APPENDIX B
Drainage Analysis

DRAINAGE ANALYSIS

Draft Report

WO #15 – Dairy Ashford Road, Harris County, TX
Limits: Memorial Drive to Briar Forest Drive
WBS No.: N-320100-0010-3
City of Houston – Public Works

Interim Review Only
Not to be used for construction, bidding, permitting, or regulatory approval purposes.

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May 2022

DAIRY ASHFORD ROAD FROM IH-10 TO WESTEIMER ROAD
DRAINAGE ANALYSIS-DRAFT REPORT

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF EXHIBITS

DAIRY ASHFORD ROAD FROM IH-10 TO WESTEIMER ROAD
DRAINAGE ANALYSIS-DRAFT REPORT

TABLE OF CONTENTS

LIST OF APPENDICES

Chapter 1 Project Overview

1.1 PROJECT AUTHORIZATION

Gunda Corporation, LLC (GUNDA) was authorized by City of Houston (COH) to provide Engineering Services for traffic and drainage analysis along Dairy Ashford Road from Memorial Drive to Briar Forest Drive.

1.2 PROJECT LOCATION

The project is located in the Memorial Super Neighborhood, within the City of Houston, Council District G, approximately 17.00 miles west of downtown Houston in Harris County, Texas. The total length of the project is approximately 1.13 miles with boundary streets of Memorail Drive (north) and Briar Forest Drive (south). The relevant Key Map pages are 488 D, H, M, R and V. GIMS block map numbers are 4856 A and C; 4857 A and C; 4858 C. A Vicinity Map is provided in **Exhibit 1**. **Exhibit 2** – Project Location Map provides a detailed overview of the project area. **Exhibit 3** –shows the Project Layout Map.

1.3 PROJECT DESCRIPTION

Dairy Ashford Road is a two-way major thoroughfare with two (2) lanes in each direction between Briar Forest Drive and south of Memorial drive. There are three (3) signalized intersections and one bridge over Buffalo Bayou within the project limits. Posted speed limit is 35 mph along the study corridor. In general, Dairy Ashford Road runs from the energy corridor at IH-10 in the north to IH-69 in the south, serving as a vital connection to major highways such as Westpark Tollway and US 90.

1.4 SCOPE OF THE STUDY

The scope of the drainage study is to establish a hydraulic model based on the existing drainage systems and demonstrate that the proposed drainage improvements will effectively convey flow to the project outfalls.

This following design and analysis steps were performed:

- Determine the existing drainage boundaries.
- Perform a hydrologic and hydraulic analysis of the existing drainage system to understand and identify any existing drainage deficiencies.
- Perform hydrologic and hydraulic analysis to accommodate proposed roadway improvements and rectify any drainage deficiencies.

1.5 DESIGN CRITERIA

This analysis was performed based on the COH and Harris County Flood Control District (HCFCD) criteria found in the following references:

Infrastructure Design Manual. City of Houston Department of Public Works and Engineering, July 2020 (IDM).

Technical Paper 100- Storm Sewer Design Applications for the City of Houston, Texas. Capital Improvement Plan Projects, City of Houston Department of Public Works and Engineering, October 2005.

Technical Paper 101- Guidelines for Consideration of Overland Flow for the Extreme Event for Improvement Projects in the City of Houston. Harris County, Texas Region. City of Houston Department of Public Works and Engineering, April 2005.

Policy, Criteria, and Procedure Manual for Approval and Acceptance of Infrastructure. Harris County Flood Control District, December 2019 (HCFCD Manual).

According to the COH Major Thoroughfare and Freeway Plan (MTFP), Dairy Ashford Road is classified as a Major Thoroughfare (T-6-100) in the north-south direction. Memorial Drive and Briar Forest Drive crossing Dairy Ashford Road are also designated as Major Thoroughfares in the east-west direction. There are several local/residential streets crossing Dairy Ashford Road within the project limits.

2.1 Existing Pavement

Dairy Ashford Road is a two-way major thoroughfare with two (2) lanes in each direction between Memorial Drive and Briar Forest Drive. Dairy Ashford Road is a concrete roadway with concrete curb and gutter. Pavement and striping conditions were fair to poor. There is continuous sidewalk along the study corridor, except at north of River Forest Drive in the northbound direction. Existing Roadway Typical Sections are shown on **Exhibit 4.**

2.2 Existing Right-of-Way (ROW)

Based on City of Houston GIMS website, Dairy Ashford Road has 100-foot to 105-foot wide right-of-way between Memorial Drive and Briar Forest Drive.

2.3 Existing Storm Sewer

The drainage along Dairy Ashford Road is conveyed via underground storm sewer systems to the project outfalls. The following **Table 2-1** lists the existing storm sewers with the size and type, the COH Plan Number, and Plan Year. **Exhibit 9** shows existing storm sewers.

Table 2-1: Existing Storm Sewers

Street Name	From	To	Pipe Size/Material	Plan No. / Year in Service
Dairy Ashford	Memorial Drive	Buffalo Bayou	24" to 60" RCP & CMP	26366/1976
Dairy Ashford	Briar Forest Drive	Buffalo Bayou	24" to 144" RCP & CMP	26366/1976

The drainage from the project, outfalls into HCFCD channels Buffalo Bayou (W100-00-00) which crosses the project alignment between Memorial Drive and Briar Forest Drive . The north section storm sewer begins at Kimberly Lane and drains south. The south section storm sewer begins at Westheimer Road and drains north .

2.4 Floodplain Information

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Number 48201C0640M, **Dairy Ashford Road at Buffalo Bayou is located in 100-year floodplain (Zone AE). Exhibit 5** shows the FEMA FIRM Map for the project area.

2.5 311 Flood Complaints

The COH receives and records complaints of flooding or drainage issues within the project limits as 311 complaints. **Table 2-2** shows the 311 Ponding and Flooding complaints for the years 2012 through 2020. See **Exhibit 6** for the 311 Calls Complaints Map.

Table 2-2: 311 Call Complaints

Drainage System	311 Flooding
North (Memorial Drive to Buffalo Bayou)	52
South (Briar Forest Drive to Buffalo Bayou)	32
Total	**84**

All the complaints reported and recorded are located along or adjacent to the Dairy Ashford Road project.

2.6 Land Use

Developments within the project area are mixture of residential communities, commercial establishments, offices, schools, churches, and green areas (parks). Prominent attractions and features proximate to Dairy Ashford Road include: Stratford High School, Terry Hershey bike trail along Buffalo Bayou, fire station and Forest Park Westheimer cemetery.

Chapter 3 Methodology

GUNDA used PGAL Pre-Engineering report, HNTB Preliminary Engineering Report, field investigation, information from GIMS database available on COH website, data provided by the COH, and information from the 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.

3.1 Drainage Analysis Criteria

The drainage analysis was performed in accordance with the COH design procedures and standards for public infrastructure capital improvements, as described in the following documents:

- **Infrastructure Design Manual**, City of Houston Department of Public Works and Engineering, July 2020 IDM.
- **Technical Paper No. 100 – Storm Sewer Applications for the City of Houston, Texas, Capital Improvement Plan Projects**, City of Houston Department of Public Works and Engineering, October 2005 (TP-100).
- **Technical Paper No. 101 – Guidelines for Consideration of Overland Flow for the Extreme Event for Improvement Projects in the City of Houston, Harris County, Texas Region**, City of Houston Department of Public Works and Engineering, April 2005 (TP-101).
- **Policy, Criteria, and Procedure Manual for Approval and Acceptance of Infrastructure**, Harris County Flood Control District, December 2019 (HCFCD Manual).

3.2 Drainage 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 COH's current standards.

The following design and analysis steps were considered:

- Identify the existing drainage systems
- Define drainage area boundaries and sub-basins for each drainage systems
- Establish hydrologic parameters
- Calculate Time of Concentration based on City's criteria
- Compute existing peak flows
- Establish tailwater conditions
- Evaluate the efficiency of existing storm sewers under existing conditions
- Identify deficiencies of existing storm sewer system
- Compute ponding depths, water surface elevation, flow paths using 2d dynamic model
- Compute Proposed Flows
- Design proposed storm sewer improvements for the 2-year rainfall event and evaluate drainage systems for 100-year rainfall events
- Determine and provide the detention volume required for increase in impervious area

- Compute ponding depths, water surface elevation, flow paths using 2d dynamic model

3.3 Hydrology Approach

The Rational Method formula, Q = CiA, was used to calculate peak flow rates from each sub-basin, where Q is peak discharge (cfs), I is rainfall intensity (in/hr), A is sub-basin drainage area in acres and C is runoff coefficient. Peak flows were computed for multiple frequencies including 2-, and 100-year rainfall events.

Rainfall intensity (i) was derived from the method published by the City as follows:

$$i = \frac{b}{(d+Tc)^e}$$

Where:
i = rainfall intensity (in/hr)
Tc = time of concentration (min)
e, b, d = intensity coefficients

e, b, d coefficients are based on HCFCD ATLAS 14 data published in the COH IDM. Time of concentration was calculated using the City established formula TC = 10*A(^0.1761)+15. The drainage areas "A" were delineated based topographic survey, LiDAR topographic data, GIMS, and field investigations.

Hydrographs for each sub-basin were developed using US Army Corps of Engineers (USACE) software HEC-HMS (3.3 version). Green and Ampt Loss computation methodology was used in HEC-HMS model to compute the losses. The parameters for Green and Ampt methodology were based on the Tropical Storm Allison Recovery Project (TSARP) White Papers. A Clarke Unit Hydrograph transformation method was used to generate the hydrographs. Clark Unit Hydrograph transformation method requires "Time of Concentration (Tc)" and "Storage Coefficient" inputs to compute peak flow hydrographs. The Storage Coefficient was calibrated to generate 2-year rainfall hydrographs to match the peak flows computed using Rational Method. The same Storage Coefficient was used to compute other rainfall event hydrographs for both existing and proposed conditions. ATLAS 14 -24 hours rainfall amounts are used meteorological input parameters in HEC-HMS model.

3.4 Hydraulic Approach

The XPSWMM (Version 2019) was used as hydraulic model to evaluate the existing storm sewers and to design the proposed storm sewers. The existing elevations, flowlines and pipe sizes are based on COH GIMS database and record drawings.

XPSWMM computer program was selected based on the ability to route hydrographs through the systems. This model can more readily determine impacts of changed hydrologic conditions and to assist in the mitigation design. The XPSWMM model includes links for both conduits and open channel flow. This allows modeling of street conveyance, ponding, storage, and overland flow in the streets, as well as flow in the storm sewer system and open-ditches.

In XPSWMM Model, each sub drainage area was modeled as a node, and the hydrographs generated by HEC-HMS model was used as hydrologic input data for each node. XPSWMM 1D/2D analysis was performed to understand ponding depths, overland flow patterns, water surface elevations, flow and velocities with respect to time.

Chapter 4 Existing Drainage Analysis and Findings

4.1 Watershed

The project alignment is located within the Buffalo Bayou watershed. HCFCD channel, Buffalo Bayou (W100-00-00) crosses Dairy Ashford Road, between Memorial Drive and Briar Forest Drive.

4.2 Existing Storm Sewer Systems

Based on the COH Comprehensive Drainage Plan (CDP), Dairy Ashford Road drainage network is divided into multiple drainage systems. There are two (2) systems (W0195 and W0223) north of Buffalo Bayou and one (1) system (W0006) south of Buffalo Bayou. **Exhibit 7** illustrates the CDP Drainage Area Map.

The project alignment is served by three (3) independent storm sewer systems, as shown on **Exhibit 8**. The storm sewer mapping is prepared from record drawings, and the City's GIMS website. Runoff from the three (3) systems eventually discharges into HCFCD Channel W100-00-00 (Buffalo Bayou).

- System A – Briar Forest Drive to HCFCD Channel (CDP-W0006)
- System B – Memorial Drive to HCFCD Channel (CDP-W0195)
- System C – Memorial Drive to HCFCD Channel (CDP-W0223)

4.3 Drainage Areas

The drainage area boundaries for the project were developed from record drawings, historic data, LiDAR topographic data, GIMS, and field investigations. **Exhibit 8** shows Existing Drainage Area Map. **Table 4-1** shows drainage systems and associated sub-drainage areas.

Table 4-1: Drainage Systems and Sub Drainage Areas

Drainage System	CDP-Drainage System	Sub-Drainage Area
System A	W0006	A-South, A16 and A17
System B	W0195	B-North, B9, B12, B13, B14, B15 AND B16
System C	W0223	C1 to C6

4.4 Tailwater Condition

All the three (3) drainage systems within the project area outfall into HCFCD Channel W100-00-00 (Buffalo Bayou). W100-00-00 is a FEMA studied stream with flood elevations determined by detailed study methods. The tailwater elevation for the 2-year rainfall event was assumed to be the 10-year Water Surface Elevation (WSEL) of Buffalo Bayou (W100-00-00) channel. The tailwater for 100-year rainfall event was assumed to be the 100-year WSEL of Buffalo Bayou (W100-00-00) channel. For both the rainfall events, a variable tailwater for was used. Tailwater conditions

for both rainfall events are shown **Table 4-2. Table 4-3** shows the WSEL in conjunction with natural ground elevation at each outfall location for both the rainfall events.

Table 4-2: Tailwater Condition

Design Storm	Tailwater Condition
2-year	10-year WSEL (Buffalo Bayou)
100-year	100-year WSEL (Buffalo Bayou)

Table 4-3: Tailwater Elevations

Drainage System ID	2-Year	100-Year	Natural Ground
System A	64.0	72.0	75.0
System B	64.0	72.0	74.8
System C	64.0	72.0	74.8

4.5 Existing Peak Flows

There are total of sixteen (16) sub-drainage areas within the project limits. The following **Table 4-4** shows the Hydrological Computations (using Rational Method) for the each drainage area for 2- and 100-year rainfall events.

Table 4-4: Existing Hydrological Computations

Area ID	Total Area (Acres)	Tc (min.)	C	Intensity 2-Year (in/hr)	Intensity 100-Year (in/hr)	Peak Flows (cfs)	
						2-Year	100-Year
A-South (Offsite Area)	344.97	43.20	0.72	2.76	6.48	688.00	1613.78
A16	29.92	33.19	0.73	3.21	7.40	69.78	160.93
A17	6.90	29.05	0.56	3.46	7.92	13.39	30.66
B-North (Offsite Area)	68.23	36.00	0.79	3.06	7.10	165.87	384.45
B9	6.80	29.02	0.48	3.46	7.83	18.83	43.12
B12	4.93	28.24	0.80	3.51	8.03	13.86	31.69
B13	4.72	28.14	0.65	3.52	8.05	10.80	24.69
B14	1.34	25.53	0.73	3.71	8.45	3.61	8.21
B15	1.40	25.61	0.73	3.70	8.44	3.76	8.56
B16	1.62	25.89	0.73	3.68	8.39	4.33	9.86
C1	6.80	29.02	0.55	3.46	7.93	12.95	29.65
C2	11.89	30.46	0.55	3.37	7.73	22.03	50.58
C3	6.96	29.07	0.55	3.46	7.92	13.24	30.31
C4	8.39	29.54	0.55	3.43	7.86	15.82	36.25
C5	1.72	26.00	0.70	3.67	8.37	4.40	10.03
C6	2.08	26.38	0.70	3.65	8.31	5.32	12.13

4.6 EXISTING HYDRAULICS

Hydraulic analysis was performed for 2- and 100-year rainfall events to determine drainage system Level of Service (LOS).

An XPSWMM model was developed for each storm sewer system and for each rainfall event to evaluate the capacity of storm sewer, ponding in the streets, and overland flow in the streets.

- Each contributing drainage area was modeled as a node with the hydrograph inserted from the Clark Unit Hydrograph Method, modeled in HEC-HMS.
- The storm sewer conduit elevations were based on COH GIMS and record drawings.
- A variable tailwater at each outfall for each individual rainfall event was inserted into the XP SWMM model.

The configurations of nodes and links for the existing conditions XPSWMM models are shown on the schematic in **Appendix A.**

For the 2-year rainfall event, System B, Dairy Ashford Road at Memorial Drive do not have capacity to convery flows. All the three (3) systems do not have capacity to convey 100-year rainfall event flows. The criteria for 2-year rainfall event is for the Hydraulic Grade Line (HGL) to be below the pavement gutter line and for 100-year to be below right of way elevation. **Table 4-5** below shows the existing LOS for all the drainage systems within the project limits. The hydraulic data table outputs for existing conditions are in **Appendix B**. **Exhibit 13 and Exhibit 14** shows the 2-year and 100-year Ponding Area Map.

Table 4-5: Existing Drainage System - LOS

Drainage System ID	Rainfall Events	
	2-Year	100-Year
System A		X
System B	X	X
System C		X

NOTE: 'X' represents the systems that do not meet the required criteria

4.7 OVERLAND FLOW

The Overland flow map was developed using ArcGIS software's spatial analyst tool. The overland flow path is provided in **Exhibit 12** –Overland Flow Map. Overland flow drainage areas were considered in determining the sub-drainage areas and hydraulic analysis within the project limits.

Chapter 5 Proposed Drainage Analysis and Findings

5.1 Proposed Pavement Improvements

The proposed improvements along Dairy Ashford Road includes reconstruction of the existing roadway maintaining the existing lane configuration (2 lanes in each direction). The proposed roadway geometry will have a total of two (2) 12-foot travel lanes in each direction with a 32-foot wide median seperation, and 10-foot pedestrian realm on each side the pavement through the entire length of the project. The Proposed Typical Sections are shown in **Exhibit 4**.

5.2 Proposed Drainage Analysis

5.2.1 Proposed Drainage Areas

The drainage boundaries within the right of way and areas outside the right of way remained unchanged. **Exhibit 10** illustrates the Proposed Drainage Area Map.

5.2.2 Proposed Hydrology

The "C" values for each sub-drainage area within the right of way were computed based on the proposed impervious area. The "C" values for off-site areas outside the right of way will remain unchanged. A similar approach/methodology for proposed hydrology as described in the existing conditions was used to generate the peak flows using Rational Method. The following **Table 5-1** shows the proposed hydrological computations.

Table 5-1: Proposed Hydrological Computations

Area ID	Total Area (Acres)	Tc (min.)	C	Intensity 2-Year (in/hr)	Intensity 100-Year (in/hr)	Peak Flows (cfs)	
						2-Year	100-Year
A-South (Offsite Area)	344.97	43.20	0.72	2.76	6.48	688.00	1613.78
A16	29.92	33.19	0.73	3.21	7.40	69.87	161.15
A17	6.90	29.05	0.57	3.46	7.92	13.49	30.90
B-North (Offsite Area)	68.23	36.00	0.79	3.06	7.10	165.87	384.45
B9	6.80	29.02	0.8	3.46	7.93	18.83	43.12
B12	4.93	28.24	0.80	3.51	8.03	13.86	31.69
B13	4.72	28.14	0.65	3.52	8.05	10.81	24.71
B14	1.34	25.53	0.73	3.71	8.45	3.62	8.25
B15	1.40	25.61	0.73	3.70	8.44	3.78	8.61
B16	1.62	25.89	0.73	3.68	8.39	4.35	9.92
C1	6.80	29.02	0.55	3.46	7.93	12.95	29.66
C2	11.89	30.46	0.55	3.37	7.73	22.04	50.60
C3	6.96	29.07	0.55	3.46	7.92	13.24	30.33
C4	8.39	29.54	0.55	3.43	7.86	15.82	36.26
C5	1.72	26.00	0.70	3.67	8.37	4.42	10.07

Area ID	Total Area (Acres)	Tc (min.)	C	Intensity 2-Year (in/hr)	Intensity 100-Year (in/hr)	Peak Flows (cfs)	
						2-Year	100-Year
C6	2.08	26.38	0.71	3.65	8.31	5.35	12.20

5.2.3 Proposed Hydraulics

A similar approach as discussed in the existing condition was used to design the proposed system. The proposed storm sewers were designed to convey the 2-year rainfall event and checked for 100-year rainfall events.

The XPSWMM software was used to design the proposed system. Similar assumptions as described in existing conditions were considered to perform the proposed hydraulic analysis.

The existing XPSWMM models were modified to develop the proposed conditions models, as follows:

- Revised hydrographs were inserted into XPSWMM model.
- The storm sewers were re-sized to meet hydraulic grade line requirements for the 2-year.
- The storm sewer were checked for 100-year rainfall events.

Based on proposed hydraulic analysis, Systems A, System B and Systems C have capacity to convey 2-year and 100-year rainfall event flows.

The following **Table 5-2** shows the required improvements to the storm sewers in order to convey the 2-year and 100-year flows and meet the City requirements. **Exhibits 11** show the proposed storm sewer layout. **Exhibit 15** and **Exhibit 16** shows the Proposed 2-year and 100-year Ponding Map. The configurations of nodes and links for the proposed conditions XPSWMM models are shown on the **Appendix C**. The hydraulic data tables for proposed conditions are in **Appendix D**.

Table 5-2: Proposed Storm Sewer improvements

System Name	Existing Storm Size	Proposed Storm Size
System A	108” to 114”	132” to 162”
System B	54” to 60”	72” to 114”
System C	24” to 36”	42” to 78”

In general, the existing storm sewers and leads will be either abandoned and grouted in place, or removed and replaced. Existing inlets will typically be removed to accommodate the paving improvements.

5.3 Existing and Proposed Level of Service (LOS) Comparison

Table 5-3 shows comparison between existing and proposed drainage level of service.

Table 5-3: Existing vs Proposed - LOS

Drainage System ID	Rainfall Events			
	2-Year		100-Year	
	Exist	Prop	Exist	Prop
System A			X	
System B	X		X	
System C			X	

Note: 'X' represents the systems that do not meet the required criteria

Under proposed conditions all the systems have capacity to convey 2-year and 100-year rainfall event flow. Based on analysis, the HGL's for the proposed drainage systems are lower than the existing conditions HGL's.

5.4 Detention Computations

Detention volume for the increase in impervious area was calculated based on the 2020 IDM detention requirements for capital improvement projects. The net increase in impervious area within the right of way for each drainage system is shown in **Table 5-4**.

Table 5- 4: Impervious Cover Calculation

System	Existing Impervious Area in ROW (Acres)	Proposed Impervious Area in ROW (Acres)	Increase in Impervious Area (Acres)
Buffalo Bayou Watershed			
System A, B &C	9.92	10.97	1.06

Per the City's criteria, the total detention volume required is 0.75 acre-feet per acre of increase in impervious area, which is 0.80 acre-feet (approximately 34,630 cft). The required detention volume is provided as in-line detention (upsizing the proposed storm sewers). **Table 5-5** shows the additional volume provided as in-line detention.

Table 5-5: Detention Volume Provided

System	Existing In-Line Detention (CFT) (D1)	Proposed In-Line Detention (CFT) (D2)	Additional In-Line Detention (CFT) (D2-D1)
System A	184,357.03	300,503.76	116,146.73
System B	49,798.20	106,017.20	56,219.00
System C	16,278.50	43,233.47	26,954.97
Detention Volume Provided			**199,320.70**

5.5 Peak Flow Impact Analysis

A comparison between existing and proposed 2-year outfall flow rates at each individual outfall was made to check if the proposed storm sewer improvements have any adverse flow impact on the receiving system. For the 2-year rainfall event, System B and C have an increase in flow of 36.21 and 28.45 cfs respectively at the outfalls. For the 2-year rainfall event, System A has a decrease in flow of 20.08 cfs at the outfall.

Chapter 6 Conclusions

This study investigates the drainage requirements and impacts of proposed paving improvements along Dairy Ashford Road from Memorial Drive to Brair Forest Drive. An additional objective of the drainage impact study is to determine if the existing drainage system has adequate capacity to convey the flow and meet the COH drainage criteria. The intent of the study was to address any drainage deficiencies.

The drainage study includes analysis of the existing storm sewer for a 2- and 100-year rainfall event to determine the capacity and LOS of each drainage system. From existing analysis, it was determined that the existing storm sewers along Dairy Ashford Road do not have sufficient capacity to convey runoffs from 100-year rainfall event. Therefore, new storm sewer systems were designed for the 2-year event and also analyzed for the 100-year rainfall event. The proposed Systems A, B and C can convey flows from the 2-year rainfall event and accommodate the flows from 100-year rainfall event.

The total required detention volume due to increase in impervious area is approximately 34,630 cubic feet. The required detention volume is provided as in-line detention, by upsizing the proposed storm sewers.

A comparison of existing and proposed 2-year outfall flow rates was made to determine if the proposed improvements have any adverse impact to the receiving system. For the 2-year rainfall event, System B and C have an increase in flow of 36.21 and 28.45 cfs respectively at the system outfalls. System A has a decrease in flow of 20.08 cfs at the outfall.

Exhibit E1
Vicinity Map

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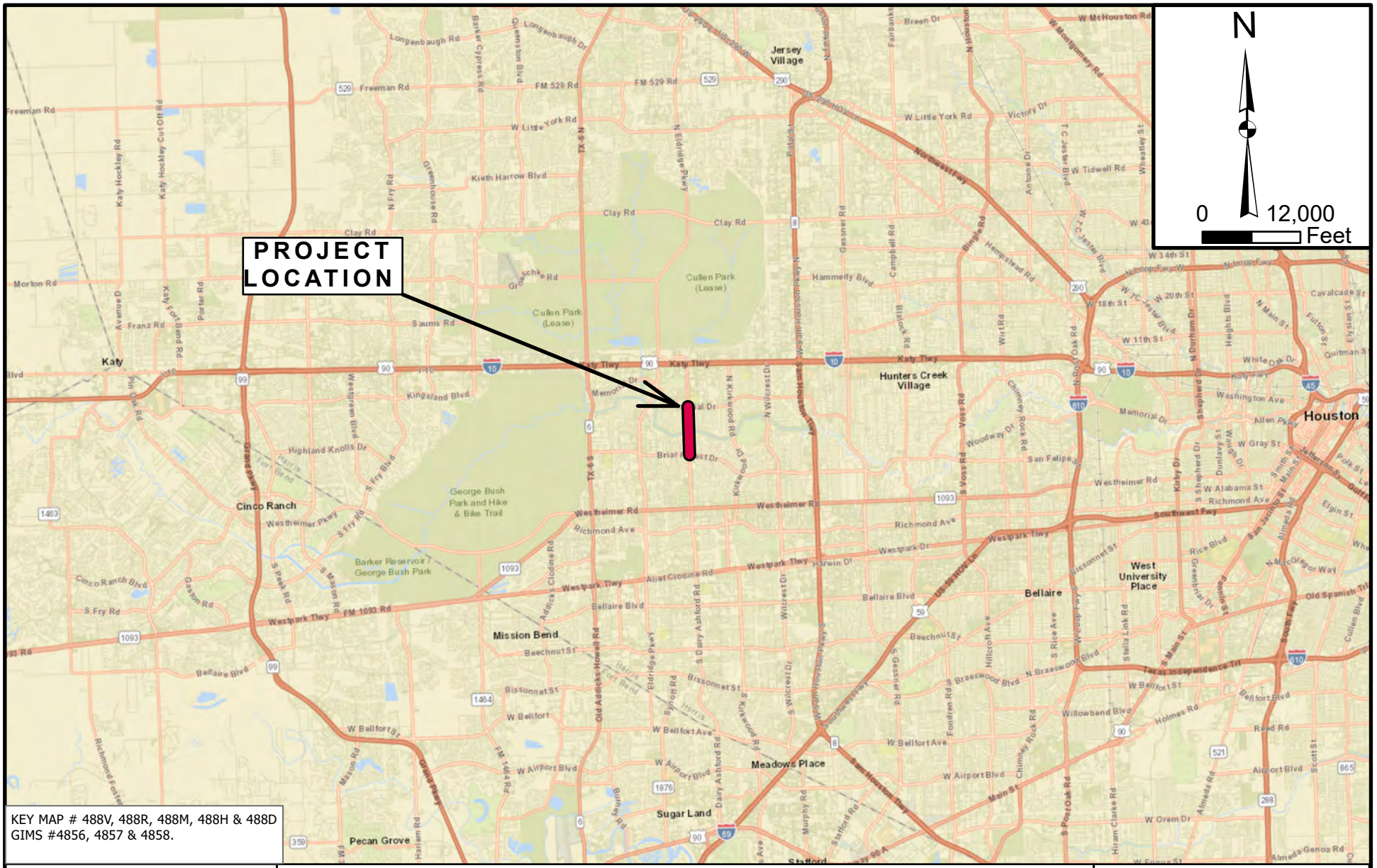

KEY MAP # 488V, 488R, 488M, 488H & 488D
GIMS #4856, 4857 & 4858.

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HOUSTON PUBLIC WORKS

PROJECT VICINITY MAP

LEGEND

PROJECT LIMITS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

EXHIBIT NO: 1

City of Houston, HPB, Esri, HERE, Garmin, NGA, USGS, NPS

Exhibit E2
Location Map

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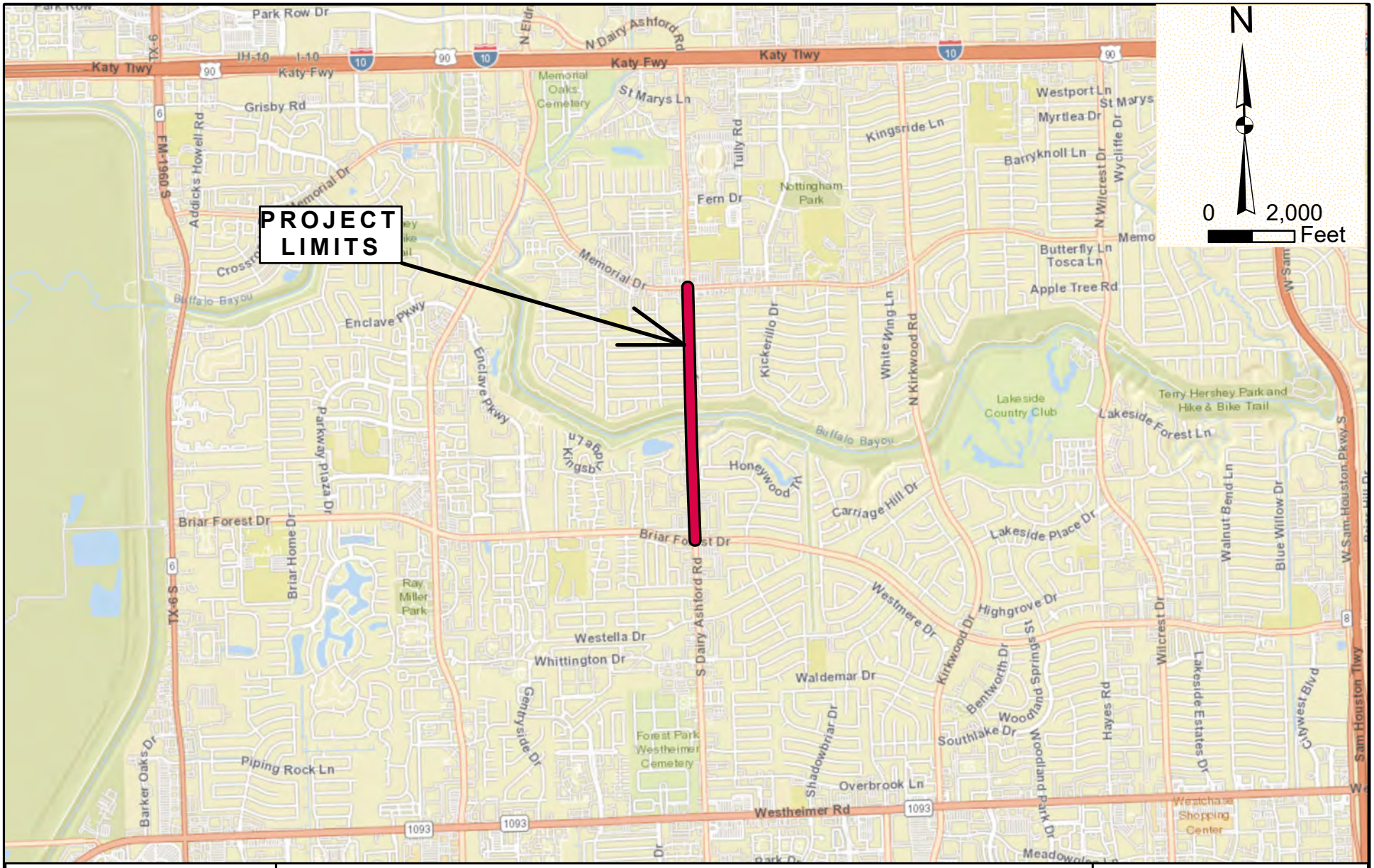

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HOUSTON PUBLIC WORKS

LOCATION MAP

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

EXHIBIT NO: 2

LEGEND

PROJECT LIMITS

City of Houston, HPB, Esri, HERE, Garmin, NGA, USGS, NPS, City of Houston, HPB, Esri, HERE, Garmin, GeoTechnologies, Inc., NGA, USGS

Exhibit E3
Project Layout

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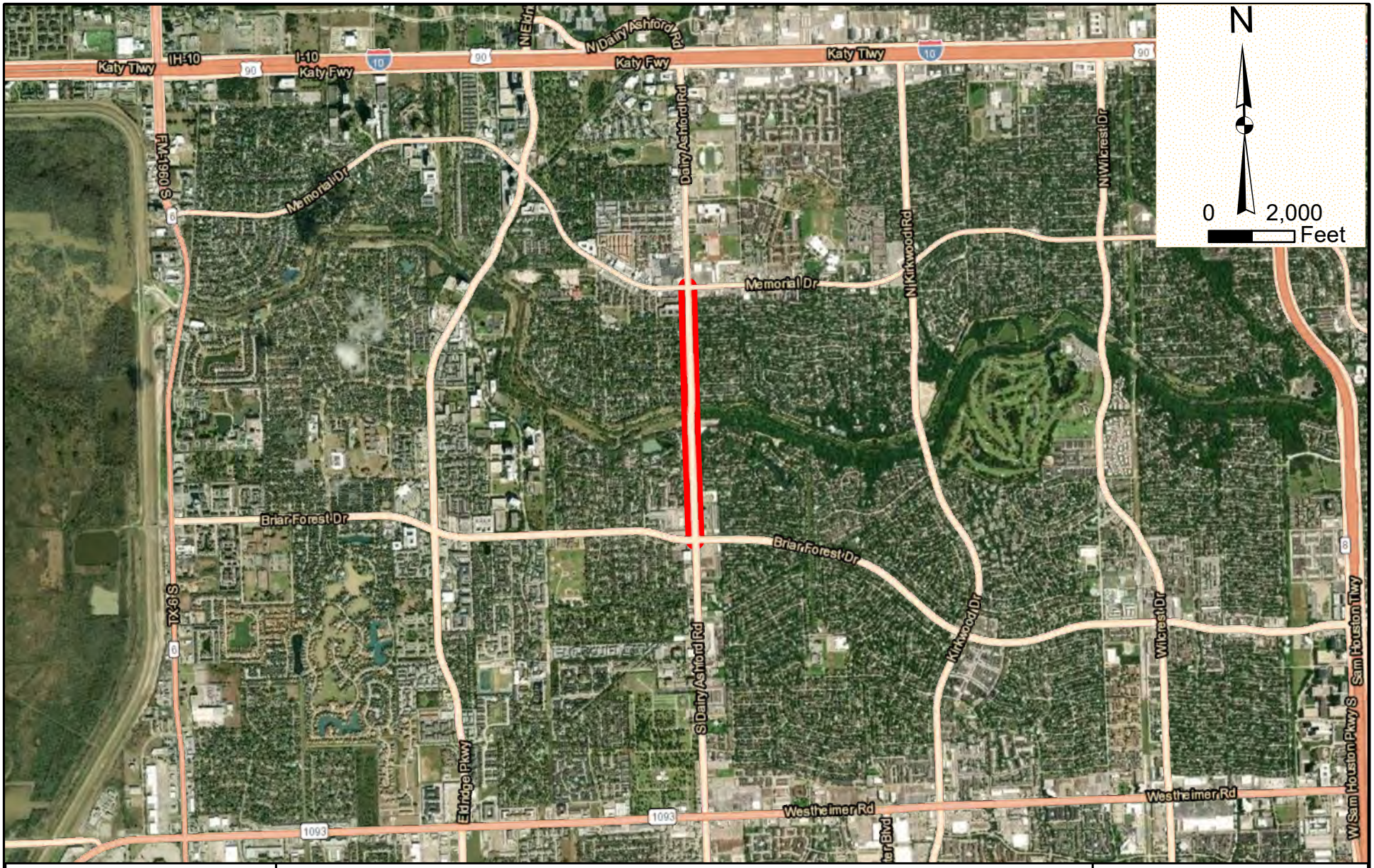

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HOUSTON PUBLIC WORKS

PROJECT LAYOUT

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

EXHIBIT NO: 3

LEGEND

Study_limit

Earthstar Geographics, City of Houston, Esri, HERE, Maxar

Exhibit E4
Roadway Typical Sections

GUNDA
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100'-105' ROW
EXTENTS:- BRIAR FOREST DRIVE TO MEMORIAL DRIVE

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Houston, Texas 77079

HOUSTON PUBLIC WORKS

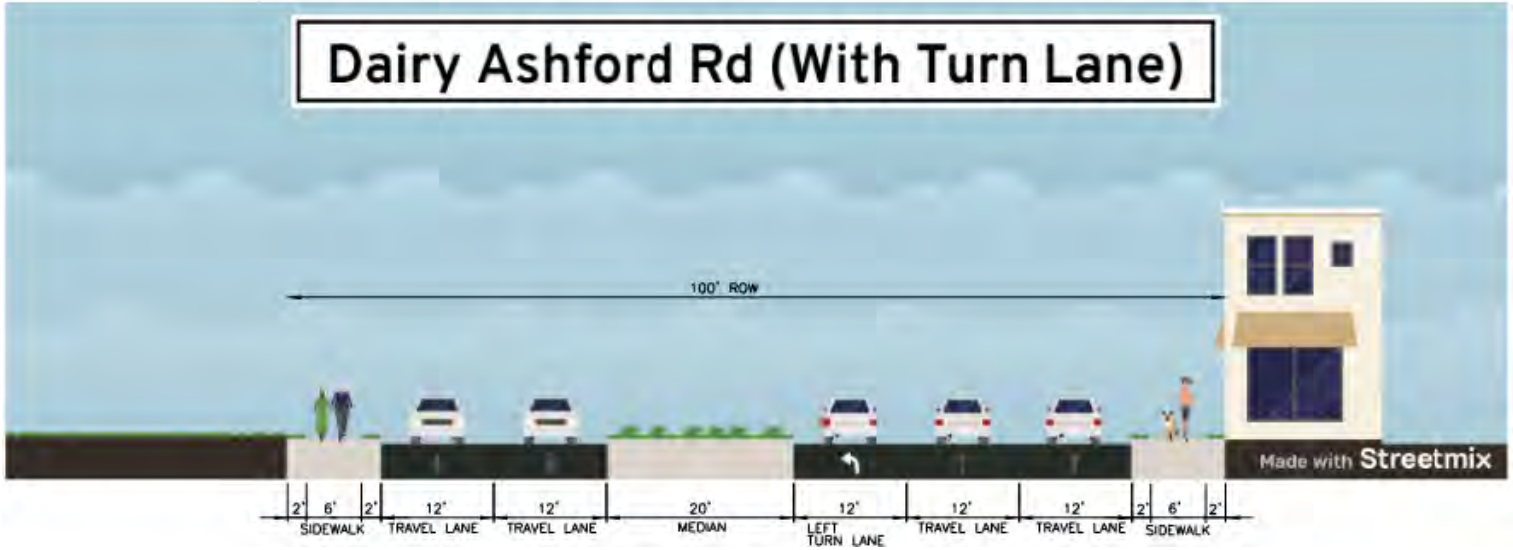
EXISTING TYPICAL SECTIONS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

EXHIBIT NO: 4 A

PROPOSED CONDITIONS



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PROPOSED TYPICAL SECTIONS

HOUSTON PUBLIC WORKS

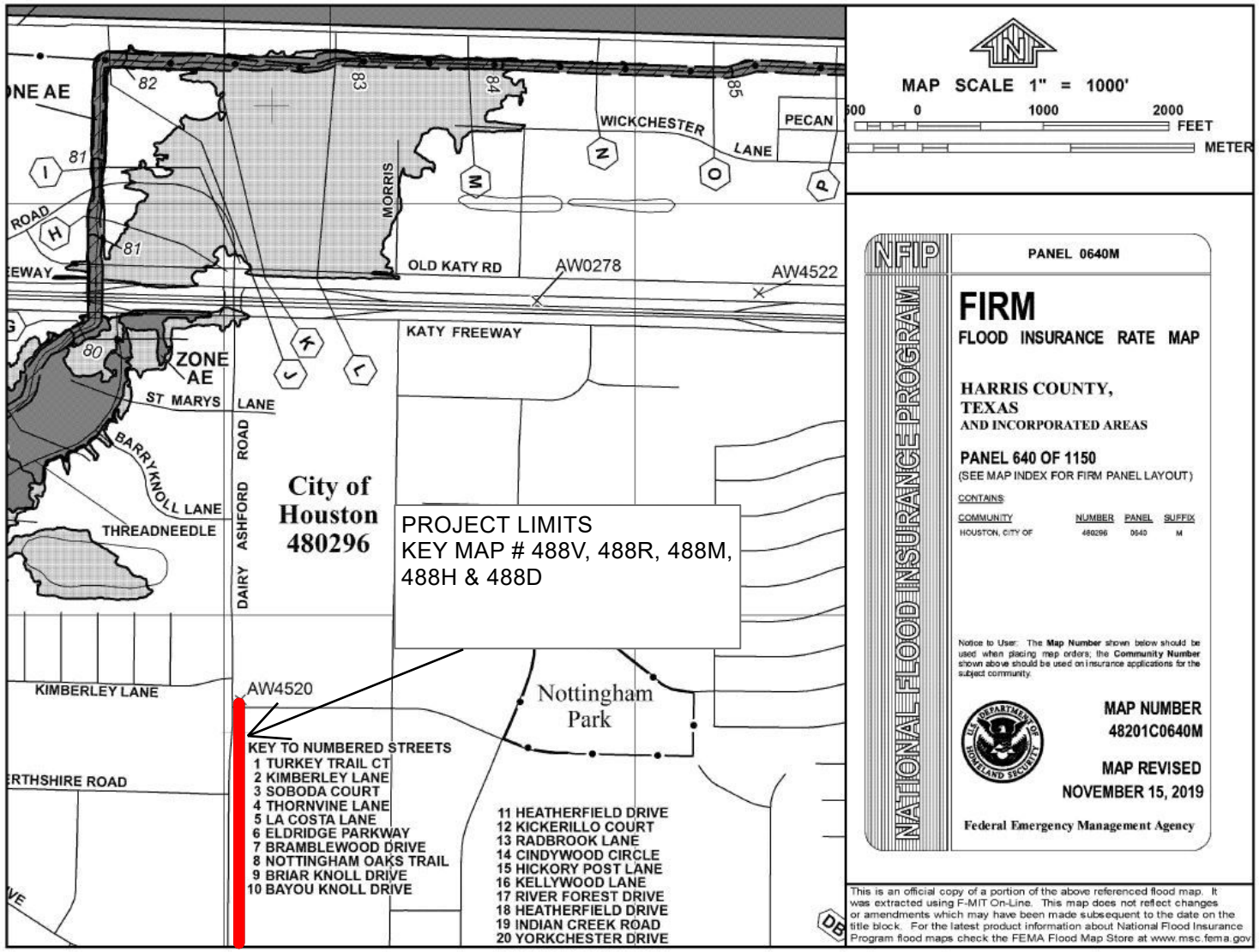
TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

EXHIBIT NO: 4 B

Exhibit E5
Floodplain Map

GUNDA
CORPORATION
Engineers, Planners & Managers



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FEMA FLOODPLAIN MAP

LEGEND

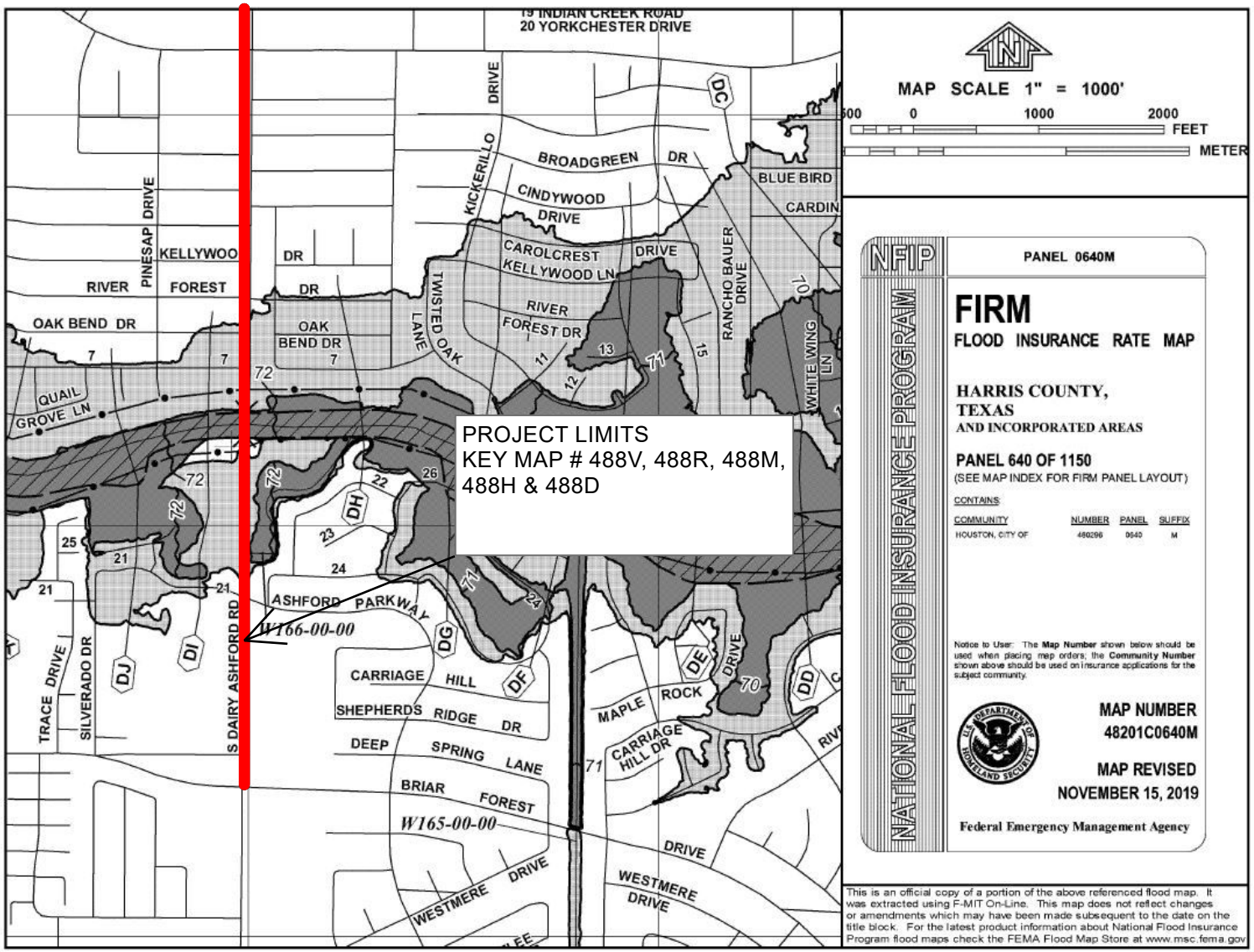
PROJECT LIMITS

HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

EXHIBIT NO: 5 A



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HOUSTON PUBLIC WORKS

FEMA FLOODPLAIN MAP

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

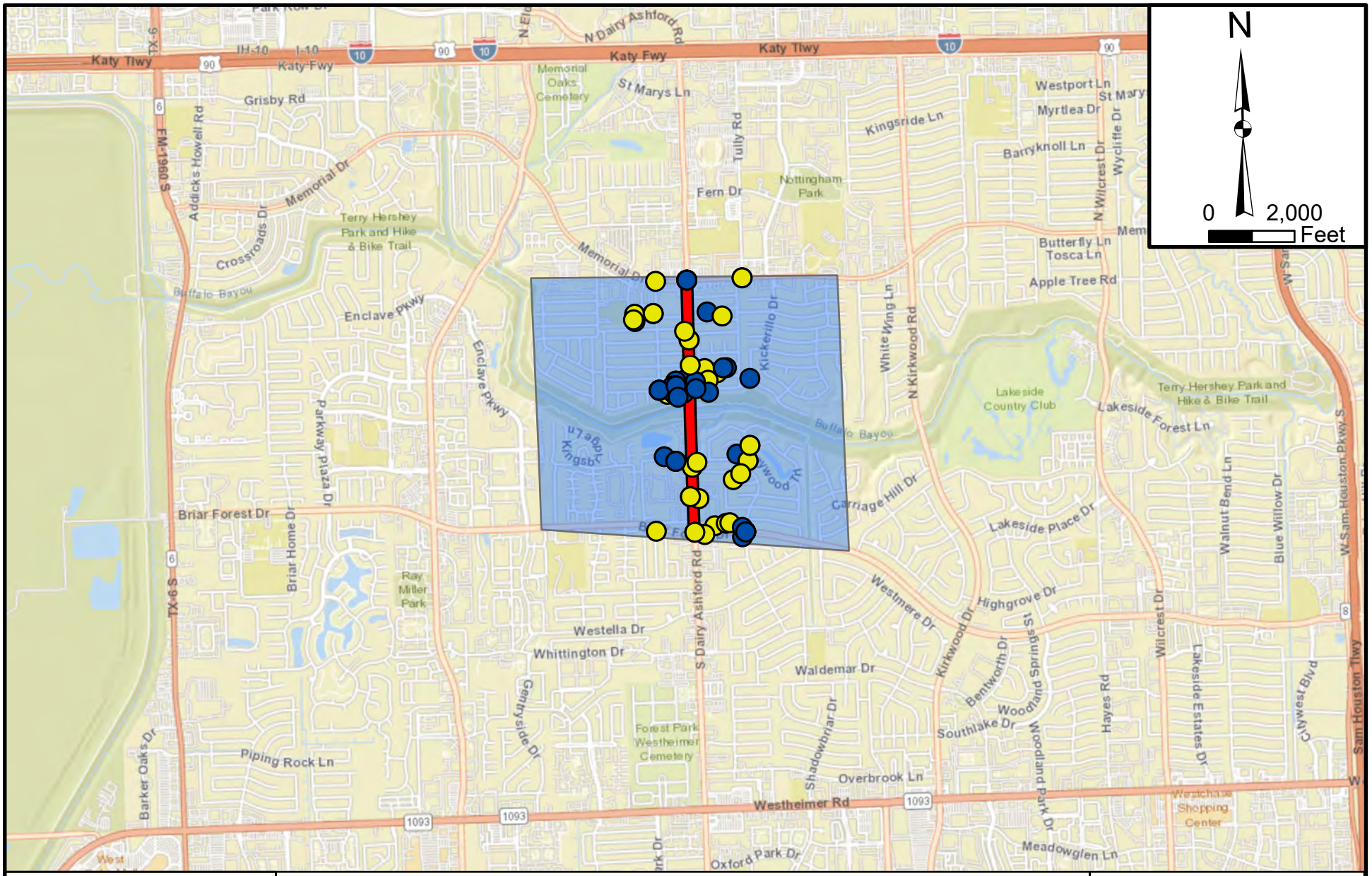
EXHIBIT NO: 5 B

LEGEND

PROJECT LIMITS

Exhibit E6
311 Complaint Map

GUNDA
CORPORATION
Engineers, Planners & Managers



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HOUSTON PUBLIC WORKS

FLOOD COMPLAINT MAP

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

EXHIBIT NO: 6

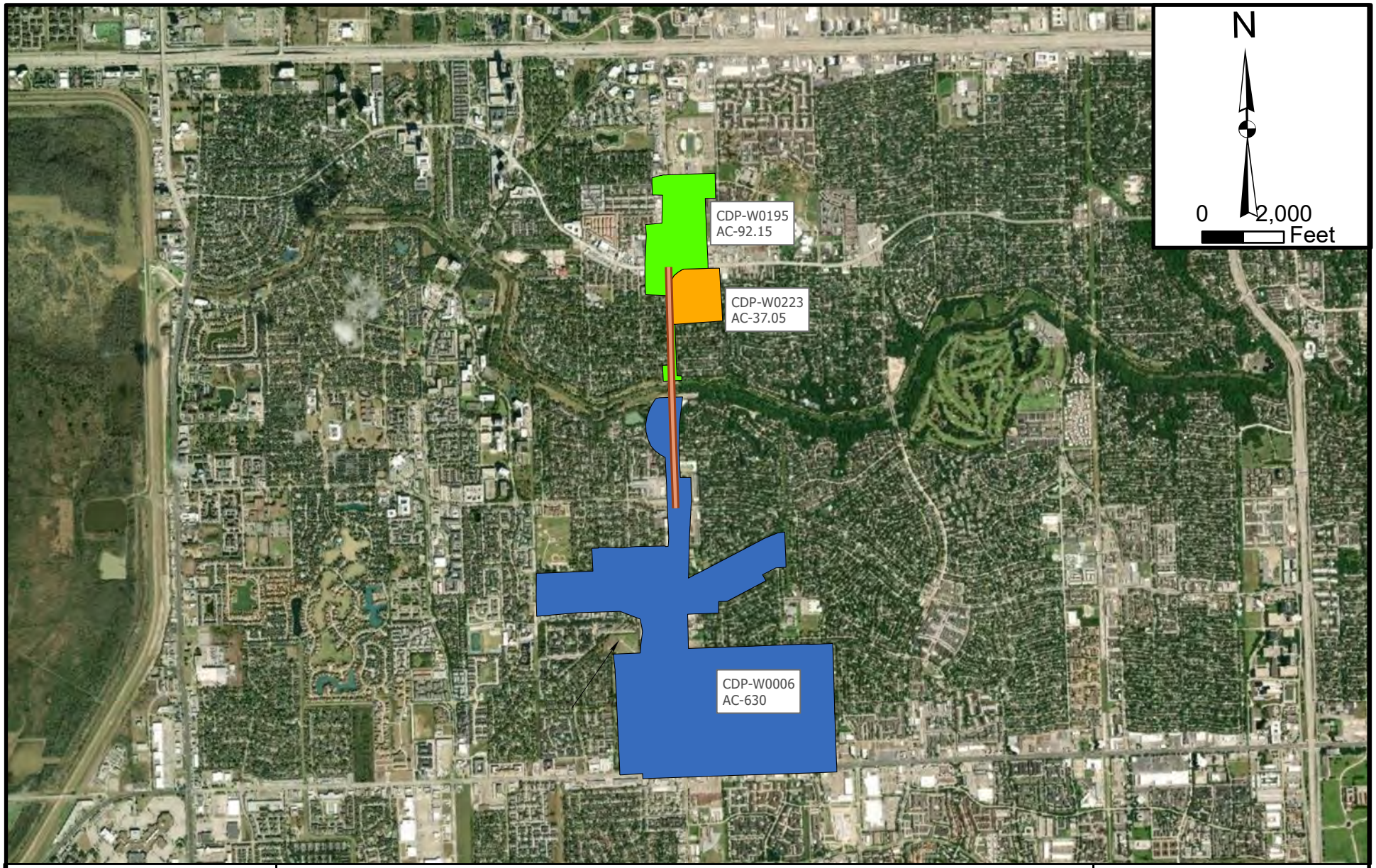
LEGEND

- DRAINAGE
- FLOODING
- PROJECT LIMITS
- STUDY AREA

City of Houston, HPB, Esri, HERE, Garmin, GeoTechnologies, Inc., NGA, USGS

Exhibit E7
CDP Drainage Area Map

GUNDA
CORPORATION
Engineers, Planners & Managers



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HOUSTON PUBLIC WORKS

OVERALL DRAINAGE AREA MAP

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

EXHIBIT NO: 7

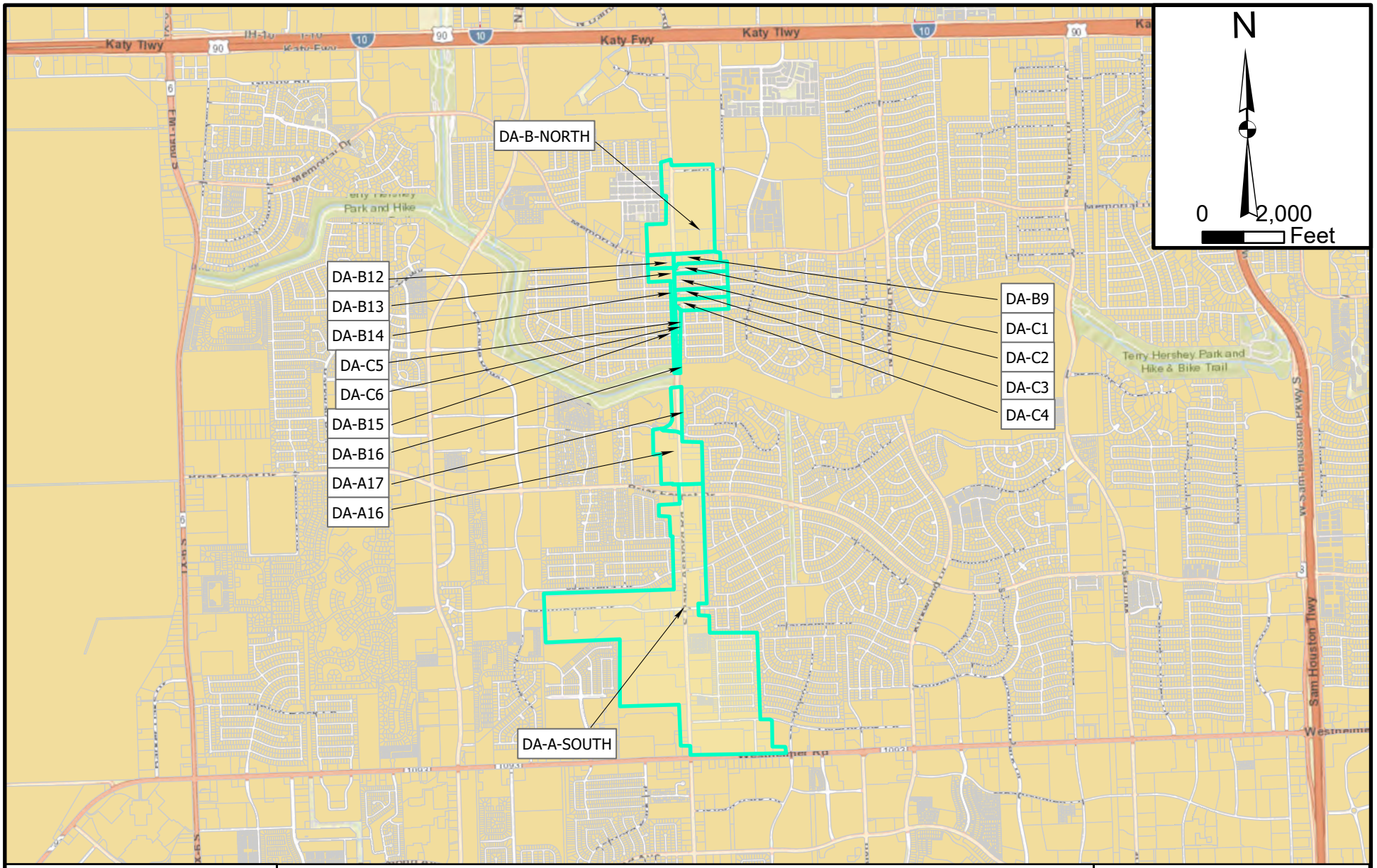
LEGEND

- PROJECT LIMITS
- W0006
- W0223
- W0195

Maxar

Exhibit E8
Existing Drainage Area Map

GUNDA
CORPORATION
Engineers, Planners & Managers



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Houston, Texas 77079

EXISTING DRAINAGE AREA MAP

LEGEND

- COH_PARCELS
- SUB DRAINAGE AREAS

HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

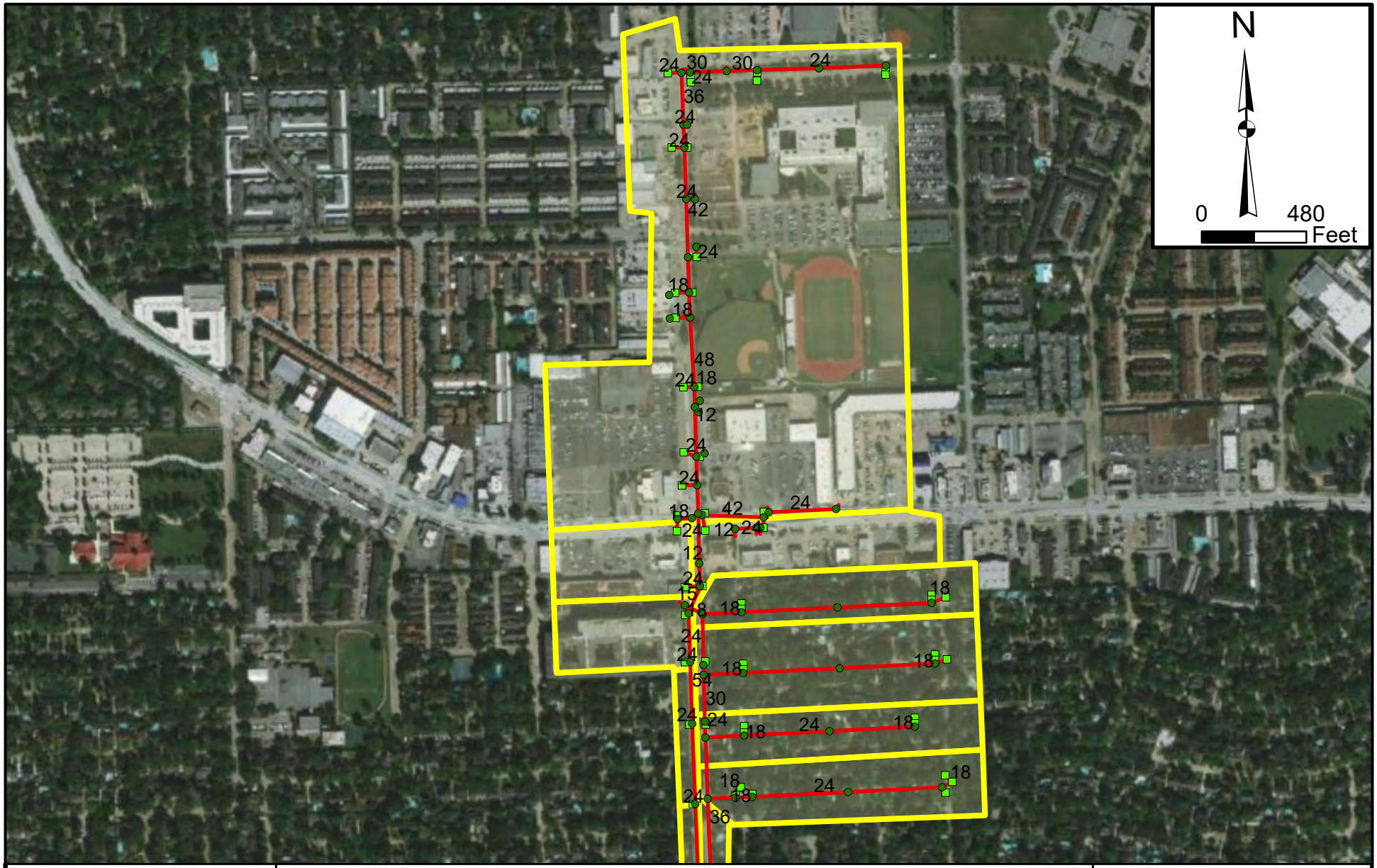
MAY 2022

EXHIBIT NO: 8

City of Houston, HPB, Esri, HERE, Garmin, GeoTechnologies, Inc., NGA, USGS

Exhibit E9
Existing Storm Sewer layout

GUNDA
CORPORATION
Engineers, Planners & Managers



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EXISTING STORM SEWER LAYOUT

HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

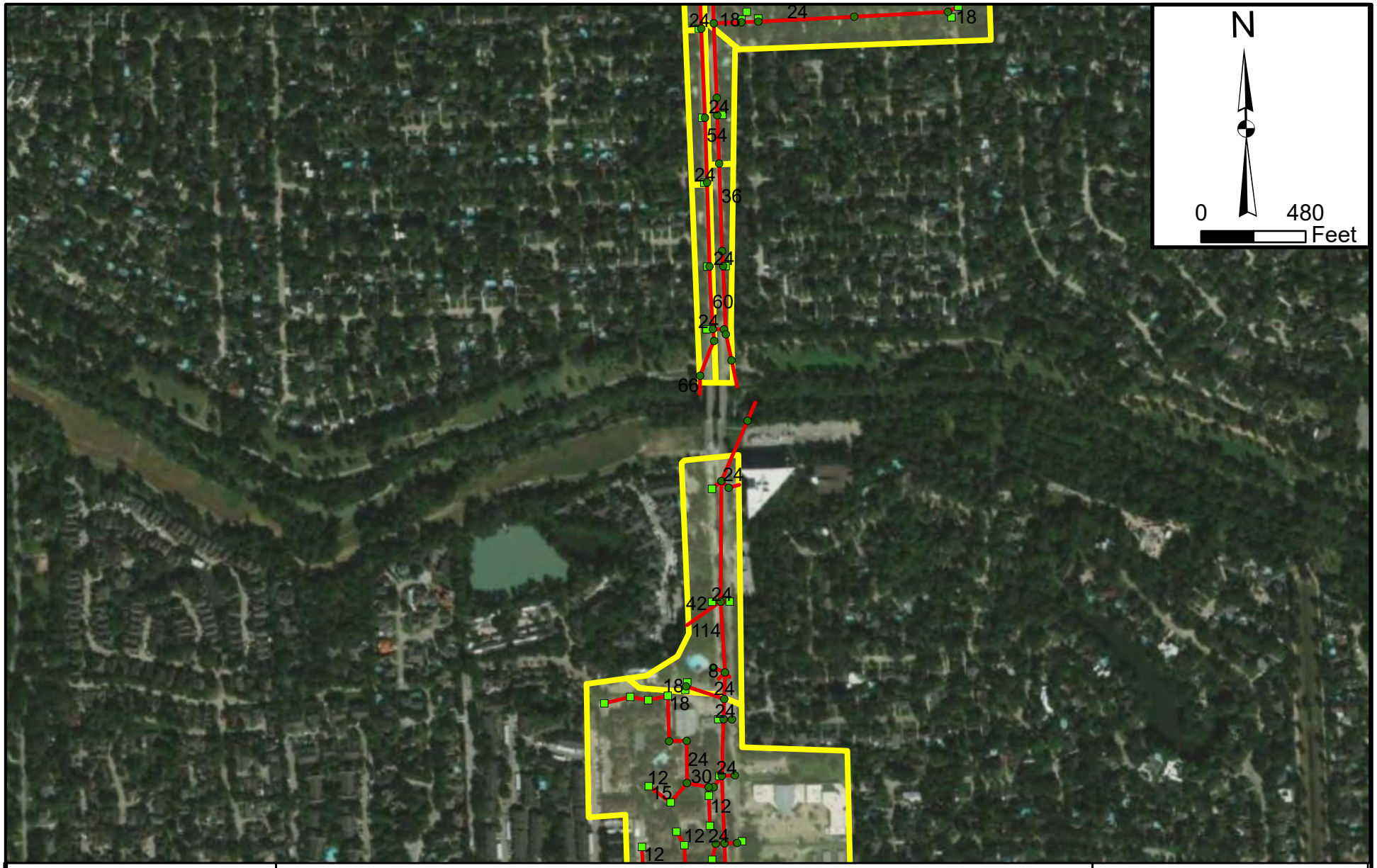
MAY 2022

EXHIBIT NO: 9 A

LEGEND

- EXISTING STORM NETWORK
- EXISTING STORM INLETS
- EXISTING STORM MH
- SUB DRAINAGE AREA

Maxar



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EXISTING STORM SEWER LAYOUT

HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

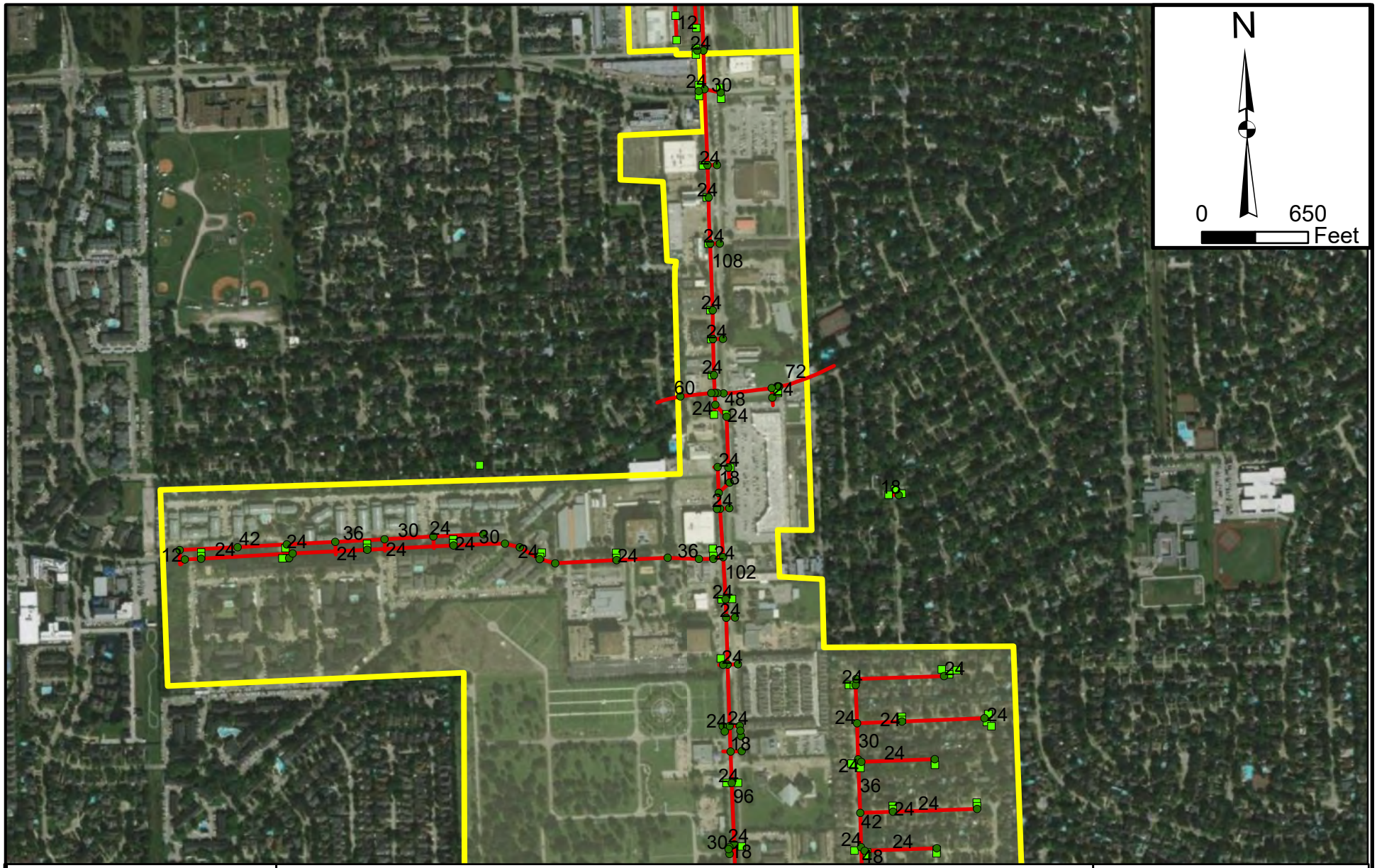
MAY 2022

EXHIBIT NO: 9 B

LEGEND

- EXISTING STORM NETWORK
- EXISTING STORM INLETS
- EXISTING STORM MH
- SUB DRAINAGE AREA

Source: Esri, Maxar



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EXISTING STORM SEWER LAYOUT

HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

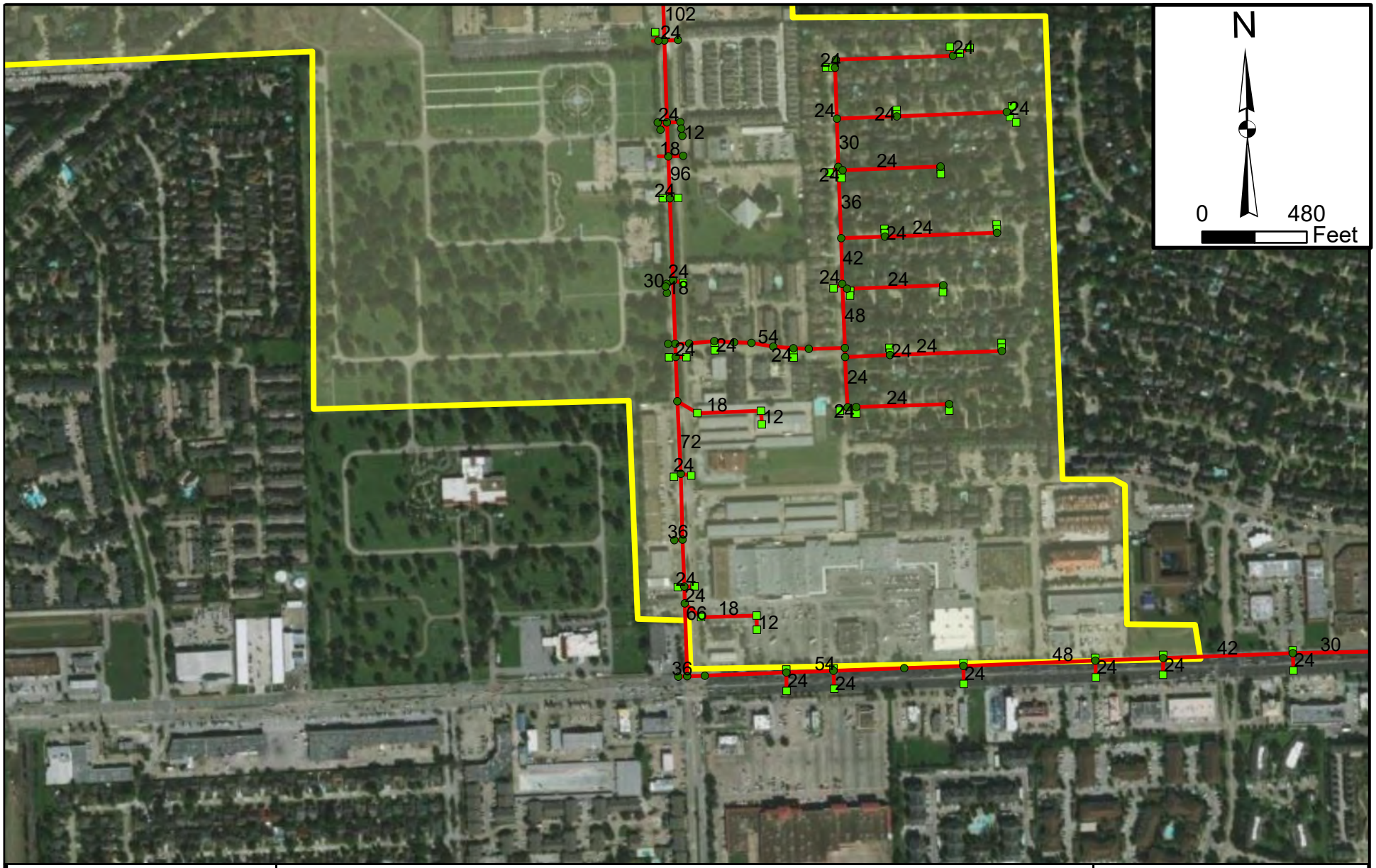
MAY 2022

EXHIBIT NO: 9 C

LEGEND

- EXISTING STORM NETWORK
- EXISTING STORM INLETS
- EXISTING STORM MH
- SUB DRAINAGE AREA

Source: Esri, Maxar



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EXISTING STORM SEWER LAYOUT

HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

EXHIBIT NO: 9 D

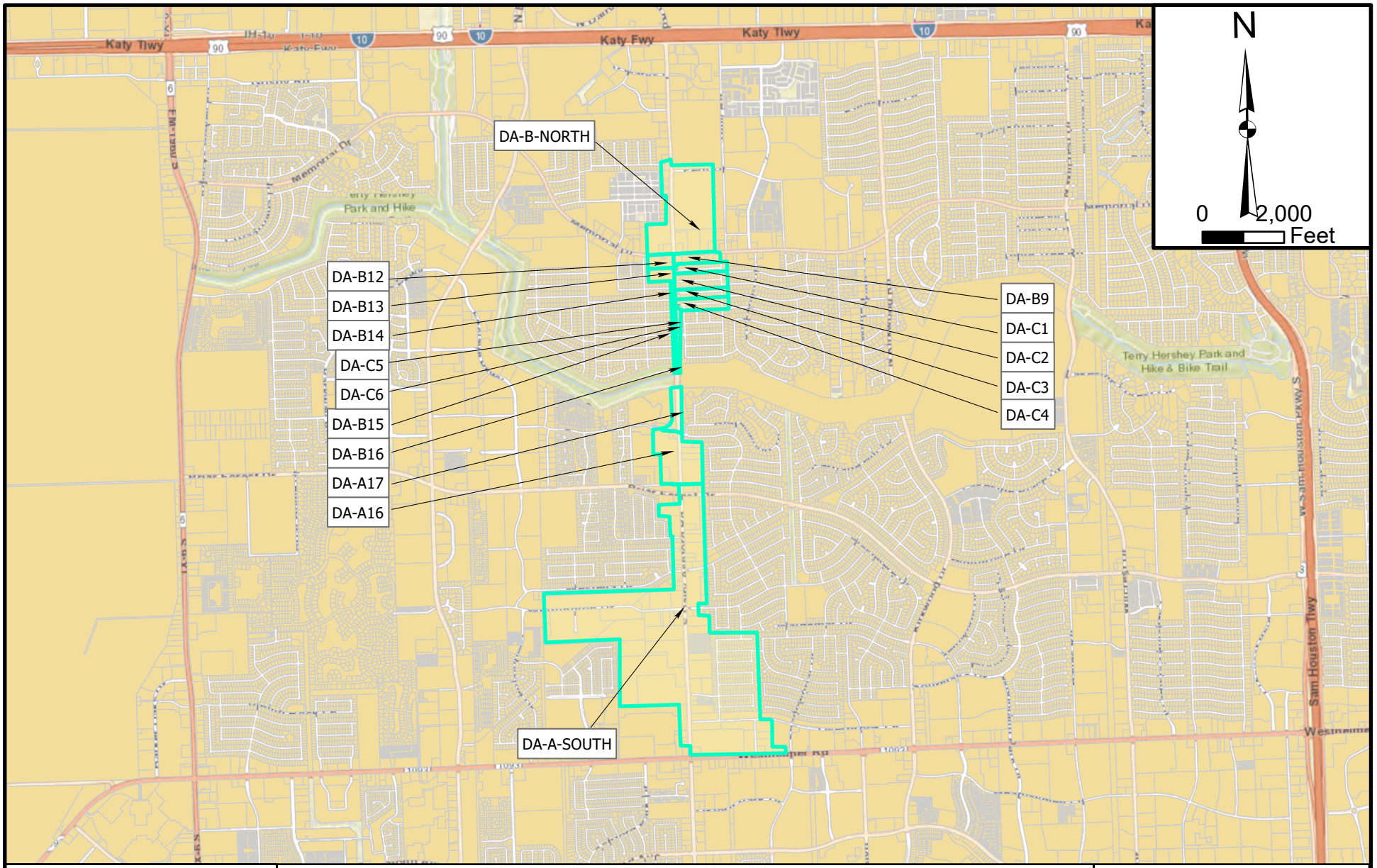
LEGEND

- EXISTING STORM NETWORK
- EXISTING STORM INLETS
- EXISTING STORM MH
- SUB DRAINAGE AREA

Source: Esri, Maxar

Exhibit E10
Proposed Drainage Area Map

GUNDA
CORPORATION
Engineers, Planners & Managers



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Houston, Texas 77079

PROPOSED DRAINAGE AREA MAP

LEGEND

- COH_PARCELS
- SUB DRAINAGE AREAS

HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

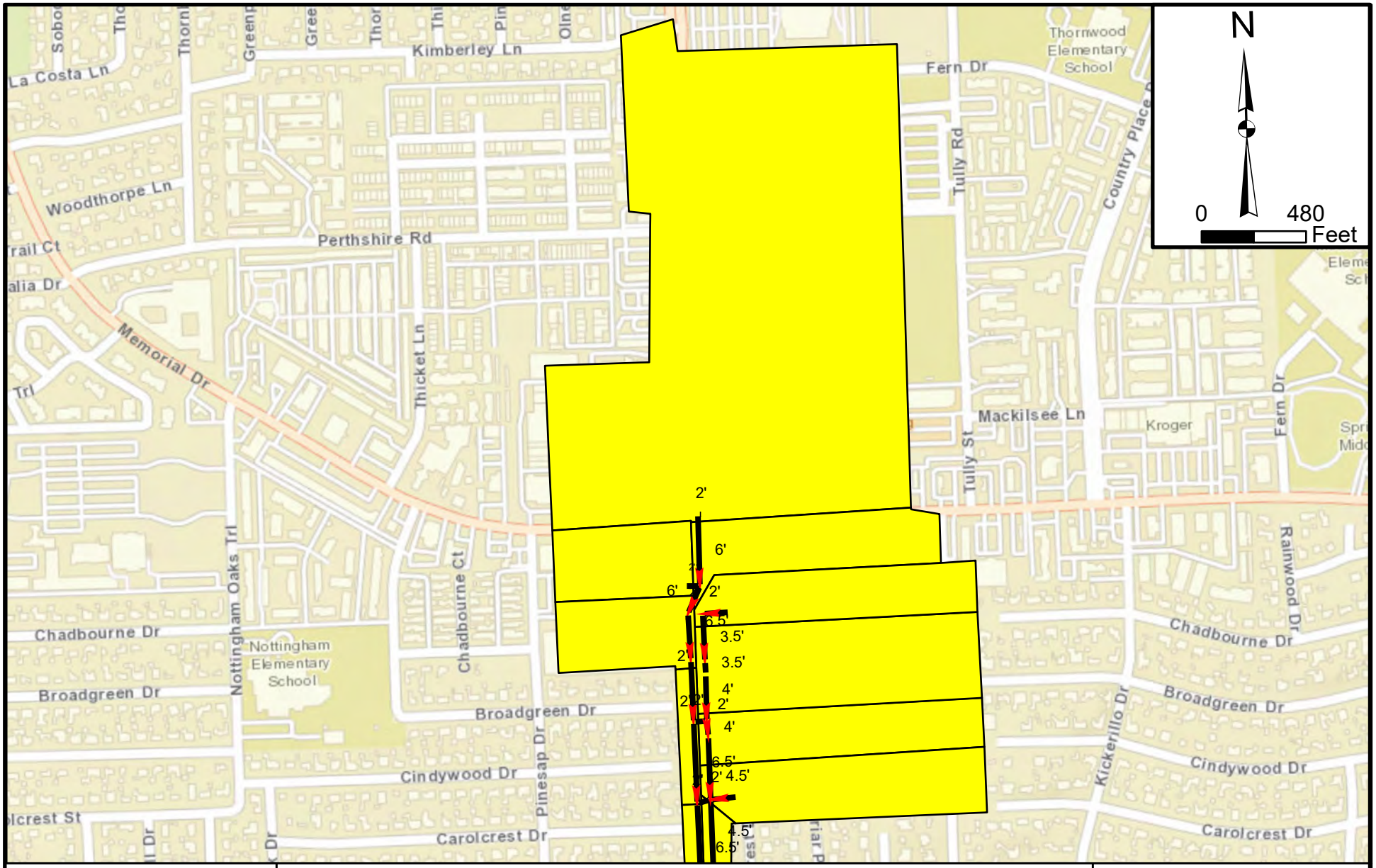
MAY 2022

EXHIBIT NO: 10

City of Houston, HPB, Esri, HERE, Garmin, GeoTechnologies, Inc., NGA, USGS

Exhibit E11
Proposed Storm Sewer Layout

GUNDA
CORPORATION
Engineers, Planners & Managers



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Houston, Texas 77079

PROPOSED STORM SEWER LAYOUT

LEGEND

- SUB DRAINAGE AREA
- North Sub System Proposed Links
- South Sub System Proposed Links

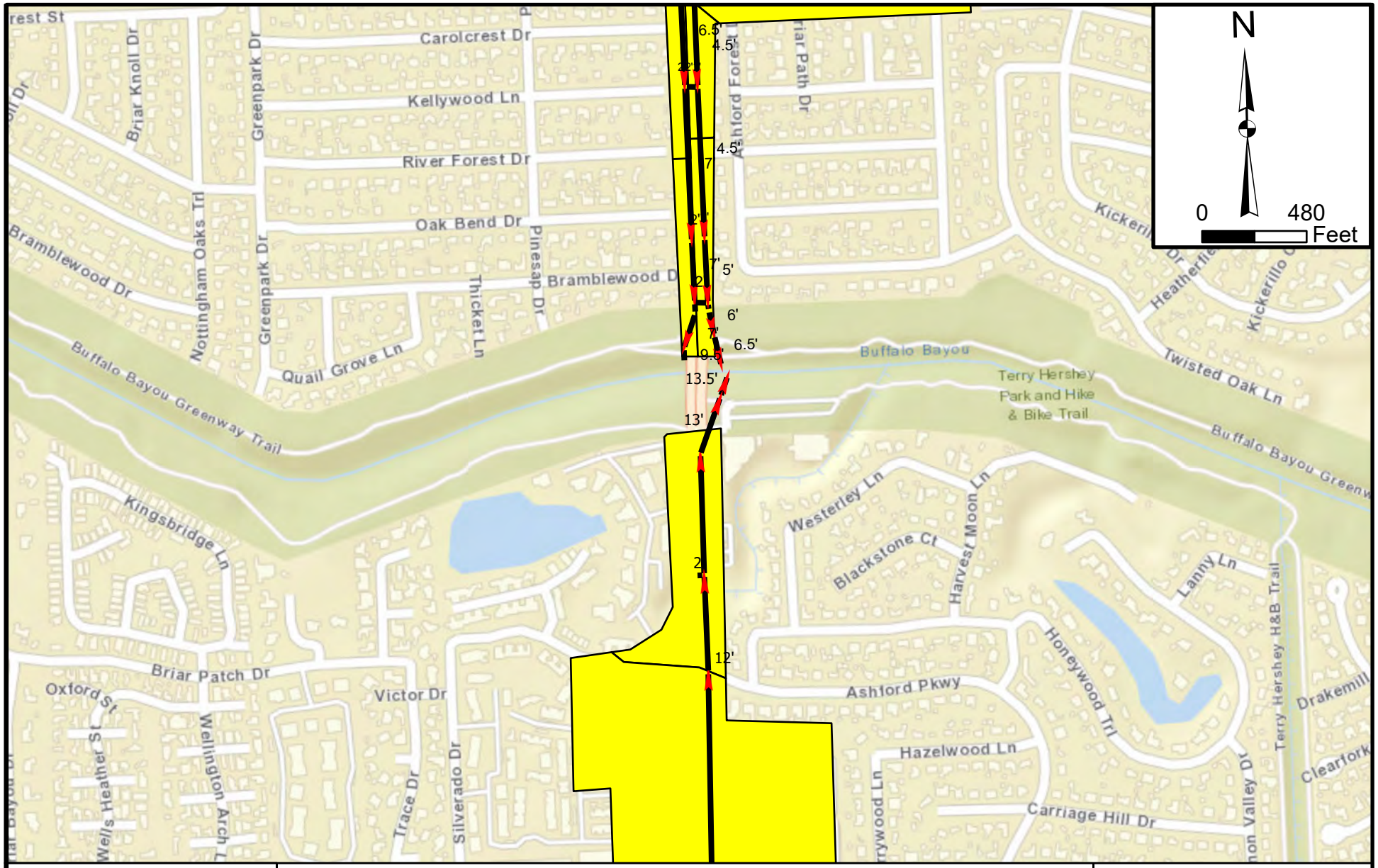
HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

EXHIBIT NO: 11A

City of Houston, HPB, Esri, HERE, Garmin, GeoTechnologies, Inc., NGA, USGS



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Houston, Texas 77079

PROPOSED STORM SEWER LAYOUT

LEGEND

- SUB DRAINAGE AREA
- North Sub System Proposed Links
- South Sub System Proposed Links

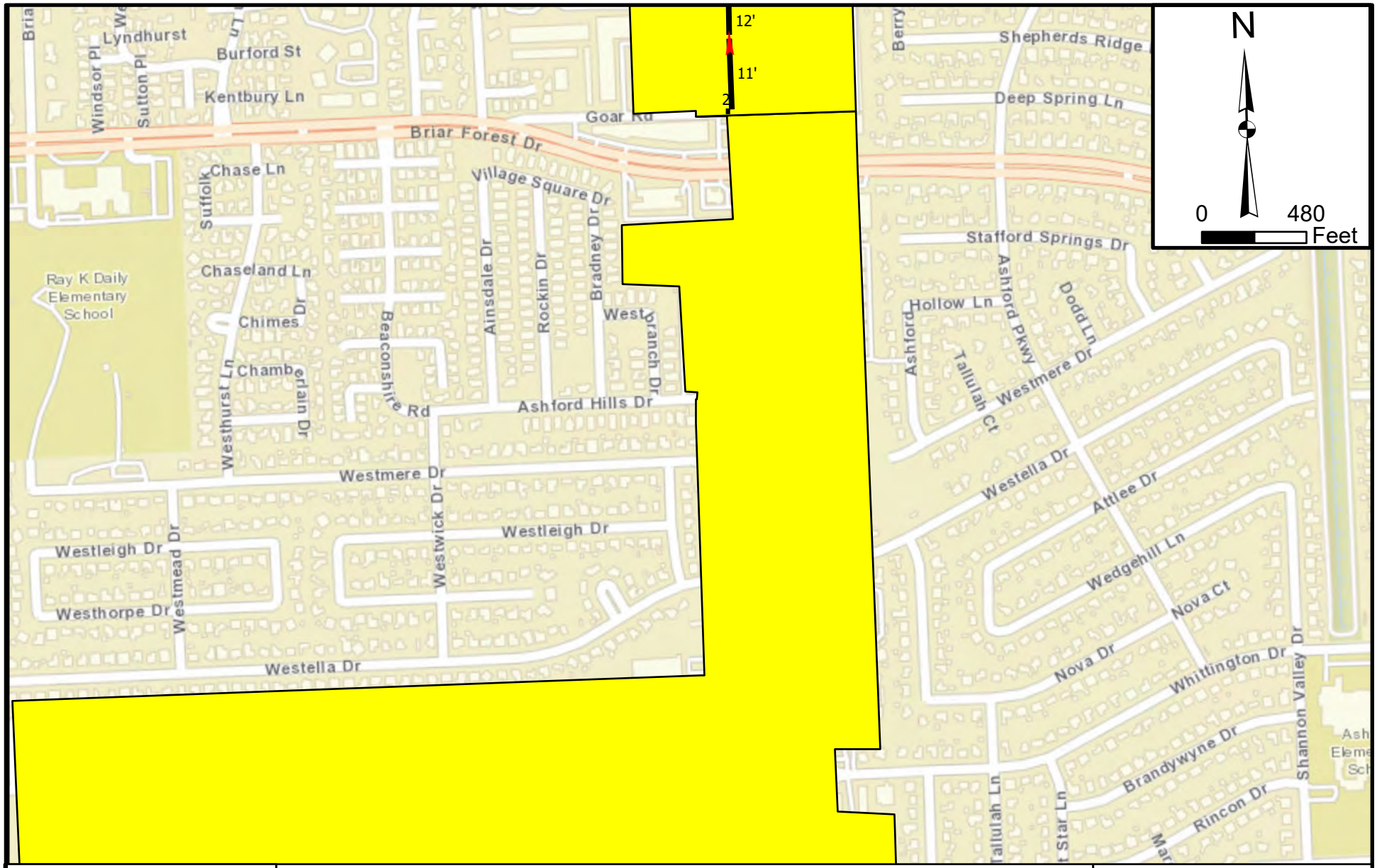
HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

EXHIBIT NO: 11B

City of Houston, HPB, Esri, HERE, Garmin, GeoTechnologies, Inc., NGA, USGS



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Houston, Texas 77079

PROPOSED STORM SEWER LAYOUT

LEGEND

- SUB DRAINAGE AREA
- North Sub System Proposed Links
- South Sub System Proposed Links

HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

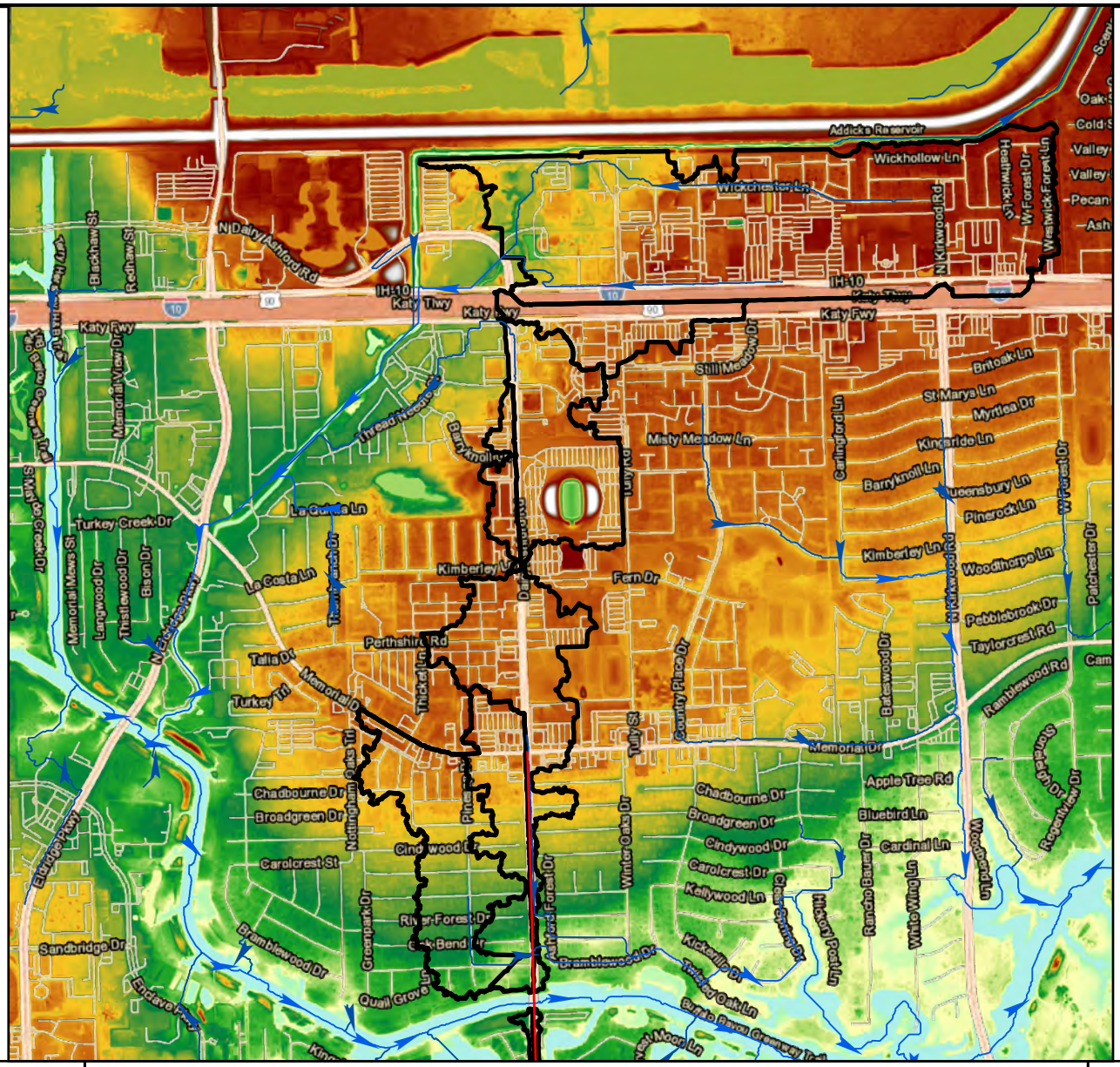
MAY 2022

EXHIBIT NO: 11C

City of Houston, HPB, Esri, HERE, Garmin, GeoTechnologies, Inc., NGA, USGS

Exhibit E12
Overland Flow Map

GUNDA
CORPORATION
Engineers, Planners & Managers



N

0 1,900 Feet

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HOUSTON PUBLIC WORKS

OVERALAND FLOW MAP

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

EXHIBIT NO: 12 A

LEGEND

PROJECT LIMITS

OVERLAND DRAIN AREA

Layer

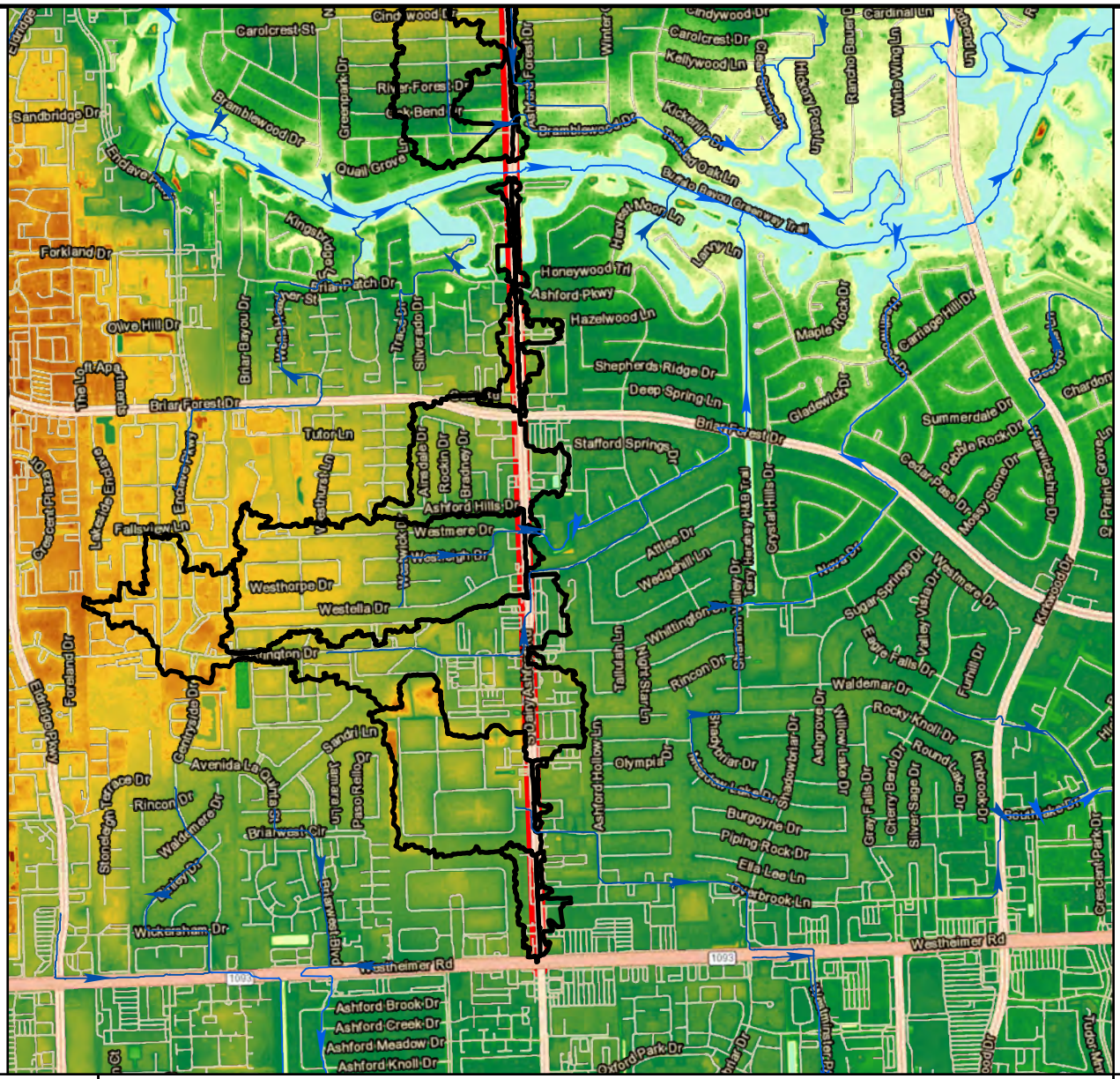
Value

120.87

48.45

FLOW PATH

City of Houston, Esri, HERE, GeoTechnologies, Inc., Esri, FAO, NOAA, Maxar



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Houston, Texas 77079

HOUSTON PUBLIC WORKS

OVERALAND FLOW MAP

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

EXHIBIT NO: 12 B

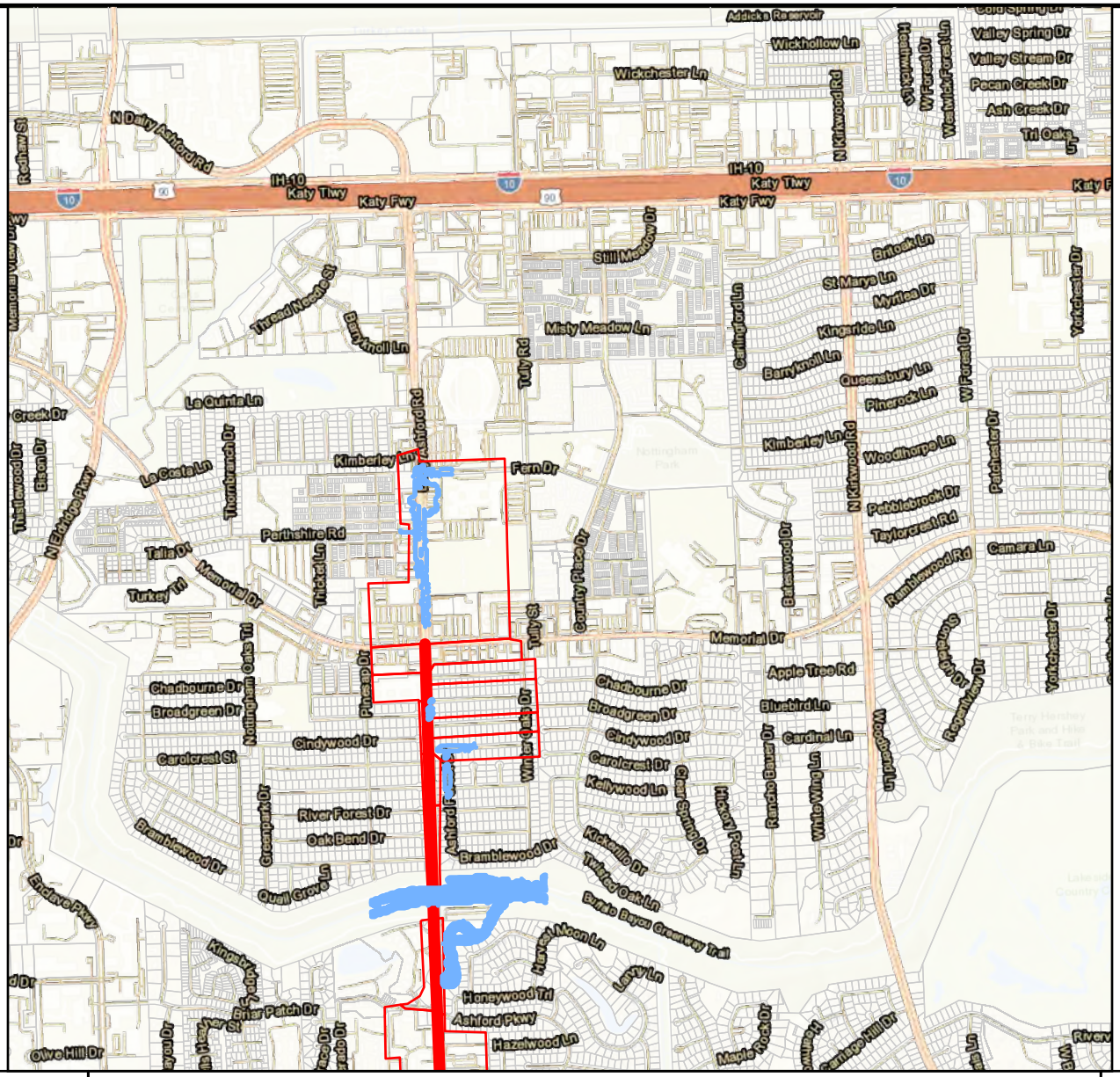
LEGEND

PROJECT LIMITS
OVERLAND DRAIN AREA
Layer
Value
120.87
48.45
FLOW PATH

City of Houston, Esri, HERE, GeoTechnologies, Inc., Esri, FAO, NOAA, Maxar

Exhibit E13
Existing 2-Year Ponding Map

GUNDA
CORPORATION
Engineers, Planners & Managers



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Houston, Texas 77079

2 YEAR PONDING MAP (For Existing Sewer Network)

HOUSTON PUBLIC WORKS

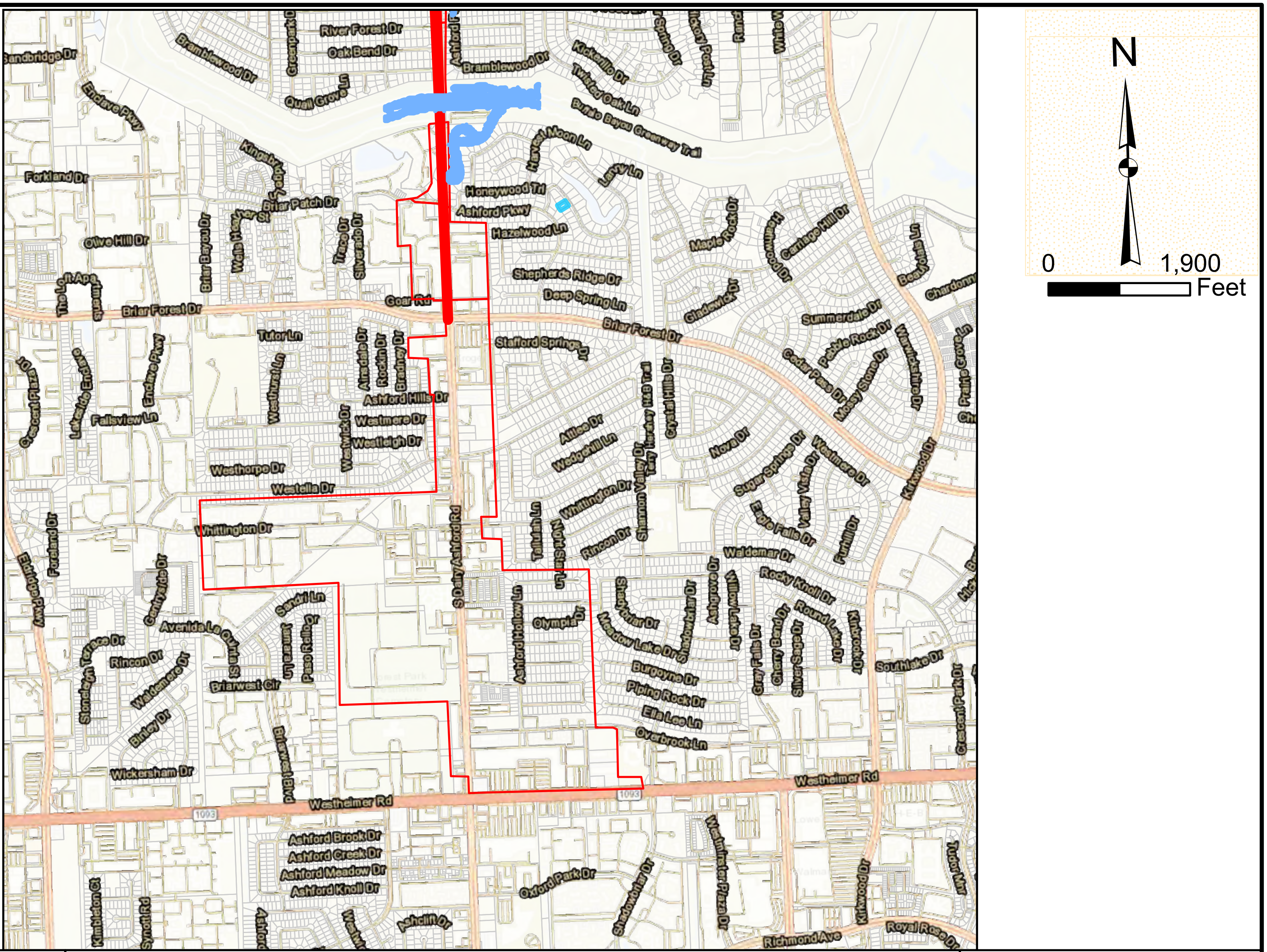
TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

EXHIBIT NO: 13 A

LEGEND

- PROJECT LIMITS
- 2 YEAR PONDING
- COH_PARCELS
- SUB DRAINAGE AREA



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Houston, Texas 77079

2 YEAR PONDING MAP (For Existing Sewer Network)

HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

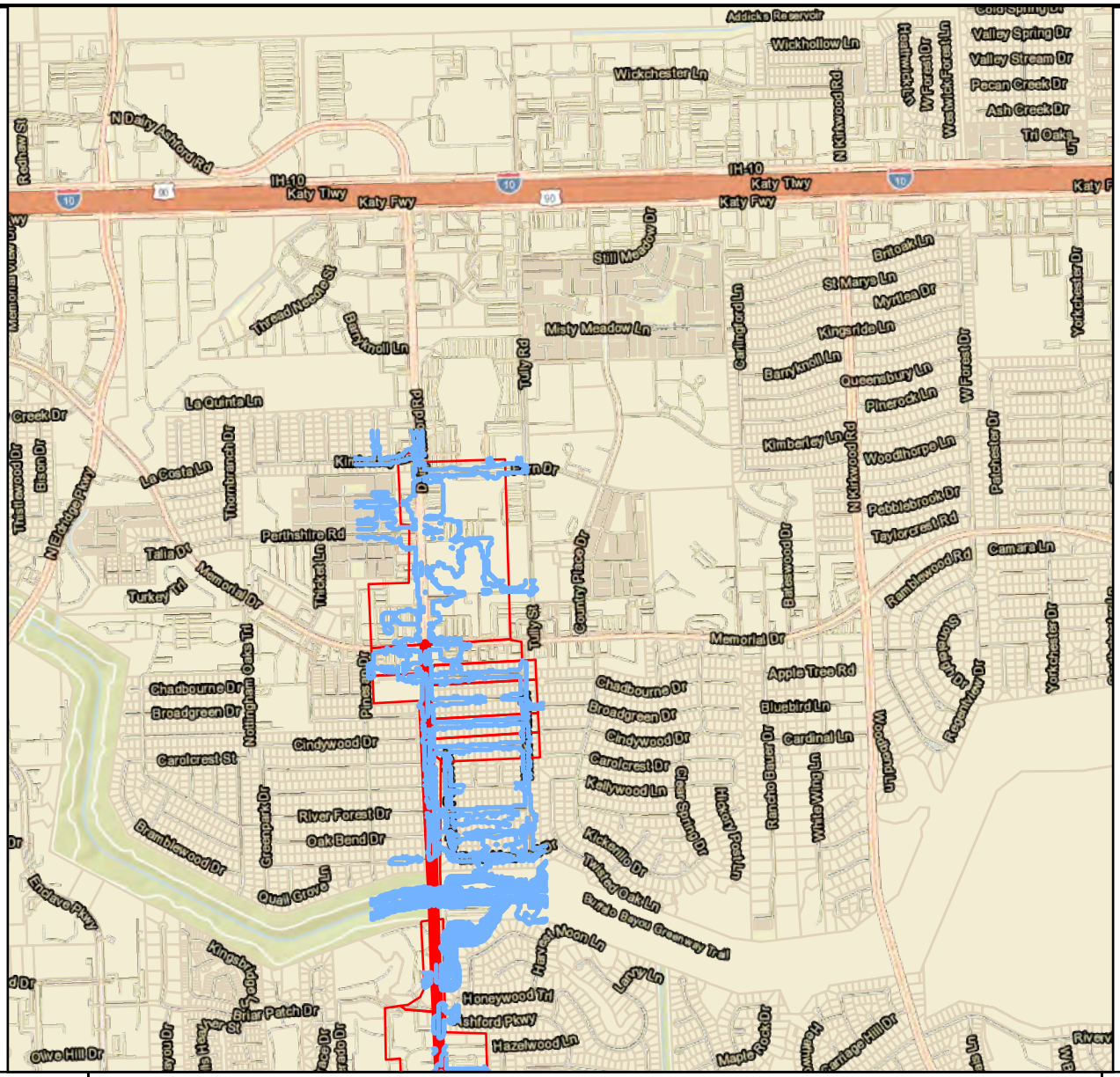
EXHIBIT NO: 13 B

LEGEND
🟥 PROJECT LIMITS
— 2 YEAR PONDING
☐ COH_PARCELS
☐ SUB DRAINAGE AREA

City of Houston, Esri, HERE, GeoTechnologies, Inc., City of Houston, HPB, Esri, HERE, Garmin, GeoTechnologies, Inc., NGA, USGS

Exhibit E14
Existing 100-Year Ponding Map

GUNDA
CORPORATION
Engineers, Planners & Managers



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0 1,900 Feet

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Engineers, Planners & Managers
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Houston, Texas 77079

100 YEAR PONDING MAP (For Existing Sewer Network)

HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

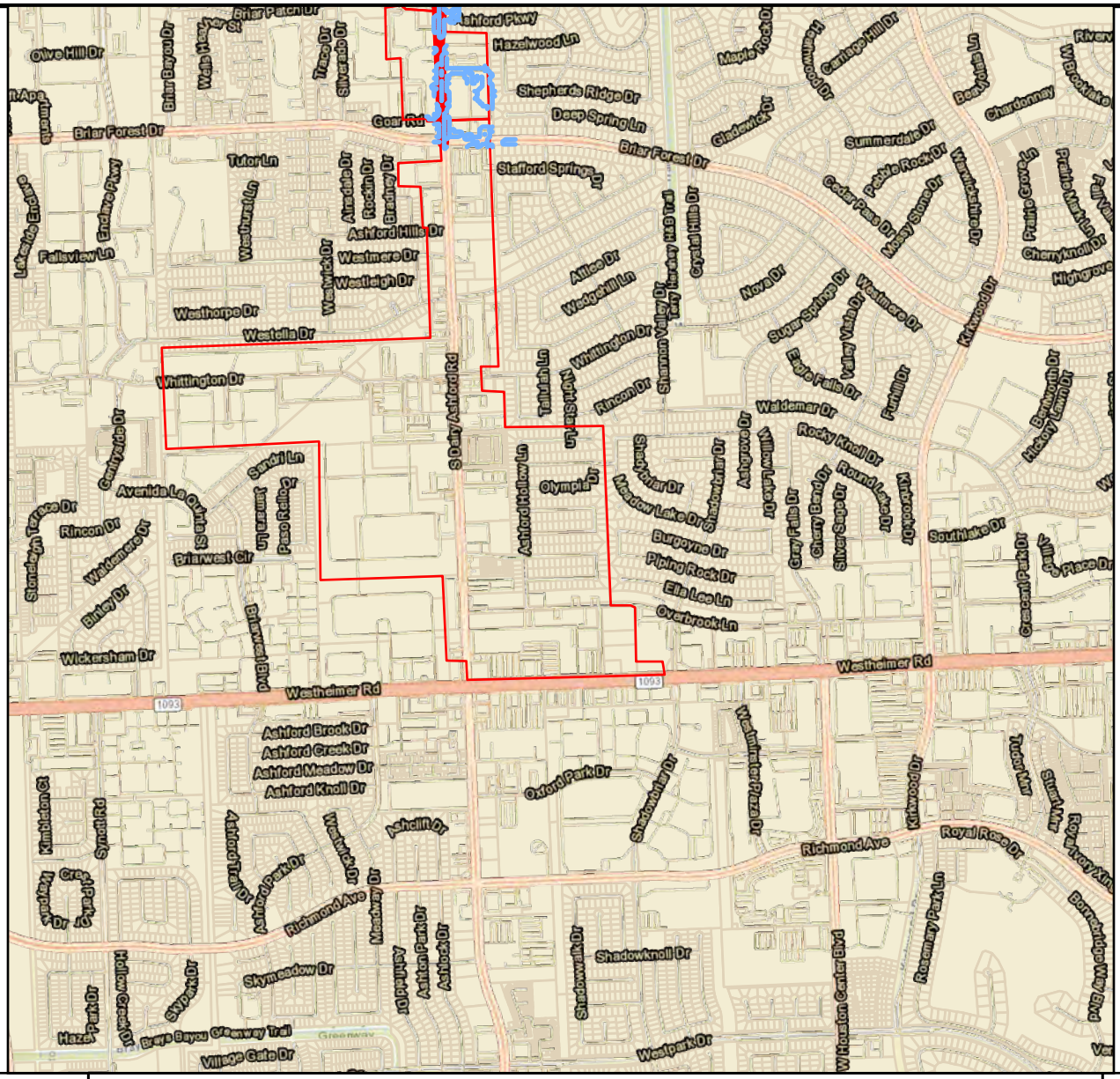
MAY 2022

EXHIBIT NO: 14 A

LEGEND

- PROJECT LIMITS
- COH_PARCELS
- 100 YEAR PONDING
- SUB DRAINAGE AREA

City of Houston, Esri, HERE, GeoTechnologies, Inc., City of Houston, HPB, Esri, HERE, Garmin, GeoTechnologies, Inc., NGA, USGS



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100 YEAR PONDING MAP (For Existing Sewer Network)

HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

EXHIBIT NO: 14 B

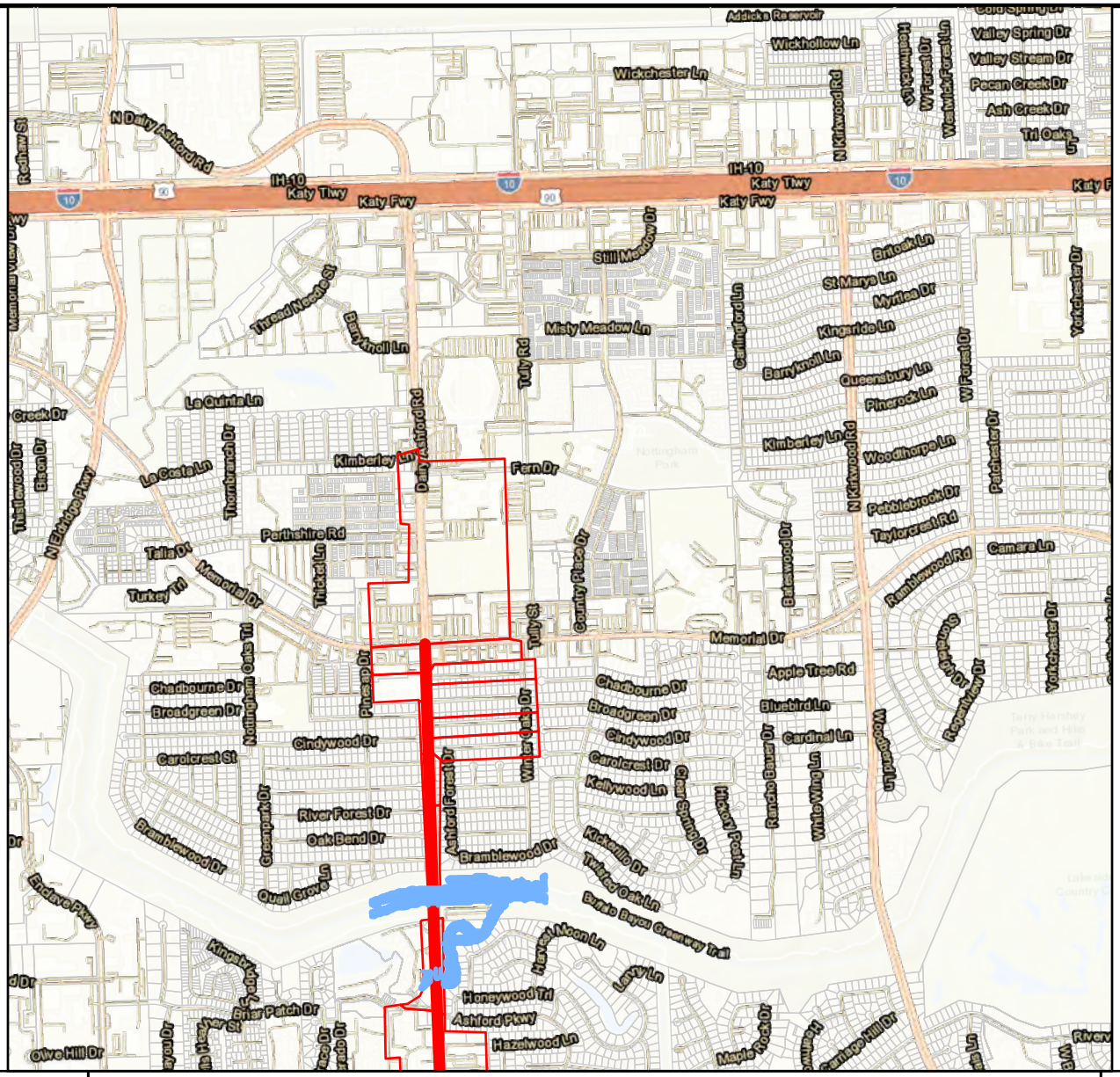
LEGEND

- PROJECT LIMITS
- COH_PARCELS
- 100 YEAR PONDING
- SUB DRAINAGE AREA

City of Houston, Esri, HERE, GeoTechnologies, Inc., City of Houston, HPB, Esri, HERE, Garmin, GeoTechnologies, Inc., NGA, USGS

Exhibit E15
Proposed 2-Year Ponding Map

GUNDA
CORPORATION
Engineers, Planners & Managers



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GUNDA CORPORATION
Engineers, Planners & Managers
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Houston, Texas 77079

2 YEAR PONDING MAP (For Proposed Sewer Network)

LEGEND

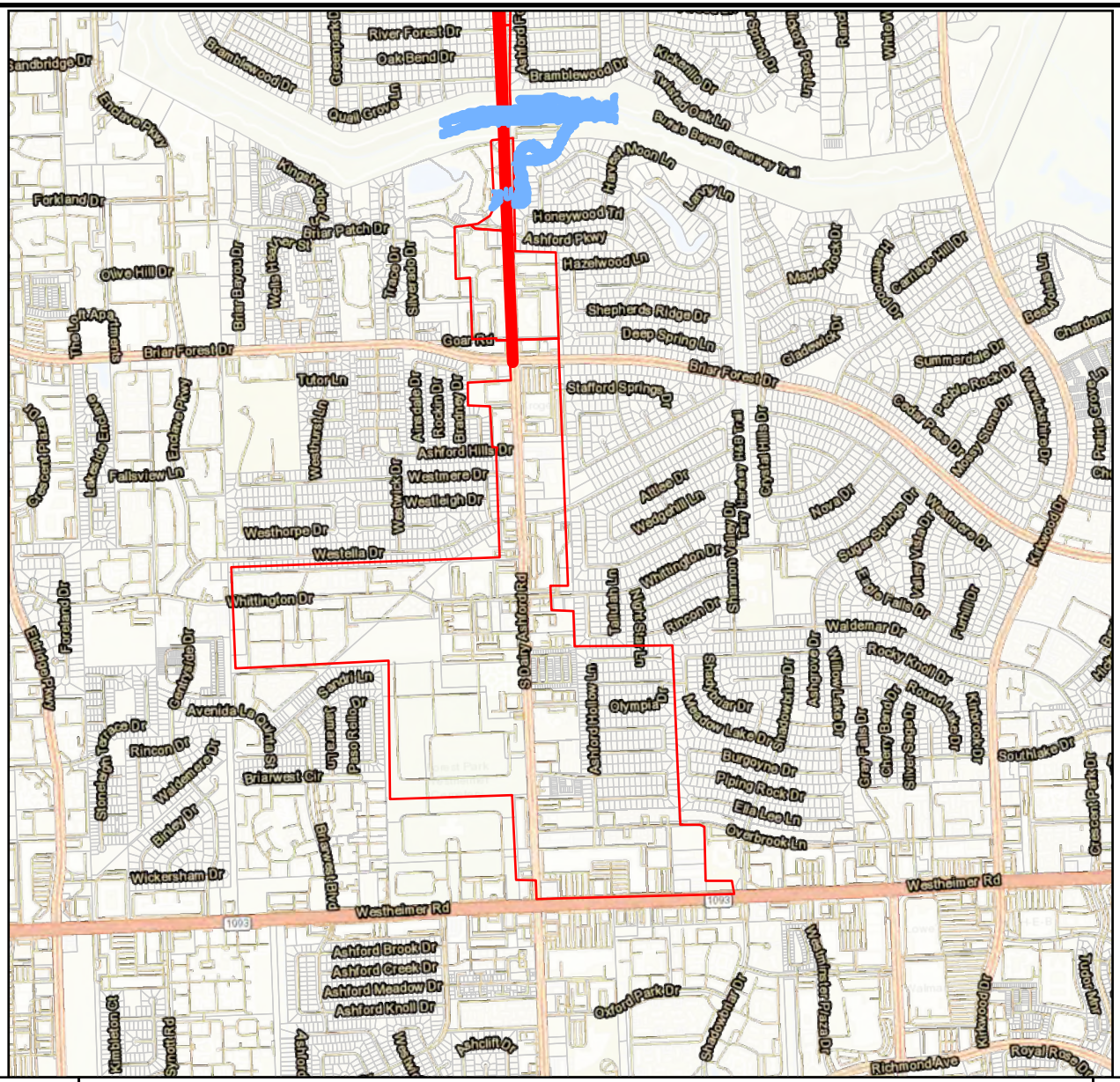
- PROJECT LIMITS
- COH_PARCELS
- SUB DRAINAGE AREA
- 2 YEAR PONDING (PROPOSED SYSTEM)

HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

EXHIBIT NO: 15 A



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0 1,900 Feet

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Engineers, Planners & Managers
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Houston, Texas 77079

2 YEAR PONDING MAP (For Proposed Sewer Network)

LEGEND

- PROJECT LIMITS
- COH_PARCELS
- SUB DRAINAGE AREA
- 2 YEAR PONDING (PROPOSED SYSTEM)

HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

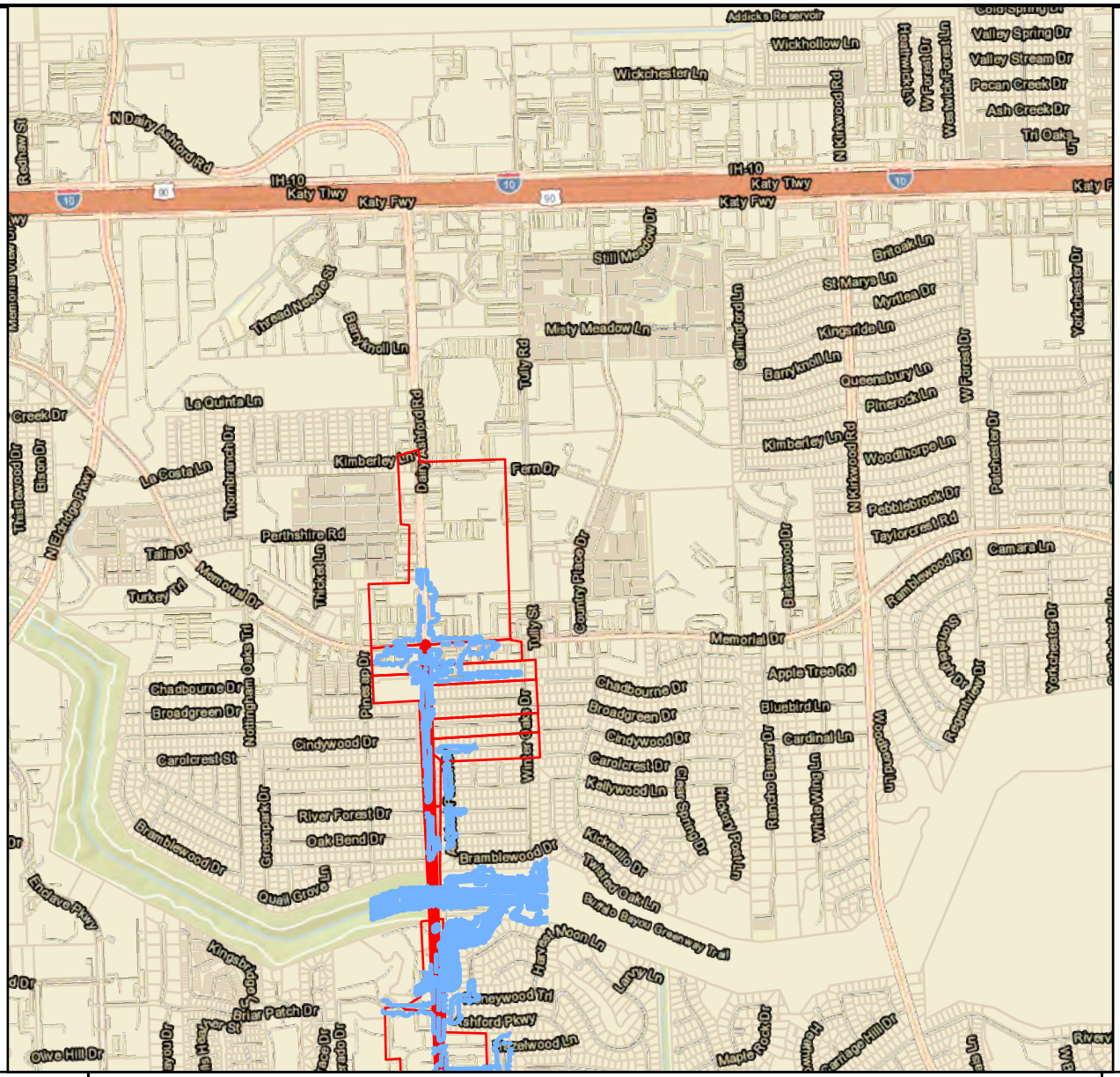
MAY 2022

EXHIBIT NO: 15 B

City of Houston, Esri, HERE, GeoTechnologies, Inc., City of Houston, HPB, Esri, HERE, Garmin, GeoTechnologies, Inc., NGA, USGS

Exhibit E16
Proposed 100-Year Ponding Map

GUNDA
CORPORATION
Engineers, Planners & Managers



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0 1,900 Feet

GUNDA CORPORATION
Engineers, Planners & Managers
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Houston, Texas 77079

100 YEAR PONDING MAP (For Proposed Sewer Network)

LEGEND

- PROJECT LIMITS
- COH_PARCELS
- SUB DRAINAGE AREA
- 100 YEAR PONDING (Proposed System)

HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

EXHIBIT NO: 16 A

City of Houston, Esri, HERE, GeoTechnologies, Inc., City of Houston, HPB, Esri, HERE, Garmin, GeoTechnologies, Inc., NGA, USGS

LEGEND

🟥 PROJECT LIMITS

▭ COH_PARCELS

▭ SUB DRAINAGE AREA

— 100 YEAR PONDING (Proposed System)

GUNDA CORPORATION
Engineers, Planners & Managers
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Houston, Texas 77079

100 YEAR PONDING MAP (For Proposed Sewer Network)

HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

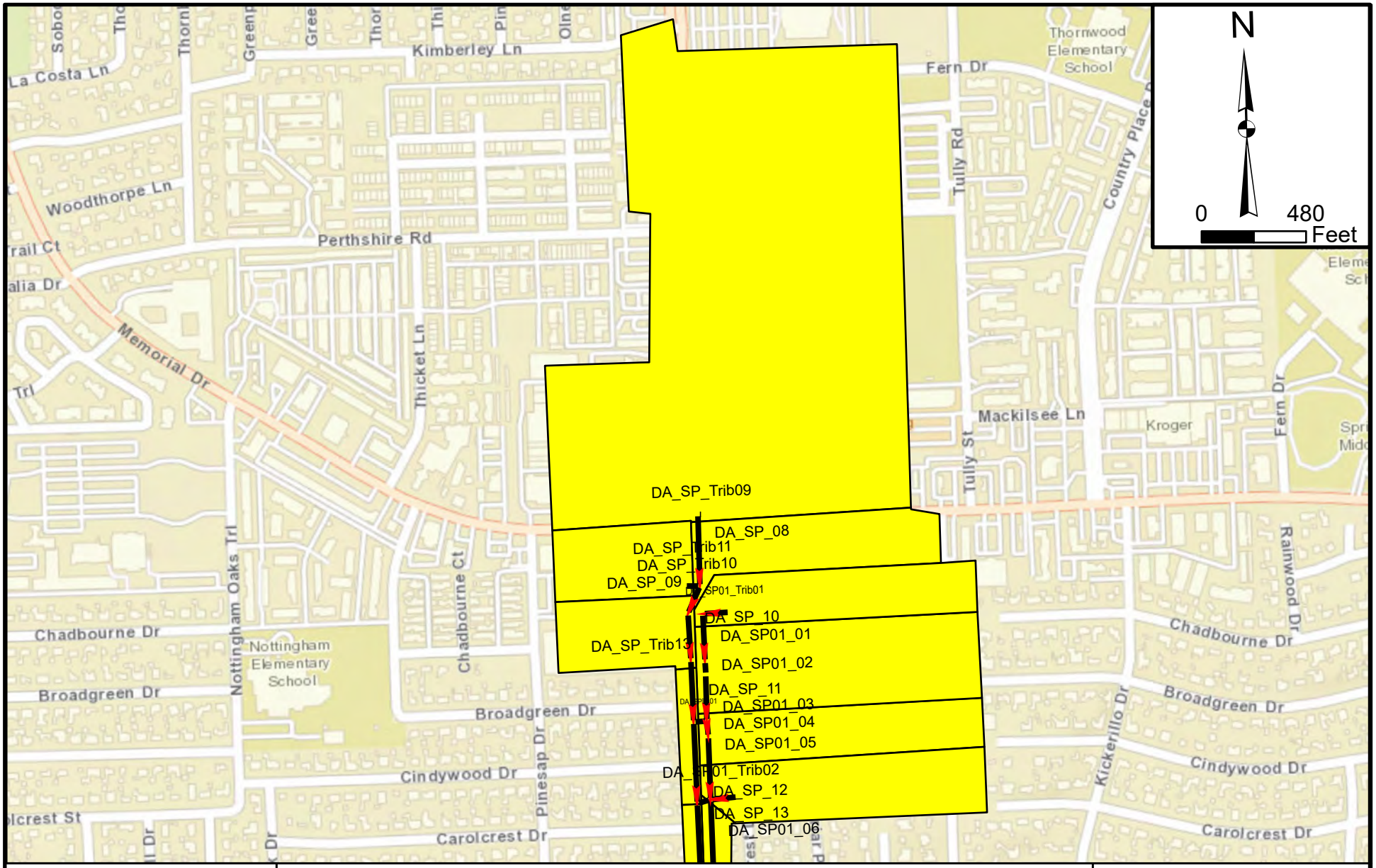
MAY 2022

EXHIBIT NO: 16 B

City of Houston, Esri, HERE, GeoTechnologies, Inc., City of Houston, HPB, Esri, HERE, Garmin, GeoTechnologies, Inc., NGA, USGS

APPENDIX A
EXISTING - XPSWMM SCHEMATICS

GUNDA CORPORATION
Engineers, Planners & Managers



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Engineers, Planners & Managers
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Houston, Texas 77079

XPSWMM SCHEMATICS (EXISTING CONDITION)

LEGEND

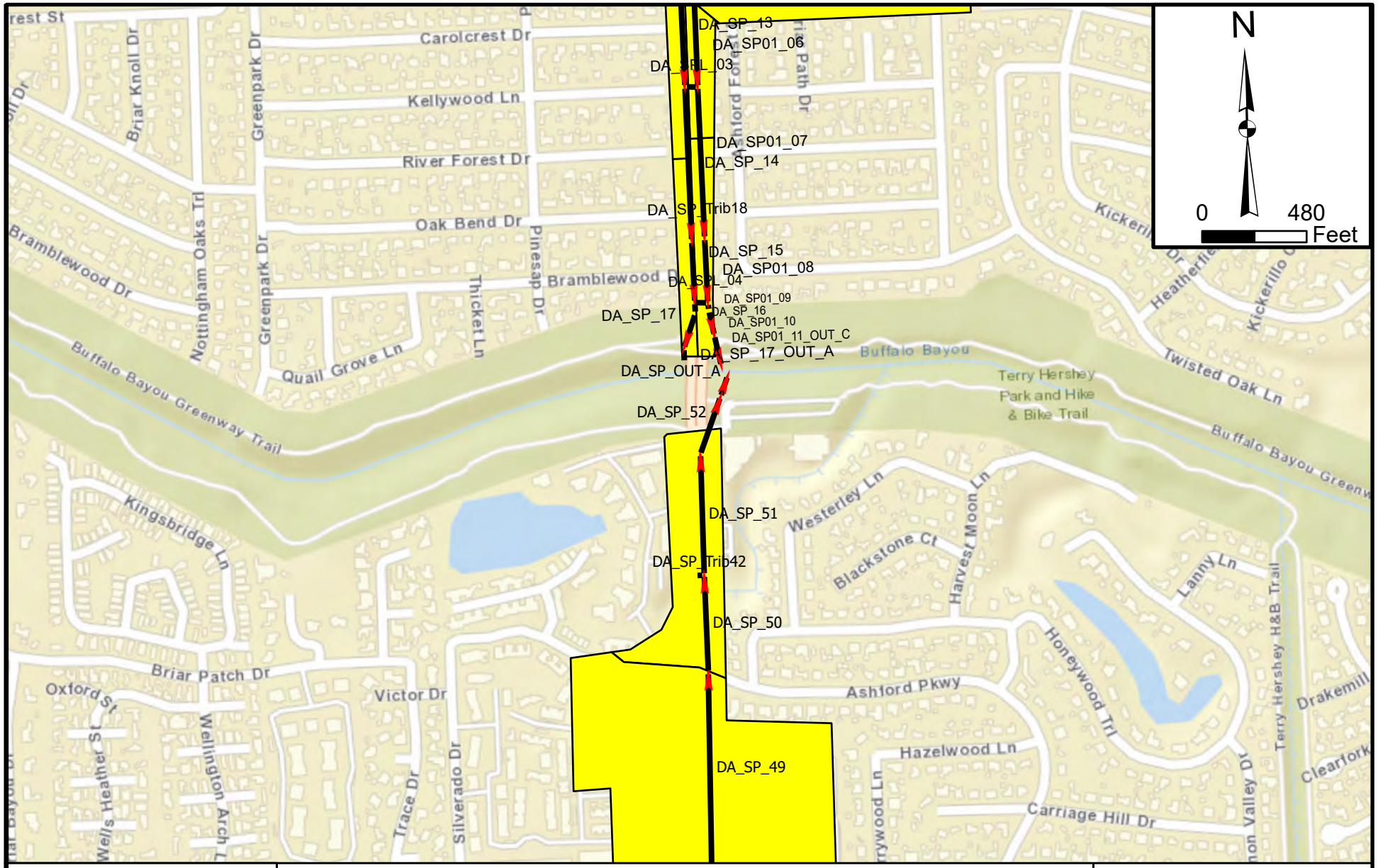
- SUB DRAINAGE AREA
- North Sub System Existing Links
- South Sub System Existing Links

HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

APPENDIX-A1



GUNDA CORPORATION
Engineers, Planners & Managers
11750 Katy Freeway, Suite 300
Houston, Texas 77079

XPSWMM SCHEMATICS (EXISTING CONDITION)

LEGEND

- SUB DRAINAGE AREA
- North Sub System Existing Links
- South Sub System Existing Links

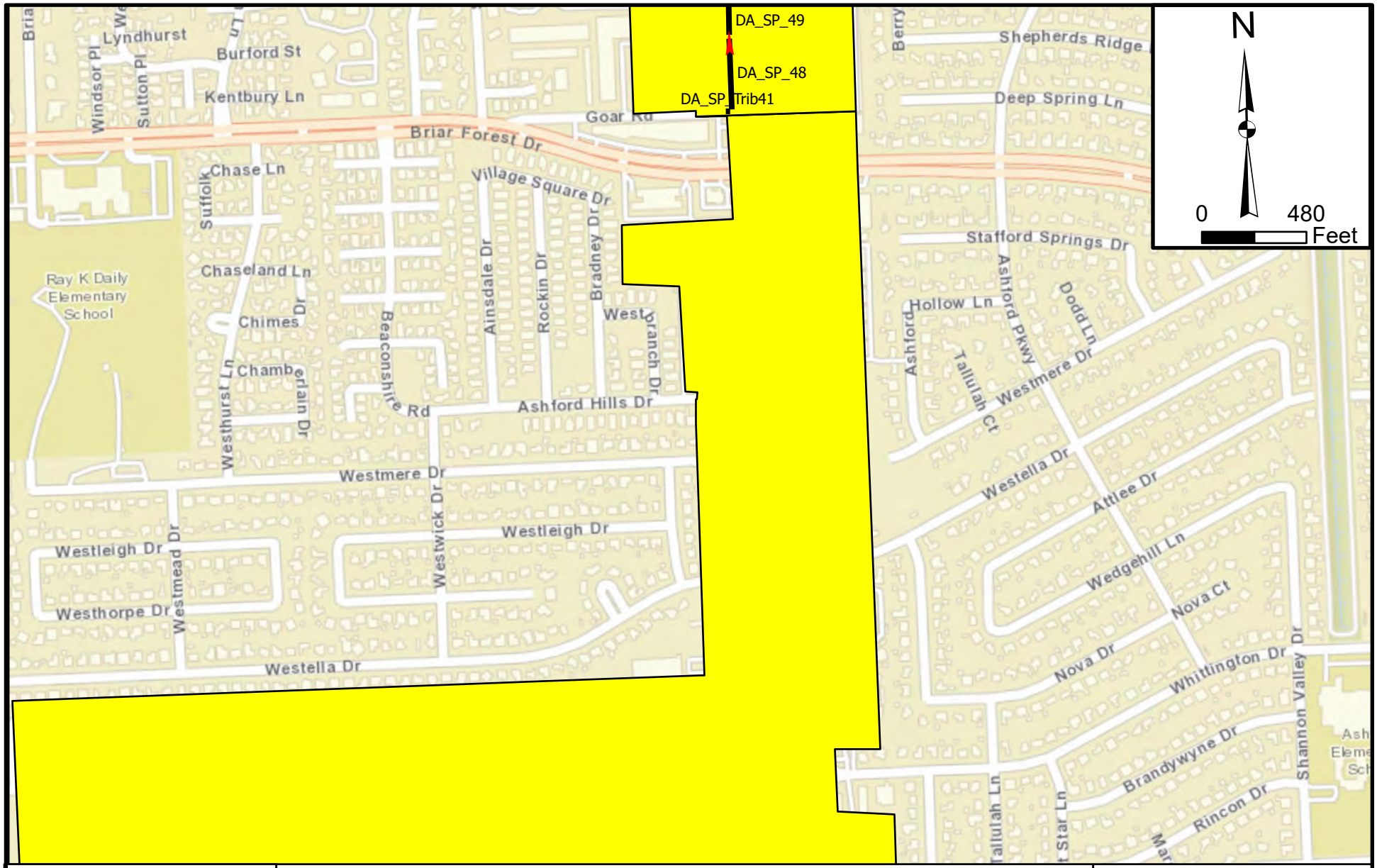
HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

APPENDIX-A2

City of Houston, HPB, Esri, HERE, Garmin, GeoTechnologies, Inc., NGA, USGS



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XPSWMM SCHEMATICS (EXISTING CONDITION)

LEGEND

- SUB DRAINAGE AREA
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HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

APPENDIX-A3

APPENDIX B
EXISTING - XPSWMM HYDRAULIC DATA

GUNDA CORPORATION
Engineers, Planners & Managers

Existing drainage system - 2 year results

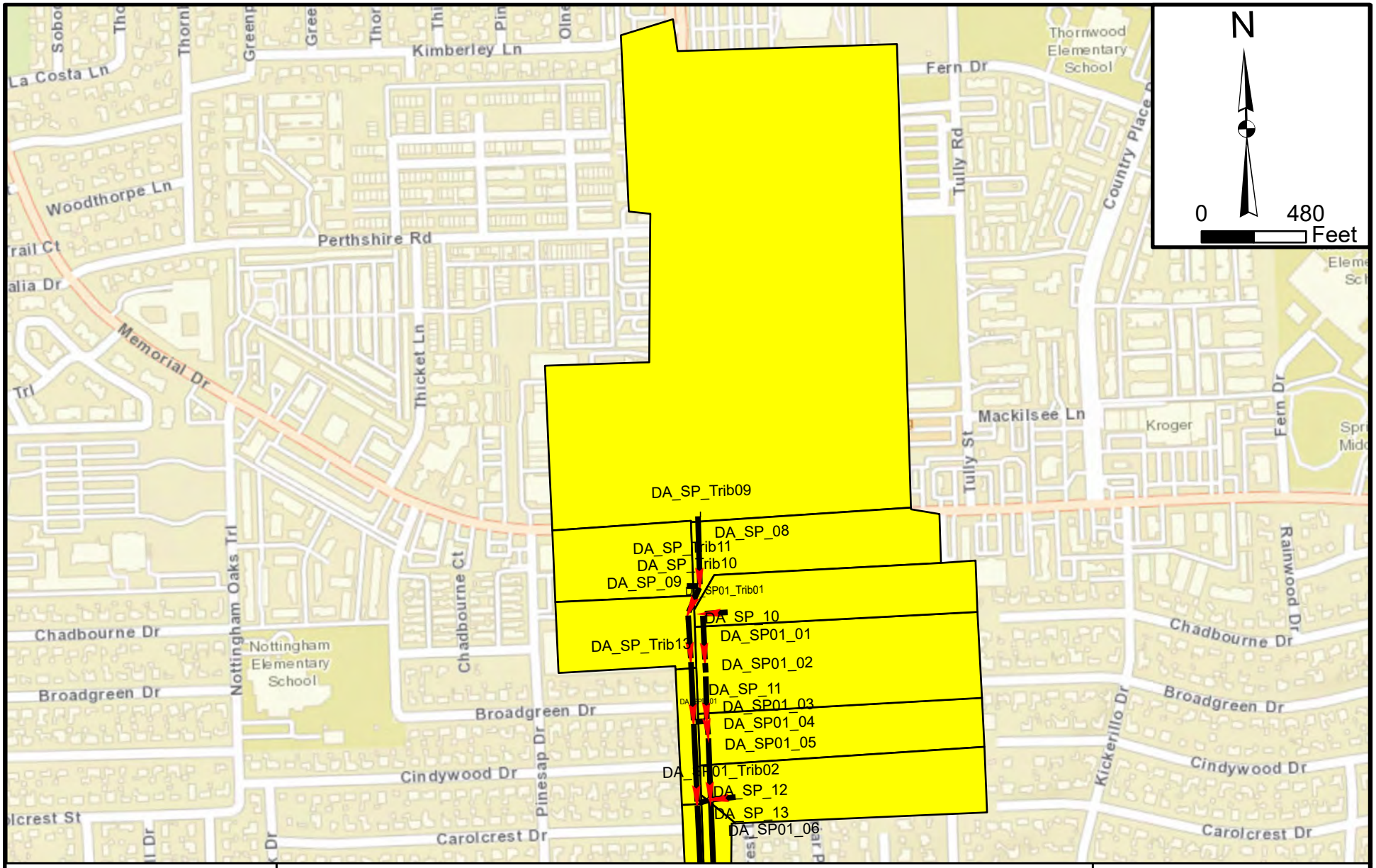
Name	Upstream Node Name	Downstream Node Name	Link Name	Shape	Dia. ft	Length ft	Conduit Slope	Roughness	Upstream Invert Elevation ft	Downstream Invert Elevation ft	Design Full Flow cfs	Max Flow cfs	Design Velocity ft/s	Max Velocity ft/s	Ground Elevation (Spill Crest) ft	Ground Elevation (Spill Crest) ft	Maximum Water Elevation (US) ft	Maximum Water Elevation (DS) ft	Max Volume ft^3
DA_SP_Trib11	DA_IN_B9	DA_MH_08	DA_SP_Trib11	Cir.	2	10.80	4.82	0.013	78.61	78.09	49.64	18.80	15.80	13.73	84.09	83.72	84.18	84.18	35.12
DA_SP_Trib10	DA_IN_B12	DA_MH_08	DA_SP_Trib10	Cir.	2	69.28	0.88	0.013	74.74	74.13	21.23	17.94	6.76	6.02	83.72	83.72	84.07	84.18	223.50
DA_SP_09	DA_MH_08	DA_MH_09	DA_SP_09	Cir.	4.5	138.03	0.40	0.013	71.97	71.42	124.13	165.59	7.80	10.31	83.72	83.37	84.18	83.57	2301.35
DA_SP01_01	DA_MH_C_01	DA_MH_C_02	DA_SP01_01	Cir.	2	218.48	0.06	0.013	73.59	73.45	5.73	19.43	1.82	6.04	83.26	81.74	83.56	82.02	719.54
DA_SP_10	DA_MH_09	DA_MH_10	DA_SP_10	Cir.	4.5	214.31	0.35	0.013	71.33	70.58	116.33	173.73	7.31	10.82	83.37	82.14	83.57	82.18	3572.87
DA_SP_Trib12	DA_IN_B13	DA_MH_09	DA_SP_Trib12	Cir.	2	15.75	0.50	0.013	78.79	78.71	16.02	14.53	5.10	5.17	83.85	83.37	83.85	83.57	51.87
DA_SP01_Trib01	DA_IN_C1	DA_MH_C_01	DA_SP01_Trib01	Cir.	2	122.53	0.50	0.013	74.35	73.74	16.00	14.03	5.09	4.38	84.15	83.26	84.15	83.56	396.45
DA_SP_17_OUT_A	DA_MH_17	DA_OF_B	DA_SP_17_OUT_A	Cir.	5	63.37	0.66	0.022	48.19	47.77	125.29	200.92	6.38	10.08	76.10	52.77	65.23	65.07	1304.39
DA_SP_16	DA_MH_15	DA_MH_16	DA_SP_16	Cir.	5	50.30	1.15	0.013	56.62	56.04	279.67	200.92	14.24	10.17	74.08	74.75	66.52	66.22	1035.36
DA_SP01_09	DA_MH_C_09	DA_MH_C_10	DA_SP01_09	Cir.	3	35.74	1.23	0.013	63.15	62.71	74.01	46.48	10.47	6.54	74.34	74.49	66.85	66.66	264.84
DA_SPL_04	DA_MH_C_09	DA_MH_15	DA_SPL_04	Cir.	2	60.39	0.27	0.013	63.94	63.78	11.64	17.21	3.71	5.47	74.34	74.08	66.85	66.52	198.89
DA_SP_Trib18	DA_IN_B16	DA_MH_14	DA_SP_Trib18	Cir.	2	15.00	11.96	0.013	68.45	66.56	80.30	4.30	25.56	9.83	72.26	71.84	68.97	68.90	30.99
DA_SP01_Trib05	DA_IN_C6	DA_MH_C_08	DA_SP01_Trib05	Cir.	2	12.00	0.35	0.013	67.20	67.16	13.06	5.30	4.16	4.12	71.96	71.66	69.56	69.55	39.52
DA_SP_15	DA_MH_14	DA_MH_15	DA_SP_15	Cir.	5	282.59	0.18	0.013	64.06	63.56	109.55	184.19	5.58	9.64	71.84	74.08	68.90	67.44	5048.65
DA_SP01_08	DA_MH_C_08	DA_MH_C_09	DA_SP01_08	Cir.	3	298.03	0.14	0.013	63.42	62.99	25.33	63.40	3.58	8.91	71.66	74.34	69.55	66.85	2208.45
DA_SP_Trib16	DA_IN_B15	DA_MH_13	DA_SP_Trib16	Cir.	2	12.99	3.70	0.013	73.68	73.20	43.49	4.51	13.84	8.31	78.68	78.48	74.86	74.87	29.42
DA_SP_Trib17	DA_IN_C5	DA_MH_C_07	DA_SP_Trib17	Cir.	2	16.00	0.00	0.013	69.58	69.50	16.00	4.69	5.09	2.31	77.90	77.90	74.85	74.82	52.69
DA_SP01_07	DA_MH_C_07	DA_MH_C_08	DA_SP01_07	Cir.	3	695.12	0.89	0.013	69.52	63.36	62.79	58.43	8.88	8.53	77.90	71.66	74.82	69.55	4944.50
DA_SPL_03	DA_MH_C_07	DA_MH_13	DA_SPL_03	Cir.	2	58.98	0.98	0.013	69.42	68.84	22.43	-6.55	7.14	5.83	77.90	78.48	74.82	74.87	189.82
DA_SP_14	DA_MH_13	DA_MH_14	DA_SP_14	Cir.	4.5	709.55	0.40	0.013	67.46	64.60	124.85	180.59	7.85	11.34	78.48	71.84	74.87	68.90	11216.67
DA_SP01_Trib02	DA_IN_C4	DA_MH_C_06	DA_SP01_Trib02	Cir.	2	123.53	0.35	0.013	71.77	71.34	13.35	17.00	4.25	5.34	79.61	79.42	78.57	77.90	406.51
DA_SP01_06	DA_MH_C_06	DA_MH_C_07	DA_SP01_06	Cir.	3	401.61	0.31	0.013	70.54	69.28	37.36	58.39	5.29	8.20	79.42	77.90	77.90	74.82	2935.16
DA_SPL_02	DA_MH_C_06	DA_MH_12	DA_SPL_02	Cir.	2	63.50	0.30	0.013	71.10	70.91	12.37	11.95	3.94	3.76	79.42	79.81	77.90	77.84	209.13
DA_SP_08	DA_MH_07	DA_MH_08	DA_SP_08	Cir.	4.5	329.49	0.31	0.013	72.96	71.95	108.88	141.13	6.85	8.77	85.09	83.72	85.74	84.18	5493.54
DA_SP_11	DA_MH_10	DA_MH_11	DA_SP_11	Cir.	4.5	284.39	0.35	0.013	70.71	69.73	115.44	172.91	7.26	10.78	82.14	81.09	82.18	80.45	4741.38
DA_SP01_03	DA_MH_C_03	DA_MH_C_04	DA_SP01_03	Cir.	2.5	214.01	0.42	0.013	73.06	72.16	26.60	32.35	5.42	6.51	81.44	80.82	81.44	80.41	1097.21
DA_SP_Trib14	DA_IN_B14	DA_MH_11	DA_SP_Trib14	Cir.	2	12.32	0.50	0.013	76.51	76.45	16.05	13.48	5.11	4.26	81.33	81.09	80.55	80.45	40.57
DA_SP_12	DA_MH_11	DA_MH_12	DA_SP_12	Cir.	4.5	374.39	0.35	0.013	69.73	68.43	115.88	167.59	7.29	10.45	81.09	79.81	80.45	77.84	6240.71
DA_SPL_01	DA_MH_C_04	DA_MH_11	DA_SPL_01	Cir.	2	60.74	0.50	0.013	72.10	71.80	16.00	14.11	5.09	6.01	80.82	81.09	80.41	80.45	200.00
DA_SP01_04	DA_MH_C_04	DA_MH_C_05	DA_SP01_04	Cir.	2.5	71.30	0.22	0.013	72.16	72.00	19.43	52.19	3.96	10.50	80.82	80.54	80.41	79.44	366.90
DA_SP_Trib15	DA_IN_C3	DA_MH_C_04	DA_SP_Trib15	Cir.	2	7.96	2.64	0.013	76.65	76.44	36.74	14.68	11.70	9.99	81.22	80.82	80.44	80.41	26.19
DA_SP_Trib13	DA_IN_C2	DA_MH_C_02	DA_SP_Trib13	Cir.	2	10.00	0.56	0.013	77.58	77.55	12.39	22.00	3.94	6.95	82.33	81.74	82.11	82.02	32.93
DA_SP01_02	DA_MH_C_02	DA_MH_C_03	DA_SP01_02	Cir.	2	60.44	0.56	0.013	73.26	72.92	16.97	33.47	5.40	10.44	81.74	81.44	82.02	81.44	198.89
DA_SP_13	DA_MH_12	DA_MH_13	DA_SP_13	Cir.	4.5	383.41	0.29	0.013	68.45	67.34	105.81	174.52	6.65	10.91	79.81	78.48	77.84	74.87	6340.02
DA_SP_17	DA_MH_16	DA_MH_17	DA_SP_17	Cir.	5	168.75	0.20	0.013	56.15	55.81	116.90	200.91	5.95	10.17	74.75	76.10	66.22	65.23	3473.51
DA_SP01_10	DA_MH_C_10	DA_MH_C_11	DA_SP01_10	Cir.	3	117.31	0.55	0.013	62.69	62.05	49.26	46.45	6.97	6.56	74.49	75.42	66.66	66.09	867.67
DA_SP01_11_OUT_C	DA_MH_C_11	DA_OF_C	DA_SP01_11_OUT_C	Cir.	3	142.12	7.11	0.022	62.12	52.02	105.07	46.43	14.86	6.54	75.42	58.25	66.09	65.06	1025.91
DA_SP01_05	DA_MH_C_05	DA_MH_C_06	DA_SP01_05	Cir.	3	290.91	0.15	0.013	71.24	70.80	25.94	51.07	3.67	7.16	80.54	79.42	79.44	77.90	2155.67
DA_SP_OUT_A	DA_MH_60	DA_OF_A	DA_SP_OUT_A	Cir.	9.5	101.56	0.44	0.022	47.25	46.80	567.31	765.78	8.00	10.75	75.05	56.30	64.45	64.00	7546.67
DA_SP_52	DA_MH_59	DA_MH_60	DA_SP_52	Cir.	9.5	280.68	0.11	0.013	51.63	51.33	471.53	765.78	6.65	10.77	72.24	75.05	65.26	64.45	20856.62
DA_SP_51	DA_MH_58	DA_MH_59	DA_SP_51	Cir.	9.5	554.91	0.10	0.013	52.18	51.63	454.07	765.75	6.41	10.77	73.20	72.24	66.86	65.26	41233.97
DA_SP_Trib42	DA_IN_A17	DA_MH_58	DA_SP_Trib42	Cir.	2	39.84	0.50	0.013	67.30	67.10	15.99	13.41	5.09	5.95	73.40	73.20	68.65	68.42	88.75
DA_SP_48	DA_MH_55	DA_MH_56	DA_SP_48	Cir.	9	341.84	0.10	0.013	57.95	57.61	393.79	753.64	6.19	11.81	78.51	77.36	76.67	70.73	22797.82
DA_SP_Trib41	DA_IN_A16	DA_MH_55	DA_SP_Trib41	Cir.	2	37.2	0.50	0.013	72.92	72.73	16.17	69.82	5.15	22.02	78.60	78.51	78.60	76.67	120.90
DA_SP_49	DA_MH_56	DA_MH_57	DA_SP_49	Cir.	9.5	910.14	0.10	0.013	57.11	56.19	458.56	753.61	6.47	10.60	77.36	76.02	70.73	68.09	67630.21
DA_SP_50	DA_MH_57	DA_MH_58	DA_SP_50	Cir.	9.5	446.8	0.10	0.013	52.62	52.18	452.61	753.57	6.39	10.59	76.02	73.20	68.09	66.86	33200.58

Existing drainage system - 100 year results

Name	Upstream Node Name	Downstream Node Name	Link Name	Shape	Dia. ft	Length ft	Conduit Slope	Roughness	Upstream Invert Elevation ft	Downstream Invert Elevation ft	Design Full Flow cfs	Max Flow cfs	Design Velocity ft/s; m/s	Max Velocity ft/s	Ground Elevation (Spill Crest) ft	Ground Elevation (Spill Crest) ft	Maximum Water Elevation (US) ft	Maximum Water Elevation (DS) ft	Max Volume ft^3
DA_SP_17_OUT_A	DA_MH_17	DA_OF_B	DA_SP_17_OUT_A	Cir.	5	63.37	0.66	0.022	48.19	47.77	125.29	205.24	6.38	10.24	76.10	52.77	72.13	72.11	1304.39
DA_SP_16	DA_MH_15	DA_MH_16	DA_SP_16	Cir.	5	50.30	1.15	0.013	56.62	56.04	279.67	204.99	14.24	10.32	74.08	74.75	72.15	72.15	1035.36
DA_SP01_09	DA_MH_C_09	DA_MH_C_10	DA_SP01_09	Cir.	3	35.74	1.23	0.013	63.15	62.71	74.01	45.02	10.47	6.30	74.34	74.49	72.16	72.15	264.84
DA_SPL_04	DA_MH_C_09	DA_MH_15	DA_SPL_04	Cir.	2	60.39	0.27	0.013	63.94	63.78	11.64	15.56	3.71	4.87	74.34	74.08	72.16	72.15	198.89
DA_SP_Trib18	DA_IN_B16	DA_MH_14	DA_SP_Trib18	Cir.	2	15.00	11.96	0.013	68.45	66.56	80.30	10.05	25.56	8.77	72.26	71.84	72.96	72.96	47.78
DA_SP01_Trib05	DA_IN_C6	DA_MH_C_08	DA_SP01_Trib05	Cir.	2	12.00	0.35	0.013	67.20	67.16	13.06	4.72	4.16	3.39	71.96	71.66	72.80	72.80	39.52
DA_SP_15	DA_MH_14	DA_MH_15	DA_SP_15	Cir.	5	282.59	0.18	0.013	64.06	63.56	109.55	201.52	5.58	10.21	71.84	74.08	72.96	72.15	5816.77
DA_SP01_08	DA_MH_C_08	DA_MH_C_09	DA_SP01_08	Cir.	3	298.03	0.14	0.013	63.42	62.99	25.33	52.40	3.58	7.32	71.66	74.34	72.80	72.16	2208.45
DA_SP_Trib16	DA_IN_B15	DA_MH_13	DA_SP_Trib16	Cir.	2	12.99	3.70	0.013	73.68	73.20	43.49	52.11	13.84	16.43	78.68	78.48	78.99	78.96	42.60
DA_SP_Trib17	DA_IN_C5	DA_MH_C_07	DA_SP_Trib17	Cir.	2	16.00	0.00	0.013	69.58	69.50	16.00	25.52	5.09	7.97	77.90	77.90	78.69	78.69	52.69
DA_SP01_07	DA_MH_C_07	DA_MH_C_08	DA_SP01_07	Cir.	3	695.12	0.89	0.013	69.52	63.36	62.79	62.74	8.88	8.76	77.90	71.66	78.69	72.80	4988.44
DA_SPL_03	DA_MH_C_07	DA_MH_13	DA_SPL_03	Cir.	2	58.98	0.98	0.013	69.42	68.84	22.43	20.86	7.14	6.50	77.90	78.48	78.69	78.96	190.08
DA_SP_14	DA_MH_13	DA_MH_14	DA_SP_14	Cir.	4.5	709.55	0.40	0.013	67.46	64.60	124.85	181.00	7.85	11.28	78.48	71.84	78.96	72.96	11828.01
DA_SP01_Trib02	DA_IN_C4	DA_MH_C_06	DA_SP01_Trib02	Cir.	2	123.53	0.35	0.013	71.77	71.34	13.35	17.60	4.25	5.51	79.61	79.42	80.28	80.43	405.18
DA_SP01_06	DA_MH_C_06	DA_MH_C_07	DA_SP01_06	Cir.	3	401.61	0.31	0.013	70.54	69.28	37.36	57.37	5.29	8.01	79.42	77.90	80.43	78.69	2955.37
DA_SPL_02	DA_MH_C_06	DA_MH_12	DA_SPL_02	Cir.	2	63.50	0.30	0.013	71.10	70.91	12.37	-14.47	3.94	-4.50	79.42	79.81	80.43	80.59	209.13
DA_SP_Trib11	DA_IN_B9	DA_MH_08	DA_SP_Trib11	Cir.	2	10.80	4.82	0.013	78.61	78.09	49.64	17.81	15.80	12.75	84.09	83.72	84.84	84.84	34.97
DA_SP_Trib10	DA_IN_B12	DA_MH_08	DA_SP_Trib10	Cir.	2	69.28	0.88	0.013	74.74	74.13	21.23	13.49	6.76	5.67	83.72	83.72	84.77	84.84	223.68
DA_SP_09	DA_MH_08	DA_MH_09	DA_SP_09	Cir.	4.5	138.03	0.40	0.013	71.97	71.42	124.13	146.45	7.80	9.12	83.72	83.37	84.84	84.27	2301.36
DA_SP_08	DA_MH_07	DA_MH_08	DA_SP_08	Cir.	4.5	329.49	0.31	0.013	72.96	71.95	108.88	150.38	6.85	9.33	85.09	83.72	86.70	84.84	5490.78
DA_SP01_01	DA_MH_C_01	DA_MH_C_02	DA_SP01_01	Cir.	2	218.48	0.06	0.013	73.59	73.45	5.73	19.65	1.82	6.10	83.26	81.74	84.10	82.70	719.54
DA_SP_10	DA_MH_09	DA_MH_10	DA_SP_10	Cir.	4.5	214.31	0.35	0.013	71.33	70.58	116.33	154.07	7.31	9.59	83.37	82.14	84.27	83.12	3572.94
DA_SP_Trib12	DA_IN_B13	DA_MH_09	DA_SP_Trib12	Cir.	2	15.75	0.50	0.013	78.79	78.71	16.02	14.15	5.10	4.89	83.85	83.37	84.31	84.27	51.87
DA_SP01_Trib01	DA_IN_C1	DA_MH_C_01	DA_SP01_Trib01	Cir.	2	122.53	0.50	0.013	74.35	73.74	16.00	15.51	5.09	4.82	84.15	83.26	84.15	84.10	396.07
DA_SP_11	DA_MH_10	DA_MH_11	DA_SP_11	Cir.	4.5	284.39	0.35	0.013	70.71	69.73	115.44	154.05	7.26	9.60	82.14	81.09	83.12	81.96	4740.09
DA_SP01_03	DA_MH_C_03	DA_MH_C_04	DA_SP01_03	Cir.	2.5	214.01	0.42	0.013	73.06	72.16	26.60	33.47	5.42	6.74	81.44	80.82	81.44	81.75	1095.44
DA_SP_Trib14	DA_IN_B14	DA_MH_11	DA_SP_Trib14	Cir.	2	12.32	0.50	0.013	76.51	76.45	16.05	11.28	5.11	3.57	81.33	81.09	81.97	81.96	40.57
DA_SP_12	DA_MH_11	DA_MH_12	DA_SP_12	Cir.	4.5	374.39	0.35	0.013	69.73	68.43	115.88	151.27	7.29	9.42	81.09	79.81	81.96	80.59	6242.11
DA_SPL_01	DA_MH_C_04	DA_MH_11	DA_SPL_01	Cir.	2	60.74	0.50	0.013	72.10	71.80	16.00	-17.10	5.09	5.65	80.82	81.09	81.75	81.96	200.01
DA_SP01_04	DA_MH_C_04	DA_MH_C_05	DA_SP01_04	Cir.	2.5	71.30	0.22	0.013	72.16	72.00	19.43	45.38	3.96	9.10	80.82	80.54	81.75	81.59	366.91
DA_SP_Trib15	DA_IN_C3	DA_MH_C_04	DA_SP_Trib15	Cir.	2	7.96	2.64	0.013	76.65	76.44	36.74	18.40	11.70	10.23	81.22	80.82	81.72	81.75	26.22
DA_SP_Trib13	DA_IN_C2	DA_MH_C_02	DA_SP_Trib13	Cir.	2	10.00	0.56	0.013	77.58	77.55	12.39	28.44	3.94	8.97	82.33	81.74	82.70	82.70	32.93
DA_SP01_02	DA_MH_C_02	DA_MH_C_03	DA_SP01_02	Cir.	2	60.44	0.56	0.013	73.26	72.92	16.97	33.39	5.40	10.42	81.74	81.44	82.70	81.44	198.95
DA_SP_13	DA_MH_12	DA_MH_13	DA_SP_13	Cir.	4.5	383.41	0.29	0.013	68.45	67.34	105.81	165.92	6.65	10.33	79.81	78.48	80.59	78.96	6376.60
DA_SP_17	DA_MH_16	DA_MH_17	DA_SP_17	Cir.	5	168.75	0.20	0.013	56.15	55.81	116.90	204.77	5.95	10.31	74.75	76.10	72.15	72.13	3473.51
DA_SP01_10	DA_MH_C_10	DA_MH_C_11	DA_SP01_10	Cir.	3	117.31	0.55	0.013	62.69	62.05	49.26	44.82	6.97	6.27	74.49	75.42	72.15	72.14	862.54
DA_SP01_11_OUT_C	DA_MH_C_11	DA_OF_C	DA_SP01_11_OUT_C	Cir.	3	142.12	7.11	0.022	62.12	52.02	105.07	44.70	14.86	6.24	75.42	58.25	72.14	72.09	1040.99
DA_SP01_05	DA_MH_C_05	DA_MH_C_06	DA_SP01_05	Cir.	3	290.91	0.15	0.013	71.24	70.80	25.94	45.19	3.67	6.31	80.54	79.42	81.59	80.43	2155.69
DA_SP_52	DA_MH_59	DA_MH_60	DA_SP_52	Cir.	9.5	280.68	0.11	0.013	51.63	51.33	471.53	939.06	6.65	13.16	72.24	75.05	72.33	71.99	20856.62
DA_SP_51	DA_MH_58	DA_MH_59	DA_SP_51	Cir.	9.5	554.91	0.10	0.013	52.18	51.63	454.07	939.05	6.41	13.14	73.20	72.24	74.16	72.33	41233.97
DA_SP_OUT_A	DA_MH_60	DA_OF_A	DA_SP_OUT_A	Cir.	9.5	101.56	0.44	0.022	47.25	46.80	567.31	939.05	8.00	13.13	75.05	56.30	71.99	71.98	7546.67
DA_SP_Trib42	DA_IN_A17	DA_MH_58	DA_SP_Trib42	Cir.	2	39.84	0.50	0.013	67.30	67.10	15.99	27.12	5.09	8.59	73.40	73.20	73.40	74.16	131.21
DA_SP_48	DA_MH_55	DA_MH_56	DA_SP_48	Cir.	9	341.84	0.10	0.013	57.95	57.61	393.79	885.81	6.19	13.78	78.51	77.36	81.97	80.27	22797.82
DA_SP_Trib41	DA_IN_A16	DA_MH_55	DA_SP_Trib41	Cir.	2	37.2	0.50	0.013	72.92	72.73	16.17	71.57	5.15	22.54	78.60	78.51	81.08	81.97	122.51
DA_SP_49	DA_MH_56	DA_MH_57	DA_SP_49	Cir.	9.5	910.14	0.10	0.013	57.11	56.19	458.56	1012.42	6.47	14.16	77.36	76.02	80.27	76.85	67630.21
DA_SP_50	DA_MH_57	DA_MH_58	DA_SP_50	Cir.	9.5	446.8	0.10	0.013	52.62	52.18	452.61	1023.85	6.39	14.31	76.02	73.20	76.85	74.16	33200.58

APPENDIX C
PROPOSED - XPSWMM SCHEMATICS

GUNDA CORPORATION
Engineers, Planners & Managers



GUNDA CORPORATION
Engineers, Planners & Managers
11750 Katy Freeway, Suite 300
Houston, Texas 77079

XPSWMM SCHEMATICS (PROPOSED CONDITION)

LEGEND

- SUB DRAINAGE AREA
- North Sub System Proposed Links
- South Sub System Proposed Links

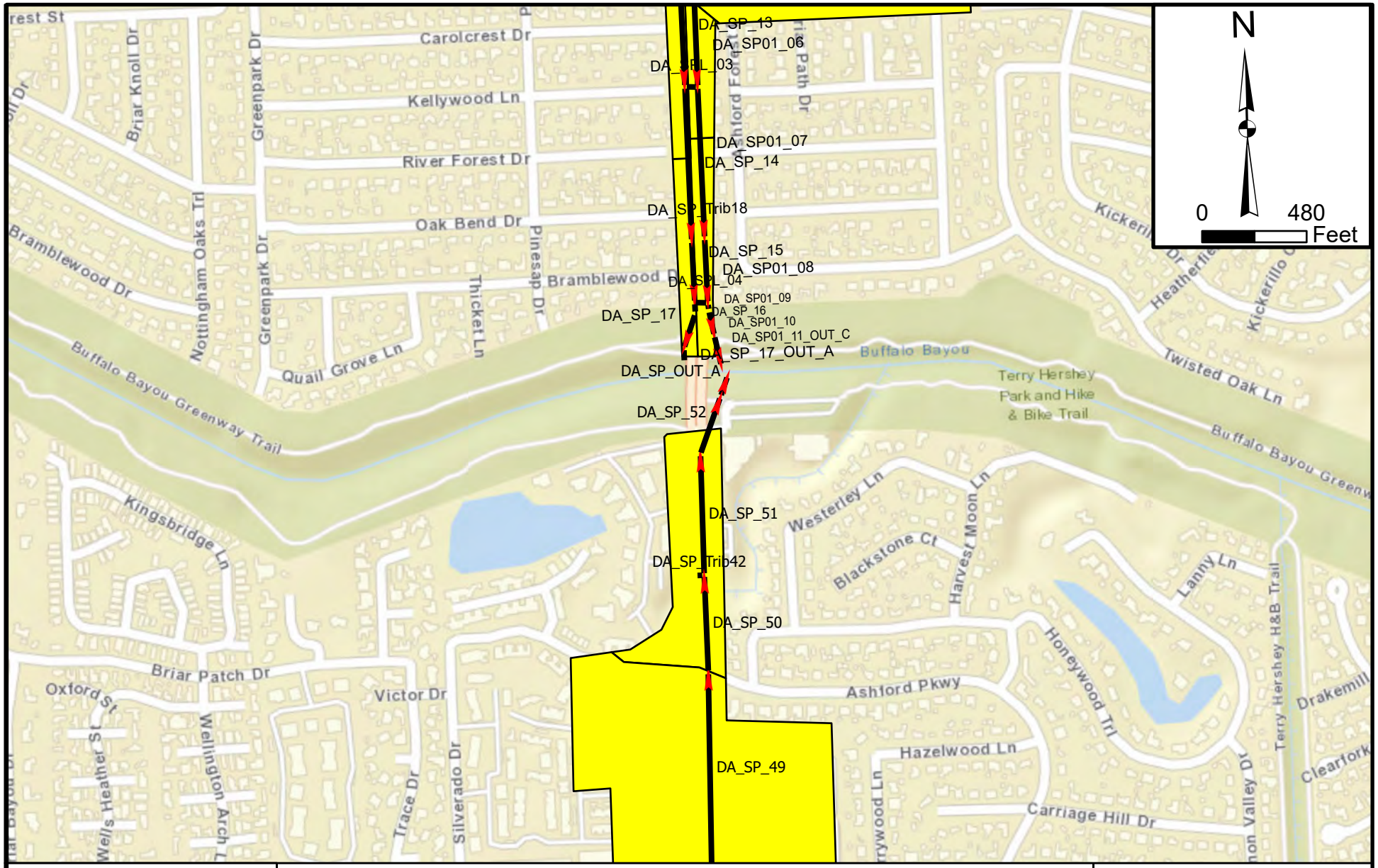
HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

APPENDIX-C1

City of Houston, HPB, Esri, HERE, Garmin, GeoTechnologies, Inc., NGA, USGS



GUNDA CORPORATION
Engineers, Planners & Managers
11750 Katy Freeway, Suite 300
Houston, Texas 77079

XPSWMM SCHEMATICS (PROPOSED CONDITION)

LEGEND

- SUB DRAINAGE AREA
- North Sub System Proposed Links
- South Sub System Proposed Links

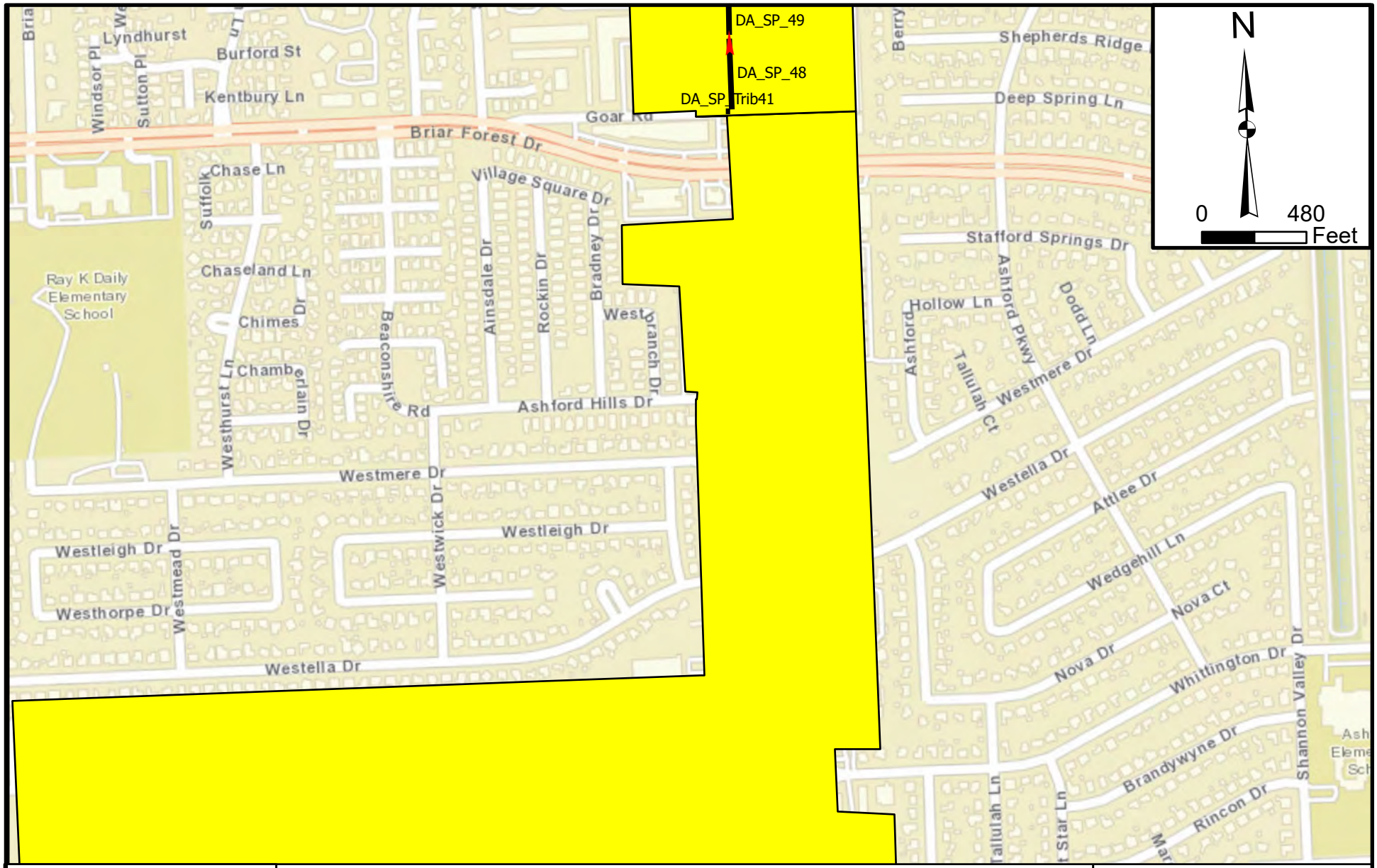
HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

APPENDIX-C2

City of Houston, HPB, Esri, HERE, Garmin, GeoTechnologies, Inc., NGA, USGS



GUNDA CORPORATION
Engineers, Planners & Managers
11750 Katy Freeway, Suite 300
Houston, Texas 77079

XPSWMM SCHEMATICS (PROPOSED CONDITION)

LEGEND

- SUB DRAINAGE AREA
- North Sub System Proposed Links
- South Sub System Proposed Links

HOUSTON PUBLIC WORKS

TRAFFIC AND DRAINAGE ANALYSIS (WO#15)
DAIRY ASHFORD ROAD
MEMORIAL DR TO BRIAR FOREST DR

MAY 2022

APPENDIX-C3

City of Houston, HPB, Esri, HERE, Garmin, GeoTechnologies, Inc., NGA, USGS

APPENDIX D
PROPOSED - XPSWMM HYDRAULIC DATA

GUNDA CORPORATION
Engineers, Planners & Managers

Proposed drainage system - 2 year results

Name	Upstream Node Name	Downstream Node Name	Link Name	Shape	Dia. ft	Length ft	Conduit Slope	Roughness	Upstream Invert Elevation ft	Downstream Invert Elevation ft	Design Full Flow cfs	Max Flow cfs	Design Velocity ft/s; m/s	Max Velocity ft/s	Ground Elevation (Spill Crest) ft	Ground Elevation (Spill Crest) ft	Maximum Water Elevation (US) ft	Maximum Water Elevation (DS) ft	Max Volume ft^3
DA_SP01_01	DA_MH_C_01	DA_MH_C_02	DA_SP01_01	Cir.	3.5	218.48	0.31	0.013	61.09	60.41	56.02	13.08	5.82	1.55	83.26	81.74	66.28	66.24	2192.12
DA_SP_17_OUT_A	DA_MH_17	DA_OF_B	DA_SP_17_OUT_A	Cir.	9.5	63.37	0.24	0.022	47.92	47.77	417.53	238.43	5.89	3.35	76.10	57.28	65.07	65.07	4708.87
DA_SP_16	DA_MH_15	DA_MH_16	DA_SP_16	Cir.	7	50.30	0.13	0.013	50.71	50.64	230.33	238.43	5.99	6.16	74.08	74.75	65.07	65.07	2029.31
DA_SP01_09	DA_MH_C_09	DA_MH_C_10	DA_SP01_09	Cir.	6	35.74	0.16	0.013	53.33	53.28	169.40	75.64	5.99	2.66	74.34	74.49	65.06	65.06	1059.36
DA_SPL_04	DA_MH_C_09	DA_MH_15	DA_SPL_04	Cir.	2	60.39	0.27	0.013	63.94	63.78	11.67	-2.38	3.71	-2.08	74.34	74.08	65.06	65.07	119.40
DA_SP_Trib18	DA_IN_B16	DA_MH_14	DA_SP_Trib18	Cir.	2	15.00	11.96	0.013	68.45	66.56	80.30	4.40	25.56	13.69	72.26	71.84	68.77	66.88	0.81
DA_SP01_Trib05	DA_IN_C6	DA_MH_C_08	DA_SP01_Trib05	Cir.	2	12.00	0.35	0.013	67.20	67.16	12.99	5.40	4.14	4.33	71.96	71.66	68.04	67.98	14.77
DA_SP_15	DA_MH_14	DA_MH_15	DA_SP_15	Cir.	7	282.59	0.13	0.013	51.07	50.71	230.34	240.23	5.99	6.20	71.84	74.08	65.17	65.07	11400.88
DA_SP01_08	DA_MH_C_08	DA_MH_C_09	DA_SP01_08	Cir.	5	298.03	0.20	0.013	54.93	54.33	116.47	73.51	5.93	3.72	71.66	74.34	65.06	65.06	6134.59
DA_SP_Trib16	DA_IN_B15	DA_MH_13	DA_SP_Trib16	Cir.	2	12.99	3.70	0.013	73.68	73.20	43.51	3.80	13.85	8.51	78.68	78.48	74.08	73.60	4.82
DA_SP_Trib17	DA_IN_C5	DA_MH_C_07	DA_SP_Trib17	Cir.	2	16.00	0.00	0.013	69.58	69.50	16.03	4.40	5.10	4.35	77.90	77.90	70.30	70.22	16.19
DA_SP01_07	DA_MH_C_07	DA_MH_C_08	DA_SP01_07	Cir.	4.5	695.12	0.22	0.013	56.96	55.43	92.24	68.18	5.80	4.26	77.90	71.66	65.36	65.06	11194.01
DA_SPL_03	DA_MH_C_07	DA_MH_13	DA_SPL_03	Cir.	2	58.98	0.98	0.013	69.42	68.84	22.44	0.00	7.14	0.00	77.90	78.48			0.00
DA_SP_14	DA_MH_13	DA_MH_14	DA_SP_14	Cir.	7	709.55	0.13	0.013	52.00	51.07	230.33	235.93	5.99	6.09	78.48	71.84	66.19	65.17	28626.25
DA_SP01_Trib02	DA_IN_C4	DA_MH_C_06	DA_SP01_Trib02	Cir.	2	123.53	0.35	0.013	71.77	71.34	13.34	15.81	4.25	5.65	79.61	79.42	73.47	72.77	323.93
DA_SP01_06	DA_MH_C_06	DA_MH_C_07	DA_SP01_06	Cir.	4.5	401.61	0.22	0.013	57.84	56.96	92.24	63.97	5.80	4.00	79.42	77.90	65.79	65.36	6658.19
DA_SPL_02	DA_MH_C_06	DA_MH_12	DA_SPL_02	Cir.	2	63.50	0.30	0.013	71.10	70.91	12.37	0.00	3.94	0.00	79.42	79.81			0.00
DA_SP_Trib11	DA_IN_B9	DA_MH_08	DA_SP_Trib11	Cir.	2	10.80	4.82	0.013	78.61	78.09	49.65	18.80	15.81	14.72	84.09	83.72	79.46	78.94	13.80
DA_SP_Trib10	DA_IN_B12	DA_MH_08	DA_SP_Trib10	Cir.	2	69.28	0.88	0.013	74.74	74.13	21.23	13.92	6.76	7.21	83.72	83.72	75.92	75.31	133.82
DA_SP_Trib09	DA_IN_B8	DA_MH_07	DA_SP_Trib09	Cir.	2	22.60	2.74	0.013	74.34	73.72	37.47	17.40	11.93	11.72	84.74	85.09	75.30	74.68	33.60
DA_SP_09	DA_MH_08	DA_MH_09	DA_SP_09	Cir.	6	138.03	0.15	0.013	54.96	54.75	164.03	217.46	5.80	7.63	83.72	83.37	68.81	68.44	4091.30
DA_SP_08	DA_MH_07	DA_MH_08	DA_SP_08	Cir.	6	329.49	0.15	0.013	55.46	54.96	164.02	184.82	5.80	6.48	85.09	83.72	69.42	68.81	9766.30
DA_SP_10	DA_MH_09	DA_MH_10	DA_SP_10	Cir.	6.5	214.31	0.14	0.013	54.25	53.95	196.17	228.31	5.91	6.83	83.37	82.14	68.44	68.03	7455.12
DA_SP_Trib12	DA_IN_B13	DA_MH_09	DA_SP_Trib12	Cir.	2	15.75	0.50	0.013	78.79	78.71	16.06	10.80	5.11	5.59	83.85	83.37	79.97	79.89	30.39
DA_SP01_Trib01	DA_IN_C1	DA_MH_C_01	DA_SP01_Trib01	Cir.	2	122.53	0.50	0.013	74.35	73.74	16.01	13.01	5.09	5.76	84.15	83.26	75.71	75.04	271.02
DA_SP_11	DA_MH_10	DA_MH_11	DA_SP_11	Cir.	6.5	284.39	0.14	0.013	53.95	53.56	196.17	228.40	5.91	6.83	82.14	81.09	68.03	67.53	9892.96
DA_SP01_03	DA_MH_C_03	DA_MH_C_04	DA_SP01_03	Cir.	4	214.01	0.26	0.013	59.72	59.17	73.24	34.96	5.83	2.77	81.44	80.82	66.17	66.04	2819.29
DA_SP_Trib14	DA_IN_B14	DA_MH_11	DA_SP_Trib14	Cir.	2	12.32	0.50	0.013	76.51	76.45	15.99	3.60	5.09	4.11	81.33	81.09	77.16	77.09	10.80
DA_SP_12	DA_MH_11	DA_MH_12	DA_SP_12	Cir.	6.5	374.39	0.14	0.013	53.56	53.03	196.17	232.00	5.91	6.94	81.09	79.81	67.53	66.85	13023.76
DA_SPL_01	DA_MH_C_04	DA_MH_11	DA_SPL_01	Cir.	2	60.74	0.50	0.013	72.10	71.80	15.98	0.00	5.09	0.00	80.82	81.09			0.00
DA_SP01_04	DA_MH_C_04	DA_MH_C_05	DA_SP01_04	Cir.	4	71.30	0.26	0.013	59.17	58.98	73.24	48.13	5.83	3.81	80.82	80.54	66.04	65.96	939.28
DA_SP_Trib15	DA_IN_C3	DA_MH_C_04	DA_SP_Trib15	Cir.	2	7.96	2.64	0.013	76.65	76.44	36.78	13.20	11.71	10.75	81.22	80.82	77.48	77.27	9.78
DA_SP_Trib13	DA_IN_C2	DA_MH_C_02	DA_SP_Trib13	Cir.	2	10.00	0.56	0.013	77.58	77.55	12.31	22.00	3.92	7.63	82.33	81.74	79.31	79.23	28.50
DA_SP01_02	DA_MH_C_02	DA_MH_C_03	DA_SP01_02	Cir.	3.5	60.44	0.31	0.013	60.41	60.22	56.02	34.95	5.82	3.62	81.74	81.44	66.24	66.17	609.60
DA_SP_13	DA_MH_12	DA_MH_13	DA_SP_13	Cir.	6.5	383.41	0.14	0.013	53.03	52.50	196.17	232.14	5.91	6.95	79.81	78.48	66.85	66.19	13337.53
DA_SP_17	DA_MH_16	DA_MH_17	DA_SP_17	Cir.	7	168.75	0.13	0.013	50.64	50.42	230.29	238.45	5.98	6.16	74.75	76.10	65.07	65.07	6808.09
DA_SP01_10	DA_MH_C_10	DA_MH_C_11	DA_SP01_10	Cir.	6	117.31	0.16	0.013	53.28	53.09	169.41	75.70	5.99	2.66	74.49	75.42	65.06	65.06	3477.15
DA_SP01_11_OUT_C	DA_MH_C_11	DA_OF_C	DA_SP01_11_OUT_C	Cir.	6.5	142.12	0.40	0.022	52.59	52.02	195.93	75.73	5.90	2.27	75.42	58.53	65.06	65.06	4943.87
DA_SP01_05	DA_MH_C_05	DA_MH_C_06	DA_SP01_05	Cir.	4.5	290.91	0.22	0.013	58.48	57.84	92.24	48.13	5.80	3.01	80.54	79.42	65.96	65.79	4850.30
DA_SP_OUT_A	DA_MH_60	DA_OF_A	DA_SP_OUT_A	Cir.	14	101.56	0.15	0.022	46.95	46.80	842.52	900.43	5.89	6.28	75.05	60.31	68.44	64.00	15239.67
DA_SP_52	DA_MH_59	DA_MH_60	DA_SP_52	Cir.	13	280.68	0.06	0.013	47.61	47.45	780.70	891.77	5.88	6.71	72.24	75.05	72.56	68.44	39055.62
DA_SP_51	DA_MH_58	DA_MH_59	DA_SP_51	Cir.	12	554.91	0.06	0.013	48.94	48.61	658.70	876.70	5.82	7.73	73.20	72.24	73.76	72.56	65791.59
DA_SP_Trib42	DA_IN_A17	DA_MH_58	DA_SP_Trib42	Cir.	2	39.84	0.50	0.013	67.30	67.10	16.00	-29.99	5.09	-9.41	73.40	73.20	73.40	73.76	131.21
DA_SP_48	DA_MH_55	DA_MH_56	DA_SP_48	Cir.	11	341.84	0.07	0.013	50.98	50.75	543.63	826.59	5.72	8.65	78.51	77.36	78.61	77.55	34056.00
DA_SP_Trib41	DA_IN_A16	DA_MH_55	DA_SP_Trib41	Cir.	2	37.2	0.50	0.013	72.92	72.73	16.17	69.92	5.15	22.05	78.60	78.51	78.60	78.61	122.51
DA_SP_49	DA_MH_56	DA_MH_57	DA_SP_49	Cir.	12	910.14	0.06	0.013	49.75	49.21	658.69	843.78	5.82	7.43	77.36	76.02	77.55	76.00	107908.60
DA_SP_50	DA_MH_57	DA_MH_58	DA_SP_50	Cir.	12	446.8	0.06	0.013	49.21	48.94	658.69	835.62	5.82	7.36	76.02	73.20	76.00	73.76	52973.79

Existing drainage system - 100 year results

Name	Upstream Node Name	Downstream Node Name	Link Name	Shape	Dia. ft	Length ft	Conduit Slope	Roughness	Upstream Invert Elevation ft	Downstream Invert Elevation ft	Design Full Flow cfs	Max Flow cfs	Design Velocity ft/s; m/s	Max Velocity ft/s	Ground Elevation (Spill Crest) ft	Ground Elevation (Spill Crest) ft	Maximum Water Elevation (US) ft	Maximum Water Elevation (DS) ft	Max Volume ft^3
DA_SP_17_OUT_A	DA_MH_17	DA_OF_B	DA_SP_17_OUT_A	Cir.	9.5	63.37	0.24	0.022	47.92	47.77	417.53	447.35	5.89	6.26	76.10	57.28	72.10	72.10	4708.87
DA_SP_16	DA_MH_15	DA_MH_16	DA_SP_16	Cir.	7	50.30	0.13	0.013	50.71	50.64	230.33	447.19	5.99	11.49	74.08	74.75	72.15	72.10	2029.31
DA_SP01_09	DA_MH_C_09	DA_MH_C_10	DA_SP01_09	Cir.	6	35.74	0.16	0.013	53.33	53.28	169.40	189.61	5.99	6.63	74.34	74.49	72.09	72.09	1059.36
DA_SPL_04	DA_MH_C_09	DA_MH_15	DA_SPL_04	Cir.	2	60.39	0.27	0.013	63.94	63.78	11.67	-28.27	3.71	-8.86	74.34	74.08	72.09	72.15	198.89
DA_SP_Trib18	DA_IN_B16	DA_MH_14	DA_SP_Trib18	Cir.	2	15.00	11.96	0.013	68.45	66.56	80.30	18.06	25.56	9.46	72.26	71.84	72.96	72.82	47.76
DA_SP01_Trib05	DA_IN_C6	DA_MH_C_08	DA_SP01_Trib05	Cir.	2	12.00	0.35	0.013	67.20	67.16	12.99	13.42	4.14	4.25	71.96	71.66	72.10	72.10	39.52
DA_SP_15	DA_MH_14	DA_MH_15	DA_SP_15	Cir.	7	282.59	0.13	0.013	51.07	50.71	230.34	464.41	5.99	11.92	71.84	74.08	72.82	72.15	11400.88
DA_SP01_08	DA_MH_C_08	DA_MH_C_09	DA_SP01_08	Cir.	5	298.03	0.20	0.013	54.93	54.33	116.47	170.22	5.93	8.55	71.66	74.34	72.10	72.09	6134.59
DA_SP_Trib16	DA_IN_B15	DA_MH_13	DA_SP_Trib16	Cir.	2	12.99	3.70	0.013	73.68	73.20	43.51	23.50	13.85	11.37	78.68	78.48	76.81	76.28	42.33
DA_SP_Trib17	DA_IN_C5	DA_MH_C_07	DA_SP_Trib17	Cir.	2	16.00	0.00	0.013	69.58	69.50	16.03	12.95	5.10	4.30	77.90	77.90	76.37	76.24	52.69
DA_SP01_07	DA_MH_C_07	DA_MH_C_08	DA_SP01_07	Cir.	4.5	695.12	0.22	0.013	56.96	55.43	92.24	157.96	5.80	9.75	77.90	71.66	76.24	72.10	11245.81
DA_SPL_03	DA_MH_C_07	DA_MH_13	DA_SPL_03	Cir.	2	58.98	0.98	0.013	69.42	68.84	22.44	19.33	7.14	6.54	77.90	78.48	76.24	76.28	194.10
DA_SP_14	DA_MH_13	DA_MH_14	DA_SP_14	Cir.	7	709.55	0.13	0.013	52.00	51.07	230.33	456.44	5.99	11.69	78.48	71.84	76.28	72.82	28626.25
DA_SP01_Trib02	DA_IN_C4	DA_MH_C_06	DA_SP01_Trib02	Cir.	2	123.53	0.35	0.013	71.77	71.34	13.34	34.26	4.25	10.77	79.61	79.42	79.61	78.21	404.65
DA_SP01_06	DA_MH_C_06	DA_MH_C_07	DA_SP01_06	Cir.	4.5	401.61	0.22	0.013	57.84	56.96	92.24	159.03	5.80	9.79	79.42	77.90	78.21	76.24	6658.46
DA_SPL_02	DA_MH_C_06	DA_MH_12	DA_SPL_02	Cir.	2	63.50	0.30	0.013	71.10	70.91	12.37	20.76	3.94	6.57	79.42	79.81	78.21	78.12	209.13
DA_SP_Trib11	DA_IN_B9	DA_MH_08	DA_SP_Trib11	Cir.	2	10.80	4.82	0.013	78.61	78.09	49.65	40.62	15.81	16.17	84.09	83.72	84.21	84.21	35.41
DA_SP_Trib10	DA_IN_B12	DA_MH_08	DA_SP_Trib10	Cir.	2	69.28	0.88	0.013	74.74	74.13	21.23	46.48	6.76	14.48	83.72	83.72	84.25	84.21	228.12
DA_SP_Trib09	DA_IN_B8	DA_MH_07	DA_SP_Trib09	Cir.	2	22.60	2.74	0.013	74.34	73.72	37.47	66.39	11.93	20.59	84.74	85.09	85.94	86.02	73.63
DA_SP_09	DA_MH_08	DA_MH_09	DA_SP_09	Cir.	6	138.03	0.15	0.013	54.96	54.75	164.03	413.40	5.80	14.29	83.72	83.37	84.21	83.58	4091.30
DA_SP_08	DA_MH_07	DA_MH_08	DA_SP_08	Cir.	6	329.49	0.15	0.013	55.46	54.96	164.02	358.28	5.80	12.36	85.09	83.72	86.02	84.21	9766.30
DA_SP01_01	DA_MH_C_01	DA_MH_C_02	DA_SP01_01	Cir.	3.5	218.48	0.31	0.013	61.09	60.41	56.02	37.81	5.82	3.81	83.26	81.74	82.42	81.73	2192.18
DA_SP_10	DA_MH_09	DA_MH_10	DA_SP_10	Cir.	6.5	214.31	0.14	0.013	54.25	53.95	196.17	436.00	5.91	12.87	83.37	82.14	83.58	82.23	7455.12
DA_SP_Trib12	DA_IN_B13	DA_MH_09	DA_SP_Trib12	Cir.	2	15.75	0.50	0.013	78.79	78.71	16.06	32.53	5.11	10.31	83.85	83.37	83.85	83.58	51.87
DA_SP01_Trib01	DA_IN_C1	DA_MH_C_01	DA_SP01_Trib01	Cir.	2	122.53	0.50	0.013	74.35	73.74	16.01	31.07	5.09	9.74	84.15	83.26	84.15	82.42	403.47
DA_SP_11	DA_MH_10	DA_MH_11	DA_SP_11	Cir.	6.5	284.39	0.14	0.013	53.95	53.56	196.17	435.66	5.91	12.87	82.14	81.09	82.23	80.80	9892.96
DA_SP01_03	DA_MH_C_03	DA_MH_C_04	DA_SP01_03	Cir.	4	214.01	0.26	0.013	59.72	59.17	73.24	90.80	5.83	7.04	81.44	80.82	81.16	80.18	2819.29
DA_SP_Trib14	DA_IN_B14	DA_MH_11	DA_SP_Trib14	Cir.	2	12.32	0.50	0.013	76.51	76.45	15.99	27.81	5.09	8.87	81.33	81.09	80.91	80.80	40.57
DA_SP_12	DA_MH_11	DA_MH_12	DA_SP_12	Cir.	6.5	374.39	0.14	0.013	53.56	53.03	196.17	426.46	5.91	12.61	81.09	79.81	80.80	78.12	13023.76
DA_SPL_01	DA_MH_C_04	DA_MH_11	DA_SPL_01	Cir.	2	60.74	0.50	0.013	72.10	71.80	15.98	-35.36	5.09	-11.04	80.82	81.09	80.18	80.80	200.03
DA_SP01_04	DA_MH_C_04	DA_MH_C_05	DA_SP01_04	Cir.	4	71.30	0.26	0.013	59.17	58.98	73.24	137.78	5.83	10.68	80.82	80.54	80.18	79.85	939.28
DA_SP_Trib15	DA_IN_C3	DA_MH_C_04	DA_SP_Trib15	Cir.	2	7.96	2.64	0.013	76.65	76.44	36.78	31.40	11.71	12.80	81.22	80.82	80.38	80.18	26.22
DA_SP_Trib13	DA_IN_C2	DA_MH_C_02	DA_SP_Trib13	Cir.	2	10.00	0.56	0.013	77.58	77.55	12.31	50.65	3.92	16.03	82.33	81.74	82.16	81.73	32.93
DA_SP01_02	DA_MH_C_02	DA_MH_C_03	DA_SP01_02	Cir.	3.5	60.44	0.31	0.013	60.41	60.22	56.02	90.68	5.82	9.14	81.74	81.44	81.73	81.16	609.60
DA_SP_13	DA_MH_12	DA_MH_13	DA_SP_13	Cir.	6.5	383.41	0.14	0.013	53.03	52.50	196.17	437.19	5.91	12.95	79.81	78.48	78.12	76.28	13337.53
DA_SP_17	DA_MH_16	DA_MH_17	DA_SP_17	Cir.	7	168.75	0.13	0.013	50.64	50.42	230.29	447.23	5.98	11.49	74.75	76.10	72.10	72.10	6808.09
DA_SP01_10	DA_MH_C_10	DA_MH_C_11	DA_SP01_10	Cir.	6	117.31	0.16	0.013	53.28	53.09	169.41	189.67	5.99	6.64	74.49	75.42	72.09	72.09	3477.15
DA_SP01_11_OUT_C	DA_MH_C_11	DA_OF_C	DA_SP01_11_OUT_C	Cir.	6.5	142.12	0.40	0.022	52.59	52.02	195.93	189.71	5.90	5.66	75.42	58.53	72.09	72.09	4943.87
DA_SP01_05	DA_MH_C_05	DA_MH_C_06	DA_SP01_05	Cir.	4.5	290.91	0.22	0.013	58.48	57.84	92.24	137.81	5.80	8.47	80.54	79.42	79.85	78.21	4850.30
DA_SP_52	DA_MH_59	DA_MH_60	DA_SP_52	Cir.	13	280.68	0.06	0.013	47.61	47.45	780.70	1799.33	5.88	13.49	72.24	75.05	73.57	72.35	39055.62
DA_SP_51	DA_MH_58	DA_MH_59	DA_SP_51	Cir.	12	554.91	0.06	0.013	48.94	48.61	658.70	1799.34	5.82	15.81	73.20	72.24	75.41	73.57	65791.59
DA_SP_OUT_A	DA_MH_60	DA_OF_A	DA_SP_OUT_A	Cir.	14	101.56	0.15	0.022	46.95	46.80	842.52	1799.33	5.89	12.52	75.05	60.31	72.35	71.98	15239.67
DA_SP_Trib42	DA_IN_A17	DA_MH_58	DA_SP_Trib42	Cir.	2	39.84	0.50	0.013	67.30	67.10	16.00	-43.41	5.09	-13.58	73.40	73.20	73.41	75.41	131.21
DA_SP_48	DA_MH_55	DA_MH_56	DA_SP_48	Cir.	11	341.84	0.07	0.013	50.98	50.75	543.63	1656.10	5.72	17.26	78.51	77.36	81.01	79.50	34056.00
DA_SP_Trib41	DA_IN_A16	DA_MH_55	DA_SP_Trib41	Cir.	2	37.2	0.50	0.013	72.92	72.73	16.17	75.64	5.15	23.81	78.60	78.51	80.61	81.01	122.51
DA_SP_49	DA_MH_56	DA_MH_57	DA_SP_49	Cir.	12	910.14	0.06	0.013	49.75	49.21	658.69	1776.26	5.82	15.57	77.36	76.02	79.50	77.95	107908.60
DA_SP_50	DA_MH_57	DA_MH_58	DA_SP_50	Cir.	12	446.8	0.06	0.01	49.21	48.94	658.69	1776.25	5.82	15.59	76.02	73.20	77.95	75.41	52973.79