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Shady Grove Drainage Study
City of Grand Prairie, TX
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1.0 EXECUTIVE SUMMARY

The Shady Grove area of Grand Prairie, TX has experienced significant development in recent years. New commercial, residential, and major transportation infrastructure have been built in this area since the citywide StormCAD storm drain model was developed by Halff & Associates in 2015 and since the last Master Plan was performed in 2003 by Knowlton-English-Flowers, Inc. (KEF). In the study area a comprehensive storm drain model was developed based on the Halff & Associates StormCAD model but was then updated by adding all new stormwater infrastructure items which were built after the StormCAD model was developed. The new model was built using InfoWorks ICM software and utilizes rainfall-on-mesh two-dimensional (2D) surface flow capabilities to model rainfall runoff as it flows across the terrain. This model was then used to evaluate the KEF Master Plan recommended storm drain improvements to determine which recommendations would provide useful and viable Capital Improvement Projects (CIP). The study applies the scoring system developed by Halff & Associates in the 2010 City-Wide Drainage Master Plan Road Map and the cost estimating and CIP scoring Excel calculators developed by Burton Johnson Engineering under a separate task of this contract.

The 2D modeling technology adds a surface flow visualization component to the KEF Master Plan. This provides a more comprehensive and enriched Master Plan and also generates input parameters for the City's scoring calculations. This allows the KEF recommendations to be evaluated and scored consistently with the City's other potential stormwater CIPs.

The Shady Grove Master Plan Study area is shown on **Exhibit 1** and can be roughly described as being about a 3 square mile area located south of Rock Island Rd., east of Roy Orr Blvd., north of Trinity Blvd., and west of Belt Line Rd. in Grand Prairie, TX. President George Bush Turnpike, Bear Creek, and Dry Creek all run through the study area. There is FEMA floodplain in this area from these sources and others, however, this study is focused on the performance of local storm drain infrastructure and does not address FEMA floodplain issues. The overall area was divided into two distinct models, an East and a West area, divided along Bear Creek. This was done to reduce model run times, output dataset size, and node count limits of the software.

This analysis includes both existing conditions hydrology as well as future developed hydrology. Land use data for each of these scenarios was developed or used in GIS to calculate composite NRCS CNs. Storm events modeled were the 2-Yr, 10-Yr, 25-Yr, and 100-Yr rainfall events. These various storms were modeled by developing a balanced rainfall hyetograph which accounts for runoff losses using the calculated composite CNs.

The existing storm drain model network was developed from record drawings, the City's GIS inventory, the City's 2015 StormCAD model, LIDAR, and limited survey data. The 2D model surface was developed from the 2016 Citywide LIDAR dataset developed by McKim & Creed. In total, the models contain more than 400 inlets, 82,000 linear feet (LF) of pipe, and 2,000 nodes.

The proposed storm drain model network is based on the 2003 KEF Master Plan, as modified to account for current 2017 system infrastructure. These modifications were made for any of several reasons, including that the pipes may have been built since then or a different system was built in the same location (i.e. Commercial/Residential development or SH 161 systems were built). Additionally three areas of proposed grading were modeled to simulate potential regional surface water storage features. These can be found in Basins F, X, and Manana. Across the entire study area the whole updated master plan removes 103 structures from potential flooding of 0.5’ deep or greater. Since the 2003 KEF master plan was developed without the aid of a detailed 2D surface flow model, there still remains a significant amount of surface/runoff flooding. A new analysis aimed at identifying, quantifying, and solving those surface flow issues is beyond this scope, but this model and report can be used as the starting point for that analysis. From the modified KEF Master Plan improvements, nine potential Capital Projects were identified. These were identified based on a brief analysis of 2D rain on mesh model results and GIS data. Improvements which benefited nearby buildings, addressed complaints, addressed hydraulic grade line issues in the network, and/or provided an obvious reduction in surface flooding were selected as potential Capital Project candidates. These nine candidate projects were then priced using the Cost Estimate and CIP Scoring calculators developed by Burton Johnson Engineering, Inc. under a separate task of this contract. The following tables summarize the estimated costs and CIP scoring of each of the nine candidate projects.

Table 1: Summary of Conceptual Estimated Candidate Project Costs

Basin ID	Project Name	Cost
X	Gilbert Drainage Improvements - All	$4,627,823.87
U	Shady Grove Rd., Gilbert Rd., Wright Rd. Storm Drain Improvements - All	$2,174,464.13
V	Shady Grove - Jones Storm Drain Improvements	$1,298,792.92
Y	Thousand Oaks Storm Drain Improvements	$649,150.78
B	River Ridge Blvd. Storm Drain Improvements	$5,083,439.29
C	Shady Grove Storm Drain Improvements	$4,849,204.70
F	Parker Rd - Hardrock Rd Storm Drain Improvements	$4,257,437.56
K-L	Jelmak Rd - Hardrock Rd Storm Drain Improvements	$3,845,517.64
MANANA	Manana Channel Improvements	$757,321.25
	Total	**$26,785,830.88**

Table 2: Overall Ranking of Candidate Projects within City's CIP

Storm Drain Projects		
Final CIP Rank	**Final Score**	**Project Name**
2	26.35	Shady Grove - Jones Storm Drain Improvements
10	32	Thousand Oaks Storm Drain Improvements
16	39.19	Gilbert Drainage Improvements - All
23	45	Jelmak Rd - Hardrock Rd Storm Drain Improvements
25	48	Parker Rd - Hardrock Rd Storm Drain Improvements
28	52.29	Shady Grove Rd., Gilbert Rd., Wright Rd. Storm Drain Improvements - All
32	59.26	Shady Grove Storm Drain Improvements
33	59.3	River Ridge Blvd. Storm Drain Improvements
Open Channel Projects		
10	31	Manana Channel Improvements

2.0 INTRODUCTION & BACKGROUND

2.1. Purpose & Scope

The goal of the Shady Grove Study is to evaluate the 2003 KEF Master Plan using a 2D rainfall-on-mesh model, to modify the KEF plan based on current site conditions, where applicable, and to determine if any of the KEF recommendations are viable City CIPs. The existing conditions model is based on the 2015 Citywide StormCAD model developed by Halff & Associates and includes recently constructed storm drain systems. The proposed model is based on the modified 2003 KEF Master Plan. This study maps surface flooding for the 2-Yr, 10-Yr, 25-Yr, and 100-Yr storms and recommends CIPs based on these evaluation results and cost estimates.

2.2. Project Area Description

As shown on **Exhibit 1**, the study area is bounded by Rock Island Rd. on the north, Roy Orr Blvd on the west, Oakdale Rd (west of TX161) and Trinity Blvd. (east of TX161) on the on the south and Dry Creek (Belt Line Rd.) on the east.

2.3. Project Criteria

The project model and technical analysis were prepared using methods consistent with the City of Grand Prairie's Drainage Design Manual (DDM), Volumes 1&2, January 2017 and the City of Grand Prairie Technical Modeling Standards for Watershed Wide Storm Drain Master Plans Using InfoWorks SD, December 2012 by LAN, Inc., (TMS) where applicable.

2.4. Software Used

This project was produced and delivered using ESRI's ArcGIS 10.3, HEC-HMS 3.5, and Innnovyze's InfoWorks ICM 7.0 2D modeling software.

2.5. Floodplain Information

This study area is located within FEMA Flood Insurance Rate Map (FIRM) panels 48113C0285K, 48113C0305K, 48113C0295K, and 48113C0315K. There is FEMA floodplain present within the study area from both Bear Creek and Dry Creek. Floodplain was not modeled or modified in any way, since this study focuses only on local storm drain performance and overland runoff getting to these drainage ways. The interaction of the storm drain with the major receiving streams was accounted for by using the Coincidental Tailwater frequencies found in Table 7.6 "Receiving Stream Coincident Frequency Flood" from Volume 1 of the DDM.

2.6. Split Model Approach

This study model uses two separate InfoWorks ICM models to analyze the total project area. The project area was divided into an East and a West area along Bear Creek. This was done in order to reduce model size to control model run times, output data size, and node count limits of the software. The results of each individual side can also be shown together on exhibits for planning and analysis purposes. See **Exhibit 2a and 2b** for further details of the existing system and study boundaries.

3.0 DATA COLLECTION

Necessary data required to build the model was collected from various sources. **Table 3** shows data which was collected, its source and its application on this project. Completeness of each dataset varied from one dataset to the next. Where data was incomplete or discrepancies were found, values were interpolated or inferred based on adjacent storm drain network geometry, field observation, LIDAR/aerial data or other engineering judgement.

Table 3: Data Collected for Study

Data Type	Source	Application
Record Drawings	Provided by City	Used to determine connectivity of storm drains, develop/append storm drain network, and determine storm drain feature technical details and parameters.
Citywide StormCAD model	Provided by City, developed by Halff & Associates	Imported network and model parameters into GIS as basis of this project model
Shady Grove Drainage MP	Provided by City, developed by Knowlton-English-Flowers, Inc.	Reference document to determine what has developed since last master plan
Soils GIS Data	USDA/SSURGO Soils Data Mart	Used to develop hydrology
Storm Drain GIS inventory	Provided by City	Used to supplement StormCAD and record drawing data to build out project model network.
Future Land Use GIS Data	Provided by City as of 06/15/2017	Used to determine future/ultimate developed conditions hydrology.
Various GIS background data	Provided by City	Used as basemap data in maps and exhibits
2016 LIDAR Data	McKim & Creed	Used as basis for 2D model surface
2003 KEF Master Plan	Provided by City	Used as basis for proposed model network

4.0 HYDROLOGY

For this rainfall-on-mesh 2D study, the only required hydrologic input to the 2D model is a rainfall intensity hyetograph. This rainfall hyetograph is then applied uniformly across the 2D mesh, where it is routed and accumulates as runoff. Due to this configuration, drainage area size and Time of Concentration (Tc) are not required parameters for this approach. However, infiltration losses are still necessary to account for. This model uses Natural Resources Conservation Service (NRCS) Curve Number (CN) methodology to estimate infiltration losses. HEC-HMS 3.5 was used to generate Frequency Storm (balanced hyetograph) rainfall hyetographs (with NRCS CN losses removed) which were then input into the 2D model. Both existing conditions and future developed conditions hydrology were produced for each of the 2D areas. See **Exhibits 3 – 5**.

4.1. Balanced Hyetograph Development

A balanced rainfall hyetograph was created in HEC-HMS using rainfall depths provided in the City's DDM. **Table 4** shows the partial duration rainfall depths used for this model. The 24 hour frequency storm hyetograph uses a timestep of 5 minutes with the peak intensity position located at the middle (50%) time ordinate.

Table 4: Partial Duration Rainfall Depths (in) for Balanced Hyetograph

Storm Event	5 min	15 min	1 hr	2 hr	3 hr	6 hr	12 hr	24 hr
2-Yr	0.49	1.04	1.85	2.22	2.45	2.91	3.45	3.95
10-Yr	0.63	1.36	2.86	3.55	3.85	4.65	5.50	6.40
25-Yr	0.73	1.56	3.35	4.15	4.55	5.45	6.50	7.50
100-Yr	0.87	1.87	4.25	5.20	5.70	6.92	8.40	9.55

4.2. NRCS Curve Numbers

NRCS CNs were determined for each of the two model areas, East and West. Each 2D area is modeled by using one single composite CN value representing land use specific to it. Composite CNs for the existing hydrology scenario were calculated based on current/observed land use and impervious cover. Composite CNs for the future developed hydrology was calculated based on the City's Future Land Use GIS data. Soils were assumed to remain the same for both scenarios. CNs were then calculated in GIS using area weighted averages of each land use type located within each respective area. **Table 5** shows the calculated composite CNs.

Table 5: Calculated CN's for Existing and Future Land Use Scenarios

Scenario	West	East
Existing Land Use Composite CN	77.06	80.81
Future Land Use Composite CN	85.83	85.84

5.0 HYDRAULICS

The hydraulic model for this study consists of 1D links and nodes and a 2D surface. The 1D links and nodes represent the storm drain pipes, manholes, culverts, curb & grate inlets, and other storm drain infrastructure. The 2D surface represents the ground surface in the area.

5.1. Storm Drain Network

The storm drain network in this model was developed from the City's StormCAD model and GIS inventory. Record drawings were used to draw new system configurations where development and roadways have been built since these datasets were developed. These updated GIS datasets were populated with invert elevations, pipe sizes, and other information relevant to the model. Only pipes larger than 18" in diameter or which were necessary to drain a sump in the 2D surface were modeled. All curb and grate inlets were modeled by using a configuration of a 2D node connected to a weir which is connected to a pipe. This allows for the weir to control flow transfers between the 2D surface and the pipe network (or the reverse) using the standard weir and orifice flow equations. **Table 6** summarizes quantities of each model's 1D network.

Table 6: 1D Existing Model Network Summary

	Inlets (count)	Pipe (LF)	Total Model Nodes (Count)
East	77	21,775	452
West	273	81,715	927
Total	350	103,490	1,379

For this study, outfall nodes were defined to be the outlet of a storm drain pipe system which discharges from the system into a receiving channel outside the extents of the 2D mesh area. There are a total of 10 outfalls for the East area and 12 outfalls for the West area. For this model, it was necessary to perform a Coincidental Occurrence analysis using Table 7.6 "Receiving Stream Coincident Frequency Flood" from Volume 1 of the DDM. This analysis uses the Basin Area Ratio (B.A.R.) between the receiving stream and local storm drain watershed areas to estimate an appropriate receiving stream tailwater event and water level. Where applicable, outfall nodes use tailwater elevations taken from the City's updated Bear Creek and Dry Creek Citywide Drainage Master Plan report (Bear & Dry Creek Report) and HEC-RAS hydraulic models. In some cases, the top of pipe elevation was used for the tailwater level, either as a substitute for a 1 YR coincidental storm or where the outfalls are not impacted by either creek.

Table 7: Summary of Bear Creek Coincidental Occurrence Analysis

	Bear Creek Drainage Area (SQ MI)	Shady Grove Area to Bear Creek (SQ MI)	Ratio (Calculated)	Ratio (Used)
SG East	85.19	0.66	129.1	> 50:1 B.A.R.
SG West	85.19	0.94	90.6	> 50:1 B.A.R.

Table 8: Summary of Dry Creek Coincidental Occurrence Analysis

	Dry Creek Drainage Area (SQ MI)	Shady Grove Area to Dry Creek (SQ MI)	Ratio (Calculated)	Ratio (Used)
SG East	3.49	0.42	8.3	> 3:1 B.A.R.
SG West	3.49	--N/A--	--N/A--	--N/A--

Table 9: Coincidental Occurrence Events Used (East Model)

Shady Grove East Model	2YR	10YR	25YR	100YR
Dry Creek	Top Pipe	5	10	50
Bear Creek	Top Pipe	5	10	25

Table 10: Coincidental Occurrence Events Used (West Model)

Shady Grove East Model	2YR	10YR	25YR	100YR
Bear Creek	Top Pipe	5	10	25
Other Outfall	Top Pipe	Top Pipe	Top Pipe	Top Pipe

5.2. 2D Surface

Each of the model areas has its own 2D surface. The surface is a Triangular Irregular Network (TIN) generated within InfoWorks ICM. Elevation data is imported from GIS into ICM as a ground model and then ICM generates a TIN within the specified 2D Zone polygon. Minimum and maximum element sizes are then specified. The option to limit vertical variation from the ground model was used. This prevents the ICM generated TIN from triangulating an element which meets size requirements but may be off vertically from the ground model. The maximum allowable vertical departure was set to 0.25 feet. The default boundary condition for the surface was set to Normal. This provides for a normal depth calculation as flow on the edges of the surface exits the model. **Table 11** summarizes parameters used on each 2D mesh.

Table 11: 2D Model Surface Parameter Summary

2D Mesh Parameter	West	East
Total 2D Area (Ac)	985.4	694.8
Min. Element Area (SF)	100	100
Max Triangle Area (SF)	4,000	4,000
Max Height Variation from Ground Model (FT)	0.25	0.25
Minimum Angle (Degree)	15	15
Boundary Condition	Normal	Normal
Default Roughness Value (n)	0.24	0.24
Total Number of 2D Elements	221,508	163,641

Since the 2D mesh for each model runs adjacent to Bear Creek and Dry Creek, tailwater conditions must be applied to the mesh in the same way as the outfall nodes. 2D boundary lines were drawn along edges which are adjacent to either Bear Creek or Dry Creek. The 2D boundary lines were then assigned tailwater elevations from the same Bear Creek & Dry Creek report that was used for the outfall nodes. On edges of the 2D surface which are adjacent to either creek, the boundary condition is the tailwater elevation. On edges that don't have a tailwater assigned, the boundary condition is Normal Depth. Flow is allowed to leave the mesh.

Roughness polygons were also imported in order to provide a better approximation of overland flow across various surfaces such as concrete, grass, and brushy woods. The City's DDM and Table 4.5B of the City's DDM was used to determine 2D roughness values.

Table 12: Summary of 2D Surface Roughness Values

Surface Type	Roughness Value
Short Dense Grass (default)	0.24
Concrete (Per City directive)	0.016
Woods with Light Underbrush	0.40

6.0 EXISTING SYSTEM RESULTS

6.1. Existing Network, Existing Hydrology

This scenario models the existing storm drain pipe network with rainfall runoff based on existing/observed land use (existing hydrology). This scenario represents the condition of the area as it exists today, as closely as possible based on the data provided for this study and identifies potential deficiencies which may be an issue today, with no further development. InfoWorks ICM output for flood depth, pipe flow, pipe surcharge state, and 2D results lines were used to perform review and analysis of these results. Maximum values for flood depth and pipe flow results are output automatically by InfoWorks ICM into node results and pipe results file respectively. Maximum pipe surcharge state is also output automatically to a pipe results layer. Surcharging in this application means that a pipe's capacity is exceeded. There are three possible values (classes) for "surcharge state", as defined by InfoWorks ICM:

- (Class: <1) Not surcharged
    - Both hydraulic head and flow are contained in pipe
- (Class: 1) Head surcharged
    - Hydraulic head, or hydraulic grade line (HGL), is above the top of pipe
    - However, flow rate through the pipe is less than the calculated maximum full flow capacity of the pipe.
    - Indicative of tailwater or adverse grade issues.
        - Example: outlet tailwater is above top of pipe, but pipe still has conveyance capacity.
- (Class: 2) Flow and head surcharged
    - HGL is above the top of pipe
    - AND flow rate through pipe exceeds the calculated full flow capacity of pipe
    - Indicative of undersized pipe
        - Example: A small pipe exceeding its flow capacity with downstream backwater causing submerged tailwater/pipe conditions, so the resulting HGL is above the pipe.

Table 13: InfoWorks ICM Surcharge State Classes

Surcharge Value	Description
< 1	No surcharging.
1	Head surcharged due to tailwater
2	Head and flow surcharged

This output provides an evaluation of pipe capacity/performance in each individual scenario. This data provides easy insight into pipe network capacity deficiencies.

2D results lines are polylines which can be drawn across any 2D surface in the model and will provide feedback for flow rate across the line, maximum depth along the line, or average velocity normal to the line. These were used in this study to determine flow and depth at certain points of interest in each scenario. These results are summarized in the following sections, with more detailed output attached in **Appendix A.**

6.1.1. East Model

On the East side of the study, the existing conditions analysis shows some minor localized flooding as runoff flows from lot to lot towards a storm drain and/or City right-of-way (ROW). This will always occur during rainfall runoff events. The storm drain in this model area experiences node flooding and surcharging in all events. Node flooding is defined as any 1D pipe node (end point/junction of a pipe) where the HGL is above ground level. **Table 14** and **Table 15** summarize 1D link and node results. These results can be seen in **Exhibits 6a – 6d**.

Table 14: Total Flooded Nodes, East Model (Existing/Existing)

	2YR	10YR	25YR	100YR
Number of Flooded Nodes (WSEL > Ground Elevation)	2	29	27	98
Average Depth of Node Flooding (FT)	0.42	0.69	0.89	1.00

Table 15: Total Surcharged Pipes, East Model (Existing/Existing)

	2YR	10YR	25YR	100YR
Number of Surcharged Pipes (Class 1)	49	103	123	136
Number of Surcharged Pipes (Class 2)	2	18	23	35

In addition to the 1D network results above, several locations were selected to measure 2D surface flow. Surface flow is measured within InfoWorks ICM by using Results Lines or Polygon items. The line or polygon measures flow across the line, generated by summing 2D results for each individual 2D mesh triangle underneath the Results Line or Polygon. **Table 16** provides a summary of surface flows for selected 2D flow locations. Refer to **Exhibits 6a – 6d.**

Table 16: Summary of Existing Peak 2D Surface Flows, East Model

Results Line ID	2YR Q (CFS)	10YR Q (CFS)	25YR Q (CFS)	100YR Q (CFS)
E1a	11.58	37.92	50.7	72.44
E1b	5.94	23.96	57.24	118.28
E1e	0.01	0.02	0.01	0.03
E1f	2.72	4.33	4.95	5.32
E2	2.78	4.21	3.71	23.59
E3	8.32	22.04	30.56	48.07
E5	22.4	44.53	56.33	75.61
E5b	47.79	87.84	108.29	140.68

6.1.2. West Model

The West side of the study also shows there are some flooded nodes and surcharged pipes in each of the modeled storms. There is also "lot to lot" runoff present, as there was in the East model. **Table 17** and **Table 18** summarize the overall 1D model results for the West model. Selected locations to measure 2D surface flow were evaluated using the same method as described in **6.1.1** above. **Table 19** below provides a summary of surface flow in each of these locations. These results can be seen in **Exhibits 6a – 6d**.

Table 17: Total Flooded Nodes, West Model (Existing/Existing)

	2YR	10YR	25YR	100YR
Number of Flooded Nodes (WSEL > Ground Elevation)	11	18	23	52
Average Depth of Node Flooding (FT)	0.87	1.11	1.07	1.00

Table 18: Total Surcharged Pipes, West Model (Existing/Existing)

	2YR	10YR	25YR	100YR
Number of Surcharged Pipes (Class 1)	44	95	131	232
Number of Surcharged Pipes (Class 2)	2	9	18	39

Table 19: Summary of Existing Peak 2D Surface Flows, West Model

Results Line ID	2YR Q (CFS)	10YR Q (CFS)	25YR Q (CFS)	100YR Q (CFS)
W1	37.18	112.83	154.96	239.13
W3	15.00	45.29	73.47	121.45
W4	81.68	273.86	362.79	521.99
W5	84.41	227.52	294.92	419.18
W6	5.86	27.04	36.49	51.06
W7	8.88	29.27	39.79	55.90

6.2. Existing Network, Fully Developed Hydrology

This model scenario represents how the existing drainage network in this area, as it exists today, according to data provided for this study, may perform if all parcels in this area were to fully build out to their designated zoning land use and were allowed to discharge runoff uncontrolled. This also assumes that no additional storm drain infrastructure is built as this hypothetical development occurs. Designated land use for fully developed conditions was provided by the City for this evaluation.

6.2.1. East Model

The East model results indicate that under fully developed conditions this area will experience more widespread and severe flooding than it experiences in the existing condition. This is due to the additional runoff generated by the increase in impervious surface, compared to existing conditions. **Table 20** and **Table 21** summarize the 1D results of this scenario. The same selected locations to measure 2D flow in the existing scenario were evaluated again in this scenario. **Table 22** provides a summary of the surface flows in these locations. These results can be seen in **Exhibits 7a-d.**

Table 20: Total Flooded Nodes, East Model (Existing/Fully Developed)

	2YR	10YR	25YR	100YR
Number of Flooded Nodes (WSEL > Ground Elevation)	2	31	40	101
Average Depth of Node Flooding (FT)	0.71	0.76	0.90	1.90

Table 21: Total Surcharged Pipes, East Model (Existing/Fully Developed)

	2YR	10YR	25YR	100YR
Number of Surcharged Pipes (Class 1)	62	115	130	137
Number of Surcharged Pipes (Class 2)	3	21	24	35

Table 22: Summary of Fully Developed Peak 2D Surface Flows, East Model

Results Line ID	2YR Q (CFS)	10YR Q (CFS)	25YR Q (CFS)	100YR Q (CFS)
E1a	17.09	45.72	58.75	79.08
E1b	12.01	43.75	76.22	136.78
E1e	0.02	0.01	0.02	0.04
E1f	3.31	4.63	5.28	5.61
E2	2.65	4.32	3.78	32.42
E3	11.89	25.94	36.71	52.88
E5	28.78	50.78	62.37	81.34
E5b	59.38	98.21	118.11	149.9

6.2.2. West Model

The West model results indicate that under fully developed conditions this area will experience more widespread and severe flooding than it experiences in the existing condition. This is due to the additional runoff generated by the increase in impervious surface, compared to existing conditions. **Table 23** and **Table 24** summarize the 1D results of this scenario. The same selected locations to measure 2D flow in the existing scenario were evaluated again in this scenario. **Table 25** provides a summary of the surface flows in these locations. These results can be seen in **Exhibits 7a-d**.

Table 23: Total Flooded Nodes, West Model (Existing/Fully Developed)

	2YR	10YR	25YR	100YR
Number of Flooded Nodes (WSEL > Ground Elevation)	12	23	35	65
Average Depth of Node Flooding (FT)	1.21	1.06	0.91	1.03

Table 24: Total Surcharged Pipes, West Model (Existing/Fully Developed)

	2YR	10YR	25YR	100YR
Number of Surcharged Pipes (Class 1)	53	130	154	258
Number of Surcharged Pipes (Class 2)	6	18	29	44

Table 25: Summary of Fully Developed Peak 2D Surface Flows, West Model

Results Line ID	2YR Q (CFS)	10YR Q (CFS)	25YR Q (CFS)	100YR Q (CFS)
W1	72.13	153.66	199.13	277.57
W3	26.75	72.07	100.08	140.66
W4	162.78	360.37	452.81	587.33
W5	147.2	290.32	360.53	479.41
W6	16.89	36.26	45.09	57.97
W7	17.27	39.63	48.78	62.28

6.3. Comparison Tables

This section provides a comparison of the surface flow results, comparing existing hydrology results with fully developed hydrology results at the specified 2D surface flow location.

Table 26: Comparison of East Model Surface Flow

Results Line ID	2YR ΔQ (CFS)	10YR ΔQ (CFS)	25YR ΔQ (CFS)	100YR ΔQ (CFS)
E1a	5.51	7.8	8.05	6.64
E1b	6.07	19.79	18.98	18.5
E1e	0	0	0.01	0.01
E1f	0.59	0.3	0.33	0.29
E2	-0.13	0.11	0.07	8.83
E3	3.57	3.9	6.15	4.81
E5	6.38	6.25	6.04	5.73
E5b	11.59	10.37	9.82	9.22

Table 27: Comparison of West Model Surface Flows

Results Line ID	2YR ΔQ (CFS)	10YR ΔQ (CFS)	25YR ΔQ (CFS)	100YR ΔQ (CFS)
W1	34.95	40.83	44.17	38.44
W3	11.75	26.78	26.61	19.21
W4	81.1	86.51	90.02	65.34
W5	62.79	62.8	65.61	60.23
W6	11.03	9.22	8.6	6.91
W7	8.39	10.36	8.99	6.38

7.0 PROPOSED SYSTEM RESULTS

This study used the same rain on mesh approach as the existing and fully developed conditions models above to evaluate the 2003 KEF Master Plan proposed improvements, extract any feasible potential stormwater CIPs from them for the City to consider implementing. Proposed pipes from the KEF Master Plan were evaluated and assessed to develop an updated/final proposed pipe dataset to evaluate for feasible CIPs. Undeveloped areas were not evaluated for future development needs; refer back to the 2003 KEF Master Plan for this, if needed.

This analysis evaluated the relevance of the 2003 proposed pipes based on current (2017) study area conditions. When the KEF Master Plan was developed in 2003, the study area was much less developed than at the time of this study. Several new commercial developments and SH161 were built. Therefore it was not feasible to model all of the KEF proposed pipes as they were originally configured. The KEF proposed pipes were modified based on the 2017 current infrastructure conditions in the watershed. See **Exhibit 8a** for a map showing the original "as-proposed" 2003 KEF Master Plan pipes plus the 2017 existing pipe network. See **Exhibit 8b** for a comparison map showing the original KEF recommended pipes versus the final updated proposed pipe configuration used in the model. See **Exhibit 8c** for a map showing only the final updated proposed pipe configuration which was evaluated for viable City CIP projects.

Table 28: 1D Proposed Model Network Summary

	Inlets (count)	Pipe (LF)	Total Model Nodes (Count)
East	181	39,916	655
West	475	102,347	1,214
Total	656	142,263	1,869

At the request of the City, potential areas for regional surface water storage features were conceptually considered. Due to the complex nature of these storage systems, they were not modeled in detail and will require more detailed evaluation prior to implementation. This study takes the previous master plan another step farther by recommending efficient locations for these features based on the 2D surface flow patterns. These areas are discussed in detail below.

Also at the request of the City, one specific repeat "Hot Spot" problem area was conceptually evaluated. This area is located at Greater Allen Temple AME Church located on Gilbert Rd at Gilbert Circle. The evaluated Master Plan improvements do address this issue. However, due to the magnitude of improvements to completely construct the Master Plan in this area, other "interim" solutions are discussed below. The next step for this area would be to perform a "hot spot" concept design evaluation similar to the other Hot Spot concept designs performed under other tasks of this contract. A detailed 2D model may be a beneficial tool for the design process.

7.1. Proposed System, Fully Developed Hydrology

This scenario models the proposed Master Plan network with fully developed hydrology. This scenario simulates the performance of this proposed network configuration with a fully built out watershed. Sections 7.1.1 and 7.1.2 discuss this simulation configuration. This simulation identifies areas which benefit from the proposed improvements as well as areas where more detailed analysis may be required. **Exhibits 9a – d** map the results of these scenarios.

7.1.1. East Model

The proposed Master Plan East model includes adding new storm drain lines in areas with none now (basins P, Q, R, BC1, BC2, BC3, V, W, X, Y2, Z, Z6, Z7, Z8, Z9, Z10, Z11, Z12, Z13) or increasing storm drain sizes of existing lines (Y). These basins were evaluated for potential CIPs. Undeveloped areas were not evaluated for CIPs. In addition to these pipes, two areas of proposed grading were conceptually modeled to determine if these could provide any flood reduction benefits. First, a conceptual expansion to the Manana channel was modeled to determine potential benefits of additional storage and conveyance capacity. The other area is the upland areas of Gilbert Branch in Basin X. This area was digitally graded into a better defined channel upstream of Gilbert Rd. and widened to provide storage between Gilbert Rd and Enchanted Ct. All of these improvements were run and the results are summarized below. **Table 29** and
Table 30 summarize the 1D model results. The same selected locations used to measure 2D flow in the existing scenarios were evaluated again in this scenario. **Table 31** provides a summary of the surface flows in these locations. These results can be seen on **Exhibits 9a-d**.

Table 29: Total Flooded Nodes, West Model (Master Plan/Fully Developed)

	2YR	10YR	25YR	100YR
Number of Flooded Nodes (WSEL > Ground Elevation)	13	52	63	120
Average Depth of Node Flooding (FT)	3.19	1.90	2.20	2.55

Table 30: Total Surcharged Pipes, East Model (Master Plan/Fully Developed)

	2YR	10YR	25YR	100YR
Number of Surcharged Pipes (Class 1)	109	146	168	190
Number of Surcharged Pipes (Class 2)	5	17	22	38

Table 31: Summary of Master Plan/Fully Developed Peak 2D Surface Flows, East Model

Results Line ID	2YR Q (CFS)	10YR Q (CFS)	25YR Q (CFS)	100YR Q (CFS)
E1a	5.14	9.12	14.48	33.25
E1b	0.46	0.59	0.68	0.76
E1e	4.51	7.71	9.19	11.41
E1f	4.44	6.91	7.65	8.21
E2	2.55	5.32	5.91	6.86
E3	6.25	9.71	11.7	14.6
E5	13.23	24.78	31.82	43.57
E5b	24.15	40.86	49.98	64.02

Using these results, a difference in 2D surface flow can be calculated to indicate the reduction in surface flow provided by the proposed improvements. In other words, the proposed Master Plan improvements convey more water underground thereby reducing the flow on the surface. This calculation is tabulated in **Table 32**.

Table 32: Summary of Reduction, East Model

Results Line ID	2YR ΔQ (CFS)	10YR ΔQ (CFS)	25YR ΔQ (CFS)	100YR ΔQ (CFS)
E1a	-11.95	-36.6	-44.27	-45.83
E1b	-11.55	-43.16	-75.54	-136.02
E1e	4.49	7.7	9.17	11.37
E1f	1.13	2.28	2.37	2.6
E2	-0.1	1	2.13	-25.56
E3	-5.64	-16.23	-25.01	-38.28
E5	-15.55	-26	-30.55	-37.77
E5b	-35.23	-57.35	-68.13	-85.88

Using the Master Plan 2D surface flow results in GIS, it is possible to determine which buildings are removed from flooding due to the proposed improvements. For this exercise, a minimum depth threshold of 0.5′ was used. This means that buildings which have a 2D depth of at least 0.5′ adjacent to them were defined as "at risk" of flooding. This is a planning level estimate for use as a prioritization aid only, and actual results will vary based on more detailed analysis and actual field conditions during a rainfall event. **Table *33*** shows the number of these "at risk" buildings which are potentially removed from flooding of at least 0.5′, per each basin.

Table 33: Summary of "At Risk" Buildings Potentially Removed from Flooding, Depth > 0.5 FT, East Model

	Buildings Removed From Flooding			
Basin ID	2YR	10YR	25YR	100YR
BC1	0	0	0	0
BC2	0	0	0	0
BC3	0	0	0	0
P	0	0	0	0
Q	0	0	0	0
U	0	2	2	5
V	0	1	1	1
W	0	0	0	0
X	7	14	16	13
Y	1	1	2	4
Z	0	0	0	0
Z10	0	0	0	0
Z12	0	0	0	0

Basin ID	Buildings Removed From Flooding			
	2YR	10YR	25YR	100YR
Z13	0	0	0	0
Z3	0	0	0	0
Z4	0	0	0	0
Z5	0	0	0	0
Z6	8	4	5	6
Z7	0	0	1	1
Z8	0	0	0	0
Z9	0	0	0	0

7.1.2. West Model

The West Master Plan model includes adding several new storm drain closed conduit lines were there currently are none (B, D, E, K-L) or extending/upsizing existing systems (A, C, F, N). As with the East model, some proposed pipes from the KEF Master Plan were removed from this analysis. In the West model, the removed pipes primarily are those which now conflict with SH161. At the time of the 2003 KEF Master Plan, SH161 had not been constructed in its entirety in this area. Now that this construction is complete, this is a major highway facility complete with its own storm drain system, drainage channels, underground utilities, bridge piers through the elevated mainlane bridge areas, embankments and other obstacles. Therefore, it is not feasible to cross under this facility 4 different times, as the 2003 KEF Master Plan indicated. However, the proposed pipes west of SH161 from the 2003 KEF Master Plan provide significant benefit. Therefore, a new proposed configuration was developed to retain the 2003 KEF Master Plan systems to the west of SH161 but which also reduces the number of highway crossings from 4 down to 2. In addition to these improvements, a conceptual surface storage feature was modeled running along the western edge of Hardrock Rd. All these improvements were run and results were documents. **Table 34** and **Table 35** summarize the 1D model results. The same selected locations used to measure 2D flow in the existing scenarios were evaluated again in this scenario. **Table *36*** provides a summary of the surface flows in these locations. These results can be seen in **Exhibits 9a-d**.

Table 34: Total Flooded Nodes, West Model (Master Plan/Fully Developed)

	2YR	10YR	25YR	100YR
Number of Flooded Nodes (WSEL > Ground Elevation)	12	26	29	54
Average Depth of Node Flooding (FT)	1.04	0.81	0.86	0.99

Table 35: Total Surcharged Pipes, East Model (Master Plan/Fully Developed)

	2YR	10YR	25YR	100YR
Number of Surcharged Pipes (Class 1)	54	126	157	279
Number of Surcharged Pipes (Class 2)	4	10	20	44

Table 36: Summary of Fully Developed Peak 2D Surface Flows, West Model

Results Line ID	2YR Q (CFS)	10YR Q (CFS)	25YR Q (CFS)	100YR Q (CFS)
W1	63.94	126.43	157.4	215.5
W3	10.46	24.59	31.65	82.52
W4	48.88	98.25	127.76	183.11
W5	9.51	18.58	24.77	51.14
W6	1.73	2.43	2.5	5.42
W7	6.18	16.15	20.73	28.46

Using these results, a difference in 2D surface flow can be calculated to indicate the reduction in surface flow provided by the proposed improvements. In other words, the proposed Master Plan improvements convey more water underground thereby reducing the flow on the surface. This calculation is tabulated in **Table 37**.

Table 37: Summary of Reduction, West Model

Results Line ID	2YR ΔQ (CFS)	10YR ΔQ (CFS)	25YR ΔQ (CFS)	100YR ΔQ (CFS)
W1	-8.19	-27.23	-41.73	-62.07
W3	-16.29	-47.48	-68.43	-58.14
W4	-113.9	-262.12	-325.05	-404.22
W5	-137.69	-271.74	-335.76	-428.27
W6	-15.16	-33.83	-42.59	-52.55
W7	-11.09	-23.48	-28.05	-33.82

Using the Master Plan 2D surface flow results in GIS, the same analysis as described in 7.1.1 was used to estimate how many buildings are potentially removed from flooding of at least 0.5′ due to the proposed improvements. **Table 38** shows the number of these "at risk" buildings which are potentially removed from flooding of at least 0.5′, per each basin.

Table 38: Summary of Buildings Removed from Flooding, Depth > 0.5 FT, West Model

	Buildings Removed From Flooding			
Basin ID	2YR	10YR	25YR	100YR
A	0	0	0	1
A4	0	0	0	0
B	3	10	24	45
C	0	1	1	1
D	0	0	0	0
E	0	1	1	2
F	1	2	4	5
K-L	2	9	10	9
N	0	0	0	0

8.0 Capital Project Prioritization & Master Plan Update

After all the above modeling was run, the results showed that benefits of the proposed Master Plan infrastructure varied greatly. Some areas saw large numbers of buildings removed from flooding while other areas saw none. Some areas experienced massive reductions in surface flow and others saw none. In an effort to merge all benefits together, the following scoring system was implemented utilizing the results from the modeling.

8.1. Project Scoring & Capital Project Selection

Table 39 below presents a basic scoring system, derived from model results and GIS data, which was used to screen only those proposed Master Plan improvements which provide significant benefits. The highest scored improvements will then be evaluated in more detail. **Table 41** and **Table 42** show the results of this scoring and are presented in order of scoring.

Table 39: Prioritization Scoring Summary

Scoring Item	Description
Building Score	Number of buildings removed from 100YR flooding, depth > 0.5 Ft.
Complaint Score	Number of complaints within the basin
Node Score	Count of nodes with 100YR HGL above ground within the basin
2D Score	Based on reduction in surface flow measured at given location.
Total Score	Sum of all scores.

Table 40: Scoring Matrix Summary

	Count Range				
Score Component	>20	10 - 20	5 - 10	1 - 5	0
Building Score	20	15	7	3	0
Complaint Score	20	15	7	3	0
Node Score	10	5	3	1	0
	Percent Reduction				
	>70%	50% - 70 %	25% - 50%	<25%	
2D Score	10	5	1	0	

Table 41: East Area Project Prioritization

Basin ID	Building Score	Complaints	Node Score	2D Scoring	Total Score
X	15	20	10	5	50
U	7	15	10	10	42
Y	3	20	5	5	33
V	3	7	10	10	30
Z5	0	20	1	0	21
Manana	3	7	0	10	20
Z6	7	3	0	5	15

Basin ID	Building Score	Complaints	Node Score	2D Scoring	Total Score
Z7	3	3	0	5	11
Z4	0	7	3	0	10
Z	0	3	5	0	8
Z3	0	7	0	0	7
Z8	0	0	0	5	5
Z9	0	0	0	5	5
W	0	3	1	0	4
Q	0	3	1	0	4
BC1	0	0	0	0	0
BC2	0	0	0	0	0
BC3	0	0	0	0	0
P	0	0	0	0	0
Z10	0	0	0	0	0
Z12	0	0	0	0	0
Z13	0	0	0	0	0

Table 42: West Area Project Prioritization

Basin ID	Building Score	Complaints Score	Node Score	2D Scoring	Total Score
B	20	15	5	5	45
C	3	15	10	5	33
K-L	7	15	0	5	27
F	7	3	5	10	25
E	3	3	0	10	16
D	0	3	1	10	14
A	3	3	3	0	9
A4	0	0	1	0	1
N	0	0	0	0	0

8.2. Candidate Capital Project Descriptions and Costs

Projects scoring 20 or higher were then selected to be evaluated for cost estimates and CIP scoring using the Project Cost Estimate and CIP Ranking calculators developed by Burton Johnson Engineering under a separate scope item of this contract. This results in 9 potential Capital Improvement Projects (CIPs) to be evaluated. **Table 43** indicates which 9 basins qualified for further evaluation and the preliminary CIP name for each. The following sections describe these 9 projects and provide a conceptual opinion of construction cost as well as a conceptual CIP score. Detailed cost estimates are provided in Appendix **B.** See **Exhibits 11 (1-9).**

Table 43: Relationship between Basins ID, CIP Name, and Excel Tab Name

Basin ID	CIP Name	Cost Estimate Tab Name
B	River Ridge Blvd. Storm Drain Improvements	ShadyGrove5
C	Shady Grove Storm Drain Improvements	ShadyGrove6
F	Parker Rd - Hardrock Rd Storm Drain Improvements	ShadyGrove7
K-L	Jelmak Rd - Hardrock Rd Storm Drain Improvements	ShadyGrove8
MANANA	Manana Channel Improvements	ShadyGrove9
U	Gilbert West Storm Drain Improvements	ShadyGrove2
V	Shady Grove - Jones Storm Drain Improvements	ShadyGrove3
X	Gilbert Drainage Improvements - All	ShadyGrove1
Y	Thousand Oaks Storm Drain Improvements	ShadyGrove4
Z5	Not evaluated. See below	-

8.2.1. Basin B – River Ridge Blvd Storm Drain Improvements

The 2003 Kef Master Plan recommends installing approximately 7,100 LF of closed conduit ranging in size from 27″ to 84″ to replace the existing concrete lined channel which drains the Grand Place mobile home park and replacing the dual 24″ RCP between Trinity Blvd. and Big Bend Dr. with a single 60″ RCP. These recommended improvements were tweaked to fit current site conditions or were extended to the west to aid in draining areas of local surface flooding identified by the 2D model to the west of the mobile home park. In total approximately 7,100 LF of conduit ranging in size from 18″to 84″ as well as approximately 81~ 10′ curb inlets and 5~ Type Y inlets This is a large scale project with a large cost. As shown in the scoring, this area would benefit from these improvements. In addition to the main trunkline improvements along the existing channel, there are four lateral lines. The laterals along Farmer, Oak Knoll, Big Bend and Blackberry all provide benefits in their immediate vicinity. ***Table 44*** shows peak outflows.

Table 44: Summary of Peak System Discharge – Basin B

Scenario	Peak Discharge at Outlet Pipe:	
	Existing/FD (CFS)	Proposed (CFS)
10YR	125	232
100YR	150	347

All of the existing drainage system components in the mobile home park are privately owned. The channel, bridges, pipes, etc. are located on private property and are not owned or maintained by the City. Therefore, in order to implement t these improvements the City must purchase or acquire easements or ROW to perform this work. Since there are no storm drain easement here currently, a 15′ wide (minimum) easement should be purchased for the entire length of all recommended conduit. See **Exhibit 11W-1.**

Estimated Cost = $5.0 MM

8.2.2. Basin C – Shady Grove Storm Drain Improvements

The 2003 KEF Master Plan recommends constructing or replacing (enlarging) the system along W Shady Grove Rd. from Ellis Dr. to Bear Creek. Currently, portions of the W Shady Grove Rd. system match the recommended sizes from the KEF Master Plan. Therefore these portions were not modified. Other portions of this system were modified (enlarged) to match the 2003 KEF pipe size recommendation. Two major developments have occurred in this area since the 2003 KEF Master Plan was initially developed. One is the construction of the SH161 mainlanes and the other is the office building complex south of W Shady Grove Rd. along Trinity Blvd. Each of these developments include storm drain systems which alter the drainage patterns from what they were, presumably, when the 2003 KEF Master Plan was developed. The 2003 KEF Master Plan recommendations are still relevant because the system along W Shady Grove Rd. is a major drainage artery conveying stormwater west of SH161 under SH161 to the east over to Bear Creek. The SH161 system ties into the Shady Grove system, so the recommended enlargement still provides benefit. The final size and configuration of the enlarged Shady Grove system should be analyzed in more detail during design efforts. The updated 2003 KEF Master Plan improvements were modeled, analyzed, and priced to develop a CIP. These improvements include converting approximately 3,200 LF of Shady Grove Rd. and 700 LF of Ellis Dr. to a concrete curb and gutter road way, adding approximately 13~ 10′ curb inlets and 5~ 15′ curb inlets as well as increasing 3,600 LF of trunkline conduit ranging in size from 36″ to 8′x10′ RCBs. The trunk line enlargement would provide more conveyance/outlet capacity for all systems from the west of SH161 tying into this trunkline. This results in a reduction of surface flow in the area. The reduced surface flow benefits a nearby business as well as reducing the street flooding along Shady Grove Rd. Since most of these improvements are located within City ROW, there is not much ROW to purchase. The downstream most 400′ of the existing tunkline, near the outfall to Bear Creek appears to cross private property. It is recommended that the City investigate this in more detail and acquire any necessary ROW. See **Exhibit 11W-2.** A summary of peak system outflows is provided in **Table 45**.

Table 45: Summary of Peak System Discharge – Basin C

Scenario	Peak Discharge at Outlet Pipe:	
	Existing/FD (CFS)	Proposed (CFS)
10YR	173	97
100YR	205	150

Estimated Cost = $4.8 MM

8.2.3. Basin F – Parker Rd - Hardrock Rd Storm Drain Improvements

The 2003 KEF Master Plan recommends 3 separate systems in this area totaling approximately 5,700 LF of pipe ranging from 36″ to 90″. Each of the proposed systems crosses SH161 and individually outfall into Bear Creek. At the time that the 2003 KEF Master Plan was developed, SH161 was not completed in this area. Current conditions now include SH161 main lanes, frontage road, and multiple storm sewers servicing the roadway. Due to this major change in conditions, the 2003 KEF Master Plan recommendations were modified. Systems F, G, and J from the 2003 KEF Master Plan were modified by creating one new merged system and outfall called Basin F. All the area served by the 3 KEF proposed systems are now served by either the existing SH161 system or the proposed Basin F system. The updated Basin F system consists of approximately 4,900 LF of new conduit ranging in size from 36″ to 90″. These improvements include converting approximately 1,300 LF of Parker Rd. (from current end point of curb and gutter section east to Hardrock Rd.) and approximately 2,600 LF of Hardrock Rd. (from just north of Jelmak Rd. north to Rock Island Rd.) to curb and gutter roadways and adding 27~ 10′ curb inlets and 3~ 15′ curb inlets. Lowering the road profile along Hardrock Rd. to create a curb and gutter section is not enough to capture all the sheet flow crossing the roadway. Therefore, a regional interceptor swale on the west side of Hardrock Rd. is recommended. The interceptor swale is approximately 1,500 LF and runs from Parker Rd. north to Rock Island Rd. This swale should contain approximately 6~ Type Y inlets to drain the swale and connect to the new proposed storm drain along Hardrock Rd. The swale was modeled with a depth of 5′ to test the concept. Due to potential design constraints such as ROW, existing grades, required capacity, etc. it is recommended that the final configuration should be evaluated in more detail during design. Currently runoff sheet flows from west to east across Hardrock Rd. This sheet flow contributes to flooding issues east of Hardrock Rd. The proposed new roadway, drainage system, and interceptor swale should be designed to catch all this sheet flow and re-route it through the proposed underground system.

Currently the Parker Rd. system discharges into a road side ditch just east of High Prairie Rd. Part of the updated Basin F system includes connecting to the Parker Rd. system using closed conduit instead of utilizing the current roadside ditch. Conceptually, it is anticipated that the new alignment for the City's system could cross SH161 near TXDOT's current outlet pipe to Bear Creek and possibly share the same easement. This could possibly save cost in acquiring a new easement east of SH161. Additionally, it should be noted that SH161 is elevated in this area, which with careful alignment planning, could potentially mean this crossing could be open cut instead of bored. The future design team will have to evaluate this option at that time and under those current conditions. **Table 46** compares peak surface flow across Hardrock Rd.

Table 46: Summary of Peak System Discharge – Basin F

Scenario	Peak 2D flow across Hardrock Rd.	
	Existing/FD (CFS)	Proposed (CFS)
10YR	41	9
100YR	73	23

Approximately 20′ – 30′ wide ROW will need to be purchased along Hardrock Rd. to accommodate the interceptor swale. A 15′ wide (minimum) easement will also need to be purchased east of Hardrock Rd. along the outfall pipe alignment all the way to Bear Creek. Exact location and size of purchased easements will have to be evaluated in more detail during design. Conceptual locations and sizes are shown on **Exhibit 11W-3.**

Estimated Cost = $4.2 MM

8.2.4. Basin K-L – Jelmak Rd - Hardrock Rd Storm Drain Improvements

The 2003 KEF Master Plan recommends 2 separate systems in this area totaling approximately 6,850 LF of pipe ranging from 24″ to 90″. Each of the KEF proposed systems cross SH161 and individually outfall into Bear Creek. At the time that the 2003 KEF Master Plan was developed, SH161 was not completed in this area. Current conditions now include SH161 main lanes, frontage road, and multiple storm sewers servicing the roadway. Due to this major change in conditions, the 2003 KEF Master Plan recommendations were modified. Systems K and L from the 2003 KEF Master Plan were modified by creating one new merged system and outfall called Basin K-L. All the area served by the 2 KEF proposed systems are now served by either the existing SH161 system or the proposed Basin K-L system. The updated Basin K-L system consists of approximately 5,200 LF of new conduit ranging in size from 36″ to 90″. These improvements include converting approximately 1,300 LF of Jelmak Rd. (all of it) and approximately 2,000 LF of Hardrock Rd. (from W Shady Grove Rd. to approximately 200 LF north of Jelmak Rd.) to curb and gutter roadways and adding 29~ 10′ curb inlets and 6~ 15′ curb inlets. Lowering the road profile along Hardrock Rd. to create a curb and gutter section is not enough to capture all the sheet flow crossing the roadway. Therefore, a regional interceptor swale on the west side of Hardrock Rd. is recommended. The interceptor swale is approximately 1,700 LF and runs approximately 200 LF north of Jelmak Rd. and 1,500 LF south of Jelmak Rd. This swale should contain approximately 1~ Type Y inlet (or more depending on design) to drain the swale and connect to the new proposed storm drain along Hardrock Rd. The swale was modeled in concept only. Due to potential design constraints such as ROW, existing grades, required capacity, etc. it is recommended that the final configuration should be evaluated in more detail during design.

Currently this area has no storm drain infrastructure along either road and water sheet flows from the west to the east, across Hardrock Rd. and into the SH161 ROW. Jelmak Rd. freely discharges water onto Hardrock Rd. and this discharge cascades as overland flow all the way to SH161. Adding a system along Jelmak Rd. intercepts the majority of this flow before it reaches Hardrock Rd. and thereby greatly reduces the overland discharge onto Hardrock. The proposed new roadway, drainage system, and interceptor swale should be designed to catch all this sheet flow and re-route it through the proposed underground system. This water would then need to be conveyed under SH161 and discharged into Bear Creek. This crossing could also be located in the elevated section of SH161 and could also potentially be open. The future design team will have to evaluate this option at that time and under those current conditions. **Table 47** shows a comparison of surface flows (fully developed hydrology) across Hardrock Rd.

Table 47: Summary of Peak System Discharge - Basin K- L

Scenario	Peak 2D flow across Hardrock Rd.	
	Existing/FD (CFS)	Proposed (CFS)
10YR	131	57
100YR	199	130

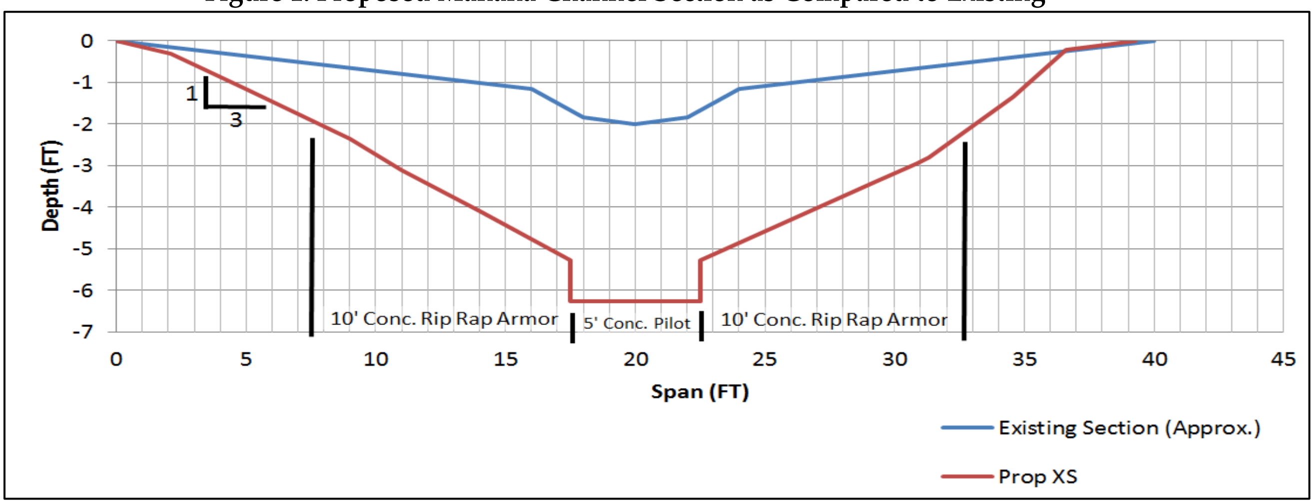
Approximately 20′ – 30′ wide ROW will need to be purchased along Hardrock Rd. to accommodate the interceptor swale. A 15′ wide (minimum) easement will also need to be purchased east of Hardrock Rd. along the outfall pipe alignment all the way to Bear Creek. Exact location and size of purchased easements will have to be evaluated in more detail during design. Conceptual locations and sizes are shown on **Exhibit 11W-4.**

Estimated Cost = $3.8 MM

8.2.5. Basin Manana – Manana Channel Improvements

The 2003 KEF Master Plan recommends approximately 900 LF of 24″ and 30″ RCP behind the houses along Manana Dr. However, in Spring of 2016 the City performed some minor grading in this exact location as a good faith gesture to the local resident who were complaining of various drainage issues at the time. Due to these current conditions the 2003 KEF Master Plan recommendations were modified. This study analyzed an expansion of the existing channel to intercept overland flow before it reaches the houses to the south along Manana Dr. and convey this flow to Dry Creek. This expansion involves digging out the existing Manana channel deeper, building a pilot channel, and armoring the side slopes. The current swale is roughly 8 ft wide by 1 ft deep, on average. The proposed improvements would expand this channel significantly and take advantage of the full width of the corridor in which it lies. The proposed channel would be roughly 40 ft wide by approximately 6 ft deep with a 5′ wide concrete pilot channel and with 3:1 side slopes armored with concrete riprap 10′ out from the pilot channel. compares the conceptual proposed cross section to the existing cross section.

Figure 1: Proposed Manana Channel Section as Compared to Existing



The channel would run approximately 1,600 LF from the east side of the church parking towards Dry Creek. The upstream invert elevation would be approximately 504.1 and drop to approximately 471.8 (approximately 2% slope). These improvements capture, retain, and convey water which currently escapes the channel in high flow events, i.e. more flow stays in the channel. The escaped flow impacts homes along Manana St. and gets into the Manana St. storm drain system as well as impacts commercial/industrial sites along Rock Island Rd. This additional channel capacity alleviates flooding to these houses and eases the load of the Manana St. storm drain. These improvements also provide significant reduction in surface flooding in Haynes Rd, Slocum St, and some of the commercial/industrial sites north of the Channel. A summary of peak flow in the channel at the downstream end is provided in **Table 48**.

Table 48: Summary of Peak System Discharge – Basin Manana

Scenario	Peak flow in channel.	
	Existing/FD (CFS)	Proposed (CFS)
10YR	8	10
100YR	11	14

It is important to note that the City would have to purchase a significant amount of property to perform this work. Due to the size of the channel, the City would need at least a 40' wide ROW for the length of the channel. Currently, this channel sits in a sliver parcel situated between private residential lots on the south (Manana Dr. homes) and multiple industrial tracts to the north. This sliver ranges in width from about 40' to about 90' in places. It is recommended that the City purchase all land between the Manana Dr. homes and the industrial tracts to the north, so as to leave no remaining slivers of private land along this corridor. This would allow the City to maintain the channel by accessing the channel property from City ROW located along Slocum St. and Haynes Rd. Currently the City does not own any easement for the existing grading that is there now. The existing grading was performed on property owned by the Greater Allen Temple AME Church. In addition to ownership issues, the church does not properly maintain this swale. Therefore the City has no means of performing additional work on this property or providing any additional maintenance unless all necessary property is acquired by the City. See **Exhibit 11E-5.**

Estimated Cost = $0.75 MM

8.2.6. Basin U – Shady Grove Rd., Gilbert Rd., Wright Blvd. Storm Drain Improvements

The 2003 KEF Master Plan proposes enlarging the existing storm drain system which serves W. Shady Grove Rd. and the Shady Grove Ranch mobile home park as well as modifying existing outfalls in the existing detention pond south of Thoroughbred Ln. by creating a new direct outfall into Bear Creek. One recommended update to the 2003 KEF Master Plan is an additional new storm drain extension north of W. Shady Grove Rd., along Gilbert Rd. north to Wright Blvd. The extension will intercept overland runoff before it reaches W. Shady Grove Rd. and the Shady Grove Ranch mobile home park. This prevents roadway and structure flooding in this area, and can be constructed entirely in City owner ROW. The total proposed storm drain improvements are approximately 3,125 LF of storm drain ranging in size from 18" to 72" and approximately 4 ~ 15' curb inlets and 10 ~ 10' curb inlets. These improvements were then evaluated, scored, and cost estimates were developed. These are presented in two phases. Refer to **Exhibits 11E-6, 11E-6a, and 11E-6b. Table 49** compares flows over top of Shady Grove Rd.

Table 49: Summary of Peak Flows – Basin U

Scenario	Flow Over Shady Grove Rd.	
	Existing/FD (CFS)	Proposed (CFS)
10YR	4	4
100YR	32	7

Phase 1

The first phase of improvements includes the new storm drain extension north of Shady Grove Rd. along Gilbert Rd. north to Wright Blvd. as well as enlarging portions of the existing system and adding a few new inlets within the Shady Grove Ranch mobile home park along the existing alignment, as shown on **Exhibit 11E-6a**. The storm drain extension includes approximately 885 LF of storm drain ranging in size from 18" to 36" as well as approximately 4~ 15' curb inlets and 10 ~ 10' curb inlets to capture surface flow. It is recommended that inlet sizes and locations be more precisely evaluated during design efforts. Approximately 1,000 LF of Shady Grove, 450 LF of Gilbert Rd. and 500 LF of Wright Rd. near this alignment will also need to be replaced with a concrete curb and gutter roadway section.

In addition to this storm drain extension, enlarging approximately 840 LF of existing system and adding an additional 5 curb inlets are proposed in the Shady Grove Ranch mobile home park along Stallion Ln., Colt Terrace, Filly Ln. These inlets will require the City to purchase easements, since these are private streets. These improvements provide significant benefit by capturing surface flow and conveying it underground to the existing pond to the south.

Estimate Cost = $1.5 MM

Phase 2

Phase 2 involves connecting the three existing system outfalls located in the existing pond south of Thoroughbred Ln. with approximately 1,375 LF of new underground conduit ranging in size from 36" to 72" underneath the existing pond and discharging directly into Bear Creek, as shown on **Exhibit 11E-6b**. The new conduit would tie 3 existing outfalls together and create one single direct outfall into Bear Creek. Currently, the existing pond stores discharge from these systems, conveys it to the east, crosses under Trinity Blvd. and discharges into Bear Creek. The initial intent of the KEF Master Plan to reconfigure these systems is unclear. At this time, this analysis does not recommend pursuing this phase of this potential CIP. However, Phase 1 may potentially be implemented as a standalone project. Further evaluation, including evaluating Bear Creek, is needed to determine the hydraulic impacts of Phase 2 of the Master Plan.

Estimate Cost = $0.6 MM

Estimated Cost (All phases) = $2.1 MM

8.2.7. Basin V - Shady Grove - Jones Storm Drain Improvements

The 2003 KEF Master Plan recommends approximately 2,700 LF of closed conduit ranging in size from 24" to 96". The proposed alignment is to take flow from E Shady Grove Rd. and convey it underground where it discharges into a ditch/tributary to Bear Creek, just north of Trinity Blvd. This alignment runs underneath what are currently the Kevco Electric and NATGUN office buildings. Therefore, this alignment was modified to fit current conditions. The new alignment used in this study begins at the same place upstream (servicing E. Shady Grove Rd.) but cuts to the east on the north side of the Kevco Electric and NATGUN office buildings, while still discharging into the same ditch/tributary near Trinity Blvd. as the original alignment. These improvements were modeled, evaluated, scored and priced to develop a potential CIP. These improvements involve converting approximately 800 LF of Shady Grove Rd.and 425 LF of Jones Rd. to a concrete curb and gutter section roadway with approximately 2~ 10' curb inlets and 2~ 15' curb inlets and 1 additional 10' curb inlet near the Rocky Spring Missionary Baptist Church parking lot. The underground storm drain system consists of approximately 2,400 LF of pipe ranging from 24" to 48". Currently E. Shady Grove Rd. and north along Jones Rd. is drained by roadside ditches and culverts for both roadways. The main outlet of this area near the church and north of E Shady Grove Rd. is a single culvert running south underneath E Shady Grove Rd. All runoff from north of Shady Grove is discharged though this culvert onto private property. This was documented during a rain storm on 4/18/2017 and is shown on . Refer to **Exhibit 11E-7.**

Figure 2: Culvert under Shady Grove Discharging onto Private Property

This discharge then runs overland across private property southward towards a ditch/tributary near Trinity Blvd. which conveys this and other flow underneath Trinity Blvd. and into Bear Creek. In order to reduce this free discharge of stormwater onto private property, it is recommended that the City purchase a 15' wide (minimum) easement for the entire length of the proposed alignment and install an underground pipe network to convey stormwater from the proposed redesigned roadways to the ditch/swale discharge channel near Trinity Blvd. **Table 50** compares peak overland flows downstream of the current culvert discharge location.

Table 50: Summary of Peak Flows – Basin V

Scenario	Overland Flow Downstream of Culvert	
	Existing/FD (CFS)	Proposed (CFS)
10YR	26	10
100YR	53	15

Estimated Cost = $1.3 MM

8.2.8. Basin X - Gilbert Drainage Improvements

This basin begins accumulating runoff in the vicinity of Gilbert Circle and Gilbert Rd. just south of Rock Island and ultimately flows into the FEMA studied Gilbert Branch. Under existing system conditions and fully developed runoff conditions, the flow in the existing channel between Gilbert Cir. and Gilbert Cir. is about 81 CFS in the 10YR event and is about 120 CFS in the 100YR event. The flow in the channel as it enters Gilbert Branch between Enchanted Ct. and Wandering Brook St. is about 213 CFS in the 10YR event and about 355 CFS in the 100YR event. A comparison of these flows with post-project (proposed) flows are provided in ***Table 51*** below. There is a drainage complaint "Hot Spot" in this area, at the Texas Pro Diesel Repair just north of the Greater Allen Temple AME Church driveway on Gilbert Rd. south of Rock Island Rd. and is discussed below. The 2003 KEF Master Plan recommends approximately 3,500 LF of storm drain improvements and 4,100 LF of channel improvements. This update to the 2003 KEF plan modifies the original recommended configuration based on current drainage network and infrastructure needs. This study recommends a total of 4,400 LF of storm drain and 2,200 LF of channel improvements. The modifications include adding new conduit in the upstream reaches of the watershed and terminating the channel improvements upstream of the mapped FEMA floodplain and the concrete lined Gilbert Branch channel. These improvements were modeled, evaluated, scored and priced to develop a potential CIP. These improvements are presented in three phases. Refer to **Exhibits 11E-8, 11E-8a (Phase 1), 11E-8b (Phase 2), and 11E-8c (Phase 3).** **Table 51** below compares peak discharges at key locations.

Table 51: Comparison of Flows for Basin X

	Discharge from Prop. 36" RCP. into swale	Flow through natural swale between Gilbert Cir.		Flow in channel as it enters Gilbert Branch downstream	
	Proposed Only	Existing	Proposed	Existing	Proposed
10YR	45	81	82	213	116
100YR	65	120	160	355	298

Phase 1

The first phase must be ROW acquisition, since much of the surface flow path is on private property. The main flow path for this entire basin runs from the headwaters near the intersection of Gilbert Cir. and Gilbert Rd. towards the southeast down to the FEMA studied Gilbert Branch channel. The existing swale south of Gilbert Rd. is located on private property. An easement is recommended to be purchased by the City so that a proper channel can be graded to convey the design storm and can also be properly protected from encroachments. The 2D rain on mesh model results indicates the width of the overland flow path along the natural swale is approximately 100′ – 150′ wide for 100-YR fully developed flow deeper than 0.25′. The exact size of this easement needs to be determined based on detailed engineering analysis and surveying practice. The easement width must be determined based on proposed grading and channel design. A channel should be designed to contain the design flow to prevent flood damage to adjacent structures. The final designed configuration of an engineered channel will establish the required width of the easement. Per Section 2.5 (A) of the City's DDM, channel easements must be at least 20′ wider than the width of the top banks of the channel. The swale then flows south to the intersection of Gilbert Cir. and Gilbert Rd. to the south, near Bear Creek South Park. A new headwall on the north side of Gilbert Cir. and 270 LF of new 7′ x 4′ RCB box culvert under the roadway as well as a 4′ x 4′ Type Y inlet and 75 LF of 24″ lateral connecting the Type Y inlet to the 7′ x 4′ box are proposed in this location. This culvert then discharges into a channel located in the City's Bear Creek South Park. It is recommended that the City purchase 3 whole parcels between Bear Creek South Park and Autumn View Dr. The other 6 parcels in this area are owned by Grand Prairie ISD (2) or Irving ISD (4). Ideally an agreement between Grand Prairie ISD and Irving ISD could be reached to use this property jointly, possibly as an "outdoor learning center" or park. Under this circumstance, purchasing the 3 privately held parcels would provide a contiguous block of land which could potentially be excavated and used as a regional detention pond for flood control applications. This phase would include excavating this area, constructing an earthen dam on the downstream side, and installing approximately 140 LF of 24″ outlet pipe. If Irving ISD is not receptive to a joint agreement for these parcels, then the City should try to purchase those 4 parcels currently held by Irving. The cost estimate for this phase assumes a joint agreement can be reached and does not include the cost of those 4 other parcels held by Irving. This proposed potential regional detention reduces the flow in the channel as it enters Gilbert Branch between Enchanted Ct. and Wandering Brook St. At this location the proposed network/fully developed runoff flow in the channel, downstream of these proposed improvements, is about 116 CFS in the 10YR and about 298 CFS in the 100YR event. Refer to **Exhibit 11E-8a.**

Estimated Cost = $1.4 MM

Phase 2

The second phase of this project includes repaving 3,550 LF of neighborhood streets and installing approximately 2,260 LF of storm drain ranging in size from 24″ to 36″ to create three individual small storm drain systems along Gilbert Rd., Gilbert Cir. and Rose Lee Seaton Rd.

On the north (upstream) end of the watershed, near Gilbert Rd. and Gilbert Cir. south of Rock Island Rd. (near the aforementioned "hot spot" area), approximately 1,200 LF of new storm drain ranging in size from 24" to 36" along with approximately 12 curb inlets are proposed. This system would collect runoff from the hot spot area and convey it underground where it then discharges approximately 45 CFS (10YR) and 65 CFS (100YR) into the natural swale south of Gilbert Cir. (purchased by City in Phase 1). Under proposed network conditions and fully developed runoff, the natural swale between Gilbert Cir. and Gilbert. Cir. conveys approximately 82 CFS in the 10YR event and 160 CFS in the 100YR event.

Then, along Rose Lee Seaton Rd., mid-block between both intersections with Gilbert Cir., another system is proposed. This system consists of approximately 600 LF of storm drain ranging in size from 27" to 33" as well as 3 ~ 10' curb inlets and 2 ~ 15' curb inlets. The combined road repaving and storm system will drain the mid-block sump and also will intersect overland flow which comes from the west of Rose Lee Seaton Rd. This flow will then be discharged into the natural swale which was purchased by the City in Phase 1 above. These proposed systems would all discharge into the swale purchased and graded in Phase 1.

Near the south intersection of Gilbert Cir. and Gilbert Rd. (near Bear Creek South Park) another small storm drain system is proposed. This system consists of approximately 460 LF of 24" pipe and approximately 2 curb inlets along Gilbert Cir. and another located at the sump in the curve of Gilbert Cir. and Gilbert Rd. This system will facilitate the necessary drainage associated with repaving Gilbert Cir. into a curb and gutter roadway as well as collecting local runoff from the north and west of Gilbert Cir. and Gilbert Rd., respectively, at the natural low point north of the roadway. This system will tie into the proposed 7' x 4' box culvert which is proposed in Phase 1 above. Also in this area, approximately 800 LF of culvert will need to be removed to facilitate the new street repaving in this area. The flow once conveyed by these culverts and ditches will then be conveyed in the new curb and gutter roadways in this area. Refer to **Exhibit 11E-8b.**

Estimated Cost = $2.3 MM

Phase 3

The remaining KEF Master Plan improvements in this basin involve installing 5 new individual storm drain systems in various places to collect surface runoff and convey it underground into Gilbert Branch as well as repaving approximately 350 LF of neighborhood roadway. In all the storm drain improvements total approximately 1,750 LF in length ranging from 18" to 60" as well as approximately 5 ~ 4'x4' Type Y inlets and 10 ~ 10' curb inlets. Almost all of the proposed storm drain lines in this phase are located on private property and therefore will require another round of easement purchase.

At Gilbert Rd. near South Bear Creek Park approximately 285 LF of storm drain ranging in size from 18" to 60", a new headwall to the east and 2 ~ 4x4 Type Y inlets north of Gilbert Rd. are proposed. This system collects surface runoff and conveys it underground where it discharges into the pond proposed in Phase 1. This system could be constructed within City owned ROW.

The other 4 KEF Master Plan proposed systems are all located on the western portion of the Sherwood Village Mobile Home Park property, and as such will require easement acquisition. These improvements consist of approximately 1,455 LF of storm drain ranging from 24" to 30" and approximately 10 ~ 10' curb inlets and 2 ~ 4'x'4' Type Y inlets.

The aforementioned pond could potentially be utilized to mitigate any potential increases in flow due to these new storm drains discharging into Gilbert Branch. Refer to **Exhibit 11E-8c.**

Estimated Cost = $0.9 MM

Total Estimated Cost (All phases) = $4.6 MM

Hot Spot Area

There have been complaints of flooding at Texas Pro Diesel Repair just north of the Greater Allen Temple AME Church driveway near Gilbert Cir. and Gilbert Rd., allegedly due to a new church parking lot blocking the drainage path for surface runoff trying to flow south along Gilbert Rd. During the course of this study, this area was investigated to determine the nature of the surface drainage in this vicinity. Based on field observations, LIDAR data, and 2D surface flow model, it looks like Gilbert Rd. has a local sump in the vicinity of the church driveway. This sump in the roadway should allow runoff to escape the properties on the east side of Gilbert Rd. by allowing water to enter the Gilbert Rd ROW at the sump and then conveys it to the west side of Gilbert Rd. Water appears to pond up on the east side of Gilbert Rd. to depths less than 1 foot during a 100-YR event, mostly along the edge of the Gilbert Rd. pavement. **Figure 3** shows this area during construction of the driveway, prior to completion.

Figure 3: Gilbert Cir. Hot Spot Area - Pre Driveway Conditions from Google Maps

The evaluated Basin X Master Plan improvements proposed in the 2003 KEF Master Plan start at this location. In this vicinity, the Master Plan improvements consist of converting Gilbert Rd. from an asphalt road with very small swales into a concrete curb & gutter roadway with a closed conduit drainage system. The closed system includes multiple curb inlets and pipes ranging in size from 24" to 36". This proposed system should pick up runoff from both sides of Gilbert Rd. and sump area, including the complaint location. During detailed design efforts, a more detailed evaluation should be performed to ensure that inlets are placed at precise locations to drain the properties on the east side of Gilbert Rd. It is possible that inlets may potentially be placed near or on private property, including purchasing appropriate easements, to ensure positive drainage away from the church parking lot.

Since these improvements are part of a larger master plan, this area may need a solution sooner than the Master Plan implementation will allow. If a solution in this area is urgent, then it is recommended to move forward with a separate "hot spot" design evaluation immediately. The following scenarios should be investigated in more detail under that effort to determine more precise design configuration, quantities, and specifications.

Figure 4: Hot Spot Location flow patterns near church parking lot.

<u>Option 1: Build a portion of the 2003 KEF Master Plan storm drain improvements in this area.</u>
This option would involve executing Phase 1 of the Basin X Master Plan to purchase necessary ROW and then building only a portion of Phase 2 of the Basin X storm drain improvements (675 LF of 24"RCP and 530 LF of 36" RCP and approximately 12 standard 10' Curb Inlets) in the immediate vicinity of Gilbert Cir. and Gilbert Rd. This storm drain would collect runoff along Gilbert Rd. north of Gilbert Cir. and convey it underground along Gilbert Rd. and then discharge it into the existing swale south of Gilbert Cir. The 10YR discharge from this 36" RCP would be approximately 45 CFS and the 100YR would be about 65 CFS. It is necessary to execute Phase 1 first so that all stormwater discharged by the City's storm drain is then contained within City ROW all the way to its confluence with the Gilbert Branch channel

downstream. If Phase 1 is not executed prior to constructing the storm drain in this area, then this could potentially put the City at risk because the discharge from the new storm drain would flow across private property all the way down to Gilbert Branch. Discharging public stormwater onto private property to freely flow overland is not advisable. These legal issues and liabilities should be evaluated before proceeding.

<u>Option 2: Manana Channel improvements (described below) + relief storm drain line.</u>
This option would include further excavating the Manana channel to a depth of about 6 feet for approximately 1700 LF and then running a storm drain line from the eastern ROW line of Gilbert Rd. underneath the church parking lot to the east and daylighting the outfall of the pipe into the deepened Manana Channel. The additional excavation is necessary to do this because there is currently not enough elevation fall between the alleged flooding location and the current Manana channel bottom east of the church parking lot. It should be noted that the City would need to purchase most or all of this parcel to establish ROW to perform this work. Currently the City does not own this property and therefore has no ability to modify the existing channel any further.

<u>Option 3: Build new storm drain running north under Rock Island.</u>
This option would involve constructing very similar storm drain improvements as those described in Option 1 above, but running the outfall pipe north, under Rock Island Rd. (approximately 400 LF) and discharging into the ditch adjacent to the TRE train tracks. This study did not evaluate this option for hydraulic performance. This is only a conceptual alternative which should be evaluated in detail before moving forward. In concept, it appears that there is enough elevation fall between the complaint location and the TRE ditch for this to work hydraulically. This would keep storm drain conduit within City street ROW at least until the discharge point north of Rock Island Dr. Further property ownership investigation and agreements with all other agencies should be vetted before proceeding with this option.

8.2.9. Basin Y - Thousand Oaks Storm Drain Improvements

The 2003 KEF Master Plan recommended constructing or replacing (enlarging) the system along Post Oak Dr. as well as connecting the sump inlet on Thousand Oaks Dr. to the Post Oak Dr. system with underground conduit. Currently, portions of the Post Oak Dr. system match the recommended sizes from the KEF Master Plan. Therefore these portions were not modified. Other portions of this system were modified (enlarged) to match the 2003 KEF pipe size recommendation. The sump inlets on Thousand Oaks Dr. currently discharge into a drainage swale for approximately 250 feet where it is then picked up by a headwall and 27" RCP which then ties in to the Post Oak Dr. system. The 2003 KEF Master Plan recommends connecting the Thousand Oaks Dr. sump inlets to the Post Oak Dr. system completely underground using 38" and 42" RCP. Since a 38" RCP is not a standard size, this study modified this run of pipe to use 42" pipe instead. This underground conveyance would prevent the overland flooding of houses in the immediate vicinity. Along with this pipe, a new Type Y inlet is required to collect overland flow remaining in the existing drainage swale. In total, the updated configuration of these improvements consists of replacing/enlarging approximately 1,500 LF of storm drain along Post Oak Dr. ranging in size from 30" to 42" and installing approximately 250 LF of new 42" RCP to connect the Thousand Oaks Dr. sump to the Post Oak Dr. system. These improvements were modeled, evaluated, scored and priced to develop a potential CIP. This study assumes that Manana Dr. and Post Oak Dr. are City ROWs. Therefore the only easement purchase is along the proposed alignment of the connecter line between the Thousand Oaks Dr. sump inlets and the Post Oak Dr. system. Refer to **Exhibit 11E-9. Table 52** compares peak system discharges at the downstream pipe.

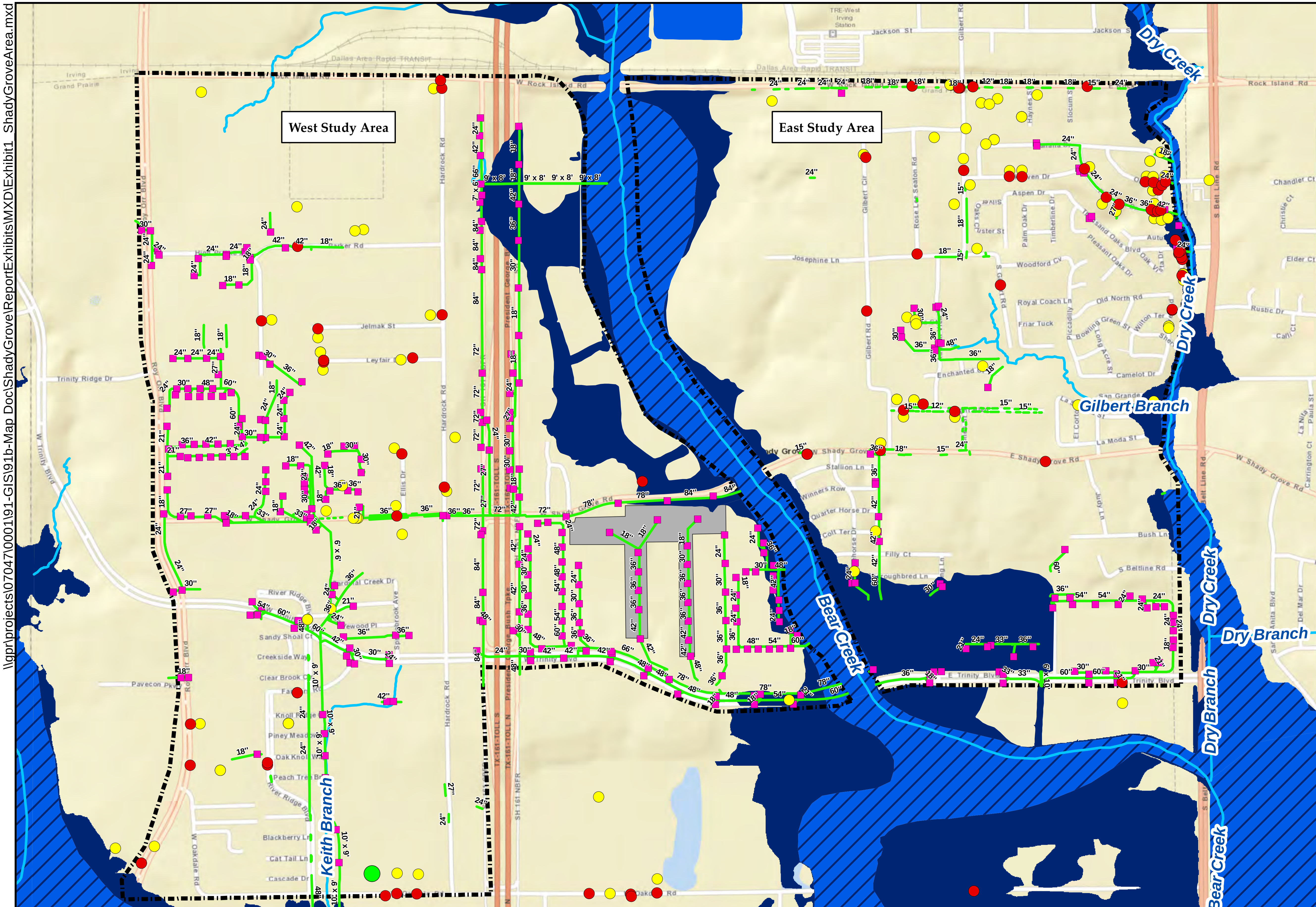
Table 52: Summary of Peak Flows – Basin Y

Scenario	Peak Discharge at Outlet Pipe:	
	Existing/FD (CFS)	Proposed (CFS)
10YR	130	150
100YR	136	163

Estimated Cost = $0.7 MM

8.2.10. Basin Z5

Basin Z5 was not evaluated as a storm water Capital Project because this study indicates that the potential flooding issues in this area appear to be due to floodplain issues along Dry Creek. Basin Z5, and other areas along Dry Creek, show a high number of complaints, but no 2D flow reduction due to proposed storm drain infrastructure. This indicates that the flooding shown is a tailwater issue stemming from flood levels coming from Dry Creek. In other words, storm drain does not reduce flooding in these areas but reducing the flood levels in Dry Creek may. Evaluating the Dry Creek watershed and channel is not in this scope of work, therefore no capital projects are being evaluated for these areas under this study.



Flooded Structure Due to Private Drainage
Flooded Structure Due to Public Drainage
Complaints from KEF MP
Other Drainage Complaints
Inlets
Pipes
Streams
Model Boundary
Existing Detention Basin

FEMA Flood Zone

A,
AE
AE, FLOODWAY

Note: Drainage Complaints as of July 8, 2015.

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Shady Grove Study Area - Existing Network

Shady Grove Area

Prepared For:
City of Grand Prairie

Jan. 2018 | Exhibit 1

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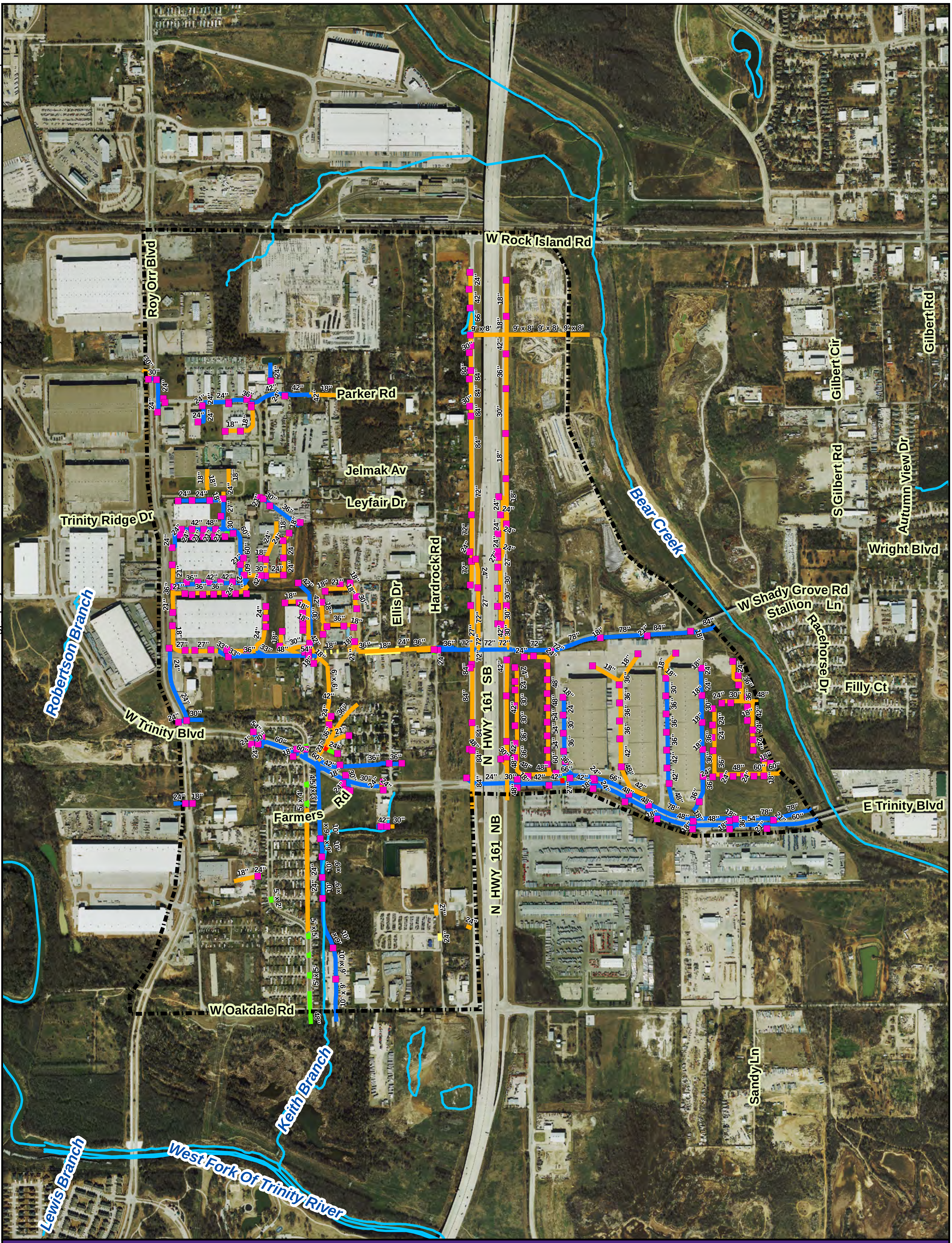

Existing Drainage System Map West

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Model Boundary

Modeled Pipes, by data source.
Pipes, No Data/Infered from AsBuilt or Model
Pipes, from As Built Drawings
Pipes, LIDAR (for Inverts)
Pipes, from StormCAD Model
Pipes, from Field Survey

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System Map West

Prepared For:
City of Grand Prairie

Jan. 2018	Exhibit 2a

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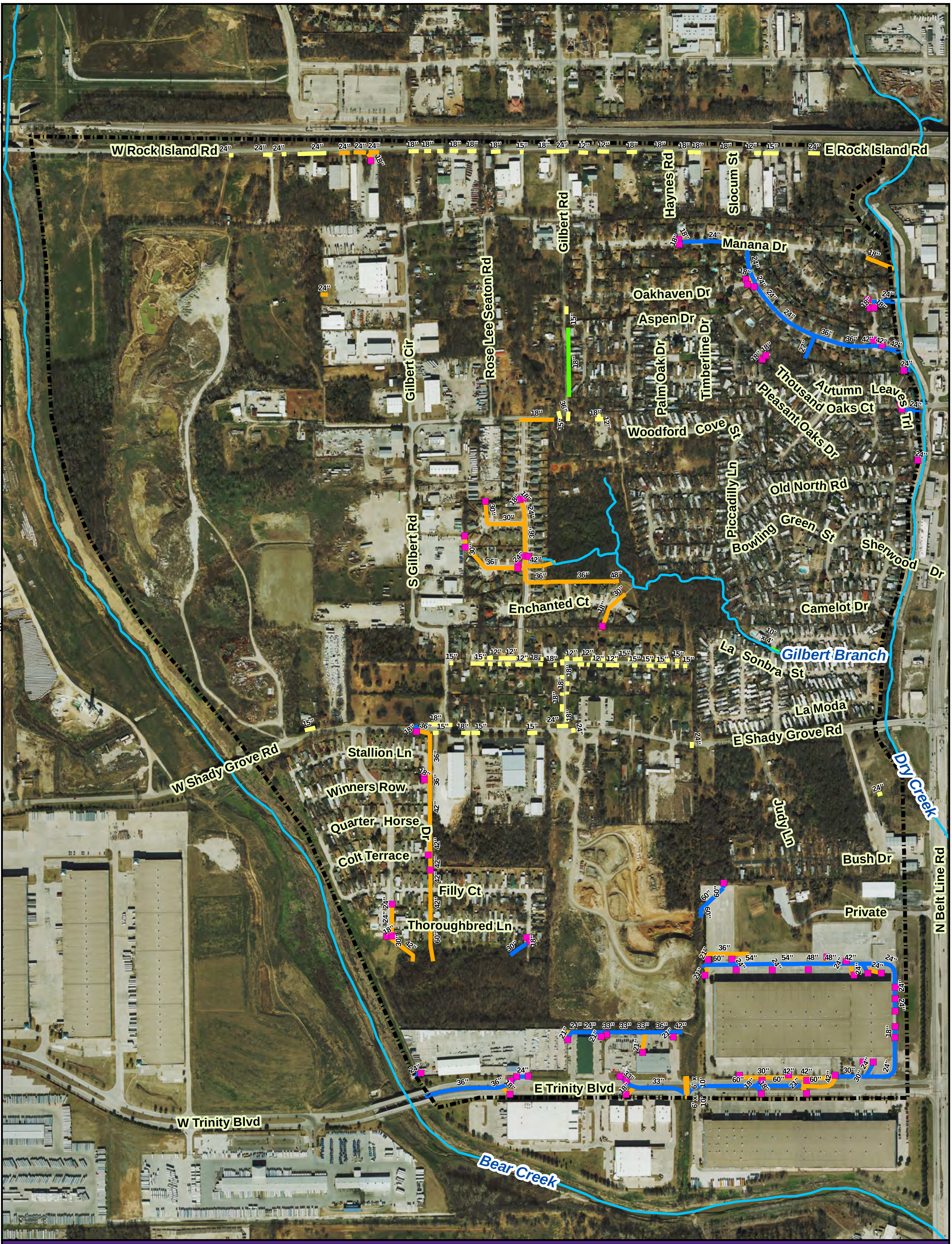

Existing Drainage System Map East

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Inlets

Streams

Model Boundary

Model Pipes, by data source.

Pipes, No Data/Infered from AsBuilt or Model

Pipes, from As Built Drawings

Pipes, LIDAR (for Inverts)

Pipes, from StormCAD Model

Pipes, from Field Survey

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System Map East

Prepared For: City of Grand Prairie

Jan. 2018	Exhibit 2b

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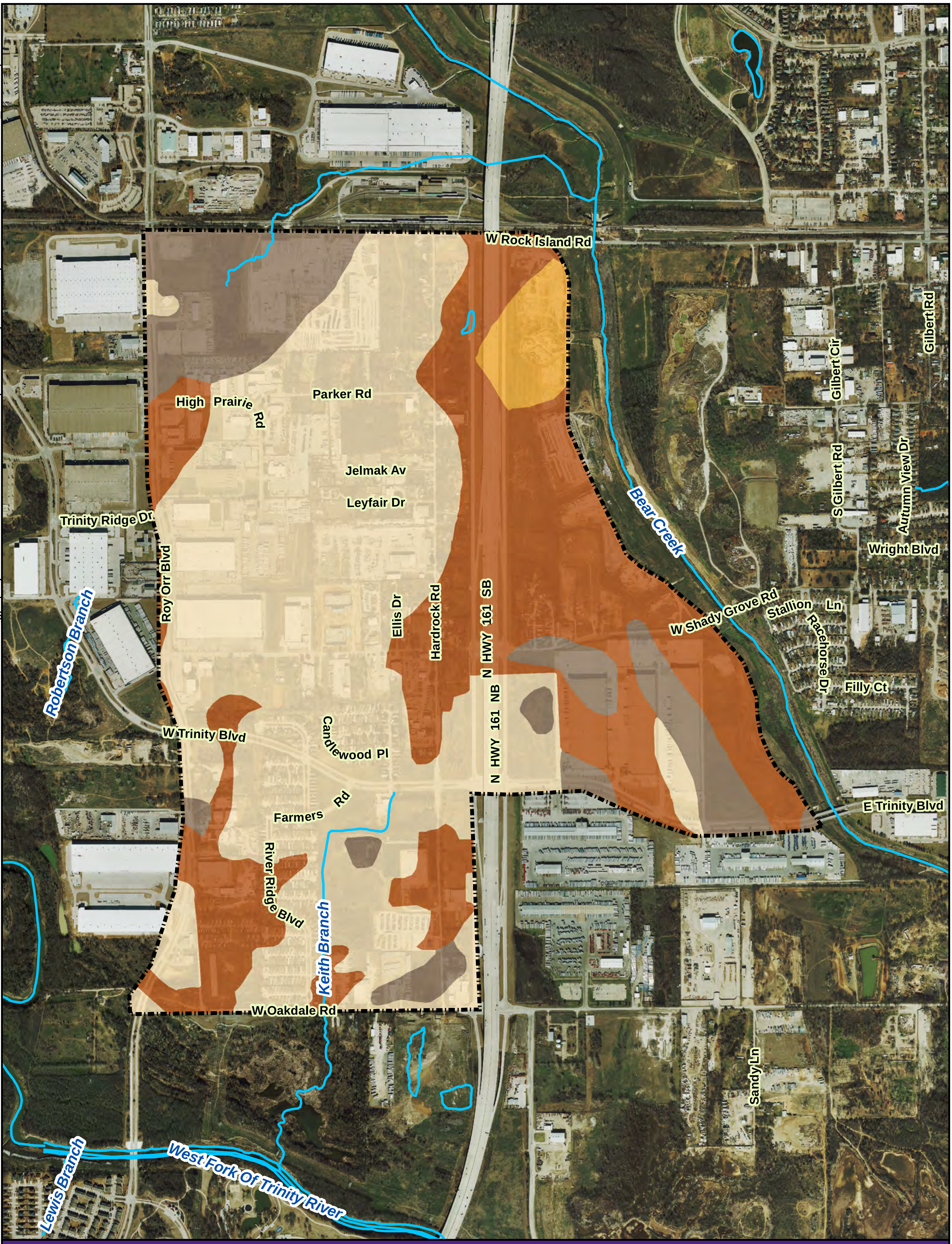

Soils Map West

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Streams
Model Boundary
Hydrologic Soil Group
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C
D

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Soils Map West

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Dec. 2017	Exhibit 3a

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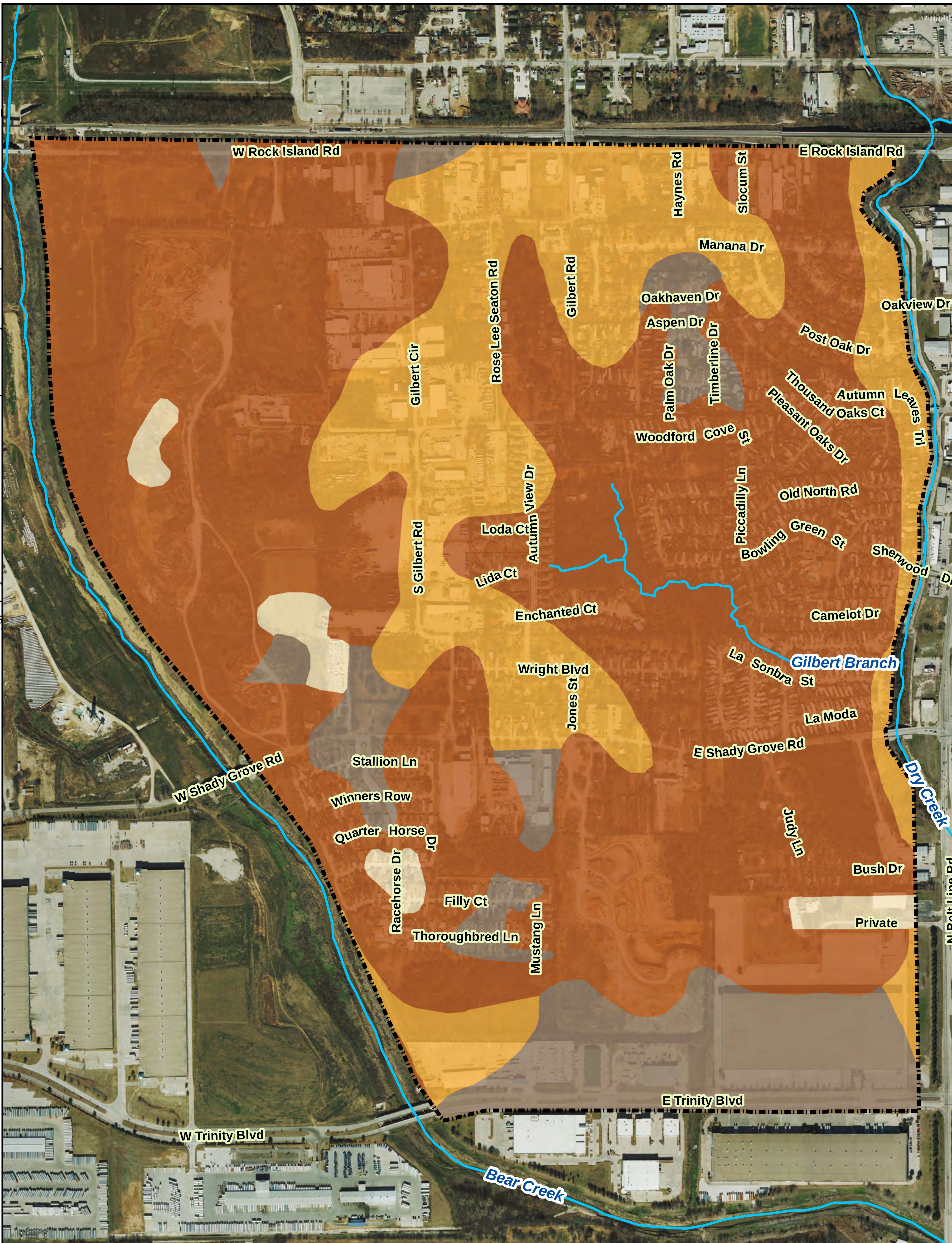

Soils Map East

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Model Boundary
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Soils Map East

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Dec. 2017	Exhibit 3b

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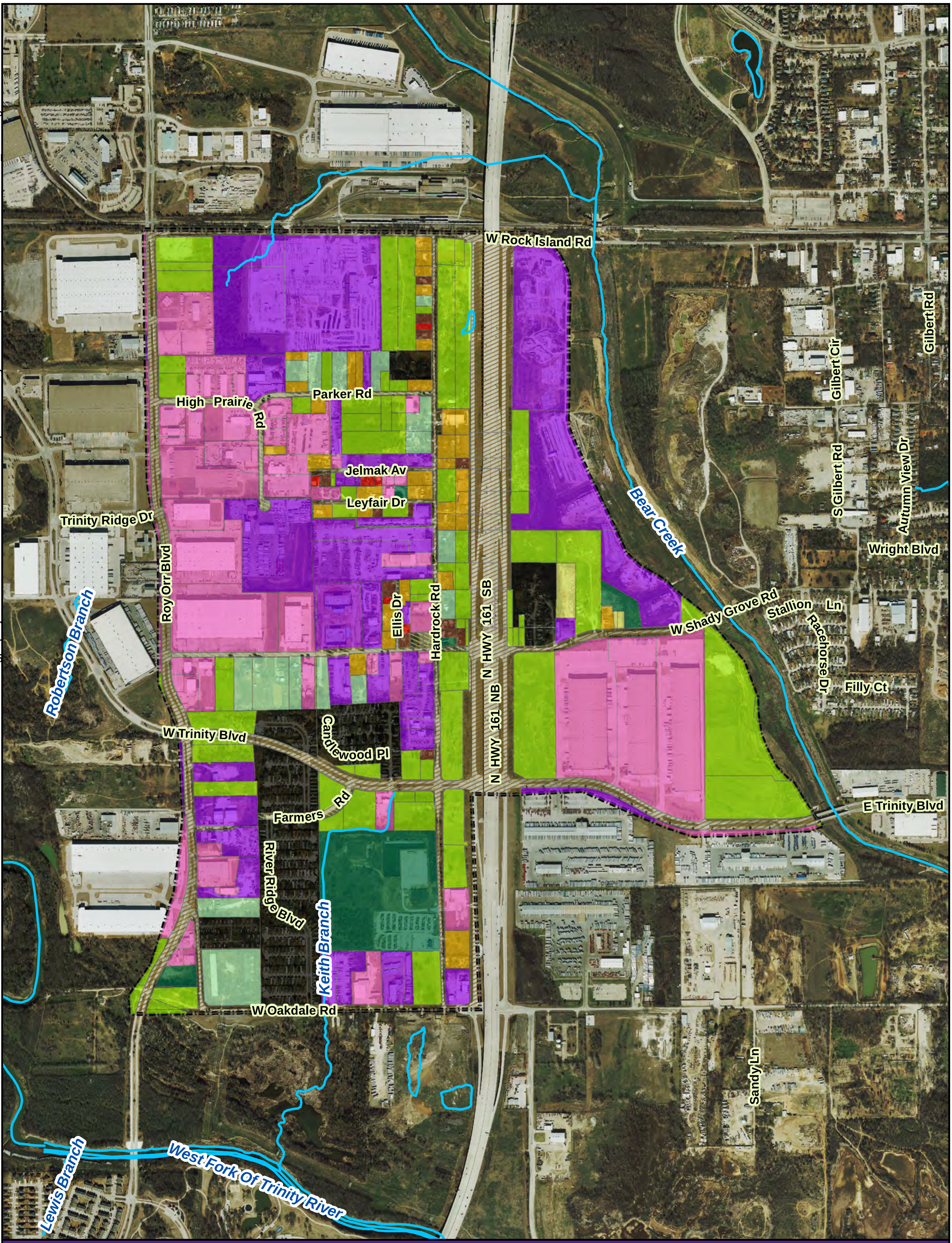

Existing Land Use Map West

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Streams

Model Boundary

Existing Land Use

- Commercial and Business
- Industrial
- Open Space Fair Condition
- Open Space Good Condition
- Open Space Poor Condition
- Residential 1 Acre
- Residential 1/2 Acre
- Residential 1/3 Acre
- Residential 1/4 Acre
- Residential 1/8 Acre
- Residential 2 Acre
- Streets and Roads, Paved, Parking Lots
- Streets and Roads, Paved, Open ditches

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Existing Land Use West

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Dec. 2017 | Exhibit 4a

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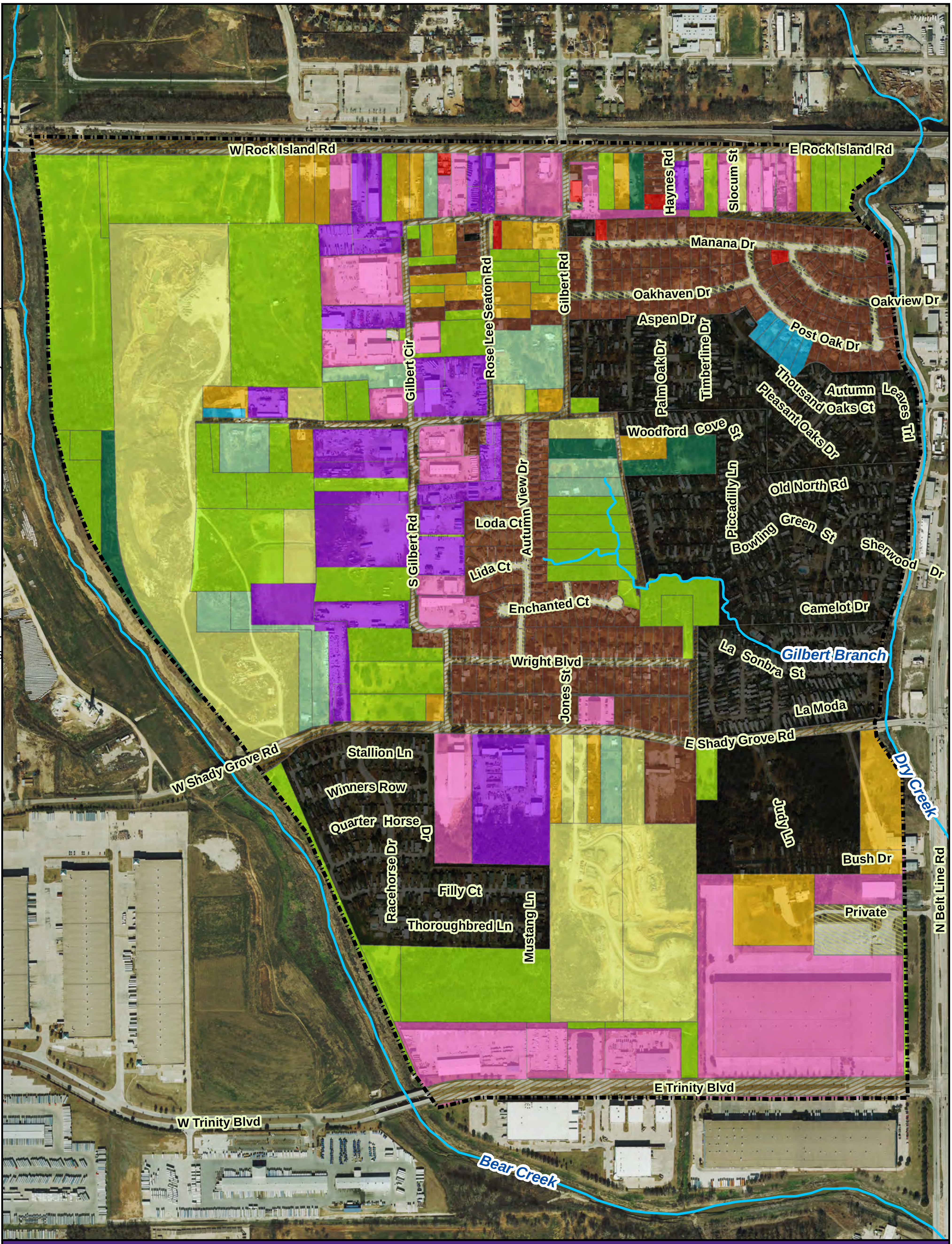

Existing Land Use Map East

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0 600 1,200

Feet

N

Streams

Model Boundary

Existing Land Use

- Commercial and Business
- Industrial
- Open Space Fair Condition
- Open Space Good Condition
- Open Space Poor Condition
- Residential 1 Acre
- Residential 1/2 Acre
- Residential 1/3 Acre
- Residential 1/4 Acre
- Residential 1/8 Acre
- Residential 2 Acre
- Streets and Roads, Paved, Parking Lots
- Streets and Roads, Paved, Open ditches

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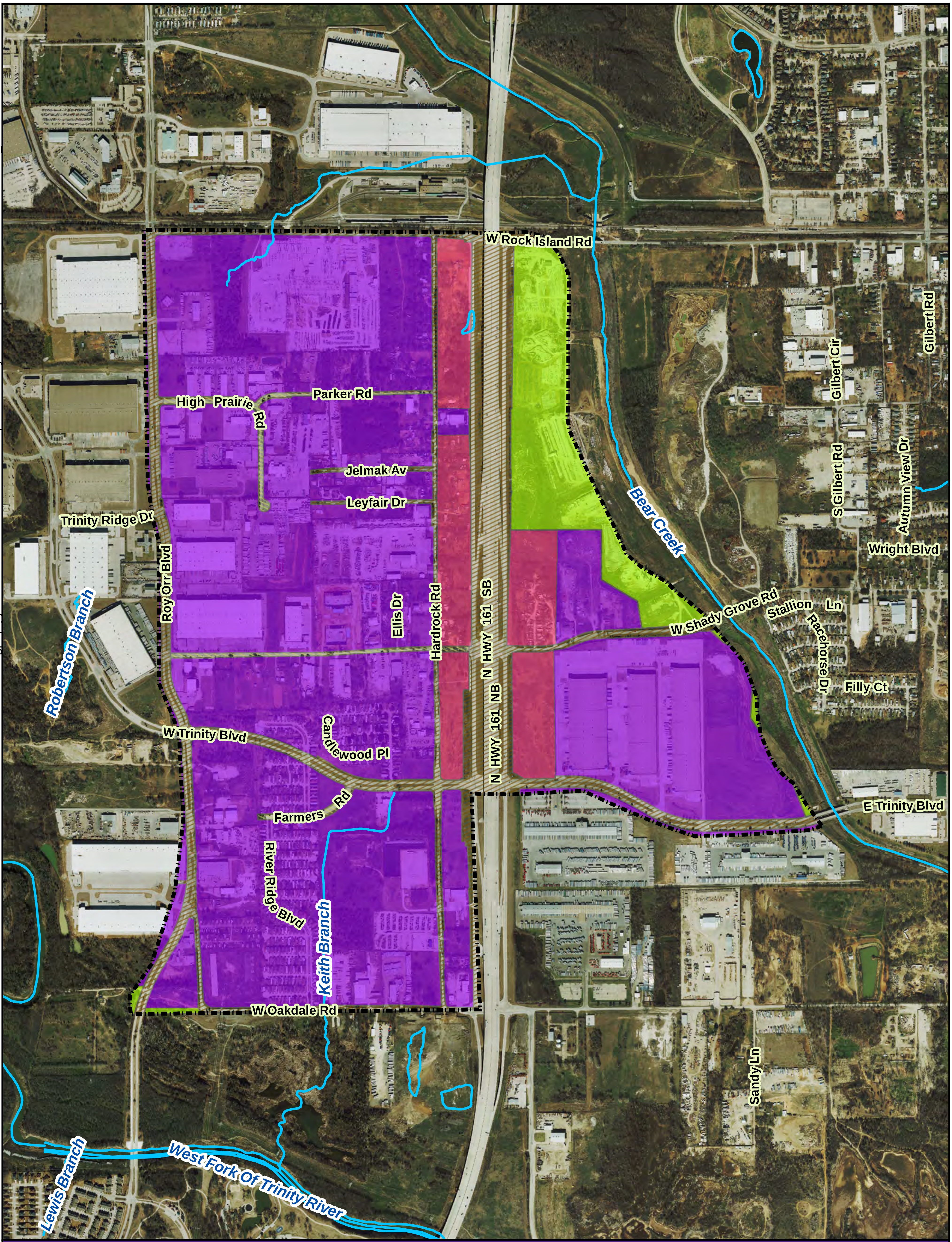
Tel: (817) 484-5695

Existing Land Use East

Prepared For: City of Grand Prairie

Dec. 2017 | Exhibit 4b

\\gpr\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit5a_FutureLandUseWest.mxd



Future Land Use Map West

Map Disclaimer: This product is for informational purposes only and is based on some unverified information provided by others. This product has not been prepared for nor is it suitable for legal, engineering, or surveying purposes. It represents only the approximate relative location of property boundaries. McKim & Creed, Inc. assumes no liability or damages due to inaccuracies, errors or

0 1,000 2,000

Feet

N

Streams

Model Boundary

Future Land Use

- COMMERCIAL/RETAIL/OFFICE
- LIGHT INDUSTRIAL
- OPEN SPACE/DRAINAGE
- HIGH DENSITY RESIDENTIAL
- LOW DENSITY RESIDENTIAL
- Streets and Roads, Paved, Parking Lots
- Streets and Roads, Paved, Open ditches

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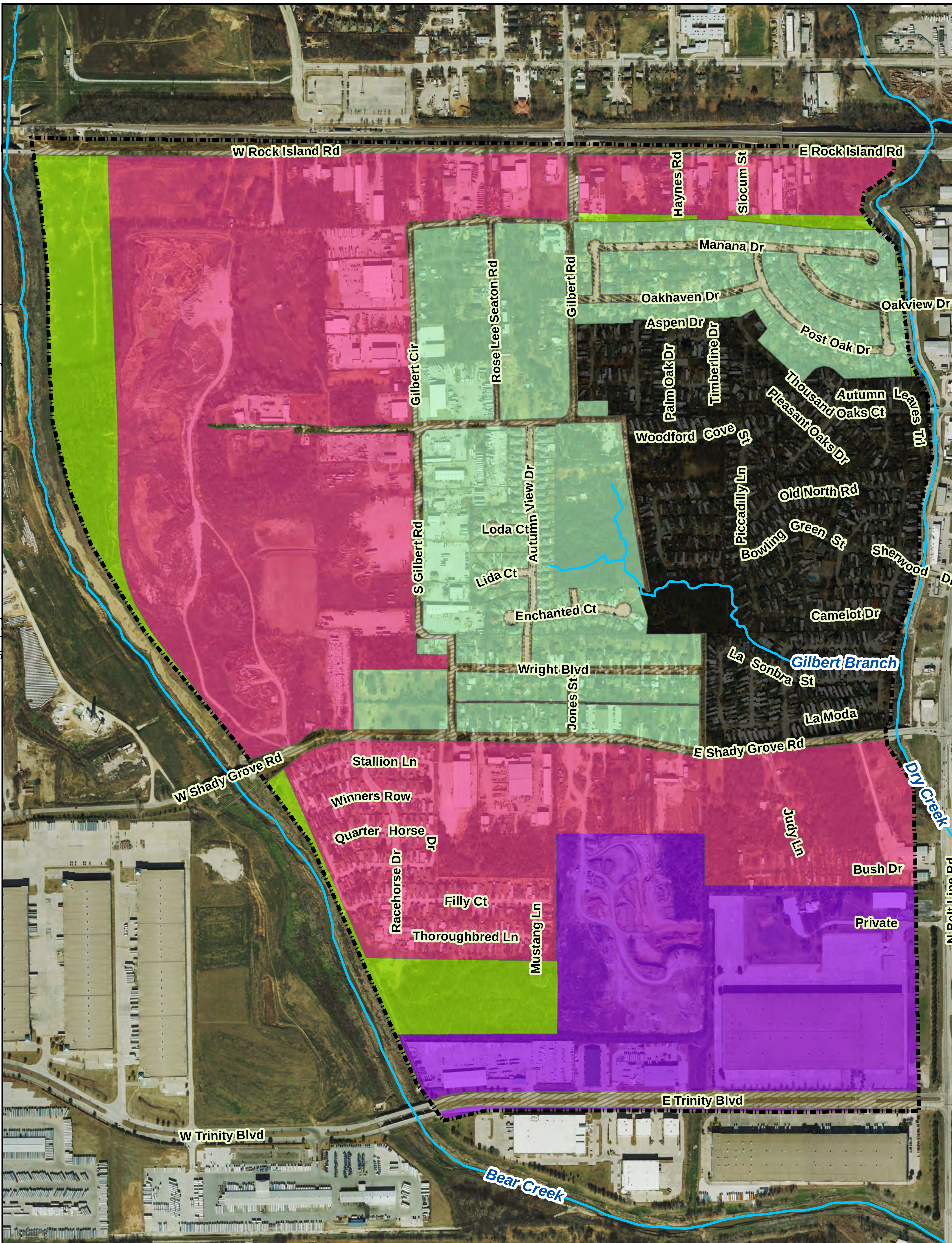
Addison, TX 75001
Tel: (817) 484-5695

Future Land Use West

Prepared For: City of Grand Prairie

Dec. 2017 | **Exhibit 5a**

\\gpr\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit5b_FutureLandUseEast.mxd



Future Land Use Map East

Map Disclaimer: This product is for informational purposes only and is based on some unverified information provided by others. This product has not been prepared for nor is it suitable for legal, engineering, or surveying purposes. It represents only the approximate relative location of property boundaries. McKim & Creed, Inc. assumes no liability or damages due to inaccuracies, errors or

0 600 1,200
Feet

N

Streams

Model Boundary

Future Land Use

- COMMERCIAL/RETAIL/OFFICE
- LIGHT INDUSTRIAL
- OPEN SPACE/DRAINAGE
- HIGH DENSITY RESIDENTIAL
- LOW DENSITY RESIDENTIAL
- Streets and Roads, Paved, Parking Lots
- Streets and Roads, Paved, Open ditches

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Future Land Use East

Prepared For: City of Grand Prairie

Dec. 2017	Exhibit 5b

- Outfall
- FloodDepth
  - HGL Below Ground
  - HGL Above Ground
- Streams
- Modeled Pipes Capacity Rating
  - <1, Capacity not exceeded and tailwater does not submerge the system
  - 1, Capacity not exceeded, but tailwater submerges system
  - 2, Capacity exceeded and tailwater submerges system
- Flow Direction
- 2D Results Line
- 2D Results Polygon
- Model Boundary
- 2D Model Depth (FT)
  - < 0.1 (not Shown)
  - 0.1 - 0.5
  - 0.5 - 1.0
  - 1.0 - 2.0
  - 2.0 - 5.0
  - > 5.0
- FEMA Flood Zone
  - A,
  - AE
  - AE, FLOODWAY

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N

0 500 1,000

Feet

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Addison, TX 75001
Tel: (817) 484-5695

Shady Grove - Existing 2Yr

Existing 2Yr	
Prepared For: City of Grand Prairie	
Dec. 2017	Exhibit 6a

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Outfall

FloodDepth

HGL Below Ground

HGL Above Ground

Streams

Modeled Pipes Capacity Rating

<1, Capacity not exceeded and tailwater does not submerge the system

1, Capacity not exceeded, but tailwater submerges system

2, Capacity exceeded and tailwater submerges system

Flow Direction

2D Results Line

2D Results Polygon

Model Boundary

2D Model Depth (FT)

< 0.1 (not Shown)

0.1 - 0.5

0.5 - 1.0

1.0 - 2.0

2.0 - 5.0

> 5.0

FEMA Flood Zone

A,

AE

AE, FLOODWAY

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N

0 500 1,000

Feet

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Tel: (817) 484-5695

Shady Grove - Existing 10Yr

Existing 10Yr

Prepared For: City of Grand Prairie

Dec. 2017 | Exhibit 6b

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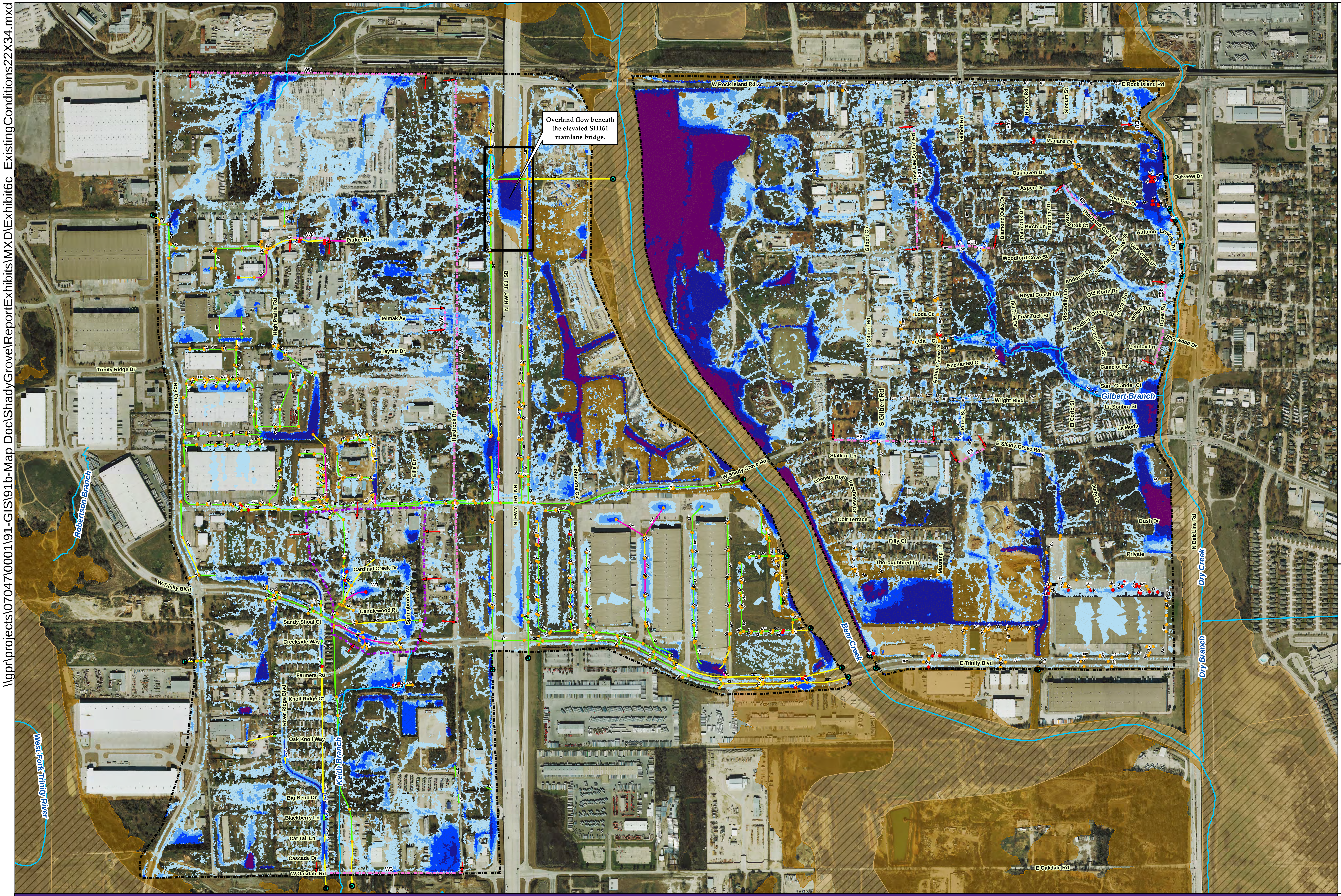

- Outfall
- FloodDepth
  - HGL Below Ground
  - HGL Above Ground
- Streams
- Modeled Pipes Capacity Rating
  - <1, Capacity not exceeded and tailwater does not submerge the system
  - 1, Capacity not exceeded, but tailwater submerges system
  - 2, Capacity exceeded and tailwater submerges system
- Flow Direction
- 2D Results Line
- 2D Results Polygon
- Model Boundary
- 2D Model Depth (FT)
  - < 0.1 (not Shown)
  - 0.1 - 0.5
  - 0.5 - 1.0
  - 1.0 - 2.0
  - 2.0 - 5.0
  - > 5.0
- FEMA Flood Zone
  - A,
  - AE
  - AE, FLOODWAY

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N

0 500 1,000

Feet

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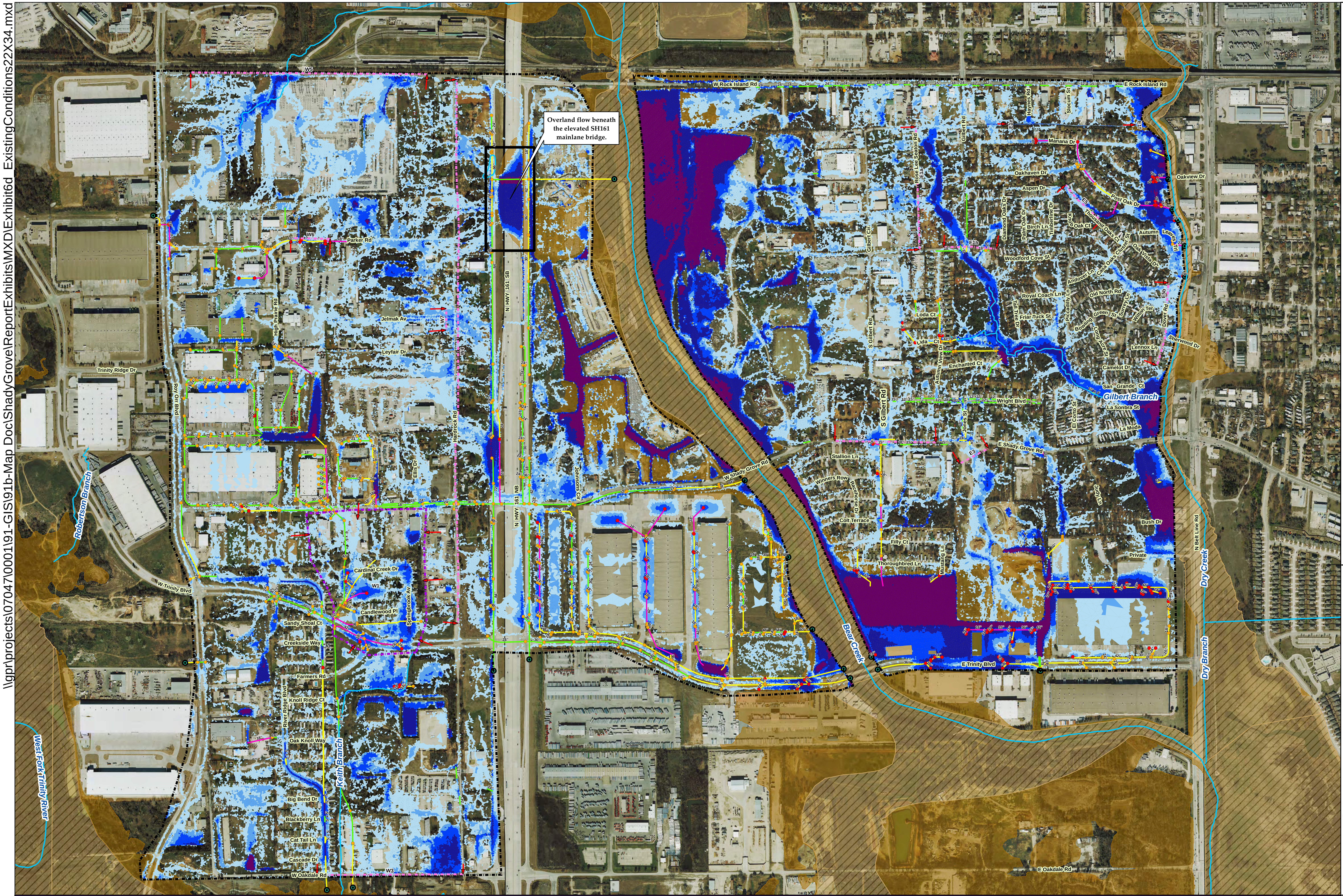
Shady Grove - Existing 25Yr

Existing 25Yr

Prepared For:
City of Grand Prairie

Dec. 2017 | Exhibit 6c

\\gprl\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit6d_ExistingConditions22x34.mxd



Outfall

FloodDepth

HGL Below Ground

HGL Above Ground

Streams

Modeled Pipes Capacity Rating

<1, Capacity not exceeded and tailwater does not submerge the system

1, Capacity not exceeded, but tailwater submerges system

2, Capacity exceeded and tailwater submerges system

Flow Direction

2D Results Line

2D Results Polygon

Model Boundary

2D Model Depth (FT)

< 0.1 (not Shown)

0.1 - 0.5

0.5 - 1.0

1.0 - 2.0

2.0 - 5.0

> 5.0

FEMA Flood Zone

A,

AE

AE, FLOODWAY

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N

0 500 1,000

Feet

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Addison, TX 75001

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Shady Grove - Existing 100Yr

Existing 100Yr

Prepared For: City of Grand Prairie

Dec. 2017 | Exhibit 6d

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Outfall

FloodDepth

HGL Below Ground

HGL Above Ground

Streams

Modeled Pipes Capacity Rating

<1, Capacity not exceeded and tailwater does not submerge the system

1, Capacity not exceeded, but tailwater submerges system

2, Capacity exceeded and tailwater submerges system

Flow Direction

2D Results Line

2D Results Polygon

Model Boundary

2D Model Depth (FT)

< 0.1 (not Shown)

0.1 - 0.5

0.5 - 1.0

1.0 - 2.0

2.0 - 5.0

> 5.0

FEMA Flood Zone

A,

AE

AE, FLOODWAY

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N

0 500 1,000

Feet

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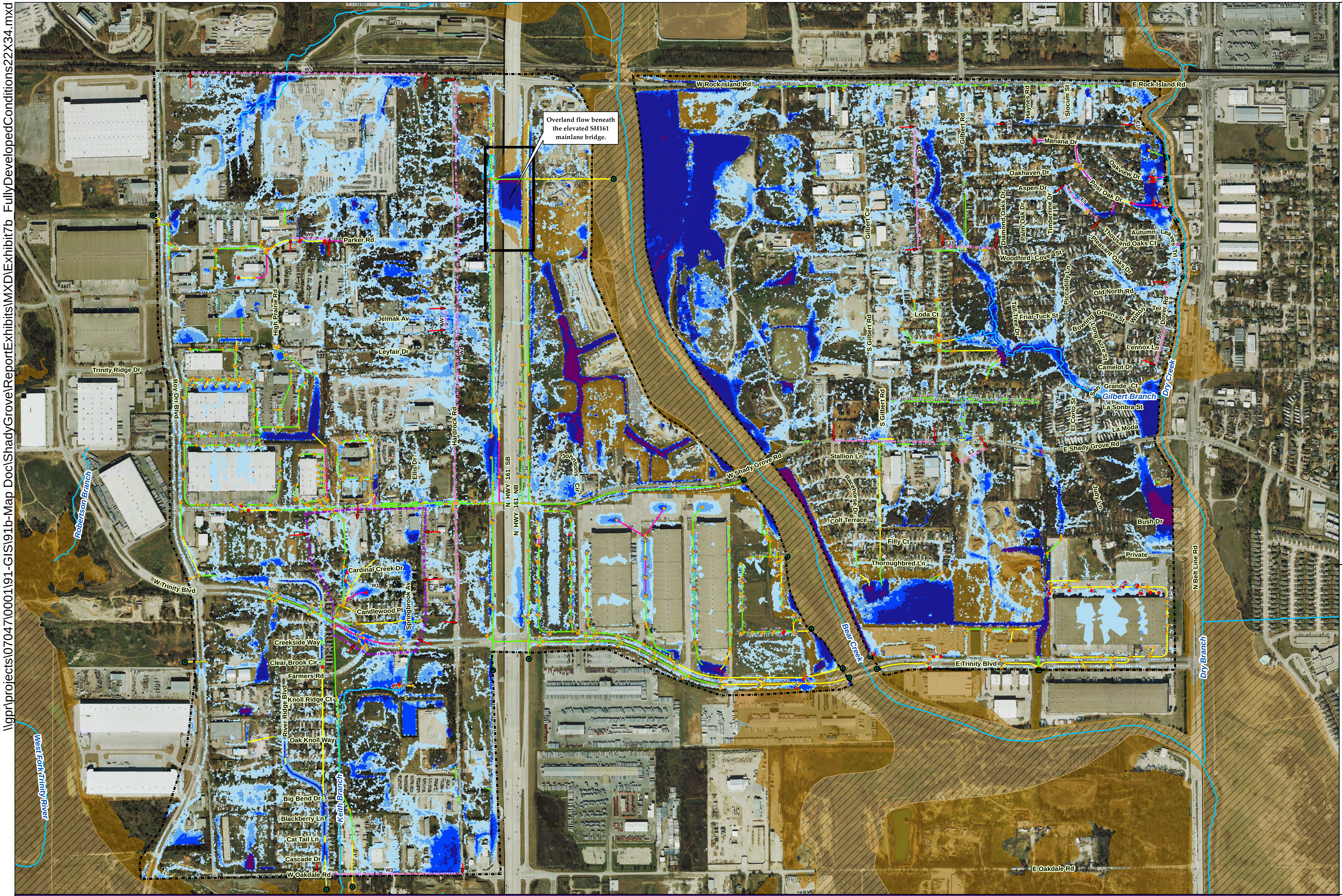
Shady Grove - Fully Developed 2Yr

Fully Developed 2Yr

Prepared For: City of Grand Prairie

Dec. 2017 | Exhibit 7a

\\gpr\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit7b_FullyDevelopedConditions22x34.mxd



Outfall

FloodDepth

HGL Below Ground

HGL Above Ground

Streams

Modeled Pipes Capacity Rating

<1, Capacity not exceeded and tailwater does not submerge the system

1, Capacity not exceeded, but tailwater submerges system

2, Capacity exceeded and tailwater submerges system

Flow Direction

2D Results Line

2D Results Polygon

Model Boundary

2D Model Depth (FT)

< 0.1 (not Shown)

0.1 - 0.5

0.5 - 1.0

1.0 - 2.0

2.0 - 5.0

> 5.0

FEMA Flood Zone

A,

AE

AE, FLOODWAY

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N

0 500 1,000

Feet

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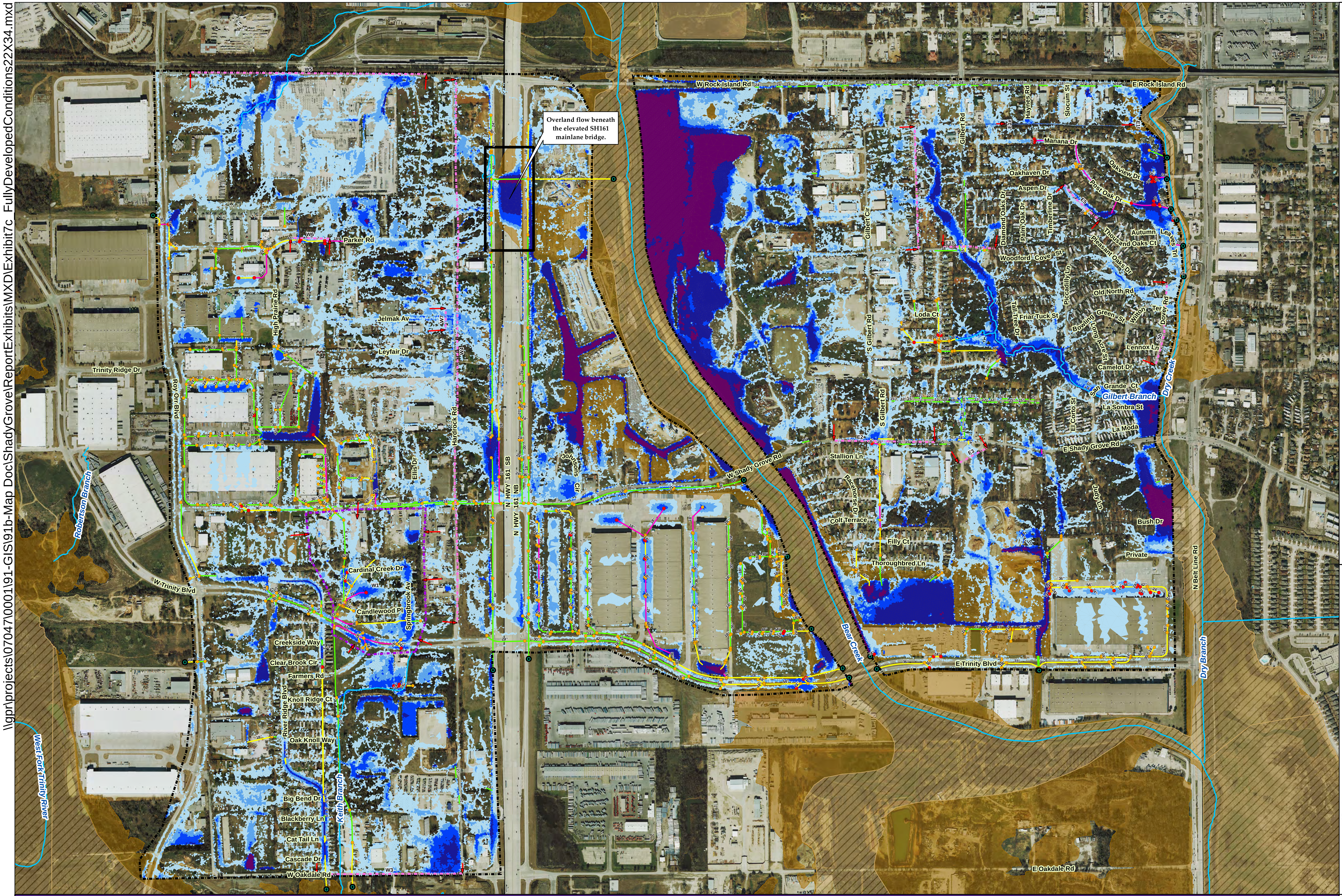
Shady Grove - Fully Developed 10Yr

Fully Developed 10Yr

Prepared For: City of Grand Prairie

Dec. 2017 | Exhibit 7b

\\gpr\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit7c_FullyDevelopedConditions22x34.mxd



Outfall

FloodDepth

HGL Below Ground

HGL Above Ground

Streams

Modeled Pipes Capacity Rating

<1, Capacity not exceeded and tailwater does not submerge the system

1, Capacity not exceeded, but tailwater submerges system

2, Capacity exceeded and tailwater submerges system

Flow Direction

2D Results Line

2D Results Polygon

Model Boundary

2D Model Depth (FT)

< 0.1 (not Shown)

0.1 - 0.5

0.5 - 1.0

1.0 - 2.0

2.0 - 5.0

> 5.0

FEMA Flood Zone

A,

AE

AE, FLOODWAY

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N

0 500 1,000

Feet

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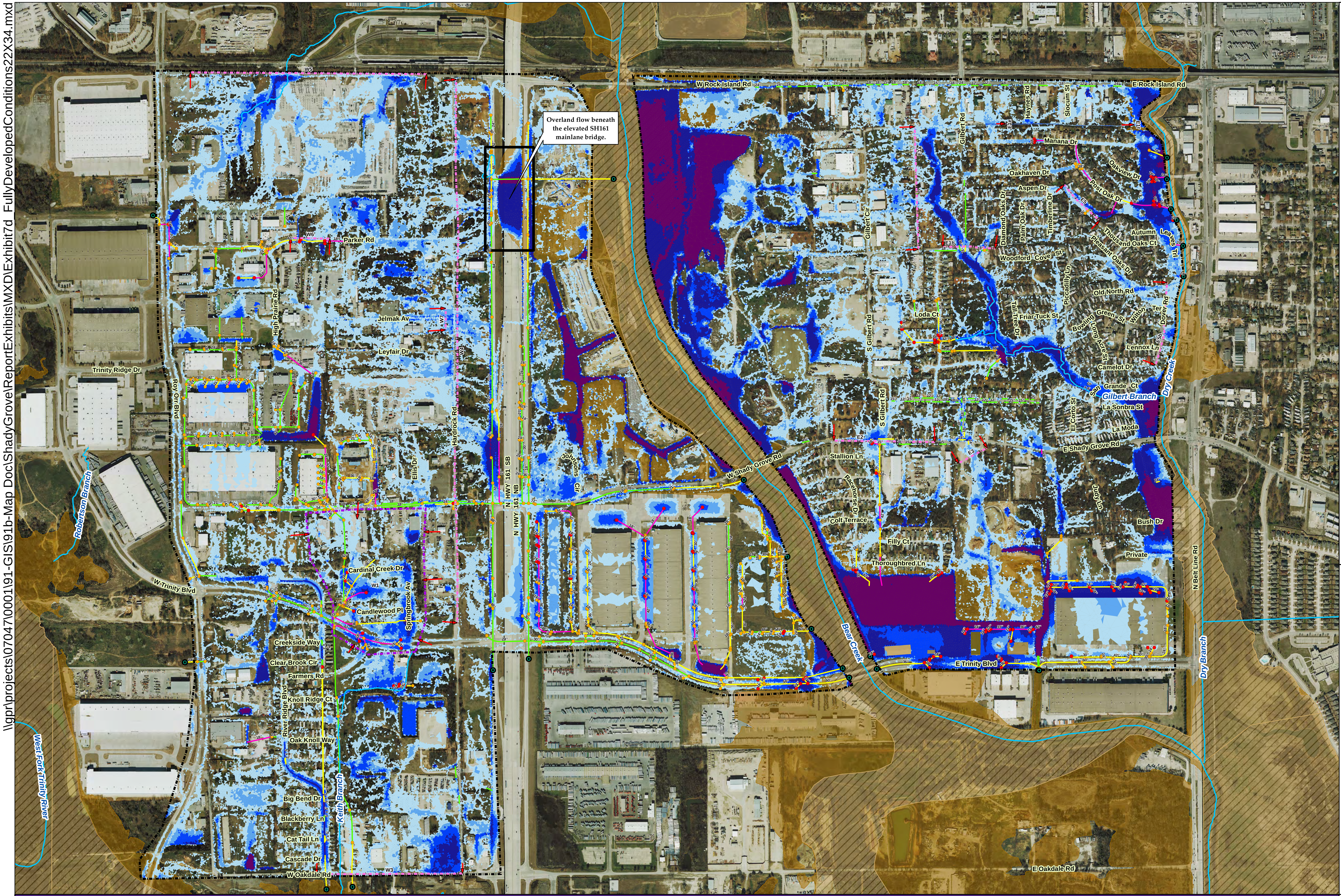
Shady Grove - Fully Developed 25Yr

Fully Developed 25Yr

Prepared For:
City of Grand Prairie

Dec. 2017 | Exhibit 7c



Outfall

FloodDepth

HGL Below Ground

HGL Above Ground

Streams

Modeled Pipes Capacity Rating

<1, Capacity not exceeded and tailwater does not submerge the system

1, Capacity not exceeded, but tailwater submerges system

2, Capacity exceeded and tailwater submerges system

Flow Direction

2D Results Line

2D Results Polygon

Model Boundary

2D Model Depth (FT)

< 0.1 (not Shown)

0.1 - 0.5

0.5 - 1.0

1.0 - 2.0

2.0 - 5.0

> 5.0

FEMA Flood Zone

A,

AE

AE, FLOODWAY

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N

0 500 1,000

Feet

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Fully Developed 100Yr

Prepared For:
City of Grand Prairie

Dec. 2017 | Exhibit 7d

Shady Grove - Fully Developed 100Yr

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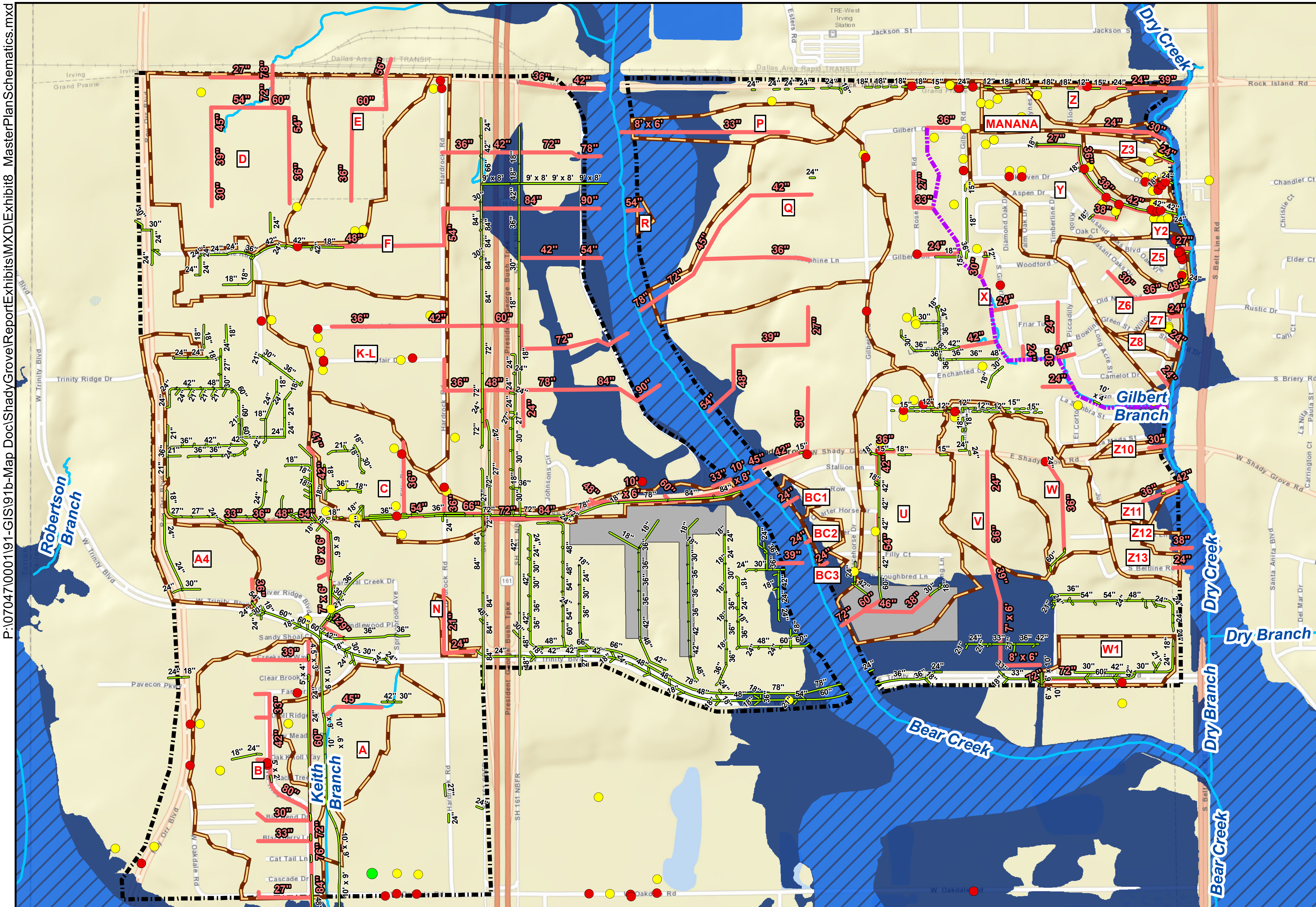

Complaints from KEF MP
Other Drainage Complaints
Flooded Structures 7-8-2015
Flooded Structure Due to Private Drainage
Flooded Structure Due to Public Drainage
Streams
Existing Storm Drain Pipe
KEF Master Plan Recommendations
Channel Improvements
Pipe Improvements
Master Plan Basins
Model Boundary
Existing Detention Basin
FEMA Flood Zone
A,
AE
AE, FLOODWAY

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N

0 1,000 2,000
Feet

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Addison, TX 75001
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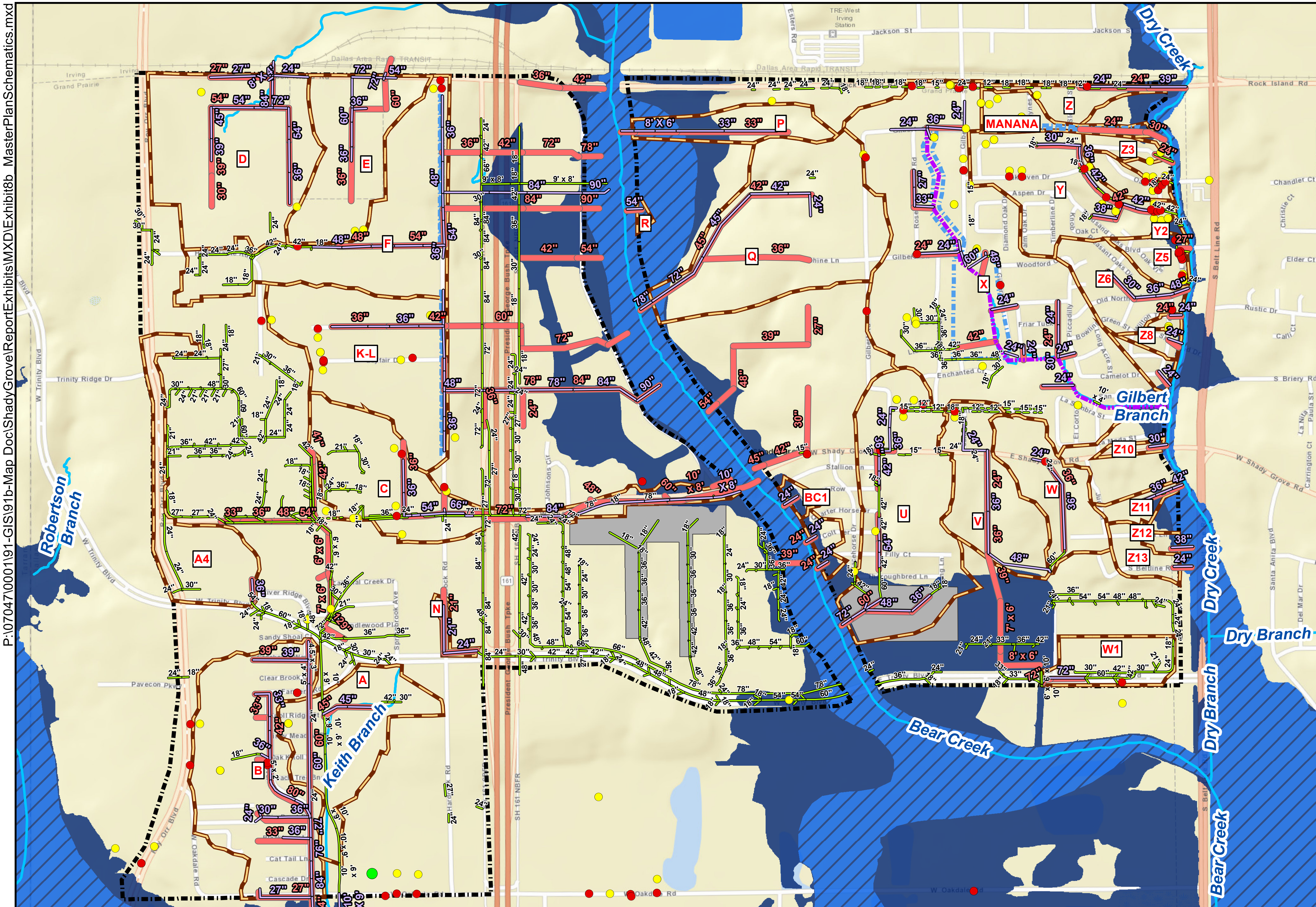
2003 KEF Master Plan Recommendations + Existing Network

2003 KEF Master Plan Updates

Prepared For:
City of Grand Prairie

Jan. 2018 | Exhibit 8a

P:\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit8b_MasterPlanSchematics.mxd



- Complaints from KEF MP
- Other Drainage Complaints

Flooded Structures 7-8-2015

- Flooded Structure Due to Private Drainage
- Flooded Structure Due to Public Drainage
- Streams

KEF Master Plan Recommendations

- Channel Improvements
- Pipe Improvements

Final Modeled Network Pipes

- Existing Pipe
- Proposed Pipe for Evaluation
- Potential Detention Areas
- Master Plan Basins
- Model Boundary
- Existing Detention Basin

FEMA Flood Zone

- A,
- AE
- AE, FLOODWAY

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N

0 1,000 2,000

Feet

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Addison, TX 75001

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2003 KEF Master Plan Recommendations vs. Final Proposed Pipes

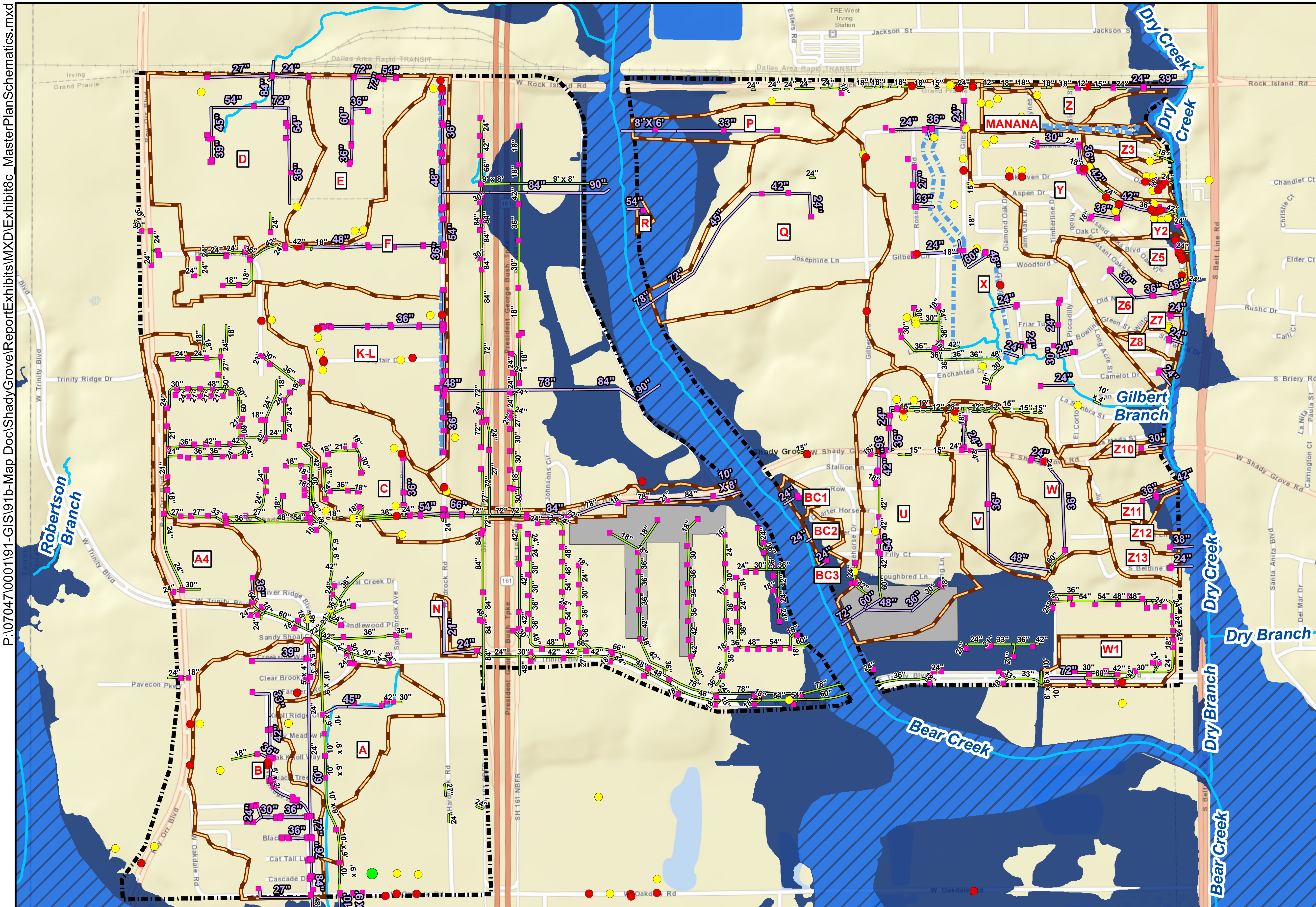
2003 KEF Master Plan Updates

Prepared For:
City of Grand Prairie

Jan. 2018

Exhibit 8b

P:\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit8c_MasterPlanSchematics.mxd



- Complaints from KEF MP
- Other Drainage Complaints

Flooded Structures 7-8-2015

- Flooded Structure Due to Private Drainage
- Flooded Structure Due to Public Drainage
- Inlets
- Streams

Final Modeled Network Pipes

- Existing Pipe
- Proposed Pipe for Evaluation
- Potential Detention Areas
- Master Plan Basins
- Model Boundary
- Existing Detention Basin

FEMA Flood Zone

- A,
- AE
- AE, FLOODWAY

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N

0 1,000 2,000
Feet

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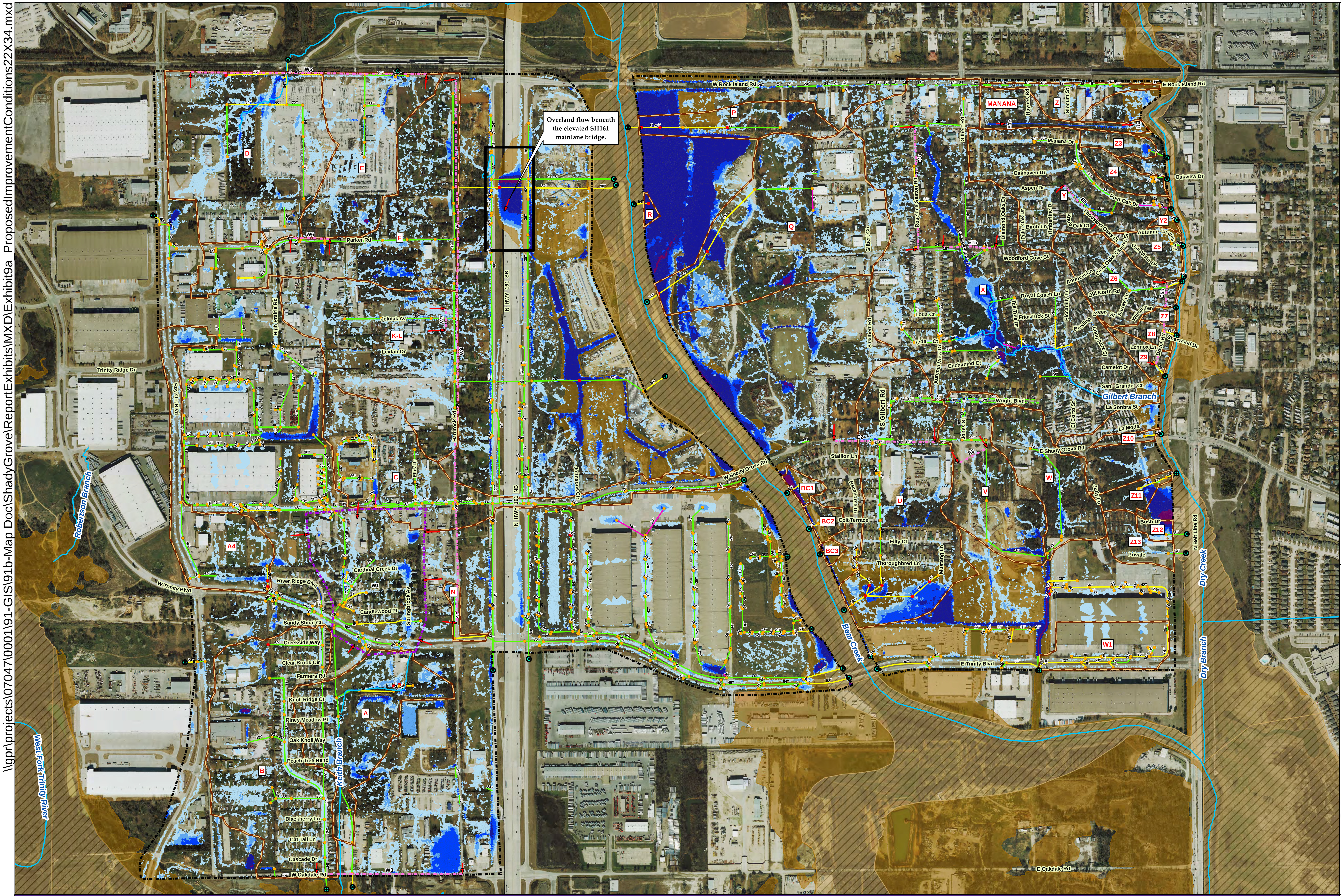
Final Proposed Pipes for Evaluation

2003 KEF Master Plan Updates

Prepared For:
City of Grand Prairie

Jan. 2018	Exhibit 8c



Outfall

FloodDepth

HGL Below Ground

HGL Above Ground

Streams

Modeled Pipes Capacity Rating

<1, Capacity not exceeded and tailwater does not submerge the system

1, Capacity not exceeded, but tailwater submerges system

2, Capacity exceeded and tailwater submerges system

Flow Direction

2D Results Line

2D Results Polygon

Basin

Model Boundary

2D Model Depth (FT)

< 0.1 (not Shown)

0.1 - 0.5

0.5 - 1.0

1.0 - 2.0

2.0 - 5.0

> 5.0

FEMA Flood Zone

A,

AE

AE, FLOODWAY

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N

0 500 1,000

Feet

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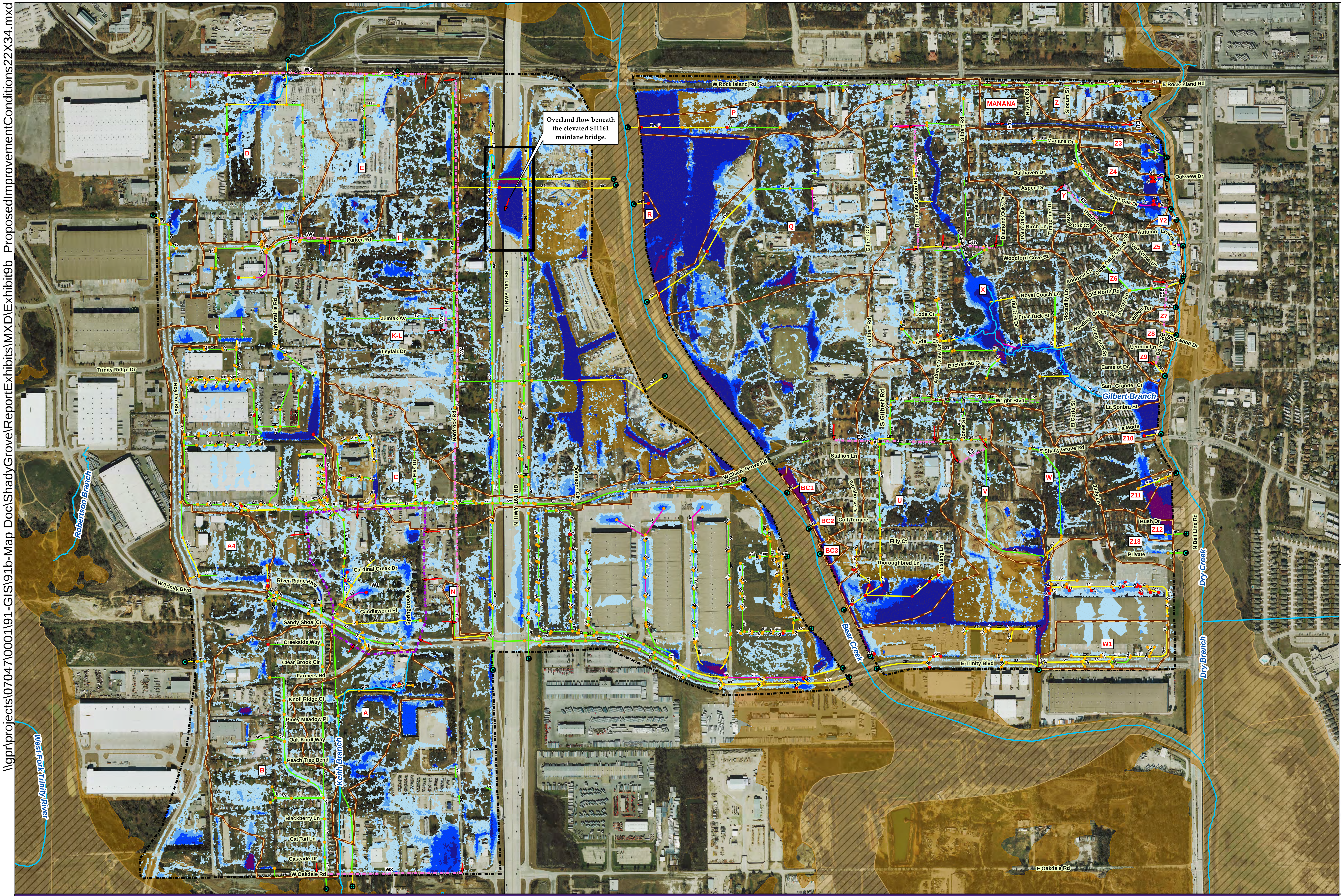
Shady Grove - Proposed Master Plan 2Yr Results

Proposed 2Yr Results

Prepared For:
City of Grand Prairie

Jan. 2018 | Exhibit 9a

\\gpr\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit9b_ProposedImprovementConditions22X34.mxd



Outfall

FloodDepth

HGL Below Ground

HGL Above Ground

Streams

Modeled Pipes Capacity Rating

<1, Capacity not exceeded and tailwater does not submerge the system

1, Capacity not exceeded, but tailwater submerges system

2, Capacity exceeded and tailwater submerges system

Flow Direction

2D Results Line

2D Results Polygon

Basin

Model Boundary

2D Model Depth (FT)

< 0.1 (not Shown)

0.1 - 0.5

0.5 - 1.0

1.0 - 2.0

2.0 - 5.0

> 5.0

FEMA Flood Zone

A,

AE

AE, FLOODWAY

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N

0 500 1,000

Feet

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Tel: (817) 484-5695

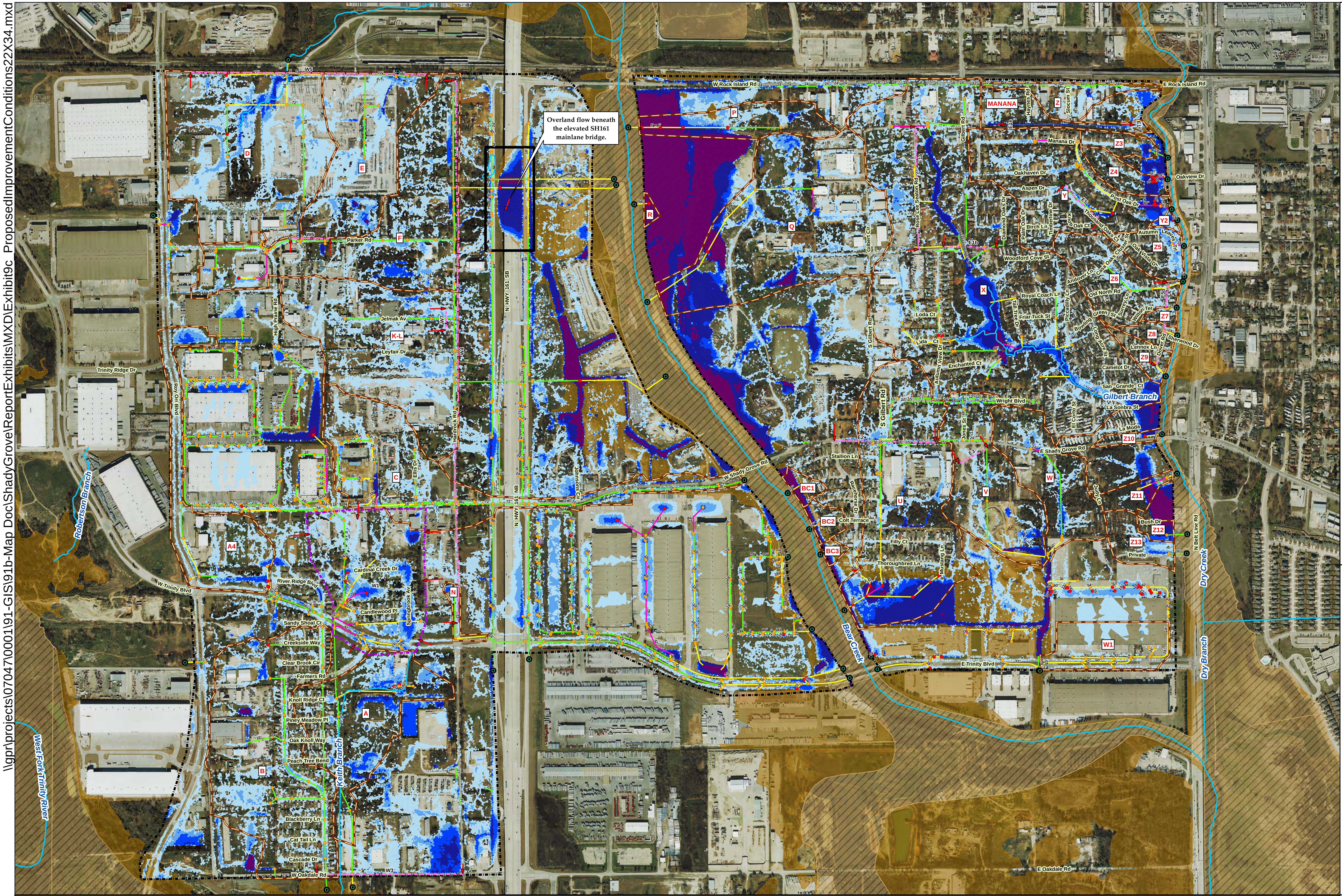
Shady Grove - Proposed Master Plan 10Yr Results

Proposed 10Yr Results

Prepared For:
City of Grand Prairie

Jan. 2018 | Exhibit 9b

\\gprh\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit9c_ProposedImprovementConditions22X34.mxd



Outfall

FloodDepth

- HGL Below Ground
- HGL Above Ground

Streams

Modeled Pipes Capacity Rating

- <1, Capacity not exceeded and tailwater does not submerge the system
- 1, Capacity not exceeded, but tailwater submerges system
- 2, Capacity exceeded and tailwater submerges system

Flow Direction

2D Results Line

2D Results Polygon

Basin

Model Boundary

2D Model Depth (FT)

- < 0.1 (not Shown)
- 0.1 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 5.0
- > 5.0

FEMA Flood Zone

- A,
- AE
- AE, FLOODWAY

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N

0 500 1,000

Feet

McKIM&CREED

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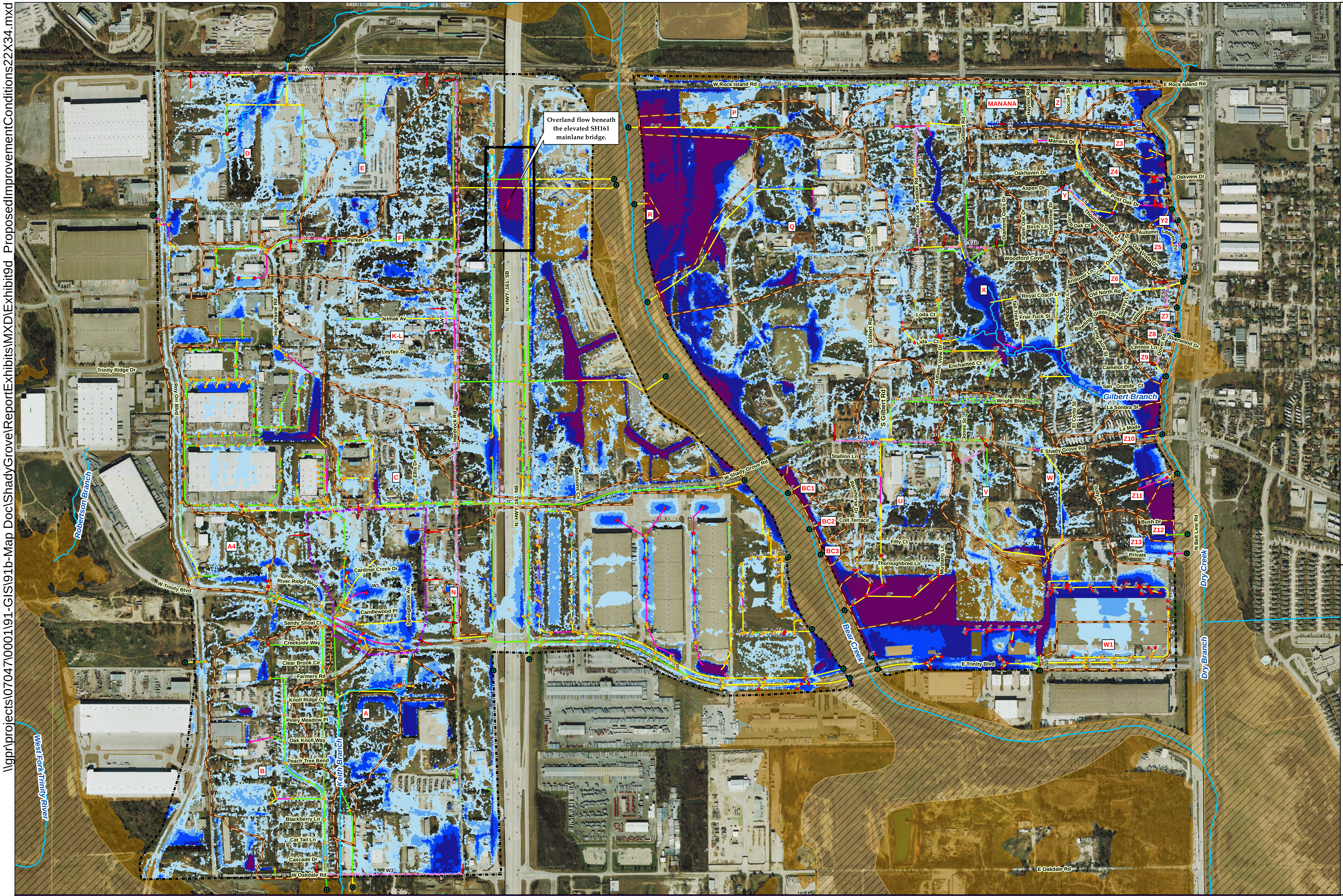
Addison, TX 75001
Tel: (817) 484-5695

Shady Grove - Proposed Master Plan 25Yr Results

Proposed 25Yr Results

Prepared For:
City of Grand Prairie

Jan. 2018 | Exhibit 9b



\\gph\projects\07047\0001\91-GIS\91b-Map Docs\ShadyGrove\ReportExhibits\MXD\Exhibit9d_ProposedImprovementConditions22x34.mxd

- Outfall
- FloodDepth
  - HGL Below Ground
  - HGL Above Ground
- Streams
- Modeled Pipes Capacity Rating
  - <1, Capacity not exceeded and tailwater does not submerge the system
  - 1, Capacity not exceeded, but tailwater submerges system
  - 2, Capacity exceeded and tailwater submerges system
- Flow Direction
- 2D Results Line
- 2D Results Polygon
- Basin
- Model Boundary
- 2D Model Depth (FT)
  - < 0.1 (not Shown)
  - 0.1 - 0.5
  - 0.5 - 1.0
  - 1.0 - 2.0
  - 2.0 - 5.0
  - > 5.0
- FEMA Flood Zone
  - A,
  - AE
  - AE, FLOODWAY

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N

0 500 1,000
Feet

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Shady Grove - Proposed Master Plan 100Yr Results

Proposed 100Yr Results

Prepared For:
City of Grand Prairie

Jan. 2018 | Exhibit 9d

Outfall

Pipe Nodes

HGL Below Ground

HGL Above Ground

Streams

Modeled Pipes Capacity Rating

<1, Capacity not exceeded and tailwater does not submerge the system

1, Capacity not exceeded, but tailwater submerges system

2, Capacity exceeded and tailwater submerges system

Flow Direction

2D Results Line

2D Results Polygon

Basins

EX 2D Depths > 0.5'

PROP 2D Depths > 0.5'

Buildings Removed from Flooding > 0.5'

NO

YES

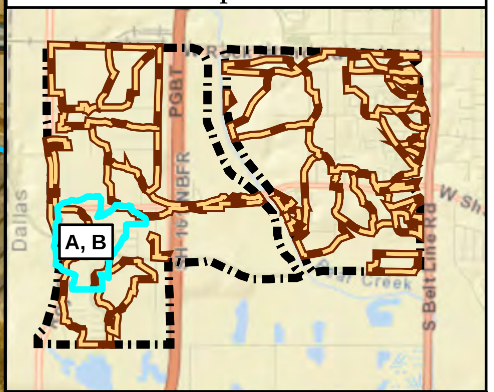
FEMA Flood Zone

A,

AE

AE, FLOODWAY

Index map not to scale.



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N

0 1,000 2,000

Feet

Proposed 2YR Results Comparison: A, B

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Prop 2YR Comparison

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Jan. 2018 | Exhibit 10Wa - 1

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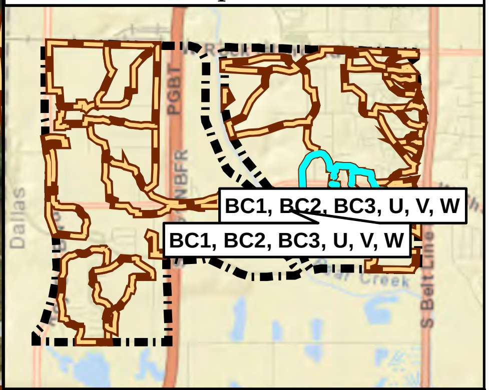
- Outfall
- Pipe Nodes
  - HGL Below Ground
  - HGL Above Ground
- Streams
- Modeled Pipes Capacity Rating
  - <1, Capacity not exceeded and tailwater does not submerge the system
  - 1, Capacity not exceeded, but tailwater submerges system
  - 2, Capacity exceeded and tailwater submerges system
- Flow Direction
- 2D Results Line
- 2D Results Polygon
- Basins
- EX 2D Depths > 0.5'
- PROP 2D Depths > 0.5'
- Buildings Removed from Flooding > 0.5'
  - NO
  - YES
- FEMA Flood Zone
  - A,
  - AE
  - AE, FLOODWAY

Index map not to scale.



N

0 300 600
Feet

Proposed 2YR Results Comparison: BC1, BC2, BC3, U, V, W

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Prop 2YR Comparison

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Jan. 2018 | Exhibit 10Ea - 2

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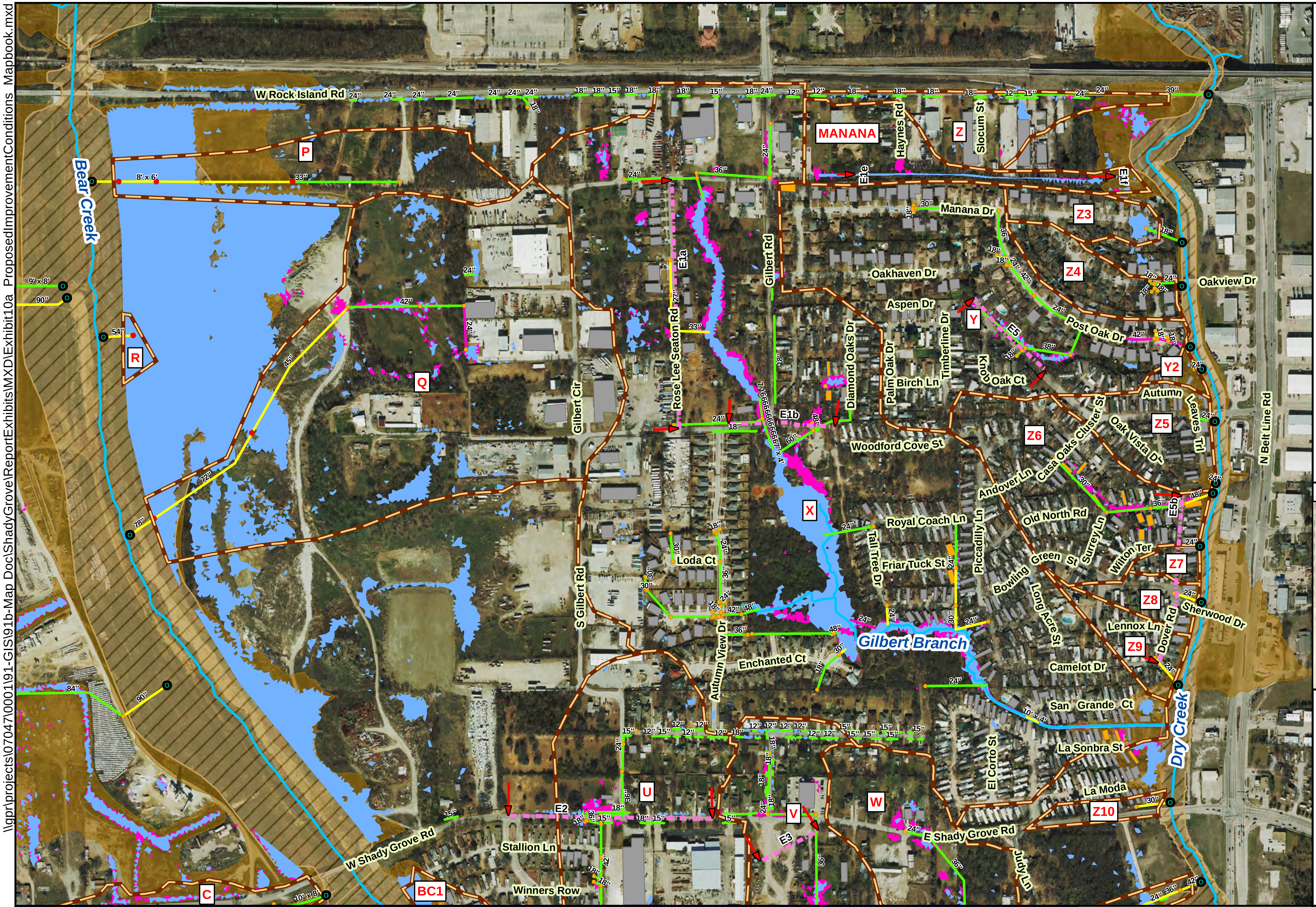
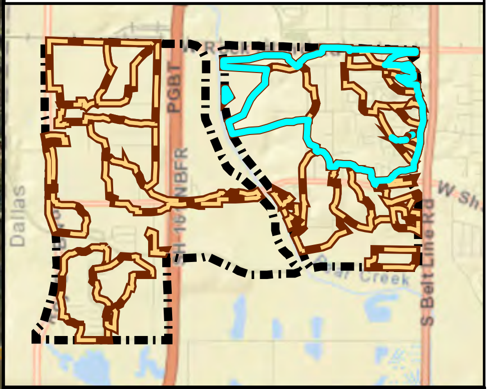


- Outfall
- Pipe Nodes
  - HGL Below Ground
  - HGL Above Ground
- Streams
- Modeled Pipes Capacity Rating
  - <1, Capacity not exceeded and tailwater does not submerge the system
  - 1, Capacity not exceeded, but tailwater submerges system
  - 2, Capacity exceeded and tailwater submerges system
- Flow Direction
- 2D Results Line
- 2D Results Polygon
- Basins
- EX 2D Depths > 0.5'
- PROP 2D Depths > 0.5'
- Buildings Removed from Flooding > 0.5'
  - NO
  - YES
- FEMA Flood Zone
  - A,
  - AE
  - AE, FLOODWAY

Index map not to scale.



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N

0 500 1,000
Feet

Proposed 2YR Results Comparison: MANANA, P, Q, R, X, Y, Y2, Z, Z3, Z4, Z5, Z6, Z7, Z8, Z9

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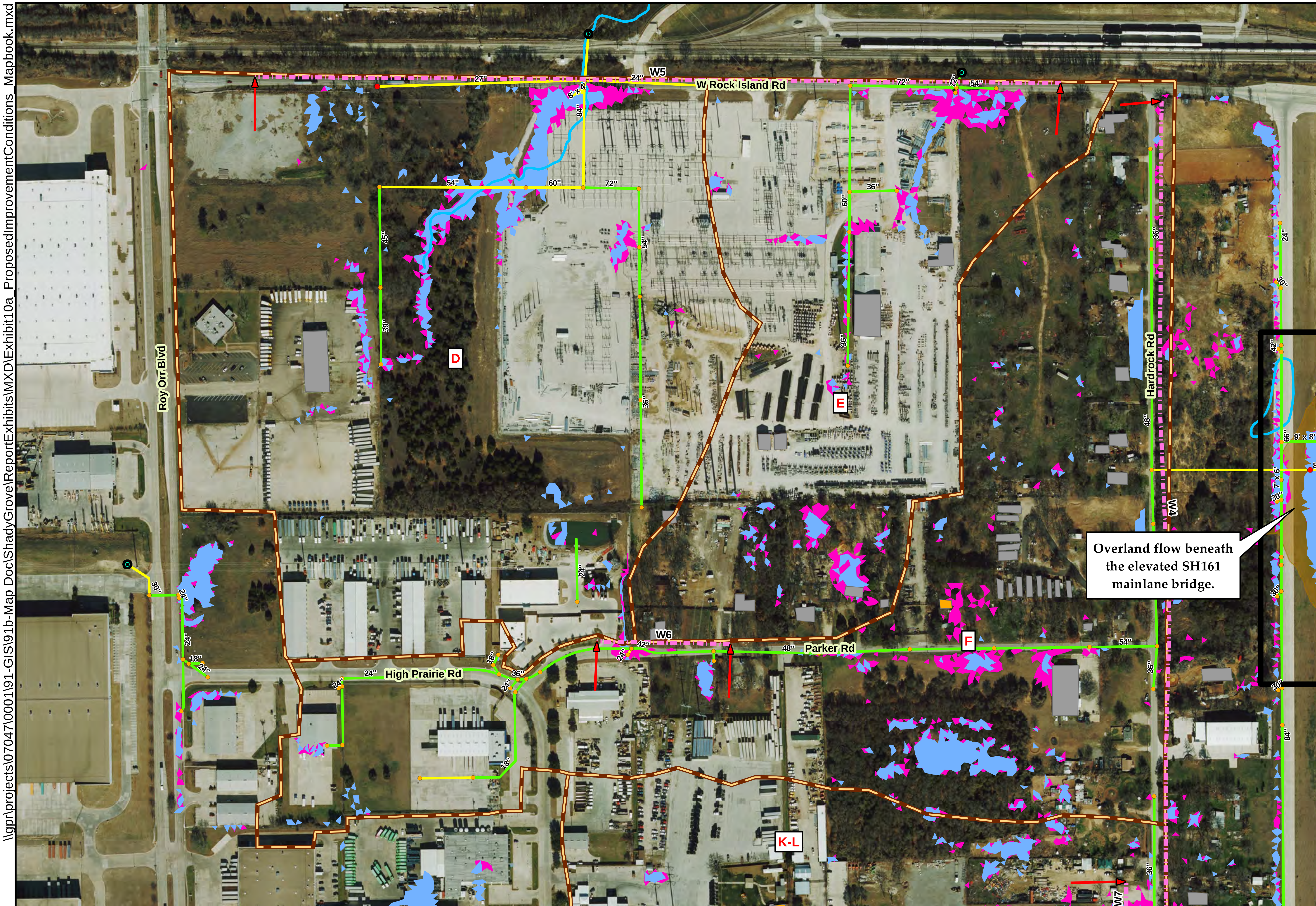
Prop 2YR Comparison

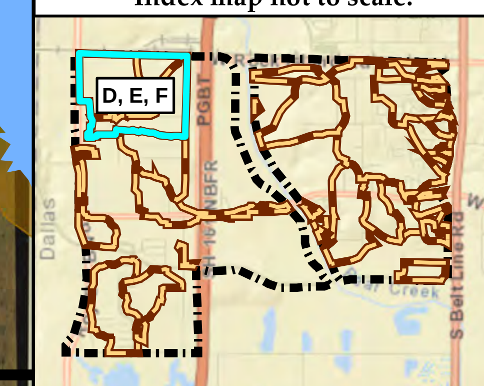
Prepared For: City of Grand Prairie

Jan. 2018 | Exhibit 10Ea - 3



Outfall
Pipe Nodes
HGL Below Ground
HGL Above Ground
Streams
Modeled Pipes Capacity Rating
<1, Capacity not exceeded and tailwater does not submerge the system
1, Capacity not exceeded, but tailwater submerges system
2, Capacity exceeded and tailwater submerges system
Flow Direction
2D Results Line
2D Results Polygon
Basins
EX 2D Depths > 0.5'
PROP 2D Depths > 0.5'
Buildings Removed from Flooding > 0.5'
NO
YES
FEMA Flood Zone
A,
AE
AE, FLOODWAY

Index map not to scale.



N

0 300 600
Feet

Proposed 2YR Results Comparison: D, E, F

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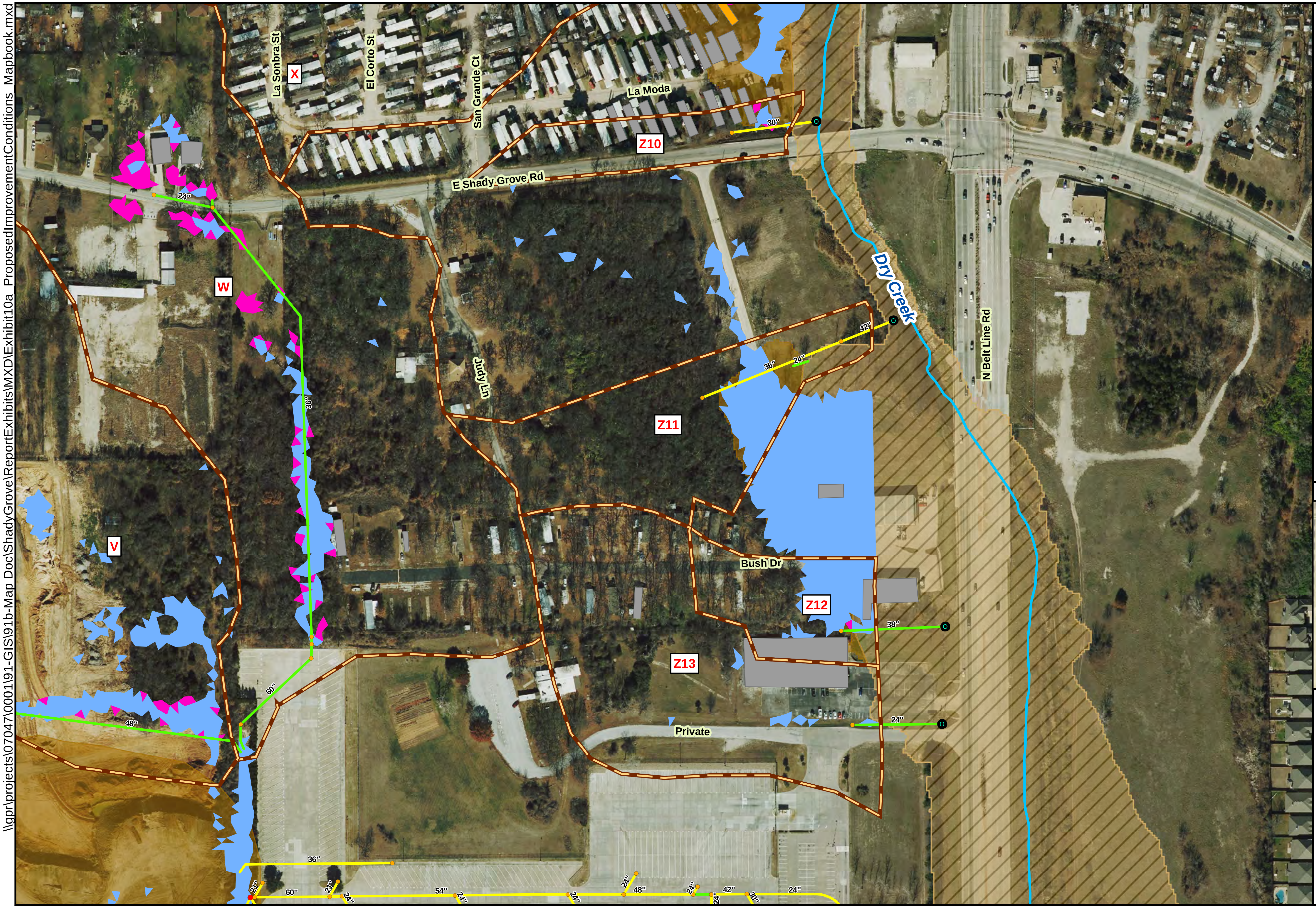
Prop 2YR Comparison

Prepared For:
City of Grand Prairie

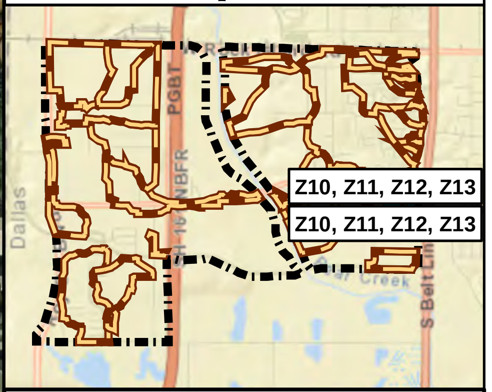
Jan. 2018 | Exhibit 10Wa - 4

\\gpr\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit10a_ProposedImprovementConditions_Mapbook.mxd



Outfall
Pipe Nodes
HGL Below Ground
HGL Above Ground
Streams
Modeled Pipes Capacity Rating
<1, Capacity not exceeded and tailwater does not submerge the system
1, Capacity not exceeded, but tailwater submerges system
2, Capacity exceeded and tailwater submerges system
Flow Direction
2D Results Line
2D Results Polygon
Basins
EX 2D Depths > 0.5'
PROP 2D Depths > 0.5'
Buildings Removed from Flooding > 0.5'
NO
YES
FEMA Flood Zone
A,
AE
AE, FLOODWAY

Index map not to scale.



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N

0 200 400
Feet

Proposed 2YR Results Comparison: Z10, Z11, Z12, Z13

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Prop 2YR Comparison

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Jan. 2018 | Exhibit 10Ea - 5

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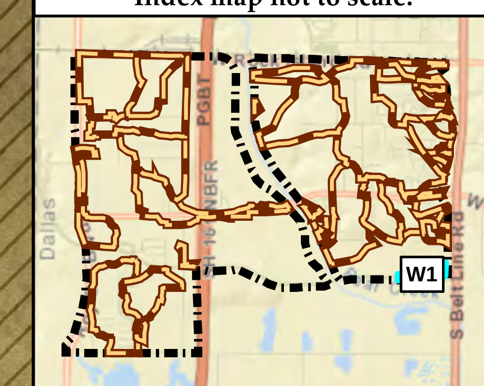
Outfall
Pipe Nodes
HGL Below Ground
HGL Above Ground
Streams
Modeled Pipes Capacity Rating
<1, Capacity not exceeded and tailwater does not submerge the system
1, Capacity not exceeded, but tailwater submerges system
2, Capacity exceeded and tailwater submerges system
Flow Direction
2D Results Line
2D Results Polygon
Basins
EX 2D Depths > 0.5'
PROP 2D Depths > 0.5'
Buildings Removed from Flooding > 0.5'
NO
YES
FEMA Flood Zone
A,
AE
AE, FLOODWAY

Index map not to scale.



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N

0 200 400
Feet

Proposed 2YR Results Comparison: W1

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Prop 2YR Comparison

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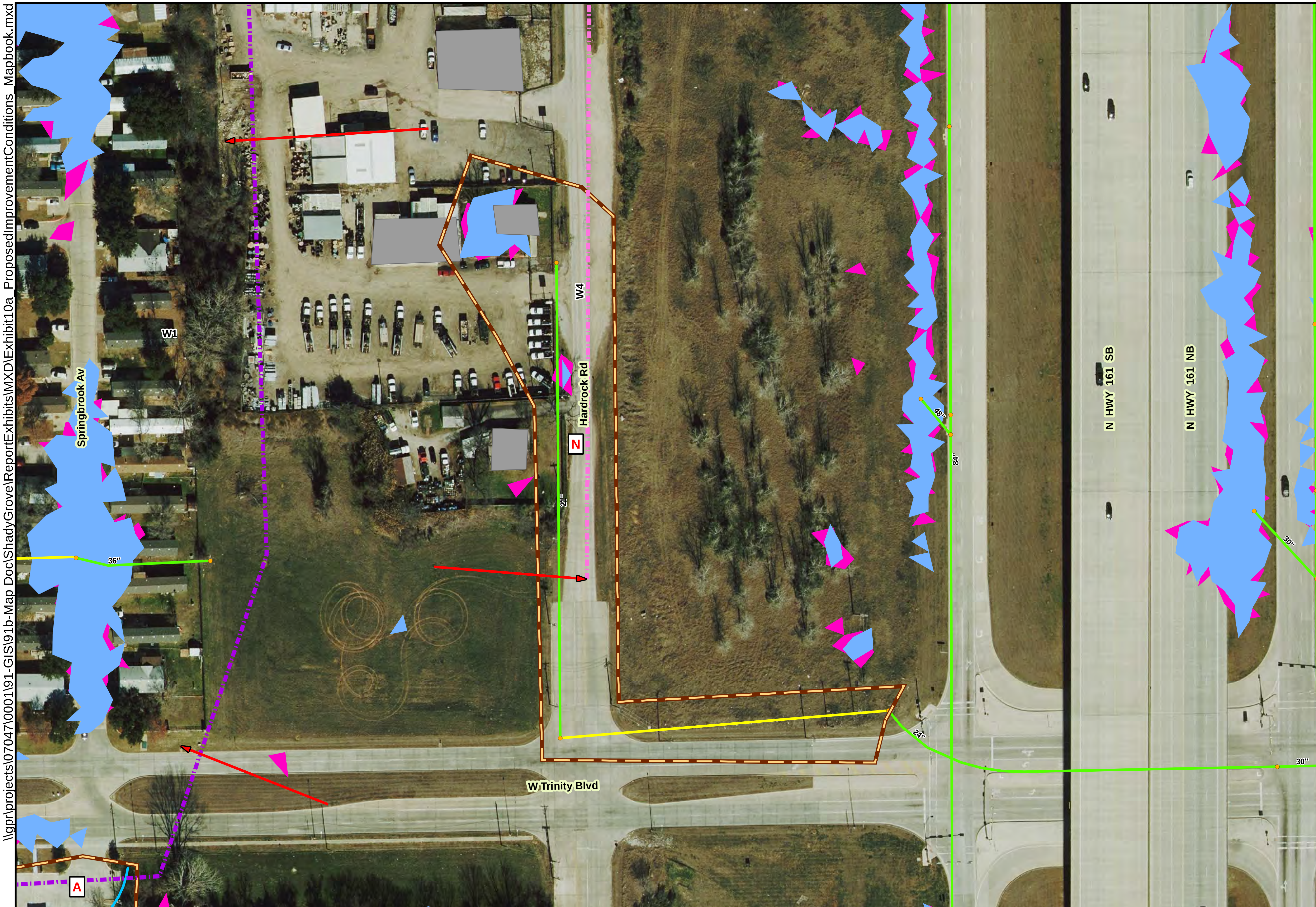
Jan. 2018 | Exhibit 10Ea - 6



Outfall

Pipe Nodes

HGL Below Ground

HGL Above Ground

Streams

Modeled Pipes Capacity Rating

<1, Capacity not exceeded and tailwater does not submerge the system

1, Capacity not exceeded, but tailwater submerges system

2, Capacity exceeded and tailwater submerges system

Flow Direction

2D Results Line

2D Results Polygon

Basins

EX 2D Depths > 0.5'

PROP 2D Depths > 0.5'

Buildings Removed from Flooding > 0.5'

NO

YES

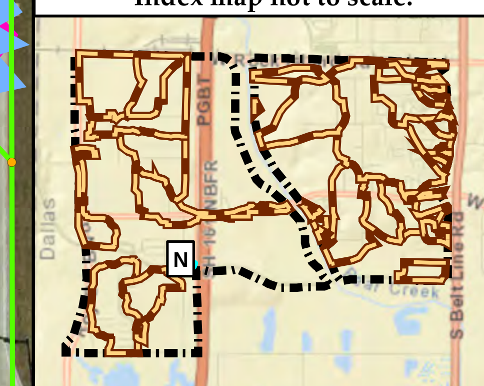
FEMA Flood Zone

A,

AE

AE, FLOODWAY

Index map not to scale.



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N

0 100 200

Feet

Proposed 2YR Results Comparison: N

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Prop 2YR Comparison

Prepared For: City of Grand Prairie

Jan. 2018	Exhibit 10Wa - 7

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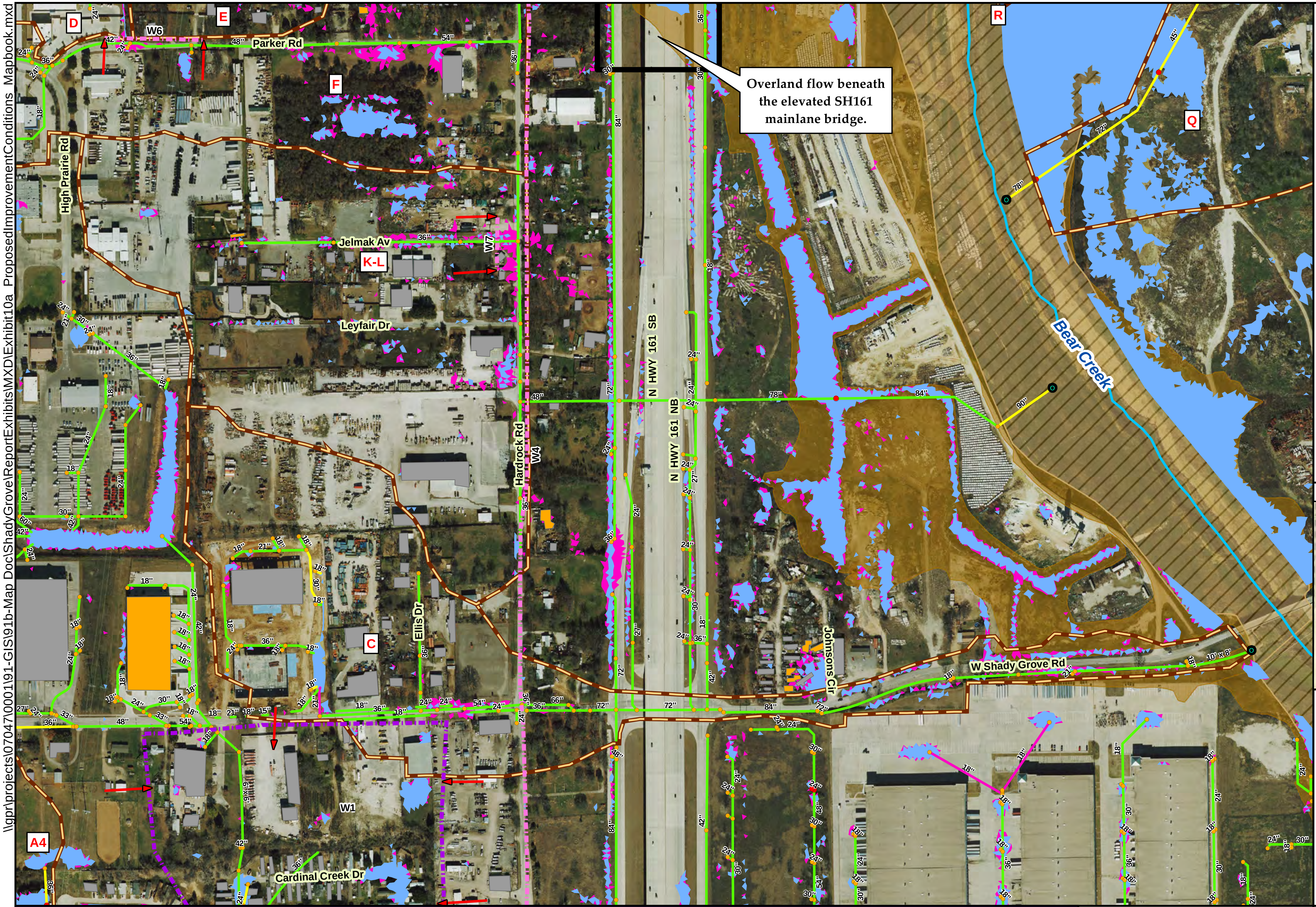
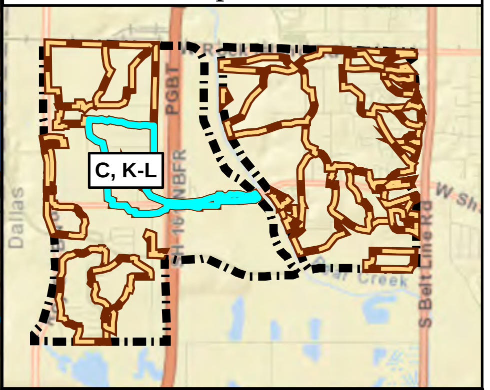


Outfall
Pipe Nodes
HGL Below Ground
HGL Above Ground
Streams
Modeled Pipes Capacity Rating
<1, Capacity not exceeded and tailwater does not submerge the system
1, Capacity not exceeded, but tailwater submerges system
2, Capacity exceeded and tailwater submerges system
Flow Direction
2D Results Line
2D Results Polygon
Basins
EX 2D Depths > 0.5'
PROP 2D Depths > 0.5'
Buildings Removed from Flooding > 0.5'
NO
YES
FEMA Flood Zone
A,
AE
AE, FLOODWAY

Index map not to scale.



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0 400 800
Feet

Proposed 2YR Results Comparison: C, K-L

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Prop 2YR Comparison

Prepared For: City of Grand Prairie

Jan. 2018 | Exhibit 10Wa - 8

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Outfall

Pipe Nodes
- HGL Below Ground
- HGL Above Ground

Streams

Modeled Pipes Capacity Rating
- <1, Capacity not exceeded and tailwater does not submerge the system
- 1, Capacity not exceeded, but tailwater submerges system
- 2, Capacity exceeded and tailwater submerges system

Flow Direction

2D Results Line

2D Results Polygon

Basins

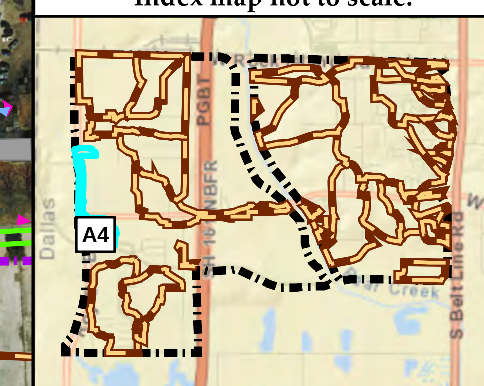
EX 2D Depths > 0.5'

PROP 2D Depths > 0.5'

Buildings Removed from Flooding > 0.5'
- NO
- YES

FEMA Flood Zone
- A,
- AE
- AE, FLOODWAY

Index map not to scale.



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N

0 300 600

Feet

Proposed 2YR Results Comparison: A4

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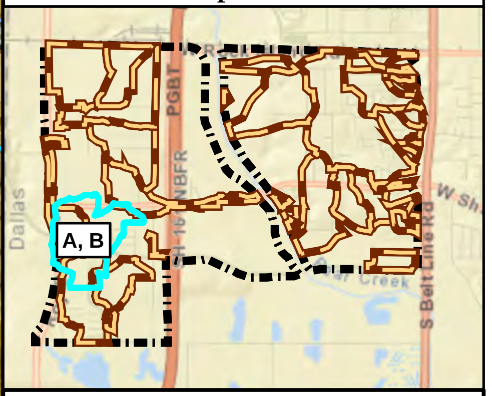
Prop 2YR Comparison

Prepared For: City of Grand Prairie

Jan. 2018 | Exhibit 10Wa - 9

- Outfall
- Pipe Nodes
  - HGL Below Ground
  - HGL Above Ground
- Streams
- Modeled Pipes Capacity Rating
  - <1, Capacity not exceeded and tailwater does not submerge the system
  - 1, Capacity not exceeded, but tailwater submerges system
  - 2, Capacity exceeded and tailwater submerges system
- Flow Direction
- 2D Results Line
- 2D Results Polygon
- Basins
- EX 2D Depths > 0.5'
- PROP 2D Depths > 0.5'
- Buildings Removed from Flooding > 0.5'
  - NO
  - YES
- FEMA Flood Zone
  - A,
  - AE
  - AE, FLOODWAY

Index map not to scale.



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N

0 1,000 2,000
Feet

Proposed 10YR Results Comparison: A, B

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Prop 10YR Comparison

Prepared For:
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Jan. 2018	Exhibit 10Wb - 1

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Outfall

Pipe Nodes

- HGL Below Ground
- HGL Above Ground

Streams

Modeled Pipes Capacity Rating

- <1, Capacity not exceeded and tailwater does not submerge the system
- 1, Capacity not exceeded, but tailwater submerges system
- 2, Capacity exceeded and tailwater submerges system

Flow Direction

2D Results Line

2D Results Polygon

Basins

EX 2D Depths > 0.5'

PROP 2D Depths > 0.5'

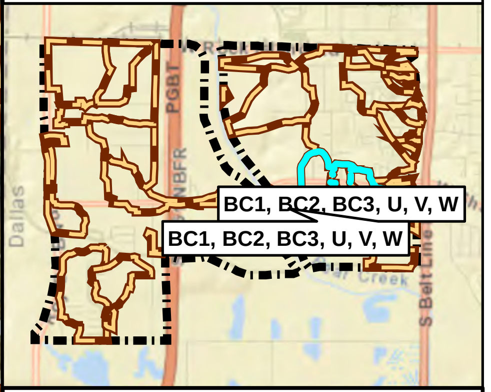
Buildings Removed from Flooding > 0.5'

- NO
- YES

FEMA Flood Zone

- A,
- AE
- AE, FLOODWAY

Index map not to scale.



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N

0 300 600

Feet

Proposed 10YR Results Comparison: BC1, BC2, BC3, U, V, W

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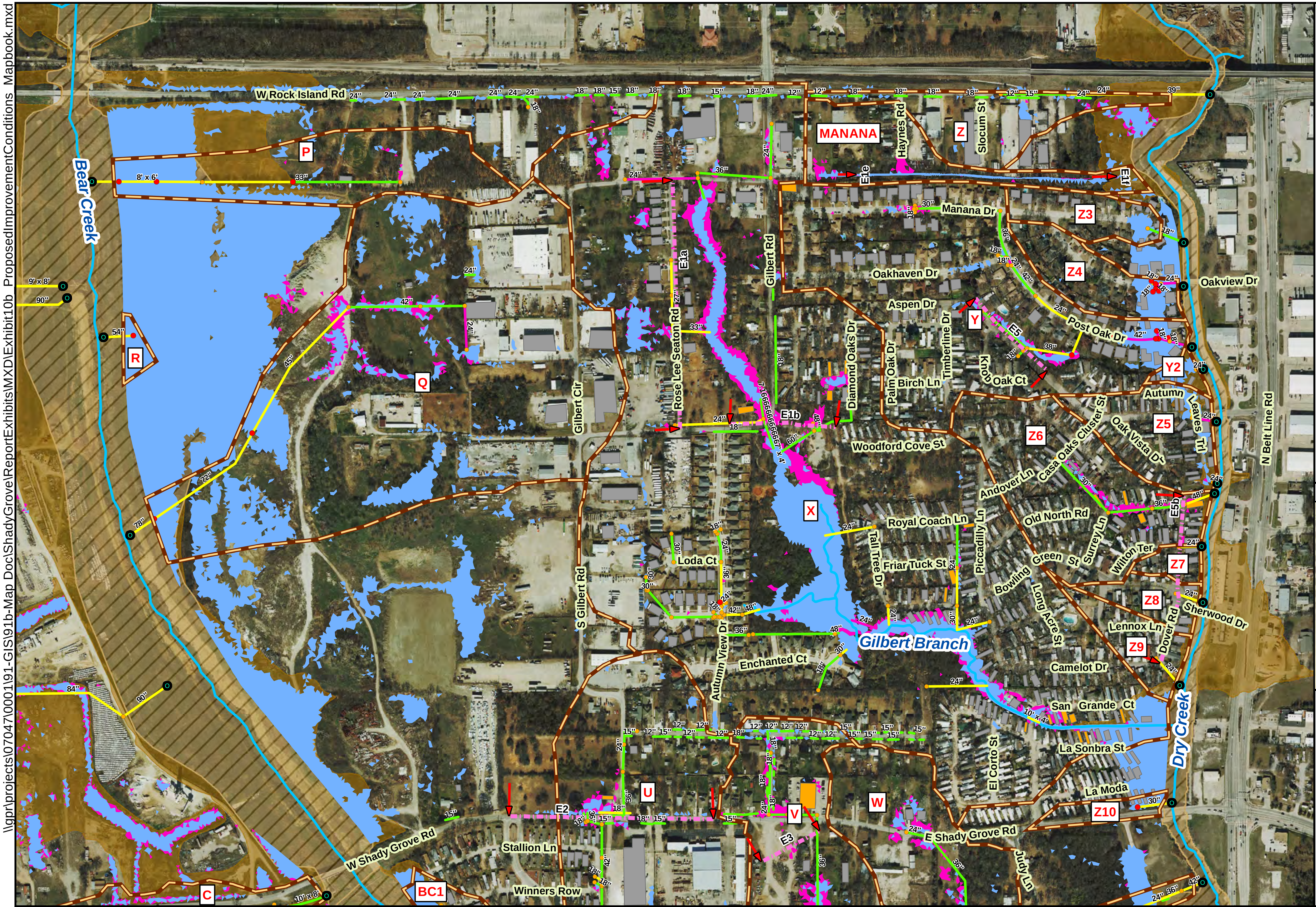
Prop 10YR Comparison

Prepared For:

City of Grand Prairie

Jan. 2018

Exhibit 10Eb - 2



Outfall

Pipe Nodes

- HGL Below Ground
- HGL Above Ground

Streams

Modeled Pipes Capacity Rating

- <1, Capacity not exceeded and tailwater does not submerge the system
- 1, Capacity not exceeded, but tailwater submerges system
- 2, Capacity exceeded and tailwater submerges system

Flow Direction

2D Results Line

2D Results Polygon

Basins

EX 2D Depths > 0.5'

PROP 2D Depths > 0.5'

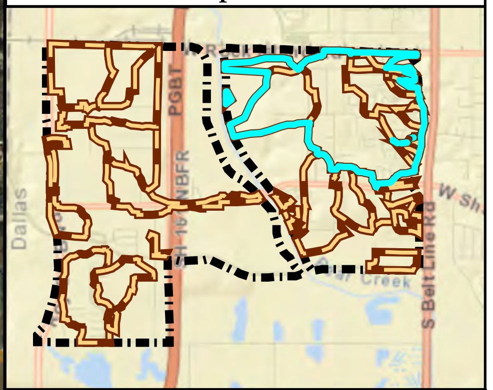
Buildings Removed from Flooding > 0.5'

- NO
- YES

FEMA Flood Zone

- A,
- AE
- AE, FLOODWAY

Index map not to scale.



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N

0 500 1,000

Feet

Proposed 10YR Results Comparison: MANANA, P, Q, R, X, Y, Y2, Z, Z3, Z4, Z5, Z6, Z7, Z8, Z9

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Prop 10YR Comparison

Prepared For:
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Jan. 2018

Exhibit 10Eb - 3

\\gpr\projects\07047\0001\91-GIS\91b-Map Docs\ShadyGrove\ReportExhibits\MXD\Exhibit10b_ProposedImprovementConditions_Mapbook.mxd

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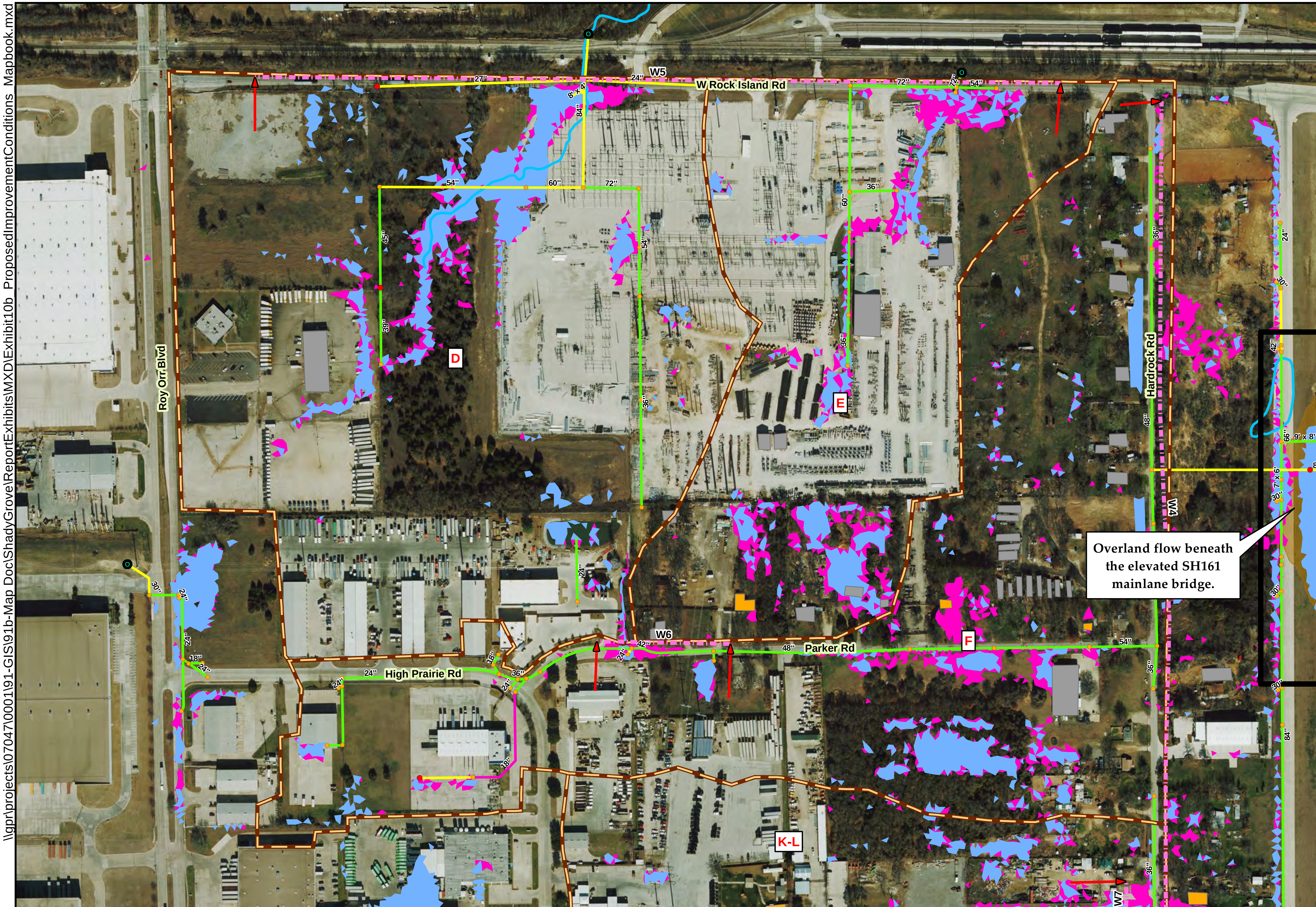

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Proposed 10YR Results Comparison: D, E, F

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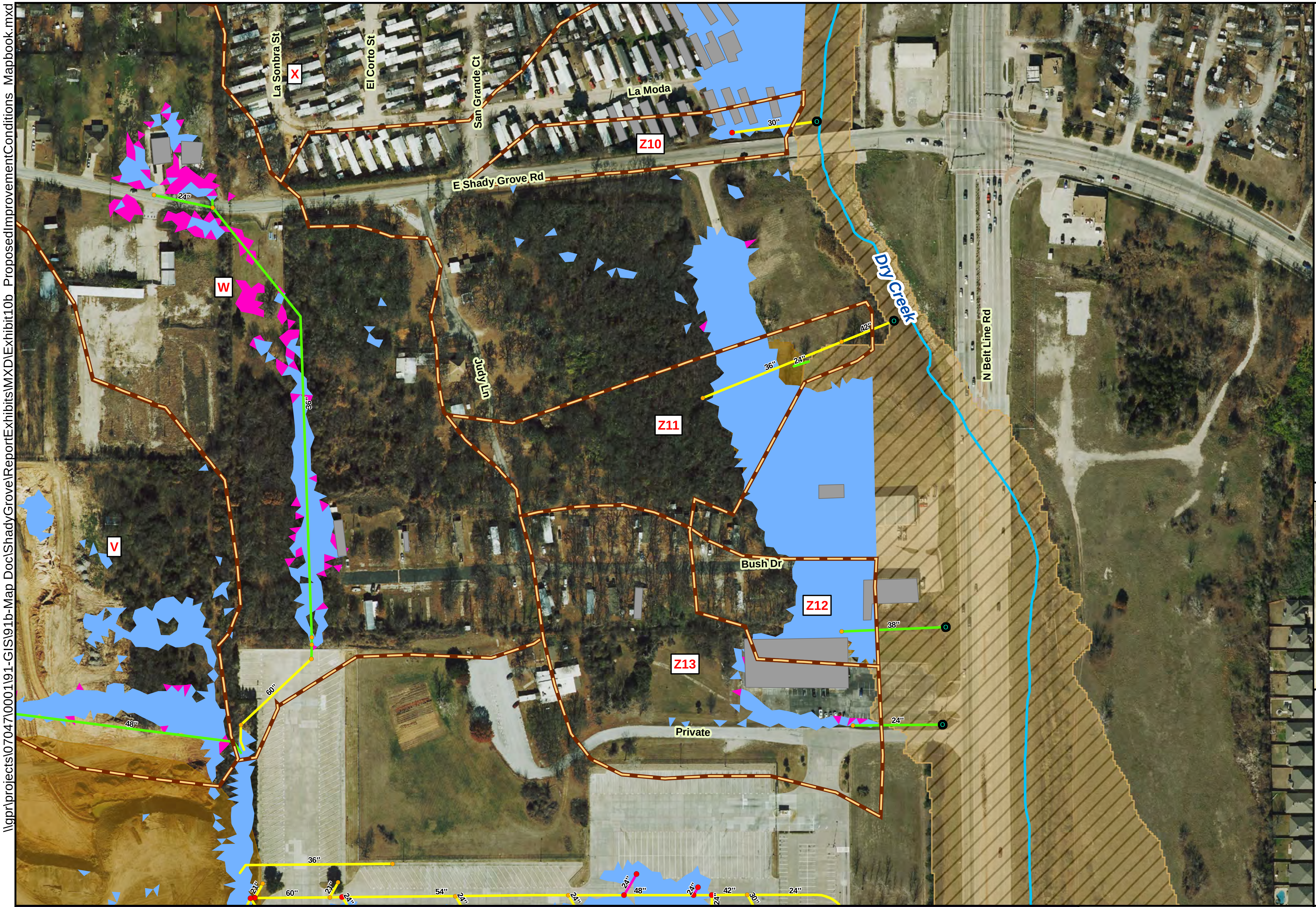
Prop 10YR Comparison

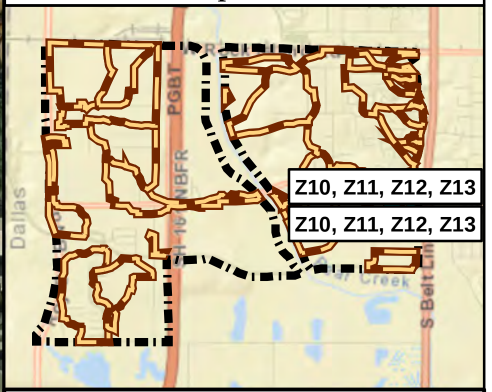
Prepared For: City of Grand Prairie

Jan. 2018 | Exhibit 10Wb - 4



- Outfall
- Pipe Nodes
  - HGL Below Ground
  - HGL Above Ground
- Streams
- Modeled Pipes Capacity Rating
  - <1, Capacity not exceeded and tailwater does not submerge the system
  - 1, Capacity not exceeded, but tailwater submerges system
  - 2, Capacity exceeded and tailwater submerges system
- Flow Direction
- 2D Results Line
- 2D Results Polygon
- Basins
- EX 2D Depths > 0.5'
- PROP 2D Depths > 0.5'
- Buildings Removed from Flooding > 0.5'
  - NO
  - YES
- FEMA Flood Zone
  - A,
  - AE
  - AE, FLOODWAY

Index map not to scale.



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N

0 200 400
Feet

Proposed 10YR Results Comparison: Z10, Z11, Z12, Z13

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Tel: (817) 484-5695

Prop 10YR Comparison

Prepared For:
City of Grand Prairie

Jan. 2018	Exhibit 10Eb - 5

\\gpr\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGroveReportExhibits\MXD\Exhibit10b_ProposedImprovementConditions_Mapbook.mxd

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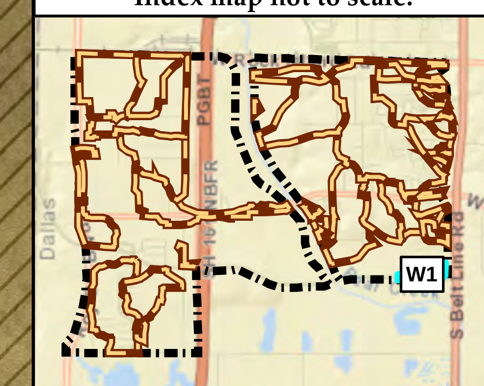
- Outfall
- Pipe Nodes
  - HGL Below Ground
  - HGL Above Ground
- Streams
- Modeled Pipes Capacity Rating
  - <1, Capacity not exceeded and tailwater does not submerge the system
  - 1, Capacity not exceeded, but tailwater submerges system
  - 2, Capacity exceeded and tailwater submerges system
- Flow Direction
- 2D Results Line
- 2D Results Polygon
- Basins
- EX 2D Depths > 0.5'
- PROP 2D Depths > 0.5'
- Buildings Removed from Flooding > 0.5'
  - NO
  - YES
- FEMA Flood Zone
  - A,
  - AE
  - AE, FLOODWAY

Index map not to scale.



N

0 200 400
Feet

Proposed 10YR Results Comparison: W1

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Prop 10YR Comparison

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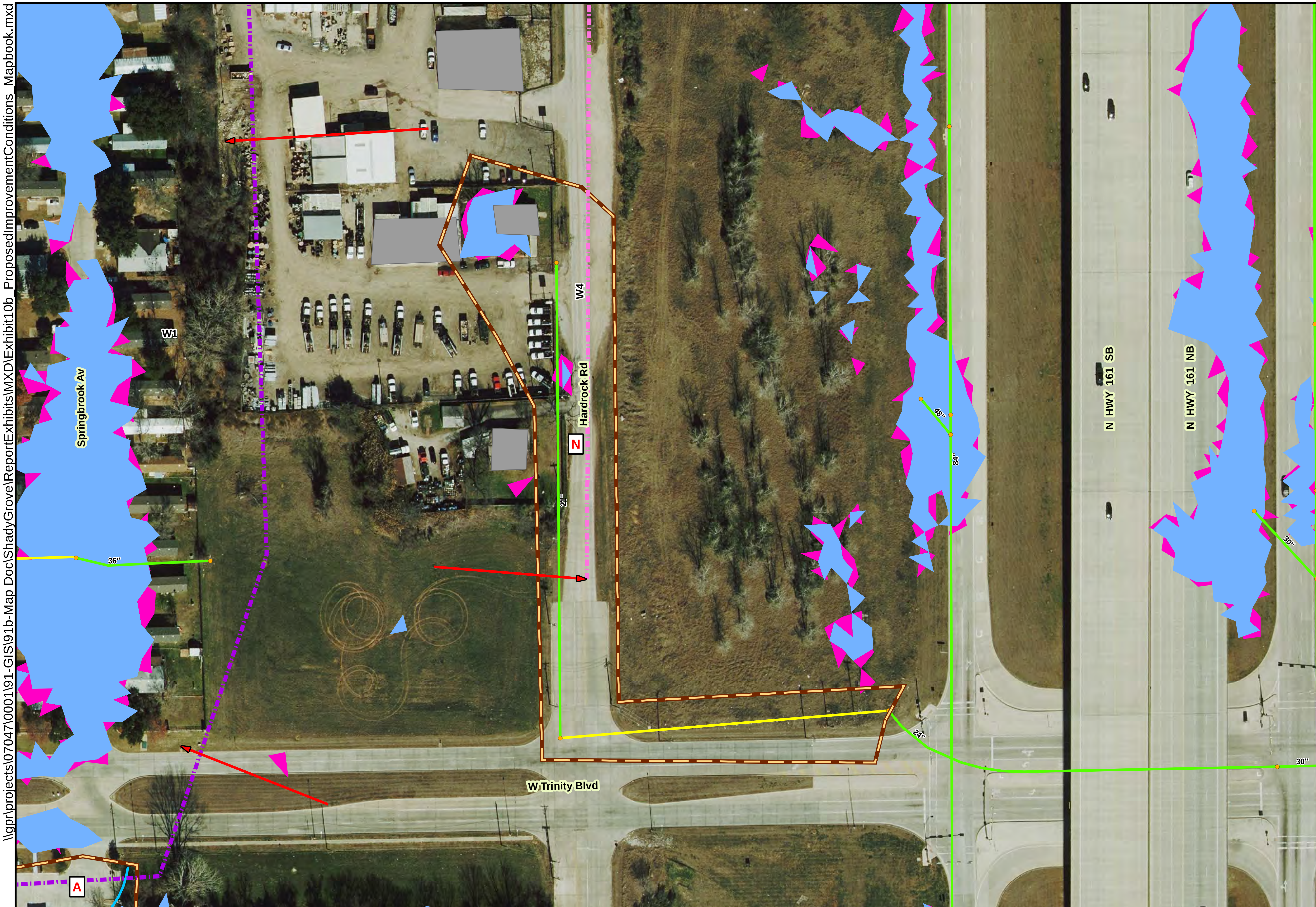
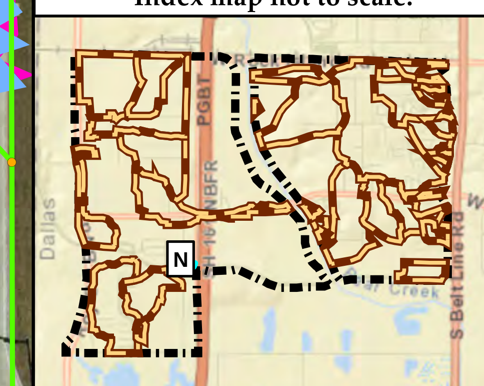
Jan. 2018 | Exhibit 10Eb - 6

\\gpr\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit10b_ProposedImprovementConditions_Mapbook.mxd



Outfall
Pipe Nodes
HGL Below Ground
HGL Above Ground
Streams
Modeled Pipes Capacity Rating
<1, Capacity not exceeded and tailwater does not submerge the system
1, Capacity not exceeded, but tailwater submerges system
2, Capacity exceeded and tailwater submerges system
Flow Direction
2D Results Line
2D Results Polygon
Basins
EX 2D Depths > 0.5'
PROP 2D Depths > 0.5'
Buildings Removed from Flooding > 0.5'
NO
YES
FEMA Flood Zone
A,
AE
AE, FLOODWAY

Index map not to scale.



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N

0 100 200
Feet

Proposed 10YR Results Comparison: N

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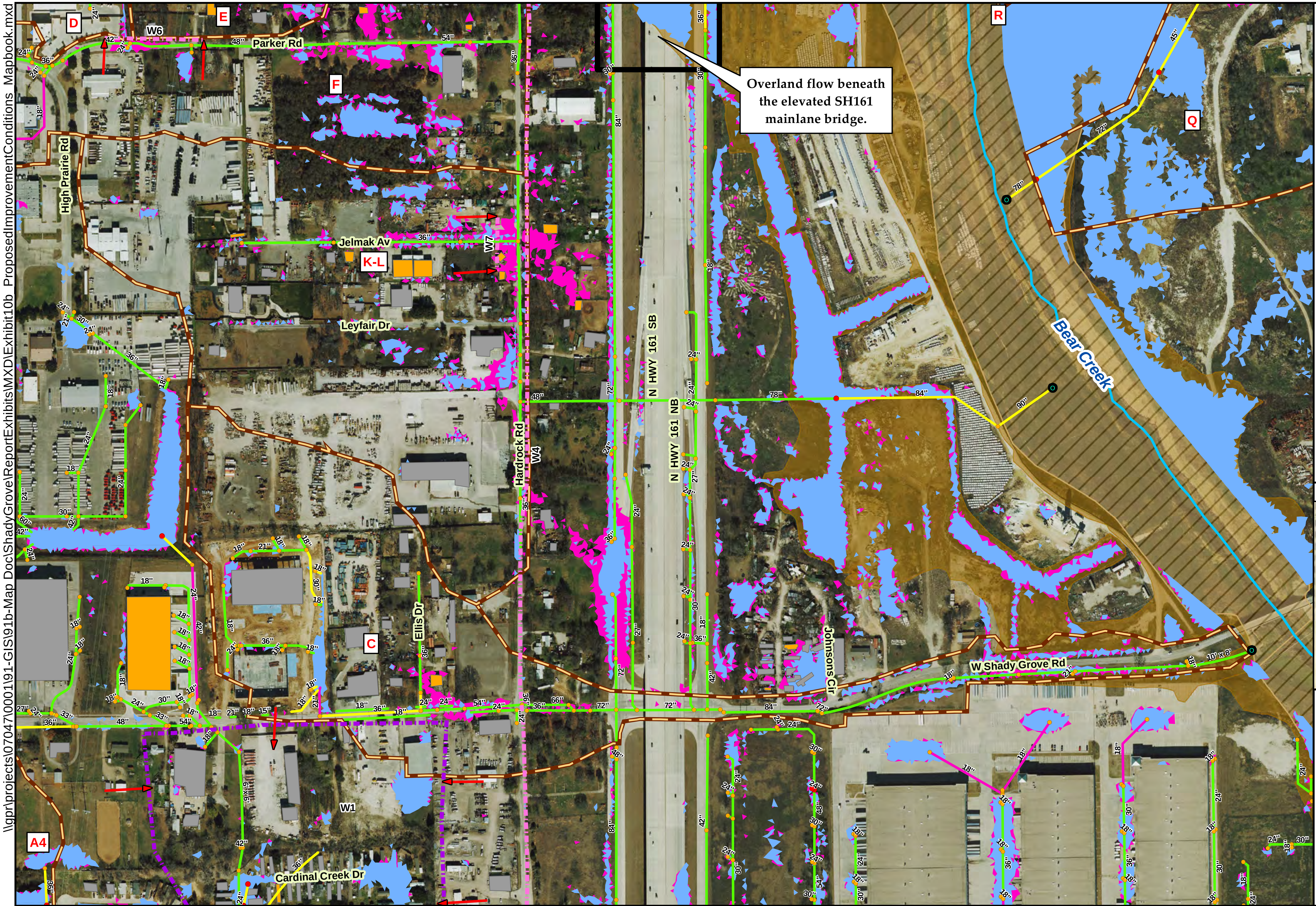
Prop 10YR Comparison

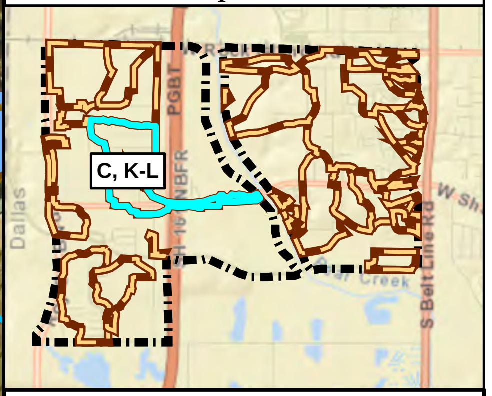
Prepared For:
City of Grand Prairie

Jan. 2018 | Exhibit 10Wb - 7



- Outfall
- Pipe Nodes
  - HGL Below Ground
  - HGL Above Ground
- Streams
- Modeled Pipes Capacity Rating
  - <1, Capacity not exceeded and tailwater does not submerge the system
  - 1, Capacity not exceeded, but tailwater submerges system
  - 2, Capacity exceeded and tailwater submerges system
- Flow Direction
- 2D Results Line
- 2D Results Polygon
- Basins
- EX 2D Depths > 0.5'
- PROP 2D Depths > 0.5'
- Buildings Removed from Flooding > 0.5'
  - NO
  - YES
- FEMA Flood Zone
  - A,
  - AE
  - AE, FLOODWAY

Index map not to scale.



N

0 400 800
Feet

Proposed 10YR Results Comparison: C, K-L

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Prop 10YR Comparison

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Jan. 2018 | Exhibit 10Wb - 8

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Outfall

Pipe Nodes

HGL Below Ground

HGL Above Ground

Streams

Modeled Pipes Capacity Rating

<1, Capacity not exceeded and tailwater does not submerge the system

1, Capacity not exceeded, but tailwater submerges system

2, Capacity exceeded and tailwater submerges system

Flow Direction

2D Results Line

2D Results Polygon

Basins

EX 2D Depths > 0.5'

PROP 2D Depths > 0.5'

Buildings Removed from Flooding > 0.5'

NO

YES

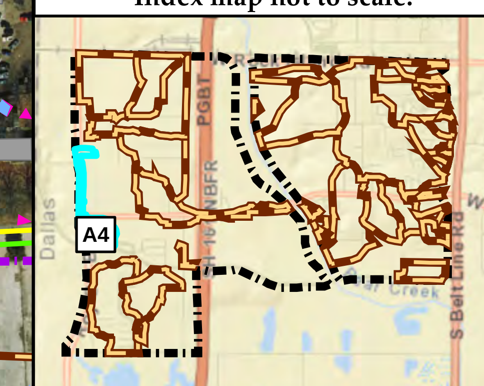
FEMA Flood Zone

A,

AE

AE, FLOODWAY

Index map not to scale.



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N

0 300 600

Feet

Proposed 10YR Results Comparison: A4

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Prop 10YR Comparison

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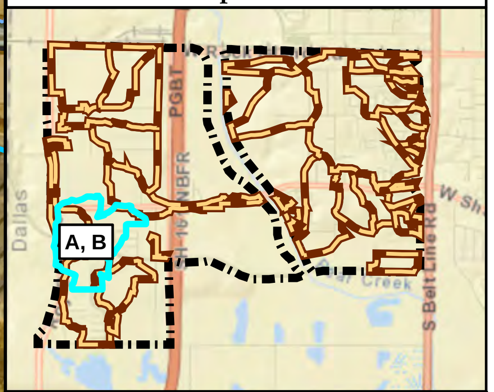
- Outfall
- Pipe Nodes
  - HGL Below Ground
  - HGL Above Ground
- Streams
- Modeled Pipes Capacity Rating
  - <1, Capacity not exceeded and tailwater does not submerge the system
  - 1, Capacity not exceeded, but tailwater submerges system
  - 2, Capacity exceeded and tailwater submerges system
- Flow Direction
- 2D Results Line
- 2D Results Polygon
- Areas of Interest
- EX 2D Depths > 0.5'
- PROP 2D Depths > 0.5'
- Buildings Removed from Flooding > 0.5'
  - NO
  - YES
- FEMA Flood Zone
  - A,
  - AE
  - AE, FLOODWAY

Index map not to scale.



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N

0 1,000 2,000
Feet

Proposed 25YR Results Comparison: A, B

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Prop 25YR Comparison

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Jan. 2018 | Exhibit 10Wc - 1

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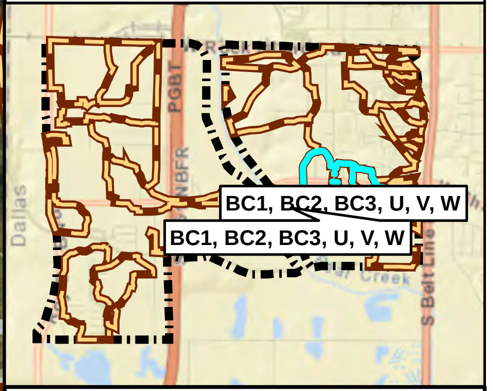
- Outfall
- Pipe Nodes
  - HGL Below Ground
  - HGL Above Ground
- Streams
- Modeled Pipes Capacity Rating
  - <1, Capacity not exceeded and tailwater does not submerge the system
  - 1, Capacity not exceeded, but tailwater submerges system
  - 2, Capacity exceeded and tailwater submerges system
- Flow Direction
- 2D Results Line
- 2D Results Polygon
- Areas of Interest
- EX 2D Depths > 0.5'
- PROP 2D Depths > 0.5'
- Buildings Removed from Flooding > 0.5'
  - NO
  - YES
- FEMA Flood Zone
  - A,
  - AE
  - AE, FLOODWAY

Index map not to scale.



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N

0 300 600
Feet

Proposed 25YR Results Comparison: BC1, BC2, BC3, U, V, W

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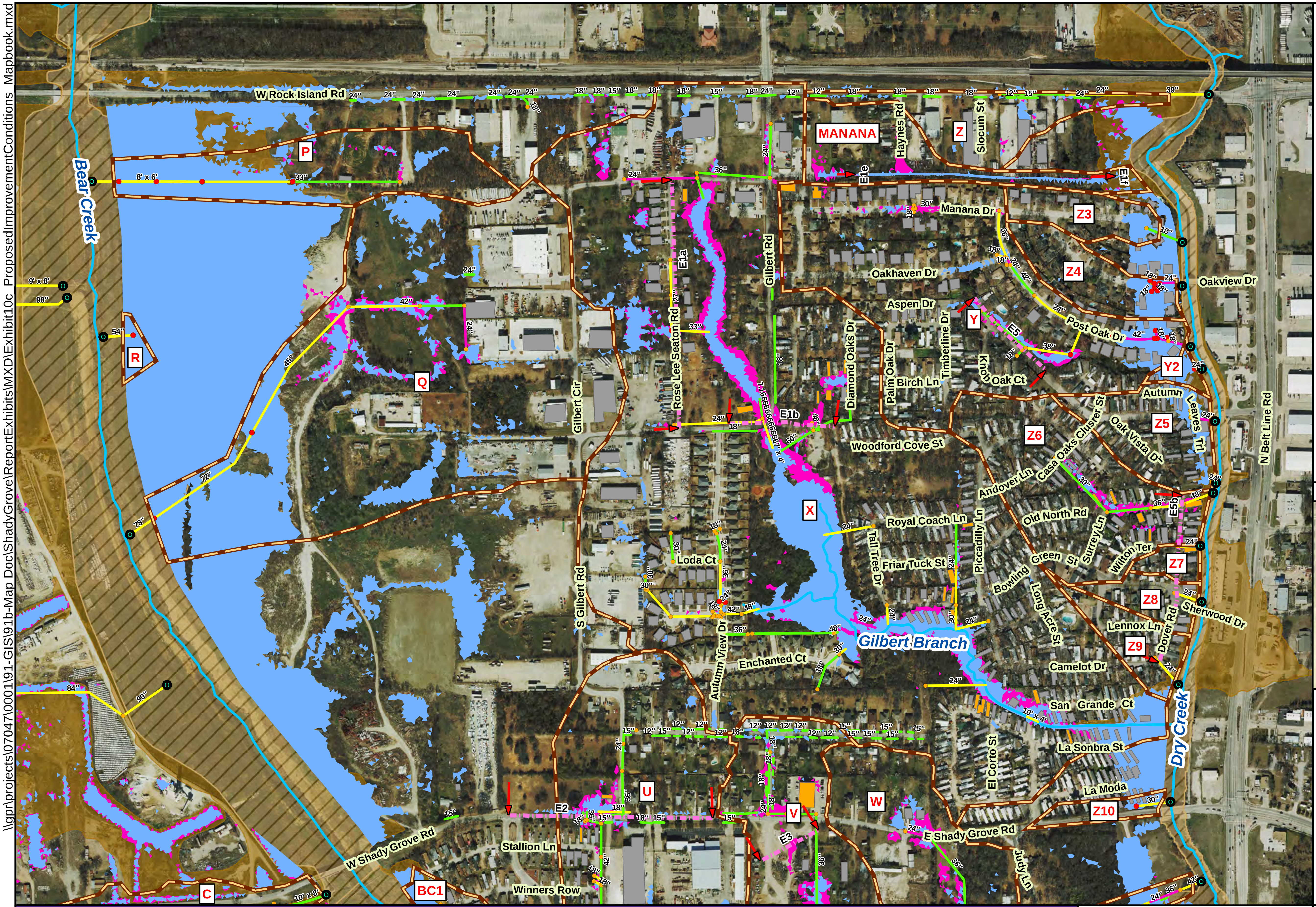
Prop 25YR Comparison

Prepared For: City of Grand Prairie

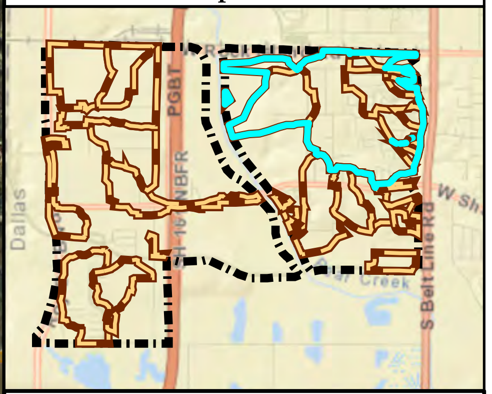
Jan. 2018 | Exhibit 10Ec - 2

\\gpr\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit10c_ProposedImprovementConditions_Mapbook.mxd



- Outfall
- Pipe Nodes
  - HGL Below Ground
  - HGL Above Ground
- Streams
- Modeled Pipes Capacity Rating
  - <1, Capacity not exceeded and tailwater does not submerge the system
  - 1, Capacity not exceeded, but tailwater submerges system
  - 2, Capacity exceeded and tailwater submerges system
- Flow Direction
- 2D Results Line
- 2D Results Polygon
- Areas of Interest
- EX 2D Depths > 0.5'
- PROP 2D Depths > 0.5'
- Buildings Removed from Flooding > 0.5'
  - NO
  - YES
- FEMA Flood Zone
  - A,
  - AE
  - AE, FLOODWAY

Index map not to scale.



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N

0 500 1,000
Feet

Proposed 25YR Results Comparison: MANANA, P, Q, R, X, Y, Y2, Z, Z3, Z4, Z5, Z6, Z7, Z8, Z9

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Prop 25YR Comparison

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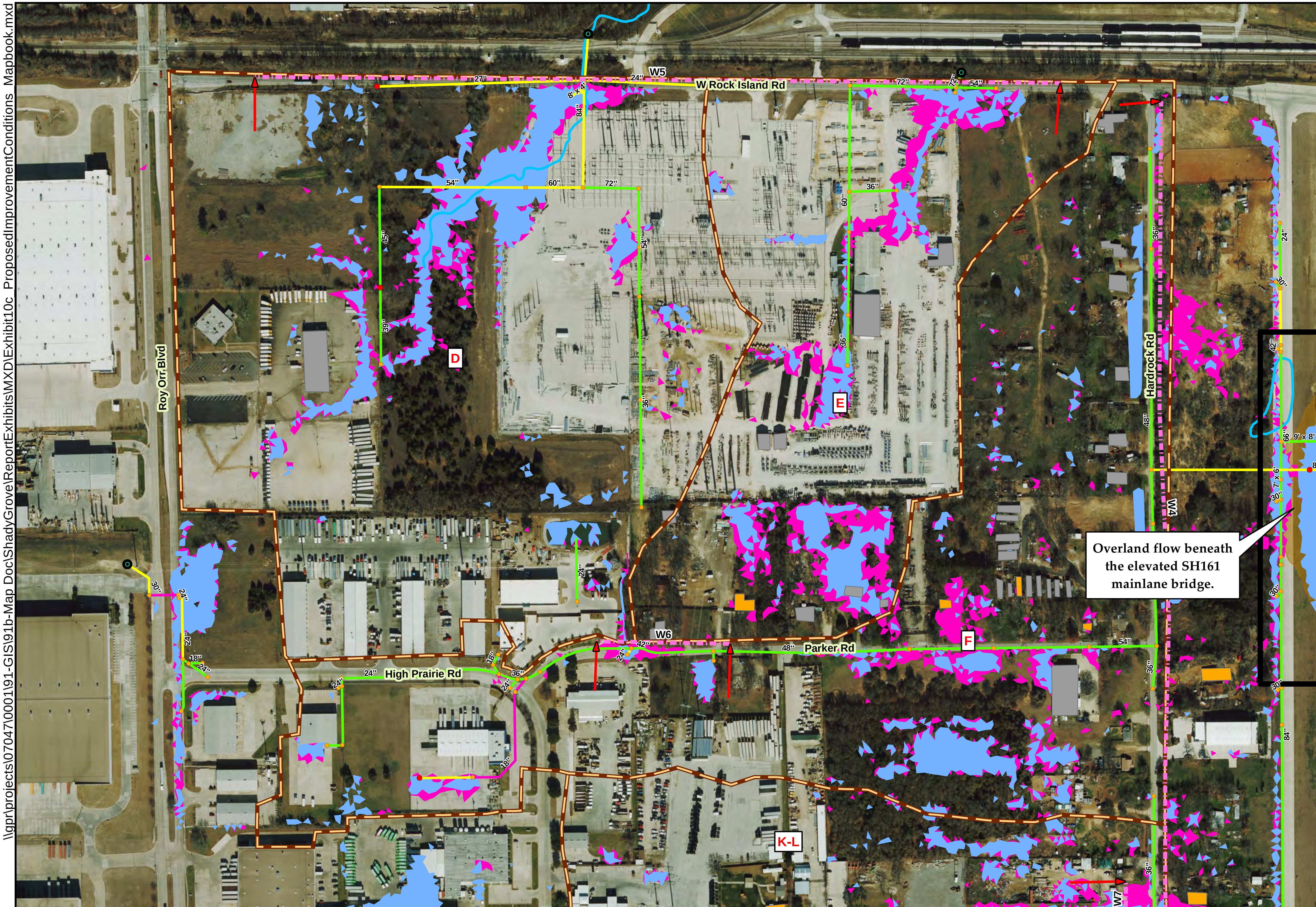
Jan. 2018 | Exhibit 10Ec - 3



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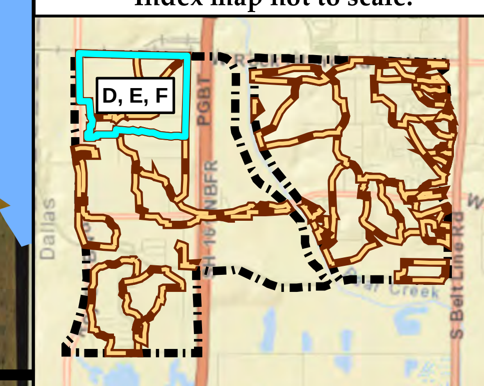
Outfall
Pipe Nodes
HGL Below Ground
HGL Above Ground
Streams
Modeled Pipes Capacity Rating
<1, Capacity not exceeded and tailwater does not submerge the system
1, Capacity not exceeded, but tailwater submerges system
2, Capacity exceeded and tailwater submerges system
Flow Direction
2D Results Line
2D Results Polygon
Areas of Interest
EX 2D Depths > 0.5'
PROP 2D Depths > 0.5'
Buildings Removed from Flooding > 0.5'
NO
YES
FEMA Flood Zone
A,
AE
AE, FLOODWAY

Index map not to scale.



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N

0 300 600
Feet

Proposed 25YR Results Comparison: D, E, F

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Prop 25YR Comparison

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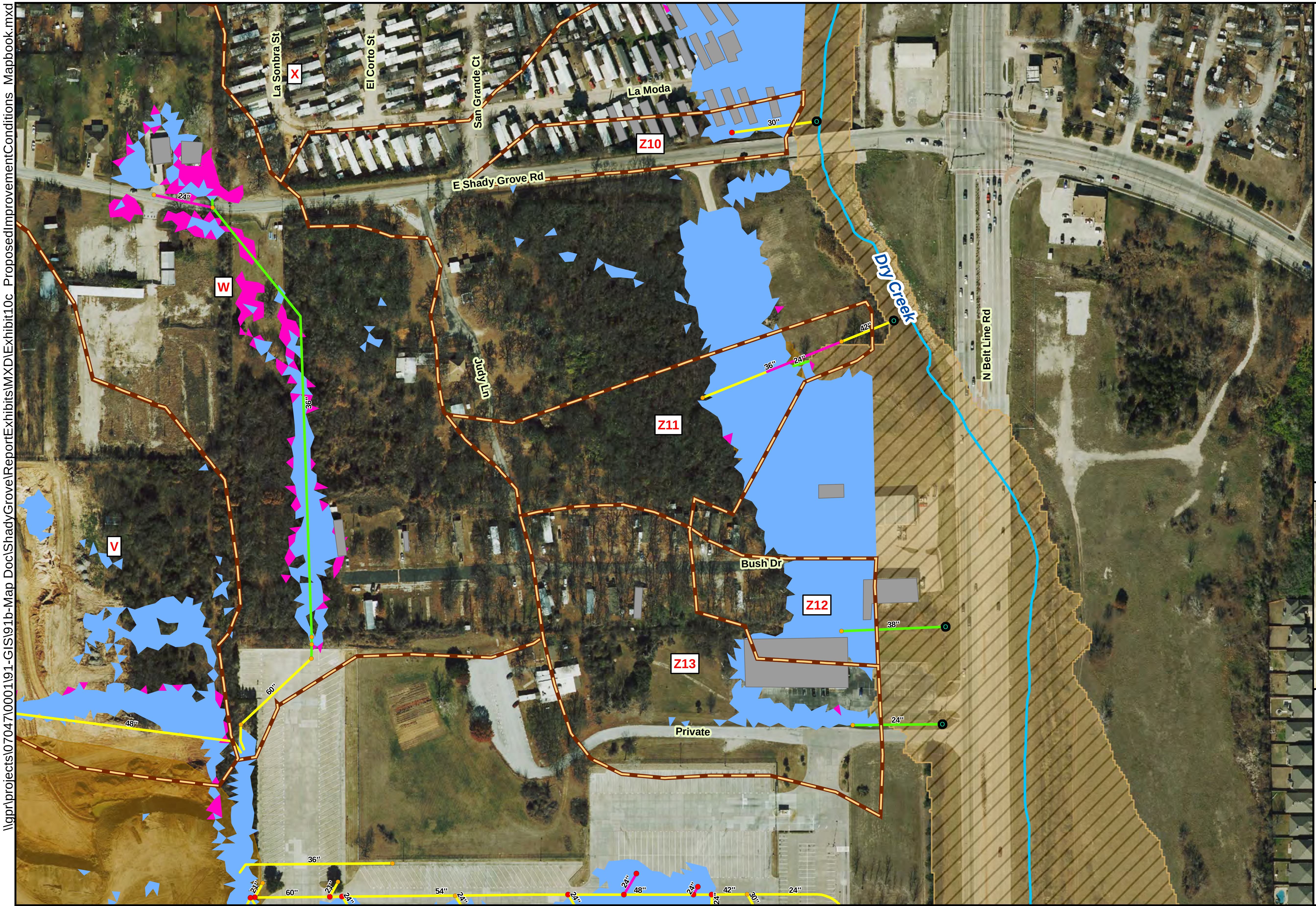
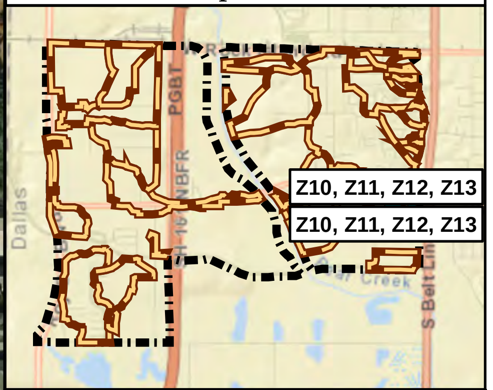
Jan. 2018 | Exhibit 10Wc - 4



- Outfall
- Pipe Nodes
  - HGL Below Ground
  - HGL Above Ground
- Streams
- Modeled Pipes Capacity Rating
  - <1, Capacity not exceeded and tailwater does not submerge the system
  - 1, Capacity not exceeded, but tailwater submerges system
  - 2, Capacity exceeded and tailwater submerges system
- Flow Direction
- 2D Results Line
- 2D Results Polygon
- Areas of Interest
- EX 2D Depths > 0.5'
- PROP 2D Depths > 0.5'
- Buildings Removed from Flooding > 0.5'
  - NO
  - YES
- FEMA Flood Zone
  - A,
  - AE
  - AE, FLOODWAY

Index map not to scale.



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N

0 200 400

Feet

Proposed 25YR Results Comparison: Z10, Z11, Z12, Z13

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Prop 25YR Comparison

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Proposed 25YR Results Comparison: W1

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Prop 25YR Comparison

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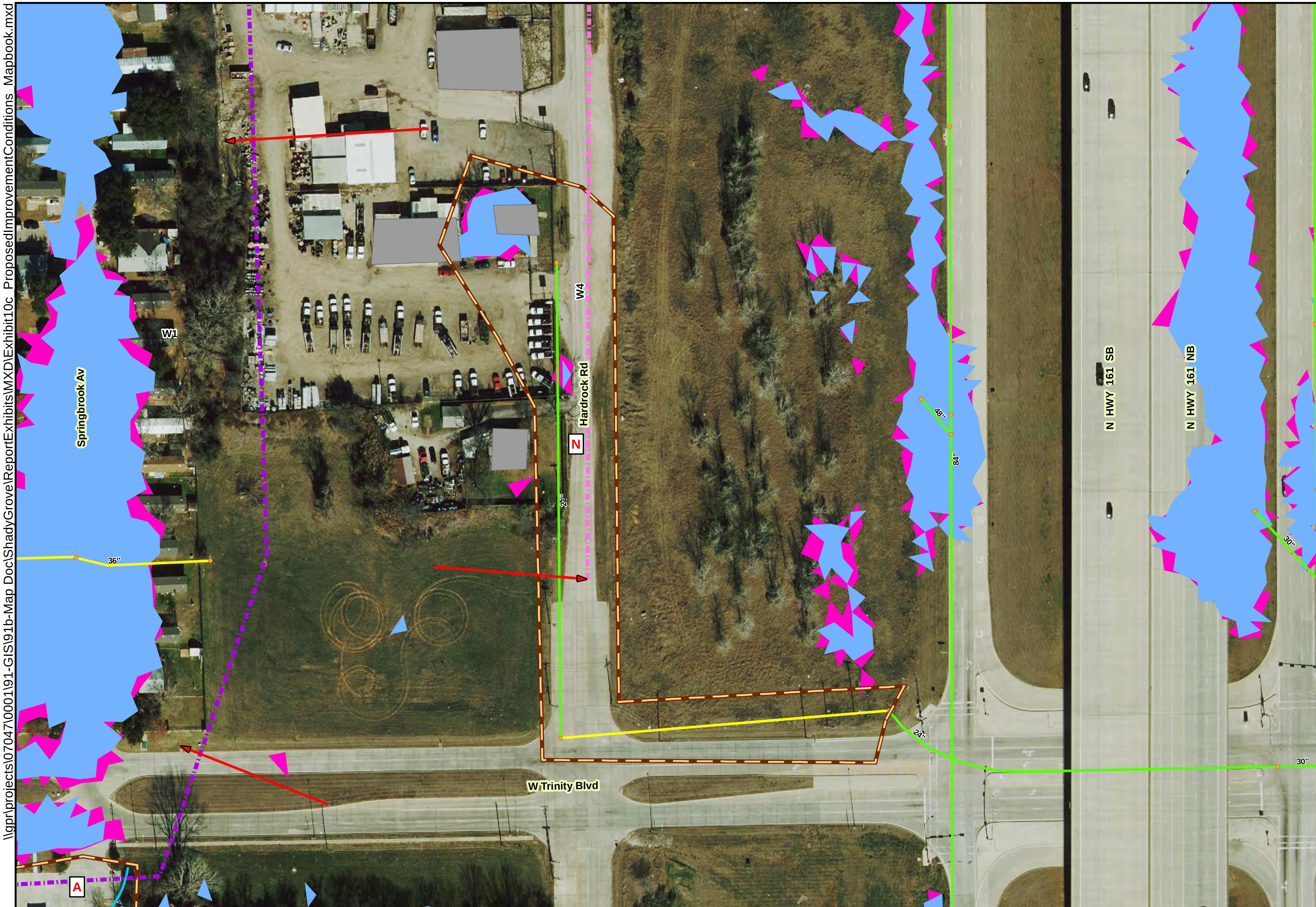


Outfall

Pipe Nodes

HGL Below Ground

HGL Above Ground

Streams

Modeled Pipes Capacity Rating

<1, Capacity not exceeded and tailwater does not submerge the system

1, Capacity not exceeded, but tailwater submerges system

2, Capacity exceeded and tailwater submerges system

Flow Direction

2D Results Line

2D Results Polygon

Areas of Interest

EX 2D Depths > 0.5'

PROP 2D Depths > 0.5'

Buildings Removed from Flooding > 0.5'

NO

YES

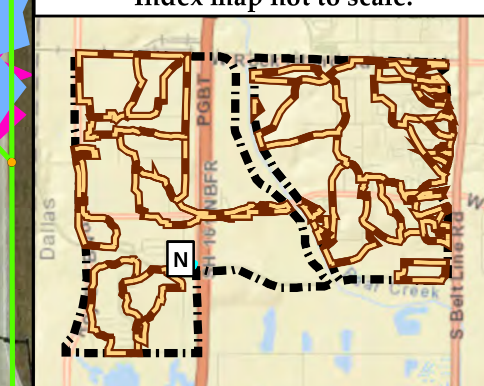
FEMA Flood Zone

A,

AE

AE, FLOODWAY

Index map not to scale.



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N

0 100 200

Feet

Proposed 25YR Results Comparison: N

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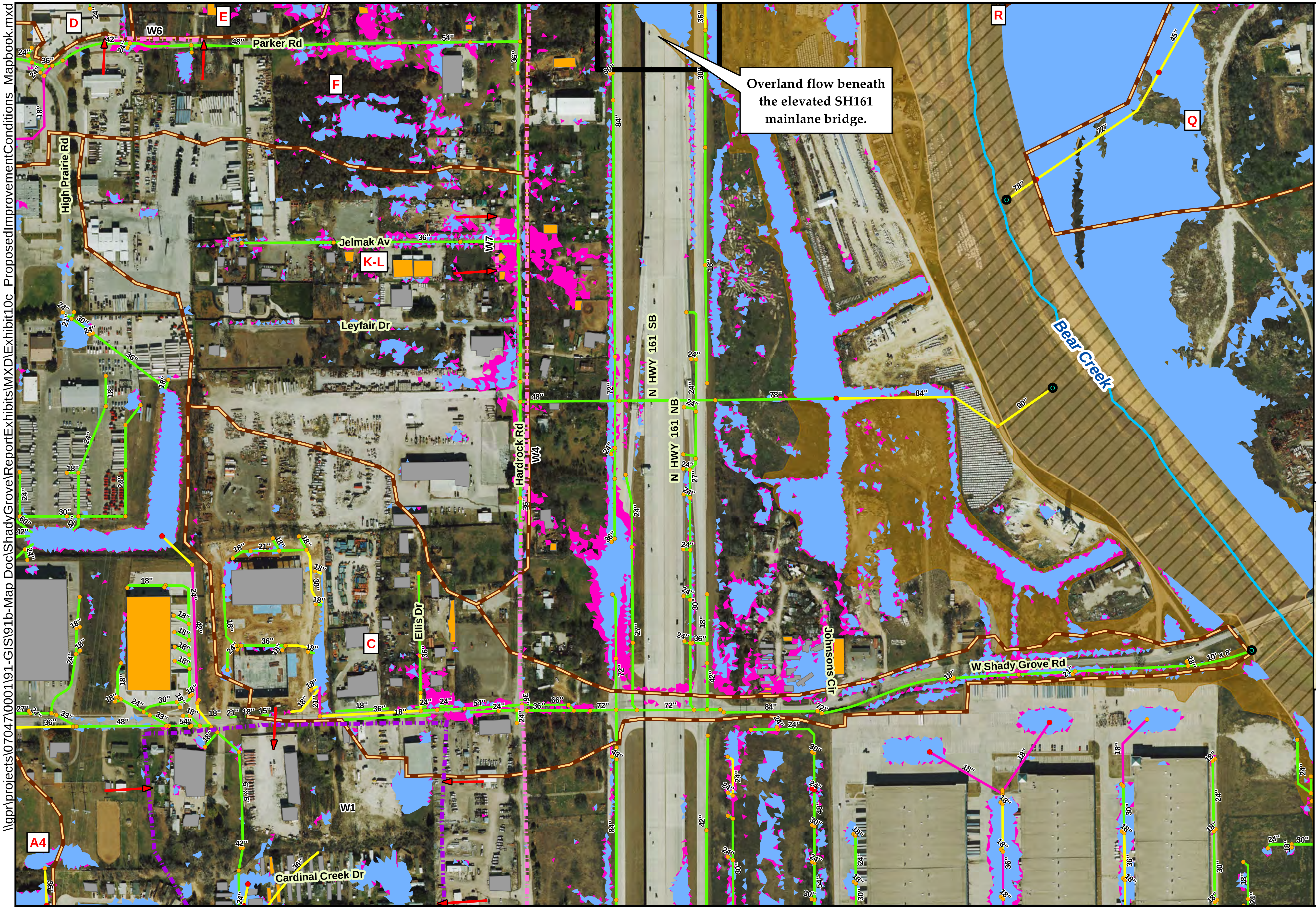
Prop 25YR Comparison

Prepared For: City of Grand Prairie

Jan. 2018 | Exhibit 10Wc - 7



Outfall

Pipe Nodes

HGL Below Ground

HGL Above Ground

Streams

Modeled Pipes Capacity Rating

<1, Capacity not exceeded and tailwater does not submerge the system

1, Capacity not exceeded, but tailwater submerges system

2, Capacity exceeded and tailwater submerges system

Flow Direction

2D Results Line

2D Results Polygon

Areas of Interest

EX 2D Depths > 0.5'

PROP 2D Depths > 0.5'

Buildings Removed from Flooding > 0.5'

NO

YES

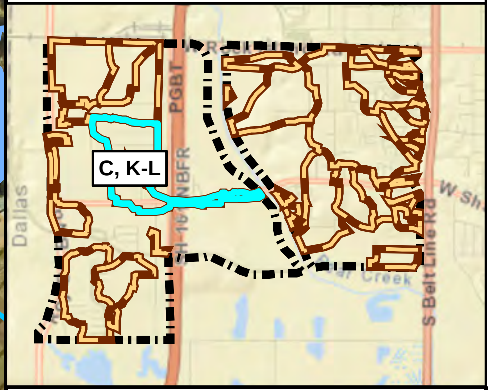
FEMA Flood Zone

A,

AE

AE, FLOODWAY

Index map not to scale.



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N

0 400 800

Feet

Proposed 25YR Results Comparison: C, K-L

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Prop 25YR Comparison

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Jan. 2018

Exhibit 10Wc - 8

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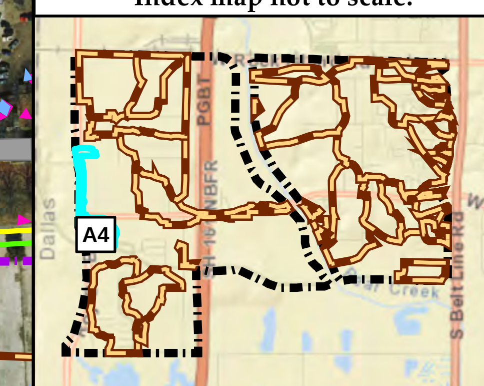
Outfall
Pipe Nodes
HGL Below Ground
HGL Above Ground
Streams
Modeled Pipes Capacity Rating
<1, Capacity not exceeded and tailwater does not submerge the system
1, Capacity not exceeded, but tailwater submerges system
2, Capacity exceeded and tailwater submerges system
Flow Direction
2D Results Line
2D Results Polygon
Areas of Interest
EX 2D Depths > 0.5'
PROP 2D Depths > 0.5'
Buildings Removed from Flooding > 0.5'
NO
YES
FEMA Flood Zone
A,
AE
AE, FLOODWAY

Index map not to scale.



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N
0 300 600
Feet

Proposed 25YR Results Comparison: A4

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Prop 25YR Comparison

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Jan. 2018 | Exhibit 10Wc - 9

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- Outfall
- Pipe Nodes
  - HGL Below Ground
  - HGL Above Ground
- Streams
- Modeled Pipes Capacity Rating
  - <1, Capacity not exceeded and tailwater does not submerge the system
  - 1, Capacity not exceeded, but tailwater submerges system
  - 2, Capacity exceeded and tailwater submerges system
- Flow Direction
- 2D Results Line
- 2D Results Polygon
- Areas of Interest
- EX 2D Depths > 0.5'
- PROP 2D Depths > 0.5'
- Buildings Removed from Flooding > 0.5'
  - NO
  - YES
- FEMA Flood Zone
  - A,
  - AE
  - AE, FLOODWAY

Index map not to scale.

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N

0 1,000 2,000
Feet

Proposed 100YR Results Comparison: A, B

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Prop 100YR Comparison

Prepared For:
City of Grand Prairie

Jan. 2018 | Exhibit 10Wd - 1

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Outfall

Pipe Nodes

- HGL Below Ground
- HGL Above Ground

Streams

Modeled Pipes Capacity Rating

- <1, Capacity not exceeded and tailwater does not submerge the system
- 1, Capacity not exceeded, but tailwater submerges system
- 2, Capacity exceeded and tailwater submerges system

Flow Direction

2D Results Line

2D Results Polygon

Areas of Interest

EX 2D Depths > 0.5'

PROP 2D Depths > 0.5'

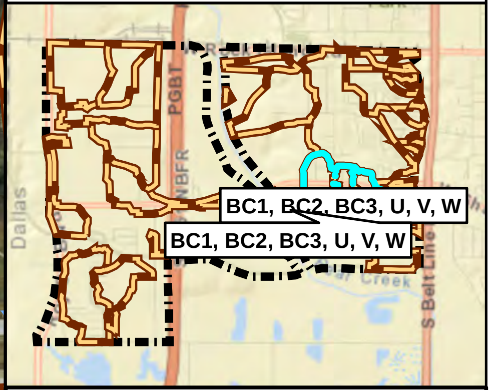
Buildings Removed from Flooding > 0.5'

- NO
- YES

FEMA Flood Zone

- A,
- AE
- AE, FLOODWAY

Index map not to scale.



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N

0 300 600

Feet

Proposed 100YR Results Comparison: BC1, BC2, BC3, U, V, W

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Prop 100YR Comparison

Prepared For:
City of Grand Prairie

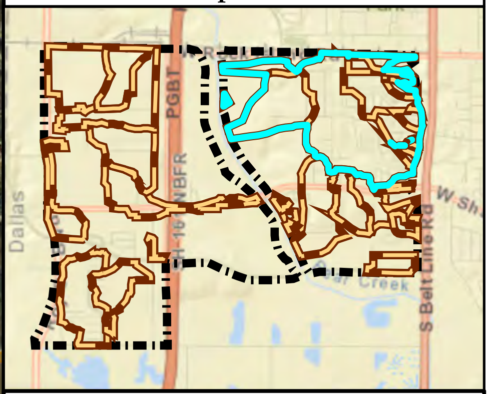
Jan. 2018

Exhibit 10Ed - 2

\\gpr\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGroveReportExhibits\MXD\Exhibit10d_ProposedImprovementConditions_Mapbook.mxd

- Outfall
- Pipe Nodes
  - HGL Below Ground
  - HGL Above Ground
- Streams
- Modeled Pipes Capacity Rating
  - <1, Capacity not exceeded and tailwater does not submerge the system
  - 1, Capacity not exceeded, but tailwater submerges system
  - 2, Capacity exceeded and tailwater submerges system
- Flow Direction
- 2D Results Line
- 2D Results Polygon
- Areas of Interest
- EX 2D Depths > 0.5'
- PROP 2D Depths > 0.5'
- Buildings Removed from Flooding > 0.5'
  - NO
  - YES
- FEMA Flood Zone
  - A,
  - AE
  - AE, FLOODWAY

Index map not to scale.



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N

0 500 1,000
Feet

Proposed 100YR Results Comparison: MANANA, P, Q, R, X, Y, Y2, Z, Z3, Z4, Z5, Z6, Z7, Z8, Z9

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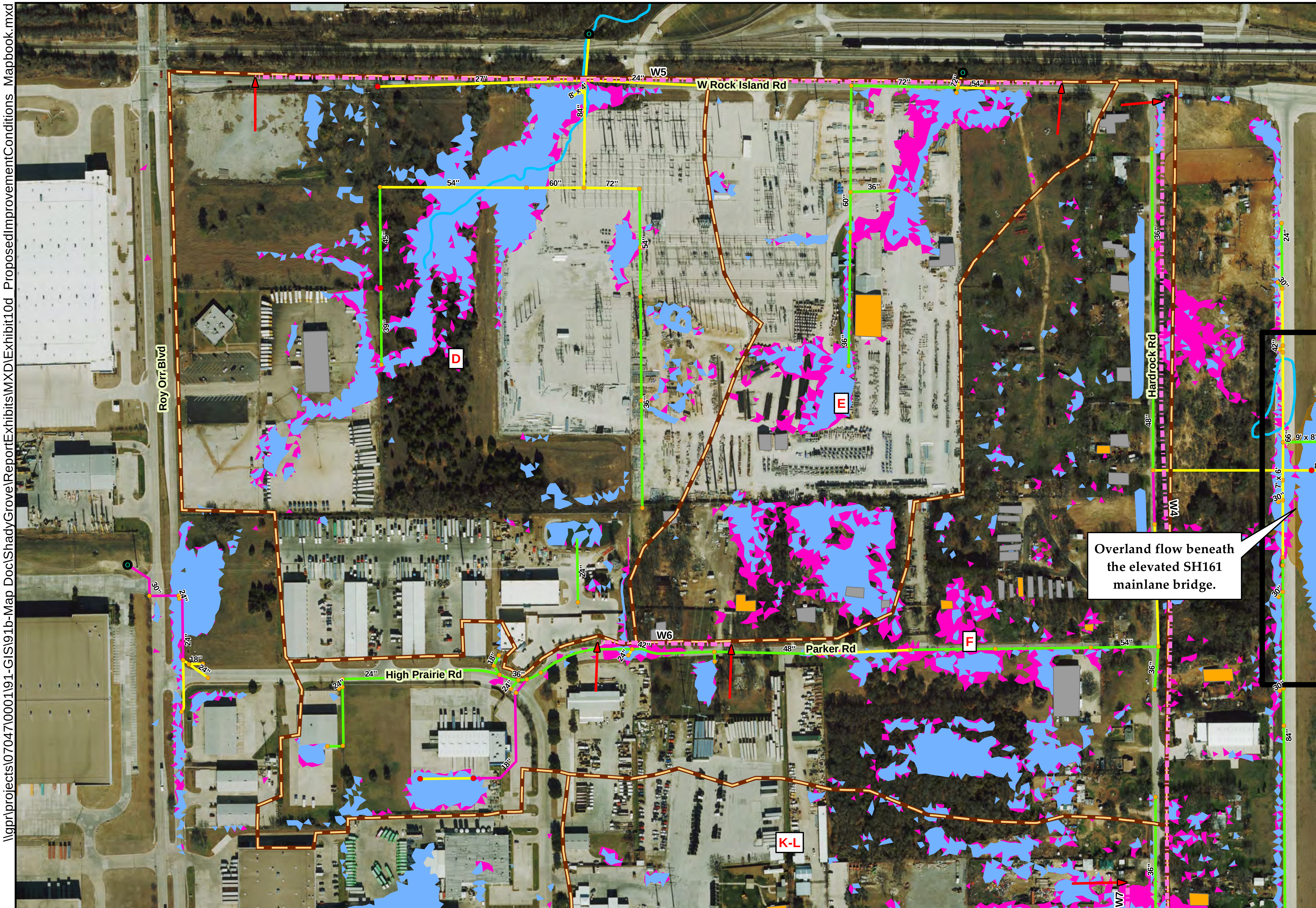
4275 Kellway Circle, Suite 144
Addison, TX 75001
Tel: (817) 484-5695

Prop 100YR Comparison

Prepared For:
City of Grand Prairie

Jan. 2018 | Exhibit 10Ed - 3



Outfall

Pipe Nodes

HGL Below Ground

HGL Above Ground

Streams

Modeled Pipes Capacity Rating

<1, Capacity not exceeded and tailwater does not submerge the system

1, Capacity not exceeded, but tailwater submerges system

2, Capacity exceeded and tailwater submerges system

Flow Direction

2D Results Line

2D Results Polygon

Areas of Interest

EX 2D Depths > 0.5'

PROP 2D Depths > 0.5'

Buildings Removed from Flooding > 0.5'

NO

YES

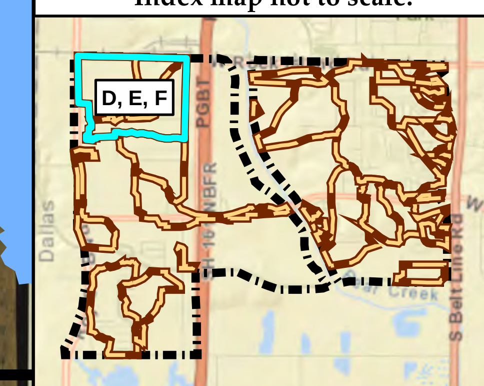
FEMA Flood Zone

A,

AE

AE, FLOODWAY

Index map not to scale.



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N

0 300 600

Feet

Proposed 100YR Results Comparison: D, E, F

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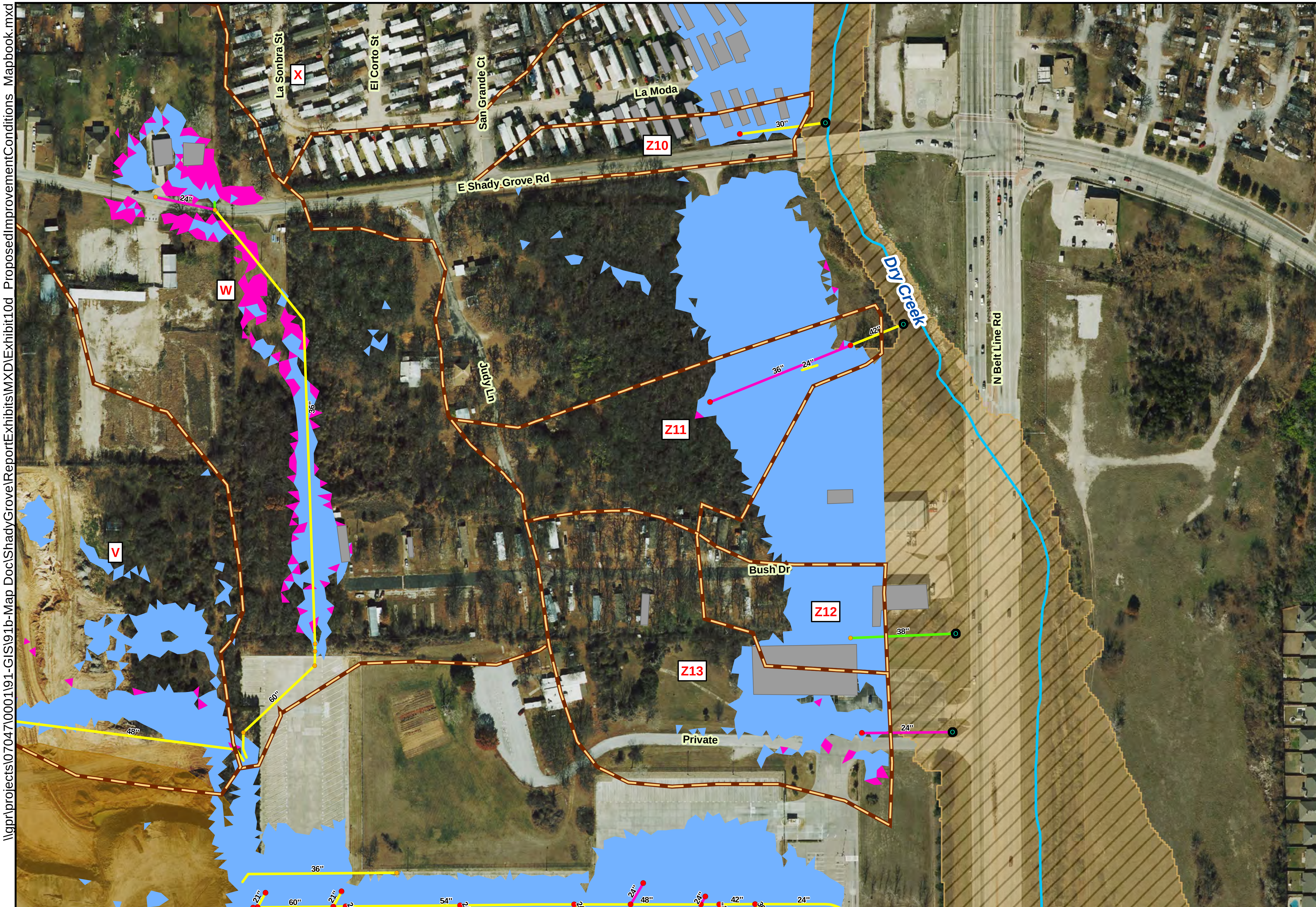
Addison, TX 75001
Tel: (817) 484-5695

Prop 100YR Comparison

Prepared For: City of Grand Prairie

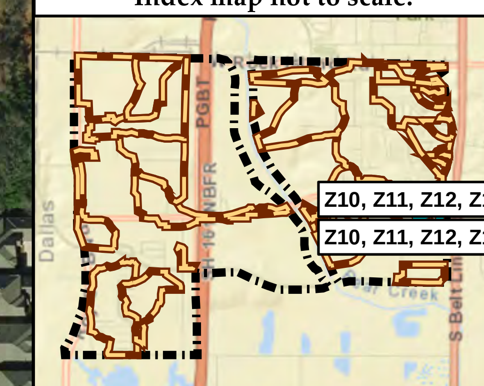
Jan. 2018 | Exhibit 10Wd - 4

\\gpr\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit10d_ProposedImprovementConditions_Mapbook.mxd



- Outfall
- Pipe Nodes
  - HGL Below Ground
  - HGL Above Ground
- Streams
- Modeled Pipes Capacity Rating
  - <1, Capacity not exceeded and tailwater does not submerge the system
  - 1, Capacity not exceeded, but tailwater submerges system
  - 2, Capacity exceeded and tailwater submerges system
- Flow Direction
- 2D Results Line
- 2D Results Polygon
- Areas of Interest
- EX 2D Depths > 0.5'
- PROP 2D Depths > 0.5'
- Buildings Removed from Flooding > 0.5'
  - NO
  - YES
- FEMA Flood Zone
  - A,
  - AE
  - AE, FLOODWAY

Index map not to scale.



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N

0 200 400
Feet

Proposed 100YR Results Comparison: Z10, Z11, Z12, Z13

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Prop 100YR Comparison

Prepared For:
City of Grand Prairie

Jan. 2018 | Exhibit 10Ed - 5

\\gpr\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit10d_ProposedImprovementConditions_Mapbook.mxd

- Outfall
- Pipe Nodes
  - HGL Below Ground
  - HGL Above Ground
- Streams
- Modeled Pipes Capacity Rating
  - <1, Capacity not exceeded and tailwater does not submerge the system
  - 1, Capacity not exceeded, but tailwater submerges system
  - 2, Capacity exceeded and tailwater submerges system
- Flow Direction
- 2D Results Line
- 2D Results Polygon
- Areas of Interest
- EX 2D Depths > 0.5'
- PROP 2D Depths > 0.5'
- Buildings Removed from Flooding > 0.5'
  - NO
  - YES
- FEMA Flood Zone
  - A,
  - AE
  - AE, FLOODWAY

Index map not to scale.

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N

0 200 400
Feet

Proposed 100YR Results Comparison: W1

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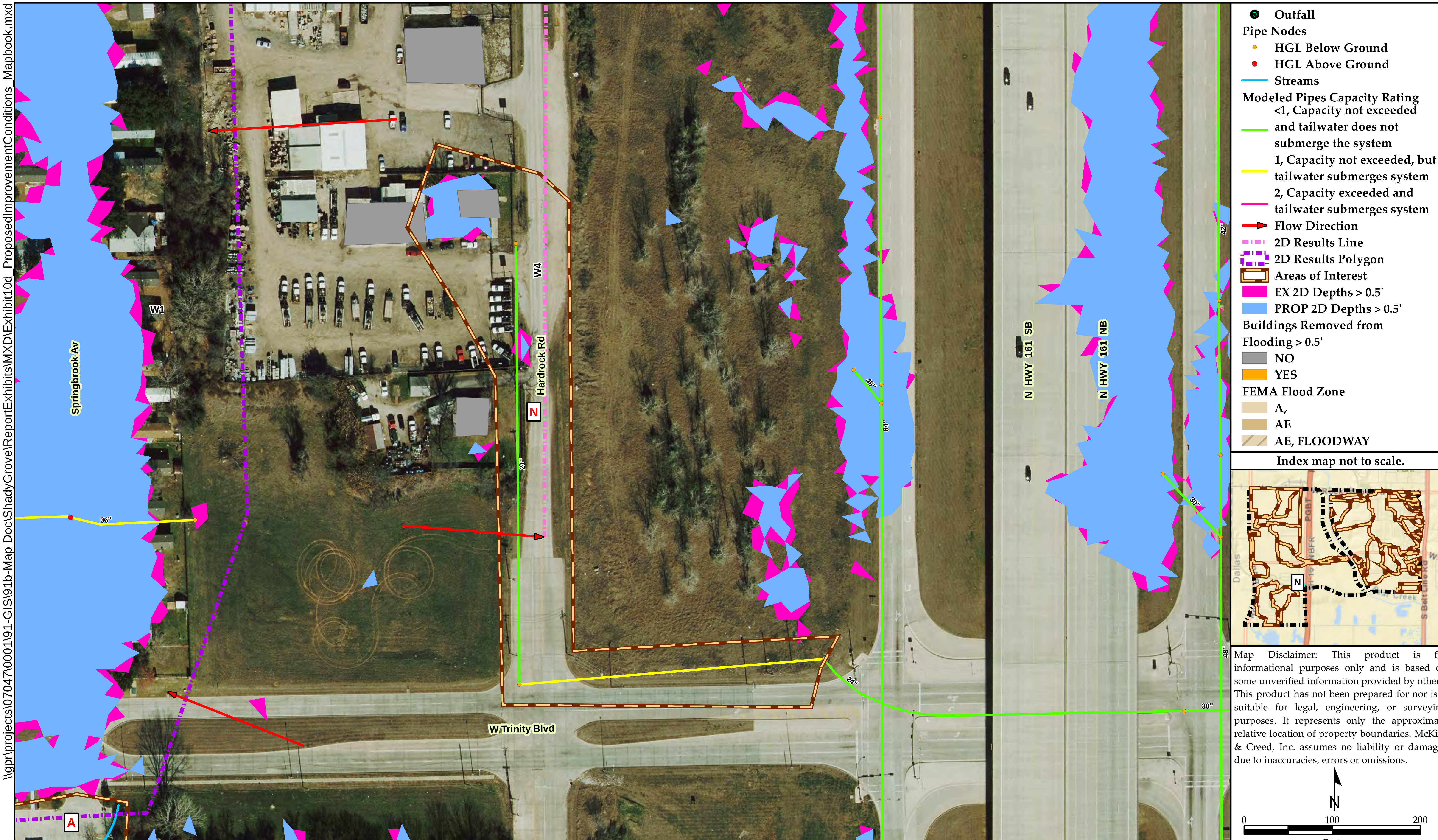
Prop 100YR Comparison

Prepared For: City of Grand Prairie

Jan. 2018 | Exhibit 10Ed - 6

\\gprl\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit10d_ProposedImprovementConditions_Mapbook.mxd



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Proposed 100YR Results Comparison: N

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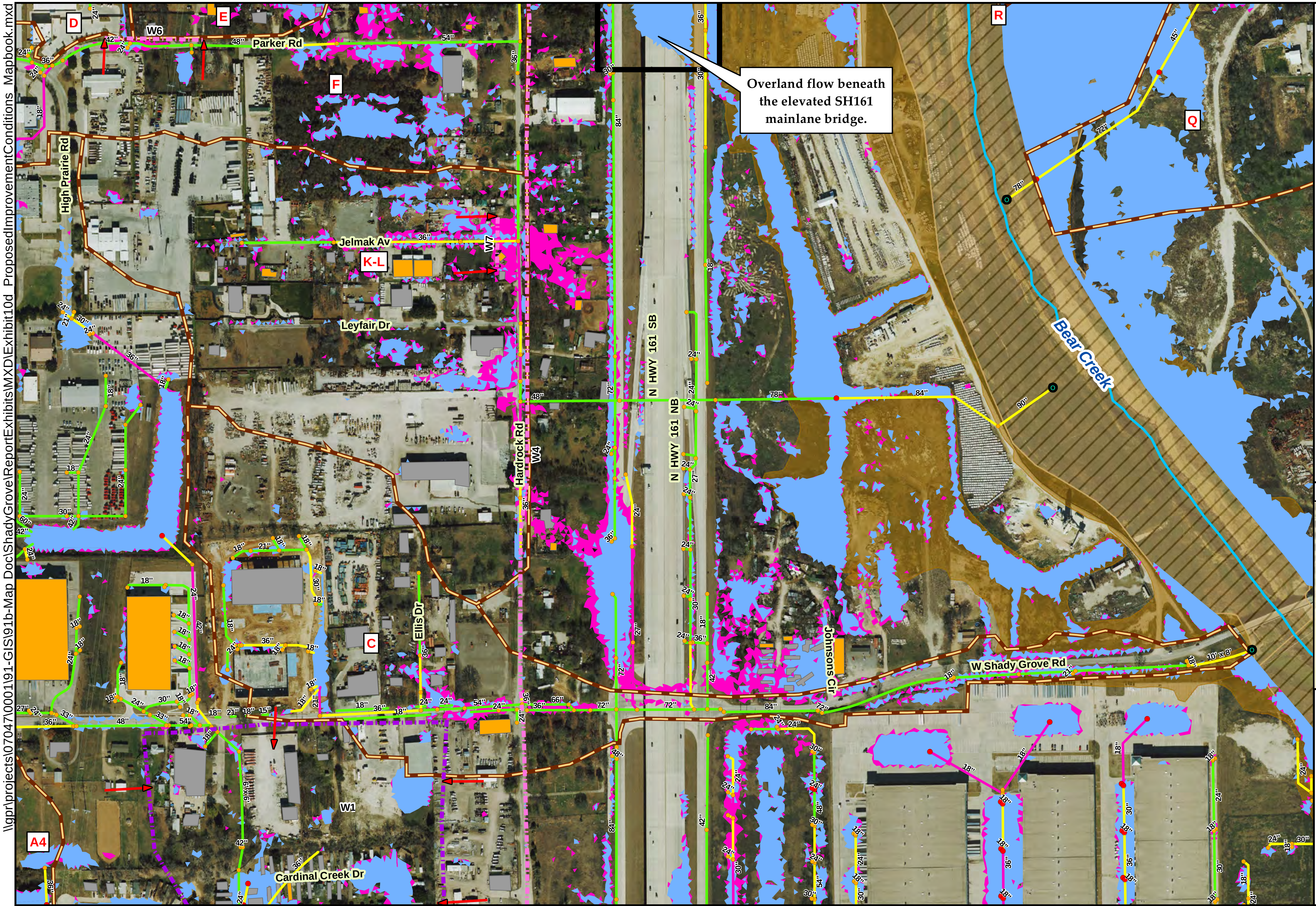
Prop 100YR Comparison

Prepared For: City of Grand Prairie

Jan. 2018 | Exhibit 10Wd - 7



Outfall

Pipe Nodes
- HGL Below Ground
- HGL Above Ground

Streams

Modeled Pipes Capacity Rating
- <1, Capacity not exceeded and tailwater does not submerge the system
- 1, Capacity not exceeded, but tailwater submerges system
- 2, Capacity exceeded and tailwater submerges system

Flow Direction

2D Results Line

2D Results Polygon

Areas of Interest

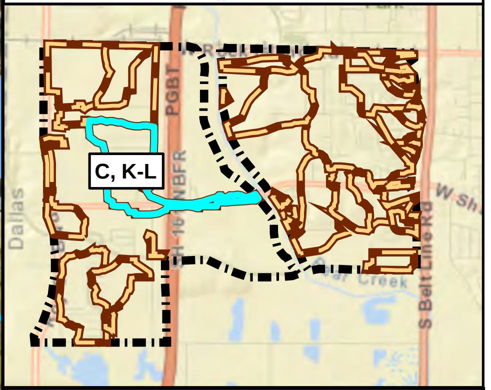
EX 2D Depths > 0.5'

PROP 2D Depths > 0.5'

Buildings Removed from Flooding > 0.5'
- NO
- YES

FEMA Flood Zone
- A,
- AE
- AE, FLOODWAY

Index map not to scale.



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N

0 400 800
Feet

Proposed 100YR Results Comparison: C, K-L

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Prop 100YR Comparison

Prepared For: City of Grand Prairie

Jan. 2018 | Exhibit 10Wd - 8

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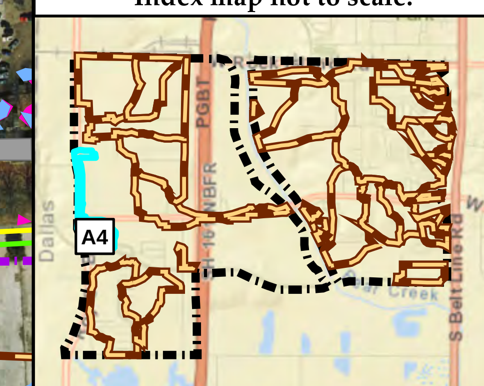
Outfall
Pipe Nodes
HGL Below Ground
HGL Above Ground
Streams
Modeled Pipes Capacity Rating
<1, Capacity not exceeded and tailwater does not submerge the system
1, Capacity not exceeded, but tailwater submerges system
2, Capacity exceeded and tailwater submerges system
Flow Direction
2D Results Line
2D Results Polygon
Areas of Interest
EX 2D Depths > 0.5'
PROP 2D Depths > 0.5'
Buildings Removed from Flooding > 0.5'
NO
YES
FEMA Flood Zone
A,
AE
AE, FLOODWAY

Index map not to scale.



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N

0 300 600
Feet

Proposed 100YR Results Comparison: A4

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Prop 100YR Comparison

Prepared For:
City of Grand Prairie

Jan. 2018

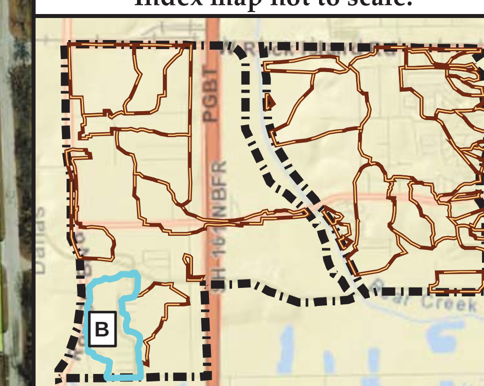
Exhibit 10Wd - 9

- Existing Inlet
- Proposed Grate Inlet
- Proposed Curb Inlet
- Proposed Type Y Inlet
- Flow Direction
- 2D Network Result Line
- Proposed Pipes
- Existing Pipes
- Roads to be Reconstructed as curb and gutter section
- Potential Detention Areas
- 2D Results Polygon
- Basins
- Property to be Acquired
- Buildings Benefited from CIP

Parcels by Ownership

- Owned by Others
- Owned By Grand Prairie
- Owned by Irving

Index map not to scale.



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N

0 300 600
Feet

River Ridge Blvd. Storm Drain Improvements

McKIM&CREED
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Addison, TX 75001
Tel: (817) 484-5695

Proposed Layout

Prepared For: City of Grand Prairie

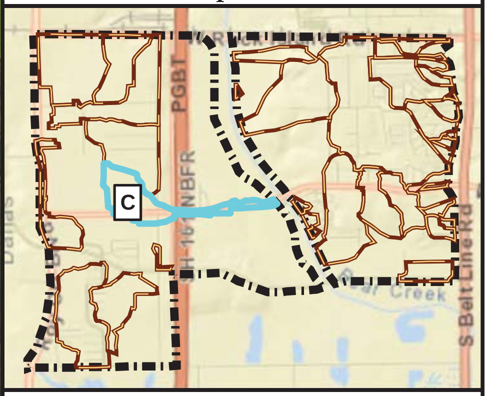
Jan. 2018 | Exhibit 11W - 1

\\gprlprojects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit11_ProposedPipes_Mapbook.mxd

Existing Inlet
Proposed Grate Inlet
Proposed Curb Inlet
Proposed Type Y Inlet
Flow Direction
Proposed Pipe
Existing Pipe
Remove Existing
2D Network Result Line
Roads to be Reconstructed as curb and gutter section
Potential Detention Areas
Basins
Property to be Acquired
Buildings Benefited from CIP

Parcels by Ownership
Owned by Others
Owned By Grand Prairie
Owned by Irving

Index map not to scale.



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0 400 800
Feet

Shady Grove Storm Drain Improvements

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4275 Kellway Circle, Suite 144
Addison, TX 75001
Tel: (817) 484-5695

Proposed Layout

Prepared For: City of Grand Prairie

Jan. 2018 | Exhibit 11W - 2

\\gpr\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit11_ProposedPipes_Mapbook.mxd

Existing Inlet
Proposed Grate Inlet
Proposed Curb Inlet
Proposed Type Y Inlet
Flow Direction
2D Network Result Line
Proposed Pipes
Existing Pipes
Roads to be Reconstructed as curb and gutter section
Potential Detention Areas
2D Results Polygon
Basins
Property to be Acquired
Buildings Benefited from CIP

Parcels by Ownership

Owned by Others
Owned By Grand Prairie
Owned by Irving

Index map not to scale.

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0 300 600
Feet

\\gpr\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit11_ProposedPipes_Mapbook.mxd

Parker Rd - Hardrock Rd Storm Drain Improvements

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Proposed Layout

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City of Grand Prairie

Jan. 2018 | Exhibit 11W - 3

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Jelmak Rd - Hardrock Rd Storm Drain Improvements

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Proposed Layout

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Jan. 2018 | Exhibit 11W - 4

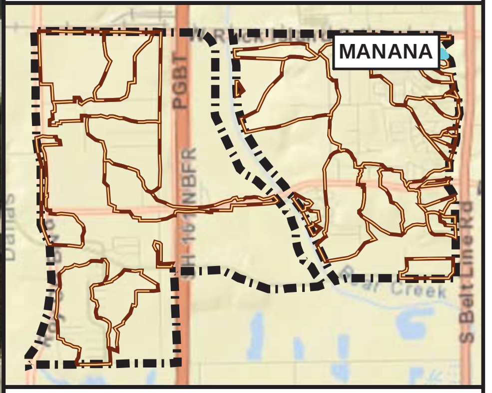
\\gpr\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit11_ProposedPipes_Mapbook.mxd

- Existing Inlet
- Proposed Grate Inlet
- Proposed Curb Inlet
- Proposed Type Y Inlet
- Flow Direction
- 2D Network Result Line
- Proposed Pipes
- Existing Pipes
- Roads to be Reconstructed as curb and gutter section
- Potential Detention Areas
- 2D Results Polygon
- Basins
- Property to be Acquired
- Buildings Benefited from CIP

Parcels by Ownership

- Owned by Others
- Owned By Grand Prairie
- Owned by Irving

Index map not to scale.



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N

0 200 400

Feet

Manana Channel Improvements

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Addison, TX 75001
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Proposed Layout

Prepared For: City of Grand Prairie

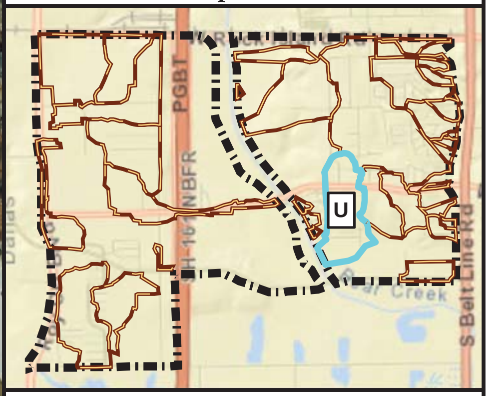
Jan. 2018 | Exhibit 11E - 5

\\gpr\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit11_U_all.mxd

Existing Inlet
Proposed Grate Inlet
Proposed Curb Inlet
Proposed Type Y Inlet
Flow Direction
2D Network Result Line
Proposed Pipe
Existing Pipe
Remove Existing
Roads to be Reconstructed as curb and gutter section
Potential Detention Areas
Basins
Property to be Acquired
Buildings Benefited from CIP
Existing Detention Basin

Parcels by Ownership
Owned by Others
Owned By Grand Prairie
Owned by Irving

Index map not to scale.



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N

0 300 600
Feet

Shady Grove Rd., Gilbert Rd., Wright Rd. Storm Drain Improvements - All

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4275 Kellway Circle, Suite 144
Addison, TX 75001
Tel: (817) 484-5695

Proposed Layout

Prepared For: City of Grand Prairie

Jan. 2018 | Exhibit 11E - 6

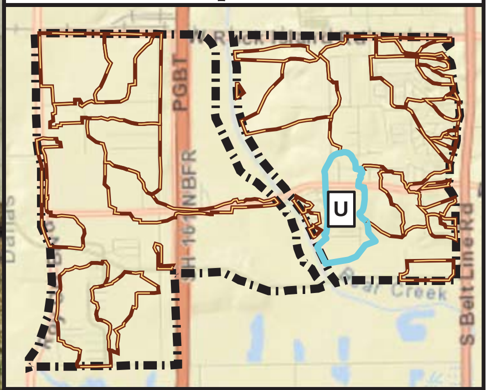
\\ggr\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit11a_Construction_Phase1.mxd

- Existing Inlet
- Proposed Grate Inlet
- Proposed Curb Inlet
- Proposed Type Y Inlet
- Flow Direction
- 2D Network Result Line
- Existing Pipe
- Proposed Pipe
- Remove Existing
- Roads to be Reconstructed as curb and gutter section
- Basins
- Property to be Acquired
- Buildings Benefited from CIP

Parcels by Ownership

- Owned by Others
- Owned By Grand Prairie
- Owned by Irving

Index map not to scale.



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N

0 200 400

Feet

Shady Grove Rd., Gilbert Rd., Wright Rd. Storm Drain Improvements - Phase 1

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Proposed Layout

Prepared For: City of Grand Prairie

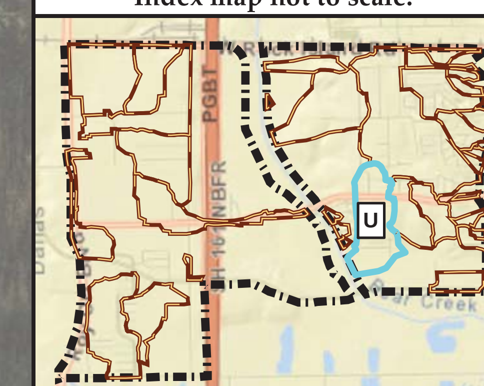
Jan. 2018 | Exhibit 11E - 6a

\\gpr\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit11b_Construction_Phase2.mxd

Existing Inlet
Proposed Grate Inlet
Proposed Curb Inlet
Proposed Type Y Inlet
Flow Direction
2D Network Result Line
Existing Pipe
Proposed Pipe
Remove Existing
Roads to be Reconstructed as curb and gutter section
Basins
Property to be Acquired
Buildings Benefited from CIP
Existing Detention Basin

Parcels by Ownership
Owned by Others
Owned By Grand Prairie
Owned by Irving

Index map not to scale.



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N

0 100 200
Feet

Shady Grove Rd., Gilbert Rd., Wright Rd.
Storm Drain Improvements - Phase 2

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Addison, TX 75001
Tel: (817) 484-5695

Proposed Layout

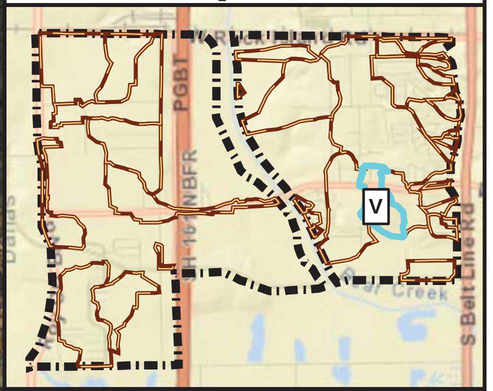
Prepared For: City of Grand Prairie

Jan. 2018 | Exhibit 11E - 6b

\\gpr\projects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit11_ProposedPipes_Mapbook.mxd

Existing Inlet
Proposed Grate Inlet
Proposed Curb Inlet
Proposed Type Y Inlet
Flow Direction
Proposed Pipe
Existing Pipe
Remove Existing
2D Network Result Line
Roads to be Reconstructed as curb and gutter section
Potential Detention Areas
Basins
Property to be Acquired
Buildings Benefited from CIP
Parcels by Ownership
Owned by Others
Owned By Grand Prairie
Owned by Irving

Index map not to scale.



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N

0 200 400
Feet

Shady Grove - Jones Storm Drain Improvements

McKIM&CREED
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Addison, TX 75001
Tel: (817) 484-5695

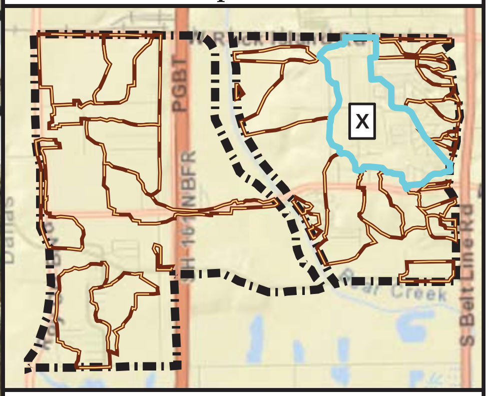
Proposed Layout

Prepared For:
City of Grand Prairie

Jan. 2018 | Exhibit 11E - 7

\\gprlprojects\07047\0001\91-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit11_ProposedPipes_Mapbook.mxd

Index map not to scale.



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N

0 400 800

Feet

Gilbert Drainage Improvements - All

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Addison, TX 75001
Tel: (817) 484-5695

Proposed Layout

Prepared For:
City of Grand Prairie

Jan. 2018 | Exhibit 11E - 8

\\gpr\projects\07047\000191-GIS\91b-Map Doc\ShadyGrove\ReportExhibits\MXD\Exhibit11X Construction Phase1 JKW.mxd

- Existing Inlet
- Proposed Grate Inlet
- Proposed Curb Inlet
- Proposed Type Y Inlet
- Proposed Inlet (Previous Phase)
- Flow Direction
- 2D Network Result Line
- Basins
- Buildings Benefited from CIP

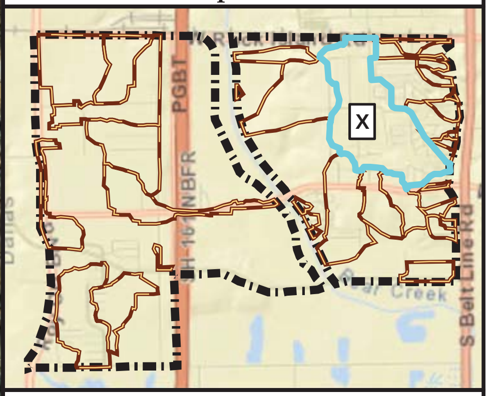
Current Phase

- Existing Pipe
- Proposed Pipe
- Remove Existing
- Roads to be Reconstructed as curb and gutter section (Current)
- Property to be Acquired (Current)
- Potential Detention Areas

Parcels by Ownership

- Owned by Others
- Owned By Grand Prairie
- Owned by Irving

Index map not to scale.



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N

0 300 600
Feet

Gilbert Drainage Improvements - Phase 1

McKIM&CREED
4275 Kellway Circle, Suite 144
Addison, TX 75001
Tel: (817) 484-5695

Proposed Layout

Prepared For:
City of Grand Prairie

Jan. 2018 | Exhibit 11E - 8a

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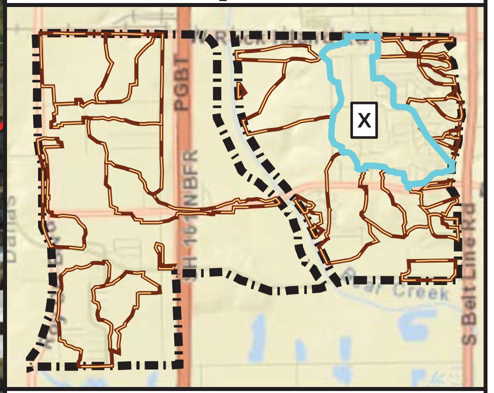
- Existing Inlet
- Proposed Grate Inlet
- Proposed Curb Inlet
- Proposed Type Y Inlet
- Proposed Inlet (Previous Phase)
- Flow Direction
- 2D Network Result Line
- Basins
- Buildings Benefited from CIP

Current Phase
- Existing Pipe
- Proposed Pipe
- Remove Existing
- Roads to be Reconstructed as curb and gutter section (Current)
- Property to be Acquired (Current)

Previous Phase
- Proposed Pipe
- Remove Existing
- Potential Detention Areas
- Property to be Acquired (Previous)

Index map not to scale.



Map Disclaimer: This product is for informational purposes only and is based on some unverified information provided by others. This product has not been prepared for nor is it suitable for legal, engineering, or surveying purposes. It represents only the approximate relative location of property boundaries. McKim & Creed, Inc. assumes no liability or damages due to inaccuracies, errors or omissions.

N

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Feet

Gilbert Drainage Improvements - Phase 2

McKIM&CREED
4275 Kellway Circle, Suite 144
Addison, TX 75001
Tel: (817) 484-5695

Proposed Layout

Prepared For: City of Grand Prairie

Jan. 2018 | Exhibit 11E - 8b

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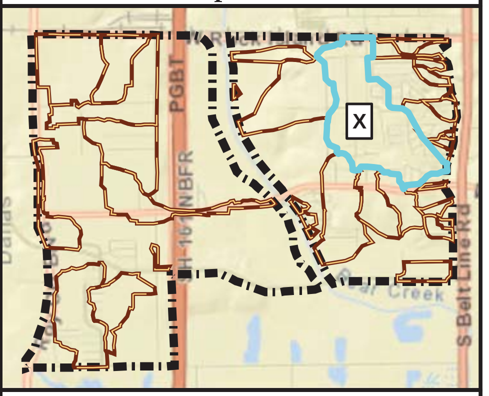
- Existing Inlet
- Proposed Grate Inlet
- Proposed Curb Inlet
- Proposed Type Y Inlet
- Proposed Inlet (Previous Phase)
- Flow Direction
- 2D Network Result Line
- Basins
- Buildings Benefited from CIP

Current Phase
- Existing Pipe
- Proposed Pipe
- Remove Existing
- Roads to be Reconstructed as curb and gutter section (Current)
- Property to be Acquired (Current)

Previous Phase
- Proposed Pipe
- Remove Existing
- Roads to be Reconstructed as curb and gutter section (Previous Phase)
- Potential Detention Areas
- Property to be Acquired (Previous)

Index map not to scale.



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Feet

Gilbert Drainage Improvements - Phase 3

McKIM&CREED
4275 Kellway Circle, Suite 144
Addison, TX 75001
Tel: (817) 484-5695

Proposed Layout

Prepared For:
City of Grand Prairie

Jan. 2018 | Exhibit 11E - 8c

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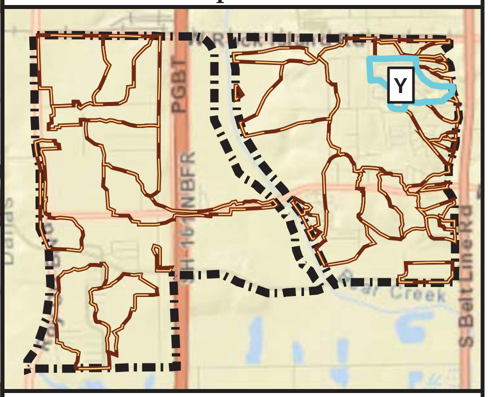
- Existing Inlet
- Proposed Grate Inlet
- Proposed Curb Inlet
- Proposed Type Y Inlet
- Flow Direction
- Proposed Pipe
- Existing Pipe
- Remove Existing
- 2D Network Result Line
- Roads to be Reconstructed as curb and gutter section
- Potential Detention Areas
- Basins
- Property to be Acquired
- Buildings Benefited from CIP

Parcels by Ownership

- Owned by Others
- Owned By Grand Prairie
- Owned by Irving

Index map not to scale.



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Feet

Thousand Oaks Storm Drain Improvements

McKIM&CREED
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Addison, TX 75001
Tel: (817) 484-5695

Proposed Layout

Prepared For: City of Grand Prairie

Jan. 2018 | Exhibit 11E - 9