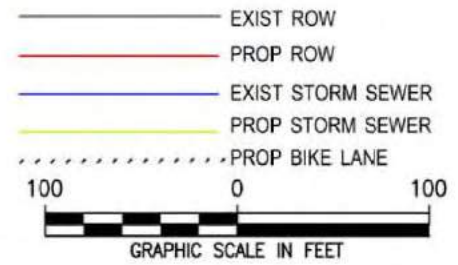
**NORTH PROJECT
SUB-PROJECT 1
CROSS SECTION 3
DURHAM DRIVE**

**CROSS SECTION 1
SHEPHERD DRIVE**

LEGEND

- EXIST PAVEMENT
- PROP PAVEMENT
- PROP SIDEWALK
- PROP BUFFER / MEDIAN

- EXIST BUS STOP (TO REMAIN)
- EXIST BUS STOP (TO BE CONSOLIDATED / RELOCATED)
- PROP BUS STOP
- TRAFFIC SIGNAL



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PROJECT NAME:
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NT-03
SHEPHERD DRIVE
& DURHAM DRIVE
WASHINGTON AVENUE TO
INTERSTATE HIGHWAY 610**

SHEET TITLE:
**CANDIDATE
PROJECT LAYOUT
PAVING & DRAINAGE**
SHEET 6 OF 12

GUNDA PROJ. NO.
14013-23

DATE:
OCT 2017

SHEET NO.
EXHIBIT E4

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NORTH PROJECT SUB-PROJECT 1 CROSS SECTION 3 DURHAM DRIVE

PROP 247 LF
12'X10' STM SWR

PROP 247 LF
60" STM SWR
TIE-IN TO EXIST STM

PROP 54" STM SWR

TIE-IN TO EXIST STM

PROP 48" STM SWR

TIE-IN TO EXIST STM

CROSS SECTION 1 SHEPHERD DRIVE

PROP 12'X10' STM SWR

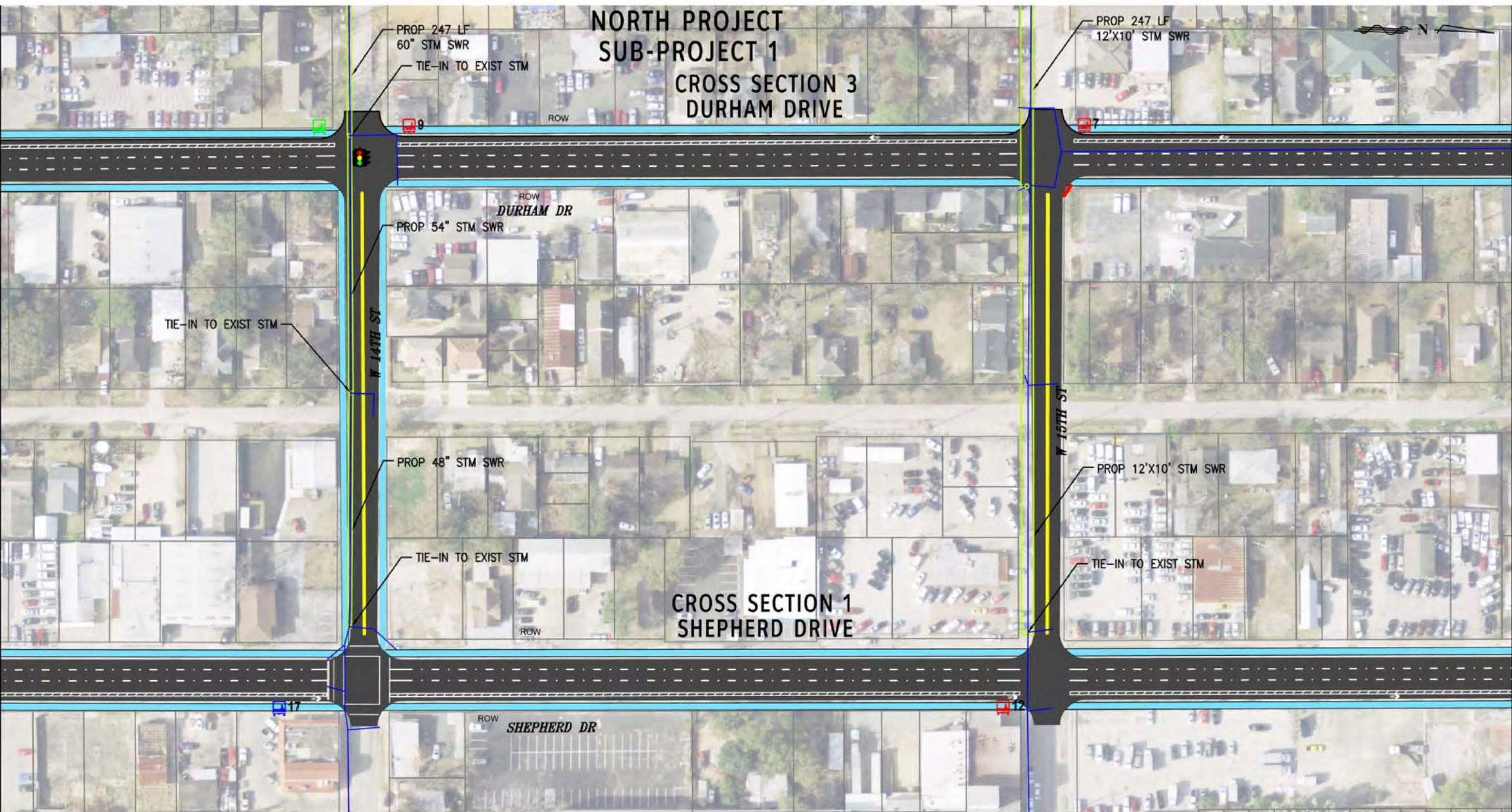
TIE-IN TO EXIST STM

PROP 247 LF
60" STM SWR
TIE-IN TO EXIST STM

PROP 247 LF
12'X10' STM SWR

MATCHLINE F-F

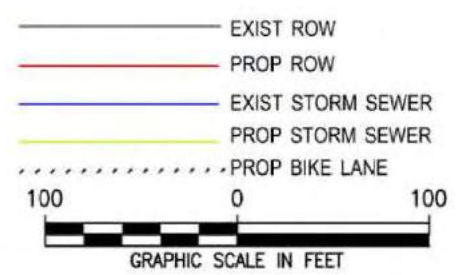
MATCHLINE G-G



LEGEND

- EXIST PAVEMENT
- PROP PAVEMENT
- PROP SIDEWALK
- PROP BUFFER / MEDIAN

- EXIST BUS STOP (TO REMAIN)
- EXIST BUS STOP (TO BE CONSOLIDATED / RELOCATED)
- PROP BUS STOP
- TRAFFIC SIGNAL



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SHEPHERD DRIVE
& DURHAM DRIVE
WASHINGTON AVENUE TO
INTERSTATE HIGHWAY 610**

SHEET TITLE:
**CANDIDATE
PROJECT LAYOUT
PAVING & DRAINAGE**
SHEET 7 OF 12

GUNDA PROJ. NO.
14013-23

DATE:
OCT 2017

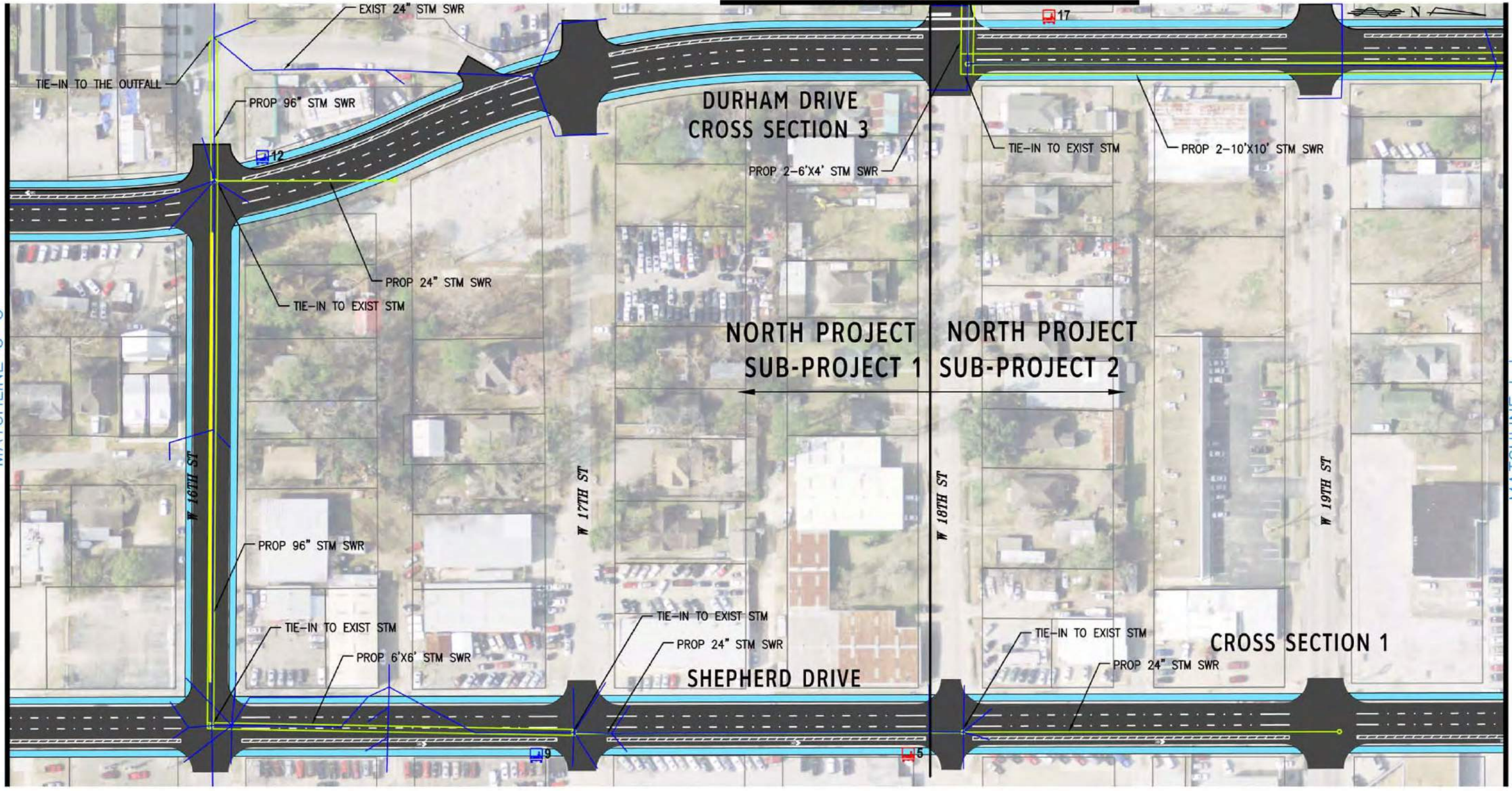
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EXHIBIT E4

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MATCHLINE H-H

MATCHLINE G-G

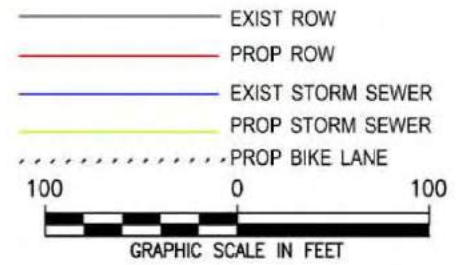
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LEGEND

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- PROP PAVEMENT
- PROP SIDEWALK
- PROP BUFFER / MEDIAN

- EXIST BUS STOP (TO REMAIN)
- EXIST BUS STOP (TO BE CONSOLIDATED / RELOCATED)
- PROP BUS STOP
- TRAFFIC SIGNAL



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PROJECT NAME:
**CITY OF HOUSTON
 PRE-ENGINEERING WO#12D
 NT-03
 SHEPHERD DRIVE
 & DURHAM DRIVE
 WASHINGTON AVENUE TO
 INTERSTATE HIGHWAY 610**

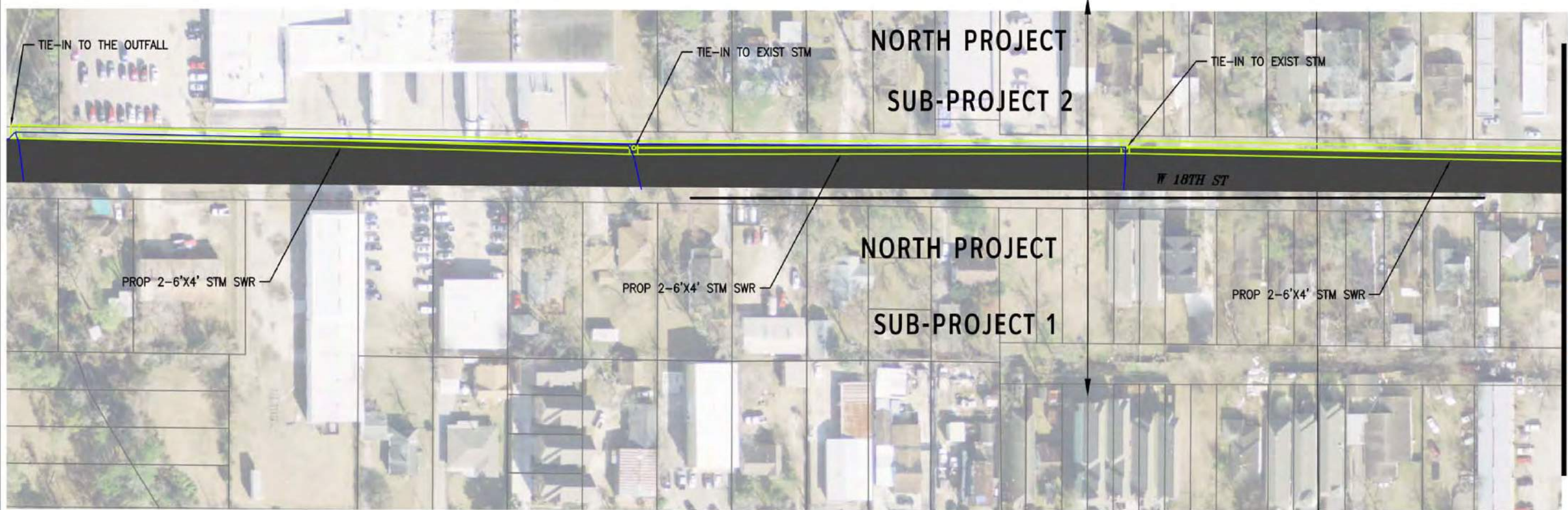
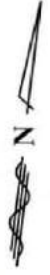
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**CANDIDATE
 PROJECT LAYOUT
 PAVING & DRAINAGE**
 SHEET 8 OF 12

GUNDA PROJ. NO.
14013-23

DATE:
OCT 2017

SHEET NO.
EXHIBIT E4

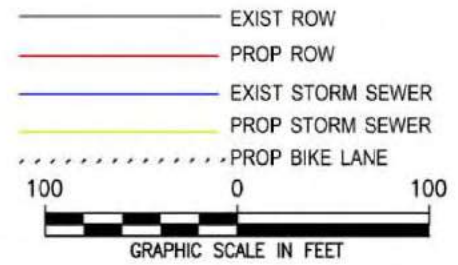
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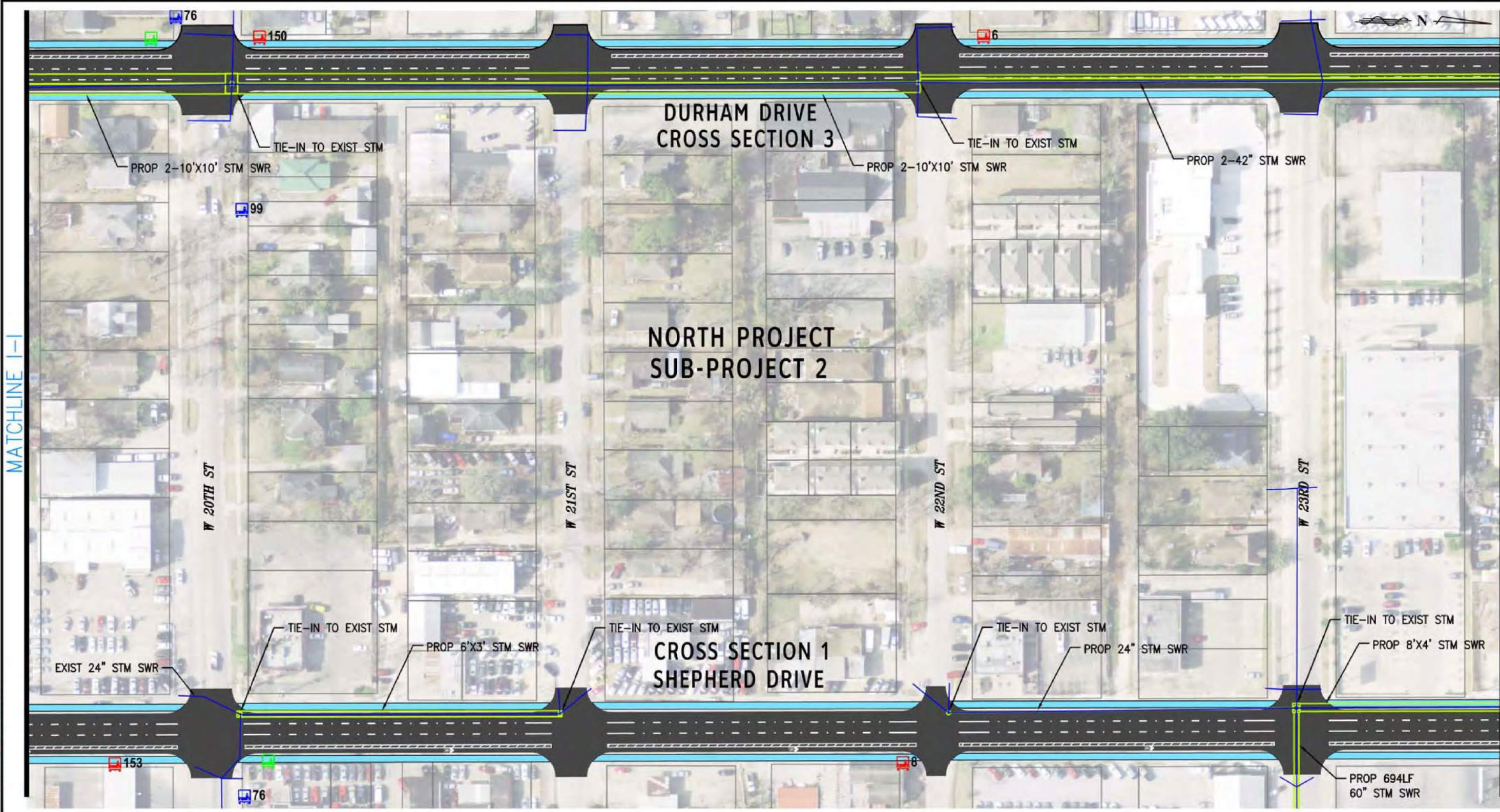
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-  PROP SIDEWALK
-  PROP BUFFER / MEDIAN

-  EXIST BUS STOP (TO REMAIN)
-  EXIST BUS STOP (TO BE CONSOLIDATED / RELOCATED)
-  PROP BUS STOP
-  TRAFFIC SIGNAL



GUNDA CORPORATION
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 <p>GUNDA CORPORATION Engineers, Planners & Managers 4161 Savoy, Suite 500 Houston, Texas 77036 713.541.3530 • www.gundacorp.com T&E Registration Number: F-3531</p>		PROJECT NAME: CITY OF HOUSTON PRE-ENGINEERING WO#12D NT-03 SHEPHERD DRIVE & DURHAM DRIVE WASHINGTON AVENUE TO INTERSTATE HIGHWAY 610		SHEET TITLE: CANDIDATE PROJECT LAYOUT PAVING & DRAINAGE SHEET 9 OF 12	
		GUNDA PROJ. NO. 14013-23		SHEET NO. EXHIBIT E4	
		DATE: OCT 2017			



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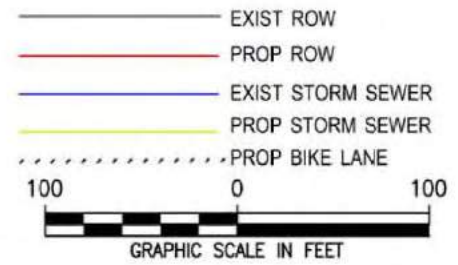
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LEGEND

- EXIST PAVEMENT
- PROP PAVEMENT
- PROP SIDEWALK
- PROP BUFFER / MEDIAN

- EXIST BUS STOP (TO REMAIN)
- EXIST BUS STOP (TO BE CONSOLIDATED / RELOCATED)
- PROP BUS STOP
- TRAFFIC SIGNAL



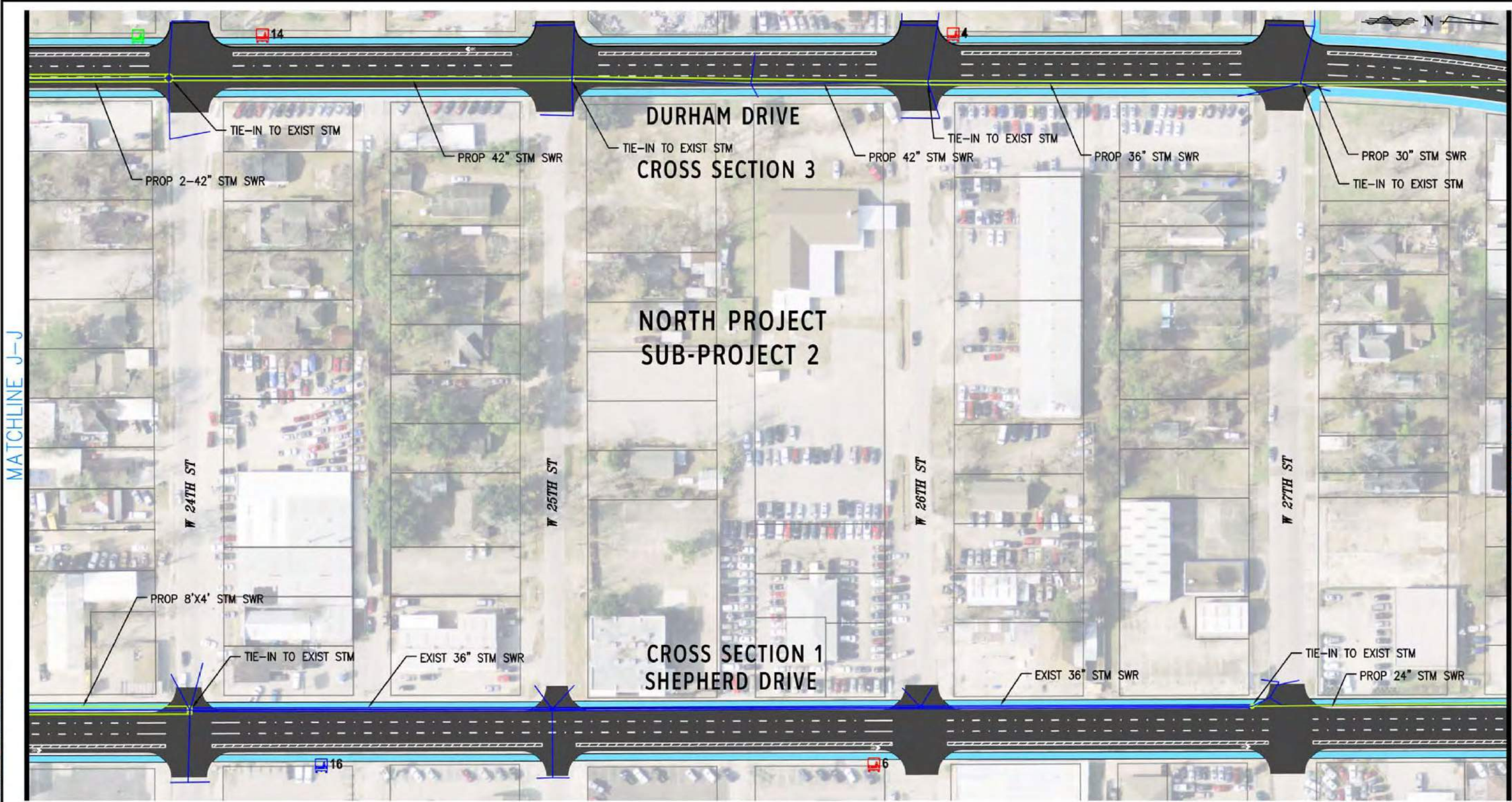
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NT-03
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& DURHAM DRIVE
WASHINGTON AVENUE TO
INTERSTATE HIGHWAY 610**

SHEET TITLE:
**CANDIDATE
PROJECT LAYOUT
PAVING & DRAINAGE**
SHEET 10 OF 12

GUNDA PROJ. NO. 14013-23	SHEET NO. EXHIBIT E4
DATE: OCT 2017	



MATCHLINE J-J

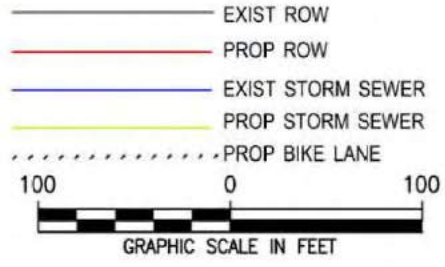
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LEGEND

- EXIST PAVEMENT
- PROP PAVEMENT
- PROP SIDEWALK
- PROP BUFFER / MEDIAN

- EXIST BUS STOP (TO REMAIN)
- EXIST BUS STOP (TO BE CONSOLIDATED / RELOCATED)
- PROP BUS STOP
- TRAFFIC SIGNAL



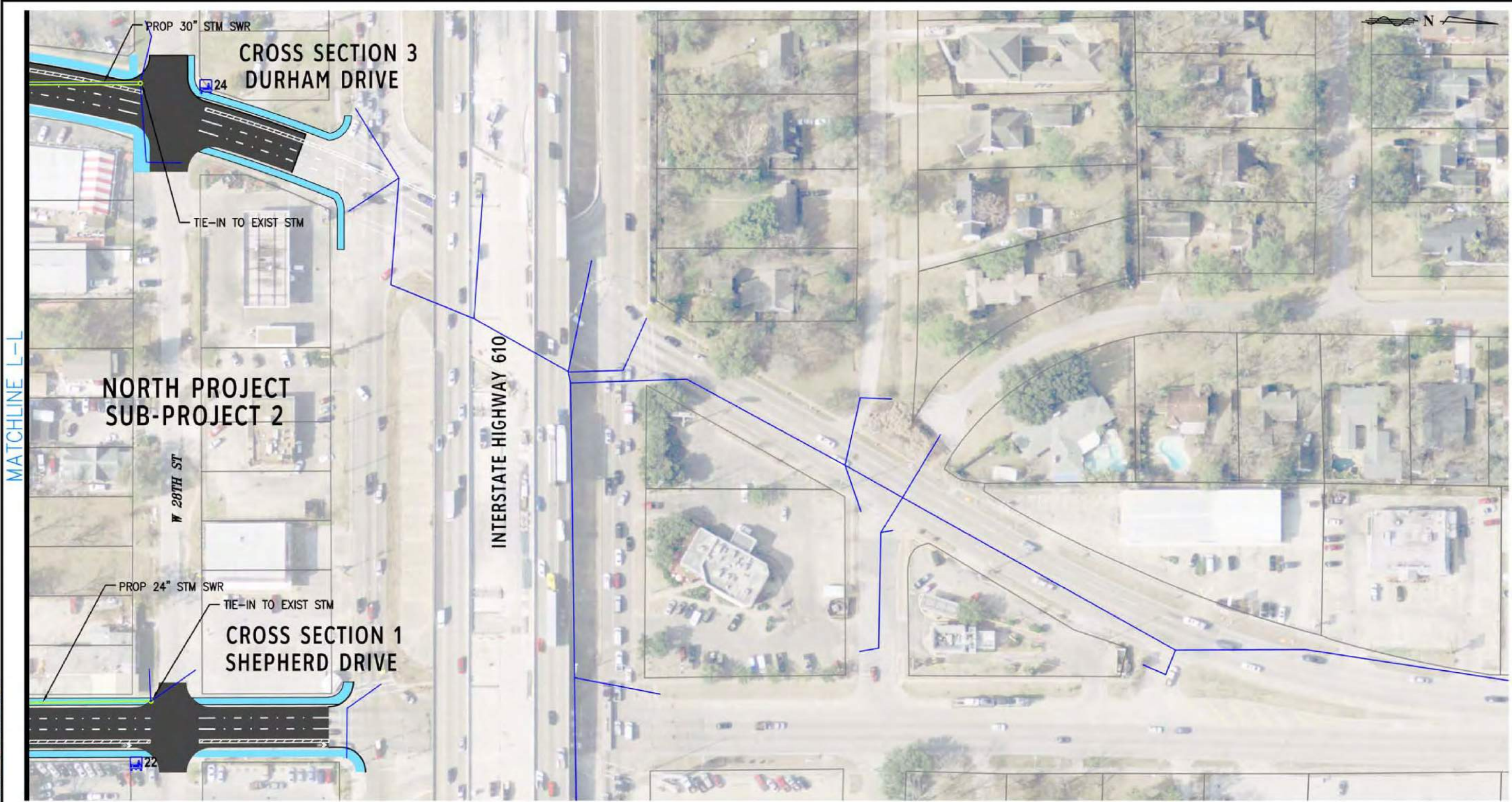
GUNDA CORPORATION
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TSP# Registration Number: F-3531



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NT-03
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& DURHAM DRIVE
WASHINGTON AVENUE TO
INTERSTATE HIGHWAY 610**

SHEET TITLE:
**CANDIDATE
PROJECT LAYOUT
PAVING & DRAINAGE**
SHEET 11 OF 12

GUNDA PROJ. NO. 14013-23	SHEET NO. EXHIBIT E4
DATE: OCT 2017	



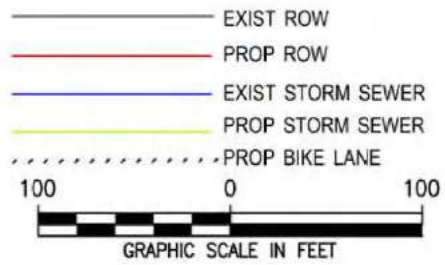
MATCHLINE L-L



LEGEND

- EXIST PAVEMENT
- PROP PAVEMENT
- PROP SIDEWALK
- PROP BUFFER / MEDIAN

- EXIST BUS STOP (TO REMAIN)
- EXIST BUS STOP (TO BE CONSOLIDATED / RELOCATED)
- PROP BUS STOP
- TRAFFIC SIGNAL



PROJECT NAME:
**CITY OF HOUSTON
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 NT-03
 SHEPHERD DRIVE
 & DURHAM DRIVE
 WASHINGTON AVENUE TO
 INTERSTATE HIGHWAY 610**

SHEET TITLE:
**CANDIDATE
 PROJECT LAYOUT
 PAVING & DRAINAGE**
 SHEET 12 OF 12

GUNDA PROJ. NO. 14013-23	SHEET NO. EXHIBIT E4
DATE: OCT 2017	

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Exhibit E5
City of Houston
Water and Wastewater
Recommendations



N-2016T-0004 Shepherd & Durham WL Recommendations Exhibit



8_WL
12_WL

0 1,000 2,000 4,000 Feet

Date Revised: 12/29/2017

Replace 8" WL (2740 LF)
with same size

Replace 8" WL (1800 LF)
with same size

Replace 12" WL (3700 LF)
with same size

Replace 6" WL (620 LF)
with minimum IDM
requirement

Replace 8" & 2" WL
with minimum IDM
requirement

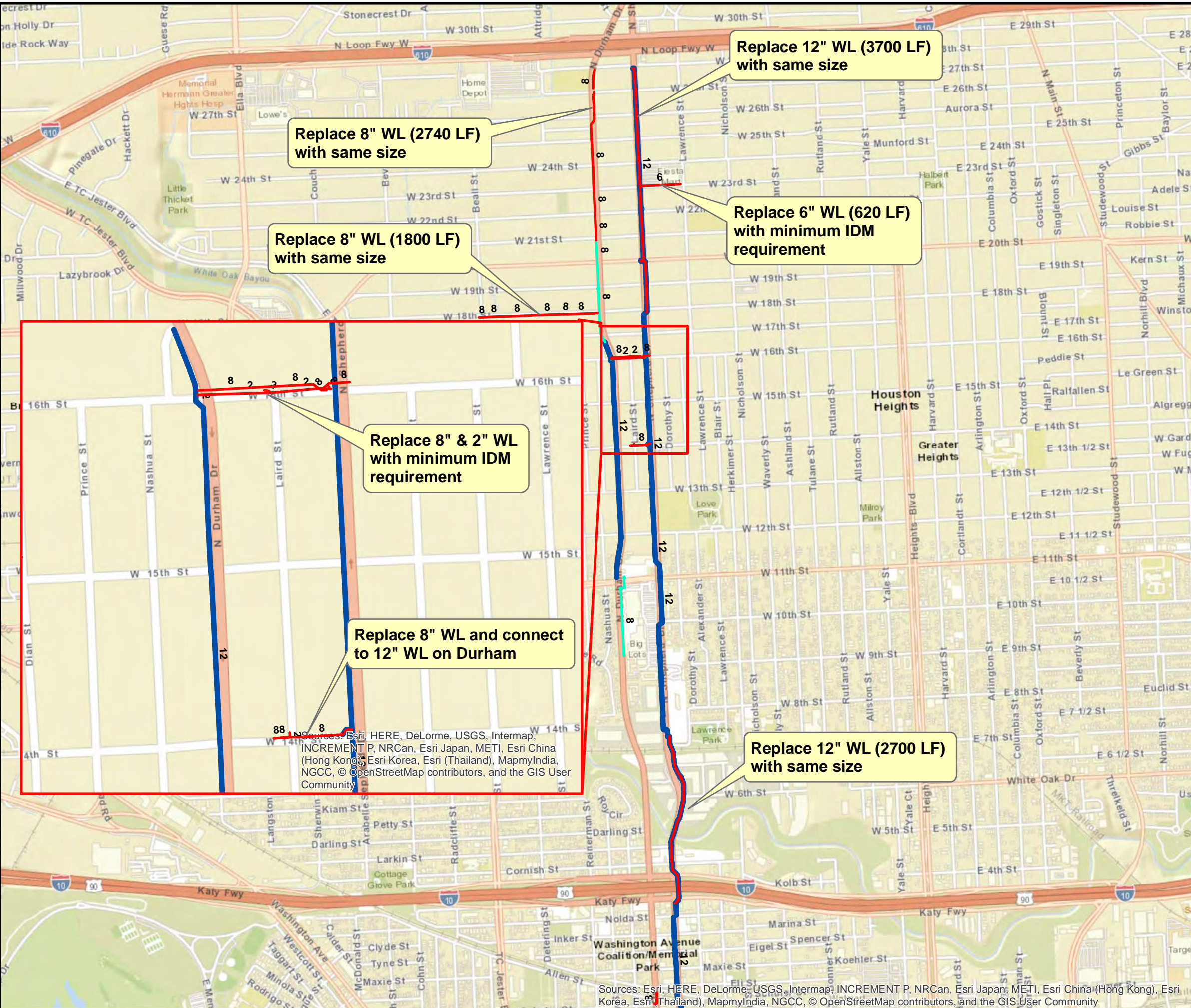
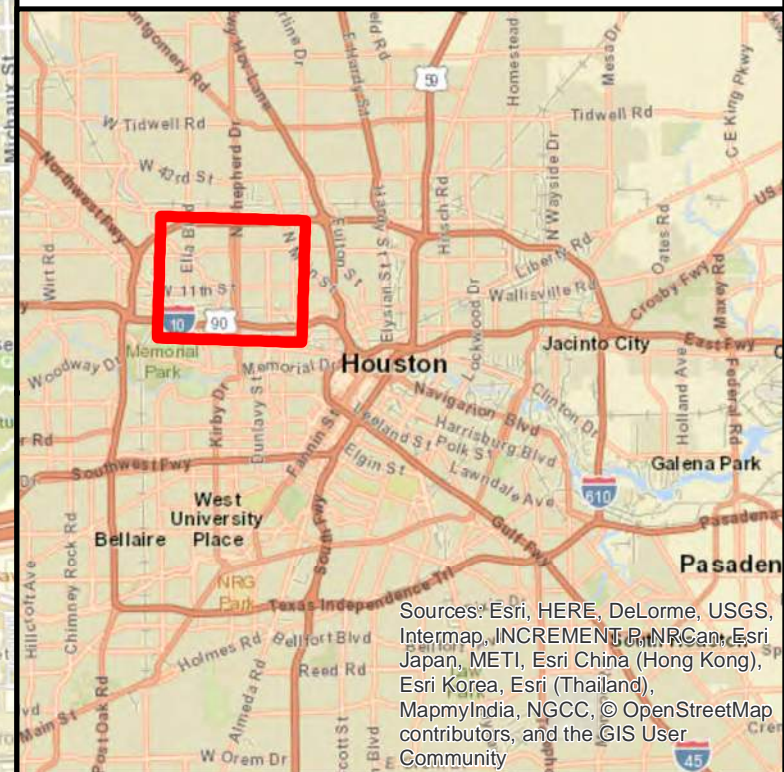
Replace 8" WL and connect
to 12" WL on Durham

Replace 12" WL (2700 LF)
with same size

Sources: Esri, HERE, DeLorme, USGS, Intermap,
INCREMENT P, NRCan, Esri Japan, METI, Esri China
(Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia,
NGCC, © OpenStreetMap contributors, and the GIS User
Community

Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

Sources: Esri, HERE, DeLorme, USGS,
Intermap, INCREMENT P, NRCan, Esri
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MapmyIndia, NGCC, © OpenStreetMap
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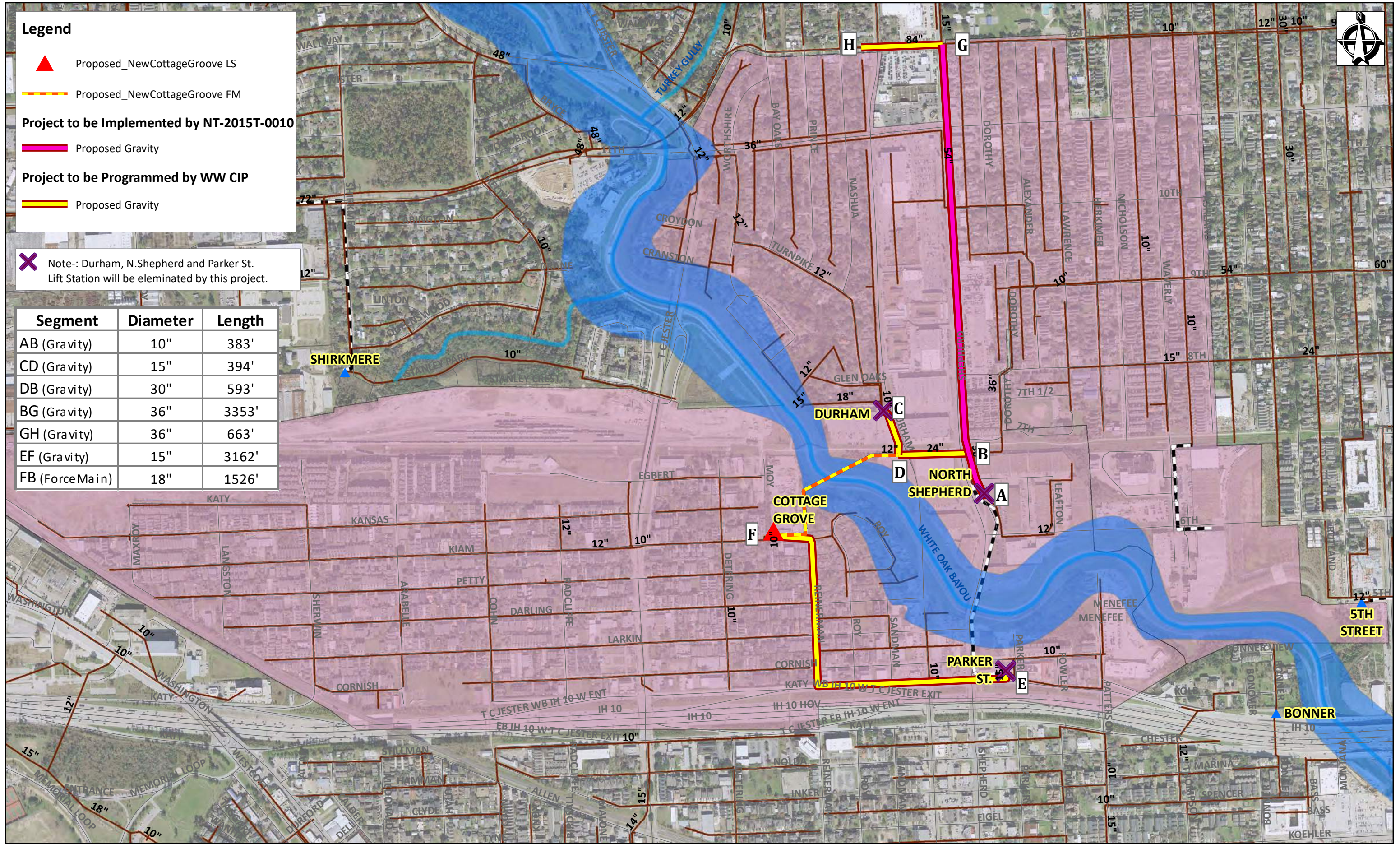
IPB Recommended Project (Draft) in Vicinity of NT-2015-0010 (North Shepherd Area)

Legend

- Proposed_NewCottageGroove LS
- Proposed_NewCottageGroove FM
- Project to be Implemented by NT-2015T-0010**
- Proposed Gravity
- Project to be Programmed by WW CIP**
- Proposed Gravity



Note:- Durham, N.Shepherd and Parker St. Lift Station will be eliminated by this project.

Segment	Diameter	Length
AB (Gravity)	10"	383'
CD (Gravity)	15"	394'
DB (Gravity)	30"	593'
BG (Gravity)	36"	3353'
GH (Gravity)	36"	663'
EF (Gravity)	15"	3162'
FB (ForceMain)	18"	1526'




Alternative To Project (Draft) NT-2015-0010 (North Shepherd Area 36" Sewer From Durham Dr)


Legend


-  Proposed_NewCottageGrove LS
-  Proposed_NewCottageGrove FM

Project to be Implemented by N-2016T-0004

-  Proposed Gravity

Project to be Programmed by WW CIP

-  Proposed Gravity

 Note:- Durham, N.Shepherd and Parker St. Lift Station will be eliminated by this project.

Segment	Diameter	Length
AB (Gravity)	10"	1021'
BC (Gravity)	30"	392'
CD (Gravity)	36"	3154'
EF (Gravity)	15"	3162'
FB (Force Main)	18"	1526'

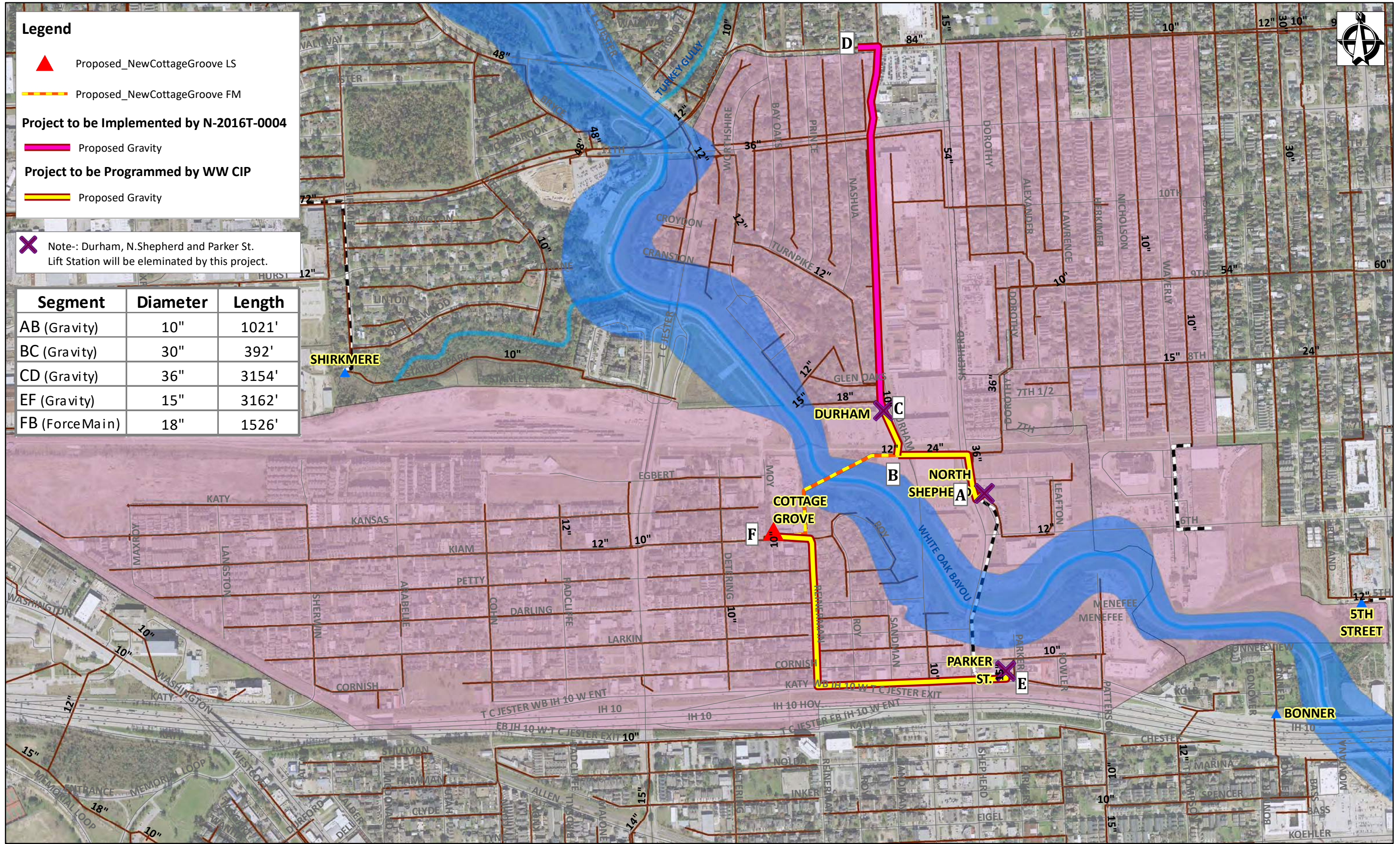
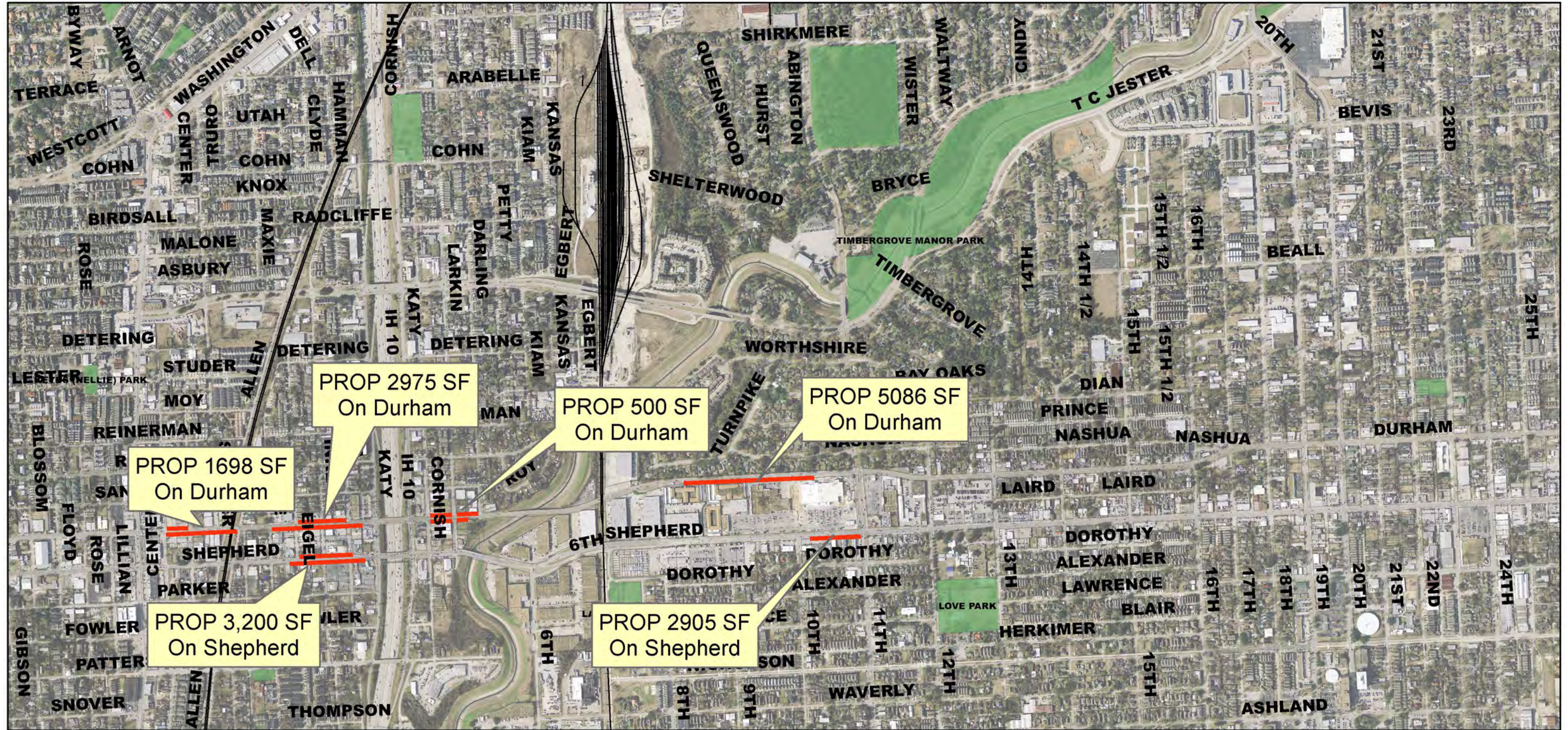


Exhibit E6
Land Acquisition



Shepherd Drive and Durham Drive Pre-Engineering for Street and Paving Improvements (Interstate 610 to Washington Avenue)



**SHEPHERD DRIVE AND
DURHAM DRIVE
(N-2016T-0004)**

LAND ACQUISITION MAP



Legend

- ROW
- Railroad
- Parcel
- Park



1 inch = 1,000 feet

Appendix A
Planning 1 – Problem Definition



GUNDA used field investigation, information from GIMS data available on COH website, data provided by the COH, correspondence with private utilities, and information from Harris County Appraisal District (HCAD) to understand and evaluate the existing conditions. As such, all information provided, although established by the best available means, should be considered approximate. Listed below are the GUNDA findings and observations.

A.1 EXISTING CONDITIONS

Shepherd Drive is a designated as a principal thoroughfare between Interstate 610 and Washington Avenue. Shepherd Drive is a 35 mile per hour (mph) street with four (4) lanes northbound in varying lane configurations. Between Washington Avenue and Interstate 610, the Shepherd Drive consists of four (4) travel lanes with sidewalks along the east and west sides of the pavement. Between West 6th Street and West 9th Street, the Shepherd Bridge consists of four (4) travel lanes with a narrow raised sidewalk on the west side with a northbound feeder road to West 9th Street. Between West 9th Street and Interstate 610, Shepherd Drive continues as a 4-lane northbound road. The existing lanes vary between 10 to 12 feet in width.

Durham Drive is designated as a principal thoroughfare between Interstate 610 and Washington Avenue. Durham Drive is a 35 mile per hour (mph) street with four (4) lanes southbound with varying lane configurations. The lane configurations for Durham Drive are similar to those for Shepherd Drive. Between West 6th Street and West 9th Street, Durham Drive consists of a single, continuous narrow 3-lane bridge with a raised sidewalk along the west side. From West 9th Street to Interstate 610, Durham Drive is a 4-lane southbound road. The existing lanes vary from 10 feet to 12 feet in width. Typical cross sections are provided in Exhibit E3.

The existing Shepherd Drive and Durham Drive roadway sections consists of an existing asphalt overlay over concrete pavement with concrete curb and gutter. The pavement conditions were observed to be generally in fair to poor condition. Potholes, pavement settlement, and broken curbs are prevalent through the project area. Table A-1 lists the Pavement Condition Index (PCI) scores obtained from the City of Houston for Shepherd Drive between Interstate 610 and Washington Avenue. PCI scores were assessed in 2016.

Table A-1: Shepherd Drive Pavement Scores

Limits	PCI Scores	Avg Score
West 28 th Street to Interstate 610	56	55.5
West 27 th Street to West 28 th Street	39-52	
West 26 th Street to West 27 th Street	48-58	
West 25 th Street to West 26 th Street	52-55	
West 24 th Street to West 25 th Street	33-66	
West 23 rd Street to West 24 th Street	49	
West 22 nd Street to West 23 rd Street	70-78	
West 21 st Street to West 22 nd Street	65	
West 20 th Street to West 21 st Street	69	



Table A-1: Shepherd Drive Pavement Scores

Limits	PCI Scores	Avg Score
West 19 th Street to West 20 th Street	62	49.4
West 18 th Street to West 19 th Street	36	
West 17 th Street to West 18 th Street	56	
West 16 th Street to West 17 th Street	61	
West 15 th Street to West 16 th Street	59	
West 14 th Street to West 15 th Street	51	
West 13 th Street to West 14 th Street	49	
West 12 th Street to West 13 th Street	49	
West 11 th Street to West 12 th Street	21	
West 10 th Street to West 11 th Street	13-85	68.9
West 8 th Street to West 10 th Street	57-68	
West 7 th Street to West 8 th Street	90	
West 6 th Street to West 7 th Street	60-91	
White Oak Bayou to West 6 th Street	72	
Darling Street to White Oak Bayou	75	
Larkin Street to Darling Street	71	
Cornish Street to Larkin Street	66	
Interstate 10 North Feeder to Cornish Street	59	
Interstate 10 South Feeder to Interstate North Feeder	89	83.5
Nolda Street to Interstate 10 South Feeder	85	
Inker Street to Nolda Street	88	
Eigel Street to Inker Street	93	
Maxie Street to Eigel Street	72	
Eli Street to Maxie Street	91	
Allen Street to Eli Street	88	
Schuler Street to Allen Street	78	
Nett Street to Schuler Street	77	
Center Street to Nett Street	86	
Washington Avenue to Center Street	77	

Table A-2 lists the PCI scores obtained from the City of Houston for Durham Drive between Interstate 610 and Washington Avenue.

Table A-2: Durham Drive Pavement Scores

Limits	PCI Scores	Avg Score
West 28 th Street to Interstate 610	60	77.4
West 27 th Street to West 28 th Street	78	
West 26 th Street to West 27 th Street	81-86	
West 25 th Street to West 26 th Street	82-88	
West 24 th Street to West 25 th Street	72-76	
West 23 rd Street to West 24 th Street	68-90	
West 22 nd Street to West 23 rd Street	81-92	
West 21 st Street to West 22 nd Street	72	
West 20 th Street to West 21 st Street	81	
West 19 th Street to West 20 th Street	66	
West 18 th Street to West 19 th Street	65	
West 17 th Street to West 18 th Street	79	74.1
West 16 th Street to West 17 th Street	86	
West 15 th Street to West 16 th Street	76	
West 14 th Street to West 15 th Street	69	
West 13 th Street to West 14 th Street	71	
West 12 th Street to West 13 th Street	71	
West 11 th Street to West 12 th Street	67	
West 10 th Street to West 11 th Street	47	61.6
West 8 th Street to West 10 th Street	40	
West 7 th Street to West 8 th Street	71	
West 6 th Street to West 7 th Street	57	
White Oak Bayou to West 6 th Street	58	
Darling Street to White Oak Bayou	67	
Larkin Street to Darling Street	74	
Cornish Street to Larkin Street	63	
Interstate 10 North Feeder to Cornish Street	47	
Interstate 10 South Feeder to Interstate North Feeder	92	
Nolda Street to Interstate 10 South Feeder	60	68.9
Inker Street to Nolda Street	77	
Eigel Street to Inker Street	82	
Maxie Street to Eigel Street	75	
Eli Street to Maxie Street	57	
Allen Street to Eli Street	64	
UPRR to Allen Street	80	
Schuler Street to UPRR	57	
Nett Street to Schuler Street	63	
Center Street to Nett Street	71	
Washington Avenue to Center Street	72	

Development along the corridor is a mixture of commercial and residential land uses. Points of interest include, but are not limited to: Park Place Weekly Homes, Tom Vaughn Ford, Colonial Apartments, Taqueria Arandas, Merchants Park Shopping Center, Love Elementary School, and Arabic Immersion Magnet School.

The following are observations made of Shepherd Drive and Durham Drive during multiple site visits. Corresponding photographs are provided in Appendix D. TIRZ 5 Street signs were observed adjacent to Durham Drive.

Shepherd Drive and Durham Drive: Washington Avenue to West 14th Street

- Metered parking was observed along Center Street.
- AT&T markers observed on Maxie Street.
- Parking lots sit higher than the roadway in multiple locations.
- The overlay on Eigel Street is raveling.
- The pavement on Shepherd Drive is asphalt and in fair to poor condition.
- The pavement on Durham Drive is asphalt and in fair condition.
- The bridges over Interstate 10 are concrete and in good condition.
- The ramps at Shepherd Drive and Cornish are new and offset.
- New construction observed on the northeast corner of Shepherd Drive and Cornish Street.
- The sidewalk on the east side of Shepherd Drive ends at White Oak Bayou.
- The concrete rail of the bridge over White Oak Bayou is broken in several places with exposed rebar.
- The sidewalks on Durham Drive are overgrown between Cornish Street and White Oak Bayou.
- One continuous bridge carries Durham Drive over White Oak Bayou and the former rail right-of-way.
- One bridge carries Shepherd Drive over White Oak Bayou. A separate bridge carries Shepherd Drive over the former rail right-of-way.
- Access to a shared use path along the former rail right-of-way is possible via a feeder road for Shepherd Drive adjacent to the Shepherd Bridge.
- There is no access from Durham Drive to the shared use trail.
- Damage to the sewer drains can be observed near the merge lane of Shepherd Drive north of West 8th Street.
- Commercial land uses are present along the west and east right-of-way.
- The shared use trail continues east and west of the project area.
- There are a few METRO bus stops located along the road.
- Damage to the rail of the ramp on Shepherd Drive can be observed.
- Deteriorating side of the curve on the ramp on Shepherd Drive.
- There are 4 lanes going the same direction (north) all throughout the Shepherd Drive project area.
- 35 miles per hour (mph) speed limit signs posted.

- Land uses along Shepherd Drive north of White Oak Bayou to West 14th Street are mostly car lots with some commercial near West 11th Street and Love Elementary at West 13th Street.
- Land use along Durham Drive north of White Oak Bayou to West 14th Street is primarily residential with single family homes to the west and apartments to the east.
- The area between Shepherd Drive and Durham Drive is mostly commercial.
- West 11th Street is a major roadway with heavy vehicular and pedestrian traffic.
- The building at the southeast corner of Durham Drive and West 11th Street is at or on the right-of-way. The sidewalk is narrow with little to no refuge for pedestrians at the corner.
- Love Elementary lies along the east right-of-way of Shepherd Drive between West 12th Street and West 13th Street. The property is bordered by large oak trees.
- The market on the southeast corner of Shepherd Drive and West 14th Street sits near the property line. Parking on the site is limited. Additional parking is provided on the northwest corner of the intersection.

Shepherd Drive and Durham Drive: West 14th Street to Interstate 610

- Sidewalks are generally four (4) to six (6) feet wide.
- Ramps are missing at most intersections.
- Ponding was noted along the west curb line of Shepherd Drive.
- Commercial land uses were noted along Shepherd Drive and Durham Drive.
- A car wash was observed on the northeast corner of Shepherd Drive and West 16th Street.
- New construction was noted on the southwest corner of Shepherd Drive and West 18th Street (Lowell Street Market). Construction includes new storm sewer along the south side of West 18th Street.
- A new mast arm signal with pedestrian heads and audible countdown was noted at the intersection of Shepherd Drive and West 19th Street.
- The area between the edge of the roadway and the west right-of-way on Shepherd Drive holds water.
- A mid-block crossing was striped north of West 21st Street.
- A large grocery store was observed on the northeast corner of Shepherd Drive and West 23rd Street.
- Pavement markings are faded or worn through the project corridor.
- Between West 20th Street and West 28th Street, no curbs were observed along Shepherd Drive.
- A granite street name marker was observed on the southwest corner of Shepherd Drive and West 28th Street.
- The intersections of Shepherd Drive and Durham Drive at the service roads for Interstate 610 have been recently reconstructed with concrete pavement.

Table A-3 lists the following complaints have been documented by Houston 311.

Table A-3: Houston 311 Complaints

Type	Location	Description	Resolution	Status	Create Date	Due Date	Request ID
A	923 ALEXANDER ST, HOUSTON, TX, 77008	ROW- Flooding	07.Investigation/ Inspection completed	M	Thursday, May 21, 2015 2:43:00 PM	Thursday, May 21, 2015 4:08:00 PM	11889989

A.2 RIGHT-OF-WAY

The existing right-of-way along Shepherd Drive between Interstate 610 and Washington Avenue varies between 50 and 300 feet. The existing right-of-way along Durham Drive between Interstate 610 and Washington Avenue varies between 60 and 145 feet. Table A-4 lists existing rights-of-way along Shepherd Drive and Durham Drive.

Table A-4: Rights-of-Way Widths

Cross Street	Right-of-Way Width (feet)	
	Shepherd Drive	Durham Drive
Interstate 610 Westbound Service Road	95	85
Interstate 610 Eastbound Service Road	70	70-110
West 28 th Street	70	70-72
West 27 th Street	70	70
West 26 th Street	70	70
West 25 th Street	70	75
West 24 th Street	75	70
West 23 rd Street	70	75
West 22 nd Street	72	70
West 21 st Street	62-70	70-75
West 20 th Street	75	65-70
West 19 th Street	70	70
West 18 th Street	70	70-90
West 17 th Street	70	70-90
West 16 th Street	68	65-68
West 15 th Street	70-72	65
West 14 th Street	68-70	60-65
West 13 th Street	80	60
West 12 th Street	75	60-62
West 11 th Street	72	65
West 10 th Street	72-78	62-65
West 8 th Street	78-110	60-150
West 7 th Street / UPRR	150-170	60-65
West 6 th Street	70-85	65

Table A-4: Rights-of-Way Widths

Cross Street	Right-of-Way Width (feet)	
	Shepherd Drive	Durham Drive
White Oak Bayou	85	65-110
Darling Street	65-85	58-60
Larkin Street	55	62-65
Cornish Street	85	85
Interstate 10 North Feeder	60	60
Interstate 10 South Feeder	55-60	55
Nolda Street	55	55
Inker Street	58	58
Eigel Street	60	60
Maxie Street	60	60
Eli Street	60	65
UPRR	60-65	65
Allen Street	65	60
Schuler Street	65	60
Nett Street	60	70
Center Street	60-62	62-65
Washington Avenue	60	65-60

A.3 BRIDGES

White Oak Bayou to West 9th Street

Shepherd Drive and Durham Drive span White Oak Bayou and a former railroad corridor. The Shepherd Bridge, was originally built in 1929 and reconstructed in 1996, begins at the south bank of White Oak Bayou and ends near West 6th Street. A second bridge begins north of West 6th Street and ends near West 9th Street. The Durham Bridge, which was built in 1963, begins at the south bank of White Oak Bayou and ends near West 9th Street. The bridges are in good condition. The pedestrian elements on the bridge include narrow (3 to 4 feet wide) sidewalks on west side of the travel lanes which may be harrowing for pedestrian traffic.

A bridge inspection, dated December 14, 2013, was conducted for the Shepherd Bridge at White Oak Bayou by an Engineer, and a signed and sealed report was generated (see Appendix D). The following are descriptions of the observations mentioned in the report.

- Concrete deck surface has a minor longitudinal cracking and minor scaling.
- Deck soffit has minor cracks with efflorescence and several minor spalls with exposed rebar due to insufficient cover.
- The joint seal at Bent 2 (from the north) is deteriorated and approximately one-half is missing.
- The west curb has minor spalling.
- The east railing has impact damage on the south end.

- The concrete girders have minor flexural cracks at the floor beams and minor spalls with exposed rebar due to insufficient cover.
- The floor beams have several minor spalls with exposed rebar due to insufficient cover. The floor beam spalls at Bend 2 have been patched. The patches are cracking and spalling.
- The concrete columns have a few minor spalls and honeycombed areas.
- The tie beam at the middle bent has minor spalling and scaling.
- The concrete backwalls and wingwalls have minor cracking.
- The concrete riprap (slope paving) has minor cracking. One section at the middle bent has cracked and settled.
- Erosion due to embankment runoff has undermined the east edge of the south riprap.
- The approach slabs have minor cracking.
- The southeast guard fence has moderate impact damage at the connection to the bridge.
- The northwest guard fence has minor impact damage.
- Safety transitions are not properly attached to the bridge.
- Traffic safety approach guard rail ends are non-standard.

A bridge inspection, dated December 14, 2013, was conducted for the Durham Bridge by an Engineer, and a signed and sealed report was generated (see Appendix D). The following are descriptions of the observations mentioned in the report.

- Concrete deck surface has widespread minor cracks and moderate scaling and has a few minor spalls. Rebar is exposed at spall locations due to insufficient cover.
- Joint armor plates have minor distortion. Joint seals have failed.
- Concrete curbs have minor cracks and spalls.
- Aluminum railings are dented in several locations due to impact damage.
- The cap at Bend 12 (from the south) is spalled under the west girder bearing.
- Abutment caps have minor cracking.
- Backwalls have moderate spalling and are leaning inward and causing cracking of the wingwalls due to pressure of the approach pavement.
- Concrete caps have minor cracks.
- Columns in the channel have moderate scaling and honeycombing with exposed rebar.
- Channel bed has a minor drift accumulation at Bent 7 (from the south).
- Riprap has minor cracking.
- Approach slabs have minor cracking and are uneven due to settlement.
- Pavement joint seals have failed. Dirt have accumulated in the joints and caused pressure that pushes the pavement into the top of the abutment backwalls.
- The timber posts have minor weathering and decay. The northwest guard fence is very low.
- The concrete and aluminum railing is non-standard.
- There are no traffic safety approach guard rails.

A.4 PEDESTRIAN FACILITIES

It was observed that the sidewalks are generally in poor condition, with significant deterioration in some areas. Sidewalk widths along the corridor range from four (4) to six (6) feet on Shepherd Drive. There are some sidewalks that are wider and extend between the curb and right-of-way. Sidewalk widths along the corridor range from four (4) to six (6) feet on Durham Drive. Several areas of sidewalk in the project corridor are overgrown with vegetation or covered by washed out debris. Sidewalk cracks were observed throughout both corridors. Sidewalk clearance at a few locations is minimal due to utility pole obstructions and landscaping. The pedestrian facilities throughout the study area need significant improvement. Sidewalks are generally in poor condition along some parts of both Shepherd Drive and Durham Drive. At the intersections in the project area, pedestrian ramps are in poor condition and do not meet ADA requirements for safe utilization. There are audible pedestrian signals (APS), pedestrian push buttons, and signal heads at the signalized intersections of Shepherd Drive and Durham Drive at West 11th Street and West 19th Street; however, they do not meet ADA standards.

A.5 BIKEWAYS

Future on-street bicycle facilities are planned for Shepherd Drive and Durham Drive. Multiple bicycle routes cross both Shephard Drive and Durham Drive within the project area. On-street routes cross the project corridors along Washington Avenue and West 23rd Street. Shared use paths cross Shepherd Drive and Durham Drive along White Oak Bayou and West 7th Street. Future on-street bicycle facilities are planned along Nolda Street, Cornish Street, West 11th Street, West 14th Street, West 18th Street, and West 24th Street.

A.6 METRO SYSTEM

Multiple bus routes run through the project area along both Shepherd Drive and Durham Drive and crossing along West 20th Street, West 11th Street, Interstate 10 Service Road, and Washington Avenue. Table A-5 lists the routes, names, and stop locations.

Table A-5: METRO Bus Routes and Stops

Route Number	Route Name	Location
027	Shepherd	At West 26 th Street
027	Shepherd	At West 24 th Street
027	Shepherd	At West 22 nd Street
027	Shepherd	At West 20 th Street
026	Long Point/ Cavalcade	On West 20 th Street
027	Shepherd	At West 18 th Street
027	Shepherd	At West 16 th Street
027	Shepherd	At West 15 th Street
027	Shepherd	At West 14 th Street
027	Shepherd	At West 13 th Street
027	Shepherd	At West 12 th Street

Table A-5: METRO Bus Routes and Stops

Route Number	Route Name	Location
027	Shepherd	At West 11 th Street
030	Clinton/Ella	On West 11 th Street
027	Shepherd	At West 10 th Street
027	Shepherd	At West 7 th Street/ Glen Oaks
027	Shepherd	At West 6 th Street
027	Shepherd	At Larkin Street/ Cornish Street
027	Shepherd	At Interstate 10 Westbound Service Road
027	Shepherd	At Nolda Street
027	Shepherd	At Eigel Street
027	Shepherd	At Allen Street
027	Shepherd	At Schuler Street
027	Shepherd	At Washington Avenue
071	Cottage Grove	On Washington Avenue
085	Antoine/ Washington	On Washington Avenue

A.7 SCHOOLS

There are 39 schools located within a mile and a half of the project area.

There is two (2) school located on Shepherd Drive in or within a mile of the project area. Love School is located on Shepherd Drive between West 12th Street and West 13th Street. The Kipling School is located on Shepherd Drive and between Floyd Street and Blossom Street and is 0.91 miles south of the intersection of Shepherd Drive and West 6th Street.

There are 16 schools located within a mile of the project area:

- Houston Heights High School is located 0.20 miles northeast of the intersection of Shephard Drive and West 11th Street on West 12th Street and Lawrence Street.
- Houston Heights Learning Academy is located 0.21 miles east of the intersection of Shepherd Drive and West 7th Street on West 7 1/2th Street between Herkimer Street and Lawrence Street.
- Mc Cheeks Academy is located 0.41 miles southeast of the intersection of Shepherd Drive and West 11th Street on West 9th Street and Waverly Street.
- Eight Avenue Elementary School is located 0.52 miles southeast of the intersection of Shepherd Drive and West 11th Street on Heights Bike Trail and Waverly Street.
- Three R's Plus Montessori School is located 0.60 miles northeast of the intersection of Shepherd Drive and West 11th Street on West 15th Street and Herkimer Street.
- Urban Jungle Self Defense (Martial Arts School) is located 0.63 miles northeast of the intersection of Shepherd Drive and West 11th Street on the northern side of West 7th Street and the west side of Yale Street.
- Esperanza After School is located 0.69 miles southeast of the intersection of Shepherd Drive and West 6th Street on West 5th Street and on the west side of Heights Boulevard.

- Spanish Over Coffee (Language School) is located 0.71 miles east on West 11th Street and on the west side of Heights Boulevard.
- The New School in The Heights is located 0.72 miles southeast of the intersection of Shepherd Drive and West 11th Street on West 4th Street and the west side of Heights Boulevard.
- Heights Green School is located 0.81 miles northwest of the intersection of Durham Drive and West 11th Street on West 6th Street and between Beall Street and Bevis Street.
- All Saints School is located 0.85 miles southeast of the intersection of Shepherd Street and West 11th Street on West 10th Street and between Cortland Street and Harvard Street.
- White Horse Academy of Martial Arts (Martial Arts School) is located 0.86 miles east of the intersection of Shepherd Drive and West 11th Street on West 11th Street and on the west side of Cortland Street.
- Harvard Elementary School is located 0.89 miles southeast of the intersection of Shepherd Drive and West 11th Street on West 8th Street and Harvard Street.
- Messiah Lutheran School is located 0.89 miles southwest of Durham Drive at the level of West 6th Street on the south side of Rose Street and the west side of Roy Street.
- Stevenson Elementary School is located 0.90 miles southwest of the intersection of Shepherd Drive and West 11th Street on Larkin Street and TC Jester Boulevard.
- Ole School of Spanish is located 0.94 miles northeast of the intersection of Shepherd Drive and West 11th Street on West 19th Street and the east side of Ashland Street.

There are 21 schools located within a mile and a mile and a half of the project area:

- Helms Elementary School is located 1.03 miles northwest of the intersection of Shepherd Drive and West 11th Street on West 21st Street and Lawrence Street.
- Sinclair Elementary School is located 1.03 miles northwest of the intersection of Durham Drive and West 11th Street on Grovewood Lane and the west side of Ella Boulevard.
- Claire School of Dance is located 1.05 miles northeast of the intersection of Shepherd Drive and West 11th Street on the south side of West 18th Street and the west side of Heights Boulevard.
- John H. Reagan High School is located 1.05 miles northwest of the intersection of Shepherd Drive and West 11th Street on West 13th Street and Arlington Street.
- Immanuel Lutheran School is located 1.06 miles northeast of the intersection of Shepherd Drive and West 11th Street on West 15th Street and Cortland Street.
- St. Andrew's Episcopal School is located 1.08 miles northeast of the intersection of Shepherd Drive and West 11th Street, between West 18th Street and West 19th Street and the east side of Yale Street.
- Houston High School is located 1.10 miles southwest of the intersection of Shepherd Drive and West 6th Street on Feagan Street and the west side of Reinerman Street.
- The Goddard School is located 1.15 miles north on Durham Drive and the north side of West 23rd Street.
- High School for Law Enforcement and Criminal Justice is located 1.15 miles southeast of the intersection of Shepherd Drive and West 6th Street on Dickinson Street between Shepherd Drive and Patterson Street.

- Heritage Oaks School is located 1.17 miles northwest of the intersection of Durham Drive and West 11th Street on the west side of Ella Boulevard and between West 11th Street and West 12th Street.
- St. Thomas High School is located 1.23 miles south of the intersection of Shepherd Drive and West 6th Street on Memorial Drive and east of Shepherd Drive.
- Hamilton Middle School is located 1.24 miles northeast of the intersection of Shepherd Drive and West 11th Street on West 20th Street and on the east side of Yale Street.
- Depelchin-Elkins Campus is located 1.24 miles southwest of the intersection of Shepherd Drive and West 6th Street on Scotland Street and the east side of Sandman Street.
- SSQQ Dance Studio (Dance School) is located 1.25 miles northwest of the intersection of Durham Drive and West 11th Street, between ETC Jester Boulevard and West 20th Street.
- Memorial Elementary School is located 1.26 southwest of the intersection of Shepherd Drive and West 6th Street on Byway Street and Haskell Street.
- Arabic Immersion Magnet School is located 1.32 miles north on the west side of Durham Drive and West 27th Street.
- St. Theresa Catholic School is located 1.39 miles southwest of the intersection of Shepherd Drive and West 6th Street on Durford Street and Haskell Street.
- Heights Preschool is located 1.45 miles northeast of the intersection of Shepherd Drive and West 11th Street on 20th Street and Oxford Street.
- Hogg Middle School is located 1.45 miles southeast of the intersection of Shepherd Drive and West 11th Street on Merrill Street and between Pineridge Street and Oakridge Street.
- IDEA Lab Kids (school) is located 1.46 miles northeast of the intersection of Shepherd Drive and West 11th Street on West 17th Street and between Studewood and Beverly Street.
- Eugene Field Elementary School is located 1.47 miles northeast of the intersection of Shepherd Drive and West 11th Street on West 17th Street and between Studewood Street and Beverly Street.

A.8 CHURCHES

There are 29 churches located within a mile of the project area.

There is one (1) churches located on Durham Drive in or within a mile of the project area. Wayman chapel AME Church is located on Durham Drive between West 19th Street and West 20th Street and is 0.89 miles north of the intersection of Durham Drive and West 11th Street. There is one (1) church located on Shepherd Drive in or within a mile of the project area. Bethel United Church of Christ is located on Shepherd Drive and between Center Street and Nett Street and is 0.68 miles south of the intersection of Shepherd Drive and West 11th Street.

There are nine (9) churches located within a half mile of the project area:

- Eighth Street Gospel Temple Church of God in Christ is located 0.17 miles northeast of the intersection of Shepherd Drive and West 7th Street on West 8th Street and Alexander Street.
- West Eleventh Church of God is located 0.17 miles west on West 11th Street and on the west side of Lawrence Street.

- Open Door Deliverance-Jesus is located 0.35 miles southeast of the intersection of Shepherd Drive and West 6th Street on the north side of Nolda Street and the east side of Fowler Street.
- St. Stephen Baptist Church is located 0.35 miles southeast of the intersection of Shepherd Drive and West 6th Street on Nolda Street and the west side of Fowler Street.
- Church of the Apostles Houston is located 0.40 miles northeast of the intersection of Shepherd Drive and West 11th Street on West 14th Street and the east side of Dorothy Street.
- Grace Bible Church is located 0.43 miles northeast of the intersection of Shepherd Drive and West 11th Street on West 14th Street and Alexander Street.
- Mt. Sinai Baptist Church is located 0.43 miles southeast of the intersection of Shepherd Drive and West 11th Street on West 8th Street and Herkimer Street.
- St. Marks United Methodist Church is located 0.45 miles southeast of the intersection of Shepherd Drive and West 11th Street on the west side of Patterson Street and between Eigel Street and Inker Street.
- Resurrection Metropolitan Community Church is located 0.50 miles west of the intersection of Shepherd Drive and West 11th Street on West 11th Street and west of White Oak Bayou.

There are 18 churches located between a half mile and a mile away from the project area:

- St. Mary Church is located 0.53 miles southeast of the intersection of Shepherd Drive and West 6th Street on the north side of Eli Street and between Fowler Street and Parker Street.
- Mt. Calvary Baptist Church is located 0.57 miles northeast of the intersection of Shepherd Drive and West 6th Street on West 10th Street and the east side of Herkimer Street.
- Saint Albans Catholic Church is located 0.69 miles northeast of the intersection of Shepherd Drive and West 11th Street on West 12th Street and the east side of Yale Street.
- Sukyo Mahikari Houston is located 0.69 miles southeast of the intersection of Shepherd Drive and West 11th Street on West 8th Street and Allston Street.
- Grace United Methodist Church is located 0.72 miles northeast of the intersection of Shepherd Drive and West 11th Street on the south side of West 13th Street and the west side of Heights Boulevard.
- The Grove Fellowship is located 0.77 miles northwest of the intersection of Shepherd Drive and West 11th Street between West 16th Street and West 17th Street.
- Healing Waters Fellowship is located 0.83 miles southeast of the intersection of Shepherd Drive and West 11th Street on the south side of West 11th Street and the west side of Harvard Street.
- All Saints Catholic Church is located 0.84 miles southeast of the intersection of Shepherd Drive and West 11th Street on West 10th Street and the east side of Harvard Street.
- First Baptist Church Heights is located 0.85 miles southeast of the intersection of Shepherd Drive and West 11th Street on West 9th Street and Harvard Street.
- Messiah Lutheran Church is located 0.85 miles southwest of Durham Drive at the level of West 6th Street on the east side of Roy Street and between Rose Street and Lillian Street.

- North Star Baptist Church is located 0.85 miles northwest of the intersection of Durham Drive and West 11th Street on the south side of West 19th Street and between Durham Drive and Beall Street.
- Iglesia Pentecostes Iluminados is located 0.87 miles southwest of the intersection of Shepherd Drive and West 11th Street on Kansas Street and between Cohn Street and Radcliffe Street.
- St Luke Baptist Church is located 0.93 miles southwest of Durham Drive at the level of West 6th Street on the east side of Detering Street and between Floyd Street and Lillian Street.
- Greater Pleasant Hill Missionary Baptist Church is located 0.95 miles north of the intersection of Shepherd Drive and West 11th Street on West 20th Street and west of Durham Drive.
- Touch Outreach Ministries Inc. is located 0.98 miles northeast of the intersection of Shepherd Drive and West 11th Street on the south side of West 21st Street and between Lawrence Street and Shepherd Street.
- Heights Presbyterian Church is located 0.99 miles northeast of the intersection of Shepherd Drive and West 11th Street on West 18th Street and Rutland Street.
- Heights Christian Church is located 0.99 miles northeast of the intersection of Shepherd Drive and West 11th Street on West 17th Street and the west side of Heights Boulevard.
- Heights Church of Christ is located 0.99 miles northeast of the intersection of Shepherd Drive and West 11th Street on the south side of West 6th Street and west side of Harvard Street.

A.9 PARKS

Heights Hike and Bike Trail runs through the project area and crosses both Shepherd Drive and Durham Drive just south of West 7th Street. White Oak Bayou runs through the project area and crosses Durham Drive at the level of West 6th Street.

There are eight (8) parks located within a mile of the project area. Love Park is located 0.26 miles northeast of the intersection of Shepherd Drive and West 11th Street between West 22nd Street and West 23rd Street. Lawrence Park is located 0.45 miles southeast of the intersection of Shepherd Drive and West 11th Street on Lawrence Street and Dorothy Street. Houston Bark Park and Daycare is located 0.52 miles southwest of the intersection of Shepherd Drive and West 6th Street on the south side of Maxie Street and between Durham Drive and Sandman Street. Milroy Park is located 0.66 miles northeast of the intersection of Shepherd Drive and West 11th Street on West 12th Street between Yale Street and Allston Street. West 11th Street Park is located 0.80 miles west of the intersection of Shepherd Drive and West 11th Street on West 11th Street between Shelterwood Drive and Shikmere Road. Cottage Grove Park is located 0.87 miles southwest of the intersection of Shepherd Drive and West 6th Street on Larkin Street and between Cohn Street and Arabelle Street. Donovan Park is located 0.89 miles southeast of the intersection of Shepherd Drive and West 11th Street on West 7th Street and Heights Boulevard. Nellie Keyes Park is located 0.90 miles south of the intersection of Shepherd Drive and West 6th Street between Rose Street and Lillian Street.

A.10 CITY OF HOUSTON MAJOR THOROUGHFARE AND FREEWAY PLAN

Table A-6 summarizes the designations in the 2016 City of Houston Major Thoroughfare and Freeway Plan for Shepherd and Durham Drive within the study limits:

Table A-6 – Major Thoroughfare Designations

Street	Start	End	Designation
Shepherd Drive	Washington Avenue	West 11 th Street	Principal Thoroughfare, four (4) lanes in one direction, 60-foot right-of-way (P-4-60)
	West 11 th Street	Interstate 610	Principal Thoroughfare, four (4) lanes in one direction, 70-foot right-of-way (P-4-70)
Durham Drive	Interstate 10	West 20 th street	Principal Thoroughfare, four (4) lanes in one direction, 60-foot right-of-way (P-4-60)
	West 20 th street	Interstate 610	Principal Thoroughfare, four (4) lanes in one direction, 70-foot right-of-way (P-4-70)
	Washington Avenue	Interstate 10	Principal Thoroughfare, four (4) lanes in one direction, 70-foot right-of-way (P-4-70)

A.11 INTER-AGENCY COORDINATION

GUNDA coordinated with the City’s Inter-Agency Coordination Group (IACG) to identify other City, METRO, TxDOT, or Railroad facility projects that could impact the final design of the proposed roadway. Existing projects are found in Table A-7:

Table A-7 – Interagency Coordination

Project Number	Project Name	Project Type	Status	Constr. Start	Constr. End
-	West 21 st Street	Asphalt	Complete	-	1/2017
S-000701-0014	West 19 th Street: Beall to Durham	SREP	Complete	11/2013	11/2016
N-000389-0002	NSR 460	NLSR	Design	8/2019	9/2020
N-000650-0071	West 11 th Street: Hempstead to N Shepherd	NTS	Construction	May-2016	Unknown
-	Nolda Street, Inker Street, Maxie Street, Eli Street, Allen Street, Nett Street, Center Street	Asphalt	Complete	7/2011	6/2012
N-100003-0001	Shepherd Drive and Durham Drive	NMT, MSD, R500	Design	4/2018	5/2019

A.12 UTILITIES

A. Public Utilities

The following public utilities were found within the study area:



Water

Table A-8 lists the existing water lines and their sizes, types of material, and the years they were built for Shepherd Drive. Table A-9 lists the existing water lines and their sizes, types of material, and the years they were built for Durham Drive.

Table A-8: Shepherd Drive Water Lines

From	To	Size (in.)	Material	Year
West 30 th Street	West 28 th Street	24	Cast Iron/ Steel	1959
West 28 th Street	West 20 th Street	12	Asbestos Concrete	1979
West 20 th Street	West 18 th Street	12	Cast Iron	1940
West 18 th Street	West 7 th Street	12	PVC	1994
West 7 th Street	Interstate 10 Westbound Service Road	12	Steel/ Cast Iron	1984
Interstate 10 Westbound Service Road	Interstate 10 Eastbound Service Road	12	Steel	1963
Interstate 10 Eastbound Service Road	UPRR	12	PVC	1988
UPRR	Washington Avenue	12	PVC	1993
West 28 th Street (crossing)	-	8	Cast Iron	1954
West 27 th Street (crossing)	-	6	Asbestos Concrete	1982
West 26 th Street (crossing)	-	6	Asbestos Concrete	1983
West 25 th Street (crossing)	-	8	PVC	1987
West 24 th Street (crossing)	-	84 8	Steel PVC	2001 1987
West 23 rd Street (crossing)	-	8	PVC	1987
West 22 nd Street (crossing)	-	8	PVC	1987
West 21 st Street (crossing)	-	8	PVC	1987
West 20 th Street (crossing)	-	24 8	Cast Iron PVC	1958 1989
West 19 th Street (crossing)	-	6	Asbestos Concrete	1982
West 18 th Street (crossing)	-	8	Asbestos Concrete	1970
West 17 th Street (crossing)	-	8	PVC	1988
West 16 th Street (crossing)	-	8 2	Cast Iron Gal. Stl.	1940 1940
West 15 th Street (crossing)	-	6	PVC	1994
West 14 th Street (crossing)	-	8	PVC	1975
West 13 th Street (crossing)	-	8	Cast Iron	1960
West 12 th Street (crossing)	-	8 6	Cast Iron Cast Iron	1962 1970
West 11 th Street (crossing)	-	12	Cast Iron	1953

Table A-8: Shepherd Drive Water Lines

From	To	Size (in.)	Material	Year
Between West 10 th Street and West 9 th Street (crossing)	-	8	PVC	2009
West 7 th Street (crossing)	-	3	Gal. Stl.	1981
West 6 th Street (crossing)	-	8	Cast Iron	1953
Larkin Street (crossing)	-	8	PVC	1997
Cornish Street (crossing)	-	8	PVC	1989
Interstate 10 Westbound Service Road (crossing)	-	8	Cast Iron	1966
Interstate 10 Eastbound Service Road (crossing)	-	8	Asbestos Concrete	1984
Nolda Street (crossing)	-	12	PVC	1988
Inker Street (crossing)	-	8	PVC	1988
Eigel Street (crossing)	-	6	PVC	1988
Maxie Street (crossing)	-	8	PVC	1988
Eli Street (crossing)	-	8	PVC	1988
Nett Street (crossing)	-	8	PVC	1910
Center Street (crossing)	-	16	Cast Iron	1941
Washington Avenue (crossing)	-	8	Cast Iron	1933

Table A-9: Durham Drive Water Lines

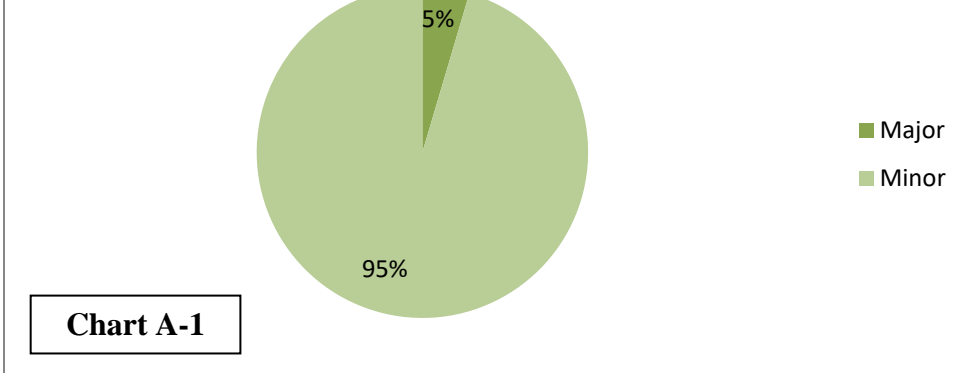
From	To	Size (in.)	Material	Year
West 28 th Street	West 27 th Street	8	Asbestos Concrete	1984
West 27 th Street	West 26 th Street	8	Asbestos Concrete	1984
West 26 th Street	West 20 th Street	8	PVC	1987
West 20 th Street	West 19 th Street	24 8	Cast Iron PVC	1958 1987
West 19 th Street	West 17 th Street	8	PVC	1987
West 17 th Street	West 11 th Street	12	PVC	1997
West 11 th Street	Between West 10 th Street and West 9 th Street	8	PVC	2009
Between West 10 th Street and West 9 th Street	Interstate 10 Eastbound Service Road	None	-	-
Interstate 10 Eastbound Service Road	Inker Street	6	PVC	1984
Inker Street	UPRR	6	PVC	1988
UPRR	Schuler Street	8	Cast Iron	1942
Schuler Street	Washington Avenue	None	-	-
West 28 th Street (crossing)	-	8	Cast Iron	1954
West 27 th Street (crossing)	-	8	PVC	1997
West 26 th Street (crossing)	-	6	Asbestos Concrete	1983
West 25 th Street (crossing)	-	8	PVC	1987
West 24 th Street (crossing)	-	84 8	Steel PVC	2001 1987

Table A-9: Durham Drive Water Lines

From	To	Size (in.)	Material	Year
West 23 rd Street (crossing)	-	8	PVC	1987
West 22 nd Street (crossing)	-	8	PVC	1987
West 21 st Street (crossing)	-	8	PVC	1987
West 20 th Street (crossing)	-	24 8	Cast Iron PVC	1958 1989
West 19 th Street (crossing)	-	24 6	Cast Iron PVC	1958 1988
West 18 th Street (crossing)	-	8	Asbestos Concrete	1970
West 17 th Street (crossing)	-	8	PVC	1988
West 16 th Street (crossing)	-	8 2	Cast Iron Gal. Stl.	1940 1940
West 13 th Street (crossing)	-	8	Cast Iron	1960
West 12 th Street (crossing)	-	8	Cast Iron	1962
West 11 th Street (crossing)	-	12	Cast Iron	1953
Between West 10 th Street and West 9 th Street (crossing)	-	8	PVC	2009
Larkin Street (crossing)	-	8	PVC	1997
Cornish Street (crossing)	-	8	PVC	1989
Interstate 10 Westbound Service Road (crossing)	-	8	Cast Iron	1966
Interstate 10 Eastbound Service Road (crossing)	-	8	Asbestos Concrete	1984
Nolda Street (crossing)	-	12	PVC	1988
Inker Street (crossing)	-	8	PVC	1988
Eigel Street (crossing)	-	6	PVC	1988
Maxie Street (crossing)	-	8	PVC	1988
Eli Street (crossing)	-	8	PVC	1988
Nett Street (crossing)	-	8	PVC	1910
Center Street (crossing)	-	24	Cast Iron	1971
Washington Avenue (crossing)	-	8	Cast Iron	1933

15 major complaints and 312 minor complaints related to water were received within the study area. Minor complaints include discoloration, odor, taste, and repair service line. The major complaints received involved major line repairs. Water complaints for the project area from COH database for year 2011 through 2015 are presented in Chart A-1 below.

Shepherd Drive and Durham Drive Water Complaints (2011 - 2015)



Sanitary Sewers

Table A-10 lists the existing sanitary sewers and their sizes, types of material, and the years they were built for Shepherd Drive. Table A-11 lists the existing sanitary sewers and their sizes, types of material, and the years they were built for Durham Drive.

Table A-10: Shepherd Drive Sanitary Sewers

From	To	Size (in.)	Material	Year
Force Main				
West 7 th Street	Interstate 10 Westbound Service Road	21	Reinforced conc pipe	1950
Gravity Main				
Mid-block south of West 28 th Street	Mid-block south of West 27 th Street	8	Concrete	1990
West 16 th Street	West 15 th Street	8	PEP	2005
West 15 th Street	West 13 th Street	8	PEP	2005
West 13 th Street	West 12 th Street	15	PVC	1998
		8	PEP	2005
West 11 th Street	West 10 th Street	54	MRC	1953
West 7 th Street	216 feet south	36	RCP	1984
Mid-block south of Allen Street	Mid-block south of Nett Street	8	PEP	1990
Center Street	Mid-block south of Center Street	8	PVC	1997
Interstate 610 Eastbound Service Road (crossing)		8	PEP	1943/ 1996
Mid-block south of West 28 th Street (crossing)		8	Concrete/ PEP	1996
Mid-block south of West 27 th Street (crossing)		8	PEP	1996
Mid-block south of West 26 th Street (crossing)		8	PEP	1990

Table A-10: Shepherd Drive Sanitary Sewers

From	To	Size (in.)	Material	Year
Mid-block south of West 25 th Street (crossing)		8	PEP	2009
Mid-block south of West 24 th Street (crossing)		8	Concrete	1940
Mid-block south of West 23 th Street (crossing)		8	PEP	1998
Mid-block south of West 22 th Street (crossing)		8	Concrete	1940
Mid-block south of West 21 th Street (crossing)		8	PEP	1990
Mid-block south of West 20 th Street (crossing)		8	PEP	1996
Mid-block south of West 19 th Street (crossing)		8	PEP	2009
Mid-block south of West 18 th Street (crossing)		8	PEP	2009
Mid-block south of West 17 th Street (crossing)		8	PEP	1996
West 16 th Street (crossing)		8	PEP	1996
West 13 th Street (crossing)		15 8	PVC PVC	1998 1998
West 12 th Street (crossing)		84	Concrete/ PEP	2004
West 11 th Street (crossing)		54	MRC	1953
West 10 th Street (crossing)		54	MRC	1953
West 7 th Street (crossing)		24	Concrete	1950
Interstate 10 Westbound Service Road (crossing)		10	Concrete	1968
Mid-block south of Interstate 10 Eastbound Service Road (crossing)		8	PEP	2003
Mid-block south of Nolda Street (crossing)		8	PEP	2008
Mid-block south of Inker Street (crossing)		8	PEP	2009
Mid-block south of Eigel Street (crossing)		8	PEP	2008
Mid-block south of Maxie Street (crossing)		8	PEP	1931/ 1997
Allen Street (crossing)		8	PVC	1997
Nett Street (crossing)		8	PEP	1990
Mid-block south of Center Street (crossing)		8	PEP	1997

Table A-11: Durham Drive Sanitary Sewers

From	To	Size (in.)	Material	Year
Force Main				
West 7 th Street	370 feet North	10	Cast Iron	1966
Gravity Main				
Interstate 610 Eastbound Service Road	West 28 th Street	6	Unknown/ PEP	1963/2009
West 24 th Street	Mid-block south of West 24 th Street	8	PVC	2015
West 16 th Street	West 15 th Street	8	PVC	1998
West 15 th Street	Mid-block south of West 15 th Street	6	PVC	1998
Mid-block south of West 15 th Street	Mid-block south of West 14 th Street	6	PVC	1998
Mid-block south of West 14 th Street	West 13 th Street	8	PEP	2004
West 13 th Street	West 12 th Street	8	PEP	2005
West 12 th Street	West 11 th Street	8	PEP	2012
West 11 th Street	Glen Oaks Street	6	PVC	1998
		8	PVC	1998
Glen Oaks Street	Durham Lift Station	10	PEP	2012
		12	PVC	1995
Mid-block south of Darling Street	Mid-block south of Larkin Street	8	PEP	2013
Mid-block south of Larkin Street	Interstate 10 Westbound Service Road	10	CIPP	1997
Mid-block south of Nett Street	Mid-block south of Center Street	8	Concrete	1966
Interstate 610 Eastbound Service Road (crossing)		8	PEP	1943/1996
Mid-block south of West 28 th Street (crossing)		8	Concrete/ PEP	1996
Mid-block south of West 27 th Street (crossing)		8	PEP	1996
Mid-block south of West 26 th Street (crossing)		8	PEP	1990
Mid-block south of West 25 th Street (crossing)		8	PEP	2009
Mid-block south of West 24 th Street (crossing)		8	Concrete	1940
Mid-block south of West 23 th Street (crossing)		8	PEP	1998
Mid-block south of West 22 th Street (crossing)		8	Concrete	1940
Mid-block south of West 21 th Street (crossing)		8	PEP	1990
Mid-block south of West 20 th Street (crossing)		8	PEP	1996
Mid-block south of West 19 th Street (crossing)		8	PEP	2009
Mid-block south of West 17 th Street		8	PEP	1996



Table A-11: Durham Drive Sanitary Sewers

From	To	Size (in.)	Material	Year
(crossing)				
West 16 th Street (crossing)		8	PEP	1996
West 13 th Street (crossing)		15 8	PVC PVC	1998 1998
West 12 th Street (crossing)		84	Concrete/ PEP	2004
West 11 th Street (crossing)		54	MRC	1953
West 7 th Street (crossing)		24	Concrete	1950
Mid-block south of Darling Street (crossing)		8	PEP	2013
Mid-block south of Larkin Street (crossing)		8 10	Concrete CIPP	1910 1997
Interstate 10 Westbound Service Road (crossing)		10	Concrete	1968
Interstate 10 Westbound Service Road (crossing)		10	Concrete	1968
Mid-block south of Interstate 10 Eastbound Service Road (crossing)		8	PEP	2003
Mid-block south of Nolda Street (crossing)		8	PEP	2008
Mid-block south of Inker Street (crossing)		8	PEP	2009
Mid-block south of Eigel Street (crossing)		8	PEP	2008
Mid-block south of Maxie Street (crossing)		8	PEP	1931/ 1997
Allen Street (crossing)		8	PVC	1997
Mid-block south of Schuler Street (crossing)		8	PEP	1990
Mid-block south of Center Street (crossing)		8	PEP	1997

Along Durham Drive there were three (3) reports of odor, seven (7) reports of sanitary sewer overflows, and 44 reports of stoppages. Along Shepherd Drive there were three (3) reports of odor three (3) reports of sanitary sewer overflows, and 16 reports of stoppages. These complaints are located throughout the need area with recurrent complaints within the 800 and 1200 blocks of Shepherd Drive. Also these complains are located throughout the need are with recurrent complaints within the 700 and 1100 blocks of Durham Drive.

Storm Sewers

Table A-12 lists the existing storm sewers and their sizes, types of material, and the years they were built for Shepherd Drive. Table A-13 lists the existing storm sewers and their sizes, types of material, and the years they were built for Durham Drive.

Table A-12: Shepherd Drive Storm Sewers

From	To	Size (in.)	Material	Year
West 28 th Street	West 27 th Street	18	Concrete	1944
West 27 th Street	West 25 th Street	36	MRC	1944
West 25 th Street	West 23 rd Street	42	MRC	1944
West 23 rd Street	West 22 nd Street	18	Concrete	1944
West 21 st Street	West 20 th Street	18	Concrete	1944
West 18 th Street	West 17 th Street	21	Unknown	1921
West 17 th Street	West 16 th Street	24	Unknown	1921
		24	MRC	1937
West 12 th Street	West 11 th Street	24	MRC	1946
West 11 th Street	West 7 th Street	36	MRC	1962
West 7 th Street	Outfall	42	MRC	1927
West 6 th Street	Outfall	Unk.	RCP	Unk.
White Oak Bayou	Interstate 10 Westbound Service Road	36	MRC	1927
Interstate 10 Eastbound Service Road	Maxie Street	36	MRC	1927
Maxie Street	Allen Street	21	MRC	1927
Allen Street	Nett Street	18	RCP	Unk.
Nett Street	Center Street	21	RCP	Unk.
Center Street	Washington Avenue	36	MRC	Unk.
West 23 rd Street (crossing)		24	RCP	1987
		48	MRC	1944
West 20 th Street (crossing)		24	RCP	1944
West 18 th Street (crossing)		24	RCP	2016
West 16 th Street (crossing)		90	MRC	1937
West 15 th Street (crossing)		84	MRC	Unk.
West 14 th Street (crossing)		36	MRC	Unk.
West 13 th Street (crossing)		24	RCP	1963
West 12 th Street (crossing)		36	MRC	1946
West 10 th Street (crossing)		24	RCP	1939
West 7 th Street (crossing)		24	RCP	Unk.
Cornish Street (crossing)		36	RCP	2015
Interstate 10 (crossing)		120	MRC	Unk.
Interstate 10 Eastbound Service Road (crossing)		36	RCP	1962
Center Street (crossing)		18	RCP	1941

Table A-13: Durham Drive Storm Sewers

From	To	Size (in.)	Material	Year
West 28 th Street	West 27 th Street	18	RCP	1963
West 27 th Street	West 26 th Street	30	RCP	1963
West 26 th Street	West 25 th Street	36	RCP	1963
West 25 th Street	West 23 rd Street	42	MRC	1963
West 23 rd Street	West 20 th Street	48	MRC	1963
West 20 th Street	West 19 th Street	30	Concrete	1963
West 19 th Street	West 18 th Street	24	Concrete	1963

Table A-13: Durham Drive Storm Sewers

From	To	Size (in.)	Material	Year
Mid-block south of West 17 th Street	West 16 th Street	24	RCP	2011
West 16 th Street	West 15 th Street	18	Concrete	1963
West 11 th Street	Mid-block south of West 11 th Street	18	Concrete	1962
Mid-block south of West 11 th Street	West 10 th Street	21	Concrete	1962
West 10 th Street	Colonial Apartments	24	Concrete	1962
Colonial Apartments	Glen Oaks Street	30	Concrete	1962
Glen Oaks Street	Outfall	36	Concrete	1962
Darling Street	Cornish Street	24	Concrete	1962
Interstate 10 Eastbound Service Road	Eigel Street	30	Concrete	1962
Eigel Street	Maxie Street	24	Concrete	1962
Schuler Street	Center Street	18	Concrete	1962
West 27 th Street (crossing)		24	RCP	1974
West 23 rd Street (crossing)		24	RCP	1987
West 20 th Street (crossing)		60	MRC	1963
West 16 th Street (crossing)		90	MRC	1937
West 15 th Street (crossing)		84	MRC	Unk.
West 14 th Street (crossing)		42	MRC	1946
West 13 th Street (crossing)		42	MRC	1963
West 12 th Street (crossing)		18	Concrete	1946
West 11 th Street (crossing)		21	RCP	1959
Darling Street (crossing)		30	Concrete	1962
Interstate 10 (crossing)		120	MRC	Unk.
Interstate 10 Eastbound Service Road (crossing)		36	RCP	1962
Nolda Street (crossing)		24	RCP	1998
Center Street (crossing)		18	RCP	1941
Washington Avenue (crossing)		18	Concrete	1968

B. Private Utilities

The following private utilities were found within the study area:

CenterPoint Energy (electric) owns and maintains poles, Street lights and overhead and underground facilities along the east and west right-of-way of Shepherd Drive and Durham Drive with several crossings throughout the project corridor.

CenterPoint Energy (gas) owns and maintains multiple gas lines in the following locations within the study area:

- 6-inch and 8-inch intermediate pressure (IP) steel lines along Shepherd Drive through the project area.
- 2-inch IP steel along Durham Drive between West 11th Street and White Oak Bayou.
- 6-inch IP and high pressure (HP) steel lines crossing Shepherd Drive and Durham Drive along West 11th Street.



- Multiple 2-inch and 3-inch IP steel and plastic lines crossing Shepherd Drive and Durham Drive through the project area.

AT&T owns and maintains multiple underground facilities in the following locations within the study area:

- 3-3.5-inch Trans/C.I.B. on the corner of Shepherd Drive and West 11th Street
- 18- 3-inch M.C.D East of Shepherd Drive on West 11th Street
- 18-3-inch M.C.D about halfway between Shepherd Drive and Durham Drive on West 11th Street
- 1- 3.5-inch C.I.B on the northeast corner of the intersection between Durham Drive and West 11th Street
- 1-3.5-inch Trans on the northwest corner of the intersection between Durham Drive and West 11th Street (southwest of the corner)
- 1-3.5-inch Trans on the northwest corner of the intersection between Durham Drive and West 11th Street (closer to the corner)

Comcast owns and maintains aerial lines mounted on the CenterPoint Energy poles within the Shepherd Drive right-of-way.

No Zayo facilities are present in the corridors.

No response received from AT&T LD, Broadwing, Comcast, Embarq, Level 3, Phonoscope, Qwest, Wavevision, Windstream, and XO Communications.

A.13 TRAFFIC

The existing traffic volumes are at capacity on Shepherd Drive and Durham Drive in the study area between Washington Avenue and Interstate 610. The existing average daily traffic volumes on Shepherd Drive and Durham Drive are summarized Charts A-1 and A-2. The charts also summarize 2040 projections by segment. Considering a four-lane one-way facility could carry 35,000 vehicles per day; both Shepherd and Durham are operating less than theoretical capacity of similar facility.

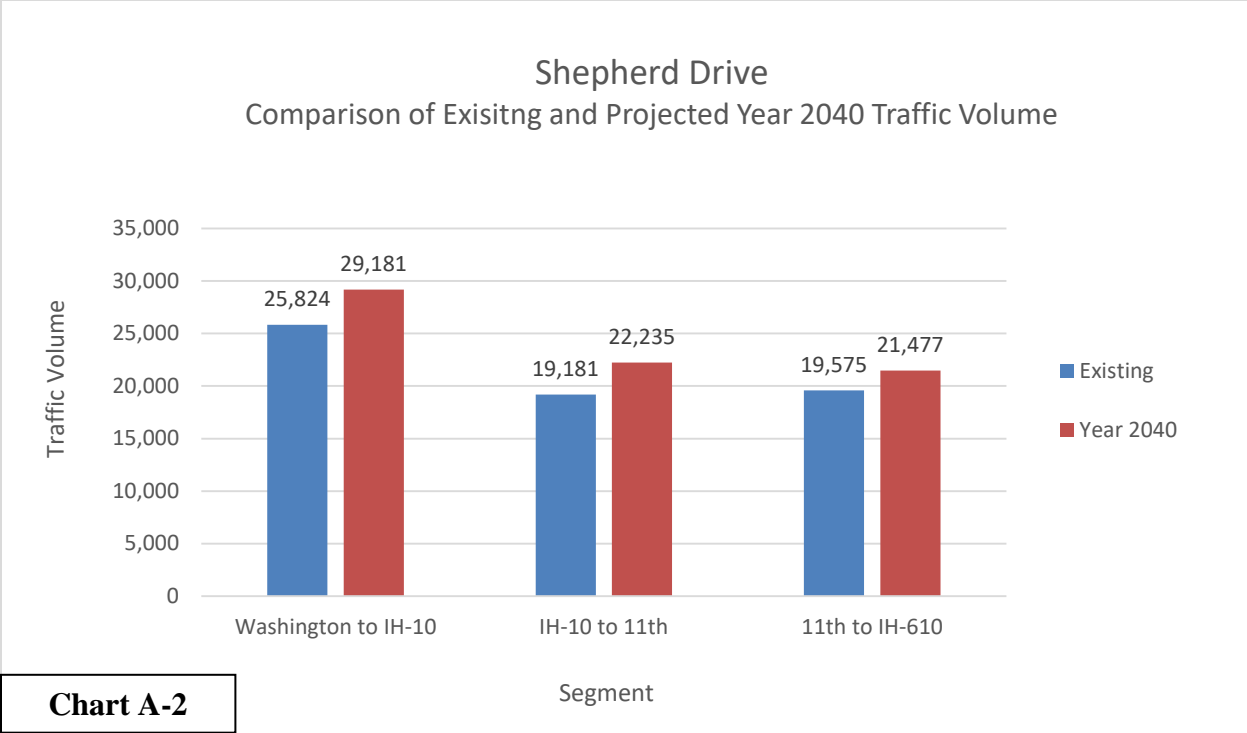


Chart A-2

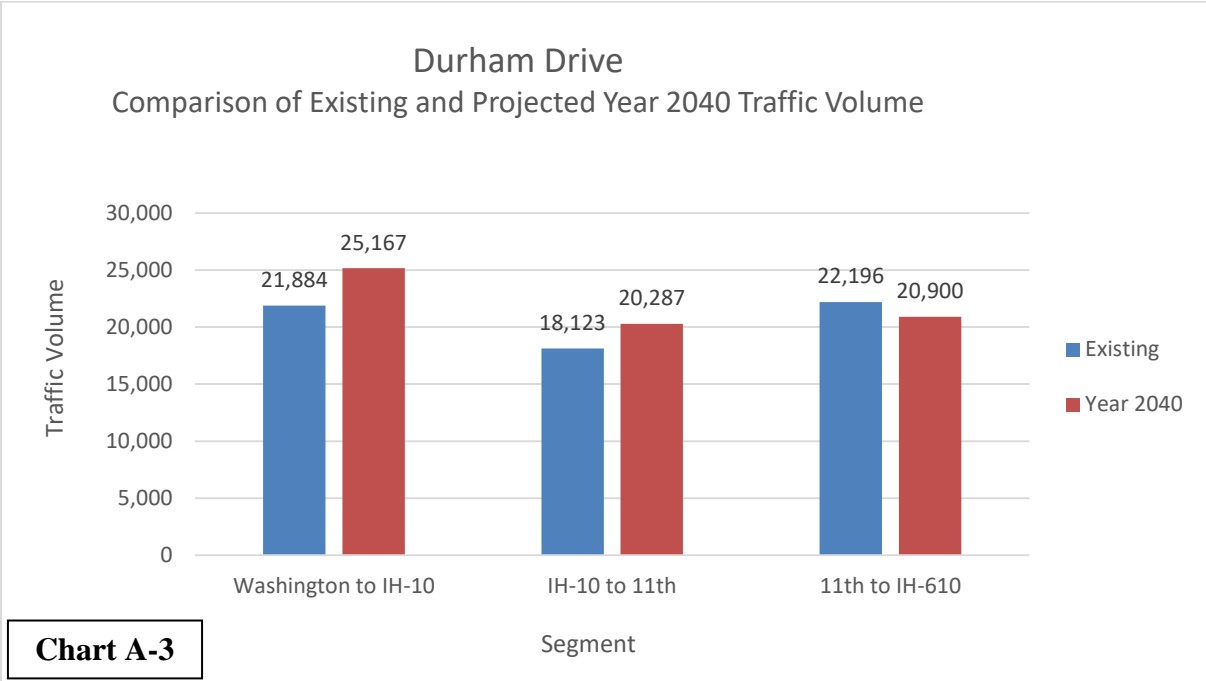


Chart A-3

The data obtained from the City of Houston indicates that both Shepherd Drive and Durham Drive should be transformed into 3-lane roads throughout the entire study areas with bike lanes. It is estimated that the annual growth rate of traffic volume for Shepherd Drive will be approximately a maximum 0.6 percent per year from existing to projected 2040. Based on this

data, by 2040, and assuming a theoretical capacity of 25,000 vehicles per day for a 3-lanes one-way facility, Shepherd Drive and Durham Drive will operate at or close to the theoretical capacity in the study area, if both Streets from Washington Avenue to Interstate 610 are changed from four (4) lanes to three (3) lanes with the bike lanes.

A.14 FEMA FLOOD HAZARD AREA

Per FEMA Panel 48201C0670M, Shepherd Drive and Durham Drive from Interstate 10 to the Heights Hike and Bike Trail (West 7th Street) is located in 100-year floodplain and 500-year floodplain (Zone AE and shaded Zone X) of White Oak Bayou (HCFCD Unit # E100-00-00). The remainder of Shepherd Drive and Durham Drive are located outside the 100-year and the 500-year floodplain (in unshaded Zone X). Exhibit E4 shows the Flood Plain Map for the need area.

A.15 DRAINAGE

A. ANALYSIS APPROACH

A preliminary analysis was performed to determine if the existing drainage systems have the capacity to drain the existing flows from their respective drainage areas based on the COH current standards.

Drainage areas for the systems were delineated based on aerial photographs, field visits, the COH's Comprehensive Drainage Plan (CDP) 2-year outfall drainage areas and HCAD parcel data. The drainage areas were further divided into sub-drainage areas generally corresponding with changes in pipe sizes along the drainage system.

The Rational Method was used to compute the 2-year design peak flows. The design flow for a particular sub-drainage area was computed based on peak flow versus area curves that were developed for the preset study. The curves represent the peak flow that HouStorm would compute for a particular drainage area and average c-value.

The capacity of the existing storm sewer systems was computed using Manning's formula. The hydraulic information on the pipes such as flow line, size, length, and material were obtained from the utility database provided by the COH and from record construction drawings.

The 2-year design peak flows for sub-drainage areas were compared with the capacity of the corresponding segment of the drainage system. If the capacity of the drainage segment was greater than the design flows, then the drainage segment was identified as having adequate capacity, otherwise, the drainage segment was identified as inadequate to convey the design flows. In addition, the drainage segments where the CDP proposed future improvements were also identified along with the proposed configuration. An inlet and lateral level of detail analysis was not performed.

Extreme event overland drainage areas were also identified for each drainage system. The overland drainage areas were delineated using 2008 LiDAR DEM data.

B. EXISTING DRAINAGE CONDITIONS

The existing areas adjacent and along Durham Drive and Shepherd Drive are served by curb and gutter storm sewer systems identified by Drainage Systems W0530, E00035, E00039, E00040, E0041, E0042, E0051, E0145, E0146, E0147, and E0150. The land use in Drainage System E0041 and E0042 is mostly commercial, industrial and multi-family, while Drainage System E0051 is mostly single family residential.

The storm sewer trunk for Drainage System W0530 ranges from an 18-inch RCP to a 36-inch RCP along Shepherd Drive and Durham Drive. The storm systems drain south along Center Street and ultimately discharge into Buffalo Bayou (HCFCD Unit W100-00-00) via a 54-inch storm sewer. The storm sewers serve approximately 122 acres and do not have the capacity to convey the 2-year design flows. The storm sewers are on average 71 years old. The CDP indicates that the upper end of the system is inadequate and recommends the replacement of the existing 18-inch storm sewers with 21-inch pipe.

The storm sewer trunk for Drainage System E0036 drains the area between Interstate 10 and UPRR. The storm sewer pipes range from 21-inch to 36-inch pipe and are approximately 54 to 89 years old. Two (2) separate storm systems collect flows along Shepherd Drive and Durham Drive and collect in a 36-inch pipe along the eastbound service road for Interstate 10. The Interstate 10 storm system ultimately outfalls into White Oak Bayou (HCFCD Unit E100-00-00) via a 120-inch storm sewer. The drainage area serves approximately 361 acres. The existing storm sewers do not have adequate capacity to convey the 2-year design flows. The outfall into White Oak Bayou does have adequate capacity. The CDP recommends replacement of the existing 21-inch and 36-inch storm sewers with 30-inch and 42-inch pipes respectively.

The storm sewer trunk for Drainage System E0039 drains approximately nine (9) acres in a 36-inch storm sewer along Shepherd Drive that outfalls into White Oak Bayou (HCFCD Unit E100-00-00). The existing storm sewer is approximately 89 years old but has adequate capacity to convey the 2-year design flows.

The storm sewer trunk for Drainage System E0040 drainage approximately eight (8) acres in a 24-inch storm sewer along Durham Drive that outfalls via a 30-inch CMP into White Oak Bayou (HCFCD Unit E100-00-00). The existing storm sewer is approximately 54 years old and has sufficient capacity for the 2-year design flows.

The storm sewer trunk for Drainage System E0041 ranges from a 24-inch RCP to a 42-inch RCP along Shepherd Drive and drains into White Oak Bayou (HCFCD Unit E100-00-00). The bridge over the MKT Trail was designed with inlets that allow water to fall directly below the bridge where it is collected by inlets into the E0041 trunk. The storm sewer trunk drains approximately 58 acres and mostly does not have sufficient capacity to convey the 2-

year design flows. This storm sewer system ranges from 54 to 90 years old. The CDP has also determined the storm sewer system to be inadequate and recommends improvement.

The storm sewer trunk for Drainage System E0042 ranges from an 18-inch RCP to a 36-inch RCP along Durham Drive and drains into White Oak Bayou (HCFCD Unit E100-00-00). This trunk along Durham Drive drains approximately 15.6 acres and the outfall and portions of the existing storm sewer have adequate capacity to drain the 2-year design flows. While the 18-inch and 21-inch RCP have adequate capacity to drain the 2-year design flows, the pipes do not meet the City of Houston Infrastructure Design Manual criteria for 24-inch minimum pipe size. The storm sewer system is 54 years old. The CDP does not recommend storm sewer improvements for this drainage system.

The storm sewer trunk of Drainage System E0051 ranges from a 21-inch RCP to a 42-inch RCP along West 11th Street and drains into White Oak Bayou (HCFD Unit E100-00-00). The 21-inch storm sewer along West 11th Street has sufficient capacity for the 2.4 acres drainage area, but does not meet the City of Houston Infrastructure Design Manual criteria for minimum pipe size. The 42-inch outfall drains the entire 26.1 acre drainage area and does not have adequate capacity to convey the 2-year design flows. The storm sewer system is 57 years old, and the CDP does not recommend storm sewer improvements for this drainage system.

The storm sewer trunk for Drainage System E0145 ranges from 24-inch to 42-inch RCP. The storm sewers collect into a 66-inch pipe along West 13th Street and outfall into Turkey Gully (HCFCD Unit E106-00-00), a tributary to White Oak Bayou. The existing storm sewers are approximately 54 to 70 years old and do not have adequate capacity to convey the 2-year design flows. The CDP has determined that the system is inadequate and has recommended replacing the existing 24-inch, 36-inch, and 42-inch storm sewers with 36-inch, 42-inch, 48-inch, and 54-inch pipes.

The storm sewer trunk for Drainage System E0146 is a 7-foot by 6-foot reinforced concrete box sewer along West 15th Street. The box conveys approximately 242 acres to Turkey Gully (HCFCD Unit E106-00-00), a tributary to White Oak Bayou, via an 84-inch outfall. The storm system does not have adequate capacity to convey the 2-year design flows. The CDP has determined that the system is inadequate and recommends replacing the existing boxes with 120-inch, or equivalent, pipe.

The storm sewer trunk for Drainage System E0147 ranges from 18-inch to 90-inch pipe. The storm sewers collect into a 90-inch MRC along West 20th Street and outfall into Turkey Gully (HCFCD Unit E106-00-00), a tributary to White Oak Bayou. The storm sewers are approximately 73 to 95 years old and do not have adequate capacity to convey the 2-year design flows. The storm system drains approximately 214 acres. The CDP has determined that the system is inadequate and has recommended replacing the existing storm sewers with 24-inch to 132-inch pipes.

The storm sewer trunk for Drainage System E0150 ranges from 18-inch to 60-inch RCP. The storm sewers collect into a 66-inch MRC along West 18th Street and outfall into Turkey

Gully (HCFCD Unit E106-00-00), a tributary to White Oak Bayou. The storm sewers are approximately 54 years old and generally do not have adequate capacity to convey the 2-year design flows. The storm system drains approximately 129 acres. The CDP has determined that the system is inadequate and recommends replacing the existing 18-inch to 54-inch storm sewers with 30-inch to 66-inch pipes.

Extreme event overland flows generally follow the drainage patterns within the drainage areas identified, but are significantly larger. Extreme event overland flow between Interstate 610 and West 22nd Street flows west to east. The area between West 22nd Street and West 13th Street flows east to west. The area between West 13th Street and Interstate 10 flows towards White Oak Bayou. The area between Interstate 10 and UPRR flows north towards Interstate 10. The area south of UPRR to Washington Avenue flows south.

Both Durham Drive and Shepherd Drive experience minimal ponding along the project limits. Durham shows between 0.5 to 1 foot of ponding in the area before the ramp to the bridge, and as well as a few areas along the curb and gutter. Shepherd Drive shows between one-half (0.5) to one (1) foot of ponding at the intersection of West 10th Street and also the intersection of West 7th Street, just north of the previously existing railroad.

C. EXTERNAL DRAINAGE SYSTEMS

All of the storm sewers within the Need Area outfall into White Oak Bayou, HCFCD Unit E100-00-00 with the exception of Drainage area W0530 that flows to Buffalo Bayou, HCFCD Unit W100-00-00. HCFCD has partnered with the United States Army Corps of Engineer to perform Federal Flood Damage Reduction Project on White Oak Bayou. Upon completion of the project, the one percent (1%) Annual Exceedance Probability (AEP) water surface elevations (100-year) are anticipated to be lowered between one-half (0.5) and one and one-half (1.5) feet. Currently White Oak Bayou at the storm sewer outfalls for this Need Area has a capacity of ten percent (10%) of the 500 year floodplain.

Table A-14 – Existing Drainage Summary

SYSTEM ID	LOCATION DESCRIPTION			EXISTING SYSTEM								CDP	
												Span	Rise/Dia
	Location	From	To	Drainage Area (ac)	2-Yr Flow (cfs)	Span (ft)	Rise/Dia (ft/in)	Length (ft)	Slope (%)	Pipe Capacity (cfs)	Sufficient Capacity	Span (ft)	Rise/Dia (ft/in)
E0146	15th	Shepherd	Laird	221.7	374.3	7	6	244	0.11	194.5	No		120
	15th	Durham	Nashua	228.5	385.0	7	6	204	0.12	196.9	No		120
	15th	Dian	Outfall	242.3	406.7		84	15	0.12	120.2	No		120
E0147	Shepherd	28th	27th	2.3	6.0		18	370	0.34	6.1	Yes		24
	Shepherd	27th	25th	10.8	26.7		36	728	0.17	27.4	Yes		
	Shepherd	25th	23th	23.2	51.6		42	741	0.13	35.7	No		54
	Shepherd	22th	23th	2.8	6.8		18	354	0.39	6.6	No		
	23th	Shepherd	Lawrence	35.1	76.4		48	694	0.27	75.2	No		54
	Shepherd	21st	20th	2.8	6.9		18	325	0.32	6.0	No		24
	20th	Shepherd	Lawrence	5.7	13.6		24	72	0.08	6.5	No		36
	Shepherd	18th	17th	7.6	17.9		21	352	0.51	11.3	No		24
	Shepherd	17th	16th	10.6	24.6		24	234	0.51	16.2	No		30
	Shepherd	17th	16th	12.8	29.4		24	175	0.51	16.2	No		30
	Shepherd	16th	--	14.2	32.5		21	20	0.51	11.3	No		
	Shepherd	16th	--	1.9	5.2		21	23	0.51	11.3	Yes		
	16th	Shepherd	Laird	188.2	346.0		90	296	0.14	282.9	No		96
	16th	Durham	Prince	195.3	358.1		90	143	0.14	282.9	No		96
16th	Dian	Outfall	213.7	389.5		90	551	0.17	321.5	No		132	
E0150	Durham	28th	27th	6.4	14.2		18	326	0.23	5.1	No		30
	Durham	27th	26th	12.3	26.4		30	377	0.19	17.7	No		36
	Durham	26th	25th	27.0	51.7		36	360	0.17	28.0	No		42
	Durham	25th	23th	51.4	95.0		42	734	0.20	44.8	No		48
	Durham	23th	20th	75.0	135.6		48	1109	0.28	75.8	No		54
	20th	Durham	Beall	84.6	151.8		60	620	0.20	115.9	No		66
	Durham	18th	19th	4.5	9.4		24	375	0.23	10.9	Yes		



Table A-14 – Existing Drainage Summary

SYSTEM ID	LOCATION DESCRIPTION			EXISTING SYSTEM								CDP		
												Proposed	Size	
	Location	From	To	Drainage Area	2-Yr Flow	Span	Rise/Dia	Length	Slope	Pipe Capacity	Sufficient Capacity	Span	Rise/Dia	
				(ac)	(cfs)	(ft)	(ft/in)	(ft)	%	(cfs)		(ft)	(ft/in)	
E0150	Durham	19th	20th	10.4	20.9		30	372	0.35	24.4	Yes			
	20th	Beall	Outfall	128.7	225.0		66	42	0.02	52.0	No			
E0145	14th	Shepherd	Laird	36.7	69.0		36	231	0.30	36.8	No		42	
	14th	Durham	Nashua	42.1	78.6		42	247	0.20	45.4	No		48	
	13th	Shepherd	Laird	22.1	36.3		24	303	0.82	20.5	No		36	
	13th	Durham	Prince	66.5	121.0		42	497	0.41	65.0	No		54	
	Durham	12th	13th	44.7	70.4		36	674	0.65	53.7	No			
	Durham	14th	13th	2.4	5.5		24	226	0.24	11.2	Yes			
	13th	Bay Oaks	Outfall	127.4	222.9		66	77	0.05	76.8	No			
E0042	Durham	--	--	1.6	4.3		18	275	0.40	6.6	Yes			
	Durham	--	--	4.2	10.8		21	276	0.40	10.0	No			
	Durham	--	--	7.4	18.6		24	468	0.40	14.3	No			
	Durham	--	--	11.4	28.2		30	498	0.60	31.9	Yes			
	Durham	--	--	14.4	35.2		30	341	0.49	28.8	No			
	Durham	--	--	16.5	39.9		36	160	0.54	49.0	Yes			
E0041	N. Shepherd	12th	11th	4.6	11.1		24	675	0.09	6.8	No			
		10th	Dorothy	Shepherd	6.2	14.7		24	281	0.21	10.5	No		
	N. Shepherd	11th	--	26.1	57.7		36	1492	0.09	20.1	No		42	
	N. Shepherd	--	7th	37.8	82.0		36	1124	0.66	54.3	No		42	
	N. Shepherd	7th	--	49.1	105.1		42	507	0.91	96.4	No			
	N. Shepherd	--	6th	51.0	108.8		42	318	0.91	96.2	No			
	N. Shepherd	6th	E100-00-00	59.3	125.5		42	450	0.91	96.2	No			
E0039	Shepherd	Katy	Larkin St.	9.0	21.1		36	334	1.67	86.5	Yes			
	Shepherd	Larkin St.	E100-00-00	9.0	21.1		36	172	13.13	242.3	Yes			

Table A-14 – Existing Drainage Summary

SYSTEM ID	LOCATION DESCRIPTION			EXISTING SYSTEM								CDP	
												Proposed	Size
	Location	From	To	Drainage Area	2-Yr Flow	Span	Rise/Dia	Length	Slope	Pipe Capacity	Sufficient Capacity	Span	Rise/Dia
				(ac)	(cfs)	(ft)	(ft/in)	(ft)	%	(cfs)		(ft)	(ft/in)
E0040	Durham	Cornish	Darling	4.3	10.5		24	532	0.40	14.3	Yes		
E0040	Durham	Darling	--	7.9	17.2		30	142	0.70	34.5	Yes		
	--	--	E100-00-00	7.9	17.2		30	35	0.03	7.0	No		
E0051	11th	N. Durham	Nashua	2.4	5.2		21	206	0.36	9.6	Yes		
	11th	TC Jester	E100-00-00	25.5	49.0		42	82	0.10	31.5	No		
E0036	Durham	Maxie	Eigel	3.0	6.8		24	243	1.29	25.8	Yes		
	Durham	Eigel	Katy	14.8	31.4		30	794	0.08	11.5	No		
	Katy	--	--	15.8	33.4		36	27	0.08	18.3	No		
	Shepherd	Allen	Eli	8.0	17.5		21	121	0.14	5.9	No		
	Shepherd	Eli	Maxie	10.0	21.6		21	253	0.14	5.9	No		30
	Shepherd	Maxie	Katy	19.8	44.5		36	1078	0.47	45.6	Yes		
	Katy	--	--	20.9	46.9		36	47	1.16	72.0	Yes		42
	Katy	--	E100-00-00	361.0	635.0		120	84	0.18	699.1	Yes		
W0530	Durham	Schuler	Center	4.5	10.1		18	511	0.19	4.6	No		21
	Center	Durham	Shepherd	6.0	13.3		18	336	0.27	5.4	No		21
	Shepherd	Allen	Nett	2.4	6.5		18	242	0.05	2.3	No		
	Shepherd	Nett	Center	4.5	11.5		21	276	0.56	11.9	Yes		
	Shepherd	Center	Washington	14.5	35.3		36	286	0.06	16.3	No		
	Shepherd	Washington	Lillian	14.5	35.3		36	257	0.10	21.3	No		
	--	--	W100-00-00	121.8	213.7		54	1746	0.92	189.2	No		

A.16 TREE IMPACT

There are a few mature trees within the right-of-way whose canopies extend over the existing roadway and pedestrian areas. In order to obtain adequate passable height clearances, these trees will require trimming and pruning.

A.17 PERMITS

The following Permits are required for this project at the end of Phase II design:

- Construction drawings will be submitted to a consulting firm approved by the Texas Department of Licensing and Regulation (TDLR) for compliance with the Architectural Barriers Act (ABA).
- A Notice of Intent (NOI) will be filed for coverage under the General Permit for Storm Water Discharge from Construction Activities.
- Street cut and lane closure permits will be required from the City of Houston.
- Permits from HCFCO will be required for construction and proposed runoff outfalls around and into White Oak Bayou (E100-00-00).
- Permits will be required from City of Houston for construction of proposed improvements within the Shepherd Drive and Durham Drive corridor. These permits include road/lane closure permits, traffic control permits, and Street cut permits.
- An SW3P will be developed in accordance with Texas Pollutant discharge Elimination System (TPDES) requirements. As stated in the Texas General permit TXR150000, issued by the Texas Commission on Environmental Quality (TCEQ), a TPDES permit is required for the construction activity if the total disturbed area is equal to or more than one acre. The proposed construction activity related to the improvement of Shepherd Drive and Durham Drive is expected to disturb approximately 348 acres of land area. Therefore, the Contractor will be responsible for implementation, maintenance and inspection of storm water pollution prevention control measure including but not limited to source controls for erosion and sedimentation controls, waste collection and disposal, filter fabric fence, reinforced filter fabric barrier, stabilized construction exit and other practices.

A.18 CHALLENGES

A primary challenge for Shepherd Drive and Durham Drive between Interstate 610 and Washington Avenue is poor pavement conditions. Other challenges are limited right-of-way, non-ADA compliant pedestrian facilities, and an undersized drainage system.

A.19 OPPORTUNITIES

- Improve pavement conditions along Shepherd Drive and Durham Drive.
- Improve vehicular mobility at signalized intersections.
- Update pedestrian mobility and access to provide safe pedestrian travel.
- The recommendation complies with the Houston Bike Plan.

- Reduce traffic accidents.
- Update drainage system to meet the latest standard design criteria.
- Update water and sanitary sewer system to meet the latest standard design criteria.

Appendix B
List of Record Construction Drawings



Pre-Engineering Record Drawing Log

WO#12D - N-2016T-0004: Shepherd Drive and Durham Drive

Plan # (P)	Title	Limits
Unknown	Lateral Service	Halfway between West 6 th Street and West 7 th Street to northwest of halfway between West 6 th Street to West 7 th Street
Unknown	Lateral Service	North of hallway between West 8 th Street and West 9 th Street to west of the main line
Unknown	Lateral Service	Halfway between West 9 th Street and West 10 th Street to west of the main line
Unknown	Lateral Service	North of halfway between West 9 th Street and West 10 th Street to east and west of the main line
Unknown	Pump Pressure Main	East of the intersection of West 10 th Street and Shepherd Drive to east the intersection towards Dorothy Street
Unknown	Pump Pressure Main	North of the intersection of Shepherd Drive and West 10 th Street to southeast of the main line
Unknown	Lateral Service	Halfway between West 10 th Street and West 11 th Street to east of the main line
Unknown	Wastewater (Gravity Main)	North of the intersection of Shepherd Drive and West 10 th Street to west of the main line
Unknown	Storm water	West 6 th Street to north the intersection of Shepherd Drive and West 6 th Street
Unknown	Storm water	North of the intersection of Shepherd Drive and West 7 th Street to west and east of the main line
Unknown	Storm water	North of halfway between West 7 th Street and West 7 1/2 th Street east and west of the main line
Unknown	Wastewater (Gravity Main)	Halfway between West 9 th Street and West 10 th Street to South pf West 11 th street (in between Shepherd Drive and Durham Drive)
P4116	Wastewater	Paving and Storm Sewer Profile of Shepherd Drive from Buffalo Drive to Westheimer Road
WD224	Wastewater	From Allen Street to Schuler Street
WD2477	Storm Water	Across Katy Freeway
WD7194	Storm Water	From Dorothy Street to Katy Freeway
WD7544	Wastewater	From Katy Freeway to Allen Street
WD8259	Storm Water	From Allen Street to Washington Avenue (Water Replacement Project No. 10099)
WD8342	Wastewater	From West 14th Street to Dorothy Street
736	Pump Pressure Main	North of West 6 th Street to east of the intersection of Shepherd Drive and West 6 th Street
1034	Wastewater	From West 14th Street to West 13th Street
1942	Storm water	Intersection of West 10 th Street and Shepherd Drive

Pre-Engineering Record Drawing Log

WO#12D - N-2016T-0004: Shepherd Drive and Durham Drive

Plan # (P)	Title	Limits
		to east of the main line
4232	Wastewater	From Maxie Street to Allen Street
4588	Storm water	From West 11th Street to Maxie Street
4829	Storm water	North of the intersection of Shepherd Drive and West 6 th Street to southwest of the main line
6725	Storm water	from Katy Freeway to Inker Street
7194	Pump Pressure Main	South of West 6 th Street to West 7 th Street
7544	Wastewater (Gravity Main)	From Maxie Street to Allen Street
8342	Pump Pressure Main	West 7 th Street to north of West 11 th Street
9121	Storm water	From West 12th Street to West 11th Street
9138	Wastewater (Gravity Main)	West 10 th Street to east of the intersection of Shepherd Drive and West 10 th Street
9146	Wastewater (Gravity Main)	South of the Heights Hike and Bike trail
9147	Wastewater (Force Main)	South of West 6 th Street to halfway between West 6 th Street and West 7 th Street
9147	Wastewater	From West 6th Street to Katy Freeway
9593	Wastewater (Gravity Main)	West 6 th Street to West 7 th Street
9682	Storm water	North of the intersection of Shepherd Drive and West 10 th Street to east of the main line
9803	Wastewater (Gravity Main)	From West 11th Street to Darling Street
9939	Wastewater (Gravity Main)	West 10 th Street to West 11 th Street
11280	Storm water	South of West 11 th Street to north of West 11 th Street
11280	Wastewater	From West 11th Street to Katy Freeway
12782	Lateral Services	West 9 th Street to West 11 th Street
14041	Storm water, Wastewater	From West 11th Street to Maxie Street
14041	Water	From Darling Street to Washington Avenue
14153	Wastewater	From West 14th Street to West 12th Street
14748	Wastewater (Force Main)	South of West 7 th Street to south of West 7 1/2 th Street
14748	Water	From West 11th Street to Darling Street
26674	Wastewater (Gravity Main)	North of halfway between West 6 th Street and West 7 th Street to south of the Heights Hike and Bike trail
26674	Water	From West 7th Street to West 6th Street

Pre-Engineering Record Drawing Log

WO#12D - N-2016T-0004: Shepherd Drive and Durham Drive

Plan # (P)	Title	Limits
31116	Wastewater (Gravity Main)	West 6 th Street to West 8 th Street
31116	Water	From West 11th Street to Darling Street
31481	Storm	From Center Street to Washington Avenue
31619	Water	From West 13th Street to West 12th Street
32442	Water	From West 14th Street to West 11th Street
32540	Wastewater (Force Main)	Halfway between West 6 th Street and West 7 th Street to south of West 7 th Street and east of halfway between West 6 th Street and West 7 th Street
32540	Water	West 7th Street to West 6th Street
34305	Water	Schuler Street to Nett Street
44983	Pump Pressure Main	North of West 9 th Street to north of West 11 th Street
44983	Water	From West 11th Street to Katy Freeway
47102	Water	8-inch Water Line to Serve St. Thomas High School

Appendix C

Project Photographs





Photo 1 – Multiple driveways, grass growing in sidewalks



Photo 2 – Settling inlet



Photo 3 – Settled sidewalk, uneven and weathered patching

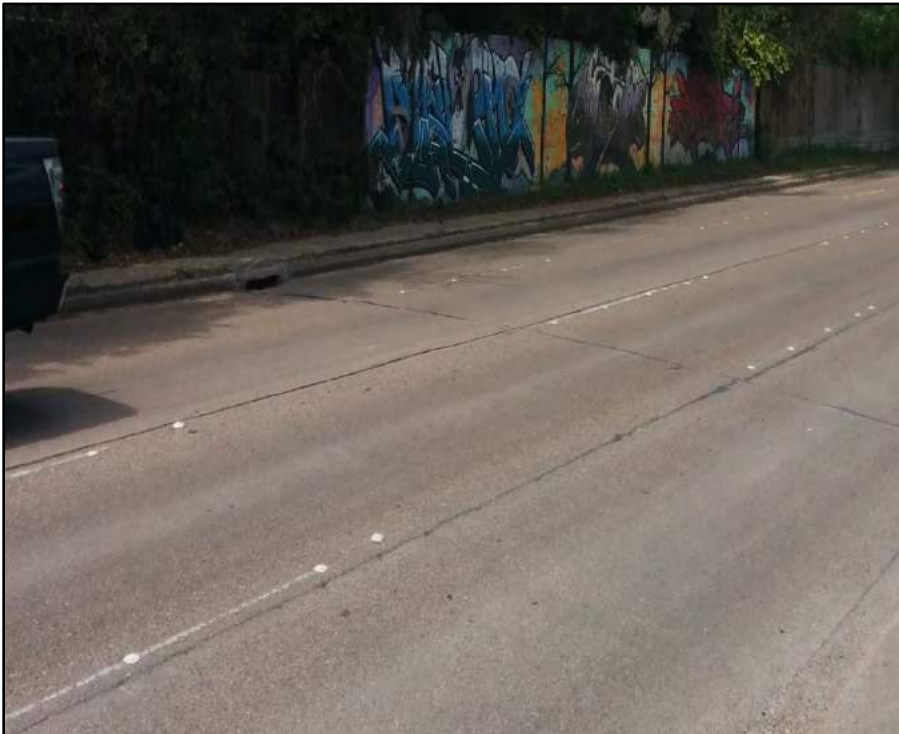


Photo 4 – Faded pavement markings



Photo 5 – Pavement Failure



Photo 6 – Pedestrian crossing mid-block



Photo 7 – Missing ramp



Photo 8 – Cracks through patches



Photo 9 –Access Drive under Durham Bridge



Photo 10 – Crack at ends of sidewalks on Durham Drive



Photo 11 – Settling drain along Durham Drive



Photo 12 – Cracked sidewalk in Shepherd Drive



Photo 13 – Sidewalk cracking and grass growing between the cracks at Shepherd Drive



Photo 14 – Shepherd Drive feeder road under Shepherd Bridge



Photo 15 – Durham Drive leading to Durham Bridge



Photo 16 – Shepherd Bridge at White Oak Bayou

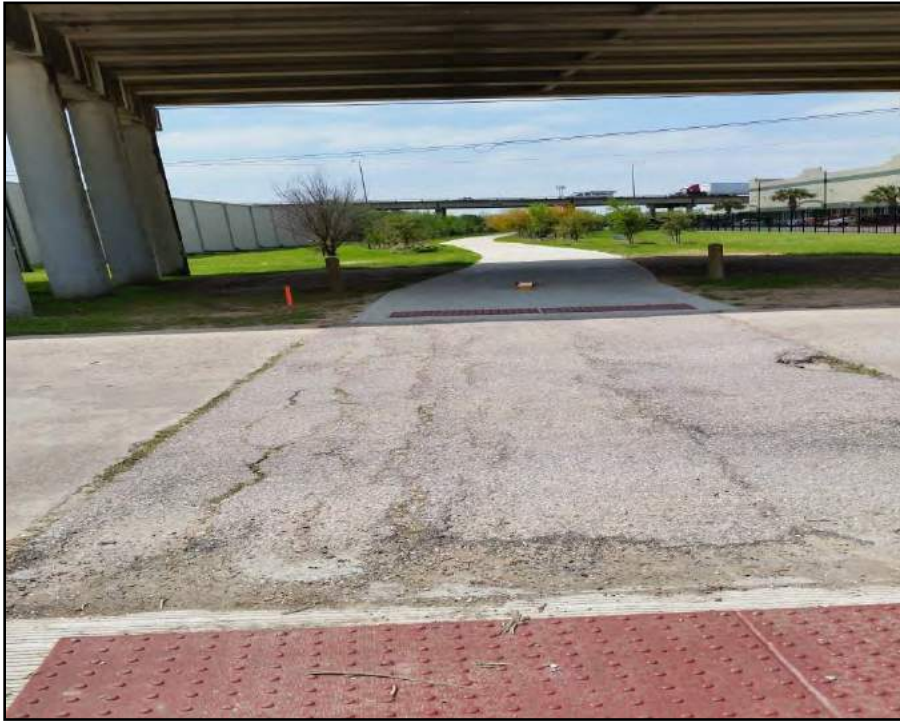


Photo 17 – Heights Trail underneath both Shepherd Bridge and Durham Bridge



Photo 18 – Durham Drive behind Kroger



Photo 19 – Heights Trail at Shepherd Drive



Photo 20 – Heights Trail west of Durham Bridge



Photo 21 – Wider sidewalk that extends between the curb and right-of-way



Photo 22 – Extreme parking encroachments on Shepherd Drive



Photo 23 – Continued construction on Shepherd Drive

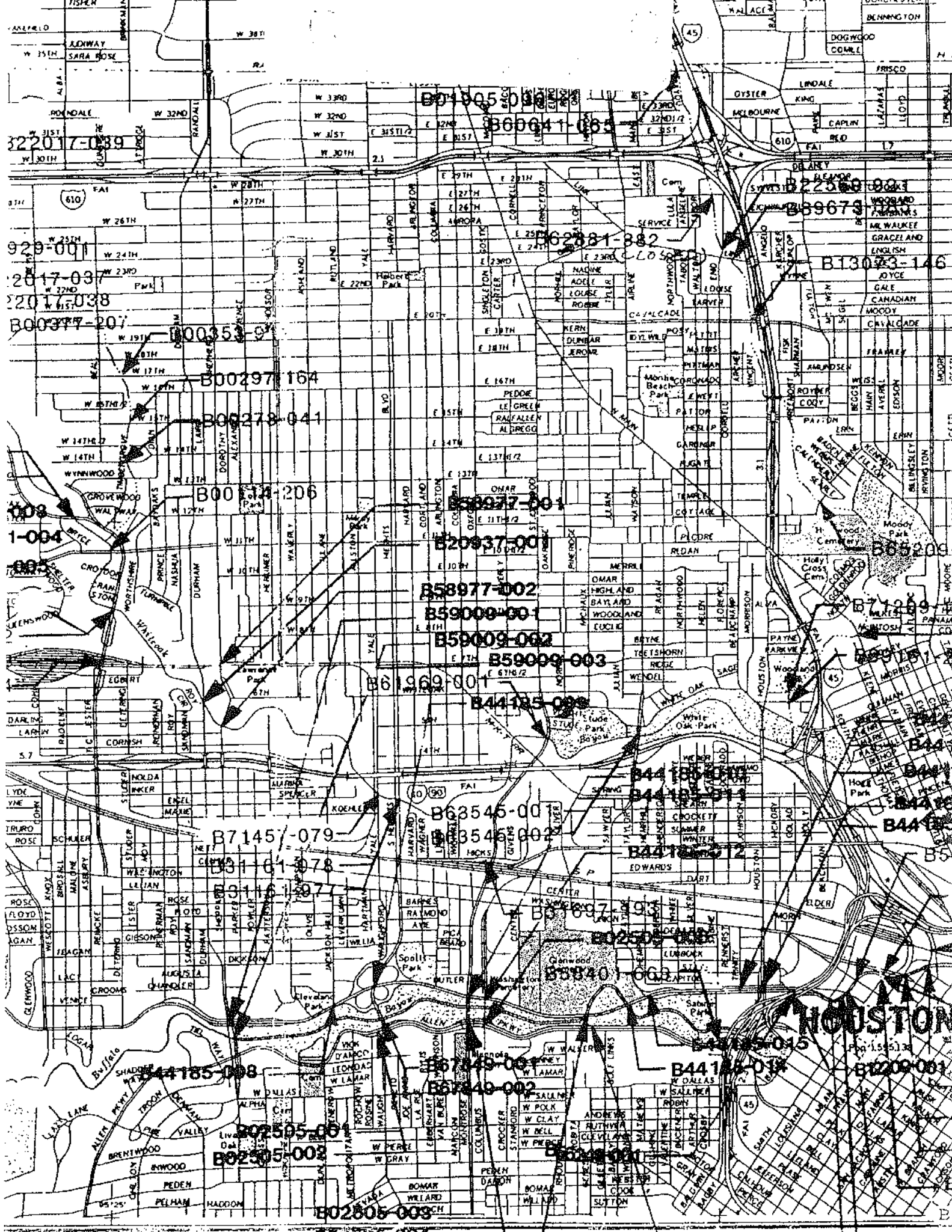
Appendix D

Bridge Inspection Reports



Bridge Report #22





322017-089

929-001
2817-037
220165038
B00377-207

B00353-97

B00297-164

B00278-041

B00244-206

1-004

003

003

B61969-001

B71457-079

B31116-1877

B44185-008

B02505-001

B02505-002

B02805-003

B02805-003

B02805-003

B02805-003

B02805-003

B02805-003

B02805-003

B02805-003

B02805-003

B02805-003

B02805-003

B01505-0301

B60641-065

B62881-382

B22588-001

B39673-043

B13073-146

B59097-001

B20937-001

B58977-002

B59009-001

B59009-062

B59009-003

B64185-008

B63546-001

B63546-002

B63546-003

B63546-004

B63546-005

B63546-006

B63546-007

B63546-008

B63546-009

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Modified (12-5-2000)
for Microsoft Word 7.0, WIN95 & NT

Bridge Summary Sheet

District: 12 County: 102 Cont-Sec: B589-77 Structure: 002 Route: N Shepherd Dr #22
 Feature Crossed: White Oak Bayou Inspector's Signature: Robert F. Groleau, P.E. Date: 12/14/2013
 Company Name: Pickett, Kelm & Associates, Inc. (F-1491) City of Houston #22

Selected Component Description and Rating:

Selected Component Description and Rating:	Inspection Rating (1085)	Inventory Rating		Operating Rating	
		H	HS	H	HS
Concrete Girder Variable Depth (Assumed)	6		15		20
Concrete Substructure	7		15		20

Comments and/or Upgrade Recommendations (if applicable):

Repair the damaged guardfence at the SE corner.



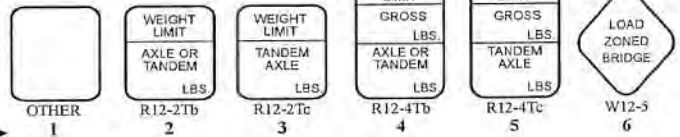
Load Posting Limits for Present Condition (if applicable):

Inventory

Operating

- lbs Gross
 - lbs Tandem Axle
 - lbs Axle or Tandem
 - Sign Code

- lbs Gross
 - lbs Tandem Axle
 - lbs Axle or Tandem
 - Sign Code



Posting Recommendation: None - Load posting is not required.

Previous Load Posting Recommendations:

Observed Load Posting at Bridge:

 R12-2Tb None
 R12-2Tc lbs Gross
 R12-4Tb lbs Tandem Axle
 R12-4Tc lbs Axle or Tandem

 R12-2Tb None
 R12-2Tc lbs Gross
 R12-4Tb lbs Tandem Axle
 R12-4Tc lbs Axle or Tandem
 Other (desc.):

Material Needed

- R12-2Tb
- R12-2Tc
- R12-4Tb
- R12-4Tc
- W12-5
- Posts
- Hardware Sets
- Decals



Sign Code
Condition Code
Maintenance Need

Advanced Warning (optional)

Bridge Approach

Bridge Approach

Advanced Warning (optional)

- | | | | | |
|---------------------------|--------------------------|------------------------|---------------------------|------------------------|
| A. Visible & Legible | D. Improper Position | G. Sign Missing | K. Clean Sign | N. None |
| B. Obscured by Vegetation | E. Damaged Beyond Repair | H. Sign & Post Missing | L. Reposition Sign | P. Replace Sign |
| C. Sign Needs Cleaning | F. Sign Down | J. Clear Vegetation | M. Reposition Sign & Post | S. Replace Sign & Post |



Bridge Inspection Record

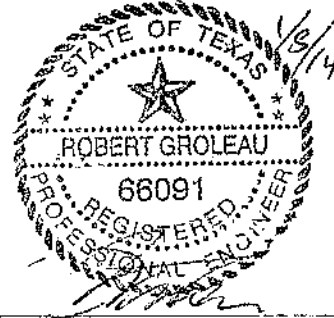
District: 12 County: 102 Cont-Sec: B589-77 Structure: 002 Route: N SHEPHERD DR Maint Sect:

Description: 4 span (3 continuous and 1 simple) variable depth concrete slab and girder bridge

Feature Crossed: WHITE OAK BAYOU Inspector's Signature: [Signature] Date: 12/14/2013

Company Name: Pickett, Kelm & Associates, Inc. [F-1491] Inspector: Robert Groleau, P.E.

Rating	Description
-	Not Applicable
9	Excellent condition
8	Very good condition
7	Good condition - some minor problems
6	Satisfactory condition - minor deterioration of structural elements (limited)
5	Fair condition - minor deterioration of structural elements (extensive)
4	Poor condition - deterioration significantly affects structural capacity
3	Serious condition - deterioration seriously affects structural capacity
2	Critical condition - bridge should be closed until repaired
1	Failing condition - bridge closed but repairable
0	Failed condition - bridge closed but beyond repair



Min.	Deck (Item 58)	Rating
1	Deck - Rating	(1) 7
6	Wearing - Surface	-
6	Joints, Expansion, Open	-
6	Joints, Expansion, Sealed	(2) 6
6	Joints, Other	-
6	Drainage System	8
6	Curbs, Sidewalks & Parapets	(3) 7
6	Median Barrier	-
6	Railings	(4) 7
7	Railing Protective Coating	-
7	Delineation (curve markers)	-
	Other	-

- Comments:
- Concrete deck surface has minor longitudinal cracking and minor scaling. Deck soffit has minor cracking with efflorescence and several minor spalls with exposed rebar due to insufficient cover.
 - The joint seal at bent 2 from the north is deteriorated and about half of it is gone.
 - The west curb has minor spalling.
 - The east railing has impact damage at the south end. The spalls have been patched.

Min.	Superstructure (Item 59)	Rating
0	Main Members - Steel	-
0	Main Members - Concrete	(1) 6
0	Main Members - Timber	-
0	Main Members - Connections	-
1	Floor System Members	(2) 6
1	Floor System Connections	Sec (2) 7
5	Secondary Members	-
5	Secondary Member Connections	-
6	Expansion Bearings	8
6	Fixed Bearings	-
6	Steel Protective Coating	-
	Other	-
	Component rating	6

- Comments:
- Concrete girders have minor flexure cracks at the floorbeams and minor spalls with exposed rebar due to insufficient cover (see photo).
 - The floor beams have several minor spalls with exposed rebar due to insufficient cover. The floor beam spalls at bent 2 from the north have been patched but the patches are cracking and spalling again.

Substructure (Item 60)		Rating	Comments:
Min.			
0	Abutment Caps _____	-	(1) Concrete columns have a few minor spalls and honeycombed areas. The tie beam at the middle bent has minor spalling and scaling. (2) Concrete backwalls and wingwalls have minor cracking.
0	Above Ground _____ (1)	7	
0	Below Ground or Foundation _____	8	
0	Backwalls & Wingwalls _____ (2)	7	
0	Intermediate Supports		
	Caps - Concrete _____	-	
	Caps - Steel _____	-	
	Caps - Timber _____	-	
	Above Ground - Concrete See (1)	7	
	Above Ground - Steel _____	-	
	Above Ground - Timber _____	-	
	Above Ground - Masonry _____	-	
	Below Ground or Foundation _____	8	
5	Collision Protection System _____	-	
6	Steel Protective Coating _____	-	
	Component rating _____	7	

Channel (Item 61)		Rating	Comments:
Min.			
0	Channel Banks _____	8	(1) Concrete riprap has minor cracks. One section is cracked and has settled at the middle bent.
0	Channel Bed _____	8	
5	Rip Rap, Toe Walls & Apron _____ (1)	6	
5	Dikes _____	-	
5	Jetties _____	-	
	Other _____	-	
	Component rating _____	6	

Culverts (Item 62)		Rating
Min.		
0	Top Slabs _____	-
0	Bottom Slab or Footing _____	-
0	Abutments & Intermediate Supports _____	-
5	Headwalls & Wingwalls _____	-
	Other _____	-
	Component rating _____	N

Approaches (Item 65)		Rating	Comments:
Min.			
0	Embankments _____	(1) <input type="text" value="7"/>	(1) Erosion due to embankment runoff is undermined the east edge of the south riprap.
4	Embankment Retaining Walls _____	<input type="text" value="-"/>	(2) Approach slabs have minor cracking.
5	Slope Protection _____ See (1)	<input type="text" value="7"/>	(3) The guardfence at the SE corner has moderate impact damage at the connection to the bridge (see photo). The NW guardfence has minor impact damage.
5	Roadway _____	(2) <input type="text" value="7"/>	
6	Relief Joints _____	<input type="text" value="-"/>	
6	Drainage _____	<input type="text" value="8"/>	
6	Guardfence _____	(3) <input type="text" value="6"/>	
7	Delineation _____	<input type="text" value="8"/>	
7	Sight Distance _____	<input type="text" value="8"/>	
	Other _____	<input type="text" value="-"/>	
	Component rating _____	<input type="text" value="6"/>	

Miscellaneous		Rating	Comments:
Min.			
7	Signs _____	<input type="text" value="-"/>	(1) A manhole cover is missing at the SE corner. A traffic sign has been placed on top of the hole but it is not secured.
7	Illumination _____	<input type="text" value="-"/>	
7	Warning Devices _____	<input type="text" value="-"/>	
7	Utility Lines _____	(1) <input type="text" value="7"/>	
	Other _____	<input type="text" value="-"/>	

Traffic Safety (Item 36)		Rating	Comments:
	Traffic Safety Bridge Railings (036.1)	<input type="text" value="1"/>	Standard T411 railing
	Traffic Safety Transitions (036.2)	<input type="text" value="0"/>	Improper attachment to bridge
	Traffic Safety Approach Guardrail (036.3)	<input type="text" value="1"/>	
	Traffic Safety Approach Guardrail Ends (036.4)	<input type="text" value="0"/>	Non-standard terminal

Appraisal Ratings		Rating	Comments:
	Waterway Adequacy (071)	<input type="text" value="8"/>	
	Approach Roadway Alignment (072)	<input type="text" value="8"/>	



Modified 12-5-2009
Microsoft Word 7.0, WIN95 & NT

Bridge Inventory Record

District: 12 County: 102 Cont-Sec: B589-77 Structure: 002 Route: N Shepherd Dr
 Feature Crossed: White Oak Bayou Inspector's Signature: James Ewald Date: 12/31/2011
 Company Name: XR Structural (F-758)
 Location: 0.20 Mi N of IH 10 Maintenance Section: City of Houston #22
 Latitude: N 29° 46' 45.83" Longitude: W 95° 24' 34.44" Milepoint: 2.400

General Description:
4 span (3 continuous and 1 simple) concrete girder bridge on concrete supports. Standard concrete rail with non-standard guardfence (obsolete transition and terminal). Bridge is on a low-speed, paved road with very high ADT (~ 10,000 vpd).

Bridge Length: 179 ft. Deck Width: 56.3 ft. Lanes On: 4 Lanes Under: 0
 Skew Angle: 0 Deg. Lf. Fwd. Rt. Fwd. Bridge Rail: Type T411 and C411
 Clear Width Between: 47.6 ft. Curbs, Rails, Pvmnt Edges Approach Rdway Wid: 44 ft.

Deck Type: Concrete

Surfacing: No separately applied wearing surface Vertical Over-Clearance: _____ ft. Unimpaired

Stringers: Spans: 1
 Type: Concrete Girder Size: 24" x 54" Number: 2
 Spacing: 36'-0" Controlling Span Length (C-C bearings): ~33 ft.

Stringers: Spans: 2 to 4
 Type: Concrete Girder Size: 24" x (54" to 60" variable) Number: 2
 Spacing: 36'-0" Controlling Span Length (C-C bearings): 44-55-45 ft.

Stringers: Spans: _____
 Type: _____ Size: _____ Number: _____
 Spacing: _____ Controlling Span Length (C-C bearings)- _____ ft.

Est Deck Overlapping Freq: >100 11 - 100 3 - 10 <3
 Est Approach Overlap. Freq: >100 11 - 100 3 - 10 <3

Horizontal / Vertical Alignment: Good / Good

Date Built / Design Load: 1929 (reconstructed 1996) / H20 Unknown

Regulatory / Advisory Speeds: 30 mph / 30 mph

Posted Load Restriction: _____ None

Comments:



DATE: 14 DEC 2013
COUNTY: 102
CONT-SEC: B589-77
STR: 002



ROADWAY OVER BRIDGE

Looking North



ELEVATION

Looking West



DATE: 14 DEC 2013
COUNTY: 102
CONT-SEC: B589-77
STR: 002

SUPERSTRUCTURE

Looking Northeast



STREAM UNDER BRIDGE

Looking West



DATE: 14 DEC 2013
COUNTY: 102
CONT-SEC: B589-77
STR: 002

UPSTREAM VIEW
FROM BRIDGE

Looking Northwest



DOWNSTREAM VIEW
FROM BRIDGE

Looking East



DATE: 14 DEC 2013
COUNTY: 102
CONT-SEC: B589-77
STR: 002

IMPACT DAMAGE TO
SE GUARDFENCE

Looking Northwest

NOTE: 1. The guardfence has impact damage at the connection to the bridge.
2. A traffic sign has been placed over the open manhole, but it is not secured.



SPALLING OF CONCRETE
GIRDER

Looking Northeast

NOTE: 1. Concrete girders have minor spalling with exposed rebar due to insufficient cover.

Bridge Report #149





B62937-001
B62937-002

B22017-039

B04505-010
B66641-085

B62929-001

B22017-037

B22017-038

B00377-001

B00353-001

B00297-164

B00278-041

B62937-014

B62937-043

B31281-008

B31281-004

B31281-001

B62921-001

B62921-002

B62921-003

B62921-004

B00344-206

B20937-001

B58977-002

B59000-001

B59009-002

B59009-003

B61969-001

B44185-001

4185-006

4185-007

B7145-079

B3161-078

B3161-077

B63546-001

B63546-002

B44185-002

PARK

B44185-008

B02505-004

B02505-002

B67245-001

B67249-002

B44185-003

B02805-003

B02805-004



Modified (12-5-2000)
for Microsoft Word 7.0, WIN95 & NT

Bridge Summary Sheet

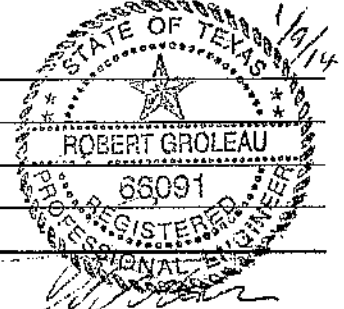
District: 12 County: 102 Cont-Sec: B209-37 Structure: 001 Route: Durham St #149
 Feature Crossed: White Oak Byu/Abandon RR Inspector's Signature: Robert F. Groleau, P.E. Date: 12/14/2013
 Company Name: Pickett, Kelm & Associates, Inc. (F-1491) City of Houston #149

Selected Component Description and Rating:

Selected Component Description and Rating:	Inspection Rating (1085)	Inventory Rating		Operating Rating	
		H	HS	H	HS
Prestressed Concrete Girder (Assumed)	7		15		20
Concrete Substructure	6		15		20

Comments and/or Upgrade Recommendations (if applicable):

Clean and patch the scaled areas of the columns with exposed rebar in the main channel.



Load Posting Limits for Present Condition (if applicable):

Inventory		Operating		Sign Codes					
-	lbs Gross	-	lbs Gross	OTHER	WEIGHT LIMIT AXLE OR TANDEM LBS	WEIGHT LIMIT TANDEM AXLE LBS	WEIGHT LIMIT GROSS LBS AXLE OR TANDEM LBS	WEIGHT LIMIT GROSS LBS TANDEM AXLE LBS	LOAD ZONED BRIDGE
-	lbs Tandem Axle	-	lbs Tandem Axle	1	2	3	4	5	6
-	lbs Axle or Tandem	-	lbs Axle or Tandem						
-	Sign Code	-	Sign Code						

Posting Recommendation: None - Load posting is not required.

Previous Load Posting Recommendations:

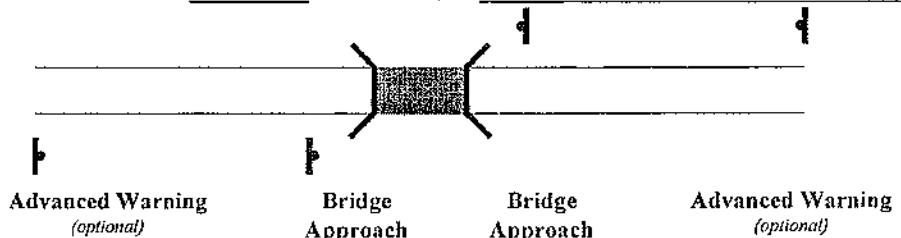
<u> </u>	R12-2Tb	<u> X </u>	None
<u> </u>	R12-2Tc	<u> </u>	lbs Gross
<u> </u>	R12-4Tb	<u> </u>	lbs Tandem Axle
<u> </u>	R12-4Tc	<u> </u>	lbs Axle or Tandem

Observed Load Posting at Bridge:

<u> </u>	R12-2Tb	<u> X </u>	None
<u> </u>	R12-2Tc	<u> </u>	lbs Gross
<u> </u>	R12-4Tb	<u> </u>	lbs Tandem Axle
<u> </u>	R12-4Tc	<u> </u>	lbs Axle or Tandem
<u> </u>	Other (desc.):	<u> </u>	

Material Needed

- R12-2Tb
- R12-2Tc
- R12-4Tb
- R12-4Tc
- W12-5
- Posts
- Hardware Sets
- Decals



Sign Code			
Condition Code			
Maintenance Need			


- | | | | | |
|---------------------------|--------------------------|------------------------|---------------------------|------------------------|
| A. Visible & Legible | D. Improper Position | G. Sign Missing | K. Clean Sign | N. None |
| B. Obscured by Vegetation | E. Damaged Beyond Repair | H. Sign & Post Missing | L. Reposition Sign | P. Replace Sign |
| C. Sign Needs Cleaning | F. Sign Down | J. Clear Vegetation | M. Reposition Sign & Post | S. Replace Sign & Post |



Bridge Inspection Record

District: 12 County: 102 Cont-Sec: B209-37 Structure: 001 Route: DURHAM ST Maint Sect:

Description: 26 simple span prestressed concrete girder bridge; Variable skew

Feature Crossed: WHITE OAK BYU/ABANDON RR Inspector's Signature:  Date: 12/14/2013

Company Name: Pickett, Kelm & Associates, Inc. [F-1491] Inspector: Robert Groleau, P.E.

Rating	Description
-	- Not Applicable
9	- Excellent condition
8	- Very good condition
7	- Good condition - some minor problems
6	- Satisfactory condition - minor deterioration of structural elements (limited)
5	- Fair condition - minor deterioration of structural elements (extensive)
4	- Poor condition - deterioration significantly affects structural capacity
3	- Serious condition - deterioration seriously affects structural capacity
2	- Critical condition - bridge should be closed until repaired
1	- Failing condition - bridge closed but repairable
0	- Failed condition - bridge closed but beyond repair



Min.	Deck (Item 58)	Rating
1	Deck - Rating _____	(1) 6
6	Wearing - Surface _____	-
6	Joints, Expansion, Open _____	(2) 7
6	Joints, Expansion, Sealed _____ See (2)	6
6	Joints, Other _____	-
6	Drainage System _____	(3) 7
6	Curbs, Sidewalks & Parapets _____	(4) 7
6	Median Barrier _____	-
6	Railings _____	(5) 6
7	Railing Protective Coating _____	-
7	Delineation (curve markers) _____	-
	Other _____	-

- Comments:**
- (1) Concrete deck surface has widespread minor cracking and moderate scaling with some minor spalling at the joints and some other areas. Some rebar is exposed at the spalls due to insufficient cover.
 - (2) Joint armor plates have minor distortion. Joint seals have failed.
 - (3) Some drains are clogged.
 - (4) The concrete curbs have minor cracking and spalling.
 - (5) The aluminum railings are dented in several places due to impact damage.

Min.	Superstructure (Item 59)	Rating
0	Main Members - Steel _____	-
0	Main Members - Concrete _____	8
0	Main Members - Timber _____	-
0	Main Members - Connections _____	-
1	Floor System Members _____	-
1	Floor System Connections _____	-
5	Secondary Members _____	8
5	Secondary Member Connections _____	8
6	Expansion Bearings _____	-
6	Fixed Bearings _____	(1) 7
6	Steel Protective Coating _____	-
	Other _____	-
	Component rating _____	7

- Comments:**
- (1) The cap at bent 2 from the south is spalled under the west girder bearing.

Min.	Substructure (Item 60)	Rating	Comments:
0	Abutment Caps _____	(1) <input style="width: 30px; text-align: center;" type="text" value="7"/>	
0	Above Ground _____	<input style="width: 30px; text-align: center;" type="text" value="-"/>	
0	Below Ground or Foundation _____	<input style="width: 30px; text-align: center;" type="text" value="8"/>	
0	Backwalls & Wingwalls _____	(2) <input style="width: 30px; text-align: center;" type="text" value="6"/>	
0	Intermediate Supports		
	Caps - Concrete _____	(3) <input style="width: 30px; text-align: center;" type="text" value="7"/>	
	Caps - Steel _____	<input style="width: 30px; text-align: center;" type="text" value="-"/>	
	Caps - Timber _____	<input style="width: 30px; text-align: center;" type="text" value="-"/>	
	Above Ground - Concrete _____	(4) <input style="width: 30px; text-align: center;" type="text" value="6"/>	
	Above Ground - Steel _____	<input style="width: 30px; text-align: center;" type="text" value="-"/>	
	Above Ground - Timber _____	<input style="width: 30px; text-align: center;" type="text" value="-"/>	
	Above Ground - Masonry _____	<input style="width: 30px; text-align: center;" type="text" value="-"/>	
	Below Ground or Foundation _____	<input style="width: 30px; text-align: center;" type="text" value="8"/>	
5	Collision Protection System _____	<input style="width: 30px; text-align: center;" type="text" value="-"/>	
6	Steel Protective Coating _____	<input style="width: 30px; text-align: center;" type="text" value="-"/>	
	Component rating _____	<input style="width: 30px; text-align: center;" type="text" value="6"/>	

Min.	Channel (Item 61)	Rating	Comments:
0	Channel Banks _____	<input style="width: 30px; text-align: center;" type="text" value="8"/>	
0	Channel Bed _____	(1) <input style="width: 30px; text-align: center;" type="text" value="7"/>	
5	Rip Rap, Toe Walls & Apron _____	(2) <input style="width: 30px; text-align: center;" type="text" value="7"/>	
5	Dikes _____	<input style="width: 30px; text-align: center;" type="text" value="-"/>	
5	Jetties _____	<input style="width: 30px; text-align: center;" type="text" value="-"/>	
	Other _____	<input style="width: 30px; text-align: center;" type="text" value="-"/>	
	Component rating _____	<input style="width: 30px; text-align: center;" type="text" value="7"/>	

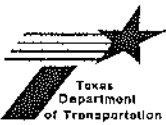
Min.	Culverts (Item 62)	Rating
0	Top Slabs _____	<input style="width: 30px; text-align: center;" type="text" value="-"/>
0	Bottom Slab or Footing _____	<input style="width: 30px; text-align: center;" type="text" value="-"/>
0	Abutments & Intermediate Supports _____	<input style="width: 30px; text-align: center;" type="text" value="-"/>
5	Headwalls & Wingwalls _____	<input style="width: 30px; text-align: center;" type="text" value="-"/>
	Other _____	<input style="width: 30px; text-align: center;" type="text" value="-"/>
	Component rating _____	<input style="width: 30px; text-align: center;" type="text" value="N"/>

Approaches (Item 65)		Rating	Comments:
Min.			
0	Embankments <u>See (1)</u>	6	(1) Approach slabs have minor cracking and are a bit uneven due to settlement. (2) Pavement joint seals have failed allowing dirt into the joints causing pressure which pushes the pavement into the top of the abutment backwalls. (3) Timber posts have minor weathering and decay. The NW guardfence is very low.
4	Embankment Retaining Walls	-	
5	Slope Protection	8	
5	Roadway (1)	6	
6	Relief Joints (2)	6	
6	Drainage	8	
6	Guardfence (3)	6	
7	Delineation	8	
7	Sight Distance	8	
	Other	-	
	Component rating	6	

Miscellaneous		Rating
Min.		
7	Signs	-
7	Illumination	8
7	Warning Devices	-
7	Utility Lines	8
	Other	-

Traffic Safety (Item 36)		Rating	Comments:
	Traffic Safety Bridge Railings (036.1)	0	Non-standard concrete & aluminum railing
	Traffic Safety Transitions (036.2)	0	
	Traffic Safety Approach Guardrail (036.3)	0	No guardfence
	Traffic Safety Approach Guardrail Ends (036.4)	0	

Appraisal Ratings		Rating	Comments:
	Waterway Adequacy (071)	9	
	Approach Roadway Alignment (072)	8	



dlfiled 12-5-2013
Microsoft Word 7.0, WIN95 & NT

Bridge Inventory Record

District: 12 County: 102 Cont-Sec: B209-37 Structure: 001 Route: Durham St
 Feature Crossed: White Oak Bayou & RR Inspector's Signature: Robert Groleau, P.E. Date: 12/14/2013
 Company Name: Pickett, Kelm & Associates, Inc. (F-1491)
 Location: 0.40 Mi N of IH 10 Maintenance Section: City of Houston #149
 Latitude: N 29° 46' 49.98" Longitude: W 95° 24' 38.81" Milepoint: 2.300

General Description:

26 simple span prestressed concrete girder bridge on concrete supports. Non-standard railing with no guardfence. Bridge is on a low-speed paved road with very high ADT (~15030 vpd).

Bridge Length: 1456 ft. Deck Width: 43.7 ft. Lanes On: 3 Lanes Under: 0
 Skew Angle: Var Deg. Lf. Fwd. Rt. Fwd. Bridge Rail: Concrete & Aluminum
 Clear Width Between: 36.0 ft. Curbs, Rails, Pvmnt Edges Approach Rdway Width: 36 ft.

Deck Type: Concrete

Surfacing: No separately applied Vertical Over-Clearance: _____ ft. Unimpaired

Stringers: Spans: 1 to 18 and 26
 Type: Prestressed Concrete Girder Size: TxDOT Type B Number: 7
 Spacing: 6'-2" Controlling Span Length (C-C bearings): 50.6 ft.

Stringers: Spans: 19 to 25
 Type: Prestressed Concrete Girder Size: TxDOT Type 54 Number: 7
 Spacing: 6'-2" Controlling Span Length (C-C bearings): 81.1 ft.

Stringers: Spans: _____
 Type: _____ Size: _____ Number: _____
 Spacing: _____ Controlling Span Length (C-C bearings)- _____ ft.

Est Deck Overtopping Freq: >100 11 - 100 3 - 10 <3
 Est Approach Overtop. Freq: >100 11 - 100 3 - 10 <3

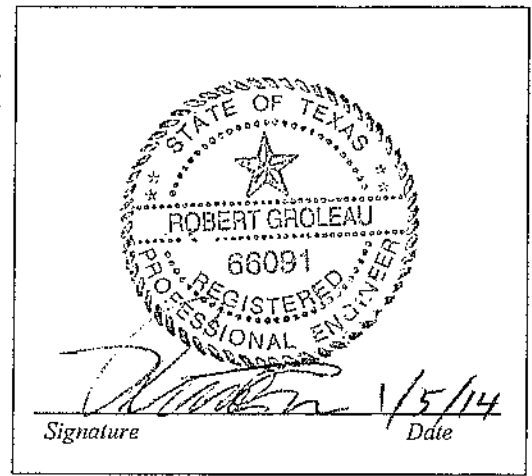
Horizontal / Vertical Alignment: Good / Good

Date Built / Design Load: 1963 (Plaque) / Unknown

Regulatory / Advisory Speeds: 35 mph / None

Posted Load Restriction: _____ None

Comments:





DATE: 14 DEC 2013
COUNTY: 102
CONT-SEC: B209-37
STR: 001

ROADWAY OVER BRIDGE

Looking North



ELEVATION

Looking Southwest



DATE: 14 DEC 2013
COUNTY: 102
CONT-SEC: B209-37
STR: 001

SUPERSTRUCTURE

Looking Northwest



STREAM UNDER BRIDGE

Looking Northwest



DATE: 14 DEC 2013
COUNTY: 102
CONT-SEC: B209-37
STR: 001

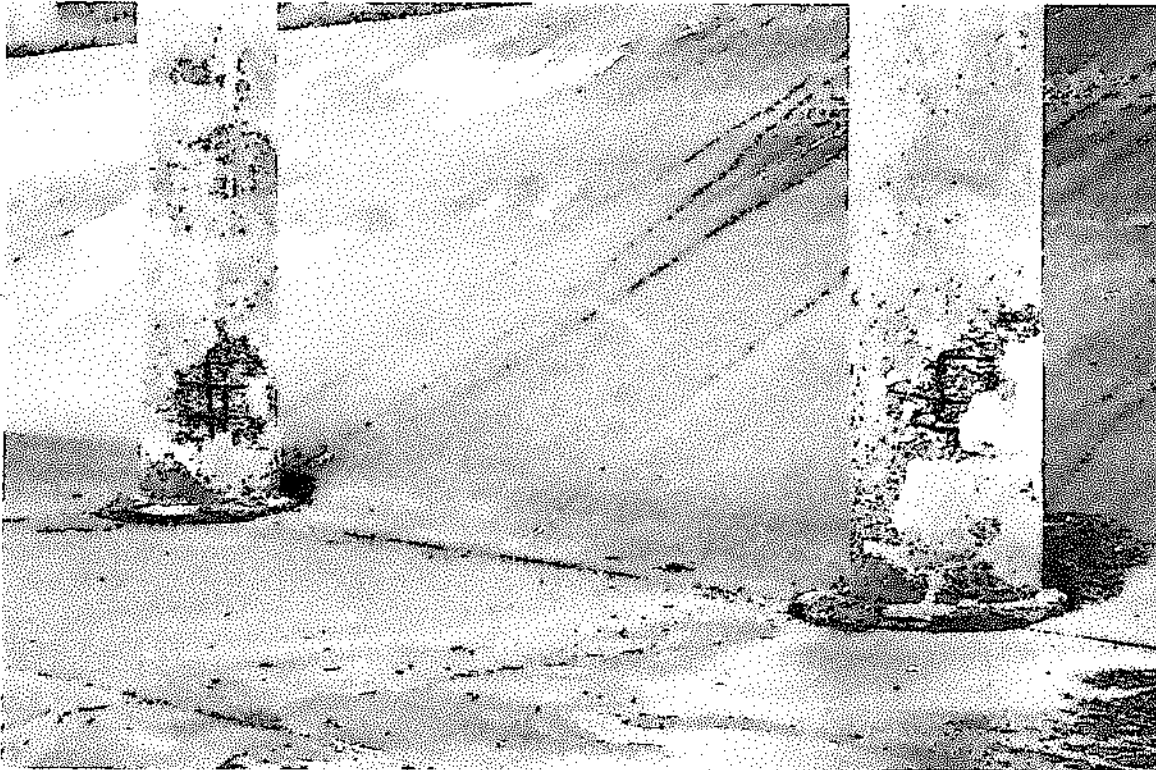
UPSTREAM VIEW
FROM BRIDGE

Looking Northwest



DOWNSTREAM VIEW
FROM BRIDGE

Looking Southeast



DATE: 14 DEC 2013
COUNTY: 102
CONT-SEC: B209-37
STR: 001

SCALING OF CONCRETE
COLUMNS

Looking Northwest

NOTE: 1. The columns of bent 7 from the south in the channel have moderate scaling and honeycombing with exposed rebar.

Appendix E

Planning II Alternative Analysis



Within the study area limits, the 2016 City of Houston Major Thoroughfare and Freeway Plan (MTFP) designates Shepherd Drive as a Principal Thoroughfare (P) with four (4) lanes within varied rights-of-way with the following limits:

- Washington Avenue to West 11th Street in a 60-foot right-of-way (P-4-60)
- West 11th Street and Interstate 610 in a 70-foot right-of-way (P-4-70)

Durham Drive is designated as a Principal Thoroughfare (P) with four (4) lanes within varied rights-of-way with the following limits:

- Washington Avenue to Interstate 10 within a 70-foot right-of-way (P-4-70)
- Interstate 10 to West 20th Street within a 60-foot right-of-way (P-4-60)
- West 20th Street to Interstate 610 within a 70-foot right-of-way (P-4-70)

The existing configurations meet the current major thoroughfare plan designations. Shepherd Drive and Durham Drive are generally in poor condition within the study limits.

E.1 TRAFFIC

Intersection level of service (LOS) analyses were performed in accordance with the procedures set forth and recommended by the Highway Capacity Manual level of service methodologies for evaluation of signalized and un-signalized intersections. Traffic analysis software SYNCHRO was used to evaluate the operation of the study intersections. The LOS criteria for signalized and un-signalized intersections are listed below in Table E-1.

**Table E-1
Level of Service (LOS) Criteria for Intersections
Shepherd Drive Traffic Analysis**

LOS	Signalized Intersection	Unsignalized Intersections
	Delay (sec/veh)	Delay (sec/veh)
A	0-10	0-10
B	>10-20	>10-15
C	>20-35	>15-25
D	>35-55	>25-35
E	>55-80	>35-50
F	>80	>50

LOS A is considered best free-flowing condition, and LOS F is a failing condition.

Utilizing the existing traffic data of the study intersections, the AM and PM peak hour levels of service for the study intersections along Shepherd Drive and Durham Drive were calculated.

The existing peak hour levels of service of the analysis intersections are summarized in Table E-2, while detailed level of service analysis are included in Appendix G of this report. As presented in Table E-1, all study intersections except the intersections of Shepherd Drive at Interstate 10 Eastbound Frontage Road, Interstate 10 Westbound Frontage Road, and Interstate 610 Westbound Frontage Road are presently operating at acceptable LOS D or better. The results show that Shepherd-Durham is well used north-south route which favors major through movements and directional congestion at interchanges.

Table E-2
Intersection Level of Service - Existing Conditions
Shepherd Drive and Durham Drive Traffic Analysis

Intersection	AM-Peak		PM-Peak	
	LOS	Delay	LOS	Delay
Shepherd at Washington Avenue	C	33.8	D	39.6
Shepherd at Center Street	A	5.6	A	8.0
Shepherd at Interstate 10 EBFR	C	21.6	F	121.2
Shepherd at Interstate 10 WBFR	B	17.7	E	56.3
Shepherd at West 11 th Street	C	26.6	C	34.7
Shepherd at West 14 th Street	B	18.3	B	19.8
Shepherd at West 19 th Street	B	10.4	D	35.8
Shepherd at West 20 th Street	A	7.3	C	21.1
Shepherd at West 24 th Street	A	8.2	D	53.3
Shepherd at Interstate 610 EBFR	B	11.2	B	18.8
Shepherd at Interstate 610 WBFR	A	8.5	B	12.2
Durham at Washington Avenue	D	38.0	D	44.0
Durham at Center Street	A	-	A	-
Durham at Interstate 10 EBFR	C	27.2	C	26.8
Durham at Interstate 10 WBFR	D	38.2	C	23.1
Durham at West 11 th Street	C	24.4	D	43.7
Durham at West 14 th Street	B	14.6	B	16.3
Durham at West 19 th Street	C	24.7	B	10.8
Durham at West 20 th Street	D	35.8	B	14.5
Durham at West 24 th Street	B	16.9	A	8.3
Durham at Interstate 610 EBFR	B	13.0	B	13.6
Durham at Interstate 610 WBFR	F	83.0	B	12.3
LOS – Level of Service				
Delay - Seconds per vehicle				

In order to improve mobility along the study corridor, bicycle and pedestrian oriented improvements were considered.

2040 Traffic Analysis

The traffic analysis for Year 2040 traffic conditions was conducted for the proposed improvements. Year 2040 traffic volumes were obtained by projecting Year 2015 traffic volumes using the maximum average annual growth rate of 0.6% per year which was estimated by comparing the Year 2015 and Year 2040 traffic volumes provided by City of Houston, as well as volumes from the Inner Loop Mobility Study.

As mentioned above the COH directed GUNDA to utilize the same typical section that is being designed currently along Shepherd-Durham between Dickson and Washington Avenue. Essentially the typical section includes 3-lanes, buffered on-street bicycle facility and left-turn lanes at some of the major signalized intersections. Based on that directive; the results of the LOS analysis are presented in Tables E-3 and E-4. As presented in Tables E-3 and E-4, with the proposed improvements and some signal timing improvement and coordination along Shepherd-Durham one-way pair the overall intersections delays at the signalized intersection the same level of service or better can be achieved as compared to the no-build condition except in the morning peak period at the intersections of Durham/11th Street and Durham/Interstate 610 EBFR which is not significant deterioration looking at average delay.

Table E-3: Intersection Level of Service - Year 2040 Traffic Conditions Shepherd Drive Traffic Analysis

Shepherd Drive Intersections	AM Peak				PM Peak			
	No-Build		Build		No-Build		Build	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Washington Avenue	41.7	D	37.1	D	76.5	E	76.6	E
Center Street	8.6	A	5.7	A	13.1	B	30.1	C
Interstate 10 EBFR	24.6	C	23.8	C	90.7	F	83.3	F
Interstate 10 WBFR	22.4	C	23.7	C	57.4	E	64.5	E
West 11 th Street	21.4	C	22.5	C	122.3	F	123.7	F
West 14 th Street	22.5	C	24.0	C	24.8	C	29.8	C
West 19 th Street	10.9	B	11.9	B	28.1	C	54.7	D
West 20 th Street	7.9	A	9.8	A	22.3	C	48.6	D
West 24 th Street	8.9	A	11.2	B	46.1	D	41.1	D
Interstate 610 EBFR	15.4	B	14.9	B	60.0	E	60.4	E
Interstate 610 WBFR	10.3	B	10.9	B	29.6	C	47.4	D
LOS - Level of Service Delay – Seconds per vehicle								

Table E-4: Intersection Level of Service - Year 2040 Traffic Conditions Durham Drive Traffic Analysis

Durham Drive Intersections	AM Peak				PM Peak			
	No-Build		Build		No-Build		Build	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Washington Avenue	41.7	D	41.2	D	48.5	D	49.1	D
Center Street	-	A	-	A	-	A	-	A
Interstate 10 EBFR	51.5	D	52.4	D	43.1	D	44.2	D
Interstate 10 WBFR	60.4	E	69.4	E	45.7	D	68.8	E
West 11 th Street	48.6	D	79.7	E	81.0	F	82.7	F
West 14 th Street	17.4	B	20.7	C	19.8	B	24.1	C
West 19 th Street	76.8	E	36.9	D	13.6	B	16.6	B
West 20 th Street	90.4	F	55.0	D	19.1	B	24.4	C
West 24 th Street	67.5	E	36.0	D	10.3	B	26.2	C
Interstate 610 EBFR	20.9	C	77.7	E	21.2	C	22.2	C
Interstate 610 WBFR	144.5	F	144.9	F	25.1	C	24.0	C
LOS - Level of Service Delay – Seconds per vehicle								

E.2 ACCESS MANAGEMENT

The purpose of access management study is to identify transportation improvements that reduce crashes, improve traffic flow, reduce motorist delay, and to address multi-modal/land use context.

As part of access management solutions, driveway density analysis is performed to determine if driveway consolidation is required in order to reduce the crash rates and improve safety along the corridor. Driveway density is defined as the number of driveways per mile. Roadway segments with more than 30 driveways per mile are considered unacceptable, and an access management solution, such as driveway consolidation, should be considered.

In the study area of Shepherd Drive and Durham Drive from Interstate 610 to Washington Avenue, the average density for Shepherd Drive/Durham Drive is 20 to 30 driveways per mile. This is relatively high density, hence, driveway consolidation need not be considered during the design phase of selected segments.

E.3 SPEED ANALYSIS

In the study area, the existing speed limit is 30 miles per hour (mph) from Interstate 610 to Washington Avenue.

E.4 PAVEMENT IMPROVEMENTS AND BICYCLE ROUTING

Per instruction of the COH, GUNDA utilized Alternative 2 from the Pre-Engineering analysis of Shepherd/Durham Drives between Dickson and Washington Avenue for pavement improvements as shown below.

ALTERNATIVE 2: THREE (3) LANES WITH BICYCLE LANE

Due to the limited width of the existing bridges over Interstate 10 and White Oak Bayou, GUNDA developed Alternative 2 to reconstruct Shepherd Drive and Durham Drive with three (3) 11-foot wide travel lanes and one (1) 6-foot wide bicycle lane. A buffer will be provided between the outside travel lane and the bicycle lane. This alternative allows for sidewalks that are six (6) feet wide or greater where the right-of-way is the typical 60-foot.

In the selected Alternative 2 concept; the existing bridges over Shepherd Drive bridge over White Oak Bayou can be utilized to carry the proposed cross section. The Durham Drive bridge over White Oak Bayou will require modification to carry the proposed bicycle lane in the future when the bridge is reconstructed. In addition, the bridge over Interstate 10 is proposed to remain the same for vehicular traffic until the bridge is reconstructed at a later date in the future. Therefore, Appendix K illustrates the agreements and recommendations reached in coordination with Memorial-Heights TIRZ and COH; to come up with the refined cross sections included in this report. The “purple” lines illustrated in Appendix K are intended to be future improvements that will need to be implemented as part of future improvement plans to compliment the recommendations included in the proposed layout of this study.

As such in some portions of Shepherd Drive (approximately between MKT Trail and West 11th Street), bi-directional bicycle lanes are recommended along Shepherd Drive, in addition to low speed off-street shared pedestrian/bicycle path on both Shepherd and Durham to add connectivity to the MKT trail and at the same time address missing on-street bicycle facilities on the Durham Drive bridge over White Oak Bayou. Another critical refinement of the recommended cross section (Alternative 2) is the addition of shared pedestrian/bicycle paths on West 11th Street between Shepherd and Durham.

In addition, due to the lack of enough pavement width across Interstate 10 bridges along Shepherd and Durham; Nolda Street and Cornish Street should be reconstructed between Shepherd Drive and Durham Drive with bicycle facilities to implement the recommended concept.

E.5 DRAINAGE

A. DRAINAGE ANALYSIS

A preliminary analysis was performed to determine if the existing drainage systems have the capacity to drain the existing flows from their respective drainage areas based on the COH current standards.

Drainage areas for the systems were delineated based on aerial photographs, field visits, the COH’s Comprehensive Drainage Plan (CDP), and Harris County Appraisal District (HCAD) parcel data. The drainage areas were further divided into sub-drainage areas generally corresponding with changes in pipe sizes along the drainage system.

The Rational Method was used to compute the 2-year design peak flows. The capacity of the existing storm sewer systems was computed using Manning’s formula. The hydraulic information on the pipes such as flow line, size, length, and material was obtained from the utility database provided by the COH.

B. PROPOSED DRAINAGE CONDITIONS

In the proposed condition, each drainage system was designed to meet the COH current design criteria and continue to outfall to White Oak and Buffalo Bayous. The drainage report and analysis are attached in Appendix F. It is important to note that there are some streets beyond Shepherd and Durham that are recommended to be reconstructed due to the necessary upgrades to the storm drain system. At these location locations; such as West 18th Street reconstruction west of Durham; in depth analysis of traffic, parking, pavement, and general access conditions have not been performed since it was not included in the original scope of work.

The proposed pipe sizes and lengths are presented in Table E-5.

Table E-5: Proposed Drainage System

Drainage System ID	MH From	MH To	Reach Length (feet)	No. of Pipes	Proposed Diameter (inches/ feet x feet)
E0150	A9	A8	374	1	30
	A8	A7	370	1	36
	A7	A6	375	1	42
	A6	A5	369	1	42
	A5	A4	370	2	42
	A4	A3	368	2	42
	A3	A2	371	2	48
	A2	A1	368	2	48
	A1	A10	372	2	48
	A10	A11	370	2	48
	A11	A12	479	2	6x4
A12	A13	484	2	6x4	

Table E-5: Proposed Drainage System

Drainage System ID	MH From	MH To	Reach Length (feet)	No. of Pipes	Proposed Diameter (inches/ feet x feet)
	A13	A14	563	2	6x4
	A14	A-OUT	56	2	6x4
E0147	B18	B17	365	1	24
	B17	B16	372	1	36*
	B16	B15	182	1	36*
	B15	B14	190	1	36*
	B14	B13	366	1	42*
	B13	B12	371	1	48*
	B12	B-OUT	694	1	60
	B11	B10	367	1	24
	B10	B9	366	1	24
	B9	B-OUT	72	1	24
	B8	B7	373	1	24
	B7	B6	369	1	24
	B6	B5	195	1	24
	B5	B4	177	1	30
	B4	B3	293	1	96
	B3	B2	249	1	96
	B2	B1-1	143	1	96
	B1-1	B1	332	1	24*
B1	B-OUT	104	1	96	
E0146	C3	C2	33	1	10x8
	C2	C1	255	1	10x8
	C1	C-OUT	247	1	10x8
E0145	DA-3	DA-2	333	1	48
	DA-2	DA-1	255	1	54
	DA-1	DA-OUT	247	1	60
	DB-3	DB-2	263	1	48
	DB-2	DB-1	250	1	48
	DB-1-2A	DB-1-2	515	1	36*
	DB-1-2	DB-1	665	1	60
	DB-1-1	DB-1	225	1	24
DB-1	DB-OUT	269	1	66	
E0051	E1	E-OUT	206	1	24*
E0042	F7	F6	273	1	24
	F6	F5	277	1	24
	F5	F4	466	1	24
	F4	F3	499	1	30
	F3	F2	294	1	30*
	F2	F1	142	1	36
	F1	F-A	513	1	36

Table E-5: Proposed Drainage System

Drainage System ID	MH From	MH To	Reach Length (feet)	No. of Pipes	Proposed Diameter (inches/ feet x feet)
	F-A	F-B	448	1	42
	F-B	F-OUT	56	1	48
E0041	G9	G8	694	1	36*
	G8	G7	699	1	36*
	G7	G6	607	1	42
	G6	G5	502	1	48
	G5	G4	106	1	54
	G4	G3	522	1	60
	G3	G2	296	1	66
	G2	G1	341	1	66
	G1	G-OUT	133	1	72
E0040	H3	H2	267	1	24*
	H2	H1	261	1	24*
	H1	H-OUT	157	1	30*
E0039	I2	I1	264	1	30*
	I1	I-OUT	157	1	36*
E0036	JA-6	JA-5	302	1	24
	JA-5	JA-4	265	1	30
	JA-4	JA-3	266	1	36
	JA-3	JA-2	267	1	36
	JA-2	JA-1	255	1	36
	JA-1	J1	37	1	42
	JB-7	JB-6	124	1	24
	JB-6	JB-5	261	1	24
	JB-5	JB-4	265	1	30
	JB-4	JB-3	260	1	36*
	JB-3	JB-2	271	1	36*
	JB-2	JB-1	253	1	36*
	JB-1	J1	35	1	42
	J1	J-OUT	193	1	42
W0530	KB-4	KB-3	94	1	24
	KB-3	KB-2	258	1	24
	KB-2	KB-1	271	1	24
	KB-1	KA-2	349	1	30
	KA-4	KA-3	273	1	24
	KA-3	KA-2	270	1	24
	KA-2	KA-1	264	1	36*
	KA-1	KA-OUT	279	1	36*

* indicates existing pipes to remain

C. ADDITIONAL DETENTION VOLUME REQUIREMENTS

Additional detention is required to mitigate the peak flow impacts that are caused by the increased impervious area. There are two (2) options to meet the detention requirement. Inline Detention: Inline detention contains the mitigated flows wholly underground within oversized storm sewers. Pipe sized required for inline detention are shown in Table E-6 below. A restrictor will be required at the outfalls during the design phase to use the detention volume and restrict the peak outflow to existing conditions.

Table E-6: Proposed Drainage System with Inline Detention

Drainage System ID	Design Node		Pipe Length (ft)	No. of Manholes	No. of Inlets	100-Year Extreme Event		
	From MH	To MH				No. of Pipes	Span (ft)	Rise (in/ft)
E0150	A9	A8	374	1	4	1	0	2.5
	A8	A7	370	1	4	1	0	3.0
	A7	A6	375	1	4	1	0	3.5
	A6	A5	369	1	4	1	0	3.5
	A5	A4	370	1	4	1	0	3.5
	A4	A3	368	1	4	2	0	3.5
	A3	A2	371	1	4	2	10	10
	A2	A1	368	1	4	2	10	10
	A1	A10	372	1	4	2	10	10
	A10	A11	370	1	4	2	10	10
	A11	A12	479	1	4	2	6	4
	A12	A13	484	1	2	2	6	4
	A13	A14	563	1	2	2	6	4
	A14	A-OUT	56	1	2	2	6	4
Totals			9090	14	50	—	—	—
E0147	B18	B17	365	1	4	1	0	2.0
	B17	B16	372	1	4	1	0	3.0
	B16	B15	182	1	4	1	0	3.0
	B15	B14	190	1	4	1	0	3.0
	B14	B13	366	1	4	1	0	3.5
	B13	B12	371	1	4	1	8	4
	B12	B-OUT	694	1	4	1	0	5.0
	B11	B12	367	1	4	1	0	2.0
	B10	B9	366	1	4	1	6	3
	B9	B-OUT	72	1	4	1	0	2.0
	B8	B7	373	1	4	1	0	2.0
	B7	B6	369	1	4	1	0	2.0
	B6	B5	195	1	4	1	6	6
	B5	B4	177	1	4	1	6	6
	B4	B3	293	1	2	1	0	8.0
	B3	B2	249	1	4	1	0	8.0
	B2	B1	145	1	4	1	0	8.0
	B1-1	B1	332	1	4	1	0	2.0
B1	B-OUT	104	1	2	1	0	8.0	
Totals			5580	19	72	—	—	—
E0146	C3	C2	333	1	4	1	12	10
	C2	C1	255	1	4	1	12	10
	C1	C-OUT	247	1	4	1	12	10
Totals			835	3	12	—	—	—
E0145	DA-3	DA-2	333	1	4	1	0	4.0
	DA-2	DA-1	255	1	4	1	0	4.5
	DA-1	DA-OUT	247	1	4	1	0	5.0
	DB-3	DB-2	263	1	4	1	0	4.0
	DB-2	DB-1	250	1	3	1	0	4.0
	DB-1-2A	DB-1-2	515	1	4	1	5	5
	DB-1-2	DB-1	665	1	4	1	5	5
	DB-1-1	DB-1	225	1	2	1	5	5
	DB-1	DB-OUT	269	1	4	1	0	5.5
Totals			3022	9	33	—	—	—
E0051	E1	E-OUT	206	1	4	1	4	2
	Totals			206	1	4	—	—

Table E-6: Proposed Drainage System with Inline Detention

E0042	F7	F6	273	1	2	1	0	2.0
	F6	F5	277	1	2	1	0	2.0
	F5	F4	466	1	2	1	0	2.0
	F4	F3	499	1	2	1	0	2.5
	F3	F2	294	1	2	1	0	2.5
	F2	F1	142	1	2	1	0	3.0
	F1	F-A	513	1	2	1	4	2
	F-A	F-B	448	1	0	1	4	2
	F-B	F-OUT	56	1	0	1	0	4.0
	Totals			2968	9	14	---	---
E0041	G9	G8	694	1	4	1	0	3.0
	G8	G7	699	1	3	1	0	3.0
	G7	G6	607	1	2	1	0	3.5
	G6	G5	502	1	2	1	7	5
	G5	G4	306	1	2	1	10	5
	G4	G3	522	1	3	1	10	5
	G3	G2	296	1	2	1	10	5
	G2	G1	341	1	3	1	10	5
	G1	G-OUT	133	1	0	1	0	6.0
Totals			3900	9	21	---	---	---
E0040	H3	H2	267	1	4	1	0	2.0
	H2	H1	261	1	4	1	4	2
	H1	H-OUT	157	1	3	1	0	2.5
Totals			685	3	11	---	---	---
E0039	I2	I1	264	1	4	1	4	2
	I1	I-OUT	157	1	3	1	0	3.0
	Totals			421	2	7	---	---
E0036	JA-6	JA-5	302	1	4	1	0	2.0
	JA-5	JA-4	265	1	4	1	0	2.5
	JA-4	JA-3	266	1	4	1	0	3.0
	JA-3	JA-2	267	1	4	1	0	3.0
	JA-2	JA-1	255	1	4	1	0	3.0
	JA-1	J1	37	1	4	1	0	3.5
	JB-7	JB-6	124	1	4	1	0	2.0
	JB-6	JB-5	261	1	4	1	0	2.0
	JB-5	JB-4	265	1	4	1	0	2.5
	JB-4	JB-3	260	1	4	1	0	3.0
	JB-3	JB-2	271	1	4	1	5	3
	JB-2	JB-1	253	1	4	1	5	3
	JB-1	J1	35	1	4	1	5	3
J1	J-OUT	193	1	0	1	0	3.5	
Totals			3054	14	52	---	---	---
W0530	KB-4	KB-3	94	1	2	1	0	2.0
	KB-3	KB-2	258	1	3	1	0	2.0
	KB-2	KB-1	271	1	4	1	0	2.0
	KB-1	KA-2	349	1	4	1	0	2.5
	KA-4	KA-3	273	1	4	1	4	2
	KA-3	KA-2	270	1	4	1	4	2
	KA-2	KA-1	264	1	4	1	4	2
	KA-1	KA-OUT	279	1	4	1	0	3.0
Totals			2058	8	29	---	---	---

Note: Blue Cells Indicate Existing Pipes to Remain.
 Note: Orange Cells Indicate In-Line Detention Storm Sewers.

Regional Detention Pond: There is a sub-regional detention pond along White Oak Bayou near the project corridor (TC Jester Regional Pond) that can be used to mitigate the detention volume. The fee for the regional detention pond is \$44,796 per acre-foot. Approximately twelve (12) acre-feet of detention is required for a total fee of \$555,111.

E.6 PUBLIC UTILITIES

The City of Houston has developed rankings for the water infrastructure facilities throughout the City, by Key Map grid number, called Water Infrastructure Replacement Prioritization (WIRP). The WIRP rankings within the project area are listed in Table E-7 below.

**Table E-7
Water Infrastructure Replacement
Prioritization (WIRP)**

Key Map Grid	WIRP
452P	310
452R	116
452U	511
452V	212
452Y	370
452Z	169
492C	561
492D	273
492G	595
492H	284

The City recommends installation of new 10-inch, 15-inch, 30-inch, and 36-inch gravity sanitary sewers along Durham Drive, West 7th Street, and Shepherd Drive to allow for the abandonment of the Durham Lift Station and the North Shepherd Lift Station. An alternative is proposed in case the Durham improvement happens first. The 36-inch line is implemented along Durham.

The City recommends the replacement of existing 12-inch waterline along Shepherd, 8-inch line along Durham, and 8-inch along 16th Street and 18th Street, and the replacement of existing 6-inch with 8-inch along 23rd Street, replacement of 8-inch along 14th Street and connecting to 12-inch on Durham.

E.7 PROJECT CHALLENGES

E.7.1 REAL ESTATE ACQUISITIONS

Right-of-way within the corridor is typically 60 feet or wider. However, approaching Interstate 10 along Shepherd Drive and Durham Drive south of Darling Street, the right-of-way is less than 60 feet wide, and additional right-of-way is needed for the proposed

improvements. Additionally, right-of-way will be needed at the signalized intersections to accommodate new traffic signals, designated turn lanes, and sight distance requirements.

E.7.2 CONSTRUCTION TRAFFIC CONTROL

It is anticipated that the roadway and utility reconstruction will be completed for one-half (1/2) of each roadway at a time. A minimum of two (2) lanes of traffic will be maintained each on Shepherd Drive and Durham Drive throughout the construction area. Pavement removal will be limited to minimize impacts on businesses and road users. Advisory and directional/ detour signs will also be used to divert traffic to adjacent streets.

E.7.3 TREE IMPACT

The majority of the project corridor does not contain large, established trees. Love Elementary School located along the east right-of-way of Shepherd Drive between West 13th Street and West 12th Street does have large established trees that require protection and preservation. These trees are part of the character of the school and provide vital shade to the playgrounds on the school grounds.

E.7.4 METRO

METRO operates multiple bus routes along the major thoroughfares in the project area. Coordination with METRO was conducted and the recommended consolidation and relocation of bus stops should be further coordinated during design and construction as necessary.

E.7.5 PERMITS AND LICENSES

A. STORM WATER POLLUTION PROTECTION (SW3P)

An SW3P will be developed in accordance with Texas Pollutant Discharge Elimination System (TPDES) requirements. As stated in the Texas General permit TXR150000, issued by the Texas Commission on Environmental Quality (TCEQ), a TPDES permit is required for the construction activity if the total disturbed area is equal to or more than one acre. The proposed construction activity related to the improvement of Shepherd Drive is expected to disturb approximately 348 acres of land area. Therefore, the Contractor will be required to apply for TPDES permit through a Notice of Intent (NOI) sent to TCEQ regional office, TPDES Permit Division prior to start of construction. The Contractor will be responsible for implementation, maintenance and inspection of storm water pollution prevention control measures including, but not limited to source controls for erosion and sedimentation controls, waste collection and disposal, filter fabric fence, reinforced filter fabric barrier, stabilized construction exit and other practices.

B. ARCHITECTURAL BARRIERS ACT (ABA)

Construction drawings will be submitted to a private consultant approved by Texas Department of Licensing and Regulation (TDLR) for compliance with the Architectural Barriers Act (ABA).

C. CITY OF HOUSTON PERMITS

Permits will be required from City of Houston for construction of proposed improvements within the Shepherd Drive corridor. These permits include road / lane closure permits, traffic control permits, and street cut permits.

D. HARRIS COUNTY FLOOD CONTROL DISTRICT

Permits from HCFCD will be required for construction and proposed runoff outfalls around and into Buffalo Bayou (W100-00-00) and White Oak Bayou (E100-00-00).

E. US ARMY CORP OF ENGINEERS

Permits, CLOMR, and LOMR from USACOE will be required for long-term improvements including the new bridge over Buffalo Bayou (W100-00-00) between Kirby Drive/ Allen Parkway and Memorial Drive.

F. ENVIRONMENTAL AND CULTURAL INVESTIGATIONS

As part of Final Design, an Environmental Site Assessment (ESA), based on the procedures established by the City of Houston Guidelines for performing Environmental Site Assessments, will be performed. The report will contain detailed descriptions of the study performed and the conclusions reached in regard to the proposed construction of pavement, drainage, and utility improvements in the project area, relating to wetlands, endangered species, and known cultural resources in the proposed right-of-way. Determination of required permits from the US Army Corps of Engineers and the Texas Historical Commission will also be made.

G. GEOTECHNICAL INVESTIGATION

As part of Final Design, a geotechnical investigation will be performed, and recommendations will be made pertaining to the soils found in the project area relating to the design of pavement sections and trench safety.

E.8 RECOMMENDED PROJECT

The recommended improvements within the Shepherd Drive and Durham Drive corridors are as follows:

A. RECOMMENDED PAVING IMPROVEMENTS

GUNDA recommends replacing the existing pavements with concrete following the standards of City of Houston for major thoroughfares. Per the City *Infrastructure Design Manual* (dated July 1, 2016), the minimum pavement section includes 11-inch reinforced concrete pavement with 8-inch minimum lime stabilized subgrade. The pavement design must be verified during Final Design after the geotechnical investigation is completed.

GUNDA recommends replacing the pedestrian facilities along Shepherd Drive and Durham Drive. Sidewalks, bus shelters, ramps, and pedestrian signalization needs to meet ADA requirements for safe utilization.

Between Interstate 610 and Washington Avenue, GUNDA recommends improvements to Shepherd Drive and Durham Drive that follow the descriptions for Alternative 2 described in Section B.4.B.

B. RECOMMENDED DRAINAGE IMPROVEMENTS

GUNDA recommends replacement of the existing storm sewers with 24-inch to 12-foot by 10-foot box storm sewers with restrictors located at the ultimate outfall to provide conveyance and inline detention. The restrictors will be designed during the design phase.

C. TRAFFIC IMPROVEMENTS

GUNDA recommends the reconstruction of all existing signalized intersections and dedicated left turn lanes as recommended in the concept drawing.

D. WASTEWATER IMPROVEMENTS

The City recommends the installation of new 10-inch, 15-inch, 30-inch, and 36-inch gravity sanitary sewers along Durham Drive, West 7th Street, and Shepherd Drive to allow for the abandonment of the Durham Lift Station and the North Shepherd Lift Station.

An alternative exhibit shown after the recommendation is in case the Durham improvement happens first. The 36-inch line is implemented along Durham

E. WATER IMPROVEMENTS

The City recommends the replacement of existing 12-inch waterline along Shepherd, 8-inch line along Durham, and 8-inch along 16th Street and 18th Street, and the replacement of existing 6-inch with 8-inch along 23rd Street, replacement of 8-inch along 14th Street and connecting to 12-inch on Durham.

E.9 TOTAL PROJECT COSTS FOR RECOMMENDED PROJECT

Total Project Costs for the recommended improvements are included in Appendix G and are summarized below in Table E-11 and E-12:

Table E-11: South Project Costs for Recommended Improvements

	Alternative 2
Paving	\$12,548,443.16
Storm Sewer	\$5,112,665.25
Water	\$657,267.60
Wastewater	\$3,067,059.60
Contingencies (30%)	\$6,415,630.68
Construction Management (15%)	\$3,207,815.34
Engineering Fee (17%)	\$5,560,213.26
Design Management (15%)	\$834,031.99
Land Acquisition (HCAD x3)	\$2,297,557.51
Grand Total	\$39,700,684.39

The CPPS for the recommended improvements is 64.90 with a benefitted population of 45,957.

Table E-12: North Project Costs for Recommended Improvements

	Alternative 2
Paving	\$18,043,077.64
Storm Sewer	\$12,740,319.90
Water	\$2,267,520.64
Wastewater	\$594,000.00
Contingencies (30%)	\$10,093,475.45
Construction Management (15%)	\$5,046,737.73
Engineering Fee (17%)	\$8,747,678.73
Design Management (15%)	\$1,312,151.81
Land Acquisition (HCAD x3)	\$354,340.00
Grand Total	\$59,199,301.89

The CPPS for the recommended improvements is 68.16 with a benefitted population of 45,957.

E.10 PROJECT SEQUENCING

GUNDA recommends constructing the project as two projects each with 2 sub-projects. The limits for the sub-projects are recommended as follows:

- South Project:
 - Sub-Project 1: Interstate 10 to Washington Avenue
 - Sub-Project 2: West 11th Street to Interstate 10
- North Project:
 - Sub-Project 1: West 18th Street to West 11th Street
 - Sub-Project 2: Interstate 610 to West 18th Street

For each sub-project, GUNDA recommends constructing one-half (1/2) of the pavement section at a time. Two (2) lanes of traffic will be maintained on Shepherd Drive and Durham Drive throughout the construction area.

Appendix F
Drainage Report by CivilTech



CivilTech Engineering, Inc.

Civil Engineering
Water Resources
Transportation
Structures
Economic Analysis

MEMORANDUM

TO: Michael Ereti, P.E., Gunda Corporation

FROM: Connor McColloch, P.E., CivilTech Engineering, Inc.

DATE: January 12, 2018

RE: Summary of Existing Drainage, Proposed Storm Sewer Design, and Detention Mitigation; Work Order No. 3: Need Area N-2016T-0004 Street and Paving Improvement Pre-engineering Services, City of Houston; WBS No. N-320100-0010-3



1-12-2018

CivilTech Engineering, Inc. was contracted by Gunda Corporation to perform drainage services for Street and Paving Improvement Pre-engineering Services for the City of Houston (City) WBS No. N-320100-0010-3. This memorandum presents the technical findings of the existing drainage conditions analysis, proposed storm sewer design, and detention mitigation for Need Area N-2016T-0004.

A. Pre-engineering Analysis Approach

A preliminary analysis was performed to determine if the existing drainage systems have the capacity to drain existing flows from their respective drainage areas based on the City of Houston's current standards. Drainage areas for the systems were delineated based on Aerial photographs, field visits, record construction drawings, the City of Houston's Comprehensive Drainage Plan (CDP) 2-year outfall drainage areas, and Harris County Appraisal District's parcel data. The drainage areas were further divided into sub-drainage areas generally corresponding with changes in pipe sizes along the drainage system.

The Rational Method was used to compute 2-year design peak flows. The design flow for a particular sub-drainage area was computed based on peak flow versus area curves that were developed for the present study. The curves represent the peak flow that HouStorm would compute for a particular drainage area and average c-value.

The capacity of the existing storm sewer system trunk lines were computed using Manning's formula. Hydraulic information on the pipes such as flowline, size, length, and material were obtained from the utility database provided by the City of Houston and from record construction drawings.

The 2-year design peak flows for sub-drainage areas were compared with the capacity of the corresponding segment of the drainage system. If the capacity of the drainage segment was greater than the design flows, then the drainage segment was identified as having adequate capacity, otherwise, the drainage segment was identified as inadequate to convey the design flows. In addition, the drainage segments where the CDP proposed future improvements were also identified along with the proposed configuration. An inlet and lateral level of detail analysis was not performed.

Extreme event overland drainage areas were also identified for each drainage system. The overland drainage areas were delineated using 2008 LiDAR DEM data.

The proposed storm sewer system was designed using the City's storm sewer design software HouStorm. The proposed storm sewer systems were designed for the 2-year storm event to maintain the hydraulic grade line below gutter elevation. The 2-year design was upsized to meet the 100-year extreme event criteria. The 100-year extreme event analysis was performed based on the City's Method 2 approach as documented in Technical Paper 101. Method 2 combines storm sewer and roadway conveyance to maintain the 100-year flow within the right-of-way. Roadway capacity was calculated assuming normal depth flow and using typical roadway sections. Flow in excess of roadway capacity was conveyed within the storm sewer. The tailwater elevation was assumed top of pipe for the 2-year storm event. For the 100-year storm event the FEMA effective model 10-year water surface elevation was used as the tailwater at the outfall. If the 10-year water surface elevation is above the bank elevation or the receiving stream is unstudied, a tailwater of two feet below the bank elevation at the outfall was used. For drainage systems that outfall into an existing storm sewer, a tailwater of two feet above top of pipe at the outfall in the existing storm sewer was used. The tailwater assumptions are based on City of Houston Storm Water Drainage Analysis and Design Considerations for CIP Projects and Technical Paper 101.

Detention volumes required to mitigate conveyance impacts were computed based on change in travel time between existing and proposed conditions. The travel time along the storm sewer system was computed based on an average of surface velocity (2 ft/s) and pipe flow velocity (5 ft/s) along the system. The average velocity depends upon the percentage of flow carried in the pipe and on the surface. The peak flows were computed based on the Rational Method. A flow hydrograph was developed for each drainage system using HCFCD's small watershed hydrograph method for

areas less than 640 acres. Detention volume was computed by comparing the existing and proposed hydrographs.

Detention volumes required to mitigate the increase in impervious cover was calculated using the difference in pavement between existing and proposed typical sections. There are three proposed alternative sections with different pavement configurations. The City of Houston rate of 0.50 acre-feet per acre of increased impervious cover was used to determine the required detention volume.

Detention volume was calculated for each storm sewer system based on increased impervious cover and increased conveyance of each proposed road alternative. The detention volume provided in the proposed design was the total of the two values.

B. Need Area N-2016T-0004 Existing Conditions

1. Project Location and Description

Need Area N-2016T-0004 is comprised of street and paving improvements to N. Durham/N. Shepherd Dr. between Washington Ave and Interstate 610, a combined length of approximately 30,685 feet, as shown on **Exhibit 1**. The need area is located in Houston's Lazybrook/Timbergrove, Greater Heights, and Washington Avenue Coalition/Memorial Park Super Neighborhoods, City of Houston Council District C, Key Maps 452Q, 452R, 452U, 452V, 452Y, 452Z, 492C, 492D, 492G, and 492H. Per the City's Major Thoroughfare Plan, N. Shepherd Dr. is a major thoroughfare with sufficient width while N. Durham Dr. is a major thoroughfare that requires widening. Both N. Durham Dr. and N. Shepherd Dr. are one way streets separated by 300 to 500 feet of commercial/industrial/multi-family property. Traffic flows north to south on N. Durham Dr. and south to north on N. Shepherd Dr. The existing roadway for both roads consist of curb and gutter with four to three 10-ft and 11-ft travel lanes and sidewalks along both sides of either roadway. N. Durham Dr. contains two bridges, one spanning a commercial/industrial complex and the Heights Hike and Bike Trail and White Oak Bayou (HCFCD Unit # E100-00-00), and the second spanning Interstate 10. North Shepherd Dr. contains three bridges, one spanning a commercial/industrial complex and the Heights Hike and Bike Trail, the second spanning White Oak Bayou (HCFCD Unit E100-00-00), and the third spanning Interstate 10.

2. FEMA Flood Hazard Areas

The regulatory 1% floodplain and floodway is shown in the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) for Harris County, Texas and Incorporated Areas, Map number 48201C0670M, Map revised June 9, 2014, as shown on **Exhibit 2**. Both N. Shepherd Dr. and N. Durham Dr. from Interstate 10 to south of the Heights Hike and Bike Trail is located in Zone AE, within the 1% (100-year) floodplain and Zone X, 0.2% (500-year) floodplain as well as the Floodway

of White Oak Bayou (HCFCU Unit E100-00-00), however, the roadway is elevated throughout most of these areas. A small portion of N. Durham Dr. between 16th St. and 17th St. is also in the Zone X, 0.2% (500-year) floodplain. The remainder of the need area is located in unshaded Zone X outside the 1% (100-year) and the 0.2% (500-year) floodplains.

3. Existing Drainage Conditions

Design Drainage Area, Peak Flow, and Capacity

The need area is located within the White Oak Bayou Watershed and the Buffalo Bayou Watershed. The drainage systems for the need area, drainage areas, sub-drainage areas, and inadequate storm sewer segments for the need area are shown in **Exhibit 1**. The existing N. Durham Dr./N. Shepherd Dr. is served by curb and gutter storm sewer systems identified by Drainage Systems E0146, E0147, E0150, E0145, E0041, E0042, E0039, E0040, E0051, E0036, and W0530. Land use for the need area is commercial, industrial and multi-family and single family residential. The drainage systems are described in detail below. The drainage areas, peak flows, and drainage system capacities for Need Area N-2016T-0004 are presented in **Table 1**. The table also identifies storm sewer improvements recommended by the CDP.

Drainage System E0147 drains the northern portion of N. Shepherd Dr. from Interstate 610 to 16th St. and a small portion of N. Durham Dr. along 16th St. The drainage system discharges into HCFCU Unit E106-00-00 as a 90" MRC. Pipe sizes range from an 18" RCP to 90" MRC. The main storm sewer trunk system is located along Lawrence St. east of N. Shepherd Dr. which turns west along 16th St., crossing the need area as a 90" MRC. The drainage system is mainly a series of inlets and pipes along N. Shepherd Dr. that leave the need area twice north of 16th St. The drainage system drains 188 acres as it leaves N. Shepherd Dr. and 195 acres as it crosses N. Durham Dr. with only three of the fourteen pipe segments found to have sufficient capacity to convey the 2-year flows. The outfall drains a total of 214 acres and does not have sufficient capacity to convey the 2-year flows. This drainage system ranges from 73 to 95 years old. The CDP has also determined the storm sewer system to be inadequate and recommends improvements.

Drainage system E0150 drains the northern portion of N. Durham Dr. from Interstate 610 to 18th St. with pipe sizes ranging from an 18" RCP to a 60" RCP. The drainage system outfalls as a 66" MRC into HCFCU Unit E106-00-00 along 20th St. The drainage system drains a total of 85 acres in the need area and 129 acres at its outfall. The pipes located along N. Durham Dr. from 18th St. to 20th St. have sufficient capacity to convey the 2-year flows, the other pipes in the drainage system do not have sufficient capacity to convey the 2-year flows. The drainage system is 54 years old. The CDP has also determined the storm sewer system to be inadequate and recommends improvements.

Drainage System E0146 storm sewer crosses the need area along 15th St. traveling from east to west as a 7' x 6' RCB. The main trunk line starts along Ashland St. at 25th St. heading south and crosses the need area along 15th St. The drainage area totals 222 acres at N. Shepherd Dr. and 228 acres at N. Durham Dr. The 7' x 6' RCB was found to not have sufficient capacity to convey the 2-year design flows. The drainage system discharges into HCFCD Unit E106-00-00 as an 84" CMP west of the need area draining a total of 242 acres. The outfall also does not have sufficient capacity to drain the system. The CDP has also determined the storm sewer system to be inadequate and recommends improvements by upsizing the 7' x 6' RCBs to 120" RCPs.

Drainage system E0145 drains a small portion of the need area from 14th St. to 12th St. with pipe sizes ranging from a 24" RCP to a 42" RCP. The drainage system outfalls into HCFCD Unit E106-00-00 as a 66" pipe along 13th St. The drainage area collects water from Nicholson St., between 15th St. and 13th St. through two main pipes before merging into one 48" MRC at the intersection of 13th St. and Prince St. Pipes cross the need area at three locations, one along 14th St. as a 36" MRC transitioning to a 42" MRC, the second at 13th St. as a 24" RCP, and the last crossing as a 36" RCP along 12th St. The storm sewer does not have enough capacity to convey the 2-year design flows. The drainage system ranges from 54 to 70 years old. The CDP has also determined the storm sewer system to be inadequate and recommends improvements.

The storm sewer trunk of Drainage System E0051 ranges from a 21" RCP to a 42" RCP along 11th St. and drains into White Oak Bayou, HCFCD Unit E100-00-00. The storm sewer system along N. Durham Dr. is a set of inlet leads along 11th St. The storm sewer pipe along 11th St. is 21-inches in diameter and contains sufficient capacity to drain the 2.4 acres drainage area. While the 21" RCP has adequate capacity to drain the 2-year design flows, the pipes do not meet the City of Houston Infrastructure Design Manual criteria for 24" minimum pipe size. The 42" outfall drains the entire 26.1 acre drainage area and does not have adequate capacity to convey the 2-year design flows. The storm sewer system is 57 years old and the CDP does not recommend storm sewer improvements for this drainage system.

The storm sewer trunk for Drainage System E0042 ranges from an 18" RCP to a 36" RCP along N. Durham Dr. and drains into White Oak Bayou, HCFCD Unit E100-00-00. The storm sewer flows south picking up flow from the roadway, as well as flow in the parking lot adjacent to N. Durham Dr. This trunk along N. Durham Dr. drains approximately 15.6 acres and with portions of the existing storm sewer including the outfall having adequate capacity to convey the 2-year design flows. While the 18" and 21" RCP have adequate capacity to drain the 2-year design flows, the pipes do not meet the City of Houston Infrastructure Design Manual criteria for 24" minimum pipe size. Additionally, the outfall pipe was not found to be located within a City of Houston drainage easement limiting the

ability for the City to maintain its operation. The storm sewer system is 54 years old. The CDP does not recommend storm sewer improvements for this drainage system.

The storm sewer trunk for Drainage System E0041 ranges from a 24" RCP to a 42" RCP along N. Shepherd Dr. and drains into White Oak Bayou, HCFCD Unit E100-00-00. This system begins at the intersection of N. Shepherd Dr. and 12th St., and runs south along N. Shepherd Dr. As the storm sewer travels south it picks up flow through inlets located at intersections and drives to nearby properties. When the storm sewer reaches the bridge spanning the Heights Hike and Bike Trail, it veers to the west, running adjacent to the bridge. The bridge was designed with inlets that allow the water to fall directly below the bridge where it is collected by inlets along the main trunk. The storm sewer continues south where it outfalls into White Oak Bayou, HCFCD Unit E100-00-00, just upstream of the N. Shepherd Dr. bridge. The storm sewer trunk drains approximately 58 acres and does not have sufficient capacity to convey the 2-year design flows. This storm sewer system ranges from 54 to 90 years old. The CDP has also determined the storm sewer system to be inadequate and recommends improvements.

Drainage system E0039 drains a small portion of N. Shepherd Dr. south of White Oak Bayou and north of Interstate 10. The pipe is a 36" RCP along N. Shepherd Dr. and discharges into White Oak Bayou with enough capacity to convey the 2-year design flows. The drainage system is 89 years old and the CDP does not recommend any storm sewer improvements.

Drainage system E0040 drains a small portion N. Durham Dr. south of White Oak Bayou and north of Interstate 10. A 24" RCP along N. Durham Dr. drains the need area and ultimately drains into White Oak Bayou as a 30" CMP. The drainage system has enough capacity to convey the 2-year design flows. The storm sewer system is 54 years old and the CDP does not recommend storm sewer improvements for this drainage system.

Drainage system E0036 drains the need area south of Interstate 10 and north of the railroad tracks (located north of Allen St.). There are two trunk systems with pipe sizes ranging from a 21" RCP to a 36" RCP running from south to north along both N. Durham Dr. and N. Shepherd Dr. The two trunk systems join together along the eastbound frontage road to Interstate 10 as a 36" RCP. The Interstate 10 drainage system ultimately outfalls as a 120" MRC into White Oak Bayou, HCFCD Unit E100-00-00. The trunk system along N. Durham Dr. drains 16 acres and the trunk system along N. Shepherd Dr. drains 21 acres. Portions of the storm sewers in the drainage system do not have capacity to convey the 2-year design flows, however the storm sewer outfall into White Oak Bayou was shown to have adequate capacity. The storm sewer system ranges from 54 to 89 years old. The CDP has also determined the storm sewer system to be inadequate and recommends improvements.

Drainage system W0530 drains the southern portion of the need area from Washington Ave. to the railroad tracks (located north of Allen St.). There are two trunk systems with pipe sizes ranging from an 18" RCP to a 36" RCP running from north to south along both N. Durham Dr. and N. Shepherd Dr. The two trunk systems join together along Center St. and continued south along Shepherd as a 36" RCP. The system ultimately discharges into Buffalo Bayou, HCFCD Unit W100-00-00 as a 54" RCP. Most of the pipes in the drainage system, including the 54" RCP outfall, do not have capacity to convey the 2-year design flows. The storm sewer system is 54 to 91 years old. The CDP recommends improving two 18" RCPs to 21" RCPs but this will not meet current City of Houston minimum 24" pipe size requirement.

Extreme Event Overland Flow Drainage Area

The extreme event flow drainage areas contributing to the need area are shown on **Exhibit 3**. The northern limits of the project area from 22nd Street to IH 610, the overland flow generally drains from west to east across N. Shepherd and N. Durham. From 22nd Street to 13th Street, the overland flow is generally from east to west. From 13th Street to White Oak Bayou the overland flow is south along Shepherd/Durham before ultimately outfalling into White Oak Bayou. North of IH 10, the overland flow path is north towards the bayou. South of IH 10 to the railroad the overland flow goes north along Shepherd/Durham and outfalls into IH 10. South of the railroad, the overland flow drains south along Shepherd/Durham. The overland flow paths generally match the drainage pattern for the existing storm sewer systems and the extreme event overland flow drainage areas do not show a large portion of offsite drainage contributing to the existing drainage systems.

The ponding map of the need area is shown in **Exhibit 4**. Both N. Durham Dr. and N. Shepherd Dr. experience minimal ponding along the project limits. N. Durham Dr. shows between 0.5 and 1 foot of ponding in the area before the ramp to the bridge, and as well as a few areas along the curb and gutter. N. Shepherd Dr. shows between 0.5 and 1 foot of ponding at the intersection of 10th St. and also the intersection of 7th St., just north of the previously existing railroad. There are few properties along the need area with FEMA flood losses, with a higher concentration associated with the White Oak Bayou floodplain. The FEMA flood losses and flooding complaints are shown in **Exhibit 5**.

Table 1: Need Area N-2016T-0004 Drainage System Summary

SYSTEM ID	LOCATION DESCRIPTION			PLAN DETAILS			Drainage	2-yr	EXISTING SYSTEM								CDP PROPOSED SIZE			NOTES
	Location	From	To	Number	Date	Age			Area	Flow	Span	Rise/Dia	No.	Length	Slope	Material	Pipe Capacity	Sufficient	CDP	
							(years)	(ac)												
E0146	15th	Sheperd	Laird	25667	NA	NA	221.7	374.3	7	6		244	0.11	NA	194.5	No			120	Material not listed, assumed concrete pipe.
	15th	Durham	Nashua	25667	NA	NA	228.5	385.0	7	6		204	0.12	NA	196.9	No			120	
	15th	Dian	Outfall	25667	NA	NA	242.3	406.7		84		15	0.12	CMP	120.2	No			120	
E0147	Sheperd	28th	27th	9006	7/1/1944	73	2.3	6.0		18	1	370	0.34	RCP	6.1	Yes			24	
	Sheperd	27th	25th	9006	7/1/1944	73	10.8	26.7		36	1	728	0.17	MRC	27.4	Yes				
	Sheperd	25th	23th	9006	7/1/1944	73	23.2	51.6		42	1	741	0.13	MRC	35.7	No			54	
	Sheperd	22th	23th	9006	7/1/1944	73	2.8	6.8		18	1	354	0.39	RCP	6.6	No				
	23th	Sheperd	Lawrence	9006	7/1/1944	73	35.1	76.4		48	1	694	0.27	RCP	75.2	No			54	
	Sheperd	21st	20th	9006	7/1/1944	73	2.8	6.9		18	1	325	0.32	RCP	6.0	No			24	
	20th	Sheperd	Lawrence	9006	7/1/1944	73	5.7	13.6		24	1	72	0.08	RCP	6.5	No			36	
	Sheperd	18th	17th	4588	11/1/1921	95	7.6	17.9		21	1	352	0.51	NA	11.3	No			24	
	Sheperd	17th	16th	4588	11/1/1921	95	10.6	24.6		24	1	234	0.51	NA	16.2	No			30	
	Sheperd	17th	16th	5529	10/1/1937	79	12.8	29.4		24	1	175	0.51	MRC	16.2	No			30	
	Sheperd	16th	--	5529	10/1/1937	79	14.2	32.5		21	1	20	0.51	MRC	11.3	No				
	Sheperd	16th	--	5529	10/1/1937	79	1.9	5.2		21	1	23	0.51	MRC	11.3	Yes				
	16th	Sheperd	Laird	5529	10/1/1937	79	188.2	346.0		90	1	296	0.14	MRC	282.9	No			96	
16th	Durham	Prince	5529	10/1/1937	79	195.3	358.1		90	1	143	0.14	MRC	282.9	No			96		
16th	Dian	Outfall	5529	10/1/1937	79	213.7	389.5		90	1	551	0.17	MRC	321.5	No			132		
E0150	Durham	28th	27th	14153	6/1/1963	54	6.4	14.2		18	1	326	0.23	RCP	5.1	No			30	
	Durham	27th	26th	14153	6/1/1963	54	12.3	26.4		30	1	377	0.19	RCP	17.7	No			36	
	Durham	26th	25th	14153	6/1/1963	54	27.0	51.7		36	1	360	0.17	RCP	28.0	No			42	
	Durham	25th	23th	14153	6/1/1963	54	51.4	95.0		42	1	734	0.20	RCP	44.8	No			48	
	Durham	23th	20th	14153	6/1/1963	54	75.0	135.6		48	1	1109	0.28	RCP	75.8	No			54	
	20th	Durham	Beall	14153	6/1/1963	54	84.6	151.8		60	1	620	0.20	RCP	115.9	No			66	
	Durham	18th	19th	14153	6/1/1963	54	4.5	9.4		24	1	375	0.23	RCP	10.9	Yes				
	Durham	19th	20th	14153	6/1/1963	54	10.4	20.9		30	1	372	0.35	RCP	24.4	Yes				
E0145	20th	Beall	Outfall	14153	6/1/1963	54	128.7	225.0		66	1	42	0.02	MRC	52.0	No				66' from Record Drawing
	14th	Sheperd	Laird	9121	12/1/1946	70	36.7	69.0		36	1	231	0.30	MRC	36.8	No			42	
	14th	Durham	Nashua	9121	12/1/1946	70	42.1	78.6		42	1	247	0.20	MRC	45.4	No			48	
	13th	Sheperd	Laird	14153	6/1/1963	54	22.1	36.3		24	1	303	0.82	MRC	20.5	No			36	
	13th	Durham	Prince	14153	6/1/1963	54	66.5	121.0		42	1	497	0.41	MRC	65.0	No			54	
	Durham	12th	13th	14153	6/1/1963	54	44.7	70.4		36	1	674	0.65	MRC	53.7	No				
	Durham	14th	13th	14153	6/1/1963	54	2.4	5.5		24	1	226	0.24	RCP	11.2	Yes				
E0042	13th	Bay Oaks	Outfall	9121	12/1/1946	70	127.4	222.9		66	1	77	0.05		76.8	No				NOT IN CIPMS
	Durham	--	--	14041	12/1/1962	54	1.6	4.3		18	1	275	0.40	RCP	6.6	Yes				
	Durham	--	--	14041	12/1/1962	54	4.2	10.8		21	1	276	0.40	RCP	10.0	No				
	Durham	--	--	14041	12/1/1962	54	7.4	18.6		24	1	468	0.40	RCP	14.3	No				
	Durham	--	--	14041	12/1/1962	54	11.4	28.2		30	1	498	0.60	RCP	31.9	Yes				
	Durham	--	--	14041	12/1/1962	54	14.4	35.2		30	1	341	0.49	RCP	28.8	No				
	Durham	--	--	14041	12/1/1962	54	16.5	39.9		36	1	160	0.54	RCP	49.0	Yes				

Memorandum: Street and Paving Improvement Pre-engineering Services, COH; WBS No. N-320100-0010-3

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E0041	N. Sheperd	12th	11th	9121	12/1/1946	70	4.6	11.1		24	1	675	0.09	RCP	6.8	No			Material not listed, assumed concrete pipe.
	10th	Dorothy	Sheperd	1942	5/1/1939	78	6.2	14.7		24	1	281	0.21	RCP	10.5	No			
	N. Sheperd	11th	--	14041	12/1/1962	54	26.1	57.7		36	1	1492	0.09	RCP	20.1	No	0	42	Material not listed, assumed concrete pipe. Elevations not listed, assumed same slope as previous, 0.09%.
	N. Sheperd	--	7th	4588	11/1/1927	89	37.8	82.0		36	1	1124	0.66	RCP	54.3	No	0	42	Material not listed, assumed concrete pipe.
	N. Sheperd	7th	--	4588	11/1/1927	89	49.1	105.1		42	1	507	0.91	RCP	96.4	No			Material not listed, assumed concrete pipe.
	N. Sheperd	--	6th	14041	11/1/1927	89	51.0	108.8		42	1	318	0.91	RCP	96.2	No			Material not listed, assumed concrete pipe. Elevations not listed, assumed same slope as previous, 0.09%.
N. Sheperd	6th	E100-00-00					59.3	125.5		42	1	450	0.91	RCP	96.2	No			GIMS/Record drawings does not show storm sewer. Field visit determined size and outfall location.
E0039	Sheperd	Katy	Larkin St.	4588	11/1/1927	89	9.0	21.1		36	1	334	1.67	RCP	86.5	Yes			Material not listed in GIMS
	Sheperd	Larkin St.	E100-00-00	4588	11/1/1927	89	9.0	21.1		36	1	172	13.13		242.3	Yes			Material not listed, assumed CMP.
E0040	Durham	Cornish	Darling	14041	12/1/1962	54	4.3	10.5		24	1	532	0.40	RCP	14.3	Yes			
	Durham	Darling	--	14041	12/1/1962	54	7.9	17.2		30	1	142	0.70	RCP	34.5	Yes			
	--	--	E100-00-00	14041	12/1/1962	54	7.9	17.2		30	1	35	0.03	CMP	7.0	No			GIMS doesn't show a slope
E0051	11th	N. Durham	Nashua	11280	11/1/1959	57	2.4	5.2		21	1	206	0.36	RCP	9.6	Yes			
	11th	TC Jester	E100-00-00	11280	11/1/1959	57	25.5	49.0		42	1	82	0.10	RCP	31.5	No			MRC IN CIPMS
E0036	Durham	Maxie	Eigel	14041	12/1/1962	54	3.0	6.8		24	1	243	1.29	RCP	25.8	Yes			
	Durham	Eigel	Katy	14041	12/1/1962	54	14.8	31.4		30	1	794	0.08	RCP	11.5	No			
	Katy	--	--	14041	12/1/1962	54	15.8	33.4		36	1	27	0.08		18.3	No			
	Sheperd	Allen	Eli	7544	NA	NA	8.0	17.5		21	1	121	0.14	RCP	5.9	No			Elevations not listed, assumed same slope as previous, 0.14%.
	Sheperd	Eli	Maxie	4588	11/1/1927	89	10.0	21.6		21	1	253	0.14	RCP	5.9	No	30		
	Sheperd	Maxie	Katy	4588	11/1/1927	89	19.8	44.5		36	1	1078	0.47	RCP	45.6	Yes			
	Katy	--	--	14041	12/1/1962	54	20.9	46.9		36	1	47	1.16	RCP	72.0	Yes		42	Material not listed, assumed concrete pipe.
	Katy	--	E100-00-00	221	NA		361.0	635.0		120	1	84	0.18	RCP	699.1	Yes			Material not listed, assumed concrete pipe.
W0530	Durham	Schuler	Center	14041	12/1/1962	54	4.5	10.1		18	1	511	0.19	RCP	4.6	No		21	from nett to center
	Center	Durham	Sheperd	1221	12/1/1941	75	6.0	13.3		18	1	336	0.27	RCP	5.4	No		21	Material not listed, assumed concrete pipe.
	Sheperd	Allen	Nett	8259	NA	NA	2.4	6.5		18	1	242	0.05	RCP	2.3	No			Material not listed, assumed concrete pipe.
	Sheperd	Nett	Center	8259	NA	NA	4.5	11.5		21	1	276	0.56	RCP	11.9	Yes			Material not listed, assumed concrete pipe.
	Sheperd	Center	Washington	8259	NA	NA	14.5	35.3		36	1	286	0.06	RCP	16.3	No			Material not listed, assumed concrete pipe.
	Sheperd	Washington	Lillian	2821	2/1/1926	91	14.5	35.3		36		257	0.10	RCP	21.3	No			
--	--	W100-00-00	9016	4/1/1945	72	121.8	213.7		54	1	1746	0.92	MRC	189.2	No			Monolithic Reinforced Concrete	

External Drainage Systems

Storm sewers within the need area ultimately outfall into White Oak Bayou (HCFCU Unit E100-00-00), HCFCU Unit E106-00-00, or Buffalo Bayou (HCFCU Unit W100-00-00). Drainage systems E0042, E0041, E0039, E0040, E0051, and E0036 discharge into White Oak Bayou. White Oak Bayou (HCFCU Unit E100-00-00) is a FEMA studied channel with flood elevations computed for the 10% (10-year), 2% (50-year), 1% (100-year), and 0.2% (500-year) storm events. HCFCU has partnered with the United States Army Corps of Engineers to perform Federal Flood Damage Reduction Project on White Oak Bayou. Upon completion of the project, 1% Annual Exceedance Probability (AEP) water surface elevations are anticipated to be lowered between 0.5-1.5 feet. Currently White Oak Bayou at the storm sewer outfalls for this Need Area has between a 10% - 2% AEP channel bank full capacity.

Drainage system W0530 discharges into Buffalo Bayou, HCFCU Unit W100-00-00. Buffalo Bayou, HCFCU Unit W100-00-00 is a FEMA studied channel with flood elevations computed for the 10% (10-year), 2% (50-year), 1% (100-year), and 0.2% (500-year) storm events. Buffalo Bayou has less than 10% AEP channel bank full capacity at the outfall for drainage system W0530.

Drainage systems E0146, E0147, E0150, and E0145 discharge into HCFCU Unit E106-00-00. HCFCU Unit E106-00-00 is a non-FEMA studied stream and therefore, has no associated floodplain. However, a study for HCFCU Unit E106-00-00 was performed by Walter P Moore to determine its capacity. An exhibit produced by Walter P Moore showing the channels capacity is provided as **Attachment 3**. The channel outfall capacity is summarized below in **Table 2**.

Table 2: Need Area N-2016T-0004 Outfall Channel Capacity

Drainage Area ID	Outfall Channel	FEMA Studied Stream	Nearest FEMA Cross Section	Channel Capacity (cfs)	Channel Capacity (frequency)
E0146	HCFCU E106-00-00	No	--	--	--
E0147	HCFCU E106-00-00	No	--	--	--
E0150	HCFCU E106-00-00	No	--	--	--
E0145	HCFCU E106-00-00	No	--	--	--
E0042	White Oak Bayou	Yes	24817	24935	10% - 2% AEP
E0041	White Oak Bayou	Yes	22983	23629	10% - 2% AEP
E0039	White Oak Bayou	Yes	22758	27395	10% - 2% AEP
E0040	White Oak Bayou	Yes	23444	29326	10% - 2% AEP
E0051	White Oak Bayou	Yes	28190	28035	10% - 2% AEP
E0036	White Oak Bayou	Yes	20521	20430	< 10% AEP
W0530	Buffalo Bayou	Yes	126647	5286	< 10% AEP

4. Proposed Drainage System

Each storm sewer system was designed to meet the current City of Houston design criteria and continues to outfall to their respective external drainage system. Each drainage system was analyzed to the limits of the need area with the exception of the new outfall along 18th Street for Drainage System E0150. It was assumed that the downstream drainage system and roadway surface will convey the design flows. Further analysis to the outfall will be required during the design phase.

Drainage system E0150 drains the northern portion of Durham Drive and outfalls into a storm sewer running west along 20th Street in existing conditions. A study performed by Walter P Moore shows HCFCU Unit E106-00-00 has 100-year capacity at 18th Street versus 10-year capacity at 20th Street, therefore the proposed outfall for the drainage system will be redirected to outfall along 18th Street. Pipe sizes were upsized to convey the 2-year and 100-year storm events. Proposed pipe sizes range from a 30" RCP to 2 – 6' x 4' box culverts. 20th Street at HCFCU Unit E106-00-00 is a low crossing limiting the outfall pipe to an estimated 4-foot pipe.

Drainage system E0147 in existing drains along Shepherd and east towards Lawrence Street storm sewer system which then crosses both Shepherd and Durham along 16th Street. The existing storm sewers were shown to not have adequate capacity; therefore, it is proposed to replace the existing storm sewers. The portion which drains from IH 610 south and then east along 23rd Street was found to need minimal upsizing. The existing 18" was upsized to a 24" RCP and the 42" which drains towards the intersection of 23rd Street was upsized to a 48" RCP. The outfall pipe from the need area was upsized from a 48" RCP to a 60" RCP. The storm sewer which drains south towards 20th street was upsized to a 24" RCP. The remaining portion of Shepherd Drive within this drainage system which drains south towards 16th Street was upsized from a 21" and 24" RCP to a 24" and 30" RCP. The existing 90" storm sewer which runs along 16th street across both Shepherd and Durham needs to be upsized to a 96" RCP in order to adequately convey both the 2-year and 100-year storm events.

Drainage system E0146 drains over 200 acres of the residential area east of the need area across Shepherd/Durham through an existing 7'x6' RCB which was identified as not having adequate capacity. Upsizing the existing pipe to a 10'x8' RCB provides the necessary capacity to convey both the 2-year and 100-year storm events.

Drainage system E0145 drains the area east of the need area across Shepherd/Durham along 12th Street, 13th Street, and 14th Street. The storm sewer along 14th Street will need to be upsized ranging from a 48" RCP to a 60" RCP. The storm sewer along 13th Street will need to be upsized to a 48" RCP and a 66" RCP leaving the need area. The storm sewer along 12th Street and Durham will need to be upsized to a 24" RCP and a 36" RCP. The Shepherd Drive and 12th Street intersection in

existing conditions drains south as part of Drainage System E0041 and does not drain into the existing system along 12th street. It is recommended that this intersection be added to the storm sewer along 12th street. These proposed improvements will provide the necessary capacity to convey both the 2-year and 100-year storm events.

Drainage system E0051 drains Durham Drive west along 11th street towards White Oak Bayou. The existing 21" pipe does not meet the City of Houston minimum pipe size requirement. Therefore, the pipe is proposed to be a 24" RCP. The 24" RCP has enough capacity to drain the 2-year and 100-year storm events.

Drainage system E0041 drains south along Shepherd Drive from 11th street towards White Oak Bayou as a 36" RCP to a 42" RCP. In order to adequately convey the 2-year and 100-year storm events, the storm sewer needs to be upsized to a 36" to a 72" RCP.

Drainage system E0042 drains south along Durham and outfalls into White Oak Bayou between parcels. Using HCAD data, it was determined that the storm sewer does not have a drainage easement for the outfall, therefore it is recommended that the storm sewer run south along Durham Drive and outfall into White Oak Bayou within the Durham right-of-way. The storm sewer will range in size from a 24" RCP to a 48" RCP at the outfall.

Drainage system E0040 and E0039 were determined in the existing conditions analysis to have adequate capacity to convey their associated drainage areas, therefore no improvements are recommended for these storm sewers.

Drainage system E0036 drains north from the railroad towards IH 10. The portion of the area which drains to the railroad, crosses under Durham and enters the storm sewer system along Shepherd. It is proposed that the storm sewer along Durham be extended towards the railroad to intercept a portion of this flow. The remaining railroad flow will continue to outfall into the existing system along Shepherd Drive. With the exception of adding the 24" RCP along Durham to the railroad, the existing system along the need area was found to have adequate capacity to convey the 2-year and 100-year storm events. It is proposed to increase the existing 36" RCP's which drain east and west from Durham and Shepherd by upsized to a 42" RCP as the existing pipe does not have the necessary capacity.

Drainage system W0530 drains the area along Shepherd/Durham south of the railroad. The existing system is mainly made up of 18" and 21" RCP pipes. Upsizing the storm sewers to 24" and 30" RCPs provides the necessary capacity to convey the 2-year and 100-year storm event. The existing 36" RCP which drains from Center Street south along Shepherd was shown to have adequate capacity.

Proposed storm sewer pipes are shown below in **Table 3**. Houstorm output is located in **Attachment 1**. The proposed storm sewer configurations are shown in **Exhibit 6**.

Table 3: Proposed Storm Sewer System – Design Summary

Drainage System ID	Design Node		Pipe Length (ft)	No. of Manholes	No. of Inlets	2-Year Design Event			100-Year Extreme Event		
	From MH	To MH				No. of Pipes	Span (ft)	Rise (ft)	No. of Pipes	Span (ft)	Rise (in/ft)
E0150	A9	A8	374	1	4	1	0	2.5	1	0	2.5
	A8	A7	370	1	4	1	0	3.0	1	0	3.0
	A7	A6	375	1	4	1	0	3.5	1	0	3.5
	A6	A5	369	1	4	1	0	3.5	1	0	3.5
	A5	A4	370	1	4	1	0	3.5	2	0	3.5
	A4	A3	368	1	4	1	0	3.5	2	0	3.5
	A3	A2	371	1	4	2	0	3.5	2	0	4.0
	A2	A1	368	1	4	2	0	3.5	2	0	4.0
	A1	A10	372	1	4	2	0	3.5	2	0	4.0
	A10	A11	370	1	4	2	0	4.0	2	0	4.0
	A11	A12	479	1	4	2	0	4.0	2	6	4
	A12	A13	484	1	2	2	0	4.0	2	6	4
	A13	A14	563	1	2	2	0	4.0	2	6	4
A14	A-OUT	56	1	2	2	0	4.0	2	6	4	
Totals			9090	14	50	---	---	---	---	---	---
E0147	B18	B17	365	1	4	1	0	2.0	1	0	2.0
	B17	B16	372	1	4	1	0	3.0	1	0	3.0
	B16	B15	182	1	4	1	0	3.0	1	0	3.0
	B15	B14	190	1	4	1	0	3.0	1	0	3.0
	B14	B13	366	1	4	1	0	3.5	1	0	3.5
	B13	B12	371	1	4	1	0	3.5	1	0	4.0
	B12	B-OUT	694	1	4	1	0	4.0	1	0	5.0
	B11	B12	367	1	4	1	0	2.0	1	0	2.0
	B10	B9	366	1	4	1	0	2.0	1	0	2.0
	B9	B-OUT	72	1	4	1	0	2.0	1	0	2.0
	B8	B7	373	1	4	1	0	2.0	1	0	2.0
	B7	B6	369	1	4	1	0	2.0	1	0	2.0
	B6	B5	195	1	4	1	0	2.0	1	0	2.0
	B5	B4	177	1	4	1	0	2.0	1	0	2.5
	B4	B3	293	1	2	1	0	7.5	1	0	8.0
B3	B2	249	1	4	1	0	7.5	1	0	8.0	
B2	B1	143	1	4	1	0	7.5	1	0	8.0	
B1-1	B1	332	1	4	1	0	2.0	1	0	2.0	
B1	B-OUT	104	1	2	1	0	7.5	1	0	8.0	
Totals			5580	19	72	---	---	---	---	---	---
E0146	C3	C2	333	1	4	1	10	6	1	10	8
	C2	C1	255	1	4	1	10	6	1	10	8
	C1	C-OUT	247	1	4	1	10	6	1	10	8
	Totals			835	3	12	---	---	---	---	---
E0145	DA-3	DA-2	333	1	4	1	0	3.0	1	0	4.0
	DA-2	DA-1	255	1	4	1	0	3.5	1	0	4.5
	DA-1	DA-OUT	247	1	4	1	0	3.5	1	0	5.0
	DB-3	DB-2	263	1	4	1	0	2.0	1	0	4.0
	DB-2	DB-1	250	1	3	1	0	2.5	1	0	4.0
	DB-1-2A	DB-1-2	515	1	4	1	0	3.0	1	0	3.0
	DB-1-2	DB-1	665	1	4	1	0	3.0	1	0	5.0
	DB-1-1	DB-1	225	1	2	1	0	2.0	1	0	2.0
DB-1	DB-OUT	269	1	4	1	0	4.0	1	0	5.5	
Totals			3022	9	33	---	---	---	---	---	---
E0051	E1	E-OUT	206	1	4	1	0	2.0	1	0	2.0
	Totals			206	1	4	---	---	---	---	---

E0042	F7	F6	273	1	2	1	0	2.0	1	0	2.0
	F6	F5	277	1	2	1	0	2.0	1	0	2.0
	F5	F4	466	1	2	1	0	2.0	1	0	2.0
	F4	F3	499	1	2	1	0	2.5	1	0	2.5
	F3	F2	294	1	2	1	0	2.5	1	0	2.5
	F2	F1	142	1	2	1	0	3.0	1	0	3.0
	F1	F-A	513	1	2	1	0	3.0	1	0	3.0
	F-A	F-B	448	1	0	1	0	3.0	1	0	3.5
	F-B	F-OUT	56	1	0	1	0	3.0	1	0	4.0
Totals			2968	9	14	---	---	---	---	---	---
E0041	G9	G8	694	1	4	1	0	3.0	1	0	3.0
	G8	G7	699	1	3	1	0	3.0	1	0	3.0
	G7	G6	607	1	2	1	0	3.0	1	0	3.5
	G6	G5	502	1	2	1	0	3.5	1	0	4.0
	G5	G4	106	1	2	1	0	3.5	1	0	4.5
	G4	G3	522	1	3	1	0	3.5	1	0	5.0
	G3	G2	296	1	2	1	0	4.0	1	0	5.5
	G2	G1	341	1	3	1	0	4.0	1	0	5.5
	G1	G-OUT	133	1	0	1	0	4.0	1	0	6.0
Totals			3900	9	21	---	---	---	---	---	---
E0040	H3	H2	267	1	4	1	0	2.0	1	0	2.0
	H2	H1	261	1	4	1	0	2.0	1	0	2.0
	H1	H-OUT	157	1	3	1	0	2.5	1	0	2.5
	Totals			685	3	11	---	---	---	---	---
E0039	I2	I1	264	1	4	1	0	3.0	1	0	3.0
	I1	I-OUT	157	1	3	1	0	3.0	1	0	3.0
	Totals			421	2	7	---	---	---	---	---
E0036	JA-6	JA-5	302	1	4	1	0	2.0	1	0	2.0
	JA-5	JA-4	265	1	4	1	0	2.0	1	0	2.5
	JA-4	JA-3	266	1	4	1	0	2.5	1	0	3.0
	JA-3	JA-2	267	1	4	1	0	2.5	1	0	3.0
	JA-2	JA-1	255	1	4	1	0	2.5	1	0	3.0
	JA-1	J1	37	1	4	1	0	3.0	1	0	3.5
	JB-7	JB-6	124	1	4	1	0	2.0	1	0	2.0
	JB-6	JB-5	261	1	4	1	0	2.0	1	0	2.0
	JB-5	JB-4	265	1	4	1	0	3.0	1	0	2.5
	JB-4	JB-3	260	1	4	1	0	3.0	1	0	3.0
	JB-3	JB-2	271	1	4	1	0	3.0	1	0	3.0
	JB-2	JB-1	253	1	4	1	0	3.0	1	0	3.0
	JB-1	J1	35	1	4	1	0	3.0	1	0	3.5
J1	J-OUT	193	1	0	1	0	3.0	1	0	3.5	
Totals			3054	14	52	---	---	---	---	---	---
W0530	KB-4	KB-3	94	1	2	1	0	2.0	1	0	2.0
	KB-3	KB-2	258	1	3	1	0	2.0	1	0	2.0
	KB-2	KB-1	271	1	4	1	0	2.0	1	0	2.0
	KB-1	KA-2	349	1	4	1	0	2.0	1	0	2.5
	KA-4	KA-3	273	1	4	1	0	2.0	1	0	2.0
	KA-3	KA-2	270	1	4	1	0	2.0	1	0	2.0
	KA-2	KA-1	264	1	4	1	0	3.0	1	0	3.0
	KA-1	KA-OUT	279	1	4	1	0	3.0	1	0	3.0
Totals			2058	8	29	---	---	---	---	---	---

Note: Blue Cells Indicate Existing Pipes to Remain.

5. Impact Analysis and Mitigation

Some of the existing storm sewers are undersized and will not convey flows from the contributing drainage areas. Therefore, the storm sewer had to be upsized to provide adequate capacity and

meet the City of Houston's design requirements. The improved conveyance along the need area causes peak flow impacts for some of the drainage systems and will require detention mitigation. Detention volume calculation summaries are shown in **Tables 4** for each alternative with full calculations located in **Attachment 2**.

The detention required to mitigate the increase impervious cover was also calculated. The existing and proposed typical sections are provided in **Attachment 2**. The actual detention volume required was the total of the two detention values. The following options are presented to mitigate the impacts:

- a. In-line detention: In-line detention may be provided by further upsizing proposed storm sewer systems. Required in-line detention pipe sizes range from 1 – 4' x 2' RCB to 12' x 10' RCBs depending on the drainage system. **Table 5** shows the in-line detention design summary. A restrictor will have to be designed at the outfall during the design phase to utilize the detention volume and restrict the peak outflow to existing conditions.
- b. Detention Ponds: There are no suitable areas along the need area to serve as surface detention ponds. However, the City of Houston report Mitigation Program for Capital Improvements Projects – Buffalo Bayou, White Oak Bayou, Greens Bayou, and Hunting Bayou Watersheds, dated April 2014, prepared by Walter P Moore & Associates, Inc. identifies one sub-regional detention pond along White Oak Bayou near the need area, which could serve as detention. **Table 6** shows the available volume and cost per acre-foot for each of the potential sub-regional detention ponds for each alternative.

Table 4: Detention Calculation Summary

Drainage System ID	Impact Caused by Increased Conveyance				Impact Caused by Increased Impervious				Total Required Detention Volume (ac-ft)
	Existing Flow	Proposed Flow	Flow Impacts	Required Detention Volume	Existing Impervious Area	Proposed Impervious Area	Change in Impervious Area	Required Detention Volume	
	(cfs)	(cfs)	(cfs)	(ac-ft)	(ac)	(ac)	(ac)	(ac-ft)	
E0150	365.6	396.9	31.3	6.45	4.34	4.68	0.34	0.17	6.62
E0147	721.5	722.6	1.1	0.53	6.39	6.76	0.37	0.18	0.72
E0146	712.5	720.4	7.9	2.07	1.32	1.41	0.09	0.04	2.11
E0145	361.9	363.8	1.9	0.45	4.77	5.10	0.32	0.16	0.61
E0051	12.3	12.3	0.0	0.00	0.58	0.63	0.05	0.02	0.02
E0042	59.3	58.5	-0.8	0.00	2.88	3.11	0.23	0.11	0.11
E0041	178.8	185.4	6.6	1.60	5.03	5.32	0.29	0.15	1.74
E0040	33.1	33.1	0.0	0.00	1.10	1.19	0.09	0.04	0.04
E0039	38.5	38.5	0.0	0.00	0.47	0.50	0.03	0.01	0.01
E0036	141.5	141.8	0.3	0.06	4.49	4.79	0.30	0.15	0.21
W0530	62.1	60.9	-1.2	0.00	4.63	4.91	0.29	0.14	0.14
Totals	---	---	---	11.2	---	---	---	1.19	12.35

Table 6: Proposed In-Line Detention Design Summary

Drainage System ID	Design Node		Pipe Length (ft)	No. of Maholes	No. of Inlets	100-Year Extreme Event		
	From MH	To MH				No. of Pipes	Span (ft)	Rise (in/ft)
E0150	A9	A8	374	1	4	1	0	2.5
	A8	A7	370	1	4	1	0	3.0
	A7	A6	375	1	4	1	0	3.5
	A6	A5	369	1	4	1	0	3.5
	A5	A4	370	1	4	2	0	3.5
	A4	A3	368	1	4	2	0	3.5
	A3	A2	371	1	4	2	10	10
	A2	A1	368	1	4	2	10	10
	A1	A10	372	1	4	2	10	10
	A10	A11	370	1	4	2	10	10
	A11	A12	479	1	4	2	6	4
	A12	A13	484	1	2	2	6	4
	A13	A14	563	1	2	2	6	4
	A14	A-OUT	56	1	2	2	6	4
	Totals		9090	14	50	---	---	---
E0147	B18	B17	365	1	4	1	0	2.0
	B17	B16	372	1	4	1	0	3.0
	B16	B15	182	1	4	1	0	3.0
	B15	B14	190	1	4	1	0	3.0
	B14	B13	366	1	4	1	0	3.5
	B13	B12	371	1	4	1	8	4
	B12	B-OUT	694	1	4	1	0	5.0
	B11	B12	367	1	4	1	0	2.0
	B10	B9	366	1	4	1	6	3
	B9	B-OUT	72	1	4	1	0	2.0
	B8	B7	373	1	4	1	0	2.0
	B7	B6	369	1	4	1	0	2.0
	B6	B5	195	1	4	1	6	6
	B5	B4	177	1	4	1	6	6
	B4	B3	293	1	2	1	0	8.0
	B3	B2	249	1	4	1	0	8.0
	B2	B1	143	1	4	1	0	8.0
	B1-1	B1	332	1	4	1	0	2.0
B1	B-OUT	104	1	2	1	0	8.0	
	Totals		5580	19	72	---	---	---
E0146	C3	C2	333	1	4	1	12	10
	C2	C1	255	1	4	1	12	10
	C1	C-OUT	247	1	4	1	12	10
		Totals		835	3	12	---	---
E0145	DA-3	DA-2	333	1	4	1	0	4.0
	DA-2	DA-1	255	1	4	1	0	4.5
	DA-1	DA-OUT	247	1	4	1	0	5.0
	DB-3	DB-2	263	1	4	1	0	4.0
	DB-2	DB-1	250	1	3	1	0	4.0
	DB-1-2A	DB-1-2	515	1	4	1	5	5
	DB-1-2	DB-1	665	1	4	1	5	5
	DB-1-1	DB-1	225	1	2	1	5	5
	DB-1	DB-OUT	269	1	4	1	0	5.5
	Totals		3022	9	33	---	---	---
E0051	E1	E-OUT	206	1	4	1	4	2
		Totals		206	1	4	---	---

E0042	F7	F6	273	1	2	1	0	2.0
	F6	F5	277	1	2	1	0	2.0
	F5	F4	466	1	2	1	0	2.0
	F4	F3	499	1	2	1	0	2.5
	F3	F2	294	1	2	1	0	2.5
	F2	F1	142	1	2	1	0	3.0
	F1	F-A	513	1	2	1	4	2
	F-A	F-B	448	1	0	1	4	2
	F-B	F-OUT	56	1	0	1	0	4.0
Totals			2968	9	14	---	---	---
E0041	G9	G8	694	1	4	1	0	3.0
	G8	G7	699	1	3	1	0	3.0
	G7	G6	607	1	2	1	0	3.5
	G6	G5	502	1	2	1	7	5
	G5	G4	106	1	2	1	10	5
	G4	G3	522	1	3	1	10	5
	G3	G2	296	1	2	1	10	5
	G2	G1	341	1	3	1	10	5
	G1	G-OUT	133	1	0	1	0	6.0
Totals			3900	9	21	---	---	---
E0040	H3	H2	267	1	4	1	0	2.0
	H2	H1	261	1	4	1	4	2
	H1	H-OUT	157	1	3	1	0	2.5
	Totals			685	3	11	---	---
E0039	I2	I1	264	1	4	1	4	2
	I1	I-OUT	157	1	3	1	0	3.0
	Totals			421	2	7	---	---
E0036	JA-6	JA-5	302	1	4	1	0	2.0
	JA-5	JA-4	265	1	4	1	0	2.5
	JA-4	JA-3	266	1	4	1	0	3.0
	JA-3	JA-2	267	1	4	1	0	3.0
	JA-2	JA-1	255	1	4	1	0	3.0
	JA-1	J1	37	1	4	1	0	3.5
	JB-7	JB-6	124	1	4	1	0	2.0
	JB-6	JB-5	261	1	4	1	0	2.0
	JB-5	JB-4	265	1	4	1	0	2.5
	JB-4	JB-3	260	1	4	1	0	3.0
	JB-3	JB-2	271	1	4	1	5	3
	JB-2	JB-1	253	1	4	1	5	3
	JB-1	J1	35	1	4	1	5	3
J1	J-OUT	193	1	0	1	0	3.5	
Totals			3054	14	52	---	---	---
W0530	KB-4	KB-3	94	1	2	1	0	2.0
	KB-3	KB-2	258	1	3	1	0	2.0
	KB-2	KB-1	271	1	4	1	0	2.0
	KB-1	KA-2	349	1	4	1	0	2.5
	KA-4	KA-3	273	1	4	1	4	2
	KA-3	KA-2	270	1	4	1	4	2
	KA-2	KA-1	264	1	4	1	4	2
	KA-1	KA-OUT	279	1	4	1	0	3.0
Totals			2058	8	29	---	---	---

Note: Blue Cells Indicate Existing Pipes to Remain.

Note: Orange Cells Indicate In-Line Detention Storm Sewers

Table 7: Sub-Regional Detention Pond Information

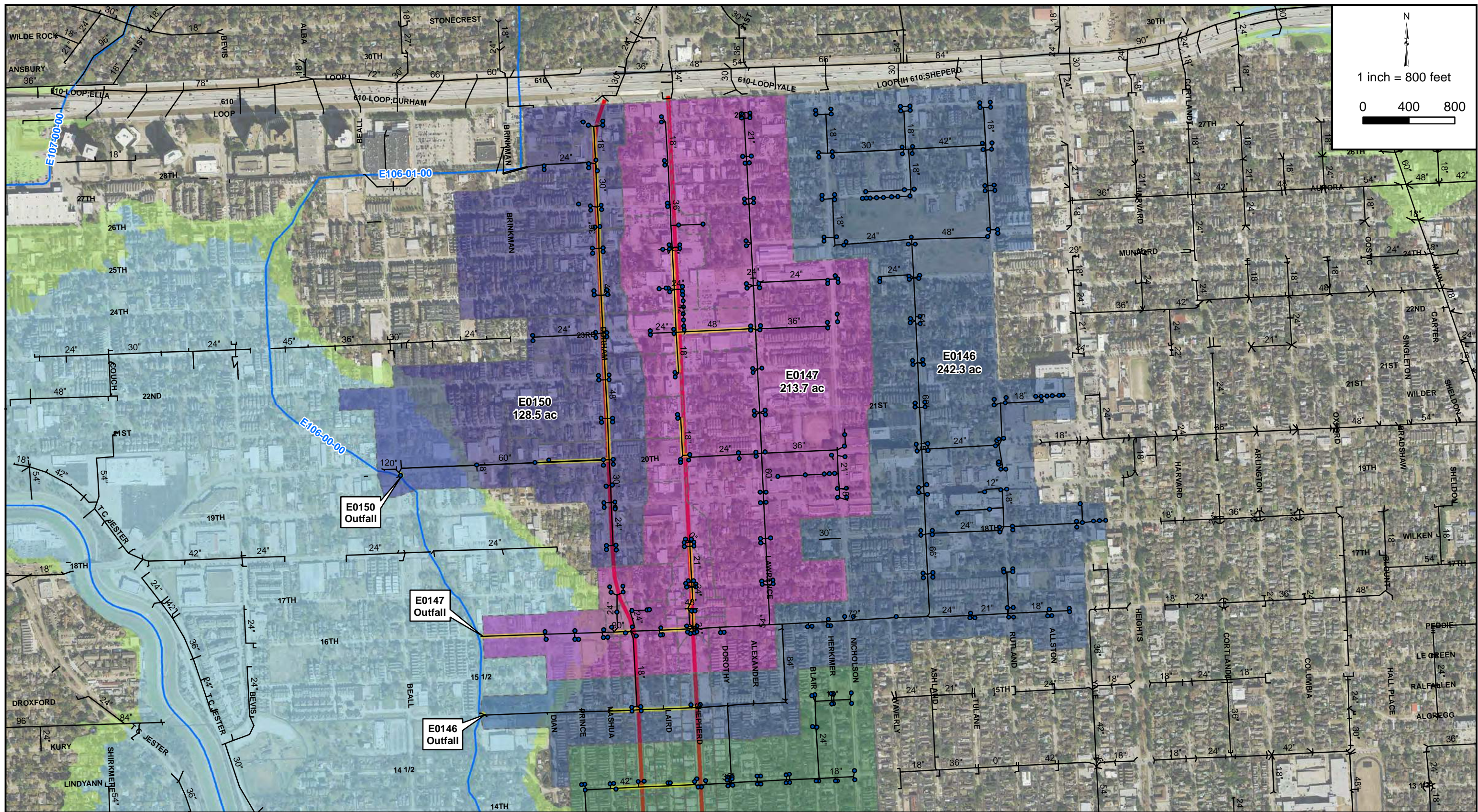
Detention Pond	Detention Volume Available	Detention Volume	Cost per Acre-Foot	Detention Pond Cost
	(ac-ft)	(ac-ft)	(\$)/ac-ft	(\$)
San Felipe	72.0	12.4	\$44,796	\$555,111

C. Conclusions

The existing conditions analysis showed that majority of the existing storm drainage systems within the need area are inadequate in conveying the 2-year design flows. Some storm sewers were undersized according the City of Houston Infrastructure Design Manual’s minimum requirement of 24-inch storm sewer. The storm sewer systems along the need area range in age between 54 and 95 years. The City of Houston’s Comprehensive Drainage Plan proposes storm sewer improvements for Drainage System E0146, E0147, E0150, E0145, E0041, E0036, and W0530.

New storm sewer systems were designed to meet the City’s design standards. Some of the proposed storm sewer systems had to be upsized to meet the City’s design standards and provide adequate capacity, which resulted in peak flow and runoff impacts. Additionally, the proposed roadway increases the impervious cover within the right-of-way and will require detention to mitigate the peak flow and runoff impacts. Detention mitigation for impacts caused by increased conveyance and impervious cover can be provided by either upsizing the proposed storm sewer and providing a restrictor at the outfalls (restrictor to be sized during design phase) or using proposed City of Houston Sub-Regional Detention Ponds.

EXHIBITS



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Legend

- Storm Sewer Inlets
- Existing Storm Sewer
- Inadequate Storm Sewer
- Project Limits
- Streams

- ▭ Parcels
- - - Sub-Drainage Area

Drainage Areas

- E0145
- E0146
- E0147
- E0150

FEMA FIRM (6/9/2014)

- 0.2 % Chance Annual Flood Hazard
- 1 % Chance Annual Flood Hazard

Notes

- 1) Inadequate Storm Sewers were identified based on preliminary Planning 1 analysis

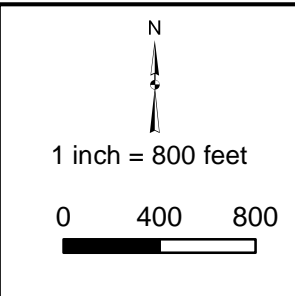
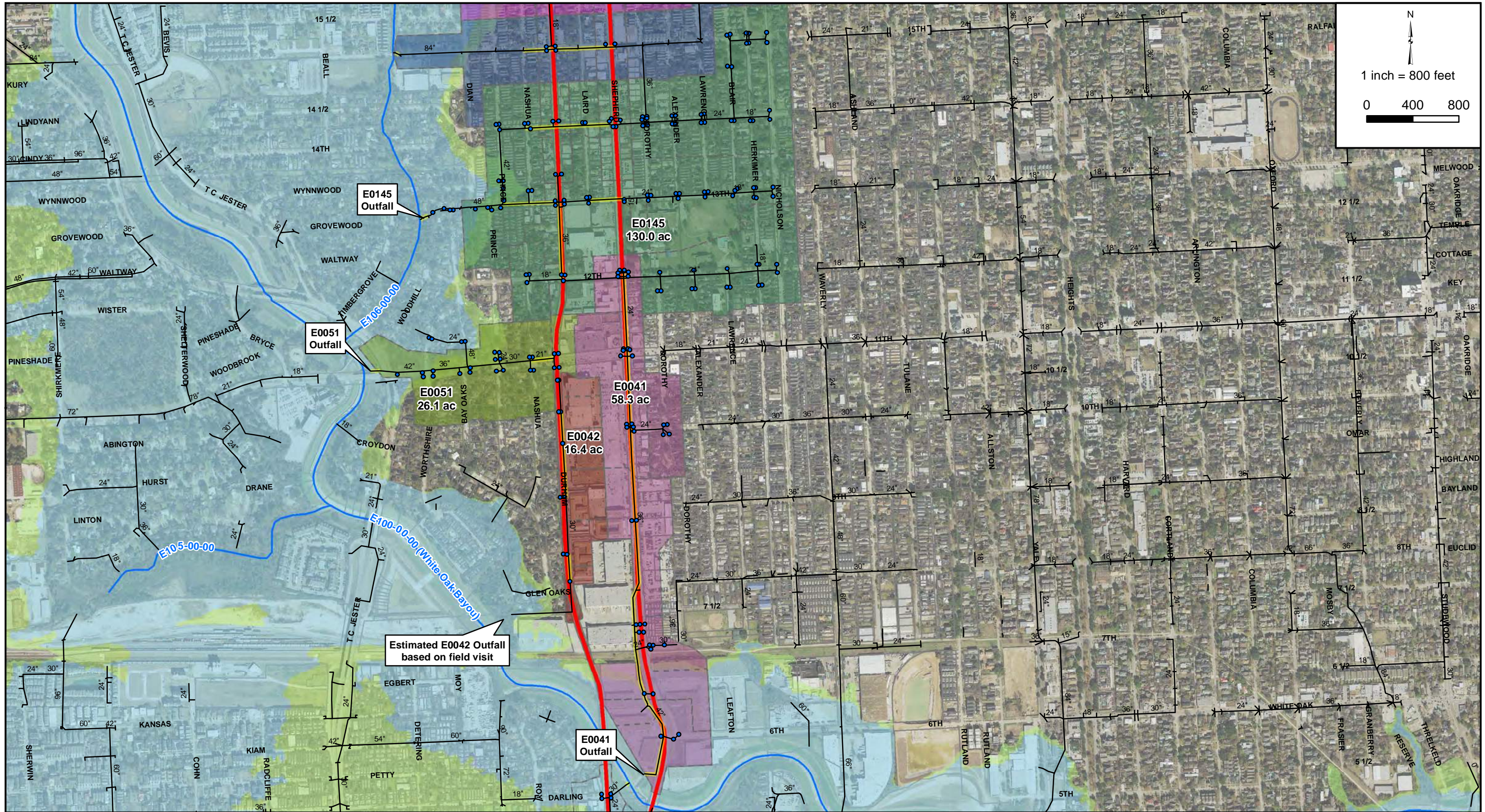
**Drainage System Map
Need Area N-2016T-0004**

Storm Water Drainage Pre-Engineering Services
City of Houston (WBS No. N-320100-0010-3)

Aerials: 2014 HGAC

December 2017

Exhibit 1a



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Legend

- Storm Sewer Inlets
- Existing Storm Sewer
- Inadequate Storm Sewer
- Project Limits
- Streams
- ▭ Parcels
- ▭ Sub-Drainage Area
- Drainage Areas**
- ▭ E0041
- ▭ E0042
- ▭ E0051
- ▭ E0145
- ▭ E0146
- ▭ E0147
- ▭ FEMA FIRM (6/9/2014)
- ▭ 0.2 % Chance Annual Flood Hazard
- ▭ 1 % Chance Annual Flood Hazard

Notes

1) Inadequate Storm Sewers were identified based on preliminary Planning 1 analysis

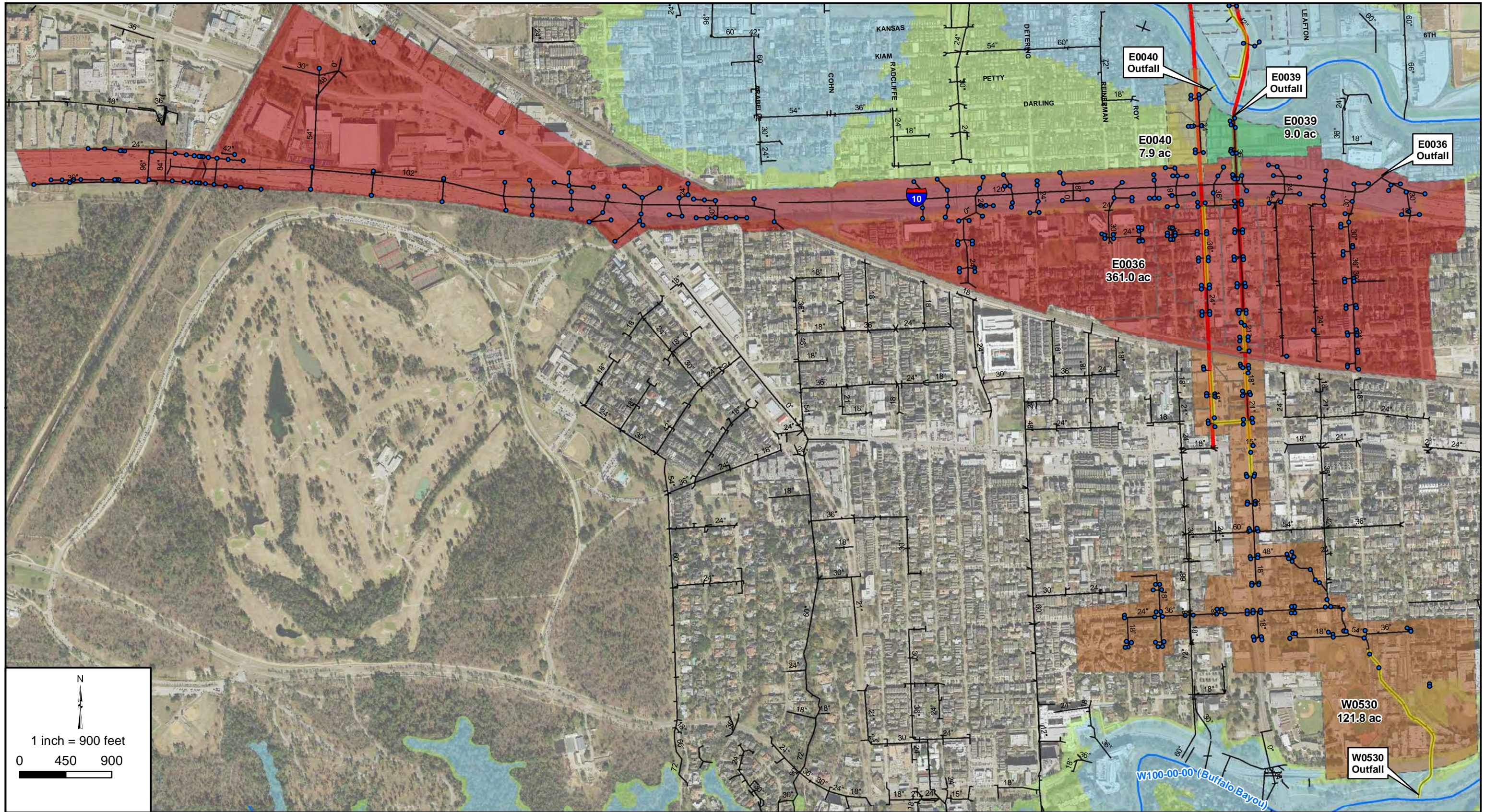
**Drainage System Map
Need Area N-2016T-0004**

Storm Water Drainage Pre-Engineering Services
City of Houston (WBS No. N-320100-0010-3)

Aerials: 2014 HGAC

December 2017

Exhibit 1b



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Legend

- Storm Sewer Inlets
- Existing Storm Sewer
- Inadequate Storm Sewer
- Project Limits
- Streams
- ▭ Parcels
- - - Sub-Drainage Area

Drainage Areas

- E0036
- E0039
- E0040
- W0530

FEMA FIRM (6/9/2014)

- 0.2 % Chance Annual Flood Hazard
- 1 % Chance Annual Flood Hazard

Notes

1) Inadequate Storm Sewers were identified based on preliminary Planning 1 analysis

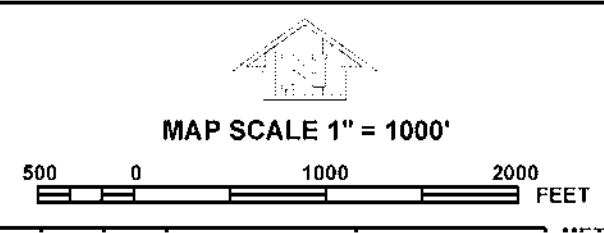
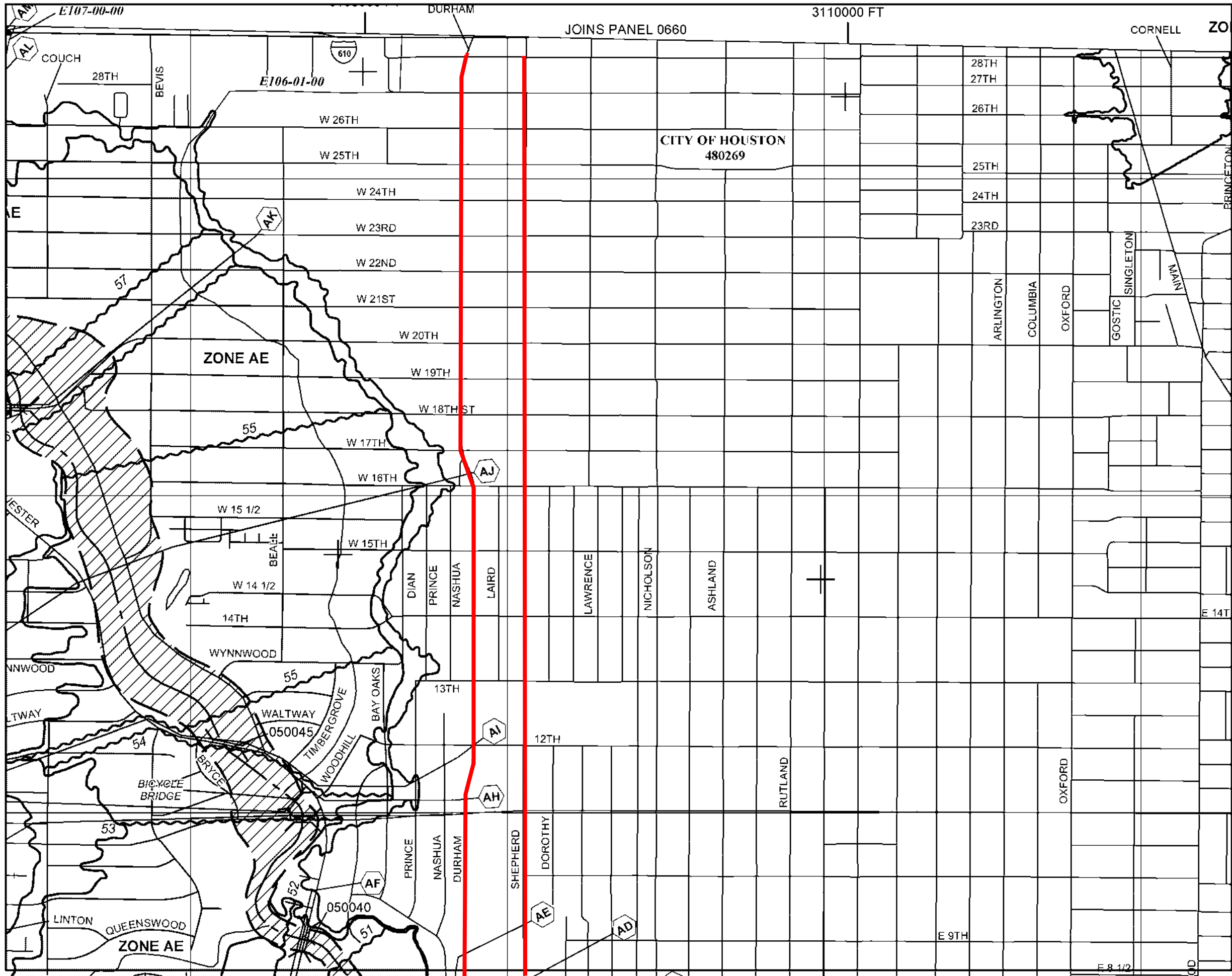
Aerials: 2014 HGAC

**Drainage System Map
Need Area N-2016T-0004**

Storm Water Drainage Pre-Engineering Services
City of Houston (WBS No. N-320100-0010-3)

December 2017

Exhibit 1c



PANEL 0670M

FIRM
 FLOOD INSURANCE RATE MAP
 HARRIS COUNTY,
 TEXAS
 AND INCORPORATED AREAS

PANEL 670 OF 1150
 (SEE MAP INDEX FOR FIRM PANEL LAYOUT)

COMMUNITY	NUMBER	PANEL	SUFFIX
HOUSTON, CITY OF	480296	0670	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
48201C0670M

MAP REVISED
JUNE 9, 2014

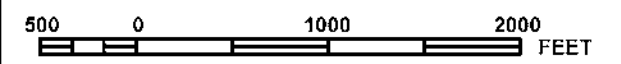
Federal Emergency Management Agency

FEMA FIRM MAP
NEED AREA N-2016T-0004
EXHIBIT 2A

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



MAP SCALE 1" = 1000'



NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0670M

FIRM
FLOOD INSURANCE RATE MAP
HARRIS COUNTY, TEXAS
AND INCORPORATED AREAS

PANEL 670 OF 1150
 (SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
HOUSTON, CITY OF	480296	0670	N

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.



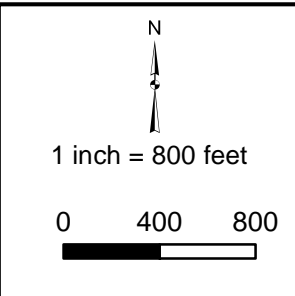
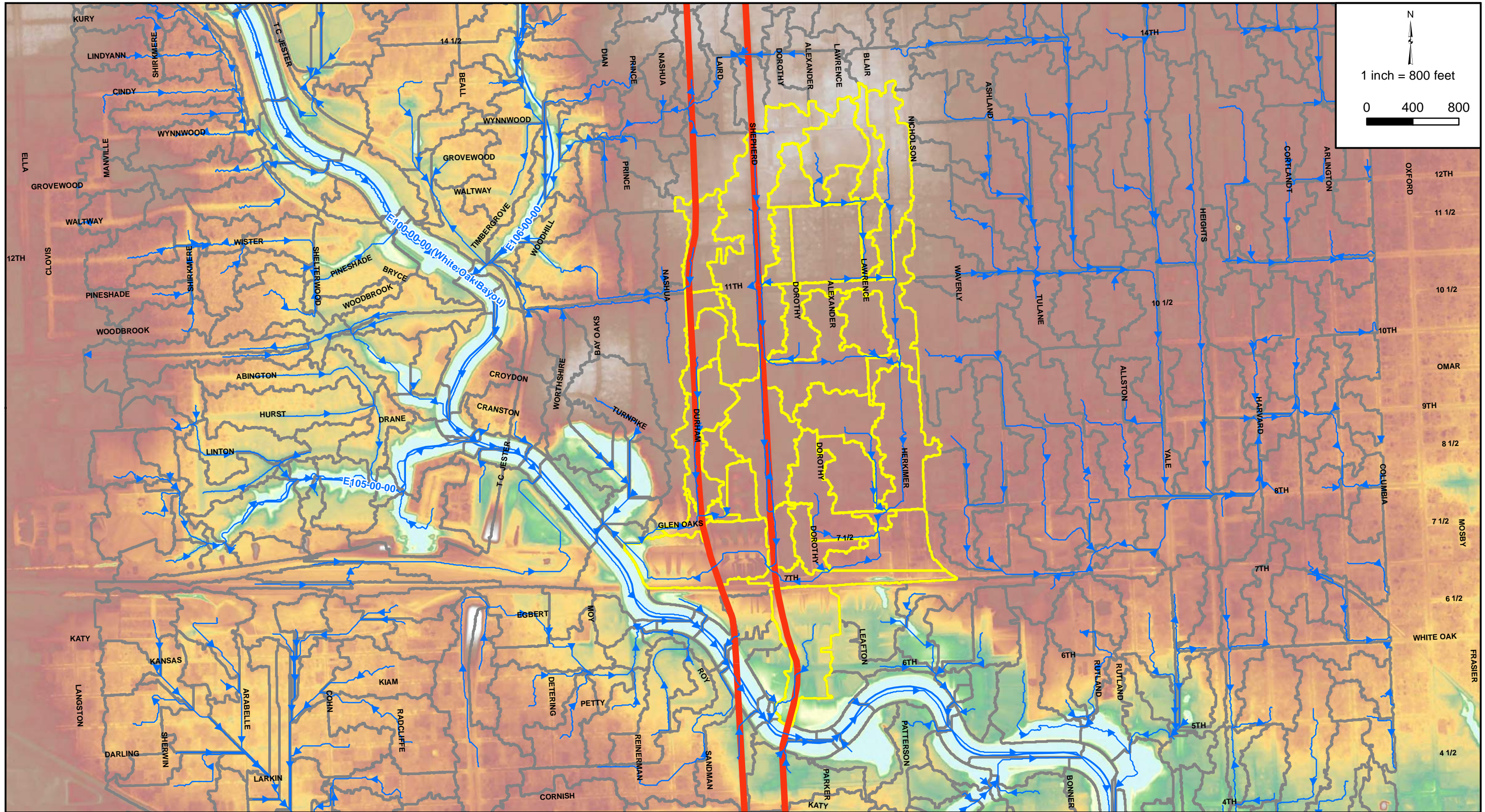
MAP NUMBER
 48201C0670M

MAP REVISED
 JUNE 9, 2014

Federal Emergency Management Agency

FEMA FIRM MAP
NEED AREA N-2016T-004
EXHIBIT 2B

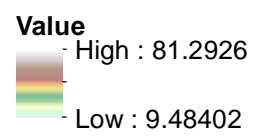
This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



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- Legend**
- N-2016T-004 Project Limits
 - Drainage Line
 - Streams
 - Drains to Need Area
 - Drains away from Need Area



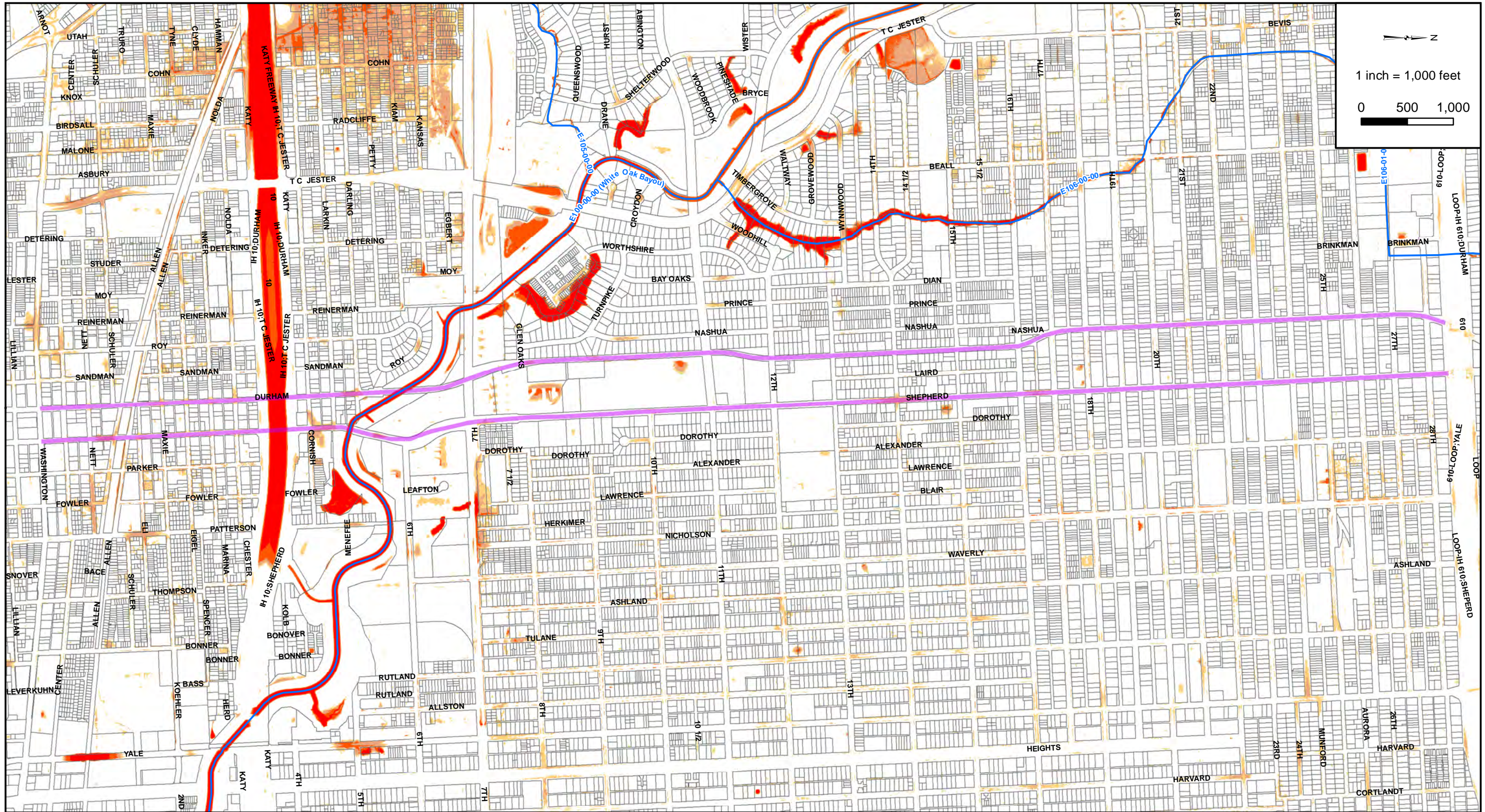
Overland Flow Map
Need Area N-2016T-0004

Storm Water Drainage Pre-Engineering Services
City of Houston (WBS No. N-320100-0010-3)

LiDAR: 2008 HGAC

December 2017

Exhibit 3



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Legend

- 1 Ft Contours
- N-2016T-004 Project Limits
- Streams
- Parcels

Ponding Depth (ft)

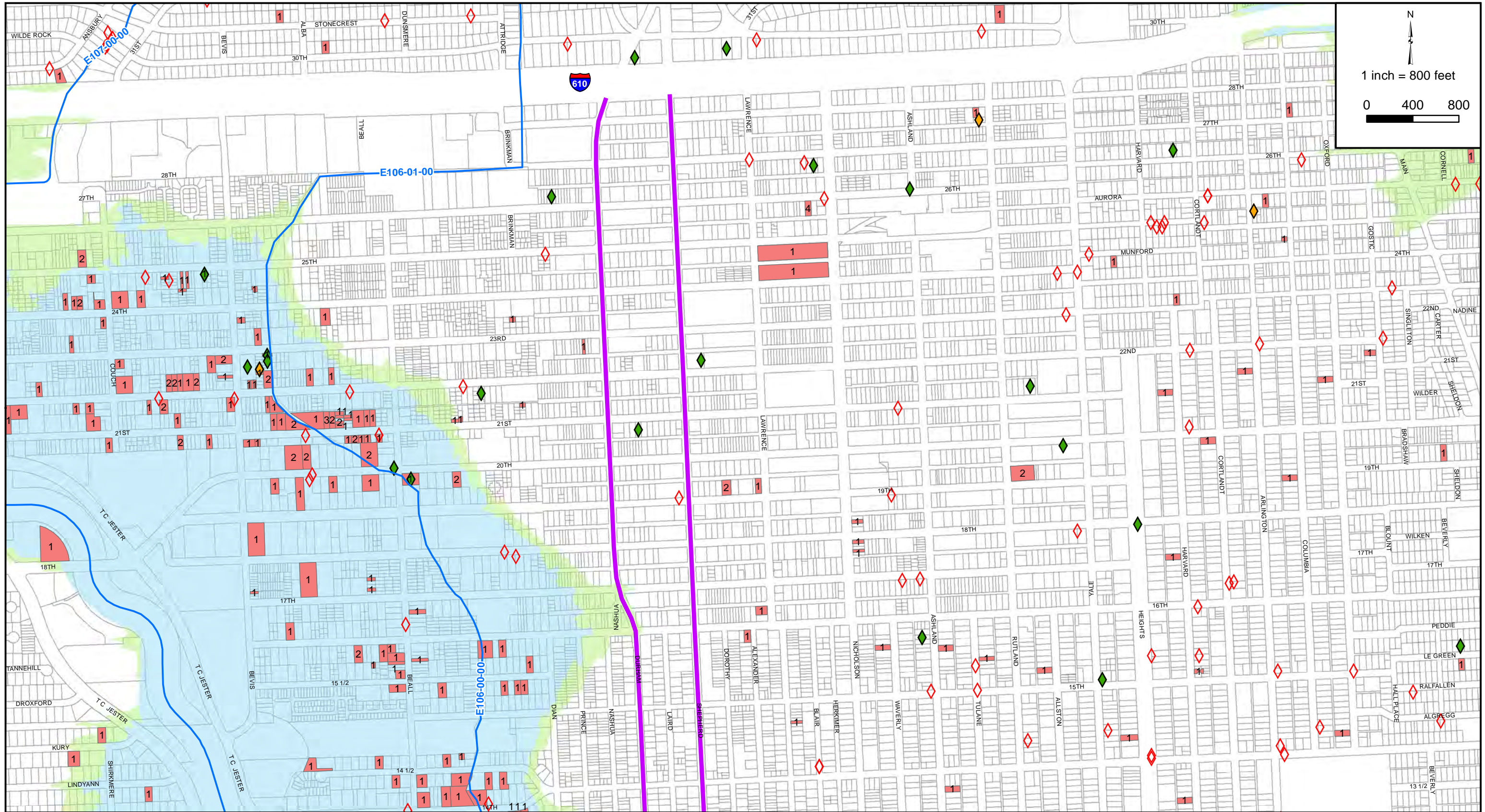
- 0.5 - 1
- 1 - 2
- 2 - 5
- 5 - 10

Ponding Map
Need Area N-2016T-0004

Storm Water Drainage Pre-Engineering Services
City of Houston (WBS No. N-320100-0010-3)

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Exhibit 4



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Legend

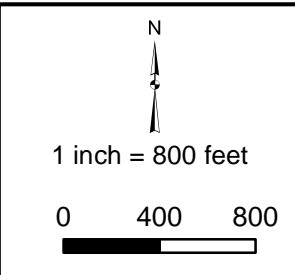
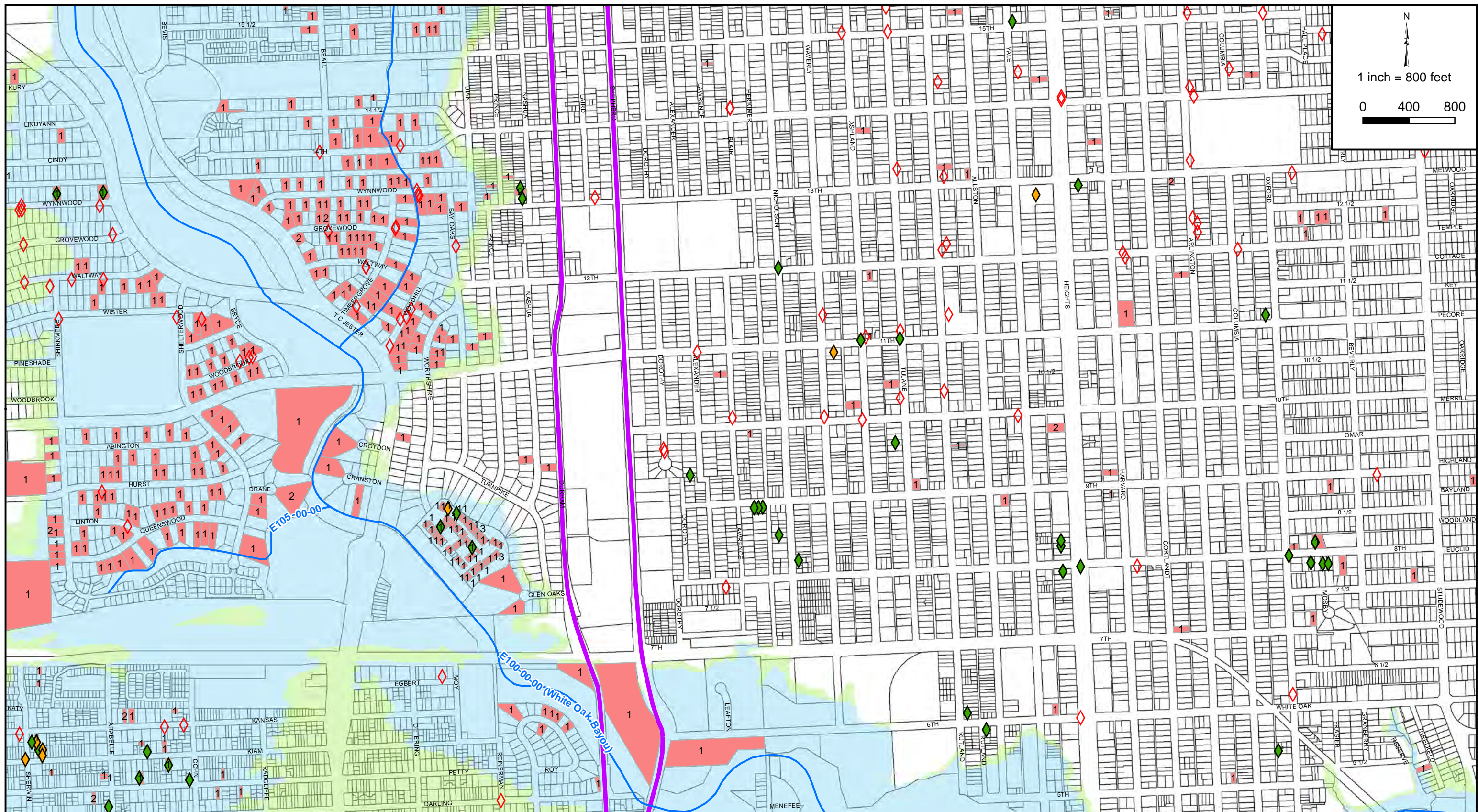
- ◊ Street Impassible
- ◊ Structural Flooding
- ◊ ROW Flooding
- Need Area N-2016T-0004
- Streams
- # FEMA Flood Loss Properties (Number of Losses)
- Parcels
- 0.2 % Chance Annual Flood Hazard
- 1 % Chance Annual Flood Hazard

Drainage System Map
Need Area N-2016T-0004

Storm Water Drainage Pre-Engineering Services
City of Houston (WBS No. N-320100-0010-3)

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Exhibit 5a



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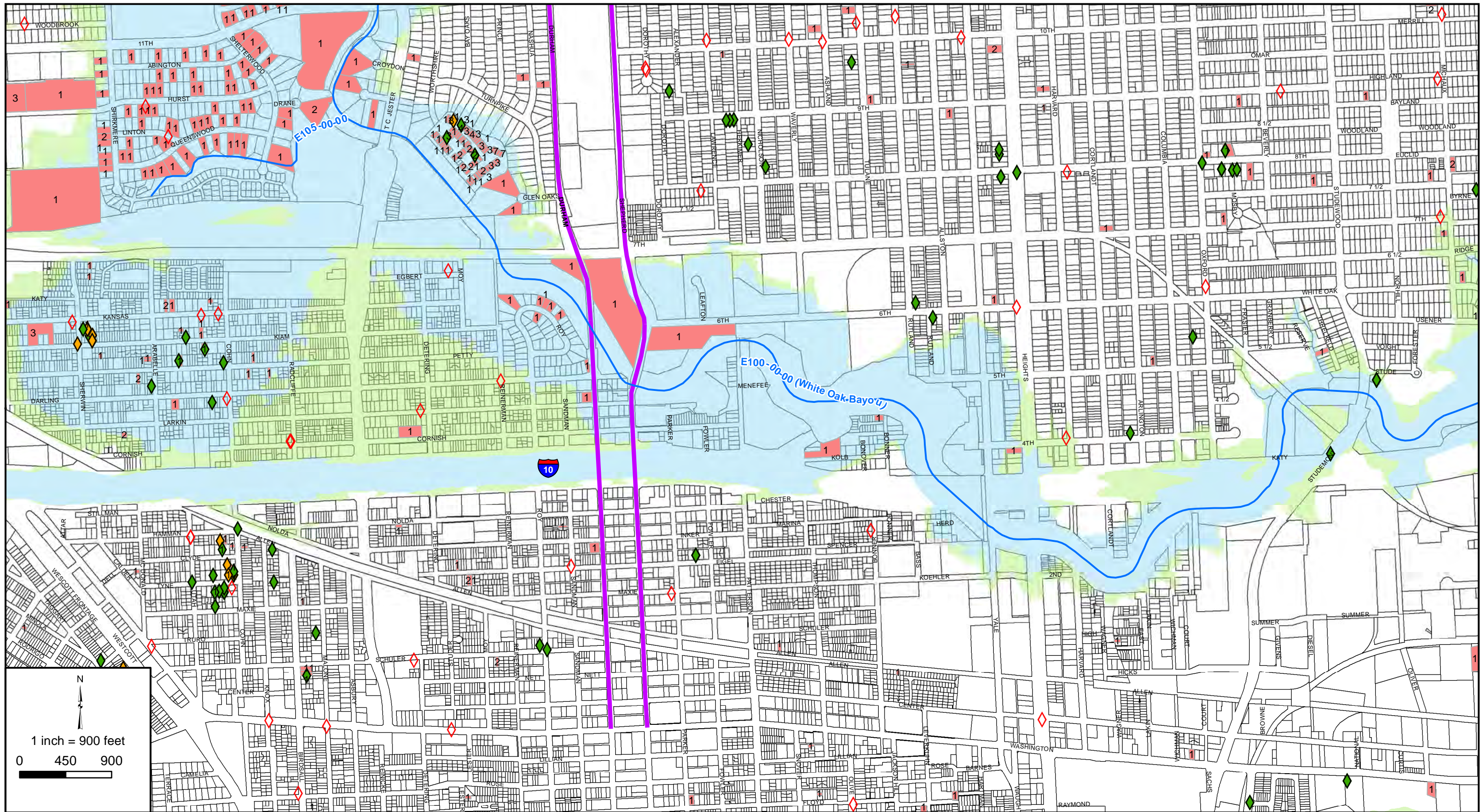
- Legend**
- ◆ Street Impassible
 - Need Area N-2016T-0004
 - # FEMA Flood Loss Properties (Number of Losses)
 - Parcels
 - ◆ COH 311 Drainage Complaints
 - Streams
 - ◆ Structural Flooding
 - ◆ ROW Flooding
 - 0.2 % Chance Annual Flood Hazard
 - 1 % Chance Annual Flood Hazard

Drainage System Map
Need Area N-2016T-0004

Storm Water Drainage Pre-Engineering Services
City of Houston (WBS No. N-320100-0010-3)

December 2017

Exhibit 5b



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Legend

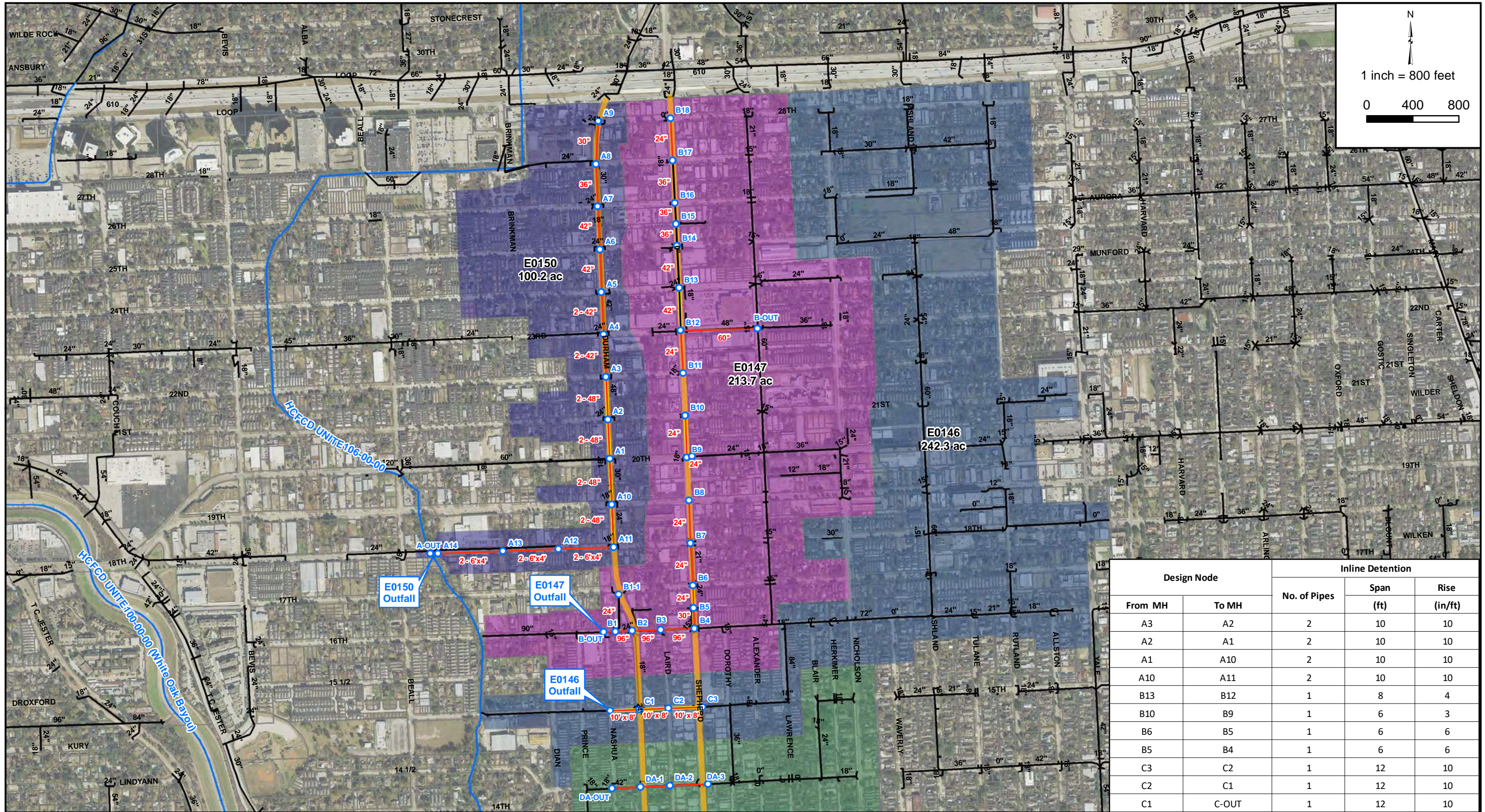
- ◊ Street Impassible
- ◊ Structural Flooding
- ◊ ROW Flooding
- Need Area N-2016T-0004
- Streams
- # FEMA Flood Loss Properties (Number of Losses)
- Parcels
- 0.2 % Chance Annual Flood Hazard
- 1 % Chance Annual Flood Hazard

Drainage System Map
Need Area N-2016T-0004

Storm Water Drainage Pre-Engineering Services
City of Houston (WBS No. N-320100-0010-3)

December 2017

Exhibit 5c



Design Node		Inline Detention		
From MH	To MH	No. of Pipes	Span (ft)	Rise (in/ft)
A3	A2	2	10	10
A2	A1	2	10	10
A1	A10	2	10	10
A10	A11	2	10	10
B13	B12	1	8	4
B10	B9	1	6	3
B6	B5	1	6	6
B5	B4	1	6	6
C3	C2	1	12	10
C2	C1	1	12	10
C1	C-OUT	1	12	10

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Legend

- HouStorm Node
 - Proposed Storm Sewer
 - Existing Storm Sewer
 - Project Limits
 - Streams
 - In-Line Detention
 - Parcels
 - Sub-Drainage Area
- Drainage Areas**
- E0145
 - E0146
 - E0147
 - E0150

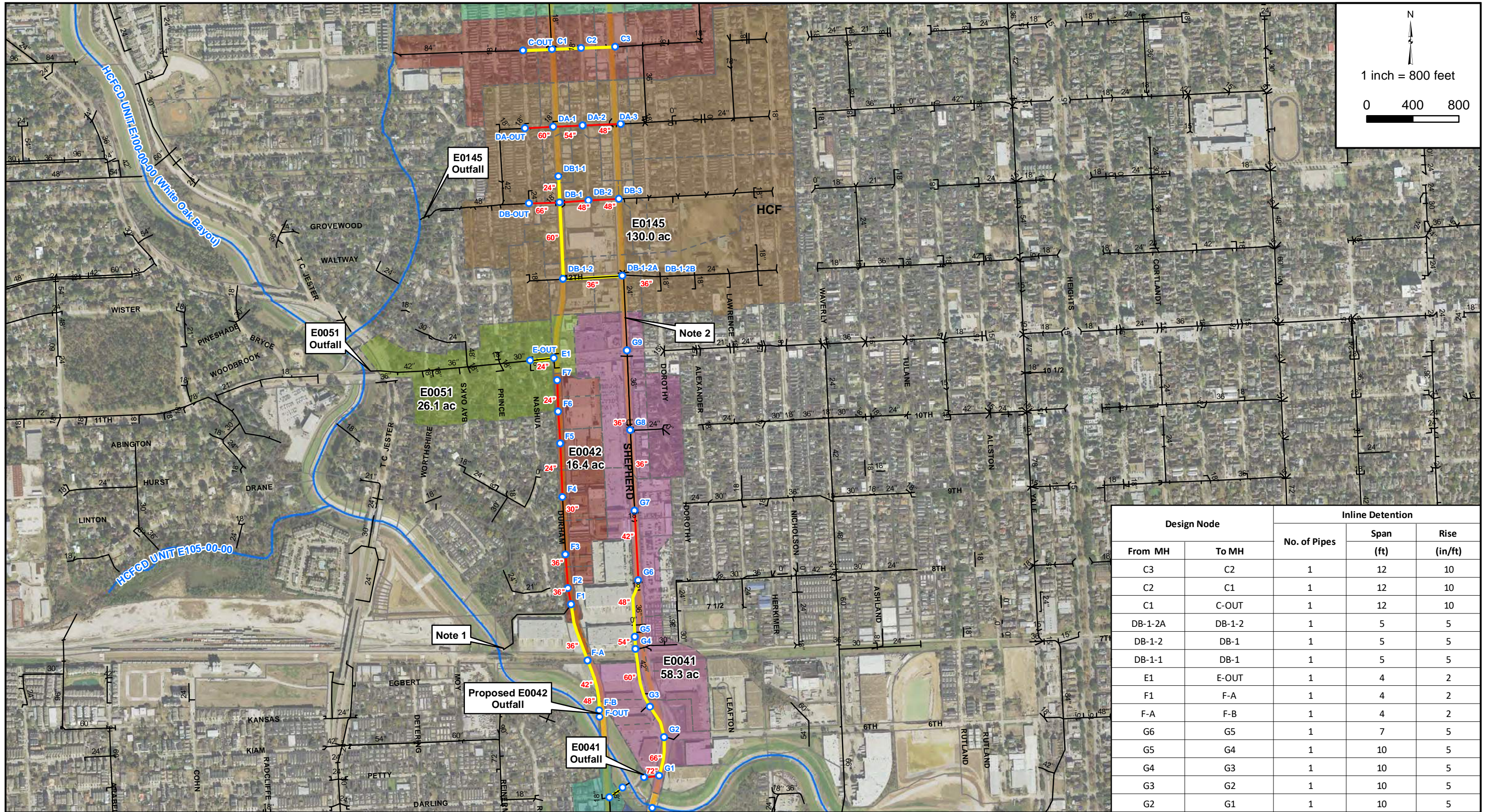
Proposed Drainage System Map
Need Area N-2016T-0004

Storm Water Drainage Pre-Engineering Services
City of Houston (WBS No. N-320100-0010-3)

Aerials: 2014 HGAC

December 2017

Exhibit 6a



Design Node		Inline Detention		
From MH	To MH	No. of Pipes	Span (ft)	Rise (in/ft)
C3	C2	1	12	10
C2	C1	1	12	10
C1	C-OUT	1	12	10
DB-1-2A	DB-1-2	1	5	5
DB-1-2	DB-1	1	5	5
DB-1-1	DB-1	1	5	5
E1	E-OUT	1	4	2
F1	F-A	1	4	2
F-A	F-B	1	4	2
G6	G5	1	7	5
G5	G4	1	10	5
G4	G3	1	10	5
G3	G2	1	10	5
G2	G1	1	10	5

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Legend

- HouStorm Node
 - Proposed Storm Sewer
 - Existing Storm Sewer
 - Streams
 - Project Limits
 - In-Line Detention
 - Parcels
 - Sub-Drainage Area
- Drainage Areas**
- E0041
 - E0042
 - E0051
 - E0145

Notes

- 1) No drainage easment identified, therefore propose to abandon the Existing Outfall.
- 2) Existing pipe to be removed.

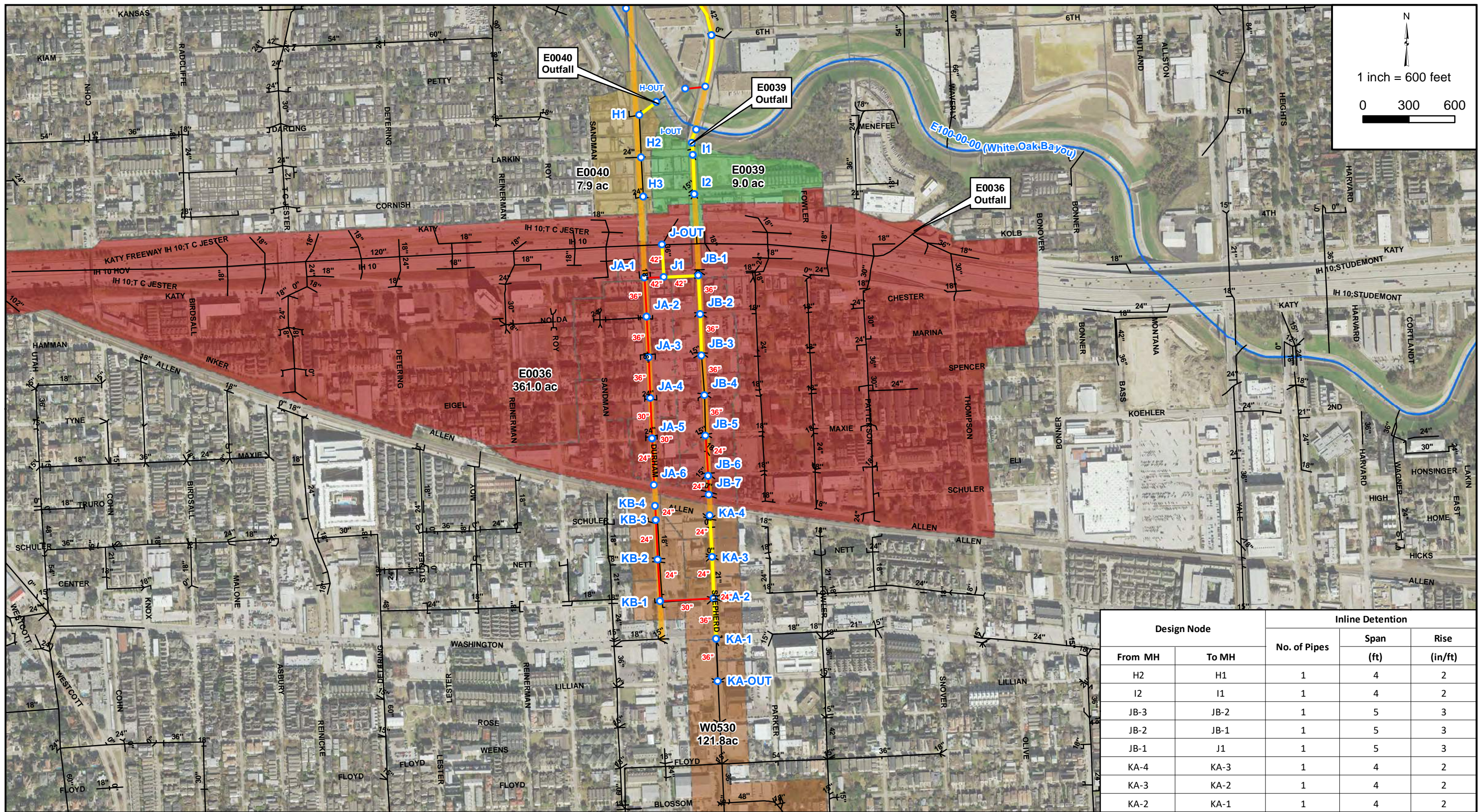
**Proposed Drainage System Map
Need Area N-2016T-0004**

Storm Water Drainage Pre-Engineering Services
City of Houston (WBS No. N-320100-0010-3)

Aerials: 2014 HGAC

December 2017

Exhibit 6b



Design Node		Inline Detention		
From MH	To MH	No. of Pipes	Span (ft)	Rise (in/ft)
H2	H1	1	4	2
I2	I1	1	4	2
JB-3	JB-2	1	5	3
JB-2	JB-1	1	5	3
JB-1	J1	1	5	3
KA-4	KA-3	1	4	2
KA-3	KA-2	1	4	2
KA-2	KA-1	1	4	2

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Legend

- HouStorm Node
 - Proposed Storm Sewer
 - Existing Storm Sewer
 - Streams
 - Project Limits
 - In-Line Detention
 - Parcels
 - Sub-Drainage Area
- Drainage Areas**
- E0036
 - E0039
 - E0040
 - W0530

**Proposed Drainage System Map
Need Area N-2016T-0004**

Storm Water Drainage Pre-Engineering Services
City of Houston (WBS No. N-320100-0010-3)

ATTACHMENT 1

HOUSTORM OUTPUTS

2-YEAR AND 100-YEAR

ATTACHMENT 1

2-YEAR HOUSTORM OUTPUT

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 9/12/2017 3:43:22 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0150-1 2-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004 Updated\SYSTEM_A 2-Y

DESIGN FREQUENCY : 2 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 2 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
A9	0.698	7.33	29.20	29.20	3.14	0.000	16.079
A8	0.62	6.59	28.94	28.94	3.16	0.000	12.891
A7	0.5	12.94	30.70	30.70	3.06	0.000	19.779
A6	0.543	12.14	30.52	30.52	3.07	0.000	20.222
A5	0.514	12.20	30.54	30.54	3.07	0.000	19.226
A4	0.563	7.76	29.34	29.34	3.13	0.000	13.697
A3	0.602	6.44	28.88	28.88	3.16	0.000	12.249
A2	0.572	9.44	29.85	29.85	3.11	0.000	16.771
A1	0.55	4.29	27.92	27.92	3.22	0.000	7.590
A10	0.667	5.83	28.64	28.64	3.18	0.000	12.340
A11	0.601	3.62	27.54	27.54	3.24	0.000	7.047
A12	0.55	3.51	27.48	27.48	3.25	0.000	6.269
A13	0.6	4.69	28.13	28.13	3.21	0.000	9.020
A14	0.7	3.43	27.42	27.42	3.25	0.000	7.796

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
A9	CrcMh	0.698	7.33	29.20	3.14		0.00	16.079
A8	CrcMh	0.661	13.92	30.68	3.06		0.00	28.146
A7	CrcMh	0.583	26.86	31.97	2.99		0.00	46.863
A6	CrcMh	0.571	39.00	33.15	2.93		0.00	65.255
A5	CrcMh	0.557	51.20	34.05	2.89		0.00	82.375
A4	CrcMh	0.558	58.96	34.77	2.85		0.00	93.878
A3	CrcMh	0.562	65.40	35.40	2.83		0.00	103.873
A2	CrcMh	0.563	74.83	36.55	2.77		0.00	116.974
A1	CrcMh	0.563	79.12	37.56	2.73		0.00	121.586
A10	CrcMh	0.570	84.95	38.54	2.69		0.00	130.225
A11	CrcMh	0.571	88.57	39.60	2.65		0.00	133.924
A12	CrcMh	0.570	92.08	40.98	2.59		0.00	136.242
A13	CrcMh	0.572	96.77	42.38	2.54		0.00	140.684
A14	CrcMh	0.576	100.20	44.05	2.48		0.00	143.381
A-OUT	Outlt	0.576	100.20	44.05	2.48		0.00	143.381

Conveyance Configuration Data

Run #	Node US	I.D. DS	FlowLine Elev.		Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	A9	A8	56.10	55.35	Cir 1	0.00	2.50	374.0	0.200	0.013
2	A8	A7	54.85	54.11	Cir 1	0.00	3.00	370.0	0.200	0.013
3	A7	A6	53.61	52.86	Cir 1	0.00	3.50	375.0	0.200	0.013
4	A6	A5	52.86	52.13	Cir 1	0.00	3.50	369.0	0.200	0.013
5	A5	A4	52.13	51.39	Cir 1	0.00	3.50	370.0	0.200	0.013
6	A4	A3	51.39	50.65	Cir 1	0.00	3.50	368.0	0.200	0.013
7	A3	A2	50.65	49.91	Cir 2	0.00	3.50	371.0	0.200	0.013
8	A2	A1	49.91	49.17	Cir 2	0.00	3.50	368.0	0.200	0.013
9	A1	A10	49.17	48.43	Cir 2	0.00	3.50	372.0	0.200	0.013
10	A10	A11	47.93	47.19	Cir 2	0.00	4.00	370.0	0.200	0.013
11	A11	A12	47.19	46.23	Cir 2	0.00	4.00	479.0	0.200	0.013
12	A12	A13	46.23	45.26	Cir 2	0.00	4.00	484.0	0.200	0.013
13	A13	A14	45.26	44.14	Cir 2	0.00	4.00	563.0	0.200	0.013
14	A14	A-OUT	44.14	44.00	Cir 2	0.00	4.00	68.0	0.200	0.013

Conveyance Hydraulic Computations. Tailwater = 48.000 (ft)

Run #	Hyd. US (ft)	Gr.line DS (ft)	Crit.Elev US (ft)	Fr.Slope (%)	Depth (ft)		Velocity (f/s)		Q (cfs)	Cap (cfs)	Junc Loss (ft)
1	64.18	64.00	64.23	0.152	1.82	2.50	4.21	3.28	16.1	18.4	0.000
2	64.00	63.91	64.44	0.177	2.32	3.00	4.80	3.98	28.1	30.0	0.000
3	63.91	63.11	64.26	0.215	3.02	3.50	5.31	4.87	46.9	45.2	0.000
4	63.11	61.57	63.68	0.417	3.50	3.50	6.78	6.78	65.3	45.2	0.000
5	61.57	59.11	63.08	0.665	3.50	3.50	8.56	8.56	82.4	45.2	0.000
6	59.11	55.93	64.07	0.863	3.50	3.50	9.76	9.76	93.9	45.2	0.000
7	55.93	54.95	64.07	0.264	3.50	3.50	5.40	5.40	103.9	90.4	0.000
8	54.95	53.72	63.12	0.335	3.50	3.50	6.08	6.08	117.0	90.4	0.000
9	53.72	52.37	63.12	0.362	3.50	3.50	6.32	6.32	121.6	90.4	0.000
10	52.37	51.62	63.22	0.204	3.33	4.00	5.83	5.18	130.2	129.0	0.000
11	51.62	50.59	60.75	0.215	3.47	4.00	5.78	5.33	133.9	129.0	0.000
12	50.59	49.51	58.01	0.223	3.56	4.00	5.76	5.42	136.2	129.0	0.000
13	49.51	48.17	52.35	0.238	4.00	4.00	5.60	5.60	140.7	129.0	0.000
14	48.17	48.00	50.53	0.247	4.00	4.00	5.70	5.70	143.4	129.0	0.000

SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

NOTE:

The convey length should be from upstream to downstream inside box.
 This length may also be used as Pay Item.
 Using hydraulic length, from node center to node center, may result in profile error,
 and this length should not be used as Pay Item.

LINKS:

Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
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Circular	Concrete	2.5	0.0	1	374.0
Circular	Concrete	3.0	0.0	1	370.0
Circular	Concrete	3.5	0.0	7	3704.0
Circular	Concrete	4.0	0.0	5	3928.0

NODES:

Type of Inlet Structure	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	14
Outlet		0.0	0.0	0.0	0.0	0.0	1

=====
END
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NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 2 Years

Run# 14 Insufficient capacity.
 Run# 13 Insufficient capacity.
 Run# 12 Insufficient capacity.
 Run# 11 Insufficient capacity.
 Run# 10 Insufficient capacity.
 Run# 9 Insufficient capacity.
 Run# 8 Insufficient capacity.
 Run# 7 Insufficient capacity.
 Run# 6 Insufficient capacity.
 Run# 5 Insufficient capacity.
 Run# 4 Insufficient capacity.
 Run# 3 Insufficient capacity.

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/30/2017 2:42:44 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0147-1 2-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\2-YR\SYSTEM_B1 2-YR.

DESIGN FREQUENCY : 2 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 2 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
B18	0.702	5.31	28.42	28.42	3.19	0.000	11.882
B17	0.603	5.57	28.53	28.53	3.18	0.000	10.695
B16	0.661	4.33	27.95	27.95	3.22	0.000	9.209
B15	0.688	2.96	27.11	27.11	3.27	0.000	6.653
B14	0.663	4.89	28.22	28.22	3.20	0.000	10.367
B13	0.713	5.47	28.49	28.49	3.18	0.000	12.413
B12	0.777	5.07	28.31	28.31	3.19	0.000	12.568
B11	0.65	4.37	27.97	27.97	3.22	0.000	9.133

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
B18	CrcMh	0.702	5.31	28.42	3.19		0.00	11.882
B17	CrcMh	0.651	10.88	30.03	3.10		0.00	21.943
B16	CrcMh	0.654	15.21	31.43	3.02		0.00	30.050
B15	CrcMh	0.660	18.17	32.10	2.98		0.00	35.778
B14	CrcMh	0.660	23.06	32.73	2.95		0.00	44.965
B13	CrcMh	0.670	28.53	33.94	2.89		0.00	55.340
B12	CrcMh	0.682	37.97	35.01	2.84		0.00	73.632
B11	CrcMh	0.650	4.37	27.97	3.22		0.00	9.133
B-OUT	Outlt	0.682	37.97	35.01	2.84		0.00	73.632

Conveyance Configuration Data

Run #	Node US	Node DS	FlowLine US (ft)	Elev. DS (ft)	Shape	#	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	B18	B17	59.24	58.59	Cir	1	0.00	2.00	365.0	0.180	0.013
2	B17	B16	57.59	56.92	Cir	1	0.00	3.00	372.0	0.180	0.013
3	B16	B15	56.92	56.59	Cir	1	0.00	3.00	182.0	0.180	0.013
4	B15	B14	56.59	56.25	Cir	1	0.00	3.00	190.0	0.180	0.013

5	B14	B13	55.75	55.09	Cir 1	0.00	3.50	366.0	0.180	0.013
6	B13	B12	55.09	54.42	Cir 1	0.00	3.50	371.0	0.180	0.013
7	B12	B-OUT	54.42	52.53	Cir 1	0.00	4.00	694.0	0.272	0.013
8	B11	B12	57.15	56.42	Cir 1	0.00	2.00	367.0	0.200	0.013

Conveyance Hydraulic Computations. Tailwater = 56.530 (ft)

Run #	Hyd. US (ft)	Gr.line DS (ft)	Crit.Elev US (ft)	Fr.Slope (%)	Depth Unif. (ft)	Actual (ft)	Velocity Unif. (f/s)	Actual (f/s)	Q (cfs)	Cap (cfs)	Junc Loss (ft)
1	61.83	60.83	63.28	0.274	2.00	2.00	3.78	3.78	11.9	9.6	0.000
2	60.83	60.56	62.81	0.107	1.99	3.00	4.42	3.10	21.9	28.4	0.000
3	60.56	60.19	63.53	0.201	2.67	3.00	4.52	4.25	30.1	28.4	0.000
4	60.19	59.65	63.00	0.285	3.00	3.00	5.06	5.06	35.8	28.4	0.000
5	59.65	58.93	62.60	0.198	3.06	3.50	5.04	4.67	45.0	42.9	0.000
6	58.93	57.64	62.38	0.300	3.50	3.50	5.75	5.75	55.3	42.9	0.000
7	57.64	56.53	63.34	0.261	3.22	4.00	6.79	5.86	73.6	75.3	0.000
8	58.64	57.64	63.44	0.162	1.48	1.48	3.65	3.65	9.1	10.2	0.000

SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

NOTE:

The convey length should be from upstream to downstream inside box.
This length may also be used as Pay Item.
Using hydraulic length, from node center to node center, may result in profile error,
and this length should not be used as Pay Item.

LINKS:

Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
Circular	Concrete	2.0	0.0	2	732.0
Circular	Concrete	3.0	0.0	3	744.0
Circular	Concrete	3.5	0.0	2	737.0
Circular	Concrete	4.0	0.0	1	694.0

NODES:

Type of Inlet Structure	Type of Inlet	Grate Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	8
Outlet		0.0	0.0	0.0	0.0	0.0	1

END

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 2 Years
Run# 6 Insufficient capacity.
Run# 5 Insufficient capacity.
Run# 4 Insufficient capacity.

Run# 3 Insufficient capacity.
Run# 1 Insufficient capacity.

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/27/2017 6:14:37 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0147-2 2-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\2-YR\SYSTEM_B2 2-YR.

DESIGN FREQUENCY : 2 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 2 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
B10	0.629	4.43	28.00	28.00	3.21	0.000	8.955
B9	0.662	4.47	28.02	28.02	3.21	0.000	9.503

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
B10	CrcMh	0.629	4.43	28.00	3.21		0.00	8.955
B9	CrcMh	0.646	8.90	29.67	3.12		0.00	17.900
B-OUT	Outlt	0.646	8.90	29.67	3.12		0.00	17.900

Conveyance Configuration Data

Run #	Node US	I.D. DS	FlowLine US Elev. (ft)	Elev. DS (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	B10	B9	57.58	56.85	Cir 1	0.00	2.00	366.0	0.200	0.013
2	B9	B-OUT	56.85	56.79	Cir 1	0.00	2.00	72.0	0.083	0.013

Conveyance Hydraulic Computations. Tailwater = 58.790 (ft)

Run #	Hyd. US (ft)	Gr.line DS (ft)	Crit.Elev US (ft)	Fr.Slope (%)	Depth Unif. (ft)	Actual (ft)	Velocity Unif. (f/s)	Actual (f/s)	Q (cfs)	Cap (cfs)	Junc Loss (ft)
1	59.41	59.24	64.12	0.155	1.46	2.00	3.64	2.85	9.0	10.2	0.000
2	59.24	58.79	63.92	0.621	2.00	2.00	5.70	5.70	17.9	6.6	0.000

SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

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NOTE:

The convey length should be from upstream to downstream inside box.
This length may also be used as Pay Item.
Using hydraulic length, from node center to node center, may result in profile error,
and this length should not be used as Pay Item.

LINKS:

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Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
Circular	Concrete	2.0	0.0	2	438.0

NODES:

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Type of Inlet Structure	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	2
Outlet		0.0	0.0	0.0	0.0	0.0	1

-----END-----

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 2 Years
Run# 2 Insufficient capacity.

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/27/2017 6:48:41 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0147-3 2-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\2-YR\SYSTEM_B3 2-YR.

DESIGN FREQUENCY : 2 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 2 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
B7	0.6	4.67	28.12	28.12	3.21	0.000	8.984
B6	0.652	2.68	26.90	26.90	3.28	0.000	5.742
B5	0.632	1.94	26.24	26.24	3.32	0.000	4.085
B4	0.609	127.41	38.48	38.48	2.69	0.000	208.792
B3	0.619	2.80	26.99	26.99	3.28	0.000	5.673
B2	0.607	4.23	27.89	27.89	3.22	0.000	8.270
B1-1	0.591	4.78	28.17	28.17	3.20	0.000	9.038
B1	0.576	0.84	24.70	24.70	3.43	0.000	1.656
B8	0.79	4.66	28.11	28.11	3.21	0.000	11.805

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
B7	CrcMh	0.695	9.33	29.76	3.11		0.00	20.166
B6	CrcMh	0.685	12.01	30.72	3.06		0.00	25.173
B5	CrcMh	0.678	13.96	31.13	3.04		0.00	28.725
B4	CrcMh	0.616	141.37	38.48	2.69		0.00	234.266
B3	CrcMh	0.616	144.17	39.06	2.67		0.00	236.830
B2	CrcMh	0.615	148.40	39.56	2.65		0.00	241.880
B1-1	CrcMh	0.591	4.78	28.17	3.20		0.00	9.038
B1	CrcMh	0.614	154.01	39.84	2.64		0.00	249.581
B8	CrcMh	0.790	4.66	28.11	3.21		0.00	11.805
B-OUT	Outlt	0.614	154.01	39.84	2.64		0.00	249.581

Conveyance Configuration Data

Run #	Node US	Node DS	FlowLine US (ft)	Elev. DS (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	B8	B7	46.91	46.16	Cir 1	0.00	2.00	373.0	0.200	0.013
2	B7	B6	46.16	45.43	Cir 1	0.00	2.00	369.0	0.200	0.013

3	B6	B5	45.43	45.04	Cir 1	0.00	2.00	195.0	0.200	0.013
4	B5	B4	45.04	44.68	Cir 1	0.00	2.00	177.0	0.200	0.013
5	B4	B3	39.18	38.60	Cir 1	0.00	7.50	293.0	0.200	0.013
6	B3	B2	38.60	38.10	Cir 1	0.00	7.50	249.0	0.200	0.013
7	B2	B1	38.10	37.81	Cir 1	0.00	7.50	143.0	0.200	0.013
8	B1-1	B1	43.98	43.31	Cir 1	0.00	2.00	332.0	0.200	0.013
9	B1	B-OUT	37.81	37.60	Cir 1	0.00	7.50	104.0	0.200	0.013

 Conveyance Hydraulic Computations. Tailwater = 45.100 (ft)
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Run #	Hyd. Gr.line		Crit.Elev		Depth		Velocity		Q (cfs)	Cap (cfs)	Junc Loss (ft)
	US (ft)	DS (ft)	US (ft)	Fr.Slope (%)	Unif. (ft)	Actual (ft)	Unif. (f/s)	Actual (f/s)			
1	55.77	54.76	62.84	0.270	2.00	2.00	3.76	3.76	11.8	10.2	0.000
2	54.76	51.85	62.25	0.788	2.00	2.00	6.42	6.42	20.2	10.2	0.000
3	51.85	49.46	59.45	1.228	2.00	2.00	8.01	8.01	25.2	10.2	0.000
4	49.46	45.96	58.61	1.599	2.00	2.00	9.14	9.14	28.7	10.2	0.000
5	45.96	45.63	60.07	0.092	4.54	7.04	8.37	5.44	234.3	344.9	0.000
6	45.63	45.36	59.53	0.094	4.58	7.26	8.37	5.41	236.8	344.9	0.000
7	45.36	45.20	57.11	0.098	4.64	7.39	8.42	5.49	241.9	344.9	0.000
8	45.45	45.20	57.18	0.158	1.48	1.89	3.63	2.94	9.0	10.2	0.000
9	45.20	45.10	56.53	0.105	4.75	7.50	8.47	5.65	249.6	344.9	0.000

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SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

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NOTE:

The convey length should be from upstream to downstream inside box.
 This length may also be used as Pay Item.
 Using hydraulic length, from node center to node center, may result in profile error,
 and this length should not be used as Pay Item.

LINKS:

Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
Circular	Concrete	2.0	0.0	5	1446.0
Circular	Concrete	7.5	0.0	4	789.0

NODES:

Type of Inlet Structure	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	9
Outlet		0.0	0.0	0.0	0.0	0.0	1

-----END-----

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 2 Years
 Run# 4 Insufficient capacity.

Run# 3 Insufficient capacity.
Run# 2 Insufficient capacity.
Run# 1 Insufficient capacity.

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/27/2017 6:16:06 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0146-1 2-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\2-YR\SYSTEM_C 2-YR.s

DESIGN FREQUENCY : 2 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 2 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
C3	0.591	221.73	40.89	40.89	2.60	0.000	340.195
C2	0.607	3.37	27.38	27.38	3.25	0.000	6.644
C1	0.547	3.36	27.38	27.38	3.25	0.000	5.982

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
C3	CrcMh	0.591	221.73	40.89	2.60		0.00	340.195
C2	CrcMh	0.591	225.09	41.66	2.57		0.00	341.651
C1	CrcMh	0.590	228.45	42.33	2.54		0.00	343.114
C-OUT	Outlt	0.590	228.45	42.33	2.54		0.00	343.114

Conveyance Configuration Data

Run #	Node US	I.D. DS	FlowLine US (ft)	Elev. DS (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	C3	C2	39.83	39.48	Box 1	10.0	6.00	296.0	0.116	0.015
2	C2	C1	39.48	39.19	Box 1	10.0	6.00	253.0	0.116	0.015
3	C1	C-OUT	39.19	38.90	Box 1	10.0	6.00	251.0	0.116	0.015

Conveyance Hydraulic Computations. Tailwater = 61.390 (ft)

Run #	Hyd. US (ft)	Gr.line DS (ft)	Crit.Elev US (ft)	Fr.Slope (%)	Depth Unif. (ft)	Actual (ft)	Velocity Unif. (f/s)	Actual (f/s)	Q (cfs)	Cap (cfs)	Junc Loss (ft)
1	62.53	62.11	63.05	0.142	5.34	6.00	6.37	5.67	340.2	308.2	0.000
2	62.11	61.75	63.95	0.143	5.37	6.00	6.37	5.69	341.7	308.2	0.000

3 61.75 61.39 63.47 0.144 5.39 6.00 6.37 5.72 343.1 308.2 0.000

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SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

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NOTE:

The convey length should be from upstream to downstream inside box.
 This length may also be used as Pay Item.
 Using hydraulic length, from node center to node center, may result in profile error,
 and this length should not be used as Pay Item.

LINKS:

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Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
Box	Concrete	6.0	10.0	3	800.0

NODES:

=====

Type of Inlet Structure	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	3
Outlet		0.0	0.0	0.0	0.0	0.0	1

=====END=====

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 2 Years

Run# 3 Insufficient capacity.

Run# 2 Insufficient capacity.

Run# 1 Insufficient capacity.

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/30/2017 2:42:05 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0145-1 2-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\2-YR\SYSTEM_DA 2-YR.

DESIGN FREQUENCY : 2 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 2 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
DA-3	0.562	36.65	33.86	33.86	2.90	0.000	59.676
DA-2	0.624	2.70	26.91	26.91	3.28	0.000	5.527
DA-1	0.589	2.72	26.93	26.93	3.28	0.000	5.257

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
DA-3	CrcMh	0.562	36.65	33.86	2.90		0.00	59.676
DA-2	CrcMh	0.566	39.35	34.51	2.87		0.00	63.861
DA-1	CrcMh	0.568	42.07	35.15	2.84		0.00	67.745
DA-OUT	Outlt	0.568	42.07	35.15	2.84		0.00	67.745

Conveyance Configuration Data

Run #	Node US	I.D. DS	FlowLine US (ft)	Elev. DS (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	DA-3	DA-2	52.42	51.45	Cir 1	0.00	3.00	333.0	0.291	0.013
2	DA-2	DA-1	51.45	50.71	Cir 1	0.00	3.50	255.0	0.291	0.013
3	DA-1	DA-OUT	50.71	49.99	Cir 1	0.00	3.50	247.0	0.291	0.013

Conveyance Hydraulic Computations. Tailwater = 53.493 (ft)

Run #	Hyd. US (ft)	Gr.line DS (ft)	Crit.Elev US (ft)	Fr.Slope (%)	Depth Unif. (ft)	Actual (ft)	Velocity Unif. (f/s)	Actual (f/s)	Q (cfs)	Cap (cfs)	Junc Loss (ft)
1	58.26	55.62	61.70	0.794	3.00	3.00	8.44	8.44	59.7	36.1	0.000
2	55.62	54.60	62.52	0.399	3.50	3.50	6.64	6.64	63.9	54.5	0.000

3 54.60 53.49 62.03 0.450 3.50 3.50 7.04 7.04 67.7 54.5 0.000

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SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

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NOTE:

The convey length should be from upstream to downstream inside box.
 This length may also be used as Pay Item.
 Using hydraulic length, from node center to node center, may result in profile error,
 and this length should not be used as Pay Item.

LINKS:

=====

Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
Circular	Concrete	3.0	0.0	1	333.0
Circular	Concrete	3.5	0.0	2	502.0

NODES:

=====

Type of Inlet Structure	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	3
Outlet		0.0	0.0	0.0	0.0	0.0	1

-----END-----

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 2 Years

Run# 3 Insufficient capacity.
 Run# 2 Insufficient capacity.
 Run# 1 Insufficient capacity.

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0145-2-1 2-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\2-YR\SYSTEM_DB 2-YR.

DESIGN FREQUENCY : 2 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 2 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
DB-3	0.51	25.84	32.73	32.73	2.95	0.000	38.930
DB-2	0.67	6.39	28.86	28.86	3.16	0.000	13.535
DB-1-2A	0.5	26.08	32.76	32.76	2.95	0.000	38.485
DB-1-2	0.576	9.22	29.79	29.79	3.11	0.000	16.520
DB-1-1	0.553	2.39	26.66	26.66	3.30	0.000	4.353
DB-1	0.597	3.93	27.73	27.73	3.23	0.000	7.581

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q cfs	Additional Q in Node (cfs)	Total Disch. (cfs)
DB-3	CrcMh	0.510	25.84	32.73	2.95		0.00	38.930
DB-2	CrcMh	0.542	32.23	33.08	2.94		0.00	51.261
DB-1-2A	CrcMh	0.500	26.08	32.76	2.95		0.00	38.485
DB-1-2	CrcMh	0.520	35.30	34.34	2.87		0.00	52.758
DB-1-1	CrcMh	0.553	2.39	26.66	3.30		0.00	4.353
DB-1	CrcMh	0.535	73.86	35.82	2.81		0.00	110.803
DB-OUT	Outlt	0.535	73.86	35.82	2.81		0.00	110.803

Conveyance Configuration Data

Run #	Node US	I.D. DS	FlowLine US (ft)	Elev. DS (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	DB-3	DB-2	48.41	47.89	Cir 1	0.00	2.00	263.0	0.200	0.013
2	DB-2	DB-1	47.39	46.89	Cir 1	0.00	2.50	250.0	0.200	0.013
3	DB-1-2	DB-1-2	48.75	47.72	Cir 1	0.00	3.00	515.0	0.200	0.013
4	DB-1-2	DB-1	47.72	46.39	Cir 1	0.00	3.00	665.0	0.200	0.013
5	DB-1-1	DB-1	47.84	47.39	Cir 1	0.00	2.00	225.0	0.200	0.013
6	DB-1	DB-OUT	45.39	44.85	Cir 1	0.00	4.00	269.0	0.200	0.013

Conveyance Hydraulic Computations. Tailwater = 48.847 (ft)

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=====
Run  Hyd. Gr.line  Crit.Elev          Depth          Velocity          Junc
#    US    DS    US    Fr.Slope  Unif. Actual  Unif. Actual    Q          Cap  Loss
   (ft) (ft) (ft)   (%)   (ft)  (ft)   (f/s) (f/s)  (cfs)  (cfs) (ft)
-----
1     62.03  54.31  62.97   2.936   2.00   2.00  12.39  12.39   38.9   10.2  0.000
2     54.31  50.43  60.82   1.549   2.50   2.50  10.44  10.44   51.3   18.4  0.000
3     56.26  54.56  61.72   0.330   3.00   3.00   5.44   5.44   38.5   30.0  0.000
4     54.56  50.43  61.63   0.620   3.00   3.00   7.46   7.46   52.8   30.0  0.000
5     50.80  50.43  58.54   0.037   0.92   2.00   3.09   1.39    4.4   10.2  0.000
6     50.43  48.85  59.31   0.590   4.00   4.00   8.82   8.82  110.8   64.5  0.000
=====

```

SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

NOTE:

The convey length should be from upstream to downstream inside box.
This length may also be used as Pay Item.
Using hydraulic length, from node center to node center, may result in profile error,
and this length should not be used as Pay Item.

LINKS:

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=====
Type of Convey  Material  Rise  Span  Number of Links  Quantity
Structure      (ft)     (ft)  of this type    (ft)
-----
Circular      Concrete  2.0   0.0     2                488.0
Circular      Concrete  2.5   0.0     1                250.0
Circular      Concrete  3.0   0.0     2               1180.0
Circular      Concrete  4.0   0.0     1                269.0
=====

```

NODES:

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=====
Type of Inlet  Type of Grate  Inlet  Grate  Grate  Grate  Grate  Quantity
Structure      Length Width Length Area  Perimeter  (each)
              (ft)  (ft)  (ft)  (ft)  (ft)
-----
Circular Manhole  0.0   0.0   0.0   0.0   0.0        6
Outlet           0.0   0.0   0.0   0.0   0.0        1
=====

```

END

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 2 Years
Run# 6 Insufficient capacity.
Run# 2 Insufficient capacity.
Run# 4 Insufficient capacity.
Run# 1 Insufficient capacity.
Run# 3 Insufficient capacity.

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/30/2017 3:40:49 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0051-1 2-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\2-YR\SYSTEM_E 2-YR.s
 DESIGN FREQUENCY : 2 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 2 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
E1	0.76	2.40	26.66	26.66	3.30	0.000	6.003

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
E1	CrcMh	0.760	2.40	26.66	3.30		0.00	6.003
E-OUT	Outlt	0.760	2.40	26.66	3.30		0.00	6.003

Conveyance Configuration Data

Run #	Node US	I.D. DS	FlowLine US (ft)	Elev. DS (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	E1	E-OUT	49.37	48.96	Cir 1	0.00	2.00	206.0	0.200	0.013

Conveyance Hydraulic Computations. Tailwater = 50.960 (ft)

Run #	Hyd. US (ft)	Gr.line DS (ft)	Crit.Elev US (ft)	Fr.Slope (%)	Depth Unif. (ft)	Actual (ft)	Velocity Unif. (f/s)	Actual (f/s)	Q (cfs)	Cap (cfs)	Junc Loss (ft)
1	51.24	50.96	58.86	0.070	1.11	2.00	3.36	1.91	6.0	10.2	0.000

SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

NOTE:

The convey length should be from upstream to downstream inside box.
 This length may also be used as Pay Item.

Using hydraulic length, from node center to node center, may result in profile error,
 and this length should not be used as Pay Item.

LINKS:

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=====
Type of Convey  Material  Rise  Span  Number of Links  Quantity
Structure      (ft)    (ft)  of this type    (ft)
-----
Circular       Concrete  2.0   0.0    1                206.0
  
```

NODES:

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=====
Type of Inlet  Type of Grate Inlet  Grate  Grate  Grate  Grate  Quantity
Structure      Length Width Length Area  Perimeter  (each)
              (ft)   (ft)  (ft)  (ft)  (ft)
-----
Circular Manhole  0.0   0.0   0.0   0.0   0.0        1
Outlet           0.0   0.0   0.0   0.0   0.0        1
=====END=====
  
```

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 2 Years

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/27/2017 6:29:09 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0042-1 2-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\2-YR\SYSTEM_F 2-YR.s

DESIGN FREQUENCY : 2 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 2 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
F7	0.8	1.61	25.87	25.87	3.35	0.000	4.312
F6	0.8	2.56	26.80	26.80	3.29	0.000	6.738
F5	0.8	3.00	27.14	27.14	3.27	0.000	7.844
F4	0.662	3.89	27.70	27.70	3.23	0.000	8.311
F3	0.395	2.85	27.02	27.02	3.27	0.000	3.679
F2	0.351	1.79	26.08	26.08	3.33	0.000	2.096
F1	0.649	0.79	24.59	24.59	3.44	0.000	1.754
F-A	0.65	0.00	15.00	0.00	0.00	0.000	0.000
F-B	0.65	0.00	15.00	0.00	0.00	0.000	0.000

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
F7	CrcMh	0.800	1.61	25.87	3.35		0.00	4.312
F6	CrcMh	0.800	4.17	27.35	3.25		0.00	10.858
F5	CrcMh	0.800	7.17	28.65	3.17		0.00	18.219
F4	CrcMh	0.751	11.06	29.99	3.10		0.00	25.746
F3	CrcMh	0.678	13.91	31.57	3.01		0.00	28.419
F2	CrcMh	0.641	15.70	32.42	2.97		0.00	29.873
F1	CrcMh	0.641	16.48	32.91	2.94		0.00	31.127
F-A	CrcMh	0.641	16.48	32.91	2.94		0.00	31.127
F-B	CrcMh	0.641	16.48	32.91	2.94		0.00	31.127
F-OUT	Outlt	0.641	16.48	32.91	2.94		0.00	31.127

Conveyance Configuration Data

Run #	Node US	Node DS	FlowLine US (ft)	Elev. DS (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	F7	F6	44.94	44.39	Cir 1	0.00	2.00	273.0	0.200	0.013
2	F6	F5	44.39	43.84	Cir 1	0.00	2.00	277.0	0.200	0.013

3	F5	F4	43.84	42.90	Cir 1	0.00	2.00	466.0	0.200	0.013
4	F4	F3	42.40	41.41	Cir 1	0.00	2.50	499.0	0.200	0.013
5	F3	F2	41.41	40.82	Cir 1	0.00	2.50	294.0	0.200	0.013
6	F2	F1	40.32	40.03	Cir 1	0.00	3.00	142.0	0.200	0.013
7	F1	F-A	40.03	39.01	Cir 1	0.00	3.00	513.0	0.200	0.013
8	F-A	F-B	39.01	38.11	Cir 1	0.00	3.00	448.0	0.200	0.013
9	F-B	F-OUT	38.11	38.00	Cir 1	0.00	3.00	56.0	0.200	0.024

 Conveyance Hydraulic Computations. Tailwater = 41.000 (ft)
 =====

Run #	Hyd. Gr.line		Crit.Elev US (ft)	Fr.Slope (%)	Depth		Velocity		Q (cfs)	Cap (cfs)	Junc Loss (ft)
	US (ft)	DS (ft)			Unif. (ft)	Actual (ft)	Unif. (f/s)	Actual (f/s)			
1	50.92	50.47	59.38	0.036	0.91	2.00	3.09	1.37	4.3	10.2	0.000
2	50.47	49.84	59.25	0.228	1.88	2.00	3.55	3.46	10.9	10.2	0.000
3	49.84	46.84	59.06	0.643	2.00	2.00	5.80	5.80	18.2	10.2	0.000
4	46.84	44.89	58.69	0.391	2.50	2.50	5.24	5.24	25.7	18.4	0.000
5	44.89	43.49	57.40	0.476	2.50	2.50	5.79	5.79	28.4	18.4	0.000
6	43.49	43.49	54.85	0.199	2.46	3.00	4.81	4.23	29.9	30.0	0.000
7	43.49	42.38	60.88	0.216	2.60	3.00	4.78	4.40	31.1	30.0	0.000
8	42.38	41.41	52.73	0.216	2.60	3.00	4.78	4.40	31.1	30.0	0.000
9	41.41	41.00	51.50	0.736	3.00	3.00	4.40	4.40	31.1	16.2	0.000

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SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

=====

NOTE:

The convey length should be from upstream to downstream inside box.
 This length may also be used as Pay Item.
 Using hydraulic length, from node center to node center, may result in profile error,
 and this length should not be used as Pay Item.

LINKS:

Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
Circular	Concrete	2.0	0.0	3	1016.0
Circular	Concrete	2.5	0.0	2	793.0
Circular	Concrete	3.0	0.0	3	1103.0
Circular		3.0	0.0	1	56.0

NODES:

Type of Inlet Structure	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	9
Outlet		0.0	0.0	0.0	0.0	0.0	1

 END
 =====

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 2 Years

Discharge decreased downstream node Id= F-A Previous intensity used.

Discharge decreased downstream node Id= F-B Previous intensity used.

Run# 9 Insufficient capacity.

Run# 8 Insufficient capacity.

Run# 7 Insufficient capacity.

Run# 5 Insufficient capacity.

Run# 4 Insufficient capacity.

Run# 3 Insufficient capacity.

Run# 2 Insufficient capacity.

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/27/2017 6:55:27 PM

PROJECT NAME : N-2016T-0008
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0041-1 2-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\2-YR\SYSTEM_G 2-YR.s
 DESIGN FREQUENCY : 2 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 2 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
G9	0.787	8.84	29.68	29.68	3.12	0.000	21.664
G8	0.688	13.22	30.76	30.76	3.06	0.000	27.791
G7	0.731	6.60	28.94	28.94	3.16	0.000	15.227
G6	0.523	3.84	27.68	27.68	3.23	0.000	6.496
G5	0.55	1.58	25.84	25.84	3.35	0.000	2.907
G4	0.556	1.89	26.19	26.19	3.33	0.000	3.499
G3	0.65	9.96	29.99	29.99	3.10	0.000	20.056
G2	0.65	8.54	29.59	29.59	3.12	0.000	17.320

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
G9	CrcMh	0.787	8.84	29.68	3.12		0.00	21.664
G8	CrcMh	0.728	22.06	32.20	2.98		0.00	47.824
G7	CrcMh	0.728	28.66	33.92	2.89		0.00	60.412
G6	CrcMh	0.704	32.50	35.10	2.84		0.00	64.955
G5	CrcMh	0.697	34.08	36.34	2.78		0.00	66.093
G4	CrcMh	0.689	35.97	36.60	2.77		0.00	68.741
G3	CrcMh	0.681	45.93	37.82	2.72		0.00	85.059
G2	CrcMh	0.676	54.47	38.54	2.69		0.00	99.046
G1	CrcMh	0.676	54.47	38.54	2.69		0.00	99.046
G-OUT	Outlt	0.676	54.47	38.54	2.69		0.00	99.046

Conveyance Configuration Data

Run #	Node US	Node DS	FlowLine Elev. US (ft)	FlowLine Elev. DS (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	G9	G8	43.80	42.41	Cir 1	0.00	3.00	694.0	0.200	0.013
2	G8	G7	42.41	41.01	Cir 1	0.00	3.00	699.0	0.200	0.013
3	G7	G6	41.01	39.80	Cir 1	0.00	3.00	607.0	0.200	0.013

4	G6	G5	39.30	38.30	Cir 1	0.00	3.50	502.0	0.200	0.013
5	G5	G4	38.30	38.08	Cir 1	0.00	3.50	106.0	0.200	0.013
6	G4	G3	38.08	37.04	Cir 1	0.00	3.50	522.0	0.200	0.013
7	G3	G2	36.54	35.95	Cir 1	0.00	4.00	296.0	0.200	0.013
8	G2	G1	35.95	35.27	Cir 1	0.00	4.00	341.0	0.200	0.013
9	G1	G-OUT	35.27	35.00	Cir 1	0.00	4.00	133.0	0.200	0.013

Conveyance Hydraulic Computations. Tailwater = 39.000 (ft)

Run #	Hyd. Gr.line		Crit.Elev		Depth		Velocity		Q (cfs)	Cap (cfs)	Junc Loss (ft)
	US (ft)	DS (ft)	US (ft)	Fr.Slope (%)	Unif. (ft)	Actual (ft)	Unif. (f/s)	Actual (f/s)			
1	56.37	55.71	59.86	0.105	1.90	3.00	4.59	3.06	21.7	30.0	0.000
2	55.71	52.15	57.94	0.510	3.00	3.00	6.77	6.77	47.8	30.0	0.000
3	52.15	47.21	57.63	0.813	3.00	3.00	8.55	8.55	60.4	30.0	0.000
4	47.21	45.13	55.66	0.413	3.50	3.50	6.75	6.75	65.0	45.2	0.000
5	45.13	44.68	54.44	0.428	3.50	3.50	6.87	6.87	66.1	45.2	0.000
6	44.68	42.26	54.99	0.463	3.50	3.50	7.14	7.14	68.7	45.2	0.000
7	42.26	41.23	48.97	0.348	4.00	4.00	6.77	6.77	85.1	64.5	0.000
8	41.23	39.63	45.66	0.471	4.00	4.00	7.88	7.88	99.0	64.5	0.000
9	39.63	39.00	42.13	0.471	4.00	4.00	7.88	7.88	99.0	64.5	0.000

SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

NOTE:

The convey length should be from upstream to downstream inside box.
This length may also be used as Pay Item.
Using hydraulic length, from node center to node center, may result in profile error,
and this length should not be used as Pay Item.

LINKS:

Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
Circular	Concrete	3.0	0.0	3	2000.0
Circular	Concrete	3.5	0.0	3	1130.0
Circular	Concrete	4.0	0.0	2	637.0
Circular	Concrete	4.0	0.0	1	133.0

NODES:

Type of Inlet Structure	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	9
Outlet		0.0	0.0	0.0	0.0	0.0	1

END

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 2 Years

Discharge decreased downstream node Id= G1 Previous intensity used.

Run# 9 Insufficient capacity.

Run# 8 Insufficient capacity.

Run# 7 Insufficient capacity.

Run# 6 Insufficient capacity.

Run# 5 Insufficient capacity.

Run# 4 Insufficient capacity.

Run# 3 Insufficient capacity.

Run# 2 Insufficient capacity.

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/30/2017 3:38:11 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0040-1 2-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\2-YR\SYSTEM_H 2-YR.s
 DESIGN FREQUENCY : 2 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 2 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
H3	0.769	2.24	26.53	26.53	3.31	0.000	5.697
H2	0.619	2.30	26.58	26.58	3.30	0.000	4.701
H1	0.625	3.07	27.18	27.18	3.26	0.000	6.266

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
H3	CrcMh	0.769	2.24	26.53	3.31		0.00	5.697
H2	CrcMh	0.693	4.54	27.57	3.24		0.00	10.196
H1	CrcMh	0.666	7.61	28.44	3.19		0.00	16.149
H-OUT	Outlt	0.666	7.61	28.44	3.19		0.00	16.149

Conveyance Configuration Data

Run #	Node US	I.D. DS	FlowLine US (ft)	Elev. DS (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	H3	H2	41.02	39.98	Cir 1	0.00	2.00	267.0	0.390	0.013
2	H2	H1	39.98	38.90	Cir 1	0.00	2.00	261.0	0.414	0.013
3	H1	H-OUT	38.10	37.10	Cir 1	0.00	2.50	157.0	0.637	0.013

Conveyance Hydraulic Computations. Tailwater = 39.598 (ft)

Run #	Hyd. US (ft)	Gr.line DS (ft)	Crit.Elev US (ft)	Fr.Slope (%)	Depth Unif. (ft)	Actual (ft)	Velocity Unif. (f/s)	Actual (f/s)	Q (cfs)	Cap (cfs)	Junc Loss (ft)
1	41.90	41.21	50.00	0.063	0.88	1.23	4.25	2.80	5.7	14.2	0.000
2	41.21	39.84	47.59	0.201	1.23	1.23	5.01	5.01	10.2	14.6	0.000

3* 39.84 39.60 46.29 0.154 1.24 2.50 6.65 5.93 16.1 32.9 0.000
 =====
 * Supercritical flow.

SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

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NOTE:

The convey length should be from upstream to downstream inside box.
 This length may also be used as Pay Item.
 Using hydraulic length, from node center to node center, may result in profile error,
 and this length should not be used as Pay Item.

LINKS:

=====

Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
Circular	Concrete	2.0	0.0	2	528.0
Circular	Concrete	2.5	0.0	1	157.0

NODES:

=====

Type of Inlet Structure	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	3
Outlet		0.0	0.0	0.0	0.0	0.0	1

=====END=====

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 2 Years

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/27/2017 7:19:37 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0039-1 2-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\2-YR\SYSTEM_I 2-YR.s

DESIGN FREQUENCY : 2 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 2 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
I2	0.709	5.11	28.33	28.33	3.19	0.000	11.581
I1	0.672	3.46	27.44	27.44	3.25	0.000	7.544

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
I2	CrcMh	0.709	5.11	28.33	3.19		0.00	11.581
I1	CrcMh	0.694	8.57	29.44	3.13		0.00	18.615
I-OUT	Outlt	0.694	8.57	29.44	3.13		0.00	18.615

Conveyance Configuration Data

Run #	Node US	I.D. DS	FlowLine US Elev. (ft)	FlowLine DS Elev. (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	I2	I1	36.62	36.09	Cir 1	0.00	3.00	264.0	0.200	0.013
2	I1	I-OUT	36.09	35.77	Cir 1	0.00	3.00	157.0	0.200	0.013

Conveyance Hydraulic Computations. Tailwater = 38.774 (ft)

Run #	Hyd. US (ft)	Gr.line DS (ft)	Crit.Elev US (ft)	Fr.Slope (%)	Depth Unif. (ft)	Depth Actual (ft)	Velocity Unif. (f/s)	Velocity Actual (f/s)	Q (cfs)	Cap (cfs)	Junc Loss (ft)
1	39.43	38.97	47.33	0.030	1.30	2.89	3.95	1.66	11.6	30.0	0.000
2	38.97	38.77	46.38	0.077	1.72	3.00	4.45	2.63	18.6	30.0	0.000

SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

=====

NOTE:

The convey length should be from upstream to downstream inside box.
This length may also be used as Pay Item.
Using hydraulic length, from node center to node center, may result in profile error,
and this length should not be used as Pay Item.

LINKS:

=====

Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
Circular	Concrete	3.0	0.0	2	421.0

NODES:

=====

Type of Inlet Structure	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	2
Outlet		0.0	0.0	0.0	0.0	0.0	1

-----END-----

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 2 Years

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/27/2017 7:20:18 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0036-1 2-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\2-YR\SYSTEM_J 2-YR.s

DESIGN FREQUENCY : 2 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 2 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
JA-6	0.553	7.68	29.32	29.32	3.14	0.000	13.317
JA-5	0.64	1.93	26.22	26.22	3.32	0.000	4.103
JA-4	0.688	2.87	27.04	27.04	3.27	0.000	6.466
JA-3	0.639	3.83	27.67	27.67	3.23	0.000	7.920
JA-2	0.701	4.05	27.79	27.79	3.23	0.000	9.162
JA-1	0.85	2.04	26.33	26.33	3.32	0.000	5.742
JB-7	0.46	1.34	25.53	25.53	3.37	0.000	2.083
JB-6	0.718	1.56	25.82	25.82	3.35	0.000	3.760
JB-5	0.701	2.16	26.46	26.46	3.31	0.000	5.021
JB-4	0.73	2.38	26.65	26.65	3.30	0.000	5.740
JB-3	0.671	2.48	26.73	26.73	3.29	0.000	5.475
JB-2	0.707	2.40	26.67	26.67	3.30	0.000	5.597
JB-1	0.843	1.97	26.26	26.26	3.32	0.000	5.510
J1	0.85	0.00	15.00	27.79	0.00	0.000	0.000

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr. Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
JB-3	CrcMh	0.671	9.93	29.81	3.11		0.00	20.701
JB-2	CrcMh	0.678	12.33	30.80	3.05		0.00	25.521
JB-1	CrcMh	0.701	14.30	31.69	3.01		0.00	30.113
J1	CrcMh	0.667	36.70	33.94	2.89		0.00	70.870
JA-6	CrcMh	0.553	7.68	29.32	3.14		0.00	13.317
JA-5	CrcMh	0.571	9.61	30.51	3.07		0.00	16.822
JA-4	CrcMh	0.598	12.48	31.33	3.02		0.00	22.556
JA-3	CrcMh	0.607	16.31	32.30	2.97		0.00	29.469
JA-2	CrcMh	0.626	20.36	33.04	2.94		0.00	37.443
JA-1	CrcMh	0.646	22.40	33.59	2.91		0.00	42.130
JB-7	CrcMh	0.460	1.34	25.53	3.37		0.00	2.083
JB-6	CrcMh	0.599	2.90	26.35	3.32		0.00	5.770
JB-5	CrcMh	0.642	5.07	27.65	3.23		0.00	10.533
JB-4	CrcMh	0.671	7.45	28.80	3.17		0.00	15.822
J-OUT	Outlt	0.667	36.70	33.94	2.89		0.00	70.870

Conveyance Configuration Data

Run #	Node US	I.D. DS	FlowLine US (ft)	Elev. DS (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	JA-6	JA-5	46.46	45.86	Cir 1	0.00	2.00	302.0	0.200	0.013
2	JA-5	JA-4	45.86	45.33	Cir 1	0.00	2.00	265.0	0.200	0.013
3	JA-4	JA-3	44.83	44.29	Cir 1	0.00	2.50	266.0	0.200	0.013
4	JA-3	JA-2	44.29	43.76	Cir 1	0.00	2.50	267.0	0.200	0.013
5	JA-2	JA-1	43.76	43.25	Cir 1	0.00	2.50	255.0	0.200	0.013
6	JA-1	J1	42.75	42.50	Cir 1	0.00	3.00	125.0	0.200	0.013
7	JB-7	JB-6	46.82	46.58	Cir 1	0.00	2.00	124.0	0.200	0.013
8	JB-6	JB-5	46.58	46.05	Cir 1	0.00	2.00	261.0	0.200	0.013
9	JB-5	JB-4	45.05	44.52	Cir 1	0.00	3.00	265.0	0.200	0.013
10	JB-4	JB-3	44.52	44.00	Cir 1	0.00	3.00	260.0	0.200	0.013
11	JB-3	JB-2	44.00	43.46	Cir 1	0.00	3.00	271.0	0.200	0.013
12	JB-2	JB-1	43.46	42.96	Cir 1	0.00	3.00	253.0	0.200	0.013
13	JB-1	J1	42.96	42.50	Cir 1	0.00	3.00	228.0	0.200	0.013
14	J1	J-OUT	31.07	30.65	Cir 1	0.00	3.00	211.0	0.200	0.013

Conveyance Hydraulic Computations. Tailwater = 33.647 (ft)

Run #	Hyd. US (ft)	Gr.line DS (ft)	Crit.Elev US (ft)	Fr.Slope (%)	Depth Unif. (ft)	Actual (ft)	Velocity Unif. (f/s)	Actual (f/s)	Q (cfs)	Cap (cfs)	Junc Loss (ft)
1	52.76	51.72	54.42	0.344	2.00	2.00	4.24	4.24	13.3	10.2	0.000
2	51.72	50.27	52.62	0.548	2.00	2.00	5.35	5.35	16.8	10.2	0.000
3	50.27	49.47	52.66	0.300	2.50	2.50	4.60	4.60	22.6	18.4	0.000
4	49.47	48.10	52.66	0.512	2.50	2.50	6.00	6.00	29.5	18.4	0.000
5	48.10	45.99	52.60	0.826	2.50	2.50	7.63	7.63	37.4	18.4	0.000
6	45.99	45.50	53.33	0.396	3.00	3.00	5.96	5.96	42.1	30.0	0.000
7	47.87	47.66	53.67	0.008	0.62	1.08	2.54	1.20	2.1	10.2	0.000
8	47.66	47.12	51.80	0.065	1.08	1.08	3.33	3.33	5.8	10.2	0.000
9	47.12	46.69	52.36	0.025	1.23	2.17	3.86	1.93	10.5	30.0	0.000
10	46.69	46.36	51.96	0.056	1.55	2.36	4.28	2.65	15.8	30.0	0.000
11	46.36	46.11	52.16	0.096	1.84	2.65	4.55	3.13	20.7	30.0	0.000
12	46.11	45.96	52.10	0.145	2.13	3.00	4.75	3.61	25.5	30.0	0.000
13	45.96	45.50	52.26	0.202	2.48	3.00	4.81	4.26	30.1	30.0	0.000
14	36.01	33.65	51.99	1.119	3.00	3.00	10.03	10.03	70.9	30.0	0.000

SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

NOTE:

The convey length should be from upstream to downstream inside box.
 This length may also be used as Pay Item.
 Using hydraulic length, from node center to node center, may result in profile error,
 and this length should not be used as Pay Item.

LINKS:

Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)

Circular	Concrete	2.0	0.0	4	952.0
Circular	Concrete	2.5	0.0	3	788.0
Circular	Concrete	3.0	0.0	7	1613.0

NODES:

Type of Inlet Structure	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	14
Outlet		0.0	0.0	0.0	0.0	0.0	1

END

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 2 Years

- Run# 14 Insufficient capacity.
- HGL elevation below invert. Downstream HGL set to soffit elevation at Run# 6
- HGL elevation below invert. Downstream HGL set to soffit elevation at Run# 13
- Run# 6 Insufficient capacity.
- Run# 13 Insufficient capacity.
- Run# 5 Insufficient capacity.
- Run# 4 Insufficient capacity.
- Run# 3 Insufficient capacity.
- Run# 2 Insufficient capacity.
- Run# 1 Insufficient capacity.

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/30/2017 3:37:46 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System W0530-1 2-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\2-YR\SYSTEM_K 2-YR.s
 DESIGN FREQUENCY : 2 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 2 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
KB-4	0.3	0.49	23.83	23.83	3.49	0.000	0.518
KB-3	0.65	1.35	25.54	25.54	3.37	0.000	2.949
KB-2	0.599	2.16	26.45	26.45	3.31	0.000	4.279
KB-1	0.748	2.00	26.30	26.30	3.32	0.000	4.975
KA-4	0.546	2.44	26.70	26.70	3.29	0.000	4.392
KA-3	0.688	2.07	26.36	26.36	3.32	0.000	4.717
KA-2	0.755	2.21	26.50	26.50	3.31	0.000	5.519
KA-1	0.756	2.47	26.72	26.72	3.29	0.000	6.139

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
KB-4	CrcMh	0.300	0.49	23.83	3.49		0.00	0.518
KB-3	CrcMh	0.556	1.84	25.54	3.37		0.00	3.449
KB-2	CrcMh	0.579	4.00	27.01	3.27		0.00	7.584
KB-1	CrcMh	0.636	6.00	28.29	3.20		0.00	12.191
KA-4	CrcMh	0.546	2.44	26.70	3.29		0.00	4.392
KA-3	CrcMh	0.611	4.51	28.17	3.20		0.00	8.828
KA-2	CrcMh	0.648	12.72	29.79	3.11		0.00	25.616
KA-1	CrcMh	0.665	15.19	30.72	3.06		0.00	30.895
KA-OUT	Outlt	0.665	15.19	30.72	3.06		0.00	30.895

Conveyance Configuration Data

Run #	Node US	Node DS	FlowLine US (ft)	Elev. DS (ft)	Shape	#	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	KB-4	KB-3	48.83	48.64	Cir	1	0.00	2.00	94.0	0.200	0.013
2	KB-3	KB-2	48.64	48.12	Cir	1	0.00	2.00	258.0	0.200	0.013
3	KB-2	KB-1	48.12	47.58	Cir	1	0.00	2.00	271.0	0.200	0.013
4	KB-1	KA-2	47.58	46.88	Cir	1	0.00	2.00	349.0	0.200	0.013

5	KA-4	KA-3	47.97	47.42	Cir 1	0.00	2.00	273.0	0.200	0.013
6	KA-3	KA-2	47.42	46.88	Cir 1	0.00	2.00	270.0	0.200	0.013
7	KA-2	KA-1	45.88	45.35	Cir 1	0.00	3.00	264.0	0.200	0.013
8	KA-1	KA-OUT	45.35	44.80	Cir 1	0.00	3.00	279.0	0.200	0.013

Conveyance Hydraulic Computations. Tailwater = 47.797 (ft)

Run #	Hyd. Gr.line		Crit.Elev		Depth		Velocity		Q (cfs)	Cap (cfs)	Junc Loss (ft)
	US (ft)	DS (ft)	US (ft)	Fr.Slope (%)	Unif. (ft)	Actual (ft)	Unif. (f/s)	Actual (f/s)			
1	50.69	50.50	54.78	0.001	0.31	1.87	1.69	0.17	0.5	10.2	0.000
2	50.50	50.04	52.57	0.023	0.80	1.92	2.92	1.11	3.4	10.2	0.000
3	50.04	49.79	51.89	0.111	1.29	2.00	3.53	2.41	7.6	10.2	0.000
4	49.79	48.54	51.86	0.288	2.00	2.00	3.88	3.88	12.2	10.2	0.000
5	49.24	48.87	52.91	0.037	0.92	1.45	3.10	1.81	4.4	10.2	0.000
6	48.87	48.54	53.35	0.151	1.45	1.66	3.63	3.17	8.8	10.2	0.000
7	48.54	48.39	52.81	0.146	2.14	3.00	4.74	3.62	25.6	30.0	0.000
8	48.39	47.80	53.57	0.213	2.57	3.00	4.80	4.37	30.9	30.0	0.000

SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

NOTE:

The convey length should be from upstream to downstream inside box.
This length may also be used as Pay Item.
Using hydraulic length, from node center to node center, may result in profile error,
and this length should not be used as Pay Item.

LINKS:

Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
Circular	Concrete	2.0	0.0	6	1515.0
Circular	Concrete	3.0	0.0	2	543.0

NODES:

Type of Inlet Structure	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	8
Outlet		0.0	0.0	0.0	0.0	0.0	1

END

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 2 Years
Run# 8 Insufficient capacity.
Run# 4 Insufficient capacity.

ATTACHMENT 1

100-YEAR HOUSTORM OUTPUT

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0150-1 100-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004 Updated\SYSTEM_A 100
 DESIGN FREQUENCY : 100 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 100 Years
 =====

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
A9	0.698	7.33	29.20	29.20	6.57	0.000	33.621
A8	0.62	6.59	28.94	28.94	6.60	0.000	26.929
A7	0.5	12.94	30.70	30.70	6.43	0.000	41.575
A6	0.543	12.14	30.52	30.52	6.45	0.000	42.480
A5	0.514	12.20	30.54	30.54	6.44	0.000	40.392
A4	0.563	7.76	29.34	29.34	6.56	0.000	28.654
A3	0.602	6.44	28.88	28.88	6.60	0.000	25.582
A2	0.572	9.44	29.85	29.85	6.51	0.000	35.149
A1	0.55	4.29	27.92	27.92	6.70	0.000	15.796
A10	0.667	5.83	28.64	28.64	6.63	0.000	25.750
A11	0.601	3.62	27.54	27.54	6.74	0.000	14.644
A12	0.55	3.51	27.48	27.48	6.74	0.000	13.025
A13	0.6	4.69	28.13	28.13	6.68	0.000	18.786
A14	0.7	3.43	27.42	27.42	6.75	0.000	16.194

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
A9	CrcMh	0.698	7.33	29.20	6.57		-15.10	18.521
A8	CrcMh	0.661	13.92	30.67	6.43		-29.10	30.076
A7	CrcMh	0.583	26.86	31.95	6.32		-52.10	46.859
A6	CrcMh	0.571	39.00	33.13	6.22		-73.00	65.323
A5	CrcMh	0.557	51.20	34.03	6.14		-82.00	93.116
A4	CrcMh	0.558	58.96	35.19	6.05		-82.00	116.853
A3	CrcMh	0.562	65.40	36.20	5.97		-82.00	137.370
A2	CrcMh	0.563	74.83	37.28	5.88		-82.00	166.139
A1	CrcMh	0.563	79.12	38.21	5.82		-82.00	176.974
A10	CrcMh	0.570	84.95	39.09	5.75		-82.00	196.519
A11	CrcMh	0.571	88.57	39.88	5.70		-30.00	258.231
A12	CrcMh	0.570	92.08	41.18	5.61		-30.00	264.579
A13	CrcMh	0.572	96.77	42.50	5.52		-30.00	275.589
A14	CrcMh	0.576	100.20	44.01	5.43		-30.00	283.329
A-OUT	Outlt	0.576	100.20	44.01	5.43		-30.00	283.329

Conveyance Configuration Data

Run #	Node		FlowLine Elev.		Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
	US	DS	US (ft)	DS (ft)						
1	A9	A8	56.10	55.35	Cir 1	0.00	2.50	374.0	0.200	0.013
2	A8	A7	54.85	54.11	Cir 1	0.00	3.00	370.0	0.200	0.013
3	A7	A6	53.61	52.86	Cir 1	0.00	3.50	375.0	0.200	0.013
4	A6	A5	52.86	52.13	Cir 1	0.00	3.50	369.0	0.200	0.013
5	A5	A4	52.13	51.39	Cir 2	0.00	3.50	370.0	0.200	0.013
6	A4	A3	51.39	50.65	Cir 2	0.00	3.50	368.0	0.200	0.013
7	A3	A2	50.15	49.41	Cir 2	0.00	4.00	371.0	0.200	0.013
8	A2	A1	49.41	48.67	Cir 2	0.00	4.00	368.0	0.200	0.013
9	A1	A10	48.67	47.93	Cir 2	0.00	4.00	372.0	0.200	0.013
10	A10	A11	47.93	47.19	Cir 2	0.00	4.00	370.0	0.200	0.013
11	A11	A12	47.19	46.23	Box 2	6.00	4.00	479.0	0.200	0.015
12	A12	A13	46.23	45.26	Box 2	6.00	4.00	484.0	0.200	0.015
13	A13	A14	45.26	44.14	Box 2	6.00	4.00	563.0	0.200	0.015
14	A14	A-OUT	44.14	44.00	Box 2	6.00	4.00	68.0	0.200	0.015

Conveyance Hydraulic Computations. Tailwater = 49.220 (ft)

Run #	Hyd. Gr.line		Crit.Elev US (ft)	Fr.Slope (%)	Depth		Velocity		Q (cfs)	Cap (cfs)	Junc Loss (ft)
	US (ft)	DS (ft)			Unif. (ft)	Actual (ft)	Unif. (f/s)	Actual (f/s)			
1	64.22	63.46	65.23	0.202	2.07	2.50	4.26	3.77	18.5	18.4	0.000
2	63.46	62.72	65.44	0.202	2.48	3.00	4.81	4.25	30.1	30.0	0.000
3	62.72	61.91	65.26	0.215	3.02	3.50	5.31	4.87	46.9	45.2	0.000
4	61.91	60.37	64.68	0.418	3.50	3.50	6.79	6.79	65.3	45.2	0.000
5	60.37	59.58	64.08	0.212	2.99	3.50	5.31	4.84	93.1	90.4	0.000
6	59.58	58.35	65.07	0.334	3.50	3.50	6.07	6.07	116.9	90.4	0.000
7	58.35	57.51	65.07	0.227	3.63	4.00	5.74	5.47	137.4	129.0	0.000
8	57.51	56.29	64.12	0.332	4.00	4.00	6.61	6.61	166.1	129.0	0.000
9	56.29	54.89	64.12	0.376	4.00	4.00	7.04	7.04	177.0	129.0	0.000
10	54.89	53.17	64.22	0.464	4.00	4.00	7.82	7.82	196.5	129.0	0.000
11	53.17	52.07	61.75	0.231	3.52	4.00	6.12	5.38	258.2	240.1	0.000
12	52.07	50.89	59.01	0.243	3.59	4.00	6.14	5.51	264.6	240.1	0.000
13	50.89	49.41	53.35	0.263	3.70	4.00	6.20	5.74	275.6	240.1	0.000
14	49.41	49.22	51.53	0.278	3.78	4.00	6.24	5.90	283.3	240.1	0.000

SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

NOTE:

The convey length should be from upstream to downstream inside box.
 This length may also be used as Pay Item.
 Using hydraulic length, from node center to node center, may result in profile error,
 and this length should not be used as Pay Item.

LINKS:

Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
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Circular	Concrete	2.5	0.0	1	374.0
Circular	Concrete	3.0	0.0	1	370.0
Circular	Concrete	3.5	0.0	4	2220.0
Circular	Concrete	4.0	0.0	4	2962.0
Box	Concrete	4.0	6.0	4	3188.0

NODES:

Type of Inlet Structure	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	14
Outlet		0.0	0.0	0.0	0.0	0.0	1

=====END=====

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

- Runoff Frequency of: 100 Years
- Run# 14 Insufficient capacity.
 - Run# 13 Insufficient capacity.
 - Run# 12 Insufficient capacity.
 - Run# 11 Insufficient capacity.
 - Run# 10 Insufficient capacity.
 - Run# 9 Insufficient capacity.
 - Run# 8 Insufficient capacity.
 - Run# 7 Insufficient capacity.
 - Run# 6 Insufficient capacity.
 - Run# 5 Insufficient capacity.
 - Run# 4 Insufficient capacity.
 - Run# 3 Insufficient capacity.
 - Run# 2 Insufficient capacity.
 - Run# 1 Insufficient capacity.

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/27/2017 7:27:21 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0147-1 100-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\100-YEAR\SYSTEM_B1 1

DESIGN FREQUENCY : 100 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 100 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
B18	0.702	5.31	28.42	28.42	6.65	0.000	24.773
B17	0.603	5.57	28.53	28.53	6.64	0.000	22.308
B16	0.661	4.33	27.95	27.95	6.69	0.000	19.168
B15	0.688	2.96	27.11	27.11	6.78	0.000	13.803
B14	0.663	4.89	28.22	28.22	6.67	0.000	21.599
B13	0.713	5.47	28.49	28.49	6.64	0.000	25.888
B12	0.777	5.07	28.31	28.31	6.66	0.000	26.193
B11	0.65	4.37	27.97	27.97	6.69	0.000	19.009

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr. Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
B18	CrcMh	0.702	5.31	28.42	6.65		-12.90	11.873
B17	CrcMh	0.651	10.88	30.03	6.49		-24.10	21.917
B16	CrcMh	0.654	15.21	31.43	6.36		-33.20	30.125
B15	CrcMh	0.660	18.17	32.10	6.30		-39.80	35.762
B14	CrcMh	0.660	23.06	32.73	6.25		-50.20	44.957
B13	CrcMh	0.670	28.53	33.94	6.15		-62.30	55.268
B12	CrcMh	0.682	37.97	35.02	6.06		-30.00	126.943
B11	CrcMh	0.650	4.37	27.97	6.69		0.00	19.009
B-OUT	Outlt	0.682	37.97	35.02	6.06		-30.00	126.943

Conveyance Configuration Data

Run #	Node US	Node DS	FlowLine US Elev. (ft)	FlowLine DS Elev. (ft)	Shape	#	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	B18	B17	59.24	58.59	Cir	1	0.00	2.00	365.0	0.180	0.013
2	B17	B16	57.59	56.92	Cir	1	0.00	3.00	372.0	0.180	0.013
3	B16	B15	56.92	56.59	Cir	1	0.00	3.00	182.0	0.180	0.013
4	B15	B14	56.59	56.25	Cir	1	0.00	3.00	190.0	0.180	0.013

5	B14	B13	55.75	55.09	Cir 1	0.00	3.50	366.0	0.180	0.013
6	B13	B12	55.09	54.42	Cir 1	0.00	3.50	371.0	0.180	0.013
7	B12	B-OUT	53.42	51.53	Cir 1	0.00	5.00	694.0	0.272	0.013
8	B11	B12	57.15	56.42	Cir 1	0.00	2.00	367.0	0.200	0.013

Conveyance Hydraulic Computations. Tailwater = 59.530 (ft)

Run #	Hyd. US (ft)	Gr.line DS (ft)	Crit.Elev US (ft)	Fr.Slope (%)	Depth Unif. (ft)	Actual (ft)	Velocity Unif. (f/s)	Actual (f/s)	Q (cfs)	Cap (cfs)	Junc Loss (ft)
1	63.80	62.80	64.28	0.273	2.00	2.00	3.78	3.78	11.9	9.6	0.000
2	62.80	62.53	63.81	0.107	1.98	3.00	4.43	3.10	21.9	28.4	0.000
3	62.53	62.16	64.53	0.202	2.70	3.00	4.50	4.26	30.1	28.4	0.000
4	62.16	61.62	64.00	0.285	3.00	3.00	5.06	5.06	35.8	28.4	0.000
5	61.62	60.90	63.60	0.198	3.06	3.50	5.04	4.67	45.0	42.9	0.000
6	60.90	59.79	63.38	0.299	3.50	3.50	5.74	5.74	55.3	42.9	0.000
7	59.79	59.53	64.34	0.236	3.83	5.00	7.87	6.47	126.9	136.5	0.000
8	62.36	59.79	64.44	0.700	2.00	2.00	6.05	6.05	19.0	10.2	0.000

SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

NOTE:

The convey length should be from upstream to downstream inside box.
This length may also be used as Pay Item.
Using hydraulic length, from node center to node center, may result in profile error,
and this length should not be used as Pay Item.

LINKS:

Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
Circular	Concrete	2.0	0.0	2	732.0
Circular	Concrete	3.0	0.0	3	744.0
Circular	Concrete	3.5	0.0	2	737.0
Circular	Concrete	5.0	0.0	1	694.0

NODES:

Type of Inlet Structure	Type of Inlet	Grate Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	8
Outlet		0.0	0.0	0.0	0.0	0.0	1

END

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 100 Years
Run# 8 Insufficient capacity.
Run# 6 Insufficient capacity.
Run# 5 Insufficient capacity.

Run# 4 Insufficient capacity.
Run# 3 Insufficient capacity.
Run# 1 Insufficient capacity.

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/27/2017 7:28:23 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0147-2 100-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\100-YEAR\SYSTEM_B2 1
 DESIGN FREQUENCY : 100 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 100 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
B10	0.629	4.43	28.00	28.00	6.69	0.000	18.642
B9	0.662	4.47	28.02	28.02	6.69	0.000	19.784

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
B10	CrcMh	0.629	4.43	28.00	6.69		-8.30	10.342
B9	CrcMh	0.646	8.90	29.66	6.53		-8.30	29.194
B-OUT	Outlt	0.646	8.90	29.66	6.53		-8.30	29.194

Conveyance Configuration Data

Run #	Node US	I.D. DS	FlowLine US Elev. (ft)	Elev. DS (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	B10	B9	57.58	56.85	Cir 1	0.00	2.00	366.0	0.200	0.013
2	B9	B-OUT	56.85	56.79	Cir 1	0.00	2.00	72.0	0.083	0.013

Conveyance Hydraulic Computations. Tailwater = 60.790 (ft)

Run #	Hyd. US (ft)	Gr.line DS (ft)	Crit.Elev US (ft)	Fr.Slope (%)	Depth Unif. (ft)	Actual (ft)	Velocity Unif. (f/s)	Actual (f/s)	Q (cfs)	Cap (cfs)	Junc Loss (ft)
1	62.74	61.98	64.12	0.207	1.69	2.00	3.66	3.29	10.3	10.2	0.000
2	61.98	60.79	63.92	1.651	2.00	2.00	9.29	9.29	29.2	6.6	0.000

SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

=====

NOTE:

The convey length should be from upstream to downstream inside box.
This length may also be used as Pay Item.
Using hydraulic length, from node center to node center, may result in profile error,
and this length should not be used as Pay Item.

LINKS:

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Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
Circular	Concrete	2.0	0.0	2	438.0

NODES:

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Type of Inlet Structure	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	2
Outlet		0.0	0.0	0.0	0.0	0.0	1

-----END-----

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 100 Years
Run# 2 Insufficient capacity.
Run# 1 Insufficient capacity.

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/27/2017 7:28:55 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0147-1 100-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\100-YEAR\SYSTEM_B3 1

DESIGN FREQUENCY : 100 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 100 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
B2	0.607	4.23	27.89	27.89	6.70	0.000	17.208
B1-1	0.591	4.78	28.17	28.17	6.67	0.000	18.827
B1	0.576	0.84	24.70	24.70	7.04	0.000	3.403
B7	0.6	4.67	28.12	28.12	6.68	0.000	18.710
B6	0.652	2.68	26.90	26.90	6.80	0.000	11.904
B5	0.632	1.94	26.24	26.24	6.87	0.000	8.446
B4	0.609	127.41	38.48	38.48	5.80	0.000	449.540
B3	0.619	2.80	26.99	26.99	6.79	0.000	11.764
B8	0.79	4.66	28.11	28.11	6.68	0.000	24.585

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
B7	CrcMh	0.695	9.33	28.90	6.60		-22.40	20.387
B6	CrcMh	0.685	12.01	29.85	6.51		-22.40	31.187
B5	CrcMh	0.678	13.96	30.18	6.48		-22.40	38.895
B4	CrcMh	0.616	141.37	38.48	5.80		-22.40	481.988
B3	CrcMh	0.616	144.17	38.99	5.76		-22.40	488.790
B2	CrcMh	0.615	148.40	39.42	5.73		-22.40	500.830
B1-1	CrcMh	0.591	4.78	28.17	6.67		0.00	18.827
B1	CrcMh	0.614	154.01	39.66	5.71		-22.40	518.183
B8	CrcMh	0.790	4.66	28.11	6.68		0.00	24.585
B-OUT	Outlt	0.614	154.01	39.66	5.71		-22.40	518.183

Conveyance Configuration Data

Run #	Node US	Node DS	FlowLine US (ft)	Elev. DS (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	B8	B7	46.91	46.16	Cir 1	0.00	2.00	373.0	0.200	0.013
2	B7	B6	46.16	45.43	Cir 1	0.00	2.00	369.0	0.200	0.013

3	B6	B5	45.43	45.04	Cir 1	0.00	2.00	195.0	0.200	0.013
4	B5	B4	45.04	44.68	Cir 1	0.00	2.50	177.0	0.200	0.013
5	B4	B3	39.18	38.60	Cir 1	0.00	8.00	293.0	0.200	0.013
6	B3	B2	38.60	38.10	Cir 1	0.00	8.00	249.0	0.200	0.013
7	B2	B1	38.10	37.81	Cir 1	0.00	8.00	143.0	0.200	0.013
8	B1-1	B1	43.98	43.31	Cir 1	0.00	2.00	332.0	0.200	0.013
9	B1	B-OUT	37.81	37.60	Cir 1	0.00	8.00	104.0	0.200	0.013

Conveyance Hydraulic Computations. Tailwater = 47.100 (ft)

Run #	Hyd. Gr.line		Crit.Elev		Depth		Velocity		Q (cfs)	Cap (cfs)	Junc Loss (ft)
	US (ft)	DS (ft)	US (ft)	Fr.Slope (%)	Unif. (ft)	Actual (ft)	Unif. (f/s)	Actual (f/s)			
1	61.97	57.60	63.84	1.171	2.00	2.00	7.83	7.83	24.6	10.2	0.000
2	57.60	54.63	62.25	0.805	2.00	2.00	6.49	6.49	20.4	10.2	0.000
3	54.63	50.96	59.45	1.884	2.00	2.00	9.93	9.93	31.2	10.2	0.000
4	50.96	49.38	58.61	0.892	2.50	2.50	7.92	7.92	38.9	18.4	0.000
5	49.38	48.57	60.07	0.277	8.00	8.00	9.59	9.59	482.0	409.6	0.000
6	48.57	47.86	59.53	0.285	8.00	8.00	9.72	9.72	488.8	409.6	0.000
7	47.86	47.43	57.11	0.299	8.00	8.00	9.96	9.96	500.8	409.6	0.000
8	49.71	47.43	57.18	0.687	2.00	2.00	5.99	5.99	18.8	10.2	0.000
9	47.43	47.10	56.53	0.320	8.00	8.00	10.31	10.31	518.2	409.6	0.000

SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

NOTE:

The convey length should be from upstream to downstream inside box.
This length may also be used as Pay Item.
Using hydraulic length, from node center to node center, may result in profile error,
and this length should not be used as Pay Item.

LINKS:

Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
Circular	Concrete	2.0	0.0	4	1269.0
Circular	Concrete	2.5	0.0	1	177.0
Circular	Concrete	8.0	0.0	4	789.0

NODES:

Type of Inlet Structure	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	9
Outlet		0.0	0.0	0.0	0.0	0.0	1

END

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 100 Years

Run# 9 Insufficient capacity.
Run# 7 Insufficient capacity.
Run# 8 Insufficient capacity.
Run# 6 Insufficient capacity.
Run# 5 Insufficient capacity.
Run# 4 Insufficient capacity.
Run# 3 Insufficient capacity.
Run# 2 Insufficient capacity.
Run# 1 Insufficient capacity.

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/27/2017 7:32:42 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0146-1 100-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\100-YEAR\SYSTEM_C 10

DESIGN FREQUENCY : 100 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 100 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
C3	0.591	221.73	40.89	40.89	5.63	0.000	737.199
C2	0.607	3.37	27.38	27.38	6.75	0.000	13.799
C1	0.547	3.36	27.38	27.38	6.75	0.000	12.424

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
C3	CrcMh	0.591	221.73	40.89	5.63		0.00	737.199
C2	CrcMh	0.591	225.09	41.42	5.59		0.00	743.942
C1	CrcMh	0.590	228.45	41.88	5.56		0.00	750.202
C-OUT	Outlt	0.590	228.45	41.88	5.56		0.00	750.202

Conveyance Configuration Data

Run #	Node US	I.D. DS	FlowLine US (ft)	Elev. DS (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	C3	C2	39.83	39.48	Box 1	10.0	8.00	296.0	0.116	0.015
2	C2	C1	39.48	39.19	Box 1	10.0	8.00	253.0	0.116	0.015
3	C1	C-OUT	39.19	38.90	Box 1	10.0	8.00	251.0	0.116	0.015

Conveyance Hydraulic Computations. Tailwater = 61.390 (ft)

Run #	Hyd. US (ft)	Gr.line DS (ft)	Crit.Elev US (ft)	Fr.Slope (%)	Depth Unif. (ft)	Actual (ft)	Velocity Unif. (f/s)	Actual (f/s)	Q (cfs)	Cap (cfs)	Junc Loss (ft)
1	63.82	62.93	64.05	0.298	8.00	8.00	9.21	9.21	737.2	460.2	0.000
2	62.93	62.17	64.95	0.304	8.00	8.00	9.30	9.30	743.9	460.2	0.000

3 62.17 61.39 64.47 0.309 8.00 8.00 9.38 9.38 750.2 460.2 0.000

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SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

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NOTE:

The convey length should be from upstream to downstream inside box.
 This length may also be used as Pay Item.
 Using hydraulic length, from node center to node center, may result in profile error,
 and this length should not be used as Pay Item.

LINKS:

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Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
Box	Concrete	8.0	10.0	3	800.0

NODES:

=====

Type of Inlet Structure	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	3
Outlet		0.0	0.0	0.0	0.0	0.0	1

=====END=====

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 100 Years
 Run# 3 Insufficient capacity.
 Run# 2 Insufficient capacity.
 Run# 1 Insufficient capacity.

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/27/2017 7:31:40 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0145-1 100-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\100-YEAR\SYSTEM_DA 1
 DESIGN FREQUENCY : 100 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 100 Years
 =====

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
DA-3	0.562	36.65	33.86	33.86	6.15	0.000	126.747
DA-2	0.624	2.70	26.91	26.91	6.80	0.000	11.458
DA-1	0.589	2.72	26.93	26.93	6.80	0.000	10.899

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
DA-3	CrcMh	0.562	36.65	33.86	6.15		-20.00	106.747
DA-2	CrcMh	0.566	39.35	34.51	6.10		-20.00	115.921
DA-1	CrcMh	0.568	42.07	35.09	6.05		-20.00	124.578
DA-OUT	Outlt	0.568	42.07	35.09	6.05		-20.00	124.578

Conveyance Configuration Data

Run #	Node US	I.D. DS	FlowLine US (ft)	Elev. DS (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	DA-3	DA-2	52.42	51.45	Cir 1	0.00	4.00	333.0	0.291	0.013
2	DA-2	DA-1	51.45	50.71	Cir 1	0.00	4.50	255.0	0.291	0.013
3	DA-1	DA-OUT	50.71	49.99	Cir 1	0.00	5.00	247.0	0.291	0.013

Conveyance Hydraulic Computations. Tailwater = 59.440 (ft)

Run #	Hyd. US (ft)	Gr.line DS (ft)	Crit.Elev US (ft)	Fr.Slope (%)	Depth Unif. (ft)	Actual (ft)	Velocity Unif. (f/s)	Actual (f/s)	Q (cfs)	Cap (cfs)	Junc Loss (ft)
1	62.30	60.48	62.70	0.548	4.00	4.00	8.49	8.49	106.7	77.8	0.000
2	60.48	59.60	63.52	0.345	4.50	4.50	7.29	7.29	115.9	106.5	0.000

3 59.60 59.44 63.03 0.227 3.66 5.00 8.08 6.34 124.6 141.1 0.000

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SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

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NOTE:

The convey length should be from upstream to downstream inside box.
 This length may also be used as Pay Item.
 Using hydraulic length, from node center to node center, may result in profile error,
 and this length should not be used as Pay Item.

LINKS:

=====

Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
Circular	Concrete	4.0	0.0	1	333.0
Circular	Concrete	4.5	0.0	1	255.0
Circular	Concrete	5.0	0.0	1	247.0

NODES:

=====

Type of Inlet Structure	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	3
Outlet		0.0	0.0	0.0	0.0	0.0	1

=====END=====

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 100 Years
 Run# 2 Insufficient capacity.
 Run# 1 Insufficient capacity.

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/30/2017 4:42:12 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0145-2 100-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\100-YEAR\SYSTEM_DB 1

DESIGN FREQUENCY : 100 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 100 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
DB-3	0.51	25.84	32.73	32.73	6.25	0.000	82.389
DB-2	0.67	6.39	28.86	28.86	6.60	0.000	28.266
DB-1-2A	0.5	26.08	32.76	32.76	6.25	0.000	81.455
DB-1-2	0.576	9.22	29.79	29.79	6.51	0.000	34.616
DB-1-1	0.553	2.39	26.66	26.66	6.83	0.000	9.016
DB-1	0.597	3.93	27.73	27.73	6.72	0.000	15.766

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
DB-3	CrcMh	0.510	25.84	32.73	6.25		0.00	82.389
DB-2	CrcMh	0.542	32.23	33.40	6.19		0.00	108.145
DB-1-2A	CrcMh	0.500	26.08	32.76	6.25		-43.00	38.455
DB-1-2	CrcMh	0.520	35.30	34.34	6.11		0.20	112.422
DB-1-1	CrcMh	0.553	2.39	26.66	6.83		0.00	9.016
DB-1	CrcMh	0.535	73.86	35.98	5.98		0.20	236.480
DB-OUT	Outlt	0.535	73.86	35.98	5.98		0.20	236.480

Conveyance Configuration Data

Run #	Node US	I.D. DS	FlowLine US (ft)	Elev. DS (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	DB-3	DB-2	47.91	47.39	Cir 1	0.00	4.00	263.0	0.200	0.013
2	DB-2	DB-1	47.39	46.89	Cir 1	0.00	4.00	250.0	0.200	0.013
3	DB-1-2	DB-1-2	50.25	49.22	Cir 1	0.00	3.00	515.0	0.200	0.013
4	DB-1-2	DB-1	47.22	45.89	Cir 1	0.00	5.00	665.0	0.200	0.013
5	DB-1-1	DB-1	49.34	48.89	Cir 1	0.00	2.00	225.0	0.200	0.013
6	DB-1	DB-OUT	45.39	44.85	Cir 1	0.00	5.50	269.0	0.200	0.013

Conveyance Hydraulic Computations. Tailwater = 56.930 (ft)

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=====
Run  Hyd. Gr.line  Crit.Elev          Depth          Velocity          Junc
#    US    DS    US    Fr.Slope  Unif. Actual  Unif. Actual    Q          Cap  Loss
   (ft) (ft) (ft)  (%)      (ft)  (ft)  (f/s) (f/s)  (cfs)  (cfs) (ft)
-----
1     60.52 59.66 62.97   0.326   4.00   4.00   6.56   6.56   82.4   64.5 0.000
2     59.66 58.25 60.82   0.562   4.00   4.00   8.61   8.61  108.1   64.5 0.000
3     60.05 58.35 61.72   0.330   3.00   3.00   5.44   5.44   38.5   30.0 0.000
4     58.35 58.25 61.63   0.185   3.95   5.00   6.76   5.73  112.4  117.0 0.000
5     58.35 58.25 58.54   0.157   1.47   2.00   3.65   2.87   9.0   10.2 0.000
6     58.25 56.93 59.31   0.492   5.50   5.50   9.95   9.95  236.5  150.8 0.000
=====

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SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

NOTE:

The convey length should be from upstream to downstream inside box.
This length may also be used as Pay Item.
Using hydraulic length, from node center to node center, may result in profile error,
and this length should not be used as Pay Item.

LINKS:

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Type of Convey  Material  Rise  Span  Number of Links  Quantity
Structure      (ft)     (ft)  of this type    (ft)
-----
Circular      Concrete  4.0   0.0     2                513.0
Circular      Concrete  3.0   0.0     1                515.0
Circular      Concrete  5.0   0.0     1                665.0
Circular      Concrete  2.0   0.0     1                225.0
Circular      Concrete  5.5   0.0     1                269.0
=====

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NODES:

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=====
Type of Inlet  Type of Grate  Inlet  Grate  Grate  Grate  Grate  Quantity
Structure      Length Width Length Area  Perimeter  (each)
              (ft)  (ft)  (ft)  (ft)  (ft)
-----
Circular Manhole  0.0   0.0   0.0   0.0   0.0   6
Outlet           0.0   0.0   0.0   0.0   0.0   1
=====

```

END

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 100 Years
Run# 6 Insufficient capacity.
Run# 2 Insufficient capacity.
Run# 1 Insufficient capacity.
Run# 3 Insufficient capacity.

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/27/2017 7:50:21 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0051-1 100-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\100-YEAR\SYSTEM_E 10
 DESIGN FREQUENCY : 100 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 100 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
E1	0.76	2.40	26.66	26.66	6.83	0.000	12.432

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
E1	CrcMh	0.760	2.40	26.66	6.83		0.00	12.432
E-OUT	Outlt	0.760	2.40	26.66	6.83		0.00	12.432

Conveyance Configuration Data

Run #	Node US	I.D. DS	FlowLine US (ft)	Elev. DS (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	E1	E-OUT	49.37	48.96	Cir 1	0.00	2.00	206.0	0.200	0.013

Conveyance Hydraulic Computations. Tailwater = 55.200 (ft)

Run #	Hyd. US (ft)	Gr.line DS (ft)	Crit.Elev US (ft)	Fr.Slope (%)	Depth Unif. (ft)	Actual Depth (ft)	Velocity Unif. (f/s)	Actual Velocity (f/s)	Q (cfs)	Cap (cfs)	Loss (ft)
1	55.82	55.20	59.86	0.299	2.00	2.00	3.96	3.96	12.4	10.2	0.000

SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

NOTE:

The convey length should be from upstream to downstream inside box.
 This length may also be used as Pay Item.

Using hydraulic length, from node center to node center, may result in profile error,
 and this length should not be used as Pay Item.

LINKS:

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=====
Type of Convey  Material  Rise  Span  Number of Links  Quantity
Structure      (ft)    (ft)  of this type    (ft)
-----
Circular       Concrete  2.0   0.0    1                206.0
  
```

NODES:

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=====
Type of Inlet  Type of Grate  Inlet  Grate  Grate  Grate  Grate  Quantity
Structure      Length        (ft)  Width Length Area  Perimeter  (each)
              (ft)          (ft)  (ft)  (ft)  (ft)  (ft)
-----
Circular Manhole  0.0    0.0    0.0    0.0    0.0    0.0    1
Outlet           0.0    0.0    0.0    0.0    0.0    0.0    1
=====END=====
  
```

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 100 Years
 Run# 1 Insufficient capacity.

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/27/2017 7:51:26 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0042-1 100-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\100-YEAR\SYSTEM_F 10
 DESIGN FREQUENCY : 100 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 100 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
F7	0.8	1.61	25.87	25.87	6.91	0.000	8.903
F6	0.8	2.56	26.80	26.80	6.81	0.000	13.962
F5	0.8	3.00	27.14	27.14	6.78	0.000	16.276
F4	0.662	3.89	27.70	27.70	6.72	0.000	17.281
F3	0.395	2.85	27.02	27.02	6.79	0.000	7.630
F2	0.351	1.79	26.08	26.08	6.89	0.000	4.331
F1	0.649	0.79	24.59	24.59	7.06	0.000	3.602
F-A	0.65	0.00	15.00	0.00	0.00	0.000	0.000
F-B	0.65	0.00	15.00	0.00	0.00	0.000	0.000

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
F7	CrcMh	0.800	1.61	25.87	6.91		0.00	8.903
F6	CrcMh	0.800	4.17	27.12	6.78		-11.70	10.925
F5	CrcMh	0.800	7.17	28.45	6.64		-19.90	18.230
F4	CrcMh	0.751	11.06	29.79	6.51		-28.40	25.739
F3	CrcMh	0.678	13.91	31.38	6.37		-31.70	28.380
F2	CrcMh	0.641	15.70	32.22	6.29		-33.40	29.928
F1	CrcMh	0.641	16.48	32.72	6.25		0.00	66.089
F-A	CrcMh	0.641	16.48	32.72	6.25		0.00	66.089
F-B	CrcMh	0.641	16.48	32.72	6.25		0.00	66.089
F-OUT	Outlt	0.641	16.48	32.72	6.25		0.00	66.089

Conveyance Configuration Data

Run #	Node US	Node DS	FlowLine US (ft)	Elev. DS (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	F7	F6	44.94	44.39	Cir 1	0.00	2.00	273.0	0.200	0.013
2	F6	F5	44.39	43.84	Cir 1	0.00	2.00	277.0	0.200	0.013

3	F5	F4	43.84	42.90	Cir 1	0.00	2.00	466.0	0.200	0.013
4	F4	F3	42.40	41.41	Cir 1	0.00	2.50	499.0	0.200	0.013
5	F3	F2	41.41	40.82	Cir 1	0.00	2.50	294.0	0.200	0.013
6	F2	F1	40.32	40.03	Cir 1	0.00	3.00	142.0	0.200	0.013
7	F1	F-A	40.03	39.01	Cir 1	0.00	3.00	513.0	0.200	0.013
8	F-A	F-B	39.01	38.11	Cir 1	0.00	4.00	448.0	0.200	0.013
9	F-B	F-OUT	38.11	38.00	Cir 1	0.00	4.00	56.0	0.200	0.024

Conveyance Hydraulic Computations. Tailwater = 43.720 (ft)

Run #	Hyd. Gr.line		Crit.Elev US (ft)	Fr.Slope (%)	Depth		Velocity		Q (cfs)	Cap (cfs)	Junc Loss (ft)
	US (ft)	DS (ft)			Unif. (ft)	Actual (ft)	Unif. (f/s)	Actual (f/s)			
1	57.17	57.04	59.38	0.154	1.45	2.00	3.64	2.83	8.9	10.2	0.000
2	57.04	56.40	59.25	0.231	2.00	2.00	3.48	3.48	10.9	10.2	0.000
3	56.40	53.40	59.06	0.644	2.00	2.00	5.80	5.80	18.2	10.2	0.000
4	53.40	51.45	58.69	0.390	2.50	2.50	5.24	5.24	25.7	18.4	0.000
5	51.45	50.06	57.40	0.475	2.50	2.50	5.78	5.78	28.4	18.4	0.000
6	50.06	50.05	54.85	0.200	2.47	3.00	4.80	4.23	29.9	30.0	0.000
7	50.05	45.06	60.88	0.974	3.00	3.00	9.35	9.35	66.1	30.0	0.000
8	45.06	44.12	52.23	0.210	3.39	4.00	5.82	5.26	66.1	64.5	0.000
9	44.12	43.72	51.50	0.715	4.00	4.00	5.26	5.26	66.1	34.9	0.000

SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

NOTE:

The convey length should be from upstream to downstream inside box.
This length may also be used as Pay Item.
Using hydraulic length, from node center to node center, may result in profile error,
and this length should not be used as Pay Item.

LINKS:

Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
Circular	Concrete	2.0	0.0	3	1016.0
Circular	Concrete	2.5	0.0	2	793.0
Circular	Concrete	3.0	0.0	2	655.0
Circular	Concrete	4.0	0.0	1	448.0
Circular		4.0	0.0	1	56.0

NODES:

Type of Inlet Structure	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	9
Outlet		0.0	0.0	0.0	0.0	0.0	1

END

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 100 Years

Discharge decreased downstream node Id= F-A Previous intensity used.

Discharge decreased downstream node Id= F-B Previous intensity used.

Run# 9 Insufficient capacity.

Run# 8 Insufficient capacity.

Run# 7 Insufficient capacity.

Run# 5 Insufficient capacity.

Run# 4 Insufficient capacity.

Run# 3 Insufficient capacity.

Run# 2 Insufficient capacity.

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/27/2017 7:52:08 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0041-1 100-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\100-YEAR\SYSTEM_G 10

DESIGN FREQUENCY : 100 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 100 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
G2	0.65	8.54	29.59	29.59	6.53	0.000	36.267
G9	0.787	8.84	29.68	29.68	6.52	0.000	45.376
G8	0.688	13.22	30.76	30.76	6.42	0.000	58.428
G7	0.731	6.60	28.94	28.94	6.60	0.000	31.808
G6	0.523	3.84	27.68	27.68	6.72	0.000	13.506
G5	0.55	1.58	25.84	25.84	6.92	0.000	6.001
G4	0.556	1.89	26.19	26.19	6.88	0.000	7.234
G3	0.65	9.96	29.99	29.99	6.50	0.000	42.054

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr. Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
G9	CrcMh	0.787	8.84	29.68	6.52		-15.50	29.876
G8	CrcMh	0.728	22.06	32.08	6.31		-53.40	47.797
G7	CrcMh	0.728	28.66	33.80	6.16		-68.00	60.534
G6	CrcMh	0.704	32.50	35.41	6.03		0.00	137.927
G5	CrcMh	0.697	34.08	36.17	5.97		0.00	141.744
G4	CrcMh	0.689	35.97	36.37	5.95		0.00	147.643
G3	CrcMh	0.681	45.93	37.53	5.87		0.00	183.457
G2	CrcMh	0.676	54.47	38.17	5.82		0.00	214.292
G1	CrcMh	0.676	54.47	38.17	5.82		0.00	214.292
G-OUT	Outlt	0.676	54.47	38.17	5.82		0.00	214.292

Conveyance Configuration Data

Run #	Node US	Node DS	FlowLine Elev. US (ft)	FlowLine Elev. DS (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	G9	G8	45.80	44.41	Cir 1	0.00	3.00	694.0	0.200	0.013
2	G8	G7	44.41	43.01	Cir 1	0.00	3.00	699.0	0.200	0.013
3	G7	G6	42.51	41.30	Cir 1	0.00	3.50	607.0	0.200	0.013

4	G6	G5	40.80	39.80	Cir 1	0.00	4.00	502.0	0.200	0.013
5	G5	G4	39.30	39.08	Cir 1	0.00	4.50	106.0	0.200	0.013
6	G4	G3	38.58	37.54	Cir 1	0.00	5.00	522.0	0.200	0.013
7	G3	G2	37.04	36.45	Cir 1	0.00	5.50	296.0	0.200	0.013
8	G2	G1	36.45	35.77	Cir 1	0.00	5.50	341.0	0.200	0.013
9	G1	G-OUT	35.27	35.00	Cir 1	0.00	6.00	133.0	0.200	0.024

Conveyance Hydraulic Computations. Tailwater = 42.740 (ft)

Run #	Hyd. US (ft)	Gr.line DS (ft)	Crit.Elev US (ft)	Fr.Slope (%)	Depth Unif. (ft)	Actual (ft)	Velocity Unif. (f/s)	Actual (f/s)	Q (cfs)	Cap (cfs)	Junc Loss (ft)
1	58.69	58.68	60.86	0.199	2.46	3.00	4.81	4.23	29.9	30.0	0.000
2	58.68	55.12	58.94	0.509	3.00	3.00	6.76	6.76	47.8	30.0	0.000
3	55.12	52.94	58.63	0.359	3.50	3.50	6.29	6.29	60.5	45.2	0.000
4	52.94	48.35	56.66	0.914	4.00	4.00	10.98	10.98	137.9	64.5	0.000
5	48.35	47.81	55.44	0.515	4.50	4.50	8.91	8.91	141.7	88.3	0.000
6	47.81	46.14	55.99	0.319	5.00	5.00	7.52	7.52	147.6	117.0	0.000
7	46.14	45.27	50.56	0.296	5.50	5.50	7.72	7.72	183.5	150.8	0.000
8	45.27	43.89	46.66	0.404	5.50	5.50	9.02	9.02	214.3	150.8	0.000
9	43.89	42.74	44.50	0.865	6.00	6.00	7.58	7.58	214.3	103.0	0.000

SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

NOTE:

The convey length should be from upstream to downstream inside box.
This length may also be used as Pay Item.
Using hydraulic length, from node center to node center, may result in profile error,
and this length should not be used as Pay Item.

LINKS:

Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
Circular	Concrete	3.0	0.0	2	1393.0
Circular	Concrete	3.5	0.0	1	607.0
Circular	Concrete	4.0	0.0	1	502.0
Circular	Concrete	4.5	0.0	1	106.0
Circular	Concrete	5.0	0.0	1	522.0
Circular	Concrete	5.5	0.0	2	637.0
Circular	Concrete	6.0	0.0	1	133.0

NODES:

Type of Inlet Structure	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	9
Outlet		0.0	0.0	0.0	0.0	0.0	1

END

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 100 Years

Discharge decreased downstream node Id= G1 Previous intensity used.

Run# 9 Insufficient capacity.

Run# 8 Insufficient capacity.

Run# 7 Insufficient capacity.

Run# 6 Insufficient capacity.

Run# 5 Insufficient capacity.

Run# 4 Insufficient capacity.

Run# 3 Insufficient capacity.

Run# 2 Insufficient capacity.

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/30/2017 4:52:48 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0040-1 100-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\100-YEAR\SYSTEM_H 10
 DESIGN FREQUENCY : 100 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 100 Years
 =====

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
H3	0.769	2.24	26.53	26.53	6.84	0.000	11.792
H2	0.619	2.30	26.58	26.58	6.84	0.000	9.734
H1	0.625	3.07	27.18	27.18	6.77	0.000	13.004

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
H3	CrcMh	0.769	2.24	26.53	6.84		0.00	11.792
H2	CrcMh	0.693	4.54	27.41	6.75		0.00	21.242
H1	CrcMh	0.666	7.61	28.06	6.68		0.00	33.869
H-OUT	Outlt	0.666	7.61	28.06	6.68		0.00	33.869

Conveyance Configuration Data

Run #	Node US	I.D. DS	FlowLine US (ft)	Elev. DS (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	H3	H2	41.02	39.98	Cir 1	0.00	2.00	267.0	0.390	0.013
2	H2	H1	39.98	38.90	Cir 1	0.00	2.00	261.0	0.414	0.013
3	H1	H-OUT	38.10	37.10	Cir 1	0.00	2.50	157.0	0.637	0.013

Conveyance Hydraulic Computations. Tailwater = 43.720 (ft)

Run #	Hyd. US (ft)	Gr.line DS (ft)	Crit.Elev US (ft)	Fr.Slope (%)	Depth Unif. (ft)	Actual (ft)	Velocity Unif. (f/s)	Actual (f/s)	Q (cfs)	Cap (cfs)	Junc Loss (ft)
1	47.38	47.06	51.00	0.269	1.40	2.00	5.03	3.75	11.8	14.2	0.000
2	47.06	44.78	48.59	0.874	2.00	2.00	6.76	6.76	21.2	14.6	0.000

3 44.78 43.72 47.29 0.676 2.14 2.50 7.57 6.90 33.9 32.9 0.000

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SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

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NOTE:

The convey length should be from upstream to downstream inside box.
 This length may also be used as Pay Item.
 Using hydraulic length, from node center to node center, may result in profile error,
 and this length should not be used as Pay Item.

LINKS:

=====

Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
Circular	Concrete	2.0	0.0	2	528.0
Circular	Concrete	2.5	0.0	1	157.0

NODES:

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Type of Inlet Structure	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	3
Outlet		0.0	0.0	0.0	0.0	0.0	1

-----END-----

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 100 Years
 Run# 3 Insufficient capacity.
 Run# 2 Insufficient capacity.

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/27/2017 7:56:36 PM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0039-1 100-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\100-YEAR\SYSTEM_I 10
 DESIGN FREQUENCY : 100 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 100 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
I2	0.709	5.11	28.33	28.33	6.66	0.000	24.139
I1	0.672	3.46	27.44	27.44	6.75	0.000	15.672

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr.Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
I2	CrcMh	0.709	5.11	28.33	6.66		0.00	24.139
I1	CrcMh	0.694	8.57	29.27	6.56		0.00	39.056
I-OUT	Outlt	0.694	8.57	29.27	6.56		0.00	39.056

Conveyance Configuration Data

Run #	Node US	I.D. DS	FlowLine Elev. US (ft)	Elev. DS (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	I2	I1	37.12	36.59	Cir 1	0.00	3.00	264.0	0.200	0.013
2	I1	I-OUT	36.09	35.77	Cir 1	0.00	3.00	157.0	0.200	0.024

Conveyance Hydraulic Computations. Tailwater = 42.740 (ft)

Run #	Hyd. US (ft)	Gr.line DS (ft)	Crit.Elev US (ft)	Fr.Slope (%)	Depth Unif. (ft)	Actual (ft)	Velocity Unif. (f/s)	Actual (f/s)	Q (cfs)	Cap (cfs)	Junc Loss (ft)
1	44.75	44.56	48.33	0.130	2.05	3.00	4.69	3.42	24.1	30.0	0.000
2	44.56	42.74	47.38	1.159	3.00	3.00	5.53	5.53	39.1	16.2	0.000

SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

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NOTE:

The convey length should be from upstream to downstream inside box.
This length may also be used as Pay Item.
Using hydraulic length, from node center to node center, may result in profile error,
and this length should not be used as Pay Item.

LINKS:

=====

Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
Circular	Concrete	3.0	0.0	2	421.0

NODES:

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Type of Inlet Structure	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	2
Outlet		0.0	0.0	0.0	0.0	0.0	1

-----END-----

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 100 Years
Run# 2 Insufficient capacity.

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System E0036-1 100-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\100-YEAR\SYSTEM_J 10
 DESIGN FREQUENCY : 100 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 100 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
JA-6	0.553	7.68	29.32	29.32	6.56	0.000	27.856
JA-5	0.64	1.93	26.22	26.22	6.87	0.000	8.482
JA-4	0.688	2.87	27.04	27.04	6.79	0.000	13.411
JA-3	0.639	3.83	27.67	27.67	6.72	0.000	16.466
JA-2	0.701	4.05	27.79	27.79	6.71	0.000	19.059
JA-1	0.85	2.04	26.33	26.33	6.86	0.000	11.876
JB-7	0.46	1.34	25.53	25.53	6.95	0.000	4.294
JB-6	0.718	1.56	25.82	25.82	6.92	0.000	7.760
JB-5	0.701	2.16	26.46	26.46	6.85	0.000	10.390
JB-4	0.73	2.38	26.65	26.65	6.83	0.000	11.888
JB-3	0.671	2.48	26.73	26.73	6.82	0.000	11.342
JB-2	0.707	2.40	26.67	26.67	6.83	0.000	11.592
JB-1	0.843	1.97	26.26	26.26	6.87	0.000	11.395
J1	0.85	0.00	15.00	27.79	0.00	0.000	0.000

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr. Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
JA-6	CrcMh	0.553	7.68	29.32	6.56		-14.60	13.256
JA-5	CrcMh	0.571	9.61	30.51	6.45		-13.50	21.834
JA-4	CrcMh	0.598	12.48	31.50	6.36		-13.50	33.899
JA-3	CrcMh	0.607	16.31	32.43	6.28		-13.50	48.662
JA-2	CrcMh	0.626	20.36	33.08	6.22		0.00	79.278
JA-1	CrcMh	0.646	22.40	33.45	6.19		0.00	89.579
JB-7	CrcMh	0.460	1.34	25.53	6.95		-1.80	2.494
JB-6	CrcMh	0.599	2.90	26.31	6.87		-3.80	8.143
JB-5	CrcMh	0.642	5.07	27.52	6.74		-2.80	19.143
JB-4	CrcMh	0.671	7.45	28.51	6.64		-12.80	20.379
JB-3	CrcMh	0.671	9.93	29.46	6.55		0.00	43.600
JB-2	CrcMh	0.678	12.33	30.19	6.48		0.00	54.135
JB-1	CrcMh	0.701	14.30	30.74	6.43		0.00	64.368
J1	CrcMh	0.667	36.70	33.68	6.17		0.00	151.105
J-OUT	Outlt	0.667	36.70	33.68	6.17		0.00	151.105

Conveyance Configuration Data

Run #	Node US	I.D. DS	FlowLine Elev.		Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	JA-6	JA-5	46.96	46.36	Cir 1	0.00	2.00	302.0	0.200	0.013
2	JA-5	JA-4	45.86	45.33	Cir 1	0.00	2.50	265.0	0.200	0.013
3	JA-4	JA-3	44.83	44.29	Cir 1	0.00	3.00	266.0	0.200	0.013
4	JA-3	JA-2	44.29	43.76	Cir 1	0.00	3.00	267.0	0.200	0.013
5	JA-2	JA-1	43.76	43.25	Cir 1	0.00	3.00	255.0	0.200	0.013
6	JA-1	J1	42.75	42.50	Cir 1	0.00	3.50	125.0	0.200	0.013
7	JB-7	JB-6	47.32	47.08	Cir 1	0.00	2.00	124.0	0.200	0.013
8	JB-6	JB-5	47.08	46.55	Cir 1	0.00	2.00	261.0	0.200	0.013
9	JB-5	JB-4	45.55	45.02	Cir 1	0.00	3.00	265.0	0.200	0.013
10	JB-4	JB-3	45.02	44.50	Cir 1	0.00	3.00	260.0	0.200	0.013
11	JB-3	JB-2	44.50	43.96	Cir 1	0.00	3.00	271.0	0.200	0.013
12	JB-2	JB-1	43.96	43.46	Cir 1	0.00	3.00	253.0	0.200	0.013
13	JB-1	J1	42.96	42.50	Cir 1	0.00	3.50	228.0	0.200	0.013
14	J1	J-OUT	31.07	30.65	Cir 1	0.00	3.50	211.0	0.200	0.013

Conveyance Hydraulic Computations. Tailwater = 34.147 (ft)

Run #	Hyd. US (ft)	Gr.line DS (ft)	Crit.Elev US (ft)	Fr.Slope (%)	Depth (ft)		Velocity (f/s)		Q (cfs)	Cap (cfs)	Junc Loss (ft)
1	54.42	53.39	55.42	0.340	2.00	2.00	4.22	4.22	13.3	10.2	0.000
2	53.39	52.65	53.62	0.281	2.50	2.50	4.45	4.45	21.8	18.4	0.000
3	52.65	51.96	53.66	0.256	3.00	3.00	4.80	4.80	33.9	30.0	0.000
4	51.96	50.55	53.66	0.528	3.00	3.00	6.88	6.88	48.7	30.0	0.000
5	50.55	46.98	53.60	1.401	3.00	3.00	11.22	11.22	79.3	30.0	0.000
6	46.98	46.00	54.33	0.786	3.50	3.50	9.31	9.31	89.6	45.2	0.000
7	50.74	50.51	54.67	0.012	0.68	2.00	2.67	0.79	2.5	10.2	0.000
8	50.51	50.32	52.80	0.128	1.36	2.00	3.58	2.59	8.1	10.2	0.000
9	50.32	50.01	53.36	0.082	1.75	3.00	4.48	2.71	19.1	30.0	0.000
10	50.01	49.73	52.96	0.093	1.82	3.00	4.54	2.88	20.4	30.0	0.000
11	49.73	48.58	53.16	0.424	3.00	3.00	6.17	6.17	43.6	30.0	0.000
12	48.58	46.93	53.10	0.653	3.00	3.00	7.66	7.66	54.1	30.0	0.000
13	46.93	46.00	53.26	0.406	3.50	3.50	6.69	6.69	64.4	45.2	0.000
14	38.87	34.15	52.99	2.237	3.50	3.50	15.71	15.71	151.1	45.2	0.000

SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

NOTE:

The convey length should be from upstream to downstream inside box.
 This length may also be used as Pay Item.
 Using hydraulic length, from node center to node center, may result in profile error,
 and this length should not be used as Pay Item.

LINKS:

Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)

Circular	Concrete	2.0	0.0	3	687.0
Circular	Concrete	2.5	0.0	1	265.0
Circular	Concrete	3.0	0.0	7	1837.0
Circular	Concrete	3.5	0.0	3	564.0

NODES:

Type of Inlet Structure	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole		0.0	0.0	0.0	0.0	0.0	14
Outlet		0.0	0.0	0.0	0.0	0.0	1

=====
END
=====

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 100 Years

- Run# 14 Insufficient capacity.
HGL elevation below invert. Downstream HGL set to soffit elevation at Run# 6
- HGL elevation below invert. Downstream HGL set to soffit elevation at Run# 13
- Run# 6 Insufficient capacity.
- Run# 13 Insufficient capacity.
- Run# 5 Insufficient capacity.
- Run# 12 Insufficient capacity.
- Run# 4 Insufficient capacity.
- Run# 11 Insufficient capacity.
- Run# 3 Insufficient capacity.
- Run# 2 Insufficient capacity.
- Run# 1 Insufficient capacity.

HouStorm (City Of Houston STORM DRAIN DESIGN)
 Nov/01/2007

Version 2.1, Update:

Run @ 1/31/2017 8:31:05 AM

PROJECT NAME : N-2016T-0004
 JOB NUMBER : 345023
 PROJECT DESCRIPTION : Drainage System W0530-1 100-Year
 PROJECT File: Q:\2014\345023\Models\Houstorm\N-2016T-0004\100-YEAR\SYSTEM_K 10
 DESIGN FREQUENCY : 100 Years
 MEASUREMENT UNITS: ENGLISH

OUTPUT FOR DESIGN FREQUENCY of: 100 Years

Runoff Computation for Design Frequency.

ID	C Value	Area (acre)	Tc (min)	Tc Used (min)	Intensity (in/hr)	Supply Q (cfs)	Total Q (cfs)
KA-1	0.756	2.47	26.72	26.72	6.82	0.000	12.718
KB-4	0.3	0.49	23.83	23.83	7.14	0.000	1.060
KB-3	0.65	1.35	25.54	25.54	6.95	0.000	6.080
KB-2	0.599	2.16	26.45	26.45	6.85	0.000	8.855
KB-1	0.748	2.00	26.30	26.30	6.87	0.000	10.288
KA-4	0.546	2.44	26.70	26.70	6.82	0.000	9.098
KA-3	0.688	2.07	26.36	26.36	6.86	0.000	9.757
KA-2	0.755	2.21	26.50	26.50	6.84	0.000	11.423

Cumulative Junction Discharge Computations

Node I.D.	Node Type	Weighted C-Value	Cumulat. Dr. Area (acres)	Cumulat. Tc (min)	Intens. (in/hr)	User Supply Q (cfs)	Additional Q in Node (cfs)	Total Disch. (cfs)
KB-4	CrcMh	0.300	0.49	23.83	7.14		0.00	1.060
KB-3	CrcMh	0.556	1.84	25.54	6.95		0.00	7.111
KB-2	CrcMh	0.579	4.00	26.77	6.82		-5.50	10.287
KB-1	CrcMh	0.636	6.00	28.00	6.69		-7.00	18.517
KA-4	CrcMh	0.546	2.44	26.70	6.82		0.00	9.098
KA-3	CrcMh	0.611	4.51	27.95	6.69		-8.10	10.348
KA-2	CrcMh	0.648	12.72	29.37	6.55		-23.90	30.110
KA-1	CrcMh	0.665	15.19	30.28	6.47		-23.90	41.458
KA-OUT	Outlt	0.665	15.19	30.28	6.47		-23.90	41.458

Conveyance Configuration Data

Run #	Node US	Node DS	FlowLine US (ft)	Elev. DS (ft)	Shape #	Span (ft)	Rise (ft)	Length (ft)	Slope (%)	n_value
1	KB-4	KB-3	48.83	48.64	Cir 1	0.00	2.00	94.0	0.200	0.013
2	KB-3	KB-2	48.64	48.12	Cir 1	0.00	2.00	258.0	0.200	0.013
3	KB-2	KB-1	47.62	47.08	Cir 1	0.00	2.00	271.0	0.200	0.013
4	KB-1	KA-2	46.58	45.88	Cir 1	0.00	2.50	349.0	0.200	0.013

5	KA-4	KA-3	48.47	47.92	Cir 1	0.00	2.00	273.0	0.200	0.013
6	KA-3	KA-2	47.92	47.38	Cir 1	0.00	2.00	270.0	0.200	0.013
7	KA-2	KA-1	45.88	45.35	Cir 1	0.00	3.00	264.0	0.200	0.013
8	KA-1	KA-OUT	45.35	44.80	Cir 1	0.00	3.00	279.0	0.200	0.013

Conveyance Hydraulic Computations. Tailwater = 49.790 (ft)

Run #	Hyd. Gr.line		Crit.Elev US (ft)	Fr.Slope (%)	Depth		Velocity		Q (cfs)	Cap (cfs)	Junc Loss (ft)
	US (ft)	DS (ft)			Unif. (ft)	Actual (ft)	Unif. (f/s)	Actual (f/s)			
1	53.10	52.92	55.78	0.002	0.44	2.00	2.08	0.34	1.1	10.2	0.000
2	52.92	52.65	53.57	0.098	1.23	2.00	3.49	2.26	7.1	10.2	0.000
3	52.65	52.10	52.89	0.205	1.67	2.00	3.67	3.27	10.3	10.2	0.000
4	52.10	51.39	52.86	0.202	2.07	2.50	4.26	3.77	18.5	18.4	0.000
5	52.06	51.95	53.91	0.160	1.48	2.00	3.64	2.90	9.1	10.2	0.000
6	51.95	51.39	54.35	0.207	1.69	2.00	3.66	3.29	10.3	10.2	0.000
7	51.39	50.86	53.81	0.202	2.48	3.00	4.81	4.26	30.1	30.0	0.000
8	50.86	49.79	54.57	0.383	3.00	3.00	5.87	5.87	41.5	30.0	0.000

SUMMARY OF STORM DRAIN STRUCTURE QUANTITIES

NOTE:

The convey length should be from upstream to downstream inside box.
This length may also be used as Pay Item.
Using hydraulic length, from node center to node center, may result in profile error,
and this length should not be used as Pay Item.

LINKS:

Type of Convey Structure	Material	Rise (ft)	Span (ft)	Number of Links of this type	Quantity (ft)
Circular	Concrete	2.0	0.0	5	1166.0
Circular	Concrete	2.5	0.0	1	349.0
Circular	Concrete	3.0	0.0	2	543.0

NODES:

Type of Inlet Structure	Type of Inlet	Type of Grate	Inlet Length (ft)	Grate Width (ft)	Grate Length (ft)	Grate Area (ft)	Grate Perimeter (ft)	Quantity (each)
Circular Manhole			0.0	0.0	0.0	0.0	0.0	8
Outlet			0.0	0.0	0.0	0.0	0.0	1

END

NORMAL TERMINATION OF HOUSTORM.

Warning Messages for current project:

Runoff Frequency of: 100 Years
Run# 8 Insufficient capacity.
Run# 7 Insufficient capacity.
Run# 4 Insufficient capacity.
Run# 6 Insufficient capacity.

Run# 3 Insufficient capacity.

ATTACHMENT 2

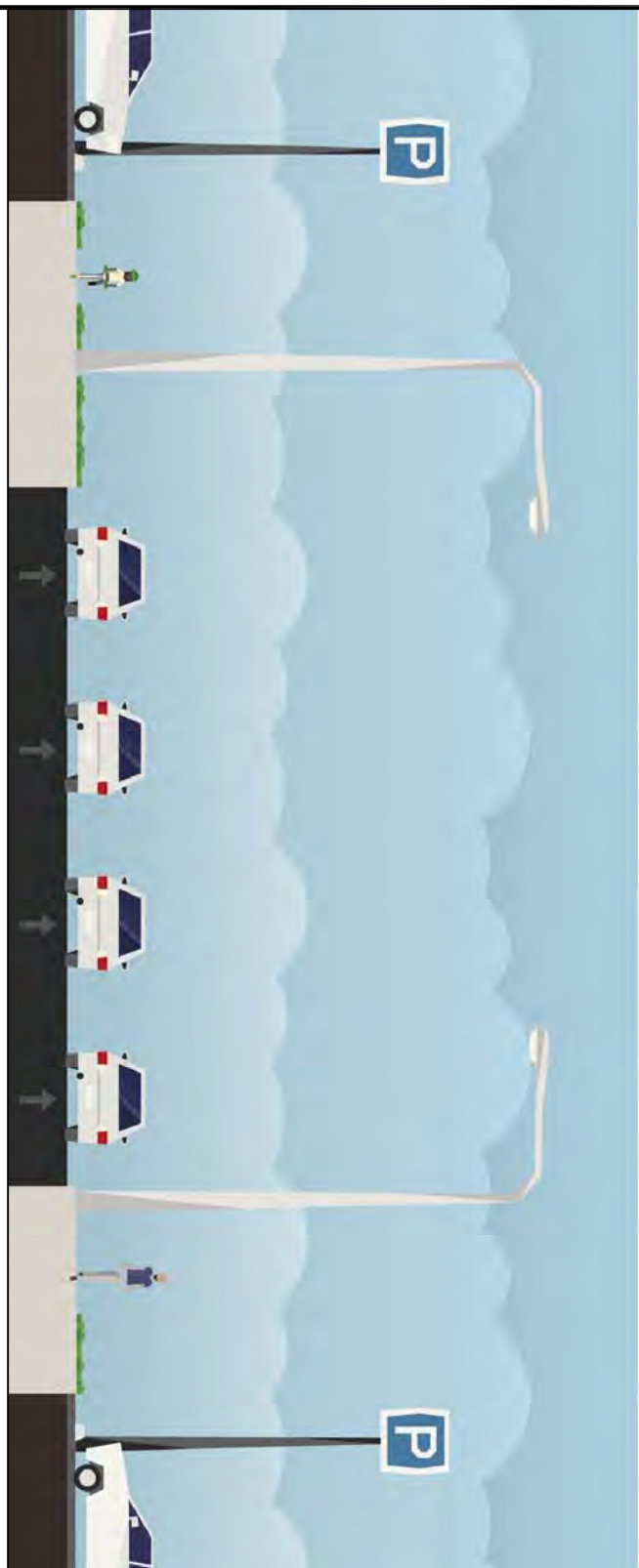
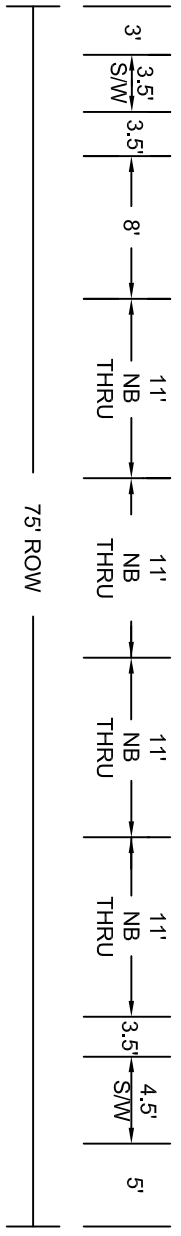
DETENTION CALCULATIONS

&

TYPICAL SECTIONS

TYPICAL SECTIONS

Shepherd Drive West 8th to West 11th Street



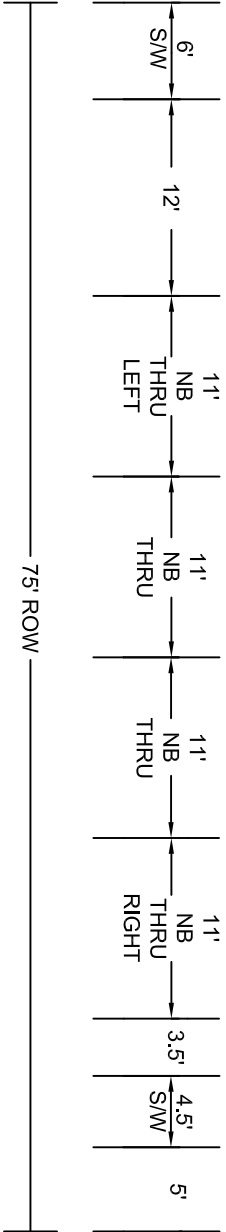
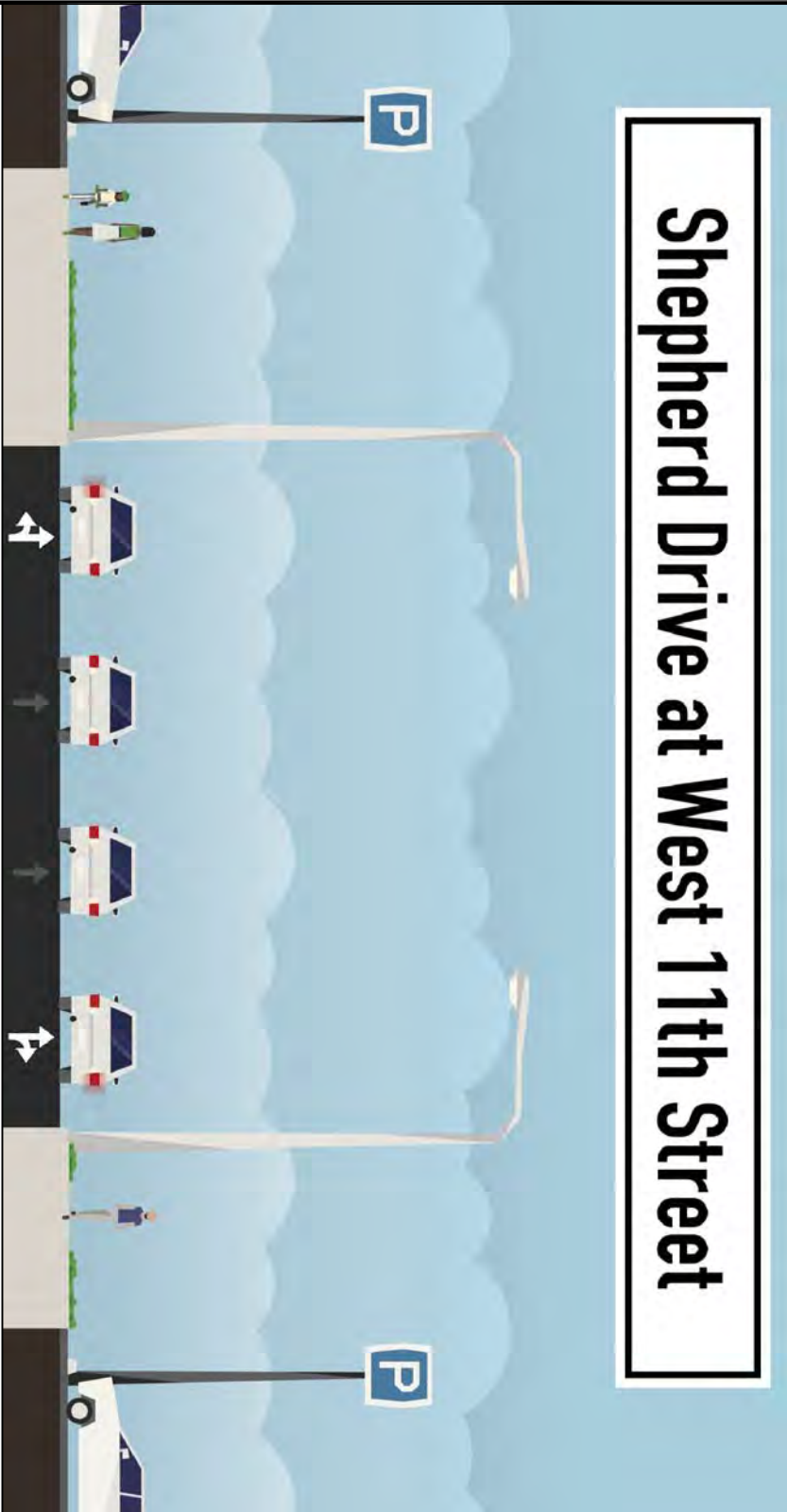
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CITY OF HOUSTON
N-2016T-0004
SHEPHERD DRIVE AND
DURHAM DRIVE
W. 6TH STREET TO
W. 11TH STREET

SHEET TITLE:
EXISTING CROSS
SECTIONS

14013-21

GUNDA PROJ NO: 14013-21	SHEET NO: EXHIBIT E3
DATE: JULY, 2016	

Shepherd Drive at West 11th Street



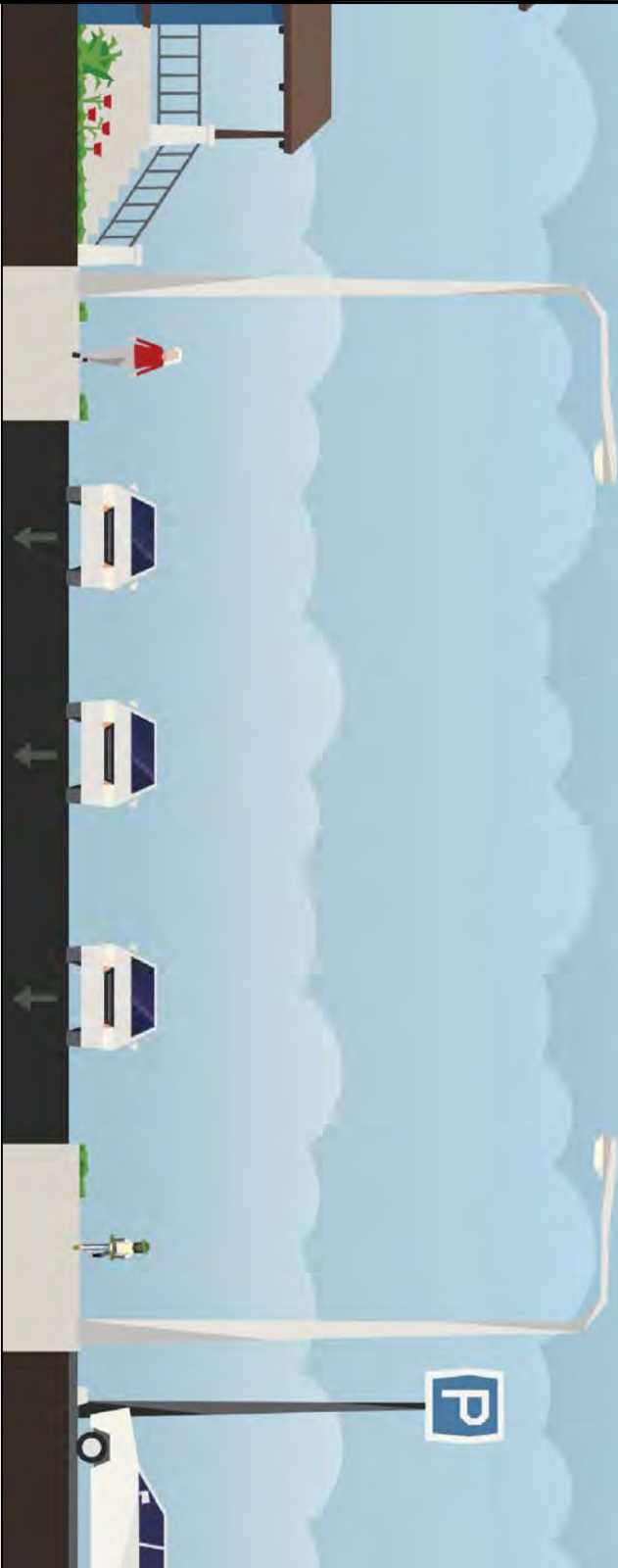
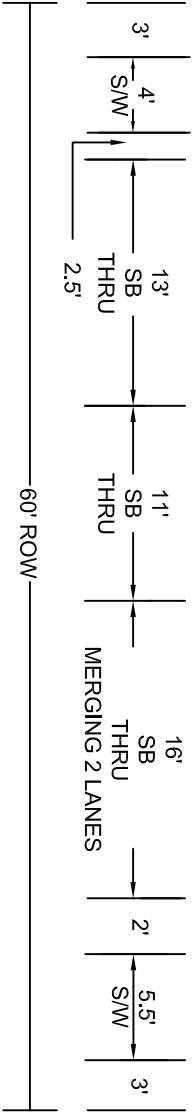
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 CITY OF HOUSTON
 N-2016T-0004
 SHEPHERD DRIVE AND
 DURHAM DRIVE
 W. 6TH STREET TO
 W. 11TH STREET

SHEET TITLE:
 EXISTING CROSS
 SECTIONS

14013-21

GUNDA PROJ NO: 14013-21	SHEET NO: EXHIBIT E3
DATE: JULY, 2016	

Durham Drive at West 8th Street



PROJECT NAME:

CITY OF HOUSTON
N-2016T-0004
SHEPHERD DRIVE AND
DURHAM DRIVE

W. 6TH STREET TO
W. 11TH STREET

SHEET TITLE:

EXISTING CROSS
SECTIONS

14013-21

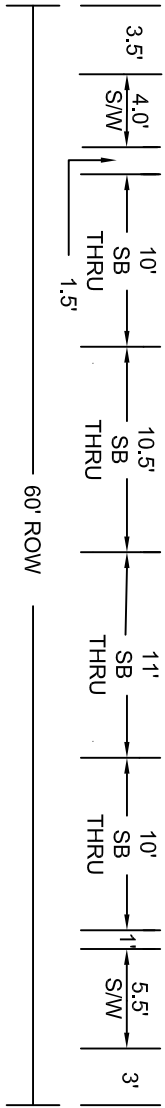
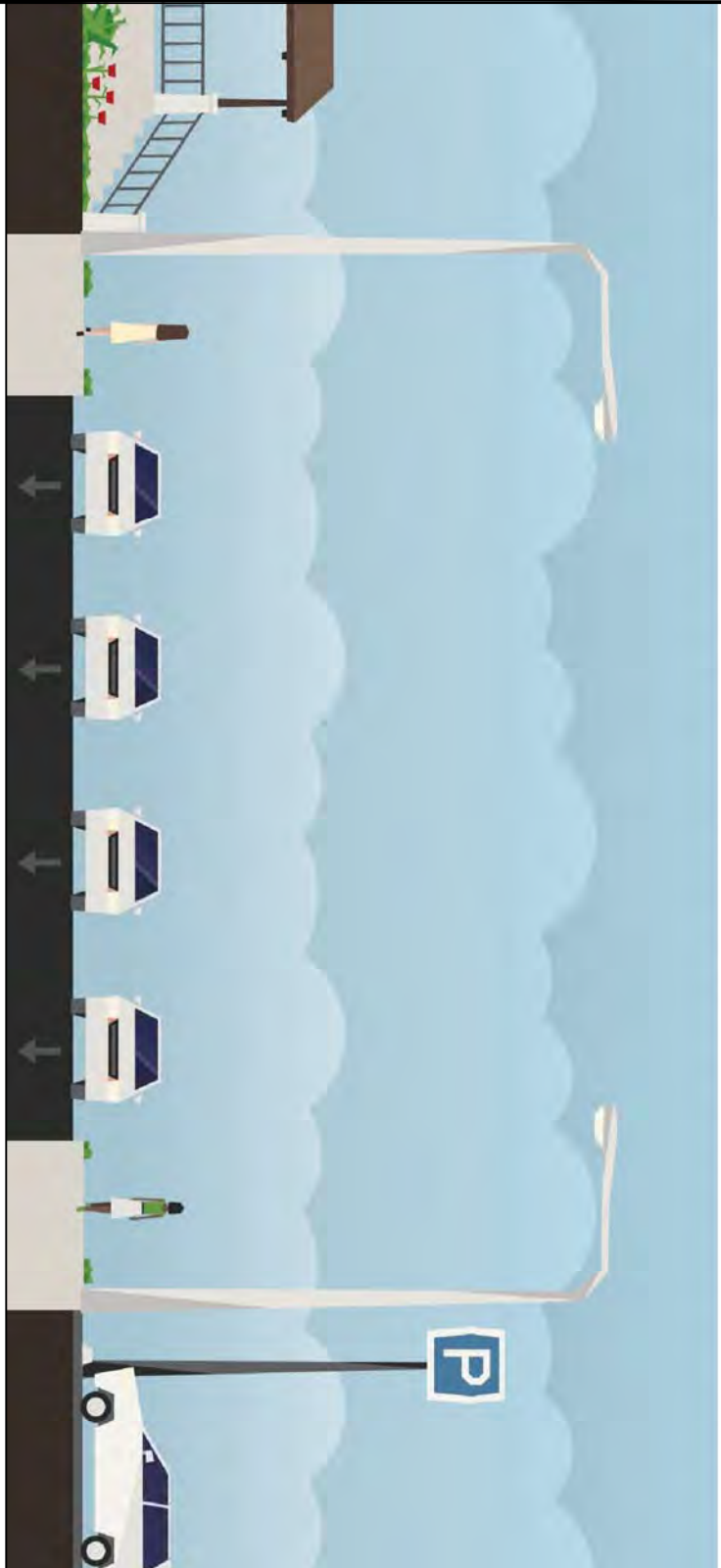
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14013-21

DATE:
JULY, 2016

SHEET NO:

EXHIBIT E3

Durham Drive West 8th to West 11th Street



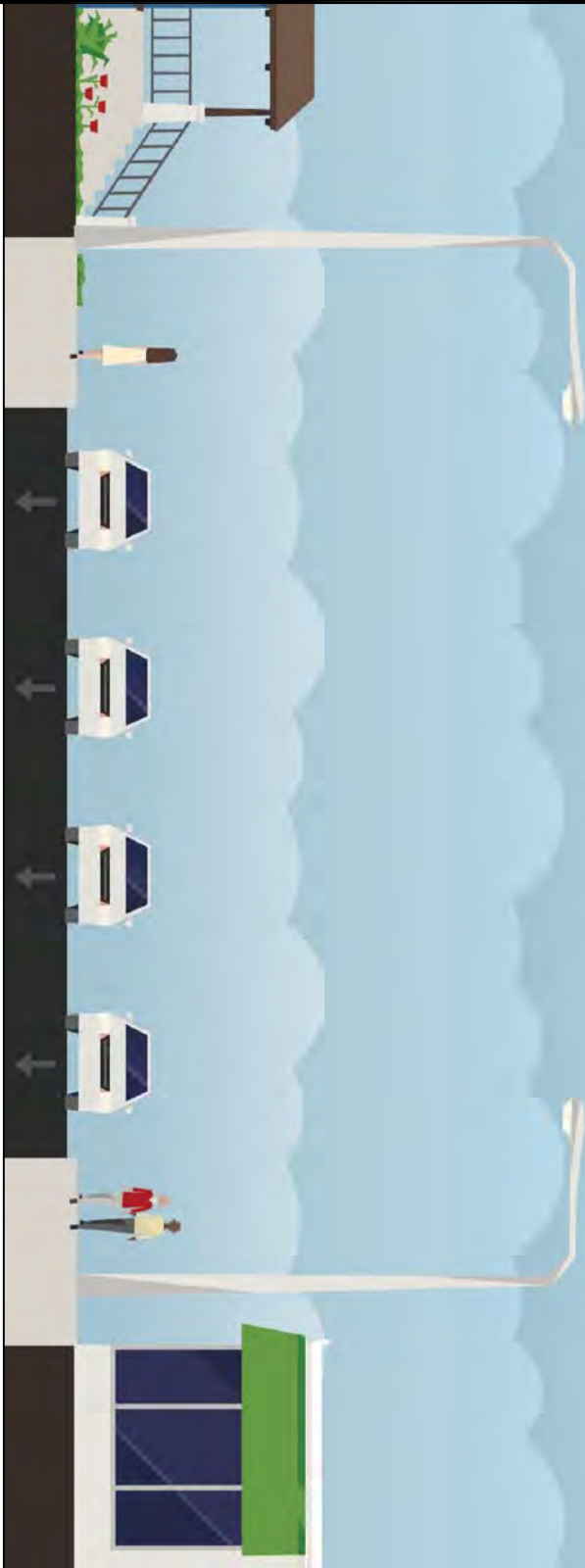
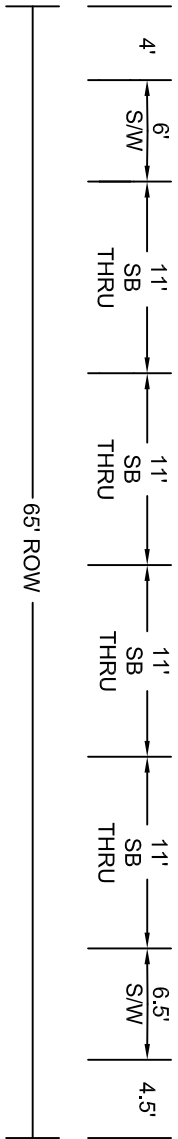
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CITY OF HOUSTON
N-2016T-0004
SHEPHERD DRIVE AND
DURHAM DRIVE
W. 6TH STREET TO
W. 11TH STREET

SHEET TITLE:
EXISTING CROSS
SECTIONS

14013-21

GUNDA PROJ NO: 14013-21	SHEET NO: EXHIBIT E3
DATE: JULY, 2016	

Durham Drive at West 11th Street



PROJECT NAME:

CITY OF HOUSTON
N-2016T-0004
SHEPHERD DRIVE AND
DURHAM DRIVE

W. 6TH STREET TO
W. 11TH STREET

SHEET TITLE:

EXISTING CROSS
SECTIONS

14013-21

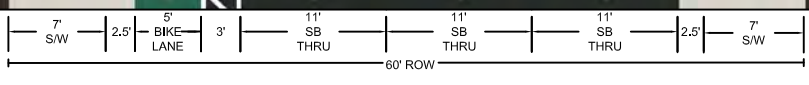
GUNDA PROJ NO:
14013-21

DATE:
JULY, 2016

SHEET NO:

EXHIBIT E3

Durham Drive (Alt. 2)



GUNDA CORPORATION
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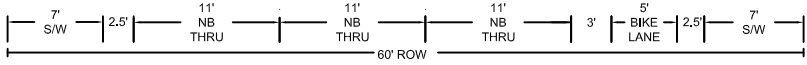
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CITY OF HOUSTON
N-2016T-0004
SHEPHERD DRIVE AND
DURHAM DRIVE
W. 6TH STREET TO W. 11TH
STREET

SHEET TITLE:
PROPOSED CROSS
SECTIONS

14013-21

GUNDA PROJ NO: 14013-21	SHEET NO: EXHIBIT 3
DATE: JUL., 2016	

Shepherd Drive (Alt. 2)



GUNDA CORPORATION
 P:\2014 Projects\14013-21 COH Pre-Engineering\14013-21_Son Felipe_Shepherd_CAD\1401321-N-2016T-0004-1-08Shepherd_Alt2.dwg Jul 07, 2016-2:54pm aruz



PROJECT NAME:
 CITY OF HOUSTON
 N-2016T-0004
**SHEPHERD DRIVE AND
 DURHAM DRIVE**
 W. 6TH STREET TO W. 11TH
 STREET

SHEET TITLE:
**PROPOSED CROSS
 SECTIONS**
 14013-21
GUNDA PROJ NO:
14013-21 **SHEET NO:**
EXHIBIT 3
DATE:
JUL., 2016

DETENTION CALCULATIONS

Drainage System E0150, E0147, E0146, E0145, E0051, E0042, E0041, E0040, E0039, E0036, W530 Detention Summary

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston WBS No. N-000100-0002-3
 Project No.: 345023
 Location: Houston, Texas
 Date: 12/21/17
 Performed By: ML
 Checked By:

Drainage System ID: E0150, E0147, E0146, E0145, E0051, E0042, E0041, E0040, E0039, E0036, W530
 Alternative: 1

Condition	Drainage System	From Node	To Node	Cumulative		Number	Span	Rise	Length	Pipe Area	Flow	Velocity	Travel Time	Tc	Q		
				Area	C												
---	---	---	---	(ac)	---	---	(ft)	(ft)	(ft ²)	(cfs)	(ft/s)	(min)	(min)	(cfs)			
Existing	E0150 (North)	A9	A8	7.33	0.70	1	0	1.5	374	1.8	33.6	2.37	2.63	31.83	335.1		
		A8	A7	13.92	0.66	1	0	2.5	370	4.9	58.2	2.68	2.30	34.13			
		A7	A6	26.86	0.58	1	0	3.0	375	7.1	96.0	2.57	2.44	36.57			
		A6	A5	39.00	0.57	1	0	3.5	369	9.6	132.2	2.56	2.40	38.97			
		A5	A4	51.20	0.56	1	0	3.5	370	9.6	164.3	2.43	2.54	41.51			
		A4	A3	58.96	0.56	1	0	4.0	368	12.6	183.8	2.52	2.44	43.95			
		A3	A2	65.40	0.56	1	0	4.0	371	12.6	199.7	2.47	2.51	46.46			
		A2	A1	74.83	0.56	1	0	4.0	368	12.6	222.7	2.41	2.55	49.00			
		A11	A10	3.62	0.60	1	0	2.0	479	3.1	14.6	4.66	1.71	19.25			
		A10	A1	9.44	0.64	1	0	2.5	370	4.9	39.8	3.18	1.94	31.20			
		A1	A15	88.57	0.57	1	0	5.0	610	19.6	259.9	2.59	3.93	52.94			
		A15	A16	94.83	0.57	1	0	5.0	535	19.6	266.2	2.57	3.47	56.41			
		A16	A17	98.12	0.57	1	0	5.0	656	19.6	266.3	2.57	4.26	60.67			
		A17	A-OUT	128.49	0.57	1	0	5.0	30	19.6	335.7	2.43	0.21	60.87			
		A12	A13	3.51	0.55	1	0	2.0	484	3.1	13.0	4.15	1.95	29.42			
		E0150 (South)	A13	A14	8.20	0.58	1	0	2.0	563	3.1	31.1	2.87	3.27		32.69	44.5
			A14	A-OUT	11.63	0.61	1	0	2.0	56	3.1	44.7	2.53	0.37		33.06	
	E0147 (A)	B18	B17	5.31	0.70	1	0	1.5	365	1.8	24.8	2.54	2.39	30.81	141.8		
		B17	B16	10.88	0.65	1	0	3.0	372	7.1	45.5	3.75	1.66	32.46			
		B16	B15	15.21	0.65	1	0	3.0	182	7.1	62.4	3.03	1.00	33.47			
		B15	B14	18.17	0.66	1	0	3.0	190	7.1	74.2	2.80	1.13	34.60			
		B14	B13	23.06	0.66	1	0	3.5	366	9.6	92.8	2.90	2.10	36.70			
		B13	B12	28.53	0.67	1	0	3.5	371	9.6	113.4	2.68	2.30	39.00			
		B12	B-OUT	37.97	0.68	1	0	4.0	694	12.6	149.2	2.68	4.32	43.32			
		B11	B12	4.37	0.65	1	0	1.5	367	1.8	19.1	2.77	2.21	30.18			
		B10	B9	4.43	0.63	1	0	1.5	366	1.8	18.6	2.79	2.18	30.18			
		E0147 (B)	B9	B-OUT	8.90	0.65	1	0	2.0	72	3.1	37.2	2.68	0.45		30.63	37.0
	E0147 (C)	B7	B6	9.33	0.69	1	0	2.0	369	3.1	42.2	2.58	2.39	32.21	542.8		
		B6	B5	12.01	0.68	1	0	2.0	195	3.1	51.8	2.44	1.33	33.53			
		B5	B4	13.96	0.68	1	0	2.5	177	4.9	58.4	2.67	1.10	34.64			
		B4	B3	141.37	0.62	1	0	8.0	293	50.3	504.4	2.85	1.71	36.35			
		B3	B2	144.17	0.62	1	0	8.0	249	50.3	528.5	2.80	1.48	37.83			
		B2	B1	148.40	0.62	1	0	8.0	143	50.3	533.6	2.79	0.85	38.69			
		B1-1	B1	4.78	0.59	1	0	2.0	332	3.1	18.8	4.00	1.38	29.55			
		B1	B-OUT	153.17	0.62	1	0	8.0	104	50.3	547.0	2.76	0.63	39.32			
	E0146	C3	C2	221.73	0.59	1	7	6.0	296	42.0	737.2	2.41	2.05	42.93	712.5		
		C2	C1	225.09	0.59	1	7	6.0	253	42.0	730.9	2.42	1.74	44.68			
		C1	C-OUT	228.45	0.59	1	7	6.0	251	42.0	726.4	2.42	1.73	46.41			
	E0145 (A)	DA-3	DA-2	36.65	0.56	1	0	3.0	333	7.1	126.7	2.40	2.31	36.17	136.8		
		DA-2	DA-1	39.35	0.57	1	0	3.5	255	9.6	133.0	2.55	1.66	37.83			
		DA-1	DA-OUT	42.07	0.57	1	0	3.5	247	9.6	139.6	2.52	1.63	39.46			
	E0145 (B)	DB-1-2A	DB-1-2	26.08	0.50	1	0	3.0	515	7.1	82.3	2.69	3.19	35.94	225.2		
DB-1-2		DB-1	35.30	0.52	1	0	5.0	665	19.6	110.6	4.28	2.59	38.54				
DB-3		DB-2	25.84	0.51	1	0	4.0	263	12.6	82.4	3.69	1.19	33.92				
DB-2		DB-1	32.23	0.54	1	0	4.0	250	12.6	107.4	3.08	1.35	35.27				
DB-1-1		DB-1	2.39	0.55	1	0	2.0	225	3.1	9.0	2.87	1.31	27.96				
	DB-1	DB-OUT	73.86	0.54	1	0	5.5	269	23.8	229.5	2.90	1.55	40.08				

Drainage System E0150, E0147, E0146, E0145, E0051, E0042, E0041, E0040, E0039, E0036, W530 Detention Summary

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston WBS No. N-000100-0002-3
 Project No.: 345023
 Location: Houston, Texas
 Date: 12/21/17
 Performed By: ML
 Checked By:

Drainage System ID: E0150, E0147, E0146, E0145, E0051, E0042, E0041, E0040, E0039, E0036, W530
 Alternative: 1

Condition	Drainage System	From Node	To Node	Cumulative		Number	Span (ft)	Rise (ft)	Length (ft)	Pipe Area (ft2)	Flow (cfs)	Velocity (ft/s)	Travel Time (min)	Tc (min)	Q (cfs)
				Area (ac)	C										
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Existing Cont.	E0051	E1	E-OUT	2.40	0.76	1	0	1.8	206	2.4	12.4	4.77	0.72	27.39	12.3
	E0042	F7	F6	1.61	0.80	1	0	1.5	273	1.8	8.9	4.94	0.92	26.80	59.3
		F6	F5	4.17	0.80	1	0	1.8	277	2.5	22.7	3.01	1.53	28.33	
		F5	F4	7.17	0.80	1	0	2.0	466	3.1	38.2	2.66	2.93	31.25	
		F4	F3	11.06	0.75	1	0	2.5	499	4.9	53.0	2.77	3.00	34.26	
		F3	F2	13.91	0.68	1	0	2.5	294	4.9	57.7	2.68	1.83	36.08	
		F2	F1	15.70	0.64	1	0	3.0	142	7.1	60.1	3.09	0.77	36.85	
		F1	F-OUT	16.48	0.64	1	0	3.0	779	7.1	62.6	3.03	4.29	41.14	
	E0041	G9	G8	8.84	0.79	1	0	3.0	694	7.1	45.4	3.75	3.08	32.76	178.9
		G8	G7	22.06	0.73	1	0	3.0	699	7.1	100.3	2.54	4.59	37.35	
		G7	G6	28.66	0.73	1	0	3.0	607	7.1	122.7	2.42	4.18	41.54	
		G6	G5	32.50	0.70	1	0	3.0	502	7.1	127.8	2.40	3.49	45.03	
		G5	G4	34.08	0.70	1	0	3.0	106	7.1	127.4	2.40	0.74	45.76	
		G4	G3	35.97	0.69	1	0	3.5	522	9.6	132.0	2.56	3.40	49.16	
		G3	G2	45.93	0.68	1	0	3.5	296	9.6	160.4	2.44	2.02	51.18	
		G2	G1	54.47	0.68	1	0	3.5	341	9.6	184.9	2.37	2.40	53.58	
	E0040	H3	H2	2.24	0.77	1	0	2.0	267	3.1	11.8	3.75	1.19	27.71	33.1
		H2	H1	4.54	0.69	1	0	2.0	261	3.1	21.1	3.61	1.21	28.92	
		H1	H-OUT	7.61	0.67	1	0	2.5	157	4.9	33.4	3.57	0.73	29.65	
	E0039	I2	I1	5.11	0.71	1	0	3.0	264	7.1	24.1	3.41	1.29	29.62	38.5
		I1	I-OUT	8.57	0.69	1	0	3.0	157	7.1	38.9	4.40	0.59	30.21	
	E0036	JB-7	JB-6	1.34	0.46	1	0	1.8	124	2.5	4.3	1.69	1.22	26.76	141.5
		JB-6	JB-5	2.90	0.60	1	0	1.8	261	2.5	11.9	4.66	0.93	27.69	
		JB-5	JB-4	5.07	0.64	1	0	3.0	265	7.1	21.9	3.10	1.43	29.12	
		JB-4	JB-3	7.45	0.67	1	0	3.0	260	7.1	32.9	4.65	0.93	30.05	
		JB-3	JB-2	9.93	0.67	1	0	3.0	271	7.1	43.2	3.93	1.15	31.20	
		JB-2	JB-1	12.33	0.68	1	0	3.0	253	7.1	53.4	3.32	1.27	32.47	
		JB-1	J1	14.30	0.70	1	0	3.0	228	7.1	62.8	3.02	1.26	33.73	
		JA-5	JA-4	9.61	0.57	1	0	2.0	265	3.1	35.6	2.72	1.62	31.52	
		JA-4	JA-3	12.48	0.60	1	0	2.5	266	4.9	47.4	2.90	1.53	33.05	
		JA-3	JA-2	16.31	0.61	1	0	2.5	267	4.9	61.6	2.63	1.69	34.74	
		JA-2	JA-1	20.36	0.63	1	0	2.5	255	4.9	77.5	2.47	1.72	36.46	
		JA-1	J1	22.40	0.65	1	0	3.0	125	7.1	86.1	2.65	0.79	37.25	
		J1	J-OUT	36.70	0.67	1	0	3.0	211	7.1	144.2	2.34	1.50	38.75	
	W0530	KB-3	KB-2	1.84	0.56	1	0	1.5	258	1.8	7.0	3.99	1.08	27.21	62.2
		KB-2	KB-1	4.00	0.58	1	0	1.5	271	1.8	15.7	3.02	1.49	28.71	
		KB-1	KA-2	6.00	0.64	1	0	1.5	349	1.8	25.2	2.53	2.30	31.01	
		KA-4	KA-3	2.44	0.55	1	0	1.5	273	1.8	9.1	4.79	0.95	27.65	
		KA-3	KA-2	4.51	0.61	1	0	1.8	270	2.5	18.5	3.40	1.32	28.98	
		KA-2	KA-1	12.72	0.65	1	0	3.0	264	7.1	52.7	3.34	1.32	32.32	
		KA-1	KA-OUT	15.19	0.67	1	0	3.0	279	7.1	63.5	3.00	1.55	33.87	

Drainage System E0150, E0147, E0146, E0145, E0051, E0042, E0041, E0040, E0039, E0036, W530 Detention Summary

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston WBS No. N-000100-0002-3
 Project No.: 345023
 Location: Houston, Texas
 Date: 12/21/17
 Performed By: ML
 Checked By:

Drainage System ID: E0150, E0147, E0146, E0145, E0051, E0042, E0041, E0040, E0039, E0036, W530
 Alternative: 1

Condition	Drainage System	From Node	To Node	Cumulative		Number	Span	Rise	Length	Pipe Area	Flow	Velocity	Travel Time	Tc	Q
				Area	C										
---	---	---	---	(ac)	---	---	(ft)	(ft)	(ft)	(ft ²)	(cfs)	(ft/s)	(min)	(min)	(cfs)
Proposed	E0150 (North)	A15	A16	6.27	0.54	1	0	5.0	535	19.6	22.3	1.14	7.84	36.66	123.5
		A16	A17	9.56	0.55	1	0	5.0	656	19.6	31.2	1.59	6.87	43.53	
		A17	A-OUT	39.92	0.57	1	0	5.0	30	19.6	123.7	3.82	0.13	43.66	
	E0150 (South)	A9	A8	7.33	0.70	1	0.0	2.5	374	4.9	33.6	3.56	1.75	30.95	276.4
		A8	A7	13.92	0.66	1	0.0	3.0	370	7.1	58.9	3.12	1.97	32.93	
		A7	A6	26.86	0.58	1	0.0	3.5	375	9.6	97.6	2.84	2.20	35.13	
		A6	A5	39.00	0.57	1	0.0	3.5	369	9.6	134.7	2.55	2.42	37.55	
		A5	A4	51.20	0.56	2	0.0	3.5	370	19.2	167.3	3.05	2.02	39.56	
		A4	A3	58.96	0.56	2	0.0	3.5	368	19.2	188.1	2.89	2.13	41.69	
		A3	A2	65.40	0.56	2	0.0	4.0	371	25.1	205.0	3.16	1.95	43.64	
		A2	A1	74.83	0.56	2	0.0	4.0	368	25.1	229.8	2.98	2.06	45.71	
		A1	A10	79.12	0.56	2	0.0	4.0	372	25.1	237.1	2.93	2.11	47.82	
		A10	A11	84.95	0.57	2	0.0	4.0	370	25.1	251.9	2.85	2.16	49.98	
		A11	A12	88.57	0.57	2	6.0	4.0	479	48.0	257.2	4.54	1.76	51.74	
		A12	A13	92.08	0.57	2	6.0	4.0	484	48.0	262.3	4.44	1.82	53.56	
		A13	A14	96.77	0.57	2	6.0	4.0	563	48.0	271.3	4.26	2.20	55.76	
		A14	A-OUT	100.20	0.58	2	6.0	4.0	56	48.0	277.0	4.17	0.22	55.98	
	E0147 (A)	B18	B17	5.31	0.70	1	0	2.0	365	3.1	24.8	3.23	1.88	30.30	143.9
		B17	B16	10.88	0.65	1	0	3.0	372	7.1	45.8	3.72	1.67	31.97	
		B16	B15	15.21	0.65	1	0	3.0	182	7.1	62.8	3.02	1.00	32.97	
		B15	B14	18.17	0.66	1	0	3.0	190	7.1	74.7	2.79	1.13	34.11	
		B14	B13	23.06	0.66	1	0	3.5	366	9.6	93.4	2.89	2.11	36.21	
		B13	B12	28.53	0.67	1	0	3.5	371	9.6	114.1	2.68	2.31	38.52	
		B12	B-OUT	37.97	0.68	1	0	5.0	694	19.6	150.1	3.29	3.51	42.04	
	E0147 (B)	B10	B9	4.43	0.63	1	0	2.0	366	3.1	18.6	4.05	1.51	29.50	37.3
		B9	B-OUT	8.90	0.65	1	0	2.0	72	3.1	37.6	2.67	0.45	29.95	
	E0147 (C)	B8	B7	4.66	0.79	1	0	2.0	373	3.1	24.5	3.25	1.91	30.02	541.5
		B7	B6	9.33	0.69	1	0	2.0	369	3.1	42.1	2.58	2.39	32.41	
		B6	B5	12.01	0.68	1	0	2.0	195	3.1	51.6	2.45	1.33	33.74	
		B5	B4	13.96	0.68	1	0	2.5	177	4.9	58.3	2.68	1.10	34.84	
		B4	B3	141.37	0.62	1	0	8.0	293	50.3	504.4	2.85	1.71	36.55	
		B3	B2	144.17	0.62	1	0	8.0	249	50.3	527.1	2.80	1.48	38.03	
		B2	B1	148.40	0.62	1	0	8.0	143	50.3	532.2	2.79	0.85	38.89	
		B1-1	B1	4.78	0.59	1	0	2.0	332	3.1	18.8	4.00	1.38	29.55	
	B1	B-OUT	153.17	0.62	1	0	8.0	104	50.3	545.7	2.76	0.63	39.52		
	E0146	C3	C2	221.73	0.59	1	10	8.0	296	80.0	737.2	2.97	1.66	42.55	720.7
		C2	C1	225.09	0.59	1	10	8.0	253	80.0	734.1	2.97	1.42	43.97	
		C1	C-OUT	228.45	0.59	1	10	8.0	251	80.0	732.2	2.98	1.41	45.38	
	E0145 (A)	DA-3	DA-2	36.65	0.56	1	0	4.0	333	12.6	126.7	2.85	1.95	35.81	138.6
		DA-2	DA-1	39.35	0.57	1	0	4.5	255	15.9	133.6	3.11	1.37	37.17	
		DA-1	DA-OUT	42.07	0.57	1	0	5.0	247	19.6	140.7	3.44	1.20	38.37	
	E0145 (B)	DB-1-2A	DB-1-2	26.08	0.50	1	0	3.0	515	7.1	82.3	2.69	3.19	35.94	225.2
		DB-1-2	DB-1	35.30	0.52	1	0	5.0	665	19.6	110.6	4.28	2.59	38.54	
		DB-3	DB-2	25.84	0.51	1	0	4.0	263	12.6	82.4	3.69	1.19	33.92	
		DB-2	DB-1	32.23	0.54	1	0	4.0	250	12.6	107.4	3.08	1.35	35.27	
		DB-1-1	DB-1	2.39	0.55	1	0	2.0	225	3.1	9.0	2.87	1.31	27.96	
		DB-1	DB-OUT	73.86	0.54	1	0	5.5	269	23.8	229.5	2.90	1.55	40.08	

Drainage System E0150, E0147, E0146, E0145, E0051, E0042, E0041, E0040, E0039, E0036, W530 Detention Summary

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston WBS No. N-000100-0002-3
 Project No.: 345023
 Location: Houston, Texas
 Date: 12/21/17
 Performed By: ML
 Checked By:

Drainage System ID: E0150, E0147, E0146, E0145, E0051, E0042, E0041, E0040, E0039, E0036, W530
 Alternative: 1

Condition	Drainage System	From Node	To Node	Cumulative		Number	Span	Rise	Length	Pipe Area	Flow	Velocity	Travel Time	Tc	Q
				Area	C										
---	---	---	---	(ac)	---	---	(ft)	(ft)	(ft2)	(cfs)	(ft/s)	(min)	(min)	(cfs)	
Proposed Cont.	E0051	E1	E-OUT	2.40	0.76	1	0	2.0	206	3.1	12.4	3.96	0.87	27.53	12.3
	E0042	F7	F6	1.61	0.80	1	0	2.0	273	3.1	8.9	2.83	1.61	27.48	58.5
		F6	F5	4.17	0.80	1	0	2.0	277	3.1	22.5	3.44	1.34	28.82	
		F5	F4	7.17	0.80	1	0	2.0	466	3.1	37.9	2.66	2.92	31.74	
		F4	F3	11.06	0.75	1	0	2.5	499	4.9	52.7	2.78	3.00	34.74	
		F3	F2	13.91	0.68	1	0	2.5	294	4.9	57.4	2.69	1.82	36.56	
		F2	F1	15.70	0.64	1	0	3.0	142	7.1	59.8	3.10	0.76	37.32	
		F1	F-A	16.48	0.64	1	0	3.0	513	7.1	62.2	3.03	2.82	40.14	
		F-A	F-B	16.48	0.64	1	0	3.5	448	9.6	60.1	3.85	1.94	42.08	
	F-B	F-OUT	16.48	0.64	1	0	4.0	56	12.6	58.7	4.67	0.20	42.28		
	E0041	G9	G8	8.84	0.79	1	0	3.0	694	7.1	45.4	3.75	3.08	32.76	185.4
		G8	G7	22.06	0.73	1	0	3.0	699	7.1	100.3	2.54	4.59	37.35	
		G7	G6	28.66	0.73	1	0	3.5	607	9.6	122.7	2.62	3.87	41.22	
		G6	G5	32.50	0.70	1	0	4.0	502	12.6	128.3	2.83	2.95	44.17	
		G5	G4	34.08	0.70	1	0	4.5	106	15.9	128.6	3.18	0.56	44.73	
		G4	G3	35.97	0.69	1	0	5.0	522	19.6	133.5	3.58	2.43	47.16	
		G3	G2	45.93	0.68	1	0	5.5	296	23.8	163.9	3.54	1.39	48.55	
		G2	G1	54.47	0.68	1	0	5.5	341	23.8	190.1	3.20	1.78	50.33	
	G1	G-OUT	54.47	0.68	1	0	6.0	133	28.3	186.6	3.67	0.60	50.94		
	E0040	H3	H2	2.24	0.77	1	0	2.0	267	3.1	11.8	3.75	1.19	27.71	33.1
		H2	H1	4.54	0.69	1	0	2.0	261	3.1	21.1	3.61	1.21	28.92	
		H1	H-OUT	7.61	0.67	1	0	2.5	157	4.9	33.4	3.57	0.73	29.65	
	E0039	I2	I1	5.11	0.71	1	0	3.0	264	7.1	24.1	3.41	1.29	29.62	38.5
		I1	I-OUT	8.57	0.69	1	0	3.0	157	7.1	38.9	4.40	0.59	30.21	
	E0036	JB-7	JB-6	1.34	0.46	1	0	2.0	124	3.1	4.3	1.37	1.51	27.04	141.8
		JB-6	JB-5	2.90	0.60	1	0	2.0	261	3.1	11.8	3.76	1.16	28.20	
		JB-5	JB-4	5.07	0.64	1	0	3.0	265	7.1	21.7	3.07	1.44	29.64	
		JB-4	JB-3	7.45	0.67	1	0	3.0	260	7.1	32.6	4.62	0.94	30.58	
		JB-3	JB-2	9.93	0.67	1	0	3.0	271	7.1	42.9	3.95	1.14	31.72	
		JB-2	JB-1	12.33	0.68	1	0	3.0	253	7.1	53.0	3.34	1.26	32.98	
		JB-1	J1	14.30	0.70	1	0	3.5	228	9.6	62.4	3.72	1.02	34.01	
		JA-6	JA-5	7.68	0.55	1	0	2.0	302	3.1	27.9	3.02	1.67	30.98	
		JA-5	JA-4	9.61	0.57	1	0	2.5	265	4.9	35.1	3.45	1.28	32.27	
		JA-4	JA-3	12.48	0.60	1	0	3.0	266	7.1	46.9	3.65	1.21	33.48	
		JA-3	JA-2	16.31	0.61	1	0	3.0	267	7.1	61.3	3.06	1.45	34.93	
		JA-2	JA-1	20.36	0.63	1	0	3.0	255	7.1	77.3	2.76	1.54	36.48	
		JA-1	J1	22.40	0.65	1	0	3.5	125	9.6	86.1	3.01	0.69	37.17	
		J1	J-OUT	36.70	0.67	1	0	3.5	211	9.6	144.3	2.50	1.41	38.58	
	W0530	KB-4	KB-3	0.49	0.30	1	0	2.0	94	3.1	1.1	0.34	4.64	28.48	60.9
		KB-3	KB-2	1.84	0.56	1	0	2.0	258	3.1	6.8	2.16	1.99	30.47	
		KB-2	KB-1	4.00	0.58	1	0	2.0	271	3.1	14.9	4.76	0.95	31.42	
		KB-1	KA-2	6.00	0.64	1	0	2.5	349	4.9	24.3	4.95	1.18	32.59	
KA-4		KA-3	2.44	0.55	1	0	2.0	273	3.1	9.1	2.90	1.57	28.28		
KA-3		KA-2	4.51	0.61	1	0	2.0	270	3.1	18.4	4.11	1.09	29.37		
KA-2		KA-1	12.72	0.65	1	0	3.0	264	7.1	51.6	3.40	1.30	33.89		
KA-1		KA-OUT	15.19	0.67	1	0	3.0	279	7.1	62.2	3.04	1.53	35.42		

Note

1) Existing node IDs were based on nearest proposed node ID.

Drainage System E0146 Hydrograph Comparison

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Hous
 Project No.: 345023
 Location: Houston, Texas
 Date: 12/21/17
 Performed By: ML
 Checked By: CM

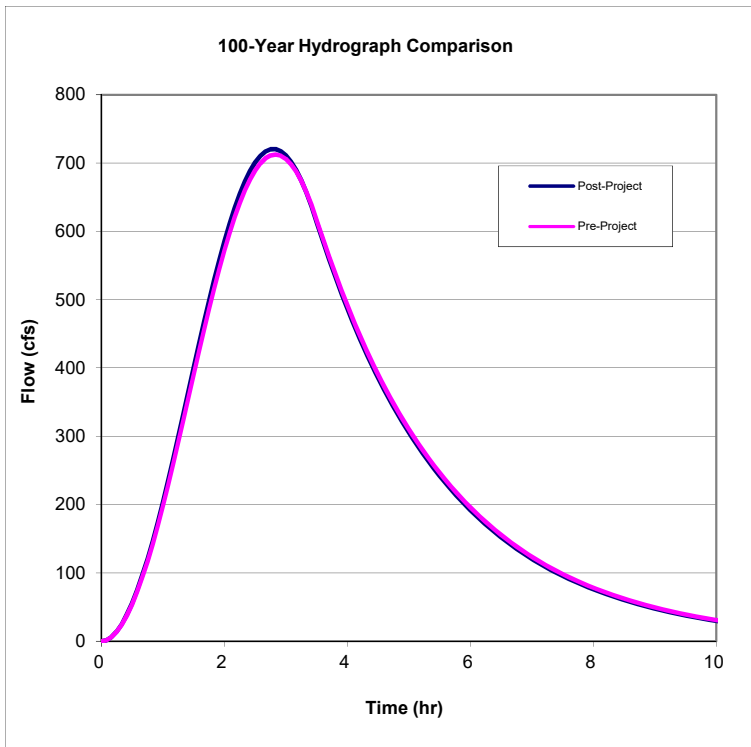
Watershed: White Oak Bayou
HCFC Unit: E100-00-00
Drainage System ID: E0146
Alternative: 1

Computation Parameters:

Design Storm = 100 year
 Storm Duration = 24 hours
 Drainage Area = 228.45 acres

*Peak flow from HouStorm

Condition	Peak Flow (cfs)	Peak Flow Impact (cfs)	Detention Volume (ac-ft)
Pre-Project	712.5	7.9	2.1
Post-Project	720.4		



Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
0	0.00	0.0	0.0	0.0	0	0
5	0.08	1.6	1.5	0.1	0.00	0.00
10	0.17	6.3	6.1	0.2	0.00	0.00
15	0.25	14.1	13.7	0.5	0.00	0.00
20	0.33	25.0	24.1	0.8	0.00	0.01
25	0.42	38.8	37.5	1.3	0.01	0.02
30	0.50	55.4	53.6	1.8	0.01	0.03
35	0.58	74.7	72.2	2.5	0.01	0.04
40	0.67	96.5	93.3	3.1	0.02	0.06
45	0.75	120.6	116.7	3.9	0.02	0.08
50	0.83	146.8	142.1	4.7	0.03	0.11
55	0.92	174.8	169.3	5.5	0.04	0.15
60	1.00	204.5	198.1	6.4	0.04	0.19
65	1.08	235.6	228.3	7.3	0.05	0.24
70	1.17	267.8	259.6	8.1	0.05	0.29
75	1.25	300.7	291.7	9.0	0.06	0.35
80	1.33	334.2	324.4	9.8	0.06	0.41
85	1.42	367.9	357.3	10.6	0.07	0.48
90	1.50	401.6	390.3	11.3	0.08	0.56
95	1.58	434.9	422.9	12.0	0.08	0.64
100	1.67	467.5	455.0	12.6	0.08	0.73
105	1.75	499.2	486.2	13.0	0.09	0.81
110	1.83	529.7	516.3	13.4	0.09	0.90
115	1.92	558.7	545.0	13.7	0.09	1.00
120	2.00	586.0	572.2	13.8	0.09	1.09
125	2.08	611.2	597.4	13.8	0.10	1.19
130	2.17	634.3	620.6	13.7	0.09	1.28
135	2.25	655.0	641.6	13.4	0.09	1.38
140	2.33	673.1	660.1	13.0	0.09	1.47
145	2.42	688.5	676.0	12.5	0.09	1.55
150	2.50	701.0	689.1	11.8	0.08	1.64
155	2.58	710.5	699.4	11.0	0.08	1.72
160	2.67	716.9	706.8	10.1	0.07	1.79
165	2.75	720.2	711.2	9.0	0.07	1.86
170	2.83	720.4	712.5	7.9	0.06	1.91
175	2.92	717.4	710.8	6.6	0.05	1.96
180	3.00	711.2	706.0	5.2	0.04	2.00
185	3.08	702.0	698.3	3.8	0.03	2.04
190	3.17	689.9	687.6	2.3	0.02	2.06
195	3.25	674.8	674.1	0.7	0.01	2.07
200	3.33	656.9	657.8	-0.9	0.00	2.07
205	3.42	636.5	639.0	-2.5	-0.01	2.05
210	3.50	614.4	617.7	-3.3	-0.02	2.03
215	3.58	591.0	595.5	-4.4	-0.03	2.01
220	3.67	568.6	573.1	-4.5	-0.03	1.98
225	3.75	547.0	551.6	-4.6	-0.03	1.95
230	3.83	526.2	530.8	-4.7	-0.03	1.91

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
235	3.92	506.2	510.9	-4.7	-0.03	1.88
240	4.00	486.9	491.7	-4.7	-0.03	1.85
245	4.08	468.4	473.2	-4.8	-0.03	1.82
250	4.17	450.6	455.4	-4.8	-0.03	1.78
255	4.25	433.5	438.3	-4.8	-0.03	1.75
260	4.33	417.0	421.8	-4.8	-0.03	1.72
265	4.42	401.2	406.0	-4.8	-0.03	1.68
270	4.50	385.9	390.7	-4.8	-0.03	1.65
275	4.58	371.3	376.0	-4.8	-0.03	1.62
280	4.67	357.2	361.9	-4.7	-0.03	1.58
285	4.75	343.6	348.3	-4.7	-0.03	1.55
290	4.83	330.5	335.2	-4.7	-0.03	1.52
295	4.92	318.0	322.6	-4.7	-0.03	1.49
300	5.00	305.9	310.5	-4.6	-0.03	1.46
305	5.08	294.2	298.8	-4.6	-0.03	1.42
310	5.17	283.1	287.6	-4.5	-0.03	1.39
315	5.25	272.3	276.8	-4.5	-0.03	1.36
320	5.33	262.0	266.4	-4.4	-0.03	1.33
325	5.42	252.0	256.4	-4.4	-0.03	1.30
330	5.50	242.4	246.7	-4.3	-0.03	1.27
335	5.58	232.2	237.5	-4.2	-0.03	1.24
340	5.67	224.3	228.5	-4.2	-0.03	1.21
345	5.75	215.8	219.9	-4.1	-0.03	1.18
350	5.83	207.6	211.7	-4.1	-0.03	1.16
355	5.92	199.7	203.7	-4.0	-0.03	1.13
360	6.00	192.1	196.1	-3.9	-0.03	1.10
365	6.08	184.8	188.7	-3.9	-0.03	1.07
370	6.17	177.8	181.6	-3.8	-0.03	1.05
375	6.25	171.0	174.8	-3.7	-0.03	1.02
380	6.33	164.5	168.2	-3.7	-0.03	1.00
385	6.42	158.3	161.9	-3.6	-0.02	0.97
390	6.50	152.3	155.8	-3.5	-0.02	0.95
395	6.58	146.5	149.9	-3.5	-0.02	0.92
400	6.67	140.9	144.3	-3.4	-0.02	0.90
405	6.75	135.6	138.9	-3.3	-0.02	0.88
410	6.83	130.4	133.7	-3.3	-0.02	0.85
415	6.92	125.5	128.6	-3.2	-0.02	0.83
420	7.00	120.7	123.8	-3.1	-0.02	0.81
425	7.08	116.1	119.2	-3.1	-0.02	0.79
430	7.17	111.7	114.7	-3.0	-0.02	0.77
435	7.25	107.4	110.4	-2.9	-0.02	0.75
440	7.33	103.4	106.2	-2.9	-0.02	0.73
445	7.42	99.4	102.2	-2.8	-0.02	0.71
450	7.50	95.7	98.4	-2.7	-0.02	0.69
455	7.58	92.0	94.7	-2.7	-0.02	0.67
460	7.67	88.5	91.1	-2.6	-0.02	0.65
465	7.75	85.2	87.7	-2.5	-0.02	0.63
470	7.83	81.9	84.4	-2.5	-0.02	0.62

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
475	7.92	78.8	81.2	-2.4	-0.02	0.60
480	8.00	75.8	78.2	-2.4	-0.02	0.58
485	8.08	72.9	75.2	-2.3	-0.02	0.57
490	8.17	70.2	72.4	-2.3	-0.02	0.55
495	8.25	67.5	69.7	-2.2	-0.02	0.54
500	8.33	64.9	67.1	-2.1	-0.01	0.52
505	8.42	62.5	64.6	-2.1	-0.01	0.51
510	8.50	60.1	62.1	-2.0	-0.01	0.49
515	8.58	57.8	59.8	-2.0	-0.01	0.48
520	8.67	55.6	57.5	-1.9	-0.01	0.46
525	8.75	53.5	55.4	-1.9	-0.01	0.45
530	8.83	51.5	53.3	-1.8	-0.01	0.44
535	8.92	49.5	51.3	-1.8	-0.01	0.43
540	9.00	47.6	49.4	-1.7	-0.01	0.41
545	9.08	45.8	47.5	-1.7	-0.01	0.40
550	9.17	44.1	45.7	-1.7	-0.01	0.39
555	9.25	42.4	44.0	-1.6	-0.01	0.38
560	9.33	40.8	42.4	-1.6	-0.01	0.37
565	9.42	39.2	40.8	-1.5	-0.01	0.36
570	9.50	37.7	39.2	-1.5	-0.01	0.35
575	9.58	36.3	37.8	-1.4	-0.01	0.34
580	9.67	34.9	36.3	-1.4	-0.01	0.33
585	9.75	33.6	35.0	-1.4	-0.01	0.32
590	9.83	32.3	33.7	-1.3	-0.01	0.31
595	9.92	31.1	32.4	-1.3	-0.01	0.30
600	10.00	29.9	31.2	-1.3	-0.01	0.29
605	10.08	28.8	30.0	-1.2	-0.01	0.28
610	10.17	27.7	28.9	-1.2	-0.01	0.27
615	10.25	26.6	27.8	-1.2	-0.01	0.27
620	10.33	25.6	26.7	-1.1	-0.01	0.26
625	10.42	24.6	25.7	-1.1	-0.01	0.25
630	10.50	23.7	24.8	-1.1	-0.01	0.24
635	10.58	22.8	23.8	-1.0	-0.01	0.24
640	10.67	21.9	22.9	-1.0	-0.01	0.23
645	10.75	21.1	22.1	-1.0	-0.01	0.22
650	10.83	20.3	21.3	-1.0	-0.01	0.21
655	10.92	19.5	20.5	-0.9	-0.01	0.21
660	11.00	18.8	19.7	-0.9	-0.01	0.20
665	11.08	18.1	18.9	-0.9	-0.01	0.20
670	11.17	17.4	18.2	-0.8	-0.01	0.19
675	11.25	16.7	17.5	-0.8	-0.01	0.18
680	11.33	16.1	16.9	-0.8	-0.01	0.18
685	11.42	15.5	16.3	-0.8	-0.01	0.17
690	11.50	14.9	15.6	-0.8	-0.01	0.17
695	11.58	14.3	15.1	-0.7	-0.01	0.16
700	11.67	13.8	14.5	-0.7	0.00	0.16
705	11.75	13.3	13.9	-0.7	0.00	0.15
710	11.83	12.8	13.4	-0.7	0.00	0.15

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs			Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)	Flow Difference Qp-Qe (cfs)	Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
715	11.92	12.3	12.9	-0.6	0.00	0.14
720	12.00	11.8	12.4	-0.6	0.00	0.14
725	12.08	11.4	12.0	-0.6	0.00	0.14
730	12.17	10.9	11.5	-0.6	0.00	0.13
735	12.25	10.5	11.1	-0.6	0.00	0.13
740	12.33	10.1	10.7	-0.6	0.00	0.12
745	12.42	9.7	10.3	-0.5	0.00	0.12
750	12.50	9.4	9.9	-0.5	0.00	0.12
755	12.58	9.0	9.5	-0.5	0.00	0.11
760	12.67	8.7	9.1	-0.5	0.00	0.11
765	12.75	8.3	8.8	-0.5	0.00	0.11
770	12.83	8.0	8.5	-0.5	0.00	0.10
775	12.92	7.7	8.2	-0.4	0.00	0.10
780	13.00	7.4	7.8	-0.4	0.00	0.10
785	13.08	7.1	7.6	-0.4	0.00	0.09
790	13.17	6.9	7.3	-0.4	0.00	0.09
795	13.25	6.6	7.0	-0.4	0.00	0.09
800	13.33	6.3	6.7	-0.4	0.00	0.08
805	13.42	6.1	6.5	-0.4	0.00	0.08
810	13.50	5.9	6.2	-0.4	0.00	0.08
815	13.58	5.7	6.0	-0.4	0.00	0.08
820	13.67	5.4	5.8	-0.3	0.00	0.07
825	13.75	5.2	5.6	-0.3	0.00	0.07
830	13.83	5.0	5.4	-0.3	0.00	0.07
835	13.92	4.8	5.2	-0.3	0.00	0.07
840	14.00	4.7	5.0	-0.3	0.00	0.07
845	14.08	4.5	4.8	-0.3	0.00	0.06
850	14.17	4.3	4.6	-0.3	0.00	0.06
855	14.25	4.1	4.4	-0.3	0.00	0.06
860	14.33	4.0	4.3	-0.3	0.00	0.06
865	14.42	3.8	4.1	-0.3	0.00	0.06
870	14.50	3.7	3.9	-0.2	0.00	0.05
875	14.58	3.6	3.8	-0.2	0.00	0.05
880	14.67	3.4	3.6	-0.2	0.00	0.05
885	14.75	3.3	3.5	-0.2	0.00	0.05
890	14.83	3.2	3.4	-0.2	0.00	0.05
895	14.92	3.0	3.3	-0.2	0.00	0.05
900	15.00	2.9	3.1	-0.2	0.00	0.05
905	15.08	2.8	3.0	-0.2	0.00	0.04
910	15.17	2.7	2.9	-0.2	0.00	0.04
915	15.25	2.6	2.8	-0.2	0.00	0.04
920	15.33	2.5	2.7	-0.2	0.00	0.04
925	15.42	2.4	2.6	-0.2	0.00	0.04
930	15.50	2.3	2.5	-0.2	0.00	0.04
935	15.58	2.2	2.4	-0.2	0.00	0.04
940	15.67	2.1	2.3	-0.2	0.00	0.04
945	15.75	2.1	2.2	-0.2	0.00	0.03
950	15.83	2.0	2.1	-0.1	0.00	0.03

Drainage System E0147A Hydrograph Comparison

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Hous
 Project No.: 345023
 Location: Houston, Texas
 Date: 12/21/17
 Performed By: ML
 Checked By: CM

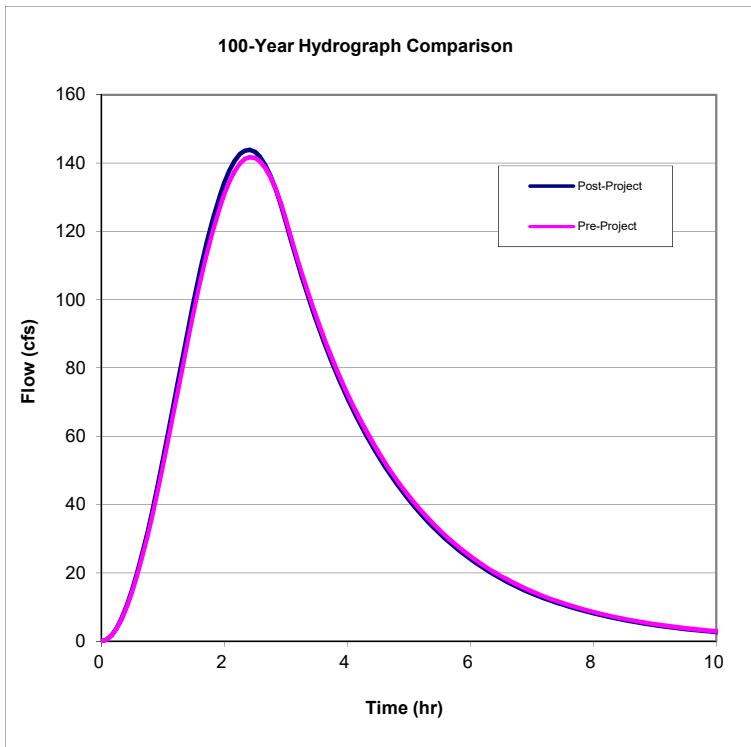
Watershed: White Oak Bayou
HCFC Unit: E100-00-00
Drainage System ID: E0147A
Alternative: 1

Computation Parameters:

Design Storm = 100 year
 Storm Duration = 24 hours
 Drainage Area = 37.97 acres

*Peak flow from HouStorm

Condition	Peak Flow (cfs)	Peak Flow Impact (cfs)	Detention Volume (ac-ft)
Pre-Project	141.7	2.1	0.46
Post-Project	143.9		



Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
0	0.00	0.0	0.0	0.0	0	0
5	0.08	0.4	0.4	0.0	0.00	0.00
10	0.17	1.7	1.6	0.1	0.00	0.00
15	0.25	3.8	3.7	0.2	0.00	0.00
20	0.33	6.8	6.5	0.3	0.00	0.00
25	0.42	10.5	10.0	0.5	0.00	0.01
30	0.50	14.9	14.3	0.6	0.00	0.01
35	0.58	20.0	19.2	0.9	0.01	0.01
40	0.67	25.8	24.7	1.1	0.01	0.02
45	0.75	32.1	30.7	1.3	0.01	0.03
50	0.83	38.8	37.2	1.6	0.01	0.04
55	0.92	46.0	44.1	1.9	0.01	0.05
60	1.00	53.5	51.3	2.1	0.01	0.06
65	1.08	61.2	58.8	2.4	0.02	0.08
70	1.17	69.0	66.4	2.6	0.02	0.10
75	1.25	76.8	74.0	2.9	0.02	0.12
80	1.33	84.6	81.6	3.1	0.02	0.14
85	1.42	92.3	89.0	3.3	0.02	0.16
90	1.50	99.7	96.3	3.4	0.02	0.18
95	1.58	106.8	103.2	3.5	0.02	0.21
100	1.67	113.4	109.8	3.6	0.02	0.23
105	1.75	119.6	116.0	3.6	0.02	0.25
110	1.83	125.2	121.6	3.6	0.02	0.28
115	1.92	130.1	126.6	3.5	0.02	0.30
120	2.00	134.4	131.0	3.4	0.02	0.33
125	2.08	137.9	134.7	3.2	0.02	0.35
130	2.17	140.7	137.6	3.0	0.02	0.37
135	2.25	142.6	139.8	2.8	0.02	0.39
140	2.33	143.6	141.2	2.5	0.02	0.41
145	2.42	143.9	141.7	2.1	0.02	0.43
150	2.50	143.2	141.5	1.7	0.01	0.44
155	2.58	141.7	140.4	1.3	0.01	0.45
160	2.67	139.4	138.5	0.9	0.01	0.46
165	2.75	136.3	135.9	0.4	0.00	0.46
170	2.83	132.4	132.5	-0.1	0.00	0.46
175	2.92	127.8	128.3	-0.6	0.00	0.46
180	3.00	122.7	123.5	-0.9	0.00	0.46
185	3.08	117.2	118.4	-1.2	-0.01	0.45
190	3.17	112.1	113.2	-1.2	-0.01	0.44
195	3.25	107.1	108.3	-1.2	-0.01	0.43
200	3.33	102.4	103.6	-1.2	-0.01	0.42
205	3.42	97.8	99.1	-1.2	-0.01	0.42
210	3.50	93.5	94.8	-1.2	-0.01	0.41
215	3.58	89.4	90.6	-1.3	-0.01	0.40
220	3.67	85.4	86.7	-1.3	-0.01	0.39
225	3.75	81.7	82.9	-1.3	-0.01	0.38
230	3.83	78.0	79.3	-1.3	-0.01	0.37

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
235	3.92	74.6	75.8	-1.2	-0.01	0.36
240	4.00	71.3	72.5	-1.2	-0.01	0.36
245	4.08	68.1	69.4	-1.2	-0.01	0.35
250	4.17	65.1	66.4	-1.2	-0.01	0.34
255	4.25	62.3	63.5	-1.2	-0.01	0.33
260	4.33	59.5	60.7	-1.2	-0.01	0.32
265	4.42	56.9	58.1	-1.2	-0.01	0.31
270	4.50	54.4	55.5	-1.2	-0.01	0.31
275	4.58	52.0	53.1	-1.2	-0.01	0.30
280	4.67	49.7	50.8	-1.1	-0.01	0.29
285	4.75	47.5	48.6	-1.1	-0.01	0.28
290	4.83	45.4	46.5	-1.1	-0.01	0.27
295	4.92	43.4	44.4	-1.1	-0.01	0.27
300	5.00	41.4	42.5	-1.1	-0.01	0.26
305	5.08	39.6	40.7	-1.0	-0.01	0.25
310	5.17	37.9	38.9	-1.0	-0.01	0.25
315	5.25	36.2	37.2	-1.0	-0.01	0.24
320	5.33	34.6	35.6	-1.0	-0.01	0.23
325	5.42	33.1	34.0	-1.0	-0.01	0.23
330	5.50	31.6	32.5	-0.9	-0.01	0.22
335	5.58	30.2	31.1	-0.9	-0.01	0.21
340	5.67	28.9	29.8	-0.9	-0.01	0.21
345	5.75	27.6	28.5	-0.9	-0.01	0.20
350	5.83	26.4	27.2	-0.9	-0.01	0.19
355	5.92	25.2	26.0	-0.8	-0.01	0.19
360	6.00	24.1	24.9	-0.8	-0.01	0.18
365	6.08	23.0	23.8	-0.8	-0.01	0.18
370	6.17	22.0	22.8	-0.8	-0.01	0.17
375	6.25	21.0	21.8	-0.8	-0.01	0.17
380	6.33	20.1	20.8	-0.7	-0.01	0.16
385	6.42	19.2	19.9	-0.7	-0.01	0.16
390	6.50	18.4	19.1	-0.7	0.00	0.15
395	6.58	17.6	18.2	-0.7	0.00	0.15
400	6.67	16.8	17.4	-0.7	0.00	0.14
405	6.75	16.0	16.7	-0.6	0.00	0.14
410	6.83	15.3	16.0	-0.6	0.00	0.13
415	6.92	14.7	15.3	-0.6	0.00	0.13
420	7.00	14.0	14.6	-0.6	0.00	0.12
425	7.08	13.4	14.0	-0.6	0.00	0.12
430	7.17	12.8	13.4	-0.6	0.00	0.12
435	7.25	12.2	12.8	-0.5	0.00	0.11
440	7.33	11.7	12.2	-0.5	0.00	0.11
445	7.42	11.2	11.7	-0.5	0.00	0.11
450	7.50	10.7	11.2	-0.5	0.00	0.10
455	7.58	10.2	10.7	-0.5	0.00	0.10
460	7.67	9.8	10.2	-0.5	0.00	0.10
465	7.75	9.3	9.8	-0.5	0.00	0.09
470	7.83	8.9	9.3	-0.4	0.00	0.09

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs			Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)	Flow Difference Qp-Qe (cfs)	Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
475	7.92	8.5	8.9	-0.4	0.00	0.09
480	8.00	8.1	8.6	-0.4	0.00	0.08
485	8.08	7.8	8.2	-0.4	0.00	0.08
490	8.17	7.4	7.8	-0.4	0.00	0.08
495	8.25	7.1	7.5	-0.4	0.00	0.07
500	8.33	6.8	7.2	-0.4	0.00	0.07
505	8.42	6.5	6.8	-0.4	0.00	0.07
510	8.50	6.2	6.5	-0.3	0.00	0.07
515	8.58	5.9	6.3	-0.3	0.00	0.07
520	8.67	5.7	6.0	-0.3	0.00	0.06
525	8.75	5.4	5.7	-0.3	0.00	0.06
530	8.83	5.2	5.5	-0.3	0.00	0.06
535	8.92	5.0	5.2	-0.3	0.00	0.06
540	9.00	4.7	5.0	-0.3	0.00	0.05
545	9.08	4.5	4.8	-0.3	0.00	0.05
550	9.17	4.3	4.6	-0.3	0.00	0.05
555	9.25	4.1	4.4	-0.3	0.00	0.05
560	9.33	3.9	4.2	-0.2	0.00	0.05
565	9.42	3.8	4.0	-0.2	0.00	0.05
570	9.50	3.6	3.8	-0.2	0.00	0.04
575	9.58	3.4	3.7	-0.2	0.00	0.04
580	9.67	3.3	3.5	-0.2	0.00	0.04
585	9.75	3.1	3.4	-0.2	0.00	0.04
590	9.83	3.0	3.2	-0.2	0.00	0.04
595	9.92	2.9	3.1	-0.2	0.00	0.04
600	10.00	2.8	2.9	-0.2	0.00	0.04
605	10.08	2.6	2.8	-0.2	0.00	0.03
610	10.17	2.5	2.7	-0.2	0.00	0.03
615	10.25	2.4	2.6	-0.2	0.00	0.03
620	10.33	2.3	2.5	-0.2	0.00	0.03
625	10.42	2.2	2.4	-0.2	0.00	0.03
630	10.50	2.1	2.2	-0.2	0.00	0.03
635	10.58	2.0	2.2	-0.1	0.00	0.03
640	10.67	1.9	2.1	-0.1	0.00	0.03
645	10.75	1.8	2.0	-0.1	0.00	0.03
650	10.83	1.7	1.9	-0.1	0.00	0.02
655	10.92	1.7	1.8	-0.1	0.00	0.02
660	11.00	1.6	1.7	-0.1	0.00	0.02
665	11.08	1.5	1.6	-0.1	0.00	0.02
670	11.17	1.5	1.6	-0.1	0.00	0.02
675	11.25	1.4	1.5	-0.1	0.00	0.02
680	11.33	1.3	1.4	-0.1	0.00	0.02
685	11.42	1.3	1.4	-0.1	0.00	0.02
690	11.50	1.2	1.3	-0.1	0.00	0.02
695	11.58	1.2	1.3	-0.1	0.00	0.02
700	11.67	1.1	1.2	-0.1	0.00	0.02
705	11.75	1.1	1.2	-0.1	0.00	0.02
710	11.83	1.0	1.1	-0.1	0.00	0.02

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100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs			Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)	Flow Difference Qp-Qe (cfs)	Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
715	11.92	1.0	1.1	-0.1	0.00	0.02
720	12.00	0.9	1.0	-0.1	0.00	0.01
725	12.08	0.9	1.0	-0.1	0.00	0.01
730	12.17	0.8	0.9	-0.1	0.00	0.01
735	12.25	0.8	0.9	-0.1	0.00	0.01
740	12.33	0.8	0.8	-0.1	0.00	0.01
745	12.42	0.7	0.8	-0.1	0.00	0.01
750	12.50	0.7	0.8	-0.1	0.00	0.01
755	12.58	0.7	0.7	-0.1	0.00	0.01
760	12.67	0.6	0.7	-0.1	0.00	0.01
765	12.75	0.6	0.7	-0.1	0.00	0.01
770	12.83	0.6	0.6	-0.1	0.00	0.01
775	12.92	0.6	0.6	-0.1	0.00	0.01
780	13.00	0.5	0.6	-0.1	0.00	0.01
785	13.08	0.5	0.6	0.0	0.00	0.01
790	13.17	0.5	0.5	0.0	0.00	0.01
795	13.25	0.5	0.5	0.0	0.00	0.01
800	13.33	0.5	0.5	0.0	0.00	0.01
805	13.42	0.4	0.5	0.0	0.00	0.01
810	13.50	0.4	0.5	0.0	0.00	0.01
815	13.58	0.4	0.4	0.0	0.00	0.01
820	13.67	0.4	0.4	0.0	0.00	0.01
825	13.75	0.4	0.4	0.0	0.00	0.01
830	13.83	0.3	0.4	0.0	0.00	0.01
835	13.92	0.3	0.4	0.0	0.00	0.01
840	14.00	0.3	0.3	0.0	0.00	0.01
845	14.08	0.3	0.3	0.0	0.00	0.01
850	14.17	0.3	0.3	0.0	0.00	0.01
855	14.25	0.3	0.3	0.0	0.00	0.01
860	14.33	0.3	0.3	0.0	0.00	0.01
865	14.42	0.3	0.3	0.0	0.00	0.01
870	14.50	0.2	0.3	0.0	0.00	0.00
875	14.58	0.2	0.3	0.0	0.00	0.00
880	14.67	0.2	0.2	0.0	0.00	0.00
885	14.75	0.2	0.2	0.0	0.00	0.00
890	14.83	0.2	0.2	0.0	0.00	0.00
895	14.92	0.2	0.2	0.0	0.00	0.00
900	15.00	0.2	0.2	0.0	0.00	0.00
905	15.08	0.2	0.2	0.0	0.00	0.00
910	15.17	0.2	0.2	0.0	0.00	0.00
915	15.25	0.2	0.2	0.0	0.00	0.00
920	15.33	0.2	0.2	0.0	0.00	0.00
925	15.42	0.1	0.2	0.0	0.00	0.00
930	15.50	0.1	0.2	0.0	0.00	0.00
935	15.58	0.1	0.1	0.0	0.00	0.00
940	15.67	0.1	0.1	0.0	0.00	0.00
945	15.75	0.1	0.1	0.0	0.00	0.00
950	15.83	0.1	0.1	0.0	0.00	0.00

Drainage System E0147B Hydrograph Comparison

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Hous
 Project No.: 345023
 Location: Houston, Texas
 Date: 12/21/17
 Performed By: ML
 Checked By: CM

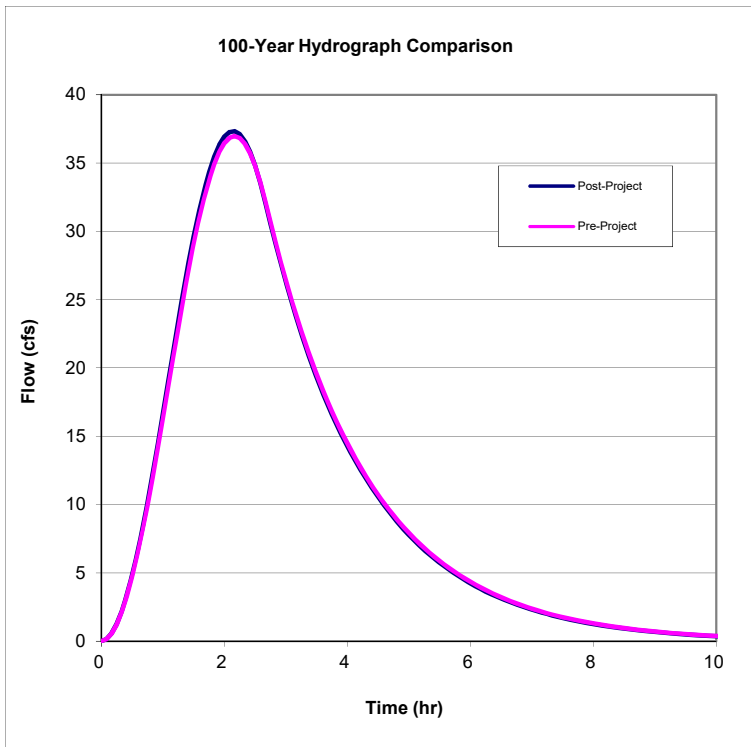
Watershed: White Oak Bayou
HCFC Unit: E100-00-00
Drainage System ID: E0147B
Alternative: 1

Computation Parameters:

Design Storm = 100 year
 Storm Duration = 24 hours
 Drainage Area = 37.97 acres

*Peak flow from HouStorm

Condition	Peak Flow (cfs)	Peak Flow Impact (cfs)	Detention Volume (ac-ft)
Pre-Project	37.0	0.3	0.07
Post-Project	37.3		



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Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
0	0.00	0.0	0.0	0.0	0	0
5	0.08	0.1	0.1	0.0	0.00	0.00
10	0.17	0.6	0.5	0.0	0.00	0.00
15	0.25	1.2	1.2	0.0	0.00	0.00
20	0.33	2.2	2.1	0.1	0.00	0.00
25	0.42	3.4	3.3	0.1	0.00	0.00
30	0.50	4.8	4.7	0.1	0.00	0.00
35	0.58	6.4	6.3	0.2	0.00	0.00
40	0.67	8.2	8.0	0.2	0.00	0.00
45	0.75	10.2	9.9	0.3	0.00	0.01
50	0.83	12.3	12.0	0.3	0.00	0.01
55	0.92	14.5	14.1	0.4	0.00	0.01
60	1.00	16.7	16.3	0.4	0.00	0.01
65	1.08	19.0	18.6	0.5	0.00	0.02
70	1.17	21.3	20.8	0.5	0.00	0.02
75	1.25	23.5	23.0	0.5	0.00	0.02
80	1.33	25.7	25.1	0.6	0.00	0.03
85	1.42	27.7	27.2	0.6	0.00	0.03
90	1.50	29.7	29.1	0.6	0.00	0.04
95	1.58	31.4	30.8	0.6	0.00	0.04
100	1.67	33.0	32.4	0.6	0.00	0.04
105	1.75	34.3	33.8	0.6	0.00	0.05
110	1.83	35.5	34.9	0.6	0.00	0.05
115	1.92	36.3	35.8	0.5	0.00	0.06
120	2.00	36.9	36.5	0.5	0.00	0.06
125	2.08	37.3	36.9	0.4	0.00	0.06
130	2.17	37.3	37.0	0.3	0.00	0.06
135	2.25	37.1	36.8	0.3	0.00	0.07
140	2.33	36.6	36.4	0.2	0.00	0.07
145	2.42	35.8	35.7	0.1	0.00	0.07
150	2.50	34.8	34.8	0.0	0.00	0.07
155	2.58	33.5	33.6	-0.1	0.00	0.07
160	2.67	32.1	32.2	-0.2	0.00	0.07
165	2.75	30.5	30.7	-0.2	0.00	0.07
170	2.83	29.0	29.2	-0.2	0.00	0.07
175	2.92	27.6	27.8	-0.2	0.00	0.06
180	3.00	26.2	26.4	-0.2	0.00	0.06
185	3.08	24.9	25.1	-0.2	0.00	0.06
190	3.17	23.7	23.9	-0.2	0.00	0.06
195	3.25	22.5	22.7	-0.2	0.00	0.06
200	3.33	21.4	21.6	-0.2	0.00	0.06
205	3.42	20.4	20.6	-0.2	0.00	0.06
210	3.50	19.3	19.6	-0.2	0.00	0.05
215	3.58	18.4	18.6	-0.2	0.00	0.05
220	3.67	17.5	17.7	-0.2	0.00	0.05
225	3.75	16.6	16.8	-0.2	0.00	0.05
230	3.83	15.8	16.0	-0.2	0.00	0.05

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Time (minutes)	Time (hours)	Runoff Hydrographs			Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)	Flow Difference Qp-Qe (cfs)	Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
235	3.92	15.0	15.2	-0.2	0.00	0.05
240	4.00	14.3	14.5	-0.2	0.00	0.05
245	4.08	13.6	13.8	-0.2	0.00	0.04
250	4.17	12.9	13.1	-0.2	0.00	0.04
255	4.25	12.3	12.5	-0.2	0.00	0.04
260	4.33	11.7	11.9	-0.2	0.00	0.04
265	4.42	11.1	11.3	-0.2	0.00	0.04
270	4.50	10.5	10.7	-0.2	0.00	0.04
275	4.58	10.0	10.2	-0.2	0.00	0.04
280	4.67	9.5	9.7	-0.2	0.00	0.04
285	4.75	9.1	9.2	-0.2	0.00	0.03
290	4.83	8.6	8.8	-0.2	0.00	0.03
295	4.92	8.2	8.3	-0.2	0.00	0.03
300	5.00	7.8	7.9	-0.2	0.00	0.03
305	5.08	7.4	7.5	-0.2	0.00	0.03
310	5.17	7.0	7.2	-0.1	0.00	0.03
315	5.25	6.7	6.8	-0.1	0.00	0.03
320	5.33	6.4	6.5	-0.1	0.00	0.03
325	5.42	6.0	6.2	-0.1	0.00	0.03
330	5.50	5.7	5.9	-0.1	0.00	0.03
335	5.58	5.5	5.6	-0.1	0.00	0.02
340	5.67	5.2	5.3	-0.1	0.00	0.02
345	5.75	4.9	5.1	-0.1	0.00	0.02
350	5.83	4.7	4.8	-0.1	0.00	0.02
355	5.92	4.5	4.6	-0.1	0.00	0.02
360	6.00	4.2	4.3	-0.1	0.00	0.02
365	6.08	4.0	4.1	-0.1	0.00	0.02
370	6.17	3.8	3.9	-0.1	0.00	0.02
375	6.25	3.6	3.7	-0.1	0.00	0.02
380	6.33	3.5	3.6	-0.1	0.00	0.02
385	6.42	3.3	3.4	-0.1	0.00	0.02
390	6.50	3.1	3.2	-0.1	0.00	0.02
395	6.58	3.0	3.1	-0.1	0.00	0.02
400	6.67	2.8	2.9	-0.1	0.00	0.02
405	6.75	2.7	2.8	-0.1	0.00	0.01
410	6.83	2.6	2.6	-0.1	0.00	0.01
415	6.92	2.4	2.5	-0.1	0.00	0.01
420	7.00	2.3	2.4	-0.1	0.00	0.01
425	7.08	2.2	2.3	-0.1	0.00	0.01
430	7.17	2.1	2.2	-0.1	0.00	0.01
435	7.25	2.0	2.1	-0.1	0.00	0.01
440	7.33	1.9	2.0	-0.1	0.00	0.01
445	7.42	1.8	1.9	-0.1	0.00	0.01
450	7.50	1.7	1.8	-0.1	0.00	0.01
455	7.58	1.6	1.7	-0.1	0.00	0.01
460	7.67	1.5	1.6	-0.1	0.00	0.01
465	7.75	1.5	1.5	-0.1	0.00	0.01
470	7.83	1.4	1.4	-0.1	0.00	0.01

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		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
475	7.92	1.3	1.4	0.0	0.00	0.01
480	8.00	1.3	1.3	0.0	0.00	0.01
485	8.08	1.2	1.2	0.0	0.00	0.01
490	8.17	1.1	1.2	0.0	0.00	0.01
495	8.25	1.1	1.1	0.0	0.00	0.01
500	8.33	1.0	1.1	0.0	0.00	0.01
505	8.42	1.0	1.0	0.0	0.00	0.01
510	8.50	0.9	1.0	0.0	0.00	0.01
515	8.58	0.9	0.9	0.0	0.00	0.01
520	8.67	0.8	0.9	0.0	0.00	0.01
525	8.75	0.8	0.8	0.0	0.00	0.01
530	8.83	0.8	0.8	0.0	0.00	0.01
535	8.92	0.7	0.8	0.0	0.00	0.01
540	9.00	0.7	0.7	0.0	0.00	0.00
545	9.08	0.7	0.7	0.0	0.00	0.00
550	9.17	0.6	0.6	0.0	0.00	0.00
555	9.25	0.6	0.6	0.0	0.00	0.00
560	9.33	0.6	0.6	0.0	0.00	0.00
565	9.42	0.5	0.6	0.0	0.00	0.00
570	9.50	0.5	0.5	0.0	0.00	0.00
575	9.58	0.5	0.5	0.0	0.00	0.00
580	9.67	0.5	0.5	0.0	0.00	0.00
585	9.75	0.4	0.5	0.0	0.00	0.00
590	9.83	0.4	0.4	0.0	0.00	0.00
595	9.92	0.4	0.4	0.0	0.00	0.00
600	10.00	0.4	0.4	0.0	0.00	0.00
605	10.08	0.4	0.4	0.0	0.00	0.00
610	10.17	0.3	0.4	0.0	0.00	0.00
615	10.25	0.3	0.3	0.0	0.00	0.00
620	10.33	0.3	0.3	0.0	0.00	0.00
625	10.42	0.3	0.3	0.0	0.00	0.00
630	10.50	0.3	0.3	0.0	0.00	0.00
635	10.58	0.3	0.3	0.0	0.00	0.00
640	10.67	0.2	0.3	0.0	0.00	0.00
645	10.75	0.2	0.3	0.0	0.00	0.00
650	10.83	0.2	0.2	0.0	0.00	0.00
655	10.92	0.2	0.2	0.0	0.00	0.00
660	11.00	0.2	0.2	0.0	0.00	0.00
665	11.08	0.2	0.2	0.0	0.00	0.00
670	11.17	0.2	0.2	0.0	0.00	0.00
675	11.25	0.2	0.2	0.0	0.00	0.00
680	11.33	0.2	0.2	0.0	0.00	0.00
685	11.42	0.2	0.2	0.0	0.00	0.00
690	11.50	0.2	0.2	0.0	0.00	0.00
695	11.58	0.1	0.2	0.0	0.00	0.00
700	11.67	0.1	0.1	0.0	0.00	0.00
705	11.75	0.1	0.1	0.0	0.00	0.00
710	11.83	0.1	0.1	0.0	0.00	0.00

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
715	11.92	0.1	0.1	0.0	0.00	0.00
720	12.00	0.1	0.1	0.0	0.00	0.00
725	12.08	0.1	0.1	0.0	0.00	0.00
730	12.17	0.1	0.1	0.0	0.00	0.00
735	12.25	0.1	0.1	0.0	0.00	0.00
740	12.33	0.1	0.1	0.0	0.00	0.00
745	12.42	0.1	0.1	0.0	0.00	0.00
750	12.50	0.1	0.1	0.0	0.00	0.00
755	12.58	0.1	0.1	0.0	0.00	0.00
760	12.67	0.1	0.1	0.0	0.00	0.00
765	12.75	0.1	0.1	0.0	0.00	0.00
770	12.83	0.1	0.1	0.0	0.00	0.00
775	12.92	0.1	0.1	0.0	0.00	0.00
780	13.00	0.1	0.1	0.0	0.00	0.00
785	13.08	0.1	0.1	0.0	0.00	0.00
790	13.17	0.1	0.1	0.0	0.00	0.00
795	13.25	0.1	0.1	0.0	0.00	0.00
800	13.33	0.0	0.1	0.0	0.00	0.00
805	13.42	0.0	0.1	0.0	0.00	0.00
810	13.50	0.0	0.0	0.0	0.00	0.00
815	13.58	0.0	0.0	0.0	0.00	0.00
820	13.67	0.0	0.0	0.0	0.00	0.00
825	13.75	0.0	0.0	0.0	0.00	0.00
830	13.83	0.0	0.0	0.0	0.00	0.00
835	13.92	0.0	0.0	0.0	0.00	0.00
840	14.00	0.0	0.0	0.0	0.00	0.00
845	14.08	0.0	0.0	0.0	0.00	0.00
850	14.17	0.0	0.0	0.0	0.00	0.00
855	14.25	0.0	0.0	0.0	0.00	0.00
860	14.33	0.0	0.0	0.0	0.00	0.00
865	14.42	0.0	0.0	0.0	0.00	0.00
870	14.50	0.0	0.0	0.0	0.00	0.00
875	14.58	0.0	0.0	0.0	0.00	0.00
880	14.67	0.0	0.0	0.0	0.00	0.00
885	14.75	0.0	0.0	0.0	0.00	0.00
890	14.83	0.0	0.0	0.0	0.00	0.00
895	14.92	0.0	0.0	0.0	0.00	0.00
900	15.00	0.0	0.0	0.0	0.00	0.00
905	15.08	0.0	0.0	0.0	0.00	0.00
910	15.17	0.0	0.0	0.0	0.00	0.00
915	15.25	0.0	0.0	0.0	0.00	0.00
920	15.33	0.0	0.0	0.0	0.00	0.00
925	15.42	0.0	0.0	0.0	0.00	0.00
930	15.50	0.0	0.0	0.0	0.00	0.00
935	15.58	0.0	0.0	0.0	0.00	0.00
940	15.67	0.0	0.0	0.0	0.00	0.00
945	15.75	0.0	0.0	0.0	0.00	0.00
950	15.83	0.0	0.0	0.0	0.00	0.00

Drainage System E0147C Hydrograph Comparison

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Hous
 Project No.: 345023
 Location: Houston, Texas
 Date: 12/21/17
 Performed By: ML
 Checked By: CM

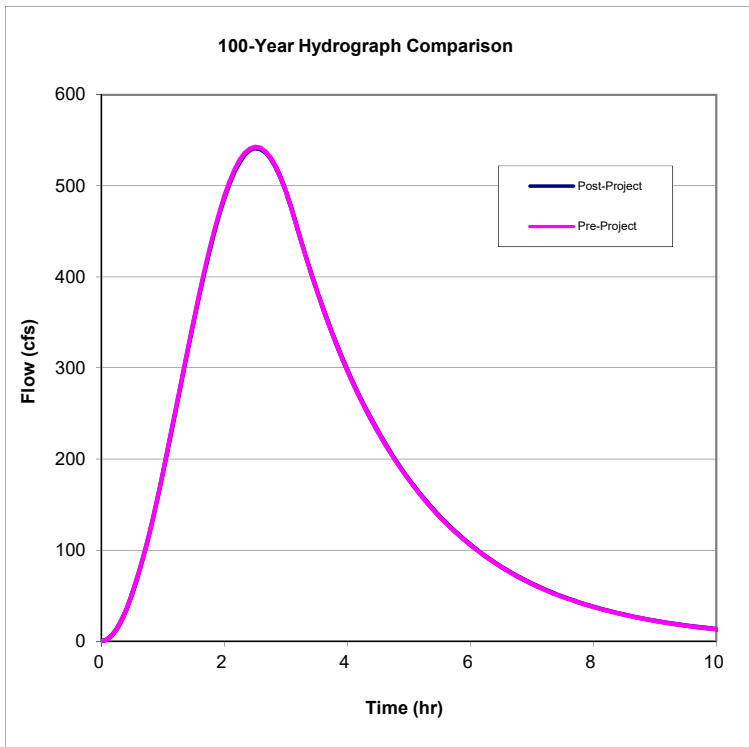
Watershed: White Oak Bayou
HCFC Unit: E100-00-00
Drainage System ID: E0147C
Alternative: 1

Computation Parameters:

Design Storm = 100 year
 Storm Duration = 24 hours
 Drainage Area = 37.97 acres

*Peak flow from HouStorm

Condition	Peak Flow (cfs)	Peak Flow Impact (cfs)	Detention Volume (ac-ft)
Pre-Project	542.8	-1.4	0.00
Post-Project	541.4		



Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
0	0.00	0.0	0.0	0.0	0	0
5	0.08	1.5	1.5	0.0	0.00	0.00
10	0.17	5.8	5.9	0.0	0.00	0.00
15	0.25	13.1	13.2	-0.1	0.00	0.00
20	0.33	23.1	23.2	-0.2	0.00	0.00
25	0.42	35.8	36.0	-0.3	0.00	0.00
30	0.50	51.0	51.4	-0.4	0.00	-0.01
35	0.58	68.6	69.1	-0.5	0.00	-0.01
40	0.67	88.4	89.0	-0.6	0.00	-0.01
45	0.75	110.1	110.9	-0.8	0.00	-0.02
50	0.83	133.6	134.5	-0.9	-0.01	-0.02
55	0.92	158.6	159.6	-1.1	-0.01	-0.03
60	1.00	184.7	186.0	-1.2	-0.01	-0.04
65	1.08	211.8	213.2	-1.4	-0.01	-0.05
70	1.17	239.6	241.1	-1.6	-0.01	-0.06
75	1.25	267.7	269.3	-1.7	-0.01	-0.07
80	1.33	295.8	297.6	-1.8	-0.01	-0.08
85	1.42	323.6	325.5	-1.9	-0.01	-0.09
90	1.50	350.9	352.9	-2.1	-0.01	-0.11
95	1.58	377.3	379.4	-2.1	-0.01	-0.12
100	1.67	402.5	404.7	-2.2	-0.01	-0.14
105	1.75	426.4	428.6	-2.2	-0.02	-0.15
110	1.83	448.5	450.8	-2.2	-0.02	-0.17
115	1.92	468.7	471.0	-2.2	-0.02	-0.18
120	2.00	486.8	489.0	-2.2	-0.02	-0.20
125	2.08	502.6	504.7	-2.1	-0.01	-0.21
130	2.17	515.8	517.9	-2.0	-0.01	-0.23
135	2.25	526.5	528.4	-1.9	-0.01	-0.24
140	2.33	534.3	536.1	-1.7	-0.01	-0.25
145	2.42	539.3	540.9	-1.6	-0.01	-0.26
150	2.50	541.4	542.8	-1.4	-0.01	-0.27
155	2.58	540.6	541.7	-1.1	-0.01	-0.28
160	2.67	536.9	537.8	-0.9	-0.01	-0.29
165	2.75	530.2	530.9	-0.6	-0.01	-0.30
170	2.83	520.8	521.2	-0.4	0.00	-0.30
175	2.92	508.7	508.8	-0.1	0.00	-0.30
180	3.00	494.0	493.8	0.2	0.00	-0.30
185	3.08	477.0	476.5	0.5	0.00	-0.30
190	3.17	458.3	457.6	0.7	0.00	-0.29
195	3.25	439.0	438.2	0.7	0.00	-0.29
200	3.33	420.5	419.8	0.7	0.01	-0.28
205	3.42	402.8	402.0	0.8	0.01	-0.28
210	3.50	385.8	385.1	0.8	0.01	-0.27
215	3.58	369.6	368.8	0.8	0.01	-0.27
220	3.67	354.0	353.2	0.8	0.01	-0.26
225	3.75	339.1	338.3	0.8	0.01	-0.26
230	3.83	324.8	324.1	0.8	0.01	-0.25

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs			Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)	Flow Difference Qp-Qe (cfs)	Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
235	3.92	311.2	310.4	0.8	0.01	-0.25
240	4.00	298.1	297.3	0.8	0.01	-0.24
245	4.08	285.5	284.7	0.8	0.01	-0.24
250	4.17	273.5	272.7	0.8	0.01	-0.23
255	4.25	262.0	261.2	0.8	0.01	-0.22
260	4.33	250.9	250.2	0.8	0.01	-0.22
265	4.42	240.4	239.6	0.8	0.01	-0.21
270	4.50	230.3	229.5	0.7	0.01	-0.21
275	4.58	220.6	219.8	0.7	0.01	-0.20
280	4.67	211.3	210.5	0.7	0.01	-0.20
285	4.75	202.4	201.7	0.7	0.00	-0.19
290	4.83	193.9	193.1	0.7	0.00	-0.19
295	4.92	185.7	185.0	0.7	0.00	-0.18
300	5.00	177.9	177.2	0.7	0.00	-0.18
305	5.08	170.4	169.7	0.7	0.00	-0.17
310	5.17	163.2	162.5	0.7	0.00	-0.17
315	5.25	156.3	155.7	0.7	0.00	-0.17
320	5.33	149.8	149.1	0.6	0.00	-0.16
325	5.42	143.4	142.8	0.6	0.00	-0.16
330	5.50	137.4	136.8	0.6	0.00	-0.15
335	5.58	131.6	131.0	0.6	0.00	-0.15
340	5.67	126.1	125.5	0.6	0.00	-0.14
345	5.75	120.8	120.2	0.6	0.00	-0.14
350	5.83	115.7	115.1	0.6	0.00	-0.14
355	5.92	110.8	110.3	0.6	0.00	-0.13
360	6.00	106.1	105.6	0.5	0.00	-0.13
365	6.08	101.7	101.1	0.5	0.00	-0.12
370	6.17	97.4	96.9	0.5	0.00	-0.12
375	6.25	93.3	92.8	0.5	0.00	-0.12
380	6.33	89.4	88.9	0.5	0.00	-0.11
385	6.42	85.6	85.1	0.5	0.00	-0.11
390	6.50	82.0	81.5	0.5	0.00	-0.11
395	6.58	78.5	78.1	0.5	0.00	-0.10
400	6.67	75.2	74.8	0.4	0.00	-0.10
405	6.75	72.1	71.6	0.4	0.00	-0.10
410	6.83	69.0	68.6	0.4	0.00	-0.09
415	6.92	66.1	65.7	0.4	0.00	-0.09
420	7.00	63.3	62.9	0.4	0.00	-0.09
425	7.08	60.7	60.3	0.4	0.00	-0.09
430	7.17	58.1	57.7	0.4	0.00	-0.08
435	7.25	55.7	55.3	0.4	0.00	-0.08
440	7.33	53.3	53.0	0.4	0.00	-0.08
445	7.42	51.1	50.7	0.4	0.00	-0.08
450	7.50	48.9	48.6	0.3	0.00	-0.07
455	7.58	46.9	46.5	0.3	0.00	-0.07
460	7.67	44.9	44.6	0.3	0.00	-0.07
465	7.75	43.0	42.7	0.3	0.00	-0.07
470	7.83	41.2	40.9	0.3	0.00	-0.06

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
475	7.92	39.5	39.2	0.3	0.00	-0.06
480	8.00	37.8	37.5	0.3	0.00	-0.06
485	8.08	36.2	35.9	0.3	0.00	-0.06
490	8.17	34.7	34.4	0.3	0.00	-0.06
495	8.25	33.2	33.0	0.3	0.00	-0.05
500	8.33	31.8	31.6	0.3	0.00	-0.05
505	8.42	30.5	30.2	0.2	0.00	-0.05
510	8.50	29.2	29.0	0.2	0.00	-0.05
515	8.58	28.0	27.7	0.2	0.00	-0.05
520	8.67	26.8	26.6	0.2	0.00	-0.05
525	8.75	25.7	25.4	0.2	0.00	-0.04
530	8.83	24.6	24.4	0.2	0.00	-0.04
535	8.92	23.6	23.3	0.2	0.00	-0.04
540	9.00	22.6	22.4	0.2	0.00	-0.04
545	9.08	21.6	21.4	0.2	0.00	-0.04
550	9.17	20.7	20.5	0.2	0.00	-0.04
555	9.25	19.8	19.6	0.2	0.00	-0.04
560	9.33	19.0	18.8	0.2	0.00	-0.04
565	9.42	18.2	18.0	0.2	0.00	-0.03
570	9.50	17.4	17.3	0.2	0.00	-0.03
575	9.58	16.7	16.5	0.2	0.00	-0.03
580	9.67	16.0	15.8	0.2	0.00	-0.03
585	9.75	15.3	15.2	0.2	0.00	-0.03
590	9.83	14.7	14.5	0.1	0.00	-0.03
595	9.92	14.1	13.9	0.1	0.00	-0.03
600	10.00	13.5	13.3	0.1	0.00	-0.03
605	10.08	12.9	12.8	0.1	0.00	-0.03
610	10.17	12.4	12.2	0.1	0.00	-0.02
615	10.25	11.8	11.7	0.1	0.00	-0.02
620	10.33	11.3	11.2	0.1	0.00	-0.02
625	10.42	10.9	10.7	0.1	0.00	-0.02
630	10.50	10.4	10.3	0.1	0.00	-0.02
635	10.58	10.0	9.9	0.1	0.00	-0.02
640	10.67	9.5	9.4	0.1	0.00	-0.02
645	10.75	9.1	9.0	0.1	0.00	-0.02
650	10.83	8.8	8.7	0.1	0.00	-0.02
655	10.92	8.4	8.3	0.1	0.00	-0.02
660	11.00	8.0	7.9	0.1	0.00	-0.02
665	11.08	7.7	7.6	0.1	0.00	-0.02
670	11.17	7.4	7.3	0.1	0.00	-0.02
675	11.25	7.1	7.0	0.1	0.00	-0.02
680	11.33	6.8	6.7	0.1	0.00	-0.02
685	11.42	6.5	6.4	0.1	0.00	-0.01
690	11.50	6.2	6.1	0.1	0.00	-0.01
695	11.58	5.9	5.9	0.1	0.00	-0.01
700	11.67	5.7	5.6	0.1	0.00	-0.01
705	11.75	5.5	5.4	0.1	0.00	-0.01
710	11.83	5.2	5.2	0.1	0.00	-0.01

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
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100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs			Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)	Flow Difference Qp-Qe (cfs)	Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
715	11.92	5.0	4.9	0.1	0.00	-0.01
720	12.00	4.8	4.7	0.1	0.00	-0.01
725	12.08	4.6	4.5	0.1	0.00	-0.01
730	12.17	4.4	4.3	0.1	0.00	-0.01
735	12.25	4.2	4.2	0.1	0.00	-0.01
740	12.33	4.0	4.0	0.1	0.00	-0.01
745	12.42	3.9	3.8	0.1	0.00	-0.01
750	12.50	3.7	3.7	0.0	0.00	-0.01
755	12.58	3.5	3.5	0.0	0.00	-0.01
760	12.67	3.4	3.4	0.0	0.00	-0.01
765	12.75	3.3	3.2	0.0	0.00	-0.01
770	12.83	3.1	3.1	0.0	0.00	-0.01
775	12.92	3.0	2.9	0.0	0.00	-0.01
780	13.00	2.9	2.8	0.0	0.00	-0.01
785	13.08	2.7	2.7	0.0	0.00	-0.01
790	13.17	2.6	2.6	0.0	0.00	-0.01
795	13.25	2.5	2.5	0.0	0.00	-0.01
800	13.33	2.4	2.4	0.0	0.00	-0.01
805	13.42	2.3	2.3	0.0	0.00	-0.01
810	13.50	2.2	2.2	0.0	0.00	-0.01
815	13.58	2.1	2.1	0.0	0.00	-0.01
820	13.67	2.0	2.0	0.0	0.00	-0.01
825	13.75	1.9	1.9	0.0	0.00	-0.01
830	13.83	1.9	1.8	0.0	0.00	0.00
835	13.92	1.8	1.8	0.0	0.00	0.00
840	14.00	1.7	1.7	0.0	0.00	0.00
845	14.08	1.6	1.6	0.0	0.00	0.00
850	14.17	1.6	1.5	0.0	0.00	0.00
855	14.25	1.5	1.5	0.0	0.00	0.00
860	14.33	1.4	1.4	0.0	0.00	0.00
865	14.42	1.4	1.4	0.0	0.00	0.00
870	14.50	1.3	1.3	0.0	0.00	0.00
875	14.58	1.3	1.2	0.0	0.00	0.00
880	14.67	1.2	1.2	0.0	0.00	0.00
885	14.75	1.2	1.1	0.0	0.00	0.00
890	14.83	1.1	1.1	0.0	0.00	0.00
895	14.92	1.1	1.0	0.0	0.00	0.00
900	15.00	1.0	1.0	0.0	0.00	0.00
905	15.08	1.0	1.0	0.0	0.00	0.00
910	15.17	0.9	0.9	0.0	0.00	0.00
915	15.25	0.9	0.9	0.0	0.00	0.00
920	15.33	0.9	0.8	0.0	0.00	0.00
925	15.42	0.8	0.8	0.0	0.00	0.00
930	15.50	0.8	0.8	0.0	0.00	0.00
935	15.58	0.8	0.7	0.0	0.00	0.00
940	15.67	0.7	0.7	0.0	0.00	0.00
945	15.75	0.7	0.7	0.0	0.00	0.00
950	15.83	0.7	0.7	0.0	0.00	0.00

Drainage System E0150 Hydrograph Comparison

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Hous
 Project No.: 345023
 Location: Houston, Texas
 Date: 12/21/17
 Performed By: ML
 Checked By: CM

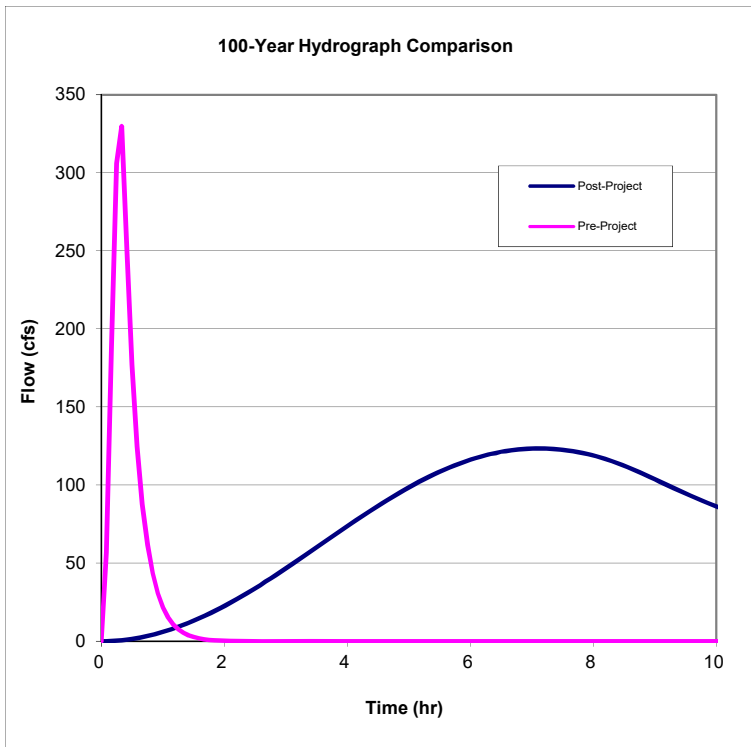
Watershed: White Oak Bayou
HCFC Unit: E100-00-00
Drainage System ID: E0150
Alternative: 1

Computation Parameters:

Design Storm = 100 year
 Storm Duration = 24 hours
 Drainage Area = 100.20 acres

*Peak flow from HouStorm

Condition	Peak Flow (cfs)	Peak Flow Impact (cfs)	Detention Volume (ac-ft)
Pre-Project	329.8	-206.3	56.42
Post-Project	123.5		



Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs			Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)	Flow Difference Qp-Qe (cfs)	Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
0	0.00	0.0	0.0	0.0	0	0
5	0.08	0.0	56.7	-56.7	-0.20	-0.20
10	0.17	0.2	188.5	-188.4	-0.84	-1.04
15	0.25	0.4	306.1	-305.7	-1.70	-2.74
20	0.33	0.7	329.8	-329.2	-2.19	-4.93
25	0.42	1.0	251.5	-250.4	-2.00	-6.92
30	0.50	1.5	177.0	-175.5	-1.47	-8.39
35	0.58	2.0	124.6	-122.6	-1.03	-9.42
40	0.67	2.7	87.7	-85.1	-0.72	-10.13
45	0.75	3.4	61.8	-58.4	-0.49	-10.63
50	0.83	4.1	43.5	-39.3	-0.34	-10.96
55	0.92	5.0	30.6	-25.6	-0.22	-11.19
60	1.00	5.9	21.5	-15.6	-0.14	-11.33
65	1.08	6.9	15.2	-8.2	-0.08	-11.41
70	1.17	8.0	10.7	-2.7	-0.04	-11.45
75	1.25	9.2	7.5	1.6	0.00	-11.45
80	1.33	10.4	5.3	5.1	0.02	-11.43
85	1.42	11.7	3.7	8.0	0.04	-11.38
90	1.50	13.0	2.6	10.4	0.06	-11.32
95	1.58	14.5	1.8	12.6	0.08	-11.24
100	1.67	16.0	1.3	14.7	0.09	-11.15
105	1.75	17.5	0.9	16.6	0.11	-11.04
110	1.83	19.1	0.6	18.5	0.12	-10.92
115	1.92	20.8	0.5	20.4	0.13	-10.78
120	2.00	22.5	0.3	22.2	0.15	-10.64
125	2.08	24.3	0.2	24.1	0.16	-10.48
130	2.17	26.2	0.2	26.0	0.17	-10.30
135	2.25	28.0	0.1	27.9	0.19	-10.12
140	2.33	30.0	0.1	29.9	0.20	-9.92
145	2.42	31.9	0.1	31.9	0.21	-9.71
150	2.50	33.9	0.0	33.9	0.23	-9.48
155	2.58	36.0	0.0	36.0	0.24	-9.24
160	2.67	38.1	0.0	38.0	0.25	-8.99
165	2.75	40.2	0.0	40.2	0.27	-8.72
170	2.83	42.3	0.0	42.3	0.28	-8.43
175	2.92	44.5	0.0	44.5	0.30	-8.13
180	3.00	46.7	0.0	46.7	0.31	-7.82
185	3.08	48.9	0.0	48.9	0.33	-7.49
190	3.17	51.1	0.0	51.1	0.34	-7.15
195	3.25	53.4	0.0	53.4	0.36	-6.79
200	3.33	55.6	0.0	55.6	0.38	-6.41
205	3.42	57.9	0.0	57.9	0.39	-6.02
210	3.50	60.2	0.0	60.2	0.41	-5.61
215	3.58	62.4	0.0	62.4	0.42	-5.19
220	3.67	64.7	0.0	64.7	0.44	-4.75
225	3.75	67.0	0.0	67.0	0.45	-4.30
230	3.83	69.2	0.0	69.2	0.47	-3.83

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
235	3.92	71.5	0.0	71.5	0.48	-3.35
240	4.00	73.7	0.0	73.7	0.50	-2.85
245	4.08	75.9	0.0	75.9	0.52	-2.33
250	4.17	78.1	0.0	78.1	0.53	-1.80
255	4.25	80.3	0.0	80.3	0.55	-1.26
260	4.33	82.5	0.0	82.5	0.56	-0.70
265	4.42	84.6	0.0	84.6	0.58	-0.12
270	4.50	86.7	0.0	86.7	0.59	0.47
275	4.58	88.8	0.0	88.8	0.60	1.07
280	4.67	90.8	0.0	90.8	0.62	1.69
285	4.75	92.8	0.0	92.8	0.63	2.32
290	4.83	94.7	0.0	94.7	0.65	2.97
295	4.92	96.6	0.0	96.6	0.66	3.63
300	5.00	98.5	0.0	98.5	0.67	4.30
305	5.08	100.3	0.0	100.3	0.68	4.98
310	5.17	102.0	0.0	102.0	0.70	5.68
315	5.25	103.7	0.0	103.7	0.71	6.39
320	5.33	105.3	0.0	105.3	0.72	7.11
325	5.42	106.9	0.0	106.9	0.73	7.84
330	5.50	108.4	0.0	108.4	0.74	8.58
335	5.58	109.9	0.0	109.9	0.75	9.33
340	5.67	111.3	0.0	111.3	0.76	10.10
345	5.75	112.6	0.0	112.6	0.77	10.87
350	5.83	113.9	0.0	113.9	0.78	11.65
355	5.92	115.1	0.0	115.1	0.79	12.43
360	6.00	116.2	0.0	116.2	0.80	13.23
365	6.08	117.2	0.0	117.2	0.80	14.03
370	6.17	118.2	0.0	118.2	0.81	14.85
375	6.25	119.1	0.0	119.1	0.82	15.66
380	6.33	119.9	0.0	119.9	0.82	16.49
385	6.42	120.6	0.0	120.6	0.83	17.31
390	6.50	121.3	0.0	121.3	0.83	18.15
395	6.58	121.8	0.0	121.8	0.84	18.98
400	6.67	122.3	0.0	122.3	0.84	19.82
405	6.75	122.7	0.0	122.7	0.84	20.67
410	6.83	123.1	0.0	123.1	0.85	21.51
415	6.92	123.3	0.0	123.3	0.85	22.36
420	7.00	123.5	0.0	123.5	0.85	23.21
425	7.08	123.5	0.0	123.5	0.85	24.06
430	7.17	123.5	0.0	123.5	0.85	24.91
435	7.25	123.4	0.0	123.4	0.85	25.76
440	7.33	123.3	0.0	123.3	0.85	26.61
445	7.42	123.0	0.0	123.0	0.85	27.46
450	7.50	122.7	0.0	122.7	0.85	28.31
455	7.58	122.3	0.0	122.3	0.84	29.15
460	7.67	121.8	0.0	121.8	0.84	29.99
465	7.75	121.2	0.0	121.2	0.84	30.83
470	7.83	120.5	0.0	120.5	0.83	31.66

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
475	7.92	119.8	0.0	119.8	0.83	32.49
480	8.00	118.9	0.0	118.9	0.82	33.31
485	8.08	118.0	0.0	118.0	0.82	34.13
490	8.17	117.1	0.0	117.1	0.81	34.94
495	8.25	116.0	0.0	116.0	0.80	35.74
500	8.33	114.9	0.0	114.9	0.80	36.53
505	8.42	113.7	0.0	113.7	0.79	37.32
510	8.50	112.4	0.0	112.4	0.78	38.10
515	8.58	111.1	0.0	111.1	0.77	38.87
520	8.67	109.7	0.0	109.7	0.76	39.63
525	8.75	108.2	0.0	108.2	0.75	40.38
530	8.83	106.7	0.0	106.7	0.74	41.12
535	8.92	105.2	0.0	105.2	0.73	41.85
540	9.00	103.6	0.0	103.6	0.72	42.57
545	9.08	102.1	0.0	102.1	0.71	43.28
550	9.17	100.5	0.0	100.5	0.70	43.97
555	9.25	99.0	0.0	99.0	0.69	44.66
560	9.33	97.5	0.0	97.5	0.68	45.34
565	9.42	96.1	0.0	96.1	0.67	46.00
570	9.50	94.6	0.0	94.6	0.66	46.66
575	9.58	93.2	0.0	93.2	0.65	47.31
580	9.67	91.8	0.0	91.8	0.64	47.94
585	9.75	90.4	0.0	90.4	0.63	48.57
590	9.83	89.0	0.0	89.0	0.62	49.19
595	9.92	87.7	0.0	87.7	0.61	49.80
600	10.00	86.3	0.0	86.3	0.60	50.40
605	10.08	85.0	0.0	85.0	0.59	50.99
610	10.17	83.8	0.0	83.8	0.58	51.57
615	10.25	82.5	0.0	82.5	0.57	52.14
620	10.33	81.2	0.0	81.2	0.56	52.71
625	10.42	80.0	0.0	80.0	0.56	53.26
630	10.50	78.8	0.0	78.8	0.55	53.81
635	10.58	77.6	0.0	77.6	0.54	54.35
640	10.67	76.4	0.0	76.4	0.53	54.88
645	10.75	75.3	0.0	75.3	0.52	55.40
650	10.83	74.2	0.0	74.2	0.51	55.91
655	10.92	73.0	0.0	73.0	0.51	56.42
660	11.00	71.9	0.0	71.9	0.50	56.92
665	11.08	70.8	0.0	70.8	0.49	57.41
670	11.17	69.8	0.0	69.8	0.48	57.90
675	11.25	68.7	0.0	68.7	0.48	58.37
680	11.33	67.7	0.0	67.7	0.47	58.84
685	11.42	66.7	0.0	66.7	0.46	59.31
690	11.50	65.7	0.0	65.7	0.46	59.76
695	11.58	64.7	0.0	64.7	0.45	60.21
700	11.67	63.7	0.0	63.7	0.44	60.65
705	11.75	62.7	0.0	62.7	0.44	61.09
710	11.83	61.8	0.0	61.8	0.43	61.52

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
715	11.92	60.8	0.0	60.8	0.42	61.94
720	12.00	59.9	0.0	59.9	0.42	62.35
725	12.08	59.0	0.0	59.0	0.41	62.76
730	12.17	58.1	0.0	58.1	0.40	63.17
735	12.25	57.3	0.0	57.3	0.40	63.56
740	12.33	56.4	0.0	56.4	0.39	63.96
745	12.42	55.5	0.0	55.5	0.39	64.34
750	12.50	54.7	0.0	54.7	0.38	64.72
755	12.58	53.9	0.0	53.9	0.37	65.09
760	12.67	53.1	0.0	53.1	0.37	65.46
765	12.75	52.3	0.0	52.3	0.36	65.82
770	12.83	51.5	0.0	51.5	0.36	66.18
775	12.92	50.7	0.0	50.7	0.35	66.53
780	13.00	49.9	0.0	49.9	0.35	66.88
785	13.08	49.2	0.0	49.2	0.34	67.22
790	13.17	48.4	0.0	48.4	0.34	67.56
795	13.25	47.7	0.0	47.7	0.33	67.89
800	13.33	47.0	0.0	47.0	0.33	68.21
805	13.42	46.3	0.0	46.3	0.32	68.54
810	13.50	45.6	0.0	45.6	0.32	68.85
815	13.58	44.9	0.0	44.9	0.31	69.16
820	13.67	44.2	0.0	44.2	0.31	69.47
825	13.75	43.5	0.0	43.5	0.30	69.77
830	13.83	42.9	0.0	42.9	0.30	70.07
835	13.92	42.2	0.0	42.2	0.29	70.36
840	14.00	41.6	0.0	41.6	0.29	70.65
845	14.08	41.0	0.0	41.0	0.28	70.94
850	14.17	40.3	0.0	40.3	0.28	71.22
855	14.25	39.7	0.0	39.7	0.28	71.49
860	14.33	39.1	0.0	39.1	0.27	71.76
865	14.42	38.5	0.0	38.5	0.27	72.03
870	14.50	38.0	0.0	38.0	0.26	72.29
875	14.58	37.4	0.0	37.4	0.26	72.55
880	14.67	36.8	0.0	36.8	0.26	72.81
885	14.75	36.3	0.0	36.3	0.25	73.06
890	14.83	35.7	0.0	35.7	0.25	73.31
895	14.92	35.2	0.0	35.2	0.24	73.55
900	15.00	34.6	0.0	34.6	0.24	73.79
905	15.08	34.1	0.0	34.1	0.24	74.03
910	15.17	33.6	0.0	33.6	0.23	74.26
915	15.25	33.1	0.0	33.1	0.23	74.49
920	15.33	32.6	0.0	32.6	0.23	74.72
925	15.42	32.1	0.0	32.1	0.22	74.94
930	15.50	31.6	0.0	31.6	0.22	75.16
935	15.58	31.1	0.0	31.1	0.22	75.38
940	15.67	30.7	0.0	30.7	0.21	75.59
945	15.75	30.2	0.0	30.2	0.21	75.80
950	15.83	29.8	0.0	29.8	0.21	76.01

Drainage System E0145A Hydrograph Comparison

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Hous
 Project No.: 345023
 Location: Houston, Texas
 Date: 12/21/17
 Performed By: ML
 Checked By: CM

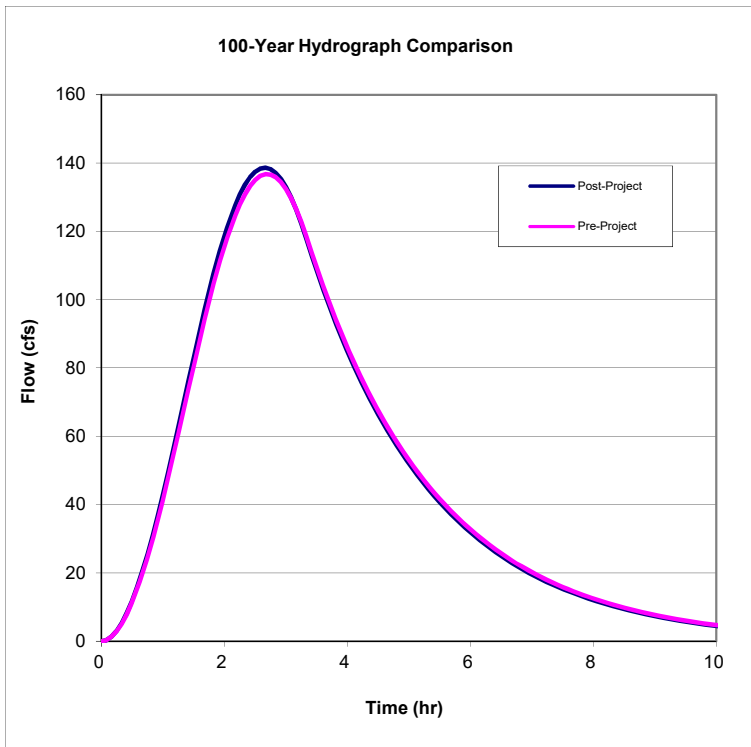
Watershed: White Oak Bayou
HCFC Unit: E100-00-00
Drainage System ID: E0145A
Alternative: 1

Computation Parameters:

Design Storm = 100 year
 Storm Duration = 24 hours
 Drainage Area = 42.07 acres

*Peak flow from HouStorm

Condition	Peak Flow (cfs)	Peak Flow Impact (cfs)	Detention Volume (ac-ft)
Pre-Project	136.7	1.9	0.45
Post-Project	138.6		



Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
0	0.00	0.0	0.0	0.0	0	0
5	0.08	0.3	0.3	0.0	0.00	0.00
10	0.17	1.3	1.3	0.1	0.00	0.00
15	0.25	3.0	2.9	0.1	0.00	0.00
20	0.33	5.3	5.1	0.2	0.00	0.00
25	0.42	8.2	7.9	0.3	0.00	0.00
30	0.50	11.8	11.3	0.5	0.00	0.01
35	0.58	15.8	15.2	0.6	0.00	0.01
40	0.67	20.4	19.7	0.8	0.00	0.02
45	0.75	25.5	24.6	1.0	0.01	0.02
50	0.83	31.0	29.9	1.2	0.01	0.03
55	0.92	36.9	35.5	1.4	0.01	0.04
60	1.00	43.1	41.5	1.6	0.01	0.05
65	1.08	49.5	47.7	1.8	0.01	0.06
70	1.17	56.2	54.2	2.0	0.01	0.07
75	1.25	62.9	60.7	2.2	0.01	0.09
80	1.33	69.7	67.3	2.4	0.02	0.10
85	1.42	76.5	74.0	2.6	0.02	0.12
90	1.50	83.3	80.6	2.7	0.02	0.14
95	1.58	89.9	87.1	2.9	0.02	0.16
100	1.67	96.3	93.4	3.0	0.02	0.18
105	1.75	102.5	99.4	3.1	0.02	0.20
110	1.83	108.3	105.2	3.1	0.02	0.22
115	1.92	113.8	110.6	3.1	0.02	0.24
120	2.00	118.8	115.6	3.1	0.02	0.26
125	2.08	123.3	120.2	3.1	0.02	0.28
130	2.17	127.3	124.3	3.0	0.02	0.30
135	2.25	130.8	127.9	2.9	0.02	0.33
140	2.33	133.6	130.8	2.8	0.02	0.34
145	2.42	135.9	133.3	2.6	0.02	0.36
150	2.50	137.4	135.0	2.4	0.02	0.38
155	2.58	138.4	136.2	2.2	0.02	0.40
160	2.67	138.6	136.7	1.9	0.01	0.41
165	2.75	138.2	136.6	1.6	0.01	0.42
170	2.83	137.1	135.9	1.3	0.01	0.43
175	2.92	135.4	134.4	0.9	0.01	0.44
180	3.00	133.0	132.4	0.6	0.01	0.44
185	3.08	130.0	129.8	0.2	0.00	0.45
190	3.17	126.4	126.6	-0.2	0.00	0.45
195	3.25	122.3	122.8	-0.6	0.00	0.44
200	3.33	117.7	118.5	-0.8	0.00	0.44
205	3.42	113.0	114.1	-1.0	-0.01	0.43
210	3.50	108.5	109.6	-1.0	-0.01	0.43
215	3.58	104.2	105.2	-1.1	-0.01	0.42
220	3.67	100.0	101.1	-1.1	-0.01	0.41
225	3.75	96.0	97.1	-1.1	-0.01	0.41
230	3.83	92.2	93.3	-1.1	-0.01	0.40

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
235	3.92	88.5	89.6	-1.1	-0.01	0.39
240	4.00	85.0	86.1	-1.1	-0.01	0.38
245	4.08	81.6	82.7	-1.1	-0.01	0.38
250	4.17	78.3	79.4	-1.1	-0.01	0.37
255	4.25	75.2	76.3	-1.1	-0.01	0.36
260	4.33	72.2	73.3	-1.1	-0.01	0.35
265	4.42	69.3	70.4	-1.1	-0.01	0.35
270	4.50	66.5	67.6	-1.1	-0.01	0.34
275	4.58	63.9	64.9	-1.1	-0.01	0.33
280	4.67	61.3	62.4	-1.1	-0.01	0.32
285	4.75	58.9	59.9	-1.1	-0.01	0.32
290	4.83	56.5	57.6	-1.0	-0.01	0.31
295	4.92	54.3	55.3	-1.0	-0.01	0.30
300	5.00	52.1	53.1	-1.0	-0.01	0.29
305	5.08	50.0	51.0	-1.0	-0.01	0.29
310	5.17	48.0	49.0	-1.0	-0.01	0.28
315	5.25	46.1	47.1	-1.0	-0.01	0.27
320	5.33	44.2	45.2	-1.0	-0.01	0.27
325	5.42	42.5	43.4	-0.9	-0.01	0.26
330	5.50	40.8	41.7	-0.9	-0.01	0.25
335	5.58	39.2	40.1	-0.9	-0.01	0.25
340	5.67	37.6	38.5	-0.9	-0.01	0.24
345	5.75	36.1	37.0	-0.9	-0.01	0.24
350	5.83	34.6	35.5	-0.9	-0.01	0.23
355	5.92	33.3	34.1	-0.9	-0.01	0.22
360	6.00	31.9	32.8	-0.8	-0.01	0.22
365	6.08	30.7	31.5	-0.8	-0.01	0.21
370	6.17	29.4	30.2	-0.8	-0.01	0.21
375	6.25	28.3	29.0	-0.8	-0.01	0.20
380	6.33	27.1	27.9	-0.8	-0.01	0.20
385	6.42	26.0	26.8	-0.8	-0.01	0.19
390	6.50	25.0	25.7	-0.7	-0.01	0.18
395	6.58	24.0	24.7	-0.7	-0.01	0.18
400	6.67	23.0	23.8	-0.7	0.00	0.17
405	6.75	22.1	22.8	-0.7	0.00	0.17
410	6.83	21.2	21.9	-0.7	0.00	0.17
415	6.92	20.4	21.0	-0.7	0.00	0.16
420	7.00	19.6	20.2	-0.6	0.00	0.16
425	7.08	18.8	19.4	-0.6	0.00	0.15
430	7.17	18.0	18.7	-0.6	0.00	0.15
435	7.25	17.3	17.9	-0.6	0.00	0.14
440	7.33	16.6	17.2	-0.6	0.00	0.14
445	7.42	16.0	16.5	-0.6	0.00	0.14
450	7.50	15.3	15.9	-0.6	0.00	0.13
455	7.58	14.7	15.3	-0.5	0.00	0.13
460	7.67	14.1	14.7	-0.5	0.00	0.12
465	7.75	13.6	14.1	-0.5	0.00	0.12
470	7.83	13.0	13.5	-0.5	0.00	0.12

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
475	7.92	12.5	13.0	-0.5	0.00	0.11
480	8.00	12.0	12.5	-0.5	0.00	0.11
485	8.08	11.5	12.0	-0.5	0.00	0.11
490	8.17	11.1	11.5	-0.5	0.00	0.10
495	8.25	10.6	11.1	-0.4	0.00	0.10
500	8.33	10.2	10.6	-0.4	0.00	0.10
505	8.42	9.8	10.2	-0.4	0.00	0.09
510	8.50	9.4	9.8	-0.4	0.00	0.09
515	8.58	9.0	9.4	-0.4	0.00	0.09
520	8.67	8.7	9.0	-0.4	0.00	0.09
525	8.75	8.3	8.7	-0.4	0.00	0.08
530	8.83	8.0	8.3	-0.4	0.00	0.08
535	8.92	7.7	8.0	-0.4	0.00	0.08
540	9.00	7.4	7.7	-0.3	0.00	0.08
545	9.08	7.1	7.4	-0.3	0.00	0.07
550	9.17	6.8	7.1	-0.3	0.00	0.07
555	9.25	6.5	6.8	-0.3	0.00	0.07
560	9.33	6.2	6.6	-0.3	0.00	0.07
565	9.42	6.0	6.3	-0.3	0.00	0.07
570	9.50	5.8	6.0	-0.3	0.00	0.06
575	9.58	5.5	5.8	-0.3	0.00	0.06
580	9.67	5.3	5.6	-0.3	0.00	0.06
585	9.75	5.1	5.4	-0.3	0.00	0.06
590	9.83	4.9	5.1	-0.3	0.00	0.06
595	9.92	4.7	4.9	-0.2	0.00	0.05
600	10.00	4.5	4.8	-0.2	0.00	0.05
605	10.08	4.3	4.6	-0.2	0.00	0.05
610	10.17	4.2	4.4	-0.2	0.00	0.05
615	10.25	4.0	4.2	-0.2	0.00	0.05
620	10.33	3.8	4.0	-0.2	0.00	0.05
625	10.42	3.7	3.9	-0.2	0.00	0.04
630	10.50	3.5	3.7	-0.2	0.00	0.04
635	10.58	3.4	3.6	-0.2	0.00	0.04
640	10.67	3.3	3.4	-0.2	0.00	0.04
645	10.75	3.1	3.3	-0.2	0.00	0.04
650	10.83	3.0	3.2	-0.2	0.00	0.04
655	10.92	2.9	3.1	-0.2	0.00	0.04
660	11.00	2.8	2.9	-0.2	0.00	0.04
665	11.08	2.7	2.8	-0.2	0.00	0.03
670	11.17	2.5	2.7	-0.2	0.00	0.03
675	11.25	2.4	2.6	-0.2	0.00	0.03
680	11.33	2.3	2.5	-0.1	0.00	0.03
685	11.42	2.3	2.4	-0.1	0.00	0.03
690	11.50	2.2	2.3	-0.1	0.00	0.03
695	11.58	2.1	2.2	-0.1	0.00	0.03
700	11.67	2.0	2.1	-0.1	0.00	0.03
705	11.75	1.9	2.0	-0.1	0.00	0.03
710	11.83	1.8	2.0	-0.1	0.00	0.03

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
715	11.92	1.8	1.9	-0.1	0.00	0.02
720	12.00	1.7	1.8	-0.1	0.00	0.02
725	12.08	1.6	1.7	-0.1	0.00	0.02
730	12.17	1.6	1.7	-0.1	0.00	0.02
735	12.25	1.5	1.6	-0.1	0.00	0.02
740	12.33	1.4	1.5	-0.1	0.00	0.02
745	12.42	1.4	1.5	-0.1	0.00	0.02
750	12.50	1.3	1.4	-0.1	0.00	0.02
755	12.58	1.3	1.4	-0.1	0.00	0.02
760	12.67	1.2	1.3	-0.1	0.00	0.02
765	12.75	1.2	1.3	-0.1	0.00	0.02
770	12.83	1.1	1.2	-0.1	0.00	0.02
775	12.92	1.1	1.2	-0.1	0.00	0.02
780	13.00	1.0	1.1	-0.1	0.00	0.02
785	13.08	1.0	1.1	-0.1	0.00	0.02
790	13.17	1.0	1.0	-0.1	0.00	0.02
795	13.25	0.9	1.0	-0.1	0.00	0.01
800	13.33	0.9	1.0	-0.1	0.00	0.01
805	13.42	0.8	0.9	-0.1	0.00	0.01
810	13.50	0.8	0.9	-0.1	0.00	0.01
815	13.58	0.8	0.8	-0.1	0.00	0.01
820	13.67	0.7	0.8	-0.1	0.00	0.01
825	13.75	0.7	0.8	-0.1	0.00	0.01
830	13.83	0.7	0.7	-0.1	0.00	0.01
835	13.92	0.7	0.7	-0.1	0.00	0.01
840	14.00	0.6	0.7	-0.1	0.00	0.01
845	14.08	0.6	0.7	-0.1	0.00	0.01
850	14.17	0.6	0.6	0.0	0.00	0.01
855	14.25	0.6	0.6	0.0	0.00	0.01
860	14.33	0.5	0.6	0.0	0.00	0.01
865	14.42	0.5	0.6	0.0	0.00	0.01
870	14.50	0.5	0.5	0.0	0.00	0.01
875	14.58	0.5	0.5	0.0	0.00	0.01
880	14.67	0.5	0.5	0.0	0.00	0.01
885	14.75	0.4	0.5	0.0	0.00	0.01
890	14.83	0.4	0.5	0.0	0.00	0.01
895	14.92	0.4	0.4	0.0	0.00	0.01
900	15.00	0.4	0.4	0.0	0.00	0.01
905	15.08	0.4	0.4	0.0	0.00	0.01
910	15.17	0.4	0.4	0.0	0.00	0.01
915	15.25	0.3	0.4	0.0	0.00	0.01
920	15.33	0.3	0.4	0.0	0.00	0.01
925	15.42	0.3	0.3	0.0	0.00	0.01
930	15.50	0.3	0.3	0.0	0.00	0.01
935	15.58	0.3	0.3	0.0	0.00	0.01
940	15.67	0.3	0.3	0.0	0.00	0.01
945	15.75	0.3	0.3	0.0	0.00	0.01
950	15.83	0.3	0.3	0.0	0.00	0.01

Drainage System E0145B Hydrograph Comparison

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Hous
 Project No.: 345023
 Location: Houston, Texas
 Date: 12/21/17
 Performed By: ML
 Checked By: CM

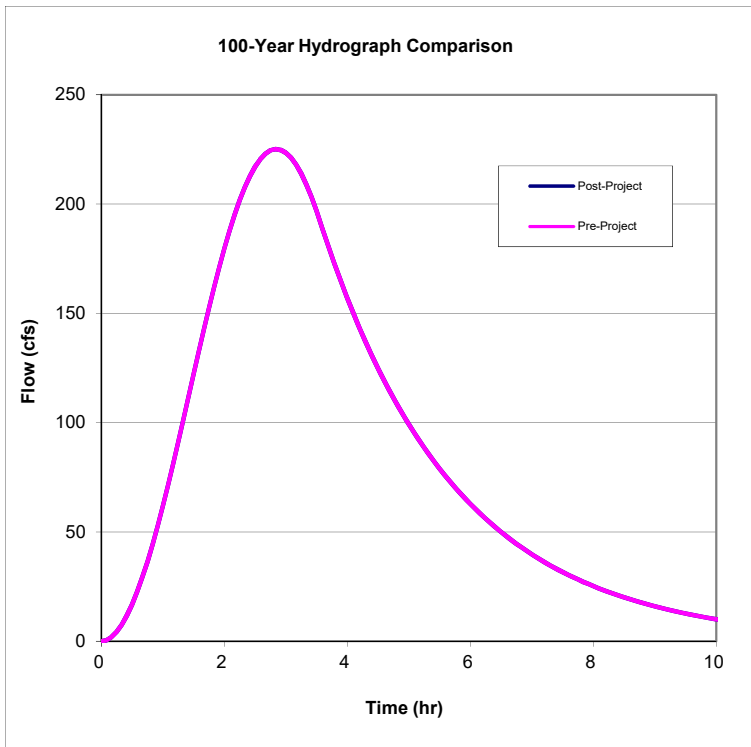
Watershed: White Oak Bayou
HCFC Unit: E100-00-00
Drainage System ID: E0145B
Alternative: 1

Computation Parameters:

Design Storm = 100 year
 Storm Duration = 24 hours
 Drainage Area = 42.07 acres

*Peak flow from HouStorm

Condition	Peak Flow (cfs)	Peak Flow Impact (cfs)	Detention Volume (ac-ft)
Pre-Project	225.1	0.0	0.00
Post-Project	225.1		



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100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
0	0.00	0.0	0.0	0.0	0	0
5	0.08	0.5	0.5	0.0	0.00	0.00
10	0.17	1.9	1.9	0.0	0.00	0.00
15	0.25	4.3	4.3	0.0	0.00	0.00
20	0.33	7.6	7.6	0.0	0.00	0.00
25	0.42	11.7	11.7	0.0	0.00	0.00
30	0.50	16.8	16.8	0.0	0.00	0.00
35	0.58	22.6	22.6	0.0	0.00	0.00
40	0.67	29.2	29.2	0.0	0.00	0.00
45	0.75	36.5	36.5	0.0	0.00	0.00
50	0.83	44.5	44.5	0.0	0.00	0.00
55	0.92	53.0	53.0	0.0	0.00	0.00
60	1.00	62.0	62.0	0.0	0.00	0.00
65	1.08	71.5	71.5	0.0	0.00	0.00
70	1.17	81.3	81.3	0.0	0.00	0.00
75	1.25	91.4	91.4	0.0	0.00	0.00
80	1.33	101.7	101.7	0.0	0.00	0.00
85	1.42	112.0	112.0	0.0	0.00	0.00
90	1.50	122.4	122.4	0.0	0.00	0.00
95	1.58	132.6	132.6	0.0	0.00	0.00
100	1.67	142.7	142.7	0.0	0.00	0.00
105	1.75	152.6	152.6	0.0	0.00	0.00
110	1.83	162.1	162.1	0.0	0.00	0.00
115	1.92	171.2	171.2	0.0	0.00	0.00
120	2.00	179.8	179.8	0.0	0.00	0.00
125	2.08	187.8	187.8	0.0	0.00	0.00
130	2.17	195.2	195.2	0.0	0.00	0.00
135	2.25	201.9	201.9	0.0	0.00	0.00
140	2.33	207.8	207.8	0.0	0.00	0.00
145	2.42	212.9	212.9	0.0	0.00	0.00
150	2.50	217.2	217.2	0.0	0.00	0.00
155	2.58	220.6	220.6	0.0	0.00	0.00
160	2.67	223.0	223.0	0.0	0.00	0.00
165	2.75	224.6	224.6	0.0	0.00	0.00
170	2.83	225.1	225.1	0.0	0.00	0.00
175	2.92	224.8	224.8	0.0	0.00	0.00
180	3.00	223.5	223.5	0.0	0.00	0.00
185	3.08	221.2	221.2	0.0	0.00	0.00
190	3.17	218.0	218.0	0.0	0.00	0.00
195	3.25	213.9	213.9	0.0	0.00	0.00
200	3.33	209.0	209.0	0.0	0.00	0.00
205	3.42	203.2	203.2	0.0	0.00	0.00
210	3.50	196.7	196.7	0.0	0.00	0.00
215	3.58	189.8	189.8	0.0	0.00	0.00
220	3.67	182.7	182.7	0.0	0.00	0.00
225	3.75	175.9	175.9	0.0	0.00	0.00
230	3.83	169.3	169.3	0.0	0.00	0.00

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
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100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
235	3.92	162.9	162.9	0.0	0.00	0.00
240	4.00	156.9	156.9	0.0	0.00	0.00
245	4.08	151.0	151.0	0.0	0.00	0.00
250	4.17	145.3	145.3	0.0	0.00	0.00
255	4.25	139.9	139.9	0.0	0.00	0.00
260	4.33	134.7	134.7	0.0	0.00	0.00
265	4.42	129.6	129.6	0.0	0.00	0.00
270	4.50	124.8	124.8	0.0	0.00	0.00
275	4.58	120.1	120.1	0.0	0.00	0.00
280	4.67	115.6	115.6	0.0	0.00	0.00
285	4.75	111.3	111.3	0.0	0.00	0.00
290	4.83	107.1	107.1	0.0	0.00	0.00
295	4.92	103.1	103.1	0.0	0.00	0.00
300	5.00	99.3	99.3	0.0	0.00	0.00
305	5.08	95.6	95.6	0.0	0.00	0.00
310	5.17	92.0	92.0	0.0	0.00	0.00
315	5.25	88.6	88.6	0.0	0.00	0.00
320	5.33	85.2	85.2	0.0	0.00	0.00
325	5.42	82.1	82.1	0.0	0.00	0.00
330	5.50	79.0	79.0	0.0	0.00	0.00
335	5.58	76.0	76.0	0.0	0.00	0.00
340	5.67	73.2	73.2	0.0	0.00	0.00
345	5.75	70.5	70.5	0.0	0.00	0.00
350	5.83	67.8	67.8	0.0	0.00	0.00
355	5.92	65.3	65.3	0.0	0.00	0.00
360	6.00	62.8	62.8	0.0	0.00	0.00
365	6.08	60.5	60.5	0.0	0.00	0.00
370	6.17	58.2	58.2	0.0	0.00	0.00
375	6.25	56.1	56.1	0.0	0.00	0.00
380	6.33	54.0	54.0	0.0	0.00	0.00
385	6.42	51.9	51.9	0.0	0.00	0.00
390	6.50	50.0	50.0	0.0	0.00	0.00
395	6.58	48.1	48.1	0.0	0.00	0.00
400	6.67	46.3	46.3	0.0	0.00	0.00
405	6.75	44.6	44.6	0.0	0.00	0.00
410	6.83	42.9	42.9	0.0	0.00	0.00
415	6.92	41.3	41.3	0.0	0.00	0.00
420	7.00	39.8	39.8	0.0	0.00	0.00
425	7.08	38.3	38.3	0.0	0.00	0.00
430	7.17	36.9	36.9	0.0	0.00	0.00
435	7.25	35.5	35.5	0.0	0.00	0.00
440	7.33	34.2	34.2	0.0	0.00	0.00
445	7.42	32.9	32.9	0.0	0.00	0.00
450	7.50	31.6	31.6	0.0	0.00	0.00
455	7.58	30.5	30.5	0.0	0.00	0.00
460	7.67	29.3	29.3	0.0	0.00	0.00
465	7.75	28.2	28.2	0.0	0.00	0.00
470	7.83	27.2	27.2	0.0	0.00	0.00

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
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100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
475	7.92	26.2	26.2	0.0	0.00	0.00
480	8.00	25.2	25.2	0.0	0.00	0.00
485	8.08	24.2	24.2	0.0	0.00	0.00
490	8.17	23.3	23.3	0.0	0.00	0.00
495	8.25	22.5	22.5	0.0	0.00	0.00
500	8.33	21.6	21.6	0.0	0.00	0.00
505	8.42	20.8	20.8	0.0	0.00	0.00
510	8.50	20.0	20.0	0.0	0.00	0.00
515	8.58	19.3	19.3	0.0	0.00	0.00
520	8.67	18.6	18.6	0.0	0.00	0.00
525	8.75	17.9	17.9	0.0	0.00	0.00
530	8.83	17.2	17.2	0.0	0.00	0.00
535	8.92	16.6	16.6	0.0	0.00	0.00
540	9.00	15.9	15.9	0.0	0.00	0.00
545	9.08	15.3	15.3	0.0	0.00	0.00
550	9.17	14.8	14.8	0.0	0.00	0.00
555	9.25	14.2	14.2	0.0	0.00	0.00
560	9.33	13.7	13.7	0.0	0.00	0.00
565	9.42	13.2	13.2	0.0	0.00	0.00
570	9.50	12.7	12.7	0.0	0.00	0.00
575	9.58	12.2	12.2	0.0	0.00	0.00
580	9.67	11.7	11.7	0.0	0.00	0.00
585	9.75	11.3	11.3	0.0	0.00	0.00
590	9.83	10.9	10.9	0.0	0.00	0.00
595	9.92	10.5	10.5	0.0	0.00	0.00
600	10.00	10.1	10.1	0.0	0.00	0.00
605	10.08	9.7	9.7	0.0	0.00	0.00
610	10.17	9.3	9.3	0.0	0.00	0.00
615	10.25	9.0	9.0	0.0	0.00	0.00
620	10.33	8.7	8.7	0.0	0.00	0.00
625	10.42	8.3	8.3	0.0	0.00	0.00
630	10.50	8.0	8.0	0.0	0.00	0.00
635	10.58	7.7	7.7	0.0	0.00	0.00
640	10.67	7.4	7.4	0.0	0.00	0.00
645	10.75	7.2	7.2	0.0	0.00	0.00
650	10.83	6.9	6.9	0.0	0.00	0.00
655	10.92	6.6	6.6	0.0	0.00	0.00
660	11.00	6.4	6.4	0.0	0.00	0.00
665	11.08	6.1	6.1	0.0	0.00	0.00
670	11.17	5.9	5.9	0.0	0.00	0.00
675	11.25	5.7	5.7	0.0	0.00	0.00
680	11.33	5.5	5.5	0.0	0.00	0.00
685	11.42	5.3	5.3	0.0	0.00	0.00
690	11.50	5.1	5.1	0.0	0.00	0.00
695	11.58	4.9	4.9	0.0	0.00	0.00
700	11.67	4.7	4.7	0.0	0.00	0.00
705	11.75	4.5	4.5	0.0	0.00	0.00
710	11.83	4.4	4.4	0.0	0.00	0.00

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
715	11.92	4.2	4.2	0.0	0.00	0.00
720	12.00	4.0	4.0	0.0	0.00	0.00
725	12.08	3.9	3.9	0.0	0.00	0.00
730	12.17	3.7	3.7	0.0	0.00	0.00
735	12.25	3.6	3.6	0.0	0.00	0.00
740	12.33	3.5	3.5	0.0	0.00	0.00
745	12.42	3.3	3.3	0.0	0.00	0.00
750	12.50	3.2	3.2	0.0	0.00	0.00
755	12.58	3.1	3.1	0.0	0.00	0.00
760	12.67	3.0	3.0	0.0	0.00	0.00
765	12.75	2.9	2.9	0.0	0.00	0.00
770	12.83	2.8	2.8	0.0	0.00	0.00
775	12.92	2.7	2.7	0.0	0.00	0.00
780	13.00	2.6	2.6	0.0	0.00	0.00
785	13.08	2.5	2.5	0.0	0.00	0.00
790	13.17	2.4	2.4	0.0	0.00	0.00
795	13.25	2.3	2.3	0.0	0.00	0.00
800	13.33	2.2	2.2	0.0	0.00	0.00
805	13.42	2.1	2.1	0.0	0.00	0.00
810	13.50	2.0	2.0	0.0	0.00	0.00
815	13.58	2.0	2.0	0.0	0.00	0.00
820	13.67	1.9	1.9	0.0	0.00	0.00
825	13.75	1.8	1.8	0.0	0.00	0.00
830	13.83	1.7	1.7	0.0	0.00	0.00
835	13.92	1.7	1.7	0.0	0.00	0.00
840	14.00	1.6	1.6	0.0	0.00	0.00
845	14.08	1.6	1.6	0.0	0.00	0.00
850	14.17	1.5	1.5	0.0	0.00	0.00
855	14.25	1.4	1.4	0.0	0.00	0.00
860	14.33	1.4	1.4	0.0	0.00	0.00
865	14.42	1.3	1.3	0.0	0.00	0.00
870	14.50	1.3	1.3	0.0	0.00	0.00
875	14.58	1.2	1.2	0.0	0.00	0.00
880	14.67	1.2	1.2	0.0	0.00	0.00
885	14.75	1.1	1.1	0.0	0.00	0.00
890	14.83	1.1	1.1	0.0	0.00	0.00
895	14.92	1.1	1.1	0.0	0.00	0.00
900	15.00	1.0	1.0	0.0	0.00	0.00
905	15.08	1.0	1.0	0.0	0.00	0.00
910	15.17	0.9	0.9	0.0	0.00	0.00
915	15.25	0.9	0.9	0.0	0.00	0.00
920	15.33	0.9	0.9	0.0	0.00	0.00
925	15.42	0.8	0.8	0.0	0.00	0.00
930	15.50	0.8	0.8	0.0	0.00	0.00
935	15.58	0.8	0.8	0.0	0.00	0.00
940	15.67	0.8	0.8	0.0	0.00	0.00
945	15.75	0.7	0.7	0.0	0.00	0.00
950	15.83	0.7	0.7	0.0	0.00	0.00

Drainage System E0042 Hydrograph Comparison

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Hous
 Project No.: 345023
 Location: Houston, Texas
 Date: 12/21/17
 Performed By: ML
 Checked By: CM

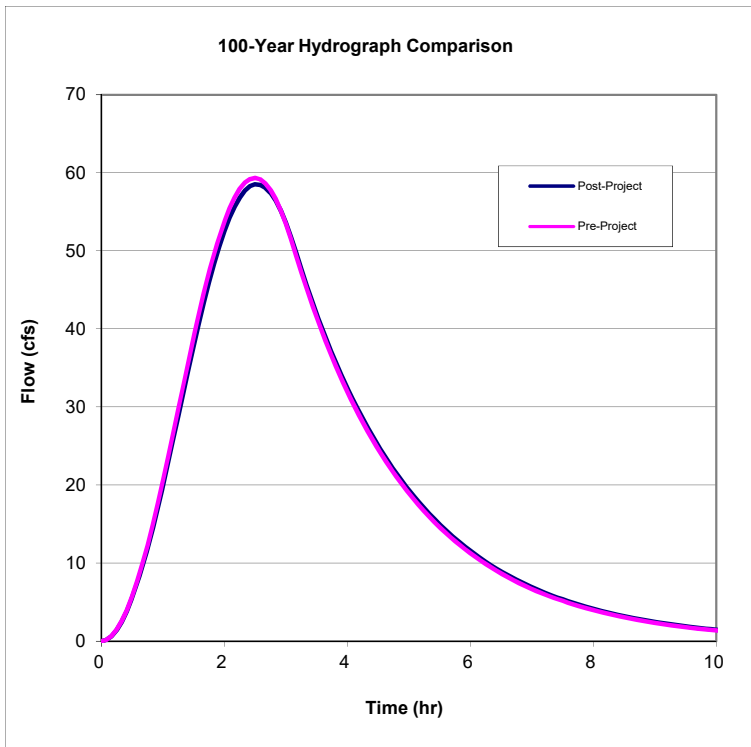
Watershed: White Oak Bayou
HCFC Unit: E100-00-00
Drainage System ID: E0042
Alternative: 1

Computation Parameters:

Design Storm = 100 year
 Storm Duration = 24 hours
 Drainage Area = 16.48 acres

*Peak flow from HouStorm

Condition	Peak Flow (cfs)	Peak Flow Impact (cfs)	Detention Volume (ac-ft)
Pre-Project	59.3	-0.8	0.00
Post-Project	58.5		



Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
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100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
0	0.00	0.0	0.0	0.0	0	0
5	0.08	0.2	0.2	0.0	0.00	0.00
10	0.17	0.6	0.7	0.0	0.00	0.00
15	0.25	1.4	1.5	-0.1	0.00	0.00
20	0.33	2.5	2.6	-0.1	0.00	0.00
25	0.42	3.8	4.0	-0.2	0.00	0.00
30	0.50	5.5	5.7	-0.2	0.00	0.00
35	0.58	7.4	7.7	-0.3	0.00	0.00
40	0.67	9.5	9.9	-0.4	0.00	-0.01
45	0.75	11.8	12.3	-0.5	0.00	-0.01
50	0.83	14.4	14.9	-0.6	0.00	-0.01
55	0.92	17.0	17.7	-0.6	0.00	-0.02
60	1.00	19.9	20.6	-0.7	0.00	-0.02
65	1.08	22.8	23.6	-0.8	-0.01	-0.03
70	1.17	25.8	26.7	-0.9	-0.01	-0.03
75	1.25	28.8	29.8	-1.0	-0.01	-0.04
80	1.33	31.8	32.9	-1.1	-0.01	-0.05
85	1.42	34.8	36.0	-1.2	-0.01	-0.06
90	1.50	37.8	39.0	-1.2	-0.01	-0.06
95	1.58	40.6	41.9	-1.3	-0.01	-0.07
100	1.67	43.4	44.7	-1.3	-0.01	-0.08
105	1.75	45.9	47.3	-1.3	-0.01	-0.09
110	1.83	48.3	49.7	-1.3	-0.01	-0.10
115	1.92	50.5	51.9	-1.3	-0.01	-0.11
120	2.00	52.5	53.8	-1.3	-0.01	-0.12
125	2.08	54.2	55.5	-1.3	-0.01	-0.13
130	2.17	55.7	56.9	-1.2	-0.01	-0.14
135	2.25	56.8	58.0	-1.1	-0.01	-0.14
140	2.33	57.7	58.7	-1.0	-0.01	-0.15
145	2.42	58.3	59.2	-0.9	-0.01	-0.16
150	2.50	58.5	59.3	-0.8	-0.01	-0.16
155	2.58	58.5	59.1	-0.7	-0.01	-0.17
160	2.67	58.1	58.6	-0.5	0.00	-0.17
165	2.75	57.4	57.8	-0.4	0.00	-0.18
170	2.83	56.4	56.6	-0.2	0.00	-0.18
175	2.92	55.2	55.2	0.0	0.00	-0.18
180	3.00	53.6	53.5	0.1	0.00	-0.18
185	3.08	51.8	51.5	0.3	0.00	-0.18
190	3.17	49.8	49.4	0.4	0.00	-0.17
195	3.25	47.7	47.3	0.4	0.00	-0.17
200	3.33	45.7	45.3	0.4	0.00	-0.17
205	3.42	43.8	43.3	0.5	0.00	-0.16
210	3.50	42.0	41.5	0.5	0.00	-0.16
215	3.58	40.2	39.7	0.5	0.00	-0.16
220	3.67	38.5	38.0	0.5	0.00	-0.16
225	3.75	36.9	36.4	0.5	0.00	-0.15
230	3.83	35.3	34.9	0.5	0.00	-0.15

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
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100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
235	3.92	33.9	33.4	0.5	0.00	-0.15
240	4.00	32.4	32.0	0.5	0.00	-0.14
245	4.08	31.1	30.6	0.5	0.00	-0.14
250	4.17	29.8	29.3	0.5	0.00	-0.14
255	4.25	28.5	28.1	0.5	0.00	-0.13
260	4.33	27.3	26.9	0.5	0.00	-0.13
265	4.42	26.2	25.7	0.4	0.00	-0.13
270	4.50	25.1	24.6	0.4	0.00	-0.12
275	4.58	24.0	23.6	0.4	0.00	-0.12
280	4.67	23.0	22.6	0.4	0.00	-0.12
285	4.75	22.0	21.6	0.4	0.00	-0.11
290	4.83	21.1	20.7	0.4	0.00	-0.11
295	4.92	20.2	19.8	0.4	0.00	-0.11
300	5.00	19.4	19.0	0.4	0.00	-0.11
305	5.08	18.6	18.2	0.4	0.00	-0.10
310	5.17	17.8	17.4	0.4	0.00	-0.10
315	5.25	17.0	16.7	0.4	0.00	-0.10
320	5.33	16.3	15.9	0.4	0.00	-0.10
325	5.42	15.6	15.3	0.4	0.00	-0.09
330	5.50	15.0	14.6	0.4	0.00	-0.09
335	5.58	14.4	14.0	0.4	0.00	-0.09
340	5.67	13.8	13.4	0.4	0.00	-0.09
345	5.75	13.2	12.8	0.3	0.00	-0.08
350	5.83	12.6	12.3	0.3	0.00	-0.08
355	5.92	12.1	11.8	0.3	0.00	-0.08
360	6.00	11.6	11.3	0.3	0.00	-0.08
365	6.08	11.1	10.8	0.3	0.00	-0.07
370	6.17	10.6	10.3	0.3	0.00	-0.07
375	6.25	10.2	9.9	0.3	0.00	-0.07
380	6.33	9.8	9.5	0.3	0.00	-0.07
385	6.42	9.4	9.1	0.3	0.00	-0.07
390	6.50	9.0	8.7	0.3	0.00	-0.06
395	6.58	8.6	8.3	0.3	0.00	-0.06
400	6.67	8.2	8.0	0.3	0.00	-0.06
405	6.75	7.9	7.6	0.3	0.00	-0.06
410	6.83	7.5	7.3	0.3	0.00	-0.06
415	6.92	7.2	7.0	0.2	0.00	-0.05
420	7.00	6.9	6.7	0.2	0.00	-0.05
425	7.08	6.6	6.4	0.2	0.00	-0.05
430	7.17	6.4	6.1	0.2	0.00	-0.05
435	7.25	6.1	5.9	0.2	0.00	-0.05
440	7.33	5.8	5.6	0.2	0.00	-0.05
445	7.42	5.6	5.4	0.2	0.00	-0.04
450	7.50	5.4	5.2	0.2	0.00	-0.04
455	7.58	5.1	4.9	0.2	0.00	-0.04
460	7.67	4.9	4.7	0.2	0.00	-0.04
465	7.75	4.7	4.5	0.2	0.00	-0.04
470	7.83	4.5	4.3	0.2	0.00	-0.04

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
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100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
475	7.92	4.3	4.1	0.2	0.00	-0.04
480	8.00	4.1	4.0	0.2	0.00	-0.04
485	8.08	4.0	3.8	0.2	0.00	-0.03
490	8.17	3.8	3.6	0.2	0.00	-0.03
495	8.25	3.6	3.5	0.2	0.00	-0.03
500	8.33	3.5	3.3	0.2	0.00	-0.03
505	8.42	3.3	3.2	0.1	0.00	-0.03
510	8.50	3.2	3.1	0.1	0.00	-0.03
515	8.58	3.1	2.9	0.1	0.00	-0.03
520	8.67	2.9	2.8	0.1	0.00	-0.03
525	8.75	2.8	2.7	0.1	0.00	-0.03
530	8.83	2.7	2.6	0.1	0.00	-0.03
535	8.92	2.6	2.5	0.1	0.00	-0.02
540	9.00	2.5	2.4	0.1	0.00	-0.02
545	9.08	2.4	2.3	0.1	0.00	-0.02
550	9.17	2.3	2.2	0.1	0.00	-0.02
555	9.25	2.2	2.1	0.1	0.00	-0.02
560	9.33	2.1	2.0	0.1	0.00	-0.02
565	9.42	2.0	1.9	0.1	0.00	-0.02
570	9.50	1.9	1.8	0.1	0.00	-0.02
575	9.58	1.8	1.7	0.1	0.00	-0.02
580	9.67	1.8	1.7	0.1	0.00	-0.02
585	9.75	1.7	1.6	0.1	0.00	-0.02
590	9.83	1.6	1.5	0.1	0.00	-0.02
595	9.92	1.5	1.5	0.1	0.00	-0.02
600	10.00	1.5	1.4	0.1	0.00	-0.02
605	10.08	1.4	1.3	0.1	0.00	-0.02
610	10.17	1.4	1.3	0.1	0.00	-0.01
615	10.25	1.3	1.2	0.1	0.00	-0.01
620	10.33	1.2	1.2	0.1	0.00	-0.01
625	10.42	1.2	1.1	0.1	0.00	-0.01
630	10.50	1.1	1.1	0.1	0.00	-0.01
635	10.58	1.1	1.0	0.1	0.00	-0.01
640	10.67	1.0	1.0	0.1	0.00	-0.01
645	10.75	1.0	0.9	0.1	0.00	-0.01
650	10.83	1.0	0.9	0.1	0.00	-0.01
655	10.92	0.9	0.9	0.1	0.00	-0.01
660	11.00	0.9	0.8	0.1	0.00	-0.01
665	11.08	0.8	0.8	0.1	0.00	-0.01
670	11.17	0.8	0.8	0.1	0.00	-0.01
675	11.25	0.8	0.7	0.0	0.00	-0.01
680	11.33	0.7	0.7	0.0	0.00	-0.01
685	11.42	0.7	0.7	0.0	0.00	-0.01
690	11.50	0.7	0.6	0.0	0.00	-0.01
695	11.58	0.7	0.6	0.0	0.00	-0.01
700	11.67	0.6	0.6	0.0	0.00	-0.01
705	11.75	0.6	0.6	0.0	0.00	-0.01
710	11.83	0.6	0.5	0.0	0.00	-0.01

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
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100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
715	11.92	0.6	0.5	0.0	0.00	-0.01
720	12.00	0.5	0.5	0.0	0.00	-0.01
725	12.08	0.5	0.5	0.0	0.00	-0.01
730	12.17	0.5	0.5	0.0	0.00	-0.01
735	12.25	0.5	0.4	0.0	0.00	-0.01
740	12.33	0.4	0.4	0.0	0.00	-0.01
745	12.42	0.4	0.4	0.0	0.00	-0.01
750	12.50	0.4	0.4	0.0	0.00	-0.01
755	12.58	0.4	0.4	0.0	0.00	-0.01
760	12.67	0.4	0.3	0.0	0.00	0.00
765	12.75	0.4	0.3	0.0	0.00	0.00
770	12.83	0.3	0.3	0.0	0.00	0.00
775	12.92	0.3	0.3	0.0	0.00	0.00
780	13.00	0.3	0.3	0.0	0.00	0.00
785	13.08	0.3	0.3	0.0	0.00	0.00
790	13.17	0.3	0.3	0.0	0.00	0.00
795	13.25	0.3	0.3	0.0	0.00	0.00
800	13.33	0.3	0.2	0.0	0.00	0.00
805	13.42	0.3	0.2	0.0	0.00	0.00
810	13.50	0.2	0.2	0.0	0.00	0.00
815	13.58	0.2	0.2	0.0	0.00	0.00
820	13.67	0.2	0.2	0.0	0.00	0.00
825	13.75	0.2	0.2	0.0	0.00	0.00
830	13.83	0.2	0.2	0.0	0.00	0.00
835	13.92	0.2	0.2	0.0	0.00	0.00
840	14.00	0.2	0.2	0.0	0.00	0.00
845	14.08	0.2	0.2	0.0	0.00	0.00
850	14.17	0.2	0.2	0.0	0.00	0.00
855	14.25	0.2	0.2	0.0	0.00	0.00
860	14.33	0.2	0.1	0.0	0.00	0.00
865	14.42	0.2	0.1	0.0	0.00	0.00
870	14.50	0.1	0.1	0.0	0.00	0.00
875	14.58	0.1	0.1	0.0	0.00	0.00
880	14.67	0.1	0.1	0.0	0.00	0.00
885	14.75	0.1	0.1	0.0	0.00	0.00
890	14.83	0.1	0.1	0.0	0.00	0.00
895	14.92	0.1	0.1	0.0	0.00	0.00
900	15.00	0.1	0.1	0.0	0.00	0.00
905	15.08	0.1	0.1	0.0	0.00	0.00
910	15.17	0.1	0.1	0.0	0.00	0.00
915	15.25	0.1	0.1	0.0	0.00	0.00
920	15.33	0.1	0.1	0.0	0.00	0.00
925	15.42	0.1	0.1	0.0	0.00	0.00
930	15.50	0.1	0.1	0.0	0.00	0.00
935	15.58	0.1	0.1	0.0	0.00	0.00
940	15.67	0.1	0.1	0.0	0.00	0.00
945	15.75	0.1	0.1	0.0	0.00	0.00
950	15.83	0.1	0.1	0.0	0.00	0.00

Drainage System E0041 Hydrograph Comparison

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Hous
 Project No.: 345023
 Location: Houston, Texas
 Date: 12/21/17
 Performed By: ML
 Checked By: CM

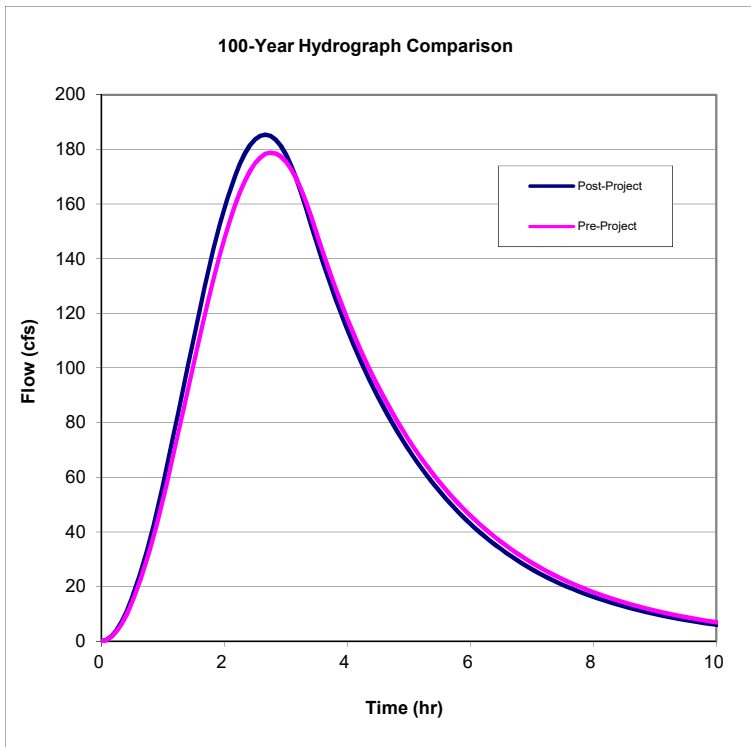
Watershed: White Oak Bayou
HCFC Unit: E100-00-00
Drainage System ID: E0041
Alternative: 1

Computation Parameters:

Design Storm = 100 year
 Storm Duration = 24 hours
 Drainage Area = 54.47 acres

*Peak flow from HouStorm

Condition	Peak Flow (cfs)	Peak Flow Impact (cfs)	Detention Volume (ac-ft)
Pre-Project	178.8	6.6	1.60
Post-Project	185.4		



Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
0	0.00	0.0	0.0	0.0	0	0
5	0.08	0.4	0.4	0.0	0.00	0.00
10	0.17	1.8	1.6	0.2	0.00	0.00
15	0.25	4.0	3.6	0.4	0.00	0.00
20	0.33	7.1	6.4	0.7	0.00	0.01
25	0.42	11.0	9.9	1.1	0.01	0.01
30	0.50	15.7	14.1	1.6	0.01	0.02
35	0.58	21.1	19.0	2.1	0.01	0.04
40	0.67	27.2	24.5	2.7	0.02	0.05
45	0.75	34.0	30.6	3.3	0.02	0.07
50	0.83	41.3	37.3	4.0	0.03	0.10
55	0.92	49.1	44.4	4.7	0.03	0.13
60	1.00	57.4	51.9	5.4	0.04	0.16
65	1.08	66.0	59.8	6.2	0.04	0.20
70	1.17	74.8	67.9	6.9	0.05	0.25
75	1.25	83.8	76.2	7.6	0.05	0.30
80	1.33	92.9	84.7	8.3	0.05	0.35
85	1.42	102.0	93.1	8.9	0.06	0.41
90	1.50	111.0	101.6	9.4	0.06	0.47
95	1.58	119.9	109.9	9.9	0.07	0.54
100	1.67	128.4	118.1	10.4	0.07	0.61
105	1.75	136.6	126.0	10.7	0.07	0.68
110	1.83	144.4	133.5	10.9	0.07	0.76
115	1.92	151.7	140.7	11.1	0.08	0.83
120	2.00	158.5	147.4	11.1	0.08	0.91
125	2.08	164.6	153.6	11.0	0.08	0.99
130	2.17	170.0	159.2	10.8	0.07	1.06
135	2.25	174.6	164.2	10.4	0.07	1.13
140	2.33	178.5	168.5	10.0	0.07	1.20
145	2.42	181.5	172.1	9.4	0.07	1.27
150	2.50	183.7	175.0	8.8	0.06	1.33
155	2.58	185.0	177.0	8.0	0.06	1.39
160	2.67	185.4	178.3	7.1	0.05	1.44
165	2.75	184.9	178.8	6.1	0.05	1.49
170	2.83	183.5	178.5	5.0	0.04	1.53
175	2.92	181.3	177.4	3.8	0.03	1.56
180	3.00	178.2	175.5	2.6	0.02	1.58
185	3.08	174.2	172.9	1.4	0.01	1.59
190	3.17	169.5	169.5	0.0	0.00	1.60
195	3.25	164.0	165.3	-1.3	0.00	1.59
200	3.33	158.1	160.5	-2.4	-0.01	1.58
205	3.42	151.8	155.1	-3.3	-0.02	1.56
210	3.50	145.7	149.3	-3.6	-0.02	1.54
215	3.58	139.9	143.6	-3.7	-0.03	1.51
220	3.67	134.3	138.1	-3.7	-0.03	1.49
225	3.75	129.0	132.7	-3.8	-0.03	1.46
230	3.83	123.8	127.6	-3.8	-0.03	1.44

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
235	3.92	118.9	122.7	-3.8	-0.03	1.41
240	4.00	114.2	118.0	-3.8	-0.03	1.38
245	4.08	109.6	113.5	-3.8	-0.03	1.36
250	4.17	105.2	109.1	-3.9	-0.03	1.33
255	4.25	101.0	104.9	-3.8	-0.03	1.30
260	4.33	97.0	100.9	-3.8	-0.03	1.28
265	4.42	93.1	97.0	-3.8	-0.03	1.25
270	4.50	89.4	93.2	-3.8	-0.03	1.22
275	4.58	85.9	89.7	-3.8	-0.03	1.20
280	4.67	82.4	86.2	-3.8	-0.03	1.17
285	4.75	79.2	82.9	-3.7	-0.03	1.15
290	4.83	76.0	79.7	-3.7	-0.03	1.12
295	4.92	73.0	76.6	-3.7	-0.03	1.10
300	5.00	70.1	73.7	-3.6	-0.03	1.07
305	5.08	67.3	70.8	-3.6	-0.02	1.05
310	5.17	64.6	68.1	-3.5	-0.02	1.02
315	5.25	62.0	65.5	-3.5	-0.02	1.00
320	5.33	59.5	63.0	-3.4	-0.02	0.97
325	5.42	57.2	60.6	-3.4	-0.02	0.95
330	5.50	54.9	58.2	-3.3	-0.02	0.93
335	5.58	52.7	56.0	-3.3	-0.02	0.90
340	5.67	50.6	53.8	-3.2	-0.02	0.88
345	5.75	48.6	51.8	-3.2	-0.02	0.86
350	5.83	46.6	49.8	-3.1	-0.02	0.84
355	5.92	44.8	47.8	-3.1	-0.02	0.82
360	6.00	43.0	46.0	-3.0	-0.02	0.80
365	6.08	41.3	44.2	-3.0	-0.02	0.77
370	6.17	39.6	42.5	-2.9	-0.02	0.75
375	6.25	38.1	40.9	-2.8	-0.02	0.73
380	6.33	36.5	39.3	-2.8	-0.02	0.72
385	6.42	35.1	37.8	-2.7	-0.02	0.70
390	6.50	33.7	36.4	-2.7	-0.02	0.68
395	6.58	32.3	35.0	-2.6	-0.02	0.66
400	6.67	31.1	33.6	-2.6	-0.02	0.64
405	6.75	29.8	32.3	-2.5	-0.02	0.62
410	6.83	28.6	31.1	-2.4	-0.02	0.61
415	6.92	27.5	29.9	-2.4	-0.02	0.59
420	7.00	26.4	28.7	-2.3	-0.02	0.57
425	7.08	25.3	27.6	-2.3	-0.02	0.56
430	7.17	24.3	26.6	-2.2	-0.02	0.54
435	7.25	23.4	25.5	-2.2	-0.02	0.53
440	7.33	22.4	24.6	-2.1	-0.01	0.51
445	7.42	21.5	23.6	-2.1	-0.01	0.50
450	7.50	20.7	22.7	-2.0	-0.01	0.48
455	7.58	19.9	21.8	-2.0	-0.01	0.47
460	7.67	19.1	21.0	-1.9	-0.01	0.46
465	7.75	18.3	20.2	-1.9	-0.01	0.44
470	7.83	17.6	19.4	-1.8	-0.01	0.43

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
475	7.92	16.9	18.7	-1.8	-0.01	0.42
480	8.00	16.2	17.9	-1.7	-0.01	0.41
485	8.08	15.6	17.2	-1.7	-0.01	0.39
490	8.17	14.9	16.6	-1.7	-0.01	0.38
495	8.25	14.3	15.9	-1.6	-0.01	0.37
500	8.33	13.8	15.3	-1.6	-0.01	0.36
505	8.42	13.2	14.7	-1.5	-0.01	0.35
510	8.50	12.7	14.2	-1.5	-0.01	0.34
515	8.58	12.2	13.6	-1.4	-0.01	0.33
520	8.67	11.7	13.1	-1.4	-0.01	0.32
525	8.75	11.2	12.6	-1.4	-0.01	0.31
530	8.83	10.8	12.1	-1.3	-0.01	0.30
535	8.92	10.4	11.6	-1.3	-0.01	0.29
540	9.00	9.9	11.2	-1.3	-0.01	0.28
545	9.08	9.5	10.8	-1.2	-0.01	0.28
550	9.17	9.2	10.4	-1.2	-0.01	0.27
555	9.25	8.8	10.0	-1.2	-0.01	0.26
560	9.33	8.4	9.6	-1.1	-0.01	0.25
565	9.42	8.1	9.2	-1.1	-0.01	0.24
570	9.50	7.8	8.9	-1.1	-0.01	0.24
575	9.58	7.5	8.5	-1.0	-0.01	0.23
580	9.67	7.2	8.2	-1.0	-0.01	0.22
585	9.75	6.9	7.9	-1.0	-0.01	0.21
590	9.83	6.6	7.6	-0.9	-0.01	0.21
595	9.92	6.4	7.3	-0.9	-0.01	0.20
600	10.00	6.1	7.0	-0.9	-0.01	0.20
605	10.08	5.9	6.7	-0.9	-0.01	0.19
610	10.17	5.6	6.5	-0.8	-0.01	0.18
615	10.25	5.4	6.2	-0.8	-0.01	0.18
620	10.33	5.2	6.0	-0.8	-0.01	0.17
625	10.42	5.0	5.7	-0.8	-0.01	0.17
630	10.50	4.8	5.5	-0.7	-0.01	0.16
635	10.58	4.6	5.3	-0.7	-0.01	0.16
640	10.67	4.4	5.1	-0.7	0.00	0.15
645	10.75	4.2	4.9	-0.7	0.00	0.15
650	10.83	4.1	4.7	-0.7	0.00	0.14
655	10.92	3.9	4.5	-0.6	0.00	0.14
660	11.00	3.7	4.4	-0.6	0.00	0.13
665	11.08	3.6	4.2	-0.6	0.00	0.13
670	11.17	3.5	4.0	-0.6	0.00	0.12
675	11.25	3.3	3.9	-0.6	0.00	0.12
680	11.33	3.2	3.7	-0.6	0.00	0.12
685	11.42	3.1	3.6	-0.5	0.00	0.11
690	11.50	2.9	3.5	-0.5	0.00	0.11
695	11.58	2.8	3.3	-0.5	0.00	0.11
700	11.67	2.7	3.2	-0.5	0.00	0.10
705	11.75	2.6	3.1	-0.5	0.00	0.10
710	11.83	2.5	2.9	-0.5	0.00	0.10

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
715	11.92	2.4	2.8	-0.4	0.00	0.09
720	12.00	2.3	2.7	-0.4	0.00	0.09
725	12.08	2.2	2.6	-0.4	0.00	0.09
730	12.17	2.1	2.5	-0.4	0.00	0.08
735	12.25	2.0	2.4	-0.4	0.00	0.08
740	12.33	2.0	2.3	-0.4	0.00	0.08
745	12.42	1.9	2.2	-0.4	0.00	0.08
750	12.50	1.8	2.2	-0.4	0.00	0.07
755	12.58	1.7	2.1	-0.3	0.00	0.07
760	12.67	1.7	2.0	-0.3	0.00	0.07
765	12.75	1.6	1.9	-0.3	0.00	0.07
770	12.83	1.5	1.8	-0.3	0.00	0.06
775	12.92	1.5	1.8	-0.3	0.00	0.06
780	13.00	1.4	1.7	-0.3	0.00	0.06
785	13.08	1.4	1.6	-0.3	0.00	0.06
790	13.17	1.3	1.6	-0.3	0.00	0.06
795	13.25	1.2	1.5	-0.3	0.00	0.05
800	13.33	1.2	1.5	-0.3	0.00	0.05
805	13.42	1.2	1.4	-0.2	0.00	0.05
810	13.50	1.1	1.3	-0.2	0.00	0.05
815	13.58	1.1	1.3	-0.2	0.00	0.05
820	13.67	1.0	1.2	-0.2	0.00	0.05
825	13.75	1.0	1.2	-0.2	0.00	0.05
830	13.83	0.9	1.2	-0.2	0.00	0.04
835	13.92	0.9	1.1	-0.2	0.00	0.04
840	14.00	0.9	1.1	-0.2	0.00	0.04
845	14.08	0.8	1.0	-0.2	0.00	0.04
850	14.17	0.8	1.0	-0.2	0.00	0.04
855	14.25	0.8	0.9	-0.2	0.00	0.04
860	14.33	0.7	0.9	-0.2	0.00	0.04
865	14.42	0.7	0.9	-0.2	0.00	0.03
870	14.50	0.7	0.8	-0.2	0.00	0.03
875	14.58	0.7	0.8	-0.2	0.00	0.03
880	14.67	0.6	0.8	-0.2	0.00	0.03
885	14.75	0.6	0.7	-0.1	0.00	0.03
890	14.83	0.6	0.7	-0.1	0.00	0.03
895	14.92	0.6	0.7	-0.1	0.00	0.03
900	15.00	0.5	0.7	-0.1	0.00	0.03
905	15.08	0.5	0.6	-0.1	0.00	0.03
910	15.17	0.5	0.6	-0.1	0.00	0.03
915	15.25	0.5	0.6	-0.1	0.00	0.02
920	15.33	0.5	0.6	-0.1	0.00	0.02
925	15.42	0.4	0.5	-0.1	0.00	0.02
930	15.50	0.4	0.5	-0.1	0.00	0.02
935	15.58	0.4	0.5	-0.1	0.00	0.02
940	15.67	0.4	0.5	-0.1	0.00	0.02
945	15.75	0.4	0.5	-0.1	0.00	0.02
950	15.83	0.4	0.4	-0.1	0.00	0.02

Drainage System E0039 Hydrograph Comparison

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Hous
 Project No.: 345023
 Location: Houston, Texas
 Date: 12/21/17
 Performed By: ML
 Checked By: CM

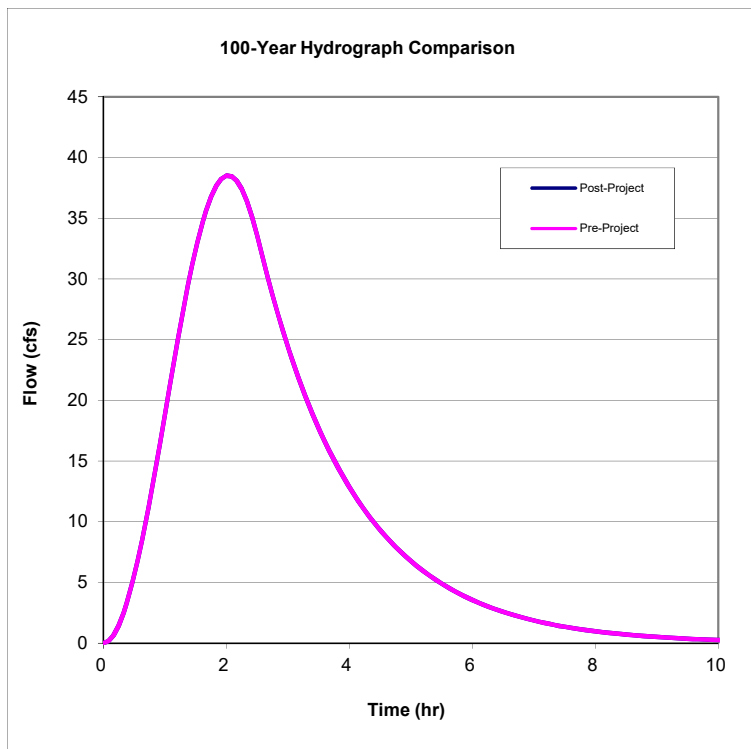
Watershed: White Oak Bayou
HCFC Unit: E100-00-00
Drainage System ID: E0039
Alternative: 1

Computation Parameters:

Design Storm = 100 year
 Storm Duration = 24 hours
 Drainage Area = 8.57 acres

*Peak flow from HouStorm

Condition	Peak Flow (cfs)	Peak Flow Impact (cfs)	Detention Volume (ac-ft)
Pre-Project	38.5	0.0	0.00
Post-Project	38.5		



Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
0	0.00	0.0	0.0	0.0	0	0
5	0.08	0.2	0.2	0.0	0.00	0.00
10	0.17	0.6	0.6	0.0	0.00	0.00
15	0.25	1.4	1.4	0.0	0.00	0.00
20	0.33	2.5	2.5	0.0	0.00	0.00
25	0.42	3.9	3.9	0.0	0.00	0.00
30	0.50	5.5	5.5	0.0	0.00	0.00
35	0.58	7.3	7.3	0.0	0.00	0.00
40	0.67	9.4	9.4	0.0	0.00	0.00
45	0.75	11.6	11.6	0.0	0.00	0.00
50	0.83	14.0	14.0	0.0	0.00	0.00
55	0.92	16.4	16.4	0.0	0.00	0.00
60	1.00	18.9	18.9	0.0	0.00	0.00
65	1.08	21.3	21.3	0.0	0.00	0.00
70	1.17	23.8	23.8	0.0	0.00	0.00
75	1.25	26.2	26.2	0.0	0.00	0.00
80	1.33	28.4	28.4	0.0	0.00	0.00
85	1.42	30.5	30.5	0.0	0.00	0.00
90	1.50	32.4	32.4	0.0	0.00	0.00
95	1.58	34.1	34.1	0.0	0.00	0.00
100	1.67	35.6	35.6	0.0	0.00	0.00
105	1.75	36.8	36.8	0.0	0.00	0.00
110	1.83	37.7	37.7	0.0	0.00	0.00
115	1.92	38.2	38.2	0.0	0.00	0.00
120	2.00	38.5	38.5	0.0	0.00	0.00
125	2.08	38.4	38.4	0.0	0.00	0.00
130	2.17	38.1	38.1	0.0	0.00	0.00
135	2.25	37.4	37.4	0.0	0.00	0.00
140	2.33	36.4	36.4	0.0	0.00	0.00
145	2.42	35.1	35.1	0.0	0.00	0.00
150	2.50	33.6	33.6	0.0	0.00	0.00
155	2.58	31.9	31.9	0.0	0.00	0.00
160	2.67	30.2	30.2	0.0	0.00	0.00
165	2.75	28.7	28.7	0.0	0.00	0.00
170	2.83	27.2	27.2	0.0	0.00	0.00
175	2.92	25.8	25.8	0.0	0.00	0.00
180	3.00	24.4	24.4	0.0	0.00	0.00
185	3.08	23.1	23.1	0.0	0.00	0.00
190	3.17	21.9	21.9	0.0	0.00	0.00
195	3.25	20.8	20.8	0.0	0.00	0.00
200	3.33	19.7	19.7	0.0	0.00	0.00
205	3.42	18.7	18.7	0.0	0.00	0.00
210	3.50	17.7	17.7	0.0	0.00	0.00
215	3.58	16.8	16.8	0.0	0.00	0.00
220	3.67	15.9	15.9	0.0	0.00	0.00
225	3.75	15.1	15.1	0.0	0.00	0.00
230	3.83	14.3	14.3	0.0	0.00	0.00

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
235	3.92	13.6	13.6	0.0	0.00	0.00
240	4.00	12.9	12.9	0.0	0.00	0.00
245	4.08	12.2	12.2	0.0	0.00	0.00
250	4.17	11.6	11.6	0.0	0.00	0.00
255	4.25	11.0	11.0	0.0	0.00	0.00
260	4.33	10.4	10.4	0.0	0.00	0.00
265	4.42	9.8	9.8	0.0	0.00	0.00
270	4.50	9.3	9.3	0.0	0.00	0.00
275	4.58	8.8	8.8	0.0	0.00	0.00
280	4.67	8.4	8.4	0.0	0.00	0.00
285	4.75	7.9	7.9	0.0	0.00	0.00
290	4.83	7.5	7.5	0.0	0.00	0.00
295	4.92	7.1	7.1	0.0	0.00	0.00
300	5.00	6.8	6.8	0.0	0.00	0.00
305	5.08	6.4	6.4	0.0	0.00	0.00
310	5.17	6.1	6.1	0.0	0.00	0.00
315	5.25	5.8	5.8	0.0	0.00	0.00
320	5.33	5.5	5.5	0.0	0.00	0.00
325	5.42	5.2	5.2	0.0	0.00	0.00
330	5.50	4.9	4.9	0.0	0.00	0.00
335	5.58	4.7	4.7	0.0	0.00	0.00
340	5.67	4.4	4.4	0.0	0.00	0.00
345	5.75	4.2	4.2	0.0	0.00	0.00
350	5.83	4.0	4.0	0.0	0.00	0.00
355	5.92	3.8	3.8	0.0	0.00	0.00
360	6.00	3.6	3.6	0.0	0.00	0.00
365	6.08	3.4	3.4	0.0	0.00	0.00
370	6.17	3.2	3.2	0.0	0.00	0.00
375	6.25	3.0	3.0	0.0	0.00	0.00
380	6.33	2.9	2.9	0.0	0.00	0.00
385	6.42	2.7	2.7	0.0	0.00	0.00
390	6.50	2.6	2.6	0.0	0.00	0.00
395	6.58	2.5	2.5	0.0	0.00	0.00
400	6.67	2.3	2.3	0.0	0.00	0.00
405	6.75	2.2	2.2	0.0	0.00	0.00
410	6.83	2.1	2.1	0.0	0.00	0.00
415	6.92	2.0	2.0	0.0	0.00	0.00
420	7.00	1.9	1.9	0.0	0.00	0.00
425	7.08	1.8	1.8	0.0	0.00	0.00
430	7.17	1.7	1.7	0.0	0.00	0.00
435	7.25	1.6	1.6	0.0	0.00	0.00
440	7.33	1.5	1.5	0.0	0.00	0.00
445	7.42	1.4	1.4	0.0	0.00	0.00
450	7.50	1.4	1.4	0.0	0.00	0.00
455	7.58	1.3	1.3	0.0	0.00	0.00
460	7.67	1.2	1.2	0.0	0.00	0.00
465	7.75	1.2	1.2	0.0	0.00	0.00
470	7.83	1.1	1.1	0.0	0.00	0.00

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
475	7.92	1.0	1.0	0.0	0.00	0.00
480	8.00	1.0	1.0	0.0	0.00	0.00
485	8.08	0.9	0.9	0.0	0.00	0.00
490	8.17	0.9	0.9	0.0	0.00	0.00
495	8.25	0.8	0.8	0.0	0.00	0.00
500	8.33	0.8	0.8	0.0	0.00	0.00
505	8.42	0.8	0.8	0.0	0.00	0.00
510	8.50	0.7	0.7	0.0	0.00	0.00
515	8.58	0.7	0.7	0.0	0.00	0.00
520	8.67	0.6	0.6	0.0	0.00	0.00
525	8.75	0.6	0.6	0.0	0.00	0.00
530	8.83	0.6	0.6	0.0	0.00	0.00
535	8.92	0.5	0.5	0.0	0.00	0.00
540	9.00	0.5	0.5	0.0	0.00	0.00
545	9.08	0.5	0.5	0.0	0.00	0.00
550	9.17	0.5	0.5	0.0	0.00	0.00
555	9.25	0.4	0.4	0.0	0.00	0.00
560	9.33	0.4	0.4	0.0	0.00	0.00
565	9.42	0.4	0.4	0.0	0.00	0.00
570	9.50	0.4	0.4	0.0	0.00	0.00
575	9.58	0.4	0.4	0.0	0.00	0.00
580	9.67	0.3	0.3	0.0	0.00	0.00
585	9.75	0.3	0.3	0.0	0.00	0.00
590	9.83	0.3	0.3	0.0	0.00	0.00
595	9.92	0.3	0.3	0.0	0.00	0.00
600	10.00	0.3	0.3	0.0	0.00	0.00
605	10.08	0.3	0.3	0.0	0.00	0.00
610	10.17	0.2	0.2	0.0	0.00	0.00
615	10.25	0.2	0.2	0.0	0.00	0.00
620	10.33	0.2	0.2	0.0	0.00	0.00
625	10.42	0.2	0.2	0.0	0.00	0.00
630	10.50	0.2	0.2	0.0	0.00	0.00
635	10.58	0.2	0.2	0.0	0.00	0.00
640	10.67	0.2	0.2	0.0	0.00	0.00
645	10.75	0.2	0.2	0.0	0.00	0.00
650	10.83	0.2	0.2	0.0	0.00	0.00
655	10.92	0.2	0.2	0.0	0.00	0.00
660	11.00	0.1	0.1	0.0	0.00	0.00
665	11.08	0.1	0.1	0.0	0.00	0.00
670	11.17	0.1	0.1	0.0	0.00	0.00
675	11.25	0.1	0.1	0.0	0.00	0.00
680	11.33	0.1	0.1	0.0	0.00	0.00
685	11.42	0.1	0.1	0.0	0.00	0.00
690	11.50	0.1	0.1	0.0	0.00	0.00
695	11.58	0.1	0.1	0.0	0.00	0.00
700	11.67	0.1	0.1	0.0	0.00	0.00
705	11.75	0.1	0.1	0.0	0.00	0.00
710	11.83	0.1	0.1	0.0	0.00	0.00

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
715	11.92	0.1	0.1	0.0	0.00	0.00
720	12.00	0.1	0.1	0.0	0.00	0.00
725	12.08	0.1	0.1	0.0	0.00	0.00
730	12.17	0.1	0.1	0.0	0.00	0.00
735	12.25	0.1	0.1	0.0	0.00	0.00
740	12.33	0.1	0.1	0.0	0.00	0.00
745	12.42	0.1	0.1	0.0	0.00	0.00
750	12.50	0.1	0.1	0.0	0.00	0.00
755	12.58	0.1	0.1	0.0	0.00	0.00
760	12.67	0.0	0.0	0.0	0.00	0.00
765	12.75	0.0	0.0	0.0	0.00	0.00
770	12.83	0.0	0.0	0.0	0.00	0.00
775	12.92	0.0	0.0	0.0	0.00	0.00
780	13.00	0.0	0.0	0.0	0.00	0.00
785	13.08	0.0	0.0	0.0	0.00	0.00
790	13.17	0.0	0.0	0.0	0.00	0.00
795	13.25	0.0	0.0	0.0	0.00	0.00
800	13.33	0.0	0.0	0.0	0.00	0.00
805	13.42	0.0	0.0	0.0	0.00	0.00
810	13.50	0.0	0.0	0.0	0.00	0.00
815	13.58	0.0	0.0	0.0	0.00	0.00
820	13.67	0.0	0.0	0.0	0.00	0.00
825	13.75	0.0	0.0	0.0	0.00	0.00
830	13.83	0.0	0.0	0.0	0.00	0.00
835	13.92	0.0	0.0	0.0	0.00	0.00
840	14.00	0.0	0.0	0.0	0.00	0.00
845	14.08	0.0	0.0	0.0	0.00	0.00
850	14.17	0.0	0.0	0.0	0.00	0.00
855	14.25	0.0	0.0	0.0	0.00	0.00
860	14.33	0.0	0.0	0.0	0.00	0.00
865	14.42	0.0	0.0	0.0	0.00	0.00
870	14.50	0.0	0.0	0.0	0.00	0.00
875	14.58	0.0	0.0	0.0	0.00	0.00
880	14.67	0.0	0.0	0.0	0.00	0.00
885	14.75	0.0	0.0	0.0	0.00	0.00
890	14.83	0.0	0.0	0.0	0.00	0.00
895	14.92	0.0	0.0	0.0	0.00	0.00
900	15.00	0.0	0.0	0.0	0.00	0.00
905	15.08	0.0	0.0	0.0	0.00	0.00
910	15.17	0.0	0.0	0.0	0.00	0.00
915	15.25	0.0	0.0	0.0	0.00	0.00
920	15.33	0.0	0.0	0.0	0.00	0.00
925	15.42	0.0	0.0	0.0	0.00	0.00
930	15.50	0.0	0.0	0.0	0.00	0.00
935	15.58	0.0	0.0	0.0	0.00	0.00
940	15.67	0.0	0.0	0.0	0.00	0.00
945	15.75	0.0	0.0	0.0	0.00	0.00
950	15.83	0.0	0.0	0.0	0.00	0.00

Drainage System E0040 Hydrograph Comparison

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Hous
 Project No.: 345023
 Location: Houston, Texas
 Date: 12/21/17
 Performed By: ML
 Checked By: CM

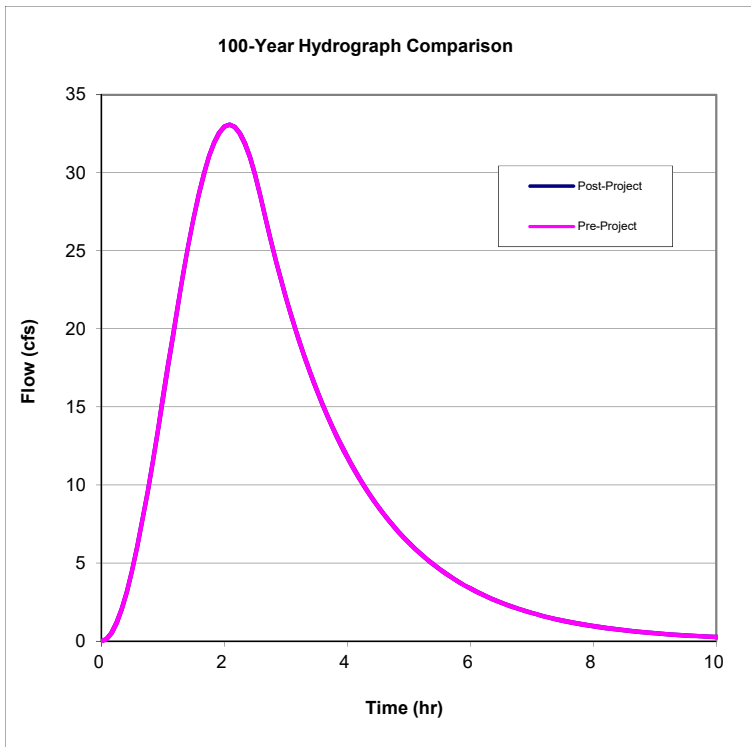
Watershed: White Oak Bayou
HCFC Unit: E100-00-00
Drainage System ID: E0040
Alternative: 1

Computation Parameters:

Design Storm = 100 year
 Storm Duration = 24 hours
 Drainage Area = 8.57 acres

*Peak flow from HouStorm

Condition	Peak Flow (cfs)	Peak Flow Impact (cfs)	Detention Volume (ac-ft)
Pre-Project	33.1	0.0	0.00
Post-Project	33.1		



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100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
0	0.00	0.0	0.0	0.0	0	0
5	0.08	0.1	0.1	0.0	0.00	0.00
10	0.17	0.5	0.5	0.0	0.00	0.00
15	0.25	1.2	1.2	0.0	0.00	0.00
20	0.33	2.1	2.1	0.0	0.00	0.00
25	0.42	3.2	3.2	0.0	0.00	0.00
30	0.50	4.5	4.5	0.0	0.00	0.00
35	0.58	6.0	6.0	0.0	0.00	0.00
40	0.67	7.7	7.7	0.0	0.00	0.00
45	0.75	9.5	9.5	0.0	0.00	0.00
50	0.83	11.5	11.5	0.0	0.00	0.00
55	0.92	13.5	13.5	0.0	0.00	0.00
60	1.00	15.5	15.5	0.0	0.00	0.00
65	1.08	17.6	17.6	0.0	0.00	0.00
70	1.17	19.7	19.7	0.0	0.00	0.00
75	1.25	21.7	21.7	0.0	0.00	0.00
80	1.33	23.6	23.6	0.0	0.00	0.00
85	1.42	25.4	25.4	0.0	0.00	0.00
90	1.50	27.1	27.1	0.0	0.00	0.00
95	1.58	28.6	28.6	0.0	0.00	0.00
100	1.67	30.0	30.0	0.0	0.00	0.00
105	1.75	31.1	31.1	0.0	0.00	0.00
110	1.83	31.9	31.9	0.0	0.00	0.00
115	1.92	32.6	32.6	0.0	0.00	0.00
120	2.00	33.0	33.0	0.0	0.00	0.00
125	2.08	33.1	33.1	0.0	0.00	0.00
130	2.17	32.9	32.9	0.0	0.00	0.00
135	2.25	32.5	32.5	0.0	0.00	0.00
140	2.33	31.9	31.9	0.0	0.00	0.00
145	2.42	31.0	31.0	0.0	0.00	0.00
150	2.50	29.9	29.9	0.0	0.00	0.00
155	2.58	28.5	28.5	0.0	0.00	0.00
160	2.67	27.1	27.1	0.0	0.00	0.00
165	2.75	25.7	25.7	0.0	0.00	0.00
170	2.83	24.4	24.4	0.0	0.00	0.00
175	2.92	23.2	23.2	0.0	0.00	0.00
180	3.00	22.0	22.0	0.0	0.00	0.00
185	3.08	20.9	20.9	0.0	0.00	0.00
190	3.17	19.8	19.8	0.0	0.00	0.00
195	3.25	18.8	18.8	0.0	0.00	0.00
200	3.33	17.9	17.9	0.0	0.00	0.00
205	3.42	17.0	17.0	0.0	0.00	0.00
210	3.50	16.1	16.1	0.0	0.00	0.00
215	3.58	15.3	15.3	0.0	0.00	0.00
220	3.67	14.5	14.5	0.0	0.00	0.00
225	3.75	13.8	13.8	0.0	0.00	0.00
230	3.83	13.1	13.1	0.0	0.00	0.00

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
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100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

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		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
235	3.92	12.4	12.4	0.0	0.00	0.00
240	4.00	11.8	11.8	0.0	0.00	0.00
245	4.08	11.2	11.2	0.0	0.00	0.00
250	4.17	10.6	10.6	0.0	0.00	0.00
255	4.25	10.1	10.1	0.0	0.00	0.00
260	4.33	9.6	9.6	0.0	0.00	0.00
265	4.42	9.1	9.1	0.0	0.00	0.00
270	4.50	8.6	8.6	0.0	0.00	0.00
275	4.58	8.2	8.2	0.0	0.00	0.00
280	4.67	7.8	7.8	0.0	0.00	0.00
285	4.75	7.4	7.4	0.0	0.00	0.00
290	4.83	7.0	7.0	0.0	0.00	0.00
295	4.92	6.6	6.6	0.0	0.00	0.00
300	5.00	6.3	6.3	0.0	0.00	0.00
305	5.08	6.0	6.0	0.0	0.00	0.00
310	5.17	5.7	5.7	0.0	0.00	0.00
315	5.25	5.4	5.4	0.0	0.00	0.00
320	5.33	5.1	5.1	0.0	0.00	0.00
325	5.42	4.9	4.9	0.0	0.00	0.00
330	5.50	4.6	4.6	0.0	0.00	0.00
335	5.58	4.4	4.4	0.0	0.00	0.00
340	5.67	4.2	4.2	0.0	0.00	0.00
345	5.75	3.9	3.9	0.0	0.00	0.00
350	5.83	3.7	3.7	0.0	0.00	0.00
355	5.92	3.6	3.6	0.0	0.00	0.00
360	6.00	3.4	3.4	0.0	0.00	0.00
365	6.08	3.2	3.2	0.0	0.00	0.00
370	6.17	3.0	3.0	0.0	0.00	0.00
375	6.25	2.9	2.9	0.0	0.00	0.00
380	6.33	2.7	2.7	0.0	0.00	0.00
385	6.42	2.6	2.6	0.0	0.00	0.00
390	6.50	2.5	2.5	0.0	0.00	0.00
395	6.58	2.3	2.3	0.0	0.00	0.00
400	6.67	2.2	2.2	0.0	0.00	0.00
405	6.75	2.1	2.1	0.0	0.00	0.00
410	6.83	2.0	2.0	0.0	0.00	0.00
415	6.92	1.9	1.9	0.0	0.00	0.00
420	7.00	1.8	1.8	0.0	0.00	0.00
425	7.08	1.7	1.7	0.0	0.00	0.00
430	7.17	1.6	1.6	0.0	0.00	0.00
435	7.25	1.5	1.5	0.0	0.00	0.00
440	7.33	1.5	1.5	0.0	0.00	0.00
445	7.42	1.4	1.4	0.0	0.00	0.00
450	7.50	1.3	1.3	0.0	0.00	0.00
455	7.58	1.3	1.3	0.0	0.00	0.00
460	7.67	1.2	1.2	0.0	0.00	0.00
465	7.75	1.1	1.1	0.0	0.00	0.00
470	7.83	1.1	1.1	0.0	0.00	0.00

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs			Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)	Flow Difference Qp-Qe (cfs)	Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
475	7.92	1.0	1.0	0.0	0.00	0.00
480	8.00	1.0	1.0	0.0	0.00	0.00
485	8.08	0.9	0.9	0.0	0.00	0.00
490	8.17	0.9	0.9	0.0	0.00	0.00
495	8.25	0.8	0.8	0.0	0.00	0.00
500	8.33	0.8	0.8	0.0	0.00	0.00
505	8.42	0.7	0.7	0.0	0.00	0.00
510	8.50	0.7	0.7	0.0	0.00	0.00
515	8.58	0.7	0.7	0.0	0.00	0.00
520	8.67	0.6	0.6	0.0	0.00	0.00
525	8.75	0.6	0.6	0.0	0.00	0.00
530	8.83	0.6	0.6	0.0	0.00	0.00
535	8.92	0.5	0.5	0.0	0.00	0.00
540	9.00	0.5	0.5	0.0	0.00	0.00
545	9.08	0.5	0.5	0.0	0.00	0.00
550	9.17	0.5	0.5	0.0	0.00	0.00
555	9.25	0.4	0.4	0.0	0.00	0.00
560	9.33	0.4	0.4	0.0	0.00	0.00
565	9.42	0.4	0.4	0.0	0.00	0.00
570	9.50	0.4	0.4	0.0	0.00	0.00
575	9.58	0.4	0.4	0.0	0.00	0.00
580	9.67	0.3	0.3	0.0	0.00	0.00
585	9.75	0.3	0.3	0.0	0.00	0.00
590	9.83	0.3	0.3	0.0	0.00	0.00
595	9.92	0.3	0.3	0.0	0.00	0.00
600	10.00	0.3	0.3	0.0	0.00	0.00
605	10.08	0.3	0.3	0.0	0.00	0.00
610	10.17	0.2	0.2	0.0	0.00	0.00
615	10.25	0.2	0.2	0.0	0.00	0.00
620	10.33	0.2	0.2	0.0	0.00	0.00
625	10.42	0.2	0.2	0.0	0.00	0.00
630	10.50	0.2	0.2	0.0	0.00	0.00
635	10.58	0.2	0.2	0.0	0.00	0.00
640	10.67	0.2	0.2	0.0	0.00	0.00
645	10.75	0.2	0.2	0.0	0.00	0.00
650	10.83	0.2	0.2	0.0	0.00	0.00
655	10.92	0.2	0.2	0.0	0.00	0.00
660	11.00	0.1	0.1	0.0	0.00	0.00
665	11.08	0.1	0.1	0.0	0.00	0.00
670	11.17	0.1	0.1	0.0	0.00	0.00
675	11.25	0.1	0.1	0.0	0.00	0.00
680	11.33	0.1	0.1	0.0	0.00	0.00
685	11.42	0.1	0.1	0.0	0.00	0.00
690	11.50	0.1	0.1	0.0	0.00	0.00
695	11.58	0.1	0.1	0.0	0.00	0.00
700	11.67	0.1	0.1	0.0	0.00	0.00
705	11.75	0.1	0.1	0.0	0.00	0.00
710	11.83	0.1	0.1	0.0	0.00	0.00

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
715	11.92	0.1	0.1	0.0	0.00	0.00
720	12.00	0.1	0.1	0.0	0.00	0.00
725	12.08	0.1	0.1	0.0	0.00	0.00
730	12.17	0.1	0.1	0.0	0.00	0.00
735	12.25	0.1	0.1	0.0	0.00	0.00
740	12.33	0.1	0.1	0.0	0.00	0.00
745	12.42	0.1	0.1	0.0	0.00	0.00
750	12.50	0.1	0.1	0.0	0.00	0.00
755	12.58	0.1	0.1	0.0	0.00	0.00
760	12.67	0.1	0.1	0.0	0.00	0.00
765	12.75	0.0	0.0	0.0	0.00	0.00
770	12.83	0.0	0.0	0.0	0.00	0.00
775	12.92	0.0	0.0	0.0	0.00	0.00
780	13.00	0.0	0.0	0.0	0.00	0.00
785	13.08	0.0	0.0	0.0	0.00	0.00
790	13.17	0.0	0.0	0.0	0.00	0.00
795	13.25	0.0	0.0	0.0	0.00	0.00
800	13.33	0.0	0.0	0.0	0.00	0.00
805	13.42	0.0	0.0	0.0	0.00	0.00
810	13.50	0.0	0.0	0.0	0.00	0.00
815	13.58	0.0	0.0	0.0	0.00	0.00
820	13.67	0.0	0.0	0.0	0.00	0.00
825	13.75	0.0	0.0	0.0	0.00	0.00
830	13.83	0.0	0.0	0.0	0.00	0.00
835	13.92	0.0	0.0	0.0	0.00	0.00
840	14.00	0.0	0.0	0.0	0.00	0.00
845	14.08	0.0	0.0	0.0	0.00	0.00
850	14.17	0.0	0.0	0.0	0.00	0.00
855	14.25	0.0	0.0	0.0	0.00	0.00
860	14.33	0.0	0.0	0.0	0.00	0.00
865	14.42	0.0	0.0	0.0	0.00	0.00
870	14.50	0.0	0.0	0.0	0.00	0.00
875	14.58	0.0	0.0	0.0	0.00	0.00
880	14.67	0.0	0.0	0.0	0.00	0.00
885	14.75	0.0	0.0	0.0	0.00	0.00
890	14.83	0.0	0.0	0.0	0.00	0.00
895	14.92	0.0	0.0	0.0	0.00	0.00
900	15.00	0.0	0.0	0.0	0.00	0.00
905	15.08	0.0	0.0	0.0	0.00	0.00
910	15.17	0.0	0.0	0.0	0.00	0.00
915	15.25	0.0	0.0	0.0	0.00	0.00
920	15.33	0.0	0.0	0.0	0.00	0.00
925	15.42	0.0	0.0	0.0	0.00	0.00
930	15.50	0.0	0.0	0.0	0.00	0.00
935	15.58	0.0	0.0	0.0	0.00	0.00
940	15.67	0.0	0.0	0.0	0.00	0.00
945	15.75	0.0	0.0	0.0	0.00	0.00
950	15.83	0.0	0.0	0.0	0.00	0.00

Drainage System E0051 Hydrograph Comparison

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Hous
 Project No.: 345023
 Location: Houston, Texas
 Date: 12/21/17
 Performed By: ML
 Checked By: CM

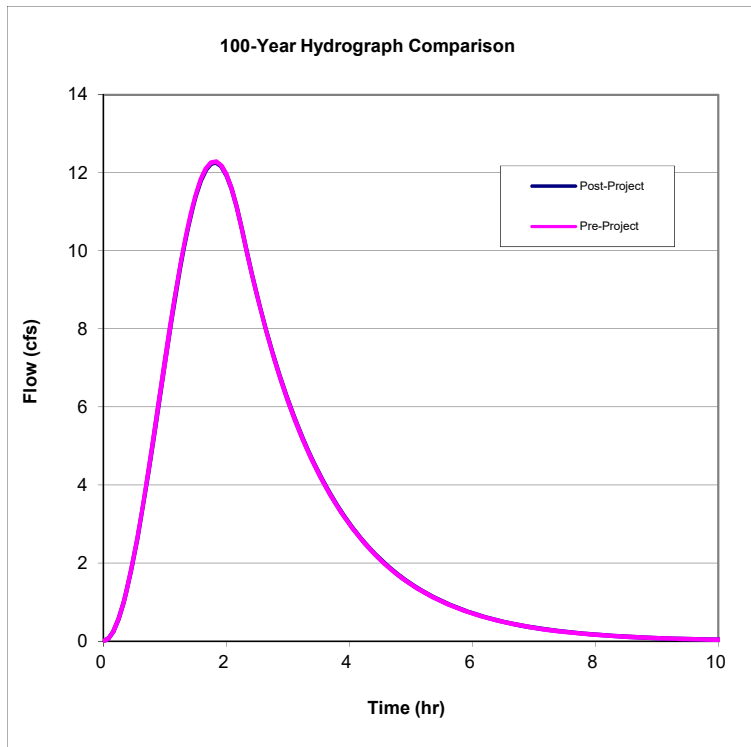
Watershed: White Oak Bayou
HCFC Unit: E100-00-00
Drainage System ID: E0051
Alternative: 1

Computation Parameters:

Design Storm = 100 year
 Storm Duration = 24 hours
 Drainage Area = 8.57 acres

*Peak flow from HouStorm

Condition	Peak Flow (cfs)	Peak Flow Impact (cfs)	Detention Volume (ac-ft)
Pre-Project	12.3	0.0	0.00
Post-Project	12.3		



Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
0	0.00	0.0	0.0	0.0	0	0
5	0.08	0.1	0.1	0.0	0.00	0.00
10	0.17	0.3	0.3	0.0	0.00	0.00
15	0.25	0.6	0.6	0.0	0.00	0.00
20	0.33	1.0	1.0	0.0	0.00	0.00
25	0.42	1.5	1.5	0.0	0.00	0.00
30	0.50	2.2	2.2	0.0	0.00	0.00
35	0.58	2.9	2.9	0.0	0.00	0.00
40	0.67	3.7	3.7	0.0	0.00	0.00
45	0.75	4.5	4.5	0.0	0.00	0.00
50	0.83	5.4	5.4	0.0	0.00	0.00
55	0.92	6.3	6.3	0.0	0.00	0.00
60	1.00	7.1	7.2	0.0	0.00	0.00
65	1.08	8.0	8.0	0.0	0.00	0.00
70	1.17	8.8	8.9	0.0	0.00	0.00
75	1.25	9.6	9.6	0.0	0.00	0.00
80	1.33	10.3	10.3	0.0	0.00	0.00
85	1.42	10.9	10.9	0.0	0.00	0.00
90	1.50	11.4	11.4	0.0	0.00	0.00
95	1.58	11.8	11.8	0.0	0.00	0.00
100	1.67	12.1	12.1	0.0	0.00	0.00
105	1.75	12.2	12.3	0.0	0.00	0.00
110	1.83	12.3	12.3	0.0	0.00	0.00
115	1.92	12.2	12.2	0.0	0.00	0.00
120	2.00	11.9	12.0	0.0	0.00	0.00
125	2.08	11.6	11.6	0.0	0.00	0.00
130	2.17	11.1	11.1	0.0	0.00	0.00
135	2.25	10.6	10.6	0.0	0.00	0.00
140	2.33	10.0	10.0	0.0	0.00	0.00
145	2.42	9.4	9.4	0.0	0.00	0.00
150	2.50	8.8	8.8	0.0	0.00	0.00
155	2.58	8.3	8.3	0.0	0.00	0.00
160	2.67	7.8	7.8	0.0	0.00	0.00
165	2.75	7.4	7.4	0.0	0.00	0.00
170	2.83	7.0	6.9	0.0	0.00	0.00
175	2.92	6.6	6.5	0.0	0.00	0.00
180	3.00	6.2	6.2	0.0	0.00	0.00
185	3.08	5.8	5.8	0.0	0.00	0.00
190	3.17	5.5	5.5	0.0	0.00	0.00
195	3.25	5.2	5.1	0.0	0.00	0.00
200	3.33	4.9	4.8	0.0	0.00	0.00
205	3.42	4.6	4.6	0.0	0.00	0.00
210	3.50	4.3	4.3	0.0	0.00	0.00
215	3.58	4.1	4.1	0.0	0.00	0.00
220	3.67	3.8	3.8	0.0	0.00	0.00
225	3.75	3.6	3.6	0.0	0.00	0.00
230	3.83	3.4	3.4	0.0	0.00	0.00

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
235	3.92	3.2	3.2	0.0	0.00	0.00
240	4.00	3.0	3.0	0.0	0.00	0.00
245	4.08	2.8	2.8	0.0	0.00	0.00
250	4.17	2.7	2.7	0.0	0.00	0.00
255	4.25	2.5	2.5	0.0	0.00	0.00
260	4.33	2.4	2.4	0.0	0.00	0.00
265	4.42	2.2	2.2	0.0	0.00	0.00
270	4.50	2.1	2.1	0.0	0.00	0.00
275	4.58	2.0	2.0	0.0	0.00	0.00
280	4.67	1.9	1.9	0.0	0.00	0.00
285	4.75	1.8	1.7	0.0	0.00	0.00
290	4.83	1.7	1.6	0.0	0.00	0.00
295	4.92	1.6	1.6	0.0	0.00	0.00
300	5.00	1.5	1.5	0.0	0.00	0.00
305	5.08	1.4	1.4	0.0	0.00	0.00
310	5.17	1.3	1.3	0.0	0.00	0.00
315	5.25	1.2	1.2	0.0	0.00	0.00
320	5.33	1.2	1.1	0.0	0.00	0.00
325	5.42	1.1	1.1	0.0	0.00	0.00
330	5.50	1.0	1.0	0.0	0.00	0.00
335	5.58	1.0	1.0	0.0	0.00	0.00
340	5.67	0.9	0.9	0.0	0.00	0.00
345	5.75	0.9	0.9	0.0	0.00	0.00
350	5.83	0.8	0.8	0.0	0.00	0.00
355	5.92	0.8	0.8	0.0	0.00	0.00
360	6.00	0.7	0.7	0.0	0.00	0.00
365	6.08	0.7	0.7	0.0	0.00	0.00
370	6.17	0.6	0.6	0.0	0.00	0.00
375	6.25	0.6	0.6	0.0	0.00	0.00
380	6.33	0.6	0.6	0.0	0.00	0.00
385	6.42	0.5	0.5	0.0	0.00	0.00
390	6.50	0.5	0.5	0.0	0.00	0.00
395	6.58	0.5	0.5	0.0	0.00	0.00
400	6.67	0.4	0.4	0.0	0.00	0.00
405	6.75	0.4	0.4	0.0	0.00	0.00
410	6.83	0.4	0.4	0.0	0.00	0.00
415	6.92	0.4	0.4	0.0	0.00	0.00
420	7.00	0.3	0.3	0.0	0.00	0.00
425	7.08	0.3	0.3	0.0	0.00	0.00
430	7.17	0.3	0.3	0.0	0.00	0.00
435	7.25	0.3	0.3	0.0	0.00	0.00
440	7.33	0.3	0.3	0.0	0.00	0.00
445	7.42	0.3	0.3	0.0	0.00	0.00
450	7.50	0.2	0.2	0.0	0.00	0.00
455	7.58	0.2	0.2	0.0	0.00	0.00
460	7.67	0.2	0.2	0.0	0.00	0.00
465	7.75	0.2	0.2	0.0	0.00	0.00
470	7.83	0.2	0.2	0.0	0.00	0.00

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
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100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
475	7.92	0.2	0.2	0.0	0.00	0.00
480	8.00	0.2	0.2	0.0	0.00	0.00
485	8.08	0.2	0.2	0.0	0.00	0.00
490	8.17	0.2	0.1	0.0	0.00	0.00
495	8.25	0.1	0.1	0.0	0.00	0.00
500	8.33	0.1	0.1	0.0	0.00	0.00
505	8.42	0.1	0.1	0.0	0.00	0.00
510	8.50	0.1	0.1	0.0	0.00	0.00
515	8.58	0.1	0.1	0.0	0.00	0.00
520	8.67	0.1	0.1	0.0	0.00	0.00
525	8.75	0.1	0.1	0.0	0.00	0.00
530	8.83	0.1	0.1	0.0	0.00	0.00
535	8.92	0.1	0.1	0.0	0.00	0.00
540	9.00	0.1	0.1	0.0	0.00	0.00
545	9.08	0.1	0.1	0.0	0.00	0.00
550	9.17	0.1	0.1	0.0	0.00	0.00
555	9.25	0.1	0.1	0.0	0.00	0.00
560	9.33	0.1	0.1	0.0	0.00	0.00
565	9.42	0.1	0.1	0.0	0.00	0.00
570	9.50	0.1	0.1	0.0	0.00	0.00
575	9.58	0.1	0.1	0.0	0.00	0.00
580	9.67	0.1	0.1	0.0	0.00	0.00
585	9.75	0.0	0.0	0.0	0.00	0.00
590	9.83	0.0	0.0	0.0	0.00	0.00
595	9.92	0.0	0.0	0.0	0.00	0.00
600	10.00	0.0	0.0	0.0	0.00	0.00
605	10.08	0.0	0.0	0.0	0.00	0.00
610	10.17	0.0	0.0	0.0	0.00	0.00
615	10.25	0.0	0.0	0.0	0.00	0.00
620	10.33	0.0	0.0	0.0	0.00	0.00
625	10.42	0.0	0.0	0.0	0.00	0.00
630	10.50	0.0	0.0	0.0	0.00	0.00
635	10.58	0.0	0.0	0.0	0.00	0.00
640	10.67	0.0	0.0	0.0	0.00	0.00
645	10.75	0.0	0.0	0.0	0.00	0.00
650	10.83	0.0	0.0	0.0	0.00	0.00
655	10.92	0.0	0.0	0.0	0.00	0.00
660	11.00	0.0	0.0	0.0	0.00	0.00
665	11.08	0.0	0.0	0.0	0.00	0.00
670	11.17	0.0	0.0	0.0	0.00	0.00
675	11.25	0.0	0.0	0.0	0.00	0.00
680	11.33	0.0	0.0	0.0	0.00	0.00
685	11.42	0.0	0.0	0.0	0.00	0.00
690	11.50	0.0	0.0	0.0	0.00	0.00
695	11.58	0.0	0.0	0.0	0.00	0.00
700	11.67	0.0	0.0	0.0	0.00	0.00
705	11.75	0.0	0.0	0.0	0.00	0.00
710	11.83	0.0	0.0	0.0	0.00	0.00

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100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs			Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)	Flow Difference Qp-Qe (cfs)	Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
715	11.92	0.0	0.0	0.0	0.00	0.00
720	12.00	0.0	0.0	0.0	0.00	0.00
725	12.08	0.0	0.0	0.0	0.00	0.00
730	12.17	0.0	0.0	0.0	0.00	0.00
735	12.25	0.0	0.0	0.0	0.00	0.00
740	12.33	0.0	0.0	0.0	0.00	0.00
745	12.42	0.0	0.0	0.0	0.00	0.00
750	12.50	0.0	0.0	0.0	0.00	0.00
755	12.58	0.0	0.0	0.0	0.00	0.00
760	12.67	0.0	0.0	0.0	0.00	0.00
765	12.75	0.0	0.0	0.0	0.00	0.00
770	12.83	0.0	0.0	0.0	0.00	0.00
775	12.92	0.0	0.0	0.0	0.00	0.00
780	13.00	0.0	0.0	0.0	0.00	0.00
785	13.08	0.0	0.0	0.0	0.00	0.00
790	13.17	0.0	0.0	0.0	0.00	0.00
795	13.25	0.0	0.0	0.0	0.00	0.00
800	13.33	0.0	0.0	0.0	0.00	0.00
805	13.42	0.0	0.0	0.0	0.00	0.00
810	13.50	0.0	0.0	0.0	0.00	0.00
815	13.58	0.0	0.0	0.0	0.00	0.00
820	13.67	0.0	0.0	0.0	0.00	0.00
825	13.75	0.0	0.0	0.0	0.00	0.00
830	13.83	0.0	0.0	0.0	0.00	0.00
835	13.92	0.0	0.0	0.0	0.00	0.00
840	14.00	0.0	0.0	0.0	0.00	0.00
845	14.08	0.0	0.0	0.0	0.00	0.00
850	14.17	0.0	0.0	0.0	0.00	0.00
855	14.25	0.0	0.0	0.0	0.00	0.00
860	14.33	0.0	0.0	0.0	0.00	0.00
865	14.42	0.0	0.0	0.0	0.00	0.00
870	14.50	0.0	0.0	0.0	0.00	0.00
875	14.58	0.0	0.0	0.0	0.00	0.00
880	14.67	0.0	0.0	0.0	0.00	0.00
885	14.75	0.0	0.0	0.0	0.00	0.00
890	14.83	0.0	0.0	0.0	0.00	0.00
895	14.92	0.0	0.0	0.0	0.00	0.00
900	15.00	0.0	0.0	0.0	0.00	0.00
905	15.08	0.0	0.0	0.0	0.00	0.00
910	15.17	0.0	0.0	0.0	0.00	0.00
915	15.25	0.0	0.0	0.0	0.00	0.00
920	15.33	0.0	0.0	0.0	0.00	0.00
925	15.42	0.0	0.0	0.0	0.00	0.00
930	15.50	0.0	0.0	0.0	0.00	0.00
935	15.58	0.0	0.0	0.0	0.00	0.00
940	15.67	0.0	0.0	0.0	0.00	0.00
945	15.75	0.0	0.0	0.0	0.00	0.00
950	15.83	0.0	0.0	0.0	0.00	0.00

Drainage System E0036 Hydrograph Comparison

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Hous
 Project No.: 345023
 Location: Houston, Texas
 Date: 12/21/17
 Performed By: ML
 Checked By: CM

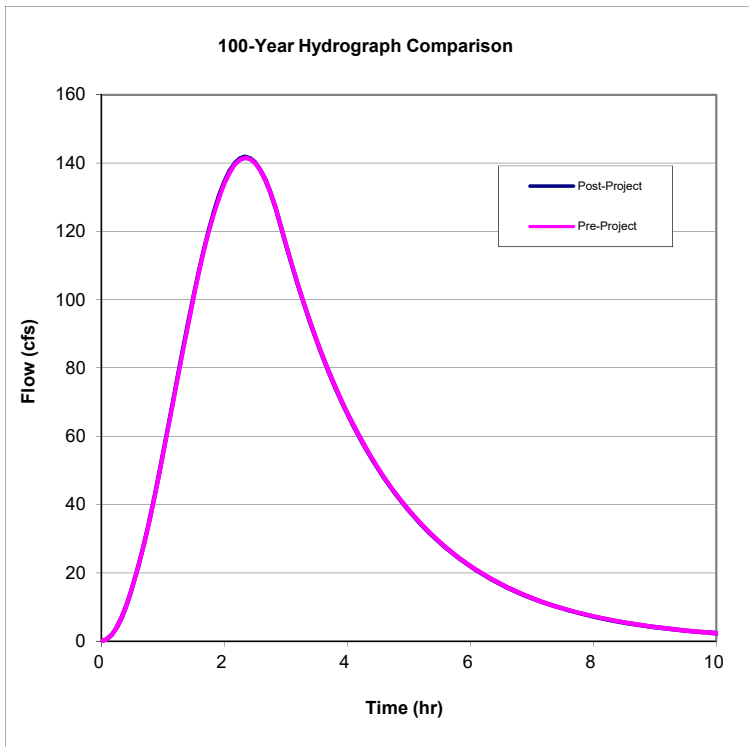
Watershed: White Oak Bayou
HCFC Unit: E100-00-00
Drainage System ID: E0036
Alternative: 1

Computation Parameters:

Design Storm = 100 year
 Storm Duration = 24 hours
 Drainage Area = 36.70 acres

*Peak flow from HouStorm

Condition	Peak Flow (cfs)	Peak Flow Impact (cfs)	Detention Volume (ac-ft)
Pre-Project	141.5	0.3	0.06
Post-Project	141.8		



Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs			Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)	Flow Difference Qp-Qe (cfs)	Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
0	0.00	0.0	0.0	0.0	0	0
5	0.08	0.4	0.4	0.0	0.00	0.00
10	0.17	1.8	1.8	0.0	0.00	0.00
15	0.25	4.0	3.9	0.0	0.00	0.00
20	0.33	7.0	6.9	0.0	0.00	0.00
25	0.42	10.8	10.7	0.1	0.00	0.00
30	0.50	15.4	15.3	0.1	0.00	0.00
35	0.58	20.7	20.5	0.1	0.00	0.00
40	0.67	26.6	26.4	0.2	0.00	0.00
45	0.75	33.0	32.8	0.2	0.00	0.00
50	0.83	39.9	39.7	0.2	0.00	0.01
55	0.92	47.3	47.0	0.3	0.00	0.01
60	1.00	54.9	54.6	0.3	0.00	0.01
65	1.08	62.7	62.3	0.3	0.00	0.01
70	1.17	70.6	70.2	0.4	0.00	0.01
75	1.25	78.5	78.1	0.4	0.00	0.02
80	1.33	86.3	85.9	0.4	0.00	0.02
85	1.42	94.0	93.5	0.5	0.00	0.02
90	1.50	101.3	100.8	0.5	0.00	0.03
95	1.58	108.3	107.8	0.5	0.00	0.03
100	1.67	114.8	114.3	0.5	0.00	0.03
105	1.75	120.7	120.2	0.5	0.00	0.04
110	1.83	126.0	125.5	0.5	0.00	0.04
115	1.92	130.7	130.2	0.5	0.00	0.04
120	2.00	134.6	134.1	0.5	0.00	0.05
125	2.08	137.7	137.2	0.4	0.00	0.05
130	2.17	139.9	139.5	0.4	0.00	0.05
135	2.25	141.3	140.9	0.4	0.00	0.06
140	2.33	141.8	141.5	0.3	0.00	0.06
145	2.42	141.4	141.2	0.3	0.00	0.06
150	2.50	140.2	140.0	0.2	0.00	0.06
155	2.58	138.1	137.9	0.1	0.00	0.06
160	2.67	135.1	135.0	0.1	0.00	0.06
165	2.75	131.3	131.3	0.0	0.00	0.06
170	2.83	126.8	126.9	-0.1	0.00	0.06
175	2.92	121.6	121.7	-0.2	0.00	0.06
180	3.00	116.2	116.4	-0.2	0.00	0.06
185	3.08	111.0	111.1	-0.2	0.00	0.06
190	3.17	105.9	106.1	-0.2	0.00	0.06
195	3.25	101.2	101.3	-0.2	0.00	0.06
200	3.33	96.6	96.7	-0.2	0.00	0.06
205	3.42	92.2	92.4	-0.2	0.00	0.05
210	3.50	88.0	88.2	-0.2	0.00	0.05
215	3.58	84.1	84.2	-0.2	0.00	0.05
220	3.67	80.2	80.4	-0.2	0.00	0.05
225	3.75	76.6	76.8	-0.2	0.00	0.05
230	3.83	73.2	73.3	-0.2	0.00	0.05

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
235	3.92	69.8	70.0	-0.2	0.00	0.05
240	4.00	66.7	66.9	-0.2	0.00	0.05
245	4.08	63.7	63.8	-0.2	0.00	0.05
250	4.17	60.8	61.0	-0.2	0.00	0.04
255	4.25	58.0	58.2	-0.2	0.00	0.04
260	4.33	55.4	55.6	-0.2	0.00	0.04
265	4.42	52.9	53.1	-0.2	0.00	0.04
270	4.50	50.5	50.7	-0.2	0.00	0.04
275	4.58	48.2	48.4	-0.2	0.00	0.04
280	4.67	46.0	46.2	-0.2	0.00	0.04
285	4.75	44.0	44.1	-0.2	0.00	0.04
290	4.83	42.0	42.1	-0.1	0.00	0.04
295	4.92	40.1	40.2	-0.1	0.00	0.03
300	5.00	38.3	38.4	-0.1	0.00	0.03
305	5.08	36.5	36.7	-0.1	0.00	0.03
310	5.17	34.9	35.0	-0.1	0.00	0.03
315	5.25	33.3	33.4	-0.1	0.00	0.03
320	5.33	31.8	31.9	-0.1	0.00	0.03
325	5.42	30.3	30.5	-0.1	0.00	0.03
330	5.50	29.0	29.1	-0.1	0.00	0.03
335	5.58	27.7	27.8	-0.1	0.00	0.03
340	5.67	26.4	26.5	-0.1	0.00	0.03
345	5.75	25.2	25.3	-0.1	0.00	0.03
350	5.83	24.1	24.2	-0.1	0.00	0.02
355	5.92	23.0	23.1	-0.1	0.00	0.02
360	6.00	21.9	22.1	-0.1	0.00	0.02
365	6.08	21.0	21.1	-0.1	0.00	0.02
370	6.17	20.0	20.1	-0.1	0.00	0.02
375	6.25	19.1	19.2	-0.1	0.00	0.02
380	6.33	18.2	18.3	-0.1	0.00	0.02
385	6.42	17.4	17.5	-0.1	0.00	0.02
390	6.50	16.6	16.7	-0.1	0.00	0.02
395	6.58	15.9	16.0	-0.1	0.00	0.02
400	6.67	15.2	15.2	-0.1	0.00	0.02
405	6.75	14.5	14.6	-0.1	0.00	0.02
410	6.83	13.8	13.9	-0.1	0.00	0.02
415	6.92	13.2	13.3	-0.1	0.00	0.02
420	7.00	12.6	12.7	-0.1	0.00	0.02
425	7.08	12.0	12.1	-0.1	0.00	0.01
430	7.17	11.5	11.6	-0.1	0.00	0.01
435	7.25	11.0	11.0	-0.1	0.00	0.01
440	7.33	10.5	10.5	-0.1	0.00	0.01
445	7.42	10.0	10.1	-0.1	0.00	0.01
450	7.50	9.5	9.6	-0.1	0.00	0.01
455	7.58	9.1	9.2	-0.1	0.00	0.01
460	7.67	8.7	8.8	-0.1	0.00	0.01
465	7.75	8.3	8.4	-0.1	0.00	0.01
470	7.83	7.9	8.0	-0.1	0.00	0.01

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
475	7.92	7.6	7.6	-0.1	0.00	0.01
480	8.00	7.2	7.3	-0.1	0.00	0.01
485	8.08	6.9	6.9	-0.1	0.00	0.01
490	8.17	6.6	6.6	0.0	0.00	0.01
495	8.25	6.3	6.3	0.0	0.00	0.01
500	8.33	6.0	6.0	0.0	0.00	0.01
505	8.42	5.7	5.8	0.0	0.00	0.01
510	8.50	5.5	5.5	0.0	0.00	0.01
515	8.58	5.2	5.3	0.0	0.00	0.01
520	8.67	5.0	5.0	0.0	0.00	0.01
525	8.75	4.8	4.8	0.0	0.00	0.01
530	8.83	4.5	4.6	0.0	0.00	0.01
535	8.92	4.3	4.4	0.0	0.00	0.01
540	9.00	4.1	4.2	0.0	0.00	0.01
545	9.08	4.0	4.0	0.0	0.00	0.01
550	9.17	3.8	3.8	0.0	0.00	0.01
555	9.25	3.6	3.6	0.0	0.00	0.01
560	9.33	3.4	3.5	0.0	0.00	0.01
565	9.42	3.3	3.3	0.0	0.00	0.01
570	9.50	3.1	3.2	0.0	0.00	0.01
575	9.58	3.0	3.0	0.0	0.00	0.00
580	9.67	2.9	2.9	0.0	0.00	0.00
585	9.75	2.7	2.8	0.0	0.00	0.00
590	9.83	2.6	2.6	0.0	0.00	0.00
595	9.92	2.5	2.5	0.0	0.00	0.00
600	10.00	2.4	2.4	0.0	0.00	0.00
605	10.08	2.3	2.3	0.0	0.00	0.00
610	10.17	2.2	2.2	0.0	0.00	0.00
615	10.25	2.1	2.1	0.0	0.00	0.00
620	10.33	2.0	2.0	0.0	0.00	0.00
625	10.42	1.9	1.9	0.0	0.00	0.00
630	10.50	1.8	1.8	0.0	0.00	0.00
635	10.58	1.7	1.7	0.0	0.00	0.00
640	10.67	1.6	1.7	0.0	0.00	0.00
645	10.75	1.6	1.6	0.0	0.00	0.00
650	10.83	1.5	1.5	0.0	0.00	0.00
655	10.92	1.4	1.4	0.0	0.00	0.00
660	11.00	1.4	1.4	0.0	0.00	0.00
665	11.08	1.3	1.3	0.0	0.00	0.00
670	11.17	1.2	1.3	0.0	0.00	0.00
675	11.25	1.2	1.2	0.0	0.00	0.00
680	11.33	1.1	1.1	0.0	0.00	0.00
685	11.42	1.1	1.1	0.0	0.00	0.00
690	11.50	1.0	1.0	0.0	0.00	0.00
695	11.58	1.0	1.0	0.0	0.00	0.00
700	11.67	0.9	1.0	0.0	0.00	0.00
705	11.75	0.9	0.9	0.0	0.00	0.00
710	11.83	0.9	0.9	0.0	0.00	0.00

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
715	11.92	0.8	0.8	0.0	0.00	0.00
720	12.00	0.8	0.8	0.0	0.00	0.00
725	12.08	0.7	0.8	0.0	0.00	0.00
730	12.17	0.7	0.7	0.0	0.00	0.00
735	12.25	0.7	0.7	0.0	0.00	0.00
740	12.33	0.7	0.7	0.0	0.00	0.00
745	12.42	0.6	0.6	0.0	0.00	0.00
750	12.50	0.6	0.6	0.0	0.00	0.00
755	12.58	0.6	0.6	0.0	0.00	0.00
760	12.67	0.5	0.5	0.0	0.00	0.00
765	12.75	0.5	0.5	0.0	0.00	0.00
770	12.83	0.5	0.5	0.0	0.00	0.00
775	12.92	0.5	0.5	0.0	0.00	0.00
780	13.00	0.4	0.5	0.0	0.00	0.00
785	13.08	0.4	0.4	0.0	0.00	0.00
790	13.17	0.4	0.4	0.0	0.00	0.00
795	13.25	0.4	0.4	0.0	0.00	0.00
800	13.33	0.4	0.4	0.0	0.00	0.00
805	13.42	0.4	0.4	0.0	0.00	0.00
810	13.50	0.3	0.3	0.0	0.00	0.00
815	13.58	0.3	0.3	0.0	0.00	0.00
820	13.67	0.3	0.3	0.0	0.00	0.00
825	13.75	0.3	0.3	0.0	0.00	0.00
830	13.83	0.3	0.3	0.0	0.00	0.00
835	13.92	0.3	0.3	0.0	0.00	0.00
840	14.00	0.3	0.3	0.0	0.00	0.00
845	14.08	0.2	0.2	0.0	0.00	0.00
850	14.17	0.2	0.2	0.0	0.00	0.00
855	14.25	0.2	0.2	0.0	0.00	0.00
860	14.33	0.2	0.2	0.0	0.00	0.00
865	14.42	0.2	0.2	0.0	0.00	0.00
870	14.50	0.2	0.2	0.0	0.00	0.00
875	14.58	0.2	0.2	0.0	0.00	0.00
880	14.67	0.2	0.2	0.0	0.00	0.00
885	14.75	0.2	0.2	0.0	0.00	0.00
890	14.83	0.2	0.2	0.0	0.00	0.00
895	14.92	0.2	0.2	0.0	0.00	0.00
900	15.00	0.1	0.2	0.0	0.00	0.00
905	15.08	0.1	0.1	0.0	0.00	0.00
910	15.17	0.1	0.1	0.0	0.00	0.00
915	15.25	0.1	0.1	0.0	0.00	0.00
920	15.33	0.1	0.1	0.0	0.00	0.00
925	15.42	0.1	0.1	0.0	0.00	0.00
930	15.50	0.1	0.1	0.0	0.00	0.00
935	15.58	0.1	0.1	0.0	0.00	0.00
940	15.67	0.1	0.1	0.0	0.00	0.00
945	15.75	0.1	0.1	0.0	0.00	0.00
950	15.83	0.1	0.1	0.0	0.00	0.00

Drainage System W00530 Hydrograph Comparison

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Hous
 Project No.: 345023
 Location: Houston, Texas
 Date: 12/21/17
 Performed By: ML
 Checked By: CM

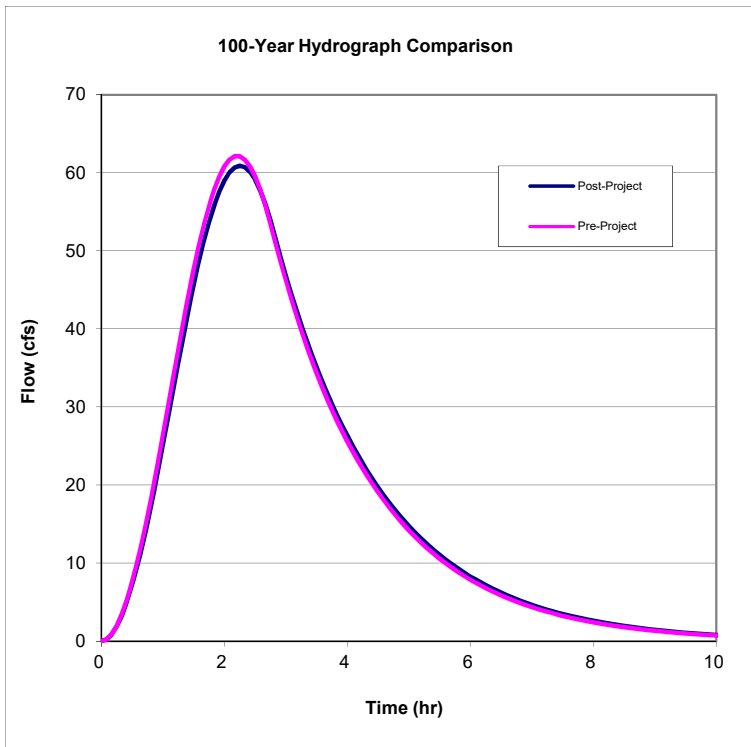
Watershed: Buffalo Bayou
HCFC Unit: W100-00-00
Drainage System ID: W00530
Alternative: 1

Computation Parameters:

Design Storm = 100 year
 Storm Duration = 24 hours
 Drainage Area = 15.19 acres

*Peak flow from HouStorm

Condition	Peak Flow (cfs)	Peak Flow Impact (cfs)	Detention Volume (ac-ft)
Pre-Project	62.1	-1.2	0.00
Post-Project	60.9		



Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
0	0.00	0.0	0.0	0.0	0	0
5	0.08	0.2	0.2	0.0	0.00	0.00
10	0.17	0.8	0.9	-0.1	0.00	0.00
15	0.25	1.8	1.9	-0.1	0.00	0.00
20	0.33	3.2	3.4	-0.2	0.00	0.00
25	0.42	5.0	5.3	-0.3	0.00	0.00
30	0.50	7.1	7.5	-0.4	0.00	-0.01
35	0.58	9.5	10.1	-0.6	0.00	-0.01
40	0.67	12.2	13.0	-0.7	0.00	-0.01
45	0.75	15.2	16.1	-0.9	-0.01	-0.02
50	0.83	18.3	19.4	-1.1	-0.01	-0.03
55	0.92	21.7	22.9	-1.2	-0.01	-0.03
60	1.00	25.1	26.5	-1.4	-0.01	-0.04
65	1.08	28.6	30.2	-1.6	-0.01	-0.05
70	1.17	32.1	33.9	-1.7	-0.01	-0.07
75	1.25	35.7	37.5	-1.8	-0.01	-0.08
80	1.33	39.1	41.1	-2.0	-0.01	-0.09
85	1.42	42.4	44.5	-2.0	-0.01	-0.10
90	1.50	45.6	47.7	-2.1	-0.01	-0.12
95	1.58	48.6	50.7	-2.1	-0.01	-0.13
100	1.67	51.3	53.4	-2.1	-0.01	-0.15
105	1.75	53.7	55.8	-2.1	-0.01	-0.16
110	1.83	55.8	57.9	-2.0	-0.01	-0.18
115	1.92	57.6	59.5	-1.9	-0.01	-0.19
120	2.00	59.0	60.8	-1.8	-0.01	-0.20
125	2.08	60.1	61.7	-1.6	-0.01	-0.22
130	2.17	60.7	62.1	-1.4	-0.01	-0.23
135	2.25	60.9	62.1	-1.2	-0.01	-0.24
140	2.33	60.7	61.7	-1.0	-0.01	-0.24
145	2.42	60.1	60.8	-0.7	-0.01	-0.25
150	2.50	59.1	59.5	-0.4	0.00	-0.25
155	2.58	57.7	57.8	-0.1	0.00	-0.25
160	2.67	56.0	55.8	0.2	0.00	-0.25
165	2.75	53.9	53.4	0.5	0.00	-0.25
170	2.83	51.6	50.9	0.7	0.00	-0.25
175	2.92	49.1	48.4	0.7	0.00	-0.24
180	3.00	46.8	46.1	0.7	0.00	-0.24
185	3.08	44.6	43.9	0.7	0.00	-0.23
190	3.17	42.5	41.8	0.7	0.01	-0.23
195	3.25	40.5	39.8	0.7	0.01	-0.22
200	3.33	38.6	37.9	0.7	0.01	-0.22
205	3.42	36.8	36.1	0.7	0.01	-0.21
210	3.50	35.1	34.4	0.7	0.01	-0.21
215	3.58	33.4	32.7	0.7	0.01	-0.20
220	3.67	31.9	31.1	0.7	0.01	-0.20
225	3.75	30.4	29.7	0.7	0.01	-0.19
230	3.83	29.0	28.2	0.7	0.01	-0.19

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs		Flow Difference Qp-Qe (cfs)	Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)		Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
235	3.92	27.6	26.9	0.7	0.00	-0.18
240	4.00	26.3	25.6	0.7	0.00	-0.18
245	4.08	25.1	24.4	0.7	0.00	-0.17
250	4.17	23.9	23.2	0.7	0.00	-0.17
255	4.25	22.8	22.1	0.7	0.00	-0.16
260	4.33	21.7	21.0	0.7	0.00	-0.16
265	4.42	20.7	20.0	0.7	0.00	-0.15
270	4.50	19.7	19.1	0.6	0.00	-0.15
275	4.58	18.8	18.2	0.6	0.00	-0.14
280	4.67	17.9	17.3	0.6	0.00	-0.14
285	4.75	17.1	16.5	0.6	0.00	-0.14
290	4.83	16.3	15.7	0.6	0.00	-0.13
295	4.92	15.5	14.9	0.6	0.00	-0.13
300	5.00	14.8	14.2	0.6	0.00	-0.12
305	5.08	14.1	13.5	0.6	0.00	-0.12
310	5.17	13.4	12.9	0.5	0.00	-0.12
315	5.25	12.8	12.3	0.5	0.00	-0.11
320	5.33	12.2	11.7	0.5	0.00	-0.11
325	5.42	11.6	11.1	0.5	0.00	-0.10
330	5.50	11.1	10.6	0.5	0.00	-0.10
335	5.58	10.6	10.1	0.5	0.00	-0.10
340	5.67	10.1	9.6	0.5	0.00	-0.09
345	5.75	9.6	9.1	0.5	0.00	-0.09
350	5.83	9.1	8.7	0.4	0.00	-0.09
355	5.92	8.7	8.3	0.4	0.00	-0.09
360	6.00	8.3	7.9	0.4	0.00	-0.08
365	6.08	7.9	7.5	0.4	0.00	-0.08
370	6.17	7.5	7.1	0.4	0.00	-0.08
375	6.25	7.2	6.8	0.4	0.00	-0.07
380	6.33	6.8	6.5	0.4	0.00	-0.07
385	6.42	6.5	6.2	0.4	0.00	-0.07
390	6.50	6.2	5.9	0.3	0.00	-0.07
395	6.58	5.9	5.6	0.3	0.00	-0.06
400	6.67	5.6	5.3	0.3	0.00	-0.06
405	6.75	5.4	5.1	0.3	0.00	-0.06
410	6.83	5.1	4.8	0.3	0.00	-0.06
415	6.92	4.9	4.6	0.3	0.00	-0.06
420	7.00	4.7	4.4	0.3	0.00	-0.05
425	7.08	4.4	4.2	0.3	0.00	-0.05
430	7.17	4.2	4.0	0.3	0.00	-0.05
435	7.25	4.0	3.8	0.3	0.00	-0.05
440	7.33	3.8	3.6	0.3	0.00	-0.05
445	7.42	3.7	3.4	0.2	0.00	-0.04
450	7.50	3.5	3.3	0.2	0.00	-0.04
455	7.58	3.3	3.1	0.2	0.00	-0.04
460	7.67	3.2	3.0	0.2	0.00	-0.04
465	7.75	3.0	2.8	0.2	0.00	-0.04
470	7.83	2.9	2.7	0.2	0.00	-0.04

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs			Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)	Flow Difference Qp-Qe (cfs)	Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
475	7.92	2.7	2.5	0.2	0.00	-0.04
480	8.00	2.6	2.4	0.2	0.00	-0.03
485	8.08	2.5	2.3	0.2	0.00	-0.03
490	8.17	2.4	2.2	0.2	0.00	-0.03
495	8.25	2.3	2.1	0.2	0.00	-0.03
500	8.33	2.2	2.0	0.2	0.00	-0.03
505	8.42	2.1	1.9	0.2	0.00	-0.03
510	8.50	2.0	1.8	0.2	0.00	-0.03
515	8.58	1.9	1.7	0.1	0.00	-0.03
520	8.67	1.8	1.6	0.1	0.00	-0.02
525	8.75	1.7	1.6	0.1	0.00	-0.02
530	8.83	1.6	1.5	0.1	0.00	-0.02
535	8.92	1.5	1.4	0.1	0.00	-0.02
540	9.00	1.5	1.3	0.1	0.00	-0.02
545	9.08	1.4	1.3	0.1	0.00	-0.02
550	9.17	1.3	1.2	0.1	0.00	-0.02
555	9.25	1.3	1.2	0.1	0.00	-0.02
560	9.33	1.2	1.1	0.1	0.00	-0.02
565	9.42	1.2	1.1	0.1	0.00	-0.02
570	9.50	1.1	1.0	0.1	0.00	-0.02
575	9.58	1.0	1.0	0.1	0.00	-0.02
580	9.67	1.0	0.9	0.1	0.00	-0.02
585	9.75	1.0	0.9	0.1	0.00	-0.01
590	9.83	0.9	0.8	0.1	0.00	-0.01
595	9.92	0.9	0.8	0.1	0.00	-0.01
600	10.00	0.8	0.7	0.1	0.00	-0.01
605	10.08	0.8	0.7	0.1	0.00	-0.01
610	10.17	0.7	0.7	0.1	0.00	-0.01
615	10.25	0.7	0.6	0.1	0.00	-0.01
620	10.33	0.7	0.6	0.1	0.00	-0.01
625	10.42	0.6	0.6	0.1	0.00	-0.01
630	10.50	0.6	0.6	0.1	0.00	-0.01
635	10.58	0.6	0.5	0.1	0.00	-0.01
640	10.67	0.6	0.5	0.1	0.00	-0.01
645	10.75	0.5	0.5	0.1	0.00	-0.01
650	10.83	0.5	0.5	0.1	0.00	-0.01
655	10.92	0.5	0.4	0.1	0.00	-0.01
660	11.00	0.5	0.4	0.0	0.00	-0.01
665	11.08	0.4	0.4	0.0	0.00	-0.01
670	11.17	0.4	0.4	0.0	0.00	-0.01
675	11.25	0.4	0.4	0.0	0.00	-0.01
680	11.33	0.4	0.3	0.0	0.00	-0.01
685	11.42	0.4	0.3	0.0	0.00	-0.01
690	11.50	0.3	0.3	0.0	0.00	-0.01
695	11.58	0.3	0.3	0.0	0.00	-0.01
700	11.67	0.3	0.3	0.0	0.00	-0.01
705	11.75	0.3	0.3	0.0	0.00	-0.01
710	11.83	0.3	0.3	0.0	0.00	-0.01

Project Name: Storm Water Drainage Services for Pre-Engineering of Street and Paving Improvements, City of Houston
 Project No.: 345023
 Date: 12/21/17

100-YEAR HYDROGRAPH AND VOLUME COMPUTATIONS

Time Interval (min) = 5

Time (minutes)	Time (hours)	Runoff Hydrographs			Runoff Volumes	
		Proposed Runoff Q (cfs)	Existing Runoff Q (cfs)	Flow Difference Qp-Qe (cfs)	Incremental Volume (ac-ft)	Cumulative Volume (ac-ft)
715	11.92	0.3	0.2	0.0	0.00	0.00
720	12.00	0.3	0.2	0.0	0.00	0.00
725	12.08	0.2	0.2	0.0	0.00	0.00
730	12.17	0.2	0.2	0.0	0.00	0.00
735	12.25	0.2	0.2	0.0	0.00	0.00
740	12.33	0.2	0.2	0.0	0.00	0.00
745	12.42	0.2	0.2	0.0	0.00	0.00
750	12.50	0.2	0.2	0.0	0.00	0.00
755	12.58	0.2	0.2	0.0	0.00	0.00
760	12.67	0.2	0.2	0.0	0.00	0.00
765	12.75	0.2	0.1	0.0	0.00	0.00
770	12.83	0.2	0.1	0.0	0.00	0.00
775	12.92	0.2	0.1	0.0	0.00	0.00
780	13.00	0.1	0.1	0.0	0.00	0.00
785	13.08	0.1	0.1	0.0	0.00	0.00
790	13.17	0.1	0.1	0.0	0.00	0.00
795	13.25	0.1	0.1	0.0	0.00	0.00
800	13.33	0.1	0.1	0.0	0.00	0.00
805	13.42	0.1	0.1	0.0	0.00	0.00
810	13.50	0.1	0.1	0.0	0.00	0.00
815	13.58	0.1	0.1	0.0	0.00	0.00
820	13.67	0.1	0.1	0.0	0.00	0.00
825	13.75	0.1	0.1	0.0	0.00	0.00
830	13.83	0.1	0.1	0.0	0.00	0.00
835	13.92	0.1	0.1	0.0	0.00	0.00
840	14.00	0.1	0.1	0.0	0.00	0.00
845	14.08	0.1	0.1	0.0	0.00	0.00
850	14.17	0.1	0.1	0.0	0.00	0.00
855	14.25	0.1	0.1	0.0	0.00	0.00
860	14.33	0.1	0.1	0.0	0.00	0.00
865	14.42	0.1	0.1	0.0	0.00	0.00
870	14.50	0.1	0.1	0.0	0.00	0.00
875	14.58	0.1	0.1	0.0	0.00	0.00
880	14.67	0.1	0.0	0.0	0.00	0.00
885	14.75	0.1	0.0	0.0	0.00	0.00
890	14.83	0.1	0.0	0.0	0.00	0.00
895	14.92	0.0	0.0	0.0	0.00	0.00
900	15.00	0.0	0.0	0.0	0.00	0.00
905	15.08	0.0	0.0	0.0	0.00	0.00
910	15.17	0.0	0.0	0.0	0.00	0.00
915	15.25	0.0	0.0	0.0	0.00	0.00
920	15.33	0.0	0.0	0.0	0.00	0.00
925	15.42	0.0	0.0	0.0	0.00	0.00
930	15.50	0.0	0.0	0.0	0.00	0.00
935	15.58	0.0	0.0	0.0	0.00	0.00
940	15.67	0.0	0.0	0.0	0.00	0.00
945	15.75	0.0	0.0	0.0	0.00	0.00
950	15.83	0.0	0.0	0.0	0.00	0.00

Drainage System Impervious Detention Calculation

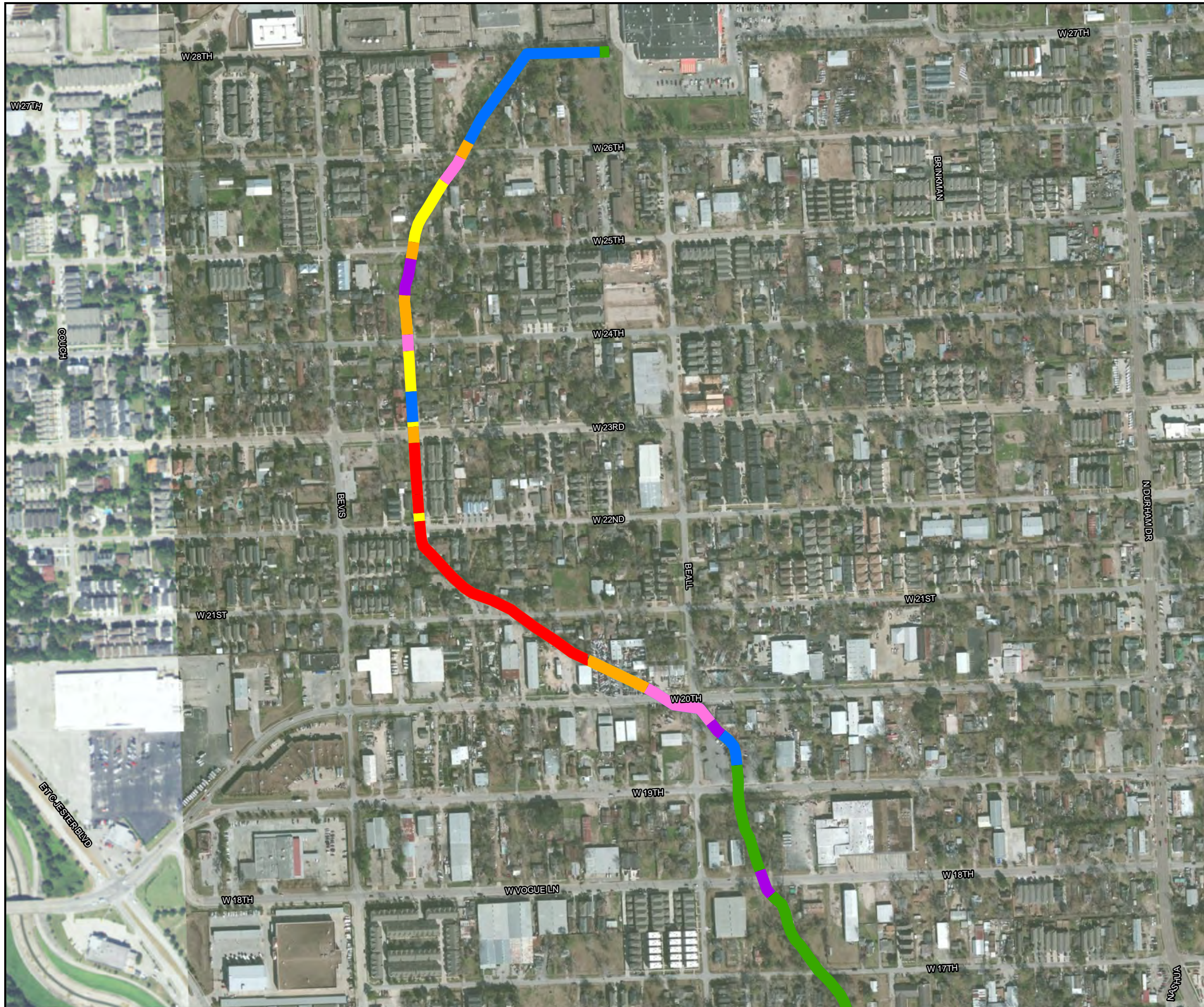
Project Name: Storm Water and Drainage Pre-engineering Services, City of Houston (WBS No. N-320100-0010-3)
 Project No.: 345023.00
 Location: Houston, Texas
 Date: 01/27/17
 Performed By: AG
 Checked By:

Drainage System ID: E0150, E0147, E0146, E0145, E0051, E0042, E0041, E0040, E0039, E0036, W530
 Alternative: 1

Drainage System	Location Description		Length (ft)	Existing Impervious Width (ft)	Proposed Impervious Width (ft)	Change In Impervious (ac)	Detention Required (0.5 ac-ft/ac) (ac-ft)	Total Detention (ac-ft)
	From Street (-)	To Street (-)						
E0150	IH 610	18TH	3710	51	55	0.34	0.17	0.17
E0147	IH 610	16TH	5357	52	55	0.37	0.18	0.18
E0146	15 1/2	14 1/2	557	51	55	0.05	0.03	0.04
	15 1/2	14 1/2	557	52	55	0.04	0.02	
E0145	14 1/2	12 Th	2016	52	55	0.14	0.07	0.16
	14 1/2	12 Th	2021	51	55	0.19	0.09	
E0051	12 TH	11 TH	496	51	55	0.05	0.02	0.02
E0042	11TH	6TH	2463	51	55	0.23	0.11	0.11
E0041	11TH	6TH	4213	52	55	0.29	0.15	0.15
E0040	Darling	IH 10	942	51	55	0.09	0.04	0.04
E0039	Larkin	IH 10	397	52	55	0.03	0.01	0.01
E0036	I10	Allen	1830	51	55	0.17	0.08	0.15
	I10	Allen	1965	52	55	0.14	0.07	
W530	Allen	Center	821	51	55	0.08	0.04	0.14
	Allen	Scotland	3070	52	55	0.21	0.11	
Total	--	--	30415	--	--	2.39	1.19	1.19

ATTACHMENT 3

**WALTER P MOORE TURKEY GULLY,
HCFCD UNIT 106-00-00 CAPACITY EXHIBIT**



Legend

Channel Capacity (Existing)

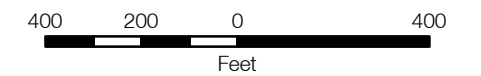
- <2YR
- 2YR
- 5YR
- 10YR
- 50YR
- 100YR
- >100YR

Note

Existing channel capacities downstream of 18th Street to the confluence with White Oak Bayou are greater than the 100-year event.

Data Sources

Channel Capacities: WPM, 2012
Aerial Photo: ArcGIS Online, 2016



Coordinate System

Projection: State Plane NAD83 (Grid)
Zone: Texas South Central
Units: Feet

WALTER P MOORE

WALTER P. MOORE AND ASSOCIATES, INC.
1301 MCKINNEY, SUITE 1100
HOUSTON, TX 77010

PHONE: 713.630.7300 FAX: 713.630.7396

Turkey Gully
Houston, Texas

PRELIMINARY - NOT FINAL

Existing Channel Capacity

Job Number: H20-13004-00	Date: July 2017	Drawn By: MWH	Exhibit: 2
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Appendix G

Traffic Models



Existing AM Peak



Lanes, Volumes, Timings
450: Durham & Washington

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑		↖	↑↑						↑↑↑↑	
Volume (vph)	0	506	235	173	621	0	0	0	0	235	1629	47
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	150		0	0		0	0		0
Storage Lanes	0		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3369	0	1770	3539	0	0	0	0	0	6344	0
Flt Permitted				0.950							0.994	
Satd. Flow (perm)	0	3369	0	1770	3539	0	0	0	0	0	6344	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		64										5
Link Speed (mph)		30			30			30				30
Link Distance (ft)		2207			322			520				238
Travel Time (s)		50.2			7.3			11.8				5.4
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	772	0	180	647	0	0	0	0	0	1991	0
Turn Type		NA		Prot	NA					Perm		NA
Protected Phases		2		1	6							4
Permitted Phases											4	
Detector Phase		2		1	6						4	4
Switch Phase												
Minimum Initial (s)		10.0		5.0	10.0					10.0	10.0	
Minimum Split (s)		21.0		10.0	21.0					18.0	18.0	
Total Split (s)		40.0		25.0	65.0					55.0	55.0	
Total Split (%)		33.3%		20.8%	54.2%					45.8%	45.8%	
Yellow Time (s)		3.6		3.6	3.6					3.6	3.6	
All-Red Time (s)		1.4		1.4	1.4					1.4	1.4	
Lost Time Adjust (s)		0.0		0.0	0.0							0.0
Total Lost Time (s)		5.0		5.0	5.0							5.0
Lead/Lag		Lag		Lead								
Lead-Lag Optimize?		Yes		Yes								
Recall Mode		Max		None	Max					C-Max	C-Max	
Act Effect Green (s)		38.3		16.7	60.0							50.0
Actuated g/C Ratio		0.32		0.14	0.50							0.42
v/c Ratio		0.69		0.73	0.37							0.75
Control Delay		30.5		78.9	18.0							43.3
Queue Delay		0.0		0.3	1.0							0.0
Total Delay		30.5		79.2	19.0							43.3
LOS		C		E	B							D

Lanes, Volumes, Timings
450: Durham & Washington

11/26/2017

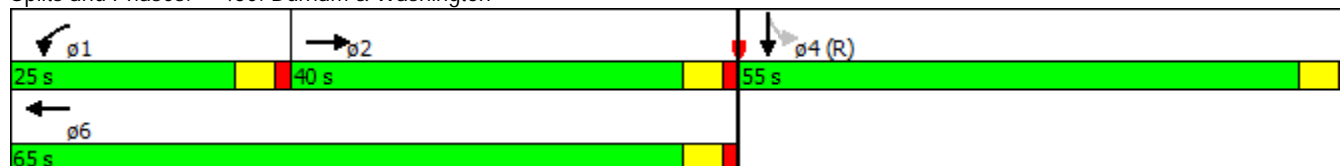


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		30.5			32.1							43.3
Approach LOS		C			C							D
Queue Length 50th (ft)		317		150	104							386
Queue Length 95th (ft)		388		m206	166							423
Internal Link Dist (ft)		2127			242			440				158
Turn Bay Length (ft)				150								
Base Capacity (vph)		1119		295	1769							2646
Starvation Cap Reductn		0		8	804							0
Spillback Cap Reductn		0		0	0							0
Storage Cap Reductn		0		0	0							0
Reduced v/c Ratio		0.69		0.63	0.67							0.75

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	0 (0%), Referenced to phase 4:SBTL, Start of Green
Natural Cycle:	60
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	0.75
Intersection Signal Delay:	38.0
Intersection LOS:	D
Intersection Capacity Utilization:	71.6%
ICU Level of Service:	C
Analysis Period (min):	15
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 450: Durham & Washington



Lanes, Volumes, Timings
451: Durham & Center

11/26/2017



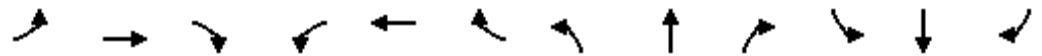
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	20	24	9	27	0	0	0	0	26	2088	31
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1730	0	0	1839	0	0	0	0	0	6382	0
Flt Permitted					0.987						0.999	
Satd. Flow (perm)	0	1730	0	0	1839	0	0	0	0	0	6382	0
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		534			320			238			2187	
Travel Time (s)		12.1			7.3			4.6			42.6	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.56	0.60	0.56	0.61	0.93	0.93	0.93	0.93	0.86	0.93	0.70
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	76	0	0	60	0	0	0	0	0	2319	0
Sign Control		Stop			Stop			Stop			Free	

Intersection Summary

Area Type:	Other
Control Type:	Unsignalized
Intersection Capacity Utilization	46.4%
ICU Level of Service	A
Analysis Period (min)	15

Lanes, Volumes, Timings
452: Durham & IH10 - EBFR

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑									←↑↑↑	
Volume (vph)	0	606	410	0	0	0	0	0	0	274	1761	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	4770	0	0	0	0	0	0	0	0	6363	0
Flt Permitted											0.993	
Satd. Flow (perm)	0	4770	0	0	0	0	0	0	0	0	6363	0
Right Turn on Red			Yes			Yes			Yes	Yes		Yes
Satd. Flow (RTOR)		18										64
Link Speed (mph)		40			40			35				35
Link Distance (ft)		594			306			2187				312
Travel Time (s)		10.1			5.2			42.6				6.1
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.90	0.87	0.93	0.93	0.93	0.93	0.93	0.93	0.90	0.95	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	1144	0	0	0	0	0	0	0	0	2158	0
Turn Type		NA								Perm	NA	
Protected Phases		4 12										1 2
Permitted Phases										1 2		
Detector Phase		4 12								1 2	1 2	
Switch Phase												
Minimum Initial (s)												
Minimum Split (s)												
Total Split (s)												
Total Split (%)												
Yellow Time (s)												
All-Red Time (s)												
Lost Time Adjust (s)												
Total Lost Time (s)												
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode												
Act Effct Green (s)		35.8									74.2	
Actuated g/C Ratio		0.30									0.62	
v/c Ratio		0.96dr									0.54	
Control Delay		43.1									8.1	
Queue Delay		0.0									10.7	
Total Delay		43.1									18.8	
LOS		D									B	

Lane Group	ø1	ø2	ø4	ø6	ø8	ø12	ø16
Lane Configurations							
Volume (vph)							
Ideal Flow (vphpl)							
Lane Width (ft)							
Grade (%)							
Storage Length (ft)							
Storage Lanes							
Taper Length (ft)							
Satd. Flow (prot)							
Flt Permitted							
Satd. Flow (perm)							
Right Turn on Red							
Satd. Flow (RTOR)							
Link Speed (mph)							
Link Distance (ft)							
Travel Time (s)							
Confl. Peds. (#/hr)							
Confl. Bikes (#/hr)							
Peak Hour Factor							
Growth Factor							
Heavy Vehicles (%)							
Bus Blockages (#/hr)							
Parking (#/hr)							
Mid-Block Traffic (%)							
Shared Lane Traffic (%)							
Lane Group Flow (vph)							
Turn Type							
Protected Phases	1	2	4	6	8	12	16
Permitted Phases							
Detector Phase							
Switch Phase							
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	21.0	21.0	21.0	20.0	20.0
Total Split (s)	58.0	21.0	21.0	57.0	21.0	20.0	42.0
Total Split (%)	48%	18%	18%	48%	18%	17%	35%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)							
Total Lost Time (s)							
Lead/Lag	Lag	Lead	Lag	Lead	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	
Recall Mode	None	Max	None	C-Max	Max	None	None
Act Effct Green (s)							
Actuated g/C Ratio							
v/c Ratio							
Control Delay							
Queue Delay							
Total Delay							
LOS							

Lanes, Volumes, Timings
452: Durham & IH10 - EBFR

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		43.1										18.8
Approach LOS		D										B
Queue Length 50th (ft)		293										329
Queue Length 95th (ft)		350										314
Internal Link Dist (ft)		514			226			2107				232
Turn Bay Length (ft)												
Base Capacity (vph)		1443										3960
Starvation Cap Reductn		0										1804
Spillback Cap Reductn		0										0
Storage Cap Reductn		0										0
Reduced v/c Ratio		0.79										1.00

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	94 (78%), Referenced to phase 6:SBT, Start of Green
Natural Cycle:	105
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	0.86
Intersection Signal Delay:	27.2
Intersection LOS:	C
Intersection Capacity Utilization:	58.9%
ICU Level of Service:	B
Analysis Period (min):	15
dr	Defacto Right Lane. Recode with 1 though lane as a right lane.

Splits and Phases: 452: Durham & IH10 - EBFR

#452 ↓ ϕ2 21 s	#452 → ϕ4 21 s	#452 → ϕ12 20 s	#452 ↓ ϕ1 58 s
#453 ← ϕ16 42 s	#453 ↓ ϕ6 (R) 57 s	#453 ← ϕ8 21 s	

Lane Group	ø1	ø2	ø4	ø6	ø8	ø12	ø16
Approach Delay							
Approach LOS							
Queue Length 50th (ft)							
Queue Length 95th (ft)							
Internal Link Dist (ft)							
Turn Bay Length (ft)							
Base Capacity (vph)							
Starvation Cap Reductn							
Spillback Cap Reductn							
Storage Cap Reductn							
Reduced v/c Ratio							
Intersection Summary							

Lanes, Volumes, Timings
453: Durham & IH10 - WBFR

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑↑↑						↑↑↑	
Volume (vph)	0	0	0	243	882	0	0	0	0	0	1793	487
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	0	5029	0	0	0	0	0	6196	0
Flt Permitted					0.989							
Satd. Flow (perm)	0	0	0	0	5029	0	0	0	0	0	6196	0
Right Turn on Red			Yes	Yes		Yes			Yes			Yes
Satd. Flow (RTOR)					64						71	
Link Speed (mph)		40			40			35			35	
Link Distance (ft)		575			310			312			2613	
Travel Time (s)		9.8			5.3			6.1			50.9	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.89	0.89	0.93	0.93	0.93	0.93	0.93	0.98	0.96
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	0	1264	0	0	0	0	0	2337	0
Turn Type				Perm	NA						NA	
Protected Phases					8 16						6	
Permitted Phases				8 16								
Detector Phase				8 16	8 16						6	
Switch Phase												
Minimum Initial (s)											4.0	
Minimum Split (s)											21.0	
Total Split (s)											57.0	
Total Split (%)											47.5%	
Yellow Time (s)											3.5	
All-Red Time (s)											1.5	
Lost Time Adjust (s)											0.0	
Total Lost Time (s)											5.0	
Lead/Lag											Lead	
Lead-Lag Optimize?											Yes	
Recall Mode											C-Max	
Act Effct Green (s)					58.0						52.0	
Actuated g/C Ratio					0.48						0.43	
v/c Ratio					0.51						0.86	
Control Delay					21.8						26.6	
Queue Delay					2.2						19.4	
Total Delay					24.0						45.9	
LOS					C						D	

Lanes, Volumes, Timings
453: Durham & IH10 - WBFR

11/26/2017

Lane Group	ø1	ø2	ø4	ø8	ø12	ø16
Lane Configurations						
Volume (vph)						
Ideal Flow (vphpl)						
Lane Width (ft)						
Grade (%)						
Storage Length (ft)						
Storage Lanes						
Taper Length (ft)						
Satd. Flow (prot)						
Flt Permitted						
Satd. Flow (perm)						
Right Turn on Red						
Satd. Flow (RTOR)						
Link Speed (mph)						
Link Distance (ft)						
Travel Time (s)						
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor						
Growth Factor						
Heavy Vehicles (%)						
Bus Blockages (#/hr)						
Parking (#/hr)						
Mid-Block Traffic (%)						
Shared Lane Traffic (%)						
Lane Group Flow (vph)						
Turn Type						
Protected Phases	1	2	4	8	12	16
Permitted Phases						
Detector Phase						
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	21.0	21.0	20.0	20.0
Total Split (s)	58.0	21.0	21.0	21.0	20.0	42.0
Total Split (%)	48%	18%	18%	18%	17%	35%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)						
Total Lost Time (s)						
Lead/Lag	Lag	Lead	Lag	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	
Recall Mode	None	Max	None	Max	None	None
Act Effct Green (s)						
Actuated g/C Ratio						
v/c Ratio						
Control Delay						
Queue Delay						
Total Delay						
LOS						

Lanes, Volumes, Timings
453: Durham & IH10 - WBFR

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					24.0							45.9
Approach LOS					C							D
Queue Length 50th (ft)					287							240
Queue Length 95th (ft)					266							351
Internal Link Dist (ft)		495			230			232				2533
Turn Bay Length (ft)												
Base Capacity (vph)					2463							2725
Starvation Cap Reductn					1012							0
Spillback Cap Reductn					1							464
Storage Cap Reductn					0							0
Reduced v/c Ratio					0.87							1.03

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	94 (78%), Referenced to phase 6:SBT, Start of Green
Natural Cycle:	105
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	0.86
Intersection Signal Delay:	38.2
Intersection LOS:	D
Intersection Capacity Utilization:	64.4%
ICU Level of Service:	C
Analysis Period (min):	15

Splits and Phases: 453: Durham & IH10 - WBFR

#452 ↓ ρ2 21 s	#452 → ρ4 21 s	#452 → ρ12 20 s	#452 ↓ ρ1 58 s
#453 ← ρ16 42 s	#453 ↓ ρ6 (R) 57 s	#453 ← ρ8 21 s	

Lane Group	ø1	ø2	ø4	ø8	ø12	ø16
Approach Delay						
Approach LOS						
Queue Length 50th (ft)						
Queue Length 95th (ft)						
Internal Link Dist (ft)						
Turn Bay Length (ft)						
Base Capacity (vph)						
Starvation Cap Reductn						
Spillback Cap Reductn						
Storage Cap Reductn						
Reduced v/c Ratio						
Intersection Summary						

Lanes, Volumes, Timings
454: W 11th

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑	↑	↑	↑↑						↑↑↑	
Volume (vph)	0	458	228	199	567	0	0	0	0	262	1908	413
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		150	50		0	0		0	0		0
Storage Lanes	0		1	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3360	1441	1770	3539	0	0	0	0	0	6210	0
Flt Permitted				0.326							0.995	
Satd. Flow (perm)	0	3360	1441	607	3539	0	0	0	0	0	6210	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		3	21									63
Link Speed (mph)		30			30			35				35
Link Distance (ft)		421			536			1925				2048
Travel Time (s)		9.6			12.2			37.5				39.9
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.87	0.84	0.94	0.90	0.93	0.93	0.93	0.93	0.91	0.92	0.83
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)			12%									
Lane Group Flow (vph)	0	559	238	212	630	0	0	0	0	0	2860	0
Turn Type		NA	Perm	Perm	NA					Perm	NA	
Protected Phases		2			6							4
Permitted Phases			2	6						4		
Detector Phase		2	2	6	6					4	4	
Switch Phase												
Minimum Initial (s)		10.0	10.0	10.0	10.0					10.0	10.0	
Minimum Split (s)		21.2	21.2	21.2	21.2					21.3	21.3	
Total Split (s)		55.0	55.0	55.0	55.0					65.0	65.0	
Total Split (%)		45.8%	45.8%	45.8%	45.8%					54.2%	54.2%	
Yellow Time (s)		3.6	3.6	3.6	3.6					3.6	3.6	
All-Red Time (s)		1.6	1.6	1.6	1.6					1.7	1.7	
Lost Time Adjust (s)		0.0	0.0	0.0	0.0							0.0
Total Lost Time (s)		5.2	5.2	5.2	5.2							5.3
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		None	None	None	None					C-Max	C-Max	
Act Effect Green (s)		43.3	43.3	43.3	43.3							66.2
Actuated g/C Ratio		0.36	0.36	0.36	0.36							0.55
v/c Ratio		0.46	0.45	0.97	0.49							0.83
Control Delay		29.7	28.0	77.1	16.2							21.0
Queue Delay		0.0	0.0	0.0	0.0							0.0
Total Delay		29.7	28.0	77.1	16.2							21.0
LOS		C	C	E	B							C

Lanes, Volumes, Timings

454: W 11th

11/26/2017

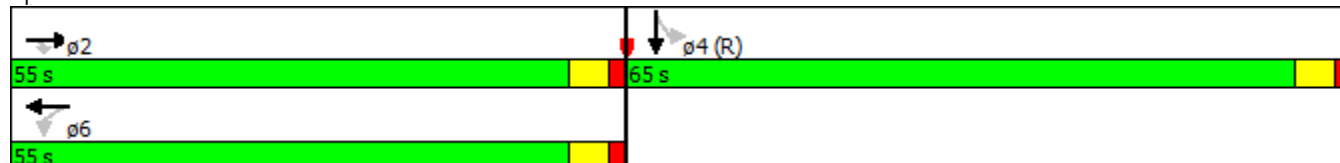


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		29.2			31.6							21.0
Approach LOS		C			C							C
Queue Length 50th (ft)		168	129	91	132							347
Queue Length 95th (ft)		204	184	#226	227							430
Internal Link Dist (ft)		341			456			1845				1968
Turn Bay Length (ft)			150	50								
Base Capacity (vph)		1396	610	251	1468							3453
Starvation Cap Reductn		0	0	0	0							0
Spillback Cap Reductn		0	0	0	0							0
Storage Cap Reductn		0	0	0	0							0
Reduced v/c Ratio		0.40	0.39	0.84	0.43							0.83

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 15 (13%), Referenced to phase 4:SBTL, Start of Green
 Natural Cycle: 60
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.97
 Intersection Signal Delay: 24.4
 Intersection LOS: C
 Intersection Capacity Utilization 77.7%
 ICU Level of Service D
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 454: W 11th



Lanes, Volumes, Timings

455: W 14th

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	23	90	94	37	0	0	0	0	61	2231	15
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1669	0	0	1799	0	0	0	0	0	6382	0
Flt Permitted					0.508						0.998	
Satd. Flow (perm)	0	1669	0	0	946	0	0	0	0	0	6382	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		5										4
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		332			488			2048			157	
Travel Time (s)		7.5			11.1			39.9			3.1	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.57	0.66	0.84	0.77	0.93	0.93	0.93	0.93	0.76	0.92	0.47
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	176	0	0	160	0	0	0	0	0	2537	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		2			6						4	
Permitted Phases				6						4		
Detector Phase		2		6	6					4	4	
Switch Phase												
Minimum Initial (s)		11.0		11.0	11.0					11.0	11.0	
Minimum Split (s)		22.7		20.7	20.7					21.1	21.1	
Total Split (s)		39.0		39.0	39.0					81.0	81.0	
Total Split (%)		32.5%		32.5%	32.5%					67.5%	67.5%	
Yellow Time (s)		3.2		3.2	3.2					3.6	3.6	
All-Red Time (s)		1.5		1.5	1.5					1.5	1.5	
Lost Time Adjust (s)		0.0			0.0						0.0	
Total Lost Time (s)		4.7			4.7						5.1	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		None		None	None					C-Max	C-Max	
Act Effect Green (s)		22.6			22.6							87.6
Actuated g/C Ratio		0.19			0.19							0.73
v/c Ratio		0.55			0.90							0.54
Control Delay		48.2			74.2							8.5
Queue Delay		0.0			0.0							0.0
Total Delay		48.2			74.2							8.5
LOS		D			E							A

Lanes, Volumes, Timings

455: W 14th

11/26/2017



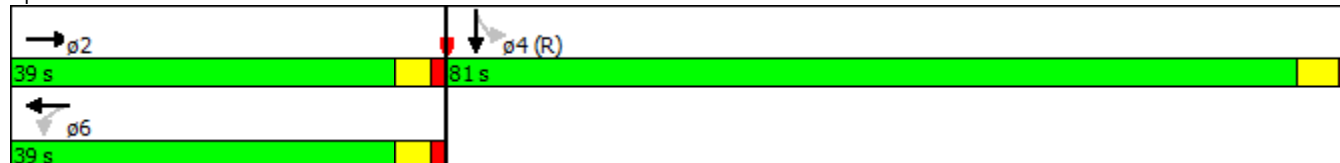
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		48.2			74.2							8.5
Approach LOS		D			E							A
Queue Length 50th (ft)		121			131							225
Queue Length 95th (ft)		104			160							335
Internal Link Dist (ft)		252			408			1968				77
Turn Bay Length (ft)												
Base Capacity (vph)		480			270							4660
Starvation Cap Reductn		0			0							0
Spillback Cap Reductn		0			0							0
Storage Cap Reductn		0			0							0
Reduced v/c Ratio		0.37			0.59							0.54

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 13 (11%), Referenced to phase 4:SBTL, Start of Green
 Natural Cycle: 55
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.90
 Intersection Signal Delay: 14.6
 Intersection Capacity Utilization 55.5%
 Analysis Period (min) 15

Intersection LOS: B
 ICU Level of Service B

Splits and Phases: 455: W 14th



Lanes, Volumes, Timings
456: N Durham Dr & W 19th St

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	129	87	54	131	0	0	0	0	69	2038	33
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1755	0	0	1835	0	0	0	0	0	6382	0
Flt Permitted					0.816						0.998	
Satd. Flow (perm)	0	1755	0	0	1520	0	0	0	0	0	6382	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)												9
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		618			668			633			368	
Travel Time (s)		14.0			15.2			12.3			7.2	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.79	0.70	0.71	0.78	0.93	0.93	0.93	0.93	0.75	0.89	0.82
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	287	0	0	244	0	0	0	0	0	2422	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		4			8						6	
Permitted Phases				8						6		
Detector Phase		4		8	8					6	6	
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0					4.0	4.0	
Minimum Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (%)		50.0%		50.0%	50.0%					50.0%	50.0%	
Yellow Time (s)		3.5		3.5	3.5					3.5	3.5	
All-Red Time (s)		1.5		1.5	1.5					1.5	1.5	
Lost Time Adjust (s)		0.0			0.0						0.0	
Total Lost Time (s)		5.0			5.0						5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max		Max	Max					Max	Max	
Act Effect Green (s)		15.0			15.0						15.0	
Actuated g/C Ratio		0.38			0.38						0.38	
v/c Ratio		0.44			0.43						1.01	
Control Delay		12.0			20.4						26.7	
Queue Delay		0.0			0.0						0.0	
Total Delay		12.0			20.4						26.7	
LOS		B			C						C	

Lanes, Volumes, Timings
 456: N Durham Dr & W 19th St

11/26/2017

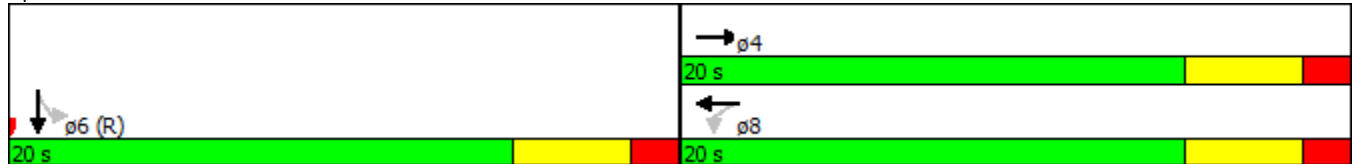


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		12.0			20.4							26.7
Approach LOS		B			C							C
Queue Length 50th (ft)		45			58							~103
Queue Length 95th (ft)		76			97							m98
Internal Link Dist (ft)		538			588			553				288
Turn Bay Length (ft)												
Base Capacity (vph)		658			570							2398
Starvation Cap Reductn		0			0							0
Spillback Cap Reductn		0			0							0
Storage Cap Reductn		0			0							0
Reduced v/c Ratio		0.44			0.43							1.01

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 45
 Control Type: Pretimed
 Maximum v/c Ratio: 1.01
 Intersection Signal Delay: 24.7
 Intersection LOS: C
 Intersection Capacity Utilization 65.6%
 ICU Level of Service C
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 456: N Durham Dr & W 19th St



Lanes, Volumes, Timings
457: N Durham Dr & W 20th St

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	121	39	83	179	0	0	0	0	88	2047	131
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1790	0	0	1833	0	0	0	0	0	6331	0
Flt Permitted					0.827						0.998	
Satd. Flow (perm)	0	1790	0	0	1540	0	0	0	0	0	6331	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)												42
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		582			183			368			1486	
Travel Time (s)		13.2			4.2			7.2			28.9	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.82	0.65	0.83	0.84	0.93	0.93	0.93	0.93	0.81	0.92	0.80
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	208	0	0	313	0	0	0	0	0	2498	0
Turn Type		NA		Perm	NA						Perm	NA
Protected Phases		4			8							6
Permitted Phases				8							6	
Detector Phase		4		8	8						6	6
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0						4.0	4.0
Minimum Split (s)		20.0		20.0	20.0						20.0	20.0
Total Split (s)		20.0		20.0	20.0						20.0	20.0
Total Split (%)		50.0%		50.0%	50.0%						50.0%	50.0%
Yellow Time (s)		3.5		3.5	3.5						3.5	3.5
All-Red Time (s)		1.5		1.5	1.5						1.5	1.5
Lost Time Adjust (s)		0.0			0.0							0.0
Total Lost Time (s)		5.0			5.0							5.0
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max		Max	Max						Max	Max
Act Effect Green (s)		15.0			15.0							15.0
Actuated g/C Ratio		0.38			0.38							0.38
v/c Ratio		0.31			0.54							1.04
Control Delay		10.5			22.8							39.5
Queue Delay		0.0			0.0							0.0
Total Delay		10.5			22.8							39.5
LOS		B			C							D

Lanes, Volumes, Timings
457: N Durham Dr & W 20th St

11/26/2017

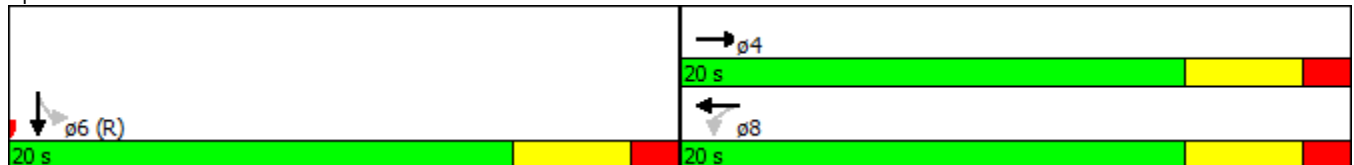


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		10.5			22.8							39.5
Approach LOS		B			C							D
Queue Length 50th (ft)		31			71							~205
Queue Length 95th (ft)		59			122							m#222
Internal Link Dist (ft)		502			103			288				1406
Turn Bay Length (ft)												
Base Capacity (vph)		671			577							2400
Starvation Cap Reductn		0			0							0
Spillback Cap Reductn		0			0							0
Storage Cap Reductn		0			0							0
Reduced v/c Ratio		0.31			0.54							1.04

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 50
 Control Type: Pretimed
 Maximum v/c Ratio: 1.04
 Intersection Signal Delay: 35.8
 Intersection LOS: D
 Intersection Capacity Utilization 68.4%
 ICU Level of Service C
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 457: N Durham Dr & W 20th St



Lanes, Volumes, Timings
458: N Durham Dr & W 24th St

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	18	47	36	17	0	0	0	0	23	2152	33
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1667	0	0	1807	0	0	0	0	0	6382	0
Flt Permitted					0.801						0.999	
Satd. Flow (perm)	0	1667	0	0	1492	0	0	0	0	0	6382	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)												10
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		555			660			1486			1120	
Travel Time (s)		12.6			15.0			28.9			21.8	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.75	0.56	0.69	0.53	0.93	0.93	0.93	0.93	0.82	0.96	0.75
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	108	0	0	84	0	0	0	0	0	2314	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		4			8						6	
Permitted Phases				8						6		
Detector Phase		4		8	8					6	6	
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0					4.0	4.0	
Minimum Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (%)		50.0%		50.0%	50.0%					50.0%	50.0%	
Yellow Time (s)		3.5		3.5	3.5					3.5	3.5	
All-Red Time (s)		1.5		1.5	1.5					1.5	1.5	
Lost Time Adjust (s)		0.0			0.0						0.0	
Total Lost Time (s)		5.0			5.0						5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max		Max	Max					Max	Max	
Act Effect Green (s)		15.0			15.0						15.0	
Actuated g/C Ratio		0.38			0.38						0.38	
v/c Ratio		0.17			0.15						0.96	
Control Delay		9.3			11.3						17.5	
Queue Delay		0.0			0.0						0.0	
Total Delay		9.3			11.3						17.5	
LOS		A			B						B	

Lanes, Volumes, Timings
458: N Durham Dr & W 24th St

11/26/2017

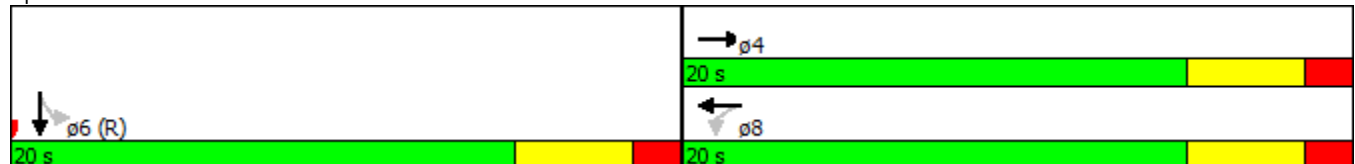


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		9.3			11.3							17.5
Approach LOS		A			B							B
Queue Length 50th (ft)		15			10							144
Queue Length 95th (ft)		31			16							m#244
Internal Link Dist (ft)		475			580			1406				1040
Turn Bay Length (ft)												
Base Capacity (vph)		625			559							2399
Starvation Cap Reductn		0			0							0
Spillback Cap Reductn		0			0							0
Storage Cap Reductn		0			0							0
Reduced v/c Ratio		0.17			0.15							0.96

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 45
 Control Type: Pretimed
 Maximum v/c Ratio: 0.96
 Intersection Signal Delay: 16.9
 Intersection LOS: B
 Intersection Capacity Utilization 50.0%
 ICU Level of Service A
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 458: N Durham Dr & W 24th St



Lanes, Volumes, Timings
459: N Durham Dr & IH 610 EBFR

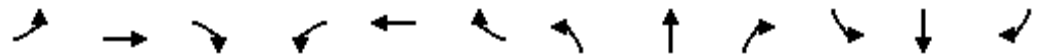
11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑								↘	↑↑↑↑	
Volume (vph)	0	768	231	0	0	0	0	0	0	561	1989	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	4897	0	0	0	0	0	0	0	1770	6408	0
Flt Permitted										0.950		
Satd. Flow (perm)	0	4897	0	0	0	0	0	0	0	1770	6408	0
Right Turn on Red			Yes			Yes			Yes	Yes		Yes
Satd. Flow (RTOR)										55		
Link Speed (mph)		45			10			30				30
Link Distance (ft)		410			526			607				264
Travel Time (s)		6.2			35.9			13.8				6.0
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.85	0.79	0.93	0.93	0.93	0.93	0.93	0.93	0.89	0.97	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	1196	0	0	0	0	0	0	0	630	2051	0
Turn Type		NA								Perm	NA	
Protected Phases		4									6	
Permitted Phases										6		
Detector Phase		4								6	6	
Switch Phase												
Minimum Initial (s)		4.0								4.0	4.0	
Minimum Split (s)		20.0								20.0	20.0	
Total Split (s)		20.0								20.0	20.0	
Total Split (%)		50.0%								50.0%	50.0%	
Yellow Time (s)		3.5								3.5	3.5	
All-Red Time (s)		1.5								1.5	1.5	
Lost Time Adjust (s)		0.0								0.0	0.0	
Total Lost Time (s)		5.0								5.0	5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max								Max	Max	
Act Effct Green (s)		15.0								15.0	15.0	
Actuated g/C Ratio		0.38								0.38	0.38	
v/c Ratio		0.65								0.90	0.85	
Control Delay		12.4								16.3	11.9	
Queue Delay		0.0								1.5	0.0	
Total Delay		12.4								17.8	11.9	
LOS		B								B	B	

Lanes, Volumes, Timings
 459: N Durham Dr & IH 610 EBFR

11/26/2017

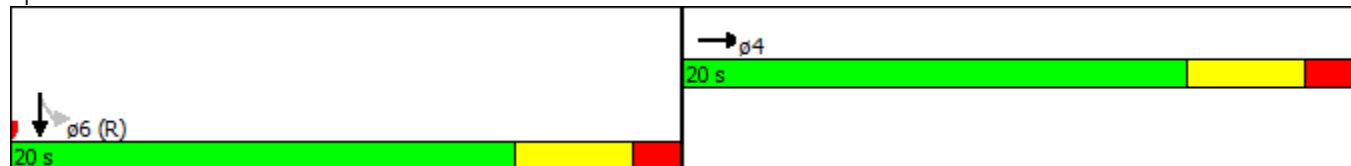


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		12.4										13.3
Approach LOS		B										B
Queue Length 50th (ft)		76								89	93	
Queue Length 95th (ft)		101								m89	m86	
Internal Link Dist (ft)		330			446			527				184
Turn Bay Length (ft)												
Base Capacity (vph)		1836								698	2403	
Starvation Cap Reductn		0								16	0	
Spillback Cap Reductn		0								0	0	
Storage Cap Reductn		0								0	0	
Reduced v/c Ratio		0.65								0.92	0.85	

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 50
 Control Type: Pretimed
 Maximum v/c Ratio: 0.90
 Intersection Signal Delay: 13.0 Intersection LOS: B
 Intersection Capacity Utilization 73.0% ICU Level of Service C
 Analysis Period (min) 15
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 459: N Durham Dr & IH 610 EBFR



Lanes, Volumes, Timings
460: N Durham Dr & IH 610 WBFR

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	666	535	0	0	0	0	0	1963	800
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	1610	3333	0	0	0	0	0	6126	0
Flt Permitted				0.950	0.983							
Satd. Flow (perm)	0	0	0	1610	3333	0	0	0	0	0	6126	0
Right Turn on Red			Yes	Yes		Yes			Yes			Yes
Satd. Flow (RTOR)				55	55							135
Link Speed (mph)		45			45			35				35
Link Distance (ft)		407			398			264				706
Travel Time (s)		6.2			6.0			5.1				13.8
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.88	0.90	0.93	0.93	0.93	0.93	0.93	0.96	0.95
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)				42%								
Lane Group Flow (vph)	0	0	0	439	912	0	0	0	0	0	2887	0
Turn Type				Perm	NA							NA
Protected Phases					8							6
Permitted Phases				8								
Detector Phase				8	8							6
Switch Phase												
Minimum Initial (s)				4.0	4.0							4.0
Minimum Split (s)				20.0	20.0							20.0
Total Split (s)				20.0	20.0							20.0
Total Split (%)				50.0%	50.0%							50.0%
Yellow Time (s)				3.5	3.5							3.5
All-Red Time (s)				1.5	1.5							1.5
Lost Time Adjust (s)				0.0	0.0							0.0
Total Lost Time (s)				5.0	5.0							5.0
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode				Max	Max							Max
Act Effect Green (s)				15.0	15.0							15.0
Actuated g/C Ratio				0.38	0.38							0.38
v/c Ratio				0.69	0.71							1.21
Control Delay				12.6	9.7							116.8
Queue Delay				0.0	0.0							0.1
Total Delay				12.6	9.7							116.9
LOS				B	A							F

Lanes, Volumes, Timings
 460: N Durham Dr & IH 610 WBFR

11/26/2017

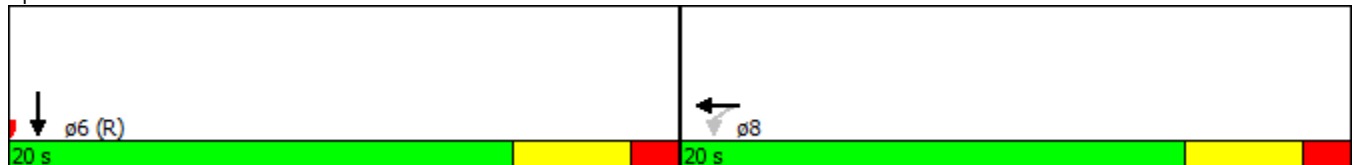


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					10.6							116.9
Approach LOS					B							F
Queue Length 50th (ft)				23	48							~244
Queue Length 95th (ft)				m#103	98							#315
Internal Link Dist (ft)		327			318			184				626
Turn Bay Length (ft)												
Base Capacity (vph)				638	1284							2381
Starvation Cap Reductn				0	0							0
Spillback Cap Reductn				0	0							110
Storage Cap Reductn				0	0							0
Reduced v/c Ratio				0.69	0.71							1.27

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBT, Start of Green
 Natural Cycle: 60
 Control Type: Pretimed
 Maximum v/c Ratio: 1.21
 Intersection Signal Delay: 83.0 Intersection LOS: F
 Intersection Capacity Utilization 73.0% ICU Level of Service C
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 460: N Durham Dr & IH 610 WBFR



Lanes, Volumes, Timings
461: Shepherd & Washington

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	29	698	0	0	532	109	264	868	75	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	90		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1770	3539	0	0	3416	0	0	6280	0	0	0	0
Flt Permitted	0.950							0.989				
Satd. Flow (perm)	1770	3539	0	0	3416	0	0	6280	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					19			16				
Link Speed (mph)		30			30			30				30
Link Distance (ft)		322			1068			522				252
Travel Time (s)		7.3			24.3			11.9				5.7
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	5	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	30	720	0	0	660	0	0	1244	0	0	0	0
Turn Type	Prot	NA			NA		Perm	NA				
Protected Phases	5	2			6			8				
Permitted Phases							8					
Detector Phase	5	2			6		8	8				
Switch Phase												
Minimum Initial (s)	5.0	10.0			10.0		10.0	10.0				
Minimum Split (s)	10.0	21.0			21.0		18.0	18.0				
Total Split (s)	20.0	55.0			35.0		65.0	65.0				
Total Split (%)	16.7%	45.8%			29.2%		54.2%	54.2%				
Yellow Time (s)	3.6	3.6			3.6		3.6	3.6				
All-Red Time (s)	1.4	1.4			1.4		1.4	1.4				
Lost Time Adjust (s)	0.0	0.0			0.0			0.0				
Total Lost Time (s)	5.0	5.0			5.0			5.0				
Lead/Lag	Lead				Lag							
Lead-Lag Optimize?	Yes				Yes							
Recall Mode	Max	Max			Max		C-Max	C-Max				
Act Effct Green (s)	15.0	50.0			30.0			60.0				
Actuated g/C Ratio	0.12	0.42			0.25			0.50				
v/c Ratio	0.14	0.49			0.76			0.40				
Control Delay	70.4	17.0			52.3			32.4				
Queue Delay	0.0	0.7			0.0			0.0				
Total Delay	70.4	17.7			52.3			32.4				
LOS	E	B			D			C				

Lanes, Volumes, Timings
461: Shepherd & Washington

11/26/2017

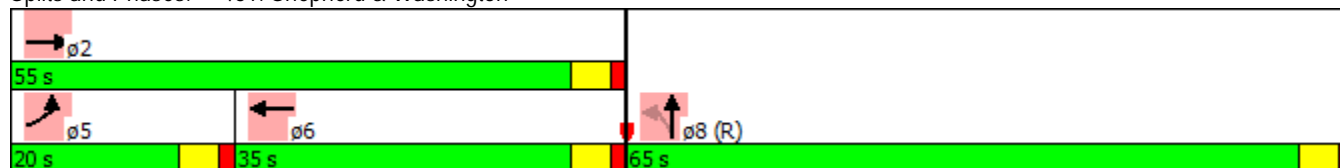


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		19.8			52.3			32.4				
Approach LOS		B			D			C				
Queue Length 50th (ft)	25	106			254			255				
Queue Length 95th (ft)	m36	168			m319			297				
Internal Link Dist (ft)		242			988			442			172	
Turn Bay Length (ft)	90											
Base Capacity (vph)	221	1474			868			3148				
Starvation Cap Reductn	0	406			0			0				
Spillback Cap Reductn	0	0			0			82				
Storage Cap Reductn	0	0			0			0				
Reduced v/c Ratio	0.14	0.67			0.76			0.41				

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 0 (0%), Referenced to phase 8:NBTL, Start of Green
 Natural Cycle: 50
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.76
 Intersection Signal Delay: 33.8
 Intersection LOS: C
 Intersection Capacity Utilization 71.6%
 ICU Level of Service C
 Analysis Period (min) 15
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 461: Shepherd & Washington



Lanes, Volumes, Timings
462: Shepherd & Center

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕↕↕				
Volume (vph)	30	24	0	0	18	28	9	1011	17	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1820	0	0	1730	0	0	6382	0	0	0	0
Flt Permitted		0.858						0.999				
Satd. Flow (perm)	0	1598	0	0	1730	0	0	6382	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					40			6				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		320			502			252				2176
Travel Time (s)		7.3			11.4			4.9				42.4
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.83	0.60	0.93	0.93	0.50	0.70	0.56	0.93	0.71	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	76	0	0	76	0	0	1127	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4						2					
Detector Phase	4	4			8		2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (s)	42.0	42.0			42.0		78.0	78.0				
Total Split (%)	35.0%	35.0%			35.0%		65.0%	65.0%				
Yellow Time (s)	3.5	3.5			3.5		3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5		1.5	1.5				
Lost Time Adjust (s)		0.0			0.0			0.0				
Total Lost Time (s)		5.0			5.0			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max		Max	Max				
Act Effct Green (s)		37.0			37.0			73.0				
Actuated g/C Ratio		0.31			0.31			0.61				
v/c Ratio		0.15			0.14			0.29				
Control Delay		29.8			16.7			3.1				
Queue Delay		0.0			0.0			0.2				
Total Delay		29.8			16.7			3.2				
LOS		C			B			A				

Lanes, Volumes, Timings
462: Shepherd & Center

11/26/2017

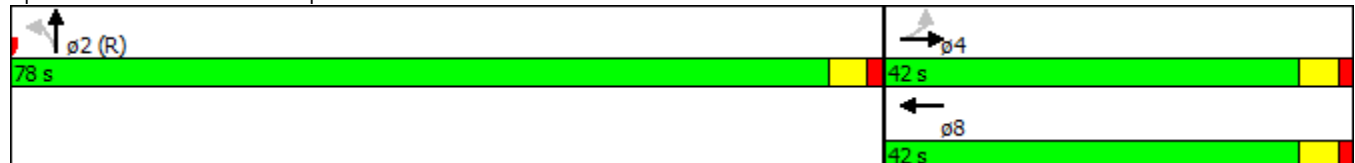


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		29.8			16.7			3.2				
Approach LOS		C			B			A				
Queue Length 50th (ft)		47			20			34				
Queue Length 95th (ft)		55			21			41				
Internal Link Dist (ft)		240			422			172			2096	
Turn Bay Length (ft)												
Base Capacity (vph)		492			561			3884				
Starvation Cap Reductn		0			0			1570				
Spillback Cap Reductn		0			0			0				
Storage Cap Reductn		0			0			0				
Reduced v/c Ratio		0.15			0.14			0.49				

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
Natural Cycle:	40
Control Type:	Pretimed
Maximum v/c Ratio:	0.29
Intersection Signal Delay:	5.6
Intersection LOS:	A
Intersection Capacity Utilization	33.0%
ICU Level of Service	A
Analysis Period (min)	15

Splits and Phases: 462: Shepherd & Center



Lanes, Volumes, Timings
463: Shepherd & IH10 - EBFR

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	412	463	0	0	0	0	0	985	131	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1610	3356	0	0	0	0	0	6286	0	0	0	0
Flt Permitted	0.950	0.990										
Satd. Flow (perm)	1610	3356	0	0	0	0	0	6286	0	0	0	0
Right Turn on Red	Yes		Yes			Yes			Yes			Yes
Satd. Flow (RTOR)	64	64						34				
Link Speed (mph)		40			40			35				35
Link Distance (ft)		306			534			2176				316
Travel Time (s)		5.2			9.1			42.4				6.2
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.95	0.89	0.93	0.93	0.93	0.93	0.93	0.89	0.80	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	3	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)	29%											
Lane Group Flow (vph)	308	646	0	0	0	0	0	1271	0	0	0	0
Turn Type	Perm	NA						NA				
Protected Phases		4 12						2				
Permitted Phases	4 12											
Detector Phase	4 12	4 12						2				
Switch Phase												
Minimum Initial (s)								4.0				
Minimum Split (s)								21.0				
Total Split (s)								47.0				
Total Split (%)								39.2%				
Yellow Time (s)								3.5				
All-Red Time (s)								1.5				
Lost Time Adjust (s)								0.0				
Total Lost Time (s)								5.0				
Lead/Lag								Lead				
Lead-Lag Optimize?								Yes				
Recall Mode								C-Max				
Act Effct Green (s)	67.8	67.8						42.2				
Actuated g/C Ratio	0.56	0.56						0.35				
v/c Ratio	0.33	0.34						0.57				
Control Delay	5.9	6.9						32.4				
Queue Delay	0.9	0.5						0.0				
Total Delay	6.8	7.4						32.4				
LOS	A	A						C				

Lanes, Volumes, Timings
 463: Shepherd & IH10 - EBFR

11/26/2017

Lane Group	ø4	ø5	ø6	ø8	ø12	ø16
Lane Configurations						
Volume (vph)						
Ideal Flow (vphpl)						
Lane Width (ft)						
Grade (%)						
Storage Length (ft)						
Storage Lanes						
Taper Length (ft)						
Satd. Flow (prot)						
Flt Permitted						
Satd. Flow (perm)						
Right Turn on Red						
Satd. Flow (RTOR)						
Link Speed (mph)						
Link Distance (ft)						
Travel Time (s)						
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor						
Growth Factor						
Heavy Vehicles (%)						
Bus Blockages (#/hr)						
Parking (#/hr)						
Mid-Block Traffic (%)						
Shared Lane Traffic (%)						
Lane Group Flow (vph)						
Turn Type						
Protected Phases	4	5	6	8	12	16
Permitted Phases						
Detector Phase						
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	20.0	21.0	20.0	20.0
Total Split (s)	28.0	54.0	20.0	25.0	45.0	21.0
Total Split (%)	23%	45%	17%	21%	38%	18%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)						
Total Lost Time (s)						
Lead/Lag	Lag	Lag	Lead	Lag		Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes		Yes
Recall Mode	Max	None	None	None	None	None
Act Effct Green (s)						
Actuated g/C Ratio						
v/c Ratio						
Control Delay						
Queue Delay						
Total Delay						
LOS						

Lanes, Volumes, Timings
 463: Shepherd & IH10 - EBFR

11/26/2017

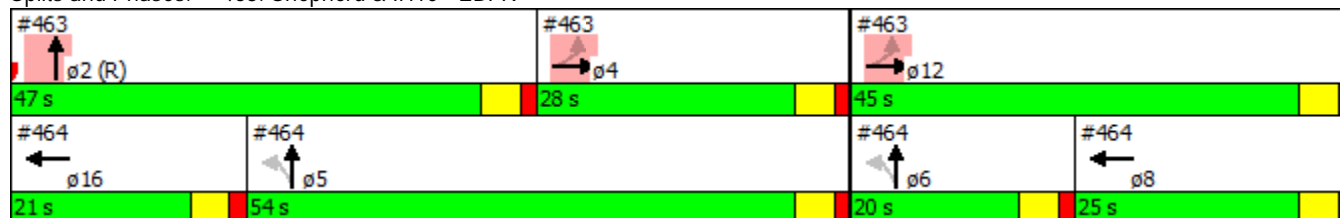


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		7.2						32.4				
Approach LOS		A						C				
Queue Length 50th (ft)	34	42						151				
Queue Length 95th (ft)	m51	60						187				
Internal Link Dist (ft)		226			454			2096			236	
Turn Bay Length (ft)												
Base Capacity (vph)	940	1929						2230				
Starvation Cap Reductn	375	806						0				
Spillback Cap Reductn	0	0						87				
Storage Cap Reductn	0	0						0				
Reduced v/c Ratio	0.55	0.58						0.59				

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	17 (14%), Referenced to phase 2:NBT, Start of Green
Natural Cycle:	85
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	0.62
Intersection Signal Delay:	21.6
Intersection LOS:	C
Intersection Capacity Utilization:	41.3%
ICU Level of Service:	A
Analysis Period (min):	15
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 463: Shepherd & IH10 - EBFR



Lane Group	ø4	ø5	ø6	ø8	ø12	ø16
Approach Delay						
Approach LOS						
Queue Length 50th (ft)						
Queue Length 95th (ft)						
Internal Link Dist (ft)						
Turn Bay Length (ft)						
Base Capacity (vph)						
Starvation Cap Reductn						
Spillback Cap Reductn						
Storage Cap Reductn						
Reduced v/c Ratio						
Intersection Summary						

Lanes, Volumes, Timings
464: Shepherd & IH10 - WBFR

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑↑↑			↑↑↑				
Volume (vph)	0	0	0	0	595	229	472	940	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	0	4867	0	0	6299	0	0	0	0
Flt Permitted								0.983				
Satd. Flow (perm)	0	0	0	0	4867	0	0	6299	0	0	0	0
Right Turn on Red			Yes			Yes	Yes		Yes			Yes
Satd. Flow (RTOR)					92			78				
Link Speed (mph)		40			40			35			35	
Link Distance (ft)		310			534			316			3871	
Travel Time (s)		5.3			9.1			6.2			75.4	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.93	0.88	0.84	0.87	0.93	0.93	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	0	949	0	0	1554	0	0	0	0
Turn Type					NA		Perm	NA				
Protected Phases					8 16			5 6				
Permitted Phases							5 6					
Detector Phase					8 16		5 6	5 6				
Switch Phase												
Minimum Initial (s)												
Minimum Split (s)												
Total Split (s)												
Total Split (%)												
Yellow Time (s)												
All-Red Time (s)												
Lost Time Adjust (s)												
Total Lost Time (s)												
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode												
Act Effct Green (s)					36.1			73.9				
Actuated g/C Ratio					0.30			0.62				
v/c Ratio					0.62			0.40				
Control Delay					34.1			6.9				
Queue Delay					0.1			0.6				
Total Delay					34.2			7.5				
LOS					C			A				

Lanes, Volumes, Timings
 464: Shepherd & IH10 - WBFR

11/26/2017

Lane Group	ø2	ø4	ø5	ø6	ø8	ø12	ø16
Lane Configurations							
Volume (vph)							
Ideal Flow (vphpl)							
Lane Width (ft)							
Grade (%)							
Storage Length (ft)							
Storage Lanes							
Taper Length (ft)							
Satd. Flow (prot)							
Flt Permitted							
Satd. Flow (perm)							
Right Turn on Red							
Satd. Flow (RTOR)							
Link Speed (mph)							
Link Distance (ft)							
Travel Time (s)							
Confl. Peds. (#/hr)							
Confl. Bikes (#/hr)							
Peak Hour Factor							
Growth Factor							
Heavy Vehicles (%)							
Bus Blockages (#/hr)							
Parking (#/hr)							
Mid-Block Traffic (%)							
Shared Lane Traffic (%)							
Lane Group Flow (vph)							
Turn Type							
Protected Phases	2	4	5	6	8	12	16
Permitted Phases							
Detector Phase							
Switch Phase							
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	21.0	20.0	21.0	20.0	20.0
Total Split (s)	47.0	28.0	54.0	20.0	25.0	45.0	21.0
Total Split (%)	39%	23%	45%	17%	21%	38%	18%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)							
Total Lost Time (s)							
Lead/Lag	Lead	Lag	Lag	Lead	Lag		Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes		Yes
Recall Mode	C-Max	Max	None	None	None	None	None
Act Effct Green (s)							
Actuated g/C Ratio							
v/c Ratio							
Control Delay							
Queue Delay							
Total Delay							
LOS							

Lanes, Volumes, Timings
464: Shepherd & IH10 - WBFR

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					34.2			7.5				
Approach LOS					C			A				
Queue Length 50th (ft)					213			159				
Queue Length 95th (ft)					234			201				
Internal Link Dist (ft)		230			454			236			3791	
Turn Bay Length (ft)												
Base Capacity (vph)					1728			3922				
Starvation Cap Reductn					0			1811				
Spillback Cap Reductn					132			117				
Storage Cap Reductn					0			0				
Reduced v/c Ratio					0.59			0.74				

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	17 (14%), Referenced to phase 2:NBT, Start of Green
Natural Cycle:	85
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	0.62
Intersection Signal Delay:	17.7
Intersection LOS:	B
Intersection Capacity Utilization	51.1%
ICU Level of Service	A
Analysis Period (min)	15

Splits and Phases: 464: Shepherd & IH10 - WBFR

#463 ↑ ø2 (R) 47 s	#463 → ø4 28 s	#463 → ø12 45 s
#464 ← ø16 21 s	#464 ↑ ø5 54 s	#464 ↑ ø6 20 s
		#464 ← ø8 25 s

Lane Group	ø2	ø4	ø5	ø6	ø8	ø12	ø16
Approach Delay							
Approach LOS							
Queue Length 50th (ft)							
Queue Length 95th (ft)							
Internal Link Dist (ft)							
Turn Bay Length (ft)							
Base Capacity (vph)							
Starvation Cap Reductn							
Spillback Cap Reductn							
Storage Cap Reductn							
Reduced v/c Ratio							
Intersection Summary							

Lanes, Volumes, Timings
465: W 11th

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↖	↑↑			↑↑			↑↑↑				
Volume (vph)	107	468	1	0	534	99	187	793	92	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	50		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1770	3536	0	0	3468	0	0	6261	0	0	0	0
Flt Permitted	0.188							0.991				
Satd. Flow (perm)	350	3536	0	0	3468	0	0	6261	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		1			23			23				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		536			448			700				2008
Travel Time (s)		12.2			10.2			13.6				39.1
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.81	0.87	0.25	0.93	0.76	0.92	0.79	0.86	0.74	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	132	542	0	0	811	0	0	1283	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		2			6			8				
Permitted Phases	2						8					
Detector Phase	2	2			6		8	8				
Switch Phase												
Minimum Initial (s)	7.0	7.0			5.0		7.0	7.0				
Minimum Split (s)	21.2	21.2			21.2		21.0	21.0				
Total Split (s)	73.0	73.0			73.0		47.0	47.0				
Total Split (%)	60.8%	60.8%			60.8%		39.2%	39.2%				
Yellow Time (s)	3.6	3.6			3.6		3.6	3.6				
All-Red Time (s)	1.6	1.6			1.6		1.4	1.4				
Lost Time Adjust (s)	0.0	0.0			0.0			0.0				
Total Lost Time (s)	5.2	5.2			5.2			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	None	None			None		C-Max	C-Max				
Act Effct Green (s)	41.8	41.8			41.8			68.0				
Actuated g/C Ratio	0.35	0.35			0.35			0.57				
v/c Ratio	1.09	0.44			0.66			0.36				
Control Delay	139.4	32.8			34.0			6.8				
Queue Delay	0.0	0.0			0.0			0.0				
Total Delay	139.4	32.8			34.0			6.8				
LOS	F	C			C			A				

Lanes, Volumes, Timings
465: W 11th

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		53.7			34.0			6.8				
Approach LOS		D			C			A				
Queue Length 50th (ft)	~110	156			281			73				
Queue Length 95th (ft)	m#82	91			202			103				
Internal Link Dist (ft)		456			368			620			1928	
Turn Bay Length (ft)	50											
Base Capacity (vph)	197	1998			1969			3560				
Starvation Cap Reductn	0	0			0			0				
Spillback Cap Reductn	0	0			0			0				
Storage Cap Reductn	0	0			0			0				
Reduced v/c Ratio	0.67	0.27			0.41			0.36				

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 14 (12%), Referenced to phase 8:NBTL, Start of Green
 Natural Cycle: 45
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.09
 Intersection Signal Delay: 26.2
 Intersection LOS: C
 Intersection Capacity Utilization 52.6%
 ICU Level of Service A
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 465: W 11th



Lanes, Volumes, Timings
466: W 14th

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕↕↕				
Volume (vph)	31	58	0	0	93	31	35	896	36	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1833	0	0	1799	0	0	6350	0	0	0	0
Flt Permitted		0.632						0.998				
Satd. Flow (perm)	0	1177	0	0	1799	0	0	6350	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					22			9				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		488			473			2008				644
Travel Time (s)		11.1			10.8			39.1				12.5
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.78	0.69	0.93	0.93	0.86	0.86	0.73	0.87	0.69	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	124	0	0	144	0	0	1130	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		2			6			8				
Permitted Phases	2						8					
Detector Phase	2	2			6		8	8				
Switch Phase												
Minimum Initial (s)	11.0	11.0			11.0		11.0	11.0				
Minimum Split (s)	45.0	45.0			45.0		40.0	40.0				
Total Split (s)	70.0	70.0			70.0		50.0	50.0				
Total Split (%)	58.3%	58.3%			58.3%		41.7%	41.7%				
Yellow Time (s)	3.5	3.5			3.5		3.2	3.2				
All-Red Time (s)	1.7	1.7			1.7		1.8	1.8				
Lost Time Adjust (s)		0.0			0.0			0.0				
Total Lost Time (s)		5.2			5.2			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	None	None			None		C-Max	C-Max				
Act Effct Green (s)		15.1			15.1			94.7				
Actuated g/C Ratio		0.13			0.13			0.79				
v/c Ratio		0.84			0.59			0.23				
Control Delay		93.6			51.0			5.8				
Queue Delay		0.0			0.0			0.0				
Total Delay		93.6			51.0			5.8				
LOS		F			D			A				

Lanes, Volumes, Timings

466: W 14th

11/26/2017

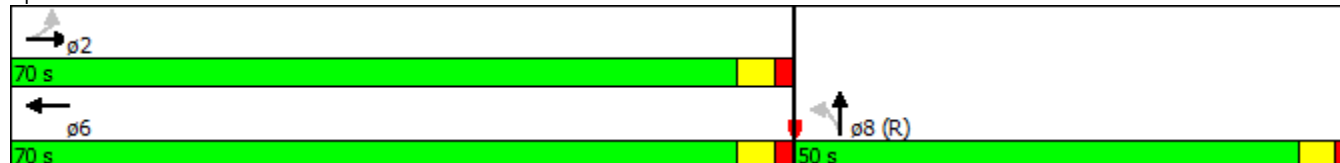


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		93.6			51.0			5.8				
Approach LOS		F			D			A				
Queue Length 50th (ft)		98			91			60				
Queue Length 95th (ft)		120			143			123				
Internal Link Dist (ft)		408			393			1928			564	
Turn Bay Length (ft)												
Base Capacity (vph)		635			981			5013				
Starvation Cap Reductn		0			0			0				
Spillback Cap Reductn		0			0			0				
Storage Cap Reductn		0			0			0				
Reduced v/c Ratio		0.20			0.15			0.23				

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	20 (17%), Referenced to phase 8:NBTL, Start of Green
Natural Cycle:	85
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	0.84
Intersection Signal Delay:	18.3
Intersection LOS:	B
Intersection Capacity Utilization	45.3%
ICU Level of Service	A
Analysis Period (min)	15

Splits and Phases: 466: W 14th



Lanes, Volumes, Timings
467: N Shepherd Dr & W 19th St

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↔			↑	↗		↔↔↔↔				
Volume (vph)	35	130	0	0	130	60	43	954	35	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		85	0		0	0		0	0		0
Storage Lanes	0		1	0		1	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3500	0	0	1863	1583	0	6357	0	0	0	0
Flt Permitted		0.873						0.998				
Satd. Flow (perm)	0	3090	0	0	1863	1583	0	6357	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						55		22				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		668			574			1789				375
Travel Time (s)		15.2			13.0			34.9				7.3
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.73	0.76	0.93	0.93	0.85	0.79	0.77	0.92	0.80	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	219	0	0	153	76	0	1137	0	0	0	0
Turn Type	Perm	NA			NA	Perm	Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4					8	2					
Detector Phase	4	4			8	8	2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0	4.0	4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0	20.0	20.0	20.0				
Total Split (s)	20.0	20.0			20.0	20.0	20.0	20.0				
Total Split (%)	50.0%	50.0%			50.0%	50.0%	50.0%	50.0%				
Yellow Time (s)	3.5	3.5			3.5	3.5	3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5	1.5	1.5	1.5				
Lost Time Adjust (s)		0.0			0.0	0.0		0.0				
Total Lost Time (s)		5.0			5.0	5.0		5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max	Max	Max	Max				
Act Effect Green (s)		15.0			15.0	15.0		15.0				
Actuated g/C Ratio		0.38			0.38	0.38		0.38				
v/c Ratio		0.19			0.22	0.12		0.47				
Control Delay		14.5			9.6	4.7		10.1				
Queue Delay		0.0			0.0	0.0		0.0				
Total Delay		14.5			9.6	4.7		10.1				
LOS		B			A	A		B				

Lanes, Volumes, Timings
 467: N Shepherd Dr & W 19th St

11/26/2017

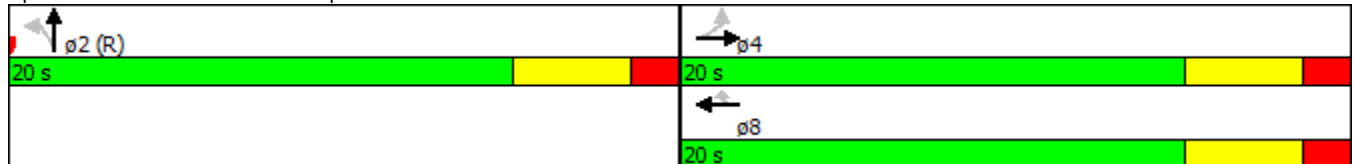


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		14.5			8.0			10.1				
Approach LOS		B			A			B				
Queue Length 50th (ft)		21			22	3		51				
Queue Length 95th (ft)		m29			46	16		73				
Internal Link Dist (ft)		588			494			1709			295	
Turn Bay Length (ft)												
Base Capacity (vph)		1158			698	628		2397				
Starvation Cap Reductn		0			0	0		0				
Spillback Cap Reductn		0			0	0		0				
Storage Cap Reductn		0			0	0		0				
Reduced v/c Ratio		0.19			0.22	0.12		0.47				

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
 Natural Cycle: 40
 Control Type: Pretimed
 Maximum v/c Ratio: 0.47
 Intersection Signal Delay: 10.4
 Intersection LOS: B
 Intersection Capacity Utilization 39.0%
 ICU Level of Service A
 Analysis Period (min) 15
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 467: N Shepherd Dr & W 19th St



Lanes, Volumes, Timings
468: N Shepherd Dr & W 20th St

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↔			↔↔			↔↔↔				
Volume (vph)	43	187	0	0	195	56	34	962	68	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		100	0		0	0		0	0		0
Storage Lanes	0		1	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3507	0	0	3394	0	0	6331	0	0	0	0
Flt Permitted		0.848						0.998				
Satd. Flow (perm)	0	3001	0	0	3394	0	0	6331	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					25			41				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		140			536			375				1478
Travel Time (s)		3.2			12.2			7.3				28.8
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.77	0.77	0.93	0.93	0.87	0.67	0.61	0.92	0.90	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	299	0	0	308	0	0	1178	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4						2					
Detector Phase	4	4			8		2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (%)	50.0%	50.0%			50.0%		50.0%	50.0%				
Yellow Time (s)	3.5	3.5			3.5		3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5		1.5	1.5				
Lost Time Adjust (s)		0.0			0.0			0.0				
Total Lost Time (s)		5.0			5.0			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max		Max	Max				
Act Effct Green (s)		15.0			15.0			15.0				
Actuated g/C Ratio		0.38			0.38			0.38				
v/c Ratio		0.27			0.24			0.49				
Control Delay		13.6			8.5			5.3				
Queue Delay		0.0			0.0			0.0				
Total Delay		13.6			8.5			5.3				
LOS		B			A			A				

Lanes, Volumes, Timings
468: N Shepherd Dr & W 20th St

11/26/2017

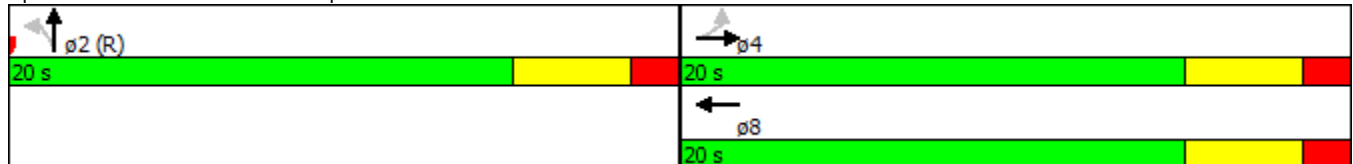


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		13.6			8.5			5.3				
Approach LOS		B			A			A				
Queue Length 50th (ft)		26			21			22				
Queue Length 95th (ft)		m35			38			32				
Internal Link Dist (ft)		60			456			295			1398	
Turn Bay Length (ft)												
Base Capacity (vph)		1125			1288			2399				
Starvation Cap Reductn		0			0			0				
Spillback Cap Reductn		0			0			0				
Storage Cap Reductn		0			0			0				
Reduced v/c Ratio		0.27			0.24			0.49				

Intersection Summary

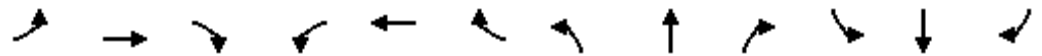
Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
 Natural Cycle: 40
 Control Type: Pretimed
 Maximum v/c Ratio: 0.49
 Intersection Signal Delay: 7.3
 Intersection LOS: A
 Intersection Capacity Utilization 41.7%
 ICU Level of Service A
 Analysis Period (min) 15
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 468: N Shepherd Dr & W 20th St



Lanes, Volumes, Timings
469: N Shepherd Dr & W 24th St

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	17	7	0	0	29	24	25	1126	7	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1809	0	0	1753	0	0	6382	0	0	0	0
Flt Permitted		0.857						0.998				
Satd. Flow (perm)	0	1596	0	0	1753	0	0	6382	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					11			6				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		660			543			1478				1697
Travel Time (s)		15.0			12.3			28.8				33.1
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.71	0.44	0.93	0.93	0.81	0.86	0.57	0.89	0.44	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	40	0	0	64	0	0	1325	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4						2					
Detector Phase	4	4			8		2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (%)	50.0%	50.0%			50.0%		50.0%	50.0%				
Yellow Time (s)	3.5	3.5			3.5		3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5		1.5	1.5				
Lost Time Adjust (s)		0.0			0.0			0.0				
Total Lost Time (s)		5.0			5.0			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max		Max	Max				
Act Effct Green (s)		15.0			15.0			15.0				
Actuated g/C Ratio		0.38			0.38			0.38				
v/c Ratio		0.07			0.10			0.55				
Control Delay		11.0			7.6			8.1				
Queue Delay		0.0			0.0			0.0				
Total Delay		11.0			7.6			8.1				
LOS		B			A			A				

Lanes, Volumes, Timings
 469: N Shepherd Dr & W 24th St

11/26/2017

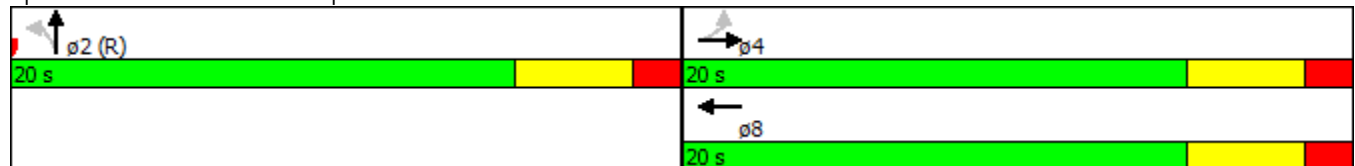


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		11.0			7.6			8.1				
Approach LOS		B			A			A				
Queue Length 50th (ft)		5			7			51				
Queue Length 95th (ft)		m6			21			96				
Internal Link Dist (ft)		580			463			1398			1617	
Turn Bay Length (ft)												
Base Capacity (vph)		598			664			2397				
Starvation Cap Reductn		0			0			0				
Spillback Cap Reductn		0			0			0				
Storage Cap Reductn		0			0			0				
Reduced v/c Ratio		0.07			0.10			0.55				

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
 Natural Cycle: 40
 Control Type: Pretimed
 Maximum v/c Ratio: 0.55
 Intersection Signal Delay: 8.2
 Intersection LOS: A
 Intersection Capacity Utilization 33.1%
 ICU Level of Service A
 Analysis Period (min) 15
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 469: N Shepherd Dr & W 24th St



Lanes, Volumes, Timings
470: N Shepherd Dr & IH 610 EBFR

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	456	878	0	0	0	0	0	860	303	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1610	3373	0	0	0	0	0	6139	0	0	0	0
Flt Permitted	0.950	0.995										
Satd. Flow (perm)	1610	3373	0	0	0	0	0	6139	0	0	0	0
Right Turn on Red	Yes		Yes			Yes			Yes			Yes
Satd. Flow (RTOR)	55	55						35				
Link Speed (mph)		45			45			35				35
Link Distance (ft)		526			314			1697				251
Travel Time (s)		8.0			4.8			33.1				4.9
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.76	0.92	0.93	0.93	0.93	0.93	0.93	0.89	0.82	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)	16%											
Lane Group Flow (vph)	504	1050	0	0	0	0	0	1336	0	0	0	0
Turn Type	Perm	NA						NA				
Protected Phases		4						2				
Permitted Phases	4											
Detector Phase	4	4						2				
Switch Phase												
Minimum Initial (s)	4.0	4.0						4.0				
Minimum Split (s)	20.0	20.0						20.0				
Total Split (s)	20.0	20.0						20.0				
Total Split (%)	50.0%	50.0%						50.0%				
Yellow Time (s)	3.5	3.5						3.5				
All-Red Time (s)	1.5	1.5						1.5				
Lost Time Adjust (s)	0.0	0.0						0.0				
Total Lost Time (s)	5.0	5.0						5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max						Max				
Act Effct Green (s)	15.0	15.0						15.0				
Actuated g/C Ratio	0.38	0.38						0.38				
v/c Ratio	0.79	0.81						0.57				
Control Delay	16.9	13.2						7.5				
Queue Delay	0.0	0.0						0.0				
Total Delay	16.9	13.2						7.5				
LOS	B	B						A				

Lanes, Volumes, Timings
470: N Shepherd Dr & IH 610 EBFR

11/26/2017

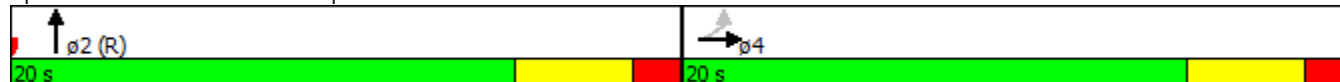


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		14.4						7.5				
Approach LOS		B						A				
Queue Length 50th (ft)	65	75						92				
Queue Length 95th (ft)	m116	m#130						123				
Internal Link Dist (ft)		446			234			1617			171	
Turn Bay Length (ft)												
Base Capacity (vph)	638	1299						2324				
Starvation Cap Reductn	0	0						0				
Spillback Cap Reductn	0	0						0				
Storage Cap Reductn	0	0						0				
Reduced v/c Ratio	0.79	0.81						0.57				

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2:NBT and 6:, Start of Green
 Natural Cycle: 45
 Control Type: Pretimed
 Maximum v/c Ratio: 0.81
 Intersection Signal Delay: 11.2
 Intersection LOS: B
 Intersection Capacity Utilization 50.9%
 ICU Level of Service A
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 470: N Shepherd Dr & IH 610 EBFR



Lanes, Volumes, Timings
471: N Shepherd Dr & IH 610 WBFR

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑↑↑		↖	↑↑↑				
Volume (vph)	0	0	0	0	817	369	336	972	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	1		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	0	4846	0	1433	6017	0	0	0	0
Flt Permitted							0.950	0.997				
Satd. Flow (perm)	0	0	0	0	4846	0	1433	6017	0	0	0	0
Right Turn on Red			Yes			Yes	Yes		Yes			Yes
Satd. Flow (RTOR)					16		55	55				
Link Speed (mph)		45			45			35				35
Link Distance (ft)		398			334			251				1261
Travel Time (s)		6.0			5.1			4.9				24.6
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.93	0.95	0.93	0.93	0.84	0.93	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)							19%					
Lane Group Flow (vph)	0	0	0	0	1257	0	292	1226	0	0	0	0
Turn Type					NA		Perm	NA				
Protected Phases					8			2				
Permitted Phases							2					
Detector Phase					8		2	2				
Switch Phase												
Minimum Initial (s)					4.0		4.0	4.0				
Minimum Split (s)					20.0		20.0	20.0				
Total Split (s)					20.0		20.0	20.0				
Total Split (%)					50.0%		50.0%	50.0%				
Yellow Time (s)					3.5		3.5	3.5				
All-Red Time (s)					1.5		1.5	1.5				
Lost Time Adjust (s)					0.0		0.0	0.0				
Total Lost Time (s)					5.0		5.0	5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode					Max		Max	Max				
Act Effct Green (s)					15.0		15.0	15.0				
Actuated g/C Ratio					0.38		0.38	0.38				
v/c Ratio					0.69		0.51	0.54				
Control Delay					12.7		5.8	4.8				
Queue Delay					0.0		0.0	0.0				
Total Delay					12.7		5.9	4.8				
LOS					B		A	A				

Lanes, Volumes, Timings
 471: N Shepherd Dr & IH 610 WBFR

11/26/2017

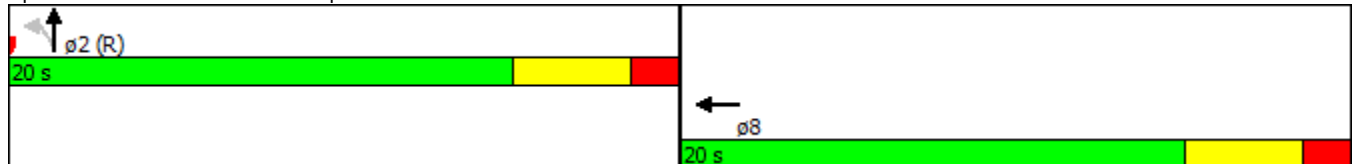


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					12.7			5.0				
Approach LOS					B			A				
Queue Length 50th (ft)					80		6	10				
Queue Length 95th (ft)					117		m50	47				
Internal Link Dist (ft)		318			254			171			1181	
Turn Bay Length (ft)												
Base Capacity (vph)					1827		571	2290				
Starvation Cap Reductn					0		5	0				
Spillback Cap Reductn					0		0	0				
Storage Cap Reductn					0		0	0				
Reduced v/c Ratio					0.69		0.52	0.54				

Intersection Summary

Area Type:	Other
Cycle Length:	40
Actuated Cycle Length:	40
Offset:	0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
Natural Cycle:	40
Control Type:	Pretimed
Maximum v/c Ratio:	0.69
Intersection Signal Delay:	8.5
Intersection LOS:	A
Intersection Capacity Utilization	73.0%
ICU Level of Service	C
Analysis Period (min)	15
m	Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 471: N Shepherd Dr & IH 610 WBFR



Existing PM Peak



Lanes, Volumes, Timings

450: Durham & Washington

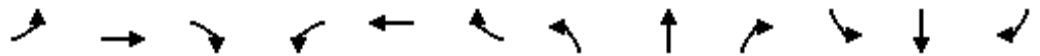
11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑		↖	↑↑						↑↑↑	
Volume (vph)	0	544	239	110	1070	0	0	0	0	231	984	59
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	150		0	0		0	0		0
Storage Lanes	0		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3376	0	1770	3539	0	0	0	0	0	6306	0
Flt Permitted				0.950							0.991	
Satd. Flow (perm)	0	3376	0	1770	3539	0	0	0	0	0	6306	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		59									10	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		2207			322			520			238	
Travel Time (s)		50.2			7.3			11.8			5.4	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	816	0	115	1115	0	0	0	0	0	1327	0
Turn Type		NA		Prot	NA					Perm	NA	
Protected Phases		2		1	6						4	
Permitted Phases										4		
Detector Phase		2		1	6					4	4	
Switch Phase												
Minimum Initial (s)		10.0		5.0	10.0					10.0	10.0	
Minimum Split (s)		21.0		10.0	21.0					18.0	18.0	
Total Split (s)		40.0		25.0	65.0					55.0	55.0	
Total Split (%)		33.3%		20.8%	54.2%					45.8%	45.8%	
Yellow Time (s)		3.6		3.6	3.6					3.6	3.6	
All-Red Time (s)		1.4		1.4	1.4					1.4	1.4	
Lost Time Adjust (s)		0.0		0.0	0.0						0.0	
Total Lost Time (s)		5.0		5.0	5.0						5.0	
Lead/Lag		Lag		Lead								
Lead-Lag Optimize?		Yes		Yes								
Recall Mode		Max		None	Max					C-Max	C-Max	
Act Effect Green (s)		41.9		13.1	60.0						50.0	
Actuated g/C Ratio		0.35		0.11	0.50						0.42	
v/c Ratio		0.67		0.60	0.63						0.50	
Control Delay		27.7		55.9	22.1						31.5	
Queue Delay		0.0		0.0	47.3						0.0	
Total Delay		27.7		55.9	69.5						31.5	
LOS		C		E	E						C	

Lanes, Volumes, Timings
450: Durham & Washington

11/26/2017

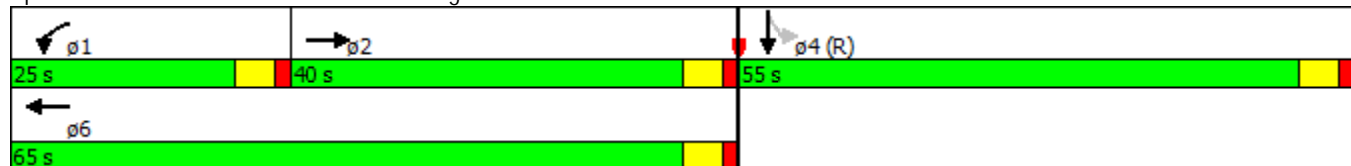


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		27.7			68.2							31.5
Approach LOS		C			E							C
Queue Length 50th (ft)		161		94	275							186
Queue Length 95th (ft)		411		m103	352							227
Internal Link Dist (ft)		2127			242			440				158
Turn Bay Length (ft)				150								
Base Capacity (vph)		1218		295	1769							2633
Starvation Cap Reductn		0		0	750							0
Spillback Cap Reductn		0		0	0							0
Storage Cap Reductn		0		0	0							0
Reduced v/c Ratio		0.67		0.39	1.09							0.50

Intersection Summary

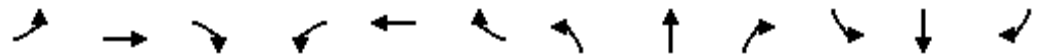
Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	0 (0%), Referenced to phase 4:SBTL, Start of Green
Natural Cycle:	50
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	0.67
Intersection Signal Delay:	44.0
Intersection LOS:	D
Intersection Capacity Utilization:	105.5%
ICU Level of Service:	G
Analysis Period (min):	15
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 450: Durham & Washington



Lanes, Volumes, Timings
451: Durham & Center

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	49	24	27	45	0	0	0	0	42	1310	21
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1760	0	0	1829	0	0	0	0	0	6369	0
Flt Permitted					0.982						0.998	
Satd. Flow (perm)	0	1760	0	0	1829	0	0	0	0	0	6369	0
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		534			320			238			2187	
Travel Time (s)		12.1			7.3			4.6			42.6	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.77	0.55	0.75	0.75	0.93	0.93	0.93	0.93	0.66	0.88	0.52
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	108	0	0	96	0	0	0	0	0	1593	0
Sign Control		Stop			Stop			Stop			Free	

Intersection Summary

Area Type:	Other
Control Type:	Unsignalized
Intersection Capacity Utilization	37.2%
ICU Level of Service	A
Analysis Period (min)	15

Lanes, Volumes, Timings
452: Durham & IH10 - EBFR

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑									←↑↑↑	
Volume (vph)	0	865	347	0	0	0	0	0	0	234	1005	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	4846	0	0	0	0	0	0	0	0	6350	0
Flt Permitted											0.991	
Satd. Flow (perm)	0	4846	0	0	0	0	0	0	0	0	6350	0
Right Turn on Red			Yes			Yes			Yes	Yes		Yes
Satd. Flow (RTOR)		91										64
Link Speed (mph)		40			40				35			35
Link Distance (ft)		594			306				2187			312
Travel Time (s)		10.1			5.2				42.6			6.1
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.83	0.93	0.93	0.93	0.93	0.93	0.93	0.86	0.87	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	1348	0	0	0	0	0	0	0	0	1427	0
Turn Type		NA								Perm	NA	
Protected Phases		4 12										1 2
Permitted Phases											1 2	
Detector Phase		4 12									1 2	1 2
Switch Phase												
Minimum Initial (s)												
Minimum Split (s)												
Total Split (s)												
Total Split (%)												
Yellow Time (s)												
All-Red Time (s)												
Lost Time Adjust (s)												
Total Lost Time (s)												
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode												
Act Effct Green (s)		36.0									74.0	
Actuated g/C Ratio		0.30									0.62	
v/c Ratio		0.89									0.36	
Control Delay		45.7									8.3	
Queue Delay		0.0									0.6	
Total Delay		45.7									8.9	
LOS		D									A	

Lane Group	ø1	ø2	ø4	ø6	ø8	ø12	ø16
Lane Configurations							
Volume (vph)							
Ideal Flow (vphpl)							
Lane Width (ft)							
Grade (%)							
Storage Length (ft)							
Storage Lanes							
Taper Length (ft)							
Satd. Flow (prot)							
Flt Permitted							
Satd. Flow (perm)							
Right Turn on Red							
Satd. Flow (RTOR)							
Link Speed (mph)							
Link Distance (ft)							
Travel Time (s)							
Confl. Peds. (#/hr)							
Confl. Bikes (#/hr)							
Peak Hour Factor							
Growth Factor							
Heavy Vehicles (%)							
Bus Blockages (#/hr)							
Parking (#/hr)							
Mid-Block Traffic (%)							
Shared Lane Traffic (%)							
Lane Group Flow (vph)							
Turn Type							
Protected Phases	1	2	4	6	8	12	16
Permitted Phases							
Detector Phase							
Switch Phase							
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	21.0	21.0	21.0	20.0	20.0
Total Split (s)	58.0	21.0	21.0	57.0	21.0	20.0	42.0
Total Split (%)	48%	18%	18%	48%	18%	17%	35%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)							
Total Lost Time (s)							
Lead/Lag	Lag	Lead	Lag	Lead	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	
Recall Mode	None	Max	None	C-Max	Max	None	None
Act Effct Green (s)							
Actuated g/C Ratio							
v/c Ratio							
Control Delay							
Queue Delay							
Total Delay							
LOS							

Lanes, Volumes, Timings
452: Durham & IH10 - EBFR

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		45.7										8.9
Approach LOS		D										A
Queue Length 50th (ft)		343										235
Queue Length 95th (ft)		407										216
Internal Link Dist (ft)		514			226			2107				232
Turn Bay Length (ft)												
Base Capacity (vph)		1517										3940
Starvation Cap Reductn		0										1922
Spillback Cap Reductn		0										0
Storage Cap Reductn		0										0
Reduced v/c Ratio		0.89										0.71

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	94 (78%), Referenced to phase 6:SBT, Start of Green
Natural Cycle:	85
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	0.89
Intersection Signal Delay:	26.8
Intersection LOS:	C
Intersection Capacity Utilization:	50.9%
ICU Level of Service:	A
Analysis Period (min):	15

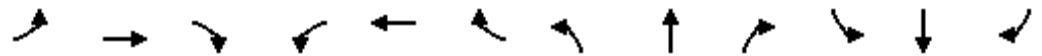
Splits and Phases: 452: Durham & IH10 - EBFR

#452 ↓ ϕ2 21 s	#452 → ϕ4 21 s	#452 → ϕ12 20 s	#452 ↓ ϕ1 58 s
#453 ← ϕ16 42 s	#453 ↓ ϕ6 (R) 57 s	#453 ← ϕ8 21 s	

Lane Group	ø1	ø2	ø4	ø6	ø8	ø12	ø16
Approach Delay							
Approach LOS							
Queue Length 50th (ft)							
Queue Length 95th (ft)							
Internal Link Dist (ft)							
Turn Bay Length (ft)							
Base Capacity (vph)							
Starvation Cap Reductn							
Spillback Cap Reductn							
Storage Cap Reductn							
Reduced v/c Ratio							
Intersection Summary							

Lanes, Volumes, Timings
453: Durham & IH10 - WBFR

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑↑↑						↑↑↑	
Volume (vph)	0	0	0	193	955	0	0	0	0	0	1099	425
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	0	5040	0	0	0	0	0	6145	0
Flt Permitted					0.991							
Satd. Flow (perm)	0	0	0	0	5040	0	0	0	0	0	6145	0
Right Turn on Red			Yes	Yes		Yes			Yes			Yes
Satd. Flow (RTOR)					64						62	
Link Speed (mph)		40			40			35			35	
Link Distance (ft)		575			310			312			2613	
Travel Time (s)		9.8			5.3			6.1			50.9	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.80	0.92	0.93	0.93	0.93	0.93	0.93	0.92	0.94
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	0	1279	0	0	0	0	0	1647	0
Turn Type				Perm	NA						NA	
Protected Phases					8 16						6	
Permitted Phases				8 16								
Detector Phase				8 16	8 16						6	
Switch Phase												
Minimum Initial (s)											4.0	
Minimum Split (s)											21.0	
Total Split (s)											57.0	
Total Split (%)											47.5%	
Yellow Time (s)											3.5	
All-Red Time (s)											1.5	
Lost Time Adjust (s)											0.0	
Total Lost Time (s)											5.0	
Lead/Lag											Lead	
Lead-Lag Optimize?											Yes	
Recall Mode											C-Max	
Act Effct Green (s)					58.0						52.0	
Actuated g/C Ratio					0.48						0.43	
v/c Ratio					0.52						0.61	
Control Delay					18.1						23.1	
Queue Delay					4.9						0.2	
Total Delay					23.0						23.3	
LOS					C						C	

Lanes, Volumes, Timings
453: Durham & IH10 - WBFR

11/26/2017

Lane Group	ø1	ø2	ø4	ø8	ø12	ø16
Lane Configurations						
Volume (vph)						
Ideal Flow (vphpl)						
Lane Width (ft)						
Grade (%)						
Storage Length (ft)						
Storage Lanes						
Taper Length (ft)						
Satd. Flow (prot)						
Flt Permitted						
Satd. Flow (perm)						
Right Turn on Red						
Satd. Flow (RTOR)						
Link Speed (mph)						
Link Distance (ft)						
Travel Time (s)						
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor						
Growth Factor						
Heavy Vehicles (%)						
Bus Blockages (#/hr)						
Parking (#/hr)						
Mid-Block Traffic (%)						
Shared Lane Traffic (%)						
Lane Group Flow (vph)						
Turn Type						
Protected Phases	1	2	4	8	12	16
Permitted Phases						
Detector Phase						
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	21.0	21.0	20.0	20.0
Total Split (s)	58.0	21.0	21.0	21.0	20.0	42.0
Total Split (%)	48%	18%	18%	18%	17%	35%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)						
Total Lost Time (s)						
Lead/Lag	Lag	Lead	Lag	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	
Recall Mode	None	Max	None	Max	None	None
Act Effct Green (s)						
Actuated g/C Ratio						
v/c Ratio						
Control Delay						
Queue Delay						
Total Delay						
LOS						

Lanes, Volumes, Timings
 453: Durham & IH10 - WBFR

11/26/2017

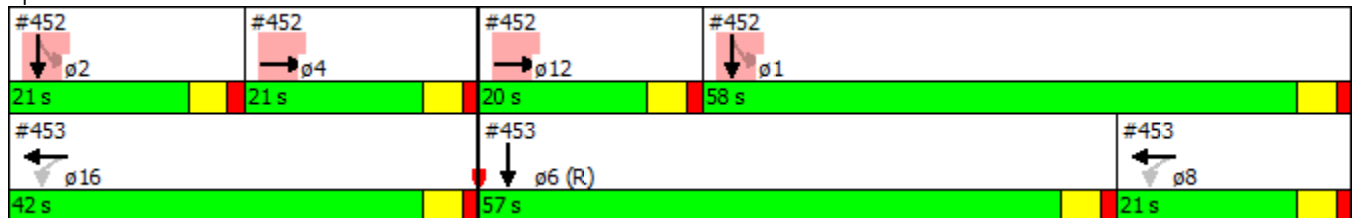


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					23.0							23.3
Approach LOS					C							C
Queue Length 50th (ft)					187							207
Queue Length 95th (ft)					252							m207
Internal Link Dist (ft)		495			230			232				2533
Turn Bay Length (ft)												
Base Capacity (vph)					2469							2697
Starvation Cap Reductn					1107							0
Spillback Cap Reductn					0							266
Storage Cap Reductn					0							0
Reduced v/c Ratio					0.94							0.68

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 94 (78%), Referenced to phase 6:SBT, Start of Green
 Natural Cycle: 85
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.89
 Intersection Signal Delay: 23.1
 Intersection LOS: C
 Intersection Capacity Utilization 53.8%
 ICU Level of Service A
 Analysis Period (min) 15
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 453: Durham & IH10 - WBFR



Lane Group	ø1	ø2	ø4	ø8	ø12	ø16
Approach Delay						
Approach LOS						
Queue Length 50th (ft)						
Queue Length 95th (ft)						
Internal Link Dist (ft)						
Turn Bay Length (ft)						
Base Capacity (vph)						
Starvation Cap Reductn						
Spillback Cap Reductn						
Storage Cap Reductn						
Reduced v/c Ratio						
Intersection Summary						

Lanes, Volumes, Timings
454: W 11th

11/26/2017

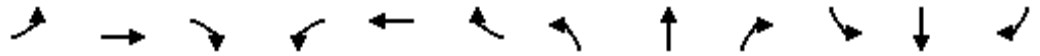


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑	↑	↑	↑↑						↑↑↑	
Volume (vph)	0	822	179	165	741	0	0	0	0	269	1047	115
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		150	50		0	0		0	0		0
Storage Lanes	0		1	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3380	1441	1770	3539	0	0	0	0	0	6261	0
Flt Permitted				0.147							0.990	
Satd. Flow (perm)	0	3380	1441	274	3539	0	0	0	0	0	6261	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		2	47									24
Link Speed (mph)		30			30			35				35
Link Distance (ft)		421			536			1925			2048	
Travel Time (s)		9.6			12.2			37.5			39.9	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.87	0.90	0.84	0.95	0.93	0.93	0.93	0.93	0.85	0.90	0.85
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)			10%									
Lane Group Flow (vph)	0	965	179	196	780	0	0	0	0	0	1614	0
Turn Type		NA	Perm	Perm	NA					Perm	NA	
Protected Phases		2			6							4
Permitted Phases			2	6						4		
Detector Phase		2	2	6	6					4	4	
Switch Phase												
Minimum Initial (s)		10.0	10.0	10.0	10.0					10.0	10.0	
Minimum Split (s)		21.2	21.2	21.2	21.2					21.3	21.3	
Total Split (s)		55.0	55.0	55.0	55.0					65.0	65.0	
Total Split (%)		45.8%	45.8%	45.8%	45.8%					54.2%	54.2%	
Yellow Time (s)		3.6	3.6	3.6	3.6					3.6	3.6	
All-Red Time (s)		1.6	1.6	1.6	1.6					1.7	1.7	
Lost Time Adjust (s)		0.0	0.0	0.0	0.0						0.0	
Total Lost Time (s)		5.2	5.2	5.2	5.2						5.3	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		None	None	None	None					C-Max	C-Max	
Act Effect Green (s)		49.8	49.8	49.8	49.8						59.7	
Actuated g/C Ratio		0.42	0.42	0.42	0.42						0.50	
v/c Ratio		0.69	0.29	1.73	0.53						0.52	
Control Delay		31.8	18.3	384.4	27.5						20.2	
Queue Delay		0.0	0.0	0.0	0.0						0.0	
Total Delay		31.8	18.3	384.4	27.5						20.2	
LOS		C	B	F	C						C	

Lanes, Volumes, Timings

454: W 11th

11/26/2017

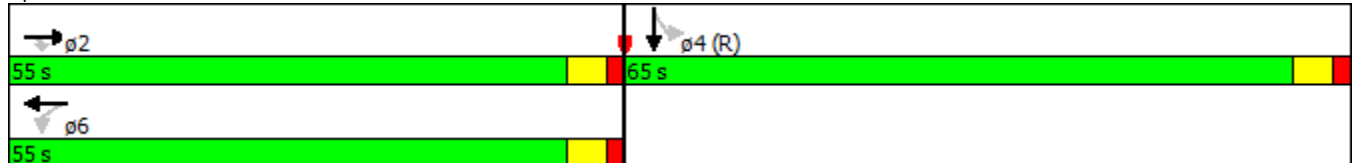


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		29.7			99.2							20.2
Approach LOS		C			F							C
Queue Length 50th (ft)		330	71	~216	286							159
Queue Length 95th (ft)		389	131	m#275	m322							247
Internal Link Dist (ft)		341			456			1845				1968
Turn Bay Length (ft)			150	50								
Base Capacity (vph)		1403	625	113	1468							3126
Starvation Cap Reductn		0	0	0	0							0
Spillback Cap Reductn		0	0	0	0							0
Storage Cap Reductn		0	0	0	0							0
Reduced v/c Ratio		0.69	0.29	1.73	0.53							0.52

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 15 (13%), Referenced to phase 4:SBTL, Start of Green
 Natural Cycle: 55
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.73
 Intersection Signal Delay: 43.7
 Intersection LOS: D
 Intersection Capacity Utilization 68.0%
 ICU Level of Service C
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 454: W 11th



Lanes, Volumes, Timings
455: W 14th

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↖			↗						↖↗↘↙	
Volume (vph)	0	23	90	94	37	0	0	0	0	61	2231	15
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1650	0	0	1794	0	0	0	0	0	6395	0
Flt Permitted					0.521						0.999	
Satd. Flow (perm)	0	1650	0	0	970	0	0	0	0	0	6395	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		4										2
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		332			488			2048			157	
Travel Time (s)		7.5			11.1			39.9			3.1	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.86	0.60	0.64	0.86	0.93	0.93	0.93	0.93	0.93	0.88	0.75
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	177	0	0	190	0	0	0	0	0	2621	0
Turn Type		NA		Perm	NA						Perm	NA
Protected Phases		2			6							4
Permitted Phases				6							4	
Detector Phase		2		6	6						4	4
Switch Phase												
Minimum Initial (s)		11.0		11.0	11.0					11.0	11.0	
Minimum Split (s)		22.7		20.7	20.7					21.1	21.1	
Total Split (s)		39.0		39.0	39.0					81.0	81.0	
Total Split (%)		32.5%		32.5%	32.5%					67.5%	67.5%	
Yellow Time (s)		3.2		3.2	3.2					3.6	3.6	
All-Red Time (s)		1.5		1.5	1.5					1.5	1.5	
Lost Time Adjust (s)		0.0			0.0						0.0	
Total Lost Time (s)		4.7			4.7						5.1	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		None		None	None					C-Max	C-Max	
Act Effect Green (s)		26.0			26.0							84.2
Actuated g/C Ratio		0.22			0.22							0.70
v/c Ratio		0.49			0.90							0.58
Control Delay		43.5			71.2							10.5
Queue Delay		0.0			0.0							0.0
Total Delay		43.5			71.2							10.5
LOS		D			E							B

Lanes, Volumes, Timings

455: W 14th

11/26/2017

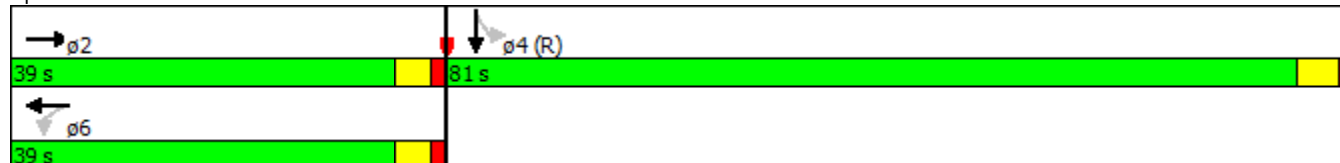


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		43.5			71.2							10.5
Approach LOS		D			E							B
Queue Length 50th (ft)		117			141							273
Queue Length 95th (ft)		164			208							362
Internal Link Dist (ft)		252			408			1968				77
Turn Bay Length (ft)												
Base Capacity (vph)		474			277							4487
Starvation Cap Reductn		0			0							0
Spillback Cap Reductn		0			0							0
Storage Cap Reductn		0			0							0
Reduced v/c Ratio		0.37			0.69							0.58

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	13 (11%), Referenced to phase 4:SBTL, Start of Green
Natural Cycle:	55
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	0.90
Intersection Signal Delay:	16.3
Intersection LOS:	B
Intersection Capacity Utilization	55.5%
ICU Level of Service	B
Analysis Period (min)	15

Splits and Phases: 455: W 14th



Lanes, Volumes, Timings
456: N Durham Dr & W 19th St

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	246	76	76	176	0	0	0	0	121	1294	44
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1799	0	0	1837	0	0	0	0	0	6331	0
Flt Permitted					0.809						0.995	
Satd. Flow (perm)	0	1799	0	0	1507	0	0	0	0	0	6331	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		5										26
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		618			668			633			368	
Travel Time (s)		14.0			15.2			12.3			7.2	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.95	0.86	0.91	0.81	0.93	0.93	0.93	0.93	0.72	0.90	0.58
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	347	0	0	301	0	0	0	0	0	1682	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		4			8						6	
Permitted Phases				8						6		
Detector Phase		4		8	8					6	6	
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0					4.0	4.0	
Minimum Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (%)		50.0%		50.0%	50.0%					50.0%	50.0%	
Yellow Time (s)		3.5		3.5	3.5					3.5	3.5	
All-Red Time (s)		1.5		1.5	1.5					1.5	1.5	
Lost Time Adjust (s)		0.0			0.0						0.0	
Total Lost Time (s)		5.0			5.0						5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max		Max	Max					Max	Max	
Act Effect Green (s)		15.0			15.0						15.0	
Actuated g/C Ratio		0.38			0.38						0.38	
v/c Ratio		0.51			0.53						0.70	
Control Delay		12.8			20.4						8.7	
Queue Delay		0.0			0.0						0.0	
Total Delay		12.8			20.4						8.7	
LOS		B			C						A	

Lanes, Volumes, Timings
 456: N Durham Dr & W 19th St

11/26/2017

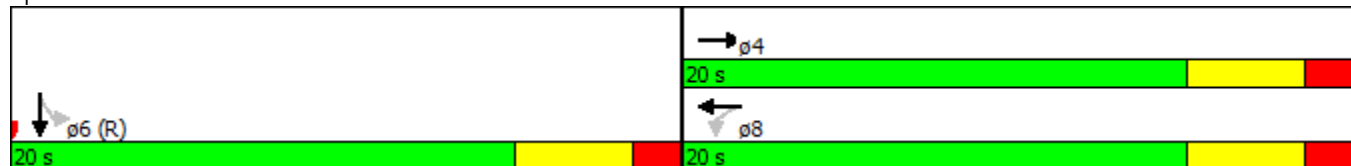


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		12.8			20.4							8.7
Approach LOS		B			C							A
Queue Length 50th (ft)		56			63							47
Queue Length 95th (ft)		110			m93							82
Internal Link Dist (ft)		538			588			553				288
Turn Bay Length (ft)												
Base Capacity (vph)		677			565							2390
Starvation Cap Reductn		0			0							0
Spillback Cap Reductn		0			0							0
Storage Cap Reductn		0			0							0
Reduced v/c Ratio		0.51			0.53							0.70

Intersection Summary

Area Type:	Other
Cycle Length:	40
Actuated Cycle Length:	40
Offset:	0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
Natural Cycle:	40
Control Type:	Pretimed
Maximum v/c Ratio:	0.70
Intersection Signal Delay:	10.8
Intersection LOS:	B
Intersection Capacity Utilization:	64.9%
ICU Level of Service:	C
Analysis Period (min):	15
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 456: N Durham Dr & W 19th St



Lanes, Volumes, Timings
457: N Durham Dr & W 20th St

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↗			↖						↖↗↘↙	
Volume (vph)	0	303	42	80	183	0	0	0	0	116	1371	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1824	0	0	1833	0	0	0	0	0	6331	0
Flt Permitted					0.710						0.996	
Satd. Flow (perm)	0	1824	0	0	1323	0	0	0	0	0	6331	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		4										35
Link Speed (mph)		30			30			35				35
Link Distance (ft)		582			183			368			1486	
Travel Time (s)		13.2			4.2			7.2			28.9	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.92	0.70	0.77	0.82	0.93	0.93	0.93	0.93	0.81	0.90	0.90
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	389	0	0	327	0	0	0	0	0	1766	0
Turn Type		NA		Perm	NA						Perm	NA
Protected Phases		4			8							6
Permitted Phases				8							6	
Detector Phase		4		8	8						6	6
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0					4.0	4.0	
Minimum Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (%)		50.0%		50.0%	50.0%					50.0%	50.0%	
Yellow Time (s)		3.5		3.5	3.5					3.5	3.5	
All-Red Time (s)		1.5		1.5	1.5					1.5	1.5	
Lost Time Adjust (s)		0.0			0.0						0.0	
Total Lost Time (s)		5.0			5.0						5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max		Max	Max					Max	Max	
Act Effect Green (s)		15.0			15.0							15.0
Actuated g/C Ratio		0.38			0.38							0.38
v/c Ratio		0.57			0.66							0.74
Control Delay		13.8			28.9							11.9
Queue Delay		0.0			0.0							0.0
Total Delay		13.8			28.9							11.9
LOS		B			C							B

Lanes, Volumes, Timings
457: N Durham Dr & W 20th St

11/26/2017

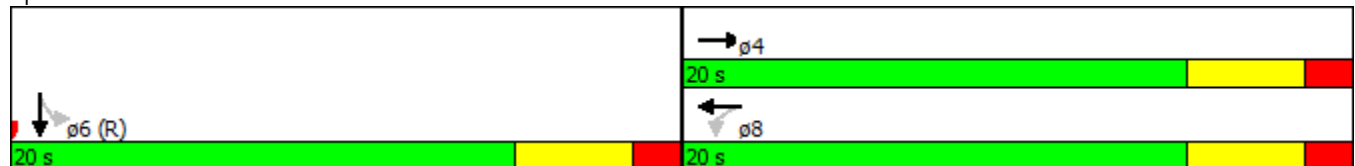


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		13.8			28.9							11.9
Approach LOS		B			C							B
Queue Length 50th (ft)		65			0							131
Queue Length 95th (ft)		125			m0							163
Internal Link Dist (ft)		502			103			288				1406
Turn Bay Length (ft)												
Base Capacity (vph)		686			496							2396
Starvation Cap Reductn		0			0							0
Spillback Cap Reductn		0			0							0
Storage Cap Reductn		0			0							0
Reduced v/c Ratio		0.57			0.66							0.74

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 40
 Control Type: Pretimed
 Maximum v/c Ratio: 0.74
 Intersection Signal Delay: 14.5
 Intersection LOS: B
 Intersection Capacity Utilization 68.2%
 ICU Level of Service C
 Analysis Period (min) 15
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 457: N Durham Dr & W 20th St



Lanes, Volumes, Timings
458: N Durham Dr & W 24th St

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	39	42	60	53	0	0	0	0	32	1520	39
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1732	0	0	1818	0	0	0	0	0	6357	0
Flt Permitted					0.826						0.998	
Satd. Flow (perm)	0	1732	0	0	1539	0	0	0	0	0	6357	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		3										23
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		555			660			1486			1120	
Travel Time (s)		12.6			15.0			28.9			21.8	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.75	0.75	0.94	0.78	0.93	0.93	0.93	0.93	0.57	0.95	0.57
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	108	0	0	132	0	0	0	0	0	1724	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		4			8						6	
Permitted Phases				8						6		
Detector Phase		4		8	8					6	6	
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0					4.0	4.0	
Minimum Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (%)		50.0%		50.0%	50.0%					50.0%	50.0%	
Yellow Time (s)		3.5		3.5	3.5					3.5	3.5	
All-Red Time (s)		1.5		1.5	1.5					1.5	1.5	
Lost Time Adjust (s)		0.0			0.0						0.0	
Total Lost Time (s)		5.0			5.0						5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max		Max	Max					Max	Max	
Act Effect Green (s)		15.0			15.0						15.0	
Actuated g/C Ratio		0.38			0.38						0.38	
v/c Ratio		0.17			0.23						0.72	
Control Delay		9.0			10.4						8.1	
Queue Delay		0.0			0.0						0.0	
Total Delay		9.0			10.4						8.1	
LOS		A			B						A	

Lanes, Volumes, Timings
458: N Durham Dr & W 24th St

11/26/2017

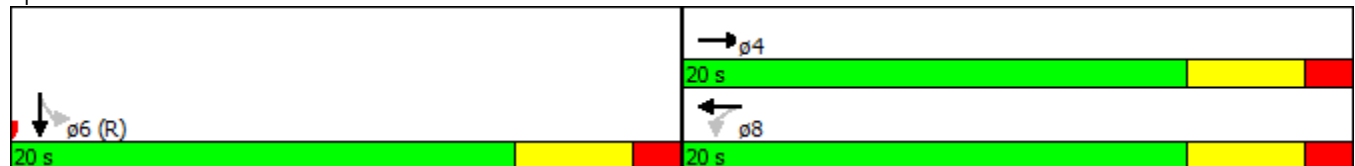


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		9.0			10.4							8.1
Approach LOS		A			B							A
Queue Length 50th (ft)		15			15							76
Queue Length 95th (ft)		30			m19							m118
Internal Link Dist (ft)		475			580			1406				1040
Turn Bay Length (ft)												
Base Capacity (vph)		651			577							2398
Starvation Cap Reductn		0			0							0
Spillback Cap Reductn		0			0							0
Storage Cap Reductn		0			0							0
Reduced v/c Ratio		0.17			0.23							0.72

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 40
 Control Type: Pretimed
 Maximum v/c Ratio: 0.72
 Intersection Signal Delay: 8.3
 Intersection LOS: A
 Intersection Capacity Utilization 44.3%
 ICU Level of Service A
 Analysis Period (min) 15
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 458: N Durham Dr & W 24th St



Lanes, Volumes, Timings
459: N Durham Dr & IH 610 EBFR

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑								↘	↑↑↑	
Volume (vph)	0	1218	179	0	0	0	0	0	0	467	1270	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	4979	0	0	0	0	0	0	0	1770	6408	0
Flt Permitted										0.950		
Satd. Flow (perm)	0	4979	0	0	0	0	0	0	0	1770	6408	0
Right Turn on Red			Yes			Yes			Yes	Yes		Yes
Satd. Flow (RTOR)		7								55		
Link Speed (mph)		45			10			30			30	
Link Distance (ft)		410			526			607			264	
Travel Time (s)		6.2			35.9			13.8			6.0	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.89	0.81	0.93	0.93	0.93	0.93	0.93	0.93	0.89	0.92	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	1590	0	0	0	0	0	0	0	525	1380	0
Turn Type		NA								Perm	NA	
Protected Phases		4									6	
Permitted Phases										6		
Detector Phase		4								6	6	
Switch Phase												
Minimum Initial (s)		4.0								4.0	4.0	
Minimum Split (s)		20.0								20.0	20.0	
Total Split (s)		20.0								20.0	20.0	
Total Split (%)		50.0%								50.0%	50.0%	
Yellow Time (s)		3.5								3.5	3.5	
All-Red Time (s)		1.5								1.5	1.5	
Lost Time Adjust (s)		0.0								0.0	0.0	
Total Lost Time (s)		5.0								5.0	5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max								Max	Max	
Act Effct Green (s)		15.0								15.0	15.0	
Actuated g/C Ratio		0.38								0.38	0.38	
v/c Ratio		0.85								0.75	0.57	
Control Delay		17.7								14.4	8.6	
Queue Delay		0.0								0.2	0.0	
Total Delay		17.7								14.6	8.6	
LOS		B								B	A	

Lanes, Volumes, Timings
 459: N Durham Dr & IH 610 EBFR

11/26/2017

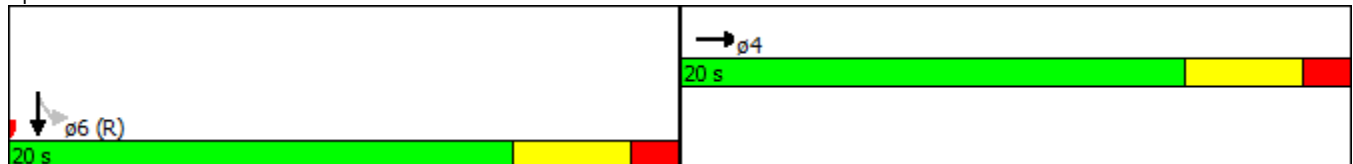


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		17.7										10.3
Approach LOS		B										B
Queue Length 50th (ft)		112								43	47	
Queue Length 95th (ft)		#173								m96	m74	
Internal Link Dist (ft)		330			446			527				184
Turn Bay Length (ft)												
Base Capacity (vph)		1871								698	2403	
Starvation Cap Reductn		0								10	0	
Spillback Cap Reductn		0								0	0	
Storage Cap Reductn		0								0	0	
Reduced v/c Ratio		0.85								0.76	0.57	

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 40
 Control Type: Pretimed
 Maximum v/c Ratio: 0.85
 Intersection Signal Delay: 13.6
 Intersection LOS: B
 Intersection Capacity Utilization 61.7%
 ICU Level of Service B
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 459: N Durham Dr & IH 610 EBFR



Lanes, Volumes, Timings
460: N Durham Dr & IH 610 WBFR

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	446	475	0	0	0	0	0	1316	488
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	1610	3350	0	0	0	0	0	6132	0
Flt Permitted				0.950	0.988							
Satd. Flow (perm)	0	0	0	1610	3350	0	0	0	0	0	6132	0
Right Turn on Red			Yes	Yes		Yes			Yes			Yes
Satd. Flow (RTOR)				55	55							161
Link Speed (mph)		45			45			35				35
Link Distance (ft)		407			398			264				706
Travel Time (s)		6.2			6.0			5.1				13.8
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.86	0.87	0.93	0.93	0.93	0.93	0.93	0.92	0.85
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)				33%								
Lane Group Flow (vph)	0	0	0	348	717	0	0	0	0	0	2004	0
Turn Type				Perm	NA							NA
Protected Phases					8							6
Permitted Phases				8								
Detector Phase				8	8							6
Switch Phase												
Minimum Initial (s)				4.0	4.0							4.0
Minimum Split (s)				20.0	20.0							20.0
Total Split (s)				20.0	20.0							20.0
Total Split (%)				50.0%	50.0%							50.0%
Yellow Time (s)				3.5	3.5							3.5
All-Red Time (s)				1.5	1.5							1.5
Lost Time Adjust (s)				0.0	0.0							0.0
Total Lost Time (s)				5.0	5.0							5.0
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode				Max	Max							Max
Act Effect Green (s)				15.0	15.0							15.0
Actuated g/C Ratio				0.38	0.38							0.38
v/c Ratio				0.55	0.56							0.83
Control Delay				7.7	7.0							14.9
Queue Delay				0.0	0.0							0.1
Total Delay				7.7	7.0							15.0
LOS				A	A							B

Lanes, Volumes, Timings
 460: N Durham Dr & IH 610 WBFR

11/26/2017

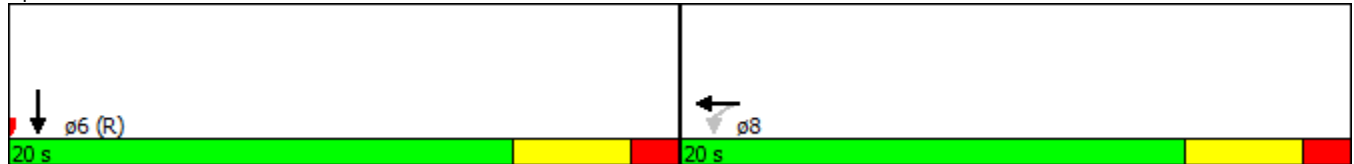


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					7.3							15.0
Approach LOS					A							B
Queue Length 50th (ft)				29	36							102
Queue Length 95th (ft)				m75	m73							#145
Internal Link Dist (ft)		327			318			184				626
Turn Bay Length (ft)												
Base Capacity (vph)				638	1290							2400
Starvation Cap Reductn				0	0							0
Spillback Cap Reductn				0	0							29
Storage Cap Reductn				0	0							0
Reduced v/c Ratio				0.55	0.56							0.85

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBT, Start of Green
 Natural Cycle: 40
 Control Type: Pretimed
 Maximum v/c Ratio: 0.83
 Intersection Signal Delay: 12.3 Intersection LOS: B
 Intersection Capacity Utilization 55.7% ICU Level of Service B
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 460: N Durham Dr & IH 610 WBFR



Lanes, Volumes, Timings
461: Shepherd & Washington

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	78	678	0	0	587	127	600	1909	150	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	90		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1770	3539	0	0	3409	0	0	6287	0	0	0	0
Flt Permitted	0.950							0.989				
Satd. Flow (perm)	1770	3539	0	0	3409	0	0	6287	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					20			14				
Link Speed (mph)		30			30			30				30
Link Distance (ft)		322			1068			522				252
Travel Time (s)		7.3			24.3			11.9				5.7
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	5	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	80	699	0	0	736	0	0	2742	0	0	0	0
Turn Type	Prot	NA			NA		Perm	NA				
Protected Phases	5	2			6			8				
Permitted Phases							8					
Detector Phase	5	2			6		8	8				
Switch Phase												
Minimum Initial (s)	5.0	10.0			10.0		10.0	10.0				
Minimum Split (s)	10.0	21.0			21.0		18.0	18.0				
Total Split (s)	20.0	55.0			35.0		65.0	65.0				
Total Split (%)	16.7%	45.8%			29.2%		54.2%	54.2%				
Yellow Time (s)	3.6	3.6			3.6		3.6	3.6				
All-Red Time (s)	1.4	1.4			1.4		1.4	1.4				
Lost Time Adjust (s)	0.0	0.0			0.0			0.0				
Total Lost Time (s)	5.0	5.0			5.0			5.0				
Lead/Lag	Lead				Lag							
Lead-Lag Optimize?	Yes				Yes							
Recall Mode	Max	Max			Max		C-Max	C-Max				
Act Effct Green (s)	15.0	50.0			30.0			60.0				
Actuated g/C Ratio	0.12	0.42			0.25			0.50				
v/c Ratio	0.36	0.47			0.85			0.87				
Control Delay	77.8	16.1			57.1			37.8				
Queue Delay	0.0	0.6			0.1			1.8				
Total Delay	77.8	16.7			57.2			39.6				
LOS	E	B			E			D				

Lanes, Volumes, Timings
461: Shepherd & Washington

11/26/2017

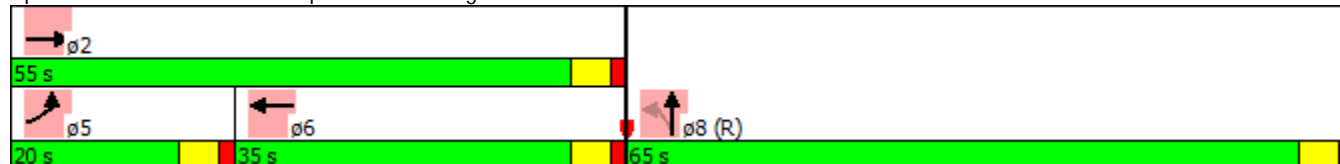


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		23.0			57.2			39.6				
Approach LOS		C			E			D				
Queue Length 50th (ft)	66	96			290			614				
Queue Length 95th (ft)	m105	154			m#363			652				
Internal Link Dist (ft)		242			988			442			172	
Turn Bay Length (ft)	90											
Base Capacity (vph)	221	1474			867			3150				
Starvation Cap Reductn	0	406			0			0				
Spillback Cap Reductn	0	0			3			255				
Storage Cap Reductn	0	0			0			0				
Reduced v/c Ratio	0.36	0.65			0.85			0.95				

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 0 (0%), Referenced to phase 8:NBTL, Start of Green
 Natural Cycle: 70
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.87
 Intersection Signal Delay: 39.6
 Intersection LOS: D
 Intersection Capacity Utilization 105.5%
 ICU Level of Service G
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 461: Shepherd & Washington



Lanes, Volumes, Timings
462: Shepherd & Center

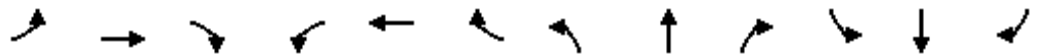
11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕↕↕				
Volume (vph)	49	70	0	0	42	78	24	2161	44	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1824	0	0	1719	0	0	6376	0	0	0	0
Flt Permitted		0.782						0.999				
Satd. Flow (perm)	0	1457	0	0	1719	0	0	6376	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					5			8				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		320			502			252				2176
Travel Time (s)		7.3			11.4			4.9				42.4
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.68	0.76	0.93	0.93	0.55	0.78	0.75	0.92	0.65	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	164	0	0	176	0	0	2449	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4						2					
Detector Phase	4	4			8		2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (s)	42.0	42.0			42.0		78.0	78.0				
Total Split (%)	35.0%	35.0%			35.0%		65.0%	65.0%				
Yellow Time (s)	3.5	3.5			3.5		3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5		1.5	1.5				
Lost Time Adjust (s)		0.0			0.0			0.0				
Total Lost Time (s)		5.0			5.0			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max		Max	Max				
Act Effct Green (s)		37.0			37.0			73.0				
Actuated g/C Ratio		0.31			0.31			0.61				
v/c Ratio		0.37			0.33			0.63				
Control Delay		36.4			33.1			3.4				
Queue Delay		0.0			0.0			1.0				
Total Delay		36.4			33.1			4.3				
LOS		D			C			A				

Lanes, Volumes, Timings
462: Shepherd & Center

11/26/2017

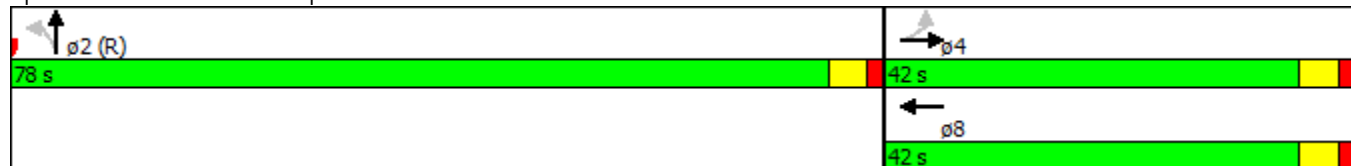


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		36.4			33.1			4.3				
Approach LOS		D			C			A				
Queue Length 50th (ft)		110			102			64				
Queue Length 95th (ft)		m141			93			74				
Internal Link Dist (ft)		240			422			172			2096	
Turn Bay Length (ft)												
Base Capacity (vph)		449			533			3881				
Starvation Cap Reductn		0			0			1051				
Spillback Cap Reductn		0			0			0				
Storage Cap Reductn		0			0			0				
Reduced v/c Ratio		0.37			0.33			0.87				

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
Natural Cycle:	45
Control Type:	Pretimed
Maximum v/c Ratio:	0.63
Intersection Signal Delay:	8.0
Intersection LOS:	A
Intersection Capacity Utilization	53.8%
ICU Level of Service	A
Analysis Period (min)	15
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 462: Shepherd & Center



Lanes, Volumes, Timings
463: Shepherd & IH10 - EBFR

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	610	512	0	0	0	0	0	2215	162	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1610	3336	0	0	0	0	0	6344	0	0	0	0
Flt Permitted	0.950	0.984										
Satd. Flow (perm)	1610	3336	0	0	0	0	0	6344	0	0	0	0
Right Turn on Red	Yes		Yes			Yes			Yes			Yes
Satd. Flow (RTOR)	64	64						13				
Link Speed (mph)		40			40			35				35
Link Distance (ft)		306			534			2176				316
Travel Time (s)		5.2			9.1			42.4				6.2
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.94	0.93	0.93	0.93	0.93	0.93	0.83	0.86	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	3	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)	41%											
Lane Group Flow (vph)	391	817	0	0	0	0	0	2857	0	0	0	0
Turn Type	Perm	NA						NA				
Protected Phases		4 12						2				
Permitted Phases	4 12											
Detector Phase	4 12	4 12						2				
Switch Phase												
Minimum Initial (s)								4.0				
Minimum Split (s)								21.0				
Total Split (s)								47.0				
Total Split (%)								39.2%				
Yellow Time (s)								3.5				
All-Red Time (s)								1.5				
Lost Time Adjust (s)								0.0				
Total Lost Time (s)								5.0				
Lead/Lag								Lead				
Lead-Lag Optimize?								Yes				
Recall Mode								C-Max				
Act Effct Green (s)	68.0	68.0						42.0				
Actuated g/C Ratio	0.57	0.57						0.35				
v/c Ratio	0.42	0.43						1.28				
Control Delay	3.9	4.4						168.9				
Queue Delay	1.1	0.7						1.5				
Total Delay	4.9	5.1						170.4				
LOS	A	A						F				

Lanes, Volumes, Timings
 463: Shepherd & IH10 - EBFR

11/26/2017

Lane Group	ø4	ø5	ø6	ø8	ø12	ø16
Lane Configurations						
Volume (vph)						
Ideal Flow (vphpl)						
Lane Width (ft)						
Grade (%)						
Storage Length (ft)						
Storage Lanes						
Taper Length (ft)						
Satd. Flow (prot)						
Flt Permitted						
Satd. Flow (perm)						
Right Turn on Red						
Satd. Flow (RTOR)						
Link Speed (mph)						
Link Distance (ft)						
Travel Time (s)						
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor						
Growth Factor						
Heavy Vehicles (%)						
Bus Blockages (#/hr)						
Parking (#/hr)						
Mid-Block Traffic (%)						
Shared Lane Traffic (%)						
Lane Group Flow (vph)						
Turn Type						
Protected Phases	4	5	6	8	12	16
Permitted Phases						
Detector Phase						
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	20.0	21.0	20.0	20.0
Total Split (s)	28.0	54.0	20.0	25.0	45.0	21.0
Total Split (%)	23%	45%	17%	21%	38%	18%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)						
Total Lost Time (s)						
Lead/Lag	Lag	Lag	Lead	Lag		Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes		Yes
Recall Mode	Max	None	None	None	None	None
Act Effct Green (s)						
Actuated g/C Ratio						
v/c Ratio						
Control Delay						
Queue Delay						
Total Delay						
LOS						

Lanes, Volumes, Timings
 463: Shepherd & IH10 - EBFR

11/26/2017

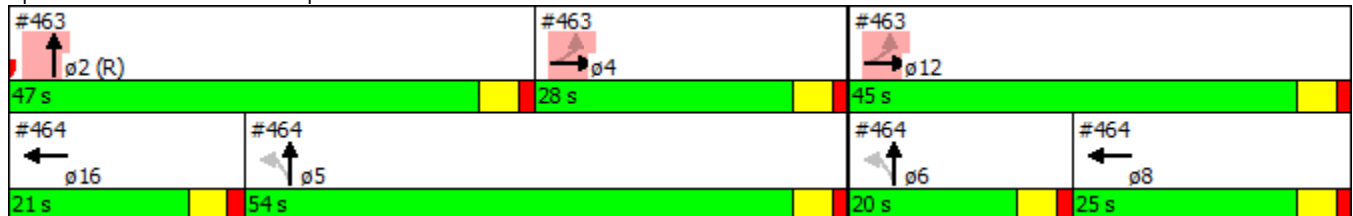


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		5.0						170.4				
Approach LOS		A						F				
Queue Length 50th (ft)	17	37						~803				
Queue Length 95th (ft)	m30	m45						#766				
Internal Link Dist (ft)		226			454			2096			236	
Turn Bay Length (ft)												
Base Capacity (vph)	940	1918						2228				
Starvation Cap Reductn	322	687						0				
Spillback Cap Reductn	8	3						869				
Storage Cap Reductn	0	0						0				
Reduced v/c Ratio	0.63	0.66						2.10				

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 17 (14%), Referenced to phase 2:NBT, Start of Green
 Natural Cycle: 115
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.28
 Intersection Signal Delay: 121.2 Intersection LOS: F
 Intersection Capacity Utilization 64.4% ICU Level of Service C
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 463: Shepherd & IH10 - EBFR



Lane Group	ø4	ø5	ø6	ø8	ø12	ø16
Approach Delay						
Approach LOS						
Queue Length 50th (ft)						
Queue Length 95th (ft)						
Internal Link Dist (ft)						
Turn Bay Length (ft)						
Base Capacity (vph)						
Starvation Cap Reductn						
Spillback Cap Reductn						
Storage Cap Reductn						
Reduced v/c Ratio						
Intersection Summary						

Lanes, Volumes, Timings
464: Shepherd & IH10 - WBFR

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑↑↑			↑↑↑				
Volume (vph)	0	0	0	0	458	347	701	2134	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	0	4750	0	0	6331	0	0	0	0
Flt Permitted								0.988				
Satd. Flow (perm)	0	0	0	0	4750	0	0	6331	0	0	0	0
Right Turn on Red			Yes			Yes	Yes		Yes			Yes
Satd. Flow (RTOR)					5			112				
Link Speed (mph)		40			40			35			35	
Link Distance (ft)		310			534			316			3871	
Travel Time (s)		5.3			9.1			6.2			75.4	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.93	0.89	0.86	0.97	0.94	0.93	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	0	918	0	0	2993	0	0	0	0
Turn Type					NA		Perm	NA				
Protected Phases					8 16			5 6				
Permitted Phases							5 6					
Detector Phase					8 16		5 6	5 6				
Switch Phase												
Minimum Initial (s)												
Minimum Split (s)												
Total Split (s)												
Total Split (%)												
Yellow Time (s)												
All-Red Time (s)												
Lost Time Adjust (s)												
Total Lost Time (s)												
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode												
Act Effct Green (s)					36.0			74.0				
Actuated g/C Ratio					0.30			0.62				
v/c Ratio					0.64			0.76				
Control Delay					38.2			14.7				
Queue Delay					0.1			47.1				
Total Delay					38.3			61.8				
LOS					D			E				

Lanes, Volumes, Timings
 464: Shepherd & IH10 - WBFR

11/26/2017

Lane Group	ø2	ø4	ø5	ø6	ø8	ø12	ø16
Lane Configurations							
Volume (vph)							
Ideal Flow (vphpl)							
Lane Width (ft)							
Grade (%)							
Storage Length (ft)							
Storage Lanes							
Taper Length (ft)							
Satd. Flow (prot)							
Flt Permitted							
Satd. Flow (perm)							
Right Turn on Red							
Satd. Flow (RTOR)							
Link Speed (mph)							
Link Distance (ft)							
Travel Time (s)							
Confl. Peds. (#/hr)							
Confl. Bikes (#/hr)							
Peak Hour Factor							
Growth Factor							
Heavy Vehicles (%)							
Bus Blockages (#/hr)							
Parking (#/hr)							
Mid-Block Traffic (%)							
Shared Lane Traffic (%)							
Lane Group Flow (vph)							
Turn Type							
Protected Phases	2	4	5	6	8	12	16
Permitted Phases							
Detector Phase							
Switch Phase							
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	21.0	20.0	21.0	20.0	20.0
Total Split (s)	47.0	28.0	54.0	20.0	25.0	45.0	21.0
Total Split (%)	39%	23%	45%	17%	21%	38%	18%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)							
Total Lost Time (s)							
Lead/Lag	Lead	Lag	Lag	Lead	Lag		Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes		Yes
Recall Mode	C-Max	Max	None	None	None	None	None
Act Effct Green (s)							
Actuated g/C Ratio							
v/c Ratio							
Control Delay							
Queue Delay							
Total Delay							
LOS							

Lanes, Volumes, Timings
 464: Shepherd & IH10 - WBFR

11/26/2017

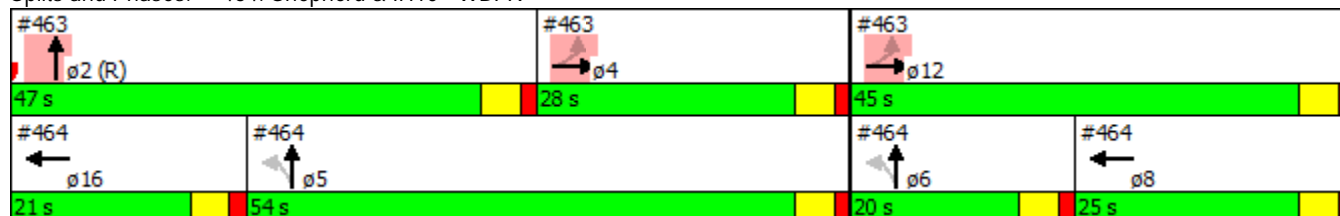


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					38.3			61.8				
Approach LOS					D			E				
Queue Length 50th (ft)					225			637				
Queue Length 95th (ft)					252			m533				
Internal Link Dist (ft)		230			454			236			3791	
Turn Bay Length (ft)												
Base Capacity (vph)					1626			3945				
Starvation Cap Reductn					0			1681				
Spillback Cap Reductn					107			31				
Storage Cap Reductn					0			0				
Reduced v/c Ratio					0.60			1.32				

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	17 (14%), Referenced to phase 2:NBT, Start of Green
Natural Cycle:	115
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	1.28
Intersection Signal Delay:	56.3
Intersection LOS:	E
Intersection Capacity Utilization:	66.6%
ICU Level of Service:	C
Analysis Period (min):	15
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 464: Shepherd & IH10 - WBFR



Lane Group	ø2	ø4	ø5	ø6	ø8	ø12	ø16
Approach Delay							
Approach LOS							
Queue Length 50th (ft)							
Queue Length 95th (ft)							
Internal Link Dist (ft)							
Turn Bay Length (ft)							
Base Capacity (vph)							
Starvation Cap Reductn							
Spillback Cap Reductn							
Storage Cap Reductn							
Reduced v/c Ratio							
Intersection Summary							

Lanes, Volumes, Timings

465: W 11th

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	246	741	1	0	466	160	360	1841	157	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	50		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1770	3536	0	0	3398	0	0	6287	0	0	0	0
Flt Permitted	0.319							0.992				
Satd. Flow (perm)	594	3536	0	0	3398	0	0	6287	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		1						16				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		536			448			700				2008
Travel Time (s)		12.2			10.2			13.6				39.1
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.87	0.95	0.25	0.93	0.90	0.85	0.87	0.93	0.80	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	283	784	0	0	706	0	0	2590	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		2			6			8				
Permitted Phases	2						8					
Detector Phase	2	2			6		8	8				
Switch Phase												
Minimum Initial (s)	7.0	7.0			5.0		7.0	7.0				
Minimum Split (s)	21.2	21.2			21.2		21.0	21.0				
Total Split (s)	73.0	73.0			73.0		47.0	47.0				
Total Split (%)	60.8%	60.8%			60.8%		39.2%	39.2%				
Yellow Time (s)	3.6	3.6			3.6		3.6	3.6				
All-Red Time (s)	1.6	1.6			1.6		1.4	1.4				
Lost Time Adjust (s)	0.0	0.0			0.0			0.0				
Total Lost Time (s)	5.2	5.2			5.2			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	None	None			None		C-Max	C-Max				
Act Effct Green (s)	60.9	60.9			60.9			48.9				
Actuated g/C Ratio	0.51	0.51			0.51			0.41				
v/c Ratio	0.94	0.44			0.41			1.01				
Control Delay	55.5	13.3			18.5			43.3				
Queue Delay	0.0	0.0			0.0			0.0				
Total Delay	55.5	13.3			18.5			43.3				
LOS	E	B			B			D				

Lanes, Volumes, Timings

465: W 11th

11/26/2017

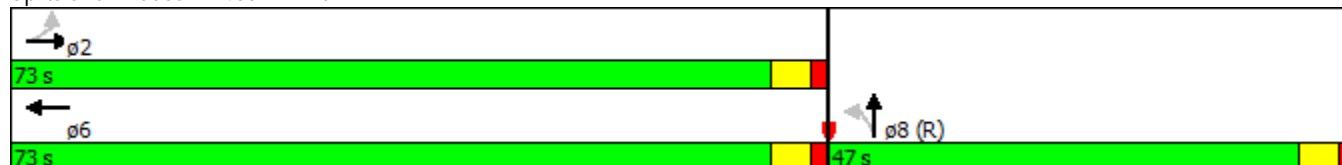


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		24.5			18.5			43.3				
Approach LOS		C			B			D				
Queue Length 50th (ft)	79	80			154			~661				
Queue Length 95th (ft)	#327	105			191			#756				
Internal Link Dist (ft)		456			368			620			1928	
Turn Bay Length (ft)	50											
Base Capacity (vph)	335	1998			1919			2569				
Starvation Cap Reductn	0	0			0			0				
Spillback Cap Reductn	0	0			0			0				
Storage Cap Reductn	0	0			0			0				
Reduced v/c Ratio	0.84	0.39			0.37			1.01				

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 14 (12%), Referenced to phase 8:NBTL, Start of Green
 Natural Cycle: 90
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.01
 Intersection Signal Delay: 34.7
 Intersection LOS: C
 Intersection Capacity Utilization 79.2%
 ICU Level of Service D
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 465: W 11th



Lanes, Volumes, Timings

466: W 14th

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕↕↕				
Volume (vph)	24	63	0	0	82	45	72	2262	63	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1837	0	0	1775	0	0	6363	0	0	0	0
Flt Permitted		0.700						0.998				
Satd. Flow (perm)	0	1304	0	0	1775	0	0	6363	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)								6				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		488			473			2008				644
Travel Time (s)		11.1			10.8			39.1				12.5
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.86	0.88	0.93	0.93	0.68	0.70	0.75	0.96	0.72	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	100	0	0	185	0	0	2540	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		2			6			8				
Permitted Phases	2						8					
Detector Phase	2	2			6		8	8				
Switch Phase												
Minimum Initial (s)	11.0	11.0			11.0		11.0	11.0				
Minimum Split (s)	45.0	45.0			45.0		40.0	40.0				
Total Split (s)	70.0	70.0			70.0		50.0	50.0				
Total Split (%)	58.3%	58.3%			58.3%		41.7%	41.7%				
Yellow Time (s)	3.5	3.5			3.5		3.2	3.2				
All-Red Time (s)	1.7	1.7			1.7		1.8	1.8				
Lost Time Adjust (s)		0.0			0.0			0.0				
Total Lost Time (s)		5.2			5.2			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	None	None			None		C-Max	C-Max				
Act Effct Green (s)		18.3			18.3			91.5				
Actuated g/C Ratio		0.15			0.15			0.76				
v/c Ratio		0.51			0.69			0.52				
Control Delay		55.7			60.4			15.5				
Queue Delay		0.0			0.0			0.0				
Total Delay		55.7			60.4			15.5				
LOS		E			E			B				

Lanes, Volumes, Timings

466: W 14th

11/26/2017

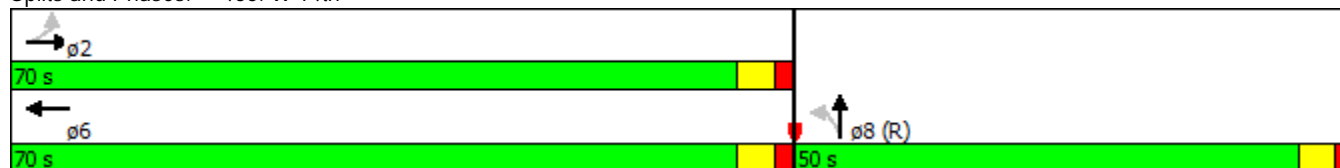


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		55.7			60.4			15.5				
Approach LOS		E			E			B				
Queue Length 50th (ft)		75			137			389				
Queue Length 95th (ft)		125			146			m413				
Internal Link Dist (ft)		408			393			1928			564	
Turn Bay Length (ft)												
Base Capacity (vph)		704			958			4853				
Starvation Cap Reductn		0			0			0				
Spillback Cap Reductn		0			0			0				
Storage Cap Reductn		0			0			0				
Reduced v/c Ratio		0.14			0.19			0.52				

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	20 (17%), Referenced to phase 8:NBTL, Start of Green
Natural Cycle:	85
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	0.69
Intersection Signal Delay:	19.8
Intersection LOS:	B
Intersection Capacity Utilization:	66.1%
ICU Level of Service:	C
Analysis Period (min):	15
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 466: W 14th



Lanes, Volumes, Timings
467: N Shepherd Dr & W 19th St

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↔			↑	↗		↔↔↔				
Volume (vph)	60	290	0	0	166	111	87	2090	128	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		85	0		0	0		0	0		0
Storage Lanes	0		1	0		1	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3504	0	0	1863	1583	0	6337	0	0	0	0
Flt Permitted		0.860						0.998				
Satd. Flow (perm)	0	3044	0	0	1863	1583	0	6337	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						55		39				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		668			574			1789				375
Travel Time (s)		15.2			13.0			34.9				7.3
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.75	0.88	0.93	0.93	0.90	0.90	0.87	0.94	0.84	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	410	0	0	184	123	0	2475	0	0	0	0
Turn Type	Perm	NA			NA	Perm	Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4					8	2					
Detector Phase	4	4			8	8	2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0	4.0	4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0	20.0	20.0	20.0				
Total Split (s)	20.0	20.0			20.0	20.0	20.0	20.0				
Total Split (%)	50.0%	50.0%			50.0%	50.0%	50.0%	50.0%				
Yellow Time (s)	3.5	3.5			3.5	3.5	3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5	1.5	1.5	1.5				
Lost Time Adjust (s)		0.0			0.0	0.0		0.0				
Total Lost Time (s)		5.0			5.0	5.0		5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max	Max	Max	Max				
Act Effct Green (s)		15.0			15.0	15.0		15.0				
Actuated g/C Ratio		0.38			0.38	0.38		0.38				
v/c Ratio		0.36			0.26	0.20		1.03				
Control Delay		14.9			10.0	6.3		42.6				
Queue Delay		0.0			0.0	0.0		0.0				
Total Delay		14.9			10.0	6.3		42.6				
LOS		B			A	A		D				

Lanes, Volumes, Timings
467: N Shepherd Dr & W 19th St

11/26/2017

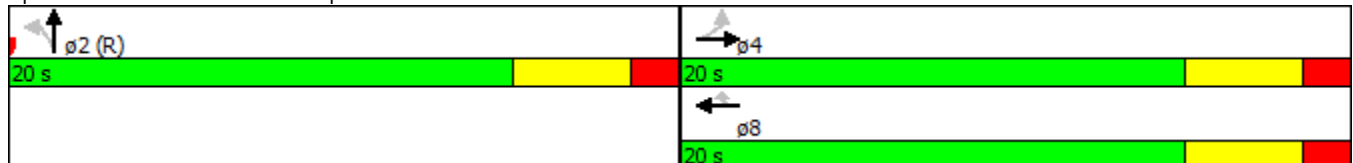


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		14.9			8.5			42.6				
Approach LOS		B			A			D				
Queue Length 50th (ft)		42			27	9		~162				
Queue Length 95th (ft)		m67			58	32		#253				
Internal Link Dist (ft)		588			494			1709			295	
Turn Bay Length (ft)												
Base Capacity (vph)		1141			698	628		2400				
Starvation Cap Reductn		0			0	0		0				
Spillback Cap Reductn		0			0	0		0				
Storage Cap Reductn		0			0	0		0				
Reduced v/c Ratio		0.36			0.26	0.20		1.03				

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
 Natural Cycle: 45
 Control Type: Pretimed
 Maximum v/c Ratio: 1.03
 Intersection Signal Delay: 35.8
 Intersection LOS: D
 Intersection Capacity Utilization 64.7%
 ICU Level of Service C
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 467: N Shepherd Dr & W 19th St



Lanes, Volumes, Timings
468: N Shepherd Dr & W 20th St

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↔			↔↔			↔↔↔				
Volume (vph)	98	295	0	0	210	140	59	2114	103	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		100	0		0	0		0	0		0
Storage Lanes	0		1	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3490	0	0	3337	0	0	6350	0	0	0	0
Flt Permitted		0.726						0.999				
Satd. Flow (perm)	0	2569	0	0	3337	0	0	6350	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)								30				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		140			536			375				1478
Travel Time (s)		3.2			12.2			7.3				28.8
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.77	0.93	0.93	0.93	0.75	0.81	0.87	0.96	0.86	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	444	0	0	453	0	0	2390	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4						2					
Detector Phase	4	4			8		2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (%)	50.0%	50.0%			50.0%		50.0%	50.0%				
Yellow Time (s)	3.5	3.5			3.5		3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5		1.5	1.5				
Lost Time Adjust (s)		0.0			0.0			0.0				
Total Lost Time (s)		5.0			5.0			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max		Max	Max				
Act Effct Green (s)		15.0			15.0			15.0				
Actuated g/C Ratio		0.38			0.38			0.38				
v/c Ratio		0.46			0.36			1.00				
Control Delay		18.3			10.1			23.7				
Queue Delay		0.0			0.0			0.0				
Total Delay		18.3			10.1			23.7				
LOS		B			B			C				

Lanes, Volumes, Timings
 468: N Shepherd Dr & W 20th St

11/26/2017

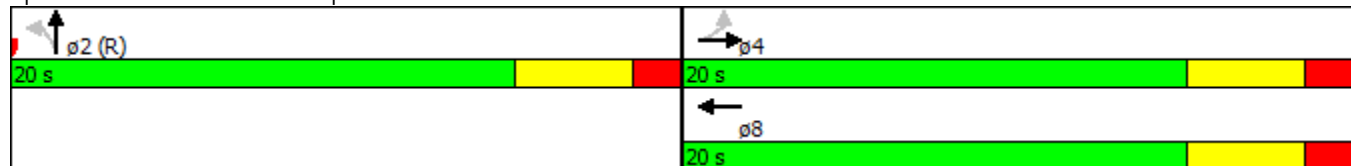


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		18.3			10.1			23.7				
Approach LOS		B			B			C				
Queue Length 50th (ft)		53			36			99				
Queue Length 95th (ft)		m84			49			m99				
Internal Link Dist (ft)		60			456			295			1398	
Turn Bay Length (ft)												
Base Capacity (vph)		963			1251			2400				
Starvation Cap Reductn		0			0			0				
Spillback Cap Reductn		0			0			0				
Storage Cap Reductn		0			0			0				
Reduced v/c Ratio		0.46			0.36			1.00				

Intersection Summary

Area Type:	Other
Cycle Length:	40
Actuated Cycle Length:	40
Offset:	0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
Natural Cycle:	45
Control Type:	Pretimed
Maximum v/c Ratio:	1.00
Intersection Signal Delay:	21.1
Intersection LOS:	C
Intersection Capacity Utilization:	67.0%
ICU Level of Service:	C
Analysis Period (min):	15
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 468: N Shepherd Dr & W 20th St



Lanes, Volumes, Timings
469: N Shepherd Dr & W 24th St

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	34	36	0	0	36	26	74	2230	26	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1818	0	0	1742	0	0	6382	0	0	0	0
Flt Permitted		0.831						0.998				
Satd. Flow (perm)	0	1548	0	0	1742	0	0	6382	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)								6				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		660			543			1478				1697
Travel Time (s)		15.0			12.3			28.8				33.1
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.65	0.69	0.93	0.93	0.64	0.50	0.80	0.90	0.81	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	104	0	0	108	0	0	2602	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4						2					
Detector Phase	4	4			8		2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (%)	50.0%	50.0%			50.0%		50.0%	50.0%				
Yellow Time (s)	3.5	3.5			3.5		3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5		1.5	1.5				
Lost Time Adjust (s)		0.0			0.0			0.0				
Total Lost Time (s)		5.0			5.0			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max		Max	Max				
Act Effct Green (s)		15.0			15.0			15.0				
Actuated g/C Ratio		0.38			0.38			0.38				
v/c Ratio		0.18			0.17			1.09				
Control Delay		12.6			9.2			56.8				
Queue Delay		0.0			0.0			0.0				
Total Delay		12.6			9.2			56.8				
LOS		B			A			E				

Lanes, Volumes, Timings
 469: N Shepherd Dr & W 24th St

11/26/2017

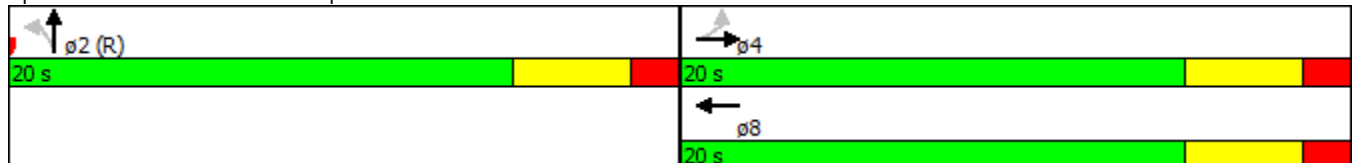


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		12.6			9.2			56.8				
Approach LOS		B			A			E				
Queue Length 50th (ft)		14			15			~214				
Queue Length 95th (ft)		m24			25			m#227				
Internal Link Dist (ft)		580			463			1398			1617	
Turn Bay Length (ft)												
Base Capacity (vph)		580			653			2397				
Starvation Cap Reductn		0			0			0				
Spillback Cap Reductn		0			0			0				
Storage Cap Reductn		0			0			0				
Reduced v/c Ratio		0.18			0.17			1.09				

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
 Natural Cycle: 45
 Control Type: Pretimed
 Maximum v/c Ratio: 1.09
 Intersection Signal Delay: 53.3
 Intersection LOS: D
 Intersection Capacity Utilization 52.7%
 ICU Level of Service A
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 469: N Shepherd Dr & W 24th St



Lanes, Volumes, Timings
470: N Shepherd Dr & IH 610 EBFR

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	582	1158	0	0	0	0	0	1729	327	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1610	3383	0	0	0	0	0	6254	0	0	0	0
Flt Permitted	0.950	0.998										
Satd. Flow (perm)	1610	3383	0	0	0	0	0	6254	0	0	0	0
Right Turn on Red	Yes		Yes			Yes			Yes			Yes
Satd. Flow (RTOR)	55	55						14				
Link Speed (mph)		45			45			35				35
Link Distance (ft)		526			314			1697				251
Travel Time (s)		8.0			4.8			33.1				4.9
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.97	0.93	0.93	0.93	0.93	0.93	0.94	0.95	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)	10%											
Lane Group Flow (vph)	570	1257	0	0	0	0	0	2183	0	0	0	0
Turn Type	Perm	NA						NA				
Protected Phases		4						2				
Permitted Phases	4											
Detector Phase	4	4						2				
Switch Phase												
Minimum Initial (s)	4.0	4.0						4.0				
Minimum Split (s)	20.0	20.0						20.0				
Total Split (s)	20.0	20.0						20.0				
Total Split (%)	50.0%	50.0%						50.0%				
Yellow Time (s)	3.5	3.5						3.5				
All-Red Time (s)	1.5	1.5						1.5				
Lost Time Adjust (s)	0.0	0.0						0.0				
Total Lost Time (s)	5.0	5.0						5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max						Max				
Act Effct Green (s)	15.0	15.0						15.0				
Actuated g/C Ratio	0.38	0.38						0.38				
v/c Ratio	0.89	0.96						0.93				
Control Delay	25.0	26.0						9.6				
Queue Delay	0.1	0.0						3.4				
Total Delay	25.1	26.0						13.0				
LOS	C	C						B				

Lanes, Volumes, Timings
 470: N Shepherd Dr & IH 610 EBFR

11/26/2017

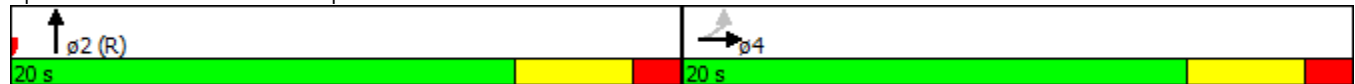


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		25.7						13.0				
Approach LOS		C						B				
Queue Length 50th (ft)	48	82						115				
Queue Length 95th (ft)	m#147	m#215						m83				
Internal Link Dist (ft)		446			234			1617			171	
Turn Bay Length (ft)												
Base Capacity (vph)	638	1303						2354				
Starvation Cap Reductn	0	0						0				
Spillback Cap Reductn	1	0						116				
Storage Cap Reductn	0	0						0				
Reduced v/c Ratio	0.89	0.96						0.98				

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2:NBT and 6:, Start of Green
 Natural Cycle: 60
 Control Type: Pretimed
 Maximum v/c Ratio: 0.96
 Intersection Signal Delay: 18.8
 Intersection LOS: B
 Intersection Capacity Utilization 71.5%
 ICU Level of Service C
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 470: N Shepherd Dr & IH 610 EBFR



Lanes, Volumes, Timings
471: N Shepherd Dr & IH 610 WBFR

11/26/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑↑↑		↖	↑↑↑				
Volume (vph)	0	0	0	0	597	406	398	1884	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	1		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	0	4775	0	1433	6029	0	0	0	0
Flt Permitted							0.950	0.999				
Satd. Flow (perm)	0	0	0	0	4775	0	1433	6029	0	0	0	0
Right Turn on Red			Yes			Yes	Yes		Yes			Yes
Satd. Flow (RTOR)							108	55				
Link Speed (mph)		45			45			35				35
Link Distance (ft)		398			334			251				1261
Travel Time (s)		6.0			5.1			4.9				24.6
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.93	0.91	0.91	0.86	0.92	0.93	0.93	0.93	0.93
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)							10%					
Lane Group Flow (vph)	0	0	0	0	1102	0	417	2094	0	0	0	0
Turn Type					NA		Perm	NA				
Protected Phases					8			2				
Permitted Phases							2					
Detector Phase					8		2	2				
Switch Phase												
Minimum Initial (s)					4.0		4.0	4.0				
Minimum Split (s)					20.0		20.0	20.0				
Total Split (s)					20.0		20.0	20.0				
Total Split (%)					50.0%		50.0%	50.0%				
Yellow Time (s)					3.5		3.5	3.5				
All-Red Time (s)					1.5		1.5	1.5				
Lost Time Adjust (s)					0.0		0.0	0.0				
Total Lost Time (s)					5.0		5.0	5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode					Max		Max	Max				
Act Effct Green (s)					15.0		15.0	15.0				
Actuated g/C Ratio					0.38		0.38	0.38				
v/c Ratio					0.62		0.69	0.91				
Control Delay					12.0		9.8	12.5				
Queue Delay					0.0		0.2	0.3				
Total Delay					12.0		9.9	12.8				
LOS					B		A	B				

Lanes, Volumes, Timings
 471: N Shepherd Dr & IH 610 WBFR

11/26/2017

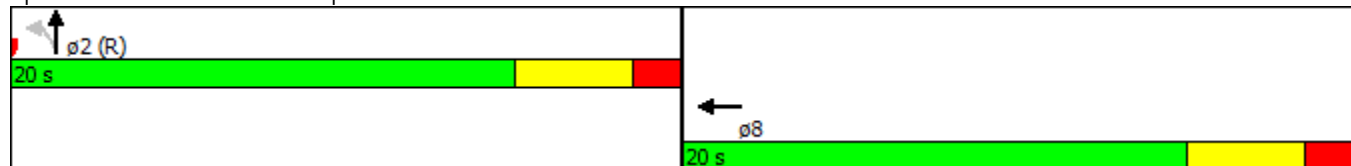


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					12.0			12.3				
Approach LOS					B			B				
Queue Length 50th (ft)					69		38	78				
Queue Length 95th (ft)					101		m46	m93				
Internal Link Dist (ft)		318			254			171			1181	
Turn Bay Length (ft)												
Base Capacity (vph)					1790		604	2295				
Starvation Cap Reductn					0		11	26				
Spillback Cap Reductn					0		0	0				
Storage Cap Reductn					0		0	0				
Reduced v/c Ratio					0.62		0.70	0.92				

Intersection Summary

Area Type:	Other
Cycle Length:	40
Actuated Cycle Length:	40
Offset:	0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
Natural Cycle:	45
Control Type:	Pretimed
Maximum v/c Ratio:	0.91
Intersection Signal Delay:	12.2
Intersection LOS:	B
Intersection Capacity Utilization:	55.7%
ICU Level of Service:	B
Analysis Period (min):	15
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 471: N Shepherd Dr & IH 610 WBFR



2040 AM Peak No-Build



Lanes, Volumes, Timings
450: Durham & Washington

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑		↖	↑↑						↑↑↑↑	
Volume (vph)	0	506	235	173	621	0	0	0	0	235	1629	47
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	150		0	0		0	0		0
Storage Lanes	0		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3369	0	1770	3539	0	0	0	0	0	6344	0
Flt Permitted				0.950							0.994	
Satd. Flow (perm)	0	3369	0	1770	3539	0	0	0	0	0	6344	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		63										5
Link Speed (mph)		30			30			30				30
Link Distance (ft)		2207			322			520				238
Travel Time (s)		50.2			7.3			11.8				5.4
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	888	0	207	744	0	0	0	0	0	2289	0
Turn Type		NA		Prot	NA						Perm	NA
Protected Phases		2		1	6							4
Permitted Phases											4	
Detector Phase		2		1	6						4	4
Switch Phase												
Minimum Initial (s)		10.0		5.0	10.0						10.0	10.0
Minimum Split (s)		21.0		10.0	21.0						18.0	18.0
Total Split (s)		40.0		25.0	65.0						55.0	55.0
Total Split (%)		33.3%		20.8%	54.2%						45.8%	45.8%
Yellow Time (s)		3.6		3.6	3.6						3.6	3.6
All-Red Time (s)		1.4		1.4	1.4						1.4	1.4
Lost Time Adjust (s)		0.0		0.0	0.0							0.0
Total Lost Time (s)		5.0		5.0	5.0							5.0
Lead/Lag		Lag		Lead								
Lead-Lag Optimize?		Yes		Yes								
Recall Mode		Max		None	Max					C-Max	C-Max	
Act Effect Green (s)		37.2		17.8	60.0							50.0
Actuated g/C Ratio		0.31		0.15	0.50							0.42
v/c Ratio		0.82		0.79	0.42							0.87
Control Delay		34.2		79.4	19.9							47.6
Queue Delay		0.0		1.4	1.6							0.0
Total Delay		34.2		80.8	21.5							47.6
LOS		C		F	C							D

Lanes, Volumes, Timings
450: Durham & Washington

11/30/2017

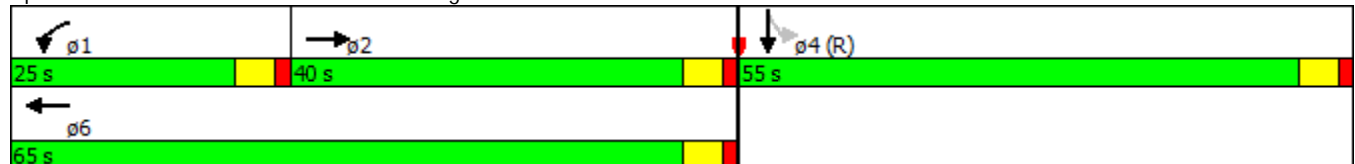


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		34.2			34.4							47.6
Approach LOS		C			C							D
Queue Length 50th (ft)		376		172	138							489
Queue Length 95th (ft)		#447		m216	m188							530
Internal Link Dist (ft)		2127			242			440				158
Turn Bay Length (ft)				150								
Base Capacity (vph)		1089		295	1769							2646
Starvation Cap Reductn		0		19	804							0
Spillback Cap Reductn		0		0	0							0
Storage Cap Reductn		0		0	0							0
Reduced v/c Ratio		0.82		0.75	0.77							0.87

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 0 (0%), Referenced to phase 4:SBTL, Start of Green
 Natural Cycle: 80
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.87
 Intersection Signal Delay: 41.7
 Intersection LOS: D
 Intersection Capacity Utilization 80.4%
 ICU Level of Service D
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 450: Durham & Washington



Lanes, Volumes, Timings
451: Durham & Center

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	20	24	9	27	0	0	0	0	26	2088	31
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1730	0	0	1839	0	0	0	0	0	6382	0
Flt Permitted					0.987						0.999	
Satd. Flow (perm)	0	1730	0	0	1839	0	0	0	0	0	6382	0
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		534			320			238			2187	
Travel Time (s)		12.1			7.3			4.6			42.6	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.56	0.60	0.56	0.61	0.93	0.93	0.93	0.93	0.86	0.93	0.70
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	87	0	0	69	0	0	0	0	0	2668	0
Sign Control		Stop			Stop			Stop			Free	

Intersection Summary

Area Type:	Other
Control Type:	Unsignalized
Intersection Capacity Utilization	51.4%
ICU Level of Service	A
Analysis Period (min)	15

Lanes, Volumes, Timings
452: Durham & IH10 - EBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑								↓	↑↑↑	
Volume (vph)	0	606	410	0	0	0	0	0	0	274	1761	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	4770	0	0	0	0	0	0	0	1522	4801	0
Flt Permitted										0.950	0.999	
Satd. Flow (perm)	0	4770	0	0	0	0	0	0	0	1522	4801	0
Right Turn on Red			Yes			Yes			Yes	Yes		Yes
Satd. Flow (RTOR)		8								64	64	
Link Speed (mph)		40			40			35			35	
Link Distance (ft)		594			306			2187			312	
Travel Time (s)		10.1			5.2			42.6			6.1	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.90	0.87	0.93	0.93	0.93	0.93	0.93	0.93	0.90	0.95	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)										10%		
Lane Group Flow (vph)	0	1316	0	0	0	0	0	0	0	315	2167	0
Turn Type		NA								Perm	NA	
Protected Phases		4 12									1 2	
Permitted Phases										1 2		
Detector Phase		4 12								1 2	1 2	
Switch Phase												
Minimum Initial (s)												
Minimum Split (s)												
Total Split (s)												
Total Split (%)												
Yellow Time (s)												
All-Red Time (s)												
Lost Time Adjust (s)												
Total Lost Time (s)												
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode												
Act Effct Green (s)		38.0								72.0	72.0	
Actuated g/C Ratio		0.32								0.60	0.60	
v/c Ratio		1.05dr								0.34	0.75	
Control Delay		45.7								3.5	13.8	
Queue Delay		0.0								3.5	47.8	
Total Delay		45.7								7.0	61.5	
LOS		D								A	E	

Lane Group	ø1	ø2	ø4	ø6	ø8	ø12	ø16
Lane Configurations							
Volume (vph)							
Ideal Flow (vphpl)							
Lane Width (ft)							
Grade (%)							
Storage Length (ft)							
Storage Lanes							
Taper Length (ft)							
Satd. Flow (prot)							
Flt Permitted							
Satd. Flow (perm)							
Right Turn on Red							
Satd. Flow (RTOR)							
Link Speed (mph)							
Link Distance (ft)							
Travel Time (s)							
Confl. Peds. (#/hr)							
Confl. Bikes (#/hr)							
Peak Hour Factor							
Growth Factor							
Heavy Vehicles (%)							
Bus Blockages (#/hr)							
Parking (#/hr)							
Mid-Block Traffic (%)							
Shared Lane Traffic (%)							
Lane Group Flow (vph)							
Turn Type							
Protected Phases	1	2	4	6	8	12	16
Permitted Phases							
Detector Phase							
Switch Phase							
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	21.0	21.0	21.0	20.0	20.0
Total Split (s)	56.0	21.0	22.0	56.0	21.0	21.0	43.0
Total Split (%)	47%	18%	18%	47%	18%	18%	36%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)							
Total Lost Time (s)							
Lead/Lag	Lag	Lead	Lag	Lead	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	
Recall Mode	None	Max	None	C-Max	Max	None	None
Act Effct Green (s)							
Actuated g/C Ratio							
v/c Ratio							
Control Delay							
Queue Delay							
Total Delay							
LOS							

Lanes, Volumes, Timings
452: Durham & IH10 - EBFR

11/30/2017

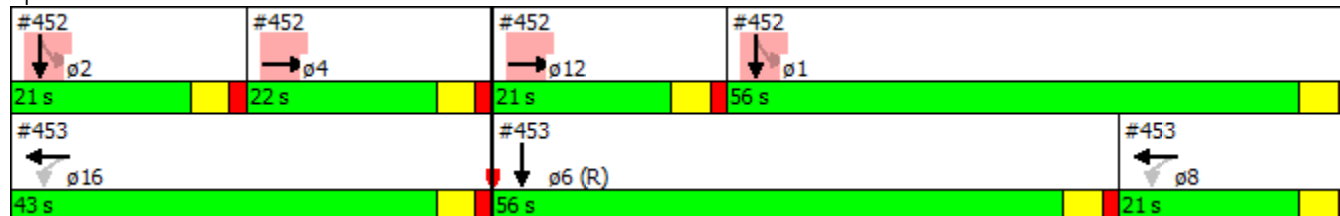


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		45.7										54.6
Approach LOS		D										D
Queue Length 50th (ft)		349								65		606
Queue Length 95th (ft)		412								m70		m621
Internal Link Dist (ft)		514			226			2107				232
Turn Bay Length (ft)												
Base Capacity (vph)		1515								938		2906
Starvation Cap Reductn		0								519		1229
Spillback Cap Reductn		0								0		0
Storage Cap Reductn		0								0		0
Reduced v/c Ratio		0.87								0.75		1.29

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 94 (78%), Referenced to phase 6:SBT, Start of Green
 Natural Cycle: 115
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.01
 Intersection Signal Delay: 51.5 Intersection LOS: D
 Intersection Capacity Utilization 72.9% ICU Level of Service C
 Analysis Period (min) 15
 m Volume for 95th percentile queue is metered by upstream signal.
 dr Defacto Right Lane. Recode with 1 though lane as a right lane.

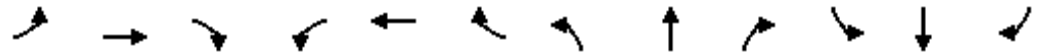
Splits and Phases: 452: Durham & IH10 - EBFR



Lane Group	ø1	ø2	ø4	ø6	ø8	ø12	ø16
Approach Delay							
Approach LOS							
Queue Length 50th (ft)							
Queue Length 95th (ft)							
Internal Link Dist (ft)							
Turn Bay Length (ft)							
Base Capacity (vph)							
Starvation Cap Reductn							
Spillback Cap Reductn							
Storage Cap Reductn							
Reduced v/c Ratio							
Intersection Summary							

Lanes, Volumes, Timings
453: Durham & IH10 - WBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑↑↑						↑↑↑	
Volume (vph)	0	0	0	243	882	0	0	0	0	0	1793	487
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	0	5029	0	0	0	0	0	6196	0
Flt Permitted					0.989							
Satd. Flow (perm)	0	0	0	0	5029	0	0	0	0	0	6196	0
Right Turn on Red			Yes	Yes		Yes			Yes			Yes
Satd. Flow (RTOR)					64						49	
Link Speed (mph)		40			40			35			35	
Link Distance (ft)		575			310			312			2613	
Travel Time (s)		9.8			5.3			6.1			50.9	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.89	0.89	0.93	0.93	0.93	0.93	0.93	0.98	0.96
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	0	1454	0	0	0	0	0	2687	0
Turn Type				Perm	NA						NA	
Protected Phases					8 16						6	
Permitted Phases				8 16								
Detector Phase				8 16	8 16						6	
Switch Phase												
Minimum Initial (s)											4.0	
Minimum Split (s)											21.0	
Total Split (s)											56.0	
Total Split (%)											46.7%	
Yellow Time (s)											3.5	
All-Red Time (s)											1.5	
Lost Time Adjust (s)											0.0	
Total Lost Time (s)											5.0	
Lead/Lag											Lead	
Lead-Lag Optimize?											Yes	
Recall Mode											C-Max	
Act Effct Green (s)					59.0						51.0	
Actuated g/C Ratio					0.49						0.42	
v/c Ratio					0.58						1.01	
Control Delay					23.3						42.6	
Queue Delay					4.1						35.6	
Total Delay					27.3						78.3	
LOS					C						E	

Lanes, Volumes, Timings
 453: Durham & IH10 - WBFR

11/30/2017

Lane Group	ø1	ø2	ø4	ø8	ø12	ø16
Lane Configurations						
Volume (vph)						
Ideal Flow (vphpl)						
Lane Width (ft)						
Grade (%)						
Storage Length (ft)						
Storage Lanes						
Taper Length (ft)						
Satd. Flow (prot)						
Flt Permitted						
Satd. Flow (perm)						
Right Turn on Red						
Satd. Flow (RTOR)						
Link Speed (mph)						
Link Distance (ft)						
Travel Time (s)						
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor						
Growth Factor						
Heavy Vehicles (%)						
Bus Blockages (#/hr)						
Parking (#/hr)						
Mid-Block Traffic (%)						
Shared Lane Traffic (%)						
Lane Group Flow (vph)						
Turn Type						
Protected Phases	1	2	4	8	12	16
Permitted Phases						
Detector Phase						
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	21.0	21.0	20.0	20.0
Total Split (s)	56.0	21.0	22.0	21.0	21.0	43.0
Total Split (%)	47%	18%	18%	18%	18%	36%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)						
Total Lost Time (s)						
Lead/Lag	Lag	Lead	Lag	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	
Recall Mode	None	Max	None	Max	None	None
Act Effct Green (s)						
Actuated g/C Ratio						
v/c Ratio						
Control Delay						
Queue Delay						
Total Delay						
LOS						

Lanes, Volumes, Timings
 453: Durham & IH10 - WBFR

11/30/2017

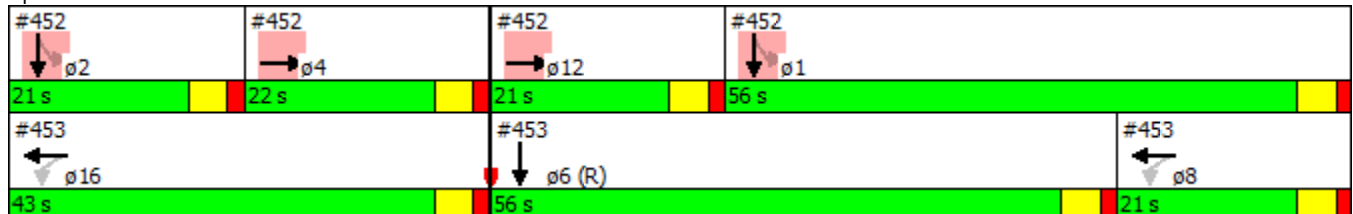


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					27.3							78.3
Approach LOS					C							E
Queue Length 50th (ft)					335							~505
Queue Length 95th (ft)					310							m426
Internal Link Dist (ft)		495			230			232				2533
Turn Bay Length (ft)												
Base Capacity (vph)					2505							2661
Starvation Cap Reductn					950							0
Spillback Cap Reductn					2							576
Storage Cap Reductn					0							0
Reduced v/c Ratio					0.94							1.29

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	94 (78%), Referenced to phase 6:SBT, Start of Green
Natural Cycle:	115
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	1.01
Intersection Signal Delay:	60.4
Intersection LOS:	E
Intersection Capacity Utilization:	72.9%
ICU Level of Service:	C
Analysis Period (min):	15
~ Volume exceeds capacity, queue is theoretically infinite. Queue shown is maximum after two cycles.	
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 453: Durham & IH10 - WBFR



Lane Group	ø1	ø2	ø4	ø8	ø12	ø16
Approach Delay						
Approach LOS						
Queue Length 50th (ft)						
Queue Length 95th (ft)						
Internal Link Dist (ft)						
Turn Bay Length (ft)						
Base Capacity (vph)						
Starvation Cap Reductn						
Spillback Cap Reductn						
Storage Cap Reductn						
Reduced v/c Ratio						
Intersection Summary						

Lanes, Volumes, Timings
454: W 11th

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑	↑	↑	↑↑						↑↑↑	
Volume (vph)	0	458	228	199	567	0	0	0	0	262	1908	413
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		150	50		0	0		0	0		0
Storage Lanes	0		1	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3360	1441	1770	3539	0	0	0	0	0	6210	0
Flt Permitted				0.302							0.995	
Satd. Flow (perm)	0	3360	1441	563	3539	0	0	0	0	0	6210	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		1	21									63
Link Speed (mph)		30			30			35				35
Link Distance (ft)		421			536			1925				2048
Travel Time (s)		9.6			12.2			37.5				39.9
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.87	0.84	0.94	0.90	0.93	0.93	0.93	0.93	0.91	0.92	0.83
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)			12%									
Lane Group Flow (vph)	0	642	275	243	724	0	0	0	0	0	3288	0
Turn Type		NA	Perm	Perm	NA					Perm	NA	
Protected Phases		2			6							4
Permitted Phases			2	6						4		
Detector Phase		2	2	6	6					4	4	
Switch Phase												
Minimum Initial (s)		10.0	10.0	10.0	10.0					10.0	10.0	
Minimum Split (s)		21.2	21.2	21.2	21.2					21.3	21.3	
Total Split (s)		55.0	55.0	55.0	55.0					65.0	65.0	
Total Split (%)		45.8%	45.8%	45.8%	45.8%					54.2%	54.2%	
Yellow Time (s)		3.6	3.6	3.6	3.6					3.6	3.6	
All-Red Time (s)		1.6	1.6	1.6	1.6					1.7	1.7	
Lost Time Adjust (s)		0.0	0.0	0.0	0.0						0.0	
Total Lost Time (s)		5.2	5.2	5.2	5.2						5.3	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		None	None	None	None					C-Max	C-Max	
Act Effect Green (s)		49.8	49.8	49.8	49.8						59.7	
Actuated g/C Ratio		0.42	0.42	0.42	0.42						0.50	
v/c Ratio		0.46	0.45	1.04	0.49						1.05	
Control Delay		26.7	26.1	96.4	17.6						58.1	
Queue Delay		0.0	0.0	0.0	0.0						0.0	
Total Delay		26.7	26.1	96.4	17.6						58.1	
LOS		C	C	F	B						E	

Lanes, Volumes, Timings

454: W 11th

11/30/2017

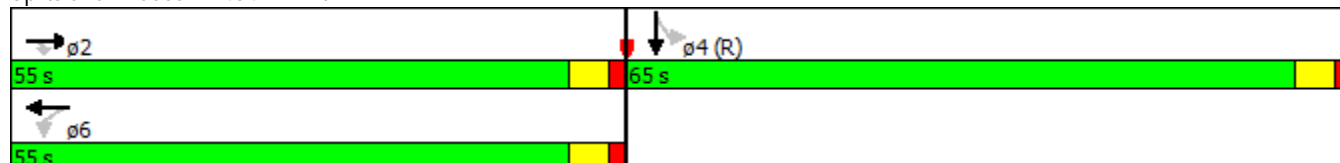


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		26.5			37.4							58.1
Approach LOS		C			D							E
Queue Length 50th (ft)		193	152	~143	204							~779
Queue Length 95th (ft)		239	216	#301	294							#848
Internal Link Dist (ft)		341			456			1845				1968
Turn Bay Length (ft)			150	50								
Base Capacity (vph)		1394	610	233	1468							3121
Starvation Cap Reductn		0	0	0	0							0
Spillback Cap Reductn		0	0	0	0							0
Storage Cap Reductn		0	0	0	0							0
Reduced v/c Ratio		0.46	0.45	1.04	0.49							1.05

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 15 (13%), Referenced to phase 4:SBTL, Start of Green
 Natural Cycle: 120
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.05
 Intersection Signal Delay: 48.6
 Intersection LOS: D
 Intersection Capacity Utilization 87.4%
 ICU Level of Service E
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 454: W 11th



Lanes, Volumes, Timings

455: W 14th

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	23	90	94	37	0	0	0	0	61	2231	15
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1669	0	0	1799	0	0	0	0	0	6382	0
Flt Permitted					0.484						0.998	
Satd. Flow (perm)	0	1669	0	0	902	0	0	0	0	0	6382	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		2										4
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		332			488			2048			157	
Travel Time (s)		7.5			11.1			39.9			3.1	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.57	0.66	0.84	0.77	0.93	0.93	0.93	0.93	0.76	0.92	0.47
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	203	0	0	184	0	0	0	0	0	2918	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		2			6						4	
Permitted Phases				6						4		
Detector Phase		2		6	6					4	4	
Switch Phase												
Minimum Initial (s)		11.0		11.0	11.0					11.0	11.0	
Minimum Split (s)		22.7		20.7	20.7					21.1	21.1	
Total Split (s)		39.0		39.0	39.0					81.0	81.0	
Total Split (%)		32.5%		32.5%	32.5%					67.5%	67.5%	
Yellow Time (s)		3.2		3.2	3.2					3.6	3.6	
All-Red Time (s)		1.5		1.5	1.5					1.5	1.5	
Lost Time Adjust (s)		0.0			0.0						0.0	
Total Lost Time (s)		4.7			4.7						5.1	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		None		None	None					C-Max	C-Max	
Act Effect Green (s)		26.1			26.1						84.1	
Actuated g/C Ratio		0.22			0.22						0.70	
v/c Ratio		0.56			0.94						0.65	
Control Delay		46.1			76.6						11.7	
Queue Delay		0.0			0.0						0.0	
Total Delay		46.1			76.6						11.7	
LOS		D			E						B	

Lanes, Volumes, Timings

455: W 14th

11/30/2017



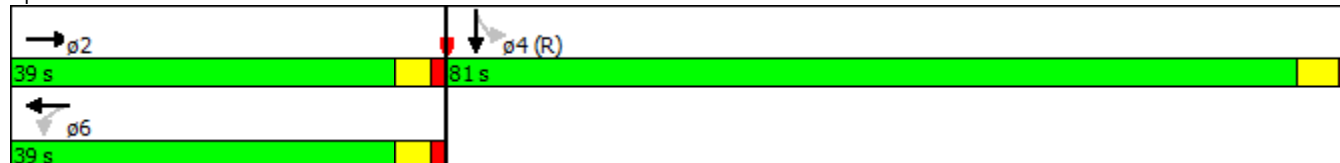
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		46.1			76.6							11.7
Approach LOS		D			E							B
Queue Length 50th (ft)		138			150							332
Queue Length 95th (ft)		117			174							453
Internal Link Dist (ft)		252			408			1968				77
Turn Bay Length (ft)												
Base Capacity (vph)		478			257							4472
Starvation Cap Reductn		0			0							0
Spillback Cap Reductn		0			0							0
Storage Cap Reductn		0			0							0
Reduced v/c Ratio		0.42			0.72							0.65

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 13 (11%), Referenced to phase 4:SBTL, Start of Green
 Natural Cycle: 60
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.94
 Intersection Signal Delay: 17.4
 Intersection Capacity Utilization 69.0%
 Analysis Period (min) 15

Intersection LOS: B
 ICU Level of Service C

Splits and Phases: 455: W 14th



Lanes, Volumes, Timings
456: N Durham Dr & W 19th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	129	87	54	131	0	0	0	0	69	2038	33
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1755	0	0	1835	0	0	0	0	0	6382	0
Flt Permitted					0.796						0.998	
Satd. Flow (perm)	0	1755	0	0	1483	0	0	0	0	0	6382	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)												9
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		618			668			633			368	
Travel Time (s)		14.0			15.2			12.3			7.2	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.79	0.70	0.71	0.78	0.93	0.93	0.93	0.93	0.75	0.89	0.82
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	331	0	0	280	0	0	0	0	0	2785	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		4			8						6	
Permitted Phases				8						6		
Detector Phase		4		8	8					6	6	
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0					4.0	4.0	
Minimum Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (%)		50.0%		50.0%	50.0%					50.0%	50.0%	
Yellow Time (s)		3.5		3.5	3.5					3.5	3.5	
All-Red Time (s)		1.5		1.5	1.5					1.5	1.5	
Lost Time Adjust (s)		0.0			0.0						0.0	
Total Lost Time (s)		5.0			5.0						5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max		Max	Max					Max	Max	
Act Effect Green (s)		15.0			15.0						15.0	
Actuated g/C Ratio		0.38			0.38						0.38	
v/c Ratio		0.50			0.50						1.16	
Control Delay		12.9			21.8						89.9	
Queue Delay		0.0			0.0						0.0	
Total Delay		12.9			21.8						89.9	
LOS		B			C						F	

Lanes, Volumes, Timings
 456: N Durham Dr & W 19th St

11/30/2017

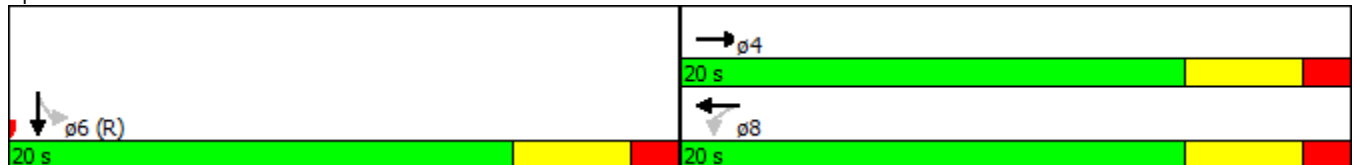


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		12.9			21.8							89.9
Approach LOS		B			C							F
Queue Length 50th (ft)		54			68							~201
Queue Length 95th (ft)		89			109							m#100
Internal Link Dist (ft)		538			588			553				288
Turn Bay Length (ft)												
Base Capacity (vph)		658			556							2398
Starvation Cap Reductn		0			0							0
Spillback Cap Reductn		0			0							0
Storage Cap Reductn		0			0							0
Reduced v/c Ratio		0.50			0.50							1.16

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 55
 Control Type: Pretimed
 Maximum v/c Ratio: 1.16
 Intersection Signal Delay: 76.8
 Intersection LOS: E
 Intersection Capacity Utilization 73.6%
 ICU Level of Service D
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 456: N Durham Dr & W 19th St



Lanes, Volumes, Timings
457: N Durham Dr & W 20th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	121	39	83	179	0	0	0	0	88	2047	131
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1790	0	0	1833	0	0	0	0	0	6331	0
Flt Permitted					0.810						0.998	
Satd. Flow (perm)	0	1790	0	0	1509	0	0	0	0	0	6331	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)												42
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		582			183			368			1486	
Travel Time (s)		13.2			4.2			7.2			28.9	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.82	0.65	0.83	0.84	0.93	0.93	0.93	0.93	0.81	0.92	0.80
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	239	0	0	360	0	0	0	0	0	2872	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		4			8						6	
Permitted Phases				8						6		
Detector Phase		4		8	8					6	6	
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0					4.0	4.0	
Minimum Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (%)		50.0%		50.0%	50.0%					50.0%	50.0%	
Yellow Time (s)		3.5		3.5	3.5					3.5	3.5	
All-Red Time (s)		1.5		1.5	1.5					1.5	1.5	
Lost Time Adjust (s)		0.0			0.0						0.0	
Total Lost Time (s)		5.0			5.0						5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max		Max	Max					Max	Max	
Act Effect Green (s)		15.0			15.0						15.0	
Actuated g/C Ratio		0.38			0.38						0.38	
v/c Ratio		0.36			0.64						1.20	
Control Delay		10.9			26.0						105.1	
Queue Delay		0.0			0.0						0.0	
Total Delay		10.9			26.0						105.1	
LOS		B			C						F	

Lanes, Volumes, Timings
457: N Durham Dr & W 20th St

11/30/2017

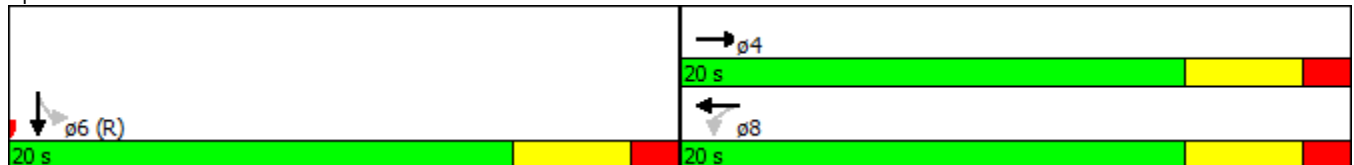


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		10.9			26.0							105.1
Approach LOS		B			C							F
Queue Length 50th (ft)		36			83							~265
Queue Length 95th (ft)		67			144							m#228
Internal Link Dist (ft)		502			103			288				1406
Turn Bay Length (ft)												
Base Capacity (vph)		671			565							2400
Starvation Cap Reductn		0			0							0
Spillback Cap Reductn		0			0							0
Storage Cap Reductn		0			0							0
Reduced v/c Ratio		0.36			0.64							1.20

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 60
 Control Type: Pretimed
 Maximum v/c Ratio: 1.20
 Intersection Signal Delay: 90.4
 Intersection LOS: F
 Intersection Capacity Utilization 76.8%
 ICU Level of Service D
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 457: N Durham Dr & W 20th St



Lanes, Volumes, Timings
458: N Durham Dr & W 24th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	18	47	36	17	0	0	0	0	23	2152	33
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1667	0	0	1807	0	0	0	0	0	6382	0
Flt Permitted					0.786						0.999	
Satd. Flow (perm)	0	1667	0	0	1464	0	0	0	0	0	6382	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)												10
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		555			660			1486			1120	
Travel Time (s)		12.6			15.0			28.9			21.8	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.75	0.56	0.69	0.53	0.93	0.93	0.93	0.93	0.82	0.96	0.75
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	125	0	0	97	0	0	0	0	0	2661	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		4			8						6	
Permitted Phases				8						6		
Detector Phase		4		8	8					6	6	
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0					4.0	4.0	
Minimum Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (%)		50.0%		50.0%	50.0%					50.0%	50.0%	
Yellow Time (s)		3.5		3.5	3.5					3.5	3.5	
All-Red Time (s)		1.5		1.5	1.5					1.5	1.5	
Lost Time Adjust (s)		0.0			0.0						0.0	
Total Lost Time (s)		5.0			5.0						5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max		Max	Max					Max	Max	
Act Effect Green (s)		15.0			15.0						15.0	
Actuated g/C Ratio		0.38			0.38						0.38	
v/c Ratio		0.20			0.18						1.11	
Control Delay		9.5			11.9						72.3	
Queue Delay		0.0			0.0						0.0	
Total Delay		9.5			11.9						72.3	
LOS		A			B						E	

Lanes, Volumes, Timings
458: N Durham Dr & W 24th St

11/30/2017

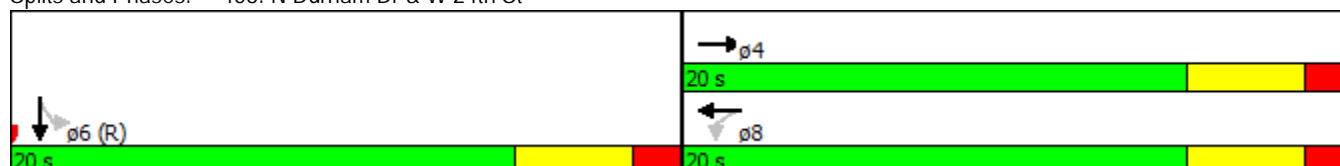


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		9.5			11.9							72.3
Approach LOS		A			B							E
Queue Length 50th (ft)		18			12							~214
Queue Length 95th (ft)		34			18							#284
Internal Link Dist (ft)		475			580			1406				1040
Turn Bay Length (ft)												
Base Capacity (vph)		625			549							2399
Starvation Cap Reductn		0			0							0
Spillback Cap Reductn		0			0							0
Storage Cap Reductn		0			0							0
Reduced v/c Ratio		0.20			0.18							1.11

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 50
 Control Type: Pretimed
 Maximum v/c Ratio: 1.11
 Intersection Signal Delay: 67.5
 Intersection LOS: E
 Intersection Capacity Utilization 55.2%
 ICU Level of Service B
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 458: N Durham Dr & W 24th St



Lanes, Volumes, Timings
459: N Durham Dr & IH 610 EBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑								↘	↑↑↑	
Volume (vph)	0	768	231	0	0	0	0	0	0	561	1989	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	4897	0	0	0	0	0	0	0	1770	6408	0
Flt Permitted										0.950		
Satd. Flow (perm)	0	4897	0	0	0	0	0	0	0	1770	6408	0
Right Turn on Red			Yes			Yes			Yes	Yes		Yes
Satd. Flow (RTOR)		1								44		
Link Speed (mph)		45			10			30			30	
Link Distance (ft)		410			526			607			264	
Travel Time (s)		6.2			35.9			13.8			6.0	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.85	0.79	0.93	0.93	0.93	0.93	0.93	0.93	0.89	0.97	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	1375	0	0	0	0	0	0	0	725	2358	0
Turn Type		NA								Perm	NA	
Protected Phases		4									6	
Permitted Phases										6		
Detector Phase		4								6	6	
Switch Phase												
Minimum Initial (s)		4.0								4.0	4.0	
Minimum Split (s)		20.0								20.0	20.0	
Total Split (s)		20.0								30.0	30.0	
Total Split (%)		40.0%								60.0%	60.0%	
Yellow Time (s)		3.5								3.5	3.5	
All-Red Time (s)		1.5								1.5	1.5	
Lost Time Adjust (s)		0.0								0.0	0.0	
Total Lost Time (s)		5.0								5.0	5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max								Max	Max	
Act Effct Green (s)		15.0								25.0	25.0	
Actuated g/C Ratio		0.30								0.50	0.50	
v/c Ratio		0.94								0.80	0.74	
Control Delay		31.7								18.9	11.6	
Queue Delay		0.0								25.4	3.1	
Total Delay		31.7								44.3	14.7	
LOS		C								D	B	

Lanes, Volumes, Timings
 459: N Durham Dr & IH 610 EBFR

11/30/2017

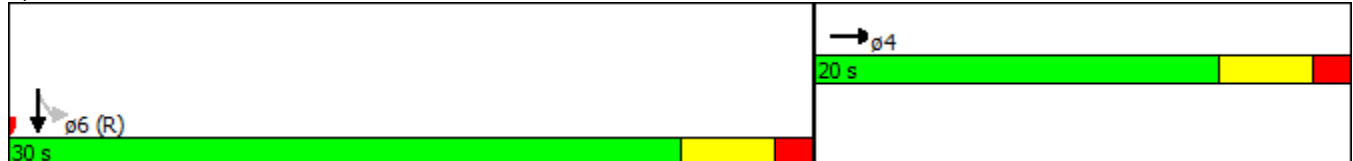


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		31.7										21.6
Approach LOS		C										C
Queue Length 50th (ft)		141								149	143	
Queue Length 95th (ft)		#206								#331	182	
Internal Link Dist (ft)		330			446			527				184
Turn Bay Length (ft)												
Base Capacity (vph)		1469								907	3204	
Starvation Cap Reductn		0								205	720	
Spillback Cap Reductn		0								0	0	
Storage Cap Reductn		0								0	0	
Reduced v/c Ratio		0.94								1.03	0.95	

Intersection Summary

Area Type: Other
 Cycle Length: 50
 Actuated Cycle Length: 50
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 55
 Control Type: Pretimed
 Maximum v/c Ratio: 0.94
 Intersection Signal Delay: 24.7
 Intersection LOS: C
 Intersection Capacity Utilization 109.8%
 ICU Level of Service H
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 459: N Durham Dr & IH 610 EBFR



Lanes, Volumes, Timings
460: N Durham Dr & IH 610 WBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	666	535	0	0	0	0	0	1963	800
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	1610	3333	0	0	0	0	0	6126	0
Flt Permitted				0.950	0.983							
Satd. Flow (perm)	0	0	0	1610	3333	0	0	0	0	0	6126	0
Right Turn on Red			Yes	Yes		Yes			Yes			Yes
Satd. Flow (RTOR)				55	55							97
Link Speed (mph)		45			45			35				35
Link Distance (ft)		407			398			264				706
Travel Time (s)		6.2			6.0			5.1				13.8
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.88	0.90	0.93	0.93	0.93	0.93	0.93	0.96	0.95
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)				42%								
Lane Group Flow (vph)	0	0	0	505	1049	0	0	0	0	0	3320	0
Turn Type				Perm	NA							NA
Protected Phases					8							6
Permitted Phases				8								
Detector Phase				8	8							6
Switch Phase												
Minimum Initial (s)				4.0	4.0							4.0
Minimum Split (s)				20.0	20.0							20.0
Total Split (s)				20.0	20.0							20.0
Total Split (%)				50.0%	50.0%							50.0%
Yellow Time (s)				3.5	3.5							3.5
All-Red Time (s)				1.5	1.5							1.5
Lost Time Adjust (s)				0.0	0.0							0.0
Total Lost Time (s)				5.0	5.0							5.0
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode				Max	Max							Max
Act Effect Green (s)				15.0	15.0							15.0
Actuated g/C Ratio				0.38	0.38							0.38
v/c Ratio				0.79	0.82							1.46dr
Control Delay				17.7	13.9							204.8
Queue Delay				0.0	0.0							0.0
Total Delay				17.7	13.9							204.8
LOS				B	B							F

Lanes, Volumes, Timings
460: N Durham Dr & IH 610 WBFR

11/30/2017

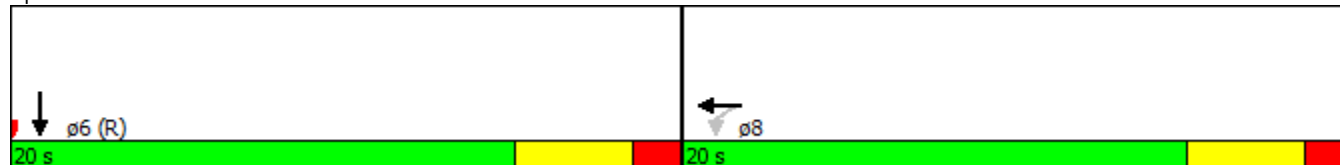


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					15.1							204.8
Approach LOS					B							F
Queue Length 50th (ft)				57	66							~314
Queue Length 95th (ft)				m#123	m#125							#387
Internal Link Dist (ft)		327			318			184				626
Turn Bay Length (ft)												
Base Capacity (vph)				638	1284							2357
Starvation Cap Reductn				0	0							0
Spillback Cap Reductn				0	0							0
Storage Cap Reductn				0	0							0
Reduced v/c Ratio				0.79	0.82							1.41

Intersection Summary

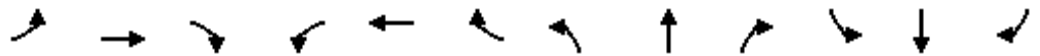
Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBT, Start of Green
 Natural Cycle: 90
 Control Type: Pretimed
 Maximum v/c Ratio: 1.41
 Intersection Signal Delay: 144.4 Intersection LOS: F
 Intersection Capacity Utilization 82.6% ICU Level of Service E
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.
 dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Splits and Phases: 460: N Durham Dr & IH 610 WBFR



Lanes, Volumes, Timings
461: Shepherd & Washington

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	29	698	0	0	532	109	264	868	75	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	90		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1770	3539	0	0	3416	0	0	6280	0	0	0	0
Flt Permitted	0.950							0.989				
Satd. Flow (perm)	1770	3539	0	0	3416	0	0	6280	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					19			16				
Link Speed (mph)		30			30			30				30
Link Distance (ft)		322			1068			522				252
Travel Time (s)		7.3			24.3			11.9				5.7
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	5	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	34	828	0	0	760	0	0	1431	0	0	0	0
Turn Type	Prot	NA			NA		Perm	NA				
Protected Phases	5	2			6			8				
Permitted Phases							8					
Detector Phase	5	2			6		8	8				
Switch Phase												
Minimum Initial (s)	5.0	10.0			10.0		10.0	10.0				
Minimum Split (s)	10.0	21.0			21.0		18.0	18.0				
Total Split (s)	20.0	55.0			35.0		65.0	65.0				
Total Split (%)	16.7%	45.8%			29.2%		54.2%	54.2%				
Yellow Time (s)	3.6	3.6			3.6		3.6	3.6				
All-Red Time (s)	1.4	1.4			1.4		1.4	1.4				
Lost Time Adjust (s)	0.0	0.0			0.0			0.0				
Total Lost Time (s)	5.0	5.0			5.0			5.0				
Lead/Lag	Lead				Lag							
Lead-Lag Optimize?	Yes				Yes							
Recall Mode	Max	Max			Max		C-Max	C-Max				
Act Effct Green (s)	15.0	50.0			30.0			60.0				
Actuated g/C Ratio	0.12	0.42			0.25			0.50				
v/c Ratio	0.15	0.56			0.88			0.45				
Control Delay	68.2	19.5			59.3			33.9				
Queue Delay	0.0	1.5			0.0			0.0				
Total Delay	68.2	21.0			59.3			34.0				
LOS	E	C			E			C				

Lanes, Volumes, Timings
461: Shepherd & Washington

11/30/2017

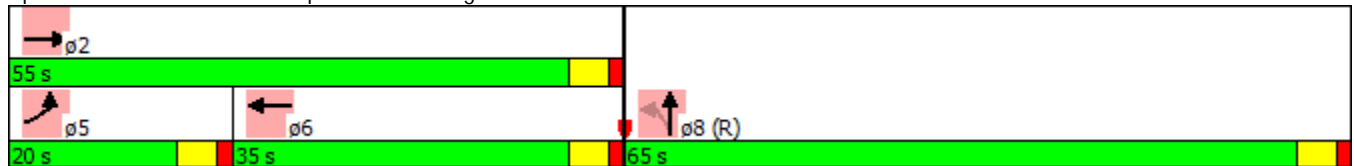


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		22.8			59.3			34.0				
Approach LOS		C			E			C				
Queue Length 50th (ft)	28	138			305			304				
Queue Length 95th (ft)	m33	m204			m#363			350				
Internal Link Dist (ft)		242			988			442			172	
Turn Bay Length (ft)	90											
Base Capacity (vph)	221	1474			868			3148				
Starvation Cap Reductn	0	429			0			0				
Spillback Cap Reductn	0	0			1			170				
Storage Cap Reductn	0	0			0			0				
Reduced v/c Ratio	0.15	0.79			0.88			0.48				

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 0 (0%), Referenced to phase 8:NBTL, Start of Green
 Natural Cycle: 50
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.88
 Intersection Signal Delay: 37.1
 Intersection LOS: D
 Intersection Capacity Utilization 80.4%
 ICU Level of Service D
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 461: Shepherd & Washington



Lanes, Volumes, Timings
462: Shepherd & Center

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕↕↕				
Volume (vph)	30	24	0	0	18	28	9	1011	17	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1820	0	0	1730	0	0	6382	0	0	0	0
Flt Permitted		0.845						0.999				
Satd. Flow (perm)	0	1574	0	0	1730	0	0	6382	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					46			6				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		320			502			252				2176
Travel Time (s)		7.3			11.4			4.9				42.4
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.83	0.60	0.93	0.93	0.50	0.70	0.56	0.93	0.71	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	88	0	0	87	0	0	1296	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4						2					
Detector Phase	4	4			8		2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (s)	41.0	41.0			41.0		79.0	79.0				
Total Split (%)	34.2%	34.2%			34.2%		65.8%	65.8%				
Yellow Time (s)	3.5	3.5			3.5		3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5		1.5	1.5				
Lost Time Adjust (s)		0.0			0.0			0.0				
Total Lost Time (s)		5.0			5.0			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max		Max	Max				
Act Effct Green (s)		36.0			36.0			74.0				
Actuated g/C Ratio		0.30			0.30			0.62				
v/c Ratio		0.19			0.16			0.33				
Control Delay		29.3			16.8			2.9				
Queue Delay		0.0			0.0			0.1				
Total Delay		29.3			16.8			3.1				
LOS		C			B			A				

Lanes, Volumes, Timings
462: Shepherd & Center

11/30/2017

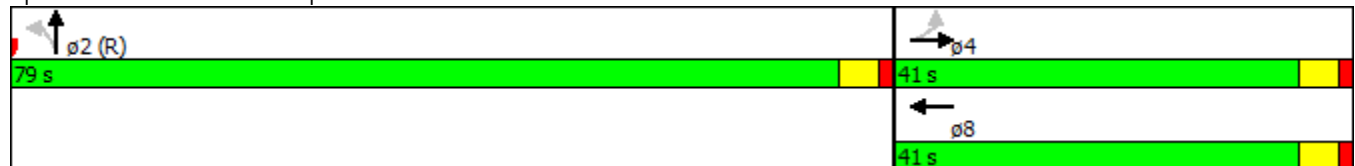


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		29.3			16.8			3.1				
Approach LOS		C			B			A				
Queue Length 50th (ft)		51			23			39				
Queue Length 95th (ft)		m59			22			44				
Internal Link Dist (ft)		240			422			172			2096	
Turn Bay Length (ft)												
Base Capacity (vph)		472			551			3937				
Starvation Cap Reductn		0			0			1380				
Spillback Cap Reductn		0			0			0				
Storage Cap Reductn		0			0			0				
Reduced v/c Ratio		0.19			0.16			0.51				

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
Natural Cycle:	40
Control Type:	Pretimed
Maximum v/c Ratio:	0.33
Intersection Signal Delay:	5.5
Intersection LOS:	A
Intersection Capacity Utilization:	35.7%
ICU Level of Service:	A
Analysis Period (min):	15
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 462: Shepherd & Center



Lanes, Volumes, Timings
463: Shepherd & IH10 - EBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	412	463	0	0	0	0	0	985	131	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1610	3356	0	0	0	0	0	6286	0	0	0	0
Flt Permitted	0.950	0.990										
Satd. Flow (perm)	1610	3356	0	0	0	0	0	6286	0	0	0	0
Right Turn on Red	Yes		Yes			Yes			Yes			Yes
Satd. Flow (RTOR)	64	64						34				
Link Speed (mph)		40			40			35				35
Link Distance (ft)		306			534			2176				316
Travel Time (s)		5.2			9.1			42.4				6.2
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.95	0.89	0.93	0.93	0.93	0.93	0.93	0.89	0.80	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	3	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)	29%											
Lane Group Flow (vph)	354	743	0	0	0	0	0	1461	0	0	0	0
Turn Type	Perm	NA						NA				
Protected Phases		4 12						2				
Permitted Phases	4 12											
Detector Phase	4 12	4 12						2				
Switch Phase												
Minimum Initial (s)								4.0				
Minimum Split (s)								21.0				
Total Split (s)								47.0				
Total Split (%)								39.2%				
Yellow Time (s)								3.5				
All-Red Time (s)								1.5				
Lost Time Adjust (s)								0.0				
Total Lost Time (s)								5.0				
Lead/Lag								Lead				
Lead-Lag Optimize?								Yes				
Recall Mode								C-Max				
Act Effct Green (s)	68.0	68.0						42.0				
Actuated g/C Ratio	0.57	0.57						0.35				
v/c Ratio	0.38	0.39						0.66				
Control Delay	4.8	5.5						36.7				
Queue Delay	1.1	0.7						0.3				
Total Delay	5.9	6.2						37.0				
LOS	A	A						D				

Lane Group	ø4	ø5	ø6	ø8	ø12	ø16
Lane Configurations						
Volume (vph)						
Ideal Flow (vphpl)						
Lane Width (ft)						
Grade (%)						
Storage Length (ft)						
Storage Lanes						
Taper Length (ft)						
Satd. Flow (prot)						
Flt Permitted						
Satd. Flow (perm)						
Right Turn on Red						
Satd. Flow (RTOR)						
Link Speed (mph)						
Link Distance (ft)						
Travel Time (s)						
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor						
Growth Factor						
Heavy Vehicles (%)						
Bus Blockages (#/hr)						
Parking (#/hr)						
Mid-Block Traffic (%)						
Shared Lane Traffic (%)						
Lane Group Flow (vph)						
Turn Type						
Protected Phases	4	5	6	8	12	16
Permitted Phases						
Detector Phase						
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	20.0	21.0	20.0	20.0
Total Split (s)	24.0	49.0	20.0	29.0	49.0	22.0
Total Split (%)	20%	41%	17%	24%	41%	18%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)						
Total Lost Time (s)						
Lead/Lag	Lag	Lag	Lead	Lag		Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes		Yes
Recall Mode	Max	None	None	None	None	None
Act Effct Green (s)						
Actuated g/C Ratio						
v/c Ratio						
Control Delay						
Queue Delay						
Total Delay						
LOS						

Lanes, Volumes, Timings
 463: Shepherd & IH10 - EBFR

11/30/2017

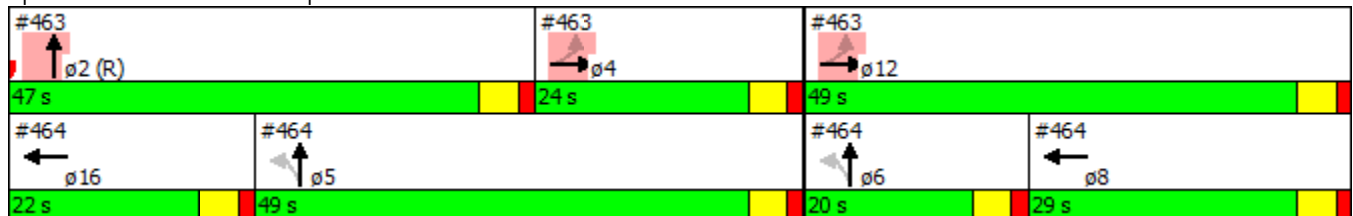


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		6.1						37.0				
Approach LOS		A						D				
Queue Length 50th (ft)	25	42						191				
Queue Length 95th (ft)	m43	m60						229				
Internal Link Dist (ft)		226			454			2096			236	
Turn Bay Length (ft)												
Base Capacity (vph)	940	1929						2224				
Starvation Cap Reductn	363	781						0				
Spillback Cap Reductn	2	1						252				
Storage Cap Reductn	0	0						0				
Reduced v/c Ratio	0.61	0.65						0.74				

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 17 (14%), Referenced to phase 2:NBT, Start of Green
 Natural Cycle: 85
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.66
 Intersection Signal Delay: 23.8 Intersection LOS: C
 Intersection Capacity Utilization 51.4% ICU Level of Service A
 Analysis Period (min) 15
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 463: Shepherd & IH10 - EBFR



Lane Group	ø4	ø5	ø6	ø8	ø12	ø16
Approach Delay						
Approach LOS						
Queue Length 50th (ft)						
Queue Length 95th (ft)						
Internal Link Dist (ft)						
Turn Bay Length (ft)						
Base Capacity (vph)						
Starvation Cap Reductn						
Spillback Cap Reductn						
Storage Cap Reductn						
Reduced v/c Ratio						
Intersection Summary						

Lanes, Volumes, Timings
464: Shepherd & IH10 - WBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑↑↑		↑	↑↑↑				
Volume (vph)	0	0	0	0	595	229	472	940	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	1		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	0	4867	0	1522	4772	0	0	0	0
Flt Permitted							0.950	0.993				
Satd. Flow (perm)	0	0	0	0	4867	0	1522	4772	0	0	0	0
Right Turn on Red			Yes			Yes	Yes		Yes			Yes
Satd. Flow (RTOR)					59		73	64				
Link Speed (mph)		40			40			35				35
Link Distance (ft)		310			534			316				3871
Travel Time (s)		5.3			9.1			6.2				75.4
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.93	0.88	0.84	0.87	0.93	0.93	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)							31%					
Lane Group Flow (vph)	0	0	0	0	1092	0	431	1355	0	0	0	0
Turn Type					NA		Perm	NA				
Protected Phases					8 16			5 6				
Permitted Phases							5 6					
Detector Phase					8 16		5 6	5 6				
Switch Phase												
Minimum Initial (s)												
Minimum Split (s)												
Total Split (s)												
Total Split (%)												
Yellow Time (s)												
All-Red Time (s)												
Lost Time Adjust (s)												
Total Lost Time (s)												
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode												
Act Effct Green (s)					40.8		69.2	69.2				
Actuated g/C Ratio					0.34		0.58	0.58				
v/c Ratio					0.64		0.47	0.49				
Control Delay					33.3		10.6	11.2				
Queue Delay					2.6		3.6	1.8				
Total Delay					35.8		14.1	12.9				
LOS					D		B	B				

Lanes, Volumes, Timings
 464: Shepherd & IH10 - WBFR

11/30/2017

Lane Group	ø2	ø4	ø5	ø6	ø8	ø12	ø16
Lane Configurations							
Volume (vph)							
Ideal Flow (vphpl)							
Lane Width (ft)							
Grade (%)							
Storage Length (ft)							
Storage Lanes							
Taper Length (ft)							
Satd. Flow (prot)							
Flt Permitted							
Satd. Flow (perm)							
Right Turn on Red							
Satd. Flow (RTOR)							
Link Speed (mph)							
Link Distance (ft)							
Travel Time (s)							
Confl. Peds. (#/hr)							
Confl. Bikes (#/hr)							
Peak Hour Factor							
Growth Factor							
Heavy Vehicles (%)							
Bus Blockages (#/hr)							
Parking (#/hr)							
Mid-Block Traffic (%)							
Shared Lane Traffic (%)							
Lane Group Flow (vph)							
Turn Type							
Protected Phases	2	4	5	6	8	12	16
Permitted Phases							
Detector Phase							
Switch Phase							
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	21.0	20.0	21.0	20.0	20.0
Total Split (s)	47.0	24.0	49.0	20.0	29.0	49.0	22.0
Total Split (%)	39%	20%	41%	17%	24%	41%	18%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)							
Total Lost Time (s)							
Lead/Lag	Lead	Lag	Lag	Lead	Lag		Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes		Yes
Recall Mode	C-Max	Max	None	None	None	None	None
Act Effct Green (s)							
Actuated g/C Ratio							
v/c Ratio							
Control Delay							
Queue Delay							
Total Delay							
LOS							

Lanes, Volumes, Timings
 464: Shepherd & IH10 - WBFR

11/30/2017

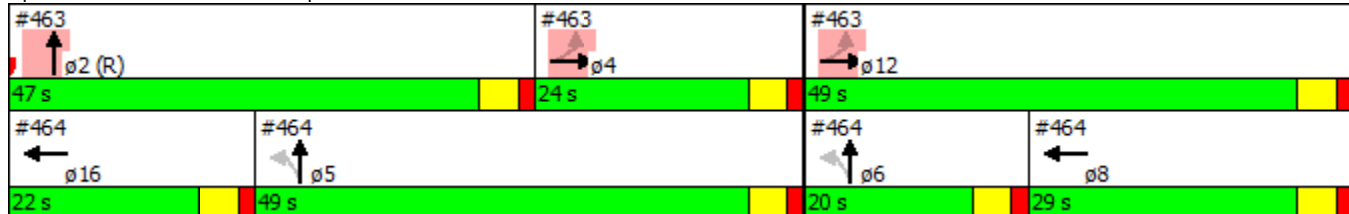


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					35.8			13.2				
Approach LOS					D			B				
Queue Length 50th (ft)					250		186	218				
Queue Length 95th (ft)					268		410	391				
Internal Link Dist (ft)		230			454			236			3791	
Turn Bay Length (ft)												
Base Capacity (vph)					1862		908	2778				
Starvation Cap Reductn					0		375	1194				
Spillback Cap Reductn					620		126	124				
Storage Cap Reductn					0		0	0				
Reduced v/c Ratio					0.88		0.81	0.86				

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	17 (14%), Referenced to phase 2:NBT, Start of Green
Natural Cycle:	85
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	0.66
Intersection Signal Delay:	21.8
Intersection LOS:	C
Intersection Capacity Utilization	51.4%
ICU Level of Service	A
Analysis Period (min)	15

Splits and Phases: 464: Shepherd & IH10 - WBFR



Lane Group	ø2	ø4	ø5	ø6	ø8	ø12	ø16
Approach Delay							
Approach LOS							
Queue Length 50th (ft)							
Queue Length 95th (ft)							
Internal Link Dist (ft)							
Turn Bay Length (ft)							
Base Capacity (vph)							
Starvation Cap Reductn							
Spillback Cap Reductn							
Storage Cap Reductn							
Reduced v/c Ratio							
Intersection Summary							

Lanes, Volumes, Timings
465: W 11th

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↘	↑↑			↑↑			↑↑↑				
Volume (vph)	107	468	1	0	534	99	187	793	92	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	50		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1770	3536	0	0	3468	0	0	6255	0	0	0	0
Flt Permitted	0.183							0.991				
Satd. Flow (perm)	341	3536	0	0	3468	0	0	6255	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		1			18			23				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		536			448			700				2008
Travel Time (s)		12.2			10.2			13.6				39.1
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.81	0.87	0.25	0.93	0.76	0.92	0.79	0.86	0.74	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	152	624	0	0	932	0	0	1475	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		2			6			8				
Permitted Phases	2						8					
Detector Phase	2	2			6		8	8				
Switch Phase												
Minimum Initial (s)	7.0	7.0			5.0		7.0	7.0				
Minimum Split (s)	21.2	21.2			21.2		21.0	21.0				
Total Split (s)	73.0	73.0			73.0		47.0	47.0				
Total Split (%)	60.8%	60.8%			60.8%		39.2%	39.2%				
Yellow Time (s)	3.6	3.6			3.6		3.6	3.6				
All-Red Time (s)	1.6	1.6			1.6		1.4	1.4				
Lost Time Adjust (s)	0.0	0.0			0.0			0.0				
Total Lost Time (s)	5.2	5.2			5.2			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	None	None			None		C-Max	C-Max				
Act Effct Green (s)	51.2	51.2			51.2			58.6				
Actuated g/C Ratio	0.43	0.43			0.43			0.49				
v/c Ratio	1.05	0.41			0.63			0.48				
Control Delay	106.1	19.7			27.4			9.6				
Queue Delay	0.0	0.0			0.0			0.0				
Total Delay	106.1	19.7			27.4			9.6				
LOS	F	B			C			A				

Lanes, Volumes, Timings

465: W 11th

11/30/2017

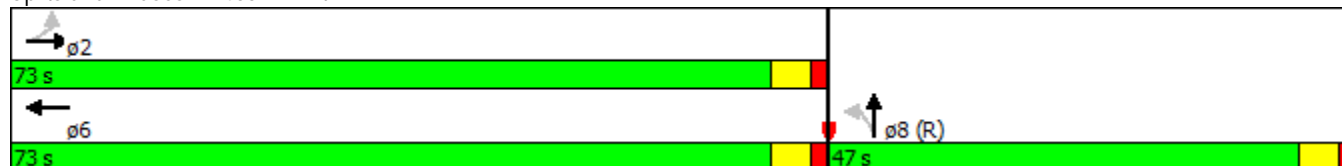


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		36.6			27.4			9.6				
Approach LOS		D			C			A				
Queue Length 50th (ft)	~80	100			281			105				
Queue Length 95th (ft)	m67	m82			205			115				
Internal Link Dist (ft)		456			368			620			1928	
Turn Bay Length (ft)	50											
Base Capacity (vph)	192	1998			1967			3065				
Starvation Cap Reductn	0	0			0			0				
Spillback Cap Reductn	0	0			0			0				
Storage Cap Reductn	0	0			0			0				
Reduced v/c Ratio	0.79	0.31			0.47			0.48				

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 14 (12%), Referenced to phase 8:NBTL, Start of Green
 Natural Cycle: 45
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.05
 Intersection Signal Delay: 21.4
 Intersection LOS: C
 Intersection Capacity Utilization 58.5%
 ICU Level of Service B
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 465: W 11th



Lanes, Volumes, Timings
466: W 14th

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕↕↕				
Volume (vph)	31	58	0	0	93	31	35	896	36	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1833	0	0	1799	0	0	6350	0	0	0	0
Flt Permitted		0.575						0.998				
Satd. Flow (perm)	0	1071	0	0	1799	0	0	6350	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					15			9				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		488			473			2008				644
Travel Time (s)		11.1			10.8			39.1				12.5
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.78	0.69	0.93	0.93	0.86	0.86	0.73	0.87	0.69	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	143	0	0	165	0	0	1299	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		2			6			8				
Permitted Phases	2						8					
Detector Phase	2	2			6		8	8				
Switch Phase												
Minimum Initial (s)	11.0	11.0			11.0		11.0	11.0				
Minimum Split (s)	45.0	45.0			45.0		40.0	40.0				
Total Split (s)	70.0	70.0			70.0		50.0	50.0				
Total Split (%)	58.3%	58.3%			58.3%		41.7%	41.7%				
Yellow Time (s)	3.5	3.5			3.5		3.2	3.2				
All-Red Time (s)	1.7	1.7			1.7		1.8	1.8				
Lost Time Adjust (s)		0.0			0.0			0.0				
Total Lost Time (s)		5.2			5.2			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	None	None			None		C-Max	C-Max				
Act Effct Green (s)		16.5			16.5			93.3				
Actuated g/C Ratio		0.14			0.14			0.78				
v/c Ratio		0.97			0.63			0.26				
Control Delay		115.5			54.8			8.1				
Queue Delay		0.0			0.0			0.0				
Total Delay		115.5			54.8			8.1				
LOS		F			D			A				

Lanes, Volumes, Timings

466: W 14th

11/30/2017

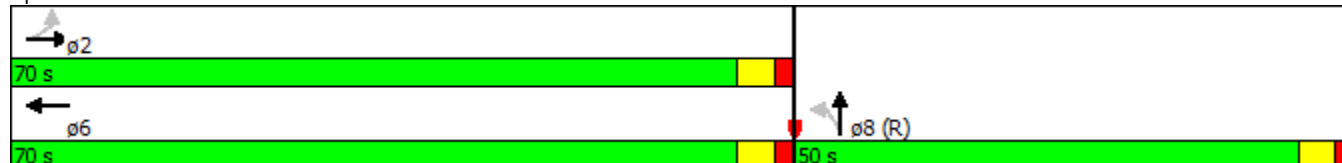


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		115.5			54.8			8.1				
Approach LOS		F			D			A				
Queue Length 50th (ft)		114			112			101				
Queue Length 95th (ft)		135			165			181				
Internal Link Dist (ft)		408			393			1928			564	
Turn Bay Length (ft)												
Base Capacity (vph)		578			978			4937				
Starvation Cap Reductn		0			0			0				
Spillback Cap Reductn		0			0			0				
Storage Cap Reductn		0			0			0				
Reduced v/c Ratio		0.25			0.17			0.26				

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	20 (17%), Referenced to phase 8:NBTL, Start of Green
Natural Cycle:	85
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	0.97
Intersection Signal Delay:	22.4
Intersection LOS:	C
Intersection Capacity Utilization	47.4%
ICU Level of Service	A
Analysis Period (min)	15

Splits and Phases: 466: W 14th



Lanes, Volumes, Timings
467: N Shepherd Dr & W 19th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↔			↑	↗		↔↔↔				
Volume (vph)	35	130	0	0	130	60	43	954	35	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		85	0		0	0		0	0		0
Storage Lanes	0		1	0		1	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3500	0	0	1863	1583	0	6357	0	0	0	0
Flt Permitted		0.865						0.998				
Satd. Flow (perm)	0	3061	0	0	1863	1583	0	6357	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						55		22				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		668			574			1789				375
Travel Time (s)		15.2			13.0			34.9				7.3
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.73	0.76	0.93	0.93	0.85	0.79	0.77	0.92	0.80	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	252	0	0	176	87	0	1306	0	0	0	0
Turn Type	Perm	NA			NA	Perm	Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4					8	2					
Detector Phase	4	4			8	8	2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0	4.0	4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0	20.0	20.0	20.0				
Total Split (s)	20.0	20.0			20.0	20.0	20.0	20.0				
Total Split (%)	50.0%	50.0%			50.0%	50.0%	50.0%	50.0%				
Yellow Time (s)	3.5	3.5			3.5	3.5	3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5	1.5	1.5	1.5				
Lost Time Adjust (s)		0.0			0.0	0.0		0.0				
Total Lost Time (s)		5.0			5.0	5.0		5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max	Max	Max	Max				
Act Effct Green (s)		15.0			15.0	15.0		15.0				
Actuated g/C Ratio		0.38			0.38	0.38		0.38				
v/c Ratio		0.22			0.25	0.14		0.54				
Control Delay		14.4			9.9	5.1		10.7				
Queue Delay		0.0			0.0	0.0		0.0				
Total Delay		14.4			9.9	5.1		10.7				
LOS		B			A	A		B				

Lanes, Volumes, Timings
467: N Shepherd Dr & W 19th St

11/30/2017

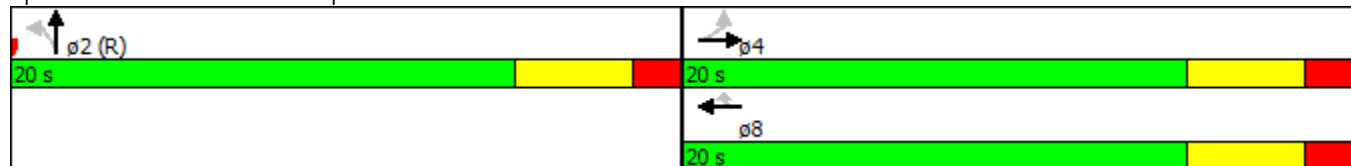


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		14.4			8.3			10.7				
Approach LOS		B			A			B				
Queue Length 50th (ft)		24			26	4		61				
Queue Length 95th (ft)		m32			52	19		86				
Internal Link Dist (ft)		588			494			1709			295	
Turn Bay Length (ft)												
Base Capacity (vph)		1147			698	628		2397				
Starvation Cap Reductn		0			0	0		0				
Spillback Cap Reductn		0			0	0		0				
Storage Cap Reductn		0			0	0		0				
Reduced v/c Ratio		0.22			0.25	0.14		0.54				

Intersection Summary

Area Type:	Other
Cycle Length:	40
Actuated Cycle Length:	40
Offset:	0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
Natural Cycle:	40
Control Type:	Pretimed
Maximum v/c Ratio:	0.54
Intersection Signal Delay:	10.9
Intersection LOS:	B
Intersection Capacity Utilization:	43.0%
ICU Level of Service:	A
Analysis Period (min):	15
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 467: N Shepherd Dr & W 19th St



Lanes, Volumes, Timings
468: N Shepherd Dr & W 20th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↔			↔↔			↔↔↔				
Volume (vph)	43	187	0	0	195	56	34	962	68	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		100	0		0	0		0	0		0
Storage Lanes	0		1	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3507	0	0	3394	0	0	6331	0	0	0	0
Flt Permitted		0.833						0.998				
Satd. Flow (perm)	0	2948	0	0	3394	0	0	6331	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					14			41				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		140			536			375				1478
Travel Time (s)		3.2			12.2			7.3				28.8
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.77	0.77	0.93	0.93	0.87	0.67	0.61	0.92	0.90	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	343	0	0	354	0	0	1353	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4						2					
Detector Phase	4	4			8		2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (%)	50.0%	50.0%			50.0%		50.0%	50.0%				
Yellow Time (s)	3.5	3.5			3.5		3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5		1.5	1.5				
Lost Time Adjust (s)		0.0			0.0			0.0				
Total Lost Time (s)		5.0			5.0			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max		Max	Max				
Act Effct Green (s)		15.0			15.0			15.0				
Actuated g/C Ratio		0.38			0.38			0.38				
v/c Ratio		0.31			0.28			0.56				
Control Delay		13.8			9.1			6.2				
Queue Delay		0.0			0.0			0.0				
Total Delay		13.8			9.1			6.2				
LOS		B			A			A				

Lanes, Volumes, Timings
 468: N Shepherd Dr & W 20th St

11/30/2017

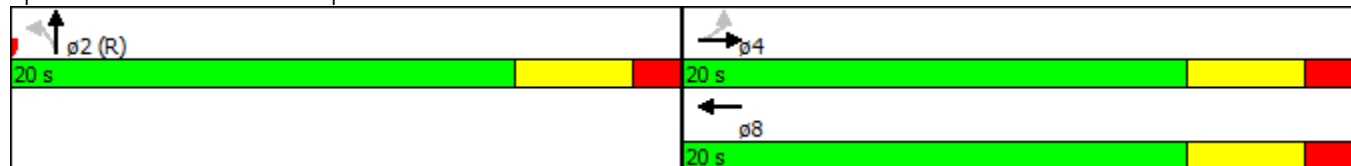


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		13.8			9.1			6.2				
Approach LOS		B			A			A				
Queue Length 50th (ft)		31			26			26				
Queue Length 95th (ft)		m38			45			48				
Internal Link Dist (ft)		60			456			295			1398	
Turn Bay Length (ft)												
Base Capacity (vph)		1105			1281			2399				
Starvation Cap Reductn		0			0			0				
Spillback Cap Reductn		0			0			0				
Storage Cap Reductn		0			0			0				
Reduced v/c Ratio		0.31			0.28			0.56				

Intersection Summary

Area Type:	Other
Cycle Length:	40
Actuated Cycle Length:	40
Offset:	0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
Natural Cycle:	40
Control Type:	Pretimed
Maximum v/c Ratio:	0.56
Intersection Signal Delay:	7.9
Intersection LOS:	A
Intersection Capacity Utilization:	46.1%
ICU Level of Service:	A
Analysis Period (min):	15
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 468: N Shepherd Dr & W 20th St



Lanes, Volumes, Timings
469: N Shepherd Dr & W 24th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕↕↕				
Volume (vph)	17	7	0	0	29	24	25	1126	7	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1807	0	0	1753	0	0	6382	0	0	0	0
Flt Permitted		0.847						0.998				
Satd. Flow (perm)	0	1578	0	0	1753	0	0	6382	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					5			6				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		660			543			1478				1697
Travel Time (s)		15.0			12.3			28.8				33.1
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.71	0.44	0.93	0.93	0.81	0.86	0.57	0.89	0.44	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	46	0	0	73	0	0	1523	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4						2					
Detector Phase	4	4			8		2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (%)	50.0%	50.0%			50.0%		50.0%	50.0%				
Yellow Time (s)	3.5	3.5			3.5		3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5		1.5	1.5				
Lost Time Adjust (s)		0.0			0.0			0.0				
Total Lost Time (s)		5.0			5.0			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max		Max	Max				
Act Effct Green (s)		15.0			15.0			15.0				
Actuated g/C Ratio		0.38			0.38			0.38				
v/c Ratio		0.08			0.11			0.64				
Control Delay		11.1			8.3			8.9				
Queue Delay		0.0			0.0			0.0				
Total Delay		11.1			8.3			8.9				
LOS		B			A			A				

Lanes, Volumes, Timings
469: N Shepherd Dr & W 24th St

11/30/2017

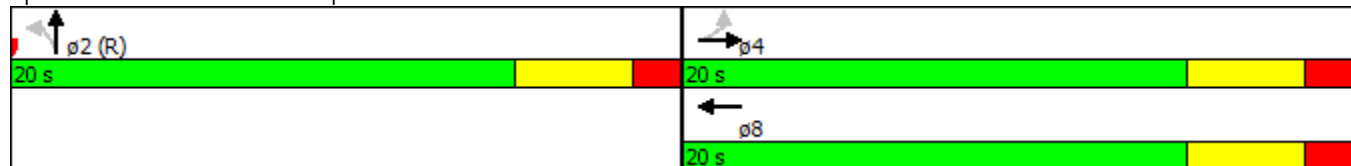


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		11.1			8.3			8.9				
Approach LOS		B			A			A				
Queue Length 50th (ft)		6			9			86				
Queue Length 95th (ft)		m7			24			135				
Internal Link Dist (ft)		580			463			1398			1617	
Turn Bay Length (ft)												
Base Capacity (vph)		591			660			2397				
Starvation Cap Reductn		0			0			0				
Spillback Cap Reductn		0			0			0				
Storage Cap Reductn		0			0			0				
Reduced v/c Ratio		0.08			0.11			0.64				

Intersection Summary

Area Type:	Other
Cycle Length:	40
Actuated Cycle Length:	40
Offset:	0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
Natural Cycle:	40
Control Type:	Pretimed
Maximum v/c Ratio:	0.64
Intersection Signal Delay:	8.9
Intersection LOS:	A
Intersection Capacity Utilization	35.8%
ICU Level of Service	A
Analysis Period (min)	15
m	Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 469: N Shepherd Dr & W 24th St



Lanes, Volumes, Timings
470: N Shepherd Dr & IH 610 EBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	456	878	0	0	0	0	0	860	303	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1610	3373	0	0	0	0	0	6139	0	0	0	0
Flt Permitted	0.950	0.995										
Satd. Flow (perm)	1610	3373	0	0	0	0	0	6139	0	0	0	0
Right Turn on Red	Yes		Yes			Yes			Yes			Yes
Satd. Flow (RTOR)	55	55						20				
Link Speed (mph)		45			45			35				35
Link Distance (ft)		526			314			1697				251
Travel Time (s)		8.0			4.8			33.1				4.9
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.76	0.92	0.93	0.93	0.93	0.93	0.93	0.89	0.82	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)	16%											
Lane Group Flow (vph)	580	1208	0	0	0	0	0	1536	0	0	0	0
Turn Type	Perm	NA						NA				
Protected Phases		4						2				
Permitted Phases	4											
Detector Phase	4	4						2				
Switch Phase												
Minimum Initial (s)	4.0	4.0						4.0				
Minimum Split (s)	20.0	20.0						20.0				
Total Split (s)	20.0	20.0						20.0				
Total Split (%)	50.0%	50.0%						50.0%				
Yellow Time (s)	3.5	3.5						3.5				
All-Red Time (s)	1.5	1.5						1.5				
Lost Time Adjust (s)	0.0	0.0						0.0				
Total Lost Time (s)	5.0	5.0						5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max						Max				
Act Effct Green (s)	15.0	15.0						15.0				
Actuated g/C Ratio	0.38	0.38						0.38				
v/c Ratio	0.91	0.93						0.66				
Control Delay	34.7	27.6						8.1				
Queue Delay	0.0	0.0						0.0				
Total Delay	34.7	27.6						8.1				
LOS	C	C						A				

Lanes, Volumes, Timings
 470: N Shepherd Dr & IH 610 EBFR

11/30/2017

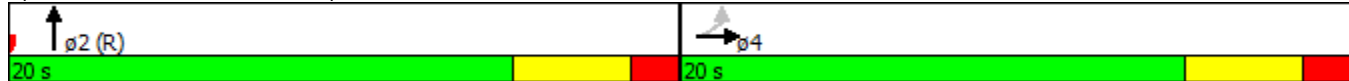


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		29.9						8.1				
Approach LOS		C						A				
Queue Length 50th (ft)	115	128						110				
Queue Length 95th (ft)	#216	#253						144				
Internal Link Dist (ft)		446			234			1617			171	
Turn Bay Length (ft)												
Base Capacity (vph)	638	1299						2314				
Starvation Cap Reductn	0	0						0				
Spillback Cap Reductn	0	0						0				
Storage Cap Reductn	0	0						0				
Reduced v/c Ratio	0.91	0.93						0.66				

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2:NBT and 6:, Start of Green
 Natural Cycle: 50
 Control Type: Pretimed
 Maximum v/c Ratio: 0.93
 Intersection Signal Delay: 19.8
 Intersection LOS: B
 Intersection Capacity Utilization 57.3%
 ICU Level of Service B
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 470: N Shepherd Dr & IH 610 EBFR



Lanes, Volumes, Timings
471: N Shepherd Dr & IH 610 WBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑↑↑		↔	↑↑↑				
Volume (vph)	0	0	0	0	817	369	336	972	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	1		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	0	4846	0	1433	6017	0	0	0	0
Flt Permitted							0.950	0.997				
Satd. Flow (perm)	0	0	0	0	4846	0	1433	6017	0	0	0	0
Right Turn on Red			Yes			Yes	Yes		Yes			Yes
Satd. Flow (RTOR)					8		55	55				
Link Speed (mph)		45			45			35				35
Link Distance (ft)		398			334			251				1261
Travel Time (s)		6.0			5.1			4.9				24.6
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.93	0.95	0.93	0.93	0.84	0.93	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)							19%					
Lane Group Flow (vph)	0	0	0	0	1445	0	336	1410	0	0	0	0
Turn Type					NA		Perm	NA				
Protected Phases					8			2				
Permitted Phases							2					
Detector Phase					8		2	2				
Switch Phase												
Minimum Initial (s)					4.0		4.0	4.0				
Minimum Split (s)					20.0		20.0	20.0				
Total Split (s)					20.0		20.0	20.0				
Total Split (%)					50.0%		50.0%	50.0%				
Yellow Time (s)					3.5		3.5	3.5				
All-Red Time (s)					1.5		1.5	1.5				
Lost Time Adjust (s)					0.0		0.0	0.0				
Total Lost Time (s)					5.0		5.0	5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode					Max		Max	Max				
Act Effct Green (s)					15.0		15.0	15.0				
Actuated g/C Ratio					0.38		0.38	0.38				
v/c Ratio					0.79		0.59	0.62				
Control Delay					15.4		7.5	5.9				
Queue Delay					0.0		0.0	0.0				
Total Delay					15.4		7.5	6.0				
LOS					B		A	A				

Lanes, Volumes, Timings
 471: N Shepherd Dr & IH 610 WBFR

11/30/2017

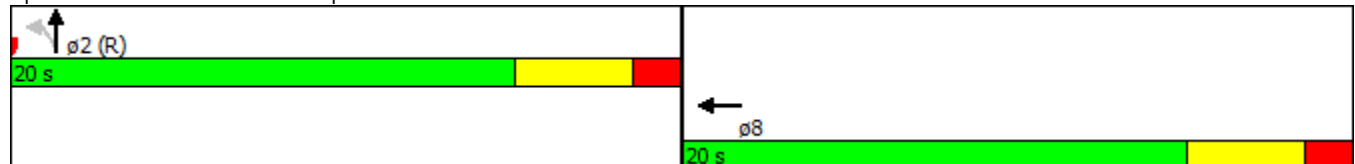


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					15.4			6.3				
Approach LOS					B			A				
Queue Length 50th (ft)					98		29	40				
Queue Length 95th (ft)					#144		m65	m66				
Internal Link Dist (ft)		318			254			171			1181	
Turn Bay Length (ft)												
Base Capacity (vph)					1822		571	2290				
Starvation Cap Reductn					0		5	37				
Spillback Cap Reductn					0		0	0				
Storage Cap Reductn					0		0	0				
Reduced v/c Ratio					0.79		0.59	0.63				

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
 Natural Cycle: 40
 Control Type: Pretimed
 Maximum v/c Ratio: 0.79
 Intersection Signal Delay: 10.4
 Intersection LOS: B
 Intersection Capacity Utilization 82.6%
 ICU Level of Service E
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 471: N Shepherd Dr & IH 610 WBFR



2040 PM Peak No-Build



Lanes, Volumes, Timings
450: Durham & Washington

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑		↖	↑↑						↑↑↑↑	
Volume (vph)	0	544	239	110	1070	0	0	0	0	231	984	59
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	150		0	0		0	0		0
Storage Lanes	0		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3376	0	1770	3539	0	0	0	0	0	6306	0
Flt Permitted				0.950							0.991	
Satd. Flow (perm)	0	3376	0	1770	3539	0	0	0	0	0	6306	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		58									10	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		2207			322			520			238	
Travel Time (s)		50.2			7.3			11.8			5.4	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	938	0	132	1282	0	0	0	0	0	1527	0
Turn Type		NA		Prot	NA					Perm	NA	
Protected Phases		2		1	6						4	
Permitted Phases											4	
Detector Phase		2		1	6						4	4
Switch Phase												
Minimum Initial (s)		10.0		5.0	10.0					10.0	10.0	
Minimum Split (s)		21.0		10.0	21.0					18.0	18.0	
Total Split (s)		40.0		25.0	65.0					55.0	55.0	
Total Split (%)		33.3%		20.8%	54.2%					45.8%	45.8%	
Yellow Time (s)		3.6		3.6	3.6					3.6	3.6	
All-Red Time (s)		1.4		1.4	1.4					1.4	1.4	
Lost Time Adjust (s)		0.0		0.0	0.0						0.0	
Total Lost Time (s)		5.0		5.0	5.0						5.0	
Lead/Lag		Lag		Lead								
Lead-Lag Optimize?		Yes		Yes								
Recall Mode		Max		None	Max					C-Max	C-Max	
Act Effect Green (s)		40.8		14.2	60.0						50.0	
Actuated g/C Ratio		0.34		0.12	0.50						0.42	
v/c Ratio		0.79		0.63	0.72						0.58	
Control Delay		31.1		52.0	23.5						38.3	
Queue Delay		0.0		0.0	49.4						0.0	
Total Delay		31.1		52.0	73.0						38.3	
LOS		C		D	E						D	

Lanes, Volumes, Timings
450: Durham & Washington

11/30/2017

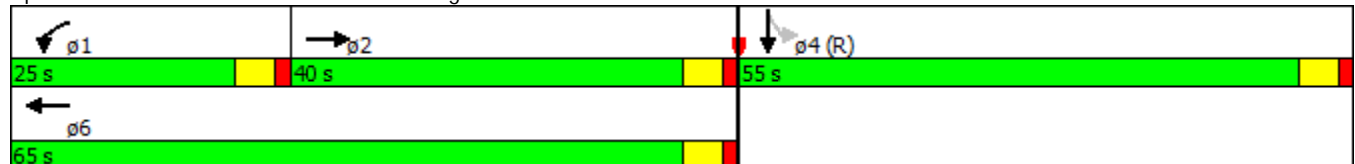


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		31.1			71.0							38.3
Approach LOS		C			E							D
Queue Length 50th (ft)		396		101	348							274
Queue Length 95th (ft)		#485		m102	m357							311
Internal Link Dist (ft)		2127			242			440				158
Turn Bay Length (ft)				150								
Base Capacity (vph)		1186		295	1769							2633
Starvation Cap Reductn		0		0	749							0
Spillback Cap Reductn		0		0	0							0
Storage Cap Reductn		0		0	0							0
Reduced v/c Ratio		0.79		0.45	1.26							0.58

Intersection Summary

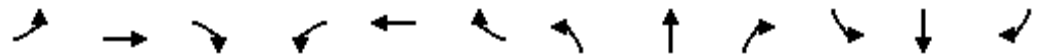
Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	0 (0%), Referenced to phase 4:SBTL, Start of Green
Natural Cycle:	55
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	0.79
Intersection Signal Delay:	48.5
Intersection LOS:	D
Intersection Capacity Utilization:	120.7%
ICU Level of Service:	H
Analysis Period (min):	15
#	95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after two cycles.
m	Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 450: Durham & Washington



Lanes, Volumes, Timings
451: Durham & Center

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	49	24	27	45	0	0	0	0	42	1310	21
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1760	0	0	1829	0	0	0	0	0	6369	0
Flt Permitted					0.982						0.998	
Satd. Flow (perm)	0	1760	0	0	1829	0	0	0	0	0	6369	0
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		534			320			238			2187	
Travel Time (s)		12.1			7.3			4.6			42.6	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.77	0.55	0.75	0.75	0.93	0.93	0.93	0.93	0.66	0.88	0.52
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	123	0	0	110	0	0	0	0	0	1831	0
Sign Control		Stop			Stop			Stop			Free	

Intersection Summary

Area Type:	Other
Control Type:	Unsignalized
Intersection Capacity Utilization	40.7%
ICU Level of Service	A
Analysis Period (min)	15

Lanes, Volumes, Timings
452: Durham & IH10 - EBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑								↓	↑↑↑	
Volume (vph)	0	865	347	0	0	0	0	0	0	234	1005	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	4846	0	0	0	0	0	0	0	1522	4801	0
Flt Permitted										0.950	0.999	
Satd. Flow (perm)	0	4846	0	0	0	0	0	0	0	1522	4801	0
Right Turn on Red			Yes			Yes			Yes	Yes		Yes
Satd. Flow (RTOR)		36								64	64	
Link Speed (mph)		40			40			35			35	
Link Distance (ft)		594			306			2187			312	
Travel Time (s)		10.1			5.2			42.6			6.1	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.83	0.93	0.93	0.93	0.93	0.93	0.93	0.86	0.87	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)										10%		
Lane Group Flow (vph)	0	1551	0	0	0	0	0	0	0	282	1359	0
Turn Type		NA								Perm	NA	
Protected Phases		4 12									1 2	
Permitted Phases										1 2		
Detector Phase		4 12								1 2	1 2	
Switch Phase												
Minimum Initial (s)												
Minimum Split (s)												
Total Split (s)												
Total Split (%)												
Yellow Time (s)												
All-Red Time (s)												
Lost Time Adjust (s)												
Total Lost Time (s)												
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode												
Act Effct Green (s)		46.7								63.3	63.3	
Actuated g/C Ratio		0.39								0.53	0.53	
v/c Ratio		0.81								0.34	0.53	
Control Delay		36.2								5.1	12.0	
Queue Delay		0.3								3.2	33.8	
Total Delay		36.5								8.4	45.8	
LOS		D								A	D	

Lane Group	ø1	ø2	ø4	ø6	ø8	ø12	ø16
Lane Configurations							
Volume (vph)							
Ideal Flow (vphpl)							
Lane Width (ft)							
Grade (%)							
Storage Length (ft)							
Storage Lanes							
Taper Length (ft)							
Satd. Flow (prot)							
Flt Permitted							
Satd. Flow (perm)							
Right Turn on Red							
Satd. Flow (RTOR)							
Link Speed (mph)							
Link Distance (ft)							
Travel Time (s)							
Confl. Peds. (#/hr)							
Confl. Bikes (#/hr)							
Peak Hour Factor							
Growth Factor							
Heavy Vehicles (%)							
Bus Blockages (#/hr)							
Parking (#/hr)							
Mid-Block Traffic (%)							
Shared Lane Traffic (%)							
Lane Group Flow (vph)							
Turn Type							
Protected Phases	1	2	4	6	8	12	16
Permitted Phases							
Detector Phase							
Switch Phase							
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	21.0	21.0	21.0	20.0	20.0
Total Split (s)	47.0	21.0	31.0	47.0	21.0	21.0	52.0
Total Split (%)	39%	18%	26%	39%	18%	18%	43%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)							
Total Lost Time (s)							
Lead/Lag	Lag	Lead	Lag	Lead	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	
Recall Mode	None	Max	None	C-Max	Max	None	None
Act Effct Green (s)							
Actuated g/C Ratio							
v/c Ratio							
Control Delay							
Queue Delay							
Total Delay							
LOS							

Lanes, Volumes, Timings
452: Durham & IH10 - EBFR

11/30/2017

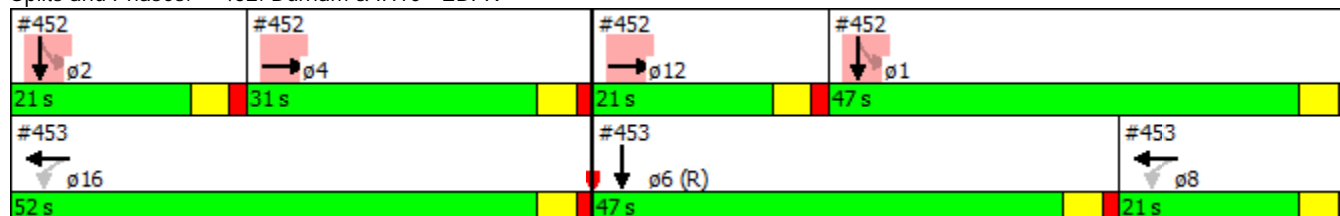


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		36.5										39.4
Approach LOS		D										D
Queue Length 50th (ft)		379								95		376
Queue Length 95th (ft)		442								m100		355
Internal Link Dist (ft)		514			226			2107				232
Turn Bay Length (ft)												
Base Capacity (vph)		1919								833		2564
Starvation Cap Reductn		0								444		1285
Spillback Cap Reductn		71								0		0
Storage Cap Reductn		0								0		0
Reduced v/c Ratio		0.84								0.72		1.06

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	94 (78%), Referenced to phase 6:SBT, Start of Green
Natural Cycle:	95
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	0.86
Intersection Signal Delay:	38.0
Intersection LOS:	D
Intersection Capacity Utilization:	60.6%
ICU Level of Service:	B
Analysis Period (min):	15
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 452: Durham & IH10 - EBFR



Lane Group	ø1	ø2	ø4	ø6	ø8	ø12	ø16
Approach Delay							
Approach LOS							
Queue Length 50th (ft)							
Queue Length 95th (ft)							
Internal Link Dist (ft)							
Turn Bay Length (ft)							
Base Capacity (vph)							
Starvation Cap Reductn							
Spillback Cap Reductn							
Storage Cap Reductn							
Reduced v/c Ratio							
Intersection Summary							

Lanes, Volumes, Timings
453: Durham & IH10 - WBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑↑↑						↑↑↑	
Volume (vph)	0	0	0	193	955	0	0	0	0	0	1099	425
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	0	5040	0	0	0	0	0	6145	0
Flt Permitted					0.991							
Satd. Flow (perm)	0	0	0	0	5040	0	0	0	0	0	6145	0
Right Turn on Red			Yes	Yes		Yes			Yes			Yes
Satd. Flow (RTOR)					64						65	
Link Speed (mph)		40			40			35			35	
Link Distance (ft)		575			310			312			2613	
Travel Time (s)		9.8			5.3			6.1			50.9	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.80	0.92	0.93	0.93	0.93	0.93	0.93	0.92	0.94
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	0	1471	0	0	0	0	0	1894	0
Turn Type				Perm	NA						NA	
Protected Phases					8 16						6	
Permitted Phases				8 16								
Detector Phase				8 16	8 16						6	
Switch Phase												
Minimum Initial (s)											4.0	
Minimum Split (s)											21.0	
Total Split (s)											47.0	
Total Split (%)											39.2%	
Yellow Time (s)											3.5	
All-Red Time (s)											1.5	
Lost Time Adjust (s)											0.0	
Total Lost Time (s)											5.0	
Lead/Lag											Lead	
Lead-Lag Optimize?											Yes	
Recall Mode											C-Max	
Act Effct Green (s)					68.0						42.0	
Actuated g/C Ratio					0.57						0.35	
v/c Ratio					0.51						0.86	
Control Delay					13.1						30.5	
Queue Delay					8.8						33.6	
Total Delay					21.9						64.2	
LOS					C						E	

Lane Group	ø1	ø2	ø4	ø8	ø12	ø16
Lane Configurations						
Volume (vph)						
Ideal Flow (vphpl)						
Lane Width (ft)						
Grade (%)						
Storage Length (ft)						
Storage Lanes						
Taper Length (ft)						
Satd. Flow (prot)						
Flt Permitted						
Satd. Flow (perm)						
Right Turn on Red						
Satd. Flow (RTOR)						
Link Speed (mph)						
Link Distance (ft)						
Travel Time (s)						
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor						
Growth Factor						
Heavy Vehicles (%)						
Bus Blockages (#/hr)						
Parking (#/hr)						
Mid-Block Traffic (%)						
Shared Lane Traffic (%)						
Lane Group Flow (vph)						
Turn Type						
Protected Phases	1	2	4	8	12	16
Permitted Phases						
Detector Phase						
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	21.0	21.0	20.0	20.0
Total Split (s)	47.0	21.0	31.0	21.0	21.0	52.0
Total Split (%)	39%	18%	26%	18%	18%	43%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)						
Total Lost Time (s)						
Lead/Lag	Lag	Lead	Lag	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	
Recall Mode	None	Max	None	Max	None	None
Act Effct Green (s)						
Actuated g/C Ratio						
v/c Ratio						
Control Delay						
Queue Delay						
Total Delay						
LOS						

Lanes, Volumes, Timings
453: Durham & IH10 - WBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					21.9							64.2
Approach LOS					C							E
Queue Length 50th (ft)					226							241
Queue Length 95th (ft)					305							m235
Internal Link Dist (ft)		495			230			232				2533
Turn Bay Length (ft)												
Base Capacity (vph)					2883							2193
Starvation Cap Reductn					1383							0
Spillback Cap Reductn					1							421
Storage Cap Reductn					0							0
Reduced v/c Ratio					0.98							1.07

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	94 (78%), Referenced to phase 6:SBT, Start of Green
Natural Cycle:	95
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	0.86
Intersection Signal Delay:	45.7
Intersection LOS:	D
Intersection Capacity Utilization:	60.6%
ICU Level of Service:	B
Analysis Period (min):	15
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 453: Durham & IH10 - WBFR

#452 ↓ ϕ2 21 s	#452 → ϕ4 31 s	#452 → ϕ12 21 s	#452 ↓ ϕ1 47 s
#453 ← ϕ16 52 s	#453 ↓ ϕ6 (R) 47 s	#453 ← ϕ8 21 s	

Lane Group	ø1	ø2	ø4	ø8	ø12	ø16
Approach Delay						
Approach LOS						
Queue Length 50th (ft)						
Queue Length 95th (ft)						
Internal Link Dist (ft)						
Turn Bay Length (ft)						
Base Capacity (vph)						
Starvation Cap Reductn						
Spillback Cap Reductn						
Storage Cap Reductn						
Reduced v/c Ratio						
Intersection Summary						

Lanes, Volumes, Timings
454: W 11th

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑	↑	↑	↑↑						↑↑↑	
Volume (vph)	0	822	179	165	741	0	0	0	0	269	1047	115
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		150	50		0	0		0	0		0
Storage Lanes	0		1	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3380	1441	1770	3539	0	0	0	0	0	6261	0
Flt Permitted				0.093							0.990	
Satd. Flow (perm)	0	3380	1441	173	3539	0	0	0	0	0	6261	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		2	29									24
Link Speed (mph)		30			30			35				35
Link Distance (ft)		421			536			1925			2048	
Travel Time (s)		9.6			12.2			37.5			39.9	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.87	0.90	0.84	0.95	0.93	0.93	0.93	0.93	0.85	0.90	0.85
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)			10%									
Lane Group Flow (vph)	0	1110	206	226	897	0	0	0	0	0	1858	0
Turn Type		NA	Perm	Perm	NA					Perm	NA	
Protected Phases		2			6							4
Permitted Phases			2	6						4		
Detector Phase		2	2	6	6					4	4	
Switch Phase												
Minimum Initial (s)		10.0	10.0	10.0	10.0					10.0	10.0	
Minimum Split (s)		21.2	21.2	21.2	21.2					21.3	21.3	
Total Split (s)		55.0	55.0	55.0	55.0					65.0	65.0	
Total Split (%)		45.8%	45.8%	45.8%	45.8%					54.2%	54.2%	
Yellow Time (s)		3.6	3.6	3.6	3.6					3.6	3.6	
All-Red Time (s)		1.6	1.6	1.6	1.6					1.7	1.7	
Lost Time Adjust (s)		0.0	0.0	0.0	0.0						0.0	
Total Lost Time (s)		5.2	5.2	5.2	5.2						5.3	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		None	None	None	None					C-Max	C-Max	
Act Effect Green (s)		49.8	49.8	49.8	49.8						59.7	
Actuated g/C Ratio		0.42	0.42	0.42	0.42						0.50	
v/c Ratio		0.79	0.34	3.18	0.61						0.59	
Control Delay		35.6	22.1	1019.9	29.5						25.0	
Queue Delay		0.0	0.0	0.0	0.4						0.0	
Total Delay		35.6	22.1	1019.9	29.9						25.0	
LOS		D	C	F	C						C	

Lanes, Volumes, Timings

454: W 11th

11/30/2017



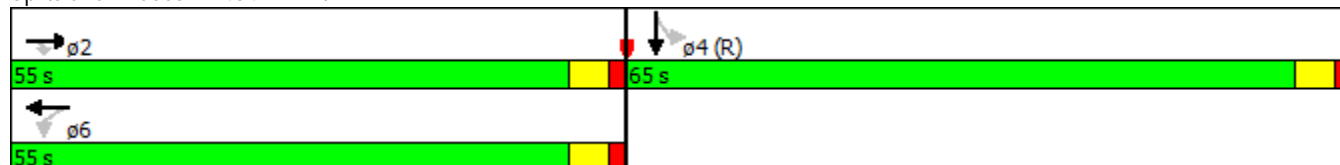
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		33.5			229.2							25.0
Approach LOS		C			F							C
Queue Length 50th (ft)		404	100	~302	337							256
Queue Length 95th (ft)		471	168	m#328	m332							312
Internal Link Dist (ft)		341			456			1845				1968
Turn Bay Length (ft)			150	50								
Base Capacity (vph)		1403	614	71	1468							3126
Starvation Cap Reductn		0	0	0	200							0
Spillback Cap Reductn		0	0	0	0							0
Storage Cap Reductn		0	0	0	0							0
Reduced v/c Ratio		0.79	0.34	3.18	0.71							0.59

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 15 (13%), Referenced to phase 4:SBTL, Start of Green
 Natural Cycle: 45
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 3.18
 Intersection Signal Delay: 80.9
 Intersection LOS: F
 Intersection Capacity Utilization 76.3%
 ICU Level of Service D
 Analysis Period (min) 15

- ~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
- # 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
- m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 454: W 11th



Lanes, Volumes, Timings

455: W 14th

11/30/2017

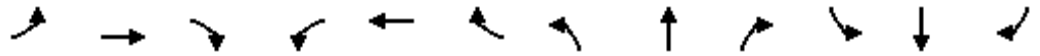


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔						↔↔↔↔	
Volume (vph)	0	23	90	94	37	0	0	0	0	61	2231	15
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1650	0	0	1794	0	0	0	0	0	6395	0
Flt Permitted					0.501						0.999	
Satd. Flow (perm)	0	1650	0	0	933	0	0	0	0	0	6395	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		2									2	
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		332			488			2048			157	
Travel Time (s)		7.5			11.1			39.9			3.1	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.86	0.60	0.64	0.86	0.93	0.93	0.93	0.93	0.93	0.88	0.75
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	203	0	0	218	0	0	0	0	0	3014	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		2			6						4	
Permitted Phases				6						4		
Detector Phase		2		6	6					4	4	
Switch Phase												
Minimum Initial (s)		11.0		11.0	11.0					11.0	11.0	
Minimum Split (s)		22.7		20.7	20.7					21.1	21.1	
Total Split (s)		39.0		39.0	39.0					81.0	81.0	
Total Split (%)		32.5%		32.5%	32.5%					67.5%	67.5%	
Yellow Time (s)		3.2		3.2	3.2					3.6	3.6	
All-Red Time (s)		1.5		1.5	1.5					1.5	1.5	
Lost Time Adjust (s)		0.0			0.0						0.0	
Total Lost Time (s)		4.7			4.7						5.1	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		None		None	None					C-Max	C-Max	
Act Effect Green (s)		29.9			29.9						80.3	
Actuated g/C Ratio		0.25			0.25						0.67	
v/c Ratio		0.49			0.94						0.70	
Control Delay		41.5			76.5						14.3	
Queue Delay		0.0			0.0						0.0	
Total Delay		41.5			76.5						14.3	
LOS		D			E						B	

Lanes, Volumes, Timings

455: W 14th

11/30/2017

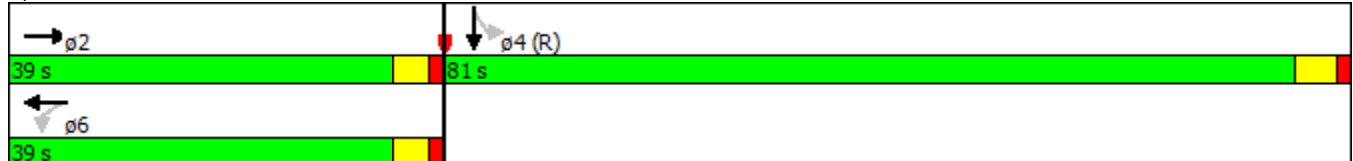


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		41.5			76.5							14.3
Approach LOS		D			E							B
Queue Length 50th (ft)		129			162							420
Queue Length 95th (ft)		189			#274							459
Internal Link Dist (ft)		252			408			1968				77
Turn Bay Length (ft)												
Base Capacity (vph)		473			266							4278
Starvation Cap Reductn		0			0							0
Spillback Cap Reductn		0			0							0
Storage Cap Reductn		0			0							0
Reduced v/c Ratio		0.43			0.82							0.70

Intersection Summary

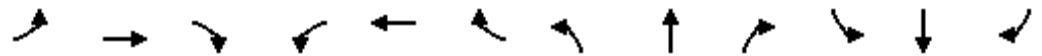
Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 13 (11%), Referenced to phase 4:SBTL, Start of Green
 Natural Cycle: 60
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.94
 Intersection Signal Delay: 19.8
 Intersection LOS: B
 Intersection Capacity Utilization 69.0%
 ICU Level of Service C
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 455: W 14th



Lanes, Volumes, Timings
456: N Durham Dr & W 19th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	246	76	76	176	0	0	0	0	121	1294	44
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1799	0	0	1837	0	0	0	0	0	6331	0
Flt Permitted					0.734						0.995	
Satd. Flow (perm)	0	1799	0	0	1367	0	0	0	0	0	6331	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		2										26
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		618			668			633			368	
Travel Time (s)		14.0			15.2			12.3			7.2	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.95	0.86	0.91	0.81	0.93	0.93	0.93	0.93	0.72	0.90	0.58
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	400	0	0	346	0	0	0	0	0	1933	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		4			8						6	
Permitted Phases				8						6		
Detector Phase		4		8	8					6	6	
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0					4.0	4.0	
Minimum Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (%)		50.0%		50.0%	50.0%					50.0%	50.0%	
Yellow Time (s)		3.5		3.5	3.5					3.5	3.5	
All-Red Time (s)		1.5		1.5	1.5					1.5	1.5	
Lost Time Adjust (s)		0.0			0.0						0.0	
Total Lost Time (s)		5.0			5.0						5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max		Max	Max					Max	Max	
Act Effect Green (s)		15.0			15.0						15.0	
Actuated g/C Ratio		0.38			0.38						0.38	
v/c Ratio		0.59			0.68						0.81	
Control Delay		14.4			19.8						11.3	
Queue Delay		0.0			0.0						0.0	
Total Delay		14.4			19.8						11.3	
LOS		B			B						B	

Lanes, Volumes, Timings
456: N Durham Dr & W 19th St

11/30/2017

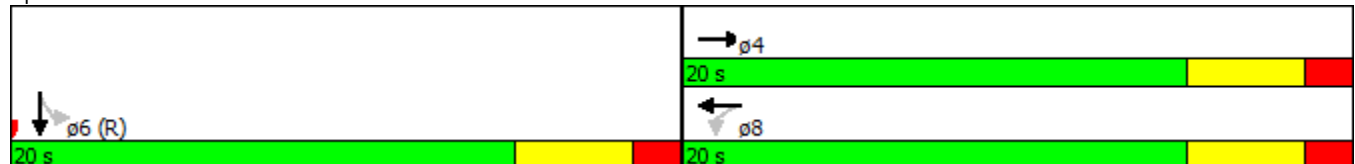


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		14.4			19.8							11.3
Approach LOS		B			B							B
Queue Length 50th (ft)		68			61							67
Queue Length 95th (ft)		131			#110							m95
Internal Link Dist (ft)		538			588			553				288
Turn Bay Length (ft)												
Base Capacity (vph)		675			512							2390
Starvation Cap Reductn		0			0							0
Spillback Cap Reductn		0			0							0
Storage Cap Reductn		0			0							0
Reduced v/c Ratio		0.59			0.68							0.81

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 45
 Control Type: Pretimed
 Maximum v/c Ratio: 0.81
 Intersection Signal Delay: 12.9 Intersection LOS: B
 Intersection Capacity Utilization 72.7% ICU Level of Service C
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 456: N Durham Dr & W 19th St



Lanes, Volumes, Timings
457: N Durham Dr & W 20th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↗			↖						↖↗↘↙	
Volume (vph)	0	303	42	80	183	0	0	0	0	116	1371	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1824	0	0	1833	0	0	0	0	0	6331	0
Flt Permitted					0.594						0.996	
Satd. Flow (perm)	0	1824	0	0	1106	0	0	0	0	0	6331	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		2										35
Link Speed (mph)		30			30			35				35
Link Distance (ft)		582			183			368			1486	
Travel Time (s)		13.2			4.2			7.2			28.9	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.92	0.70	0.77	0.82	0.93	0.93	0.93	0.93	0.81	0.90	0.90
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	448	0	0	376	0	0	0	0	0	2032	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		4			8						6	
Permitted Phases				8						6		
Detector Phase		4		8	8					6	6	
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0					4.0	4.0	
Minimum Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (%)		50.0%		50.0%	50.0%					50.0%	50.0%	
Yellow Time (s)		3.5		3.5	3.5					3.5	3.5	
All-Red Time (s)		1.5		1.5	1.5					1.5	1.5	
Lost Time Adjust (s)		0.0			0.0						0.0	
Total Lost Time (s)		5.0			5.0						5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max		Max	Max					Max	Max	
Act Effect Green (s)		15.0			15.0						15.0	
Actuated g/C Ratio		0.38			0.38						0.38	
v/c Ratio		0.65			0.91						0.85	
Control Delay		16.2			44.6						13.9	
Queue Delay		0.0			0.0						0.0	
Total Delay		16.2			44.6						13.9	
LOS		B			D						B	

Lanes, Volumes, Timings
457: N Durham Dr & W 20th St

11/30/2017

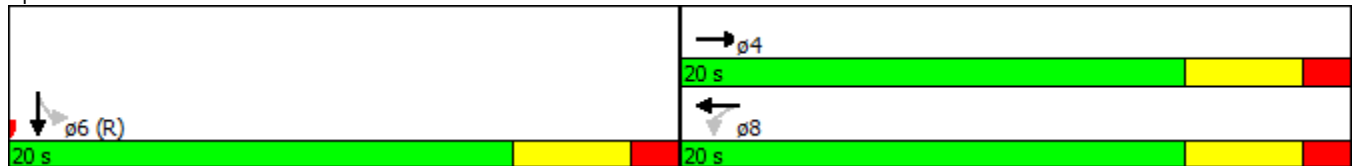


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		16.2			44.6							13.9
Approach LOS		B			D							B
Queue Length 50th (ft)		78			75							152
Queue Length 95th (ft)		#157			#175							m#194
Internal Link Dist (ft)		502			103			288				1406
Turn Bay Length (ft)												
Base Capacity (vph)		685			414							2396
Starvation Cap Reductn		0			0							0
Spillback Cap Reductn		0			0							0
Storage Cap Reductn		0			0							0
Reduced v/c Ratio		0.65			0.91							0.85

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 45
 Control Type: Pretimed
 Maximum v/c Ratio: 0.91
 Intersection Signal Delay: 18.3
 Intersection LOS: B
 Intersection Capacity Utilization 76.5%
 ICU Level of Service D
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 457: N Durham Dr & W 20th St



Lanes, Volumes, Timings
458: N Durham Dr & W 24th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	39	42	60	53	0	0	0	0	32	1520	39
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1732	0	0	1818	0	0	0	0	0	6357	0
Flt Permitted					0.814						0.998	
Satd. Flow (perm)	0	1732	0	0	1516	0	0	0	0	0	6357	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		1										23
Link Speed (mph)		30			30			35				35
Link Distance (ft)		555			660			1486				1120
Travel Time (s)		12.6			15.0			28.9				21.8
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.75	0.75	0.94	0.78	0.93	0.93	0.93	0.93	0.57	0.95	0.57
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	124	0	0	151	0	0	0	0	0	1984	0
Turn Type		NA		Perm	NA						Perm	NA
Protected Phases		4			8							6
Permitted Phases				8							6	
Detector Phase		4		8	8						6	6
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0						4.0	4.0
Minimum Split (s)		20.0		20.0	20.0						20.0	20.0
Total Split (s)		20.0		20.0	20.0						20.0	20.0
Total Split (%)		50.0%		50.0%	50.0%						50.0%	50.0%
Yellow Time (s)		3.5		3.5	3.5						3.5	3.5
All-Red Time (s)		1.5		1.5	1.5						1.5	1.5
Lost Time Adjust (s)		0.0			0.0							0.0
Total Lost Time (s)		5.0			5.0							5.0
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max		Max	Max						Max	Max
Act Effect Green (s)		15.0			15.0							15.0
Actuated g/C Ratio		0.38			0.38							0.38
v/c Ratio		0.19			0.27							0.83
Control Delay		9.4			10.3							10.4
Queue Delay		0.0			0.0							0.0
Total Delay		9.4			10.3							10.4
LOS		A			B							B

Lanes, Volumes, Timings
 458: N Durham Dr & W 24th St

11/30/2017

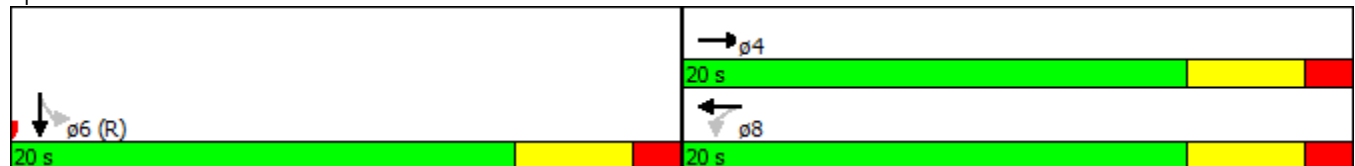


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		9.4			10.3							10.4
Approach LOS		A			B							B
Queue Length 50th (ft)		18			22							97
Queue Length 95th (ft)		34			43							m151
Internal Link Dist (ft)		475			580			1406				1040
Turn Bay Length (ft)												
Base Capacity (vph)		650			568							2398
Starvation Cap Reductn		0			0							0
Spillback Cap Reductn		0			0							0
Storage Cap Reductn		0			0							0
Reduced v/c Ratio		0.19			0.27							0.83

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 40
 Control Type: Pretimed
 Maximum v/c Ratio: 0.83
 Intersection Signal Delay: 10.3
 Intersection LOS: B
 Intersection Capacity Utilization 48.7%
 ICU Level of Service A
 Analysis Period (min) 15
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 458: N Durham Dr & W 24th St



Lanes, Volumes, Timings
459: N Durham Dr & IH 610 EBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑								↘	↑↑↑	
Volume (vph)	0	1218	179	0	0	0	0	0	0	467	1270	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	4979	0	0	0	0	0	0	0	1770	6408	0
Flt Permitted										0.950		
Satd. Flow (perm)	0	4979	0	0	0	0	0	0	0	1770	6408	0
Right Turn on Red			Yes			Yes			Yes	Yes		Yes
Satd. Flow (RTOR)		3								55		
Link Speed (mph)		45			10			30			30	
Link Distance (ft)		410			526			607			264	
Travel Time (s)		6.2			35.9			13.8			6.0	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.89	0.81	0.93	0.93	0.93	0.93	0.93	0.93	0.89	0.92	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	1828	0	0	0	0	0	0	0	603	1588	0
Turn Type		NA								Perm	NA	
Protected Phases		4									6	
Permitted Phases										6		
Detector Phase		4								6	6	
Switch Phase												
Minimum Initial (s)		4.0								4.0	4.0	
Minimum Split (s)		20.0								20.0	20.0	
Total Split (s)		20.0								20.0	20.0	
Total Split (%)		50.0%								50.0%	50.0%	
Yellow Time (s)		3.5								3.5	3.5	
All-Red Time (s)		1.5								1.5	1.5	
Lost Time Adjust (s)		0.0								0.0	0.0	
Total Lost Time (s)		5.0								5.0	5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max								Max	Max	
Act Effct Green (s)		15.0								15.0	15.0	
Actuated g/C Ratio		0.38								0.38	0.38	
v/c Ratio		0.98								0.86	0.66	
Control Delay		31.3								19.3	9.8	
Queue Delay		0.0								0.6	0.0	
Total Delay		31.3								19.9	9.8	
LOS		C								B	A	

Lanes, Volumes, Timings
 459: N Durham Dr & IH 610 EBFR

11/30/2017

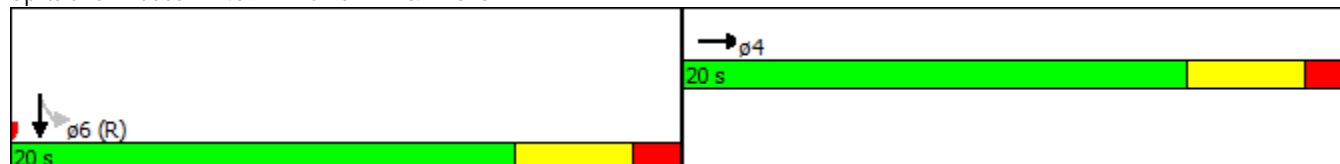


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		31.3										12.5
Approach LOS		C										B
Queue Length 50th (ft)		139								81		65
Queue Length 95th (ft)		#239								m98		m76
Internal Link Dist (ft)		330			446			527				184
Turn Bay Length (ft)												
Base Capacity (vph)		1869								698		2403
Starvation Cap Reductn		0								11		0
Spillback Cap Reductn		0								0		0
Storage Cap Reductn		0								0		0
Reduced v/c Ratio		0.98								0.88		0.66

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 55
 Control Type: Pretimed
 Maximum v/c Ratio: 0.98
 Intersection Signal Delay: 21.1
 Intersection LOS: C
 Intersection Capacity Utilization 69.7%
 ICU Level of Service C
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 459: N Durham Dr & IH 610 EBFR



Lanes, Volumes, Timings
460: N Durham Dr & IH 610 WBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	446	475	0	0	0	0	0	1316	488
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	1610	3350	0	0	0	0	0	6132	0
Flt Permitted				0.950	0.988							
Satd. Flow (perm)	0	0	0	1610	3350	0	0	0	0	0	6132	0
Right Turn on Red			Yes	Yes		Yes			Yes			Yes
Satd. Flow (RTOR)				55	55							119
Link Speed (mph)		45			45			35				35
Link Distance (ft)		407			398			264				706
Travel Time (s)		6.2			6.0			5.1				13.8
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.86	0.87	0.93	0.93	0.93	0.93	0.93	0.92	0.85
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)				33%								
Lane Group Flow (vph)	0	0	0	399	825	0	0	0	0	0	2305	0
Turn Type				Perm	NA							NA
Protected Phases					8							6
Permitted Phases				8								
Detector Phase				8	8							6
Switch Phase												
Minimum Initial (s)				4.0	4.0							4.0
Minimum Split (s)				20.0	20.0							20.0
Total Split (s)				20.0	20.0							20.0
Total Split (%)				50.0%	50.0%							50.0%
Yellow Time (s)				3.5	3.5							3.5
All-Red Time (s)				1.5	1.5							1.5
Lost Time Adjust (s)				0.0	0.0							0.0
Total Lost Time (s)				5.0	5.0							5.0
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode				Max	Max							Max
Act Effect Green (s)				15.0	15.0							15.0
Actuated g/C Ratio				0.38	0.38							0.38
v/c Ratio				0.63	0.64							0.97
Control Delay				9.6	8.4							27.1
Queue Delay				0.0	0.0							3.0
Total Delay				9.6	8.4							30.1
LOS				A	A							C

Lanes, Volumes, Timings
 460: N Durham Dr & IH 610 WBFR

11/30/2017

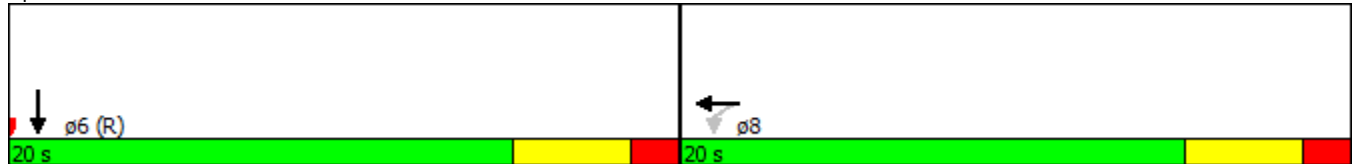


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					8.8							30.1
Approach LOS					A							C
Queue Length 50th (ft)				39	46							132
Queue Length 95th (ft)				m87	m93							#224
Internal Link Dist (ft)		327			318			184				626
Turn Bay Length (ft)												
Base Capacity (vph)				638	1290							2373
Starvation Cap Reductn				0	0							0
Spillback Cap Reductn				0	0							48
Storage Cap Reductn				0	0							0
Reduced v/c Ratio				0.63	0.64							0.99

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBT, Start of Green
 Natural Cycle: 50
 Control Type: Pretimed
 Maximum v/c Ratio: 0.97
 Intersection Signal Delay: 22.7
 Intersection LOS: C
 Intersection Capacity Utilization 62.8%
 ICU Level of Service B
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 460: N Durham Dr & IH 610 WBFR



Lanes, Volumes, Timings
461: Shepherd & Washington

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	78	678	0	0	587	127	600	1909	150	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	90		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1770	3539	0	0	3409	0	0	6287	0	0	0	0
Flt Permitted	0.950							0.989				
Satd. Flow (perm)	1770	3539	0	0	3409	0	0	6287	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					20			14				
Link Speed (mph)		30			30			30				30
Link Distance (ft)		322			1068			522				252
Travel Time (s)		7.3			24.3			11.9				5.7
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	5	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	92	804	0	0	847	0	0	3152	0	0	0	0
Turn Type	Prot	NA			NA		Perm	NA				
Protected Phases	5	2			6			8				
Permitted Phases							8					
Detector Phase	5	2			6		8	8				
Switch Phase												
Minimum Initial (s)	5.0	10.0			10.0		10.0	10.0				
Minimum Split (s)	10.0	21.0			21.0		18.0	18.0				
Total Split (s)	20.0	55.0			35.0		65.0	65.0				
Total Split (%)	16.7%	45.8%			29.2%		54.2%	54.2%				
Yellow Time (s)	3.6	3.6			3.6		3.6	3.6				
All-Red Time (s)	1.4	1.4			1.4		1.4	1.4				
Lost Time Adjust (s)	0.0	0.0			0.0			0.0				
Total Lost Time (s)	5.0	5.0			5.0			5.0				
Lead/Lag	Lead				Lag							
Lead-Lag Optimize?	Yes				Yes							
Recall Mode	Max	Max			Max		C-Max	C-Max				
Act Effct Green (s)	15.0	50.0			30.0			60.0				
Actuated g/C Ratio	0.12	0.42			0.25			0.50				
v/c Ratio	0.42	0.55			0.98			1.00				
Control Delay	77.6	18.7			73.4			53.5				
Queue Delay	0.0	1.1			0.8			38.1				
Total Delay	77.6	19.8			74.3			91.6				
LOS	E	B			E			F				

Lanes, Volumes, Timings
461: Shepherd & Washington

11/30/2017

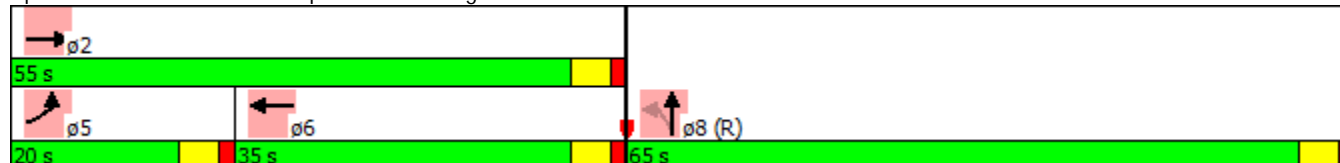


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		25.7			74.3			91.6				
Approach LOS		C			E			F				
Queue Length 50th (ft)	76	110			347			~737				
Queue Length 95th (ft)	m107	192			m#447			#817				
Internal Link Dist (ft)		242			988			442			172	
Turn Bay Length (ft)	90											
Base Capacity (vph)	221	1474			867			3150				
Starvation Cap Reductn	0	414			0			0				
Spillback Cap Reductn	0	0			4			345				
Storage Cap Reductn	0	0			0			0				
Reduced v/c Ratio	0.42	0.76			0.98			1.12				

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 0 (0%), Referenced to phase 8:NBTL, Start of Green
 Natural Cycle: 90
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.00
 Intersection Signal Delay: 76.5
 Intersection LOS: E
 Intersection Capacity Utilization 120.7%
 ICU Level of Service H
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 461: Shepherd & Washington



Lanes, Volumes, Timings
462: Shepherd & Center

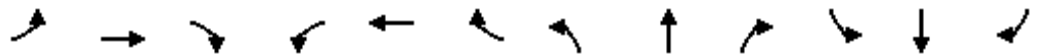
11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕↕↕				
Volume (vph)	49	70	0	0	42	78	24	2161	44	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1824	0	0	1721	0	0	6376	0	0	0	0
Flt Permitted		0.710						0.999				
Satd. Flow (perm)	0	1323	0	0	1721	0	0	6376	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					2			8				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		320			502			252				2176
Travel Time (s)		7.3			11.4			4.9				42.4
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.68	0.76	0.93	0.93	0.55	0.78	0.75	0.92	0.65	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	189	0	0	203	0	0	2816	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4						2					
Detector Phase	4	4			8		2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (s)	42.0	42.0			42.0		78.0	78.0				
Total Split (%)	35.0%	35.0%			35.0%		65.0%	65.0%				
Yellow Time (s)	3.5	3.5			3.5		3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5		1.5	1.5				
Lost Time Adjust (s)		0.0			0.0			0.0				
Total Lost Time (s)		5.0			5.0			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max		Max	Max				
Act Effct Green (s)		37.0			37.0			73.0				
Actuated g/C Ratio		0.31			0.31			0.61				
v/c Ratio		0.46			0.38			0.73				
Control Delay		38.9			34.8			3.6				
Queue Delay		0.0			0.0			6.2				
Total Delay		38.9			34.8			9.8				
LOS		D			C			A				

Lanes, Volumes, Timings
462: Shepherd & Center

11/30/2017

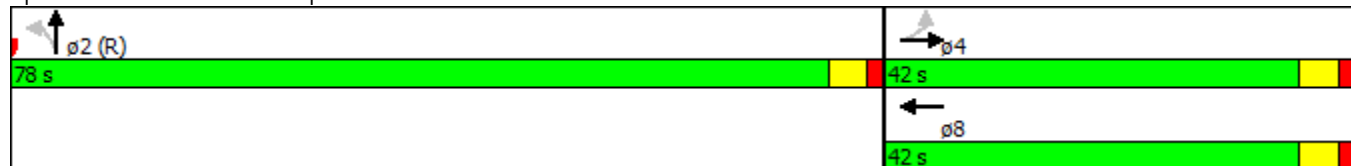


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		38.9			34.8			9.8				
Approach LOS		D			C			A				
Queue Length 50th (ft)		130			122			77				
Queue Length 95th (ft)		m168			108			m82				
Internal Link Dist (ft)		240			422			172			2096	
Turn Bay Length (ft)												
Base Capacity (vph)		407			532			3881				
Starvation Cap Reductn		0			0			1025				
Spillback Cap Reductn		0			0			0				
Storage Cap Reductn		0			0			0				
Reduced v/c Ratio		0.46			0.38			0.99				

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
Natural Cycle:	50
Control Type:	Pretimed
Maximum v/c Ratio:	0.73
Intersection Signal Delay:	13.1
Intersection LOS:	B
Intersection Capacity Utilization:	65.2%
ICU Level of Service:	C
Analysis Period (min):	15
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 462: Shepherd & Center



Lanes, Volumes, Timings
463: Shepherd & IH10 - EBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	610	512	0	0	0	0	0	2215	162	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1610	3336	0	0	0	0	0	6344	0	0	0	0
Flt Permitted	0.950	0.984										
Satd. Flow (perm)	1610	3336	0	0	0	0	0	6344	0	0	0	0
Right Turn on Red	Yes		Yes			Yes			Yes			Yes
Satd. Flow (RTOR)	64	64						16				
Link Speed (mph)		40			40			35				35
Link Distance (ft)		306			534			2176				316
Travel Time (s)		5.2			9.1			42.4				6.2
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.94	0.93	0.93	0.93	0.93	0.93	0.83	0.86	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	3	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)	41%											
Lane Group Flow (vph)	450	938	0	0	0	0	0	3286	0	0	0	0
Turn Type	Perm	NA						NA				
Protected Phases		4 12						2				
Permitted Phases	4 12											
Detector Phase	4 12	4 12						2				
Switch Phase												
Minimum Initial (s)								4.0				
Minimum Split (s)								21.0				
Total Split (s)								58.0				
Total Split (%)								48.3%				
Yellow Time (s)								3.5				
All-Red Time (s)								1.5				
Lost Time Adjust (s)								0.0				
Total Lost Time (s)								5.0				
Lead/Lag								Lead				
Lead-Lag Optimize?								Yes				
Recall Mode								C-Max				
Act Effct Green (s)	57.0	57.0						53.0				
Actuated g/C Ratio	0.48	0.48						0.44				
v/c Ratio	0.56	0.58						1.17				
Control Delay	7.4	8.0						112.5				
Queue Delay	4.3	3.4						0.6				
Total Delay	11.7	11.5						113.1				
LOS	B	B						F				

Lane Group	ø4	ø5	ø6	ø8	ø12	ø16
Lane Configurations						
Volume (vph)						
Ideal Flow (vphpl)						
Lane Width (ft)						
Grade (%)						
Storage Length (ft)						
Storage Lanes						
Taper Length (ft)						
Satd. Flow (prot)						
Flt Permitted						
Satd. Flow (perm)						
Right Turn on Red						
Satd. Flow (RTOR)						
Link Speed (mph)						
Link Distance (ft)						
Travel Time (s)						
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor						
Growth Factor						
Heavy Vehicles (%)						
Bus Blockages (#/hr)						
Parking (#/hr)						
Mid-Block Traffic (%)						
Shared Lane Traffic (%)						
Lane Group Flow (vph)						
Turn Type						
Protected Phases	4	5	6	8	12	16
Permitted Phases						
Detector Phase						
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	20.0	21.0	20.0	20.0
Total Split (s)	21.0	59.0	20.0	21.0	41.0	20.0
Total Split (%)	18%	49%	17%	18%	34%	17%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)						
Total Lost Time (s)						
Lead/Lag	Lag	Lag	Lead	Lag		Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes		Yes
Recall Mode	Max	None	None	None	None	None
Act Effct Green (s)						
Actuated g/C Ratio						
v/c Ratio						
Control Delay						
Queue Delay						
Total Delay						
LOS						

Lanes, Volumes, Timings
463: Shepherd & IH10 - EBFR

11/30/2017

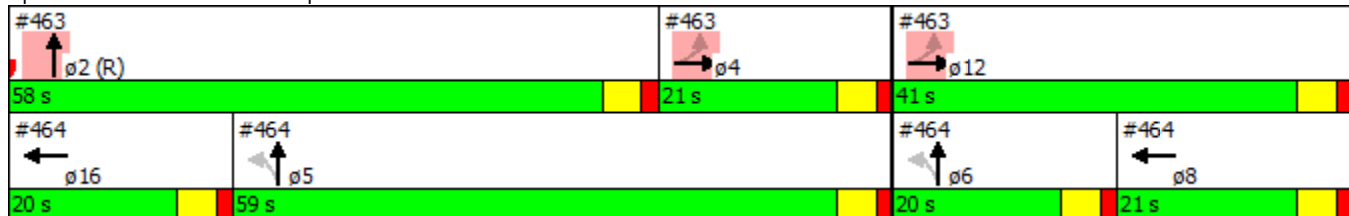


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		11.6						113.1				
Approach LOS		B						F				
Queue Length 50th (ft)	48	114						~869				
Queue Length 95th (ft)	m173	191						#808				
Internal Link Dist (ft)		226			454			2096			236	
Turn Bay Length (ft)												
Base Capacity (vph)	798	1618						2810				
Starvation Cap Reductn	266	565						0				
Spillback Cap Reductn	6	4						692				
Storage Cap Reductn	0	0						0				
Reduced v/c Ratio	0.85	0.89						1.55				

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 17 (14%), Referenced to phase 2:NBT, Start of Green
 Natural Cycle: 125
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.17
 Intersection Signal Delay: 82.9 Intersection LOS: F
 Intersection Capacity Utilization 85.8% ICU Level of Service E
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 463: Shepherd & IH10 - EBFR



Lane Group	ø4	ø5	ø6	ø8	ø12	ø16
Approach Delay						
Approach LOS						
Queue Length 50th (ft)						
Queue Length 95th (ft)						
Internal Link Dist (ft)						
Turn Bay Length (ft)						
Base Capacity (vph)						
Starvation Cap Reductn						
Spillback Cap Reductn						
Storage Cap Reductn						
Reduced v/c Ratio						
Intersection Summary						

Lanes, Volumes, Timings
464: Shepherd & IH10 - WBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑↑↑		↑	↑↑↑				
Volume (vph)	0	0	0	0	458	347	701	2134	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	1		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	0	4750	0	1522	4796	0	0	0	0
Flt Permitted							0.950	0.998				
Satd. Flow (perm)	0	0	0	0	4750	0	1522	4796	0	0	0	0
Right Turn on Red			Yes			Yes	Yes		Yes			Yes
Satd. Flow (RTOR)					3		79	64				
Link Speed (mph)		40			40			35				35
Link Distance (ft)		310			534			316				3871
Travel Time (s)		5.3			9.1			6.2				75.4
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.93	0.89	0.86	0.97	0.94	0.93	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)							10%					
Lane Group Flow (vph)	0	0	0	0	1056	0	748	2694	0	0	0	0
Turn Type					NA		Perm	NA				
Protected Phases					8 16			5 6				
Permitted Phases							5 6					
Detector Phase					8 16		5 6	5 6				
Switch Phase												
Minimum Initial (s)												
Minimum Split (s)												
Total Split (s)												
Total Split (%)												
Yellow Time (s)												
All-Red Time (s)												
Lost Time Adjust (s)												
Total Lost Time (s)												
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode												
Act Effct Green (s)					35.3		74.7	74.7				
Actuated g/C Ratio					0.29		0.62	0.62				
v/c Ratio					0.97dr		0.77	0.90				
Control Delay					42.2		11.1	15.9				
Queue Delay					1.4		51.3	46.3				
Total Delay					43.7		62.4	62.2				
LOS					D		E	E				

Lane Group	ø2	ø4	ø5	ø6	ø8	ø12	ø16
Lane Configurations							
Volume (vph)							
Ideal Flow (vphpl)							
Lane Width (ft)							
Grade (%)							
Storage Length (ft)							
Storage Lanes							
Taper Length (ft)							
Satd. Flow (prot)							
Flt Permitted							
Satd. Flow (perm)							
Right Turn on Red							
Satd. Flow (RTOR)							
Link Speed (mph)							
Link Distance (ft)							
Travel Time (s)							
Confl. Peds. (#/hr)							
Confl. Bikes (#/hr)							
Peak Hour Factor							
Growth Factor							
Heavy Vehicles (%)							
Bus Blockages (#/hr)							
Parking (#/hr)							
Mid-Block Traffic (%)							
Shared Lane Traffic (%)							
Lane Group Flow (vph)							
Turn Type							
Protected Phases	2	4	5	6	8	12	16
Permitted Phases							
Detector Phase							
Switch Phase							
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	21.0	20.0	21.0	20.0	20.0
Total Split (s)	58.0	21.0	59.0	20.0	21.0	41.0	20.0
Total Split (%)	48%	18%	49%	17%	18%	34%	17%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)							
Total Lost Time (s)							
Lead/Lag	Lead	Lag	Lag	Lead	Lag		Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes		Yes
Recall Mode	C-Max	Max	None	None	None	None	None
Act Effct Green (s)							
Actuated g/C Ratio							
v/c Ratio							
Control Delay							
Queue Delay							
Total Delay							
LOS							

Lanes, Volumes, Timings
 464: Shepherd & IH10 - WBFR

11/30/2017

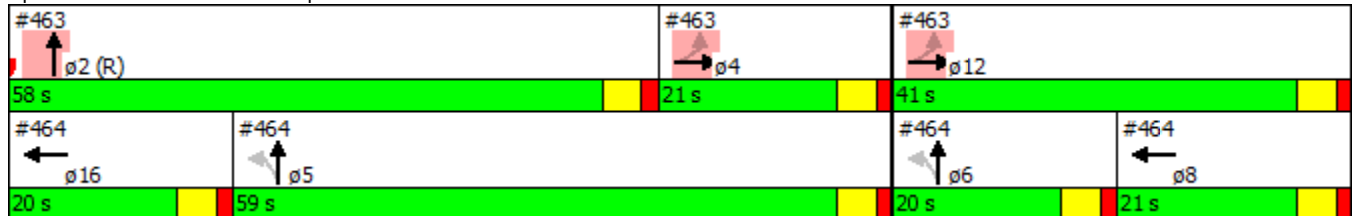


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					43.7			62.3				
Approach LOS					D			E				
Queue Length 50th (ft)					268		586	787				
Queue Length 95th (ft)					318		m510	m670				
Internal Link Dist (ft)		230			454			236			3791	
Turn Bay Length (ft)												
Base Capacity (vph)					1427		976	3009				
Starvation Cap Reductn					0		356	1016				
Spillback Cap Reductn					193		3	1				
Storage Cap Reductn					0		0	0				
Reduced v/c Ratio					0.86		1.21	1.35				

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 17 (14%), Referenced to phase 2:NBT, Start of Green
 Natural Cycle: 125
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.17
 Intersection Signal Delay: 57.9 Intersection LOS: E
 Intersection Capacity Utilization 96.1% ICU Level of Service F
 Analysis Period (min) 15
 m Volume for 95th percentile queue is metered by upstream signal.
 dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Splits and Phases: 464: Shepherd & IH10 - WBFR



Lane Group	ø2	ø4	ø5	ø6	ø8	ø12	ø16
Approach Delay							
Approach LOS							
Queue Length 50th (ft)							
Queue Length 95th (ft)							
Internal Link Dist (ft)							
Turn Bay Length (ft)							
Base Capacity (vph)							
Starvation Cap Reductn							
Spillback Cap Reductn							
Storage Cap Reductn							
Reduced v/c Ratio							
Intersection Summary							

Lanes, Volumes, Timings
465: W 11th

11/30/2017

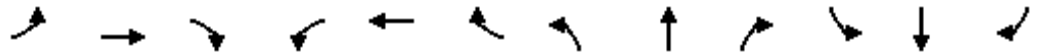


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	246	741	1	0	466	160	360	1841	157	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	50		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1770	3536	0	0	3398	0	0	6287	0	0	0	0
Flt Permitted	0.289							0.992				
Satd. Flow (perm)	538	3536	0	0	3398	0	0	6287	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		1						16				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		536			448			700				2008
Travel Time (s)		12.2			10.2			13.6				39.1
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.87	0.95	0.25	0.93	0.90	0.85	0.87	0.93	0.80	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	325	902	0	0	811	0	0	2979	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		2			6			8				
Permitted Phases	2						8					
Detector Phase	2	2			6		8	8				
Switch Phase												
Minimum Initial (s)	7.0	7.0			5.0		7.0	7.0				
Minimum Split (s)	21.2	21.2			21.2		21.0	21.0				
Total Split (s)	73.0	73.0			73.0		47.0	47.0				
Total Split (%)	60.8%	60.8%			60.8%		39.2%	39.2%				
Yellow Time (s)	3.6	3.6			3.6		3.6	3.6				
All-Red Time (s)	1.6	1.6			1.6		1.4	1.4				
Lost Time Adjust (s)	0.0	0.0			0.0			0.0				
Total Lost Time (s)	5.2	5.2			5.2			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	None	None			None		C-Max	C-Max				
Act Effct Green (s)	67.8	67.8			67.8			42.0				
Actuated g/C Ratio	0.56	0.56			0.56			0.35				
v/c Ratio	1.07	0.45			0.42			1.35				
Control Delay	85.8	10.4			15.8			189.0				
Queue Delay	0.0	0.2			0.0			0.0				
Total Delay	85.8	10.6			15.8			189.0				
LOS	F	B			B			F				

Lanes, Volumes, Timings

465: W 11th

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		30.5			15.8			189.0				
Approach LOS		C			B			F				
Queue Length 50th (ft)	~151	94			180			~869				
Queue Length 95th (ft)	m#415	164			226			#941				
Internal Link Dist (ft)		456			368			620			1928	
Turn Bay Length (ft)	50											
Base Capacity (vph)	303	1998			1919			2210				
Starvation Cap Reductn	0	378			0			0				
Spillback Cap Reductn	0	0			0			0				
Storage Cap Reductn	0	0			0			0				
Reduced v/c Ratio	1.07	0.56			0.42			1.35				

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 14 (12%), Referenced to phase 8:NBTL, Start of Green
 Natural Cycle: 140
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.35
 Intersection Signal Delay: 122.2
 Intersection LOS: F
 Intersection Capacity Utilization 89.2%
 ICU Level of Service E
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 465: W 11th



Lanes, Volumes, Timings

466: W 14th

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	24	63	0	0	82	45	72	2262	63	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1837	0	0	1775	0	0	6363	0	0	0	0
Flt Permitted		0.652						0.998				
Satd. Flow (perm)	0	1215	0	0	1775	0	0	6363	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)								6				
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		488			473			2008			644	
Travel Time (s)		11.1			10.8			39.1			12.5	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.86	0.88	0.93	0.93	0.68	0.70	0.75	0.96	0.72	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	114	0	0	213	0	0	2921	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		2			6			8				
Permitted Phases	2						8					
Detector Phase	2	2			6		8	8				
Switch Phase												
Minimum Initial (s)	11.0	11.0			11.0		11.0	11.0				
Minimum Split (s)	45.0	45.0			45.0		40.0	40.0				
Total Split (s)	70.0	70.0			70.0		50.0	50.0				
Total Split (%)	58.3%	58.3%			58.3%		41.7%	41.7%				
Yellow Time (s)	3.5	3.5			3.5		3.2	3.2				
All-Red Time (s)	1.7	1.7			1.7		1.8	1.8				
Lost Time Adjust (s)		0.0			0.0			0.0				
Total Lost Time (s)		5.2			5.2			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	None	None			None		C-Max	C-Max				
Act Effct Green (s)		20.4			20.4			89.4				
Actuated g/C Ratio		0.17			0.17			0.74				
v/c Ratio		0.55			0.71			0.62				
Control Delay		53.7			59.2			21.1				
Queue Delay		0.0			0.0			0.0				
Total Delay		53.7			59.2			21.1				
LOS		D			E			C				

Lanes, Volumes, Timings

466: W 14th

11/30/2017

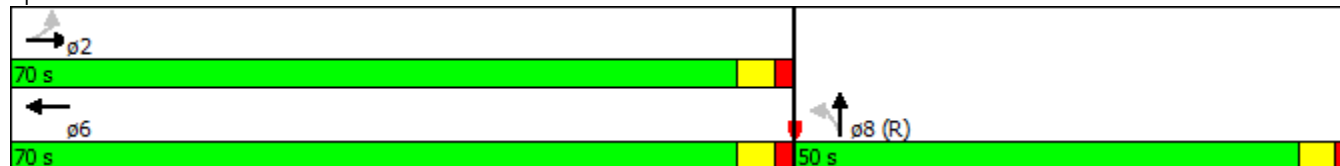


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		53.7			59.2			21.1				
Approach LOS		D			E			C				
Queue Length 50th (ft)		85			158			477				
Queue Length 95th (ft)		m124			161			m376				
Internal Link Dist (ft)		408			393			1928			564	
Turn Bay Length (ft)												
Base Capacity (vph)		656			958			4742				
Starvation Cap Reductn		0			0			0				
Spillback Cap Reductn		0			0			0				
Storage Cap Reductn		0			0			0				
Reduced v/c Ratio		0.17			0.22			0.62				

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 20 (17%), Referenced to phase 8:NBTL, Start of Green
 Natural Cycle: 85
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.71
 Intersection Signal Delay: 24.8
 Intersection LOS: C
 Intersection Capacity Utilization 71.3%
 ICU Level of Service C
 Analysis Period (min) 15
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 466: W 14th



Lanes, Volumes, Timings
467: N Shepherd Dr & W 19th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↔			↑	↗		↔↔↔				
Volume (vph)	60	290	0	0	166	111	87	2090	128	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		85	0		0	0		0	0		0
Storage Lanes	0		1	0		1	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3504	0	0	1863	1583	0	6337	0	0	0	0
Flt Permitted		0.845						0.998				
Satd. Flow (perm)	0	2991	0	0	1863	1583	0	6337	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						48		39				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		668			574			1789				375
Travel Time (s)		15.2			13.0			34.9				7.3
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.75	0.88	0.93	0.93	0.90	0.90	0.87	0.94	0.84	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	471	0	0	212	142	0	2847	0	0	0	0
Turn Type	Perm	NA			NA	Perm	Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4					8	2					
Detector Phase	4	4			8	8	2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0	4.0	4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0	20.0	20.0	20.0				
Total Split (s)	20.0	20.0			20.0	20.0	25.0	25.0				
Total Split (%)	44.4%	44.4%			44.4%	44.4%	55.6%	55.6%				
Yellow Time (s)	3.5	3.5			3.5	3.5	3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5	1.5	1.5	1.5				
Lost Time Adjust (s)		0.0			0.0	0.0		0.0				
Total Lost Time (s)		5.0			5.0	5.0		5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max	Max	Max	Max				
Act Effct Green (s)		15.0			15.0	15.0		20.0				
Actuated g/C Ratio		0.33			0.33	0.33		0.44				
v/c Ratio		0.47			0.34	0.25		1.00				
Control Delay		13.8			13.2	9.2		32.4				
Queue Delay		0.0			0.0	0.0		0.0				
Total Delay		13.8			13.2	9.2		32.4				
LOS		B			B	A		C				

Lanes, Volumes, Timings
 467: N Shepherd Dr & W 19th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		13.8			11.6			32.4				
Approach LOS		B			B			C				
Queue Length 50th (ft)		48			40	17		~196				
Queue Length 95th (ft)		79			80	47		#308				
Internal Link Dist (ft)		588			494			1709			295	
Turn Bay Length (ft)												
Base Capacity (vph)		997			621	559		2838				
Starvation Cap Reductn		0			0	0		0				
Spillback Cap Reductn		0			0	0		0				
Storage Cap Reductn		0			0	0		0				
Reduced v/c Ratio		0.47			0.34	0.25		1.00				

Intersection Summary

Area Type: Other
 Cycle Length: 45
 Actuated Cycle Length: 45
 Offset: 0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
 Natural Cycle: 50
 Control Type: Pretimed
 Maximum v/c Ratio: 1.00
 Intersection Signal Delay: 28.1
 Intersection LOS: C
 Intersection Capacity Utilization 72.6%
 ICU Level of Service C
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 467: N Shepherd Dr & W 19th St



Lanes, Volumes, Timings
468: N Shepherd Dr & W 20th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↔			↔↔			↔↔↔↔				
Volume (vph)	98	295	0	0	210	140	59	2114	103	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		100	0		0	0		0	0		0
Storage Lanes	0		1	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3490	0	0	3337	0	0	6350	0	0	0	0
Flt Permitted		0.700						0.999				
Satd. Flow (perm)	0	2477	0	0	3337	0	0	6350	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)								30				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		140			536			375				1478
Travel Time (s)		3.2			12.2			7.3				28.8
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.77	0.93	0.93	0.93	0.75	0.81	0.87	0.96	0.86	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	511	0	0	521	0	0	2748	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4						2					
Detector Phase	4	4			8		2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (s)	20.0	20.0			20.0		25.0	25.0				
Total Split (%)	44.4%	44.4%			44.4%		55.6%	55.6%				
Yellow Time (s)	3.5	3.5			3.5		3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5		1.5	1.5				
Lost Time Adjust (s)		0.0			0.0			0.0				
Total Lost Time (s)		5.0			5.0			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max		Max	Max				
Act Effct Green (s)		15.0			15.0			20.0				
Actuated g/C Ratio		0.33			0.33			0.44				
v/c Ratio		0.62			0.47			0.97				
Control Delay		16.6			13.6			15.7				
Queue Delay		0.0			0.0			0.0				
Total Delay		16.6			13.6			15.7				
LOS		B			B			B				

Lanes, Volumes, Timings
 468: N Shepherd Dr & W 20th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		16.6			13.6			15.7				
Approach LOS		B			B			B				
Queue Length 50th (ft)		56			54			101				
Queue Length 95th (ft)		96			70			m103				
Internal Link Dist (ft)		60			456			295			1398	
Turn Bay Length (ft)												
Base Capacity (vph)		825			1112			2838				
Starvation Cap Reductn		0			0			0				
Spillback Cap Reductn		0			0			0				
Storage Cap Reductn		0			0			0				
Reduced v/c Ratio		0.62			0.47			0.97				

Intersection Summary

Area Type:	Other
Cycle Length:	45
Actuated Cycle Length:	45
Offset:	0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
Natural Cycle:	60
Control Type:	Pretimed
Maximum v/c Ratio:	0.97
Intersection Signal Delay:	15.5
Intersection LOS:	B
Intersection Capacity Utilization:	75.2%
ICU Level of Service:	D
Analysis Period (min):	15
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 468: N Shepherd Dr & W 20th St



Lanes, Volumes, Timings
469: N Shepherd Dr & W 24th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	34	36	0	0	36	26	74	2230	26	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1818	0	0	1742	0	0	6382	0	0	0	0
Flt Permitted		0.812						0.998				
Satd. Flow (perm)	0	1513	0	0	1742	0	0	6382	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)								6				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		660			543			1478				1697
Travel Time (s)		15.0			12.3			28.8				33.1
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.65	0.69	0.93	0.93	0.64	0.50	0.80	0.90	0.81	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	120	0	0	125	0	0	2992	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4						2					
Detector Phase	4	4			8		2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (s)	20.0	20.0			20.0		25.0	25.0				
Total Split (%)	44.4%	44.4%			44.4%		55.6%	55.6%				
Yellow Time (s)	3.5	3.5			3.5		3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5		1.5	1.5				
Lost Time Adjust (s)		0.0			0.0			0.0				
Total Lost Time (s)		5.0			5.0			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max		Max	Max				
Act Effct Green (s)		15.0			15.0			20.0				
Actuated g/C Ratio		0.33			0.33			0.44				
v/c Ratio		0.24			0.22			1.05				
Control Delay		12.5			12.0			45.9				
Queue Delay		0.0			0.0			0.0				
Total Delay		12.5			12.0			45.9				
LOS		B			B			D				

Lanes, Volumes, Timings
 469: N Shepherd Dr & W 24th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		12.5			12.0			45.9				
Approach LOS		B			B			D				
Queue Length 50th (ft)		22			22			~281				
Queue Length 95th (ft)		37			34			m#303				
Internal Link Dist (ft)		580			463			1398			1617	
Turn Bay Length (ft)												
Base Capacity (vph)		504			580			2839				
Starvation Cap Reductn		0			0			0				
Spillback Cap Reductn		0			0			0				
Storage Cap Reductn		0			0			0				
Reduced v/c Ratio		0.24			0.22			1.05				

Intersection Summary

Area Type: Other
 Cycle Length: 45
 Actuated Cycle Length: 45
 Offset: 0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
 Natural Cycle: 55
 Control Type: Pretimed
 Maximum v/c Ratio: 1.05
 Intersection Signal Delay: 43.4
 Intersection LOS: D
 Intersection Capacity Utilization 58.3%
 ICU Level of Service B
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 469: N Shepherd Dr & W 24th St



Lanes, Volumes, Timings
470: N Shepherd Dr & IH 610 EBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	582	1158	0	0	0	0	0	1729	327	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1610	3380	0	0	0	0	0	6254	0	0	0	0
Flt Permitted	0.950	0.997										
Satd. Flow (perm)	1610	3380	0	0	0	0	0	6254	0	0	0	0
Right Turn on Red	Yes		Yes			Yes			Yes			Yes
Satd. Flow (RTOR)	55	55						7				
Link Speed (mph)		45			45			35				35
Link Distance (ft)		526			314			1697				251
Travel Time (s)		8.0			4.8			33.1				4.9
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.97	0.93	0.93	0.93	0.93	0.93	0.94	0.95	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)	10%											
Lane Group Flow (vph)	655	1446	0	0	0	0	0	2511	0	0	0	0
Turn Type	Perm	NA						NA				
Protected Phases		4						2				
Permitted Phases	4											
Detector Phase	4	4						2				
Switch Phase												
Minimum Initial (s)	4.0	4.0						4.0				
Minimum Split (s)	20.0	20.0						20.0				
Total Split (s)	20.0	20.0						20.0				
Total Split (%)	50.0%	50.0%						50.0%				
Yellow Time (s)	3.5	3.5						3.5				
All-Red Time (s)	1.5	1.5						1.5				
Lost Time Adjust (s)	0.0	0.0						0.0				
Total Lost Time (s)	5.0	5.0						5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max						Max				
Act Effct Green (s)	15.0	15.0						15.0				
Actuated g/C Ratio	0.38	0.38						0.38				
v/c Ratio	1.03	1.11						1.07				
Control Delay	45.2	71.1						56.4				
Queue Delay	1.0	0.0						13.5				
Total Delay	46.2	71.1						69.8				
LOS	D	E						E				

Lanes, Volumes, Timings
 470: N Shepherd Dr & IH 610 EBFR

11/30/2017

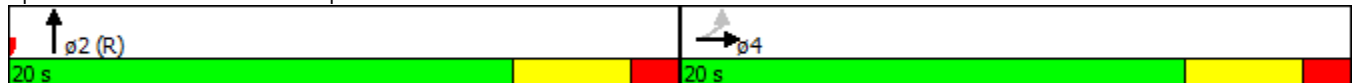


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		63.4						69.8				
Approach LOS		E						E				
Queue Length 50th (ft)	~124	~194						~195				
Queue Length 95th (ft)	m#146	m#219						#265				
Internal Link Dist (ft)		446			234			1617			171	
Turn Bay Length (ft)												
Base Capacity (vph)	638	1301						2349				
Starvation Cap Reductn	0	0						0				
Spillback Cap Reductn	2	1						287				
Storage Cap Reductn	0	0						0				
Reduced v/c Ratio	1.03	1.11						1.22				

Intersection Summary

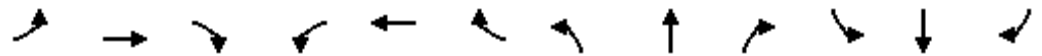
Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2:NBT and 6:, Start of Green
 Natural Cycle: 80
 Control Type: Pretimed
 Maximum v/c Ratio: 1.11
 Intersection Signal Delay: 66.9
 Intersection LOS: E
 Intersection Capacity Utilization 100.7%
 ICU Level of Service G
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 470: N Shepherd Dr & IH 610 EBFR



Lanes, Volumes, Timings
471: N Shepherd Dr & IH 610 WBFR

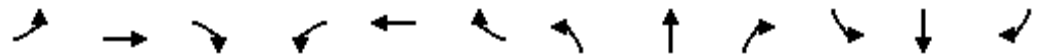
11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑↑↑		↖	↑↑↑				
Volume (vph)	0	0	0	0	597	406	398	1884	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	1		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	0	4775	0	1433	6029	0	0	0	0
Flt Permitted							0.950	0.999				
Satd. Flow (perm)	0	0	0	0	4775	0	1433	6029	0	0	0	0
Right Turn on Red			Yes			Yes	Yes		Yes			Yes
Satd. Flow (RTOR)							75	55				
Link Speed (mph)		45			45			35				35
Link Distance (ft)		398			334			251				1261
Travel Time (s)		6.0			5.1			4.9				24.6
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.93	0.91	0.91	0.86	0.92	0.93	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)							10%					
Lane Group Flow (vph)	0	0	0	0	1267	0	479	2408	0	0	0	0
Turn Type					NA		Perm	NA				
Protected Phases					8			2				
Permitted Phases							2					
Detector Phase					8		2	2				
Switch Phase												
Minimum Initial (s)					4.0		4.0	4.0				
Minimum Split (s)					20.0		20.0	20.0				
Total Split (s)					20.0		20.0	20.0				
Total Split (%)					50.0%		50.0%	50.0%				
Yellow Time (s)					3.5		3.5	3.5				
All-Red Time (s)					1.5		1.5	1.5				
Lost Time Adjust (s)					0.0		0.0	0.0				
Total Lost Time (s)					5.0		5.0	5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode					Max		Max	Max				
Act Effct Green (s)					15.0		15.0	15.0				
Actuated g/C Ratio					0.38		0.38	0.38				
v/c Ratio					0.71		0.82	1.05				
Control Delay					13.3		12.1	36.7				
Queue Delay					0.0		0.3	4.8				
Total Delay					13.3		12.3	41.6				
LOS					B		B	D				

Lanes, Volumes, Timings
471: N Shepherd Dr & IH 610 WBFR

11/30/2017

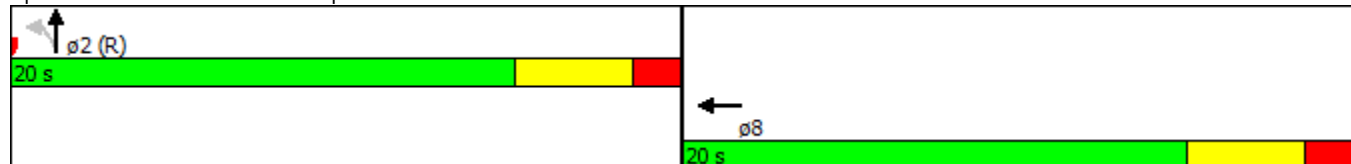


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					13.3			36.7				
Approach LOS					B			D				
Queue Length 50th (ft)					83		61	~109				
Queue Length 95th (ft)					120		m55	m93				
Internal Link Dist (ft)		318			254			171			1181	
Turn Bay Length (ft)												
Base Capacity (vph)					1790		584	2295				
Starvation Cap Reductn					0		6	26				
Spillback Cap Reductn					0		0	0				
Storage Cap Reductn					0		0	0				
Reduced v/c Ratio					0.71		0.83	1.06				

Intersection Summary

Area Type:	Other
Cycle Length:	40
Actuated Cycle Length:	40
Offset:	0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
Natural Cycle:	60
Control Type:	Pretimed
Maximum v/c Ratio:	1.05
Intersection Signal Delay:	29.6
Intersection LOS:	C
Intersection Capacity Utilization:	62.8%
ICU Level of Service:	B
Analysis Period (min):	15
~ Volume exceeds capacity, queue is theoretically infinite. Queue shown is maximum after two cycles.	
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 471: N Shepherd Dr & IH 610 WBFR



2040 AM Peak Build



Lanes, Volumes, Timings
450: Durham & Washington

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑		↖	↑↑						↑↑↑↑	
Volume (vph)	0	506	235	173	621	0	0	0	0	235	1629	47
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	150		0	0		0	0		0
Storage Lanes	0		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3369	0	1770	3539	0	0	0	0	0	6344	0
Flt Permitted				0.950							0.994	
Satd. Flow (perm)	0	3369	0	1770	3539	0	0	0	0	0	6344	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		63										5
Link Speed (mph)		30			30			30				30
Link Distance (ft)		2207			322			520				238
Travel Time (s)		50.2			7.3			11.8				5.4
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	888	0	207	744	0	0	0	0	0	2289	0
Turn Type		NA		Prot	NA						Perm	NA
Protected Phases		2		1	6							4
Permitted Phases											4	
Detector Phase		2		1	6						4	4
Switch Phase												
Minimum Initial (s)		10.0		5.0	10.0						10.0	10.0
Minimum Split (s)		21.0		10.0	21.0						18.0	18.0
Total Split (s)		40.0		25.0	65.0						55.0	55.0
Total Split (%)		33.3%		20.8%	54.2%						45.8%	45.8%
Yellow Time (s)		3.6		3.6	3.6						3.6	3.6
All-Red Time (s)		1.4		1.4	1.4						1.4	1.4
Lost Time Adjust (s)		0.0		0.0	0.0							0.0
Total Lost Time (s)		5.0		5.0	5.0							5.0
Lead/Lag		Lag		Lead								
Lead-Lag Optimize?		Yes		Yes								
Recall Mode		Max		None	Max					C-Max	C-Max	
Act Effect Green (s)		37.2		17.8	60.0							50.0
Actuated g/C Ratio		0.31		0.15	0.50							0.42
v/c Ratio		0.82		0.79	0.42							0.87
Control Delay		34.2		79.4	19.9							52.1
Queue Delay		0.0		1.4	1.6							0.0
Total Delay		34.2		80.8	21.5							52.1
LOS		C		F	C							D

Lanes, Volumes, Timings
450: Durham & Washington

11/30/2017

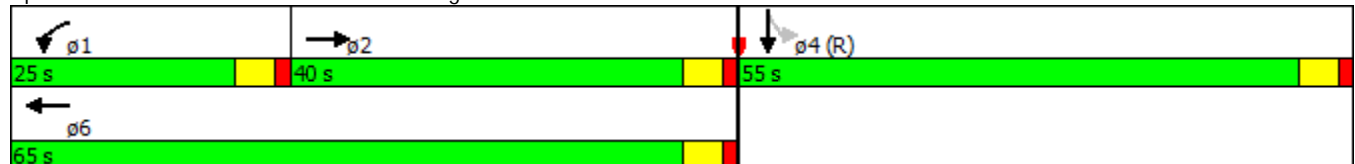


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		34.2			34.4							52.1
Approach LOS		C			C							D
Queue Length 50th (ft)		376		172	138							524
Queue Length 95th (ft)		#447		m216	m188							m566
Internal Link Dist (ft)		2127			242			440				158
Turn Bay Length (ft)				150								
Base Capacity (vph)		1089		295	1769							2646
Starvation Cap Reductn		0		19	804							0
Spillback Cap Reductn		0		0	0							0
Storage Cap Reductn		0		0	0							0
Reduced v/c Ratio		0.82		0.75	0.77							0.87

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 0 (0%), Referenced to phase 4:SBTL, Start of Green
 Natural Cycle: 80
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.87
 Intersection Signal Delay: 44.2
 Intersection LOS: D
 Intersection Capacity Utilization 80.4%
 ICU Level of Service D
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 450: Durham & Washington



Lanes, Volumes, Timings
451: Durham & Center

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	20	24	9	27	0	0	0	0	26	2088	31
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1730	0	0	1839	0	0	0	0	0	6382	0
Flt Permitted					0.987						0.999	
Satd. Flow (perm)	0	1730	0	0	1839	0	0	0	0	0	6382	0
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		534			320			238			443	
Travel Time (s)		12.1			7.3			4.6			8.6	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.56	0.60	0.56	0.61	0.93	0.93	0.93	0.93	0.86	0.93	0.70
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	87	0	0	69	0	0	0	0	0	2668	0
Sign Control		Stop			Stop			Stop			Free	

Intersection Summary

Area Type:	Other
Control Type:	Unsignalized
Intersection Capacity Utilization	51.4%
ICU Level of Service	A
Analysis Period (min)	15

Lanes, Volumes, Timings
452: Durham & IH10 - EBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑								↓	↑↑↑	
Volume (vph)	0	606	410	0	0	0	0	0	0	274	1761	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	4770	0	0	0	0	0	0	0	1522	4801	0
Flt Permitted										0.950	0.999	
Satd. Flow (perm)	0	4770	0	0	0	0	0	0	0	1522	4801	0
Right Turn on Red			Yes			Yes			Yes	Yes		Yes
Satd. Flow (RTOR)		10								64	64	
Link Speed (mph)		40			40			35			35	
Link Distance (ft)		594			306			1744			312	
Travel Time (s)		10.1			5.2			34.0			6.1	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.90	0.87	0.93	0.93	0.93	0.93	0.93	0.93	0.90	0.95	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)										10%		
Lane Group Flow (vph)	0	1316	0	0	0	0	0	0	0	315	2167	0
Turn Type		NA								Perm	NA	
Protected Phases		4 12									1 2	
Permitted Phases										1 2		
Detector Phase		4 12								1 2	1 2	
Switch Phase												
Minimum Initial (s)												
Minimum Split (s)												
Total Split (s)												
Total Split (%)												
Yellow Time (s)												
All-Red Time (s)												
Lost Time Adjust (s)												
Total Lost Time (s)												
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode												
Act Effct Green (s)		35.0								75.0	75.0	
Actuated g/C Ratio		0.29								0.62	0.62	
v/c Ratio		1.14dr								0.32	0.72	
Control Delay		55.1								5.1	14.5	
Queue Delay		0.0								3.3	47.8	
Total Delay		55.1								8.4	62.3	
LOS		E								A	E	

Lane Group	ø1	ø2	ø4	ø6	ø8	ø12	ø16
Lane Configurations							
Volume (vph)							
Ideal Flow (vphpl)							
Lane Width (ft)							
Grade (%)							
Storage Length (ft)							
Storage Lanes							
Taper Length (ft)							
Satd. Flow (prot)							
Flt Permitted							
Satd. Flow (perm)							
Right Turn on Red							
Satd. Flow (RTOR)							
Link Speed (mph)							
Link Distance (ft)							
Travel Time (s)							
Confl. Peds. (#/hr)							
Confl. Bikes (#/hr)							
Peak Hour Factor							
Growth Factor							
Heavy Vehicles (%)							
Bus Blockages (#/hr)							
Parking (#/hr)							
Mid-Block Traffic (%)							
Shared Lane Traffic (%)							
Lane Group Flow (vph)							
Turn Type							
Protected Phases	1	2	4	6	8	12	16
Permitted Phases							
Detector Phase							
Switch Phase							
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	21.0	21.0	21.0	20.0	20.0
Total Split (s)	59.0	21.0	12.0	66.0	21.0	28.0	33.0
Total Split (%)	49%	18%	10%	55%	18%	23%	28%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)							
Total Lost Time (s)							
Lead/Lag	Lag	Lead	Lag	Lead	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	
Recall Mode	None	Max	None	C-Max	Max	None	None
Act Effct Green (s)							
Actuated g/C Ratio							
v/c Ratio							
Control Delay							
Queue Delay							
Total Delay							
LOS							

Lanes, Volumes, Timings
452: Durham & IH10 - EBFR

11/30/2017

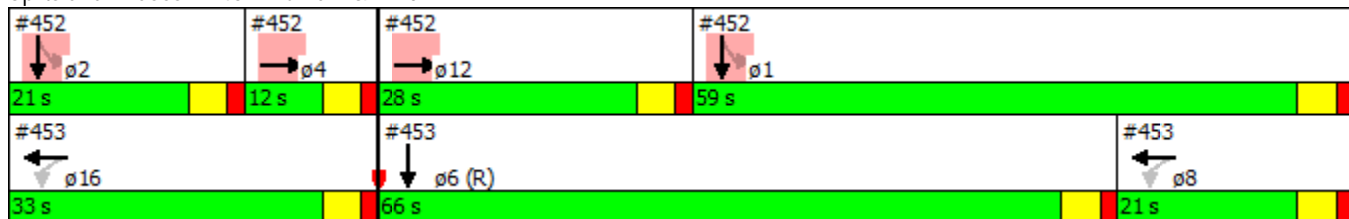


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		55.1										55.5
Approach LOS		E										E
Queue Length 50th (ft)		362								89		609
Queue Length 95th (ft)		#458								m89		m587
Internal Link Dist (ft)		514			226			1664				232
Turn Bay Length (ft)												
Base Capacity (vph)		1398								975		3024
Starvation Cap Reductn		0								551		1310
Spillback Cap Reductn		0								0		0
Storage Cap Reductn		0								0		0
Reduced v/c Ratio		0.94								0.74		1.26

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 94 (78%), Referenced to phase 6:SBT, Start of Green
 Natural Cycle: 145
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.07
 Intersection Signal Delay: 55.3 Intersection LOS: E
 Intersection Capacity Utilization 88.7% ICU Level of Service E
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.
 dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Splits and Phases: 452: Durham & IH10 - EBFR



Lane Group	ø1	ø2	ø4	ø6	ø8	ø12	ø16
Approach Delay							
Approach LOS							
Queue Length 50th (ft)							
Queue Length 95th (ft)							
Internal Link Dist (ft)							
Turn Bay Length (ft)							
Base Capacity (vph)							
Starvation Cap Reductn							
Spillback Cap Reductn							
Storage Cap Reductn							
Reduced v/c Ratio							
Intersection Summary							

Lanes, Volumes, Timings
453: Durham & IH10 - WBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↙	↕						↕	↘
Volume (vph)	0	0	0	243	882	0	0	0	0	0	1793	487
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	1770	3539	0	0	0	0	0	4917	0
Flt Permitted				0.950								
Satd. Flow (perm)	0	0	0	1770	3539	0	0	0	0	0	4917	0
Right Turn on Red			Yes	Yes		Yes			Yes			Yes
Satd. Flow (RTOR)				64								25
Link Speed (mph)		40			40			35				35
Link Distance (ft)		575			310			312				440
Travel Time (s)		9.8			5.3			6.1				8.6
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.89	0.89	0.93	0.93	0.93	0.93	0.93	0.98	0.96
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	314	1140	0	0	0	0	0	2687	0
Turn Type				Perm	NA							NA
Protected Phases					8 16							6
Permitted Phases				8 16								
Detector Phase				8 16	8 16							6
Switch Phase												
Minimum Initial (s)												4.0
Minimum Split (s)												21.0
Total Split (s)												66.0
Total Split (%)												55.0%
Yellow Time (s)												3.5
All-Red Time (s)												1.5
Lost Time Adjust (s)												0.0
Total Lost Time (s)												5.0
Lead/Lag												Lead
Lead-Lag Optimize?												Yes
Recall Mode												C-Max
Act Effect Green (s)				49.0	49.0							61.0
Actuated g/C Ratio				0.41	0.41							0.51
v/c Ratio				0.41	0.79							1.07
Control Delay				21.6	36.6							54.5
Queue Delay				2.8	49.1							13.3
Total Delay				24.4	85.7							67.8
LOS				C	F							E

Lanes, Volumes, Timings
 453: Durham & IH10 - WBFR

11/30/2017

Lane Group	ø1	ø2	ø4	ø8	ø12	ø16
Lane Configurations						
Volume (vph)						
Ideal Flow (vphpl)						
Lane Width (ft)						
Grade (%)						
Storage Length (ft)						
Storage Lanes						
Taper Length (ft)						
Satd. Flow (prot)						
Flt Permitted						
Satd. Flow (perm)						
Right Turn on Red						
Satd. Flow (RTOR)						
Link Speed (mph)						
Link Distance (ft)						
Travel Time (s)						
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor						
Growth Factor						
Heavy Vehicles (%)						
Bus Blockages (#/hr)						
Parking (#/hr)						
Mid-Block Traffic (%)						
Shared Lane Traffic (%)						
Lane Group Flow (vph)						
Turn Type						
Protected Phases	1	2	4	8	12	16
Permitted Phases						
Detector Phase						
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	21.0	21.0	20.0	20.0
Total Split (s)	59.0	21.0	12.0	21.0	28.0	33.0
Total Split (%)	49%	18%	10%	18%	23%	28%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)						
Total Lost Time (s)						
Lead/Lag	Lag	Lead	Lag	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	
Recall Mode	None	Max	None	Max	None	None
Act Effct Green (s)						
Actuated g/C Ratio						
v/c Ratio						
Control Delay						
Queue Delay						
Total Delay						
LOS						

Lanes, Volumes, Timings
 453: Durham & IH10 - WBFR

11/30/2017

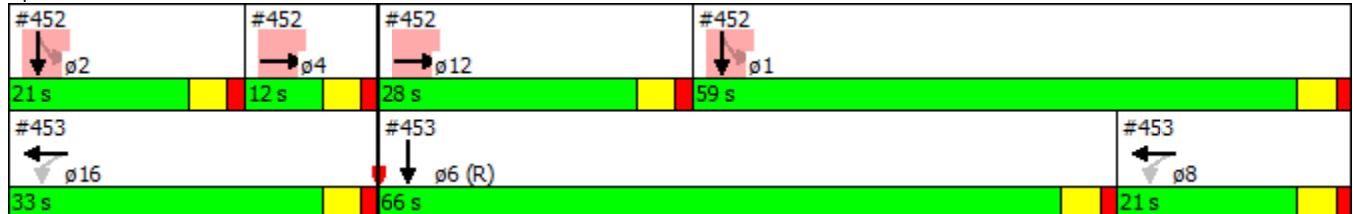


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					72.4							67.8
Approach LOS					E							E
Queue Length 50th (ft)				133	486							~826
Queue Length 95th (ft)				203	501							m297
Internal Link Dist (ft)		495			230			232				360
Turn Bay Length (ft)												
Base Capacity (vph)				760	1445							2511
Starvation Cap Reductn				329	470							0
Spillback Cap Reductn				6	0							537
Storage Cap Reductn				0	0							0
Reduced v/c Ratio				0.73	1.17							1.36

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 94 (78%), Referenced to phase 6:SBT, Start of Green
 Natural Cycle: 145
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.07
 Intersection Signal Delay: 69.4
 Intersection LOS: E
 Intersection Capacity Utilization 88.7%
 ICU Level of Service E
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 453: Durham & IH10 - WBFR



Lane Group	ø1	ø2	ø4	ø8	ø12	ø16
Approach Delay						
Approach LOS						
Queue Length 50th (ft)						
Queue Length 95th (ft)						
Internal Link Dist (ft)						
Turn Bay Length (ft)						
Base Capacity (vph)						
Starvation Cap Reductn						
Spillback Cap Reductn						
Storage Cap Reductn						
Reduced v/c Ratio						
Intersection Summary						

Lanes, Volumes, Timings
454: W 11th

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑	↑	↑	↑↑					↑	↑↑↑	
Volume (vph)	0	458	228	199	567	0	0	0	0	262	1908	413
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		150	50		0	0		0	150		0
Storage Lanes	0		1	1		0	0		0	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3360	1441	1770	3539	0	0	0	0	1770	4938	0
Flt Permitted				0.302						0.950		
Satd. Flow (perm)	0	3360	1441	563	3539	0	0	0	0	1770	4938	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		1	21									67
Link Speed (mph)		30			30			35				35
Link Distance (ft)		421			536			1925			2048	
Travel Time (s)		9.6			12.2			37.5			39.9	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.87	0.84	0.94	0.90	0.93	0.93	0.93	0.93	0.91	0.92	0.83
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)			12%									
Lane Group Flow (vph)	0	642	275	243	724	0	0	0	0	331	2957	0
Turn Type		NA	Perm	Perm	NA					Perm	NA	
Protected Phases		2			6							4
Permitted Phases			2	6						4		
Detector Phase		2	2	6	6					4	4	
Switch Phase												
Minimum Initial (s)		10.0	10.0	10.0	10.0					10.0	10.0	
Minimum Split (s)		21.2	21.2	21.2	21.2					21.3	21.3	
Total Split (s)		55.0	55.0	55.0	55.0					65.0	65.0	
Total Split (%)		45.8%	45.8%	45.8%	45.8%					54.2%	54.2%	
Yellow Time (s)		3.6	3.6	3.6	3.6					3.6	3.6	
All-Red Time (s)		1.6	1.6	1.6	1.6					1.7	1.7	
Lost Time Adjust (s)		0.0	0.0	0.0	0.0					0.0	0.0	
Total Lost Time (s)		5.2	5.2	5.2	5.2					5.3	5.3	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		None	None	None	None					C-Max	C-Max	
Act Effect Green (s)		49.8	49.8	49.8	49.8					59.7	59.7	
Actuated g/C Ratio		0.42	0.42	0.42	0.42					0.50	0.50	
v/c Ratio		0.46	0.45	1.04	0.49					0.38	1.19	
Control Delay		26.7	26.1	97.4	17.9					23.8	116.1	
Queue Delay		0.0	0.0	0.0	0.0					0.0	0.0	
Total Delay		26.7	26.1	97.4	17.9					23.8	116.1	
LOS		C	C	F	B					C	F	

Lanes, Volumes, Timings

454: W 11th

11/30/2017



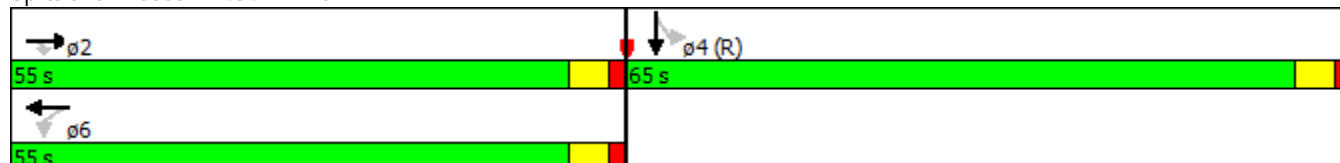
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		26.5				37.9						106.8
Approach LOS		C				D						F
Queue Length 50th (ft)		193	152	~141	206					152	~988	
Queue Length 95th (ft)		239	216	#301	295					m242	#1079	
Internal Link Dist (ft)		341			456			1845				1968
Turn Bay Length (ft)			150	50						150		
Base Capacity (vph)		1394	610	233	1468					880	2490	
Starvation Cap Reductn		0	0	0	0					0	0	
Spillback Cap Reductn		0	0	0	0					0	0	
Storage Cap Reductn		0	0	0	0					0	0	
Reduced v/c Ratio		0.46	0.45	1.04	0.49					0.38	1.19	

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 15 (13%), Referenced to phase 4:SBTL, Start of Green
 Natural Cycle: 130
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.19
 Intersection Signal Delay: 79.7
 Intersection LOS: E
 Intersection Capacity Utilization 96.1%
 ICU Level of Service F
 Analysis Period (min) 15

- ~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
- # 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
- m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 454: W 11th



Lanes, Volumes, Timings

455: W 14th

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	23	90	94	37	0	0	0	0	61	2231	15
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	150		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1669	0	0	1799	0	0	0	0	1770	5075	0
Flt Permitted					0.484					0.950		
Satd. Flow (perm)	0	1669	0	0	902	0	0	0	0	1770	5075	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		2										3
Link Speed (mph)		30			30			35				35
Link Distance (ft)		332			488			2048				157
Travel Time (s)		7.5			11.1			39.9				3.1
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.57	0.66	0.84	0.77	0.93	0.93	0.93	0.93	0.76	0.92	0.47
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	203	0	0	184	0	0	0	0	92	2826	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		2			6							4
Permitted Phases				6						4		
Detector Phase		2		6	6					4		4
Switch Phase												
Minimum Initial (s)		11.0		11.0	11.0					11.0		11.0
Minimum Split (s)		22.7		20.7	20.7					21.1		21.1
Total Split (s)		39.0		39.0	39.0					81.0		81.0
Total Split (%)		32.5%		32.5%	32.5%					67.5%		67.5%
Yellow Time (s)		3.2		3.2	3.2					3.6		3.6
All-Red Time (s)		1.5		1.5	1.5					1.5		1.5
Lost Time Adjust (s)		0.0			0.0					0.0		0.0
Total Lost Time (s)		4.7			4.7					5.1		5.1
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		None		None	None					C-Max		C-Max
Act Effect Green (s)		26.1			26.1					84.1		84.1
Actuated g/C Ratio		0.22			0.22					0.70		0.70
v/c Ratio		0.56			0.94					0.07		0.79
Control Delay		46.1			77.5					7.1		15.6
Queue Delay		0.0			0.0					0.0		0.0
Total Delay		46.1			77.5					7.1		15.6
LOS		D			E					A		B

Lanes, Volumes, Timings

455: W 14th

11/30/2017

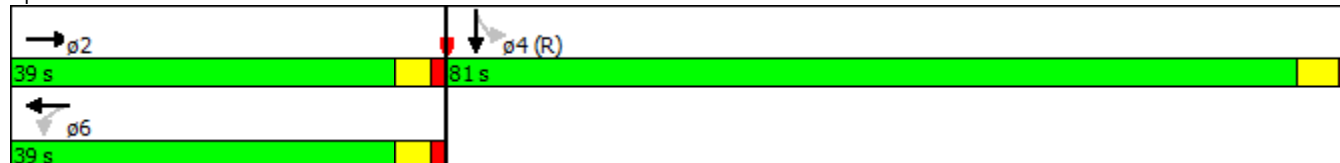


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		46.1			77.5							15.3
Approach LOS		D			E							B
Queue Length 50th (ft)		138			151					21		498
Queue Length 95th (ft)		117			193					39		697
Internal Link Dist (ft)		252			408			1968				77
Turn Bay Length (ft)										150		
Base Capacity (vph)		478			257					1240		3556
Starvation Cap Reductn		0			0					0		0
Spillback Cap Reductn		0			0					0		0
Storage Cap Reductn		0			0					0		0
Reduced v/c Ratio		0.42			0.72					0.07		0.79

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	13 (11%), Referenced to phase 4:SBTL, Start of Green
Natural Cycle:	70
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	0.94
Intersection Signal Delay:	20.7
Intersection LOS:	C
Intersection Capacity Utilization	80.4%
ICU Level of Service	D
Analysis Period (min)	15

Splits and Phases: 455: W 14th



Lanes, Volumes, Timings
456: N Durham Dr & W 19th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	129	87	54	131	0	0	0	0	69	2038	33
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	150		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1755	0	0	1835	0	0	0	0	1770	5070	0
Flt Permitted					0.671					0.950		
Satd. Flow (perm)	0	1755	0	0	1250	0	0	0	0	1770	5070	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		1										7
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		618			668			633			368	
Travel Time (s)		14.0			15.2			12.3			7.2	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.79	0.70	0.71	0.78	0.93	0.93	0.93	0.93	0.75	0.89	0.82
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	331	0	0	280	0	0	0	0	106	2679	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		4			8						6	
Permitted Phases				8						6		
Detector Phase		4		8	8					6	6	
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0					4.0	4.0	
Minimum Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (s)		20.0		20.0	20.0					30.0	30.0	
Total Split (%)		40.0%		40.0%	40.0%					60.0%	60.0%	
Yellow Time (s)		3.5		3.5	3.5					3.5	3.5	
All-Red Time (s)		1.5		1.5	1.5					1.5	1.5	
Lost Time Adjust (s)		0.0			0.0					0.0	0.0	
Total Lost Time (s)		5.0			5.0					5.0	5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max		Max	Max					Max	Max	
Act Effect Green (s)		15.0			15.0					25.0	25.0	
Actuated g/C Ratio		0.30			0.30					0.50	0.50	
v/c Ratio		0.63			0.75					0.12	1.06	
Control Delay		21.4			31.7					6.5	37.8	
Queue Delay		0.0			0.0					0.0	2.7	
Total Delay		21.4			31.7					6.5	40.5	
LOS		C			C					A	D	

Lanes, Volumes, Timings
456: N Durham Dr & W 19th St

11/30/2017

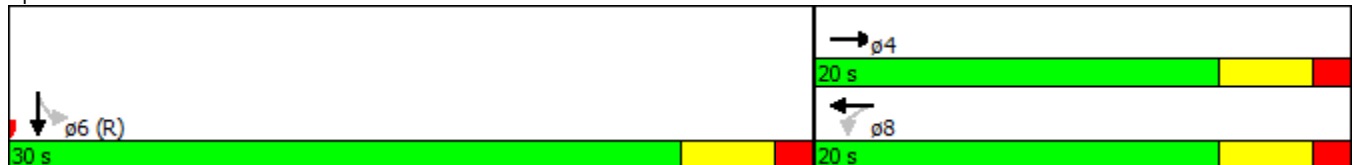


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		21.4			31.7							39.2
Approach LOS		C			C							D
Queue Length 50th (ft)		82			73					12		~133
Queue Length 95th (ft)		126			#137					m11		m109
Internal Link Dist (ft)		538			588			553				288
Turn Bay Length (ft)										150		
Base Capacity (vph)		527			375					885		2538
Starvation Cap Reductn		0			0					0		16
Spillback Cap Reductn		0			0					0		0
Storage Cap Reductn		0			0					0		0
Reduced v/c Ratio		0.63			0.75					0.12		1.06

Intersection Summary

Area Type: Other
 Cycle Length: 50
 Actuated Cycle Length: 50
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 70
 Control Type: Pretimed
 Maximum v/c Ratio: 1.06
 Intersection Signal Delay: 36.9
 Intersection LOS: D
 Intersection Capacity Utilization 83.9%
 ICU Level of Service E
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 456: N Durham Dr & W 19th St



Lanes, Volumes, Timings
457: N Durham Dr & W 20th St

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	121	39	83	179	0	0	0	0	88	2047	131
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	150		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1790	0	0	1833	0	0	0	0	1770	5034	0
Flt Permitted					0.784					0.950		
Satd. Flow (perm)	0	1790	0	0	1460	0	0	0	0	1770	5034	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		1										33
Link Speed (mph)		30			30			35				35
Link Distance (ft)		582			183			368				1486
Travel Time (s)		13.2			4.2			7.2				28.9
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.82	0.65	0.83	0.84	0.93	0.93	0.93	0.93	0.81	0.92	0.80
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	239	0	0	360	0	0	0	0	125	2747	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		4			8						6	
Permitted Phases				8						6		
Detector Phase		4		8	8					6	6	
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0					4.0	4.0	
Minimum Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (s)		20.0		20.0	20.0					30.0	30.0	
Total Split (%)		40.0%		40.0%	40.0%					60.0%	60.0%	
Yellow Time (s)		3.5		3.5	3.5					3.5	3.5	
All-Red Time (s)		1.5		1.5	1.5					1.5	1.5	
Lost Time Adjust (s)		0.0			0.0					0.0	0.0	
Total Lost Time (s)		5.0			5.0					5.0	5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max		Max	Max					Max	Max	
Act Effect Green (s)		15.0			15.0					25.0	25.0	
Actuated g/C Ratio		0.30			0.30					0.50	0.50	
v/c Ratio		0.45			0.82					0.14	1.08	
Control Delay		17.3			35.6					10.4	62.8	
Queue Delay		0.0			0.0					0.0	0.0	
Total Delay		17.3			35.6					10.4	62.8	
LOS		B			D					B	E	

Lanes, Volumes, Timings
457: N Durham Dr & W 20th St

11/30/2017

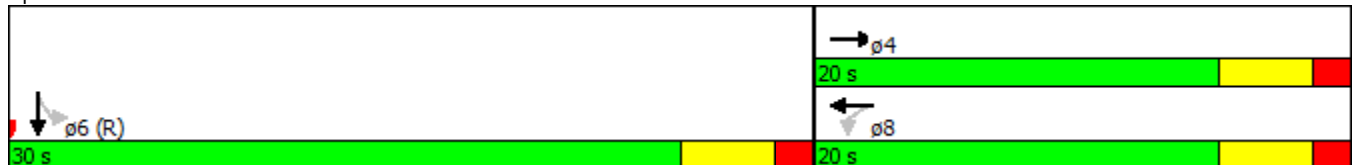


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		17.3			35.6							60.5
Approach LOS		B			D							E
Queue Length 50th (ft)		55			96					28		~372
Queue Length 95th (ft)		94			#196					m30		m#360
Internal Link Dist (ft)		502			103			288				1406
Turn Bay Length (ft)										150		
Base Capacity (vph)		537			438					885		2533
Starvation Cap Reductn		0			0					0		0
Spillback Cap Reductn		0			0					0		281
Storage Cap Reductn		0			0					0		0
Reduced v/c Ratio		0.45			0.82					0.14		1.22

Intersection Summary

Area Type: Other
 Cycle Length: 50
 Actuated Cycle Length: 50
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 65
 Control Type: Pretimed
 Maximum v/c Ratio: 1.08
 Intersection Signal Delay: 55.0 Intersection LOS: D
 Intersection Capacity Utilization 87.5% ICU Level of Service E
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 457: N Durham Dr & W 20th St



Lanes, Volumes, Timings
458: N Durham Dr & W 24th St

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	18	47	36	17	0	0	0	0	23	2152	33
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	150		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1667	0	0	1807	0	0	0	0	1770	5070	0
Flt Permitted					0.773					0.950		
Satd. Flow (perm)	0	1667	0	0	1440	0	0	0	0	1770	5070	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		1										8
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		555			660			1486			1120	
Travel Time (s)		12.6			15.0			28.9			21.8	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.75	0.56	0.69	0.53	0.93	0.93	0.93	0.93	0.82	0.96	0.75
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	125	0	0	97	0	0	0	0	32	2629	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		4			8						6	
Permitted Phases				8						6		
Detector Phase		4		8	8					6	6	
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0					4.0	4.0	
Minimum Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (s)		20.0		20.0	20.0					30.0	30.0	
Total Split (%)		40.0%		40.0%	40.0%					60.0%	60.0%	
Yellow Time (s)		3.5		3.5	3.5					3.5	3.5	
All-Red Time (s)		1.5		1.5	1.5					1.5	1.5	
Lost Time Adjust (s)		0.0			0.0					0.0	0.0	
Total Lost Time (s)		5.0			5.0					5.0	5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max		Max	Max					Max	Max	
Act Effect Green (s)		15.0			15.0					25.0	25.0	
Actuated g/C Ratio		0.30			0.30					0.50	0.50	
v/c Ratio		0.25			0.22					0.04	1.04	
Control Delay		14.8			14.9					5.1	38.2	
Queue Delay		0.0			0.0					0.0	0.0	
Total Delay		14.8			14.9					5.1	38.2	
LOS		B			B					A	D	

Lanes, Volumes, Timings
458: N Durham Dr & W 24th St

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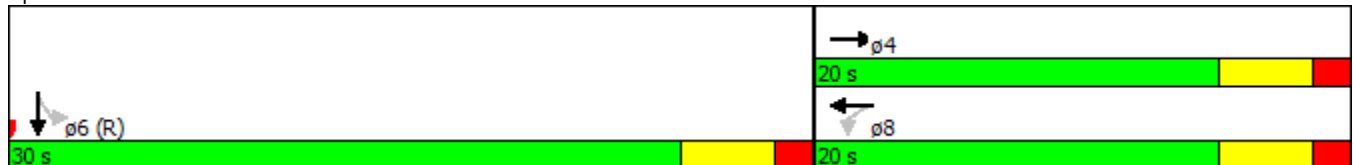


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		14.8			14.9							37.8
Approach LOS		B			B							D
Queue Length 50th (ft)		27			21					4		~333
Queue Length 95th (ft)		48			27					m4		m#384
Internal Link Dist (ft)		475			580			1406				1040
Turn Bay Length (ft)										150		
Base Capacity (vph)		500			432					885		2539
Starvation Cap Reductn		0			0					0		0
Spillback Cap Reductn		0			0					0		0
Storage Cap Reductn		0			0					0		0
Reduced v/c Ratio		0.25			0.22					0.04		1.04

Intersection Summary

Area Type: Other
 Cycle Length: 50
 Actuated Cycle Length: 50
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 60
 Control Type: Pretimed
 Maximum v/c Ratio: 1.04
 Intersection Signal Delay: 36.0
 Intersection LOS: D
 Intersection Capacity Utilization 67.0%
 ICU Level of Service C
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 458: N Durham Dr & W 24th St



Lanes, Volumes, Timings
459: N Durham Dr & IH 610 EBFR

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑								↘	↑↑↑	
Volume (vph)	0	768	231	0	0	0	0	0	0	561	1989	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	4897	0	0	0	0	0	0	0	1770	5085	0
Flt Permitted										0.950		
Satd. Flow (perm)	0	4897	0	0	0	0	0	0	0	1770	5085	0
Right Turn on Red			Yes			Yes			Yes	Yes		Yes
Satd. Flow (RTOR)		1								44		
Link Speed (mph)		45			10			30			30	
Link Distance (ft)		410			526			607			264	
Travel Time (s)		6.2			35.9			13.8			6.0	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.85	0.79	0.93	0.93	0.93	0.93	0.93	0.93	0.89	0.97	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	1375	0	0	0	0	0	0	0	725	2358	0
Turn Type		NA								Perm	NA	
Protected Phases		4									6	
Permitted Phases										6		
Detector Phase		4								6	6	
Switch Phase												
Minimum Initial (s)		4.0								4.0	4.0	
Minimum Split (s)		20.0								20.0	20.0	
Total Split (s)		20.0								30.0	30.0	
Total Split (%)		40.0%								60.0%	60.0%	
Yellow Time (s)		3.5								3.5	3.5	
All-Red Time (s)		1.5								1.5	1.5	
Lost Time Adjust (s)		0.0								0.0	0.0	
Total Lost Time (s)		5.0								5.0	5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max								Max	Max	
Act Effct Green (s)		15.0								25.0	25.0	
Actuated g/C Ratio		0.30								0.50	0.50	
v/c Ratio		0.94								0.80	0.93	
Control Delay		31.7								18.9	20.5	
Queue Delay		0.0								25.4	45.2	
Total Delay		31.7								44.3	65.7	
LOS		C								D	E	

Lanes, Volumes, Timings
 459: N Durham Dr & IH 610 EBFR

11/30/2017

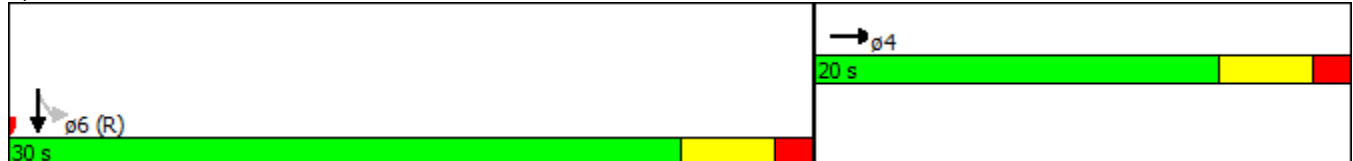


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		31.7										60.7
Approach LOS		C										E
Queue Length 50th (ft)		141								149	212	
Queue Length 95th (ft)		#206								#331	#342	
Internal Link Dist (ft)		330			446			527				184
Turn Bay Length (ft)												
Base Capacity (vph)		1469								907	2542	
Starvation Cap Reductn		0								205	515	
Spillback Cap Reductn		0								0	0	
Storage Cap Reductn		0								0	0	
Reduced v/c Ratio		0.94								1.03	1.16	

Intersection Summary

Area Type: Other
 Cycle Length: 50
 Actuated Cycle Length: 50
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 60
 Control Type: Pretimed
 Maximum v/c Ratio: 0.94
 Intersection Signal Delay: 51.7
 Intersection LOS: D
 Intersection Capacity Utilization 109.8%
 ICU Level of Service H
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 459: N Durham Dr & IH 610 EBFR



Lanes, Volumes, Timings
460: N Durham Dr & IH 610 WBFR

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	666	535	0	0	0	0	0	1963	800
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	1610	3333	0	0	0	0	0	6126	0
Flt Permitted				0.950	0.983							
Satd. Flow (perm)	0	0	0	1610	3333	0	0	0	0	0	6126	0
Right Turn on Red			Yes	Yes		Yes			Yes			Yes
Satd. Flow (RTOR)				55	55							97
Link Speed (mph)		45			45			35				35
Link Distance (ft)		407			398			264				706
Travel Time (s)		6.2			6.0			5.1				13.8
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.88	0.90	0.93	0.93	0.93	0.93	0.93	0.96	0.95
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)				42%								
Lane Group Flow (vph)	0	0	0	505	1049	0	0	0	0	0	3320	0
Turn Type				Perm	NA							NA
Protected Phases					8							6
Permitted Phases				8								
Detector Phase				8	8							6
Switch Phase												
Minimum Initial (s)				4.0	4.0							4.0
Minimum Split (s)				20.0	20.0							20.0
Total Split (s)				20.0	20.0							20.0
Total Split (%)				50.0%	50.0%							50.0%
Yellow Time (s)				3.5	3.5							3.5
All-Red Time (s)				1.5	1.5							1.5
Lost Time Adjust (s)				0.0	0.0							0.0
Total Lost Time (s)				5.0	5.0							5.0
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode				Max	Max							Max
Act Effect Green (s)				15.0	15.0							15.0
Actuated g/C Ratio				0.38	0.38							0.38
v/c Ratio				0.79	0.82							1.46dr
Control Delay				17.7	13.9							204.8
Queue Delay				0.0	0.0							0.0
Total Delay				17.7	13.9							204.8
LOS				B	B							F

Lanes, Volumes, Timings
460: N Durham Dr & IH 610 WBFR

11/30/2017

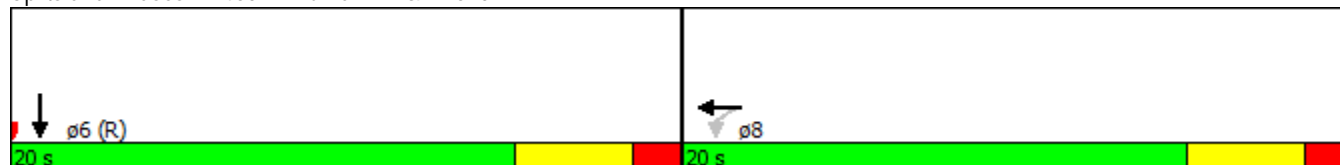


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					15.1							204.8
Approach LOS					B							F
Queue Length 50th (ft)				57	66							~314
Queue Length 95th (ft)				m#124	m#125							#387
Internal Link Dist (ft)		327			318			184				626
Turn Bay Length (ft)												
Base Capacity (vph)				638	1284							2357
Starvation Cap Reductn				0	0							0
Spillback Cap Reductn				0	0							0
Storage Cap Reductn				0	0							0
Reduced v/c Ratio				0.79	0.82							1.41

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBT, Start of Green
 Natural Cycle: 90
 Control Type: Pretimed
 Maximum v/c Ratio: 1.41
 Intersection Signal Delay: 144.4 Intersection LOS: F
 Intersection Capacity Utilization 82.6% ICU Level of Service E
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.
 dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Splits and Phases: 460: N Durham Dr & IH 610 WBFR



Lanes, Volumes, Timings
461: Shepherd & Washington

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	29	698	0	0	532	109	264	868	75	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	90		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1770	3539	0	0	3416	0	0	6280	0	0	0	0
Flt Permitted	0.950							0.989				
Satd. Flow (perm)	1770	3539	0	0	3416	0	0	6280	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					19			16				
Link Speed (mph)		30			30			30				30
Link Distance (ft)		322			1068			522				252
Travel Time (s)		7.3			24.3			11.9				5.7
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	5	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	34	828	0	0	760	0	0	1431	0	0	0	0
Turn Type	Prot	NA			NA		Perm	NA				
Protected Phases	5	2			6			8				
Permitted Phases							8					
Detector Phase	5	2			6		8	8				
Switch Phase												
Minimum Initial (s)	5.0	10.0			10.0		10.0	10.0				
Minimum Split (s)	10.0	21.0			21.0		18.0	18.0				
Total Split (s)	20.0	55.0			35.0		65.0	65.0				
Total Split (%)	16.7%	45.8%			29.2%		54.2%	54.2%				
Yellow Time (s)	3.6	3.6			3.6		3.6	3.6				
All-Red Time (s)	1.4	1.4			1.4		1.4	1.4				
Lost Time Adjust (s)	0.0	0.0			0.0			0.0				
Total Lost Time (s)	5.0	5.0			5.0			5.0				
Lead/Lag	Lead				Lag							
Lead-Lag Optimize?	Yes				Yes							
Recall Mode	Max	Max			Max		C-Max	C-Max				
Act Effct Green (s)	15.0	50.0			30.0			60.0				
Actuated g/C Ratio	0.12	0.42			0.25			0.50				
v/c Ratio	0.15	0.56			0.88			0.45				
Control Delay	68.3	19.7			59.3			33.9				
Queue Delay	0.0	1.5			0.0			0.0				
Total Delay	68.3	21.1			59.3			34.0				
LOS	E	C			E			C				

Lanes, Volumes, Timings
461: Shepherd & Washington

11/30/2017

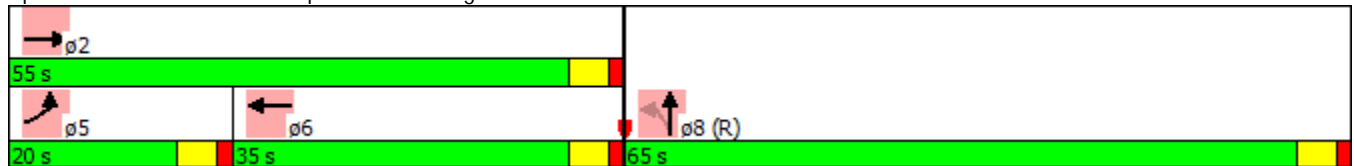


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		23.0			59.3			34.0				
Approach LOS		C			E			C				
Queue Length 50th (ft)	28	138			305			304				
Queue Length 95th (ft)	m33	m204			m#363			350				
Internal Link Dist (ft)		242			988			442			172	
Turn Bay Length (ft)	90											
Base Capacity (vph)	221	1474			868			3148				
Starvation Cap Reductn	0	429			0			0				
Spillback Cap Reductn	0	0			1			170				
Storage Cap Reductn	0	0			0			0				
Reduced v/c Ratio	0.15	0.79			0.88			0.48				

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 0 (0%), Referenced to phase 8:NBTL, Start of Green
 Natural Cycle: 50
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.88
 Intersection Signal Delay: 37.2
 Intersection LOS: D
 Intersection Capacity Utilization 80.4%
 ICU Level of Service D
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 461: Shepherd & Washington



Lanes, Volumes, Timings

462: Shepherd & Center

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕↕↕				
Volume (vph)	30	24	0	0	18	28	9	1011	17	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1820	0	0	1730	0	0	5065	0	0	0	0
Flt Permitted		0.846						0.999				
Satd. Flow (perm)	0	1576	0	0	1730	0	0	5065	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					46			5				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		320			502			252				1820
Travel Time (s)		7.3			11.4			4.9				35.5
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.83	0.60	0.93	0.93	0.50	0.70	0.56	0.93	0.71	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	88	0	0	87	0	0	1296	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4						2					
Detector Phase	4	4			8		2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (s)	42.0	42.0			42.0		78.0	78.0				
Total Split (%)	35.0%	35.0%			35.0%		65.0%	65.0%				
Yellow Time (s)	3.5	3.5			3.5		3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5		1.5	1.5				
Lost Time Adjust (s)		0.0			0.0			0.0				
Total Lost Time (s)		5.0			5.0			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max		Max	Max				
Act Effect Green (s)		37.0			37.0			73.0				
Actuated g/C Ratio		0.31			0.31			0.61				
v/c Ratio		0.18			0.15			0.42				
Control Delay		26.7			16.4			3.3				
Queue Delay		0.0			0.0			0.1				
Total Delay		26.7			16.4			3.5				
LOS		C			B			A				

Lanes, Volumes, Timings

462: Shepherd & Center

11/30/2017

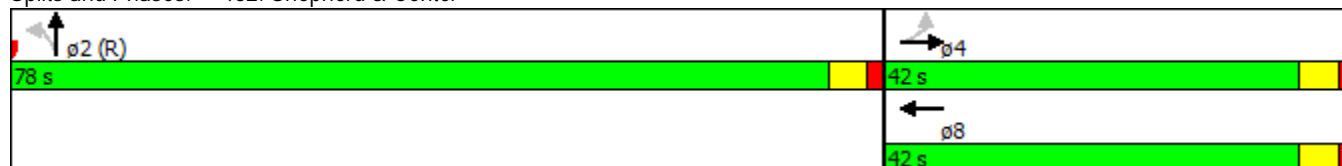


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		26.7			16.4			3.5				
Approach LOS		C			B			A				
Queue Length 50th (ft)		47			22			50				
Queue Length 95th (ft)		m55			22			60				
Internal Link Dist (ft)		240			422			172			1740	
Turn Bay Length (ft)												
Base Capacity (vph)		485			565			3083				
Starvation Cap Reductn		0			0			684				
Spillback Cap Reductn		0			0			0				
Storage Cap Reductn		0			0			0				
Reduced v/c Ratio		0.18			0.15			0.54				

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
Natural Cycle:	40
Control Type:	Pretimed
Maximum v/c Ratio:	0.42
Intersection Signal Delay:	5.6
Intersection LOS:	A
Intersection Capacity Utilization:	41.5%
ICU Level of Service:	A
Analysis Period (min):	15
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 462: Shepherd & Center



Lanes, Volumes, Timings
463: Shepherd & IH10 - EBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	412	463	0	0	0	0	0	985	131	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1610	3356	0	0	0	0	0	6286	0	0	0	0
Flt Permitted	0.950	0.990										
Satd. Flow (perm)	1610	3356	0	0	0	0	0	6286	0	0	0	0
Right Turn on Red	Yes		Yes			Yes			Yes			Yes
Satd. Flow (RTOR)	64	64						34				
Link Speed (mph)		40			40			35				35
Link Distance (ft)		306			534			356				316
Travel Time (s)		5.2			9.1			6.9				6.2
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.95	0.89	0.93	0.93	0.93	0.93	0.93	0.89	0.80	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	3	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)	29%											
Lane Group Flow (vph)	354	743	0	0	0	0	0	1461	0	0	0	0
Turn Type	Perm	NA						NA				
Protected Phases		4 12						2				
Permitted Phases	4 12											
Detector Phase	4 12	4 12						2				
Switch Phase												
Minimum Initial (s)								4.0				
Minimum Split (s)								21.0				
Total Split (s)								47.0				
Total Split (%)								39.2%				
Yellow Time (s)								3.5				
All-Red Time (s)								1.5				
Lost Time Adjust (s)								0.0				
Total Lost Time (s)								5.0				
Lead/Lag								Lead				
Lead-Lag Optimize?								Yes				
Recall Mode								C-Max				
Act Effct Green (s)	68.0	68.0						42.0				
Actuated g/C Ratio	0.57	0.57						0.35				
v/c Ratio	0.38	0.39						0.66				
Control Delay	6.8	7.6						36.6				
Queue Delay	1.0	0.7						0.5				
Total Delay	7.8	8.2						37.1				
LOS	A	A						D				

Lanes, Volumes, Timings
 463: Shepherd & IH10 - EBFR

11/30/2017

Lane Group	ø4	ø5	ø6	ø8	ø12	ø16
Lane Configurations						
Volume (vph)						
Ideal Flow (vphpl)						
Lane Width (ft)						
Grade (%)						
Storage Length (ft)						
Storage Lanes						
Taper Length (ft)						
Satd. Flow (prot)						
Flt Permitted						
Satd. Flow (perm)						
Right Turn on Red						
Satd. Flow (RTOR)						
Link Speed (mph)						
Link Distance (ft)						
Travel Time (s)						
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor						
Growth Factor						
Heavy Vehicles (%)						
Bus Blockages (#/hr)						
Parking (#/hr)						
Mid-Block Traffic (%)						
Shared Lane Traffic (%)						
Lane Group Flow (vph)						
Turn Type						
Protected Phases	4	5	6	8	12	16
Permitted Phases						
Detector Phase						
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	20.0	21.0	20.0	20.0
Total Split (s)	23.0	48.0	20.0	30.0	50.0	22.0
Total Split (%)	19%	40%	17%	25%	42%	18%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)						
Total Lost Time (s)						
Lead/Lag	Lag	Lag	Lead	Lag		Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes		Yes
Recall Mode	Max	None	None	None	None	None
Act Effct Green (s)						
Actuated g/C Ratio						
v/c Ratio						
Control Delay						
Queue Delay						
Total Delay						
LOS						

Lanes, Volumes, Timings
 463: Shepherd & IH10 - EBFR

11/30/2017

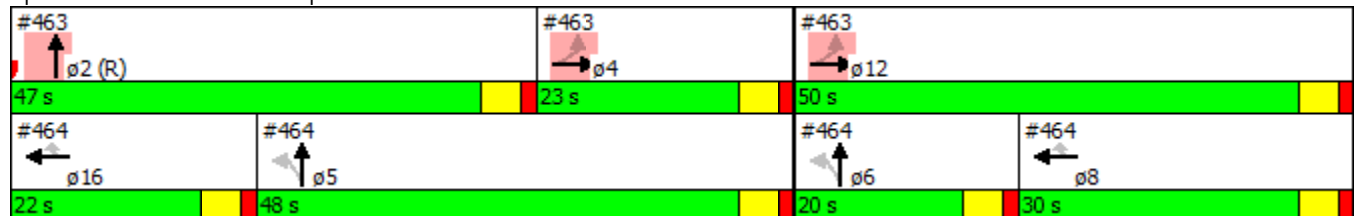


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		8.1						37.1				
Approach LOS		A						D				
Queue Length 50th (ft)	49	65						191				
Queue Length 95th (ft)	m62	m78						226				
Internal Link Dist (ft)		226			454			276			236	
Turn Bay Length (ft)												
Base Capacity (vph)	940	1929						2222				
Starvation Cap Reductn	354	773						0				
Spillback Cap Reductn	3	1						343				
Storage Cap Reductn	0	0						0				
Reduced v/c Ratio	0.60	0.64						0.78				

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 17 (14%), Referenced to phase 2:NBT, Start of Green
 Natural Cycle: 85
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.68
 Intersection Signal Delay: 24.7
 Intersection LOS: C
 Intersection Capacity Utilization 54.0%
 ICU Level of Service A
 Analysis Period (min) 15
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 463: Shepherd & IH10 - EBFR



Lane Group	ø4	ø5	ø6	ø8	ø12	ø16
Approach Delay						
Approach LOS						
Queue Length 50th (ft)						
Queue Length 95th (ft)						
Internal Link Dist (ft)						
Turn Bay Length (ft)						
Base Capacity (vph)						
Starvation Cap Reductn						
Spillback Cap Reductn						
Storage Cap Reductn						
Reduced v/c Ratio						
Intersection Summary						

Lanes, Volumes, Timings
464: Shepherd & IH10 - WBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑↑	↑	↑	↑↑↑				
Volume (vph)	0	0	0	0	595	229	472	940	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		1	1		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	0	3370	1441	1522	4772	0	0	0	0
Flt Permitted							0.950	0.993				
Satd. Flow (perm)	0	0	0	0	3370	1441	1522	4772	0	0	0	0
Right Turn on Red			Yes			Yes	Yes		Yes			Yes
Satd. Flow (RTOR)					4	109	77	64				
Link Speed (mph)		40			40			35			35	
Link Distance (ft)		310			534			316			3871	
Travel Time (s)		5.3			9.1			6.2			75.4	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.93	0.88	0.84	0.87	0.93	0.93	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)						10%	31%					
Lane Group Flow (vph)	0	0	0	0	809	283	431	1355	0	0	0	0
Turn Type					NA	Perm	Perm	NA				
Protected Phases					8 16			5 6				
Permitted Phases						8 16	5 6					
Detector Phase					8 16	8 16	5 6	5 6				
Switch Phase												
Minimum Initial (s)												
Minimum Split (s)												
Total Split (s)												
Total Split (%)												
Yellow Time (s)												
All-Red Time (s)												
Lost Time Adjust (s)												
Total Lost Time (s)												
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode												
Act Effct Green (s)					42.5	42.5	67.5	67.5				
Actuated g/C Ratio					0.35	0.35	0.56	0.56				
v/c Ratio					0.68	0.49	0.48	0.50				
Control Delay					35.7	20.5	13.7	14.6				
Queue Delay					6.2	0.0	3.9	2.1				
Total Delay					41.9	20.5	17.7	16.8				
LOS					D	C	B	B				

Lanes, Volumes, Timings
 464: Shepherd & IH10 - WBFR

11/30/2017

Lane Group	ø2	ø4	ø5	ø6	ø8	ø12	ø16
Lane Configurations							
Volume (vph)							
Ideal Flow (vphpl)							
Lane Width (ft)							
Grade (%)							
Storage Length (ft)							
Storage Lanes							
Taper Length (ft)							
Satd. Flow (prot)							
Flt Permitted							
Satd. Flow (perm)							
Right Turn on Red							
Satd. Flow (RTOR)							
Link Speed (mph)							
Link Distance (ft)							
Travel Time (s)							
Confl. Peds. (#/hr)							
Confl. Bikes (#/hr)							
Peak Hour Factor							
Growth Factor							
Heavy Vehicles (%)							
Bus Blockages (#/hr)							
Parking (#/hr)							
Mid-Block Traffic (%)							
Shared Lane Traffic (%)							
Lane Group Flow (vph)							
Turn Type							
Protected Phases	2	4	5	6	8	12	16
Permitted Phases							
Detector Phase							
Switch Phase							
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	21.0	20.0	21.0	20.0	20.0
Total Split (s)	47.0	23.0	48.0	20.0	30.0	50.0	22.0
Total Split (%)	39%	19%	40%	17%	25%	42%	18%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)							
Total Lost Time (s)							
Lead/Lag	Lead	Lag	Lag	Lead	Lag		Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes		Yes
Recall Mode	C-Max	Max	None	None	None	None	None
Act Effct Green (s)							
Actuated g/C Ratio							
v/c Ratio							
Control Delay							
Queue Delay							
Total Delay							
LOS							

Lanes, Volumes, Timings
 464: Shepherd & IH10 - WBFR

11/30/2017

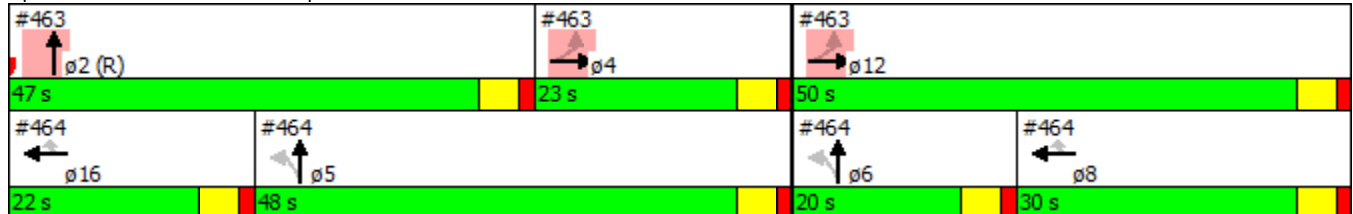


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					36.3			17.0				
Approach LOS					D			B				
Queue Length 50th (ft)					292	113	205	241				
Queue Length 95th (ft)					330	168	426	424				
Internal Link Dist (ft)		230			454			236			3791	
Turn Bay Length (ft)												
Base Capacity (vph)					1323	630	889	2712				
Starvation Cap Reductn					0	0	365	1162				
Spillback Cap Reductn					454	0	159	237				
Storage Cap Reductn					0	0	0	0				
Reduced v/c Ratio					0.93	0.45	0.82	0.87				

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	17 (14%), Referenced to phase 2:NBT, Start of Green
Natural Cycle:	85
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	0.68
Intersection Signal Delay:	24.3
Intersection LOS:	C
Intersection Capacity Utilization	54.0%
ICU Level of Service	A
Analysis Period (min)	15

Splits and Phases: 464: Shepherd & IH10 - WBFR



Lane Group	ø2	ø4	ø5	ø6	ø8	ø12	ø16
Approach Delay							
Approach LOS							
Queue Length 50th (ft)							
Queue Length 95th (ft)							
Internal Link Dist (ft)							
Turn Bay Length (ft)							
Base Capacity (vph)							
Starvation Cap Reductn							
Spillback Cap Reductn							
Storage Cap Reductn							
Reduced v/c Ratio							
Intersection Summary							

Lanes, Volumes, Timings
465: W 11th

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↖	↗			↖		↖	↗				
Volume (vph)	107	468	1	0	534	99	187	793	92	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	50		0	0		0	150		0	0		0
Storage Lanes	1		0	0		0	1		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1770	3536	0	0	3468	0	1770	4994	0	0	0	0
Flt Permitted	0.183						0.950					
Satd. Flow (perm)	341	3536	0	0	3468	0	1770	4994	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		1			17			22				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		536			448			700				2008
Travel Time (s)		12.2			10.2			13.6				39.1
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.81	0.87	0.25	0.93	0.76	0.92	0.79	0.86	0.74	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	152	624	0	0	932	0	272	1203	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		2			6			8				
Permitted Phases	2						8					
Detector Phase	2	2			6		8	8				
Switch Phase												
Minimum Initial (s)	7.0	7.0			5.0		7.0	7.0				
Minimum Split (s)	21.2	21.2			21.2		21.0	21.0				
Total Split (s)	73.0	73.0			73.0		47.0	47.0				
Total Split (%)	60.8%	60.8%			60.8%		39.2%	39.2%				
Yellow Time (s)	3.6	3.6			3.6		3.6	3.6				
All-Red Time (s)	1.6	1.6			1.6		1.4	1.4				
Lost Time Adjust (s)	0.0	0.0			0.0		0.0	0.0				
Total Lost Time (s)	5.2	5.2			5.2		5.0	5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	None	None			None		C-Max	C-Max				
Act Effct Green (s)	51.2	51.2			51.2		58.6	58.6				
Actuated g/C Ratio	0.43	0.43			0.43		0.49	0.49				
v/c Ratio	1.05	0.41			0.63		0.31	0.49				
Control Delay	116.0	22.5			27.4		9.1	8.3				
Queue Delay	0.0	0.0			0.0		0.0	0.0				
Total Delay	116.0	22.5			27.4		9.1	8.3				
LOS	F	C			C		A	A				

Lanes, Volumes, Timings
465: W 11th

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		40.8			27.4			8.5				
Approach LOS		D			C			A				
Queue Length 50th (ft)	~80	108			281		50	78				
Queue Length 95th (ft)	#191	107			206		81	113				
Internal Link Dist (ft)		456			368			620			1928	
Turn Bay Length (ft)	50						150					
Base Capacity (vph)	192	1998			1966		864	2449				
Starvation Cap Reductn	0	0			0		0	0				
Spillback Cap Reductn	0	0			0		0	0				
Storage Cap Reductn	0	0			0		0	0				
Reduced v/c Ratio	0.79	0.31			0.47		0.31	0.49				

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 14 (12%), Referenced to phase 8:NBTL, Start of Green
 Natural Cycle: 45
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.05
 Intersection Signal Delay: 21.9
 Intersection LOS: C
 Intersection Capacity Utilization 60.2%
 ICU Level of Service B
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 465: W 11th



Lanes, Volumes, Timings
466: W 14th

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕		↕	↕↕↕				
Volume (vph)	31	58	0	0	93	31	35	896	36	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	150		0	0		0
Storage Lanes	0		0	0		0	1		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1833	0	0	1799	0	1770	5050	0	0	0	0
Flt Permitted		0.575					0.950					
Satd. Flow (perm)	0	1071	0	0	1799	0	1770	5050	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					15			7				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		488			473			2008				644
Travel Time (s)		11.1			10.8			39.1				12.5
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.78	0.69	0.93	0.93	0.86	0.86	0.73	0.87	0.69	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	143	0	0	165	0	55	1244	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		2			6			8				
Permitted Phases	2						8					
Detector Phase	2	2			6		8	8				
Switch Phase												
Minimum Initial (s)	11.0	11.0			11.0		11.0	11.0				
Minimum Split (s)	45.0	45.0			45.0		40.0	40.0				
Total Split (s)	70.0	70.0			70.0		50.0	50.0				
Total Split (%)	58.3%	58.3%			58.3%		41.7%	41.7%				
Yellow Time (s)	3.5	3.5			3.5		3.2	3.2				
All-Red Time (s)	1.7	1.7			1.7		1.8	1.8				
Lost Time Adjust (s)		0.0			0.0		0.0	0.0				
Total Lost Time (s)		5.2			5.2		5.0	5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	None	None			None		C-Max	C-Max				
Act Effct Green (s)		16.5			16.5		93.3	93.3				
Actuated g/C Ratio		0.14			0.14		0.78	0.78				
v/c Ratio		0.97			0.63		0.04	0.32				
Control Delay		124.4			54.8		8.4	9.5				
Queue Delay		0.0			0.0		0.0	0.0				
Total Delay		124.4			54.8		8.4	9.5				
LOS		F			D		A	A				

Lanes, Volumes, Timings

466: W 14th

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		124.4			54.8			9.5				
Approach LOS		F			D			A				
Queue Length 50th (ft)		115			112		17	147				
Queue Length 95th (ft)		135			165		m37	230				
Internal Link Dist (ft)		408			393			1928			564	
Turn Bay Length (ft)							150					
Base Capacity (vph)		578			978		1375	3927				
Starvation Cap Reductn		0			0		0	0				
Spillback Cap Reductn		0			0		0	0				
Storage Cap Reductn		0			0		0	0				
Reduced v/c Ratio		0.25			0.17		0.04	0.32				

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 20 (17%), Referenced to phase 8:NBTL, Start of Green
 Natural Cycle: 85
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.97
 Intersection Signal Delay: 24.3
 Intersection LOS: C
 Intersection Capacity Utilization 52.0%
 ICU Level of Service A
 Analysis Period (min) 15
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 466: W 14th



Lanes, Volumes, Timings
467: N Shepherd Dr & W 19th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↔			↑	↗	↘	↑↑↑				
Volume (vph)	35	130	0	0	130	60	43	954	35	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		85	0		0	150		0	0		0
Storage Lanes	0		1	0		1	1		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3500	0	0	1863	1583	1770	5055	0	0	0	0
Flt Permitted		0.865					0.950					
Satd. Flow (perm)	0	3061	0	0	1863	1583	1770	5055	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						55		18				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		668			574			1789				375
Travel Time (s)		15.2			13.0			34.9				7.3
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.73	0.76	0.93	0.93	0.85	0.79	0.77	0.92	0.80	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	252	0	0	176	87	64	1242	0	0	0	0
Turn Type	Perm	NA			NA	Perm	Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4					8	2					
Detector Phase	4	4			8	8	2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0	4.0	4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0	20.0	20.0	20.0				
Total Split (s)	20.0	20.0			20.0	20.0	20.0	20.0				
Total Split (%)	50.0%	50.0%			50.0%	50.0%	50.0%	50.0%				
Yellow Time (s)	3.5	3.5			3.5	3.5	3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5	1.5	1.5	1.5				
Lost Time Adjust (s)		0.0			0.0	0.0	0.0	0.0				
Total Lost Time (s)		5.0			5.0	5.0	5.0	5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max	Max	Max	Max				
Act Effct Green (s)		15.0			15.0	15.0	15.0	15.0				
Actuated g/C Ratio		0.38			0.38	0.38	0.38	0.38				
v/c Ratio		0.22			0.25	0.14	0.10	0.65				
Control Delay		9.2			9.9	5.1	8.7	12.2				
Queue Delay		0.0			0.0	0.0	0.0	0.0				
Total Delay		9.2			9.9	5.1	8.7	12.2				
LOS		A			A	A	A	B				

Lanes, Volumes, Timings
467: N Shepherd Dr & W 19th St

11/30/2017

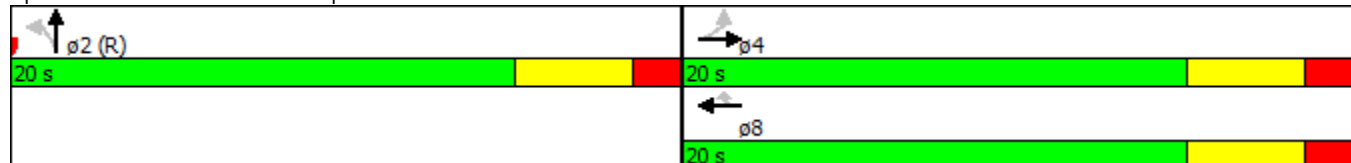


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		9.2			8.3			12.0				
Approach LOS		A			A			B				
Queue Length 50th (ft)		18			26	4	9	78				
Queue Length 95th (ft)		30			52	19	21	112				
Internal Link Dist (ft)		588			494			1709			295	
Turn Bay Length (ft)							150					
Base Capacity (vph)		1147			698	628	663	1906				
Starvation Cap Reductn		0			0	0	0	0				
Spillback Cap Reductn		0			0	0	0	0				
Storage Cap Reductn		0			0	0	0	0				
Reduced v/c Ratio		0.22			0.25	0.14	0.10	0.65				

Intersection Summary

Area Type:	Other
Cycle Length:	40
Actuated Cycle Length:	40
Offset:	0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
Natural Cycle:	40
Control Type:	Pretimed
Maximum v/c Ratio:	0.65
Intersection Signal Delay:	11.1
Intersection LOS:	B
Intersection Capacity Utilization	47.8%
ICU Level of Service	A
Analysis Period (min)	15

Splits and Phases: 467: N Shepherd Dr & W 19th St



Lanes, Volumes, Timings
468: N Shepherd Dr & W 20th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↔			↔↔		↔	↔↔↔				
Volume (vph)	43	187	0	0	195	56	34	962	68	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		100	0		0	150		0	0		0
Storage Lanes	0		1	0		0	1		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3507	0	0	3394	0	1770	5034	0	0	0	0
Flt Permitted		0.833					0.950					
Satd. Flow (perm)	0	2948	0	0	3394	0	1770	5034	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					14			33				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		140			536			375				1478
Travel Time (s)		3.2			12.2			7.3				28.8
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.77	0.77	0.93	0.93	0.87	0.67	0.61	0.92	0.90	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	343	0	0	354	0	64	1289	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4						2					
Detector Phase	4	4			8		2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (%)	50.0%	50.0%			50.0%		50.0%	50.0%				
Yellow Time (s)	3.5	3.5			3.5		3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5		1.5	1.5				
Lost Time Adjust (s)		0.0			0.0		0.0	0.0				
Total Lost Time (s)		5.0			5.0		5.0	5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max		Max	Max				
Act Effct Green (s)		15.0			15.0		15.0	15.0				
Actuated g/C Ratio		0.38			0.38		0.38	0.38				
v/c Ratio		0.31			0.28		0.10	0.68				
Control Delay		9.8			9.1		8.0	8.5				
Queue Delay		0.0			0.0		0.0	0.0				
Total Delay		9.8			9.1		8.0	8.5				
LOS		A			A		A	A				

Lanes, Volumes, Timings
468: N Shepherd Dr & W 20th St

11/30/2017

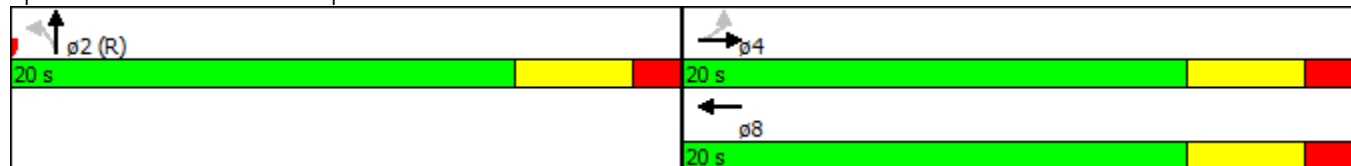


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		9.8			9.1			8.5				
Approach LOS		A			A			A				
Queue Length 50th (ft)		26			26		5	33				
Queue Length 95th (ft)		40			45		m13	77				
Internal Link Dist (ft)		60			456			295			1398	
Turn Bay Length (ft)							150					
Base Capacity (vph)		1105			1281		663	1908				
Starvation Cap Reductn		0			0		0	0				
Spillback Cap Reductn		0			0		0	0				
Storage Cap Reductn		0			0		0	0				
Reduced v/c Ratio		0.31			0.28		0.10	0.68				

Intersection Summary

Area Type:	Other
Cycle Length:	40
Actuated Cycle Length:	40
Offset:	0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
Natural Cycle:	40
Control Type:	Pretimed
Maximum v/c Ratio:	0.68
Intersection Signal Delay:	8.8
Intersection LOS:	A
Intersection Capacity Utilization:	51.3%
ICU Level of Service:	A
Analysis Period (min):	15
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 468: N Shepherd Dr & W 20th St



Lanes, Volumes, Timings
469: N Shepherd Dr & W 24th St

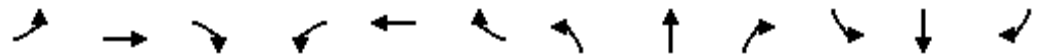
11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕		↕	↕↕↕				
Volume (vph)	17	7	0	0	29	24	25	1126	7	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	150		0	0		0
Storage Lanes	0		0	0		0	1		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1807	0	0	1753	0	1770	5075	0	0	0	0
Flt Permitted		0.847					0.950					
Satd. Flow (perm)	0	1578	0	0	1753	0	1770	5075	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					5			5				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		660			543			1478				1409
Travel Time (s)		15.0			12.3			28.8				27.4
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.71	0.44	0.93	0.93	0.81	0.86	0.57	0.89	0.44	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	46	0	0	73	0	50	1473	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4						2					
Detector Phase	4	4			8		2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (%)	50.0%	50.0%			50.0%		50.0%	50.0%				
Yellow Time (s)	3.5	3.5			3.5		3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5		1.5	1.5				
Lost Time Adjust (s)		0.0			0.0		0.0	0.0				
Total Lost Time (s)		5.0			5.0		5.0	5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max		Max	Max				
Act Effect Green (s)		15.0			15.0		15.0	15.0				
Actuated g/C Ratio		0.38			0.38		0.38	0.38				
v/c Ratio		0.08			0.11		0.08	0.77				
Control Delay		8.6			8.3		5.3	11.7				
Queue Delay		0.0			0.0		0.0	0.0				
Total Delay		8.6			8.3		5.3	11.7				
LOS		A			A		A	B				

Lanes, Volumes, Timings
 469: N Shepherd Dr & W 24th St

11/30/2017

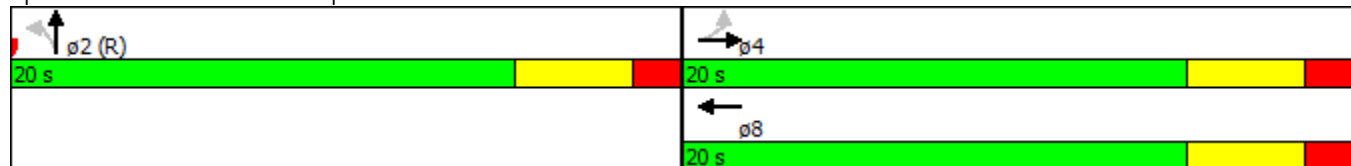


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		8.6			8.3			11.5				
Approach LOS		A			A			B				
Queue Length 50th (ft)		6			9		4	132				
Queue Length 95th (ft)		9			24		m9	167				
Internal Link Dist (ft)		580			463			1398			1329	
Turn Bay Length (ft)							150					
Base Capacity (vph)		591			660		663	1906				
Starvation Cap Reductn		0			0		0	0				
Spillback Cap Reductn		0			0		0	0				
Storage Cap Reductn		0			0		0	0				
Reduced v/c Ratio		0.08			0.11		0.08	0.77				

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
 Natural Cycle: 40
 Control Type: Pretimed
 Maximum v/c Ratio: 0.77
 Intersection Signal Delay: 11.3
 Intersection LOS: B
 Intersection Capacity Utilization 41.7%
 ICU Level of Service A
 Analysis Period (min) 15
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 469: N Shepherd Dr & W 24th St



Lanes, Volumes, Timings
470: N Shepherd Dr & IH 610 EBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	456	878	0	0	0	0	0	860	303	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1610	3373	0	0	0	0	0	6139	0	0	0	0
Flt Permitted	0.950	0.995										
Satd. Flow (perm)	1610	3373	0	0	0	0	0	6139	0	0	0	0
Right Turn on Red	Yes		Yes			Yes			Yes			Yes
Satd. Flow (RTOR)	55	55						20				
Link Speed (mph)		45			45			35				35
Link Distance (ft)		526			314			288				251
Travel Time (s)		8.0			4.8			5.6				4.9
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.76	0.92	0.93	0.93	0.93	0.93	0.93	0.89	0.82	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)	16%											
Lane Group Flow (vph)	580	1208	0	0	0	0	0	1536	0	0	0	0
Turn Type	Perm	NA						NA				
Protected Phases		4						2				
Permitted Phases	4											
Detector Phase	4	4						2				
Switch Phase												
Minimum Initial (s)	4.0	4.0						4.0				
Minimum Split (s)	20.0	20.0						20.0				
Total Split (s)	20.0	20.0						20.0				
Total Split (%)	50.0%	50.0%						50.0%				
Yellow Time (s)	3.5	3.5						3.5				
All-Red Time (s)	1.5	1.5						1.5				
Lost Time Adjust (s)	0.0	0.0						0.0				
Total Lost Time (s)	5.0	5.0						5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max						Max				
Act Effct Green (s)	15.0	15.0						15.0				
Actuated g/C Ratio	0.38	0.38						0.38				
v/c Ratio	0.91	0.93						0.66				
Control Delay	34.7	27.6						7.1				
Queue Delay	0.0	0.0						0.0				
Total Delay	34.7	27.6						7.1				
LOS	C	C						A				

Lanes, Volumes, Timings
 470: N Shepherd Dr & IH 610 EBFR

11/30/2017

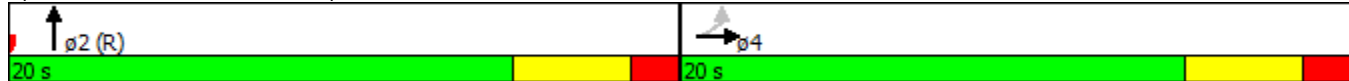


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		29.9						7.1				
Approach LOS		C						A				
Queue Length 50th (ft)	115	128						68				
Queue Length 95th (ft)	#216	#253						63				
Internal Link Dist (ft)		446			234			208			171	
Turn Bay Length (ft)												
Base Capacity (vph)	638	1299						2314				
Starvation Cap Reductn	0	0						0				
Spillback Cap Reductn	0	0						0				
Storage Cap Reductn	0	0						0				
Reduced v/c Ratio	0.91	0.93						0.66				

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2:NBT and 6:, Start of Green
 Natural Cycle: 50
 Control Type: Pretimed
 Maximum v/c Ratio: 0.93
 Intersection Signal Delay: 19.3
 Intersection LOS: B
 Intersection Capacity Utilization 80.9%
 ICU Level of Service D
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 470: N Shepherd Dr & IH 610 EBFR



Lanes, Volumes, Timings
471: N Shepherd Dr & IH 610 WBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑↑↑		↑	↑↑↑				
Volume (vph)	0	0	0	0	817	369	336	972	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%				0%
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	1		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	0	4846	0	1770	5085	0	0	0	0
Flt Permitted							0.950					
Satd. Flow (perm)	0	0	0	0	4846	0	1770	5085	0	0	0	0
Right Turn on Red			Yes			Yes	Yes		Yes			Yes
Satd. Flow (RTOR)					8		55					
Link Speed (mph)		45			45			35				35
Link Distance (ft)		398			334			251				1261
Travel Time (s)		6.0			5.1			4.9				24.6
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.93	0.95	0.93	0.93	0.84	0.93	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	0	1445	0	415	1331	0	0	0	0
Turn Type					NA		Perm	NA				
Protected Phases					8			2				
Permitted Phases							2					
Detector Phase					8		2	2				
Switch Phase												
Minimum Initial (s)					4.0		4.0	4.0				
Minimum Split (s)					20.0		20.0	20.0				
Total Split (s)					20.0		20.0	20.0				
Total Split (%)					50.0%		50.0%	50.0%				
Yellow Time (s)					3.5		3.5	3.5				
All-Red Time (s)					1.5		1.5	1.5				
Lost Time Adjust (s)					0.0		0.0	0.0				
Total Lost Time (s)					5.0		5.0	5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode					Max		Max	Max				
Act Effct Green (s)					15.0		15.0	15.0				
Actuated g/C Ratio					0.38		0.38	0.38				
v/c Ratio					0.79		0.59	0.70				
Control Delay					15.4		7.1	7.1				
Queue Delay					0.0		0.4	0.2				
Total Delay					15.4		7.5	7.3				
LOS					B		A	A				

Lanes, Volumes, Timings
 471: N Shepherd Dr & IH 610 WBFR

11/30/2017

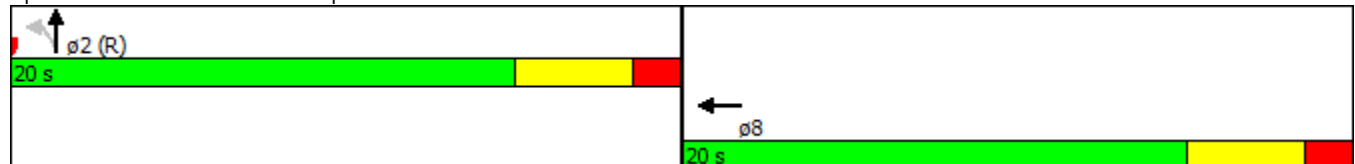


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					15.4			7.3				
Approach LOS					B			A				
Queue Length 50th (ft)					98		31	50				
Queue Length 95th (ft)					#144		m69	m80				
Internal Link Dist (ft)		318			254			171			1181	
Turn Bay Length (ft)												
Base Capacity (vph)					1822		698	1906				
Starvation Cap Reductn					0		51	100				
Spillback Cap Reductn					0		0	0				
Storage Cap Reductn					0		0	0				
Reduced v/c Ratio					0.79		0.64	0.74				

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
 Natural Cycle: 40
 Control Type: Pretimed
 Maximum v/c Ratio: 0.79
 Intersection Signal Delay: 11.0
 Intersection LOS: B
 Intersection Capacity Utilization 82.6%
 ICU Level of Service E
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 471: N Shepherd Dr & IH 610 WBFR



2040 PM Peak Build



Lanes, Volumes, Timings
450: Durham & Washington

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑		↖	↑↑						↑↑↑↑	
Volume (vph)	0	544	239	110	1070	0	0	0	0	231	984	59
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	150		0	0		0	0		0
Storage Lanes	0		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3376	0	1770	3539	0	0	0	0	0	6306	0
Flt Permitted				0.950							0.991	
Satd. Flow (perm)	0	3376	0	1770	3539	0	0	0	0	0	6306	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		58									10	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		2207			322			520			238	
Travel Time (s)		50.2			7.3			11.8			5.4	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	938	0	132	1282	0	0	0	0	0	1527	0
Turn Type		NA		Prot	NA					Perm	NA	
Protected Phases		2		1	6						4	
Permitted Phases											4	
Detector Phase		2		1	6						4	4
Switch Phase												
Minimum Initial (s)		10.0		5.0	10.0					10.0	10.0	
Minimum Split (s)		21.0		10.0	21.0					18.0	18.0	
Total Split (s)		40.0		25.0	65.0					55.0	55.0	
Total Split (%)		33.3%		20.8%	54.2%					45.8%	45.8%	
Yellow Time (s)		3.6		3.6	3.6					3.6	3.6	
All-Red Time (s)		1.4		1.4	1.4					1.4	1.4	
Lost Time Adjust (s)		0.0		0.0	0.0						0.0	
Total Lost Time (s)		5.0		5.0	5.0						5.0	
Lead/Lag		Lag		Lead								
Lead-Lag Optimize?		Yes		Yes								
Recall Mode		Max		None	Max					C-Max	C-Max	
Act Effect Green (s)		40.8		14.2	60.0						50.0	
Actuated g/C Ratio		0.34		0.12	0.50						0.42	
v/c Ratio		0.79		0.63	0.72						0.58	
Control Delay		31.1		52.0	23.5						39.8	
Queue Delay		0.0		0.0	49.4						0.0	
Total Delay		31.1		52.0	73.0						39.8	
LOS		C		D	E						D	

Lanes, Volumes, Timings
450: Durham & Washington

11/30/2017

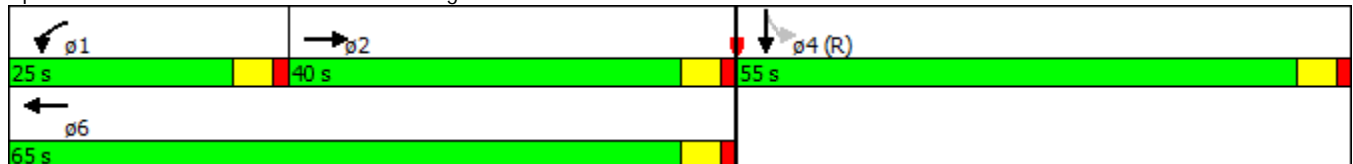


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		31.1			71.0							39.8
Approach LOS		C			E							D
Queue Length 50th (ft)		396		101	348							280
Queue Length 95th (ft)		#485		m102	m357							317
Internal Link Dist (ft)		2127			242			440				158
Turn Bay Length (ft)				150								
Base Capacity (vph)		1186		295	1769							2633
Starvation Cap Reductn		0		0	749							0
Spillback Cap Reductn		0		0	0							0
Storage Cap Reductn		0		0	0							0
Reduced v/c Ratio		0.79		0.45	1.26							0.58

Intersection Summary

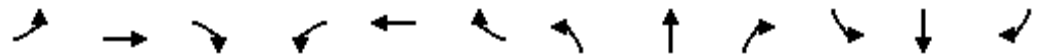
Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	0 (0%), Referenced to phase 4:SBTL, Start of Green
Natural Cycle:	55
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	0.79
Intersection Signal Delay:	49.1
Intersection LOS:	D
Intersection Capacity Utilization:	120.7%
ICU Level of Service:	H
Analysis Period (min):	15
#	95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after two cycles.
m	Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 450: Durham & Washington



Lanes, Volumes, Timings
451: Durham & Center

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	49	24	27	45	0	0	0	0	42	1310	21
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1760	0	0	1829	0	0	0	0	0	6369	0
Flt Permitted					0.982						0.998	
Satd. Flow (perm)	0	1760	0	0	1829	0	0	0	0	0	6369	0
Link Speed (mph)		30			30			35			35	
Link Distance (ft)		534			320			238			266	
Travel Time (s)		12.1			7.3			4.6			5.2	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.77	0.55	0.75	0.75	0.93	0.93	0.93	0.93	0.66	0.88	0.52
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	123	0	0	110	0	0	0	0	0	1831	0
Sign Control		Stop			Stop			Stop			Free	

Intersection Summary

Area Type:	Other
Control Type:	Unsignalized
Intersection Capacity Utilization	40.7%
ICU Level of Service	A
Analysis Period (min)	15

Lanes, Volumes, Timings
452: Durham & IH10 - EBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑								↓	↑↑↑	
Volume (vph)	0	865	347	0	0	0	0	0	0	234	1005	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	4846	0	0	0	0	0	0	0	1522	4801	0
Flt Permitted										0.950	0.999	
Satd. Flow (perm)	0	4846	0	0	0	0	0	0	0	1522	4801	0
Right Turn on Red			Yes			Yes			Yes	Yes		Yes
Satd. Flow (RTOR)		36								64	64	
Link Speed (mph)		40			40			35			35	
Link Distance (ft)		594			306			1921			312	
Travel Time (s)		10.1			5.2			37.4			6.1	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.83	0.93	0.93	0.93	0.93	0.93	0.93	0.86	0.87	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)										10%		
Lane Group Flow (vph)	0	1551	0	0	0	0	0	0	0	282	1359	0
Turn Type		NA								Perm	NA	
Protected Phases		4 12									1 2	
Permitted Phases										1 2		
Detector Phase		4 12								1 2	1 2	
Switch Phase												
Minimum Initial (s)												
Minimum Split (s)												
Total Split (s)												
Total Split (%)												
Yellow Time (s)												
All-Red Time (s)												
Lost Time Adjust (s)												
Total Lost Time (s)												
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode												
Act Effct Green (s)		46.7								63.3	63.3	
Actuated g/C Ratio		0.39								0.53	0.53	
v/c Ratio		0.81								0.34	0.53	
Control Delay		36.2								4.8	11.1	
Queue Delay		0.2								3.9	49.2	
Total Delay		36.4								8.7	60.4	
LOS		D								A	E	

Lane Group	ø1	ø2	ø4	ø6	ø8	ø12	ø16
Lane Configurations							
Volume (vph)							
Ideal Flow (vphpl)							
Lane Width (ft)							
Grade (%)							
Storage Length (ft)							
Storage Lanes							
Taper Length (ft)							
Satd. Flow (prot)							
Flt Permitted							
Satd. Flow (perm)							
Right Turn on Red							
Satd. Flow (RTOR)							
Link Speed (mph)							
Link Distance (ft)							
Travel Time (s)							
Confl. Peds. (#/hr)							
Confl. Bikes (#/hr)							
Peak Hour Factor							
Growth Factor							
Heavy Vehicles (%)							
Bus Blockages (#/hr)							
Parking (#/hr)							
Mid-Block Traffic (%)							
Shared Lane Traffic (%)							
Lane Group Flow (vph)							
Turn Type							
Protected Phases	1	2	4	6	8	12	16
Permitted Phases							
Detector Phase							
Switch Phase							
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	21.0	21.0	21.0	20.0	20.0
Total Split (s)	47.0	21.0	30.0	47.0	22.0	22.0	51.0
Total Split (%)	39%	18%	25%	39%	18%	18%	43%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)							
Total Lost Time (s)							
Lead/Lag	Lag	Lead	Lag	Lead	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	
Recall Mode	None	Max	None	C-Max	Max	None	None
Act Effct Green (s)							
Actuated g/C Ratio							
v/c Ratio							
Control Delay							
Queue Delay							
Total Delay							
LOS							

Lanes, Volumes, Timings
452: Durham & IH10 - EBFR

11/30/2017

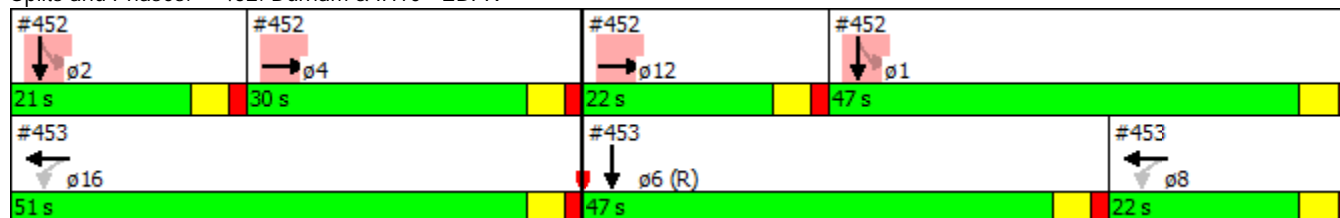


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		36.4										51.5
Approach LOS		D										D
Queue Length 50th (ft)		379								81	324	
Queue Length 95th (ft)		442								m77	m261	
Internal Link Dist (ft)		514			226			1841				232
Turn Bay Length (ft)												
Base Capacity (vph)		1919								833	2564	
Starvation Cap Reductn		0								459	1356	
Spillback Cap Reductn		57								0	0	
Storage Cap Reductn		0								0	0	
Reduced v/c Ratio		0.83								0.75	1.13	

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 94 (78%), Referenced to phase 6:SBT, Start of Green
 Natural Cycle: 105
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.08
 Intersection Signal Delay: 44.2 Intersection LOS: D
 Intersection Capacity Utilization 74.0% ICU Level of Service D
 Analysis Period (min) 15
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 452: Durham & IH10 - EBFR



Lane Group	ø1	ø2	ø4	ø6	ø8	ø12	ø16
Approach Delay							
Approach LOS							
Queue Length 50th (ft)							
Queue Length 95th (ft)							
Internal Link Dist (ft)							
Turn Bay Length (ft)							
Base Capacity (vph)							
Starvation Cap Reductn							
Spillback Cap Reductn							
Storage Cap Reductn							
Reduced v/c Ratio							
Intersection Summary							

Lanes, Volumes, Timings
453: Durham & IH10 - WBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↙	↕						↕	↘
Volume (vph)	0	0	0	193	955	0	0	0	0	0	1099	425
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	1770	3539	0	0	0	0	0	4877	0
Flt Permitted				0.950								
Satd. Flow (perm)	0	0	0	1770	3539	0	0	0	0	0	4877	0
Right Turn on Red			Yes	Yes		Yes			Yes			Yes
Satd. Flow (RTOR)				64								65
Link Speed (mph)		40			40			35				35
Link Distance (ft)		575			310			312				2600
Travel Time (s)		9.8			5.3			6.1				50.6
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.80	0.92	0.93	0.93	0.93	0.93	0.93	0.92	0.94
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	277	1194	0	0	0	0	0	1894	0
Turn Type				Perm	NA							NA
Protected Phases					8 16							6
Permitted Phases				8 16								
Detector Phase				8 16	8 16							6
Switch Phase												
Minimum Initial (s)												4.0
Minimum Split (s)												21.0
Total Split (s)												47.0
Total Split (%)												39.2%
Yellow Time (s)												3.5
All-Red Time (s)												1.5
Lost Time Adjust (s)												0.0
Total Lost Time (s)												5.0
Lead/Lag												Lead
Lead-Lag Optimize?												Yes
Recall Mode												C-Max
Act Effect Green (s)				68.0	68.0							42.0
Actuated g/C Ratio				0.57	0.57							0.35
v/c Ratio				0.27	0.60							1.08
Control Delay				8.4	15.5							71.9
Queue Delay				2.1	49.6							7.8
Total Delay				10.4	65.1							79.7
LOS				B	E							E

Lane Group	ø1	ø2	ø4	ø8	ø12	ø16
Lane Configurations						
Volume (vph)						
Ideal Flow (vphpl)						
Lane Width (ft)						
Grade (%)						
Storage Length (ft)						
Storage Lanes						
Taper Length (ft)						
Satd. Flow (prot)						
Flt Permitted						
Satd. Flow (perm)						
Right Turn on Red						
Satd. Flow (RTOR)						
Link Speed (mph)						
Link Distance (ft)						
Travel Time (s)						
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor						
Growth Factor						
Heavy Vehicles (%)						
Bus Blockages (#/hr)						
Parking (#/hr)						
Mid-Block Traffic (%)						
Shared Lane Traffic (%)						
Lane Group Flow (vph)						
Turn Type						
Protected Phases	1	2	4	8	12	16
Permitted Phases						
Detector Phase						
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	21.0	21.0	20.0	20.0
Total Split (s)	47.0	21.0	30.0	22.0	22.0	51.0
Total Split (%)	39%	18%	25%	18%	18%	43%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)						
Total Lost Time (s)						
Lead/Lag	Lag	Lead	Lag	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	
Recall Mode	None	Max	None	Max	None	None
Act Effct Green (s)						
Actuated g/C Ratio						
v/c Ratio						
Control Delay						
Queue Delay						
Total Delay						
LOS						

Lanes, Volumes, Timings
453: Durham & IH10 - WBFR

11/30/2017

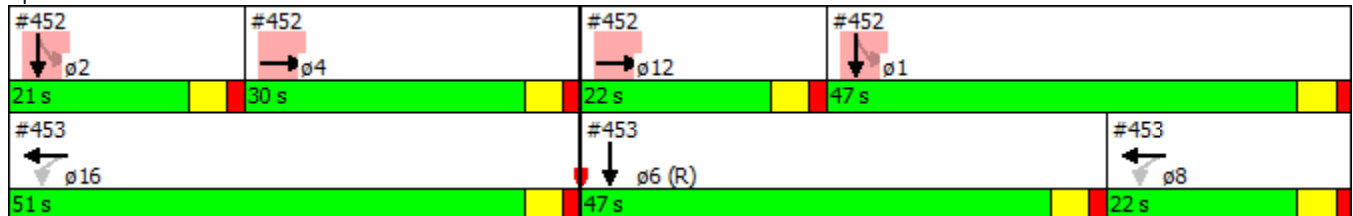


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					54.8							79.7
Approach LOS					D							E
Queue Length 50th (ft)				75	282							~588
Queue Length 95th (ft)				m118	m387							m#565
Internal Link Dist (ft)		495			230			232				2520
Turn Bay Length (ft)												
Base Capacity (vph)				1030	2005							1749
Starvation Cap Reductn				601	924							0
Spillback Cap Reductn				3	0							296
Storage Cap Reductn				0	0							0
Reduced v/c Ratio				0.65	1.10							1.30

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	94 (78%), Referenced to phase 6:SBT, Start of Green
Natural Cycle:	105
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	1.08
Intersection Signal Delay:	68.8
Intersection LOS:	E
Intersection Capacity Utilization:	74.0%
ICU Level of Service:	D
Analysis Period (min):	15
~	Volume exceeds capacity, queue is theoretically infinite. Queue shown is maximum after two cycles.
#	95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after two cycles.
m	Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 453: Durham & IH10 - WBFR



Lane Group	ø1	ø2	ø4	ø8	ø12	ø16
Approach Delay						
Approach LOS						
Queue Length 50th (ft)						
Queue Length 95th (ft)						
Internal Link Dist (ft)						
Turn Bay Length (ft)						
Base Capacity (vph)						
Starvation Cap Reductn						
Spillback Cap Reductn						
Storage Cap Reductn						
Reduced v/c Ratio						
Intersection Summary						

Lanes, Volumes, Timings
454: W 11th

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑	↑	↑	↑↑					↑	↑↑↑	
Volume (vph)	0	822	179	165	741	0	0	0	0	269	1047	115
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		150	50		0	0		0	150		0
Storage Lanes	0		1	1		0	0		0	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3380	1441	1770	3539	0	0	0	0	1770	5004	0
Flt Permitted				0.093						0.950		
Satd. Flow (perm)	0	3380	1441	173	3539	0	0	0	0	1770	5004	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		2	29									24
Link Speed (mph)		30			30			35				35
Link Distance (ft)		421			536			1925				2048
Travel Time (s)		9.6			12.2			37.5				39.9
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.87	0.90	0.84	0.95	0.93	0.93	0.93	0.93	0.85	0.90	0.85
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)			10%									
Lane Group Flow (vph)	0	1110	206	226	897	0	0	0	0	364	1494	0
Turn Type		NA	Perm	Perm	NA					Perm	NA	
Protected Phases		2			6							4
Permitted Phases			2	6						4		
Detector Phase		2	2	6	6					4	4	
Switch Phase												
Minimum Initial (s)		10.0	10.0	10.0	10.0					10.0	10.0	
Minimum Split (s)		21.2	21.2	21.2	21.2					21.3	21.3	
Total Split (s)		55.0	55.0	55.0	55.0					65.0	65.0	
Total Split (%)		45.8%	45.8%	45.8%	45.8%					54.2%	54.2%	
Yellow Time (s)		3.6	3.6	3.6	3.6					3.6	3.6	
All-Red Time (s)		1.6	1.6	1.6	1.6					1.7	1.7	
Lost Time Adjust (s)		0.0	0.0	0.0	0.0					0.0	0.0	
Total Lost Time (s)		5.2	5.2	5.2	5.2					5.3	5.3	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		None	None	None	None					C-Max	C-Max	
Act Effect Green (s)		49.8	49.8	49.8	49.8					59.7	59.7	
Actuated g/C Ratio		0.42	0.42	0.42	0.42					0.50	0.50	
v/c Ratio		0.79	0.34	3.18	0.61					0.41	0.60	
Control Delay		35.6	22.1	1029.3	31.3					26.3	27.3	
Queue Delay		0.0	0.0	0.0	0.4					0.0	0.0	
Total Delay		35.6	22.1	1029.3	31.8					26.3	27.3	
LOS		D	C	F	C					C	C	

Lanes, Volumes, Timings
454: W 11th

11/30/2017

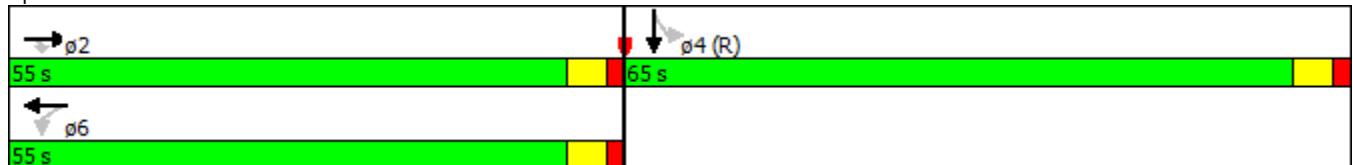


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		33.5			232.5							27.1
Approach LOS		C			F							C
Queue Length 50th (ft)		404	100	~302	337					199	297	
Queue Length 95th (ft)		471	168	m#381	407					m246	353	
Internal Link Dist (ft)		341			456			1845			1968	
Turn Bay Length (ft)			150	50						150		
Base Capacity (vph)		1403	614	71	1468					880	2501	
Starvation Cap Reductn		0	0	0	200					0	0	
Spillback Cap Reductn		0	0	0	0					0	0	
Storage Cap Reductn		0	0	0	0					0	0	
Reduced v/c Ratio		0.79	0.34	3.18	0.71					0.41	0.60	

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 15 (13%), Referenced to phase 4:SBTL, Start of Green
 Natural Cycle: 45
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 3.18
 Intersection Signal Delay: 82.7
 Intersection LOS: F
 Intersection Capacity Utilization 78.1%
 ICU Level of Service D
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 454: W 11th



Lanes, Volumes, Timings

455: W 14th

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	23	90	94	37	0	0	0	0	61	2231	15
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	150		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1650	0	0	1794	0	0	0	0	1770	5080	0
Flt Permitted					0.501					0.950		
Satd. Flow (perm)	0	1650	0	0	933	0	0	0	0	1770	5080	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		2										2
Link Speed (mph)		30			30			35				35
Link Distance (ft)		332			488			2048				157
Travel Time (s)		7.5			11.1			39.9				3.1
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.86	0.60	0.64	0.86	0.93	0.93	0.93	0.93	0.93	0.88	0.75
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	203	0	0	218	0	0	0	0	75	2939	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		2			6							4
Permitted Phases				6						4		
Detector Phase		2		6	6					4	4	
Switch Phase												
Minimum Initial (s)		11.0		11.0	11.0					11.0	11.0	
Minimum Split (s)		22.7		20.7	20.7					21.1	21.1	
Total Split (s)		39.0		39.0	39.0					81.0	81.0	
Total Split (%)		32.5%		32.5%	32.5%					67.5%	67.5%	
Yellow Time (s)		3.2		3.2	3.2					3.6	3.6	
All-Red Time (s)		1.5		1.5	1.5					1.5	1.5	
Lost Time Adjust (s)		0.0			0.0					0.0	0.0	
Total Lost Time (s)		4.7			4.7					5.1	5.1	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		None		None	None					C-Max	C-Max	
Act Effect Green (s)		29.9			29.9					80.3	80.3	
Actuated g/C Ratio		0.25			0.25					0.67	0.67	
v/c Ratio		0.49			0.94					0.06	0.86	
Control Delay		41.5			66.1					8.1	20.2	
Queue Delay		0.0			0.0					0.0	0.0	
Total Delay		41.5			66.1					8.1	20.2	
LOS		D			E					A	C	

Lanes, Volumes, Timings

455: W 14th

11/30/2017

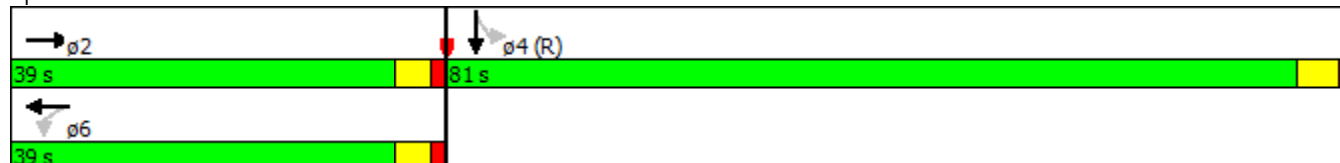


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		41.5			66.1							19.9
Approach LOS		D			E							B
Queue Length 50th (ft)		129			178					20		648
Queue Length 95th (ft)		189			#280					40		719
Internal Link Dist (ft)		252			408			1968				77
Turn Bay Length (ft)										150		
Base Capacity (vph)		473			266					1184		3399
Starvation Cap Reductn		0			0					0		0
Spillback Cap Reductn		0			0					0		0
Storage Cap Reductn		0			0					0		0
Reduced v/c Ratio		0.43			0.82					0.06		0.86

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 13 (11%), Referenced to phase 4:SBTL, Start of Green
 Natural Cycle: 75
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.94
 Intersection Signal Delay: 24.1
 Intersection LOS: C
 Intersection Capacity Utilization 80.4%
 ICU Level of Service D
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 455: W 14th



Lanes, Volumes, Timings
456: N Durham Dr & W 19th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	246	76	76	176	0	0	0	0	121	1294	44
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	150		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1799	0	0	1837	0	0	0	0	1770	5045	0
Flt Permitted					0.734					0.950		
Satd. Flow (perm)	0	1799	0	0	1367	0	0	0	0	1770	5045	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		2										23
Link Speed (mph)		30			30			35				35
Link Distance (ft)		618			668			633				368
Travel Time (s)		14.0			15.2			12.3				7.2
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.95	0.86	0.91	0.81	0.93	0.93	0.93	0.93	0.72	0.90	0.58
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	400	0	0	346	0	0	0	0	193	1740	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		4			8						6	
Permitted Phases				8						6		
Detector Phase		4		8	8					6	6	
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0					4.0	4.0	
Minimum Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (%)		50.0%		50.0%	50.0%					50.0%	50.0%	
Yellow Time (s)		3.5		3.5	3.5					3.5	3.5	
All-Red Time (s)		1.5		1.5	1.5					1.5	1.5	
Lost Time Adjust (s)		0.0			0.0					0.0	0.0	
Total Lost Time (s)		5.0			5.0					5.0	5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max		Max	Max					Max	Max	
Act Effect Green (s)		15.0			15.0					15.0	15.0	
Actuated g/C Ratio		0.38			0.38					0.38	0.38	
v/c Ratio		0.59			0.68					0.29	0.91	
Control Delay		14.4			19.8					10.7	15.6	
Queue Delay		0.0			0.0					0.0	0.0	
Total Delay		14.4			19.8					10.7	15.6	
LOS		B			B					B	B	

Lanes, Volumes, Timings
456: N Durham Dr & W 19th St

11/30/2017

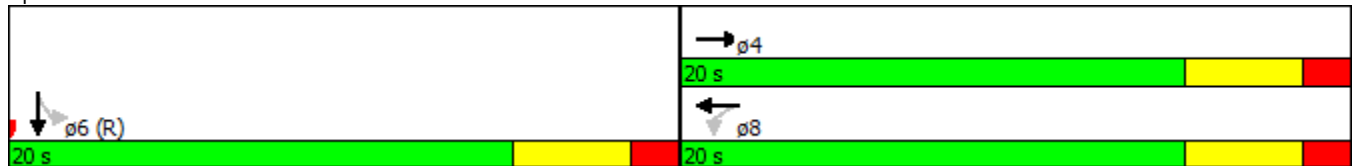


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		14.4			19.8							15.1
Approach LOS		B			B							B
Queue Length 50th (ft)		68			61					26		90
Queue Length 95th (ft)		131			#110					m28		m95
Internal Link Dist (ft)		538			588			553				288
Turn Bay Length (ft)										150		
Base Capacity (vph)		675			512					663		1906
Starvation Cap Reductn		0			0					0		0
Spillback Cap Reductn		0			0					0		0
Storage Cap Reductn		0			0					0		0
Reduced v/c Ratio		0.59			0.68					0.29		0.91

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 45
 Control Type: Pretimed
 Maximum v/c Ratio: 0.91
 Intersection Signal Delay: 15.6
 Intersection LOS: B
 Intersection Capacity Utilization 78.1%
 ICU Level of Service D
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 456: N Durham Dr & W 19th St



Lanes, Volumes, Timings
457: N Durham Dr & W 20th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	303	42	80	183	0	0	0	0	116	1371	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	150		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1824	0	0	1833	0	0	0	0	1770	5040	0
Flt Permitted					0.594					0.950		
Satd. Flow (perm)	0	1824	0	0	1106	0	0	0	0	1770	5040	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		2										29
Link Speed (mph)		30			30			35				35
Link Distance (ft)		582			183			368				1486
Travel Time (s)		13.2			4.2			7.2				28.9
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.92	0.70	0.77	0.82	0.93	0.93	0.93	0.93	0.81	0.90	0.90
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	448	0	0	376	0	0	0	0	165	1867	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		4			8						6	
Permitted Phases				8						6		
Detector Phase		4		8	8					6	6	
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0					4.0	4.0	
Minimum Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (%)		50.0%		50.0%	50.0%					50.0%	50.0%	
Yellow Time (s)		3.5		3.5	3.5					3.5	3.5	
All-Red Time (s)		1.5		1.5	1.5					1.5	1.5	
Lost Time Adjust (s)		0.0			0.0					0.0	0.0	
Total Lost Time (s)		5.0			5.0					5.0	5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max		Max	Max					Max	Max	
Act Effect Green (s)		15.0			15.0					15.0	15.0	
Actuated g/C Ratio		0.38			0.38					0.38	0.38	
v/c Ratio		0.65			0.91					0.25	0.98	
Control Delay		16.2			44.6					6.6	22.3	
Queue Delay		0.0			0.0					0.0	0.0	
Total Delay		16.2			44.6					6.6	22.3	
LOS		B			D					A	C	

Lanes, Volumes, Timings
458: N Durham Dr & W 24th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	39	42	60	53	0	0	0	0	32	1520	39
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	150		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1732	0	0	1818	0	0	0	0	1770	5055	0
Flt Permitted					0.814					0.950		
Satd. Flow (perm)	0	1732	0	0	1516	0	0	0	0	1770	5055	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		1										18
Link Speed (mph)		30			30			35				35
Link Distance (ft)		555			660			1486				1120
Travel Time (s)		12.6			15.0			28.9				21.8
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.75	0.75	0.94	0.78	0.93	0.93	0.93	0.93	0.57	0.95	0.57
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	124	0	0	151	0	0	0	0	65	1919	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		4			8						6	
Permitted Phases				8						6		
Detector Phase		4		8	8					6	6	
Switch Phase												
Minimum Initial (s)		4.0		4.0	4.0					4.0	4.0	
Minimum Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (s)		20.0		20.0	20.0					20.0	20.0	
Total Split (%)		50.0%		50.0%	50.0%					50.0%	50.0%	
Yellow Time (s)		3.5		3.5	3.5					3.5	3.5	
All-Red Time (s)		1.5		1.5	1.5					1.5	1.5	
Lost Time Adjust (s)		0.0			0.0					0.0	0.0	
Total Lost Time (s)		5.0			5.0					5.0	5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max		Max	Max					Max	Max	
Act Effect Green (s)		15.0			15.0					15.0	15.0	
Actuated g/C Ratio		0.38			0.38					0.38	0.38	
v/c Ratio		0.19			0.27					0.10	1.01	
Control Delay		9.4			10.3					3.8	29.1	
Queue Delay		0.0			0.0					0.0	0.0	
Total Delay		9.4			10.3					3.8	29.1	
LOS		A			B					A	C	

Lanes, Volumes, Timings
458: N Durham Dr & W 24th St

11/30/2017

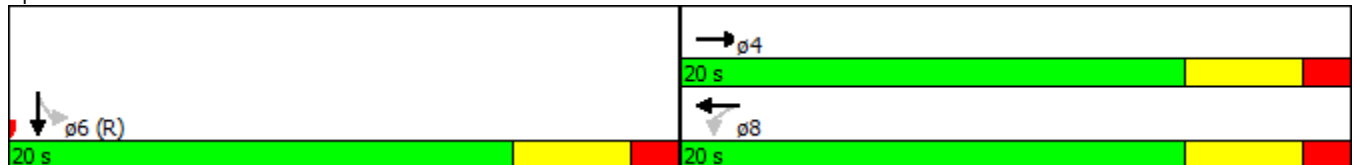


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		9.4			10.3							28.3
Approach LOS		A			B							C
Queue Length 50th (ft)		18			22					3		~194
Queue Length 95th (ft)		34			43					m4		m#263
Internal Link Dist (ft)		475			580			1406				1040
Turn Bay Length (ft)										150		
Base Capacity (vph)		650			568					663		1906
Starvation Cap Reductn		0			0					0		0
Spillback Cap Reductn		0			0					0		0
Storage Cap Reductn		0			0					0		0
Reduced v/c Ratio		0.19			0.27					0.10		1.01

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 45
 Control Type: Pretimed
 Maximum v/c Ratio: 1.01
 Intersection Signal Delay: 26.0 Intersection LOS: C
 Intersection Capacity Utilization 56.8% ICU Level of Service B
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 458: N Durham Dr & W 24th St



Lanes, Volumes, Timings
459: N Durham Dr & IH 610 EBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑								↙	↑↑↑	
Volume (vph)	0	1218	179	0	0	0	0	0	0	467	1270	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	4979	0	0	0	0	0	0	0	1770	5085	0
Flt Permitted										0.950		
Satd. Flow (perm)	0	4979	0	0	0	0	0	0	0	1770	5085	0
Right Turn on Red			Yes			Yes			Yes	Yes		Yes
Satd. Flow (RTOR)		3								55		
Link Speed (mph)		45			10			30			30	
Link Distance (ft)		410			526			607			264	
Travel Time (s)		6.2			35.9			13.8			6.0	
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.89	0.81	0.93	0.93	0.93	0.93	0.93	0.93	0.89	0.92	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	1828	0	0	0	0	0	0	0	603	1588	0
Turn Type		NA								Perm	NA	
Protected Phases		4									6	
Permitted Phases										6		
Detector Phase		4								6	6	
Switch Phase												
Minimum Initial (s)		4.0								4.0	4.0	
Minimum Split (s)		20.0								20.0	20.0	
Total Split (s)		20.0								20.0	20.0	
Total Split (%)		50.0%								50.0%	50.0%	
Yellow Time (s)		3.5								3.5	3.5	
All-Red Time (s)		1.5								1.5	1.5	
Lost Time Adjust (s)		0.0								0.0	0.0	
Total Lost Time (s)		5.0								5.0	5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode		Max								Max	Max	
Act Effct Green (s)		15.0								15.0	15.0	
Actuated g/C Ratio		0.38								0.38	0.38	
v/c Ratio		0.98								0.86	0.83	
Control Delay		31.3								19.5	13.0	
Queue Delay		0.0								0.6	0.0	
Total Delay		31.3								20.1	13.0	
LOS		C								C	B	

Lanes, Volumes, Timings
 459: N Durham Dr & IH 610 EBFR

11/30/2017

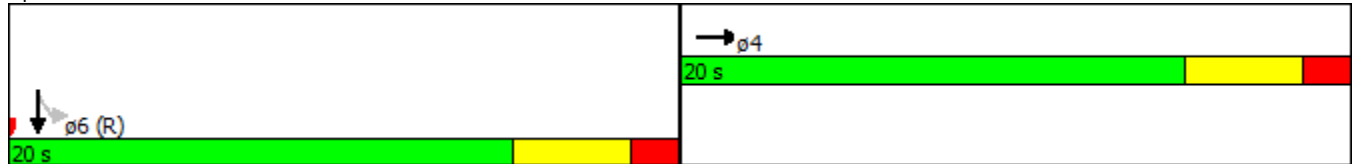


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		31.3										15.0
Approach LOS		C										B
Queue Length 50th (ft)		139								81		87
Queue Length 95th (ft)		#239								m98		m99
Internal Link Dist (ft)		330			446			527				184
Turn Bay Length (ft)												
Base Capacity (vph)		1869								698		1906
Starvation Cap Reductn		0								11		4
Spillback Cap Reductn		0								0		0
Storage Cap Reductn		0								0		0
Reduced v/c Ratio		0.98								0.88		0.83

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
 Natural Cycle: 55
 Control Type: Pretimed
 Maximum v/c Ratio: 0.98
 Intersection Signal Delay: 22.4
 Intersection LOS: C
 Intersection Capacity Utilization 95.5%
 ICU Level of Service F
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 459: N Durham Dr & IH 610 EBFR



Lanes, Volumes, Timings
460: N Durham Dr & IH 610 WBFR

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	446	475	0	0	0	0	0	1316	488
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	1610	3350	0	0	0	0	0	6132	0
Flt Permitted				0.950	0.988							
Satd. Flow (perm)	0	0	0	1610	3350	0	0	0	0	0	6132	0
Right Turn on Red			Yes	Yes		Yes			Yes			Yes
Satd. Flow (RTOR)				55	55							119
Link Speed (mph)		45			45			35				35
Link Distance (ft)		407			398			264				234
Travel Time (s)		6.2			6.0			5.1				4.6
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.86	0.87	0.93	0.93	0.93	0.93	0.93	0.92	0.85
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)				33%								
Lane Group Flow (vph)	0	0	0	399	825	0	0	0	0	0	2305	0
Turn Type				Perm	NA							NA
Protected Phases					8							6
Permitted Phases				8								
Detector Phase				8	8							6
Switch Phase												
Minimum Initial (s)				4.0	4.0							4.0
Minimum Split (s)				20.0	20.0							20.0
Total Split (s)				20.0	20.0							20.0
Total Split (%)				50.0%	50.0%							50.0%
Yellow Time (s)				3.5	3.5							3.5
All-Red Time (s)				1.5	1.5							1.5
Lost Time Adjust (s)				0.0	0.0							0.0
Total Lost Time (s)				5.0	5.0							5.0
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode				Max	Max							Max
Act Effect Green (s)				15.0	15.0							15.0
Actuated g/C Ratio				0.38	0.38							0.38
v/c Ratio				0.63	0.64							0.97
Control Delay				14.1	12.3							27.1
Queue Delay				0.0	0.0							4.8
Total Delay				14.1	12.3							31.9
LOS				B	B							C

Lanes, Volumes, Timings
460: N Durham Dr & IH 610 WBFR

11/30/2017

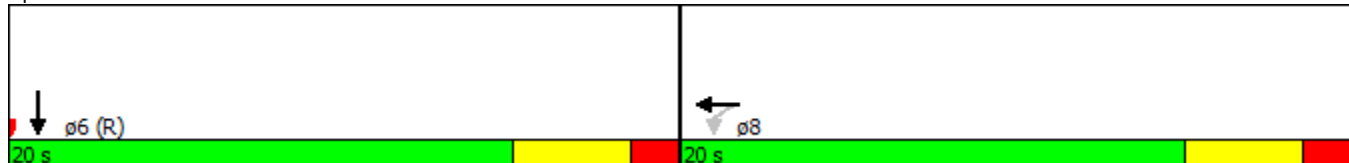


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					12.9							31.9
Approach LOS					B							C
Queue Length 50th (ft)				63	72							132
Queue Length 95th (ft)				126	112							#224
Internal Link Dist (ft)		327			318			184				154
Turn Bay Length (ft)												
Base Capacity (vph)				638	1290							2373
Starvation Cap Reductn				0	0							0
Spillback Cap Reductn				0	0							68
Storage Cap Reductn				0	0							0
Reduced v/c Ratio				0.63	0.64							1.00

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2: and 6:SBT, Start of Green
 Natural Cycle: 50
 Control Type: Pretimed
 Maximum v/c Ratio: 0.97
 Intersection Signal Delay: 25.3
 Intersection LOS: C
 Intersection Capacity Utilization 73.9%
 ICU Level of Service D
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 460: N Durham Dr & IH 610 WBFR



Lanes, Volumes, Timings
461: Shepherd & Washington

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	78	678	0	0	587	127	600	1909	150	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	90		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1770	3539	0	0	3409	0	0	6287	0	0	0	0
Flt Permitted	0.950							0.989				
Satd. Flow (perm)	1770	3539	0	0	3409	0	0	6287	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					20			14				
Link Speed (mph)		30			30			30				30
Link Distance (ft)		322			1068			522				252
Travel Time (s)		7.3			24.3			11.9				5.7
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	5	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	92	804	0	0	847	0	0	3152	0	0	0	0
Turn Type	Prot	NA			NA		Perm	NA				
Protected Phases	5	2			6			8				
Permitted Phases							8					
Detector Phase	5	2			6		8	8				
Switch Phase												
Minimum Initial (s)	5.0	10.0			10.0		10.0	10.0				
Minimum Split (s)	10.0	21.0			21.0		18.0	18.0				
Total Split (s)	20.0	55.0			35.0		65.0	65.0				
Total Split (%)	16.7%	45.8%			29.2%		54.2%	54.2%				
Yellow Time (s)	3.6	3.6			3.6		3.6	3.6				
All-Red Time (s)	1.4	1.4			1.4		1.4	1.4				
Lost Time Adjust (s)	0.0	0.0			0.0			0.0				
Total Lost Time (s)	5.0	5.0			5.0			5.0				
Lead/Lag	Lead				Lag							
Lead-Lag Optimize?	Yes				Yes							
Recall Mode	Max	Max			Max		C-Max	C-Max				
Act Effct Green (s)	15.0	50.0			30.0			60.0				
Actuated g/C Ratio	0.12	0.42			0.25			0.50				
v/c Ratio	0.42	0.55			0.98			1.00				
Control Delay	77.7	18.8			73.4			53.5				
Queue Delay	0.0	1.1			0.8			38.1				
Total Delay	77.7	19.9			74.3			91.6				
LOS	E	B			E			F				

Lanes, Volumes, Timings
461: Shepherd & Washington

11/30/2017

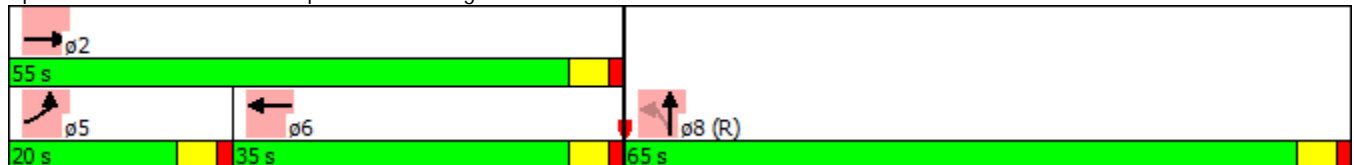


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		25.9			74.3			91.6				
Approach LOS		C			E			F				
Queue Length 50th (ft)	76	110			347			~737				
Queue Length 95th (ft)	m107	192			m#447			#817				
Internal Link Dist (ft)		242			988			442			172	
Turn Bay Length (ft)	90											
Base Capacity (vph)	221	1474			867			3150				
Starvation Cap Reductn	0	414			0			0				
Spillback Cap Reductn	0	0			4			345				
Storage Cap Reductn	0	0			0			0				
Reduced v/c Ratio	0.42	0.76			0.98			1.12				

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 0 (0%), Referenced to phase 8:NBTL, Start of Green
 Natural Cycle: 90
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.00
 Intersection Signal Delay: 76.6
 Intersection LOS: E
 Intersection Capacity Utilization 120.7%
 ICU Level of Service H
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 461: Shepherd & Washington



Lanes, Volumes, Timings
462: Shepherd & Center

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕↕↕				
Volume (vph)	49	70	0	0	42	78	24	2161	44	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1824	0	0	1721	0	0	5060	0	0	0	0
Flt Permitted		0.710						0.999				
Satd. Flow (perm)	0	1323	0	0	1721	0	0	5060	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					2			6				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		320			502			252				1943
Travel Time (s)		7.3			11.4			4.9				37.9
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.68	0.76	0.93	0.93	0.55	0.78	0.75	0.92	0.65	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	189	0	0	203	0	0	2816	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4						2					
Detector Phase	4	4			8		2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (s)	42.0	42.0			42.0		78.0	78.0				
Total Split (%)	35.0%	35.0%			35.0%		65.0%	65.0%				
Yellow Time (s)	3.5	3.5			3.5		3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5		1.5	1.5				
Lost Time Adjust (s)		0.0			0.0			0.0				
Total Lost Time (s)		5.0			5.0			5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max		Max	Max				
Act Effct Green (s)		37.0			37.0			73.0				
Actuated g/C Ratio		0.31			0.31			0.61				
v/c Ratio		0.46			0.38			0.91				
Control Delay		39.0			34.8			8.3				
Queue Delay		0.0			0.0			20.8				
Total Delay		39.0			34.8			29.1				
LOS		D			C			C				

Lanes, Volumes, Timings
462: Shepherd & Center

11/30/2017

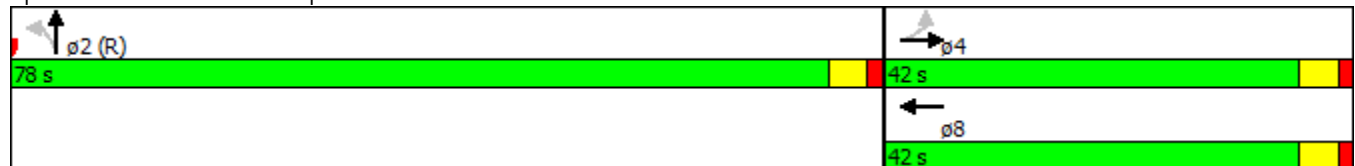


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		39.0			34.8			29.1				
Approach LOS		D			C			C				
Queue Length 50th (ft)		132			122			98				
Queue Length 95th (ft)		m171			108			m105				
Internal Link Dist (ft)		240			422			172			1863	
Turn Bay Length (ft)												
Base Capacity (vph)		407			532			3080				
Starvation Cap Reductn		0			0			375				
Spillback Cap Reductn		0			0			0				
Storage Cap Reductn		0			0			0				
Reduced v/c Ratio		0.46			0.38			1.04				

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
Natural Cycle:	60
Control Type:	Pretimed
Maximum v/c Ratio:	0.91
Intersection Signal Delay:	30.1
Intersection LOS:	C
Intersection Capacity Utilization	77.6%
ICU Level of Service	D
Analysis Period (min)	15
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 462: Shepherd & Center



Lanes, Volumes, Timings
463: Shepherd & IH10 - EBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	610	512	0	0	0	0	0	2215	162	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1610	3336	0	0	0	0	0	6344	0	0	0	0
Flt Permitted	0.950	0.984										
Satd. Flow (perm)	1610	3336	0	0	0	0	0	6344	0	0	0	0
Right Turn on Red	Yes		Yes			Yes			Yes			Yes
Satd. Flow (RTOR)	64	64						16				
Link Speed (mph)		40			40			35				35
Link Distance (ft)		306			534			233				316
Travel Time (s)		5.2			9.1			4.5				6.2
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.94	0.93	0.93	0.93	0.93	0.93	0.83	0.86	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	3	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)	41%											
Lane Group Flow (vph)	450	938	0	0	0	0	0	3286	0	0	0	0
Turn Type	Perm	NA						NA				
Protected Phases		4 12						2				
Permitted Phases	4 12											
Detector Phase	4 12	4 12						2				
Switch Phase												
Minimum Initial (s)								4.0				
Minimum Split (s)								21.0				
Total Split (s)								58.0				
Total Split (%)								48.3%				
Yellow Time (s)								3.5				
All-Red Time (s)								1.5				
Lost Time Adjust (s)								0.0				
Total Lost Time (s)								5.0				
Lead/Lag								Lead				
Lead-Lag Optimize?								Yes				
Recall Mode								C-Max				
Act Effct Green (s)	57.0	57.0						53.0				
Actuated g/C Ratio	0.48	0.48						0.44				
v/c Ratio	0.56	0.58						1.17				
Control Delay	7.8	8.5						112.9				
Queue Delay	3.9	3.0						0.6				
Total Delay	11.8	11.5						113.6				
LOS	B	B						F				

Lane Group	ø4	ø5	ø6	ø8	ø12	ø16
Lane Configurations						
Volume (vph)						
Ideal Flow (vphpl)						
Lane Width (ft)						
Grade (%)						
Storage Length (ft)						
Storage Lanes						
Taper Length (ft)						
Satd. Flow (prot)						
Flt Permitted						
Satd. Flow (perm)						
Right Turn on Red						
Satd. Flow (RTOR)						
Link Speed (mph)						
Link Distance (ft)						
Travel Time (s)						
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor						
Growth Factor						
Heavy Vehicles (%)						
Bus Blockages (#/hr)						
Parking (#/hr)						
Mid-Block Traffic (%)						
Shared Lane Traffic (%)						
Lane Group Flow (vph)						
Turn Type						
Protected Phases	4	5	6	8	12	16
Permitted Phases						
Detector Phase						
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	20.0	21.0	20.0	20.0
Total Split (s)	21.0	59.0	20.0	21.0	41.0	20.0
Total Split (%)	18%	49%	17%	18%	34%	17%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)						
Total Lost Time (s)						
Lead/Lag	Lag	Lag	Lead	Lag		Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes		Yes
Recall Mode	Max	None	None	None	None	None
Act Effct Green (s)						
Actuated g/C Ratio						
v/c Ratio						
Control Delay						
Queue Delay						
Total Delay						
LOS						

Lanes, Volumes, Timings
463: Shepherd & IH10 - EBFR

11/30/2017

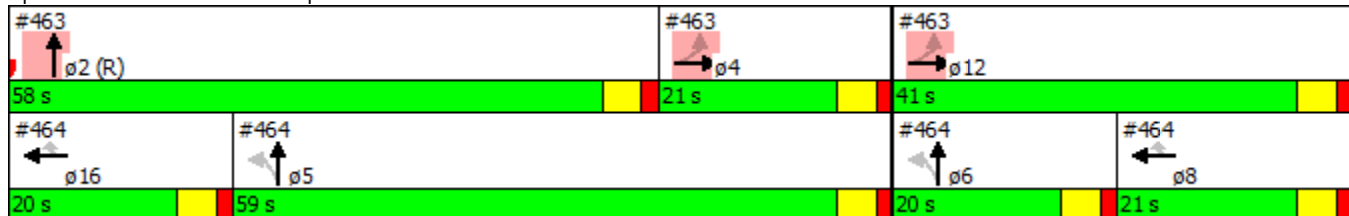


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		11.6						113.6				
Approach LOS		B						F				
Queue Length 50th (ft)	16	99						~867				
Queue Length 95th (ft)	m154	174						#809				
Internal Link Dist (ft)		226			454			153			236	
Turn Bay Length (ft)												
Base Capacity (vph)	798	1618						2810				
Starvation Cap Reductn	260	552						0				
Spillback Cap Reductn	6	4						695				
Storage Cap Reductn	0	0						0				
Reduced v/c Ratio	0.84	0.88						1.55				

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 17 (14%), Referenced to phase 2:NBT, Start of Green
 Natural Cycle: 125
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.17
 Intersection Signal Delay: 83.3 Intersection LOS: F
 Intersection Capacity Utilization 85.4% ICU Level of Service E
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

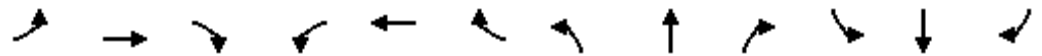
Splits and Phases: 463: Shepherd & IH10 - EBFR



Lane Group	ø4	ø5	ø6	ø8	ø12	ø16
Approach Delay						
Approach LOS						
Queue Length 50th (ft)						
Queue Length 95th (ft)						
Internal Link Dist (ft)						
Turn Bay Length (ft)						
Base Capacity (vph)						
Starvation Cap Reductn						
Spillback Cap Reductn						
Storage Cap Reductn						
Reduced v/c Ratio						
Intersection Summary						

Lanes, Volumes, Timings
464: Shepherd & IH10 - WBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑↑	↑	↑	↑↑↑				
Volume (vph)	0	0	0	0	458	347	701	2134	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		1	1		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	0	3292	1441	1522	4796	0	0	0	0
Flt Permitted							0.950	0.998				
Satd. Flow (perm)	0	0	0	0	3292	1441	1522	4796	0	0	0	0
Right Turn on Red			Yes			Yes	Yes		Yes			Yes
Satd. Flow (RTOR)					3	109	79	64				
Link Speed (mph)		40			40			35				35
Link Distance (ft)		310			534			316				3871
Travel Time (s)		5.3			9.1			6.2				75.4
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.93	0.89	0.86	0.97	0.94	0.93	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)						31%	10%					
Lane Group Flow (vph)	0	0	0	0	736	320	748	2694	0	0	0	0
Turn Type					NA	Perm	Perm	NA				
Protected Phases					8 16			5 6				
Permitted Phases						8 16	5 6					
Detector Phase					8 16	8 16	5 6	5 6				
Switch Phase												
Minimum Initial (s)												
Minimum Split (s)												
Total Split (s)												
Total Split (%)												
Yellow Time (s)												
All-Red Time (s)												
Lost Time Adjust (s)												
Total Lost Time (s)												
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode												
Act Effct Green (s)					35.1	35.1	74.9	74.9				
Actuated g/C Ratio					0.29	0.29	0.62	0.62				
v/c Ratio					0.76	0.64	0.76	0.89				
Control Delay					44.3	30.3	11.0	15.8				
Queue Delay					45.9	0.0	51.3	46.3				
Total Delay					90.2	30.3	62.4	62.2				
LOS					F	C	E	E				

Lanes, Volumes, Timings
 464: Shepherd & IH10 - WBFR

11/30/2017

Lane Group	ø2	ø4	ø5	ø6	ø8	ø12	ø16
Lane Configurations							
Volume (vph)							
Ideal Flow (vphpl)							
Lane Width (ft)							
Grade (%)							
Storage Length (ft)							
Storage Lanes							
Taper Length (ft)							
Satd. Flow (prot)							
Flt Permitted							
Satd. Flow (perm)							
Right Turn on Red							
Satd. Flow (RTOR)							
Link Speed (mph)							
Link Distance (ft)							
Travel Time (s)							
Confl. Peds. (#/hr)							
Confl. Bikes (#/hr)							
Peak Hour Factor							
Growth Factor							
Heavy Vehicles (%)							
Bus Blockages (#/hr)							
Parking (#/hr)							
Mid-Block Traffic (%)							
Shared Lane Traffic (%)							
Lane Group Flow (vph)							
Turn Type							
Protected Phases	2	4	5	6	8	12	16
Permitted Phases							
Detector Phase							
Switch Phase							
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	21.0	20.0	21.0	20.0	20.0
Total Split (s)	58.0	21.0	59.0	20.0	21.0	41.0	20.0
Total Split (%)	48%	18%	49%	17%	18%	34%	17%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)							
Total Lost Time (s)							
Lead/Lag	Lead	Lag	Lag	Lead	Lag		Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes		Yes
Recall Mode	C-Max	Max	None	None	None	None	None
Act Effct Green (s)							
Actuated g/C Ratio							
v/c Ratio							
Control Delay							
Queue Delay							
Total Delay							
LOS							

Lanes, Volumes, Timings
464: Shepherd & IH10 - WBFR

11/30/2017

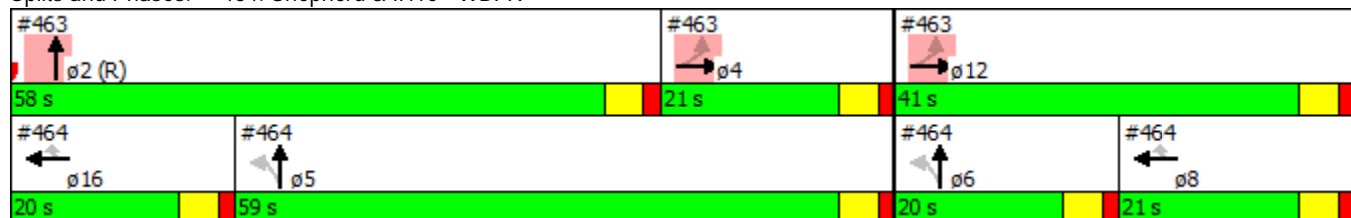


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					72.1			62.2				
Approach LOS					E			E				
Queue Length 50th (ft)					280	154	586	787				
Queue Length 95th (ft)					352	248	m510	m670				
Internal Link Dist (ft)		230			454			236			3791	
Turn Bay Length (ft)												
Base Capacity (vph)					989	508	979	3017				
Starvation Cap Reductn					0	0	356	1016				
Spillback Cap Reductn					312	0	8	2				
Storage Cap Reductn					0	0	0	0				
Reduced v/c Ratio					1.09	0.63	1.20	1.35				

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	17 (14%), Referenced to phase 2:NBT, Start of Green
Natural Cycle:	125
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	1.17
Intersection Signal Delay:	64.5
Intersection LOS:	E
Intersection Capacity Utilization:	95.8%
ICU Level of Service:	F
Analysis Period (min):	15
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 464: Shepherd & IH10 - WBFR



Lane Group	ø2	ø4	ø5	ø6	ø8	ø12	ø16
Approach Delay							
Approach LOS							
Queue Length 50th (ft)							
Queue Length 95th (ft)							
Internal Link Dist (ft)							
Turn Bay Length (ft)							
Base Capacity (vph)							
Starvation Cap Reductn							
Spillback Cap Reductn							
Storage Cap Reductn							
Reduced v/c Ratio							
Intersection Summary							

Lanes, Volumes, Timings
465: W 11th

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↘	↑↑			↑↑		↘	↑↑↑				
Volume (vph)	246	741	1	0	466	160	360	1841	157	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	50		0	0		0	150		0	0		0
Storage Lanes	1		0	0		0	1		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1770	3536	0	0	3398	0	1770	5014	0	0	0	0
Flt Permitted	0.289						0.950					
Satd. Flow (perm)	538	3536	0	0	3398	0	1770	5014	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		1						15				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		536			448			700				2008
Travel Time (s)		12.2			10.2			13.6				39.1
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.87	0.95	0.25	0.93	0.90	0.85	0.87	0.93	0.80	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	325	902	0	0	811	0	476	2503	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		2			6			8				
Permitted Phases	2						8					
Detector Phase	2	2			6		8	8				
Switch Phase												
Minimum Initial (s)	7.0	7.0			5.0		7.0	7.0				
Minimum Split (s)	21.2	21.2			21.2		21.0	21.0				
Total Split (s)	73.0	73.0			73.0		47.0	47.0				
Total Split (%)	60.8%	60.8%			60.8%		39.2%	39.2%				
Yellow Time (s)	3.6	3.6			3.6		3.6	3.6				
All-Red Time (s)	1.6	1.6			1.6		1.4	1.4				
Lost Time Adjust (s)	0.0	0.0			0.0		0.0	0.0				
Total Lost Time (s)	5.2	5.2			5.2		5.0	5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	None	None			None		C-Max	C-Max				
Act Effct Green (s)	67.8	67.8			67.8		42.0	42.0				
Actuated g/C Ratio	0.56	0.56			0.56		0.35	0.35				
v/c Ratio	1.07	0.45			0.42		0.77	1.42				
Control Delay	88.1	11.2			15.8		37.9	220.1				
Queue Delay	0.0	0.2			0.0		0.0	0.0				
Total Delay	88.1	11.4			15.8		37.9	220.1				
LOS	F	B			B		D	F				

Lanes, Volumes, Timings

465: W 11th

11/30/2017

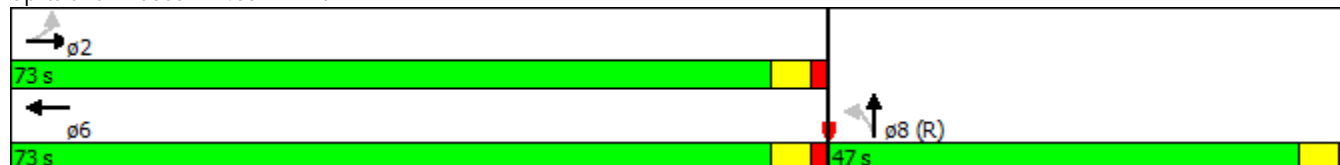


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		31.7			15.8			191.0				
Approach LOS		C			B			F				
Queue Length 50th (ft)	~152	102			180		260	~947				
Queue Length 95th (ft)	m#415	171			226		m348	#1045				
Internal Link Dist (ft)		456			368			620			1928	
Turn Bay Length (ft)	50						150					
Base Capacity (vph)	303	1998			1919		619	1764				
Starvation Cap Reductn	0	379			0		0	0				
Spillback Cap Reductn	0	0			0		0	0				
Storage Cap Reductn	0	0			0		0	0				
Reduced v/c Ratio	1.07	0.56			0.42		0.77	1.42				

Intersection Summary

Area Type: Other
 Cycle Length: 120
 Actuated Cycle Length: 120
 Offset: 14 (12%), Referenced to phase 8:NBTL, Start of Green
 Natural Cycle: 110
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.42
 Intersection Signal Delay: 123.7
 Intersection LOS: F
 Intersection Capacity Utilization 94.1%
 ICU Level of Service F
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 465: W 11th



Lanes, Volumes, Timings
466: W 14th

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↖			↗		↖	↖↖↖				
Volume (vph)	24	63	0	0	82	45	72	2262	63	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%				0%
Storage Length (ft)	0		0	0		0	150		0	0		0
Storage Lanes	0		0	0		0	1		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1837	0	0	1775	0	1770	5060	0	0	0	0
Flt Permitted		0.652					0.950					
Satd. Flow (perm)	0	1215	0	0	1775	0	1770	5060	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)								5				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		488			473			2008				644
Travel Time (s)		11.1			10.8			39.1				12.5
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.86	0.88	0.93	0.93	0.68	0.70	0.75	0.96	0.72	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	114	0	0	213	0	110	2811	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		2			6			8				
Permitted Phases	2						8					
Detector Phase	2	2			6		8	8				
Switch Phase												
Minimum Initial (s)	11.0	11.0			11.0		11.0	11.0				
Minimum Split (s)	45.0	45.0			45.0		40.0	40.0				
Total Split (s)	70.0	70.0			70.0		50.0	50.0				
Total Split (%)	58.3%	58.3%			58.3%		41.7%	41.7%				
Yellow Time (s)	3.5	3.5			3.5		3.2	3.2				
All-Red Time (s)	1.7	1.7			1.7		1.8	1.8				
Lost Time Adjust (s)		0.0			0.0		0.0	0.0				
Total Lost Time (s)		5.2			5.2		5.0	5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	None	None			None		C-Max	C-Max				
Act Effct Green (s)		20.4			20.4		89.4	89.4				
Actuated g/C Ratio		0.17			0.17		0.74	0.74				
v/c Ratio		0.55			0.71		0.08	0.75				
Control Delay		59.9			59.2		11.7	27.1				
Queue Delay		0.0			0.0		0.0	0.0				
Total Delay		59.9			59.2		11.7	27.1				
LOS		E			E		B	C				

Lanes, Volumes, Timings

466: W 14th

11/30/2017

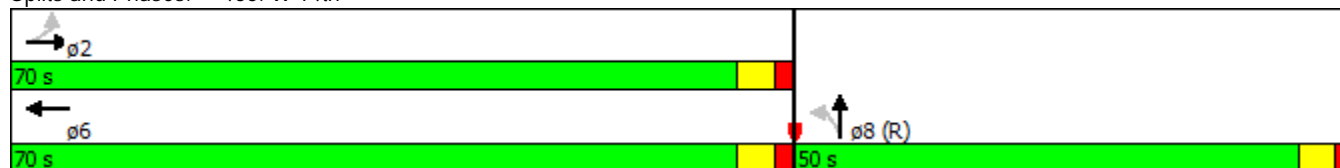


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		59.9			59.2			26.5				
Approach LOS		E			E			C				
Queue Length 50th (ft)		86			158		49	638				
Queue Length 95th (ft)		138			161		m41	m449				
Internal Link Dist (ft)		408			393			1928			564	
Turn Bay Length (ft)							150					
Base Capacity (vph)		656			958		1318	3770				
Starvation Cap Reductn		0			0		0	0				
Spillback Cap Reductn		0			0		0	0				
Storage Cap Reductn		0			0		0	0				
Reduced v/c Ratio		0.17			0.22		0.08	0.75				

Intersection Summary

Area Type:	Other
Cycle Length:	120
Actuated Cycle Length:	120
Offset:	20 (17%), Referenced to phase 8:NBTL, Start of Green
Natural Cycle:	105
Control Type:	Actuated-Coordinated
Maximum v/c Ratio:	0.75
Intersection Signal Delay:	29.8
Intersection LOS:	C
Intersection Capacity Utilization:	83.0%
ICU Level of Service:	E
Analysis Period (min):	15
m Volume for 95th percentile queue is metered by upstream signal.	

Splits and Phases: 466: W 14th



Lanes, Volumes, Timings
467: N Shepherd Dr & W 19th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↔			↑	↗	↘	↑↑↑				
Volume (vph)	60	290	0	0	166	111	87	2090	128	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		85	0		0	150		0	0		0
Storage Lanes	0		1	0		1	1		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3504	0	0	1863	1583	1770	5034	0	0	0	0
Flt Permitted		0.841					0.950					
Satd. Flow (perm)	0	2976	0	0	1863	1583	1770	5034	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						44		31				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		668			574			1789				375
Travel Time (s)		15.2			13.0			34.9				7.3
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.75	0.88	0.93	0.93	0.90	0.90	0.87	0.94	0.84	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	471	0	0	212	142	115	2732	0	0	0	0
Turn Type	Perm	NA			NA	Perm	Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4					8	2					
Detector Phase	4	4			8	8	2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0	4.0	4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0	20.0	20.0	20.0				
Total Split (s)	20.0	20.0			20.0	20.0	30.0	30.0				
Total Split (%)	40.0%	40.0%			40.0%	40.0%	60.0%	60.0%				
Yellow Time (s)	3.5	3.5			3.5	3.5	3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5	1.5	1.5	1.5				
Lost Time Adjust (s)		0.0			0.0	0.0	0.0	0.0				
Total Lost Time (s)		5.0			5.0	5.0	5.0	5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max	Max	Max	Max				
Act Effect Green (s)		15.0			15.0	15.0	25.0	25.0				
Actuated g/C Ratio		0.30			0.30	0.30	0.50	0.50				
v/c Ratio		0.53			0.38	0.28	0.13	1.08				
Control Delay		17.2			16.3	11.5	7.2	59.2				
Queue Delay		0.0			0.0	0.0	0.0	9.2				
Total Delay		17.2			16.3	11.5	7.2	68.4				
LOS		B			B	B	A	E				

Lanes, Volumes, Timings
 467: N Shepherd Dr & W 19th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		17.2			14.4			66.0				
Approach LOS		B			B			E				
Queue Length 50th (ft)		59			48	21	16	~343				
Queue Length 95th (ft)		93			94	55	35	#437				
Internal Link Dist (ft)		588			494			1709			295	
Turn Bay Length (ft)							150					
Base Capacity (vph)		892			558	505	885	2532				
Starvation Cap Reductn		0			0	0	0	0				
Spillback Cap Reductn		0			0	2	0	281				
Storage Cap Reductn		0			0	0	0	0				
Reduced v/c Ratio		0.53			0.38	0.28	0.13	1.21				

Intersection Summary

Area Type: Other
 Cycle Length: 50
 Actuated Cycle Length: 50
 Offset: 0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
 Natural Cycle: 60
 Control Type: Pretimed
 Maximum v/c Ratio: 1.08
 Intersection Signal Delay: 54.7
 Intersection LOS: D
 Intersection Capacity Utilization 83.5%
 ICU Level of Service E
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 467: N Shepherd Dr & W 19th St



Lanes, Volumes, Timings
468: N Shepherd Dr & W 20th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↔			↔↔		↔	↔↔↔				
Volume (vph)	98	295	0	0	210	140	59	2114	103	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		100	0		0	150		0	0		0
Storage Lanes	0		1	0		0	1		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	3490	0	0	3337	0	1770	5045	0	0	0	0
Flt Permitted		0.682					0.950					
Satd. Flow (perm)	0	2414	0	0	3337	0	1770	5045	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					1			24				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		140			536			375				1478
Travel Time (s)		3.2			12.2			7.3				28.8
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.77	0.93	0.93	0.93	0.75	0.81	0.87	0.96	0.86	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	511	0	0	521	0	78	2670	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4						2					
Detector Phase	4	4			8		2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (s)	20.0	20.0			20.0		30.0	30.0				
Total Split (%)	40.0%	40.0%			40.0%		60.0%	60.0%				
Yellow Time (s)	3.5	3.5			3.5		3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5		1.5	1.5				
Lost Time Adjust (s)		0.0			0.0		0.0	0.0				
Total Lost Time (s)		5.0			5.0		5.0	5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max		Max	Max				
Act Effct Green (s)		15.0			15.0		25.0	25.0				
Actuated g/C Ratio		0.30			0.30		0.50	0.50				
v/c Ratio		0.71			0.52		0.09	1.05				
Control Delay		22.3			16.7		6.6	36.9				
Queue Delay		0.0			0.0		0.0	2.7				
Total Delay		22.3			16.7		6.6	39.7				
LOS		C			B		A	D				

Lanes, Volumes, Timings
468: N Shepherd Dr & W 20th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		22.3			16.7			38.7				
Approach LOS		C			B			D				
Queue Length 50th (ft)		68			65		9	~134				
Queue Length 95th (ft)		#118			82		m9	m110				
Internal Link Dist (ft)		60			456			295			1398	
Turn Bay Length (ft)							150					
Base Capacity (vph)		724			1001		885	2534				
Starvation Cap Reductn		0			0		0	16				
Spillback Cap Reductn		0			0		0	0				
Storage Cap Reductn		0			0		0	0				
Reduced v/c Ratio		0.71			0.52		0.09	1.06				

Intersection Summary

Area Type: Other
 Cycle Length: 50
 Actuated Cycle Length: 50
 Offset: 0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
 Natural Cycle: 60
 Control Type: Pretimed
 Maximum v/c Ratio: 1.05
 Intersection Signal Delay: 33.5
 Intersection LOS: C
 Intersection Capacity Utilization 86.6%
 ICU Level of Service E
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 468: N Shepherd Dr & W 20th St



Lanes, Volumes, Timings
469: N Shepherd Dr & W 24th St

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↖			↗		↖	↑↑↑				
Volume (vph)	34	36	0	0	36	26	74	2230	26	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	150		0	0		0
Storage Lanes	0		0	0		0	1		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	1818	0	0	1742	0	1770	5075	0	0	0	0
Flt Permitted		0.802					0.950					
Satd. Flow (perm)	0	1494	0	0	1742	0	1770	5075	0	0	0	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)					1			5				
Link Speed (mph)		30			30			35				35
Link Distance (ft)		660			543			1478				1450
Travel Time (s)		15.0			12.3			28.8				28.2
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.65	0.69	0.93	0.93	0.64	0.50	0.80	0.90	0.81	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	120	0	0	125	0	106	2886	0	0	0	0
Turn Type	Perm	NA			NA		Perm	NA				
Protected Phases		4			8			2				
Permitted Phases	4						2					
Detector Phase	4	4			8		2	2				
Switch Phase												
Minimum Initial (s)	4.0	4.0			4.0		4.0	4.0				
Minimum Split (s)	20.0	20.0			20.0		20.0	20.0				
Total Split (s)	20.0	20.0			20.0		35.0	35.0				
Total Split (%)	36.4%	36.4%			36.4%		63.6%	63.6%				
Yellow Time (s)	3.5	3.5			3.5		3.5	3.5				
All-Red Time (s)	1.5	1.5			1.5		1.5	1.5				
Lost Time Adjust (s)		0.0			0.0		0.0	0.0				
Total Lost Time (s)		5.0			5.0		5.0	5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max			Max		Max	Max				
Act Effct Green (s)		15.0			15.0		30.0	30.0				
Actuated g/C Ratio		0.27			0.27		0.55	0.55				
v/c Ratio		0.29			0.26		0.11	1.04				
Control Delay		18.3			17.4		6.5	44.4				
Queue Delay		0.0			0.0		0.0	0.0				
Total Delay		18.3			17.4		6.5	44.4				
LOS		B			B		A	D				

Lanes, Volumes, Timings
 469: N Shepherd Dr & W 24th St

11/30/2017

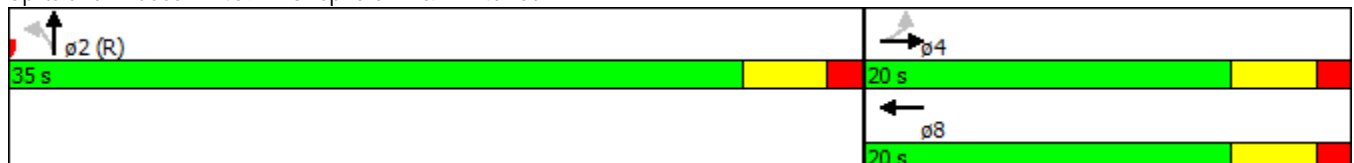


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		18.3			17.4			43.0				
Approach LOS		B			B			D				
Queue Length 50th (ft)		31			32		15	~390				
Queue Length 95th (ft)		50			46		29	#486				
Internal Link Dist (ft)		580			463			1398			1370	
Turn Bay Length (ft)							150					
Base Capacity (vph)		407			475		965	2770				
Starvation Cap Reductn		0			0		0	0				
Spillback Cap Reductn		0			0		0	0				
Storage Cap Reductn		0			0		0	0				
Reduced v/c Ratio		0.29			0.26		0.11	1.04				

Intersection Summary

Area Type: Other
 Cycle Length: 55
 Actuated Cycle Length: 55
 Offset: 0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
 Natural Cycle: 60
 Control Type: Pretimed
 Maximum v/c Ratio: 1.04
 Intersection Signal Delay: 41.1 Intersection LOS: D
 Intersection Capacity Utilization 69.6% ICU Level of Service C
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 469: N Shepherd Dr & W 24th St



Lanes, Volumes, Timings
470: N Shepherd Dr & IH 610 EBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	582	1158	0	0	0	0	0	1729	327	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	1		0	0		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1610	3380	0	0	0	0	0	6254	0	0	0	0
Flt Permitted	0.950	0.997										
Satd. Flow (perm)	1610	3380	0	0	0	0	0	6254	0	0	0	0
Right Turn on Red	Yes		Yes			Yes			Yes			Yes
Satd. Flow (RTOR)	55	55						7				
Link Speed (mph)		45			45			35				35
Link Distance (ft)		526			314			247				251
Travel Time (s)		8.0			4.8			4.8				4.9
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.97	0.93	0.93	0.93	0.93	0.93	0.94	0.95	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)	10%											
Lane Group Flow (vph)	655	1446	0	0	0	0	0	2511	0	0	0	0
Turn Type	Perm	NA						NA				
Protected Phases		4						2				
Permitted Phases	4											
Detector Phase	4	4						2				
Switch Phase												
Minimum Initial (s)	4.0	4.0						4.0				
Minimum Split (s)	20.0	20.0						20.0				
Total Split (s)	20.0	20.0						20.0				
Total Split (%)	50.0%	50.0%						50.0%				
Yellow Time (s)	3.5	3.5						3.5				
All-Red Time (s)	1.5	1.5						1.5				
Lost Time Adjust (s)	0.0	0.0						0.0				
Total Lost Time (s)	5.0	5.0						5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max						Max				
Act Effct Green (s)	15.0	15.0						15.0				
Actuated g/C Ratio	0.38	0.38						0.38				
v/c Ratio	1.03	1.11						1.07				
Control Delay	45.2	71.1						56.4				
Queue Delay	0.0	0.0						0.0				
Total Delay	45.2	71.1						56.4				
LOS	D	E						E				

Lanes, Volumes, Timings
470: N Shepherd Dr & IH 610 EBFR

11/30/2017

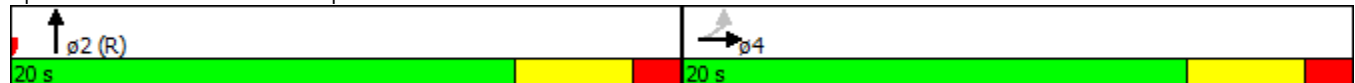


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay		63.1						56.4				
Approach LOS		E						E				
Queue Length 50th (ft)	~124	~194						~195				
Queue Length 95th (ft)	m#146	m#219						#265				
Internal Link Dist (ft)		446			234			167			171	
Turn Bay Length (ft)												
Base Capacity (vph)	638	1301						2349				
Starvation Cap Reductn	0	0						0				
Spillback Cap Reductn	0	0						0				
Storage Cap Reductn	0	0						0				
Reduced v/c Ratio	1.03	1.11						1.07				

Intersection Summary

Area Type: Other
 Cycle Length: 40
 Actuated Cycle Length: 40
 Offset: 0 (0%), Referenced to phase 2:NBT and 6:, Start of Green
 Natural Cycle: 80
 Control Type: Pretimed
 Maximum v/c Ratio: 1.11
 Intersection Signal Delay: 59.4 Intersection LOS: E
 Intersection Capacity Utilization 100.7% ICU Level of Service G
 Analysis Period (min) 15
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 470: N Shepherd Dr & IH 610 EBFR



Lanes, Volumes, Timings
471: N Shepherd Dr & IH 610 WBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑↑↑		↑	↑↑↑				
Volume (vph)	0	0	0	0	597	406	398	1884	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	0		0	0		0	0		0	0		0
Storage Lanes	0		0	0		0	1		0	0		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	0	0	0	0	4775	0	1770	5085	0	0	0	0
Flt Permitted							0.950					
Satd. Flow (perm)	0	0	0	0	4775	0	1770	5085	0	0	0	0
Right Turn on Red			Yes			Yes	Yes		Yes			Yes
Satd. Flow (RTOR)					1		44					
Link Speed (mph)		45			45			35				35
Link Distance (ft)		398			334			251				1261
Travel Time (s)		6.0			5.1			4.9				24.6
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.93	0.93	0.93	0.93	0.91	0.91	0.86	0.92	0.93	0.93	0.93	0.93
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%				0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	0	1267	0	532	2355	0	0	0	0
Turn Type					NA		Perm	NA				
Protected Phases					8			2				
Permitted Phases							2					
Detector Phase					8		2	2				
Switch Phase												
Minimum Initial (s)					4.0		4.0	4.0				
Minimum Split (s)					20.0		20.0	20.0				
Total Split (s)					20.0		30.0	30.0				
Total Split (%)					40.0%		60.0%	60.0%				
Yellow Time (s)					3.5		3.5	3.5				
All-Red Time (s)					1.5		1.5	1.5				
Lost Time Adjust (s)					0.0		0.0	0.0				
Total Lost Time (s)					5.0		5.0	5.0				
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode					Max		Max	Max				
Act Effect Green (s)					15.0		25.0	25.0				
Actuated g/C Ratio					0.30		0.50	0.50				
v/c Ratio					1.06dr		0.59	0.93				
Control Delay					26.4		11.3	20.4				
Queue Delay					0.0		4.5	45.4				
Total Delay					26.4		15.9	65.8				
LOS					C		B	E				

Lanes, Volumes, Timings
 471: N Shepherd Dr & IH 610 WBFR

11/30/2017



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Delay					26.4			56.6				
Approach LOS					C			E				
Queue Length 50th (ft)					127		90	212				
Queue Length 95th (ft)					#205		153	#341				
Internal Link Dist (ft)		318			254			171			1181	
Turn Bay Length (ft)												
Base Capacity (vph)					1433		907	2542				
Starvation Cap Reductn					0		295	627				
Spillback Cap Reductn					0		0	0				
Storage Cap Reductn					0		0	0				
Reduced v/c Ratio					0.88		0.87	1.23				

Intersection Summary

Area Type: Other
 Cycle Length: 50
 Actuated Cycle Length: 50
 Offset: 0 (0%), Referenced to phase 2:NBTL and 6:, Start of Green
 Natural Cycle: 60
 Control Type: Pretimed
 Maximum v/c Ratio: 0.93
 Intersection Signal Delay: 47.4
 Intersection LOS: D
 Intersection Capacity Utilization 73.9%
 ICU Level of Service D
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Splits and Phases: 471: N Shepherd Dr & IH 610 WBFR



Appendix H
Quantities and Cost Data (410 Bid Tab) for
Recommended Candidate Project



Total Project



MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between Interstate 610 and Washington Avenue
ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

**BID FORM
PART B**

Document 00410B Note 1

BID FORM - PART B

1.0 TOTAL BID PRICE HAS BEEN CALCULATED BY BIDDER, USING THE FOLLOWING COMPONENT PRICES AND

A. STIPULATED PRICE \$ N/A
 (Total Bid Price; minus Base Unit Prices, Extra Unit Process, Cash Allowance and All Alternates, if any)

B. BASE UNIT PRICE TABLE:

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - PAVING ITEMS							
1	222101	02221	Remove and Dispose of Existing Pavement and Curb -Assumes all concrete pavement thicknesses with or without asphalt overlay	SY	156,680	\$6.00	\$940,080.00
2	222102	02221	Remove and Dispose of Existing Driveways and Sidewalks	SY	23,087	\$5.00	\$115,435.50
3	275106	02751	11" Reinforced Concrete Pavement (Complete in Place)	SY	154,140	\$70.00	\$10,789,800.00
4	233601	02336	Lime stabilized subgrade (6" thick)	SY	1,020	\$3.00	\$3,060.00
5	233602	02336	Lime stabilized subgrade (8" thick)	SY	169,550	\$4.00	\$678,200.00
6	233603	02336	Lime (6, 7% By Weight)	Ton	3,390	\$164.00	\$555,960.00
7	277101	02771	6" Concrete Curb	LF	69,250	\$4.00	\$277,000.00
8	275201	02752	Expansion Joint	LF	17,380	\$8.00	\$139,040.00
9	275401	02754	6" Concrete for Driveways	SF	91,920	\$8.00	\$735,360.00
10	277501	02775	4-1/2" Concrete for Sidewalks	SF	415,510	\$7.00	\$2,908,570.00
11	292201	02922	Sodding	SY	11,540	\$5.00	\$57,700.00
12	289301	02893	Traffic Signal/Intersection	EA	15	\$325,000.00	\$4,875,000.00
13	-	-	Railroad Crossing	EA	2	\$1,000,000.00	\$2,000,000.00
14	231501	02315	Roadway Excavation	CY	10,050	\$16.00	\$160,800.00
15	-	-	Pedestrian Bridge	LF	400	\$110.00	\$44,000.00
16	1601001	-	Street Light Removal	EA	152	\$272.00	\$41,344.00
17	1601002	-	Street Light Installation (includes conduit and Temporary Lighting during Construction)	LF	33,046	\$32.00	\$1,057,472.00
			Ancillary items (10%)				\$2,432,134.95
			SubTotal of Paving				\$27,810,956.45
			General Items (10% of Paving Subtotal)				\$2,781,095.65
TOTAL - PAVING ITEMS							\$30,592,052.10

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - STORM SEWER ITEMS							
1	222103	02221	Remove Storm Sewer Pipe (All Types)	LF	22,190	\$20.00	\$443,800.00
2	222105	02221	Remove Inlets (All Types)	EA	300	\$370.00	\$111,000.00
3	222106	02221	Remove Manholes (All Types, All Depths)	EA	80	\$390.00	\$31,200.00
4	263301	02633	Curb Inlets (All Types)	EA	250	\$2,910.00	\$727,500.00
5	208201	02082	Manholes (For 42" Dia. Pipe and Smaller) (All Types)	EA	34	\$3,470.00	\$117,980.00
6	208202	02082	Manholes (For 48" to 72" Dia. Pipe) (All Types)	EA	20	\$6,340.00	\$126,800.00

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between Interstate 610 and Washington Avenue

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
7	208203	02082	Manholes (For 78" Dia. Pipe and Larger) (All Types)	EA	30	\$16,500.00	\$495,000.00
8	263101	02631	24-inch RCP	LF	10,610	\$115.00	\$1,220,150.00
9	263102	02631	30-inch RCP	LF	1,750	\$150.00	\$262,500.00
10	263103	02631	36-inch RCP	LF	1,300	\$180.00	\$234,000.00
11	263104	02631	42-inch RCP	LF	3,060	\$215.00	\$657,900.00
12	263105	02631	48-inch RCP	LF	900	\$250.00	\$225,000.00
13	263106	02631	54-inch RCP	LF	260	\$270.00	\$70,200.00
14	263107	02631	60-inch RCP	LF	940	\$350.00	\$329,000.00
15	263108	02631	66-inch RCP	LF	270	\$360.00	\$97,200.00
16	263109	02631	72-inch RCP	LF	130	\$485.00	\$63,050.00
17	263113	02631	96-inch RCP	LF	790	\$730.00	\$576,700.00
18	263123	02631	4x2 RCB	LF	2,500	\$250.00	\$625,000.00
19	263126	02631	5x3 RCB	LF	750	\$300.00	\$225,000.00
20	263128	02631	5X5 RCB	LF	1,410	\$350.00	\$493,500.00
21	263129	02631	6x3 RCB	LF	370	\$350.00	\$129,500.00
22	263130	02631	6x4 RCB	LF	3,160	\$445.00	\$1,406,200.00
23	263132	02631	6X6 RCB	LF	370	\$480.00	\$177,600.00
24	263134	02631	7X5 RCB	LF	500	\$580.00	\$290,000.00
25	263137	02631	8x4 RCB	LF	370	\$580.00	\$214,600.00
26	263147	02631	10X5 RCB	LF	1,270	\$850.00	\$1,079,500.00
27	263152	02631	10X10 RCB	LF	2,960	\$1,300.00	\$3,848,000.00
28	263161	02631	12x10 RCB	LF	840	\$1,335.00	\$1,121,400.00
29	226001	02260	Trench Safety System	LF	34,500	\$2.00	\$69,000.00
30	231504	02315	Fill Existing Ditch	CY	100	\$6.00	\$600.00
			Ancillary items (10%)				\$773,444.00
			SubTotal of Storm Sewer				\$16,242,324.00
			General Items (10% of Storm Sewer Subtotal)				\$1,624,232.40
TOTAL UNIT PRICES - STORM SEWER ITEMS							\$17,866,556.40

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - WASTEWATER							
1	222108	02221	Remove Existing Sanitary Sewer Manhole (All Types)	EA	0	\$800.00	\$0.00
2	222201	02221	Abandon and Fill Existing Sanitary Sewer Manhole (All Types)	EA	4	\$1,000.00	\$4,000.00
3	222109	02221	Remove Existing Sanitary Sewer Pipe (All Types)	LF	0	\$20.00	\$0.00
4	222202	02222	Abandon and Fill Existing Sanitary Sewer Pipe (All Sizes)	LF	1,039	\$20.00	\$20,780.00
5	-	02222	Abandon Existing Sanitary Sewer Lift Station	EA	2	\$100,000.00	\$200,000.00
6	253103	02531	10" PVC	LF	383	\$160.00	\$61,280.00
7	253105	02531	15" PVC	LF	394	\$230.00	\$90,620.00
8	253108	02531	30" PVC	LF	593	\$480.00	\$284,640.00
9	253109	02531	36" PVC	LF	3,399	\$590.00	\$2,005,410.00
10	253401	02534	Service Leads (Assume 6" Lead)	LF	0	\$120.00	\$0.00
11	208204	02082	Sanitary Sewer Manholes (4' diameter)	EA	4	\$4,200.00	\$16,800.00
12	208204	02082	Sanitary Sewer Manholes (5'-8' diameter)	EA	12	\$7,500.00	\$90,000.00
			Ancillary Items (20%)				\$554,706.00

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between Interstate 610 and Washington Avenue
ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

**BID FORM
PART B**

			SubTotal of Wastewater				\$3,328,236.00
			General Items (10% of Wastewater Subtotal)				\$332,823.60
TOTAL UNIT PRICES - WASTEWATER							\$3,661,059.60

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price <small>(this column controls)</small>	Total in Figures
UNIT PRICES - WATER							
1	252001	02520	Remove and Salvage Fire Hydrants	EA	42	\$400.00	\$16,894.67
2	222107	02221	Remove Existing Water Line (All Types)	LF	13,238	\$16.00	\$211,808.00
3	251601	02516	Cut, Plug, and Abandon Existing Water Line (All Types)	EA		\$910.00	\$0.00
4	251102	02511	8" Water Line	LF	6,271	\$100.00	\$627,100.00
5	251104	02511	12" Water Line	LF	6,400	\$140.00	\$896,000.00
6	252002	02520	Fire Hydrant Assembly	EA	42	\$5,400.00	\$228,078.00
7	251201	02512	¾-1" Long Side	EA	20	\$1,500.00	\$30,000.00
8	251202	02512	¾-1" Short Side	EA	38	\$830.00	\$31,540.00
9	251203	02512	1½-2" Long Side	EA	46	\$2,500.00	\$115,000.00
10	251204	02512	1½-2" Short Side	EA	38	\$1,800.00	\$68,400.00
		-	Ancillary items (20%)				\$444,964.13
			SubTotal				\$2,669,784.80
			General Items (10% of Water SubTotal)				\$266,978.48
TOTAL UNIT PRICES - WATER							\$2,936,763.28

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price <small>(this column controls)</small>	Total in Figures
UNIT PRICES - DETENTION							
1		-	Excavation (Detention Pond) (Dry)	AC-FT			
2		-	Excavation (Detention Pond) (Wet)	AC-FT			
3		-	Regional Detention	AC-FT		\$44,796.00	\$0.00
TOTAL UNIT PRICES - DETENTION							\$0.00

TOTAL BASE UNIT PRICE:

\$55,056,431.38

Note:

1. This is not a Standard Document 00410B (Form 410). The Form 410 was modified for the purpose of planning level cost estimates for Pre-Engineering Studies.
2. The "Item Reference No." shall be designated for each item listed. The numbers serve as reference and will be used for the future cost updates.

South Project

Sub-Project 1



MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between Interstate 10 and Washington Avenue (South Project Sub-Project 1)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

Document 00410B ^{Note 1}

BID FORM - PART B

1.0 TOTAL BID PRICE HAS BEEN CALCULATED BY BIDDER, USING THE FOLLOWING COMPONENT PRICES AND

A. STIPULATED PRICE

\$ N/A

(Total Bid Price; minus Base Unit Prices, Extra Unit Process, Cash Allowance and All Alternates, if any)

B. BASE UNIT PRICE TABLE:

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - PAVING ITEMS							
1	222101	02221	Remove and Dispose of Existing Pavement and Curb -Assumes all concrete pavement thicknesses with or without asphalt overlay	SY	18,650	\$6.00	\$111,900.00
2	222102	02221	Remove and Dispose of Existing Driveways and Sidewalks	SY	4,187	\$5.00	\$20,933.50
3	275106	02751	11" Reinforced Concrete Pavement (Complete in Place)	SY	18,590	\$70.00	\$1,301,300.00
4	233601	02336	Lime stabilized subgrade (6" thick)	SY	260	\$3.00	\$780.00
5	233602	02336	Lime stabilized subgrade (8" thick)	SY	20,440	\$4.00	\$81,760.00
6	233603	02336	Lime (6, 7% By Weight)	Ton	410	\$160.00	\$65,600.00
7	277101	02771	6" Concrete Curb	LF	8,460	\$4.00	\$33,840.00
8	275201	02752	Expansion Joint	LF	2,130	\$8.00	\$17,040.00
9	275401	02754	6" Concrete for Driveways	SF	23,200	\$8.00	\$185,600.00
10	277501	02775	4-1/2" Concrete for Sidewalks	SF	50,740	\$7.00	\$355,180.00
11	292201	02922	Sodding	SY	1,410	\$5.00	\$7,050.00
12	289301	02893	Traffic Signal/Intersection	EA	5	\$300,000.00	\$1,500,000.00
13	-	-	Railroad Crossing	EA	2	\$1,000,000.00	\$2,000,000.00
14	231501	02315	Roadway Excavation	CY	1,210	\$15.00	\$18,150.00
15	-	-	Pedestrian Bridge	LF	400	\$110.00	\$44,000.00
16	1601001	-	Street Light Removal	EA	47	\$272.00	\$12,784.00
17	1601002	-	Street Light Installation (includes conduit and Temporary Lighting during Construction)	LF	3,620	\$32.00	\$115,840.00
			Ancillary items (10%)				\$575,591.75
			SubTotal of Paving				\$6,447,349.25
			General Items (10% of Paving Subtotal)				\$644,734.93
TOTAL - PAVING ITEMS							\$7,092,084.18

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - STORM SEWER ITEMS							
1	222103	02221	Remove Storm Sewer Pipe (All Types)	LF	4,573	\$20.00	\$91,460.00
2	222105	02221	Remove Inlets (All Types)	EA	80	\$370.00	\$29,600.00
3	222106	02221	Remove Manholes (All Types, All Depths)	EA	22	\$390.00	\$8,580.00
4	263301	02633	Curb Inlets (All Types)	EA	70	\$2,910.00	\$203,700.00
5	208201	02082	Manholes (For 42" Dia. Pipe and Smaller) (All Types)	EA	14	\$3,470.00	\$48,580.00
6	208202	02082	Manholes (For 48" to 72" Dia. Pipe) (All Types)	EA	10	\$6,340.00	\$63,400.00

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between Interstate 10 and Washington Avenue (South Project Sub-Project 1)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
7	208203	02082	Manholes (For 78" Dia. Pipe and Larger) (All Types)	EA	0	\$16,500.00	\$0.00
8	263101	02631	24-inch RCP	LF	3,010	\$115.00	\$346,150.00
9	263102	02631	30-inch RCP	LF	880	\$150.00	\$132,000.00
10	263103	02631	36-inch RCP	LF	790	\$180.00	\$142,200.00
11	263104	02631	42-inch RCP	LF	230	\$215.00	\$49,450.00
12	263105	02631	48-inch RCP	LF	0	\$250.00	\$0.00
13	263106	02631	54-inch RCP	LF	0	\$270.00	\$0.00
14	263107	02631	60-inch RCP	LF	0	\$350.00	\$0.00
15	263108	02631	66-inch RCP	LF	0	\$360.00	\$0.00
16	263109	02631	72-inch RCP	LF	0	\$485.00	\$0.00
17	263113	02631	96-inch RCP	LF	0	\$730.00	\$0.00
18	263123	02631	4x2 RCB	LF	810	\$250.00	\$202,500.00
19	263126	02631	5x3 RCB	LF	750	\$300.00	\$225,000.00
20	263128	02631	5X5 RCB	LF	0	\$350.00	\$0.00
21	263129	02631	6x3 RCB	LF	0	\$350.00	\$0.00
22	263130	02631	6x4 RCB	LF	0	\$445.00	\$0.00
23	263132	02631	6X6 RCB	LF	0	\$480.00	\$0.00
24	263134	02631	7X5 RCB	LF	0	\$580.00	\$0.00
25	263137	02631	8x4 RCB	LF	0	\$580.00	\$0.00
26	263147	02631	10X5 RCB	LF	0	\$850.00	\$0.00
27	263152	02631	10X10 RCB	LF	0	\$1,300.00	\$0.00
28	263161	02631	12x10 RCB	LF	0	\$1,335.00	\$0.00
29	226001	02260	Trench Safety System	LF	6,470	\$2.00	\$12,940.00
30	231504	02315	Fill Existing Ditch	CY	0	\$6.00	\$0.00
			Ancillary items (10%)				\$77,778.00
			SubTotal of Storm Sewer				\$1,633,338.00
			General Items (10% of Storm Sewer Subtotal)				\$163,333.80
TOTAL UNIT PRICES - STORM SEWER ITEMS							\$1,796,671.80

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - WASTEWATER							
1	222108	02221	Remove Existing Sanitary Sewer Manhole (All Types)	EA		\$800.00	\$0.00
2	222201	02221	Abandon and Fill Existing Sanitary Sewer Manhole (All Types)	EA		\$1,000.00	\$0.00
3	222109	02221	Remove Existing Sanitary Sewer Pipe (All Types)	LF		\$20.00	\$0.00
4	222202	02222	Abandon and Fill Existing Sanitary Sewer Pipe (All Sizes)	LF		\$20.00	\$0.00
5	222205	02222	Abandon Existing Sanitary Sewer Lift Station	EA		\$100,000.00	\$0.00
6	253103	02531	10" PVC	LF		\$160.00	\$0.00
7	253105	02531	15" PVC	LF		\$230.00	\$0.00
8	253108	02531	30" PVC	LF		\$480.00	\$0.00
9	253109	02531	36" PVC	LF		\$590.00	\$0.00
10	253401	02534	Service Leads (Assume 6" Lead)	LF		\$120.00	\$0.00
11	208204	02082	Sanitary Sewer Manholes (4' diameter)	EA		\$4,200.00	\$0.00
12	208204	02082	Sanitary Sewer Manholes (5'-8' diameter)	EA		\$7,500.00	\$0.00
			Ancillary Items (20%)				\$0.00

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between Interstate 10 and Washington Avenue (South Project Sub-Project 1)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

			SubTotal of Wastewater				\$0.00
			General Items (10% of Wastewater Subtotal)				\$0.00
TOTAL UNIT PRICES - WASTEWATER							\$0.00

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - WATER							
1	252001	02520	Remove and Salvage Fire Hydrants	EA		\$400.00	\$0.00
2	222107	02221	Remove Existing Water Line (All Types)	LF		\$16.00	\$0.00
3	251601	02516	Cut, Plug, and Abandon Existing Water Line (All Types)	EA		\$910.00	\$0.00
4	251102	02511	8" Water Line	LF		\$100.00	\$0.00
5	251104	02511	12" Water Line	LF		\$140.00	\$0.00
6	252002	02520	Fire Hydrant Assembly	EA		\$5,400.00	\$0.00
7	251201	02512	¾-1" Long Side	EA		\$1,500.00	\$0.00
8	251202	02512	¾-1" Short Side	EA		\$830.00	\$0.00
9	251203	02512	1½-2" Long Side	EA		\$2,500.00	\$0.00
10	251204	02512	1½-2" Short Side	EA		\$1,800.00	\$0.00
		-	Ancillary items (20%)				\$0.00
			SubTotal				\$0.00
		-	General Items (10% of Water SubTotal)				\$0.00
TOTAL UNIT PRICES - WATER							\$0.00

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - DETENTION							
1		-	Excavation (Detention Pond) (Dry)	AC-FT			
2		-	Excavation (Detention Pond) (Wet)	AC-FT			
3		-	Regional Detention	AC-FT		\$44,796.00	\$0.00
TOTAL UNIT PRICES - DETENTION							\$0.00

TOTAL BASE UNIT PRICE:

\$8,888,755.98

Note:

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South Project

Sub-Project 2



MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between West 11th and Interstate 10 (South Project Sub-Project 2)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

Document 00410B ^{Note 1}

BID FORM - PART B

1.0 TOTAL BID PRICE HAS BEEN CALCULATED BY BIDDER, USING THE FOLLOWING COMPONENT PRICES AND

A. STIPULATED PRICE

\$ N/A

(Total Bid Price; minus Base Unit Prices, Extra Unit Process, Cash Allowance and All Alternates, if any)

B. BASE UNIT PRICE TABLE:

Item No.	Item Reference No. ^{Note 2}	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - PAVING ITEMS							
1	222101	02221	Remove and Dispose of Existing Pavement and Curb -Assumes all concrete pavement thicknesses with or without asphalt overlay	SY	31,660	\$6.00	\$189,960.00
2	222102	02221	Remove and Dispose of Existing Driveways and Sidewalks	SY	4,774	\$5.00	\$23,869.00
3	275106	02751	11" Reinforced Concrete Pavement (Complete in Place)	SY	31,390	\$70.00	\$2,197,300.00
4	233601	02336	Lime stabilized subgrade (6" thick)	SY	230	\$3.00	\$690.00
5	233602	02336	Lime stabilized subgrade (8" thick)	SY	34,530	\$4.00	\$138,120.00
6	233603	02336	Lime (6, 7% By Weight)	Ton	690	\$164.00	\$113,160.00
7	277101	02771	6" Concrete Curb	LF	13,310	\$4.00	\$53,240.00
8	275201	02752	Expansion Joint	LF	3,570	\$8.00	\$28,560.00
9	275401	02754	6" Concrete for Driveways	SF	21,040	\$8.00	\$168,320.00
10	277501	02775	4-1/2" Concrete for Sidewalks	SF	79,840	\$7.00	\$558,880.00
11	292201	02922	Sodding	SY	2,220	\$5.00	\$11,100.00
12	289301	02893	Traffic Signal/Intersection	EA	2	\$325,000.00	\$650,000.00
13	-	-	Railroad Crossing	EA	0	\$1,000,000.00	\$0.00
14	231501	02315	Roadway Excavation	CY	2,050	\$16.00	\$32,800.00
15	-	-	Pedestrian Bridge	LF	0	\$110.00	\$0.00
16	1601001	-	Street Light Removal	EA	20	\$272.00	\$5,440.00
17	1601002	-	Street Light Installation (includes conduit and Temporary Lighting during Construction)	LF	5,481	\$32.00	\$175,392.00
			Ancillary items (10%)				\$417,143.90
			SubTotal of Paving				\$4,763,974.90
			General Items (10% of Paving Subtotal)				\$476,397.49
TOTAL - PAVING ITEMS							\$5,240,372.39

Item No.	Item Reference No. ^{Note 2}	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - STORM SEWER ITEMS							
1	222103	02221	Remove Storm Sewer Pipe (All Types)	LF	5,910	\$20.00	\$118,200.00
2	222105	02221	Remove Inlets (All Types)	EA	60	\$370.00	\$22,200.00
3	222106	02221	Remove Manholes (All Types, All Depths)	EA	21	\$390.00	\$8,190.00
4	263301	02633	Curb Inlets (All Types)	EA	40	\$2,910.00	\$116,400.00
5	208201	02082	Manholes (For 42" Dia. Pipe and Smaller) (All Types)	EA	10	\$3,470.00	\$34,700.00

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between West 11th and Interstate 10 (South Project Sub-Project 2)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price <small>(this column controls)</small>	Total in Figures
6	208202	02082	Manholes (For 48" to 72" Dia. Pipe) (All Types)	EA	10	\$6,340.00	\$63,400.00
7	208203	02082	Manholes (For 78" Dia. Pipe and Larger) (All Types)	EA	10	\$16,500.00	\$165,000.00
8	263101	02631	24-inch RCP	LF	2,300	\$115.00	\$264,500.00
9	263102	02631	30-inch RCP	LF	500	\$150.00	\$75,000.00
10	263103	02631	36-inch RCP	LF	140	\$180.00	\$25,200.00
11	263104	02631	42-inch RCP	LF	600	\$215.00	\$129,000.00
12	263105	02631	48-inch RCP	LF	50	\$250.00	\$12,500.00
13	263106	02631	54-inch RCP	LF	0	\$270.00	\$0.00
14	263107	02631	60-inch RCP	LF	0	\$350.00	\$0.00
15	263108	02631	66-inch RCP	LF	0	\$360.00	\$0.00
16	263109	02631	72-inch RCP	LF	130	\$485.00	\$63,050.00
17	263113	02631	96-inch RCP	LF	0	\$730.00	\$0.00
18	263123	02631	4x2 RCB	LF	1,690	\$250.00	\$422,500.00
19	263126	02631	5x3 RCB	LF	0	\$300.00	\$0.00
20	263128	02631	5X5 RCB	LF	0	\$350.00	\$0.00
21	263129	02631	6x3 RCB	LF	0	\$350.00	\$0.00
22	263130	02631	6x4 RCB	LF	0	\$445.00	\$0.00
23	263132	02631	6X6 RCB	LF	0	\$480.00	\$0.00
24	263134	02631	7X5 RCB	LF	500	\$580.00	\$290,000.00
25	263137	02631	8x4 RCB	LF	0	\$580.00	\$0.00
26	263147	02631	10X5 RCB	LF	1,270	\$850.00	\$1,079,500.00
27	263152	02631	10X10 RCB	LF	0	\$1,300.00	\$0.00
28	263161	02631	12x10 RCB	LF	0	\$1,335.00	\$0.00
29	226001	02260	Trench Safety System	LF	7,190	\$2.00	\$14,380.00
30	231504	02315	Fill Existing Ditch	CY	0	\$6.00	\$0.00
			Ancillary items (10%)				\$145,186.00
			SubTotal of Storm Sewer				\$3,048,906.00
			General Items (10% of Storm Sewer Subtotal)				\$304,890.60
TOTAL UNIT PRICES - STORM SEWER ITEMS							\$3,353,796.60

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price <small>(this column controls)</small>	Total in Figures
UNIT PRICES - WASTEWATER							
1	222108	02221	Remove Existing Sanitary Sewer Manhole (All Types)	EA	0	\$800.00	\$0.00
2	222201	02221	Abandon and Fill Existing Sanitary Sewer Manhole (All Types)	EA	4	\$1,000.00	\$4,000.00
3	222109	02221	Remove Existing Sanitary Sewer Pipe (All Types)	LF	0	\$20.00	\$0.00
4	222202	02222	Abandon and Fill Existing Sanitary Sewer Pipe (All Sizes)	LF	1,039	\$20.00	\$20,780.00
5	-	02222	Abandon Existing Sanitary Sewer Lift Station	EA	2	\$100,000.00	\$200,000.00
6	253103	02531	10" PVC	LF	383	\$160.00	\$61,280.00
7	253105	02531	15" PVC	LF	394	\$230.00	\$90,620.00
8	253108	02531	30" PVC	LF	593	\$480.00	\$284,640.00
9	253109	02531	36" PVC	LF	2,649	\$590.00	\$1,562,910.00
10	253401	02534	Service Leads (Assume 6" Lead)	LF	0	\$120.00	\$0.00
11	208204	02082	Sanitary Sewer Manholes (4' diameter)	EA	4	\$4,200.00	\$16,800.00

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between West 11th and Interstate 10 (South Project Sub-Project 2)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

12	208204	02082	Sanitary Sewer Manholes (5'-8' diameter)	EA	11	\$7,500.00	\$82,500.00
			Ancillary Items (20%)				\$464,706.00
			SubTotal of Wastewater				\$2,788,236.00
			General Items (10% of Wastewater Subtotal)				\$278,823.60
TOTAL UNIT PRICES - WASTEWATER							\$3,067,059.60

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price <small>(this column controls)</small>	Total in Figures
UNIT PRICES - WATER							
1	252001	02520	Remove and Salvage Fire Hydrants	EA	9	\$400.00	\$3,600.00
2	222107	02221	Remove Existing Water Line (All Types)	LF	2,700	\$16.00	\$43,200.00
3	251601	02516	Cut, Plug, and Abandon Existing Water Line (All Types)	EA		\$910.00	\$0.00
4	251102	02511	8" Water Line	LF		\$100.00	\$0.00
5	251104	02511	12" Water Line	LF	2,700	\$140.00	\$378,000.00
6	252002	02520	Fire Hydrant Assembly	EA	9	\$5,400.00	\$48,600.00
7	251201	02512	¾-1" Long Side	EA		\$1,500.00	\$0.00
8	251202	02512	¾-1" Short Side	EA	1	\$830.00	\$830.00
9	251203	02512	1½-2" Long Side	EA	3	\$2,500.00	\$7,500.00
10	251204	02512	1½-2" Short Side	EA	9	\$1,800.00	\$16,200.00
			Ancillary items (20%)				\$99,586.00
			SubTotal				\$597,516.00
			General Items (10% of Water SubTotal)				\$59,751.60
TOTAL UNIT PRICES - WATER							\$657,267.60

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price <small>(this column controls)</small>	Total in Figures
UNIT PRICES - DETENTION							
1		-	Excavation (Detention Pond) (Dry)	AC-FT			
2		-	Excavation (Detention Pond) (Wet)	AC-FT			
3		-	Regional Detention	AC-FT		\$44,796.00	\$0.00
TOTAL UNIT PRICES - DETENTION							\$0.00

TOTAL BASE UNIT PRICE:

\$12,318,496.19

Note:

1. This is not a Standard Document 00410B (Form 410). The Form 410 was modified for the purpose of planning level cost estimates for Pre-Engineering Studies.
2. The "Item Reference No." shall be designated for each item listed. The numbers serve as reference and will be used for the future cost updates.

North Project

Sub-Project 1



MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between West 18th Street and West 11th Street (North Project Sub-Project 1)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

Document 00410B ^{Note 1}

BID FORM - PART B

1.0 TOTAL BID PRICE HAS BEEN CALCULATED BY BIDDER, USING THE FOLLOWING COMPONENT PRICES AND

A. STIPULATED PRICE

\$ N/A

(Total Bid Price; minus Base Unit Prices, Extra Unit Process, Cash Allowance and All Alternates, if any)

B. BASE UNIT PRICE TABLE:

Item No.	Item Reference No. ^{Note 2}	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - PAVING ITEMS							
1	222101	02221	Remove and Dispose of Existing Pavement and Curb -Assumes all concrete pavement thicknesses with or without asphalt overlay	SY	46,730	\$6.00	\$280,380.00
2	222102	02221	Remove and Dispose of Existing Driveways and Sidewalks	SY	6,218	\$5.00	\$31,089.00
3	275106	02751	11" Reinforced Concrete Pavement (Complete in Place)	SY	45,780	\$70.00	\$3,204,600.00
4	233601	02336	Lime stabilized subgrade (6" thick)	SY	240	\$3.00	\$720.00
5	233602	02336	Lime stabilized subgrade (8" thick)	SY	50,350	\$4.00	\$201,400.00
6	233603	02336	Lime (6, 7% By Weight)	Ton	1,010	\$164.00	\$165,640.00
7	277101	02771	6" Concrete Curb	LF	21,780	\$4.00	\$87,120.00
8	275201	02752	Expansion Joint	LF	5,150	\$8.00	\$41,200.00
9	275401	02754	6" Concrete for Driveways	SF	21,600	\$8.00	\$172,800.00
10	277501	02775	4-1/2" Concrete for Sidewalks	SF	130,680	\$7.00	\$914,760.00
11	292201	02922	Sodding	SY	3,630	\$5.00	\$18,150.00
12	289301	02893	Traffic Signal/Intersection	EA	2	\$325,000.00	\$650,000.00
13	-	-	Railroad Crossing	EA	0	\$1,000,000.00	\$0.00
14	231501	02315	Roadway Excavation	CY	2,980	\$16.00	\$47,680.00
15	-	-	Pedestrian Bridge	LF	0	\$110.00	\$0.00
16	1601001	-	Street Light Removal	EA	85	\$272.00	\$23,120.00
17	1601002	-	Street Light Installation (includes conduit and Temporary Lighting during Construction)	LF	8,590	\$32.00	\$274,880.00
			Ancillary items (10%)				\$583,865.90
			SubTotal of Paving				\$6,697,404.90
			General Items (10% of Paving Subtotal)				\$669,740.49
TOTAL - PAVING ITEMS							\$7,367,145.39
Item No.	Item Reference No. ^{Note 2}	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - STORM SEWER ITEMS							
1	222103	02221	Remove Storm Sewer Pipe (All Types)	LF	5,580	\$20.00	\$111,600.00
2	222105	02221	Remove Inlets (All Types)	EA	73	\$370.00	\$27,010.00
3	222106	02221	Remove Manholes (All Types, All Depths)	EA	19	\$390.00	\$7,410.00
4	263301	02633	Curb Inlets (All Types)	EA	73	\$2,910.00	\$212,430.00
5	208201	02082	Manholes (For 42" Dia. Pipe and Smaller) (All Types)	EA	2	\$3,470.00	\$6,940.00
6	208202	02082	Manholes (For 48" to 72" Dia. Pipe) (All Types)	EA	5	\$6,340.00	\$31,700.00

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between West 18th Street and West 11th Street (North Project Sub-Project 1) **BID FORM**

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention **PART B**

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
7	208203	02082	Manholes (For 78" Dia. Pipe and Larger) (All Types)	EA	20	\$16,500.00	\$330,000.00
8	263101	02631	24-inch RCP	LF	2,150	\$115.00	\$247,250.00
9	263102	02631	30-inch RCP	LF	0	\$150.00	\$0.00
10	263103	02631	36-inch RCP	LF	0	\$180.00	\$0.00
11	263104	02631	42-inch RCP	LF	1	\$215.00	\$186.12
12	263105	02631	48-inch RCP	LF	850	\$250.00	\$212,500.00
13	263106	02631	54-inch RCP	LF	260	\$270.00	\$70,200.00
14	263107	02631	60-inch RCP	LF	247	\$350.00	\$86,450.00
15	263108	02631	66-inch RCP	LF	269	\$360.00	\$96,840.00
16	263109	02631	72-inch RCP	LF	0	\$485.00	\$0.00
17	263113	02631	96-inch RCP	LF	790	\$730.00	\$576,699.41
18	263123	02631	4x2 RCB	LF	0	\$250.00	\$0.00
19	263126	02631	5x3 RCB	LF	0	\$300.00	\$0.00
20	263128	02631	5X5 RCB	LF	1,410	\$350.00	\$493,500.00
21	263129	02631	6x3 RCB	LF	0	\$350.00	\$0.00
22	263130	02631	6x4 RCB	LF	0	\$445.00	\$0.00
23	263132	02631	6X6 RCB	LF	370	\$480.00	\$177,600.00
24	263134	02631	7X5 RCB	LF	0	\$580.00	\$0.00
25	263137	02631	8x4 RCB	LF	0	\$580.00	\$0.00
26	263147	02631	10X5 RCB	LF	0	\$850.00	\$0.00
27	263152	02631	10X10 RCB	LF	0	\$1,300.00	\$0.00
28	263161	02631	12x10 RCB	LF	840	\$1,335.00	\$1,121,400.00
29	226001	02260	Trench Safety System	LF	7,170	\$2.00	\$14,340.00
30	231504	02315	Fill Existing Ditch	CY	100	\$6.00	\$600.00
			Ancillary items (10%)				\$191,232.78
			SubTotal of Storm Sewer				\$4,015,888.31
			General Items (10% of Storm Sewer Subtotal)				\$401,588.83
TOTAL UNIT PRICES - STORM SEWER ITEMS							\$4,417,477.13

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - WASTEWATER							
1	222108	02221	Remove Existing Sanitary Sewer Manhole (All Types)	EA		\$800.00	\$0.00
2	222201	02221	Abandon and Fill Existing Sanitary Sewer Manhole (All Types)	EA		\$1,000.00	\$0.00
3	222109	02221	Remove Existing Sanitary Sewer Pipe (All Types)	LF		\$20.00	\$0.00
4	222202	02222	Abandon and Fill Existing Sanitary Sewer Pipe (All Sizes)	LF		\$20.00	\$0.00
5	222205	02222	Abandon Existing Sanitary Sewer Lift Station	EA		\$100,000.00	\$0.00
6	253103	02531	10" PVC	LF		\$160.00	\$0.00
7	253105	02531	15" PVC	LF		\$230.00	\$0.00
8	253108	02531	30" PVC	LF		\$480.00	\$0.00
9	253109	02531	36" PVC	LF	750	\$590.00	\$442,500.00
10	253401	02534	Service Leads (Assume 6" Lead)	LF		\$120.00	\$0.00
11	208204	02082	Sanitary Sewer Manholes (4' diameter)	EA		\$4,200.00	\$0.00
12	208204	02082	Sanitary Sewer Manholes (5'-8' diameter)	EA	1	\$7,500.00	\$7,500.00
			Ancillary Items (20%)				\$90,000.00

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between West 18th Street and West 11th Street (North Project Sub-Project 1)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

			SubTotal of Wastewater				\$540,000.00
			General Items (10% of Wastewater Subtotal)				\$54,000.00
TOTAL UNIT PRICES - WASTEWATER							\$594,000.00

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price <small>(this column controls)</small>	Total in Figures
UNIT PRICES - WATER							
1	252001	02520	Remove and Salvage Fire Hydrants	EA	4	\$400.00	\$1,481.33
2	222107	02221	Remove Existing Water Line (All Types)	LF	1,111	\$16.00	\$17,776.00
3	251601	02516	Cut, Plug, and Abandon Existing Water Line (All Types)	EA		\$910.00	\$0.00
4	251102	02511	8" Water Line	LF	1,111	\$100.00	\$111,100.00
5	251104	02511	12" Water Line	LF		\$140.00	\$0.00
6	252002	02520	Fire Hydrant Assembly	EA	4	\$5,400.00	\$19,998.00
7	251201	02512	¾-1" Long Side	EA	4	\$1,500.00	\$6,000.00
8	251202	02512	¾-1" Short Side	EA	6	\$830.00	\$4,980.00
9	251203	02512	1½-2" Long Side	EA	2	\$2,500.00	\$5,000.00
10	251204	02512	1½-2" Short Side	EA	2	\$1,800.00	\$3,600.00
		-	Ancillary items (20%)				\$33,987.07
			SubTotal				\$203,922.40
		-	General Items (10% of Water SubTotal)				\$20,392.24
TOTAL UNIT PRICES - WATER							\$224,314.64

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price <small>(this column controls)</small>	Total in Figures
UNIT PRICES - DETENTION							
1		-	Excavation (Detention Pond) (Dry)	AC-FT			
2		-	Excavation (Detention Pond) (Wet)	AC-FT			
3		-	Regional Detention	AC-FT		\$44,796.00	\$0.00
TOTAL UNIT PRICES - DETENTION							\$0.00

TOTAL BASE UNIT PRICE:

\$12,602,937.16

Note:

1. This is not a Standard Document 00410B (Form 410). The Form 410 was modified for the purpose of planning level cost estimates for Pre-Engineering Studies.
2. The "Item Reference No." shall be designated for each item listed. The numbers serve as reference and will be used for the future cost updates.

North Project

Sub-Project 2



MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between Interstate 610 and West 18th Street (North Project Sub-Project 2)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

Document 00410B Note 1

BID FORM - PART B

1.0 TOTAL BID PRICE HAS BEEN CALCULATED BY BIDDER, USING THE FOLLOWING COMPONENT PRICES AND

A. STIPULATED PRICE

\$ N/A

(Total Bid Price; minus Base Unit Prices, Extra Unit Process, Cash Allowance and All Alternates, if any)

B. BASE UNIT PRICE TABLE:

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price <small>(this column controls)</small>	Total in Figures
UNIT PRICES - PAVING ITEMS							
1	222101	02221	Remove and Dispose of Existing Pavement and Curb -Assumes all concrete pavement thicknesses with or without asphalt overlay	SY	59,640	\$6.00	\$357,840.00
2	222102	02221	Remove and Dispose of Existing Driveways and Sidewalks	SY	7,909	\$5.00	\$39,544.50
3	275106	02751	11" Reinforced Concrete Pavement (Complete in Place)	SY	58,390	\$70.00	\$4,087,300.00
4	233601	02336	Lime stabilized subgrade (6" thick)	SY	7,310	\$3.00	\$21,930.00
5	233602	02336	Lime stabilized subgrade (8" thick)	SY	64,220	\$4.00	\$256,880.00
6	233603	02336	Lime (6, 7% By Weight)	Ton	1,390	\$164.00	\$227,960.00
7	277101	02771	6" Concrete Curb	LF	25,710	\$4.00	\$102,840.00
8	275201	02752	Expansion Joint	LF	6,570	\$8.00	\$52,560.00
9	275401	02754	6" Concrete for Driveways	SF	26,080	\$8.00	\$208,640.00
10	277501	02775	4-1/2" Concrete for Sidewalks	SF	154,260	\$7.00	\$1,079,820.00
11	292201	02922	Sodding	SY	3,760	\$5.00	\$18,800.00
12	289301	02893	Traffic Signal/Intersection	EA	6	\$325,000.00	\$1,950,000.00
13	-	-	Railroad Crossing	EA	0	\$1,000,000.00	\$0.00
14	231501	02315	Roadway Excavation	CY	3,810	\$16.00	\$60,960.00
15	-	-	Pedestrian Bridge	LF	0	\$110.00	\$0.00
16	1601001	-	Street Light Removal	EA	85	\$272.00	\$23,120.00
17	1601002	-	Street Light Installation (includes conduit and Temporary Lighting during Construction)	LF	11,275	\$32.00	\$360,800.00
			Ancillary items (10%)				\$848,819.45
			SubTotal of Paving				\$9,697,813.95
			General Items (10% of Paving Subtotal)				\$969,781.40
TOTAL - PAVING ITEMS							\$10,667,595.35

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price <small>(this column controls)</small>	Total in Figures
UNIT PRICES - STORM SEWER ITEMS							
1	222103	02221	Remove Storm Sewer Pipe (All Types)	LF	5,640	\$20.00	\$112,800.00
2	222105	02221	Remove Inlets (All Types)	EA	90	\$370.00	\$33,300.00
3	222106	02221	Remove Manholes (All Types, All Depths)	EA	16	\$390.00	\$6,240.00
4	263301	02633	Curb Inlets (All Types)	EA	60	\$2,910.00	\$174,600.00
5	208201	02082	Manholes (For 42" Dia. Pipe and Smaller) (All Types)	EA	10	\$3,470.00	\$34,700.00

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between Interstate 610 and West 18th Street (North Project Sub-Project 2)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
6	208202	02082	Manholes (For 48" to 72" Dia. Pipe) (All Types)	EA	1	\$6,340.00	\$6,340.00
7	208203	02082	Manholes (For 78" Dia. Pipe and Larger) (All Types)	EA	10	\$16,500.00	\$165,000.00
8	263101	02631	24-inch RCP	LF	3,151	\$115.00	\$362,365.00
9	263102	02631	30-inch RCP	LF	370	\$150.00	\$55,500.00
10	263103	02631	36-inch RCP	LF	370	\$180.00	\$66,600.00
11	263104	02631	42-inch RCP	LF	2,221	\$215.00	\$477,486.12
12	263105	02631	48-inch RCP	LF	0	\$250.00	\$0.00
13	263106	02631	54-inch RCP	LF	0	\$270.00	\$0.00
14	263107	02631	60-inch RCP	LF	694	\$350.00	\$242,900.00
15	263108	02631	66-inch RCP	LF	0	\$360.00	\$0.00
16	263109	02631	72-inch RCP	LF	0	\$485.00	\$0.00
17	263113	02631	96-inch RCP	LF	0	\$730.00	\$0.00
18	263123	02631	4x2 RCB	LF	0	\$250.00	\$0.00
19	263126	02631	5x3 RCB	LF	0	\$300.00	\$0.00
20	263128	02631	5X5 RCB	LF	0	\$350.00	\$0.00
21	263129	02631	6x3 RCB	LF	370	\$350.00	\$129,500.00
22	263130	02631	6x4 RCB	LF	3,160	\$445.00	\$1,406,200.00
23	263132	02631	6X6 RCB	LF	0	\$480.00	\$0.00
24	263134	02631	7X5 RCB	LF	0	\$580.00	\$0.00
25	263137	02631	8x4 RCB	LF	370	\$580.00	\$214,600.00
26	263147	02631	10X5 RCB	LF	0	\$850.00	\$0.00
27	263152	02631	10X10 RCB	LF	2,960	\$1,300.00	\$3,848,000.00
28	263161	02631	12x10 RCB	LF	0	\$1,335.00	\$0.00
29	226001	02260	Trench Safety System	LF	13,670	\$2.00	\$27,340.00
30	231504	02315	Fill Existing Ditch	CY	0	\$6.00	\$0.00
			Ancillary items (10%)				\$368,173.56
			SubTotal of Storm Sewer				\$7,731,644.68
			General Items (10% of Storm Sewer Subtotal)				\$773,164.47
TOTAL UNIT PRICES - STORM SEWER ITEMS							\$8,504,809.13

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - WASTEWATER							
1	222108	02221	Remove Existing Sanitary Sewer Manhole (All Types)	EA		\$800.00	\$0.00
2	222201	02221	Abandon and Fill Existing Sanitary Sewer Manhole (All Types)	EA		\$1,000.00	\$0.00
3	222109	02221	Remove Existing Sanitary Sewer Pipe (All Types)	LF		\$20.00	\$0.00
4	222202	02222	Abandon and Fill Existing Sanitary Sewer Pipe (All Sizes)	LF		\$20.00	\$0.00
5	222205	02222	Abandon Existing Sanitary Sewer Lift Station	EA		\$100,000.00	\$0.00
6	253103	02531	10" PVC	LF		\$160.00	\$0.00
7	253105	02531	15" PVC	LF		\$230.00	\$0.00
8	253108	02531	30" PVC	LF		\$480.00	\$0.00
9	253109	02531	36" PVC	LF		\$590.00	\$0.00
10	253401	02534	Service Leads (Assume 6" Lead)	LF		\$120.00	\$0.00
11	208204	02082	Sanitary Sewer Manholes (4' diameter)	EA		\$4,200.00	\$0.00

MODIFIED SAMPLE 410

NEED AREA: N-2016T-0004: Shepherd and Durham between Interstate 610 and West 18th Street (North Project Sub-Project 2)

BID FORM

ALTERNATIVE: 2 - 3-lane with Bicycle Lane, Inline Detention

PART B

12	208204	02082	Sanitary Sewer Manholes (5'-8' diameter)	EA		\$7,500.00	\$0.00
			Ancillary Items (20%)				\$0.00
			SubTotal of Wastewater				\$0.00
			General Items (10% of Wastewater Subtotal)				\$0.00
TOTAL UNIT PRICES - WASTEWATER							\$0.00

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - WATER							
1	252001	02520	Remove and Salvage Fire Hydrants	EA	30	\$400.00	\$11,813.33
2	222107	02221	Remove Existing Water Line (All Types)	LF	8,860	\$16.00	\$141,760.00
3	251601	02516	Cut, Plug, and Abandon Existing Water Line (All Types)	EA		\$910.00	\$0.00
4	251102	02511	8" Water Line	LF	5,160	\$100.00	\$516,000.00
5	251104	02511	12" Water Line	LF	3,700	\$140.00	\$518,000.00
6	252002	02520	Fire Hydrant Assembly	EA	30	\$5,400.00	\$159,480.00
7	251201	02512	¾-1" Long Side	EA	16	\$1,500.00	\$24,000.00
8	251202	02512	¾-1" Short Side	EA	31	\$830.00	\$25,730.00
9	251203	02512	1½-2" Long Side	EA	41	\$2,500.00	\$102,500.00
10	251204	02512	1½-2" Short Side	EA	27	\$1,800.00	\$48,600.00
		-	Ancillary items (20%)				\$309,576.67
			SubTotal				\$1,857,460.00
		-	General Items (10% of Water SubTotal)				\$185,746.00
TOTAL UNIT PRICES - WATER							\$2,043,206.00

Item No.	Item Reference No. <small>Note 2</small>	Spec No.	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
UNIT PRICES - DETENTION							
1		-	Excavation (Detention Pond) (Dry)	AC-FT			
2		-	Excavation (Detention Pond) (Wet)	AC-FT			
3		-	Regional Detention	AC-FT		\$44,796.00	\$0.00
TOTAL UNIT PRICES - DETENTION							\$0.00

TOTAL BASE UNIT PRICE:

\$21,215,610.48

Note:

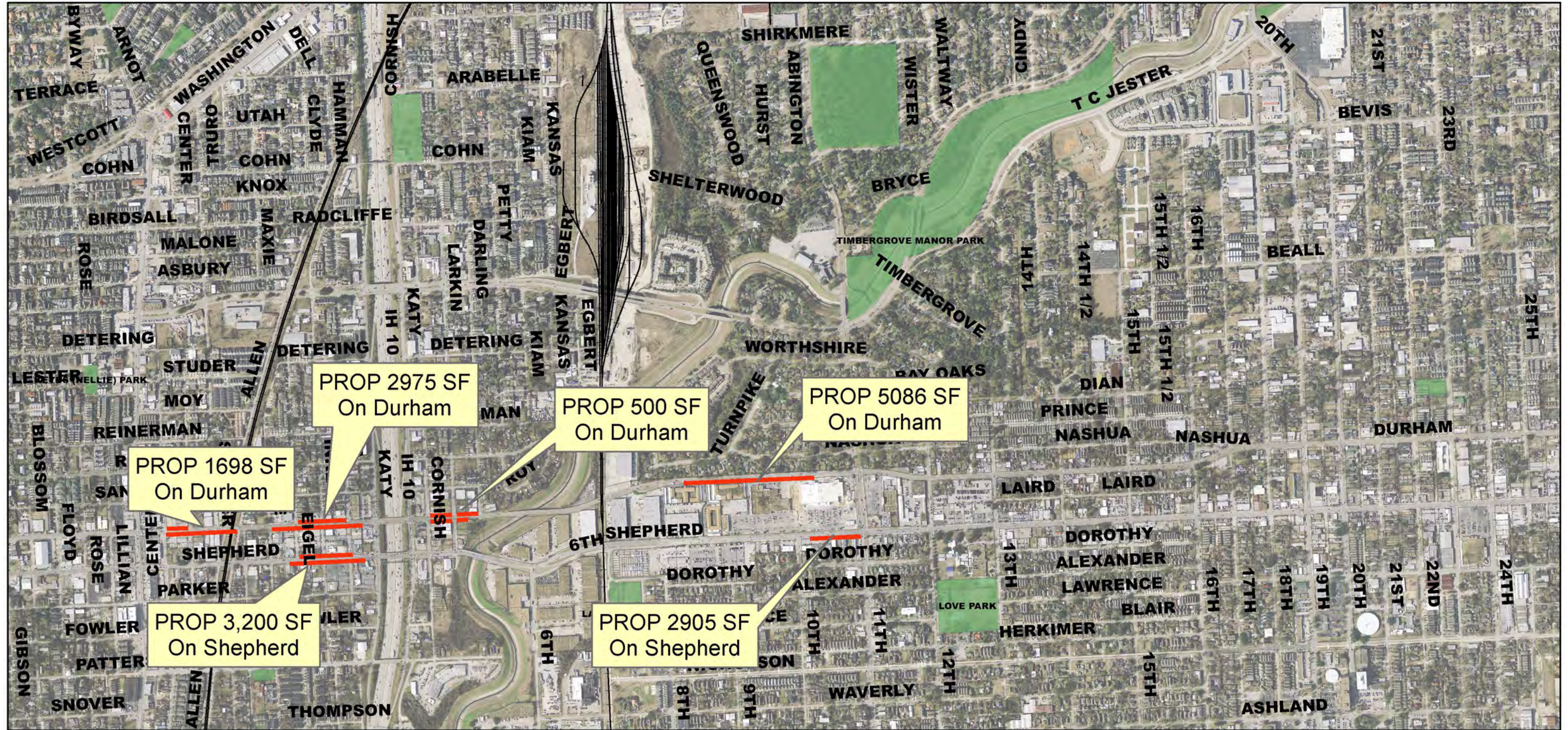
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2. The "Item Reference No." shall be designated for each item listed. The numbers serve as reference and will be used for the future cost updates.

Appendix I

Land Acquisition Costs



Shepherd Drive and Durham Drive Pre-Engineering for Street and Paving Improvements (Interstate 610 to Washington Avenue)



**SHEPHERD DRIVE AND DURHAM DRIVE
(N-2016T-0004)**
LAND ACQUISITION MAP



Legend

- ROW
- Railroad
- Parcel
- Park

1 inch = 1,000 feet

Shepherd Drive

HCAD #	Owner Name	Use	Area	\$/sf	Total Land Cost	Improvements	Total Cost
0391280000048	DAVALOS SEVANDO	Commercial	200	\$ 120.00	\$ 24,000.00		\$ 24,000.00
0391280000030	CROWLEY JOHN D & FELICIA D	Commercial	150	\$ 120.00	\$ 18,000.00		\$ 18,000.00
0391280000032	CROWLEY JOHN D & FELICIA D	Commercial	100	\$ 120.00	\$ 12,000.00		\$ 12,000.00
0391280000034	DRAUGHON HAROLD E	Commercial	100	\$ 120.00	\$ 12,000.00		\$ 12,000.00
0391280000036	DRAUGHON HAROLD E	Commercial	100	\$ 120.00	\$ 12,000.00		\$ 12,000.00
1322440010001	SKIPPER BEVERAGE COMPANY LLC	Commercial	217	\$ 120.00	\$ 26,032.80		\$ 26,032.80
0391320010001	LAACO LTD	Commercial	990	\$ 120.00	\$ 118,828.80		\$ 118,828.80
0200770000049	DRAPELA ENTERPRISES INC	Commercial	592	\$ 120.00	\$ 71,040.00		\$ 71,040.00
0200770000001	POLK GEORGE J JR	Commercial	456	\$ 114.00	\$ 51,984.00		\$ 51,984.00
0073140000020	AA & SA ENTERPRISES	Commercial/ Vacant	500	\$ 48.00	\$ 24,000.00		\$ 24,000.00
0073140000001	2101 SHEPHERD LLC	Commercial	500	\$ 75.00	\$ 37,500.00		\$ 37,500.00
0072930000011	SETTEGAST CARLITA	Commercial	500	\$ 135.00	\$ 67,500.00		\$ 67,500.00
0072930000001	MARINA ACQUISITION CORP OF FLORIDA	Commercial	500	\$ 135.00	\$ 67,500.00		\$ 67,500.00
0072860000011	DAVIS JOHN PINKNEY, c/o ELOIS E DAVIS	Commercial	500	\$ 135.00	\$ 67,500.00		\$ 67,500.00
0072860000001	DAVIS ELOIS E	Commercial	500	\$ 135.00	\$ 67,500.00		\$ 67,500.00
0072790000010	BGM LLC	Commercial	100	\$ 135.00	\$ 13,500.00		\$ 13,500.00
0072790000014	BGM LLC	Commercial/ Vacant	100	\$ 135.00	\$ 13,500.00		\$ 13,500.00
	Corner Clips		2,200	\$ 118.06	\$ 259,729.41		\$ 259,729.41
				\$ -	\$ -		\$ -
				\$ -	\$ -		\$ -
				\$ -	\$ -		\$ -
				\$ -	\$ -		\$ -
			8,305			Total Cost	\$964,115.01

Durham Drive

HCAD #	Owner Name	Use	Area	\$/sf	Total Land Cost	Improvements	Total Cost
0073200000008	YUPPIE DOG LLC	Commercial	200	\$ 68.25	\$ 13,650.00		\$ 13,650.00
0072790000013	LESTER FAMILY INTERESTS LLC	Commercial	100	\$ 135.00	\$ 13,500.00		\$ 13,500.00
0072790000001	AAR FLO LTD	Single Family	100	\$ 135.00	\$ 13,500.00		\$ 13,500.00
0072930000012	FRANK JAY TAFT & LYNDA W	Commercial	250	\$ 135.00	\$ 33,750.00		\$ 33,750.00
0072930000017	TAFT FRANK J, WHITLEY LYNDA	Commercial	250	\$ 135.00	\$ 33,750.00		\$ 33,750.00
1339160010001	SUMMITE REAL ESTATE VENTURES LP	Commercial	798	\$ 135.00	\$ 107,784.00		\$ 107,784.00
1249200010001	R & D BUSINESS GROUP LLC	Commercial	250	\$ 135.00	\$ 33,763.50		\$ 33,763.50
1249200010001	R & D BUSINESS GROUP LLC	Commercial	250	\$ 135.00	\$ 33,763.50		\$ 33,763.50
0072790000007	BGM LLC	Commercial	250	\$ 135.00	\$ 33,750.00		\$ 33,750.00
0072790000006	ALLEN REBECCA A, ONEILL KATHERINE E	Commercial	250	\$ 135.00	\$ 33,750.00		\$ 33,750.00
1341400010001	CALUMET 6 REAL ESTATE LLC	Commercial	250	\$ 135.00	\$ 33,750.00		\$ 33,750.00
0072920000001	DURHAM I 10 LLC ET AL	Commercial	975	\$ 135.00	\$ 131,625.00		\$ 131,625.00
1249200030001	2300 RICHMOND AVE LTD	Commercial	250	\$ 135.00	\$ 33,766.88		\$ 33,766.88
0072870000001	LUU BAO XUAN	Commercial	250	\$ 135.00	\$ 33,750.00		\$ 33,750.00
0072780000009	HODLIK BILL W	Commercial	250	\$ 135.00	\$ 33,750.00		\$ 33,750.00
0072780000001	HODLIK BILL W	Commercial	250	\$ 135.00	\$ 33,750.00		\$ 33,750.00
1218500010001	LANGMAN JOHN & JOHNNIE H WEST JR PRTNRSH	Commercial	250	\$ 135.00	\$ 33,750.00		\$ 33,750.00
1341400020001	CALUMET 6 REAL ESTATE LLC	Commercial	250	\$ 135.00	\$ 33,750.00		\$ 33,750.00
0072650000007	CITY OF HOUSTON (N SHEPHERD-NAHSUA CONNECTION)	Government	250	\$ 135.00	\$ 33,750.00		\$ 33,750.00
0072650000005	ELIZALDE ELIZABETH B	Single Family	200	\$ 165.06	\$ 33,012.30		\$ 33,012.30
0072580000001	KB INVESTMENTS LLC	Single Family	75	\$ 142.88	\$ 10,715.63		\$ 10,715.63
0400330010001	SOUTHERN PACIFIC RAILROAD COMPANY UNION PACIFIC RA	Railroad	250	\$ 135.00	\$ 33,750.00		\$ 33,750.00
0072510000007	HRD INTERESTS LLC, ATTN: CHRISTOPHER DRAY	Commercial	662	\$ 135.00	\$ 89,387.55		\$ 89,387.55
0072510000006	CRAMER HAROLD L	Commercial	400	\$ 135.00	\$ 54,000.00		\$ 54,000.00
0072370000001	WASHINGTON SHEPHERD PARTNERS	Commercial	578	\$ 150.00	\$ 86,700.00		\$ 86,700.00
1218500020001	LANGMAN JOHN & JOHNNIE H WEST JR PRTNRSH	Commercial	250	\$ 135.00	\$ 33,750.00		\$ 33,750.00
0072640000005	DURHAM PROPERTY INVESTMENTS LLC	Commercial	250	\$ 135.00	\$ 33,750.00		\$ 33,750.00
0400330010001	SOUTHERN PACIFIC RAILROAD COMPANY UNION PACIFIC RA	Railroad	250	\$ 135.00	\$ 33,750.00		\$ 33,750.00
0072590000001	MURIEL LLC	Commercial	121	\$ 135.00	\$ 16,274.25		\$ 16,274.25
0072500000009	DURHAM DRIVE LLC	Commercial	500	\$ 135.00	\$ 67,500.00		\$ 67,500.00
0072500000005	ARGOS 1956 PROPERTIES LLC, NETT STREET INVESTMENTS S	Commercial	400	\$ 135.00	\$ 54,000.00		\$ 54,000.00
1222600010001	KEATING REVOCABLE TRUST	Commercial	400	\$ 135.00	\$ 54,010.80		\$ 54,010.80
0072360000001	WASHINGTON DURHAM PRTS LTD, C/O ROBERT C OOR JR	Commercial	250	\$ 150.00	\$ 37,500.00		\$ 37,500.00
	Corner Clips		2,200	\$ 135.04	\$ 297,079.10		\$ 297,079.10
				\$ -	\$ -		\$ -
				\$ -	\$ -		\$ -
				\$ -	\$ -		\$ -
			12,459			Total Cost	\$1,687,782.50

Appendix J
Memorial-Heights TIRZ Concepts



Shepherd Drive Project Summary

In an effort to develop a project that achieves the goals of several entities, Memorial Heights Redevelopment Authority (TIRZ No. 5) has reviewed the existing conditions of traffic, utilities, economic development, and pedestrian and bicycle facilities and connections along the Shepherd Drive and Durham Drive corridor (from 6th Street to 610). From this review, TIRZ No. 5 has conceptualized a plan forward that will spur continued economic development, support the goals of the community, have a strong case for federal funding, and will accomplish the objectives of all agencies involved.

Funding Opportunities – Significant funding opportunities are available for this project.

- H-GAC is anticipated to hold a Transportation Improvement Program (TIP) Call for Projects in late summer/early fall.
- A federal infrastructure funding program is expected to be announced within the next several months; this may provide additional funding that can be applied to projects throughout the region.
- Potential for the Redevelopment Authority to pursue issuance of bonds/C.O.s to provide additional local investment for the project.

Traffic – Traffic counts gathered and models projected to 2040.

- Reduction from four lanes to three lanes supported by microsimulation traffic model.
- Intersection modifications improve level of service at 11th and 20th Streets.
- Complete streets cross section promotes multi-modal access.

Complete Streets – The plan for Shepherd Drive focuses on complete streets.

- Shepherd Drive has 10 additional feet of ROW when compared to Durham Drive, our team recommends a bidirectional bike lane on Shepherd with no bike lane on Durham in order to minimize ROW acquisition.
- The bidirectional bike lane and sidewalk will allow both bicyclists and pedestrians to take advantage of a safe facility separated from vehicular traffic.
- The design keeps the bikes on the opposite side of the roadway from buses – reducing the bike/bus interaction, which is safer.

Economic Development – A top priority for TIRZ No. 5 is economic development.

- Large portions of the corridor are underdeveloped; upgrade in infrastructure will spur private investment towards redevelopment.
- Investments in active transportation, such as bicycling and walking, are proven to spur economic development both in Houston and nationwide.
- Growing interest in health and fitness and in urban, pedestrian lifestyle have both contributed to significant returns on investments in active transportation.
- Studies show that proximity to bicycle and pedestrian facilities increases property values and retail sales.

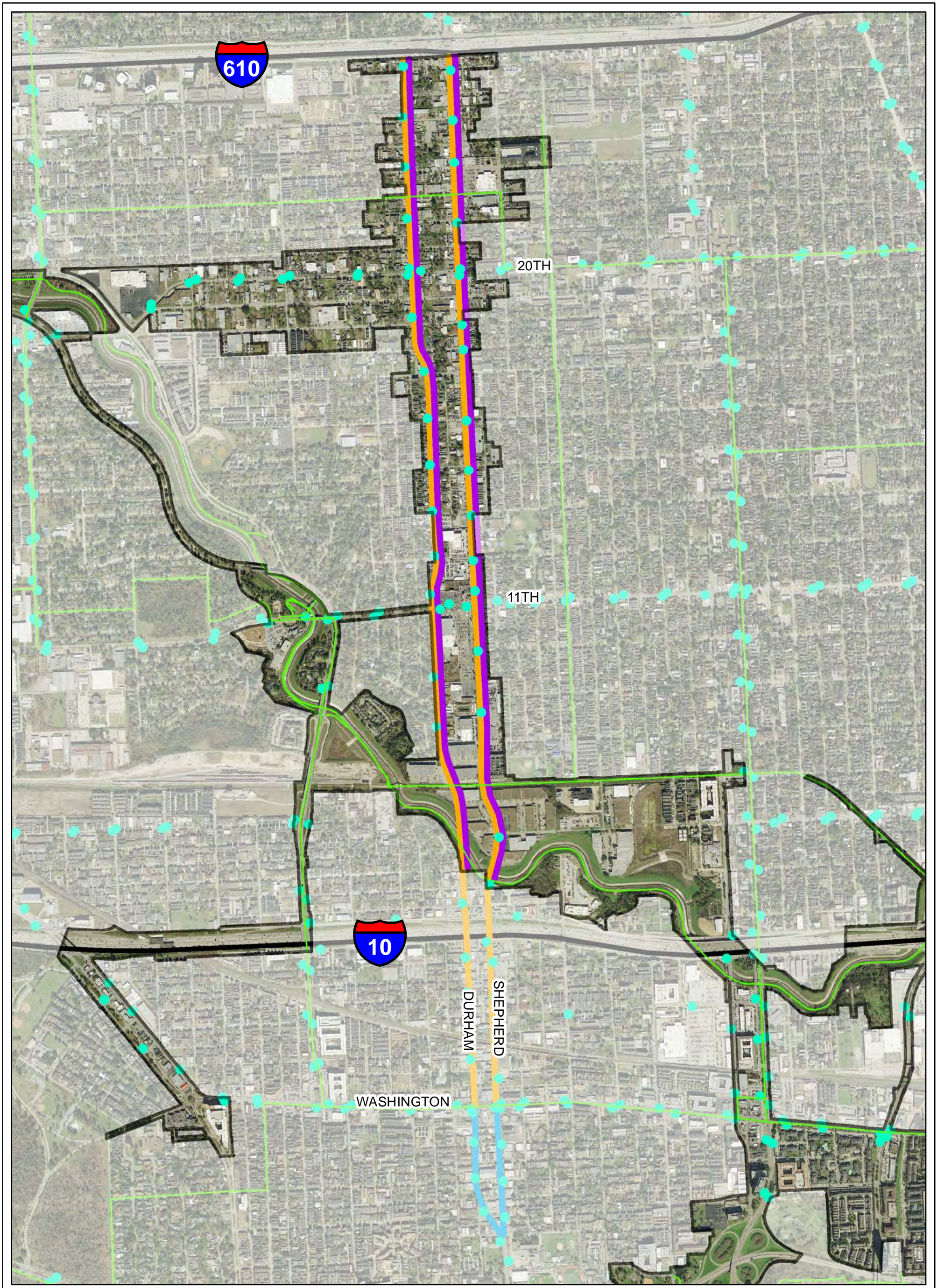


METRO Coordination – Early coordination shows opportunity to implement METRO’s key initiatives:

- Reducing the number of stops – reduce stops to every other block.
- Enhancing the design of bus stops.
- Moving stops to the far side of the intersection.

Included with this summary are the following items:

1. Overall map of Shepherd/Durham study areas
2. Existing Shepherd Drive Cross Section
3. Proposed Shepherd Drive Cross Section
4. Shepherd Drive matchline map
5. Shepherd at 11th Intersection Improvements
6. Shepherd at 20th Intersection Improvements
7. Plan view of proposed Shepherd Drive project from south of 11th Street to IH-610



LEGEND

- TIRZ 5 Boundary
- Existing Bikeways
- METRO Bus Stop
- TIRZ Study Area (T-0523)
- COH Study Area (N2016T-0004)
- Under Design (N-100003-001)

1 inch equals 1,300 feet

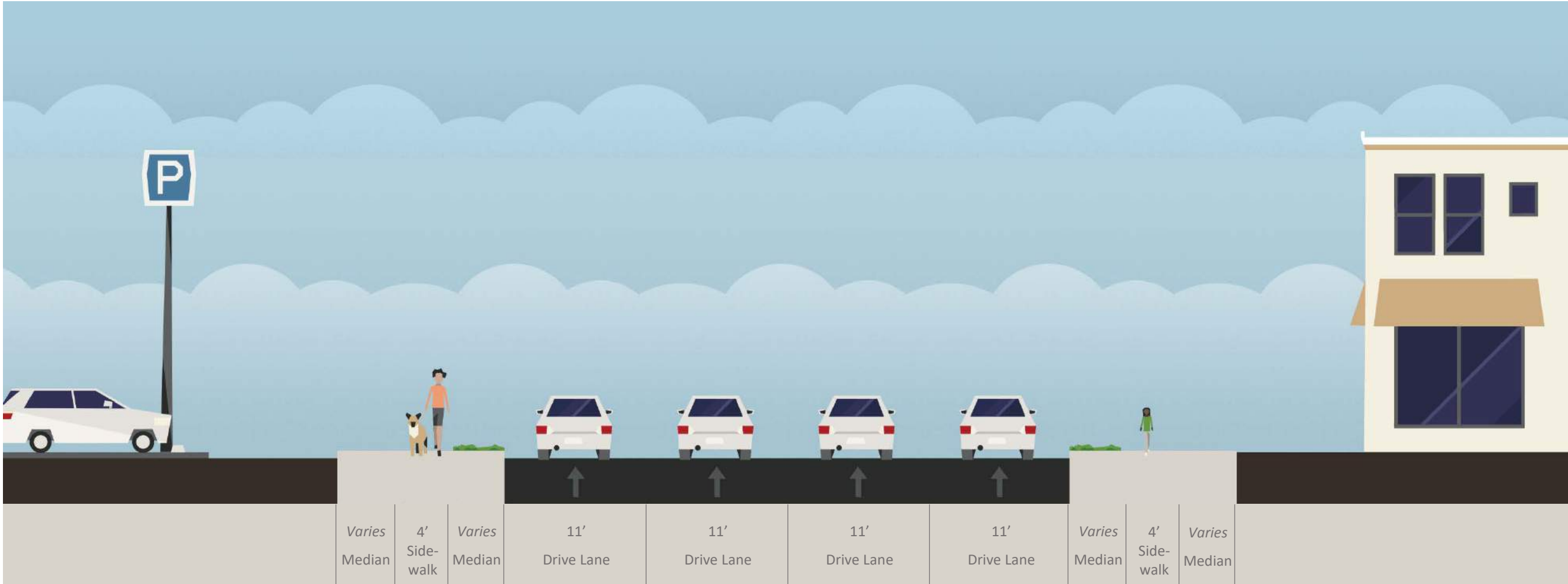
**MEMORIAL HEIGHTS
REDEVELOPMENT AUTHORITY
(TIRZ No. 5)**

Shepherd Drive Work in Progress

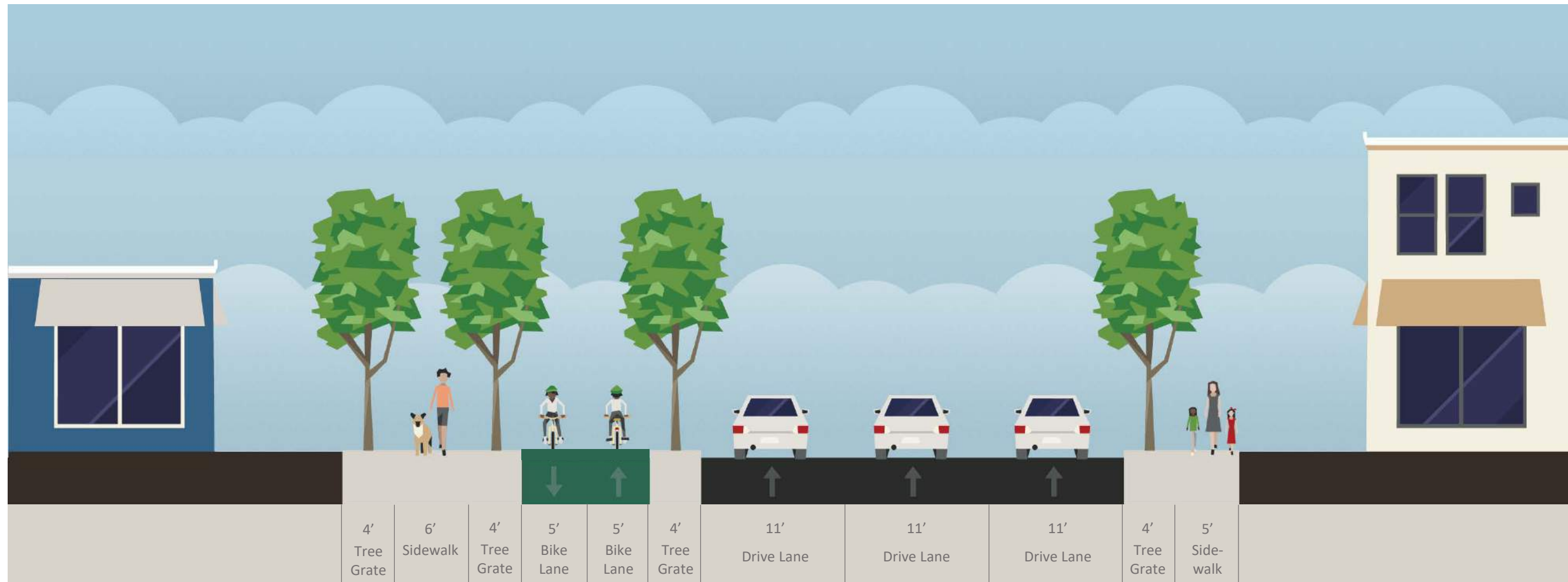
JONES | CARTER

VICINITY MAP
Scale: 1 inch equals 10 miles

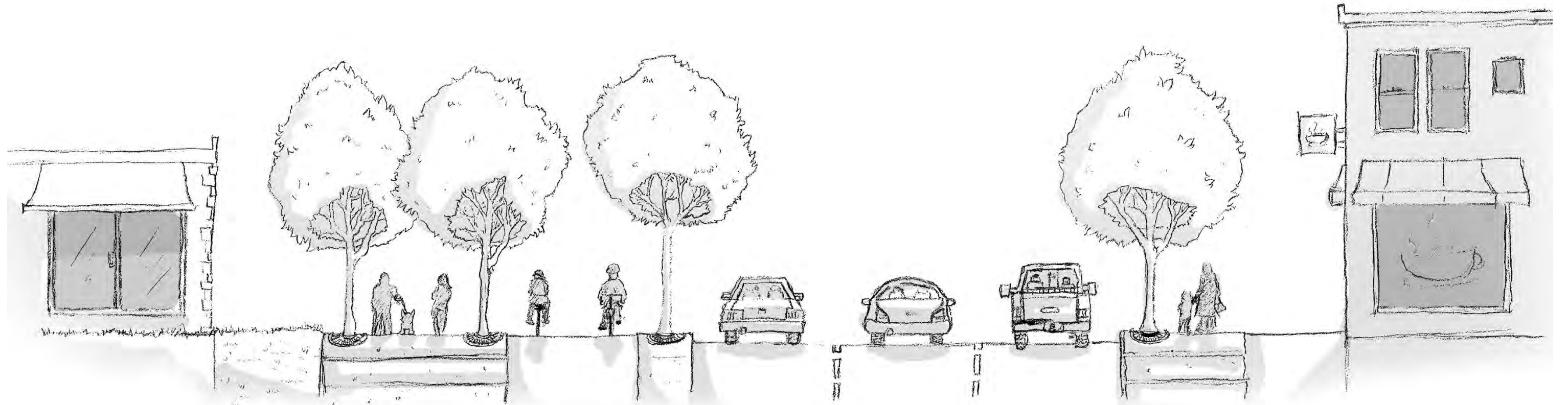
SHEPHERD DRIVE (EXISTING)

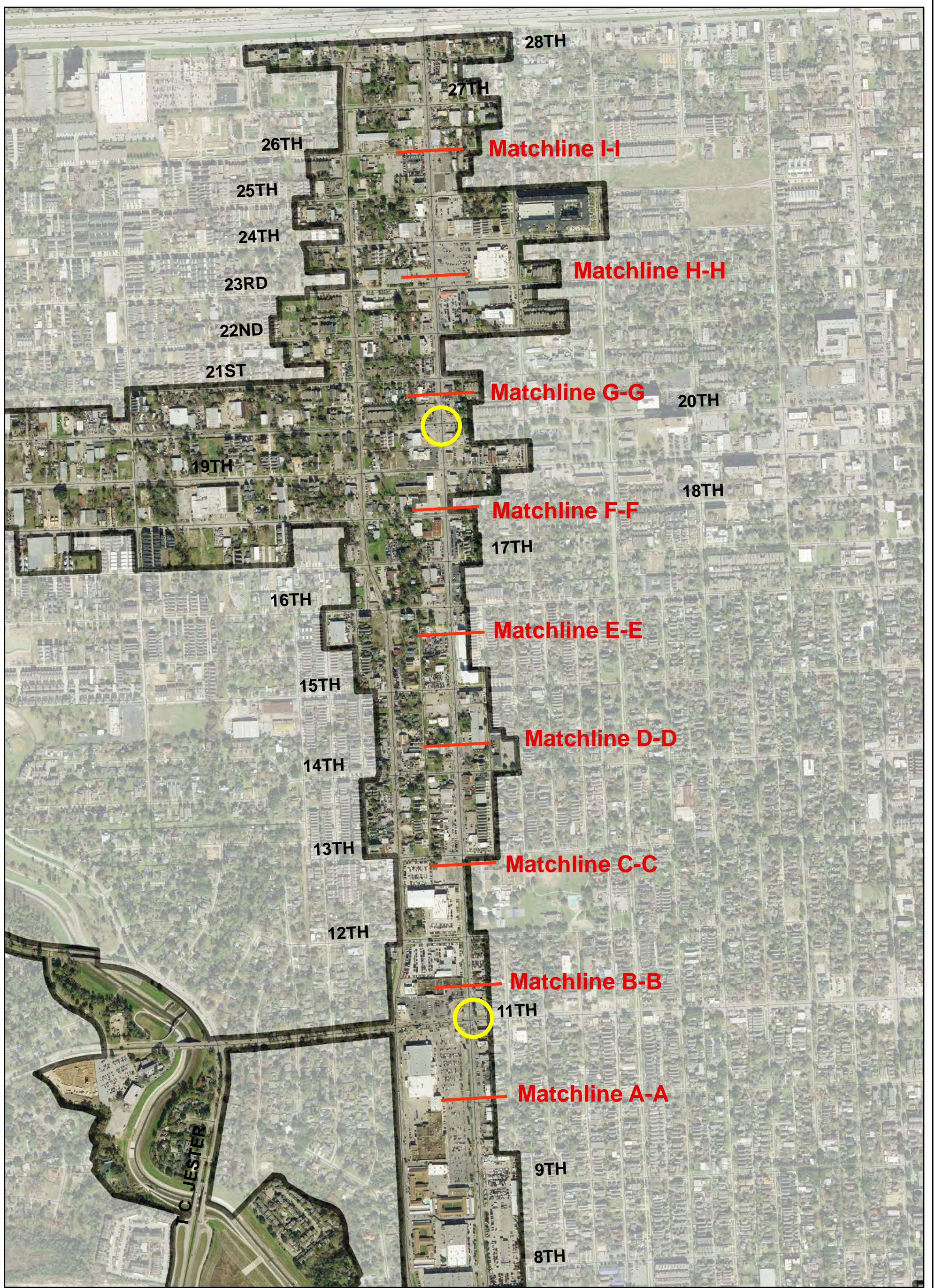


SHEPHERD DRIVE (PROPOSED)







Shepherd Drive - Proposed





LEGEND

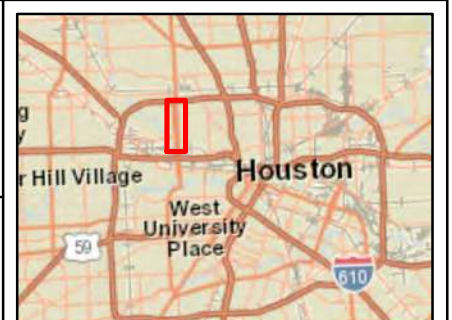
-  TIRZ 5 Boundary
-  Matchline
-  MTFP
-  Intersection Improvements



1 inch equals 43,445 feet

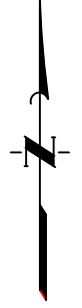
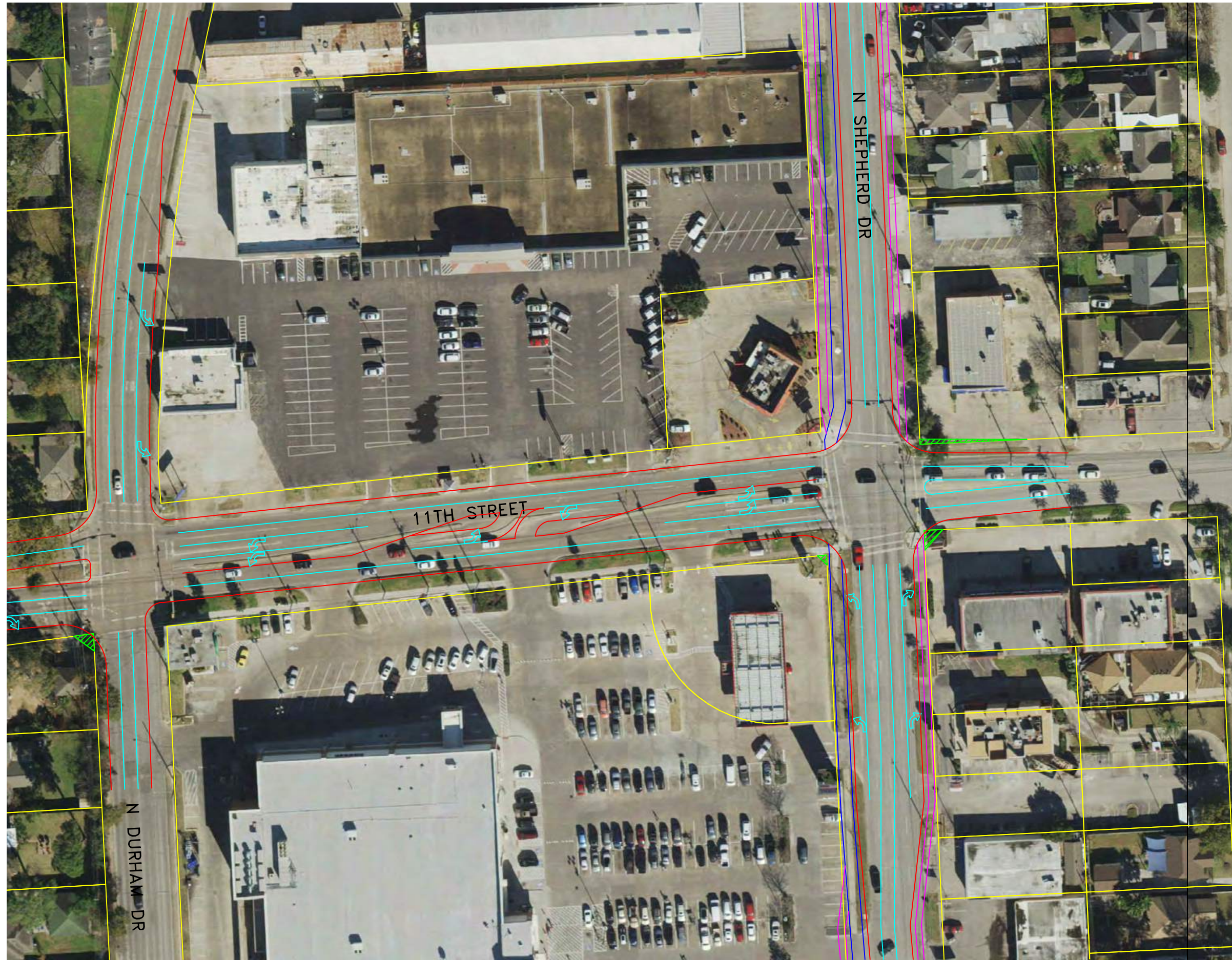
**MEMORIAL HEIGHTS
REDEVELOPMENT AUTHORITY
(TIRZ No. 5)**

Shepherd Drive Schematic Layout

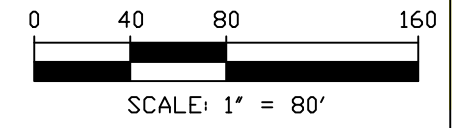


VICINITY MAP

Scale: 1 inch equals 10 miles



- LEGEND:**
- EXISTING ROW
 - PROPOSED ROW
 - STRIPE
 - PAVEMENT
 - SIDEWALK
 - BIKE LANE



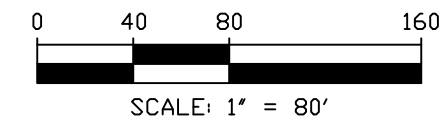
MEMORIAL HEIGHTS REDEVELOPMENT AUTHORITY
 11TH STREET
 PROPOSED IMPROVEMENTS
 PRELIMINARY SCHEMATIC
 OPTION 3





LEGEND:

- EXISTING ROW
- PROPOSED ROW
- STRIPE
- PAVEMENT
- SIDEWALK
- BIKE LANE

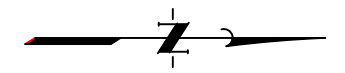
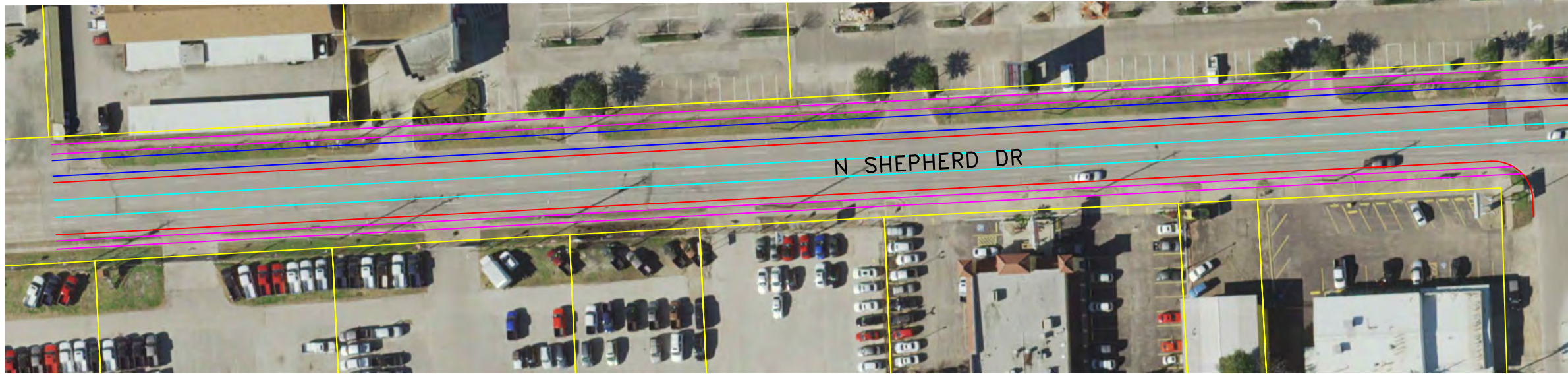


MEMORIAL HEIGHTS REDEVELOPMENT AUTHORITY

**20TH STREET
PROPOSED IMPROVEMENTS
PRELIMINARY SCHEMATIC**

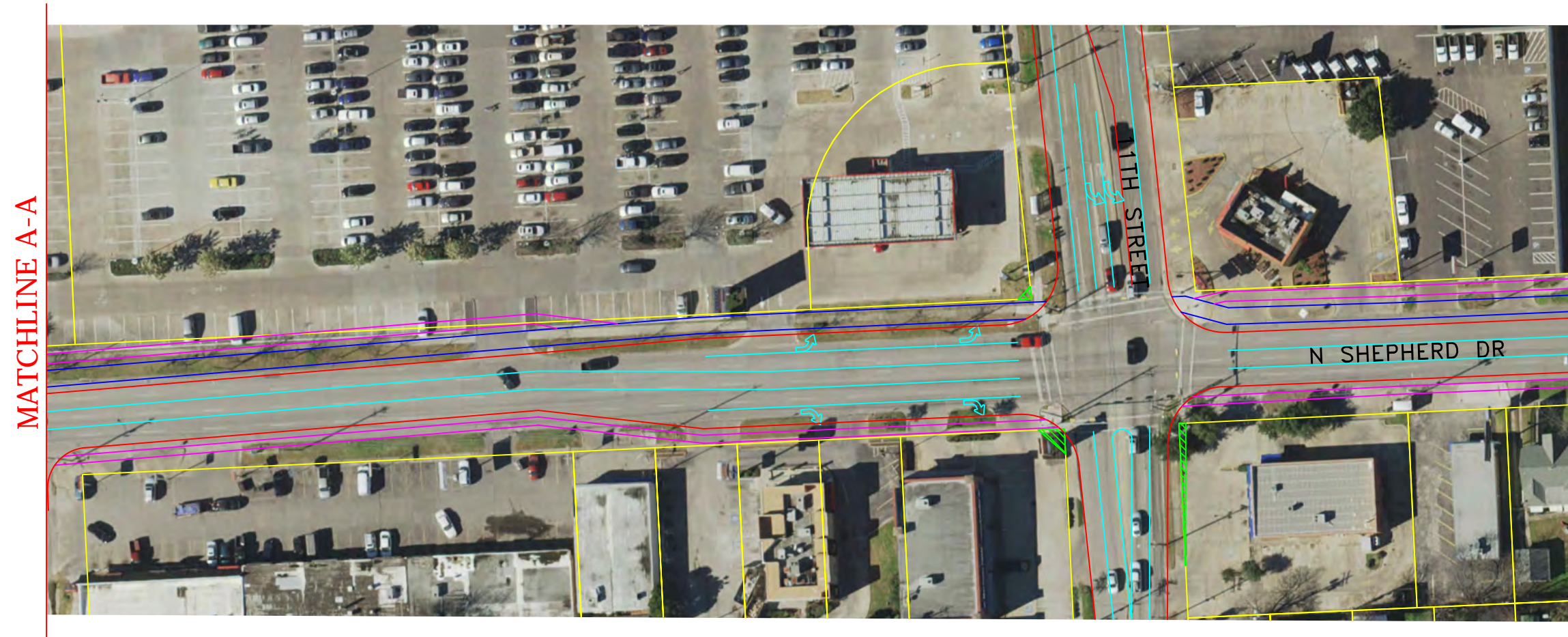
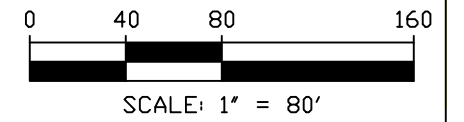


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LEGEND:

- EXISTING ROW
- PROPOSED ROW
- STRIPE
- PAVEMENT
- SIDEWALK
- BIKE LANE



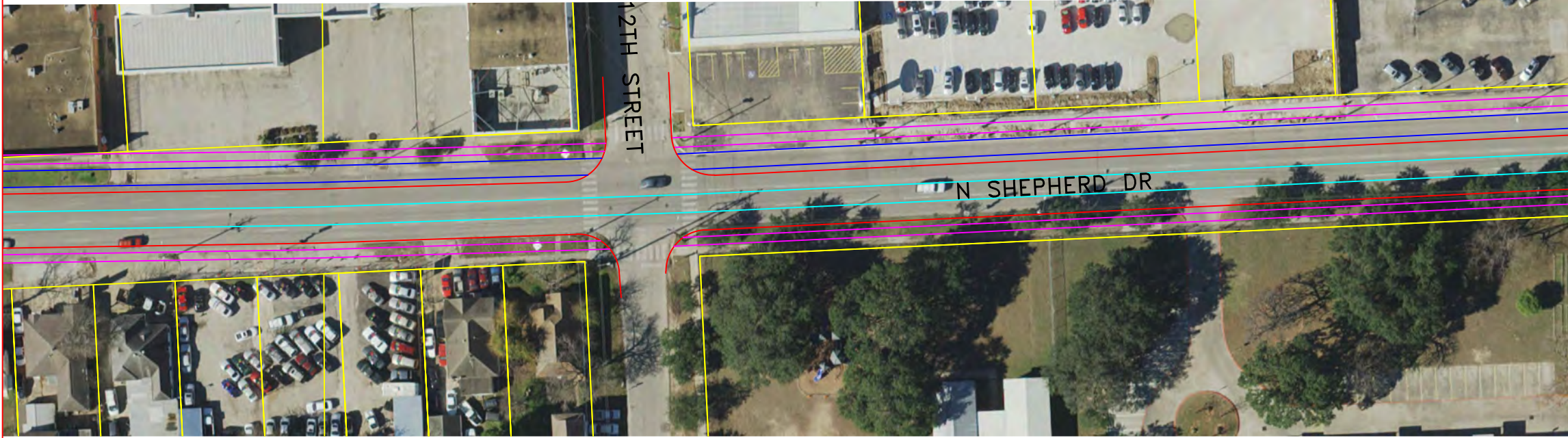
MATCHLINE A-A

MATCHLINE B-B

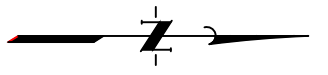
MEMORIAL HEIGHTS REDEVELOPMENT AUTHORITY
 N SHEPHERD DRIVE
 PROPOSED IMPROVEMENTS
 PRELIMINARY SCHEMATIC
 SHEET (1 OF 5)



MATCHLINE B-B



MATCHLINE C-C

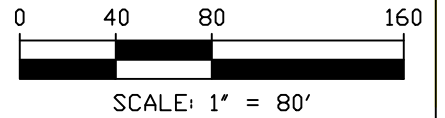


- LEGEND:**
- EXISTING ROW
 - PROPOSED ROW
 - STRIPE
 - PAVEMENT

MATCHLINE C-C

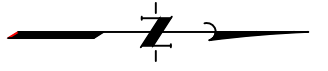


MATCHLINE D-D

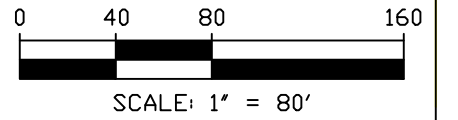


MEMORIAL HEIGHTS REDEVELOPMENT AUTHORITY
 N SHEPHERD DRIVE
 PROPOSED IMPROVEMENTS
 PRELIMINARY SCHEMATIC
 SHEET (2 OF 5)





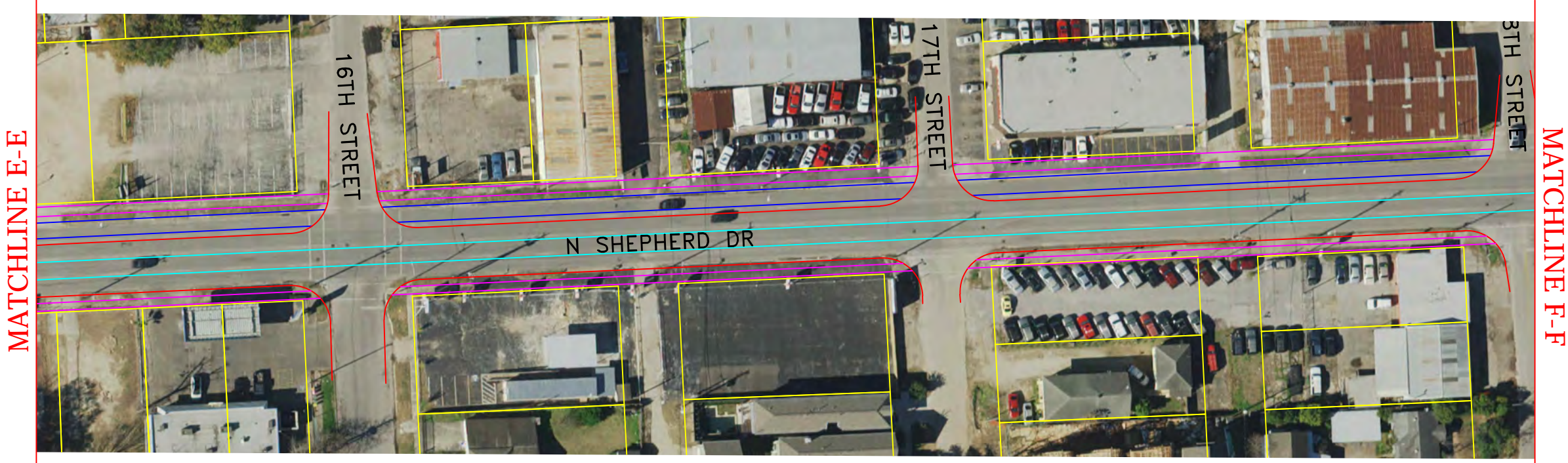
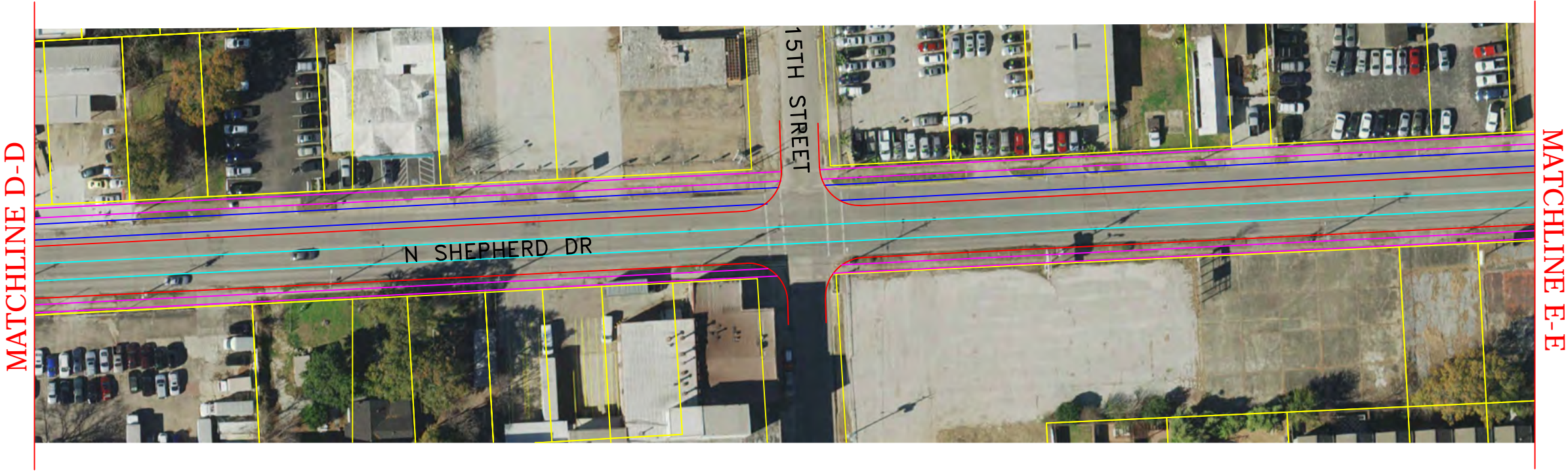
- LEGEND:**
- EXISTING ROW
 - PROPOSED ROW
 - STRIPE
 - PAVEMENT

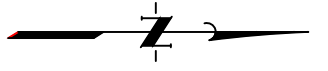


MEMORIAL HEIGHTS REDEVELOPMENT AUTHORITY





N SHEPHERD DRIVE
PROPOSED IMPROVEMENTS
PRELIMINARY SCHEMATIC
SHEET (3 OF 5)

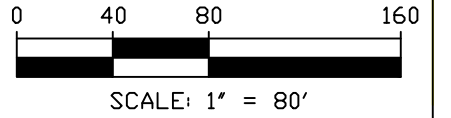
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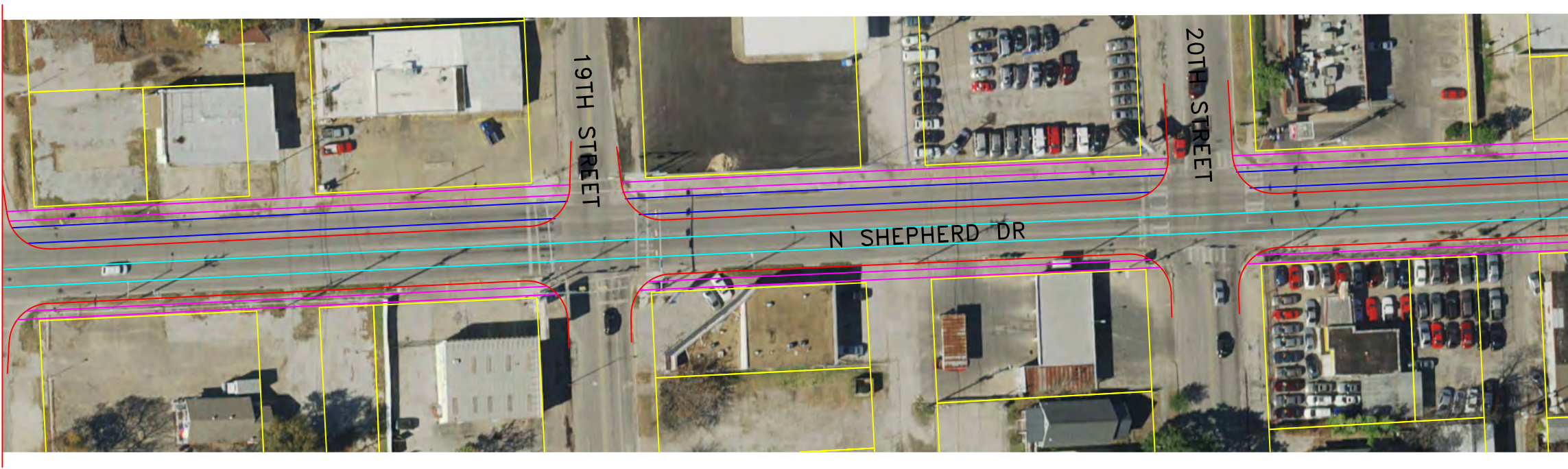


LEGEND:

-  EXISTING ROW
-  PROPOSED ROW
-  STRIPE
-  PAVEMENT

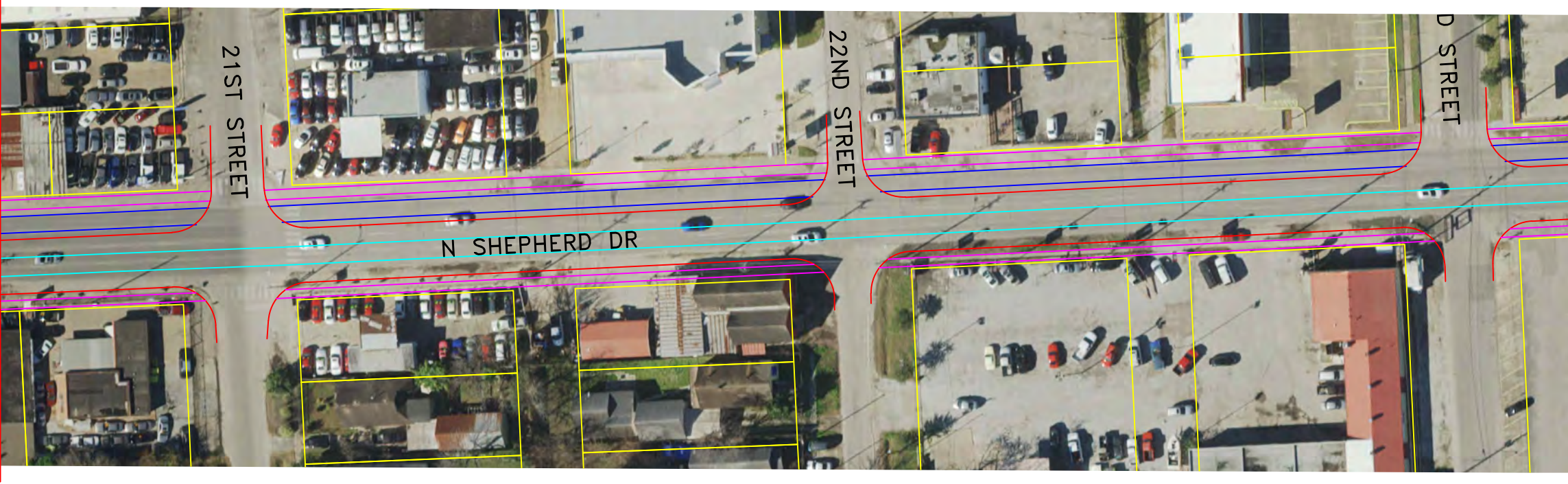


MATCHLINE F-F



MATCHLINE G-G

MATCHLINE G-G



MATCHLINE H-H

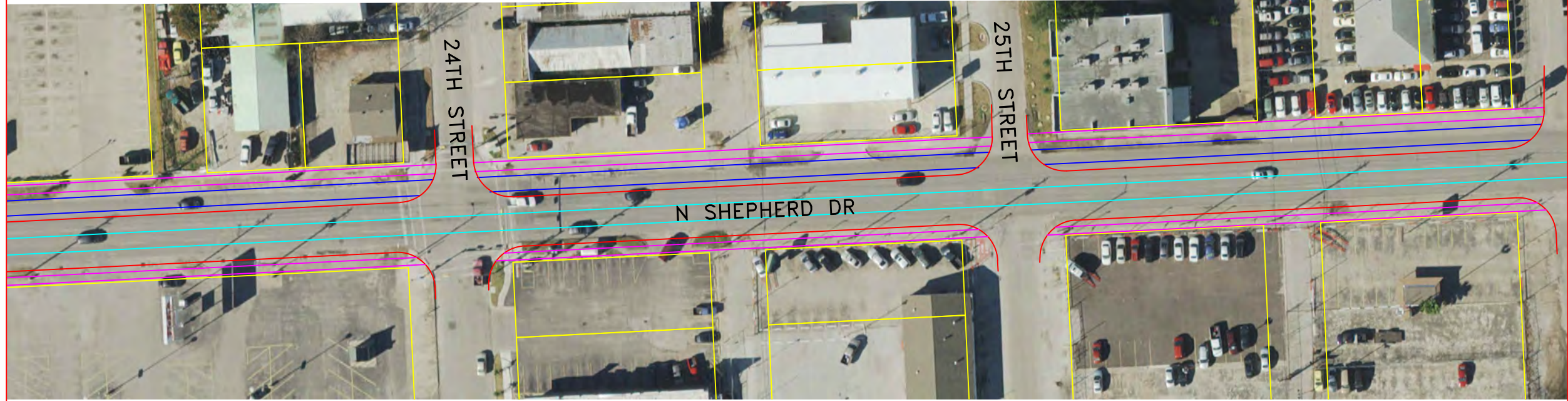
MEMORIAL HEIGHTS REDEVELOPMENT AUTHORITY

N SHEPHERD DRIVE
PROPOSED IMPROVEMENTS
PRELIMINARY SCHEMATIC

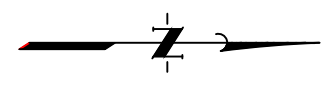
SHEET (4 OF 5)



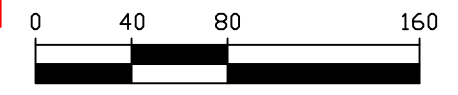
MATCHLINE H-H



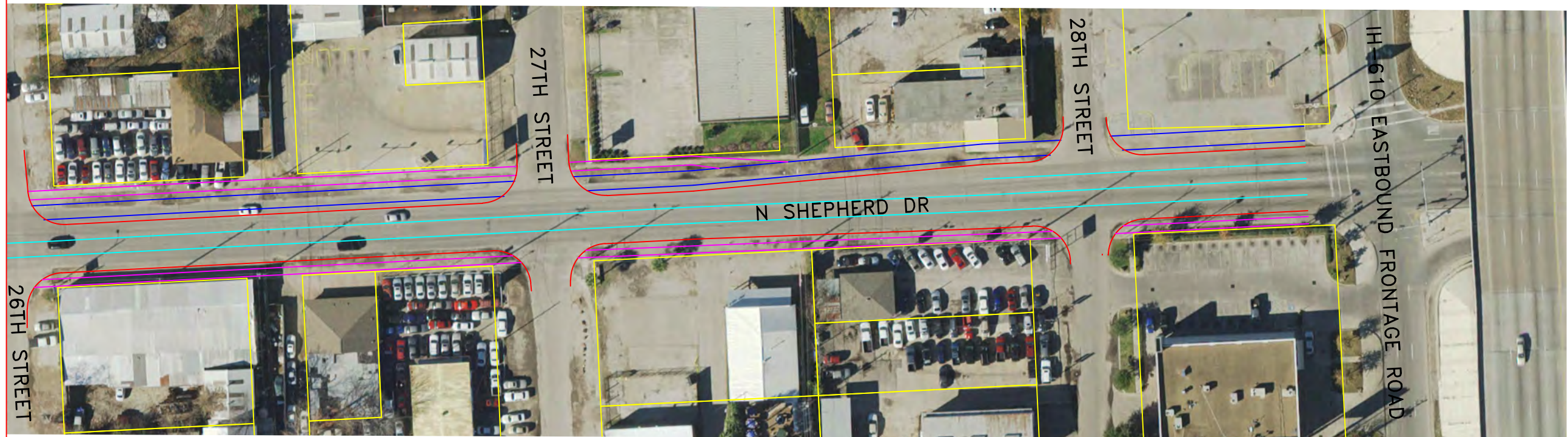
MATCHLINE I-I



- LEGEND:**
- EXISTING ROW
 - PROPOSED ROW
 - STRIPE
 - PAVEMENT



MATCHLINE I-I



MEMORIAL HEIGHTS REDEVELOPMENT AUTHORITY
 N SHEPHERD DRIVE
 PROPOSED IMPROVEMENTS
 PRELIMINARY SCHEMATIC
 SHEET (5 OF 5)

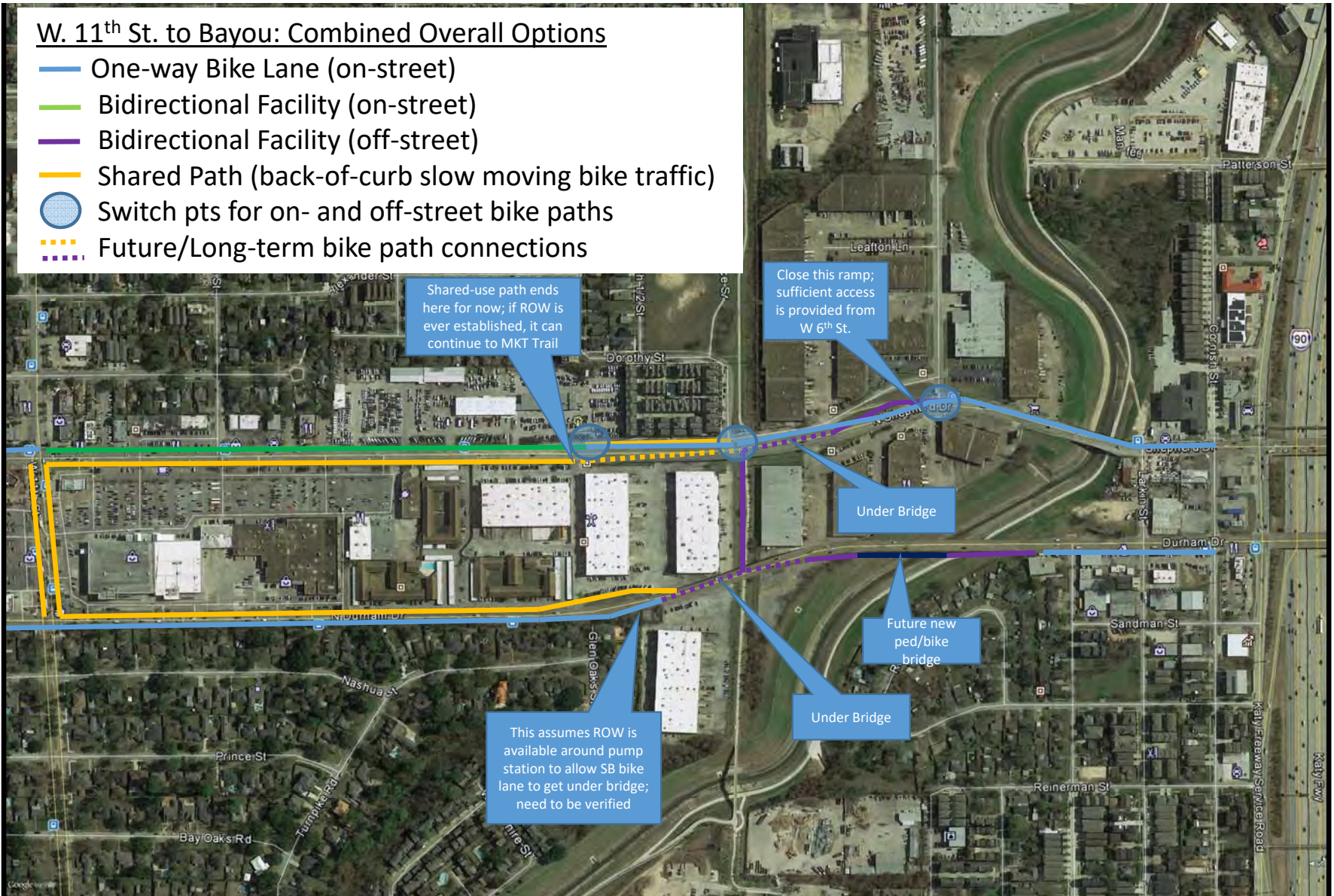


Appendix K
COH Proposed Concepts within Memorial-
Heights TIRZ



W. 11th St. to Bayou: Combined Overall Options

- One-way Bike Lane (on-street)
- Bidirectional Facility (on-street)
- Bidirectional Facility (off-street)
- Shared Path (back-of-curb slow moving bike traffic)
- Switch pts for on- and off-street bike paths
- ⋯ Future/Long-term bike path connections



Shared-use path ends here for now; if ROW is ever established, it can continue to MKT Trail

Close this ramp; sufficient access is provided from W 6th St.

Under Bridge

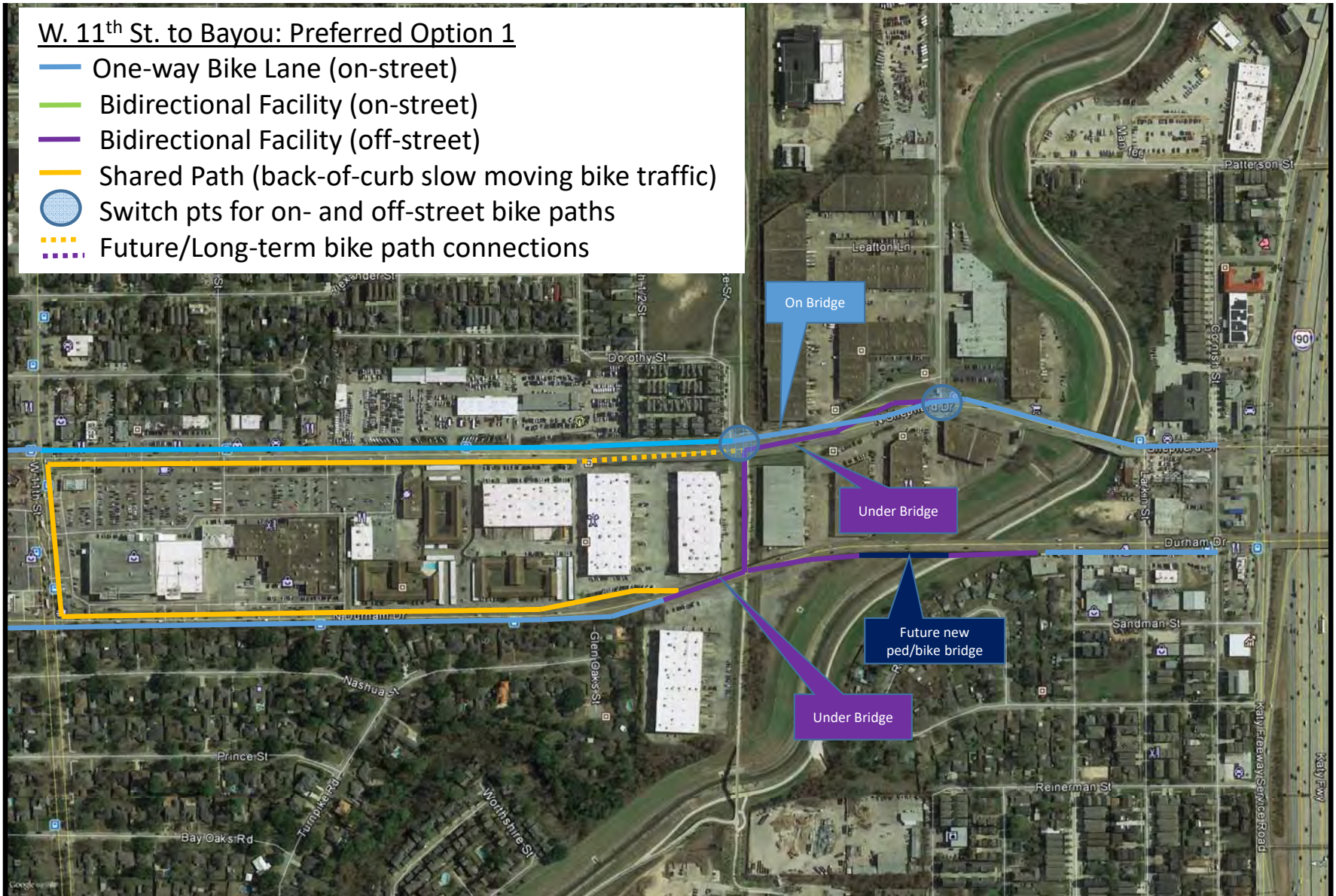
Future new ped/bike bridge

Under Bridge

This assumes ROW is available around pump station to allow SB bike lane to get under bridge; need to be verified

W. 11th St. to Bayou: Preferred Option 1

- One-way Bike Lane (on-street)
- Bidirectional Facility (on-street)
- Bidirectional Facility (off-street)
- Shared Path (back-of-curb slow moving bike traffic)
- Switch pts for on- and off-street bike paths
- ⋯ Future/Long-term bike path connections



W. 11th St. to Bayou: Option 2

- One-way Bike Lane (on-street)
- Bidirectional Facility (on-street)
- Bidirectional Facility (off-street)
- Shared Path (back-of-curb slow moving bike traffic)
- Switch pts for on- and off-street bike paths
- ⋯ Future/Long-term bike path connections



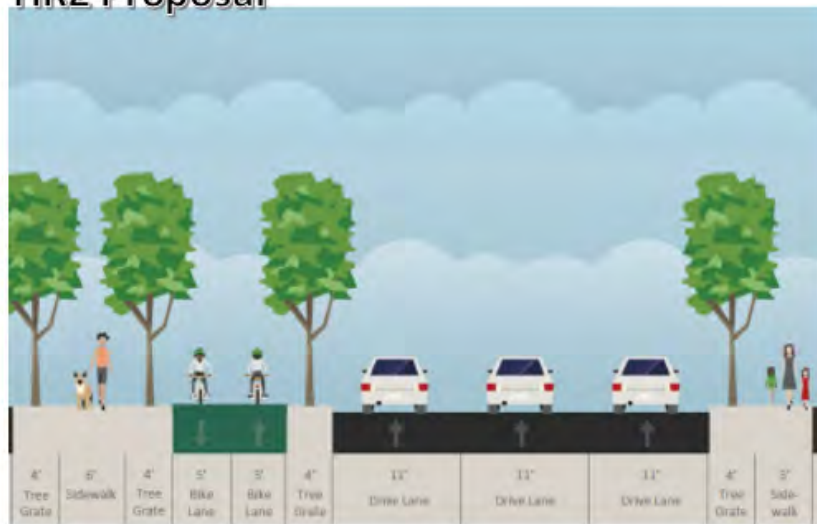
W. 11th St. to Bayou: Option 3

- One-way Bike Lane (on-street)
- Bidirectional Facility (on-street)
- Bidirectional Facility (off-street)
- Shared Path (back-of-curb slow moving bike traffic)
- Switch pts for on- and off-street bike paths
- ⋯ Future/Long-term bike path connections



Shepherd – Loop 610 to 11th St., Approx. 600' N. of MKT Trail to Bayou (70' ROW Option)

TIRZ Proposal



City Compromise



*Yellow Path

Blue Path

* Please note Yellow Path width may vary based on available ROW, driveway frequency, buffer zone required for wider turning radius on both sides of the roadway, utility and pole locations, etc. Private easement dedication and alternative funding mechanism may be required to achieve desired path width and tree coverage.

Similar considerations should apply to proposed tree planting and how it interacts with path width and usage in terms of space and shading.

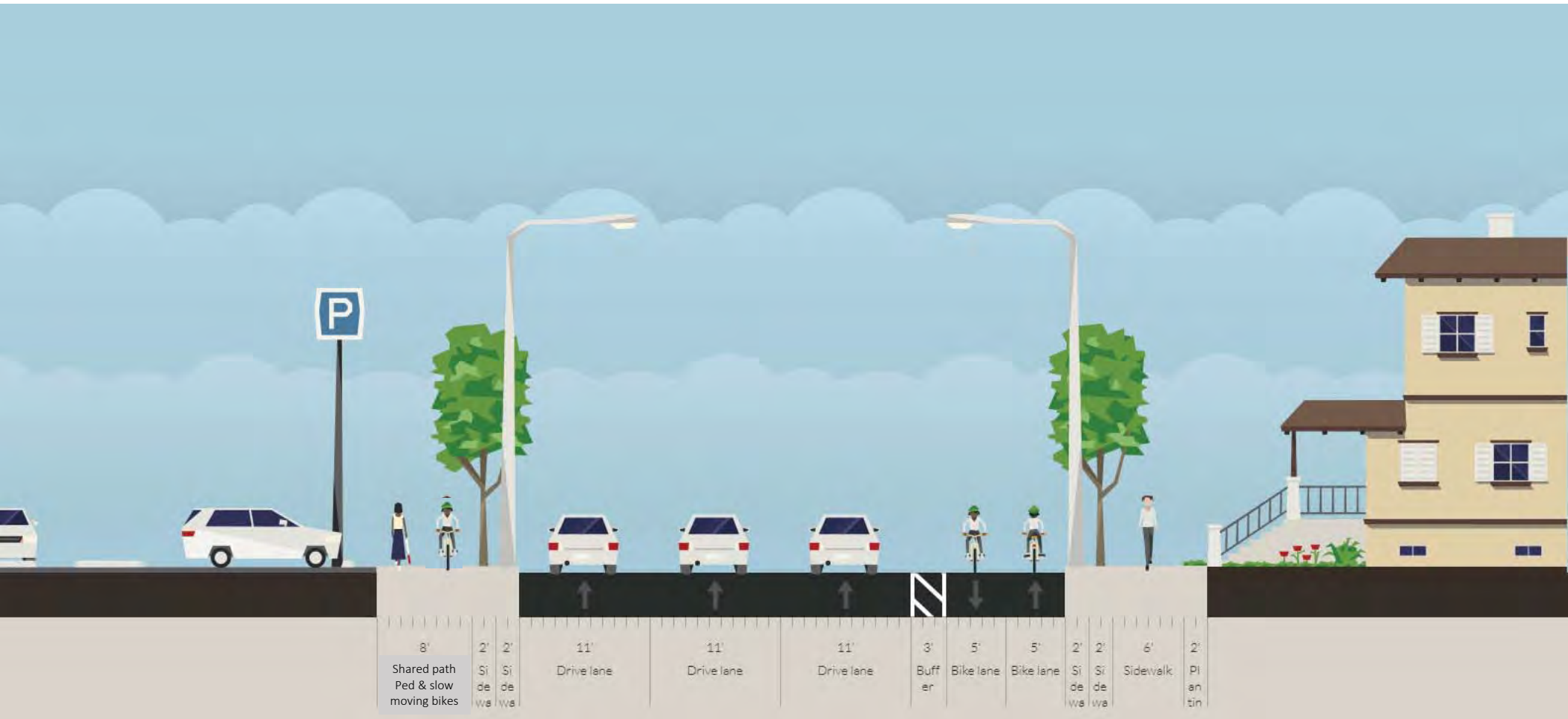
Shepherd –Loop 610 to 11th St. (60'- 65' ROW Option)



*Yellow Path

Blue Path

Shepherd – 11th St. to Approx. 900' N. of MKT Trail (70' ROW Min.)



*Yellow Path

Green Path

Durham – Loop 610 to MKT Trail (60' ROW + 3' easement
 required to be dedicated for wider shared path bounding east commercial areas if/when desired)



Blue Path

*Yellow Path

Appendix L
CD of Models, Shape Files, and Report

