Kemah City Council Meeting

October 7, 2020

7:00p.m.

A G E N D A

OCTOBER 7, 2020 7:00P.M.

CITY OF KEMAH - CITY COUNCIL
AND KEMAH PUBLIC FACILITIES CORPORATION

Council Chambers, Kemah City Hall,
1401 State Hwy 146, Kemah, Texas

VIRTUAL MEETING

Terri Gale – Mayor

Teresa Vazquez-Evans	Wanda Zimmer	Kyle Burks	Robin Collins	Isaac Saldaña
Council Position 1	Council Position 2	Council Position 3	Council Position 4	Council Position 5

In accordance with the Texas Open Meetings Act the agenda is posted for public information, at all times, for at least 72 hours preceding the scheduled time of the meeting on the bulletin board located on the front exterior wall of the City Hall Building, except in case of emergency meetings or emergency items posted in accordance with law.Texas Criminal and Traffic Law Handbook Penal Code Sec. 38.13 Hindering Proceedings by Disorderly Conduct. A person commits an offense if he intentionally hinders an official proceeding by noise or violent or tumultuous behavior or disturbance. Penal Code Section 42.05 Disrupting Meeting or Procession. A person commits an offense if, with intent to prevent or disrupt a lawful meeting, procession, or gathering, he obstructs or interferes with the meeting, procession, or gathering by physical action or verbal utterance.The City Council reserves the right to meet in closed session on any of the below items should the need arise and if applicable, pursuant to authorization by Title 5, Chapter 551 of the Texas Government Code.

1. **Pledges**

2. **Prayer**

3. **Invitation to Address Council**
(State law prohibits the Mayor and members of the City Council from commenting on any statement or engaging in dialogue without an appropriate agenda item being posted in accordance with the Texas Open Meetings Law. Comments should be directed to the entire Council, not individual members. Engaging in verbal attacks or comments intended to insult, abuse, malign or slander any individual shall be cause for termination of speaking privileges and expulsion from Council Chambers. Your comments are limited to two (2) minutes.)

4. **Council Members Comments and Announcements (Items of Community Interest Only)**

5. **Mayor's Comments**

6. **City Administrator Report:**
   - Financials
   - Economic Development
   - Events and Operations

7. **CIP**

8. **Police and Emergency Management Report**
   - Events and Operations
   - Emergency Services

9. **Communications and Marketing Report**

10. **Consent Agenda**
    - **A. Quarterly Investment Report**
      - July-September 2020
    - **B. To approve the preliminary plat for 2401 Park Ave – Corinthian Cove**

11. **Consideration and Possible Action: to schedule a public workshop to discuss the proposed Kemah Conference Center**

12. **Consideration and Possible Action: to define and approve holiday events, including Trunk or Treat and Christmas**

13. **Consideration and Possible Action: to approve the Master Drainage Plan for the City of Kemah**

14. **Consideration and Possible Action: to determine a process and timeline to backfill an open KCDC position**

15. **Consideration and Possible Action: on the approval of an evaluation scoring matrix to be used in the RFP selection process for the schoolhouse and train depot lease.**

16. **Consideration and Possible Action: to approve an ordinance requiring bars and over 50% alcohol restaurants to have licensed peace officers in their security staff**

17. **Consideration and Possible Action: to revise the configuration, timing, signage, and any other aspects of the bollards, lighting, parking areas, and other safety-related changes for 6th street and the Lighthouse District**

18. **Consideration and Possible Action: to determine staffing of Kemah police officers for certain shifts throughout the week and weekend and supplementing certain shifts with outside agencies to potentially include, but not limited to, Galveston County.**

19. **Council Member Closing Comments**

20. **Mayor's Closing Comments**

21. **Adjourn**

ONLINE: https://global.gotomeeting.com/join/711186805

PHONE: United States (Toll Free): 1 877 309 2073

United States: +1 (646) 749-3129

ACCESS CODE: 711-186-805

CERTIFICATION

This is to certify that a copy of the Notice of the Regular City Council meeting for **Wednesday, October 7, 2020**, was posted on the bulletin board at City Hall, 1401 Highway 146, Kemah, Texas, on this the 2nd day of October, 2020, prior to 7:00 p.m.

_____ 10/07/2020

Melissa Chilcote, City Secretary Date

I certify this notice was removed by me from the Kemah City Hall bulletin board on the ____ day of _____, 2020.

Kemah City Council Agenda Item

#10A Investment Report

Consent Agenda Item #10A: Investment Report

1: July-September 2020

CITY OF KEMAH
QUARTERLY INVESTMENT REPORT
JULY - SEPTEMBER 2020

CERTICATES OF DEPOSIT:

Current Interest Rate	**0.60%**
Maturity Date - Quarterly	**2/16/2018**

	#1705 BOOK VALUE
Beginning Balance 06/30/2020	**$ 509,917**
Deposits	
Withdrawals	
Interest Earned	**64**
Ending Balance 09/30/2020	**$ 509,982**

KEMAH GROWTH FUND
Current Yield .35 Annual

	MMA
Beginning Balance 06/30/2020	**$ 469,093**
Deposits	**75,373**
Withdrawals	**-**
Interest	**415**
Ending Balance at 9/30/2020	**$ 544,881**

This report meets the requirements of Section 2256.023 sub section (a) of the Public Funds Investment Act "INTERNAL MANAGEMENT REPORTS" that requires "not less than Quarterly Investment Reports.

Terri Gale, Mayor

Rebecca Roseberry, Interim Finance Director

Kemah City Council Agenda Item

#10B Preliminary Plat Approval for Corinthian Cove

Once form is complete and departmental clearances are obtained, this form should be forwarded to the City Secretary as soon as possible prior to the date that the item is expected to be placed on the City Council agenda.

Date requested for Council consideration: 10/07/2020

Prepared by:Jimmy/Cris

Subject: Preliminary Plat Approval for Corinthian Cove

Proceeding: Consent

Originating Department: Community Services

Plan Reference: 17SP- or 17OP-

Texas Ethics Commission Form 1295 required? *n/a*

If YES, is copy of Form attached? Contract Identification Number on Form:

City Attorney Review: *Yes*

Expenditure Required: Amount Budgeted:

Appropriation Required: Source of Funds:

Finance Approval: n/a

City Administrator Approval:

SUMMARY / ORIGINATING CAUSE

Applicant has submitted a preliminary plat for a 1.98 acre subdivided into 2 lots at 2401 Park Ave. Lots are accessed from a private road within a 40' access utility and drainage reserve. Owner proposes a gravel surfaced private roadway.

IMMINENT CONSEQUENCES / BENEFIT TO COMMUNITY

Staff has reviewed and preliminary plat is recommended for approval with the following revisions:

1. Correct width of Reserve "A" to 40 feet.
2. Add a paragraph to dedication stating that Reserves A & B are hereby dedicated to the lot owners for the purpose of access, utility, and drainage purposes.

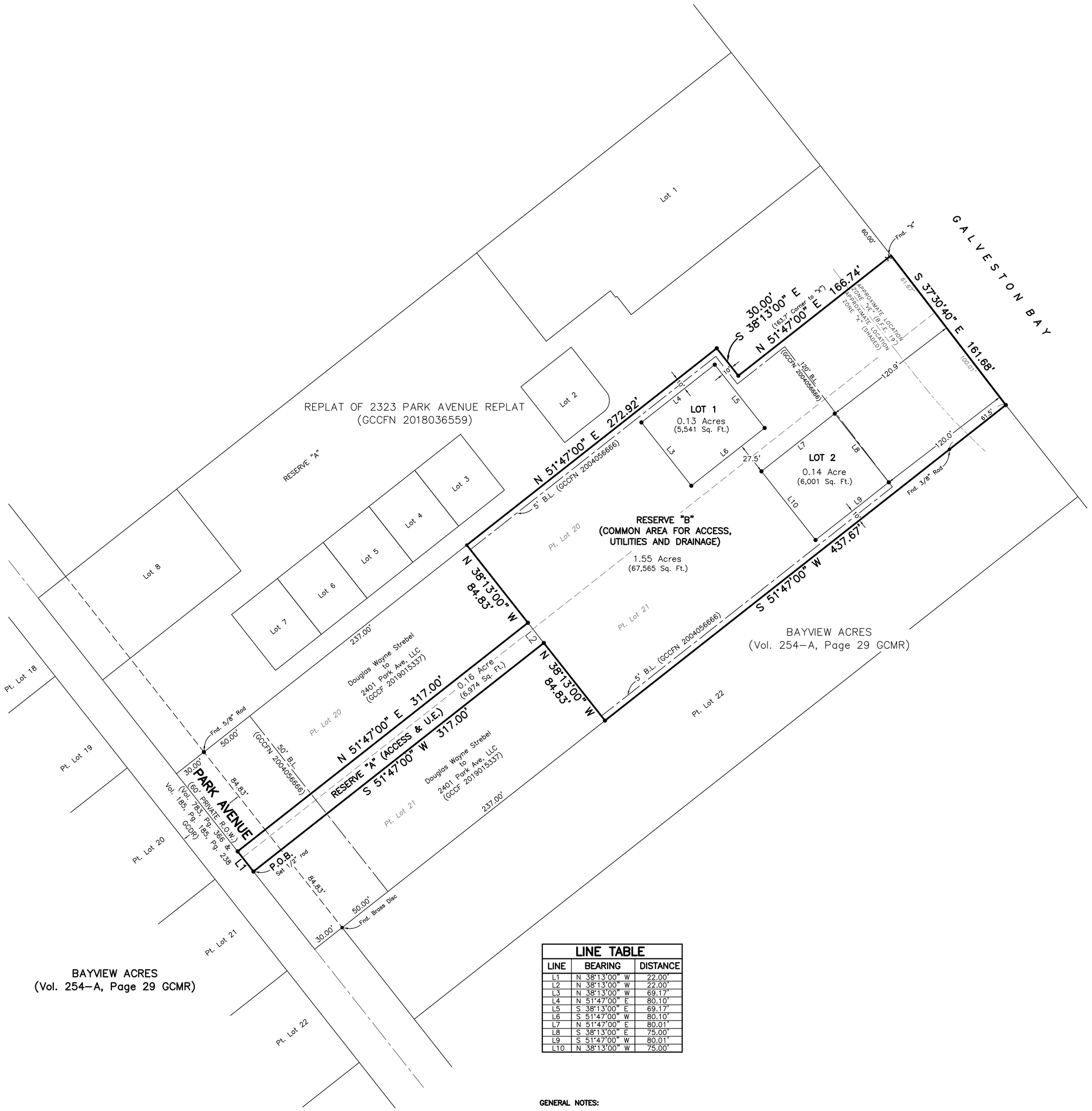
Once approved, a final plat will be submitted to the City for approval. If there are any minor changes a final plat will be presented to Council at the next Council Meeting.

RECOMMENDATIONS

Approve

ATTACHMENTS

Preliminary Plat



LINE TABLE		
LINE	BEARING	DISTANCE
L1	N 38°13'00" W	22.00'
L2	N 38°13'00" W	22.00'
L3	N 38°13'00" W	69.17'
L4	N 51°47'00" E	80.10'
L5	S 38°13'00" E	69.17'
L6	S 51°47'00" W	80.10'
L7	N 51°47'00" E	80.01'
L8	S 38°13'00" E	75.00'
L9	S 51°47'00" W	80.01'
L10	N 38°13'00" W	75.00'

GENERAL NOTES:

1.) This property lies in Zones "X" (Shaded), and "VE" Base Flood Elevation (B.F.E.) 19 feet, defined by FEMA as areas of minimal flooding, as scaled from Flood Insurance Rate Map Community-Panel Number 48167C0044G, effective date August 15, 2019.

2.) This survey has been prepared without the benefit of a current title report or title commitment. This property may be subject to matters of record not reflected hereon which such a title report or title commitment may reveal.

3.) Bearings shown hereon based on BAYVIEW ACRES subdivision, Volume 254-A, Page 29 of the Galveston County Map Records.

4.) The herein subdivided tract or parcel of land lies entirely within the incorporated limits of the City of Kemah, Texas.

5.) The herein subdivided tract or parcel of land lies within the Clear Creek Independent School District.

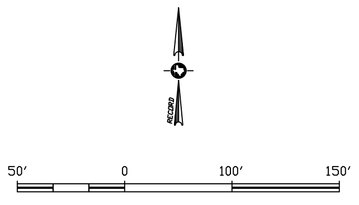
6.) All building lines shall be as per City of Kemah Ordinances or as shown on plat.

7.) The reason for this plat is to create two Lots and two Reserves.

8.) This plat does not attempt to amend or remove any covenants or restrictions.

9.) All corners are set 1/2" rod with cap stamped "High Tide Surveying" unless otherwise noted.

REVISED:	AUGUST 17, 2020
SURVEY DATE:	AUGUST 6, 2020
FILE No.:	1600-0000-0021-001
DRAFTING:	JTK/ECM
JOB No.:	20-0394



ABBREVIATIONS:

P.O.B.	Point of Beginning
B.L.	Building Line
U.E.	Utility Easement
GCDR	Galveston County Deed Records
GCMR	Galveston County Map Records
GCCFN	Galveston County Clerk's File Number
R.O.W.	Right of Way

STATE OF TEXAS {{

COUNTY OF GALVESTON {{ KNOW ALL MEN BY THESE PRESENTS

THAT 2401 Park Ave LLC, owners of the property subdivided in the above and foregoing map of **CORINTHIAN COVE** do hereby make subdivision of said property, according to the lines, street, alleys, parks, and easements therein shown, and designate said subdivision as **CORINTHIAN COVE** in the **RAFAEL BASQUEZ SURVEY**, Abstract 32, an addition to the City of Kemah, Galveston County, Texas; and dedicate to public use, as such, the streets, alleys, parks, and easements shown thereon forever except where noted on the map for private streets; and do hereby waive any claims for damages occasioned by the establishing of grades as approved for the streets and alleys dedicated, or occasioned by the alteration of the surface of any portion of the streets or alleys to conform to such grade; and do hereby bind ourselves, our successors and assigns to warrant and forever defend the title to the land so dedicated.

There is also dedicated for utilities an unobstructed aerial easement five feet wide from a plane 20 feet above the ground upward located adjacent to each side of all utility easements shown hereon.

We 2401 Park Ave LLC, do hereby dedicate forever to the public a strip of land 25 feet wide of the centerline of all gullies, ravines, draws, sloughs, or other natural drainage causes shown located in said subdivision as easements for drainage purposes, giving the City of Kemah and/or any other public agency the right to enter upon said easement at any and all times for the purpose of constructing and/or maintaining drainage work and/or structures.

Further, 2401 Park Ave LLC, do hereby relinquish all rights of access to major or larger streets or highways shown hereon except by way of the platted streets shown.

WITNESS MY HAND in _____, Galveston County, Texas, this _____ day of _____, 2020.

_____
Clark G. Thompson, Jr., Member
2401 Park Ave LLC

THE STATE OF TEXAS

COUNTY OF GALVESTON

Before me, the undersigned authority, on this day personally appeared Clark G. Thompson, Jr., Member of 2401 Park Ave LLC, known to me to be the person whose name is subscribed to the above and foregoing instrument, and acknowledged to me that he executed the same for the purposes and considerations therein expressed.

WITNESS MY HAND AND SEAL OF OFFICE this _____ day of _____, 2020.

_____
Notary Public in and for
The State of Texas
My Commission Expires:___

This is to certify that I, Stephen C. Blaskey, a Registered Professional Land Surveyor for the State of Texas, Registration #5856, have platted the above and foregoing subdivision from an actual survey made on the ground and under my direction; that this plat accurately represents the facts as found by that survey made by me, and; that all corners have been, or will be, properly monumented.

PRELIMINARY
NOT TO BE RECORDED
FOR ANY PURPOSE

_____
Stephen C. Blaskey
Registered Professional Land Surveyor 5856

This is to certify that the City Council of the City of Kemah, Texas, on motion made and seconded and adopted, has approved this plat and subdivision of **CORINTHIAN COVE** as shown hereon, and ordered said plat filed on record in the office of the County Clerk of Galveston County, Texas.

IN TESTIMONY WHEREOF, witness the official signatures this _____ day of _____, 2020.

_____
Melissa Chilcote
City Secretary

_____
Terri Gale
Mayor

THE STATE OF TEXAS

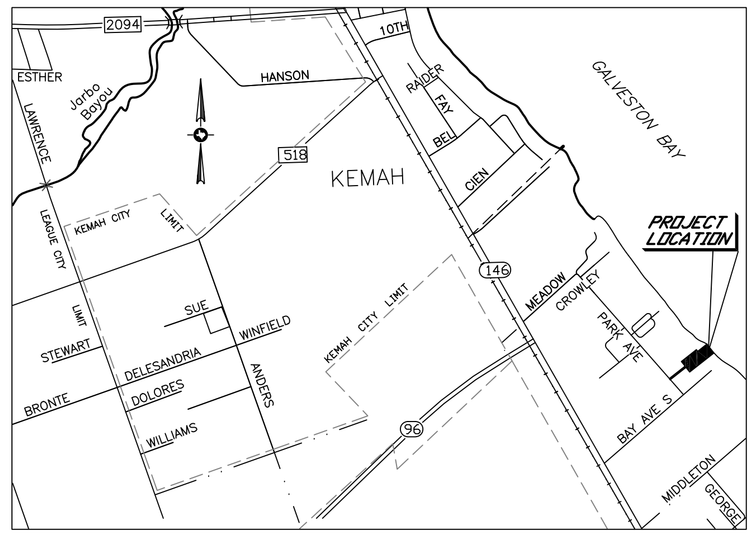
COUNTY OF GALVESTON

I, Dwight Sullivan, County Clerk, Galveston County, Texas, do hereby certify that this written instrument was filed for record in my office on _____, 2020, at __ o'clock, ___.m., and duly recorded on _____, 2020, at __ o'clock, ___.m., in PLAT RECORD _____, MAP NUMBER _____, Galveston County Map Records.

WITNESS MY HAND AND SEAL OF OFFICE at Galveston, Texas, the day and date last above written.

Dwight Sullivan
County Clerk
Galveston County, Texas

By:_____, Deputy



VICINITY MAP
NOT TO SCALE

PROPERTY DESCRIPTION:

All that certain 1.98 acres (86,081 Square Feet) tract or parcel of land being a part of Lots 20 and 21 of BAYVIEW ACRES, a subdivision out of the RAFAEL BASQUEZ SURVEY, ABSTRACT 32, in Galveston County, Texas, according to the map or plat thereof recorded in Volume 254-A, Page 29 of the Map Records in the Office of the County Clerk of Galveston County, Texas, and being part of a called 3.21 acre tract described in a General Warranty Deed dated March 25, 2019 from Douglas Wayne Strebel to 2401 Park Ave LLC, a Texas limited liability company, and found of record in Clerk's File Number 2019015337 of the Official Public Records of Galveston County, Texas; and being more fully described by metes and bounds as follows:

BEGINNING at point on the centerline of a permanent easement for private road (Park Avenue) as shown on said plat of BAYVIEW ACRES, and conveyed by Deed executed on April 30th, 1948 from Dorothy Sorrells to the County of Galveston as found of record in Volume 783, Page 366, of the Galveston County Deed Records;

THENCE, N 38°13'00" W along and with the Northerly right-of-way line of Park Avenue, a distance of 22.00 feet to a point for corner;

THENCE, through the interior of aforesaid 2401 Park Ave LLC 3.21 acre tract, the following two (2) courses and distances:

N 51°47'00" E a distance of 317.00 feet to a point for corner;
N 38°13'00" W, a distance of 84.83 feet to a point on the Northerly line of said 2401 Park Ave. LLC 3.21 acre tract;

THENCE, along the Northerly line of said 2401 Park Ave LLC 3.21 acre tract, the following three (3) courses and distances:

N 51°47'00" E a distance of 272.92 feet to a point for corner;
S 38°13'00" E a distance of 30.00 feet to a point for corner;
N 51°47'00" E at a distance of 163.7 feet pass an "X" found in concrete, and continuing for a total distance of 166.74 feet to a point for corner in the water's edge of Galveston Bay;

THENCE, S 37°30'40" E along said Galveston Bay, a distance of 161.68 feet to a point for corner being in the Southeasterly line of said Lot 21;

THENCE, S 51°47'00" W, along the Southeasterly line of said Lot 21, at a distance of 61.5 feet pass a 3/8 inch rod found on line, and continuing for a total distance of 437.67 feet to a point for corner;

THENCE, through the interior of aforesaid 2401 Park Ave LLC 3.21 acre tract, the following two (2) courses and distances:

N 38°13'00" W, a distance of 84.83 feet to a point for corner;
S 51°47'00" W a distance of 317.00 feet to the POINT OF BEGINNING and containing a calculated area of 1.98 acres (86,081 Square Feet) of land.

PRELIMINARY PLAT OF

CORINTHIAN COVE

A SUBDIVISION OUT OF THE RAFAEL BASQUEZ SURVEY, ABSTRACT 32, BEING A PART OF LOTS 20 AND 21 OF BAYVIEW ACRES, VOLUME 254-A, PAGE 29, G.C.M.R.

CITY OF KEMAH,
GALVESTON COUNTY, TEXAS

1.98 ACRES

2 LOTS, 2 RESERVES

OWNER:
2401 Park Ave LLC
10814 Roaring Brook Lane
Houston, Texas 77024

SURVEYOR:
High Tide Land Surveying, LLC
200 Houston Ave. Suite B
League City, TX 77573

Kemah City Council Agenda Item

#11 Kemah Conference Center Public Hearing

Once form is complete and departmental clearances are obtained, this form should be forwarded to the City Secretary as soon as possible prior to the date that the item is expected to be placed on the City Council agenda.

Date requested for Council consideration: 10/07/2020

Prepared by:Mayor Gale

Subject: to schedule a public workshop to discuss the proposed Kemah Conference Center

Proceeding: Consent

Originating Department: Admin

Plan Reference: 17SP- or 17OP-

Texas Ethics Commission Form 1295 required? *n/a*

If YES, is copy of Form attached? Contract Identification Number on Form:

City Attorney Review: *n/a*

Expenditure Required: Amount Budgeted:

Appropriation Required: Source of Funds:

Finance Approval: n/a

City Administrator Approval:

SUMMARY / ORIGINATING CAUSE

IMMINENT CONSEQUENCES / BENEFIT TO COMMUNITY

RECOMMENDATIONS

Schedule a Workshop for the Confernce Center discussion

ATTACHMENTS

Kemah City Council Agenda Item

#12 Trunk or Treat and Christmas

Once form is complete and departmental clearances are obtained, this form should be forwarded to the City Secretary as soon as possible prior to the date that the item is expected to be placed on the City Council agenda.

Date requested for Council consideration: 10/07/2020

Prepared by:Mayor Gale

Subject: to define and approve holiday events, including Trunk or Treat and Christmas

Proceeding: Consideration and Possible Action

Originating Department: Admin

Plan Reference: 17SP- or 17OP-

Texas Ethics Commission Form 1295 required? *n/a*

If YES, is copy of Form attached? Contract Identification Number on Form:

City Attorney Review: *n/a*

Expenditure Required: Amount Budgeted:

Appropriation Required: Source of Funds:

Finance Approval: n/a

City Administrator Approval:

SUMMARY / ORIGINATING CAUSE

IMMINENT CONSEQUENCES / BENEFIT TO COMMUNITY

RECOMMENDATIONS

ATTACHMENTS

Kemah City Council Agenda Item

#13 Master Drainage Plan

Once form is complete and departmental clearances are obtained, this form should be forwarded to the City Secretary as soon as possible prior to the date that the item is expected to be placed on the City Council agenda.

Date requested for Council consideration: 10/07/2020

Prepared by:Jessica Koutny

Subject: to approve the Master Drainage Plan for the City of Kemah

Proceeding: Consideration and Possible Action

Originating Department: Admin

Plan Reference: 17SP- or 17OP-

Texas Ethics Commission Form 1295 required? *n/a*

If YES, is copy of Form attached? Contract Identification Number on Form:

City Attorney Review: *n/a*

Expenditure Required: Amount Budgeted:

Appropriation Required: Source of Funds:

Finance Approval: n/a

City Administrator Approval:

SUMMARY / ORIGINATING CAUSE

IMMINENT CONSEQUENCES / BENEFIT TO COMMUNITY

RECOMMENDATIONS

To approve the Master Drainage Plan

ATTACHMENTS

City of Kemah

Master Drainage Plan

PREPARED FOR:

City of Kemah
1401 State Highway 146
Kemah, TX 77565

PREPARED BY:

LJA Engineering, Inc.

3600 W Sam Houston Pkwy S, Suite 600
Houston, TX 77042
PH: (713) 953 – 5200 FAX: (713) 953 – 5026
FIRM REGISTRATION #: F-1386
Job Number: 2335-1901

STATE OF TEXAS
ISAAC MUÑIZ
125839
LICENSED PROFESSIONAL ENGINEER
10/2/2020

October 2020

TABLE OF CONTENTS

TABLES

EXHIBITS

APPENDICES

EXECUTIVE SUMMARY

The City of Kemah (City) contracted LJA Engineering, Inc. (LJA) to develop a Master Drainage Plan (MDP) that addresses conveyance and detention improvements necessary to reduce the frequency and severity of flooding throughout the City. The City is in northeast Galveston County adjacent to the Gulf of Mexico. The City limits are bounded by FM 518 and Clear Creek Channel to the north, SH 96 and Bay Ave to the south, Galveston Bay to the east, and Lawrence Road to the west.

The City is served by three primary outfalls: Jarbo Bayou, Clear Creek Channel and Galveston Bay. For this study, the City is broken down into five areas: Bayview Acres, the Lighthouse District, Kemah Oaks, South Kemah, and West Kemah. The area studied for this MDP includes the entire City with focus on the Bayview Area, South Kemah, and Kemah Oaks.

The City is comprised of 1,217 acres or 1.9 square mile area along the coast. The proximity to the coast presents challenges for conveyance to designated outfalls as generally the topography is flat with natural ground elevations within the study area ranging from 22 feet to 0 feet base on LIDAR data obtained from the Houston-Galveston Area Council (HGAC).

Overall, the LIDAR data shows that the overland flows generally travel from south to north across most of the City except for the Bayview Acres area which generally flows west to east. There is an area that potentially overflows in extreme events to the City drainage system from the west in the South Kemah area along Lawrence Road that does need to be accommodated in any drainage improvements within this area. For South Kemah and Kemah Oaks, the flows outfall to Jarbo Ditch which outfalls to Jarbo Bayou and ultimately out to Clear Creek Channel. All West Kemah and most of the Lighthouse District outfall directly to Clear Creek Channel. Bayview Acres and the bay fronting sections of the of the Lighthouse District outfall to Galveston Bay.

Each of the five areas within the City were studied as to the existing drainage issues with varying amounts of available data. In general, it was determined that the existing drainage facilities throughout the City have capacity issues for both conveyance and storage which results in frequent localized flooding. The West Kemah and Lighthouse Districts have been previously studied with recommendations for de-silting of ditches, ditch re-grading, culvert resizing and storm sewer improvements. Kemah Oaks is experiencing frequent flooding due to an undersized storm sewer system and detention facility. Bayview Acres is experiencing frequent flooding due to undersized outfalls and lack of conveyance capacity with the roadside ditches. South Kemah is experiencing flooding due to undersized and inconsistent conveyance systems, lack of outfall depth to Jarbo Ditch and lack of storage capacity.

Because the areas of West Kemah and the Lighthouse District have had past drainage evaluations which provided guidance and recommendations for some drainage improvements to these areas, this study focused on improvements to Bayview Acres, South Kemah, and Kemah Oaks. For each of these three areas, at least two (2) alternatives have been evaluated to improve conveyance and detention (if required). The recommendations for these various drainage areas within the City of Kemah are as follows:

- *Bayview Acres* - Alternative 1, which includes upsizing the existing outfalls at Meadow Ln and Bay Ave as well as providing one (1) additional outfall along the northside of Yacht Club, is recommended for the Bayview Acres area. This alternative is less expensive than Alternative 2, which includes two (2) new outfalls. Although larger outfalls will be required for Yacht Club North and Bay Ave, this alternative prevents the City from acquiring two separate drainage easements and reduces the amount of storm sewer pipe that would need to be maintained by the City. This recommended alternative allows for faster construction since only three (3) outfalls would be

installed rather than 4 outfalls and requires less right of way acquistion. This alternative would also provide a 100-year LOS. The cost of Alternative 1 is **$2,206,590**.

- *Kemah Oaks* - Alternative 2, which expands the Bel Rd linear detention ditch southeast of the subdivision and would provide enough storage to avoid the installation of a stormwater pump station, is recommended for the Kemah Oaks subdivision. The existing Kemah Oaks detention basin can be converted to a dry bottom basin. If the City wishes to proceed with this alternative, this alternative would require further design analysis during final design to analyze and design the overflow spillway, adjust outfalls and evaluate the interaction between the two detention facilities to ensure no adverse impacts to service area of the existing Bel Rd detention facility. The cost of Alternative 2 is **$2,062,850**.

  It is recommended that while Alternative 2 is ultimately implemented, Alternative 4 is pursued by the City to provide some relief to the Kemah Oaks area. Alternative 4 provides an emergency spillway for the Kemah Oaks detention basin and can be implemented within the available capital improvement budget for fiscal year and can provide much needed relief to this area while the City seeks routes to implement the recommendation to improve Jarbo Ditch and Alternative 2 for Kemah Oaks. The cost of Alternative 4 is **$171,650**.

- *South Kemah and Jarbo Ditch* - Alternative 1, which includes conveyance improvements in three specific drainage conveyance routes, is recommended for the South Kemah area. This alternative allows for discharge only to Jarbo Ditch. The cost of Alternative 1 is **$3,884,510**.

  Two scenarios for improvements were evaluated for Jarbo Ditch and it is recommended that both be implemented. While the improvements to Jarbo Ditch can be implemented in phases, Scenario 1 is recommended first to widen the lower section of Jarbo Ditch to a 25-year conveyance capacity which provides the move conveyance for the recommended Alternative 1 for South Kemah. The cost of Scenario 1 is **$4,030,115** which includes land acquisition. It is then recommended that Scenario 2 is implemented, which provides conveyance improvements to the upper section of Jarbo Ditch to the most upstream point. The cost of Scenario 2 is **$1,359,915**, which includes land acquisition.

  Additionally, Alternative 2 for South Kemah is recommended to provide some regional detention storage for the South Kemah area but it is recommended to reevaluate the amount of regional detention required once the Jarbo Bayou study is completed. The current cost of Alternative 2 is **$4,120,010**, although this amount is expected to change after re-evaluating the amount of detention the City would provide in a less frequent, more intense storm event.

- *Lighthouse District and West Kemah* - It is recommended that the City continue implementing the recommendations made from previous drainage evaluation in these two areas. LJA is continuing to investigate if there are critical areas that need immediate improvements to alleviate flooding issues. It is likely that quick fixes beyond the recommendations in the previous report are not available and the City needs to plan to invest in re-constructing the storm sewer systems that are undersized in future capital improvement plans. The City also needs to determine the LOS for storm water drainage that it wishes to provide in these areas, since these areas directly discharge to Clear Creek Channel or to Galveston Bay.

Finally, in addition to the recommended improvements in the five areas within the City, the LJA was asked to review and provided recommendations for updates to Chapter 38 and Chapter 46 regarding stormwater management drainage criteria and floodplain regulations, respectively. Working with City staff, LJA finalized the recommendations for updates to drainage, detention, and floodplain fill criteria

throughout the City for changes to Chapters 38 and 46. The recommended changes to Chapters 38 and 46 were adopted by the City in May and June of 2020, respectively.

The following concerns were addressed in the updates to Chapter 38:

- Adopt Galveston County detention rate requirements.
- Establish requirements to ensure developers are maintaining their on-site stormwater pump stations.
- Establish minimum diameter pipe size for driveway replacements.
- Require further analysis when filling in ditches and replacing with enclosed conduits.
- Establish a criteria for calculating Time of Concentration.
- Incorporate IDF empirical values for rain events.
- Establish minimum LOS criteria.
- Require removing and replacing infrastructure within a developments immediate vicinity if re-development will occur.

The following concerns were addressed in the updates to Chapter 46:

- Provide allowance for maintenance fill for gardens.
- Require drainage plans sealed by an engineer when fill exceeds 60 cubic yards.
- Require notification to Floodplain Administrator for minor fill in the floodplain.
- Set permitting and mitigation requirements for fill in the floodplain.
- Provide requirements to maintain natural flow within the floodplain.

1.0 INTRODUCTION

1.1. Project Purpose and Scope

The City of Kemah (City) contracted LJA Engineering, Inc. (LJA) to develop a Master Drainage Plan (MDP). The City is adjacent to the Gulf of Mexico, therefore, on-going flooding issues can be attributed to riverine flooding, tidal (storm surge) flooding or a combination of both. As detailed in the authorized proposal, this MDP focuses on riverine flooding only and no analysis was conducted to assess tidal flooding.

This study focuses on assessing the City's storm sewer system existing conditions based on available data (i.e. LiDAR, record and as-built drawings, etc.) and providing alternatives for conveyance improvements which will alleviate the on-going flooding. The MDP also aims to investigate offsite flow from outside the City limits that may also be impacting the City's systems. The scope of work (SOW) for this MDP includes performing a detailed hydrologic and hydraulic analysis of the City of Kemah. Since the City is adjacent to the Gulf of Mexico, the study is broken into five areas since the storm sewer systems behave differently dependent on the point of outfall. Furthermore, LJA has reviewed the City's current drainage criteria, Chapter 38 and 46 in the Code of Ordinances, and will provide recommendations to the City to update the current document to reflect appropriate design standards due to more intense rains as shown by updated data by the National Oceanic Atmospheric Administration (NOAA).

1.2. Project Location

The City is in southeast Texas, southeast of Houston in Galveston County. The City limits are bounded by FM 518 and Clear Creek Channel to the north, SH 96 and Bay Ave to the south, Galveston Bay to the east and Lawrence Rd to the west, see **Exhibit 1.0**. The City is served by Jarbo Bayou, Clear Creek Channel and Galveston Bay. This study is broken into five areas: Bayview Acres, Lighthouse District, Kemah Oaks, South Kemah and West Kemah.

Bayview Acres

This area is bounded by Solomon Rd to the north, Bay Ave to the south, Galveston Bay to the east and State Highway (SH) 146 to the west, see **Exhibit 1.1**. The area is a mixture of developed and undeveloped land, with development being single family and multi-family residential homes. This area outfalls to Galveston Bay.

Lighthouse District

This area is bounded by Clear Creek Channel to the north, 10th St to the south, Galveston Bay to the east and SH 146 St to the west, see **Exhibit 1.2**. The area is fully developed with a mixture of single family residential, multi-family residential and commercial developments. This area outfalls to Galveston Bay and Clear Creek Channel.

Kemah Oaks

This area is bounded by Farm-to-Market (FM) 518 to the north, a 57-Acre Park to the south, a Centerpoint Energy (CPE) Fee Strip to the east and Jarbo Ditch to the west, see **Exhibit 1.3**. The area is fully developed with only single family residential homes. This area outfalls to Jarbo Ditch, which is a tributary of Jarbo Bayou.

South Kemah

This area is generally bounded by FM 518 to the north, SH 96 to the south, SH 146 to the east and Lawrence Rd to the west, see **Exhibit 1.4.** The area is a mixture of developed and undeveloped land, with

development being single family residential, multi-family residential and commercial developments. This area outfalls to Jarbo Ditch, which is a tributary of Jarbo Bayou.

West Kemah

This area is bounded by Grove Rd to the north, FM 2094 to the south, SH 146 to the east and Lazy Ln to the west, see **Exhibit 1.5**. The area is a mixture of developed and undeveloped land, with development being single family residential and commercial developments. This area outfalls to Clear Creek Channel.

1.3. Floodplain Mapping

Based on FIRM maps 48167C0042G and 48167C0044G, both effective on August 15, 2019, half of the City is located within Zone AE, also known as the area in the 100-year floodplain and the other half is located within shaded Zone X, also known as the area in the 500-year floodplain. See **Appendix B** for a copy of the FEMA maps. The FIRM map updates adopted in 2019 within the City include both riverine and wave run-up (storm surge) analysis in setting the base flood elevations (BFE) within the community.

1.4. Prior Studies

Two prior studies have been done for the City. A master drainage study[1] of the Lighthouse District was conducted in October 2009 (see **Appendix C**). The study concluded that development and re-development contributed to an increase in impervious cover which resulted in an increase in surface runoff. Due to an increase in surface runoff, the storm sewer system in the area was deemed inadequate. The study recommended to re-construct the existing storm sewer system and increase the conveyance capacity. The study also recommended replacing an existing stormwater pump station. Based on record drawings[2] from 2012, the stormwater pump station was replaced with a three (3) pump system, one (1) pump a standby, to convey the increased flows. The stormwater pump station was built for future expansion and allow installation of a fourth pump.

A drainage study[3] of West Kemah was conducted in September 2016 (see **Appendix D**). The drainage study concluded that the existing ditches and culverts were undersized to serve their service area. The study also noted that reverse grades in the system exacerbated the deficiencies in the ditch and culvert system. The study recommended to remove undersized culverts and replace with larger, adequately sized culverts. In addition, the study recommended to desilt and re-grade ditches to re-establish positive flow. The study also identified several ditch segments that required widening to increase the conveyance capacity.

1.5. Supporting Investigations

1.5.1. Survey Information

As part of this MDP, limited survey information was available to assist in the analysis of this study. A topographic survey of the Kemah Oaks detention basin was conducted by LJA Engineering, Inc. The survey included top of bank, toe, flowline and water mark elevations. Additionally, inlet and outlet pipe inverts in the detention basin were gathered. The purpose of the survey was to confirm the volume storage

[1] LJA Engineering & Surveying, Inc., *"Master Drainage Study"*, for the City of Kemah, October 2009
[2] LJA Engineering & Surveying, Inc., "*City of Kemah Construction Plans For: Storm Water Pump Station*", November 2010
[3] LJA Engineering & Surveying, Inc., "*West Kemah Drainage Study*", for the City of Kemah, September 2016

provided in the basin, since the basin as constructed does not reflect the record drawings[4]. The elevation data for this survey is based on NAVD 88, 2002 adjusted datum.

A limited topographic survey of Bayview Acres conducted in August 2012 by Ted K. Guthrie was provided. The survey included culvert sizes and flowlines and ditch flowlines. Ditch top of bank elevations and widths were not delineated as part of this survey, therefore, ditch cross-sections could not extrapolated from this data to analyze conveyance capacity. The elevation data for this survey is based on NAVD88 datum.

1.5.2. Record Drawings and As-builts

The City provided several record drawings and as-builts for several street segments in the study area, however, many of these drawings contained limited topographic information which could aid in the study of the area.

1.5.3. Interviews

Several interviews were conducted with City residents that live in the study areas. A template of the interview questions is in **Appendix E**. The purpose the interviews was to gather firsthand historical knowledge of the drainage issues experienced by the residents.

[4] Century Engineering, Inc., "*City of Kemah Construction Documents for Kemah Oaks Subdivision, Section One – Paving, Storm Sewer, Sanitary Sewer, Drainage, Potable Water and Detention*", February 1992

2.0 EXISTING CONDITIONS

2.1. Topography

The City is comprised of 1,217 acres or 1.9 square mile area in Galveston County, Texas. The topography is relatively flat with natural ground elevations in the study area ranging from 0 feet to 20 feet based on LiDAR.

Overall, the LiDAR data shows that overland flows generally travel from south to north. The LiDAR also shows flows that enters from outside the City limits from the west and south. The flows naturally are conveyed towards Jarbo Bayou, Clear Creek Channel and Galveston Bay.

Bayview Acres

Bayview Acres flows from west to east, flowing to Galveston Bay. SH 146 is a high point in the drainage boundary which prevents overland flow from entering the area from the west. The natural ground elevations range from 0 to 18, although at the edge of Galveston Bay, there is an approximately 10-foot drop off, therefore, the land is relatively flat sloping at an approximately 0.40% slope. See **Exhibit 2.1** for a LiDAR elevation map of Bayview Acres.

Lighthouse District

The Lighthouse District flows south to north towards Clear Creek Channel. SH 146 is a high point in the drainage boundary which prevents overland flow from entering the area from the west. Overland flows from the south are likely entering this area during heavy rain events since this area is the lowest point in the City. The natural ground elevations range from 0 to 10. The land is relatively flat sloping at an approximate 0.30% slope. See **Exhibit 2.2** for a LiDAR elevation map of the Lighthouse District.

Kemah Oaks

The Kemah Oaks Subdivision flows from south to north. The north boundary of the subdivision appears to be a drainage high point preventing overland flow to enter from the south side. The east boundary of the subdivision also appears to be a high point, preventing overland flow from entering from the east. The CPE fee strip appears to be a natural low point which directs stormwater towards FM 518. The subdivision streets are low relative to the lot elevations and FM 518. A sheet flow release point towards the point is located at the intersection of Oak Meadow Dr and Bay Oaks St to theoretically drain the neighborhood during more intense storm events. See **Exhibit 2.3** for a LiDAR elevation map of Kemah Oaks.

South Kemah

The South Kemah area generally flows south to north. SH 96 appears to act as a natural high point for the drainage area preventing additional overland flow from entering the drainage boundary, however, the drainage boundaries do extend outside the City limits. The natural ground elevations range from 12 to 22. The land is relatively flat sloping at approximate 0.25-0.30% slope. See **Exhibit 2.4** for a LiDAR elevation map of South Kemah.

West Kemah

The West Kemah area flows from south to north, although it is not very well defined due to relative flat grades in the area. A true drainage pattern is not distinguishable, even with contours broken down to the 0.5-ft level. A few high points exist south of the area's boundary, but overall the area ranges between 6.5 to 7.5 ft elevations. It is possible that overland flows from south of FM 2094 may enter the area during an intense rain event and stormwater may move slowly through the area due to poorly defined grades. Low points are located to the north and west of the area, but a defined overland flow path can not be defined. See **Exhibit 2.5** for a LiDAR elevation map of West Kemah.

2.2. Land Use

The City is comprised of commercial developments and mostly residential lots. Each individual area, as defined previously, was analyzed based on the existing development. For the development of post developed flows, assumptions were made regarding undeveloped land dependent on the surrounding area.

The land use for Bayview Acres and South Kemah were assigned a C-factor based on the existing composition of the lot. Parcels were gathered from Galveston County Appraisal District (GCAD) and were assigned a land use type and C factor. **Table 1** shows a breakdown of land use type and the associated C coefficient.

Table 1 - Land Use Type C Coefficient

Land Use Type	C
SFR <1/4	0.55
SFR 1/4 to 1/2	0.45
SFR >1/2	0.35
MF <20	0.65
MF >20	0.80
Business	0.80
Industrial Light	0.65
Industrial Heavy	0.75
Industrial RR	0.30
Parks/Open Area	0.18
ROW	0.80
Water	0.95

2.3. Existing Facilities

Each studied area has a different drainage system which ultimately conveys flow towards an outfall.

Bayview Acres

The Bayview Acres area is comprised of concrete and asphalt roads with grass-lined roadside ditches and reinforced concrete pipe (RCP) culverts. The City owns and maintains three (3) main roads in this area: Bay Ave, Meadow Ln and Park Ave. Based on the record drawings[5], Meadow Ln is a crowned road re-constructed with a longitudinal slope of 0.0% and a cross slope of 2%. The re-construction of Meadow Ln incorporated drainage improvements which included filling in existing ditches and placing an enclosed 24-inch diameter storm sewer with grate inlets and swales on the southeast side of the road. The northwest side of the road remained relatively untouched besides improvements to the existing outfall, which replaced dual 18-inch diameter pipes with a single 30-inch diameter RCP culvert.

Based on existing topo from 2012 (see Section 1.5.1), the majority of Park Ave ditches are graded to flow west to east, except for 400-feet east of the Meadow Ln and Park Ave intersection, which were re-graded as part of the Meadow Ln re-construction. The existing culverts are sized 18-inches and 24-inches in diameter. A profile of the Park Ave ditches was created based on the topo provided, see **Exhibit 3.2**. It

[5] LJA Engineering, Inc., "*City of Kemah Construction Plans For: Cien Road and Meadow Lane Concrete Paving*", November 2016

appears that at the time of the survey, there were segments of ditch which had accumulated silt, thus reducing the conveyance capacity. On Bay Ave, the ditches west of the Bay Ave and Park Ave intersection are graded from west to east. Park Ave and Bay Ave ultimately flow towards an existing 24-inch diameter culvert located in a 15-foot drainage easement and outfalls at Galveston Bay through an 18-inch diameter RCP.

Lighthouse District

The Lighthouse District is comprised of concrete and asphalts roads with a combination of grass-lined roadside ditches, RCP culverts, grate inlets with sub-surface storm sewer and grass-lined swales and curb inlets. The storm sewer sizes range from 15-inch to 54-inch in diameter. The storm sewer system appears to convey towards a stormwater pump station, where discharges into an 8-foot x 4-foot RCB. This pump station is located between 1st and 3rd street off Texas Ave and outfalls to Clear Creek Channel. The stormwater pump station is a three (3) pump system, with one (1) pump being a standby. The stormwater pump station was designed to add an additional pump in the future.

Kemah Oaks

The Kemah Oaks Subdivision is comprised of curb and gutter streets with curb inlets. The sub-surface storm sewer system conveys flow to an existing detention basin at the southwest corner of the subdivision. The storm sewer system sizes range from 24-inches to 48-inches. The storm sewer trunkline is located within the two main roads in the subdivision, Kemah Oaks Dr and Bay Oaks Dr. A segment of pipe is located along Oak Briar Dr. In general, the other cul-de-sac streets in the subdivision are graded to drain towards the subdivision main streets. The high point is located at the cul-de-sac and stormwater drains towards the street intersections, where it is conveyed to storm sewer via curb inlets with 5-foot openings.

The detention basin is a wet bottom basin with a 42-inch corrugated metal pipe (CMP) that outfalls to Jarbo Ditch. Based on record drawings, the detention basin design included a concrete pilot channel at the basin bottom and the outfall pipe should have matched the lowest flowline in the basin to create a dry bottom basin. The basin bottom was designed with 1% cross slopes towards the concrete pilot channel which ultimately conveyed stormwater to the outfall. Additionally, an emergency spillway at the southwest side of basin was not constructed. The record drawings indicate that the detention basin was designed to provide 23.85 acre-feet of volume storage although only 19.94 acre-feet were required. Based on volume storage analysis performed with AutoCAD Civil 3D, the current volume storage provided in the existing basin is 17.42 acre-feet. The volume storage was based on comparing the lowest top of bank elevation and the permanent pool elevation at the bottom of the basin.

Based on record drawings, the detention basin was designed with a 100-year water surface elevation (WSEL) which exceeded the designed top of curb elevations for several streets. This information conveys that the existing streets are will hold stormwater during an extreme rain event, until the WSEL in the basin reduces to allow additional stormwater to drain into the basin, see **Figure 1** for represented example. Furthermore, **Exhibit 4.2** is a copy of the record drawings marked with the detention designed 100-year WSEL.

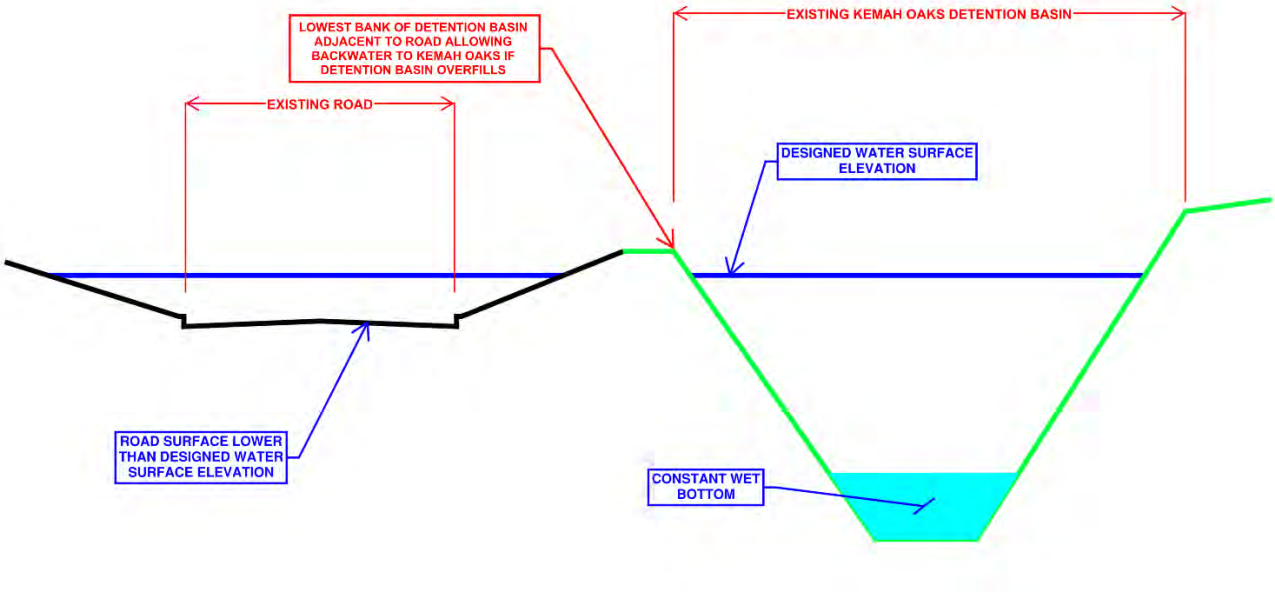


Figure 1 - Representation of Kemah Oaks Basin 100-yr WSEL Relative to Existing Neighborhood Streets

South Kemah

The South Kemah area is comprised of concrete and asphalts roads with a combination of grass-lined roadside ditches, RCP culverts, grate inlets with sub-surface storm sewer and grass-lined swales and curb inlets. Limited information is available for the existing South Kemah storm sewer infrastructure. The area ultimately appears to drain towards Jarbo Ditch.

West Kemah

The West Kemah area is comprised of concrete roads with grass-lined roadside ditches and RCP culverts. The roads were re-constructed in 2014, however, no drainage improvements were incorporated besides the removal of four (4) RCP culverts (18-inch, 2 – 24-inch and 1 – 30-inch) which were replaced with one (1) 6-foot x 4-foot reinforced concrete box (RCB) culvert. Based on the record drawings[6], the proposed roadway longitudinal grades are flat with slopes generally between 0.0 – 0.2%. The road is a crowned road, with 2% cross slopes, which conveys stormwater to roadside ditches. It appears that storm sewer system ultimately outfalls to Clear Creek Channel.

Jarbo Ditch

Jarbo Ditch serves the Kemah Oaks and South Kemah areas. Jarbo Ditch is a tributary of Jarbo Bayou and it extends from the South Kemah Dr and Winfield Ln intersection to Jarbo Bayou. An existing HEC-RAS model was not available of Jarbo Ditch or Jarbo Bayou. Based on a ditch cross-section de-lineated from a topographic survey conducted of the Kemah Oaks detention basin, the existing channel appears to have 870 cfs of conveyance capacity using manning's equation.

[6] LJA Engineering, Inc., "*City of Kemah Construction Plans For: West Kemah Street Improvements*", January 2014

2.4. Existing Conditions Model, Hydrologic Parameters and Hydraulic Model

In general, for the study areas, Atlas 14 rainfall data was applied to the storm sewer system analysis. The National Oceanic Atmospheric Administration (NOAA) in September 2018 published the NOAA Atlas 14, Volume 11 Precipitation-Frequency Atlas of the United, Texas[7] (Atlas 14), which increased the rainfall values for many areas within the state of Texas, including Galveston County. The Houston-Galveston area were among some of the largest increases in rainfall values, ranging between 15 to 30%. These increases in rainfall are producing larger flows, particularly in the less frequent rainfall events of the 50-, 100- and 500-year events.

Drainage area boundaries for each area were developed using a combination of LiDAR data and available record drawing as-builts. The existing and proposed flows for each drainage area were generated using the rational method. This is an adequate method to calculate the flows for drainage areas that are less than 600 acres. The formula is the following:

$$Q = CIA$$

Q indicates flows, which is measured in cubic feet per second (cfs), C is the runoff coefficient which is unitless, I is intensity defined in inches per hour (in/hr) and A is the drainage area defined in acres. The runoff coefficient used for each area varied depending on the developments in the existing area. To calculate the intensity for each drainage area, a time of concentration was calculated based on a standard formula used by other jurisdictions such as Galveston Drainage District #1 (GDD1), City of Houston (COH) and others. The formula is the following:

$$T_c = 10A^{0.1761} + 15$$

T_c indicates the time of concentration in minutes and A indicates the drainage area in acres. This formula is adequate to use in scenarios with smaller drainage areas since it is a good approximation for time of concentration. The intensity values were calculated based on the following formula:

$$I = \frac{b}{(T_c + d)^e}$$

Intensity (I) is defined in inches per hour. The b, d and e values are empirical values developed based on rainfall data. The rainfall data used is Atlas 14 values. The b, d and e values are presented in **Table 2**.

Table 2 - Galveston County Rainfall IDF Coefficients

Coefficient	50% (2-year)	20% (5-year)	10% (10-year)	4% (25-year)	2% (50-year)	1% (100-year)
e	0.80	0.78	0.76	0.74	0.72	0.71
b (in)	66.15	80.12	90.16	102.99	110.99	120.52
d (min)	13.17	13.18	13.24	13.42	13.44	13.86

The conveyance capacity of the existing drainage outfalls was calculated using manning's equation. The formula is the following:

$$Q = \frac{1.49}{n} * A * R^{\frac{2}{3}} * \sqrt{S}$$

[7] "*NOAA Atlas 14 Precipitation-Frequency Atlas of the United States - Volume 11 Version 2.0: Texas*", 2018

Q indicates the flow defined as cubic feet per second. A indicates the cross-sectional area of the pipe. R is the hydraulic radius, which is a function of the wetted perimeter over the cross-sectional area of the pipe. For the simplicity of this analysis, it was assumed that the pipes are flowing full. S is the slope of the pipe.

Bayview Acres

Drainage areas for the Bayview Acres area were generated using available LiDAR data. The area was broken into seven (7) sub-drainage boundaries and a flow was generated for each individual area using the rational method (see **Table 3**). Based on analyzing LiDAR information, it was determined that two (2) sub-drainage areas flow to the Meadow Ln outfall and five (5) sub-drainage area boundaries flow to the Bay Ave outfall.

Table 3 - Bayview Acres Existing Flows

DA ID	Area (ac)	C-factor	2-year Flow (cfs)	100-year Flow (cfs)
DA-1	3.82	0.35	4.46	11.59
DA-2	7.75	0.53	13.41	34.98
DA-3	16.17	0.34	16.98	44.52
DA-4	12.47	0.37	14.52	37.99
DA-5	10.91	0.34	11.64	30.43
DA-6	19.69	0.56	34.18	89.73
DA-7	39.02	0.36	39.46	104.14

The existing conveyance capacity of the Meadow Ln and Bay Ave outfalls were calculated using Manning's Equation. Drainage IDs 1 and 2 were assigned to the Meadow Ln outfall and drainage IDs 3, 4, 5, 6 and 7 were assigned to the Bay Ave outfall. **Table 4** shows that the existing outfall conveyance capacity versus the amount of flow that the outfall receives. A drainage area map can be found in **Exhibit 3.1**.

Table 4 - Bayview Acres Existing Outfall Capacity

Outfall	DA ID	2-yr Q_{peak} (cfs)	100-yr Q_{peak} (cfs)	Pipe Size (in)	Q_{pipe} (cfs)	2-yr Adequate?	100-yr Adequate?
Meadow Ln	1, 2	18	47	30	29	**Yes**	**No**
Bay Ave	3, 4, 5, 6, 7	117	307	18	23	**No**	**No**

The existing Bay Ave outfall is currently providing less than a 2-year LOS. The Meadow Ln outfall is adequately sized for a 2-year LOS, however, is not adequately sized to provide a 100-year LOS. There is insufficient data to properly analyze the conveyance capacity of the existing ditches for Bayview Acres, however, based on 2012 survey data provided by the City, it was determined that at the time of survey, the existing ditches were silted up. A ditch that has silt accumulation will lose its conveyance capacity, thus reducing the LOS of the service area that it serves. A byproduct of silt accumulation is that flow velocities are reduced, thus allowing additional silt to accumulate at the ditch bottom and further reducing the LOS provided to the area.

Lighthouse District

The drainage issues in the Lighthouse District are documented in a Master Drainage Study conducted in 2009. Based on LiDAR information, it appears that ponding issues near the Harris Ave and 7th St intersection may be on-going due to a low spot in this area that would require a significant amount of head to push stormwater out. Another issue is that as properties have been re-developed, existing drainage inlets have been left in place and in some cases do not appear located in low spots. It is likely that this area will continue to flood unless significant drainage improvements are conducted as recommended in the 2009 master drainage study conducted of the area.

Kemah Oaks

A WinStorm model of the drainage infrastructure within the Kemah Oaks subdivision was created based on record drawings of the existing drainage facilities. As shown in **Exhibit 4.1**, the contributing flows to the area are only from the subdivision. LiDAR demonstrates that the residential lots drainage high is at the back-end property line and the lots are graded to drain to the local streets. Based on field reconnaissance, an earthen swale was placed between the residential lots property lines to facilitate the drainage of water in between lots to the local streets.

The existing storm sewer system was designed in the early 1990s, which used prior rainfall data that does not reflect current standards. Based on flooding records, it appears that Kemah Oaks has experienced consistent flooding issues over the last several years. The existing model developed for this subdivision used pre-Atlas 14 rainfall data to investigate the LOS the existing system currently provides. The overall drainage areas shown on **Exhibit 4.1** were further broken down to the inlet level to develop a full analysis of the area.

WinStorm is a static 1D model, which analyzes the conveyance capacity of the underground drainage system. The program calculates a hydraulic grade line (HGL) which is compared to a critical elevation as assigned by the user. If the HGL exceeds the critical elevation, this indicates a deficiency in the system. The HGL analysis starts at the downstream end with a fixed tailwater assigned based on engineering judgement. For this model, the fixed tailwater for the 2-year and 5-year storm event was set at the top of pipe, which indicates a pipe flowing full. Additionally, the critical elevations were set to the gutter line which is typical of other jurisdictions in proximity to the City. The software generates flows using the rational method as previously discussed. A C-factor of 0.55, which is representative of single-family residential lots less than half (1/2) an acre, was used in the equation.

A series of nodes and runs were used to create a model of the subdivision. Inlets and manholes were assigned nodes and pipes from node to node were assigned as runs. Individual drainage areas were assigned to each inlet node. In general, manholes are not assigned drainage areas or flows, unless the model is done as a manhole level analysis or additional flows, including offsite flows are entering the system.

Based on the 2-yr storm analysis, there are several deficiencies in the system. Multiple critical elevations were exceeded. The software calculated a 2-year HGL which is overlaid on the record drawings, see **Exhibit 4.2**. The record drawings profile shows top of curb elevations only; therefore, clouds and call outs were added for clarification at areas of deficiencies. Node labels were also added to the record drawings. The results state that the existing system is inadequate to provide a 2-year LOS. **Table 5** below has been organized to show the output from the WinStorm analysis. Cells filled in red indicate an area of deficiency. As stated previously, a fixed tailwater of top of pipe was used for this analysis.

Table 5 - WinStorm Existing Conditions 2-year Analysis

Run #	US DA ID	DS DA ID	HGL US (ft)	HGL DS (ft)	Cumulative Q (cfs)	$Q_{capacity}$	Critical Elev (ft)	CE - HGL_{US}
1	B-1	OUT	6.50	6.30	91.68	58.65	10.38	3.88
2	B-2	B-1	6.72	6.50	91.68	58.65	10.76	4.04
3	B-3	B-2	7.23	6.72	91.68	49.57	10.61	3.38
4	B-3A1	B-3	7.28	7.23	8.82	12.09	8.95	1.67
5	B-3A2	B-3A1	7.29	7.28	4.56	13.52	8.95	1.66
6	B-3B	B-3	7.33	7.23	9.15	8.87	10.00	2.67
7*	B-3B1	B-3B	7.35	7.33	9.15	25.30	8.95	1.60
8	B-3B2	B-3B1	7.36	7.35	4.74	13.52	8.95	1.59
9	B-4	B-3	7.97	7.23	76.85	45.43	11.22	3.25
10	B-4A1	B-4	8.02	7.97	9.06	13.06	9.10	1.08
11	B-4A2	B-4A1	8.03	8.02	4.50	13.52	9.10	1.07
12	B-4B	B-4	8.08	7.97	9.43	2.87	11.20	3.12
13*	B-4B1	B-4B	8.09	8.08	9.43	24.00	9.10	1.01
14	B-4B2	B-4B1	8.11	8.09	4.71	13.52	9.10	0.99
15	B-5	B-4	8.45	7.97	61.35	45.43	10.97	2.52
16	B-5A1	B-5	8.58	8.45	25.30	16.99	9.50	0.92
17*	B-5A2	B-5A1	8.59	8.58	6.06	25.30	8.50	**-0.09**
18	B-5A3	B-5A2	8.60	8.59	4.19	13.52	8.50	**-0.10**
19	B-5AB	B-5A1	9.44	8.58	20.36	15.35	10.00	0.56
20*	B-5AB1	B-5AB	9.45	9.44	5.83	25.30	8.93	**-0.52**
21	B-5AB2	B-5AB1	9.46	9.45	4.15	13.52	8.93	**-0.53**
22	B-5AC	B-5AB	9.78	9.44	15.07	9.78	10.95	1.17
23	B-5AD	B-5AC	10.15	9.78	15.07	9.50	11.00	0.85
24	B-5AE	B-5AD	10.16	10.15	1.91	8.61	9.71	**-0.45**
25	B-5AF	B-5AE	10.16	10.16	1.33	8.94	9.71	**-0.45**
26	B-5AD1	B-5AD	11.03	10.15	13.61	9.63	10.50	**-0.53**
27*	B-5AD2	B-5AD1	11.06	11.03	13.61	25.30	9.20	**-1.86**
28	B-5AD3	B-5AD2	11.09	11.06	7.77	13.52	9.20	**-1.89**
29	B-5B1	B-5	8.60	8.45	19.63	15.04	10.25	1.65
30*	B-5B2	B-5B1	8.61	8.60	6.44	25.30	9.10	0.49
31*	B-5B3	B-5B2	8.62	8.61	4.39	19.12	9.10	0.48
32	B-5BA	B-5B1	10.34	8.60	14.08	9.61	10.25	**-0.09**
33*	B-5BA1	B-5BA	10.37	10.34	14.08	40.80	9.19	**-1.18**
34*	B-5BA2	B-5BA1	10.40	10.37	7.11	19.12	9.19	**-1.21**
35	B-6	B-5	9.65	8.45	17.56	9.60	10.25	0.60
36*	B-6A1	B-6	9.66	9.65	4.94	25.30	9.21	**-0.45**
37*	B-6A2	B-6A1	9.66	9.66	4.10	19.12	9.21	**-0.45**
38	B-7	B-6	9.88	9.65	13.04	9.75	10.25	0.37
39*	B-7A1	B-7	9.89	9.88	3.86	25.30	9.21	**-0.68**
40	B-8	B-7	10.62	9.88	9.93	9.60	11.00	0.38
41	B-9	B-8	10.74	10.62	9.93	9.77	11.00	0.26
42	B-10	B-9	10.81	10.74	9.93	11.76	10.34	**-0.47**
43	B-11	B-10	10.82	10.81	5.45	13.52	10.34	**-0.48**

A 100-year analysis was not conducted with WinStorm and requires higher level software and data to model the interaction between a sub-surface and surface system. Since the existing pipes do not currently provide a 2-year LOS, it is likely that the software will produce exaggerated 100-year HGLs which are not

realistic. It is typical that most jurisdictions design the underground storm sewer systems to convey less intense rains and for extreme events to be conveyed via a combination of underground storm sewer and roadway. For roadway conveyance, the goal is to keep stormwater within the City right-of-way (ROW) and prevent structures from flooding.

Based on historical data, the flooding during extreme events is an issue for the Kemah Oaks subdivision. There have been multiple reported flooded structures in the area and most them occurred at street intersections with the main arterial streets, Bay Oaks Ave and Kemah Oaks Ave. Per the record drawings, the intersections were designed to be the low points and as previously mentioned, the 100-year WSEL of the basin was designed to be higher than these points. In addition, the basin was not constructed as originally designed which exacerbates the drainage issues in this subdivision. The existing detention basin is a wet bottom basin which does not contain an emergency spillway.

A topographic survey of the basin was conducted and based on the elevations provided, the detention basin lowest top of bank elevation is 10.3, which is at the Bay Oaks and Oak Meadow Dr intersection. Adjacent to Jarbo Ditch, the top of bank elevations range between 10.9 and 13.3. Since an emergency spillway was not constructed, it is possible that during an intense rain event, when the basin is full, the basin backs up into the subdivision streets due to lack of capacity to store a 100-year storm event. As previously stated, the existing basin volume is 17.42 acre-feet, a 2.52 acre-feet difference from the required volume storage based on the design drawings (19.94 acre-feet).

In addition, results from an existing steady HEC-RAS conditions model conducted of Jarbo Ditch, indicates that Kemah Oaks streets will pond even during less intense storm events since it appears the subdivision streets sit lower than surrounding areas, thus allowing water to accumulate. See **Exhibits 6.2 – 6.7** for inundation maps created from the model.

Due to updated rainfall data, required detention storage required to serve this area is higher. Using the Small Watershed Method (Malcomn's Method), a comparison of 100-year, 24-hour storm event pre-developed and post-developed flow rates were compared. Two hydrographs, one existing and one proposed were used to develop the required detention volume based on the peak flows developed using rational method. The assumptions to compile this data is shown in **Table 6** below.

Table 6 - Small Watershed Method Input Parameters

Storm	Duration	Rainfall Excess (inches)	Exist Peak Q (cfs)	Prop Peak Q (cfs)	Exist C	Prop C
100-yr	24-hr	9.70	75.34	207.19	0.20	0.55

The input data is pre-Atlas 14 values used to compute existing and proposed peak flows. The rainfall excess is an assumption based on GDD1 criteria. The calculated required volume is 26.65 acre-feet, therefore, based on an existing storage of 17.42 acre-feet, an additional 9.23 acre-feet of storage is required. The storage volume for Kemah Oaks calculates at a storage rate of 0.46 acre-feet per acre.

South Kemah

Very limited data is available of the South Kemah area. Drainage area boundaries were delineated using LiDAR elevations. Based on the drainage area, pre-developed and post-developed flows were calculated based on the rational method. Insufficient data is available to develop a detailed existing model of the area. It is recommended that additional topographic survey be gathered to supplement various information missing from the limited library of record drawings. LiDAR does a poor job of capturing actual

roadside ditch data since LiDAR points are built on a 5-foot by 5-foot grid, which does not allow smaller ditch cross-sections to be captured. In addition, the area has multiple culverts which span a considerable length and more detailed invert information is needed to input into the hydraulic model.

A detention analysis of the area was done using parameters set in the GCDD1 drainage criteria manual, see **Table 6** below. The GCDD1 criteria recommends an intensity of 0.56 inch per hour be used to analyze a 100-year, 24-hour event. This value will produce lower peak flows. The Triangular Hydrograph Method was used to calculate the required storage volume for the South Kemah area. A storage rate of 178.67 acre-feet (0.58 acre-feet per acre) will be needed for the South Kemah area to be provided for regional detention in the area. This detention storage only accounts for drainage south of FM 518. It is anticipated that all future developments in the area would require their own on-site detention to store the volume generated between pre-developed and post-developed flows due to the likely inadequate systems which exists in the South Kemah area.

Table 7 - South Kemah Area Parameters for Triangular Hydrograph Method

Drainage Area (acres)	Intensity (in/hr)	Pre-Developed C-factor	Post-Developed C-factor	Pre-Developed 100-yr Q_{peak} (cfs)	Post-Developed 100-yr Q_{peak} (cfs)	Total Basin Inflow Volume (acre-feet)
306	0.56	0.30	0.72	64	154	306

The C-factors used for this calculation assumed a pre-developed c-factor which reflects mostly undeveloped land (approximately 17% impervious area). The post-developed c-factor accounts for a fully developed area, which is approximately 87% impervious area.

A detention basin within the area would in the area would discharge to Jarbo Ditch.

West Kemah

A previous analysis of the West Kemah area was conducted in 2016. The LiDAR elevations convey that the area is relatively flat, with hardly any elevation change. The commercial developments and school built on the south side of the West Kemah boundary were built relatively higher than the surrounding area. The 2016 study identified several ditch and culvert improvements that were necessary to improve the conveyance in the area. The streets were rebuilt recently, however, there were limited drainage improvements to the area. Further investigation will be on-going to identify critical areas that may require immediate attention.

Jarbo Ditch

An existing condition analysis for Jarbo Ditch was conducted to determine the existing LOS that can be conveyed in the ditch. As described in **Section 2.3**, Jarbo Ditch services the South Kemah and Kemah Oaks area. A total of nineteen (19) sub-drainage areas were delineated for the Jarbo Ditch watershed boundary. The drainage areas were delineated based on LiDAR. On the east side of Jarbo Ditch, there are a few undeveloped tracts with a high point near the middle of the tract that splits the flows towards Jarbo Ditch and SH 146. These tracts are adjacent to existing utility corridors. It was assumed that future development would discharge to Jarbo Ditch. Furthermore, it was assumed that grading in the utility corridors would also be graded towards Jarbo Ditch. This accounted for a worst-case scenario to properly assess the LOS in Jarbo Ditch. Additionally, it was assumed that flows from FM 518, east of the FM 518/Jarbo Ditch intersection, are being discharged to Jarbo Ditch.

Peak flows were generated using the Rational Method. Land use for each sub-drainage area was generated as explained in **Section 2.2**. Time of concentration for each drainage area was calculated using the previously stated formula. Drainage are ID, DA-1, had a calculated larger sub-drainage area of 306 acres, which calculated a low time of concentration number, thus generating a larger flow. The time of concentration for DA-1 was updated to reflect time of concentration as calculated in the TxDOT Hydraulic Design Manual (HDM), which generated a higher time of concentration, thus reducing the peak flow from this sub-drainage area. **Exhibit 5.1** shows the delineated drainage areas that flow to Jarbo Ditch. The calculated peak flows are shown in **Table 8**:

Table 8 - South Kemah Peak Flows Using Rational Method

DA_ID	Area (acre)	Composite C-Factor	Q_2 (cfs)	Q_{10} (cfs)	Q_{100} (cfs)
DA-1	309.25	0.52	225.95	314.90	658.57
DA-2	16.47	0.95	48.76	65.98	127.86
DA-3	86.50	0.33	81.26	110.35	215.84
DA-4	35.40	0.31	32.89	44.57	86.73
DA-5	11.41	0.80	28.97	39.17	75.76
DA-6	5.47	0.80	14.39	19.44	37.47
DA-7	36.57	0.80	87.28	118.29	230.21
DA-9	60.72	0.18	32.11	43.57	85.03
DA-11	8.14	0.81	21.30	28.79	55.59
DA-12	2.98	0.80	8.06	10.88	20.91
DA-13	10.58	0.26	8.74	11.81	22.84
DA-14	0.37	0.80	1.09	1.46	2.79
DA-15	57.04	0.62	103.19	139.99	273.13
DA-16	15.44	0.58	28.23	38.20	73.99
DA-17	20.81	0.23	14.89	20.15	39.10
DA-18	0.37	0.80	1.09	1.47	2.80
DA-19	11.47	0.58	20.96	28.34	54.82
DA-20	2.19	0.80	5.99	8.08	15.50
DA-21	8.01	0.80	20.70	27.97	54.01

The peak flows generated by the rational method were input into a HEC-RAS steady state model. Cross-sections from the existing terrain were generated using 2018 LiDAR data. A topographic survey was not conducted for this investigation which limits the accuracy of the HEC-RAS output. A model is not available for Jarbo Bayou, Jarbo Ditch's discharge point, which also limits the accuracy of the HEC-RAS model. The tailwater assumed for this model was normal depth. It is understood that League City is currently working on a model for Jarbo Bayou, however, that model will not be completed until later in 2020 and thus, it was not available for our use to understand the impacts from Jarbo Bayou. Discharge flows were strategically placed along the existing corridor based on discharge point assumptions.

Based on available record data and existing topography, most of the discharge to Jarbo Ditch occurs prior to the FM 518 and Jarbo Ditch crossing. Historically, residents in both South Kemah and Kemah Oaks have complained of restrictions at this crossing. The HEC-RAS model demonstrates that Jarbo Ditch, only provides a 5-year LOS to the area. Additionally, due to the Kemah Oaks subdivision streets lying lower

than the surrounding area, the model demonstrates that these subdivision streets pond at the 2-year storm event. The model also shows significant ponding issues west of Jarbo Ditch and east of Anders Ln.

Based on the HEC-RAS output, found in **Appendix F**, the FM 518 crossing is acting as one of several restrictors in the ditch which allows water to back up starting at this crossing. Furthermore, another restriction is located upstream of Jarbo Ditch, between the Kemah Oaks detention basin and the 57-acre park since the ditch is not wide enough to provide adequate conveyance for storm events greater than the 5-year event.

The existing condition storm inundation maps for the 2, 5, 10, 25, 50 and 100-year storm events are found in **Exhibits 6.2 – 6.7**.

3.0 PROPOSED CONDITION ANALYSIS

The alternative analysis for each area depended largely on the data available to create an existing conditions model to compare versus the recommended proposed conditions. For the Lighthouse District and West Kemah areas, based on previous drainage reports prepared, it is beneficial that the City consider implementing recommendations provided in those drainage reports. There are no small-scale repairs that can improve the performance of the drainage system during an extreme event rainfall. The City can continue implementing a maintenance program that include: de-silting storm sewers, de-silting ditches, re-grading ditches to re-establish positive flow and removing blockages on above surface inlet grates that may reduce the capturing capacity of the inlet.

3.1. Proposed Conditions Model

The proposed conditions were modeled based on the criteria described in **Section 2.0**. There was no deviation for Bayview Acres, Kemah Oaks or South Kemah. As previously stated, for South Kemah, additional information is required to fill-in gaps that are missing in the data. The record drawings available for the area are limited and do not provide enough information to allow for the construction of a proper hydraulic model.

The recently updated, Atlas 14 rainfall data was used to calculate peak flows and apply to the hydraulic analysis for the proposed conditions.

3.2. Changes to Existing Condition Model

Bayview Acres

Two alternatives were explored for this area to increase the LOS. The existing ditches and culverts in the area currently drain to inadequately sized outfalls which are likely causing backwater effects due to the outfalls choking the system. The effects are a reduced LOS in the existing roadside ditches and culverts since water does not drain efficiently, thus causing street flooding and ultimately ponding outside the City ROW.

No regional detention is recommended for either alternative. Since the outfalls discharge into Galveston Bay, detaining stormwater will not provide any benefit for the area. However, it is recommended that the City require future multi-family, industrial or commercial development in the area to provide on-site detention or discharge directly to Galveston Bay to prevent overwhelming the receiving storm sewer system due to increases in runoff.

The roadside ditch sizes presented in **Appendix I** were calculated based on manning's equation and assumed that the normal depth is at top of bank. As explained in **Section 2.4**, peak flows were generated using rational method. Similarly, the outfalls were calculated by applying manning's equation and comparison the pipe capacity to the flow conveyed to the outfall. Further analysis will be required during preliminary engineering and final design to properly conduct an HGL analysis on the recommended improvements, however, the recommendations made here provide a baseline in regards to the drainage improvements needed to increase the LOS for the area.

<u>Alternative 1</u>

The following changes are proposed for Alternative 1:

- Remove the existing 30-inch diameter outfall for Meadow Ln and replace with a 42-inch diameter pipe.

    - Drainage areas 1 and 2 (see **Table 9**) would continue to be serviced by this outfall and no additional area is added.
- Combine drainage areas 3, 4 and 5 (see **Table 9**) and install a 54-inch outfall north of the Yacht Club (104 Park Circle).
    - A 20-foot drainage easement would be required to access the outfall for maintenance and construction.
- Remove the existing 18-inch diameter outfall for Bay Ave and replace with a 6-foot by 4-foot RCB.
    - The proposed pipe can be installed within the existing 15-foot drainage easement and the contributing drainage area would be reduced. Only drainage areas 7 would drain to this outfall (see **Table 9**).
- Upsize culverts and widen and re-grade ditches to re-direct flow.
    - Topographic survey will be required to accurately model the needed sizes to increase conveyance of the existing roadside ditch/culvert system. Preliminary sizing of the roadside ditches, assuming that the City owns a 60-foot ROW within Bay Ave and Park Ave, has been provided in **Appendix I**.

Table 9 - Bayview Acres Alternative 1 Proposed Outfall Capacity

Outfall	DA ID	2-yr Q_{peak} (cfs)	100-yr Q_{peak} (cfs)	Pipe Size	Q_{pipe} (cfs)	2-yr Adequate?	100-yr Adequate?
Meadow Ln	1, 2	18	47	42”	63	**Yes**	**Yes**
Yacht Club North	3, 4, 5, 6	77	203	6’ x 4’	219	**Yes**	**Yes**
Bay Ave	7	40	105	54”	140	**Yes**	**Yes**

The cost of Alternative 1, including the cost of land acquisition, is estimated at **$2,206,590**. The outfalls would be sized to provide a 100-year LOS based on Atlas 14 rainfall. A detailed cost estimate of this alternative can be found in **Appendix A**.

Alternative 2

The following changes are proposed for Alternative 2:

- Remove the existing 30-inch diameter outfall for Meadow Ln and replace with a 42-inch diameter pipe.
    - Drainage areas 1 and 2 (see **Table 10**) would continue to be serviced by this outfall and no additional area is added.
- Combine drainage areas 3, 4 and 5 (see **Table 10**) and install a 54-inch outfall north of the Yacht Club (104 Park Circle).
    - A 20-foot drainage easement would be required to access the outfall for maintenance and construction.
- Install a 48-inch outfall south of the Yacht Club to serve drainage area 6 (See **Table 10**).
- Remove the existing 18-inch diameter outfall for Bay Ave and replace with 54-inch diameter pipe. (See **Table 10**)
- Upsize the culverts and widen and re-grade ditches to re-direct flow.
    - Topographic survey will be required to accurately model the needed sizes to increase conveyance of the existing roadside ditch/culvert system. Preliminary sizing of the roadside ditches, assuming that the City owns a 60-foot ROW within Bay Ave and Park Ave, has been provided in **Appendix I**.

Table 10 - Bayview Acres Alternative 2 Proposed Outfall Capacity

Outfall	DA ID	2-yr Q_{peak} (cfs)	100-yr Q_{peak} (cfs)	Pipe Size	Q_{pipe} (cfs)	2-yr Adequate?	100-yr Adequate?
Meadow Ln	1, 2	18	47	42”	63	**Yes**	**Yes**
Yacht Club North	3, 4, 5	44	113	54”	123	**Yes**	**Yes**
Yacht Club South	6	34	90	48”	90	**Yes**	**Yes**
Bay Ave	7	40	105	54”	140	**Yes**	**Yes**

The cost of Alternative 2, including the cost of land acquisition, is estimated at **$2,123,480**. The outfalls would be sized to provide a 100-year LOS. A detailed cost estimate of this alternative can be found in **Appendix A**.

Kemah Oaks

Four alternatives were analyzed for the Kemah Oaks area to increase the LOS. As per the existing analysis presented in Section **2.3**, the existing drainage system is inadequately sized to provide a minimum 2-year LOS to the existing subdivision. In addition, the existing detention basin is undersized to provide an adequate LOS needed during an extreme event.

Alternative 1

The following changes are proposed for Alternative 1:

- Remove 1,950 linear feet (LF) of 24-inch diameter RCP and 390 LF of 30-inch diameter RCP and replace with 1,550 LF of 30-inch diameter RCP and 790 LF of 36-inch diameter RCP.
    - Full depth concrete pavement repair will be necessary in areas where pipes beneath pavement are being removed and replaced.

The cost of Alternative 1 is **$846,050**. In this scenario, the storm sewer system would be upsized to provide up to a 2-year LOS. **Table 11** reflects the updated “CE – HGL_{US}” which shows that the HGL no longer exceeds the critical elevation during a 2-year storm event based on the proposed upsized pipes. A detailed cost estimate of this alternative can be found in **Appendix A**.

Table 11 - WinStorm Proposed Conditions 2-year Analysis

Run #	US DA ID	DS DA ID	HGL US (ft)	HGL DS (ft)	Cumulative Q (cfs)	$Q_{capacity}$	Critical Elevation (ft)	CE - HGL_{US}
1	B-1	OUT	6.49	6.30	91.18	58.65	10.38	3.89
2	B-2	B-1	6.71	6.49	91.18	58.65	10.76	4.05
3	B-3	B-2	7.22	6.71	91.18	49.57	10.61	3.39
4	B-3A1	B-3	7.27	7.22	8.82	12.09	8.95	1.68
5	B-3A2	B-3A1	7.28	7.27	4.56	13.52	8.95	1.67
6	B-3B	B-3	7.32	7.22	9.15	8.87	10.00	2.68
7*	B-3B1	B-3B	7.34	7.32	9.15	25.30	8.95	1.61
8	B-3B2	B-3B1	7.35	7.34	4.74	13.52	8.95	1.60
9	B-4	B-3	7.95	7.22	76.42	45.43	11.22	3.27
10	B-4A1	B-4	8.00	7.95	9.06	13.06	9.10	1.10
11	B-4A2	B-4A1	8.01	8.00	4.50	13.52	9.10	1.09
12	B-4B	B-4	8.06	7.95	9.43	2.87	11.20	3.14
13*	B-4B1	B-4B	8.08	8.06	9.43	24.00	9.10	1.02
14	B-4B2	B-4B1	8.09	8.08	4.71	13.52	9.10	1.01
15	B-5	B-4	8.42	7.95	61.01	45.43	10.97	2.55
16	B-5A1	B-5	8.47	8.42	25.17	27.62	9.50	1.03
17*	B-5A2	B-5A1	8.47	8.47	6.06	45.87	8.50	0.03
18	B-5A3	B-5A2	8.48	8.47	4.19	24.52	8.50	0.02
19	B-5AB	B-5A1	8.80	8.47	20.29	24.96	10.00	1.20
20*	B-5AB1	B-5AB	8.80	8.80	5.83	45.87	8.93	0.13
21	B-5AB2	B-5AB1	8.80	8.80	4.15	24.52	8.93	0.13
22	B-5AC	B-5AB	8.83	8.80	15.05	28.82	10.95	2.12
23	B-5AD	B-5AC	8.88	8.83	15.05	28.02	11.00	2.12
24	B-5AE	B-5AD	8.88	8.88	1.91	15.62	9.71	0.83
25	B-5AF	B-5AE	8.88	8.88	1.33	16.22	9.71	0.83
26	B-5AD1	B-5AD	8.98	8.88	13.61	28.39	10.50	1.52
27*	B-5AD2	B-5AD1	8.99	8.98	13.61	45.87	9.20	0.21
28	B-5AD3	B-5AD2	9.00	8.99	7.77	24.52	9.20	0.20
29	B-5B1	B-5	8.58	8.42	19.53	15.04	10.25	1.67
30*	B-5B2	B-5B1	8.58	8.58	6.44	25.30	9.10	0.52
31*	B-5B3	B-5B2	8.59	8.58	4.39	19.12	9.10	0.51
32	B-5BA	B-5B1	9.10	8.58	14.08	17.42	10.25	1.15
33*	B-5BA1	B-5BA	9.11	9.10	14.08	73.97	9.19	0.08
34*	B-5BA2	B-5BA1	9.12	9.11	7.11	34.67	9.19	0.07
35	B-6	B-5	8.79	8.42	17.60	17.40	10.25	1.46
36*	B-6A1	B-6	8.79	8.79	4.94	45.87	9.21	0.42
37*	B-6A2	B-6A1	8.80	8.79	4.10	34.67	9.21	0.41
38	B-7	B-6	8.86	8.79	13.07	17.68	10.25	1.39
39*	B-7A1	B-7	8.86	8.86	3.86	45.87	9.21	0.35
40	B-8	B-7	9.09	8.86	9.93	17.41	11.00	1.91
41	B-9	B-8	9.12	9.09	9.93	17.71	11.00	1.88
42	B-10	B-9	9.14	9.12	9.93	21.33	10.34	1.20
43	B-11	B-10	9.15	9.14	5.45	24.52	10.34	1.19

Alternative 2

The following changes are proposed for Alternative 2:

- Remove 1,950 linear feet (LF) of 24-inch diameter RCP and 390 LF of 30-inch diameter RCP and replace with 1,550 LF of 30-inch diameter RCP and 790 LF of 36-inch diameter RCP.
    - Full depth concrete pavement repair will be necessary in areas where pipes beneath pavement are being removed and replaced.
- Expand the linear detention basin for Bel Rd, southeast of Kemah Oaks subdivision to include an additional 10 acre-feet of detention volume.
    - An emergency spillway would be constructed between the two basins to provide an extreme event structure that would prevent the Kemah Oaks existing detention basin from backing up into the Kemah Oaks streets.
    - A concrete pilot channel would be added to the Bel Rd linear ditch basin to facilitate.

The purpose of this alternatives is to increase the LOS of the Kemah Oaks storm sewer and detention basin to provide a 100-year LOS. The Bel Rd linear detention ditch would be expanded to allow for a reduction in the WSEL of the Kemah Oaks detention basin, which would reduce the amount of stormwater currently stored in the Kemah Oaks subdivision streets. The emergency spillway would allow for water to flow into the expanded Bel Rd linear detention ditch.

The cost of Alternative 2 is **$2,062,850**, a detailed cost breakdown of this alternative can be found in **Appendix A**. Land acquisition would not be required for this alternative since it is understood that the property the Bel Rd linear detention basin is currently on is owned by the County and an agreement is in place for the City to make use of this site. If this is not the case, the City would be required to purchase additional land to expand the detention.

To further investigate this alternative, it is recommended that the City allow for a survey of foundation slabs of previously flooded properties to ensure that the expanded detention basin is optimized to reduce the WSEL and reduce the risk of structural flooding.

Alternative 3

The following changes are proposed for Alternative 3:

- Remove 1,950 linear feet (LF) of 24-inch diameter RCP and 390 LF of 30-inch diameter RCP and replace with 1,550 LF of 30-inch diameter RCP and 790 LF of 36-inch diameter RCP.
    - Full depth concrete pavement repair will be necessary in areas where pipes beneath pavement are being removed and replaced.
- Excavate an additional 9.82 acre-feet within the existing basin.
- Construct an emergency spillway to the Bel Rd linear detention ditch.
- Install a stormwater pump station.
    - A stormwater pump station would be required since the Jarbo Ditch is limited in depth. The existing basin footprint is fixed, therefore, only depth is available to get more increase the volume storage capacity of the basin. It is likely that a small amount of storage would need to be extended along the Bel Rd linear detention ditch.

The cost of Alternative 3 is **$1,780,620**. A detailed cost analysis can be found in **Appendix A.** A service drop and generator would also need to be considered for a stormwater pump station. Ultimately, this alternative would require the long term maintenance of a stormwater pump station, which the City may not want to take on.

Alternative 4

The following changes are proposed for Alternative 4:

- Construct an extreme event emergency spillway from the Kemah Oaks existing detention basin.
    - This will prevent stormwater from backing up into the Kemah Oaks subdivision when Jarbo Ditch is not flowing full. Ultimately, as demonstrated by Jarbo Ditch HEC-RAS existing condition analysis, if Jarbo Ditch is flowing full, stormwater will back up into the Kemah Oaks subdivision since it is the lowest point relative to the rest of the Jarbo Ditch service area.
- Remove existing Inlet and 24-inch at the Oak Meadow Dr/Bay Oaks Dr intersection and upsize to convey the difference between the 2-year and 100-year flow.
    - The purpose is to convey stormwater to the detention basin via an underground system, since the system as currently design depends on spilling over the top bank of the basin, thus ponding water in neighborhood streets and causing mobility issues.

The cost of Alternative 4 is **$171,650**. A detailed cost analysis can be found in **Appendix A**. This alternative does not consider any alterations to existing detention basin and is considered a temporary solution until the City is able to get additional funds to expand the detention basin and widen Jarbo Ditch.

South Kemah

Two alternatives were explored for the South Kemah area based on the limited amount of data available. Based on previous documented rain events in the area, it is understood that the existing roadside ditch and culvert system that serves most of the area are either undersized, graded to flow incorrectly, silted up or a combination of all three.

Alternative 1

It is understood that the existing ditches and culverts are undersized, and that local conveyance is easily overwhelmed during more frequent, less intense storm events. Currently, the City has a preliminary set of plans for the street reconstruction of Anders Ln which include drainage conveyance improvements. LJA recommends that this project is funded and constructed as part of this alternative.

The improvements in the South Kemah area were split into three separate drainage outfalls, also regarded as System A, System B and System C. System drainage improvements were sized based on a 5-year storm event. Furthermore, the hydrology was performed based on assigning C-Factor values to each parcel as currently developed and peak flows were calculated using the rational method.

An HGL analysis was not conducted due to insufficient topographic data available. Pipes were sized based on calculating the capacity of pipe by using manning's equation. If the capacity was exceeded, then the pipe was upsized until the capacity exceeded the 5-year peak flow. Additionally, peak flows were not determined based on a cumulative time of concentration and instead, individual peak flows were added together to create the cumulative flows needed to size each system. These recommendations provide a base to start the design, however, preliminary engineering will need to be conducted prior to the start of design to properly analyze the proposed system and confirm the proposed drainage area as delineated. Preliminary engineering would include full topographic survey, which would be needed to verify where the existing ditch and underground systems flow.

System A

System A provides improvements to Delores St, Delesandri Ln and Winfield Ln and discharges to Jarbo Ditch. The following are the improvements recommended for System A:

- Remove and dispose of 1,250 LF of 18-inch RCP
- Remove and dispose of 1,700 LF of 24-inch RCP
- 825 LF of 7-foot by 4-foot RCB along Windfield Ln
- 1,000 LF of 5-foot by 4-foot along Delesandri Ln
- 420 LF of 30-inch diameter RCP along an existing 20-foot drainage easement.
    - The 20-foot drainage easement has not been confirmed, however, the City believes this easement exists and the cost of easement acquisition was not taken into account.
    - The easement extends from Delores St to Delesandri Ln
- Ditch improvements along Delores St, including driveway repair and culvert replacement

The cost of System A improvements is $1,570,000. A detailed cost is included in **Appendix A**. The opinion of probable cost shows a subtotal of $924,610 for System A, however, this subtotal did not include extra work items, permitting, engineering fees, construction management and a 30-percent contingency, which the aforementioned overall total cost does reflect.

<u>System B</u>

System B improvements encompasses Williams Dr and Lewis Dr. The following are the improvements recommended for System B:

- Remove and dispose of 2,030 LF of 24-inch RCP
- 1,075 LF of 7-foot by 4-foot RCB along an existing 20-foot drainage easement Jarbo Ditch to Anders Ln
    - The City stated that there is an existing drainage easement in this area, therefore, easement acquisition was not considered in the cost.
- Ditch improvements along Lewis Dr and Williams Dr, including driveway repair and culvert replacement
- 200 LF of 6-foot by 3-foot RCB along an existing 20-foot easement.
    - The City stated that there is an existing drainage easement in this area, therefore, easement acquisition was not considered in the cost.

The cost of System B improvements is $1,270,000. A detailed cost is included in **Appendix A**. The opinion of probable cost shows a subtotal of $750,710 for System B, however, this subtotal did not include extra work items, permitting, engineering fees, construction management and a 30-percent contingency, which the aforementioned overall total cost does reflect.

<u>System C</u>

System C improvements encompasses South Kemah Dr. The following are the improvements recommended for System C. A detailed cost is included in **Appendix A**. The opinion of probable cost shows a subtotal of $622,880 for System C, however, this subtotal did not include extra work items, permitting, engineering fees, construction management and a 30-percent contingency, which the aforementioned overall total cost does reflect.

- Remove and dispose of 1,200 LF of 24-inch RCP
- Remove and dispose of 780 LF of 36-inch RCP
- 1,200 LF of 30-inch RCP along South Kemah Dr
- 780 LF of 6-foot by 3-foot RCB along South Kemah Drive
- De-silt existing ditches

The cost of System C improvements is $1,060,000. A detailed cost is included in **Appendix A**. The opinion of probable cost shows a subtotal of $622,880 for System B, however, this subtotal did not include extra

work items, permitting, engineering fees, construction management and a 30-percent contingency, which the aforementioned overall total cost does reflect.

Alternative 2

Since entire South Kemah drains into Jarbo Ditch, a regional detention basin alternative was explored for the area. As stated in **Section 2.3**, Jarbo Ditch is an unstudied stream and a topographic survey of the entire ditch is required to complete a proper channel analysis. A preliminary steady state HEC-RAS model was conducted using 2018 LiDAR and assuming a tailwater condition at the confluence with Jarbo Bayou. The existing conditions analysis indicated that Jarbo Ditch has a 5-year LOS based on the existing configuration of the ditch. The existing condition analysis was ran based on the existing land use of South Kemah and assuming a normal depth outfall to Jarbo Bayou. Based on historical imagery, prior to 1990, South Kemah was mostly undeveloped.

This alternative explores regional detention under the assumption that the increase in flows from the development of single-family residential developments (present and future) and business developments (present) has adversely impacted conveyance in the area. To remediate the issue, it is proposed that a regional detention basin is constructed to mitigate the increase in flows from present and future development, as shown on **Exhibit 5.7**. As requested by the City, not all lots were taken under consideration, therefore, any lot not identified in the aforementioned exhibit will require on-site detention at a rate of 0.60 acre-feet per acre to prevent adverse impacts to Jarbo Ditch.

Alternative 2 proposes the following:

- Parcel acquisition for the construction of a detention basin.
    - The opinion of probable cost only considers a portion of the land needed to make the acquisition.
- Excavate a basin which provides nearly 62 acre-feet of storage.
- Construct a 5-foot by 5-foot outfall to Jarbo Ditch, which restricts the flow to pre-developed conditions of the South Kemah area.
- Install ditch interceptor structures along the boundary of the basin to limit erosion control issues for the lifetime of the basin.
- A stormwater pump station may be required to limit the amount of property acquisition likely needed for the construction of the basin.

The cost of this alternative, including property acquisition, is **$4,120,010.** A detailed cost breakdown can be found in **Appendix A.** Additional land acquisition may be needed to accomplish the necessary detention. Additionally, it would be prudent that this Alternative is re-visited prior to design to determine if detaining stormwater for a 100-year storm event is necessary in this area. The scope of work for this MDP did not provide a budget for detailed hydraulic modeling that included tidal influences, therefore, attempting to withhold a 100-year storm event is only a baseline start, however, the City may want to consider only holding for a lesser rain event.

Jarbo Ditch

As stated in **Section 2.4**, an existing condition steady state HEC-RAS analysis was conducted on Jarbo Ditch to understand the current LOS it provides its service area. An alternative analysis was not conducted on Jarbo Ditch, instead two viable scenarios were analyzed to provide a short term goal (Scenario 1) and long-term goal (Scenario 2) to increase the LOS provided by this ditch. A proposed conditions steady state HEC-RAS model was prepared for both scenarios and the flows applied to the existing conditions as presented in **Table 8** were also applied to these scenarios. As done with the existing conditions analysis,

a normal depth was assumed as the tailwater for the hydraulic analysis of both scenarios. This study can be further refined once a study for Jarbo Bayou is completed and proposed condition analysis can be meshed with the Jarbo Bayou model. Scenario 1 focused on the following:

- Increase LOS of Jarbo Ditch, starting 1,100 LF south of the FM 518 crossing and ending at the confluence of Jarbo Bayou
    - There is available undeveloped land south and north of this crossing.
- Upsize the FM 518 crossing.
    - The FM 518 crossing is currently a restrictor in the existing model which prevents a limited LOS.

Based on the analysis conducted for Scenario 1, a 25-year LOS was provided to the South Kemah area. This scenario requires the following:

- Acquire 50-feet of additional ROW, north of the FM 518 crossing.
    - The ROW would be acquired to the east of the existing ROW.
    - The proposed channel would be a trapezoidal earthen channel with a 30-foot bottom and a 100-foot top and 4:1 side slopes. It would also include a 20-foot maintenance berm.
- Acquire 40-feet of additional ROW, south of the FM 518 crossing.
    - The ROW acquisition would be limited from the FM 518 crossing to 1,100 LF south of the FM 518 crossing, just north of the existing City maintenance facility.
    - The proposed channel would be a trapezoidal earthen channel with a 25-foot bottom and a 90-foot top and 3:1 side slopes. It would also include a 20-foot maintenance berm.
- Install an additional 8-foot by 7-foot RCB at FM 518.
    - The existing dual 8-foot by 7-foot RCB would remain in place.
- Utility relocations would likely be necessary and a contingency amount was included in the opinion of probable cost.
- Inundation Maps for proposed improvements are shown in **Exhibit 6.9 – 6.14**.

The cost of Scenario 1, which includes land acquisition, is **$4,030,115**. A detailed cost breakdown can be found in **Appendix A**. Scenario 1 widens Jarbo Ditch, although it does not deepen Jarbo Ditch (see **Exhibit 6.8** for proposed ROW acquisition needed in Scenario 1). Based on current known information, Jarbo Ditch is currently at the lowest point and the flowline cannot be lowered. Until the Jarbo Bayou study is completed, it is not known if Jarbo Bayou may be dredged to gain additional depth. The City requested that LJA explore the opportunity of providing regional detention, as presented under South Kemah alternatives, north of the FM 518 crossing; however, due to the limited amount of land available the FM 518 crossing to widen the channel, conveying the full 100-year flow north of the crossing is not possible; therefore, widening the channel for regional detention would not provide any benefit. Also, regional detention this close to the coast can create additional concerns during storm surge events that may exacerbate flooding in the area. As discussed under Alternative 2 of South Kemah, LJA recommends further study that expands the scope of work to conduct a detailed hydraulic model of the area which includes regional detention and tidal influences.

Scenario 2 is a continuation of Jarbo Ditch improvements and assumes that Scenario 1 is built. Upstream of the Scenario 1 improvements, there are severe restrictions regarding available, undeveloped properties. Additionally, there is an elevated portion of land that cannot be used for drainage purposes and this poses additional challenges to accomplish a higher LOS within Jarbo Ditch. Furthermore, this elevated land restricts flows that overtop Jarbo Ditch from spreading to undeveloped land and rather

pushes flow towards developed properties in South Kemah. It is recommended that the City considers lowering this land, although this is not part of the recommendation for Scenario 2.

Scenario 2 requires the following:

- Acquire 60-feet of additional ROW within an existing 88-acre tract.
    - The county and the City own property and ROW within this scenario which allows for a reduction in land acquisition.
    - The channel would be a trapezoidal earthen channel with a 25-foot bottom and a top that ranges between 60 to 90-feet.
        - The reason for the variance is that the channel becomes a lot shallower, approximately 3-4-feet as just north of the 57-acre park.
    - This scenario does not consider any culverts needed within the corridor.
    - An assumption was made regarding potential utility relocations in the corridor, additional data is needed to formalize a plan.
- Inundation Maps for proposed improvements are shown in **Exhibit 6.15 – 6.20**.

The cost of Scenario 2, which includes land acquisition, is **$1,359,915**. A detailed cost breakdown can be found in **Appendix A**. Scenario 2 only widens Jarbo Ditch and does not deepen it (see **Exhibit 6.8** for proposed ROW acquisition needed in Scenario 2). As previously stated, Jarbo Ditch cannot be deepened unless a study of Jarbo Bayou reveals that Jarbo Bayou can and will be deepened which would allow for Jarbo Ditch to be deepened. Scenario 2 will also only provide a 25-year LOS to the Jarbo Ditch service area.

The total cost of Scenarios 1 and 2 is **$5,390,030** which includes a 30% contingency. Ultimately, if the City wishes to provide a 100-year LOS to the Jarbo Ditch service area, it is necessary to acquire additional land to allow for additional box culverts to be installed at the FM 518 crossing. Due to the current configuration of FM 518 and Jarbo Ditch, realignment of the Jarbo Ditch and possibly FM 518 would be required to further increase the capacity of the FM 518 culvert crossing. Even with ROW acquisition, the ROW is constrained, and land acquisition would need to consider the taking of a few properties in the Kemah Oaks subdivision that are adjacent to Jarbo Ditch.

A detailed preliminary engineering study will need to be conducted of Jarbo Ditch. Ultimately, the recommendations made in this MDP relied on limited data and the scope of work did not include the detailed level of modeling needed to fine tune the recommendation. The preliminary engineering study would likely explore a 1D/2D unsteady model, which would integrate the Jarbo Bayou model and create a more accurate representation of the Jarbo Ditch service area.

4.0 RECOMMENDATIONS

The following alternatives are recommended for each area:

Bayview Acres

Alternative 1 is recommended for the Bayview Acres area. Although larger outfalls will be required for Yacht Club North and Bay Ave, this alternative prevents the City from acquiring two separate drainage easements and reduces the amount of pipe that would need to be maintained. This recommended alternative allows for faster construction since only three (3) outfalls would be installed rather than 4 outfalls.

This alternative would provide a 100-year LOS for the Bayview Acres provided that future development includes detention to mitigate flows to existing conditions.

Kemah Oaks

Ultimately, Alternative 2 is recommended for the Kemah Oaks subdivision. This alternative expands the Bel Rd linear detention ditch southeast of the subdivision and would provide enough storage to avoid the installation of a stormwater pump station. The existing Kemah Oaks detention basin can be converted to a dry bottom. If the City wishes to proceed with this alternative, this alternative would require further design analysis during final design to analyze and design the overflow spillway, adjust outfalls and evaluate the interaction between the two detention facilities.

Alternative 4 was included in this MDP based on discussions with the City and short term "band-aid" fixes that could be implemented based on the available budget for the fiscal year. It is recommended that while Alternative 2 is ultimately implemented, Alternative 4 is pursued by the City to provide some relief to the Kemah Oaks area. As discussed in **Section 2.4**, Jarbo Ditch has a 5-year LOS, which has a direct impact to the Kemah Oaks subdivision, however, the emergency overflow would provide much needed relief to this area while the City seeks routes to implement the recommendation to improve Jarbo Ditch.

South Kemah and Jarbo Ditch

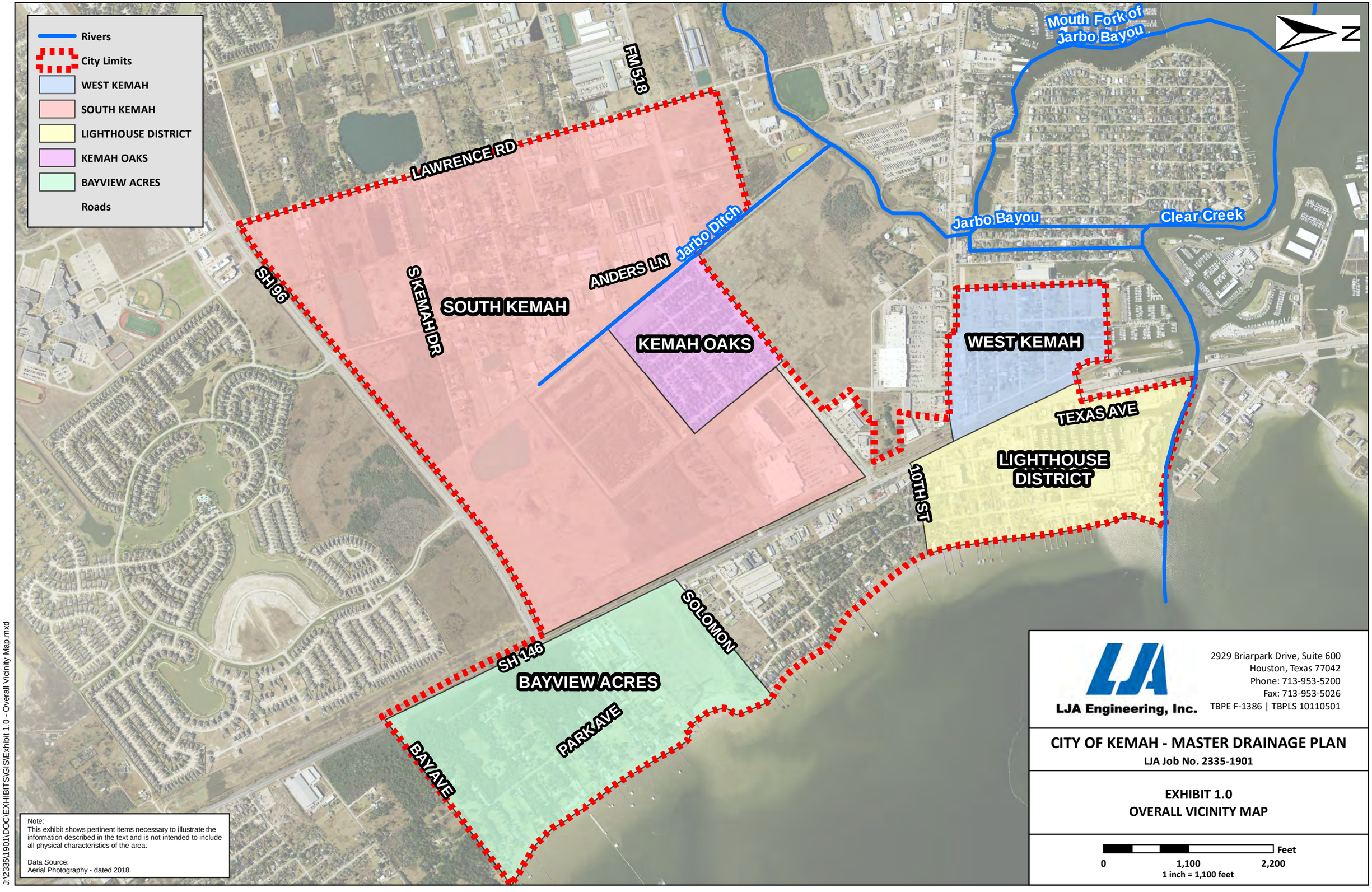
It is recommended that both Alternatives 1 and 2 are implemented for the South Kemah area. As noted, the area has undersized culverts and ditches that do not allow proper conveyance of stormwater to Jarbo Ditch. Additionally, the majority of lots that have been developed thus far within this area did not consider the increase in flows due to their development and constructing a regional detention basin to retro-actively hold the increase in flows prior to releasing to Jarbo Ditch, would help minimize the impact of Jarbo Ditch.

It is also recommended that Scenarios 1 and 2 are implemented for Jarbo Ditch to increase the conveyance capacity for the area and reduce the amount of ponding. Scenario 1 is presented as a short term solution, which would have the greatest impact in the area by increasing the conveyance through FM 518. Scenario 2 could then be implemented when additional funds are acquired. As mentioned previously, it is highly critical that the City conduct a preliminary engineering study of Jarbo Ditch and implement higher level modeling to finalize the recommended design. It will also be beneficial to understand the results and recommendations for Jarbo Bayou, prior to finalizing the recommendation for Jarbo Ditch. LJA recommends that the City allocate additional funds to conduct a proper study of the Jarbo Ditch watershed and incorporate the Jarbo Bayou model being created by League City. Ultimately, the improvements discussed for Scenario 1 and 2 do not incorporate the possible backwater effects from Jarbo Bayou and therefore, the recommendations may reflect a less than 100-year LOS.

Lighthouse District and West Kemah

It is recommended that they City continue implementing the recommendations made from previous studies in these two areas. LJA is continuing to investigate if there are critical areas that need immediate improvements to alleviate flooding issues. It is likely that quick fixes beyond the recommendations in the previous report are not available and the City needs to invest in re-constructing the storm sewer systems that are undersized. The City also needs to determine the LOS it wishes to provide in these areas, since these areas directly discharge to Clear Creek Channel or to Galveston Bay.

EXHIBITS



Note:
This exhibit shows pertinent items necessary to illustrate the information described in the text and is not intended to include all physical characteristics of the area.

Data Source:
Aerial Photography - dated 2018.

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TBPE F-1386 | TBPLS 10110501

CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 1.0
OVERALL VICINITY MAP

Feet
0 1,100 2,200
1 inch = 1,100 feet

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City of Kemah Limits

BAYVIEW ACRES

N

SH 146

SH 146

CIEN RD

BAYSHORE DR

SOLOMON

MAUDLIN CIR

CROWLEY LN

PARK AVE

MEADOW LN

SOUTH KEMAH

BAYVIEW ACRES

PARK CIR

EXETER

GALAN

PARK CIR

PARK CIR

SH 146

SH 96

SH 96

BAY AVE

Note:
This exhibit shows pertinent items necessary to illustrate the information described in the text and is not intended to include all physical characteristics of the area.

Data Source:
Aerial Photography - dated 2018.

J:\2335\1901\DOCIEXHIBITS\GIS\Exhibit 1.1 - Bayview Acres Vicinity Map.mxd

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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 1.1
BAYVIEW ACRES
VICINITY MAP

Feet
0 500 1,000
1 inch = 500 feet

City of Kemah Limits

LIGHTHOUSE DISTRICT

N

LIGHTHOUSE DISTRICT

WEST KEMAH

PORTOFINO PLAZA

GROVE RD

3RD ST

TEXAS AVE

4TH ST

W 4TH ST

MILLER AVE

5TH ST

SH 146

W 5TH ST

CAROLYN ST

6TH ST

BRADFORD AVE

KIPP AVE

W 6TH ST

7TH ST

HARRIS AVE

W 7TH ST

8TH ST

W 8TH ST

9TH ST

MARINA BAY DR

10TH ST

FAY RD

Note:
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Data Source:
Aerial Photography - dated 2018.

J:\2335\1901\DOC\EXHIBITS\GIS\Exhibit 1.2 - Lighthouse District Vicinity Map.mxd

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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 1.2
LIGHTHOUSE DISTRICT
VICINITY MAP

Feet
0 400 800
1 inch = 400 feet

City of Kemah Limits

KEMAH OAKS

N

FM 518

FM 518

OAK BRIAR DR

KEMAH OAKS DR

OAK HILL DR

BAY OAKS ST

PARK OAKS ST

OAK VALLEY DR

KEMAH OAKS

OAK BERRY DR

KEMAH OAKS DR

OAK GLEN DR

OAK MEADOW DR

OAK RIDGE DR

BAY OAKS ST

ANDERS LN

KEMAH VILLAGE DR

KEMAH VILLAGE DR

KEMAH VILLAGE DR

KEMAH VILLAGE DR

SOUTH KEMAH

SUE DR

Note:
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Data Source:
Aerial Photography - dated 2018.

J:\2335\1901\DOC\EXHIBITS\GIS\Exhibit 1.3 - Kemah Oaks Vicinity Map.mxd

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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 1.3
KEMAH OAKS
VICINITY MAP

Feet

0 250 500

1 inch = 250 feet

City of Kemah Limits

SOUTH KEMAH

N

KEMAH OAKS

BAYVIEW ACRES

SOUTH KEMAH

LAWRENCE RD

FM 518

OAK BRIAR DR

OAK HILL DR

PARK OAKS ST

OAK MEADOW DR

OAK RIDGE DR

OAK GLEN DR

KEMAH VILLAGE DR

SUE DR

WINFIELD LN

DELESANDRI LN

ANDERS LN

DELORES ST

LEWIS DR

WILLIAMS DR

LAKEVIEW BEND LN

S KEMAH DR

LAWRENCE LN

SH 146

SH 96

FAY RD

KIPP AVE

BEL RD

CIEN RD

SOLOMON

BAYSHORE DR

MAUDLIN CIR

MEADOW LN

PARK AVE

PARK CIR

EXETER

GALAN

Note:
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CITY OF KEMAH - MASTER DRAINAGE PLAN

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EXHIBIT 1.4
SOUTH KEMAH
VICINITY MAP

Feet
0 810 1,620
1 inch = 800 feet

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City of Kemah Limits

WEST KEMAH

N

PORTOFINO PLAZA

GROVE RD

3RD ST

4TH ST

TEXAS AVE

BRADFORD AVE

KIPP AVE

BAY AVE

5TH ST

W 4TH ST

MILLER AVE

W 5TH ST

LIGHTHOUSE DISTRICT

6TH ST

WEST KEMAH

W 6TH ST

CAROLYN ST

SH 146

7TH ST

W 7TH ST

HARRIS AV

W 8TH ST

MARINA BAY DR

Note:
This exhibit shows pertinent items necessary to illustrate the information described in the text and is not intended to include all physical characteristics of the area.

Data Source:
Aerial Photography - dated 2018.

J:\23351901\DOC\EXHIBITS\GIS\Exhibit 1.5 - West Kemah Vicinity Map.mxd

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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 1.5
WEST KEMAH
VICINITY MAP

Feet
0 250 500
1 inch = 250 feet

City of Kemah Limits
Flow Direction
Parcels (GCAD)
Kemah_Precincts

2018 LiDAR Elevation

Value
High : 30
Low : 0

BEL RD
KIPP AVE
BAYSHORE DR
CIEN RD
SOLOMON
MAUDLIN CIR
CROWLEY LN
MEADOW LN
SH 146
PARK CIR
PARK AVE
EXETER
GALAN
BAY AVE
SH 96
S KEMAH DR

OAKS
BAYVIEW ACRES
SOUTH KEMAH

N

Note:
This exhibit shows pertinent items necessary to illustrate the information described in the text and is not intended to include all physical characteristics of the area.

Data Source:
Aerial Photography - dated 2018.

J:\2335\1901\DOC\EXHIBITS\GIS\Exhibit 2.1 - Bayview Acres Elevation Map.mxd

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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 2.1
BAYVIEW ACRES
ELEVATION MAP

Feet
0 510 1,020
1 inch = 510 feet

City of Kemah Limits
Flow Direction
Parcels (GCAD)
Kemah_Precincts

2018 LiDAR Elevation

Value

High : 30

Low : 0

N

PORTOFINO PLAZA
GROVE RD
3RD ST
TEXAS AVE
4TH ST
W 4TH ST
MILLER AVE
5TH ST
SH 146
W 5TH ST
CAROLYN ST
W 6TH ST
W 7TH ST
W 8TH ST
MARINA BAY DR
MARINA BAY DR

WEST KEMAH

LIGHTHOUSE DISTRICT

3RD ST
4TH ST
BAY AVE
5TH ST
BRADFORD AVE
6TH ST
KIPP AVE
7TH ST
HARRIS AVE
8TH ST
9TH ST
10TH ST

Note:
This exhibit shows pertinent items necessary to illustrate the information described in the text and is not intended to include all physical characteristics of the area.

Data Source:
Aerial Photography - dated 2018.

J:\2335\19011DOC\EXHIBIT\GIS\Exhibit 2.2 - Lighthouse District Elevation Map.mxd

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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 2.2
LIGHTHOUSE DISTRICT
ELEVATION MAP

Feet
0 350 700
1 inch = 350 feet

City of Kemah Limits
Flow Direction
Parcels (GCAD)
Kemah_Precincts

2018 LiDAR Elevation

Value

High : 30

Low : 0

N

FM 518

OAK BRIAR DR

KEMAH OAKS DR

OAK HILL DR

BAY OAKS ST

PARK OAKS ST

KEMAH OAKS

OAK BERRY DR

OAK VALLEY DR

KEMAH OAKS DR

OAK GLEN DR

OAK MEADOW DR

OAK RIDGE DR

BAY OAKS ST

SOUTH KEMAH

KEMAH VILLAGE DR

KEMAH VILLAGE DR

KEMAH VILLAGE DR

KEMAH VILLAGE DR

ANDERS LN

SUE DR

Note:
This exhibit shows pertinent items necessary to illustrate the information described in the text and is not intended to include all physical characteristics of the area.

Data Source:
Aerial Photography - dated 2018.

J:\2335\1901\DOC\EXHIBIT\GIS\Exhibit 2.3 - Kemah Oaks Elevation Map.mxd

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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 2.3
KEMAH OAKS
ELEVATION MAP

Feet
0 250 500
1 inch = 250 feet

City of Kemah Limits
Flow Direction
Parcels (GCAD)
Kemah_Precincts

2018 LiDAR Elevation

Value
High : 30
Low : 0

N

KEMAH OAKS
SOUTH KEMAH
BAYVIEW ACRES

FAY RD
BEL RD
KIP AVE
BAYSHORE DR
CIEN RD
SOLOMON
MAUDLIN CIR
CROWLEY LN
PARK AVE
PARK CIR
MEADOW LN
SH 146
OAK BRIAR DR
KEMAH OAKS ST
OAK HILL DR
BAY OAKS ST
PARK OAKS ST
OAK BERRY DR
OAK GLEN DR
OAK VALLEY DR
OAK RIDGE DR
OAK MEADOW DR
FM 518
KEMAH VILLAGE DR
LAWRENCE RD
SUE DR
WINFIELD LN
DELESANDRI LN
DELORES ST
ANDERS LN
LEWIS DR
WILLIAMS DR
LAKEVIEW BEND LN
S KEMAH DR
SH 96

Note:
This exhibit shows pertinent items necessary to illustrate the information described in the text and is not intended to include all physical characteristics of the area.

Data Source:
Aerial Photography - dated 2018.

J:\2335\1901\DOC\EXHIBIT S\GIS\Exhibit 2.4 - South Kemah Elevation Map.mxd

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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 2.4
SOUTH KEMAH
ELEVATION MAP

Feet
0 650 1,300
1 inch = 650 feet

City of Kemah Limits
Flow Direction
Parcels (GCAD)
Kemah_Precincts

2018 LiDAR Elevation

Value

High : 30

Low : 0

N

PORTOFINO PLAZA
GROVE RD
3RD ST
4TH ST
W 4TH ST
MILLER AVE
TEXAS AVE
5TH ST
W 5TH ST
CAROLYN ST
SH 146
6TH ST
BRADFORD AVE
KIPP AVE
BAY AVE
7TH ST
HARRIS AV
W 6TH ST
W 7TH ST
W 8TH ST
MARINA BAY DR

LIGHTHOUSE DISTRICT

WEST KEMAH

Note:
This exhibit shows pertinent items necessary to illustrate the information described in the text and is not intended to include all physical characteristics of the area.

Data Source:
Aerial Photography - dated 2018.

J:\2335\1901\DOC\EXHIBIT\GIS\EXhibit 2.5 - West Kemah Elevation Map.mxd

LJA Engineering, Inc.
2929 Briarpark Drive, Suite 600
Houston, Texas 77042
Phone: 713-953-5200
Fax: 713-953-5026
TBPE F-1386 | TBPLS 10110501

CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 2.5
WEST KEMAH
ELEVATION MAP

Feet
0 250 500
1 inch = 250 feet

City Limits
Drainage Area
Name

Parcels (GCAD)
Bay Ave Outfall
Meadow Ln Outfall

SH 96
SH 146
BAY AVE
MEADOW LN
CROWLEY LN
MAUDLIN CIR
PARK CIR
PARK AVE
EXETER
GALAN

DA-1
3.82 ac
DA-2
7.75 ac
DA-3
16.17 ac
DA-4
12.47 ac
DA-5
10.91 ac
DA-6
19.69 ac
DA-7
39.02 ac

Note:
This exhibit shows pertinent items necessary to illustrate the information described in the text and is not intended to include all physical characteristics of the area.

Data Source:
Aerial Photography - dated 2018.

LJA Engineering, Inc.
2929 Briarpark Drive, Suite 600
Houston, Texas 77042
Phone: 713-953-5200
Fax: 713-953-5026
TBPE F-1386 | TBPLS 10110501

CITY OF KEMAH - MASTER DRAINAGE PLAN

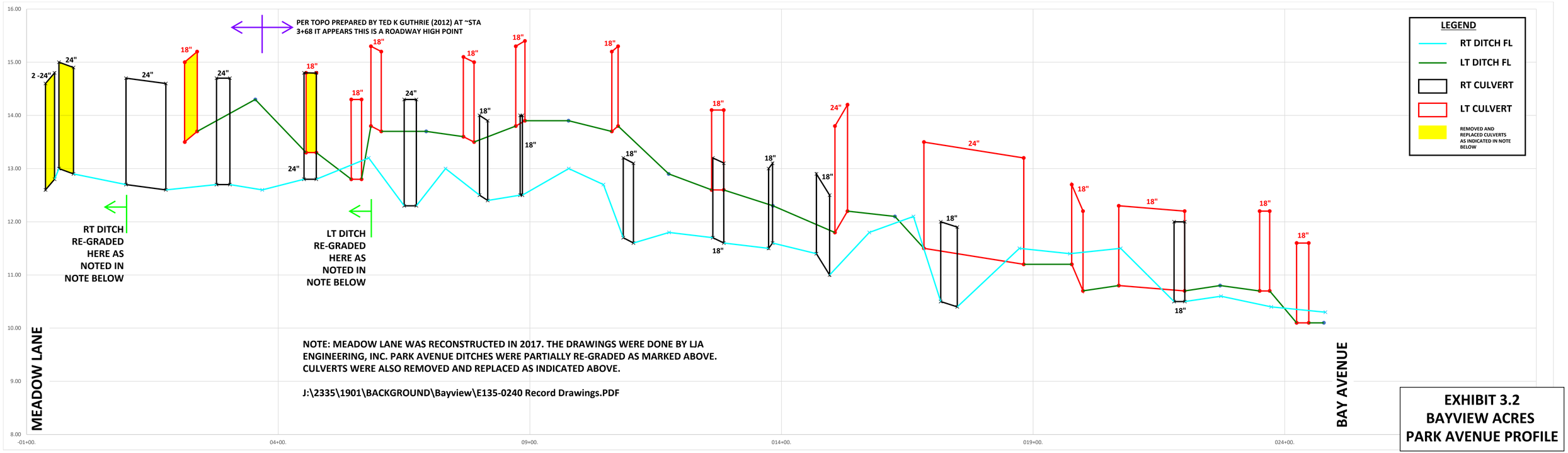
LJA Job No. 2335-1901

EXHIBIT 3.1
BAYVIEW ACRES
EXISTING DRAINAGE AREA MAP

Feet
0 300 600
1 inch = 300 feet

J:\2335\1901\DOC\EXHIBITS\GIS\EXhibit 3.1 - Bayview Acres - Drainage Area Map.mxd

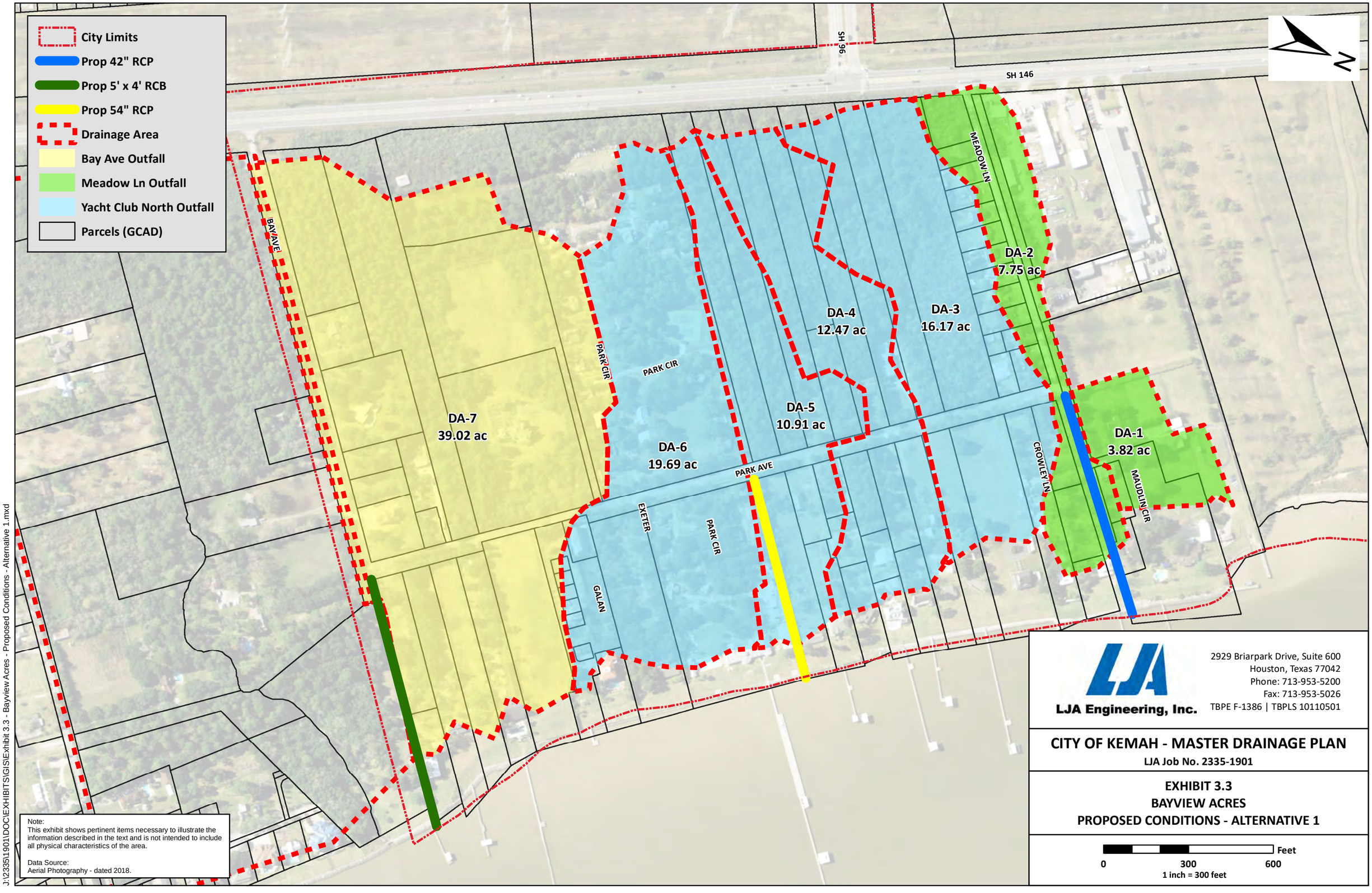
PARK AVENUE



NOTE: MEADOW LANE WAS RECONSTRUCTED IN 2017. THE DRAWINGS WERE DONE BY LJA ENGINEERING, INC. PARK AVENUE DITCHES WERE PARTIALLY RE-GRADED AS MARKED ABOVE. CULVERTS WERE ALSO REMOVED AND REPLACED AS INDICATED ABOVE.

J:\2335\1901\BACKGROUND\Bayview\E135-0240 Record Drawings.PDF

EXHIBIT 3.2
BAYVIEW ACRES
PARK AVENUE PROFILE



J:\2335\1901\DOC\EXHIBIT\GIS\Exhibit 3.3 - Bayview Acres - Proposed Conditions - Alternative 1.mxd

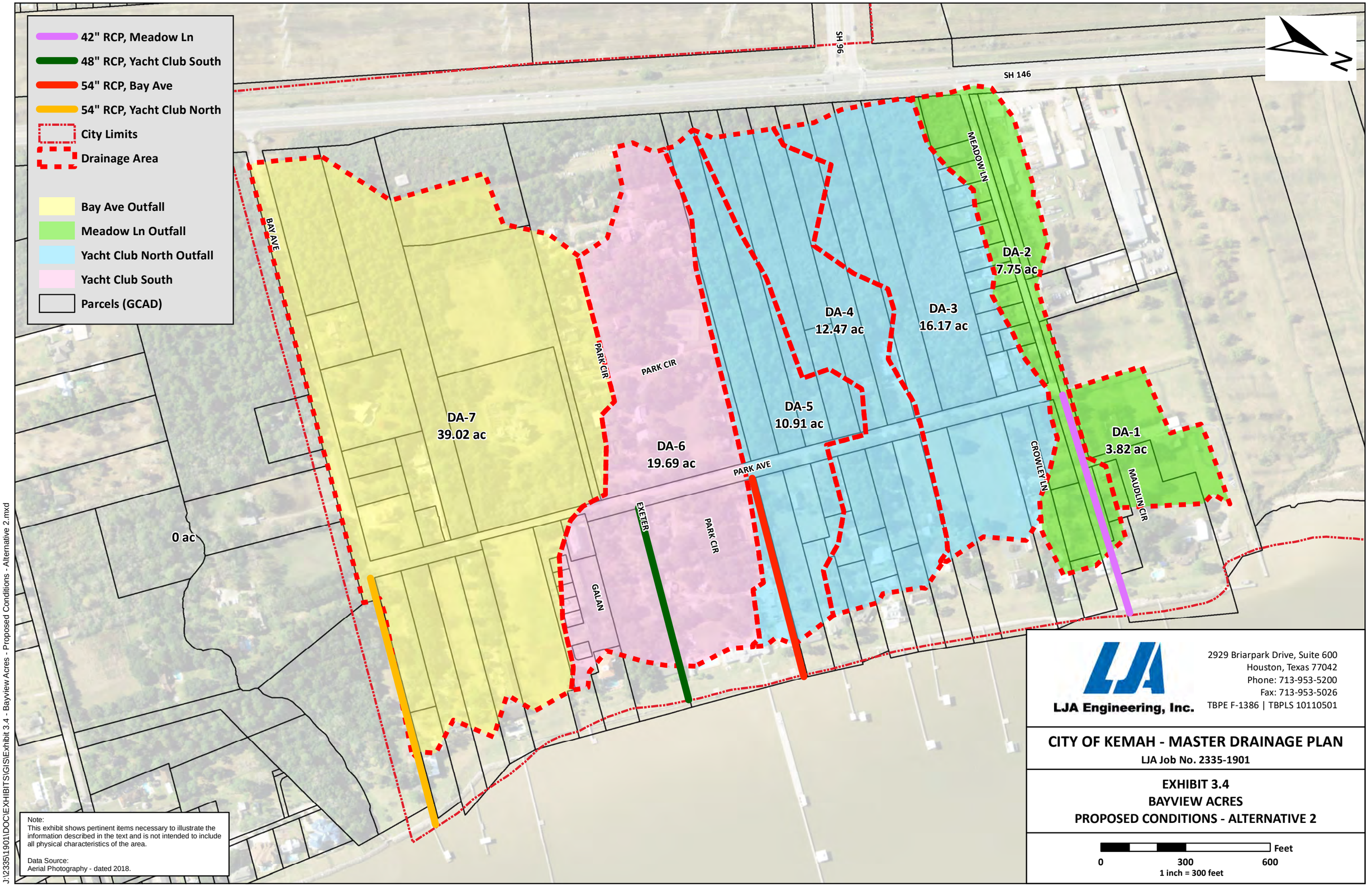
LJA Engineering, Inc.
2929 Briarpark Drive, Suite 600
Houston, Texas 77042
Phone: 713-953-5200
Fax: 713-953-5026
TBPE F-1386 | TBPLS 10110501

CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 3.3
BAYVIEW ACRES
PROPOSED CONDITIONS - ALTERNATIVE 1

Feet
0 300 600
1 inch = 300 feet



Note:
This exhibit shows pertinent items necessary to illustrate the information described in the text and is not intended to include all physical characteristics of the area.

Data Source:
Aerial Photography - dated 2018.

J:\2335\1901\DOC\EXHIBIT\GIS\Exhibit 3.4 - Bayview Acres - Proposed Conditions - Alternative 2.mxd

LJA Engineering, Inc.
2929 Briarpark Drive, Suite 600
Houston, Texas 77042
Phone: 713-953-5200
Fax: 713-953-5026
TBPE F-1386 | TBPLS 10110501

CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 3.4
BAYVIEW ACRES
PROPOSED CONDITIONS - ALTERNATIVE 2

Feet
0 300 600
1 inch = 300 feet

City Limits
Drainage Area

Parcels (GCAD)
Business
Industrial Heavy
Industrial Light
MF <20
MF >20
Parks/Open Area
ROW
SFR 1/4 to 1/2
SFR <1/4
SFR >1/2
Water

SH 96
SH 146
BAY AVE
PARK CIR
PARK CIR
MEADOW LN
PARK AVE
EXETER
PARK CIR
GALAN
CROWLEY LN
MAUDLIN CIR

Note:
This exhibit shows pertinent items necessary to illustrate the information described in the text and is not intended to include all physical characteristics of the area.

Data Source:
Aerial Photography - dated 2018.

J:\2335\1901\DOC\EXHIBIT\GIS\Exhibit 3.5 - Bayview Acres - Land Use.mxd

LJA Engineering, Inc.
2929 Briarpark Drive, Suite 600
Houston, Texas 77042
Phone: 713-953-5200
Fax: 713-953-5026
TBPE F-1386 | TBPLS 10110501

CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 3.5
BAYVIEW ACRES
LAND USE

Feet
0 300 600
1 inch = 300 feet

Parcels (GCAD)

Drainage Area Boundary

Inlet/Manhole

Inlet/Manhole

Inlet

Manhole

KO_SS

Pipe Size

24"

24" LEAD

24" RCP

30" RCP

48"

48" RCP

N

DA-1

DA-2

DA-3

DA-4

DA-5

DA-6

FM 518

OAK BRIAR DR

OAK HILL DR

KEMAH OAKS DR

BAY OAK DR

OAK VALLEY DR

OAK RIDGE DR

OAK MEADOW DR

OAK BERRY DR

OAK GLEN DR

PARK OAK DR

ANDERS LN

Note:
This exhibit shows pertinent items necessary to illustrate the information described in the text and is not intended to include all physical characteristics of the area.

Data Source:
Aerial Photography - dated 2018.

J:\2335\1901\DOC\EXHIBITS\GIS\Exhibit 4.1 - Kemah Oaks Drainage Area Map.mxd

LJA Engineering, Inc.
2929 Briarpark Drive, Suite 600
Houston, Texas 77042
Phone: 713-953-5200
Fax: 713-953-5026
TBPE F-1386 | TBPLS 10110501

CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 4.1
KEMAH OAKS
DRAINAGE AREA MAP

Feet

0 250 500

1 inch = 250 feet

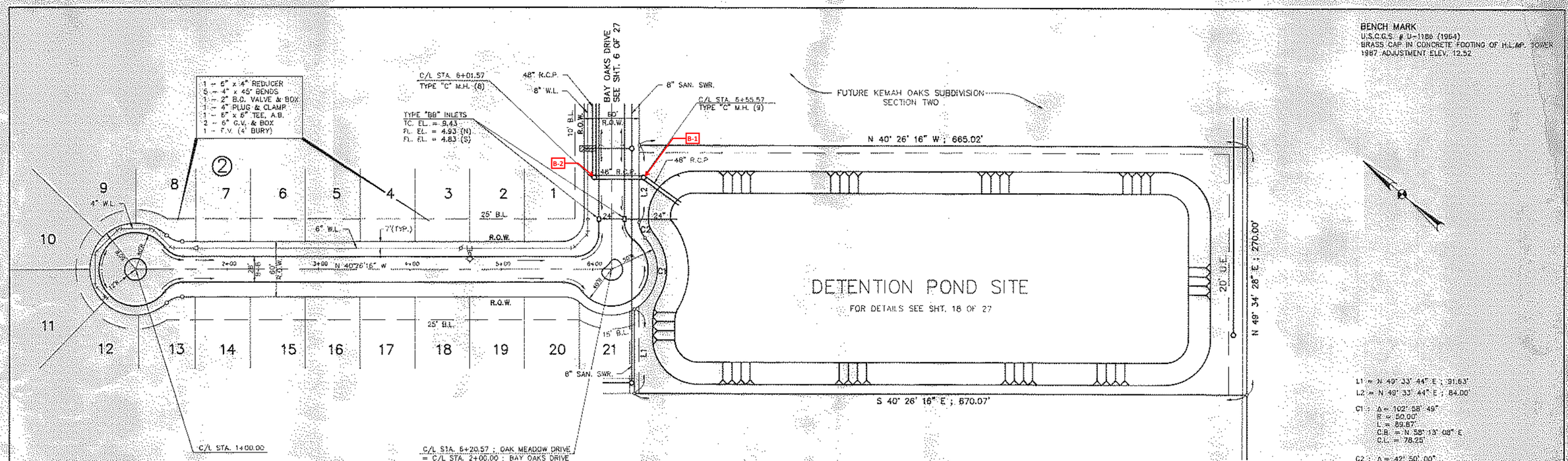


EXHIBIT 4.2
KEMAH OAKS HGL PROFILES
(SHEET 1 OF 9)

ALL MARK-UPS IN BLUE, RED OR GREEN HAVE BEEN DONE BY LJA ENGINEERING, INC FOR PURPOSE OF AN EXHIBIT.

THIS EXHIBIT IS NOT TO SCALE

CENTURY ENGINEERING, INC.
9950 WESTPARK, SUITE 200, HOUSTON, TEXAS 77063 (713) 780-9871

CITY OF KEMAH
KEMAH OAKS SUBDIVISION, SECTION ONE
GALVESTON COUNTY, TEXAS
PLAN & PROFILE
OAK MEADOW DRIVE
STA. 1+00.00 TO STA. END

File Name: ED1.DWG	Scale: HORIZ. 1"=50' VERT. 1"=5'	Date: FEB. 1992
Designed By:	Checked By:	Job No. 91015-00.0
Drawn By:	Approved By:	Sheet 5 of 27

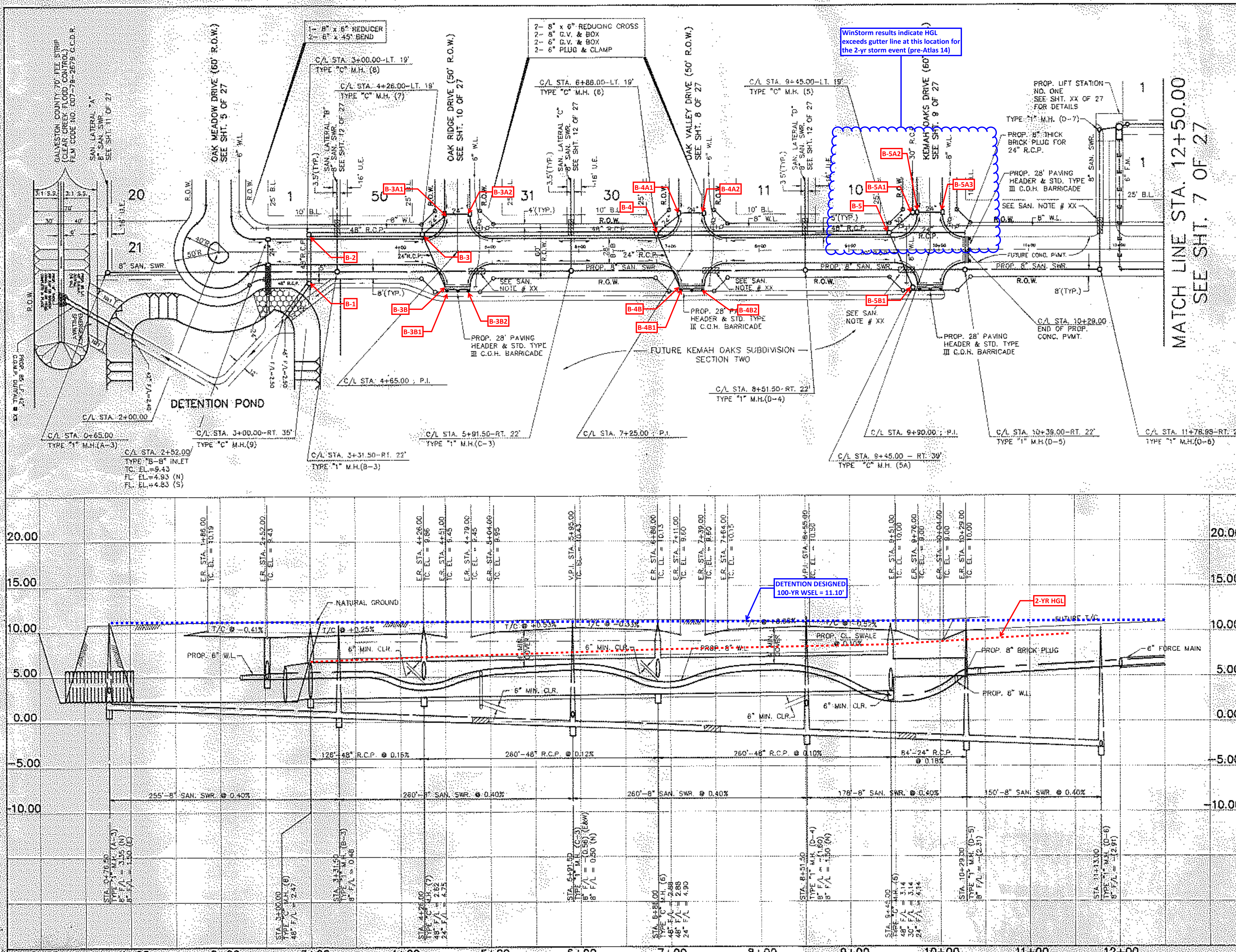


EXHIBIT 4.2
KEMAH OAKS HGL PROFILES
(SHEET 2 OF 9)

ALL MARK-UPS IN BLUE, RED OR GREEN HAVE BEEN DONE BY LJA ENGINEERING, INC FOR PURPOSE OF AN EXHIBIT.

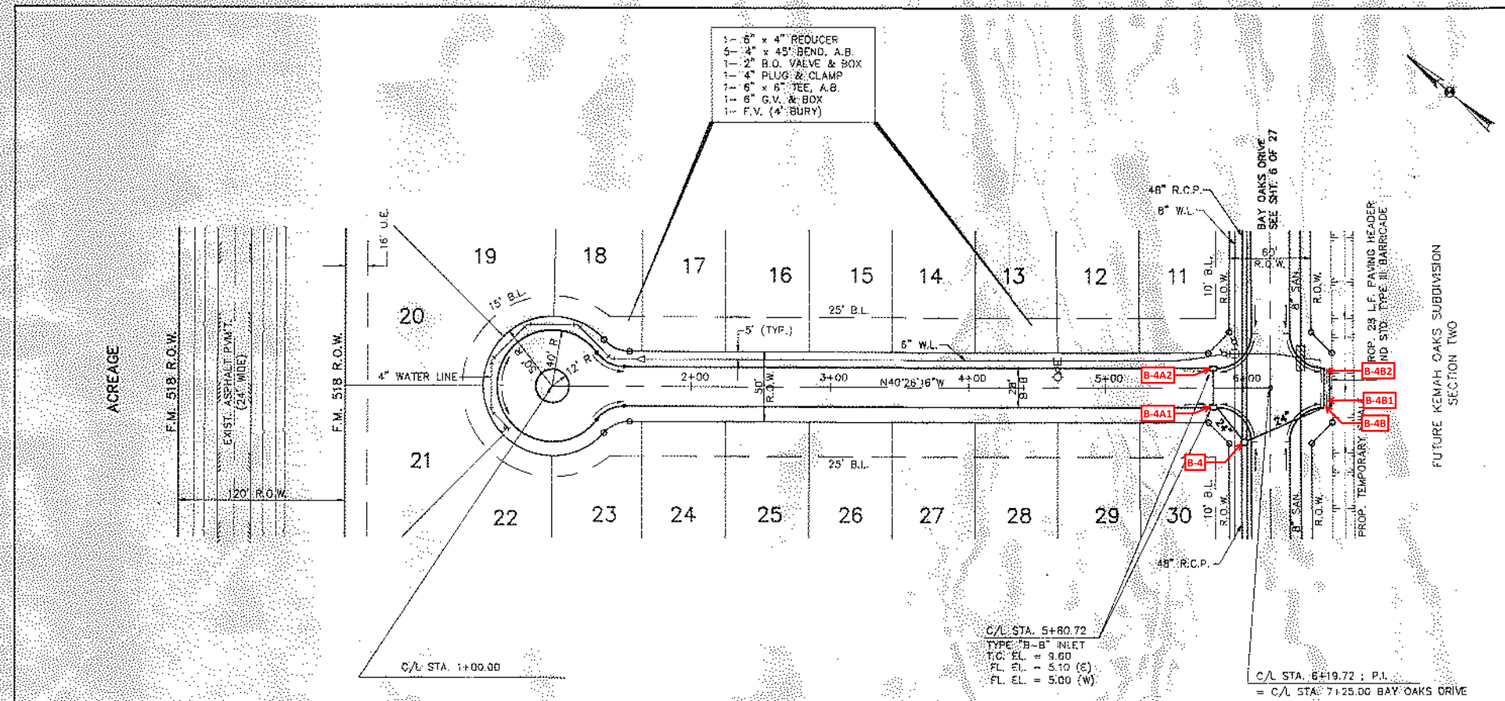
THIS EXHIBIT IS NOT TO SCALE

CENTURY ENGINEERING, INC.

CITY OF KEMAH
KEMAH OAKS SUBDIVISION, SECTION ONE
GALVESTON COUNTY, TEXAS
PLAN & PROFILE
BAY OAKS DRIVE
STA. 2+00.00 TO STA. 12+50.00

File Name: ED2.DWG | Date: FEB. 1992 | Sheet 6 of 27

BENCH MARK
U.S.C.G.S. # U-1186 (1964)
BRASS CAP IN CONCRETE FOOTING OF H.L.&P. TOWER
1967 ADJUSTMENT ELEV. 12.52



OAK VALLEY DRIVE

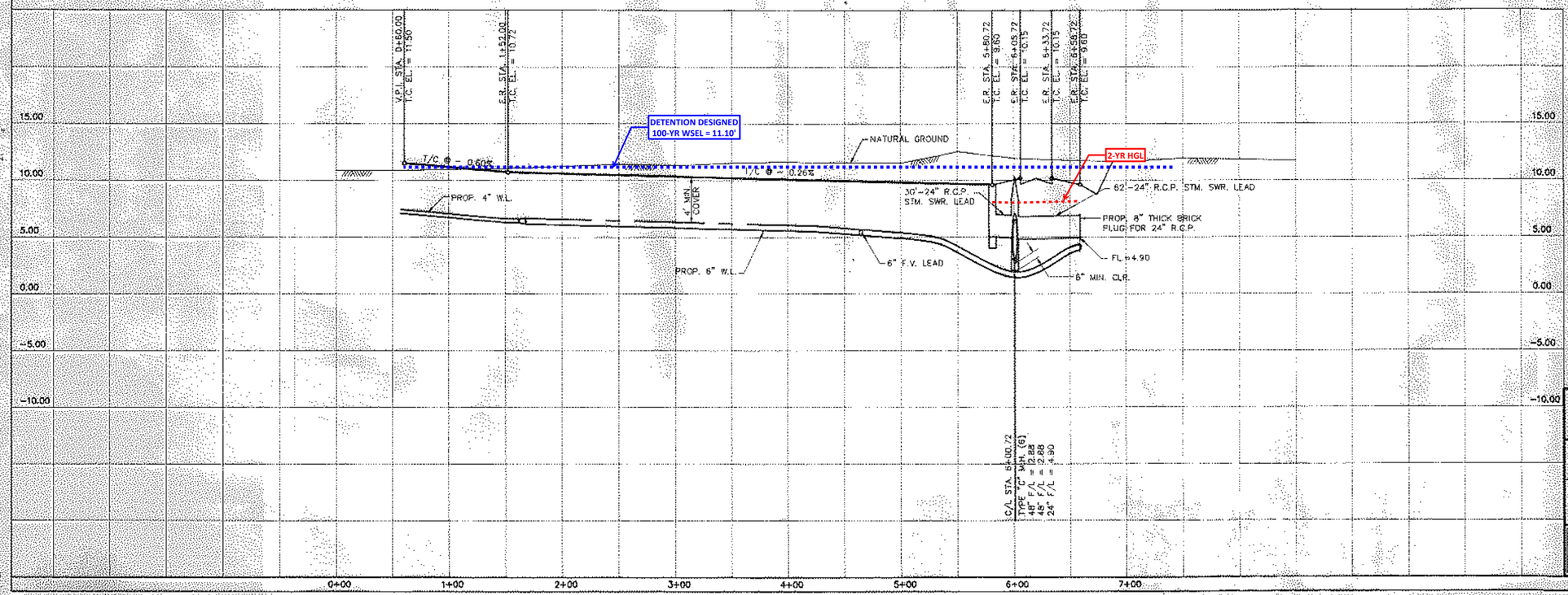


EXHIBIT 4.2
KEMAH OAKS HGL PROFILES
(SHEET 3 OF 9)

ALL MARK-UPS IN BLUE, RED OR GREEN HAVE BEEN DONE BY LJA ENGINEERING, INC FOR PURPOSE OF AN EXHIBIT.

THIS EXHIBIT IS NOT TO SCALE

CENTURY ENGINEERING, INC.
9950 WESTPARK, SUITE 200, HOUSTON, TEXAS 77063 (713) 780-9871

CITY OF KEMAH
KEMAH OAKS SUBDIVISION, SECTION ONE
GALVESTON COUNTY, TEXAS
PLAN & PROFILE

OAK VALLEY DRIVE
STA. 1+00.00 TO STA. 6+19.72

File Name: ED5.DWG	Scale: HORIZ. 1"=50' VERT. 1"=5'	Date: FEB., 1992
Designed By:	Checked By:	Job No. 91016-00.0
Drawn By:	Approved By:	Sheet 5 of 27

WinStorm results indicate HGL exceeds gutter line at this location during 2-yr storm event (pre-Atlas 14), in addition the ponded widths are exceeded in this area.

Ponded Allowable Width = 13.5-feet

At the time of creating WinStorm model, we did not have the KO - Section 2 record drawings, therefore, made reasonable assumptions based on design of KO - Section 1 and Section 3

WinStorm results indicate HGL exceeds gutter line at this location during 2-yr storm event (pre-Atlas 14)

WinStorm results indicate HGL exceeds gutter line at this location for the 2-yr storm event (pre-Atlas 14)

BENCH MARK
U.S.C.G.S. # U-1186 (1964)
BRASS CAP IN CONCRETE FOOTING OF H.L.&P. TOWER
1987 ADJUSTMENT ELEV. 12.52

EDGE OF CONC. PVM'T. CURVE DATA

(C1) Δ = 05°41'04"
R = 490.00'
L = 48.61'
C.L. = 48.59'
C.B. = S37°34'27"E.

(C2) Δ = 05°42'21"
R = 490.00'
L = 48.80'
C.L. = 48.78'
C.B. = S37°35'06"E.

(L1) S34°43'55"E. ; 48.24'

(L2) S34°43'55"E. ; 86.04'

(L3) S46°08'38"E. ; 212.67'

C/L STA. 1+00.00
@ F.M. 518 R.O.W.

P.C. C/L STA. 1+00.18=LT. 40.00'
BEGIN 7" CONC. PVM'T.

P.T. C/L STA. 1+48.72=LT. 37.57'

C/L STA. 1+96.72
TYPE "B-B" INLET
TC. EL. = 10.21
FL. EL. = 5.71 (W)
FL. EL. = 5.61 (E)

C/L STA. 2+60.21 – LT. 49.86'
TYPE "C" M.H. (1)

P.R. C/L STA. 2+74.72=LT. 24.48'

P.C. C/L STA. 3+80.34=LT. 16.43'

C/L STA. 3+73.17
TYPE "B-B" INLET

P.T. C/L STA. 4+09.05=LT. 14.00'

C/L STA. 7+29.21
TYPE "B-B" INLET
TC. EL. 9.00
FL. EL. 4.50 (E)
FL. EL. 4.40 (W)

1- 8" PLUG & CLAMP
2- 8" x 8" TEE, A.B.
3- 8" G.V. & BOX

BAY OAKS DRIVE
SEE SHT. 6 OF 27

PROP. 28 L.F. PAVING HEADER & STD. TYPE III BARRICADE

C/L STA. 7+68.21 ; P.I.

PROP. 28' PAVING HEADER & STD. TYPE III BARRICADE

PROP. 28 L.F. PAVING HEADER & STD. TYPE III BARRICADE

PROP. 28 L.F. PAVING HEADER & STD. TYPE III BARRICADE

B-5AE
B-5AD
B-5AD2
B-5AD3
B-5AD1
B-5AB2
B-5AB1
B-5AF
B-5AC
B-5AB
B-5A3
B-5A2
B-5A1
B-5

F.M. 518 R.O.W.

EDGE OF EXIST. ASPHALT RD.

PROP. 110'-24" R.C.P. CULVERT @ 0.20%

120' R.O.W.

PROP. 2" H.M.A.C. WITH 10" CRUSHED ROCK BASE. (SHOWN AS CROSS-HATCHED AREA) SEE DETAILS ON THIS SHEET.

5' (TYP.)

R.O.W.

8" W.L.

8" SAN.

24" R.C.P.

30" R.C.P. STM. SWR.

6' (TYP.)

25'B.L.

48" R.C.P.

R.O.W.

PROP. TEMPORARY SWALE

C/L STA. 2+18.21

C/L STA. 3+73.17 – RT. 22'
TYPE "C" M.H. (3)

C/L STA. 2+99.66 – RT. 27.52'
TYPE "C" M.H. (2)

C/L STA. 7+29.21 – RT. 22'
TYPE "C" M.H. (4)

C/L STA. 2+38.21 ; P.I.

P.T. C/L STA. 1+48.72=RT. 37.57'

P.T. C/L STA. 4+09.05=RT. 14.00'
END 7" CONC. PVM'T.
BEGIN 6" CONC. PVM'T.

PROP. 80' WIDE ASPHALT PAVEMENT

PROP. 10" THICK CRUSHED LIMESTONE BASE

KEMAH OAKS DRIVE
ASPHALT PAVED ENTRANCE TYPICAL SECTION
N.T.S.

STA. 1+00.00
END CONC. PVM'T.
BEGIN ASPHALT
T/C EL. = 10.89

ER. STA. 1+96.72
TC. EL. = 10.21

ER. STA. 2+23.20
TC. EL. = 10.51

V.P.I. STA. 2+38.21
TC. EL. = 10.31

ER. STA. 2+52.20
TC. EL. = 10.61

ER. STA. 2+74.72
TC. EL. = 10.06

V.P.I. STA. 3+73.17
TC. EL. = 9.43

ER. STA. 4+04.21
TC. EL. = 9.65

ER. STA. 4+89.21
TC. EL. = 10.02

V.P.I. STA. 5+03.21
TC. EL. = 9.75

ER. STA. 5+17.21
TC. EL. = 10.02

ER. STA. 5+49.21
TC. EL. = 9.62

ER. STA. 7+29.21
TC. EL. = 9.00

ER. STA. 7+54.21
TC. EL. = 10.00

2-YR HGL

DETENTION DESIGNED
100-YR WSEL = 11.10'

T/C @ -0.10%

T/C @ - 0.64%

T/C @ 0.24%

T/C @ -0.33%

10' TEMPORARY SWALE

4' MIN. COVER

8" WATER LINE

6" MIN. CLR.

8" WATER LINE

85'-24" R.C.P. STM. SWR. @ 0.18%

75'-24" R.C.P. STM. SWR. @ 0.18%

350'-30" R.C.P. STM. SWR. @ 0.14%

35'-30" R.C.P. STM. SWR. @ 0.17%

C/L STA. 2+60.21
TYPE "C" M.H. (1)
24" F/L = 4.48

C/L STA. 2+99.66
TYPE "C" M.H. (2)
24" F/L = 4.33

C/L STA. 3+73.21
TYPE "C" M.H. (3)
24" F/L = 4.19 (N)
24" F/L = 4.73 (E)
30" F/L = 3.69

C/L STA. 7+29.21
TYPE "C" M.H. (4)
24" F/L = 3.86 (N)
24" F/L = 4.30 (E)
30" F/L = 3.20

C/L STA. 7+49.21
TYPE "C" M.H. (5)
42" F/L = 3.14
30" F/L = 3.14
24" F/L = 4.14

15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00

0+00 1+00 2+00 3+00 4+00 5+00 6+00 7+00 8+00 9+00

EXHIBIT 4.2
KEMAH OAKS HGL PROFILES
(SHEET 4 OF 9)

ALL MARK-UPS IN BLUE, RED OR GREEN HAVE BEEN DONE BY LJA ENGINEERING, INC FOR PURPOSE OF AN EXHIBIT.

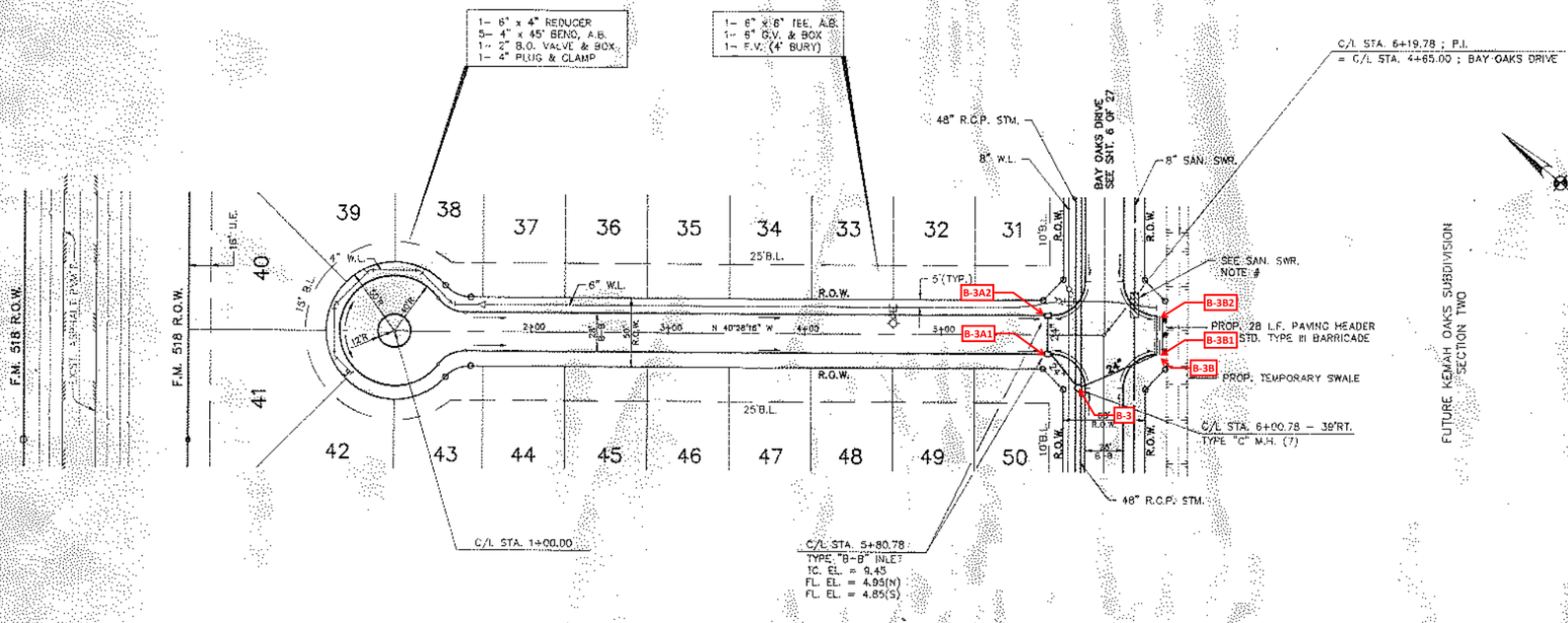
THIS EXHIBIT IS NOT TO SCALE

CENTURY ENGINEERING, INC.
9990 WESTPARK, SUITE 200, HOUSTON, TEXAS 77063 (713) 780-8871

CITY OF KEMAH
KEMAH OAKS SUBDIVISION, SECTION ONE
GALVESTON COUNTY, TEXAS
PLAN & PROFILE
KEMAH OAKS DRIVE
STA. 1+00.00 TO STA. 7+68.21

File Name: ED6.DWG	Scale: HORIZ. 1"=50' VERT. 1"=5'	Date: FEB. 1992
Designed By:	Checked By:	Job No. 9108-00.0
Drawn By:	Approved By:	Sheet 9 of 27

BENCH MARK
U.S.C.G.S. # U-1196 (1964)
BRASS CAP IN CONCRETE FOOTING OF HIGH 67' TOWER
1987 ADJUSTMENT ELEV.: 12.52



OAK RIDGE DRIVE

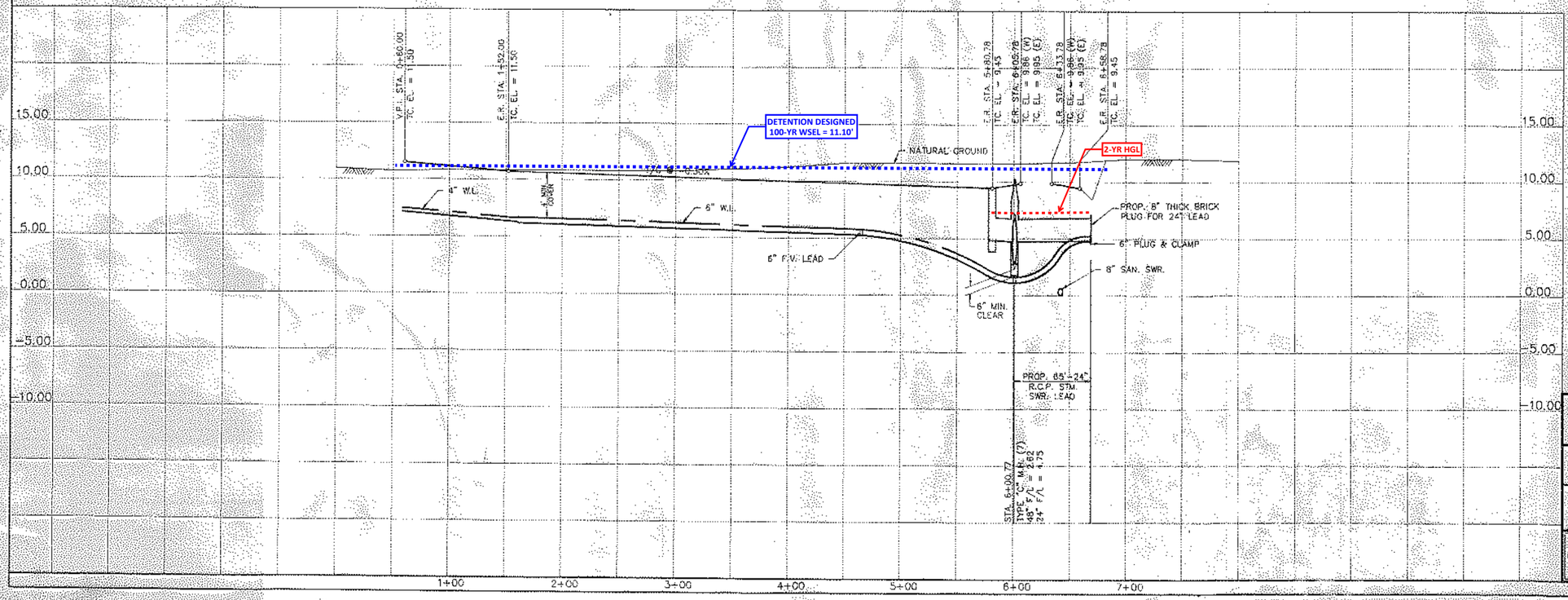


EXHIBIT 4.2
KEMAH OAKS HGL PROFILES
(SHEET 5 OF 9)

ALL MARK-UPS IN BLUE, RED OR GREEN HAVE BEEN DONE BY LJA ENGINEERING, INC FOR PURPOSE OF AN EXHIBIT.

THIS EXHIBIT IS NOT TO SCALE

CENTURY ENGINEERING, INC.
9990 WESTPARK, SUITE 200, HOUSTON, TEXAS 77063 (713) 780-8671

CITY OF KEMAH
KEMAH OAKS SUBDIVISION, SECTION ONE
GALVESTON COUNTY, TEXAS
PLAN & PROFILE
OAK RIDGE DRIVE
STA. 1+00.00 TO STA. X+XX

File Name: ED4.DWG	Scale: HORIZ. 1"=50' VERT. 1"=5'	Date: FEB. 1992
Designed By:	Checked By:	Job No. 91016-00.0
Drawn By:	Approved By:	Sheet 10 of 27

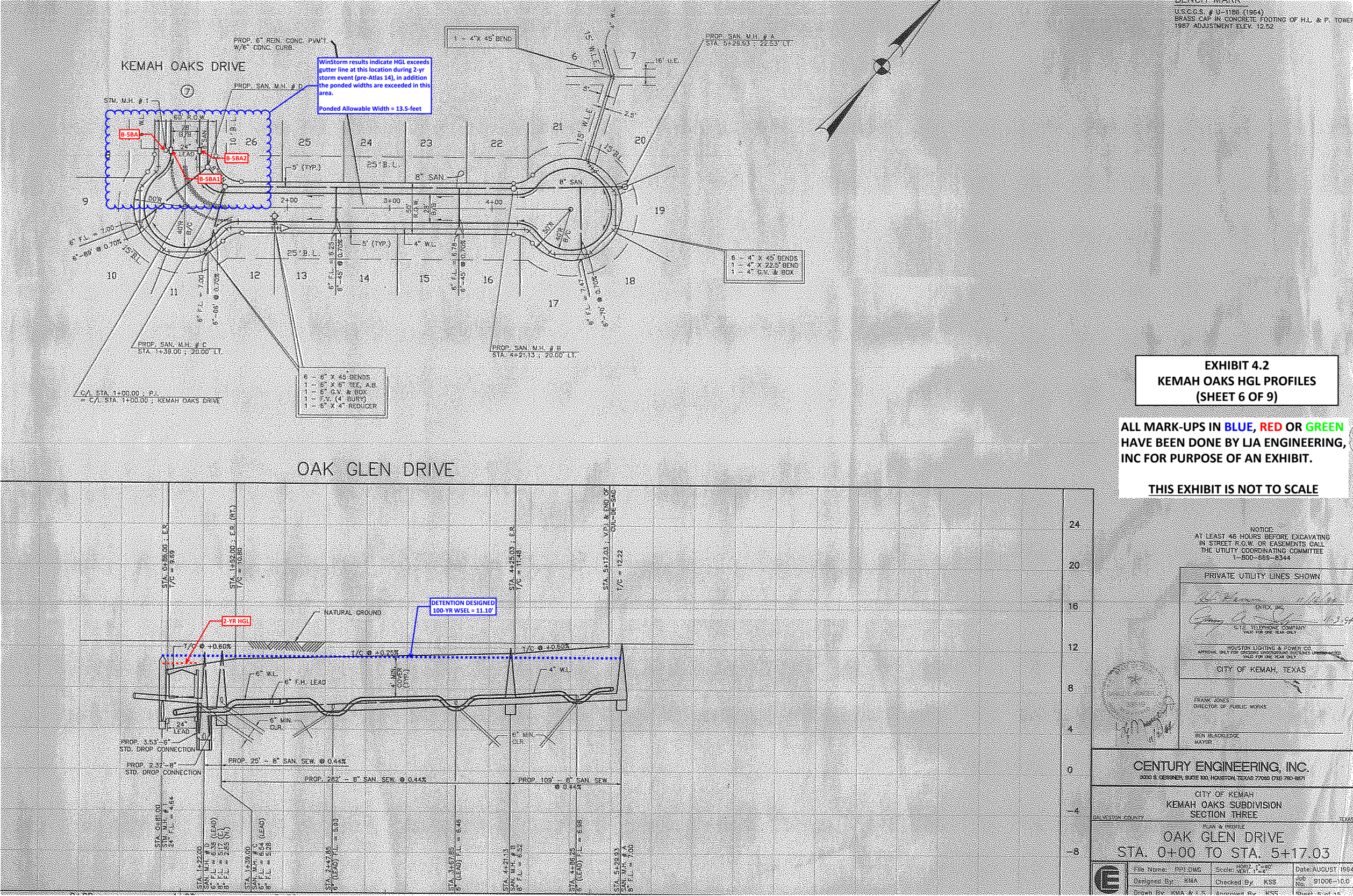


EXHIBIT 4.2
KEMAH OAKS HGL PROFILES
(SHEET 6 OF 9)

ALL MARK-UPS IN BLUE, RED OR GREEN HAVE BEEN DONE BY LJA ENGINEERING, INC FOR PURPOSE OF AN EXHIBIT.

THIS EXHIBIT IS NOT TO SCALE

NOTICE:
AT LEAST 48 HOURS BEFORE EXCAVATING IN STREET R.O.W. OR EASEMENTS CALL THE UTILITY COORDINATING COMMITTEE 1-800-669-8344

PRIVATE UTILITY LINES SHOWN

ENTEX, INC.

S.T.E. TELEPHONE COMPANY
VALID FOR ONE YEAR ONLY

HOUSTON LIGHTING & POWER CO.
APPROVAL ONLY FOR PROPOSED OVERHEAD & PROPOSED UNDERGROUND
VALID FOR ONE YEAR ONLY

CITY OF KEMAH, TEXAS

FRANK JONES
DIRECTOR OF PUBLIC WORKS

BOY BRADSHAW
MAYOR

CENTURY ENGINEERING, INC.
9330 S. DAIRY ASHFORD, SUITE 100, HOUSTON, TEXAS 77063 (713) 780-9871

CITY OF KEMAH
KEMAH OAKS SUBDIVISION
SECTION THREE
GALVESTON COUNTY, TEXAS

PLAN & PROFILE
OAK GLEN DRIVE
STA. 0+00 TO STA. 5+17.03

File Name: PP1.DWG	Scale: HORIZ. 1"=40' VERT. 1"=4'		Date: AUGUST 1994
Designed By: KMA	Checked By: KSS		Job No. 91006-10.0
Drawn By: KMA & J.S.	Approved By: KSS		Sheet 6 of 15

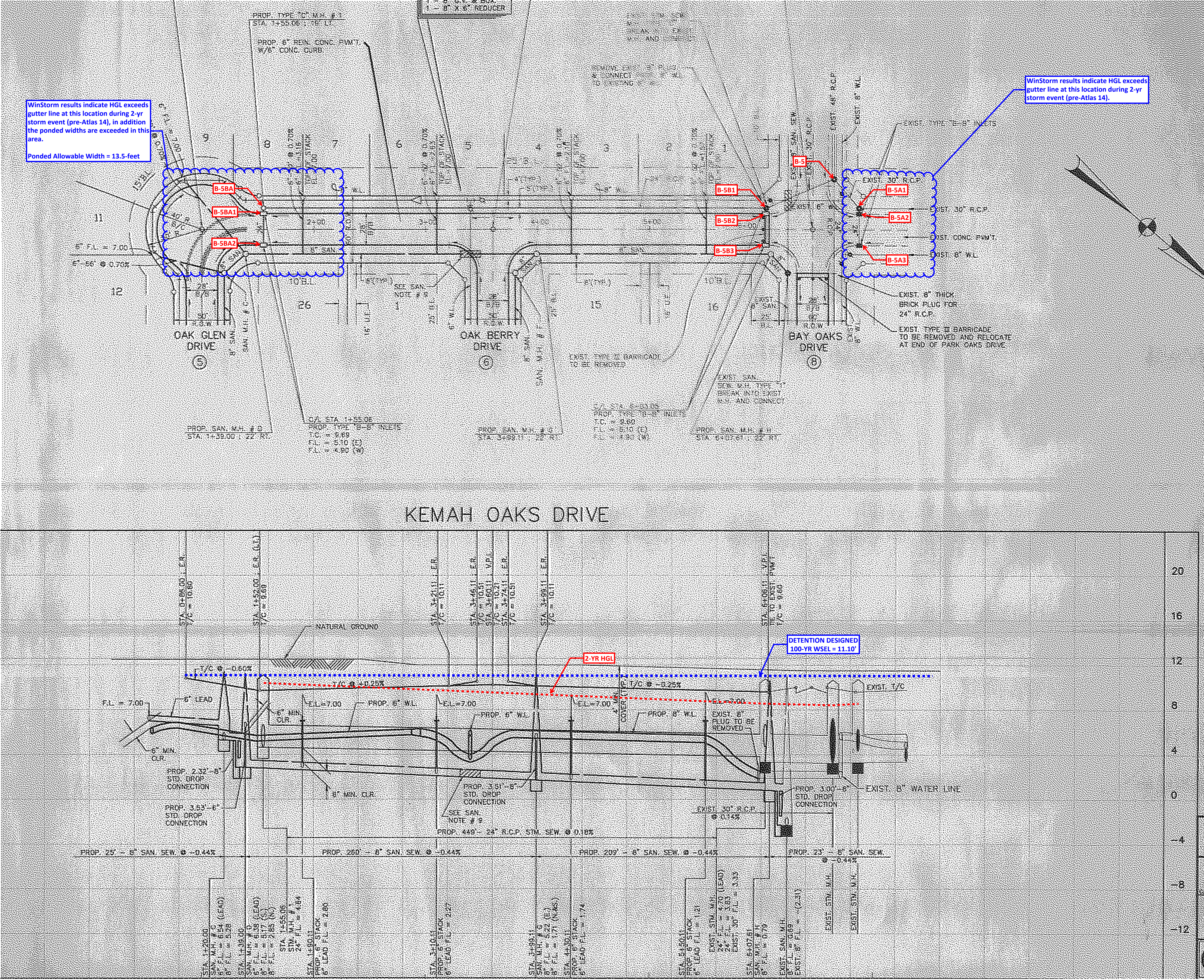


EXHIBIT 4.2
KEMAH OAKS HGL PROFILES
(SHEET 7 OF 9)

ALL MARK-UPS IN BLUE, RED OR GREEN HAVE BEEN DONE BY LJA ENGINEERING, INC FOR PURPOSE OF AN EXHIBIT.

THIS EXHIBIT IS NOT TO SCALE

NOTICE:
AT LEAST 48 HOURS BEFORE EXCAVATING IN STREET R.O.W. OR EASEMENTS CALL THE UTILITY COORDINATING COMMITTEE 1-800-669-8344

PRIVATE UTILITY LINES SHOWN
ENTEX, INC.
G.T.E. TELEPHONE COMPANY
VALID FOR ONE YEAR ONLY
HOUSTON LIGHTING & POWER CO.
APPROVAL ONLY FOR CROSSING UNDERGROUND FACILITIES UNLESS NOTED VALID FOR ONE YEAR ONLY

CITY OF KEMAH, TEXAS
FRANK JONES
DIRECTOR OF PUBLIC WORKS
BEN BLACKLEDGE
MAYOR

CENTURY ENGINEERING, INC.
3030 S. GESSNER, SUITE 100, HOUSTON, TEXAS 77063 (713) 780-8871

CITY OF KEMAH
KEMAH OAKS SUBDIVISION
SECTION THREE
GALVESTON COUNTY — TEXAS
PLAN & PROFILE
KEMAH OAKS DRIVE
STA. 0+00 TO STA. 6+06.11

File Name: PP3.DWG	Scale: HORIZ. 1"=40' VERT. 1"=4'	Date: AUGUST 1994
Designed By: KMA	Checked By: KSS	Job No. 91006-10.0
Drawn By: KMA & L.S.	Approved By: KSS	Sheet 7 of 15

U.S.C.G.S. # D-1186 (1984)
BRASS CAP IN CONCRETE FOOTING OF H.L. & P. TOWER
1987 ADJUSTMENT ELEV. 12.52

EXIST. TYPE "B" INLETS

PROP. 6" REIN. CONC. PVM'T. W/6" CONC. CURB

PROP. TYPE "C" M.H. # 4
STA. 2+25.05 ; 19' LT.

REMOVE EXIST. 8" BRICK PLUG & CONNECT PROP. 24" R.C.P. TO EXIST. 24" R.C.P.

REMOVE EXIST. BARRICADE AND TIE INTO EXIST. REINFORCED CONC. PVM'T.

EXIST. STM. M.H.

EXIST. 8" W.L.

EXIST. 48" R.C.P.

EXIST. CONC. PVM'T.

EXIST. 30" R.C.P.

EXIST. 8" SAN.

PROP. TYPE "B" INLETS

8" W.L.

EXIST. 24" R.C.P.

EXIST. 8" SAN.

EXIST. 6" F.M.

EXIST. SAN. M.H.

PROP. SAN. M.H. # H

8" SAN.

10' B.L.

25' B.L.

28' B/B

60' R.O.W.

KEMAH OAKS DRIVE

(7)

B-5A1 B-5A2 B-5A3 B-5 B-5B1 B-5B2 B-5B B-6 B-6A1 B-6A2 B-7 B7A1

WinStorm results indicate HGL exceeds gutter line at this location for the 2-yr storm event (pre-Atlas 14)

C/L STA. 1+55.00
PROP. TYPE "B-B" INLET
T.C. = 9.71
F.L. = 5.21 (E)
F.L. = 5.01 (W)

EXIST. SAN. SEW. M.H. TYPE "I" BREAK INTO EXIST. M.H. AND CONNC.

PROP. SAN. M.H. # M
STA. 2+15.00 ; 31' RT.

C/L STA. 2+25.05
PROP. TYPE "B-B" INLET
T.C. = 9.66
F.L. = 5.38

C/L STA. 6+62.03 ; P.I.
= C/L STA. 1+00.00 ; PARK OAKS DRIVE

PROP. TYPE "C" M.H. # 2
STA. 6+40.55 ; 28.35' RT.

WinStorm results indicate HGL exceeds gutter line at this location for the 2-yr storm event (pre-Atlas 14)

PROP. SAN. M.H. # I
STA. 6+13.25 ; 31' RT.

PROP. SAN. M.H. # K
STA. 6+31.03 ; 48.68' RT.

PROP. TYPE "B" INLETS

24" R.C.P.

8" SAN.

10' B.L.

15' B.L.

10' S.S.E.

9'(TYP.)

25' B.L.

24' B/B

25' R.O.W.

PARK OAKS DRIVE

(9)

B-8 B-9 B-10 B-11

S = 4.68
S = 0.70%

BAY OAKS DRIVE

REMOVE EXIST. 8" THICK BRICK PLUG FOR EXIST. 24" R.C.P. AND CONNECT PROP. 24" R.C.P.

STA. 0+39.00 ; V.P.I.
T/C = 10.01

STA. 1+55.00 ; V.P.I.
T/C = 9.71

STA. 1+77.99 ; E.R.
T/C = 9.77

STA. 2+21.99 ; E.R.
T/C = 9.68

DETENTION DESIGNED
100-YR WSEL = 11.10'

2-YR HGL

NATURAL GROUND

STA. 6+07.55 ; V.P.I. & E.R.
T/C = 10.64

STA. 6+75.03 ; V.P.I. & E.R.
T/C = 10.84

STA. 6+91.73 ; V.P.I.
T/C = 11.42

EXIST. T/C

T/C @ -0.25%

T/C @ +0.25%

T/C @ +0.60%

EXIST. 8" W.L.

EXIST. 6" FORCE MAIN

6" SAN. LEAD

F.L.=4.68

EXIST. 24" F.L.=4.39

6" MIN. CLR.

24" (LEAD)

EXIST. 6" FORCE MAIN SHOULD BE REALIGNED TO KEEP 6" MIN. CLR. FROM 24" R.C.P.

BREAK INTO EXIST. M.H. AND CONNECT PROP. 8" SAN. TO THE M.H.

PROP. 4.93'-8" STD. DROP CONNECTION

EXIST. 48" R.C.P. @ 0.10%

EXIST. 84"-24" R.C.P. @ 0.18%

PROP. 116'-24" R.C.P. @ 0.16%

PROP. 70'-24" R.C.P. @ 0.18%

PROP. 383'-24" R.C.P. @ 0.18%

PROP. 59'-24" R.C.P. @ 0.18%

EXIST. 6" SAN. SEW. @ 0.40%

EXIST. 150'-8" SAN. SEW. @ 0.40%

PROP. 26'-8" SAN. SEW. @ 0.44%

PROP. 398'-8" SAN. SEW. @ 0.44%

PROP. 25'-8" SAN. SEW. @ 0.44%

EXIST. STM. M.H. 24" F.L. = 3.24 EXIST. 24" F.L. = 3.24 EXIST. 48" F.L. = 3.24

EXIST. TYPE "I" SAN. M.H. PROP. 8" F.L. = 0.69 EXIST. 8" F.L. = -(2.31)

STA. 1+55.00 STM. M.H. # 5 24" F.L. = 4.60

EXIST. TYPE "I" SAN. M.H. PROP. 8" F.L. = -0.07 EXIST. 8" F.L. = -(2.91)

STA. 2+15.00 SAN. M.H. # N 8" F.L. = 2.14

STA. 2+25.05 STM. M.H. # 4 24" F.L. = 4.76

STA. 6+07.55 STM. M.H. # 3 24" F.L. = 5.42

STA. 6+13.35 SAN. M.H. # G 8" F.L. = 5.69

STA. 6+31.03 SAN. M.H. # K 8" F.L. = 4.50 8" F.L. = 4.00 8" F.L. = 4.00

STA. 6+40.55 STM. M.H. # 2 24" F.L. = 4.53

20 16 12 8 4 0 -4 -8 -12

EXHIBIT 4.2
KEMAH OAKS HGL PROFILES
(SHEET 8 OF 9)

ALL MARK-UPS IN BLUE, RED OR GREEN HAVE BEEN DONE BY LJA ENGINEERING, INC FOR PURPOSE OF AN EXHIBIT.

THIS EXHIBIT IS NOT TO SCALE

NOTICE:
AT LEAST 48 HOURS BEFORE EXCAVATING IN STREET R.O.W. OR EASEMENTS CALL THE UTILITY COORDINATING COMMITTEE 1-800-669-8344

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G.T.E. TELEPHONE COMPANY
VALID FOR ONE YEAR ONLY

HOUSTON LIGHTING & POWER CO.
APPROVAL ONLY FOR CROSSING UNDERGROUND FACILITIES UNLESS NOTED
VALID FOR ONE YEAR ONLY

CITY OF KEMAH, TEXAS

FRANK JONES
DIRECTOR OF PUBLIC WORKS

BEN BLACKLEDGE
MAYOR

CENTURY ENGINEERING, INC.
3000 S. GESSNER, SUITE 100, HOUSTON, TEXAS 77063 (713) 780-8671

CITY OF KEMAH
KEMAH OAKS SUBDIVISION
SECTION THREE
GALVESTON COUNTY, TEXAS

PLAN & PROFILE
BAY OAKS DRIVE
STA. 0+00 TO STA. 7+04.03

File Name: PP4.DWG	Scale: HORIZ. 1"=50' VERT. 1"=5'		Date: AUGUST 1994
Designed By: KMA	Checked By: KSS		Job No. 91C06-10.0
Drawn By: KMA & L.S.	Approved By: KSS		Sheet 8 of 15

U.S.C.G.S. # U-1186 (1964)
BRASS CAP IN CONCRETE FOOTING OF H.L. & P. TOWER
1967 ADJUSTMENT ELEV. 12.52

PROP. TYPE "C" M.H. # 2
STA. 129.35 ; 21.46' RT.

PROP. 6" REIN. CONC. PVMT. W/6" CONC. CURB

WinStorm results indicate HGL exceeds gutter line at this location for the 2-yr storm event (pre-Atlas 14)

EXIST. 8" FORCE MAIN

20' U.E.

60'

EXIST. 6" FORCE MAIN

RELOCATE DEAD END BARRICADE

PROP. 12" W.L. (BY OTHERS)

EXIST. 8" SAN. SEW.

20' U.E.

EXIST. 8" FORCE MAIN

EXIST. 8" W.L.

EXIST. 6" F.M.

B-11

B-10

B-8

B-9

50' R.

41' B.C.

24" W.C.P.

28'

B/B

60'

R.O.W.

15' B.L.

25' B.L.

6"-6" D.I.P. SAN. LEAD @ 0.70%

10' S.S.E.

9' (TYP.)

PROP. 6" SAN.

8" SAN.

EXIST. 8" W.L.

24" R.C.P.

BAY OAKS DRIVE

(6)

PROP. TYPE "C" M.H. # 3

C/L STA. 1+57.54
PROP. TYPE "S-6" INLETS
T.C. = 10.64
F.L. = 6.24 (N)
F.L. = 6.04 (S)

PROP. SAN. M.H. # L
STA. 1+31.00 ; 48.68' RT.

PROP. SAN. M.H. # K
STA. 1+48.68 ; 31' RT.

PROP. SAN. M.H. # J
STA. 4+30.13 ; 31' RT.

PROP. SAN. M.H. # I
STA. 7+22.63 ; 31' RT.

U.S.C.G.S. # U-1186 (1964)
BRASS CAP IN CONCRETE FOOTING OF H.L. & P. TOWER
1967 ADJUSTMENT ELEV. 12.52

PARK OAKS DRIVE

STA. 0+70.30 ; V.P.I.
T/C = 11.42
STA. 0+86.00 ; E.R.& V.P.I.
T/C = 10.84

STA. 1+54.48 ; E.R. & V.P.I.
T/C = 10.84

STA. 7+95.30 ; V.P.I.
T/C = 12.44

DETENTION DESIGNED 100-YR WSEL = 11.10'

2-YR HGL

NATURAL GROUND

T/C @ -0.60%

T/C @ +0.25%

6" MIN. CLR.

EXIST. 8" W.L.

EXIST. 6" FORCE MAIN

EXIST. 8" F.M.

3.39'

24" LEAD

PROP. 59' - 24" R.C.P. @ 0.18%

PROP. 25' - 8" SAN. SEW. @ 0.44%

PROP. 281' - 8" SAN. SEW. @ 0.44%

PROP. 293' - 8" SAN. SEW. @ 0.44%

EXIST. SAN. M.H. TYPE "1"

STA. 0+81.08
STM. M.H. # 3
24" F.L. = 5.42

STA. 1+29.35
STM. M.H. # 2
24" F.L. = 5.53

STA. 1+31.00
SAN. M.H. # L
8" F.L. = 5.68

STA. 1+48.68
SAN. M.H. # K
8" F.L. = 4.17 (LEAD)
8" F.L. = 4.10
8" F.L. = 4.00

STA. 2+60.53
8" (LEAD) F.L. = 5.12

STA. 3+70.33
8" (LEAD) F.L. = 5.64

STA. 4+30.13
SAN. M.H. # J
8" F.L. = 5.74

STA. 4+90.33
8" (LEAD) F.L. = 6.17

STA. 6+10.33
8" (LEAD) F.L. = 6.76

STA. 7+22.63
SAN. M.H. # I
8" F.L. = 7.20
8" F.L. = 7.03

EXIST. SAN. M.H. TYPE "1"

24
20
16
12
8
4
0
-4
-8

EXHIBIT 4.2
KEMAH OAKS HGL PROFILES
(SHEET 9 OF 9)

ALL MARK-UPS IN BLUE, RED OR GREEN HAVE BEEN DONE BY LJA ENGINEERING, INC FOR PURPOSE OF AN EXHIBIT.

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FRANK JONES
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BEN BLACKLEDGE
MAYOR

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3000 B. GESSNER, SUITE 100, HOUSTON, TEXAS 77080 (713) 780-8671

CITY OF KEMAH
KEMAH OAKS SUBDIVISION
SECTION THREE
GALVESTON COUNTY, TEXAS

PLAN & PROFILE
PARK OAKS DRIVE
STA. 0+00 TO STA. 7+95.30

File Name: PP5.DWG	Scale: HORIZ. 1"=40' VERT. 1"=4'		Date: AUGUST 1994
Designed By: KMA	Checked By: KSS	Job No.	91006-10.0
Drawn By: KMA & L.S.	Approved By: KSS		Sheet 9 of 15

Inlet
Manhole
Rivers
Parcels (GCAD)

Existing Storm Sewer

24" RCP
30" RCP
48" RCP

Proposed Storm Sewer

30"
36"
Proposed Detention Pond

N

FM 518
OAK BRIAR DR
OAK HILL DR
KEMAH OAKS DR
BAY OAK DR
OAK VALLEY DR
OAK RIDGE DR
OAK MEADOW DR
PARK OAK DR
OAK BERRY DR
OAK GLEN DR
Jarbo Ditch
ANDERS LN

Note:
This exhibit shows pertinent items necessary to illustrate the information described in the text and is not intended to include all physical characteristics of the area.

Data Source:
Aerial Photography - dated 2018.

J:\23351901\DOC\EXHIBITS\GIS\Exhibit 4.3 - Kemah Oaks Proposed Alternatives 1 & 2.mxd

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Fax: 713-953-5026
TBPE F-1386 | TBPLS 10110501

CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 4.3
KEMAH OAKS
PROPOSED ALTERNATIVES 1 & 2

Feet
0 250 500
1 inch = 250 feet

City of Kemah Limits

Rivers

Parcels (GCAD)

Drainage Area and Flows Conveyed To

Jarbo Ditch

SH 96

Tributary of Jarbo Bayou

Jarbo Bayou

Jarbo Ditch

DA-1

DA-2

DA-3

DA-4

DA-5

DA-6

DA-7

DA-8

DA-9

DA-10

DA-11

DA-12

DA-13

DA-14

DA-15

DA-16

DA-17

DA-18

DA-19

DA-20

DA-21

Note:
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J:\2335\1901\DOC\EXHIBITS\GIS\Exhibit 5.1 - South Kemah Existing Conditions.mxd

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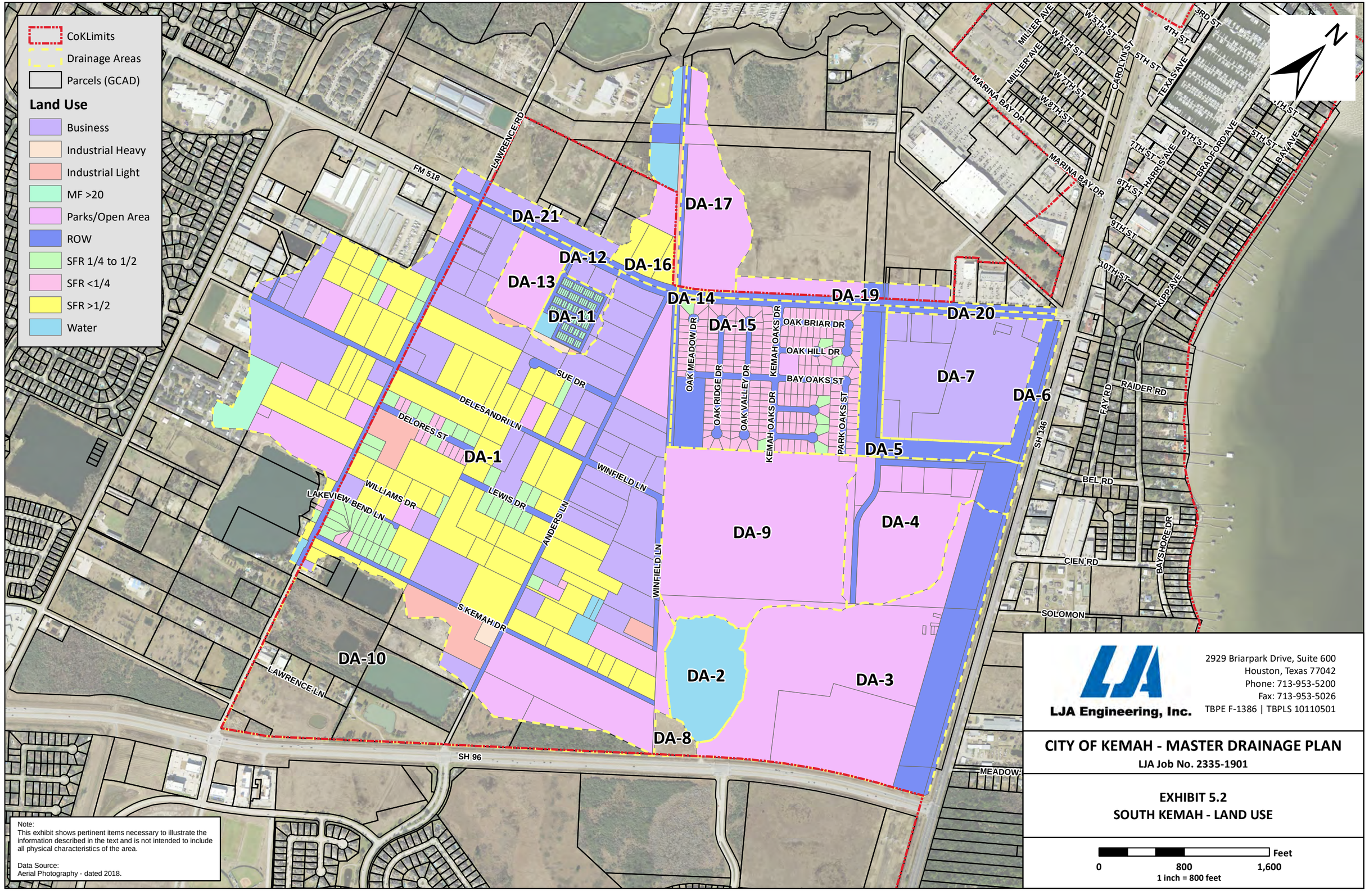
CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 5.1
SOUTH KEMAH
EXISTING CONDITIONS

Feet
0 810 1,620
1 inch = 800 feet



Note:
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Data Source:
Aerial Photography - dated 2018.

J:\2335\19011\DOC\EXHIBIT\GIS\Exhibit 5.2 - South Kemah Land Use.mxd

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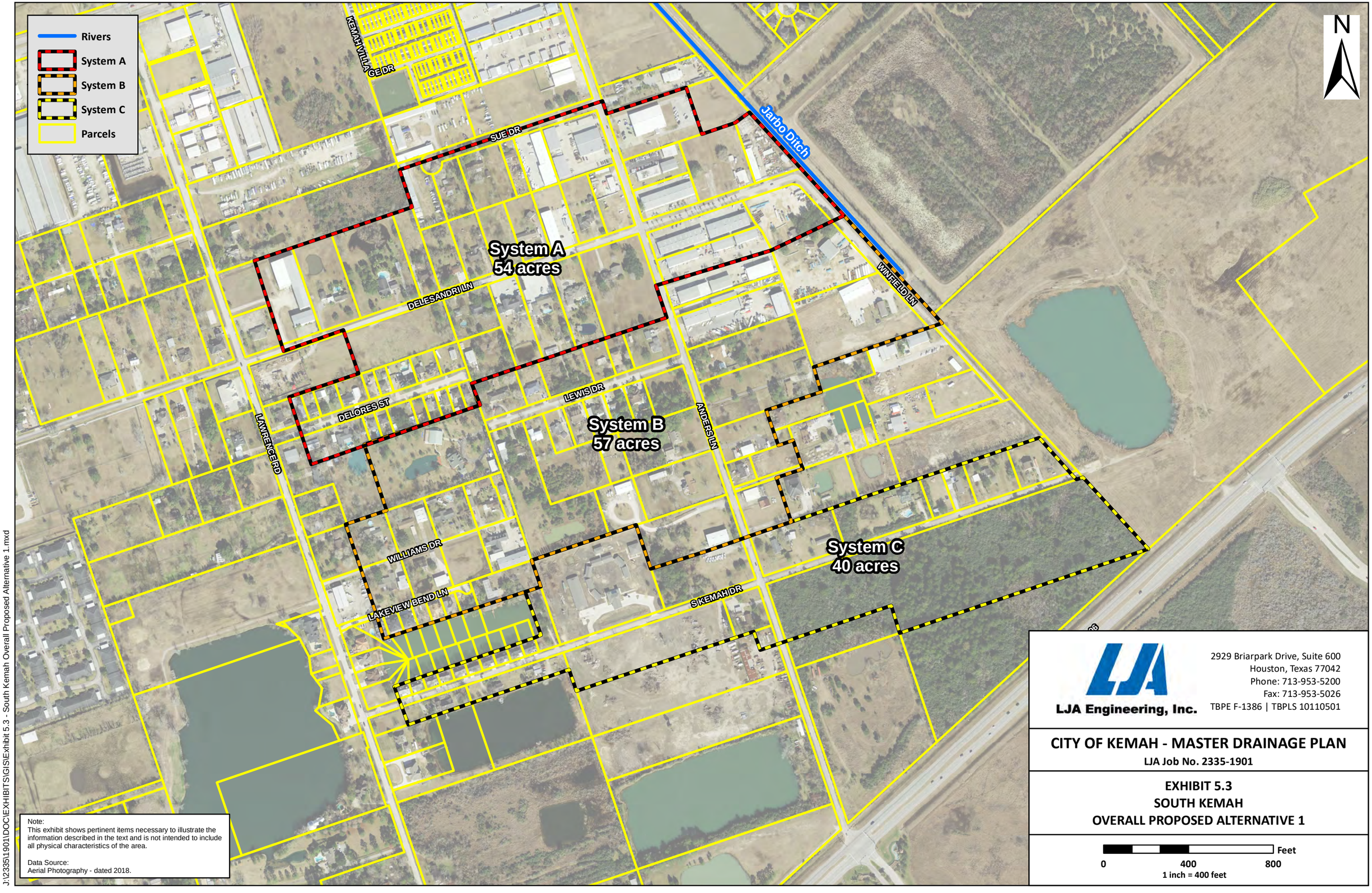
CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 5.2
SOUTH KEMAH - LAND USE

Feet
0 800 1,600
1 inch = 800 feet



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J:\2335\1901\DOC\EXHIBITS\GIS\Exhibit 5.3 - South Kemah Overall Proposed Alternative 1.mxd

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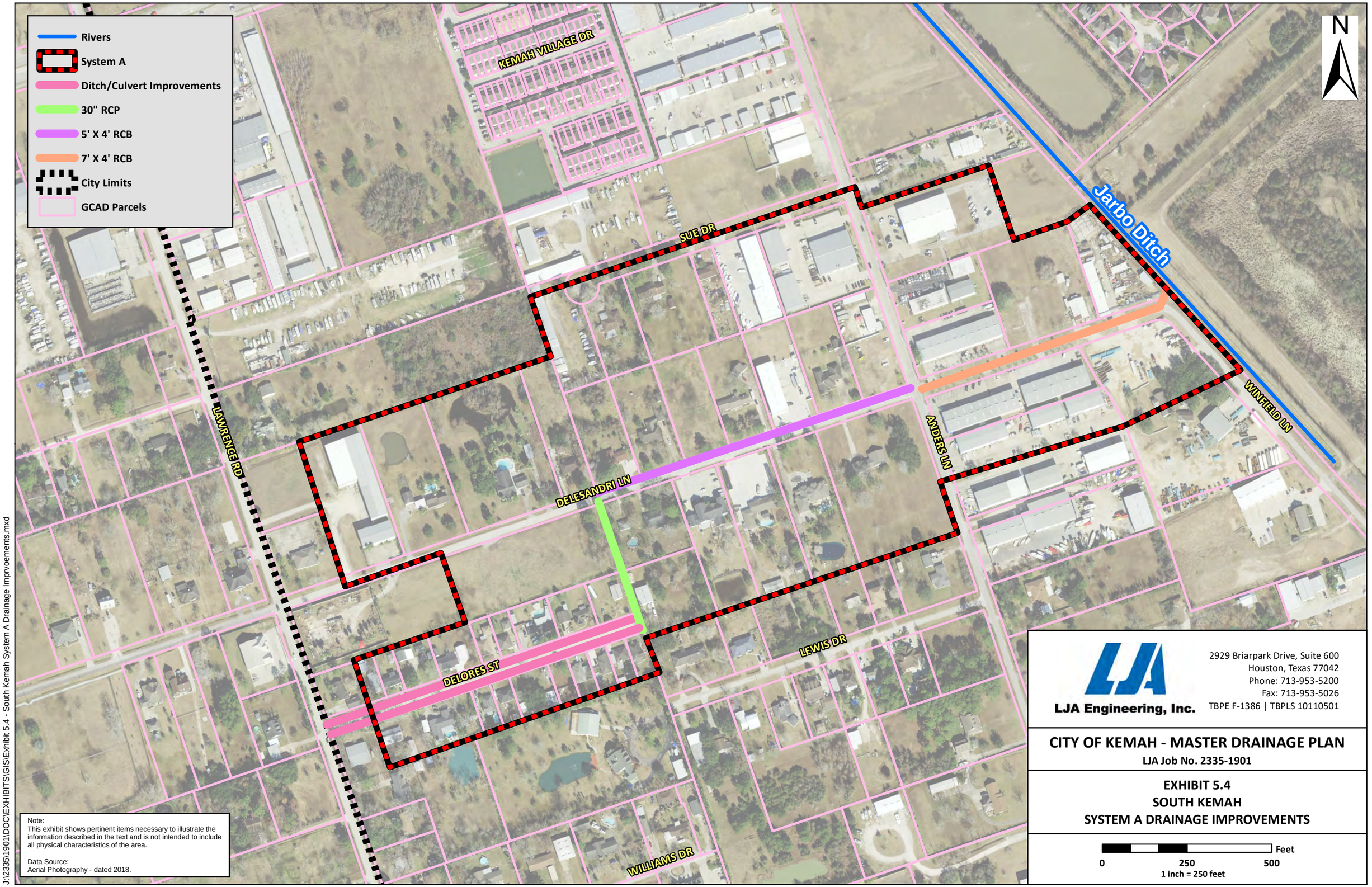
CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 5.3
SOUTH KEMAH
OVERALL PROPOSED ALTERNATIVE 1

Feet
0 400 800
1 inch = 400 feet



Note:
This exhibit shows pertinent items necessary to illustrate the information described in the text and is not intended to include all physical characteristics of the area.

Data Source:
Aerial Photography - dated 2018.

J:\2335\1901\DOC\EXHIBIT\GIS\Exhibit 5.4 - South Kemah System A Drainage Imprvoements.mxd

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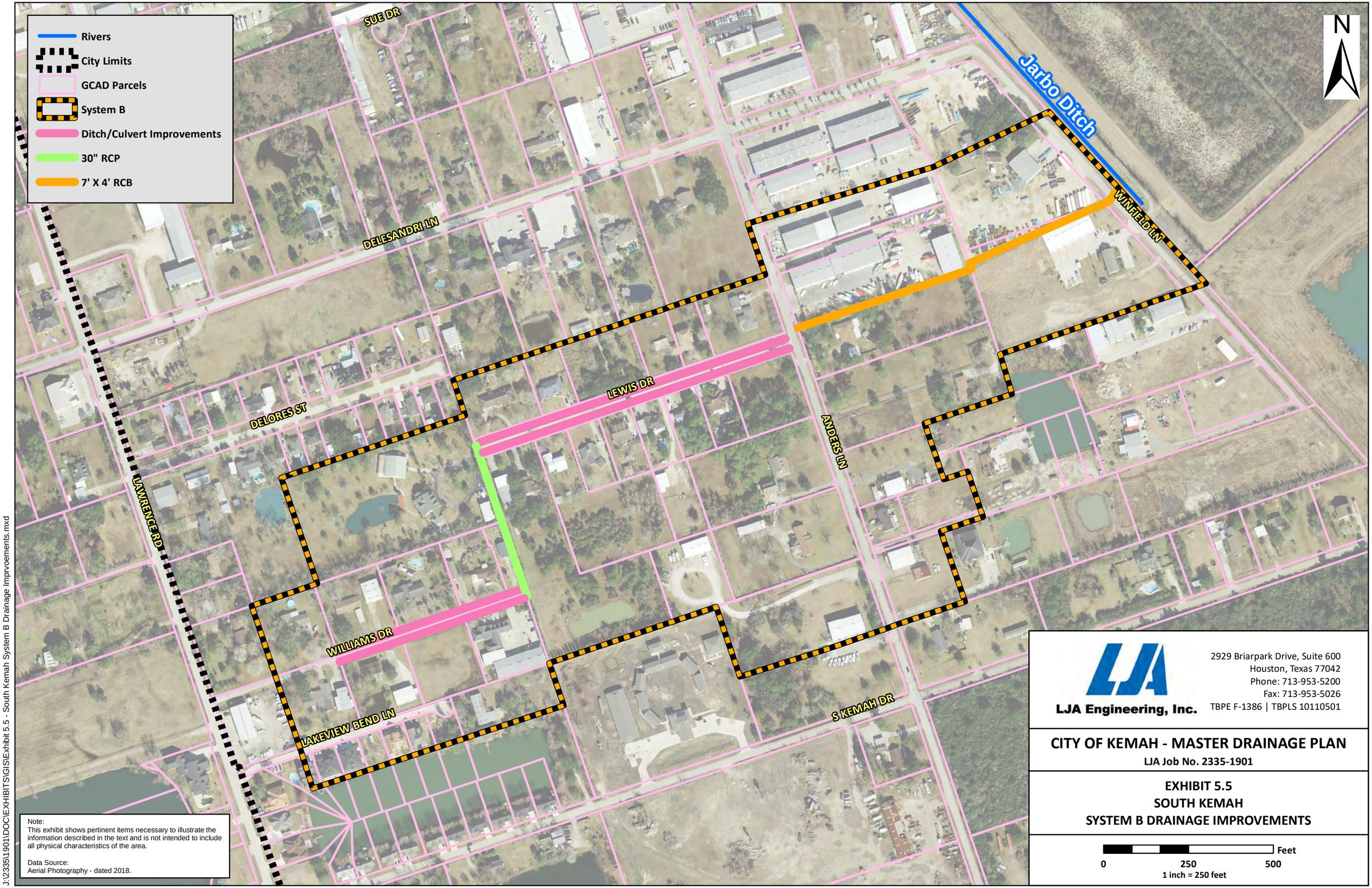
CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 5.4
SOUTH KEMAH
SYSTEM A DRAINAGE IMPROVEMENTS

Feet
0 250 500
1 inch = 250 feet



Note:
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Data Source:
Aerial Photography - dated 2018.

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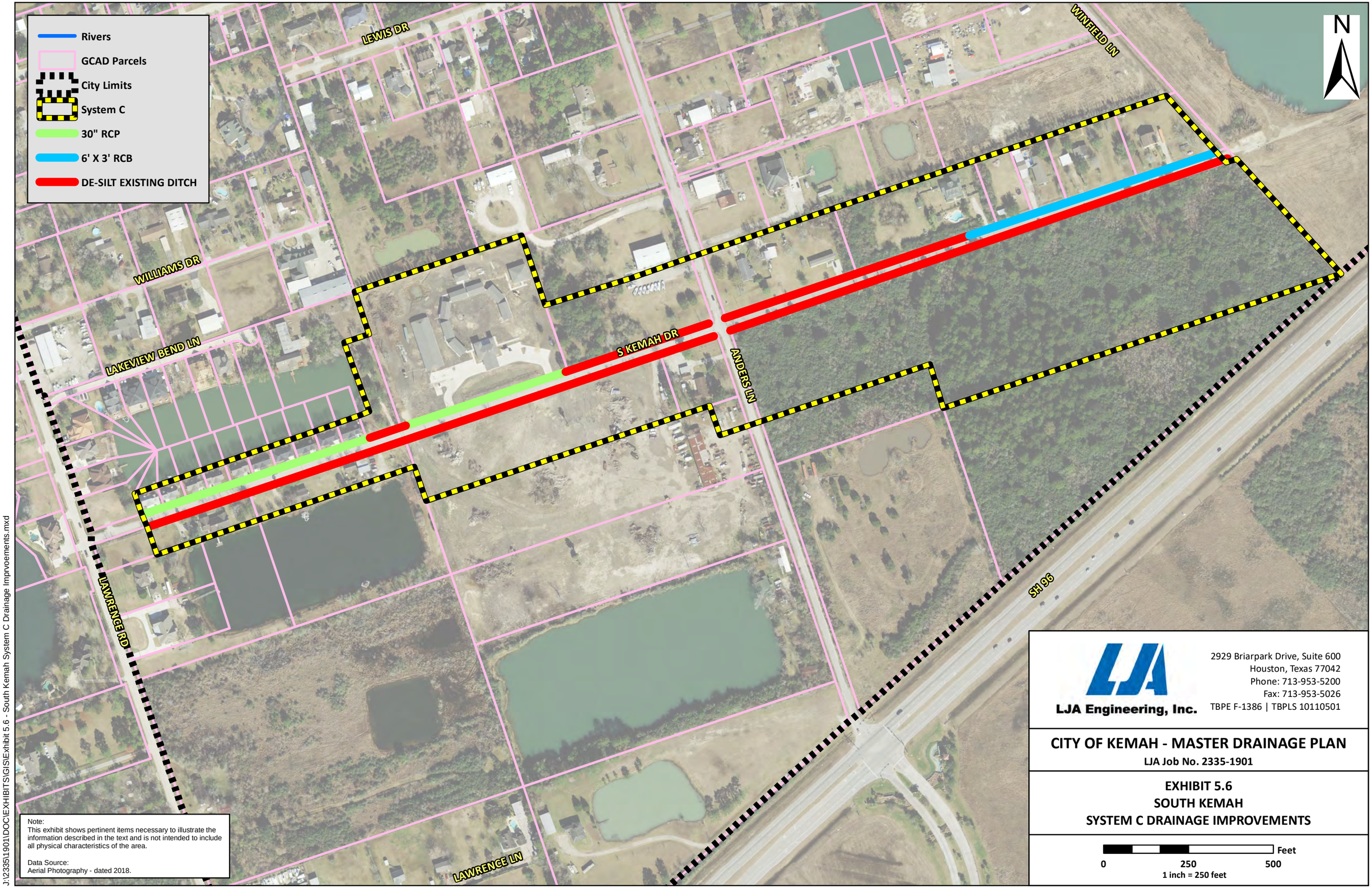
CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 5.5
SOUTH KEMAH
SYSTEM B DRAINAGE IMPROVEMENTS

Feet
0 250 500
1 inch = 250 feet

J:\12335\19011\DOC\EXHIBITS\GIS\Exhibit 5.5 - South Kemah System B Drainage Imprvoements.mxd



Note:
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Data Source:
Aerial Photography - dated 2018.

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TBPE F-1386 | TBPLS 10110501

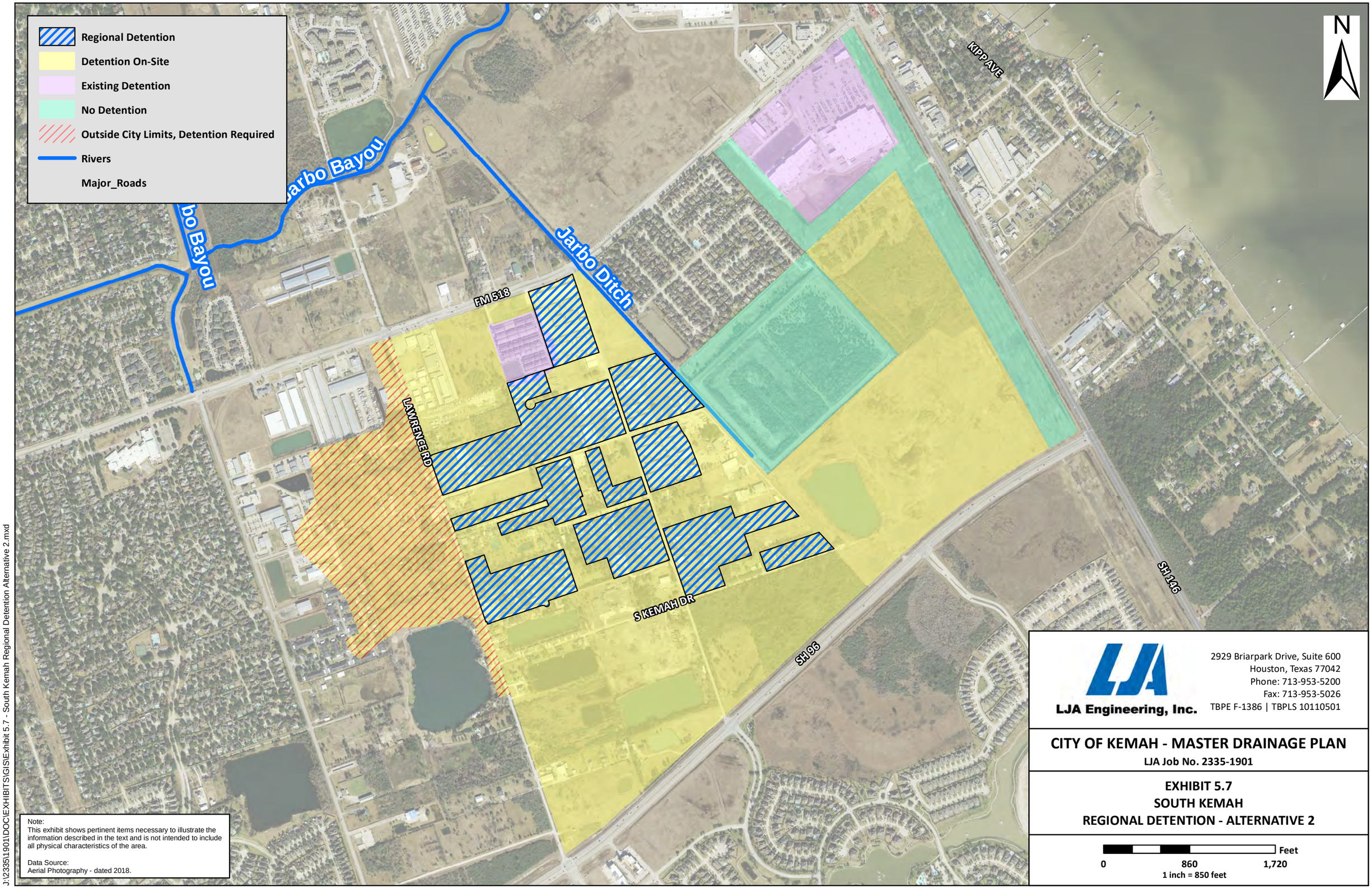
CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 5.6
SOUTH KEMAH
SYSTEM C DRAINAGE IMPROVEMENTS

Feet
0 250 500
1 inch = 250 feet

J:\2335\1901\DOC\EXHIBITS\GIS\Exhibit 5.6 - South Kemah System C Drainage Imprvoements.mxd



Note:
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Data Source:
Aerial Photography - dated 2018.

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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 5.7
SOUTH KEMAH
REGIONAL DETENTION - ALTERNATIVE 2

Feet
0 860 1,720
1 inch = 850 feet

J:\23351901\DOC\EXHIBITS\GIS\Exhibit 5.7 - South Kemah Regional Detention Alternative 2.mxd

Legend

Cross Sections

303
606
908
1211
1665
2041
2153
2270
2421
2724
3026
3326
3631
3681
3690
3761
3741
3934
4237
4539
4743
4870
4823
5079
4963
5099
5132
5144
5447
6034

N

Note:
This exhibit shows pertinent items necessary to illustrate the information described in the text and is not intended to include all physical characteristics of the area.

Data Source:
Aerial Photography - dated 2018.

J:\23351901\DOC\EXHIBITS\GIS\2020-07-29 SKemah Drainage_10.5.mxd

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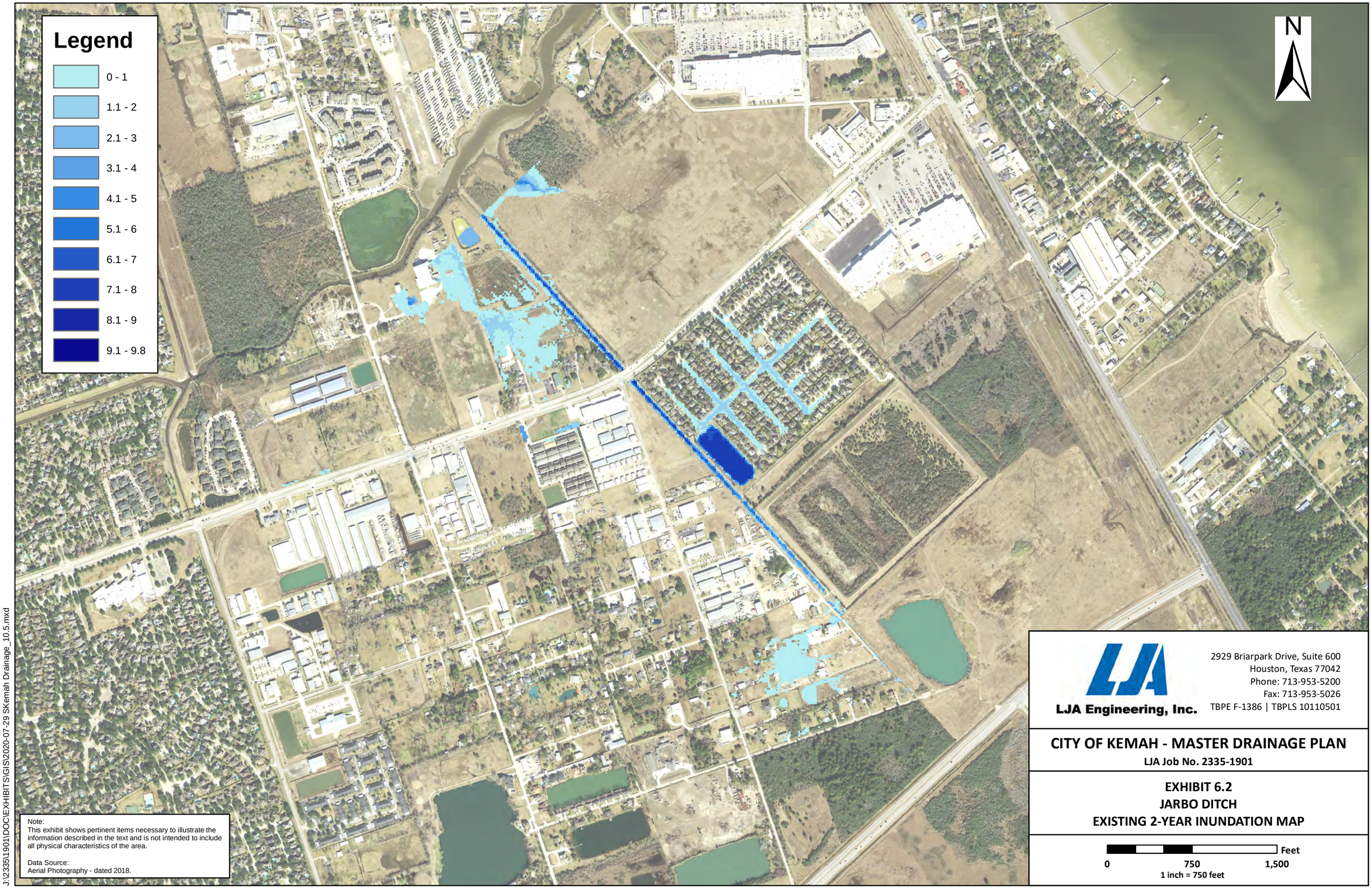
CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 6.1
JARBO DITCH
HEC-RAS CROSS-SECTION LAYOUT

Feet
0 750 1,500
1 inch = 750 feet



Note:
This exhibit shows pertinent items necessary to illustrate the information described in the text and is not intended to include all physical characteristics of the area.

Data Source:
Aerial Photography - dated 2018.

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Phone: 713-953-5200
Fax: 713-953-5026
TBPE F-1386 | TBPLS 10110501

CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 6.2
JARBO DITCH
EXISTING 2-YEAR INUNDATION MAP

Feet
0 — 750 — 1,500
1 inch = 750 feet

J:\23351901\DOC\EXHIBITS\GIS\2020-07-29 SKemah Drainage_10.5.mxd

Legend

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- 5.1 - 6
- 6.1 - 7
- 7.1 - 8
- 8.1 - 9
- 9.1 - 9.8

N

Note:
This exhibit shows pertinent items necessary to illustrate the information described in the text and is not intended to include all physical characteristics of the area.

Data Source:
Aerial Photography - dated 2018.

J:\23351901\DOC\EXHIBITS\GIS\2020-07-29 SKemah Drainage_10.5.mxd

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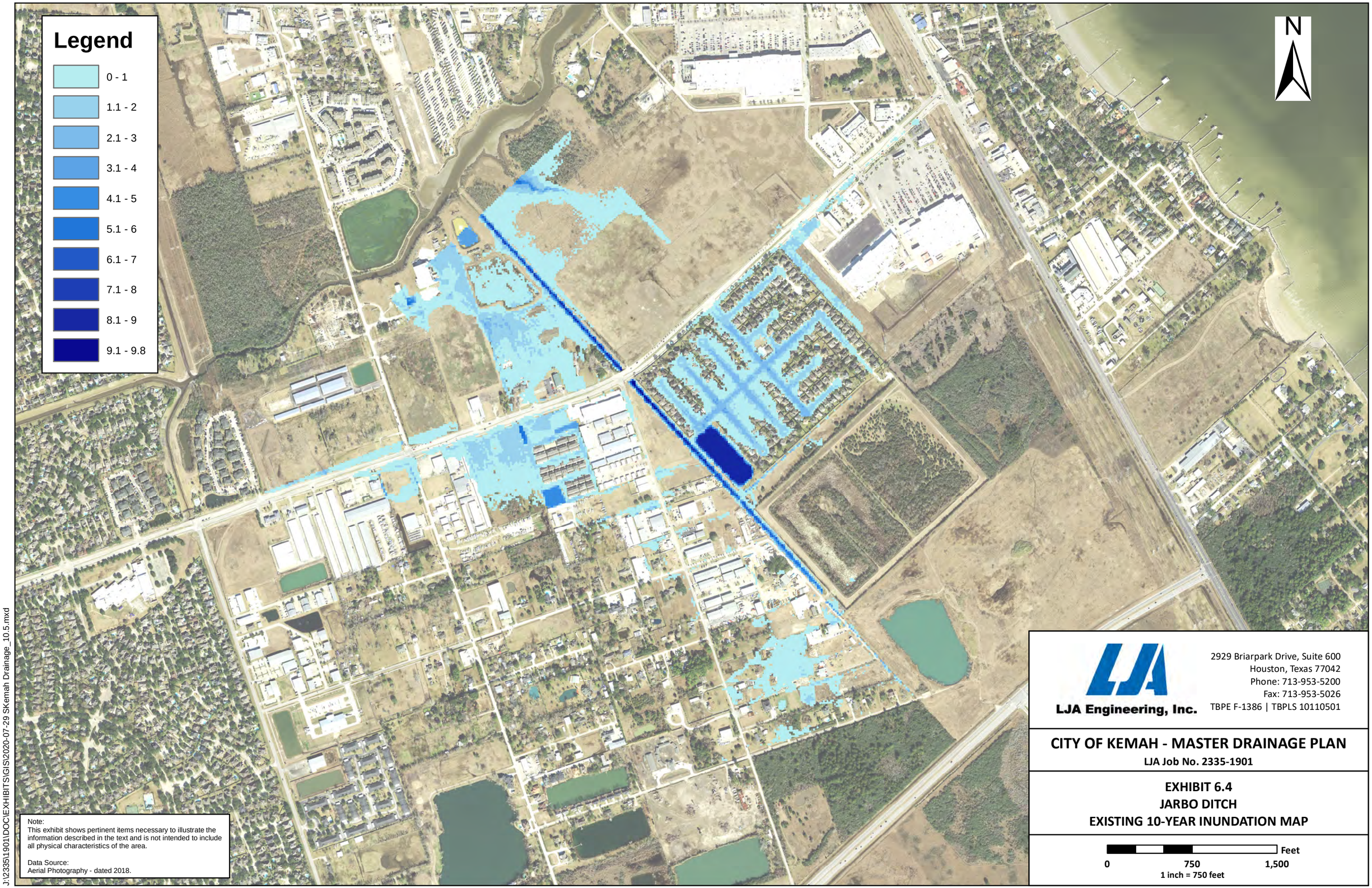
CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 6.3
JARBO DITCH
EXISTING 5-YEAR INUNDATION MAP

Feet
0 750 1,500
1 inch = 750 feet



Note:
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Data Source:
Aerial Photography - dated 2018.

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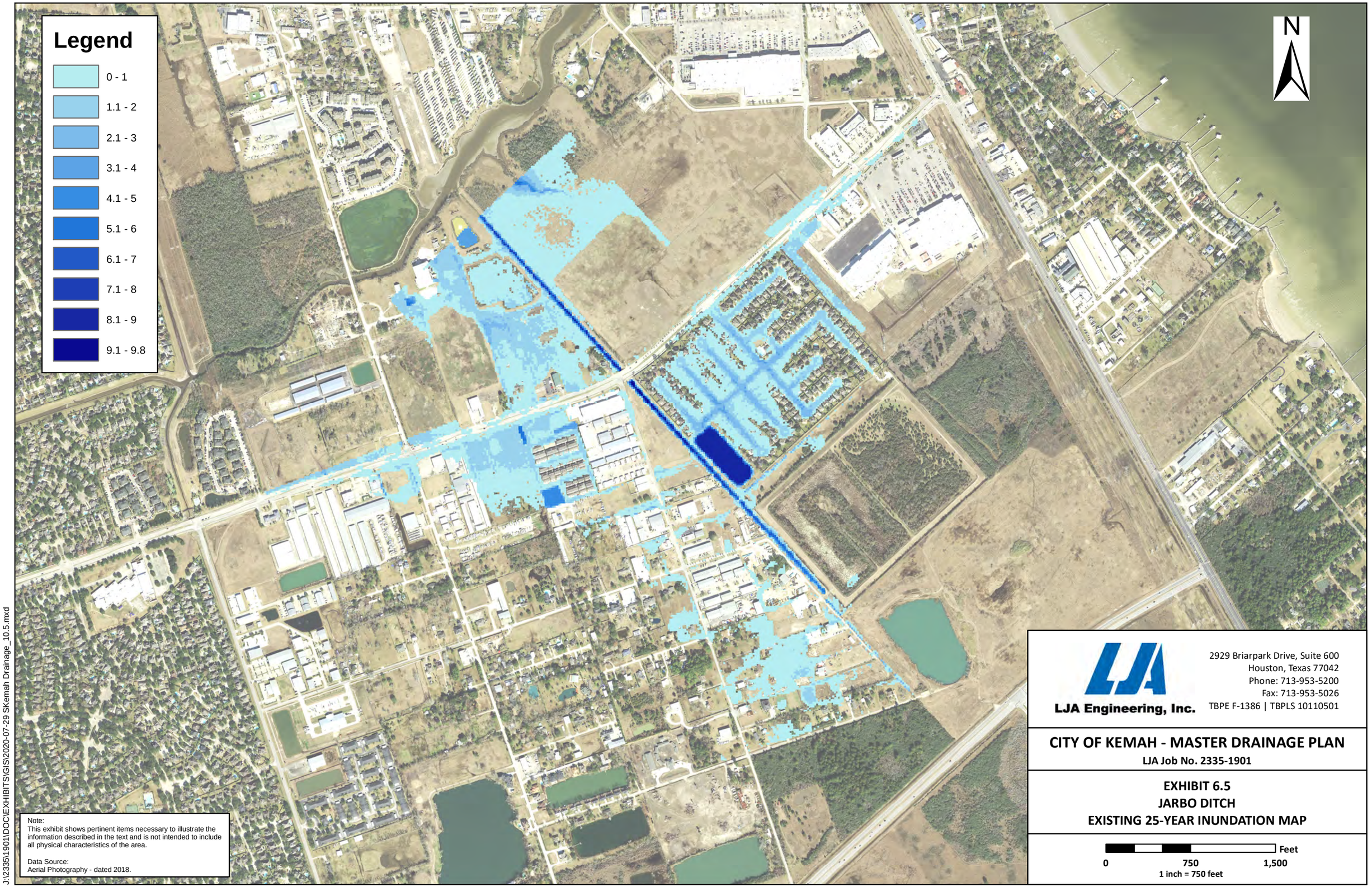
CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 6.4
JARBO DITCH
EXISTING 10-YEAR INUNDATION MAP

Feet
0 750 1,500
1 inch = 750 feet



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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 6.5
JARBO DITCH
EXISTING 25-YEAR INUNDATION MAP

Feet
0 — 750 — 1,500
1 inch = 750 feet

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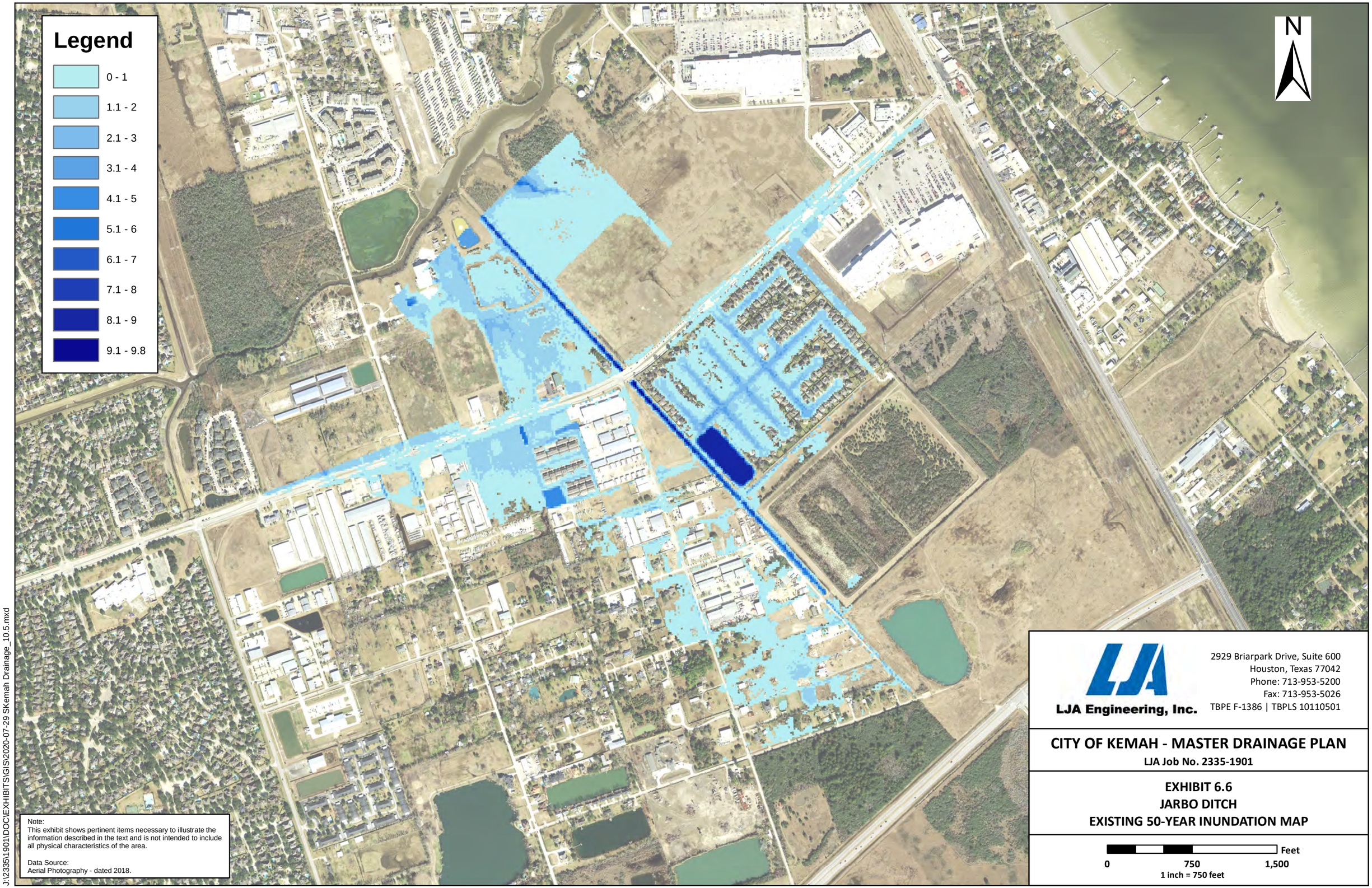

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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 6.6
JARBO DITCH
EXISTING 50-YEAR INUNDATION MAP

Feet
0 750 1,500
1 inch = 750 feet

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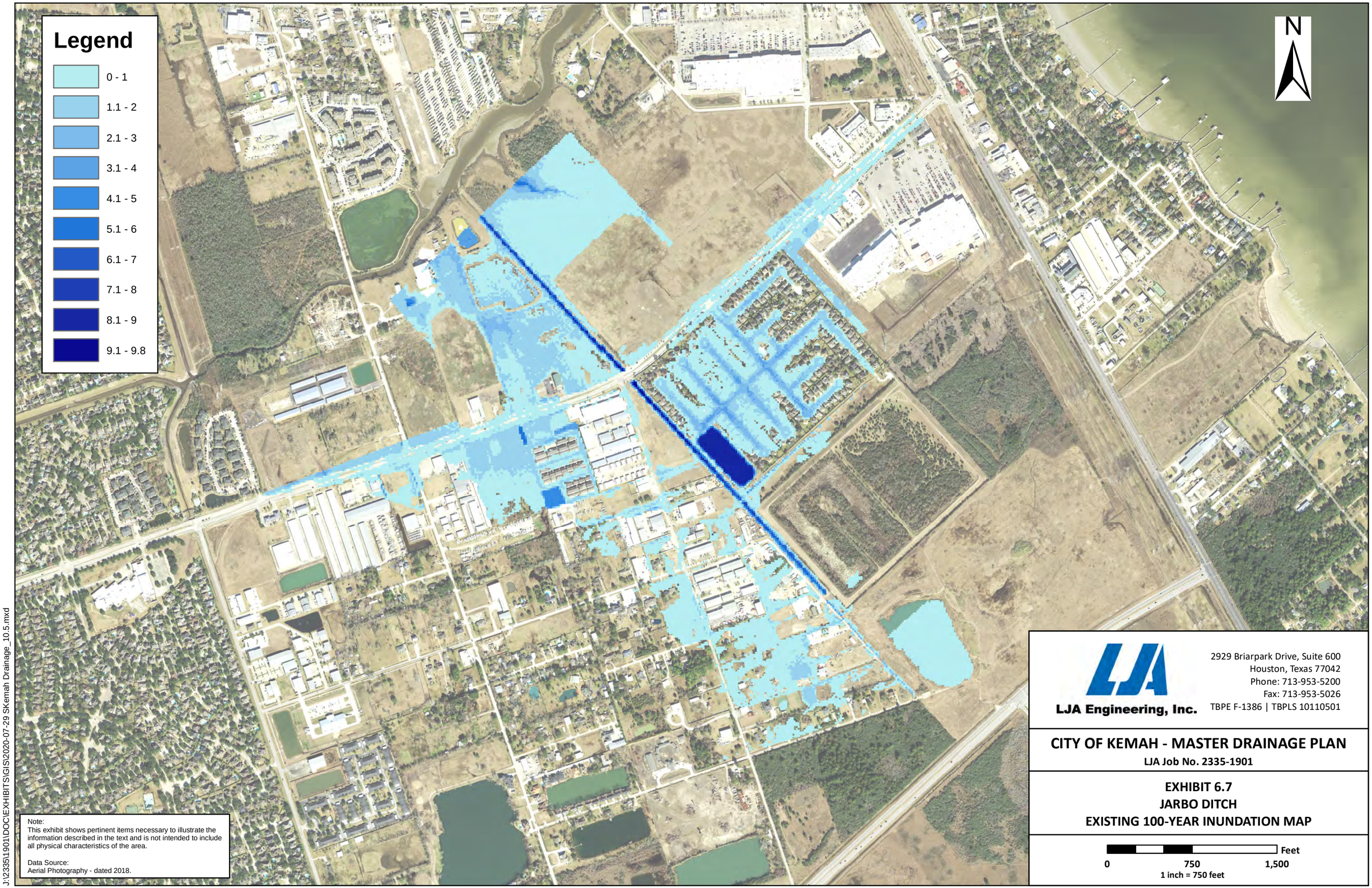

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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 6.7
JARBO DITCH
EXISTING 100-YEAR INUNDATION MAP

Feet
0 750 1,500
1 inch = 750 feet

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Legend

- 30ft Flat Bottom 4:1 Side Slopes with 140ft ROW, Scenario 1
- 25ft Flat Bottom 3:1 Side Slopes with 110ft ROW, Scenario 1
- 25ft Flat Bottom 3:1 Side Slopes with 70-80ft ROW, Scenario 1
- 25ft Flat Bottom 3:1 Side Slopes with 90-110ft ROW, Scenario 2
- 40ft ROW Acquisition
- 50ft ROW Acquisition
- 60ft ROW Acquisition
- Parcels (GCAD)

N

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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 6.8
JARBO DITCH
PROPOSED CHANNEL IMPROVEMENTS

Feet
0 500 1,000
1 inch = 500 feet

Legend

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- 5.1 - 6
- 6.1 - 7
- 7.1 - 8
- 8.1 - 9
- 9.1 - 9.8

N

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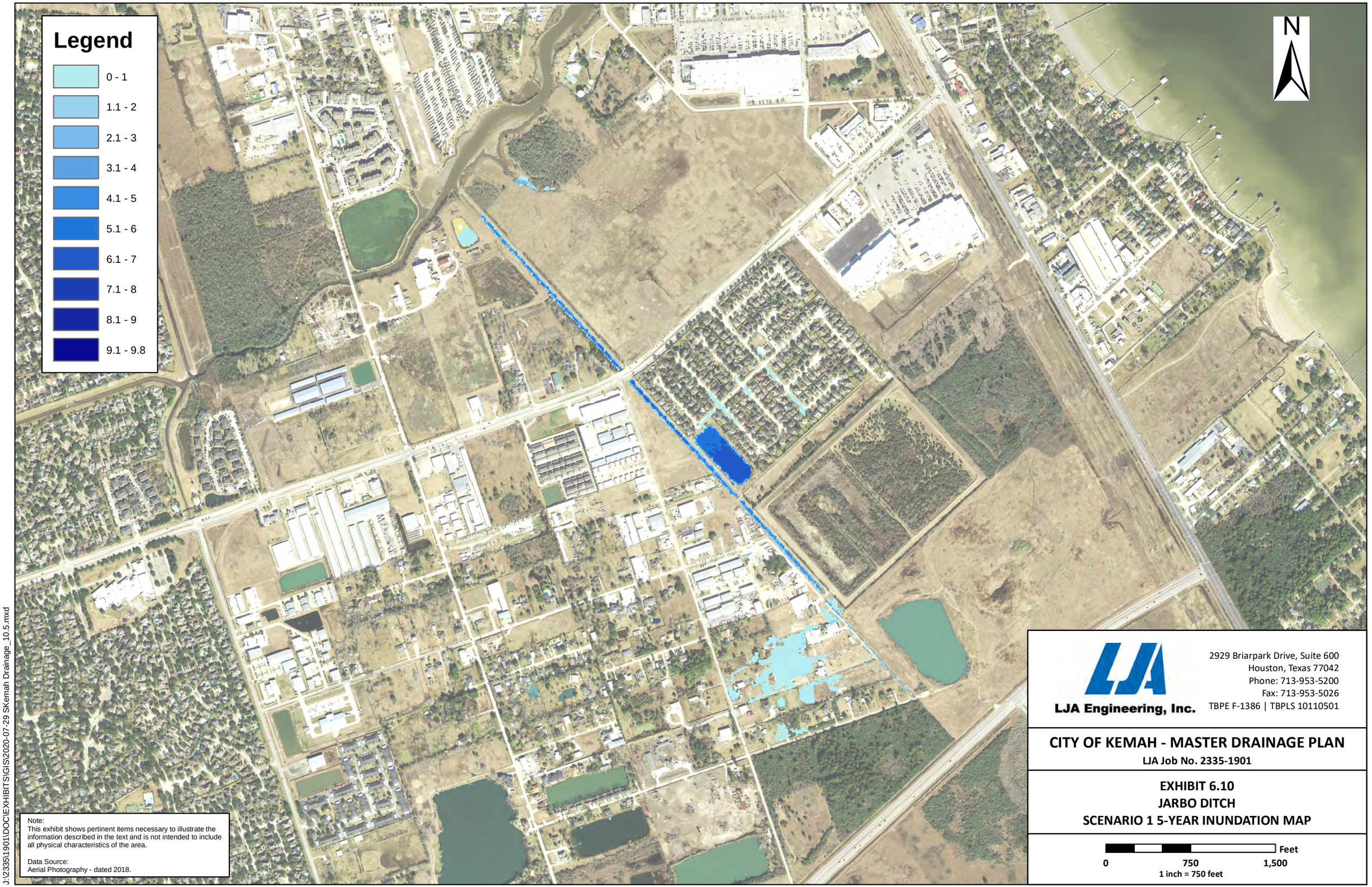
CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 6.9
JARBO DITCH
SCENARIO 1 2-YEAR INUNDATION MAP

Feet
0 750 1,500
1 inch = 750 feet



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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 6.10
JARBO DITCH
SCENARIO 1 5-YEAR INUNDATION MAP

Feet
0 750 1,500
1 inch = 750 feet

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Legend

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- 5.1 - 6
- 6.1 - 7
- 7.1 - 8
- 8.1 - 9
- 9.1 - 9.8

N

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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 6.11
JARBO DITCH
SCENARIO 1 10-YEAR INUNDATION MAP

Feet
0 750 1,500
1 inch = 750 feet

Legend

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- 5.1 - 6
- 6.1 - 7
- 7.1 - 8
- 8.1 - 9
- 9.1 - 9.8

N

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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 6.12
JARBO DITCH
SCENARIO 1 25-YEAR INUNDATION MAP

Feet
0 750 1,500
1 inch = 750 feet

Legend

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- 5.1 - 6
- 6.1 - 7
- 7.1 - 8
- 8.1 - 9
- 9.1 - 9.8

N

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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 6.13
JARBO DITCH
SCENARIO 1 50-YEAR INUNDATION MAP

Feet
0 750 1,500
1 inch = 750 feet

Legend

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- 5.1 - 6
- 6.1 - 7
- 7.1 - 8
- 8.1 - 9
- 9.1 - 9.8

N

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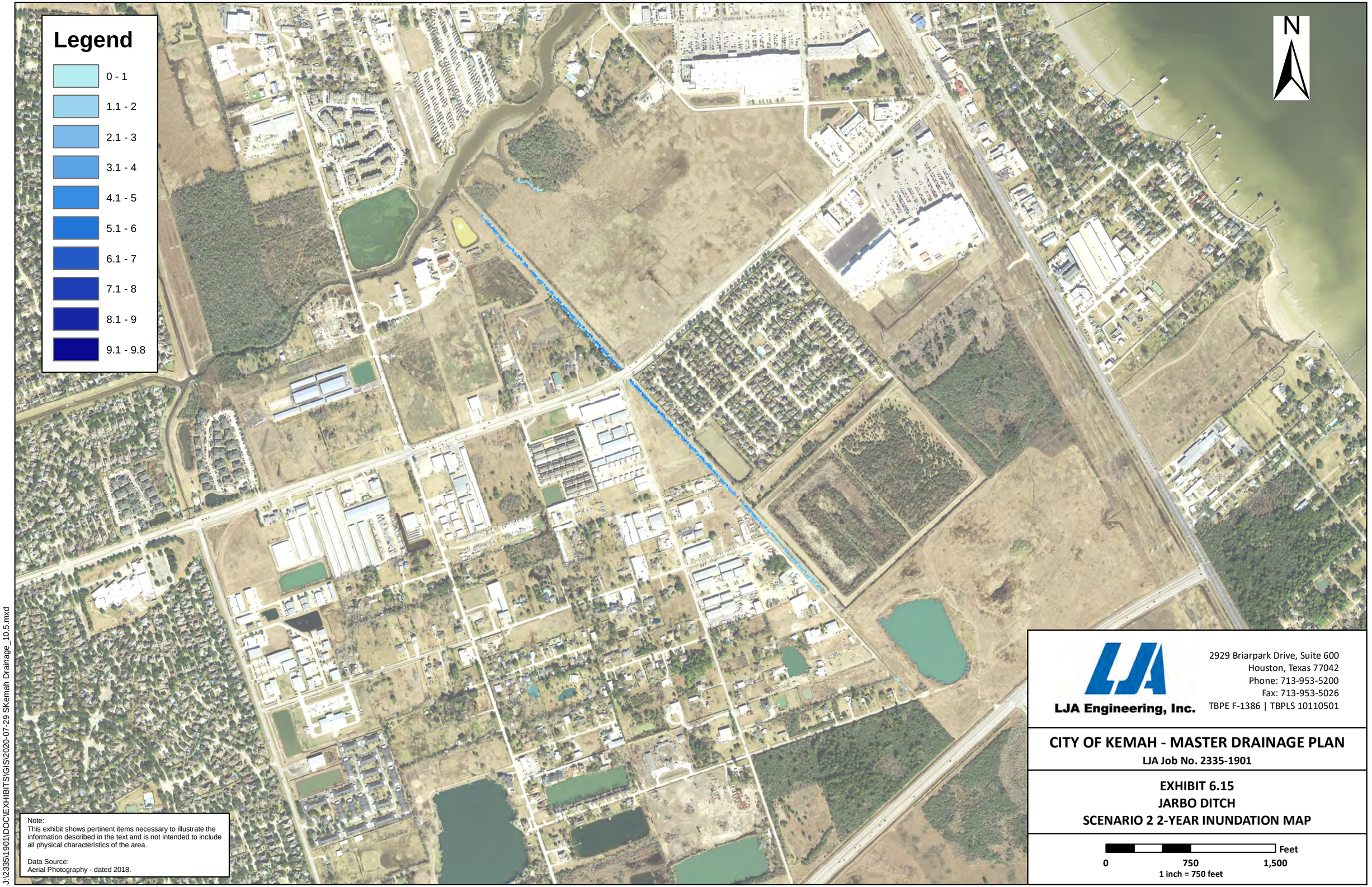
CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 6.14
JARBO DITCH
SCENARIO 1 100-YEAR INUNDATION MAP

Feet
0 750 1,500
1 inch = 750 feet



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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 6.15
JARBO DITCH
SCENARIO 2 2-YEAR INUNDATION MAP

Feet
0 750 1,500
1 inch = 750 feet

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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 6.16
JARBO DITCH
SCENARIO 2 5-YEAR INUNDATION MAP

Feet
0 — 750 — 1,500
1 inch = 750 feet

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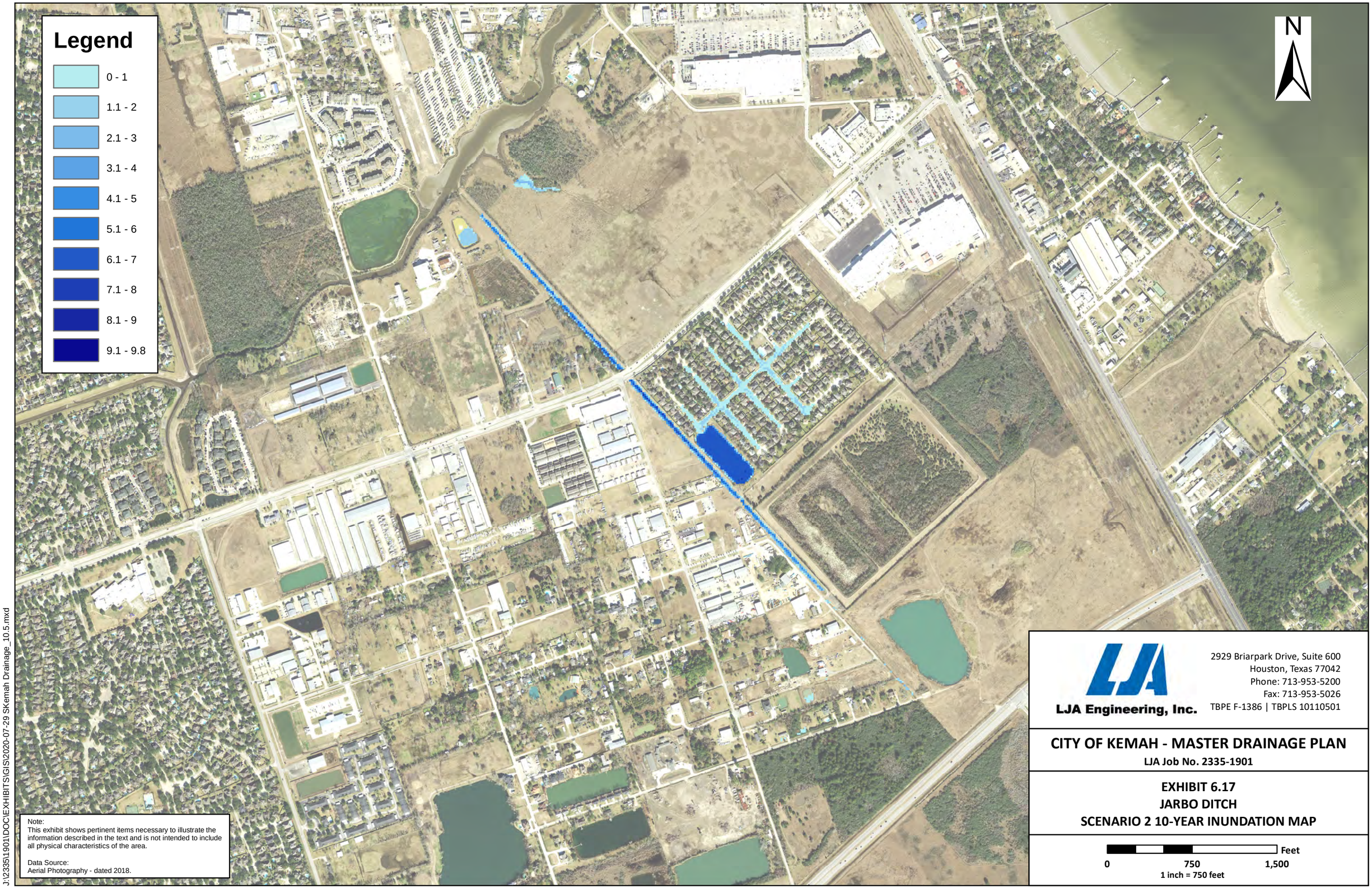

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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 6.17
JARBO DITCH
SCENARIO 2 10-YEAR INUNDATION MAP

Feet
0 750 1,500
1 inch = 750 feet

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Legend

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- 5.1 - 6
- 6.1 - 7
- 7.1 - 8
- 8.1 - 9
- 9.1 - 9.8

N

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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 6.18
JARBO DITCH
SCENARIO 2 25-YEAR INUNDATION MAP

Feet
0 750 1,500
1 inch = 750 feet

Legend

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- 5.1 - 6
- 6.1 - 7
- 7.1 - 8
- 8.1 - 9
- 9.1 - 9.8

N

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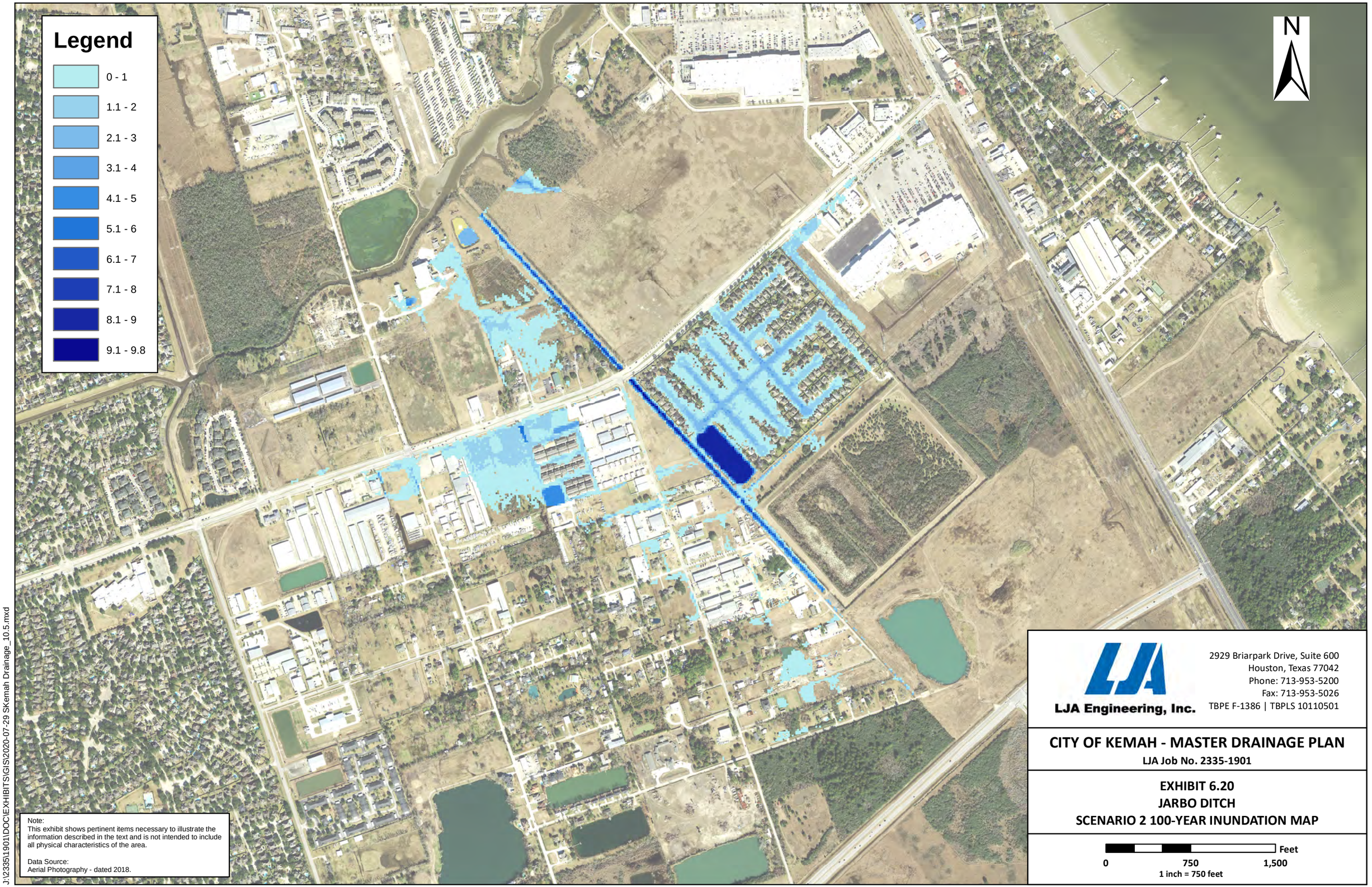
CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 6.19
JARBO DITCH
SCENARIO 2 50-YEAR INUNDATION MAP

Feet
0 750 1,500
1 inch = 750 feet



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CITY OF KEMAH - MASTER DRAINAGE PLAN

LJA Job No. 2335-1901

EXHIBIT 6.20
JARBO DITCH
SCENARIO 2 100-YEAR INUNDATION MAP

Feet
0 750 1,500
1 inch = 750 feet

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APPENDIX A
OPINION OF PROBABLE COST

BAYVIEW ACRES
ALTERNATIVE 1
OPINION OF PROBABLE COST

Appendix A
City of Kemah - Master Drainage Plan
Bayview Acres - Alternative 1
Opinion of Probable Cost

Item	Unit	Quantity		Unit Price		Total Cost
Mobilization	%	5%	$	1,281,000	$	64,050
STORM SEWER						
Remove and Dispose - 18" RCP	LF	60	$	9	$	540
Remove and Dispose - 24" RCP	LF	340	$	10	$	3,400
Remove and Dispose - 30" RCP	LF	800	$	12	$	9,600
Storm Pipe 42" RC Pipe (CL III)	LF	850	$	140	$	119,000
Storm Pipe 54" RC Pipe (CL III)	LF	720	$	210	$	151,200
Concrete Box Culvert (6 ft x 4 ft)	LF	960	$	450	$	432,000
Cement Stabilized Sand Backfill	CY	2500	$	25	$	62,500
Ditch Widening and Regrading	LF	8000	$	20	$	160,000
Culvert Resizing and Driveway Reconstruction	LS	1	$	300,000	$	300,000
GENERAL ITEMS						
Groundwater Control	LF	2530	$	20	$	50,600
Trench Safety System	LF	2530	$	2	$	5,060
MISCELLANEOUS ITEMS						
Extra Work Items	%	4%	$	1,281,000	$	51,240
SW3P, Bonds & Permits	%	5%	$	1,281,000	$	64,050
Planning, Engineering & Design	%	15%	$	1,281,000	$	192,150
Construction Management	%	10%	$	1,281,000	$	128,100
Easement Acquisition	SF	14400	$	2.00	$	28,800
Contingency	%	30%	$	1,281,000	$	384,300
	Total				**$**	**2,206,590**

BAYVIEW ACRES
ALTERNATIVE 2
OPINION OF PROBABLE COST

Appendix A
City of Kemah - Master Drainage Plan
Bayview Acres - Alternative 2
Opinion of Probable Cost

Item	Unit	Quantity		Unit Price		Total Cost
Mobilization	%	5%	$	1,214,000	$	60,700
STORM SYSTEM						
Remove and Dispose - 18" RCP	LF	60	$	9	$	540
Remove and Dispose - 24" RCP	LF	340	$	10	$	3,400
Remove and Dispose - 30" RCP	LF	800	$	12	$	9,600
Storm Pipe 42" RC Pipe (CL III)	LF	850	$	140	$	119,000
Storm Pipe 48" RC Pipe (CL III)	LF	760	$	140	$	106,400
Storm Pipe 54" RC Pipe (CL III)	LF	1680	$	210	$	352,800
Cement Stabilized Sand Backfill	CY	4100	$	25	$	102,500
Ditch Widening and Regrading	LF	8000	$	20	$	160,000
Culvert Resizing and Driveway Reconstruction	LS	1	$	300,000	$	300,000
GENERAL ITEMS						
Groundwater Control	LF	3290	$	20	$	65,800
Trench Safety System	LF	3290	$	2	$	6,580
MISCELLANEOUS ITEMS						
Extra Work Items	%	4%	$	1,214,000	$	48,560
SW3P, Bonds & Permits	%	5%	$	1,214,000	$	60,700
Planning, Engineering & Design	%	15%	$	1,214,000	$	182,100
Construction Management	%	10%	$	1,214,000	$	121,400
Easement Acquisition	SF	29600	$	2.00	$	59,200
Contingency	%	30%	$	1,214,000	$	364,200
	Total				**$**	**2,123,480**

KEMAH OAKS
ALTERNATIVE 1
OPINION OF PROBABLE COST

Appendix A
City of Kemah - Master Drainage Plan
Kemah Oaks Subdivision - Alternative 1
Opinion of Probable Cost

Item	Unit	Quantity	Unit Price	Total Cost
Mobilization	%	5%	$ 501,000	$ 25,050
STORM SEWER				
Remove and Dispose - 24" RCP	LF	1950	$ 10	$ 19,500
Remove and Dispose - 30" RCP	LF	390	$ 12	$ 4,680
Storm Pipe 30" RC Pipe (CL III)	LF	1550	$ 90	$ 139,500
Storm Pipe 36" RC Pipe (CL III)	LF	790	$ 120	$ 94,800
Cement Stabilized Sand Backfill	CY	1000	$ 125	$ 125,000
GENERAL ITEMS				
Site Restoration	LF	1,820	$ 10	$ 18,200
Groundwater Control	LF	2340	$ 20	$ 46,800
Trench Safety System	LF	2340	$ 2	$ 4,680
Traffic Control	LS	1	$ 20,000	$ 20,000
Full Depth Pavement Repair (7"), including subgrade and concrete curbs, all depths	SY	320	$ 85	$ 27,200
MISCELLANEOUS ITEMS				
Extra Work Items	%	4%	$ 501,000	$ 20,040
SW3P, Bonds & Permits	%	5%	$ 501,000	$ 25,050
Planning, Engineering & Design	%	15%	$ 501,000	$ 75,150
Construction Management	%	10%	$ 501,000	$ 50,100
Contingency	%	30%	$ 501,000	$ 150,300
Total				**$ 846,050**

KEMAH OAKS
ALTERNATIVE 2
OPINION OF PROBABLE COST

Appendix A
City of Kemah - Master Drainage Plan
Kemah Oaks Subdivision - Alternative 2
Opinion of Probable Cost

Item	Unit	Quantity	Unit Price	Total Cost
Mobilization	%	5%	$ 1,221,000	$ 61,050
STORM SEWER ITEMS				
Remove and Dispose - 24" RCP	LF	1950	$ 10	$ 19,500
Remove and Dispose - 30" RCP	LF	390	$ 12	$ 4,680
Storm Pipe 30" RC Pipe (CL III)	LF	1550	$ 90	$ 139,500
Storm Pipe 36" RC Pipe (CL III)	LF	790	$ 120	$ 94,800
Cement Stabilized Sand Backfill	CY	1000	$ 25	$ 25,000
DETENTION ITEMS				
Excavation and Off-Site Disposal (Detention)	CY	60000	$ 8	$ 480,000
Hydromulch	AC	10	$ 2,000	$ 20,000
Ditch Interceptor Structure (Class A)	EA	3	$ 3,000	$ 9,000
Concrete Pilot Channel (Class A)	CY	210	$ 600	$ 126,000
Outfall and Emergency Overflow	LS	1	$ 50,000	$ 50,000
GENERAL ITEMS				
Site Restoration	LF	1,820	$ 10	$ 18,200
Utility Relocations	LS	1	$ 135,000	$ 135,000
Groundwater Control	LF	2340	$ 20	$ 46,800
Trench Safety System	LF	2340	$ 2	$ 4,680
Traffic Control	LS	1	$ 20,000	$ 20,000
Full Depth Pavement Repair (7"), including subgrade and concrete curbs, all depths	SY	320	$ 85	$ 27,200
MISCELLANEOUS ITEMS				
Extra Work Items	%	4%	$ 1,221,000	$ 48,840
SW3P, Bonds & Permits	%	5%	$ 1,221,000	$ 61,050
Planning, Engineering & Design	%	15%	$ 1,221,000	$ 183,150
Construction Management	%	10%	$ 1,221,000	$ 122,100
Contingency	%	30%	$ 1,221,000	$ 366,300
Total				**$ 2,062,850**

KEMAH OAKS
ALTERNATIVE 3
OPINION OF PROBABLE COST

Appendix A
City of Kemah - Master Drainage Plan
Kemah Oaks Subdivision - Alternative 3
Opinion of Probable Cost

Item	Unit	Quantity	Unit Price	Total Cost
Mobilization	%	5%	$ 1,054,000	$ 52,700
STORM SEWER ITEMS				
Remove and Dispose - 24" RCP	LF	1950	$ 10	$ 19,500
Remove and Dispose - 30" RCP	LF	390	$ 12	$ 4,680
Storm Pipe 30" RC Pipe (CL III)	LF	1550	$ 90	$ 139,500
Storm Pipe 36" RC Pipe (CL III)	LF	790	$ 120	$ 94,800
Cement Stabilized Sand Backfill	CY	1000	$ 125	$ 125,000
DETENTION ITEMS				
Excavation and Off-Site Disposal (Detention)	CY	19500	$ 8	$ 156,000
Hydromulch	AC	2	$ 2,000	$ 4,000
Ditch Interceptor Structure (Class A)	EA	3	$ 3,000	$ 9,000
Concrete Pilot Channel (Class A)	CY	140	$ 600	$ 84,000
Stormwater pump station	LS	1	$ 300,000	$ 300,000
GENERAL ITEMS				
Site Restoration	LF	1,820	$ 10	$ 18,200
Groundwater Control	LF	2340	$ 20	$ 46,800
Trench Safety System	LF	2340	$ 2	$ 4,680
Traffic Control	LS	1	$ 20,000	$ 20,000
Full Depth Pavement Repair (7"), including subgrade and concrete curbs, all depths	SY	320	$ 85	$ 27,200
MISCELLANEOUS ITEMS				
Extra Work Items	%	4%	$ 1,054,000	$ 42,160
SW3P, Bonds & Permits	%	5%	$ 1,054,000	$ 52,700
Planning, Engineering & Design	%	15%	$ 1,054,000	$ 158,100
Construction Management	%	10%	$ 1,054,000	$ 105,400
Contingency	%	30%	$ 1,054,000	$ 316,200
Total				**$ 1,780,620**

KEMAH OAKS
ALTERNATIVE 4
OPINION OF PROBABLE COST

Appendix A
City of Kemah - Master Drainage Plan
Kemah Oaks Subdivision - Alternative 4
Opinion of Probable Cost

Item	Unit	Quantity	Unit Price	Total Cost
Mobilization	%	5%	$ 102,000	$ 5,100
STORM SEWER				
Remove and Dispose - 24" RCP	LF	60	$ 10	$ 600
Remove and Dispose - Inlet	EA	1	$ 500	$ 500
Type C-2A Inlet	EA	2	$ 7,500	$ 15,000
Concrete Box Culvert (6 ft x 4 ft)	LF	60	$ 450	$ 27,000
5" Concrete Slope Paving	SY	560	$ 80	$ 44,800
Cement Stabilized Sand Backfill	CY	54	$ 25	$ 1,350
GENERAL ITEMS				
Site Restoration	LF	60	$ 10	$ 600
Groundwater Control	LF	60	$ 20	$ 1,200
Trench Safety System	LF	60	$ 2	$ 120
Traffic Control	LS	1	$ 5,000	$ 5,000
Full Depth Pavement Repair (7"), including subgrade and concrete curbs, all depths	SY	60	$ 85	$ 5,100
MISCELLANEOUS ITEMS				
Extra Work Items	%	4%	$ 102,000	$ 4,080
SW3P, Bonds & Permits	%	5%	$ 102,000	$ 5,100
Planning, Engineering & Design	%	15%	$ 102,000	$ 15,300
Construction Management	%	10%	$ 102,000	$ 10,200
Contingency	%	30%	$ 102,000	$ 30,600
Total				**$ 171,650**

SOUTH KEMAH
ALTERNATIVE 1
OPINION OF PROBABLE COST

Appendix A
City of Kemah - Master Drainage Plan
South Kemah Area - Alternative 1
Opinion of Probable Cost

Item	Unit	Quantity	Unit Price	Total Cost
Mobilization	%	5%	$ 2,299,000	$ 114,950
	SYSTEM A			
DEMOLITION				
Remove and Dispose - 18" RCP	LF	1250	$ 10	$ 12,500
Remove and Dispose - 24" RCP	LF	1700	$ 10	$ 17,000
Removing Concrete (Driveways)	SY	240	$ 10	$ 2,400
STORM WATER ITEMS				
Storm Pipe 30" RC Pipe (CL III)	LF	420	$ 90	$ 37,800
Concrete Box Culvert (5 ft x 4 ft)	LF	1000	$ 350	$ 350,000
Concrete Box Culvert (7 ft x 4 ft)	LF	825	$ 450	$ 371,250
Cement Stabilized Sand Backfill	CY	1400	$ 25	$ 35,000
Excavation and Off-Site Disposal (Ditch)	CY	1270	$ 8	$ 10,160
Hydromulch	AC	1	$ 2,000	$ 2,000
GENERAL ITEMS				
Groundwater Control	LF	2250	$ 20	$ 45,000
Trench Safety System	LF	2250	$ 2	$ 4,500
Traffic Control	LS	1	$ 25,000	$ 25,000
Concrete Driveway Repair	SY	240	$ 50	$ 12,000
			SUBTOTAL - SYSTEM A	**$ 924,610**
	SYSTEM B			
DEMOLITION				
Remove and Dispose - 24" RCP	LF	2030	$ 10	$ 20,300
Removing Concrete (Driveways)	SY	450	$ 10	$ 4,500
STORM WATER ITEMS				
Storm Pipe 24" RC Pipe (CL III)	LF	220	$ 70	$ 15,400
Storm Pipe 30" RC Pipe (CL III)	LF	140	$ 90	$ 12,600
Concrete Box Culvert (6 ft x 3 ft)	LF	200	$ 400	$ 80,000
Concrete Box Culvert (7 ft x 4 ft)	LF	1075	$ 450	$ 483,750
Cement Stabilized Sand Backfill	CY	980	$ 25	$ 24,500
Excavation and Off-Site Disposal (Ditch)	CY	3010	$ 8	$ 24,080
Hydromulch	AC	1	$ 2,000	$ 2,000

Appendix A
City of Kemah - Master Drainage Plan
South Kemah Area - Alternative 1
Opinion of Probable Cost

GENERAL ITEMS						
Groundwater Control	LF	1640	$	20	$	32,800
Trench Safety System	LF	1640	$	2	$	3,280
Traffic Control	LS	1	$	25,000	$	25,000
Concrete Driveway Repair	SY	450	$	50	$	22,500
			SUBTOTAL - SYSTEM B		**$**	**750,710**
	SYSTEM C					
DEMOLITION						
Remove and Dispose - 24" RCP	LF	1200	$	10	$	12,000
Remove and Dispose - 36" RCP	LF	780	$	10	$	7,800
Removing Concrete (Driveways)	SY	210	$	10	$	2,100
Remove and Dispose Inlets (All Sizes)	EA	14	$	500	$	7,000
STORM WATER ITEMS						
Storm Pipe 30" RC Pipe (CL III)	LF	1200	$	90	$	108,000
De-Silt Ditches	LF	4640	$	15	$	69,600
Concrete Box Culvert (6 ft x 3 ft)	LF	780	$	400	$	312,000
Cement Stabilized Sand Backfill	CY	1270	$	25	$	31,750
Type A Inlet	EA	14	$	2,000	$	28,000
GENERAL ITEMS						
Groundwater Control	LF	1200	$	20	$	24,000
Trench Safety System	LF	1200	$	2	$	2,400
Traffic Control	LS	1	$	5,000	$	5,000
Concrete Driveway (Residential)	SF	1890	$	7	$	13,230
			SUBTOTAL - SYSTEM C		**$**	**622,880**
MISCELLANEOUS ITEMS						
Extra Work Items	%	4%	$	2,299,000	$	91,960
SW3P, Bonds & Permits	%	5%	$	2,299,000	$	114,950
Planning, Engineering & Design	%	15%	$	2,299,000	$	344,850
Construction Management	%	10%	$	2,299,000	$	229,900
Contingency	%	30%	$	2,299,000	$	689,700
	Total				**$**	**3,884,510**

SOUTH KEMAH
ALTERNATIVE 2
OPINION OF PROBABLE COST

Appendix A
City of Kemah - Master Drainage Plan
South Kemah Area - Alternative 1
Opinion of Probable Cost

Item	Unit	Quantity		Unit Price		Total Cost
Mobilization	%	5%	$	1,665,000	$	83,250
STORM SEWER						
Concrete Box Culvert (5 ft x 5 ft)	LF	30	$	350	$	10,500
Concrete Box Culvert (9 ft x 6 ft)	LF	100	$	850	$	85,000
Cement Stabilized Sand Backfill	CY	100	$	25	$	2,500
DETENTION POND						
Class C Concrete Headwall	CY	20	$	800	$	16,000
Concrete Rip Rap (Class B)	CY	10	$	250	$	2,500
Excavation and Off-Site Disposal (Detention)	CY	120000	$	8	$	960,000
Concrete Pilot Channel (Class A)	CY	80	$	600	$	48,000
Hydromulch	AC	6	$	2,000	$	12,000
Ditch Interceptor Structure (Class A)	EA	5	$	3,000	$	15,000
Stormwater Pump Station	LS	1	$	500,000	$	500,000
GENERAL ITEMS						
Groundwater Control	LF	130	$	20	$	2,600
Trench Safety System	LF	130	$	2	$	260
Traffic Control	LS	1	$	10,000	$	10,000
MISCELLANEOUS ITEMS						
Extra Work Items	%	4%	$	1,665,000	$	66,600
SW3P, Bonds & Permits	%	5%	$	1,665,000	$	83,250
Planning, Engineering & Design	%	15%	$	1,665,000	$	249,750
Construction Management	%	10%	$	1,665,000	$	166,500
Parcel Acquisition	**SF**	**261360**	**$**	**5**	**$**	**1,306,800**
Contingency	%	30%	$	1,665,000	$	499,500
	Total				**$**	**4,120,010**

JARBO DITCH
SCENARIO 1
OPINION OF PROBABLE COST

Appendix A
City of Kemah - Master Drainage Plan
Jarbo Ditch - Scenario 1
Opinion of Probable Cost

Item	Unit	Quantity		Unit Price		Total Cost
Mobilization	%	5%	$	907,000	$	45,350
STORM SEWER						
Concrete Box Culvert (8 ft x 7 ft)	LF	130	$	650	$	84,500
Cement Stabilized Sand Backfill	CY	100	$	25	$	2,500
CHANNEL						
Class C Concrete Headwall	CY	100	$	800	$	80,000
Concrete Rip Rap (Class B)	CY	170	$	250	$	42,500
Excavation and Off-Site Disposal (Channel)	CY	32000	$	13	$	416,000
Hydromulch	AC	8	$	2,000	$	16,000
Ditch Interceptor Structure (Class A)	EA	10	$	3,000	$	30,000
5" Concrete Slope Paving	SY	1060	$	80	$	84,800
Concrete Retaining Wall	SF	400	$	75	$	30,000
Backslope Drainage System Swales	LF	6600	$	5	$	33,000
Crushed Limestone Flexible Base, 6" Thickness	SY	3700	$	20	$	74,000
GENERAL ITEMS						
Groundwater Control	LF	130	$	20	$	2,600
Trench Safety System	LF	130	$	2	$	260
Traffic Control	LS	1	$	10,000	$	10,000
Full Depth Pavement Repair (11"), including subgrade and concrete curbs, all depths	SY	145	$	125	$	18,125
Utility Relocations (Estimate)	LS	1	$	500,000	$	500,000
MISCELLANEOUS ITEMS						
Extra Work Items	%	4%	$	907,000	$	36,280
SW3P, Bonds & Permits	%	5%	$	907,000	$	45,350
Planning, Engineering & Design	%	15%	$	907,000	$	136,050
Construction Management	%	10%	$	907,000	$	90,700
Parcel Acquisition	**SF**	**198000**	**$**	**10**	**$**	**1,980,000**
Contingency	%	30%	$	907,000	$	272,100
	Total				**$**	**4,030,115**

JARBO DITCH
SCENARIO 2
OPINION OF PROBABLE COST

Appendix A
City of Kemah - Master Drainage Plan
Jarbo Ditch - Scenario 2
Opinion of Probable Cost

Item	Unit	Quantity	Unit Price	Total Cost
Mobilization	%	5%	$ 291,000	$ 14,550
CHANNEL				
Excavation and Off-Site Disposal (Channel)	CY	10000	$ 13	$ 130,000
Hydromulch	AC	5	$ 2,000	$ 10,000
Ditch Interceptor Structure (Class A)	EA	8	$ 3,000	$ 24,000
Concrete Retaining Wall	SF	400	$ 75	$ 30,000
Backslope Drainage System Swales	LF	5400	$ 5	$ 27,000
Crushed Limestone Flexible Base, 6" Thickness	SY	3000	$ 20	$ 60,000
GENERAL ITEMS				
Traffic Control	LS	1	$ 10,000	$ 10,000
Full Depth Pavement Repair (11"), including subgrade and concrete curbs, all depths	SY	145	$ 125	$ 18,125
Utility Relocations (Estimate)	LS	1	$ 250,000	$ 250,000
MISCELLANEOUS ITEMS				
Extra Work Items	%	4%	$ 291,000	$ 11,640
SW3P, Bonds & Permits	%	5%	$ 291,000	$ 14,550
Planning, Engineering & Design	%	15%	$ 291,000	$ 43,650
Construction Management	%	10%	$ 291,000	$ 29,100
Parcel Acquisition	**SF**	**60000**	**$ 10**	**$ 600,000**
Contingency	%	30%	$ 291,000	$ 87,300
	Total			**$ 1,359,915**

APPENDIX B
FEMA MAPS

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988. Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was STATE PLANE TEXAS SOUTH CENTRAL FIPS 4204. The **horizontal datum** was the North American Datum of 1983 (NAD 83), GRS1980 Spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at https://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland, 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at https://www.ngs.noaa.gov/.

Base Map information shown on this FIRM was derived from Galveston Central Appraisal District, NOAA, National Geodetic Survey, Texas Natural Resources Information System, U.S. Fish and Wildlife Service and the U.S. Geological Survey and were provided in digital format using source material at a scale of 1:20,000 or better.

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Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Information eXchange** at 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letter of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Information eXchange may also be reached by Fax at 1-800-358-9620 and their website at https://www.msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at https://www.fema.gov/national-flood-insurance-program.

The AE Zone category has been divided by a Limit of Moderate Wave Action (LiMWA). The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave. The effects of wave hazards between the VE Zone and the LiMWA (or between the shoreline and the LiMWA for areas where VE Zones are not identified) will be similar to, but less severe than those in the VE Zone.

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

- Floodplain Boundary
- Floodway Boundary
- Zone D Boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- Limit of Moderate Wave Action
- 513 — Base Flood Elevation line and value; elevation in feet*
- (EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

- A — A — Cross section line
- 23 — 23 — Transect line
- Culvert
- Bridge
- Footbridge
- 45° 02' 08", 93° 02' 12" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
- 4989000mN — 1000-meter Universal Transverse Mercator grid ticks, zone 15
- 4989000FT — 5000-foot grid values: Texas State Plane Coordinate System, (FIPS Zone 4204), Lambert Conformal Conic
- DX5510 — Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5 — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
AUGUST 15, 2019

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0042G

FIRM
FLOOD INSURANCE RATE MAP

GALVESTON COUNTY, TEXAS
AND INCORPORATED AREAS

PANEL 42 OF 600
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CLEAR LAKE SHORES, CITY OF	485461	0042	G
GALVESTON COUNTY	485470	0042	G
KEMAH, CITY OF	485481	0042	G

MAP NUMBER
48167C0042G

EFFECTIVE DATE
AUGUST 15, 2019

Federal Emergency Management Agency

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NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
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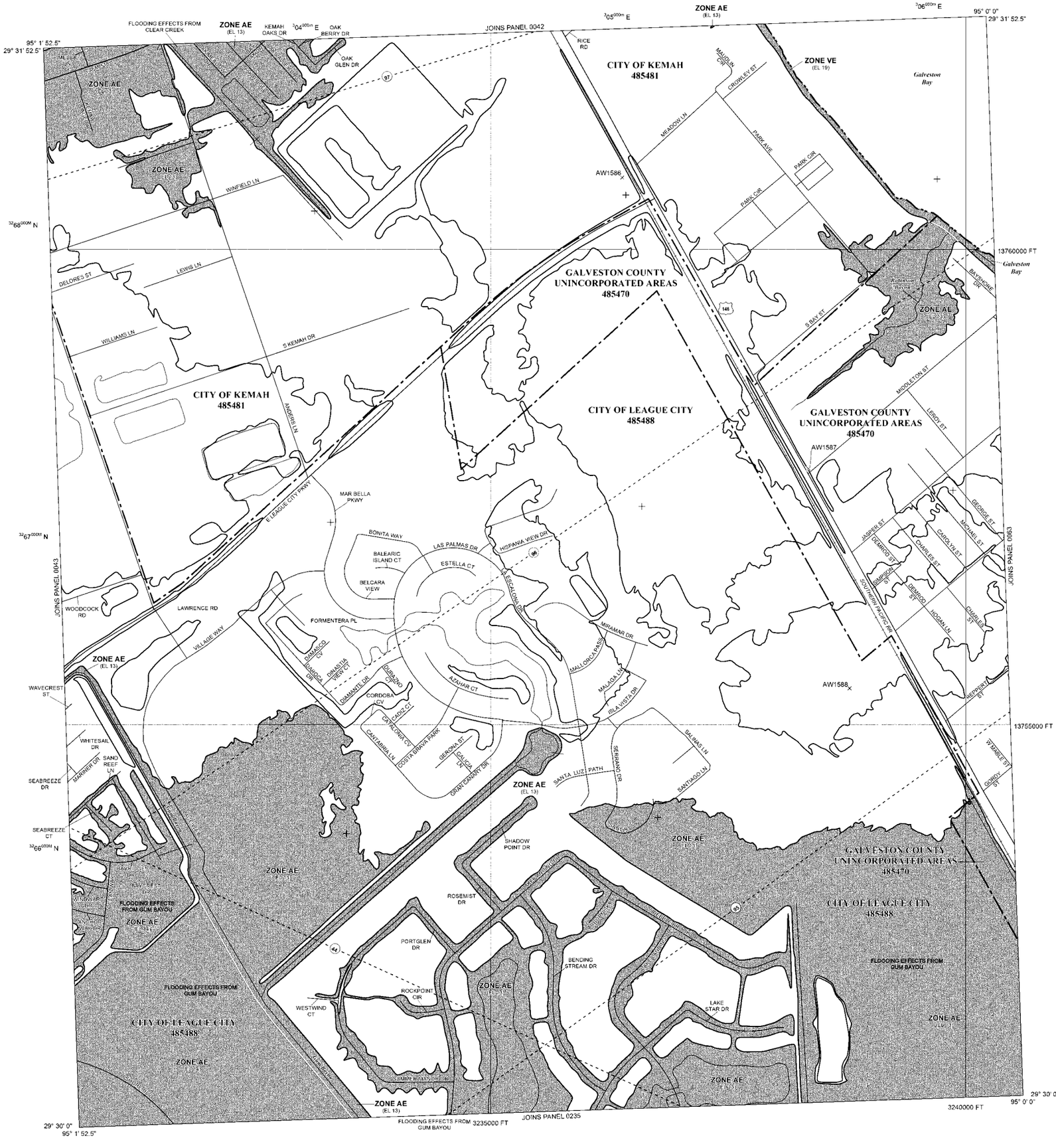

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

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ZONE A No Base Flood Elevations determined.

ZONE AE Base Flood Elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

Floodplain Boundary
Floodway Boundary
Zone D Boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities
Limit of Moderate Wave Action
513 — Base Flood Elevation line and value; elevation in feet*
(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*
*Referenced to the North American Vertical Datum of 1988
A — A — Cross section line
23 — 23 — Transect line
Culvert
Bridge
Footbridge
45° 02' 08", 93° 02' 12" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
3289000mN — 1000-meter Universal Transverse Mercator grid ticks, zone 15
4989000FT — 5000-foot grid values: Texas State Plane Coordinate System, (FIPS Zone 4204), Lambert Conformal Conic
DX5510 — Bench mark (see explanation in Notes to Users section of this FIRM panel)
M1.5 — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
AUGUST 15, 2019

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'
250 0 500 1000 FEET
150 0 150 300 METERS

NFIP NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0044G

FIRM
FLOOD INSURANCE RATE MAP

GALVESTON COUNTY, TEXAS AND INCORPORATED AREAS

PANEL 44 OF 600
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
GALVESTON COUNTY	485470	0044	G
KEMAH, CITY OF	485481	0044	G
LEAGUE CITY, CITY OF	485488	0044	G

MAP NUMBER
48167C0044G

EFFECTIVE DATE
AUGUST 15, 2019

Federal Emergency Management Agency

APPENDIX C
LIGHTHOUSE DISTRICT MASTER DRAINAGE STUDY

Report

Master Drainage Study

OCTOBER 2009

LJA Project No. E135-0090

LJA Engineering & Surveying, Inc.

East Houston Office
11821 East Freeway, Suite 400
Houston, Texas 77029
Ph: 713.450.1300
Firm Registration No.: F-1386

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EXHIBITS

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I. INTRODUCTION

Purpose and Scope

On June 15, 2009, LJA Engineering and Surveying, Inc. was authorized, by action of the City Council for the City of Kemah, to prepare a Master Drainage Study for the marina area business district of the City served by the City's existing drainage pump station. The marina area business district is generally bounded by Clear Creek on the north, Galveston Bay on the east, Tenth Street on the south, and by State Highway 146 on the west. Exhibit 1 shows the planned study area.

The City of Kemah Master Drainage Plan for the marina business district was completed with the intent to gather previous information regarding the study area, provide analysis, review current and anticipated development, determine the extent and operation of the existing drainage system(s), address existing drainage conditions, develop proposed improvements to correct and/or reduce flooding in the area, and generate costs associated with the necessary improvements.

Data Sources

Data was gathered from a variety of sources including earlier drainage projects, street improvement projects, Texas Department of Transportation plans, aerial photography, TSARP photogrammetry, field reconnaissance, from discussions and correspondence with area entities, and observations of citizens and City personnel.

Background Information

Over the course of the last 20 years, the City of Kemah, in general and especially within the marina area, has seen commercial development and some residential development. Most of the commercial development (which includes parking facilities) has been through redevelopment of existing property. In most cases single family housing has been lost to the commercial development.

The City of Kemah has the sole responsibility to provide and maintain storm sewers and their outfalls. However, many of the storm sewers in various locations within the marina area have been constructed by the developer during the redevelopment of various properties. Some of these drainage facilities either remain the developer's responsibility for maintenance while others have become the City's responsibility for maintenance.

Drainage controls in and around the marina area of the City of Kemah include most every type of drainage structure currently used in the practice of storm water management. Included in the overall drainage controls for the City are natural drainage channels; improved earthen ditches; roadside ditches with culverts of various shapes, sizes, and materials; piped roadside ditches; storm sewer systems; detention facilities (mostly private); and a storm water pump station.

II. BACKGROUND CONSIDERATIONS

Base Map Development

The base map for the study was developed from existing information. The base map utilizes an aerial of the study area supplemented by data from the FEMA flood plain map for Galveston County – Kemah area, the 7th Street Paving and Drainage project, previous surveys associated with the storm water pump station facility, and additional site reconnaissance coupled with spot topographic survey data.

No existing storm sewer map was found for the City of Kemah. Previous survey information was coupled with the field reconnaissance in an attempt to determine the existing storm sewer size and location along 6th Street and Texas Avenue.

Texas Department of Transportation plans indicate little to none of the State Highway 146 drainage enters into the City of Kemah system but is self contained with discharge to the Clear Creek Channel. The two systems appear to combine downstream of the City's stormwater pump station.

Land Use Update

The land use was developed based upon the latest aerial maps (2006) supplemented by field reconnaissance. The final land plan for the study was also affected by the changes observed from a previous drainage investigation undertaken with the 7th Street Paving and Drainage project. The study area has become increasingly more impervious as older single family residences are replaced with commercial establishments and/or parking facilities. Even in areas along Galveston Bay where single family residences are replaced with new single family residences, most new residences contain a larger foot print with greater under roof area and thus are more impervious. Generally the study area will become more impervious and the analysis part of the study will reflect greater runoff.

Hydrologic Parameters

Hydrologic parameters for each sub-drainage area were updated using the anticipated and updated land use database. The land use categories were assigned a numerical runoff coefficient quantified by the percent development and percent impervious. The land use plan was merged with the sub-drainage area boundaries to obtain a database consistent with the existing and/or anticipated land use within each sub-drainage area. A composite percent development and percent imperviousness was computed for each sub-drainage area.

Drainage Areas

The study area was determined to contain several areas not connected to the existing system served by the stormwater pump station. The marina area, boardwalk area, and the transition area (south of the boardwalk, east of the marina, north of mid block between 5th and 6th Streets, and Galveston Bay) are not served by the storm water pump station thus are not included in the drainage evaluation.

The stormwater pump station drainage system is comprised of approximately 48.5 acres. The overall drainage area can be subdivided into approximately 71 subareas or sub-drainage areas. The number of sub-drainage areas has increased over the years due to the alteration of the land use from its original concept of single family residential to commercial/parking. The original concept of sheet flow drainage from the rear of each lot to the front of each lot has been altered by the development. Exhibit 2 provides an overview of each sub-drainage area contained within the study area.

Facilities

Storm Sewer System

The existing storm sewer system is comprised of numerous small diameter collector storm sewers, piped road side ditches, and some remaining open roadside ditches. A trunk storm sewer extends from the existing pump station at Texas and 2nd Street to approximately 7th Street and Bradford.

The trunk sewer is comprised of an older section from the pump station to 6th near Harris. The older section is believed to be 54-inches from beginning to end. A portion of the system is currently flooded. The system generally extends along the west side of Texas from 2nd Street to 3rd Street and is believed to angle across Texas to the east side then along the east side of Texas to 6th Street. The 54-inch storm sewer extends along the north side of 6th Street to mid block between Texas and Harris. A major blockage of some type exists between the existing storm water pump station fore bay (existing manhole at Texas Avenue and 2nd Street) and the existing manhole at Texas and 3rd Street. The two manholes connect the 54-inch storm sewer along the west side of Texas Avenue. The manhole at Texas Avenue and 2nd Street is dry with little evidence of siltation. The manhole at 3rd Street and Texas Avenue is flooded with evidence of major siltation. Siltation, due to system backup, was noted as far upstream as 6th Street and Harris Street.

The newer section of trunk storm sewer was constructed with the City's roadway improvements along 7th Street in 2002. The trunk sewer is comprised of 8'x4' box culverts along the south side of 6th Street from mid block between Texas and

Harris to Harris, a 6'x4' box culvert along Harris from 6th to 7th Streets , and a 54-inch pipe storm sewer along 7th Street to Bradford. Three 30-inch pipe storm sewers connect the new trunk sewer with the old trunk sewer across 6th Street.

Pump Station

The existing pump station is comprised of small forebay and at the time of the field reconnaissance a single storm water pump. The existing station has capacity and condition limitations which affect the overall performance and ability of the storm sewer system.

III. DESIGN CRITERIA

Methodology

Typically, for areas up to 200 acres served by storm sewers or roadside ditches, peak discharges are based upon the Rational Method.

Rational Method

The hydrologic method use to calculate peak flow rates for the drainage area was the Rational Method. The Rational Method equations are as follows:

$Q = CIA$

where:

Q = maximum rate of runoff, in cfs
C = runoff coefficient (weighted average)
i = average rainfall intensity, in inches/hour
A= drainage area, in acres

Runoff Coefficient

The runoff coefficient (C) is determined using typical Engineering Design Criteria for drainage systems utilized by other municipalities within the greater Houston area. The runoff coefficients vary based upon land use. Since the drainage area consists of pavement, residential areas, and commercial, the following C values were used to represent the land use within the drainage area.

Drainage Area Description	*Runoff Coefficient*
Pavement/Roofs	0.95
Residential – lots less than 5,000 sf	0.70
Residential – lots 5,000 sf to 8,000 sf	0.60
Residential – lots 8,000 sf to 0.25 ac	0.50
Residential – Multi Family	0.75
Parks/Open Areas	0.20
Commercial	0.90

Weighted composite C values were computed for the sub-drainage areas within the watershed. The composite values give equal weight to each sub-drainage area as a part of the whole drainage area. The composite values are dependant

upon each sub-drainage areas type of development and its impact upon the overall drainage system's coefficient.

Time of Concentration

The time of concentration for storm sewers and/or roadside ditches shall be the time of concentration of the previous upstream contribution area plus the time of flow in the pipe or ditch. Typically for undeveloped areas the time of concentration of the first analysis point shall consist of the inlet time plus a 15 minute initial concentration time. Typically for developed areas the time of concentration of the first analysis point shall consist of the inlet time plus a 10 minute initial concentration time,

Intensity – Duration Values

The time of concentration of runoff is used to determine the rainfall intensity component of the Rational Method formula. Typically intensity-duration curves are used for storm sewer and roadside ditch design. The curves are derived from the National Weather Service publications HYDRO-35 and Technical Paper No. 40 along with the U.S.G.S. WRI Report 98-4044. The curves are a family of curves for various rainfall events-the 3-year, 5-year, 10-year, 25-year, and 100-year events. Typically, storm sewers within the greater Houston area are designed to handle the 3-year frequency events runoff. The 3-year event, which is equivalent to a rainfall intensity of having a 33% probability of being exceeded in any given rainfall event, was selected for the analysis within this report. Rainfall intensity for the 3-year event is 6.2 inches per hour at an initial time of concentration of 10 minutes and is 5.3 inches per hour at an initial time of concentration of 15 minutes.

IV. DRAINAGE PLAN

Development within the study area has had significant impact on the ability of the existing drainage system to convey storm water away from especially low elevation areas such as Harris and 7th Street. The study area has experienced an increase in the imperviousness as a part of redevelopment and consequently most rainfall events result in more runoff than most of the existing system is capable of handling. The exception is the storm sewers installed in 2002 with the 7th Street roadway project. These storm sewers have sufficient capacity to handle the additional runoff. The overall condition, single operational unit, lack of firm pumping capacity, along with the lack of pump protection (debris racks) dictate the storm water pump station be replaced.

Storm Sewers

Two storm sewer drainage plan alternatives were developed to provide drainage to the study area. Both proposed storm sewer alternatives utilize all of the 2002 constructed storm sewers. Much of the two storm sewer alternatives are the same. The lower reach of both storm sewer systems, between the pump station and the intersection of Harris and 7th Street is exactly identical in size, location, and cost. The same is true of the upper reach from Bradford and 9th Street to upper terminus near 10th Street and Kipp Street. The middle portion of each trunk sewer provides the primary differences of routing between the two alternatives. The trunk sewer of Alternative "A", shown on Exhibit 3, travels a more central to the overall drainage area for the middle reach route. The central portion of trunk sewer for Alternative "B", as shown on Exhibit 4, lies closer to businesses fronting along State Highway 146. The entire drainage area is served by both alternatives by slightly different collector storm sewers. Exhibits 5 and 6 provide a typical roadway cross section of storm water systems combined with upgraded piped ditch drainage. Both plans require the replacement of the existing storm water pump station to be effective.

Alternative "A"

The routing of trunk storm sewer Alternative "A" proceeds east along 7th Street (existing sewer to remain), thence south along Bradford to 9th Street. The route is more central to the overall drainage area. However, the previously constructed storm sewer stub across 7th Street at Bradford is now two small needing to be a 48-inch in lieu of the constructed 36-inch. The proposed Alternative "A" would construct approximately 3,003 linear feet of storm sewer ranging from 8'x4' box culverts to 24-inch pipe storm sewers. The trunk storm sewer for Alternative "A" also requires 15 manholes with an expected construction cost of $1,116,000.00. The alternative requires five collector storm sewers consisting of approximately 2,672 linear feet of storm sewer ranging from 24-inch to 48-inch along with twenty one manholes. The expected construction cost for the collector storm sewers is $283,728.00. The overall estimated construction cost for the trunk and

collection sewers for Alternative "A" is $1,399,728.00. The proposed storm water pump station cost must be added to the sewer costs for a complete project cost.

Alternative "B"

The routing of trunk storm sewer Alternative "B" proceeds south along Harris Street thence east along 9th Street to Bradford. The route is more westerly (closer to businesses along State Highway 146) of the overall drainage area. Again, 7th Street would need to be crossed but this time at Bradford with a new, previously not planned, 54-inch storm sewer. The proposed Alternative "B" would construct approximately 3,615 linear feet of storm sewer ranging from 8'x4' box culverts to 24-inch pipe storm sewers. The trunk storm sewer for Alternative "B" also requires fifteen manholes with an expected construction cost of $1,192,758.00. The alternative requires five collector storm sewers consisting of approximately 2,327 linear feet of storm sewer ranging from 24-inch to 54-inch along with twenty manholes. The expected construction cost for the collector storm sewers is $243,348.00. The overall estimated construction cost for the trunk and collection sewers for Alternative "B" is $1,436,106.00. The proposed storm water pump station cost must be added to the sewer costs for a complete project cost.

Pump Station

A replacement for the existing pump station would be a multiple pump facility consisting of three pumps each capable of 18,000 gallons per minute (120 cubic feet per second). The proposed pump station would replace the existing facility within the public right-of-way of 2nd Street between Texas and State Highway 146. The new station will require forebay improvements, a trash rack (pump protection), and downstream channel rectification besides the new pumping units and appurtenances. The estimated construction cost for the storm water pump station is $1,066,395.00.

V. RECOMMENDATIONS

Two things are clear based upon data collected for the project. First, if the existing or future storm sewers were connected directly to the Clear Creek Channel or the Marina, water would begin to pool in the low area of Harris Street (near 7th Street) during any event of water surface elevations from the bay in excess of two (2) feet. Water would pool even during non-rainfall events. Secondly, most of the marina bulkhead is slightly below elevation 5.0. Therefore, water surfaces at or above elevation 5.0 overflow from the Clear Creek Channel and/or the Marina would begin to enter the storm sewer system. The overflow would set up a sort of "do loop" where water would circulate between the storm sewer to pump station to channel/marina to storm sewer. Consequently, the storm sewer and pump station would only be effective for those events not accompanied by high water levels within the Clear Creek Channel and/or Marina.

Development within the study area has had significant impact on the ability of the existing drainage system to convey storm water away from especially low elevation areas – Harris and 7th Street. The study area has experienced an increase in the imperviousness as a part of redevelopment and consequently most rainfall events result in more runoff than the existing system is capable of handling. The condition is exasperated currently by a blockage within the main trunk storm sewer on Texas between 2nd Street and 3rd Street. The extent and reason for the blockage is unknown but siltation due to the blockage extends upstream for over one thousand feet to the area of 6th Street and Harris. The blockage creates flooding conditions, especially along Harris Street at 7th Street, for even the slightest rainfall event. The blockage should be removed and the existing storm sewer de-silted.

The existing storm water pump station is in poor condition with only one pump available for service at the time of the field reconnaissance. The pump station should be replaced in order to provide adequate storm water removal from the existing and/or proposed storm water sewer system.

The existing trunk storm sewer and collection storm system should be expanded and replaced to provide drainage within the study area. Either alternative would provide the City with an adequate drainage system. Alternative "A", which is slightly cheaper, would require cutting the 7th Street pavement at two locations (Bradford and Harris Streets). Alternative "B" would require cutting the 7th Street pavement only at Harris Street. Alternative "B" will provide greater flexibility to the City; especially should the City select to phase the construction over an extended period of time. Table 1 provides an estimated project cost for the recommended project.

Table 1
City of Kemah
Recommended Drainage Project
Probable Costs

Construction Costs (Estimated)

Trunk & Collector Sewers (Alternative "B")		
Collector Sewer A (trunk sewer)	$	993,965.00
Collector Sewer B		29,250.00
Collector Sewer C		53,520.00
Collector Sewer D		36,320.00
Collector Sewer E		71,060.00
Collector Sewer F		12,640.00
Storm Water Pump Station		927,300.00
Total Construction Costs	***$***	***2,124,055.00***
Construction Contingency		***378,446.00***
Total Construction Costs	***$***	***2,502,501.00***

Non-Construction Costs (Estimated)

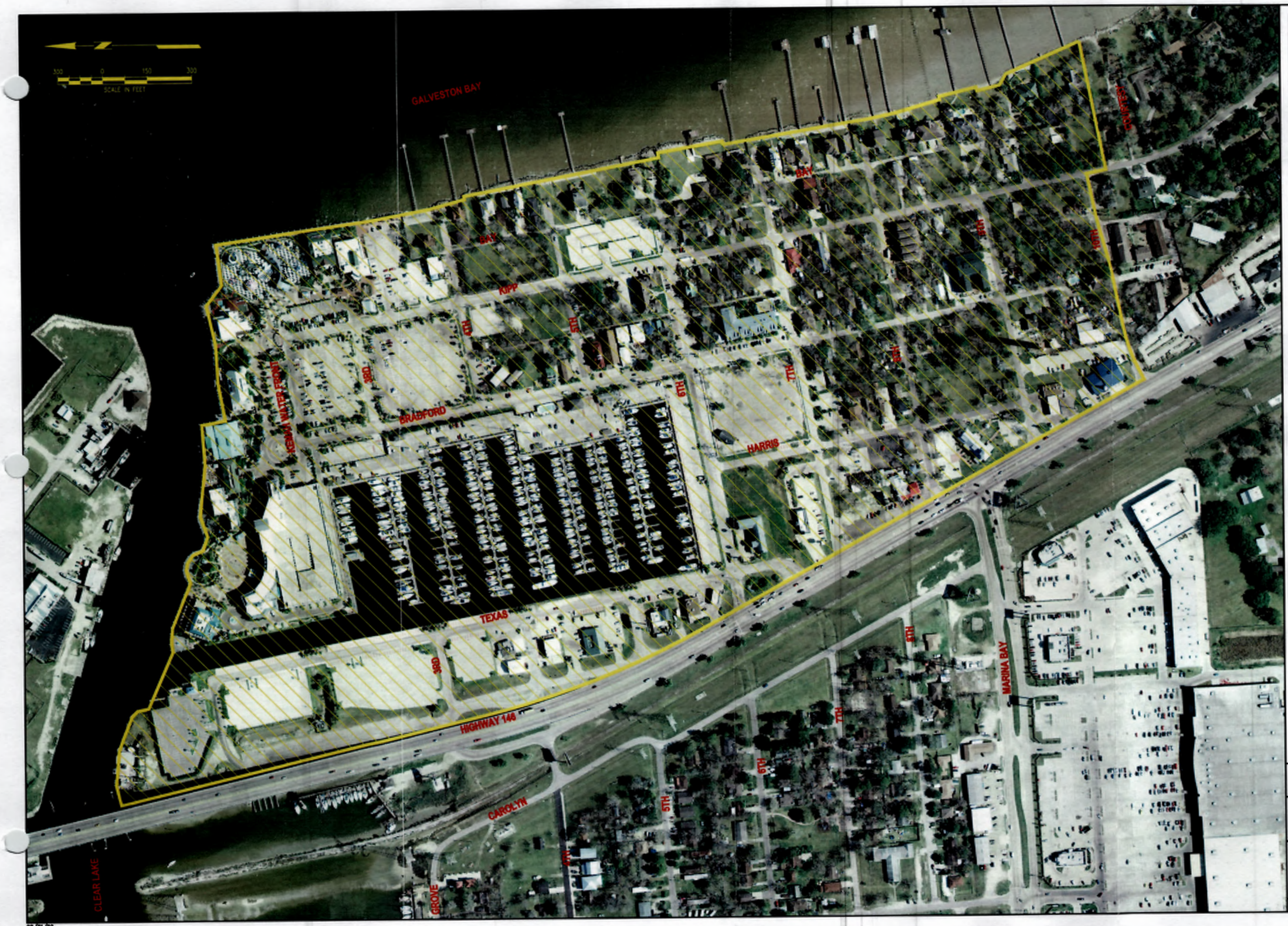
Engineering		
Preliminary & Design	$	170,170.00
Bidding		10,650.00
Construction		31,900.00
Surveys		67,500.00
Geotechnical		20,000.00
Materials Testing		30,000.00
Project Representative		125,000.00
Miscellaneous		5,000.00
Total Non-Construction Costs	***$***	***460,220.00***
Non-Construction Contingency	***$***	***46,020.00***
Total Non-Construction Costs	***$***	***506,240.00***
Total Project Costs	***$***	***3,008,741.00***

The project can be phase constructed to allow the City to construct different portions of the overall project as funding becomes available. The phased construction must proceed in an orderly manner to ensure the facilities will provide the intended service. The following are the prescribed order for the phased construction:

1. Storm Water Pump Station

2. Collection System A (trunk storm sewer)
   The trunk sewer can also be phased from downstream to upstream.

3. Collection Systems B, C, D, E, & F
   The collection systems can also be phased dependant upon completion of System A



LEGEND

DRAINAGE AREA & SUB-AREA DIVIDE

CITY OF KEMAH
MASTER DRAINAGE STUDY

STUDY AREA

LJA Engineering & Surveying, Inc.
11821 East Freeway
Suite 400
Houston, Texas 77029
Phone 713.450.1300
Fax 713.450.1385

SCALE: 1" = 300' | JOB No. 0135-0080 | EXHIBIT No. 1

135-009-EXH 1 THRU 4 (11X17-1:1)

08/31/09

LEGEND

DRAINAGE AREA & SUB-AREA DIVIDE

AAA 0.91 — SUB-AREA DESIGNATION / AREA IN ACRES

CITY OF KEMAH
MASTER DRAINAGE STUDY

DRAINAGE AREAS AND SUB-AREAS

LJA Engineering & Surveying, Inc.
11921 East Freeway
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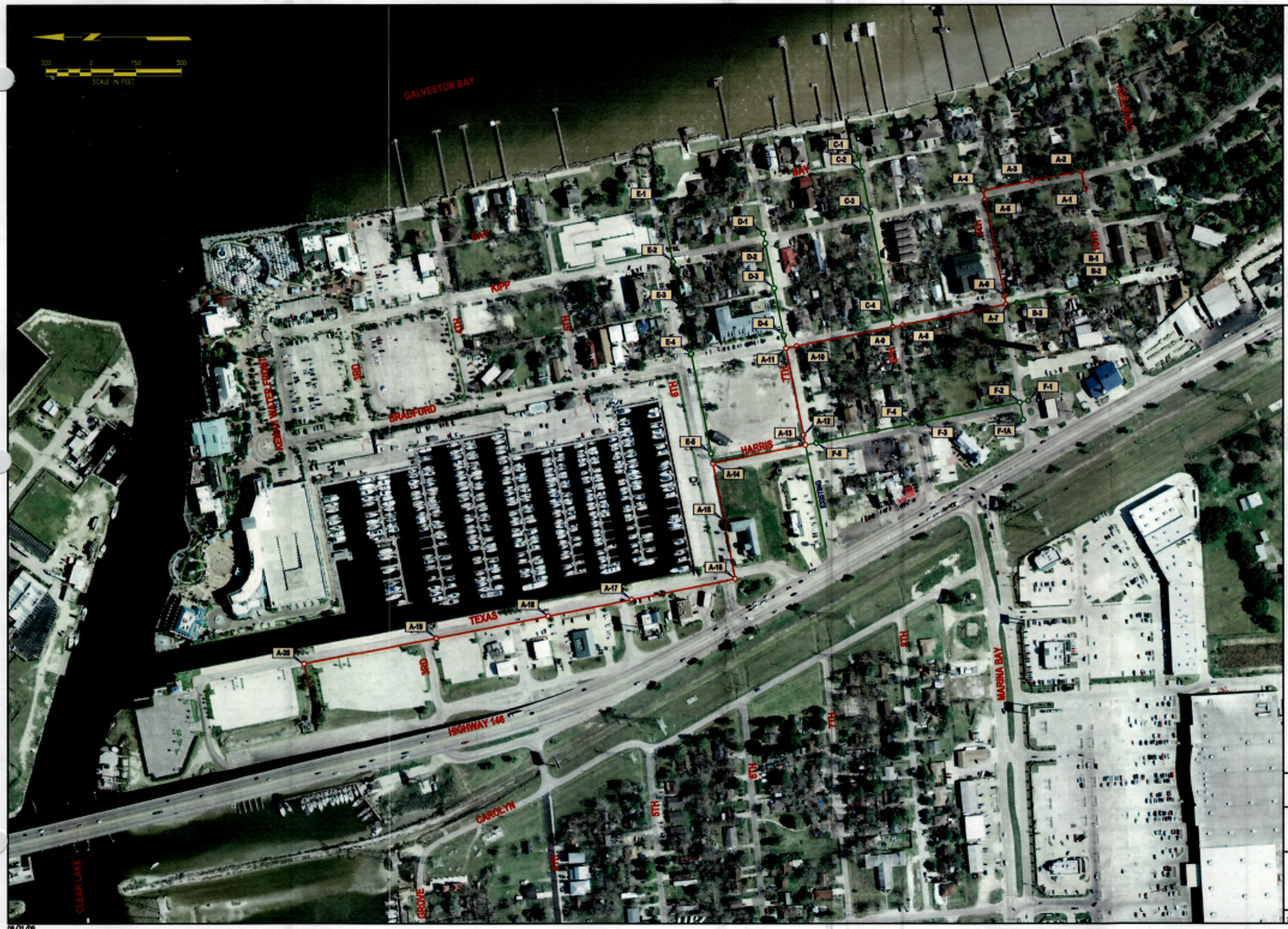
Houston, Texas 77029
Phone 713.450.1300
Fax 713.450.1385

SCALE: 1" = 300' | JOB No. 0135-0080 | EXHIBIT No. 2

08/31/09

135-009-EXH 1 THRU 4 (11X17-1:1)



LEGEND

- PROPOSED TRUNK STORM SEWER
- PROPOSED COLLECTOR STORM SEWER
- A-20 PROPOSED STORM SEWER MANHOLE

CITY OF KEMAH
MASTER DRAINAGE STUDY

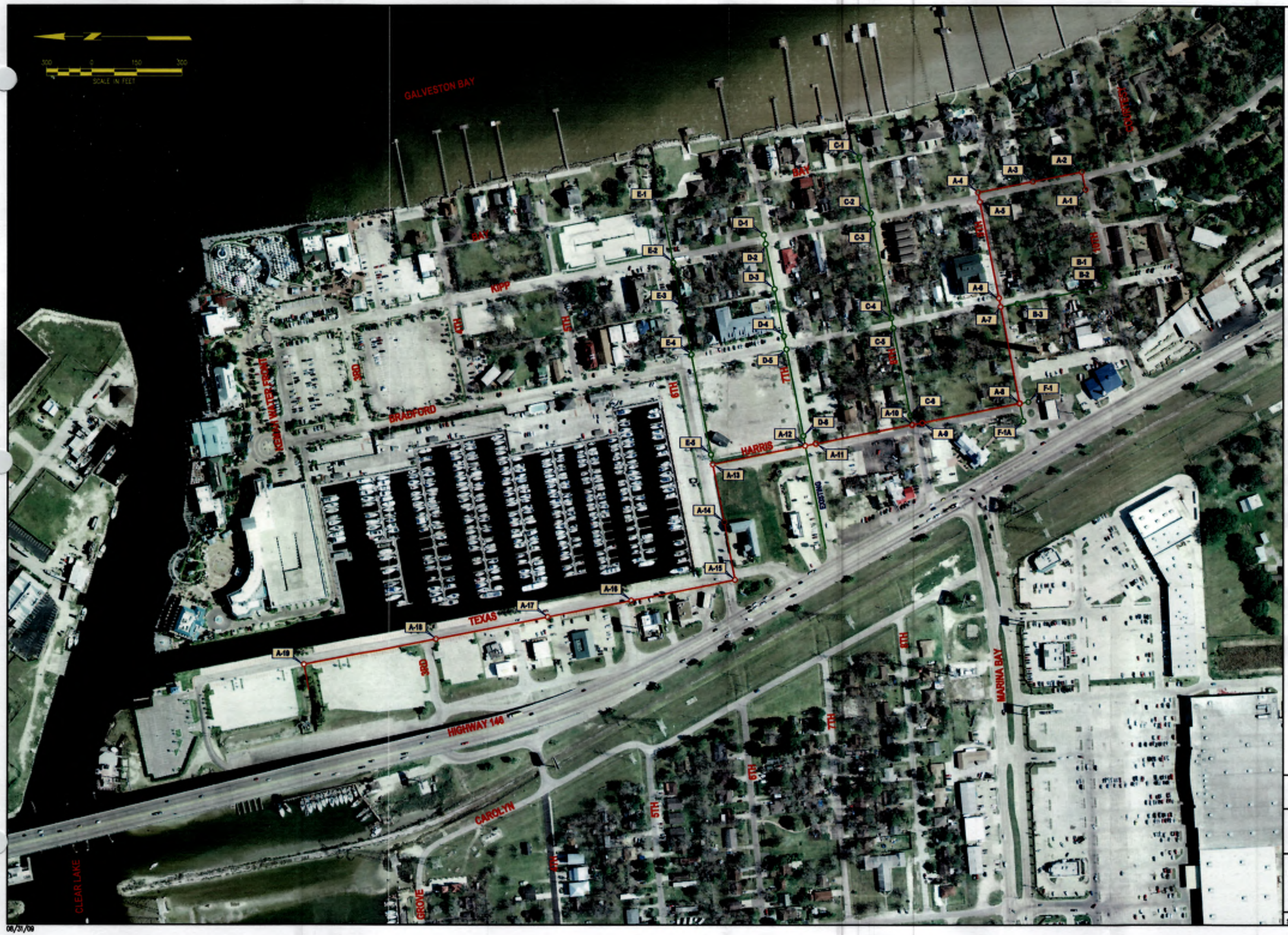
PROPOSED STORM SEWER ALTERNATIVE "A"

LJA Engineering & Surveying, Inc.
11821 East Freeway
Suite 400
Houston, Texas 77029
Phone 713.460.1300
Fax 713.460.1385

SCALE: 1" = 300'	JOB No. 0135-0060	EXHIBIT No. 3

02/31/09

135-009-EXH 1 THRU 4 (11X17-1:1)



LEGEND

- PROPOSED TRUNK STORM SEWER
- PROPOSED COLLECTOR STORM SEWER
- A-20 PROPOSED STORM SEWER MANHOLE

CITY OF KEMAH
MASTER DRAINAGE STUDY

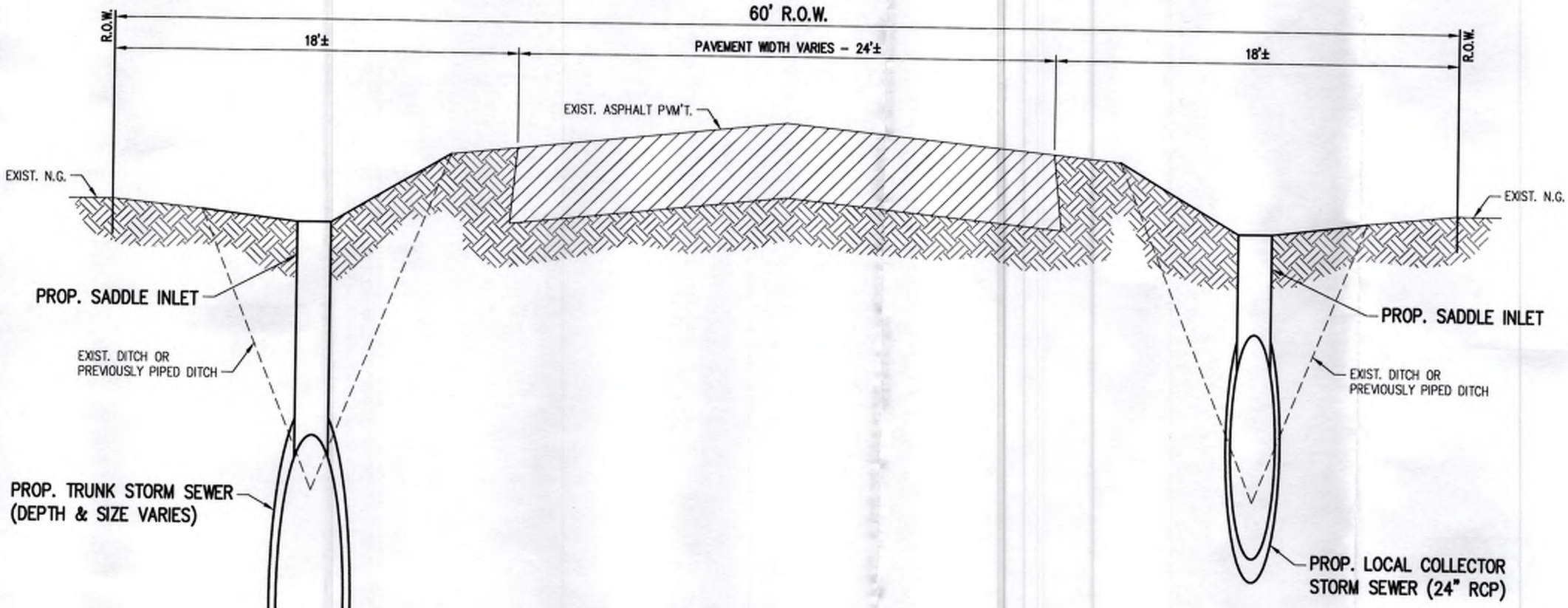
PROPOSED STORM SEWER ALTERNATIVE "B"

LJA Engineering & Surveying, Inc.
11821 East Freeway
Suite 400
Houston, Texas 77029
Phone 713.450.1300
Fax 713.450.1305

SCALE: 1" = 300' | JOB No. 0135-0090 | EXHIBIT No. 4

08/31/09

135-009-EXH 1 THRU 4 (11007-fc1)



TYPICAL ROADWAY PLAN w/ TRUNK & COLLECTOR STORM SEWERS

SCALE: 1" = 5' HORIZ.
1" = 1' VERT.

08/27/09

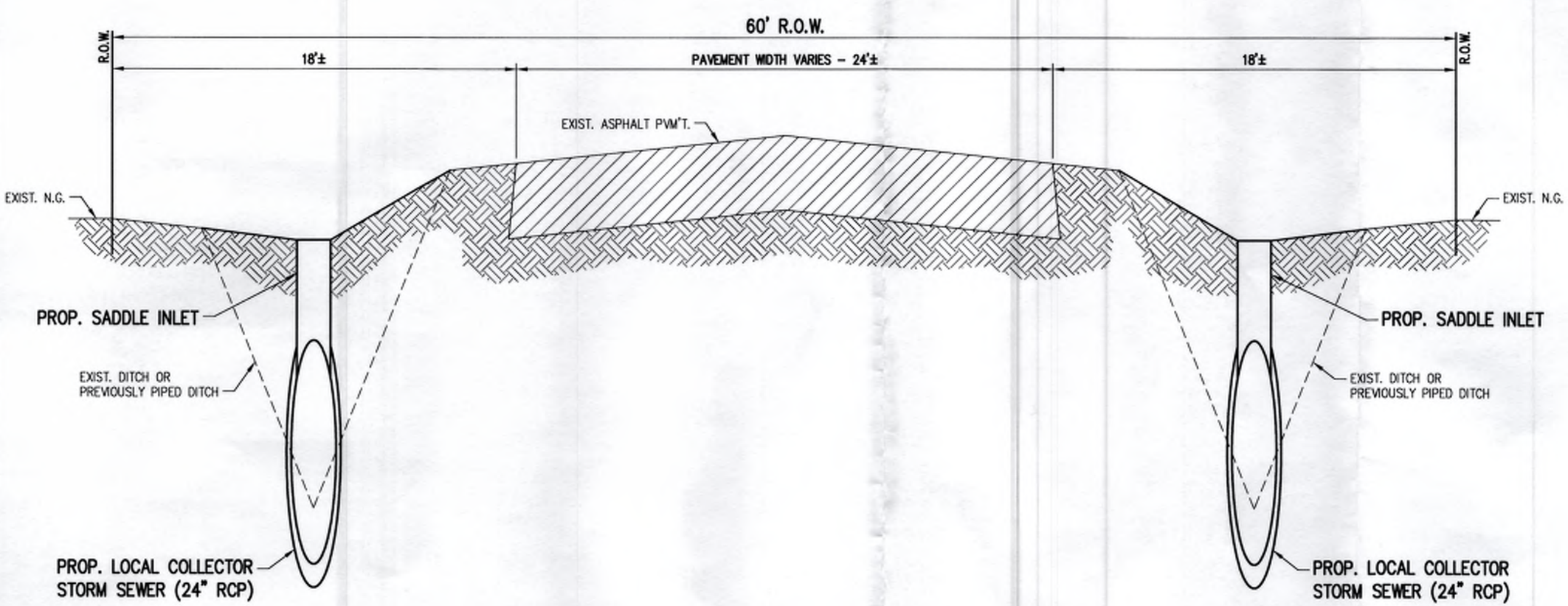
CITY OF KEMAH
MASTER DRAINAGE STUDY

TYPICAL ROADWAY PLAN w/ TRUNK STORM SEWER

LJA Engineering & Surveying, Inc.
11821 East Freeway
Suite 400
Houston, Texas 77029
Phone 713.450.1300
Fax 713.450.1385

SCALE: 1" = 5' HORIZ.
1" = 1' VERT. JOB No. 0135-0090 EXHIBIT No. 5

135-009-EXH5 TYP SECT (11X17-1:5)



TYPICAL ROADWAY PLAN
w/ COLLECTOR STORM SEWERS ONLY

SCALE: 1" = 5' HORIZ.
1" = 1' VERT.

CITY OF KEMAH
MASTER DRAINAGE STUDY

TYPICAL ROADWAY PLAN w/ COLLECTOR STORM SEWERS ONLY

LJA Engineering & Surveying, Inc.
11921 East Freeway
Suite 400
Houston, Texas 77029
Phone 713.450.1300
Fax 713.450.1385

SCALE: 1" = 5' HORIZ. 1" = 1' VERT. JOB No. 6135-0090 EXHIBIT No. 6

08/27/09

135-009-EX46 TYP SECT (11X17-1:5)

APPENDIX A

CITY OF KEMAH
Drainage System - Alternative "A"

Mark Number	FROM Sta	TO Sta	Area (ac)	TOTAL AREA (ac)	TIME (Min.)	RUNOFF COEF. "C" (weighted)	Intensity I (in/hr)	Runoff Qd (cfs)	REACH Length (ft)	LINE SIZE	LINE Mann. Const.	LINE SLOPE (%)	DESIGN Qc (cfs)	DESIGN V (fps)	RATIO Qd/Qc	SLOPE FALL (ft)	OTHER LOSSES (ft)	FLOWLINE UP-STR. (ft)	FLOWLINE DN-STR. (ft)	ACTUAL VEL. (fps)	SLOPE HYDGRD %	Change in HGL (ft)	UP-STR. H.G.L. (ft)	DN-STR. H.G.L. (ft)	UP-STR. N.G. (ft)	DEPTH BELOW (ft)
A	A-1	A-2	0.57	0.57	15.27	0.60	5.24	1.79	30	24"	0.013	0.17	9.5	3.0	0.19	0.05	0.00	2.46	2.41	2.7	0.03	0.01	1.46	1.46	10.00	8.54
A	A-2	A-3	1.31	1.88	15.44	0.46	5.21	4.51	160	24"	0.013	0.17	9.5	3.0	0.47	0.31	0.00	2.41	2.11	3.3	0.07	0.13	1.46	1.33	9.00	7.54
A	A-3	A-4	1.19	3.07	16.44	0.44	5.06	6.84	170	24"	0.013	0.17	9.5	3.0	0.72	0.29	0.00	2.11	1.82	3.4	0.07	0.12	1.33	1.21	9.00	7.67
A	A-4	A-5	2.99	6.06	17.38	0.60	4.92	17.91	53	30"	0.013	0.22	19.0	3.0	0.94	0.12	0.50	1.32	1.20	3.8	0.08	0.04	1.21	1.17	9.00	7.79
A	A-5	A-6	0.25	6.31	17.68	0.60	4.88	18.49	325	30"	0.013	0.22	19.0	3.0	0.97	0.72	0.00	1.20	0.49	3.8	0.08	0.28	1.17	0.91	9.00	7.83
A	A-6	A-7	2.81	9.12	19.48	0.63	4.65	26.70	25	42"	0.013	0.08	29.0	3.0	0.92	0.02	1.00	-0.51	-0.53	3.0	0.08	0.02	0.91	0.89	9.00	8.09
A	A-7	A-8	0.73	9.85	19.62	0.62	4.63	28.28	330	42"	0.013	0.08	29.0	3.0	0.98	0.26	0.00	-0.53	-0.80	3.0	0.08	0.26	0.89	0.62	8.00	7.11
A	A-8	A-9	2.84	12.69	21.45	0.62	4.41	34.73	25	48"	0.013	0.07	36.0	3.0	0.96	0.02	0.50	-1.30	-1.32	3.0	0.08	0.02	0.62	0.60	9.00	8.38
A	A-9	A-10	2.23	14.92	21.59	0.61	4.40	40.03	330	48"	0.013	0.08	40.0	3.2	1.00	0.26	0.00	-1.32	-1.58	3.3	0.08	0.26	0.60	0.34	6.50	5.90
A	A-10	A-11	0.17	15.09	23.31	0.61	4.21	38.79	25	48"	0.013	0.08	40.0	3.2	0.97	0.02	0.00	-1.58	-1.60	3.3	0.10	0.03	0.34	0.32	6.50	6.16
A	A-11	A-12	7.12	22.21	23.44	0.61	4.20	56.92	296	54"	0.013	0.10	64.0	3.8	0.89	0.30	0.50	-2.10	-2.40	3.8	0.10	0.30	0.32	0.02	2.50	2.18
A	A-12	A-13	0.17	22.38	24.74	0.61	4.07	55.60	23	54"	0.013	0.10	54.0	3.8	1.03	0.02	0.00	-2.40	-2.42	3.8	0.11	0.03	0.02	-0.01	2.50	2.48
A	A-13	A-14	12.94	35.32	24.84	0.62	4.06	88.98	313	6'X4'	0.013	0.10	98.0	4.1	0.91	0.31	0.00	-2.42	-2.73	3.7	0.06	0.19	-0.01	-0.19	4.00	4.01
A	A-14	A-15	7.12	42.44	26.11	0.64	3.95	107.17	199	8'X4'	0.013	0.12	153.0	4.8	0.70	0.24	0.00	-2.73	-2.97	3.5	0.04	0.08	-0.19	-0.27	5.00	5.19
A	A-15	A-16	0.00	42.44	26.80	0.64	3.88	105.51	190	8'X4'	0.013	0.12	153.0	4.8	0.69	0.23	0.00	-2.97	-3.20	3.5	0.04	0.08	-0.27	-0.35	6.00	6.27
A	A-16	A-17	0.41	42.85	27.46	0.64	3.83	104.98	380	8'X4'	0.013	0.12	153.0	4.8	0.69	0.46	0.00	-3.20	-3.65	3.5	0.04	0.15	-0.35	-0.50	4.50	4.85
A	A-17	A-18	0.86	43.71	28.78	0.65	3.72	105.68	365	8'X4'	0.013	0.12	153.0	4.8	0.69	0.44	0.00	-3.65	-4.09	3.5	0.04	0.15	-0.50	-0.65	4.00	4.50
A	A-18	A-19	2.43	46.14	30.05	0.66	3.62	110.27	300	8'X4'	0.013	0.12	153.0	4.8	0.72	0.36	0.00	-4.09	-4.45	3.7	0.04	0.12	-0.65	-0.77	4.00	4.65
A	A-19	A-20	2.35	48.49	31.09	0.67	3.54	115.13	415	8'X4'	0.013	0.12	153.0	4.8	0.75	0.50	0.00	-4.45	-4.95	3.8	0.05	0.21	-0.77	-0.98	4.00	4.77
A	A-20	Outfall	0.00	48.49	32.53	0.69	3.44	115.17	50	8'X4'	0.013	0.12	153.0	4.8	0.75	0.06	0.00	-4.95	-5.01	3.9	0.05	0.03	-0.98	-1.00	4.00	4.98
B	B-1	B-2	0.17	0.17	10.00	0.60	6.23	0.64	40	24"	0.013	0.17	9.5	3.0	0.07	0.07	0.00	1.68	1.62	2.7	0.07	0.03	1.22	1.19	10.00	8.78
B	B-2	B-3	0.39	0.56	10.22	0.65	6.18	2.25	350	24"	0.013	0.17	9.5	3.0	0.24	0.60	0.00	1.62	1.02	2.8	0.08	0.28	1.19	0.91	10.00	8.81
B	B-3	A-7	0.17	0.73	12.17	0.64	5.78	2.70	30	24	0.013	0.17	9.5	3.0	0.28	0.05	0.00	1.02	0.97	2.8	0.08	0.02	0.91	0.89	8.00	7.09
C	C-1	C-2	0.74	0.74	10.00	0.69	6.23	3.18	30	24"	0.013	0.17	9.5	3.0	0.33	0.05	0.00	1.06	1.01	3.0	0.08	0.02	0.84	0.82	10.00	9.16
C	C-2	C-3	0.08	0.82	10.17	0.68	6.20	3.45	155	24"	0.013	0.17	9.5	3.0	0.36	0.26	0.00	1.01	0.74	3.0	0.11	0.17	0.82	0.65	10.00	9.18
C	C-3	C-4	1.24	2.06	11.03	0.54	6.01	6.69	23	24"	0.013	0.17	9.5	3.0	0.70	0.04	0.00	0.74	0.71	3.3	0.14	0.03	0.65	0.61	10.00	9.35
C	C-4	A-9	0.17	2.23	11.16	0.54	5.98	7.21	15	24"	0.013	0.17	9.5	3.0	0.76	0.03	0.00	0.71	0.68	3.3	0.07	0.01	0.61	0.60	6.00	5.39
D	D-1	D-2	2.82	2.82	10.00	0.64	6.23	11.25	46	24"	0.013	0.20	10.5	3.3	1.07	0.09	0.00	4.10	4.01	3.3	0.07	0.03	0.62	0.59	10.00	9.38
D	D-2	D-3	0.08	2.90	10.23	0.64	6.18	11.47	157	24"	0.013	0.74	20.0	6.3	0.57	1.16	0.00	4.01	2.85	7.0	0.07	0.11	0.59	0.48	10.00	9.41
D	D-3	D-4	1.98	4.88	10.65	0.63	6.09	18.72	138	24"	0.013	0.74	20.0	6.3	0.94	1.02	0.00	2.85	1.83	6.3	0.07	0.10	0.48	0.38	9.00	8.52
D	D-4	A-11	2.24	7.12	11.01	0.62	6.01	26.55	58	24	0.013	0.74	20.0	6.3	1.33	0.43	0.00	1.83	1.40	6.3	0.07	0.04	0.38	0.34	8.00	7.62
E	E-1	E-2	1.52	1.52	10.00	0.60	6.23	5.68	160	24"	0.013	0.17	9.5	3.0	0.60	0.27	0.00	0.48	0.21	3.0	0.07	0.11	0.38	0.27	10.00	9.62
E	E-2	E-3	1.52	3.04	10.89	0.60	6.04	11.02	200	30"	0.013	0.13	15.0	3.0	0.73	0.26	0.50	-0.29	-0.55	3.0	0.08	0.16	0.27	0.11	10.00	9.73
E	E-3	E-4	1.49	4.53	12.00	0.61	5.81	16.07	160	30"	0.013	0.18	17.0	3.5	0.95	0.29	0.00	-0.55	-0.84	3.5	0.08	0.13	0.11	-0.02	7.00	6.89
E	E-4	E-5	1.49	6.02	12.76	0.62	5.67	21.16	320	36"	0.013	0.11	22.0	3.2	0.96	0.35	0.50	-1.34	-1.69	3.2	0.05	0.16	-0.02	-0.18	6.00	6.02
E	E-5	A-14	1.73	7.75	14.43	0.71	5.38	29.58	30	42"	0.013	0.13	36.0	3.7	0.82	0.04	0.50	-2.19	-2.23	3.8	0.05	0.02	-0.18	-0.19	4.00	4.18
F	F-1	F-2	3.19	3.19	10.00	0.70	6.23	13.92	20	30"	0.013	0.13	15.0	3.0	0.93	0.03	0.00	0.12	0.09	3.0	0.05	0.01	0.74	0.73	3.00	2.26
F	F-2	F-3	0.22	3.41	10.11	0.68	6.21	14.39	340	30"	0.013	0.18	17.0	3.5	0.85	0.61	0.00	0.09	-0.52	3.5	0.10	0.34	0.73	0.39	3.00	2.27
F	F-3	F-4	4.33	7.74	11.73	0.63	5.87	28.61	30	42"	0.013	0.08	29.0	3.0	0.99	0.02	1.00	-1.52	-1.54	3.0	0.10	0.03	0.39	0.36	7.00	6.61
F	F-4	F-5	0.31	8.05	11.90	0.63	5.83	29.59	330	42"	0.013	0.10	32.0	3.3	0.92	0.33	0.00	-1.54	-1.87	3.3	0.10	0.33	0.36	0.03	9.00	8.64
F	F-5	A-13	4.89	12.94	13.56	0.63	5.52	45.04	40	48"	0.013	0.12	50.0	3.8	0.90	0.05	0.50	-2.37	-2.42	3.8	0.10	0.04	0.03	-0.01	9.00	8.97

APPENDIX B

CITY OF KEMAH
Drainage System - Alternative B

Mark Number	FROM Sta	TO Sta	Area (ac)	TOTAL AREA (ac)	TIME (Min.)	RUNOFF COEF. "C" (weighted)	Intensity I (in/hr)	Runoff Qd (cfs)	REACH Length (ft)	LINE SIZE	LINE Mann. Const.	LINE SLOPE (%)	DESIGN Qc (cfs)	DESIGN V (fps)	RATIO Qd/Qc	SLOPE FALL (ft)	OTHER LOSSES (ft)	FLOWLINE UP-STR. (ft)	FLOWLINE DN-STR. (ft)	ACTUAL VEL. (fps)	SLOPE HYDGRD %	Change in HGL (ft)	UP-STR. H.G.L. (ft)	DN-STR. H.G.L. (ft)	UP-STR. N.G. (ft)	DEPTH BELOW (ft)
A	A-1	A-2	0.57	0.57	15.27	0.60	5.24	1.79	30	24"	0.013	0.17	9.5	3.0	0.19	0.05	0.00	2.77	2.72	2.7	0.03	0.01	1.75	1.74	10.00	8.25
A	A-2	A-3	1.31	1.88	15.44	0.46	5.21	4.51	180	24"	0.013	0.17	9.5	3.0	0.47	0.31	0.00	2.72	2.41	3.3	0.07	0.13	1.74	1.62	9.00	7.26
A	A-3	A-4	1.19	3.07	16.44	0.44	5.06	6.84	170	24"	0.013	0.17	9.5	3.0	0.72	0.29	0.00	2.41	2.12	3.4	0.07	0.12	1.62	1.50	9.00	7.38
A	A-4	A-5	2.99	6.06	17.38	0.60	4.92	17.91	53	30"	0.013	0.22	19.0	3.0	0.94	0.12	0.50	1.62	1.50	3.8	0.08	0.04	1.50	1.46	9.00	7.50
A	A-5	A-6	0.25	6.31	17.68	0.60	4.88	18.49	325	30"	0.013	0.22	19.0	3.0	0.97	0.72	0.00	1.50	0.79	3.8	0.08	0.26	1.46	1.20	9.00	7.54
A	A-6	A-7	2.81	9.12	19.48	0.63	4.65	26.70	25	42"	0.013	0.08	29.0	3.0	0.92	0.02	1.00	-0.21	-0.23	3.0	0.08	0.02	1.20	1.18	8.00	6.80
A	A-7	A-8	0.73	9.85	19.62	0.62	4.63	28.28	330	42"	0.013	0.08	29.0	3.0	0.98	0.26	0.00	-0.23	-0.50	3.0	0.08	0.26	1.18	0.91	6.00	4.82
A	A-8	A-9	3.41	13.26	21.45	0.62	4.41	36.29	340	48"	0.013	0.08	41.0	3.0	0.89	0.27	0.50	-1.00	-1.27	3.0	0.08	0.27	0.91	0.64	6.00	5.09
A	A-9	A-10	4.33	17.59	23.34	0.61	4.21	45.19	25	48"	0.013	0.10	46.0	3.6	0.98	0.03	0.00	-1.27	-1.29	3.6	0.08	0.02	0.64	0.62	6.00	5.36
A	A-10	A-11	0.31	17.90	23.46	0.61	4.20	45.85	330	48"	0.013	0.10	46.0	3.2	1.00	0.33	0.00	-1.29	-1.62	3.3	0.10	0.33	0.62	0.29	4.00	3.38
A	A-11	A-12	4.89	22.79	25.18	0.61	4.03	56.05	296	54"	0.013	0.10	64.0	3.8	0.88	0.30	0.50	-2.12	-2.42	3.8	0.10	0.30	0.29	-0.01	2.00	1.71
A	A-12	A-13	11.90	34.69	26.47	0.62	3.91	84.17	313	6'X4'	0.013	0.10	98.0	4.1	0.86	0.31	0.00	-2.42	-2.73	3.7	0.08	0.19	-0.01	-0.19	4.00	4.01
A	A-13	A-14	7.75	42.44	27.75	0.64	3.80	103.32	199	8'X4'	0.013	0.12	153.0	4.8	0.68	0.24	0.00	-2.73	-2.97	3.5	0.04	0.08	-0.19	-0.27	5.00	5.19
A	A-14	A-15	0.00	42.44	28.44	0.64	3.75	101.78	190	8'X4'	0.013	0.12	153.0	4.8	0.67	0.23	0.00	-2.97	-3.20	3.5	0.04	0.08	-0.27	-0.35	6.00	6.27
A	A-15	A-16	0.41	42.85	29.10	0.64	3.69	101.32	380	8'X4'	0.013	0.12	153.0	4.8	0.66	0.46	0.00	-3.20	-3.65	3.5	0.04	0.15	-0.35	-0.50	4.50	4.85
A	A-16	A-17	0.86	43.71	30.42	0.65	3.59	102.09	365	8'X4'	0.013	0.12	153.0	4.8	0.67	0.44	0.00	-3.65	-4.09	3.5	0.04	0.15	-0.50	-0.65	4.00	4.50
A	A-17	A-18	2.43	46.14	31.88	0.66	3.50	106.62	300	8'X4'	0.013	0.12	153.0	4.8	0.70	0.36	0.00	-4.09	-4.45	3.7	0.04	0.12	-0.65	-0.77	4.00	4.65
A	A-18	A-19	2.35	48.49	32.73	0.67	3.43	111.41	415	8'X4'	0.013	0.12	153.0	4.8	0.73	0.50	0.00	-4.45	-4.95	3.8	0.05	0.21	-0.77	-0.98	4.00	4.77
A	A-19	Outfall	0.00	48.49	34.17	0.69	3.33	111.55	50	8'X4'	0.013	0.12	153.0	4.8	0.73	0.06	0.00	-4.95	-5.01	3.9	0.05	0.03	-0.98	-1.00	4.00	4.98
B	B-1	B-2	0.17	0.17	10.00	0.60	6.23	0.64	40	24"	0.013	0.17	9.5	3.0	0.07	0.07	0.00	0.48	0.41	2.7	0.07	0.03	1.79	1.76	10.00	8.21
B	B-2	B-3	0.39	0.56	10.22	0.65	6.18	2.25	350	24"	0.013	0.17	9.5	3.0	0.24	0.60	0.00	0.41	-0.18	2.8	0.08	0.28	1.76	1.48	10.00	8.24
B	B-3	A-7	0.17	0.73	12.17	0.64	5.78	2.70	30	24	0.013	0.17	9.5	3.0	0.28	0.05	0.00	-0.18	-0.23	2.8	0.08	0.02	1.48	1.46	8.00	6.52
C	C-1	C-2	0.74	0.74	10.00	0.69	6.23	3.18	30	24"	0.013	0.17	9.5	3.0	0.33	0.05	0.00	0.34	0.29	3.0	0.08	0.02	1.15	1.13	10.00	8.85
C	C-2	C-3	0.08	0.82	10.17	0.68	6.20	3.45	155	24"	0.013	0.17	9.5	3.0	0.36	0.26	0.00	0.29	0.02	3.0	0.11	0.17	1.13	0.95	10.00	8.87
C	C-3	C-4	1.24	2.06	11.03	0.54	6.01	6.69	23	24"	0.013	0.17	9.5	3.0	0.70	0.04	0.00	0.02	-0.02	3.3	0.14	0.03	0.95	0.92	10.00	9.05
C	C-4	C-5	0.17	2.23	11.16	0.54	5.98	7.21	15	24"	0.013	0.17	9.5	3.0	0.76	0.03	0.00	-0.02	-0.04	3.3	0.07	0.01	0.92	0.91	6.00	5.08
C	C-5	C-6	1.50	3.73	11.24	0.61	5.97	13.58	330	30"	0.013	0.22	19.0	3.0	0.71	0.73	0.50	-0.54	-1.27	3.0	0.08	0.26	0.90	0.64	8.00	7.10
C	C-6	A-10	0.60	4.33	13.07	0.61	5.61	14.82	25	36"	0.013	0.10	22.0	3.0	0.67	0.03	0.00	-1.27	-1.29	3.3	0.10	0.03	0.64	0.62	8.00	7.36
D	D-1	D-2	2.82	2.82	10.00	0.64	6.23	11.25	46	24"	0.013	0.20	10.5	3.3	1.07	0.09	0.00	3.11	3.01	3.3	0.07	0.03	0.89	0.86	10.00	9.11
D	D-2	D-3	0.08	2.90	10.23	0.64	6.18	11.47	157	24"	0.013	0.74	20.0	6.3	0.57	1.16	0.00	3.01	1.85	7.0	0.07	0.11	0.86	0.75	10.00	9.14
D	D-3	D-4	1.98	4.88	10.65	0.63	6.09	18.72	138	24"	0.013	0.74	20.0	6.3	0.94	1.02	0.00	1.85	0.83	6.3	0.07	0.10	0.75	0.65	9.00	8.25
D	D-4	D-5	2.24	7.12	11.01	0.62	6.01	26.55	58	24"	0.013	0.74	20.0	6.3	1.33	0.43	0.00	0.83	0.40	6.3	0.07	0.04	0.65	0.61	8.00	7.35
D	D-5	D-6	0.75	7.87	11.17	0.65	5.98	30.60	296	54"	0.013	0.10	64.0	3.8	0.48	0.30	2.50	-2.10	-2.40	3.7	0.10	0.30	0.61	0.31	6.00	5.39
D	D-6	A-12	4.03	11.90	12.46	0.65	5.72	44.28	23	54"	0.013	0.10	64.0	3.8	0.69	0.02	0.00	-2.40	-2.42	3.8	0.10	0.02	0.31	0.29	2.00	1.69
E	E-1	E-2	1.52	1.52	10.00	0.60	6.23	5.68	160	24"	0.013	0.17	9.5	3.0	0.60	0.27	0.00	-0.02	-0.29	3.0	0.07	0.11	0.38	0.27	10.00	9.62
E	E-2	E-3	1.52	3.04	10.89	0.60	6.04	11.02	200	30"	0.013	0.13	15.0	3.0	0.73	0.26	0.50	-0.79	-1.05	3.0	0.08	0.16	0.27	0.11	10.00	9.73
E	E-3	E-4	1.49	4.53	12.00	0.61	5.81	16.07	160	30"	0.013	0.18	17.0	3.5	0.95	0.29	0.00	-1.05	-1.34	3.5	0.08	0.13	0.11	-0.02	8.00	7.89
E	E-4	E-5	1.49	6.02	12.76	0.62	5.67	21.16	320	36"	0.013	0.11	22.0	3.2	0.96	0.35	0.50	-1.84	-2.19	3.2	0.05	0.16	-0.02	-0.18	6.00	6.02
E	E-5	A-13	1.73	7.75	14.43	0.71	5.38	29.58	30	42"	0.013	0.13	36.0	3.7	0.82	0.04	0.50	-2.69	-2.73	3.8	0.05	0.02	-0.18	-0.19	4.00	4.18
F	F-1	A-8	3.19	3.19	10.00	0.70	6.23	13.92	25	30"	0.013	0.13	15.0	3.0	0.93	0.03	0.00	-0.96	-1.00	3.0	0.05	0.01	0.95	0.94	9.00	8.05
F	F-1A	A-8	0.22	3.41	10.14	0.68	6.20	14.38	25	30"	0.013	0.18	17.0	3.5	0.85	0.05	0.00	-0.95	-1.00	3.5	0.10	0.03	0.94	0.91	9.00	8.06

APPENDIX C

CITY OF KEMAH
DRAINAGE SYSTEM - ALTERNATIVE "A"
CONSTRUCTION COST ESTIMATE

System A

Item No.	*Description*	*Unit*	*Quantity*	*Unit Cost*	*Total Cost*
1	Manholes [1]	EA	15	$1,500.00	$22,500.00
2	Inlets	EA	48	$800.00	$38,400.00
3	24" Reinf. Conc. Pipe	LF	380	$40.00	$15,200.00
4	30" Reinf. Conc. Pipe	LF	378	$50.00	$18,900.00
5	42" Reinf. Conc. Pipe	LF	355	$80.00	$28,400.00
6	48" Reinf. Conc. Pipe	LF	380	$95.00	$36,100.00
7	54" Reinf. Conc. Pipe [2]	LF	0	$115.00	$0.00
8	6' x 4' Box Culvert [3]	LF	0	$420.00	$0.00
9	8' x 4' Box Culvert [4]	LF	1510	$450.00	$679,500.00
10	Remove & Replace Roadway Pvmt.	SY	500	$70.00	$35,000.00
11	Remove & Replace Driveway Pvmt.	SY	800	$70.00	$56,000.00

Subtotal System A Construction Cost	***$930,000.00***
Contingency (20%)	***$186,000.00***
Total System A Construction Cost	***$1,116,000.00***

[1] Total is 20 manholes with 5 manholes existing
[2] Total is 319 lf with all 319 lf existing
[3] Total is 319 lf with all 319 lf existing
[4] Total is 1899 lf with 389 lf existing

System B

Item No.	*Description*	*Unit*	*Quantity*	*Unit Cost*	*Total Cost*
1	Manholes	EA	3	$1,500.00	$4,500.00
2	Inlets	EA	6	$800.00	$4,800.00
3	24" Reinf. Conc. Pipe	LF	420	$40.00	$16,800.00
4	Remove & Replace Roadway Pvmt.	SY	30	$70.00	$2,100.00
5	Remove & Replace Driveway Pvmt.	SY	15	$70.00	$1,050.00

Subtotal System B Construction Cost	***$29,250.00***
Contingency (20%)	***$5,850.00***
Total System B Construction Cost	***$35,100.00***

System C

Item No.	Description	Unit	Quantity	Unit Cost	Total Cost
1	Manholes	EA	4	$1,500.00	$6,000.00
2	Inlets	EA	9	$800.00	$7,200.00
3	24" Reinf. Conc. Pipe	LF	223	$40.00	$8,920.00
4	Remove & Replace Roadway Pvmt.	SY	55	$70.00	$3,850.00
5	Remove & Replace Driveway Pvmt.	SY	20	$70.00	$1,400.00
	Subtotal System C Construction Cost				***$27,370.00***
	Contingency (20%)				***$5,474.00***
	Total System C Construction Cost				***$32,844.00***

System D

Item No.	Description	Unit	Quantity	Unit Cost	Total Cost
1	Manholes	EA	4	$1,500.00	$6,000.00
2	Inlets	EA	9	$800.00	$7,200.00
3	24" Reinf. Conc. Pipe	LF	399	$40.00	$15,960.00
4	Remove & Replace Roadway Pvmt.	SY	50	$70.00	$3,500.00
5	Remove & Replace Driveway Pvmt.	SY	18	$70.00	$1,260.00
	Subtotal System D Construction Cost				***$33,920.00***
	Contingency (20%)				***$6,784.00***
	Total System D Construction Cost				***$40,704.00***

System E

Item No.	Description	Unit	Quantity	Unit Cost	Total Cost
1	Manholes	EA	5	$1,500.00	$7,500.00
2	Inlets	EA	12	$800.00	$9,600.00
3	24" Reinf. Conc. Pipe	LF	160	$40.00	$6,400.00
4	30" Reinf. Conc. Pipe	LF	360	$50.00	$18,000.00
5	36" Reinf. Conc. Pipe	LF	320	$70.00	$22,400.00
6	42" Reinf. Conc. Pipe	LF	30	$80.00	$2,400.00
7	Remove & Replace Roadway Pvmt.	SY	50	$70.00	$3,500.00
8	Remove & Replace Driveway Pvmt.	SY	18	$70.00	$1,260.00
	Subtotal System E Construction Cost				***$71,060.00***
	Contingency (20%)				***$14,212.00***
	Total System E Construction Cost				***$85,272.00***

System F

Item No.	Description	Unit	Quantity	Unit Cost	Total Cost
1	Manholes	EA	5	$1,500.00	$7,500.00
2	Inlets	EA	12	$800.00	$9,600.00
3	30" Reinf. Conc. Pipe	LF	360	$50.00	$18,000.00
4	42" Reinf. Conc. Pipe	LF	360	$80.00	$28,800.00
5	48" Reinf. Conc. Pipe	LF	40	$95.00	$3,800.00
6	Remove & Replace Roadway Pvmt.	SY	32	$70.00	$2,240.00
7	Remove & Replace Driveway Pvmt.	SY	70	$70.00	$4,900.00

Subtotal System F Construction Cost	***$74,840.00***
Contingency (20%)	***$14,968.00***
Total System F Construction Cost	***$89,808.00***

Storm Water Pump Station

Item No.	Description	Unit	Quantity	Unit Cost	Total Cost
1	Site Work				
	Finish Grading	LS	1	$15,500.00	$15,500.00
	Rip Rap	SY	795	$40.00	$31,800.00
2	Structure				
	Concrete	LS	1	$216,000.00	$216,000.00
	Bar Screen	EA	1	$16,000.00	$16,000.00
3	Pumps	LS	1	$285,000.00	$285,000.00
4	Controls	LS	1	$55,000.00	$55,000.00
5	Electrical	LS	1	$125,000.00	$125,000.00
6	Piping & Valves	LS	1	$80,000.00	$80,000.00
7	Demolition	LS	1	$58,000.00	$58,000.00
8	Channel Rectification	LS	1	$45,000.00	$45,000.00

Subtotal Storm Water Pump Station Construction Cost	***$927,300.00***
Contingency (15%)	***$139,095.00***
Total Storm Water Pump Station Construction Co:	***$1,066,395.00***

Total Alternative "A" Construction Cost	***$2,466,123.00***

APPENDIX D

CITY OF KEMAH
DRAINAGE SYSTEM - ALTERNATIVE "B"
CONSTRUCTION COST ESTIMATE

System A

Item No.	*Description*	*Unit*	*Quantity*	*Unit Cost*	*Total Cost*
1	Manholes [1]	EA	15	$1,500.00	$22,500.00
2	Inlets	EA	48	$800.00	$38,400.00
3	24" Reinf. Conc. Pipe	LF	380	$40.00	$15,200.00
4	30" Reinf. Conc. Pipe	LF	378	$50.00	$18,900.00
5	42" Reinf. Conc. Pipe	LF	355	$80.00	$28,400.00
6	48" Reinf. Conc. Pipe	LF	695	$95.00	$66,025.00
7	54" Reinf. Conc. Pipe	LF	296	$115.00	$34,040.00
8	6' x 4' Box Culvert [2]	LF	0	$420.00	$0.00
9	8' x 4' Box Culvert [3]	LF	1510	$450.00	$679,500.00
10	Remove & Replace Roadway Pvmt.	SY	500	$70.00	$35,000.00
11	Remove & Replace Driveway Pvmt.	SY	800	$70.00	$56,000.00
	Subtotal System A Construction Cost				***$993,965.00***
	Contingency (20%)				***$198,793.00***
	Total System A Construction Cost				***$1,192,758.00***

[1] Total is 19 manholes with 4 manholes existing
[2] Total is 319 lf with all 319 lf existing
[3] Total is 1899 lf with 389 lf existing

System B

Item No.	*Description*	*Unit*	*Quantity*	*Unit Cost*	*Total Cost*
1	Manholes	EA	3	$1,500.00	$4,500.00
2	Inlets	EA	6	$800.00	$4,800.00
3	24" Reinf. Conc. Pipe	LF	420	$40.00	$16,800.00
4	Remove & Replace Roadway Pvmt.	SY	30	$70.00	$2,100.00
5	Remove & Replace Driveway Pvmt.	SY	15	$70.00	$1,050.00
	Subtotal System B Construction Cost				***$29,250.00***
	Contingency (20%)				***$5,850.00***
	Total System B Construction Cost				***$35,100.00***

System C

Item No.	Description	Unit	Quantity	Unit Cost	Total Cost
1	Manholes	EA	6	$1,500.00	$9,000.00
2	Inlets	EA	12	$800.00	$9,600.00
3	24" Reinf. Conc. Pipe	LF	233	$40.00	$9,320.00
4	30" Reinf. Conc. Pipe	LF	330	$50.00	$16,500.00
5	36" Reinf. Conc. Pipe	LF	25	$70.00	$1,750.00
6	Remove & Replace Roadway Pvmt.	SY	75	$70.00	$5,250.00
7	Remove & Replace Driveway Pvmt.	SY	30	$70.00	$2,100.00
	Subtotal System C Construction Cost				***$53,520.00***
	Contingency (20%)				***$10,704.00***
	Total System C Construction Cost				***$64,224.00***

System D

Item No.	Description	Unit	Quantity	Unit Cost	Total Cost
1	Manholes [1]	EA	4	$1,500.00	$6,000.00
2	Inlets	EA	12	$800.00	$9,600.00
3	24" Reinf. Conc. Pipe	LF	399	$40.00	$15,960.00
4	54" Reinf. Conc. Pipe [2]	LF	0	$40.00	$0.00
5	Remove & Replace Roadway Pvmt.	SY	50	$70.00	$3,500.00
6	Remove & Replace Driveway Pvmt.	SY	18	$70.00	$1,260.00
	Subtotal System D Construction Cost				***$36,320.00***
	Contingency (20%)				***$7,264.00***
	Total System D Construction Cost				***$43,584.00***

[1] Total is 6 manholes with 2 manholes existing
[2] Total is 319 lf with all 319 lf existing

System E

Item No.	Description	Unit	Quantity	Unit Cost	Total Cost
1	Manholes	EA	5	$1,500.00	$7,500.00
2	Inlets	EA	12	$800.00	$9,600.00
3	24" Reinf. Conc. Pipe	LF	160	$40.00	$6,400.00
4	30" Reinf. Conc. Pipe	LF	360	$50.00	$18,000.00
5	36" Reinf. Conc. Pipe	LF	320	$70.00	$22,400.00
6	42" Reinf. Conc. Pipe	LF	30	$80.00	$2,400.00
7	Remove & Replace Roadway Pvmt.	SY	50	$70.00	$3,500.00
8	Remove & Replace Driveway Pvmt.	SY	18	$70.00	$1,260.00
	Subtotal System E Construction Cost				***$71,060.00***
	Contingency (20%)				***$14,212.00***
	Total System E Construction Cost				***$85,272.00***

System F

Item No.	Description	Unit	Quantity	Unit Cost	Total Cost
1	Manholes	EA	2	$1,500.00	$3,000.00
2	30" Reinf. Conc. Pipe	LF	50	$50.00	$2,500.00
3	Remove & Replace Roadway Pvmt.	SY	32	$70.00	$2,240.00
4	Remove & Replace Driveway Pvmt.	SY	70	$70.00	$4,900.00

Subtotal System F Construction Cost	***$12,640.00***
Contingency (20%)	***$2,528.00***
Total System F Construction Cost	***$15,168.00***

Storm Water Pump Station

Item No.	Description	Unit	Quantity	Unit Cost	Total Cost
1	Site Work				
	Finish Grading	LS	1	$15,500.00	$15,500.00
	Rip Rap	SY	795	$40.00	$31,800.00
2	Structure				
	Concrete	LS	1	$216,000.00	$216,000.00
	Bar Screen	EA	1	$16,000.00	$16,000.00
3	Pumps	LS	1	$285,000.00	$285,000.00
4	Controls	LS	1	$55,000.00	$55,000.00
5	Electrical	LS	1	$125,000.00	$125,000.00
6	Piping & Valves	LS	1	$80,000.00	$80,000.00
7	Demolition	LS	1	$58,000.00	$58,000.00
8	Channel Rectification	LS	1	$45,000.00	$45,000.00

Subtotal Storm Water Pump Station Construction Cost	***$927,300.00***
Contingency (15%)	***$139,095.00***
Total Storm Water Pump Station Construction Cost	***$1,066,395.00***

Total Alternative "B" Construction Cost	***$2,502,501.00***

APPENDIX D
WEST KEMAH DRAINAGE STUDY

CITY OF KEMAH

WEST KEMAH DRAINAGE STUDY

CITY OF KEMAH
1401 STATE HIGHWAY 146
KEMAH, TEXAS 77565

LJA Engineering & Surveying, Inc.
East Houston Office
11821 East Freeway Suite 360
Houston, Texas 77029
713-450-1300

LJA Engineering, Inc.

11821 East Freeway
Suite 360
Houston, Texas 77029
TBPE № F-1386

Phone 713.450.1300
Fax 713.450.1385
www.ljaengineering.com

September 28, 2016

Jimmy Thompson
City Engineer
City of Kemah
1401 State Hwy 146
Kemah, Texas 77565

Re: West Kemah Drainage Study

Dear Mr. Thompson:

The specific scope of this project is to analyze the existing drainage conditions within a section of the City of Kemah. Specifically, West Kemah, has existing drainage conditions that were not planned, maintained, or developed at the same time. This has led to a drainage system that is currently undersized and with flowlines that do not help the water drain to the bay in an efficient manner. In some areas of West Kemah, the water becomes stagnant and does not drain but instead backs up until it evaporates overtime. This analysis provides the city a future plan to redevelop the drainage system with proper sizes and flowlines that will ensure this section of the City will drain properly under the given assumptions. It also provides probable construction cost estimates for the city's use in budgeting the proposed capital improvements that will need to be incorporated into the budget. This analysis is based on current field surveys and known pipeline depths from best available records. Excavation of the existing conditions once in construction could uncover variables that were not known about.

Methods and Means

Flow was developed for the drainage study based on the Rational Method. The chosen intensity of rainfall was based on a 2 year storm event from the City of Houston's Infrastructure Design Manual, table 9.1 rainfall intensity parameters, of b = 75.01, d = 16.2, and e = .8315. The watershed coefficient was based on City of Houston's Infrastructure Design Manual Land Use Type Chart, within the storm water design requirements chapter 9, where C = 0.45 for lots ¼ to ½ acre.

Rational Method
Q = I * (CA)
C = watershed coefficient
A = area (acres)
I = rainfall intensity (inches per hour)

Once a flow was developed for a 2 year storm event, the size of the ditches and reinforced concrete pipe was calculated from Manning's Equation below.

Manning's Equation:
V = (K/n) R^(2/3) Sf^(1/2)
Where: K = 1.49 for English units,
1.00 for metric units
V = velocity (ft./sec or m/sec)
R = hydraulic radius (ft. or m) (area/wetted perimeter)
Sf = channel slope (ft-ft)
n = 0.013 for concrete pipes
0.045 for Earthen Section

Then once the sizes were calculated, the most advantageous route for redirecting the storm water was designed in order to minimize probable construction cost. This meant directing as much water as possible into the ditch along Carolyn Street while not impacting the known pipeline locations. This allows for much less length of pipe and smaller pipe throughout all of West Kemah. If the water could not be directed to Carolyn a much larger collection pipe would have to be installed along Miller that would incur the city more construction cost to achieve the same result. Also due to pipeline elevations and flowline depths certain pipes had to be converted to arch pipe and doubled up to guarantee the same flow would be maintained.

With the impending expansion of TxDot Highway 146, drainage considerations had to be taken for the neighborhood to see if TxDot would impact or add flow to the drainage system. Mr. Elie Arkhoury informed us that the expansion would take all increased runoff from the increased impervious cover and drain or detain it on its own. The new highway will be designed to not flow excess storm water to the west of the railroad tracks that run parallel with Carolyn Street. No

special consideration needed to be taken for the West Kemah Drainage Study in relation to the TxDot Expansion of 146.

Probable Construction Cost Estimates

All eight construction costs totals and a length of ditch and pipe associated with them

	Pipe Length	Ditch Length	Cost
Grove Street	382	174	$218,165
4th Street	2464	586	$409,548
5th Street	2624	894	$395,840
6th Street	1984	1290	$354,543
7th Street	995	1070	$217,024
8th Street	1031	1250	$202,149
Miller Avenue	1180	2420	$325,465
Carolyn Street	551	4435	$320,062

Results

All eight streets will need to be completely reworked and flowlines set accordingly for this drainage plan to be effective. The City may so elect to construct this plan in a manner that constructs certain streets at a time but will need to construct the streets from the bottom flowline and up with elevations getting higher as it goes. Based upon the probable construction cost the total is 2.44 million dollars.

Sincerely,

Mark Havran, PE
Project Manager

Attachments

WEST KEMAH

LAYOUTS & COSTS

West Kemah Carolyn Street Drainage Rehabilitation

Length Ditch 4435 Ft

Length Reinforced Concrete Pipe 551 Ft

Item No.	Description	Est Qty	Units	Unit Price	Total Price Per Item
1	Excavate Existing Concrete for Depth of Flowline	750	SY	$17	$12,750
2	Cut for Storm Pipe Finish and Grade	4693	CY	$10	$46,930
3	Embankment for Storm Pipe Finished Grade	115	CY	$7	$805
4	8-inch Subgrade Manipulation	825	SY	$6	$4,950
5	Lime for Stabilized Sub-grade 6% by Dryweight (27 lb/sy)	12	TON	$165	$1,980
6	Cement Stabilized Sand	266	CY	$35	$9,310
7	Bank Sand	23	CY	$15	$345
8	7-Inch Reinforced Concrete	170	SY	$120	$20,400
9	Dirt Work/Ditch Realignment	4435	LF	$15	$66,525
10	Surface Restoration Gravel/Limestone	278	SY	$60	$16,680
11	18 Inch Reinforced Concrete Pipe	74	LF	$50	$3,700
12	18 Inch Reinforced Concrete Arch Pipe	106	LF	$68	$7,208
13	24 Inch Reinforced Concrete Arch Pipe	161	LF	$105	$16,905
14	24 Inch Reinforced Concrete Pipe	144	LF	$75	$10,800
15	30 Inch Reinforced Concrete Arch Pipe	66	LF	$155	$10,230
16	Traffic Control During Construction	3	Months	$4,000	$12,000
17	Permanent Traffic Markings	1	LS	$3,000	$3,000
18	Traffic Sign Relocation and Replacement	7	EA	$100	$700
19	Hydromulch Turf Establishment	2	ACRES	$3,250	$6,500
20	SWPPP	1	LS	$5,000	$5,000
21	Pipeline Matting and Protection	1	LS	$10.000	$10,000
Sub Total					**$266,718**
Contingency (20%)					**$53,344**
Total					**$320,062**

*This cost estimate uses best available information from pipeline representatives. It does not gurantee that future unforeseen depths that are not known at this time will not affect the future flowlines or cost of the work to be performed.

**This is a probable cost for construction along Carolyn alone and does not include engineering.

CULVERT I.D.	UPSTREAM ELEV.	DOWNSTREAM ELEV.	LENGTH
24A-CAROLYN-001 A	1.47	1.44	40
24A-CAROLYN-001 B	1.47	1.44	40
18-CAROLYN-002 A	3.57	3.54	37
18-CAROLYN-002 B	3.57	3.54	37
30A-CAROLYN-003 A	2.34	2.31	33
30A-CAROLYN-003 B	2.34	2.31	33
24-CAROLYN-004	3.40	3.38	26
18A-5TH-027 A	3.70	3.64	53
18A-5TH-027 B	3.70	3.64	53

50 0 50 100
SCALE IN FEET

LEGEND

- 15" CULVERT
- 15" ARCH CULVERT
- 18" CULVERT
- 18" ARCH CULVERT
- 24" CULVERT
- 24" ARCH CULVERT
- 30" CULVERT
- 30" ARCH CULVERT
- 36" CULVERT
- 36" ARCH CULVERT
- 42" CULVERT
- 42" ARCH CULVERT

INLET

FLOW

CITY OF KEMAH

CAROLYN STREET

LJA Engineering, Inc.
11821 East Freeway
Suite # 360
Houston, Texas 77029
Phone 713.450.1300
Fax 713.450.1385
FRN - F-1386

SCALE: AS SHOWN JOB No. E135-0280 EXHIBIT No. 01A

09/28/16

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CULVERT I.D.	UPSTREAM ELEV.	DOWNSTREAM ELEV.	LENGTH
24-CAROLYN-004	3.65	3.62	26
24-CAROLYN-005	3.77	3.74	27
24-CAROLYN-006	3.40	3.38	26
18A-5TH-027 A	3.70	3.64	53
18A-5TH-027 B	3.70	3.64	53
24A-6TH-026 A	3.62	3.59	27
24A-6TH-026 B	3.62	3.59	27
24A-7TH-022	3.58	3.55	27
24-8TH-025	3.59	3.56	38

24-MILLER-004

24-CAROLYN-005

24-CAROLYN-006

CAROLYN STREET

18A-5TH-027 A/B

24A-6TH-026 A/B

24A-7TH-022

24-8TH-025

WEST 6TH STREET

WEST 7TH STREET

WEST 8TH STREET

50 0 50 100

SCALE IN FEET

LEGEND

- 15" CULVERT
- 15" ARCH CULVERT
- 18" CULVERT
- 18" ARCH CULVERT
- 24" CULVERT
- 24" ARCH CULVERT
- 30" CULVERT
- 30" ARCH CULVERT
- 36" CULVERT
- 36" ARCH CULVERT
- 42" CULVERT
- 42" ARCH CULVERT

INLET

FLOW

CITY OF KEMAH

CAROLYN STREET

LJA Engineering, Inc.
11821 East Freeway
Suite # 360
Houston, Texas 77029
Phone 713.450.1300
Fax 713.450.1385
FRN - F-1386

SCALE: AS SHOWN JOB No. E135-0280 EXHIBIT No. 01B

09/28/16

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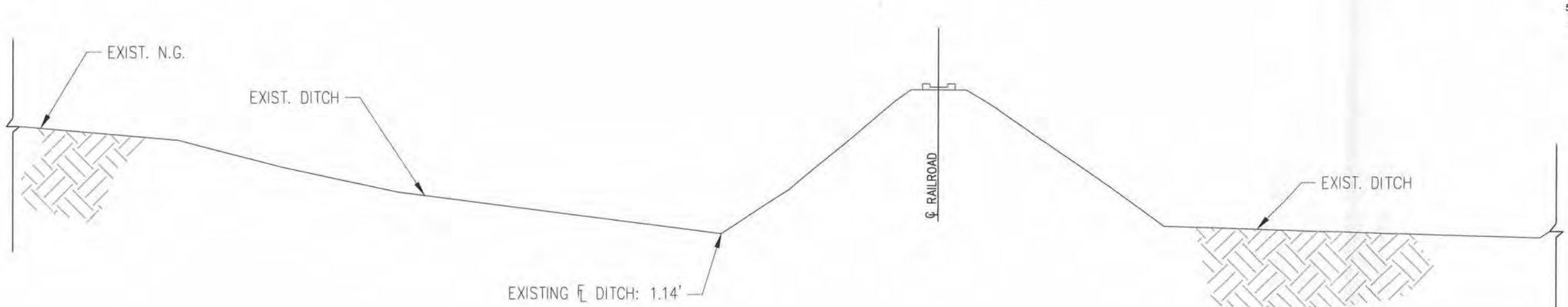
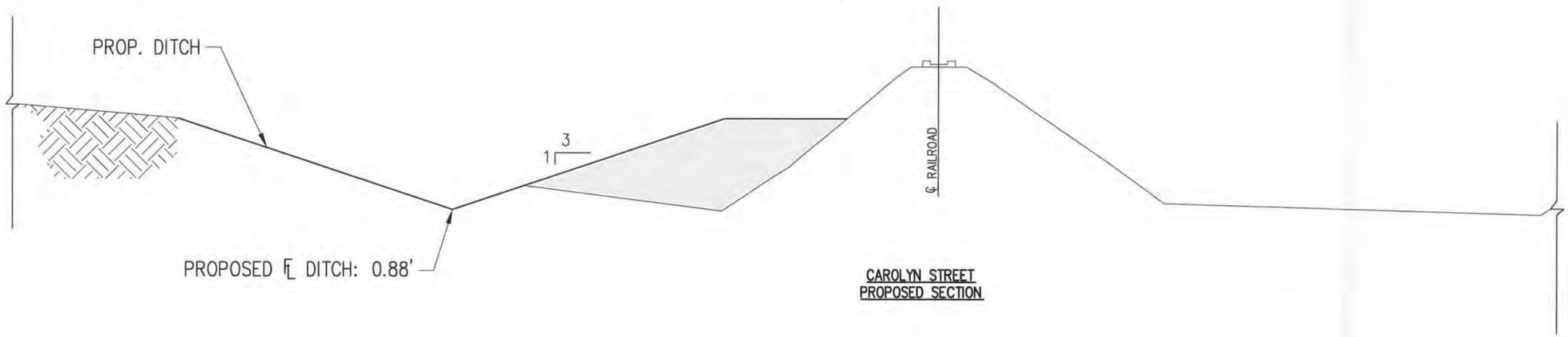


CAROLYN STREET
EXISTING SECTION



CAROLYN STREET
PROPOSED SECTION

SECTION A/1C
SCALE: 1":10'

5 0 5 10
SCALE IN FEET

LEGEND

FILL

CITY OF KEMAH

CAROLYN DITCH SECTION "A"

LJA Engineering, Inc.
11821 East Freeway
Suite 360
Houston, Texas 77029
Phone 713.450.1300
Fax 713.450.1385
FRN - F-1386

SCALE: 1":10' | JOB No. E135-0280 | EXHIBIT No. 01C

09/28/16

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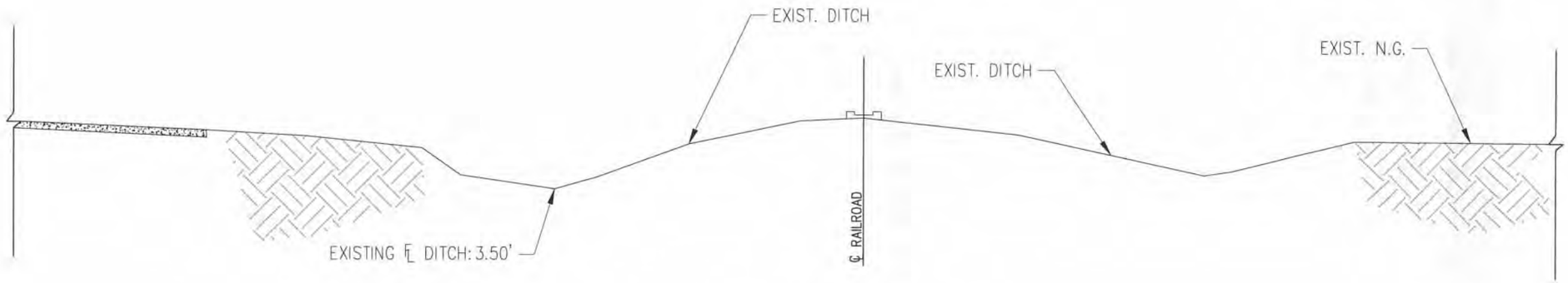
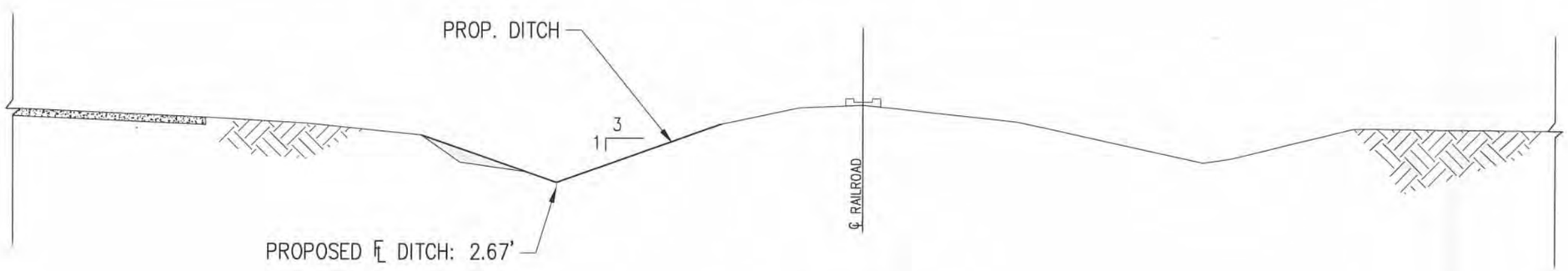


CAROLYN STREET
EXISTING SECTION



CAROLYN STREET
PROPOSED SECTION

SECTION B/10
SCALE: N.T.S.

5 0 5 10
SCALE IN FEET

LEGEND

FILL

CITY OF KEMAH

CAROLYN DITCH SECTION "B"

LJA Engineering, Inc.
11821 East Freeway
Suite 360
Houston, Texas 77029
Phone 713.450.1300
Fax 713.450.1385
FRN - F-1386

SCALE: N.T.S. | JOB No. E135-0280 | EXHIBIT No. 01D

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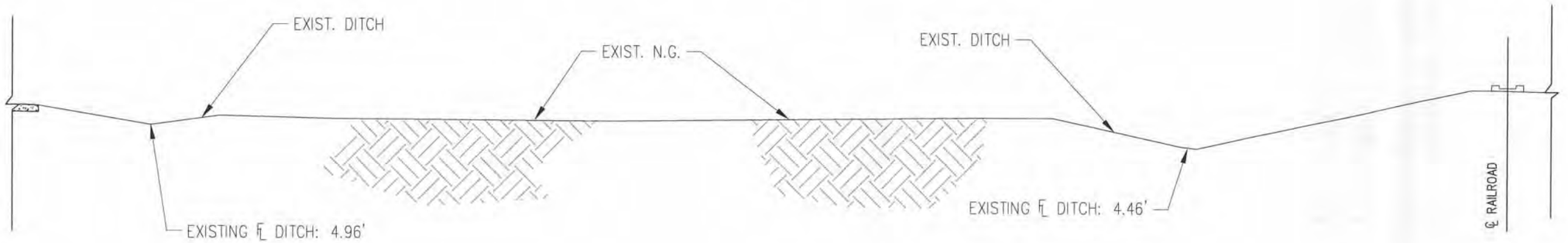
09/28/16



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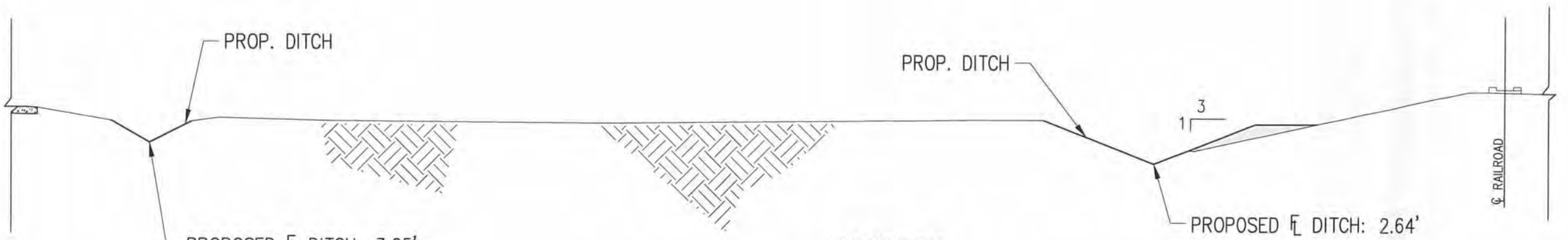
SCALE IN FEET

LEGEND

FILL

CAROLYN STREET
EXISTING SECTION



CAROLYN STREET
PROPOSED SECTION

SECTION C/1E
SCALE: 1":10'

CITY OF KEMAH

CAROLYN DITCH SECTION "C"

LJA Engineering, Inc.
11821 East Freeway
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Houston, Texas 77029
Phone 713.450.1300
Fax 713.450.1385
FRN - F-1386

SCALE: 1":10'	JOB No. E135-0280	EXHIBIT No. 01E

09/28/16

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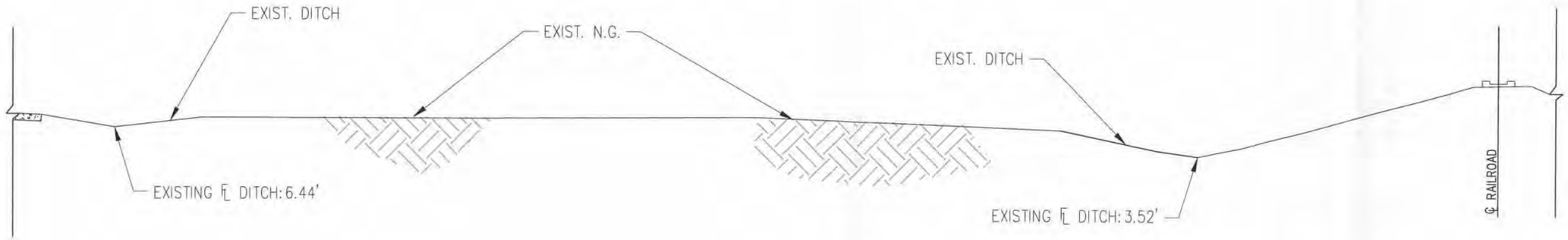
SCALE IN FEET



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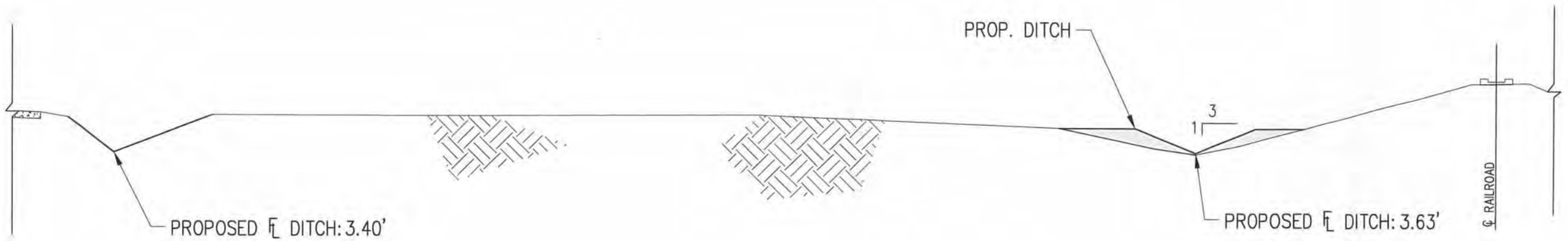
EXISTING SECTION



CAROLYN STREET
PROPOSED SECTION

SECTION D/1F
SCALE: 1":10'

LEGEND

FILL

CITY OF KEMAH

CAROLYN DITCH SECTION "D"

LJA Engineering, Inc.
11821 East Freeway
Suite 360
Houston, Texas 77029
Phone 713.450.1300
Fax 713.450.1385
FRN - F-1386

SCALE: 1":10' | JOB No. E135-0280 | EXHIBIT No. 01F

09/28/16

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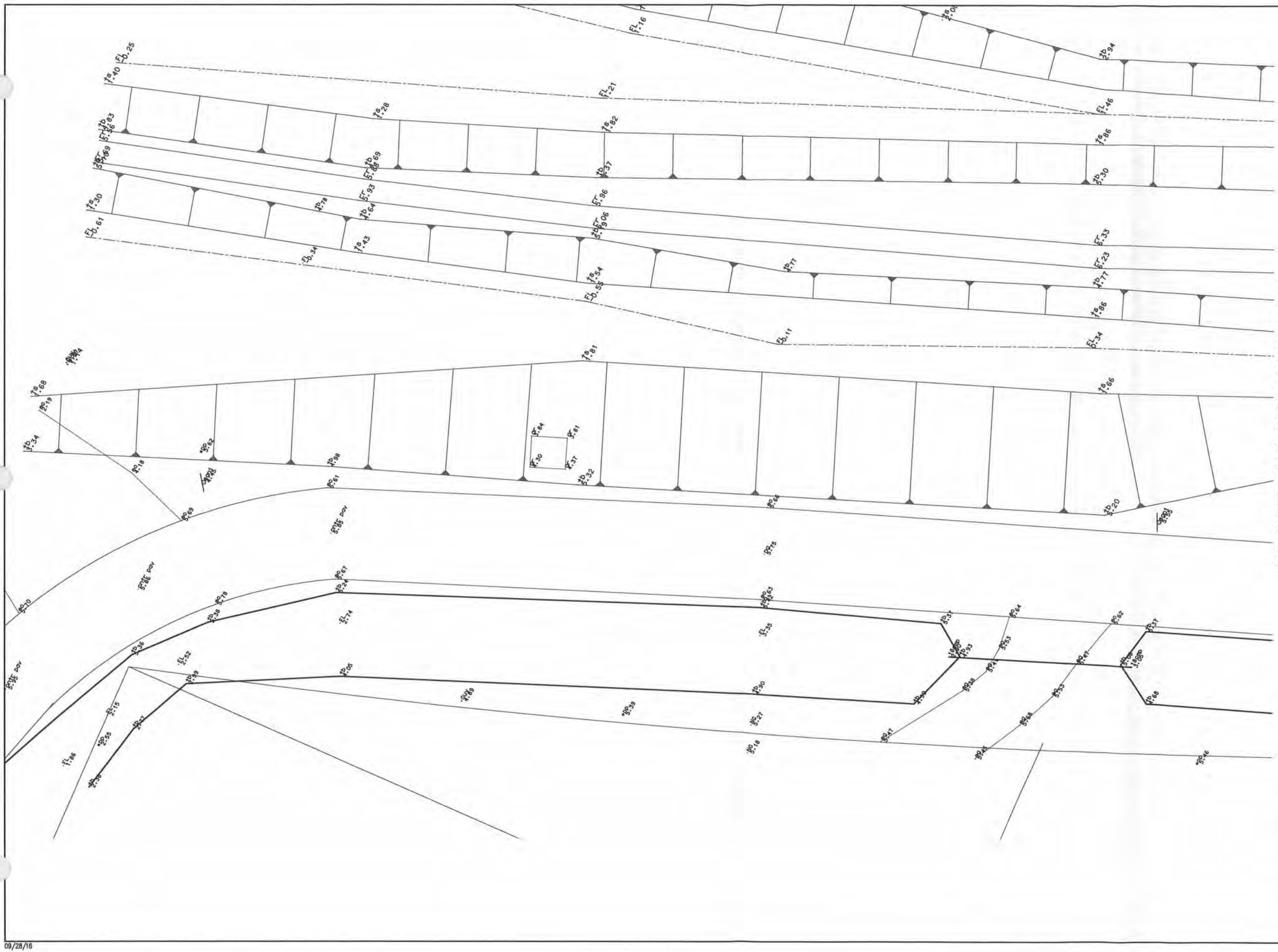

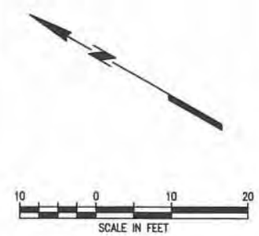

INDEX:

PP–POWER POLE
RR–RAILROAD
TB–TOP OF BANK
TS–TOE SLOPE
FL–FLOW LINE
EC–EDGE OF CONCRETE
EG–EDGE OF GRAVEL
NG–NATURAL GROUND
GUY–GUIDEWIRE

CITY OF KEMAH

CAROLYN TOPOGRAPHY SECTION
1 of 8

LJA Engineering, Inc.
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SCALE: 1":20'	JOB No. E135-0280	EXHIBIT No. 01C

H:\ACAD\Clients\135\0280\Carolyn Topo Exhibit.dwg (XREF: Base)

09/28/16

SEE SHEET 01G FOR CONTINUATION

SEE SHEET 01I FOR CONTINUATION

30" PIPE FL 1.0

30" PIPE FL 1.9

BILL BOARD

ASPHALT

4" I.P.

10 0 10 20
SCALE IN FEET

INDEX:

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CITY OF KEMAH

CAROLYN TOPOGRAPHY SECTION
2 of 8

LJA Engineering, Inc.
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FRN - F-1386

SCALE: 1":20' | JOB No. E135-0280 | EXHIBIT No. 01H

09/28/16

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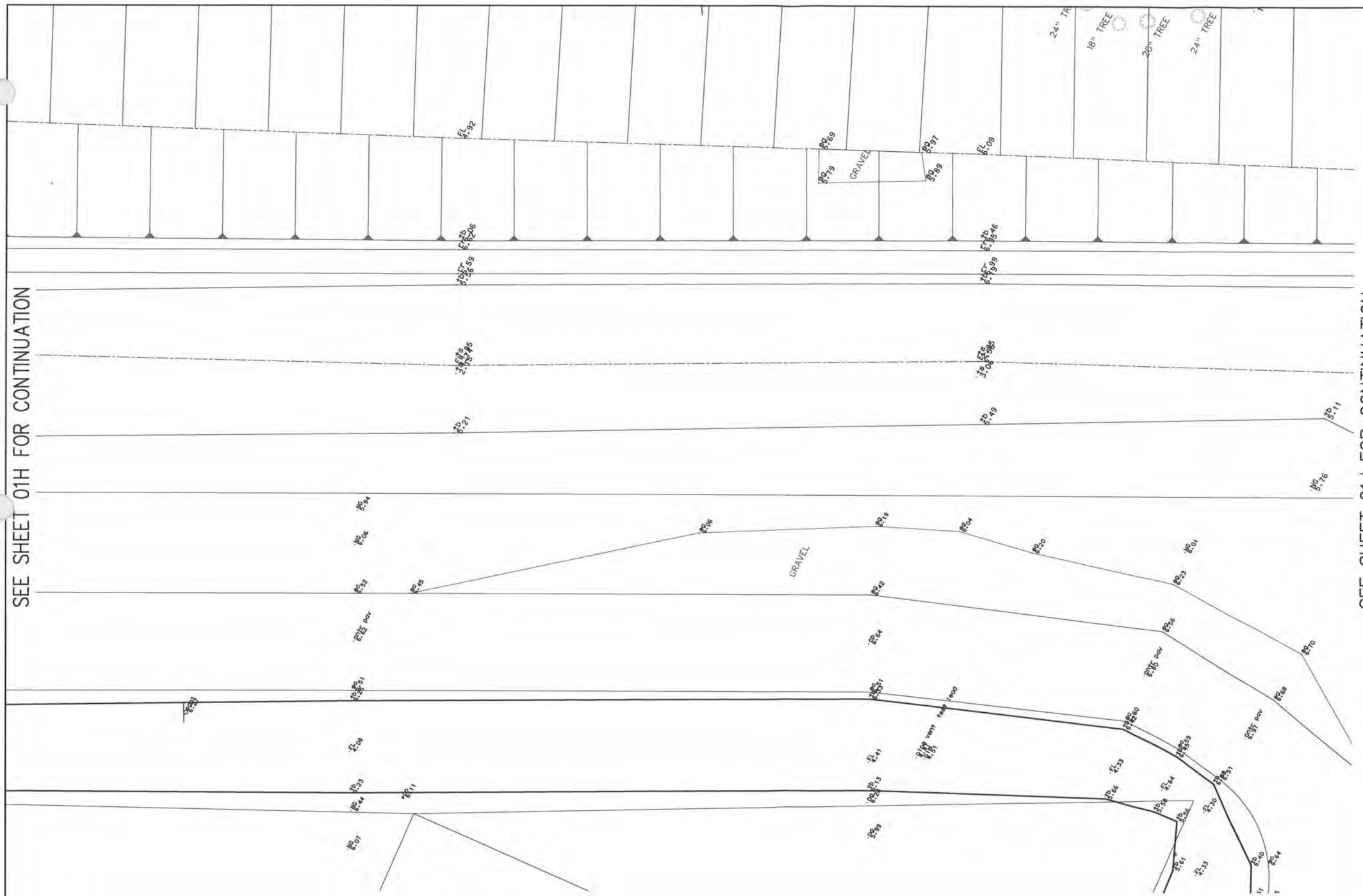

10 0 10 20
SCALE IN FEET

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CITY OF KEMAH

CAROLYN TOPOGRAPHY SECTION
3 of 8

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FRN - F-1386

SCALE: 1":20' | JOB No. E135-0280 | EXHIBIT No. 011

09/28/16

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SEE SHEET 011 FOR CONTINUATION

SEE SHEET 01K FOR CONTINUATION

GRAVEL DRIVE

10 0 10 20
SCALE IN FEET

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GUY–GUIDEWIRE

CITY OF KEMAH

CAROLYN TOPOGRAPHY SECTION
4 of 8

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FRN - F-1386

SCALE: 1":20' | JOB No. E135-0280 | EXHIBIT No. 01J

09/28/16

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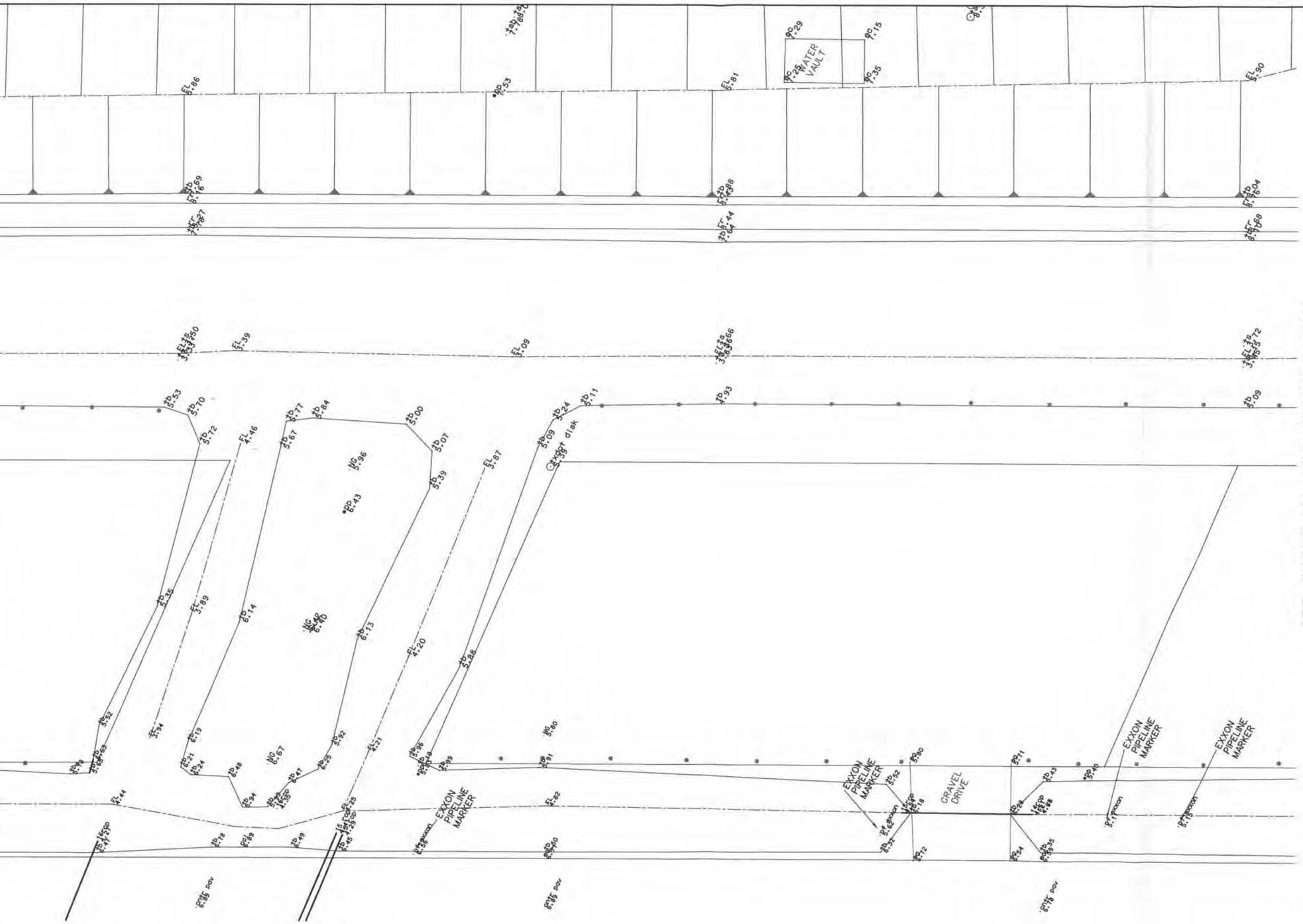
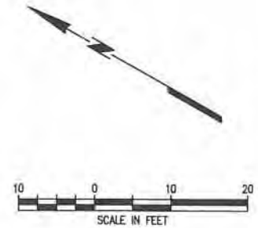
SEE SHEET 01J FOR CONTINUATION

SEE SHEET 01L FOR CONTINUATION





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GUY–GUIDEWIRE

CITY OF KEMAH

CAROLYN TOPOGRAPHY SECTION
5 of 8

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SCALE: 1"=20'	JOB No. E135-0280	EXHIBIT No. 01K

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09/28/16

SEE SHEET 01M FOR CONTINUATION

SEE SHEET 01M FOR CONTINUATION

EXXON PIPELINE MARKER

ENTERPRISE PIPELINE MARKER

COI CP # 20 ELEV. 6.72

CAROLYN AVENUE

10 0 10 20
SCALE IN FEET

INDEX:

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CITY OF KEMAH

CAROLYN TOPOGRAPHY SECTION
6 of 8

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SCALE: 1":20' | JOB No. E135-0280 | EXHIBIT No. 01L

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09/28/16

SEE SHEET 01L FOR CONTINUATION

SEE SHEET 01N FOR CONTINUATION

INLET TOP 6.1 FL 2.4

OVERHEAD SIGN

15" TREE

10" TREE

20" TREE

24" TREE

ENTERPRISE PIPELINE MARKER

GRAVEL

10 0 10 20
SCALE IN FEET

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GUY–GUIDEWIRE

CITY OF KEMAH

CAROLYN TOPOGRAPHY SECTION
7 of 8

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FRN - F-1388

SCALE: 1":20' | JOB No. E135-0280 | EXHIBIT No. 01M

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09/28/16

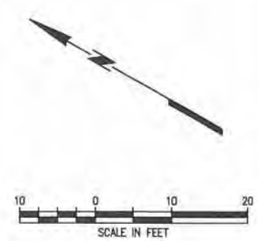
SEE SHEET 01M FOR CONTINUATION

TRAFFIC SIGN POLE

CABLE PAINT STRIPING

24" PIPE FL 4.1

FND. 1" I.P.



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CITY OF KEMAH

CAROLYN TOPOGRAPHY SECTION
8 of 8

LJA Engineering, Inc.
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Phone 713.450.1300
Fax 713.450.1385
FRN - F-1386

SCALE: 1":20' | JOB No. E135-0280 | EXHIBIT No. 01N

09/28/16

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West Kemah Miller Avenue Drainage Rehabilitation

Length Ditch 2420 Ft
Length Reinforced Concrete Pipe 1180 Ft

Item No.	Description	Est Qty	Units	Unit Price	Total Price Per Item
1	Excavate Existing Concrete for Depth of Flowline	115	SY	$17	$1,955
2	Cut for Storm Pipe Finish and Grade	2829	CY	$11	$31,119
3	Embankment for Storm Pipe Finished Grade	236	CY	$7	$1,652
4	8-inch Subgrade Manipulation	140	SY	$6	$840
5	Lime for Stabilized Sub-grade 6% by Dryweight (27 lb/sy)	2	TON	$165	$330
6	Cement Stabilized Sand	795	CY	$35	$27,825
7	7-Inch Reinforced Concrete	115	SY	$120	$13,800
8	6-Inch Reinforced Concrete Driveways	78	SY	$100	$7,800
9	2-Inch Asphalt Surface & 8-Inch Asphalt Base	10	SY	$75	$750
10	Drain Inlet	4	EA	$2,500	$10,000
11	24 Inch Reinforced Concrete Pipe	703	LF	$75	$52,725
12	30 Inch Reinforced Concrete Arch Pipe	418	LF	$155	$64,790
13	30 Inch Reinforced Concrete Pipe	59	LF	$115	$6,785
14	Traffic Control During Construction	3	Months	$4,000	$12,000
15	Permanent Traffic Markings	1	LS	$3,000	$3,000
16	Traffic Sign Relocation and Replacement	13	EA	$100	$1,300
17	Hydromulch Turf Establishment	0.6	ACRES	$3,250	$1,950
18	SWPPP	1	LS	$5,000	$5,000
19	4.5-Inch Sidewalk Remove and Replace & Includes Ramp	360	SY	$75	$27,000
20	Mailbox Remove & Relocate	2	EA	$300	$600
Sub Total					**$271,221**
Contingency (20%)					**$54,244**
Total					**$325,465**

*This cost estimate uses best available information from pipeline representatives. It does not gurantee that future unforeseen depths that are not known at this time will not affect the future flowlines or cost of the work to be performed.
**This is a probable cost for construction along Miller Avenue alone and does not include engineering.

CULVERT I.D.	UPSTREAM ELEV.	DOWNSTREAM ELEV.	LENGTH
30-MILLER-001	2.86	2.82	34
30A-MILLER-002 A	3.02	2.86	164
30A-MILLER-002 B	3.02	2.86	164
30-MILLER-003	2.90	2.87	25
30A-MILLER-004 A	3.10	3.05	45
30A-MILLER-004 B	3.10	3.05	45
24-MILLER-005	3.18	3.06	125
24-MILLER-006	3.21	3.18	28
24-MILLER-007	3.25	3.21	42

CULVERT I.D.	UPSTREAM ELEV.	DOWNSTREAM ELEV.	LENGTH
24-MILLER-008	3.32	3.27	51
24-MILLER-009	3.55	3.25	300
24-MILLER-010	3.51	3.47	39
24-MILLER-011	3.72	3.69	30
24-MILLER-012	3.66	3.63	26
24-MILLER-013	2.93	2.86	62

GROVE STREET
WEST 4TH STREET
WEST 5TH STREET
WEST 6TH STREET
MILLER AVENUE
30-MILLER-001
30-MILLER-003
24-MILLER-005
24-MILLER-006
24-MILLER-007
24-MILLER-008
24-MILLER-009
24-MILLER-010
24-MILLER-011
24-MILLER-012
24-MILLER-013
24-MILLER-014
30A-MILLER-002 A/B
30A-MILLER-004 A/B

50 0 50 100
SCALE IN FEET

LEGEND
- 15" CULVERT
- 15" ARCH CULVERT
- 18" CULVERT
- 18" ARCH CULVERT
- 24" CULVERT
- 24" ARCH CULVERT
- 30" CULVERT
- 30" ARCH CULVERT
- 36" CULVERT
- 36" ARCH CULVERT
- 42" CULVERT
- 42" ARCH CULVERT
- INLET
- FLOW

09/28/16

CITY OF KEMAH

MILLER AVENUE

LJA Engineering, Inc.
11821 East Freeway
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Phone 713.450.1300
Fax 713.450.1385
FRN - F-1386

SCALE: AS SHOWN | JOB No. E135-0280 | EXHIBIT No. 02A

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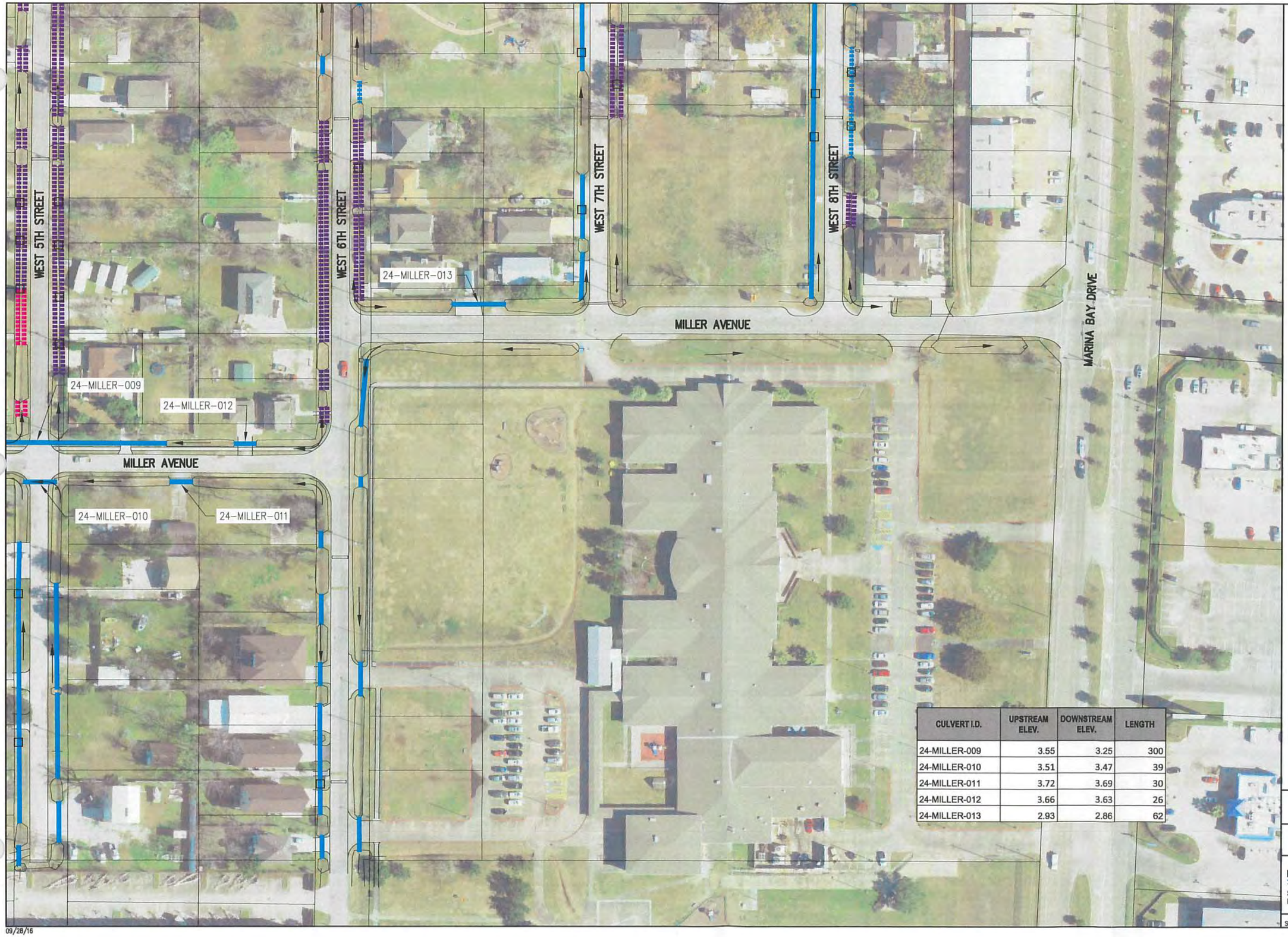

50 0 50 100
SCALE IN FEET

LEGEND

- 15" CULVERT
- 15" ARCH CULVERT
- 18" CULVERT
- 18" ARCH CULVERT
- 24" CULVERT
- 24" ARCH CULVERT
- 30" CULVERT
- 30" ARCH CULVERT
- 36" CULVERT
- 36" ARCH CULVERT
- 42" CULVERT
- 42" ARCH CULVERT

INLET

FLOW

CULVERT I.D.	UPSTREAM ELEV.	DOWNSTREAM ELEV.	LENGTH
24-MILLER-009	3.55	3.25	300
24-MILLER-010	3.51	3.47	39
24-MILLER-011	3.72	3.69	30
24-MILLER-012	3.66	3.63	26
24-MILLER-013	2.93	2.86	62

CITY OF KEMAH

MILLER AVENUE

LJA Engineering, Inc.
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Fax 713.450.1385
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SCALE: AS SHOWN | JOB No. E135-0280 | EXHIBIT No. 02B

09/28/16

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West Kemah Grove Street Drainage Rehabilitation

Length Ditch 174 Ft
Length Reinforced Concrete Pipe 382 Ft

Item No.	Description	Est Qty	Units	Unit Price	Total Price Per Item
1	Excavate Existing Concrete for Depth of Flowline	445	SY	$17	$7,565
2	Cut for Storm Pipe Finish and Grade	85	CY	$10	$850
3	Embankment for Storm Pipe Finished Grade	23	CY	$7	$161
4	8-inch Subgrade Manipulation	530	SY	$6	$3,180
5	Lime for Stabilized Sub-grade 6% by Dryweight (27 lb/sy)	6	TON	$165	$990
6	Cement Stabilized Sand	254	CY	$35	$8,890
7	7-Inch Reinforced Concrete	445	SY	$120	$53,400
8	6-Inch Reinforced Concrete Driveways	25	SY	$100	$2,500
9	2-Inch Asphalt Surface & 8-Inch Asphalt Base	12	SY	$75	$900
10	Dirt Work/Ditch Realignment	174	LF	$15	$2,610
11	Drain Inlet	3	EA	$2,500	$7,500
12	36 Inch Reinforced Concrete Pipe	58	LF	$130	$7,540
13	42 Inch Reinforced Concrete Arch Pipe	281	LF	$203	$57,043
14	42 Inch Reinforced Concrete Pipe	43	LF	$150	$6,450
15	Traffic Control During Construction	3	Months	$4,000	$12,000
16	Permanent Traffic Markings	1	LS	$3,000	$3,000
17	Traffic Sign Relocation and Replacement	5	EA	$100	$500
18	Hydromulch Turf Establishment	0.1	ACRES	$3,250	$325
19	SWPPP	1	LS	$5,000	$5,000
20	Rip Rap remove and replace	1	LS	$500	$500
21	Mailbox Remove & Relocate	3	EA	300	$900
22	Curb				
Sub Total					**$181,804**
Contingency (20%)					**$36,361**
Total					**$218,165**

*This cost estimate uses best available information from pipeline representatives. It does not gurantee that future unforeseen depths that are not known at this time will not affect the future flowlines or cost of the work to be performed.
**This is a probable cost for construction along Grove Street alone and does not include engineering.

CULVERT I.D.	UPSTREAM ELEV.	DOWNSTREAM ELEV.	LENGTH
36-GROVE-001	1.12	1.06	58
42A-GROVE-002	1.06	0.88	180
42A-GROVE-003	0.88	0.85	32
42A-GROVE-004	0.85	0.80	49
42A-GROVE-005	0.77	0.75	20
42-GROVE-006	0.68	0.64	43

50 0 50 100
SCALE IN FEET

LEGEND

- 15" CULVERT
- 15" ARCH CULVERT
- 18" CULVERT
- 18" ARCH CULVERT
- 24" CULVERT
- 24" ARCH CULVERT
- 30" CULVERT
- 30" ARCH CULVERT
- 36" CULVERT
- 36" ARCH CULVERT
- 42" CULVERT
- 42" ARCH CULVERT
- INLET
- FLOW

CITY OF KEMAH

GROVE STREET

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FRN - F-1386

SCALE: AS SHOWN | JOB No. E135-0280 | EXHIBIT No. 03

09/28/16

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West Kemah 4th Street Drainage Rehabilitation

Length Ditch	586	Ft
Length Reinforced Concrete Pipe	2464	Ft

Item No.	Description	Est Qty	Units	Unit Price	Total Price Per Item
1	Excavate Existing Concrete for Depth of Flowline	23	SY	$17	$391
2	Cut for Storm Pipe Finish and Grade	404	CY	$10	$4,040
3	Embankment for Storm Pipe Finished Grade	28	CY	$7	$196
4	8-inch Subgrade Manipulation	28	SY	$6	$168
5	Lime for Stabilized Sub-grade 6% by Dryweight (27 lb/sy)	2	TON	$165	$330
6	Cement Stabilized Sand	1980	CY	$35	$69,300
7	7-Inch Reinforced Concrete	23	SY	$120	$2,760
8	6-Inch Reinforced Concrete Driveways	107	SY	$100	$10,700
9	2-Inch Asphalt Surface & 8-Inch Asphalt Base	37	EA	$75	$2,775.00
10	Dirt Work/Ditch Realignment	586	LF	$15	$8,790.00
11	Drain Inlet	7	EA	$2,500	$17,500
12	18 Inch Reinforced Concrete Arch Pipe	1798	LF	$68	$121,365
13	24 Inch Reinforced Concrete Pipe	666	LF	$75	$49,950
14	Traffic Control During Construction	3	Months	$4,000	$12,000
15	Permanent Traffic Markings	1	LS	$3,000	$3,000
16	Traffic Sign Relocation and Replacement	4	EA	$100	$400
17	Hydromulch Turf Establishment	0.5	ACRES	$3,250	$1,625
18	SWPPP	1	LS	$5,000	$5,000
19	4.5-Inch Sidewalk Remove and Replace	360	SY	$70	$25,200
20	Mailbox Remove & Relocate	1	EA	$300	$300
21	100 W 4th Street Residential Landscaping Replacement/Repair	1	LS	$3,500	$3,500
22	40 W 4th Street Residential Landscaping Replacement/Repair	1	LS	$2,000	$2,000
Sub Total					**$341,290**
Contingency (20%)					**$68,258**
Total					**$409,548**

*This cost estimate uses best available information from pipeline representatives. It does not gurantee that future unforeseen depths that are not known at this time will not affect the future flowlines or cost of the work to be performed.
**This is a probable cost for construction along 4th Street alone and does not include engineering.

CULVERT I.D.	UPSTREAM ELEV.	DOWNSTREAM ELEV.	LENGTH
24-4TH-001	3.44	3.30	143
24-4TH-002	3.59	3.40	185
24-4TH-003	3.40	3.17	238
24-4TH-004	3.24	3.23	18
24-4TH-005	3.18	3.14	39
24-4TH-006	3.09	3.07	25
18A-4TH-007 A	4.16	4.01	152
18A-4TH-007 B	4.16	4.01	152
18A-4TH-008 A	4.09	4.07	18
18A-4TH-008 B	4.09	4.07	18
18A-4TH-009 A	4.01	3.99	20
18A-4TH-009 B	4.01	3.99	20
18A-4TH-010 A	3.98	3.96	23
18A-4TH-010 B	3.98	3.96	23

CULVERT I.D.	UPSTREAM ELEV.	DOWNSTREAM ELEV.	LENGTH
18A-4TH-011 A	4.01	3.80	212
18A-4TH-011 B	4.01	3.80	212
18A-4TH-012 A	3.91	3.88	25
18A-4TH-012 B	3.91	3.88	25
18A-4TH-013 A	3.85	3.81	47
18A-4TH-013 B	3.85	3.81	47
18A-4TH-014 A	3.81	3.75	53
18A-4TH-014 B	3.81	3.75	53
18A-4TH-015 A	3.80	3.66	140
18A-4TH-015 B	3.80	3.66	140
18A-4TH-016 A	3.75	3.70	52
18A-4TH-016B	3.75	3.70	52
18A-4TH-017 A	3.70	3.54	157
18A-4TH-017 B	3.70	3.54	157

GROVE STREET

MILLER AVENUE

CAROLYN STREET

WEST 4TH STREET

WEST 5TH STREET

24-4TH-001

24-4TH-004

24-4TH-005

24-4TH-006

24-4TH-002

24-4TH-003

18A-4TH-009 A/B

18A-4TH-010 A/B

18A-4TH-013 A/B

18A-4TH-008 A/B

18A-4TH-012 A/B

18A-4TH-014 A/B

18A-4TH-016 A/B

18A-4TH-017 A/B

18A-4TH-007 A/B

18A-4TH-011 A/B

18A-4TH-015 A/B

50 0 50 100

SCALE IN FEET

LEGEND

- 15" CULVERT
- 15" ARCH CULVERT
- 18" CULVERT
- 18" ARCH CULVERT
- 24" CULVERT
- 24" ARCH CULVERT
- 30" CULVERT
- 30" ARCH CULVERT
- 36" CULVERT
- 36" ARCH CULVERT
- 42" CULVERT
- 42" ARCH CULVERT

INLET

FLOW

CITY OF KEMAH

WEST 4TH STREET

LJA Engineering, Inc.
11821 East Freeway
Suite 360
Houston, Texas 77029
Phone 713.450.1300
Fax 713.450.1385
FRN - F-1386

SCALE: AS SHOWN | JOB No. E135-0280 | EXHIBIT No. 04

09/28/16

H:\ACAD\Clients\135\0280\Cost Estimate Exhibits\EX-04-4th street.dwg (XREF: Base)

West Kemah 5th Street Drainage Rehabilitation

Length Ditch 894 Ft

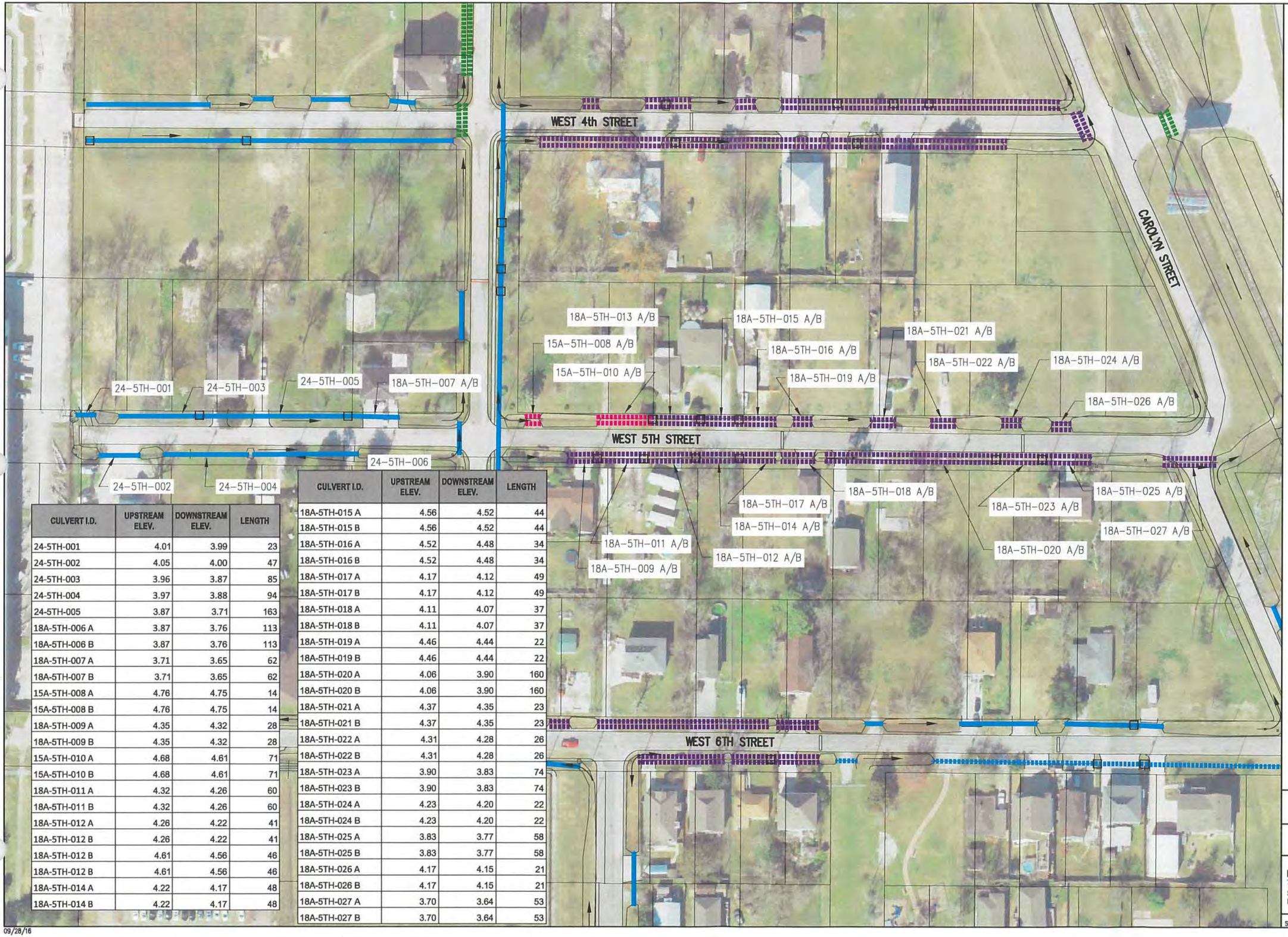
Length Reinforced Concrete Pipe 2624 Ft

Item No.	Description	Est Qty	Units	Unit Price	Total Price Per Item
1	Cut for Storm Pipe Finish and Grade	1304	CY	$10	$13,040
2	Embankment for Storm Pipe Finished Grade	73	CY	$7	$511
3	Cement Stabilized Sand	2031	CY	$35	$71,085
4	6-Inch Reinforced Concrete Driveways	78	SY	$100	$7,800
5	2-Inch Asphalt Surface & 8-Inch Asphalt Base	18	SY	$75	$1,350
6	Drain Inlet	11	EA	$2,500	$27,500
7	15 Inch Reinforced Concrete Arch Pipe	170	LF	$80	$13,600
8	18 Inch Reinforced Concrete Arch Pipe	2042	LF	$68	$138,856
9	24 Inch Reinforced Concrete Pipe	412	LF	$75	$30,900
10	Traffic Control During Construction	3	Months	$4,000	$12,000
11	Permanent Traffic Markings	1	LS	$3,000	$3,000
12	Traffic Sign Relocation and Replacement	2	EA	$100	$200
13	Hydromulch Turf Establishment	0.5	ACRES	$3,250	$1,625
14	SWPPP	1	LS	$5,000	$5,000
15	Mailbox Remove & Relocate	10	EA	$300	$3,000
16	160 W 5th Street Residential Landscaping Replacement/Repair	1	LS	$400	$400

Sub Total	**$329,867**
Contingency (20%)	**$65,973**
Total	**$395,840**

*This cost estimate uses best available information from pipeline representatives. It does not gurantee that future unforeseen depths that are not known at this time will not affect the future flowlines or cost of the work to be performed.

**This is a probable cost for construction along 5th Street alone and does not include engineering.



CULVERT I.D.	UPSTREAM ELEV.	DOWNSTREAM ELEV.	LENGTH
24-5TH-001	4.01	3.99	23
24-5TH-002	4.05	4.00	47
24-5TH-003	3.96	3.87	85
24-5TH-004	3.97	3.88	94
24-5TH-005	3.87	3.71	163
18A-5TH-006 A	3.87	3.76	113
18A-5TH-006 B	3.87	3.76	113
18A-5TH-007 A	3.71	3.65	62
18A-5TH-007 B	3.71	3.65	62
15A-5TH-008 A	4.76	4.75	14
15A-5TH-008 B	4.76	4.75	14
18A-5TH-009 A	4.35	4.32	28
18A-5TH-009 B	4.35	4.32	28
15A-5TH-010 A	4.68	4.61	71
15A-5TH-010 B	4.68	4.61	71
18A-5TH-011 A	4.32	4.26	60
18A-5TH-011 B	4.32	4.26	60
18A-5TH-012 A	4.26	4.22	41
18A-5TH-012 B	4.26	4.22	41
18A-5TH-012 B	4.61	4.56	46
18A-5TH-012 B	4.61	4.56	46
18A-5TH-014 A	4.22	4.17	48
18A-5TH-014 B	4.22	4.17	48
18A-5TH-015 A	4.56	4.52	44
18A-5TH-015 B	4.56	4.52	44
18A-5TH-016 A	4.52	4.48	34
18A-5TH-016 B	4.52	4.48	34
18A-5TH-017 A	4.17	4.12	49
18A-5TH-017 B	4.17	4.12	49
18A-5TH-018 A	4.11	4.07	37
18A-5TH-018 B	4.11	4.07	37
18A-5TH-019 A	4.46	4.44	22
18A-5TH-019 B	4.46	4.44	22
18A-5TH-020 A	4.06	3.90	160
18A-5TH-020 B	4.06	3.90	160
18A-5TH-021 A	4.37	4.35	23
18A-5TH-021 B	4.37	4.35	23
18A-5TH-022 A	4.31	4.28	26
18A-5TH-022 B	4.31	4.28	26
18A-5TH-023 A	3.90	3.83	74
18A-5TH-023 B	3.90	3.83	74
18A-5TH-024 A	4.23	4.20	22
18A-5TH-024 B	4.23	4.20	22
18A-5TH-025 A	3.83	3.77	58
18A-5TH-025 B	3.83	3.77	58
18A-5TH-026 A	4.17	4.15	21
18A-5TH-026 B	4.17	4.15	21
18A-5TH-027 A	3.70	3.64	53
18A-5TH-027 B	3.70	3.64	53

50 0 50 100
SCALE IN FEET

LEGEND

- 15" CULVERT
- 15" ARCH CULVERT
- 18" CULVERT
- 18" ARCH CULVERT
- 24" CULVERT
- 24" ARCH CULVERT
- 30" CULVERT
- 30" ARCH CULVERT
- 36" CULVERT
- 36" ARCH CULVERT
- 42" CULVERT
- 42" ARCH CULVERT

INLET

FLOW

CITY OF KEMAH

WEST 5TH STREET

LJA Engineering, Inc.
11821 East Freeway
Suite 360
Houston, Texas 77029
Phone 713.450.1300
Fax 713.450.1385
FRN - F-1386

SCALE: AS SHOWN | JOB No. E135-0280 | EXHIBIT No. 05

09/28/16

I:\LJACAD\Clients\135\0280\Cost Estimate Exhibits\EX-05-5th street.dwg (XREF: Base)

West Kemah 6th Street Drainage Rehabilitation

Length Ditch 1290 Ft

Length Reinforced Concrete Pipe 1984 Ft

Item No.	Description	Est Qty	Units	Unit Price	Total Price Per Item
1	Cut for Storm Pipe Finish and Grade	354	CY	$10	$3,540
2	Embankment for Storm Pipe Finished Grade	315	CY	$7	$2,205
3	Cement Stabilized Sand	1606	CY	$35	$56,210
4	6-Inch Reinforced Concrete Driveways	211	SY	$100	$21,100
5	2-Inch Asphalt Surface & 8-Inch Asphalt Base	130	SY	$75	$9,750
6	7-Inch Reinforced Concrete	41	SY	$120	$4,920
7	Drain Inlet	5	EA	$2,500	$12,500
8	18 Inch Reinforced Concrete Arch Pipe	914	LF	$68	$61,695
9	24 Inch Reinforced Concrete Arch Pipe	486	LF	$101	$49,208
10	24 Inch Reinforced Concrete Pipe	584	LF	$75	$43,800
11	Traffic Control During Construction	3	Months	$4,000	$12,000
12	Permanent Traffic Markings	1	LS	$3,000	$3,000
13	Traffic Sign Relocation and Replacement	10	EA	$100	$1,000
14	Hydromulch Turf Establishment	0.5	ACRES	$3,250	$1,625
15	SWPPP	1	LS	$5,000	$5,000
16	Mailbox Remove & Relocate	11	EA	$300	$3,300
17	223 W 6th Street Residential Landscaping Replacement/Repair	1	LS	$700	$700
18	219 W 6th Street Residential Landscaping Replacement/Repair	1	LS	$1,200	$1,200
19	125 W 6th Street Residential Landscaping Replacement/Repair	1	LS	$700	$700
20	40 W 6th Street Residential Landscaping Replacement/Repair	1	LS	$2,000	$2,000
Sub Total					**$295,453**
Contingency (20%)					**$59,091**
Total					**$354,543**

*This cost estimate uses best available information from pipeline representatives. It does not gurantee that future unforeseen depths that are not known at this time will not affect the future flowlines or cost of the work to be performed.

**This is a probable cost for construction along 6th Street alone and does not include engineering.

CULVERT I.D.	UPSTREAM ELEV.	DOWNSTREAM ELEV.	LENGTH
24-6TH-001	3.22	3.20	23
24-6TH-002	3.46	3.42	35
24-6TH-003	3.28	3.25	34
24-6TH-004	3.37	3.28	87
24-6TH-005	3.63	3.60	31
24-6TH-006	3.42	3.39	26
24-6TH-007	3.50	3.47	35
24-6TH-008	3.57	3.56	18
24-6TH-009	3.83	3.82	9
24-6TH-010	3.97	3.89	73
18A-6TH-011 A	4.50	4.48	19
18A-6TH-011 B	4.50	4.48	19
18A-6TH-012 A	4.46	4.44	22
18A-6TH-012 B	4.46	4.44	22
18A-6TH-013 A	4.40	4.22	189
18A-6TH-013 B	4.40	4.22	189
18A-6TH-014 A	4.37	4.28	91
18A-6TH-014 B	4.37	4.28	91

CULVERT I.D.	UPSTREAM ELEV.	DOWNSTREAM ELEV.	LENGTH
18A-6TH-015 A	4.27	4.22	45
18A-6TH-015 B	4.27	4.22	45
18A-6TH-016 A	4.22	4.17	49
18A-6TH-016 B	4.22	4.17	49
18A-6TH-017 A	4.20	4.16	42
18A-6TH-017 B	4.20	4.16	42
24A-6TH-018	4.15	4.12	24
24-6TH-019	4.11	4.08	24
24A-6TH-020	4.04	3.86	176
24-6TH-021	3.99	3.91	83
24-6TH-022	3.88	3.80	77
24A-6TH-023	3.86	3.81	54
24-6TH-024	3.80	3.77	29
24A-6TH-025	3.81	3.63	178
24A-6TH-026 A	3.62	3.59	27
24A-6TH-026 B	3.62	3.59	27

MILLER AVENUE

WEST 6TH STREET

WEST 7TH STREET

24-6TH-001
24-6TH-002
24-6TH-003
24-6TH-004
24-6TH-005
24-6TH-006
24-6TH-007
24-6TH-008
24-6TH-009
24-6TH-010
18A-6TH-011 A/B
18A-6TH-012 A/B
18A-6TH-013 A/B
18A-6TH-014 A/B
18A-6TH-015 A/B
18A-6TH-016 A/B
18A-6TH-017 A/B
24-6TH-019
24-6TH-021
24-6TH-022
24-6TH-024
24A-6TH-018
24A-6TH-020
24A-6TH-023
24A-6TH-025
24A-6TH-026 A/B

50 0 50 100
SCALE IN FEET

LEGEND

- 15" CULVERT
- 15" ARCH CULVERT
- 18" CULVERT
- 18" ARCH CULVERT
- 24" CULVERT
- 24" ARCH CULVERT
- 30" CULVERT
- 30" ARCH CULVERT
- 36" CULVERT
- 36" ARCH CULVERT
- 42" CULVERT
- 42" ARCH CULVERT

INLET

FLOW

09/28/16

CITY OF KEMAH

WEST 6TH STREET

LJA Engineering, Inc.
11821 East Freeway
Suite 360
Houston, Texas 77029
Phone 713.450.1300
Fax 713.450.1385
FRN - F-1386

SCALE: AS SHOWN | JOB No. E135-0280 | EXHIBIT No. 06

H:\ACAD\Clients\135\0280\Cost Estimate Exhibits\EX-06-6th street.dwg (XREF: Base)

West Kemah 7th Street Drainage Rehabilitation

Length Ditch 1070 Ft

Length Reinforced Concrete Pipe 995 Ft

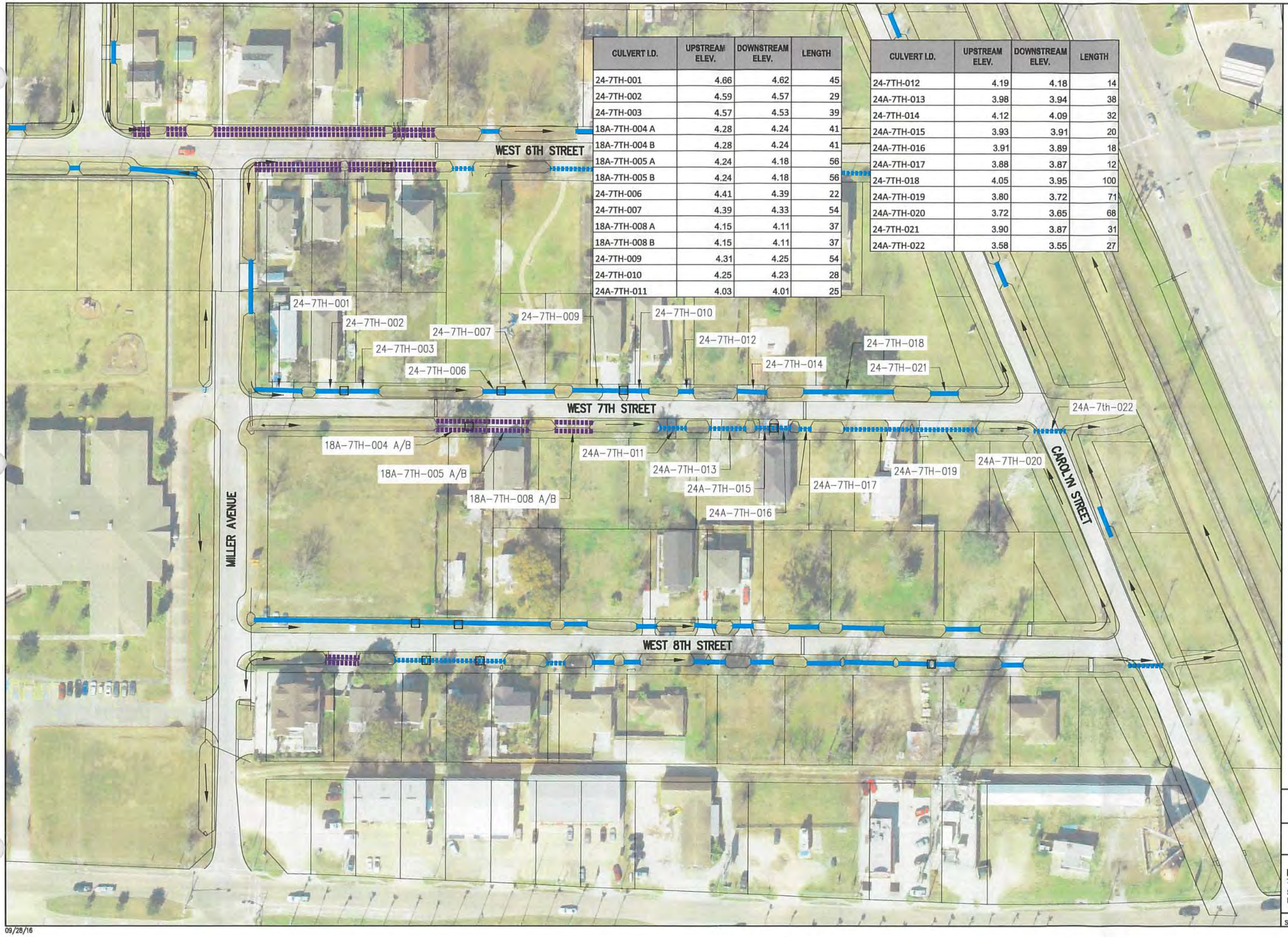
Item No.	Description	Est Qty	Units	Unit Price	Total Price Per Item
1	Excavate Existing Concrete for Depth of Flowline	180	SY	$17	$3,060
2	Cut for Storm Pipe Finish and Grade	248	CY	$10	$2,480
3	Embankment for Storm Pipe Finished Grade	21	CY	$7	$147
4	8-inch Subgrade Manipulation	180	SY	$6	$1,080
5	Lime for Stabilized Sub-grade 6% by Dryweight (27 lb/sy)	3	TON	$165	$495
6	Cement Stabilized Sand	806	CY	$35	$28,210
7	6-Inch Reinforced Concrete Driveways	149	SY	$100	$14,875
8	2-Inch Asphalt Surface & 8-Inch Asphalt Base	161	SY	$75	$12,078
9	Drain Inlet	5	EA	$2,500	$12,500
10	18 Inch Reinforced Concrete Arch Pipe	268	LF	$68	$18,224
11	24 Inch Reinforced Concrete Arch Pipe	279	LF	$101	$28,179
12	24 Inch Reinforced Concrete Pipe	448	LF	$75	$33,600
13	Traffic Control During Construction	3	Months	$4,000	$12,000
14	Permanent Traffic Markings	1	LS	$3,000	$3,000
15	Traffic Sign Relocation and Replacement	2	EA	$100	$200
16	Hydromulch Turf Establishment	0.5	ACRES	$3,250	$1,625
17	SWPPP	1	LS	$5,000	$5,000
18	Mailbox Remove & Relocate	2	EA	$300	$600
19	100 West 7th Street Residential Landscaping Replacement/Repair	1	LS	$1,000	$1,000
20	Handicap Signs, Concrete wheel stops, and paint	1	LS	$2,500	$2,500
Sub Total					**$180,853**
Contingency (20%)					**$36,171**
Total					**$217,024**

*This cost estimate uses best available information from pipeline representatives. It does not gurantee that future unforeseen depths that are not known at this time will not affect the future flowlines or cost of the work to be performed.

**This is a probable cost for construction along 7th Street alone and does not include engineering.

CULVERT I.D.	UPSTREAM ELEV.	DOWNSTREAM ELEV.	LENGTH
24-7TH-001	4.66	4.62	45
24-7TH-002	4.59	4.57	29
24-7TH-003	4.57	4.53	39
18A-7TH-004 A	4.28	4.24	41
18A-7TH-004 B	4.28	4.24	41
18A-7TH-005 A	4.24	4.18	56
18A-7TH-005 B	4.24	4.18	56
24-7TH-006	4.41	4.39	22
24-7TH-007	4.39	4.33	54
18A-7TH-008 A	4.15	4.11	37
18A-7TH-008 B	4.15	4.11	37
24-7TH-009	4.31	4.25	54
24-7TH-010	4.25	4.23	28
24A-7TH-011	4.03	4.01	25

CULVERT I.D.	UPSTREAM ELEV.	DOWNSTREAM ELEV.	LENGTH
24-7TH-012	4.19	4.18	14
24A-7TH-013	3.98	3.94	38
24-7TH-014	4.12	4.09	32
24A-7TH-015	3.93	3.91	20
24A-7TH-016	3.91	3.89	18
24A-7TH-017	3.88	3.87	12
24-7TH-018	4.05	3.95	100
24A-7TH-019	3.80	3.72	71
24A-7TH-020	3.72	3.65	68
24-7TH-021	3.90	3.87	31
24A-7TH-022	3.58	3.55	27



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SCALE IN FEET

LEGEND

- 15" CULVERT
- 15" ARCH CULVERT
- 18" CULVERT
- 18" ARCH CULVERT
- 24" CULVERT
- 24" ARCH CULVERT
- 30" CULVERT
- 30" ARCH CULVERT
- 36" CULVERT
- 36" ARCH CULVERT
- 42" CULVERT
- 42" ARCH CULVERT

□ INLET

→ FLOW

CITY OF KEMAH

WEST 7TH STREET

LJA Engineering, Inc.
11821 East Freeway
Suite 360
Houston, Texas 77029
Phone 713.450.1300
Fax 713.450.1385
FRN - F-1386

SCALE: AS SHOWN | JOB No. E135-0280 | EXHIBIT No. 07

09/28/16

H:\ACAD\Clients\135\0280\Cost Estimate Exhibits\EX-07-7th street.dwg (XREF: Base)

West Kemah 8th Street Drainage Rehabilitation

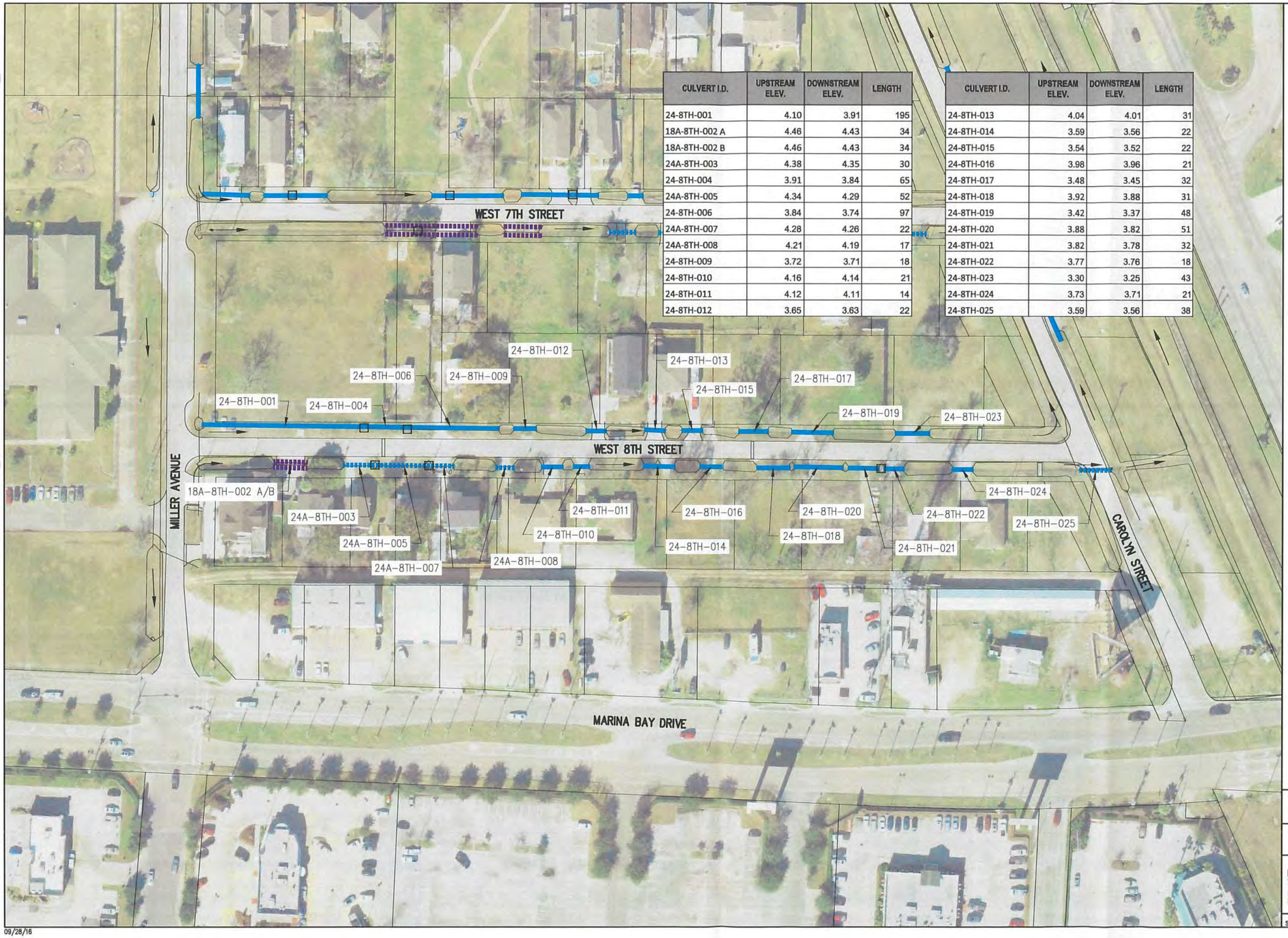
Length Ditch 1250 Ft

Length Reinforced Concrete Pipe 1031 Ft

Item No.	Description	Est Qty	Units	Unit Price	Total Price Per Item
1	Cut for Storm Pipe Finish and Grade	410	CY	$10	$4,100
2	Embankment for Storm Pipe Finished Grade	41	CY	$7	$287
3	Cement Stabilized Sand	847	CY	$35	$29,645
4	6-Inch Reinforced Concrete Driveways	57	SY	$100	$5,700
5	2-Inch Asphalt Surface & 8-Inch Asphalt Base	153	SY	$75	$11,475
6	Drain Inlet	5	EA	$2,500	$12,500
7	18 Inch Reinforced Concrete Arch Pipe	68	LF	68	$4,624
8	24 Inch Reinforced Concrete Arch Pipe	121	LF	$101.25	$12,251
9	24 Inch Reinforced Concrete Pipe	842	LF	$75	$63,150
10	Traffic Control During Construction	3	Months	$4,000	$12,000
11	Permanent Traffic Markings	1	LS	$3,000	$3,000
12	Traffic Sign Relocation and Replacement	1	EA	$100	$100
13	Hydromulch Turf Establishment	0.5	ACRES	$3,250	$1,625
14	SWPPP	1	LS	$5,000	$5,000
15	Mailbox Remove & Relocate	8	EA	$300	$2,400
16	Remove & Relocate Pedestrian Bridge	2	LS	$300	$600
Sub Total					**$168,457**
Contingency (20%)					**$33,691**
Total					**$202,149**

*This cost estimate uses best available information from pipeline representatives. It does not gurantee that future unforeseen depths that are not known at this time will not affect the future flowlines or cost of the work to be performed.

**This is a probable cost for construction along 8th Street alone and does not include engineering.



CULVERT I.D.	UPSTREAM ELEV.	DOWNSTREAM ELEV.	LENGTH
24-8TH-001	4.10	3.91	195
18A-8TH-002 A	4.46	4.43	34
18A-8TH-002 B	4.46	4.43	34
24A-8TH-003	4.38	4.35	30
24-8TH-004	3.91	3.84	65
24A-8TH-005	4.34	4.29	52
24-8TH-006	3.84	3.74	97
24A-8TH-007	4.28	4.26	22
24A-8TH-008	4.21	4.19	17
24-8TH-009	3.72	3.71	18
24-8TH-010	4.16	4.14	21
24-8TH-011	4.12	4.11	14
24-8TH-012	3.65	3.63	22

CULVERT I.D.	UPSTREAM ELEV.	DOWNSTREAM ELEV.	LENGTH
24-8TH-013	4.04	4.01	31
24-8TH-014	3.59	3.56	22
24-8TH-015	3.54	3.52	22
24-8TH-016	3.98	3.96	21
24-8TH-017	3.48	3.45	32
24-8TH-018	3.92	3.88	31
24-8TH-019	3.42	3.37	48
24-8TH-020	3.88	3.82	51
24-8TH-021	3.82	3.78	32
24-8TH-022	3.77	3.76	18
24-8TH-023	3.30	3.25	43
24-8TH-024	3.73	3.71	21
24-8TH-025	3.59	3.56	38

50 0 50 100
SCALE IN FEET

LEGEND

- 15" CULVERT
- 15" ARCH CULVERT
- 18" CULVERT
- 18" ARCH CULVERT
- 24" CULVERT
- 24" ARCH CULVERT
- 30" CULVERT
- 30" ARCH CULVERT
- 36" CULVERT
- 36" ARCH CULVERT
- 42" CULVERT
- 42" ARCH CULVERT
- INLET
- FLOW

CITY OF KEMAH

WEST 8TH STREET

LJA Engineering, Inc.
11821 East Freeway
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Phone 713.450.1300
Fax 713.450.1385
FRN - F-1386

SCALE: AS SHOWN | JOB No. E135-0280 | EXHIBIT No. 08

09/28/16

H:\ACAD\Clients\135\0280\Cost Estimate Exhibits\EX-08-8th street.dwg (XREF: Base)

APPENDIX E
SAMPLE QUESTIONAIRE

Kemah MDP
Flooding Questionnaire for Public Use

1. What flooding situations have you experienced?

2. To your knowledge, how frequent have these situations occurred?

3. Have you experienced issues with accessibility during times of flooding? If so, where? (i.e. road overtopping, ditch overflow, etc.)

4. Have you taken steps to reduce the impacts of flooding on your property and/or prepared for flooding? What steps have been taken in your area or neighborhood to reduce flood risk?

5. Within the limits of the City of Kemah are there any other areas that you find of concern? If so, where and why?

APPENDIX F
EXISTING HEC-RAS OUTPUT AND PROFILES

HEC-RAS Plan: Existing (no ineff) River: Jarbo_Ditch Reach: JB

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
JB	6034	2-year	61.00	13.51	15.92		15.93	0.000847	1.45	119.76	536.34	0.22
JB	6034	5-year	82.00	13.51	16.02		16.03	0.000696	1.22	185.54	715.02	0.20
JB	6034	10-year	98.00	13.51	16.09		16.10	0.000609	1.06	240.63	849.46	0.18
JB	6034	25-year	121.00	13.51	16.17		16.17	0.000525	1.00	306.92	954.90	0.17
JB	6034	50-year	138.00	13.51	16.22		16.22	0.000485	0.98	355.52	1014.80	0.16
JB	6034	100-year	157.00	13.51	16.27		16.27	0.000437	0.94	408.37	1083.81	0.15
JB	5447	2-year	157.00	12.55	15.07		15.10	0.001836	2.21	150.09	276.79	0.33
JB	5447	5-year	214.00	12.55	15.20		15.23	0.001901	2.30	190.76	319.52	0.33
JB	5447	10-year	259.00	12.55	15.30		15.33	0.001929	2.33	225.20	373.26	0.34
JB	5447	25-year	321.00	12.55	15.41		15.44	0.001959	2.36	270.69	457.94	0.34
JB	5447	50-year	370.00	12.55	15.49		15.52	0.001925	2.36	309.81	534.05	0.34
JB	5447	100-year	423.00	12.55	15.56		15.59	0.001926	2.35	350.94	596.41	0.34
JB	5144	2-year	157.00	12.26	14.75		14.76	0.000726	1.41	251.27	469.78	0.21
JB	5144	5-year	214.00	12.26	14.87		14.88	0.000767	1.49	310.05	493.50	0.21
JB	5144	10-year	259.00	12.26	14.94		14.96	0.000843	1.59	347.04	505.74	0.22
JB	5144	25-year	321.00	12.26	15.04		15.05	0.000906	1.58	397.20	563.59	0.23
JB	5144	50-year	370.00	12.26	15.10		15.11	0.000971	1.68	431.48	580.15	0.24
JB	5144	100-year	423.00	12.26	15.16		15.17	0.001026	1.77	465.63	594.58	0.25
JB	5132	2-year	157.00	12.21	14.74		14.75	0.000867	1.43	249.72	529.91	0.22
JB	5132	5-year	214.00	12.21	14.86		14.87	0.000896	1.46	317.04	573.37	0.23
JB	5132	10-year	259.00	12.21	14.94		14.95	0.000941	1.51	359.82	585.03	0.23
JB	5132	25-year	321.00	12.21	15.03		15.04	0.000944	1.53	416.04	621.72	0.23
JB	5132	50-year	370.00	12.21	15.09		15.10	0.000976	1.59	454.17	651.44	0.24
JB	5132	100-year	423.00	12.21	15.15		15.16	0.001012	1.65	492.28	663.72	0.24
JB	5099	2-year	157.00	12.14	14.69		14.71	0.001312	1.90	194.78	445.37	0.28
JB	5099	5-year	214.00	12.14	14.82		14.84	0.001327	1.95	255.68	543.26	0.28
JB	5099	10-year	259.00	12.14	14.89		14.91	0.001389	1.97	297.62	605.56	0.29
JB	5099	25-year	321.00	12.14	14.98		15.00	0.001441	1.93	357.44	643.91	0.29
JB	5099	50-year	370.00	12.14	15.04		15.06	0.001494	1.85	397.10	673.15	0.29
JB	5099	100-year	423.00	12.14	15.10		15.12	0.001528	1.83	436.32	692.22	0.29
JB	5079	2-year	157.00	12.00	14.68		14.69	0.000812	1.54	233.19	484.97	0.22
JB	5079	5-year	214.00	12.00	14.80		14.81	0.000890	1.62	299.52	610.56	0.23
JB	5079	10-year	259.00	12.00	14.87		14.88	0.000954	1.68	345.13	679.74	0.24
JB	5079	25-year	321.00	12.00	14.96		14.98	0.000976	1.66	414.63	802.58	0.24
JB	5079	50-year	370.00	12.00	15.02		15.04	0.001019	1.65	463.87	874.24	0.25
JB	5079	100-year	423.00	12.00	15.08		15.09	0.001054	1.64	514.81	917.10	0.25
JB	4963	2-year	222.00	11.06	14.53		14.56	0.001537	1.74	250.62	654.44	0.29
JB	4963	5-year	302.00	11.06	14.65		14.67	0.001497	1.83	336.23	811.87	0.29
JB	4963	10-year	365.00	11.06	14.70		14.73	0.001636	1.97	384.78	870.05	0.31
JB	4963	25-year	452.00	11.06	14.79		14.82	0.001724	2.10	462.79	937.24	0.32
JB	4963	50-year	520.00	11.06	14.85		14.88	0.001722	2.14	515.61	959.28	0.32
JB	4963	100-year	594.00	11.06	14.90		14.93	0.001758	2.21	566.01	987.69	0.33
JB	4870	2-year	222.00	10.60	14.12	14.12	14.29	0.005917	4.02	105.23	318.72	0.59
JB	4870	5-year	302.00	10.60	14.22	14.22	14.39	0.007561	4.19	146.52	451.71	0.65
JB	4870	10-year	365.00	10.60	14.31	14.28	14.44	0.006975	3.94	193.15	543.71	0.63
JB	4870	25-year	452.00	10.60	14.39	14.34	14.52	0.007881	4.19	237.84	704.82	0.67
JB	4870	50-year	520.00	10.60	14.44		14.57	0.008017	4.26	278.39	753.96	0.67
JB	4870	100-year	594.00	10.60	14.48		14.61	0.008373	4.39	308.18	768.93	0.69
JB	4823	2-year	222.00	9.72	12.66	12.66	13.32	0.014823	6.66	36.79	31.80	0.95
JB	4823	5-year	302.00	9.72	13.04	13.04	13.71	0.013686	6.83	50.93	41.01	0.93
JB	4823	10-year	365.00	9.72	13.31	13.31	13.96	0.012652	6.81	63.06	55.18	0.90
JB	4823	25-year	452.00	9.72	13.83	13.83	14.15	0.007124	5.29	141.15	288.66	0.68
JB	4823	50-year	520.00	9.72	13.99	13.99	14.24	0.006099	4.87	198.24	423.97	0.63
JB	4823	100-year	594.00	9.72	14.21		14.34	0.004143	3.91	316.33	614.66	0.52
JB	4743	2-year	222.00	7.79	12.08		12.19	0.001291	2.63	84.27	35.87	0.30
JB	4743	5-year	302.00	7.79	12.99		13.09	0.000915	2.53	119.56	41.79	0.26
JB	4743	10-year	365.00	7.79	13.29		13.41	0.001032	2.75	133.19	53.69	0.28
JB	4743	25-year	452.00	7.79	13.62		13.76	0.001211	2.99	175.12	207.12	0.31
JB	4743	50-year	520.00	7.79	13.86		13.98	0.001218	2.99	245.69	399.52	0.31
JB	4743	100-year	594.00	7.79	14.07		14.18	0.001152	2.90	354.28	633.81	0.30
JB	4539	2-year	222.00	7.44	11.93		11.99	0.000634	1.99	111.77	42.88	0.22
JB	4539	5-year	302.00	7.44	12.87		12.93	0.000578	1.93	156.72	62.81	0.21
JB	4539	10-year	365.00	7.44	13.17		13.23	0.000631	2.09	178.24	89.11	0.22
JB	4539	25-year	452.00	7.44	13.48		13.56	0.000699	2.28	221.77	215.73	0.23
JB	4539	50-year	520.00	7.44	13.70		13.78	0.000726	2.36	282.91	356.60	0.24
JB	4539	100-year	594.00	7.44	13.91		13.98	0.000730	2.38	368.60	467.28	0.24

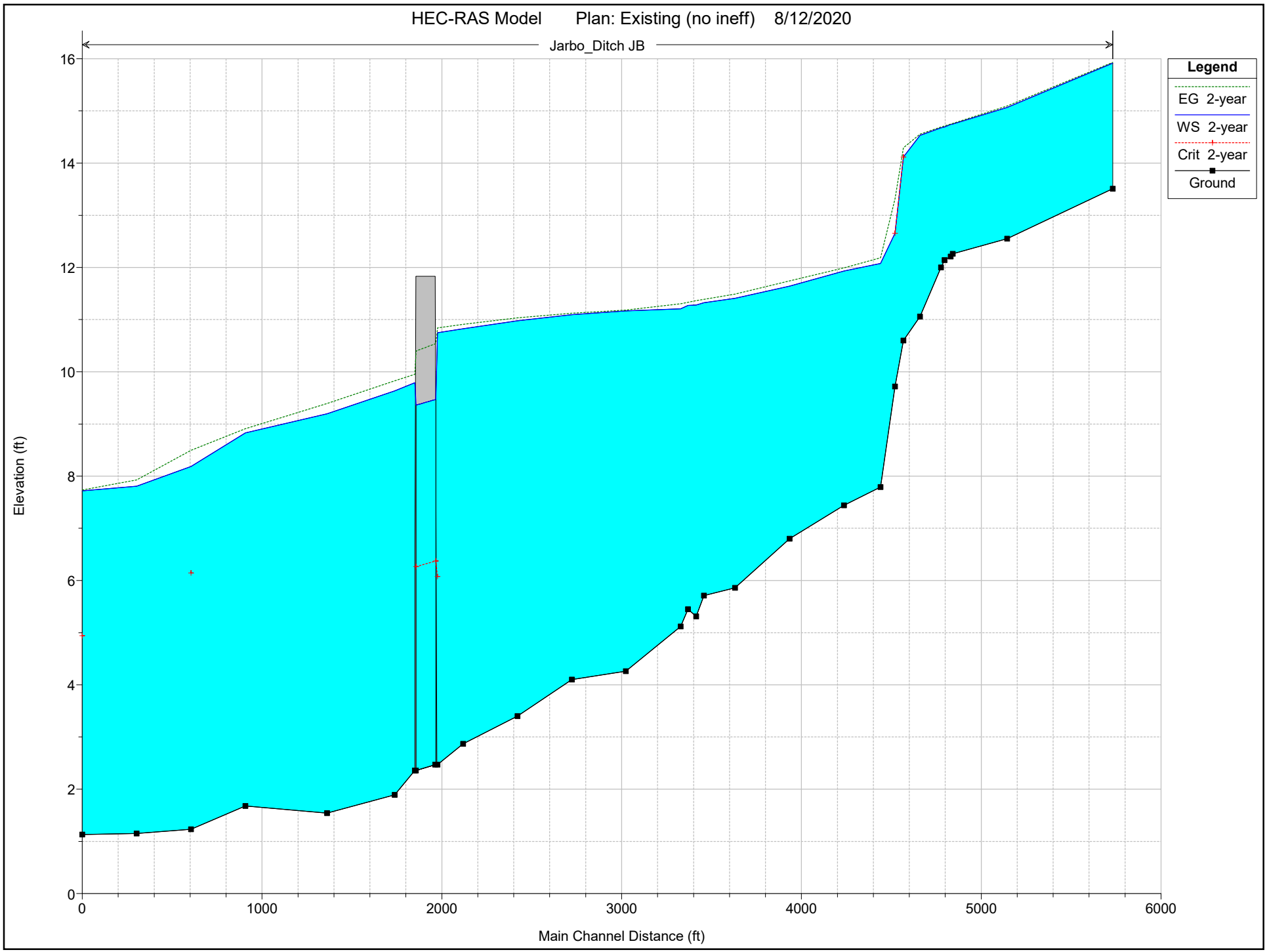
HEC-RAS Plan: Existing (no ineff) River: Jarbo_Ditch Reach: JB (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
JB	4237	2-year	312.00	6.80	11.64		11.74	0.001014	2.50	124.58	48.24	0.27
JB	4237	5-year	428.00	6.80	12.63		12.72	0.000789	2.33	190.96	91.92	0.25
JB	4237	10-year	519.00	6.80	12.90		13.00	0.000881	2.54	220.48	127.18	0.26
JB	4237	25-year	647.00	6.80	13.17		13.29	0.001029	2.83	279.75	335.28	0.29
JB	4237	50-year	747.00	6.80	13.38		13.50	0.001072	2.90	361.23	414.25	0.29
JB	4237	100-year	858.00	6.80	13.58		13.69	0.001196	2.88	449.48	496.66	0.30
JB	3934	2-year	312.00	5.86	11.41		11.49	0.000668	2.29	136.19	43.50	0.23
JB	3934	5-year	428.00	5.86	12.42		12.50	0.000671	2.27	190.61	86.92	0.23
JB	3934	10-year	519.00	5.86	12.65		12.75	0.000789	2.54	214.97	126.90	0.25
JB	3934	25-year	647.00	5.86	12.85		12.98	0.001018	2.94	249.95	234.04	0.29
JB	3934	50-year	747.00	5.86	13.01		13.16	0.001161	3.16	297.45	367.63	0.31
JB	3934	100-year	858.00	5.86	13.13		13.30	0.001362	3.40	348.57	508.28	0.33
JB	3761	2-year	312.00	5.71	11.33		11.39	0.000461	2.02	154.35	44.87	0.19
JB	3761	5-year	428.00	5.71	12.33		12.40	0.000456	2.01	224.21	114.32	0.19
JB	3761	10-year	519.00	5.71	12.55		12.63	0.000538	2.26	256.90	211.91	0.21
JB	3761	25-year	647.00	5.71	12.73		12.83	0.000693	2.64	316.96	540.46	0.24
JB	3761	50-year	747.00	5.71	12.88		12.99	0.000744	2.80	421.16	769.74	0.25
JB	3761	100-year	858.00	5.71	12.98		13.11	0.000823	3.00	507.45	948.94	0.26
JB	3710	2-year	312.00	5.31	11.28		11.36	0.000634	2.35	133.00	38.69	0.22
JB	3710	5-year	428.00	5.31	12.29		12.37	0.000722	2.28	205.86	169.86	0.23
JB	3710	10-year	519.00	5.31	12.51		12.60	0.000791	2.50	260.72	373.40	0.25
JB	3710	25-year	647.00	5.31	12.68		12.79	0.000938	2.82	346.78	640.80	0.27
JB	3710	50-year	747.00	5.31	12.85		12.96	0.000918	2.89	486.55	1012.93	0.27
JB	3710	100-year	858.00	5.31	12.95		13.06	0.000955	3.00	603.44	1227.38	0.28
JB	3690	2-year	312.00	5.45	11.27		11.33	0.000480	1.95	160.05	51.22	0.19
JB	3690	5-year	428.00	5.45	12.28		12.34	0.000398	1.94	239.39	167.92	0.18
JB	3690	10-year	519.00	5.45	12.50		12.57	0.000464	2.18	290.96	320.45	0.20
JB	3690	25-year	647.00	5.45	12.66		12.75	0.000586	2.52	352.61	441.79	0.22
JB	3690	50-year	747.00	5.45	12.82		12.92	0.000634	2.69	443.41	707.78	0.23
JB	3690	100-year	858.00	5.45	12.91		13.02	0.000738	2.94	512.02	867.24	0.25
JB	3631	2-year	416.00	5.12	11.21		11.30	0.000698	2.47	168.54	49.85	0.24
JB	3631	5-year	568.00	5.12	12.22		12.31	0.000764	2.47	247.02	192.46	0.25
JB	3631	10-year	688.00	5.12	12.42		12.54	0.000874	2.76	294.57	280.39	0.27
JB	3631	25-year	855.00	5.12	12.56		12.71	0.001127	3.22	338.78	344.38	0.30
JB	3631	50-year	987.00	5.12	12.70		12.88	0.001244	3.47	392.42	428.95	0.32
JB	3631	100-year	1131.00	5.12	12.76		12.97	0.001518	3.88	416.75	464.80	0.36
JB	3326	2-year	416.00	4.26	11.17		11.18	0.000178	1.35	569.23	434.90	0.12
JB	3326	5-year	568.00	4.26	12.22		12.23	0.000077	0.97	1128.66	718.61	0.08
JB	3326	10-year	688.00	4.26	12.43		12.44	0.000092	1.08	1296.09	901.41	0.09
JB	3326	25-year	855.00	4.26	12.57		12.59	0.000122	1.25	1438.47	1068.18	0.10
JB	3326	50-year	987.00	4.26	12.71		12.72	0.000155	1.41	1592.25	1200.59	0.12
JB	3326	100-year	1131.00	4.26	12.76		12.78	0.000195	1.57	1658.72	1243.08	0.13
JB	3026	2-year	499.00	4.10	11.10		11.12	0.000233	1.59	604.26	468.01	0.14
JB	3026	5-year	685.00	4.10	12.20		12.21	0.000099	1.09	1555.56	1471.24	0.09
JB	3026	10-year	831.00	4.10	12.40		12.41	0.000107	1.12	1882.54	1689.34	0.10
JB	3026	25-year	1035.00	4.10	12.54		12.55	0.000127	1.21	2121.11	1765.71	0.10
JB	3026	50-year	1197.00	4.10	12.67		12.68	0.000131	1.25	2363.41	1907.26	0.11
JB	3026	100-year	1375.00	4.10	12.72		12.73	0.000159	1.38	2451.68	1964.24	0.12
JB	2724	2-year	499.00	3.40	10.98		11.03	0.000351	2.03	394.77	477.17	0.17
JB	2724	5-year	685.00	3.40	12.16		12.17	0.000122	1.24	1239.11	989.92	0.10
JB	2724	10-year	831.00	3.40	12.36		12.37	0.000137	1.30	1454.02	1152.67	0.11
JB	2724	25-year	1035.00	3.40	12.48		12.50	0.000180	1.50	1604.58	1227.10	0.13
JB	2724	50-year	1197.00	3.40	12.61		12.63	0.000199	1.57	1768.40	1322.69	0.13
JB	2724	100-year	1375.00	3.40	12.65		12.67	0.000251	1.77	1810.37	1347.07	0.15
JB	2421	2-year	524.00	2.87	10.82		10.91	0.000454	2.37	232.52	112.17	0.20
JB	2421	5-year	719.00	2.87	12.11		12.13	0.000165	1.50	1200.67	1368.49	0.12
JB	2421	10-year	874.00	2.87	12.31		12.33	0.000167	1.51	1503.95	1683.48	0.12
JB	2421	25-year	1089.00	2.87	12.42		12.44	0.000209	1.69	1707.63	1907.43	0.14
JB	2421	50-year	1259.00	2.87	12.54		12.57	0.000232	1.78	1958.05	2169.44	0.14
JB	2421	100-year	1447.00	2.87	12.55		12.58	0.000299	2.02	1982.16	2188.36	0.16
JB	2270	2-year	700.00	2.47	10.75	6.08	10.84	0.000418	2.50	337.25	449.61	0.19
JB	2270	5-year	957.00	2.47	12.09	6.71	12.10	0.000080	1.08	2640.06	3032.94	0.09
JB	2270	10-year	1160.00	2.47	12.29	7.16	12.30	0.000077	1.06	3294.67	3590.36	0.08
JB	2270	25-year	1442.00	2.47	12.40	7.72	12.41	0.000095	1.18	3724.12	4250.83	0.09
JB	2270	50-year	1664.00	2.47	12.53	8.12	12.53	0.000100	1.20	4280.69	4900.83	0.10

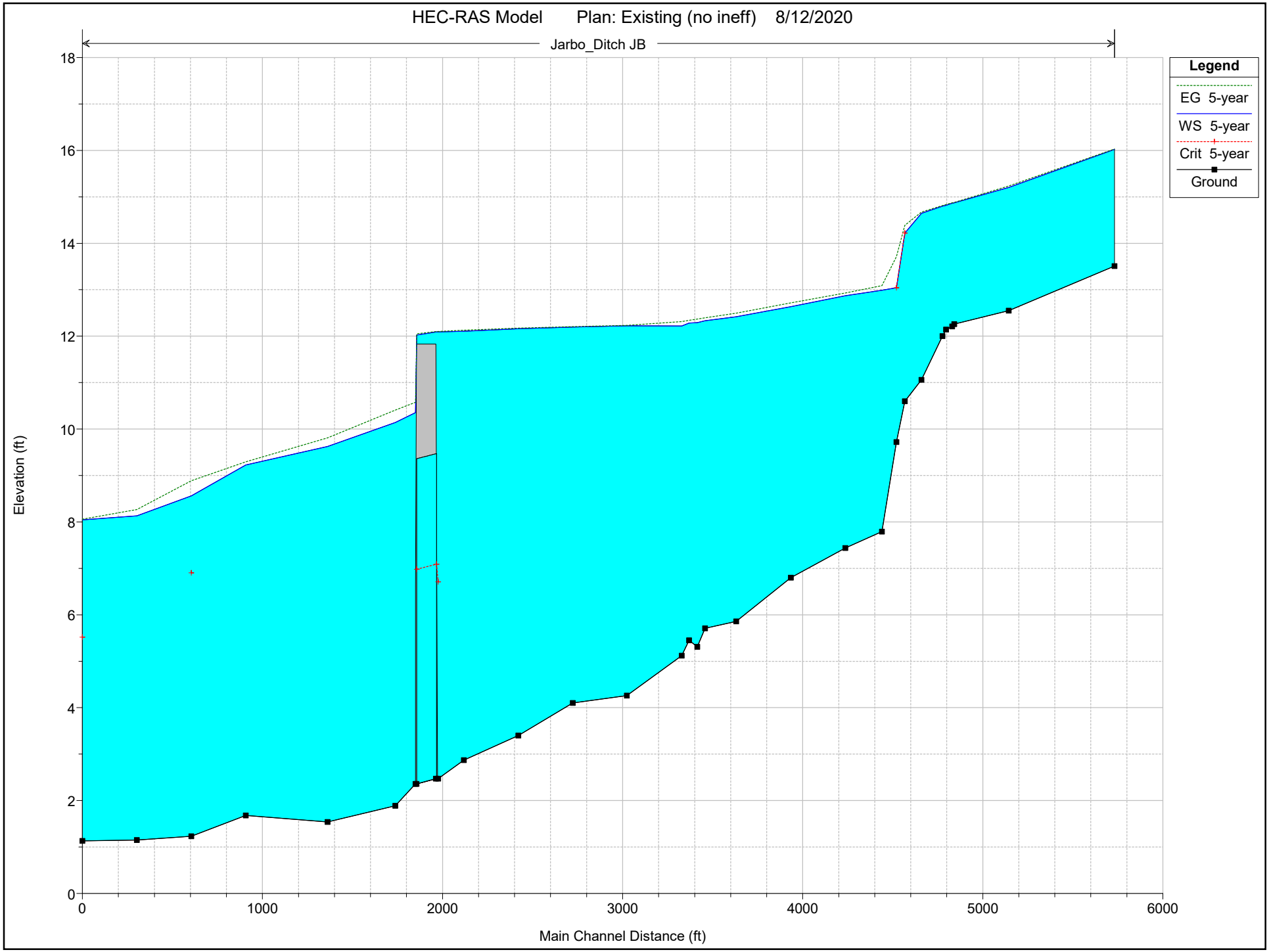
HEC-RAS Plan: Existing (no ineff) River: Jarbo_Ditch Reach: JB (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
JB	2270	100-year	1908.00	2.47	12.53	8.53	12.54	0.000130	1.37	4311.00	4932.97	0.11
JB	2209		Culvert									
JB	2153	2-year	743.00	2.36	9.79		9.95	0.000850	3.22	231.71	60.60	0.27
JB	2153	5-year	1015.00	2.36	10.35		10.57	0.001097	3.81	319.93	351.70	0.31
JB	2153	10-year	1229.00	2.36	10.69	7.49	10.91	0.001125	3.95	540.42	1190.63	0.31
JB	2153	25-year	1528.00	2.36	11.25		11.31	0.000500	2.69	1955.03	4014.44	0.21
JB	2153	50-year	1762.00	2.36	11.51		11.53	0.000317	2.10	3138.01	5038.81	0.17
JB	2153	100-year	2020.00	2.36	11.71		11.73	0.000224	1.73	4231.28	5553.58	0.14
JB	2041	2-year	745.00	1.89	9.63		9.83	0.001092	3.52	212.92	78.84	0.30
JB	2041	5-year	1019.00	1.89	10.14		10.41	0.001476	4.17	279.81	188.90	0.35
JB	2041	10-year	1234.00	1.89	10.36		10.69	0.001822	4.69	328.30	257.85	0.40
JB	2041	25-year	1533.00	1.89	10.60		11.00	0.002266	5.29	397.84	314.30	0.44
JB	2041	50-year	1768.00	1.89	10.77		11.21	0.002594	5.64	461.00	396.83	0.47
JB	2041	100-year	2027.00	1.89	10.98	9.00	11.41	0.002977	5.79	555.05	521.45	0.50
JB	1665	2-year	752.00	1.54	9.20		9.39	0.001212	3.59	247.06	363.28	0.32
JB	1665	5-year	1028.00	1.54	9.62		9.81	0.001572	3.75	465.67	625.26	0.36
JB	1665	10-year	1245.00	1.54	9.82		10.01	0.001573	3.88	599.95	709.52	0.36
JB	1665	25-year	1547.00	1.54	10.05		10.23	0.001599	4.04	766.11	762.36	0.36
JB	1665	50-year	1784.00	1.54	10.20		10.37	0.001627	4.16	883.54	836.53	0.37
JB	1665	100-year	2045.00	1.54	10.34		10.52	0.001659	4.27	1013.85	931.26	0.37
JB	1211	2-year	763.00	1.68	8.83		8.91	0.000816	2.68	520.84	541.24	0.26
JB	1211	5-year	1043.00	1.68	9.23		9.30	0.000763	2.64	769.92	713.33	0.25
JB	1211	10-year	1263.00	1.68	9.41		9.48	0.000807	2.78	902.12	762.71	0.26
JB	1211	25-year	1569.00	1.68	9.59		9.67	0.000899	3.03	1042.67	792.81	0.27
JB	1211	50-year	1810.00	1.68	9.69		9.78	0.000994	3.24	1125.71	802.51	0.29
JB	1211	100-year	2074.00	1.68	9.79		9.89	0.001093	3.46	1209.29	808.43	0.31
JB	908	2-year	771.00	1.23	8.18	6.15	8.49	0.002378	4.54	201.72	267.21	0.43
JB	908	5-year	1054.00	1.23	8.56	6.90	8.89	0.002443	4.94	379.25	707.03	0.45
JB	908	10-year	1276.00	1.23	8.74	7.39	9.06	0.002455	5.11	530.31	981.26	0.45
JB	908	25-year	1585.00	1.23	8.95	8.83	9.23	0.002362	5.18	769.18	1347.79	0.45
JB	908	50-year	1829.00	1.23	9.09	8.92	9.33	0.002171	5.08	983.59	1553.67	0.43
JB	908	100-year	2095.00	1.23	9.22	9.02	9.43	0.002071	5.06	1182.30	1600.64	0.42
JB	606	2-year	777.00	1.15	7.81		7.93	0.001258	3.18	425.46	492.18	0.31
JB	606	5-year	1061.00	1.15	8.13		8.27	0.001471	3.57	645.23	887.39	0.34
JB	606	10-year	1285.00	1.15	8.37		8.47	0.001275	3.28	883.49	1097.26	0.32
JB	606	25-year	1596.00	1.15	8.59		8.68	0.001190	3.29	1178.33	1643.60	0.31
JB	606	50-year	1840.00	1.15	8.77		8.84	0.001044	3.19	1502.00	1888.77	0.29
JB	606	100-year	2108.00	1.15	8.92		8.99	0.000926	3.08	1792.97	1909.12	0.28
JB	303	2-year	786.00	1.13	7.72	4.94	7.73	0.000302	1.53	1093.14	1082.09	0.15
JB	303	5-year	1073.00	1.13	8.04	5.52	8.06	0.000301	1.63	1487.37	1302.87	0.16
JB	303	10-year	1300.00	1.13	8.27	5.67	8.28	0.000301	1.70	1798.43	1452.96	0.16
JB	303	25-year	1614.00	1.13	8.48	6.08	8.50	0.000301	1.77	2113.72	1496.88	0.16
JB	303	50-year	1862.00	1.13	8.66	6.27	8.67	0.000301	1.82	2381.12	1525.85	0.16
JB	303	100-year	2133.00	1.13	8.81	6.46	8.83	0.000301	1.87	2614.52	1548.15	0.16

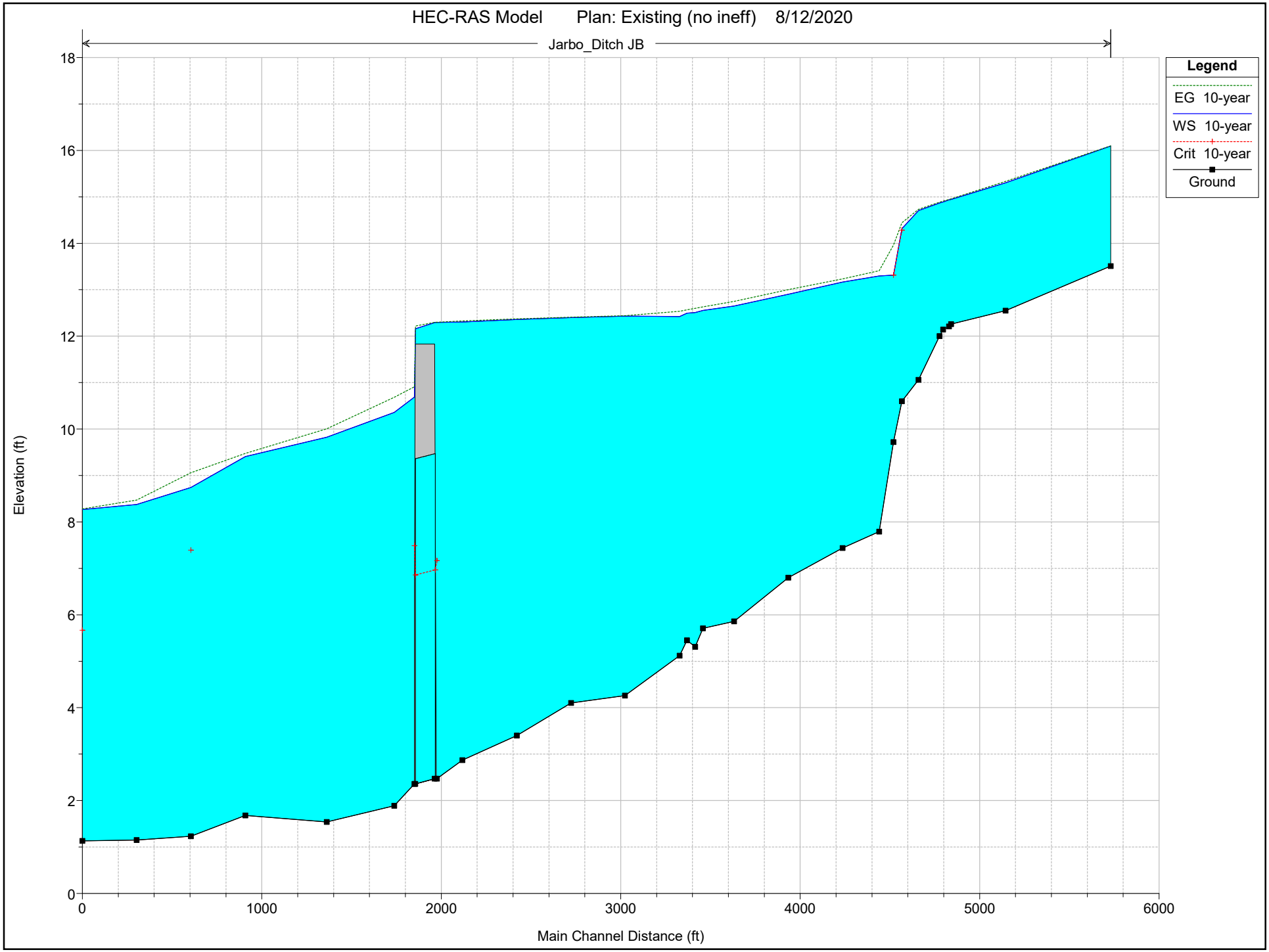
Existing 2-year Water Surface Profile



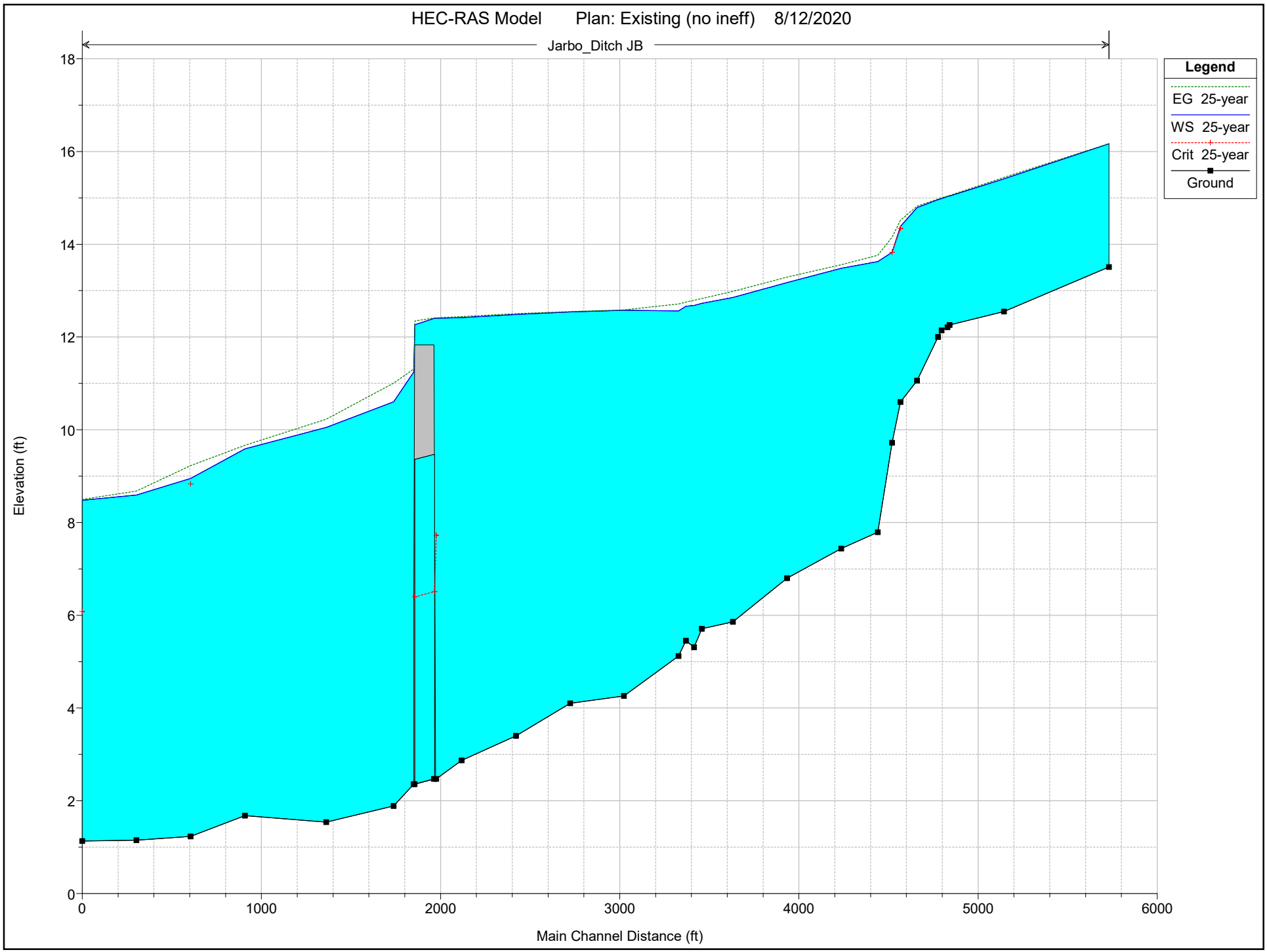
Existing 5-year Water Surface Profile



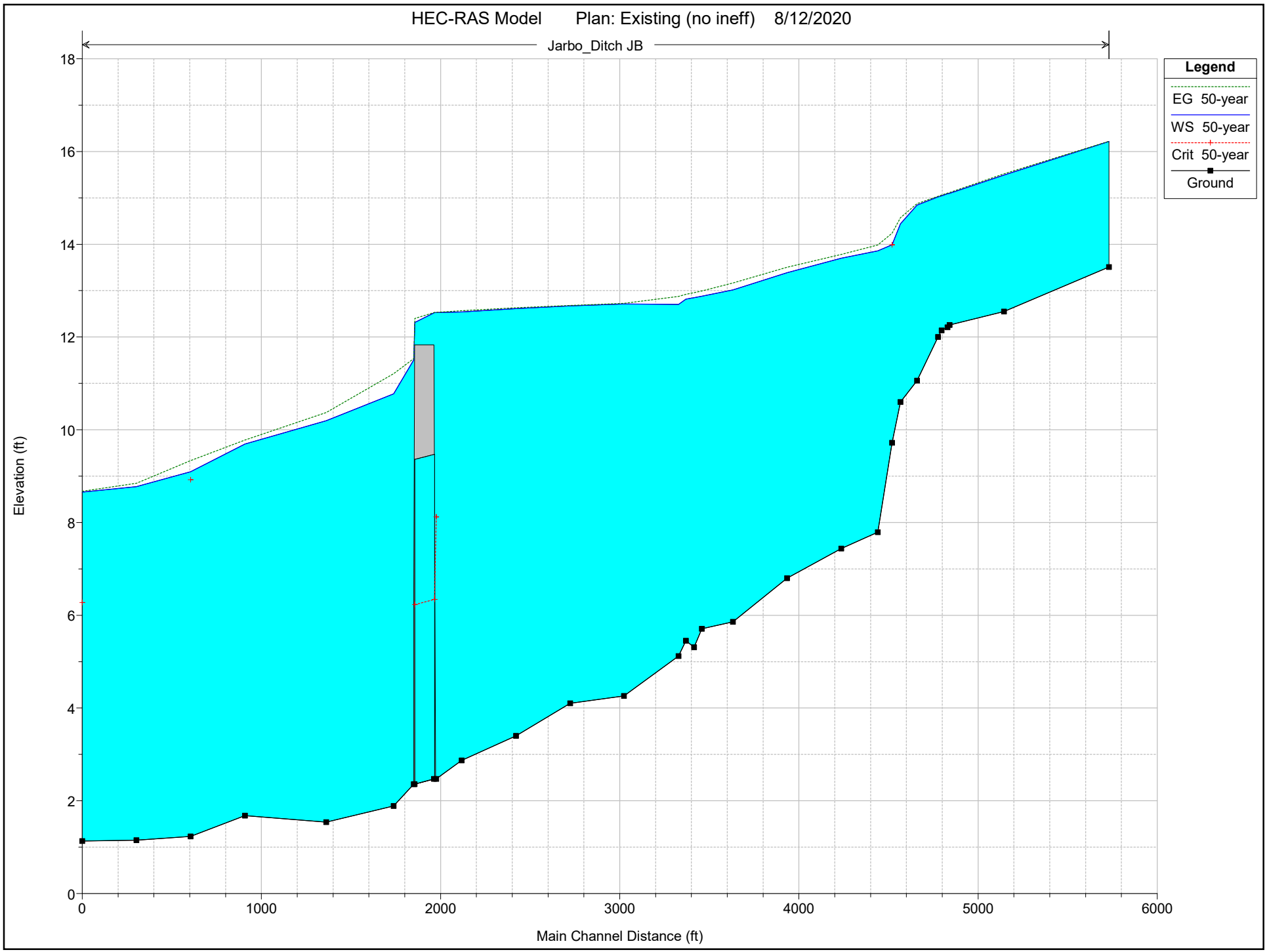
Existing 10-year Water Surface Profile



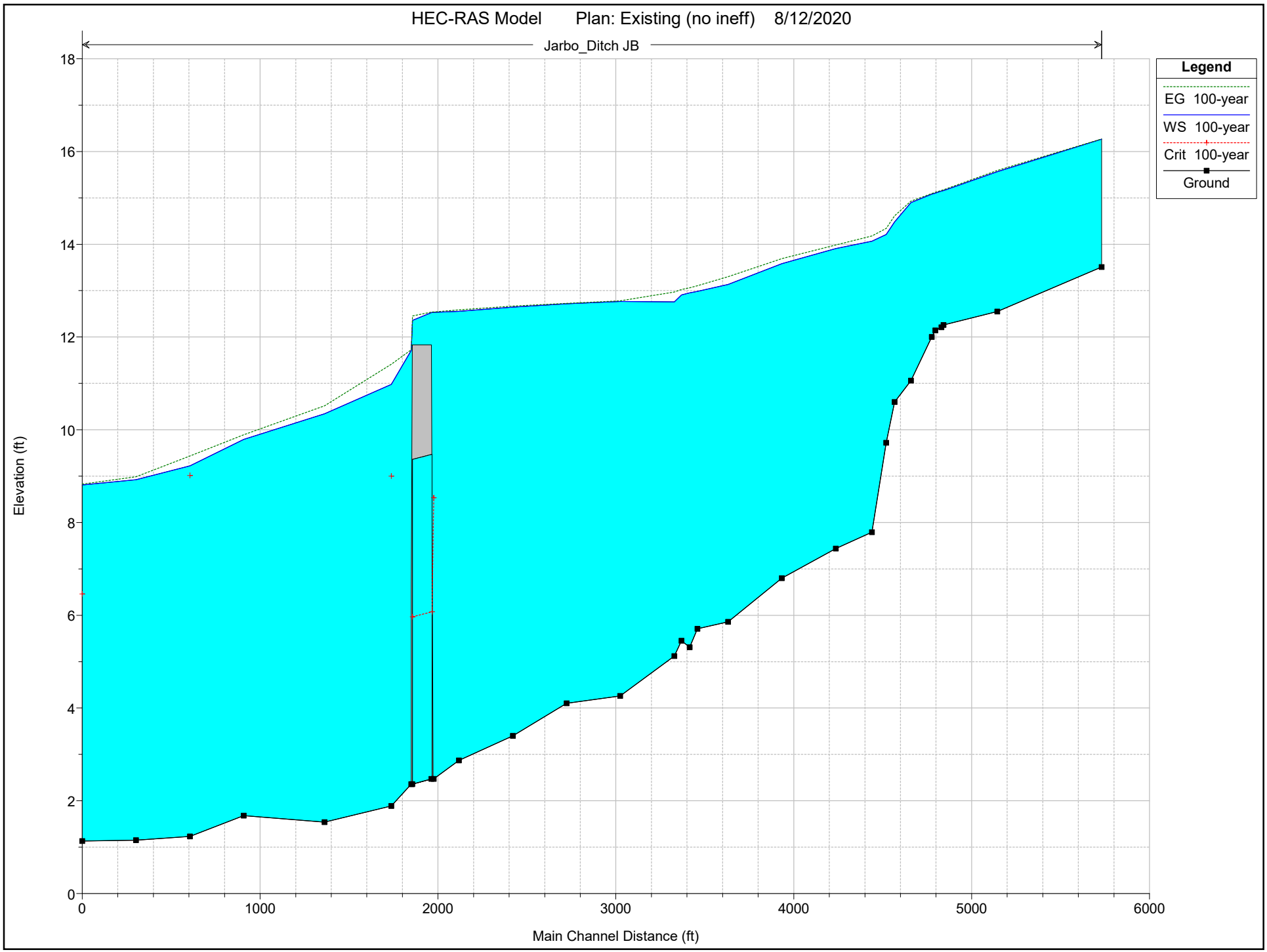
Existing 25-year Water Surface Profile



Existing 50-year Water Surface Profile



Existing 100-year Water Surface Profile



APPENDIX G
SCENARIO 1 HEC-RAS OUTPUT AND PROFILES

HEC-RAS Plan: Prop Scen 1 River: Jarbo_Ditch Reach: JB

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
JB	6034	2-year	61.00	13.51	15.89	15.07	15.91	0.001018	1.61	106.81	501.99	0.24
JB	6034	5-year	82.00	13.51	16.00		16.01	0.000829	1.30	170.49	666.27	0.21
JB	6034	10-year	98.00	13.51	16.07		16.08	0.000709	1.16	223.42	813.92	0.20
JB	6034	25-year	121.00	13.51	16.15		16.16	0.000578	1.06	293.48	927.53	0.18
JB	6034	50-year	138.00	13.51	16.21		16.21	0.000517	1.02	346.07	1005.01	0.17
JB	6034	100-year	157.00	13.51	16.26		16.26	0.000472	0.98	395.79	1068.97	0.16
JB	5447	2-year	157.00	12.55	15.05		15.08	0.001620	2.05	146.79	275.10	0.31
JB	5447	5-year	214.00	12.55	15.20		15.23	0.001669	2.14	188.76	316.47	0.31
JB	5447	10-year	259.00	12.55	15.29		15.32	0.001730	2.19	221.65	370.32	0.32
JB	5447	25-year	321.00	12.55	15.41		15.44	0.001785	2.24	269.22	455.31	0.32
JB	5447	50-year	370.00	12.55	15.48		15.51	0.001824	2.28	305.58	526.87	0.33
JB	5447	100-year	423.00	12.55	15.56		15.59	0.001855	2.29	347.36	593.68	0.33
JB	5144	2-year	157.00	12.26	14.78		14.79	0.000634	1.33	264.32	474.40	0.19
JB	5144	5-year	214.00	12.26	14.90		14.91	0.000709	1.44	322.29	497.17	0.21
JB	5144	10-year	259.00	12.26	14.97		14.98	0.000767	1.49	359.89	513.77	0.21
JB	5144	25-year	321.00	12.26	15.06		15.07	0.000846	1.54	409.63	570.71	0.22
JB	5144	50-year	370.00	12.26	15.12		15.13	0.000905	1.64	442.40	585.05	0.23
JB	5144	100-year	423.00	12.26	15.18		15.19	0.000960	1.73	476.68	598.60	0.24
JB	5132	2-year	157.00	12.21	14.77		14.78	0.000748	1.33	265.24	540.99	0.21
JB	5132	5-year	214.00	12.21	14.89		14.90	0.000813	1.39	331.77	577.79	0.21
JB	5132	10-year	259.00	12.21	14.96		14.97	0.000832	1.42	375.13	589.27	0.22
JB	5132	25-year	321.00	12.21	15.05		15.06	0.000856	1.47	430.39	637.07	0.22
JB	5132	50-year	370.00	12.21	15.11		15.12	0.000901	1.54	466.96	656.50	0.23
JB	5132	100-year	423.00	12.21	15.17		15.18	0.000939	1.60	505.13	667.87	0.24
JB	5099	2-year	157.00	12.14	14.73		14.75	0.001091	1.74	211.94	479.15	0.25
JB	5099	5-year	214.00	12.14	14.85		14.86	0.001139	1.80	273.56	568.65	0.26
JB	5099	10-year	259.00	12.14	14.92		14.94	0.001198	1.82	317.88	619.51	0.27
JB	5099	25-year	321.00	12.14	15.01		15.03	0.001271	1.78	376.09	653.29	0.27
JB	5099	50-year	370.00	12.14	15.07		15.08	0.001347	1.73	413.48	679.29	0.28
JB	5099	100-year	423.00	12.14	15.13		15.14	0.001390	1.73	452.72	706.26	0.28
JB	5079	2-year	157.00	12.00	14.71		14.72	0.001146	1.83	247.19	519.11	0.26
JB	5079	5-year	214.00	12.00	14.82		14.84	0.001209	1.89	314.87	627.57	0.27
JB	5079	10-year	259.00	12.00	14.90		14.91	0.001258	1.93	363.56	708.39	0.27
JB	5079	25-year	321.00	12.00	14.99		15.00	0.001272	1.87	433.83	830.80	0.27
JB	5079	50-year	370.00	12.00	15.04		15.06	0.001313	1.86	481.14	887.39	0.28
JB	5079	100-year	423.00	12.00	15.10		15.11	0.001336	1.84	532.78	939.70	0.28
JB	4963	2-year	222.00	11.06	14.52		14.55	0.001813	1.88	243.85	640.25	0.32
JB	4963	5-year	302.00	11.06	14.63		14.66	0.001804	1.99	324.24	794.03	0.32
JB	4963	10-year	365.00	11.06	14.69		14.73	0.001917	2.12	375.19	858.99	0.33
JB	4963	25-year	452.00	11.06	14.77		14.80	0.002134	2.31	440.50	928.32	0.36
JB	4963	50-year	520.00	11.06	14.81		14.85	0.002255	2.42	481.12	945.21	0.37
JB	4963	100-year	594.00	11.06	14.86		14.90	0.002249	2.47	533.76	967.08	0.37
JB	4870	2-year	222.00	10.60	14.09	14.09	14.26	0.005659	3.97	98.68	289.80	0.57
JB	4870	5-year	302.00	10.60	14.20	14.20	14.35	0.006864	4.01	138.87	434.77	0.62
JB	4870	10-year	365.00	10.60	14.26	14.26	14.41	0.007646	4.18	162.65	485.68	0.66
JB	4870	25-year	452.00	10.60	14.38		14.48	0.006073	3.67	233.81	696.93	0.59
JB	4870	50-year	520.00	10.60	14.44		14.53	0.005531	3.54	280.24	754.94	0.56
JB	4870	100-year	594.00	10.60	14.46		14.57	0.006474	3.85	294.85	762.62	0.61
JB	4823	2-year	222.00	9.72	12.65	12.65	13.36	0.015747	6.86	36.58	31.63	0.98
JB	4823	5-year	302.00	9.72	13.06	13.06	13.80	0.014581	7.07	51.59	41.36	0.96
JB	4823	10-year	365.00	9.72	13.73	13.73	14.06	0.006364	5.02	117.41	235.87	0.65
JB	4823	25-year	452.00	9.72	13.89	13.89	14.18	0.006284	4.98	162.26	336.61	0.64
JB	4823	50-year	520.00	9.72	13.99	13.99	14.24	0.006253	4.93	197.64	422.29	0.64
JB	4823	100-year	594.00	9.72	14.20		14.33	0.004113	3.91	306.09	605.26	0.52
JB	4743	2-year	222.00	7.79	11.73		11.88	0.001981	3.07	72.31	33.78	0.37
JB	4743	5-year	302.00	7.79	12.33		12.49	0.001796	3.23	93.48	37.50	0.36
JB	4743	10-year	365.00	7.79	12.81		12.98	0.001579	3.25	112.43	40.63	0.34
JB	4743	25-year	452.00	7.79	13.45		13.61	0.001395	3.22	145.57	130.50	0.33
JB	4743	50-year	520.00	7.79	13.77		13.91	0.001338	3.13	213.38	336.83	0.32
JB	4743	100-year	594.00	7.79	14.06		14.16	0.001106	2.84	349.33	628.22	0.29
JB	4539	2-year	222.00	7.44	11.49		11.58	0.001059	2.38	93.33	40.21	0.28
JB	4539	5-year	302.00	7.44	12.11		12.21	0.000977	2.53	119.49	44.17	0.27
JB	4539	10-year	365.00	7.44	12.62		12.72	0.000879	2.55	143.13	48.22	0.26
JB	4539	25-year	452.00	7.44	13.28		13.37	0.000868	2.48	188.99	110.98	0.26
JB	4539	50-year	520.00	7.44	13.59		13.68	0.000831	2.51	247.85	271.67	0.26
JB	4539	100-year	594.00	7.44	13.88		13.97	0.000784	2.46	358.62	456.12	0.25

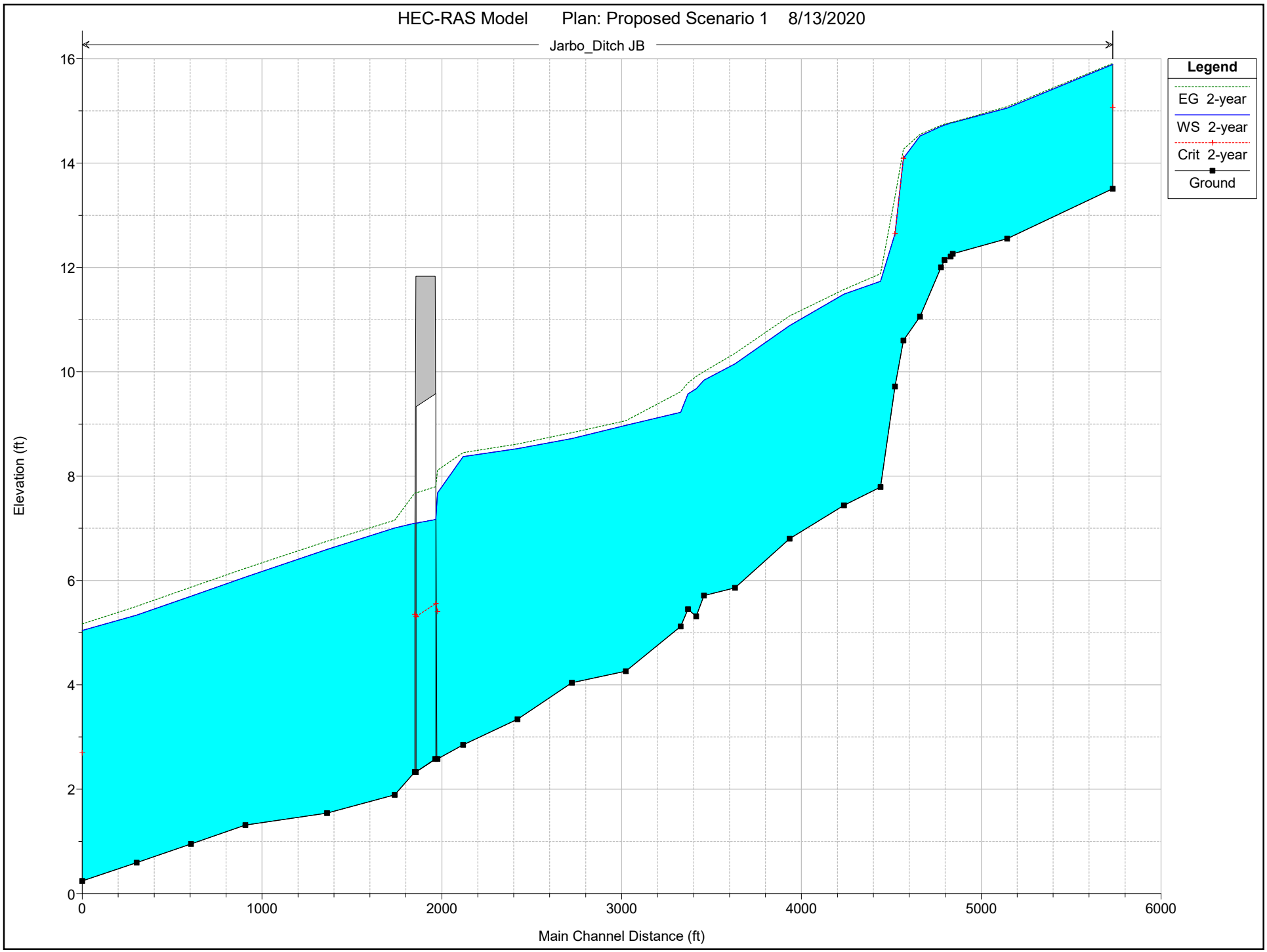
HEC-RAS Plan: Prop Scen 1 River: Jarbo_Ditch Reach: JB (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
JB	4237	2-year	312.00	6.80	10.89		11.07	0.002397	3.44	90.64	41.55	0.41
JB	4237	5-year	428.00	6.80	11.56		11.75	0.002086	3.55	120.49	47.45	0.39
JB	4237	10-year	519.00	6.80	12.11		12.30	0.002051	3.47	150.25	65.65	0.39
JB	4237	25-year	647.00	6.80	12.86		13.02	0.001430	3.23	215.14	122.72	0.33
JB	4237	50-year	747.00	6.80	13.19		13.35	0.001339	3.23	287.16	353.22	0.33
JB	4237	100-year	858.00	6.80	13.54		13.65	0.001283	2.97	428.07	468.51	0.31
JB	3934	2-year	312.00	5.86	10.15		10.35	0.002327	3.60	86.57	35.87	0.41
JB	3934	5-year	428.00	5.86	10.94		11.15	0.001905	3.67	116.61	40.34	0.38
JB	3934	10-year	519.00	5.86	11.53		11.74	0.001678	3.67	141.37	44.45	0.36
JB	3934	25-year	647.00	5.86	12.37		12.56	0.001605	3.49	186.67	80.64	0.35
JB	3934	50-year	747.00	5.86	12.71		12.91	0.001560	3.59	223.22	142.90	0.35
JB	3934	100-year	858.00	5.86	13.01		13.22	0.001588	3.70	295.13	360.05	0.36
JB	3761	2-year	312.00	5.71	9.84		10.01	0.001669	3.27	95.39	35.52	0.35
JB	3761	5-year	428.00	5.71	10.68		10.86	0.001427	3.37	127.08	40.13	0.33
JB	3761	10-year	519.00	5.71	11.29		11.47	0.001300	3.39	152.87	44.45	0.32
JB	3761	25-year	647.00	5.71	12.14		12.30	0.001261	3.23	204.93	89.75	0.32
JB	3761	50-year	747.00	5.71	12.50		12.67	0.001178	3.32	246.70	170.39	0.31
JB	3761	100-year	858.00	5.71	12.81		12.98	0.001098	3.37	369.84	678.71	0.30
JB	3710	2-year	312.00	5.31	9.67		9.91	0.002450	3.92	79.67	29.77	0.42
JB	3710	5-year	428.00	5.31	10.52		10.77	0.002056	4.02	106.39	33.26	0.40
JB	3710	10-year	519.00	5.31	11.14		11.40	0.001906	4.06	127.99	37.38	0.39
JB	3710	25-year	647.00	5.31	12.00		12.23	0.001765	3.91	169.66	87.12	0.37
JB	3710	50-year	747.00	5.31	12.36		12.60	0.001601	3.99	219.04	211.12	0.36
JB	3710	100-year	858.00	5.31	12.71	9.96	12.92	0.001355	3.89	363.63	708.89	0.34
JB	3690	2-year	312.00	5.45	9.58		9.79	0.002670	3.68	84.81	37.98	0.43
JB	3690	5-year	428.00	5.45	10.48		10.67	0.001855	3.50	122.22	44.80	0.37
JB	3690	10-year	519.00	5.45	11.12		11.30	0.001513	3.40	152.52	50.10	0.34
JB	3690	25-year	647.00	5.45	11.98		12.15	0.001194	3.23	201.88	93.69	0.31
JB	3690	50-year	747.00	5.45	12.35		12.52	0.001107	3.30	253.22	212.63	0.30
JB	3690	100-year	858.00	5.45	12.69		12.85	0.000976	3.29	368.40	510.07	0.29
JB	3631	2-year	416.00	5.12	9.22		9.62	0.005087	5.03	82.66	37.48	0.60
JB	3631	5-year	568.00	5.12	10.22		10.55	0.003053	4.62	122.89	42.99	0.48
JB	3631	10-year	688.00	5.12	10.89		11.20	0.002468	4.50	152.96	47.48	0.44
JB	3631	25-year	855.00	5.12	11.78		12.07	0.001963	4.31	199.62	63.43	0.40
JB	3631	50-year	987.00	5.12	12.13		12.44	0.001988	4.50	231.78	149.16	0.41
JB	3631	100-year	1131.00	5.12	12.46		12.78	0.001879	4.60	305.00	303.45	0.40
JB	3326	2-year	416.00	4.26	8.97		9.06	0.000714	2.43	171.06	53.19	0.24
JB	3326	5-year	568.00	4.26	10.05		10.15	0.000564	2.44	249.10	308.57	0.22
JB	3326	10-year	688.00	4.26	10.84		10.89	0.000362	2.10	532.01	410.25	0.18
JB	3326	25-year	855.00	4.26	11.83		11.86	0.000189	1.64	1005.24	551.14	0.13
JB	3326	50-year	987.00	4.26	12.20		12.23	0.000174	1.62	1234.81	712.64	0.13
JB	3326	100-year	1131.00	4.26	12.54		12.57	0.000170	1.64	1530.34	1052.01	0.13
JB	3026	2-year	499.00	4.04	8.72		8.83	0.000808	2.68	185.93	54.63	0.26
JB	3026	5-year	685.00	4.04	9.86		9.97	0.000621	2.65	318.08	220.13	0.23
JB	3026	10-year	831.00	4.04	10.69		10.77	0.000452	2.43	559.65	381.83	0.20
JB	3026	25-year	1035.00	4.04	11.74		11.79	0.000277	2.06	1148.20	989.93	0.16
JB	3026	50-year	1197.00	4.04	12.12		12.17	0.000246	1.98	1604.80	1396.60	0.15
JB	3026	100-year	1375.00	4.04	12.47		12.51	0.000215	1.91	2165.77	1735.40	0.14
JB	2724	2-year	499.00	3.34	8.53		8.62	0.000598	2.43	205.60	55.93	0.22
JB	2724	5-year	685.00	3.34	9.70		9.79	0.000502	2.49	275.44	63.55	0.21
JB	2724	10-year	831.00	3.34	10.54		10.64	0.000428	2.46	381.26	237.65	0.20
JB	2724	25-year	1035.00	3.34	11.66		11.71	0.000229	1.95	974.15	757.62	0.15
JB	2724	50-year	1197.00	3.34	12.06		12.10	0.000197	1.86	1312.05	940.05	0.14
JB	2724	100-year	1375.00	3.34	12.42		12.45	0.000173	1.77	1697.03	1211.85	0.13
JB	2421	2-year	524.00	2.85	8.37		8.45	0.000479	2.26	231.51	59.24	0.20
JB	2421	5-year	719.00	2.85	9.57		9.65	0.000415	2.34	306.80	66.74	0.19
JB	2421	10-year	874.00	2.85	10.43		10.51	0.000377	2.39	366.39	75.17	0.19
JB	2421	25-year	1089.00	2.85	11.56		11.63	0.000284	2.23	740.62	988.60	0.16
JB	2421	50-year	1259.00	2.85	11.98		12.03	0.000232	2.07	1236.11	1304.55	0.15
JB	2421	100-year	1447.00	2.85	12.36		12.40	0.000182	1.88	1804.55	1817.37	0.13
JB	2270	2-year	700.00	2.58	7.68	5.40	8.11	0.001762	5.28	132.61	73.78	0.41
JB	2270	5-year	957.00	2.58	8.68	6.06	9.25	0.001810	6.03	158.68	82.33	0.43
JB	2270	10-year	1160.00	2.58	9.39	6.53	10.05	0.001847	6.55	177.02	88.34	0.44
JB	2270	25-year	1442.00	2.58	10.29	7.15	11.09	0.001882	7.19	200.58	100.59	0.46
JB	2270	50-year	1664.00	2.58	11.96	7.61	11.99	0.000140	1.63	2562.86	2759.33	0.12

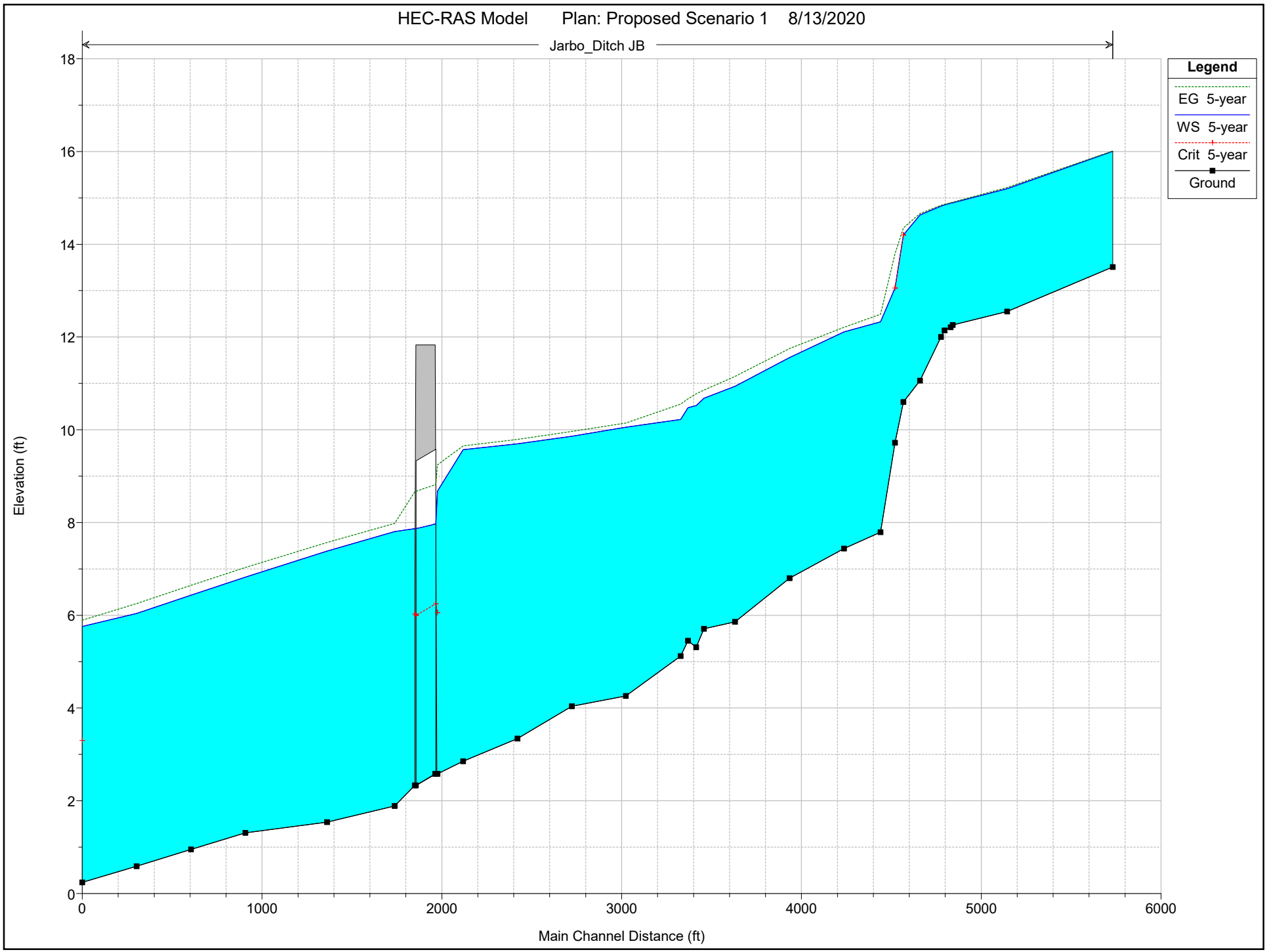
HEC-RAS Plan: Prop Scen 1 River: Jarbo_Ditch Reach: JB (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
JB	2270	100-year	1908.00	2.58	12.34	8.09	12.36	0.000098	1.39	3809.52	3912.85	0.10
JB	2209		Culvert									
JB	2153	2-year	743.00	2.33	7.10	5.35	7.68	0.002637	6.10	121.77	70.00	0.50
JB	2153	5-year	1015.00	2.33	7.87	6.03	8.67	0.002963	7.16	141.77	76.50	0.54
JB	2153	10-year	1229.00	2.33	8.37	6.53	9.35	0.003245	7.94	154.75	80.72	0.57
JB	2153	25-year	1528.00	2.33	8.96	7.17	10.21	0.003656	8.98	170.15	85.72	0.62
JB	2153	50-year	1762.00	2.33	9.35	7.64	10.84	0.004002	9.77	180.37	89.04	0.65
JB	2153	100-year	2020.00	2.33	9.68	8.14	11.46	0.004502	10.69	188.99	95.34	0.70
JB	2041	2-year	745.00	1.89	7.01		7.16	0.001056	3.10	240.64	70.49	0.30
JB	2041	5-year	1019.00	1.89	7.80		7.98	0.001079	3.40	299.47	77.27	0.30
JB	2041	10-year	1234.00	1.89	8.32		8.53	0.001108	3.62	340.90	81.70	0.31
JB	2041	25-year	1533.00	1.89	8.95		9.19	0.001151	3.89	393.79	87.06	0.32
JB	2041	50-year	1768.00	1.89	9.37		9.63	0.001195	4.10	431.24	90.67	0.33
JB	2041	100-year	2027.00	1.89	9.74		10.03	0.001279	4.36	469.59	137.65	0.35
JB	1665	2-year	752.00	1.54	6.60		6.75	0.001094	3.15	238.87	70.01	0.30
JB	1665	5-year	1028.00	1.54	7.38		7.57	0.001124	3.47	296.35	76.60	0.31
JB	1665	10-year	1245.00	1.54	7.89		8.10	0.001165	3.70	336.14	80.84	0.32
JB	1665	25-year	1547.00	1.54	8.49		8.74	0.001227	4.00	386.37	85.90	0.33
JB	1665	50-year	1784.00	1.54	8.89		9.17	0.001290	4.24	421.27	95.54	0.34
JB	1665	100-year	2045.00	1.54	9.22		9.53	0.001375	4.49	500.61	427.53	0.36
JB	1211	2-year	763.00	1.31	6.06		6.23	0.001194	3.28	232.29	68.18	0.31
JB	1211	5-year	1043.00	1.31	6.82		7.03	0.001251	3.64	286.40	74.51	0.33
JB	1211	10-year	1263.00	1.31	7.30		7.54	0.001320	3.91	323.79	85.73	0.34
JB	1211	25-year	1569.00	1.31	7.86		8.14	0.001405	4.24	382.18	143.15	0.36
JB	1211	50-year	1810.00	1.31	8.26		8.55	0.001413	4.38	478.59	382.86	0.36
JB	1211	100-year	2074.00	1.31	8.66		8.92	0.001252	4.27	672.93	525.36	0.34
JB	908	2-year	771.00	0.95	5.70		5.87	0.001203	3.30	233.52	68.43	0.32
JB	908	5-year	1054.00	0.95	6.43		6.65	0.001281	3.69	285.97	74.37	0.33
JB	908	10-year	1276.00	0.95	6.88		7.13	0.001377	3.99	319.88	77.97	0.35
JB	908	25-year	1585.00	0.95	7.40		7.70	0.001518	4.39	361.39	82.16	0.37
JB	908	50-year	1829.00	0.95	7.75		8.09	0.001624	4.67	396.68	112.56	0.38
JB	908	100-year	2095.00	0.95	8.09		8.46	0.001733	4.95	442.26	181.80	0.40
JB	606	2-year	777.00	0.59	5.33		5.50	0.001211	3.30	235.19	69.19	0.32
JB	606	5-year	1061.00	0.59	6.04		6.25	0.001308	3.71	291.14	100.90	0.33
JB	606	10-year	1285.00	0.59	6.45		6.70	0.001431	4.03	335.48	116.16	0.35
JB	606	25-year	1596.00	0.59	6.92		7.22	0.001599	4.45	401.73	162.78	0.38
JB	606	50-year	1840.00	0.59	7.24		7.59	0.001709	4.72	465.49	230.35	0.39
JB	606	100-year	2108.00	0.59	7.56		7.93	0.001774	5.00	560.71	392.68	0.40
JB	303	2-year	786.00	0.24	5.04	2.70	5.17	0.000957	2.95	314.43	132.61	0.28
JB	303	5-year	1073.00	0.24	5.76	3.30	5.89	0.000956	3.19	434.61	199.99	0.29
JB	303	10-year	1300.00	0.24	6.17	3.65	6.32	0.000957	3.32	523.50	225.57	0.29
JB	303	25-year	1614.00	0.24	6.66	4.03	6.81	0.000956	3.46	652.75	320.32	0.29
JB	303	50-year	1862.00	0.24	7.00	4.34	7.15	0.000956	3.55	797.26	539.35	0.29
JB	303	100-year	2133.00	0.24	7.33	4.57	7.48	0.000956	3.67	1003.81	754.92	0.30

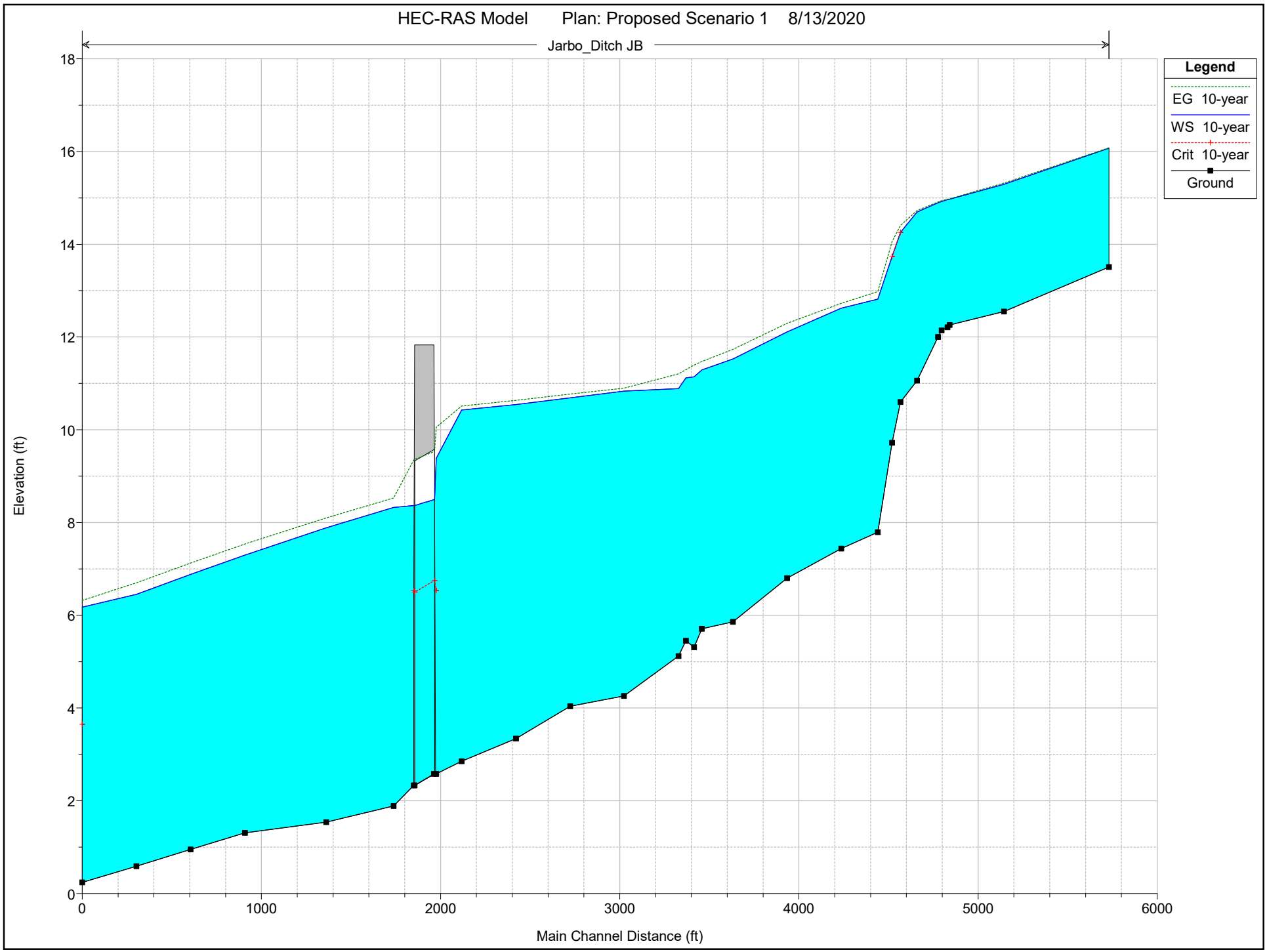
Scenario 1 2-year Water Surface Profile



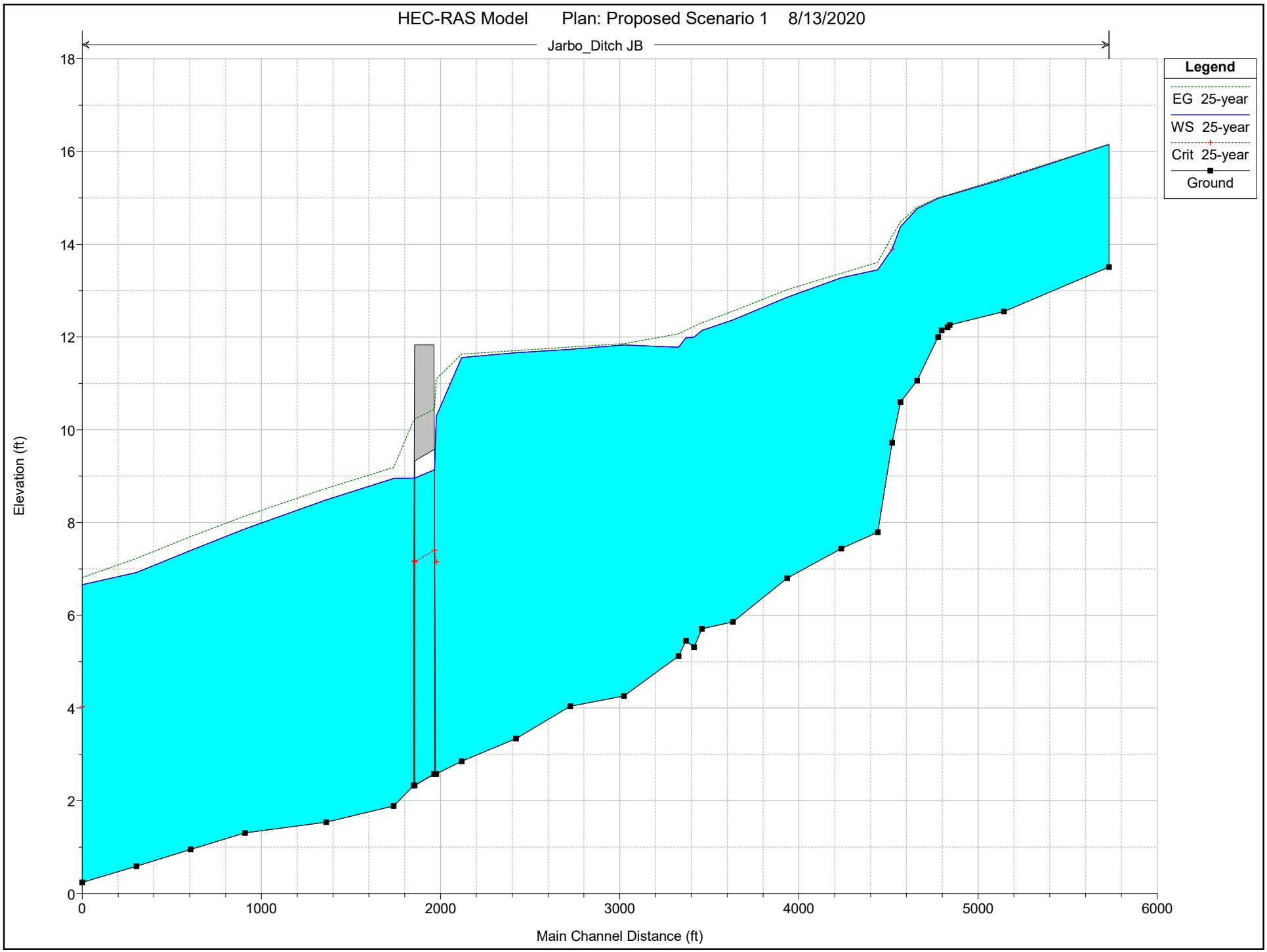
Scenario 1 5-year Water Surface Profile



Scenario 1 10-year Water Surface Profile



Scenario 1 25-year Water Surface Profile



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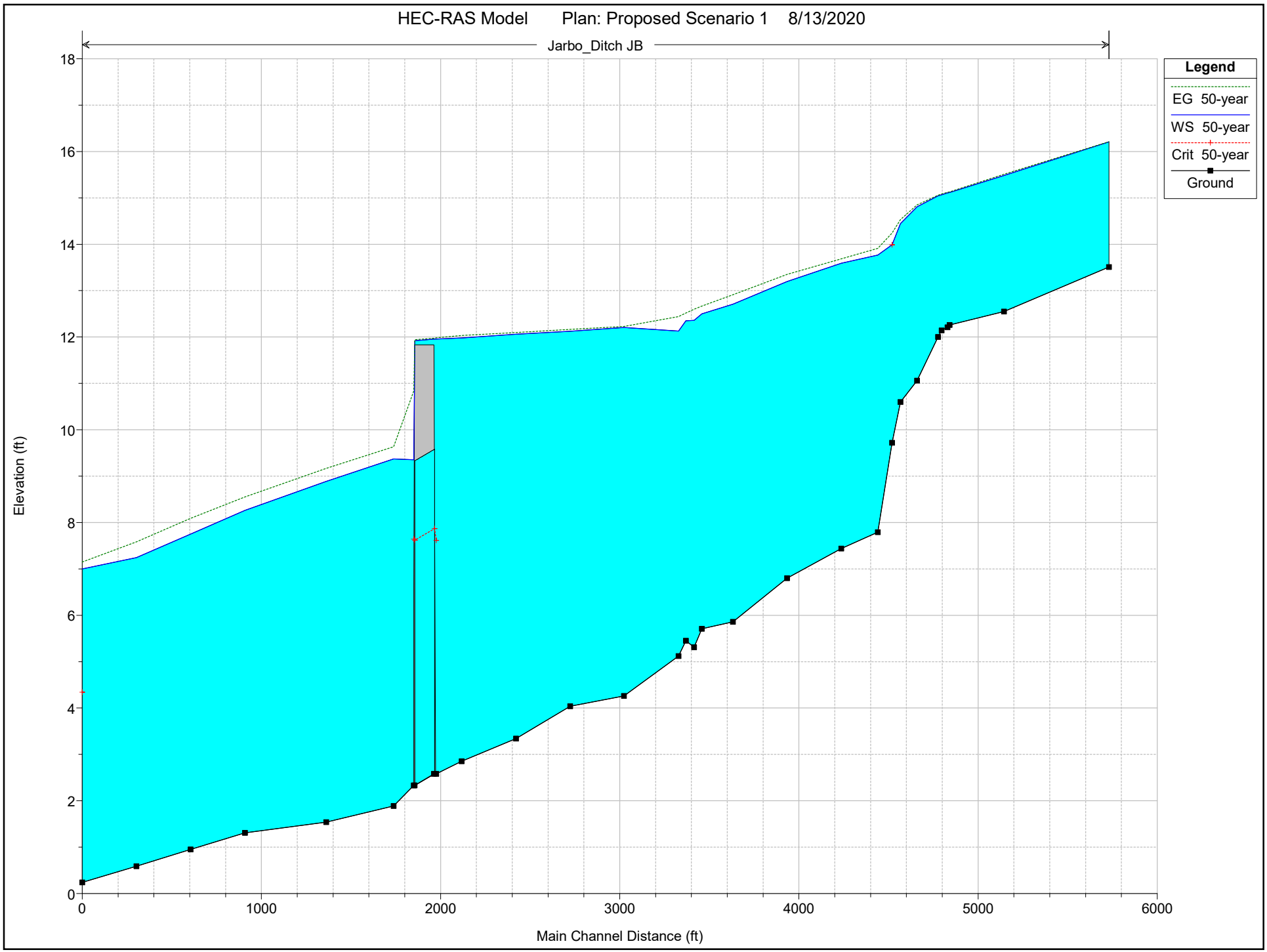
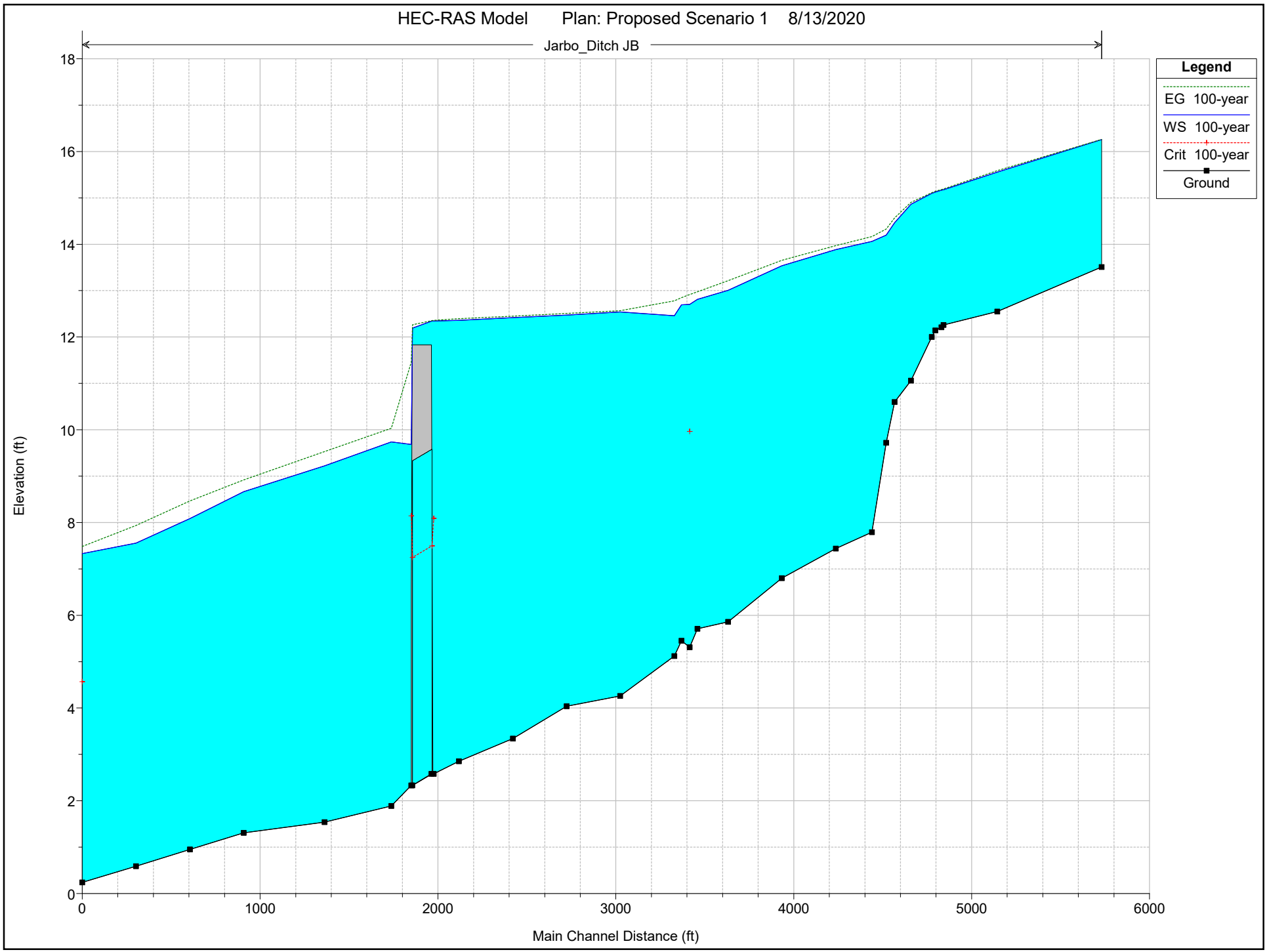


Scenario 1 100-year Water Surface Profile



APPENDIX H
SCENARIO 2 HEC-RAS OUTPUT AND PROFILES

HEC-RAS Plan: Prop Scen 2 River: Jarbo_Ditch Reach: JB

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
JB	6034	2-year	61.00	14.29	15.57		15.61	0.001183	1.55	41.86	73.93	0.26
JB	6034	5-year	82.00	14.29	15.79		15.82	0.000989	1.55	86.41	399.41	0.24
JB	6034	10-year	98.00	14.29	15.89		15.91	0.000823	1.47	134.62	526.35	0.22
JB	6034	25-year	121.00	14.29	15.96		15.99	0.000820	1.51	177.93	621.32	0.22
JB	6034	50-year	138.00	14.29	16.01	15.22	16.03	0.000812	1.52	209.66	713.64	0.22
JB	6034	100-year	157.00	14.29	16.07	15.29	16.09	0.000778	1.51	250.33	816.79	0.22
JB	5447	2-year	157.00	12.11	13.76		13.91	0.004710	3.15	49.90	35.93	0.47
JB	5447	5-year	214.00	12.11	14.10		14.28	0.004457	3.41	63.47	45.19	0.47
JB	5447	10-year	259.00	12.11	14.35		14.53	0.004174	3.52	82.18	130.11	0.46
JB	5447	25-year	321.00	12.11	14.64		14.79	0.003269	3.34	126.54	170.08	0.42
JB	5447	50-year	370.00	12.11	14.82		14.95	0.002761	3.19	164.92	238.95	0.39
JB	5447	100-year	423.00	12.11	14.97		15.09	0.002492	3.12	203.78	282.86	0.37
JB	5144	2-year	157.00	10.98	12.96		13.06	0.001812	2.46	64.08	41.83	0.34
JB	5144	5-year	214.00	10.98	13.36		13.47	0.001727	2.66	82.06	48.69	0.34
JB	5144	10-year	259.00	10.98	13.64		13.76	0.001670	2.77	96.00	52.14	0.34
JB	5144	25-year	321.00	10.98	13.98		14.11	0.001604	2.91	114.97	57.90	0.34
JB	5144	50-year	370.00	10.98	14.25		14.37	0.001405	2.89	164.27	295.07	0.32
JB	5144	100-year	423.00	10.98	14.51		14.61	0.001070	2.66	261.81	448.46	0.29
JB	5132	2-year	157.00	10.94	12.94		13.04	0.001765	2.44	64.67	43.15	0.34
JB	5132	5-year	214.00	10.94	13.34		13.45	0.001681	2.64	82.83	47.99	0.34
JB	5132	10-year	259.00	10.94	13.62		13.73	0.001630	2.77	96.50	50.81	0.34
JB	5132	25-year	321.00	10.94	13.96		14.09	0.001575	2.91	114.84	55.09	0.34
JB	5132	50-year	370.00	10.94	14.23		14.35	0.001453	2.92	156.54	257.22	0.33
JB	5132	100-year	423.00	10.94	14.49		14.59	0.001162	2.73	249.49	460.52	0.30
JB	5099	2-year	157.00	10.82	12.89		12.98	0.001636	2.41	65.35	40.76	0.33
JB	5099	5-year	214.00	10.82	13.29		13.39	0.001598	2.63	82.85	46.72	0.33
JB	5099	10-year	259.00	10.82	13.56		13.68	0.001569	2.76	96.26	49.94	0.33
JB	5099	25-year	321.00	10.82	13.91		14.04	0.001530	2.91	114.29	53.97	0.33
JB	5099	50-year	370.00	10.82	14.17		14.31	0.001456	2.97	145.32	227.09	0.33
JB	5099	100-year	423.00	10.82	14.44		14.55	0.001216	2.85	214.26	331.74	0.30
JB	5079	2-year	157.00	10.73	12.84		12.93	0.003782	2.39	65.61	38.78	0.32
JB	5079	5-year	214.00	10.73	13.24		13.35	0.003921	2.63	83.00	47.43	0.33
JB	5079	10-year	259.00	10.73	13.51		13.63	0.003992	2.78	97.58	62.98	0.33
JB	5079	25-year	321.00	10.73	13.87		13.99	0.003924	2.91	123.08	78.15	0.33
JB	5079	50-year	370.00	10.73	14.13		14.26	0.003732	2.94	155.07	240.55	0.32
JB	5079	100-year	423.00	10.73	14.41		14.51	0.003026	2.74	234.03	363.81	0.29
JB	4963	2-year	222.00	10.30	12.25		12.46	0.004041	3.68	60.28	37.25	0.51
JB	4963	5-year	302.00	10.30	12.59		12.86	0.004169	4.11	73.53	39.42	0.53
JB	4963	10-year	365.00	10.30	12.83		13.13	0.004260	4.39	83.12	40.92	0.54
JB	4963	25-year	452.00	10.30	13.16		13.50	0.004228	4.68	96.65	42.99	0.55
JB	4963	50-year	520.00	10.30	13.43		13.78	0.004019	4.79	108.49	44.72	0.54
JB	4963	100-year	594.00	10.30	13.71		14.08	0.003794	4.89	121.53	46.55	0.53
JB	4870	2-year	222.00	9.96	11.75		12.01	0.005645	4.13	53.78	36.02	0.60
JB	4870	5-year	302.00	9.96	12.06		12.39	0.005910	4.63	65.28	38.08	0.62
JB	4870	10-year	365.00	9.96	12.27	11.72	12.65	0.006130	4.97	73.45	39.51	0.64
JB	4870	25-year	452.00	9.96	12.63		13.04	0.005512	5.11	88.38	41.99	0.62
JB	4870	50-year	520.00	9.96	12.98		13.38	0.004649	5.03	103.47	44.36	0.58
JB	4870	100-year	594.00	9.96	13.33		13.72	0.004052	4.98	119.21	46.64	0.55
JB	4823	2-year	222.00	9.62	11.00	11.00	11.55	0.017694	5.96	37.25	34.00	1.00
JB	4823	5-year	302.00	9.62	11.26	11.26	11.92	0.016849	6.51	46.42	35.76	1.01
JB	4823	10-year	365.00	9.62	11.46	11.45	12.18	0.015979	6.79	53.72	37.23	1.00
JB	4823	25-year	452.00	9.62	12.42		12.78	0.005034	4.87	95.29	52.09	0.59
JB	4823	50-year	520.00	9.62	12.83		13.16	0.003849	4.63	118.49	60.54	0.53
JB	4823	100-year	594.00	9.62	13.22		13.53	0.003167	4.50	143.46	68.32	0.49
JB	4743	2-year	222.00	7.81	10.40		10.50	0.001438	2.57	86.25	41.91	0.32
JB	4743	5-year	302.00	7.81	11.14		11.24	0.001054	2.53	119.14	46.80	0.28
JB	4743	10-year	365.00	7.81	11.71		11.81	0.000846	2.48	147.20	50.59	0.26
JB	4743	25-year	452.00	7.81	12.50		12.59	0.000645	2.39	188.93	55.76	0.23
JB	4743	50-year	520.00	7.81	12.89		12.99	0.000623	2.46	211.50	58.36	0.23
JB	4743	100-year	594.00	7.81	13.27		13.37	0.000616	2.54	233.92	66.05	0.23
JB	4539	2-year	222.00	7.32	10.17		10.25	0.001022	2.29	96.80	43.22	0.27
JB	4539	5-year	302.00	7.32	10.97		11.05	0.000750	2.26	133.70	48.29	0.24
JB	4539	10-year	365.00	7.32	11.58		11.66	0.000612	2.22	164.28	52.12	0.22
JB	4539	25-year	452.00	7.32	12.40		12.47	0.000480	2.16	208.94	57.34	0.20
JB	4539	50-year	520.00	7.32	12.79		12.87	0.000473	2.24	232.32	62.01	0.20
JB	4539	100-year	594.00	7.32	13.17		13.25	0.000475	2.33	259.33	91.03	0.20

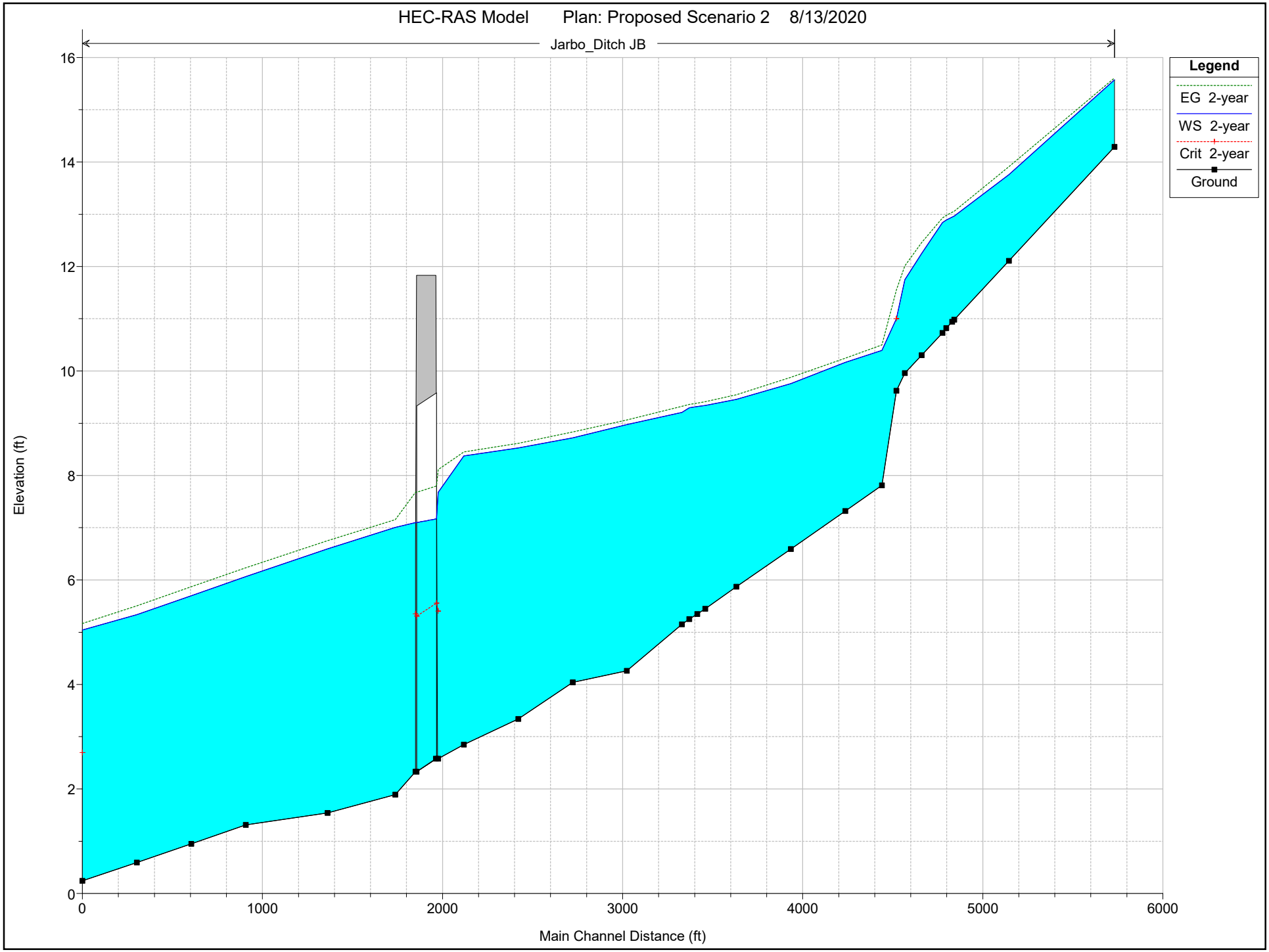
HEC-RAS Plan: Prop Scen 2 River: Jarbo_Ditch Reach: JB (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
JB	4237	2-year	312.00	6.59	9.76		9.88	0.001351	2.81	111.21	45.20	0.32
JB	4237	5-year	428.00	6.59	10.66		10.78	0.001004	2.77	154.63	51.19	0.28
JB	4237	10-year	519.00	6.59	11.31		11.43	0.000859	2.73	189.92	56.97	0.26
JB	4237	25-year	647.00	6.59	12.18		12.29	0.000691	2.67	243.22	70.81	0.24
JB	4237	50-year	747.00	6.59	12.57		12.69	0.000697	2.78	274.75	87.69	0.24
JB	4237	100-year	858.00	6.59	12.94		13.07	0.000721	2.90	314.53	132.68	0.25
JB	3934	2-year	312.00	5.87	9.46		9.55	0.000870	2.41	129.59	47.54	0.26
JB	3934	5-year	428.00	5.87	10.44		10.53	0.000655	2.39	179.31	53.71	0.23
JB	3934	10-year	519.00	5.87	11.13		11.21	0.000561	2.38	217.65	58.03	0.22
JB	3934	25-year	647.00	5.87	12.02		12.11	0.000470	2.38	272.20	63.70	0.20
JB	3934	50-year	747.00	5.87	12.40		12.50	0.000538	2.52	298.30	88.25	0.21
JB	3934	100-year	858.00	5.87	12.75		12.86	0.000620	2.67	339.71	174.92	0.22
JB	3761	2-year	312.00	5.45	9.34		9.41	0.000639	2.16	144.59	49.54	0.22
JB	3761	5-year	428.00	5.45	10.35		10.42	0.000500	2.16	197.95	56.10	0.20
JB	3761	10-year	519.00	5.45	11.05		11.12	0.000437	2.17	238.73	60.64	0.19
JB	3761	25-year	647.00	5.45	11.96		12.03	0.000370	2.18	298.82	76.60	0.18
JB	3761	50-year	747.00	5.45	12.33		12.41	0.000420	2.31	333.41	119.83	0.19
JB	3761	100-year	858.00	5.45	12.67		12.76	0.000497	2.43	400.60	388.88	0.21
JB	3710	2-year	312.00	5.35	9.32		9.39	0.000578	2.08	150.26	50.64	0.21
JB	3710	5-year	428.00	5.35	10.33		10.40	0.000455	2.09	204.98	57.10	0.19
JB	3710	10-year	519.00	5.35	11.04		11.10	0.000402	2.10	246.63	61.75	0.19
JB	3710	25-year	647.00	5.35	11.95		12.02	0.000348	2.12	308.05	88.02	0.18
JB	3710	50-year	747.00	5.35	12.32		12.39	0.000375	2.24	354.10	181.35	0.18
JB	3710	100-year	858.00	5.35	12.65		12.74	0.000372	2.33	474.12	593.68	0.18
JB	3690	2-year	312.00	5.25	9.29		9.36	0.000550	2.05	152.50	50.59	0.21
JB	3690	5-year	428.00	5.25	10.32		10.38	0.000437	2.06	207.44	57.04	0.19
JB	3690	10-year	519.00	5.25	11.02		11.09	0.000387	2.08	249.12	61.53	0.18
JB	3690	25-year	647.00	5.25	11.93		12.00	0.000341	2.10	308.87	90.52	0.17
JB	3690	50-year	747.00	5.25	12.30		12.38	0.000352	2.22	359.14	195.54	0.18
JB	3690	100-year	858.00	5.25	12.64		12.72	0.000349	2.32	469.24	473.95	0.18
JB	3631	2-year	416.00	5.15	9.21		9.32	0.000971	2.72	153.07	50.77	0.28
JB	3631	5-year	568.00	5.15	10.24		10.35	0.000765	2.72	208.88	57.80	0.25
JB	3631	10-year	688.00	5.15	10.94		11.06	0.000675	2.74	251.38	62.63	0.24
JB	3631	25-year	855.00	5.15	11.86		11.98	0.000587	2.74	312.12	75.34	0.23
JB	3631	50-year	987.00	5.15	12.22		12.35	0.000624	2.92	351.08	163.27	0.24
JB	3631	100-year	1131.00	5.15	12.55		12.69	0.000644	3.06	434.24	333.56	0.24
JB	3326	2-year	416.00	4.26	8.97		9.06	0.000714	2.43	171.06	53.19	0.24
JB	3326	5-year	568.00	4.26	10.05		10.15	0.000564	2.44	249.10	308.57	0.22
JB	3326	10-year	688.00	4.26	10.84		10.89	0.000362	2.10	532.01	410.25	0.18
JB	3326	25-year	855.00	4.26	11.83		11.86	0.000189	1.64	1005.24	551.14	0.13
JB	3326	50-year	987.00	4.26	12.20		12.23	0.000174	1.62	1234.81	712.64	0.13
JB	3326	100-year	1131.00	4.26	12.54		12.57	0.000170	1.64	1530.11	1051.81	0.13
JB	3026	2-year	499.00	4.04	8.72		8.83	0.000808	2.68	185.93	54.63	0.26
JB	3026	5-year	685.00	4.04	9.86		9.97	0.000621	2.65	318.08	220.13	0.23
JB	3026	10-year	831.00	4.04	10.69		10.77	0.000452	2.43	559.65	381.83	0.20
JB	3026	25-year	1035.00	4.04	11.74		11.79	0.000277	2.06	1148.20	989.93	0.16
JB	3026	50-year	1197.00	4.04	12.12		12.17	0.000246	1.98	1604.80	1396.60	0.15
JB	3026	100-year	1375.00	4.04	12.47		12.51	0.000215	1.91	2165.35	1735.31	0.14
JB	2724	2-year	499.00	3.34	8.53		8.62	0.000598	2.43	205.60	55.93	0.22
JB	2724	5-year	685.00	3.34	9.70		9.79	0.000502	2.49	275.44	63.55	0.21
JB	2724	10-year	831.00	3.34	10.54		10.64	0.000428	2.46	381.26	237.65	0.20
JB	2724	25-year	1035.00	3.34	11.66		11.71	0.000229	1.95	974.15	757.62	0.15
JB	2724	50-year	1197.00	3.34	12.06		12.10	0.000197	1.86	1312.05	940.05	0.14
JB	2724	100-year	1375.00	3.34	12.42		12.45	0.000173	1.78	1696.72	1211.72	0.13
JB	2421	2-year	524.00	2.85	8.37		8.45	0.000479	2.26	231.51	59.24	0.20
JB	2421	5-year	719.00	2.85	9.57		9.65	0.000415	2.34	306.80	66.74	0.19
JB	2421	10-year	874.00	2.85	10.43		10.51	0.000377	2.39	366.39	75.17	0.19
JB	2421	25-year	1089.00	2.85	11.56		11.63	0.000284	2.23	740.62	988.60	0.16
JB	2421	50-year	1259.00	2.85	11.98		12.03	0.000232	2.07	1236.11	1304.55	0.15
JB	2421	100-year	1447.00	2.85	12.36		12.39	0.000182	1.88	1804.03	1816.87	0.13
JB	2270	2-year	700.00	2.58	7.68	5.40	8.11	0.001762	5.28	132.61	73.78	0.41
JB	2270	5-year	957.00	2.58	8.68	6.06	9.25	0.001810	6.03	158.68	82.33	0.43
JB	2270	10-year	1160.00	2.58	9.39	6.53	10.05	0.001847	6.55	177.01	88.34	0.44
JB	2270	25-year	1442.00	2.58	10.29	7.15	11.09	0.001882	7.19	200.58	100.59	0.46
JB	2270	50-year	1664.00	2.58	11.96	7.61	11.99	0.000140	1.63	2562.86	2759.33	0.12

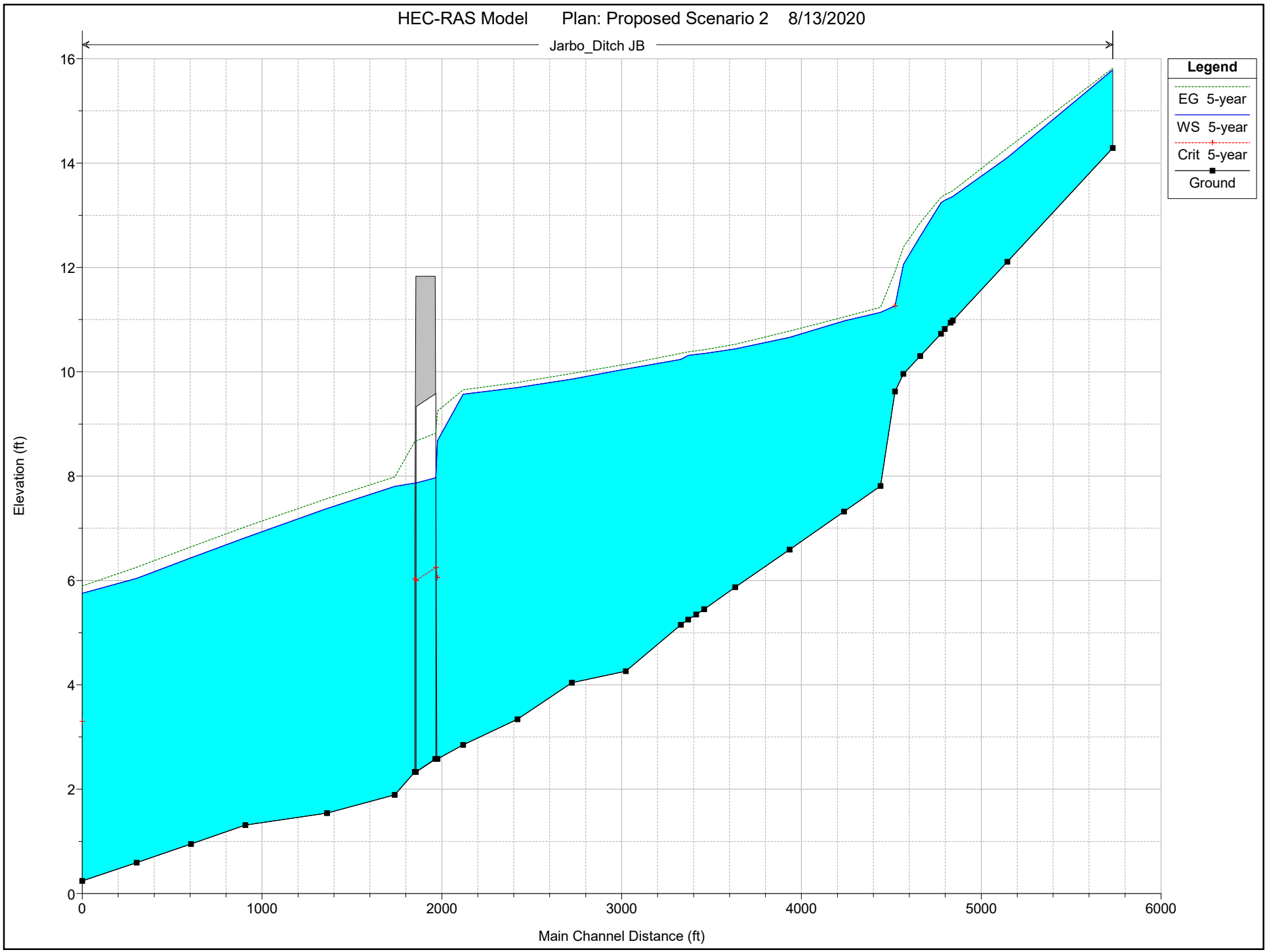
HEC-RAS Plan: Prop Scen 2 River: Jarbo_Ditch Reach: JB (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
JB	2270	100-year	1908.00	2.58	12.34	8.09	12.36	0.000098	1.39	3808.37	3911.31	0.10
JB	2209		Culvert									
JB	2153	2-year	743.00	2.33	7.10	5.35	7.68	0.002637	6.10	121.77	70.00	0.50
JB	2153	5-year	1015.00	2.33	7.87	6.03	8.67	0.002963	7.16	141.77	76.50	0.54
JB	2153	10-year	1229.00	2.33	8.37	6.53	9.35	0.003245	7.94	154.75	80.72	0.57
JB	2153	25-year	1528.00	2.33	8.96	7.17	10.21	0.003656	8.98	170.15	85.72	0.62
JB	2153	50-year	1762.00	2.33	9.35	7.64	10.84	0.004002	9.77	180.37	89.04	0.65
JB	2153	100-year	2020.00	2.33	9.68	8.14	11.46	0.004502	10.69	188.99	95.34	0.70
JB	2041	2-year	745.00	1.89	7.01		7.16	0.001056	3.10	240.64	70.49	0.30
JB	2041	5-year	1019.00	1.89	7.80		7.98	0.001079	3.40	299.47	77.27	0.30
JB	2041	10-year	1234.00	1.89	8.32		8.53	0.001108	3.62	340.90	81.70	0.31
JB	2041	25-year	1533.00	1.89	8.95		9.19	0.001151	3.89	393.79	87.06	0.32
JB	2041	50-year	1768.00	1.89	9.37		9.63	0.001195	4.10	431.24	90.67	0.33
JB	2041	100-year	2027.00	1.89	9.74		10.03	0.001279	4.36	469.59	137.65	0.35
JB	1665	2-year	752.00	1.54	6.60		6.75	0.001094	3.15	238.87	70.01	0.30
JB	1665	5-year	1028.00	1.54	7.38		7.57	0.001124	3.47	296.35	76.60	0.31
JB	1665	10-year	1245.00	1.54	7.89		8.10	0.001165	3.70	336.14	80.84	0.32
JB	1665	25-year	1547.00	1.54	8.49		8.74	0.001227	4.00	386.37	85.90	0.33
JB	1665	50-year	1784.00	1.54	8.89		9.17	0.001290	4.24	421.27	95.54	0.34
JB	1665	100-year	2045.00	1.54	9.22		9.53	0.001375	4.49	500.62	427.53	0.36
JB	1211	2-year	763.00	1.31	6.06		6.23	0.001194	3.28	232.29	68.18	0.31
JB	1211	5-year	1043.00	1.31	6.82		7.03	0.001251	3.64	286.40	74.51	0.33
JB	1211	10-year	1263.00	1.31	7.30		7.54	0.001320	3.91	323.79	85.72	0.34
JB	1211	25-year	1569.00	1.31	7.86		8.14	0.001405	4.24	382.18	143.15	0.36
JB	1211	50-year	1810.00	1.31	8.26		8.55	0.001413	4.38	478.59	382.86	0.36
JB	1211	100-year	2074.00	1.31	8.66		8.92	0.001252	4.27	672.94	525.36	0.34
JB	908	2-year	771.00	0.95	5.70		5.87	0.001203	3.30	233.52	68.43	0.32
JB	908	5-year	1054.00	0.95	6.43		6.65	0.001281	3.69	285.97	74.37	0.33
JB	908	10-year	1276.00	0.95	6.88		7.13	0.001377	3.99	319.87	77.97	0.35
JB	908	25-year	1585.00	0.95	7.40		7.70	0.001518	4.39	361.39	82.16	0.37
JB	908	50-year	1829.00	0.95	7.75		8.09	0.001624	4.67	396.68	112.56	0.38
JB	908	100-year	2095.00	0.95	8.09		8.46	0.001733	4.95	442.26	181.81	0.40
JB	606	2-year	777.00	0.59	5.33		5.50	0.001211	3.30	235.19	69.19	0.32
JB	606	5-year	1061.00	0.59	6.04		6.25	0.001308	3.71	291.14	100.89	0.33
JB	606	10-year	1285.00	0.59	6.45		6.70	0.001431	4.03	335.48	116.16	0.35
JB	606	25-year	1596.00	0.59	6.92		7.22	0.001599	4.45	401.73	162.78	0.38
JB	606	50-year	1840.00	0.59	7.24		7.59	0.001709	4.72	465.49	230.35	0.39
JB	606	100-year	2108.00	0.59	7.56		7.93	0.001773	5.00	560.72	392.69	0.40
JB	303	2-year	786.00	0.24	5.04	2.70	5.17	0.000957	2.95	314.43	132.61	0.28
JB	303	5-year	1073.00	0.24	5.76	3.30	5.89	0.000956	3.19	434.61	199.99	0.29
JB	303	10-year	1300.00	0.24	6.17	3.65	6.32	0.000957	3.32	523.49	225.56	0.29
JB	303	25-year	1614.00	0.24	6.66	4.03	6.81	0.000956	3.46	652.75	320.32	0.29
JB	303	50-year	1862.00	0.24	7.00	4.33	7.15	0.000956	3.55	797.22	539.22	0.29
JB	303	100-year	2133.00	0.24	7.33	4.58	7.48	0.000956	3.67	1003.81	754.93	0.30

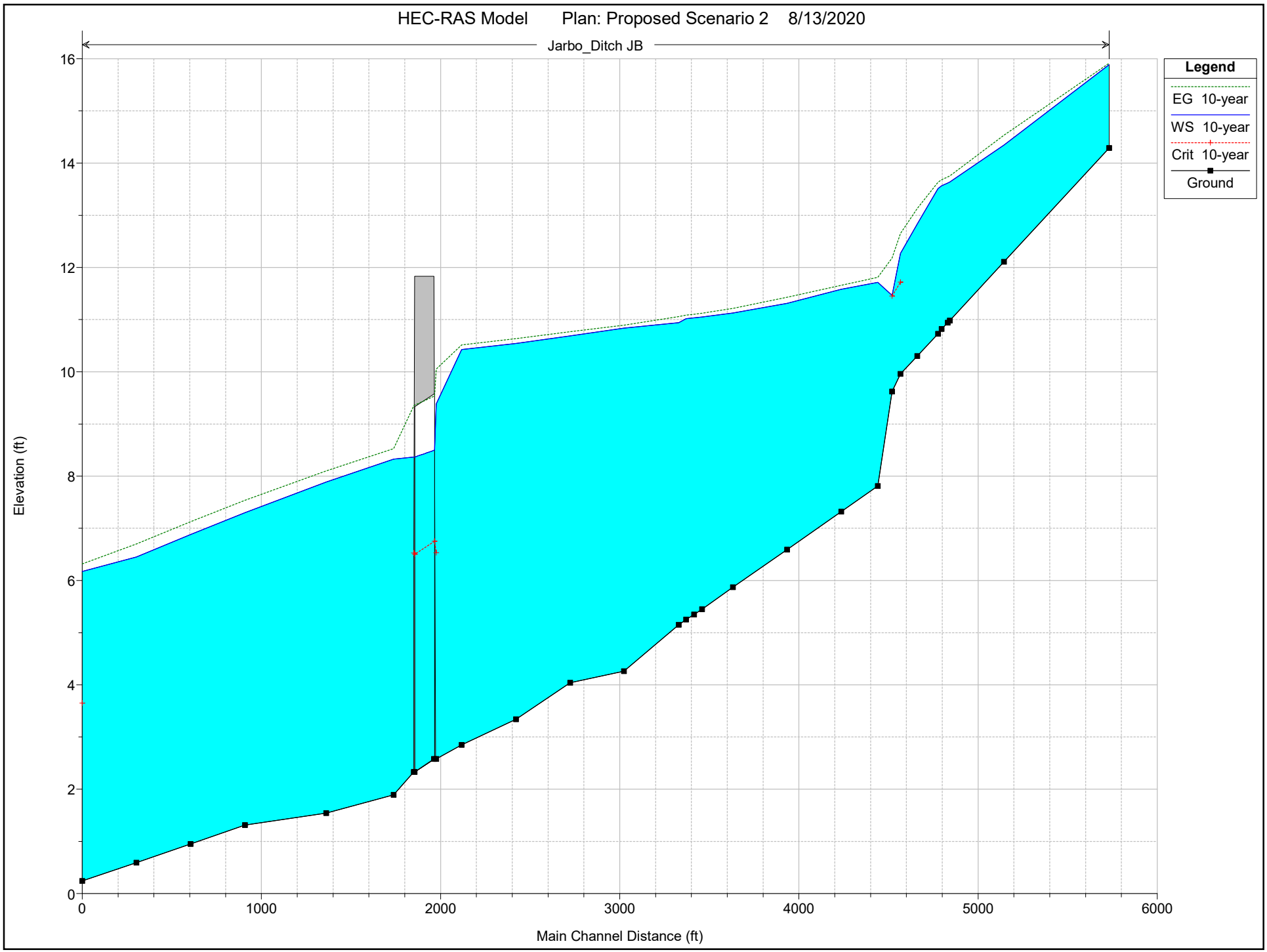
Scenario 2 2-year Water Surface Profile



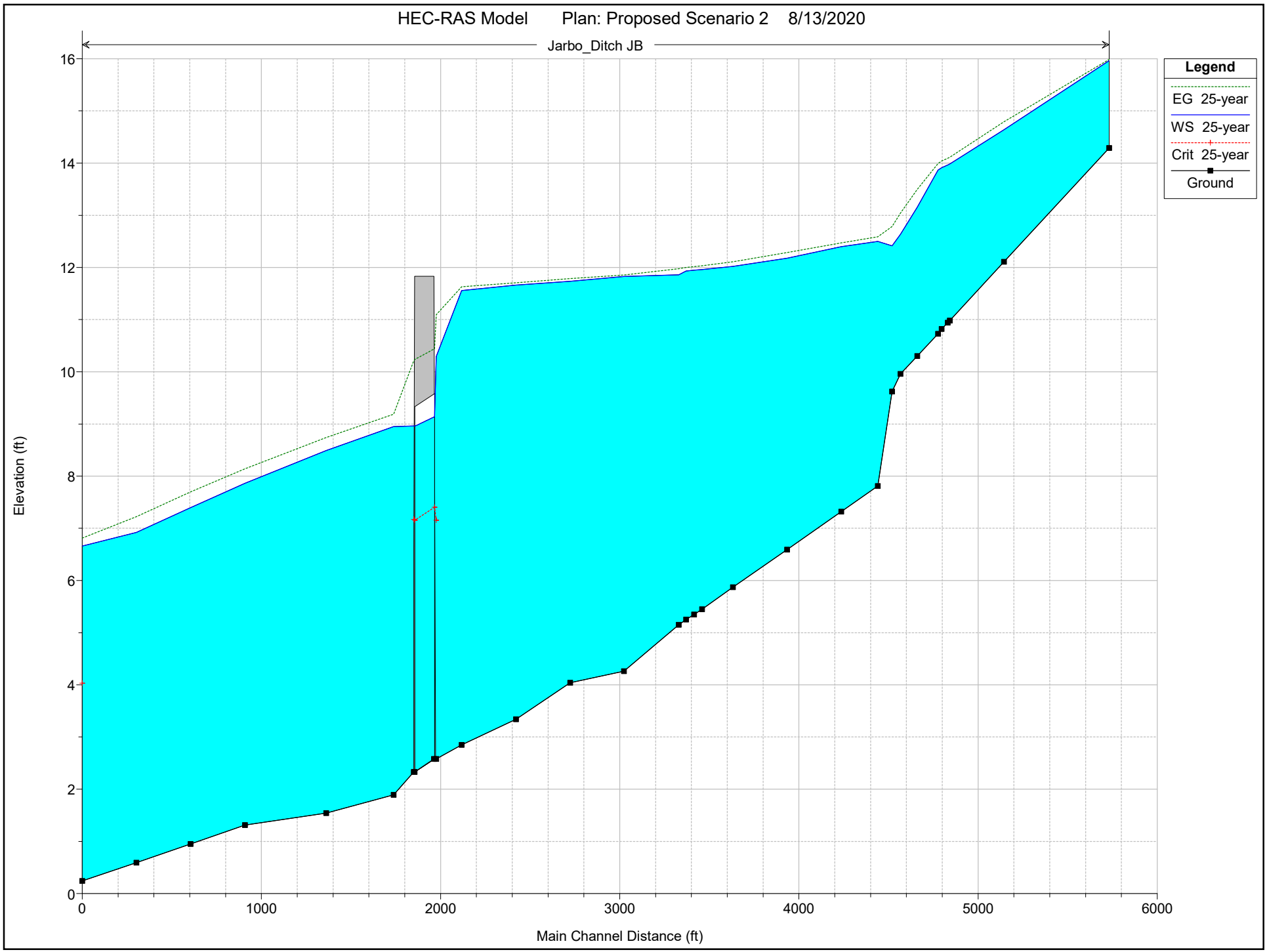
Scenario 2 5-year Water Surface Profile



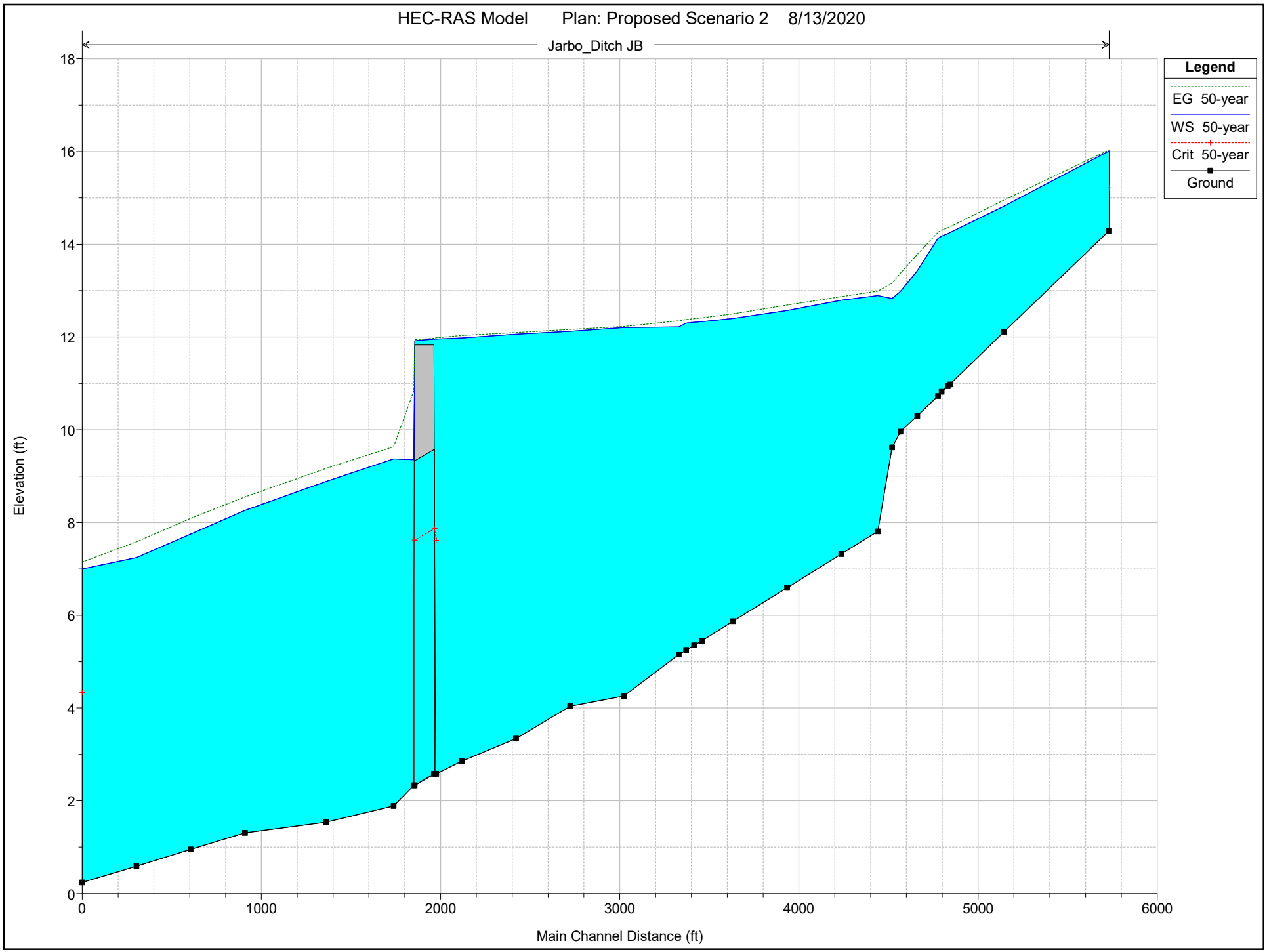
Scenario 2 10-year Water Surface Profile



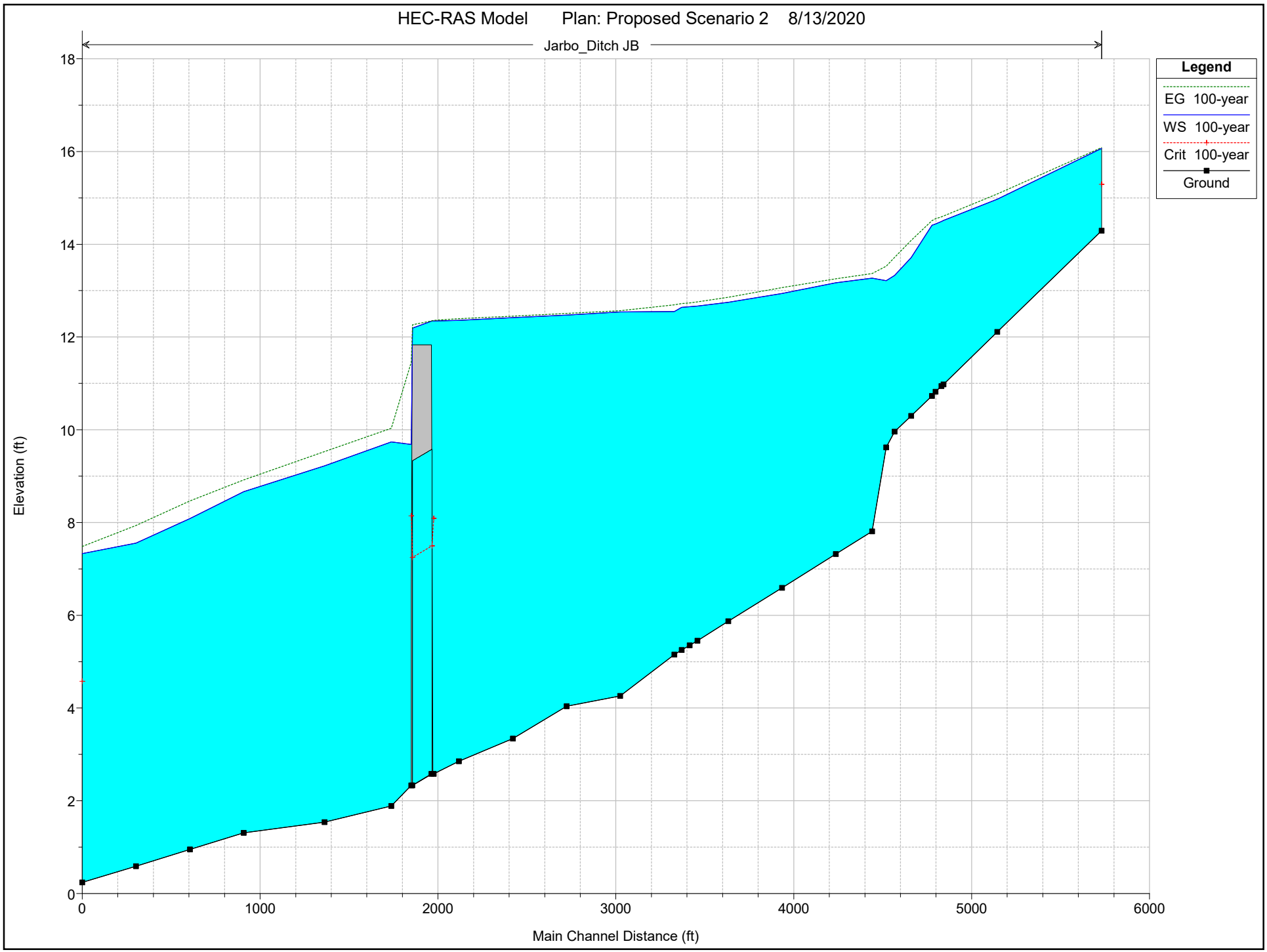
Scenario 2 25-year Water Surface Profile



Scenario 2 50-year Water Surface Profile



Scenario 2 100-year Water Surface Profile



APPENDIX I
BAYVIEW PROPOSED DITCH CALCULATIONS

Appendix I - Bayview Proposed Ditch Calculations

Type	Bottom Width (ft)	Depth (ft)	Left Side Slope (ft to ft)	Left Side Slope (ft/ft)	Length, Left Side (ft)	Right Side Slope (ft to ft)	Right Side Slope (ft/ft)	Length, Right Side (ft)	Top Width (ft)	Wetted Perimeter (ft)	Area (ft^2)	Hydraulic Radius (ft)	Ditch Surface	n	Ditch Slope (ft/ft)	Q_{DITCH} (cfs) (PER SIDE)	Associated DA-IDs	ΣQ_2 (cfs)	ΣQ_{100} (cfs)	V (fps)	Road Width (ft)	Shoulder Width (ft)	ROW Necessary (ft)	Existing ROW (ft)	Sufficient ROW?
ALTERNATIVE 1 and 2 - BAY AREA DITCH CONVEYANCE [DA-7]																									
Trapezoid	2.0	2.75	2.50 to 1.00	0.40	7.06	3.00 to 1.00	0.33	8.40	17.1	17.5	26.3	1.51	Grass-Lined	0.040	0.002	57.55	DA-7	39.46	104.14	2.19	22.0	1.0	58.3	60	Yes
ALTERNATIVE 1 - YACHT CLUB NORTH CONVEYANCE [DA-3 - DA-6]																									
Trapezoid	4.0	2.50	2.50 to 1.00	0.40	6.42	2.50 to 1.00	0.40	6.42	16.5	16.8	25.6	1.52	Grass-Lined	0.040	0.002	56.48	DA-6	34.18	89.73	2.20	22.0	1.0	57.0	60	Yes
Trapezoid	4.0	1.75	3.00 to 1.00	0.33	5.35	3.00 to 1.00	0.33	5.35	14.5	14.7	16.2	1.10	Grass-Lined	0.040	0.002	28.76	DA-3	16.98	44.52	1.78	22.0	1.0	53.0	60	Yes
Trapezoid	4.0	2.15	3.00 to 1.00	0.33	6.57	3.00 to 1.00	0.33	6.57	16.9	17.1	22.5	1.31	Grass-Lined	0.040	0.002	44.83	DA-3, DA-4	31.50	82.52	2.00	22.0	1.0	57.8	60	Yes
Trapezoid	5.0	2.50	2.50 to 1.00	0.40	6.42	2.50 to 1.00	0.40	6.42	17.5	17.8	28.1	1.58	Grass-Lined	0.040	0.002	63.47	DA-3, DA-4, DA-5	43.14	112.95	2.26	22.0	1.0	59.0	60	Yes
ALTERNATIVE 2 - YACHT CLUB NORTH CONVEYANCE [DA-5 - DA-6]																									
Trapezoid	4.0	2.50	2.50 to 1.00	0.40	6.42	2.50 to 1.00	0.40	6.42	16.5	16.8	25.6	1.52	Grass-Lined	0.040	0.002	56.48	DA-6	34.18	89.73	2.20	22.0	1.0	57.0	60	Yes
Trapezoid	4.0	2.00	3.00 to 1.00	0.33	6.11	3.00 to 1.00	0.33	6.11	16.0	16.2	20.0	1.23	Grass-Lined	0.040	0.002	38.30	DA-5	11.64	30.43	1.92	22.0	1.0	56.0	60	Yes
ALTERNATIVE 2 - YACHT CLUB SOUTH CONVEYANCE [DA-3 - DA-4]																									
																							0.0		Yes
Trapezoid	2.0	2.50	3.00 to 1.00	0.33	7.64	3.00 to 1.00	0.33	7.64	17.0	17.3	23.8	1.37	Grass-Lined	0.040	0.002	48.91	DA-3, DA-4	31.50	82.52	2.06	22.0	1.0	58.0	60	Yes
																							0.0		Yes

Kemah City Council Agenda Item

#14 Backfill KCDC Position

Once form is complete and departmental clearances are obtained, this form should be forwarded to the City Secretary as soon as possible prior to the date that the item is expected to be placed on the City Council agenda.

Date requested for Council consideration: 10/07/2020

Prepared by:Mayor Gale

Subject: to determine a process and timeline to backfill an open KCDC position

Proceeding: Consent

Originating Department: Admin

Plan Reference: 17SP- or 17OP-

Texas Ethics Commission Form 1295 required? *n/a*

If YES, is copy of Form attached? Contract Identification Number on Form:

City Attorney Review: *n/a*

Expenditure Required: Amount Budgeted:

Appropriation Required: Source of Funds:

Finance Approval: n/a

City Administrator Approval:

SUMMARY / ORIGINATING CAUSE

Les Hart will not be on KCDC Board and that vacancy will need to be filled.

IMMINENT CONSEQUENCES / BENEFIT TO COMMUNITY

RECOMMENDATIONS

To discuss a process for filling the KCDC Position.

ATTACHMENTS

Kemah City Council Agenda Item

#15 RFP Evaluation Form

Once form is complete and departmental clearances are obtained, this form should be forwarded to the City Secretary as soon as possible prior to the date that the item is expected to be placed on the City Council agenda.

Date requested for Council consideration: 10/07/2020

Prepared by: Teresa Vazquez-Evans, City Council Position 1

Subject: Consideration and Possible Action on the approval of an evaluation form to be used in the RFP selection process for the lease of the schoolhouse and train depot.

Proceeding: Consideration and Possible Action

Originating Department:

Plan Reference: 17SP- or 17OP-

Texas Ethics Commission Form 1295 required? *n/a*

If YES, is copy of Form attached? Contract Identification Number on Form:

City Attorney Review: n/a

Expenditure Required: n/a Amount Budgeted: n/a

Appropriation Required: n/a Source of Funds: n/a

Finance Approval: n/a

City Administrator Approval:

SUMMARY / ORIGINATING CAUSE

The City of Kemah issued a request for proposals for the lease of the schoolhouse and train depot on September 25, 2020. Proposals are due to the City by October 26, 2020. The RFP advertises that the City will give preference to proposals that include specific elements. The evaluation form will assign values to these varying elements and establish a consistent basis to evaluate submittals.

IMMINENT CONSEQUENCES / BENEFIT TO COMMUNITY

Approval and use of the evaluation form in the RFP selection process will promote governmental transparency and inform interested parties of the value that City Council assigns to proposal elements prior to the consideration of potential tenants.

RECOMMENDATIONS

Approve the Evaluation Form to be used in the selection process for the lease of the schoolhouse and train depot.

ATTACHMENTS

Evaluation Form

RFP - Long Term Lease of Schoolhouse and Train Depot
Evaluation Form

Name of Respondent: _____

Evaluator: _____

Favorable Lease Terms	**Pts**	**% Weight**	Score
Factors to consider	(1-10)		
Price per Square Foot			
Lease Period			
Utilization of Area			
Utility & Maintenance Terms			
		30%	0

Suitability of Tenant and Business Operations			
Factors to consider			
Established Business Operations			
Credit History			
Compatibility with Family Friendly, Fun Brand			
Does business compete or is it compatible with existing businesses and lease terms		30%	0

Economic Development			
Factors to consider			
Estimated sales tax revenue to City			
Ability to attract new visitors and revenue			
Serve Visitor Bureau function			
		20%	0

Community Development			
Factors to consider			
Preserve Historic Character			
Provide Community Meeting Space			
Promote City Holiday Events		20%	0

Total Score		Pts		Score
	Total	0		0

NOTES:

Kemah City Council Agenda Item

#16 Licensed Peace Officer at Bars with over 50% alcohol

Once form is complete and departmental clearances are obtained, this form should be forwarded to the City Secretary as soon as possible prior to the date that the item is expected to be placed on the City Council agenda.

Date requested for Council consideration: 10/07/2020

Prepared by: Mayor Gale

Subject: to approve an ordinance requiring bars and over 50% alcohol restaurants to have licensed peace officers in their security staff

Proceeding: Consideration and Possible Action

Originating Department: Admin

Plan Reference: 17SP- or 17OP-

Texas Ethics Commission Form 1295 required? *n/a*

If YES, is copy of Form attached? Contract Identification Number on Form:

City Attorney Review: *n/a*

Expenditure Required: Amount Budgeted:

Appropriation Required: Source of Funds:

Finance Approval: n/a

City Administrator Approval:

SUMMARY / ORIGINATING CAUSE

IMMINENT CONSEQUENCES / BENEFIT TO COMMUNITY

RECOMMENDATIONS

ATTACHMENTS

Kemah City Council Agenda Item

#17 Lighthouse District Safety

Once form is complete and departmental clearances are obtained, this form should be forwarded to the City Secretary as soon as possible prior to the date that the item is expected to be placed on the City Council agenda.

Date requested for Council consideration: 10/07/2020

Prepared by: Mayor Gale

Subject: to revise the configuration, timing, signage, and any other aspects of the bollards, lighting, parking areas, and other safety-related changes for 6th street and the Lighthouse District

Proceeding: Consent

Originating Department: Admin

Plan Reference: 17SP- or 17OP-

Texas Ethics Commission Form 1295 required? *n/a*

If YES, is copy of Form attached? Contract Identification Number on Form:

City Attorney Review: *n/a*

Expenditure Required: Amount Budgeted:

Appropriation Required: Source of Funds:

Finance Approval: n/a

City Administrator Approval:

SUMMARY / ORIGINATING CAUSE

At the Council Meeting on September 24th, the Council agreed to put more precautions in place in the Lighthouse District for safety measures as well as make this a reoccurring agenda item

IMMINENT CONSEQUENCES / BENEFIT TO COMMUNITY

RECOMMENDATIONS

ATTACHMENTS

Kemah City Council Agenda Item

#18 Police Department Staffing

Once form is complete and departmental clearances are obtained, this form should be forwarded to the City Secretary as soon as possible prior to the date that the item is expected to be placed on the City Council agenda.

Date requested for Council consideration: 10/07/2020

Prepared by: Kyle Burks

Subject: to determine staffing of Kemah police officers for certain shifts throughout the week and weekend and supplementing certain shifts with outside agencies to potentially include, but not limited to, Galveston County.

Proceeding: Consideration and Possible Action

Originating Department: Admin

Plan Reference: 17SP- or 17OP-

Texas Ethics Commission Form 1295 required? *n/a*

If YES, is copy of Form attached? Contract Identification Number on Form:

City Attorney Review: *n/a*

Expenditure Required: Amount Budgeted:

Appropriation Required: Source of Funds:

Finance Approval: n/a

City Administrator Approval:

SUMMARY / ORIGINATING CAUSE

IMMINENT CONSEQUENCES / BENEFIT TO COMMUNITY

RECOMMENDATIONS

ATTACHMENTS