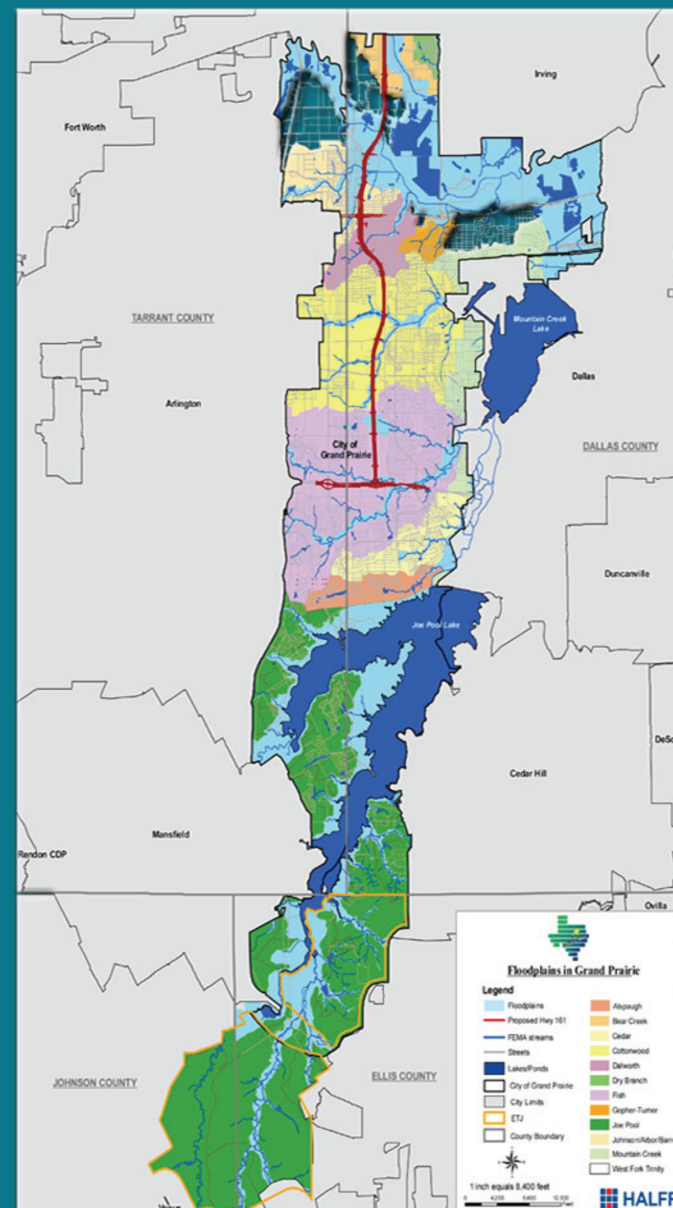
City of Grand Prairie

City-Wide Drainage Master Plan Road Map



August 2010

Prepared by

HALFF

Grand Prairie
TEXAS

RESOLUTION 10-4456

A RESOLUTION APPROVING THE CITY OF GRAND PRAIRIE CITY-WIDE DRAINAGE MASTER PLAN ROAD MAP

WHEREAS, the "City-Wide Drainage Master Plan Road Map" is about identifying the various drainage watershed basins in the City of Grand Prairie, prioritizing them and setting criteria to be used for the individual drainage master plans to reduce the impact of flooding to our citizens;

WHEREAS, as watershed and individual smaller basin studies are completed, projects will be identified and prioritized for funding consideration to reduce flooding for our citizens;

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF GRAND PRAIRIE, TEXAS:

SECTION 1. That the City of Grand Prairie, Texas, has developed the "City-Wide Drainage Master Plan Road Map" to cost-effectively manage flood or storm waters within budget constraints;

SECTION 2. That the City approves the "City-Wide Drainage Master Plan Road Map" which sets the criteria and format to perform watershed studies in order to update floodplain delineations and identify flood reduction projects.

PASSED AND APPROVED BY THE CITY COUNCIL OF THE CITY OF GRAND PRAIRIE, TEXAS, THIS 3RD DAY OF AUGUST, 2010.

____
ATTEST

____
APPROVED

____
APPROVED AS TO FORM

HALFF

August 3, 2010
AVO 24589

Mr. Romin Khavari, PE, CFM
City Engineer
City of Grand Prairie
206 W. Church Street
Grand Prairie, Texas 75053

RE: City-Wide Drainage Master Plan Road Map

Dear Mr. Khavari:

Transmitted herewith is the **FINAL** City-Wide Drainage Master Plan Road Map. This report provides the City of Grand Prairie with a road map to develop hydrologic, hydraulic, and storm drainage master plans for each of the City's major watersheds. Information is provided on current flooding problems, potential funding opportunities, current city policies, and implementation strategies. Halff provides multiple recommendations throughout the report to help guide the city for the future master plan development.

It has been a privilege and a challenge for our firm to prepare this most important study. We are especially appreciative of the cooperation of the City of Grand Prairie staff that has assisted in the development of this report. We look forward to continuing our efforts with the City.

Please do not hesitate to contact me if you have any questions or if you require additional information regarding this report.

Sincerely,

HALFF ASSOCIATES, INC.
TBPE Firm No. 312

Stephen Crawford

Stephen B. Crawford, PE, CFM
Vice President

STATE OF TEXAS
STEPHEN B. CRAWFORD
89249
LICENSED
PROFESSIONAL ENGINEER
8-3-10

C: Gabriel Johnson, PE, PH, CFM – City of Grand Prairie – Floodplain Administrator
Chris Agnew, PE – City of Grand Prairie – Assistant Storm Drainage Utility Manager

HALFF ASSOCIATES, INC.

2080 N. STATE HIGHWAY 360, SUITE 350
GRAND PRAIRIE, TX 75050-1497

TEL (214) 201-1270
FAX (214) 201-1271

WWW.HALFF.COM

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CD-ROMs (WITH WATERSHED TECHNICAL DATA)

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INTRODUCTION

I. INTRODUCTION

A. ACKNOWLEDGMENTS

Halff Associates would like to acknowledge the significant contributions of all City of Grand Prairie staff in preparation of the City-Wide Drainage Master Plan. In particular, the following individuals have provided invaluable input and assistance:

Romin Khavari – City Engineer
Joe Sherwin and Gabriel Johnson – Floodplain Administrators
Chris Agnew – Storm Drainage Engineer

B. CITY OF GRAND PRAIRIE – FLOODING AND DRAINAGE

The City of Grand Prairie is about learning lessons from the past and using these lessons to prepare for the future. The City has a history of flooding problems. Documented large floods have occurred across the City many times, including 1908, 1932, 1957, 1968, 1976, 1981, 1989, 1990, 1991, 2006, and 2007. Many other smaller floods have occurred multiple times throughout the years, sometimes affecting large areas of the City or more localized areas.

There are over 19,000 acres of floodplain in the City of Grand Prairie. This accounts for 36.7% of the total City area, more than any other City in the region. Large floodplain areas include Joe Pool Lake, Mountain Creek, and the West Fork Trinity River floodplain. Other major watersheds include Cottonwood Creek, Fish Creek, and Johnson Creek. Appendix A includes a floodplain map of the City.

City flooding and drainage problems are key issues when planning for the safety, health, and quality of life for Grand Prairie citizens. As of 2009, over 2300 drainage complaints have been filed to City staff (Appendix A includes a general map of drainage complaint locations). Also, land development in Grand Prairie continues to increase over time, thus increasing the potential for faster and greater flooding chances at many locations across the City. Many successful projects have been built in the City to provide flood control, including channels, culverts, bridges, detention, and lakes. However, many areas are still in need of additional flood control measures or repairs and improvements to existing flood control structures. The City-Wide Drainage Master Plan Road Map establishes the processes for future flood control planning for the City of Grand Prairie.

The City's primary goal and objective of the City-Wide Drainage Master Plan is to cost-effectively manage flood or storm waters within budgeting constraints so that conditions don't get worse as new and infill areas are developed – while evaluating and making conditions better (prioritized improvements) in the areas of the city that are already developed.

C. CITY OF GRAND PRAIRIE – INDIVIDUAL WATERSHEDS

The City of Grand Prairie extends in a north to south direction from north of Interstate Highway 30 to south of Interstate Highway 20. Grand Prairie, including its two ETJ's, is located in four counties: Tarrant, Dallas, Ellis, and Johnson. For the purposes of the City-wide Drainage Master Plan effort, the City of Grand Prairie has been divided into the following major watersheds (refer to maps in Appendix A & C through N for more detail):

Table I-1
Grand Prairie Individual Watersheds and Planning Study Priority

Grand Prairie Individual Watersheds	Watershed Priority
Joe Pool Lake	1
Fish Creek	2
Cottonwood Creek	3
Cedar Creek	4
Johnson/Arbor/Barrett	5
West Fork Trinity River	6
Mountain Creek	7
Dalworth Creek	8
Gopher/Turner	9
Bear Creek	10
Dry Branch	11
Alspaugh Branch	12

As shown in Table I-1, the City has determined the priority of planning studies for each of the individual watershed areas. Future planning studies will commence in this general order.

D. CITY-WIDE DRAINAGE MASTER PLAN ROAD MAP - GOALS

The City-Wide Drainage Master Plan, as outlined in this Road Map, will accomplish the following goals:

1. Provide the building blocks to reduce the existing potential for floodplain and storm water damage to public health, safety, life, property, and the environment
2. Protect and enhance the quality, quantity, and availability of surface water resources
3. Promote equitable, acceptable, and legal measures for floodplain and storm water management
4. Address the remaining flooding issues in Grand Prairie, including both inadequate storm drainage systems and floodplains
5. Provide a comprehensive, City-wide drainage inventory and assessment with recommendations for flooding and drainage issues
6. Provide a systematic and financially sound strategy for reducing or eliminating flooding in Grand Prairie
7. Provide short term goals for constructing smaller projects and a long-range plan for larger, more complex projects
8. Identify and prioritize the needed improvements for small, medium, and large projects for both City-Wide and individual watersheds.

To accomplish these goals, the individual Drainage Master Plan for each watershed will need to provide the following:

1. Careful examination of drainage and flooding issues in each watershed, including major streams, tributaries, and storm drainage systems
2. Review of citizen drainage complaints to more accurately define trouble areas
3. Review of all existing available data for each watershed, including technical studies, reports, and design projects
4. Understanding of unique attributes of each watershed
5. Preparation of sound hydrologic and hydraulic and storm drain models and making these models consistent for each watershed. A goal of these studies is also to provide new, updated models that can be calibrated against Grand Prairie's new flood warning system stream gages.
6. Provide new and updated floodplain mapping based on the best data available, including modeling, field surveys, and topography

7. Prepare detailed, innovative alternatives for streams, open channels, and storm drainage infrastructure. Considerations will be made for "less-than 100-year design" in difficult cases.
8. Document all dams, levees, detention located in each watershed and determine how these are affecting flooding issues
9. Provide updated GIS information based on watershed study results to ensure that City staff has the most current, updated information available for their use
10. Provide a schedule for maintenance on specific streams and drainage features for each watershed
11. Evaluate and Prioritize stream, open channel, and storm drainage infrastructure alternatives so projects can be built to address both major and minor flooding issues over time and in the best possible order. Weigh flood control benefits against project costs.
12. Provide detailed, easy to understand documentation for City staff to make the best decisions on which projects need to be considered at the appropriate timeframe in the future

SECTION II

CITY-WIDE DRAINAGE MASTER PLAN ROAD MAP

II. CITY-WIDE DRAINAGE MASTER PLAN ROAD MAP

A. PREVIOUS ACCOMPLISHMENTS

Phase I Study - In November 2006, the City contracted with Halff Associates to prepare an initial study for the City-Wide Drainage Master Plan. In this study, these following tasks were accomplished:

1. Public Involvement program including presentations to four regions of the City and providing an on-line questionnaire regarding flooding issues
2. Preparing a Flood Warning Feasibility Study, completed in September 2007 (David Ford Consulting)
3. Providing a storm drain modeling software overview with recommendations
4. GIS Database Coordination and Management of drainage features
5. Explore initial funding opportunities, including application for a Texas Water Development Board (TWDB) Flood Protection Planning Grant
6. Establishing preliminary ranking of watersheds and estimated fees for studying each watershed
7. Preparing the Road Map scope of work to continue with the City-Wide Drainage Master Plan effort and to further identify individual watershed scope of works

Fish Creek & Cottonwood Creek TWDB Grant – The City of Grand Prairie was awarded with a Flood Protection Planning Grant for Fish Creek and Cottonwood Creek watersheds. This work, being performed by Espey Consultants, is currently on-going. Scope of works included in Appendix D & E are tailored to coordinate with the scope being utilized for the TWDB Planning Grant work.

Flood Warning – Flood Flashers and Rain & Stream Gauge Installations – In January 2009, the City of Grand Prairie awarded a contract to High Sierra Electronics for the installation of a flood flasher system at Carrier Parkway and Cottonwood Creek (McFalls Park) and for the installation of 16 rain & stream gages located throughout the City at or near existing road crossings. The locations of the gages are as follows:

1. South Fork of Cottonwood Creek at Carrier Parkway
2. Cottonwood Creek at Belt Line Road
3. Cottonwood Creek at Great Southwest Parkway
4. Fish Creek at Carrier Parkway
5. Prairie Creek at Great Southwest Parkway
6. Fish Creek at Great Southwest Parkway
7. South Fork of Cottonwood Creek at Great Southwest Parkway

8. Bear Creek at Trinity Boulevard
9. Johnson Creek at Avenue J
10. Kirby Creek at Corn Valley Road
11. Arbor Creek at Tarrant Road
12. Dalworth Creek at Carrier Parkway
13. Gopher Branch at Belt Line Road
14. Dry Branch at Oakview Drive
15. Alspaugh Branch at Camp Wisdom Road
16. Cedar Creek at Bardin Road
17. Mountain Creek at Jefferson Blvd

2009 City of Grand Prairie LiDAR – In January 2009, the City of Grand Prairie awarded the team of Halff Associates/Terrapoint for the acquisition of 1-foot LiDAR topography for the entire City of Grand Prairie. The most recent topography for the City was flown in 1999 by traditional methods. The goal of this project is to have the most current topography of the City available for consultants to perform the new individual Drainage Master Plans for each watershed. The first study to utilize the new topography will be the Joe Pool Lake Drainage Master Plan (Halff Associates – 2009).

City also contracted Marshall Lancaster to update all G.P.S. monuments in the city. This updated information is to be used for all studies and elevation certificates.

B. INVENTORY OF AVAILABLE DATA

Halff Associates has collected all recent City studies and reports, current master drainage plans, drainage complaint files, and other related flooding and storm water data from City staff. Halff has also coordinated with local and state agencies, including NCTCOG, FEMA, and the Corps of Engineers on available data they have in the City of Grand Prairie. Additionally, Halff has coordinated common drainage and flooding problems with adjacent communities, including the City of Arlington, City of Cedar Hill, City of Dallas, City of Irving, City of Mansfield, and the City of Midlothian. The general response from the agencies and adjacent communities is that limited information is available and will have to be obtained by the consultant, as necessary, while preparing the individual watershed master plan. Halff has included CD-ROMs with technical data and reports (in PDF format) of all information available for each watershed.

Also, Halff has compiled a hydraulic model summary (included in Appendix B) for all streams in the City of Grand Prairie. This summary is separated by watershed and stream name and includes notes on the types of models that are available, such as current effective or study models. These models are also available on the enclosed CD-ROMs in this report and will be available to all study teams as they commence their watershed master plans.

Current and On-Going Projects

The City of Grand Prairie has a number of on-going projects that will also need to be taken into consideration as individual watershed master plan studies commence. The following projects/studies are active or are soon-to-be active as of 2009:

1. Cottonwood Creek Watershed
   i. Central Park – Included detailed hydrology and hydraulics along Warrior Creek from the confluence at the South Fork Cottonwood Creek to upstream of SH 161 (Halff Associates)
   ii. TWDB Flood Protection Planning Grant Study (Espey Consultants)
2. Fish Creek Watershed
   i. Prime Outlets Development – Prairie Creek
   ii. Grand Prairie Airport Detention – Kirby Creek (KSA Engineers/Kimley-Horn)
   iii. Smith Property Fill at SH 161 – Kirby Creek (Adams Engineering)
   iv. TWDB Flood Protection Planning Grant Study (Espey Consultants)
3. Dry Branch Study for the City of Irving (Freese & Nichols)
4. Johnson Creek Study (in Arlington, TX) for the U.S. Army Corps of Engineers & the City of Arlington (HDR)
5. Arbor Creek – Dam Reconstruction Design (O'Brien Engineering)
6. West Fork Trinity River
   i. Belt Line Road Reclamation Project – CDC/CLOMR (Halff Associates)
   ii. MacArthur Blvd. Study (Nathan D. Maier)
   iii. Future UTA Structural Research Lab at northeast corner of I-30 and MacArthur Blvd.
7. Gopher Branch and West Fork Trinity River
   i. Palace Parkway Study and Design (Halff Associates)
   ii. Belt Line Road Repairs at Gopher Branch – Recently Completed (Halff Associates)
   iii. Gopher Branch & Turner Branch LOMR (Halff Associates)
8. Joe Pool Lake Area
   i. Taaffe Creek Master Plan - City of Mansfield (Halff)
   ii. FEMA Map Mod Updates for Ellis and Johnson County
9. Bear Creek
   i. Dallas County Reclamation Project (on-going)
   ii. Rock Island Road bridge project (City of Irving)
10. SH 161 Construction
    i. North of IH-30 – Bridge construction affects Arbor Creek, Johnson Creek, West Fork Trinity River

ii. South of IH-30 – Bridge construction affects Dalworth Creek, Cottonwood Creek, and South Fork Cottonwood Creek
iii. Road construction affects most major watersheds in Grand Prairie from the north City limits to IH-20
iv. Main Lane Construction to be commenced and completed within the next 2 to 5 years

11. Rain & Stream Gage Installations – Rain & Stream Gages will be placed at approximately 16 locations throughout the City in various watersheds (High Sierra Electronics)
12. Miscellaneous Storm Drainage Improvement Projects – Along or near the following streets: Trinity Boulevard (north of Oakdale), Oakdale, Mayfield Road, Great Southwest Parkway, Arkansas Lane (west of Carrier), Warrior Trail (west of Carrier), January Lane (west of SH 161) and other miscellaneous site development projects involving detention basins and small storm drainage systems.
13. LiDAR Acquisition – City of Grand Prairie 1-foot topography (Halff Associates/Terrapoint)

C. ASSESSMENT OF FLOODING PROBLEMS

Known Flood Hazards

The City of Grand Prairie has a history of documented flooding problems in the City. Currently, the City has over 2,000 documented drainage complaints. Current floodplain hydraulic models also illustrate locations in the City where roadways are currently overtopped.

Drainage Complaint Database

The City of Grand Prairie continues to document drainage complaints. Halff has included the current drainage complaint database for each watershed on the attached CD-ROMs.

Roadway Overtopping

The following tables illustrate the current hydraulic model, the station and description of the roadway crossing, and if the roadway crossing is overtopped by the 10%, 2%, or 1% (10-year, 50-year, 100-year) chance flood event.

Joe Pool Lake Watershed – Roadway Crossings

Stream: Lynn Creek						
Model: D20LYNN (HEC-2)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
1.	18835	*Webb Lynn Road*	552.60	Yes WSEL=553.77	Yes WSEL=554.98	Yes WSEL=555.41
Note: Since time of HEC-2 model, Webb-Lynn Road no longer crosses Lynn Creek in Grand Prairie. Location is now SH 360. A new Lynn Creek model (currently under FEMA review) should include new bridge/culvert locations in Grand Prairie and Arlington. Roadway names/stations need to be verified for future master plan models.						

Stream: Bowman Branch						
Model: D20BOW (HEC-2)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
2.	7825	*SH 360 (?)*	539.00	No WSEL=530.67	No WSEL=532.14	No WSEL=532.66
3.	5243	*Mirabella (?)*	513.60	Yes WSEL=522.13	Yes WSEL=522.35	Yes WSEL=522.52
Note: Roadway names/stations need to be verified for future master plan models.						

Stream: Walnut Creek						
Model: WC.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
4.	10120	*SH 360 Frontage SB*	542.00	No WSEL=536.27	No WSEL=540.10	No WSEL=541.85
5.	9730	*SH 360 Frontage NB*	542.00	No WSEL=536.03	No WSEL=539.73	No WSEL=541.30
Note: SH 360 crosses Walnut Creek in the City of Mansfield. No roadway crossings in City of Grand Prairie.						

Stream: Taaffe Creek						
Model: TAAFEE_CREEK.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
6.	2703	*Seeton Road*	537.13	No WSEL=535.05	Yes WSEL=537.15	Yes WSEL=537.76

Stream: Soap Creek						
Model: MainFork.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
7.	12116	*SH 287*	553.59	No WSEL=547.81	No WSEL=550.83	No WSEL=551.93

Stream: West Soap Creek						
Model: WestFork.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
8.	6755	*Jones Road*	583.00	Yes WSEL=584.99	Yes WSEL=585.75	Yes WSEL=586.09

Stream: East Soap Creek						
Model: EastFork.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
9.	3790	*Turner Road*	612.20	No WSEL=610.56	Yes WSEL=612.96	Yes WSEL=613.29
10.	2746	*Miller Road*	606.30	No WSEL=604.19	Yes WSEL=606.98	Yes WSEL=608.01

Stream: Plains Branch						
Model: Plains.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
11.	5076	*Old Fort Worth Road*	564.40	Yes WSEL=565.34	Yes WSEL=565.90	Yes WSEL=566.19
12.	459	*SH 287*	558.72	No WSEL=549.22	No WSEL=551.78	No WSEL=553.10

Stream: Newton Branch						
Model: Newton.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
13.	8676	*Kimble Road*	561.08	Yes WSEL=562.30	Yes WSEL=563.20	Yes WSEL=563.60

Stream: Bedford Branch						
Model: BEDFORD_BRANCH.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
14.	14443	*Railroad*	570.15	No WSEL=564.77	No WSEL=566.23	No WSEL=566.89

Stream: Penwell Branch						
Model: PENWELL_BRANCH.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
15.	297	*Railroad*	548.70	No WSEL=542.20	No WSEL=543.20	No WSEL=543.59

Stream: Swadley Creek						
Model: SWADLEY_BRANCH.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
16.	689	*Tangle Ridge Road*	539.26	No WSEL=533.25	No WSEL=535.23	No WSEL=535.97

Stream: Stuart Branch						
Model: STUART_BRANCH.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
17.	3965	*Tangle Ridge Road*	566.72	No WSEL=566.40	Yes WSEL=567.19	Yes WSEL=567.31
Note: Crossing at Tangle Ridge Road is a perched culvert. Minimum top of road is not at actual stream crossing.						

Stream: Hight Branch						
Model: HollingHightBranchold.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
18.	1925	*TRA Aerial Crossing (non-roadway)*	553.05	No WSEL=538.63	No WSEL=539.33	No WSEL=539.70

<u>Fish Creek Watershed – Roadway Crossings</u>

Stream: Fish Creek						
Model: FISH94 (HEC-2)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
19.	43405	*360 Frontage Road SB*	545.60	No WSEL=536.91	No WSEL=539.00	No WSEL=539.86
20.	43120	*Green Oaks*	545.80	No WSEL=536.01	No WSEL=537.91	No WSEL=538.69
21.	42715	*360 Frontage Road NB*	545.10	No WSEL=534.63	No WSEL=536.13	No WSEL=536.72
22.	32960	*Great Southwest Parkway*	517.80	No WSEL=508.77	No WSEL=510.47	No WSEL=511.18
23.	27255	*Matthew Road (old)*	498.00	Yes WSEL=500.34	Yes WSEL=501.99	Yes WSEL=502.66
24.	19025	*Belt Line Road (Robinson Road)*	486.30	Yes WSEL=487.80	Yes WSEL=489.87	Yes WSEL=490.68
25.	16955	*I-20 Exit Ramp*	491.00	No WSEL=484.28	No WSEL=486.28	No WSEL=487.07

26.	16840	*I-20*	495.00	No WSEL=484.11	No WSEL=486.06	No WSEL=486.84
27.	16490	*I-20 Entrance Ramp*	491.00	No WSEL=483.57	No WSEL=485.34	No WSEL=486.02
28.	16055	*Carrier Parkway*	483.30	No WSEL=482.75	Yes WSEL=484.65	Yes WSEL=485.34
29.	12390	*Golf Cart Bridge*	468.00	Yes WSEL=474.93	Yes WSEL=476.12	Yes WSEL=476.62
30.	7880	*Golf Cart Bridge*	468.00	Yes WSEL=471.73	Yes WSEL=472.76	Yes WSEL=473.21
31.	10815	*Golf Cart Bridge*	464.00	Yes WSEL=468.50	Yes WSEL=469.79	Yes WSEL=470.32
32.	3030	*FM 1382*	464.70	Yes WSEL=465.85	Yes WSEL=467.11	Yes WSEL=467.52
Note: Bardin Road – Sta. 22685 – Conveys 10%, 2%, and 1% flows						

Stream: Prairie Creek						
Model: PRAIRIE.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
33.	13425	*Great Southwest Parkway*	533.27	No WSEL=529.34	Yes WSEL=534.93	Yes WSEL=535.80
34.	1079	*Robinson Road*	490.02	No WSEL=484.90	No WSEL=486.95	No WSEL=487.67
35.	1975	*I-20*	503.62	No WSEL=482.68	No WSEL=484.56	No WSEL=485.24

Stream: Kirby Creek						
Model: KIRBYCREEK.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
36.	23280	*Great Southwest Parkway*	564.40	Yes WSEL=565.34	Yes WSEL=565.54	Yes WSEL=565.64
37.	13635	*Kirbywood*	553.20	No WSEL=551.96	Yes WSEL=553.77	Yes WSEL=553.88
38.	7220	*Waterwood*	543.70	No WSEL=543.68	Yes WSEL=544.43	Yes WSEL=544.56
39.	20970	*Robinson Road*	525.00	No WSEL=524.77	Yes WSEL=525.97	Yes WSEL=526.11
40.	4620	*Carrier Parkway*	520.66	No WSEL=520.20	Yes WSEL=521.91	Yes WSEL=522.27
41.	18790	*Corn Valley*	498.80	No WSEL=491.33	No WSEL=493.73	No WSEL=494.61
42.	14560	*Ridgewood Drive*	482.29	No WSEL=481.48	Yes WSEL=485.05	Yes WSEL=486.01
Note: Great Southwest Parkway – New culverts currently under construction (2009)						

Stream: South Fork Kirby Creek						
Model: KirbyCreek.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
43.	490	*Carrier Parkway*	522.39	No WSEL=519.52	Yes WSEL=523.40	Yes WSEL=523.88

Stream: Brian Branch (Woodacre Channel)						
Model: KirbyCreek.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
44.	1190	*Beatty Drive*	517.28	No WSEL=513.06	Yes WSEL=517.67	Yes WSEL=518.01

Stream: Willis Branch						
Model: Willis_Branch_HecRas.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
45.	1078	*Private Drive*	501.33	Yes WSEL=503.19	Yes WSEL=503.90	Yes WSEL=504.15

Stream: Garden Branch						
Model: gb01.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
46.	5414	*Martin Barnes Road*	538.00	N/A	No WSEL=535.68	Yes WSEL=538.40
Note: Kingswood Blvd – New Roadway not included in model						

Cottonwood Creek Watershed – Roadway Crossings

Stream: Cottonwood Creek						
Model: CCMAINFP (HEC-2)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
47.	276.09	*Great Southwest Parkway*	524.10	Yes WSEL=527.02	Yes WSEL=529.39	Yes WSEL=530.39
48.	269.65	*T&P Railroad*	538.80	No WSEL=523.95	No WSEL=526.27	No WSEL=527.20
49.	186.10	*Robinson Road*	487.70	Yes WSEL=491.42	Yes WSEL=492.47	Yes WSEL=492.90
50.	171.25	*Carrier Parkway*	481.50	Yes WSEL=484.38	Yes WSEL=485.45	Yes WSEL=485.95
51.	144.12	*3rd Street*	478.50	Yes WSEL=481.19	Yes WSEL=482.17	Yes WSEL=482.56

52.	112.48	*4th Street*	466.40	Yes WSEL=471.62	Yes WSEL=473.29	Yes WSEL=473.95
53.	91.96	*Belt Line Road*	469.30	No WSEL=465.85	Yes WSEL=470.31	Yes WSEL=471.10
54.	51.75	*14th Street*	462.50	Yes WSEL=464.46	Yes WSEL=465.33	Yes WSEL=465.72

Stream: South Fork Cottonwood Creek

Model: CCSTHFP (HEC-2)

River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
55.	28.3	*Great Southwest Parkway*	495.00	Yes WSEL=497.11	Yes WSEL=498.22	Yes WSEL=498.57
56.	24.4	*Pioneer Parkway*	493.90	Yes WSEL=495.71	Yes WSEL=496.29	Yes WSEL=496.40
57.	8.55	*Carrier Parkway*	483.40	Yes WSEL=484.23	Yes WSEL=485.06	Yes WSEL=485.39

Stream: Warrior Creek

Model: CC8D6FP (HEC-2)

River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
58.	52.4	*Arkansas Lane (old)*	534.30	Yes WSEL=535.43	Yes WSEL=535.69	Yes WSEL=535.79
59.	31.05	*Pioneer Parkway*	526.50	No WSEL=523.33	No WSEL=525.69	No WSEL=525.85

Stream: Plattner Creek

Model: CC8D1FP (HEC-2)

River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
60.	49.155	*Coral Way*	480.00	Yes WSEL=480.59	Yes WSEL=481.63	Yes WSEL=481.98
61.	40.25	*Marshall Drive*	478.90	No WSEL=476.80	Yes WSEL=479.16	Yes WSEL=479.61

Stream: Indian Hills Branch

Model: CC8D3FP (HEC-2)

River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
62.	40.25	*4th Street*	476.40	No WSEL=474.02	No WSEL=474.76	No WSEL=475.18

Stream: Henry Branch						
Model: HenryBranch.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
63.	4240	*E. Grand Prairie Road*	511.24	No WSEL=507.52	No WSEL=509.25	No WSEL=509.98
64.	2140	*Skyline Road*	485.56	Yes WSEL=486.38	Yes WSEL=487.03	Yes WSEL=487.19

Cedar Creek Watershed – Roadway Crossings

Stream: Cedar Creek						
Model: CedarCr.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
65.	14608	*Carrier Parkway*	514.97	No WSEL=511.45	No WSEL=513.70	No WSEL=514.90
66.	10602	*Polo Road*	495.03	No WSEL=487.94	No WSEL=489.99	No WSEL=491.12
67.	7930	*Bardin Road*	484.90	No WSEL=474.42	No WSEL=475.90	No WSEL=476.60

Johnson Creek/Arbor Creek/Barrett Branch Watershed – Roadway Crossings

Stream: Johnson Creek						
Model: JOHNSONCREEK.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
68.	19532	*SH 360 Frontage Road NB*	516.40	No WSEL=508.94	No WSEL=511.30	No WSEL=512.14
69.	17940	*Avenue J*	507.72	No WSEL=504.86	No WSEL=506.51	No WSEL=507.20
70.	15810	*Great Southwest Railroad*	511.60	No WSEL=499.01	No WSEL=501.46	No WSEL=502.45
71.	9850	*Duncan Perry Road*	469.13	No WSEL=468.42	No WSEL=469.13	Yes WSEL=470.08
72.	4600	*Carrier Parkway*	459.00	No WSEL=446.44	No WSEL=448.26	No WSEL=448.94

Stream: Arbor Creek						
Model: JC1.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
73.	8685	*Duncan Perry Road*	504.79	No WSEL=501.40	No WSEL=501.80	No WSEL=502.73
74.	7500	*Tarrant Road*	494.30	Yes WSEL=497.15	Yes WSEL=500.41	Yes WSEL=501.54
75.	6303	*IH-30*	505.00	No WSEL=496.38	No WSEL=500.05	No WSEL=501.19
76.	5160	*Lakeside Drive*	481.65	No WSEL=476.30	No WSEL=476.81	No WSEL=476.96
77.	3980	*Egyptian Way*	466.30	Yes WSEL=467.96	Yes WSEL=468.62	Yes WSEL=468.68
78.	2185	*NW 19th Street*	458.91	No WSEL=454.19	No WSEL=455.18	No WSEL=455.27
79.	1450	*Carrier Parkway*	451.11	Yes WSEL=452.53	Yes WSEL=453.05	Yes WSEL=453.09

West Fork Trinity River – Roadway Crossings

Stream: West Fork Trinity River						
Model: uts.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min XS Elev./ Min Top Road**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
80.	80958	*SH 360*	465.00 / 472.50	No WSEL=455.32	No WSEL=460.79	No WSEL=463.43
81.	61198	*Roy Orr Blvd*	443.80 / 470.80	Yes* WSEL=446.90	Yes* WSEL=451.54	Yes* WSEL=453.52
82.	44291.5	*Belt Line Road*	442.30 / 449.50	No WSEL=434.88	No WSEL=439.47	No WSEL=441.30
83.	28825	*MacArthur Blvd*	427.30 / 442.00	Yes* WSEL=432.06	Yes* WSEL=434.93	Yes* WSEL=436.27
* - Overtops roadway in model cross-section, but does not overtop top of road at bridge						

Mountain Creek Watershed – Roadway Crossings

Stream: Mountain Creek							
Model: MC FINAL 20071214.prj (HEC-RAS)							
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
84.	13941	*S. Jefferson Blvd.*	425.80	Yes WSEL=433.36	Yes WSEL=435.74	Yes WSEL=437.32
85.	13830	*N. Jefferson Blvd.*	436.10	No WSEL=433.05	No WSEL=435.70	Yes WSEL=437.27
86.	13140	*SH 180*	437.90	No WSEL=432.03	No WSEL=434.58	No WSEL=436.07
87.	8723	*Railroad Bridge*	438.00	No WSEL=428.09	No WSEL=431.28	No WSEL=432.68
88.	6420	*IH-30*	435.00	No WSEL=427.16	No WSEL=430.35	No WSEL=431.74
89.	1200	*Singleton Road*	440.00	No WSEL=422.30	No WSEL=424.57	No WSEL=425.55

Dalworth Creek Watershed – Roadway Crossings

Stream: Dalworth Creek						
Model: DALWORTH.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
90.	7129	*Grass Culverts*	479.00	No WSEL=477.18	Yes WSEL=479.43	Yes WSEL=479.60
91.	6782	*Carrier Parkway*	466.79	Yes WSEL=467.63	Yes WSEL=469.62	Yes WSEL=469.98
92.	6244	*NW 9th Street*	460.18	No WSEL=458.36	No WSEL=460.18	No WSEL=460.18
93.	5630	*Turner Blvd.*	458.05	No WSEL=455.47	No WSEL=457.08	No WSEL=457.72
94.	5198	*Blackburn Ave.*	454.48	No WSEL=452.06	No WSEL=453.66	No WSEL=454.33
95.	3390	*Palace Pkwy/ NW 7th Street*	447.00	No WSEL=443.13	No WSEL=444.99	No WSEL=445.74

Gopher Branch/Turner Branch Watershed – Roadway Crossings

Stream: Gopher Branch						
Model: 25031_Gopher_070828.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
96.	4460	*5th Street*	447.92	Yes WSEL=448.55	Yes WSEL=449.29	Yes WSEL=449.52
97.	4167	*Tarrant Road*	443.98	Yes WSEL=444.41	Yes WSEL=445.59	Yes WSEL=445.87
98.	3819	*Field Culvert*	438.00	Yes WSEL=438.38	Yes WSEL=439.70	Yes WSEL=440.22
99.	3139	*Belt Line Road*	442.00	No WSEL=431.99	No WSEL=437.40	No WSEL=439.49
100.	1740	*IH-30*	447.00	No WSEL=423.51	No WSEL=425.15	No WSEL=426.02
101.	221	*TRA Pipeline (non-road)*	425.00	No WSEL=418.21	No WSEL=419.95	No WSEL=420.61
Note: WSEL do not include tailwater from West Fork Trinity River (1% chance WSEL ~ 440)						

Stream: Turner Branch						
Model: 25031_Gopher_070828.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
102.	789	*Tarrant Road*	454.00	No WSEL=436.32	No WSEL=441.12	No WSEL=443.64

Bear Creek Watershed – Roadway Crossings

Stream: Bear Creek						
Model: BigBear.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
103.	38806	*Rock Island Road*	466.00	No WSEL=459.43	No WSEL=463.44	No WSEL=465.28
104.	34252.5	*Shady Grove Road*	457.00	No WSEL=452.94	No WSEL=456.79	Yes WSEL=457.89
105.	31646	*Trinity Blvd*	452.00	No WSEL=450.65	Yes WSEL=453.24	Yes WSEL=454.09
106.	27773	*Belt Line Road*	443.21	No WSEL=442.64	Yes WSEL=444.72	Yes WSEL=445.62
107.	17118.5	*Hunter-Ferrell Road*	430.00	Yes WSEL=434.58	Yes WSEL=436.46	Yes WSEL=437.64
108.	2327	*MacArthur Blvd*	427.30 / 435.56 (@bridge)	Yes WSEL=430.60	Yes WSEL=433.46	Yes WSEL=434.89

Dry Branch Watershed – Roadway Crossings

Stream: Dry Branch						
Model: DRYEX (HEC-2)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
109.	7725	*Rock Island Road*	477.40	No WSEL=471.68	No WSEL=472.63	No WSEL=473.18
110.	6616	*Oakview Drive*	468.20	No WSEL=460.96	No WSEL=462.95	No WSEL=463.72
111.	5892	*Thousand Oaks Blvd.*	464.60	No WSEL=460.08	No WSEL=461.75	No WSEL=462.16
112.	4820	*Sherwood Drive*	458.60	Yes WSEL=458.80	Yes WSEL=459.87	Yes WSEL=460.26
113.	3710	*Shady Grove Road*	464.00	No WSEL=453.54	No WSEL=454.55	No WSEL=454.91
114.	3015	*Belt Line Road*	451.20	Yes WSEL=451.21	Yes WSEL=451.89	Yes WSEL=452.14

Alspaugh Branch Watershed – Roadway Crossings

Stream: Alspaugh Branch						
Model: ADMP2004.prj (HEC-RAS)						
River Station		**Roadway Crossing**	**Min. Top of Road Elev.**	**10% Event Overtops Road**	**2% Event Overtops Road**	**1% Event Overtops Road**
115.	9100	*Robinson Road*	524.80	N/A	N/A	No WSEL=522.74
116.	4170	*Camp Wisdom Road*	496.60	N/A	N/A	Yes WSEL=497.39
117.	1130	*Camp Wisdom Road*	470.00	N/A	N/A	Yes WSEL=474.01

Recommendations on Known Flood Hazards

Consultants are to obtain the following before preparing individual watershed master plans:

1) Current drainage complaint database for watershed being studied
2) Current effective or most current "non-effective" hydrologic and hydraulic model(s) and associated workmaps for stream(s) being studied
3) Tables of known roadway overtopping from this report

Study consultants should overlay the most recent DFIRM floodplains onto City parcel information and current aerial photographs to determine if parcels containing structures are being affected by the current delineated floodplain. Floodplain BFE's shall be reviewed and compared with most current City topography.

D. FUNDING OPPORTUNITIES

Halff Associates has researched funding opportunities for the City of Grand Prairie to supplement City fund sources, including the Capital Improvement Project program and Storm Water Utility fee. These funding opportunities can support various planning and construction measures, including flood protection planning, channel improvements, flood control improvements, structure buy-outs, bridge/culvert improvements, and erosion control improvements. A summary of funding programs follows. Funding from these different programs is very competitive and difficult to obtain in some cases. Based on our findings, Federal funding has been limited and flooding in recent years has resulted in a surge in applications for available flood and erosion funds. Additionally, some of the FEMA programs will not be available without an established/approved Hazard Mitigation Program by the City.

FEMA

Hazard Mitigation Grant Program (HMGP)
The Hazard Mitigation Grant Program (HMGP) provides grants to States and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. The HMGP is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act.
Note: Grand Prairie's HMGP plan has not been finalized as of 2008.
http://www.fema.gov/government/grant/hmgp/index.shtm

Pre-Disaster Mitigation Grant Program (PDM)
The Pre-Disaster Mitigation (PDM) program provides funds to states, territories, Indian tribal governments, communities, and universities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event.
Funding these plans and projects reduces overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations. PDM grants are to be awarded on a competitive basis and without reference to state allocations, quotas, or other formula-based allocation of funds.
http://www.fema.gov/government/grant/pdm/index.shtm

Repetitive Flood Claims Program

The Repetitive Flood Claims (RFC) grant program was authorized by the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004 (P.L. 108–264), which amended the National Flood Insurance Act (NFIA) of 1968 (42 U.S.C. 4001, et al).

Up to $10 million is available annually for FEMA to provide RFC funds to assist States and communities reduce flood damages to insured properties that have had one or more claims to the National Flood Insurance Program (NFIP).

http://www.fema.gov/government/grant/rfc/index.shtm

Severe Repetitive Loss Program

The Severe Repetitive Loss (SRL) grant program was authorized by the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004, which amended the National Flood Insurance Act of 1968 to provide funding to reduce or eliminate the long-term risk of flood damage to severe repetitive loss (SRL) structures insured under the National Flood Insurance Program (NFIP).

The definition of severe repetitive loss as applied to this program was established in section 1361A of the National Flood Insurance Act, as amended (NFIA), 42 U.S.C. 4102a. An SRL property is defined as a **residential property** that is covered under an NFIP flood insurance policy and:

(a) That has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or

(b) For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

For both (a) and (b) above, at least two of the referenced claims must have occurred within any ten-year period, and must be greater than 10 days apart.

http://www.fema.gov/government/grant/srl/index.shtm

Flood Mitigation Assistance Program (FMA)

The FMA program was created as part of the National Flood Insurance Reform Act (NFIRA) of 1994 (42 U.S.C. 4101) with the goal of reducing or eliminating claims under the National Flood Insurance Program (NFIP).

FEMA provides FMA funds to assist States and communities implement measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the National Flood Insurance Program.

Note: The City of Grand Prairie has recently completed their updates to the Grand Prairie Flood Mitigation Plan in September 2008. On January 13, 2009, FEMA approved the plan.

http://www.fema.gov/government/grant/fma/index.shtm

Landslides and Slope Failures

FEMA has created Policy 9524.2 to provide criteria to determine the eligibility of work to stabilize slopes that fail during an event that resulted in a Presidentially-declared emergency or major disaster. Stabilization is required to provide emergency protective measures or to repair or protect otherwise eligible facilities such as roads, bridges, or buildings. This policy applies to all emergencies and major disasters declared on or after the publication date of this document.

http://www.fema.gov/government/grant/pa/9524_2.shtm

TEXAS WATER DEVELOPMENT BOARD (TWDB)

The TWDB provides water planning, data collection and dissemination, financial assistance and technical assistance services to the citizens of Texas.

TWDB Flood Protection Planning Grant

Evaluation of structural and nonstructural solutions to flooding problems and considers flood protection needs of the entire watershed. Upstream and/or downstream effects of proposed solutions must be considered in the planning. The proposed planning must be regional in nature by inclusion of an entire watershed.

Note: Espey Consultants applied for a TWDB Flood Protection Planning Grant in 2008 for Fish Creek and Cottonwood Creek. TWDB approved this project for a grant. The study associated for these projects began in Fall 2008 and is currently on-going.

State Loan Program, Texas Water Development Fund II

This is essentially a pure state loan program that does not receive Federal subsidies, and is the more streamlined of the agency programs. The program includes construction loans for water supply, water quality enhancement, flood control and municipal solid waste.

http://www.twdb.state.tx.us/home/index.asp

U.S. ARMY CORPS OF ENGINEERS FLOOD CONTROL PROJECTS AND AQUATIC ECOSYSTEM RESTORATION PROGRAMS

Section 205 Flood Control Projects

The U.S. Army Corps of Engineers is authorized to study, plan, and construct small flood control projects. A project is accepted for construction only after detailed study shows its engineering feasibility, economic justification, and environmental acceptability.

Aquatic Ecosystem Restoration Program

Section 206 of the Water Resources Development Act of 1996, provides authority for the Corps to restore aquatic ecosystems. A project is accepted for construction after a detailed investigation shows it is technically feasible, environmentally acceptable, and provides cost effective environmental benefits. Each project must be complete within itself, not a part of a larger project. Note: These projects are not primarily for flood control, but instead for restoration of aquatic habitat.

http://www.swf.usace.army.mil

NATURAL RESOURCE CONSERVATION SERVICE (NRCS)

Emergency Watershed Protection Program

The purpose of the Emergency Watershed Protection (EWP) program is to undertake emergency measures, including the purchase of flood plain easements, for runoff retardation and soil erosion prevention to safeguard lives and property from floods, drought, and the products of erosion on any watershed whenever fire, flood or any other natural occurrence is causing or has caused a sudden impairment of the watershed.

Note: This program is focused on emergency projects made necessary by a large storm event or a series of large storm events. Resources are limited and requests have to be made after a significant storm event. Letter of Request is usually filed *within a reasonable time period after events. 75% is usually funded with a 25% match by the City.*

http://www.tx.nrcs.usda.gov/programs/ewp/

Watershed Protection and Flood Prevention Program

NRCS cooperates with States and local agencies to carry out works of improvement for soil conservation and for other purposes including flood prevention; conservation, development, utilization and disposal of water; and conservation and proper utilization of land. NRCS implements the Watershed Protection and Flood Prevention Act through three programs:

- Watershed Surveys and Planning
- Watershed Protection and Flood Prevention Operations
- Watershed Rehabilitation

Note: Program is intended for overall watershed planning. NRCS states that this program is usually focused on dam construction as a means of flood control, and there is difficulty acquiring funds through this program.

http://www.nrcs.usda.gov/programs/watershed/

NORTH CENTRAL TEXAS COUNCIL OF GOVERNMENTS (NCTCOG)

In cooperation with other communities, the NCTCOG continually strives for regional drainage studies, such as the Trinity River Common Vision and temporary and permanent storm water management practices, such as the iSWM. Halff recommends that the City of Grand Prairie continue to look to the NCTCOG as a potential source of study funds, perhaps on a cooperative basis.

http://www.nctcog.dst.tx.us/

STORM WATER UTILITY FEE

The City of Grand Prairie's Storm Water Utility Fund receives Storm Water Utility Fees that are used to construct, operate, and maintain the storm water drainage system. Currently, the City's approved Fiscal Year 2009/2010 budget for the Storm Water Utility Fund is $3,392,042.

The City's Fiscal Year 2009/2010 Approved Capital Improvements Project Budget includes $1,412,500 in needed Storm Drainage Capital Improvement projects (approximately 5% of the total CIP Budget).

As of October 2009, the City's Single Family Residential Parcel Stormwater Utility Fee was $1.50 per month (Tier 1 residential), $3.76 per month (Tier 2 residential), and $4.35 per month (Tier 3 residential). Other local Dallas-Fort Worth Metroplex communities Single Family Residential Parcel Stormwater Utility Fee range from as high as $8.00 (and above) to as low as $1.00.

The Mobile Home utility fee was $1.50 per month. The Duplex, tri-plex, four-plex and multi-family units' utility fee was $1.50 through December 30, 2009 and will change to $2.89, effective January 1, 2010.

Nonresidential accounts. The rates shall be calculated using a charge of one thousand and sixty-eight ten thousandths of a dollar ($.1068) per one hundred (100) square feet of impervious area according to the following formula: Storm water Utility Fee (SWUT Fee) = (Total impervious Area) X (Rate) / 100.

In the event that a site has multiple meters and multiple tenants, the impervious area of the common area of the site is divided between the tenants proportionately according to the building size as a percentage of the common area, except as otherwise provided by this article, billing, fees, and collection procedures shall be consistent with that of the water and sewer services. Storm water fees shall be identified separately on the utility billing. Billing shall be consistent with V.T.C.A., Local Government Code § 402.048. Delinquent fees shall be collected in a manner consistent with V.T.C.A., Local Government Code § 402.050. If the calculation for non-residential accounts results in a fee of less than $5.00, then a $5.00 minimum bill designation is applied. The City may grant exemptions from the storm water fee pursuant to V.T.C.A., Local Government Code § 402.053. From time to time, the city manager or his designee(s) shall adopt rules for the administration of the storm water fee subject to council approval. These rules shall include a process for the appeal of the storm water fee as it is applied to an individual property.

Based on the needed Storm Drainage Capital Improvement projects, a potential funding opportunity would be to reinvestigate the City's Stormwater Utility Fee to see if an increase is appropriate. In particular, the following criteria could be re-examined:

- Stormwater Utility Rate methodology
- Maximum possible rates
- Equivalent residential unit size (per SF)
- Examining vacant non-residential tenants (to see if they are being billed)
- Examine most current GIS parcel overlays for impervious areas (for non-residential areas). Utilize this methodology for billings of non-residential parcels.

- Examine current repetitive loss structures
- Develop updated list of stormwater CIPs and current cost estimates, based on proposed projects developed from the City-wide Drainage Master Plan
- Examine current exemptions (such as state, local, and higher learning/education facilities, etc.)
- Develop public/community awareness program to inform citizens of the need for flood control and the financial assistance that is required

Performing a Stormwater Utility Fee update requires a significant effort for a city the size of Grand Prairie. Halff recommends that this option only be pursued if the City is seriously considering a rate increase based on newer, detailed information.

DRAINAGE IMPACT FEE

Pursuant to the provisions of Chapter 395, Texas Local Government Code and Article 11, Section 5 of the Texas Constitution, the City of Grand Prairie may impose fees upon each new development project to pay the costs of constructing capital improvements to serve the new development.

The City has a mechanism to finance water and wastewater capital improvement projects or facilities using impact fees (see Article 22, Section 3 of the Unified Development Code). Creating a drainage impact fee could also assist in the funding of future drainage capital improvement projects.

Some considerations to a potential drainage impact fee are as follows:

- Development of a drainage impact fee capital improvement plan & associated costs to actually develop the drainage impact fee
- Define types of drainage facilities that could be constructed under this plan, including regional detention, bridge/culvert improvements, or public storm drainage improvements
- Determining exceptions to the drainage impact fee, such as already platted properties, etc.
- Determining how the new development utilizes and benefits from the associated drainage capital improvement project
- Determining how to calculate the drainage impact fee
- Determining when the impact fees will be collected for the new development
- Determining the legal issues involved with impact fees.

Similar to a Stormwater Utility Fee update, a drainage impact fee study would require a significant effort for the City. Halff recommends that this option only be pursued if the City is seriously considering potential locations of drainage improvement projects that would benefit from a drainage impact fee (such as a proposed regional detention pond located on Kirby Creek immediately upstream of Robinson Road).

Other Potential Funding Options

- Developer Extension/Late-Comer Fees – Storm drainage facilities (such as detention) built as part of private development could be oversized to accommodate service beyond the immediate confines of a single project. A financing method can be employed which allows an original developer to be compensated for these front-end expenses by developers subsequently building in the same area and who would be served by the oversized facilities. This funding option would be useful where an overall development master plan is available that defines the future storm drainage requirements.
- In Lieu of Construction Fees – In areas where individual small site detention ponds may negatively affect downstream flows, this option would provide for a funding mechanism where the developer can contribute a fee to help build a regional detention facility or make improvements in storm water conveyance away from the development site. A drawback is that the facility must be built ahead of the development and, therefore, an alternate funding source must be available.

E. LONG-RANGE FINANCIAL PLAN

As stated in Section D of this report, the City of Grand Prairie has both a Storm Water Utility Fee and an annual Capital Improvement Project (CIP) program as major sources of revenue. The operating budget of the Storm Water Utility program is $3,392,042 for FY 2009/2010. The CIP budget is $28,509,604, with $1,412,500 allocated for Storm Drainage Capital Improvements.

Based on the approved Flood Mitigation Plan (refer to Appendix P for TWDB Approval and City Resolution), Halff Associates has already identified over 70 potential storm drainage capital improvement projects (utilizing previous drainage study master plans and current designated Hot Spots) with a potential cost of construction totaling more than $150,000,000. These anticipated costs will most likely increase as the individual master plans are prepared, more projects are added to the list of needed improvements, and more detailed estimates are prepared.

The desired outcome of the City-wide Drainage Master Plan is to plan these projects and develop a methodology to design and construct these CIPs in a manner where the City has the greatest benefit to project costs. For the City, this will require the evaluation of the individual watershed drainage master plans as they are developed and prioritize proposed CIPs. The holistic approach will prioritize small projects that are reasonable to construct today versus larger, phased projects that may take years to construct. The planning phase will determine the anticipated project costs and benefits. The design and construction phase will occur when the City has funding available.

Recommendation – Halff recommends that, as the individual watershed master plans are being developed, the City re-evaluate the current Storm Water Utility rate structure to determine if it should be increased and that the City determine if the existing storm drainage CIP fiscal year budgets can be increased to help assist with implementing more of the future recommended drainage and floodplain improvements.

F. <u>CITY POLICIES</u>

Various City of Grand Prairie policies have an affect and/or impact on storm drainage and floodplain management. Following is a sample list of existing policies and programs, with a brief description and list of recommendations for these policies as they relate to storm drainage and floodplain management.

<u>1. Land Development Policy</u> – Land Development policies as related to storm drainage and floodplain management are primarily handled with the current drainage criteria manual (November 2009). The manual addresses site and drainage design standards for all development within the City and ETJ based on the following topics and more:

- Design Rainfall and Loss Methodologies
- Design Discharge Determination
- Street Flow
- Inlet Design
- Storm Drain Design
- Open Channel Analysis and Design
- Bridge and Culvert Design
- Detention/Retention Basin Design
- Floodplain/Floodway Development Criteria
- Trinity River Corridor Development Certificate
- Drainage Easements
- Site Design Practices
- Floodplain Permit Procedures

Recommendation – Grand Prairie has many areas that can be developed, from the northern end of the City along the West Fork Trinity River down to the southern end of the City in the Joe Pool watershed and Exclusive & Statutory ETJ areas. <u>One recommendation would be to consider the creation of land development districts for undeveloped areas in the City</u>. Along with other utility master planning efforts for these undeveloped areas, studies could be performed on these districts prior to development to determine the appropriate storm drainage and floodplain features and improvements necessary for site development based on the current site zoning. Once site development analysis and design begins, the due diligence work already performed on the site would provide the developer with a better understanding on what is involved in regards to drainage requirements. Pre-analyzed drainage requirements could help to establish greater land development coverage (benefiting the developer) while not sacrificing effective floodplain limits (benefiting the City). Parks and other open space features could be located within floodplain limits in order to preserve these corridors while maximizing developable areas. Storm drainage outfall locations on receiving streams could be pre-analyzed as to have the least impact on potential erosion at the storm drain outfall structure or on potential sedimentation/siltation issues inside the storm drain outfall pipe. Regional detention areas could be identified. Watershed divides could be provided for the undeveloped zones so developers would have a better idea on where to place outfall locations.

2. Acquisition/Relocation/Demolition ("Buy-Out") Policy – In many instances, the cost of acquisition or relocation of existing structures in flooding areas is less than the cost of structural design measures to alleviate the flooding of those structures. However, many complications arise when "Buy-Outs" are proposed to solve an existing flooding problem. Some of the complications with the property owners (and sometimes adjacent property owners) include loss of tax revenue, removal of structure and lack of maintenance on property (creating an eyesore), need to preserve the neighborhood as-is, and the owner's personal attachment to their home or business and its location.

As a primary focus, the City's current Repetitive Loss structures would be a priority for this program. FEMA's Severe Repetitive Loss (SRL) grant program can be examined for these properties to reduce or eliminate claims under the National Flood Insurance Program. Up to 90% Federal Cost share may be available for these properties.

Recommendation – For all structures subject to flooding, Halff recommends that the City determine (or have it determined by an outside consultant) the cost for acquisition/relocation/demolition of these. As improvement alternatives are developed, these costs could then be compared to the proposed structural improvement measure costs to remove these structures from the floodplain. Then, as funding and resources are available, the City could also develop a plan for temporary maintenance of the buy-out property until the lot can be re-filled above the flood elevation for potential re-sale. The acquisition/relocation/demolition program should especially be used when the affected structure is a repetitive loss structure.

3. Sedimentation Pond Policy – Soil runoff is a major pollutant to rivers and streams across the United States, and it affects the City of Grand Prairie as well. Runoff from construction sites accounts for a majority of this problem. More unnatural sediment in a stream bed can greatly affect flow characteristics and velocities of the stream bed, thus leading to more erosion and ponding issues along a stream where it would not have existed before. Public sedimentation ponds, if applicable to a given drainage outfall situation, can help minimize the flow of sedimentation into public and private lakes, ponds, and drainage systems. However, maintenance costs associated with removal of the collected sedimentation have to be considered.

Recommendation – Halff recommends that the City investigate methods to minimize soil runoff and work to include these measures as **required** elements of the Drainage Criteria Manual for site development. Soil runoff control methods could include sedimentation ponds, grass-lined swales, and bioswales.

4. Erosion Repair Program and Policy – Generally two conditions exist in regards to development along a stream where stream bank erosion is concerned. The first condition is existing developed land that is experiencing erosion problems. The second condition is undeveloped land to be located along a stream with a potential for stream bank and channel erosion. For existing developed land and associated stream bank erosion problems, Grand Prairie's Resolution No. 3919 (June 2003) states that the City will focus on improvements to the waterways that will result in a general public benefit first, and will investigate erosion problems on private property on a case-by-case basis (see Appendix P includes Resolution No. 3919). For undeveloped land, the City's Drainage Criteria Manual includes erosion hazard setbacks as a drainage plan requirement (Section 2.6). This requirement must be followed by the development community to minimize or even eliminate the need for the City to address erosion problems affecting developed properties in the future.

Note: *A valuable local guide to utilize that addresses stream erosion policies is the "Stream Bank Stabilization Manual for the Cities of Plano, Garland, McKinney, and Allen", dated June 1998.*

Recommendation #1 – Halff recommends that the City re-visit Resolution No. 3919 and make it even more stringent on private property issues. The City could require that the owner requesting to address a private erosion problem pay a nominal fee towards these repairs or pay a nominal fee towards a solution that results in a general public benefit.

Recommendation #2 – Halff recommends that the City re-visit the Erosion Hazard Setback **determination procedures** to include more stringent rules on establishing the setbacks on a stream experiencing significant natural downcutting or widening. Halff also recommends re-visiting the **variances** to the Erosion Hazard Setback, including locations where stream bank stabilization measures currently exist or will be constructed and also locations where stream banks are composed of rock.

<u>5. Water Quality and Phase II TPDES MS4 Permit Requirements</u> – In 2007, the City of Grand Prairie began a 5 year program to implement Best Management Practices (BMPs) for Stormwater Runoff Control. A listing and brief description of the BMPs are listed below:

<u>Selected BMPs for Construction Site Stormwater Runoff Control</u>

- **Review Infrastructure Plans and Designs** – Require designers to include design of erosion control measures and approved BMPs in plans and specifications in all projects in compliance with and requiring compliance with the TPDES General Permit for Construction and all local and State regulations.
- **Inspect Erosion Control Measures** – Inspection of the infrastructure and effectiveness of the required erosion control measures used on applicable construction projects.
- **Earthwork Permit** – Issue permits for site grading, when necessary, to reduce the impact to neighboring properties, downstream flooding, or channel erosion.
- **Storm Water Pollution Prevention Plan during Construction** – A Storm Water Pollution Prevention Plan (SWP3) is required on all applicable construction projects in accordance with the regulatory authorities' permit process. A copy of the NOI or Construction Site Notice on all applicable construction projects shall be required.
- **Complaint Response** – Citizen complaints regarding sediment and other development pollutants are investigated.
- **Construction Ordinance** – Work with the Environmental Services Department to include in the City of Grand Prairie Storm Water Ordinance provisions to meet the legal authorities necessary to comply with permit requirements for Construction Site Storm Water Runoff Control. Ordinance will require contractors to implement erosion and sediment control BMPs and to control construction site waste.
- **Site Development Plan Reviews** – Enhance review of site development plans to include water quality considerations, including a review of erosion control plans and proposed approved BMPs. Any amendments to the site plan review procedures will conform to the Storm Water Ordinance and post construction requirements.
- **Recording and Public Complaint Response** – Refine the system for recording and responding to calls from the public. This approach will include clarifying responsibilities, procedures, recordkeeping, and follow-up.
- **Redefine the Construction Site Inspection Program** – Develop a system to assign inspectors, track training requirements, establish schedules of inspections, establish record keeping procedures, and define enforcement procedures.
- **Construction Site Storm Water Public Education Program** – Coordinate a public education program with Environmental Services Division to provide

information to construction site operators regarding the requirements of the Construction General Permit and the MS4 General Permit.

Selected BMPs for Post-Construction Management in New Developments and Redevelopment

- **Development Review Process** – All development plans are reviewed for compliance with floodplain requirements, for adequacy of infrastructure design for drainage, and for use of detention ponds.
- **Stream Buffer Preservation** – Encourage the preservation of natural channels and the 100-year floodplain.
- **Storm Water Design Criteria and Methods** – Adopt storm water design criteria and methods that integrate considerations for drainage and water quality for post construction BMPs.
- **Revise Policies and Design Criteria in the Unified Development Code** – Revise the Unified Development Code as needed to include requirements and revised standards.
- **Long term operation and maintenance of BMPs** – Perform periodic inspections on existing post construction BMPs and work with the owners to provide needed maintenance and repairs. Failure to perform maintenance and repairs directed by the city may result in penalties.

Recommendation – Halff recommends that the City re-visit the Phase II TPDES MS4 Program after the current 5-year program is complete. The City should evaluate which construction site BMPs are effective and ineffective and the City should evaluate which Post-Construction Management BMPs are effective and ineffective. For ineffective BMPs, the City should re-evaluate measurable goals, responsible departments involved, and target dates to get the BMP on track.

Recommendation – Halff recommends that the City identify water quality problem areas and also review any water quality problem areas identified by state or federal agencies within the city. Proposed capital improvement projects identified in the individual watershed master plans can then be developed and/or improved to address water quality aspects in the identified areas, as applicable. Development of this program in the future will lead to an **integrated watershed planning approach**, utilized by many communities in the United States to address quantity and quality issues.

6. Maintenance

Background

Storm water management facilities perform the function of removal of water from street, highways, parking areas, and other drainage areas and the protection of the facilities from the effects of waters. These storm water management facilities include drop inlets, storm drains, culverts, bar ditches, slope protection, detention/retention facilities, natural and improved channels, and permanent erosion control devices.

In order for these facilities to function as designed and constructed, they must be properly maintained. Poor or nonexistent maintenance can result in additional flooding problems that could affect other portions of the storm drainage system. Lack of maintenance is widely documented in storm water facilities around the nation, with perhaps the most neglected being detention and retention structures, mostly being managed by home owner's associations or other private entities.

Consideration should be made in the design process as to the maintenance of these facilities. Reasonable access for maintenance personnel and equipment should be considered. For example, in storm drain design, proper access spacing can provide a relatively easy way to clear sediment and debris blockage or isolate a portion of the system for repairs. In large detention or retention design, provisions for a sediment trap and machinery access can greatly reduce maintenance costs.

Categories

Maintenance of public storm water management facilities usually falls into three categories:

1) **Routine** – Activities which happen on a periodic basis, which may be driven by the passage of time, not the specific deterioration of the system. Can include the following:
    1. Keeping water courses free from accumulations of debris and vegetation and storm drains free of silt, sand, and debris
    2. Correcting malfunctioning parts of a system, including settlement and breaks
    3. Detention facilities – Periodic inspection to identify restrictions on drainage by the accumulation of debris and siltation and by failed or damaged infrastructure. Critical facilities should be identified and checked after storm events.
2) **Remedial** – Corrects specific deficiencies in the existing system without upgrading its capacity
3) **Capital Improvement Projects** – Replaces deficient systems with larger or improved designs. These improvements become new systems.

Note: For maintenance of private storm water management facilities, the City should provide routine notifications to private owners, home-owners associations, etc. to ensure that they are maintaining these facilities per City ordinances. Utilizing

City GIS databases that specifically delineate locations of public and private storm water management facilities would help to assist with this process.

Storm Drain Outfall Field Assessment

The City of Grand Prairie has performed storm drain outfall field checks for many outfalls in the City of Grand Prairie. Currently, the City has 1,262 active storm drain outfalls and has documented over 1,220 of these. Additional outfalls are continuing to be constructed now and will be in the future.

Following is a brief summary of findings of the storm drain outfall field checks:

1. Approximately 10% of outfalls are classified as "Poor" or "Eroded"
    a. Descriptions include: broken structure, pipe crushed, apron eroded, outfall eroded, washed away, pipe buried in debris, wingwall separated from outfall, and pipe joint failure.
    b. During field checks, two outfalls were being repaired
2. Approximately 80% of outfalls are classified as "Good" or "New"
    a. For some outfalls under this description, warning notes were provided stating that future erosion is anticipated, some siltation was occurring, and that vegetation was dense in areas.
3. The remaining 10% of outfalls have little or no documentation on classification, mainly because they could not be located in the field or are access-prohibitive.

Detention/Retention Ponds

In most major watersheds, detention and retention ponds have been constructed. Many of these ponds have been documented with recent drainage reviews. Others still need to be documented and inspected to determine the level of maintenance that is required. The City has both private and public detention pond facilities.

City Maintenance Standards

Recommendation – Based on funding and available resources, Halff recommends that the City develop a maintenance program that follows the following guidelines.

Objectives for Storm Drain Outfall and Detention/Retention Pond Maintenance Program
1. Review all new plans and permit applications to ensure compliance with design criteria, master plans, and sound engineering judgment in design (performed during the design plan review stage)
2. Effectively inspect all construction of these facilities to ensure compliance with design criteria, conditions, and plans
3. Train maintenance crews to be able to respond effectively to the full range of drainage and flooding maintenance complaints and activities
4. Develop and maintain an up-to-date, GIS-based inventory of the storm drain outfall and detention/retention ponds located in the City (including photos), with separate layers as to public or privately owned facilities
5. Develop and implement a prioritized remedial maintenance program based on documented needs
6. Provide adequate resources for maintenance operations
7. Develop and implement operations and maintenance financing mechanisms which may possibly target special charges and fees to those requiring or causing the need for remedial maintenance services
8. Establish policies to enforce the City Maintenance Program

Maintenance Program Recommendations

Recommendation – Based on funding and available resources, Halff recommends that the City develop a revolving maintenance program, including storm drainage outfalls and detention/retention ponds to provide inspection, documentation, and maintenance of these facilities.

Storm Drainage Outfalls

Recommendation – Halff recommends the City develop standard designations for storm drain outfall conditions: **1) Good** (requires no remedial maintenance – continue normal inspections), **2) Poor** (some erosion - may require remedial maintenance – not immediate), **3) Eroded** (heavy erosion - requires immediate remedial maintenance), **4) Failure** (requires design/construction to correct problem – to be added to CIP program).

The tables below show an example of a storm drain outfall maintenance program that could be developed by the City for each of the prioritized watersheds listed in Table I-1:

Maintenance Program – Storm Drain Outfalls	
Item	**Tasks**
Inspection	Review of Field Outfall Information in GIS and physical inspection, as resources are available
Documentation	Update Classifications: Good, Poor, Eroded, or Failure. Note whether outfall needs: 1) Continue normal inspections, 2) Remedial Maintenance (not immediate or immediate), or 3) Assignment to Capital Improvement Project
	Update Master List of storm drain outfalls, update classification (Good, Poor, Eroded, or Failure) and GIS information (including photos) for each location
Maintenance	Schedule remedial maintenance for storm drain outfalls, contingent upon City Council approval and funding

Detention/Retention Facilities

Recommendation – Based on funding and available resources, Halff recommends the City develop a public detention/retention facility maintenance program.

The tables below show an example of a public detention/retention facility maintenance program that could be developed by the City:

Maintenance Program - Detention/Retention Facilities	
Item	**Tasks**
Inspection	Review of detention/retention facilities in GIS and physical inspection, as resources are available
Documentation	Update Classifications. Note whether facility needs: 1) Continue normal inspections, 2) Remedial Maintenance, or 3) Assignment to Capital Improvement Project
	Update Master List of detention/retention ponds and GIS information (including photos) for each location
Maintenance	Schedule remedial maintenance for public detention facilities, contingent upon City Council approval and funding
	Notify private owners of detention facilities where remedial maintenance is necessary

Private Detention/Retention Facilities – As the public maintenance program is established, and as funding and resources are available, Halff recommends that the City implement a notification program to private owners of detention/retention facilities in the City to remind them of City ordinances required maintenance of their facilities.

7. Issues Affecting Disaster Responses

To receive future Federal disaster funding, when needed, the City of Grand Prairie has to have a current, approved **Flood Mitigation Plan** and **Hazard Mitigation Plan**.

Background Information

The Disaster Mitigation Act of 2000 (DMA 2000) provides an opportunity for states, Tribes and local governments to take a new and revitalized approach to mitigation planning. DMA 2000 amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act (the Act) by repealing the previous mitigation planning provisions (Section 409) and replacing them with a new set of mitigation plan requirements (Section 322). This new section emphasizes the need for state, Tribal, and local entities to closely coordinate mitigation planning and implementation efforts.

The requirement for a State mitigation plan is continued as a condition of disaster assistance, adding incentives for increased coordination and integration of mitigation activities at the State level through the establishment of requirements for two different levels of state plans: "Standard" and "Enhanced." States that demonstrate an increased commitment to comprehensive mitigation planning and implementation through the development of an approved Enhanced State Plan can increase the amount of funding available through the Hazard Mitigation Grant Program (HMGP). DMA 2000 also established a new requirement for local mitigation plans and authorized up to 7% of HMGP funds available to a state to be used for development of state, Tribal, and local mitigation plans.

Flood Mitigation Plan

FEMA's Flood Mitigation Assistance (FMA) program was created as part of the National Flood Insurance Reform Act (NFIRA) of 1994 (42 U.S.C. 4101) with the goal of reducing or eliminating claims under the National Flood Insurance Program (NFIP). FEMA provides FMA funds to assist States and communities implement measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the National Flood Insurance Program.

Grand Prairie's Flood Mitigation Plan was finalized by Halff Associates in September 2008 and was approved by FEMA in January 2009. Approval letters from the Texas Water Development Board and FEMA are included in Appendix P. The plan provides details on known flood hazards, vulnerability of flood hazards, mitigation strategies, flood mitigation goals, mitigation actions, and prioritization/implementation of these actions. A copy of the FMA plan can be obtained at the City of Grand Prairie or through Halff Associates.

> ***Recommendation*** – Halff recommends the City follow the guidelines in the approved Flood Mitigation Plan and update as required.

Hazard Mitigation Plan

FEMA's Hazard Mitigation Grant Program (HMGP) provides grants to States and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. The HMGP is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act.

HMGP funds may be used to fund projects that will reduce or eliminate the losses from future disasters. Projects must provide a long-term solution to a problem, for example, elevation of a home to reduce the risk of flood damages as opposed to buying sandbags and pumps to fight the flood. In addition, a project's potential savings must be more than the cost of implementing the project. Funds may be used to protect either public or private property or to purchase property that has been subjected to, or is in danger of, repetitive damage. Examples of projects include, but are not limited to:

- Acquisition of real property for willing sellers and demolition or relocation of buildings to convert the property to open space use
- Retrofitting structures and facilities to minimize damages from high winds, earthquake, flood, wildfire, or other natural hazards
- Elevation of flood prone structures
- Development and initial implementation of vegetative management programs
- Minor flood control projects that do not duplicate the flood prevention activities of other Federal agencies
- Localized flood control projects, such as certain ring levees and floodwall systems, that are designed specifically to protect critical facilities

- Post-disaster building code related activities that support building code officials during the reconstruction process

Note: Grand Prairie is currently in the process of addressing comments to and finalizing the City's Hazard Mitigation Plan.

> ***Recommendation*** – Halff recommends the City complete, submit, and work to obtain approval from FEMA of the Hazard Mitigation Plan. The City has developed a preliminary plan and is working on finalizing the document. Additional guidance is available on FEMA's HMGP web-site at:
> http://www.fema.gov/government/grant/hmgp/index.shtm

8. Floodplain Management Criteria

The City has developed strong Floodplain Management Criteria (reference Article 15 of the Unified Development Code, included in Appendix P). FEMA establishes the guidelines for floodplain management for communities involved in the National Flood Insurance Program (per 44 CFR). However, the City of Grand Prairie has developed more stringent guidelines than those FEMA has established. These guidelines are located in Article 15 of the UDC, as mentioned above. The guidelines apply to all areas of special flood hazard within the City of Grand Prairie and its extraterritorial jurisdiction.

Halff has evaluated the City of Grand Prairie's Floodplain Management Criteria and believes it is sufficient to manage development in the City's special flood hazard areas.

StormCAD – Halff has worked closely with the City over the past few years to help evaluate the StormCAD software and implement it as the standard storm drain modeling program for future City-wide Drainage Master Plan studies. On October 28, 2009, Halff provided a Memorandum to City staff regarding StormCAD Issues and CWDMP Protocols. The Memorandum is located in Appendix P – Miscellaneous Documentation.

Halff has only a few minor recommendations:

> ***Recommendation*** #1 - Halff recommends the City update Section 5 of Article 15 to include the effective dates of the Flood Insurance Studies for both Tarrant and Dallas Counties, once the Map Modernization Program for these two counties has been finalized. ***Note:*** *Grand Prairie has recently updated this Section to reflect the new dates of the Tarrant County FIS – September 2009.*

Recommendation #2 - Halff recommends the City update Section 22 of Article 15 as the Corridor Development Certificate (CDC) is updated to ensure that the listed information matches the current version (4th Edition of the CDC Manual is forthcoming).

9. Community Rating System (CRS) Activities

The National Flood Insurance Program's (NFIP) Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS:

1. Reduce flood losses;
2. Facilitate accurate insurance rating; and
3. Promote the awareness of flood insurance

For CRS participating communities, flood insurance premium rates for policies in Special Flood Hazard Areas are discounted in increments of 5%; i.e., a Class 1 community would receive a 45% premium discount, while a Class 9 community would receive a 5% discount (a Class 10 is not participating in the CRS and receives no discount). The CRS classes for local communities are based on 18 creditable activities, organized under four categories:

1. Public Information,
2. Mapping and Regulations,
3. Flood Damage Reduction, and
4. Flood Preparedness.

Grand Prairie's current CRS Rating is Class 7, which results in a 15% discount in flood insurance rates for properties within Special Flood Hazard Areas.

Sections in this report that specifically pertain to the CRS Rating:

1. Section II.F – City Policies
2. Section II.G – Overall Implementation Strategy (including "Design Criteria for Proposed Improvement Alternatives")
3. Section II.H – Hydrologic & Hydraulic Scope of Works for each Individual Alternative (with scopes included in the Appendices)

Recommendation – **The City of Grand Prairie is currently in the process of moving to an improved CRS Rating, ultimately having a Class 5 Rating.**. Accomplishing this would result in a 25% discount in flood insurance rates for policies within Special Flood Hazard Areas. In the future, the City would need to determine if it would have the capability and resources to improve the CRS Class rating even further. The rating should be re-evaluated, as required, after the current class rating improvement is approved.

10. FEMA Cooperating Technical Partner Program, Map Modernization Program, and Map Needs Assessment

FEMA's Cooperating Technical Partner (CTP) Program utilizes communities to assist FEMA with the significant challenge of keeping flood hazard maps current. The CTP Program is an innovative approach to creating partnerships between Federal Emergency Management Agency (FEMA) and participating NFIP communities, regional agencies, and State agencies that have the interest and capability to become more active participants in the FEMA flood hazard mapping program. Grand Prairie is currently a Cooperating Technical Partner.

FEMA's Map Modernization Program goal was to reduce the reliance on paper products. This program was established to enable communities to take full advantage of the new digital maps FEMA is producing through the Map Mod program. Within FEMA, the goal is to transition to digital processes for distributing and reading the flood maps. These new digital capabilities of the flood maps will:

- Enable significant advantages in capability, precision, and cost;
- Reduce costs associated with paper map production, handling and storage;
- Encourage the use of quality local data to make administration of the NFIP more efficient and effective.

In June 2009, the Texas Water Development Board (TWDB) and the Texas Natural Resources Information System (TNRIS) entered into an agreement with NCTCOG and Halff Associates to prepare a **Map Needs Assessment** Pilot Project for Upper Trinity River watersheds. The major tasks of this pilot project were to collect, process, and prioritize regional flood mapping needs and to develop procedures and guidelines for the state-wide MNA process. In August 2009, Halff met with Grand Prairie staff to determine priorities for local stream studies. Based on the data collected, Johnson Creek, Fish Creek, and Cottonwood Creek were listed high on the priority list for new studies. The information has been submitted to the RAMPP team (FEMA Regional Floodplain Mapping Contractor) for further review and assessment.

FEMA's document, "Guidelines and Specifications for Flood Hazard Mapping Partners" describes the processes for flood studies, mapping, map revisions and amendments, and program support. These processes should be thoroughly reviewed as the City receives future flood map revision requests.

> ***Recommendation*** – The City of Grand Prairie needs to establish guidelines for map revision and map amendment submittals, according to the CTP guidelines to ensure that all future submittals are in accordance to the digital mapping standards.

> ***Recommendation*** – The City of Grand Prairie needs to continue to work with the RAMPP team to determine further funding opportunities and additional methods of performing master plan studies on Grand Prairie streams.

G. OVERALL IMPLEMENTATION STRATEGY

Comprehensive/Global/Holistic View

The goal of the City-wide Drainage Master Plan is to develop a holistic strategy to implement drainage improvements across the City as a whole. This goal can be accomplished by prioritizing the recommended projects developed in each individual watershed master plan according to the highest benefit that can be provided for that project. An evaluation criteria should be established and utilized for recommended improvements in each individual watershed and for prioritization of recommended improvements among watersheds.

Previous Designated Projects/Backlog of Needed Improvements

For the recently completed Flood Mitigation Plan (January 2009), Halff Associates developed a comprehensive list of Capital Improvement Projects with a range of probable cost estimates. These projects were developed out of current Master Drainage Plans, the 2001 Approved Bond Projects Program, and from Hot Spots developed in for the City-wide Drainage Master Plan. Following is a list of preliminary projects shown in the Flood Mitigation Plan, from approximate lowest cost to highest cost, per watershed.

Joe Pool Lake

None

Fish Creek

1. **Ridgewood Street** (south of Kirby Creek) $400,000 - $650,000
2. **Bluegrass Street** (along Fish Creek, west of Belt Line Road) $400,000 - $650,000
3. **Timber River Lane** (Prairie Creek - Erosion) $500,000 - $750,000
4. **Meadows Drive and Summerfield Lane** (west of Robinson Road) $500,000 - $750,000
5. **Santa Anna** (East of Corn Valley) $500,000 - $1,000,000
6. **Kirby Creek Slope Reconstruction at Estate Drive** $575,000
7. **Green Hollow Drive** $750,000 - $1,000,000
8. **Blacksmith** (along the south side of Beacon Branch) $750,000 - $1,250,000
9. **Paladium Drive and Forest Trail** $750,000 - $1,250,000
10. **Newport Street** (west of Carrier Parkway) $750,000 - $1,250,000
11. **Kirby Creek Gabion Slope Protection** $950,000
12. **Bent Tree and Wintercrest** $1,000,000 - $1,500,000
13. **Darbytown Road** $1,000,000 - $1,500,000
14. **Glendale Street and Elm Drive** (east of Corn Valley) $1,000,000 - $1,500,000

15. **Silver Meadow Lane and Brevito Drive** (west of Belt Line Road) $1,000,000 - $1,500,000
16. **Lindsey Lane and Stephen Street** (east of Robinson Road) $1,500,000 - $2,000,000
17. **Pinoak Street and Crossland Blvd** (east of Robinson Road) $1,500,000 - $2,000,000
18. **Prairie Creek at GSW Parkway** $2,375,000
19. **Kirby Creek 11-acre regional detention pond** $2,575,000
20. **Prairie Creek Channel Improvements** $3,600,000
21. **Along Corn Valley Road** (north of Kirby Creek) $4,000,000 - $5,000,000
22. **Kirby Creek 23-acre regional detention pond** $5,375,000
23. **IH-20 along Fish Creek** (between Robinson Road and Carrier Parkway) $20,000,000 - $22,500,000

<u>Cottonwood Creek</u>

1. **South of Sherman Street** $250,000 - $500,000
2. **Parkside Drive** (east of GSW Pkwy - Erosion) $500,000 - $750,000
3. **Along Indian Hills Branch** (property flooding, erosion) $500,000 - $750,000
4. **Tapley Street** (along Tyre Branch – Erosion) $500,000 - $1,000,000
5. **Along Jefferson and Main Street** (east of Carrier Pkwy) $750,000 - $1,250,000
6. **Phillip's Court** (east of 4th Street) $750,000 - $1,250,000
7. **South of Stratford Drive** (east of Beltline Road) $750,000 - $1,250,000
8. **Gramley Street** $750,000 - $1,250,000
9. **Carrier – Storm Drain & Detention (July 2008) -Retention Pond -** $920,000
10. **Wellington Drive** (east of Robinson Road) $1,000,000 - $1,500,000
11. **Cober and 3rd Street, Freetown and 3rd Street** $1,000,000 - $1,500,000
12. **Carrier – Storm Drain & Detention (July 2008) - 5-Year Parallel System -** $1,140,000
13. **Carrier – Storm Drain & Detention (July 2008) - 10-Year Parallel System -** $1,365,000
14. **Dallas Street to Clarice Drive** (west of 5th Street) $1,500,000 - $2,000,000
15. **Along Powers Branch** (property flooding, erosion) $1,500,00 - $2,000,000
16. **San Antonio, El Paso, and Beaumont Street** (south of Jefferson Blvd.) $2,500,000 - $3,500,000
17. **Carrier – Storm Drain & Detention (July 2008) - 100-Year Parallel System -** $2,706,000

Cedar Creek

1. **San Jacinto Drive and Bowie Lane** (east of Bardin Road) $250,000 - $750,000
2. **Sandra Lane** $1,000,000 - $1,500,000
3. **Nadine Lane** $1,500,000 - $2,000,000

Johnson Creek/Arbor Creek/Barrett Branch

1. **Arbor Rose Drive** (Arbor Creek) $250,000 - $750,000
2. **Sunnyvale Road** (Johnson Creek) $500,000 - $1,000,000
3. **North of Egyptian Way** (west side of Arbor Creek) $500,000 - $1,000,000
4. **Danish Drive, Canadian Circle, and British Blvd** (Barrett Branch) $500,000 - $1,000,000
5. **Axminster and King Richard Drive** (Johnson Creek) $500,000 - $1,000,000
6. **Nottingham and Duncan Perry Road** (Johnson Creek) $750,000 - $1,250,000
7. **Ivanhoe Circle Area** (Johnson Creek) $1,000,000 - $2,500,000

West Fork Trinity River

1. **Sunnyvale and Carrier Parkway** $500,000 - $1,500,000
2. **East of Roy Orr Blvd/South of Shady Grove Road** $500,000 - $1,500,000

Mountain Creek

1. **Lakeview and Varsity Drive** (Lakeview Area) $500,000 - $1,500,000
2. **33rd Street and Hensley** (Mountain Creek North) $500,000 - $750,000
3. **Main Street, west of 19th Street** (Thompson Branch) $750,000 - $1,000,000
4. **Airport Street and Industrial Boulevard** (Thompson Branch) $750,000 - $1,000,000
5. **Grand Prairie Road and Belt Line Road** (Penman Branch) $750,000 - $1,000,000
6. **Avenue A and Avenue B, east of 14th Street** (Cannon Branch) $750,000 - $1,000,000
7. **SE 14th Street** (Penman Branch) $750,000 - $1,000,000
8. **Lisa and Donna Drive, north of Pioneer Parkway** (Mountain Creek West) $750,000 - $1,500,000
9. **12th Street, north of Grand Prairie Road** (Penman Branch) $1,000,000 - $1,500,000
10. **Vera Cruz, west of 14th and north of Warrior Trail** (Mountain Creek West) $1,000,000 - $1,500,000
11. **Trible Street, north of Main Street** (Mountain Creek North) $1,500,000 - $2,000,000

12. **Intersection of Main Street and RR** (Mountain Creek North) $1,500,000 - $2,000,000
13. **Lakeview Area** $8,200,000

Dalworth Creek

1. **May Lane and NW 23rd Street** $500,000 - $750,000
2. **Halifax Drive** (south of Tarrant Road) $750,000 - $1,250,000
3. **Jefferson Street** (east of Carrier) $750,000 - $1,250,000
4. **Denmark Drive** (south of Tarrant Road) $1,000,000 - $1,500,000
5. **Capetown Drive and Roman Road** (west of Carrier Pkwy) $1,000,000 - $1,250,000
6. **Carrier Parkway** $4,000,000 - $5,000,000

Gopher Branch/Turner Branch

1. **North of Small Hill & West of Stadium** $500,000 - $750,000
2. **West of Center & North of Church** $750,000 - $1,000,000

Bear Creek

1. **Along Spraybary Road** (west of Hard Rock Road and north of Shady Grove Road) $250,000 - $500,000
2. **Along Wright Blvd** (north of Shady Grove Road) $250,000 - $500,000
3. **Along Shady Grove** (west of Hard Rock Road) $500,000 - $750,000

Dry Branch

1. **Gilbert Drive** (between Manana and Josephine) $500,000 - $1,000,000
2. **Shady Grove** $13,500,000

Alspaugh Branch

1. **Camp Wisdom Road** $1,750,000

Recommendations for Capital Improvement Projects – Halff recommends that:

1. Consultants utilize the preliminary list of Capital Improvement Projects in the Flood Mitigation Plan as the initial basis of recommended improvements for each watershed master plan.
2. Consultants develop detailed estimates of probable construction cost for listed and new projects developed in the watershed master plan. These proposed projects will be used to develop the Short-term and Long-term Implementation plan later described in this section.
3. As individual watershed master plans are completed, the City will update the current Flood Mitigation Plan to reflect the newest list of projects and estimates.
4. Consultants follow the design criteria listed below while evaluating proposed projects:

Design Criteria for Proposed Improvement Alternatives

When preparing proposed improvement alternatives, consultants are to consider the following criteria for storm drain, stream, channel, and/or bridge/culvert improvements:

1. Streams & Channel Improvements – All designs should consider the existing and future, fully-developed 100-year storm events. Where practical, contain the future, fully-developed 100-year flood discharge within the proposed channel. If 100-year flood discharge cannot be contained, determine maximum level of protection that can be contained: 50-year or 10-year. The goal is to maximize the level of protection.
2. Streams & Channel Improvements - Maintain non-erosive velocities. Minimize development, alteration, or modification of existing natural stream channels. Ensure that future peak flows do not increase and volumes/valley storage within the floodplain do not decrease for proposed improvements
3. Storm Drainage System Improvements – Where practical, contain 100-year flood discharge beneath road or within right-of-way. Try to maximize number of open lanes in streets in flood situations. If 100-year flood discharge cannot be contained, determine maximum level of protection that can be contained: 50-year or 10-year. The goal is to maximize the level of protection.
4. Bridge/culvert Improvements – Minimize opening area, while providing 100-year flood protection. If 100-year flood protection is not practical, provide 50-year or 10-year flood protection at a minimum.
5. All Improvements
   - Determine design constraints, including: restricted right-of-way, steep existing channel slopes, inadequate road crossings, natural beauty/features of streams, aerial utility crossings (i.e., TRA sanitary sewer lines), existing water and sewer lines adjacent to storm drainage facilities and streams, existing dry utilities, adjacent homes and businesses, other proposed projects in area, downstream hydraulic conditions, and upstream hydrologic conditions.
   - Minimize impacts to open space areas
   - Minimize the amount of additional right-of-way to be acquired
   - Minimize or avoid major utility relocations
   - Minimize environmental damage where possible. Avoid wetlands and jurisdictional waters of the U.S. for proposed projects to the best extent possible. Avoid Section 404 Individual permitting, if possible.
   - Minimize impact to local residents and businesses during construction (consider effective traffic control and erosion control where necessary)

- Perform field reconnaissance of proposed improvement locations and take note of types of structures, relative worth, out buildings, fences, utilities, and other above-ground features. Determine if there are opportunities to integrate solutions into the character of the neighborhood or area.

Short-Term Priorities and Long-Term Implementation Plan (City-wide)

Developing Short-Term Priorities and a Long-Term Implementation Plan is critical to ensure that new floodplain improvements and storm water facilities are constructed over time to provide the most benefit to the City and community. For the City-wide Drainage Master Plan, multiple improvement projects will be recommended for each individual watershed master plan. An overall, City-wide implementation plan has to be developed to prioritize these projects into short-term and long-term priorities. A preliminary implementation plan could be developed as follows:

Preliminary Short-Term and Long-Term Implementation Plan

As proposed capital improvement project (CIP) alternatives are developed for the individual master plans, the consultants should determine the following:

- **Number of properties/structures benefited** by the reduction in flood damage for the proposed CIP alternative (including residential, commercial, industrial, and public facilities).
  - This number could include (1) properties in floodplain, (2) properties experiencing flood damage due to inadequate storm drain system capacity, or (3) properties with historic drainage complaints. (Assume one structure per property. Property values do not matter for this exercise).
- **Estimates of probable cost** for the proposed CIP alternative, using minimum 25% cost contingency, 10% engineering/surveying contingency, right-of-way costs, and utility relocation costs. CIP alternatives shall be categorized as follows:
  - **Small Projects –** Less than $500,000
  - **Medium Projects** - $500,000 to $1,500,000
  - **Large Projects –** $1,500,000 to $5,000,000
  - **Extra-Large Projects –** $5,000,000 to $10,000,000
    - Consultant needs to consider phasing to reduce size, if possible
  - **Super-Size Projects –** Greater than $10,000,000
    - Consultant needs to consider phasing to reduce size, if possible

- **Roadway Type Benefited -** The consultant should categorize the road type. Categories include **HWY, P7U, P6D, P4D, P3U, M5U, M4U, M3U, C2U,** and **No Roadway** (if no roadway benefits are included with project). More information on roadway types can be found at**:** http://www.gptx.org/Modules/ShowDocument.aspx?documentid=443
- **Roadway Flood Event Protection –** Consultant shall determine the level of flood protection for the roadway, if included in the project. This should be described as 1-year, 2-year, 5-year, 10-year, 25-year, 50-year, or 100-year (existing).
- **Roadway Citizens Protected/Impacted –** Consultant shall approximate the percentage and total roadway citizens impacted per Step 3 below.
- **Citizens Impacted per Structure Benefited** – Based on the number of structures benefited for each CIP alternative, consultant shall determine the total approximate number of citizens impacted.
- **Ultimate 100-year discharge.** Consultant shall determine the Ultimate 100-year discharge at the project location.
- **Other potential hazards reduced/eliminated** for each project, including:
  - Stream Erosion-related – including severe erosion that could affect adjacent properties with structures (these structures could be included in the BCA, if appropriate) or severe erosion problems within road right-of ways (along embankments, at culverts, or under bridges)
  - Recreational Areas – including adjacent public recreation areas that may incur damage from flooding or erosion.

Implementation Plan - Steps

- **Step 1** of the Implementation Plan would develop the Initial Ranking Factor based on the estimate of probable cost versus the number of properties/structures benefited:

Step 1: Determine Initial Ranking Factor		**No. of Properties/Structures Benefited**		
		High > 10	**Medium 5 to 10**	**Small < 5**
Estimate of Probable Cost ($)	**Small < $500k**	**1**	**2**	**3**
	Medium $500k - $1.5Mil	**2**	**3**	**4**
	Large > $1.5Mil	**3**	**4**	**5**
	X-Large (> $5M)	**6**	**7**	**8**
	Super-Size (>$10M)	**9**	**10**	**11**

- **Step 2** of the Implementation Plan would be to develop a second factor for ranking based on the number of citizens impacted, by potential for roadway shutdowns if no improvements were made on existing roadways, and by a cost to benefit ratio of proposed improvements per roadway citizens impacted.

Sub-Step 1 – Determine Existing Roadway Type

Roadway Type
HWY
P7U
P6D
P4D
P3U
M5U
M4U
M3U
C2U

Sub-Step 2 – Determine Existing Conditions Roadway Flood Event Protection and Percentage of Roadway Citizens Protected

Roadway Flood Event Protection	Percentage of Citizens Protected [1]
1-Year	0%
2-Year	15%
5-Year	35%
10-Year	50%
25-Year	70%
50-Year	85%
100-Year	100%

[1]Based on approximation, using logarithmic chart, with 1-Year Event coverage protecting 0% and with 100-Year Event protecting 100%

Sub-Step 3 – Determine Percentage of Roadway Citizens Impacted

100% minus percentage of citizens protected in Sub-Step 2

Sub-Step 4 – Determine Number of Roadway Citizens Impacted

Roadway Type Benefited	Percentage of Citizens Protected [1]
HWY	20800
P7U	12740
P6D	11700
P4D	7800
P3U	5460
M5U	8450
M4U	6760
M3U	5070
C2U	2730

[1]Based on percentage of citizens impacted multiplied by [No. Lanes * 4 hours impacted *hourly volume per lane * Level of Service C Traffic Volume (see table below)]

Grand Prairie Classification	NCTCOG Classification	Lanes	Hourly Service Vol./lane	NCTCOG LOS* Roadway Capacity LOS E	LOS D	LOS C	Current UDC "LOS C" Traffic Volume
P7U	Principal Arterial-Undiv.	7	700	49,000	39,200	31,850	42,000
P6D	Principal Arterial-Divided	6	750	45,000	36,000	29,250	42,000
P4D	Principal Arterial-Divided	4	750	30,000	24,000	19,500	28,000
P3U	Principal Arterial-Undiv.	3	700	21,000	16,800	13,650	18,000
M5U	Minor Arterial	5	650	32,500	26,000	21,125	28,000
M4U	Minor Arterial	4	650	26,000	20,800	16,900	22,000
M3U	Minor Arterial	3	650	19,500	15,600	12,675	18,000
C2U	Collector	2	525	10,500	8,400	6,825	10,000
L2U	Local Street	2	525	10,500	8,400	6,825	8,000
LU	Local Street	1	525	5,250	4,200	3,413	8,000
R2U	Rural Street	2	525	10,500	8,400	6,825	8,000

* = from the Dallas-Fort Worth Regional Travel Model Manual, Exhibits 23 and 24
NCTCOG capacity: LOS E = (# lanes) * 10 * (NCTCOG Hourly Service Volume per Lane)
NCTCOG capacity: LOS D = (LOS E) * .8
NCTCOG capacity: LOS C = (LOS E) * .65

Sub-Step 5 – Determine Cost to Benefit of Roadway Number of Citizens Impacted
Divide the estimate of probable cost by the results from Sub-Step 4 to determine the cost to benefit ratio (in dollars)

Sub-Step 6 – Develop Second Ranking Factor with highest rank being the lowest cost to benefit ratio.

- **Step 3** of the Implementation Plan would be to determine the total tax value of all the properties with structures that are benefited by the project from Step 1. Develop Third Ranking Factor based on table below.

Total Tax Value of Properties with Structures Benefited	Third Ranking Factor
$2,000,000 +	1
≥ $1,900,000	2
≥ $1,800,000	3
≥ $1,700,000	4
≥ $1,600,000	5
≥ $1,500,000	6
≥ $1,400,000	7
≥ $1,300,000	8
≥ $1,200,000	9
≥ $1,100,000	10
≥ $1,000,000	11
≥ $900,000	12
≥ $800,000	13
≥ $700,000	14
≥ $600,000	15
≥ $500,000	16
≥ $400,000	17
≥ $300,000	18
≥ $200,000	19
$0 to $199,999	20

- **Step 4** – Provide sum of first, second, and third ranking factors. Next, provide the initial ranking, with the top-ranked (#1) project having the lowest total ranking factor. Continue this method until all projects are ranked.

- **Step 5** – If two or more projects are ranked the same in Step 4, then these projects need to be sorted further. The higher ranked of these projects would be the one that has the greatest ultimate 100-year discharge at the project location

- **Step 6** – Provide the Final Ranking, with the top-ranked (#1) project having the lowest total ranking factor and include the sorted project rankings from Step 5.

- **Additional Notes on Ranking**
  - Phased projects shall be ranked in order of phasing. *For example, Phase 1 of a project shall be ranked higher than Phase 2 of a project.* Note, that if this occurs, the Phased projects can only move down in the overall rankings, not up.
  - Also, if a project is dependent on another downstream project, then the consultant shall take this into account and consider this as phasing of an overall project.
  - If two projects in different watersheds have the same rank in Step 4 and need to be sorted in Step 5, but have similar ultimate 100-year discharges (within 500 cfs), then the projects should be ranked in order of the lowest estimate of probable cost.
  - Rankings will be adjusted as each individual watershed masterplan is completed. Each project will be ranked as follows:
    - Ranked among other projects in same watershed
    - Ranked among other projects in City of Grand Prairie
    - Ranked among various size projects in City of Grand Prairie (Small, Medium, Large, and Extra Large/Super Size)

Final Short-term Priorities Implementation

The consultant shall determine the **Short-term Priority CIPs** for the individual watershed master plan. These could generally be described as those projects with an initial ranking factor of 1, 2, or 3 in **Step 1** above. The Short-term Priority projects would become the City's key Capital Improvement Projects for immediate implementation, contingent upon City Council approval and allocated funding. Prior to beginning the construction process on these projects, the following key issues may need to be examined:

- Public or private participation in funding and implementation
- Drainage right-of-way or easement needs
- Permitting – FEMA, NCTCOG, U.S. Army Corps of Engineers, TCEQ, or EPA
- Public or neighborhood meetings to describe project and receive citizen feedback
- Adherence of project to City's ordinances and standards for construction

Final Long-term Plan Implementation

All other CIPs not classified as Short-term priorities will be **Long-term CIPs**. Long-term CIPs will be need to be evaluated by complexity, cost, or by number of properties/structures benefited. These need to be planned properly with funding allocated for future construction, contingent on City Council approval. Projects that could be constructed by phasing (i.e., will phasing provide immediate benefits or does the whole project need to be constructed for benefits to occur) would need to be re-evaluated by each Phase and re-ranked accordingly with the other CIP alternatives.

For the Long-term projects, the following key issues may need to be examined:

- All the Short-term issues listed above
- Longer range funding plans for larger projects, including phasing (look into State and Federal grants and construction loans)
- More global view, watershed-wide or regional type projects (look into cooperative efforts with U.S. Army Corps of Engineers, NCTCOG, or adjacent communities)
- Examine how increased development of the City's **flood warning system** could provide further benefits to these areas until funding is allocated for project implementation
- Non-structural measures including:
    - **Buy-out program** – City would need to decide on perpetual maintenance of property or re-selling property after measures are taken to remove lot from flood hazard. Recommend pursuit of City funding, if available, or associated grants (see Section II.D – Funding Opportunities), if applicable
    - Enforce **new and/or improved development standards** to restrict future development in flood hazard areas

***Recommendation* –** Halff recommends utilization of the preliminary Short-term and Long-term Implementation Plan as described above.

City Wide Drainage Master Plan

Joe Pool & Cottonwood & Fish Creeks Example

	Capital Improvement Project Alternative	Watershed	Project Size & Short-Term/Long-Term	Step 1 - Initial Ranking Factor - Estimate of Probable Cost vs. # Structures Benefited [1]			Step 2 - Second Ranking Factor - Cost to Benefit of Roadway Number of Citizens Impacted [2]							Step 3 - Tax Value of Benefited Property Structures [7]		Sum of 1st, 2nd, and 3rd Factors -	Initial Rank - Step 4	100-Year Ultimate Discharge at CIP Location - Step 5		Final Rank - Step 6
				# Structures	Cost	1st Factor [1]	Type	Roadway Flood Event Protection	Roadway % Citizens Protected [3]	Roadway % Citizens Impacted [4]	Roadway # Citizens Impacted [5]	Cost to Benefit Roadway # Citizens Impacted [6]	2nd Factor	Tax Value of Property Structures Benefited	3rd Factor	Total	Rank [8]	Ultimate Q_{100}	Sorting [9]	Rank [10]
1	Belt Line Road at Cottonwood Creek	Cottonwood Creek	X-Large/Long-Term	12	$4,719,000	3	P6D	5	35%	65%	7605	$620.51	18	$2,250,000	1	22	1	19,398		1
2	Belt Line Road at Plattner Creek	Cottonwood Creek	Small/Short-Term	0	$139,000	3	P6D	25	70%	30%	3510	$39.60	1	$0	20	24	2	1,981		2
3	Pioneer Parkway at SF Cottonwood	Cottonwood Creek	Small/Short-Term	0	$217,000	3	P6D	25	70%	30%	3510	$61.82	2	$0	20	25	3	3,987		3
4	Tangle Ridge at Stuart Branch	Joe Pool Lake	Small/Short-Term	0	$136,000	3	C2U	10	50%	50%	1365	$99.63	3	$0	20	26	4	130		4
5	Marshall Drive at SF Cottonwood	Cottonwood Creek	Medium/Long-Term	0	$787,000	4	M4U	2	15%	85%	5746	$136.96	4	$0	20	28	5	6,277	5	5
6	GSW Pkwy at SF Cottonwood	Cottonwood Creek	Small/Short-Term	0	$326,000	3	P4D	25	70%	30%	2340	$139.32	5	$0	20	28	5	4,010	6	6
7	GSW Pkwy at Prairie Creek	Fish Creek	Medium/Long-Term	0	$570,000	4	P4D	10	50%	50%	3900	$146.15	6	$0	20	30	7	10,589		7
8	CR 506 at Grassy Creek	Joe Pool Lake	Medium/Long-Term	0	$1,183,000	4	P4D	1	0%	100%	7800	$151.67	7	$0	20	31	8	7,730		8
9	Miller Road at East Soap Creek	Joe Pool Lake	Medium/Long-Term	0	$675,000	4	P4D	10	50%	50%	3900	$173.08	8	$0	20	32	9	6,100		9
10	Robinson Road at SF Cottonwood	Cottonwood Creek	Medium/Long-Term	0	$1,017,000	4	M4U	2	15%	85%	5746	$176.99	9	$0	20	33	10	6,197		10
11	Jones Road at West Soap Creek	Joe Pool Lake	Medium/Long-Term	0	$1,327,000	4	M3U	1	0%	100%	5070	$261.74	10	$0	20	34	11	7,500		11
12	Turner Road at East Soap Creek	Joe Pool Lake	Medium/Long-Term	0	$659,000	4	C2U	2	15%	85%	2320.5	$283.99	11	$0	20	35	12	5,500		12
13	IH-20/Carrier at Fish Creek	Fish Creek	Super-Size/Long-Term	10	$20,150,000	10	P6D	2	15%	85%	9945	$2,026.14	22	$1,700,000	4	36	13	26,347		13
14	CR 502 at Grassy Creek	Joe Pool Lake	Large/Long-Term	0	$1,685,000	5	M3U	1	0%	100%	5070	$332.35	12	$0	20	37	14	7,000	14	14
15	Old Fort Worth Road at Plains Branch	Joe Pool Lake	Large/Long-Term	0	$1,685,000	5	M3U	1	0%	100%	5070	$332.35	12	$0	20	37	14	4,800	15	15
16	CR 619 at Grassy Creek	Joe Pool Lake	Large/Long-Term	0	$1,924,000	5	M3U	1	0%	100%	5070	$379.49	14	$0	20	39	16	10,740		16
17	FM 661 at Mountain Creek	Joe Pool Lake	Large/Long-Term	0	$2,616,000	5	P4D	2	15%	85%	6630	$394.57	15	$0	20	40	17	39,320	17	17
18	Seeton Road at Taaffe Creek	Joe Pool Lake	Small/Short-Term	0	$433,000	3	C2U	25	70%	30%	819	$528.69	17	$0	20	40	17	2,090	18	18
19	CR 502 at West Soap Creek	Joe Pool Lake	Large/Long-Term	0	$2,017,000	5	M3U	1	0%	100%	5070	$397.83	16	$0	20	41	19	7,500		19
20	Kimble Road at Newton Branch	Joe Pool Lake	Medium/Long-Term	0	$1,449,000	4	C2U	2	15%	85%	2320.5	$624.43	19	$0	20	43	20	6,600		20
21	GSW Pkwy at Cottonwood	Cottonwood Creek	X-Large/Long-Term	0	$4,914,000	8	P4D	2	15%	85%	6630	$741.18	20	$0	20	48	21	8,888		21
22	Carrier at SF Cottonwood/Cottonwood	Cottonwood Creek	X-Large/Long-Term	0	$5,688,000	8	M5U	2	15%	85%	7182.5	$791.92	21	$0	20	49	22	18,386		22
23	3rd Street at Cottonwood	Cottonwood Creek	X-Large/Long-Term	0	$9,873,000	8	C2U	2	15%	85%	2320.5	$4,254.69	23	$0	20	51	23	18,630		23

1 Refer to City-Wide Drainage Master Plan Road Map, Section II.G - Implementation Plan - Step 1
2 Refer to City-Wide Drainage Master Plan Road Map, Section II.G - Implementation Plan - Step 2
3 Based on approximation, using logarithmic chart, with 1-Year Event coverage protecting 0% of traffic volume and 100-Year Event coverage protecting 100% of traffic volume
4 Percent Impacted = 100% minus % of Roadway Citizens Protected (approximate)
5 Number Impacted = % Impacted multiplied by [No. Lanes * 4 Hours Impacted * Hourly Volume Per Lane * Level of Service "C" Traffic Volume]
6 Cost of CIP divided by Roadway # Citizens Impacted
7 Refer to City-Wide Drainage Master Plan Road Map, Section II.G - Implementation Plan - Step 3
8 Refer to City-Wide Drainage Master Plan Road Map, Section II.G - Implementation Plan - Step 4
9 Refer to City-Wide Drainage Master Plan Road Map, Section II.G - Implementation Plan - Step 5
10 Refer to City-Wide Drainage Master Plan Road Map, Section II.G - Implementation Plan - Step 6

Additional Notes:

a. Phased projects shall be ranked in order of Phasing (i.e. Phase 1 shall be ranked higher than Phase 2, etc.)

b. In Step 5, when comparing projects between two different watersheds: If two projects have same rank in Step 4 and need to be sorted, but have similar 100-Year Ultimate Discharges, then projects should be ranked in order of lowest cost estimate

Classification	Citizens
C2U	2730
M3U	5070
M4U	6760
M5U	8450
P3U	5460
P4D	7800
P6D	11700
P7U	12740
HWY	20800

Freq	Percentage
1	0
2	15
5	35
10	50
25	70
50	85
100	100

H. HYDROLOGIC AND HYDRAULIC SCOPE OF WORKS

Halff Associates has prepared detailed scope of works for each individual watershed in the City of Grand Prairie, in the order of priority listed below.

Grand Prairie Individual Watersheds and Planning Study Priority

Grand Prairie Individual Watersheds	Watershed Priority
Joe Pool Lake	1
Fish Creek	2
Cottonwood Creek	3
Cedar Creek	4
Johnson/Arbor/Barrett	5
West Fork Trinity River	6
Mountain Creek	7
Dalworth Creek	8
Gopher/Turner	9
Bear Creek	10
Dry Branch	11
Alspaugh Branch	12

Detailed scope of works are included in Appendix C-N for each watershed, and each appendix includes a Basin-wide watershed map with individual storm drain system sub-basins shown. Preliminary FEMA Digital Flood Insurance Rate Maps (DFIRM) for areas of Grand Prairie in Tarrant and Dallas County are included in Appendix O. The scope of works identify specific items that need to be addressed for each watershed and also provide general City-Wide Drainage Master Plan tasks that will help accomplish the goals set forth in this Road Map. Note: the provided Scope of Works are established as guidelines only. Each study team will need to evaluate the included Scope of Work, provide updates based on current known conditions, provide detailed fee estimates for each task, and provide detailed project schedules with interim milestone deadlines and City review periods.

Criteria for Future LOMR Submittals Associated with Individual Watershed Drainage Master Plans

In general, LOMR submittals to FEMA will include the following:

- The 10-, 50-, 100-, and 500-year flood frequencies and floodway (if included in FIS) for existing land used conditions
- Complete and accurate technical documentation (topography, field surveys, horizontal and vertical datum, bridge data, "as-built" plans, digital workmaps, digital hydraulic and hydrologic models, previous LOMR information, etc.)
- Incorporates all known LOMC's
- Submitted as an updated entire stream model (not submitted just as the LOMR study reach). This methodology will ensure a seamless transition of the LOMR into the entire stream model and will show how the LOMR affects downstream and upstream conditions in the model.
- Geo-referenced mapping data to a known coordinate system (i.e. City Monumentation). This can be done in CADD or GIS format.
- Signed and sealed by a Registered Professional Engineer
- Complies with all City Ordinances
- All proper individual notifications and public notices are obtained and submitted to FEMA correctly
- Defendable by the City and consultant engineer during FEMA comment period

Criteria for Preparation of Elevation Certificates Associated with Individual Watershed Drainage Master Plans

In general, Elevation Certificate preparation will include the following:

- Identify property locations of structures within updated existing 100-year (1% annual chance) floodplain limits.
- Identify structures on each property that serve as the primary residence or primary use to commercial/industrial sites. For these structures, prepare field surveys of finished flood and lowest adjacent grades around structures.
- All other insurable structures found to be within the limits of the 100-year (1% annual chance) floodplain of each watershed will be identified and submitted to the City Floodplain Administrator for approval before proceeding with surveying and preparation of the elevation certificate.
- Necessary paperwork for Elevation Certificates will be per current FEMA standards
- Upon completion, prepare overall map of Elevation Certificate locations along the floodplain and submit to City along with completed Elevation Certificates.

SECTION III

INDIVIDUAL WATERSHED STUDIES – REPORT FORMAT

III. INDIVIDUAL WATERSHED STUDIES – REPORT FORMAT

Each individual watershed master plan will follow a standard report format. The format may generally include the following sections in this order. Some sections may not be necessary if they are not applicable to the actual master plan study.

Report Format

I. Introduction

a. **Purpose of Study** – *Include overall purpose of City-wide Drainage Master Plan and individual watershed primary study objectives*

b. **Watershed Description** – *Include general watershed boundaries, headwater location, receiving waters, size of watershed, percent urbanization, description and lengths of major streams and tributaries, and pertinent unique attributes of watershed related to flooding*

   i. **Major Streams and Tributaries –** *List all named streams and tributaries for each watershed*

   ii. **Unique Attributes of Watershed –** *List unique attributes of watershed (regional detention, large open water features, recent storm drainage or channel improvement projects, major road crossings, proposed future road and hydraulic improvement projects)*

c. **Principal Flooding Problems** – *Include overview of the drainage complaint database available for the watershed and principal hot-spot locations. Include database and map of hot spots in appendices and CD-ROM.*

   i. **Drainage Complaint Database** – *List total number of complaints and breakdown of complaints by structure flooding, property flooding, street flooding, and erosion complaints. Consultants can utilize the database associated with this report and include any new complaints up through the time of the watershed study*

   ii. **Hot Spot Locations –** *Describe each hot spot location identified in the City-wide Drainage Master Plan and add/describe any new hot spots determined from the watershed study*

d. **Pertinent Study and Technical Data Related to Watershed Prior to <Name of Watershed> Master Plan Preparation** – *Include listing of data collected for the study and detailed listing of all pertinent studies prepared prior to the Master Plan study and studies that are currently on-going.*

II. Hydrologic Studies

a. **General Information –** *Include type of modeling software used for the study, listing of rainfall events selected, current City Drainage Design Manual used (currently November 2008), and any other technical manuals used for the hydrologic analyses.*
b. **Watershed Hydrology Information –** *Include more detailed description of watershed or multiple watersheds (if applicable) in this section.*
c. **Land Use –** *Include basis of both existing and future land use conditions used for the study both within City limits and outside City limits*
d. **Impervious Coverage –** *Include description of percent impervious values and include Table showing percent impervious values used for the study, with references to where these are from.*
e. **Hydrologic Soil Types –** *Include what soils database was used for the study and provide descriptions of general soil types (such as A, B, C, or D) that are present within the study watershed. Also include description of antecedent moisture condition used for the study.*
f. **Loss Rates –** *Include description of loss rates used for the study. For all studies, the NRCS Curve Number method shall be used. Include description and calculation used for initial abstraction method.*
g. **NRCS Unit Hydrograph –** *Include description of the NRCS Unit Hydrograph method and method used to calculate time of concentration and lag times for the study.*
h. **Rainfall –** *Include description and table of point rainfall depths used for the study. The table should reference the current City Drainage Design Manual rainfall (currently November 2008).*
i. **Flood Routing –** *Include description of type(s) of flood routing method utilized for study. If a different flood routing method other than "modified puls" is used, describe locations and why the particular method was used. If "modified puls" is used, describe the procedures used.*
j. **Detention & Diversions (or other hydrologic elements if applicable)** *– Include descriptions of any other type of hydrologic elements in the watershed, if applicable. Describe methods of analysis for each additional hydrologic element.*

III. Hydraulic Studies – *Include description of type of model used to perform hydraulic analysis, what flood frequencies were computed, cross-section description and how these were prepared, channel and overbank roughness values, contraction/expansion coefficients, downstream (and/or upstream) boundary conditions, and any other elements used in the hydraulic study.*

IV. Hydrologic and Hydraulic Study Results

a. **Hydrologic Study Results –** *Include description and table of parameters for each sub-basin: area, lag time, hydrologic soil type percentages (A, B, C, and D), curve numbers, initial abstractions, and percent impervious values (existing and future conditions). Include description and tables for existing and future computed peak flood discharges for all flood events (compare to previous studies or FEMA FIS discharges). Include drainage area map, soils map, and land use maps (existing and future conditions).*

b. **Hydraulic Study Results –** *Include description and comparison table of existing and future conditions 100-year computed flood elevations. Describe delineations of floodplains and floodways and what they are based on (GeoRAS or manual delineation). Describe flood profiles for the stream(s) and list what flood events are included in the profile. Describe any key areas (structures, streets, properties) that are affected by the existing and future 100-year floodplain.*

V. Floodplain Mapping – *Include detailed floodplain mapping of entire studied stream areas, including all requirements of FEMA MT-2 Work Maps*

a. **LOMR Submittal –** *Describe Letter of Map Revision submittal (LOMR submittal should be provided as a separate document from the watershed master plan)*

b. **Elevation Certificates –** *Describe and tabulate elevation certificate locations (Elevation Certificates should be provided as separate documents from the watershed master plan)*

VI. Roadway Crossings

a. **Evaluation of Existing Roadway Crossings –** *Describe all road crossings and include a table of associated future 100-year computed flood elevations vs. roadway elevations.*

b. **Evaluation of Proposed and Future Roadway Crossings –** *Utilize City Master Thoroughfare Plan and describe future sizing of roadway crossings for future 100-year flood frequency capacity*

VII. Alternatives for Streams and Open Channels – *Prepare detailed descriptions of alternatives (structural and non-structural) developed for the watershed master plan and the primary features they include. Describe flood profile impacts, valley storage impacts, environmental quality and potential permitting requirements, channel stability/erosion issues, bridge/culvert improvements, and potential property buy-outs.*

VIII. Storm Water Infrastructure Analysis

a. **Overview –** *Include description of storm drainage networks studied per type of network: 1) Simple system/small basin, 2) Simple system/large basin, and 3) Complex system. In each of these descriptions, describe*

Hot Spot locations, age of each system, design discharges and method of calculation.

b. **Existing Capacity Analysis –** *Describe methodology for determining existing capacity analysis of "trunk lines" in each storm drainage basin*

c. **Optimization Analysis –** *Describe methodology used to attempt to optimize storm drainage systems, primarily for "smaller" projects*

d. **Storm Water Alternatives –** *Describe methodology used to determine alternatives to relieve flooding problems associated with storm drainage networks. Describe traditional alternatives (pipe upsizing, etc.), innovative alternatives (detention, property buy-outs, downstream improvements to lower tailwater, etc.), and include preliminary quantities and estimates of probable cost for each alternative*.

IX. Channel Stability Assessment/Erosion Hazard Analysis – *Describe methodology used for hydraulic and geomorphology analysis. Include stream bank restoration alternatives.*

X. Dams/Levees/Detention/Drainage Reviews – *Include detailed description of locations of these features, include table of existing drainage plan reviews, and include associated plans, photos, and descriptions of potential problems associated with these features*

XI. Maintenance - <Watershed Name> - *Include detailed description of locations where maintenance needs to occur for storm drain outfalls, inlets, culverts, natural channels, improved channels, bridges, etc. Describe the City's Storm Drain Outfall Field Assessment of the watershed. Describe and include a table listing specific schedules for maintenance for the watershed (based on City-wide Drainage Master Plan recommendations)*

XII. Preliminary Quantities/Estimates of Probable Cost

a. **Streams and Open Channels** – *Include summary of alternative improvements from Section VII*

b. **Storm Water Infrastructure** – *Include summary of alternative improvements from Section VIII*

c. **Stream Bank Restoration Alternatives –** *Include summary of alternative improvements from Section IX*

XIII. Evaluation & Prioritization/Phasing & Implementation

a. **Evaluation and Prioritization** – *Describe methodology utilized to evaluate and prioritize proposed alternative improvement projects.*

b. **Phasing and Implementation –** *Describe methodology utilized to help phase and implement the proposed alternative improvement projects for the watershed.*

XIV. Short Term Priorities & Long Term Plan

a. *Follow Four-step process as described in Section II.G. – Overall Implementation Strategy*

b. **Short Term Priorities –** *Develop benefit-cost analysis (BCA) ratios of proposed improvement projects and rank short-term priority projects. Describe key issues that would need to be addressed for each project.*

c. **Long Term Plan** – *Develop BCA ratios of proposed improvement projects and rank long-term projects. Describe strategy for long term implementation of larger projects and include phasing options and implementation time-frames. Describe key issues that would need to be addressed for each project.*

XV. Master Plan Study Wrap-up & Recommendations for Future Action – *Address primary goals of study (from Section I) and describe recommendations for future actions. Also list procedure for coordination of future studies performed in this watershed (see below).*

Appendices

A. Pertinent Figures – *Location, Vicinity, Hydrology, Hydraulics, Storm Drain Maps*

B. Pertinent Tables

C. Hydrologic & Hydraulic Model Output – *Primarily for cross-sections and profiles and necessary hydrologic data. Not intended for detailed generated reports.*

D. Storm Drain Model Output (StormCAD)

E. Miscellaneous Documentation – *Any other necessary information not related to one of the categories above*

F. CD-ROM

Attachments – These attachments, separate from the Report and Appendices (but still in the same document) will include any new hydrology & hydraulic studies, storm drain studies, CLOMR's, LOMR's, channel design projects, storm drain infrastructure design projects, erosion studies and design projects, etc. located within the specific watershed after the completion of the Master Plan study. A standard form (see following page) will be included in the Attachment listing the project name, City project number, engineering consultant firm name, engineering consultant project manager/contact information, and date of completed study. If hydrology and/or hydraulic models are updated and/or are approved as the new current effective model, then a CD-ROM with the updated models will be included with the Attachment stating that the models are either “New models based on the study (not current effective)” or “Current Effective Model (date of model)”.

Each update will have a new Attachment designation (A, B, C, D, E, etc.).

A. Update #1
B. Update #2
C. Update #3
D. Update #4
E. Update #5
F. Etc.

Additional Information on Master Plan Submittals

All submittals will be in hard-copy, three-ring binder format, including the report, maps, and all technical data. Digital models, maps, and the entire report (PDF) will be included on an accompanying CD-ROM. An additional CD-ROM will be added to the report to include the current effective hydrology and hydraulic models (either at time of study completion or upon completion of a Letter of Map Revision). Consultant shall also prepare a Watershed CIP Rankings spreadsheet per the examples provided in this Section and include this digital file on the accompanying CD-ROM.

____________________ MASTER PLAN
UPDATE # ____

PROJECT/STUDY NAME ____

CITY PROJECT NUMBER ____

CONSULTANT COMPANY NAME ______________________________ PHONE ____________

CONSULTANT PROJECT MANAGER ____

DATE OF COMPLETED PROJECT/STUDY ____

DESCRIPTION OF PROJECT/STUDY

DOES STUDY INCLUDE NEW HYDRAULIC OR HYDROLOGIC MODELS? _____ YES _____ NO

ARE NEW HYDRAULIC OR HYDROLOGIC MODELS CURRENT EFFECTIVE? ____ YES ____NO ____N/A

(PLEASE INCLUDE CD-ROM WITH THIS FORM)

ADDITIONAL INFORMATION

APPENDIX A
REPORT FIGURES

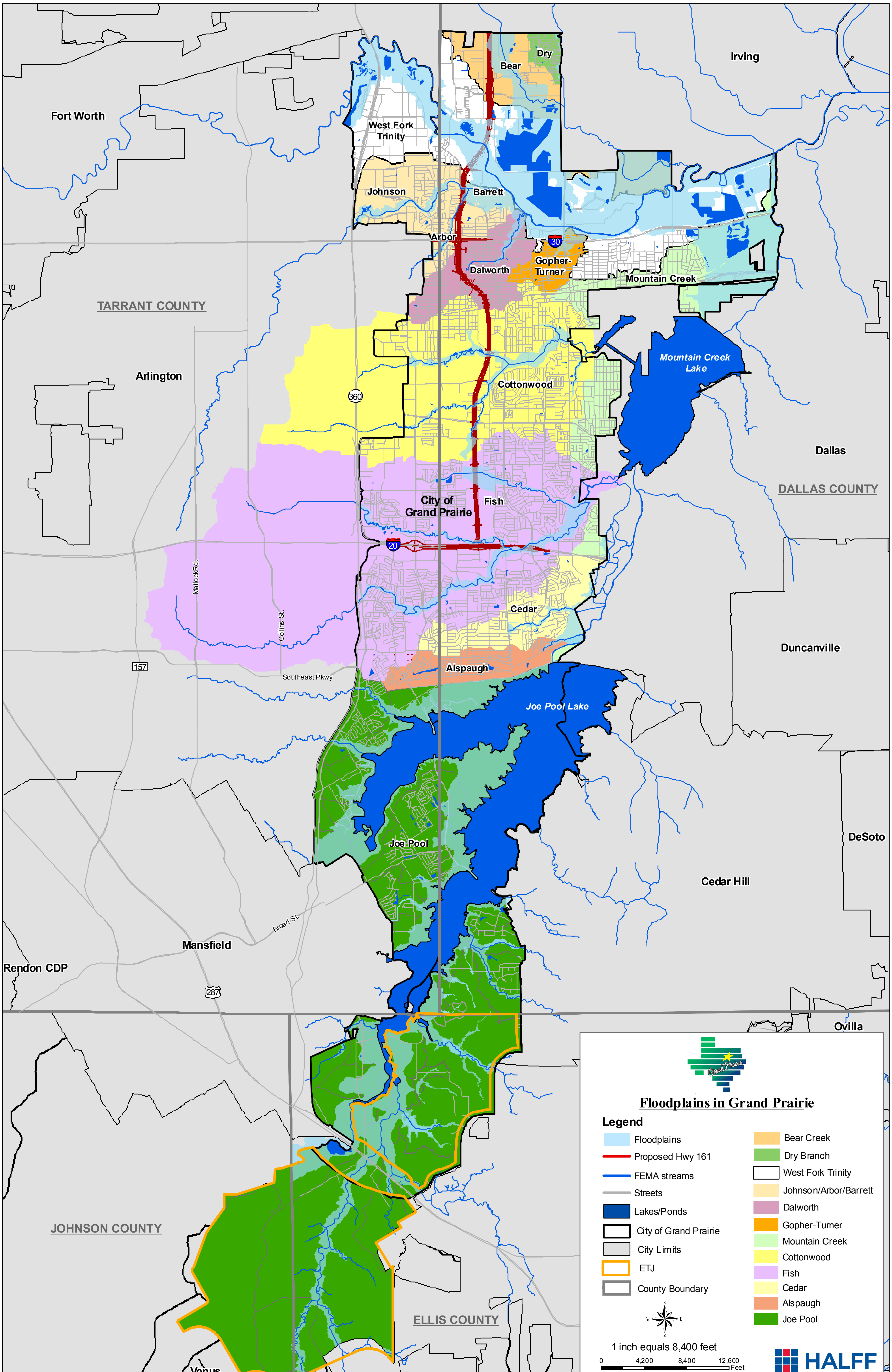

Fort Worth
Irving
Dry
Bear
West Fork Trinity
Johnson
Barrett
Arbor
Dalworth
Gopher-Turner
Mountain Creek
TARRANT COUNTY
Arlington
Mountain Creek Lake
Cottonwood
Dallas
DALLAS COUNTY
City of Grand Prairie
Fish
Cedar
Alspaugh
Southeast Pkwy
Duncanville
Joe Pool Lake
Joe Pool
DeSoto
Cedar Hill
Mansfield
Rendon CDP
Ovilla
JOHNSON COUNTY
ELLIS COUNTY
Venus
Floodplains in Grand Prairie
Legend
Floodplains
Proposed Hwy 161
FEMA streams
Streets
Lakes/Ponds
City of Grand Prairie
City Limits
ETJ
County Boundary
Bear Creek
Dry Branch
West Fork Trinity
Johnson/Arbor/Barrett
Dalworth
Gopher-Turner
Mountain Creek
Cottonwood
Fish
Cedar
Alspaugh
Joe Pool
1 inch equals 8,400 feet
0 4,200 8,400 12,600 Feet
HALFF

Figure 1

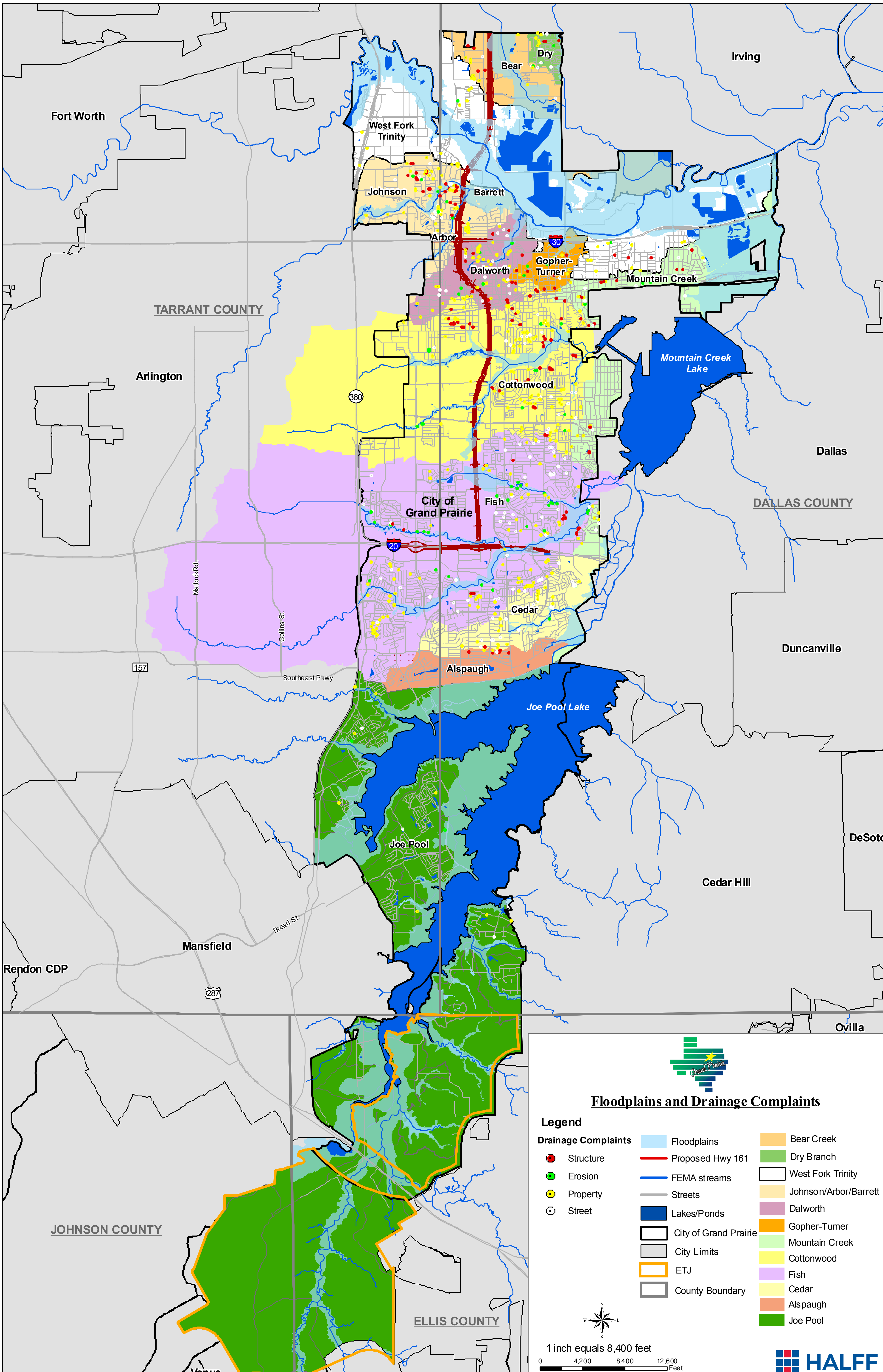
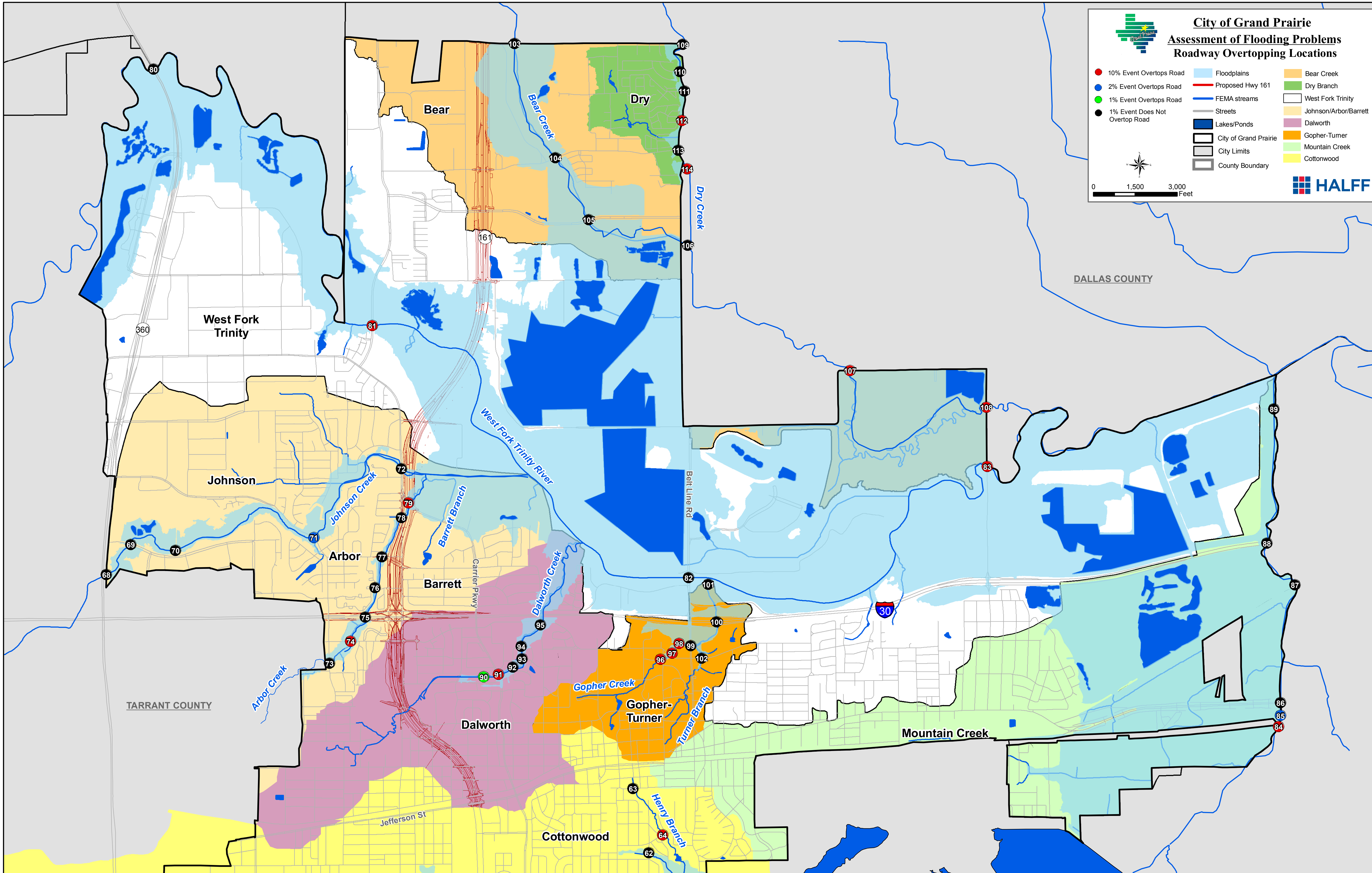
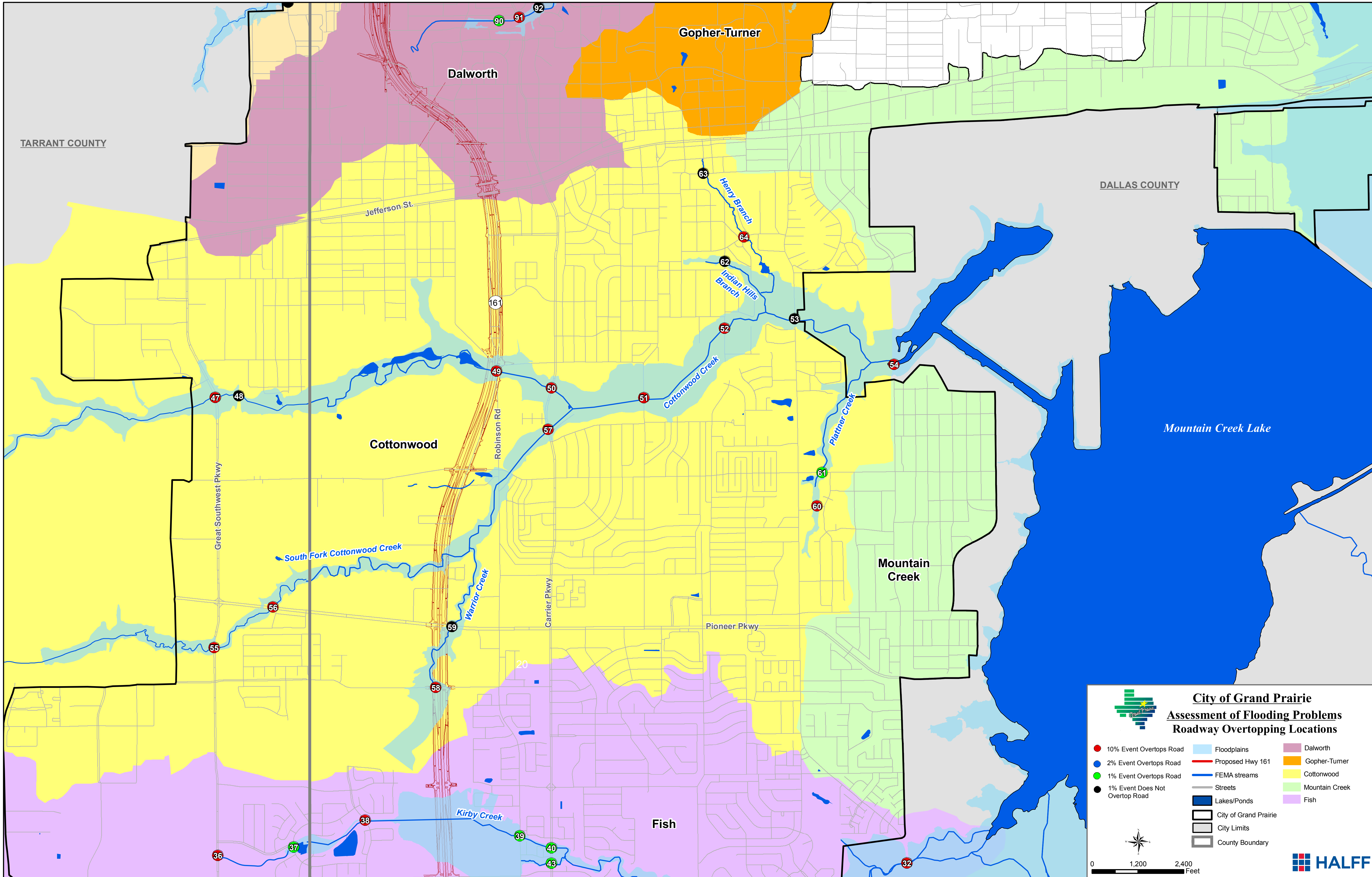

Floodplains and Drainage Complaints
Legend
Drainage Complaints
Structure
Erosion
Property
Street
Floodplains
Proposed Hwy 161
FEMA streams
Streets
Lakes/Ponds
City of Grand Prairie
City Limits
ETJ
County Boundary
Bear Creek
Dry Branch
West Fork Trinity
Johnson/Arbor/Barrett
Dalworth
Gopher-Turner
Mountain Creek
Cottonwood
Fish
Cedar
Alspaugh
Joe Pool
1 inch equals 8,400 feet
0 4,200 8,400 12,600 Feet
HALFF
Fort Worth
Irving
Arlington
Dallas
TARRANT COUNTY
DALLAS COUNTY
JOHNSON COUNTY
ELLIS COUNTY
City of Grand Prairie
Duncanville
DeSoto
Cedar Hill
Mansfield
Rendon CDP
Venus
Ovilla
Mountain Creek Lake
Joe Pool Lake
West Fork Trinity
Johnson
Barrett
Arbor
Dalworth
Gopher-Turner
Mountain Creek
Bear
Dry
Cottonwood
Fish
Cedar
Alspaugh
Joe Pool
Southeast Pkwy
Broad St.
Collins St.
MatlockRd.

Figure 2



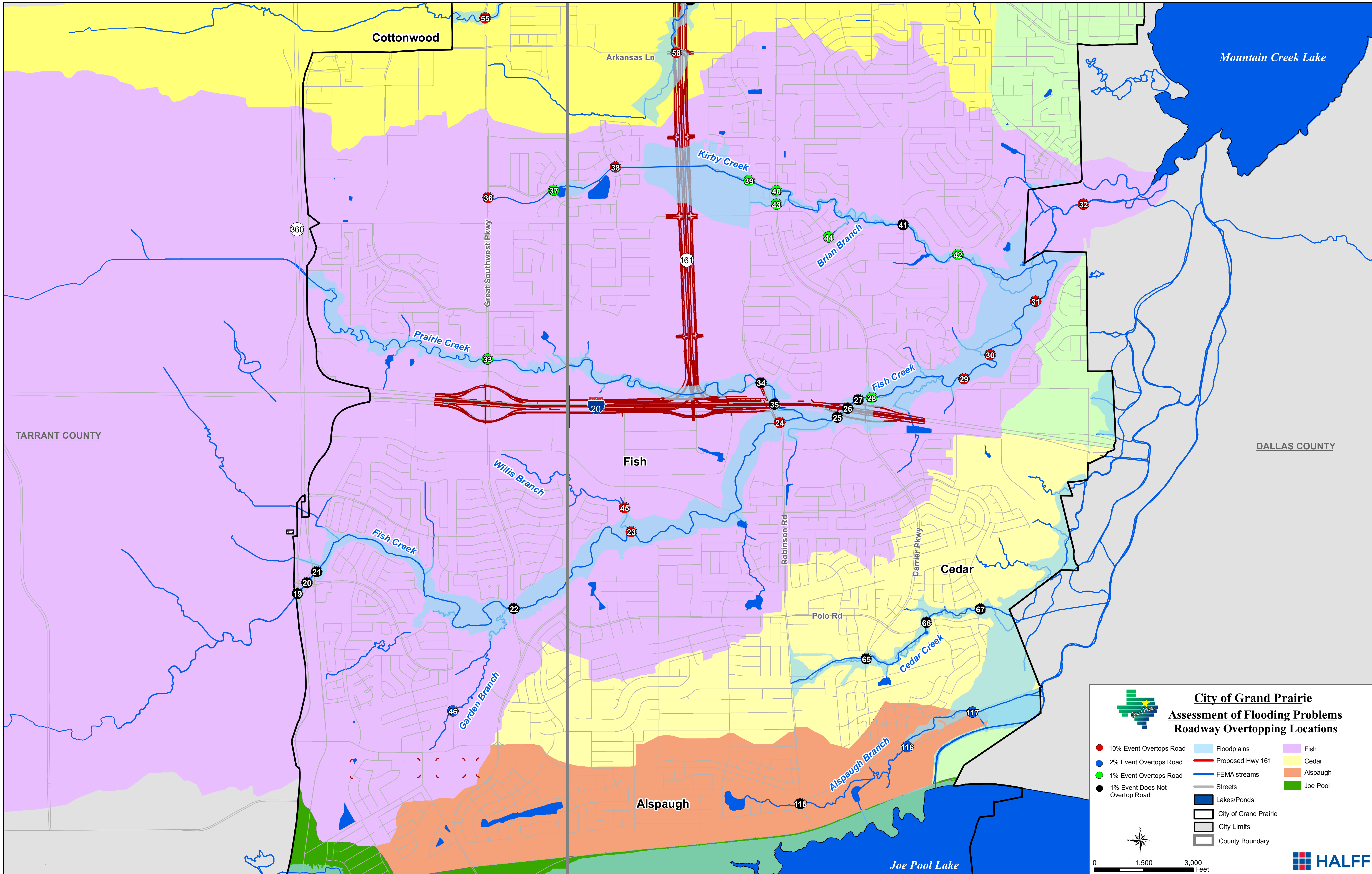
City of Grand Prairie
Assessment of Flooding Problems
Roadway Overtopping Locations
10% Event Overtops Road
2% Event Overtops Road
1% Event Overtops Road
1% Event Does Not Overtop Road
Floodplains
Proposed Hwy 161
FEMA streams
Streets
Lakes/Ponds
City of Grand Prairie
City Limits
County Boundary
Bear Creek
Dry Branch
West Fork Trinity
Johnson/Arbor/Barrett
Dalworth
Gopher-Turner
Mountain Creek
Cottonwood
0
1,500
3,000
Feet
HALFF
DALLAS COUNTY
TARRANT COUNTY
West Fork Trinity
Bear
Dry
Johnson
Arbor
Barrett
Dalworth
Gopher-Turner
Mountain Creek
Cottonwood
Bear Creek
Dry Creek
West Fork Trinity River
Johnson Creek
Barrett Branch
Dalworth Creek
Arbor Creek
Gopher Creek
Turner Branch
Henry Branch
Belt Line Rd
Carrier Pkwy
Jefferson St

Figure 3



Gopher-Turner
Dalworth
TARRANT COUNTY
DALLAS COUNTY
Jefferson St.
Henry Branch
Indian Hills Branch
Cottonwood Creek
Plattner Creek
Mountain Creek Lake
Cottonwood
Robinson Rd
Great Southwest Pkwy
South Fork Cottonwood Creek
Warrior Creek
Carrier Pkwy
Pioneer Pkwy
Mountain Creek
Kirby Creek
Fish
City of Grand Prairie
Assessment of Flooding Problems
Roadway Overtopping Locations
10% Event Overtops Road
2% Event Overtops Road
1% Event Overtops Road
1% Event Does Not Overtop Road
Floodplains
Proposed Hwy 161
FEMA streams
Streets
Lakes/Ponds
City of Grand Prairie
City Limits
County Boundary
Dalworth
Gopher-Turner
Cottonwood
Mountain Creek
Fish
0
1,200
2,400
Feet
HALFF

Figure 4


Cottonwood
Mountain Creek Lake
Arkansas Ln
Kirby Creek
Brian Branch
Prairie Creek
Great Southwest Pkwy
Fish Creek
TARRANT COUNTY
DALLAS COUNTY
Fish
Willis Branch
Robinson Rd
Carrier Pkwy
Cedar
Polo Rd
Cedar Creek
Garden Branch
Alspaugh Branch
Alspaugh
Joe Pool Lake
City of Grand Prairie
Assessment of Flooding Problems
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Proposed Hwy 161
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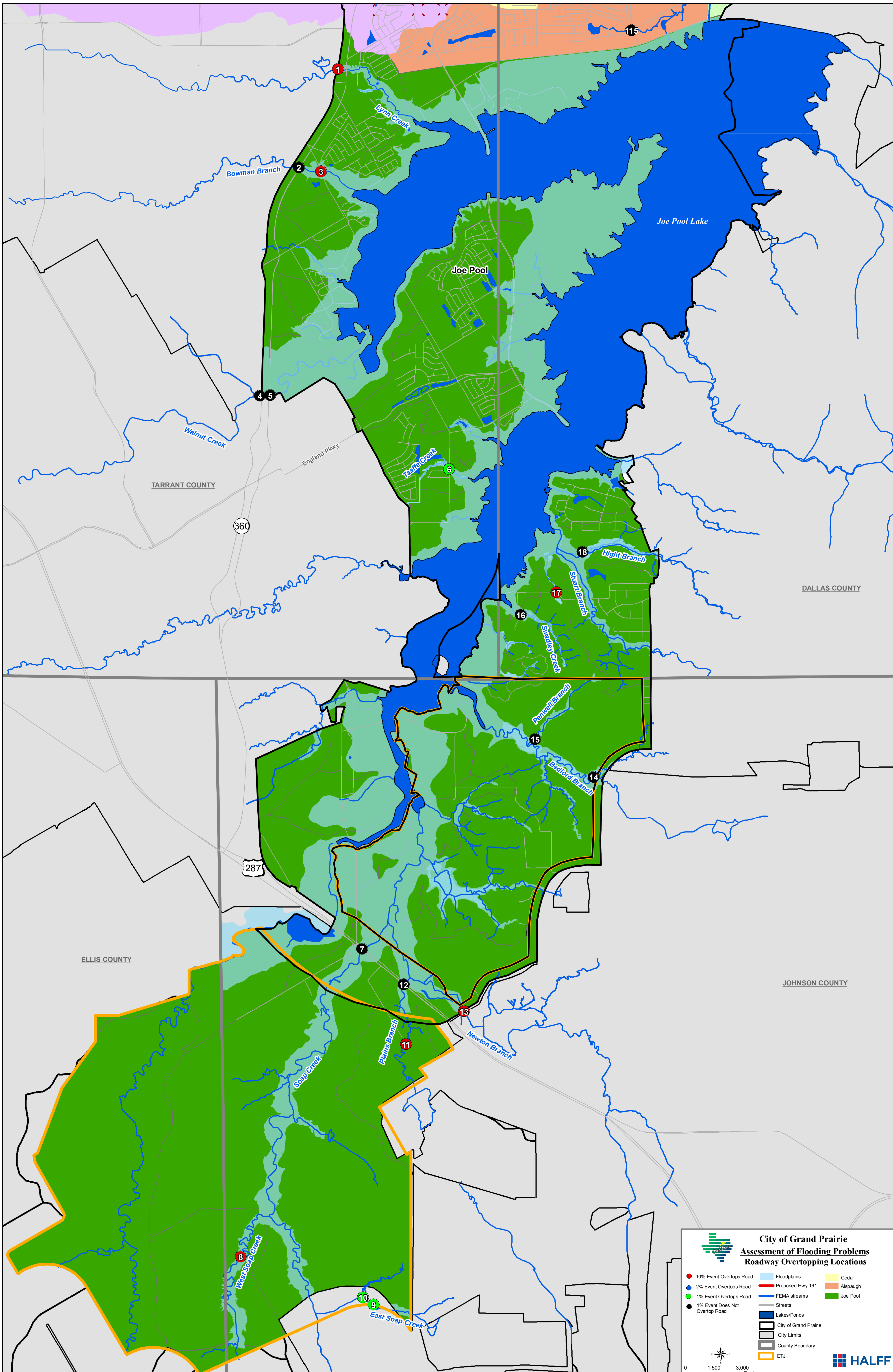
Streets
Lakes/Ponds
City of Grand Prairie
City Limits
County Boundary
Fish
Cedar
Alspaugh
Joe Pool
0
1,500
3,000
Feet
HALFF

Figure 5


City of Grand Prairie
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City of Grand Prairie
City Limits
County Boundary
ETJ
Cedar
Alspaugh
Joe Pool
0
1,500
3,000
Feet
HALFF
Joe Pool Lake
Joe Pool
TARRANT COUNTY
DALLAS COUNTY
ELLIS COUNTY
JOHNSON COUNTY
Lynn Creek
Bowman Branch
Walnut Creek
England Pkwy
Tarrant Creek
360
287
Hight Branch
Stuart Branch
Swatley Creek
Penwell Branch
Bedford Branch
Newton Branch
Plains Branch
Soap Creek
West Soap Creek
East Soap Creek

Figure 6

APPENDIX B
INVENTORY OF AVAILABLE DATA

Grand Prairie
Hydraulic Model Summary

Stream Name	Current Effective Model (FEMA) or Original FIS in-house	MapMod/LOMR (pending)	FEMA Model Exists, but not in-house (Needs EDR)	Grand Prairie Internal Study Model Exists	No Model Available	Notes
Alspaugh Branch	✓			✓		Mapped as Zone AE, hardcopy version of model is only thing available; Kimley Horn Study
Bear Creek	✓	✓				Bear Creek Original FIS; Bear Creek model in Map Mod (Halff)
Cedar Creek	✓			✓		Current Effective Model (Cedar Creek LOMR approved by FEMA - 2007); High Hawk Meadows model
						Note: Studies by AECOM for Cedar Creek in Progress - August 2010
Cottonwood Creek						**Note: Studies by Espey Consultants for Cottonwood Creek in Progress - August 2010**
Cottonwood Creek	✓			✓		Halff's HEC-2 to HEC-RAS conversion is not current effective; have 1996 Huitt Zollars models
S. Fork Cottonwood Creek	✓			✓		Halff's HEC-2 to HEC-RAS conversion is not current effective; have 1996 Huitt Zollars models
Warrior Creek (8D6)	✓			✓		Halff's HEC-2 to HEC-RAS conversion is not current effective; have original FIS model
Plattner's Branch (8D1)	✓			✓		Halff's HEC-2 to HEC-RAS conversion is not current effective
Daniels Branch (8D7)				✓		Halff's HEC-2 to HEC-RAS conversion is not current effective
Indian Hills Branch				✓		Halff's HEC-2 to HEC-RAS conversion is not current effective
Emmons Branch					✓	Tributary to Plattner's Branch, mainly storm drain
Gray's Branch					✓	Tributary to Plattner's Branch
Power's Branch					✓	Tributary to Cottonwood Creek (within limits of Cottonwood floodplain)
Henry Branch				✓		Henry Branch Watershed Study (Halff - 2003)
Williamson Branch					✓	Tributary to Cottonwood Creek (portions in Arlington)
Tyre Branch					✓	Tributary to Cottonwood Creek
Raines Branch					✓	Tributary to Cottonwood Creek
Avion Branch (D)					✓	Tributary to Cottonwood Creek (primarily in Dallas)
Dalworth Creek (8A4)	✓	✓		✓		Original FIS; currently under LOMR process; Dalworth Creek Drainage Master Plan (1996)
Dry Branch	✓					Approved LOMR in 1998
Fish Creek						**Note: Studies by Espey Consultants for Fish Creek in Progress - August 2010**
Fish Creek	✓					June 1994 LOMR by Halff; Bardin Road LOMR; still may need info near lettered cross-section G
Prairie Creek (N.Fork Fish)	✓					Prairie Creek model in Map Mod (Halff) - Current Effective as of 9/25/2009
Kirby Creek	✓	✓		✓		Original FIS; Kirby Creek LOMR currently under FEMA Review
S. Fork Kirby Creek				✓		Kirby Creek LOMR upcoming, will include S. Fork
Brian Branch				✓		Kirby Creek LOMR upcoming, will include Brian Branch (Woodacre Channel)
Vernoy Branch					✓	Pond - tributary to Kirby Creek
Willis Branch				✓		Appeal to Tarrant County DFIRM
Garden Branch				✓		Appeal to Tarrant County DFIRM
Martin Branch					✓	Tributary to Fish Creek (Tarrant County)
Beacon Branch					✓	Tributary to Fish Creek (Tarrant County)
Rodgers Branch					✓	Tributary to Fish Creek (Dallas County)
Florence Branch					✓	Tributary to Fish Creek (Dallas County)
Dechman Branch					✓	Tributary to Fish Creek (Dallas County)
O'Donnell Branch					✓	Tributary to Fish Creek (Dallas County)
Lively Branch					✓	Tributary to Fish Creek (Dallas County) - portions in Dallas
Gopher & Turner Branch				✓		LOMR to be prepared after Repairs at Belt Line Road completed

Grand Prairie
Hydraulic Model Summary

Stream Name	Current Effective Model (FEMA) or Original FIS in-house	MapMod/LOMR (pending)	FEMA Model Exists, but not in-house (Needs EDR)	Grand Prairie Internal Study Model Exists	No Model Available	Notes
Joe Pool Lake						**Note: Studies by Halff Associates for Joe Pool Lake streams in Progress - August 2010**
Lynn Creek	✓					Original FIS; Kimley Horn to provide current effective model
Bowman Branch	✓					Original FIS; LOMR obtained from FEMA
Loyd Branch		✓		✓		CWDMP for Joe Pool Lake (Halff); will be submitted to FEMA as Zone A
Ten Branch		✓		✓		CWDMP for Joe Pool Lake (Halff); will be submitted to FEMA as Zone A
Walnut Creek			✓			Mapped as Zone AE, but do not have effective model in-house
Taaffe Creek		✓		✓		Joe Pool Trib Study (Halff); will be mapped as Zone A on Tarrant County DFIRM
Webb Branch		✓		✓		CWDMP for Joe Pool Lake (Halff); will be submitted to FEMA as Zone A
Foster Branch		✓		✓		CWDMP for Joe Pool Lake (Halff); will be submitted to FEMA as Zone A
Hanger Creek		✓		✓		CWDMP for Joe Pool Lake (Halff); will be submitted to FEMA as Zone A
N. Hanger Creek		✓		✓		CWDMP for Joe Pool Lake (Halff); will be submitted to FEMA as Zone A
Ellis Branch					✓	Stream headwaters in Mansfield; no model available, but will request from Mansfield once they complete stud
Davis Branch		✓		✓		CWDMP for Joe Pool Lake (Halff); will be submitted to FEMA as Zone A
Harmon Branch (M)					✓	Stream headwaters in Mansfield; no model available, but will request from Mansfield once they complete stud
Lakeview Branch					✓	Tributary to Joe Pool Lake; controlled by backwater from Joe Pool Lake
Mountain/Grassy Creek		✓		✓		CWDMP for Joe Pool Lake (Halff); will be submitted to FEMA as Zone AE
Grassy Creek Tributary		✓		✓		CWDMP for Joe Pool Lake (Halff); will be submitted to FEMA as Zone A
Soap Creek	✓	✓		✓		CWDMP for Joe Pool Lake (Halff); will be submitted to FEMA as Zone AE
W. Soap Creek	✓	✓		✓		CWDMP for Joe Pool Lake (Halff); will be submitted to FEMA as Zone AE
E. Soap Creek	✓	✓		✓		CWDMP for Joe Pool Lake (Halff); will be submitted to FEMA as Zone AE
Plains Branch	✓	✓		✓		CWDMP for Joe Pool Lake (Halff); will be submitted to FEMA as Zone AE
Newton Branch	✓	✓		✓		CWDMP for Joe Pool Lake (Halff); will be submitted to FEMA as Zone AE
Edge Creek		✓		✓		Joe Pool Trib Study (Halff); will be mapped as Zone A on Ellis County DFIRM
Edge Creek Trib. 1		✓		✓		Joe Pool Trib Study (Halff); will be mapped as Zone A on Ellis County DFIRM
JP Trib 1, 2, & 3		✓		✓		Joe Pool Trib Study (Halff); will be mapped as Zone A on Ellis County DFIRM
Small Branch		✓		✓		Joe Pool Trib Study (Halff); will be mapped as Zone A on Ellis County DFIRM
Bedford Branch		✓		✓		Joe Pool Trib Study (Halff); will be mapped as Zone A on Ellis County DFIRM
Penwell Branch		✓		✓		Joe Pool Trib Study (Halff); will be mapped as Zone A on Ellis County DFIRM
Tarrell Creek		✓		✓		Joe Pool Trib Study (Halff); will be mapped as Zone A on Ellis County DFIRM
Mills Branch		✓		✓		Joe Pool Trib Study (Halff); will be mapped as Zone A on Ellis County DFIRM
Swadley Creek		✓		✓		Joe Pool Trib Study (Halff); will be mapped as Zone A on Ellis County DFIRM
Stuart Branch		✓		✓		Joe Pool Trib Study (Halff); will be mapped as Zone A on Dallas County DFIRM
Hollings Branch	✓	✓				Halff included Hollings & Hight study in Map Mod effort; currently Zone AE on prelim DFIRM
Hight Branch		✓				Halff included Hollings & Hight study in Map Mod effort; currently Zone A on prelim DFIRM
Unnamed JP Trib		✓		✓		CWDMP for Joe Pool Lake (Halff); will be submitted to FEMA as Zone A
Magic Valley Branch (CH)					✓	Tributary to Joe Pool Lake (east side); primarily in Cedar Hill
Baggett Branch (CH)	✓					Tributary to Joe Pool Lake (east side); primarily in Cedar Hill; have current effective model
Johnson Creek						
Johnson Creek	✓					Johnson Creek model in Map Mod - Current Effective - 9/25/2009
Arbor Creek (JC-1)	✓					Arbor Creek (JC-1) model in Map Mod - Current Effective - 9/25/2009
Barrett Branch					✓	Tributary to Arbor and Johnson Creek
Goodwin Branch					✓	Tributary to Johnson Creek
Santerre Branch					✓	Tributary to Johnson Creek
Wammack Branch					✓	Tributary to Johnson Creek

Grand Prairie
Hydraulic Model Summary

Stream Name	Current Effective Model (FEMA) or Original FIS in-house	MapMod/LOMR (pending)	FEMA Model Exists, but not in-house (Needs EDR)	Grand Prairie Internal Study Model Exists	No Model Available	Notes
Mountain Creek						
Mountain Creek	✓			✓		Current Effective HEC-2 model; Espey Mountain Creek FPP study (2007)
Thompson's Branch				✓		Espey study (2007)
Memorial Branch					✓	Tributary to Mountain Creek Lake
Cannon Branch					✓	Tributary to Mountain Creek Lake
Penman Branch					✓	Tributary to Mountain Creek Lake
Jackson Branch					✓	Tributary to Mountain Creek downstream of MCL Dam; inundated by MC floodplain
Combs Creek					✓	Tributary to Mountain Creek Lake
West Fork Trinity River						
West Fork Trinity River	✓					Current Effective FEMA Model (2000 update)
Lewis Branch					✓	Tributary to WF Trinity (Tarrant County)
Keith Branch					✓	Tributary to WF Trinity (Dallas County)
Robertson Branch (FW)					✓	Tributary to WF Trinity (Tarrant County)
Countyline Branch (FW)					✓	Tributary to WF Trinity (Tarrant County)
GPMURD Overflow					✓	Tributary to WF Trinity (Dallas County); completely inundated by WF Trinity floodplain

APPENDIX C
JOE POOL LAKE

JOE POOL LAKE MASTER PLAN
SCOPE OF WORK

A. GENERAL DESCRIPTION

The Joe Pool Lake Area watershed is located west, east and south of Joe Pool Lake. Drainage generally travels through storm drain pipes and open channels in the developed parts of the watershed and through streams and open channels in undeveloped portions of the watershed. Within the watershed, there are also two ETJ's: the Exclusive ETJ (at the south end of the lake in Ellis County) and the Statutory ETJ (south of the Exclusive ETJ in both Ellis and Johnson County)

B. DRAINAGE COMPLAINT DATABASE

Eighteen (18) drainage complaints at fourteen (14) different locations have been filed with the City from within this watershed. Of these complaints, three (3) were erosion problems, four (4) were street flooding problems, eleven (11) were property flooding problems, and none were structure flooding problems. No hot spots, based on drainage complaints, were identified for watersheds in the Joe Pool Lake study area. **Note: It is the responsibility of the consultant to obtain the latest information from the City database and evaluate all current drainage complaints at time of study.**

C. EXISTING DATA AVAILABLE

- Existing 2009 LiDAR Topography
- City-wide Drainage Master Plan Information for Joe Pool Lake area, including:
  - Inventory of Available Data
  - Inventory & Assessment of Flooding Problems
  - GIS Database
- Hollings & Hight Branch Watershed Study – Halff Associates (November 2005)
  - H&H study to develop 100-yr floodplain
- Cooperating Technical Partners – Soap Creek & Tributaries – Halff Associates (Sept. 2002)
  - H&H models and floodplain mapping for inclusion in FEMA Map Modernization program
- Soap Creek Watershed Hydraulic Analysis – Halff Associates (2002)
- Joe Pool Lake Drainage Master Plan – Halff Associates (April 2007)
  - The purpose of this study was to develop detailed H&H models, assess channel stability and erosion issues, make recommended stream bank stability improvements to help alleviate existing and potential future flood and erosion damages.

Note: Existing Data Available will be provided to consultant on a CD or DVD, including PDFs of report/figures and technical data available

D. UNIQUE ATTRIBUTES OF JOE POOL LAKE STUDY AREA

- Major Streams in Joe Pool Lake Study Area
  - Lynn Creek (studied, being updated by Teague, Nall, and Perkins)
  - Bowman Branch (studied)
  - Walnut Creek (studied)

- Hollings Branch (studied)
- Hight Branch (studied)
- Bedford Branch (studied)
- Soap Creek (studied)
- **Grassy Creek/Mountain Creek**
- Edge Creek (studied)

- Minor Streams in Joe Pool Lake Study Area
  - **Loyd Branch**
  - **Ten Branch**
  - **Webb Branch**
  - **Foster Branch**
  - **Hanger Creek**
  - **N. Hanger Creek**
  - **Taaffe Creek (studied – needs update)**
  - Stuart Branch (studied)
  - Swadley Creek (studied)
  - Mills Branch (studied)
  - Tarrell Creek (studied)
  - Penwell Branch (studied)
  - Small Branch (studied)
  - Newton Branch (studied)
  - Plains Branch (studied)
  - Edge Creek Tributary 1 (studied)
  - Joe Pool Tributary 1 (studied)
  - Joe Pool Tributary 2 (studied)
  - Joe Pool Tributary 3 (studied)
  - West Soap Creek (studied)
  - East Soap Creek (studied)
  - **Grassy Creek Tributary**
  - **Lakeview Branch**
  - **Ellis Branch**
  - **Harmon Branch**
  - **Davis Branch**

E. Scope of Work

1. Data Collection

a. For new studies, obtain all available information, including hydrologic & hydraulic models, topographic information, studies, as-built bridge/culvert plans, property information, available LOMRs, etc. <u>Note: Halff has coordinated with adjacent communities on models for common streams, but additional studies or LOMRs may be available and should be researched.</u>

b. Coordinate with the City to obtain additional survey data for pertinent structures and/or locations along the study reach.

2. Hydrologic & Hydraulic Studies - Streams and Open Channel

a. **<u>Develop new and/or updated hydrologic models</u> -** New HEC-HMS models will be developed (or updated as necessary), replacing any currently effective NUDALLAS and HEC-1 models. Analysis will include existing and future land-use conditions. Any new hydraulic models will be prepared with H&H modeling tools (Geo-HMS), procedures, and GIS tools. A frequency analysis of the existing 2-, 5-, 10-, 25-, 50-, 100-, and 500-year floods and ultimate 100-year flood will be made, at a minimum. Engineer shall utilize current Drainage Criteria Manual information for hydrologic parameters. Modified Puls shall be the methodology used for routing.

- <u>Major Streams – Grassy Creek/Mountain Creek (upstream of Joe Pool Lake)</u>
  - Develop existing conditions 10-, 50-, 100-, and 500-year and ultimate conditions 100-year hydrologic (HEC-HMS) models

- <u>Minor Streams – Taaffe Creek</u>
  - Taaffe Creek - Coordinate with City of Mansfield on approved hydrology of upper Taaffe Creek (in Mansfield City limits). Incorporate approved hydrology into Taaffe Creek hydrology model for Grand Prairie.
  - Develop existing conditions 10-, 50-, 100-, and 500-year and ultimate conditions 100-year hydrologic (HEC-HMS) models

- <u>Minor Streams – Loyd Creek, Ten Branch, Ellis Branch, Harmon Branch, Davis Branch, Lakeview Branch, N. Hanger Creek, Hanger Creek, Webb Branch, Foster Branch</u>
  - Coordinate with City of Arlington on available hydrology models for Loyd Creek and Ten Branch
  - Coordinate with City of Mansfield on available hydrology models for Ellis Branch, Harmon Branch, and Davis Branch.
  - Develop existing conditions 10-, 50-, 100-, and 500-year and ultimate conditions 100-year hydrologic (HEC-HMS) models for listed streams.

b. **<u>Develop new and/or updated floodplain hydraulic models</u>** – HEC-RAS models will be developed (or updated as necessary), replacing any currently effective HEC-2 models. Any new hydraulic models will be prepared with H&H modeling tools (Geo-RAS), procedures, and GIS tools. <u>As needed, new structures, bridges/culverts, channelization, channel cross-sections, aerial crossings and ponds will be field surveyed and incorporated into the updated H&H analyses</u>. Floodway analyses will be performed, as necessary, for Zone AE streams. Prepare rating curves for City rain & stream gauges along Joe Pool Lake.

- <u>Major Streams (future Zone AE) – Grassy Creek/Mountain Creek (upstream of Joe Pool Lake)</u>
  - Develop existing conditions 10-, 50-, 100-, and 500-year and ultimate conditions 100-year hydraulic (HEC-RAS) models

- <u>Minor Streams – Taaffe Creek (future Zone A)</u>
  - Taaffe Creek – Update hydraulic model to incorporate updated discharges from new hydrologic analysis

- Develop existing conditions 10-, 50-, 100-, and 500-year and ultimate conditions 100-year hydraulic (HEC-RAS) models

- <u>Minor Streams (future Zone A or Zone A "enhanced") – Loyd Creek, Ten Branch, Ellis Branch, Harmon Branch, Davis Branch, Lakeview Branch, Grassy Creek Tributary, N. Hanger Creek, Hanger Creek, Webb Branch, Foster Branch</u>
  - Coordinate with City of Arlington on available hydraulic models for Loyd Creek and Ten Branch
  - Coordinate with City of Mansfield on available hydraulic models for Ellis Branch, Harmon Branch, and Davis Branch.
  - Develop existing conditions 10-, 50-, 100-, and 500-year and ultimate conditions 100-year hydraulic (HEC-RAS) models, as necessary.

- <u>Erosion/Sedimentation Assessment of Hydraulic Models (for Section 4)</u>
  - Review all models in watershed and provide a summary table of the following:
    - Reaches where high channel velocities exist (erosion) for 10-yr event
    - Reaches where low channel velocities exist (sedimentation) for 10-yr event
    - Location of natural meanders of stream
    - Location of steep natural channel sections (describe average slope between two hard points, such as two culverts, along the channel)
    - Location of all existing TRA aerial crossings (based on field surveys and record drawings) – Describe erosive velocities for all frequency events.
  - Describe any field observations of stream, including locations of downcutting, locations of widening, knickpoints in channel flowline, locations of trees falling into channel, locations of trees with exposed roots, locations of wedge failures, locations of erosion at sanitary sewer aerial crossings, locations of undermining of storm drain outfalls, fences and/or structures close to erosion areas that have potential for failure or damage due to further erosion, etc. (and any other types of erosion that was observed). Include labeled photos, if available.

c. <u>Develop new and updated floodplain mapping</u> – Consolidate, make consistent, update as needed, and provide updated City-wide coverage of floodplains in the Joe Pool Lake watersheds in Grand Prairie. Updated floodplains will be delineated using digital terrain data from the best available topography and integrated into the City's GIS. The primary goal is to establish ultimate 100-year floodplain delineations with Base Flood Elevations shown, but also additional delineations, including existing 100-year & 500-year and floodway delineations for incorporation into FEMA mapping. <u>Updated data will be incorporated into FEMA mapping through the Map Mod process (Ellis and Johnson Counties) or by LOMR (Tarrant and Dallas counties)</u>**.** GIS shapefiles of floodplain delineations will be provided to the City.

<u>LOMR Submittals</u>
- Prepare brief letter report of project purpose, procedures, and results
- Prepare flood elevation tables, floodway data tables, flood profiles (RASPLOT), hydraulic work maps, and revised FEMA FIRM maps.
- Prepare necessary MT-2 application/certificate forms including:
  - Form 1 – Overview and Concurrence
  - Form 2 – Riverine Hydrology & Hydraulics

    - Form 3 – Riverine Structures (including photos, as-built plans, and survey information)
- Deliver two (2) copies of the Final LOMR Report to the City of Grand Prairie
- Work with City staff on submittal to FEMA
- Export electronic files (HEC-RAS, Word, CADD, GIS, and PDF) to CD and submit to City of Grand Prairie
- Prepare templates and tabulate information for public notification, including individual property owner notification and public notice for floodway revision. The City of Grand Prairie will distribute all public notifications to individual property owners and post the public notice. <u>Note: If properties are affected by revised floodplain elevations, engineer shall survey finished floor elevations (lowest adjacent grade) of all structures in the revised floodplain limits.</u>
- Coordinate with the City of Grand Prairie and FEMA/Technical Reviewer (via telephone and email) to address comments and questions.
- Note: Fees for review of LOMR applications are not included in scope of work

<u>Elevation Certificates</u>
- Identify property locations of structures within updated existing 100-year (1% annual chance) floodplain limits.
- Identify structures on each property that serve as the primary residence or primary use to commercial/industrial sites. For these structures, prepare field surveys of finished flood and lowest adjacent grades around structures.
- All other insurable structures found to be within the limits of the 100-year (1% annual chance) floodplain will be identified and submitted to the City Floodplain Administrator for approval before proceeding with surveying and preparation of the elevation certificate.
- Necessary paperwork for Elevation Certificates will be per current FEMA standards
- Upon completion, prepare overall map of Elevation Certificate locations along the floodplain and submit to City along with completed Elevation Certificates.

e. <u>Roadway Crossings</u>

- <u>Evaluate and tabulate flood frequency capacity of existing roadway crossings for all Joe Pool Lake study streams</u> – This information will be utilized to determine if existing roadway crossings need to be improved for 100-year flood protection

- Project Team shall analyze future roadway crossings of existing streams based on City Master Thoroughfare Plan and size crossings for future 100-year flood frequency capacity

f. <u>Update Storm Water Outfall Report prepared in the Joe Pool Lake Study in April 2007</u> – Coordinate with City staff on necessary updates to 404 Permitting section, Corps of Engineers Easement Requirements section, tables, figures, and appendices. Storm Water Outfall information will be included in the City-wide Drainage Master Plan documentation.

g. <u>Alternatives for Streams and Open Channels</u>

- Stream and Open channel alternatives will be evaluated in accordance with:

- Flood Profile Impacts
- Valley Storage (downstream impacts)
- Environmental Quality
- Channel Stability/Erosion (channel armor and bio-engineering solutions)

  \- Investigate erosion concerns at Lakeridge Addition (coordinate with City of Cedar Hill)
- Bridge/Culvert Improvements
- Future TRA aerial wastewater crossings
- Corps Section 404 Permit Requirements
- Cost (construction, ROW, engineering, operations, and maintenance).
- Non-structural and structural improvements will be considered in terms of practicality, economics, necessity, impacts to mobility, environmental concerns, etc.

3. Storm Drainage Infrastructure Analysis

- **Overview -** Storm drainage network models will be prepared utilizing a City-wide Storm Water Infrastructure GIS database and existing record plans. It is not anticipated that field surveys will supplement the storm drainage studies. If necessary and approved by the City, field surveys will be conducted to accurately locate drainage infrastructure.
  i. Analysis of storm drainage pipe networks will focus on all Joe Pool Lake systems
  ii. The age of each storm drainage pipe network will be determined utilizing as-built dates from GIS database (if available)
  iii. Storm water sub-basin delineations will be accurately defined for each storm drain area studied in detail. City GIS data will be utilized.
  iv. For the Joe Pool Lake area, a detailed storm drain model will be prepared using the most recent version of the computer program **StormCAD**.
- **Existing Capacity Analysis** – The Project Team will only use existing plans to determine discharges and determine capacity of system using StormCAD. The capacity of existing streets and underground storm drainage pipe networks, along with flood frequency that the system can contain, will be computed, as best that can be determined using StormCAD. The results of the storm drainage system analysis will be documented and incorporated into the City's Storm Water Infrastructure GIS database. For this task, Project Team will use StormCAD to model the "trunk" line(s) of the primary system or systems in the previously defined storm water sub-basin. It is the Project Team's responsibility to define the limits of the "trunk" line(s) for each sub-basin and determine if additional lateral lines (draining 20% or more of the basin) need to be modeled.
- **Optimization Analysis** – An attempt to "optimize" existing storm drainage systems will be included in the analysis. Determine where added inlets or detention, at critical points along the system, will ensure that it is optimized for the lower (as well as the higher) frequency floods. These would be categorized as "smaller projects" for the City to designate and prioritize.

- **City Coordination** - The Project Team will meet with City staff to help confirm and identify problem areas. The updated Storm Water Infrastructure GIS will then be overlaid with property maps to help classify problem areas as "public or private." This data will then be incorporated into the City's Storm Water Infrastructure GIS database. It will include information such as: coordinates (horizontal and vertical location), pipe size, material, and slope.
- **Analysis of Alternatives** – Following completion of the updated existing storm drainage analysis, the Project Team will commence the analyses of alternatives to address documented storm water infrastructure problems, including correction and future prevention. Proposed alternative improvements will be modeled using the previously prepared StormCAD models for existing infrastructure. Analysis of proposed storm water improvements will be conducted to accommodate a designated flood frequency within the proposed storm drain system, existing/proposed drainage easements, and/or existing street R.O.W.
    - i. Alternatives for Storm Drains - Storm drain alternatives will be evaluated in accordance with hydraulic grade line (HGL) and energy grade line (EGL), flooding of structures on properties, street flooding, nuisance flooding, age and condition of storm drain system, right-of-way availability, conflicting utilities, and other impacts. The 100-year frequency event will be the design storm. If alternative improvements cannot be developed to adequately contain 100-year event, then the 10-year and 2-year events will be utilized for alternatives. Note: The City of Grand Prairie requires EGL to be 1-foot below top of pavement elevations.
    - ii. Innovative Alternatives - Innovative alternatives that incorporate "non-traditional" ideas will be explored and compared with traditional solutions. For example, purchase of existing homes and properties for construction of a regional detention pond to reduce discharges, downstream pipe and culvert sizes, and lower flood profiles might be considered.
    - iii. Preliminary Quantities and Estimates of Probable Cost – For selected alternative improvements, the Project Team will prepare preliminary quantities and estimates of probable cost to implement the conceptual plan(s). These estimates of probable cost will be prepared in a digital format (Excel spreadsheets) with pertinent information such as:
        1. Date of estimate and Adjustments for inflation
        2. Costs for survey, design, ROW & Easement acquisition, utility relocations, construction management, and construction. Note: 25% contingency will be applied to construction cost estimates.

4. Channel Stability Assessment/Erosion Hazard Analysis

- a. Hydraulics
    - i. Execute HEC-RAS model with low flow and bank-full flow rates.
    - ii. Tabulate and evaluate velocities, energy, and shear stress.
    - iii. Confirm results with field observations (channel bends).
- b. Geomorphology
    - i. Conduct field reconnaissance to identify and obtain:
        1. Channel characteristics,
        2. Photos, and

3. Identify/confirm problem areas, etc.

ii. Conduct sedimentation/degradation analysis.

iii. Review 1999 topography versus 2009 topography to determine potential erosion hazard zones

iv. Review City standards to determine areas within erosion hazard zones

c. Prepare channel stability assessment/erosion hazard analysis report

d. Evaluate erosive properties of existing TRA aerial wastewater crossings

e. Prepare stream bank restoration improvement alternatives (provide preliminary quantities/estimates of probable cost per Section 8)

5. Dams/Levees/Detention/Drainage Reviews

a. Prepare GIS maps showing locations/descriptions of existing dams, levees, retention and detention areas within the Joe Pool Lake Master Plan area. Include separate layers for private and public detention ponds. Work with City GIS staff on GIS development of these layers.

b. Prepare detailed summary of existing drainage plan reviews prepared by Halff denoting project name, City project number, description of review, and if detention was included in the project

c. Obtain plans containing detention ponds and make field visits to verify detention ponds have been constructed according to as-built plans

i. Document detention ponds with photos

ii. Describe any problems associated with detention ponds (maintenance issues, outfall issues, etc.)

6. GIS Updates

a. Help identify, if detected, drainage features that are missing from GIS database or shown/labeled incorrectly in GIS database and report to the City. Update missing information accordingly. Note: This task does not include verification that all existing GIS drainage features are correct or physical field inspection of the entire system to ensure accuracy. The intent is to determine missing features or incorrect features as noticed by the Project Teams

b. Based on as-built plans, identify age of all systems (See Section 3)

c. Identify wetland and riparian areas, utilizing Wetland Inventory Maps and visual inspection

7. Maintenance – Joe Pool Lake area

a. Identify and evaluate types and locations of areas where maintenance needs to occur (storm drain outfalls, inlets, culverts, natural channels, open channels, bridges, etc.) in the Joe Pool Lake Master Plan area. **Obtain City Database on investigation of outfalls in the City.**

b. Storm Drain Outfall Field Assessment – Utilizing the City of Grand Prairie's database of field-checked storm drain outfalls for the entire City, establish criteria to rank outfalls based on necessity to repair, provide preliminary ranking of outfalls needing repair, and provide summary report of rankings for the Joe Pool Lake Master Plan area

c. Develop schedule for maintenance on specific streams/features within the Joe Pool Lake Master Plan area (i.e. by watershed)

8. Preliminary Quantities/Estimates of Probable Cost

a. Preliminary Quantities and Estimates of Probable Cost – For selected alternative improvements, the Project Team will prepare preliminary quantities and estimates of probable cost to implement the conceptual plan(s). These estimates of probable cost will be prepared in a digital format (Excel spreadsheets) with pertinent information such as

- Date of estimate and Adjustments for inflation
- Costs for survey, design, ROW & Easement acquisition, utility relocations, construction management, and construction. Note: 25% contingency will be applied to construction cost estimates.

9. Evaluation & Prioritization/Phasing & Implementation

a. Evaluation and Prioritization - Formalize a set of plans/recommendations in a report and assist City in developing rating criteria for channel and storm drain improvement alternatives in the Joe Pool Master Plan area. Develop a rating system to allow planning for future funding (refer to Section II.G of the City-Wide Drainage Master Plan Road Map). Projects, both small projects, medium projects, and large projects will then be **evaluated and prioritized** based on:

1. Levels of damage and value of homes flooded or endangered;
   a. Develop spreadsheet, to include Lowest Adjacent Grade, BFE, Structure Value, and Level of damage (# homes/damage value ($) for various flooding events, including (if available) 10-year, 25-year, 50-year, and 100-year)
2. Number of people and properties affected;
3. Life safety, prevent loss of life and minimize property damage;
4. Level of protection provided by plan;
5. Practicality and implementability,
6. Mobility (keeping main arterials open to traffic);
7. Maintaining access to public buildings, especially hospitals, fire and police departments, etc.
8. Environmental considerations (such as 404 permits, stream corridor maintenance);
9. Private-public relationships and funding agreements;
10. Available funding, participation in funding by others (TWDB, Corps, etc.), and;
11. The highest projected benefit-to-cost ratios.
12. Neighborhood Enhancement – Improve aesthetics, livability, and well-being of Grand Prairie citizens/residents;
13. Availability of Right-of-Way/Easements – Minimize disruption to property and structures.

Note: Weighting for each criteria shall be recommended to and approved by the City prior to prioritization of alternatives.

b. Phasing and Implementation - The Study Team will then assist and advise City staff in developing phasing and implementation plans and prioritizing proposed improvement projects for future CIP and related funding.

The goal is to incorporate CIPs from this study into an overall phasing and implementation plan with other drainage-related CIPs throughout the City in various other watersheds. The resulting City of Grand Prairie dataset for CIPs would be completely digital and geo-referenced, with documented spatial data, hydrologic and hydraulic data, and other features for ease of future updates.

10. Short Term Priorities & Long Term Plan

a. Short Term Priorities – Develop strategy for immediate implementation of key alternative improvement projects developed for the Joe Pool Master Plan. Focus on:

i. Cost/benefit ratio of proposed improvements. Weigh the flood control benefits against project costs
ii. Develop list of small projects (<$200,000), medium projects ($200,000 to $500,000), and larger projects (>$500,000)

b. Long Term Plan – Develop strategy for long term implementation of identified prioritized alternative improvement projects developed for the Joe Pool Master Plan. Focus on:

i. Longer range plans for larger projects, including phasing (if possible). Provide cost breakdown of phasing and time-frame for implementation.

This implementation plan would be coordinated with the future funding plan for the City-wide study.

11. City-wide Drainage Master Plan Documentation

Incorporate Joe Pool Lake Master Plan data into City-wide Drainage Master Plan Documentation. At the completion of this task, the CWDMP documentation will include the Phase 1 study, Road Map study, and the Joe Pool Lake Master Plan study. The Joe Pool Lake study will be utilized as a template for the remaining individual watershed studies.

12. Project Management/Coordination

a. Project Management – Engineer shall provide project status reports, project schedule updates, and perform personnel and data management during course of project. Engineer shall attend a project kickoff meeting, prepare and lead any project status meetings, and prepare meeting minutes of each meeting to submit to the City. Engineer will fully document all hardware, software, file structures, and data formats used during the project.

b. QA/QC – Engineer shall develop a QA/QC procedure to include a multi-level approach to ensure that scope of work components are reviewed and approved.

c. Public Involvement Program: City Council Briefing Session - Develop schedule, set up and conduct a final workshop with the City Council and certain department leaders after study completion. Provide the council with an overview of drainage and flooding issues, study results, and recommendations.

CITY OF GRAND PRAIRIE
DATA SOURCE
GIS - ENGINEERING DEPARTMENTS
JP-1: Joe Pool Watershed
Streams
Studied Basin (Older)
Studied Basin (Newer)
Unstudied Basin
County Boundary
City Limits
Floodplains (Zone AE)
Grand Prairie City Limit
Joe Pool Boundary
ETJ Boundary
Note: The floodplains depicted on these exhibits should not be used for flood insurance purposes. These floodplain delineations are based on current effective FEMA BFE elevations mapped against the City of Grand Prairie topography.
1 inch = 2,500 feet
0
2,500
5,000
7,500
Feet
HALFF
Joe Pool Lake
Arlington
Dallas
Cedar Hill
Mansfield
Midlothian
Venus
TARRANT COUNTY
DALLAS COUNTY
ELLIS COUNTY
JOHNSON COUNTY
LYNN
LYNN TRIB ZONE A ON PRELIMINARY DFIRM
BOWMAN
LOYD
LOYD BRANCH (NO MAPPING ON PRELIMINARY DFIRM)
TEN
TEN BRANCH (NO MAPPING ON PRELIMINARY DFIRM)
WALNUT
TAAFFE
TAAFFE CREEK MAPPED AS ZONE A ON PRELIMINARY FIRM
MAPPED AS BACKWATER FROM JOE POOL LAKE - ELEV. 538
INTERIOR
WEBB BRANCH
FOSTER BRANCH
HANGER CREEK
N. HANGER CREEK
UNMAPPED ON PRELIMINARY DFIRM
UNNAMED JOE POOL TRIB
HIGHT
HIGHT BRANCH SHOWN AS N. HOLLINS BRANCH ON PRELIMINARY DFRIM AND ZONE A
HOLLINGS
ELLIS BRANCH (CONTROLLED BY JOE POOL LAKE BACKWATER - ELEV. 538)
DAVIS BRANCH (CURRENTLY ZONE A AND UNMAPPED ON FIRM, MAY NEED TO BE RESTUDIED)
ELLIS, HARMON, DAVIS
Exclusive ETJ
LAKEVIEW
LAKEVIEW BRANCH (MAY BE CONTROLLED BY JOE POOL LAKE BACKWATER - ELEV. 538
JOE POOL TRIBS
STUART BRANCH
SWADLEY CREEK
MILLS BRANCH
TERRELL CREEK
BEDFORD BRANCH
PENWELL BRANCH
SMALL BRANCH
EDGE CREEK
EDGE CREEK TRIB 1
JOE POOL TRIB 1
JOE POOL TRIB 2
JOE POOL TRIB 3
JOE POOL TRIBS WILL BE MAPPED AS ZONE A'S. BEDFORD BRANCH WILL BE MAPPED AS ENHANCED ZONE A
GRASSY CREEK / MOUNTAIN CREEK (ZONE A -NEEDS STUDY)
MOUNTAIN
NEWTON
SOAP TRIBS SHOWN AS ZONE A ON FIRM
SOAP
GRASSY
PLAINS
(MAY NEED STUDY)
TRIBUTARY NO. 6 TO SOAP CREEK (CURRENTLY MAPPED AS ZONE A)
Statutory ETJ
UNSTUDIED TRIBUTARY TO EAST FORK OF SOAP CREEK (NO MAPPING ON CURRENT FIRM)
GRASSY CREEK TRIBUTARY (ZONE A NEEDS STUDY)
SOAP
SOAP TRIBS SHOWN AS ZONE A ON FIRM (MAY NEED STUDY)

APPENDIX D
FISH CREEK

FISH CREEK MASTER PLAN
SCOPE OF WORK

A. GENERAL DESCRIPTION

The Fish Creek watershed is located south of Pioneer Parkway and north of Joe Pool Lake. Drainage generally travels from west to east through storm drain pipes and culverts and open channels from SH 360 to Mountain Creek Lake. Named streams, with open channel reaches, in this watershed include **Fish Creek, Prairie Creek (North Fork Fish Creek), Kirby Creek, O'Donnell Branch, Dechman Branch, Florence Branch, Rodger's Branch, Willis Branch, Garden Branch, Beacon Branch, Martin Branch, Brian Branch, South Fork Kirby Creek, and Lively Branch**.

Note: This study will be done in conjunction with scope of work for approved TWDB Grant

B. DRAINAGE COMPLAINT DATABASE

Attachment B includes the Fish Creek drainage complaint database. Two-hundred and forty-seven (247) drainage complaints at two-hundred and eight (208) different locations have been filed with the City from 1981 to 2007 within this watershed. Of these complaints, forty (40) were erosion problems, sixty-nine (69) were street flooding problems, one-hundred and seventeen (117) were property flooding problems, and twenty-one (21) were structure flooding problems. Six (6) complaints have been filed since November 2006 (1015 Darbytown, 1019 Darbytown, 1024 Darbytown, 1003 Darbytown, intersection of Allegro and Claremont, and 2410 Warrington). From these complaints, critical areas of interest, or hot spots, were identified and are shown on the attached map. **Note: It is the responsibility of the consultant to obtain the latest information from the City database and evaluate all current drainage complaints at time of study.**

HOT SPOT LOCATIONS:

1. **Blacksmith** (along the south side of Beacon Branch)
2. **Paladium Drive and Forest Trail**
3. **Timber River Lane** (Prairie Creek)
4. **Bent Tree and Wintercrest**
5. **Darbytown Road**
6. **Lindsey Lane and Stephen Street** (east of Robinson Road)
7. **Newport Street** (west of Carrier Parkway)
8. **Meadows Drive and Summerfield Lane** (west of Robinson Road)
9. **Santa Anna** (East of Corn Valley)
10. **Along Corn Valley Road** (north of Kirby Creek)
11. **Glendale Street and Elm Drive** (east of Corn Valley)
12. **Pinoak Street and Crossland Blvd** (east of Robinson Road)
13. **Ridgewood Street** (south of Kirby Creek)
14. **Green Hollow Drive**
15. **Silver Meadow Lane and Brevito Drive** (west of Belt Line Road)
16. **Bluegrass Street** (along Fish Creek, west of Belt Line Road)
17. **IH-20 along Fish Creek** (between Robinson Road and Carrier Parkway)

C. EXISTING DATA AVAILABLE

- Watershed Technical Report – Freese & Nichols (Feb. 2005)
  - This report is part of the City of Grand Prairie Comprehensive Plan. Updated landuse plans were incorporated into the existing and ultimate conditions hydrologic models and new discharges were input into "best available" hydraulic models to produce a new 100-yr ultimate floodplain. Many structures were overtopped and detention was recommended to reduce peak flows for the smaller frequencies, although this had a minor impact on the 100-yr frequency.
- Garden Branch Watershed Study – Halff Associates (March 2003)
  - H&H study using existing landuse and existing landuse with proposed Lake Parks West Phase I Development upstream of Camp Wisdom Road.
- Technical Support Data Notebook (TSDN) – Tarrant County, Texas Phase 1 – North Fork Fish Creek (Prairie Creek) - Halff Associates (Sept. 2005)
- Hydraulic Study for Bardin Road Bridge at Fish Creek – Halff Associates (July 2002)
- LOMR for Fish Creek at Bardin Road Bridge – Halff Associates
- Kirby Creek Watershed & Erosion Master Plan – Halff Associates (January 2005)
- Capital Improvement Study along Kirby, Prairie, and Fish Creek (April 2006)
  - The purpose of this study was to identify flood prone areas and analyze potential relief measures along Kirby Creek, Prairie Creek, and Fish Creek. Detention and channel/structure improvements are recommended.
- Erosion Master Plan Study for Willis Branch (November 2006)
  - The purpose of this study was to develop hydrologic and hydraulic models, identify channel stability and erosion problems, and recommend alternative channel improvements to help alleviate existing and potential future flood and erosion damages.
- Hydrologic & Hydraulic Study for Fish Creek – NUDALLAS to HEC-HMS Conversion and HEC-2 to HEC-RAS Conversion – Halff Associates (March 2002)
- Fish Creek, North Fork Fish Creek (Prairie), and Kirby Creek Drainage Master Plan – Halff Associates (May 1990)

Note: Existing Data Available will be provided to consultant on a CD or DVD, including PDFs of report/figures and technical data available

D. SCOPE OF WORK

1. **Collection of Baseline Information -** Refer to **Section 30. Task a.** in TWDB Grant Scope of Work

   a. Additional Scope of Work: For Fish Creek, obtain all available information, including current effective and recent hydrologic & hydraulic models, topographic information, studies, as-built bridge/culvert plans, property information, available LOMRs, etc. Coordinate with the City to obtain additional survey data for pertinent structures and/or locations along the study reach . Note: Halff has coordinated with adjacent communities on models for common streams, but additional studies or LOMRs may be available and should be researched.

2. **Environmental Constraints -** Refer to **Section 30. Task b**. in TWDB Grant Scope of Work

3. **Review and Identification of Flood and Drainage Problem Areas -** Refer to **Section 30. Task c.** in TWDB Grant Scope of Work

   a. Additional Scope of Work: Obtain and evaluate all available drainage complaints (see Section B) available by the City of Grand Prairie.

4. **Necessary Field Survey Collection -** Refer to **Section 30. Task d.** in TWDB Grant Scope of Work

   a. Additional Scope of Work: As needed, new in-line structures, bridges/culverts, channelization, channel cross-sections, and in-line ponds will be field surveyed and incorporated into the H&H analysis.

5. **Hydrologic Model Development -** Refer to **Section 30. Task e.** in TWDB Grant Scope of Work

   a. Additional Scope of Work: Frequency analysis will also include **50-year** and **500-year** peak flowrates. Engineer shall utilize current Drainage Criteria Manual information for hydrologic parameters.

6. **Hydraulic Model Development -** Refer to **Section 30. Task f.** in TWDB Grant Scope of Work

   a. Additional Scope of Work: Flood profiles will also be prepared for **50-year** and **500-year** frequency storm events. The hydraulic model will also include a **floodway** run for existing conditions on Zone AE streams. Prepare rating curves for City rain & stream gauges along Fish Creek.

   b. Additional Scope of Work: Erosion/Sedimentation Assessment of Hydraulic Models (for Section 10)
      - Review all models in watershed and provide a summary table of the following:
        - Reaches where high channel velocities exist (erosion) for 10-yr event
        - Reaches where low channel velocities exist (sedimentation) for 10-yr event
        - Location of natural meanders of stream
        - Location of steep natural channel sections (describe average slope between two hard points, such as two culverts, along the channel)
        - Location of all existing TRA aerial crossings (based on field surveys and record drawings) – Describe erosive velocities for all frequency events.
      - Describe any field observations of stream, including locations of downcutting, locations of widening, knickpoints in channel flowline, locations of trees falling into channel, locations of trees with exposed roots, locations of wedge failures, locations of erosion at sanitary sewer aerial crossings, locations of undermining of storm drain outfalls, fences and/or structures close to erosion areas that have potential for failure or damage due to further erosion, etc. (and any other types of erosion that was observed). Include labeled photos, if available.

   c. Additional Scope of Work:

i. **<u>Develop new and updated floodplain mapping</u>** – Consolidate, make consistent, update as needed, and provide updated City-wide coverage of floodplains in the Fish Creek watersheds in Grand Prairie. Updated floodplains will be delineated using digital terrain data from the best available topography and integrated into the City's GIS. The primary goal is to establish ultimate 100-year floodplain delineations with Base Flood Elevations shown, but also additional delineations, including existing 100-year & 500-year and floodway delineations for incorporation into FEMA mapping. <u>Updated data will be incorporated into FEMA mapping by LOMR (Tarrant and Dallas counties)</u>**.** GIS shapefiles of floodplain delineations will be provided to the City.

<u>LOMR Submittals</u>

- Prepare brief letter report of project purpose, procedures, and results
- Prepare flood elevation tables, floodway data tables, flood profiles (RASPLOT), hydraulic work maps, and revised FEMA FIRM maps.
- Prepare necessary MT-2 application/certificate forms including:
  - Form 1 – Overview and Concurrence
  - Form 2 – Riverine Hydrology & Hydraulics
  - Form 3 – Riverine Structures (including photos, as-built plans, and survey information)
- Deliver two (2) copies of the Final LOMR Report to the City of Grand Prairie
- Work with City staff on submittal to FEMA
- Export electronic files (HEC-RAS, Word, CADD, GIS, and PDF) to CD and submit to City of Grand Prairie
- Prepare templates and tabulate information for public notification, including individual property owner notification and public notice for floodway revision. The City of Grand Prairie will distribute all public notifications to individual property owners and post the public notice. <u>Note: If properties are affected by revised floodplain elevations, engineer shall survey finished floor elevations (lowest adjacent grade) of all structures in the revised floodplain limits.</u>
- Coordinate with the City of Grand Prairie and FEMA/Technical Reviewer (via telephone and email) to address comments and questions.
  Note: Fees for review of LOMR applications are not included in scope of work

<u>Elevation Certificates</u>

- Identify property locations of structures within updated existing 100-year (1% annual chance) floodplain limits.
- Identify structures on each property that serve as the primary residence or primary use to commercial/industrial sites. For these structures, prepare field surveys of finished flood and lowest adjacent grades around structures.
- All other insurable structures found to be within the limits of the 100-year (1% annual chance) floodplain will be identified and submitted to the City Floodplain Administrator for approval before proceeding with surveying and preparation of the elevation certificate.
- Necessary paperwork for Elevation Certificates will be per current FEMA standards
- Upon completion, prepare overall map of Elevation Certificate locations along the floodplain and submit to City along with completed Elevation Certificates.

7. **Evaluation of Flood Protection Criteria, Measures, and Alternatives -** Refer to **Section 30. Task g.** in TWDB Grant Scope of Work

   a. Additional Scope of Work: Review of existing design flood criteria shall also include the 50-year and 500-year frequencies.

   b. Additional Scope of Work:

      i. **Roadway Crossings**

         - Evaluate and tabulate flood frequency capacity of existing roadway crossings for all Fish Creek study streams – This information will be utilized to determine if existing roadway crossings need to be improved for 100-year flood protection
         - Project Team shall analyze future roadway crossings of existing streams based on City Master Thoroughfare Plan and size crossings for future 100-year flood frequency capacity

8. **Hydrologic & Hydraulic Analysis of Alternatives -** Refer to **Section 30. Task h.** in TWDB Grant Scope of Work

   a. Additional Scope of Work:

      i. **Alternatives for Streams and Open Channels**

         - Stream and Open channel alternatives will be evaluated in accordance with:
         - Flood Profile Impacts
         - Valley Storage (downstream impacts)
         - Environmental Quality
         - Channel Stability/Erosion (channel armor and bio-engineering solutions)
         - Bridge/Culvert Improvements
         - Future TRA aerial wastewater crossings
         - Corps Section 404 Permit Requirements
         - Cost (construction, ROW, engineering, operations, and maintenance).
         - Non-structural and structural improvements will be considered in terms of practicality, economics, necessity, impacts to mobility, environmental concerns, etc.

      ii. **Innovative Alternatives** - Innovative alternatives that incorporate "non-traditional" ideas will be explored and compared with traditional solutions. For example, purchase of existing homes and properties for construction of a regional detention pond to reduce discharges, downstream pipe and culvert sizes, and lower flood profiles might be considered.

9. **Storm Drainage Infrastructure Analysis**

a. **<u>Overview</u> -** Storm drainage network models will be prepared utilizing a City-wide Storm Water Infrastructure GIS database and existing record plans. It is not anticipated that field surveys will supplement the storm drainage studies. If necessary and approved by the City, field surveys will be conducted to accurately locate drainage infrastructure.
    i. Analysis of storm drainage pipe networks will focus on all Fish Creek storm water sub-basins as shown in the attached map (approximate locations are shown for now). Sub-basins are classified as: 1) "Simple system/small basin", 2) "Simple system/large basin", and 3) "Complex system" (small or large basin)
    ii. Additional **"Hot Spot"** locations have been identified where the existing underground drainage system is inadequate and/or frequent flooding occurs. These "Hot Spot" locations are based on drainage complaints within the watershed.
    iii. The age of each storm drainage pipe network will be determined utilizing as-built dates from GIS database (if available)
    iv. Storm water sub-basin delineations will be accurately defined for each storm drain area studied in detail. City GIS data will be utilized.
    v. Design discharges will be based on current City criteria: For areas less than 200 acres, the rational method will be utilized and for areas greater than 200 acres, unit hydrograph techniques shall be utilized (HEC-HMS shall be model utilized for this determination).
    vi. For storm drain analysis and recommendations for design improvements, the most recent version of the computer program **<u>StormCAD</u>** shall be used.

b. **<u>Existing Capacity Analysis</u>** - The capacity of existing streets and underground storm drainage pipe networks, along with flood frequency that the system can contain, will be computed, as best that can be determined using StormCAD. The results of the storm drainage system analysis will be documented and incorporated into the City's Storm Water Infrastructure GIS database. For this task, Project Team will use StormCAD to model the "trunk" line(s) of the primary system or systems in the previously defined storm water sub-basin. It is the Project Team's responsibility to define the limits of the "trunk" line(s) for each sub-basin and determine if additional lateral lines (draining 20% or more of the basin) need to be modeled.

c. **<u>Optimization Analysis</u>** - An attempt to "optimize" existing storm drainage systems will be included in the analysis. Determine where added inlets or detention, at critical points along the system, will ensure that it is optimized for the lower (as well as the higher) frequency floods. These would be categorized as "smaller projects" for the City to designate and prioritize.

d. **<u>City Coordination</u>** - The Project Team will meet with City staff to help confirm and identify problem areas. The updated Storm Water Infrastructure GIS will then be overlaid with property maps to help classify problem areas as "public or private." This data will then be incorporated into the City's Storm Water Infrastructure GIS database. It will include information such as: coordinates (horizontal and vertical location), pipe size, material, and slope.

e. **<u>Analysis of Alternatives</u>** - Following completion of the updated existing storm drainage analysis, the Project Team will commence the analyses of alternatives to address documented storm water infrastructure problems, including correction and future prevention. Proposed alternative improvements will be modeled using the previously prepared StormCAD models for existing infrastructure. Analysis of proposed storm water improvements will be conducted to accommodate a designated flood frequency within the proposed storm drain system, existing/proposed drainage easements, and/or existing street R.O.W.

i. Alternatives for Storm Drains - Storm drain alternatives will be evaluated in accordance with hydraulic grade line (HGL) and energy grade line (EGL), flooding of structures on properties, street flooding, nuisance flooding, age and condition of storm drain system, right-of-way availability, conflicting utilities, and other impacts. The 100-year frequency event will be the design storm. If alternative improvements cannot be developed to adequately contain 100-year event, then the 10-year and 2-year events will be utilized for alternatives. Note: The City of Grand Prairie requires EGL to be 1-foot below top of pavement elevations.

ii. Innovative Alternatives - Innovative alternatives that incorporate "non-traditional" ideas will be explored and compared with traditional solutions. For example, purchase of existing homes and properties for construction of a regional detention pond to reduce discharges, downstream pipe and culvert sizes, and lower flood profiles might be considered.

iii. Preliminary Quantities and Estimates of Probable Cost – For selected alternative improvements, the Project Team will prepare preliminary quantities and estimates of probable cost to implement the conceptual plan(s). These estimates of probable cost will be prepared in a digital format (Excel spreadsheets) with pertinent information such as:
   1. Date of estimate and Adjustments for inflation
   2. Costs for survey, design, ROW & Easement acquisition, utility relocations, construction management, and construction. Note: 25% contingency will be applied to construction cost estimates.

10. Channel Stability Assessment/Erosion Hazard Analysis

a. Hydraulics
   i. Execute HEC-RAS model with low flow and bank-full flow rates.
   ii. Tabulate and evaluate velocities, energy, and shear stress.
   iii. Confirm results with field observations (channel bends).
b. Geomorphology
   i. Conduct field reconnaissance to identify and obtain:
      1. Channel characteristics,
      2. Photos, and
      3. Identify/confirm problem areas, etc.
   ii. Conduct sedimentation/degradation analysis.
   iii. Review 1999 topography versus 2009 topography to determine potential erosion hazard zones
   iv. Review City standards to determine areas within erosion hazard zones
c. Prepare channel stability assessment/erosion hazard analysis report
d. Evaluate erosive properties of existing TRA aerial wastewater crossings
e. Prepare stream bank restoration improvement alternatives (provide preliminary quantities/estimates of probable cost per Section 13)

11. Dams/Levees/Detention/Drainage Reviews

a. Prepare GIS maps showing locations/descriptions of existing dams, levees, retention and detention areas within the Fish Creek Master Plan area. Include separate layers for private and public detention ponds. Work with City GIS staff on GIS development of these layers.
b. Prepare detailed summary of existing drainage plan reviews prepared by Halff denoting project name, City project number, description of review, and if detention was included in the project
c. Obtain plans containing detention ponds and make field visits to verify detention ponds have been constructed according to as-built plans
    i. Document detention ponds with photos
    ii. Describe any problems associated with detention ponds (maintenance issues, outfall issues, etc.)

11. GIS Updates

a. Help identify, if detected, drainage features that are missing from GIS database or shown/labeled incorrectly in GIS database and report to the City. Update missing information accordingly. Note: This task does not include verification that all existing GIS drainage features are correct or physical field inspection of the entire system to ensure accuracy. The intent is to determine missing features or incorrect features as noticed by the Project Teams

b. Based on as-built plans, identify age of all systems (see Section 9)

c. Identify wetland and riparian areas, utilizing Wetland Inventory Maps and visual inspection

12. Maintenance – Fish Creek Watershed Area

a. Based on project study, prepare detailed list of locations where maintenance needs to occur (storm drain outfalls, inlets, culverts, natural channels, open channels, bridges, etc.) in the Fish Creek Master Plan area.

b. Storm Drain Outfall Field Assessment – Utilizing the City of Grand Prairie's database of field-checked storm drain outfalls for Fish Creek and City-wide Drainage Master Plan recommendations, prepare final ranking of outfalls needing repair

13. Benefit/Cost Analysis - Refer to **Section 30. Task i.** in TWDB Grant Scope of Work

a. Additional Scope of Work:

    i. Preliminary Quantities and Estimates of Probable Cost – For selected alternative improvements, the Project Team will prepare preliminary quantities and estimates of probable cost to implement the conceptual plan(s). These estimates of probable cost will be prepared in a digital format (Excel spreadsheets) with pertinent information such as

        - Date of estimate and Adjustments for inflation
        - Costs for survey, design, ROW & Easement acquisition, utility relocations, construction management, and construction. Note: 25% contingency will be applied to construction cost estimates.

14. Implementation and Phasing - Refer to **Section 30. Task j.** in TWDB Grant Scope of Work

a. Additional Scope of Work:

i. Evaluation and Prioritization - Formalize a set of plans/recommendations in a report and assist City in developing rating criteria for channel and storm drain improvement alternatives in the Fish Creek Master Plan area. Develop a rating system to allow planning for future funding (refer to Section II.G of the City-Wide Drainage Master Plan Road Map). Projects, both small projects, medium projects, and large projects will then be **evaluated and prioritized** based on:

1. Levels of damage and value of homes flooded or endangered;
   a. Develop spreadsheet, to include Lowest Adjacent Grade, BFE, Structure Value, and Level of damage (# homes/damage value ($) for various flooding events, including (if available) 10-year, 25-year, 50-year, and 100-year)
2. Number of people and properties affected;
3. Life safety, prevent loss of life and minimize property damage;
4. Level of protection provided by plan;
5. Practicality and implementability,
6. Mobility (keeping main arterials open to traffic);
7. Maintaining access to public buildings, especially hospitals, fire and police departments, etc.
8. Environmental considerations (such as 404 permits, stream corridor maintenance);
9. Private-public relationships and funding agreements;
10. Available funding, participation in funding by others (TWDB, Corps, etc.), and;
11. The highest projected benefit-to-cost ratios.
12. Neighborhood Enhancement – Improve aesthetics, livability, and well-being of Grand Prairie citizens/residents;
13. Availability of Right-of-Way/Easements – Minimize disruption to property and structures.

Note: Weighting for each criteria shall be recommended to and approved by the City prior to prioritization of alternatives.

ii. Phasing and Implementation - The Study Team will then assist and advise City staff in developing phasing and implementation plans and prioritizing proposed improvement projects for future CIP and related funding.

The goal is to incorporate CIPs from this study into an overall phasing and implementation plan with other drainage-related CIPs throughout the City in various other watersheds. The resulting City of Grand Prairie dataset for CIPs would be completely digital and geo-referenced, with documented spatial data, hydrologic and hydraulic data, and other features for ease of future updates.

15. Short Term Priorities & Long Term Plan

a. Short Term Priorities – Develop strategy for immediate implementation of key alternative improvement projects developed for the Fish Creek Master Plan. Focus on:

i. Cost/benefit ratio of proposed improvements. Weigh the flood control benefits against project costs

ii. Develop Project Improvement Needs & Prioritization List, including small projects (<$200,000), medium projects ($200,000 to $500,000), and larger projects (>$500,000)

b. Long Term Plan – Develop strategy for long term implementation of identified prioritized alternative improvement projects developed for the Fish Creek Master Plan. Focus on:

i. Longer range plans for larger projects, including phasing (if possible). Provide cost breakdown of phasing and time-frame for implementation.

This implementation plan would be coordinated with the future funding plan for the City-wide study.

16. Final Deliverables - Refer to **Section 30. Task k.** in TWDB Grant Scope of Work

Incorporate Fish Creek Master Plan data into City-wide Drainage Master Plan Documentation. At the completion of this task, the CWDMP documentation will include the Phase 1 study, Road Map study, Fish Creek Master Plan study, and other watershed Master Plan studies completed at this time.

17. Project Management/Coordination

a. Project Management – Engineer shall provide project status reports, project schedule updates, and perform personnel and data management during course of project. Engineer shall attend a project kickoff meeting, prepare and lead any project status meetings, and prepare meeting minutes of each meeting to submit to the City. Engineer will fully document all hardware, software, file structures, and data formats used during the project.

b. QA/QC – Engineer shall develop a QA/QC procedure to include a multi-level approach to ensure that scope of work components are reviewed and approved.

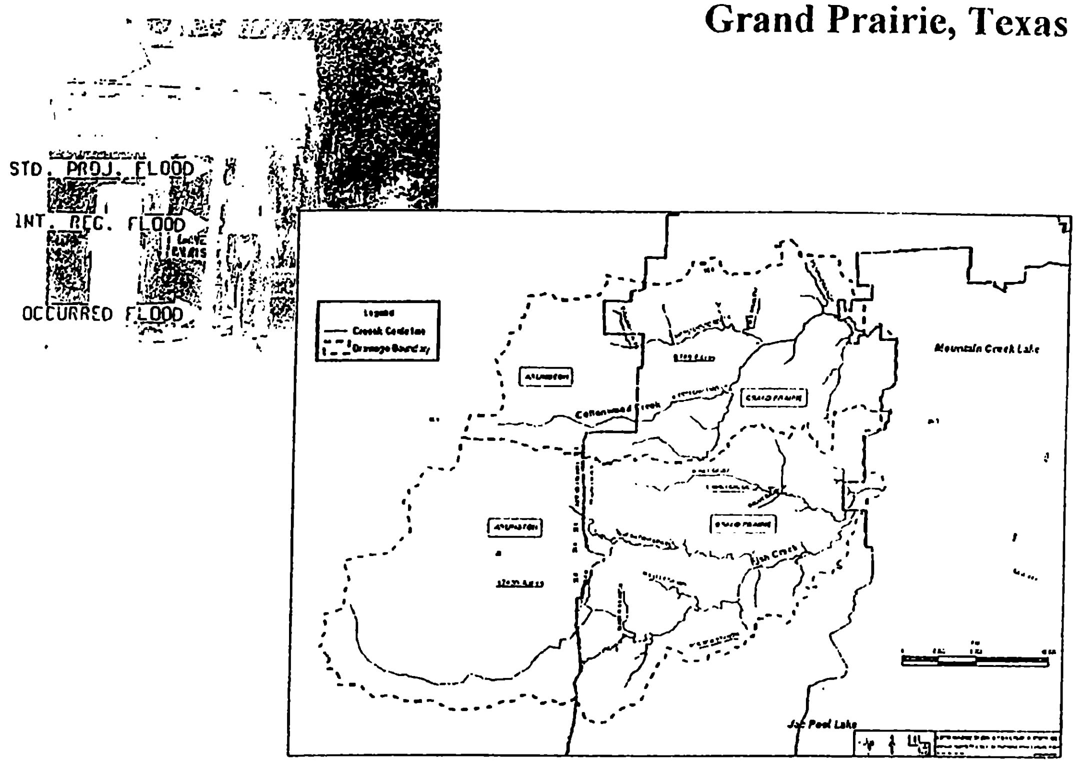
c. Public Involvement Program: **Note: This task is already incorporated into the various tasks in the attached TWDB Grant Scope of Work.**

APPENDIX A
TWDB SCOPE OF WORK
FISH CREEK

Application for Flood Protection Planning Study Grant

COTTONWOOD AND FISH CREEK WATERSHEDS FLOOD PROTECTION PLAN

Grand Prairie, Texas



Applicant: The City of Grand Prairie

US Army Corps of Engineers

Texas Department of Transportation

Including participation / support of:

- Dallas County
- Tarrant County
- City of Arlington
- U.S. Army Corps of Engineers – Ft. Worth District
- TxDOT

January 4, 2008

Project No. P0163

29. A description of how the proposed planning will coordinate with other flood protection plans or facilities in the planning area, surrounding regions, and the State.

The planning effort will bring the City of Grand Prairie and the City of Arlington, together to discuss and share previous and existing studies, and future plans, goals and objectives. The current FIS and the City of Grand Prairie's efforts to-date will be shared and integrated to best serve the planning area. Recognized impacts to unobstructed flow such as transportation corridors and planned road improvements by the State and Counties will be considered in evaluating alternatives to improving channel capacity in the main stem of each of the watersheds. An additional consideration is that there are approximately 20 large pipe diameter aerial crossings which obstruct open channel flow scattered along both Fish Creek and Cottonwood Creek resulting form a regional wastewater entity serving both the cities of Grand Prairie and Arlington. Alternatives to be considered within this study will include consideration for conversion of these aerial crossings, particularly those with significant impact, to siphons or lowering the elevation of these pipeline reaches to reduce the number of obstructions to the flow carrying capacity of the channels.

30. A detailed scope of work for proposed planning.

Historically, in part because of the two city jurisdictions, a number o f hydrologic studies have been performed within the two respective watersheds of Fish Creek and Cottonwood Creek.. To some degree, these various hydrologic studies have focused on specific drainage problems and have further reflected issues unique to the specific jurisdictions and criteria for each of the cities. The fundamental objective of this proposed flood protection planning effort is to comprehensively integrate and update the various hydrologic models that have been developed for both Fish and Cottonwood Creek watersheds. This updating would reflect current watershed conditions inclusive channel conditions, additional structures, new improvements, etc., and additional data reflected in approved and pending LOMRs as well as projected future watershed conditions particularly with the fully developed watershed condition and planned transportation improvements now being implemented. Key environmental considerations will be an integral part of this effort because of the comprehensive nature of past efforts and the need for a single focus

The following project tasks are described in detail as follows.

The project tasks are described in detail in the following sections:

a. Collection of Baseline Information – The City will begin the project with a kick-off meeting of a group of affected advisors represented by the two cities, the USACE, and the Counties composing the Flood Advisory Committee. This committee will discuss overall project scope and available data and information that may be relevant. At a minimum, the following information will be collected for the Cottonwood and Fish Creek watersheds: current FIS and USACE (Ft. Worth District) hydrologic and hydraulic models, past studies including LOMRs and reports, recent geotechnical studies, cultural resource or other related paper maps, digital GIS data of parcels, land use, soils, orthophotography and topography. Strong coordination with the participating entities will ensure that the best level of available information is utilized at the onset of the project. The major end product of this phase is the production of a comprehensive GIS base map.

b. Environmental Constraints – This project will include consideration of various environmental constraints. This will involve a review of critical environmental features already identified by the City, as well as research to identify other features that need to be considered during the development of improvements scenarios. One aspect of this study will consider the presence of a portion of some channeling that has utilized concrete and the extent to which restoration, when triggered by additional capacity needs, warrants environmental restoration to the stream channel original natural condition.

c. Review and Identification of Flood and Drainage Problem Areas – Following an extensive review of the information collected, the problem areas will be classified according to primary drainage system problems and secondary drainage system problems. Based on a preliminary review of this information, and the **first public meeting** to solicit public input on recommended areas, a brief preliminary findings report will be prepared, which will outline the specific recommended flooding and drainage problem areas for study. A list of additional required field survey data will be identified at critical bridges, channel cross-sections, slab elevations, etc. City representatives will work directly in affected neighborhoods to receive stakeholder input.

d. Necessary Field Survey Collection –During the review and identification phase, "gaps" in available cross sectional data will be identified. It is estimated that approximately 25,000 linear feet of additional survey cross-section will be required and 40 structural crossings will need to be detailed.

e. Hydrologic Model Development – Utilizing and expanding existing hydrologic model data from the FEMA and City of Grand Prairie and Arlington studies of Cottonwood and Fish Creeks and tributaries, an updated hydrologic model of the watersheds will be developed which integrates all previous modeling and new data using a georeferenced HEC-HMS model. The use of HEC-HMS will facilitate inclusion of existing City, County and GIS coverages, thereby reducing the time and effort needed to develop curve numbers and times of concentration. The model will include both existing and future land use conditions, utilizing existing City and County GIS data, and employ STATSGO or SSURGO soil information to generate runoff curve numbers using the SCS method. A detailed stream network routing will be developed, based on recent digital topographic data. Times of Concentration and the corresponding lag times will be computed using the TR-55 method.

Particular attention will be devoted to rainfall intensity and storm frequency. Coordination with NCTCOG, the cities, USACE and other entities may provide additional insight into developing the most appropriate and accurate rainfall frequency scenarios. A consideration will include the recognition that the two cities of Arlington and Grand Prairie have different criteria. Building upon prior work of the USACE, an updated frequency analysis may be performed in order to calibrate the runoff model. If this analysis does not yield data with good confidence, peak discharges that are developed with the hydrologic model will be compared to the recently-developed USGS regression equations (per Asquith and Slade, 1997) and the current FIS flowrates.

The project will develop 2-year, 10-year, 25-year, 100-year and 100-year ultimate conditions peak flowrates for use in the hydraulic model.

f. Hydraulic Model Development – Using existing model data, the collected field survey data, information from design plans, and most recently available topographic data, the existing conditions hydraulic models will be updated and converted to HEC-RAS format. The HEC-RAS model will be geo-referenced for correlation with the City GIS data. Flood profiles for the 2-year, 10-year, 25-year, and 100-year frequency storm events will be developed for the existing watershed condition. A flood profile for fully developed 100-year watershed conditions will also be developed. The hydraulic model may also include a floodway run for existing conditions.

g. Evaluation of Flood Protection Criteria, Measures and Alternatives - A review of existing design flood criteria (2-yr, 10-yr, 25-yr, 100-yr, 100-yr ultimate) will be performed for the problem areas and a determination of a desirable or acceptable level of protection within each problem area will be made.

Based upon this evaluation of desirable protection criteria, flood protection measures will be considered, and may include structural and non-structural measures as independent or combination solutions. Channel improvements, culvert upgrades, may be viable structural alternatives. Buy-out and flood-proofing measures may also be evaluated as alternatives. With input from the advisory committee and the public (at a **public meeting** during this stage), several appropriate scenarios will be evaluated. Depending on their complexity, it is anticipated that no more than six scenarios will be identified and evaluated under existing and future conditions. A public meeting will be conducted to receive input on the policy implications of the recommendations.

h. Hydrologic and Hydraulic Analysis of Alternatives – An analysis of the effects of each alternative scenario and resulting level of flood protection with respect each flood events. A detailed report that summarizes the technical aspects of the study and modeling results will be prepared, which will include a comprehensive presentation of the methods of analysis, summary of results, exhibits, and model output.

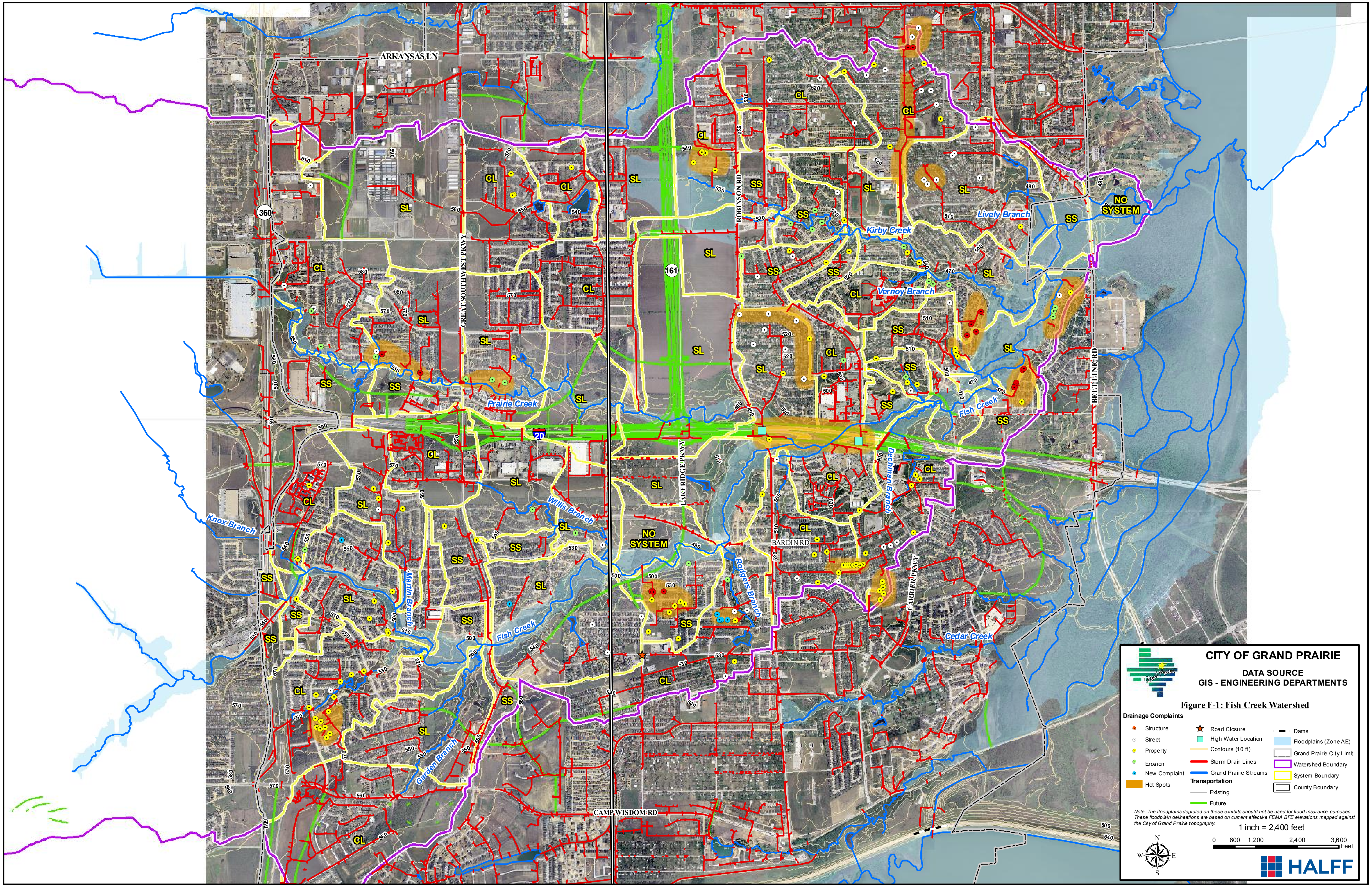
i. <u>Benefit / Cost Analysis</u> – The benefit of each alternative in terms of level of protection/reduction of flood damages, impacts, right-of-way requirements, environmental impacts, etc. will be made in comparison to the associated cost of each improvement. GIS methods will be employed to facilitate and fine-tune the combination of solutions. The City will utilize GIS data sources compiled during the data collection and hydrologic/hydraulic analysis phases. Overlaying existing and proposed floodplains to these base layers will not only provide an efficient means of tabulating potential damages, but also enable great flexibility in modeling "what-if" scenarios to refine the proposed solutions or offer other possible combinations of solutions. From this benefit/cost analysis, a set of optimum solutions will be presented in a report, which will document the benefit criteria, cost information and other considerations. The purpose of this report will be to communicate the results of the Project to a broad audience that may include technical and non-technical people. The results of the Benefit-Cost Analysis will be presented at a public meeting.

j. <u>Implementation and Phasing</u> – Following the public input pertaining to Benefit/Cost for the flood protection scenarios, the project will also include recommendations for the implementation and phasing of the identified improvements, both structural and non-structural. The implementation plan will identify potential funding sources for the improvements, such as city drainage utility fees, impact fees, public/private partnerships, special utility districts, etc., as appropriate. There is currently funding in place for a level of improvements for both watersheds, awaiting application to the results of this planning effort. Consideration of the City's current Capital Improvements Plan and the City's Comprehensive Plan will be important to ensure that the recommended flood protection strategies are coordinated and consistent with the broad objectives of the City.

k. <u>Final Deliverables</u> – At the conclusion of the planning, analysis, and first two public input meetings, a final plan will be prepared and presented at a final public meeting. Final deliverables will be presented to the TWDB following this meeting. The deliverables will likely include maps, technical analysis and supporting documentation, and the implementation and phasing plan, supported by the cost-benefit analysis.

31. A task budget for detailed scope of work by task.

Task and Expense Budget Budget Source		


ARKANSAS LN
GREAT SOUTHWEST PKWY
ROBINSON RD
LAKERIDGE PKWY
BARDIN RD
CARRIER PKWY
BELT LINE RD
CAMP WISDOM RD
360
161
20
Prairie Creek
Kirby Creek
Lively Branch
Vernoy Branch
Fish Creek
Dechman Branch
Willis Branch
Knox Branch
Martin Branch
Rodgers Branch
Cedar Creek
Garden Branch
NO SYSTEM
CL
SL
SS
CITY OF GRAND PRAIRIE
DATA SOURCE
GIS - ENGINEERING DEPARTMENTS
Figure F-1: Fish Creek Watershed
Drainage Complaints
Structure
Street
Property
Erosion
New Complaint
Hot Spots
Road Closure
High Water Location
Contours (10 ft)
Storm Drain Lines
Grand Prairie Streams
Transportation
Existing
Future
Dams
Floodplains (Zone AE)
Grand Prairie City Limit
Watershed Boundary
System Boundary
County Boundary
Note: The floodplains depicted on these exhibits should not be used for flood insurance purposes. These floodplain delineations are based on current effective FEMA BFE elevations mapped against the City of Grand Prairie topography.
1 inch = 2,400 feet
0 600 1,200 2,400 3,600 Feet
N
W
E
S
HALFF

APPENDIX E
COTTONWOOD CREEK

COTTONWOOD CREEK MASTER PLAN
SCOPE OF WORK

A. GENERAL DESCRIPTION

The Cottonwood Creek watershed is located primarily south of Jefferson Blvd and north of the Cottonwood Creek and Kirby Creek watersheds. Drainage generally travels from west to east through storm drain pipes, culverts and open channels from SH 360 to 14th Street and into Mountain Creek Lake. Named streams, with open channel reaches, in this watershed include **Cottonwood Creek, South Fork Cottonwood Creek, Plattner's Branch, Warrior Creek, Henry Branch, Daniel's Branch, Indian Hills Branch, Avion Branch, and Williamson Branch**.

Note: This study will be done in conjunction with scope of work for approved TWDB Grant

B. DRAINAGE COMPLAINT DATABASE

Attachment B includes the Cottonwood Creek drainage complaint database. Two-hundred and thirty-two (232) drainage complaints at one-hundred and eighty-one (181) different locations have been filed with the City from 1989 to 2007 within this watershed. Of these complaints, seventeen (17) were erosion problems, twenty-nine (29) were street flooding problems, one-hundred and ten (110) were property flooding problems, and seventy-six (76) were structure flooding problems. Seven (7) complaints have been filed since November 2006 (2443 Silverado Trail, 1825 Wellington, 303 W. Jefferson, 622 Sparks, Marshall/Pioneer Pkwy street intersection, 825 Cambridge, and 1826 Holland). From these complaints, critical areas of interest, or hot spots, were identified and are shown on the attached map. **Note: It is the responsibility of the consultant to obtain the latest information from the City database and evaluate all current drainage complaints at time of study.**

HOT SPOT LOCATIONS:

1. **Tapley Street** (along Tyre Branch – Erosion)
2. **San Antonio, El Paso, and Beaumont Street** (south of Jefferson Blvd.)
3. **Dallas Street to Clarice Drive** (west of 5th Street)
4. **Along Jefferson and Main Street** (east of Carrier Pkwy)
5. **Along Indian Hills Branch** (property flooding, erosion)
6. **Gramley Street**
7. **Parkside Drive** (east of GSW Pkwy)
8. **Wellington Drive** (east of Robinson Road)
9. **Cober and 3rd Street, Freetown and 3rd Street**
10. **Along Powers Branch** (property flooding, erosion)
11. **Phillip's Court** (east of 4th Street)
12. **South of Stratford Drive** (east of Beltline Road)
13. **South of Sherman Street**

C. EXISTING DATA AVAILABLE

- Watershed Technical Report – Freese & Nichols (Feb. 2005)
  - This report is part of the City of Grand Prairie Comprehensive Plan. Updated landuse plans were incorporated into the existing and ultimate conditions hydrologic models and

new discharges were input into "best available" hydraulic models to produce a new 100-yr ultimate floodplain. Many structures were overtopped and detention was recommended to reduce peak flows for the smaller frequencies, although this had a minor impact on the 100-yr frequency.

- Henry Branch Watershed Study – Halff Associates (Nov. 2005)
  - This is a supplement to the Main Street Drainage at Center Street (Y #200)
- Cottonwood Creek Drainage Master Plan – Huitt-Zollars (April 1995)
- Cottonwood Creek – HEC-2 to HEC-RAS Conversion for Cottonwood Creek and Tributaries – Halff Associates (February 2002)
- Main Street Drainage at Center Street-Preliminary Report – Halff Associates (May 2003)
  - The purpose of this study was to analyze the existing storm drain system to identify problems and recommend alternatives. Alternatives include various culvert improvements.
- Veteran's Park Conceptual Design Services Report – Halff Associates (Dec. 2006)
- Central Park – Halff Study on Warrior Creek – On-going (2008)

Note: Existing Data Available will be provided to consultant on a CD or DVD, including PDFs of report/figures and technical data available

D. UNIQUE ATTRIBUTES OF COTTONWOOD CREEK

- PolyAmerica Site along Cottonwood Creek near Great Southwest Parkway.
- Villas Del Sol future project along Cottonwood Creek near Beltline Road.
- SH 161 crosses Cottonwood Creek, South Fork Cottonwood Creek, and Warrior Creek
- Central Park to be located along Warrior Creek, including five proposed in-line ponds
- **Cottonwood Creek tributaries – South Fork Cottonwood Creek, Warrior Creek, Williamson Branch, Tyre Branch, Daniel's Branch, Raines Branch, Power's Branch, Indian Hills Branch, Henry Branch, Avion Branch**
- **Plattner's Creek tributaries – Gray's Branch**
- Detention/Retention Areas
  - Linear ponds along Cottonwood Creek west of Robinson Road and east of GSW Pkwy

E. SCOPE OF WORK

1. **Collection of Baseline Information -** Refer to **Section 30. Task a.** in TWDB Grant Scope of Work

   - Additional Scope of Work: For Cottonwood Creek, obtain all available information, including current effective and recent hydrologic & hydraulic models, topographic information, studies, as-built bridge/culvert plans, property information, available LOMRs, etc. Coordinate with the City to obtain additional survey data for pertinent structures and/or locations along the study reach . Note: Halff has coordinated with adjacent communities on models for common streams, but additional studies or LOMRs may be available and should be researched.

2. **Environmental Constraints -** Refer to **Section 30. Task b**. in TWDB Grant Scope of Work

3. **Review and Identification of Flood and Drainage Problem Areas -** Refer to **Section 30. Task c.** in TWDB Grant Scope of Work

   - Additional Scope of Work: Obtain and evaluate all available drainage complaints (see Section B) available by the City of Grand Prairie.

4. **Necessary Field Survey Collection -** Refer to **Section 30. Task d.** in TWDB Grant Scope of Work

   - Additional Scope of Work: As needed, new in-line structures, bridges/culverts, channelization, channel cross-sections, and in-line ponds will be field surveyed and incorporated into the H&H analysis.

5. **Hydrologic Model Development -** Refer to **Section 30. Task e.** in TWDB Grant Scope of Work

   - Additional Scope of Work: Frequency analysis will also include **50-year** and **500-year** peak flowrates. Engineer shall utilize current Drainage Criteria Manual information for hydrologic parameters.

6. **Hydraulic Model Development -** Refer to **Section 30. Task f.** in TWDB Grant Scope of Work

   - Additional Scope of Work: Flood profiles will also be prepared for **50-year** and **500-year** frequency storm events. The hydraulic model will also include a **floodway** run for existing conditions on Zone AE streams. Prepare rating curves for City rain & stream gauges along Cottonwood Creek.

   - Additional Scope of Work: Erosion/Sedimentation Assessment of Hydraulic Models (Section 10)
     - Review all models in watershed and provide a summary table of the following:
       - Reaches where high channel velocities exist (erosion) for 10-yr event
       - Reaches where low channel velocities exist (sedimentation) for 10-yr event
       - Location of natural meanders of stream
       - Location of steep natural channel sections (describe average slope between two hard points, such as two culverts, along the channel)
       - Location of all existing TRA aerial crossings (based on field surveys and record drawings) – Describe erosive velocities for all frequency events.
     - Describe any field observations of stream, including locations of downcutting, locations of widening, knickpoints in channel flowline, locations of trees falling into channel, locations of trees with exposed roots, locations of wedge failures, locations of erosion at sanitary sewer aerial crossings, locations of undermining of storm drain outfalls, fences and/or structures close to erosion areas that have potential for failure or damage due to further erosion, etc. (and any other types of erosion that was observed). Include labeled photos, if available.

   - Additional Scope of Work:

i. **<u>Develop new and updated floodplain mapping</u>** – Consolidate, make consistent, update as needed, and provide updated City-wide coverage of floodplains in the Cottonwood Creek watersheds in Grand Prairie. Updated floodplains will be delineated using digital terrain data from the best available topography and integrated into the City's GIS. The primary goal is to establish ultimate 100-year floodplain delineations with Base Flood Elevations shown, but also additional delineations, including existing 100-year & 500-year and floodway delineations for incorporation into FEMA mapping. <u>Updated data will be incorporated into FEMA mapping by LOMR (Tarrant and Dallas counties)</u>**.** GIS shapefiles of floodplain delineations will be provided to the City.

<u>LOMR Submittals</u>

- Prepare brief letter report of project purpose, procedures, and results
- Prepare flood elevation tables, floodway data tables, flood profiles (RASPLOT), hydraulic work maps, and revised FEMA FIRM maps.
- Prepare necessary MT-2 application/certificate forms including:
  - Form 1 – Overview and Concurrence
  - Form 2 – Riverine Hydrology & Hydraulics
  - Form 3 – Riverine Structures (including photos, as-built plans, and survey information)
- Deliver two (2) copies of the Final LOMR Report to the City of Grand Prairie
- Work with City staff on submittal to FEMA
- Export electronic files (HEC-RAS, Word, CADD, GIS, and PDF) to CD and submit to City of Grand Prairie
- Prepare templates and tabulate information for public notification, including individual property owner notification and public notice for floodway revision. The City of Grand Prairie will distribute all public notifications to individual property owners and post the public notice. <u>Note: If properties are affected by revised floodplain elevations, engineer shall survey finished floor elevations (lowest adjacent grade) of all structures in the revised floodplain limits.</u>
- Coordinate with the City of Grand Prairie and FEMA/Technical Reviewer (via telephone and email) to address comments and questions.
  Note: Fees for review of LOMR applications are not included in scope of work

<u>Elevation Certificates</u>

- Identify property locations of structures within updated existing 100-year (1% annual chance) floodplain limits.
- Identify structures on each property that serve as the primary residence or primary use to commercial/industrial sites. For these structures, prepare field surveys of finished flood and lowest adjacent grades around structures.
- All other insurable structures found to be within the limits of the 100-year (1% annual chance) floodplain will be identified and submitted to the City Floodplain Administrator for approval before proceeding with surveying and preparation of the elevation certificate.
- Necessary paperwork for Elevation Certificates will be per current FEMA standards
- Upon completion, prepare overall map of Elevation Certificate locations along the floodplain and submit to City along with completed Elevation Certificates.

7. **Evaluation of Flood Protection Criteria, Measures, and Alternatives -** Refer to **Section 30. Task g.** in TWDB Grant Scope of Work

- Additional Scope of Work: Review of existing design flood criteria shall also include the 50-year and 500-year frequencies.

- Additional Scope of Work:

  i. **Roadway Crossings**

  - Evaluate and tabulate flood frequency capacity of existing roadway crossings for all Cottonwood Creek study streams – This information will be utilized to determine if existing roadway crossings need to be improved for 100-year flood protection
  - Project Team shall analyze future roadway crossings of existing streams based on City Master Thoroughfare Plan and size crossings for future 100-year flood frequency capacity

8. **Hydrologic & Hydraulic Analysis of Alternatives -** Refer to **Section 30. Task h.** in TWDB Grant Scope of Work

- Additional Scope of Work:

  i. **Alternatives for Streams and Open Channels**

  Stream and Open channel alternatives will be evaluated in accordance with:

  - Flood Profile Impacts
  - Valley Storage (downstream impacts)
  - Environmental Quality
  - Channel Stability/Erosion (channel armor and bio-engineering solutions)
  - Bridge/Culvert Improvements – Include Cottonwood Creek structures as well as investigation of SE 14th Street crossing (City of Dallas). For SE 14th Street, investigation will include additional relief culverts only, and no new bridge.
  - Future TRA aerial wastewater crossings
  - Dam Improvements – Investigate feasibility of lowering or raising dams at Cottonwood Creek in the park east of Carrier Parkway
  - Corps Section 404 Permit Requirements
  - Cost (construction, ROW, engineering, operations, and maintenance).
  - Non-structural and structural improvements will be considered in terms of practicality, economics, necessity, impacts to mobility, environmental concerns, etc.

ii. **Innovative Alternatives** - Innovative alternatives that incorporate "non-traditional" ideas will be explored and compared with traditional solutions. For example, purchase of existing homes and properties for construction of a regional detention pond to reduce discharges, downstream pipe and culvert sizes, and lower flood profiles might be considered.

9. Storm Drainage Infrastructure Analysis

- **Overview -** Storm drainage network models will be prepared utilizing a City-wide Storm Water Infrastructure GIS database and existing record plans. It is not anticipated that field surveys will supplement the storm drainage studies. If necessary and approved by the City, field surveys will be conducted to accurately locate drainage infrastructure.
    i. Analysis of storm drainage pipe networks will focus on all Cottonwood Creek storm water sub-basins as shown in the attached map (approximate locations are shown for now). Sub-basins are classified as: 1) "Simple system/small basin", 2) "Simple system/large basin", and 3) "Complex system" (small or large basin)
    ii. Additional **"Hot Spot"** locations have been identified where the existing underground drainage system is inadequate and/or frequent flooding occurs. These "Hot Spot" locations are based on drainage complaints within the watershed.
    iii. The age of each storm drainage pipe network will be determined utilizing as-built dates from GIS database (if available)
    iv. Storm water sub-basin delineations will be accurately defined for each storm drain area studied in detail. City GIS data will be utilized.
    v. Design discharges will be based on current City criteria: For areas less than 200 acres, the rational method will be utilized and for areas greater than 200 acres, unit hydrograph techniques shall be utilized (HEC-HMS shall be model utilized for this determination).
    vi. For storm drain analysis and recommendations for design improvements, the most recent version of the computer program **StormCAD** shall be used.
- **Existing Capacity Analysis** - The capacity of existing streets and underground storm drainage pipe networks, along with flood frequency that the system can contain, will be computed, as best that can be determined using StormCAD. The results of the storm drainage system analysis will be documented and incorporated into the City's Storm Water Infrastructure GIS database. For this task, Project Team will use StormCAD to model the "trunk" line(s) of the primary system or systems in the previously defined storm water sub-basin. It is the Project Team's responsibility to define the limits of the "trunk" line(s) for each sub-basin and determine if additional lateral lines (draining 20% or more of the basin) need to be modeled.
- **Optimization Analysis** - An attempt to "optimize" existing storm drainage systems will be included in the analysis. Determine where added inlets or detention, at critical points along the system, will ensure that it is optimized for the lower (as well as the higher) frequency floods. These would be categorized as "smaller projects" for the City to designate and prioritize.
- **City Coordination** - The Project Team will meet with City staff to help confirm and identify problem areas. The updated Storm Water Infrastructure GIS will then be overlaid with property maps to help classify problem areas as "public or private." This data will then be incorporated into the City's Storm Water Infrastructure GIS database. It will

include information such as: coordinates (horizontal and vertical location), pipe size, material, and slope.

- **Analysis of Alternatives** - Following completion of the updated existing storm drainage analysis, the Project Team will commence the analyses of alternatives to address documented storm water infrastructure problems, including correction and future prevention. Proposed alternative improvements will be modeled using the previously prepared StormCAD models for existing infrastructure. Analysis of proposed storm water improvements will be conducted to accommodate a designated flood frequency within the proposed storm drain system, existing/proposed drainage easements, and/or existing street R.O.W.
    i. Alternatives for Storm Drains - Storm drain alternatives will be evaluated in accordance with hydraulic grade line (HGL) and energy grade line (EGL), flooding of structures on properties, street flooding, nuisance flooding, age and condition of storm drain system, right-of-way availability, conflicting utilities, and other impacts. The 100-year frequency event will be the design storm. If alternative improvements cannot be developed to adequately contain 100-year event, then the 10-year and 2-year events will be utilized for alternatives. Note: The City of Grand Prairie requires EGL to be 1-foot below top of pavement elevations.
    ii. Innovative Alternatives - Innovative alternatives that incorporate "non-traditional" ideas will be explored and compared with traditional solutions. For example, purchase of existing homes and properties for construction of a regional detention pond to reduce discharges, downstream pipe and culvert sizes, and lower flood profiles might be considered.
    iii. Preliminary Quantities and Estimates of Probable Cost – For selected alternative improvements, the Project Team will prepare preliminary quantities and estimates of probable cost to implement the conceptual plan(s). These estimates of probable cost will be prepared in a digital format (Excel spreadsheets) with pertinent information such as:
        1. Date of estimate and Adjustments for inflation
        2. Costs for survey, design, ROW & Easement acquisition, utility relocations, construction management, and construction. Note: 25% contingency will be applied to construction cost estimates.

10. Channel Stability Assessment/Erosion Hazard Analysis

a. Hydraulics
    i. Execute HEC-RAS model with low flow and bank-full flow rates.
    ii. Tabulate and evaluate velocities, energy, and shear stress.
    iii. Confirm results with field observations (channel bends).

b. Geomorphology
    i. Conduct field reconnaissance to identify and obtain:
        1. Channel characteristics,
        2. Photos, and
        3. Identify/confirm problem areas, etc.
    ii. Conduct sedimentation/degradation analysis.
    iii. Review 1999 topography versus 2009 topography to determine potential erosion hazard zones
    iv. Review City standards to determine areas within erosion hazard zones

c. Prepare channel stability assessment/erosion hazard analysis report
d. Evaluate erosive properties of existing TRA aerial wastewater crossings
e. Prepare stream bank restoration improvement alternatives (provide preliminary quantities/estimates of probable cost per Section 14)

11. Dams/Levees/Detention/Drainage Reviews

- Prepare GIS maps showing locations/descriptions of existing dams, levees, retention and detention areas within the Cottonwood Creek Master Plan area. Include separate layers for private and public detention ponds. Work with City GIS staff on GIS development of these layers.
- Prepare detailed summary of existing drainage plan reviews prepared by Halff denoting project name, City project number, description of review, and if detention was included in the project
- Obtain plans containing detention ponds and make field visits to verify detention ponds have been constructed according to as-built plans
  - i. Document detention ponds with photos
  - ii. Describe any problems associated with detention ponds (maintenance issues, outfall issues, etc.)

12. GIS Updates

a. Help identify, if detected, drainage features that are missing from GIS database or shown/labeled incorrectly in GIS database and report to the City. Update missing information accordingly. Note: This task does not include verification that all existing GIS drainage features are correct or physical field inspection of the entire system to ensure accuracy. The intent is to determine missing features or incorrect features as noticed by the Project Teams

b. Based on as-built plans, identify age of all systems (see Section 9)

c. Identify wetland and riparian areas, utilizing Wetland Inventory Maps and visual inspection

13. Maintenance – Cottonwood Creek Watershed Area

a. Based on project study, prepare detailed list of locations where maintenance needs to occur (storm drain outfalls, inlets, culverts, natural channels, open channels, bridges, etc.) in the Cottonwood Creek Master Plan area.

b. <u>Storm Drain Outfall Field Assessment</u> – Utilizing the City of Grand Prairie's database of field-checked storm drain outfalls for Cottonwood Creek and City-wide Drainage Master Plan recommendations, prepare final ranking of outfalls needing repair

14. Benefit/Cost Analysis - <u>Refer to **Section 30. Task i.** in TWDB Grant Scope of Work</u>

a. <u>Additional Scope of Work</u>:

i. <u>Preliminary Quantities and Estimates of Probable Cost</u> – For selected alternative improvements, the Project Team will prepare preliminary quantities and estimates of probable cost to implement the conceptual plan(s). These estimates of probable cost will be prepared in a digital format (Excel spreadsheets) with pertinent information such as

- Date of estimate and Adjustments for inflation
- Costs for survey, design, ROW & Easement acquisition, utility relocations, construction management, and construction. Note: 25% contingency will be applied to construction cost estimates.

15. Implementation and Phasing - Refer to **Section 30. Task j.** in TWDB Grant Scope of Work

a. Additional Scope of Work:

i. Evaluation and Prioritization - Formalize a set of plans/recommendations in a report and assist City in developing rating criteria for channel and storm drain improvement alternatives in the Cottonwood Creek Master Plan area. Develop a rating system to allow planning for future funding (refer to Section II.G of the City-Wide Drainage Master Plan Road Map). Projects, both small projects, medium projects, and large projects will then be **evaluated and prioritized** based on:

1. Levels of damage and value of homes flooded or endangered;
   a. Develop spreadsheet, to include Lowest Adjacent Grade, BFE, Structure Value, and Level of damage (# homes/damage value ($) for various flooding events, including (if available) 10-year, 25-year, 50-year, and 100-year)
2. Number of people and properties affected;
3. Life safety, prevent loss of life and minimize property damage;
4. Level of protection provided by plan;
5. Practicality and implementability,
6. Mobility (keeping main arterials open to traffic);
7. Maintaining access to public buildings, especially hospitals, fire and police departments, etc.
8. Environmental considerations (such as 404 permits, stream corridor maintenance);
9. Private-public relationships and funding agreements;
10. Available funding, participation in funding by others (TWDB, Corps, etc.), and;
11. The highest projected benefit-to-cost ratios.
12. Neighborhood Enhancement – Improve aesthetics, livability, and well-being of Grand Prairie citizens/residents;
13. Availability of Right-of-Way/Easements – Minimize disruption to property and structures.

Note: Weighting for each criteria shall be recommended to and approved by the City prior to prioritization of alternatives.

ii. Phasing and Implementation - The Study Team will then assist and advise City staff in developing phasing and implementation plans and prioritizing proposed improvement projects for future CIP and related funding.

The goal is to incorporate CIPs from this study into an overall phasing and implementation plan with other drainage-related CIPs throughout the City in various other watersheds. The resulting City of Grand Prairie dataset for CIPs would be completely digital and geo-referenced, with documented spatial data, hydrologic and hydraulic data, and other features for ease of future updates.

16. Short Term Priorities & Long Term Plan

a. Short Term Priorities – Develop strategy for immediate implementation of key alternative improvement projects developed for the Cottonwood Creek Master Plan. Focus on:

i. Cost/benefit ratio of proposed improvements. Weigh the flood control benefits against project costs

ii. Develop Project Improvement Needs & Prioritization List, including small projects (<$200,000), medium projects ($200,000 to $500,000), and larger projects (>$500,000)

b. Long Term Plan – Develop strategy for long term implementation of identified prioritized alternative improvement projects developed for the Cottonwood Creek Master Plan. Focus on:

i. Longer range plans for larger projects, including phasing (if possible). Provide cost breakdown of phasing and time-frame for implementation.

This implementation plan would be coordinated with the future funding plan for the City-wide study.

17. Final Deliverables - Refer to **Section 30. Task k.** in TWDB Grant Scope of Work

Incorporate Cottonwood Creek Master Plan data into City-wide Drainage Master Plan Documentation. At the completion of this task, the CWDMP documentation will include the Phase 1 study, Road Map study, Cottonwood Creek Master Plan study, and other watershed Master Plan studies completed at this time.

18. Project Management/Coordination

a. Project Management – Engineer shall provide project status reports, project schedule updates, and perform personnel and data management during course of project. Engineer shall attend a project kickoff meeting, prepare and lead any project status meetings, and prepare meeting minutes of each meeting to submit to the City. Engineer will fully document all hardware, software, file structures, and data formats used during the project.

b. QA/QC – Engineer shall develop a QA/QC procedure to include a multi-level approach to ensure that scope of work components are reviewed and approved.

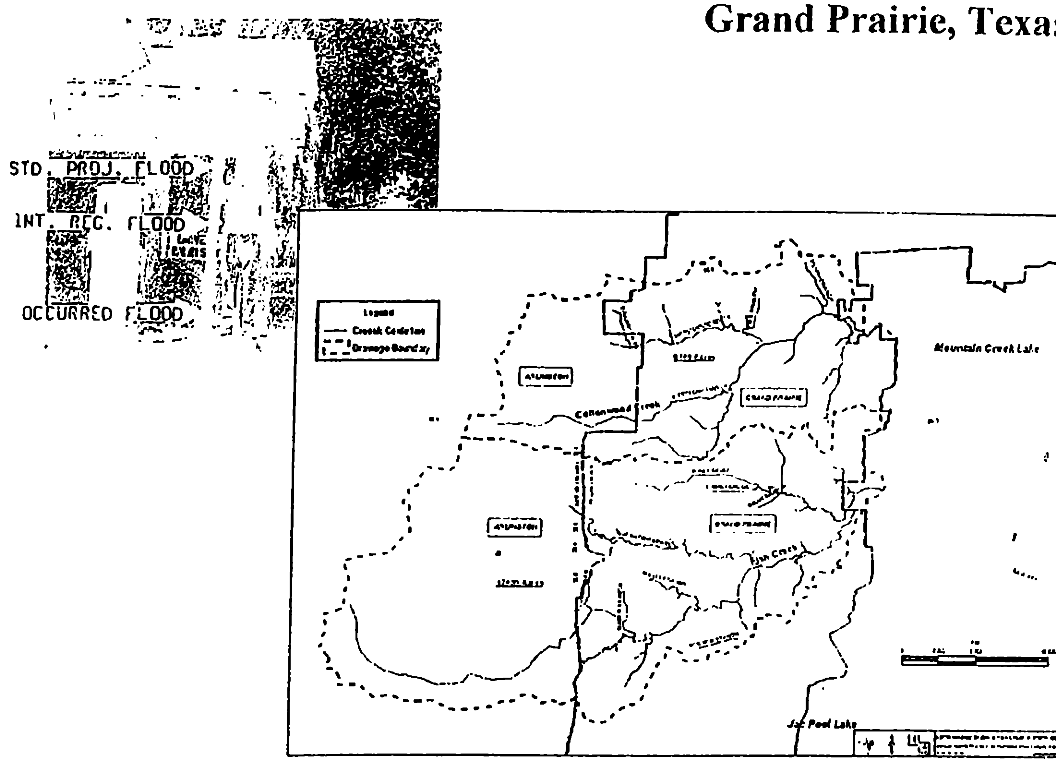
c. Public Involvement Program: **Note: This task is already incorporated into the various tasks in the attached TWDB Grant Scope of Work.**

APPENDIX A
TWDB SCOPE OF WORK
COTTONWOOD CREEK

Application for Flood Protection Planning Study Grant

COTTONWOOD AND FISH CREEK WATERSHEDS FLOOD PROTECTION PLAN

Grand Prairie, Texas



Applicant: The City of Grand Prairie

US Army Corps of Engineers

Texas Department of Transportation

Including participation / support of:

- Dallas County
- Tarrant County
- City of Arlington
- U.S. Army Corps of Engineers – Ft. Worth District
- TxDOT

January 4, 2008

Project No. P0163

29. A description of how the proposed planning will coordinate with other flood protection plans or facilities in the planning area, surrounding regions, and the State.

The planning effort will bring the City of Grand Prairie and the City of Arlington, together to discuss and share previous and existing studies, and future plans, goals and objectives. The current FIS and the City of Grand Prairie's efforts to-date will be shared and integrated to best serve the planning area. Recognized impacts to unobstructed flow such as transportation corridors and planned road improvements by the State and Counties will be considered in evaluating alternatives to improving channel capacity in the main stem of each of the watersheds. An additional consideration is that there are approximately 20 large pipe diameter aerial crossings which obstruct open channel flow scattered along both Fish Creek and Cottonwood Creek resulting form a regional wastewater entity serving both the cities of Grand Prairie and Arlington. Alternatives to be considered within this study will include consideration for conversion of these aerial crossings, particularly those with significant impact, to siphons or lowering the elevation of these pipeline reaches to reduce the number of obstructions to the flow carrying capacity of the channels.

30. A detailed scope of work for proposed planning.

Historically, in part because of the two city jurisdictions, a number o f hydrologic studies have been performed within the two respective watersheds of Fish Creek and Cottonwood Creek.. To some degree, these various hydrologic studies have focused on specific drainage problems and have further reflected issues unique to the specific jurisdictions and criteria for each of the cities. The fundamental objective of this proposed flood protection planning effort is to comprehensively integrate and update the various hydrologic models that have been developed for both Fish and Cottonwood Creek watersheds. This updating would reflect current watershed conditions inclusive channel conditions, additional structures, new improvements, etc., and additional data reflected in approved and pending LOMRs as well as projected future watershed conditions particularly with the fully developed watershed condition and planned transportation improvements now being implemented. Key environmental considerations will be an integral part of this effort because of the comprehensive nature of past efforts and the need for a single focus

The following project tasks are described in detail as follows.

The project tasks are described in detail in the following sections:

a. <u>Collection of Baseline Information</u> – The City will begin the project with a kick-off meeting of a group of affected advisors represented by the two cities, the USACE, and the Counties composing the Flood Advisory Committee. This committee will discuss overall project scope and available data and information that may be relevant. At a minimum, the following information will be collected for the Cottonwood and Fish Creek watersheds: current FIS and USACE (Ft. Worth District) hydrologic and hydraulic models, past studies including LOMRs and reports, recent geotechnical studies, cultural resource or other related paper maps, digital GIS data of parcels, land use, soils, orthophotography and topography. Strong coordination with the participating entities will ensure that the best level of available information is utilized at the onset of the project. The major end product of this phase is the production of a comprehensive GIS base map.

b. Environmental Constraints – This project will include consideration of various environmental constraints. This will involve a review of critical environmental features already identified by the City, as well as research to identify other features that need to be considered during the development of improvements scenarios. One aspect of this study will consider the presence of a portion of some channeling that has utilized concrete and the extent to which restoration, when triggered by additional capacity needs, warrants environmental restoration to the stream channel original natural condition.

c. Review and Identification of Flood and Drainage Problem Areas – Following an extensive review of the information collected, the problem areas will be classified according to primary drainage system problems and secondary drainage system problems. Based on a preliminary review of this information, and the **first public meeting** to solicit public input on recommended areas, a brief preliminary findings report will be prepared, which will outline the specific recommended flooding and drainage problem areas for study. A list of additional required field survey data will be identified at critical bridges, channel cross-sections, slab elevations, etc. City representatives will work directly in affected neighborhoods to receive stakeholder input.

d. Necessary Field Survey Collection –During the review and identification phase, "gaps" in available cross sectional data will be identified. It is estimated that approximately 25,000 linear feet of additional survey cross-section will be required and 40 structural crossings will need to be detailed.

e. Hydrologic Model Development – Utilizing and expanding existing hydrologic model data from the FEMA and City of Grand Prairie and Arlington studies of Cottonwood and Fish Creeks and tributaries, an updated hydrologic model of the watersheds will be developed which integrates all previous modeling and new data using a georeferenced HEC-HMS model. The use of HEC-HMS will facilitate inclusion of existing City, County and GIS coverages, thereby reducing the time and effort needed to develop curve numbers and times of concentration. The model will include both existing and future land use conditions, utilizing existing City and County GIS data, and employ STATSGO or SSURGO soil information to generate runoff curve numbers using the SCS method. A detailed stream network routing will be developed, based on recent digital topographic data. Times of Concentration and the corresponding lag times will be computed using the TR-55 method.

Particular attention will be devoted to rainfall intensity and storm frequency. Coordination with NCTCOG, the cities, USACE and other entities may provide additional insight into developing the most appropriate and accurate rainfall frequency scenarios. A consideration will include the recognition that the two cities of Arlington and Grand Prairie have different criteria. Building upon prior work of the USACE, an updated frequency analysis may be performed in order to calibrate the runoff model. If this analysis does not yield data with good confidence, peak discharges that are developed with the hydrologic model will be compared to the recently-developed USGS regression equations (per Asquith and Slade, 1997) and the current FIS flowrates.

The project will develop 2-year, 10-year, 25-year, 100-year and 100-year ultimate conditions peak flowrates for use in the hydraulic model.

f. Hydraulic Model Development – Using existing model data, the collected field survey data, information from design plans, and most recently available topographic data, the existing conditions hydraulic models will be updated and converted to HEC-RAS format. The HEC-RAS model will be geo-referenced for correlation with the City GIS data. Flood profiles for the 2-year, 10-year, 25-year, and 100-year frequency storm events will be developed for the existing watershed condition. A flood profile for fully developed 100-year watershed conditions will also be developed. The hydraulic model may also include a floodway run for existing conditions.

g. Evaluation of Flood Protection Criteria, Measures and Alternatives - A review of existing design flood criteria (2-yr, 10-yr, 25-yr, 100-yr, 100-yr ultimate) will be performed for the problem areas and a determination of a desirable or acceptable level of protection within each problem area will be made.

Based upon this evaluation of desirable protection criteria, flood protection measures will be considered, and may include structural and non-structural measures as independent or combination solutions. Channel improvements, culvert upgrades, may be viable structural alternatives. Buy-out and flood-proofing measures may also be evaluated as alternatives. With input from the advisory committee and the public (at a **public meeting** during this stage), several appropriate scenarios will be evaluated. Depending on their complexity, it is anticipated that no more than six scenarios will be identified and evaluated under existing and future conditions. A public meeting will be conducted to receive input on the policy implications of the recommendations.

h. Hydrologic and Hydraulic Analysis of Alternatives – An analysis of the effects of each alternative scenario and resulting level of flood protection with respect each flood events. A detailed report that summarizes the technical aspects of the study and modeling results will be prepared, which will include a comprehensive presentation of the methods of analysis, summary of results, exhibits, and model output.

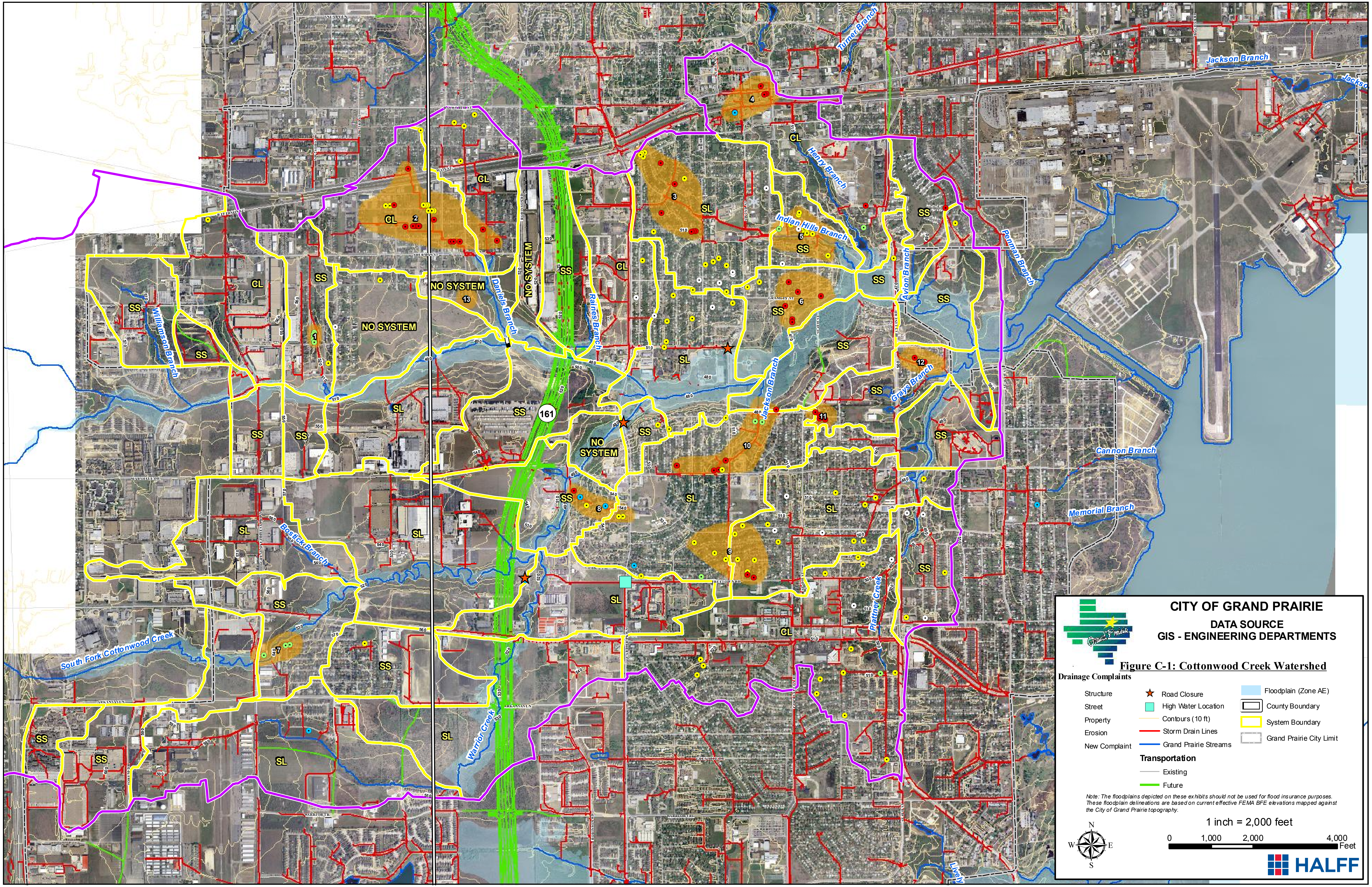
i. Benefit / Cost Analysis – The benefit of each alternative in terms of level of protection/reduction of flood damages, impacts, right-of-way requirements, environmental impacts, etc. will be made in comparison to the associated cost of each improvement. GIS methods will be employed to facilitate and fine-tune the combination of solutions. The City will utilize GIS data sources compiled during the data collection and hydrologic/hydraulic analysis phases. Overlaying existing and proposed floodplains to these base layers will not only provide an efficient means of tabulating potential damages, but also enable great flexibility in modeling "what-if" scenarios to refine the proposed solutions or offer other possible combinations of solutions. From this benefit/cost analysis, a set of optimum solutions will be presented in a report, which will document the benefit criteria, cost information and other considerations. The purpose of this report will be to communicate the results of the Project to a broad audience that may include technical and non-technical people. The results of the Benefit-Cost Analysis will be presented at a **public meeting**.

j. Implementation and Phasing – Following the public input pertaining to Benefit/Cost for the flood protection scenarios, the project will also include recommendations for the implementation and phasing of the identified improvements, both structural and non-structural. The implementation plan will identify potential funding sources for the improvements, such as city drainage utility fees, impact fees, public/private partnerships, special utility districts, etc., as appropriate. There is currently funding in place for a level of improvements for both watersheds, awaiting application to the results of this planning effort. Consideration of the City's current Capital Improvements Plan and the City's Comprehensive Plan will be important to ensure that the recommended flood protection strategies are coordinated and consistent with the broad objectives of the City.

k. Final Deliverables – At the conclusion of the planning, analysis, and first two public input meetings, a final plan will be prepared and presented at a final public meeting. Final deliverables will be presented to the TWDB following this meeting. The deliverables will likely include maps, technical analysis and supporting documentation, and the implementation and phasing plan, supported by the cost-benefit analysis.

31. A task budget for detailed scope of work by task.

Task and Expense Budget Budget Source	



Jackson Branch
Turner Branch
Henry Branch
Indian Hills Branch
Penman Branch
Avion Branch
Daniels Branch
Raines Branch
Jackson Branch
Grays Branch
Cannon Branch
Memorial Branch
Wilkinson Branch
Bosrick Branch
Platinum Creek
Warrior Creek
South Fork Cottonwood Creek
NO SYSTEM
NO SYSTEM
NO SYSTEM
CL
SS
SL
161
CITY OF GRAND PRAIRIE
DATA SOURCE
GIS - ENGINEERING DEPARTMENTS
Figure C-1: Cottonwood Creek Watershed
Drainage Complaints
Structure
Street
Property
Erosion
New Complaint
Road Closure
High Water Location
Contours (10 ft)
Storm Drain Lines
Grand Prairie Streams
Transportation
Existing
Future
Floodplain (Zone AE)
County Boundary
System Boundary
Grand Prairie City Limit
Note: The floodplains depicted on these exhibits should not be used for flood insurance purposes. These floodplain delineations are based on current effective FEMA BFE elevations mapped against the City of Grand Prairie topography.
1 inch = 2,000 feet
0
1,000
2,000
4,000
Feet
N
W
E
S
HALFF

APPENDIX F
CEDAR CREEK

CEDAR CREEK MASTER PLAN
SCOPE OF WORK

A. GENERAL DESCRIPTION

The Cedar Creek watershed is located south of IH-20 and north of Joe Pool Lake. Drainage generally travels from west to east through a series of storm drains, culverts, and open channels from Lake Ridge Parkway to Bardin Road to Mountain Creek (downstream of Joe Pool Outlet Works).

B. DRAINAGE COMPLAINT DATABASE

Forty-six (46) drainage complaints at forty-two (42) different locations have been filed with the City from 1996 to 2007 within this watershed. Of these complaints, two (2) were erosion problems, twenty-one (21) were street flooding problems, twenty-two (22) were property flooding problems, and one (1) was a structure flooding problem. Four complaints have been filed since November 2006 (1214 Sandra Lane, 5001 Oregon Court, 1013 Sandra Lane, and 636 Broadsword). **Note: It is the responsibility of the consultant to obtain the latest information from the City database and evaluate all current drainage complaints at time of study.**

Hot Spot Locations:

1. **Sandra Lane**
2. **Nadine Lane**
3. **San Jacinto Drive and Bowie Lane** (east of Bardin Road)

C. EXISTING DATA AVAILABLE

- LOMR for Stream 8C5 (Cedar Creek) – Carter & Burgess (Dec. 2005) – Under FEMA Review
  - The purpose of this LOMR was to reflect several improvements within the watershed.
    - Carrier Parkway
    - Polo Heights Sub-division
    - Major channel relocation and channelization in the upper portion of the reach
- Watershed Technical Report – Freese & Nichols (Feb. 2005)
  - This report is part of the City of Grand Prairie Comprehensive Plan. Updated landuse plans were incorporated into the existing and ultimate conditions hydrologic models and new discharges were input into "best available" hydraulic models to produce a new 100-yr ultimate floodplain. Many structures were overtopped and detention was recommended to reduce peak flows for the smaller frequencies, although this had a minor impact on the 100-yr frequency.
- Drainage Study upstream of Robinson Road
- Cedar Creek Erosion Study – Conceptual Design Report – AECOM/SMU

Note: Existing Data Available will be provided to consultant on a CD or DVD, including PDFs of report/figures and technical data available

D. Unique Attributes of Cedar Creek

- Upstream development has underground storm drainage system that outfalls into a concrete-lined channel that leads to Robinson Road.
- From Robinson Road to confluence with Mountain Creek, it is natural channel, although improved in some locations.
- Carrier Parkway has been recently improved and also contains a concrete dam/spillway immediately upstream of the culverts
- Cedar Creek has two named tributaries – Wisdom Branch and Castle Branch. Each creek has its confluence with Cedar Creek near the downstream end. Wisdom Branch is completely contained within the Mountain Creek floodplain and Castle Branch is partially within the Mountain Creek floodplain.
- Detention/Retention Areas
  - Retention pond bounded by Nadine Road, Cedar Drive, and Carrier Parkway

E. Scope of Work

1. Data Collection

a. Obtain all available information, including hydrologic & hydraulic models, topographic information, studies, as-built bridge/culvert plans, property information, available LOMRs, etc.

b. Coordinate with the City to obtain additional survey data for pertinent structures and/or locations along the study reach.

2. Hydrologic & Hydraulic Studies - Streams and Open Channel

a. Develop new and/or updated hydrologic models - New HEC-HMS models will be developed (or updated as necessary), replacing any currently effective NUDALLAS and HEC-1 models. Analysis will include existing and future land-use conditions. Any new hydrologic models will be prepared with H&H modeling tools (Geo-HMS), procedures, and GIS tools. A frequency analysis of the existing 2-, 5-, 10-, 25-, 50-, 100-, and 500-year floods and ultimate 100-year flood will be made, at a minimum. Engineer shall utilize current Drainage Criteria Manual information for hydrologic parameters. Modified Puls shall be the methodology used for routing.

b. Develop new and/or updated floodplain hydraulic models – New HEC-RAS models will be developed (or updated as necessary). Any new hydraulic models will be prepared with H&H modeling tools (Geo-RAS), procedures, and GIS tools. <u>As needed, new structures, bridges/culverts, channelization, channel cross-sections, aerial crossings and ponds will be field surveyed and incorporated into the updated H&H analyses</u>. Floodway analyses will be performed, as necessary. Prepare rating curves for City rain & stream gauges along Cedar Creek.

- <u>Erosion/Sedimentation Assessment of Hydraulic Models (for Section 4)</u>
  - Review all models in watershed and provide a summary table of the following:
    - Reaches where high channel velocities exist (erosion) for 10-yr event
    - Reaches where low channel velocities exist (sedimentation) for 10-yr event

- Location of natural meanders of stream
- Location of steep natural channel sections (describe average slope between two hard points, such as two culverts, along the channel)
- Location of all existing TRA aerial crossings (based on field surveys and record drawings) – Describe erosive velocities for all frequency events.

o Describe any field observations of stream, including locations of downcutting, locations of widening, knickpoints in channel flowline, locations of trees falling into channel, locations of trees with exposed roots, locations of wedge failures along bank, locations of erosion at sanitary sewer aerial crossings, locations of undermining of storm drain outfalls, fences and/or structures close to erosion areas that have potential for failure or damage due to further erosion, etc. (and any other types of erosion that was observed). Include labeled photos, if available.

c. Develop new and updated floodplain mapping – Consolidate, make consistent, update as needed, and provide updated City-wide coverage of the Cedar Creek floodplain in Grand Prairie. Updated floodplains will be delineated using digital terrain data from the best available topography and integrated into the City's GIS. The primary goal is to establish ultimate 100-year floodplain delineations with Base Flood Elevations shown, but also additional delineations, including existing 100-year & 500-year and floodway delineations for incorporation into FEMA mapping. Updated data will be incorporated into FEMA mapping by the LOMR process (Dallas County). GIS shapefiles of floodplain delineations will be provided to the City

LOMR Submittals

- Prepare brief letter report of project purpose, procedures, and results
- Prepare flood elevation tables, floodway data tables, flood profiles (RASPLOT), hydraulic work maps, and revised FEMA FIRM maps.
- Prepare necessary MT-2 application/certificate forms including:
  - Form 1 – Overview and Concurrence
  - Form 2 – Riverine Hydrology & Hydraulics
  - Form 3 – Riverine Structures (including photos, as-built plans, and survey information)
- Deliver two (2) copies of the Final LOMR Report to the City of Grand Prairie
- Work with City staff on submittal to FEMA
- Export electronic files (HEC-RAS, Word, CADD, GIS, and PDF) to CD and submit to City of Grand Prairie
- Prepare templates and tabulate information for public notification, including individual property owner notification and public notice for floodway revision. The City of Grand Prairie will distribute all public notifications to individual property owners and post the public notice. Note: If properties are affected by revised floodplain elevations, engineer shall survey finished floor elevations (lowest adjacent grade) of all structures in the revised floodplain limits.
- Coordinate with the City of Grand Prairie and FEMA/Technical Reviewer (via telephone and email) to address comments and questions.
- Note: Fees for review of LOMR applications are not included in scope of work

Elevation Certificates

- Identify property locations of structures within updated existing 100-year (1% annual chance) floodplain limits.
- Identify structures on each property that serve as the primary residence or primary use to commercial/industrial sites. For these structures, prepare field surveys of finished flood and lowest adjacent grades around structures.
- All other insurable structures found to be within the limits of the 100-year (1% annual chance) floodplain will be identified and submitted to the City Floodplain Administrator for approval before proceeding with surveying and preparation of the elevation certificate.
- Necessary paperwork for Elevation Certificates will be per current FEMA standards
- Upon completion, prepare overall map of Elevation Certificate locations along the floodplain and submit to City along with completed Elevation Certificates.

e. Roadway Crossings

- Evaluate and tabulate flood frequency capacity of existing roadway crossings for Cedar Creek – This information will be utilized to determine if existing roadway crossings need to be improved for 100-year flood protection
- Project Team shall analyze future roadway crossings of existing streams based on City Master Thoroughfare Plan and size crossings for future 100-year flood frequency capacity

f. Alternatives for Streams and Open Channels

- Stream and Open channel alternatives will be evaluated in accordance with:
  - Flood Profile Impacts
  - Valley Storage (downstream impacts)
  - Environmental Quality
  - Channel Stability/Erosion (channel armor and bio-engineering solutions)
  - Bridge/Culvert Improvements
  - Future TRA aerial wastewater crossings
  - Corps Section 404 Permit Requirements
  - Cost (construction, ROW, engineering, operations, and maintenance).
  - Non-structural and structural improvements will be considered in terms of practicality, economics, necessity, impacts to mobility, environmental concerns, etc.

3. Storm Drainage Infrastructure Analysis

- **Overview -** Storm drainage network models will be prepared utilizing a City-wide Storm Water Infrastructure GIS database and existing record plans. It is not anticipated that field surveys will supplement the storm drainage studies. If necessary and approved by the City, field surveys will be conducted to accurately locate drainage infrastructure.
  i. Analysis of storm drainage pipe networks will focus on all Cedar Creek storm water sub-basins as shown in the attached map (approximate locations are shown

for now). Sub-basins are classified as: 1) "Simple system/small basin", 2) "Simple system/large basin", and 3) "Complex system" (small or large basin)

ii. Additional **"Hot Spot"** locations have been identified where the existing underground drainage system is inadequate and/or frequent flooding occurs. These "Hot Spot" locations are based on drainage complaints within the watershed.

iii. The age of each storm drainage pipe network will be determined utilizing as-built dates from GIS database (if available)

iv. Storm water sub-basin delineations will be accurately defined for each storm drain area studied in detail. City GIS data will be utilized.

v. Design discharges will be based on current City criteria: For areas less than 200 acres, the rational method will be utilized and for areas greater than 200 acres, unit hydrograph techniques shall be utilized (HEC-HMS shall be model utilized for this determination).

vi. For storm drain analysis and recommendations for design improvements, the most recent version of the computer program **StormCAD** shall be used.

- **Existing Capacity Analysis** - The capacity of existing streets and underground storm drainage pipe networks, along with flood frequency that the system can contain, will be computed, as best that can be determined using StormCAD. The results of the storm drainage system analysis will be documented and incorporated into the City's Storm Water Infrastructure GIS database. For this task, Project Team will use StormCAD to model the "trunk" line(s) of the primary system or systems in the previously defined storm water sub-basin. It is the Project Team's responsibility to define the limits of the "trunk" line(s) for each sub-basin and determine if additional lateral lines (draining 20% or more of the basin) need to be modeled.
- **Optimization Analysis** - An attempt to "optimize" existing storm drainage systems will be included in the analysis. Determine where added inlets or detention, at critical points along the system, will ensure that it is optimized for the lower (as well as the higher) frequency floods. These would be categorized as "smaller projects" for the City to designate and prioritize.
- **City Coordination** - The Project Team will meet with City staff to help confirm and identify problem areas. The updated Storm Water Infrastructure GIS will then be overlaid with property maps to help classify problem areas as "public or private." This data will then be incorporated into the City's Storm Water Infrastructure GIS database. It will include information such as: coordinates (horizontal and vertical location), pipe size, material, and slope.
- **Analysis of Alternatives** - Following completion of the updated existing storm drainage analysis, the Project Team will commence the analyses of alternatives to address documented storm water infrastructure problems, including correction and future prevention. Proposed alternative improvements will be modeled using the previously prepared StormCAD models for existing infrastructure. Analysis of proposed storm water improvements will be conducted to accommodate a designated flood frequency within the proposed storm drain system, existing/proposed drainage easements, and/or existing street R.O.W.

i. Alternatives for Storm Drains - Storm drain alternatives will be evaluated in accordance with hydraulic grade line (HGL) and energy grade line (EGL), flooding of structures on properties, street flooding, nuisance flooding, age and condition of storm drain system, right-of-way availability, conflicting utilities, and other impacts. The 100-year frequency event will be the design storm. If alternative improvements cannot be developed to adequately contain 100-year event, then the 10-year and 2-year events will be utilized for alternatives. Note: The City of Grand Prairie requires EGL to be 1-foot below top of pavement elevations.

ii. Innovative Alternatives - Innovative alternatives that incorporate "non-traditional" ideas will be explored and compared with traditional solutions. For example, purchase of existing homes and properties for construction of a regional detention pond to reduce discharges, downstream pipe and culvert sizes, and lower flood profiles might be considered.

iii. Preliminary Quantities and Estimates of Probable Cost – For selected alternative improvements, the Project Team will prepare preliminary quantities and estimates of probable cost to implement the conceptual plan(s). These estimates of probable cost will be prepared in a digital format (Excel spreadsheets) with pertinent information such as:
   1. Date of estimate and Adjustments for inflation
   2. Costs for survey, design, ROW & Easement acquisition, utility relocations, construction management, and construction. Note: 25% contingency will be applied to construction cost estimates.

4. Channel Stability Assessment/Erosion Hazard Analysis

- Hydraulics
   i. Execute HEC-RAS model with low flow and bank-full flow rates.
   ii. Tabulate and evaluate velocities, energy, and shear stress.
   iii. Confirm results with field observations (channel bends).
- Geomorphology
   i. Conduct field reconnaissance to identify and obtain:
      1. Channel characteristics,
      2. Photos, and
      3. Identify/confirm problem areas, etc.
   ii. Conduct sedimentation/degradation analysis.
   iii. Review 1999 topography versus 2009 topography to determine potential erosion hazard zones
   iv. Review City standards to determine areas within erosion hazard zones
- Prepare channel stability assessment/erosion hazard analysis report
- Evaluate erosive properties of existing TRA aerial wastewater crossings
- Prepare stream bank restoration improvement alternatives (provide preliminary quantities/estimates of probable cost per Section 8)

5. Dams/Levees/Detention/Drainage Reviews

a. Prepare GIS maps showing locations/descriptions of existing dams, levees, retention and detention areas within the Cedar Creek Master Plan area. Include separate layers for private and public detention ponds. Work with City GIS staff on GIS development of these layers.

b. Prepare detailed summary of existing drainage plan reviews prepared by Halff denoting project name, City project number, description of review, and if detention was included in the project
c. Obtain plans containing detention ponds and make field visits to verify detention ponds have been constructed according to as-built plans
    i. Document detention ponds with photos
    ii. Describe any problems associated with detention ponds (maintenance issues, outfall issues, etc.)

6. GIS Updates

a. Help identify, if detected, drainage features that are missing from GIS database or shown/labeled incorrectly in GIS database and report to the City. Update missing information accordingly. Note: This task does not include verification that all existing GIS drainage features are correct or physical field inspection of the entire system to ensure accuracy. The intent is to determine missing features or incorrect features as noticed by the Project Teams

b. Based on as-built plans, identify age of all systems (See Section 3)

c. Identify wetland and riparian areas, utilizing Wetland Inventory Maps and visual inspection

7. Maintenance – Cedar Creek Watershed

a. Identify and evaluate types and locations of areas where maintenance needs to occur (storm drain outfalls, inlets, culverts, natural channels, open channels, bridges, etc.) in the Cedar Creek Master Plan area. **Obtain City Database on investigation of outfalls in the City.**

b. Storm Drain Outfall Field Assessment – Utilizing the City of Grand Prairie's database of field-checked storm drain outfalls for the entire City, establish criteria to rank outfalls based on necessity to repair, provide preliminary ranking of outfalls needing repair, and provide summary report of rankings for the Cedar Creek Master Plan area

c. Develop schedule for maintenance within the Cedar Creek Master Plan area

8. Preliminary Quantities/Estimates of Probable Cost

a. Preliminary Quantities and Estimates of Probable Cost – For selected alternative improvements, the Project Team will prepare preliminary quantities and estimates of probable cost to implement the conceptual plan(s). These estimates of probable cost will be prepared in a digital format (Excel spreadsheets) with pertinent information such as

- Date of estimate and Adjustments for inflation
- Costs for survey, design, ROW & Easement acquisition, utility relocations, construction management, and construction. Note: 25% contingency will be applied to construction cost estimates.

9. Evaluation & Prioritization/Phasing & Implementation

a. Evaluation and Prioritization - Formalize a set of plans/recommendations in a report and assist City in developing rating criteria for channel and storm drain improvement alternatives in the Cedar Creek Master Plan area. Develop a rating system to allow planning for future funding (refer to Section II.G of the City-Wide Drainage Master Plan Road Map). Projects, both small projects, medium projects, and large projects will then be **evaluated and prioritized** based on:

1. Levels of damage and value of homes flooded or endangered;
   a. Develop spreadsheet, to include Lowest Adjacent Grade, BFE, Structure Value, and Level of damage (# homes/damage value ($) for various flooding events, including (if available) 10-year, 25-year, 50-year, and 100-year)
2. Number of people and properties affected;
3. Life safety, prevent loss of life and minimize property damage;
4. Level of protection provided by plan;
5. Practicality and implementability,
6. Mobility (keeping main arterials open to traffic);
7. Maintaining access to public buildings, especially hospitals, fire and police departments, etc.
8. Environmental considerations (such as 404 permits, stream corridor maintenance);
9. Private-public relationships and funding agreements;
10. Available funding, participation in funding by others (TWDB, Corps, etc.), and;
11. The highest projected benefit-to-cost ratios.
12. Neighborhood Enhancement – Improve aesthetics, livability, and well-being of Grand Prairie citizens/residents;
13. Availability of Right-of-Way/Easements – Minimize disruption to property and structures.

Note: Weighting for each criteria shall be recommended to and approved by the City prior to prioritization of alternatives.

b. Phasing and Implementation - The Study Team will then assist and advise City staff in developing phasing and implementation plans and prioritizing proposed improvement projects for future CIP and related funding.

The goal is to incorporate CIPs from this study into an overall phasing and implementation plan with other drainage-related CIPs throughout the City in various other watersheds. The resulting City of Grand Prairie dataset for CIPs would be completely digital and geo-referenced, with documented spatial data, hydrologic and hydraulic data, and other features for ease of future updates.

10. Short Term Priorities & Long Term Plan

a. Short Term Priorities – Develop strategy for immediate implementation of key alternative improvement projects developed for the Cedar Creek Master Plan. Focus on:

i. Cost/benefit ratio of proposed improvements. Weigh the flood control benefits against project costs
ii. Develop Project Improvement Needs & Prioritization List, including small projects (<$200,000), medium projects ($200,000 to $500,000), and larger projects (>$500,000)

b. Long Term Plan – Develop strategy for long term implementation of identified prioritized alternative improvement projects developed for the Cedar Creek Master Plan. Focus on:

i. Longer range plans for larger projects, including phasing (if possible). Provide cost breakdown of phasing and time-frame for implementation.

This implementation plan would be coordinated with the future funding plan for the City-wide study.

11. City-wide Drainage Master Plan Documentation

Incorporate Cedar Creek Master Plan data into City-wide Drainage Master Plan Documentation.

12. Project Management/Coordination

a. Project Management – Engineer shall provide project status reports, project schedule updates, and perform personnel and data management during course of project. Engineer shall attend a project kickoff meeting, prepare and lead any project status meetings, and prepare meeting minutes of each meeting to submit to the City. Engineer will fully document all hardware, software, file structures, and data formats used during the project.

b. QA/QC – Engineer shall develop a QA/QC procedure to include a multi-level approach to ensure that scope of work components are reviewed and approved.

c. Public Involvement Program: City Council Briefing Session - Develop schedule, set up and conduct a final workshop with the City Council and certain department leaders after study completion. Provide the council with an overview of drainage and flooding issues, study results, and recommendations.

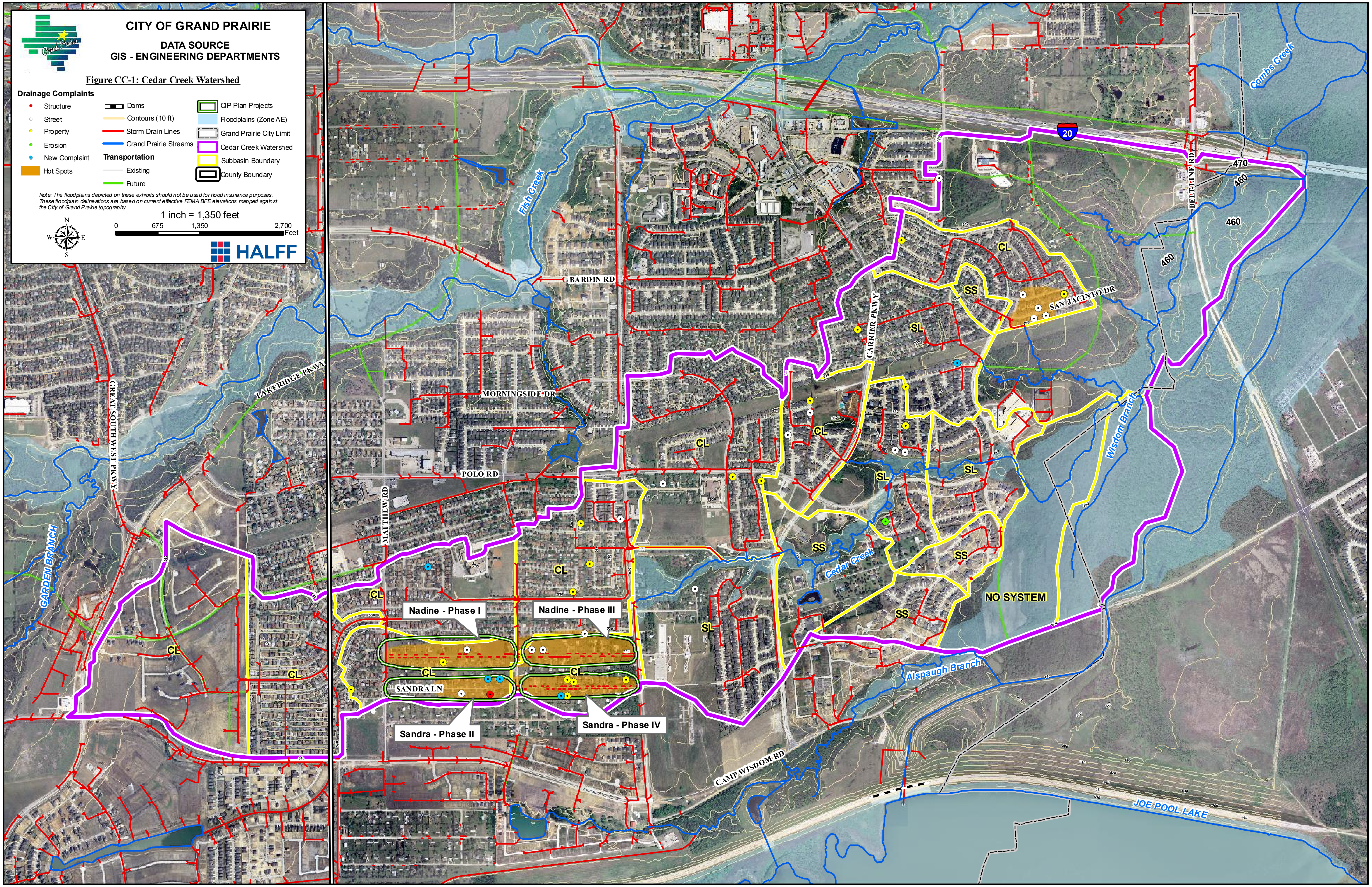


Figure CC-1: Cedar Creek Watershed

APPENDIX G
JOHNSON/ARBOR/BARRETT

JOHNSON CREEK, ARBOR CREEK, BARRETT BRANCH MASTER PLAN
SCOPE OF WORK

A. GENERAL DESCRIPTION

The Johnson Creek watershed is located east of State Highway 360, west of Egyptian Way, and south of Carrier Parkway. Arbor Creek and Barrett Creek watersheds fall within the Johnson Creek watershed. Drainage within Johnson Creek watershed generally travels from west to east through storm drain pipes and culverts as well as open channels from SH 360 to Carrier Parkway to the West Fork Trinity River. Drainage within both Arbor and Barrett Creek watersheds generally travels from south to north through storm drain pipes and culverts and open channels.

B. DRAINAGE COMPLAINT DATABASE

One-hundred and forty-seven (147) drainage complaints at one-hundred and thirteen (113) different locations have been filed with the City from 1981 to 2007 within these watersheds. Of these complaints, eight (8) were erosion problems, thirty-one (31) were street flooding problems, sixty-five (65) were property flooding problems, and forty-three (43) were structure flooding problems. Two (2) complaints have been filed since November 2006 (1710 E. Valley Lane and 2205 Ravenwood). **Note: It is the responsibility of the consultant to obtain the latest information from the City database and evaluate all current drainage complaints at time of study.**

Hot Spot Locations:

1. **Sunnyvale Road** (Johnson Creek)
2. **Nottingham and Duncan Perry Road** (Johnson Creek)
3. **Axminster and King Richard Drive** (Johnson Creek)
4. **Ivanhoe Circle Area** (Johnson Creek)

1. **Arbor Rose Drive** (Arbor Creek)
2. **North of Egyptian Way** (west side of Arbor Creek)

1. **Danish Drive, Canadian Circle, and British Blvd** (Barrett Branch)

C. EXISTING DATA AVAILABLE

- Watershed Technical Report – Freese & Nichols (Feb. 2005)
  - This report is part of the City of Grand Prairie Comprehensive Plan. Updated landuse plans were incorporated into the existing and ultimate conditions hydrologic models and new discharges were input into "best available" hydraulic models to produce a new 100-yr ultimate floodplain. Many structures were overtopped and detention was recommended to reduce peak flows for the smaller frequencies, although this had a minor impact on the 100-yr frequency.
- Johnson Creek Studies (for Arlington) – Graham Associates (1996, Oct. 2006)
- Nottingham Drainage Improvement LOMR – Halff Associates (April 1998 and April 2002)
- Technical Support Data Notebook (TSDN) – Tarrant County, Texas Phase 1 – Johnson Creek, Arbor Creek - Halff Associates (Sept. 2005)

  - The purpose of this study was to compile a hydraulic model from "best available" hydraulic information. This was not a new detailed study.
- Preliminary Design Report for the Dorchester Flood Control Levee Project on the West Fork Trinity River and Johnson Creek – Halff Associates (May 1991)
- **<u>CURRENT STUDY</u>** – Environmental Baseline Determination and NEPA Documentation for Johnson Creek, Arlington, Texas (USACE Contract No. W9126G-07-D-0010), currently being prepared by HDR, Inc. (2008)
- **<u>CURRENT STUDY</u>** – Arbor Creek Drainage Study, currently being prepared by O'Brien Engineering (2008)

<u>Note: Existing Data Available will be provided to consultant on a CD or DVD, including PDFs of report/figures and technical data available</u>

D. Scope of Work

1. Data Collection

a. Obtain all available information, including hydrologic & hydraulic models, topographic information, studies, as-built bridge/culvert plans, property information, available LOMRs, etc.

b. Coordinate with the City to obtain additional survey data for pertinent structures and/or locations along the study reach.

2. Hydrologic & Hydraulic Studies - Streams and Open Channel

a. <u>Develop new and/or updated hydrologic models</u> - New HEC-HMS models will be developed (or updated as necessary), replacing any currently effective NUDALLAS and HEC-1 models. Analysis will include existing and future land-use conditions. Any new hydrologic models will be prepared with H&H modeling tools (Geo-HMS), procedures, and GIS tools. A frequency analysis of the existing 2-, 5-, 10-, 25-, 50-, 100-, and 500-year floods and ultimate 100-year flood will be made, at a minimum. Engineer shall utilize current Drainage Criteria Manual information for hydrologic parameters. Modified Puls shall be the methodology used for routing.

b. <u>Develop new and/or updated floodplain hydraulic models</u> – New HEC-RAS models will be developed (or updated as necessary). Any new hydraulic models will be prepared with H&H modeling tools (Geo-RAS), procedures, and GIS tools. <u>As needed, new structures, bridges/culverts, channelization, channel cross-sections, aerial crossings and ponds will be field surveyed and incorporated into the updated H&H analyses</u>. Floodway analyses will be performed, as necessary. Prepare rating curves for City rain & stream gauges along Johnson Creek, Arbor Creek and Barrett Branch.

- <u>Erosion/Sedimentation Assessment of Hydraulic Models (for Section 4)</u>
  - Review all models in watershed and provide a summary table of the following:
    - Reaches where high channel velocities exist (erosion) for 10-yr event
    - Reaches where low channel velocities exist (sedimentation) for 10-yr event
    - Location of natural meanders of stream

- Location of steep natural channel sections (describe average slope between two hard points, such as two culverts, along the channel)
- Location of all existing TRA aerial crossings (based on field surveys and record drawings) – Describe erosive velocities for all frequency events.

- Describe any field observations of stream, including locations of downcutting, locations of widening, knickpoints in channel flowline, locations of trees falling into channel, locations of trees with exposed roots, locations of wedge failures, locations of erosion at sanitary sewer aerial crossings, locations of undermining of storm drain outfalls, fences and/or structures close to erosion areas that have potential for failure or damage due to further erosion, etc. (and any other types of erosion that was observed). Include labeled photos, if available.

c. Develop new and updated floodplain mapping – Consolidate, make consistent, update as needed, and provide updated City-wide coverage of the Johnson Creek, Arbor Creek, and Barrett Branch floodplains in Grand Prairie. Updated floodplains will be delineated using digital terrain data from the best available topography and integrated into the City's GIS. The primary goal is to establish ultimate 100-year floodplain delineations with Base Flood Elevations shown, but also additional delineations, including existing 100-year & 500-year and floodway delineations for incorporation into FEMA mapping. Updated data will be incorporated into FEMA mapping by the LOMR process**.** GIS shapefiles of floodplain delineations will be provided to the City

LOMR Submittals

- Prepare brief letter report of project purpose, procedures, and results
- Prepare flood elevation tables, floodway data tables, flood profiles (RASPLOT), hydraulic work maps, and revised FEMA FIRM maps.
- Prepare necessary MT-2 application/certificate forms including:
  - Form 1 – Overview and Concurrence
  - Form 2 – Riverine Hydrology & Hydraulics
  - Form 3 – Riverine Structures (including photos, as-built plans, and survey information)
- Deliver two (2) copies of the Final LOMR Report to the City of Grand Prairie
- Work with City staff on submittal to FEMA
- Export electronic files (HEC-RAS, Word, CADD, GIS, and PDF) to CD and submit to City of Grand Prairie
- Prepare templates and tabulate information for public notification, including individual property owner notification and public notice for floodway revision. The City of Grand Prairie will distribute all public notifications to individual property owners and post the public notice. Note: If properties are affected by revised floodplain elevations, engineer shall survey finished floor elevations (lowest adjacent grade) of all structures in the revised floodplain limits.
- Coordinate with the City of Grand Prairie and FEMA/Technical Reviewer (via telephone and email) to address comments and questions.
- Note: Fees for review of LOMR applications are not included in scope of work

Elevation Certificates

- Identify property locations of structures within updated existing 100-year (1% annual chance) floodplain limits.
- Identify structures on each property that serve as the primary residence or primary use to commercial/industrial sites. For these structures, prepare field surveys of finished flood and lowest adjacent grades around structures.
- All other insurable structures found to be within the limits of the 100-year (1% annual chance) floodplain will be identified and submitted to the City Floodplain Administrator for approval before proceeding with surveying and preparation of the elevation certificate.
- Necessary paperwork for Elevation Certificates will be per current FEMA standards
- Upon completion, prepare overall map of Elevation Certificate locations along the floodplain and submit to City along with completed Elevation Certificates.

e. <u>Roadway Crossings</u>

- <u>Evaluate and tabulate flood frequency capacity of existing roadway crossings for Johnson Creek, Arbor Creek, and Barrett Branch</u> – This information will be utilized to determine if existing roadway crossings need to be improved for 100-year flood protection
- Project Team shall analyze future roadway crossings of existing streams based on City Master Thoroughfare Plan and size crossings for future 100-year flood frequency capacity

f. <u>Alternatives for Streams and Open Channels</u>

- Stream and Open channel alternatives will be evaluated in accordance with:
  - Flood Profile Impacts
  - Valley Storage (downstream impacts)
  - Environmental Quality
  - Channel Stability/Erosion (channel armor and bio-engineering solutions)
  - Bridge/Culvert Improvements
  - Future TRA aerial wastewater crossings
  - Corps Section 404 Permit Requirements
  - Cost (construction, ROW, engineering, operations, and maintenance).
  - Non-structural and structural improvements will be considered in terms of practicality, economics, necessity, impacts to mobility, environmental concerns, etc.

3. Storm Drainage Infrastructure Analysis

- **<u>Overview</u> -** Storm drainage network models will be prepared utilizing a City-wide Storm Water Infrastructure GIS database and existing record plans. It is not anticipated that field surveys will supplement the storm drainage studies. If necessary and approved by the City, field surveys will be conducted to accurately locate drainage infrastructure.
  i. Analysis of storm drainage pipe networks will focus on all Johnson Creek, Arbor Creek, and Barrett Branch storm water sub-basins as shown in the attached map

(approximate locations are shown for now). Sub-basins are classified as: 1) "Simple system/small basin", 2) "Simple system/large basin", and 3) "Complex system" (small or large basin)

ii. Additional **"Hot Spot"** locations have been identified where the existing underground drainage system is inadequate and/or frequent flooding occurs. These "Hot Spot" locations are based on drainage complaints within the watershed.

iii. The age of each storm drainage pipe network will be determined utilizing as-built dates from GIS database (if available)

iv. Storm water sub-basin delineations will be accurately defined for each storm drain area studied in detail. City GIS data will be utilized.

v. Design discharges will be based on current City criteria: For areas less than 200 acres, the rational method will be utilized and for areas greater than 200 acres, unit hydrograph techniques shall be utilized (HEC-HMS shall be model utilized for this determination).

vi. For storm drain analysis and recommendations for design improvements, the most recent version of the computer program **StormCAD** shall be used.

- **Existing Capacity Analysis** - The capacity of existing streets and underground storm drainage pipe networks, along with flood frequency that the system can contain, will be computed, as best that can be determined using StormCAD. The results of the storm drainage system analysis will be documented and incorporated into the City's Storm Water Infrastructure GIS database. For this task, Project Team will use StormCAD to model the "trunk" line(s) of the primary system or systems in the previously defined storm water sub-basin. It is the Project Team's responsibility to define the limits of the "trunk" line(s) for each sub-basin and determine if additional lateral lines (draining 20% or more of the basin) need to be modeled.
- **Optimization Analysis** - An attempt to "optimize" existing storm drainage systems will be included in the analysis. Determine where added inlets or detention, at critical points along the system, will ensure that it is optimized for the lower (as well as the higher) frequency floods. These would be categorized as "smaller projects" for the City to designate and prioritize.
- **City Coordination** - The Project Team will meet with City staff to help confirm and identify problem areas. The updated Storm Water Infrastructure GIS will then be overlaid with property maps to help classify problem areas as "public or private." This data will then be incorporated into the City's Storm Water Infrastructure GIS database. It will include information such as: coordinates (horizontal and vertical location), pipe size, material, and slope.
- **Analysis of Alternatives** - Following completion of the updated existing storm drainage analysis, the Project Team will commence the analyses of alternatives to address documented storm water infrastructure problems, including correction and future prevention. Proposed alternative improvements will be modeled using the previously prepared StormCAD models for existing infrastructure. Analysis of proposed storm water improvements will be conducted to accommodate a designated flood frequency within the proposed storm drain system, existing/proposed drainage easements, and/or existing street R.O.W.

i. Alternatives for Storm Drains - Storm drain alternatives will be evaluated in accordance with hydraulic grade line (HGL) and energy grade line (EGL), flooding of structures on properties, street flooding, nuisance flooding, age and condition of storm drain system, right-of-way availability, conflicting utilities, and other impacts. The 100-year frequency event will be the design storm. If alternative improvements cannot be developed to adequately contain 100-year event, then the 10-year and 2-year events will be utilized for alternatives. Note: The City of Grand Prairie requires EGL to be 1-foot below top of pavement elevations.

ii. Innovative Alternatives - Innovative alternatives that incorporate "non-traditional" ideas will be explored and compared with traditional solutions. For example, purchase of existing homes and properties for construction of a regional detention pond to reduce discharges, downstream pipe and culvert sizes, and lower flood profiles might be considered.

iii. Preliminary Quantities and Estimates of Probable Cost – For selected alternative improvements, the Project Team will prepare preliminary quantities and estimates of probable cost to implement the conceptual plan(s). These estimates of probable cost will be prepared in a digital format (Excel spreadsheets) with pertinent information such as:

1. Date of estimate and Adjustments for inflation
2. Costs for survey, design, ROW & Easement acquisition, utility relocations, construction management, and construction. Note: 25% contingency will be applied to construction cost estimates.

4. Channel Stability Assessment/Erosion Hazard Analysis

a. Hydraulics
   i. Execute HEC-RAS model with low flow and bank-full flow rates.
   ii. Tabulate and evaluate velocities, energy, and shear stress.
   iii. Confirm results with field observations (channel bends).
b. Geomorphology
   i. Conduct field reconnaissance to identify and obtain:
      1. Channel characteristics,
      2. Photos, and
      3. Identify/confirm problem areas, etc.
   ii. Conduct sedimentation/degradation analysis.
   iii. Review 1999 topography versus 2009 topography to determine potential erosion hazard zones
   iv. Review City standards to determine areas within erosion hazard zones
c. Prepare channel stability assessment/erosion hazard analysis report
d. Evaluate erosive properties of existing TRA aerial wastewater crossings
e. Prepare stream bank restoration improvement alternatives (provide preliminary quantities/estimates of probable cost per Section 8)

5. Dams/Levees/Detention/Drainage Reviews

a. Prepare GIS maps showing locations/descriptions of existing dams, levees, retention and detention areas within the Johnson Creek, Arbor Creek, and Barrett Branch Master Plan area.

Include separate layers for private and public detention ponds. Work with City GIS staff on GIS development of these layers.

b. Prepare detailed summary of existing drainage plan reviews prepared by Halff denoting project name, City project number, description of review, and if detention was included in the project

c. Obtain plans containing detention ponds and make field visits to verify detention ponds have been constructed according to as-built plans

i. Document detention ponds with photos

ii. Describe any problems associated with detention ponds (maintenance issues, outfall issues, etc.)

6. GIS Updates

a. Help identify, if detected, drainage features that are missing from GIS database or shown/labeled incorrectly in GIS database and report to the City. Update missing information accordingly. Note: This task does not include verification that all existing GIS drainage features are correct or physical field inspection of the entire system to ensure accuracy. The intent is to determine missing features or incorrect features as noticed by the Project Teams

b. Based on as-built plans, identify age of all systems (See Section 3)

c. Identify wetland and riparian areas, utilizing Wetland Inventory Maps and visual inspection

7. Maintenance – Johnson Creek, Arbor Creek, and Barret Branch Watersheds

a. Identify and evaluate types and locations of areas where maintenance needs to occur (storm drain outfalls, inlets, culverts, natural channels, open channels, bridges, etc.) in the Johnson Creek, Arbor Creek, and Barrett Branch Master Plan area. <u>**Obtain City Database on investigation of outfalls in the City.**</u>

b. <u>Storm Drain Outfall Field Assessment</u> – Utilizing the City of Grand Prairie's database of field-checked storm drain outfalls for the entire City, establish criteria to rank outfalls based on necessity to repair, provide preliminary ranking of outfalls needing repair, and provide summary report of rankings for the Johnson Creek, Arbor Creek, and Barrett Branch Master Plan area

c. Develop schedule for maintenance within the Johnson Creek, Arbor Creek, and Barrett Branch Master Plan area

8. Preliminary Quantities/Estimates of Probable Cost

a. <u>Preliminary Quantities and Estimates of Probable Cost</u> – For selected alternative improvements, the Project Team will prepare preliminary quantities and estimates of probable cost to implement the conceptual plan(s). These estimates of probable cost will be prepared in a digital format (Excel spreadsheets) with pertinent information such as

- Date of estimate and Adjustments for inflation

- Costs for survey, design, ROW & Easement acquisition, utility relocations, construction management, and construction. Note: 25% contingency will be applied to construction cost estimates.

9. Evaluation & Prioritization/Phasing & Implementation

a. Evaluation and Prioritization - Formalize a set of plans/recommendations in a report and assist City in developing rating criteria for channel and storm drain improvement alternatives in the Johnson Creek, Arbor Creek, and Barrett Branch Master Plan area. Develop a rating system to allow planning for future funding (refer to Section II.G of the City-Wide Drainage Master Plan Road Map). Projects, both small projects, medium projects, and large projects will then be **evaluated and prioritized** based on:

1. Levels of damage and value of homes flooded or endangered;
   a. Develop spreadsheet, to include Lowest Adjacent Grade, BFE, Structure Value, and Level of damage (# homes/damage value ($) for various flooding events, including (if available) 10-year, 25-year, 50-year, and 100-year)
2. Number of people and properties affected;
3. Life safety, prevent loss of life and minimize property damage;
4. Level of protection provided by plan;
5. Practicality and implementability,
6. Mobility (keeping main arterials open to traffic);
7. Maintaining access to public buildings, especially hospitals, fire and police departments, etc.
8. Environmental considerations (such as 404 permits, stream corridor maintenance);
9. Private-public relationships and funding agreements;
10. Available funding, participation in funding by others (TWDB, Corps, etc.), and;
11. The highest projected benefit-to-cost ratios.
12. Neighborhood Enhancement – Improve aesthetics, livability, and well-being of Grand Prairie citizens/residents;
13. Availability of Right-of-Way/Easements – Minimize disruption to property and structures.

Note: Weighting for each criteria shall be recommended to and approved by the City prior to prioritization of alternatives.

b. Phasing and Implementation - The Study Team will then assist and advise City staff in developing phasing and implementation plans and prioritizing proposed improvement projects for future CIP and related funding.

The goal is to incorporate CIPs from this study into an overall phasing and implementation plan with other drainage-related CIPs throughout the City in various other watersheds. The resulting City of Grand Prairie dataset for CIPs would be completely digital and geo-referenced, with documented spatial data, hydrologic and hydraulic data, and other features for ease of future updates.

10. Short Term Priorities & Long Term Plan

a. Short Term Priorities – Develop strategy for immediate implementation of key alternative improvement projects developed for the Johnson Creek, Arbor Creek, and Barrett Branch Master Plan. Focus on:

i. Cost/benefit ratio of proposed improvements. Weigh the flood control benefits against project costs

ii. Develop Project Improvement Needs & Prioritization List, including small projects (<$200,000), medium projects ($200,000 to $500,000), and larger projects (>$500,000)

b. Long Term Plan – Develop strategy for long term implementation of identified prioritized alternative improvement projects developed for the Johnson Creek, Arbor Creek, and Barrett Branch Master Plan. Focus on:

i. Longer range plans for larger projects, including phasing (if possible). Provide cost breakdown of phasing and time-frame for implementation.

This implementation plan would be coordinated with the future funding plan for the City-wide study.

11. City-wide Drainage Master Plan Documentation

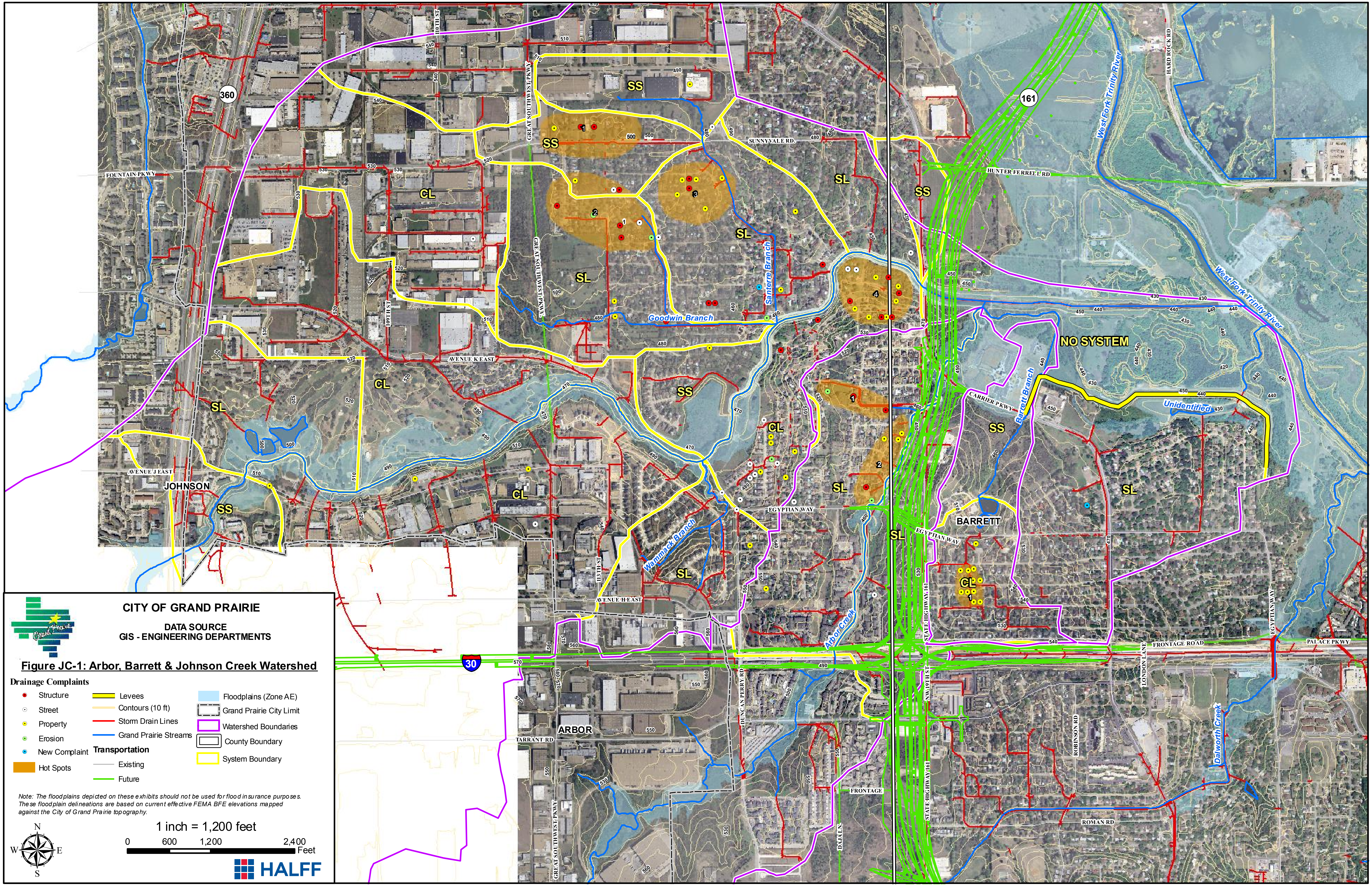
Incorporate Johnson Creek, Arbor Creek, and Barrett Branch Master Plan data into City-wide Drainage Master Plan Documentation.

12. Project Management/Coordination

a. Project Management – Engineer shall provide project status reports, project schedule updates, and perform personnel and data management during course of project. Engineer shall attend a project kickoff meeting, prepare and lead any project status meetings, and prepare meeting minutes of each meeting to submit to the City. Engineer will fully document all hardware, software, file structures, and data formats used during the project.

b. QA/QC – Engineer shall develop a QA/QC procedure to include a multi-level approach to ensure that scope of work components are reviewed and approved.

c. Public Involvement Program: City Council Briefing Session - Develop schedule, set up and conduct a final workshop with the City Council and certain department leaders after study completion. Provide the council with an overview of drainage and flooding issues, study results, and recommendations.



CITY OF GRAND PRAIRIE
DATA SOURCE
GIS - ENGINEERING DEPARTMENTS
Figure JC-1: Arbor, Barrett & Johnson Creek Watershed
Drainage Complaints
Structure
Street
Property
Erosion
New Complaint
Hot Spots
Levees
Contours (10 ft)
Storm Drain Lines
Grand Prairie Streams
Transportation
Existing
Future
Floodplains (Zone AE)
Grand Prairie City Limit
Watershed Boundaries
County Boundary
System Boundary
Note: The floodplains depicted on these exhibits should not be used for flood insurance purposes. These floodplain delineations are based on current effective FEMA BFE elevations mapped against the City of Grand Prairie topography.
1 inch = 1,200 feet
0 600 1,200 2,400 Feet
HALFF
NO SYSTEM
JOHNSON
ARBOR
BARRETT
Goodwin Branch
Santerre Branch
Barrett Branch
Wammack Branch
Arbor Creek
Dalworth Creek
West Fork Trinity River
Unidentified
FOUNTAIN PKWY
SUNNYVALE RD
HUNTER FERRELL RD
AVENUE K EAST
AVENUE J EAST
AVENUE H EAST
EGYPTIAN WAY
CARRIER PKWY
FRONTAGE ROAD
PALACE PKWY
ROMAN RD
TARRANT RD
GREAT SOUTHWEST PKWY
STATE HIGHWAY 161
HARD ROCK RD

APPENDIX H
WEST FORK TRINITY RIVER

WEST FORK TRINITY RIVER MASTER PLAN
SCOPE OF WORK

A. GENERAL DESCRIPTION

The West Fork Trinity River watershed is located north of Interstate Highway 30 and extends northwest past the city limits (Rock Island Road and SH 360). Drainage generally travels from northwest to southeast through storm drain pipes and culverts as well as open channels from Rock Island Road and SH 360 to the eastern city limits and into the City of Dallas.

The West Fork Trinity River (South of Interstate Highway 30) watershed is the section of the West Fork Trinity watershed that is located south of IH 30. Drainage generally travels from south to north through storm drain pipes and culverts as well as open channels from Main Street to IH 30.

B. DRAINAGE COMPLAINT DATABASE

West Fork Trinity River - Twenty-six (26) drainage complaints at eighteen (18) different locations have been filed with the City from 1993 to 2007 within this watershed. Of these complaints, one (1) was an erosion problem, two (2) were street flooding problems, eight (8) were property flooding problems, and fifteen (15) were structure flooding problems.

West Fork Trinity River (South) - Twenty-seven (27) drainage complaints at twenty-three (23) different locations have been filed with the City from 1982 to 2004 within this watershed. Of these complaints, one (1) was an erosion problem, twelve (12) were street flooding problems, ten (10) were property flooding problems, and four (4) were structure flooding problems. No hot spots, based on drainage complaints, were identified for these watersheds.

Note: It is the responsibility of the consultant to obtain the latest information from the City database and evaluate all current drainage complaints at time of study.

Hot Spot Locations:

1. **Sunnyvale and Carrier Parkway**
2. **East of Roy Orr Blvd/South of Shady Grove Road**

C. EXISTING DATA AVAILABLE

- Trinity River Hydraulic Models for FEMA and for NCTCOG (CDC) – USACE (2003)
- Available CLOMR, LOMR, and Study Reports for projects along Trinity River not included in current effective Trinity River Hydraulic Models
- **CURRENT STUDY** – MacArthur Boulevard Feasibility Study (2008)

Note: Existing Data Available will be provided to consultant on a CD or DVD, including PDFs of report/figures and technical data available

D. Scope of Work

1. Data Collection

a. Obtain all available information, including hydrologic & hydraulic models, topographic information, studies, as-built bridge/culvert plans, property information, available LOMRs, etc.

b. Coordinate with the City to obtain additional survey data for pertinent structures and/or locations along the study reach.

2. Hydraulic Studies

a. <u>Develop updated floodplain hydraulic models (CDC & FEMA)</u> – Incorporate all LOMRs into current effective models (both CDC & FEMA) for entire reach within City of Grand Prairie limits. Evaluate as-built plans for all existing bridges and incorporate as-built data into model to correct discrepancies. Field survey areas of discrepancy to ensure accuracy in model and as-built plans. Incorporate new bridge structures into models, such as SH 161 (obtain as-built plans and perform field surveys).

As a separate task, and once models are updated, prepare a conceptual model that incorporates any current CLOMRs or LOMRs/CLOMRs under review by FEMA (at the time of study).

- <u>Erosion/Sedimentation Assessment of Hydraulic Models in study watershed, not including West Fork Trinity River models (for Section 4)</u>
  - Review all models in watershed and provide a summary table of the following:
    - Reaches where high channel velocities exist (erosion) for 10-yr event
    - Reaches where low channel velocities exist (sedimentation) for 10-yr event
    - Location of natural meanders of stream
    - Location of steep natural channel sections (describe average slope between two hard points, such as two culverts, along the channel)
    - Location of all existing TRA aerial crossings (based on field surveys and record drawings) – Describe erosive velocities for all frequency events.
  - Describe any field observations of stream, including locations of downcutting, locations of widening, knickpoints in channel flowline, locations of trees falling into channel, locations of trees with exposed roots, locations of wedge failures along bank, locations of erosion at sanitary sewer aerial crossings, locations of undermining of storm drain outfalls, fences and/or structures close to erosion areas that have potential for failure or damage due to further erosion, etc. (and any other types of erosion that was observed). Include labeled photos, if available.

b. <u>Develop new and updated floodplain mapping</u> – Consolidate, make consistent, update as needed, and provide updated City-wide coverage of the West Fork Trinity River floodplain in Grand Prairie. Updated floodplains will be delineated using digital terrain data from the best available topography and integrated into the City's GIS. The primary goal is to establish ultimate 100-year and SPF floodplain delineations with Base Flood Elevations shown (100-year only), but also additional delineations, including existing 100-year & 500-year and floodway delineations for incorporation into FEMA mapping. <u>Updated data will be incorporated into</u>

FEMA mapping by the LOMR process. GIS shapefiles of floodplain delineations will be provided to the City

LOMR Submittals

- Prepare brief letter report of project purpose, procedures, and results
- Prepare flood elevation tables, floodway data tables, flood profiles (RASPLOT), hydraulic work maps, and revised FEMA FIRM maps.
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- Coordinate with the City of Grand Prairie and FEMA/Technical Reviewer (via telephone and email) to address comments and questions.
- Note: Fees for review of LOMR applications are not included in scope of work

Elevation Certificates

- Identify property locations of structures within updated existing 100-year (1% annual chance) floodplain limits.
- Identify structures on each property that serve as the primary residence or primary use to commercial/industrial sites. For these structures, prepare field surveys of finished flood and lowest adjacent grades around structures.
- All other insurable structures found to be within the limits of the 100-year (1% annual chance) floodplain will be identified and submitted to the City Floodplain Administrator for approval before proceeding with surveying and preparation of the elevation certificate.
- Necessary paperwork for Elevation Certificates will be per current FEMA standards
- Upon completion, prepare overall map of Elevation Certificate locations along the floodplain and submit to City along with completed Elevation Certificates.

c. Roadway Crossings

- Evaluate and tabulate flood frequency capacity of existing roadway crossings for West Fork Trinity River – This information will be utilized to determine if existing roadway crossings need to be improved for 100-year flood protection

- Project Team shall analyze future roadway crossings of existing streams based on City Master Thoroughfare Plan and size crossings for future 100-year flood frequency capacity

d. Alternatives for West Fork Trinity River

- Stream and Open channel alternatives will be evaluated in accordance with:
  - Flood Profile Impacts
  - Valley Storage (downstream impacts)
  - Environmental Quality
  - Channel Stability/Erosion (channel armor and bio-engineering solutions)
  - Bridge/Culvert Improvements
  - Future TRA aerial wastewater crossings
  - Corps Section 404 Permit Requirements
  - Cost (construction, ROW, engineering, operations, and maintenance).
  - Non-structural and structural improvements will be considered in terms of practicality, economics, necessity, impacts to mobility, environmental concerns, etc.

3. Storm Drainage Infrastructure Analysis

- **Overview** - Storm drainage network models will be prepared utilizing a City-wide Storm Water Infrastructure GIS database and existing record plans. It is not anticipated that field surveys will supplement the storm drainage studies. If necessary and approved by the City, field surveys will be conducted to accurately locate drainage infrastructure.
  - i. Analysis of storm drainage pipe networks will focus on all West Fork Trinity River storm water sub-basins as shown in the attached maps (approximate locations are shown for now). Sub-basins are classified as: 1) "Simple system/small basin", 2) "Simple system/large basin", and 3) "Complex system" (small or large basin)
  - ii. Additional **"Hot Spot"** locations have been identified where the existing underground drainage system is inadequate and/or frequent flooding occurs. These "Hot Spot" locations are based on drainage complaints within the watershed.
  - iii. The age of each storm drainage pipe network will be determined utilizing as-built dates from GIS database (if available)
  - iv. Storm water sub-basin delineations will be accurately defined for each storm drain area studied in detail. City GIS data will be utilized.
  - v. Design discharges will be based on current City criteria: For areas less than 200 acres, the rational method will be utilized and for areas greater than 200 acres, unit hydrograph techniques shall be utilized (HEC-HMS shall be model utilized for this determination).
  - vi. For storm drain analysis and recommendations for design improvements, the most recent version of the computer program **StormCAD** shall be used.

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- **City Coordination** - The Project Team will meet with City staff to help confirm and identify problem areas. The updated Storm Water Infrastructure GIS will then be overlaid with property maps to help classify problem areas as "public or private." This data will then be incorporated into the City's Storm Water Infrastructure GIS database. It will include information such as: coordinates (horizontal and vertical location), pipe size, material, and slope.
- **Analysis of Alternatives** - Following completion of the updated existing storm drainage analysis, the Project Team will commence the analyses of alternatives to address documented storm water infrastructure problems, including correction and future prevention. Proposed alternative improvements will be modeled using the previously prepared StormCAD models for existing infrastructure. Analysis of proposed storm water improvements will be conducted to accommodate a designated flood frequency within the proposed storm drain system, existing/proposed drainage easements, and/or existing street R.O.W.

    i. Alternatives for Storm Drains - Storm drain alternatives will be evaluated in accordance with hydraulic grade line (HGL) and energy grade line (EGL), flooding of structures on properties, street flooding, nuisance flooding, age and condition of storm drain system, right-of-way availability, conflicting utilities, and other impacts. The 100-year frequency event will be the design storm. If alternative improvements cannot be developed to adequately contain 100-year event, then the 10-year and 2-year events will be utilized for alternatives. Note: The City of Grand Prairie requires EGL to be 1-foot below top of pavement elevations.

    ii. Innovative Alternatives - Innovative alternatives that incorporate "non-traditional" ideas will be explored and compared with traditional solutions. For example, purchase of existing homes and properties for construction of a regional detention pond to reduce discharges, downstream pipe and culvert sizes, and lower flood profiles might be considered.

    iii. Preliminary Quantities and Estimates of Probable Cost – For selected alternative improvements, the Project Team will prepare preliminary quantities and estimates of probable cost to implement the conceptual plan(s). These estimates of probable cost will be prepared in a digital format (Excel spreadsheets) with pertinent information such as:

1. Date of estimate and Adjustments for inflation
2. Costs for survey, design, ROW & Easement acquisition, utility relocations, construction management, and construction. Note: 25% contingency will be applied to construction cost estimates.

4. Channel Stability Assessment/Erosion Hazard Analysis (for streams in study watershed, not including West Fork Trinity River)

a. Hydraulics
   i. Execute HEC-RAS model with low flow and bank-full flow rates.
   ii. Tabulate and evaluate velocities, energy, and shear stress.
   iii. Confirm results with field observations (channel bends).
b. Geomorphology
   i. Conduct field reconnaissance to identify and obtain:
      1. Channel characteristics,
      2. Photos, and
      3. Identify/confirm problem areas, etc.
   ii. Conduct sedimentation/degradation analysis.
   iii. Review 1999 topography versus 2009 topography to determine potential erosion hazard zones
   iv. Review City standards to determine areas within erosion hazard zones
c. Prepare channel stability assessment/erosion hazard analysis report
d. Evaluate erosive properties of existing TRA aerial wastewater crossings
e. Prepare stream bank restoration improvement alternatives (provide preliminary quantities/estimates of probable cost per Section 8)

5. Dams/Levees/Detention/Drainage Reviews

a. Prepare GIS maps showing locations/descriptions of existing dams, levees, retention and detention areas within the West Fork Trinity River Master Plan area. Include separate layers for private and public detention ponds. Work with City GIS staff on GIS development of these layers.

b. Prepare detailed summary of existing drainage plan reviews prepared by Halff denoting project name, City project number, description of review, and if detention was included in the project

c. Obtain plans containing detention ponds and make field visits to verify detention ponds have been constructed according to as-built plans
   i. Document detention ponds with photos
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a. Help identify, if detected, drainage features that are missing from GIS database or shown/labeled incorrectly in GIS database and report to the City. Update missing information accordingly. Note: This task does not include verification that all existing GIS drainage features are correct or physical field inspection of the entire system to ensure accuracy. The intent is to determine missing features or incorrect features as noticed by the Project Teams

b. Based on as-built plans, identify age of all systems (See Section 3)

c. Identify wetland and riparian areas, utilizing Wetland Inventory Maps and visual inspection

7. Maintenance – West Fork Trinity River Watershed

a. Identify and evaluate types and locations of areas where maintenance needs to occur (storm drain outfalls, inlets, culverts, natural channels, open channels, bridges, etc.) in the West Fork Trinity River Master Plan area. **Obtain City Database on investigation of outfalls in the City.**

b. Storm Drain Outfall Field Assessment – Utilizing the City of Grand Prairie's database of field-checked storm drain outfalls for the entire City, establish criteria to rank outfalls based on necessity to repair, provide preliminary ranking of outfalls needing repair, and provide summary report of rankings for the West Fork Trinity River Master Plan area

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1. Levels of damage and value of homes flooded or endangered;
   a. Develop spreadsheet, to include Lowest Adjacent Grade, BFE, Structure Value, and Level of damage (# homes/damage value ($) for various flooding events, including (if available) 10-year, 25-year, 50-year, and 100-year)
2. Number of people and properties affected;
3. Life safety, prevent loss of life and minimize property damage;
4. Level of protection provided by plan;

5. Practicality and implementability,
6. Mobility (keeping main arterials open to traffic);
7. Maintaining access to public buildings, especially hospitals, fire and police departments, etc.
8. Environmental considerations (such as 404 permits, stream corridor maintenance);
9. Private-public relationships and funding agreements;
10. Available funding, participation in funding by others (TWDB, Corps, etc.), and;
11. The highest projected benefit-to-cost ratios.
12. Neighborhood Enhancement – Improve aesthetics, livability, and well-being of Grand Prairie citizens/residents;
13. Availability of Right-of-Way/Easements – Minimize disruption to property and structures.

Note: Weighting for each criteria shall be recommended to and approved by the City prior to prioritization of alternatives.

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The goal is to incorporate CIPs from this study into an overall phasing and implementation plan with other drainage-related CIPs throughout the City in various other watersheds. The resulting City of Grand Prairie dataset for CIPs would be completely digital and geo-referenced, with documented spatial data, hydrologic and hydraulic data, and other features for ease of future updates.

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a. Short Term Priorities – Develop strategy for immediate implementation of key alternative improvement projects developed for the West Fork Trinity River Master Plan. Focus on:

i. Cost/benefit ratio of proposed improvements. Weigh the flood control benefits against project costs
ii. Develop Project Improvement Needs & Prioritization List, including small projects (<$200,000), medium projects ($200,000 to $500,000), and larger projects (>$500,000)

b. Long Term Plan – Develop strategy for long term implementation of identified prioritized alternative improvement projects developed for the West Fork Trinity River Master Plan. Focus on:

i. Longer range plans for larger projects, including phasing (if possible). Provide cost breakdown of phasing and time-frame for implementation.

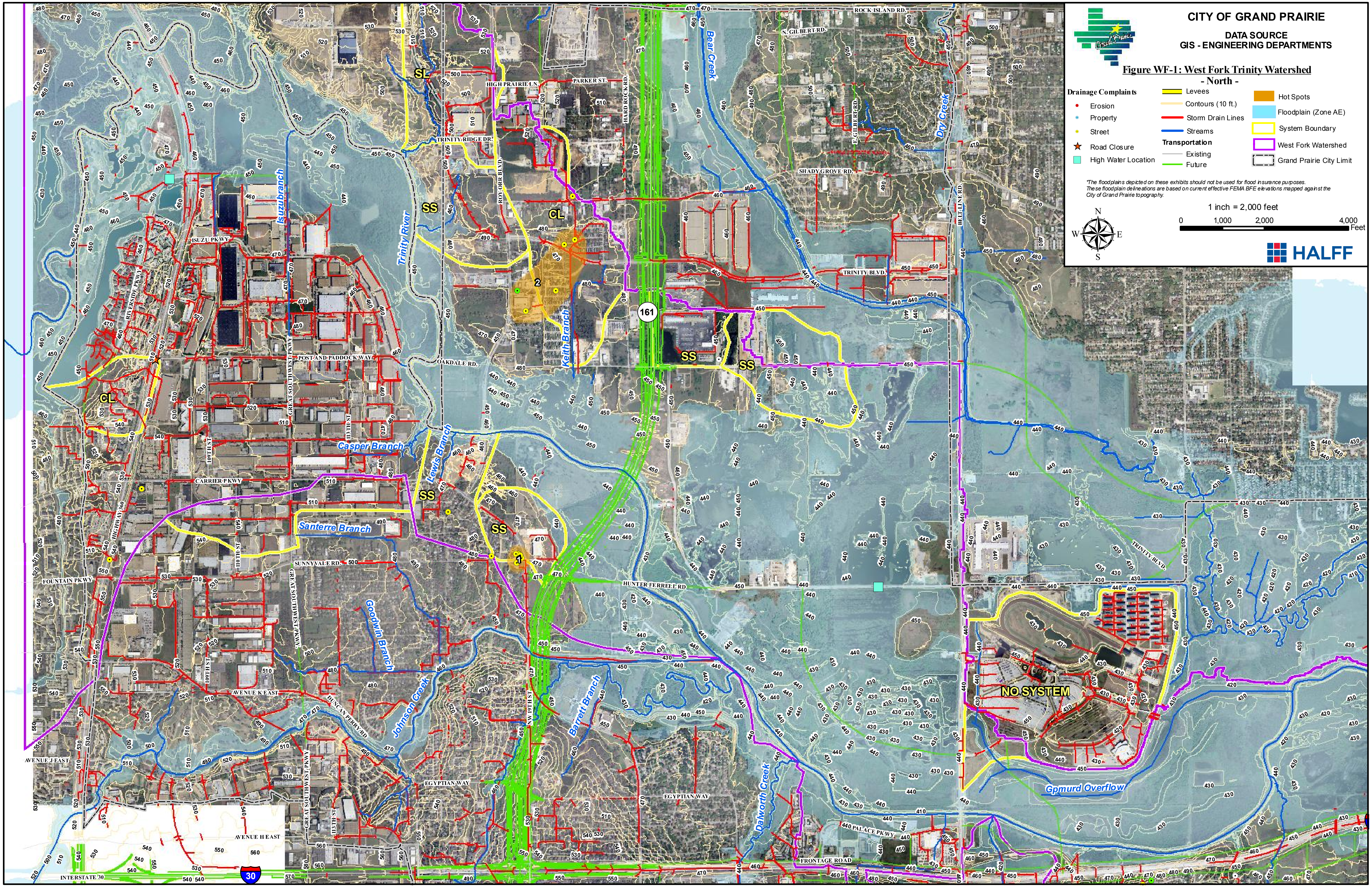
This implementation plan would be coordinated with the future funding plan for the City-wide study.

11. City-wide Drainage Master Plan Documentation

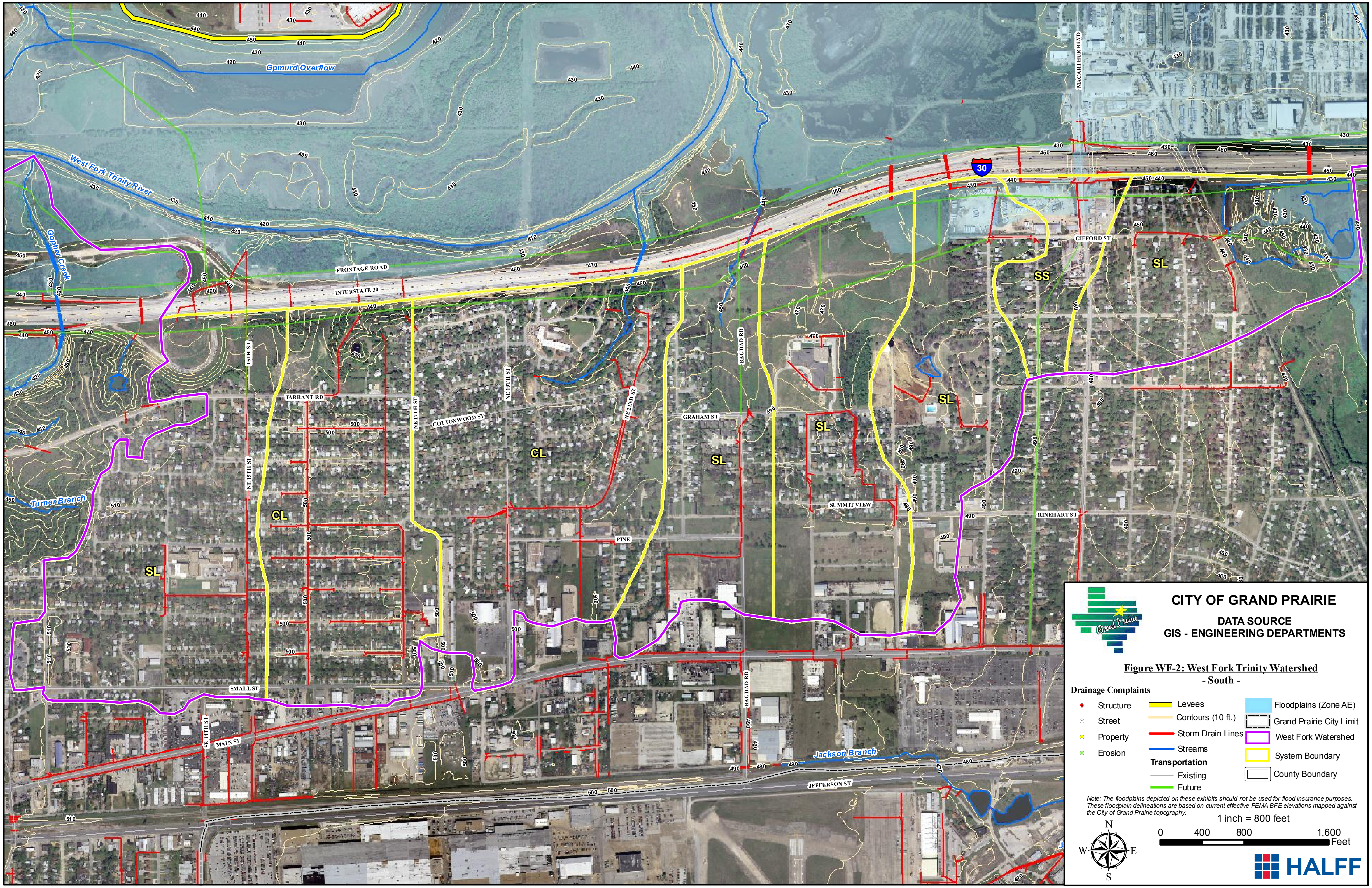
Incorporate West Fork Trinity River Master Plan data into City-wide Drainage Master Plan Documentation.

12. Project Management/Coordination

- **a.** Project Management – Engineer shall provide project status reports, project schedule updates, and perform personnel and data management during course of project. Engineer shall attend a project kickoff meeting, prepare and lead any project status meetings, and prepare meeting minutes of each meeting to submit to the City. Engineer will fully document all hardware, software, file structures, and data formats used during the project.
- **b.** QA/QC – Engineer shall develop a QA/QC procedure to include a multi-level approach to ensure that scope of work components are reviewed and approved.
- **c.** Public Involvement Program: City Council Briefing Session - Develop schedule, set up and conduct a final workshop with the City Council and certain department leaders after study completion. Provide the council with an overview of drainage and flooding issues, study results, and recommendations.



CITY OF GRAND PRAIRIE
DATA SOURCE
GIS - ENGINEERING DEPARTMENTS
Figure WF-1: West Fork Trinity Watershed
- North -
Drainage Complaints
Erosion
Property
Street
Road Closure
High Water Location
Levees
Contours (10 ft.)
Storm Drain Lines
Streams
Transportation
Existing
Future
Hot Spots
Floodplain (Zone AE)
System Boundary
West Fork Watershed
Grand Prairie City Limit
*The floodplains depicted on these exhibits should not be used for flood insurance purposes.
These floodplain delineations are based on current effective FEMA BFE elevations mapped against the City of Grand Prairie topography.
1 inch = 2,000 feet
0
1,000
2,000
4,000
Feet
N
S
E
W
HALFF
Trinity River
Bear Creek
Dry Creek
Isuzu Branch
Keith Branch
Casper Branch
Lewis Branch
Santerre Branch
Goodwin Branch
Johnson Creek
Barrett Branch
Dalworth Creek
Gpmurd Overflow
SS
SL
CL
NO SYSTEM
161
30
ROCK ISLAND RD
N. GILBERT RD.
HIGH PRAIRIE LN.
PARKER ST.
TRINITY RIDGE DR.
SHADY GROVE RD.
TRINITY BLVD.
ISUZU PKWY
POST AND PADDOCK WAY
OAKDALE RD.
CARRIER PKWY
SUNNYVALE RD.
FOUNTAIN PKWY
HUNTER FERRELL RD.
AVENUE K EAST
AVENUE J EAST
AVENUE H EAST
EGYPTIAN WAY
PALACE PKWY
FRONTAGE ROAD
INTERSTATE 30



CITY OF GRAND PRAIRIE
DATA SOURCE
GIS - ENGINEERING DEPARTMENTS
Figure WF-2: West Fork Trinity Watershed
- South -
Drainage Complaints
Structure
Street
Property
Erosion
Levees
Contours (10 ft.)
Storm Drain Lines
Streams
Transportation
Existing
Future
Floodplains (Zone AE)
Grand Prairie City Limit
West Fork Watershed
System Boundary
County Boundary
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1 inch = 800 feet
0
400
800
1,600
Feet
N
W
E
S
HALFF
Gpmurd Overflow
West Fork Trinity River
Gopher Creek
Turner Branch
Jackson Branch
FRONTAGE ROAD
INTERSTATE 30
30
MACARTHUR BLVD
GIFFORD ST
TARRANT RD
COTTONWOOD ST
GRAHAM ST
SUMMIT VIEW
RINEHART ST
PINE
SMALL ST
MAIN ST
JEFFERSON ST
BAGDAD RD
NE 15TH ST
NE 17TH ST
NE 19TH ST
NE 22ND ST
SE 14TH ST
SL
SS
CL

APPENDIX I
MOUNTAIN CREEK

WEST FORK TRINITY RIVER MASTER PLAN
SCOPE OF WORK

A. GENERAL DESCRIPTION

The West Fork Trinity River watershed is located north of Interstate Highway 30 and extends northwest past the city limits (Rock Island Road and SH 360). Drainage generally travels from northwest to southeast through storm drain pipes and culverts as well as open channels from Rock Island Road and SH 360 to the eastern city limits and into the City of Dallas.

The West Fork Trinity River (South of Interstate Highway 30) watershed is the section of the West Fork Trinity watershed that is located south of IH 30. Drainage generally travels from south to north through storm drain pipes and culverts as well as open channels from Main Street to IH 30.

B. DRAINAGE COMPLAINT DATABASE

West Fork Trinity River - Twenty-six (26) drainage complaints at eighteen (18) different locations have been filed with the City from 1993 to 2007 within this watershed. Of these complaints, one (1) was an erosion problem, two (2) were street flooding problems, eight (8) were property flooding problems, and fifteen (15) were structure flooding problems.

West Fork Trinity River (South) - Twenty-seven (27) drainage complaints at twenty-three (23) different locations have been filed with the City from 1982 to 2004 within this watershed. Of these complaints, one (1) was an erosion problem, twelve (12) were street flooding problems, ten (10) were property flooding problems, and four (4) were structure flooding problems. No hot spots, based on drainage complaints, were identified for these watersheds.

<u>**Note: It is the responsibility of the consultant to obtain the latest information from the City database and evaluate all current drainage complaints at time of study**</u>**.**

<u>Hot Spot Locations</u>:

1. **Sunnyvale and Carrier Parkway**
2. **East of Roy Orr Blvd/South of Shady Grove Road**

C. EXISTING DATA AVAILABLE

- Trinity River Hydraulic Models for FEMA and for NCTCOG (CDC) – USACE (2003)
- Available CLOMR, LOMR, and Study Reports for projects along Trinity River not included in current effective Trinity River Hydraulic Models
- <u>**CURRENT STUDY**</u> – MacArthur Boulevard Feasibility Study (2008)

<u>Note: Existing Data Available will be provided to consultant on a CD or DVD, including PDFs of report/figures and technical data available</u>

D. Scope of Work

1. Data Collection

a. Obtain all available information, including hydrologic & hydraulic models, topographic information, studies, as-built bridge/culvert plans, property information, available LOMRs, etc.

b. Coordinate with the City to obtain additional survey data for pertinent structures and/or locations along the study reach.

2. Hydraulic Studies

a. <u>Develop updated floodplain hydraulic models (CDC & FEMA)</u> – Incorporate all LOMRs into current effective models (both CDC & FEMA) for entire reach within City of Grand Prairie limits. Evaluate as-built plans for all existing bridges and incorporate as-built data into model to correct discrepancies. Field survey areas of discrepancy to ensure accuracy in model and as-built plans. Incorporate new bridge structures into models, such as SH 161 (obtain as-built plans and perform field surveys).

As a separate task, and once models are updated, prepare a conceptual model that incorporates any current CLOMRs or LOMRs/CLOMRs under review by FEMA (at the time of study).

- <u>Erosion/Sedimentation Assessment of Hydraulic Models in study watershed, not including West Fork Trinity River models (for Section 4)</u>
  - Review all models in watershed and provide a summary table of the following:
    - Reaches where high channel velocities exist (erosion) for 10-yr event
    - Reaches where low channel velocities exist (sedimentation) for 10-yr event
    - Location of natural meanders of stream
    - Location of steep natural channel sections (describe average slope between two hard points, such as two culverts, along the channel)
    - Location of all existing TRA aerial crossings (based on field surveys and record drawings) – Describe erosive velocities for all frequency events.
  - Describe any field observations of stream, including locations of downcutting, locations of widening, knickpoints in channel flowline, locations of trees falling into channel, locations of trees with exposed roots, locations of wedge failures along bank, locations of erosion at sanitary sewer aerial crossings, locations of undermining of storm drain outfalls, fences and/or structures close to erosion areas that have potential for failure or damage due to further erosion, etc. (and any other types of erosion that was observed). Include labeled photos, if available.

b. <u>Develop new and updated floodplain mapping</u> – Consolidate, make consistent, update as needed, and provide updated City-wide coverage of the West Fork Trinity River floodplain in Grand Prairie. Updated floodplains will be delineated using digital terrain data from the best available topography and integrated into the City's GIS. The primary goal is to establish ultimate 100-year and SPF floodplain delineations with Base Flood Elevations shown (100-year only), but also additional delineations, including existing 100-year & 500-year and floodway delineations for incorporation into FEMA mapping. <u>Updated data will be incorporated into</u>

FEMA mapping by the LOMR process. GIS shapefiles of floodplain delineations will be provided to the City

LOMR Submittals

- Prepare brief letter report of project purpose, procedures, and results
- Prepare flood elevation tables, floodway data tables, flood profiles (RASPLOT), hydraulic work maps, and revised FEMA FIRM maps.
- Prepare necessary MT-2 application/certificate forms including:
    - Form 1 – Overview and Concurrence
    - Form 2 – Riverine Hydrology & Hydraulics
    - Form 3 – Riverine Structures (including photos, as-built plans, and survey information)
- Deliver two (2) copies of the Final LOMR Report to the City of Grand Prairie
- Work with City staff on submittal to FEMA
- Export electronic files (HEC-RAS, Word, CADD, GIS, and PDF) to CD and submit to City of Grand Prairie
- Prepare templates and tabulate information for public notification, including individual property owner notification and public notice for floodway revision. The City of Grand Prairie will distribute all public notifications to individual property owners and post the public notice. Note: If properties are affected by revised floodplain elevations, engineer shall survey finished floor elevations (lowest adjacent grade) of all structures in the revised floodplain limits.
- Coordinate with the City of Grand Prairie and FEMA/Technical Reviewer (via telephone and email) to address comments and questions.
- Note: Fees for review of LOMR applications are not included in scope of work

Elevation Certificates

- Identify property locations of structures within updated existing 100-year (1% annual chance) floodplain limits.
- Identify structures on each property that serve as the primary residence or primary use to commercial/industrial sites. For these structures, prepare field surveys of finished flood and lowest adjacent grades around structures.
- All other insurable structures found to be within the limits of the 100-year (1% annual chance) floodplain will be identified and submitted to the City Floodplain Administrator for approval before proceeding with surveying and preparation of the elevation certificate.
- Necessary paperwork for Elevation Certificates will be per current FEMA standards
- Upon completion, prepare overall map of Elevation Certificates locations along the floodplain and submit to City along with completed Elevation Certificates.

c. Roadway Crossings

- Evaluate and tabulate flood frequency capacity of existing roadway crossings for West Fork Trinity River – This information will be utilized to determine if existing roadway crossings need to be improved for 100-year flood protection

- Project Team shall analyze future roadway crossings of existing streams based on City Master Thoroughfare Plan and size crossings for future 100-year flood frequency capacity

d. Alternatives for West Fork Trinity River

- Stream and Open channel alternatives will be evaluated in accordance with:
  - Flood Profile Impacts
  - Valley Storage (downstream impacts)
  - Environmental Quality
  - Channel Stability/Erosion (channel armor and bio-engineering solutions)
  - Bridge/Culvert Improvements
  - Future TRA aerial wastewater crossings
  - Corps Section 404 Permit Requirements
  - Cost (construction, ROW, engineering, operations, and maintenance).
  - Non-structural and structural improvements will be considered in terms of practicality, economics, necessity, impacts to mobility, environmental concerns, etc.

3. Storm Drainage Infrastructure Analysis

- **Overview -** Storm drainage network models will be prepared utilizing a City-wide Storm Water Infrastructure GIS database and existing record plans. It is not anticipated that field surveys will supplement the storm drainage studies. If necessary and approved by the City, field surveys will be conducted to accurately locate drainage infrastructure.
  - i. Analysis of storm drainage pipe networks will focus on all West Fork Trinity River storm water sub-basins as shown in the attached maps (approximate locations are shown for now). Sub-basins are classified as: 1) "Simple system/small basin", 2) "Simple system/large basin", and 3) "Complex system" (small or large basin)
  - ii. Additional **"Hot Spot"** locations have been identified where the existing underground drainage system is inadequate and/or frequent flooding occurs. These "Hot Spot" locations are based on drainage complaints within the watershed.
  - iii. The age of each storm drainage pipe network will be determined utilizing as-built dates from GIS database (if available)
  - iv. Storm water sub-basin delineations will be accurately defined for each storm drain area studied in detail. City GIS data will be utilized.
  - v. Design discharges will be based on current City criteria: For areas less than 200 acres, the rational method will be utilized and for areas greater than 200 acres, unit hydrograph techniques shall be utilized (HEC-HMS shall be model utilized for this determination).
  - vi. For storm drain analysis and recommendations for design improvements, the most recent version of the computer program **StormCAD** shall be used.

- **<u>Existing Capacity Analysis</u>** - The capacity of existing streets and underground storm drainage pipe networks, along with flood frequency that the system can contain, will be computed, as best that can be determined using StormCAD. The results of the storm drainage system analysis will be documented and incorporated into the City's Storm Water Infrastructure GIS database. For this task, Project Team will use StormCAD to model the "trunk" line(s) of the primary system or systems in the previously defined storm water sub-basin. It is the Project Team's responsibility to define the limits of the "trunk" line(s) for each sub-basin and determine if additional lateral lines (draining 20% or more of the basin) need to be modeled.
- **<u>Optimization Analysis</u>** - An attempt to "optimize" existing storm drainage systems will be included in the analysis. Determine where added inlets or detention, at critical points along the system, will ensure that it is optimized for the lower (as well as the higher) frequency floods. These would be categorized as "smaller projects" for the City to designate and prioritize.
- **<u>City Coordination</u>** - The Project Team will meet with City staff to help confirm and identify problem areas. The updated Storm Water Infrastructure GIS will then be overlaid with property maps to help classify problem areas as "public or private." This data will then be incorporated into the City's Storm Water Infrastructure GIS database. It will include information such as: coordinates (horizontal and vertical location), pipe size, material, and slope.
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ii. Develop Project Improvement Needs & Prioritization List, including small projects (<$200,000), medium projects ($200,000 to $500,000), and larger projects (>$500,000)

b. Long Term Plan – Develop strategy for long term implementation of identified prioritized alternative improvement projects developed for the West Fork Trinity River Master Plan. Focus on:

i. Longer range plans for larger projects, including phasing (if possible). Provide cost breakdown of phasing and time-frame for implementation.

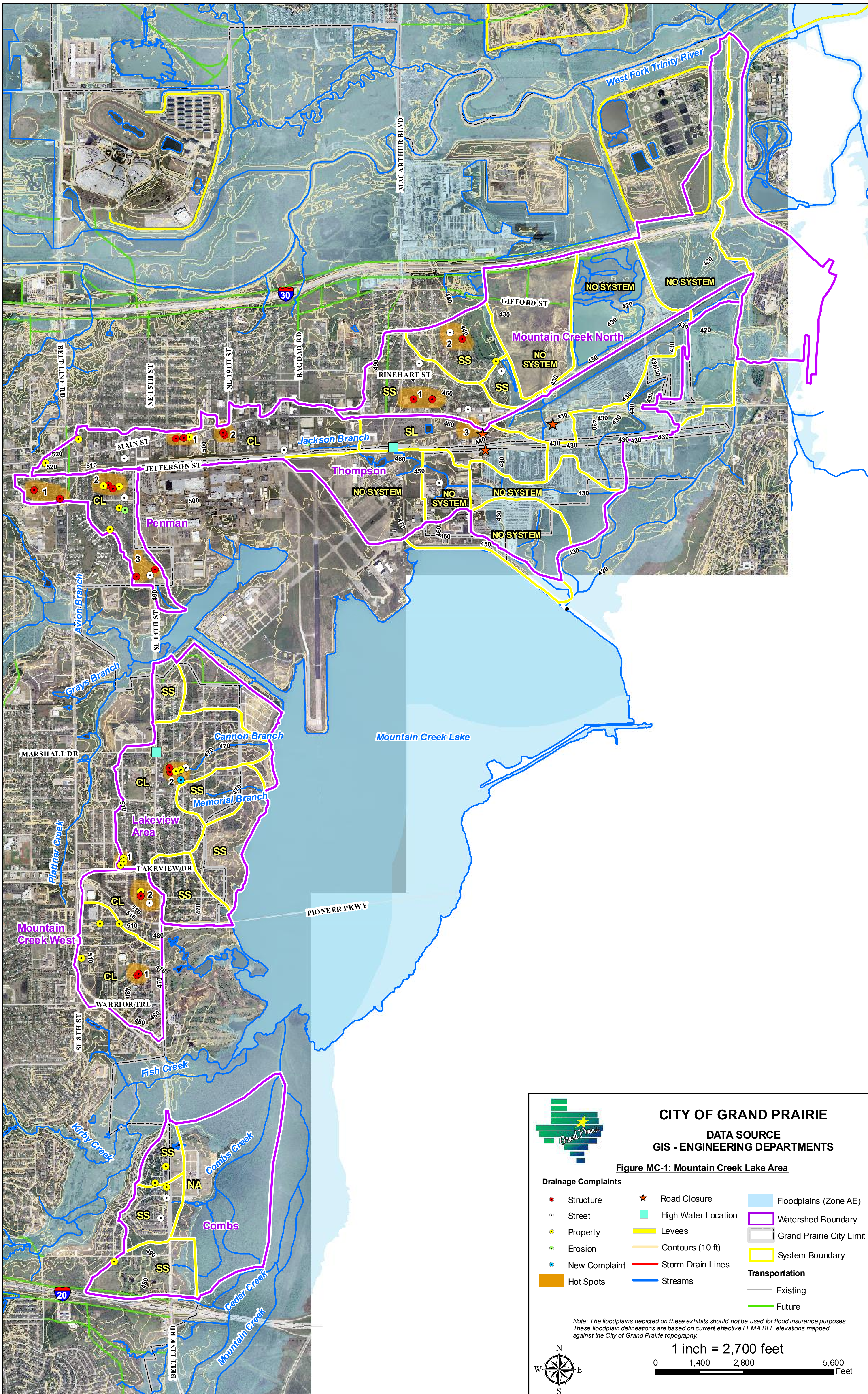
This implementation plan would be coordinated with the future funding plan for the City-wide study.

11. City-wide Drainage Master Plan Documentation

Incorporate West Fork Trinity River Master Plan data into City-wide Drainage Master Plan Documentation.

12. Project Management/Coordination

- **a.** Project Management – Engineer shall provide project status reports, project schedule updates, and perform personnel and data management during course of project. Engineer shall attend a project kickoff meeting, prepare and lead any project status meetings, and prepare meeting minutes of each meeting to submit to the City. Engineer will fully document all hardware, software, file structures, and data formats used during the project.
- **b.** QA/QC – Engineer shall develop a QA/QC procedure to include a multi-level approach to ensure that scope of work components are reviewed and approved.
- **c.** Public Involvement Program: City Council Briefing Session - Develop schedule, set up and conduct a final workshop with the City Council and certain department leaders after study completion. Provide the council with an overview of drainage and flooding issues, study results, and recommendations.


CITY OF GRAND PRAIRIE
DATA SOURCE
GIS - ENGINEERING DEPARTMENTS
Figure MC-1: Mountain Creek Lake Area
Drainage Complaints
Structure
Street
Property
Erosion
New Complaint
Hot Spots
Road Closure
High Water Location
Levees
Contours (10 ft)
Storm Drain Lines
Streams
Floodplains (Zone AE)
Watershed Boundary
Grand Prairie City Limit
System Boundary
Transportation
Existing
Future
Note: The floodplains depicted on these exhibits should not be used for flood insurance purposes. These floodplain delineations are based on current effective FEMA BFE elevations mapped against the City of Grand Prairie topography.
1 inch = 2,700 feet
0
1,400
2,800
5,600
Feet
N
S
E
W
West Fork Trinity River
Mountain Creek North
Mountain Creek Lake
Jackson Branch
Thompson
Penman
Lakeview Area
Mountain Creek West
Combs
Cannon Branch
Memorial Branch
Avion Branch
Grays Branch
Plattner Creek
Fish Creek
Kirby Creek
Combs Creek
Cedar Creek
Mountain Creek
NO SYSTEM
SS
SL
CL
NA
GIFFORD ST
RINEHART ST
MAIN ST
JEFFERSON ST
MACARTHUR BLVD
BAGDAD RD
NE 19TH ST
NE 15TH ST
BELT LINE RD
SE 14TH ST
MARSHALL DR
LAKEVIEW DR
WARRIOR TRL
SE 8TH ST
PIONEER PKWY
30
20

APPENDIX J
DALWORTH CREEK

DALWORTH CREEK MASTER PLAN
SCOPE OF WORK

A. GENERAL DESCRIPTION

The Dalworth Creek watershed is located east of Great Southwest Parkway, north of Jefferson Street, west of 2nd Street, and south of IH-30. Drainage generally travels from southwest to northeast through storm drain pipes and culverts and open channels from Jefferson Street to north of IH 30 and into the West Fork Trinity River.

B. DRAINAGE COMPLAINT DATABASE

Attachment B includes the Dalworth Creek drainage complaint database. Eighty-six (86) drainage complaints at seventy-seven (77) different locations have been filed with the City from 1976 to 2004 within this watershed. Of these complaints, six (6) were erosion problems, fifteen (15) were street flooding problems, fifty-three (53) were property flooding problems, and twelve (12) were structure flooding problems. One complaint has been filed since November 2006 (Intersection of Austrian Way and NW 7th Street). **Note: It is the responsibility of the consultant to obtain the latest information from the City database and evaluate all current drainage complaints at time of study.**

Hot Spot Locations:

1. **May Lane and NW 23rd Street**
2. **Denmark Drive** (south of Tarrant Road)
3. **Halifax Drive** (south of Tarrant Road)
4. **Capetown Drive and Roman Road** (west of Carrier Pkwy)
5. **Jefferson Street** (east of Carrier)
6. **Carrier Parkway** (potentially)

C. EXISTING DATA AVAILABLE

- Dalworth Creek Master Drainage Plan – Halff Associates (Nov. 1996)
  - The purpose of this study was to develop detailed hydrologic and hydraulic models of Dalworth Creek watershed to analyze existing and future flood problems. Several alternatives were analyzed including:
    - Detention ponds
    - U-Shaped concrete-lined channel with bridge improvements at Blackburn Drive
    - U-Shaped concrete-lined channel from Carrier Parkway to Blackburn Drive
    - Storm drainage improvements under Safari Blvd., W. Tarrant Rd., and N.W. 7th St.
- Dalworth Creek Phase I - Feasibility Study – Halff Associates (Jan. 2003)
  - This study analyzed existing channel conditions and two alternate conditions and prepared cost estimates for each. Results are preliminary.
- Dalworth Creek LOMR – Halff Associates (Feb. 2007)
  - The purpose of this study was to create a new existing conditions model to reflect recent channel and culvert improvements to the main channel including:
    - Keith Heights Channel Improvements
    - I-30 Culvert Improvements

Note: Existing Data Available will be provided to consultant on a CD or DVD, including PDFs of report/figures and technical data available

D. Unique Attributes of Dalworth Creek

- Recent Keith Heights Improvements between Carrier Parkway and Blackburn Drive.
- Recent TxDOT improvements to the Dalworth Creek channel at 7th Street and IH-30.
- Future SH 161 crosses Dalworth Creek near NW 19th Street
- Dalworth Creek LOMR maps new FEMA floodplain up to NW 14th Street
- 486-foot long multiple box culvert upstream of Carrier Parkway with "grass" top
- Detention/Retention Areas – N/A

E. Scope of Work

1. Data Collection

a. Obtain all available information, including hydrologic & hydraulic models, topographic information, studies, as-built bridge/culvert plans, property information, available LOMRs, etc.

b. Coordinate with the City to obtain additional survey data for pertinent structures and/or locations along the study reach.

2. Hydrologic & Hydraulic Studies - Streams and Open Channel

a. Develop new and/or updated hydrologic models - New HEC-HMS models will be developed (or updated as necessary), replacing any currently effective NUDALLAS and HEC-1 models. Analysis will include existing and future land-use conditions. Any new hydrologic models will be prepared with H&H modeling tools (Geo-HMS), procedures, and GIS tools. A frequency analysis of the existing 2-, 5-, 10-, 25-, 50-, 100-, and 500-year floods and ultimate 100-year flood will be made, at a minimum. Engineer shall utilize current Drainage Criteria Manual information for hydrologic parameters. Modified Puls shall be the methodology used for routing.

b. Develop new and/or updated floodplain hydraulic models – HEC-RAS models will be developed (or updated as necessary), replacing any currently effective HEC-2 models. Any new hydraulic models will be prepared with H&H modeling tools (Geo-RAS), procedures, and GIS tools. As needed, new structures, bridges/culverts, channelization, channel cross-sections, aerial crossings and ponds will be field surveyed and incorporated into the updated H&H analyses. Floodway analyses will be performed, as necessary, for Zone AE streams. Prepare rating curves for City rain & stream gauges along Dalworth Creek.

- Erosion/Sedimentation Assessment of Hydraulic Models (for Section 4)
  - Review all models in watershed and provide a summary table of the following:
    - Reaches where high channel velocities exist (erosion) for 10-yr event
    - Reaches where low channel velocities exist (sedimentation) for 10-yr event

- Location of natural meanders of stream
- Location of steep natural channel sections (describe average slope between two hard points, such as two culverts, along the channel)
- Location of all existing TRA aerial crossings (based on field surveys and record drawings) – Describe erosive velocities for all frequency events.

  - Describe any field observations of stream, including locations of downcutting, locations of widening, knickpoints in channel flowline, locations of trees falling into channel, locations of trees with exposed roots, locations of wedge failures, locations of erosion at sanitary sewer aerial crossings, locations of undermining of storm drain outfalls, fences and/or structures close to erosion areas that have potential for failure or damage due to further erosion, etc. (and any other types of erosion that was observed). Include labeled photos, if available.

c. Develop new and updated floodplain mapping – Consolidate, make consistent, update as needed, and provide updated City-wide coverage of the Dalworth Creek floodplain in Grand Prairie. Updated floodplains will be delineated using digital terrain data from the best available topography and integrated into the City's GIS. The primary goal is to establish ultimate 100-year floodplain delineations with Base Flood Elevations shown, but also additional delineations, including existing 100-year & 500-year and floodway delineations for incorporation into FEMA mapping. Updated data will be incorporated into FEMA mapping by the LOMR process (Dallas County). GIS shapefiles of floodplain delineations will be provided to the City

LOMR Submittals

- Prepare brief letter report of project purpose, procedures, and results
- Prepare flood elevation tables, floodway data tables, flood profiles (RASPLOT), hydraulic work maps, and revised FEMA FIRM maps.
- Prepare necessary MT-2 application/certificate forms including:
  - Form 1 – Overview and Concurrence
  - Form 2 – Riverine Hydrology & Hydraulics
  - Form 3 – Riverine Structures (including photos, as-built plans, and survey information)
- Deliver two (2) copies of the Final LOMR Report to the City of Grand Prairie
- Work with City staff on submittal to FEMA
- Export electronic files (HEC-RAS, Word, CADD, GIS, and PDF) to CD and submit to City of Grand Prairie
- Prepare templates and tabulate information for public notification, including individual property owner notification and public notice for floodway revision. The City of Grand Prairie will distribute all public notifications to individual property owners and post the public notice. Note: If properties are affected by revised floodplain elevations, engineer shall survey finished floor elevations (lowest adjacent grade) of all structures in the revised floodplain limits.
- Coordinate with the City of Grand Prairie and FEMA/Technical Reviewer (via telephone and email) to address comments and questions.
- Note: Fees for review of LOMR applications are not included in scope of work

Elevation Certificates

- Identify property locations of structures within updated existing 100-year (1% annual chance) floodplain limits.

- Identify structures on each property that serve as the primary residence or primary use to commercial/industrial sites. For these structures, prepare field surveys of finished flood and lowest adjacent grades around structures.
- All other insurable structures found to be within the limits of the 100-year (1% annual chance) floodplain will be identified and submitted to the City Floodplain Administrator for approval before proceeding with surveying and preparation of the elevation certificate.
- Necessary paperwork for Elevation Certificates will be per current FEMA standards
- Upon completion, prepare overall map of Elevation Certificate locations along the floodplain and submit to City along with completed Elevation Certificates.

e. Roadway Crossings

- Evaluate and tabulate flood frequency capacity of existing roadway crossings for Dalworth Creek – This information will be utilized to determine if existing roadway crossings need to be improved for 100-year flood protection
- Project Team shall analyze future roadway crossings of existing streams based on City Master Thoroughfare Plan and size crossings for future 100-year flood frequency capacity

f. Alternatives for Streams and Open Channels

- Stream and Open channel alternatives will be evaluated in accordance with:
  - Flood Profile Impacts
  - Valley Storage (downstream impacts)
  - Environmental Quality
  - Channel Stability/Erosion (channel armor and bio-engineering solutions)
  - Bridge/Culvert Improvements
  - Future TRA aerial wastewater crossings
  - Corps Section 404 Permit Requirements
  - Cost (construction, ROW, engineering, operations, and maintenance).
  - Non-structural and structural improvements will be considered in terms of practicality, economics, necessity, impacts to mobility, environmental concerns, etc.

3. Storm Drainage Infrastructure Analysis

- **Overview -** Storm drainage network models will be prepared utilizing a City-wide Storm Water Infrastructure GIS database and existing record plans. It is not anticipated that field surveys will supplement the storm drainage studies. If necessary and approved by the City, field surveys will be conducted to accurately locate drainage infrastructure.
  i. Analysis of storm drainage pipe networks will focus on all Dalworth Creek storm water sub-basins as shown in the attached map (approximate locations are shown for now). Sub-basins are classified as: 1) “Simple system/small basin”, 2) “Simple system/large basin”, and 3) “Complex system” (small or large basin)

ii. Additional **"Hot Spot"** locations have been identified where the existing underground drainage system is inadequate and/or frequent flooding occurs. These "Hot Spot" locations are based on drainage complaints within the watershed.

iii. The age of each storm drainage pipe network will be determined utilizing as-built dates from GIS database (if available)

iv. Storm water sub-basin delineations will be accurately defined for each storm drain area studied in detail. City GIS data will be utilized.

v. Design discharges will be based on current City criteria: For areas less than 200 acres, the rational method will be utilized and for areas greater than 200 acres, unit hydrograph techniques shall be utilized (HEC-HMS shall be model utilized for this determination).

vi. For storm drain analysis and recommendations for design improvements, the most recent version of the computer program **StormCAD** shall be used.

- **Existing Capacity Analysis** - The capacity of existing streets and underground storm drainage pipe networks, along with flood frequency that the system can contain, will be computed, as best that can be determined using StormCAD. The results of the storm drainage system analysis will be documented and incorporated into the City's Storm Water Infrastructure GIS database. For this task, Project Team will use StormCAD to model the "trunk" line (s) of the primary system or systems in the previously defined storm water sub-basin. It is the Project Team's responsibility to define the limits of the "trunk" line(s) for each sub-basin and determine if additional lateral lines (draining 20% or more of the basin) need to be modeled.
- **Optimization Analysis** - An attempt to "optimize" existing storm drainage systems will be included in the analysis. Determine where added inlets or detention, at critical points along the system, will ensure that it is optimized for the lower (as well as the higher) frequency floods. These would be categorized as "smaller projects" for the City to designate and prioritize.
- **City Coordination** - The Project Team will meet with City staff to help confirm and identify problem areas. The updated Storm Water Infrastructure GIS will then be overlaid with property maps to help classify problem areas as "public or private." This data will then be incorporated into the City's Storm Water Infrastructure GIS database. It will include information such as: coordinates (horizontal and vertical location), pipe size, material, and slope.
- **Analysis of Alternatives** - Following completion of the updated existing storm drainage analysis, the Project Team will commence the analyses of alternatives to address documented storm water infrastructure problems, including correction and future prevention. Proposed alternative improvements will be modeled using the previously prepared StormCAD models for existing infrastructure. Analysis of proposed storm water improvements will be conducted to accommodate a designated flood frequency within the proposed storm drain system, existing/proposed drainage easements, and/or existing street R.O.W.

i. Alternatives for Storm Drains - Storm drain alternatives will be evaluated in accordance with hydraulic grade line (HGL) and energy grade line (EGL), flooding of structures on properties, street flooding, nuisance flooding, age and condition of storm drain system, right-of-way availability, conflicting utilities, and other impacts. The 100-year frequency event will be the design storm. If alternative improvements cannot be developed to adequately contain 100-year event, then the 10-year and 2-year events will be utilized for alternatives. Note: The City of Grand Prairie requires EGL to be 1-foot below top of pavement elevations.

ii. Innovative Alternatives - Innovative alternatives that incorporate "non-traditional" ideas will be explored and compared with traditional solutions. For example, purchase of existing homes and properties for construction of a regional detention pond to reduce discharges, downstream pipe and culvert sizes, and lower flood profiles might be considered.

iii. Preliminary Quantities and Estimates of Probable Cost – For selected alternative improvements, the Project Team will prepare preliminary quantities and estimates of probable cost to implement the conceptual plan(s). These estimates of probable cost will be prepared in a digital format (Excel spreadsheets) with pertinent information such as:
   1. Date of estimate and Adjustments for inflation
   2. Costs for survey, design, ROW & Easement acquisition, utility relocations, construction management, and construction. Note: 25% contingency will be applied to construction cost estimates.

4. Channel Stability Assessment/Erosion Hazard Analysis

a. Hydraulics
   i. Execute HEC-RAS model with low flow and bank-full flow rates.
   ii. Tabulate and evaluate velocities, energy, and shear stress.
   iii. Confirm results with field observations (channel bends).

b. Geomorphology
   i. Conduct field reconnaissance to identify and obtain:
      1. Channel characteristics,
      2. Photos, and
      3. Identify/confirm problem areas, etc.
   ii. Conduct sedimentation/degradation analysis.
   iii. Review 1999 topography versus 2009 topography to determine potential erosion hazard zones
   iv. Review City standards to determine areas within erosion hazard zones

c. Prepare channel stability assessment/erosion hazard analysis report

d. Evaluate erosive properties of existing TRA aerial wastewater crossings

e. Prepare stream bank restoration improvement alternatives (provide preliminary quantities/estimates of probable cost per Section 8)

5. Dams/Levees/Detention/Drainage Reviews

a. Prepare GIS maps showing locations/descriptions of existing dams, levees, retention and detention areas within the Dalworth Creek Master Plan area. Include separate layers for private and public detention ponds. Work with City GIS staff on GIS development of these layers.

b. Prepare detailed summary of existing drainage plan reviews prepared by Halff denoting project name, City project number, description of review, and if detention was included in the project

c. Obtain plans containing detention ponds and make field visits to verify detention ponds have been constructed according to as-built plans
   i. Document detention ponds with photos
   ii. Describe any problems associated with detention ponds (maintenance issues, outfall issues, etc.)

6. GIS Updates

a. Help identify, if detected, drainage features that are missing from GIS database or shown/labeled incorrectly in GIS database and report to the City. Update missing information accordingly. Note: This task does not include verification that all existing GIS drainage features are correct or physical field inspection of the entire system to ensure accuracy. The intent is to determine missing features or incorrect features as noticed by the Project Teams

b. Based on as-built plans, identify age of all systems (see Section 3)

c. Identify wetland and riparian areas, utilizing Wetland Inventory Maps and visual inspection

7. Maintenance – Dalworth Creek Watershed

a. Identify and evaluate types and locations of areas where maintenance needs to occur (storm drain outfalls, inlets, culverts, natural channels, open channels, bridges, etc.) in the Dalworth Creek Master Plan area. **Obtain City Database on investigation of outfalls in the City.**

b. Storm Drain Outfall Field Assessment – Utilizing the City of Grand Prairie's database of field-checked storm drain outfalls for the entire City, establish criteria to rank outfalls based on necessity to repair, provide preliminary ranking of outfalls needing repair, and provide summary report of rankings for the Dalworth Creek Master Plan area

c. Develop schedule for maintenance for the Dalworth Creek Master Plan area

8. Preliminary Quantities/Estimates of Probable Cost

a. Preliminary Quantities and Estimates of Probable Cost – For selected alternative improvements, the Project Team will prepare preliminary quantities and estimates of probable cost to implement the conceptual plan(s). These estimates of probable cost will be prepared in a digital format (Excel spreadsheets) with pertinent information such as

- Date of estimate and Adjustments for inflation
- Costs for survey, design, ROW & Easement acquisition, utility relocations, construction management, and construction. Note: 25% contingency will be applied to construction cost estimates.

9. Evaluation & Prioritization/Phasing & Implementation

a. Evaluation and Prioritization - Formalize a set of plans/recommendations in a report and assist City in developing rating criteria for channel and storm drain improvement alternatives in the Dalworth Creek Master Plan area. Develop a rating system to allow planning for future funding (refer to Section II.G of the City-Wide Drainage Master Plan Road Map). Projects, both small projects, medium projects, and large projects will then be **evaluated and prioritized** based on:

1. Levels of damage and value of homes flooded or endangered;
    a. Develop spreadsheet, to include Lowest Adjacent Grade, BFE, Structure Value, and Level of damage (# homes/damage value ($) for various flooding events, including (if available) 10-year, 25-year, 50-year, and 100-year)
2. Number of people and properties affected;
3. Life safety, prevent loss of life and minimize property damage;
4. Level of protection provided by plan;
5. Practicality and implementability,
6. Mobility (keeping main arterials open to traffic);
7. Maintaining access to public buildings, especially hospitals, fire and police departments, etc.
8. Environmental considerations (such as 404 permits, stream corridor maintenance);
9. Private-public relationships and funding agreements;
10. Available funding, participation in funding by others (TWDB, Corps, etc.), and;
11. The highest projected benefit-to-cost ratios.
12. Neighborhood Enhancement – Improve aesthetics, livability, and well-being of Grand Prairie citizens/residents;
13. Availability of Right-of-Way/Easements – Minimize disruption to property and structures.

Note: Weighting for each criteria shall be recommended to and approved by the City prior to prioritization of alternatives.

b. Phasing and Implementation - The Study Team will then assist and advise City staff in developing phasing and implementation plans and prioritizing proposed improvement projects for future CIP and related funding.

The goal is to incorporate CIPs from this study into an overall phasing and implementation plan with other drainage-related CIPs throughout the City in various other watersheds. The resulting City of Grand Prairie dataset for CIPs would be completely digital and geo-referenced, with documented spatial data, hydrologic and hydraulic data, and other features for ease of future updates.

10. Short Term Priorities & Long Term Plan

a. Short Term Priorities – Develop strategy for immediate implementation of key alternative improvement projects developed for the Dalworth Creek Master Plan. Focus on:

i. Cost/benefit ratio of proposed improvements. Weigh the flood control benefits against project costs
ii. Develop Project Improvement Needs & Prioritization List, including small projects (<$200,000), medium projects ($200,000 to $500,000), and larger projects (>$500,000)

b. Long Term Plan – Develop strategy for long term implementation of identified prioritized alternative improvement projects developed for the Dalworth Creek Master Plan. Focus on:

i. Longer range plans for larger projects, including phasing (if possible). Provide cost breakdown of phasing and time-frame for implementation.

This implementation plan would be coordinated with the future funding plan for the City-wide study.

11. City-wide Drainage Master Plan Documentation

Incorporate Dalworth Creek Master Plan data into City-wide Drainage Master Plan Documentation.

12. Project Management/Coordination

a. Project Management – Engineer shall provide project status reports, project schedule updates, and perform personnel and data management during course of project. Engineer shall attend a project kickoff meeting, prepare and lead any project status meetings, and prepare meeting minutes of each meeting to submit to the City. Engineer will fully document all hardware, software, file structures, and data formats used during the project.
b. QA/QC – Engineer shall develop a QA/QC procedure to include a multi-level approach to ensure that scope of work components are reviewed and approved.
c. Public Involvement Program: City Council Briefing Session - Develop schedule, set up and conduct a final workshop with the City Council and certain department leaders after study completion. Provide the council with an overview of drainage and flooding issues, study results, and recommendations.

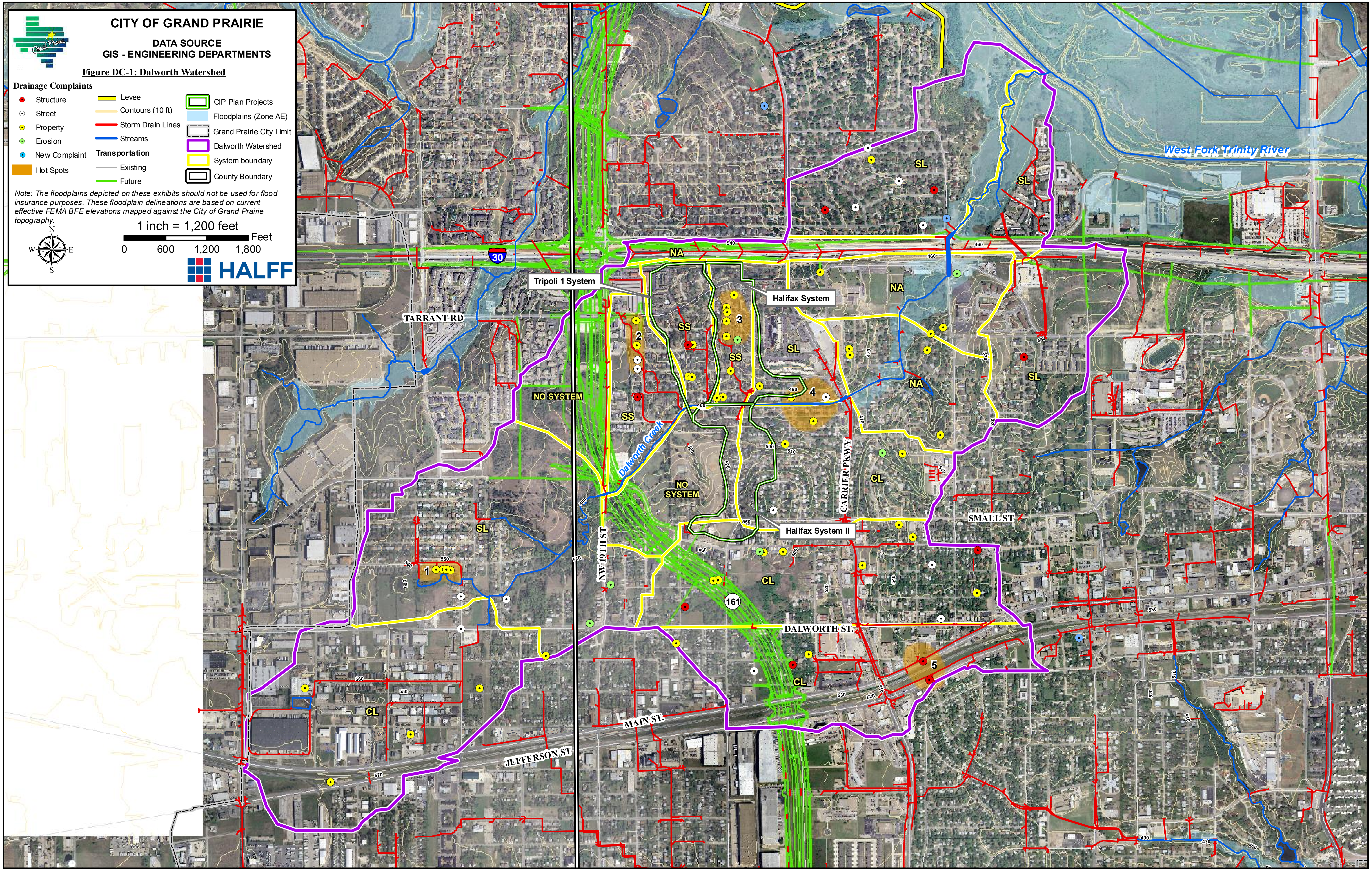

CITY OF GRAND PRAIRIE
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Figure DC-1: Dalworth Watershed
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Grand Prairie City Limit
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System boundary
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Note: The floodplains depicted on these exhibits should not be used for flood insurance purposes. These floodplain delineations are based on current effective FEMA BFE elevations mapped against the City of Grand Prairie topography.
1 inch = 1,200 feet
Feet
0 600 1,200 1,800
HALFF
West Fork Trinity River
Tripoli 1 System
Halifax System
Halifax System II
TARRANT RD
NO SYSTEM
Dalworth Creek
CARRIER PKWY
SMALL ST
NW 19TH ST
DALWORTH ST.
MAIN ST.
JEFFERSON ST
30
161
SL
NA
SS
CL
1
2
3
4
5

APPENDIX K
GOPHER BRANCH/TURNER BRANCH

GOPHER BRANCH & TURNER BRANCH MASTER PLAN
SCOPE OF WORK

A. GENERAL DESCRIPTION

The Gopher Creek and Turner Branch watersheds are located east of 7th Street, north of Jefferson Street, west of 15th Street, and south of IH-30. Drainage generally travels from southwest to northeast through storm drain pipes and culverts and open channels from Jefferson Street and 7th Street to north of IH 30 and into the West Fork Trinity River.

B. DRAINAGE COMPLAINT DATABASE

Twenty-four (24) drainage complaints at nineteen (19) different locations have been filed with the City from 1977 to 2003 within this watershed. Of these complaints, six (6) were erosion problems, three (3) were street flooding problems, six (6) were property flooding problems, and nine (9) were structure flooding problems. No hot spots, based on drainage complaints, were identified for these watersheds. **Note: It is the responsibility of the consultant to obtain the latest information from the City database and evaluate all current drainage complaints at time of study.**

C. EXISTING DATA AVAILABLE

- Watershed Technical Report – Freese & Nichols (Feb. 2005)
- Gopher Branch Study – Carter & Burgess (2002)
- Gopher Branch/Turner Branch Study for Repairs at Belt Line Road – Halff Associates (2008) Note: A LOMR will be prepared by Halff Associates on Gopher Branch/Turner Branch in 2008. Expected approval of LOMR is 2009.

Note: Existing Data Available will be provided to consultant on a CD or DVD, including PDFs of report/figures and technical data available

D. SCOPE OF WORK

1. **Data Collection**
   - **a.** Obtain all available information, including hydrologic & hydraulic models, topographic information, studies, as-built bridge/culvert plans, property information, available LOMRs, etc.
   - **b.** Coordinate with the City to obtain additional survey data for pertinent structures and/or locations along the study reach.

2. **Hydrologic & Hydraulic Studies - Streams and Open Channel**

   a. Develop new and/or updated hydrologic models - New HEC-HMS models will be developed (or updated as necessary), replacing any currently effective NUDALLAS and HEC-1 models. Analysis will include existing and future land-use conditions. Any new hydrologic models will be prepared with H&H modeling tools (Geo-HMS), procedures, and GIS tools. A frequency analysis of the existing 2-, 5-, 10-, 25-, 50-, 100-, and 500-year floods and ultimate 100-year flood will be made, at a minimum. Engineer shall utilize current Drainage Criteria Manual information for hydrologic parameters. Modified Puls shall be the methodology used for routing.

b. Develop new and/or updated floodplain hydraulic models – New HEC-RAS models will be developed (or updated as necessary). Any new hydraulic models will be prepared with H&H modeling tools (Geo-RAS), procedures, and GIS tools. As needed, new structures, bridges/culverts, channelization, channel cross-sections, aerial crossings and ponds will be field surveyed and incorporated into the updated H&H analyses. Floodway analyses will be performed, as necessary. Prepare rating curves for City rain & stream gauges along Gopher Branch and Turner Branch.

- Erosion/Sedimentation Assessment of Hydraulic Models (for Section 4)
  - Review all models in watershed and provide a summary table of the following:
    - Reaches where high channel velocities exist (erosion) for 10-yr event
    - Reaches where low channel velocities exist (sedimentation) for 10-yr event
    - Location of natural meanders of stream
    - Location of steep natural channel sections (describe average slope between two hard points, such as two culverts, along the channel)
    - Location of all existing TRA aerial crossings (based on field surveys and record drawings) – Describe erosive velocities for all frequency events.
  - Describe any field observations of stream, including locations of downcutting, locations of widening, knickpoints in channel flowline, locations of trees falling into channel, locations of trees with exposed roots, locations of wedge failures, locations of erosion at sanitary sewer aerial crossings, locations of undermining of storm drain outfalls, fences and/or structures close to erosion areas that have potential for failure or damage due to further erosion, etc. (and any other types of erosion that was observed). Include labeled photos, if available.

c. Develop new and updated floodplain mapping – Consolidate, make consistent, update as needed, and provide updated City-wide coverage of the Gopher Branch & Turner Branch floodplains in Grand Prairie. Updated floodplains will be delineated using digital terrain data from the best available topography and integrated into the City's GIS. The primary goal is to establish ultimate 100-year floodplain delineations with Base Flood Elevations shown, but also additional delineations, including existing 100-year & 500-year and floodway delineations for incorporation into FEMA mapping. Updated data will be incorporated into FEMA mapping by the LOMR process (Dallas County)**.** GIS shapefiles of floodplain delineations will be provided to the City

LOMR Submittals

- Prepare brief letter report of project purpose, procedures, and results
- Prepare flood elevation tables, floodway data tables, flood profiles (RASPLOT), hydraulic work maps, and revised FEMA FIRM maps.
- Prepare necessary MT-2 application/certificate forms including:
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- o Form 3 – Riverine Structures (including photos, as-built plans, and survey information)
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- Prepare templates and tabulate information for public notification, including individual property owner notification and public notice for floodway revision. The City of Grand Prairie will distribute all public notifications to individual property owners and post the public notice. <u>Note: If properties are affected by revised floodplain elevations, engineer shall survey finished floor elevations (lowest adjacent grade) of all structures in the revised floodplain limits.</u>
- Coordinate with the City of Grand Prairie and FEMA/Technical Reviewer (via telephone and email) to address comments and questions.
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<u>Elevation Certificates</u>

- Identify property locations of structures within updated existing 100-year (1% annual chance) floodplain limits.
- Identify structures on each property that serve as the primary residence or primary use to commercial/industrial sites. For these structures, prepare field surveys of finished flood and lowest adjacent grades around structures.
- All other insurable structures found to be within the limits of the 100-year (1% annual chance) floodplain will be identified and submitted to the City Floodplain Administrator for approval before proceeding with surveying and preparation of the elevation certificate.
- Necessary paperwork for Elevation Certificates will be per current FEMA standards
- Upon completion, prepare overall map of Elevation Certificate locations along the floodplain and submit to City along with completed Elevation Certificates.

e. <u>Roadway Crossings</u>

- <u>Evaluate and tabulate flood frequency capacity of existing roadway crossings for Gopher Branch & Turner Branch</u> – This information will be utilized to determine if existing roadway crossings need to be improved for 100-year flood protection

- Project Team shall analyze future roadway crossings of existing streams based on City Master Thoroughfare Plan and size crossings for future 100-year flood frequency capacity

f. <u>Alternatives for Streams and Open Channels</u>

- Stream and Open channel alternatives will be evaluated in accordance with:
  - o Flood Profile Impacts
  - o Valley Storage (downstream impacts)
  - o Environmental Quality
  - o Channel Stability/Erosion (channel armor and bio-engineering solutions)

- Bridge/Culvert Improvements
- Future TRA aerial wastewater crossings
- Corps Section 404 Permit Requirements
- Cost (construction, ROW, engineering, operations, and maintenance).
- Non-structural and structural improvements will be considered in terms of practicality, economics, necessity, impacts to mobility, environmental concerns, etc.

3. Storm Drainage Infrastructure Analysis

- **Overview -** Storm drainage network models will be prepared utilizing a City-wide Storm Water Infrastructure GIS database and existing record plans. It is not anticipated that field surveys will supplement the storm drainage studies. If necessary and approved by the City, field surveys will be conducted to accurately locate drainage infrastructure.
  - i. Analysis of storm drainage pipe networks will focus on all Gopher Branch & Turner Branch storm water sub-basins as shown in the attached map (approximate locations are shown for now). Sub-basins are classified as: 1) “Simple system/small basin”, 2) “Simple system/large basin”, and 3) “Complex system” (small or large basin)
  - ii. Additional **“Hot Spot”** locations have been identified where the existing underground drainage system is inadequate and/or frequent flooding occurs. These “Hot Spot” locations are based on drainage complaints within the watershed.
  - iii. The age of each storm drainage pipe network will be determined utilizing as-built dates from GIS database (if available)
  - iv. Storm water sub-basin delineations will be accurately defined for each storm drain area studied in detail. City GIS data will be utilized.
  - v. Design discharges will be based on current City criteria: For areas less than 200 acres, the rational method will be utilized and for areas greater than 200 acres, unit hydrograph techniques shall be utilized (HEC-HMS shall be model utilized for this determination).
  - vi. For storm drain analysis and recommendations for design improvements, the most recent version of the computer program **StormCAD** shall be used.
- **Existing Capacity Analysis** - The capacity of existing streets and underground storm drainage pipe networks, along with flood frequency that the system can contain, will be computed, as best that can be determined using StormCAD. The results of the storm drainage system analysis will be documented and incorporated into the City’s Storm Water Infrastructure GIS database. For this task, Project Team will use StormCAD to model the “trunk” line (s) of the primary system or systems in the previously defined storm water sub-basin. It is the Project Team’s responsibility to define the limits of the “trunk” line(s) for each sub-basin and determine if additional lateral lines (draining 20% or more of the basin) need to be modeled.
- **Optimization Analysis** - An attempt to “optimize” existing storm drainage systems will be included in the analysis. Determine where added inlets or detention, at critical points along the system, will ensure that it is optimized for the lower (as well as the higher) frequency

floods. These would be categorized as “smaller projects” for the City to designate and prioritize.

- **City Coordination** - The Project Team will meet with City staff to help confirm and identify problem areas. The updated Storm Water Infrastructure GIS will then be overlaid with property maps to help classify problem areas as “public or private.” This data will then be incorporated into the City’s Storm Water Infrastructure GIS database. It will include information such as: coordinates (horizontal and vertical location), pipe size, material, and slope.
- **Analysis of Alternatives** - Following completion of the updated existing storm drainage analysis, the Project Team will commence the analyses of alternatives to address documented storm water infrastructure problems, including correction and future prevention. Proposed alternative improvements will be modeled using the previously prepared StormCAD models for existing infrastructure. Analysis of proposed storm water improvements will be conducted to accommodate a designated flood frequency within the proposed storm drain system, existing/proposed drainage easements, and/or existing street R.O.W.
    - i. Alternatives for Storm Drains - Storm drain alternatives will be evaluated in accordance with hydraulic grade line (HGL) and energy grade line (EGL), flooding of structures on properties, street flooding, nuisance flooding, age and condition of storm drain system, right-of-way availability, conflicting utilities, and other impacts. The 100-year frequency event will be the design storm. If alternative improvements cannot be developed to adequately contain 100-year event, then the 10-year and 2-year events will be utilized for alternatives. Note: The City of Grand Prairie requires EGL to be 1-foot below top of pavement elevations.
    - ii. Innovative Alternatives - Innovative alternatives that incorporate “non-traditional” ideas will be explored and compared with traditional solutions. For example, purchase of existing homes and properties for construction of a regional detention pond to reduce discharges, downstream pipe and culvert sizes, and lower flood profiles might be considered.
    - iii. Preliminary Quantities and Estimates of Probable Cost – For selected alternative improvements, the Project Team will prepare preliminary quantities and estimates of probable cost to implement the conceptual plan(s). These estimates of probable cost will be prepared in a digital format (Excel spreadsheets) with pertinent information such as:
        1. Date of estimate and Adjustments for inflation
        2. Costs for survey, design, ROW & Easement acquisition, utility relocations, construction management, and construction. Note: 25% contingency will be applied to construction cost estimates.

4. Channel Stability Assessment/Erosion Hazard Analysis

- a. Hydraulics
    - i. Execute HEC-RAS model with low flow and bank-full flow rates.
    - ii. Tabulate and evaluate velocities, energy, and shear stress.
    - iii. Confirm results with field observations (channel bends).
- b. Geomorphology
    - i. Conduct field reconnaissance to identify and obtain:

1. Channel characteristics,
2. Photos, and
3. Identify/confirm problem areas, etc.

ii. Conduct sedimentation/degradation analysis.
iii. Review 1999 topography versus 2009 topography to determine potential erosion hazard zones
iv. Review City standards to determine areas within erosion hazard zones

c. Prepare channel stability assessment/erosion hazard analysis report
d. Evaluate erosive properties of existing TRA aerial wastewater crossings
e. Prepare stream bank restoration improvement alternatives (provide preliminary quantities/estimates of probable cost per Section 8)

5. Dams/Levees/Detention/Drainage Reviews

a. Prepare GIS maps showing locations/descriptions of existing dams, levees, retention and detention areas within the Gopher Branch & Turner Branch Master Plan area. Include separate layers for private and public detention ponds. Work with City GIS staff on GIS development of these layers.

b. Prepare detailed summary of existing drainage plan reviews prepared by Halff denoting project name, City project number, description of review, and if detention was included in the project

c. Obtain plans containing detention ponds and make field visits to verify detention ponds have been constructed according to as-built plans

i. Document detention ponds with photos
ii. Describe any problems associated with detention ponds (maintenance issues, outfall issues, etc.)

6. GIS Updates

a. Help identify, if detected, drainage features that are missing from GIS database or shown/labeled incorrectly in GIS database and report to the City. Update missing information accordingly. Note: This task does not include verification that all existing GIS drainage features are correct or physical field inspection of the entire system to ensure accuracy. The intent is to determine missing features or incorrect features as noticed by the Project Teams

b. Based on as-built plans, identify age of all systems (see Section 3)

c. Identify wetland and riparian areas, utilizing Wetland Inventory Maps and visual inspection

7. Maintenance – Gopher Branch & Turner Branch Watershed

a. Identify and evaluate types and locations of areas where maintenance needs to occur (storm drain outfalls, inlets, culverts, natural channels, open channels, bridges, etc.) in the Gopher Branch & Turner Branch Master Plan area. **Obtain City Database on investigation of outfalls in the City.**

b. Storm Drain Outfall Field Assessment – Utilizing the City of Grand Prairie's database of field-checked storm drain outfalls for the entire City, establish criteria to rank outfalls based on necessity to repair, provide preliminary ranking of outfalls needing repair, and provide summary report of rankings for the Gopher Branch & Turner Branch Master Plan area

c. Develop schedule for maintenance within the Gopher Branch & Turner Branch Master Plan area

8. Preliminary Quantities/Estimates of Probable Cost

a. Preliminary Quantities and Estimates of Probable Cost – For selected alternative improvements, the Project Team will prepare preliminary quantities and estimates of probable cost to implement the conceptual plan(s). These estimates of probable cost will be prepared in a digital format (Excel spreadsheets) with pertinent information such as

- Date of estimate and Adjustments for inflation
- Costs for survey, design, ROW & Easement acquisition, utility relocations, construction management, and construction

9. Evaluation & Prioritization/Phasing & Implementation

a. Evaluation and Prioritization - Formalize a set of plans/recommendations in a report and assist City in developing rating criteria for channel and storm drain improvement alternatives in the Gopher Branch & Turner Branch Master Plan area. Develop a rating system to allow planning for future funding (refer to Section II.G of the City-Wide Drainage Master Plan Road Map). Projects, both small projects, medium projects, and large projects will then be **evaluated and prioritized** based on:

1. Levels of damage and value of homes flooded or endangered;
   a. Develop spreadsheet, to include Lowest Adjacent Grade, BFE, Structure Value, and Level of damage (# homes/damage value ($) for various flooding events, including (if available) 10-year, 25-year, 50-year, and 100-year)
2. Number of people and properties affected;
3. Life safety, prevent loss of life and minimize property damage;
4. Level of protection provided by plan;
5. Practicality and implementability,
6. Mobility (keeping main arterials open to traffic);
7. Maintaining access to public buildings, especially hospitals, fire and police departments, etc.
8. Environmental considerations (such as 404 permits, stream corridor maintenance);
9. Private-public relationships and funding agreements;
10. Available funding, participation in funding by others (TWDB, Corps, etc.), and;
11. The highest projected benefit-to-cost ratios.
12. Neighborhood Enhancement – Improve aesthetics, livability, and well-being of Grand Prairie citizens/residents;

13. Availability of Right-of-Way/Easements – Minimize disruption to property and structures.

Note: Weighting for each criteria shall be recommended to and approved by the City prior to prioritization of alternatives.

b. Phasing and Implementation - The Study Team will then assist and advise City staff in developing phasing and implementation plans and prioritizing proposed improvement projects for future CIP and related funding.

The goal is to incorporate CIPs from this study into an overall phasing and implementation plan with other drainage-related CIPs throughout the City in various other watersheds. The resulting City of Grand Prairie dataset for CIPs would be completely digital and geo-referenced, with documented spatial data, hydrologic and hydraulic data, and other features for ease of future updates.

10. Short Term Priorities & Long Term Plan

a. Short Term Priorities – Develop strategy for immediate implementation of key projects developed for the Gopher Branch & Turner Branch Master Plan. Focus on:

i. Cost/benefit ratio of proposed improvements. Weigh the flood control benefits against project costs
ii. Develop Project Improvement Needs & Prioritization List, including small projects (<$200,000), medium projects ($200,000 to $500,000), and larger projects (>$500,000)

b. Long Term Plan – Develop strategy for long term implementation of identified prioritized projects developed for the Gopher Branch & Turner Branch Master Plan. Focus on:

i. Longer range plans for larger projects, including phasing (if possible). Provide cost breakdown of phasing and time-frame for implementation.

This implementation plan would be coordinated with the future funding plan for the City-wide study.

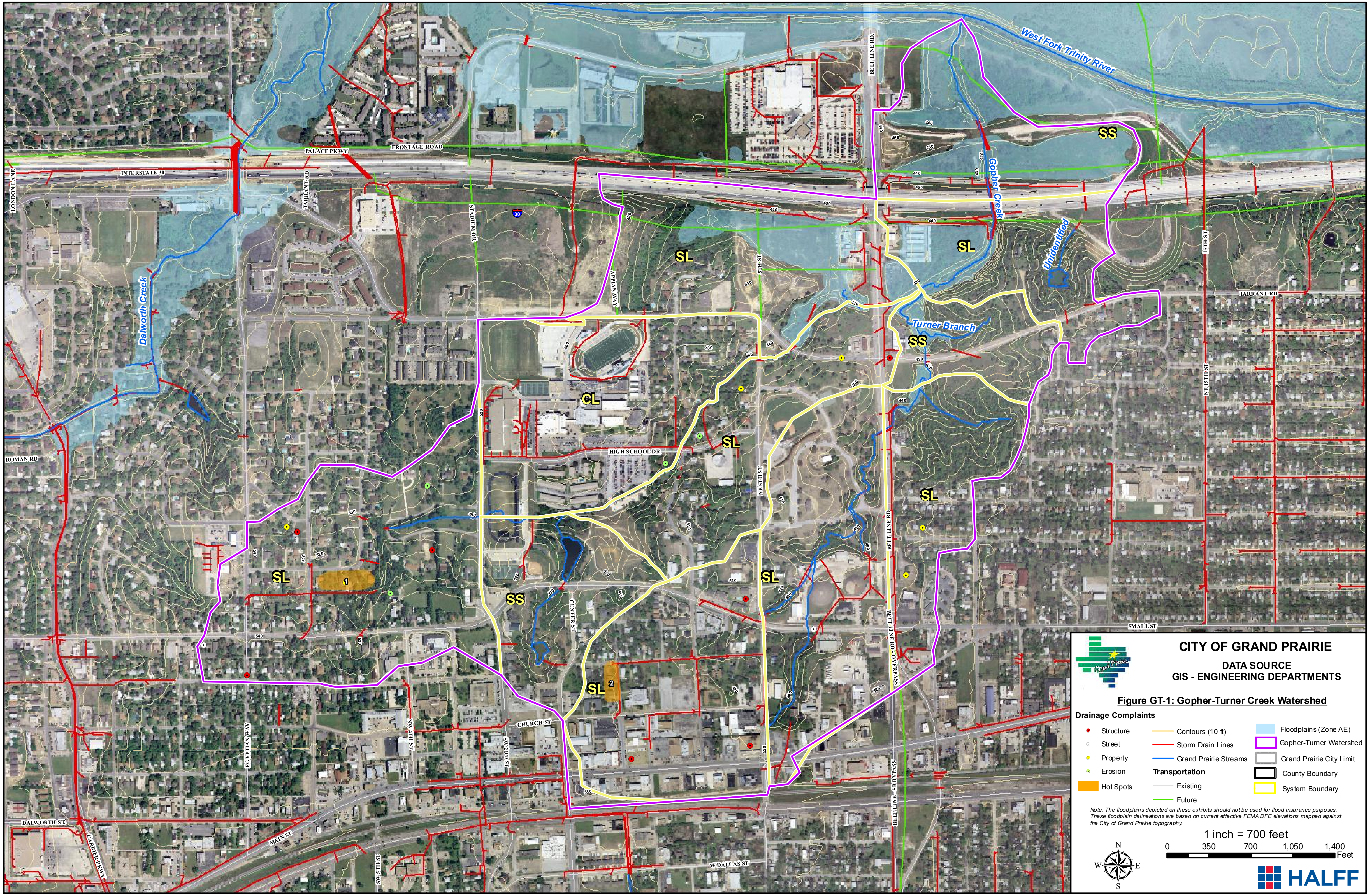
11. City-wide Drainage Master Plan Documentation

Incorporate Gopher Branch & Turner Branch Master Plan data into City-wide Drainage Master Plan Documentation.

12. Project Management/Coordination

a. Project Management – Engineer shall provide project status reports, project schedule updates, and perform personnel and data management during course of project. Engineer shall attend a project kickoff meeting, prepare and lead any project status meetings, and prepare meeting minutes of each meeting to submit to the City. Engineer will fully document all hardware, software, file structures, and data formats used during the project.
b. QA/QC – Engineer shall develop a QA/QC procedure to include a multi-level approach to ensure that scope of work components are reviewed and approved.

c. Public Involvement Program: City Council Briefing Session - Develop schedule, set up and conduct a final workshop with the City Council and certain department leaders after study completion. Provide the council with an overview of drainage and flooding issues, study results, and recommendations.


CITY OF GRAND PRAIRIE
DATA SOURCE
GIS - ENGINEERING DEPARTMENTS
Figure GT-1: Gopher-Turner Creek Watershed
Drainage Complaints
Structure
Street
Property
Erosion
Hot Spots
Contours (10 ft)
Storm Drain Lines
Grand Prairie Streams
Transportation
Existing
Future
Floodplains (Zone AE)
Gopher-Turner Watershed
Grand Prairie City Limit
County Boundary
System Boundary
Note: The floodplains depicted on these exhibits should not be used for flood insurance purposes. These floodplain delineations are based on current effective FEMA BFE elevations mapped against the City of Grand Prairie topography.
1 inch = 700 feet
0
350
700
1,050
1,400
Feet
N
S
E
W
HALFF
West Fork Trinity River
Gopher Creek
Turner Branch
Dalworth Creek
Unidentified
INTERSTATE 30
PALACE PKWY
FRONTAGE ROAD
BELT LINE RD
TARRANT RD
HIGH SCHOOL DR
NE 5TH ST
CENTER ST
EGYPTIAN WAY
SMALL ST
CHURCH ST
MAIN ST
W DALLAS ST
DALWORTH ST
CARRIER PKWY
ROMAN RD
SS
SL
CL
1
2

APPENDIX L
BEAR CREEK

BEAR CREEK MASTER PLAN
SCOPE OF WORK

A. GENERAL DESCRIPTION

The Bear Creek watershed is located north of IH-30 and extends north past the city limits (Rock Island Road). Drainage generally travels from northwest to southeast by open channel from Rock Island Road to MacArthur Boulevard to the West Fork Trinity River.

B. DRAINAGE COMPLAINT DATABASE

Twenty-two (22) drainage complaints at twenty-four (24) different locations have been filed with the City from 1992 to 2006 within this watershed. Of these complaints, two (2) were erosion problems, six (6) were street flooding problems, seventeen (17) were property flooding problems, and five (5) were structure flooding problems. <u>**Note: It is the responsibility of the consultant to obtain the latest information from the City database and evaluate all current drainage complaints at time of study**</u>**.**

<u>Hot Spot Locations</u>:

1. **Along Spraybary Road** (west of Hard Rock Road and north of Shady Grove Road)
2. **Along Shady Grove** (west of Hard Rock Road)
3. **Along Wright Blvd** (north of Shady Grove Road)

C. EXISTING DATA AVAILABLE

- Big Bear Creek-Engineering Analysis-Hydraulics – Halff Associates (Oct. 2005)
- Bear Creek – Map Modernization – Hydrology – FEMA – Halff Associates
- Bear Creek – Fully Urbanized H&H (100-year) – Halff Associates (prepared for NCTCOG communities)
- Belt Line Corridor Reclamation Master Plan – Nathan D. Maier (April 1999 & October 2004 – update)
- Bear Creek/Hunter Ferrell Road Study – Halff Associates

<u>Note: Existing Data Available will be provided to consultant on a CD or DVD, including PDFs of report/figures and technical data available</u>

D. UNIQUE ATTRIBUTES OF BEAR CREEK

- Recent existing H&H studies were performed for the entire Bear Creek watershed for NCTCOG.
- Halff Associates has prepared a fully urbanized H&H update for the Bear Creek Watershed Study (100-year only)
- Future SH 161 encroaches into the Bear Creek floodplain near Rock Island Road
- Hunter Ferrell Road will be improved in the near future. These future conditions need to be taken into consideration for the Bear Creek H&H study.
- Bear Creek Reclamation District

- Detention/Retention Areas – At industrial warehouse locations north of Trinity Blvd
- Potential for cross-flow (2D flow) from Bear Creek to Trinity River floodplains near confluence (in Grand Prairie and Irving)

E. Scope of Work

1. Data Collection

a. Obtain all available information, including hydrologic & hydraulic models, topographic information, studies, as-built bridge/culvert plans, property information, available LOMRs, etc.

b. Coordinate with the City to obtain additional survey data for pertinent structures and/or locations along the study reach.

2. Hydrologic & Hydraulic Studies - Streams and Open Channel

a. Develop new and/or updated hydrologic models – Obtain and review recently prepared HEC-HMS models and determine if any updates are necessary for sub-basins in the City of Grand Prairie. Ensure that frequency analyses have been prepared for the existing 10-, 50-, 100-, and 500-year floods and ultimate 100-year flood. Engineer shall utilize current Drainage Criteria Manual information for hydrologic parameters, if updates are needed. Modified Puls shall be the methodology used for routing.

b. Develop new and/or updated floodplain hydraulic models – Obtain and review recently prepared HEC-RAS models and determine if any updates are necessary for study reach in the City of Grand Prairie. Ensure that frequency flood events have been developed for the existing 2-, 5-, 10-, 25-, 50-, 100-, and 500-year floods and ultimate 100-year flood. As needed, new structures, bridges/culverts, channelization, channel cross-sections, aerial crossings and ponds will be field surveyed and incorporated into the updated hydraulic models. Floodway analyses will be performed, as necessary. Prepare rating curves for City rain & stream gauges along Bear Creek.

- Erosion/Sedimentation Assessment of Hydraulic Models (for Section 4)
  - Review all models in watershed and provide a summary table of the following:
    - Reaches where high channel velocities exist (erosion) for 10-yr event
    - Reaches where low channel velocities exist (sedimentation) for 10-yr event
    - Location of natural meanders of stream
    - Location of steep natural channel sections (describe average slope between two hard points, such as two culverts, along the channel)
    - Location of all existing TRA aerial crossings (based on field surveys and record drawings) – Describe erosive velocities for all frequency events.
  - Describe any field observations of stream, including locations of downcutting, locations of widening, knickpoints in channel flowline, locations of trees falling into channel, locations of trees with exposed roots, locations of wedge failures, locations of erosion at sanitary sewer aerial crossings, locations of undermining of storm drain outfalls, fences and/or structures close to erosion areas that have

potential for failure or damage due to further erosion, etc. (and any other types of erosion that was observed). Include labeled photos, if available.

c. Develop new and updated floodplain mapping – Consolidate, make consistent, update as needed, and provide updated City-wide coverage of the Bear Creek floodplain in Grand Prairie. Updated floodplains will be delineated using digital terrain data from the best available topography and integrated into the City's GIS. The primary goal is to establish ultimate 100-year floodplain delineations with Base Flood Elevations shown, but also additional delineations, including existing 100-year & 500-year and floodway delineations for incorporation into FEMA mapping. Updated data will be incorporated into FEMA mapping by the LOMR process (Dallas County). GIS shapefiles of floodplain delineations will be provided to the City

LOMR Submittals

- Prepare brief letter report of project purpose, procedures, and results
- Prepare flood elevation tables, floodway data tables, flood profiles (RASPLOT), hydraulic work maps, and revised FEMA FIRM maps.
- Prepare necessary MT-2 application/certificate forms including:
  - Form 1 – Overview and Concurrence
  - Form 2 – Riverine Hydrology & Hydraulics
  - Form 3 – Riverine Structures (including photos, as-built plans, and survey information)
- Deliver two (2) copies of the Final LOMR Report to the City of Grand Prairie
- Work with City staff on submittal to FEMA
- Export electronic files (HEC-RAS, Word, CADD, GIS, and PDF) to CD and submit to City of Grand Prairie
- Prepare templates and tabulate information for public notification, including individual property owner notification and public notice for floodway revision. The City of Grand Prairie will distribute all public notifications to individual property owners and post the public notice. Note: If properties are affected by revised floodplain elevations, engineer shall survey finished floor elevations (lowest adjacent grade) of all structures in the revised floodplain limits.
- Coordinate with the City of Grand Prairie and FEMA/Technical Reviewer (via telephone and email) to address comments and questions.
- Note: Fees for review of LOMR applications are not included in scope of work

Elevation Certificates

- Identify property locations of structures within updated existing 100-year (1% annual chance) floodplain limits.
- Identify structures on each property that serve as the primary residence or primary use to commercial/industrial sites. For these structures, prepare field surveys of finished flood and lowest adjacent grades around structures.
- All other insurable structures found to be within the limits of the 100-year (1% annual chance) floodplain will be identified and submitted to the City Floodplain Administrator for approval before proceeding with surveying and preparation of the elevation certificate.
- Necessary paperwork for Elevation Certificates will be per current FEMA standards

- Upon completion, prepare overall map of Elevation Certificate locations along the floodplain and submit to City along with completed Elevation Certificates.

e. Roadway Crossings

- Evaluate and tabulate flood frequency capacity of existing roadway crossings for Bear Creek – This information will be utilized to determine if existing roadway crossings need to be improved for 100-year flood protection
- Project Team shall analyze future roadway crossings of existing streams based on City Master Thoroughfare Plan and size crossings for future 100-year flood frequency capacity

f. Alternatives for Streams and Open Channels

- Stream and Open channel alternatives will be evaluated in accordance with:
  - Flood Profile Impacts
  - Valley Storage (downstream impacts)
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   i. Document detention ponds with photos
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3. Life safety, prevent loss of life and minimize property damage;
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7. Maintaining access to public buildings, especially hospitals, fire and police departments, etc.
8. Environmental considerations (such as 404 permits, stream corridor maintenance);
9. Private-public relationships and funding agreements;
10. Available funding, participation in funding by others (TWDB, Corps, etc.), and;
11. The highest projected benefit-to-cost ratios.
12. Neighborhood Enhancement – Improve aesthetics, livability, and well-being of Grand Prairie citizens/residents;
13. Availability of Right-of-Way/Easements – Minimize disruption to property and structures.

Note: Weighting for each criteria shall be recommended to and approved by the City prior to prioritization of alternatives.

b. Phasing and Implementation - The Study Team will then assist and advise City staff in developing phasing and implementation plans and prioritizing proposed improvement projects for future CIP and related funding.

The goal is to incorporate CIPs from this study into an overall phasing and implementation plan with other drainage-related CIPs throughout the City in various other watersheds. The resulting City of Grand Prairie dataset for CIPs would be completely digital and geo-referenced, with documented spatial data, hydrologic and hydraulic data, and other features for ease of future updates.

10. Short Term Priorities & Long Term Plan

a. Short Term Priorities – Develop strategy for immediate implementation of key projects developed for the Bear Creek Master Plan. Focus on:

i. Cost/benefit ratio of proposed improvements. Weigh the flood control benefits against project costs
ii. Develop Project Improvement Needs & Prioritization List, including small projects (<$200,000), medium projects ($200,000 to $500,000), and larger projects (>$500,000)

b. Long Term Plan – Develop strategy for long term implementation of identified prioritized projects developed for the Bear Creek Master Plan. Focus on:

i. Longer range plans for larger projects, including phasing (if possible). Provide cost breakdown of phasing and time-frame for implementation.

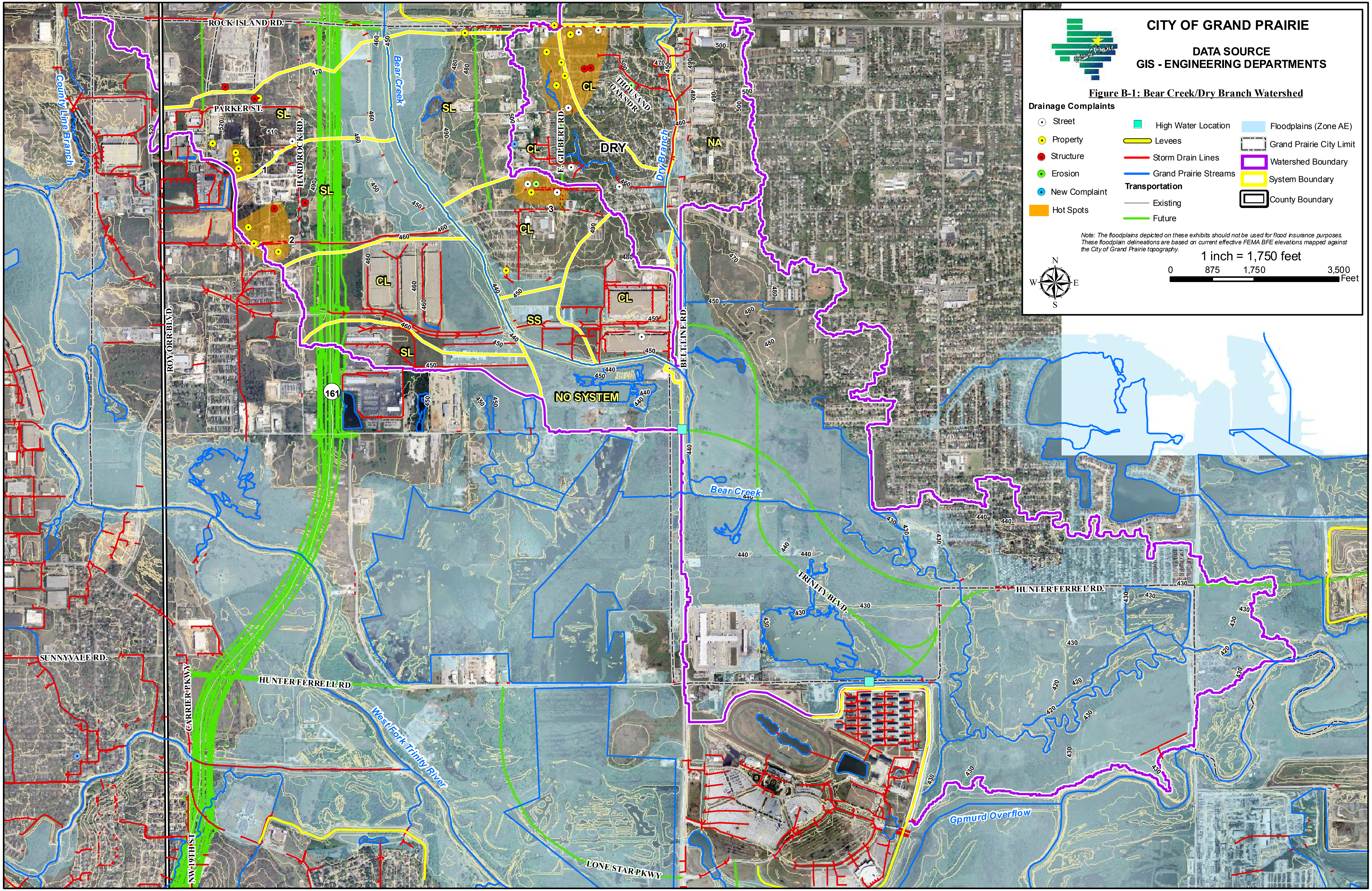
This implementation plan would be coordinated with the future funding plan for the City-wide study.

11. City-wide Drainage Master Plan Documentation

Incorporate Bear Creek Master Plan data into City-wide Drainage Master Plan Documentation.

12. Project Management/Coordination

- **a.** Project Management – Engineer shall provide project status reports, project schedule updates, and perform personnel and data management during course of project. Engineer shall attend a project kickoff meeting, prepare and lead any project status meetings, and prepare meeting minutes of each meeting to submit to the City. Engineer will fully document all hardware, software, file structures, and data formats used during the project.
- **b.** QA/QC – Engineer shall develop a QA/QC procedure to include a multi-level approach to ensure that scope of work components are reviewed and approved.
- **c.** Public Involvement Program: City Council Briefing Session - Develop schedule, set up and conduct a final workshop with the City Council and certain department leaders after study completion. Provide the council with an overview of drainage and flooding issues, study results, and recommendations.



CITY OF GRAND PRAIRIE
DATA SOURCE
GIS - ENGINEERING DEPARTMENTS
Figure B-1: Bear Creek/Dry Branch Watershed
Drainage Complaints
Street
Property
Structure
Erosion
New Complaint
Hot Spots
High Water Location
Levees
Storm Drain Lines
Grand Prairie Streams
Transportation
Existing
Future
Floodplains (Zone AE)
Grand Prairie City Limit
Watershed Boundary
System Boundary
County Boundary
Note: The floodplains depicted on these exhibits should not be used for flood insurance purposes. These floodplain delineations are based on current effective FEMA BFE elevations mapped against the City of Grand Prairie topography.
1 inch = 1,750 feet
0
875
1,750
3,500
Feet
N
W
E
S
ROCK ISLAND RD.
PARKER ST.
HARDROCK RD.
ROY ORR BLVD.
E. GILBERT RD.
THOUSAND OAKS DR
BELT LINE RD.
TRINITY BLVD.
HUNTER FERRELL RD.
SUNNYVALE RD.
CARRIER PKWY
NW 19TH ST
LONE STAR PKWY
County Line Branch
Bear Creek
Dry Branch
West Fork Trinity River
Gpmurd Overflow
DRY
NO SYSTEM
SL
CL
SS
NA
161

APPENDIX M
DRY BRANCH

DRY BRANCH MASTER PLAN
SCOPE OF WORK

A. GENERAL DESCRIPTION

The Dry Branch watershed is located north of Trinity Boulevard and extends north past the city limits (Rock Island Road). Drainage generally travels from north to south through an open concrete-lined trapezoidal channel from Rock Island Road to Shady Grove Road to Bear Creek.

B. DRAINAGE COMPLAINT DATABASE

Fifteen (15) drainage complaints at fourteen (14) different locations have been filed with the City from 1988 to 2006 within this watershed. Of these complaints, one (1) was an erosion problem, five (5) were street flooding problems, six (6) were property flooding problems, and three (3) were structure flooding problems. **Note: It is the responsibility of the consultant to obtain the latest information from the City database and evaluate all current drainage complaints at time of study.**

Hot Spot Locations:

1. **Gilbert Drive** (between Manana and Josephine)

C. EXISTING DATA AVAILABLE

- Dry Branch LOMR – Halff Associates (1998)
- Belt Line Corridor Reclamation Master Plan – Nathan D. Maier (April 1999 & October 2004 – update)
- Bear Creek – Map Modernization – Hydrology – FEMA – Halff Associates
- Bear Creek – Fully Urbanized H&H (100-year) – Halff Associates (not submitted)
- Belt Line Corridor Reclamation Master Plan – Nathan D. Maier (April 1999 & October 2004 – update)
- Dry Branch Study for the City of Irving (Ongoing) - Freese & Nichols (2008)
- Post Oak Drainage Study and Preliminary Plan

Note: Existing Data Available will be provided to consultant on a CD or DVD, including PDFs of report/figures and technical data available

D. UNIQUE ATTRIBUTES OF DRY BRANCH

- Improved concrete-lined channel from Shady Grove Road to downstream of Rock Island Road
- Watershed and floodplain are both in Irving and Grand Prairie south of Rock Island Road
- Stream crosses Belt Line Road south of Shady Grove Road

E. Scope of Work

1. Data Collection

a. Obtain all available information, including hydrologic & hydraulic models, topographic information, studies, as-built bridge/culvert plans, property information, available LOMRs, etc.

b. Coordinate with the City to obtain additional survey data for pertinent structures and/or locations along the study reach.

2. Hydrologic & Hydraulic Studies - Streams and Open Channel

a. <u>Develop new and/or updated hydrologic models</u> - New HEC-HMS models will be developed (or updated as necessary from recent Bear Creek hydrology update). Analysis will include existing and future land-use conditions. Any new hydrologic models will be prepared with H&H modeling tools (Geo-HMS), procedures, and GIS tools. A frequency analysis of the existing 2-, 5-, 10-, 25-, 50-, 100-, and 500-year floods and ultimate 100-year flood will be made, at a minimum. Engineer shall utilize current Drainage Criteria Manual information for hydrologic parameters. Modified Puls shall be the methodology used for routing.

b. <u>Develop new and/or updated floodplain hydraulic models</u> – New HEC-RAS models will be developed (or updated as necessary). Any new hydraulic models will be prepared with H&H modeling tools (Geo-RAS), procedures, and GIS tools. <u>As needed, new structures, bridges/culverts, channelization, channel cross-sections, aerial crossings and ponds will be field surveyed and incorporated into the updated H&H analyses</u>. Floodway analyses will be performed, as necessary. Prepare rating curves for City rain & stream gauges along Dry Branch.

- <u>Erosion/Sedimentation Assessment of Hydraulic Models (for Section 4)</u>
  - Review all models in watershed and provide a summary table of the following:
    - Reaches where high channel velocities exist (erosion) for 10-yr event
    - Reaches where low channel velocities exist (sedimentation) for 10-yr event
    - Location of natural meanders of stream
    - Location of steep natural channel sections (describe average slope between two hard points, such as two culverts, along the channel)
    - Location of all existing TRA aerial crossings (based on field surveys and record drawings) – Describe erosive velocities for all frequency events.
  - Describe any field observations of stream, including locations of downcutting, locations of widening, knickpoints in channel flowline, locations of trees falling into channel, locations of trees with exposed roots, locations of wedge failures, locations of erosion at sanitary sewer aerial crossings, locations of undermining of storm drain outfalls, fences and/or structures close to erosion areas that have potential for failure or damage due to further erosion, etc. (and any other types of erosion that was observed). Include labeled photos, if available.

c. <u>Develop new and updated floodplain mapping</u> – Consolidate, make consistent, update as needed, and provide updated City-wide coverage of the Dry Branch floodplain in Grand Prairie. Updated floodplains will be delineated using digital terrain data from the best available topography and integrated into the City's GIS. The primary goal is to establish ultimate 100-year floodplain delineations with Base Flood Elevations shown, but also additional delineations, including existing 100-year & 500-year and floodway delineations for incorporation into FEMA mapping. Updated data will be incorporated into FEMA mapping by the LOMR process (Dallas County). GIS shapefiles of floodplain delineations will be provided to the City

LOMR Submittals

- Prepare brief letter report of project purpose, procedures, and results
- Prepare flood elevation tables, floodway data tables, flood profiles (RASPLOT), hydraulic work maps, and revised FEMA FIRM maps.
- Prepare necessary MT-2 application/certificate forms including:
  - Form 1 – Overview and Concurrence
  - Form 2 – Riverine Hydrology & Hydraulics
  - Form 3 – Riverine Structures (including photos, as-built plans, and survey information)
- Deliver two (2) copies of the Final LOMR Report to the City of Grand Prairie
- Work with City staff on submittal to FEMA
- Export electronic files (HEC-RAS, Word, CADD, GIS, and PDF) to CD and submit to City of Grand Prairie
- Prepare templates and tabulate information for public notification, including individual property owner notification and public notice for floodway revision. The City of Grand Prairie will distribute all public notifications to individual property owners and post the public notice. Note: If properties are affected by revised floodplain elevations, engineer shall survey finished floor elevations (lowest adjacent grade) of all structures in the revised floodplain limits.
- Coordinate with the City of Grand Prairie and FEMA/Technical Reviewer (via telephone and email) to address comments and questions.
- Note: Fees for review of LOMR applications are not included in scope of work

Elevation Certificates

- Identify property locations of structures within updated existing 100-year (1% annual chance) floodplain limits.
- Identify structures on each property that serve as the primary residence or primary use to commercial/industrial sites. For these structures, prepare field surveys of finished flood and lowest adjacent grades around structures.
- All other insurable structures found to be within the limits of the 100-year (1% annual chance) floodplain will be identified and submitted to the City Floodplain Administrator for approval before proceeding with surveying and preparation of the elevation certificate.
- Necessary paperwork for Elevation Certificates will be per current FEMA standards
- Upon completion, prepare overall map of Elevation Certificate locations along the floodplain and submit to City along with completed Elevation Certificates.

e. Roadway Crossings

- Evaluate and tabulate flood frequency capacity of existing roadway crossings for Dry Branch – This information will be utilized to determine if existing roadway crossings need to be improved for 100-year flood protection

- Project Team shall analyze future roadway crossings of existing streams based on City Master Thoroughfare Plan and size crossings for future 100-year flood frequency capacity

f. <u>Alternatives for Streams and Open Channels</u>

- Stream and Open channel alternatives will be evaluated in accordance with:
  - Flood Profile Impacts
  - Valley Storage (downstream impacts)
  - Environmental Quality
  - Channel Stability/Erosion (channel armor and bio-engineering solutions)
  - Bridge/Culvert Improvements
  - Future TRA aerial wastewater crossings
  - Corps Section 404 Permit Requirements
  - Cost (construction, ROW, engineering, operations, and maintenance).
  - Non-structural and structural improvements will be considered in terms of practicality, economics, necessity, impacts to mobility, environmental concerns, etc.

3. Storm Drainage Infrastructure Analysis

- **<u>Overview</u> -** Storm drainage network models will be prepared utilizing a City-wide Storm Water Infrastructure GIS database and existing record plans. It is not anticipated that field surveys will supplement the storm drainage studies. If necessary and approved by the City, field surveys will be conducted to accurately locate drainage infrastructure.
  - i. Analysis of storm drainage pipe networks will focus on all Dry Branch storm water sub-basins as shown in the attached map (approximate locations are shown for now). Sub-basins are classified as: 1) "Simple system/small basin", 2) "Simple system/large basin", and 3) "Complex system" (small or large basin)
  - ii. Additional **"Hot Spot"** locations have been identified where the existing underground drainage system is inadequate and/or frequent flooding occurs. These "Hot Spot" locations are based on drainage complaints within the watershed.
  - iii. The age of each storm drainage pipe network will be determined utilizing as-built dates from GIS database (if available)
  - iv. Storm water sub-basin delineations will be accurately defined for each storm drain area studied in detail. City GIS data will be utilized.
  - v. Design discharges will be based on current City criteria: For areas less than 200 acres, the rational method will be utilized and for areas greater than 200 acres, unit hydrograph techniques shall be utilized (HEC-HMS shall be model utilized for this determination).
  - vi. For storm drain analysis and recommendations for design improvements, the most recent version of the computer program **<u>StormCAD</u>** shall be used.
- **<u>Existing Capacity Analysis</u>** - The capacity of existing streets and underground storm drainage pipe networks, along with flood frequency that the system can contain, will be

computed, as best that can be determined using StormCAD. The results of the storm drainage system analysis will be documented and incorporated into the City's Storm Water Infrastructure GIS database. For this task, Project Team will use StormCAD to model the "trunk" line (s) of the primary system or systems in the previously defined storm water sub-basin. It is the Project Team's responsibility to define the limits of the "trunk" line(s) for each sub-basin and determine if additional lateral lines (draining 20% or more of the basin) need to be modeled.

- **Optimization Analysis** - An attempt to "optimize" existing storm drainage systems will be included in the analysis. Determine where added inlets or detention, at critical points along the system, will ensure that it is optimized for the lower (as well as the higher) frequency floods. These would be categorized as "smaller projects" for the City to designate and prioritize.
- **City Coordination** - The Project Team will meet with City staff to help confirm and identify problem areas. The updated Storm Water Infrastructure GIS will then be overlaid with property maps to help classify problem areas as "public or private." This data will then be incorporated into the City's Storm Water Infrastructure GIS database. It will include information such as: coordinates (horizontal and vertical location), pipe size, material, and slope.
- **Analysis of Alternatives** - Following completion of the updated existing storm drainage analysis, the Project Team will commence the analyses of alternatives to address documented storm water infrastructure problems, including correction and future prevention. Proposed alternative improvements will be modeled using the previously prepared StormCAD models for existing infrastructure. Analysis of proposed storm water improvements will be conducted to accommodate a designated flood frequency within the proposed storm drain system, existing/proposed drainage easements, and/or existing street R.O.W.
    i. Alternatives for Storm Drains - Storm drain alternatives will be evaluated in accordance with hydraulic grade line (HGL) and energy grade line (EGL), flooding of structures on properties, street flooding, nuisance flooding, age and condition of storm drain system, right-of-way availability, conflicting utilities, and other impacts. The 100-year frequency event will be the design storm. If alternative improvements cannot be developed to adequately contain 100-year event, then the 10-year and 2-year events will be utilized for alternatives. Note: The City of Grand Prairie requires EGL to be 1-foot below top of pavement elevations.
    ii. Innovative Alternatives - Innovative alternatives that incorporate "non-traditional" ideas will be explored and compared with traditional solutions. For example, purchase of existing homes and properties for construction of a regional detention pond to reduce discharges, downstream pipe and culvert sizes, and lower flood profiles might be considered.
    iii. Preliminary Quantities and Estimates of Probable Cost – For selected alternative improvements, the Project Team will prepare preliminary quantities and estimates of probable cost to implement the conceptual plan(s). These estimates of probable cost will be prepared in a digital format (Excel spreadsheets) with pertinent information such as:
        1. Date of estimate and Adjustments for inflation

2. Costs for survey, design, ROW & Easement acquisition, utility relocations, construction management, and construction. Note: 25% contingency will be applied to construction cost estimates.

4. Channel Stability Assessment/Erosion Hazard Analysis

a. Hydraulics
   i. Execute HEC-RAS model with low flow and bank-full flow rates.
   ii. Tabulate and evaluate velocities, energy, and shear stress.
   iii. Confirm results with field observations (channel bends).
b. Geomorphology
   i. Conduct field reconnaissance to identify and obtain:
      1. Channel characteristics,
      2. Photos, and
      3. Identify/confirm problem areas, etc.
   ii. Conduct sedimentation/degradation analysis.
   iii. Review 1999 topography versus 2009 topography to determine potential erosion hazard zones
   iv. Review City standards to determine areas within erosion hazard zones
c. Prepare channel stability assessment/erosion hazard analysis report
d. Evaluate erosive properties of existing TRA aerial wastewater crossings
e. Prepare stream bank restoration improvement alternatives (provide preliminary quantities/estimates of probable cost per Section 8)

5. Dams/Levees/Detention/Drainage Reviews

a. Prepare GIS maps showing locations/descriptions of existing dams, levees, retention and detention areas within the Dry Branch Master Plan area. Include separate layers for private and public detention ponds. Work with City GIS staff on GIS development of these layers.
b. Prepare detailed summary of existing drainage plan reviews prepared by Halff denoting project name, City project number, description of review, and if detention was included in the project
c. Obtain plans containing detention ponds and make field visits to verify detention ponds have been constructed according to as-built plans
   i. Document detention ponds with photos
   ii. Describe any problems associated with detention ponds (maintenance issues, outfall issues, etc.)

6. GIS Updates

a. Help identify, if detected, drainage features that are missing from GIS database or shown/labeled incorrectly in GIS database and report to the City. Update missing information accordingly. Note: This task does not include verification that all existing GIS drainage features are correct or physical field inspection of the entire system to ensure accuracy. The intent is to determine missing features or incorrect features as noticed by the Project Teams

b. Based on as-built plans, identify age of all systems (see Section 3)

c. Identify wetland and riparian areas, utilizing Wetland Inventory Maps and visual inspection

7. Maintenance – Dry Branch Watershed

a. Identify and evaluate types and locations of areas where maintenance needs to occur (storm drain outfalls, inlets, culverts, natural channels, open channels, bridges, etc.) in the Dry Branch Master Plan area. **Obtain City Database on investigation of outfalls in the City.**

b. Storm Drain Outfall Field Assessment – Utilizing the City of Grand Prairie's database of field-checked storm drain outfalls for the entire City, establish criteria to rank outfalls based on necessity to repair, provide preliminary ranking of outfalls needing repair, and provide summary report of rankings for the Dry Branch Master Plan area

c. Develop schedule for maintenance within the Dry Branch Master Plan area

8. Preliminary Quantities/Estimates of Probable Cost

a. Preliminary Quantities and Estimates of Probable Cost – For selected alternative improvements, the Project Team will prepare preliminary quantities and estimates of probable cost to implement the conceptual plan(s). These estimates of probable cost will be prepared in a digital format (Excel spreadsheets) with pertinent information such as

- Date of estimate and Adjustments for inflation
- Costs for survey, design, ROW & Easement acquisition, utility relocations, construction management, and construction

9. Evaluation & Prioritization/Phasing & Implementation

a. Evaluation and Prioritization - Formalize a set of plans/recommendations in a report and assist City in developing rating criteria for channel and storm drain improvement alternatives in the Dry Branch Master Plan area. Develop a rating system to allow planning for future funding (refer to Section II.G of the City-Wide Drainage Master Plan Road Map). Projects, both small projects, medium projects, and large projects will then be **evaluated and prioritized** based on:

1. Levels of damage and value of homes flooded or endangered;
   a. Develop spreadsheet, to include Lowest Adjacent Grade, BFE, Structure Value, and Level of damage (# homes/damage value ($) for various flooding events, including (if available) 10-year, 25-year, 50-year, and 100-year)
2. Number of people and properties affected;
3. Life safety, prevent loss of life and minimize property damage;
4. Level of protection provided by plan;
5. Practicality and implementability,
6. Mobility (keeping main arterials open to traffic);
7. Maintaining access to public buildings, especially hospitals, fire and police departments, etc.

8. Environmental considerations (such as 404 permits, stream corridor maintenance);
9. Private-public relationships and funding agreements;
10. Available funding, participation in funding by others (TWDB, Corps, etc.), and;
11. The highest projected benefit-to-cost ratios.
12. Neighborhood Enhancement – Improve aesthetics, livability, and well-being of Grand Prairie citizens/residents;
13. Availability of Right-of-Way/Easements – Minimize disruption to property and structures.

Note: Weighting for each criteria shall be recommended to and approved by the City prior to prioritization of alternatives.

b. Phasing and Implementation - The Study Team will then assist and advise City staff in developing phasing and implementation plans and prioritizing proposed improvement projects for future CIP and related funding.

The goal is to incorporate CIPs from this study into an overall phasing and implementation plan with other drainage-related CIPs throughout the City in various other watersheds. The resulting City of Grand Prairie dataset for CIPs would be completely digital and geo-referenced, with documented spatial data, hydrologic and hydraulic data, and other features for ease of future updates.

10. Short Term Priorities & Long Term Plan

a. Short Term Priorities – Develop strategy for immediate implementation of key projects developed for the Dry Branch Master Plan. Focus on:

i. Cost/benefit ratio of proposed improvements. Weigh the flood control benefits against project costs
ii. Develop Project Improvement Needs & Prioritization List, including small projects (<$200,000), medium projects ($200,000 to $500,000), and larger projects (>$500,000)

b. Long Term Plan – Develop strategy for long term implementation of identified prioritized projects developed for the Dry Branch Master Plan. Focus on:

i. Longer range plans for larger projects, including phasing (if possible). Provide cost breakdown of phasing and time-frame for implementation.

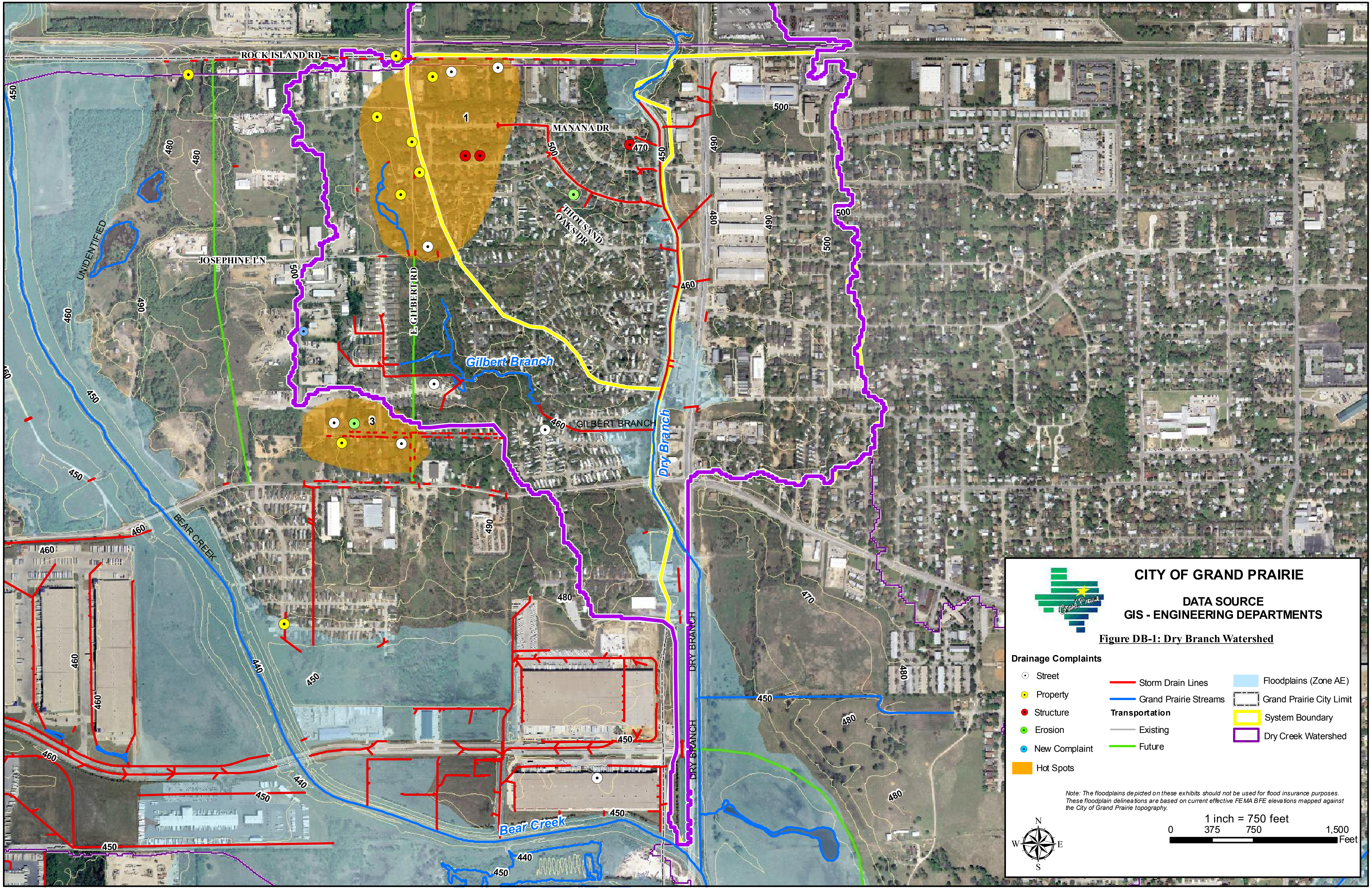
This implementation plan would be coordinated with the future funding plan for the City-wide study.

11. City-wide Drainage Master Plan Documentation

Incorporate Dry Branch Master Plan data into City-wide Drainage Master Plan Documentation.

12. Project Management/Coordination

a. Project Management – Engineer shall provide project status reports, project schedule updates, and perform personnel and data management during course of project. Engineer shall attend a project kickoff meeting, prepare and lead any project status meetings, and prepare meeting minutes of each meeting to submit to the City. Engineer will fully document all hardware, software, file structures, and data formats used during the project.
b. QA/QC – Engineer shall develop a QA/QC procedure to include a multi-level approach to ensure that scope of work components are reviewed and approved.
c. Public Involvement Program: City Council Briefing Session - Develop schedule, set up and conduct a final workshop with the City Council and certain department leaders after study completion. Provide the council with an overview of drainage and flooding issues, study results, and recommendations.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Street
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New Complaint
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Grand Prairie City Limit
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Dry Creek Watershed
Note: The floodplains depicted on these exhibits should not be used for flood insurance purposes. These floodplain delineations are based on current effective FEMA BFE elevations mapped against the City of Grand Prairie topography.
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Feet
N
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JOSEPHINE LN
E GILBERT RD
Gilbert Branch
GILBERT BRANCH
Dry Branch
DRY BRANCH
BEAR CREEK
Bear Creek
UNIDENTIFIED
1
3

APPENDIX N
ALSPAUGH BRANCH

ALSPAUGH BRANCH MASTER PLAN
SCOPE OF WORK

A. GENERAL DESCRIPTION

The Alspaugh Branch watershed is located south of IH-20 and north of Joe Pool Lake. Drainage generally travels from west to east through a series of ponds, storm drains, culverts, and open channel from Lakeridge Parkway to Camp Wisdom Road to Mountain Creek (downstream of Joe Pool Outlet Works).

B. DRAINAGE COMPLAINT DATABASE

Twenty-two (22) drainage complaints at sixteen (16) different locations have been filed with the City from 1986 to 2007 within this watershed. Of these complaints, one (1) was a street flooding problem, seven (7) were property flooding problems, and fourteen (14) were structure flooding problems. One complaint has been filed since November 2006 (1121 Alspaugh Lane). No hot spots, based on drainage complaints, were identified for this watershed. **Note: It is the responsibility of the consultant to obtain the latest information from the City database and evaluate all current drainage complaints at time of study.**

C. EXISTING DATA AVAILABLE

- Alspaugh Branch Master Drainage Plan - Kimley Horn (May 2002)
  - The purpose of this study was to evaluate existing and fully developed flooding hazards in the Alspaugh Branch watershed and to develop an overall Master Drainage Plan for the watershed. All major crossings are overtopped by fully developed discharges and the recommendations include culvert improvements or raising road profiles.
- Alspaugh Branch Master Drainage Plan - UPDATE – Kimley Horn (April 2003)
  - The purpose of this report was to properly account for developments in the western end of the watershed that were not proposed when the Alspaugh Master Drainage Plan was published. The results were similar to before, and recommendations included were culvert improvements or raising road profiles.
- Alspaugh Branch current effective FEMA hydraulic HEC-2 model (currently in hard copy format only)

Note: Existing Data Available will be provided to consultant on a CD or DVD, including PDFs of report/figures and technical data available

D. UNIQUE ATTRIBUTES OF ALSPAUGH BRANCH

- From Lakeridge Parkway to Camp Wisdom Road, Alspaugh Branch traverses through development by a series of ponds and culverts. Alspaugh Branch then enters a box culvert system at Camp Wisdom Road that outfalls to another pond east of Prairie Lane. Downstream of this pond, Alspaugh Branch is a natural channel until its confluence with Mountain Creek.
- Along Alspaugh Lane, new inlets have been constructed along the existing ditches (to be incorporated into City GIS database).

- Existing Road Crossings of Alspaugh Branch (channel) – Robinson Road & Camp Wisdom Road
- Detention/Retention Areas
  - Two small ponds west of Lakeridge Parkway
  - Linear pond east of Lakeridge Parkway
  - Pond east of Prairie Lane

E. Scope of Work

1. Data Collection

a. Obtain all available information, including hydrologic & hydraulic models, topographic information, studies, as-built bridge/culvert plans, property information, available LOMRs, etc.

b. Coordinate with the City to obtain additional survey data for pertinent structures and/or locations along the study reach.

2. Hydrologic & Hydraulic Studies - Streams and Open Channel

a. <u>Develop new and/or updated hydrologic models</u> - New HEC-HMS models will be developed (or updated as necessary), replacing any currently effective NUDALLAS and HEC-1 models. Analysis will include existing and future land-use conditions. Any new hydrologic models will be prepared with H&H modeling tools (Geo-HMS), procedures, and GIS tools. A frequency analysis of the existing 2-, 5-, 10-, 25-, 50-, 100-, and 500-year floods and ultimate 100-year flood will be made, at a minimum. Engineer shall utilize current Drainage Criteria Manual information for hydrologic parameters. Modified Puls shall be the methodology used for routing.

b. <u>Develop new and/or updated floodplain hydraulic models</u> – New HEC-RAS models will be developed (or updated as necessary). Any new hydraulic models will be prepared with H&H modeling tools (Geo-RAS), procedures, and GIS tools. <u>As needed, new structures, bridges/culverts, channelization, channel cross-sections, aerial crossings and ponds will be field surveyed and incorporated into the updated H&H analyses</u>. Floodway analyses will be performed, as necessary. Prepare rating curves for City rain & stream gauges along Alspaugh Branch.

- <u>Erosion/Sedimentation Assessment of Hydraulic Models (for Section 4)</u>
  - Review all models in watershed and provide a summary table of the following:
    - Reaches where high channel velocities exist (erosion) for 10-yr event
    - Reaches where low channel velocities exist (sedimentation) for 10-yr event
    - Location of natural meanders of stream
    - Location of steep natural channel sections (describe average slope between two hard points, such as two culverts, along the channel)
    - Location of all existing TRA aerial crossings (based on field surveys and record drawings) – Describe erosive velocities for all frequency events.
  - Describe any field observations of stream, including locations of downcutting, locations of widening, knickpoints in channel flowline, locations of trees falling

into channel, locations of trees with exposed roots, locations of wedge failures, locations of erosion at sanitary sewer aerial crossings, locations of undermining of storm drain outfalls, fences and/or structures close to erosion areas that have potential for failure or damage due to further erosion, etc. (and any other types of erosion that was observed). Include labeled photos, if available.

c. Develop new and updated floodplain mapping – Consolidate, make consistent, update as needed, and provide updated City-wide coverage of the Alspaugh Branch floodplain in Grand Prairie. Updated floodplains will be delineated using digital terrain data from the best available topography and integrated into the City's GIS. The primary goal is to establish ultimate 100-year floodplain delineations with Base Flood Elevations shown, but also additional delineations, including existing 100-year & 500-year and floodway delineations for incorporation into FEMA mapping. Updated data will be incorporated into FEMA mapping by the LOMR process (Dallas County). GIS shapefiles of floodplain delineations will be provided to the City

LOMR Submittals

- Prepare brief letter report of project purpose, procedures, and results
- Prepare flood elevation tables, floodway data tables, flood profiles (RASPLOT), hydraulic work maps, and revised FEMA FIRM maps.
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- Deliver two (2) copies of the Final LOMR Report to the City of Grand Prairie
- Work with City staff on submittal to FEMA
- Export electronic files (HEC-RAS, Word, CADD, GIS, and PDF) to CD and submit to City of Grand Prairie
- Prepare templates and tabulate information for public notification, including individual property owner notification and public notice for floodway revision. The City of Grand Prairie will distribute all public notifications to individual property owners and post the public notice. Note: If properties are affected by revised floodplain elevations, engineer shall survey finished floor elevations (lowest adjacent grade) of all structures in the revised floodplain limits.
- Coordinate with the City of Grand Prairie and FEMA/Technical Reviewer (via telephone and email) to address comments and questions.
- Note: Fees for review of LOMR applications are not included in scope of work

Elevation Certificates

- Identify property locations of structures within updated existing 100-year (1% annual chance) floodplain limits.
- Identify structures on each property that serve as the primary residence or primary use to commercial/industrial sites. For these structures, prepare field surveys of finished flood and lowest adjacent grades around structures.
- All other insurable structures found to be within the limits of the 100-year (1% annual chance) floodplain will be identified and submitted to the City Floodplain

Administrator for approval before proceeding with surveying and preparation of the elevation certificate.

- Necessary paperwork for Elevation Certificates will be per current FEMA standards
- Upon completion, prepare overall map of Elevation Certificate locations along the floodplain and submit to City along with completed Elevation Certificates.

e. Roadway Crossings

- Evaluate and tabulate flood frequency capacity of existing roadway crossings for Alspaugh Branch – This information will be utilized to determine if existing roadway crossings need to be improved for 100-year flood protection
- Project Team shall analyze future roadway crossings of existing streams based on City Master Thoroughfare Plan and size crossings for future 100-year flood frequency capacity

f. Alternatives for Streams and Open Channels

- Stream and Open channel alternatives will be evaluated in accordance with:
  - Flood Profile Impacts
  - Valley Storage (downstream impacts)
  - Environmental Quality
  - Channel Stability/Erosion (channel armor and bio-engineering solutions)
  - Bridge/Culvert Improvements
  - Future TRA aerial wastewater crossings
  - Corps Section 404 Permit Requirements
  - Cost (construction, ROW, engineering, operations, and maintenance).
  - Non-structural & structural improvements will be considered for practicality, economics, necessity, impacts to mobility, environmental concerns, etc.

3. Storm Drainage Infrastructure Analysis

- **Overview -** Storm drainage network models will be prepared utilizing a City-wide Storm Water Infrastructure GIS database and existing record plans. It is not anticipated that field surveys will supplement the storm drainage studies. If necessary and approved by the City, field surveys will be conducted to accurately locate drainage infrastructure.
  - i. Analysis of storm drainage pipe networks will focus on all Alspaugh Branch storm water sub-basins as shown in the attached map (approximate locations are shown for now). Sub-basins are classified as: 1) "Simple system/small basin", 2) "Simple system/large basin", and 3) "Complex system" (small or large basin)
  - ii. Additional **"Hot Spot"** locations have been identified where the existing underground drainage system is inadequate and/or frequent flooding occurs. These "Hot Spot" locations are based on drainage complaints within the watershed.
  - iii. The age of each storm drainage pipe network will be determined utilizing as-built dates from GIS database (if available)

iv. Storm water sub-basin delineations will be accurately defined for each storm drain area studied in detail. City GIS data will be utilized.
v. Design discharges will be based on current City criteria: For areas less than 200 acres, the rational method will be utilized and for areas greater than 200 acres, unit hydrograph techniques shall be utilized (HEC-HMS shall be model utilized for this determination).
vi. For storm drain analysis and recommendations for design improvements, the most recent version of the computer program **StormCAD** shall be used.

- **Existing Capacity Analysis** - The capacity of existing streets and underground storm drainage pipe networks, along with flood frequency that the system can contain, will be computed, as best that can be determined using StormCAD. The results of the storm drainage system analysis will be documented and incorporated into the City's Storm Water Infrastructure GIS database. For this task, Project Team will use StormCAD to model the "trunk" line (s) of the primary system or systems in the previously defined storm water sub-basin. It is the Project Team's responsibility to define the limits of the "trunk" line(s) for each sub-basin and determine if additional lateral lines (draining 20% or more of the basin) need to be modeled.
- **Optimization Analysis** - An attempt to "optimize" existing storm drainage systems will be included in the analysis. Determine where added inlets or detention, at critical points along the system, will ensure that it is optimized for the lower (as well as the higher) frequency floods. These would be categorized as "smaller projects" for the City to designate and prioritize.
- **City Coordination** - The Project Team will meet with City staff to help confirm and identify problem areas. The updated Storm Water Infrastructure GIS will then be overlaid with property maps to help classify problem areas as "public or private." This data will then be incorporated into the City's Storm Water Infrastructure GIS database. It will include information such as: coordinates (horizontal and vertical location), pipe size, material, and slope.
- **Analysis of Alternatives** - Following completion of the updated existing storm drainage analysis, the Project Team will commence the analyses of alternatives to address documented storm water infrastructure problems, including correction and future prevention. Proposed alternative improvements will be modeled using the previously prepared StormCAD models for existing infrastructure. Analysis of proposed storm water improvements will be conducted to accommodate a designated flood frequency within the proposed storm drain system, existing/proposed drainage easements, and/or existing street R.O.W.

i. Alternatives for Storm Drains - Storm drain alternatives will be evaluated in accordance with hydraulic grade line (HGL) and energy grade line (EGL), flooding of structures on properties, street flooding, nuisance flooding, age and condition of storm drain system, right-of-way availability, conflicting utilities, and other impacts. The 100-year frequency event will be the design storm. If alternative improvements cannot be developed to adequately contain 100-year event, then the 10-year and 2-year events will be utilized for alternatives. Note: The City of Grand Prairie requires EGL to be 1-foot below top of pavement elevations.
ii. Innovative Alternatives - Innovative alternatives that incorporate "non-traditional" ideas will be explored and compared with traditional solutions. For

example, purchase of existing homes and properties for construction of a regional detention pond to reduce discharges, downstream pipe and culvert sizes, and lower flood profiles might be considered.

iii. Preliminary Quantities and Estimates of Probable Cost – For selected alternative improvements, the Project Team will prepare preliminary quantities and estimates of probable cost to implement the conceptual plan(s). These estimates of probable cost will be prepared in a digital format (Excel spreadsheets) with pertinent information such as:
   1. Date of estimate and Adjustments for inflation
   2. Costs for survey, design, ROW & Easement acquisition, utility relocations, construction management, and construction. Note: 25% contingency will be applied to construction cost estimates.

4. Channel Stability Assessment/Erosion Hazard Analysis

a. Hydraulics
   i. Execute HEC-RAS model with low flow and bank-full flow rates.
   ii. Tabulate and evaluate velocities, energy, and shear stress.
   iii. Confirm results with field observations (channel bends).
b. Geomorphology
   i. Conduct field reconnaissance to identify and obtain:
      1. Channel characteristics,
      2. Photos, and
      3. Identify/confirm problem areas, etc.
   ii. Conduct sedimentation/degradation analysis.
   iii. Review 1999 topography versus 2009 topography to determine potential erosion hazard zones
   iv. Review City standards to determine areas within erosion hazard zones
c. Prepare channel stability assessment/erosion hazard analysis report
d. Evaluate erosive properties of existing TRA aerial wastewater crossings
e. Prepare stream bank restoration improvement alternatives (provide preliminary quantities/estimates of probable cost per Section 8)

5. Dams/Levees/Detention/Drainage Reviews

a. Prepare GIS maps showing locations/descriptions of existing dams, levees, retention and detention areas within the Alspaugh Branch Master Plan area. Include separate layers for private and public detention ponds. Work with City GIS staff on GIS development of these layers.
b. Prepare detailed summary of existing drainage plan reviews prepared by Halff denoting project name, City project number, description of review, and if detention was included in the project
c. Obtain plans containing detention ponds and make field visits to verify detention ponds have been constructed according to as-built plans
   i. Document detention ponds with photos
   ii. Describe any problems associated with detention ponds (maintenance issues, outfall issues, etc.)

6. GIS Updates

a. Help identify, if detected, drainage features that are missing from GIS database or shown/labeled incorrectly in GIS database and report to the City. Update missing information accordingly. Note: This task does not include verification that all existing GIS drainage features are correct or physical field inspection of the entire system to ensure accuracy. The intent is to determine missing features or incorrect features as noticed by the Project Teams

b. Based on as-built plans, identify age of all systems (see Section 3)

c. Identify wetland and riparian areas, utilizing Wetland Inventory Maps and visual inspection

7. Maintenance – Alspaugh Branch Watershed

a. Identify and evaluate types and locations of areas where maintenance needs to occur (storm drain outfalls, inlets, culverts, natural channels, open channels, bridges, etc.) in the Alspaugh Branch Master Plan area. **Obtain City Database on investigation of outfalls in the City.**

b. Storm Drain Outfall Field Assessment – Utilizing the City of Grand Prairie's database of field-checked storm drain outfalls for the entire City, establish criteria to rank outfalls based on necessity to repair, provide preliminary ranking of outfalls needing repair, and provide summary report of rankings for the Alspaugh Branch Master Plan area

c. Develop schedule for maintenance within the Alspaugh Branch Master Plan area

8. Preliminary Quantities/Estimates of Probable Cost

a. Preliminary Quantities and Estimates of Probable Cost – For selected alternative improvements, the Project Team will prepare preliminary quantities and estimates of probable cost to implement the conceptual plan(s). These estimates of probable cost will be prepared in a digital format (Excel spreadsheets) with pertinent information such as

- Date of estimate and Adjustments for inflation
- Costs for survey, design, ROW & Easement acquisition, utility relocations, construction management, and construction

9. Evaluation & Prioritization/Phasing & Implementation

a. Evaluation and Prioritization - Formalize a set of plans/recommendations in a report and assist City in developing rating criteria for channel and storm drain improvement alternatives in the Alspaugh Branch Master Plan area. Develop a rating system to allow planning for future funding (refer to Section II.G of the City-Wide Drainage Master Plan Road Map). Projects, both small projects, medium projects, and large projects will then be **evaluated and prioritized** based on:

1. Levels of damage and value of homes flooded or endangered;

a. Develop spreadsheet, to include Lowest Adjacent Grade, BFE, Structure Value, and Level of damage (# homes/damage value ($) for various flooding events, including (if available) 10-year, 25-year, 50-year, and 100-year)

2. Number of people and properties affected;
3. Life safety, prevent loss of life and minimize property damage;
4. Level of protection provided by plan;
5. Practicality and implementability,
6. Mobility (keeping main arterials open to traffic);
7. Maintaining access to public buildings, especially hospitals, fire and police departments, etc.
8. Environmental considerations (such as 404 permits, stream corridor maintenance);
9. Private-public relationships and funding agreements;
10. Available funding, participation in funding by others (TWDB, Corps, etc.), and;
11. The highest projected benefit-to-cost ratios.
12. Neighborhood Enhancement – Improve aesthetics, livability, and well-being of Grand Prairie citizens/residents;
13. Availability of Right-of-Way/Easements – Minimize disruption to property and structures.

Note: Weighting for each criteria shall be recommended to and approved by the City prior to prioritization of alternatives.

b. Phasing and Implementation - The Study Team will then assist and advise City staff in developing phasing and implementation plans and prioritizing proposed improvement projects for future CIP and related funding.

The goal is to incorporate CIPs from this study into an overall phasing and implementation plan with other drainage-related CIPs throughout the City in various other watersheds. The resulting City of Grand Prairie dataset for CIPs would be completely digital and geo-referenced, with documented spatial data, hydrologic and hydraulic data, and other features for ease of future updates.

10. Short Term Priorities & Long Term Plan

a. Short Term Priorities – Develop strategy for immediate implementation of key projects developed for the Alspaugh Branch Master Plan. Focus on:

i. Cost/benefit ratio of proposed improvements. Weigh the flood control benefits against project costs
ii. Develop Project Improvement Needs & Prioritization List, including small projects (<$200,000), medium projects ($200,000 to $500,000), and larger projects (>$500,000)

b. Long Term Plan – Develop strategy for long term implementation of identified prioritized projects developed for the Alspaugh Branch Master Plan. Focus on:

i. Longer range plans for larger projects, including phasing (if possible). Provide cost breakdown of phasing and time-frame for implementation.

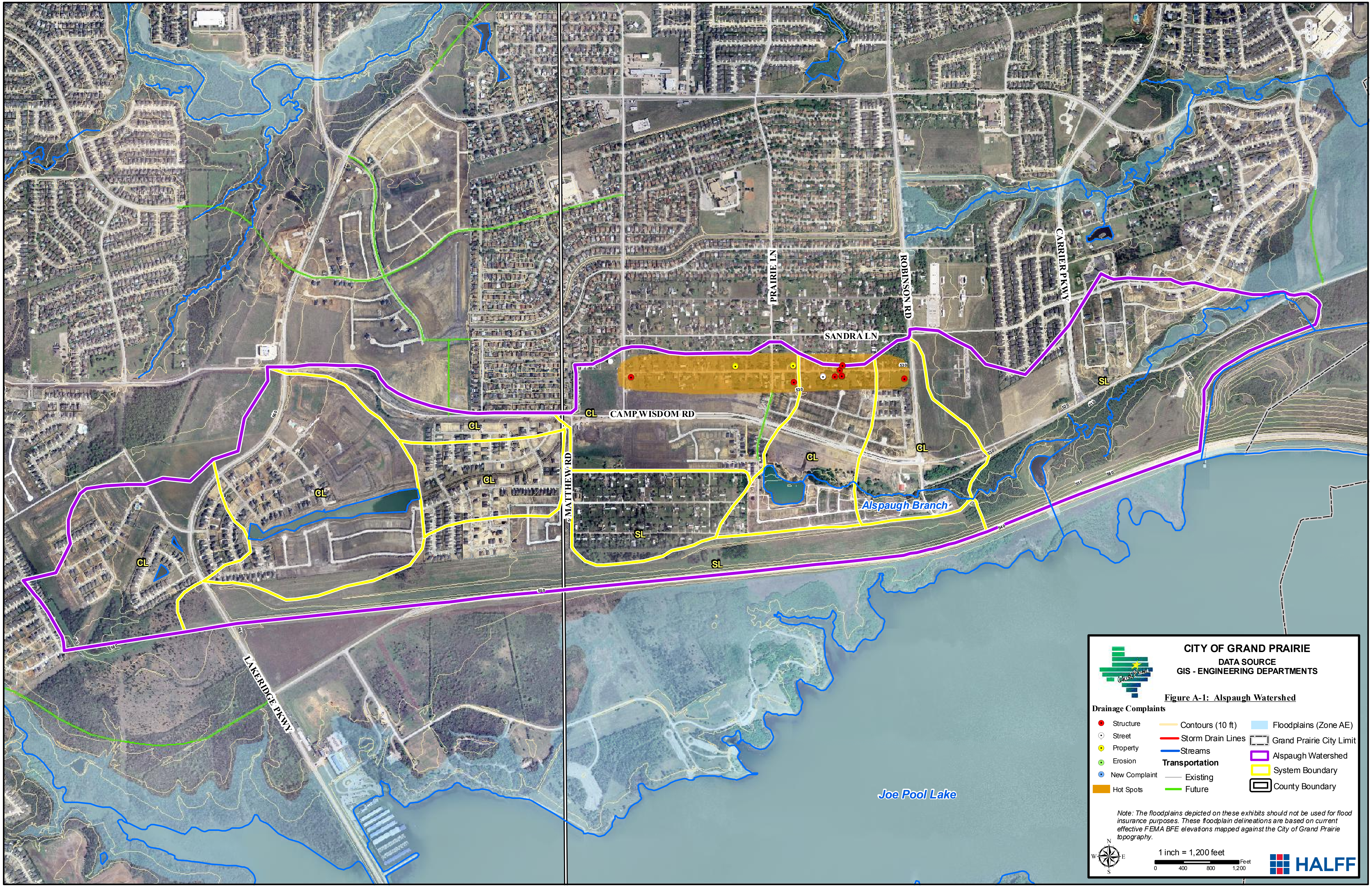
This implementation plan would be coordinated with the future funding plan for the City-wide study.

11. City-wide Drainage Master Plan Documentation

Incorporate Alspaugh Branch Master Plan data into City-wide Drainage Master Plan Documentation.

12. Project Management/Coordination

- **a.** Project Management – Engineer shall provide project status reports, project schedule updates, and perform personnel and data management during course of project. Engineer shall attend a project kickoff meeting, prepare and lead any project status meetings, and prepare meeting minutes of each meeting to submit to the City. Engineer will fully document all hardware, software, file structures, and data formats used during the project.
- **b.** QA/QC – Engineer shall develop a QA/QC procedure to include a multi-level approach to ensure that scope of work components are reviewed and approved.
- **c.** Public Involvement Program: City Council Briefing Session - Develop schedule, set up and conduct a final workshop with the City Council and certain department leaders after study completion. Provide the council with an overview of drainage and flooding issues, study results, and recommendations.



PRAIRIE LN
ROBINSON RD
CARRIER PKWY
SANDRA LN
CAMP WISDOM RD
MATTHEW RD
LAKERIDGE PKWY
CL
SL
Alspaugh Branch
Joe Pool Lake
CITY OF GRAND PRAIRIE
DATA SOURCE
GIS - ENGINEERING DEPARTMENTS
Figure A-1: Alspaugh Watershed
Drainage Complaints
Structure
Street
Property
Erosion
New Complaint
Hot Spots
Contours (10 ft)
Storm Drain Lines
Streams
Transportation
Existing
Future
Floodplains (Zone AE)
Grand Prairie City Limit
Alspaugh Watershed
System Boundary
County Boundary
Note: The floodplains depicted on these exhibits should not be used for flood insurance purposes. These floodplain delineations are based on current effective FEMA BFE elevations mapped against the City of Grand Prairie topography.
1 inch = 1,200 feet
Feet
0 400 800 1,200
HALFF

APPENDIX O
DFIRMS
TARRANT COUNTY (FINAL)
DALLAS, ELLIS & JOHNSON COUNTY (PRELIMINARY)

DFIRMS
TARRANT COUNTY

NOTES TO USERS

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

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

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NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC–3, #9202
1315 East–West Highway
Silver Spring, MD 20910–3282

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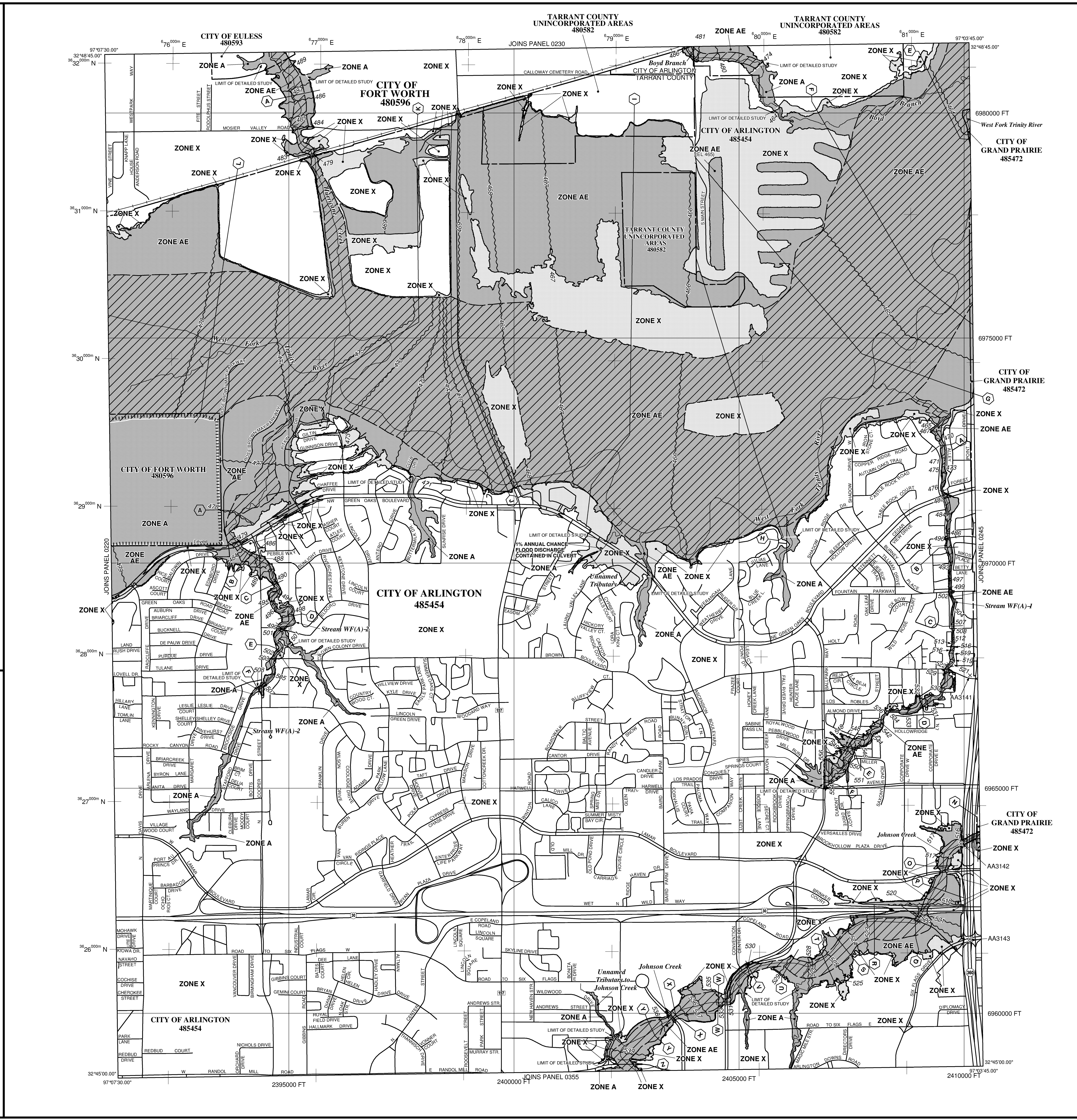

LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 - - - 23	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
42 75 000m N	1000-meter Universal Transverse Mercator grid ticks, zone 14
6000000 FT	5000-foot grid values: Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
January 6, 1993
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
August 02, 1995
August 23, 2000
September 25, 2009 –to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to revise vertical datum, to update roads and road names, to incorporate previously issued Letters of Map Revision, and to reflect updated topographic information.

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

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

N

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0240K

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

PANEL 240 OF 495
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
TARRANT COUNTY	480582	0240	K
ARLINGTON, CITY OF	485454	0240	K
EULESS, CITY OF	480593	0240	K
FORT WORTH, CITY OF	480596	0240	K
GRAND PRAIRIE, CITY OF	485472	0240	K

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

U.S. DEPARTMENT OF HOMELAND SECURITY

MAP NUMBER
48439C0240K

MAP REVISED
SEPTEMBER 25, 2009

Federal Emergency Management Agency

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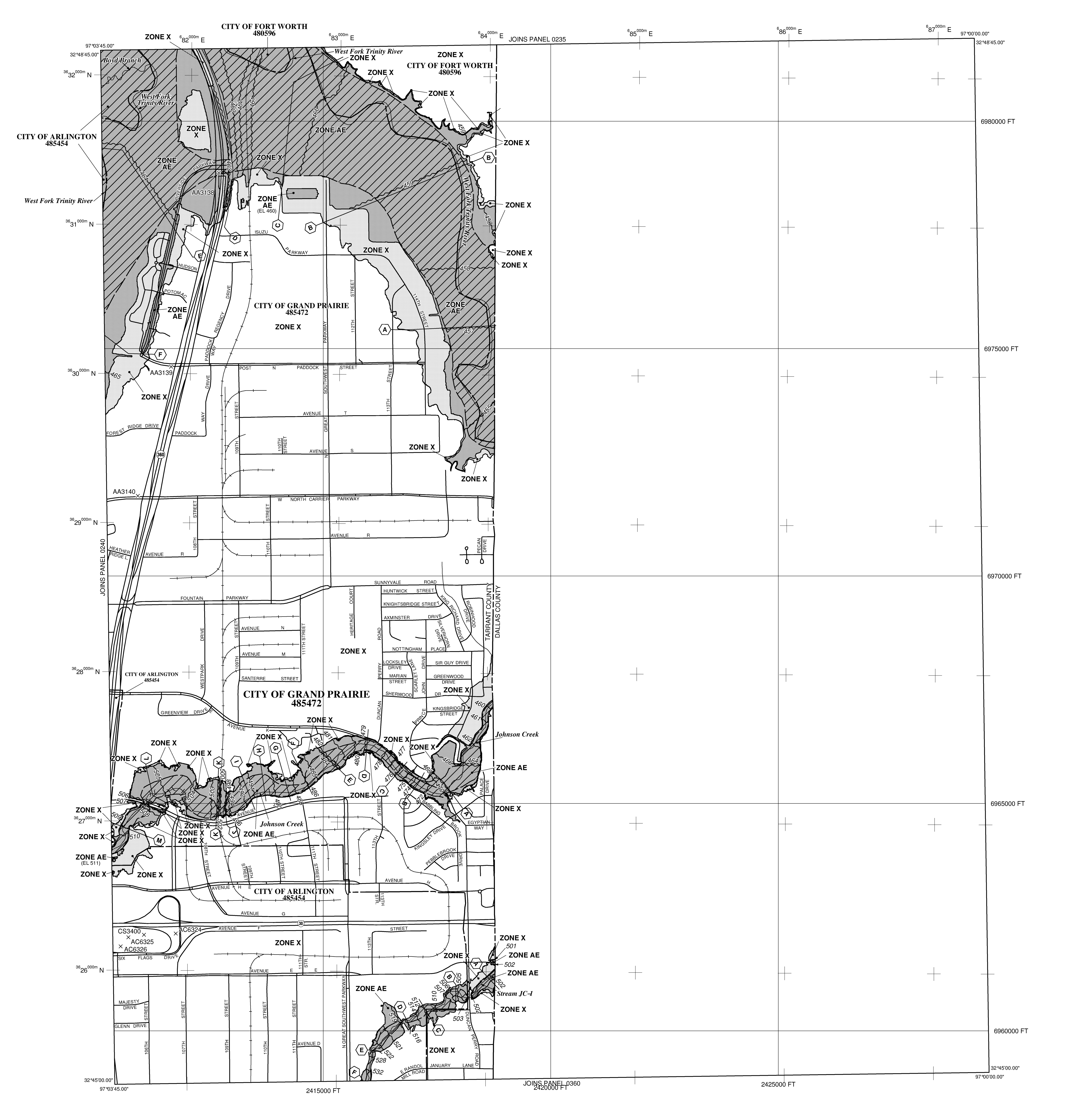

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ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

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

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 - - - 23	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000mN	1000-meter Universal Transverse Mercator grid ticks, zone 14
6000000 FT	5000-foot grid values: Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
January 6, 1993
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
August 02, 1995
August 23, 2000
September 25, 2009 -to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to revise vertical datum, to update roads and road names, to incorporate previously issued Letters of Map Revision, and to reflect updated topographic information.

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

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

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0245K

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

PANEL 245 OF 495
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ARLINGTON, CITY OF	485454	0245	K
FORT WORTH, CITY OF	480596	0245	K
GRAND PRAIRIE, CITY OF	485472	0245	K

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
48439C0245K

MAP REVISED
SEPTEMBER 25, 2009

Federal Emergency Management Agency

NOTES TO USERS

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

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

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The **projection** used in the preparation of this map was Texas State Plane north central zone (FIPSZONE 4202). The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

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

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

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

Base map information shown on this FIRM was provided in digital format by NCTCOG. This information was digitized at a scale of at least 1: 12,000 from aerial photography dated 2003.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *in the Flood Insurance Study report (which contains authoritative hydraulic data*) may reflect stream channel distances that differ from what is shown on this map.

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Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, *a Flood Insurance Study report*, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

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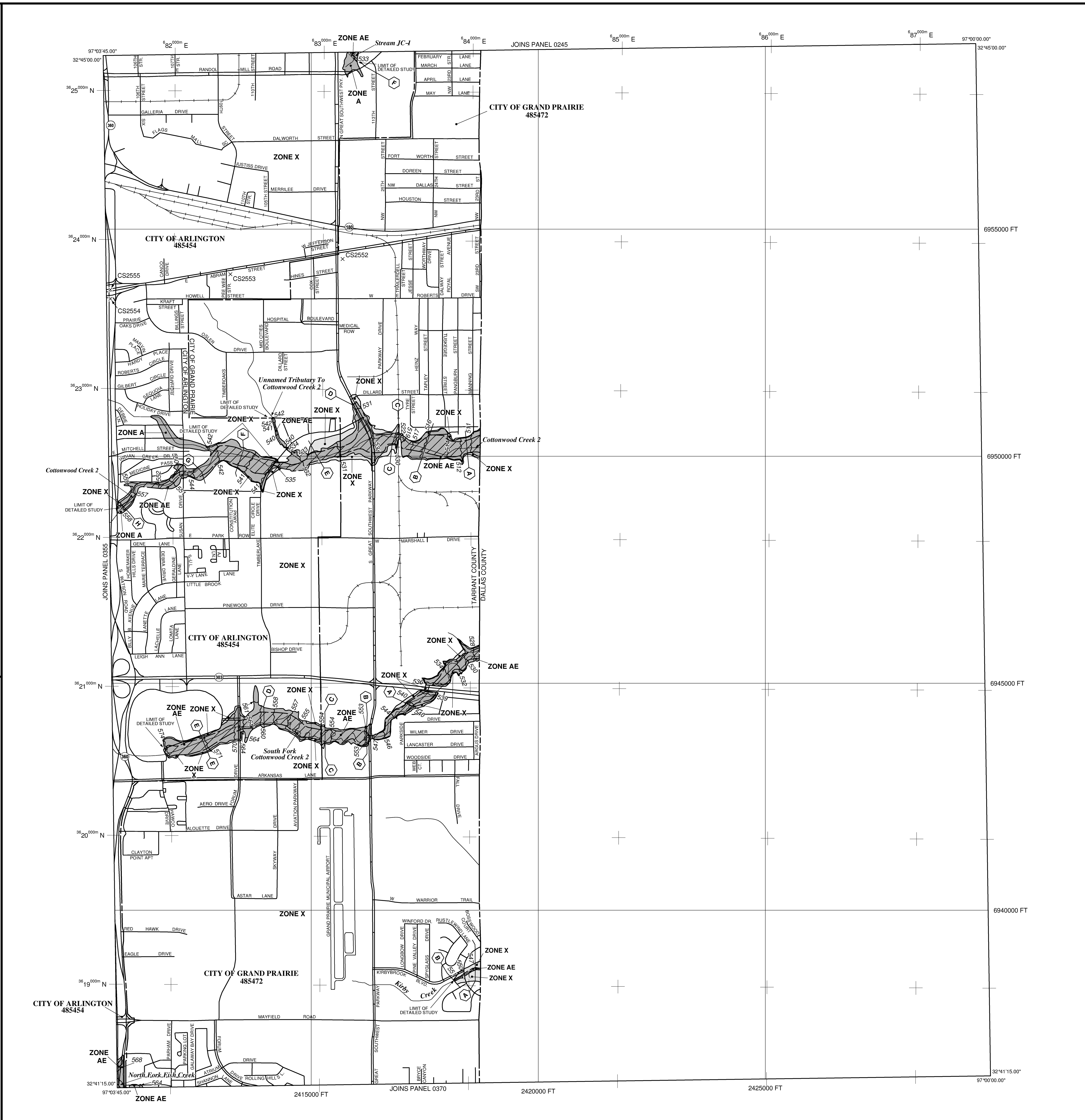

LEGEND

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

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

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
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ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
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ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

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

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 - - - 23	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 14
6000000 FT	5000-foot grid values: Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
January 6, 1993
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
August 02, 1995 August 23, 2000
September 25, 2009 -to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to revise vertical datum, to update roads and road names, to incorporate previously issued Letters of Map Revision, and to reflect updated topographic information.

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

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

N

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0360K

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

PANEL 360 OF 495
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ARLINGTON, CITY OF	485454	0360	K
GRAND PRAIRIE, CITY OF	485472	0360	K

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
48439C0360K

MAP REVISED
SEPTEMBER 25, 2009

Federal Emergency Management Agency

NOTES TO USERS

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

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NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

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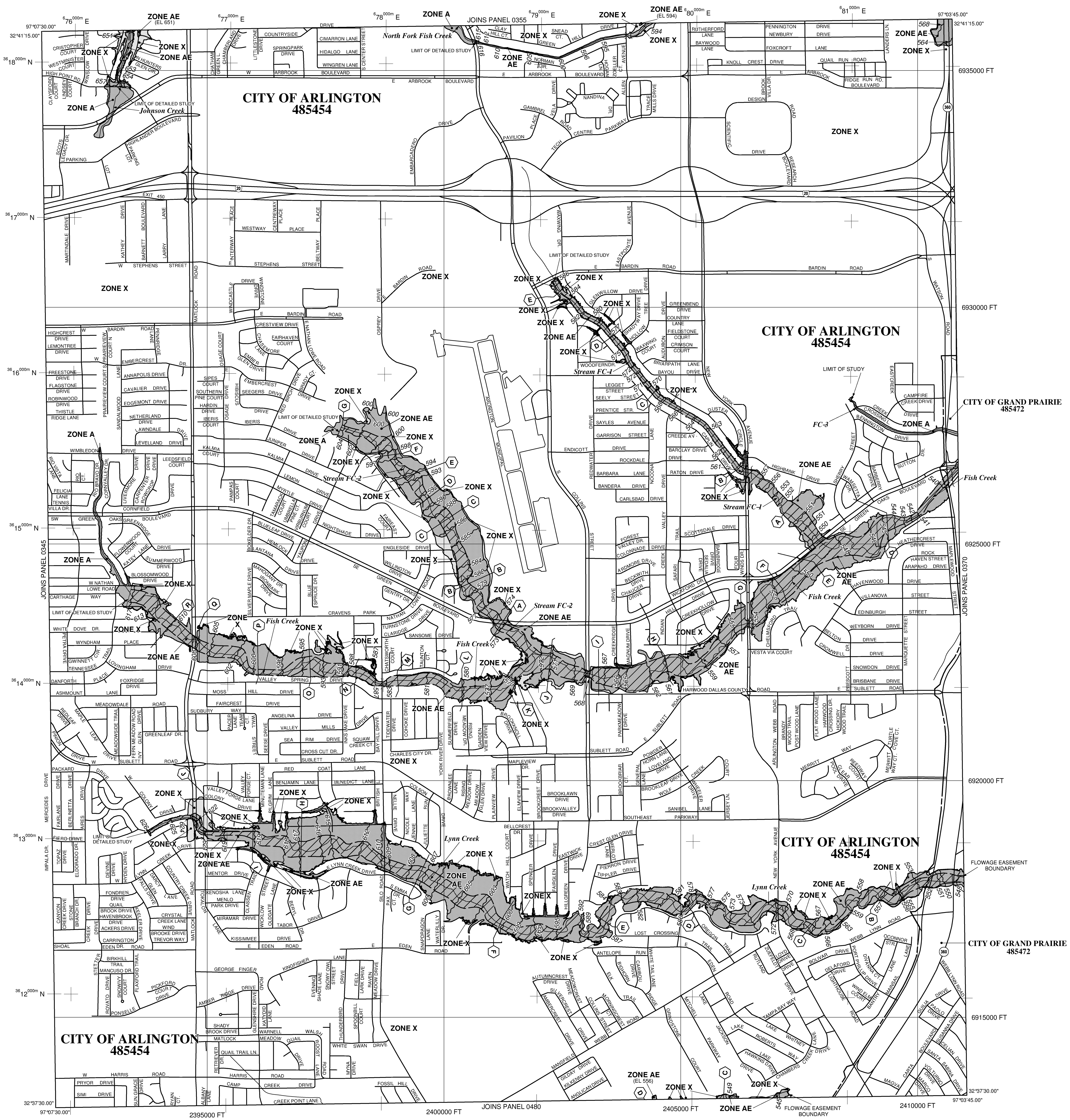

LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

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

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A —— A	Cross section line
23 - - - - 23	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 14
6000000 FT	5000-foot grid values: Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
January 6, 1993
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
August 02, 1995
August 23, 2000
September 25, 2009 -to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to revise vertical datum, to update roads and road names, to incorporate previously issued Letters of Map Revision, and to reflect updated topographic information.

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MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0365K

FIRM

FLOOD INSURANCE RATE MAP

TARRANT COUNTY, TEXAS

AND INCORPORATED AREAS

PANEL 365 OF 495

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ARLINGTON, CITY OF	485454	0365	K
GRAND PRAIRIE, CITY OF	485472	0365	K

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
48439C0365K

MAP REVISED
SEPTEMBER 25, 2009

Federal Emergency Management Agency

NOTES TO USERS

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LEGEND

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COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 14
6000000 FT	5000-foot grid values: Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
January 6, 1993
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

August 02, 1995
August 23, 2000
September 25, 2009 –to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to revise vertical datum, to update roads and road names, to incorporate previously issued Letters of Map Revision, and to reflect updated topographic information.

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

N

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0370K

FIRM

FLOOD INSURANCE RATE MAP

TARRANT COUNTY, TEXAS

AND INCORPORATED AREAS

PANEL 370 OF 495

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ARLINGTON, CITY OF	485454	0370	K
GRAND PRAIRIE, CITY OF	485472	0370	K

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

U.S. DEPARTMENT OF HOMELAND SECURITY

MAP NUMBER 48439C0370K

MAP REVISED SEPTEMBER 25, 2009

Federal Emergency Management Agency

NOTES TO USERS

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Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

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

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC−3, #9202
1315 East−West Highway
Silver Spring, MD 20910−3282

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

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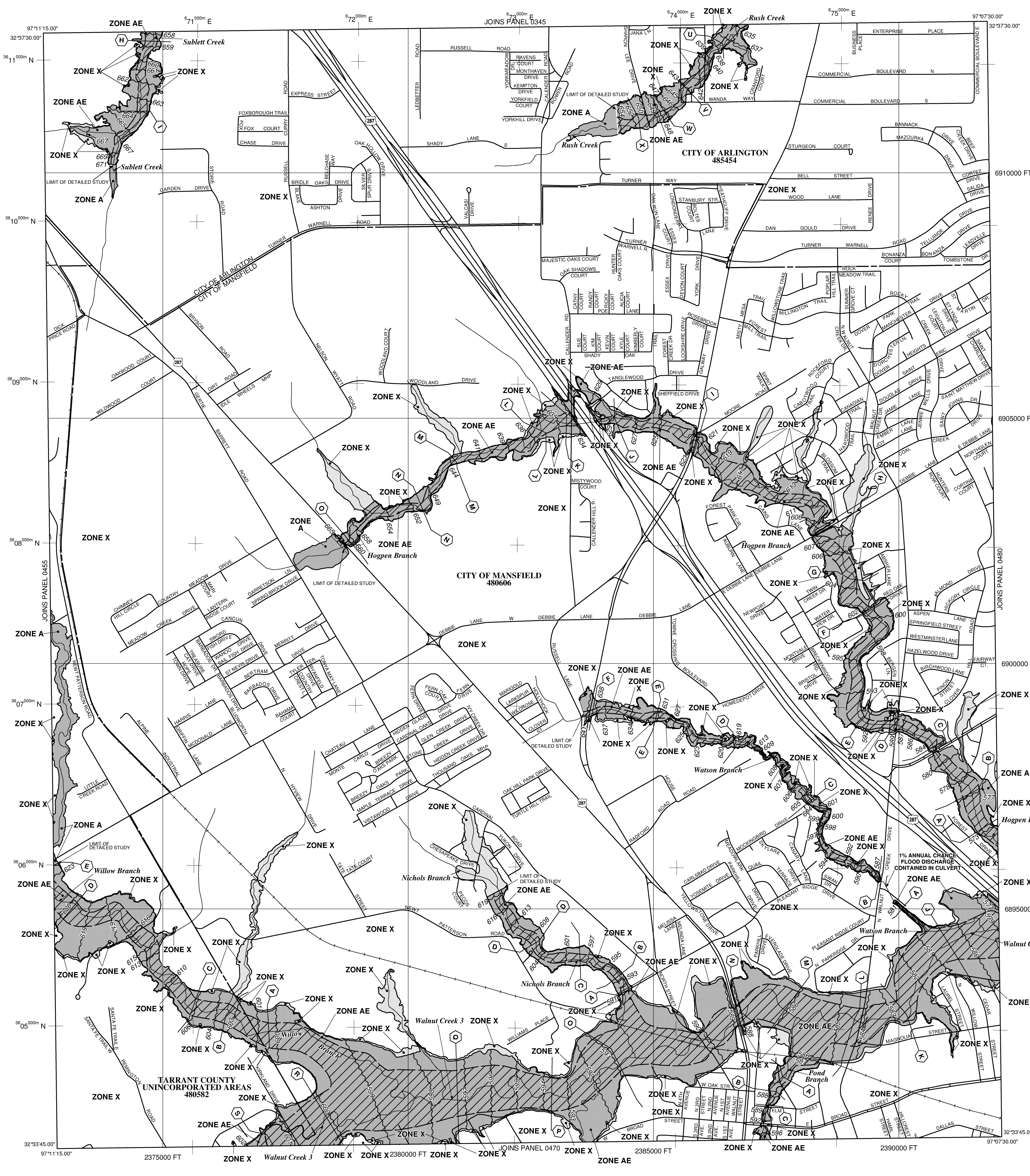

LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

~~ *513* ~~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

(A)——(A)	Cross section line
(23)- - - -(23)	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 14
6000000 FT	5000-foot grid values: Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
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FLOOD INSURANCE RATE MAP
January 6, 1993
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
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MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0460K

FIRM

FLOOD INSURANCE RATE MAP

TARRANT COUNTY, TEXAS

AND INCORPORATED AREAS

PANEL 460 OF 495

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
TARRANT COUNTY	480582	0460	K
ARLINGTON, CITY OF	485454	0460	K
MANSFIELD, CITY OF	480606	0460	K

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
48439C0460K

MAP REVISED
SEPTEMBER 25, 2009

Federal Emergency Management Agency

NOTES TO USERS

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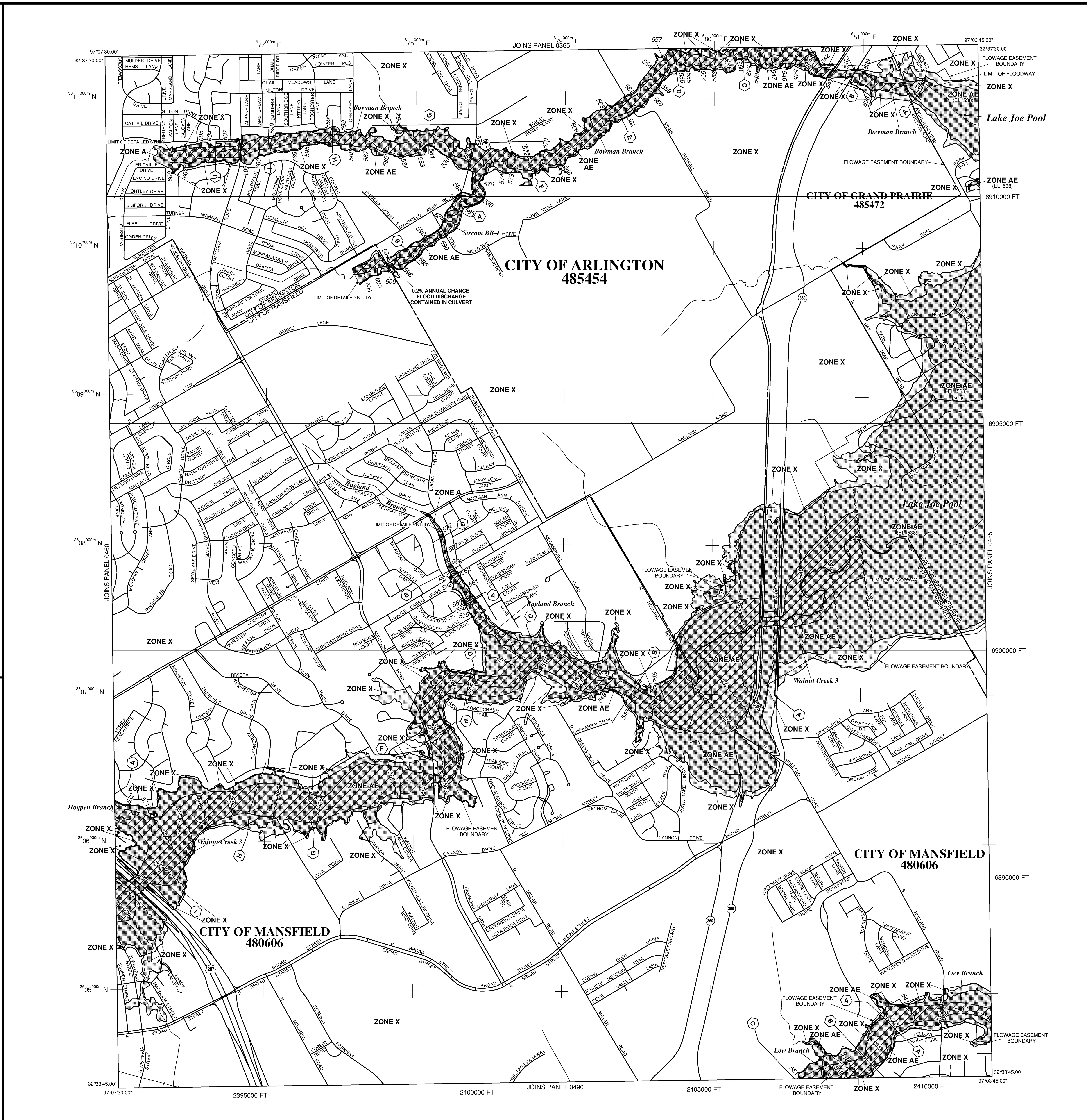

LEGEND

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

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ZONE A	No Base Flood Elevations determined.
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ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
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COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

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

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 - - - 23	Transect line
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500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0480K

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

PANEL 480 OF 495
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ARLINGTON, CITY OF	485454	0480	K
GRAND PRAIRIE, CITY OF	485472	0480	K
MANSFIELD, CITY OF	480606	0480	K

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MAP NUMBER
48439C0480K

MAP REVISED
SEPTEMBER 25, 2009

Federal Emergency Management Agency

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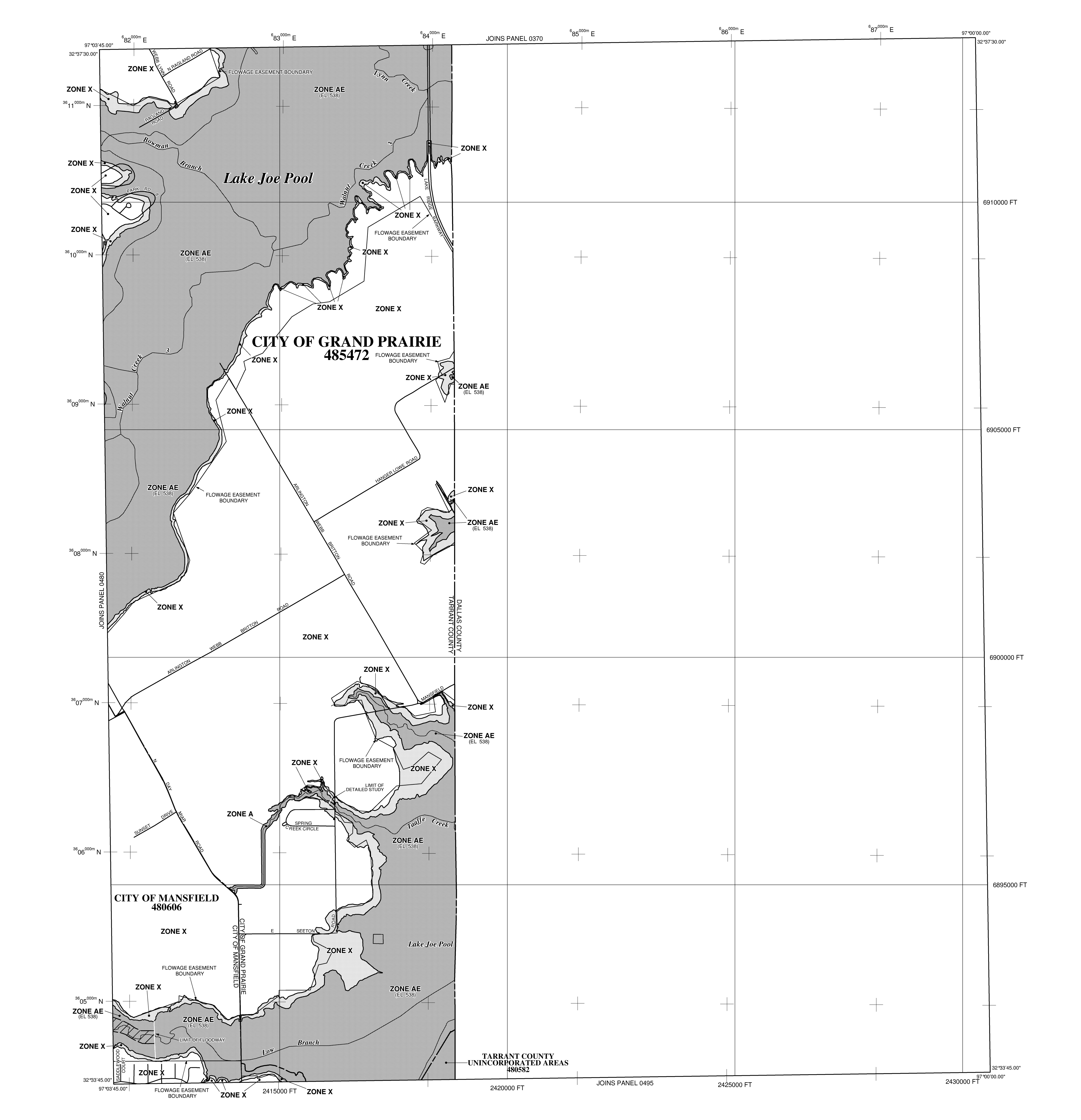

LEGEND

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FLOODWAY AREAS IN ZONE AE

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OTHER FLOOD AREAS

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Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

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MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

PANEL 0485K

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

TARRANT COUNTY, TEXAS

AND INCORPORATED AREAS

PANEL 485 OF 495

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
TARRANT COUNTY	480582	0485	K
GRAND PRAIRIE, CITY OF	485472	0485	K
MANSFIELD, CITY OF	480606	0485	K

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
48439C0485K

MAP REVISED
SEPTEMBER 25, 2009

Federal Emergency Management Agency

NOTES TO USERS

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

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

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The **projection** used in the preparation of this map was Texas State Plane north central zone (FIPSZONE 4202). The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

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

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

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

Base map information shown on this FIRM was provided in digital format by NCTCOG. This information was digitized at a scale of at least 1: 12,000 from aerial photography dated 2003.

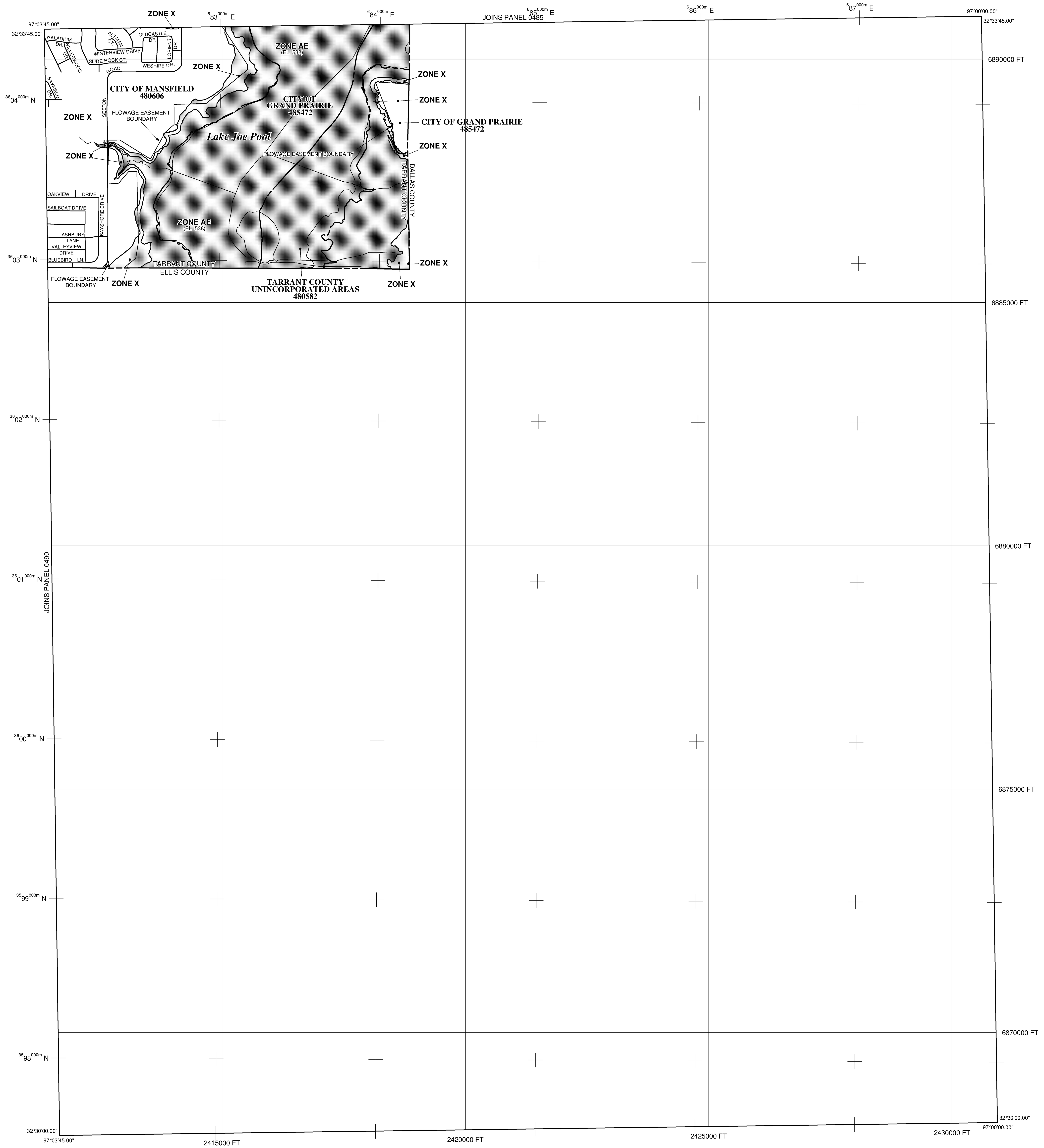
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *in the Flood Insurance Study report (which contains authoritative hydraulic data)* may reflect stream channel distances that differ from what is shown on this map.

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

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

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, *a Flood Insurance Study report,* and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

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



LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

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

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

(A)——(A)	Cross section line
(23)- - - -(23)	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000mN	1000-meter Universal Transverse Mercator grid ticks, zone 14
6000000 FT	5000-foot grid values: Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
January 6, 1993
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
August 02, 1995
August 23, 2000
September 25, 2009 -to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to revise vertical datum, to update roads and road names, to incorporate previously issued Letters of Map Revision, and to reflect updated topographic information.

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

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

MAP SCALE 1" = 1000'
500 0 1000 2000 FEET
300 0 300 600 METERS

NATIONAL FLOOD INSURANCE PROGRAM
NFIP

PANEL 0495K

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

PANEL 495 OF 495
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

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MANSFIELD, CITY OF	480606	0495	K

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MAP NUMBER
48439C0495K

MAP REVISED
SEPTEMBER 25, 2009

Federal Emergency Management Agency

MAP REPOSITORIES

(Maps available for reference only, not for distribution.)

ARLINGTON, CITY OF:
City Hall
101 West Abram Street
Arlington, Texas 76010

AZLE, CITY OF:
City Hall
613 Southeast Parkway
Azle, Texas 76020

BEDFORD, CITY OF:
City Hall
2000 Forest Ridge
Bedford, Texas 76021

BENBROOK, CITY OF:
Department Of Community Development
911 Winscott Road
Benbrook, Texas 76126

BLUE MOUND, CITY OF:
City Hall
1600 Bell Avenue
Fort Worth, Texas 76131

BURLESON, CITY OF:
City Hall
141 West Renfro Street
Burleson, Texas 76028

COLLEYVILLE, CITY OF:
City Hall
401 Oak Valley Road
Colleyville, Texas 76034

CROWLEY, CITY OF:
City Hall
120 North Hampton
Crowley, Texas 76036

DALWORTHINGTON GARDENS, CITY OF:
City Hall
2600 Roosevelt Drive
Arlington, Texas 76016

EDGECLIFF VILLAGE, TOWN OF:
Town Hall
1605 Edgecliff Road
Edgecliff Village, Texas 76134

EULESS, CITY OF:
City Hall
201 North Ector Drive
Euless, Texas 76039

EVERMAN, CITY OF:
City Hall
212 North Race
Everman, Texas 76140

FLOWER MOUND, TOWN OF:
Town Hall
2121 Cross Timbers Road
Flower Mound, Texas 75028

FOREST HILL, CITY OF:
City Hall
6800 Forest Hill Drive
Forest Hill, Texas 76140

FORT WORTH, CITY OF:
Department Of Transportation And Public Works
1000 Throckmorton Street
Fort Worth, Texas 76102

GRAND PRAIRIE, CITY OF:
City Hall
317 College Street
Grand Prairie, Texas 75053

GRAPEVINE, CITY OF:
City Hall
413 South Main Street
Grapevine, Texas 76051

HALTOM CITY, CITY OF:
City Hall
5024 Broadway Avenue
Haltom City, Texas 76117

HASLET, CITY OF:
City Hall
105 Main Street
Haslet, Texas 76052

HURST, CITY OF:
City Hall
1505 Precinct Line Road
Hurst, Texas 76054

KELLER, CITY OF:
City Hall
158 South Main
Keller, Texas 76248

KENNEDALE, CITY OF:
City Hall
209 North New Hope Road
Kennedale, Texas 76060

LAKE WORTH, CITY OF:
City Hall
6720 Telephone Road
Lake Worth, Texas 76135

LAKESIDE, CITY OF:
City Hall
9830 Confederate Park Road
Fort Worth, Texas 76108

MANSFIELD, CITY OF:
City Hall, Department Of Zoning And Planning
1305 East Broad Street
Mansfield, Texas 76063

NORTH RICHLAND HILLS, CITY OF:
City Hall
7301 Northeast Loop 820
North Richland Hills, Texas 76180

PANTEGO, TOWN OF:
Town Hall
1600 Pantego Drive
Pantego, Texas 76013

PELICAN BAY, CITY OF:
City Hall
1300 Pelican Circle
Azle, Texas 76020

RENO, TOWN OF:
City Hall
195 West Reno Road
Azle, Texas 76020

RICHLAND HILLS, CITY OF:
City Hall
3200 Diana Drive
Richland Hills, Texas 76118

RIVER OAKS, CITY OF:
City Hall
4900 River Oaks Boulevard
River Oaks, Texas 76114

ROANOKE, CITY OF:
City Hall
201 Bowie Street
Roanoke, Texas 76262

SAGINAW, CITY OF:
City Hall
333 West Mclaroy
Saginaw, Texas 76179

SANSOM PARK, CITY OF:
City Hall
5500 Buchanan
Fort Worth, Texas 76114

SOUTHLAKE, CITY OF:
Public Works Department
667 North Carroll Avenue
Southlake, Texas 76092

TARRANT COUNTY
(UNINCORPORATED AREAS):
Administrative Building, Public Works Department
100 East Weatherford Street
Fort Worth, Texas 76196

TROPHY CLUB, TOWN OF:
Town Hall
100 Municipal Drive
Trophy Club, Texas 76262

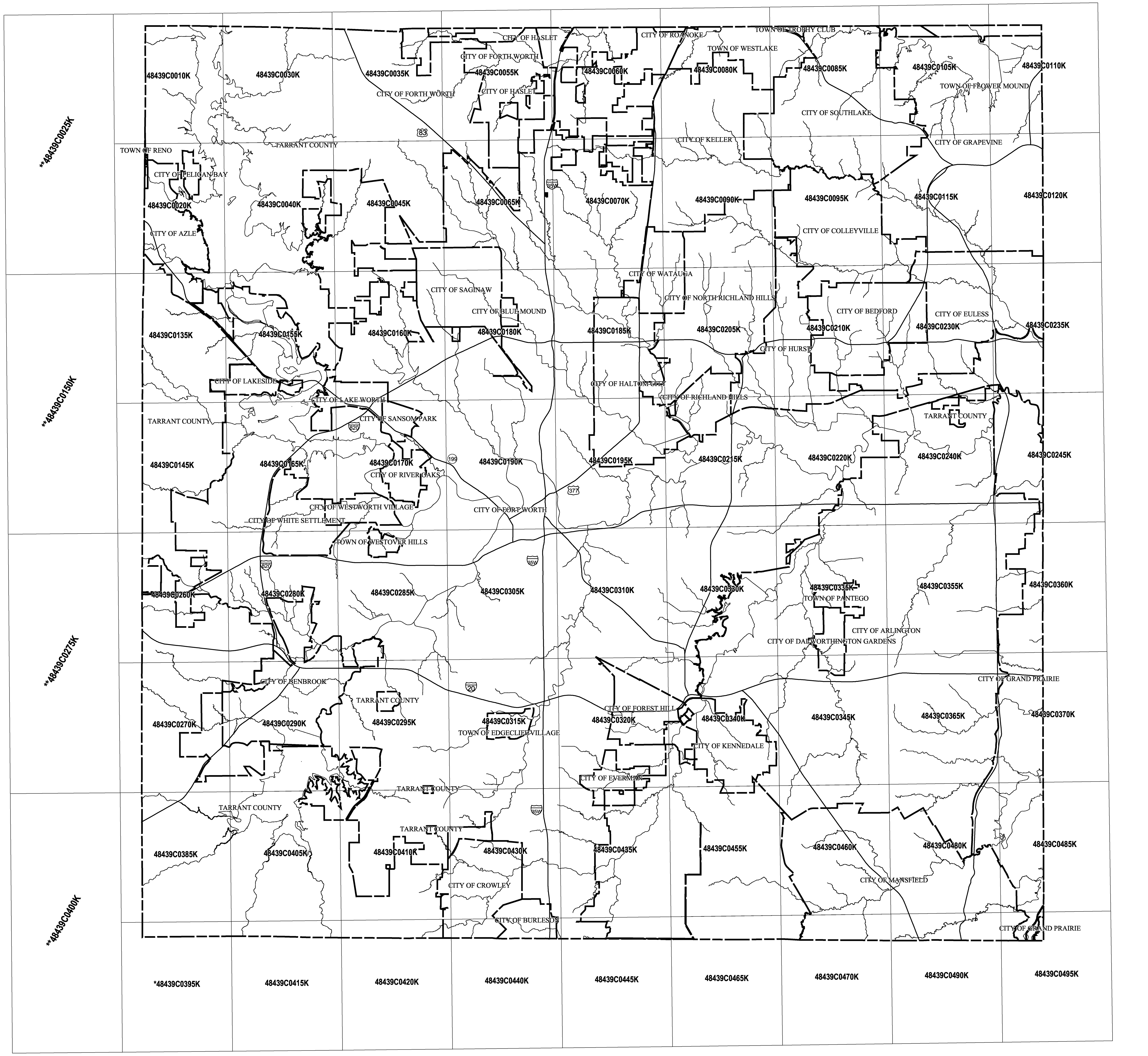
WATAUGA, CITY OF:
City Hall, Public Works Department
7101 Whitley Road
Watauga, Texas 76148

WESTLAKE, TOWN OF:
Town Hall
2650 Jt Ottinger Road
Westlake, Texas 76262

WESTOVER HILLS, TOWN OF:
Town Hall
5824 Merrymont
Westover Hills, Texas 76107

WESTWORTH VILLAGE, CITY OF:
City Hall
311 Burton Hill Road
Fort Worth, Texas 76114

WHITE SETTLEMENT, CITY OF:
City Hall
214 Meadow Park
White Settlement, Texas 76108



* PANEL NOT PRINTED - NO SPECIAL FLOOD HAZARDS AREAS
** PANEL NOT PRINTED - AREA OUTSIDE COUNTY BOUNDARY

LISTING OF COMMUNITIES

COMMUNITY NAME	COMMUNITY NUMBER	LOCATED ON PANEL(S)	INITIAL NFIP MAP DATE	INITIAL FIRM DATE	MOST RECENT FIRM PANEL DATE
ARLINGTON, CITY OF	485454	0220, 0230, 0235, 0240, 0245, 0330, 0335, 0340, 0345, 0355, 0360, 0365, 0370, 0455, 0460, 0480	August 7, 1970	December 31, 1974	September 25, 2009
AZLE, CITY OF	480584	0020, 0135	March 8, 1974	October 15, 1985	September 25, 2009
BEDFORD, CITY OF	480585	0210, 0230	December 28, 1973	July 18, 1977	September 25, 2009
BENBROOK, CITY OF	480586	0270, 0280, 0285, 0290, 0295	May 3, 1974	July 2, 1979	September 25, 2009
BLUE MOUND, CITY OF	480587	0180	December 17, 1973	July 16, 1980	September 25, 2009
BURLESON, CITY OF	485459	0430, 0440	November 2, 1973	December 31, 1974	September 25, 2009
COLLEYVILLE, CITY OF	480590	0095, 0115, 0210, 0230	May 10, 1974	December 1, 1982	September 25, 2009
CROWLEY, CITY OF	480591	0410, 0420, 0430, 0440	June 28, 1974	April 15, 1981	September 25, 2009
DALWORTHINGTON GARDENS, CITY OF	481013	0335, 0345	August 6, 1976	May 17, 1982	September 25, 2009
EDGECLIFF VILLAGE, TOWN OF	480592	0315	December 28, 1973	August 19, 1986	September 25, 2009
EULESS, CITY OF	480593	0115, 0120, 0210, 0230, 0235, 0240	March 22, 1974	April 3, 1985	September 25, 2009
EVERMAN, CITY OF	480594	0320, 0435	December 17, 1973	September 17, 1980	September 25, 2009
FLOWER MOUND, TOWN OF	480777	0105, 0110	October 29, 1976	September 18, 1986	September 25, 2009
FOREST HILL, CITY OF	480595	0310, 0320, 0340	January 23, 1974	August 1, 1978	September 25, 2009
FORT WORTH, CITY OF	480596	0035, 0040, 0045, 0055, 0060, 0065, 0070, 0080, 0135, 0145, 0155, 0160, 0165, 0170, 0180, 0185, 0190, 0195, 0210, 0215, 0220, 0230, 0235, 0240, 0245, 0260, 0270, 0280, 0285, 0290, 0295, 0305, 0310, 0315, 0320, 0330, 0335, 0340, 0405, 0410, 0430, 0435, 0440, 0445, 0455, 0465	September 17, 1971	June 4, 1980	September 25, 2009
GRAND PRAIRIE, CITY OF	485472	0235, 0240, 0245, 0360, 0365, 0370, 0480, 0485, 0495	July 6, 1973	July 1, 1974	September 25, 2009
GRAPEVINE, CITY OF	480598	0085, 0095, 0105, 0110, 0115, 0120	June 28, 1974	November 17, 1982	September 25, 2009
HALTOM CITY, CITY OF	480599	0185, 0195, 0205, 0215	June 28, 1974	February 1, 1978	September 25, 2009
HASLET, CITY OF	480600	0055, 0060, 0065	November 1, 1974	October 15, 1985	September 25, 2009
HURST, CITY OF	480601	0095, 0205, 0210, 0215, 0220	June 14, 1974	October 15, 1985	September 25, 2009
KELLER, CITY OF	480602	0060, 0070, 0080, 0085, 0090, 0095	November 19, 1976	September 30, 1982	September 25, 2009
KENNEDALE, CITY OF	480603	0340, 0455	February 1, 1974	November 15, 1984	September 25, 2009
LAKE WORTH, CITY OF	480605	0155, 0160, 0165, 0170	November 19, 1976	January 6, 1993	September 25, 2009
LAKESIDE, CITY OF	480604	0135, 0155	August 23, 2000	August 23, 2000	September 25, 2009
MANSFIELD, CITY OF	480606	0460, 0470, 0480, 0485, 0490, 0495	February 22, 1974	December 18, 1985	September 25, 2009
NORTH RICHLAND HILLS, CITY OF	480607	0090, 0095, 0185, 0195, 0205, 0210, 0215	June 28, 1974	April 1, 1981	September 25, 2009
PANTEGO, TOWN OF	481116	0335	August 13, 1976	July 16, 1980	September 25, 2009
PELICAN BAY, CITY OF	481653	0020	August 2, 1995	August 2, 1995	September 25, 2009
RENO, TOWN OF	480969	0010, 0020	September 25, 2009	September 25, 2009	September 25, 2009
RICHLAND HILLS, CITY OF	480608	0205, 0215	March 15, 1974	February 16, 1977	September 25, 2009
RIVER OAKS, CITY OF	480609	0170	December 28, 1973	June 19, 1985	September 25, 2009
ROANOKE, CITY OF	480785	0060, 0080	September 5, 1975	April 2, 1997	September 25, 2009
SAGINAW, CITY OF	480610	0045, 0065, 0160, 0180	March 8, 1974	September 17, 1980	September 25, 2009
SANSOM PARK, CITY OF	480611	0160, 0170	December 10, 1976	January 6, 1993	September 25, 2009
SOUTHLAKE, CITY OF	480612	0080, 0085, 0090, 0095, 0105, 0115	February 15, 1974	July 5, 1982	September 25, 2009
TARRANT COUNTY (UNINCORPORATED AREAS)	480582	0010, 0020, 0030, 0035, 0040, 0045, 0055, 0060, 0065, 0070, 0080, 0085, 0095, 0105, 0135, 0145, 0155, 0160, 0165, 0180, 0185, 0230, 0235, 0240, 0260, 0270, 0280, 0290, 0295, 0320, 0335, 0340, 0385, 0395*, 0405, 0410, 0415, 0420, 0430, 0435, 0445, 0455, 0460, 0465, 0470, 0485, 0495	February 7, 1975	August 4 1987	September 25, 2009
TROPHY CLUB, TOWN OF	481606	0085	May 27, 1977	August 3, 1989	September 25, 2009
WATAUGA, CITY OF	480613	0070, 0090, 0185, 0205	March 8, 1974	June 1, 1982	September 25, 2009
WESTLAKE, TOWN OF	480614	0080, 0085	December 10, 1976	June 2, 1993	September 25, 2009
WESTOVER HILLS, TOWN OF	480615	0170, 0285	August 30, 1974	June 5, 1985	September 25, 2009
WESTWORTH VILLAGE, CITY OF	480616	0165, 0170	March 8, 1974	June 3, 1986	September 25, 2009
WHITE SETTLEMENT, CITY OF	480617	0165, 0170, 0280, 0285	May 24, 1974	July 17, 1986	September 25, 2009

*Panel Not Printed

FIRM Panel Dates For Printed Panels of Tarrant County, TX And Incorporated Areas

Panel	Effective Date	Panel	Effective Date	Panel	Effective Date
0010 K	September 25, 2009	0180 K	September 25, 2009	0340 K	September 25, 2009
0020 K	September 25, 2009	0185 K	September 25, 2009	0345 K	September 25, 2009
0030 K	September 25, 2009	0190 K	September 25, 2009	0355 K	September 25, 2009
0035 K	September 25, 2009	0195 K	September 25, 2009	0360 K	September 25, 2009
0040 K	September 25, 2009	0205 K	September 25, 2009	0365 K	September 25, 2009
0045 K	September 25, 2009	0210 K	September 25, 2009	0370 K	September 25, 2009
0055 K	September 25, 2009	0215 K	September 25, 2009	0385 K	September 25, 2009
0060 K	September 25, 2009	0220 K	September 25, 2009	0405 K	September 25, 2009
0065 K	September 25, 2009	0230 K	September 25, 2009	0410 K	September 25, 2009
0070 K	September 25, 2009	0235 K	September 25, 2009	0415 K	September 25, 2009
0080 K	September 25, 2009	0240 K	September 25, 2009	0420 K	September 25, 2009
0085 K	September 25, 2009	0245 K	September 25, 2009	0430 K	September 25, 2009
0090 K	September 25, 2009	0260 K	September 25, 2009	0435 K	September 25, 2009
0095 K	September 25, 2009	0270 K	September 25, 2009	0440 K	September 25, 2009
0105 K	September 25, 2009	0280 K	September 25, 2009	0445 K	September 25, 2009
0110 K	September 25, 2009	0285 K	September 25, 2009	0455 K	September 25, 2009
0115 K	September 25, 2009	0290 K	September 25, 2009	0460 K	September 25, 2009
0120 K	September 25, 2009	0295 K	September 25, 2009	0465 K	September 25, 2009
0135 K	September 25, 2009	0305 K	September 25, 2009	0470 K	September 25, 2009
0145 K	September 25, 2009	0310 K	September 25, 2009	0480 K	September 25, 2009
0155 K	September 25, 2009	0315 K	September 25, 2009	0485 K	September 25, 2009
0160 K	September 25, 2009	0320 K	September 25, 2009	0490 K	September 25, 2009
0165 K	September 25, 2009	0330 K	September 25, 2009	0495 K	September 25, 2009
0170 K	September 25, 2009	0335 K	September 25, 2009		

ELEVATION DATUM

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

NOTE TO USER

Future revisions to this FIRM Index will only be issued to communities that are located on FIRM panels being revised. This FIRM Index therefore remains valid for FIRM panels dated September 25, 2009 or earlier. Please refer to the "MOST RECENT FIRM PANEL DATE" column in the Listing of Communities table to determine the most recent FIRM Index date for each community.

MAP DATES

This FIRM Index displays the map dates for each FIRM panel at the time that this Index was printed. Because this Index may not be distributed to unaffected communities in subsequent revisions, users may determine the most current map date for each FIRM panel by visiting the FEMA Map Service Center website at http://msc.fema.gov or by calling the Map Service Center at 1-800-358-9616.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Map Service Center at the number listed above.

BASE MAP SOURCE

Base map information shown on this FIRM was provided in digital format by NCTCOG. This information was digitized at a scale of at least 1: 12,000 from aerial photography dated 2003.

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

MAP INDEX

FIRM

FLOOD INSURANCE RATE MAP

TARRANT COUNTY, TEXAS

AND INCORPORATED AREAS

(SEE LISTING OF COMMUNITIES TABLE)

MAP INDEX

PANELS PRINTED: 10, 20, 30, 35, 40, 45, 55, 60, 65, 70, 80, 85, 90, 95, 105, 110, 115, 120, 135, 145, 155, 160, 165, 170, 180, 185, 190, 195, 205, 210, 215, 220, 230, 235, 240, 245, 260, 270, 280, 285, 290, 295, 305, 310, 315, 320, 330, 335, 340, 345, 355, 360, 365, 370, 385, 405, 410, 415, 420, 430, 435, 440, 445, 455, 460, 465, 470, 480, 485, 490, 495

MAP NUMBER 48439CIND0A

MAP REVISED SEPTEMBER 25, 2009

Federal Emergency Management Agency

PRELIMINARY DFIRMS
DALLAS COUNTY

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NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

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

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This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *in the Flood Insurance Study report (which contains authoritative hydraulic data)* may reflect stream channel distances that differ from what is shown on this map.

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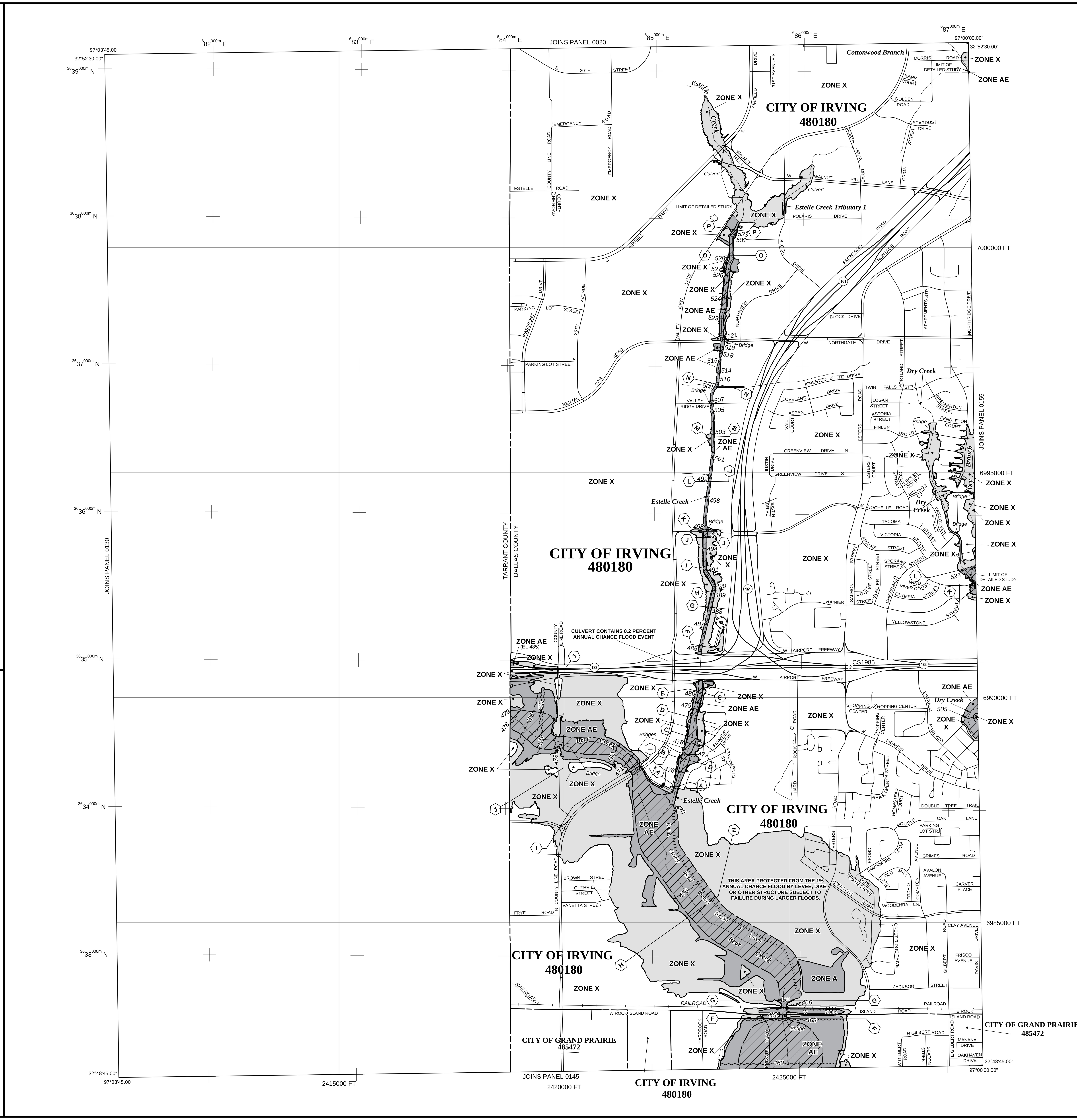
If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/.



LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

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

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 - - - 23	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 14
6000000 FT	5000-foot grid values: Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
August 23, 2001
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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

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

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0135L

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

PANEL 135 OF 495
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
GRAND PRAIRIE, CITY OF	485472	0135	L
IRVING, CITY OF	480180	0135	L

PRELIMINARY
JUN 22 2007

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
48113C0135L

MAP REVISED

Federal Emergency Management Agency

NOTES TO USERS

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

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

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The **projection** used in the preparation of this map was Texas State Plane north central zone (FIPSZONE 4202). The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

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

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

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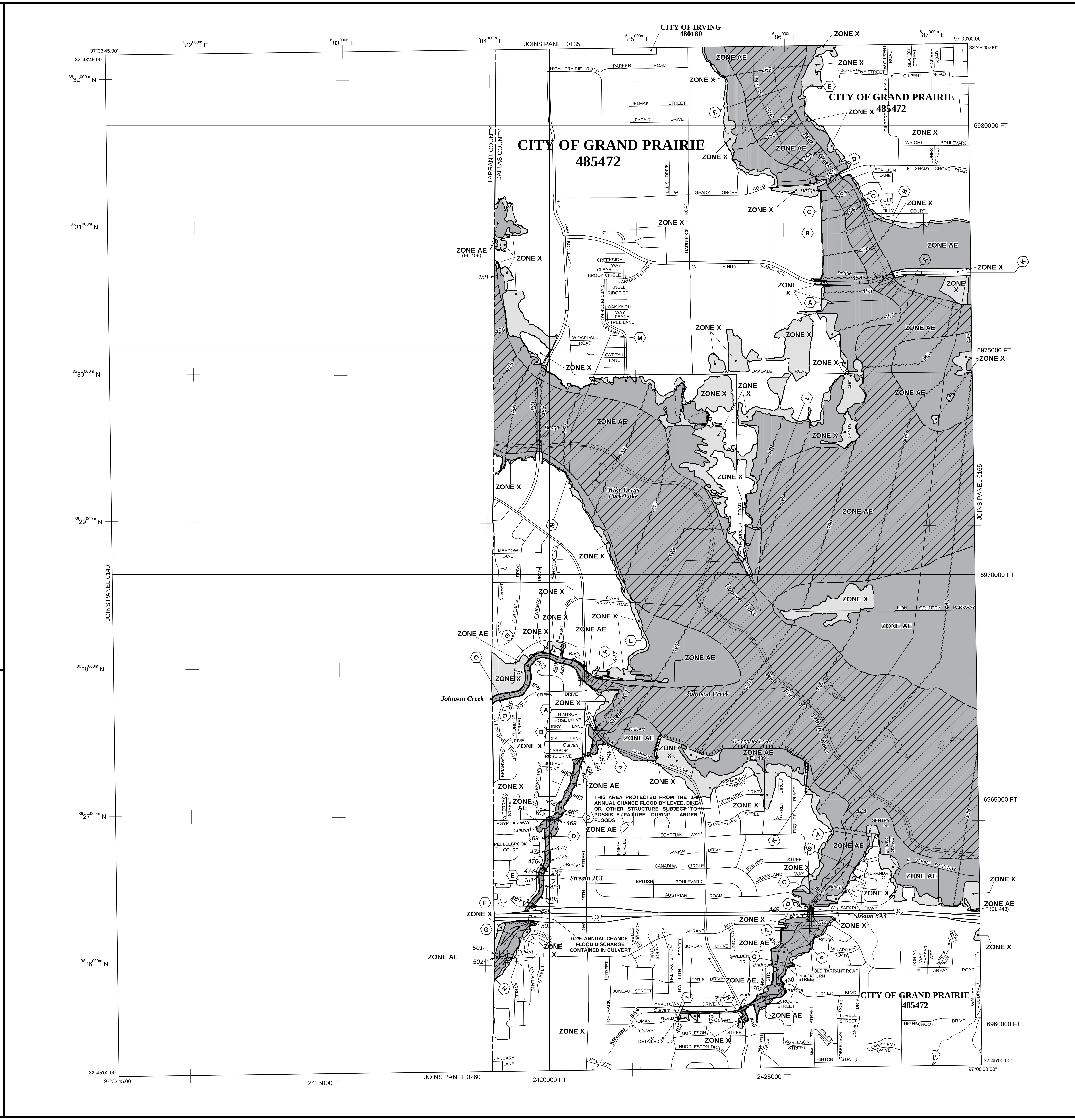

LEGEND

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- Floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 - - - - 23	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 14
6000000 FT	5000-foot grid values: Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
August 23, 2001
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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

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

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

PANEL 0145L

NATIONAL FLOOD INSURANCE PROGRAM

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

PANEL 145 OF 495
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
GRAND PRAIRIE, CITY OF	485472	0145	L
IRVING, CITY OF	480180	0145	L

PRELIMINARY
JUN 2 2 2007

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
48113C0145L

MAP REVISED

Federal Emergency Management Agency

NOTES TO USERS

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Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The **projection** used in the preparation of this map was Texas State Plane north central zone (FIPSZONE 4202). The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

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National Geodetic Survey
SSMC- 3, #9202
1315 East- West Highway
Silver Spring, MD 20910- 3282

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LEGEND

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

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ZONE A	No Base Flood Elevations determined.
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ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
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ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
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COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	Floodplain boundary
	Floodway boundary
	Zone D boundary
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97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
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6000000 FT	5000-foot grid values: Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
August 23, 2001
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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MAP SCALE 1" = 1000'

500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0155L

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

PANEL 155 OF 495
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
GRAND PRAIRIE, CITY OF	485472	0155	L
IRVING, CITY OF	480180	0155	L

PRELIMINARY
JUN 22 2007

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

U.S. DEPARTMENT OF HOMELAND SECURITY

MAP NUMBER
48113C0155L

MAP REVISED

Federal Emergency Management Agency

NOTES TO USERS

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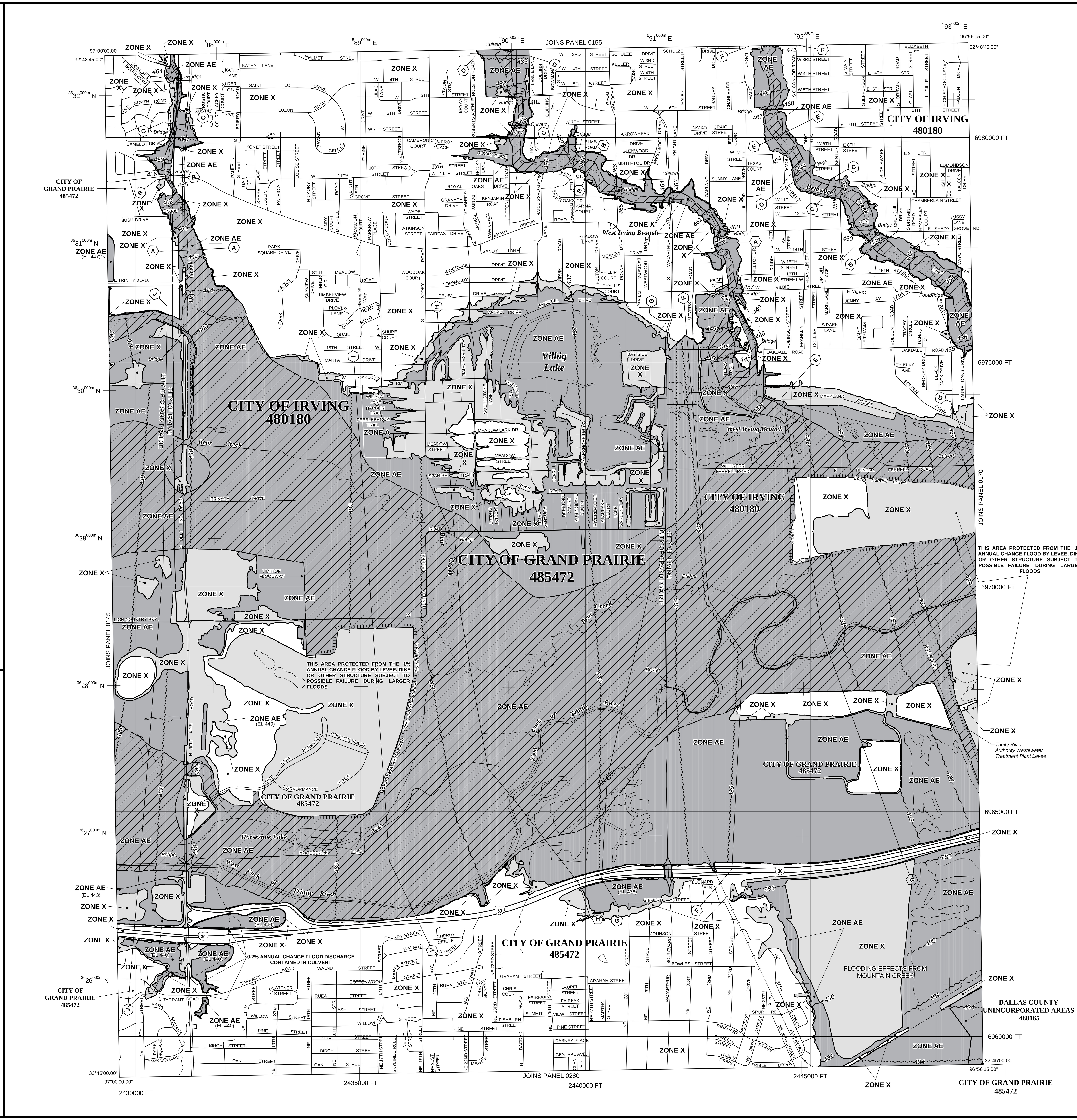


LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

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

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 - - - - 23	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid, zone 14
6000000 FT	5000-foot grid: Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
August 23, 2001
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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

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

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0165L

FIRM

FLOOD INSURANCE RATE MAP

DALLAS COUNTY, TEXAS

AND INCORPORATED AREAS

PANEL 165 OF 495

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
DALLAS COUNTY	480165	0165	L
GRAND PRAIRIE, CITY OF	485472	0165	L
IRVING, CITY OF	480180	0165	L

PRELIMINARY
JUN 22 2007

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
48113C0165L

MAP REVISED

Federal Emergency Management Agency

NOTES TO USERS

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

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

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The **projection** used in the preparation of this map was Texas State Plane north central zone (FIPSZONE 4202). The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

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

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC- 3, #9202
1315 East- West Highway
Silver Spring, MD 20910- 3282

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

Base map information shown on this FIRM was provided in digital format by the North Central Texas Council of Governments (NCTCOG). This information was photogrammetrically compiled at a scale of at least 1:24,000 from aerial photography dated 2001.

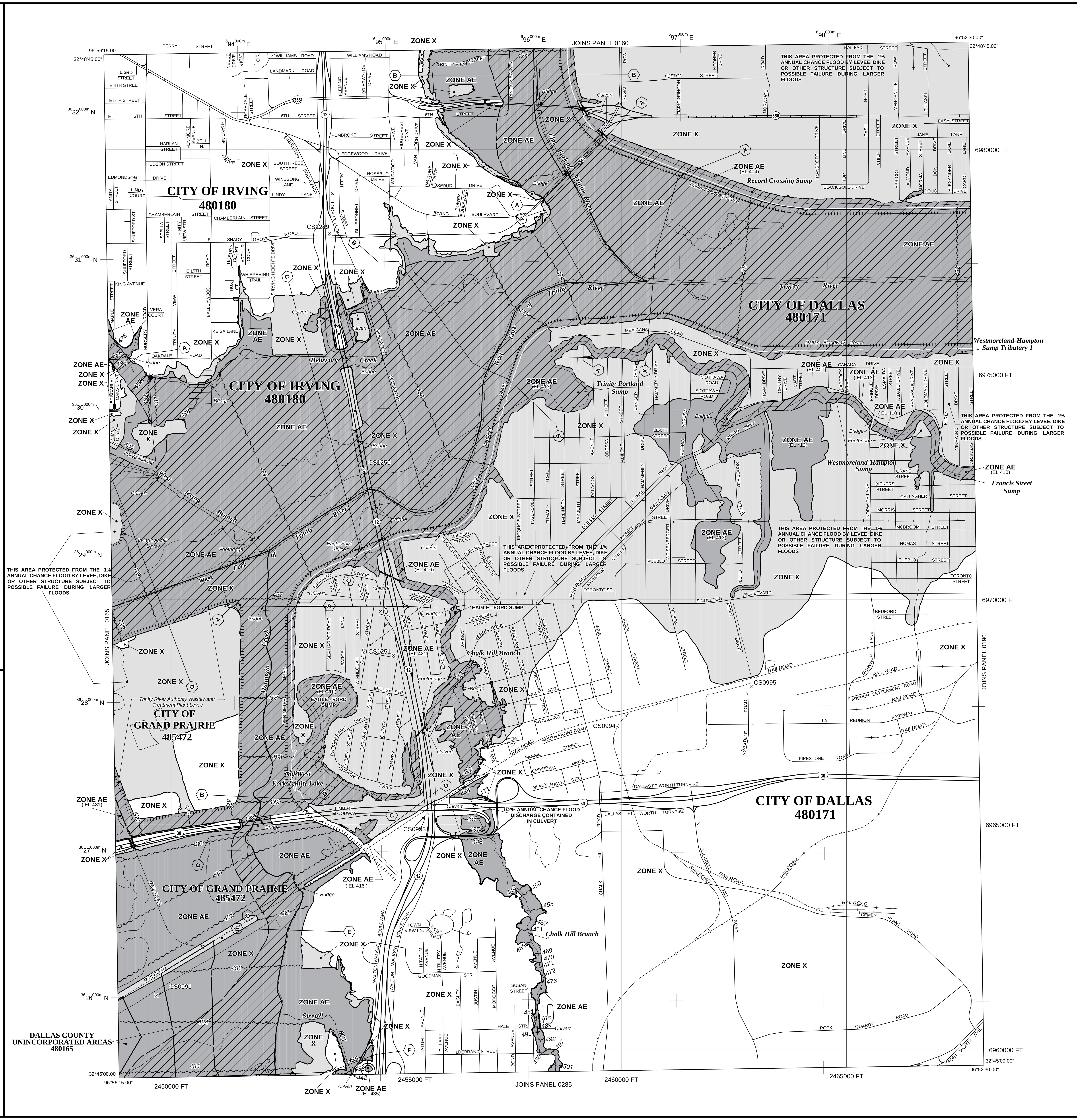
This map reflects more detailed and up- to- date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *in the Flood Insurance Study report (which contains authoritative hydraulic data*) may reflect stream channel distances that differ from what is shown on this map.

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

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

Contact the **FEMA Map Service Center** at 1- 800- 358- 9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, *a Flood Insurance Study report*, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1- 800- 358- 9620 and its website at http://www.msc.fema.gov/.

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



LEGEND

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

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

ZONE A No Base Flood Elevations determined.

ZONE AE Base Flood Elevations determined.

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

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

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

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513 — Base Flood Elevation line and value; elevation in feet*

(EL 987)

Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A Cross section line

23 — 23 Transect line

97°07'30", 32°22'30" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)

42 75 000m N — 1000-meter Universal Transverse Mercator grid ticks, zone 14

6000000 FT — 5000-foot grid values: Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic

DX5510 — Bench mark (see explanation in Notes to Users section of this FIRM panel)

M1.5 — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
August 23, 2001
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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

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

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0170L

FIRM

FLOOD INSURANCE RATE MAP

DALLAS COUNTY, TEXAS

AND INCORPORATED AREAS

PANEL 170 OF 495

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
DALLAS COUNTY	480165	0170	L
DALLAS, CITY OF	480171	0170	L
GRAND PRAIRIE, CITY OF	485472	0170	L
IRVING, CITY OF	480180	0170	L

PRELIMINARY
JUN 22 2007

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
48113C0170L

MAP REVISED

Federal Emergency Management Agency

NOTES TO USERS

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

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

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The **projection** used in the preparation of this map was Texas State Plane north central zone (FIPSZONE 4202). The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

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

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

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This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *in the Flood Insurance Study report (which contains authoritative hydraulic data)* may reflect stream channel distances that differ from what is shown on this map.

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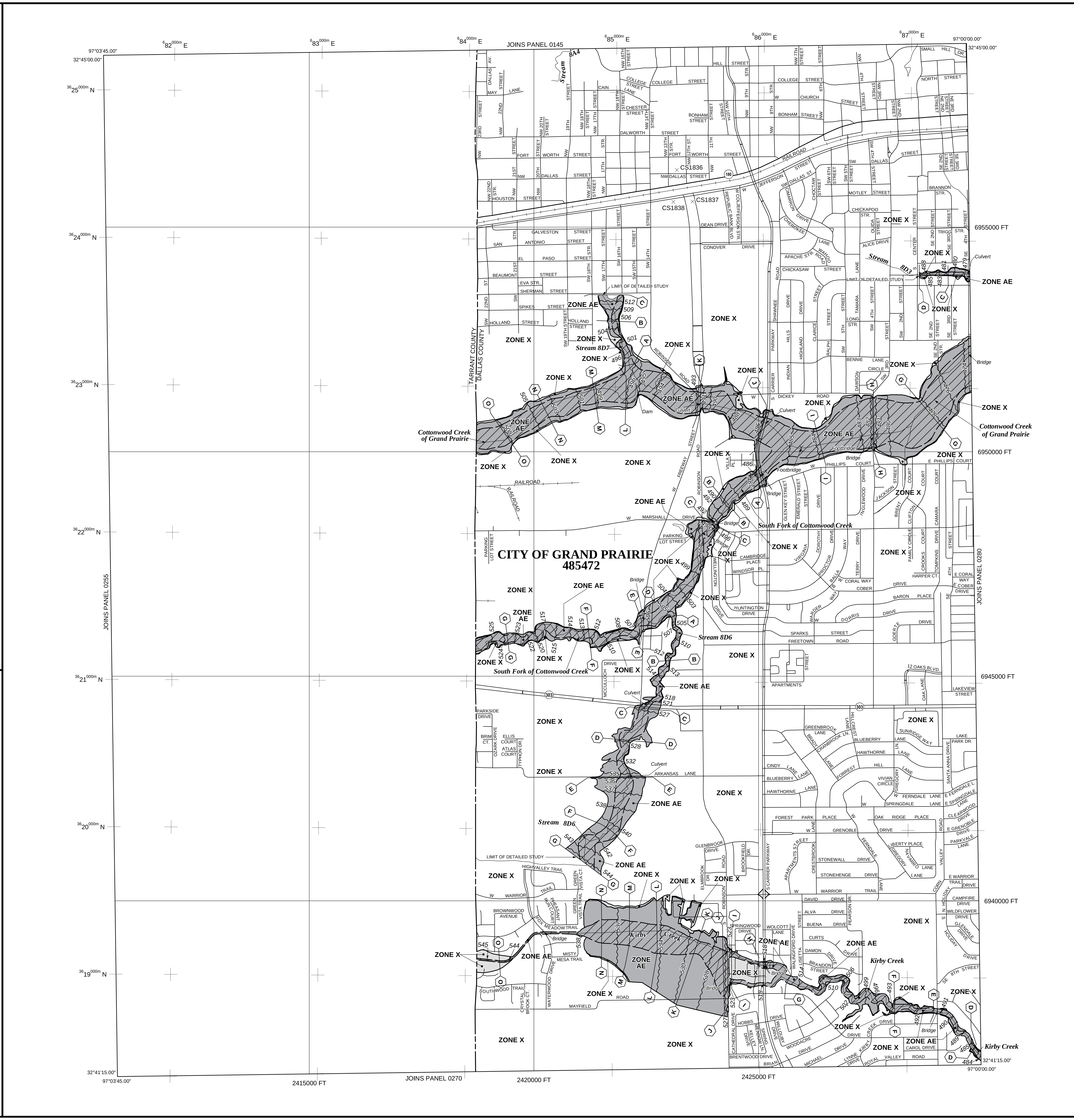
If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/.



LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

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

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 - - - - 23	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 14
6000000 FT	5000-foot grid values: Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
August 23, 2001
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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

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

N

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0260L

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

PANEL 260 OF 495
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
GRAND PRAIRIE, CITY OF	485472	0260	L

PRELIMINARY
JUN 22 2007

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
48113C0260L

MAP REVISED

Federal Emergency Management Agency

NOTES TO USERS

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The **projection** used in the preparation of this map was Texas State Plane north central zone (FIPSZONE 4202). The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

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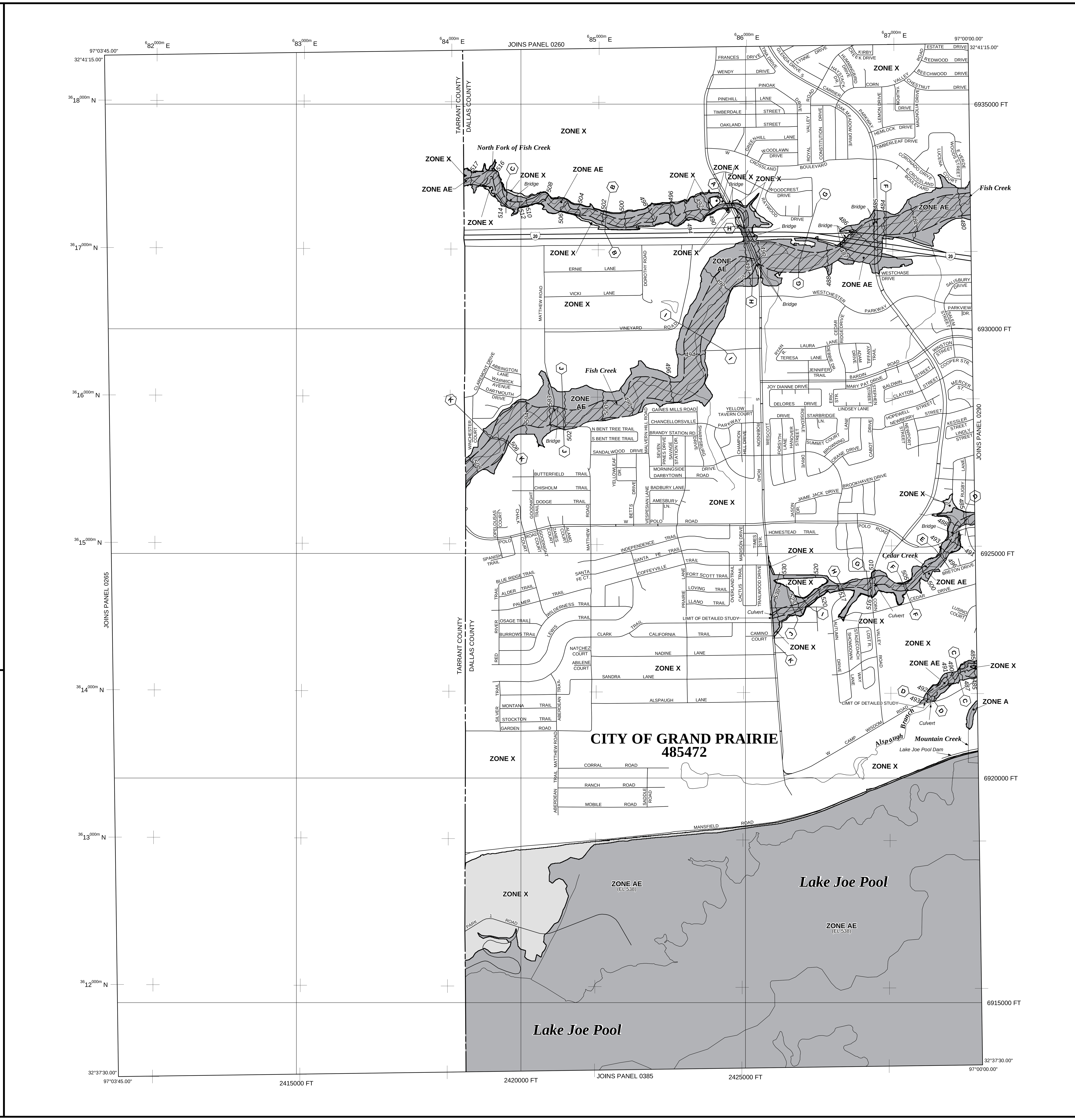

LEGEND

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FLOODWAY AREAS IN ZONE AE

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OTHER FLOOD AREAS

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

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COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 - - - - 23	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 14
6000000 FT	5000-foot grid values: Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
August 23, 2001
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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

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

N

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0270L

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

PANEL 270 OF 495

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
GRAND PRAIRIE, CITY OF	485472	0270	L

PRELIMINARY
JUN 2 2 2007

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

U.S. DEPARTMENT OF HOMELAND SECURITY

MAP NUMBER
48113C0270L

MAP REVISED

Federal Emergency Management Agency

NOTES TO USERS

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

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

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The **projection** used in the preparation of this map was Texas State Plane north central zone (FIPSZONE 4202). The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

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

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

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

Base map information shown on this FIRM was provided in digital format by the North Central Texas Council of Governments (NCTCOG). This information was photogrammetrically compiled at a scale of at least 1:24,000 from aerial photography dated 2001.

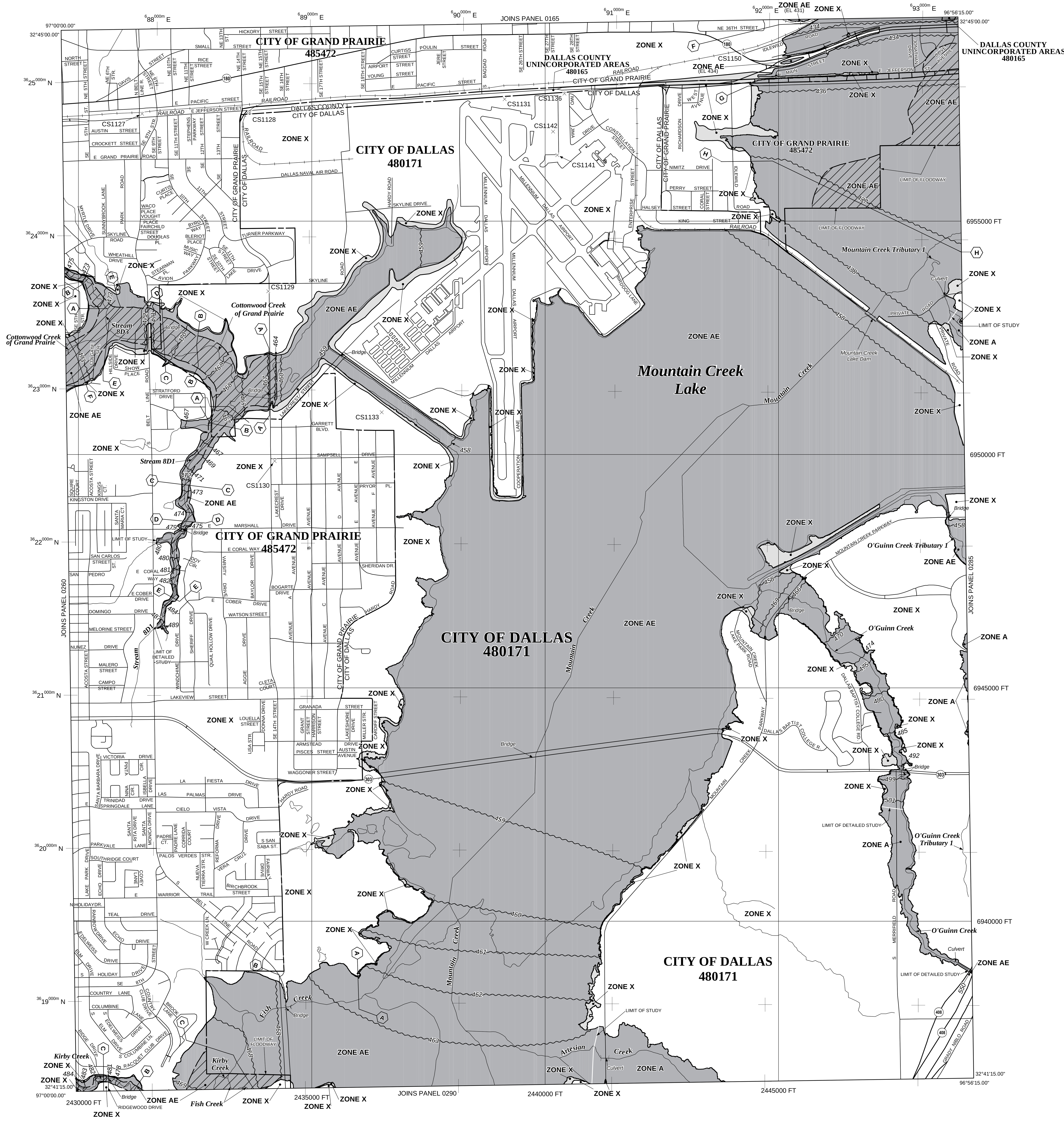
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *in the Flood Insurance Study report (which contains authoritative hydraulic data*) may reflect stream channel distances that differ from what is shown on this map.

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

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

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, *a Flood Insurance Study report*, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

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



LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 - - - - 23	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 14
6000000 FT	5000-foot grid values: Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
August 23, 2001
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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

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

N

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0280L

FIRM
FLOOD INSURANCE RATE MAP

DALLAS COUNTY,
TEXAS
AND INCORPORATED AREAS

PANEL 280 OF 495
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
DALLAS COUNTY	480165	0280	L
DALLAS, CITY OF	480171	0280	L
GRAND PRAIRIE, CITY OF	485472	0280	L

PRELIMINARY
JUN 22 2007

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

U.S. DEPARTMENT OF HOMELAND SECURITY

MAP NUMBER
48113C0280L

MAP REVISED

Federal Emergency Management Agency

NOTES TO USERS

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

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

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The **projection** used in the preparation of this map was Texas State Plane north central zone (FIPSZONE 4202). The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

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

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NOAA, N/NGS12
National Geodetic Survey
SSMC- 3, #9202
1315 East- West Highway
Silver Spring, MD 20910- 3282

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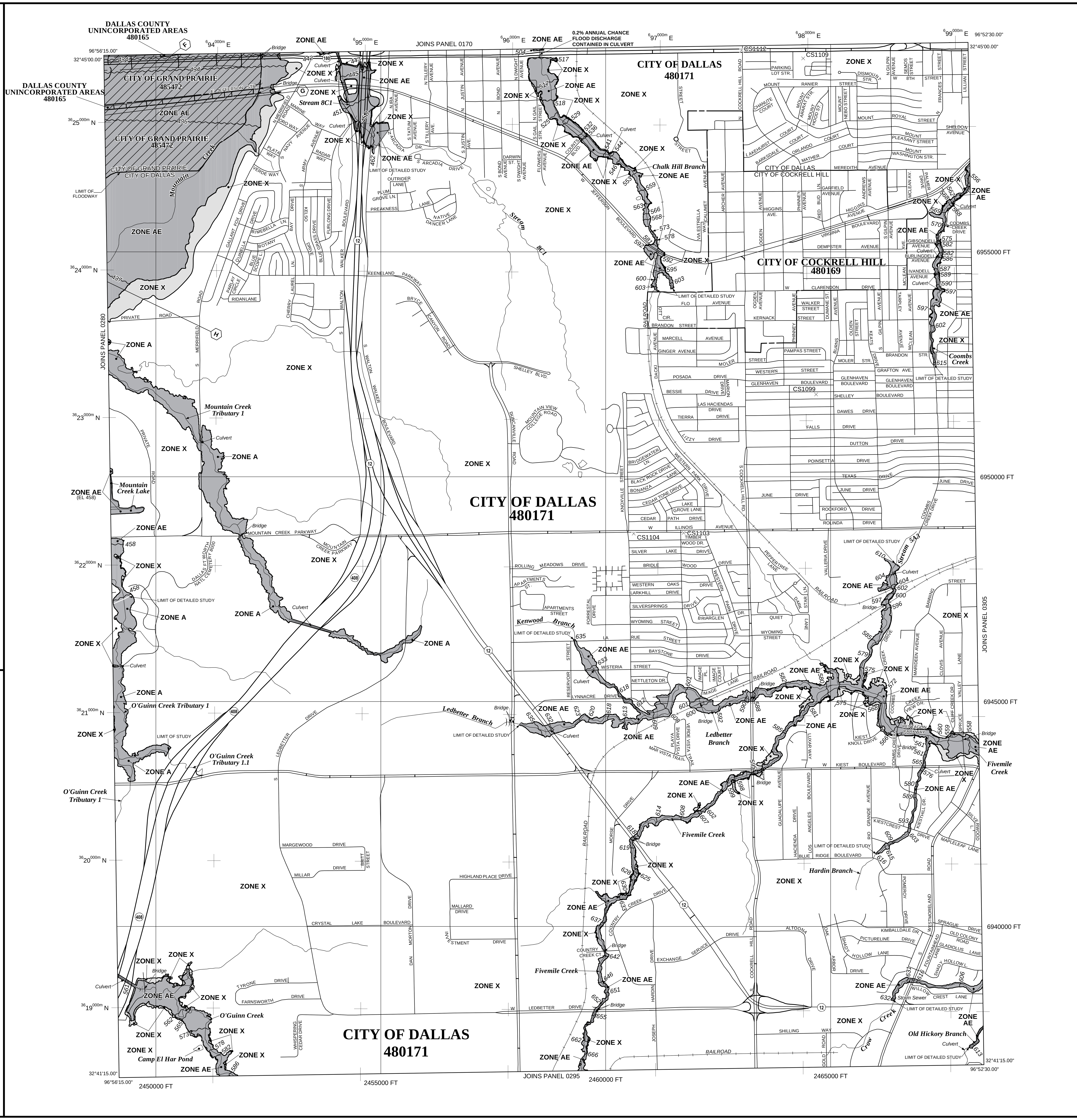

LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

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

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

(A)——(A)	Cross section line
(23)- - - - - -(23)	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 14
6000000 FT	5000-foot grid values: Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
August 23, 2001
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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MAP SCALE 1" = 1000'
500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

PANEL 0285L

NATIONAL FLOOD INSURANCE PROGRAM

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

PANEL 285 OF 495
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
DALLAS COUNTY	480165	0285	L
COCKRELL HILL, CITY OF	480169	0285	L
DALLAS, CITY OF	480171	0285	L
GRAND PRAIRIE, CITY OF	485472	0285	L

PRELIMINARY
JUN 22 2007

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
48113C0285L

MAP REVISED

Federal Emergency Management Agency

NOTES TO USERS

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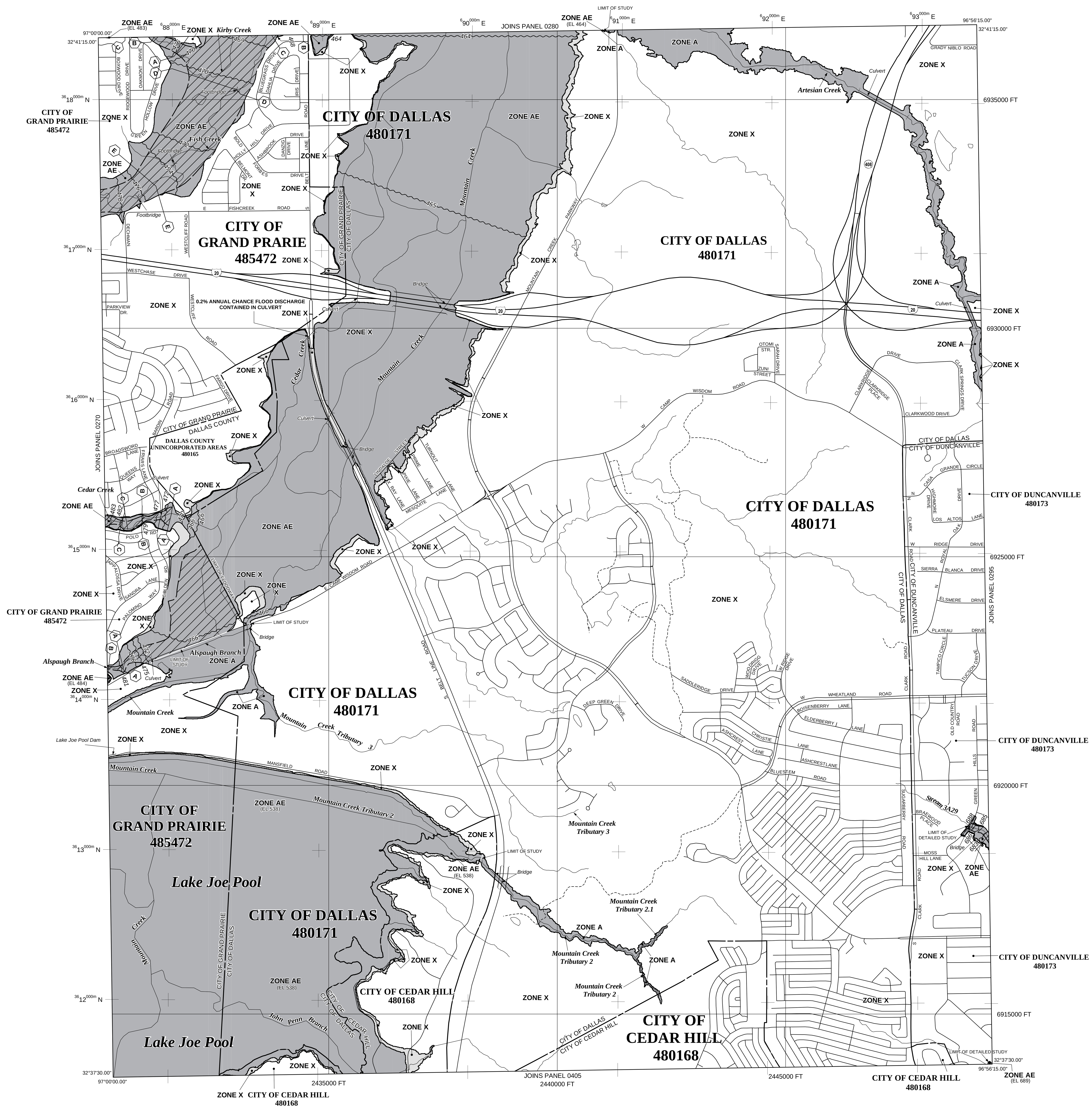

LEGEND

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
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COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	Floodplain boundary
	Floodway boundary
	Zone D boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
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6000000 FT	5000-foot grid values: Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
August 23, 2001
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0290L

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

PANEL 290 OF 495

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
DALLAS COUNTY	480165	0290	L
CEDAR HILL, CITY OF	480168	0290	L
DALLAS, CITY OF	480171	0290	L
DUNCANVILLE, CITY OF	480173	0290	L
GRAND PRAIRIE, CITY OF	485472	0290	L

PRELIMINARY
JUN 22 2007

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
48113C0290L

MAP REVISED

Federal Emergency Management Agency

NOTES TO USERS

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Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The **projection** used in the preparation of this map was Texas State Plane north central zone (FIPSZONE 4202). The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

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

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

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

Base map information shown on this FIRM was provided in digital format by the North Central Texas Council of Governments (NCTCOG). This information was photogrammetrically compiled at a scale of at least 1:24,000 from aerial photography dated 2001.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *in the Flood Insurance Study report (which contains authoritative hydraulic data*) may reflect stream channel distances that differ from what is shown on this map.

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

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, *a Flood Insurance Study report*, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

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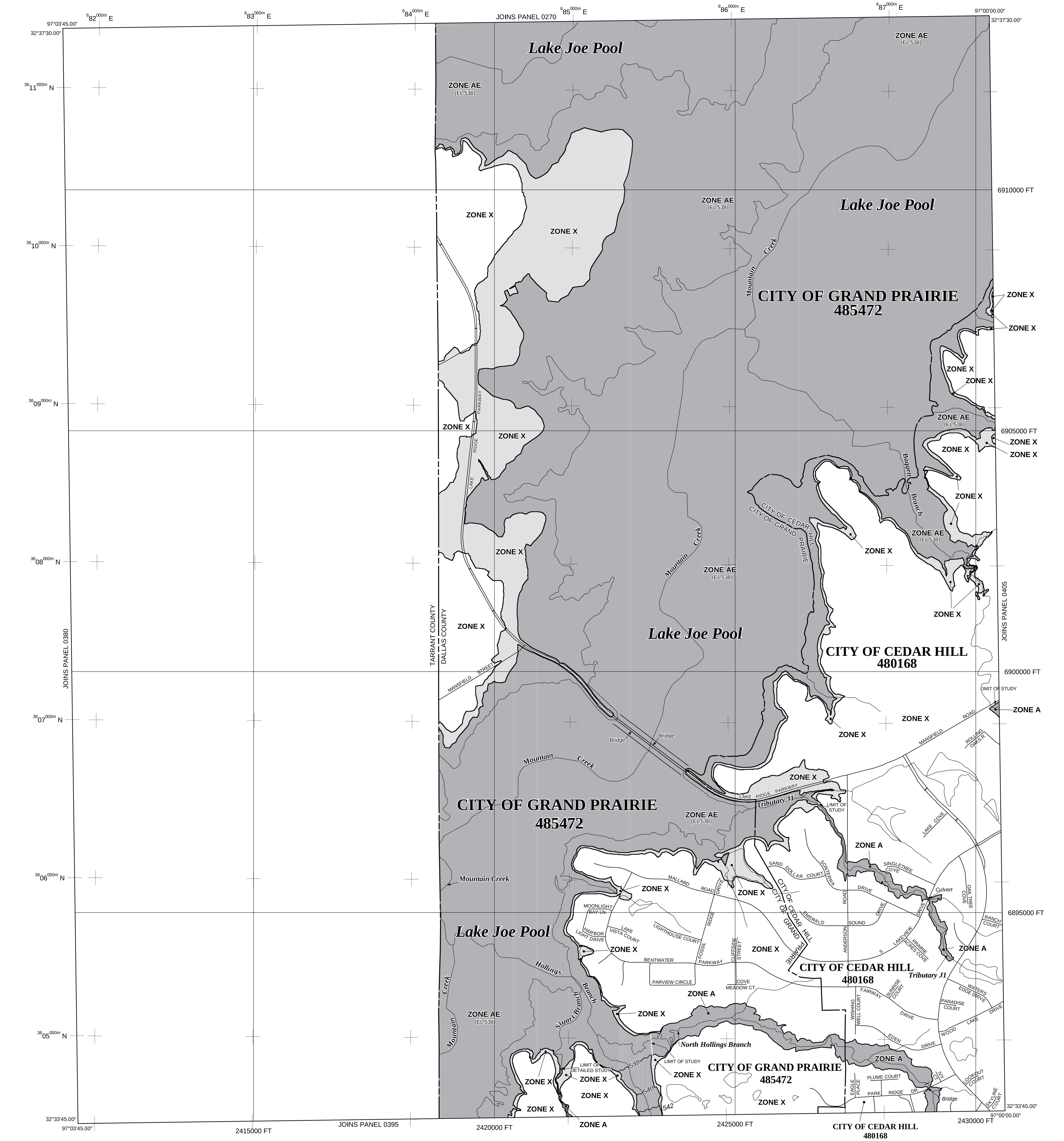

LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- Floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 - - - 23	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 14
6000000 FT	5000-foot grid values: Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
August 23, 2001
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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

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

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0385L

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

PANEL 385 OF 495
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CEDAR HILL, CITY OF	480168	0385	L
GRAND PRAIRIE, CITY OF	485472	0385	L

PRELIMINARY
JUN 2 2 2007

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

U.S. DEPARTMENT OF HOMELAND SECURITY

MAP NUMBER
48113C0385L

MAP REVISED

Federal Emergency Management Agency

NOTES TO USERS

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

The **projection** used in the preparation of this map was Texas State Plane north central zone (FIPSZONE 4202). The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

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NOAA, N/NGS12
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SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

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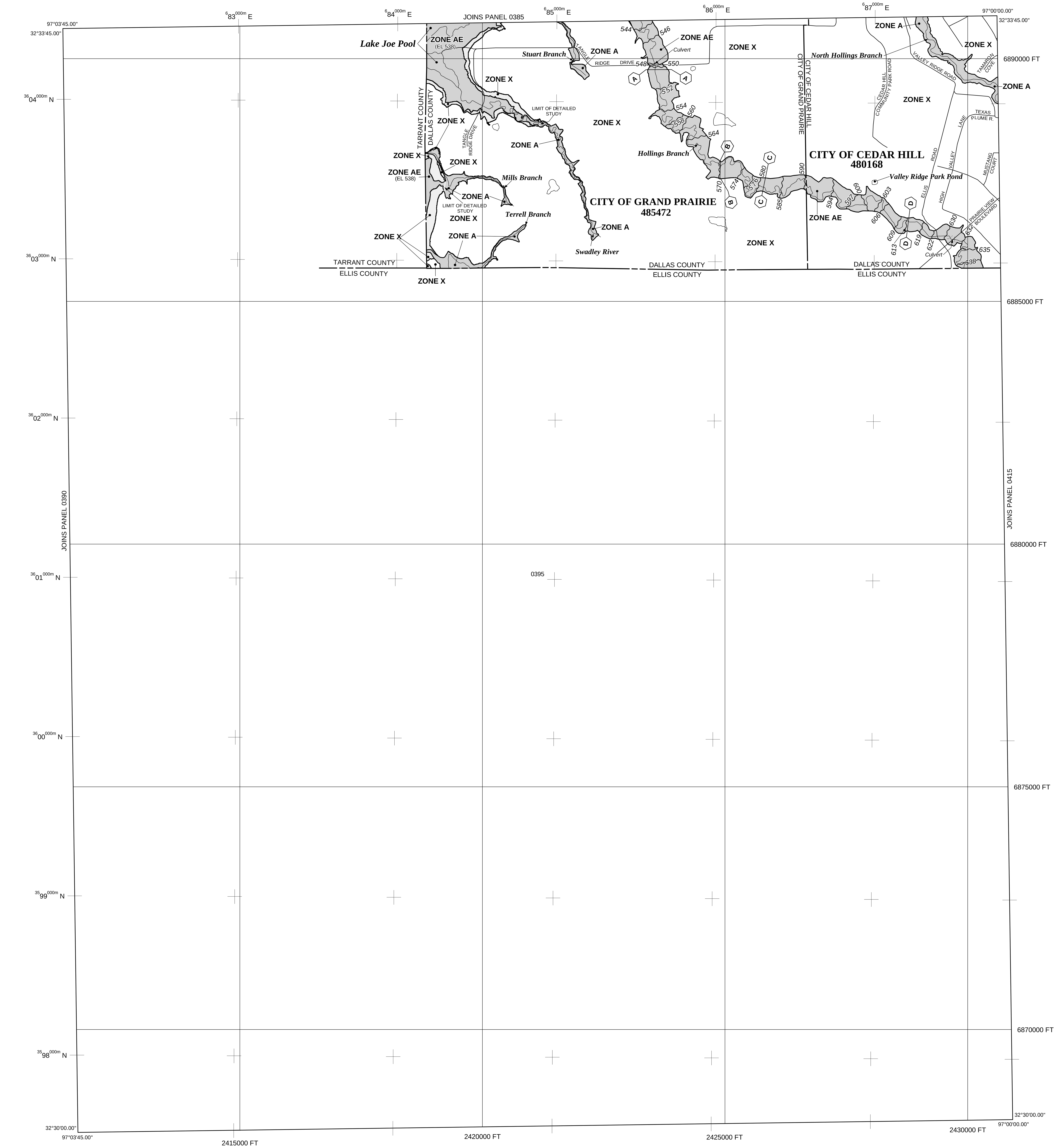

LEGEND

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

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ZONE A	No Base Flood Elevations determined.
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ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
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COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 - - - - 23	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000mN	1000-meter Universal Transverse Mercator grid ticks, zone 14
6000000 FT	5000-foot grid values: Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
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EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
August 23, 2001
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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N

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0395L

FIRM
FLOOD INSURANCE RATE MAP

DALLAS COUNTY, TEXAS
AND INCORPORATED AREAS

PANEL 395 OF 495
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CEDAR HILL, CITY OF	480168	0395	L
GRAND PRAIRIE, CITY OF	485472	0395	L

PRELIMINARY
JUN 22 2007

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U.S. DEPARTMENT OF HOMELAND SECURITY

MAP NUMBER
48113C0395L

MAP REVISED

Federal Emergency Management Agency

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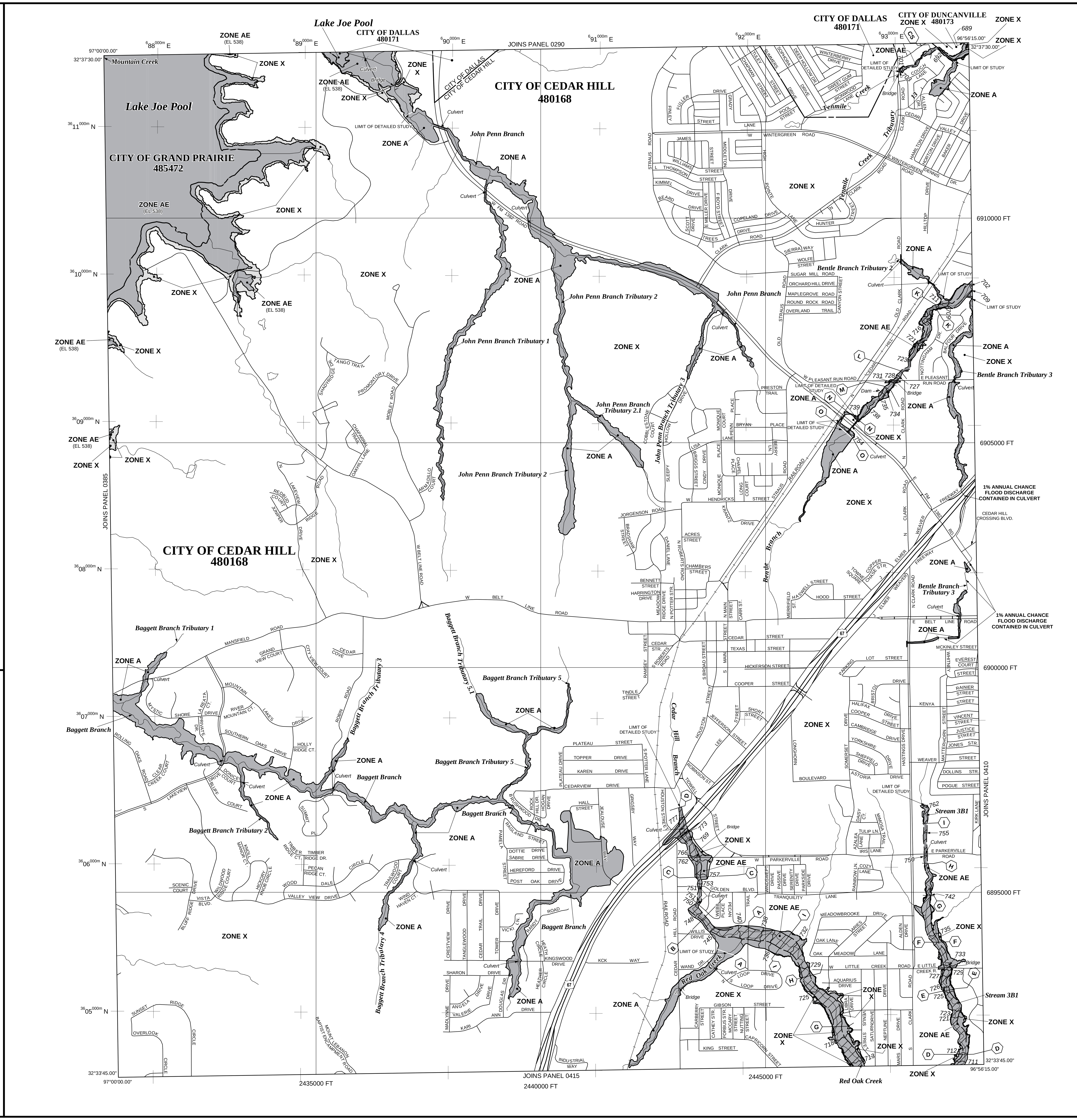

LEGEND

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
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COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

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	Floodway boundary
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MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
August 23, 2001
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0405L

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

PANEL 405 OF 495
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CEDAR HILL, CITY OF	480168	0405	L
DALLAS, CITY OF	480171	0405	L
DUNCANVILLE, CITY OF	480173	0405	L
GRAND PRAIRIE, CITY OF	485472	0405	L

PRELIMINARY
JUN 22 2007

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MAP NUMBER
48113C0405L

MAP REVISED

Federal Emergency Management Agency

PRELIMINARY DFIRMS
ELLIS COUNTY
JOHNSON COUNTY

NOTES TO USERS

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

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

The **projection** used in the preparation of this map was Texas State Plane north central zone (FIPSZONE 4202). The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

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

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC- 3, #9202
1315 East- West Highway
Silver Spring, MD 20910- 3282

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

Base map information shown on this FIRM was provided in digital format by the Texas Natural Resources Information System (TNRIS). This information was photogrammetrically compiled at a scale of at least 1:24,000 from aerial photography dated 2004.

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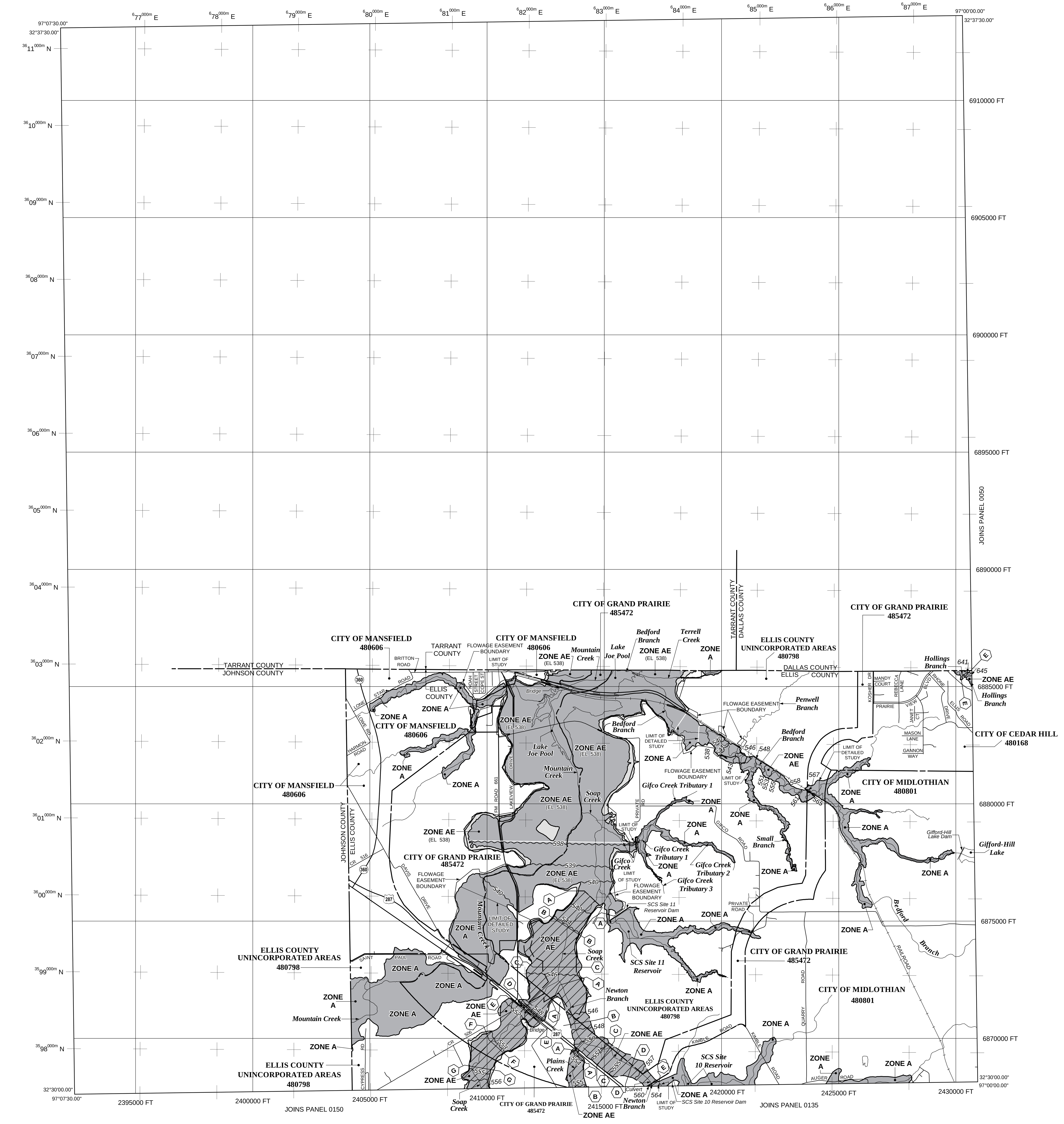
Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which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

Contact the **FEMA Map Service Center** at 1- 800- 358- 9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, *a Flood Insurance Study report*, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1- 800- 358- 9620 and its website at http://www.msc.fema.gov/.

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



LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

~~ 513 ~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 - - - - 23	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid, zone 14
6000000 FT	5000-foot grid : Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
January 20, 1999
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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

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

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET
600 0 600 1200 METERS

NFIP

PANEL 0025L

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

ELLIS COUNTY, TEXAS
AND INCORPORATED AREAS

PANEL 25 OF 600
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ELLIS COUNTY	480798	0025	L
CEDAR HILL, CITY OF	480168	0025	L
GRAND PRAIRIE, CITY OF	485472	0025	L
MANSFIELD, CITY OF	480606	0025	L
MIDLOTHIAN, CITY OF	480801	0025	L

PRELIMINARY

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
48139C0025L

MAP REVISED

Federal Emergency Management Agency

NOTES TO USERS

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National Geodetic Survey
SSMC- 3, #9202
1315 East- West Highway
Silver Spring, MD 20910- 3282

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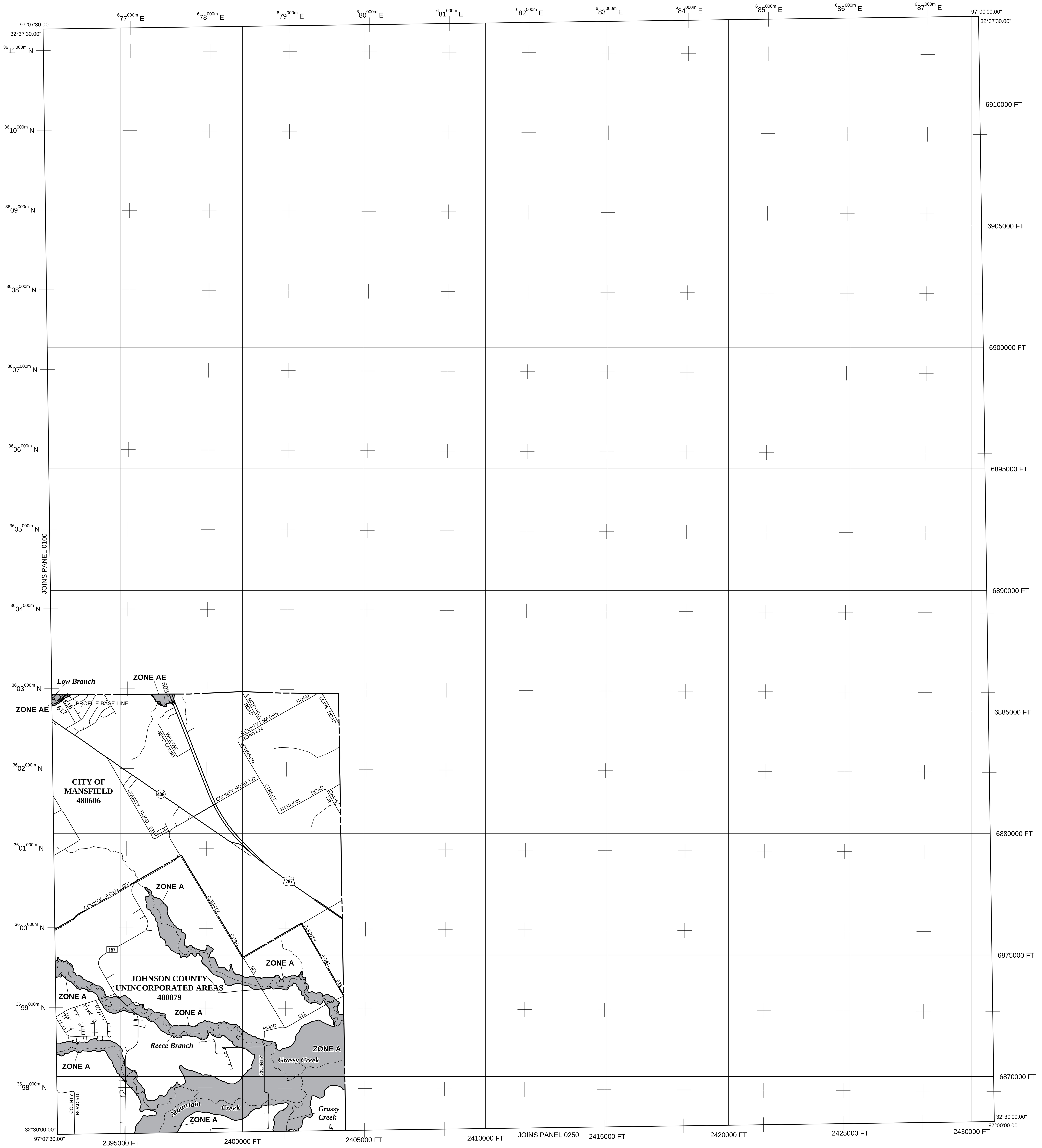

LEGEND

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ZONE A	No Base Flood Elevations determined.
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FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
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COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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Floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 - - - - 23	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 14
6000000 FT	5000-foot grid values: Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic
DX5510	Bench mark (see explanation in Notes to Users section of this FIRM panel)
M1.5	River Mile

MAP REPOSITORIES
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EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP

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

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MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET

600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0125J

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

PANEL 125 OF 475

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
JOHNSON COUNTY	480879	0125	J
MANSFIELD, CITY OF	480606	0125	J

PRELIMINARY

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MAP NUMBER 48251C0125J

MAP REVISED

Federal Emergency Management Agency

NOTES TO USERS

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NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

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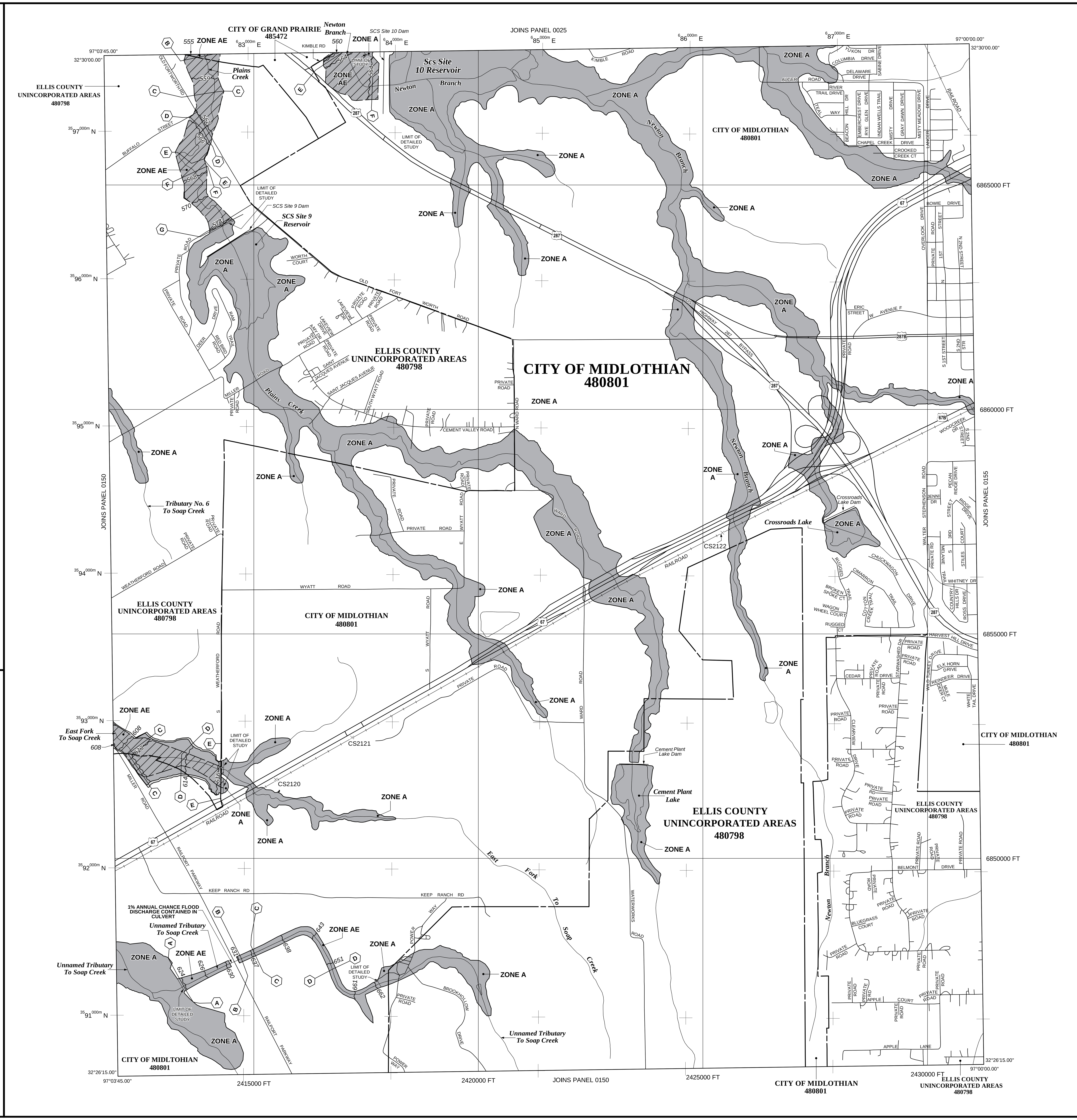

LEGEND

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
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COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	Floodplain boundary
	Floodway boundary
	Zone D boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
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MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
January 20, 1999
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0135L

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

PANEL 135 OF 600
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ELLIS COUNTY	480798	0135	L
GRAND PRAIRIE, CITY OF	485472	0135	L
MIDLOTHIAN, CITY OF	480801	0135	L

PRELIMINARY

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MAP NUMBER
48139C0135L

MAP REVISED

Federal Emergency Management Agency

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NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC- 3, #9202
1315 East- West Highway
Silver Spring, MD 20910- 3282

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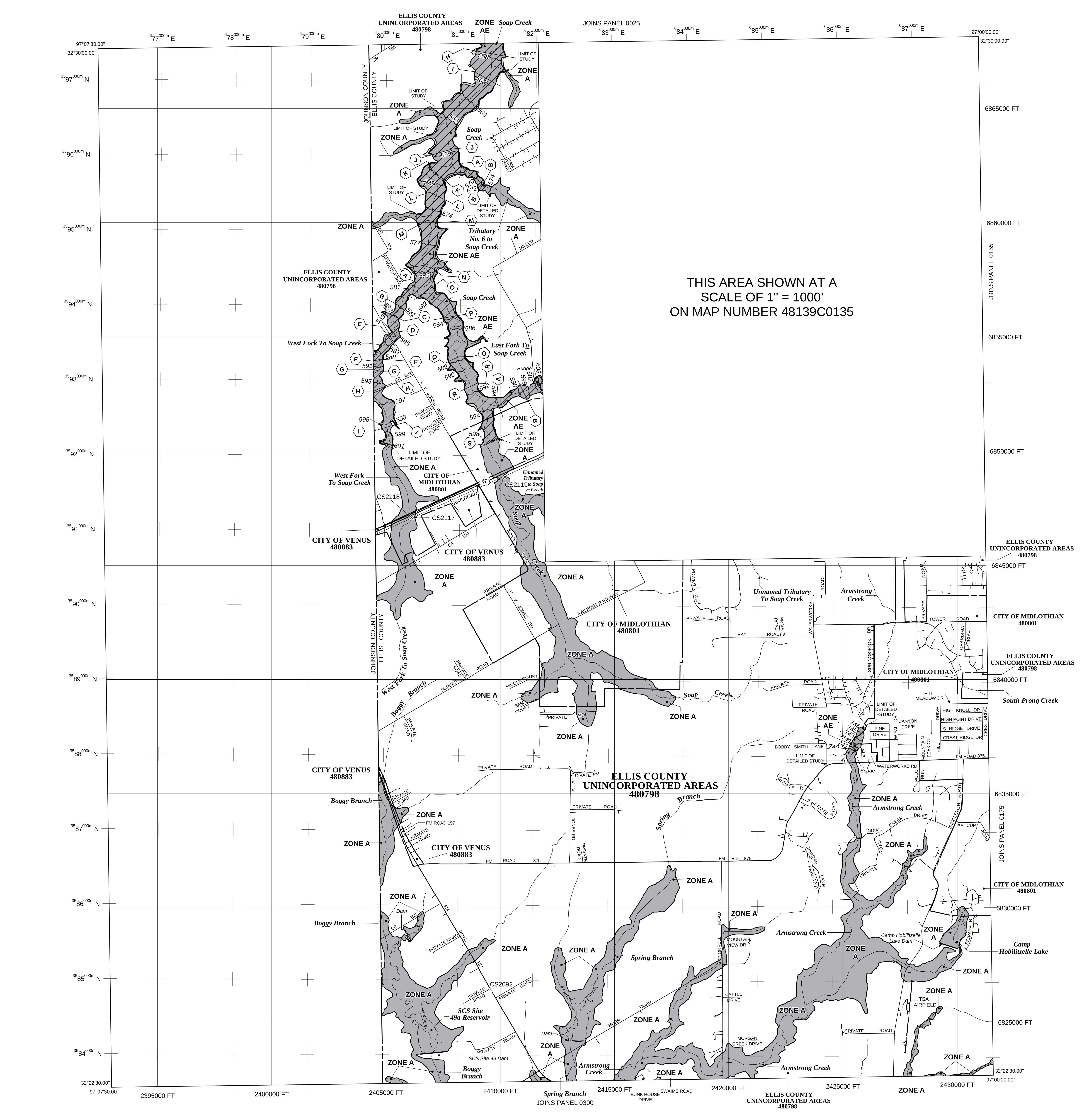
Contact the **FEMA Map Service Center** at 1- 800- 358- 9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, *a Flood Insurance Study report*, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1- 800- 358- 9620 and its website at http://www.msc.fema.gov/.

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



LEGEND

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

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

ZONE A No Base Flood Elevations determined.

ZONE AE Base Flood Elevations determined.

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

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

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

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513 — Base Flood Elevation line and value; elevation in feet*

(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A Cross section line

23 - - - 23 Transect line

97°07'30", 32°22'30" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)

$^{42}75^{000m}$N — 1000-meter Universal Transverse Mercator grid, zone 14

6000000 FT — 5000-foot grid : Texas State Plane coordinate system, north central zone (FIPSZONE 4202), Lambert Conformal Conic

DX5510 × — Bench mark (see explanation in Notes to Users section of this FIRM panel)

• M1.5 — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
January 20, 1999
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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

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

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET

600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0150L

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

PANEL 150 OF 600

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ELLIS COUNTY	480798	0150	L
MIDLOTHIAN, CITY OF	480801	0150	L
VENUS, CITY OF	480883	0150	L

PRELIMINARY

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MAP NUMBER
48139C0150L

MAP REVISED

Federal Emergency Management Agency

NOTES TO USERS

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

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

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The **projection** used in the preparation of this map was Texas State Plane north central zone (FIPSZONE 4202). The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

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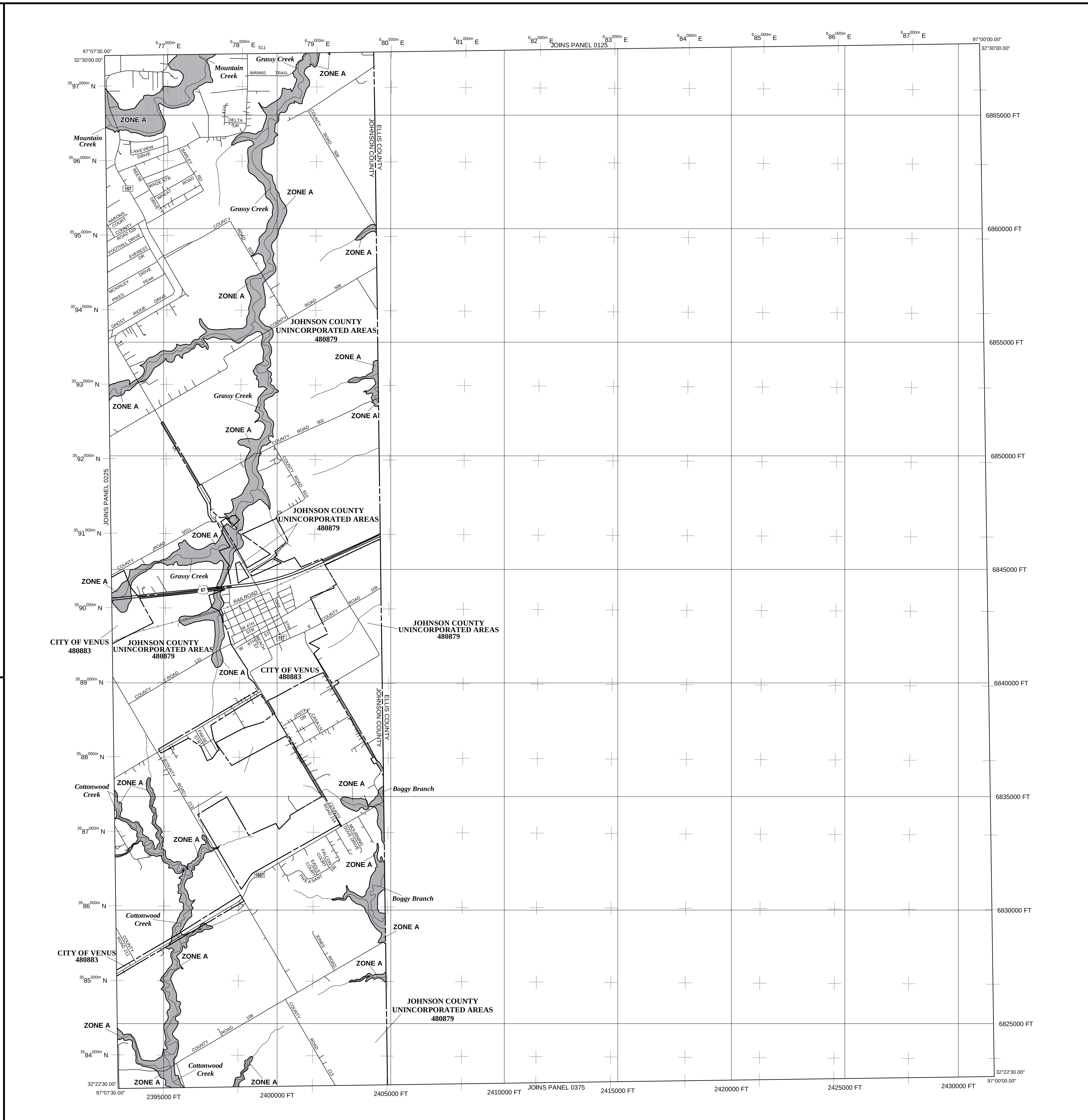

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ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the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

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OTHER FLOOD AREAS

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

OTHER AREAS

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Floodway boundary
Zone D boundary
CBRS and OPA boundary
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• M1.5	River Mile

MAP REPOSITORIES
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EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP

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

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1000 0 2000 4000 FEET
600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0250J

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

PANEL 250 OF 475
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
JOHNSON COUNTY	480879	0250	J
VENUS, CITY OF	480883	0250	J

PRELIMINARY

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MAP NUMBER
48251C0250J

MAP REVISED

Federal Emergency Management Agency

APPENDIX P

MISCELLANEOUS DOCUMENTATION

- Approval Letter for Flood Mitigation Plan
- Resolution 4341 – Flood Mitigation Plan
- Article 14 from Unified Development Code - Drainage
- Article 15 from Unified Development Code – Floodplain Management
- Section 12.0 – Floodway/Floodplain Development Criteria
- Resolution 3919 – Erosion and Other Drainage Problems Relating to Waterways
- StormCad Protocols

TEXAS WATER DEVELOPMENT BOARD

RECEIVED
JAN 20 2009
HALFF ASSOCIATES

January 13, 2009

Romin A. Khavari, P.E., City Engineer
Planning & Development
City of Grand Prairie
206 W. Church Street
Grand Prairie, Texas 75053

Re: Flood Mitigation Plan

Dear Mr. Khavari:

The Texas Water Development Board has received official notification that the Flood Protection Plan prepared and submitted by the City of Grand Prairie (City) has been reviewed and approved by the Federal Emergency Management Agency (FEMA) as meeting the planning requirements of the Flood Mitigation Assistance (FMA) Program. Enclosed is the approval letter from FEMA. The area approved under this approval includes the jurisdictional area of the City as identified by the Plan. Any future updated information concerning the Flood Mitigation Plan can be forwarded to my attention.

Should you have any questions, contact me at (512) 463-6418.

Sincerely,

Gail Lamer
for
Gilbert Ward

Gilbert R. Ward
Grants Coordinator

Enclosure

cc: John P. Ivey, P.E., CFM, Halff Associates

U.S. Department of Homeland Security
FEMA Region 6
800 North loop 288
Denton, TX 76209-3698

FEMA

January 8, 2009

Mr. Gilbert R. Ward
Texas Water Development Board
FMA Program Coordinator
1700 N. Congress Avenue
Austin, TX 78711

RE: Flood Mitigation Assistance (FMA) Plan for the City of Grand Prairie, Texas

Dear Mr. Ward:

I am pleased to inform you that the City of Grand Prairie's Flood Mitigation Assistance (FMA) Plan received in our office on November 11, 2008, has been reviewed and approved. Thank you for including the signed resolution dated September 2, 2008.

Any future planning initiatives undertaken by the City of Grand Prairie should be incorporated into the approved FMA plan. The plan should be reviewed at least once a year to evaluate the need for any plan updates.

I appreciate your dedication and support in addressing repetitive flooding problems within your State. Should you have any questions, please contact me at (940) 898-5363.

Sincerely,

Bart Moore
Senior Mitigation Specialist

RESOLUTION NO. 4341

RESOLUTION FOR APPROVAL OF THE CITY OF GRAND PRAIRIE FLOOD MITIGATION PLAN

WHEREAS, natural hazards in the City of Grand Prairie historically have caused significant flood disasters with losses of life and property and natural resources damage, including six of the top 10 costliest severe weather hazard events in Texas since 1950; and

WHEREAS, the Flood Mitigation Assistance (FMA) Program requires communities to adopt a flood mitigation action plan to be eligible for FMA Program funding; and

WHEREAS, the City of Grand Prairie coordinated the flood mitigation planning effort with the North Central Texas Council of Governments (NCTCOG) Mitigation Plan that encompasses mitigation actions at both the local and regional levels; and

WHEREAS, the City of Grand Prairie has incorporated comments and recommendations from the Texas Water Development Board and FEMA into the City of Grand Prairie's Flood Mitigation Plan; and

WHEREAS, the City of Grand Prairie's Flood Mitigation Plan is an extension of its "all-hazards" Mitigation Plan and Emergency Operations Plan; and

WHEREAS, the City of Grand Prairie's Flood Mitigation Plan is a record of the community's potential flood risks and hazards and a commitment to reducing the long-term consequences of flood hazards. The Flood Mitigation Plan outlines mitigation goals, identifies risk reduction strategies for flood hazards that threaten the area, and discusses the ongoing risk reduction strategies to be undertaken within the jurisdiction.

NOW THEREFORE, BE IT RESOLVED, BY THE CITY COUNCIL OF THE CITY OF GRAND PRAIRIE, TEXAS THAT:

SECTION 1. The City of Grand Prairie's Flood Mitigation Plan is approved in its entirety, incorporating both local and multi-jurisdictional elements.

SECTION 2. The City of Grand Prairie will pursue available funding opportunities for implementation of the proposals designated therein, and will, upon receipt of such funding or other necessary resources, seek to implement the actions contained in the mitigation strategies.

SECITON 3. The City of Grand Prairie will continue to participate in the multi-jurisdictional mitigation planning process, including reporting of progress as required by FEMA and the Texas Water Development Board.

SECTION 4. This resolution is in effect upon approval of the City Council of the City of Grand Prairie.

PASSED AND APPROVED BY THE CITY COUNCIL OF THE CITY OF GRAND PRAIRIE, TEXAS, THIS THE 2nd DAY OF SEPTEMBER, 2008.

ATTEST:

Catherine E. DiMaggio

City Secretary

APPROVED:

Charles England

Mayor

APPROVED AS TO FORM:

Donald R. Postell

City Attorney

3.1 Article 14

ARTICLE 14

DRAINAGE

ARTICLE 14 – DRAINAGE

PAGE

ARTICLE 14 - DRAINAGE

SECTION 1 - PURPOSE

14.1.1 The purpose of drainage policies and standards are to protect the general health, safety, and welfare of the public by reducing flooding potential, controlling excessive runoff, minimizing erosion and siltation problems, and eliminating damage to public facilities resulting from uncontrolled storm water runoff.

All development shall comply with all City wide and local master plan requirements, UDC Articles 14 and 15, and shall be reasonably safe from flooding. At a minimum, the requirements listed in FEMA's Technical Bulletin 10 shall be submitted to the Floodplain Administrator in order to certify a structure as reasonably safe from flooding using the best available information.

SECTION 2 - APPLICABILITY

14.2.1 The procedures, policies and standards of this Article govern storm drainage facilities within the City and its extraterritorial jurisdiction.

SECTION 3 - PROCEDURES

14.3.1 Preliminary Study Required

The owner may be required to provide, at such owner's expense, a preliminary drainage study of the area proposed for development, in conjunction with any preliminary plat submittal.

The preliminary drainage study shall be submitted to the City Engineer prior to approval of the preliminary plat by the Planning and Zoning Commission.

The study shall include:

A. A contour map of the entire drainage area contributing runoff to the subdivision equal to currently approved Public Works contour maps of the City, or two-foot contours, whichever is less. Drainage areas greater than 400 acres may be shown on a map at a scale smaller than one inch = 200 feet subject to the concurrence of the City Engineer.

B. Sufficient design calculations showing preliminary sizes and locations of all on-site, adjacent and nearby existing and proposed drainage facilities, including storm drains, culverts, channels, inlets, detention basins, floodplains, etc.

C. Design calculations and floodplain delineations supporting the floodplain information required by Article 15 "Floodplain Management".

D. HEC-HMS analysis shall be required if hydrographs are developed for sub-areas, routed and/or combined (regardless of sub-area size) to size drainage facilities.

E. Hydraulics and hydrology studies shall include the statement that no adverse impacts are expected as a result of this project up to and including the 100-year (1%) storm event.

14.3.2 Final Plan Required

The owner shall, at the owner's sole expense, provide complete final plans and specifications for the drainage facilities associated with a final plat or building permit. The plans and specifications shall be prepared by a civil engineer licensed to practice in the state and experienced in municipal drainage work. The plans and specifications shall be submitted to the City Engineer for review and concurrence prior to any construction.

No person shall fill, grade, excavate or otherwise disturb the surface of real property within the City without first having secured an earthwork development permit Appendix A.2 from the City. It shall be the duty of each person owning or having control of real property within the City to prevent soil, mud, rock or other debris from such real property being deposited or otherwise transported onto the streets, alleys, utility facilities, rights-of-way, or easements or into creeks, lakes, channels, or other water bodies. An erosion control plan is required for an earthwork development permit. A site-specific SWPPP, prepared by the Developer/Owner and Contractor with appropriate notices issued as required by the state TPDES general permit, shall be kept on the construction site at all times during the construction and updated as needed to address changing conditions. A copy of the construction site notice and NOI (if required) shall be provided to the City. See the current Drainage Design Manual for specific requirements. The City Engineer may require information as necessary to evaluate the impacts of the proposed project.

14.3.3 Responsibility for Plans and Specifications

The owner and owner's engineer shall be responsible for the accuracy of the information furnished in the design of the storm drainage facilities. The owner's engineer shall submit as-built construction plans and the owner shall be responsible for the proper construction of all drainage facilities per the City approved plans.

SECTION 4 - POLICIES

14.4.1 Types of Drainage Facilities

Earthen channels are encouraged throughout the City, particularly for channels draining areas of more than 4,000 acres and may be used for channels draining areas less than 4,000 acres in lieu of closed conduits or concrete lined channels when it is mutually agreeable to both the City and the owner. The four different types of basic drainage facilities are as follows:

A. Closed conduit systems, i.e., storm drains

B. Reinforced concrete-lined open channels

C. Earthen open channels

D. Detention basins

14.4.2 Closed Conduit Systems

Storm water runoff shall be carried in a closed conduit when either of the following apply:

A. The runoff can be carried in a pipe of 72 inches in diameter or smaller; or

B. Where it is necessary for the protection of adjacent facilities that the storm water be carried in an enclosed facility.

C. Headwalls and erosion protection shall be constructed at the outfall of all storm drainage systems.

14.4.3 Concrete-Lined Channels

Reinforced concrete-lined open channels should be used when the criteria outlined above is exceeded, or in lieu of a closed conduit when it is mutually agreeable to both the City and the owner. They shall meet all City, state and federal requirements.

Reinforced concrete-lined open channels shall conform to the following:

A. At low points in grade (sumps) of a closed conduit system, a concrete-lined overflow channel shall be provided to convey the 100-year flood overflow. If the 100-year flood is collected and conveyed in a closed conduit, then an overflow channel is not required. All such concrete overflow channels and other concrete channels that discharge 40 cfs or less shall be considered flumes. Flumes draining 20 cfs or less do not require freeboard. All other flumes with sub-critical flow must have a minimum of six inches of freeboard, and with super-critical flow, they must have one foot of freeboard.

The following items shall be for the 100-year, fully-developed flood flows with one foot freeboard, and checked for super elevation at bends:

B. Channels draining an area of 200 acres or less shall be lined with reinforced concrete in a manner which will contain the design flood plus one foot of freeboard within the concrete lining.

C. Channels draining an area of 200 acres but not more than 1,000 acres shall be concrete-lined to contain the runoff from a 25-year flood with the balance of the required design flood contained within grassed slopes no steeper than four feet horizontal to one foot vertical (4H:1V) and with a minimum of one foot freeboard.

D. Channels draining an area of 1,000 acres but not more than 4,000 acres shall be constructed with a reinforced concrete pilot channel not less than 12 feet in width and having at least six-inch curbs and a four-inch depressed invert. A stone riprap erosion protection mat four feet wide shall be placed continuously on both sides of the pilot channel. The remainder of the channel shall consist of earthen side slopes with proper vegetative cover on slopes not steeper than 4:1.

E. Channels draining an area of more than 4,000 acres shall be governed by the criteria for earthen channels.

14.4.4 Earthen Channels

Earthen channels are encouraged throughout the City, particularly for channels draining areas of more than 4,000 acres and shall meet all state and federal regulations. They may be used for channels draining areas less than 4,000 acres in lieu of closed conduits or concrete lined channels when it is mutually agreeable to both the City and the owner. When earthen channels are to be preserved, improved or constructed, an application for an earthen channel shall be submitted to the City Engineer prior to approval of the preliminary plat, final plat, or building permit. This application shall contain topographic, hydrologic, and hydraulic information sufficient to properly evaluate the proposal and showing that:

A. All land having an elevation below the 100-year flood elevation shall be contained within an easement dedicated to the public for the purpose of providing drainage. This easement shall include a ten-foot maintenance strip along the limits of the floodplain. Where maintenance access is required, one side shall be 15 feet wide. This strip area shall have a maximum slope of 10% and shall be vegetated with native grasses. Also see Item 9.0 of the Drainage Design Manual.

B. The channel easement has a minimum hydraulic capacity to accommodate a 100-year flood, plus one foot of freeboard, based on a fully developed watershed, and shall be a minimum of 20 feet wider than the top width of the channel.

C. All channel improvements, such as reshaping, realignment, etc., are protected with sodding, backsloping, cribbing, or other bank protection that is designed and constructed to control erosion from the two-, ten-, and 100-year fully-developed floods by allowing a maximum earthen channel and downstream discharge city not to exceed the maximum permissible velocities stated on Table 9.1 of the Drainage Design Manual. Improved or constructed earthen channels shall have the following minimum specifications:

    1. Constructed or improved earthen channels shall consist of a pilot channel that conveys the 2-year flood with a floodplain area consisting of overbank and sideslopes that will convey the 100-year fully-developed flood plus one foot of freeboard;

    2. The pilot channel shall be trapezoidal with maximum 4:1 sideslopes, minimum bottom width of 6 feet, and a bottom width to depth of flow ratio of not less than 2:1 (for the fully-developed 2-year flood);

    3. The floodplain shall have maximum 4:1 sideslopes and minimum ten foot width of overbank (i.e., area from pilot channel top-of-bank to toe of floodplain sideslope) on each side of pilot channel with 2%-4% cross-slopes. Access to channel bottom may require flatter side slopes in the floodplain at point locations where required by the City Engineer.

    4. Pilot channels may not be required for situations where the earthen channel is solely for the purpose of increasing conveyance under a bridge.

14.4.5 Detention Basins

Detention Basins shall be required when downstream facilities are not adequately sized to convey a design storm based on current City criteria for hydraulic capacity. Detention basins shall not be required if downstream improvements will be constructed in conjunction with the project to safely convey the undetained flows from the project. Proposed calculated peak storm water discharge from a site shall not exceed the calculated peak discharges from existing conditions, unless sufficient downstream capacity above existing discharge conditions is available. Detention facilities when required shall be designed such that peak discharges or velocities are not increased when compared to pre-project conditions for the 2-, 10- and 100-year floods.

The perimeter boundary of a detention/retention basin, or a portion thereof, that is situated within 120 feet of a street right-of-way designated on the Master Transportation Plan as a Collector or Arterial thoroughfare shall be fenced with a four-foot high wrought iron type fence, equal in design to a Type 2 Screening Fence as specified in Section 8.26 of the Grand Prairie Unified Development Code. Any portion of said fence for a basin that either directly adjoins or is situated within 15 feet of the designated street right-of-way shall contain brick columns. Said brick columns shall equal or exceed the height of the fence and be spaced a maximum of 24 feet apart on center along the designated street right-of-way. Otherwise, no brick columns shall be required for fences that do not adjoin, or are situated more than 15 feet from, the designated street right-of way.

The use of a chain link type fence as a substitute to the above requirement shall be considered by City staff if there are intervening structures or mature landscaping (existing or proposed) that would effectively screen the fence from view along the designated street right-of-way. See Item 11.0 of the Drainage Design Manual.

14.4.6 Erosion Hazard Setbacks

A. Erosion hazard setback determinations shall be made for every stream in which natural channels are to be preserved.

B. Erosion hazard setbacks, as set forth in Section 2.6 of the Drainage Design Manual, shall be required to protect structures and lot improvements from erosion hazards.

C. A person commits an offense if the person erects or maintains a structure within an erosion hazard setback.

SECTION 5 - DESIGN STANDARDS

14.5.1 Purpose

The purpose of this Section is to establish standard criteria, principles, procedures, and practices for design of storm drainage facilities. The design factors, formulas, graphs and procedures presented or referred to herein are intended for use as engineering guides in the design of drainage facilities and in the solution of drainage problems involving the quantity, method of collection, conveyance, and discharge of storm water. Methods of design other than those indicated or referred to herein may be considered in complex and difficult cases where experience clearly indicates they are preferable; however, these deviations shall not be attempted until approval has been obtained from the City Engineer.

The methods outlined or referred to herein include accepted principles of surface drainage engineering and should be a working supplement to basic design information obtainable from text books and publications on drainage.

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14.5.2 Supplemental Design Information

The following design information shall be available at the City Engineer's office, and adhered to as if contained herein:

A. Drainage Design Manual and checklist to facilitate approval of storm drainage construction plans; and

B. Standard details and technical specifications for storm drainage construction.

14.5.3 Grading Plan

A grading plan shall be prepared for all projects. The plan shall include:

A. A contour map of existing elevations based on field survey of the entire site, any off-site areas to be graded as a part of the project, and about 100 feet beyond the limits of the project or as needed to confirm the direction of local drainage. As a minimum the map shall have a scale of not less than one inch=40 feet with a one-foot contour interval. In certain cases it may be necessary to adjust the map scale, reduce the contour interval, or extend the distance of the field survey beyond the project limits to fully characterize local drainage.

B. Site layout including lot lines, easements, utility locations, buildings or pads, paving, retaining walls, storm drainage features, FEMA and fully developed floodplains/floodways with elevations, water and wastewater facilities located in the floodplain, and any other structures that may influence drainage.

C. The plan shall present the proposed finished grades at one-foot contour intervals. Spot grades shall be specified for retaining walls, to elaborate the detail on the plan and may be used on residential lots in lieu of contours. The plan shall provide drainage considerations to prevent adverse impacts to adjoining properties.

D. The grading plan shall specify the minimum finished floor (MFF) elevation for all buildings adjacent to improved streets. The MFF for residential buildings should be no lower than 0.5 feet above the top of curb or street elevation, and the grading plan shall provide for positive drainage away from the buildings. Lots and property adjoining the 100-year floodplains may require higher MFF elevations as specified by the City floodplain regulations.

E. Earthen grades for drainage being conveyed across the lot it originated on shall not be less than one percent. Maximum grades shall not exceed 25% without an engineering slope stability analysis.

Prior to release of a final building inspection, a licensed surveyor or engineer shall provide a Precise Grading Certificate to certify that lot grading is consistent with the City approved grading and drainage plans and that erosion control has been installed. Proper erosion control measures shall be shown on the plans and provided.

14.5.4 Design Discharge Determination

The Rational method (Q=1.00833CIA) shall be used for determining the design discharge on small watersheds of 200 acres or less.

Unit hydrograph techniques shall be used for areas greater than 200 acres. The technique and the data to be used for the determination of the design discharge shall be approved by the City Engineer prior to the calculations being completed. A complete set of all detail calculations must be submitted to the City Engineer for approval prior to the completion of the plans for the drainage system.

14.5.5 Drainage Area Determination

The size and shape of each watershed and associated sub-basins shall be determined for each drainage facility. This determination should be made using City topographic maps (or the most detailed topographic maps available if outside the City) with a scale of 1 inch=200 feet or greater. Where the contour interval is insufficient or physical conditions may have changed from those shown on the City topographic maps, it may be necessary to supplement the maps with field topographic surveys. The actual conditions should always be verified by a reconnaissance survey.

The outline of drainage areas must follow natural drainage features in non-urbanized areas. Flow diverted by fence or agricultural ridge rows will require a detailed ground survey and rigorous hydraulic analyses for verification. If it cannot be determined that such diversions were constructed per City Code, or if they appear to have occurred by sedimentation along a fence, it will be necessary to design any downstream storm drainage systems to accommodate runoff from such areas.

Consideration shall be given to man-made features in urbanized areas. In preparing drainage maps particular attention should be given to gutter and ditch configurations at intersections. The direction of flow in gutters (on-site and off-site) should be shown on the maps and construction plans.

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14.5.6 Runoff Coefficients

Storm drainage shall be designed for ultimate development of the watershed and, therefore, runoff coefficients used shall consider these fully developed conditions. Master plans, zoning maps, land use plans and this Unified Development Code shall be used to determine the ultimate development.

Table 14-A gives values for runoff coefficients which shall be used in the determination of storm water runoff.

TABLE 14-A
Runoff Coefficient "C"

Type of Area or Land Use	Zoning Class*	Runoff Coefficient "C"
Parks & Permanent Open Space	A, ESMNT	0.30
Single-family Residential	SFE, SF1, SF118,SF2, SF216, SF218, SF3, SF316,SF318, SF4, SF5, SF516, SF6	0.50
Multi-family Residential & Schools	MH, MF1, MF2, MF3, SFA,SFZLL SFT, 2F	0.75
Commercial/retail	O, O-1, NS, C-1, CO, C, PD, HD, GR, GR1	0.80
Industrial & Manufacturing	HC, IP, LI, HI	0.85
Central Business District (CBD)	CA	0.90
Church	All Zoning Classes	0.75

*See Unified Development Code Article 3 for Zoning Class descriptions

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14.5.7 Time of Concentration

Time of concentration is defined as the longest time that will be required for a drop of water to flow from the upper limit of the drainage area to the point of concentration. Time of concentration is a combination of inlet time and time of flow in the storm drainage facility.

Accepted minimum inlet times of concentration are shown in Table 14-B.

TABLE 14-B
Minimum Inlet Time of Concentration

Type of Area or Land Use	Minimum Inlet Time
Undeveloped, agricultural	20 minutes
Parks, permanent open areas, playgrounds	15 minutes
Single family residential	15 minutes
Multi-family residential*, schools, manufacturing, industrial, commercial/retail, church	10 minutes
Central Business District	5 minutes

* Includes zoning classes: MH, SFA, SFZLL, SFT, 2F

When inlet times of concentration which are in excess of these minimum times are used, the techniques and assumptions used in computing these times must be submitted with the plans and approved by the City Engineer.

14.5.8 Curve Charts

See Item 4.0 of the Drainage Design Manual.

14.5.9 Design Flood

It is general practice to design municipal storm drainage systems to accommodate the runoff from ten-year and 100-year storm events.

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Table 14-C shows the flood frequencies to be used in the design of drainage facilities:

TABLE 14-C
Design Flood

Type of Facility	Design Flood
Storm drains (with inlets on grade)	10-year
Storm drains draining low point inlets	100-year
Culverts, bridges, channels, creeks, low point overflows[1]	100-year

[1] 100-year flood low point overflows must be contained within easements. If low point overflows are in parking lots or access drives depth must not exceed 6 inches and must be contained in a dedicated drainage easement.

In connection with the design of facilities such as City streets conveying storm runoff and low point inlets, the discharge for a 100-year flood and the resulting possible damages there from shall be evaluated to determine if said damages are sufficient to warrant the enlargement of the planned facility. In any areas where storm water runoff concentrates at low points of grade or where discharge in excess of the storm drainage facility capacity flows across private property, the following information shall be shown:

A. The 100-year flood discharge and inundation limits.

B. The depth of inundation of this discharge.

C. An evaluation of the possible damages resulting from the overflow discharge.

D. Location and width of a dedicated drainage easement sufficient to convey the discharge to another drainage facility.

14.5.10 Head Losses

The design techniques and methods used in the determination of all head losses shall be approved by the City Engineer. See also see Item 8.5 of the Drainage Design Manual.

14.5.11 Flow in Gutters

The drainage capacities of streets and gutters shall be determined by Manning's Formula using an 'n' value of 0.016 for concrete streets. Streets and curb inlets shall be designed to flow not more than curb deep during a 10-year flood. When existing street slopes are less than five feet per 1,000, the hydraulic capacity of the street and right-of-way shall be determined assuming a slope of three feet per 1,000. Where a flow of water is directed toward a curb and is required to turn in direction, the height of the curb against which the water is directed shall not be less than the depth of water flow plus the city head of the water plus two inches. Where water is dumped from a street directly into an open watercourse, it shall be dumped through an approved type of catch basin or through a concrete lined structure.

SECTION 6 - OFF-SITE DRAINAGE, EASEMENTS, AND CONSTRUCTION

14.6.1 Off-Site Drainage

The owner or developer of property to be developed shall be responsible for all storm drainage discharge flowing on such person's property. This responsibility includes the drainage directed to that property by prior development as well as drainage naturally flowing through the property by reason of topography. In the event storm water flowing onto such person's property cannot be carried in the equivalent of a seventy-two inch pipe, the City may participate in a direct percentage method of those costs in excess of seventy-two inches based upon written agreements prior to final plat approval and availability of funds and approval by City Council.

Adequate consideration shall be given by the owner in the development of property to determine how the discharge leaving the proposed development will affect downstream property, with the city of said downstream drainage discharge into an adequate storm drain system, defined creek or waterway based on the suggested maximum permissible velocities in Table 9.1 of the Drainage Design Manual.

14.6.2 Easements and Construction

On lots or tracts where storm water runoff has been collected or concentrated, it shall not be permitted to drain onto adjacent property except in existing creeks, channels, drainage swales or storm sewers unless proper drainage easements or a letter of release of liability from the affected property owner is filed for record with the County Deed of Records.

All proposed storm drainage facilities (i.e. closed conduits, channels, graded swales, detention basins) which convey concentrated storm runoff beyond the boundary of a single property shall be placed within the limits of a dedicated drainage easement or public right-of-way. Private storm drainage systems which collect only on-site storm drainage runoff from one lot or tract shall not be placed in a dedicated storm drainage easement (no lot-to-lot drainage). Easement width for storm drain pipe shall not be less than 15 feet and easement width for open channels shall be at least 20 feet wider than the width of the top of the channel banks. Where maintenance access is required, one side shall be 15-feet wide.

Channels delineated on the FEMA study and maps as adopted by Subsection 15.2.2(A) and earthen channels accepted by the City as part of the development plan shall be placed within a dedicated drainage easement/storm water management area or public right-of-way of sufficient size to contain the 100-year fully-developed flood with a minimum ten feet over bank area within the floodplain on each side of the stream. The drainage easement shall be of sufficient size to take into account any additional width to accommodate future bank erosion as determined by engineering slope stability calculations. A future stable four feet horizontal to one foot vertical (4:1) earthen bank slope plus ten feet may be assumed in establishing the limits of the drainage easement measured from the bottom edge of the creek bottom. <u>In no case shall the slopes be steeper than 3:1</u>.

The subdivider, developer, or builder shall bear the cost of all drainage improvements required for the development of such person's subdivision or other construction, including the cost of any necessary downstream off-site channels or storm drains as described in Subsection 14.6.1 and the cost of acquisition of the required easements, with the following exceptions:

A. If the owner is unable to acquire the necessary off-site easements, such owner shall provide the City with documentation of such owner's efforts, including evidence of a reasonable offer made to the affected property owner. Upon such a written request for assistance, the City shall acquire these easements either through negotiations or condemnation. In either case, the cost of these easements shall be paid by the owner.

B. In areas where the proposed off-site improvements are to be made within existing City right-of-way, an estimate of these off-site costs shall be prepared and submitted along with the plans. Subject to availability of funds and City Council approval, cost for such off-site improvements shall be prorated such that the owner pays for a percentage of the off-site cost based on the increase of the discharge originating within the limits of such owner's property.

All construction shall be in accordance with the standard specifications and construction details for street and drainage construction in the City as currently amended.

14.6.3 Storm Water Quality and Construction

All construction activities shall be in compliance with all current City of Grand Prairie, State (TPDES) and Federal (NPDES) stormwater quality regulations. A copy of the Notice of Intent or Construction Site Notice shall be submitted to the City Engineer when runoff from a construction site enters a public system. A Storm Water Erosion Control Plan shall be included in the construction plans submitted to the City. As applicable, a Storm Water Pollution Prevention Plan (SWPPP)

shall be prepared and a general permit secured by the Developer/Owner and Contractor as required and kept on the construction site during construction with the NOI and construction site notice posted in clear view of the public at the construction entrance.

3.2 Article 15

ARTICLE 15

FLOODPLAIN MANAGEMENT

ARTICLE 15 – FLOODPLAIN MANAGEMENT

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ARTICLE 15 – FLOODPLAIN MANAGEMENT

SECTION 1 - STATUTORY AUTHORIZATION

15.1.1 The Legislature of the State of Texas has in the Flood Control Insurance Act, Texas Water Code, Section 16.315, delegated the responsibility of local governmental units to adopt regulations designed to minimize flood losses. Therefore, the City Council of The City of Grand Prairie, Texas, does ordain as follows:

15.1.2 The National Flood Insurance Program (NFIP) is a federal program established by Congress in 1968 that allows property owners to purchase federally backed flood insurance within communities that participate in the program. The City of Grand Prairie is a participant. In return for this protection, the City of Grand Prairie must implement floodplain management measures to reduce flood risk to new and existing development in accordance with federal regulations.

SECTION 2 - FINDINGS OF FACT

15.2.1 The flood hazard areas of The City of Grand Prairie are subject to periodic inundation, which may result in loss of life and property, health and safety hazards, disruption of commerce and governmental services, and extraordinary public expenditures for flood protection and relief, all of which may adversely affect the public health, safety and general welfare.

15.2.2 These flood losses are created by the cumulative effect of obstructions in floodplains which cause an increase in flood heights and velocities, and by the occupancy of flood hazard areas by uses vulnerable to floods and hazardous to other lands because they are inadequately elevated, flood proofed or otherwise protected from flood damage.

SECTION 3 - STATEMENT OF PURPOSE

15.3.1 The purpose of floodplain regulations is to promote the public health, safety, and welfare and to minimize public and private losses due to flood conditions in specific areas by provisions designed to:

A. Protect human life and health;

B. Minimize expenditure of public money for costly flood control projects;

C. Minimize the need for rescue and relief efforts associated with flooding that are generally undertaken by the City at the expense of the general public;

D. Minimize prolonged business interruptions;

E. Minimize damage to public facilities and utilities such as water and gas mains, electric, telephone and sewer lines, streets and bridges located in floodplains;

F. Help maintain a stable tax base by providing for the sound use and development of flood-prone areas in such a manner as to minimize future flood blight areas; and

G. Help potential buyers become aware of property that is subject to flooding.

SECTION 4 - LANDS TO WHICH THIS ORDINANCE APPLIES

15.4.1 This article applies to all areas of special flood hazard within the City of Grand Prairie and its extraterritorial jurisdiction. The City will not approve a final plat that does not conform to the minimum FEMA regulations regarding floodplain management.

SECTION 5 - BASIS FOR ESTABLISHING AREAS OF SPECIAL FLOOD HAZARD

15.5.1 The areas of special flood hazard are:

A. The areas of special flood hazard identified by the Federal Emergency Management Agency in the current scientific and engineering report entitled, “The Flood Insurance Study (FIS) for Dallas County, Texas and Incorporated Areas", dated June 16, 2005, with accompanying most recent Flood Insurance Rate Maps and any revisions thereto are hereby adopted by reference and declared to be a part of this ordinance.

Those areas which have not yet been delineated on the FEMA maps, but are known to constitute a special flood hazard.

SECTION 6 - FLOODWAYS

15.6.1 Located within those areas of special flood hazard are areas designated as floodways. The floodway could possibly be an extremely hazardous area due to the velocity of flood waters which carry debris, potential projectiles, and erosion potential; therefore the following provisions shall apply:

A. Encroachments are prohibited, including fill, new construction, substantial improvements of non-conforming structures and other development unless it has been demonstrated to the satisfaction of the Floodplain Administrator by a professional registered engineer that the encroachment, individually or collectively, shall not result in any increase in flood flows or damages and shall not increase the floodway elevation (zero feet) during the occurrence of the 100-year fully-developed flood discharge.

B. If the immediately preceding subsection is satisfied, all construction and substantial improvements shall comply with all applicable flood hazard reduction provisions of this Article.

C. Where it is anticipated that additional runoff incident to the development of the subdivision will overload an existing downstream drainage facility, within the “Zone of Influence” of the development, whether natural or man-made, and result in hazardous conditions, the Planning and Zoning Commission may withhold approval of the subdivision until appropriate provision has been made to accommodate the problem, and plans shall be provided which include all necessary off-site improvements, including storm drainage systems, channel grading, driveway adjustments, culvert improvements, etc.

SECTION 7 - COMPLIANCE

15.7.1 No structure or land shall hereafter be located, altered, or have its use changed without full compliance with the terms of this Article and other applicable regulations of this Code.

SECTION 8 - ABROGATION AND GREATER RESTRICTIONS

15.8.1 This Article is not intended to repeal, abrogate or impair any existing easements, covenants, or deed restrictions. However, where this Article and another conflict or overlap, whichever imposes the more stringent restrictions shall prevail.

SECTION 9 - INTERPRETATION

15.9.1 In the interpretation and application of this Article, all provisions shall be considered as minimum requirements and shall be liberally construed in favor of the City and shall not be deemed a limitation or repeal of any other powers granted by Texas statutes.

SECTION 10 - WARNING AND DISCLAIMER OF LIABILITY

15.10.1 The degree of flood protection required by this Article is considered reasonable for regulatory purposes and is based on scientific and engineering considerations. On rare occasions greater floods can and will occur and flood heights may be increased by man-made or natural causes. This Article does not imply that land outside the areas of special flood hazards or uses permitted within such areas will be free from flooding or flood damages.

15.10.2 This Article shall not create liability on the part of the City or any officer or employee thereof for any flood damages that result from reliance on this ordinance or any administrative decision lawfully made there under. In no case shall responsibility or liability arise from the design or operation of drainage facilities dedicated to the City.

SECTION 11 - DISCLOSURE OF FLOODPLAIN DESIGNATION

15.11.1 Any person or agent of any person who sells a house, lot tract, or parcel of land in any area designated as a floodplain in accordance with this Article shall reveal in writing to the buyer thereof that said property is located in a floodplain. Any lending institution which handles the commercial paper related to said transaction shall inform the borrower that flood insurance is available for said house, lot tract, or parcel of land. This information should be provided no later than two (2) working days prior to closing.

15.11.2 Any person who is found guilty of violating this section by a court of competent jurisdiction shall be fined as provided elsewhere in this Code. The penalty provided herein shall be in addition to any other remedy a buyer may have.

SECTION 12 - DESIGNATION OF FLOODPLAIN ADMINISTRATOR

15.12.1The City Manager is hereby appointed the Floodplain Administrator to administer and implement the provisions of this ordinance and other appropriate sections of 44 CFR (Emergency Management and Assistance - National Flood Insurance Program Regulations) pertaining to floodplain management. The City Manager may delegate all or part of the responsibilities as Floodplain Administrator to a person on staff.

SECTION 13 - DUTIES & RESPONSIBILITIES OF THE FLOODPLAIN ADMINISTRATOR

15.13.1 Duties and responsibilities of the Floodplain Administrator shall include, but not be limited to, the following:

A. Maintain and hold open for public inspection all records pertaining to the provisions of this Article.

B. Review building permit applications as required by Article 13, "Building Permits" for sites located in, or adjacent to, the regulatory floodplain to determine whether proposed building sites will be reasonably safe from flooding.

C. Review, approve, or deny all application for floodplain permits required by this Article. In addition, the Parks and Recreation Department will review any development or disturbance of topography within 500 feet of the centerline of the waterway.

D. Review of permits required by subsection shall include reasonable assurance that all other necessary permits have been obtained from those Federal, Texas, or local governmental agencies (including Section 404 of the Federal Water Pollution Control Act Amendments of 1972) from which prior approval is required. However, these assurances do not assume any responsibility on the part of the Floodplain Administrator or the City of Grand Prairie to enforce the conditions and requirements of permits issued by agencies other than the City.

E. Where interpretation is needed as to the exact location of the boundaries of the areas of special flood hazards (for example, where there appears to be a conflict between a mapped boundary and actual field conditions) the Floodplain Administrator shall make the necessary interpretation.

F. In riverine situations, notify adjacent communities prior to any alteration or relocation of a water course and submit evidence of such notification to the Federal Emergency Management Agency.

G. Assure that the flood carrying capacity within the altered or relocated portion of any watercourse is maintained.

H. When base flood elevations data has not been provided in accordance with this Article, the Floodplain Administrator shall obtain, review and reasonably utilize any base flood elevation data and floodway data available from a Federal, Texas, or other source, in order to administer the provisions of Section 5 "Provision of Flood Hazard Reduction," of this Article.

I. When a regulatory floodway has not been designated, the Floodplain Administrator must require that no new construction, substantial improvements, or other development (including fill) shall be permitted within Zones A1-30 and AE on the City's Flood Insurance Rate Maps (FIRM) unless it is demonstrated that the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than one foot at any point within the community.

SECTION 14 - FLOODPLAIN PERMIT PROCEDURES

15.14.1 A City of Grand Prairie Floodplain Development Permit shall be required for all proposed development in an area of special flood hazard (floodplain), to ensure conformance with the provisions of this Article. It shall be issued by the Engineering Department.

15.14.2 Application for a Floodplain Permit shall be presented to the Floodplain Administrator on forms furnished by him and shall include but not be limited to, plans in duplicate drawn to scale showing the location, dimensions, and elevation of proposed landscape alterations, existing and proposed structures, and the location of the foregoing in relation to areas of special flood hazard. Additionally, the following information is required:

A. Permit required showing necessary approval of other agencies: A permit is required for all proposed development, including single structures in any area of special flood hazard. Any development in a floodplain will comply with the floodplain regulations.

B. If the parcel of land, or lot, is less than 30 lots, of which less than three (3) acres is within the delineated floodplain, then the floodplain permit can be included with the building permit. Permits shall be reviewed for proposed development to assure that all other necessary permits have been obtained from those federal, Texas or local governmental agencies from which prior approval is required.

C. Elevation (in relation to mean sea level) of the lowest floor (including basement) of all new and substantially improved structures;

D. Elevation in relation to mean sea level to which any non-residential structure shall be flood proofed;

E. A certificate from a registered professional engineer or architect that the non-residential flood proofed structure shall meet the flood-proofing criteria of this Article;

F. Description of the extent to which any watercourse or natural drainage will be altered or relocated as a result of proposed development;

G. Maintain a record of all such information in accordance with Section 15.13.1.A of this article.

H. Base flood elevation data for subdivision proposals and other proposed development which consist of greater than 30 lots or three acres, whichever is lesser, if not otherwise provided;

I. When requested, three or more valley cross sections including the channel of the stream at points specified by the Floodplain Administrator, topographic information for areas adjoining sides of the channel, cross sections for land to be occupied by the proposed development, high water information, and other pertinent details may be required;

J. When requested, estimates of the discharge for the regulatory flood and determination of the specific flooding threat at the site of the proposed development and whether the proposed development is located in a floodway or flood fringe area may be required to be demonstrated by providing:

1. Calculation of water surface elevations and flood protection elevations based upon a hydraulic analysis of the capacity of the stream channel and overbank areas to convey the regulatory flood.

2. Flood protection elevations (Finished Floor Elevations) shall be the greater of one foot above the water surface elevations of the regulatory base flood (taking into account future full development of the basin) or two feet above the FEMA FIRM 100-year base flood elevation (utilizing existing land use conditions), whichever is higher. This information shall be shown for all proposed structures within 200 feet of the regulatory floodplain, on the plat.

3. Computation of the floodway is required to convey this flood without increasing flood heights to an extent which would cause substantial upstream or downstream damage to existing or reasonably anticipated future development.

4. Computation of the floodway elevations shall be based upon the reasonable assumption that there will be an equal degree of encroachment and reduction in conveyance on both sides of the stream within that reach.

5. Generally, any increase in flood stages attributable to encroachments on the existing floodplain of any river or stream shall not exceed one foot in any one reach or for the cumulative effect of several reaches and zero increase for the ultimate flow conditions.

6. There shall be no loss of valley storage within the fully developed 100-year floodplain.

K. After construction is completed, Elevation Certificates shall be provided to the Floodplain Administrator by a licensed surveyor or engineer in Texas for all buildings constructed within 200 feet of the 100-year floodplain to confirm compliance with this ordinance before occupation of the buildings can be approved.

15.14.3 Approval or denial of a Floodplain Permit by the Floodplain Administrator shall be based on all of the provisions of this Article and the following relevant factors:

A. The danger to life and property due to flooding or erosion damage;

B. The susceptibility of the proposed facility and its contents to flood damage and the effect of such damage on the individual owner;

C. The danger that materials may be swept onto other lands to the injury of others;

D. The compatibility of the proposed use with existing and anticipated development;

E. The safety of access to the property in times of flood for ordinary and emergency vehicles;

F. The costs of providing governmental services during and after flood conditions including maintenance and repair of streets and bridges, and public utilities and facilities such as sewer, gas, electrical, and water systems;

G. The expected heights, velocity, duration, rate of rise, and sediment transport of the flood waters and the effects of wave action, if applicable, expected at the site.

H. The necessity to the facility of a waterfront location where applicable;

I. The availability of alternative locations, not subject to flooding or erosion damage, for the proposed use; and

J. The relationship of the proposed use to the Comprehensive Plan and floodplain management program for the area.

K. Erosive velocities created by the project.

L. Loss of valley storage within the fully developed 100-year floodplain.

15.14.4 Floodplain Permit Fee:

Reference Article 22 "Fee Schedule" of the Unified Development Code for required fees.

SECTION 15 - PROVISION FOR FLOOD HAZARD REDUCTION

General Standards

15.15.1 In all areas of special flood hazards the following provisions are required for all new construction and substantial improvements:

A. All new construction or substantial improvements shall be designed (or modified) and adequately anchored to prevent flotation, collapse or lateral movement of the structure resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy;

B. All new construction or substantial improvements shall be constructed by methods and practices that minimize flood damage;

C. All new construction or substantial improvements shall be constructed by materials resistant to flood damage;

D. All new construction or substantial improvements shall be constructed with electrical, heating, ventilation, plumbing, and air conditioning equipment and other service facilities that are designed and/or located so as to prevent water from entering or accumulating within the components during conditions of flooding;

E. All new and replacement water supply systems shall be designed to minimize or eliminate infiltrations of flood waters into the system;

F. New and replacement sanitary sewage systems shall be designed to minimize or eliminate infiltration of flood waters into the system and discharge from the systems into flood waters; and

G. On-site waste disposal systems shall be located to avoid impairment to them or contamination from them during flooding.

H. Air conditioning pads shall have the same elevation as the Finished Floor Elevation of the structure.

SECTION 16 - SPECIFIC STANDARDS FOR HABITABLE STRUCTURES

15.16.1 In all areas of special flood hazards where base flood elevations data has been provided asset forth in this Article, the following provisions are required:

A. Residential Construction - New construction and substantial improvements of any residential structure shall have the lowest floor (including basement) elevated to the higher of not less than one foot above the base flood elevation (taking into account the effects of future full development) or two feet above the FEMA FIRM base flood elevation (utilizing existing land use conditions). A registered surveyor or registered professional engineer shall submit a certification to the Floodplain Administrator that the standard of this subsection as proposed in Section 15.14.2 "Floodplain Permit Procedures" of this Article has been followed.

B. Nonresidential Construction - New construction and substantial improvements of any commercial, industrial, or other non-residential structure shall either have the lowest floor (including basement) elevated to the higher of not less than one foot above the base flood level (taking into account the effects of future full development) or two feet above the FEMA FIRM base flood elevation (utilizing existing land use conditions), or, together with attendant utility and sanitary facilities, be designed so that below two feet above the base flood level the structure is water tight with walls substantially impermeable to the passage of water and with structural components having the capability or resisting hydrostatic and hydrodynamic loads and effects of buoyancy.

1. A registered professional engineer shall certify that the design and methods of construction are in accordance with accepted standards of practice as outlined in this subsection.

2. A record of such certification which includes the specific elevation (in relation to mean sea level) to which such structures are flood proofed shall be maintained by the Floodplain Administrator.

3. For structures located on fill~~s~~ within the floodplain of the base flood but outside of floodway areas, required fill areas must extend 15 feet beyond the limits of intended structures and, if the area is not to be sewered, must include areas for on-site waste disposal.

4. The lowest floor of structures for commercial, industrial and non-residential use may be permitted at a lower elevation than specified in this Section, if the area is protected to the higher of a height of not less than one foot above the base flood elevation (taking into account the effects of future full development), or to two feet above the FEMA FIRM base flood elevation, by levees, channel modifications, or other structural protective techniques.

   Where flood-proofing is used in lieu of elevation, a registered professional engineer is required to certify that the requirements of this Article have been met.

C. Enclosures - New construction and substantial improvements, with fully enclosed areas below the lowest floor that are subject to flooding shall be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exits of floodwaters. Enclosures may only be used for parking of vehicles, building access, or limited storage.

   Designs for meeting this requirement must either be certified by a registered engineer or meet or exceed the following minimum criteria:

1. A minimum of two openings having a total net area of not less than one square inch for every square foot of enclosed area subject to flooding shall be provided.

2. The bottom of all openings shall be no higher than one foot above grade.

3. Openings may be equipped with screens, louvers, valves or other coverings or devices provided that they permit the automatic entry and exit of floodwaters.

D. Manufactured Homes - No new or substantially improved manufactured home(s), parks, or subdivisions shall be placed within an Area of Special Flood Hazard.

   For expansion to existing manufactured home parks and subdivisions; and for manufactured homes not placed in a manufactured home park or subdivision the following shall apply:

1. Stands or lots shall be elevated on compacted fill or on pilings so that the lowest floor (finished floor) of the manufactured home will be one foot above the 100-

year fully developed flood level and be securely anchored to an adequately anchored foundation system to resist flotation, collapse, and lateral movement with certification by a registered professional engineer that the improvements will not increase flood flows, heights, or damages. Specific requirements for anchoring shall be per Administrative Rules for the Texas Department of Housing and Community Affairs 10 Texas Administrative Code Chapter 80, as currently amended.

2. Adequate surface drainage and access for a hauler shall be provided.

3. For elevations on pilings, piling foundations shall be placed in stable soil no more than ten (10) feet apart, and reinforcement shall be provided for pilings more than six (6) feet above the ground level.

E. Recreation Vehicles shall not be parked within an Area of Special Flood Hazard.

SECTION 17 - STANDARDS FOR SUBDIVISIONS

15.17.1 All subdivision proposals shall be consistent with the provisions of this Article.

15.17.2 All proposals for the development of subdivisions shall meet the Floodplain Permit requirements of this Article.

15.17.3 Base flood elevation data shall be generated for subdivision proposals and other proposed development which is greater than 30 lots or 3 acres, whichever is lesser, if not otherwise provided pursuant to Article 15 Section 5 or Article 15, Section 14.2 of this ordinance.

15.17.4 All subdivision proposals shall have adequate drainage provided to reduce exposure to flood hazards.

15.17.5 All subdivision proposals shall have public utilities and facilities such as sewer, gas, electrical and water systems located and constructed to minimize or eliminate flood damage.

SECTION 18 - STANDARDS FOR STREETS, DRAINAGE, AND UTILITIES

15.18.1 The finished elevation of proposed streets shall be no less than two (2) feet above the regulatory flood protection elevation.

15.18.2 Where necessary, profiles and elevations of streets may be required to determine compliance with this requirement.

15.18.3 Storm drainage facilities shall be designed to convey the flow of surface waters without causing damage to persons or property.

15.18.4 The system shall insure drainage at all points along streets, and provide positive drainage away from buildings and on-site waste disposal sites.

15.18.5 Drainage plans shall be consistent with local and regional drainage plans.

15.18.6 The facilities shall be designed to prevent the discharge of excess runoff onto adjacent properties.

15.18.7 Sewage disposal facilities requiring soil absorption systems are prohibited where such systems will not function due to high groundwater, flooding, or unsuitable soil characteristics.

15.18.8 Restrictions on a plat or deed may be required noting that soil absorption fields are prohibited in designated areas.

15.18.9 If a sanitary sewer system is located on or near the proposed development, connection to this system may be required where practical.

15.18.10 All manholes located in floodplains shall be of watertight construction with sealed manhole lids.

15.18.11 An air pressure test or similar testing method may be required to verify the water tightness of the sewer system in the floodplain.

15.18.12 All water systems, whether public or private, which are located in flood prone areas, shall be flood proofed to above the flood protection elevation.

15.18.13 Connection to an existing public water supply system may be required if practical.

15.18.14 All other utilities, such as gas and electric lines, shall be located and constructed so as to minimize or eliminate flood damage.

SECTION 19 - LEVEE SYSTEMS AND FLOOD RELIEF CHANNELS

15.19.1 The levee policy as issued by the Federal Emergency Management Agency (FEMA), and as it may be amended from time to time, is hereby adopted by reference and declared to be a part of this Article. A copy will be kept in the office of the Floodplain Administrator.

15.19.2 The owner of any levee system or flood relief channel within the City shall submit a manual of operation and maintenance to the Floodplain Administrator for approval. No levee system or flood relief channel shall be operated in the City without such approval.

A. Such manual shall delineate the maintenance procedures to be undertaken on the levee or flood relief channel itself together with the overbank area, as well as the procedures for the operation and maintenance of closure structures and pumping facilities, and all such procedures delineated shall meet or exceed such requirements as now exist or may in the future be imposed by the Federal Emergency Management Agency (FEMA).

B. On or prior to January 31st of each year, the owner of any levee system or flood relief channel in the City shall submit to the Floodplain Administrator a report which states in detail the operation and maintenance procedures which were accomplished in the preceding year. Upon review of the report, the Floodplain Administrator may order such other additional action by the owners as may be reasonably necessary for the protection of the public health, safety, and welfare and may set a reasonable time for completion of said action. Failure by the owner to comply with any such order shall constitute an offense.

C. Prior to approval by the Floodplain Administrator of any operation and maintenance manual, the owner shall enter into an agreement with the City whereby the owner shall bind himself and subsequent owners and assigns of the levee system or flood relief channel to perform the operation and maintenance of the levee system or flood relief channel in accordance with the provisions of this Section. The contract provided herein shall be prepared in a form sufficient to be recorded in the records of the clerk of the county in which the levee is located.

D. The City, upon failure by the owner to maintain or operate the private levee system or flood relief channel in accordance with the approved operation and maintenance manual or upon failure of the owner to take such action as may be

ordered by the City Engineer, as herein provided, shall by contract or otherwise perform such maintenance, operation or other action as may be required, and shall assess the cost thereof, including all administrative and legal costs against the owner, and all such amount shall be secured by a privileged lien upon the property. This remedy shall be cumulative of any other remedy provided in this chapter.

SECTION 20 - VARIANCE PROCEDURES

15.20.1 The Appeal Board (Zoning Board of Adjustment), as established by the community, shall hear and render judgment on requests for variances from the requirements of this ordinance.

15.20.2 The Appeal Board (Zoning Board of Adjustment) shall hear and render judgment on an appeal only when it is alleged there is an error in any requirement, decision, or determination made by the Floodplain Administrator in the enforcement or administration of this ordinance.

15.20.3 Any person or persons aggrieved by the decision of the Appeal Board (Zoning Board of Adjustment) may appeal such decision in the courts of competent jurisdiction.

15.20.4 The Floodplain Administrator shall maintain a record of all actions involving an appeal and shall report variances to the Federal Emergency Management Agency upon request.

15.20.5 Variances may be issued for the reconstruction, rehabilitation or restoration of structures listed on the National Register of Historic Places or the Texas Inventory of Historic Places, without regard to the procedures set forth in the remainder of this ordinance.

15.20.6 Variances may be issued for new construction and substantial improvements to be erected on a lot of 1/2 acre or less in size contiguous to and surrounded by lots with existing structures constructed below the base flood level, providing the relevant factors in Section 15.14.3 of this Article have been fully considered. As the lot size increases beyond the 1/2 acre, the technical justification required for issuing the variance increases.

15.20.7 Upon consideration of the factors noted above and the intent of this ordinance, the Appeal Board (Zoning Board of Adjustment) may attach such conditions to the granting of variances as it deems necessary to further the purpose and objectives of this ordinance (Article 15, Section 3).

15.20.8 Variances shall not be issued within any designated floodway if any increase in flood levels during the base flood discharge would result.

15.20.9 Variances may be issued for the repair or rehabilitation of historic structures upon a determination that the proposed repair or rehabilitation will not preclude the structure's continued designation as a historic structure and the variance is the minimum necessary to preserve the historic character and design of the structure.

15.20.10 Prerequisites for granting variances:

A. Variances shall only be issued upon a determination that the variance is the minimum necessary, considering the flood hazard, to afford relief.

B. Variances shall only be issued upon: (i) showing a good and sufficient cause; (ii) a determination that failure to grant the variance would result in exceptional hardship to the applicant, and (iii) a determination that the granting of a variance will not result in increased flood heights, additional threats to public safety, extraordinary public expense, create nuisances, cause fraud on or victimization of the public, or conflict with existing local laws or ordinances.

C. Any application to which a variance is granted shall be given written notice that the structure will be permitted to be built with the lowest floor elevation below the base flood elevation, and that the cost of flood insurance will be commensurate with the increased risk resulting from the reduced lowest floor elevation.

D. Variances may be issued by a community for new construction and substantial improvements and for other development necessary for the conduct of a functionally dependent use provided that (i) the criteria outlined in Section 20 are met, and (ii) the structure or other development is protected by methods that minimize flood damages during the base flood and create no additional threats to public safety.

The Floodplain Administrator shall maintain a record of all appeals taken pursuant to this Section.

SECTION 21 - DEFINITIONS

15.21.1 Unless specifically defined below, words or phrases used in this ordinance shall be interpreted to give them the meaning they have in common usage and to give this ordinance it's most reasonable application.

ALLUVIAL FAN FLOODING - means flooding occurring on the surface of an alluvial fan or similar landform which originates at the apex and is characterized by high-velocity flows; active processes of erosion, sediment transport, and deposition; and unpredictable flow paths.

APEX - means a point on an alluvial fan or similar landform below which the flow path of the major stream that formed the fan becomes unpredictable and alluvial fan flooding can occur.

APPURTENANT STRUCTURE – means a structure which is on the same parcel of property as the principal structure to be insured and the use of which is incidental to the use of the principal structure.

AREA OF FUTURE CONDITIONS FLOOD HAZARD – means the land area that would be inundated by the 1% annual chance (100-year) flood based on future conditions hydrology.

AREA OF SHALLOW FLOODING - means a designated AO, AH, AR/AO, AR/AH, or VO zone on a community's Flood Insurance Rate Map (FIRM) with a 1% or greater annual chance of flooding to an average depth of one to three feet where a clearly defined channel does not exist, where the path of flooding is unpredictable and where velocity flow may be evident. Such flooding is characterized by ponding or sheet flow.

AREA OF SPECIAL FLOOD HAZARD - is the land in the floodplain within a community subject to a 1% or greater chance of flooding in any given year. The area may be designated as Zone A on the Flood Hazard Boundary Map (FHBM). After detailed rate making has been completed in preparation for publication of the FIRM, Zone A usually is refined into Zones A, AO, AH, A1-30, AE, A99, AR, AR/A1-30, AR/AE, AR/AO, AR/AH, AR/A, VO, V1-30, VE or V.

BASE FLOOD - means the flood having a 1% chance of being equaled or exceeded in any given year.

BASE FLOOD ELEVATION – The computed elevation to which floodwater is anticipated to rise during the base flood.

BASEMENT - means any area of the building having its floor subgrade (below ground level) on all sides.

BREAKAWAY WALL – means a wall that is not part of the structural support of the building and is intended through its design and construction to collapse under specific lateral loading forces, without causing damage to the elevated portion of the building or supporting foundation system.

CRITICAL FEATURE - means an integral and readily identifiable part of a flood protection system, without which the flood protection provided by the entire system would be compromised.

DEVELOPMENT - means any man-made change to improved and unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operations or storage of equipment or materials.

ELEVATED BUILDING – means, for insurance purposes, a non-basement building, which has its lowest elevated floor, raised above ground level by foundation walls, shear walls, posts, piers, pilings, or columns.

ELEVATION CERTIFICATE - An administrative tool used by the National Flood Insurance Program (NFIP) to document the elevation of the lowest floor (including basement) of an existing, new or substantially improved building.

EROSION HAZARD AREA – Land adjacent to a watercourse regulated by this Ordinance, which is determined by the Floodplain Administrator to be subject to flood-related erosion losses.

EROSION HAZARD SETBACK - The minimum horizontal distance from the toe of the slope of the bank of a watercourse that a structure must be constructed or placed to be outside the erosion hazard area.

EXISTING CONSTRUCTION - means for the purposes of determining rates, structures for which the "start of construction" commenced before the effective date of the FIRM or before January 1, 1975, for FIRMs effective before that date. "Existing construction" may also be referred to as "existing structures."

EXISTING MANUFACTURED HOME PARK OR SUBDIVISION - means a manufactured home park or subdivision for which the construction of facilities for servicing the lots on which the manufactured homes are to be affixed (including, at a minimum, the installation of utilities, the construction of streets, and either final site grading or the pouring of concrete pads) is completed before the effective date of the floodplain management regulations adopted by a community.

EXPANSION TO AN EXISTING MANUFACTURED HOME PARK OR SUBDIVISION - means the preparation of additional sites by the construction of facilities for servicing the lots on which the manufactured homes are to be affixed (including the installation of utilities, the construction of streets, and either final site grading or the pouring of concrete pads).

FLOOD OR FLOODING - means a general and temporary condition of partial or complete inundation of normally dry land areas from:

(1) the overflow of inland or tidal waters.
(2) the unusual and rapid accumulation or runoff of surface waters from any source.

FLOOD ELEVATION STUDY – means an examination, evaluation and determination of flood hazards and, if appropriate, corresponding water surface elevations, or an examination, evaluation and determination of mudslide (i.e., mudflow) and/or flood-related erosion hazards.

FLOOD INSURANCE RATE MAP (FIRM) - means an official map of a community, on which the Federal Emergency Management Agency has delineated both the special flood hazard areas and the risk premium zones applicable to the community.

FLOOD INSURANCE STUDY (FIS) – see Flood Elevation Study

FLOODPLAIN OR FLOOD-PRONE AREA - means any land area susceptible to being inundated by water from any source (see definition of flood or flooding).

FLOODPLAIN MANAGEMENT - means the operation of an overall program of corrective and preventive measures for reducing flood damage, including but not limited to emergency preparedness plans, flood control works and floodplain management regulations.

FLOODPLAIN MANAGEMENT REGULATIONS - means zoning ordinances, subdivision regulations, building codes, health regulations, special purpose ordinances (such as a floodplain ordinance, grading ordinance and erosion control ordinance) and other applications of police power. The term describes such Texas or local regulations, in any combination thereof, which provide standards for the purpose of flood damage prevention and reduction.

FLOOD PROTECTION SYSTEM - means those physical structural works for which funds have been authorized, appropriated, and expended and which have been constructed specifically to modify flooding in order to reduce the extent of the area within a community subject to a "special flood hazard" and the extent of the depths of associated flooding. Such a system typically includes hurricane tidal barriers, dams, reservoirs, levees or dikes. These specialized flood modifying works are those constructed in conformance with sound engineering standards.

FLOOD PROOFING - means any combination of structural and non-structural additions, changes, or adjustments to structures which reduce or eliminate flood damage to real estate or improved real property, water and sanitary facilities, structures and their contents.

FLOODWAY – see Regulatory Floodway

FULLY DEVELOPED – means the condition of the watershed after the watershed has under-gone ultimate development.

FUNCTIONALLY DEPENDENT USE - means a use, which cannot perform its intended purpose unless it is located or carried out in close proximity to water. The term includes only docking facilities, port facilities that are necessary for the loading and unloading of cargo or passengers, and ship building and ship repair facilities, but does not include long-term storage or related manufacturing facilities.

HIGHEST ADJACENT GRADE - means the highest natural elevation of the ground surface prior to construction next to the proposed walls of a structure.

HISTORIC STRUCTURE - means any structure that is:

(1) Listed individually in the National Register of Historic Places (a listing maintained by the Department of Interior) or preliminarily determined by the Secretary of the Interior as meeting the requirements for individual listing on the National Register;

(2) Certified or preliminarily determined by the Secretary of the Interior as contributing to the historical significance of a registered historic district or a district preliminarily determined by the Secretary to qualify as a registered historic district;

(3) Individually listed on a Texas inventory of historic places in Texas with historic preservation programs which have been approved by the Secretary of the Interior; or

(4) Individually listed on a local inventory or historic places in communities with historic preservation programs that have been certified either:

(a) By an approved Texas program as determined by the Secretary of the Interior or;
(b) Directly by the Secretary of the Interior in Texas without approved programs.

LEVEE - means a man-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide protection from temporary flooding.

LEVEE SYSTEM - means a flood protection system which consists of a levee, or levees, and associated structures, such as closure and drainage devices, which are constructed and operated in accordance with sound engineering practices.

LOWEST FLOOR - means the lowest floor of the lowest enclosed area (including basement). An unfinished or flood resistant enclosure, usable solely for parking or vehicles, building access or storage in an area other than a basement area is not considered a building's lowest floor; provided that such enclosure is not built so as to render the structure in violation of the applicable non-elevation design requirement of Section 60.3 of the National Flood Insurance Program regulations.

MANUFACTURED HOME - means a structure transportable in one or more sections, which is built on a permanent chassis and is designed for use with or without a permanent foundation when connected to the required utilities. The term "manufactured home" does not include a "recreational vehicle".

MANUFACTURED HOME PARK OR SUBDIVISION - means a parcel (or contiguous parcels) of land divided into two or more manufactured home lots for rent or sale.

MEAN SEA LEVEL - means, for purposes of the National Flood Insurance Program, the North American Vertical Datum (NAVD) of 1988 or other datum, to which base flood elevations shown on a community's Flood Insurance Rate Map are referenced.

NEW CONSTRUCTION - means, for the purpose of determining insurance rates, structures for which the "start of construction" commenced on or after the effective date of an initial FIRM or after December 31, 1974, whichever is later, and includes any subsequent improvements to such structures. For floodplain management purposes, "new construction" means structures for which the "start of construction" commenced on or after the effective date of a floodplain management regulation adopted by a community and includes any subsequent improvements to such structures.

NEW MANUFACTURED HOME PARK OR SUBDIVISION - means a manufactured home park or subdivision for which the construction of facilities for servicing the lots on which the manufactured homes are to be affixed (including at a minimum, the installation of utilities, the construction of streets, and either final site grading or the pouring of concrete pads) is completed on or after the effective date of floodplain management regulations adopted by a community.

RECREATIONAL VEHICLE - means a vehicle which is (i) built on a single chassis; (ii) 400 square feet or less when measured at the largest horizontal projections; (iii) designed to be self-propelled or permanently towable by a light duty truck; and (iv) designed primarily not for use as a permanent dwelling but as temporary living quarters for recreational, camping, travel, or seasonal use.

REGULATORY FLOODWAY - means the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height.

RIVERINE – means relating to, formed by, or resembling a river (including tributaries), stream, brook, etc.

SPECIAL FLOOD HAZARD AREA – see Area of Special Flood Hazard

START OF CONSTRUCTION - (for other than new construction or substantial improvements under the Coastal Barrier Resources Act (Pub. L. 97-348)), includes substantial improvement and means the date the building permit was issued, provided the actual start of construction, repair, reconstruction, rehabilitation, addition placement, or other improvement was within 180 days of the permit date. The actual start means either the first placement of permanent construction of a structure on a site, such as the pouring of slab or footings, the installation of piles, the construction of columns, or any work beyond the stage of excavation; or the placement of a manufactured home on a foundation. Permanent construction does not include land preparation, such as clearing, grading and filling; nor does it include the installation of streets and/or walkways; nor does it include excavation for basement, footings, piers or foundations or the erection of temporary forms; nor does it include the installation on the property of accessory buildings, such as garages or sheds not occupied as dwelling units or not part of the main structure. For a substantial improvement, the actual start of construction means the first alteration of any wall, ceiling, floor, or other structural part of a building, whether or not that alteration affects the external dimensions of the building.

STRUCTURE – means, for floodplain management purposes, a walled and roofed building, including a gas or liquid storage tank, that is principally above ground, as well as a manufactured home.

SUBSTANTIAL DAMAGE - means damage of any origin sustained by a structure whereby the cost of restoring the structure to its before damaged condition would equal or exceed 50% of the market value of the structure before the damage occurred.

SUBSTANTIAL IMPROVEMENT - means any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50% of the market value of the structure before "start of construction" of the improvement. This term includes structures which have incurred "substantial damage", regardless of the actual repair work performed. The term does not, however, include either: (1) Any project for improvement of a structure to correct existing violations of Texas or local health, sanitary, or safety code specifications which have been identified by the local code enforcement official and which are the minimum necessary to assure safe living conditions or (2) Any alteration of a "historic structure", provided that the alteration will not preclude the structure's continued designation as a "historic structure."

VARIANCE – means a grant of relief by a community from the terms of a floodplain management regulation. (For full requirements see Section 60.6 of the National Flood Insurance Program regulations.)

VIOLATION - means the failure of a structure or other development to be fully compliant with the community's floodplain management regulations. A structure or other development without the elevation certificate, other certifications, or other evidence of compliance required in Section 60.3(b)(5), (c)(4), (c)(10), (d)(3), (e)(2), (e)(4), or (e)(5) is presumed to be in violation until such time as that documentation is provided.

WATER SURFACE ELEVATION - means the height, in relation to the North American Vertical Datum (NAVD) of 1988 (or other datum, where specified), of floods of various magnitudes and frequencies in the floodplains of coastal or riverine areas.

WATERSHED – means the area contributing storm runoff to a stream or drainage system. Equivalent terms are drainage area, drainage basin, catchment area, and contributing area.

ZONE OF INFLUENCE – The “Zone of Influence” is defined as the point downstream of a proposed development where the proposed development has no significant impact on the receiving stream, including; (1) the receiving stream or channel is adequately sized to accommodate the runoff (based on fully developed conditions in the watershed); (2) velocity increases in the channel or stream are not erosive (based on actual channel soils); and (3) there is no rise in the base flood elevation (off of the property being developed).

SECTION 22 - TRINITY RIVER CORRIDOR DEVELOPMENT CERTIFICATE

15.22.1 Testament of Purpose

The purpose of this section is to assure the orderly and proper development of the Trinity River Corridor, to provide for the overall health, safety, and welfare of our citizens.

15.22.2 Definitions

Corridor Development Certificate – the permit issued by the city prior to development within the Regulatory Zone of the Trinity River Corridor.

Corridor Development Certificate Manual – the current manual by that title.

Regulatory Zone – the area within the Trinity River Corridor as defined by the current City approved 100-year floodplain based upon fully developed conditions.

Review Zone – the area within the Trinity River Corridor that lies between the 100-year floodplain and the Standard Project Flood floodplain line.

Standard Project Flood (SPF) – the flood having a 0.30%-0.08% chance of being equaled or exceeded in any given year. The SPF generally has a volume discharge of approximately double the 100-year storm and water surface elevation of four to seven feet higher that the 100-year flood.

Trinity River Corridor – the area defined by the bed and banks of the Trinity River and the adjacent river floodplain within the city of Grand Prairie. Also referred to as Corridor.

15.22.3 The Current Edition Corridor Development Certificate Manual adopted.

The current edition of the Corridor Development Certificate Manual, is adopted as the standard for development within the Trinity River Corridor and is incorporated herein by reference.

15.22.4 Certificate Required

A person commits a violation by commencing development within the Regulatory Zone without first obtaining a Corridor Development Certificate from the Floodplain Administrator.

15.22.5 Application

An application for a Corridor Development Certificate must be filed with the Floodplain Administrator on forms provided by the Engineering Department.

15.22.6 Review of Application; Approval; Denial of Approval

The Floodplain Administrator or his duly authorized designee shall be responsible for the review of an application for a Corridor Development Certificate. The application shall be approved if it conforms to the requirements of the Corridor Development Certificate Manual, as amended, or unless exception, variance, or exemption is granted; otherwise, the application shall be denied.

15.22.7 Exemptions, Variances and Exceptions

A. Exemptions

1. An exemption from the requirements of this section may be obtained if the development involves the following activities:

   a. Ordinary maintenance of and repair to flood control structures.

   b. The construction of outfall structures and associated intake structures if the outfall has been permitted under Texas or Federal Law.

   c. Discharge of material for backfill or bedding for utility lines, provided there is not significant change in pre-existing bottom contours and excess material is removed to an area outside of the Regulatory Zone

   d. Bank stabilization.

   e. Development activity that is:
      (1) completely outside of the Regulatory Zone but within the Review Zone, and
      (2) determined by the U.S. Army Corps of Engineers that no permits are required.

   f. Any project listed in the U.S. Army Corps of Engineers March 1990 Reconnaissance Report which is attached as Appendix A to the Corridor Development Certificate Manual, or any project approved under the provisions of this Division, provided the approval, permit or authorization has not expired and no significant changes have occurred since the approval, permit, or authorization was issued.

2. Application for an exemption must be made to the Floodplain Administrator on a form provided by the Engineering Department.

3. If the Floodplain Administrator determines that an application for an exemption falls within one of the categories listed herein, the Floodplain Administrator shall issue a written exemption from the requirements from this Division and approve the application.

B. Variances. If the Floodplain Administrator determines that an application for a Corridor Development Certificate does not comply with the standard established in this Division, the applicant may apply for a variance to the standard. An application for a variance must be made to the Floodplain Administrator, who may schedule the application for consideration by the City Council. The City Council may grant a variance provided the variance will not violate any provision of federal or Texas law, result in increased flood levels, or endanger life or property.

C. Exceptions. Development within the Regulatory Zone of the Trinity River Corridor shall meet the standards provided in Section 1.6 of the Corridor Development Certificate Manual as currently amended.

SECTION 23 - SEVERABILITY

15.23.1 If any section, clause, sentence, or phrase of this Ordinance is held to be invalid or unconstitutional by any court of competent jurisdiction, then said holding shall in no way affect the validity of the remaining portions of this Ordinance.

SECTION 24 - PENALTIES FOR NONCOMPLIANCE

15.24.1 Any person who violates this ordinance or fails to comply with any of its requirements shall upon conviction thereof be fined in accordance with Section 1-8, City of Grand Prairie Code of Ordinances, for each violation, and in addition shall pay all costs and expenses involved in the case. Nothing herein contained shall prevent the City of Grand Prairie from taking such other lawful action as is necessary to prevent or remedy any violation.

SECTION 25 - CERTIFICATION OF ADOPTION

APPROVED: ____
(community official)

PASSED: November 18, 2008
(adoption date)

ORDINANCE BECOMES EFFECTIVE: (5 days after publication)

I, the undersigned, Tom Hart do hereby certify that the above is a true and correct copy of an ordinance duly adopted by the Grand Prairie City Council, at a regular meeting duly convened on November 18, 2008.

____
(Signature of Certifying Official)

(SEAL)

12.0 FLOODWAY/FLOODPLAIN DEVELOPMENT CRITERIA

All development within the areas of special flood hazard shall be approved by the City Engineer and shall be in compliance with Article 15 Floodplain Management. If the study involves a FEMA flood zone, then two reports should be submitted, one for fully developed watershed conditions for the City and one for existing watershed conditions for City and FEMA including FEMA review fees. All Hydrology and conveyance models shall, at a minimum, comply with FEMA *Guidelines and Specifications for Flood Hazard Mapping Partners.*

The Areas of Special Flood Hazard Are:

A. The areas of special flood hazard identified by the Federal Emergency Management Agency in the current scientific and engineering report entitled, "The Flood Insurance Study (FIS) for "Dallas County, Texas and Incorporated Communities," dated August 4, 2004, with accompanying Flood Insurance Rate Maps (FIRM) dated August 4, 2004 and any revisions thereto are hereby adopted by reference and declared to be a part of this ordinance.

B. Those areas that have not yet been delineated on the FEMA maps but are known to constitute a special flood hazard.

FEMA Floodplain and Floodway

A. All development within a FEMA defined floodplain shall be in accordance with the National Flood Insurance Program (NFIP) 44 CFR.

B. Where construction occurs within a FEMA defined floodplain, a Conditional Letter of Map Revision (CLOMR) and a Letter of Map Revision (LOMR) must be obtained from FEMA unless a variance for the CLOMR is obtained from the City. The CLOMR and LOMR must have properly completed FEMA forms that specify the City will conduct no maintenance of improvements (except for public streets, bridges, or culverts), and be certified by a professional engineer that structures are reasonably safe from flooding in accordance with Technical Bulletin 10. Also note that a building permit will not be issued for lot(s) that encroach on or require fill in the FEMA floodplain until CLOMR approval is issued by FEMA for the subject lot(s) and a FEMA Elevation Certificate is signed and sealed by a registered professional land surveyor.

C. Construction within a FEMA defined floodplain without an established floodway shall not increase base flood elevations by more than one (1) foot at any point within the community without specific City and FEMA approval of a CLOMR following the variance procedure outlined in 65.12 of the NFIP 44 CFR. In addition, if the stream has a floodplain defined without base flood elevations, then base flood elevations shall be developed by the engineer using existing watershed conditions and post project conditions for the FEMA submittal and fully developed watershed conditions for the City submittal.

D. Construction within a FEMA defined floodplain fringe with an established floodway shall not increase base flood elevations by more than approved in the FEMA hydraulic floodway model and most current FIS without specific City and FEMA approval.

E. Construction within a FEMA defined floodway shall not increase base flood elevations at any point within the community without specific City and FEMA approval of a

CLOMR following the variance procedure outlined in 65.12 of the NFIP 44 CFR. In addition, if a project that has construction in the FEMA floodway may cause flooding or erosion of an existing downstream drainage facility (natural or manmade) and result in hazardous conditions, plans and construction of drainage improvements to mitigate the problem may be required.

City Floodplain and Floodway

A. The City floodplain includes all areas that are known to constitute a special flood hazard.

B. Floodway elevations shall be based on an equal degree of encroachment and equal reduction in conveyance on both sides of the stream.

C. Encroachments or increased flows shall not increase flood damages.

D. No existing 100-year flood elevation shall be increased more than one (1) foot, unless all impacted property owners concur with the proposed modifications. No increase in the 100-year fully developed flood elevations shall be allowed.

E. No adverse impacts to adjacent property owners shall result from development within the 100-year fully developed floodplain. No net loss of valley storage shall be allowed within the 100-year fully developed floodplain.

F. A City Floodplain Development Permit Application must be submitted including any accompanying materials such as tables, model output, etc.

12.1 Floodplain Permit Procedures

The 100-year existing flood elevation shall not increase more than one (1) foot unless all impacted property owners concur with the proposed modifications. The 100-year ultimate flood elevations shall not increase more than 0.0 feet. No adverse impacts to adjacent property owners shall result from development within the 100-year ultimate floodplain. No net loss of valley storage shall be allowed within the 100-year ultimate floodplain.

A. Where fill or structures are to be placed within the floodplain, an Earthwork Permit, Floodplain Development Permit (FEMA floodplain), CDC (CDC regulatory zone), and Construction Permit, as applicable, will be required prior to construction (a building permit will also be required for any buildings). Prior to issuance of permits, the City must approve complete construction plans.

B. All projects that are within the CDC regulatory zone shall complete the CDC process prior to issuance of City permits.

C. If a Clean Water Act (CWA) Section 404 permit is required from the US Army Corps of Engineers (Corps), it must be issued by the Corps prior to issuance of City permits. In no case will the City be responsible for construction or maintenance of Section 404 mitigation areas.

The applicant may request a variance from the Floodplain Administrator by filing such request with the Administrator pursuant to the provisions of Article 20 "General Procedures." Refer to UDC Article 15 for variance and appeal procedures

RESOLUTION NO. 3919

A RESOLUTION ESTABLISHING A POLICY CONCERNING EROSION AND OTHER DRAINAGE PROBLEMS RELATING TO WATERWAYS.

WHEREAS, the City Council has determined that Erosion problems along the Trinity River and Creeks in the city are of concern to the City.

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF GRAND PRAIRIE, TEXAS:

SECTION 1. That it is hereby determined to be in the best interests of the City of Grand Prairie, Texas and its inhabitants to adopt the following drainage policy:

Erosion and/or flooding problems on private property will be investigated on a case-by-case basis. The City will focus on improvements to the waterways that will result in a general public benefit, such as lowering erosive velocities and increasing flow capacities in proximate streams for the general prevention of erosion and flooding.

Remedy of private property issues, such as flooding due to lot-to-lot drainage (no involvement of City property) and construction projects to protect specific private property due to proximate stream erosion, will not be undertaken by the City unless a general public benefit or public safety concern can be demonstrated, and the undertaking of such are approved by the City Council. Individual projects will be evaluated and prioritized based on available funding.

SECTION 2. That this resolution shall become effective immediately upon its passage and approval.

PASSED AND APPROVED BY THE CITY COUNCIL OF THE CITY OF GRAND PRAIRIE, TEXAS, this 17th day of June, 2003.

Charles England

Mayor, Grand Prairie, Texas

ATTEST:

for Karan J. Barrett

Catherine E. DiMaggio, City Secretary

APPROVED AS TO FORM:

Donald R. Postell

Donald R. Postell, City Attorney

HALFF

MEMORANDUM

TO:	Romin Khavari, PE, CFM Chris Agnew, PE City of Grand Prairie	**DATE:**	October 28, 2009
		AVO:	26418
FROM:	Stephen Crawford, PE, CFM Benjamin Pylant, EIT, CFM	**PROJECT:**	City-wide Drainage Master Plan for Joe Pool Lake W.O.#581.40
SUBJECT:	Review of StormCad issues and CWDMP Protocols		

Halff has worked closely with the City of Grand Prairie over the past year through the Joe Pool Master Drainage Plan to help evaluate the StormCad software and implement it as the standard storm drain modeling program for the future City-wide Drainage Master Plan projects. This memorandum is intended to summarize the results of this effort by providing methodology for consistent use of the software for future CWDMP projects. An additional section is provided after the StormCad protocols to update the City on the current status of the outstanding issues related to using StormCad for new drainage design projects.

It is not the intent of Halff that this memo or the information contained be included in the City's Drainage Design Manual or referenced in any way. The incorporation of any software program into the City's manual would require a more comprehensive effort and coordination with other consultants and stakeholders in order to ensure that acceptable documentation and procedures have been provided and agreed upon.

HALFF

STORMCAD PROTOCOLS (CWDMP PROJECTS)

The CWDMP project scope consist of converting existing plans for storm drain "trunk lines" to StormCad models. The following information is intended to provide recommendations for converting the plans and running StormCad according to the City's DDM. The options used below will allow for consistent calculations among different consultants for future CWDMP projects. This section is not a comprehensive "How-to" manual. The StormCad user manual will be the overriding documentation for questions regarding the software and the calculations.

- **Flows** – For the CWDMP projects, most lateral lines are not modeled so catch basins and catchment data cannot be incorporated. Existing flows will be input as a known flow at the appropriate nodes in StormCad. Flows can only be entered at catch basins, so each flow change node should be modeled as a catch basin with junction loss coefficients appropriate for whatever the node actually represents (i.e. junction, manhole, enlargement, etc.).
- **Conduit Length** – StormCad will calculate a length when the City's GIS storm drains are imported into the program. However, this length is approximate and should always be overridden with a user specified length. (Note: Any time that the "Length (user defined)" field is used you must check the box in the "User Defined Length" field also.)
- **Junction Losses** – Junction losses should be applied based on the City's DDM Table 8.6. The headloss method should always be Generic Headloss.
    - Inlets – Downstream coefficient = 1.5, Upstream Coefficient = 0
    - Degree Bends – Downstream coefficient =1.0, Upstream Coefficient = 1 - K_j (Refer to DDM Table 8.6 for K_j values).
    - Other Junctions – Downstream coefficient = 1, Upstream Coefficient = K_j (Refer to DDM Table 8.6 for K_j values).
- **Downstream Boundary Conditions** – The downstream boundary conditions type should always be set to user defined tailwater. The tailwater elevations should be entered as the known HGL based on the plans or the crown of pipe if HGL information is not available.
- **Physical Properties** – The physical properties of the conduit lines and nodes (including conduit sizes and shapes, invert elevations, ground elevations, etc.) should be taken directly from the design plans. The information can be entered directly into GIS and imported through Modelbuilder or entered directly into StormCad. (Note: "Set Invert to upstream" and "Set Invert to downstream" can be useful fields in the StormCad Conduit Flextable but make sure they are unchecked if they are not intended to be used)
- **Modelbuilder** – Modelbuilder can be used to import GIS, files, CAD files, excel, etc. The program allows attribute fields to be linked to StormCad fields.
- **Manning's n values** – A value of 0.013 should be used for all concrete and HDPE pipes.
- **Calculation Options** – Calculation options need to be standardized in order to get consistent hydraulic calculations. Settings under Analysis>Calculation Options can be set to match the City's DDM standards
    - Hydraulics
        - Flow Profile Method
            - Backwater Analysis = Partial Flow allowed.
            - Capacity Analysis = Full flow hydraulic calculations recommended.
        - Hydraulic Grad Convergence Test – 0.001
        - Average Velocity Method – Full flow velocity is typical
        - Minimum Structure Loss – 0.1
        - Structure Loss Mode – Hydraulic Grade
    - Generic Structure Losses
        - Governing Upstream Pipe Selection Method – Typically Pipe with Max QV

HALFF

OUTSTANDING ISSUES (New Drainage design studies)

The following information is provided to summarize some of the outstanding issues that the City may have in implementing StormCad for new drainage design studies. These issues do not affect the conversion of existing studies as in the City-wide drainage master plans.

- **Hydraulic Computations Spreadsheet –** The City's current hydraulic computations spreadsheet cannot be recreated inside StormCad. The modeler must export to Excel and go through a manually intensive process to recreate the table. This issue will hopefully be addressed in the April 2009 StormCad update. See attached email from Sharkey.
- **Parabolic Gutter Section** - An equivalent sloped section might need to be available for modeling gutter flow until StormCad is able to incorporate this option.
- **Independent Junction Losses for main and lateral –** This item cannot be completed using StormCad without creating separate models for each. StormCad has options for selecting the upstream pipe velocity when computing headloss for a structure using the Generic Headloss Method. (DDM 8.5).
    - *Pipe with Maximum QV (flow times velocity)* is typically recommended. This setting is selected under the Calculations Options. Any questionable areas should be checked and the method should be modified so that the desired upstream pipe is used for the calculation.
    - **Refer to the attached email from Mal Sharkey regarding independent junction losses; he recommends HEC-22 junction loss if the intention is to show the junction loss for each pipe separately.**

Transferring a Flextable

Here are the steps to share custom flextables with other users (as specified by StormCad product developers):

1) Create your custom flextable under the "Tables - Shared" section of the flextables manager.
2) Close the program
3) Open windows explorer and make sure hidden files are shown, as well as hidden operating system files/folders
4) Browse to C:\Documents and Settings\User.Name\Local Settings\Application Data\Bentley\StormCAD\8 (Where "User.Name" is your Windows user name)
5) The file named Flextables.xml is the file that stores the custom flextable information. Make a copy of this file and paste it in the same exact folder, on the other computers that needs the custom flextable
6) When the other user opens a model, they should have the custom flextables.
7) If you made changes to a custom flextable and wanted the others to have it, you'd have to follow this process again